MITSUBISHI ELECTRIC
Changes for the Better

Automating the World

FACTORY AUTOMATION

TOTAL MAINTENANCE SOLUTIONS

Automating the World

Our Factory Automation business is focused on "Automating the World" to make it a better, more sustainable environment supporting manufacturing and society, celebrating diversity and contributing towards an active and fulfilling role.

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.

SUSTAINABLE DEVELOPMENT GOALS

The Mitsubishi Electric Group is actively solving social issues, such as decarbonization and labor shortages, by providing production sites with energy-saving equipment and solutions that utilize automation systems, thereby helping towards a sustainable society.

FA-IT Integrated Solution

e-F@ctory

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.
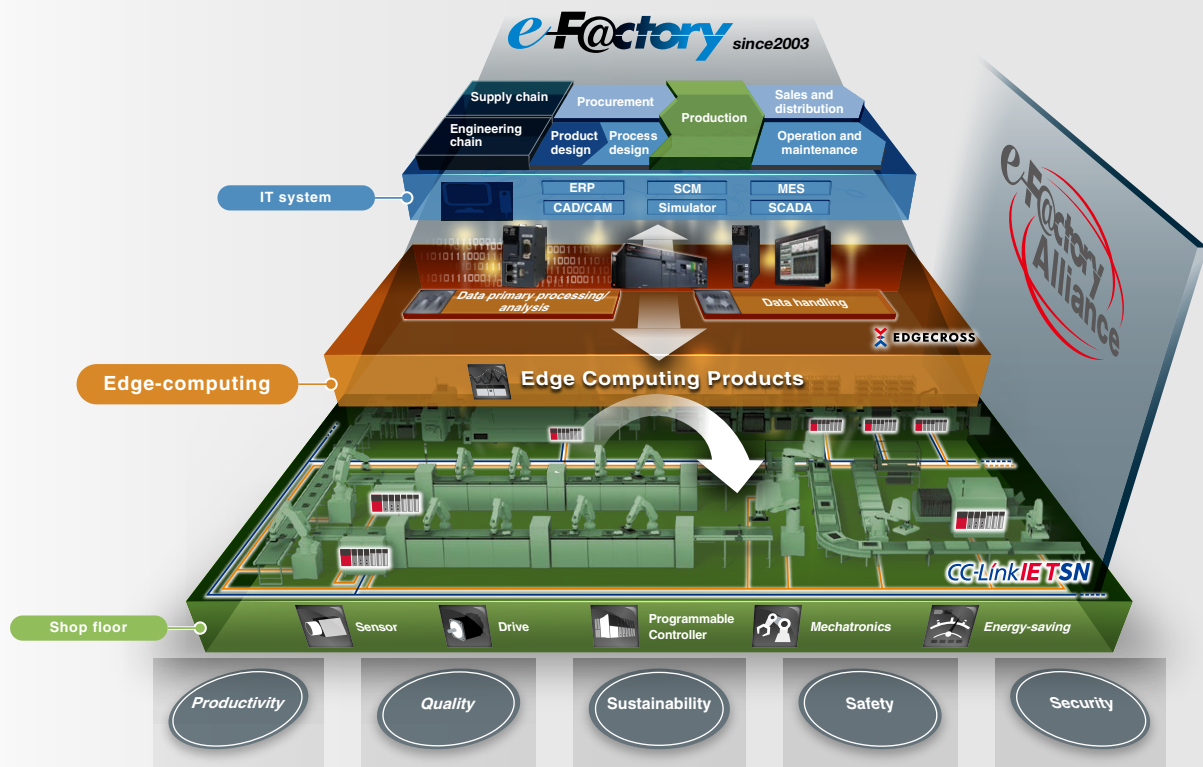
INDEX

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

- Preventing equipment outages caused by sudden failure of parts with a set service life
- Reducing costs by using parts and tools to their respective limits
- Minimizing the impact on production of a problem by quickly and efficiently investigating the cause of the problem

After Introducing Total Maintenance Solutions

Maintenance work optimization with data management

- Non-stop operation in factories
- Planned operations
- Less downtime

What is Total Maintenance Solutions?

Total Maintenance Solutions comprise of "**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 times and frequencies, as well as "**Corrective Maintenance**", which shortens the time spent on cause investigation and ensures the early recovery of equipment by utilizing historical data. These are solutions that support our customers' maintenance activities in all phases and scales, whether it be lines, devices, or equipment.
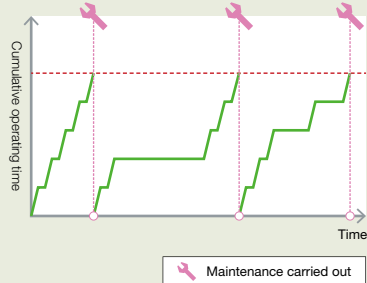
Predictive Maintenance

Threshold

Characteristic (current, vibration, etc.)

Time

🔧 Maintenance carried out
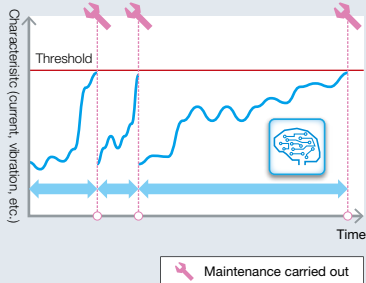
Prevents problems by detecting signs of abnormality by analyzing operation data

Maisart

Preventive Maintenance

Cumulative operating time

Time

🔧 Maintenance carried out

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

A
B
C

Corrective Maintenance

Production volume

Recovery

Downtime

Time

Downtime reduced

Production volume

Recovery

Downtime

Time

📹 Acquisition of log data, video, etc.
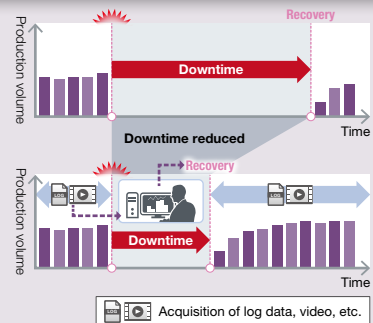
Historical data utilized for detailed cause investigation and rapid recovery

Collects log data

Reproduces log data

Maisart, Mitsubishi Electric's AI technology, helps our customers achieve non-stop manufacturing.

Mitsubishi Electric's "compact AI" technology reduces operation loads and can be implemented on site.

Mitsubishi Electric's FA knowledge supports customers in applying AI technologies to their systems.
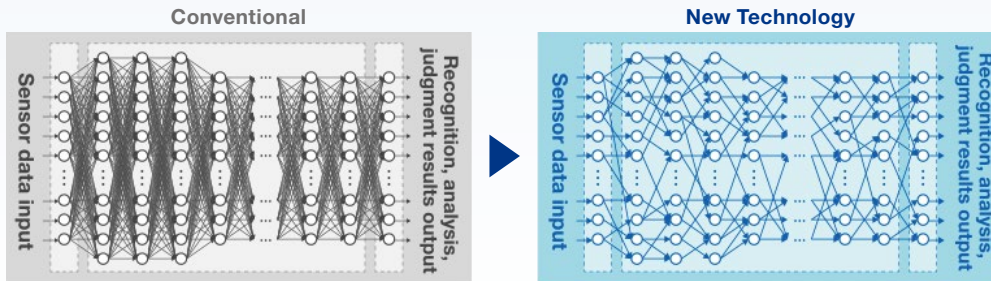
Mitsubishi Electric's edge-computing products simplify data collection and support the construction of AI systems.
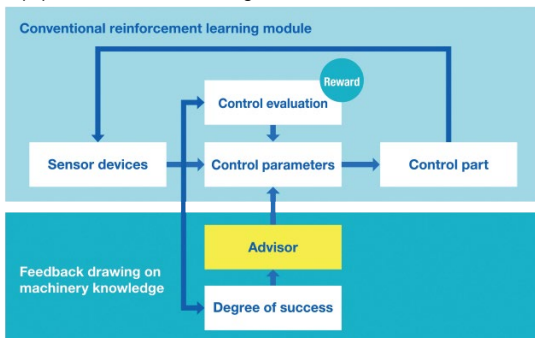
Features

Deep Learning

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

Conventional

Sensor data input → Recognition, analysis, judgment results output

New Technology

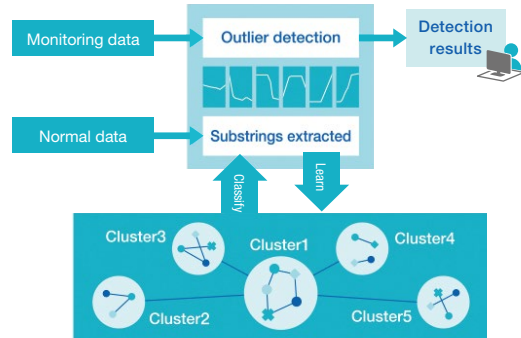Sensor data input → Recognition, analysis, judgment results output

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.

Conventional reinforcement learning module

Reward

Control evaluation

Sensor devices → Control parameters → Control part

Feedback drawing on machinery knowledge

Advisor

Degree of success

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.

Monitoring data → Outlier detection → Detection results

Normal data → Substrings extracted

Classify / Learn

Cluster3, Cluster1, Cluster4, Cluster2, Cluster5

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 shop floors and IT systems, offers solutions that meet customers' on-site challenges.

▼ Click the case you would like to see.

Case 1

Device level

| Predictive Maintenance | Preventive Maintenance | Corrective Maintenance |

Preventing defect outflow by understanding the tendency of molding defects

The tendency of defects to appear in resin molding isn't well understood,
leading to loss costs as the occurrence of continuous defects goes unnoticed.

Examples of molding defects

Bubbles Dents Flaws
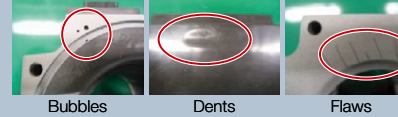
Solution

Analyze and diagnose feature quantities to prevent plastic molding machine defects from continuously occurring

Using the data collected with MELIPC industrial-use PC in the MELSOFT MaiLab (data analysis software), feature quantities from parameter waveform data that may affect molding quality are selected, the association with defects is analyzed, and diagnostic rules are created. By collecting molding machine data in real time with MELIPC and diagnosing it based on rules using MELSOFT MaiLab, signs of molding defects are identified and maintenance can be performed before multiple defects occur.

Offline analysis phase

Extract statistics (feature quantities) from waveform data

Max. value
Mean value
Min. value

Statistics

Processing times

Correlation between extracted statistics and defects is analyzed

Parameter A
Parameter B

Defecs created

Determine diagnosis rule

Mahalanobis distance

Abnormality is detected

Threshold

Number of times of molding

Analytical diagnostics using MELSOFT MaiLab

iQ Edgecross

MELSOFT MaiLab

Real-time diagnosis phase

Real-time collection of injection molder data

EDGECROSS

CSV

Direct link

MELIPC industrial-use PC or

OK?
NG?

PC

Alarm

Notify operator when a value exceeds the determined threshold set by diagnosis rule

Maintenance to prevent defects

The costs of losses due to waste is reduced by detecting signs of molding defects.

Product and Solution Introduction

Case 2

Equipment level

| **Predictive Maintenance** | Preventive Maintenance | Corrective Maintenance |

Detecting machining defects and preventing the outflow of defective products

The bonding in the metal fin caulking process is weak,
leading to fins becoming detached due to defective bonding occurs in later processes.

Solution

Utilize AI to prevent bonding defects in the caulking process

Use the similar waveform recognition function of MELSOFT MaiLab to create diagnostic rules by learning the waveform data of press loads during normal operation and correlating it with bonding defects.
Press load data is collected in real time by the MELIPC industrial-use PC and then diagnosed based on rules using MELSOFT MaiLab, allowing for bonding defects to be detected, which are then fed back to the equipment (causing equipment to stop).

Offline analysis phase

Collects press load data during normal operation

CSV

Fin

Workpiece

Pressurized bonding

A   B   C

Maisart

Learns normal waveforms

❶ **Creates diagnostic rules**

iQ Edgecross

MELSOFT MaiLab

Real-time diagnosis phase

Collects press load data in real time

EDGECROSS

CSV

Direct link

MELIPC industrial-use PC or

OK?
NG?

PC

Similar to normal pattern

✔ **OK**

Not similar to normal pattern

⚠ **NG**

NG

Defect is noticed

Equipment stops

❷ **Feedback to equipment**

Displays defect detection on screen or by Patlite (i.e., Japanese signal display system)

Defect outflows to later processes are prevented through real-time detection of bonding defects.

Product and Solution Introduction

▶ **Data Science Tool MELSOFT MaiLab**   P.42

▶ **Industrial Computer MELIPC Series**   P.44

Case 3

Equipment level

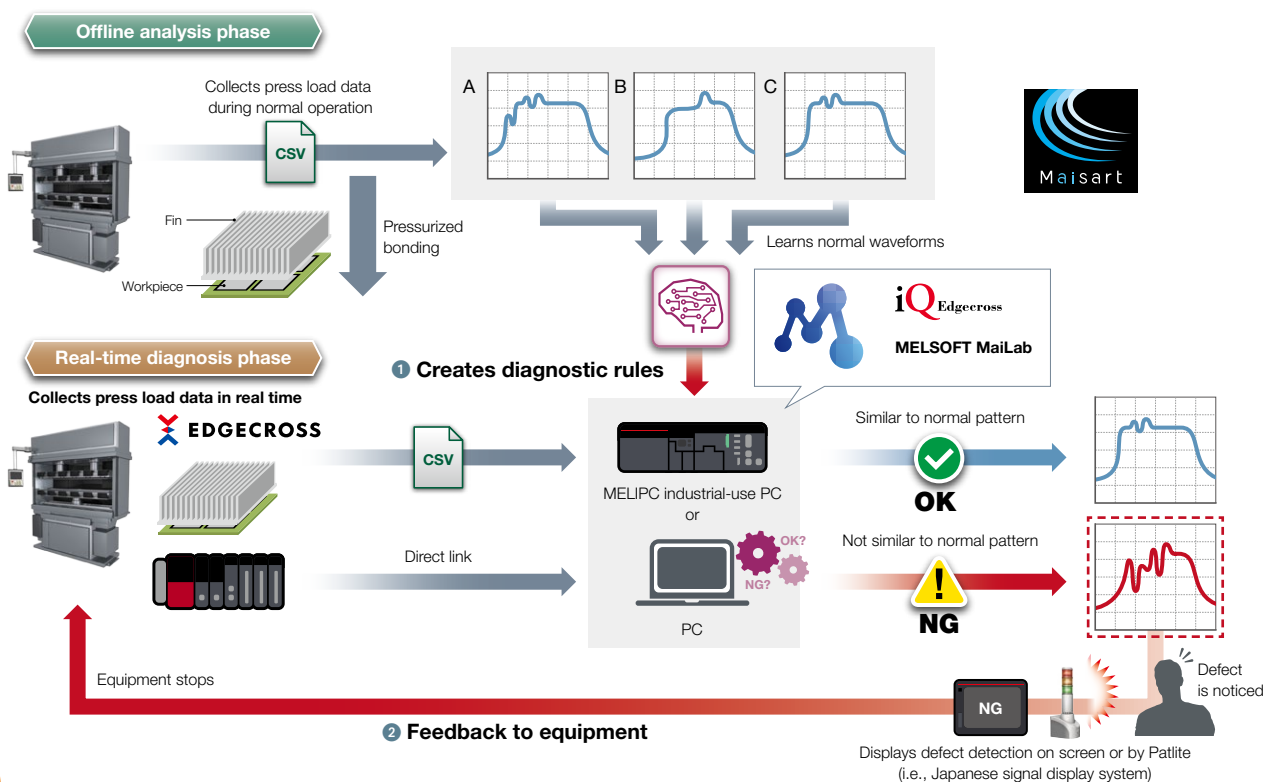| Predictive Maintenance | Preventive Maintenance | Corrective Maintenance |

Improving quality while reducing costs

Sampling inspection cannot completely prevent defect outflow and clarify when the defects occurred. Tools are replaced in a short period of time because the tool ware state is not visible.

Solution

Utilize AI to predict the machining quality through machining diagnosis, detect signs of machining errors, and diagnose tool wear.

With iQ Monozukuri Tool Wear Diagnosis for Machine Tools, create a predictive model from the relation between the machining IoT data and the machining dimension to predict the workpiece quality during machining.
Create a machining error diagnosis model from the machining IoT data to immediately detect signs of abnormality.
Replace tools at the optimal timing by capturing the deterioration trend of the cutting tools and predicting when the tool life is reached.

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1 Predicting workpiece quality during machining with AI

Learns the relation between the workpiece quality and the machining
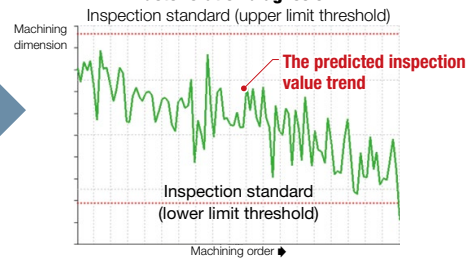
Create a machining predictive model

Machine learning

Advanced Data Science Tool

Maisart
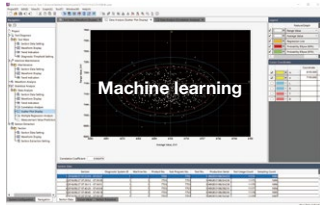
Sets a predictive model

Inspection value trend predicted at each machining

Measured and predicted value trend monitoring, deterioration diagnosis

Machining dimension

Inspection standard (upper limit threshold)

The predicted inspection value trend

Inspection standard (lower limit threshold)

Machining order ▶

Confirm the workpiece machining quality without sampling inspections.

---

2 Detecting signs of abnormality from unusual data

Create a machining error diagnosis model

Maisart

Machine learning

Advanced Data Science Tool

Sets a diagnosis model

Machining error diagnosis

Detects a rapid wear progression

Machining feature amount
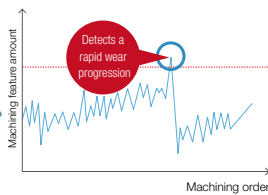
Machining order

Detect signs of abnormality through real-time monitoring.

3 Reducing tool costs by replacing tools at the optimal timing

Usages	
Predetermined times	50
Usage count	45
Predicted remaining count	40

Predicts the number of times a tool can be used until the threshold that is set based on past machining data is reached.

Maisart

Machining feature amount

Deterioration prediction line

Conventional | After introduction

50 times | 85 times

Machining order ▶ | Machining times (number of tool usages)

Machining times

Indicates that it is time to replace the tool after 40 more machining operations

Tool deterioration

The cutting load rises

Optimize tool replacement by predicting the remaining number of usages.

Prevent defect outflow with quality prediction that can detect quality abnormality immediately when it arises.
Prevent defects by detecting signs of abnormality with the machining error diagnosis.
Improve the operating rate, lower tool costs, and reduce the labor hours needed to replace tools thanks to less tool replacement frequency.

Product and Solution Introduction

▶ **iQ Monozukuri Tool Wear Diagnosis for Machine Tools**   P.36

Case 4
Equipment level

Predictive Maintenance	Preventive Maintenance	Corrective Maintenance

Monitoring changes in machine tool condition

Although the same machining task is executed with the same model,
quality abnormality occasionally occurs only on unit 2.

Solution

Confirm the machine tool condition changes through the machining load changes, which helps users perform predictive maintenance.

The Advanced Data Science Tool* monitors the variations (standard deviation) in the machining load (feature value) for the same-type machine tools executing the same machining task. The monitoring is executed at regular intervals so that users can confirm any changes in the machine condition that could become a factor of defective workpiece. This allows users to ascertain when to conduct overhaul and maintenance, as well as check the effect of maintenance conducted.

* 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**

Overhaul of Unit 2 spindle

Unit 1 — In cutting

Unit 2

Spindle motor load / Time
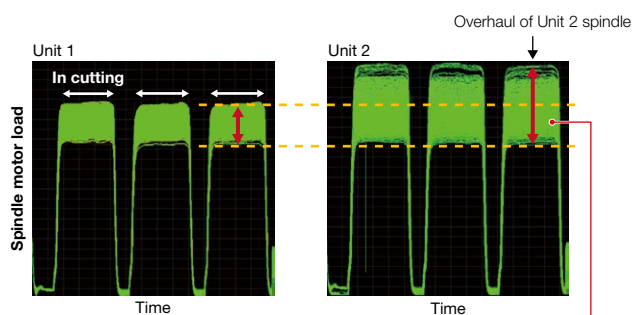
The two are the same model, but the results are different.
Wide = Large load variation

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

Unit 1

Unit 2

Probability density / Spindle motor load

$\sigma = 376$

$\sigma = 474$
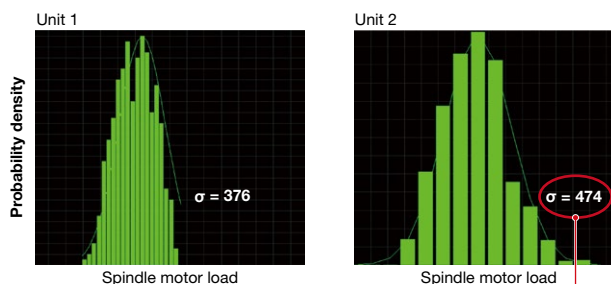
The two are the same model, but the results are different.
σ is large = Large load variation

Standard deviation of spindle motor load (σ)

Confirm the trend and schedule maintenance accordingly

Spindle

Z axis

X axis

Y axis

Plots variations in spindle motor load for every 300 pieces processed
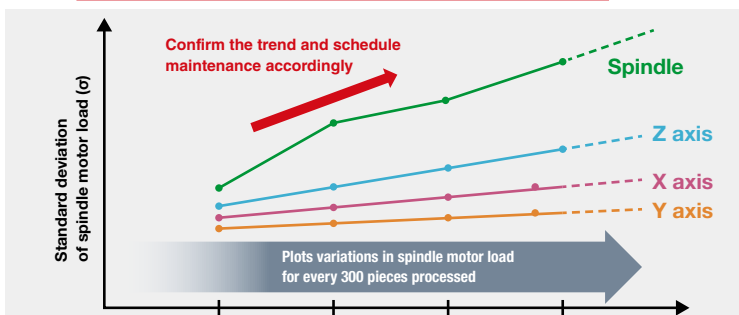
Identify the difference between the machine tools and the aging deterioration trend using quantitative metrics. This helps users perform preventive (predictive) maintenance appropriately.

By monitoring the difference of the machining load variations between the machine tools and conducting maintenance for the machine tool with large variations as required, it is possible to reduce stoppage caused by failure.

Product and Solution Introduction

▶ **iQ Monozukuri Tool Wear Diagnosis for Machine Tools**   P.36

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Case 5

Equipment level

| **Predictive Maintenance** | Preventive Maintenance | Corrective Maintenance |

Understanding the signs of errors for equipment that use rotating mechanisms

Even if equipment vibration can be seen, it is difficult understanding the difference between equipment operating normally and abnormally. Consequently, the signs of errors cannot be accurately detected, which results in downtime due to sudden failures.

Solution

Conduct pre-failure maintenance by using a vibration sensor to detect error signs

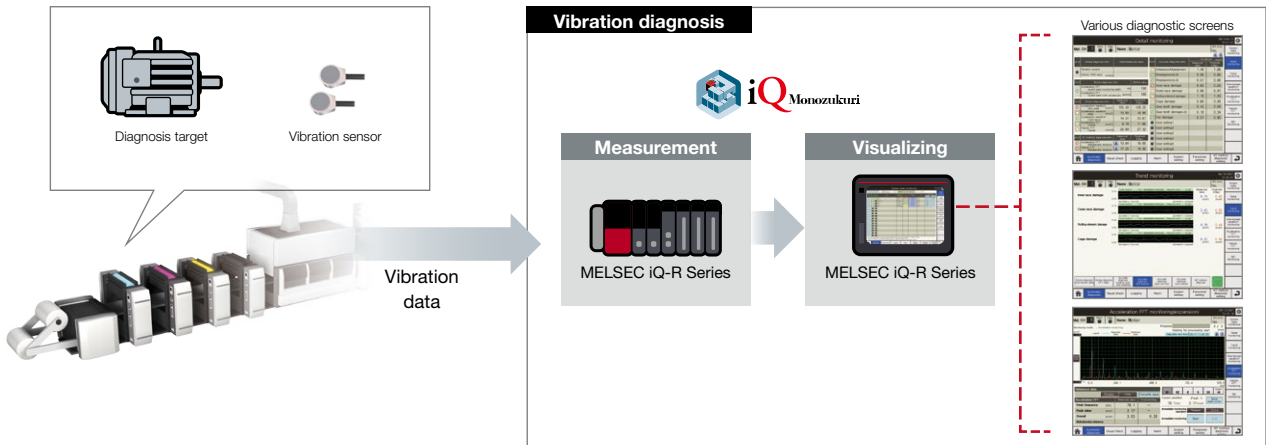iQ Monozukuri Rotary Machine Vibration Diagnosis is a function that collects, analyzes, and diagnoses equipment vibration data with rotating mechanisms to help make equipment conditions visible and estimate the location of the error.

Diagnosis target   Vibration sensor

Vibration data

Vibration diagnosis

iQ Monozukuri

Measurement
MELSEC iQ-R Series

Visualizing
MELSEC iQ-R Series

Various diagnostic screens

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/s²)	155.30	129.25
○	Acceleration waveform RMS (m/s²)	10.85	10.95
○	Acceleration waveform Crest factor	14.31	23.67
○	Acceleration FFT Overall (m/s²)	9.78	11.66
○	Velocity FFT Overall (mm/s)	22.89	27.32

Accurate diagnosis*

helps in estimating which area is faulty

Signs of inner race damage are detected

ALM	Accurate diagnosis item	Amplitude (m/s²)	
		Measurement value	Threshold value
○	Unbalance/Misalignment	1.48	1.88
○	Misalignment(×2)	0.56	0.85
○	Misalignment(×3)	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(×2)	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.

Conducting maintenance on the area where signs of errors are detected prevents sudden equipment stoppages resulting in stable operation.

Product and Solution Introduction

▶ **iQ Monozukuri Rotary Machine Vibration Diagnosis**   P.35

Case 6

Device level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance

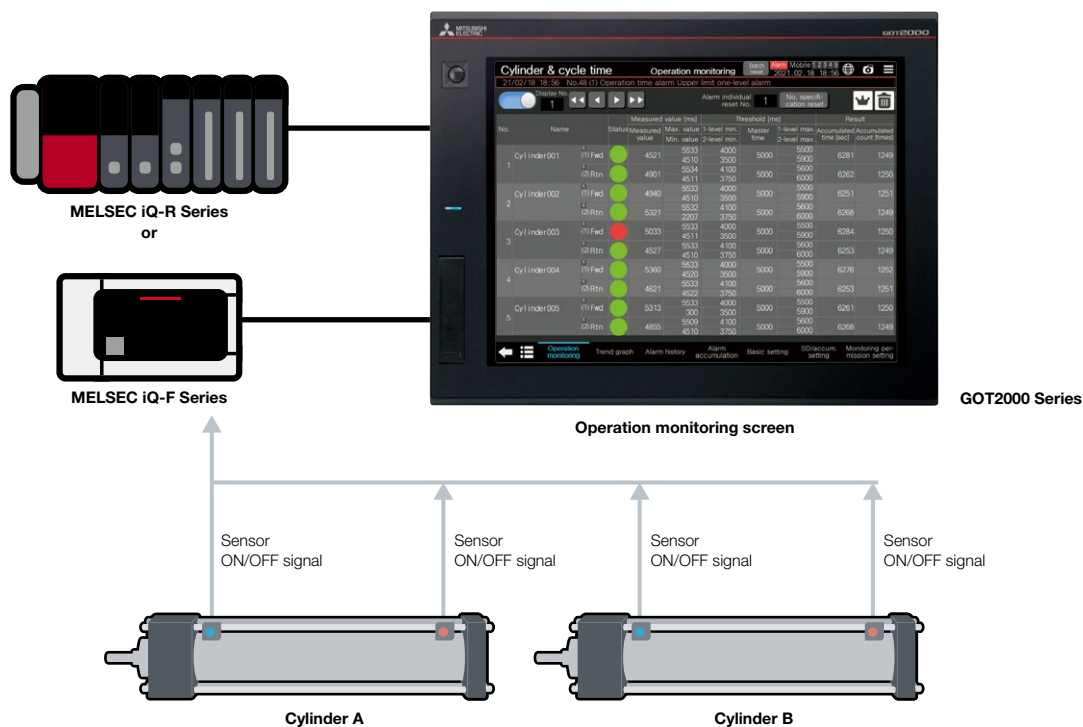## Performing maintenance work on cylinders at the right time

Delayed operation of the cylinder isn't noticed by operators,
which leads to increased equipment cycle time.

Solution

Optimize maintenance by monitoring the cylinder operating time

The Cylinder and Cycle Time Monitor function of the e-F@ctory Starter Package measures and visualizes the cylinder operation time, automatically detects delays in the 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.

MELSEC iQ-R Series
or

MELSEC iQ-F Series

GOT2000 Series

Operation monitoring screen

Sensor ON/OFF signal

Sensor ON/OFF signal

Sensor ON/OFF signal

Sensor ON/OFF signal

Cylinder A

Cylinder B

Prevents deterioration of the performance operating ratio and keeps 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

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Case 7

Equipment level

Predictive Maintenance

Preventive Maintenance

Corrective Maintenance

Running laser-processing machines in continuous automatic operation

1 Processing defects occur during automatic operation at night, so upon arriving on-site the next morning, the processing machine has stopped and workpieces have not been finished.

2 Adjusting programs when processing defects occur is time-consuming.

Solution

Utilize AI to support continuous automatic operation

An AI-assisted function automatically detects and adjusts processing defects to optimal machining conditions to support continuous automatic operation of processing machines.

Sound sensor

Light sensor
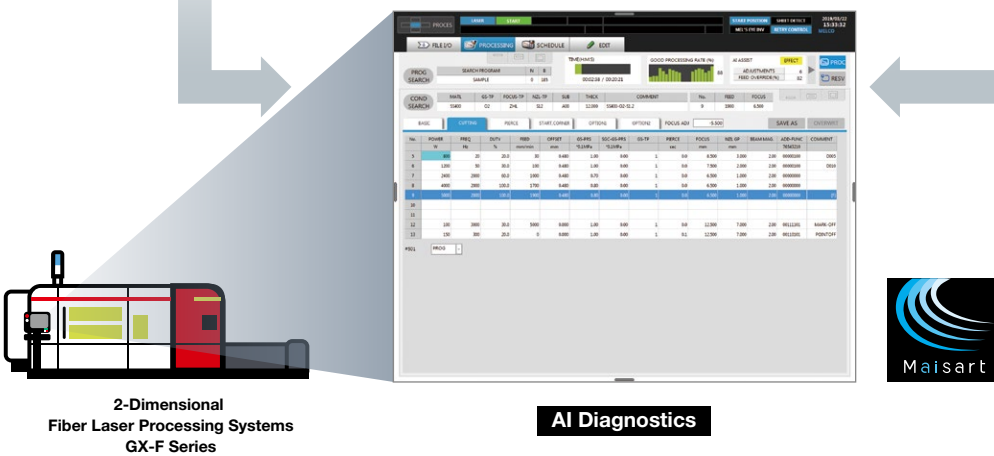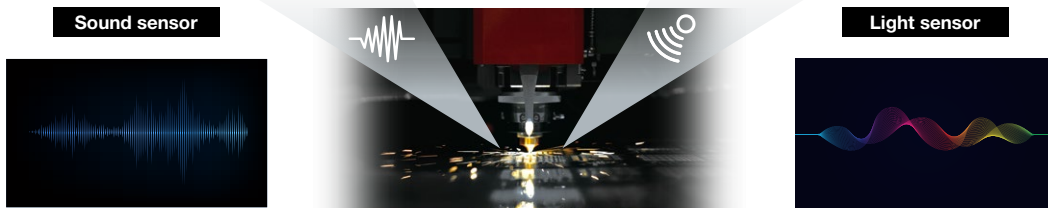
2-Dimensional Fiber Laser Processing Systems GX-F Series

AI Diagnostics

Maisart

1 Reduces manual adjustment for rectifying processing defects and enables operation to automatically continue.

2 Helps prevent sudden stoppages of processing machines during nighttime and weekend operation.

Product and Solution Introduction

▶ **2-Dimensional Fiber Laser Processing Systems GX-F Series**　　　　　　　　　　　**P.50**

Case 8

Device level

| **Predictive Maintenance** | Preventive Maintenance | Corrective Maintenance |

Detecting drive component age-related deterioration (ball screws, belts, gears)

The status of drive component (ball screws, gears, belts) deterioration is unknown, so we can only respond after a 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 the ball screw (including bearings, guide, etc.) are estimated by Maisart, and a failure warning limit is automatically generated from the estimated information. Failures are predicted by alerting users when the limit is exceeded.

▶ The friction torque of the belt is estimated by Maisart, and any drop in the belt tension is monitored. Failures are predicted by alerting users when the limit is exceeded.

▶ The amount of gear backlash is estimated, and the frictional degradation of the gear is monitored. Failures are predicted by alerting users when the threshold value is exceeded.

Maisart

Monitor on HMI (GOT) or PC

| Ball screws | Belts | Gears |

Ball screws

Failure prediction warning via machine diagnosis function

Predicts failure based on changes in friction and vibration

Kinetic friction · · · · · · · · · · Machine failure

Failure warning limit · · · **Failure warning**

Time

Belts

Failure prediction warning via machine diagnosis function

Detects drop in belt tension from friction

Belt tension · · · · · · · · · · Machine failure

Failure warning

Failure warning limit

Time

Gears

Monitoring with machine diagnostic function

Monitors gear wear using backlash amount*

Backlash value

Warning

threshold values

Time

Normal → Signs of failure ✕→ Failure

* This function can output warnings by entering threshold values.

Motion module RD78G(H)

CC-Link IE TSN

Servo Amplifier MR-J5-G Series

Predicting the service 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.45

Case 9

Equipment level

Predictive Maintenance
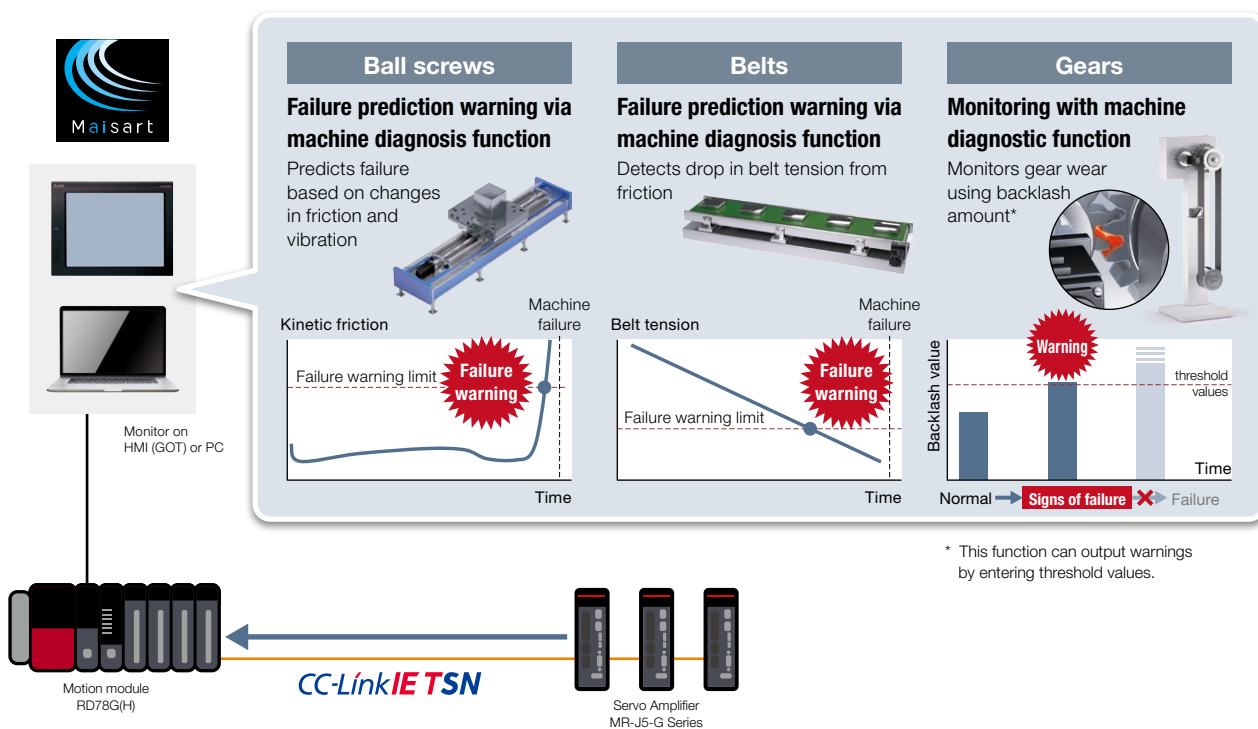
Preventive Maintenance

Corrective Maintenance

Preventing the sudden failure of old equipment

Sudden failures of equipment used for a long time results in unnecessary labor and costs.

Solution

Plan for 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.

Checks electric-current waveform

Ethernet

MELSEC iQ-R Series Energy Measuring Module

Current

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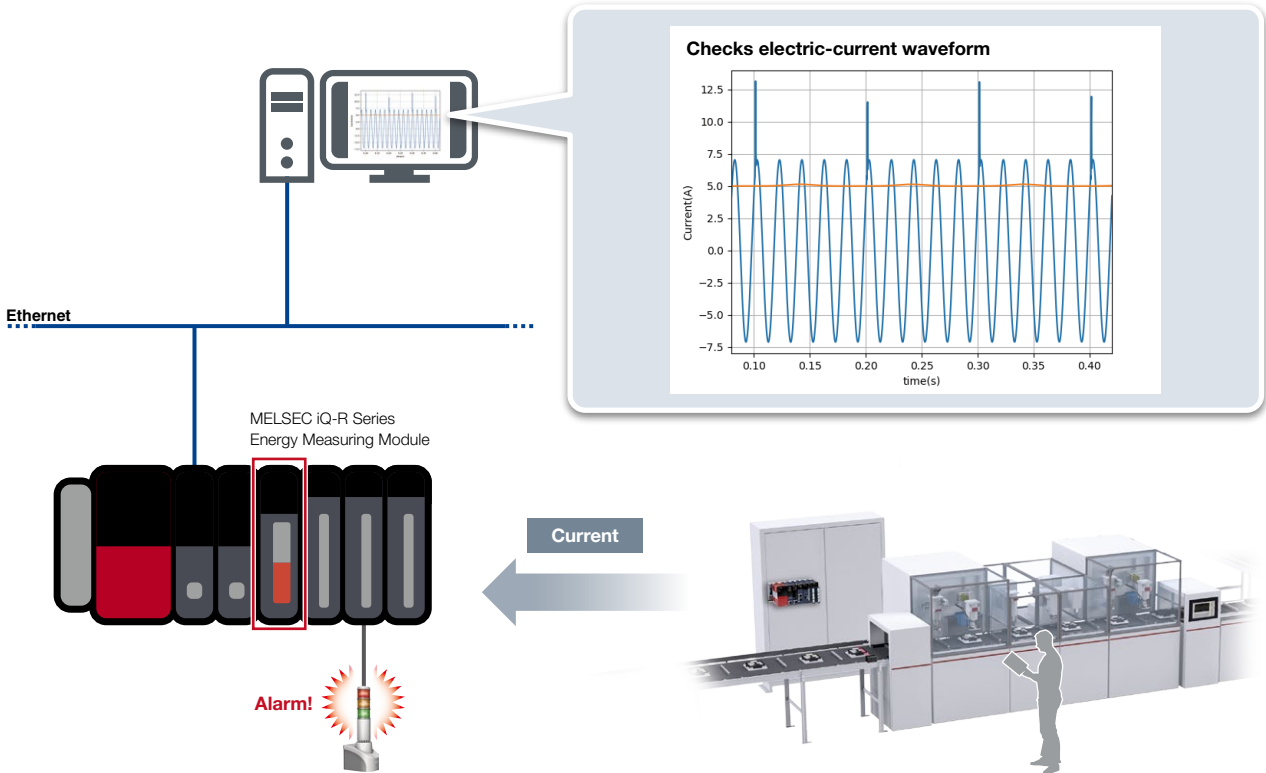
By detecting equipment failure
in advance through short cycle measurement,
maintenance planning is possible and labor costs are greatly reduced.

Product and Solution Introduction
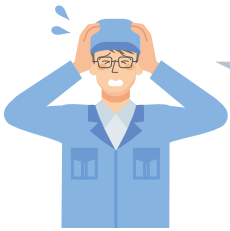
▶ **MELSEC iQ-R Series Energy Measuring Module**   **P.27**

Case 10
Device level

| Predictive Maintenance | Preventive Maintenance | Corrective Maintenance |

Conducting maintenance before robots fail

Need to conduct scheduled maintenance appropriate with a robot's operational status.

Solution

Detect part faults and deterioration by utilizing AI, and notify users of the maintenance periods that are calculated from the operational status.

▶ Failing or deteriorating robot parts can be detected at an early stage.
▶ The recommended maintenance period can be calculated with the robot operation pattern data alone at an equipment startup.
▶ The repair/replacement period for each component is notified in advance, thus achieving efficient maintenance.

1 [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 |

Warning before parts fail!

Warning

Alert

Predetermined detection level set by user

Maisart

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

2 [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.

■ **Output data**
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.

[Maintenance simulation result]

Number of years until recommended overhaul period for joint

Number of years until part replacement for joint.

Number of years until part replacement (Joint with part that needs replacing earliest)
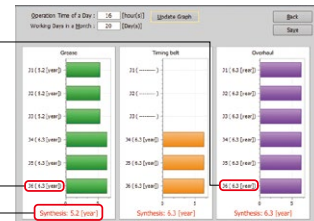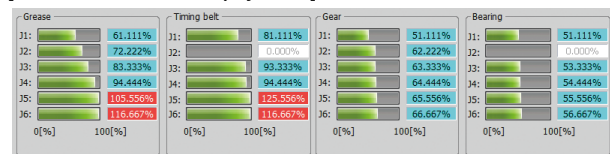
3 [Preventive Maintenance function] Wear calculation function

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.

[Wear calculation results display screen]

Grease		Timing belt		Gear		Bearing	
J1:	61.111%	J1:	81.111%	J1:	51.111%	J1:	51.111%
J2:	72.222%	J2:	0.000%	J2:	62.222%	J2:	0.000%
J3:	83.333%	J3:	93.333%	J3:	63.333%	J3:	53.333%
J4:	94.444%	J4:	94.444%	J4:	64.444%	J4:	54.444%
J5:	105.556%	J5:	125.556%	J5:	65.556%	J5:	55.556%
J6:	116.667%	J6:	116.667%	J6:	66.667%	J6:	56.667%
0[%] 100[%]		0[%] 100[%]		0[%] 100[%]		0[%] 100[%]	

The AI technology detects signs of failures, enabling maintenance before robots fail. The recommended maintenance periods are simulated from the operation pattern, which helps users schedule maintenance properly. The wear of robot parts is calculated from the operation pattern, and the maintenance periods are notified.

Product and Solution Introduction

Case 11
Device level

| Predictive Maintenance | Preventive Maintenance | Corrective Maintenance |

Understanding when to replace servo amplifiers

The sudden failure of servo amplifiers causes unexpected downtime.

Solution

Use the service life diagnosis for 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 has been turned on and off, therefore helping users understand when servo amplifiers need to replaced.
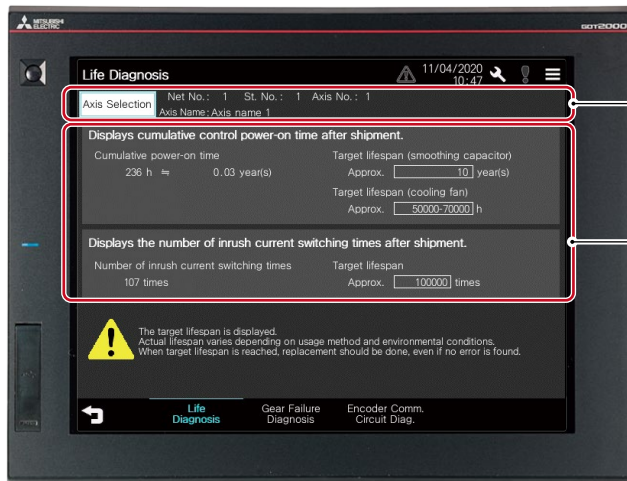There are also functions for inverters and robots[1] to check when maintenance parts should be replaced.
Please refer to the GOT2000 Series Product and Solution Introduction (P. 32) for more information.

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

GOT Drive

[1] The degree of wear for each part is a reference value calculated from the operation status of the robot and is used for supporting the maintenance and inspection plan. It 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 made 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.45 |

Case 12

Equipment level

Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance**

Identifying the cause of equipment errors

Identifying the cause of an error
by visually checking equipment is not possible as it looks in normal condition.
The video recorded with the camera runs too fast, making identifying the error cause difficult.
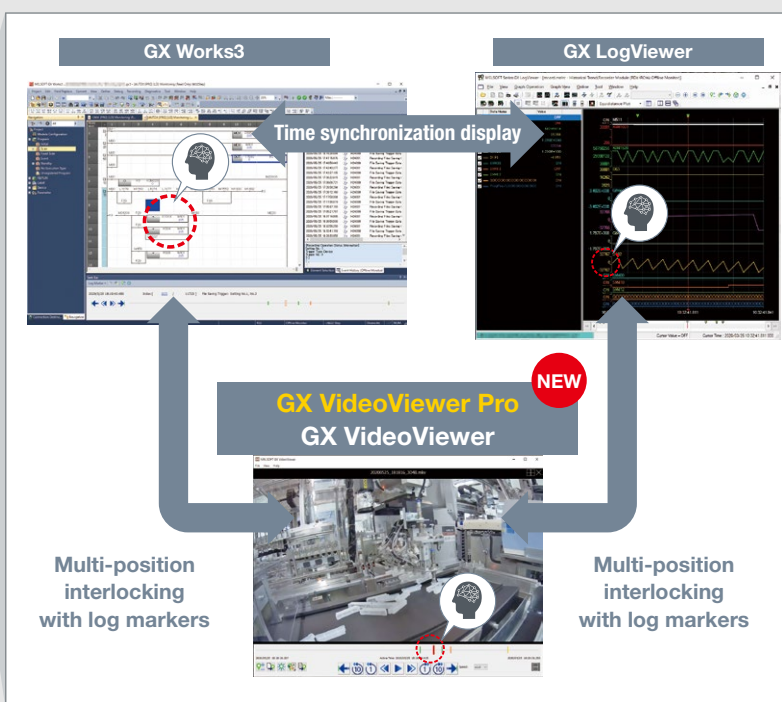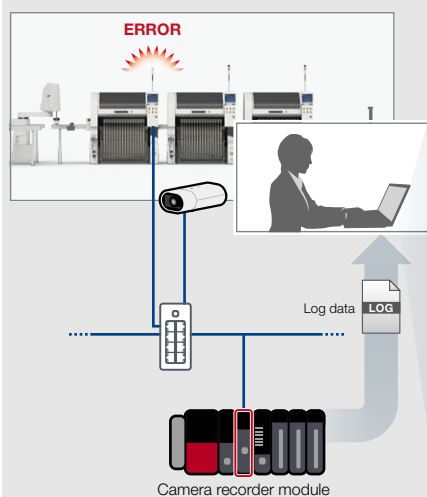
Solution

Investigate equipment error causes with a system recorder

The system recorder[1] performs system-wide recording of equipment operation data and camera images in the event of an abnormality. Analysis is made easy by displaying waveform data, programs, and video data on the same timeline. Also, GX VideoViewer Pro analyzes the video footages and indicates areas different from normal operation (differences), and milestone points (log markers) are added automatically in the meantime.

[1] System recorder: corrective maintenance solution that greatly reduces downtime through system-wide recording in the event of an abnormality and simplified analysis.

Identifying cause with Camera Recorder Module

ERROR

Log data | LOG

Camera recorder module

GX Works3

GX LogViewer

Time synchronization display

GX VideoViewer Pro
GX VideoViewer
NEW

Multi-position interlocking with log markers

Multi-position interlocking with log markers

Any causes of failures that were difficult to find before can be identified, and errors that are likely to cause failures are avoided in advance.

Product and Solution Introduction

▶ System Recorder   P.28

▶ System recorder related software   P.30

Case 13
Equipment level

| Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance** |

Responding 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 go to the site where the problem is occurring,
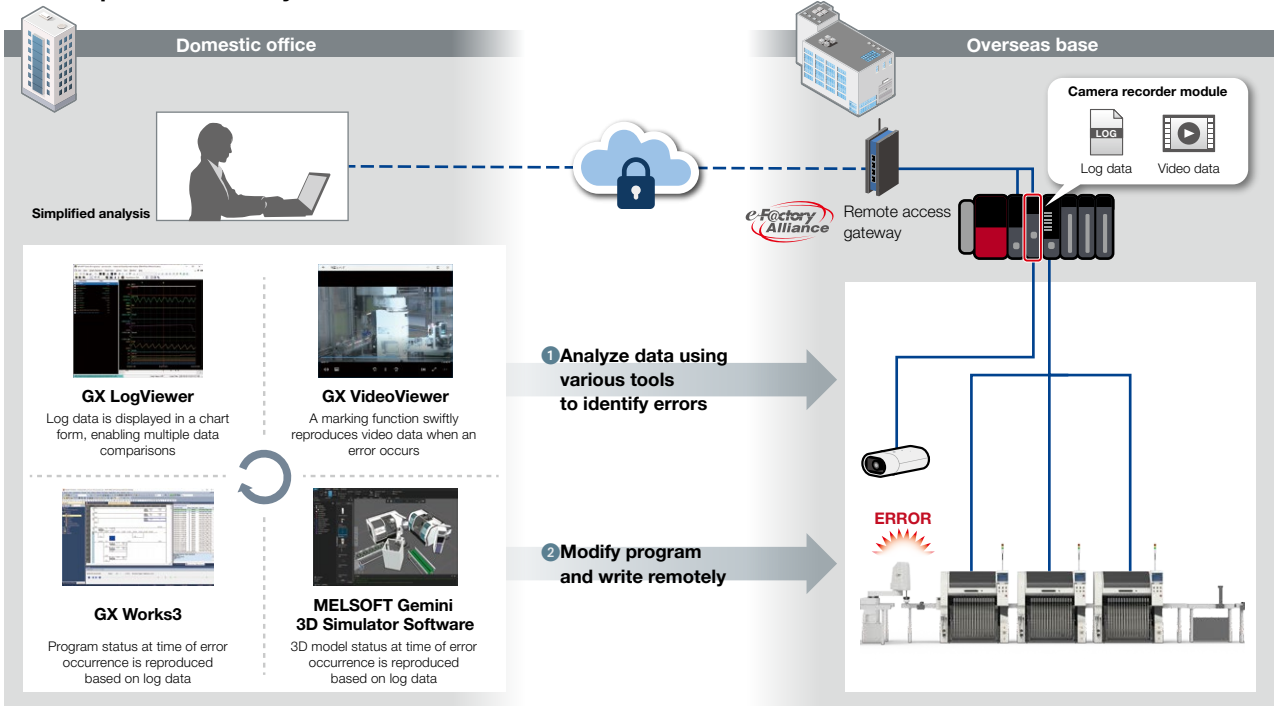and this form of response is time-consuming and costly.

Solution

**Confirm the status and error details of an equipment at a remote location
via video images and 3D simulator, and thus the cause can be found quickly.**

The system recorder[1] performs system-wide recording of equipment operation data and camera images in the event of an abnormality. Waveform data, programs, and video data of the shop floor are obtained at remote locations, and operations can be confirmed through these data by linking 3D simulator and other tools. 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.

■ Solve problems with system recorder

Domestic office / **Overseas base**

Camera recorder module — Log data / Video data

Simplified analysis

Remote access gateway

GX LogViewer
Log data is displayed in a chart form, enabling multiple data comparisons

GX VideoViewer
A marking function swiftly reproduces video data when an error occurs

GX Works3
Program status at time of error occurrence is reproduced based on log data

MELSOFT Gemini 3D Simulator Software
3D model status at time of error occurrence is reproduced based on log data

❶ **Analyze data using various tools to identify errors**

❷ **Modify program and write remotely**

ERROR

Labor hours and costs are significantly reduced by identifying error causes at an early stage from a remote location.
In addition to the video data, the 3D simulator is available to check operations and makes it possible to confirm operations of equipment blind spots or the inside of an equipment that cannot be seen physically.

Product and Solution Introduction

Case 14
Line level

| Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance** |

Monitoring 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, leading to prolonged downtime.

Solution

Remotely monitor of multiple lines

The GOT Mobile function makes it possible to view information collected by GOTs on-site from information devices such as PCs and tablets in remote locations. The operation status, error status, etc. of multiple lines installed at a factory can be monitored remotely without being on site. 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.
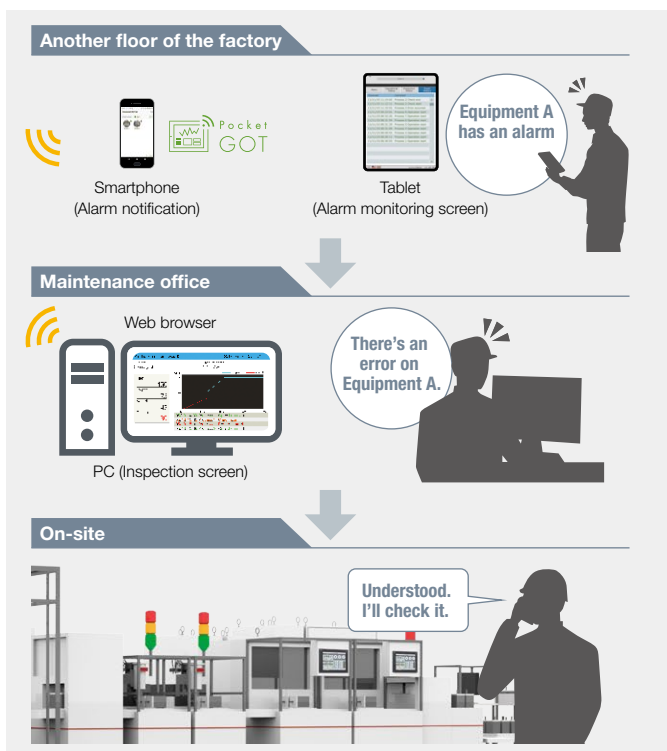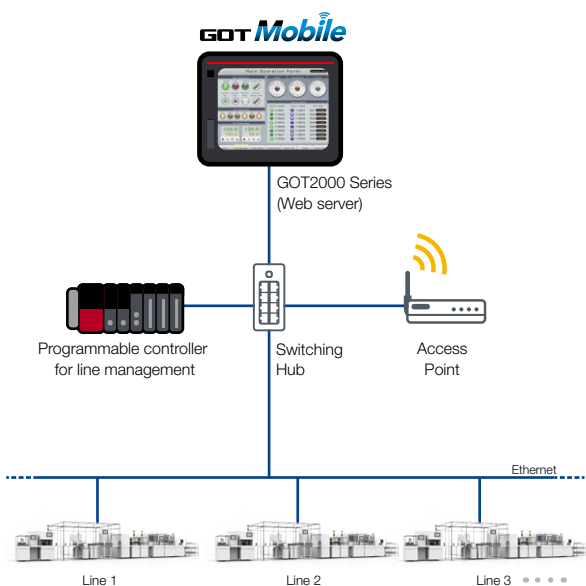
The status of the entire factory can be checked at a glance from a remote PC, reducing wasted time when an error occurs, and significantly reducing downtime.

Product and Solution Introduction

▶ **GOT2000 Series** (GOT Mobile Function)   P.33

21

Case 15
Line level

| Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance** |

Immediately detecting errors and identifying error locations in machining tools

Detecting machining abnormalities instantly can be difficult.
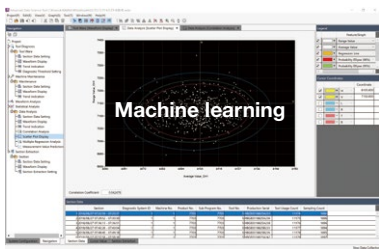The error location can be difficult to identify even when an error is detected.

Solution

Immediately detect errors with machining error diagnosis/Identify error locations in machine tools by comparing waveforms

With iQ Monozukuri Tool Wear Diagnosis for Machine Tools, create a machining error diagnosis model from the machining IoT data to detect machining errors immediately.
Identify the location of an error by comparing the abnormal machining data and the normal machining data on the Advanced Data Science Tool or GOT.
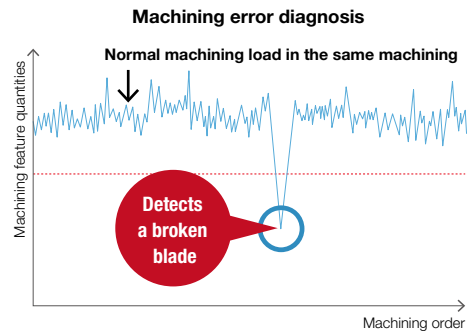
1 Detecting errors from unusual data

Create a machining error diagnosis model

Machine learning

Advanced Data Science Tool

Malsart

Sets a machining diagnosis model

Machining error diagnosis

Normal machining load in the same machining

Machining feature quantities
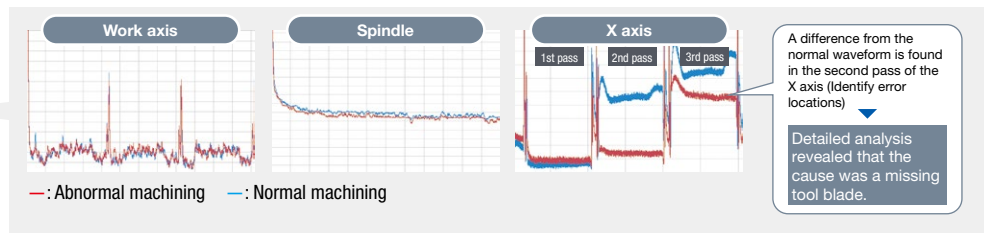
Detects a broken blade

Machining order

Immediately detect machining errors with real-time monitoring.

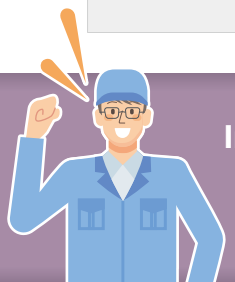### 2 Comparing waveforms to identify the location of an error in machine tools

GOT2000 series

Tool Wear Diagnosis for Machine Tools

| Work axis | Spindle | X axis |

1st pass | 2nd pass | 3rd pass

— : Abnormal machining   — : Normal machining

A difference from the normal waveform is found in the second pass of the X axis (Identify error locations)

Detailed analysis revealed that the cause was a missing tool blade.

Easily identify the location of an error by comparison with past normal data.

Immediately detect errors by monitoring the machining state in real time. Quickly troubleshoot errors by identifying the error location through comparing overlaid waveforms.

Product and Solution Introduction

▶ **iQ Monozukuri Tool Wear Diagnosis for Machine Tools**   **P.36**

Case 16

Equipment level

Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance**
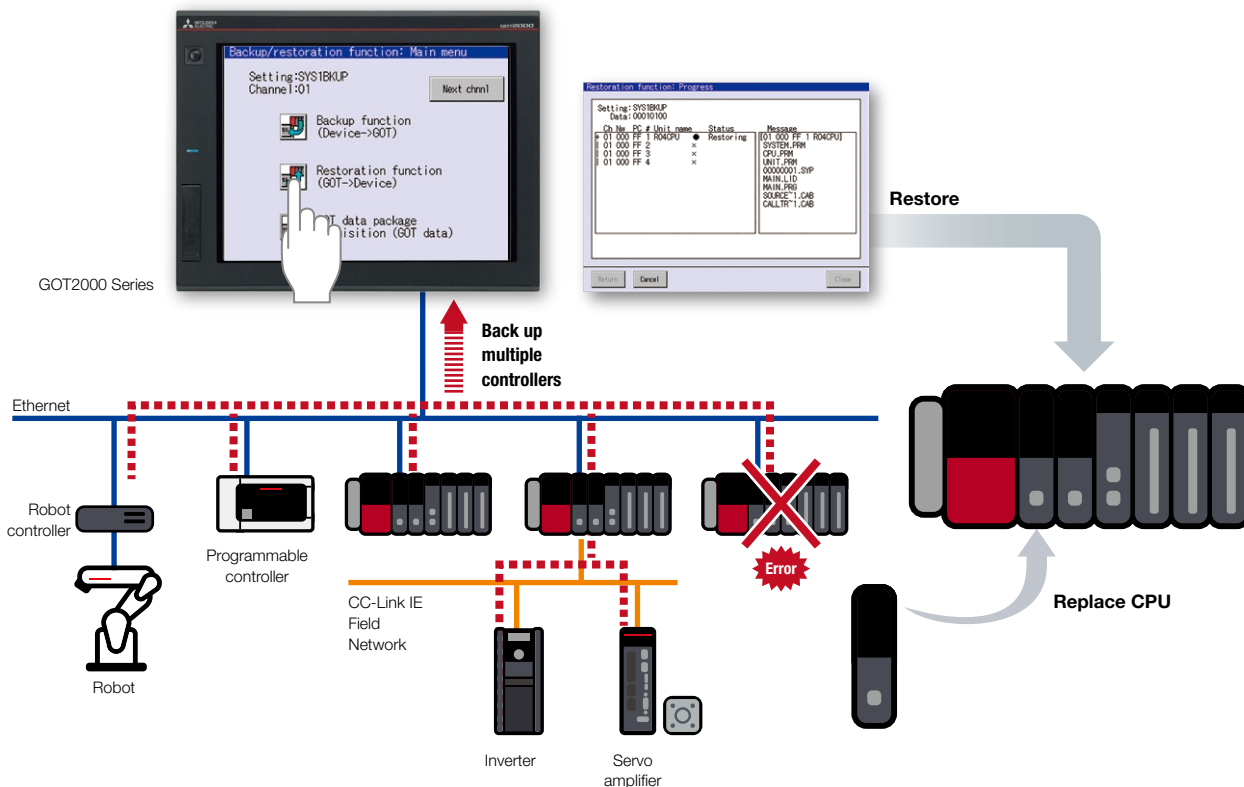
Restoring FA device programs on-site immediately

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

Solution

Enable 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 PLCs 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.

GOT2000 Series

Restore

Back up multiple controllers

Ethernet

Robot controller

Programmable controller

CC-Link IE Field Network

Error

Replace CPU

Robot

Inverter

Servo amplifier

By performing backups in advance, it is possible to restore FA devices from GOT on-site 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

Device level

| Predictive Maintenance | Preventive Maintenance | **Corrective Maintenance** |

Using robots reliably

Need to compare the current condition of a robot with when the robot was first introduced because errors that did not occur at first-time use have been occasionally occurring.

Solution

Automatically collect daily operational information and periodically save robot program

Daily operational information is automatically saved, enabling status check at the time of introduction.
Backup data is automatically saved periodically, enabling restoration from the calendar.

1 Condition management function

This function automatically saves and complies robot operation and maintenance data every day in the dedicated SD card of iQ Care MELFA Support, allowing users to refer to the operational information[1] without complicated data processing.
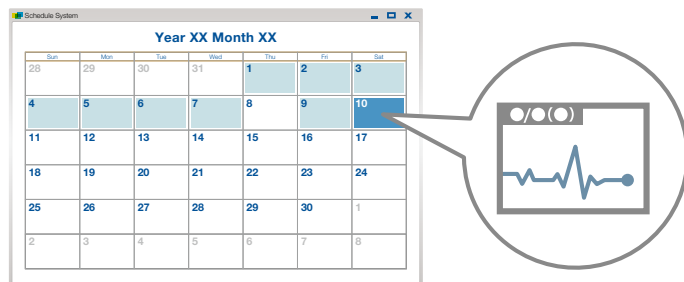Saved data is filed as text data in the csv format which can be used for secondary processing in accordance with the customer's application. By linking with the predictive maintenance function, maintenance monitoring of robots are easily performed.

[1] For data reference, RT ToolBox3 (Mitsubishi Electric's PC software supporting robots) is necessary.

Periodical data storage

No need to add host systems

Dashboard
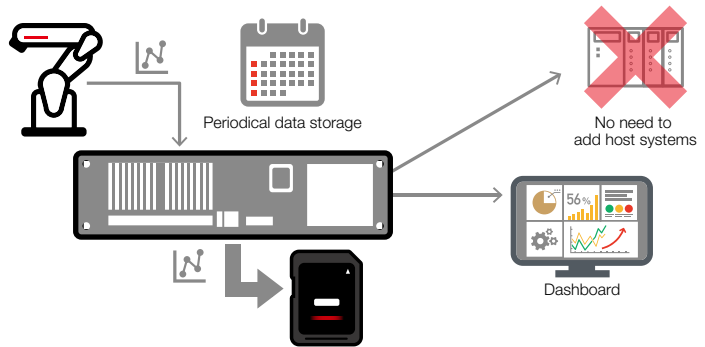
2 Recovery function

The date on which backup data is saved can be easily searched from the calendar view, and the robot settings can be restored to the status of the specified date.
Backup data is automatically saved, and thus users can operate the robot reliably without complicated saving operations.

Year XX Month XX

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	31	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	1
2	3	4	5	6	7	8

Easily compare the condition of robots with and without errors by automatically aggregating the robot daily operational information and managing the history data. Restore robot programs anytime from automatically backed up data in the SD card. In case of sudden failures, these failures can be quickly resolved.

Product and Solution Introduction

▶ **iQ Care MELFA Support**   **P.48**

Case 18

Resolving inverter issues smoothly
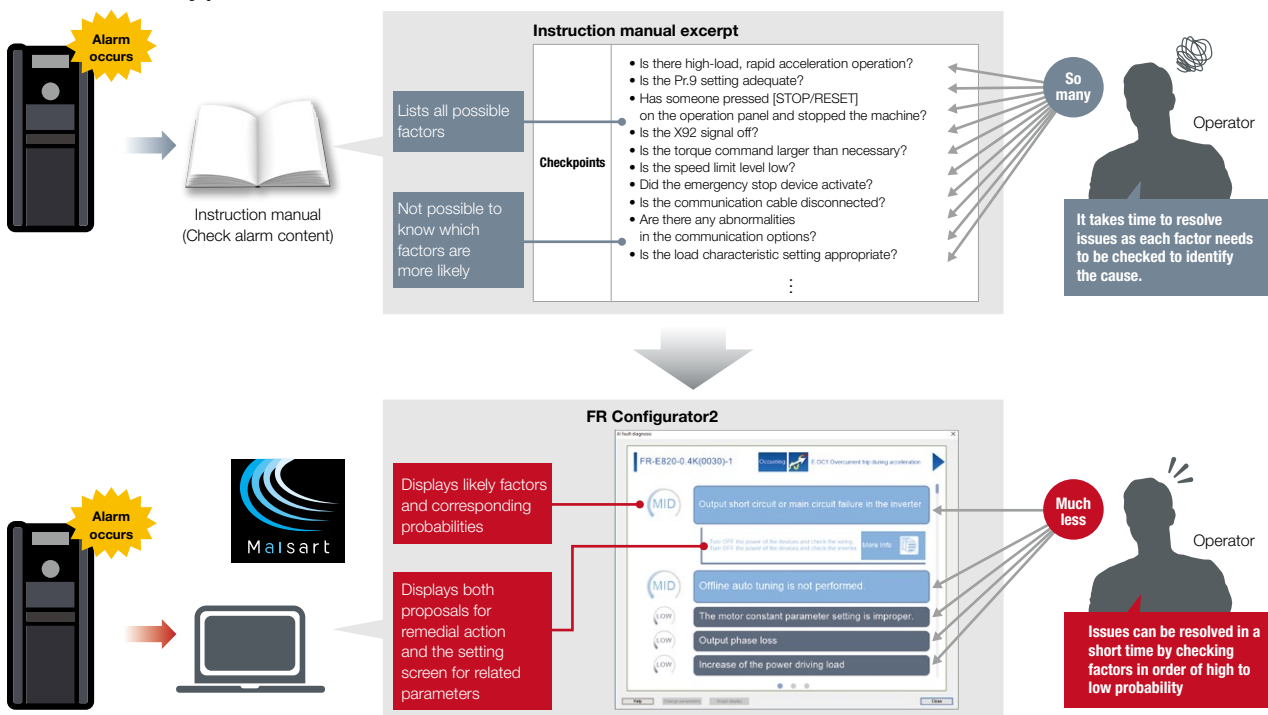
It takes time to resolve issues because checking the cause of inverter alarms one by one in the instruction manual is time consuming.

Solution

Support the use of AI inverter troubleshooting

Utilizing the AI alarm diagnostic function installed in the FR Configurator2 inverter setup software, alarm factors can be checked in order of most likely to least likely.

■ Current recovery process

Alarm occurs

Instruction manual (Check alarm content)

Lists all possible factors

Not possible to know which factors are more likely

Instruction manual excerpt

Checkpoints
- Is there high-load, rapid acceleration operation?
- Is the Pr.9 setting adequate?
- Has someone pressed [STOP/RESET] on the operation panel and stopped the machine?
- Is the X92 signal off?
- Is the torque command larger than necessary?
- Is the speed limit level low?
- Did the emergency stop device activate?
- Is the communication cable disconnected?
- Are there any abnormalities in the communication options?
- Is the load characteristic setting appropriate?
⋮

So many

Operator

It takes time to resolve issues as each factor needs to be checked to identify the cause.

Alarm occurs

Maisart

Displays likely factors and corresponding probabilities

Displays both proposals for remedial action and the setting screen for related parameters

FR Configurator2

FR-E820-0.4K(0030)-1   E.OC1 Overcurrent trip during acceleration

(MID) Output short circuit or main circuit failure in the inverter   More Info

(MID) Offline auto tuning is not performed.

(LOW) The motor constant parameter setting is improper.

(LOW) Output phase loss

(LOW) Increase of the power driving load

Much less

Operator

Issues can be resolved in a short time by checking factors in order of high to low probability

Achieve easy and quick troubleshooting that reduces downtime.

Product and Solution Introduction

▶ **FREQROL-E800 Series** (FR Configurator2)   **P.46**

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

Real-time monitor
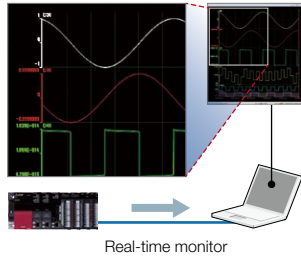
CPU/ Output module   iQ-R   iQ-F

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."
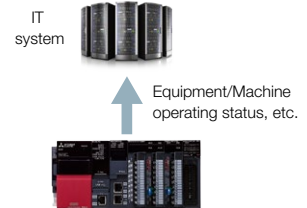

MELSEC iQ-F series

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

IT system

Equipment/Machine operating status, etc.

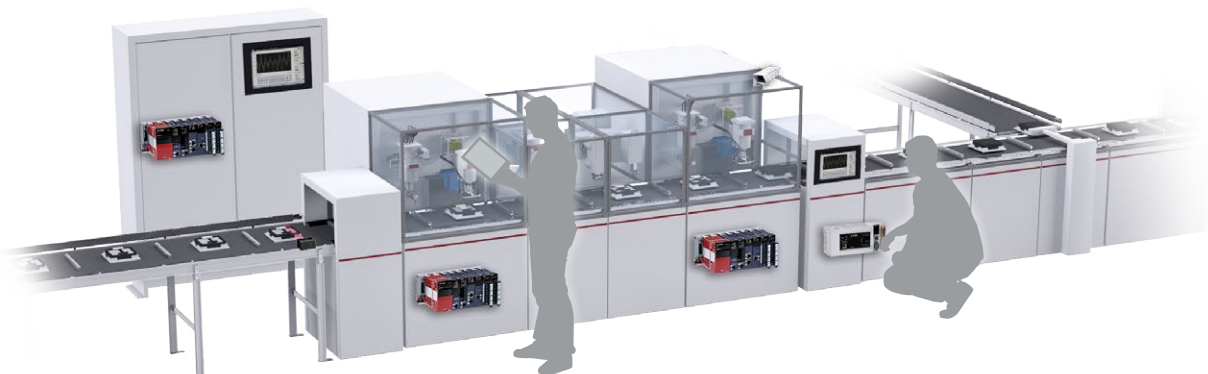### CPU/ Intelligent function module*   iQ-R   iQ-F

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

GX Works3

Ethernet/USB

.zip   SFWUPDFILES   .SYF
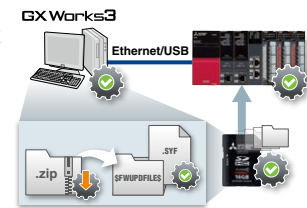
* Please refer to the manual regarding support for each model.
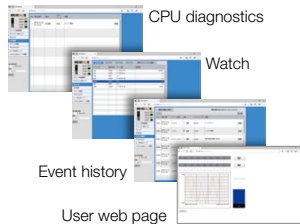
CPU module `iQ-R` `iQ-F`

### 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 diagnostics

Watch

Event history

User web page

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
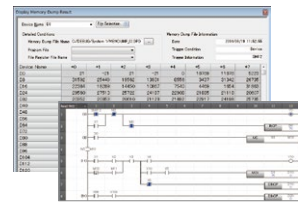
Memory dump results
(Program editor)

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.
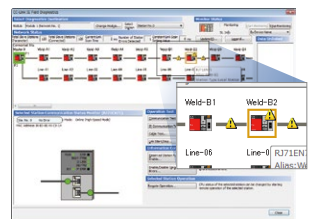
■ **High-speed data processing**

When collecting in 10 ms
When collecting in 250 ms

▶Time [ms]
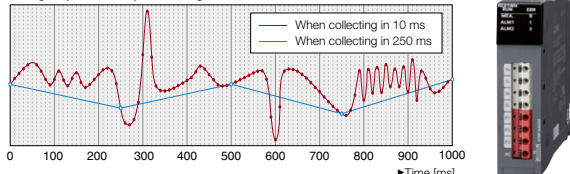
GX Works3 `iQ-R` `iQ-F`

Quickly find network errors

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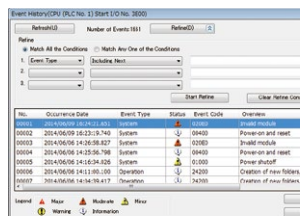- Easy network error corrective measures

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`

Switch between multiple languages for global support of maintenance

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

Japanese   English

Switch between device comment languages

27

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.

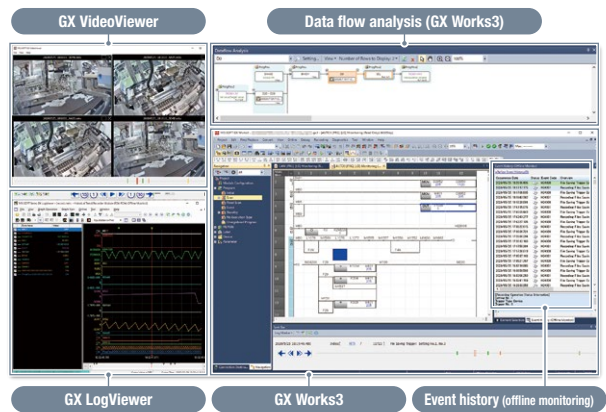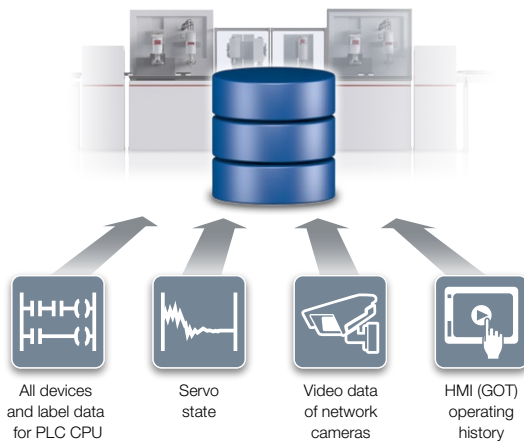## Corrective Maintenance solutions with System Recorde

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

Complete recording	Easy analysis
■ Complete recording of all data required for error analysis ■ Complete system recording ■ Complete prolonged recording	■ Display all data on the same timeline ■ Expresses influencing factors in straightforward terms ■ High-productivity programs also offer speedy solutions

All devices and label data for PLC CPU

Servo state

Video data of network cameras

HMI (GOT) operating history

GX VideoViewer

Data flow analysis (GX Works3)

GX LogViewer

GX Works3

Event history (offline monitoring)

▌ 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.

Records all data

ant to record video and data

cording 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
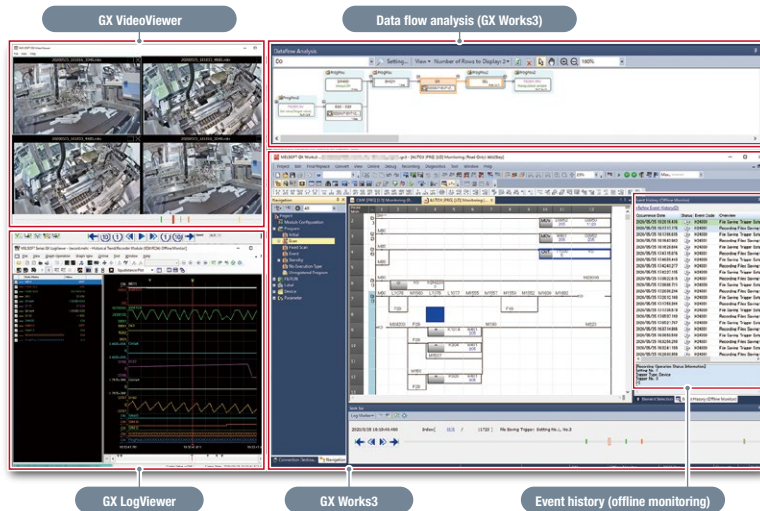
Also want to record users' operations

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   Data flow analysis (GX Works3)

GX LogViewer   GX Works3   Event history (offline monitoring)

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
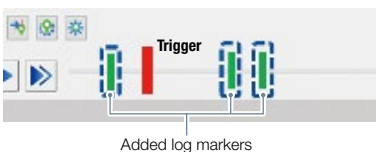Analyzes data changes

GX Works3
Displays data changes
and program relationships offline

Event history (offline monitoring)
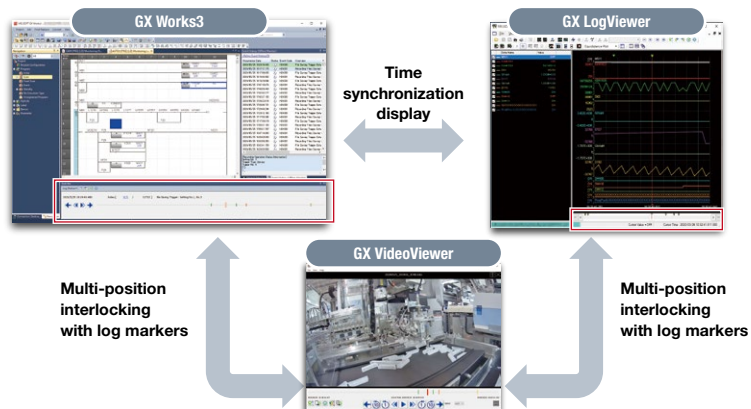Review event history during offline monitoring

■ **Conceptual Image of Function**

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

Trigger

Added log markers

❷ Share points requiring attention between tools

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

GX Works3   GX LogViewer

Time synchronization display

GX VideoViewer

Multi-position interlocking with log markers

Multi-position interlocking with log markers

System recorder related software

GX VideoViewer

Playback of recorded video up to four screens, while freely playing forward one frame, fast-forwarding, and rewinding. Each video can be linked to check in the same timeline. Color-coded log markers can be added to the video timeline, which is useful for analyzing among multiple personnel and inspection. Log markers are synchronized with related engineering software.
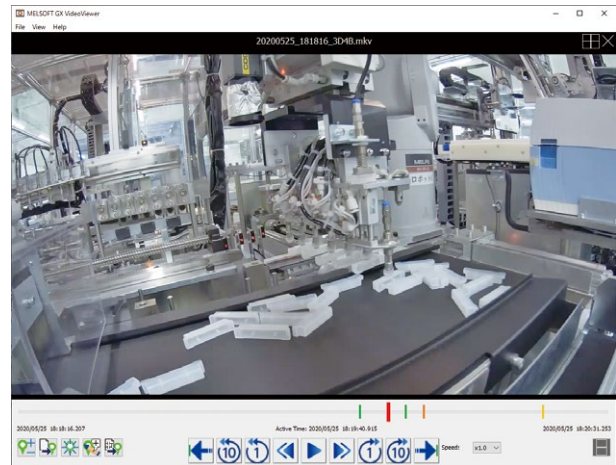
GX VideoViewer Pro

AI technology that extracts differences from the target video by comparing "appearance" and "operation" without deep learning

Industry's first[1]

In addition to the functions of GX VideoViewer, this software identifies and marks differences (abnormalities) in videos with simple settings.
*1 Based on Mitsubishi Electric research as of April 28, 2022

❶ Automatically mark differences in the recorded video feed
- Extracts differences in the video feed that differ from normal patterns and adds a mark in the video feed and on the seek bar
- AI analyzes differences of appearance and operation with unique algorithm, enabling easier error analysis
- Significantly reduce the time to find errors and such occurring at a high-speed which cannot follow with the human eye

❷ Easy 2-step setting
Automatic extraction by unique algorithms can be set up in 2 simple steps:

Step ❶ Set camera images of normal operation. (generation of normal pattern)
Step ❷ Execute difference extraction.

Differences are extracted according to changes in "appearance" and "operation", then marked on the video feed automatically. The log markers can be synchronized with other software.

Conventionally Differences from normal patterns are checked by an operator
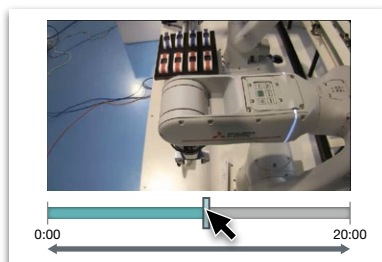
Possible differences from normal patterns are automatically extracted
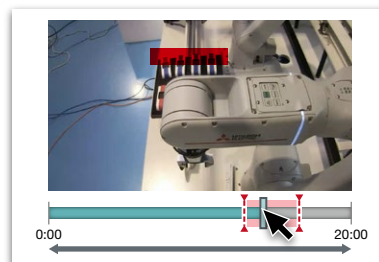
: Different area in the video

: Different area duration displayed on the seek bar

0:00 20:00

User benefits Differences are automatically extracted from the recorded video feed, saving labor time in identifying the cause of abnormalities

GX LogViewer*

GX LogViewer allows observation of device values, which represent quantities that change over time, by zooming in and out of waveforms similar to an oscilloscope. Difference can be checked by superimposing multiple waveforms and observed from repeated patterns and such.

GX Works3

GX Works3 is must-have software for designers and maintenance personnel. Program steps can be followed and device value changes can be checked offline by synchronizing the recorded system recorder data with log markers. Data flow analysis visualizes device values and programs affecting the data value change, helping to identify the cause of faults. This can reduce analysis time. Supported programs which synchronize with log markers include not only ladder programs but also function blocks that are easy to follow from the program.

GT Designer3

Screen creation software for GOT (HMI).
GOT (HMI) display/operation log/alarm history can be displayed offline by synchronizing with other applications, making it easier to visualize an error.

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.

GOT2000
Graphic Operation Terminal

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.

Back up multiple controllers

Ethernet

CC-Link IE
Field Network

Inverter   Servo amplifier
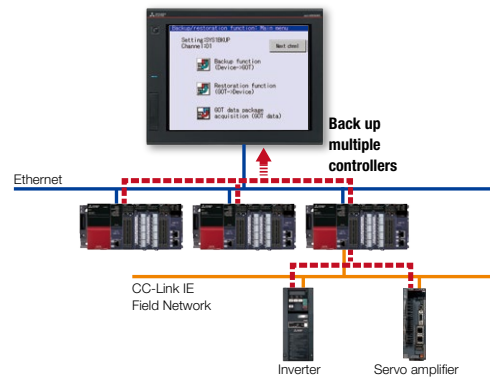
Drive Control Interaction GT27 GT25 GT23 GT21 GS21

GOT Drive

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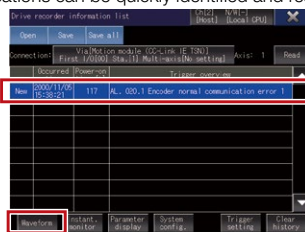
* Depending on the GOT model, restrictions apply to some functions or connectable equipment.
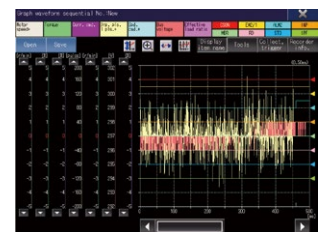
Servo amplifiers

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.
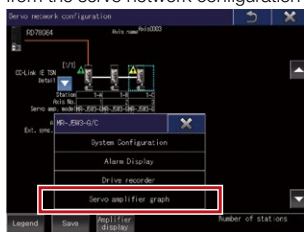
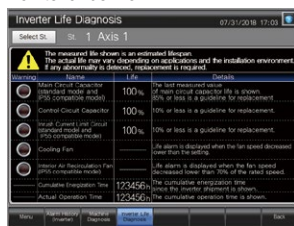System launcher screen   Drive recorder information list screen   Graph waveform screen

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.
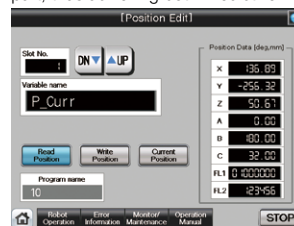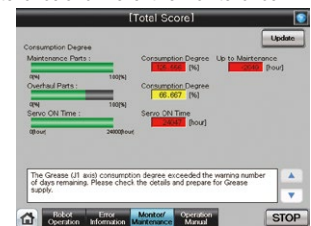
Parameter Setting screen   Inverter Life Diagnosis screen

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

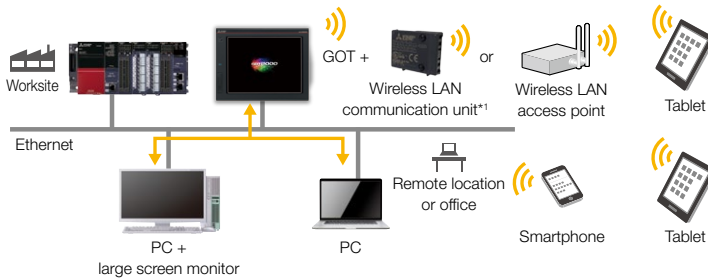## GOT Mobile Function GT27 GT25 GT23 GT21 GS21

GOT **Mobile**

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

Worksite

GOT + Wireless LAN communication unit*1 or Wireless LAN access point

Tablet

Ethernet

Remote location or office

PC + large screen monitor

PC

Smartphone

Tablet

*1 The wireless LAN communication unit cannot be used with GT2505 and GT25 handy.
An access point is required separately.
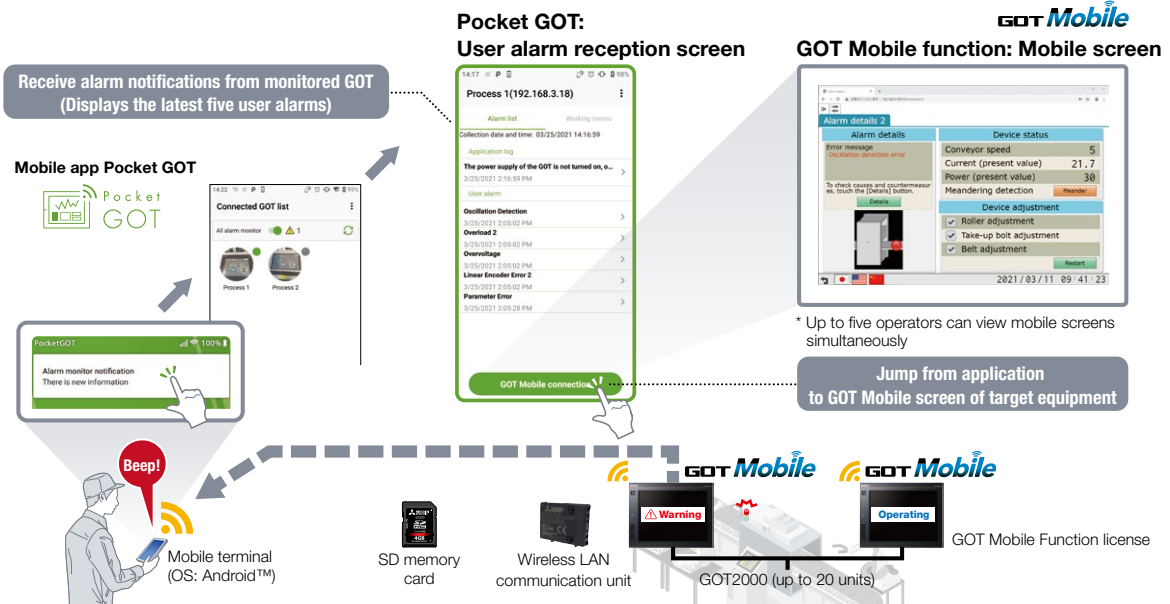
Check the status of the worksite using a web browser.

| Outside of the clean room | From a remote location | From your office |

An error occurred. How do I deal with it?

What is the problem cause?

Other usage

What's the progress? Any problems?

PC + large screen monitor

Equipment A has an error

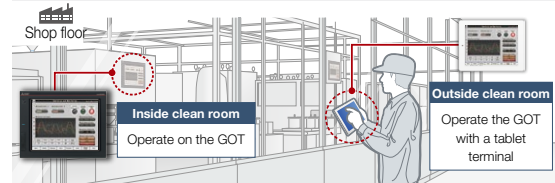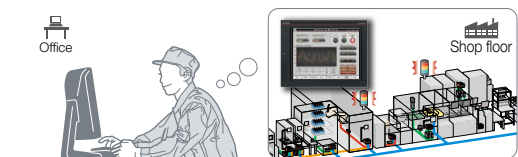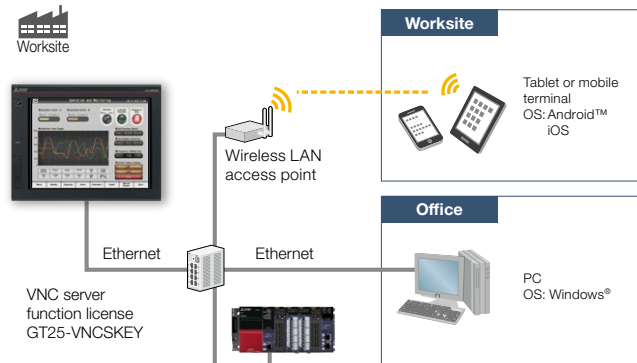| On a large screen | Up to five operators | Monitor production with one PC |

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.

Pocket GOT:
User alarm reception screen

GOT **Mobile**
GOT Mobile function: Mobile screen

Receive alarm notifications from monitored GOT
(Displays the latest five user alarms)

Mobile app Pocket GOT

Pocket GOT

PocketGOT
Alarm monitor notification
There is new information

* Up to five operators can view mobile screens simultaneously

Jump from application to GOT Mobile screen of target equipment

Beep!

Mobile terminal (OS: Android™)

SD memory card

Wireless LAN communication unit

GOT2000 (up to 20 units)

GOT Mobile Function license

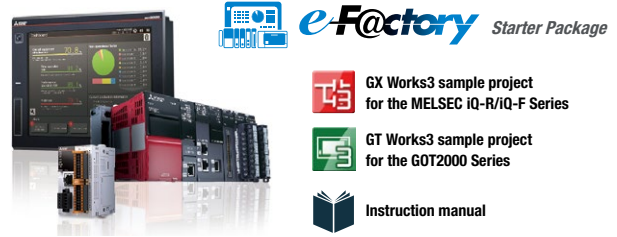## VNC Server Function GT27 GT25 GT23 GT21*2 GS21

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.

Worksite

Wireless LAN access point

Worksite
Tablet or mobile terminal OS: Android™ iOS

Office
PC OS: Windows®

Ethernet Ethernet

VNC server function license GT25-VNCSKEY

Office

Shop floor

Shop floor

Inside clean room
Operate on the GOT

Outside clean room
Operate the GOT with a tablet terminal

*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.

e-F@ctory **Starter Package**

- GX Works3 sample project for the MELSEC iQ-R/iQ-F Series
- GT Works3 sample project for the GOT2000 Series
- Instruction manual

Visualization of overall equipment efficiency iQ-R iQ-F

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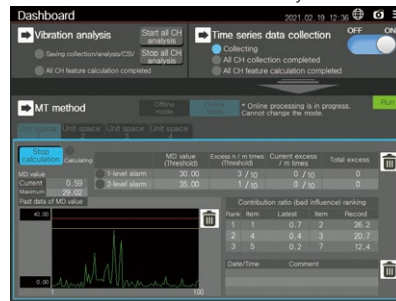

* The sample screen shown above is from the MELSEC iQ-R Series.

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.

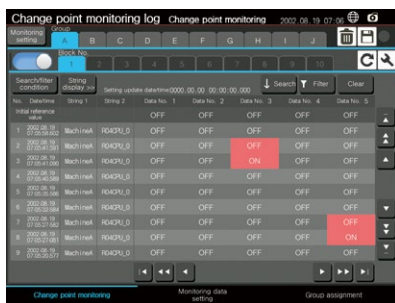* The sample screen shown above is from the MELSEC iQ-R Series.

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.

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 analog waveform status iQ-R iQ-F

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.
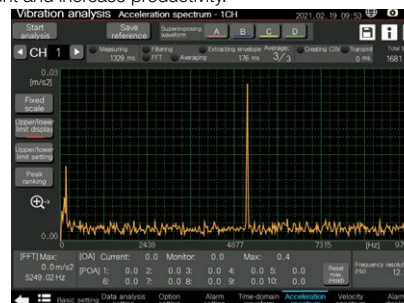

Error detection by frequency analysis of vibration waveform iQ-R

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.
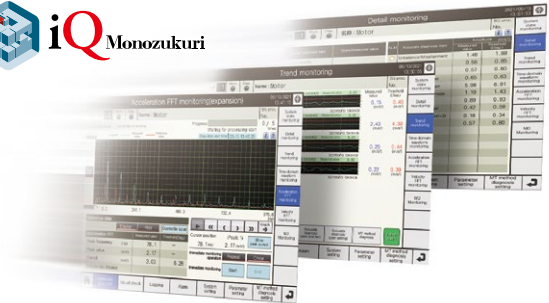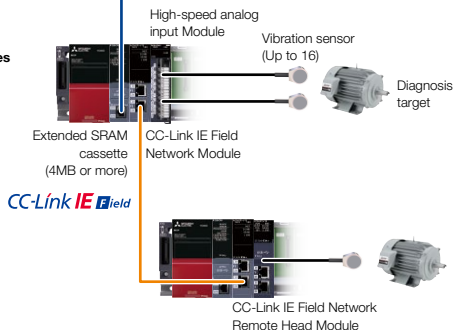
■ Package Contents

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

Package screen data

MELSEC iQ-R Series

Package control program

Extended SRAM cassette (4MB or more)

CC-Link IE Field Network Module

High-speed analog input Module

Vibration sensor (Up to 16)

Diagnosis target

CC-Link IE Field

CC-Link IE Field Network Remote Head Module

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)

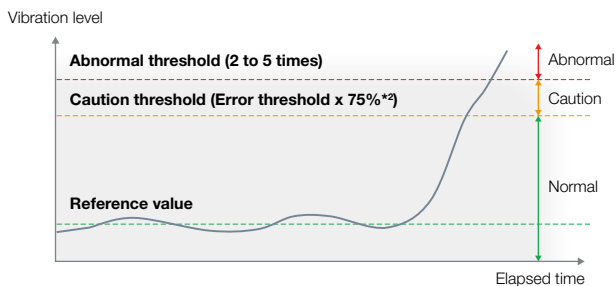Class Ⅳ[*1] : Large machine (when mounted on a soft foundation)

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

*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.

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

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

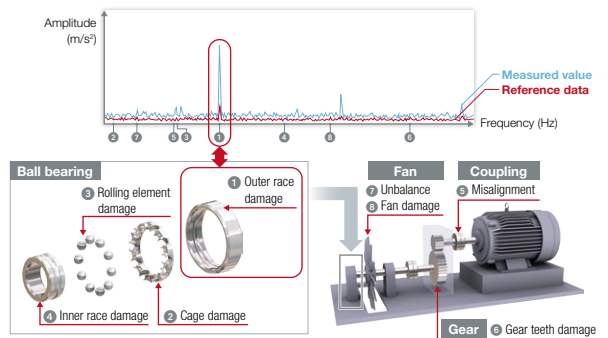## Fault detection by simple diagnosis (Relative value judgment)

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

Abnormal threshold (2 to 5 times) — Abnormal

Caution threshold (Error threshold x 75%*2) — Caution

Reference value — Normal

Elapsed time

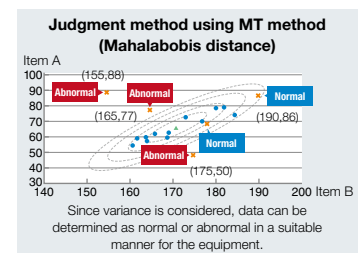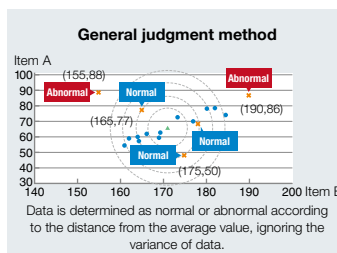*2 The multiplier (75%) can be changed to any value.

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.

Amplitude (m/s²)

Measured value
Reference data

Frequency (Hz)

Ball bearing
❸ Rolling element damage
❶ Outer race damage
❹ Inner race damage
❷ Cage damage

Fan
❼ Unbalance
❽ Fan damage

Coupling
❺ Misalignment

Gear ❻ Gear teeth damage

## 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.

General judgment method

Item A

Abnormal   Normal   Abnormal
(155,88)
(165,77)   Normal   (190,86)
Normal
(175,50)
Item B

Data is determined as normal or abnormal according to the distance from the average value, ignoring the variance of data.

Judgment method using MT method (Mahalabobis distance)

Item A

Abnormal Abnormal   Normal
(155,88)
(165,77)   (190,86)
Normal
Abnormal
(175,50)
Item B

Since variance is considered, data can be determined as normal or abnormal in a suitable manner for the equipment.

● Reference data (normal data)   ✖ Data to be judged   ▲ Average

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.
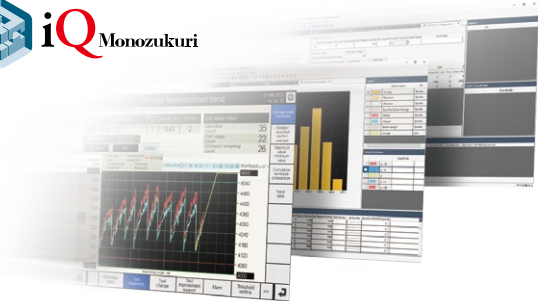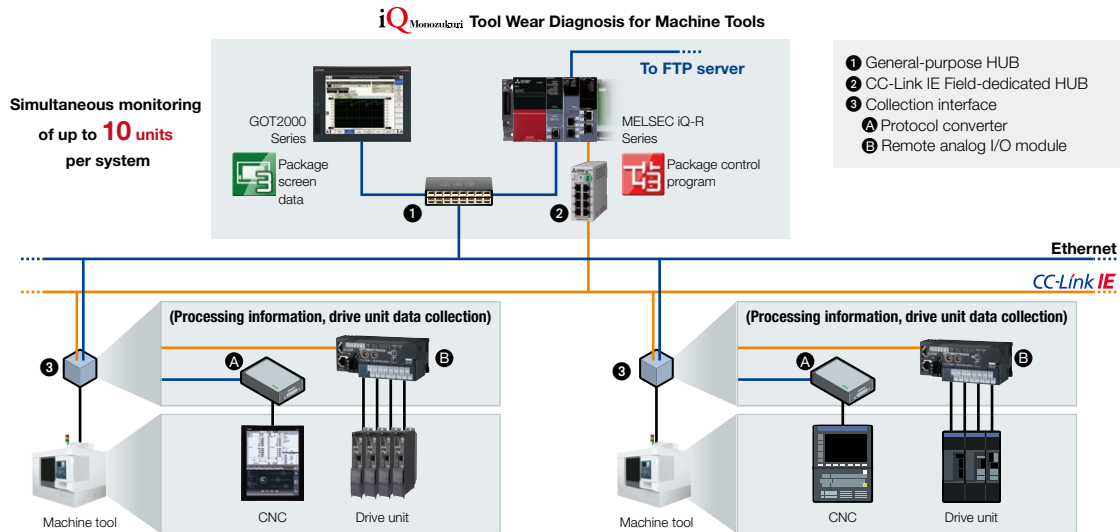
Items included in package

MELSEQ 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].

iQ Monozukuri Tool Wear Diagnosis for Machine Tools

Simultaneous monitoring
of up to **10** units
per system

To FTP server

GOT2000 Series
Package screen data

MELSEC iQ-R Series
Package control program

❶ General-purpose HUB
❷ CC-Link IE Field-dedicated HUB
❸ Collection interface
  Ⓐ Protocol converter
  Ⓑ Remote analog I/O module

Ethernet
CC-Link IE

(Processing information, drive unit data collection)

Machine tool   CNC   Drive unit

Machine tool   CNC   Drive unit

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

Reduce Cost

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.

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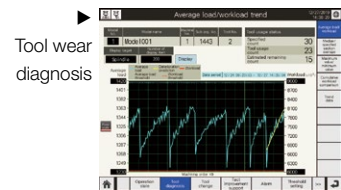
Automatically detect machining defects immediately after processing (before inspection) and perform machine maintenance according to changes in machining variation

Maintain Quality

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.

▶ Maintain Quality
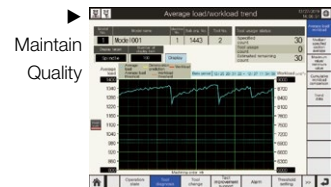
Utilize machining data to improve takt time

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.

▶ Tact improvement support
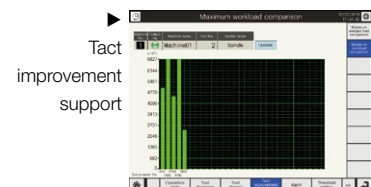
Advanced Data Science Tool*[1]
(Engineering environment that promotes digital transformation)

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.
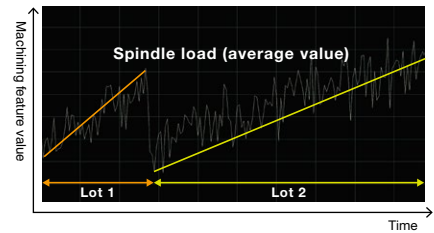
❶ Understand the difference in waveforms between an air-cut and actual machining
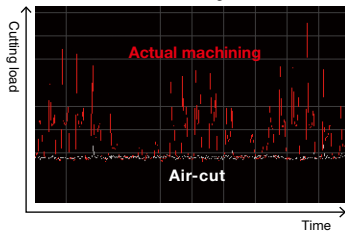
❷ Understand the difference in waveforms between worn and new tools
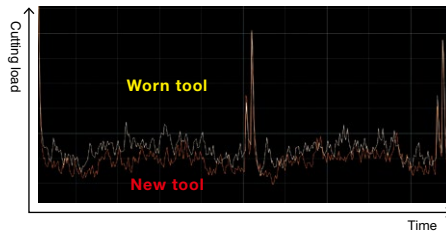
❸ Comparison of deterioration trends due to differences between lots

## 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
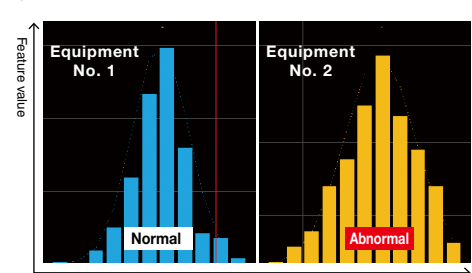
❶ Check the variation in machining trends
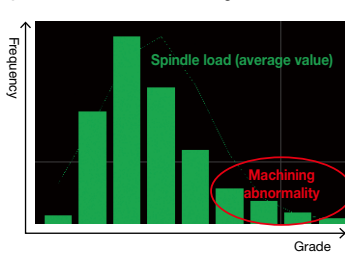
❷ Check the correlation between measurement values, inspection values, and feature values

Correlation between feature values and measurement/inspection values
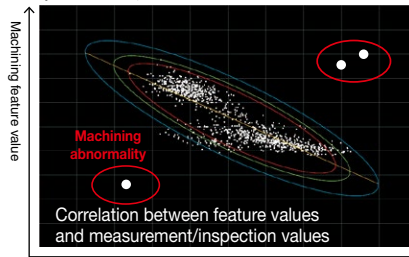
❸ Check the variation of feature values between devices

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.

❶ Automatic calculation of a predictive model

Regression Statistics

Correlation Coefficient	R-squared	Adjusted R-square	F value	Degree Of Freedom	ESS	RSS
0.918239	0.843164	0.836827	133.058462	198.000000	1838.207427	341.922137

Multiple Regression Equation

	Feature Value	CH	Partial Regression Coefficient/Intercept	Standard Error
Objective Variable	Measured Value 23		1254.736052	100.937731
Explanatory Variable	Average Value	CH1	-0.153339	0.005110
Explanatory Variable	Integral Value	CH4	-1.102982	2.538603
Explanatory Variable	Maximum Value	CH2	0.000004	0.000001
Explanatory Variable	Average Value	CH6	-0.006360	0.043054
Explanatory Variable	Integral Value	CH3	-0.000000	0.000002
Explanatory Variable	Average Value	CH5	0.083327	0.124284
Explanatory Variable	Integral Value	CH7	-0.000002	0.000005
Explanatory Variable	Minimum Value	CH8	-0.000006	0.000003

❷ Cross-validation using learning data and validation data*[2]
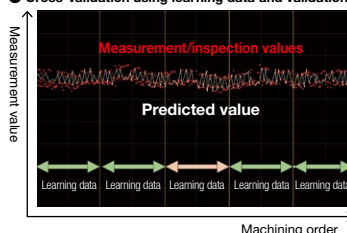
❸ Confirmation of prediction accuracy
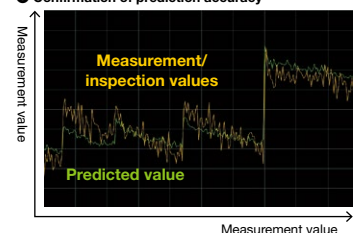
*2 All data of processes mass-produced under identical processing conditions are divided into five data groups; four of which are used to automatically generate predication models as learning data groups. Using these prediction models, finished quality is predicted from the remaining data group, and the deviation between the actual measurement and prediction is verified.
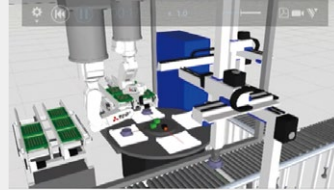
3D Simulator MELSOFT Gemini

MELSOFT Gemini is a 3D simulator that lets you pre-verify line devices and equipment in digital space, streamline each manufacturing process, and troubleshoot errors. Line and equipment simulation allows pre-verification of line productivity and equipment operation, supporting fast and simplified launch of actual equipment and lines.
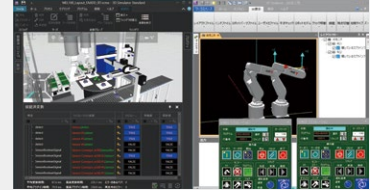
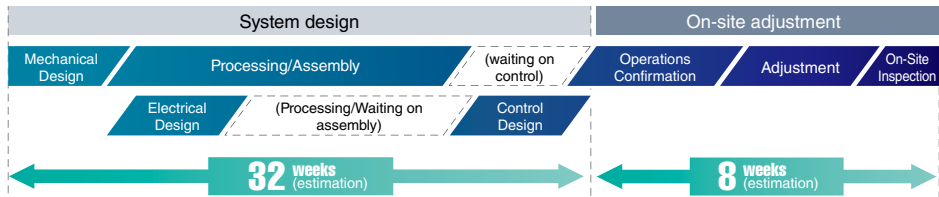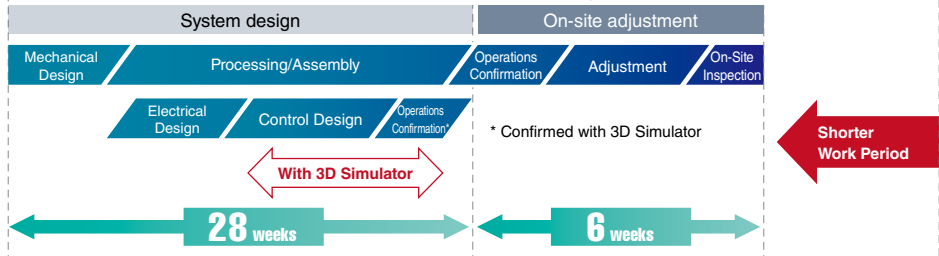| Line simulation	Equipment simulation	
Simulate flow lines of people, robots and AGVs, and line operating rate	Check interference in 3D space before launch	Confirm control logic by connecting 3D simulator to various controllers

Benefits of 3D simulator MELSOFT Gemini

During the line design/verification phase, the 3D simulator allows engineers to design equipment layouts and components optimal for production, increasing productivity, improving quality, and reducing cost.
During mechanical/electrical/control design phases, the 3D simulator allows front loading of operations confirmation and adjustment, shortening the work period from equipment design to on-site adjustment.

Conventional Design Phase and Work Duration

System design — Mechanical Design / Processing/Assembly / (waiting on control) ; Electrical Design / (Processing/Waiting on assembly) / Control Design — 32 weeks (estimation)

On-site adjustment — Operations Confirmation / Adjustment / On-Site Inspection — 8 weeks (estimation)

Design Phase and Work Duration with 3D Simulator

System design — Mechanical Design / Processing/Assembly / Operations Confirmation / Adjustment / On-Site Inspection ; Electrical Design / Control Design / Operations Confirmation* ; With 3D Simulator — 28 weeks

On-site adjustment — * Confirmed with 3D Simulator — 6 weeks

Shorter Work Period

Cost effectiveness example

| Initial cost	Construction period	Introduction effectiveness	Payback period
● Gemini software cost ● Training cost ● Labor cost to develop a system using Gemini	Approx. **6** weeks shorter * When SI costs **80 thousand** yen per day, cost reduces by **2.4 million** yen (5 days × 6 weeks).	6-week production profit due to shorter startup time * When production profit per day is **2.7 million** yen, profit increases by **81 million** yen (5 days × 6 weeks).	Approx. **5** days * Calculation example for the following case:Initial cost = 15 million Cost reduction due to shorter construction period = 2.4 million Introduction effectiveness = 2.7 million

Simple equipment layout with an abundant e-catalog

Contains all the parts necessary for line layout verification, including robots, conveyors, and machine tools (approx. 2800 parts).
Mitsubishi Electric robots are also included in the lineup, with emphasis on the MELFA RH and RV Series. Layout is possible by dragging & dropping parts and performing simply settings.
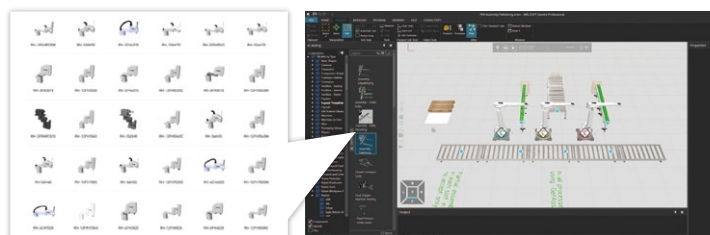
Pre-verification of machine operation & control program

Link Gemini 3D simulator with MELSOFT simulators to confirm control logic in 3D space without actual machines.
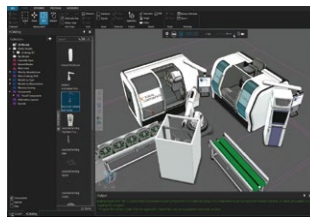
3D Simulator MELSOFT Gemini

MELSOFT iQ Works

(Program debug)
MELSOFT simulators (control design)

- PLC Simulator
- Motion Controller Simulator
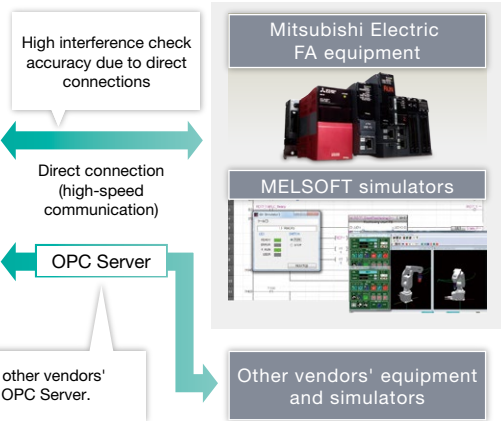- Robot Simulator
- HMI Simulator

Direct connection to Mitsubishi Electric simulators and equipment

OPC servers are unnecessary*1 because the 3D simulator directly connects to various simulators and factory automation equipment manufactured by Mitsubishi Electric, which increases the accuracy of mechanical interference checks compared to an OPC connection. The elimination of the OPC servers reduces labor hours to set up.
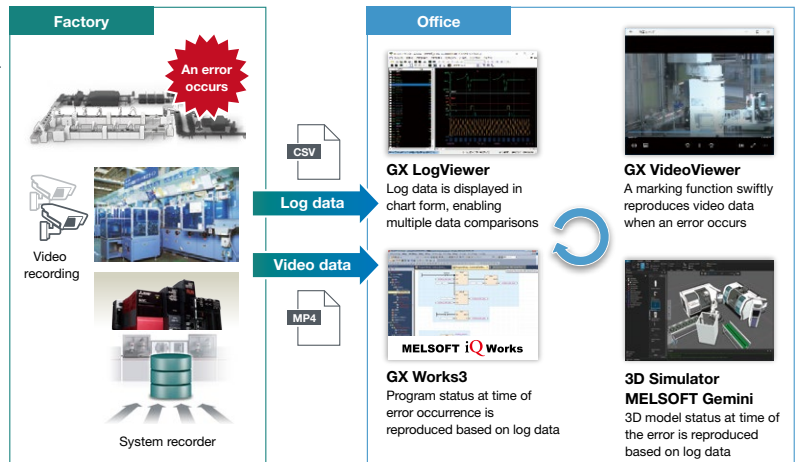*1 Connect other vendors' equipment through OPC servers.

3D Simulator MELSOFT Gemini

High interference check accuracy due to direct connections

Direct connection (high-speed communication)

OPC Server

Connection with other vendors' equipment via OPC Server.

Mitsubishi Electric FA equipment

MELSOFT simulators

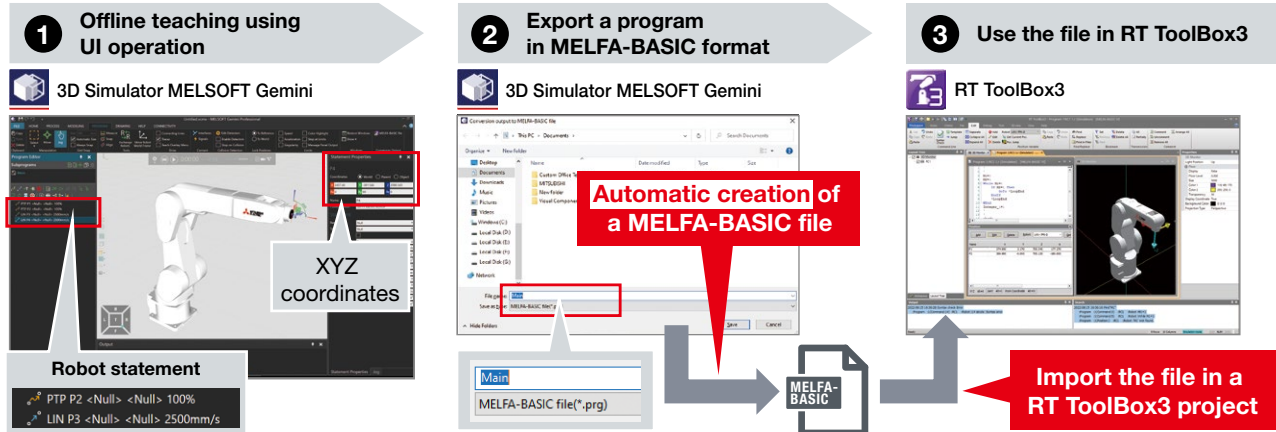Other vendors' equipment and simulators

Error reproduction with system recorder display

Operations can be compared in 3D with the 3D simulator in addition to ladder monitor display, waveform display, and video data display of log data. Examination of detailed operation status before and after an error leads to quick troubleshooting.

Factory

Office

An error occurs

Video recording

System recorder

CSV
Log data

Video data
MP4

GX LogViewer
Log data is displayed in chart form, enabling multiple data comparisons

GX VideoViewer
A marking function swiftly reproduces video data when an error occurs

MELSOFT iQ Works

GX Works3
Program status at time of error occurrence is reproduced based on log data

3D Simulator MELSOFT Gemini
3D model status at time of the error is reproduced based on log data

MELFA-BASIC program conversion output function

This function automatically generates a MELFA-BASIC program based on a robot statement of a Mitsubishi Electric robot for which teaching has been conducted in MELSOFT Gemini. This reduces time required to prepare control programs.

1 Offline teaching using UI operation

3D Simulator MELSOFT Gemini

XYZ coordinates

Robot statement

PTP P2 <Null> <Null> 100%
LIN P3 <Null> <Null> 2500mm/s

2 Export a program in MELFA-BASIC format

3D Simulator MELSOFT Gemini

Automatic creation of a MELFA-BASIC file

Main

MELFA-BASIC file(*.prg)

MELFA-BASIC

3 Use the file in RT ToolBox3

RT ToolBox3

Import the file in a RT ToolBox3 project

Open Platform Edgecross

Our manufacturing site expertise is consolidated into solutions.

Coordination of the production floor and IT system ··········

IT Gateway handles various IT protocols. You can realize seamless data coordination between various IT systems,
including analytical systems and/or Manufacturing Execution Systems (MES) in the cloud and/or on-premise server, to optimize the supply chain and engineering chain.
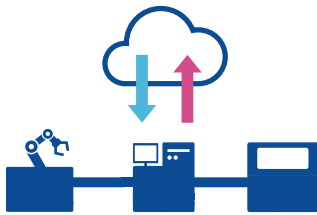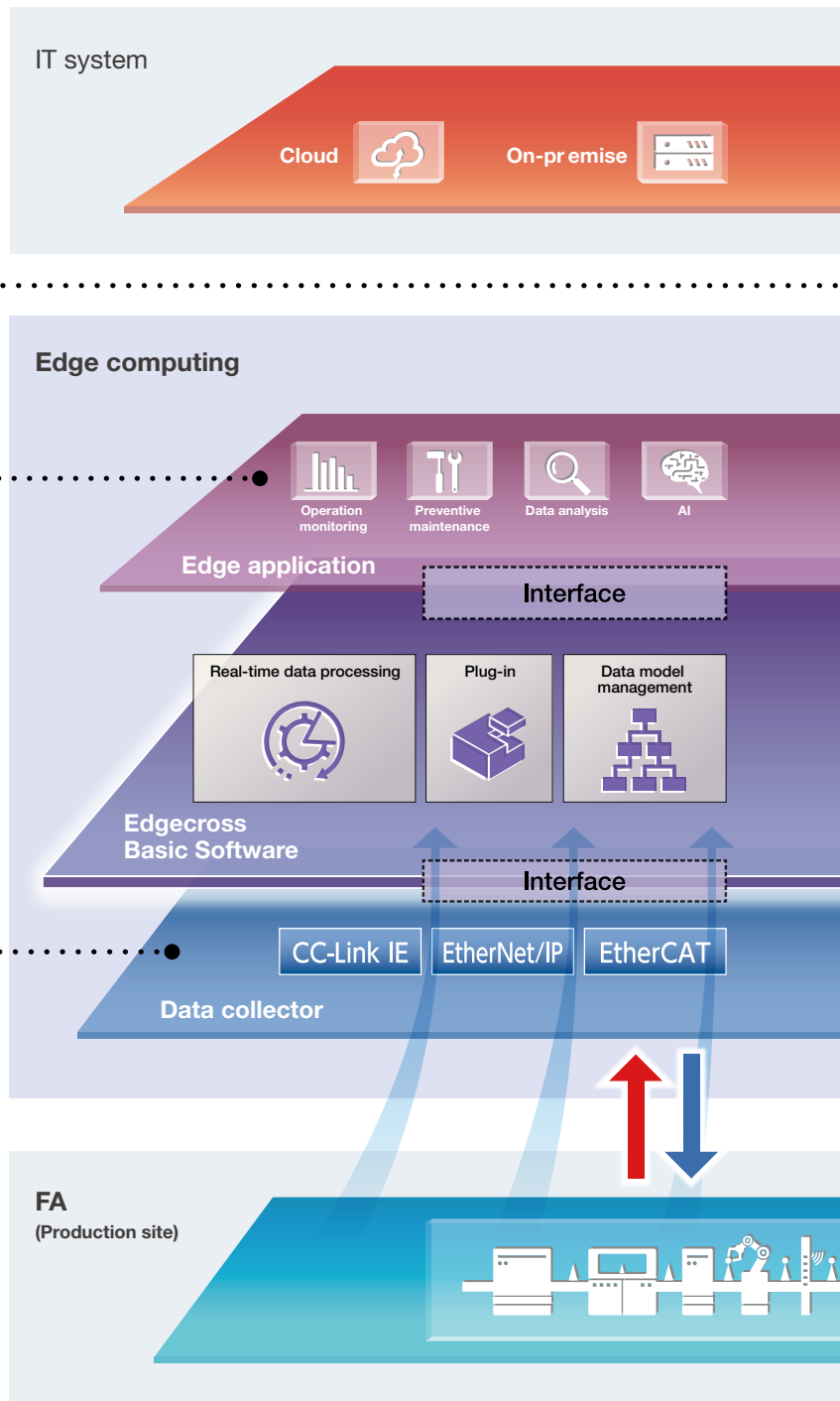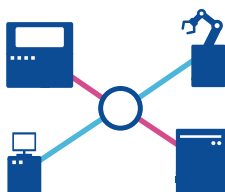
Providing diverse solutions ····

A wide variety of edge applications that handle operation monitoring, preventative maintenance, and so on is available. By choosing appropriate applications based on your needs, you can find a solution within the edge computing layer.
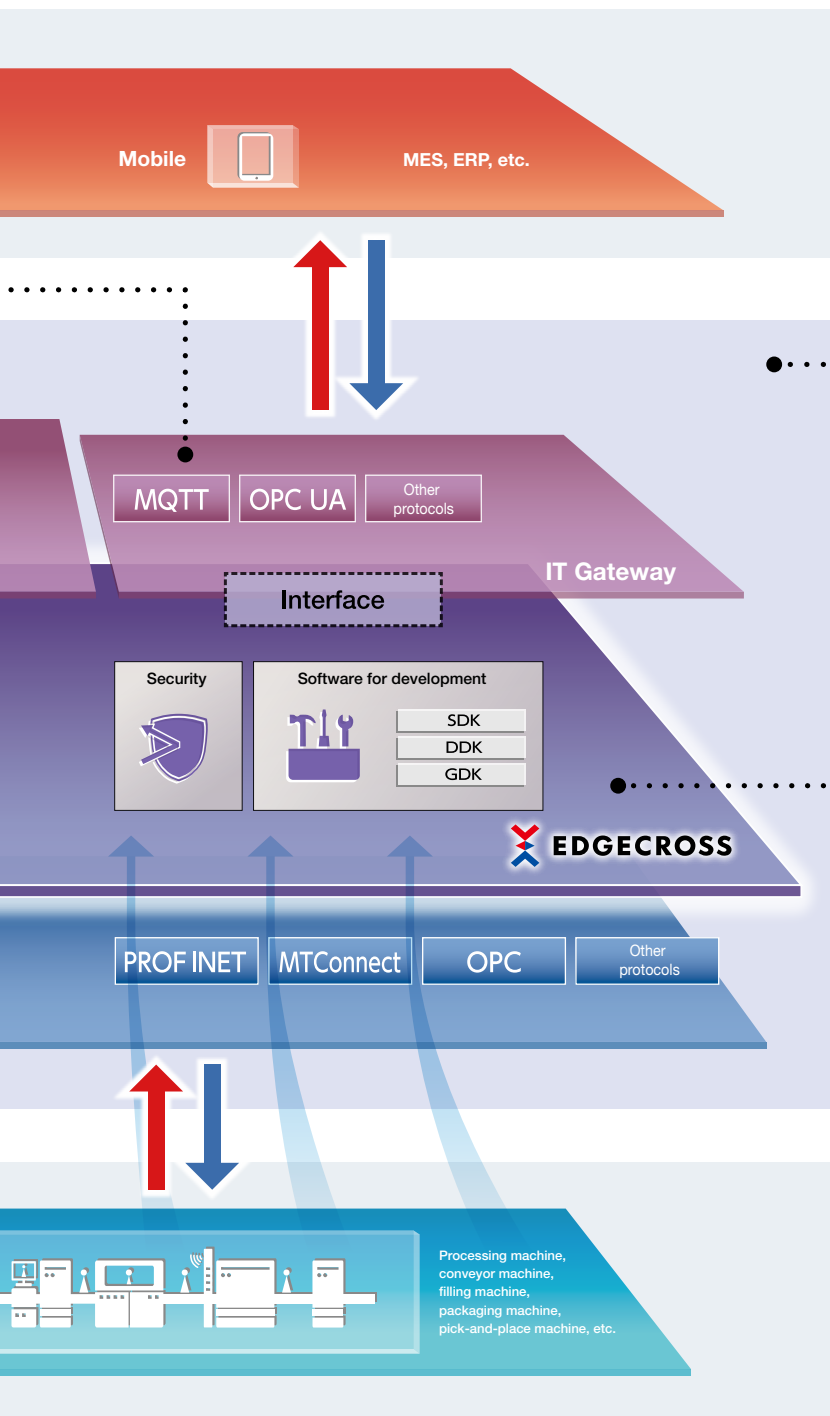
Collect data from any equipment ··········

By choosing appropriate data collectors based on your production site network, you can absorb network differences. Regardless of old or new, or manufacturer of equipment, you can easily collect and use data from various devices, equipment, lines, and cells.

IT system

Cloud   On-premise

Edge computing

Operation monitoring   Preventive maintenance   Data analysis   AI

Edge application

Interface

Real-time data processing   Plug-in   Data model management

Edgecross Basic Software

Interface

CC-Link IE   EtherNet/IP   EtherCAT

Data collector

FA
(Production site)

In Edgecross's solutions, our consortium's knowledge and expertise of the manufacturing site is consolidated.

By combining our Edgecross Basic Software with "Data Collector", "Edge Application"and "IT Gateway",

in accordance with your needs, your desired solution can be realized.

Mobile

MES, ERP, etc.

MQTT OPC UA Other protocols

IT Gateway

Interface

Security

Software for development

SDK
DDK
GDK

EDGECROSS

PROF INET MTConnect OPC Other protocols

Processing machine,
conveyor machine,
filling machine,
packaging machine,
pick-and-place machine, etc.

Abundance of operating environment

Edgecross doesn't rely on a specific hardware, and operates on various industrial PCs. You can use the industrial PC that you are already using.

Abundance of functions for utilizing data

Edgecross Basic Software has an abundance of functions that easily utilize data, from data collection to data feedback. By combination with Edge applications and IT systems, you can realize various solutions.
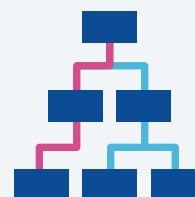
Real time data processing function

Produces time-series data in real time collected from production site and makes real-time analysis and diagnosis.

Data model management function

Manages production site data in hierarchy and abstraction manner for easy data utilization.
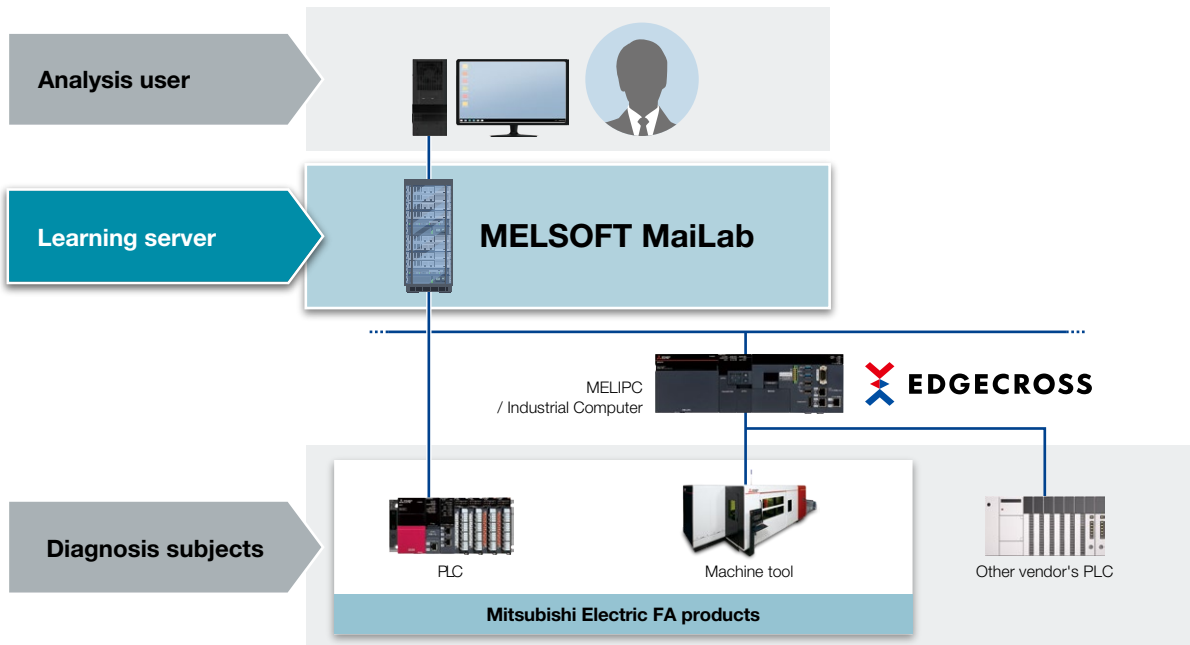
Data Science Tool MELSOFT MaiLab

Mitsubishi Electric's Data Science Tool MELSOFT MaiLab is a data science tool that further improves manufacturing by replacing "human experience and intuition" with digital technology and enabling it to be easily incorporated into control systems.
It utilizes AI technology such as deep learning and offers a variety of analysis methods, enabling automation of processes that used to rely on the experience of skilled workers, saving workforce, and improving quality and productivity.

MELSOFT MaiLab

Connectivity with a variety of manufacturing equipment and other vendors' PLCs in addition to Mitsubishi Electric PLCs

Connect MaiLab with Mitsubishi Electric PLCs directly, or connect it with other vendors' PLCs and manufacturing equipment using Edgecross.

Analysis user

Learning server — MELSOFT MaiLab

MELIPC / Industrial Computer

EDGECROSS

Diagnosis subjects

PLC · Machine tool · Other vendor's PLC

Mitsubishi Electric FA products

Shop floor data analysis/diagnosis without any specialized knowledge

The AI automatic learning function "AutoML" in MaiLab allows workers without specialized knowledge to analyze and diagnose the data from a shop floor to improve productivity. Workers with knowledge of AI can also use Python® code to customize AI as required.

Let AI manage data analysis

The AutoML function automatically conducts everything from the pre-processing of data to learning models

Automatic execution

Data → Pre-processing selection → Analysis method selection → Learning → AI → Learning model
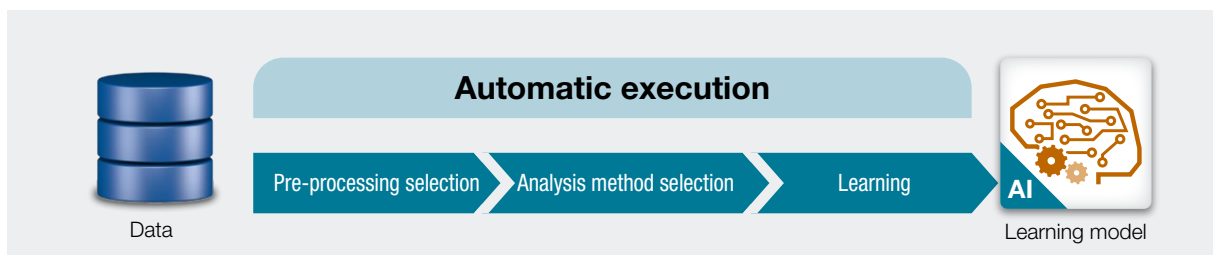
Flexible system configurations allow data analysis/diagnosis in ideal configurations

In addition to a basic license, licenses for analysis and licenses for diagnosis are also available. These additional licenses can be purchased as required according to the needs of each customer.
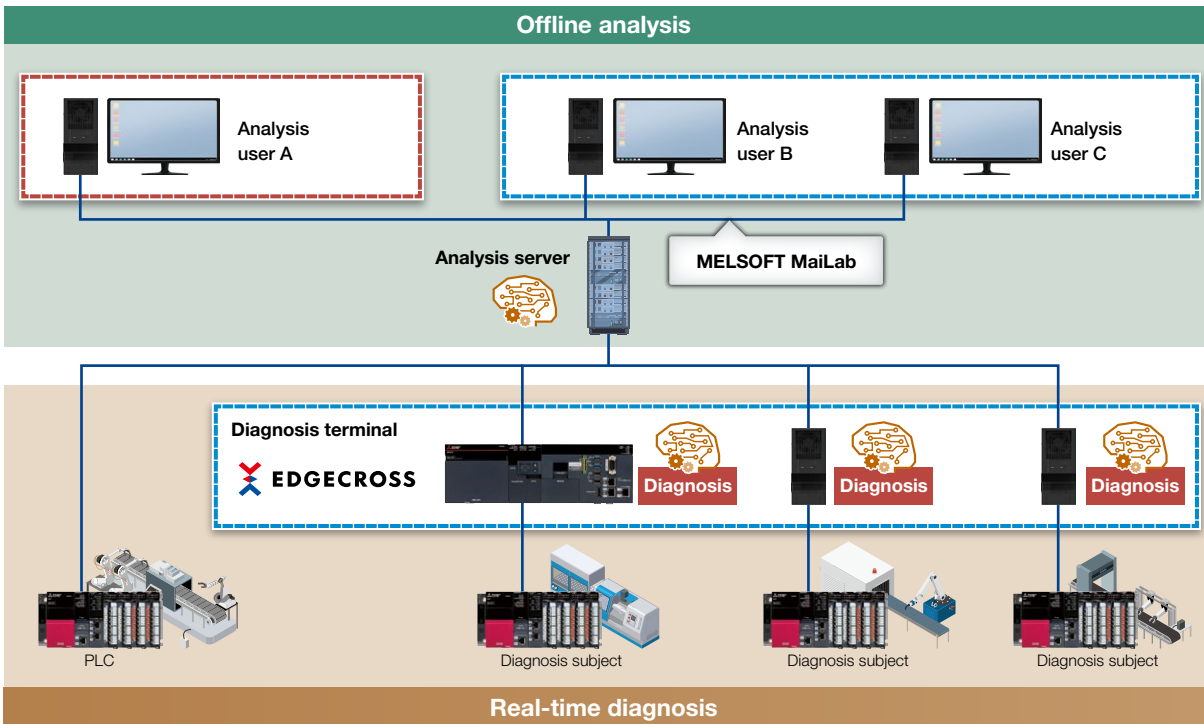
Graphical viewing for intuitive operation

An intuitive operation makes data analysis/diagnosis easy. Data from a shop floor can be displayed in a variety of graphs with sophisticated user-interface design, which enables users to analyze data from various points of views.
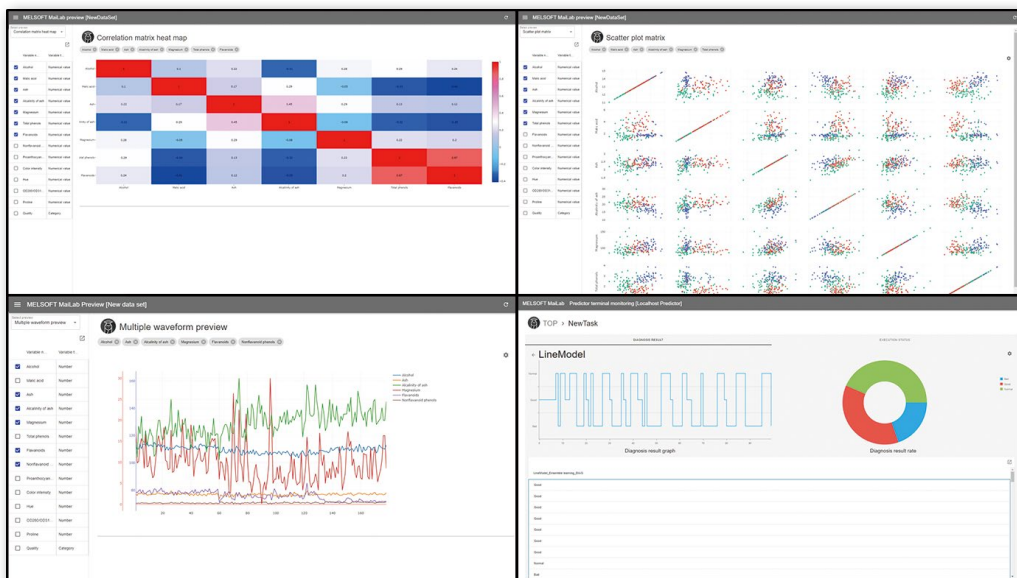
Industrial Computer MELIPC Series

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.

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

Edgecross[*1], a software platform in the edge computing domain, is preinstalled, therefore through combination with Edgecross-compatible software, it supports preventive maintenance and building of systems for quality improvement, etc. by utilizing shop floor data.

*1 An open software platform provided by the Edgecross Consortium, a general incorporated association.
https://www.edgecross.org/en/solution/feature.html

MI5000

Windows®   **VxWorks®**

One module realizing production data processing and real-time control

By running Windows® and VxWorks® real-time OS at the same time, one module can realize both device control and information processing, reducing system configuration cost and space.
Control data and production data of devices can be communicated at 1 ms via CC-Link IE Field Network, realizing highly accurate device control and high-speed production data collection.

Intel® Core™ i7

MI3000

Windows®   **VxWorks®**

All-in-One panel computer with high-resolution touch panel equipped as standard

Large-screen and high-resolution LCD panel is equipped as standard for data display and touch operation. Light-touch operation is realized with a PCAP touch panel that is widely used for smartphones and tablet devices. The touch panel with high transmittance offers clear and high visibility display. In addition, pre-installed software GT SoftGOT2000[*2] enables the same monitoring functions as the GOT2000 Series.
*2 GT SoftGOT2000 license key (for USB port) (sold separately) is not required.

GT SoftGOT2000   **21.5" widescreen Full HD**

MI2000

Windows®

Achieving optimum IoT for the production shop floor with flexible system expansion

Intel® Core™ i3 is adopted as the CPU, and performs not only data collection, but also simple analysis, diagnosis, and monitoring of collected data to contribute to quality improvement. It also features a 2.5" HDD/SSD slot[*3] and a PCI Express®/PCI slot[*4] to accumulate large amounts of data and expand functionality.
*3 Only MI2000 has 2.5-inch HDD/SSD slot.
*4 MI3000 has PCI Express® only.

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 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
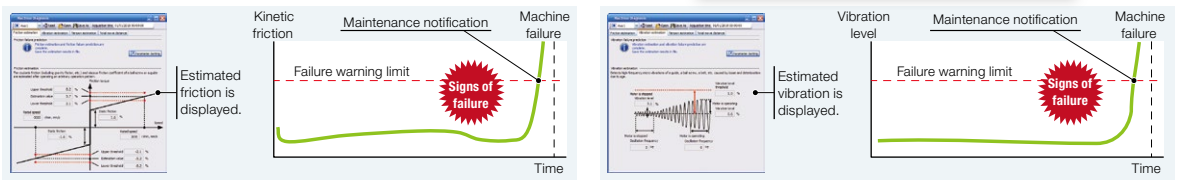
Machine Diagnosis (Belts)

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
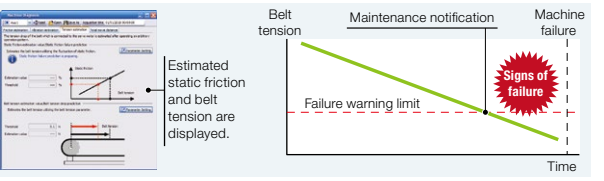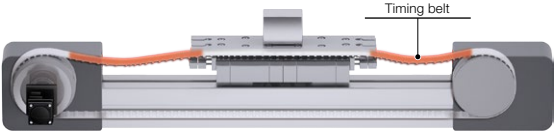
Machine Diagnosis (Gears)*

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.
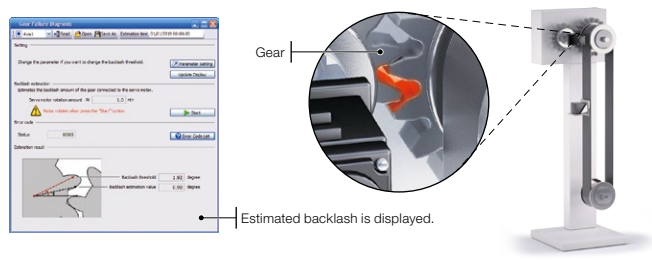
FREQROL-E800 Series

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."[2]
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)[3]	CC-Link IE Field Network Basic	MODBUS®/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™)"[5] makes it possible to identify signs of inverter damage caused by corrosive gases such as hydrogen sulfide.[6] 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.
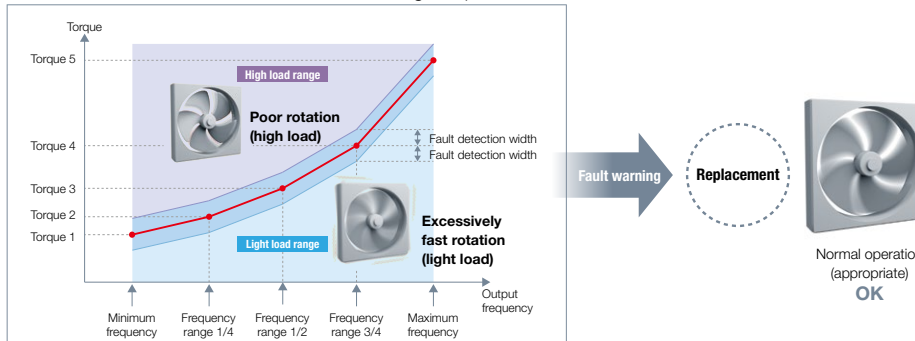
FR Configurator2 (Inverter setup software)

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.

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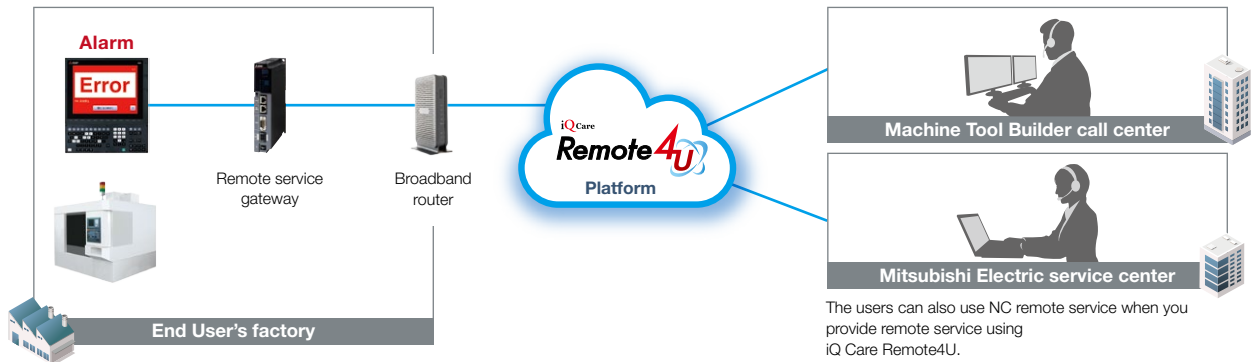
[CNC] Remote Service (for Machine Tool Builder)

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

The users can also use NC remote service when you provide remote service using
iQ Care Remote4U.

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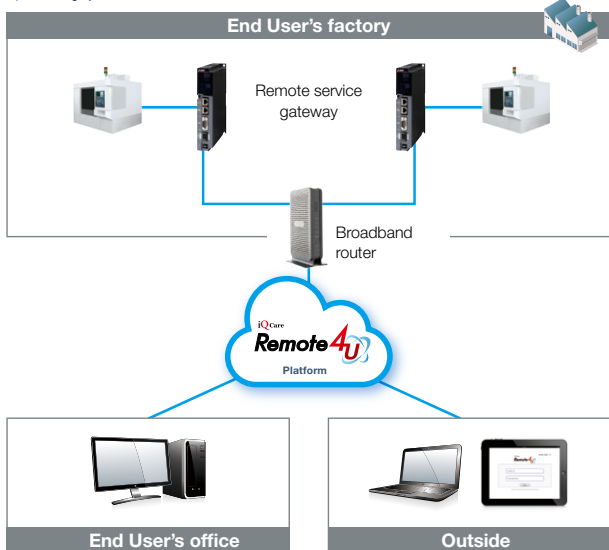
You can access the data via a web browser on
your PCs, smartphones, and tablet PCs without
installing dedicated software.
(ID and password must be entered.)

Remote diagnostics

Remote diagnostics improves maintainability
Mitsubishi Electric service center remotely supports the maintenance of Mitsubishi
Electric CNCs on your machines.
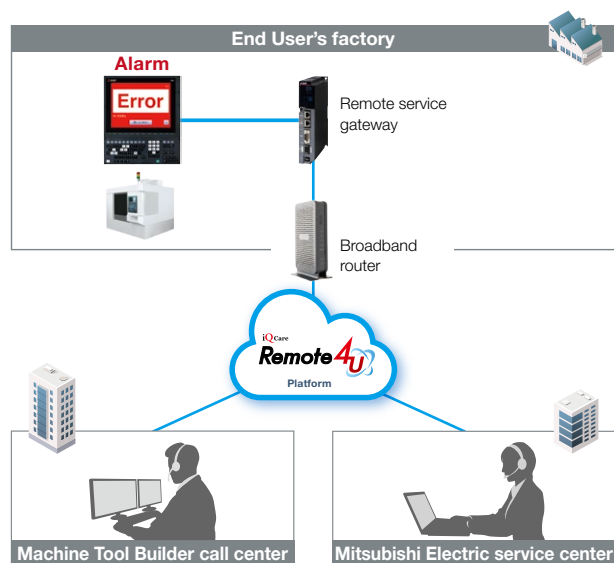
With a contract with an MTB that has the iQ Care
Remote4U platform license, remote diagnosis of
machines is also available.

iQ Care MELFA Support

This product is sold only in Japan as of June 2023 (Planned to be sold overseas sequentially). For more information on this product, contact your local sales office.

iQ Care MELFA Support is an option product that offers three services - monitoring, inspection, and extended warranty services for MELFA FR series/ CR series/ASSISTA robots. The monitoring service detects robot failures in advance by monitoring normal operation and detecting errors, contributing to productivity improvement. In addition to the robot inspection service, the extended warranty service is also provided for a stable operation of the robot system.
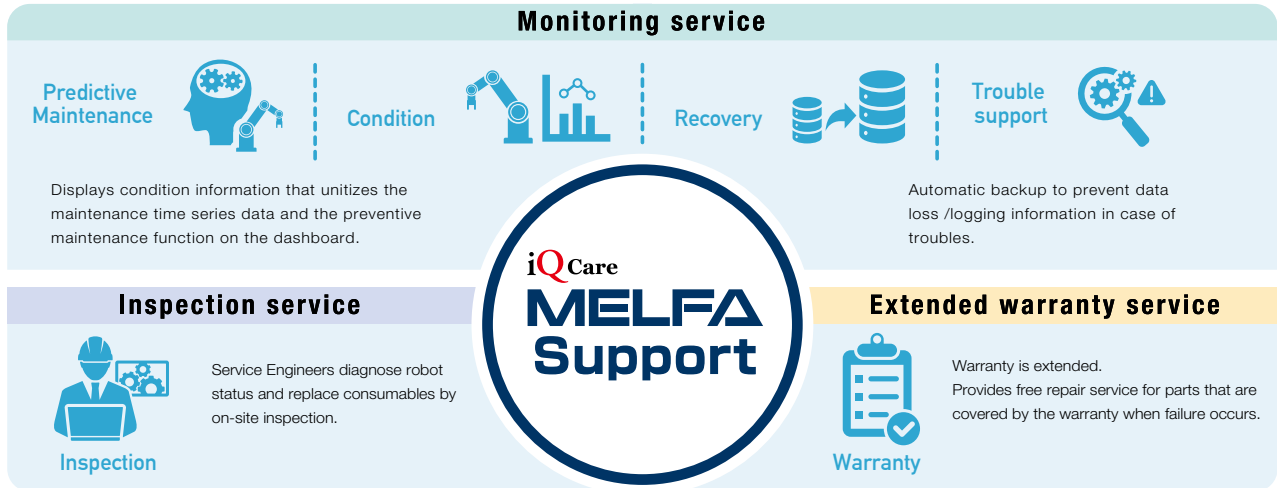
Three services - Supporting you and your MELFA robots together

Monitoring service

Predictive Maintenance / Condition / Recovery / Trouble support

Displays condition information that unitizes the maintenance time series data and the preventive maintenance function on the dashboard.

Automatic backup to prevent data loss /logging information in case of troubles.

iQ Care MELFA Support

Inspection service

Service Engineers diagnose robot status and replace consumables by on-site inspection.

Inspection

Extended warranty service

Warranty is extended.
Provides free repair service for parts that are covered by the warranty when failure occurs.

Warranty

Six plans - iQ Care MELFA Support plan options

Plan option	Model	Monitoring service		Inspection service		Extended warranty service
		Predictive Maintenance function	Condition management function Recovery function Trouble support function	Simple inspection	Detailed inspection	Extended warranty
1-year extended warranty plan	RA-1W00M□□	1 year	Unlimited	Not provided	Not provided	1 year
2-year extended warranty plan	RA-2W00M□□	2 years				2 years
Inspection service simple inspection plan	RA-0W11M□□	1 year	Unlimited	Once	Not provided	Not provided
Inspection service detailed inspection plan	RA-0W21M□□			Not provided	Once	
1-year extended warranty + Inspection service simple inspection plan	RA-1W11M□□	1 year	Unlimited	Once	Not provided	1 year
1-year extended warranty + Inspection service detailed inspection plan	RA-1W21M□□			Not provided	Once	

* This product is also applicable to existing robots (the selectable plan varies depending on whether it is within the free warranty period or not). For details, refer to the catalog/manual.
* For details of supported robot models/supported software versions, refer to the catalog/manual.
* □□ is replaced by an alphabet representing the country.

Support for stable operations and quick troubleshooting

Stable operation support

The monitoring/inspection services prevent failures of industrial robots with many components, ensuring a stable operation.

Robot▶ **Monitoring service** Predictive Maintenance function/maintenance simulation/condition management

Inspection service Consumable replacement/condition check/preventive work

Design/Set-up

Production/ Operation — Monitor the mechanical parts of the robot body (reduction gear/motor, etc.) and **replace them before failure.**

Trouble occurred

Maintenance/ Repair — **Prevent failures** through consumables replacement and preventive work. The condition check recommends the replacement of deteriorating parts at an early stage.

Troubleshooting support

Monitoring service Recovery function/drive recorder function

A variety of software is available for **quick troubleshooting**

Controller▶ **Extended warranty service** In case of sudden electronic components failures, **a free repair service** is available by extending the warranty period.
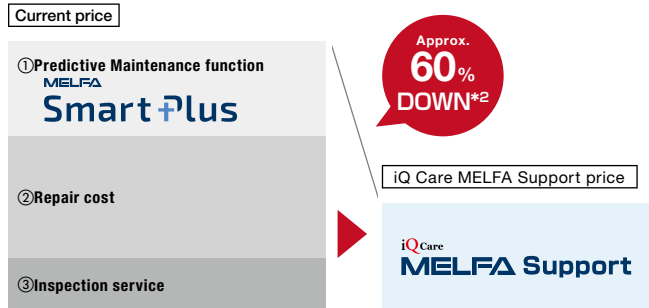
Cost effectiveness

iQ Care MELFA Support is a cost-effective product offering the following services:

❶ "Predictive Maintenance function*1" of MELFA Smart Plus, which is an option function for robots, is available. Furthermore, the newly-developed monitoring service is also available providing various software functions.

❷ Repair costs in case of sudden failure are covered by the extended warranty service.

❸ The price includes inspection service fees, offering a great deal.

*1 The Predictive Maintenance function is available
   for one year or within the warranty period.

*2 This example shows the case when purchasing the Extended warranty service + Inspection service (simple inspection) plan and repairing parts that are covered by the warranty (CPU module).

*3 For parts that are covered by the warranty, refer to the catalog.

Current price

① Predictive Maintenance function
MELFA
Smart Plus

Approx.
60%
DOWN*2

② Repair cost

iQ Care MELFA Support price

③ Inspection service

iQ Care
MELFA Support

Easy setup

Purchase iQ Care MELFA Support as a robot option. Select from just six plan options without having to go through the troublesome procedure of exchanging contracts *4.

*4 Confirm the terms in the catalog prior to purchase.
   For -R-Q type controllers, it is necessary to add a cable (prepared by the customer) between the controller and the CPU.
   Change the parameters to enable the Predictive Maintenance function.

SD
MELFA
Support

MELFA Smart Plus

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

■ MELFA Smart Plus functions

Function	Description	Type
Predictive Maintenance function	Failing drive parts are detected before abnormalities in robot behavior become apparent. Downtime of production equipment is reduced.	B FUNCTION
Preventive Maintenance function	Tracking the robot's operating status helps managing the robot's condition. Maintenance is now even more efficient.	A FUNCTION
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 FUNCTION
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 FUNCTION
Calibration assistance function	Easy set-up of 2D vision sensors and improved job precision. Time-consuming teaching is automated improving also the accuracy.	A FUNCTION
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.	A FUNCTION
Robot mechanism thermal compensation function	Compensates for thermal expansion of the robot arm to increase position accuracy.	A FUNCTION
2D vision sensor enhancement function NEW	A variety of vision applications make vision alignment set-up easy.	A FUNCTION

MELFA
Smart Plus

A FUNCTION **Intelligent function**
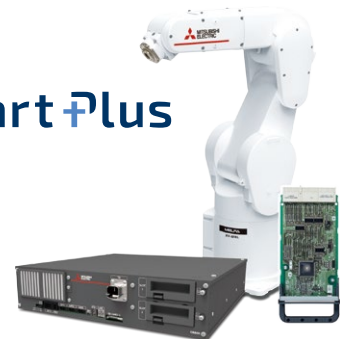
B FUNCTION **AI function**

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."
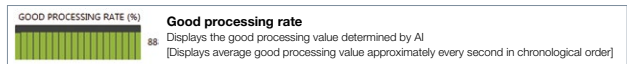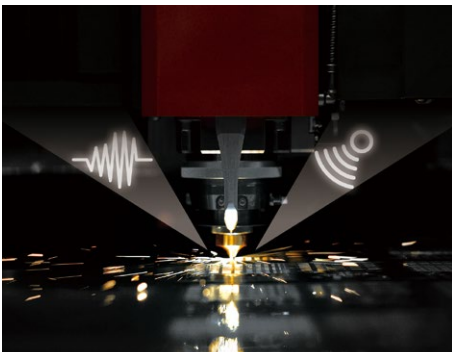
*   According to in-house research as of April 2019.
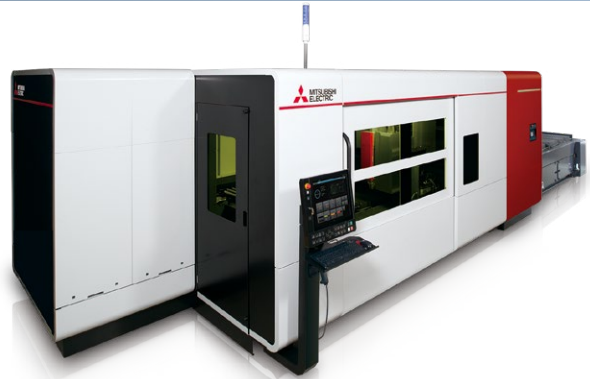
AI assist

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 preformed automatically.
In addition, AI diagnostics enables operators to always be aware of the machining status.

GOOD PROCESSING RATE (%)   88   **Good processing rate**
Displays the good processing value determined by AI
[Displays average good processing value approximately every second in chronological order]

**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.

Examples of diagnostics

Minute differences in nozzle holes can also be diagnosed
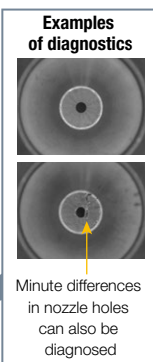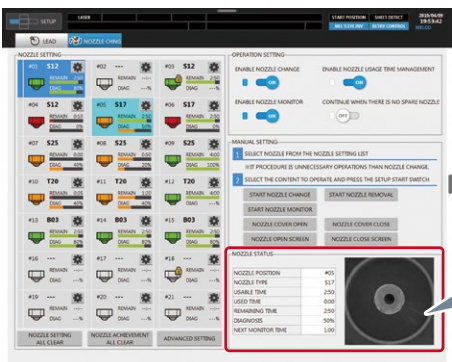
Nozzle OK
Automatically adjusts processing conditions

Nozzle NG
Automatically changes nozzle using nozzle changer

MEMO
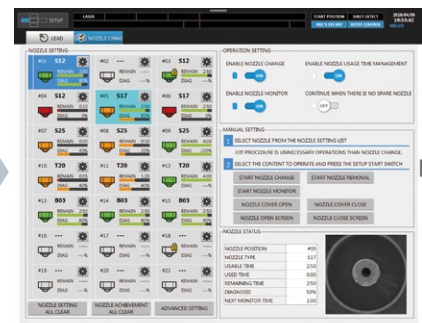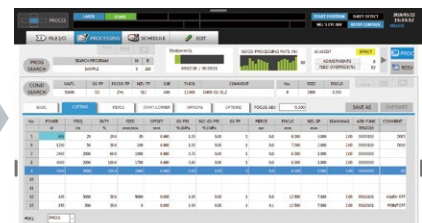
e-F@ctory Alliance

PARTNERS

Partners

MITSUBISHI ELECTRIC

Broad knowledge and skill as a comprehensive FA manufacturer

e-F@ctory Alliance

- Software Partner
- SI Partner
- Device Partner

Know-how of all fields relating to monozukuri

Co-creation

Customer

Giving customers back the values born from co-creation

e-F@ctory Alliance

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 June 2023

Collaborating with the partners across the world

SI Partner

Producing entire production systems
Achieving advanced systems integration

IT

Production shop floor
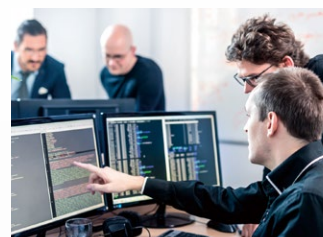

Robots

Software Partner

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

ERP/MES/SCADA

CAD/CAM/3D simulator

Data analysis

Device Partner

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.
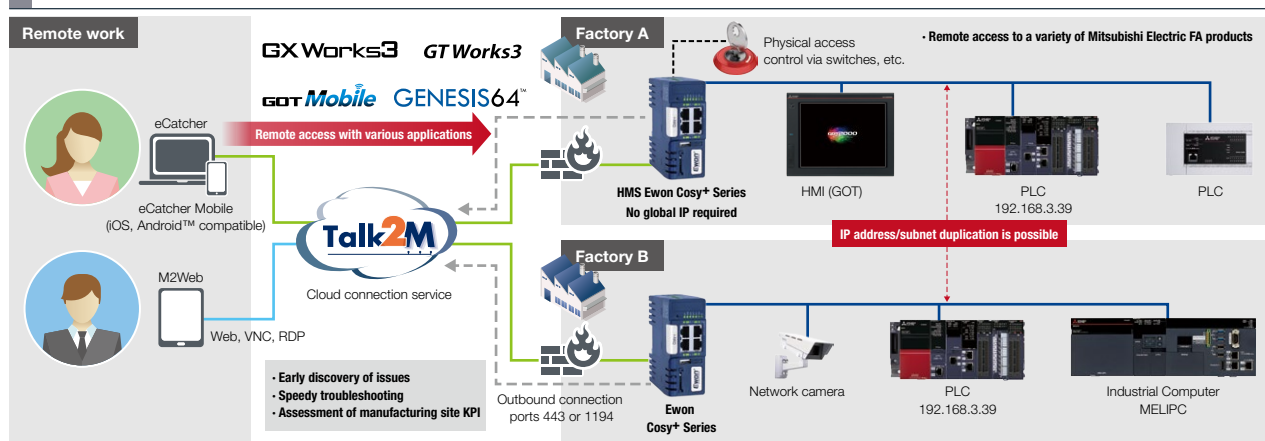Setup is easy, not requiring any IT knowledge and will be finished in a few minutes.
In addition to remote connection by PC, apps for tablets and smartphones are available.
It is possible to connect to MELEC or GOT from the browser of mobile terminals.
A secure connection is achieved through measures such as hardware security implementation, 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 security certification as a third-party certification.
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, industrial operating temperature range, and DIN rail mounting.

Conceptual image of remote access

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

| Ranked most reliable service in the North American market for six consecutive years | Easy setup that only an FA manufacturer can provide | Overwhelming number of VPN servers for connection anywhere in the world | Safe and robust connection with hardware security | Highly experienced, enriched manufacturer support | Robust product specifications suited to industrial environments |

Product data

Remote access gateway Cosy+			
Internet connection	Wired LAN	Wi-Fi	4G/LTE
Product model	EC71330	EC7133J	EC7133M
Common specifications	RJ45 x 4 (10/100 Mbps), USB x 1, DI x 2/DO x 1 Rating 12 to 24 VDC, Operating temperature range −25 to 60 °C, DIN rail mounting		

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

Free cloud service*1
Talk2M Free +

Number of registered devices	Unlimited
Number of registered users	Unlimited
Number of concurrent views	5
Number of concurrent connections	1
Monthly data volume	3GB

*1 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.
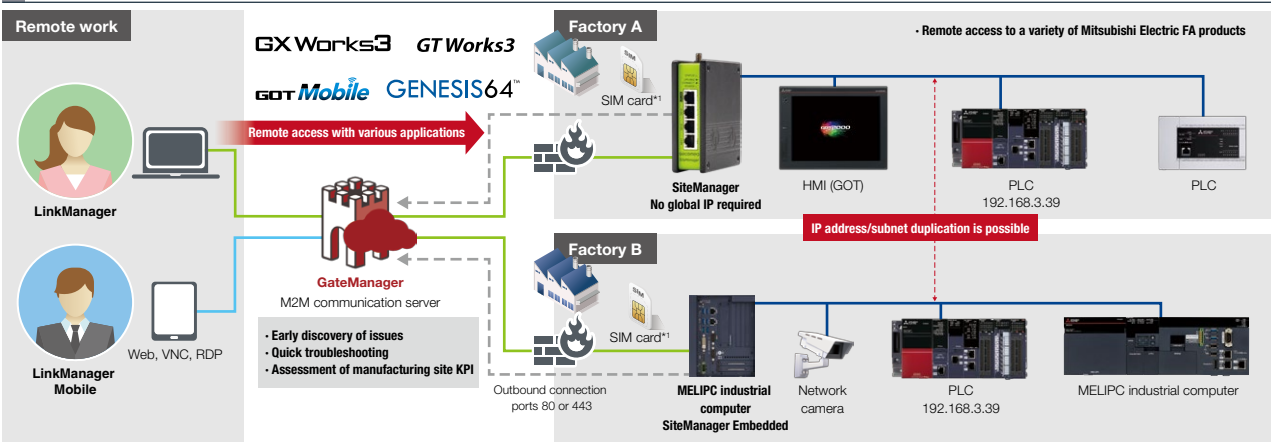
Secomea SiteManager Series

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.
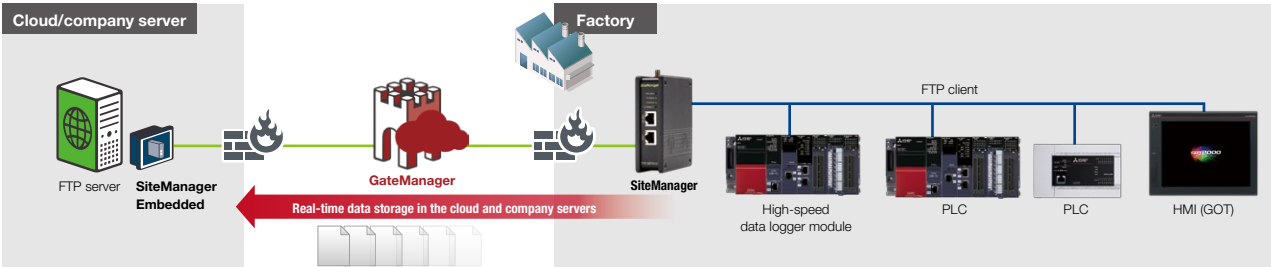
secomea
SiteManager

Conceptual image of remote access

Remote work

GX Works3   GT Works3
GOT Mobile   GENESIS64™

LinkManager

Remote access with various applications

GateManager
M2M communication server
• Early discovery of issues
• Quick troubleshooting
• Assessment of manufacturing site KPI

LinkManager Mobile

Web, VNC, RDP

Factory A
• Remote access to a variety of Mitsubishi Electric FA products

SIM card*1

SiteManager
No global IP required

HMI (GOT)

PLC
192.168.3.39

PLC

IP address/subnet duplication is possible

Factory B

SIM card*1

Outbound connection ports 80 or 443

MELIPC industrial computer
SiteManager Embedded

Network camera

PLC
192.168.3.39

MELIPC industrial computer

*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.

Cloud/company server

FTP server   SiteManager Embedded

Real-time data storage in the cloud and company servers

GateManager

Factory

FTP client

SiteManager

High-speed data logger module

PLC   PLC   HMI (GOT)

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
11xx/33xx
Series

SiteManager
15xx/35xx
Series

SiteManager Model number		Internet connection method		
		LAN	3G/4G	Wi-Fi
Number of device connections	5	1129	1139	1149
	10	1529	1539	1549
	25	3329	3339	3349
	100	3529	3539	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

MEMO

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
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⚠ For safe use

- To use the products given in this publication properly, always read the relevant
  manuals before beginning operation.
- The products have been manufactured as general-purpose parts for general
  industries, and are not designed or manufactured to be incorporated in a device or
  system used in purposes related to human life.
- Before using the products for special purposes such as nuclear power, electric
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Creating Solutions Together.

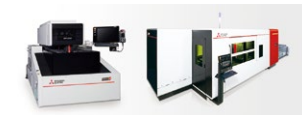|			
Low-voltage Power Distribution Products	Transformers, Med-voltage Distribution Products	Power Monitoring and Energy Saving Products	Power (UPS) and Environmental Products
Compact and Modular Controllers	Servos, Motors and Inverters	Visualization: HMIs	Edge Computing Products
Numerical Control (NC)	Collaborative and Industrial Robots	Processing machines: EDM, Lasers	SCADA, analytics and simulation software

Mitsubishi Electric's product lineup, from various controllers and drives to energy-saving devices and processing machines, all help you to automate your world. They are underpinned by software, innovative data monitoring, and modelling systems supported by advanced industrial networking and Edgecross IT/OT connectivity. Together with a worldwide partner ecosystem, Mitsubishi Electric factory automation (FA) has everything to make IoT and Digital Manufacturing a reality.

With a complete portfolio and comprehensive capabilities that combine synergies with diverse business units, Mitsubishi Electric provides a one-stop approach to how companies can tackle the shift to clean energy and energy conservation, carbon neutrality and sustainability, which are now a universal requirement of factories, buildings, and social infrastructure.

We at Mitsubishi Electric FA are your solution partners waiting to work with you as you take a step toward the realization of sustainable manufacturing and society through the application of automation.
Let's automate the world together!

Note: not all products are available in all countries

Country/Region, Sales office, Tel/Fax

USA	Mexico	Brazil
MITSUBISHI ELECTRIC AUTOMATION, INC.	MITSUBISHI ELECTRIC AUTOMATION, INC. Mexico Branch	MITSUBISHI ELECTRIC DO BRASIL COMERCIO E SERVICOS LTDA.
500 Corporate Woods Parkway, Vernon Hills, IL 60061, U.S.A.	Boulevard Miguel de Cervantes Saavedra 301, Torre Norte Piso 5, Int. 502, Ampliacion Granada, Miguel Hidalgo, Ciudad de Mexico, Mexico, C.P.11520	Avenida Adelino Cardana, 293, 21 andar, Bethaville, Barueri SP, Brasil
Tel :+1-847-478-2100 Fax:+1-847-478-2253	Tel :+52-55-3067-7500	Tel :+55-11-4689-3000 Fax:+55-11-4689-3016
Germany	UK	Ireland
MITSUBISHI ELECTRIC EUROPE B.V. German Branch	MITSUBISHI ELECTRIC EUROPE B.V. UK Branch	MITSUBISHI ELECTRIC EUROPE B.V. Irish Branch
Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany	Travellers Lane, UK-Hatfield, Hertfordshire, AL10 8XB, U.K.	Westgate Business Park, Ballymount, Dublin 24, Ireland
Tel :+49-2102-486-0 Fax:+49-2102-486-7780	Tel :+44-1707-28-8780 Fax:+44-1707-27-8695	Tel :+353-1-4198800 Fax:+353-1-4198890
Italy	Spain	France
MITSUBISHI ELECTRIC EUROPE B.V. Italian Branch	MITSUBISHI ELECTRIC EUROPE, B.V. Spanish Branch	MITSUBISHI ELECTRIC EUROPE B.V. French Branch
Campus, Energy Park Via Energy Park 14, Vimercate 20871 (MB) Italy	Carretera de Rubi, 76-80-Apdo. 420, E-08190 Sant Cugat del Valles (Barcelona), Spain	25, Boulevard des Bouvets, 92741 Nanterre Cedex, France
Tel :+39-039-60531 Fax:+39-039-6053-312	Tel :+34-935-65-3131 Fax:+34-935-89-1579	Tel :+33-1-55-68-55-68 Fax:+33-1-55-68-57-57
Czech Republic	Poland	Sweden
MITSUBISHI ELECTRIC EUROPE B.V. Czech Branch	MITSUBISHI ELECTRIC EUROPE B.V. Polish Branch	MITSUBISHI ELECTRIC EUROPE B.V. (Scandinavia)
Pekarska 621/7, 155 00 Praha 5, Czech Republic	ul. Krakowska 48, 32-083 Balice, Poland	Hedvig Mollersgata 6, 223 55 Lund, Sweden
Tel :+420-734-402-587	Tel :+48-12-347-65-00	Tel :+46-8-625-10-00 Fax:+46-46-39-70-18
Turkey	UAE	South Africa
MITSUBISHI ELECTRIC TURKEY ELEKTRIK URUNLERI A.S.	MITSUBISHI ELECTRIC EUROPE B.V. Dubai Branch	ADROIT TECHNOLOGIES
Serifali Mahallesi Kale Sokak No:41 Umraniye / Istanbul	Dubai Silicon Oasis, P.O.BOX 341241, Dubai, U.A.E.	20 Waterford Office Park, 189 Witkoppen Road, Fourways, South Africa
Tel :+90-216-969-2500 Fax:+90-216-661-4447	Tel :+971-4-3724716 Fax:+971-4-3724721	Tel :+27-11-658-8100 Fax:+27-11-658-8101
China	Taiwan	Korea
MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD.	SETSUYO ENTERPRISE CO., LTD.	MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD.
Mitsubishi Electric Automation Center, No.1386 Hongqiao Road, Shanghai, China	6F, No.105, Wugong 3rd Road, Wugu District, New Taipei City 24889, Taiwan	7F to 9F, Gangseo Hangang Xi-tower A, 401, Yangcheon-ro, Gangseo-Gu, Seoul 07528, Korea
Tel :+86-21-2322-3030 Fax:+86-21-2322-3000	Tel :+886-2-2299-2499 Fax:+886-2-2299-2509	Tel :+82-2-3660-9569 Fax:+82-2-3664-8372
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MITSUBISHI ELECTRIC ASIA PTE. LTD.	MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO., LTD.	MITSUBISHI ELECTRIC VIETNAM COMPANY LIMITED
307 Alexandra Road, Mitsubishi Electric Building, Singapore 159943	101, True Digital Park Office, 5th Floor, Sukhumvit Road, Bang Chak, Prakanong, Bangkok, Thailand	11th & 12th Floor, Viettel Tower B, 285 Cach Mang Thang 8 Street, Ward 12, District 10, Ho Chi Minh City, Vietnam.
Tel :+65-6473-2308 Fax:+65-6476-7439	Tel :+66-2682-6522-31 Fax:+66-2682-6020	Tel :+84-28-3910-5945 Fax:+84-28-3910-5947
Indonesia	India	Australia
PT. MITSUBISHI ELECTRIC INDONESIA	MITSUBISHI ELECTRIC INDIA PVT. LTD. Pune Branch	MITSUBISHI ELECTRIC AUSTRALIA PTY. LTD.
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Tel :+62-21-31926461 Fax:+62-21-31923942	Tel :+91-20-2710-2000 Fax:+91-20-2710-2100	Tel :+61-2-9684-7777 Fax:+61-2-9684-7245

Mitsubishi Electric's e-F@ctory concept utilizes both FA and IT technologies, to reduce the total cost of development, production and maintenance, with the aim of achieving manufacturing that is a "step ahead of the times". It is supported by the e-F@ctory Alliance Partners covering software, devices, and system integration, creating the optimal e-F@ctory architecture to meet the end users needs and investment plans.

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE: TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN