FA Application Package
iQ Monozukuri Rotary Machine Vibration Diagnosis

e-F@ctory

- Easily install a vibration diagnosis system!
- Identify the abnormal area by means of accurate diagnosis!
- Easily detect abnormalities by means of MT method!

iQ Monozukuri

GLOBAL IMPACT OF MITSUBISHI ELECTRIC

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

Changes for the Better

We bring together the best minds to create the best technologies. At Mitsubishi Electric, we understand that technology is the driving force of change in our lives. By bringing greater comfort to daily life, maximizing the efficiency of businesses and keeping things running across society, we integrate technology and innovation to bring changes for the better.

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.

e-F@ctory

e-F@ctory is a concept for a further step on "Monozukuri", which reduces the total cost for development, production, and maintenance, and continuously supports improvement activities of the customer by utilizing the FA technology and IT technology.
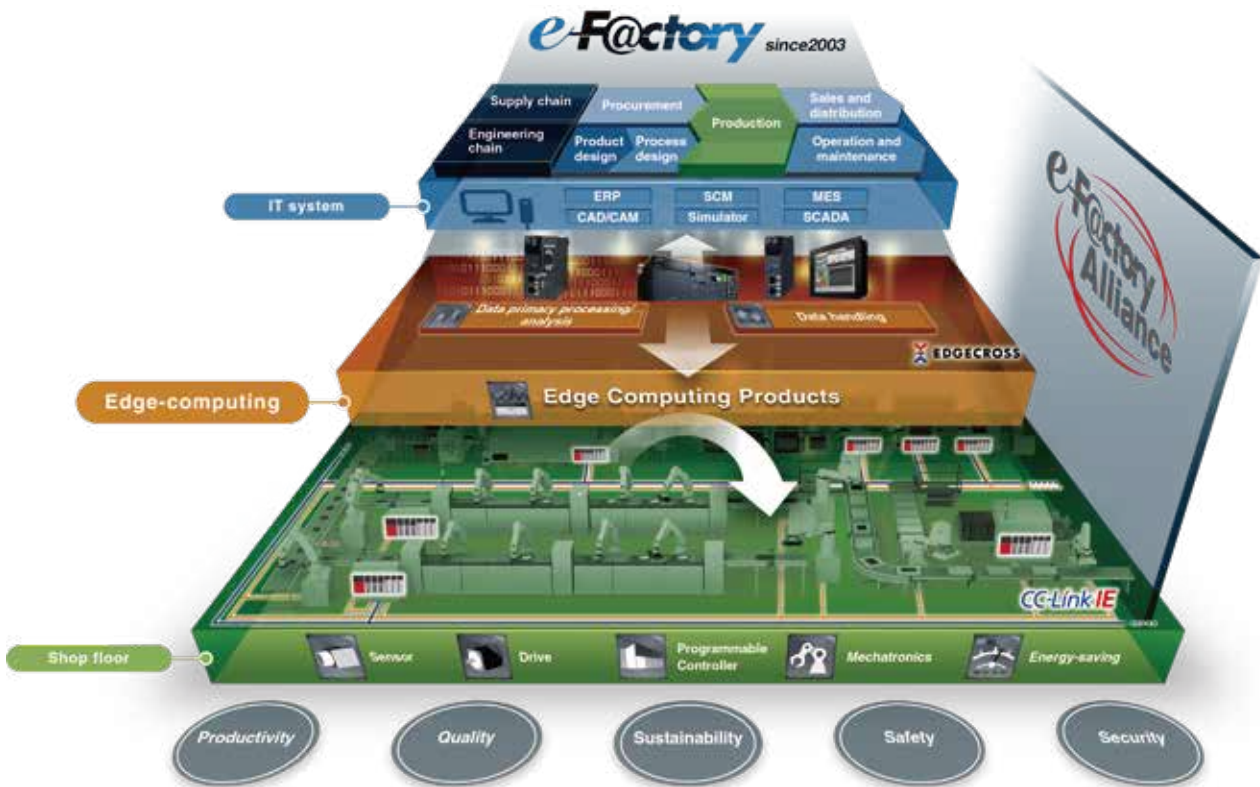
In the increasingly complex manufacturing sites, coordination between "Man" and "Machine" through the best use of information from the production site is a key concept.

Productivity and quality can be improved not only with the information obtained from the devices at the production site, but the improvement triggered by on-site notice and flexible human actions. Similarly, automatic adjustment of equipment based on the information recognized by human is indispensable for the promotion of automation.

We have realized the "Next-generation manufacturing" through the use of the "e-F@ctory" information proposed by Mitsubishi Electric, the effective and flexible manufacturing realized through the coordination between man and machine, and the optimization of the production site, and the entire supply chain and engineering chain.

Coordination between man and machine through the use of information

Information

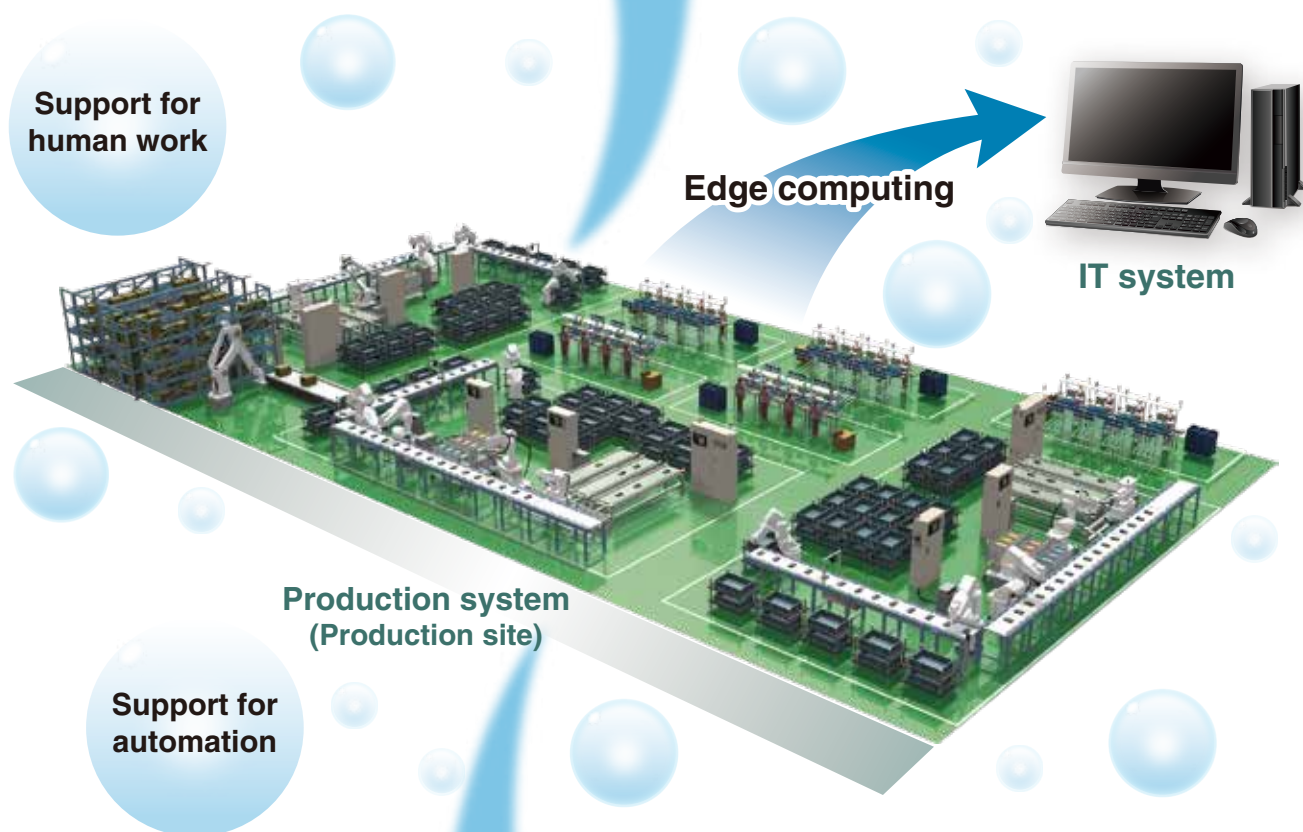Machine　　　Man

iQ Monozukuri

" iQ Monozukuri " is a step toward achieving e-F@ctory.

The FA application package "iQ Monozukuri" is a product that has been optimized through the accumulation of knowhow, which supports various problem solutions of the customer during manufacturing, and enables effective system installation, expansion, and operation/maintenance.

What iQ Monozukuri provides

- A wide range of applications prepared by "process", "usage", and "equipment"
- Know-hows and ideas about "Monozukuri" accumulated by Mitsubishi Electric and our partners over the years
- System consisting of highly reliable FA products manufactured by Mitsubishi Electric and partner companies

Support for human work

Edge computing

IT system

Production system (Production site)
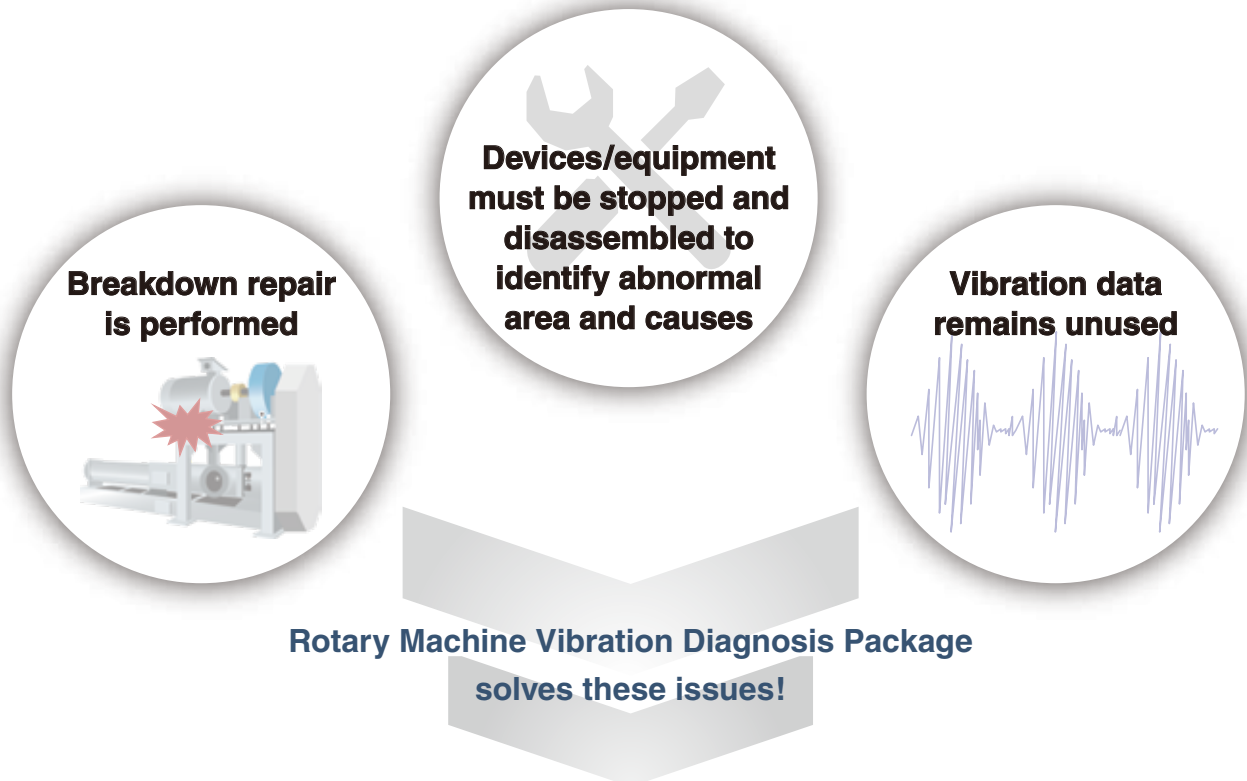
Support for automation

FA products

Mitsubishi Electric has been making persistent technical innovations from small-batch production systems to the developed flexible production systems in order to comply with the needs of the customers. It offers a wide range of extremely diverse FA products from control devices, driving devices, energy-saving support devices, and power distribution control devices to industrial mechatronics. It plays an active part in every production site for the purpose of automation, energy-saving, and quality improvement.

Control devices | Driving devices | Display devices(HMI) | Industrial robots | Low-voltage power distribution control devices | Processing machine

FA Application Package
iQ Monozukuri Rotary Machine Vibration Diagnosis

"iQ Monozukuri Rotary Machine Vibration Diagnosis" is an application that helps to visualize the equipment condition and identify abnormal causes by collecting, analyzing, and diagnosing vibration data of the devices or equipment having rotating mechanisms.

Breakdown repair is performed

Devices/equipment must be stopped and disassembled to identify abnormal area and causes

Vibration data remains unused

Rotary Machine Vibration Diagnosis Package solves these issues!

- ✓ Prevent breakdown
- ✓ Reduce down time
- ✓ Improve maintenance efficiency
- ✓ Extend periodic repair interval
- ✓ Reduce maintenance costs
- ✓ Improve equipment reliability

Since abnormalities can be identified without stopping a device or equipment, further
"Improvement in Productivity and Quality"
can be achieved.

Application example

Rotary Machine Vibration Diagnosis Package installed into devices or equipment with rotary mechanisms helps to solve issues at various production sites.

Case 1 — Rolling mill

Want to detect an abnormality as earlier as possible to maintain the large-capacity expensive motor before it breaks down

After installation of Rotary Machine Vibration Diagnosis...

Since abnormal signs can be detected by monitoring **the vibration condition of motor bearings**, maintenance timing can be optimized.[1]

System configuration example

Display device

PLC

Vibration sensor

*1: During accurate diagnosis, rotational speed and loads must be constant.

Case 2   Compressor

Want to identify abnormalities of compressors easily without disassembling equipment

After installation of Rotary Machine Vibration Diagnosis...

Abnormalities can be identified without disassembling equipment by monitoring **the vibration condition of fans and bearings**.[1]

System configuration example

Display device

PLC

Vibration sensor

iQ-R series CC-Link IE Field
remote head module
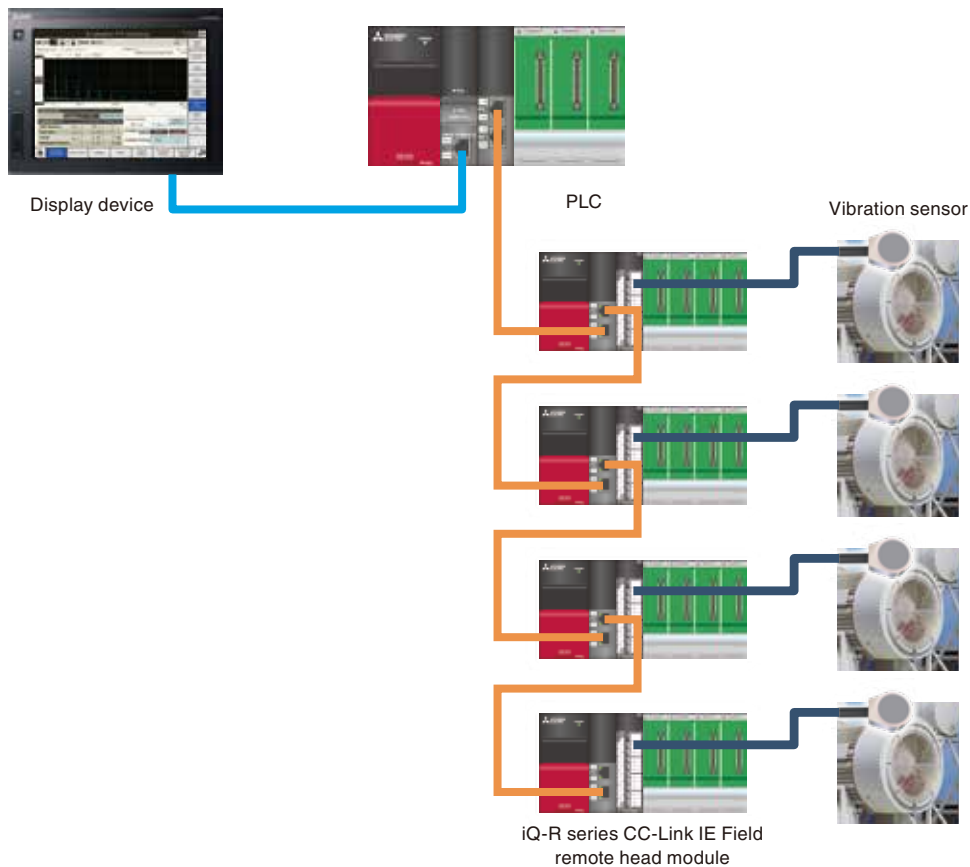
*1: During accurate diagnosis, rotational speed and loads must be constant.

Case Study

I want to try vibration diagnosis!

Easy Installation
Easily install a vibration diagnosis system!
(Refer to P.9)

I want to compare previous (normal) and current vibration condition!

Automatic Diagnosis
Visualize vibration condition through FFT analysis! (Refer to P.10)

I want to monitor the trend of vibration!
I want to detect abnormalities even if rotational speed and components are unclear!

Automatic Diagnosis (Simple diagnosis)
Trend analysis by means of simple diagnosis!
(Refer to P.11)

I want to detect abnormalities on bearings and gears!
I want to check the installation of rotating mechanism!

Automatic Diagnosis (Accurate diagnosis)
Identify the abnormal area by means of accurate diagnosis! (Refer to P.12)

I want to detect abnormalities without specialized knowledge!

Automatic Diagnosis (MT method diagnosis)
Easily detect abnormalities by means of MT method! (Refer to P.13)

I want to check the diagnosis result of the entire system at a glance!
I want to check the detailed diagnosis result of a specific channel at a glance!

Automatic Diagnosis (Simple/Accurate/MT method diagnosis)
Collectively grasp the diagnostic status of the entire system! (Refer to P.14)

I want to check if vibration data is properly collected!
I want to check the vibration condition promptly!

Visual Check
Easily check vibration condition on the waveform graph! (Refer to P.15)

I want to analyze vibration data in detail with personal computer!

Logging
Simultaneous logging of vibration data for up to 4 CHs! (Refer to P.16)

I want to save vibration data as a file!

Data Management
Save vibration data as a CSV file! (Refer to P.16)

FA Application Package
Features of iQ Monozukuri
# Rotary Machine Vibration Diagnosis

This application realizes predictive maintenance and identification of abnormal area through visualization of equipment condition by collecting, analyzing, and diagnosing vibration data of the devices or equipment having rotating mechanisms!

Easy Installation

Easily install a vibration diagnosis system!

A ready-to-use vibration diagnosis system can be built without specialized knowledge by just installing the control program in the package to the MELSEC iQ-R programmable controller and screen data to GOT2000, and setting the sensor sensitivity and equipment specification values on the GOT screen.

Step1 **Write the control program to the PLC.** [1]
Write the screen data to the GOT.

Control program

MELSEC
iQ-R PLC

Screen data

GOT2000
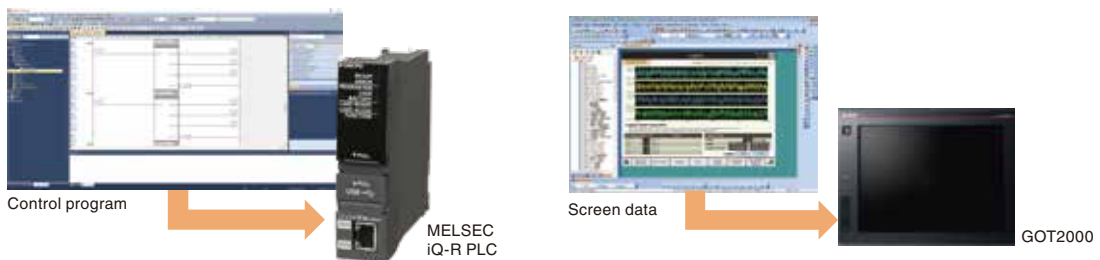
*1: Register a license to the PLC CPU in advance.

Step2 **Turn on the power of the system to startup the PLC and GOT.**

Step3 **Set the sensor sensitivity and equipment specification values on the GOT screen.**
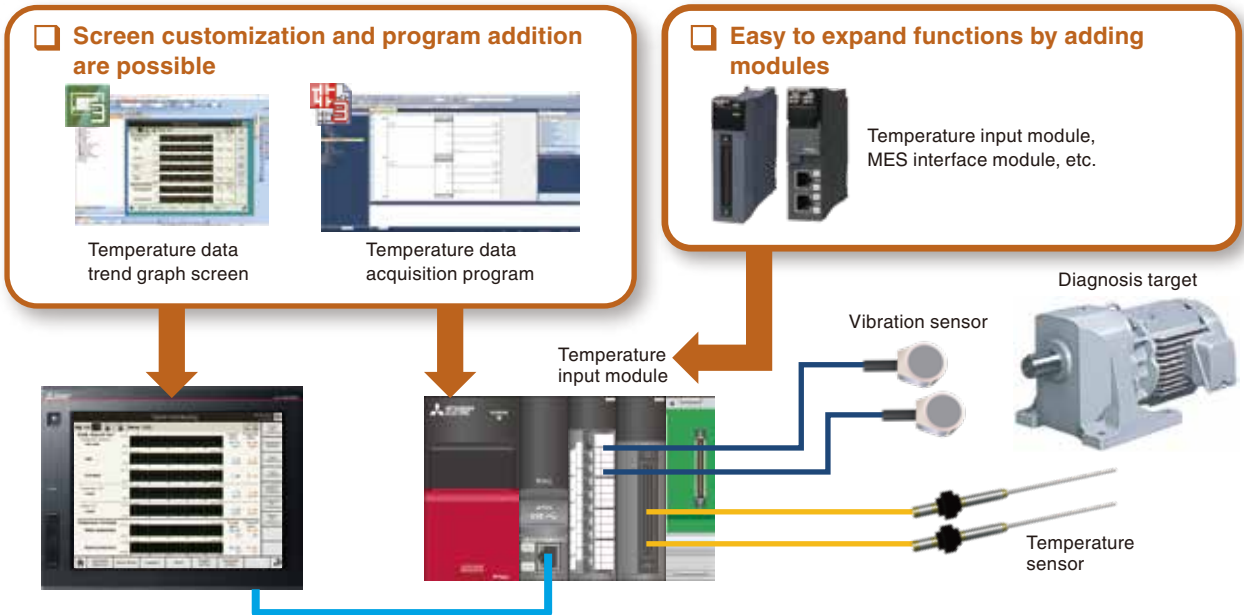
Quick diagnosis for vibration condition of devices/equipment!

Features

Easy Installation

Flexible system expansion!

With the Mitsubishi FA devices and general-purpose vibration sensors, the system can be flexibly configured to meet customer needs.
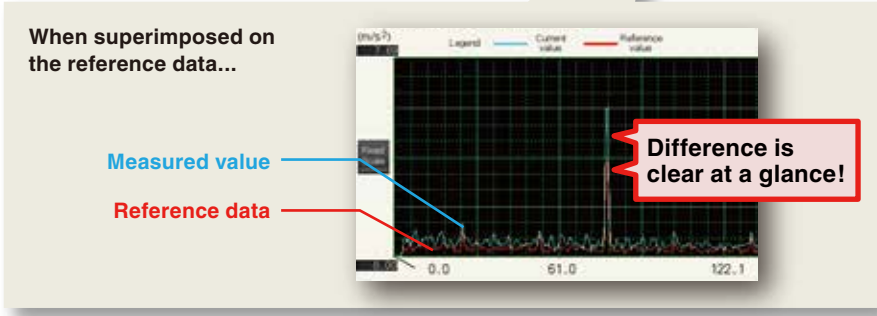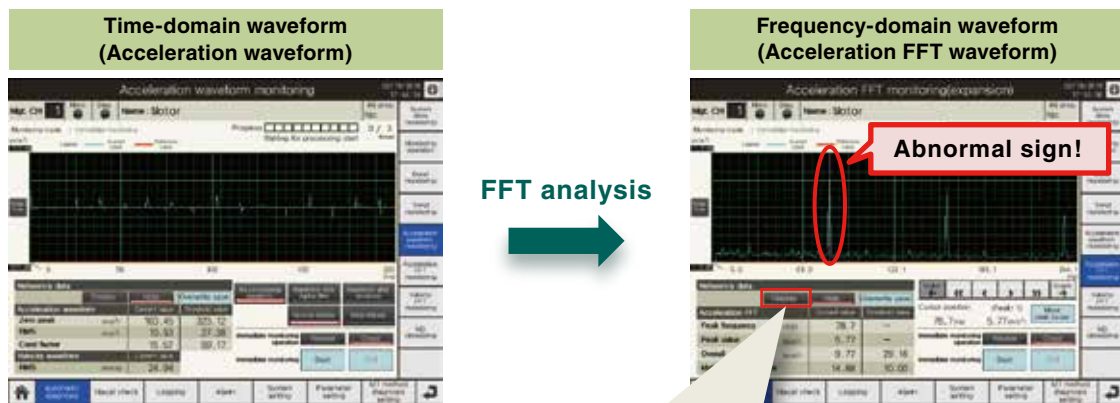Optional control programs can be added and the GOT screen can be customized.

☐ **Screen customization and program addition are possible**

Temperature data trend graph screen

Temperature data acquisition program

☐ **Easy to expand functions by adding modules**

Temperature input module, MES interface module, etc.

Diagnosis target

Vibration sensor

Temperature input module

Temperature sensor

Automatic Diagnosis

Visualize vibration condition through FFT analysis!

Invisible vibration condition can be visualized through FFT analysis of vibration data.
The vibration condition and abnormal signs can be easily identified by displaying the vibration data in a frequency-domain waveform.
The difference of the vibration level can be seen at a glance by saving the normal waveform of a device or equipment as reference data, and superimposing it on the measured vibration data.

▶ Refer to "Vibration Analysis (P.18)".

**Time-domain waveform
(Acceleration waveform)**

**Frequency-domain waveform
(Acceleration FFT waveform)**

FFT analysis

Abnormal sign!

When superimposed on the reference data...

Measured value

Reference data

Difference is clear at a glance!

Automatic Diagnosis

Trend analysis by means of simple diagnosis!

Even without information such as rotational speed or parts specification values, abnormal signs can be detected on the basis of a trend analysis by regularly performing the simple diagnosis of vibration.

▶ Refer to "Simple diagnosis (Relative value judgment method) (P.20)".

Installation procedure of simple diagnosis

1) **Measure the initial value of the simple diagnosis target.**
2) **Set the threshold value of the simple diagnosis target.**

┌─ **Simple diagnosis target** ─
· Acceleration waveform
  Zero peak, RMS, Crest factor
· Acceleration FFT Overall
· Velocity FFT Overall

* The guard band monitoring of acceleration FFT can be set.
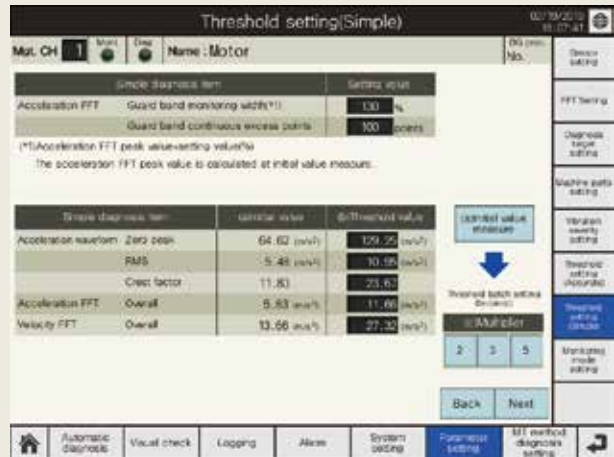
☐ Trend monitoring on a trend graph!

Trend of vibration can be monitored by displaying the result of a periodic simple diagnosis (e.g. every day or hour).
* Trend monitoring of MT method diagnosis items (Mahalanobis distance of acceleration FFT and Mahalanobis distance of velocity FFT) is also possible.

▶ Refer to "MT method diagnosis (P.21)".

### <Guard band monitoring of acceleration FFT>

Guard band monitoring is possible for the frequency-domain waveform of acceleration FFT.
The upper limit and lower limit at guard band monitoring are as follows.

Upper limit: Amplitude value of acceleration FFT reference data + Peak (amplitude) value of acceleration FFT reference data × Guard band monitoring width (%)

Lower limit: 0

Upper limit waveform
Waveform of acceleration FFT reference data
Lower limit waveform
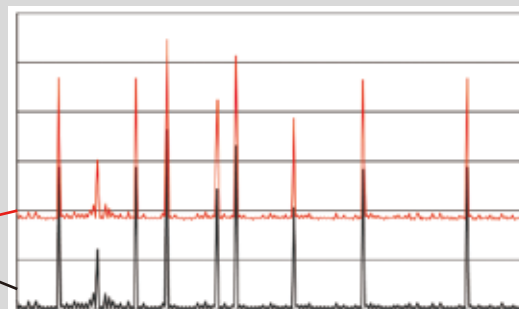
Automatic Diagnosis

# Identify abnormal area by means of accurate diagnosis!

Abnormal area can be identified by monitoring the characteristic frequency obtained from the parts specification value, leading to early detection of abnormalities.
* During accurate diagnosis, rotational speed and loads must be constant.
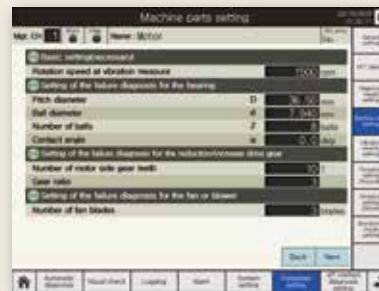
▶ Refer to "Accurate diagnosis (P.21)".

Installation procedure of accurate diagnosis

1) Select the accurate diagnosis target.
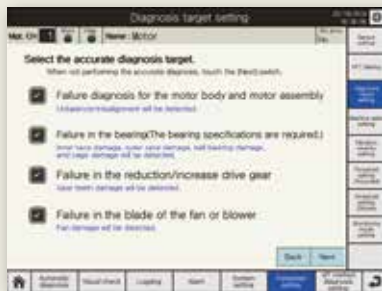
2) Set the parts specification value.

3) After setting the monitoring frequency, measure the initial value and set the threshold value.

Accurate diagnosis target

- · Unbalance
- · Ball bearing damage
- · Misalignment
- · Cage damage
- · Inner race damage
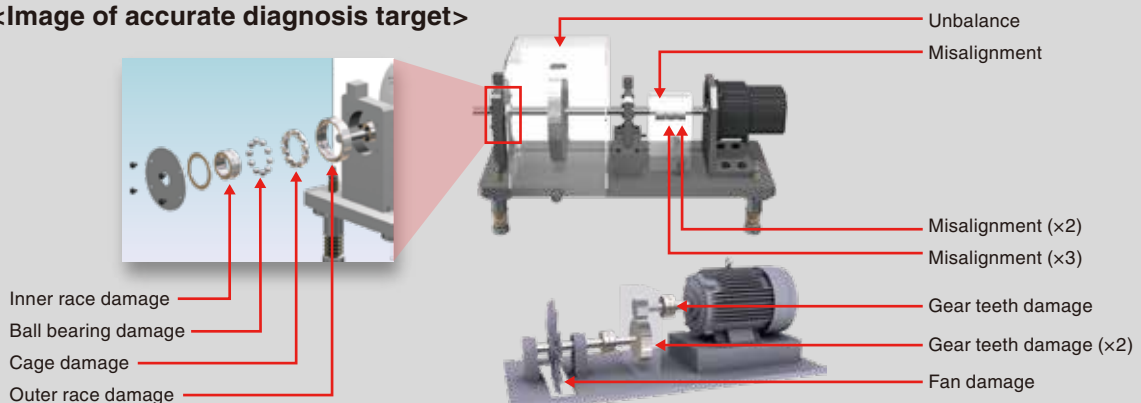- · Gear teeth damage
- · Outer race damage
- · Fan damage

☐ Accurate diagnosis results are displayed in a list!

Since diagnosis results of the accurate diagnosis target are notified by the ALM lamp, abnormalities can be identified at a glance.

ALM lamp Green: Normal, Yellow: Caution, Red: Abnormal

<Image of accurate diagnosis target>

- Unbalance
- Misalignment
- Misalignment (×2)
- Misalignment (×3)
- Gear teeth damage
- Gear teeth damage (×2)
- Fan damage
- Inner race damage
- Ball bearing damage
- Cage damage
- Outer race damage

Automatic Diagnosis

Easily detect abnormalities by means of MT method!

Even without knowledge of vibration analysis, if the reference data group called a unit space can be generated by collecting normal data of devices or equipment, an abnormality can be easily detected through the diagnosis using a single index called Mahalanobis distance.

▶ Refer to "MT method diagnosis (P.21)".

Installation procedure of MT method diagnosis

1) Set the input items of the MT method.

Partial overall (POA) in each frequency area of acceleration FFT and velocity FFT are the input items. Therefore, set the frequency range.

2) After collecting the normal data, generate a unit space.

Collect up to 100 pieces of normal data of devices or equipment as sample data of the MT method, and generate the unit space.
* Collected sample data can be saved and read as a CSV file.

3) Set the threshold value of the MT method diagnosis target.

Set the threshold value for the Mahalanobis distance of the acceleration FFT and velocity FFT.

❑ MT method diagnosis results and amount of sample data are displayed in a list!

Since diagnosis results of the MT method diagnosis target are notified by the ALM lamp, abnormalities can be identified at a glance.

ALM lamp Green: Normal, Yellow: Caution, Red: Error

The amount of sample data for acceleration FFT and velocity FFT can be checked.

Automatic Diagnosis

## Collectively grasp the diagnostic status of the entire system!

The entire system status can be checked at a glance because the diagnosis status and results of all 16 channels can be displayed in a list.

❑ Diagnostic situation and results of all 16 CHs are displayed in a list!

The diagnosis status of all 16 channels can be checked with the monitoring lamp and diagnosis lamp. The diagnosis results can be checked with the status lamp and detail message.

Monitoring lamp	Green: During monitoring, Orange: Monitoring is suspended
Diagnosis lamp	High-speed flashing in green: During diagnosis, Low-speed flashing in green: Diagnosis is reserved
Status lamp	Green: Normal, Yellow: Caution, Red: Abnormal

Touching a status lamp displays the diagnosis results of the channel together.
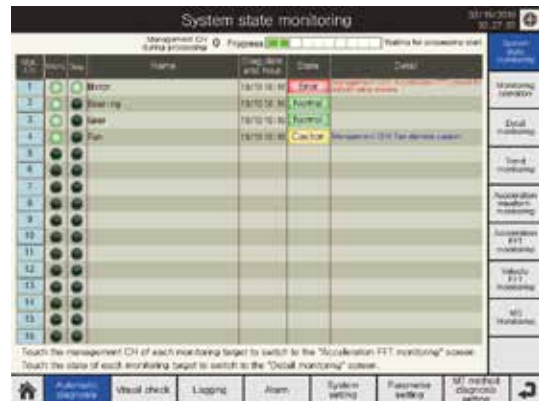
* Processing from collection to diagnosis of vibration data is executed for each channel one by one. The diagnosis lamp of a channel being processed flashes in green at high speed.

<Automatic diagnosis can be performed at any timing!>

Monitoring timing of automatic diagnosis can be selected from the following three types.
· Immediate monitoring: Collect data when the monitoring start switch is touched.
· Moni. during trigger ON: Collect data continuously while a specified device is turned on.
· Cycle monitoring: Collect the data periodically.

❑ Diagnosis results of a specific CH is displayed at once!

For a specified channel, the diagnosis results of the vibration severity, acceleration FFT guard band monitoring, simple diagnosis, accurate diagnosis, and MT method diagnosis can be checked with the ALM lamps.

ALM lamp Green: Normal, Yellow: Caution, Red: Abnormal

❑ Simple judgment based on the vibration severity!

Based on the vibration severity (compliant with ISO2372), simple judgment of vibration condition is possible using the velocity RMS value.
Equipment is classified into three classes: small, middle, and large. An alarm is notified when the velocity RMS value is in the range of C (caution) or D (warning) of each class.

▶ Refer to "Simple diagnosis (Absolute value judgment method) (P.20)".
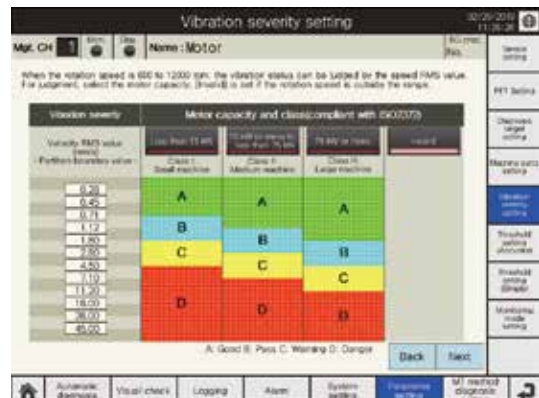
Visual Check

Easily check vibration condition on the waveform graph!

Vibration condition can be checked in the time-domain waveform and frequency-domain waveform.

☐ Easily check vibration condition in the time-domain waveform!

The vibration condition can be checked with three types of time-domain waveform (No processing waveform / Waveform after digital filter / Waveform after envelope).
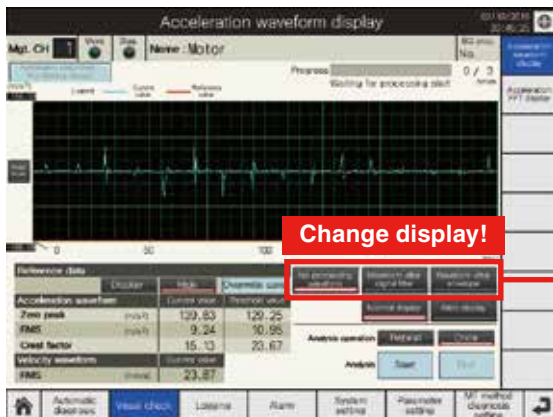
No processing waveform

The scale is converted and the display signal (vibration data) from a vibration senor.

Waveform after digital filter

No processing waveform is displayed after digital filter processing.
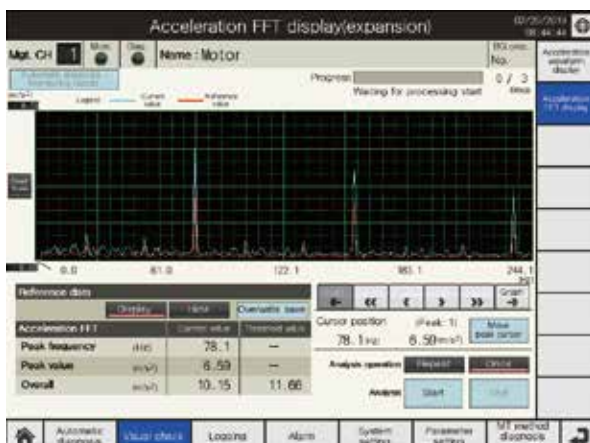
Waveform after envelope

Waveform after digital filter is displayed after envelope processing.

☐ Easily check vibration condition in the time-domain waveform!

Through FFT analysis of vibration data, vibration condition can be checked in the frequency-domain waveform.

Features

Logging

Simultaneous logging of vibration data for up to 4 CHs!

Vibration data for up to 4 channels can be simultaneously logged, and can be saved as a CSV file.
CSV files can be used for detailed analysis of the vibration data on the personal computer.
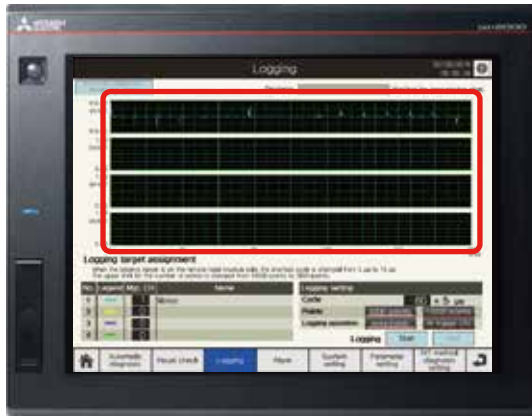
CSV file

Data Management

Save vibration data as a CSV file!

Vibration data (automatic diagnosis data, visual check data, and logging data) can be saved as a CSV file.
CSV files can be saved in an SD memory card or FTP server.

<CSV file contents>
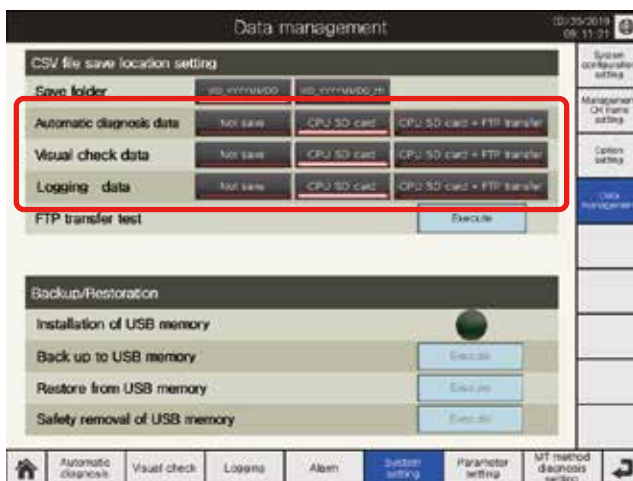
- **Automatic diagnosis data / Visual check data**
  Time (s), Acceleration waveform (m/s^2),
  Frequency (Hz), Acceleration FFT (m/s^2),
  Velocity FFT (mm/s)

- **Logging data**
  Time (s), Acceleration waveform (m/s^2)

Procedure After Installation

The following is the procedure after installation of the control program and screen data.

Step 1

System setting

Set the number of high-speed analog input module connections, channel assignment of high-speed analog input module for the management channel, and storage destination of vibration data.

Step 2

Parameter setting (Sensor setting, FFT setting)
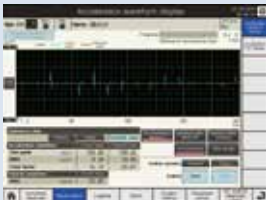
Set the necessary parameters for sensor sensitivity of vibration sensors and analysis of the vibration data.

Step 3

Vibration data check

Check that the vibration data is displayed properly on the acceleration waveform display screen and acceleration FFT display screen.

Step 4

Parameter setting (Diagnosis target setting, Component setting, Threshold setting, Monitoring mode setting)

Set the accurate diagnosis target, specification value of components such as a bearing, threshold value of simple diagnosis items and accurate diagnosis items, and the monitoring timing of automatic diagnosis.

Step 5

Automatic diagnosis start

Start automatic diagnosis on the monitoring operation screen.
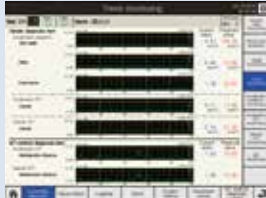
Step 6

Check for diagnostic result and vibration trend

Check the diagnosis result and vibration trend of each management channel.
When an alarm occurs, check the details and take necessary actions.

■ Perform Step 2 to 4 for each using management channel.
■ For MT method diagnosis, perform the following actions after Step 4.
   1) Item setting 2) Sample data collection 3) Unit space setting 4) Threshold setting

Vibration Analysis

What is vibration analysis?

Vibration caused by a device or equipment is quantified for checking its condition.
An analysis method called Fast Fourier Transformation (FFT) is used for vibration analysis.

Normal

Abnormal

Difficult to identify the abnormal area in the time-domain waveform

Vibration

Vibration

Time-domain waveform (Acceleration waveform)

Time

Time

FFT analysis

FFT analysis

Easy to identify the abnormal area by converting the waveform to the frequency domain

Vibration

Vibration

Frequency-domain waveform (Acceleration FFT waveform)

Frequency [Hz]

Frequency [Hz]

Vibration analysis effect

When an abnormality occurs in the equipment, a change appears in the vibration data such as magnitude of the vibration. Therefore, abnormalities can be identified without stopping or disassembling equipment by collecting and analyzing the vibration data.

Vibration analysis enables vibration diagnosis for equipment!

Vibration diagnosis

A method to quantitatively examine the equipment condition through the vibration analysis and detect the normal or abnormal condition of equipment, as well as to predict abnormal causes to take measures.

Diagnosis method

The vibration diagnosis method is divided into simple diagnosis (absolute value judgment method and relative value judgment method) and accurate diagnosis.
Generally, accurate diagnosis is performed after simple diagnosis to identify the abnormal area.
In this package, the vibration diagnosis method using the MT method is called MT method diagnosis, and it judges the equipment condition according to an indicator, Mahalanobis distance.

Absolute value judgment method

▶ Refer to "Simple diagnosis (Absolute value judgment method) (P.20)".

Simple diagnosis

Compare the vibration intensity with the reference and judge the equipment condition.

Relative value judgment method

▶ Refer to "Simple diagnosis (Relative value judgment method) (P.20)".

Vibration diagnosis

Accurate diagnosis

Perform FFT analysis and identify the abnormal area.
▶ Refer to "Accurate diagnosis (P.21)".

MT method diagnosis

Judge the equipment condition using the Mahalanobis distance only.
▶ Refer to "MT method diagnosis (P.21)".

❑ Simple diagnosis (Absolute value judgment method)

Equipment is judged as abnormal when the vibration measurement value exceeds the judgment reference value that is specified in the standards, such as ISO2372.

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: Large machine (when mounted on a soft foundation)

* Conditions to apply the vibration severity
   Number of rotations: 600 to 12000 rpm
   Vibration measuring range: 10 to 1000 Hz

Vibration severity	ISO2372			
Velocity RMS value (effective value) (mm/s)	Class I	Class II	Class III	Class IV
0.28	A	A	A	A
0.45				
0.71				
1.12	B			
1.8		B		
2.8	C		B	
4.5		C		B
7.1			C	
11.2				C
18	D	D		
28			D	D
45				

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

❑ Simple diagnosis (Relative value judgment method)

Equipment is judged as normal or abnormal on the basis of how much larger the measurement value compared to the reference value obtained by measuring vibration on the same part more than 10 times.

Vibration level

Abnormal value (4 to 6 times) — **Abnormal**

Most important equipment (2 times), Important equipment (2.5 times), Normal equipment (3 times), etc.

Caution

Caution value (2 to 3 times)

Reference value — **Normal**

Time (Day)
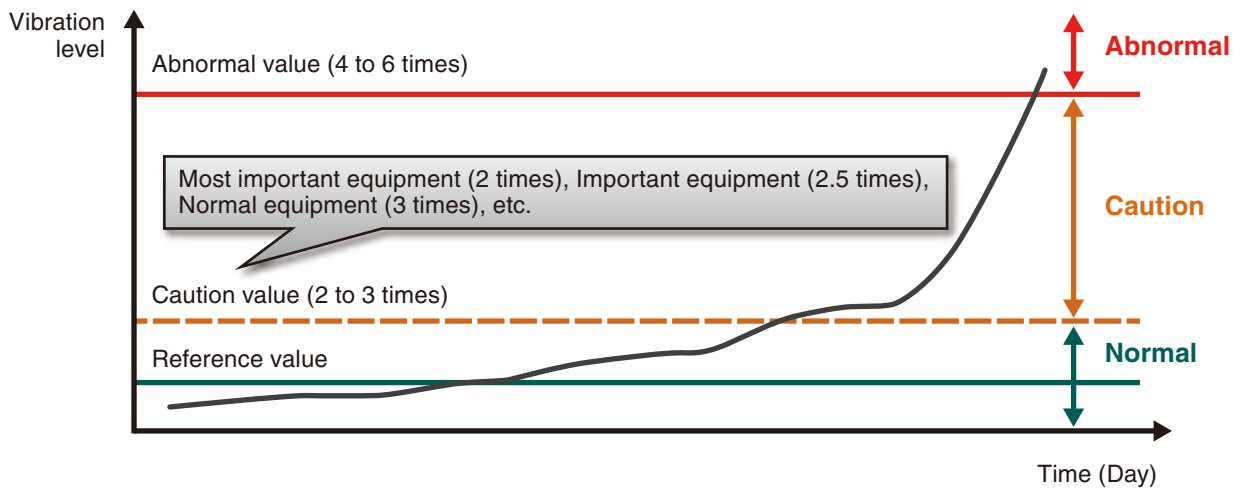
❏ Accurate diagnosis

Perform FFT analysis on the vibration data and identify the abnormal area based on the frequency distribution.

Save the normal FFT analysis result as a reference value.

Amplitude

Frequency

Compare the FFT analysis result at abnormal state and the reference value to check the changes.

Amplitude

Abnormal sign!
→ Identify the abnormal area

Frequency

—— Current value   —— Reference value
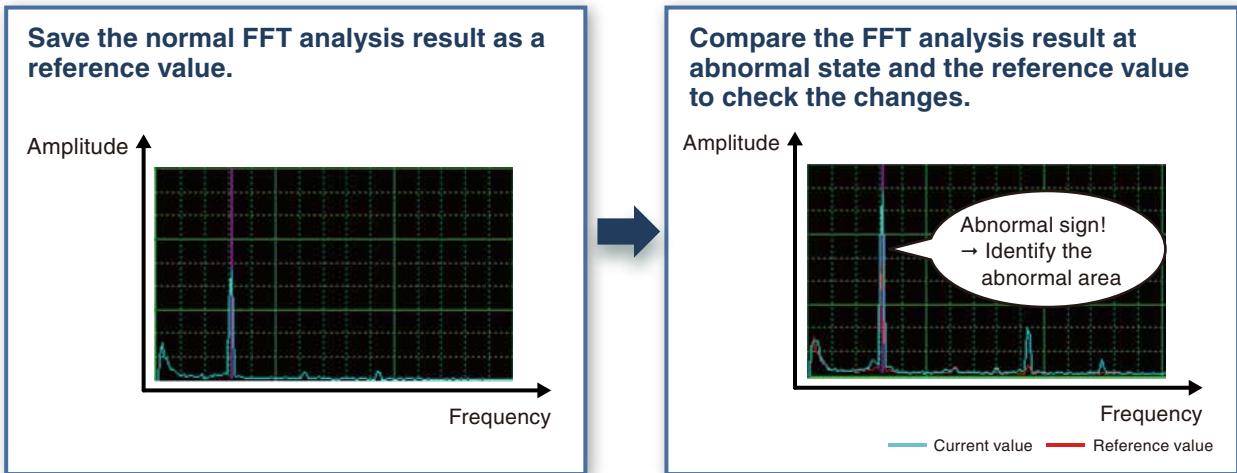
Abnormal area and causes can be identified from the changes in the characteristic frequency amplitude of the accurate diagnosis target!
Unbalance, misalignment, bearing failure, or gear failure

❏ MT method diagnosis

A group of reference data called unit space is generated from normal data (equipment data when operation is started, stable, or steady) and the deviation from normal condition can be quantified using a single index called Mahalanobis distance. This helps to identify the degree of abnormality and detect abnormal signs, as well as to judge the normal/abnormal condition.

Normal judgment method (Euclidean distance)

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

Abnormal (155, 88)
Normal (165, 77)
Abnormal (190, 86)
Normal (177, 68)
Normal (175, 50)
Normal

Item B

Judgment method using MT method (Mahalabobis distance)

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

Abnormal (155, 88)
Abnormal (165, 77)
Normal (190, 86)
Normal (177, 68)
Abnormal (175, 50)

Item B
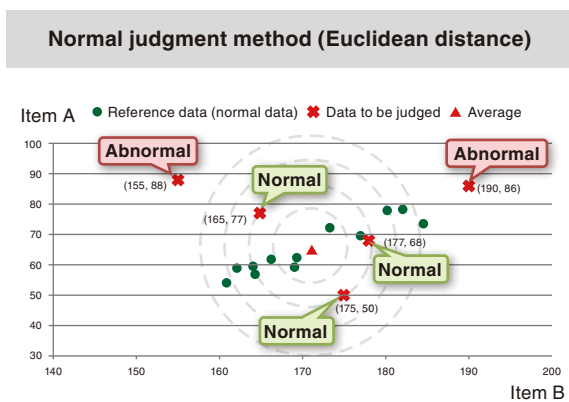
Correlation between various types of data is ignored, data is judged as abnormal if it deviates from the average.
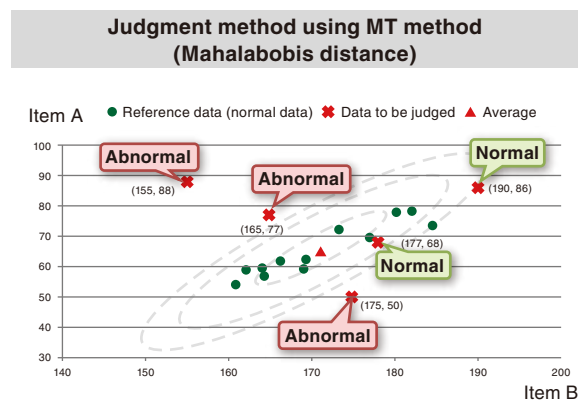
Correlation between various types of data is taken into consideration, and the normal or abnormal state is judged by calculating the correlation between the items.

Terminology of vibration analysis

❏ Envelope

Envelope processing is a process to extract the external form of absolute amplitude values. It is used for examining the periodicity of impact vibration, such as the vibration caused by damage to the bearing.

Amplitude modulation waveform of 10 Hz

Envelope processing

Changes in the amplitude are clear!

Envelope processing result
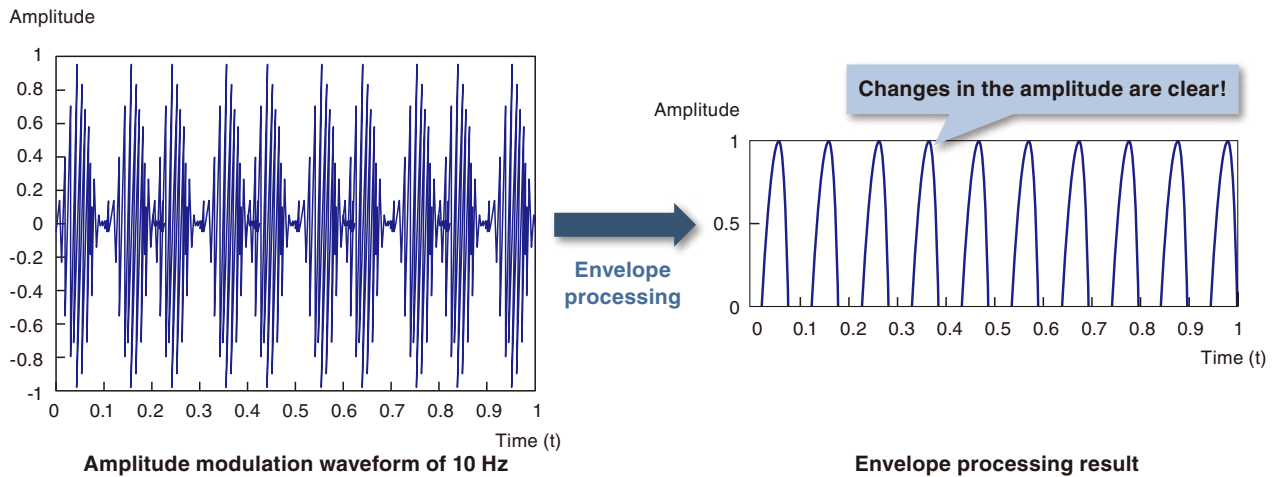
❏ Peak value

The maximum value of amplitude in a waveform for a certain period. The peak value is represented as Peak to Peak and 0-Peak. It is used for evaluating the impact vibration and vibration waveform with small variations.

0-p
p-p

p-p: Peak to Peak
0-p: 0-Peak
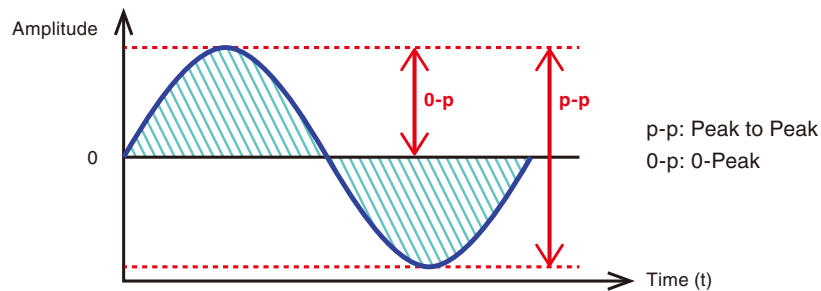
❏ RMS (effective value)

The square root of mean square for each instantaneous value within a certain period in the time-domain waveform. It indicates the average amplitude of the time-domain waveform.
It is used for evaluating the vibration waveform with few impact vibrations.
The velocity RMS is used for total judgment of the equipment condition. The acceleration RMS is used for calculation of crest factor.
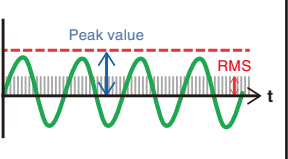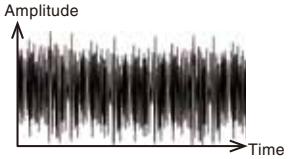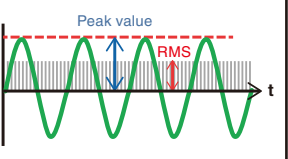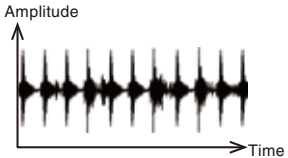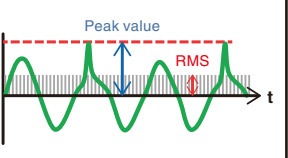
RMS

❑ Crest factor (CF)

A ratio of RMS value and peak value of time-domain waveform. (Crest factor = peak value/RMS value)
Although the peak value and RMS value depend on the rotation speed, the crest factor does not change. The crest factor is used to detect impact vibration such as damage on a bearing because it increases when impact vibration occurs.

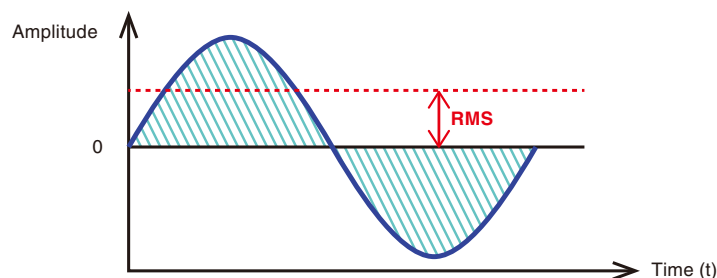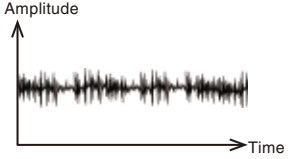| Vibration state	Time-domain waveform (Acceleration waveform)	Ratio of peak value and RMS (effective value)	Peak value	RMS (Effective value)	Crest factor value
Normal			Low	Low	Low (CF << 5)
When motor load increased			Middle to high	Middle to high	Low to middle (CF≈6)
When impact vibration occurred			High	Middle	High (CF>>6)

❑ Overall (OA)

The total size of each frequency component in the entire frequency band after FFT analysis.
Theoretically, OA equals to RMS value of the waveform before FFT analysis.
It is used to monitor the amplitude in the entire frequency band after FFT analysis.

OA: Total size of each frequency component in the entire frequency band after FFT analysis
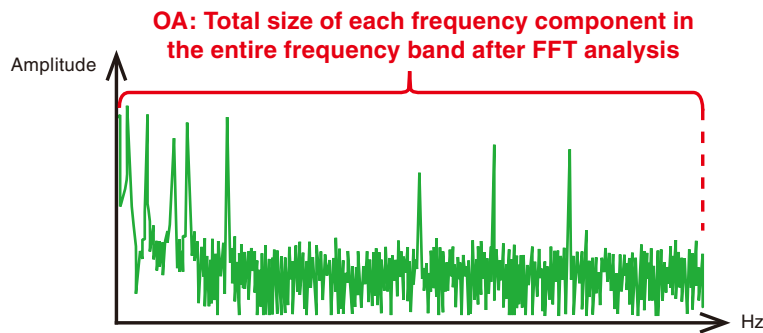
❑ Partial overall (POA)

The total size of each frequency component in the specified frequency band after FFT analysis.
It is used to monitor the amplitude in the specified frequency band after FFT analysis.

POA: Total size of each frequency component in the specified frequency band after FFT analysis
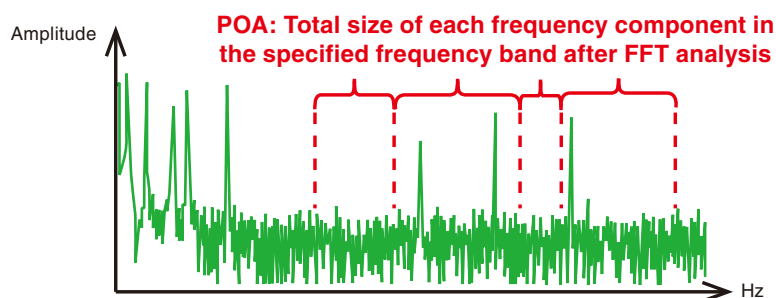
Terminology of MT method

❑ Item (Input item of MT method)

The characteristic value extracted from the source information (such as current or temperature) used to generate a unit space or calculate the Mahalanobis distance.
For example, items in the current waveform are the maximum current value and effective value.
An unnecessary item included in the unit space may decrease the accuracy of error judgment.

❑ Unit space

Reference data (normal data) group for calculating the Mahalanobis distance.

❑ Sample data

A set of data for each item of the MT method. For example, sample data of the time series data is each data item by time.

❑ Mahalanobis distance

An index of the deviation from the reference data group.

Product Contents

This product consists of software and documents. It is necessary to prepare hardware and engineering software separately.

For details, refer to "Necessary Software & Device List (P.27)".

Software

Screen data (GT Designer3 project file[1])

*1: MELSOFT GT Designer3 is required.

Screen data of GOT2000 for the rotary machine vibration diagnosis

Control program (GX Works3 project file[2])

*2: MELSOFT GX Works3 is required.

Sequence control program for the rotary machine vibration diagnosis
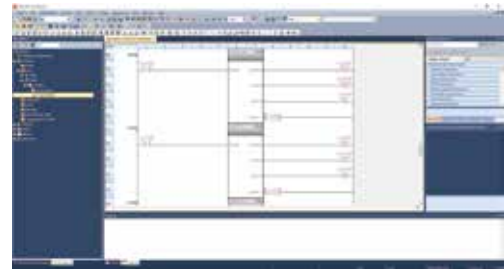
Documents

Manual (PDF file)

Instruction manual

System Configuration Diagram

GOT2000
Graphic Operation Terminal

Display device
(GT2712-S)

MELSEC iQ-R series

CPU module[1]
(R16CPU or higher)

High-speed analog input module
(R60ADH4: Max. 4 modules)

Vibration sensor
(Max. 16 sensors)[2]

Diagnosis target

Extended SRAM cassette
(4 MB or more)

CC-Link IE Field
communication module
(RJ71GF11-T2)[3]

CC-Link IE Field

iQ-R series CC-Link IE Field
remote head module
(RJ72GF15-T2)[3]

*1: When used with customer's device control programs, the rotary machine vibration diagnosis programs increase the scan time and affect the device control. In this case, use the multiple CPU configuration.
*2: Up to 16 vibration sensors can be used in a system. (Including sensors connected via networks)
*3: It is used when the diagnosis target is more than one or far away from the PLC CPU. Up to four CC-Link IE Field remote head modules for iQ-R can be connected.

Specifications

System Specifications

Item		Description
Number of vibration sensor connections		Max. 16 sensors (Vibration sensors used for vibration detection in acceleration)
Input range	Voltage	-10 to 10 V DC
	Current	0 to 20 mA DC
Number of iQ-R series CC-Link IE Field remote head module stations		Max. 4 stations
Sampling function	Cycle (Frequency range)	10 µs (40 kHz), 20 µs (20 kHz), 25 µs (16 kHz), 50 µs (8 kHz), 100 µs (4 kHz), 400 µs (1 kHz)
	Points	1024 points, 2048 points, 4096 points, 8192 points[*1]
FFT function	Spectrum format	Half amplitude
	Window function	Rectangle, Hanning, Hamming, Blackman
	Digital filter	None, Low-pass. High-pass, Band-pass
Diagnosis function	Simple diagnosis	Monitoring item: Velocity RMS value (for vibration severity), Acceleration waveform (RMS, Zero peak, Crest factor), Acceleration FFT (Overall, Guard band), Velocity FFT (Overall)
	Accurate diagnosis	Monitoring item: Unbalance, Misalignment, Inner race damage, Outer race damage, Ball bearing damage, Cage damage, Gear teeth damage, Fan damage
	MT method diagnosis	Monitoring item: Acceleration FFT (partial overall), Velocity FFT (partial overall)
Waveform display function		Time-domain waveform (No processing waveform / Waveform after digital filter / Waveform after envelope), Frequency-domain waveform (Acceleration FFT, Velocity FFT)
Trend display function		Trend graph display of monitoring items for simple diagnosis and MT method diagnosis
Diagnosis result display function		Normal / Caution / Error display
Alarm display function		Detail display, Current Alarm display, Alarm History display
Logging function	Cycle	1 to 80 (×5 µs)[*1]
	Points	5000 points, 10000 points[*1]
File save function		Save to the SD card installed in the PLC CPU or the FTP server

*1: When the high-speed analog input module installation position is the remote head module side, the upper limit for the number of sampling points is 4096 points, the shortest logging cycle is 10 µs, and the upper limit for the number of logging points is 5000 points.

Operating Environment

Item	Description	Remarks
Operation guaranteed OS	Microsoft® Windows® 10 (Home, Pro, Enterprise)	-
	Microsoft® Windows® 7 (Professional, Ultimate, Enterprise)	-
CPU	64-bit OS: 1 GHz or more / 32-bit OS: 1 GHz or more	-
Memory	64-bit OS: 2 GB or more / 32-bit OS: 1 GB or more	-
Free disk space	64-bit OS: 20 GB or more / 32-bit OS: 16 GB or more	-
Disk drive	DVD drive	Installation DVD-ROM
Interface	USB (USB1.1 or later)	For connection with the PLC CPU and GOT
Application	MELSOFT GX Works3	For editing or writing the control program
	MELSOFT GT Designer3 (GOT2000)	For editing or writing the screen data
	Microsoft® Excel®	For operating the license key registration support tool

Necessary Software & Device List

FA Application Package

Product name	Manufacturer	Model	Number of licenses[1]	Price
FA Application Package iQ Monozukuri Rotary Machine Vibration Diagnosis	Mitsubishi Electric Corporation	AP10-VID001AA-MA	1	Open price
		AP10-VID001AA-MB	5	
		AP10-VID001AA-MC	10	
		AP10-VID001AA-MD	15	
		AP10-VID001AA-ME	20	
		AP10-VID001AA-MF	25	

*1: One license is required per system.

Software

Product name	Quantity	Manufacturer	Model	Remarks
PLC Engineering Software MELSOFT GX Works3	1	Mitsubishi Electric Corporation	SW1DND-GXW3-E	Version 1.047Z or later
GOT Screen Design Software MELSOFT GT Works3[1]	1	Mitsubishi Electric Corporation	SW1DND-GTWK3-E	Version 1.200J or later
Microsoft® Excel®	1	Microsoft Corporation	Microsoft® Excel®	2013 or later

*1: MELSOFT GT Designer3 is included in MELSOFT GT Works3.

Device

Device name	Quantity	Manufacturer	Model	Remarks	
GOT	1	Mitsubishi Electric Corporation	GT2712-STBA/D	Screen size: 12.1-inch SVGA	Any of the models on the left
			GT2712-STWA/D	Screen size: 12.1-inch SVGA	
Power supply module[1]	1 to 5	Mitsubishi Electric Corporation	R61P	-	
			R62P		
			R63P		
			R64P		
Main base unit[1]	1 to 5	Mitsubishi Electric Corporation	R35B	-	
			R38B		
			R12B		
CPU module	1	Mitsubishi Electric Corporation	R16CPU	Use the product with the firmware version "28" or later.	Any of the models on the left
			R32CPU		
			R120CPU		
			R16ENCPU		
			R32ENCPU		
			R120ENCPU		
Extended SRAM cassette[2]	1	Mitsubishi Electric Corporation	NZ2MC-4MBS	Extended SRAM cassette 4MB	Any of the models on the left
			NZ2MC-8MBS	Extended SRAM cassette 8MB	
High-speed analog input module[3]	1 to 4	Mitsubishi Electric Corporation	R60ADH4	Use the product with the firmware version "04" or later.	
SD memory card[4]	0 to 2	Mitsubishi Electric Corporation	NZ1MEM-2GBSD	SD memory card 2 GB	Any of the models on the left
			NZ1MEM-4GBSD	SDHC memory card 4 GB	
			NZ1MEM-8GBSD	SDHC memory card 8 GB	
			NZ1MEM-16GBSD	SDHC memory card 16 GB	

Product List

Device name	Quantity	Manufacturer	Model	Remarks
Vibration sensor (acceleration sensor)[5]	1 to 16	TOKIN Corporation	VS-JV10A	Any of the models on the left
		Shinkawa Electric Co., Ltd.	CA-L02	
		ifm electronic gmbh	VSA004	
		PCB Piezotronics, Inc.	607M83	

*1: Use two modules for the stand-alone configuration, and two to five modules for the network support configuration.

*2: When five or more management channels are used, the NZ2MC-8MBS is required.

*3: Up to four vibration sensors (acceleration sensors) can be connected per this module.

*4: It must be installed in the PLC CPU to save the vibration data in the CSV file.
    It must be installed in the GOT to save the GOT screen capture.

*5: One of the sensors that are tested by Mitsubishi Electric are described.
    For details refer to iQ Monozukuri Rotary Machine Vibration Diagnosis Tested Device Information "Technical News BCN-E2113-0034".

Optional Devices[1]

Device name	Quantity	Manufacturer	Model	Remarks
CC-Link IE Field Network master/local module	1	Mitsubishi Electric Corporation	RJ71GF11-T2	It is used when the diagnosis target is more than one or far away from the PLC CPU.
CC-Link IE Field Network remote head module	1 to 4	Mitsubishi Electric Corporation	RJ72GF15-T2	It is used when the diagnosis target is more than one or far away from the PLC CPU. Up to four MELSEC iQ-R series CC-Link IE Field remote head modules can be connected.

*1: For other supported devices, contact your local Mitsubishi Electric representative.

Procedure for installing the system

The procedure for installing the system is as shown below.
If it is difficult for the customer to construct the system, we will introduce a system integrator.

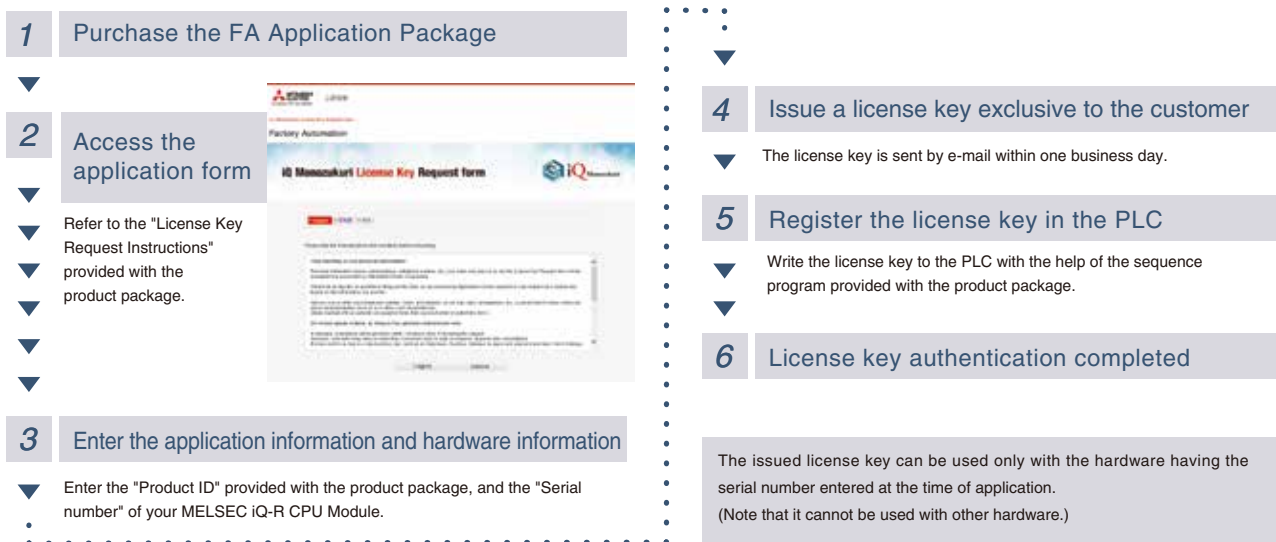**1**   Rotary Machine Vibration Diagnosis System Installation Decision

▼

2   Requirements Definition

Determine the necessary functions and system specifications.

▼

3   Estimations

Selection of devices and estimation of the engineering cost.
Engineering costs can be reduced by using "iQ Monozukuri Rotary Machine Vibration Diagnosis"!

▼

4   Design/Development

▼

5   Loading/Installation/Adjustment

▼

6   Rotary Machine Vibration Diagnosis System Installation Complete

FA Application Package Procedure of license key authentication

FA application package "iQ Monozukuri Rotary Machine Vibration Diagnosis" requires license key authentication.
The procedure of obtaining and authenticating the license key is as follows:

1   Purchase the FA Application Package

▼

2   Access the application form

Refer to the "License Key Request Instructions" provided with the product package.

▼

3   Enter the application information and hardware information

Enter the "Product ID" provided with the product package, and the "Serial number" of your MELSEC iQ-R CPU Module.

4   Issue a license key exclusive to the customer

The license key is sent by e-mail within one business day.

▼

5   Register the license key in the PLC

Write the license key to the PLC with the help of the sequence program provided with the product package.

▼

6   License key authentication completed

The issued license key can be used only with the hardware having the serial number entered at the time of application.
(Note that it cannot be used with other hardware.)

iQ Monozukuri

FA Application Package Lineup

Processes and Usages

Packages in line with the status and purposes such as where to use or with what intention

ANDON

The visualization of the production site is achieved easily through GOT2000 and a general-purpose web browser.

Deburring/Polishing

Deburring and polishing can be automated just by rough teaching.

Force sensor application

Various force sensing operations such as assembly, fitting, and inspection have been automated.

Smart Work Navigator

Systems for supporting picking and assembly work can be easily developed and operated.
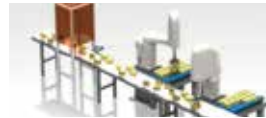
Rotary machine vibration diagnosis

Predictive maintenance can be realized for the devices and facilities with rotary machines.

Conveyor tracking

Workpieces can be transported and arranged by robots without stopping the conveyor.

Machine tool loading

The setup and development of a machine tool loading/unloading system is supported.

Equipment

Packages realizing shortening of the system development time and easy development
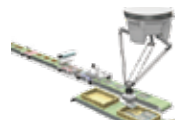
CONVERTING

The development of a converting system that requires unwinding and winding control is supported.
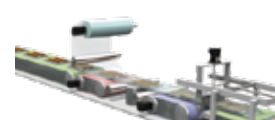
HANDLING

The development of a conveyance mechanism that requires the calculation of coordinate conversion is supported.

PACKAGING

The development of a packaging machine that requires cam control and position correction is supported.

Trademarks

Country/Region	Sales office	Tel/Fax
USA	MITSUBISHI ELECTRIC AUTOMATION, INC. 500 Corporate Woods Parkway, Vernon Hills, IL 60061, U.S.A.	Tel : +1-847-478-2100 Fax : +1-847-478-2253
Mexico	MITSUBISHI ELECTRIC AUTOMATION, INC. Mexico Branch Mariano Escobedo #69, Col. Zona Industrial, Tlalnepantla Edo. Mexico, C.P.54030	Tel : +52-55-3067-7500
Brazil	MITSUBISHI ELECTRIC DO BRASIL COMÉRCIO E SERVIÇOS LTDA. Avenida Adelino Cardana, 293, 21 andar, Bethaville, Barueri SP, Brazil	Tel : +55-11-4689-3000 Fax : +55-11-4689-3016
Germany	MITSUBISHI ELECTRIC EUROPE B.V. German Branch Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany	Tel : +49-2102-486-0 Fax : +49-2102-486-1120
UK	MITSUBISHI ELECTRIC EUROPE B.V. UK Branch Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, U.K.	Tel : +44-1707-28-8780 Fax : +44-1707-27-8695
Ireland	MITSUBISHI ELECTRIC EUROPE B.V. Irish Branch Westgate Business Park, Ballymount, Dublin 24, Ireland	Tel : +353-1-4198800 Fax : +353-1-4198890
Italy	MITSUBISHI ELECTRIC EUROPE B.V. Italian Branch Centro Direzionale Colleoni - Palazzo Sirio, Viale Colleoni 7, 20864 Agrate Brianza (MB), Italy	Tel : +39-039-60531 Fax : +39-039-6053-312
Spain	MITSUBISHI ELECTRIC EUROPE, B.V. Spanish Branch Carretera de Rubí, 76-80-Apdo. 420, 08190 Sant Cugat del Vallés (Barcelona), Spain	Tel : +34-935-65-3131 Fax : +34-935-89-1579
France	MITSUBISHI ELECTRIC EUROPE B.V. French Branch 25, Boulevard des Bouvets, 92741 Nanterre Cedex, France	Tel : +33-1-55-68-55-68 Fax : +33-1-55-68-57-57
Czech Republic	MITSUBISHI ELECTRIC EUROPE B.V. Czech Branch Avenir Business Park, Radlicka 751/113e, 158 00 Praha 5, Czech Republic	Tel : +420-251-551-470 Fax : +420-251-551-471
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Sweden	MITSUBISHI ELECTRIC EUROPE B.V. (Scandinavia) Fjelievägen 8, SE-22736 Lund, Sweden	Tel : +46-8-625-10-00 Fax : +46-46-39-70-18
Russia	MITSUBISHI ELECTRIC (RUSSIA) LLC St. Petersburg Branch Piskarevsky pr. 2, bld 2, lit "Sch", BC "Benua", office 720; 195027 St. Petersburg, Russia	Tel : +7-812-633-3497 Fax : +7-812-633-3499
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Taiwan	SETSUYO ENTERPRISE CO., LTD. 6F, No.105, Wugong 3rd Road, Wugu District, New Taipei City 24889, Taiwan	Tel : +886-2-2299-2499 Fax : +886-2-2299-2509
Korea	MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD. 7F-9F, Gangseo Hangang Xi-tower A, 401, Yangcheon-ro, Gangseo-Gu, Seoul 07528, Korea	Tel : +82-2-3660-9530 Fax : +82-2-3664-8372
Singapore	MITSUBISHI ELECTRIC ASIA PTE. LTD. 307 Alexandra Road, Mitsubishi Electric Building, Singapore 159943	Tel : +65-6473-2308 Fax : +65-6476-7439
Thailand	MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO., LTD. 12th Floor, SV.City Building, Office Tower 1, No. 896/19 and 20 Rama 3 Road, Kwaeng Bangpongpang, Khet Yannawa, Bangkok 10120, Thailand	Tel : +66-2682-6522 Fax : +66-2682-6020
Vietnam	MITSUBISHI ELECTRIC VIETNAM CO., LTD. Unit 01-04, 10th Floor, Vincom Center, 72 Le Thanh Ton Street, District 1, Ho Chi Minh City, Vietnam	Tel : +84-8-3910-5945 Fax : +84-8-3910-5947
Indonesia	PT. MITSUBISHI ELECTRIC INDONESIA Gedung Jaya 11th Floor, JL. MH. Thamrin No.12, Jakarta Pusat 10340, Indonesia	Tel : +62-21-3192-6461 Fax : +62-21-3192-3942
India	MITSUBISHI ELECTRIC INDIA PVT. LTD. Pune Branch Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune-411026, Maharashtra, India	Tel : +91-20-2710-2000 Fax : +91-20-2710-2100
Australia	MITSUBISHI ELECTRIC AUSTRALIA PTY. LTD. 348 Victoria Road, P.O. Box 11, Rydalmere, N.S.W 2116, Australia	Tel : +61-2-9684-7777 Fax : +61-2-9684-7245

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0051

ISO 9001
BUREAU VERITAS
Certification

BUREAU VERITAS 1828

UKAS MANAGEMENT SYSTEMS
0008
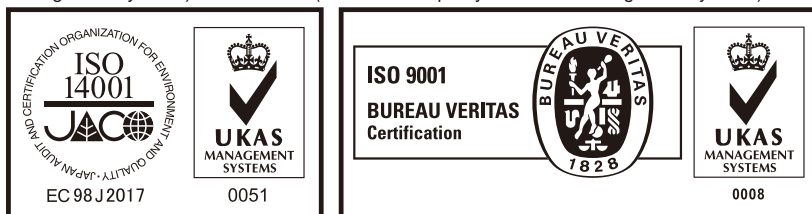
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