



for a greener tomorrow



**MITSUBISHI
ELECTRIC**

Changes for the Better

FACTORY AUTOMATION

FA Application Package

iQ Monozukuri Rotary Machine Vibration Diagnosis

e-Factory



- Easily install a vibration diagnosis system!
- Presume 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

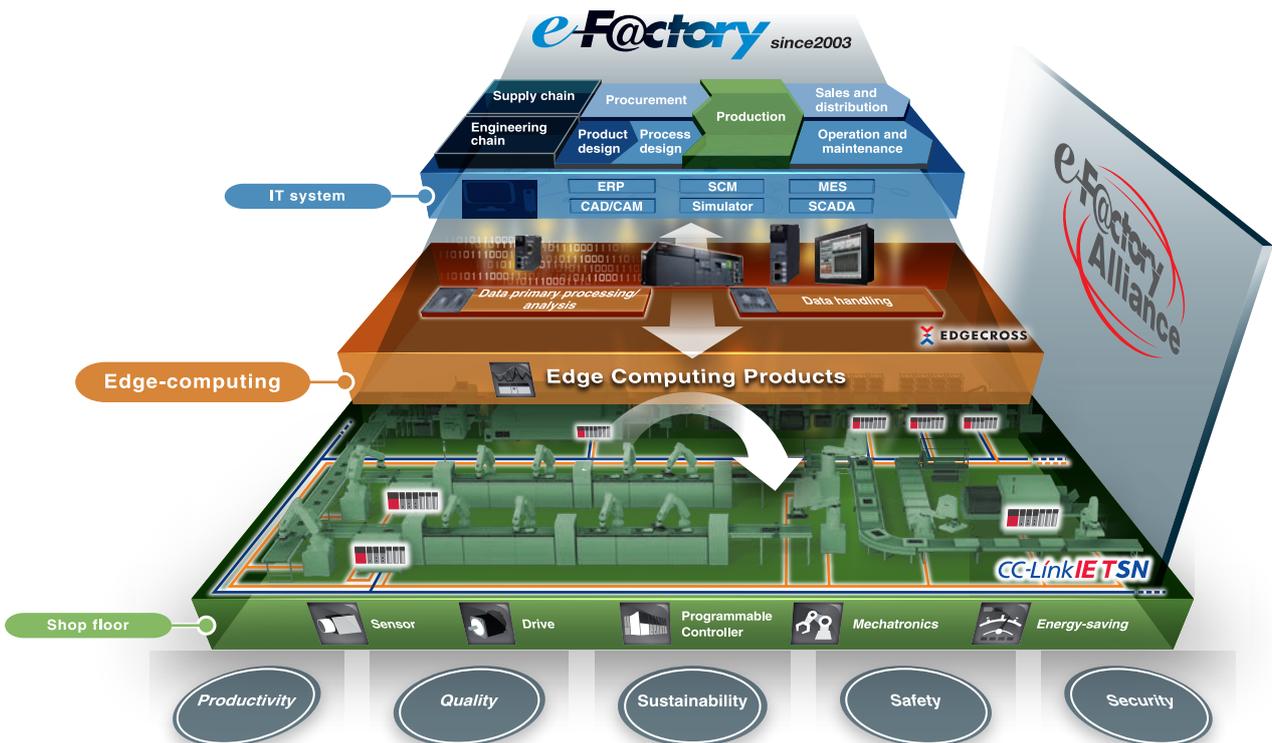
Commercial and consumer-centric equipment, products and systems.

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.

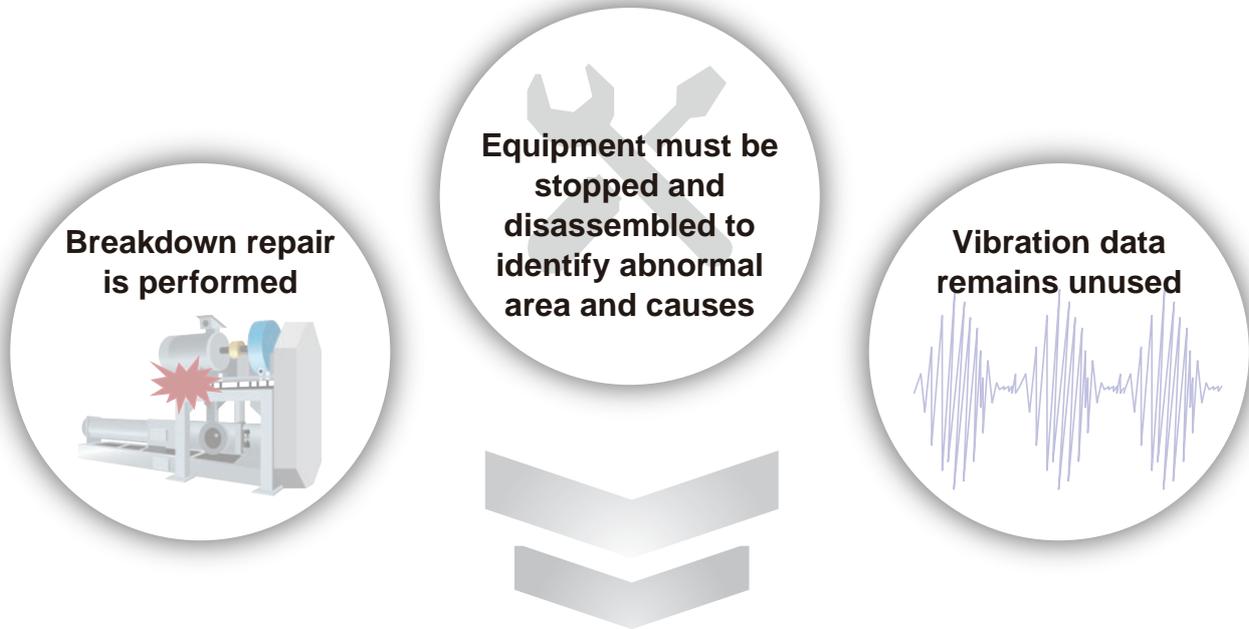
Productivity and quality can be improved not only with the information obtained from the devices at the production site, but the improvement triggered by on-site notice and flexible human actions. Similarly, automatic adjustment of equipment based on the information recognized by human is indispensable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



FA Application Package iQ Monozukuri Rotary Machine Vibration Diagnosis

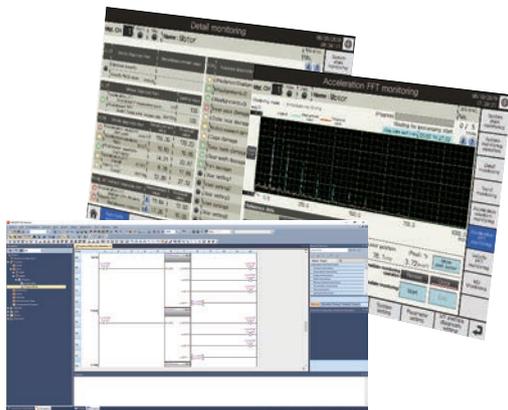
"iQ Monozukuri Rotary Machine Vibration Diagnosis" is an application that helps to visualize the equipment condition and presume the abnormal area by collecting, analyzing, and diagnosing vibration data of the equipment with a rotary mechanism.



Vibration diagnosis can be started immediately with "iQ Monozukuri Rotary Machine Vibration Diagnosis" of Mitsubishi Electric!

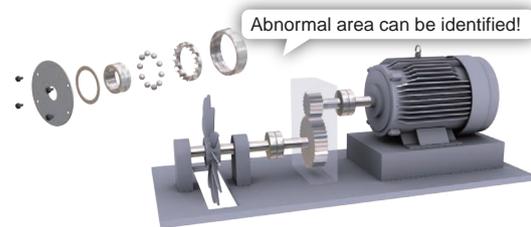
Easy introduction in one package!

Control programs certified by Mitsubishi and screen data are provided in one package. They are ready to use right after installation, and can be easily and smoothly introduced without any know-how on vibration analysis.



Support for vibration diagnosis!

This package enables not only vibration analysis but also vibration diagnosis by itself. Accurate diagnosis shows not only the existence of abnormality but also the abnormal.



Unbalance (rotation body, etc.)	Rolling element damage
Misalignment (coupling, etc.)	Cage damage
Inner race damage	Gear teeth damage
Outer race damage	Fan damage

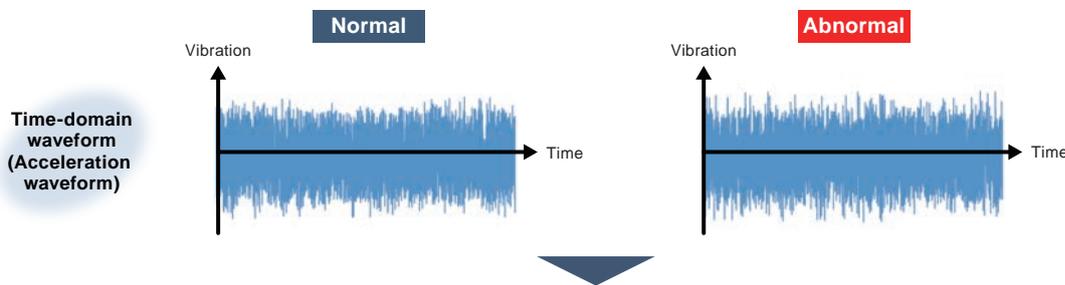
Application example

"iQ Monozukuri Rotary Machine Vibration Diagnosis" helps to solve issues at various production sites by installing it to the equipment with a rotary mechanism.

Examples of applicable equipment: Equipment with rotary mechanisms such as a motor, fan and blower, compressor, reduction and increase drive, conveyor, and converting machine

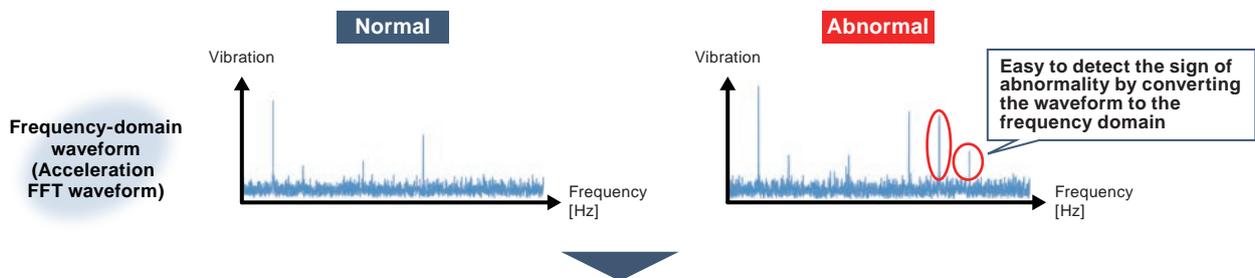
Case 1 To detect signs of abnormality and perform maintenance before failure

By observing the change in vibration caused by the equipment, the change in the condition of the equipment can be checked. In the time-domain waveform, however, the difference between normal and abnormal conditions is not clear and it is difficult to detect the signs of abnormality.



After installation of Rotary Machine Vibration Diagnosis...

Abnormal signs are detected by converting time-domain waveform to frequency-domain waveform!



Abnormal area can be presumed through simple diagnosis and accurate diagnosis!

1 Check abnormalities in equipment through **simple diagnosis**

Abnormal!

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

2 Presume the abnormal area through **accurate diagnosis**

Detect the sign of inner race damage!



ALM	Accurate diagnosis item	Measurement value	Amplitude (m/s ²)	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			

Maintenance on the area where abnormal signs are detected can prevent sudden stop of devices and reduce downtime!

Case 2 Is it difficult to detect equipment abnormalities without knowledge of vibration analysis?

Vibration analysis requires a certain level of expertise. In addition, in order to identify the abnormal area through accurate diagnosis, specification value information of the component is needed.

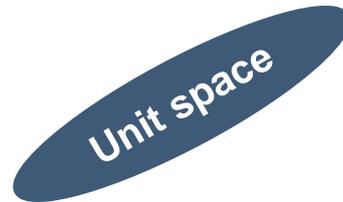


After installation of Rotary Machine Vibration Diagnosis...

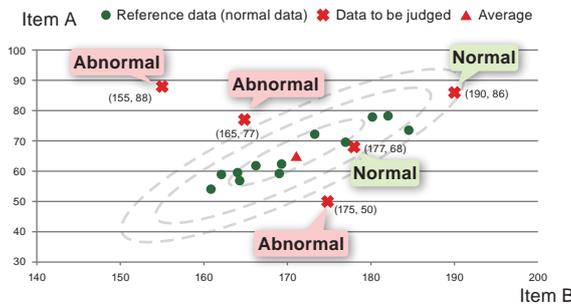
"Unusual conditions" are detected through MT method*1 diagnosis!

1 Normal vibration data more than necessary are collected before diagnosis to generate the unit space.

	Vibration [m/s ²]
Sample 1	5.0
Sample 2	4.2
Sample 3	4.5
:	:



2 Quantify the degree of deviation from the unit space with a single index called Mahalanobis distance, and judge the normal/abnormal condition.



Mahalanobis distance monitoring											
Acceleration FFT					Velocity FFT						
Man	ALL	Measurement	Threshold	Number of samples	Man	ALL	Measurement	Threshold	Number of samples		
1	○	13.84	10.00	30	47	1	○	17.26	10.00	30	47
2	○	2.30	10.00	30	100	2	○	3.50	10.00	30	100
3	○	5.10	10.00	30	52	3	○	6.00	10.00	30	52
4	○	8.50	10.00	30	60	4	○	8.70	10.00	30	60
5	○					5	○				
6	○					6	○				
7	○					7	○				
8	○					8	○				
9	○					9	○				
10	○					10	○				
11	○					11	○				
12	○					12	○				
13	○					13	○				
14	○					14	○				
15	○					15	○				
16	○					16	○				

Touch the management CH switch to switch to the FFT monitoring screen.
Color of the number of 100 (selecting) further increased 100 (selecting) number reached 100 not collected

* Combined diagnosis is possible by combining data other than vibration such as temperature and current.

Vibration diagnosis is possible without knowledge of vibration analysis! It is possible not only to judge the normal/abnormal condition, but also to grasp the degree of the abnormality and to detect the sign!

*1: The MT method (Mahalanobis-Taguchi Method) generates a pattern (unit space) of normal data and detects data having a significantly large distance from the pattern (Mahalanobis distance) as an abnormal value.

Flow of Diagnosis

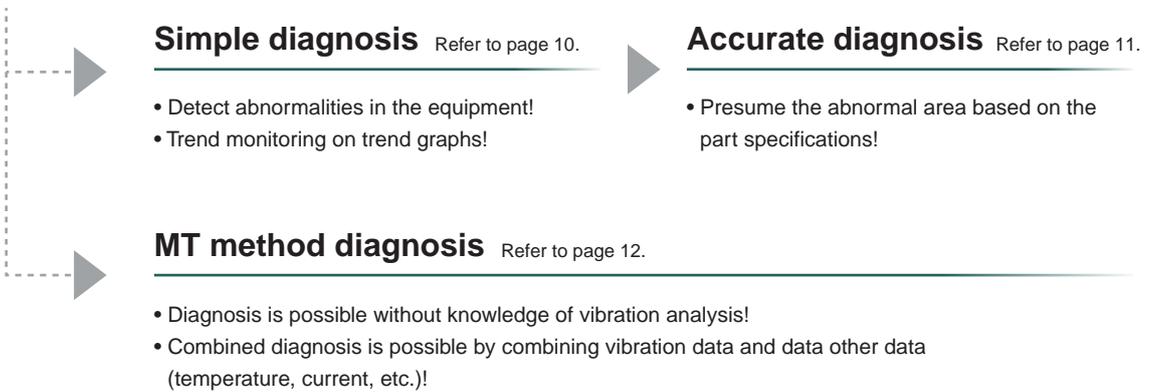
The following describes the procedure of vibration diagnosis using this package.

Easy installation Refer to page 8.

Just install the program!
Vibration diagnosis system can be installed easily and smoothly!



Easy diagnosis



Other Useful Features

- **Collectively grasp the diagnostic status of the entire system!** Refer to page 13.
- **Easily check vibration condition on the waveform graph!** Refer to page 14.
- **Save each data in a CSV file!** Refer to page 15.
- **Simultaneous logging of vibration data for up to 4 CHs!** Refer to page 15.

FA Application Package

Features of iQ Monozukuri

Rotary Machine Vibration Diagnosis

The general vibration diagnosis method is divided into simple diagnosis and accurate diagnosis. After detecting an abnormality with simple diagnosis, accurate diagnosis is used to presume the abnormal area and causes.

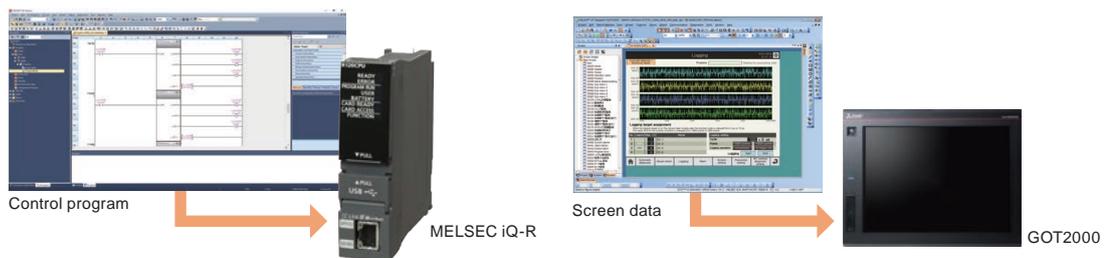
"iQ Monozukuri Rotary Machine Vibration Diagnosis" realizes predictive maintenance of equipment through MT method diagnosis using the MT method in addition to simple diagnosis and accurate diagnosis.

Easy Installation

Easily install a vibration diagnosis system!

This enables to construct a ready-to-use vibration diagnosis system without special knowledge just by installing the control program to the PLC (MELSEC iQ-R) and screen data to the GOT (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.



*1: Register a license key to the PLC CPU.

Step2 Turn on the power of the system to startup the PLC and GOT. *2



*2: Complete wiring of necessary devices such as sensors in advance.

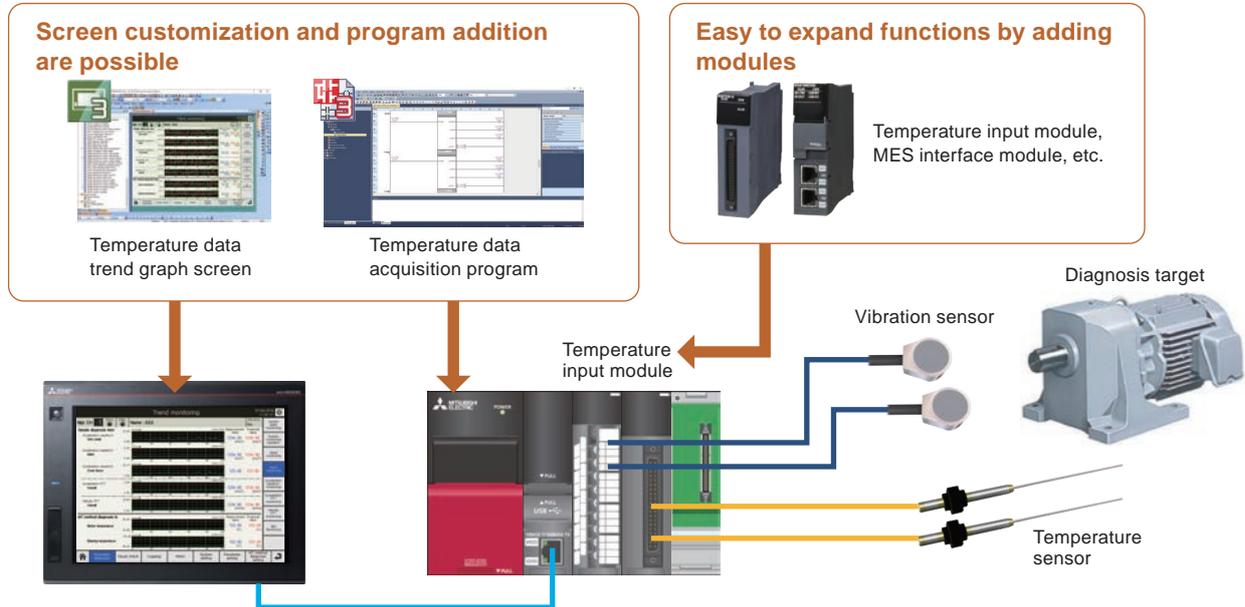
Step3 Set the sensor sensitivity and equipment specification values on the GOT screen.



Quick diagnosis for vibration condition of the equipment!

Easy Installation Flexible system expansion!

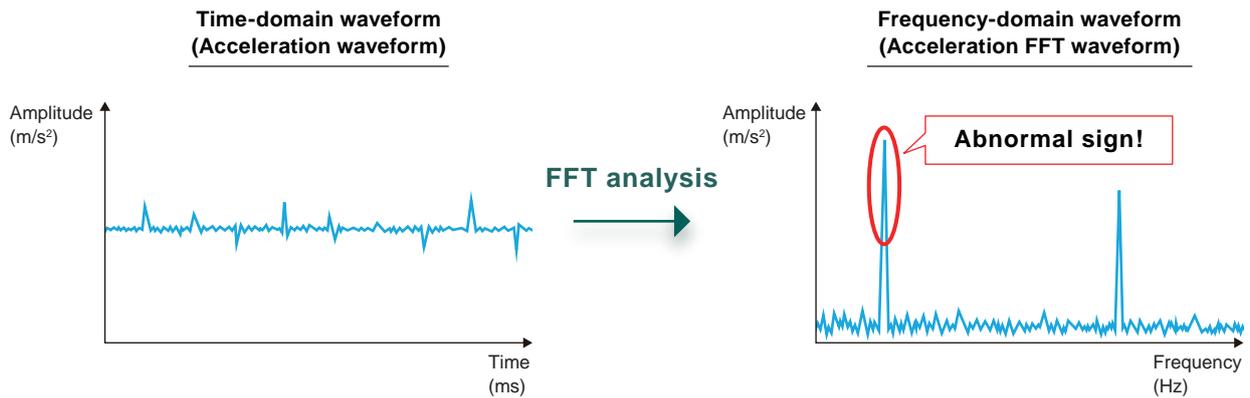
With the Mitsubishi FA devices and general-purpose vibration sensors, the system can be flexibly configured to meet customer needs. Optional control programs can be added and the GOT screen can be customized.^{*1}



*1: Any malfunction or failure due to customization is out of guarantee.

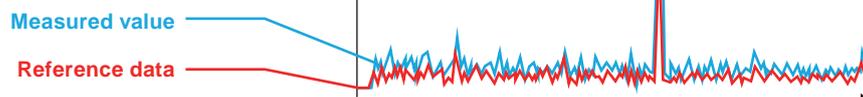
Easy diagnosis (FFT analysis) Visualize vibration condition through FFT analysis!

The vibration condition can be visualized by converting vibration data into frequency-domain waveform through FFT analysis. The vibration condition and abnormal signs can be easily identified by displaying the vibration data in a frequency-domain waveform.



<Overlapping on reference data>

The difference of the vibration level can be seen at a glance by saving the normal waveform of equipment as reference data, and overlapping it on the measured vibration data.



Easy diagnosis (Simple diagnosis)

Detect abnormalities of the equipment through simple diagnosis!

Abnormalities in the equipment and their signs can be detected by comparing the status level with the reference value.

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^{*1} : 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

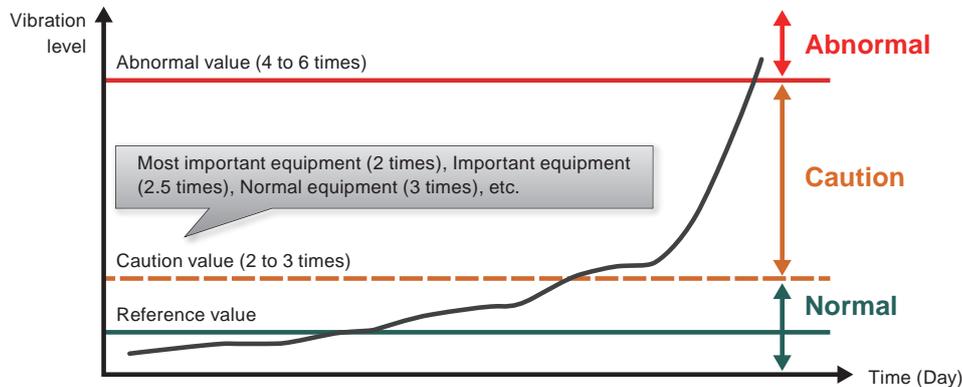
*1: In iQ Monozukuri Rotary Machine Vibration Diagnosis, Class IV under ISO 2372 is not supported because the class is determined according to the motor capacity.

Vibration severity Velocity RMS value (effective value) (mm/s)	ISO2372			
	Class I	Class II	Class III	Class IV ^{*1}
0.28	A	A	A	A
0.45				
0.71	B	B	B	B
1.12				
1.8	C	C	C	C
2.8				
4.5	D	D	D	D
7.1				
11.2	D	D	D	D
18				
28	D	D	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.



Trend monitoring on trend graphs!

Vibration trend can be monitored and the signs of abnormality can be detected by displaying the results of simple diagnosis at regular intervals such as per day or per hour in a trend graph.

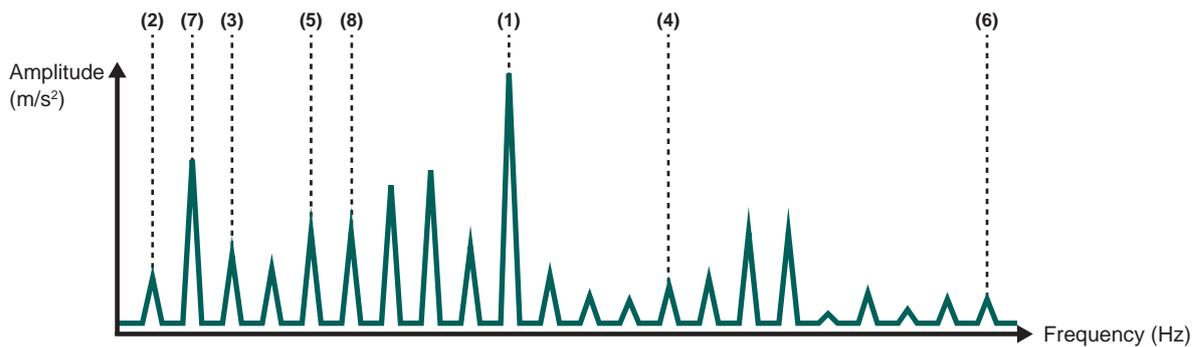
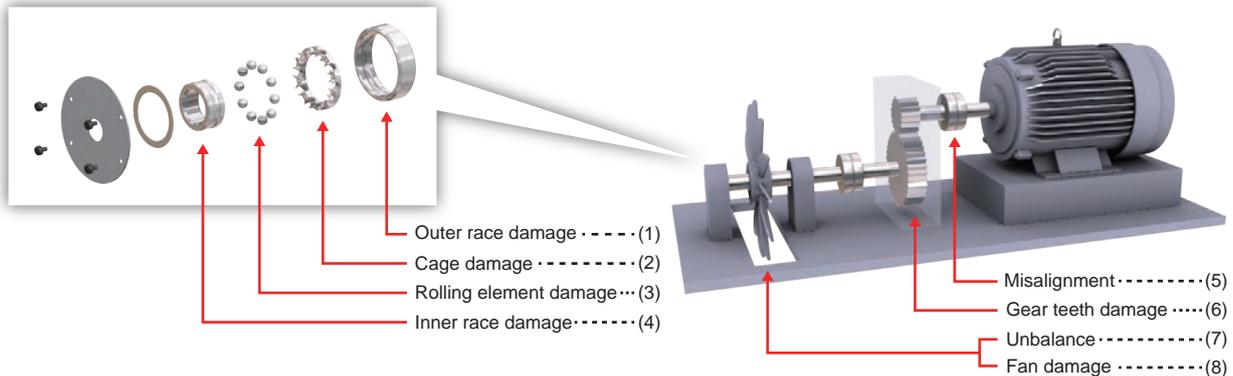
Easy diagnosis (Accurate diagnosis) Presume abnormal area by means of accurate diagnosis!

Abnormal area can be presumed by monitoring the characteristic frequency automatically calculated from the specification values of components, leading to early error detection.

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

Accurate diagnosis

Perform FFT analysis on the vibration data and presume the abnormal area according to the change in the amplitude of the characteristic frequency.



Accurate diagnosis results are displayed in a list!

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

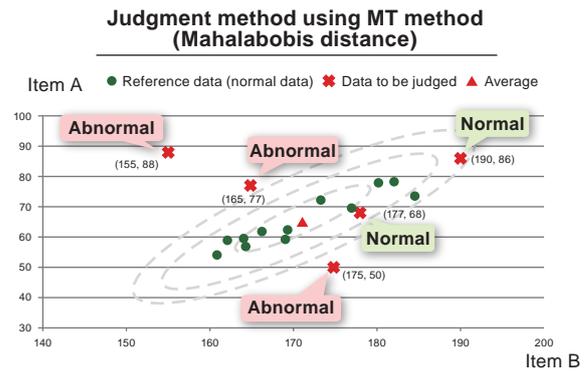
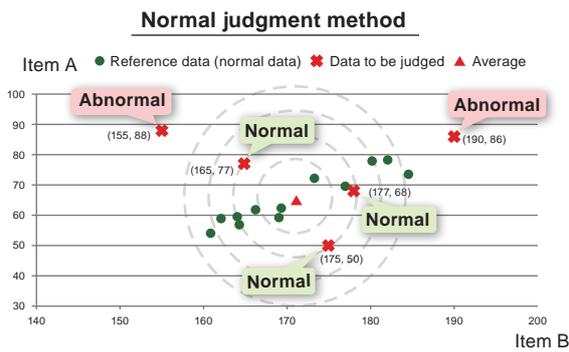
Detail monitoring				06/20/2019 09:34:11		
Mgt. CH	1	Moni.	Diag.	Name : Motor	BIG proc. No.	System state monitoring
ALM	Simple diagnosis item	State/Measurement value	ALM	Accurate diagnosis item	Amplitude (m/s ²)	
	Vibration severity			Unbalance/Misalignment	Measurement value: 1.48	Threshold value: 1.88
	Velocity RMS value (mm/s)			Misalignment(x2)	0.56	0.85
				Misalignment(x3)	0.57	0.80
ALM	Simple diagnosis item	Setting value		Inner race damage	0.65	0.63
	Acceleration FFT Guard band monitoring width (%)	130		Outer race damage	5.98	6.91
	Acceleration FFT Guard band cont. excess pts. (points)	100		Rolling element damage	1.19	1.43
ALM	Simple diagnosis item	Measurement value	Threshold value	Cage damage	0.89	0.93
	Acceleration waveform Zero peak (m/s ²)	155.30	129.25	Gear teeth damage	0.42	0.59
	Acceleration waveform RMS (m/s ²)	10.85	10.95	Gear teeth damage(x2)	0.18	0.34
	Acceleration waveform Crest factor	14.31	23.67	Fan damage	0.57	0.80
	Acceleration FFT Overall (m/s ²)	9.78	11.66	User setting1		
	Velocity FFT Overall (mm/s)	22.89	27.32	User setting2		
				User setting3		
				User setting4		
ALM	MT method diagnosis item	Measurement value	Threshold value	User setting5		
	Acceleration FFT Mahalanobis distance	13.84	10.00	User setting6		
	Velocity FFT Mahalanobis distance	17.26	10.00			

Easy diagnosis (MT method diagnosis) Easily detect abnormalities by means of MT method!

Even without knowledge of vibration analysis or parts specification values, abnormalities can be detected easily by applying the MT method (quality engineering technique) to vibration analysis. Moreover, compositive diagnosis is possible by combining vibration data with data other than vibration such as temperature and current.

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.



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.



MT method diagnosis results are displayed in a list!

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

Mahalanobis distance monitoring 06/20/2019 10:43:21

Management CH during processing 0 Progress Waiting for processing start

Mgt. CH	Acceleration FFT				Velocity FFT			
	ALM	Mahalanobis distance Measurement value	Threshold value	Number of samples Minimum Collection	ALM	Mahalanobis distance Measurement value	Threshold value	Number of samples Minimum Collection
1	●	13.84	10.00	30 47	●	17.26	10.00	30 47
2	●	2.30	10.00	30 100	●	3.50	10.00	30 100
3	●	5.10	10.00	30 52	●	6.00	10.00	30 52
4	●	8.50	10.00	30 60	●	8.70	10.00	30 60
5	●				●			
6	●				●			
7	●				●			
8	●				●			
9	●				●			
10	●				●			
11	●				●			
12	●				●			
13	●				●			
14	●				●			
15	●				●			
16	●				●			

Touch the management CH switch to switch to the FFT monitoring screen.

Color of the number of collected samples 100 Collecting (minimum number unreached) 100 Collecting (minimum number reached) 100 Not collected

Automatic diagnosis Visual check Logging Alarm System setting Parameter setting MT method diagnosis setting

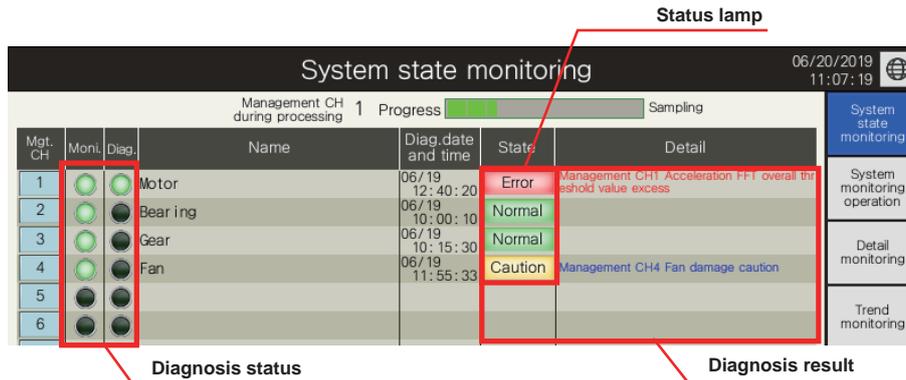
Other useful features (Diagnostic status list display) Collectively grasp the diagnostic status of the entire system!

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 status and results of all 16 CHs are displayed in a list!

The diagnosis status and results of all 16 channels can be checked with the lamp and detail message. Touching a status lamp displays the diagnosis results of the channel at once.

* Processing from collection to diagnosis of vibration data is executed for each channel one by one.



<Automatic diagnosis can be performed at any timing!>

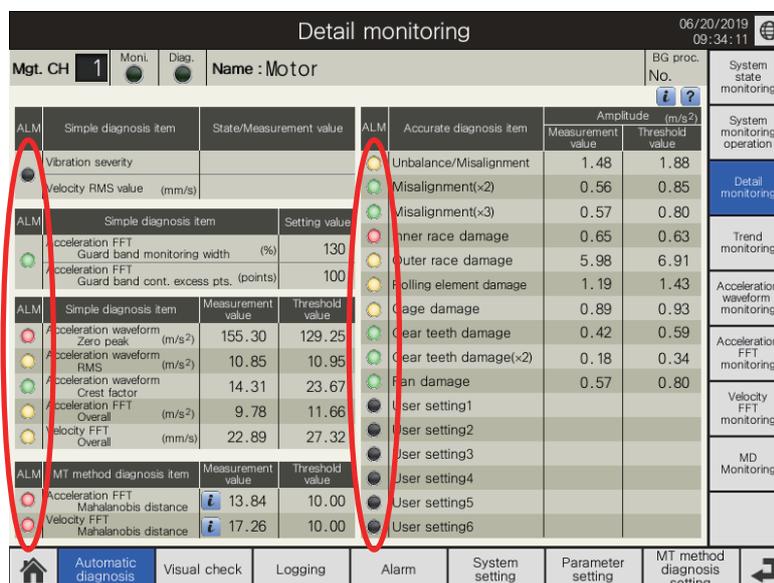
Monitoring timing of automatic diagnosis can be selected from the following three types.

- 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 lamps.

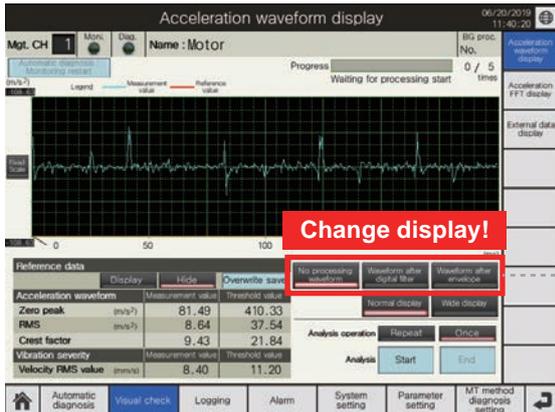


Other useful features (Visual check) Easily check vibration condition on the waveform graph!

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).



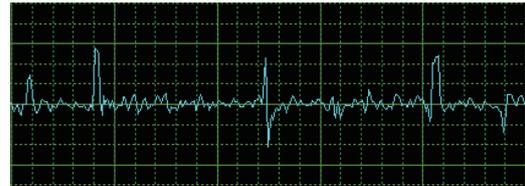
No processing waveform

This is the original waveform obtained by scaling the signal (vibration data) from the vibration sensor.



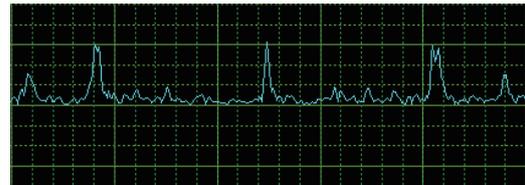
Waveform after digital filter

A digital filter is applied to eliminate noise superimposed by vibration sensors and cables.



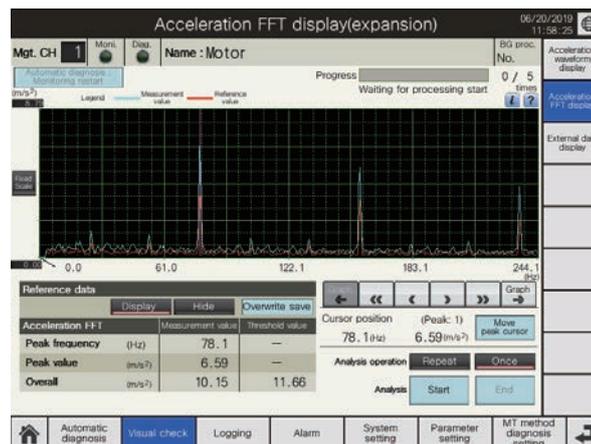
Waveform after envelope

The change in amplitude can be clearly seen by extracting the outline of amplitude absolute values (envelope processing).



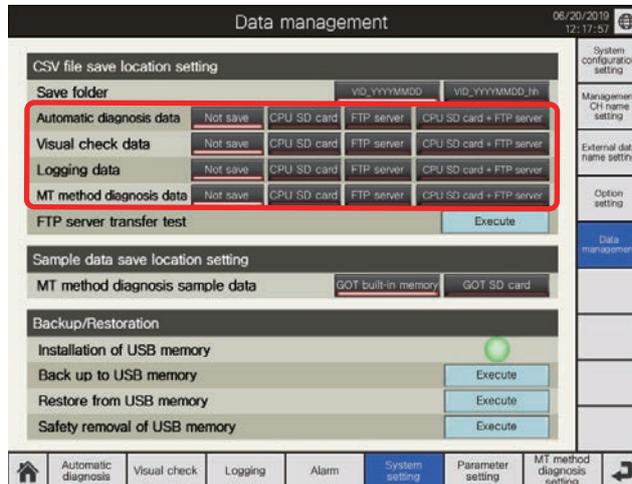
Easily check vibration condition in the time-domain waveform!

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



Other useful features (Data management) Save various data as a CSV file!

Automatic diagnosis data, visual check data, logging data, and MT method diagnosis data can be saved as a CSV file. CSV files can be saved in an SD memory card or FTP server.

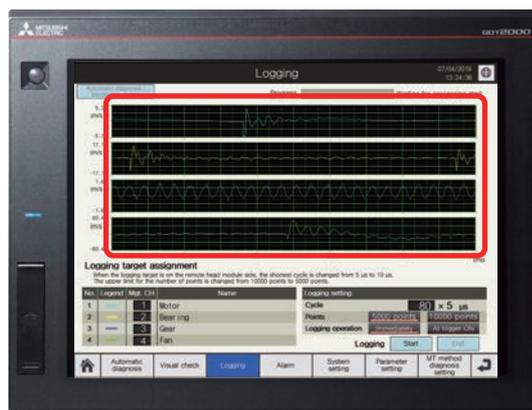


<CSV file contents>

- **Automatic diagnosis data / Visual check data**
Time (s), Acceleration waveform (m/s²), Frequency (Hz), Acceleration FFT (m/s²), Velocity FFT (mm/s)
- **Logging data**
Time (s), Acceleration waveform (m/s²)
- **MT method diagnosis data**
Acceleration MD value (measurement value), acceleration MD value (threshold value), number of acceleration items, velocity MD value (measurement value), velocity MD value (threshold value), number of velocity items, etc.

Other useful features (Logging) Simultaneous logging of vibration data for up to 4 CHs!

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



CSV file



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.18)".

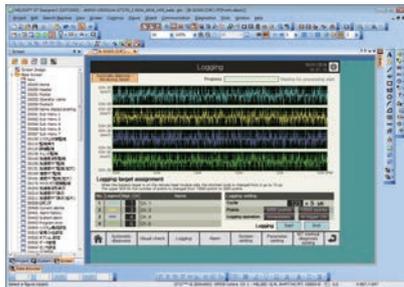
Software



Screen data (GT Designer3 project file¹⁾)

¹: MELSOFT GT Designer3 is required.

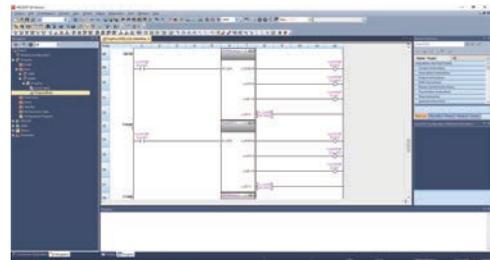
Screen data of GOT2000 for the rotary machine vibration diagnosis



Control program (GX Works3 project file²⁾)

²: MELSOFT GX Works3 is required.

Sequence control program for the rotary machine vibration diagnosis



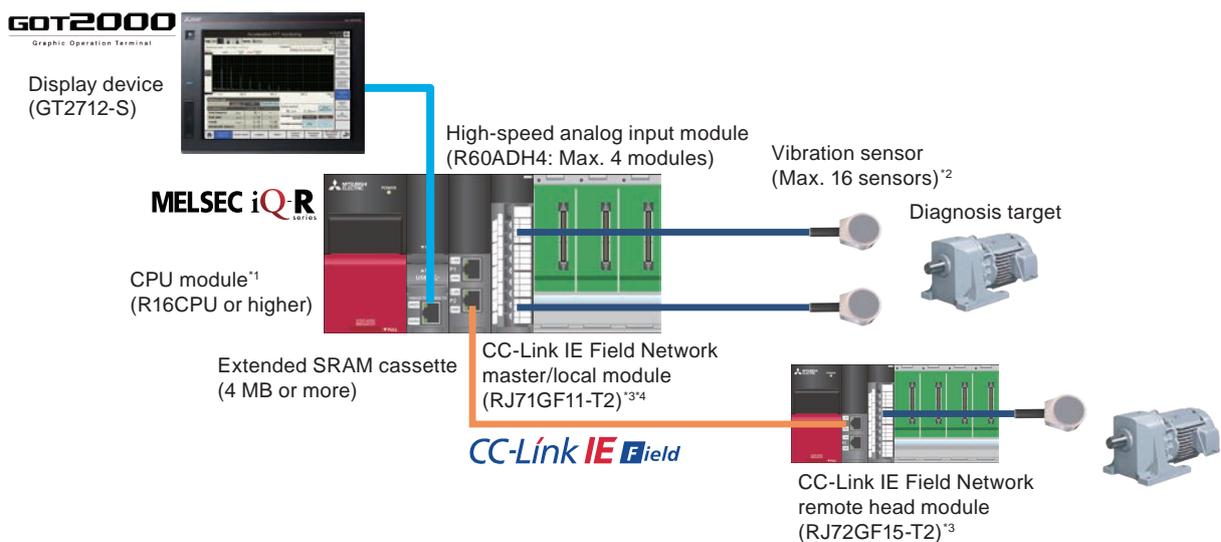
Documents



Manual (PDF file)

Instruction manual

System Configuration Diagram



- *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 MELSEC iQ-R series CC-Link IE Field Network remote head modules can be connected.
- *4: The following modules can be used as the master station of CC-Link IE Field Network.
 - R**ENCPU (** is 16 or later.)
 - RJ71EN71

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 MELSEC iQ-R series CC-Link IE Field Network remote head module stations		Max. 4 stations
Sampling function	Cycle (Frequency range)	10 μ s (40 kHz), 20 μ s (20 kHz), 25 μ s (16 kHz), 50 μ s (8 kHz), 100 μ s (4 kHz), 400 μ s (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, Rolling element damage, Cage damage, Gear teeth damage, Fan damage
	MT method diagnosis	Monitoring item: Acceleration FFT (partial overall), Velocity FFT (partial overall), External data
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 (x5 μ s) ^{*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 μ s, 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}
FA Application Package iQ Monozukuri Rotary Machine Vibration Diagnosis	Mitsubishi Electric Corporation	AP10-VID001AA-MA	1
		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 1.055H or later
GOT Screen Design Software MELSOFT GT Works3 ^{*1}	1	Mitsubishi Electric Corporation	SW1DND-GTWK3-E	Version 1.217B 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
			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	R33B	-
			R35B	
			R38B	
			R312B	
CPU module	1	Mitsubishi Electric Corporation	R16CPU	Use the product with the firmware version "40" or later.
			R32CPU	
			R120CPU	
			R16ENCPU	
			R32ENCPU	
Extended SRAM cassette ^{*2}	1	Mitsubishi Electric Corporation	NZ2MC-4MBS	Extended SRAM cassette 4MB
			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
			NZ1MEM-4GBSD	SDHC memory card 4 GB
			NZ1MEM-8GBSD	SDHC memory card 8 GB
			NZ1MEM-16GBSD	SDHC memory card 16 GB

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, an extended SRAM cassette (model: 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 inserted to the GOT to save GOT screen captures or sample data groups of MT method diagnosis.
- *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}

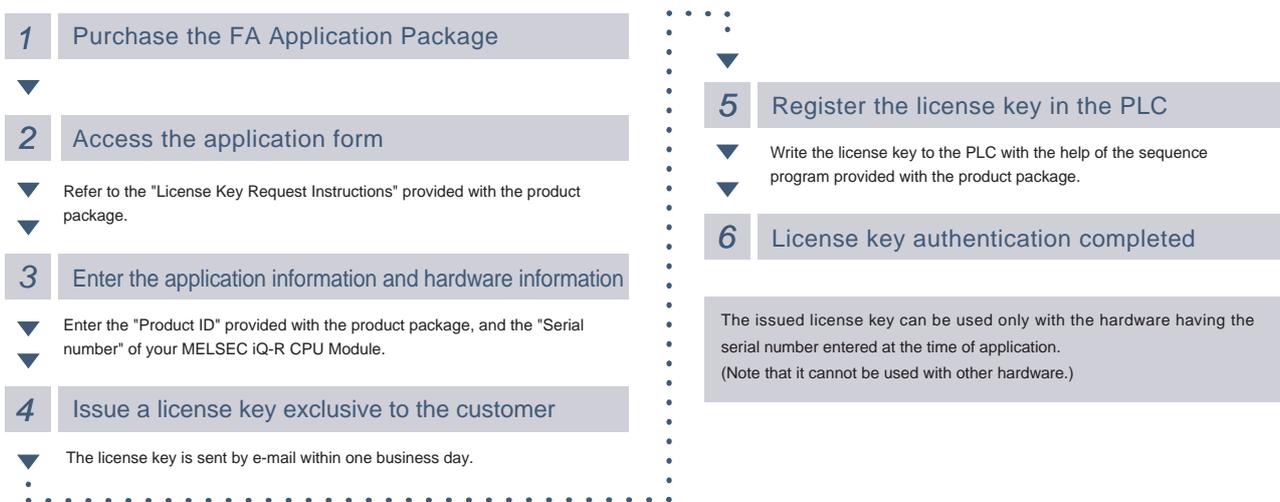
Device name	Quantity	Manufacturer	Model	Remarks
CC-Link IE Field Network master/local module ^{*2}	1	Mitsubishi Electric Corporation	RJ71GF11-T2	Any of the models on the left
Ethernet module ^{*2,3}	1	Mitsubishi Electric Corporation	RJ71EN71	
CC-Link IE Field Network remote head module ^{*2}	1 to 4	Mitsubishi Electric Corporation	RJ72GF15-T2	Up to four MELSEC iQ-R series CC-Link IE Field Network remote head modules can be connected.

- *1: For other supported devices, contact your local Mitsubishi Electric representative.
- *2: It is used when the diagnosis target is multiple devices or away from the PLC CPU.
- *3: Use this module as the CC-Link IE Field Network master module.

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:

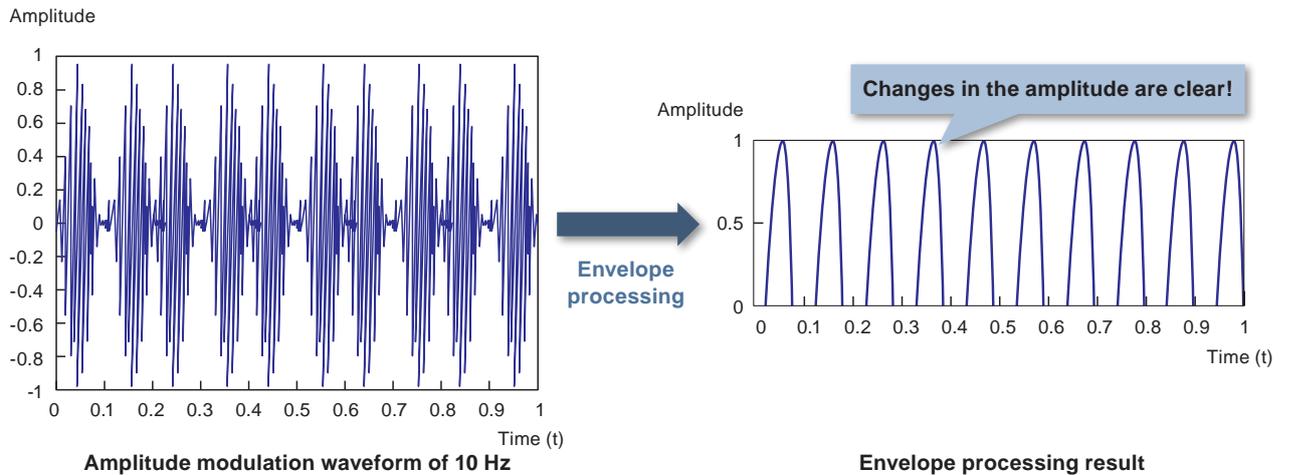


Glossary

Terminology of vibration analysis

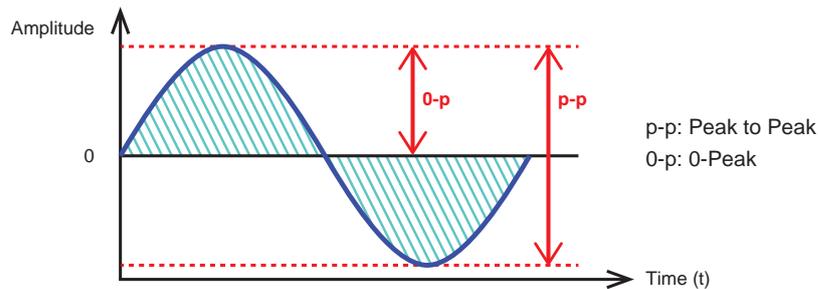
Envelope

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.



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.

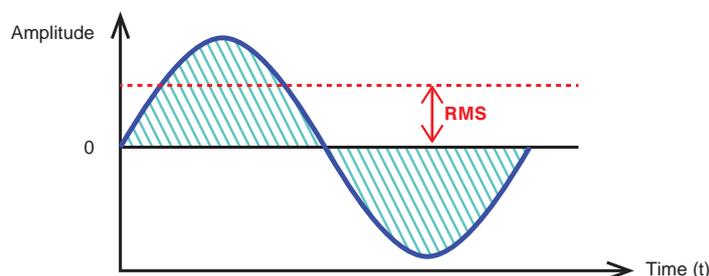


RMS (effective value)

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.

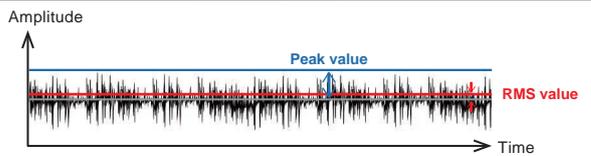
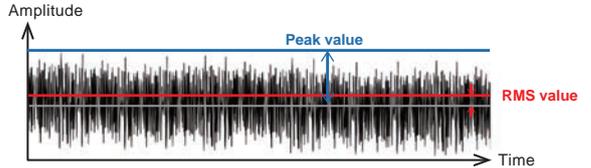
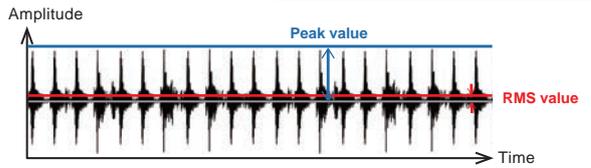
The velocity RMS is used for total judgment of the equipment condition. The acceleration RMS is used for calculation of crest factor.



□ Crest factor (CF)

A ratio of RMS value and peak value of time-domain waveform. (Crest factor = peak value/RMS value)

While the peak value and RMS value vary according to the rotation speed, the crest factor is less likely to vary but increases due to impact vibration. Therefore, the crest factor is used for detecting impact vibration such as damage on a bearing.

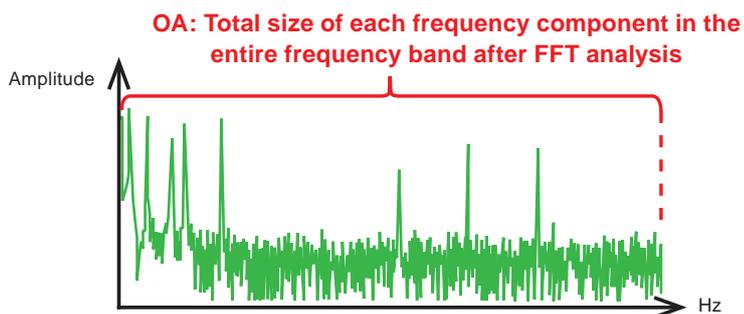
Vibration state	Time-domain waveform (Acceleration waveform)	Crest factor value (standard)
Normal		CF << 5
Motor load increased due to inadequate lubrication		CF ≈ 6
Impact vibration due to damage		CF >> 6

□ 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.

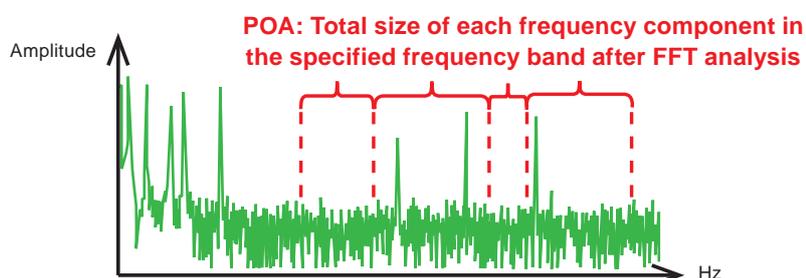
It is used to monitor the amplitude in the entire frequency band after FFT analysis.



□ 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.



Terminology of MT method

□ Item (Input item of MT method)

The characteristic value extracted from the source information (such as vibration) used to generate a unit space or calculate the Mahalanobis distance.

In "iQ Monozukuri Rotary Machine Vibration Diagnosis", the corresponding items are the POA value of vibration and others. 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

A set of data of each item measured in the normal condition, which is necessary for generating unit space of MT method. This is called sample data as well.

□ Mahalanobis distance

An index of the deviation from the reference data group.



FA Application Package Lineup

Processes and Usages

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

Smart Work Navigator

Systems for supporting picking and assembly work can be easily developed and operated.



Equipment

Packages realizing shortening of the system development time and easy development

Process Remote Monitoring

Visualizing operation status and introducing IoT technologies to the shop floor to improve manufacturing process and productivity.



Processing Machine Loading

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



ANDON

ANDON display improves productivity by sharing information between workers.



Force-sense Application

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



Rotary Machine Vibration Diagnosis

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



Deburring/Polishing

Deburring and polishing can be automated just by rough teaching.



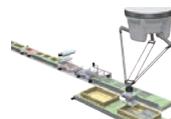
CONVERTING

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



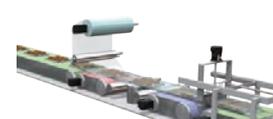
HANDLING

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.



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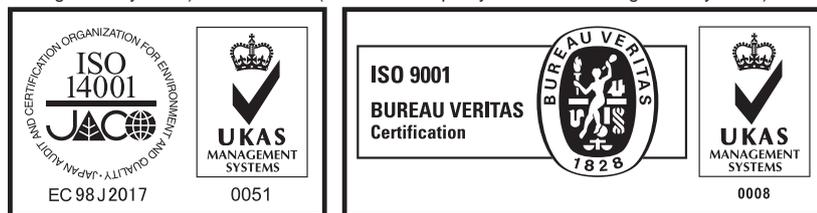
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