

# TOTAL MAINTENANCE SOLUTIONS

**e-Factory**



# GLOBAL IMPACT OF MITSUBISHI ELECTRIC



Through Mitsubishi Electric's vision, "Changes for the Better" are possible for a brighter future.

## *Changes for the Better*

"Changes for the Better" represents the Mitsubishi Electric Group's attitude to "always strive to achieve something better", as we continue to change and grow. Each one of us shares a strong will and passion to continuously aim for change, reinforcing our commitment to creating "an even better tomorrow".

Mitsubishi Electric is involved in many areas including the following:

### **Energy and Electric Systems**

A wide range of power and electrical products from generators to large-scale displays.

### **Electronic Devices**

A wide portfolio of cutting-edge semiconductor devices for systems and products.

### **Home Appliance**

Dependable consumer products like air conditioners and home entertainment systems.

### **Information and Communication Systems**

Commercial and consumer-centric equipment, products and systems.

### **Industrial Automation Systems**

Maximizing productivity and efficiency with cutting-edge automation technology.

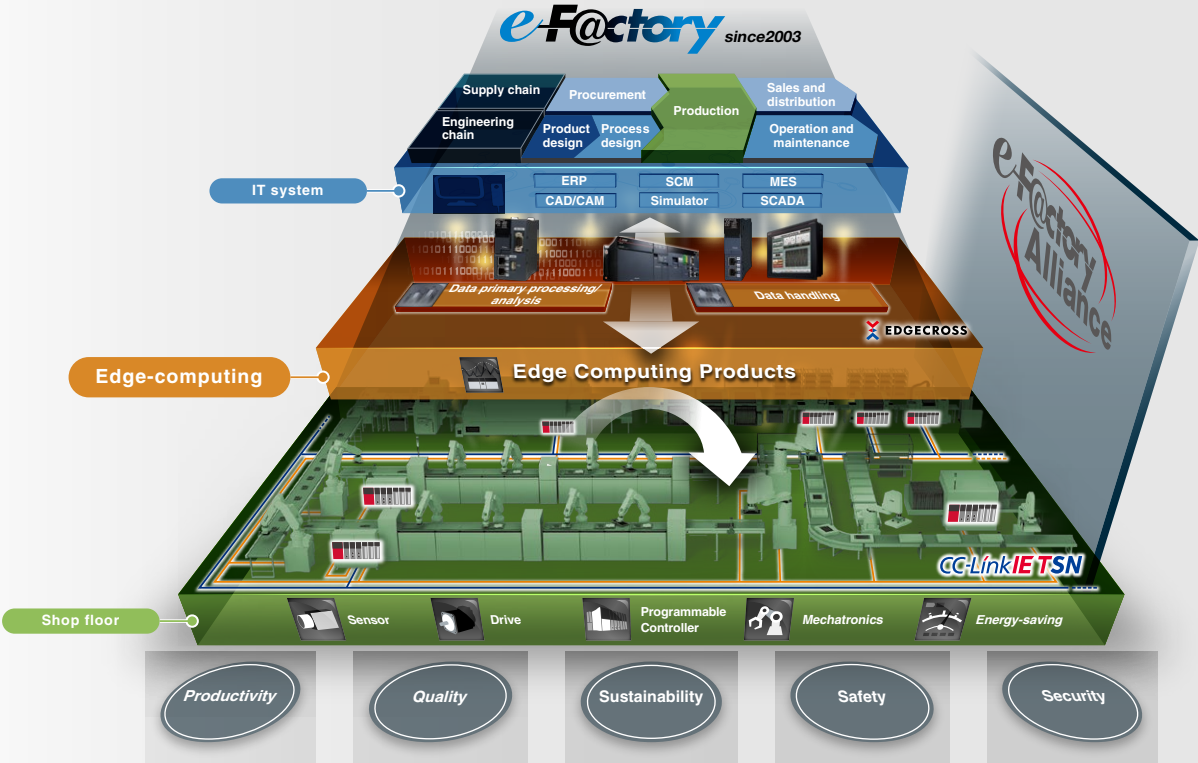
Our advances in AI and IoT are adding new value to society in diverse areas from automation to information systems. The creation of game-changing solutions is helping to transform the world, which is why we are honored to be recognized in the 2019 "Forbes Digital 100" as one of world's most influential digital corporations.



FA-IT Integrated Solution



The “e-F@ctory” FA-IT integrated solution proposes ways of utilizing FA and IT technologies that reduce the total cost of development, production, and maintenance activities, continuously support customer KAIZEN activities, and promote monozukuri that is one step ahead.



# INDEX

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Overview.....	04
Maintenance Solutions.....	08
Product and Solution Introduction .....	26
Partner Product and Solution Introduction.....	44

# Total Maintenance Solutions

In today's dramatically changing business environment, the impact of sudden equipment downtime on corporate profits is enormous, and an increasing number of businesses are implementing planned equipment maintenance with the aim of achieving non-stop factories. Meanwhile, the manufacturing industry faces another major issue of passing down the expertise of highly experienced employees.

## Current Issues



- How to prevent equipment outages caused by sudden failure of parts with a set service life?
- How to reduce costs by using parts and tools to their respective limits?
- How to minimize the impact on production by quickly and efficiently investigating the cause in the event of trouble?



## After Introducing the Total Maintenance Solutions



## Optimization of maintenance work with data management

Non-stop  
factory

Planned  
operations

Less  
downtime

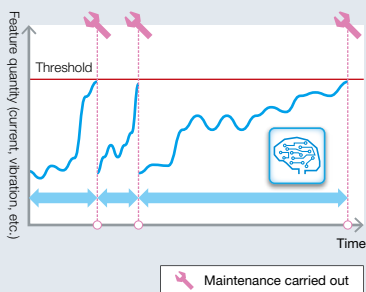




## What is Total Maintenance Solutions?

Total Maintenance Solutions comprise "**Predictive Maintenance**," which prevents problems before they arise by detecting signs of abnormalities based on data collected, "**Preventive Maintenance**," which enables planned maintenance by managing data regarding operating time and frequency, as well as "**Corrective Maintenance**," which shortens the cause investigation time to achieve early recovery of equipment by utilizing historical data. These are solutions supporting our customers' maintenance activities in all phases and scales, whether it be line, device, or equipment.

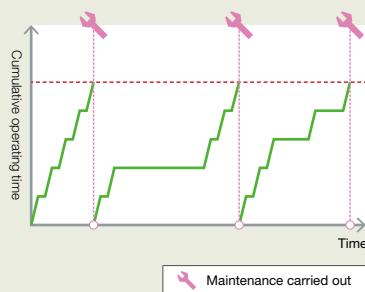
### Predictive Maintenance



Prevents trouble by detecting signs of abnormality by **analyzing operation data**



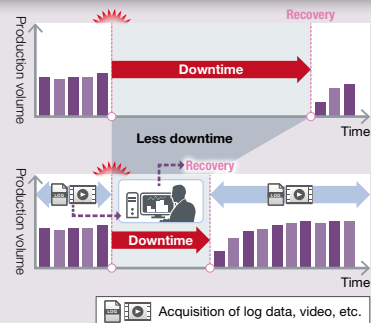
### Preventive Maintenance



Operating time and frequency **data management** utilized to prevent the generation of problems



### Corrective Maintenance



Historical **data** utilized for detailed cause investigation and rapid recovery



# Maisart, Mitsubishi Electric's AI technology supports the realization of our customers' non stop manufacture.

Mitsubishi Electric's "compact AI" technology reduces the computing load and enables the implementation on the shop floor.

Mitsubishi Electric's FA Knowledge supports the application of AI technologies to customers' systems.

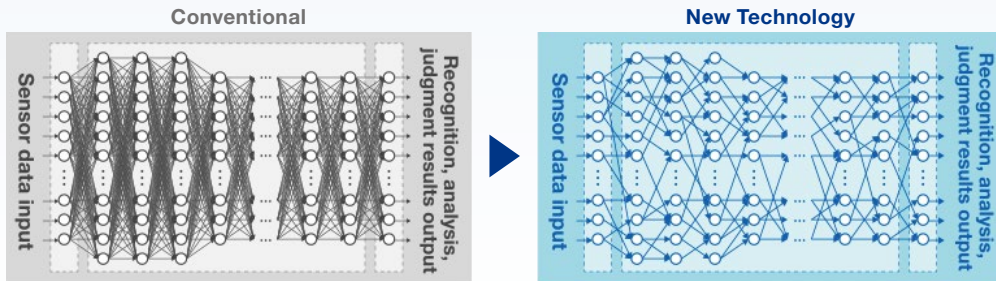
Mitsubishi Electric's edge-computing products simplify the data collection and support the construction of AI systems.



## Features

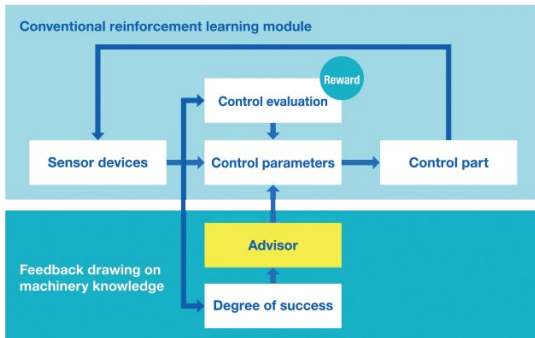
### Deep Learning

Compared with conventional methods, our compact algorithms reduce deep learning layers by 1/30- 1/100.



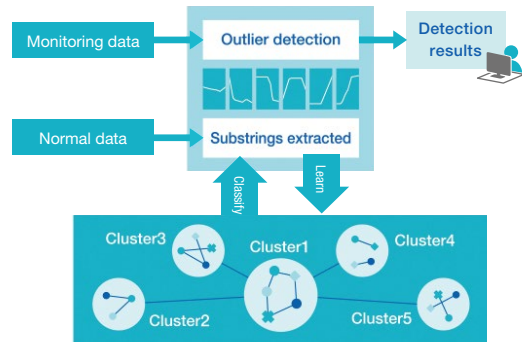
### Reinforcement Learning

Reduces the number of pre-learning trials approximately 1/50 compared to conventional methods by estimating the degree of success through improving learning efficiency using equipment domain knowledge.



### Big Data Analytics

Reduces the number of operations necessary to detect abnormal signs by 1/40 through streamlining time series data analysis using equipment domain knowledge.



Maisart is Mitsubishi Electric's brand of AI technology. The name stands for "Mitsubishi Electric's AI creates the State-of-the-ART in technology." This means that we are using our proprietary AI technology to make everything smarter.

Mitsubishi Electric, which combines solutions for production sites and IT systems, offers solutions that meet customers' on-site challenges.

<b>Case 1</b> How to perform maintenance work on cylinders at the right time? Predictive Maintenance Device level <b>P. 08</b>	<b>Case 2</b> How to perform maintenance on robots before a fault occurs? Predictive Maintenance Device level <b>P. 09</b>
<b>Case 3</b> How to use cutting tools to the life end? Predictive Maintenance Equipment level <b>P. 10</b>	<b>Case 4</b> How to eliminate the difference in machining quality for each machine tool? Predictive Maintenance Equipment level <b>P. 11</b>
<b>Case 5</b> How to prevent the outflow of machining defects? Predictive Maintenance Equipment level <b>P. 12</b>	<b>Case 6</b> How to understand signs of errors for equipment using rotating mechanisms? Predictive Maintenance Equipment level <b>P. 13</b>
<b>Case 7</b> How to understand the tendency of molding defect occurrence to prevent defect outflow? Predictive Maintenance Device level <b>P. 14</b>	<b>Case 8</b> How to detect processing defects and prevent the outflow of defective products? Predictive Maintenance Equipment level <b>P. 15</b>
<b>Case 9</b> How to run laser-processing machines in continuous automatic operation? Predictive Maintenance Equipment level <b>P. 16</b>	<b>Case 10</b> How to prevent the sudden failure of old equipment? Predictive Maintenance Equipment level <b>P. 17</b>
<b>Case 11</b> How to detect drive component age-related deterioration (ball screws, belts, gears)? Predictive Maintenance Device level <b>P. 18</b>	<b>Case 12</b> How to know when to replace servo amplifiers? Preventive Maintenance Device level <b>P. 19</b>
<b>Case 13</b> How to smoothly resolve inverter issues? Corrective Maintenance Device level <b>P. 20</b>	<b>Case 14</b> How to respond to equipment problems without going to the shop floor? Corrective Maintenance Equipment level <b>P. 21</b>
<b>Case 15</b> How to determine the cause of equipment errors? Corrective Maintenance Equipment level <b>P. 22</b>	<b>Case 16</b> How to restore FA device programs on the shop floor immediately? Corrective Maintenance Equipment level <b>P. 23</b>
<b>Case 17</b> How to monitor multiple lines from a remote location? Corrective Maintenance Line level <b>P. 24</b>	<b>Case 18</b> How to identify error locations from multiple machine tools? Corrective Maintenance Line level <b>P. 25</b>

# Case 1

Device level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



## How to perform maintenance work on cylinders at the right time?

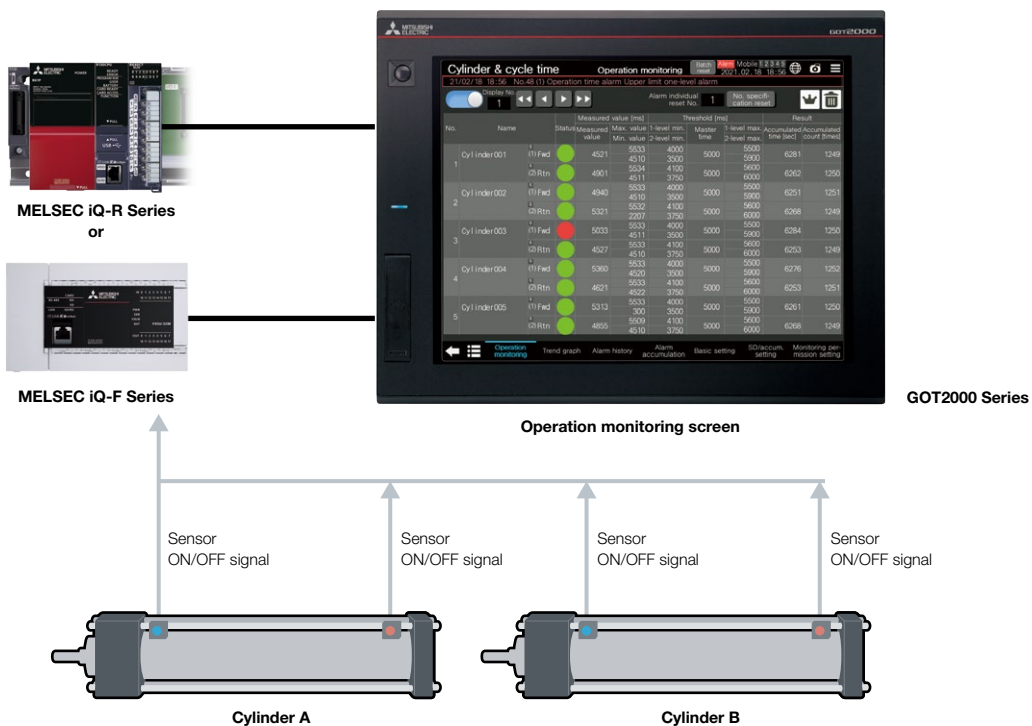
Operators don't notice delayed operation of the cylinder and this increases equipment cycle time.

### Solution

## Optimize maintenance by monitoring cylinder operating time

The Cylinder and Cycle Time Monitor function of the e-F@ctory Starter Package measures and visualizes cylinder operation time, automatically detects delays in operating time caused by various factors (e.g., sticking due to dirt) and sounds an alarm.

This facilitates timely maintenance work without the need to rely on operator intuition and experience.



Prevents deterioration of performance operating ratio and enables continuation of production within the set tact time.

### Product and Solution Introduction

▶ MELSEC iQ-R Series

P.26

▶ MELSEC iQ-F Series

P.26

▶ GOT2000 Series

P.32

▶ e-F@ctory Starter Package

P.34



## Case 2

Device level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



### How to perform maintenance on robots before a fault occurs?

- 1 Want to perform optimal maintenance suitable for a robot's operating status.
- 2 Want to reduce downtime due to parts failures.
- 3 Want to perform maintenance efficiently (procure maintenance parts, etc.) by knowing the appropriate maintenance time.

#### Solution

### Utilizing AI lifetime prediction to detect signs for robot Predictive Maintenance

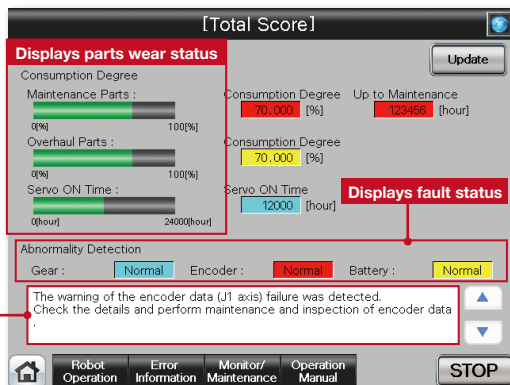
Monitors robot operation status and calculates the degree of wear on robot parts. Informs the user of the maintenance time according to the state of use. In addition, the scale of a fault is calculated by analyzing the data of the motors and reducers that drive the robot's joints using AI. This enables users to perform planned maintenance before robot failure, thus reducing downtime.



MELFA Smart Plus



#### General Evaluation Information



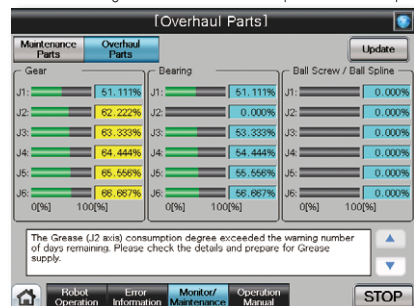
Displays maintenance-related messages

Check robot status at a glance on the general evaluation screen

\* This is a GOT sample screen from the Mitsubishi Electric FA site.

#### Wear calculation

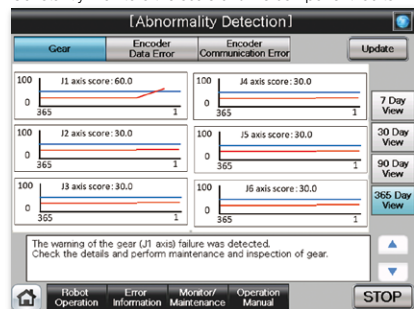
Calculates the degree of wear on maintenance parts and overhaul parts



Notifies user of estimated maintenance time in advance

#### Abnormality Detection

Constantly monitors the scale of drive component faults



Notifies user of parts failure in advance



- 1 Estimates the degree of robot part wear from the operation status and notifies user of maintenance timing.
- 2 AI technology detects signs of failure, enabling maintenance to be performed before the robot stops.
- 3 Simulates maintenance timing from operating patterns and supports maintenance planning.

#### Product and Solution Introduction

▶ MELFA Smart Plus

P.39

# Case 3

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance

## How to use cutting tools to the life end?



Frequent tool replacement impacts cost because the appropriate tool change timing is unclear.

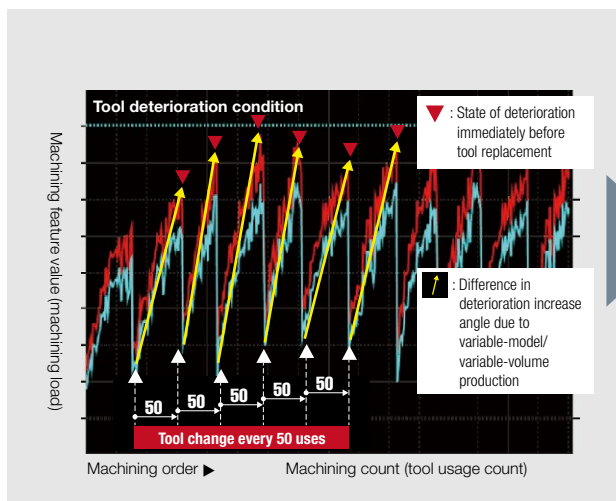
### Solution

### Automatic diagnosis of cutting tool replacement timing

iQ Monozukuri Tool Wear Diagnosis for Machine simultaneous collection of IoT machining data and machining conditions from machine tool to visualize changes in trends with identical machining conditions. Tool life prediction with IoT data works to use tools until close to the life end.

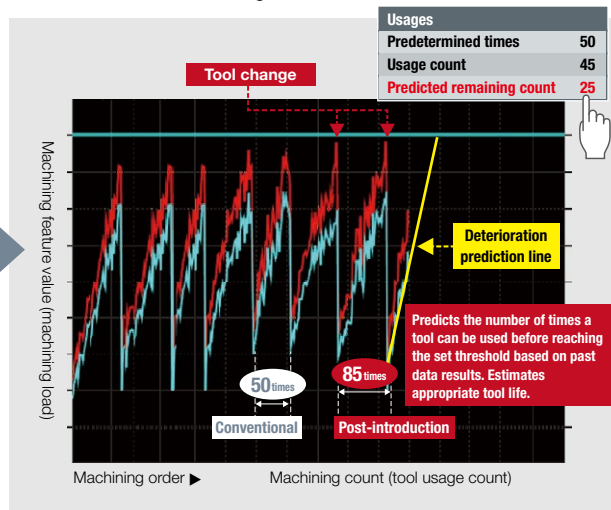
#### ● Conventional periodic replacement by TBM (machining count)

Tools Replaced before service life expiration regardless of deterioration status



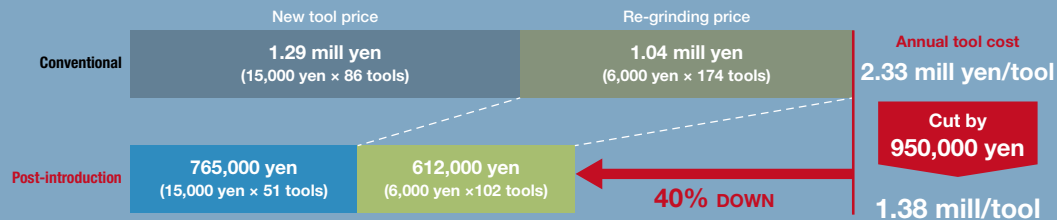
#### ● Optimal tool replacement by CBM (wer status)

Estimates increased service life by ascertaining load peak for each tool from machining data results to date



By using cutting tools for the entire service life, replacement frequency is kept to a minimum, which helps to reduce tool costs.

#### ● Annual tool cost by tool optimal tool change (example)



\* This example is based on the diagnostic results of customer's machining processes. The benefits of this solution vary depending on the specific environment of use (tool replacement frequency, machining conditions, etc.).

### Product and Solution Introduction

▶ iQ Monozukuri Tool Wear Diagnosis for Machine Tools

P.36

## Case 4

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



### How to eliminate the difference in machining quality for each machine tool?

Despite the same workpiece and the same machining process, processing capability (Cp value) is different between devices, and a method for resolving the problem is unknown.

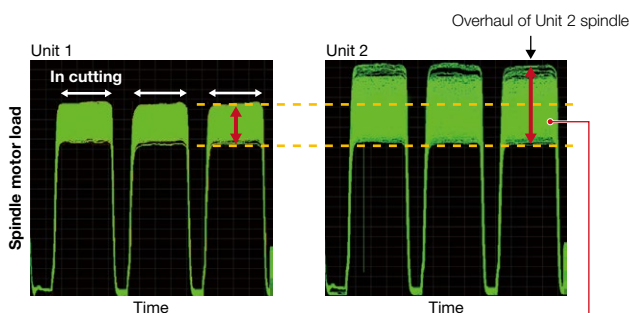
#### Solution

### Predictive Maintenance support by monitoring machine tool differences

The Advanced Data Science Tool\* makes it possible to compare variations (standard deviation) in machining load (feature values) for identical machining between machine tools at regular intervals so that users can understand any changes in machine conditions that could become a factor for defective workpieces. This allows users to ascertain the timing of overhauls and maintenance work, as well as verify post-maintenance benefits.

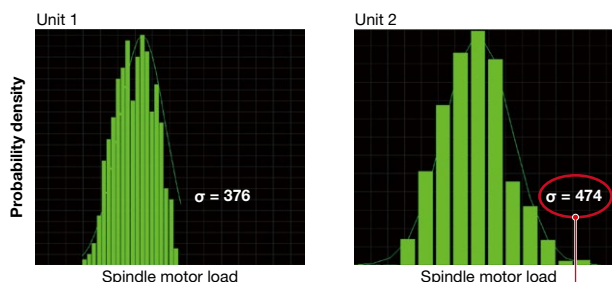
\* The Advanced Data Science Tool is a software that links to iQ Monozukuri Tool Wear Diagnosis for Machine Tools to utilize IoT data for supporting tool diagnosis, equipment maintenance, statistical analysis, etc.

#### ● Electrical current waveform of spindle motor load

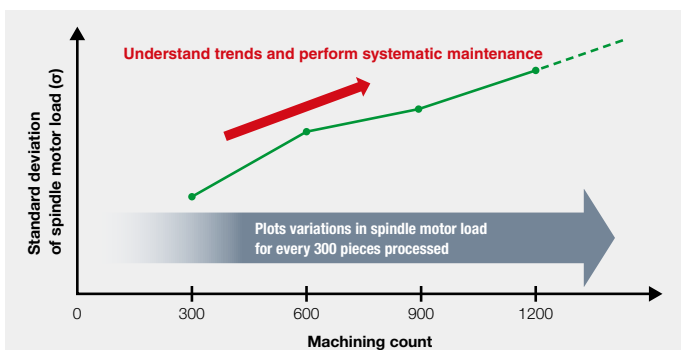


There is a difference despite being the same model.  
Wide = Large load variation

#### ● Variation of spindle motor load (feature values)



There is a difference despite being the same model.  
 $\sigma$  is large = Large load variation



Understand machine variation using quantitative metrics to determine appropriate maintenance timing



By understanding the variation in spindle motors using quantitative indicators, it is possible to both secure quality and reduce maintenance costs.

#### Product and Solution Introduction

▶ iQ Monozukuri Tool Wear Diagnosis for Machine Tools

P.36

# Case 5

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



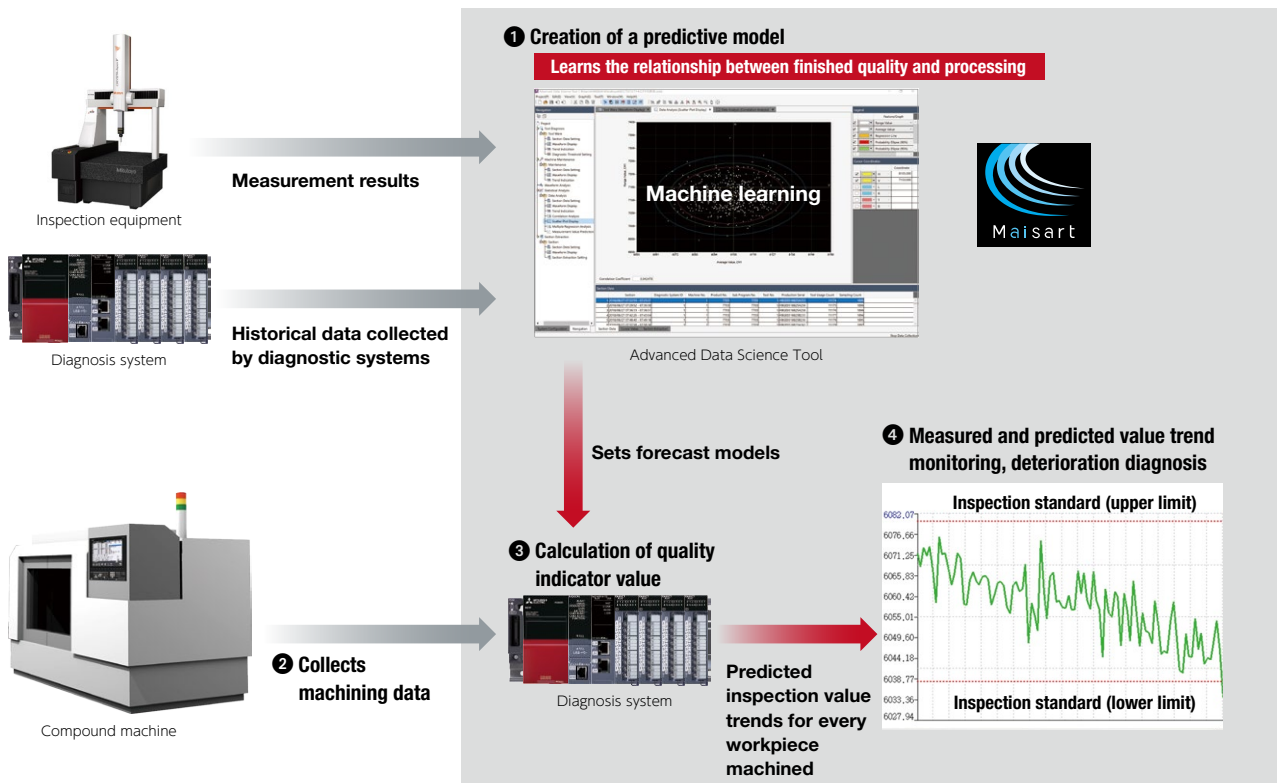
## How to prevent the outflow of machining defects?

Although quality is guaranteed by performing sampling inspections, we don't know how much of an impact is present when a part fails an inspection. Sampling inspections are also unable to detect sudden defects and or defect trends.

### Solution

## Predict geometric tolerances and finished quality from IoT data to prevent outflow of machining defects

Performs machine learning of the relationship between measurement results and IoT data, and creates predictive models of measurement results. Using the created prediction model, predicts finished quality of workpieces (inspection values) immediately after machining and prevents outflow of defects to downstream processes.



High-accuracy prediction models utilizing machine learning enables prediction of quality for each machined workpiece. Accordingly, it is possible to understand quality trends that cannot be assessed through random inspection.

### Product and Solution Introduction

▶ **iQ Monozukuri Tool Wear Diagnosis for Machine Tools**

P.37

## Case 6

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



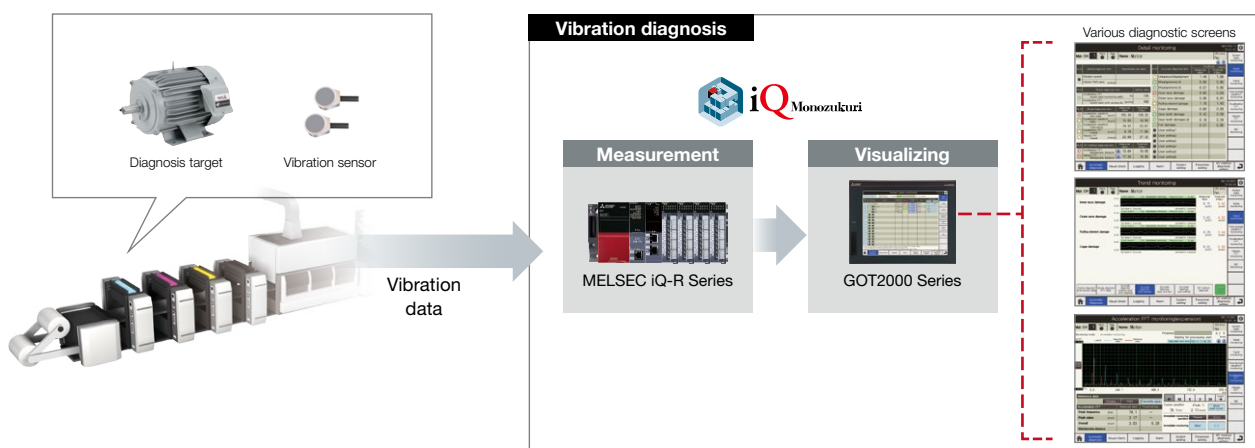
### How to understand signs of errors for equipment using rotating mechanisms?

Even if the vibration state of equipment can be seen, it is difficult to understand the difference between normal and abnormal operation, and signs of errors cannot be accurately detected, leading to downtime due to sudden failure.

#### Solution

### Pre-failure maintenance by detecting error signs using a vibration sensor

iQ Monozukuri Rotary Machine Vibration Diagnosis is a function that collects, analyzes, and diagnoses vibration data of equipment with rotating mechanisms to help make equipment conditions visible and estimate error location.



**Simple diagnosis**  
helps determine if there is a fault in equipment

There is a fault!

ALM	Simple diagnosis item	State/Measurement value	
	Vibration severity		
	Velocity RMS value (mm/s)		
ALM	Simple diagnosis item	Setting value	
	Acceleration FFT Guard band monitoring width (%)	130	
	Acceleration FFT Guard band cont. excess pts. (points)	100	
ALM	Simple diagnosis item	Measurement value	Threshold value
	Acceleration waveform Zero peak (m/s <sup>2</sup> )	155.30	129.25
	Acceleration waveform RMS (m/s <sup>2</sup> )	10.85	10.95
	Acceleration waveform Crest factor	14.31	23.67
	Acceleration FFT Overall (m/s <sup>2</sup> )	9.78	11.66
	Velocity FFT Overall (mm/s)	22.89	27.32

**Accurate diagnosis\***  
helps presume the faulty area

A sign of inner race damage is detected



ALM	Accurate diagnosis item	Amplitude (m/s <sup>2</sup> )	
		Measurement value	Threshold value
	Unbalance/Misalignment	1.48	1.88
	Misalignment(x2)	0.56	0.85
	Misalignment(x3)	0.57	0.80
	Inner race damage	0.65	0.63
	Outer race damage	5.98	6.91
	Rolling element damage	1.19	1.43
	Cage damage	0.89	0.93
	Gear teeth damage	0.42	0.59
	Gear teeth damage(x2)	0.18	0.34
	Fan damage	0.57	0.80
	User setting1		
	User setting2		
	User setting3		
	User setting4		

\* Accurate diagnosis requires specification value information of the components.



By maintaining the area where signs of errors are detected, sudden equipment stoppage is prevented and stable operation is achieved.

#### Product and Solution Introduction

▶ iQ Monozukuri Rotary Machine Vibration Diagnosis

P.35

# Case 7

Device level

Predictive Maintenance

Preventive Maintenance

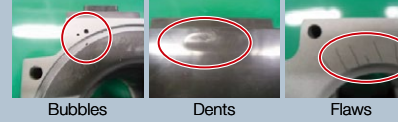
Corrective Maintenance



## How to understand the tendency of molding defect occurrence to prevent defect outflow?

The tendency of resin molding defects isn't understood, so loss cost increases as the occurrence of continuous defects goes unnoticed.

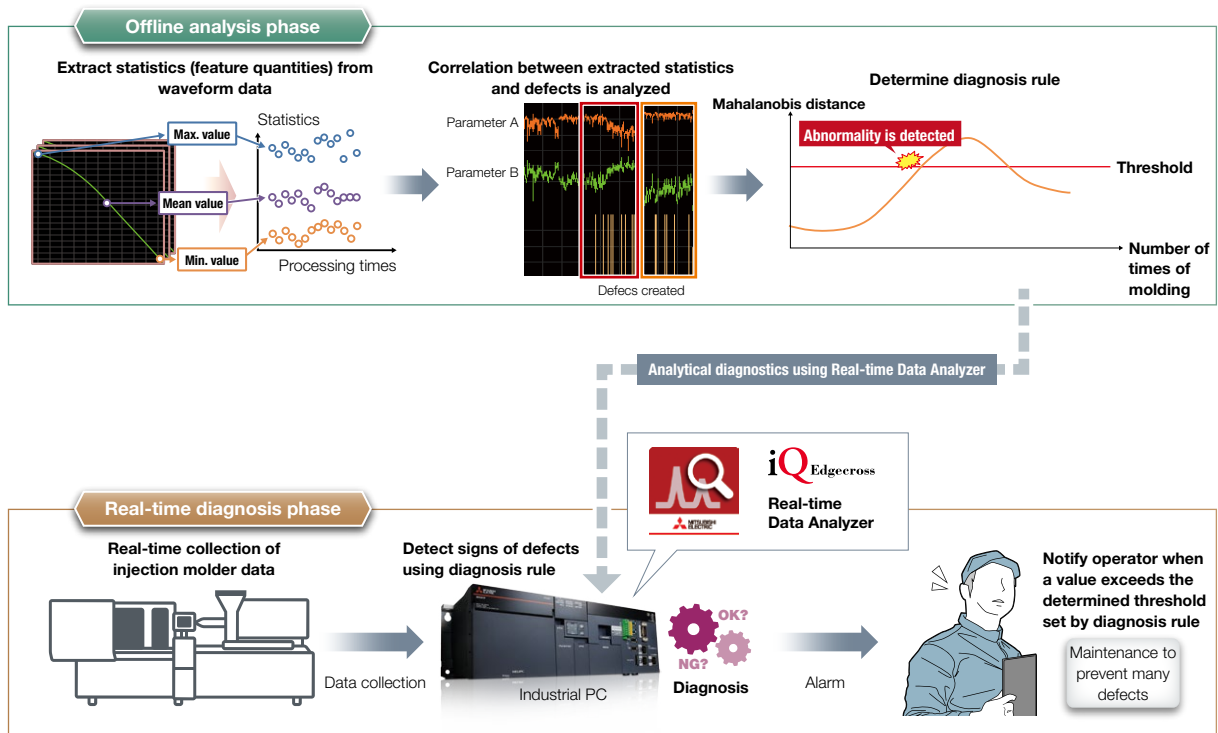
Examples of molding defects



### Solution

#### Analyze and diagnose feature quantities to prevent continuous occurrence of plastic molding machine defects

Utilizing the iQ Edgecross real-time data analyzer (data analysis and diagnostic software) of the MELIPC industrial-use PC, feature quantities from parameter waveform data that may affect molding quality are selected, the association with defects is analyzed, and diagnostic rules are created (Mahalanobis distance and threshold). By collecting machine data in real time with MELIPC and analyzing it based on rules with a real-time data analyzer, signs of defects are identified and maintenance can be performed before multiple defects occur.



Reduction of waste loss costs by detecting signs of molding defects.

### Product and Solution Introduction

▶ MELIPC Series

P.30

▶ iQ Edgecross Real-time Data Analyzer

P.31

## Case 8

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



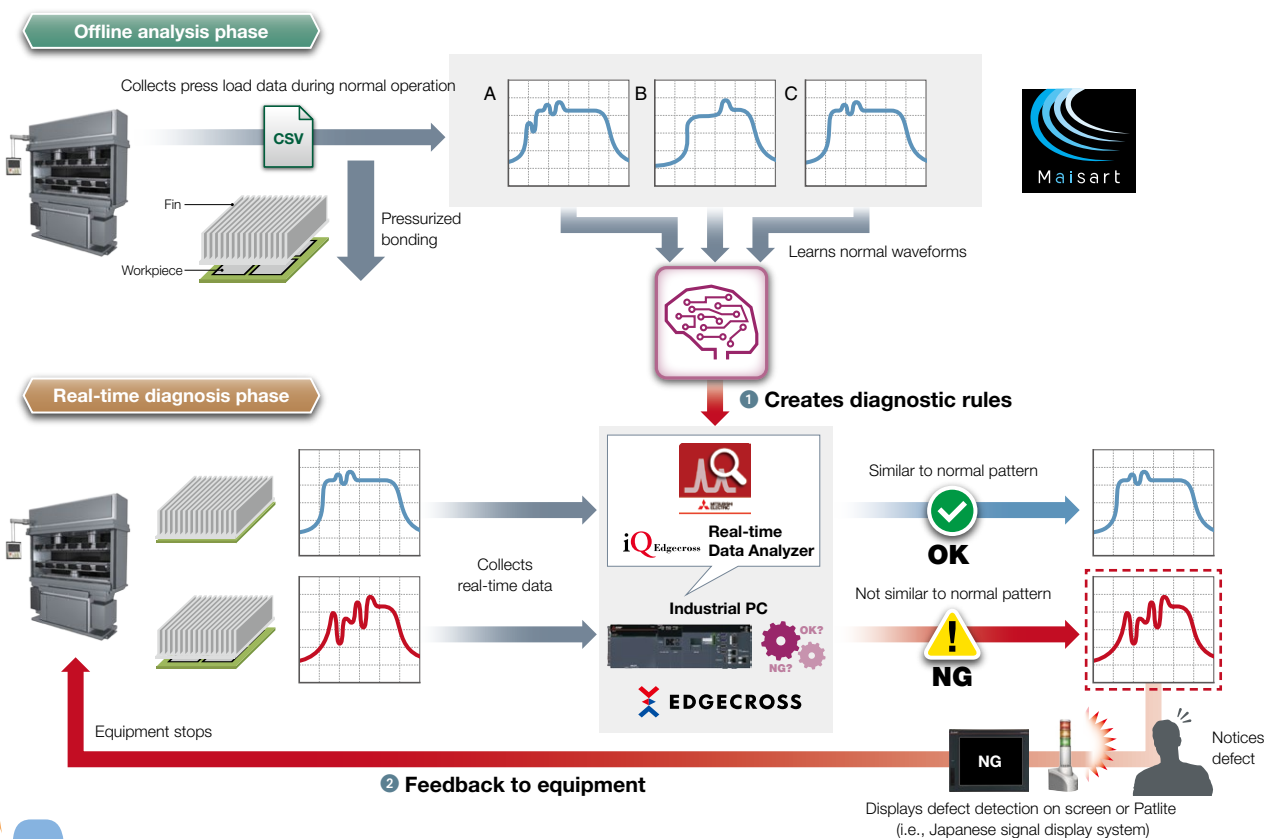
### How to detect processing defects and prevent the outflow of defective products?

The bonding in the metal fin caulking process is weak, and defective bonding of products where the fin becomes detached occurs in a later process.

#### Solution

#### Utilizing AI to prevent bonding defects in the caulking process

A similar waveform recognition function as that of the iQ Edgecross Real-Time Data Analyzer (data analysis and diagnostic software) creates diagnostic rules by learning the waveform data of press loads during normal operation and correlates it with bonding defects learned by the MELIPC industrial-use PC. These are then diagnosed based on rules determined by the Real-time Data Analyzer, bonding defects are detected, and the results are then fed back to the equipment (causing equipment to stop.)



Prevents defect outflow to later process through real-time detection of bonding defects.

#### Product and Solution Introduction

▶ MELIPC Series

P.30

▶ iQ Edgecross Real-time Data Analyzer

P.31





## Case 10

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



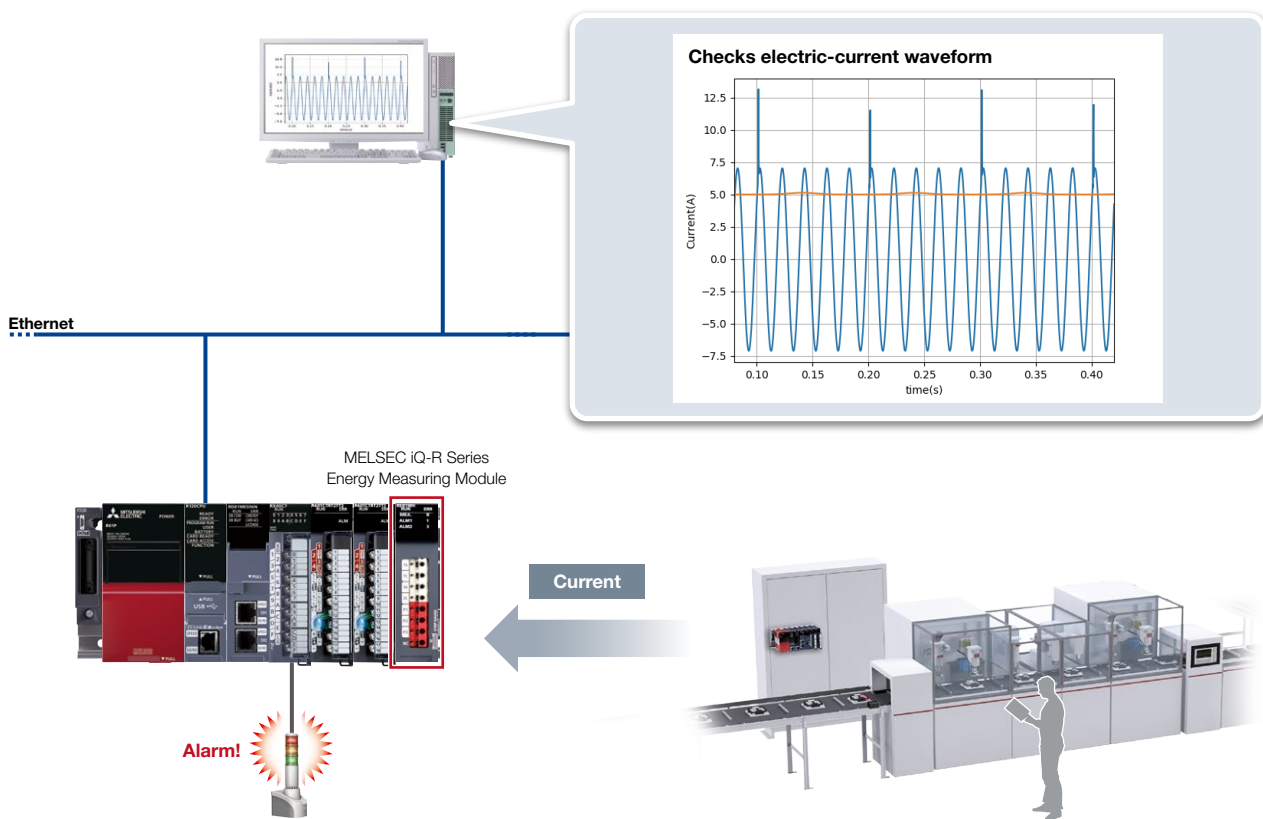
### How to prevent the sudden failure of old equipment?

Sudden failures of equipment used for a long time leads to unnecessary labor and cost.

#### Solution

### Planning equipment maintenance by monitoring current waveforms

The in-rush current waveform of equipment at the time of initial operation is measured in a short cycle of 10 ms to monitor any changes in electric-current waveform.



By detecting equipment failure in advance through short cycle measurement, maintenance planning is possible and labor is greatly reduced.

#### Product and Solution Introduction

▶ MELSEC IQ-R Series Energy Measuring Module

P.27

# Case 11

Device level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



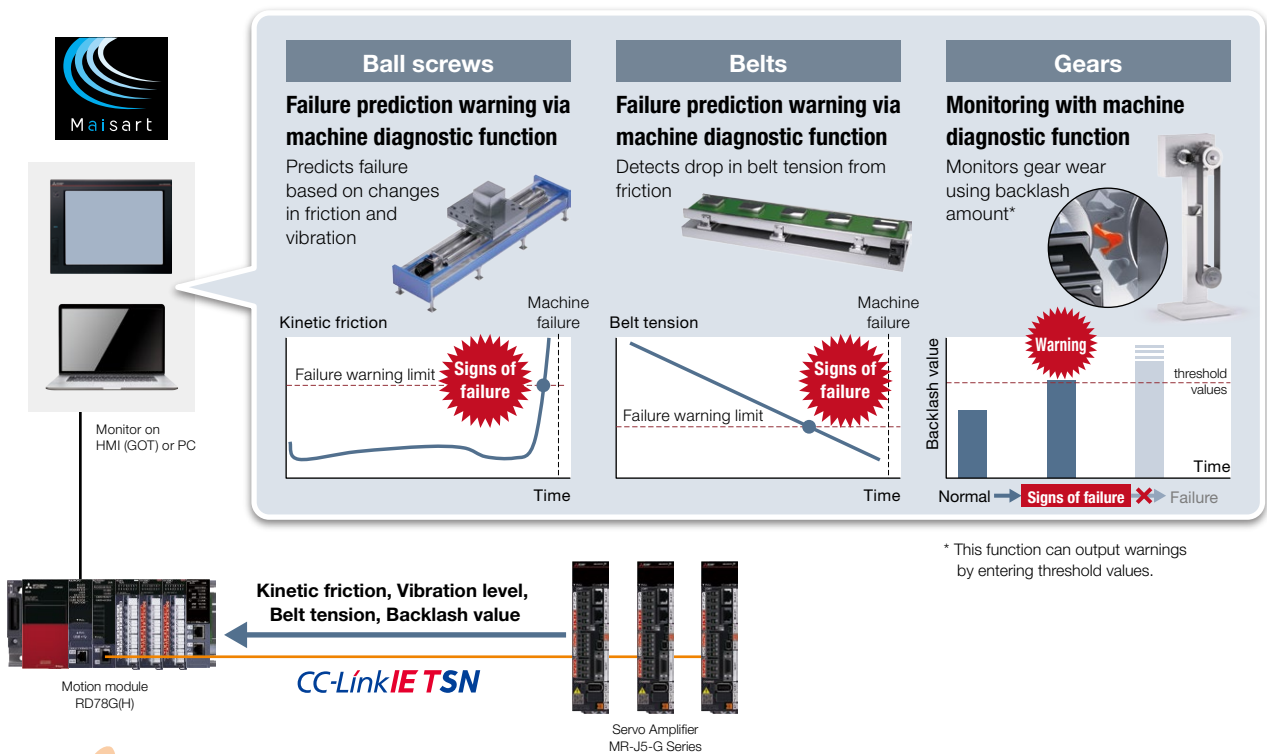
## How to detect drive component age-related deterioration (ball screws, belts, gears)?

The status of drive component (ball screws, gears, belts) deterioration is not understood, so we can only respond after failure, which requires considerable labor and cost.

### Solution

#### Detect vibration and friction changes to predict the service life of mechanical parts

- ▶ The future vibration and friction torque of ball screws (bearings, guides, etc.) is estimated by Maisart, and the judgment value is automatically generated from the estimated information. Failures are predicted by alerting users when judgment values are exceeded.
- ▶ The friction torque of the belt is estimated by Maisart, and the drop in belt tension is monitored. Failures are predicted by alerting users when judgment values are exceeded.
- ▶ The amount of gear backlash is estimated and frictional degradation of the gear is monitored. Failures are predicted by alerting users when threshold values are exceeded.



Predicting the life of mechanical parts reduces downtime and maintenance time, as well as improves equipment operating ratio, productivity, and quality.

### Product and Solution Introduction

▶ MELSERVO-J5 Series

P.38

## Case 12

Device level

Predictive Maintenance

**Preventive Maintenance**

Corrective Maintenance



### How to know when to replace servo amplifiers?

Sudden failure of servo amplifiers causes unexpected downtime.

#### Solution

### Service life diagnosis of servo systems

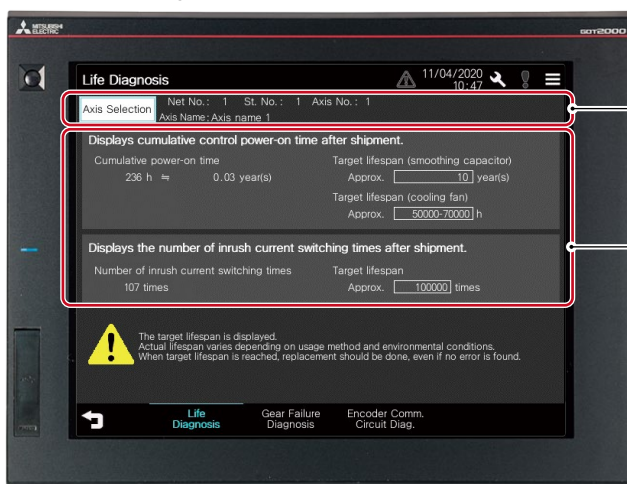
Using the GOT Servo Amplifier Life Diagnosis function, it is possible to check the accumulated energization time of smoothing capacitors and the number of times the inrush relay is turned on and off, thus enabling users to understand the replacement time of the servo amplifier.

There are also functions for inverters and robots\*1 to check when maintenance parts should be replaced. Please refer to the GOT2000 Series Product and Solution Introduction (P. 32).

#### Amplifier life diagnosis screen\*2



Periodic check



Maintenance for multiple axes can be performed on the same screen by switching the axis number

Check the smoothing capacitor energization time or the inrush relay on/off times at a glance



\*1 The degree of wear for each part is a reference value for supporting the maintenance and inspection plan calculated from the operation status of the robot and does not guarantee service life.

\*2 Ready to use sample screens (VGA) are included in GT Works3. For the details, please contact your local sales office.



Planned maintenance is possible by understanding the repair and replacement timing of servo amplifiers in advance

#### Product and Solution Introduction

▶ GOT2000 Series

P.32

▶ MELSERVO-J5 Series

P.38

# Case 13

Device level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



## How to smoothly resolve inverter issues?

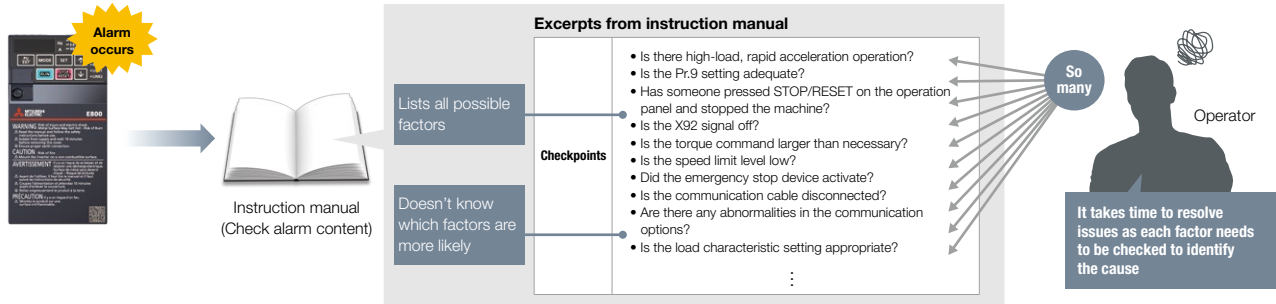
Since the alarm factors of inverters are checked manually one by one, it takes time to resolve issues.

### Solution

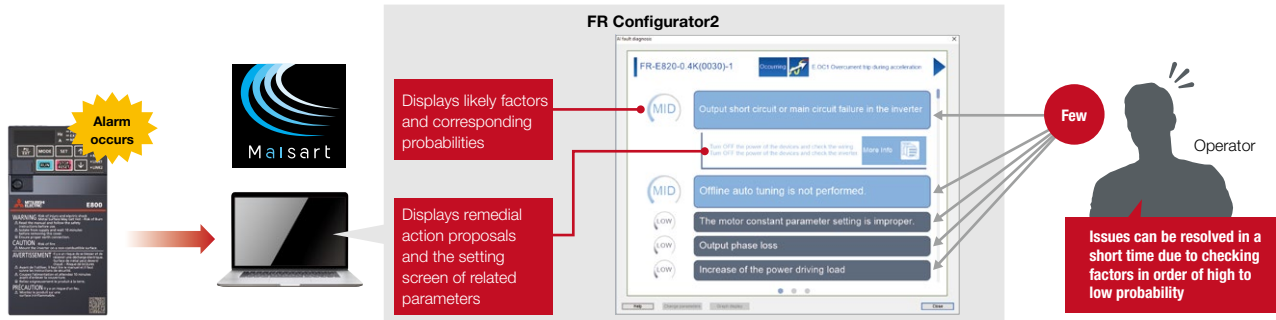
## AI supporting inverter troubleshooting

Utilizing the AI alarm diagnostic function installed in the FR Configurator2 inverter setup software, alarm factors are checked from most to least likely.

### Current recovery process



### Recovery process using AI alarm diagnostics



Achieve easy and quick troubleshooting, thus reducing downtime.

### Product and Solution Introduction

► FREQROL-E800 Series (FR Configurator2) P.40

## Case 14

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



### How to respond to equipment problems without going to the shop floor?

When an abnormality occurs on the shop floor at another facility (overseas, etc.), it is difficult to accurately understand the cause by phone or e-mail alone. In order to investigate the cause and recover the shop floor to normal operations, it is necessary to physically go to the site where the issue is occurring, and this form of response is time-consuming and costly.

#### Solution

The status and error details of equipment at a remote location can be confirmed via video images, and causes can be detected quickly

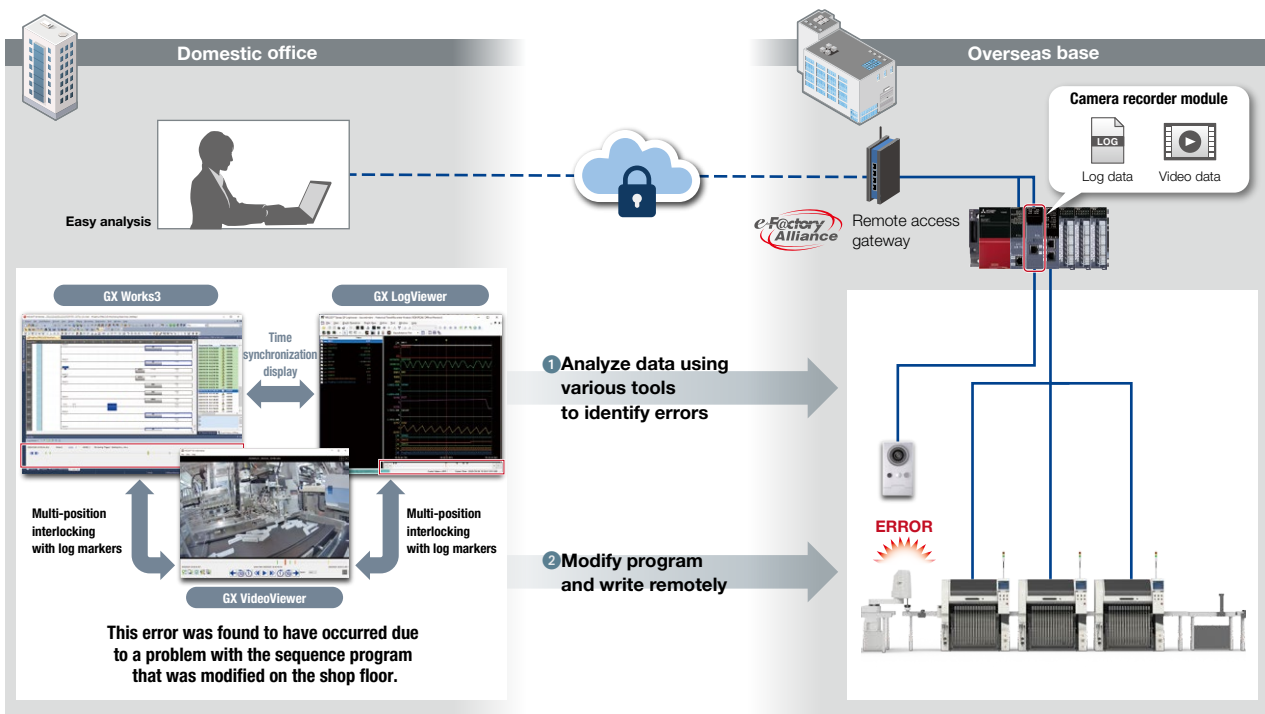
System Recorder\*<sup>1</sup> performs system-wide recording of equipment operation data and camera images in the event of an abnormality.

Log markers\*<sup>2</sup> are used at remote locations to view waveform data, programs, and video on the same timeline and share analysis details. Remote environments are easily and securely built using Ewon/Secomea remote solutions.

\*1 System Recorder: Corrective Maintenance Solution that greatly reduces downtime through system-wide recording in the event of an abnormality and simplified analysis.

\*2 Log marker function: A function to add markers to areas requiring attention for sequence programs, waveform data, and camera footage, and to load marking information from GX Works3, GX LogViewer, and GX VideoViewer.

#### ■ Solve problems with System Recorder



Significantly reduces labor and cost by enabling error causes to be identified at an early stage from a remote location.

#### Product and Solution Introduction

▶ System Recorder

P.28

▶ HMS Ewon Cosy Series

P.46

▶ Secomea SiteManager Series

P.47

# Case 15

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



## How to determine the cause of equipment errors?

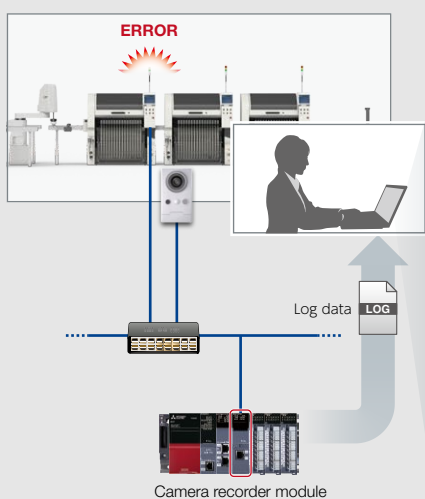
An error occurred, but it isn't possible to identify the cause even with visual confirmation on the shop floor as equipment appears normal. Even video footage recorded with the camera does not show details, and it isn't possible to identify where the error is occurring in the equipment.

### Solution

### Investigation of equipment error causes with a System Recorder

The Data Flow Analysis function of the GX Works3 engineering software allows users to narrow down the error factors in a program. By reproducing log data collected by the Camera Recorder Module with an offline monitor, it is possible to identify where errors are occurring in equipment. In addition, by displaying the error location of the equipment according to units of time in the waveform display of the GX LogViewer, users can also understand the status of the error location after the error occurs.

### Determining cause with Camera Recorder Module



**Auto switch ON position is found to be the cause!**

- 1 Use Data Flow Analysis Function to narrow down error factors.
- 2 When the error occurrence was reproduced on an offline monitor, one auto switch was not on, and an error occurred.
- 3 Since the auto switch turned on a few seconds after the error occurred, when the user checked the status of the relevant chuck in GX LogViewer, they discovered that the auto switch trigger was not on (timeout).
- 4 It was discovered that the error could be avoided by fine-tuning the ON position of the auto switch mounted on the chuck.



Identify the causes of trouble unclear until now to avoid errors that are likely to cause trouble in advance.

### Product and Solution Introduction

▶ System Recorder

P.28

## Case 16

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



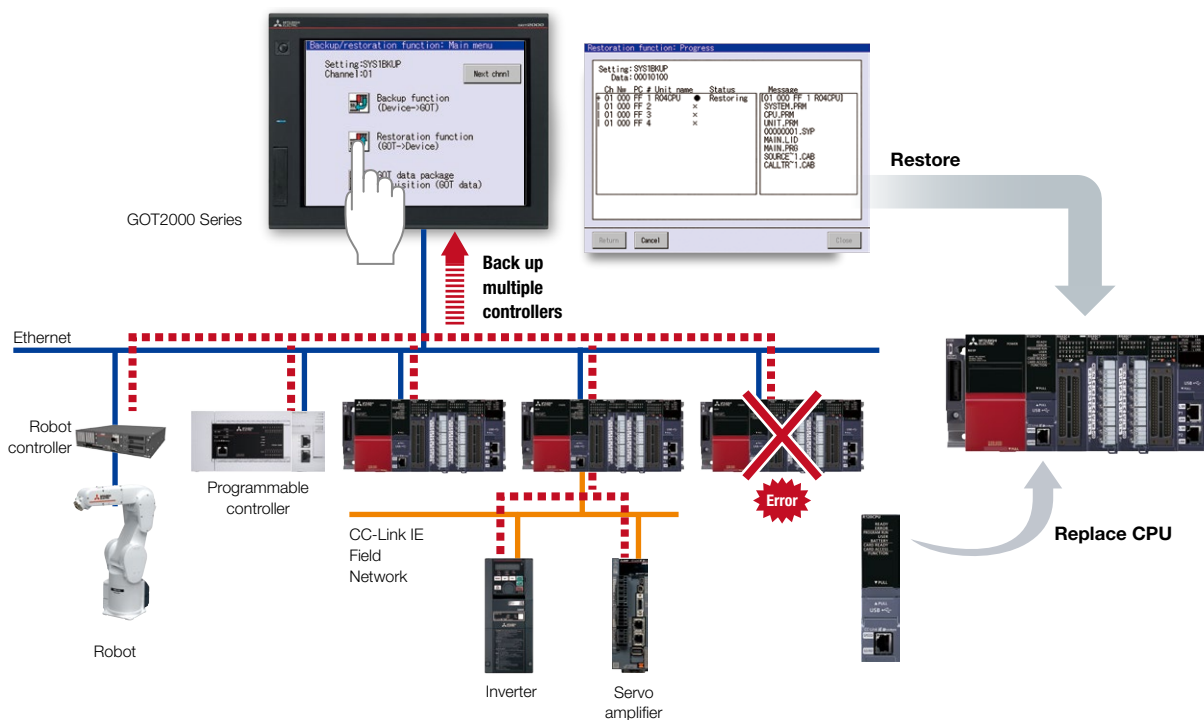
### How to restore FA device programs on the shop floor immediately?

In the event of programmable controller failure or a dead battery, new equipment and a computer for writing programs must be prepared, which means recovery takes a long time.

#### Solution

### Easy backup/restoration of FA device programs and parameters

The GOT Backup/Restoration function allows users to back up programs and parameters of FA devices such as programmable controllers to a GOT SD memory card or USB memory. Programs and parameters can be easily restored from GOT to FA devices when the devices need to be replaced.



By performing backups in advance, it is possible to restore FA devices from GOT on the shop floor without a PC in the event of an FA device failure, which reduces downtime.

#### Product and Solution Introduction

▶ MELSEC iQ-R Series P.26

▶ MELSEC iQ-F Series P.26

▶ GOT2000 Series P.32

# Case 17

Line level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



## How to monitor multiple lines from a remote location?

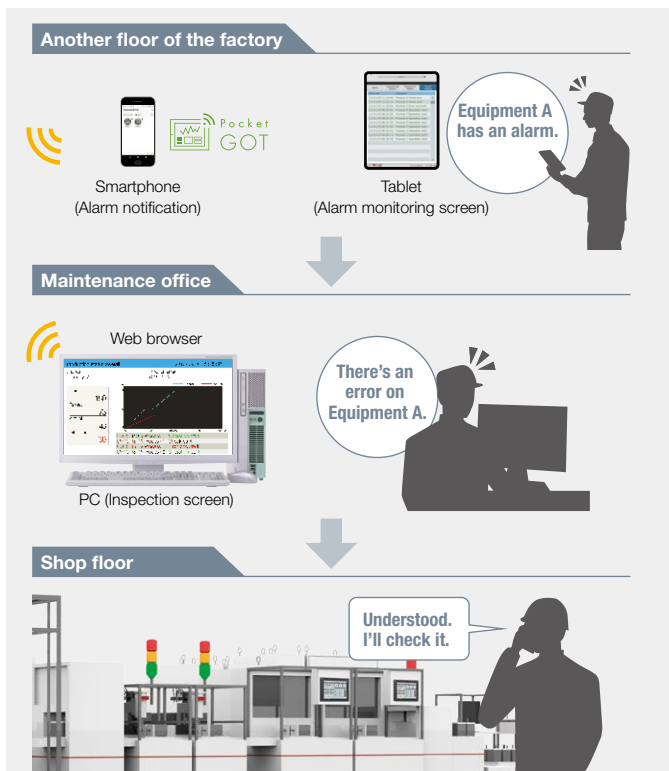
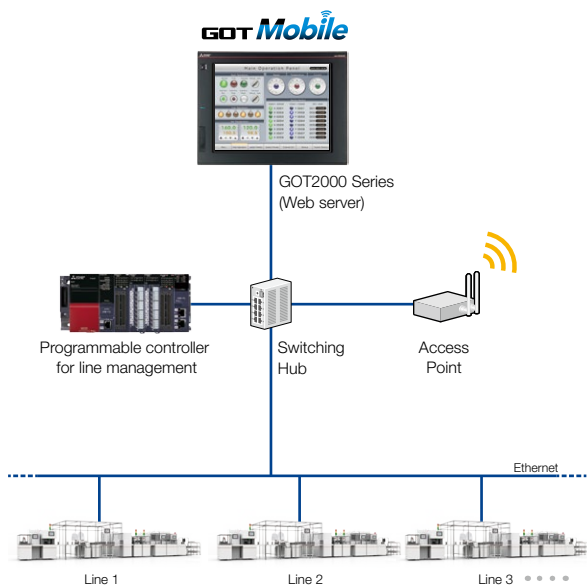
When managing multiple lines, it is necessary to switch back and forth between the lines when an error occurs, therefore line downtime is prolonged.

### Solution

### Remote monitoring of multiple lines

With the GOT Mobile function, it is possible to view information collected by GOTs on the shop floor from information devices such as PCs and tablets in remote locations. Remote monitoring of the operation status of multiple lines installed at a factory, error occurrence situation, etc. is possible.

Users can also use Pocket GOT, a mobile application for GOT, to receive notifications of user alarms that are occurring on monitored GOTs to mobile devices.



The status of the entire factory can be checked at a glance from a remote PC, reducing wasted time in the event of an error, and significantly reducing downtime.

### Product and Solution Introduction

▶ GOT2000 Series (GOT Mobile Function)

P.33



## Case 18

Line level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance



### How to identify error locations from multiple machine tools?

Errors are occurring such as noise or unusual workpiece finish, but the location is difficult to identify.

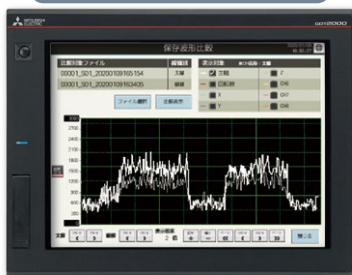
#### Solution

### Compare waveforms to detect abnormal machine tool processing

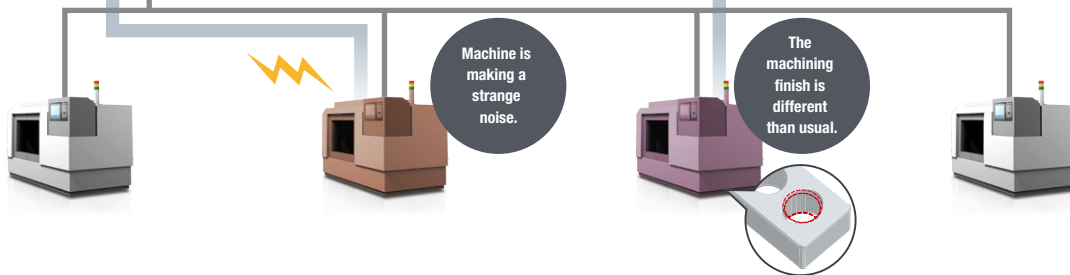
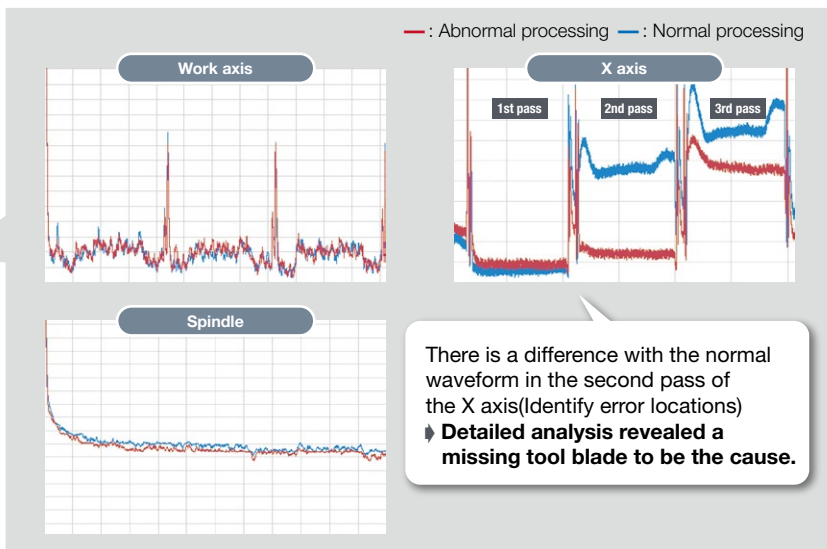
With iQ Monozukuri Tool Wear Diagnosis for Machine Tools, users can compare arbitrary load data and data from previous normal machining on the Advanced Data Science Tool or GOT (up to 60 logging data are stored), and easily check the data on the shop floor when they feel something is irregular, such as noise or machining finish.

#### Confirm data on the shop floor

Tool Wear Diagnosis for Machine Tools



GOT2000 Series



Root causes can be swiftly identified using a simple method for narrowing down error locations on the shop floor.

#### Product and Solution Introduction

▶ iQ Monozukuri Tool Wear Diagnosis for Machine Tools

P.36

## MELSEC iQ-R Series

A manufacturing plant is seldom stopped or taken offline and continuously produces the desired product or component. However, the control system occasionally requires maintenance; for example, at the time of a faulty product or system upgrade for manufacturing a new or updated component. At that time, thanks to the extensive maintenance functions embedded in the hardware and software, the user can trust the control system to handle transition into/out of the maintenance period for both preventive and post maintenance.



MELSEC iQ-R series

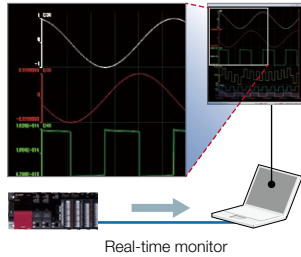


GX LogViewer

iQ-R iQ-F

### Visualize manufacturing data in real-time

- Monitor live manufacturing process data across the plant
- Very easy setup using the dedicated GX LogViewer monitoring tool



CPU/ Output module

iQ-R iQ-F

### Prevent system downtime with relay monitoring

- Monitors relay switching amount
- Check relay condition from GOT (HMI)
- Plan module maintenance prior to malfunction of relay



## MELSEC iQ-F Series

Based on the concept of "Easy, Convenient, and Excellent Cost Performance," the MELSEC iQ-F Series contributes to customers' operations with functions that are enhanced by IoT and maintenance functions that are useful for early recovery in the event of trouble. From stand-alone use to system proposals including networks, we strongly support our customers' "one-step-ahead manufacturing."



MELSEC iQ-F series

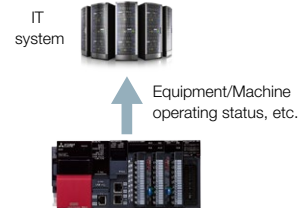


MES interface module

iQ-R

### Direct access to enterprise level

- Registers device values directly into database
- Visible shop floor data enables actions before event occurs

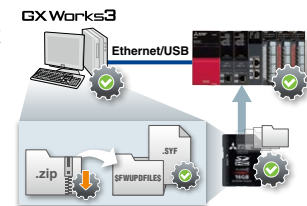


CPU/ Intelligent function module\*

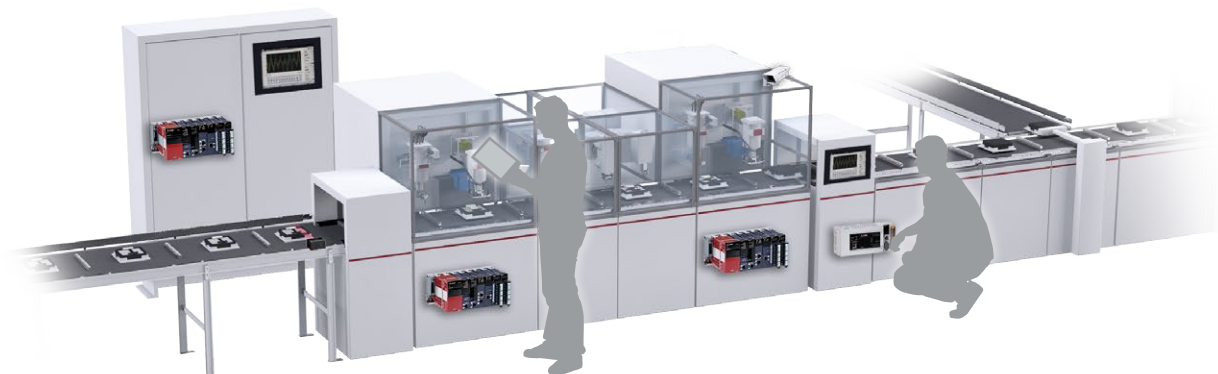
iQ-R iQ-F

### Module firmware update ensuring latest functional version module

- Utilize new functions and features immediately
- Update multiple modules using GX Works 3 in one go
- Direct updating using a SD memory card



\* Please refer to the manual regarding support for each model.



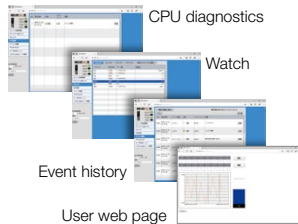


CPU module

**iQ-R** **iQ-F**

## A web server function enabling users to easily check the status of their device via web browser

- Monitor various module status data:
  - CPU diagnostics
  - Device block monitor/watch
  - Event history
- Supports custom made web pages

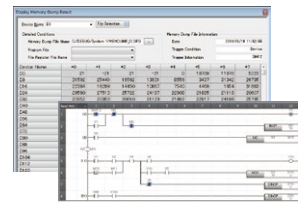


CPU module

**iQ-R** **iQ-F**

## Memory dump enables confirmation of operation problems

- Saves block of device data when error occurs
- Root cause analysis by confirming data on device monitor screen and offline via program editing window



Memory dump results (Program editor)



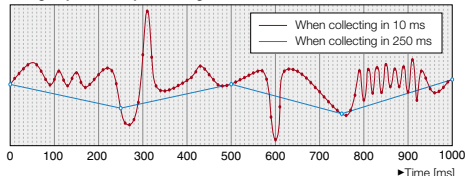
Energy Measuring Module

**iQ-R**

## Early detection of equipment errors with energy measurement leading to Preventive Maintenance

- Using only one module, highly detailed information such as electric energy (consumption and regeneration), reactive energy, current, voltage, can be measured for individual production equipment.
- Improved productivity of both equipment and the production line can be achieved by synchronizing the monitoring of consumed energy and specific energy consumption management with the control program.

### High-speed data processing

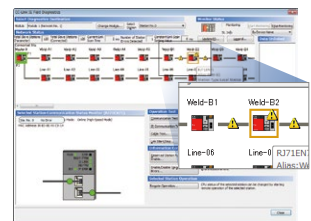


GX Works3

**iQ-R** **iQ-F**

## Quickly find network errors

- Visualize error location from network system image
- Easy network error corrective measures



CC-Link IE Field diagnosis window

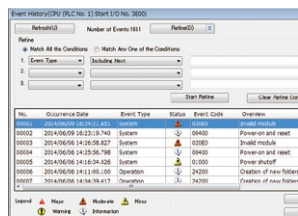


CPU module

**iQ-R** **iQ-F**

## Efficient diagnostics with extensive event logging

- Logging of program change events, errors and when the power is turned off
- Event logging displayed in list form
- Quickly detect problems due to operating mistakes by multiple users



Event log list



GX Works3

**iQ-R** **iQ-F**

## Multi-language software improves global support

- Comment/label names can be registered in multiple languages
- Easy to switch between languages
- No need for multiple programs to satisfy regional requirements



Switch between device comment languages

## System Recorder

The system recorder is a Corrective Maintenance solution that ensures effective resumption of operations reducing downtime through its extensive system-wide data recording and simplified analysis software features. Data before and after the set trigger can be collected with a timestamp every scan. This eliminates the need to worry about what data is being collected when setting up recording and supports swift recovery operations.



### Corrective Maintenance solutions with System Recorder

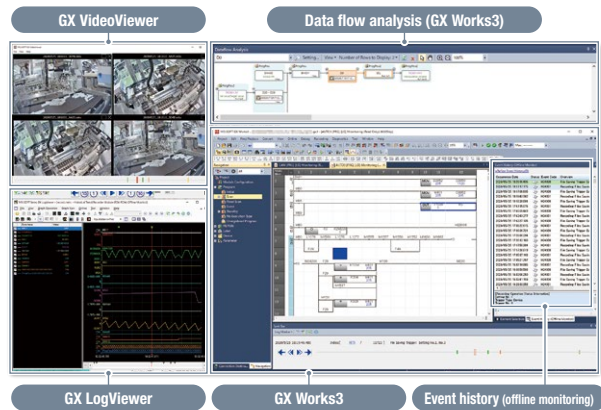
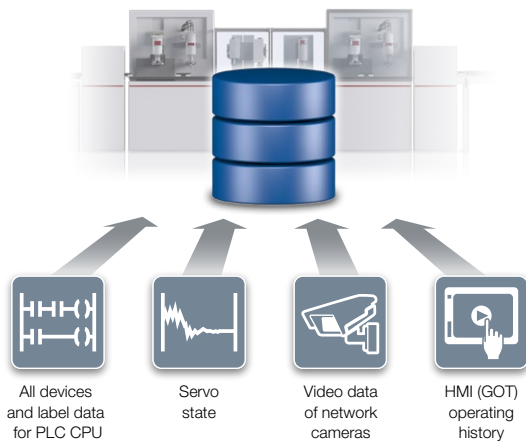
Significantly reduces machine downtime with "complete recording" and "easy analysis" of system operating status during error

#### Complete recording

- Complete recording of all data required for error analysis
- Complete system recording
- Complete prolonged recording

#### Easy analysis

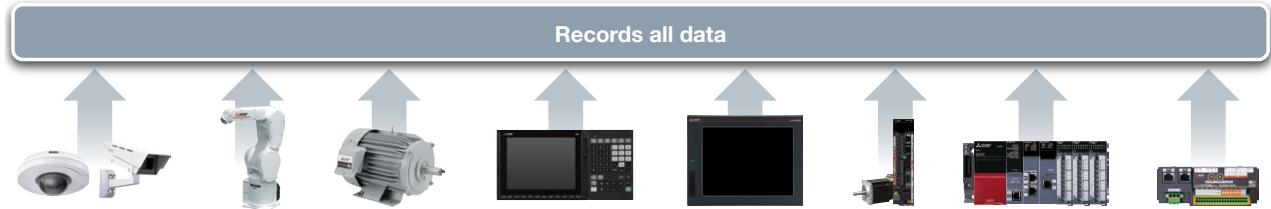
- Display all data on the same timeline
- Expresses influencing factors in straightforward terms
- High-productivity programs also offer speedy solutions



## Complete recording

When problems arise for equipment with multiple devices, it is necessary to find out the facts before and after such an occurrence (when, where, and what happened) in order to recover normal operation.

Mitsubishi Electric's system recorder can record the entire process condition and offer an operations log for control data of multiple equipment and devices, allowing the reproduction (or playback) of the process offline, helping to highlight and show the actual cause of failure.



### Want to record video and data

Recording function (MELSEC iQ-R Series)

#### All device/label logging per sequence scan

Recorder module exhaustively records changes in all devices/labels

#### All labels/FB logging of the PLC

Unconsciously records all device addresses/system configurations

#### Event history

Records device/label operations from external devices

#### General-purpose network camera video

Records visual information such as work behavior and user's behavior

### Also want to record drive system conditions

MELSERVO-J5 Series/MELSEC iQ-R Series Motion module

#### All device/label logging per sequence scan

Timestamped and accurate recording of motion control data that operates faster than a PLC scan

### Also want to record users' operations

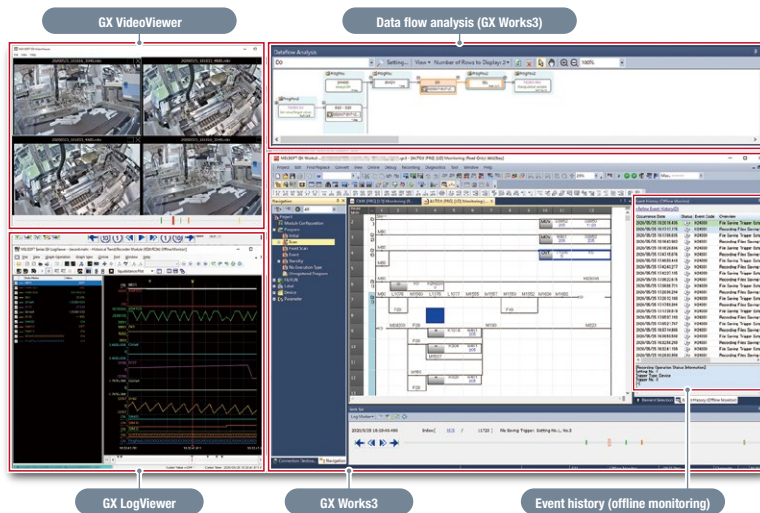
GOT2000 Series

#### Records HMI (GOT) operation history and alarm history

Records operation history of shop floor workers and alarm information for connected devices

## Easy analysis

The data collected through complete recording (recording file) can be reproduced offline together with program operation transition. Moreover, by confirming data together with camera video footage, this function enables marking of potentially problematic points (time of error occurrence) from the video. The reviewer can share the equipment conditions at the marked time with shop floor workers, maintenance personnel and designers, thus smoothly communicating to ensure everyone has the same understanding of the error occurrence status from vast amounts of video data and, ultimately, easily identifying the cause of the error.



### GX VideoViewer\*

Review video when problem occurs  
\* For information on obtaining the sample screen, please contact your local Mitsubishi Electric sales office or representative.

### Data flow analysis (GX Works3)

Extracts problematic and influencing data

### GX LogViewer

Analyzes data changes

### GX Works3

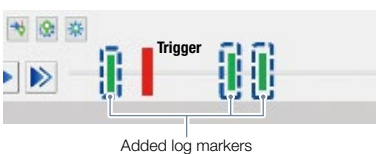
Displays data changes and program relationships offline

### Event history (offline monitoring)

Review event history during offline monitoring

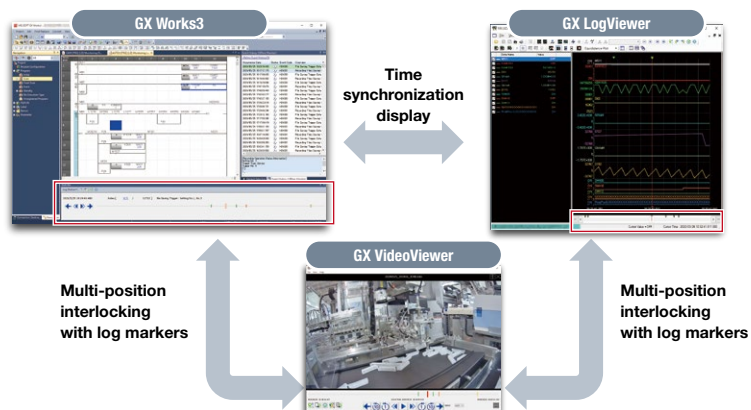
### Conceptual Image of Function

- Use the "Add Marking" button to add log markers to points requiring attention



- Share points requiring attention between tools

GX Works3	Circuit monitor toolbar
GX LogViewer	Top of waveform display graph
GX VideoViewer	Video display seek bar



## MELIPC Series

Mitsubishi Electric's industrial-use PC MELIPC Series makes it possible to build systems with edge computing utilizing IoT at a high degree of freedom due to its robust features specifically for FA use and adoption of general-purpose applications. The lineup consists of four product types to suit various data utilization scenarios depending on the application; from a high-end model supporting a high-performance processor and CC-Link IE field network capable of high-speed communication to a simple and compact low-range model.



# MELIPC

### Pre-installed with Edgexross – an open software platform suited to data utilization

MELIPC Series comes preinstalled with Edgexross\* – a software platform in the edge computing area – meaning that users can build a real-time remote monitoring system by combination with Edgexross-compatible software, etc.

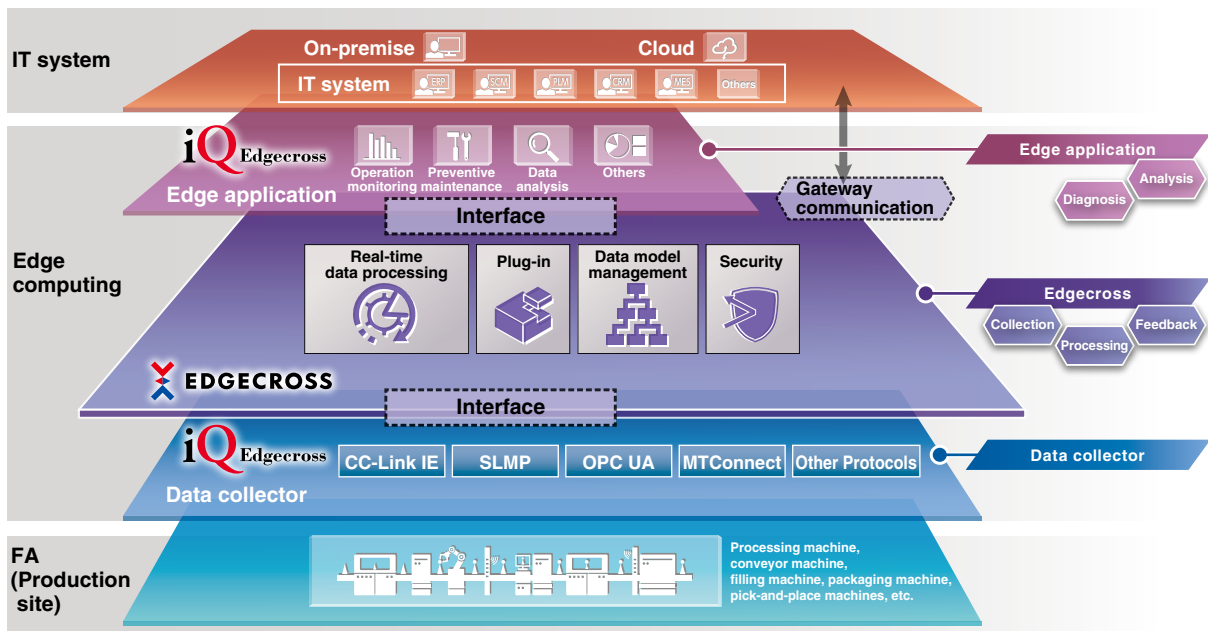
\* An open software platform provided by the Edgexross Consortium, a general incorporated association. <https://www.edgexross.org/en/solution/feature.html>

### Data model management

A function that expresses the equipment, devices, and lines of a production shop floor in an abstract way to perform hierarchical management. It offers a GUI to intuitively perform settings and operations with the same feel as Windows® Explorer. Rather than the conventional approach of managing each piece of equipment individually, by managing all data relating to production equipment for the entire factory, it is possible to consolidate factory management and maintenance.

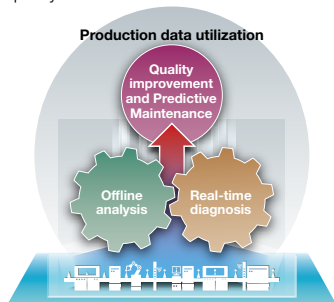
### Data collection from every kind of equipment

By selecting a data collector compatible with Edgexross and suited to the communication method of a specific piece of equipment, the necessary data for remote monitoring and maintenance can be collected.



## iQ Edgexross Real-time Data Analyzer

Data analysis and diagnosis software that easily realizes quality improvement and Predictive Maintenance on the shop floor. One software enables offline analysis and real-time diagnosis of production data. Utilization of shop floor data with AI and various statistical methods will improve manufacturing productivity and also industrial quality.



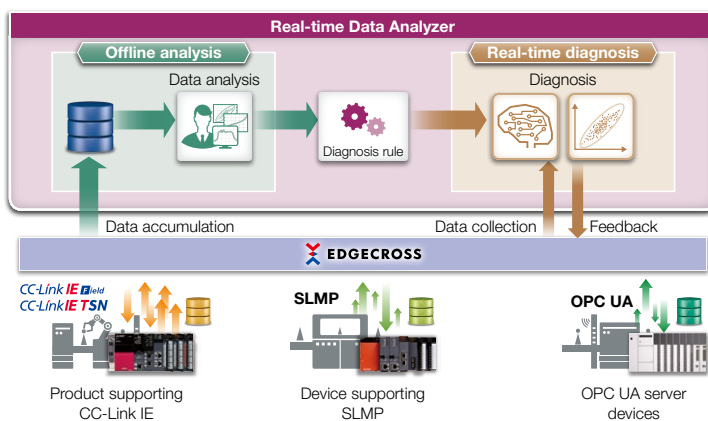
- ▶ One software realizes real-time diagnosis and offline analysis
- ▶ Artificial Intelligence (AI) and various statistical analysis methods
- ▶ Efficient graphic-based data analysis and diagnosis without a program



**iQ** Edgexross

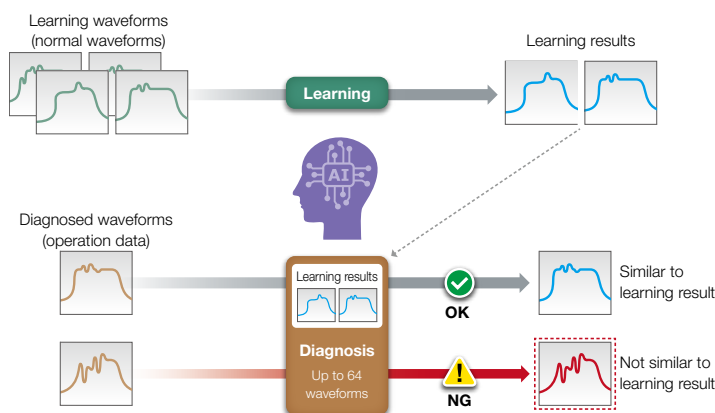
### Real-time improvement of manufacturing with offline analysis and real-time diagnosis

Production data is utilized in two phases, the phase where data is analyzed offline and the phase where collected data is diagnosed in real time. Real-time Data Analyzer can realize both offline data analysis and real-time diagnosis through direct connection with the shop floor. Separate diagnosis system configuration is unnecessary, allowing utilization of data analysis result for diagnosis.



### Similar waveform analysis using AI technology

Unique AI technology (Maisart) enables learning and recognition of similar waveforms. First, AI learns normal waveform patterns. During operation, degree of similarity of operation data and normal patterns is calculated to judge whether it passes or fails. Even if the upper and lower limits of waveform data cannot be simply diagnosed, signs of abnormalities can be detected without relying on individual knowledge.



### Various statistical analysis and diagnosis methods

Real-time Data Analyzer includes general statistical analysis methods such as multiple regression analysis and MT system. Data can be analyzed easily by using various methods without programming.

## GOT2000 Series

A full lineup that conveys the monozukuri philosophy to the world and responds to the needs of production shop floors. In addition to interaction with FA devices, the GOT2000 Series pursues good operability, and contributes to higher productivity and efficiency.

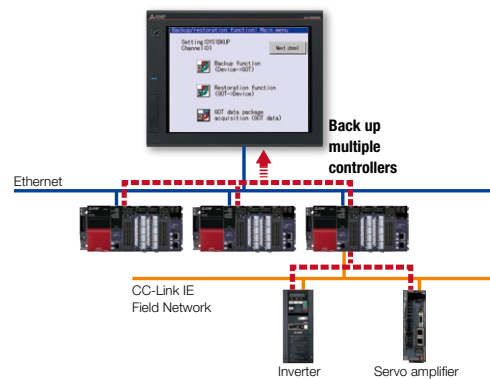


### Backup/Restoration GT27 GT25 GT23 GT21 GS21

Data such as programs and parameters of programmable controller CPUs, etc. can be stored (backed up) and written (restored) on GOT SD memory cards and USB memory devices.

By backing up data to a GOT in advance, it is possible to replace and recover using the GOT alone without the need for a PC when replacing programmable controller CPUs or other FA devices.

- \* Excludes GT2103-PMBLS.
- \* Requires a separate SD memory card or USB memory device.
- \* Depending on the GOT model, restrictions apply to some functions or connectable equipment.



### Drive Control Interaction GT27 GT25 GT23 GT21 GS21

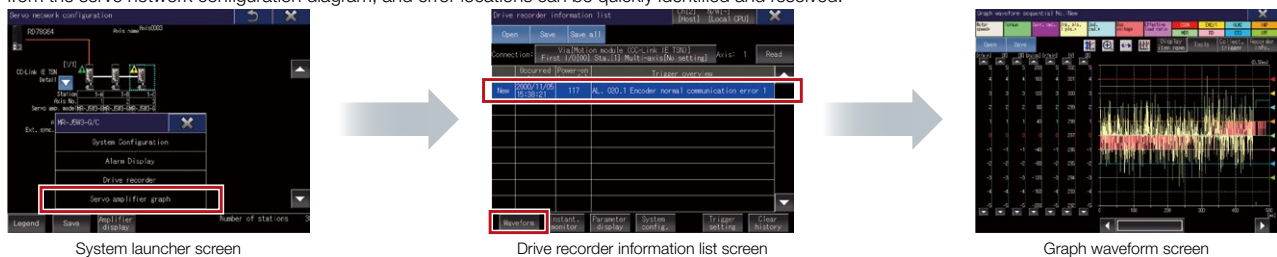


GOT can be used to achieve efficient start up, adjustment, and maintenance of drive control equipment. GOT screens (dedicated functions and sample screens) for each interactive functions are available.

- \* Depending on the GOT model, restrictions apply to some functions or connectable equipment.

### Servo amplifiers

Users can check the status of servo amplifiers connected to GOT from the servo network configuration diagram. In addition, the drive recorder can be started from the servo network configuration diagram, and error locations can be quickly identified and resolved.

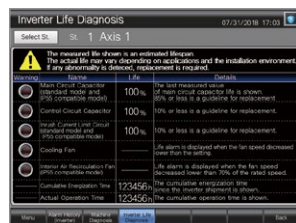


### Inverters

The GOT enables efficient parameter setting work for multiple inverters. In addition, inverter service life diagnosis checks whether or not consumable parts require replacement and supports maintenance work.



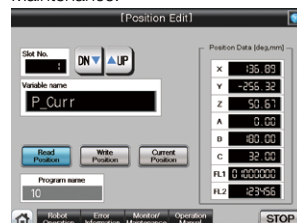
Parameter Setting screen



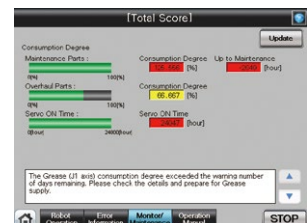
Inverter Life Diagnosis screen

### Robots

Utilizing GOTs, it is easy to start and stop robots, monitor error information, etc. In addition, GOTs can check the degree of wear and signs of failure for each robot part, thus achieving both Predictive Maintenance and Preventive Maintenance.



Position edit screen



Overall score screen



## GOT Mobile Function **GT27** **GT25** **GT23** **GT21** **GS21**

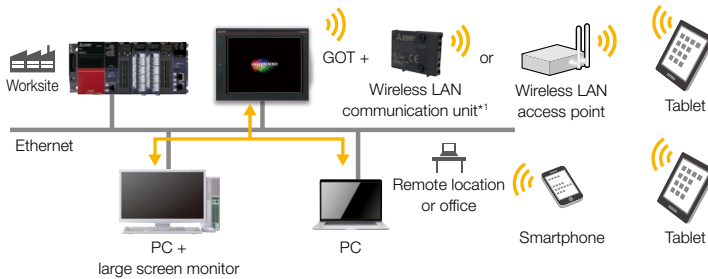


The GOT Mobile function allows users to check equipment status from a remote location via a web browser on an information device (PC, tablet, smartphone, etc.) through the GOT operating on a shop floor.

Five information devices (clients) can access such information device simultaneously, each displaying and operating a different screen.

- \* A separate license (GT25-WEBSKEY□) is required.
- \* Up to five clients can be connected to a single GOT simultaneously.

### Simultaneous monitoring from five information devices



\*1 The wireless LAN communication unit cannot be used with GT2505 and GT25 handy. An access point is required separately.

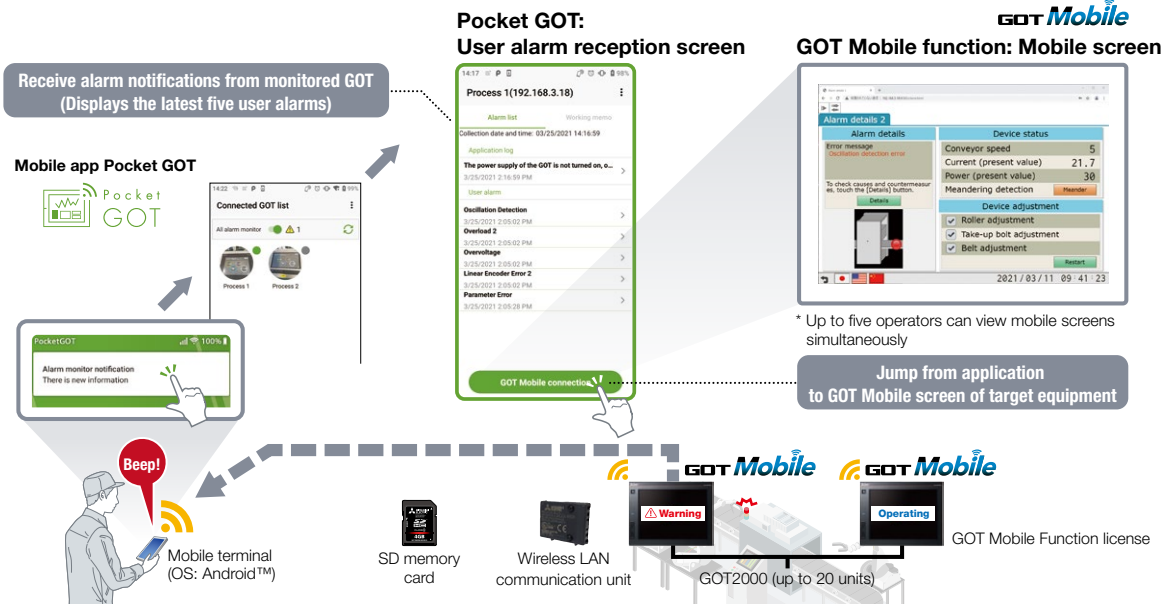
### Check the status of the worksite using a web browser.



### Other usage

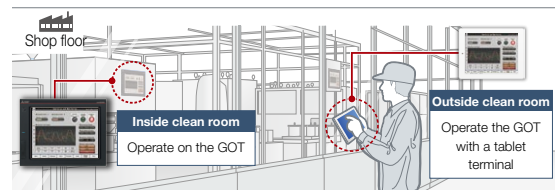
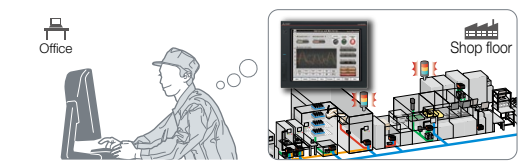
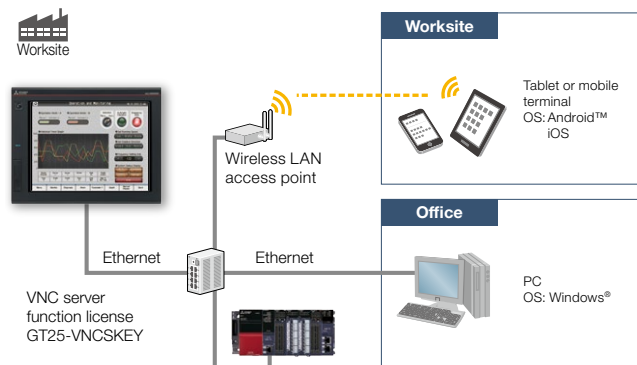


In addition, by installing the mobile app Pocket GOT on a mobile terminal, the app collects the status of user alarms occurring in the monitored GOT and notifies the users with vibration, sound, or banner when a new alarm is detected. GOT Mobile can be opened from Pocket GOT and the status of the GOT with the user alarm occurring can be checked on the user's mobile terminal.



## VNC Server Function **GT27** **GT25** **GT23** **GT21**\*2 **GS21**

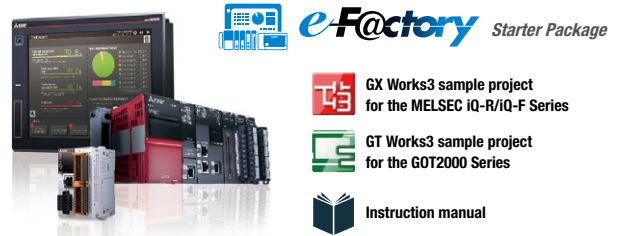
Users can view and operate GOT screens from a remote location using an information device such as a PC or tablet. There is no need to create dedicated screens.



\*2 Supported by GT2107-W only.

## e-F@ctory Starter Package

The e-F@ctory Starter Package consists of sample projects for the PLC MELSEC iQ-R/iQ-F Series and HMI GOT2000 Series. By providing programs for visualization, easy analysis, etc., in sample project form, this product single-handedly integrates IoT on the production shop floor with basic settings such as device allocation and parameter settings. The e-F@ctory Starter Package helps to provide solutions to various issues that may occur when introducing IoT systems such as investigation period and budget.



### Visualization of overall equipment efficiency **iQ-R iQ-F**

A general display of equipment production/operating status, including overall equipment efficiency and production volume.

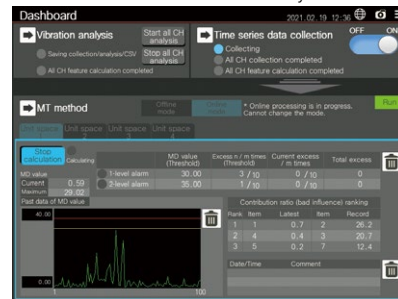


\* The sample screen shown above is from the MELSEC iQ-R Series.

### Detection of irregularities using the MT method **iQ-R iQ-F**

Expresses degree of divergence between regular data and input data in numerical form and detects errors.

The iQ-R Series also includes a function to input feature quantity derived from time series data collection and vibration analysis.



\* The sample screen shown above is from the MELSEC iQ-R Series.

### Error detection by monitoring cylinder operation time **iQ-R iQ-F**

Measures and monitors cylinder conditions, operations, and equipment operating cycles to identify any sign of errors.



\* The sample screen shown above is from the MELSEC iQ-R Series.

### Error detection by monitoring analog waveform status **iQ-R**

Uses thresholds to monitor the shape of the waveform. Guard band monitoring makes it possible to monitor the waveform status of analog waveform data such as electrical current and temperature. Accordingly, it is possible to detect abnormal waveform fluctuation that was difficult to detect with threshold monitoring based on simple upper/lower limits.



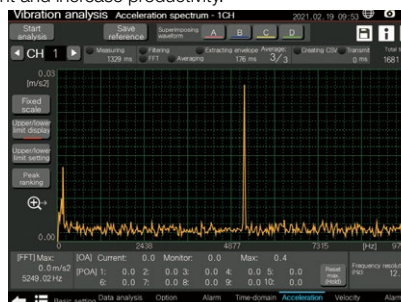
### Management of equipment/process changes **iQ-R**

Users can manage change points according to the 4M and 5M+1E perspectives used in quality management, and then use this information for cause analysis when a problem arises.



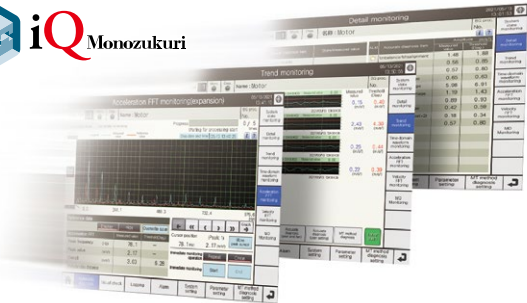
### Error detection by frequency analysis of vibration waveform **iQ-R**

Uses vibration analysis (FFT) to express vibration created by equipment, devices, and products in numerical form and visualize the status. Detection of abnormal vibration makes it possible to perform Predictive Maintenance on equipment and increase productivity.



## iQ Monozukuri Rotary Machine Vibration Diagnosis

This software package is used to collect, analyze, and diagnose vibration data from equipment that contains rotating parts. It then helps to visualize equipment status and predicts the location of abnormalities.



### Package Contents



**GX Works3 control program for MELSEC iQ-R Series**

**GT Works3 screen data for GOT2000 Series**

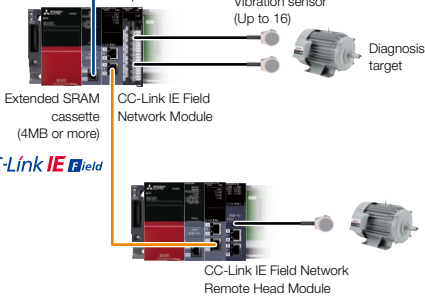
**Instruction manual (PDF)**

\* This product is equipped with software application and documentation. Hardware and engineering software are required separately. For details, please refer to each catalog [L(NA)16057ENG].

### GOT2000 Series



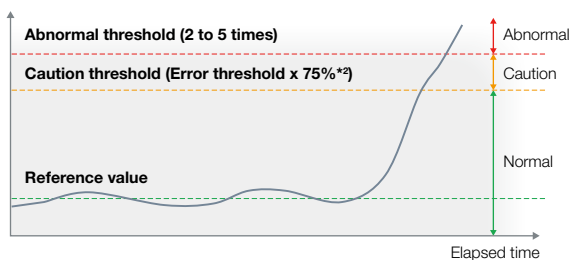
**MELSEC iQ-R Series**  
Package control program



### Fault detection by simple diagnosis (Relative value judgment)

Measure the vibration at the same location multiple times (10 times if possible) to obtain a value at the normal condition (reference value). Compare the measured value with a threshold which is specified as 2 to 5 times the reference value to determine if it is normal.

Vibration level



\*2 The multiplier (75%) can be changed to any value.

### Fault detection by simple diagnosis (Absolute value judgment)

exceeds the judgment reference value specified in ISO 10816-1, it is judged as abnormal.

#### Vibration severity

An endurance reference for the vibration of rotary machines which is specified by the ISO. The judgment standard differs depending on the size and type of equipment.

- Class I : Small machine (such as motor with power of 15 kW or less)
- Class II : Medium machine (such as motor with power between 15 to 75 kW or machine with power of 300 kW)
- Class III : Large machine (when mounted on stiff and heave foundation)
- Class IV\*1 : Large machine (when mounted on a soft foundation)

\* Conditions to apply the vibration severity  
Number of rotations: 600 to 12000 r/min  
Vibration measuring range: 10 to 1000 Hz

Vibration severity Velocity RMS value (effective value) (mm/s)	ISO 10816-1			
	Class I	Class II	Class III	Class IV*1
0.28	A	A	A	A
0.45	A	A	A	A
0.71	B	B	B	B
1.12	B	B	B	B
1.8	C	C	C	C
2.8	C	C	C	C
4.5	D	D	D	D
7.1	D	D	D	D
11.2	D	D	D	D
18	D	D	D	D
28	D	D	D	D
45	D	D	D	D

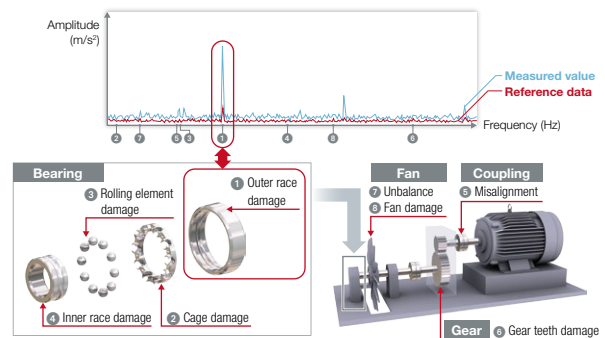
A: Good B: Pass C: Warning D: Danger

\*1 In iQ Monozukuri Rotary Machine Vibration Diagnosis, Class IV under ISO10816-1 is not supported because the class is determined according to the motor capacity.

Note: The measured value may exceed the judgment reference value due to the installation status of the equipment or the influence of noise.

### Presume the faulty area according to the accurate diagnosis

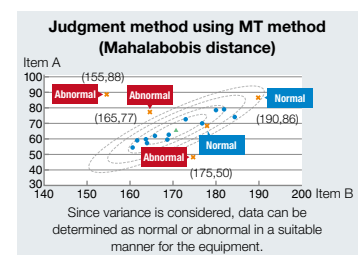
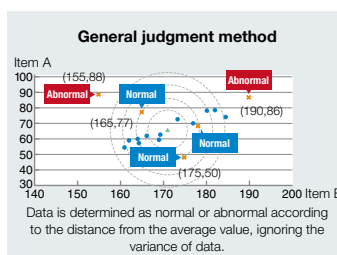
By monitoring the amplitude of the characteristic frequency calculated from the rotary speed and the specification values of components, the faulty area can be presumed and a fault can be found at an early stage. The threshold value should be set between 2 and 5 times of the reference value which is the value at the normal condition obtained by measuring the vibration from equipment multiple times (10 times if possible). This threshold value is compared with the measured value to perform pass / fail judgment.



### Easy to detect anomalies by using the MT method

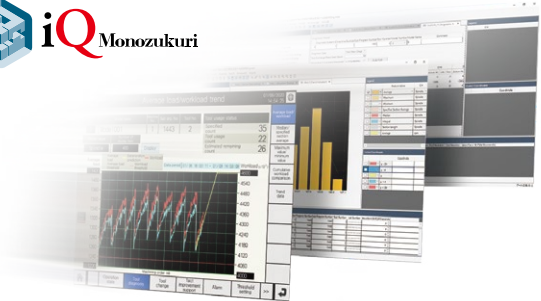
By applying the MT method (quality engineering method) to vibration analysis, anomalies can be easily detected even without knowledge about vibration analysis or specification value information of the components.

Moreover, compositive diagnosis is possible by combining vibration data with data other than vibration such as temperature and current. It is used as an equivalent to simple diagnosis.



## iQ Monozukuri Tool Wear Diagnosis for Machine Tools

iQ Monozukuri is part of the manufacturing reform that is occurring in the digital transformation (DX) era utilizing the information of things (IoT) data from gathered from machine tools. IoT data is collected and analyzed using Mitsubishi Electric proprietary technologies. This application package optimizes tool management in the metalworking process of machine tools and enables automatic detection of machining defects.



■ Items included in package

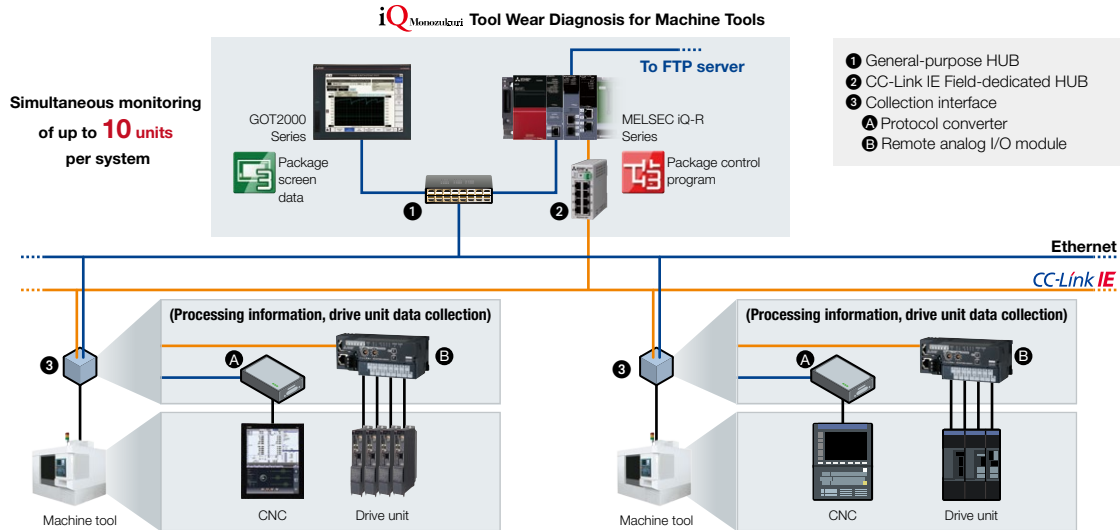
- MELSEC iQ-R Series GX Works3 control program



GOT2000 Series GT Works3 screen data

Instruction Manual (PDF)

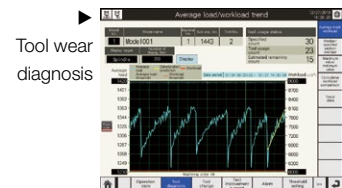
\* This product is equipped with software application and documentation. Hardware and engineering software are required separately. For details, please refer to each catalog [L(NA)16092].



### Determine the "sharpness" of tools and reduce tool costs through appropriate tool exchange



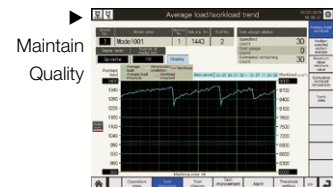
Predicts tool wear by identifying appropriate service life in accordance with spindle/feed shaft torque through IoT diagnostic technology for each processing condition. Tool exchange cost can be reduced by fully utilizing tools up until the end of service life.



### Automatically detect machining defects immediately after processing (before inspection) and perform machine maintenance according to changes in machining variation



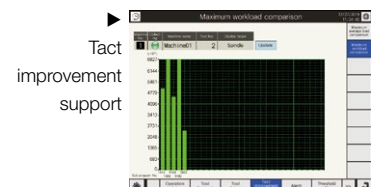
This product assists the calculation of abnormality determination thresholds based on past good product processing data and air-cut data. It detects machining defects such as tool breakage/damage, material defects, and upstream processing defects, and retains the number of defects to a maximum of one. In addition, by monitoring changes in deviation value of the feature quantity of the same machining data at predetermined workpiece interval (several hundred), it can identify signs of deterioration by individual axis.



### Utilize machining data to improve takt time



IoT data collected during machining is utilized to detect tool damage without requiring sensors. Maintenance time is reduced as there is no need to check damage detection sensors. User can easily compare maximum average load and maximum workload data per individual program or tool. By comparing the torques between machining programs using identical tools, it is possible to adjust optimum cut volume, spindle rotation speed, and feed rate, thus shortening the machining cycle time.



## Advanced Data Science Tool\*1 (Engineering environment that promotes digital transformation)

The Advanced Data Science Tool is a software that links to iQ Monozukuri Tool Wear Diagnosis for Machine Tools to utilize IoT data for the support of tool diagnosis, equipment maintenance, and statistical analysis.

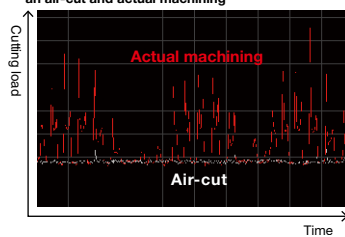
\*1 Advanced Data Science Tool is sold separately.

### Confirm changes in status when machining abnormalities occurs

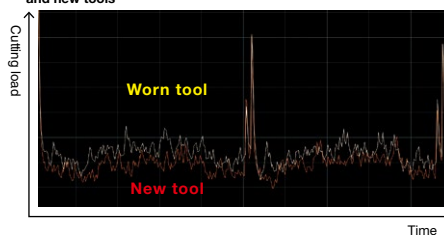
- By comparing the waveforms of air-cut data and actual machining data, it is possible to determine differences in cutting load. This information can then be used to diagnose tool abnormalities.
- Comparing the waveforms allows you to better understand the difference between worn and new tools, as well as normal and abnormal machining.
- It is possible to check any tool deterioration trends and confirm any differences between molding (lots).

By utilizing IoT data and comparing waveforms, it is possible to better understand various states during machining.

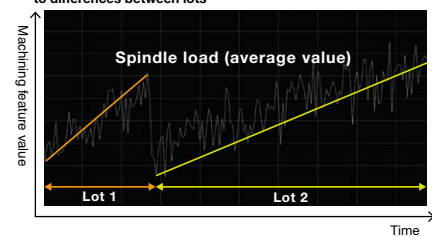
1 Understand the difference in waveforms between an air-cut and actual machining



2 Understand the difference in waveforms between worn and new tools



3 Comparison of deterioration trends due to differences between lots

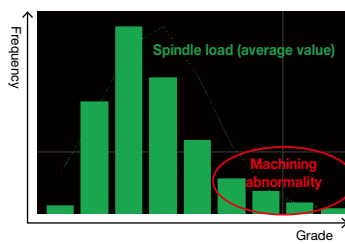


### Detect machining and equipment anomalies from big data

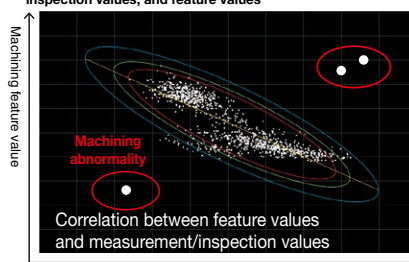
- By plotting the same machining feature value on a histogram, it is possible to check for any variations in tool wear and better grasp any trends in machining abnormality data.
- It is possible to check the correlation between feature values and machining quality (measurement/inspection values) by plotting them on a scatter diagram. This can help you to detect any machining abnormalities by easily identifying outliers.
- By comparing the feature value histograms of the same machining process between different equipment, it is possible to identify equipment differences and deterioration trends and easily detect equipment abnormalities.

Statistical analysis utilizing big data allows you to easily identify machining and equipment abnormalities

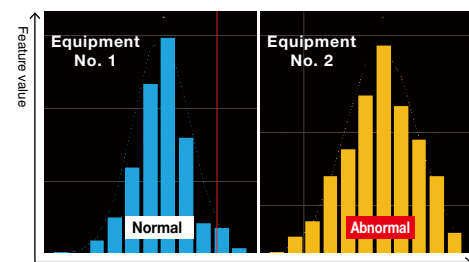
1 Check the variation in machining trends



2 Check the correlation between measurement values, inspection values, and feature values



3 Check the variation of feature values between devices



### Predict machining finish with greater accuracy from IoT data

- Machine learning is applied to the relationship between IoT data and machining quality (measurement/inspection values) and a predictive model is automatically calculated.
- Through cross-validation of learning and validation data that has been divided into blocks, it is possible to confirm the validity from the predictive model's regression analysis results. This improves overall calculation accuracy.
- It is possible to check the prediction accuracy by comparing the calculated predicted values of the model with the actual measurement values.

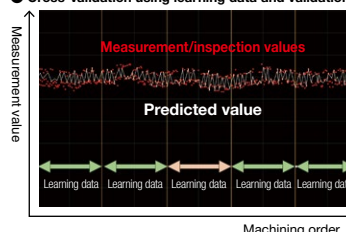


The combination of machine learning and IoT data can be used to create a highly accurate quality predictive model which minimizes machining abnormalities and defects.

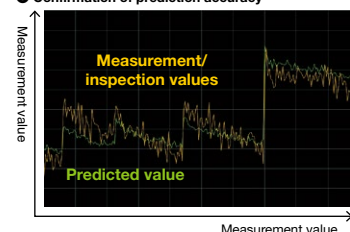
1 Automatic calculation of a predictive model

Regression Statistics						
Correlation Coefficient	R-squared	Adjusted R-square	F value	Degree Of Freedom	ESS	RSS
0.918279	0.841114	0.838827	133.058462	198.000000	1838.207427	341.922117
Multiple Regression Equation						
Objective Variable	Measured Value Z3	CH	Partial Regression Coefficient/Intercept	Standard Error		
Explanatory Variable	Average Value	CH1	1264.736552	100.937731		
Explanatory Variable	Integral Value	CH4	-0.133339	0.0051718		
Explanatory Variable	Integral Value	CH2	-0.150362	2.539822		
Explanatory Variable	Maximum Value	CH5	0.000004	0.000001		
Explanatory Variable	Average Value	CH6	-0.000362	0.043054		
Explanatory Variable	Integral Value	CH3	-0.000000	0.000002		
Explanatory Variable	Average Value	CH5	0.001117	0.134284		
Explanatory Variable	Integral Value	CH7	-0.000002	0.000003		
Explanatory Variable	Minimum Value	CH8	-0.000006	0.000003		

2 Cross-validation using learning data and validation data\*2



3 Confirmation of prediction accuracy



\*2 All data of processes mass-produced under identical processing conditions are divided into five data groups; four of which are used to automatically generate prediction models as learning data groups. Using these prediction models, finished quality is predicted from the remaining data group, and the deviation between the actual measurement and prediction is verified.

## MELSERVO-J5 Series

The MELSERVO-J5 Series servo system significantly improves the industry-leading level of basic equipment performance. Its high-speed, high-precision capabilities help to increase the productivity of our customers' equipment.

In addition to enabling maintenance-free operation, MELSERVO-J5 servo amplifiers significantly reduce equipment downtime through early detection and fault diagnosis. Leveraging know-how and drive technologies accumulated over many years, this solution achieves Predictive Maintenance and supports planned maintenance work.

MITSUBISHI ELECTRIC SERVO SYSTEM  
**MELSERVO-J5**

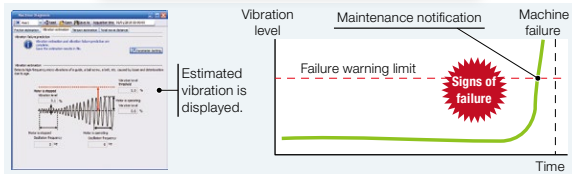
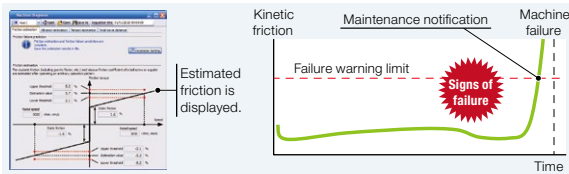


Mitsubishi Electric Maisart proprietary AI technology monitors machinery status and the servo amplifier detects signs of mechanical failure.

### Machine Diagnosis (Ball Screws/Linear Guides)

This function supports Predictive Maintenance by estimating frictions and vibrations of mechanical drive components such as ball screws and linear guides.

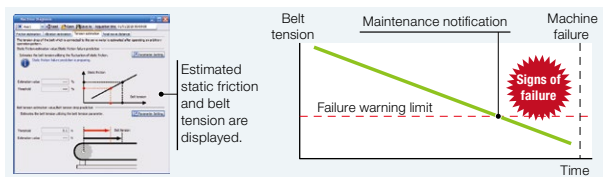
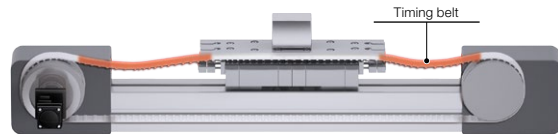
- Friction failure prediction with the friction estimation function
- Vibration failure prediction with the vibration estimation function



### Machine Diagnosis (Belts)

This function detects aging deterioration of belts in advance by the static friction failure prediction and the tension deterioration prediction with the belt tension estimation.

- Static friction failure prediction
- Belt tension deterioration prediction

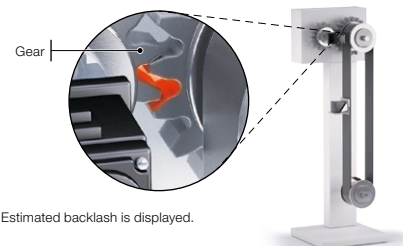
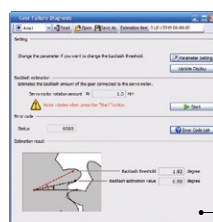


### Machine Diagnosis (Gears)\*

With this function, the servo amplifier generates commands automatically, and executes to-and-fro positioning operation to estimate the amount of gear backlash. Gear failure is predicted based on the set nominal values for backlash.

- Backlash estimation function
- Gear failure prediction

\* The machine diagnosis (gears) does not work during normal operation.



## MELFA Smart Plus

MELFA Smart Plus is an option that brings next-generation intelligence to MELFA FR series robots. Inserting a MELFA Smart Plus card into a robot controller enables a multitude of intelligent functions.



**MELFA Smart Plus**

**A** Intelligent function

**B** AI function

### MELFA Smart Plus Functions List

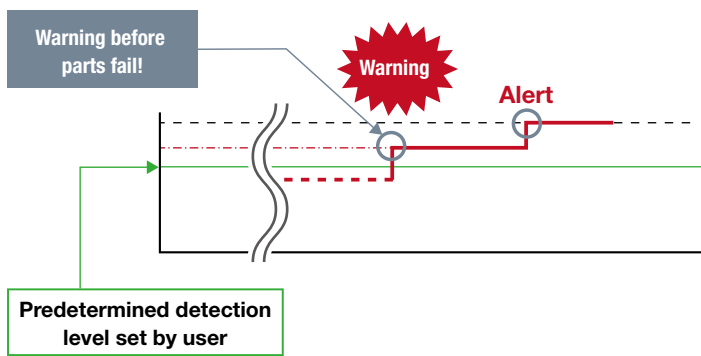
Predictive Maintenance function	Failing drive parts are detected before abnormalities in robot behavior become apparent. Downtime of production equipment is reduced.	<b>B</b>
Preventive Maintenance function	Tracking the robot's operating status helps managing the robot's condition. Maintenance is now even more efficient.	<b>A</b>
Enhancement function for force sense control	Parameters for the optimum operation pattern are found by training in a short amount of time. Set-up and tact times of a force sensor are reduced.	<b>B</b>
MELFA-3D Vision enhancement function	Reduced startup time of the MELFA-3D vision thanks to automatic parameter adjustments which utilize our proprietary AI technology "Maisart".	<b>B</b>
Calibration assistance function	Easy set-up of 2D vision sensors and improved job precision. Time-consuming teaching is automated improving also the accuracy.	<b>A</b>
Coordinated control of additional axis	Coordinated operation between the robot and an additional axis makes it possible for the robot to work on workpieces that exceed its operating range.	<b>A</b>
Robot mechanism thermal compensation function	Compensates for thermal expansion of the robot arm to increase position accuracy.	<b>A</b>

### [Predictive Maintenance function] Fault detection

This function detects faults and robot component deterioration early on using only the robot controller. By detecting part faults before signs of faults appear in the robot's behavior, downtime can be reduced. The threshold is set to suit each customer's environment. When the detection level is exceeded, a notification is sent to make the customer aware of part fault or deterioration.

It is possible to read scores (values) of a reduction gear and an encoder (data error and communication error)

It is possible to read log data of the past 365 days



Our proprietary AI technology extracts a characteristic waveform at high speed, based on accumulated machine data.

### [Preventive Maintenance function] Maintenance simulation

The preventive maintenance function estimates the recommended maintenance period and when to replace consumable parts. This is done by observing repeat patterns in sample programs used by the robot or executed in the simulator in RT Toolbox3.

**Maintenance simulation result**

Operation time of a day / Working days in a month

Number of years until part replacement for joint.

Number of years until part replacement (Joint with part that needs replacing earliest)

Back Save

Update graph

Part not used

Number of years until recommended overhaul period for joint

- Grease replenishment period (per axis) / Timing belt replacement period (per axis) / Recommended maintenance period for overhaulable parts (per axis)\*1

\*1 For overhaulable parts such as reduction gears, bearings, ball screws, the internals of ball splines, the part which needs to be overhauled the earliest will be displayed.

### [Preventive Maintenance function] Wear calculation function

A function that calculates the wear of components\*2 from the operational status (current, load, etc.) based on the robot's movements and posture. It also calculates the time left until inspection, maintenance and overhaul periods.

- Applicable parts: Consumable parts (grease, timing belts, etc.), overhaulable parts (reduction gears, bearings, ball screws, ball splines)

\*2 The wear ratio of each part is a reference value to assist the maintenance and inspection schedule calculated based on the robot's operational status. It does not guarantee that this is the actual remaining life of the part.

• Download sample GOT screen data from the Mitsubishi Electric FA Global Website.

**Wear calculation results display screen**

Grease

J1:	61.111%
J2:	72.222%
J3:	83.333%
J4:	94.444%
J5:	105.556%
J6:	116.667%

Timing belt

J1:	81.111%
J2:	0.000%
J3:	93.333%
J4:	94.444%
J5:	125.556%
J6:	116.667%

Gear

J1:	51.111%
J2:	62.222%
J3:	63.333%
J4:	64.444%
J5:	65.556%
J6:	66.667%

Bearing

J1:	51.111%
J2:	0.000%
J3:	53.333%
J4:	54.444%
J5:	55.556%
J6:	56.667%

Ball Screw / Ball Spline

J1:	0.000%
J2:	0.000%
J3:	0.000%
J4:	0.000%
J5:	0.000%
J6:	0.000%

## FREQROL-E800 Series

In addition to support for multi-networks such as industrial open network CC-Link IE TSN, these products are equipped with the world's first\*1 "corrosive gas detection circuit."<sup>\*\*2</sup>

In addition, by adopting the latest technologies such as industry-first\*1 AI technology, these products contribute to increasing operational intelligence in various areas such as factories and social infrastructure equipment. The lineup includes FR-E800 (standard specification product), FRE800-E (Ethernet specification product), and FR-E800-SCE (safety communication specification product), offering a flexible selection to best suit customers' specific applications.

\*1 According to in-house research as of September 10, 2019.

\*\*2 Supported by FR-E800-E/FR-E800-SCE Series.



Mitsubishi Electric Maisart proprietary AI technology reduces downtime by rapidly identifying alarms.



### Contributing to smarter factories and social infrastructure facilities through multi-network support

Mitsubishi Electric offers a lineup of inverter models to support major industrial Ethernet networks used in countries around the world. FR-E800 inverters support a variety of open networks without using any options, enabling the use of inverters on existing networks and assuring compatibility with various systems.

#### Supported protocols

Model	CC-Link IE TSN (100Mbps) <sup>*3</sup>	CC-Link IE Field Network Basic	MODBUS <sup>®</sup> /TCP	PROFINET	EtherNet/IP	BACnet/IP	EtherCAT
FR-E800-[]EPA	●	●	●	—	●	●	—
FR-E800-[]EPB	●	●	●	●	—	—	—
FR-E800-[]EPC	—	—	—	—	—	—	○

●: Supported ○: To be supported soon

\*3 1 Gbps is optional (to be supported).

### Contributing to reduced equipment downtime by equipping Predictive Maintenance and analysis functions

#### [ Environmental impact diagnosis function ]

The world's first\*4 "Corrosive-Attack-Level Alert System (CALAS™)"<sup>\*\*5</sup> makes it possible to identify signs of inverter damage caused by corrosive gases such as hydrogen sulfide.<sup>\*\*6</sup> This function notifies operators when factors such as the production environment needs to be improved, resulting in reduction in the equipment downtime (for coated models (-60) only).

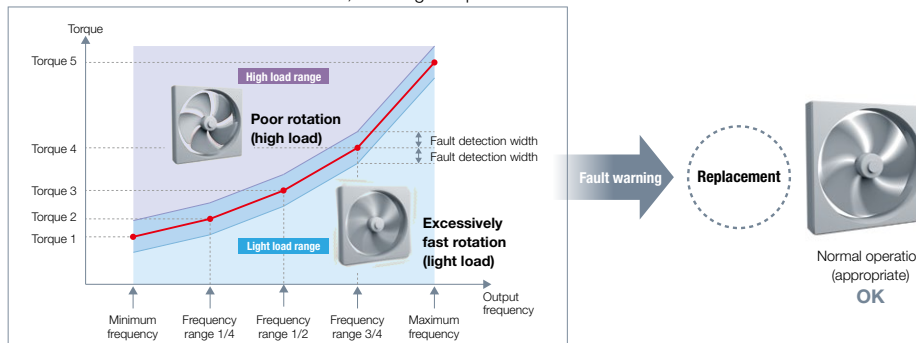
\*4 According to our investigation as of September 10, 2019.

\*5 The combined resistance of multiple metal corrosion sensors is measured to detect the degree of metal part corrosion caused by corrosive gas in the air (gradually adjust the progress of metal part corrosion caused by corrosive gas in the atmosphere by changing the material and thickness of the thin metal film used). [Patent pending]

\*6 Others will be supported in the future.

#### [ Load characteristics fault detection function ]

When a mechanical fault such as clogging of the filter occurs, the inverter outputs a warning or shuts off the output to prevent system damage. The speed-torque characteristic is stored while no fault occurs, enabling comparison between the measured data and the stored data.



### FR Configurator2 (Inverter setup software)

Software for easy configuration on a personal computer, covering everything from inverter start-up to maintenance. In addition to AI alarm diagnosis, it is possible to display graphs of inverter data, read/write limiter setting value, and more.

A trial version (available for a limited time only) can be downloaded from the Mitsubishi Electric FA site. Users can experience the same features as the full version for 20 days after installation.

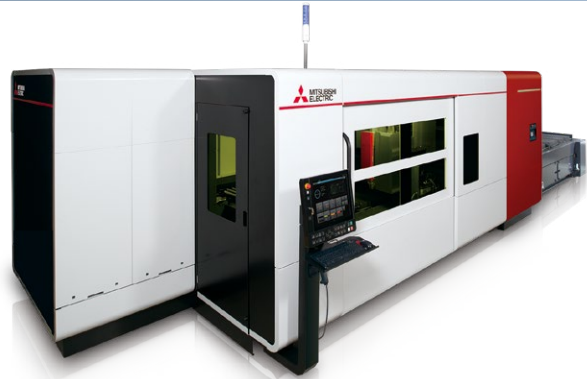


## 2-Dimensional Fiber Laser Processing Systems GX-F Series



Mitsubishi Electric Maisart proprietary AI technology determines the processing state based on sound and light detected during processing. For the first time in the world\*, a function that automatically adjusts laser-processing conditions using AI is equipped on a laser-processing machine in pursuit of a "non-stop processing machine."

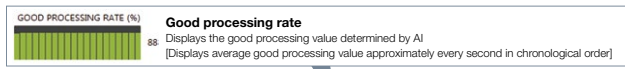
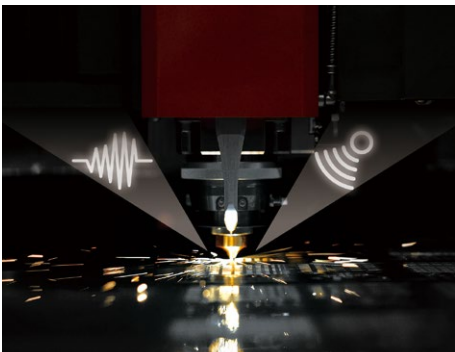
\* According to in-house research as of April 2019.



## AI Assist

### AI Assist Function: Visualizing processing state through AI diagnostics

AI Assist diagnoses intermediate processing conditions in real time. The processing state is determined by setting good processing values displayed on the control device, and when processing falls below the predetermined value, a nozzle check is performed automatically. In addition, AI diagnostics enables operators to always be aware of the machining status.

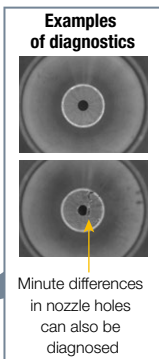
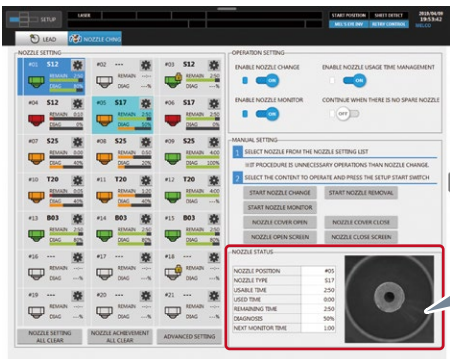


Quality of data measured during processing determined with AI



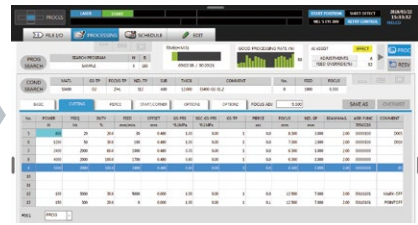
### AI Nozzle Monitor Function: AI-based nozzle check and automatic replacement

If AI Assist detects a processing defect, the AI nozzle monitor automatically checks the nozzle status. An image of the nozzle projected on the nozzle monitor is collated with the data learned by AI to diagnose the degree of nozzle wear. The diagnostic result determines whether the nozzle status is "pass" or "fail," and a worn nozzle is automatically replaced.



**Nozzle OK**  
Automatically adjusts processing conditions

**Nozzle NG**  
Automatically changes nozzle using nozzle changer



## [CNC] Remote Service iQ Care Remote4U (for Machine Tool Builder/ End Users)

This service enables real-time access to operation information of machines equipped with Mitsubishi Electric CNCs. It helps to reduce downtime by improving maintainability through remote diagnosis of user's machines equipped with our CNCs.

\* Please contact your Mitsubishi Electric overseas office regarding which regions offer this service



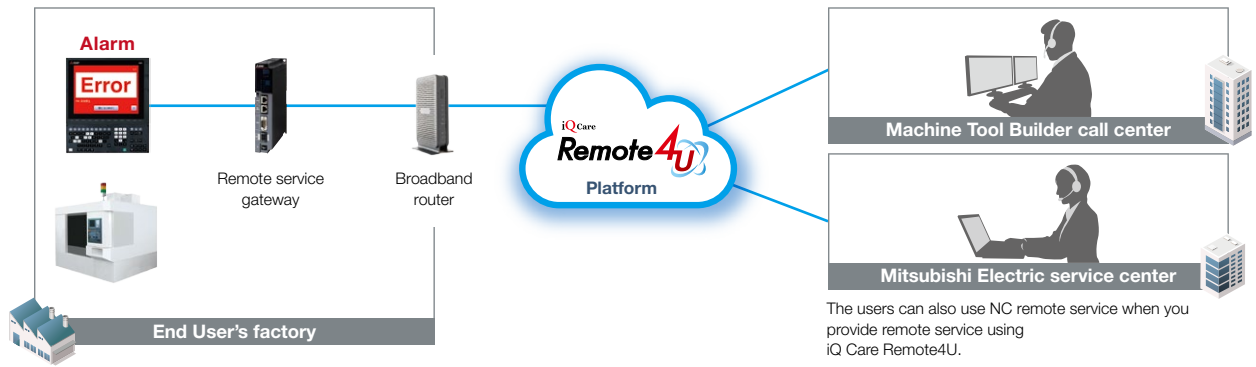
### [CNC] Remote Service (for Machine Tool Builder)

You can provide remote service of your machine tools equipped with Mitsubishi Electric CNCs simply by purchasing platform license.

You can save on the implementation and maintenance costs of remote service by using the cloud server provided by Mitsubishi Electric. You can also streamline your service work by implementing remote service.

#### iQ Care Remote4U platform

You can easily implement your machine remote service using iQ Care Remote4U platform



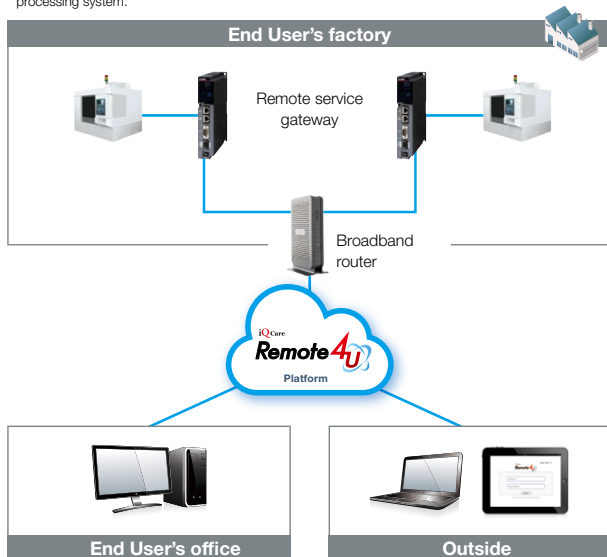
### [CNC] Remote Service (for End Users)

#### Dashboard function\*

Dashboard function helps you improve production process and reduce running costs

You can view real-time operation data of your machines equipped with Mitsubishi Electric CNCs.

\* The specifications are different from the dashboard function for Mitsubishi Electric EDM and laser processing system.

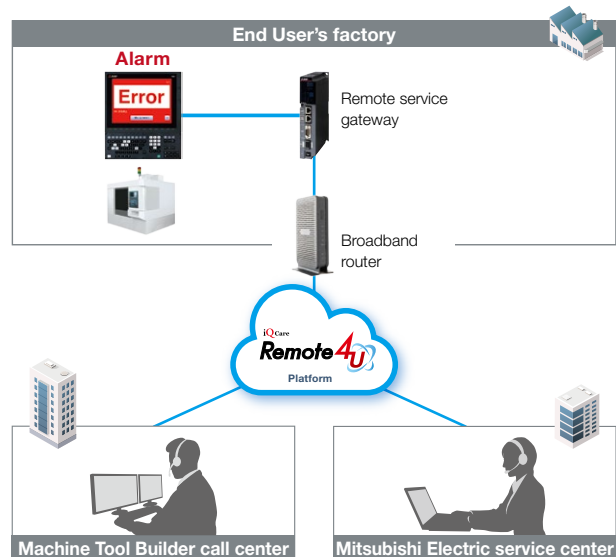


You can access the data via a web browser on your PCs, smartphones, and tablet PCs without installing dedicated software. (ID and password must be entered.)

#### Remote diagnostics

Remote diagnostics improves maintainability

Mitsubishi Electric service center remotely supports the maintenance of Mitsubishi Electric CNCs on your machines.



With a contract with an MTB that has the iQ Care Remote4U platform license, remote diagnosis of machines is also available.



# e-Factory Alliance

## PARTNERS

Partners



Broad knowledge and skill  
as a comprehensive  
FA manufacturer



Know-how of all fields  
relating to monozukuri

Co-creation

Customer



Giving customers  
back the values born  
from co-creation



# e-F@ctory Ecosystem – Co-creation with over 1000 Partners\*

As a solutions provider, we collaborate with many partners across all monozukuri fields. This ecosystem provides optimal solutions in various regions and fields in response to the issues experienced by our customers.

\*As of September 2021



Collaborating with the partners across the world



**Producing entire production systems**  
**Achieving advanced systems integration**



IT



Production shop floor



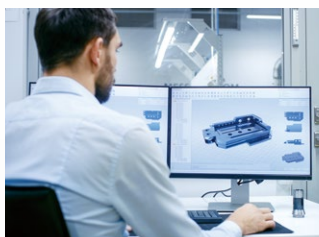
Robots



**Development of application software strengthening connection affinity with Mitsubishi Electric FA devices**



ERP/MES/SCADA



CAD/CAM/3D simulator



Data analysis



**Provide device compatibility with Mitsubishi Electric FA equipment**  
**Achieve improved system builds and maintainability**



Sensors



RFID



Related network devices

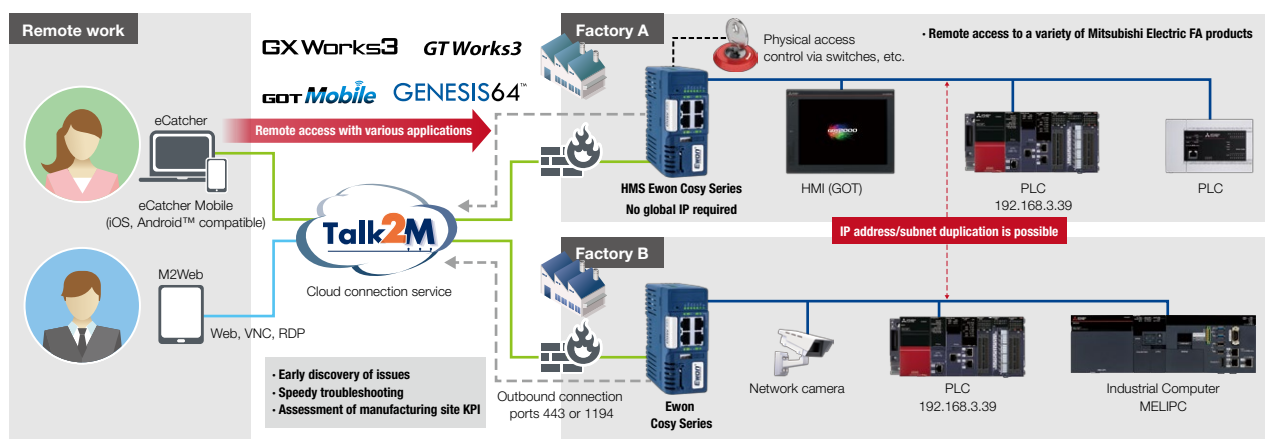
## HMS Ewon Cosy Series

With the Cosy Series (remote access gateway) and Talk2M (cloud connection service), users can access Mitsubishi Electric FA devices from anywhere in the world and safely perform troubleshooting of equipment and devices, thus reducing support cost and downtime.

A secure connection is achieved through measures such as exclusive outbound connection, two-layer authentication, connection audit tracing, and access control using physical external key switches. Additionally, HMS Ewon Cosy Series has obtained ISO27001 and ISECOM STAR security certification. In addition to SiteManager's main unit being designed with a robust aluminum housing, SiteManager Embedded (embedded software) can be used to make industrial computers such as MELIPC, etc. function as a gateway. Access is possible not only from a computer using eCatcher (client software), but also remotely from an iOS or Android™ device installed with eCatcher Mobile on a browser of MELSEC or GOT. Moreover, assuming installation on a control panel, Ewon Cosy has been designed with specifications suited to industrial use, such as 24 VDC input, industrial EMC support, wide operating temperature range, and DIN rail mounting.



### Conceptual image of remote access



### Reasons why the Ewon Cosy Series is the manufacturers' choice

<p>Ranked most reliable service in the North American market for six consecutive years</p>	<p>Easy setup that only an FA manufacturer can provide</p>	<p>Overwhelming number of VPN servers for connection anywhere in the world</p>	<p>Highly secure performance with VPN connection</p>	<p>Highly experienced, enriched manufacturer support</p>	<p>Robust product specifications suited to industrial environments</p>
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### Product data

Remote access gateway Cosy				
Internet connection	Wired LAN	Wi-Fi	3G*1	4G/LTE*1
Product model	EC61330	EC6133C	EC6133D	EC6133F
Common specifications	RJ45 x 4 (10/100Mbps), USB x 1, DI x 2/DO x 1, Rating: 12-24 VDC, Operating temperature range: -25 to 70°C, DIN rail mounting			

\*1 Antennas for 3G/4G models sold separately.

Free cloud service*2 <b>Talk2M Free +</b>	
Number of registered devices	Unlimited
Number of registered users	Unlimited
Number of concurrent views	5
Number of concurrent connections	1
Monthly data volume	3GB

\*2 Talk2M Pro is also available for a fee.



### Flexy Series - Industrial IoT gateway for host models also included in the lineup

In addition to the Cosy remote access, this solution also facilitates smooth IIoT transition by collecting data from a remote manufacturing site and connecting individual cloud services with OPC UA, MQTT, etc.

## Secomea SiteManager Series

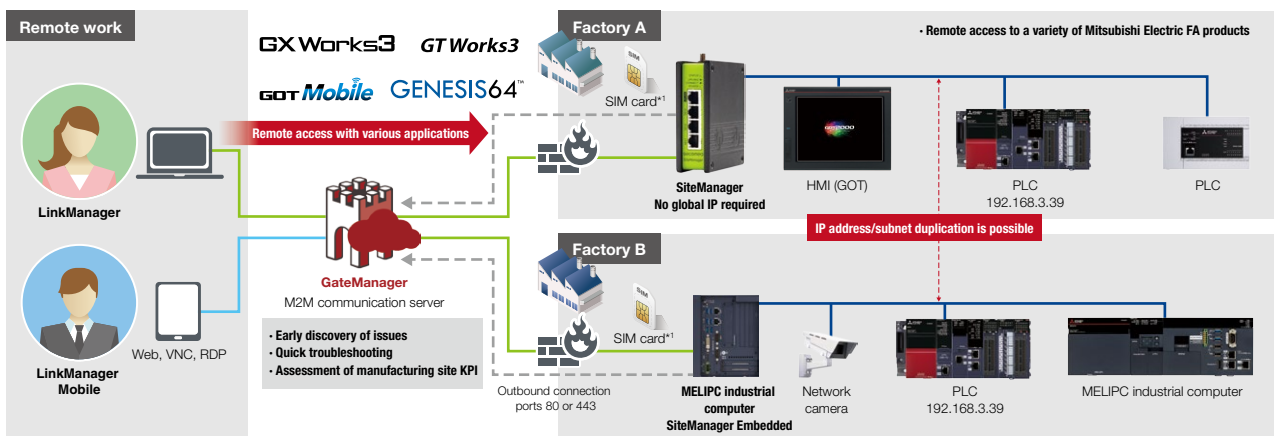
With SiteManager (remote access gateway), GateManager (relay M2M communication server), and LinkManager (client software), it is possible to access Mitsubishi Electric FA devices to monitor and perform maintenance on machinery and equipment at a manufacturing site, thus reducing business trip/transportation costs, and enabling quicker response.

A secure connection is achieved through measures such as exclusive outbound connection, encryption using SSL/TSL, multi-factor authentication using certificates, SMS, etc., access authority using an individual device, audit log, etc. The Secomea solution has obtained security certification from ProtectEM GmbH (a German third-party organization) and conforms to Industry 4.0. In addition to SiteManager's main unit being designed with a robust aluminum housing, SiteManager Embedded (embedded software) can be used to make industrial computers such as MELIPC, etc. function as a gateway.

**secomea**  
SiteManager



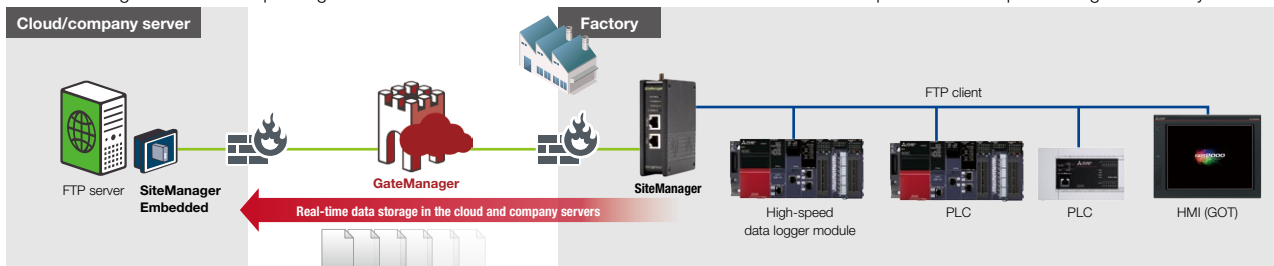
### Conceptual image of remote access



\*1 SIM card can be inserted by adding a separate communication module.

### Constant connection option "LogTunnel" use case

Two SiteManager units are set up facing each other to establish a secure constant connection with intuitive operations and a periodic log collection by FTP.



Not only FTP, but all protocols including HTTP, OPC UA, and MQTT can be used, and traceability systems as well as SCADA system construction are supported.

Secomea SiteManager also offers constant connection at the same time as maintenance of FA devices through remote access using LinkManager.

### Lineup

With various versions available to suit the user's environment and purpose of use, SiteManager Embedded software can be installed and used on industrial devices.



SiteManager Model number	Internet connection method		
	LAN	3G/4G	Wi-Fi
Number of device connections	5	1129	1149
	10	1529	1549
	25	3329	3349
	100	3529	3549



Unlike the SiteManager hardware product, SiteManager Embedded is a software gateway that can be installed in a MELIPC, etc. to function as a secure access gateway. It operates as a seamless service in the background on various OS. SiteManager Embedded is very light, and therefore uses minimal system resources.

# MEMO

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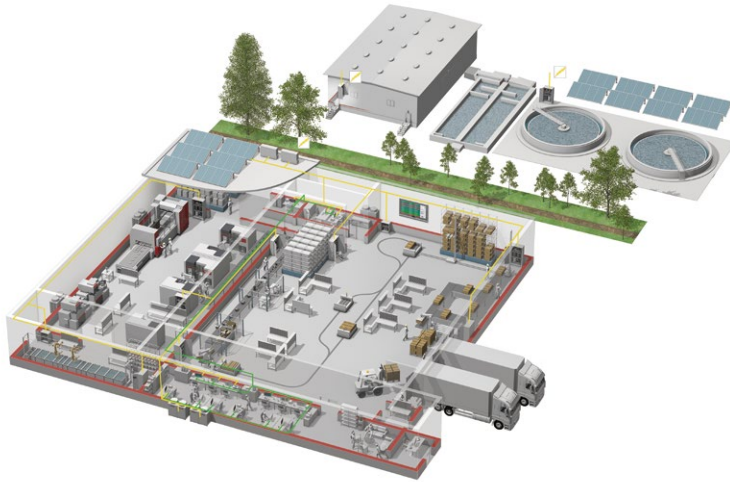
#### **Precautions before use**

This publication explains the typical features and functions of the products herein and does not provide restrictions or other information related to usage and module combinations. Before using the products, always read the product user manuals. Mitsubishi Electric will not be held liable for damage caused by factors found not to be the cause of Mitsubishi Electric; opportunity loss or lost profits caused by faults in Mitsubishi Electric products; damage, secondary damage, or accident compensation, whether foreseeable or not, caused by special factors; damage to products other than Mitsubishi Electric products; or any other duties.

#### **For safe use**

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- Before using the products for special purposes such as nuclear power, electric power, aerospace, medicine or passenger-carrying vehicles, consult with Mitsubishi Electric.
- The products have been manufactured under strict quality control. However, when installing the products where major accidents or losses could occur if the products fail, install appropriate backup or fail-safe functions in the system.

# YOUR SOLUTION PARTNER



Mitsubishi Electric offers a wide range of automation equipment from PLCs and HMIs to CNC and EDM machines.

## A NAME TO TRUST

Since its beginnings in 1870, some 45 companies use the Mitsubishi name, covering a spectrum of finance, commerce and industry.

The Mitsubishi brand name is recognized around the world as a symbol of premium quality.

Mitsubishi Electric Corporation, established in 1921, is active in space development, transportation, semi-conductors, energy systems, communications and information processing, audio visual equipment and home electronics, building and energy management and automation systems, and has 183 factories, laboratories and offices worldwide in over 140 countries.

This is why you can rely on Mitsubishi Electric automation solution - because we know first hand about the need for reliable, efficient, easy-to-use automation and control in our own factories.

As one of the world's leading companies with a global turnover of over 4 trillion Yen (over \$40 billion), employing over 146,000 people, Mitsubishi Electric has the resource and the commitment to deliver the ultimate in service and support as well as the best products.



Low-voltage Power Distribution Products



Transformers, Med-voltage Distribution Products



Power Monitoring and Energy Saving Products



Power (UPS) and Environmental Products



Compact and Modular Controllers



Servos, Motors and Inverters



Visualization: HMIs



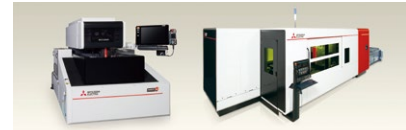
Edge Computing Products



Numerical Control (NC)



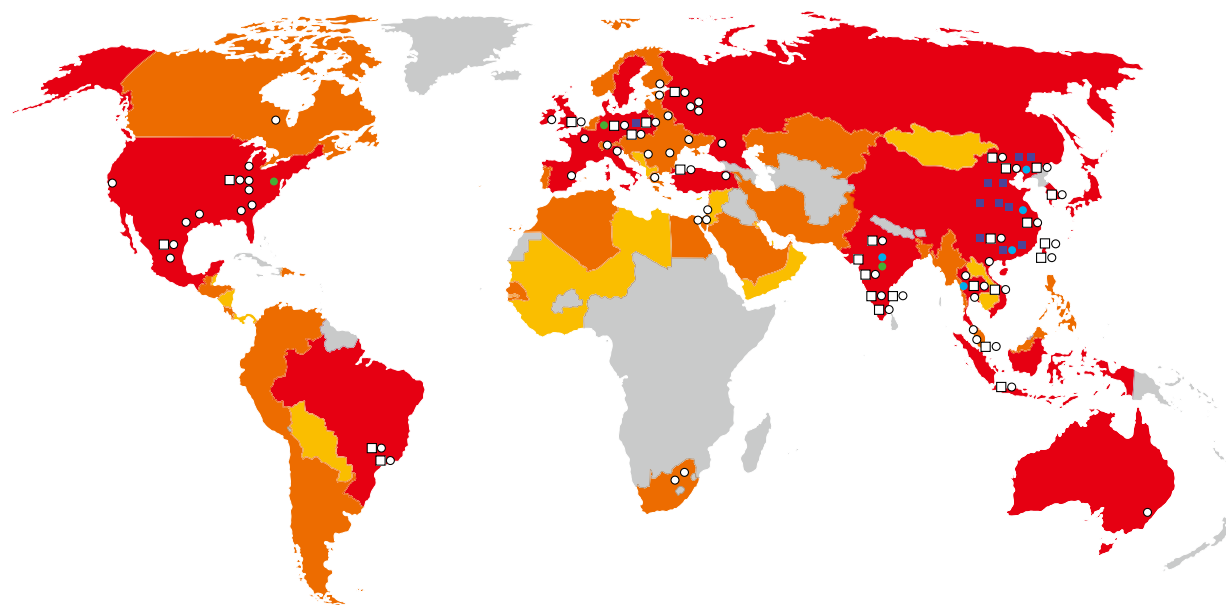
Collaborative and Industrial Robots



Processing machines: EDM, Lasers

\* Not all products are available in all countries.

# Global Partner. Local Friend.



- Sales office
- FA center
- FA center satellite
- Production center
- R&D center

Note: This is a map of our global sales and support coverage. It does not reflect any national borders.

- A region where there are direct Mitsubishi Electric FA offices (main/local and satellite).
- A region covered by primary sales partners (distributors) who have local sales offices.
- A region covered by our extended sales network which may or may not have local offices.

Country/Region	Sales office	Tel/ Fax			
USA	MITSUBISHI ELECTRIC AUTOMATION, INC. 500 Corporate Woods Parkway, Vernon Hills, IL 60061, U.S.A.	Tel : +1-847-478-2100 Fax : +1-847-478-2253	Singapore	MITSUBISHI ELECTRIC ASIA PTE. LTD. 307, Alexandra Road, Mitsubishi Electric Building, Singapore 159943	Tel : +65-6473-2308 Fax : +65-6476-7439
Mexico	MITSUBISHI ELECTRIC AUTOMATION, INC. Mexico Branch Mariano Escobedo #69, Col. Zona Industrial, Tlalnepanitla Edo. C.P.54030, Mexico	Tel : +52-55-3067-7511	Thailand	MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO., LTD. 12th Floor, SV.City Building, Office Tower 1, No. 896/19 and 20 Rama 3 Road, Kwaeng Bangpongpan, Khet Yannawa, Bangkok 10120, Thailand	Tel : +66-2682-6522 Fax : +66-2682-6020
Brazil	MITSUBISHI ELECTRIC DO BRASIL COMÉRCIO E SERVIÇOS LTDA. Avenida Adelino Cardana, 293, 21 andar, Bethaville, Barueri SP, Brazil	Tel : +55-11-4689-3000 Fax : +55-11-4689-3016	Vietnam	MITSUBISHI ELECTRIC VIETNAM COMPANY LIMITED Hanoi Branch 6-Floor, Detech Tower, 8 Ton That Thuyet Street, My Dinh 2 Ward, Nam Tu Liem District, Hanoi, Vietnam	Tel : +84-4-3937-8075 Fax : +84-4-3937-8076
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Korea	MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD. 7F-9F, Gangseo Hangang Xi-tower A, 401, Yangcheon-ro, Gangseo-Gu, Seoul 157-801, Korea	Tel : +82-2-3660-9629/ 9606/9607 Fax : +82-2-3664-0475			

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