MITSUBISHI ELECTRIC

Mitsubishi Electric Industrial Robot

CR800-D/R/Q series controller

Predictive Maintenance Function User's Manual

MELFA

BFP-A3663

⚠ Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

⚠CAUTION All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

⚠CAUTION For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

⚠WARNING Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

⚠CAUTION During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

⚠DANGER Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

⚠CAUTION Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

⚠CAUTION As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc.
Indication of maintenance work in progress.

⚠CAUTION Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below.
Refer to the actual "Safety Manual" for details.

DANGER When automatic operation of the robot is performed using multiple control devices (GOT, programmable controller, push-button switch), the interlocking of operation rights of the devices, etc. must be designed by the customer.

CAUTION Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

CAUTION Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

CAUTION Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

CAUTION Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

CAUTION Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

CAUTION Set work masses, including hands, so as not to exceed the rated load or permitted torque.
Exceeding either of these can cause an alarm or breakdown.

WARNING Securely install the hand and tool, and securely grasp the workpiece.
Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

WARNING Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

CAUTION Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

WARNING When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.

CAUTION Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

CAUTION After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

CAUTION Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

CAUTION Never carry out modifications based on personal judgments, or use non-designated maintenance parts.
Failure to observe this could lead to faults or failures.

WARNING When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

CAUTION Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

CAUTION Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

DANGER Do not connect the Handy GOT when using the GOT direct connection function of this product. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether
the operation rights are enabled or not.

DANGER Do not connect the Handy GOT to a programmable controller when using an iQ Platform compatible product with the CR800-R/CR800-Q controller. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

DANGER Do not remove the SSCNET III cable while power is supplied to the multiple CPU system or the servo amplifier. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables of the Motion CPU or the servo amplifier. Eye discomfort may be felt if exposed to the light.
(Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

DANGER Do not remove the SSCNET III cable while power is supplied to the controller.
Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables. Eye discomfort may be felt if exposed to the light.
(Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

DANGER Attach the cap to the SSCNET III connector after disconnecting the SSCNET III cable. If the cap is not attached, dirt or dust may adhere to the connector pins, resulting in deterioration connector properties, and leading to malfunction.

CAUTION Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in errors, such as the emergency stop not being released. In order to prevent errors occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emergency stop, and door switch) are working properly after the wiring setup is completed.

CAUTION Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB. When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

CAUTION To maintain the safety of the robot system against unauthorized access from external devices via the network, take appropriate measures. To maintain the safety against unauthorized access via the Internet, take measures such as installing a firewall.

■ Revisions

Revision Date	Instruction Manual No.	Revision Details
2019-04-25	BFP-A3663	• First print

■ Introduction

Thank you for purchasing the Mitsubishi industrial robot "MELFA Smart Plus Card/Card Pack Option".

This instruction manual explains the " Predictive Maintenance Function" that can be used with the MELFA Smart Plus Card/Card Pack Option.

This product provides features that support maintenance and inspection so that the robot can be used for a long time without trouble.

Efficient maintenance is supported though early detection of abnormalities or deterioration of robot components and notification of the time of maintenance parts replacement or overhaul based on theactual operating status of the robot.

Furthermore, due to the feature of estimating the parts replacement time or the recommended maintenance time, this function can be used for decision making on the maintenance cycle.

To ensure correct usage of the product, always read through this manual before starting to use "Predictive maintenance function".

For details of basic robot operation, refer to the separate "Instruction Manual / Detailed Explanations of Functions and Operations".

■ Notation used in this manual

Danger	This indicates an item for which incorrect handling could present imminent danger of death or serious injury.
Warning	This indicates an item for which incorrect handling could present a danger of death or serious injury.
Caution	This indicates an item for which incorrect handling could present a danger of injury. It could also present a danger of just physical damage.

Contents

1. Before starting use

1.1. Contents of the instruction manual

This function can be used with the RT ToolBox3 Predictive maintenance screen, parameters, status variables, and dedicated input/output signals.
In this manual, the following structure is used to explain how the predictive maintenance function using examples of the RT ToolBox3 Predictive maintenance screens.
For functions and operation methods provided in the standard robot controller, refer to the "Instruction Manual" supplied for the robot controller.

Chapter	Title	Description
1	Before starting use	Explains the structure of this manual, products compatible with this function, related manuals, and maintenance/inspection.
2	Basic specifications	Explains the specification of the predictive maintenance function.
3	Startup and initial settings	Explains how to start the predictive maintenance function and the initial setting method.
4	Basic screen structure	Each predictive maintenance function is explained using examples of the RT ToolBox3 Predictive maintenance screens.
5	Total score	
6	Consumption degree calculation function	
7	Abnormality detection function	
8	Operating information	
9	Maintenance simulation	
10	When consumption occurred/abnormality detected	Explains pause of warning occurrence related to this function and operation at the time of maintenance using examples of the RT ToolBox3 Predictive maintenance screens.
11	Maintenance	Explains actions to take when consumption or abnormality is detected.
12	Batch management of maintenance information	Explains how to collectively manage maintenance information of the entire production line with the host system.
13	Robot (system) status variables	Explains robot (system) status variables, parameters, and dedicated input/output signals related to the predictive maintenance function.
14	Parameter	
15	Dedicated input/output signals	
16	Troubleshooting	Explains error details related to the predictive maintenance function and actions to take.

1.2. Compatible products

The following products are compatible with this function.

	Item	Description		Remarks
1)	Robot arm	Vertical multi-joint type RV-FR series	RV-2FR series, RV-4FR series, RV-7FR series, RV-13FR series, RV-20FR series	Standard model 6-axis robot only
		Horizontal multi-joint type RH-FR series	RH-3FRH series, RH-6FRH series, RH-12FRH series, RH-20FRH series, RH-3FRHR series	Standard model only
2)	Robot controller	CR800-D	Ver.A4 or later	
		CR800-R	Ver.A4 or later	
		CR800-Q	Ver.A4 or later	
3)	Robot total engineering support software (Note 1)	RT ToolBox3	Ver.1.50C or later	Robot program language: MELFA-BASIC VI
		RT ToolBox3 mini (Note 2)	Ver.1.50C or later	
		RT ToolBox3 Pro	Ver.1.50C or later	
4)	Function expansion card	MELFA Smart Plus Card Pack(Note 3)	AB type (2F-DQ520)	Either one
		MELFA Smart Plus Card (Note 3)	B type (2F-DQ521)	

Note 1) Must be purchased separately.
Note 2) When RT ToolBox3 mini is used, simulation on RT ToolBox3 cannot be used.
Note 3) In this instruction manual, "MELFA Smart Plus card" may be used as the general term for MELFA Smart Plus card pack and MELFA Smart Plus card.

1) Robot arm

Vertical multi-joint type

Horizontal multi-joint type

2) Robot controller

CR800 series

3) Robot total engineering support software

RT ToolBox3

4) Function expansion card

1.3. Related manuals

The following manuals are related to the predictive maintenance function.

Manual name	Description
Robot Arm Setup & Maintenance	Explains the procedures required to operate the robot arm (unpacking, transportation, installation, confirmation of operation), and the maintenance and inspection procedures.
Detailed explanations of functions and operations	Explains details on the functions and operations such as each function and operation, commands used in the program, connection with the external input/output device, and parameters, etc.
CR800 Series Controller Instruction Manual Troubleshooting	Explains the causes and remedies to be taken when an error occurs. Explanations are given for each error No.
RT ToolBox3 / RT ToolBox3 mini User's Manual	The operation manuals for the robot total engineering support software "RT ToolBox3", "RT ToolBox3 mini", "RT ToolBox3 Pro" (Option).
MELFA Smart Plus User’s Manual	Describes the installation method and setting method of MELFA Smart Plus card (Option).
Communication Middleware Manual (MelfaRXM.ocx)	The operation manual for ActiveX controller "MelfaRXM.ocx" that communicates with the robot controller.
Ethernet Function Instruction Manual	The operation manual for the Ethernet function that enables Ethernet communication with PCs using the TCP/IP protocol. Also, explains the SLMP connection.

1.4. Maintaining the robot

This function supports maintenance and inspection so that the robot can be used for a long time without trouble.
Efficient maintenance is supported though early detection of abnormalities or deterioration of robot components and notification of the time of maintenance parts replacement or overhaul based on the actual operating status of the robot. However, in order to prevent failure beforehand and ensure prolonged service life and safety of the robot, we strongly recommend periodic maintenance and inspection be carried out.

This chapter explains maintenance and inspection of parts that are subject to this function.

For details on robot inspection items, implementation time of periodic inspection, calculation of operating time, and maintenance and inspection procedures, refer to "5. Maintenance and Inspection" in the separate volume "Instruction Manual/Robot Arm Setup & Maintenance"

1.4.1. Type of maintenance and inspection

There are two types of maintenance and inspection, daily inspection and periodic inspection.

The following table shows the type of maintenance and inspection.

■Type of maintenance and inspection

No.	Type of inspection and maintenance works		Description	Operating time (Note1)
1	Daily inspection		Inspection works to be performed every day before starting operation for the safe use of the robot.	
2	Periodic inspection	Monthly inspection	Inspection and maintenance works to be performed every month.	Every 300 hr
3		6-month inspection	Inspection and maintenance works to be performed every 6 months.	Every 1,800 hr
4		2-year inspection	Inspection and maintenance works to be performed every 2 years.	Every 7,200 hr
5		Battery replacement	Replacement of the backup battery of the robot. Replace the battery every year regardless of the operating hours.	
6		Lubrication	Lubrication of each axis of the robot. Refer to "1.4.3 Lubrication" for the lubrication schedule.	

Note 1) Robot operating hours are based on 15 hours/day, 20 days/month. If the robot operates 8 hours/day, the operation hours per month are about half the above condition. Therefore, monthly inspection shall be performed once every two months.

1.4.2. Inspecting/replacing timing belt

This robot uses a timing belt for the drive conveyance system.
Compared to gears and chains, the timing belt does not require lubrication and has a low noise. However, if the belt usage method and tension adjustment are inadequate, the life could drop and noise could be generated. depending on the robot working conditions, elongation will occur gradually over a long time. The tension must be confirmed during the periodic inspection.

The inspection/replacement method of the timing belt differs depending on the model. Perform inspection/replacement by referring to "5. Maintenance and Inspection" in the separate volume "Instruction Manual/Robot Arm Setup & Maintenance".

■Timing belt replacement period

The timing belt life is greatly affected by the robot working conditions, so a set time cannot be given. However, if the following symptoms occur, replace the belt.

1) The belt tension value becomes less than the guideline value.
2) Position mismatch or gear teeth skipping occurs.
3) Cracks or wear occurs on the belt.
4) The tooth bottom of the belt is worn out and the core is exposed.

⚠Caution The timing belt can be replaced by customers; however, if adjustment is not appropriate, it could lead to failure of related parts. When the timing belt needs to be replaced, we recommend that you contact our Mitsubishi Service Department to request replacement.

⚠Caution If you need to remove the timing belt for repair and others, measure the tension before removing the belt.

When installing the belt, make sure to install with the same degree of tension as before removal.

Failure to do so could shorten the service life of the belt and related parts.

1.4.3. Lubrication

Grease is used for the reduction gears of the robot. Grease has various roles, such as suppressing of wear of reduction gears, removal of frictional heat, and prevention of burn-in.
If you use a robot for a long period of time, the grease will deteriorate due to loads during operation (operating speed, operation frequency, heat generation condition, and others.). Degraded grease loses initial performance and adversely affects machine service life.
Therefore, periodic replacement of grease is essential.

Lubrication intervals, lubrication locations, lubrication specifications and lubrication methods for grease are different for each model.
Lubricate the robot before the lubrication interval shown in the following table elapses.

In addition, before the servo ON time reaches the specified hours (24,000 hours), overhaul work to replace the grease inside the robot is necessary.
If it is unavoidable that overhaul cannot be performed at the specified interval, lubricate at the lubrication intervals shown in the following table.
For details on overhaul, refer to "1.4.5 About Overhaul".

Refer to "5. Maintenance and Inspection" in the separate volume "Instruction manual/Robot Arm Setup & Maintenance" for lubrication locations, lubrication specifications, and lubrication methods.

■Lubrication interval

Robot type	Lubrication interval
RV-2FR / RV-2FRL	All axes: 6,000 hr
RV-4FR / RV-4FRL RV-7FR / RV-7FRL	All axes: 24,000 hr
RV-7FRLL RV-13FR / RV-13FRL RV-20FR	J1 axis to J3 axis: 20,000 hr J4 axis to J6 axis: 24,000 hr
RH-3FRH series RH-6FRH series RH-12FRH series RH-20FRH series	J1 axis to J2 axis: 24,000 hr Shaft part (ball screw / spline): 2,000 km/travel
RH-3FRHR series	J1 axis to J2 axis: 6,000 hr Shaft part: 2,000 km/travel

Caution

- The lubrication intervals are the cumulative value of operation at maximum speed. In case of intermittent operation or slow specified speed, the lubrication interval can be extended accordingly.
- Since the lubrication interval changes depending on the operation status of the robot, make decisions as necessary so that grease will not run out.
- Avoid excessive lubrication as it could cause grease leakage. Also, lubrication shall be performed a maximum of three times. For maintenance after that, overhaul work is required to replace the grease inside.

1.4.4. Replacing the battery

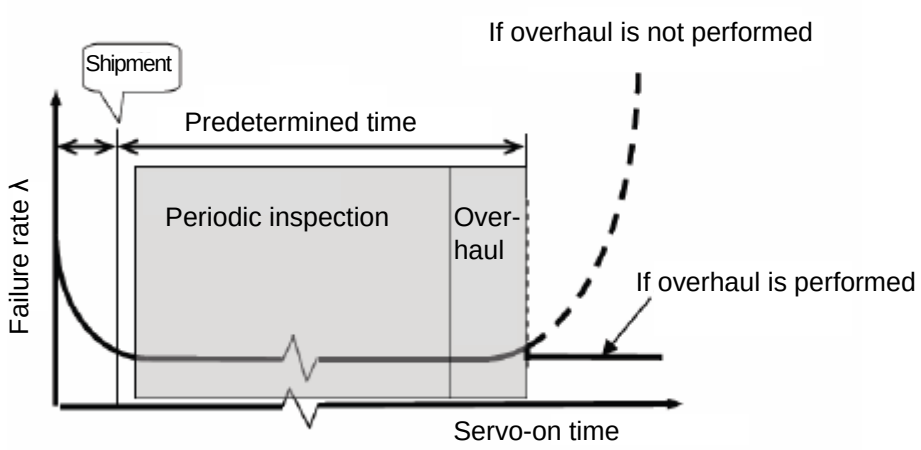
An absolute encoder is used for the position detector, so while power of controller is turned off the position must be saved by the backup battery. These batteries are installed when the robot is shipped from the factory, but as these are consumable parts, they must be replaced periodically by the customer. The guideline for replacing the battery is one year, but this will differ according to the robot's usage state. When a battery-related error occurred, replace the battery of the robot arm.
For details of battery related errors, refer to "16.1 Error number list" and "16.1.3 Abnormality detection function".
The robot arm battery replacement method differs depending on the model. Refer to "5. Maintenance and Inspection" in the separate volume "Instruction Manual/Robot Arm Setup & Maintenance".

1.4.5. About Overhaul

Robots which have been in operation for an extended period of time can suffer from wear and other forms of deterioration. In regard to such robots, we define overhaul as an operation to replace parts running out of specified service life or other parts which have been damaged, so that the robots may be put back in shape for continued use.

As a rule of thumb, it is recommended that overhaul be carried out before the total amount of servo-on time reaches the specified time (24,000 hours for the robot arm and 36,000 hours for the controller). (Refer to the figure below.)

However, the degree of the equipment's wear and deterioration presumably varies depending on their operating conditions. Especially for operation with high load and frequency, the maintenance cycle may be shorter.



2. Basic specifications

2.1. Overview of basic specification of the predictive maintenance function

The predictive maintenance function roughly consists of the following three functions.
Information on predictive maintenance by each function can be checked on the Predictive maintenance screen, status variables, and parameters of RT ToolBox3. The following features are also available.

- Allows predictive maintenance information to be output to the host system of your production line and collectively managed.
  (Compatible with MelfaRXM.ocx and SLMP)
- If you are using a CR800 series Ver.A4 or later robot controller, by enabling this function using the MELFA Smart Plus card, this function can be used by taking over the previous consumption degree and check the score log data of abormality detection even during operation of the robot.
  (For compatible cards, refer to "1.2 Compatible products , 4) Function extension card".)

	Function	Overview
1	Maintenance simulation	Using the real machine or simulations on RT ToolBox3, this function estimates the parts replacement time or the recommended maintenance time when specific motion patterns are repeated. This can be used for pre-study of maintenance cycles or parts-friendly operation verification of robots. (Refer to "9 Maintenance simulation".)
2	Consumption degree calculation function	This function calculates the consumption degree [%] of robot components based on the actual operating status (motor speed, load status, and others), and displays/notifies the period up to maintenance/inspection or overhaul. This supports efficient maintenance through notification of maintenance timing and deciding the maintenance priority order. <Target parts> Maintenance parts : Grease, timing belt Overhaul parts : Reduction gear, bearing, ball screw, ball spline (Refer to "6 Consumption degree calculation function".)
3	Abnormality detection function	This function detects abnormalities or deterioration of robot components early. Without adding sensors or analysis personal computer, the robot controller alone can detect abnormalities in reduction gear or the encoder. Early detection of abnormalities is possible thus downtime can be reduced. <Target parts> Encoder, battery, reduction gear including reduction gear (Refer to "7 Abnormality detection function".)

Caution

When using this function by upgrading from a non-compatible controller software version to a compatible controller software version, the consumption degree during the period of the non-compatible software version is not added up, thus the result of consumption degree calculation function cannot be the correct value.

The consumption degree of the robot arm is saved in the robot controller, thus it is necessary to use the correct combination of the robot arm and robot controller.
To replace the robot arm or robot controller only, perform backup/restore of predictive maintenance information to migrate the predictive maintenance information. (For backup/restore, refer to "11.3 Backup and restore".)

2.1.1. Maintenance simulation

Using the real machine (online) or simulations on RT ToolBox3, this function estimates the parts replacement time or the recommended maintenance time when specific motion patterns (robot programs) are repeated.

Maintenance simulation estimates the following items.

1) Number of years up to the time of replenishing grease
2) Number of years up to the time of timing belt replacement
3) Recommended number of years up to the maintenance time for overhauling parts
   (Of reduction gear, bearing, ball screw, and ball spline, the part for which there is the shortest number of years of maintenance)

There are two types of estimation methods, "Program operation" and "1 Cycle operation".
For the real machine (online), estimation is possible using "Program operation", and for simulation, in addition to "Program operation", "1 Cycle operation" can also be used.

•1 Cycle operation: Specify the start line and end line of the robot program to estimate the parts replacement/ the recommended maintenance time based on its 1 cycle operation pattern.
Because 1 cycle can be accurately specified on a robot program, it is possible to more accurately estimate the number of years when 1 cycle operation is repeated than when using Program operation.
The estimation result of the number of years is from the brand new robot state.

• Program operation: While running a robot program automatically, the parts replacement/ the parts replacement/ the recommended maintenance time is estimated based on the operation pattern from when the start button is pressed to when the end button is pressed.
Accurate 1 cycle (start line and end line) cannot be specified but Program operation is used when it is difficult to specify 1 cycle on the program, such as when the program uses external signals.
The estimation result for a real machine (online) is the number of years from the current consumption degree of the robot.
The estimation result for simulation is the number of years from the brand new robot state.

Output data
Number of years up to the time of replenishing grease (for each joint axis)
Number of years up to the time of timing belt replacement (for each joint axis)
Number of years up to the recommended maintenance time for overhaul parts (for each joint axis) (Of reduction gear, bearing, ball screw, and ball spline, the part for which there is the shortest number of years of maintenance)

Estimation method		
	Real machine (online)	· Program operation · Estimates the number of years from the current consumption degree of the robot.
	Simulation	· 1 Cycle operation, Program operation · Estimates the number of years from the brand new robot state.
Usage		
	Usage	RT ToolBox3 Predictive maintenance screen (Refer to 9 Maintenance simulation)
	Setting item	· Operation hours per day, operation days per month

* For models and joint axes subject to this function, refer to "2.1.4 Target models/target axes".

Caution

When RT ToolBox3 mini is used, simulation on RT ToolBox3 cannot be used.

The recommended number of years up to the replacement/maintenance time output by this function is the value calculated when the specified operation is repeated. Also, the result may vary depending on the performance of the personal computer used and the load status. The actual time changes depending on the actual operating status or load status of the robot.
Use as reference values for planning of maintenance and inspection.

Correctly set hand work conditions (weight, center of gravity, shape) actually used. If the settings differ from the actual robot settings, the consumption degree cannot be calculated correctly.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions.
For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Do not use M_TIMER(8) while programming. This function uses M_TIMER(8) for the estimation of parts replacement time and maintenance time. If M_TIMER(8) is used while programming, the number of years of replacement and maintenance cannot be estimated accurately.

After changing to M_TIMER(1) to M_TIMER(7), perform the maintenance simulation.

Note on 1 Cycle operation

(1) For command line that waits for signals to be input or robot status changes, use a comment to set the stop time.

For a program waiting for input of signal from outside or change of the robot status variable, comment out that portion and instead set a stop time (assumed) and specify the start line and end line including that line.

(2) Use a program with no infinite loop.

A program that executes an infinite loop does not give the correct calculation result.
Check that the program is not an infinite loop in a FOR or GOTO statement.

(3) Include all instructions required for 1 cycle in the line selection range.

When selecting the start line and end line of a program, specify line numbers in such a way that all instructions such as jump destinations of Gosub or hand word settings required for the robot to perform 1 cycle operation are included in the range.
When sending/receiving external signals, set the stop time as a substitute for the signal sending/receiving time and specify the line numbers including that line.

(4) About robot program "ESTPROG.prg"

When executing 1 cycle operation, "ESTPROG" is displayed as the robot program on the operating panel.
This is a program that is automatically generated when 1 cycle operation is executed. After 1 cycle operation, you can delete this program if it is unnecessary.

2.1.2. Consumption degree calculation function

This function calculates the consumption degree [%] of robot components based on the actual operating status (motor speed, load status, and others), and calculates the period up to maintenance/inspection or overhaul.
Consumption Degree [%] is calculated based on the recommended maintenance time of each part as 100 [%].
Beside consumption degree [%] of each robot component, the Total Score (Consumption Degree [%] and Up to Maintenance) of maintenance parts (grease, timing belt), and the Total Score (Consumption Degree [%]) of overhaul parts (reduction gear, bearing, ball screw, ball spline) are calculated, respectively and are displayed on the comprehensive evaluation screen.

	Target parts	Output data
Maintenance parts	Grease Timing belt	Grease consumption degree [%] (for each joint axis)
		Timing Belt consumption degree [%] (for each joint axis)
		Total Score (Consumption Degree [%], Up to Maintenance [h])*1
Overhaul parts	Reduction gear Bearing Ball screw/ball spline	Gear consumption degree [%] (for each joint axis)
		Bearing consumption degree [%] (for each joint axis)
		Ball Screw/Ball Spline consumption degree [%] (for each joint axis)
		Total Score (Consumption Degree [%])*2
Operating Information	-	Servo ON Time [h], Operation Time [h], Actual Operation Time [h], Power ON Time [h], Servo ON Count [times], Motor Cumulative Rotation Count [rotation] (for each joint axis)

*1: Of the maintenance parts (grease, timing belt), the Consumption Degree [%] and Up to Maintenance [h] of the part (joint axis) having the least remaining time are used.

*2: Of the overhaul parts (reduction gear, bearing, ball screw, ball spline), the Consumption Degree [%] of the part (joint axis) having the least up to maintenance time is used.

Information confirmation		
	Information	· Consumption Degree: See above · Up to Maintenance: See above (Total Score Maintenance Parts) · Operating Information: See above · [Consumption Status]: Existence of wear in each target part · Maintenance Log: Log data under Maintenance Reset (date & time, parts, joint axes)
	Check method	RT ToolBox3 Predictive maintenance screen (Refer to 5. Total score,.6 Consumption degree calculation function.) [Parameters] (Refer to 14.2 Consumption degree calculation function 14.2.2 Data acquisition parameters.) [Status Variable] (Refer to 13 Robot (system) status variables 13.2 Consumption degree calculation function.)
Setting/operation		
	Setting item	· Notification Day setting: Warning Remaining Number of Days, Operation Time of a Day, Notification Interval · How to Notify setting (maintenance parts): Warning Occurrence, Signal Output · How to Notify setting (overhaul parts): Warning Occurrence, Signal Output · ["I/O Signals assignment"]
	Setting method	RT ToolBox3 Predictive maintenance screen (Refer to 3.2.1 Setting how to notify.) [Parameters] (Refer to 14.2 Consumption degree calculation function 14.2.1 Setting parameters.)
	Operation item	· Maintenance Reset (reset of consumption degree) · [Notification Pause]

	Operation method	RT ToolBox3 Predictive maintenance screen (Refer to 11.1 Warning Pause 11.2 Maintenance Reset.) [Parameters] (Refer to 14.2 Consumption degree calculation function 14.2.3 Operation parameters .) [I/O Signal][*1](Refer to 15 Dedicated input/output signals 15.1 Consumption degree calculation function.)
Notification		
	Notification content	· [Consumption Status] (maintenance parts): Output for each part, for each joint axis · [Consumption Status] (overhaul parts): Output for each part, for each joint axis · Servo ON Time[*2]
	Notification method	RT ToolBox3 Predictive maintenance screen[*3] (3.2.1 Setting how to notify.) Warning Occurrence[*1] (Refer to 3.2.1 Setting how to notify.) Signal Output[*1] (Refer to 3.2.3 Setting signals.)

*1 Setting is required.

*2 Notification of overhaul intervals by servo ON time follows "How to notify the consumption degree of overhaul parts".

*3 A maintenance message is displayed.

* For models and joint axes subject to this function, refer to "2.1.4 Target models/target axes".

Caution [About calculation of the consumption degree]

- The consumption degree of each part is calculated on the assumption that the robot is used in the environment (ambient temperature, humidity) within the specification scope described in the instruction manual (standard specifications).
- The consumption degree of each part is used as a reference value for supporting the maintenance and inspection schedule calculated based on the robot operating status. It does not guarantee the service life of the robot.
- Irrespective of the consumption degree, carry out daily inspection and periodic maintenance and inspection described in the instruction manual (Standard Specifications Manual, Robot Arm Setup & Maintenance).
- When the servo ON time exceeds the specified time (24,000 hours) or the consumption degree exceeds the warning remaining number of days, we recommend you perform overhaul of the robot arm.
- Reset operation of the consumption degree of each part must not be executed except during maintenance or part replacement.
- For the total score of maintenance parts and overhaul parts, the value of the part among all joint axes having the least remaining time (Up to Maintenance) to the recommended maintenance time is output, respectively. For that reason, the consumption degree of the total score could be smaller than the maximum consumption degree value of each part.
- The remaining time is a reference value calculated based on the operating status of the robot from the previous maintenance time. Also, the remaining time is when you use the robot in the same way as before.
  Therefore, if operation is changed, the remaining time may increase or decrease.
- For the axis with multiple parts of one type, the part that wears the fastest in terms of design is the subject for the calculation. It is recommended to perform maintenance on the peripheral parts at the same time as the part replacement.

Caution [About the robot controller]

- When using this function by upgrading from a non-compatible controller software version to a compatible controller software version, the consumption degree during the period of the non-compatible software version is not added up, thus the result of consumption degree calculation function cannot be the correct value.
- The consumption degree of the robot arm is saved in the robot controller, thus it is necessary to use the correct combination of the robot arm and robot controller. To replace the robot arm or robot controller only, perform backup/restore of predictive maintenance information to migrate the predictive maintenance information.
  (For backup/restore, refer to "11.3 Backup and restore".)

Caution Depending on the operating status at startup, correct results may not be obtained at the beginning due to fluctuations until sufficient data is accumulated.

Caution Correctly set hand work conditions (weight, center of gravity, shape) actually used. If the settings differ from the actual robot settings, the consumption degree cannot be calculated correctly.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions.
For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Caution When the predictive maintenance function is valid, the maintenance forecast is not displayed and warning signals of maintenance forecast are not output. When the information is reset by the predictive maintenance function or maintenance forecast, the information in the other function is reset as well.

<<MEMO>>

2.1.3. Abnormality detection function

This function detects abnormalities or deterioration of robot reduction gear components early.
Before the robot exhibits behavior that is a sign of an abnormality, the function can detect reduction gear or encoder abnormalities.
Without adding sensors or an analysis personal computer, the robot controller alone can detect abnormalities in reduction gear or the encoder.

Target parts		Output data
Reduction gear		Score (for each joint axis) *Calculated when operating at 500 rpm or more
Encoder	Data Error	Score (for each joint axis)
	Communication Error	Score (for each joint axis)
Battery		[Battery Voltage Status] (mechanical)

Information confirmation		
	Information	· Score: See above · Log data for 365 days of Score[*1] · [Battery Voltage Status]: See above · [Abnormality Detection Status]: Existence of abnormality detection of each target part
	Check method	RT ToolBox3 Predictive maintenance screen (Refer to 5 Total score.,7 Abnormality detection function.) [Parameters] (Refer to 14.3 Abnormality detection function 14.3.2 Data acquisition parameters.) [Status Variable] (Refer to 13 Robot (system) status variables 13.3 Abnormality detection function.)
Setting/operation		
	Setting item	· How to Notify setting (abnormality detection): Warning Occurrence, Signal Output · Level Setting (reduction gear) · Level Setting (encoder data error) · Level Setting (encoder communication error) · ["I/O Signals assignment"]
	Setting method	RT ToolBox3 Predictive maintenance screen (Refer to 3.2.1 Setting how to notify, 3.2.2 Setting detection level.) [Parameters] (Refer to 14.3 Abnormality detection function 14.3.1 Setting parameters.)
	Operation item	· Maintenance Reset (reset of encoder abnormality level score) · [Notification Pause]
	Operation method	RT ToolBox3 Predictive maintenance screen (Refer to 11.1 Warning Pause, 11.2 Maintenance Reset.) [Parameters] (Refer to 14.3 Abnormality detection function 14.3.3 Operation parameters) [I/O Signal][*2] (Refer to 15 Dedicated input/output signals 15.2 Abnormality detection function.)
Notification		
	Notification content	· [Abnormality Detection Status] (abnormality detection): Output for each joint axis.
	Notification method	RT ToolBox3 Predictive maintenance screen[*3] (Refer to 3.2.1 Setting how to notify.) Warning Occurrence[*2] (Refer to 3.2.1 Setting how to notify.) Signal Output [*2] (Refer to 3.2.3 Setting signals.)

*1 Displays the data for the most recent 365 days. Old data is overwritten.
*2 Setting is required.
*3 A maintenance message is displayed.
* For notification of a battery voltage drop, a warning is output by the standard function.
* For models and joint axes subject to this function, refer to "2.1.4 Target models/target axes".

Caution

- The score output by the reduction gear abnormality detection function is calculated based on motor feedback data and is a reference value for detecting abnormalities that leads to a failure. It does not guarantee to certainly detect abnormalities before part failure. Also, this score targets aged deterioration of the robot.
- Since the score of the reduction gear abnormality detection varies depending on the operating speed and operation conditions such as the hand load by the hand and the workpiece, set the detection level according to the actual operating conditions.
  If the operating conditions such as the workpiece, the hand, and the operation program are changed, review the setting of the detection level. If the setting of the detection level is not appropriate, abnormalities may not be detected or mis-detection may occur.

Caution

When there is a vibration source outside the robot arm or robot operation is hindered by an external cable, and others. Abnormalities or deterioration of parts may not be diagnosed correctly.

Caution

Set the conditions (weight, center of gravity, and shape) of the actual hand and the workpiece to be used correctly. If the settings differ from the actual robot conditions, mis-detection may occur or abnormalities may not be detected.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions.
For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Caution

The reduction gear abnormality detection function may detect failure of driving parts other than the reduction gear, such as the bearing and the timing belt. In addition, the score of the axis without abnormality may also change.

Caution

The reduction gear abnormality detection function calculates when the motor is operating at a motor speed of 500 rpm or faster.
The score is not calculated for axes operating at less than 500 rpm.
The operation speed can be checked using the oscillograph of RT ToolBox3 or the monitoring function.
(Refer to "Checking scores with the real-time monitor oscillograph", "How to check the motor speed with the RT ToolBox3 monitor function".)

Caution

The score may fluctuate depending on changes in the ambient temperature.
To ensure that the score does not fluctuate during detection, use the robot in an environment which has a stable temperature. Review the detection level settings if the ambient temperature changes.

2.1.4. Target models/target axes

(1) Consumption degree calculation function/maintenance simulation

The table below shows the joint axes for which target parts of the consumption degree calculation function of each robot type are used. (Compatible robots are the standard models only.)
(●: Uses target parts, -: Not use target parts)

(1) RV-2FR / RV-2FRL

Joint axis		J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Maintenance parts	Grease	●	●	●	●	●	●
	Timing belt	●	●	●	●	●	●
Overhaul parts	Reduction gear	●	●	●	●	●	●
	Bearing	●	●	●	●	●	●
	Ball screw	-	-	-	-	-	-
	Ball spline	-	-	-	-	-	-

(2) RV-4FR / RV-4FRL / RV-7FR / RV-7FRL

Joint axis		J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Maintenance parts	Grease	●	●	●	●	●	●
	Timing belt	●	-	●	●	●	●
Overhaul parts	Reduction gear	●	●	●	●	●	●
	Bearing	●	-	●	●	●	●
	Ball screw	-	-	-	-	-	-
	Ball spline	-	-	-	-	-	-

(3) RV-13FR / RV-13FRL / RV-20FR / RV-7FRLL

Joint axis		J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Maintenance parts	Grease	●	●	●	●	●	●
	Timing belt	-	-	-	●	●	●
Overhaul parts	Reduction gear	●	●	●	●	●	●
	Bearing	-	-	-	●	●	●
	Ball screw	-	-	-	-	-	-
	Ball spline	-	-	-	-	-	-

(4) RH-3FRH / RH-6FRH / RH-12FRH / RH-20FRH

Joint axis		J1 axis	J2 axis	J3 axis	J4 axis
Maintenance parts	Grease	●	●	●	-
	Timing belt	-	-	●	●
Overhaul parts	Reduction gear	●	●	-	-
	Bearing	-	-	●*1	●
	Ball screw	-	-	●*2	-
	Ball spline	-	-	-	●*2

*1: For RH-3FRH, J3 axis does not use a bearing, shown as (-).
*2: RH-3FRH uses a ball screw/spline but this function assumes that the J3 axis uses a ball screw and the J4 axis uses a ball spline.

(5) RH-3FRHR

Joint axis		J1axis	J2 axis	J3 axis	J4 axis
Maintenance parts	Grease	●	●	●	-
	Timing belt	●	●	●	●
Overhaul parts	Reduction gear	●	●	-	-
	Bearing	●	●	-	●
	Ball screw	-	-	●*3	-
	Ball spline	-	-	-	●*3

*3 : The RH-3FRHR series uses a ball screw/spline but this function assumes that the J3 axis uses a ball screw and the J4 axis uses a ball spline.

(2) Abnormality detection function

The table below shows the joint axes for which target parts of the abnormality detection function of each robot type are used.

(●: Uses target parts, x: Not subject to abnormality detection)

(1) RV-2FR / RV-2FRL

Joint axis	J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Reduction gear	●	●	●	●	●	●
Encoder	●	●	●	●	●	●
Battery	●					

(2) RV-4FR / RV-4FRL / RV-7FR / RV-7FRL

Joint axis	J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Reduction gear	●	●	●	●	●	●
Encoder	●	●	●	●	●	●
Battery	●					

(3) RV-13FR / RV-13FRL / RV-20FR / RV-7FRLL

Joint axis	J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
Reduction gear	×	×	×	●	●	●
Encoder	●	●	●	●	●	●
Battery	●					

(4) RH-3FRH / RH-6FRH / RH-12FRH / RH-20FRH

Joint axis	J1 axis	J2 axis	J3 axis	J4 axis
Reduction gear	●	●	×	×
Encoder	●	●	●	●
Battery	●			

(5) RH-3FRHR

Joint axis	J1 axis	J2 axis	J3 axis	J4 axis
Reduction gear	●	●	×	×
Encoder	●	●	●	●
Battery	●			

2.2. How to utilize the predictive maintenance function

The predictive maintenance function assumes the following usages.

(1) At system startup

It is possible to estimate the replacement time of maintenance parts or the recommended maintenance time of overhaul parts when an operation pattern of the robot is repeated using "Maintenance Simulation". This function can be used for planning a maintenance schedule when starting up a system.
(For details, refer to "9 Maintenance simulation".)

(2) System operation time (at periodic inspection)

You can check the consumption degree using the "Consumption degree calculation function" or the existence of abnormalities using the "Abnormality detection function".
Because the consumption degree calculation function calculates the consumption degree based on the actual robot operation status (motor speed, loads, and others), you can check the current robot consumption degree and remaining time to replacement/maintenance.
This function is useful for reviewing or planning a maintenance schedule.
(For function details, refer to "6 Consumption degree calculation function", "7 Abnormality detection function".)

(3) System operation time (when a part is consumed)

As a result of the remaining time to replacement/maintenance calculated by the consumption degree calculation function, if the set remaining time is reached, that effect is notified by the method you set. Check detailed information and arrange or carry out maintenance.
By carrying out appropriate maintenance, it is possible to prevent the production line from stopping due to a sudden failure of the robot and reduce down time.
(For details, refer to "6 Consumption degree calculation function".)

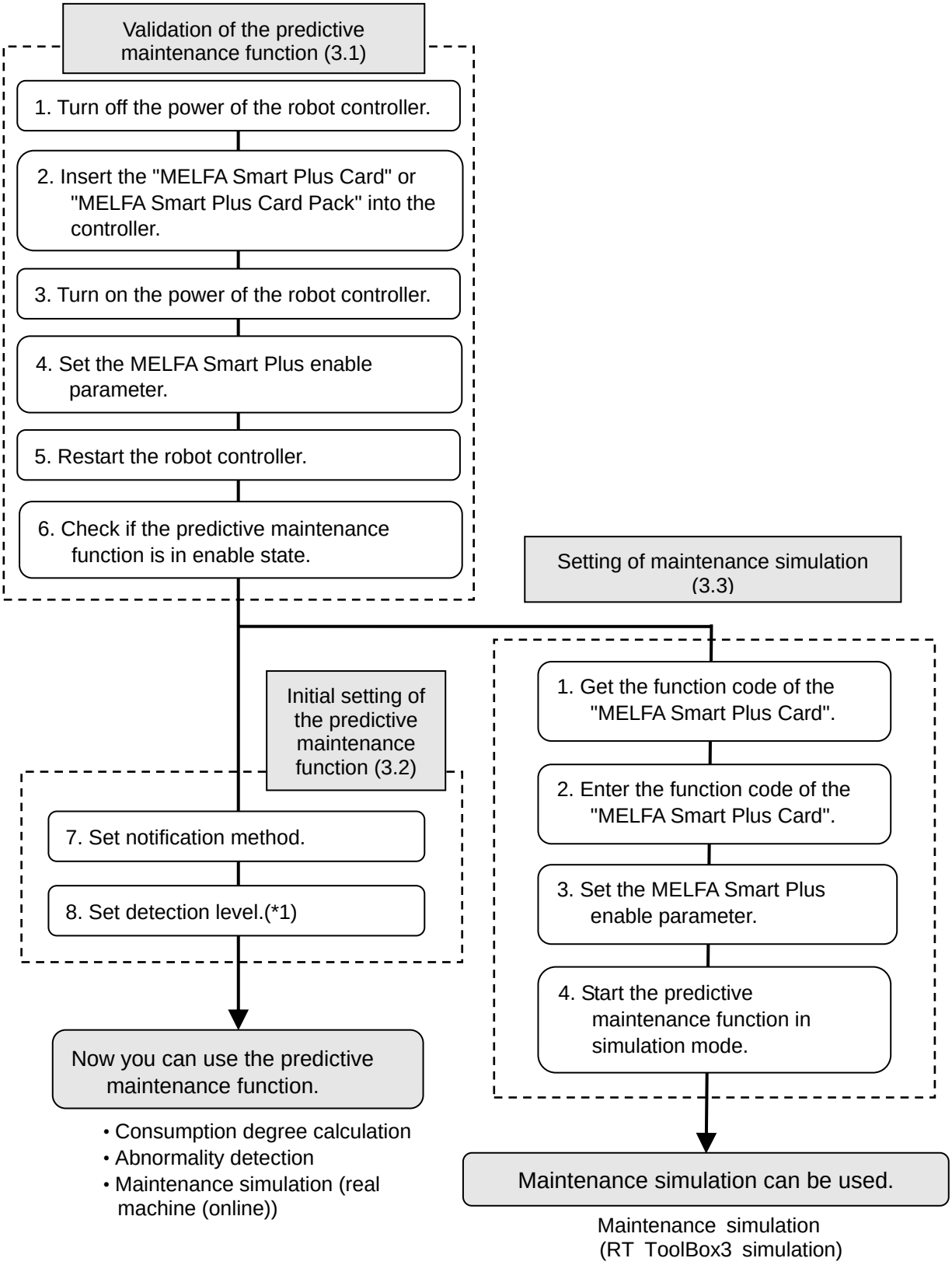
(4) System operation time (when an abnormality is detected)

When an abnormality of the robot is detected (the score exceeds the set detection level), that effect is notified by the method you set. Check detailed information and carry out maintenance such as part replacement.
Doing so could prevent the production line from stopping due to a sudden failure of the robot and reduce down time.
(For function details, refer to "7 Abnormality detection function".)

<< MEMO >>

3. Startup and initial settings

This section describes the procedure to start the predictive maintenance function.



*1) Since the score of the reduction gear abnormality detection varies depending on the operating speed and operation conditions such as the hand load by the hand and the workpiece, set the detection level according to the actual operating conditions.

3.1. Enabling the predictive maintenance function

Insert the "MELFA Smart Plus Card" into the robot controller and set parameters.

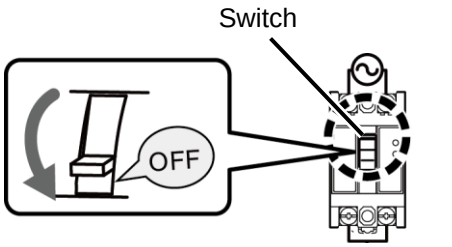
1 Turn off the power of the robot controller.

CR800-D type

1) Turn off the switch of the earth leakage circuit breaker.

CR800-R/Q type

1) Turns off the power of the robot CPU system.
2) Turn off the switch of the earth leakage circuit breaker.

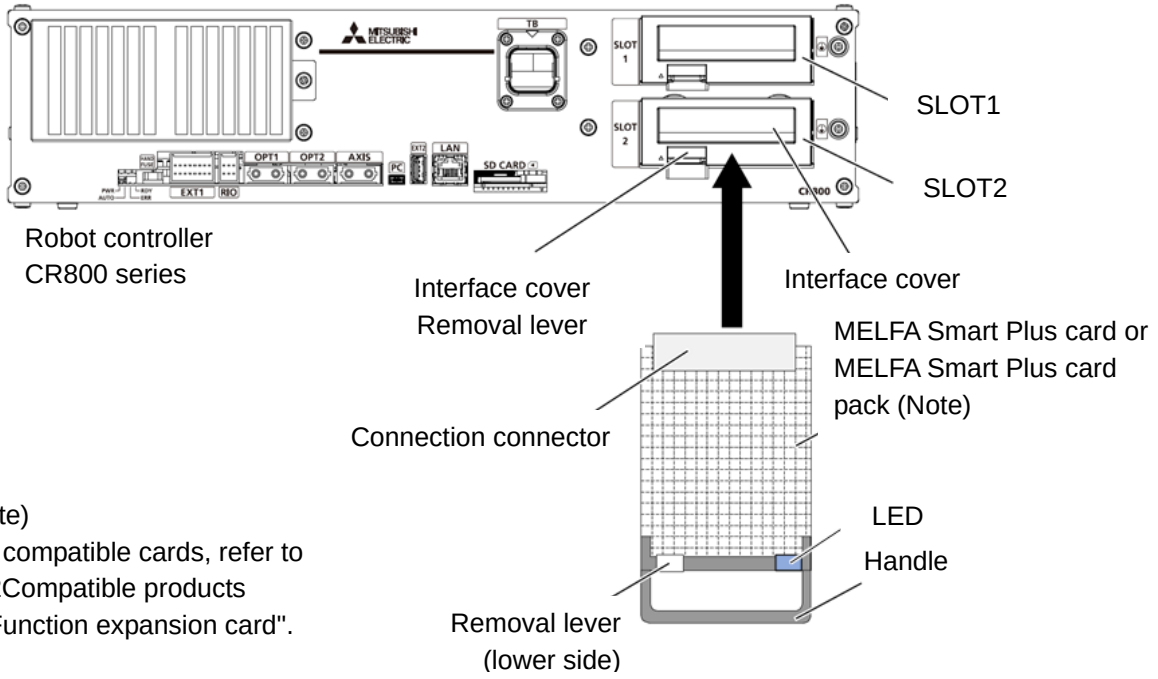


Earth leakage circuit breaker

2 Insert the MELFA Smart Plus card into the robot controller.

Insert the "MELFA Smart Plus Card" or the "MELFA Smart Plus Card Pack" in an available slot on the robot controller.
(Note: For compatible cards, refer to “1.2 Compatible products 4) Function extension card”.)

1) Lightly hold the interface cover removal lever to pull out the interface cover.
2) Hold the handle of the MELFA Smart Plus card and insert it into SLOT1 or SLOT2.
   At that time, insert in such a way that both ends of the card fit into the groove of the slot (SLOT1 or SLOT2 in the illustration).
3) Insert the connection connector all the way to the end until the removal lever clicks into place to be locked.



(Note)
For compatible cards, refer to "1.2Compatible products 4) Function expansion card".

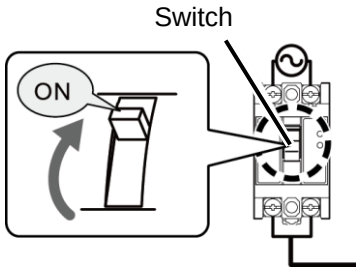
Caution

Install only one MELFA Smart Plus card.
If multiple MELFA Smart Plus cards have been installed, the LED will not flash and an error (L3782) will occur. For error details, refer to "16.1.4 MELFA Smart Plus card".

3 Turn on the power of the robot controller.

CR800-D type

1) Turn on the switch of the earth leakage circuit breaker.
2) The POWER lamp of the robot controller lights.



Earth leakage circuit breaker

CR800-R/Q type

1) Turn on the switch of the earth leakage circuit breaker.
2) The POWER lamp of the robot controller lights.
3) Next, turn on the power of the robot CPU system.

* When the robot controller starts up, the LED of the MELFA Smart Plus card flashes.
- MELFA Smart Plus Card ... Flashes in red.
- MELFA Smart Plus Card Pack ... Flashes in blue.

4 Selecting the MELFA Smart Plus function and setting the predictive maintenance function enable parameters.

With a robot controller where the "MELFA Smart Plus Card" has been inserted, set the MELFA Smart Plus function selection parameter "SMART+1" and the predictive maintenance function enable parameter "PMENA".
For this operation, use the teaching pendant or RT ToolBox3.

[When using the MELFA Smart Plus card]

1) Change the parameter "SMART+1" value to [102].
2) Change the parameter "PMENA" value to [1].

[When using the MELFA Smart Plus card pack]

1) Change the parameter "PMENA" value to [1].

5 Restart the robot controller.

CR800-D type

1) Turn off the switch of the earth leakage circuit breaker.
2) Turn on the switch of the earth leakage circuit breaker.

CR800-R/Q type

1) Turns off the power of the robot CPU system.
2) Turn off the switch of the earth leakage circuit breaker.
3) Turn on the switch of the earth leakage circuit breaker.
4) After the POWER lamp of the robot controller lights, turn on the power of the robot CPU system.

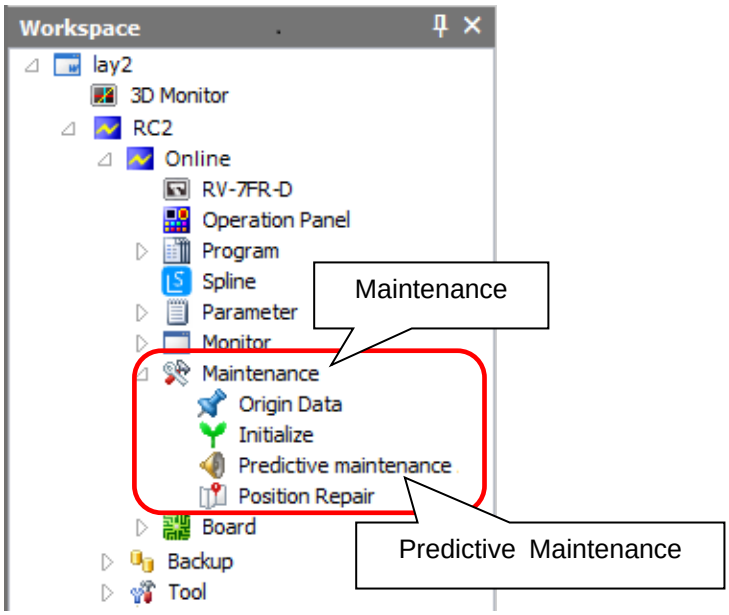
6 Check that the predictive maintenance function is enabled.

1) When the MELFA Smart Plus card is used, the LED of the MELFA Smart Plus card flashes green. When the MELFA Smart Plus card pack is used, the LED flashes blue.

2) Check that the predictive maintenance function has been enabled.

- For the teaching pendant
  Check that the "MSPPMENB" parameter is set to [1].
- For RT ToolBox3
  Connect RT ToolBox3 to the robot controller and start a project from "Online"
  Click [Online] - [Maintenance] to expand the project tree and check that "Predictive Maintenance" is displayed.

RT ToolBox3 project tree



3.2. Initial setting of the predictive maintenance function

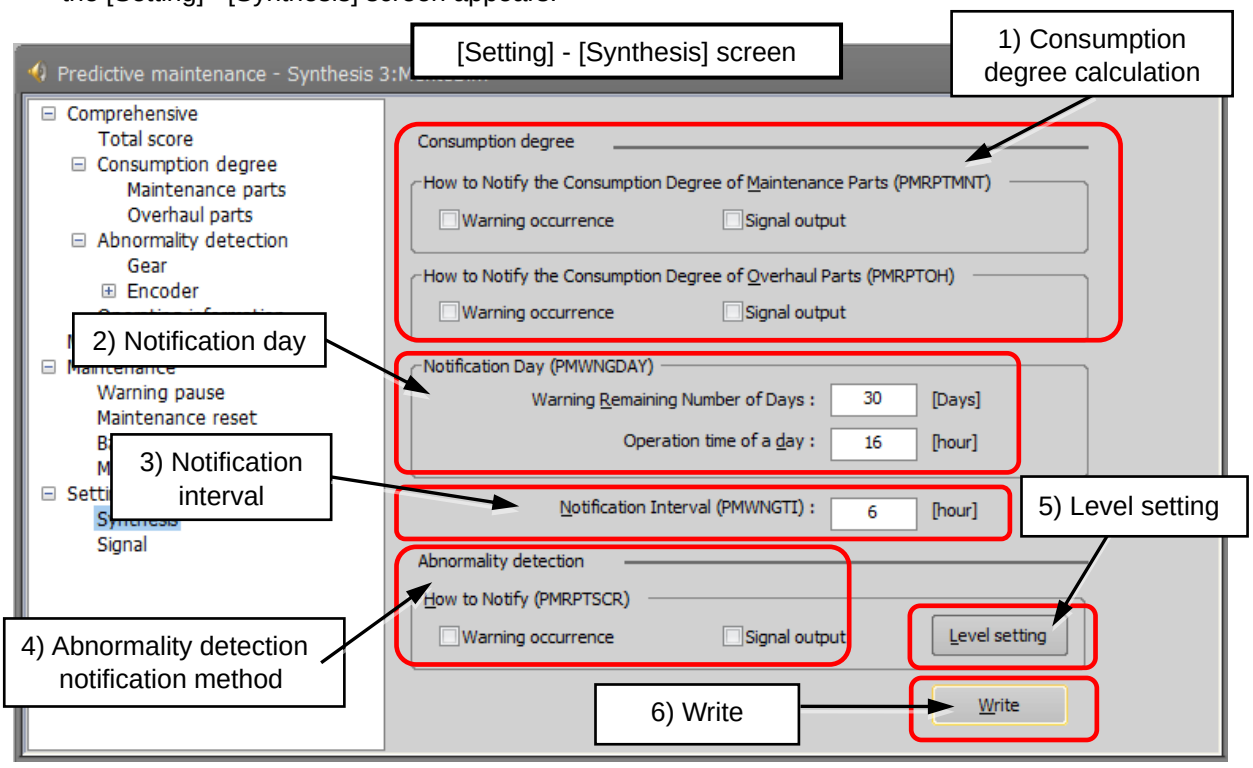
Set how to notify when consumption or abnormality of a part is detected.
Specify such as the detection level for warning occurrence, and the notification method (presence of warning/signal output, notification day).
If you have not set the notification method, upon starting the predictive maintenance function, the [Setting] - [Synthesis] screen appears.
[Note] In the default setting, notification is disabled. Make sure to set according to your environment.

3.2.1. Setting how to notify

7 Set the notification method.

1) From the RT ToolBox3 project tree, double-click [Online] - [Maintenance] - [Predictive Maintenance].

2) From the predictive maintenance tree, click [Setting] - [Synthesis].
   * If you have not set the notification method, upon clicking [Predictive Maintenance], the [Setting] - [Synthesis] screen appears.



Predictive maintenance becomes available after setting the notification method.

1) Consumption degree notification method:
Set how to notify consumption of maintenance parts and overhaul parts. You can select Warning Occurrence or Signal Output, or both.

Warning Occurrence ... A warning occurs and the error number and error message are displayed according to the situation.

Signal Output ... The status can be checked with dedicated output signals.
(Setting of signal numbers are required. Refer to "3.2.3 Setting signals".)

2) Notification day:
Warning Remaining Number of Days: Set the number of remaining days for warning to occur.
Operation Time of a Day: Set the number of hours of operation of the robot per day.

3) Notification interval: Set the interval of notification of warning.

4) Abnormality detection notification method:
Set how to notify the score. You can select Warning Occurrence or Signal Output, or both.
(Setting of Warning Occurrence and Signal Output are the same as with the abnormality detection notification method.)

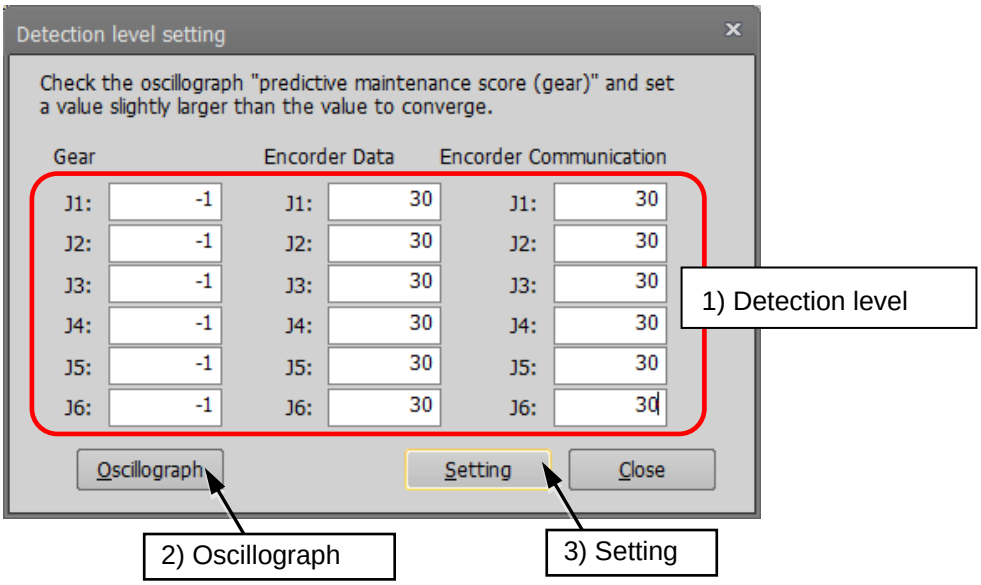
5) Level setting:
You can set the levels at which warnings occur for each joint axis. Items that can be set are the score of "Reduction gear", "Encoder Data", and "Encoder Communication".
Refer to "3.2.2 Setting detection level".

6) Write: Writes setting items on the robot controller.

3.2.2. Setting detection level

8 Set detection level.

When you click the "Detail" button in the Abnormality Detection, How to Notify area, the "Level Setting" screen appears.
You can set the levels at which warning occurs for each axis. Items that can be set are the score of "Reduction gear", "Encoder Data", and "Encoder Communication".



1) Detection level
Set the detection level of J1 to J6.

2) Reset
The detection level set in 1) above is reset to the default settings.

3) Oscillograph: Starts the RT ToolBox3 Oscillograph screen.

4) Setting: Reflects the values on the screen to the parameters.

◆Detection level setting method

(1) Reduction gear

The detection level of the reduction gear abnormality detection for each joint axis is "-1" (detection disabled) as a factory default. Since the score varies depending on the operating speed and operating conditions such as the hand load by the hand and workpiece, set the detection level according to the actual operating conditions. When the operating conditions such as the workpiece, hand, and operation program are changed, review the setting of the detection level. If the setting of the detection level is not appropriate, abnormalities may not be detected or mis-detection may occur.

The score is retained while the robot is stopped, and is gradually changed when the robot is operated. The score is converged when the cycle operation is continued under the actual operating conditions. After the score is sufficiently converged, set a larger value than the maximum value considering variations. (The score may fluctuate when the robot is restarted.)

・<Procedure>

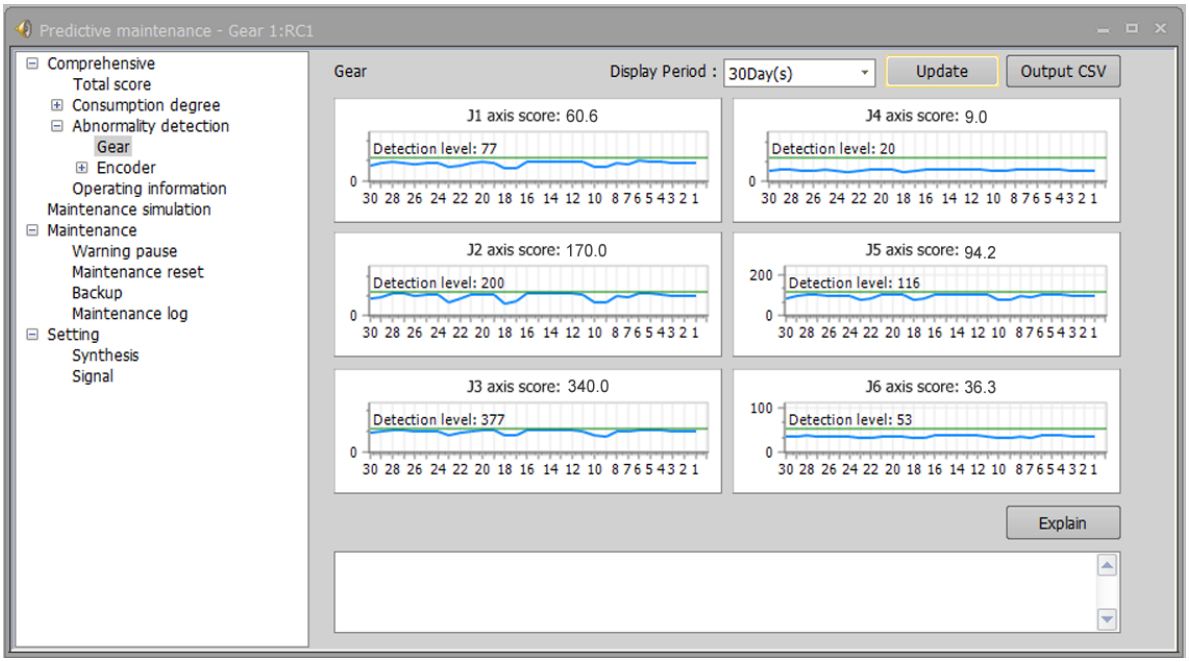
1. Operate the robot under the actual operating conditions, and collect score data for about 7 to 30 days.
2. Check the maximum score of the log data.
   365 days worth of the maximum score of the day can be saved as log data.
   (Log data can be checked by going to [Comprehensive] - [Abnormality detection] - [Gear]. (Refer to "7 Abnormality detection function ".)
3. Set the detection level higher than the maximum value (+10 as a guide) based on the log data.

* The score may fluctuate depending on whether there are changes in the ambient temperature or in how much the robot vibrates. Review the detection level if there are changes in the environment surrounding the robot.

* Review the detection level when changing operating conditions (such as program, hand, and speed).

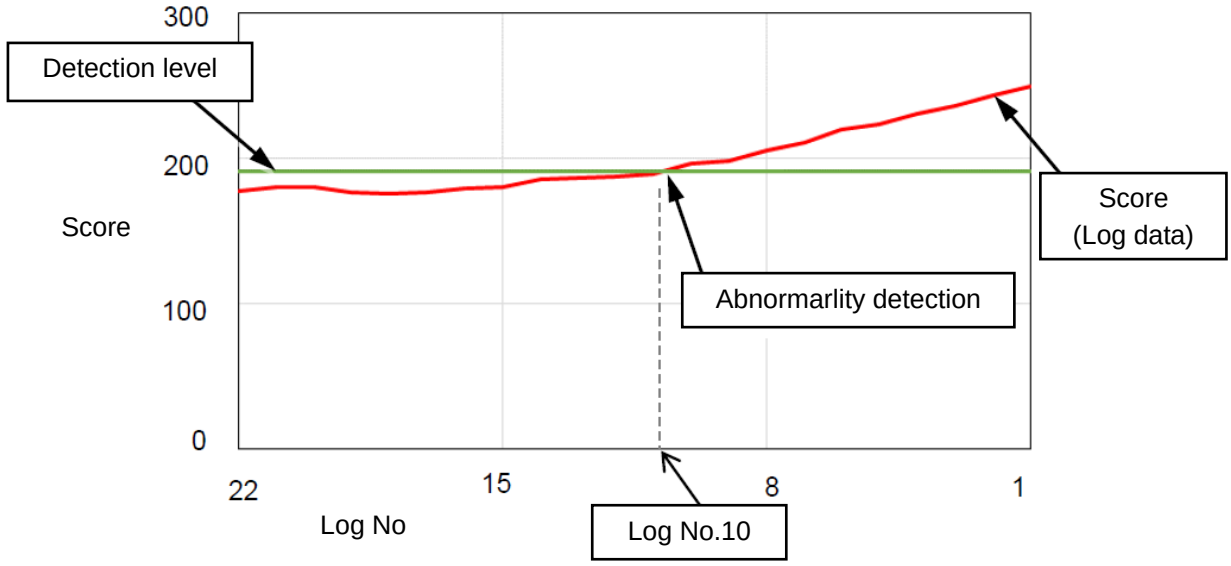
Setting example of detection level for reduction gears

The following figures show an example of log data for the past 30 days after starting operation. In the following example, the detection level is set 10 points higher than the maximum value of the past 30 days. The log data can be checked in detail by exporting it as a CSV file.



Example of robot failure:

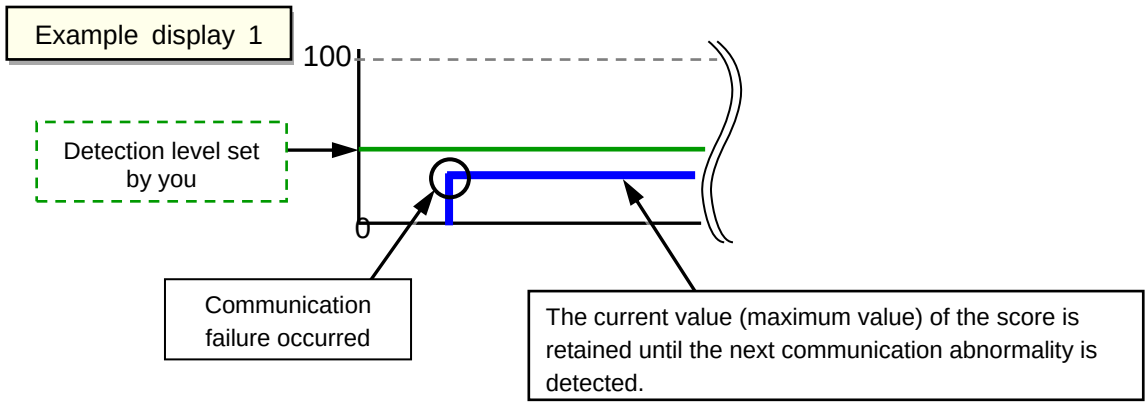
The graph below shows data resulting from reduction gear failure. The numerical value 1 of the horizontal axis (Log No.) represents the day that a robot stopped due to wear of the reduction gear. The detection level had been set to 191 which was 10 points higher than the maximum score (180.08) from 7 days worth of log data after starting operation.
An error was detected and notified by a warning and signal that were output because the score exceeded the predetermined detection level, 9 days (Log No.10) before the robot stopped.
At that point, no unusual noises or faults were detected. Later, an unusual noise was detected, and the robot started to fail and finally stopped 9 days after the score exceeded the detection level.

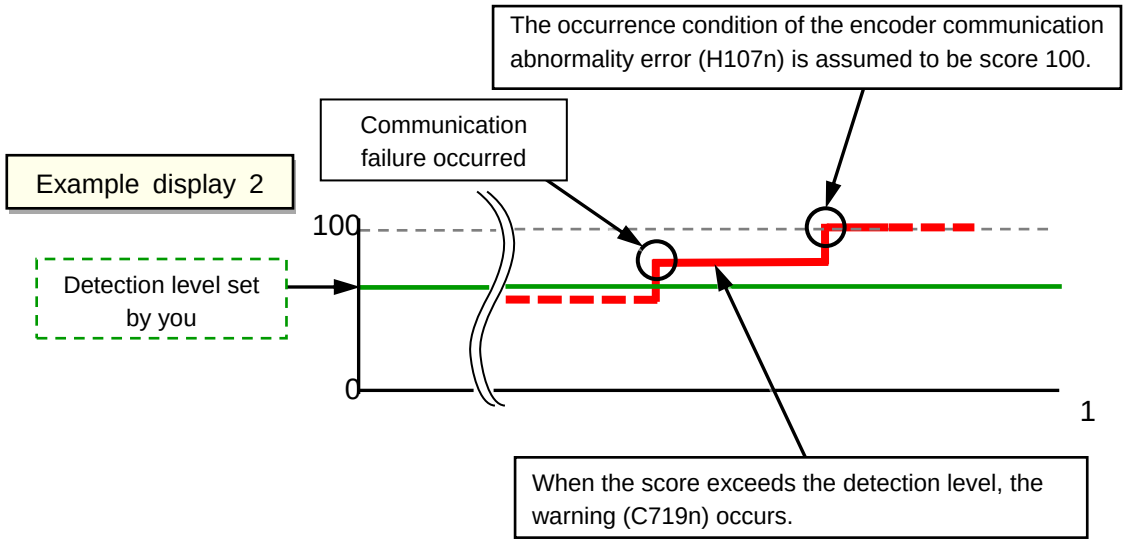


(2) Encoder data/communication abnormality

Encoder data abnormality error or communication abnormality error occurs when miscount of the certain number of times or communication failure occurs, respectively, and the robot will stop by the error.
This function uses 100 as the error occurrence condition and outputs miscount and communication failure, which did not reach an error, as the score, and notifies that an abnormality has occurred before the robot stops due to the error.
The maximum encoder data score and encoder communication score are retained.
(After replacing the motor, if you reset the score of the replaced axis, its score becomes 0.)
Since miscount and communication failure sometimes occur due to noise and others, set the detection level of the encoder data/communication score with some margin.

Example display of encoder communication abnormality log data





■ Checking scores with the real-time monitor oscillograph

The scores of the fault detection function can be monitored with the real-time monitor oscillograph.This section explains how to start the oscillograph real time monitor.
For details of the oscillograph function and how to use the real time monitor, refer to the separate "RT ToolBox3/RT ToolBox3 mini User's Manual".

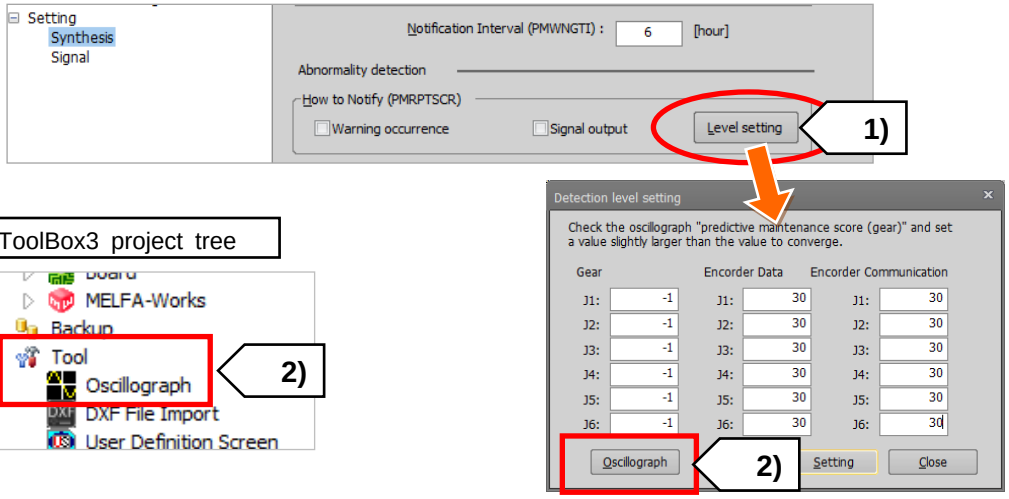
[CAUTION]

(1) When using the real time monitor function, the real time monitor mode needs to be enabled.
Check that the "MONMODE" parameter is set to [1] (Enabled).

(2) The real time monitor function can only be used in an environment where the personal computer and robot controller are connected via Ethernet. If data cannot be obtained by this method, check "Q&A connection (Ethernet)" in the separate "RT ToolBox3/RT ToolBox3 mini User's Manual".

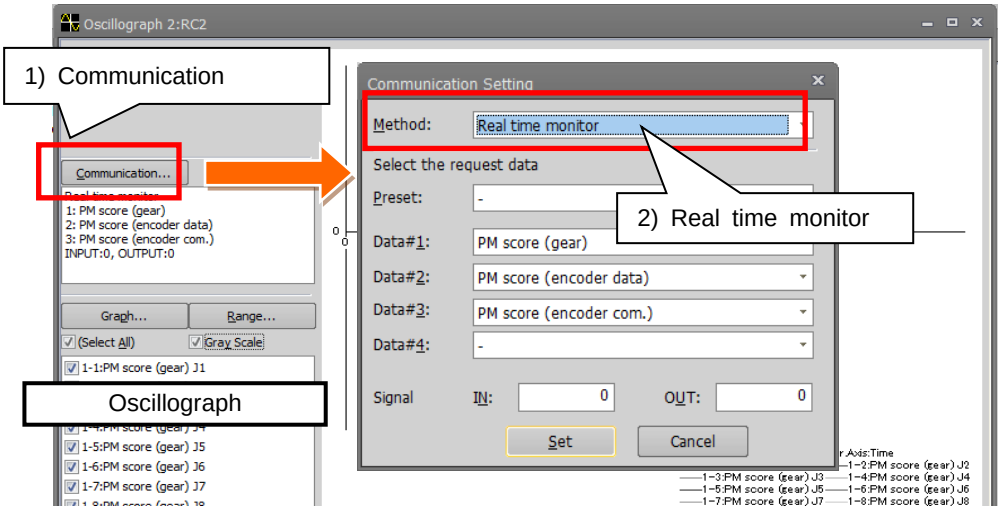
(1) Start up the oscillograph on RT ToolBox3.

1) From the Predictive maintenance - Synthesis screen, click "Level Setting" at the right side of the "Abnormality Detection", "How to Notify" area.
2) The "Level Setting" screen is displayed.
Click the "Oscillograph" button to start "Oscillograph".
Alternatively, from the RT ToolBox3 project tree, click [Tool] and then select [Oscillograph].



(2) From the Communication Setting screen of the Oscillograph screen, select "Real time monitor".

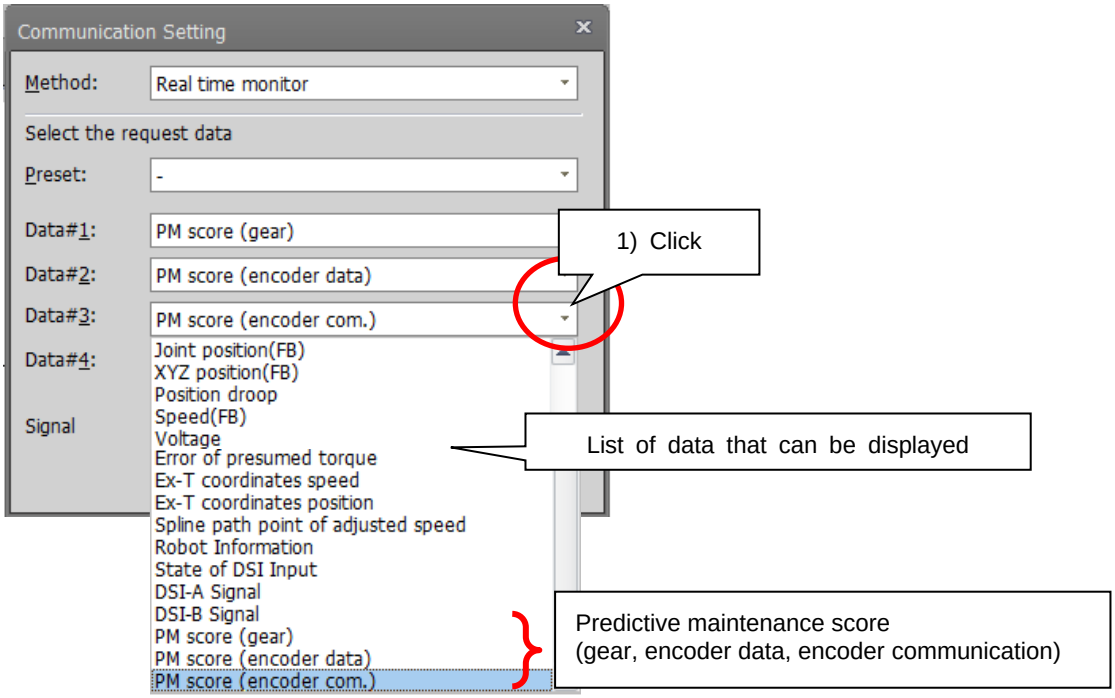
1) When you click the "Communication Setting" button at the left side of the Oscillograph screen, the "Communication Setting" screen appears.
2) From "Method" on the "Communication Setting" screen, select "Real time monitor".



(3) Start the Communication Setting screen of the Oscillograph screen of the predictive maintenance function.

1) In Data#1 to Data#4, from the data list, select the score item to be monitored.

2) Click the "Set" button to close the "Communication Setting" screen.

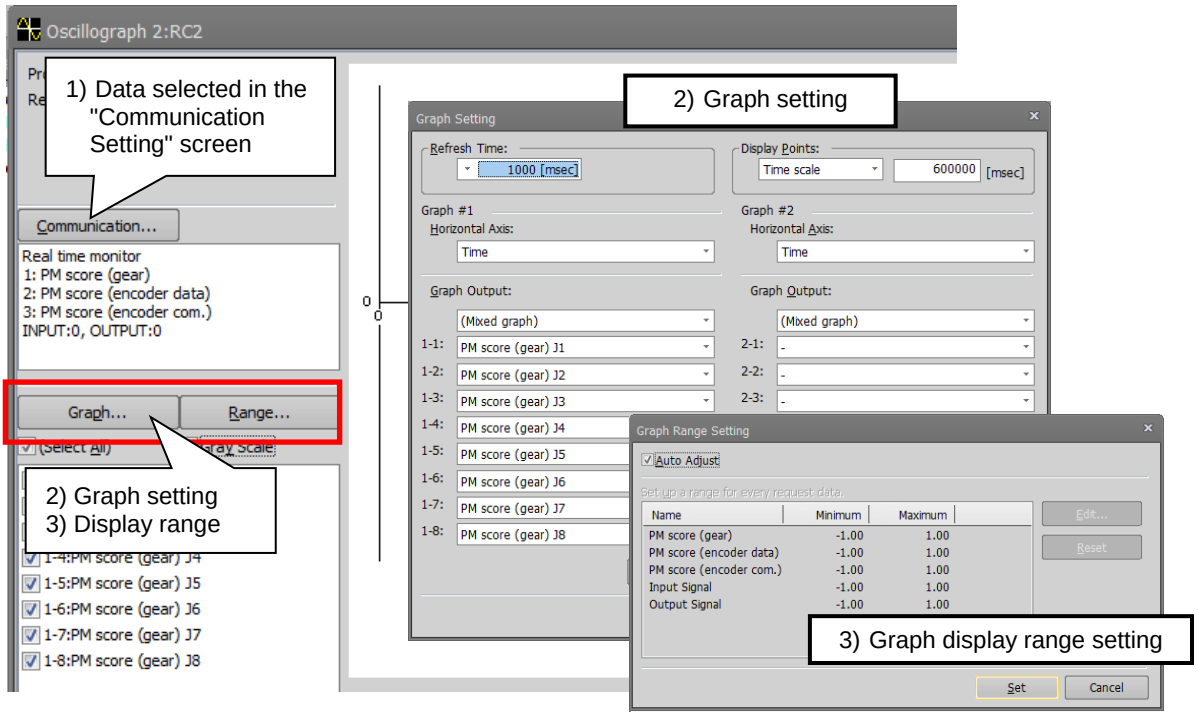


(4) Set the item to be displayed on the real time monitor and set the display range of the graph.

1) The data selected in the Communication Setting screen is displayed at the left side of Oscillograph.

2) You can set the item to be displayed in the real time monitor on the "Graph" setting screen.

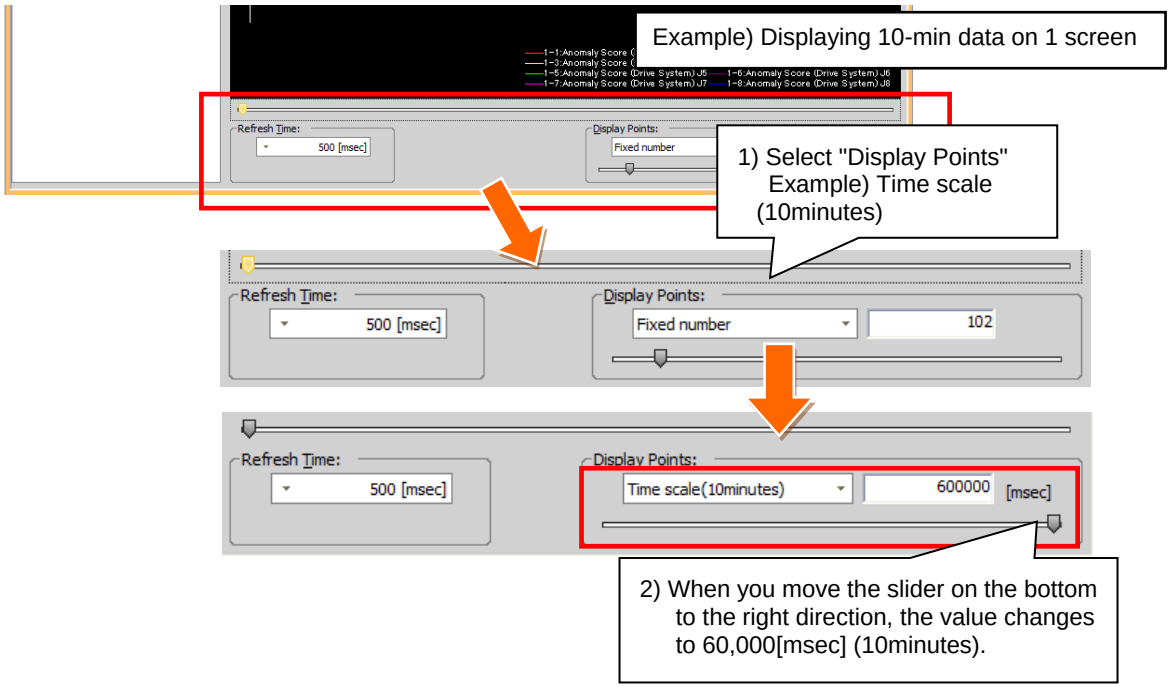
3) You can set the display range of the vertical axis of each data on the "Range" setting screen. When you select [Auto Adjust], the vertical axis of the graph is automatically adjusted.



(5) Adjust display points on the graph.

1) Change "Display Points" on the lower right side of the Oscillograph screen.
2) When you move the slider on the bottom to the right direction, the value on the right side changes.
Display points are points to be displayed on graph.
Example) When you set the display points to "Time scale (10minutes)", the data created for 10 minutes is displayed on the graph.

*Since the score (reduction gear) changes slowly, by setting "Time scale (10minutes)" for the display points, it is easy to check convergence of the score value.



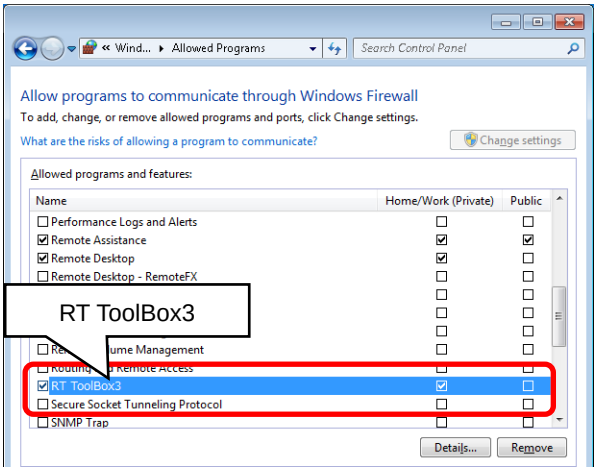
■The Oscillograph cannot be used when the communication method is set to High speed.

If you see the message "It can not communicate with the controller", please change so that the RT ToolBox3 (MELFA_RT.exe) is allowed to receive in the Windows Firewall settings.

Check item or cause

1) Show the following screen by selecting [Control panel] -> [System and Security] -> [Windows Firewall] -> [Allow a program or feature through Windows Firewall] (for Windows7).

2) Check if there is [RT ToolBox3] and communication range of the use environment in the [Allowed programs and features] list.

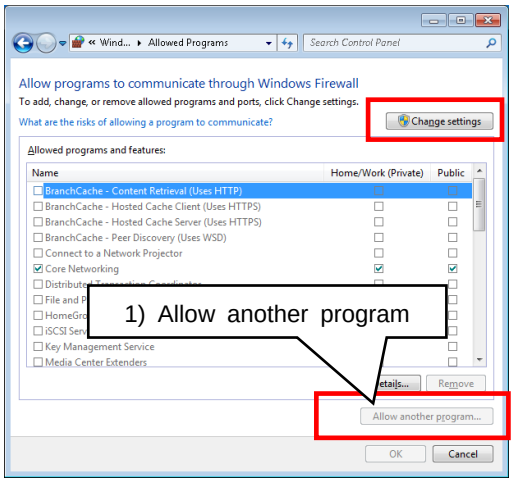


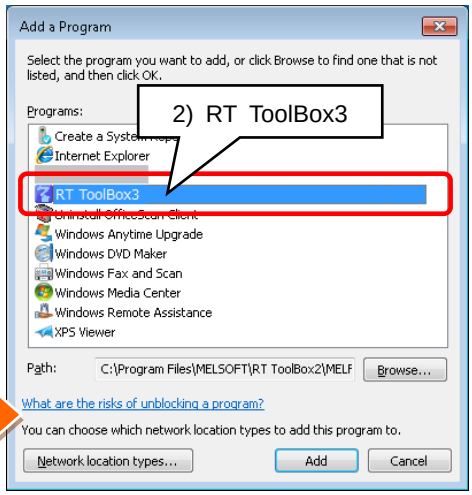
Solution

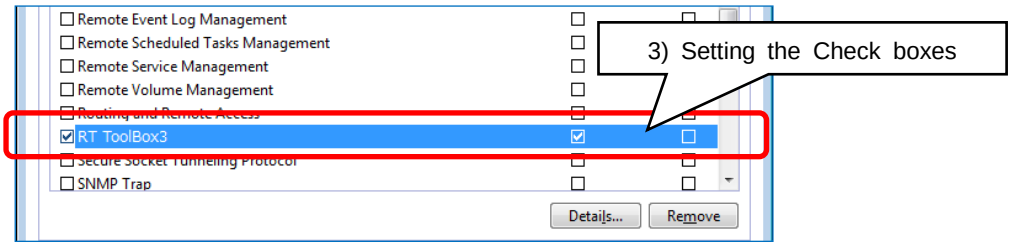
1) If [RT ToolBox3] is not in the [Allowed programs and features] list, click the [Allow another program] button.
If the [Allow another program] button is disabled, click the [Change settings] button first.

2) Select and add [RT ToolBox3] on the [Add a program] screen.

3) Set the check boxes ON according to the use environment of [Home/Work (Private)] and [Public].







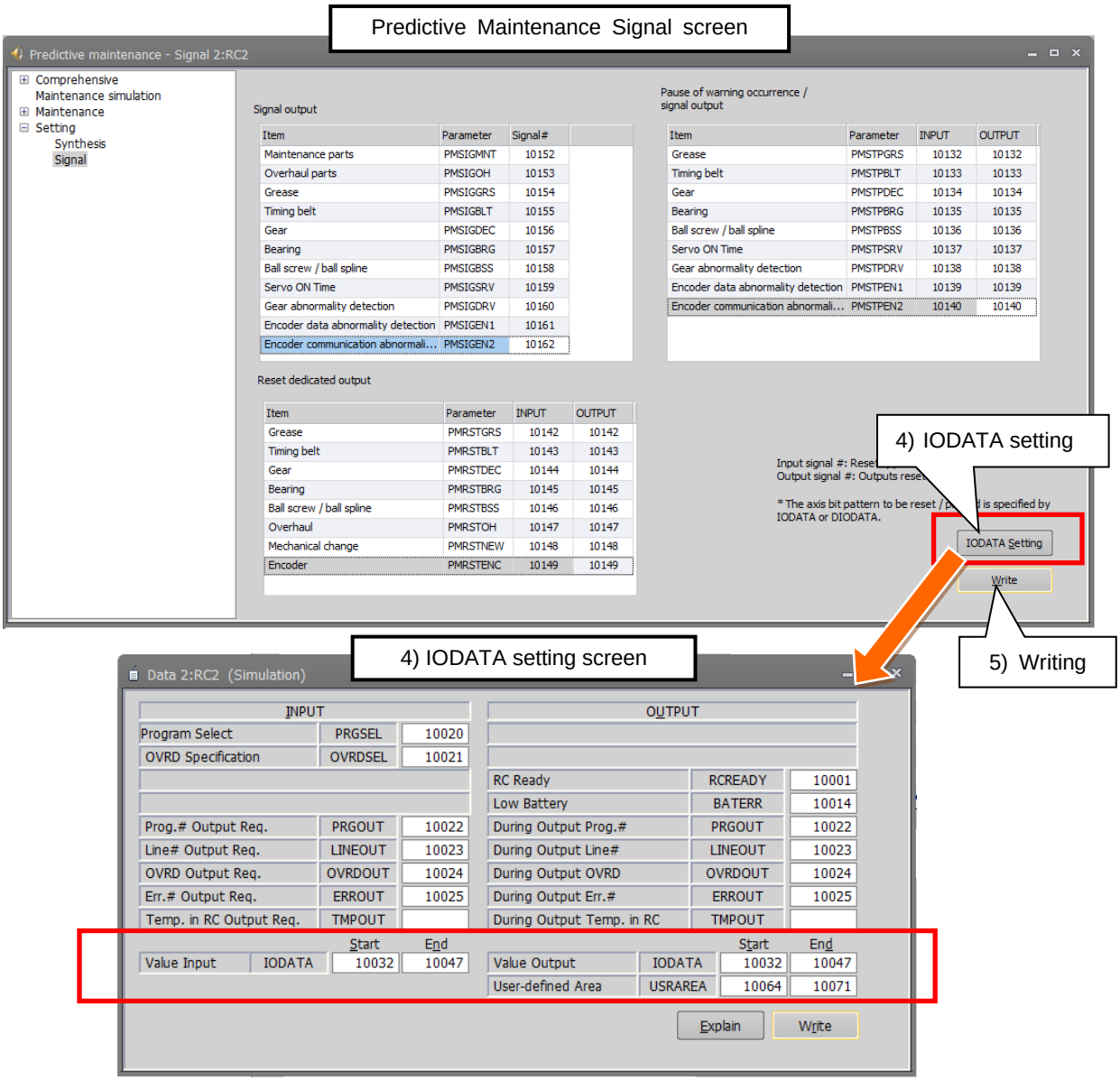
3.2.3. Setting signals

Set signal numbers when you wish to use signal input/output to implement notification when consumption or abnormality of parts is detected, reset the abnormality detection status/consumption degree, or pause warning occurrence/signal output.

For dedicated input/output signals of the predictive maintenance function, refer to "15. Dedicated input/output signals".

1) From the RT ToolBox3 project tree, double-click [Online] - [Maintenance] - [Predictive Maintenance].
2) From the Predictive Maintenance tree, click [Setting] - [Signal].
3) Enter the signal number for the item to be set. (Note 1)
4) When setting an axis bit pattern for reset/pause, click "IODATA Setting". When IODATA Setting screen appears, set necessary information and click "Write".
5) After changing the parameter values, click the Write button to write them to the robot controller.

Note 1) Set the signal numbers according to the system to be used. The range of values that can be set in the parameters are 0 to 255, 2000 to 5071, 6000 to 8047, and 10000 to 18191.



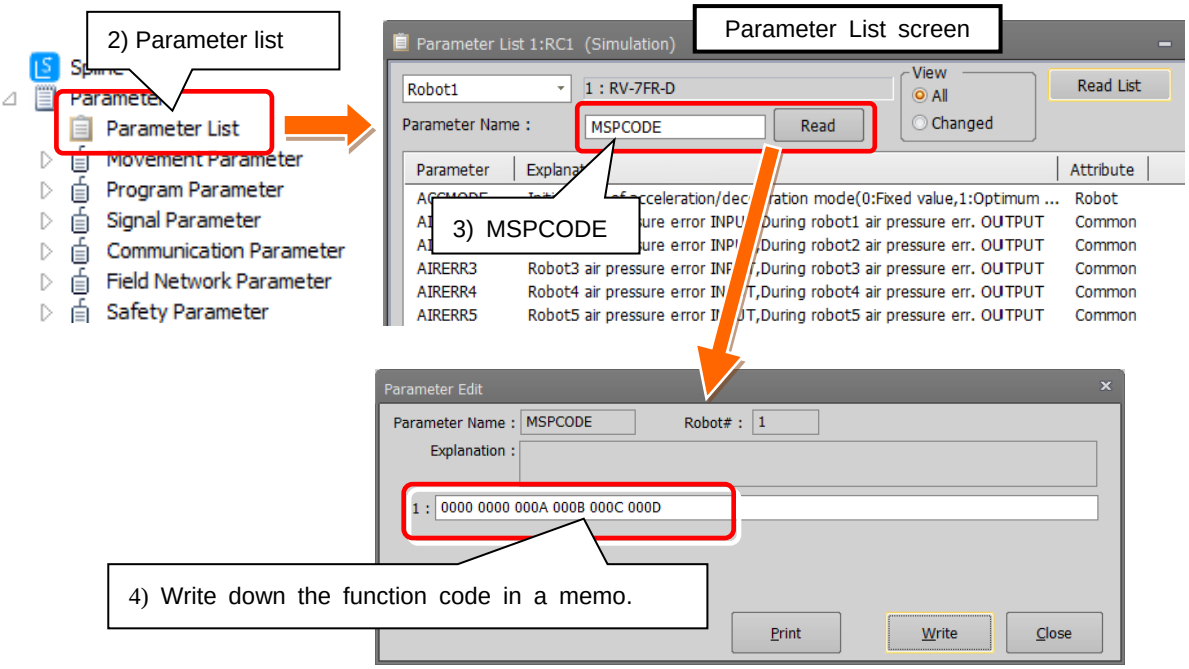
3.3. Setting of maintenance simulation

In order to use "Maintenance Simulation" for the simulation of RT ToolBox3, the function code and parameter of the MELFA Smart Plus card need to be set to RT ToolBox3.
This section explains the procedure for setting the function code of the MELFA Smart Plus card to RT Toolbox3, which is not connected to the robot controller where the MELFA Smart Plus card has been installed.
(For maintenance simulation, refer to "9 Maintenance simulation".)

1 Get the function code of the MELFA Smart Plus card.

First, get the function code from the robot controller where the MELFA Smart Plus card and predictive maintenance function have been enabled ("3.1 Enabling the predictive maintenance function" is completed).

1) Use the RT ToolBox3 connected to the robot controller where the MELFA Smart Plus card and predictive maintenance function have been enabled.
2) From the RT ToolBox3 project tree, select [Parameter List].
3) Enter "MSPCODE" for the parameter name on the Parameter List screen.
4) The function code (24 alphanumeric characters) of the "MELFA Smart Plus Card" is displayed; write it down in a memo.



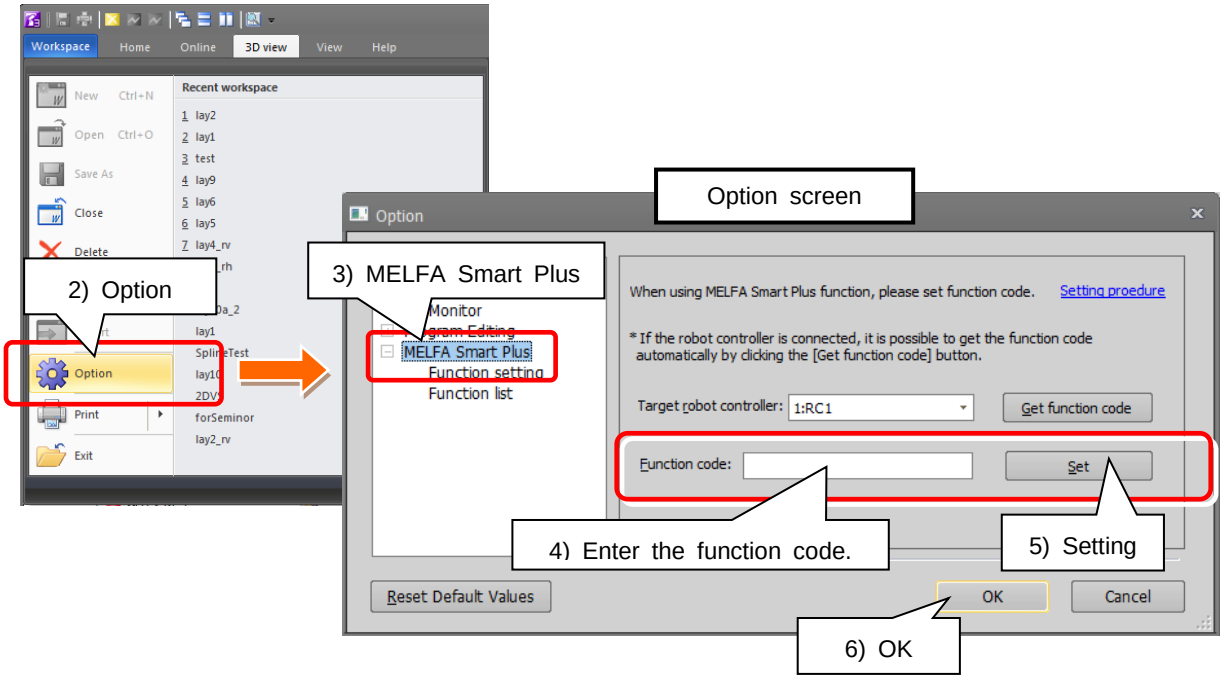
*It is possible to read the "MSPCODE" parameter with the teaching pendant.

[When using the maintenance simulation on a personal computer connected to the real machine]
1) Select [Option] from the [Workspace] tab of RT ToolBox3.
2) From the left tree on the Option screen, select MELFA Smart Plus.
3) When you click the "Get function code" button, the function code of the "MELFA Smart Plus Card" is displayed in the "Function code" field. (See the screen on the next page.)

2 Set the function code of the MELFA Smart Plus card.

Next, enter the function code obtained in Step 1 to the RT ToolBox3 that performs the maintenance simulation.

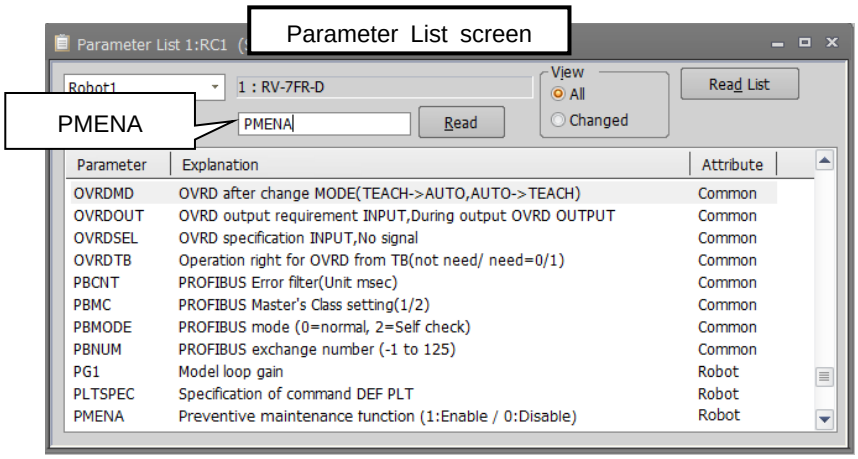
1) Start RT ToolBox3 that performs the maintenance simulation. At that time, click the right button of the mouse on the desktop icon of RT ToolBox3 and select "Implement as administrator" from the displayed menu.
2) Select [Option] from the [Workspace] tab of RT ToolBox3.
3) From the left tree on the Option screen, select MELFA Smart Plus.
4) Enter the MELFA Smart Plus card function code obtained in Step 1 to the "Function code" field.
5) Press the Set button.
6) Press the OK button and restart RT ToolBox3.



3 Set the predictive maintenance function enable parameter.

Set the parameter to enable predictive maintenance.

1) Open the workspace that performs the maintenance simulation. Open the project.
2) Open the parameter list of the project that performs the maintenance simulation.
3) Set the "PMENA" predictive maintenance function parameter to [1: Enable].

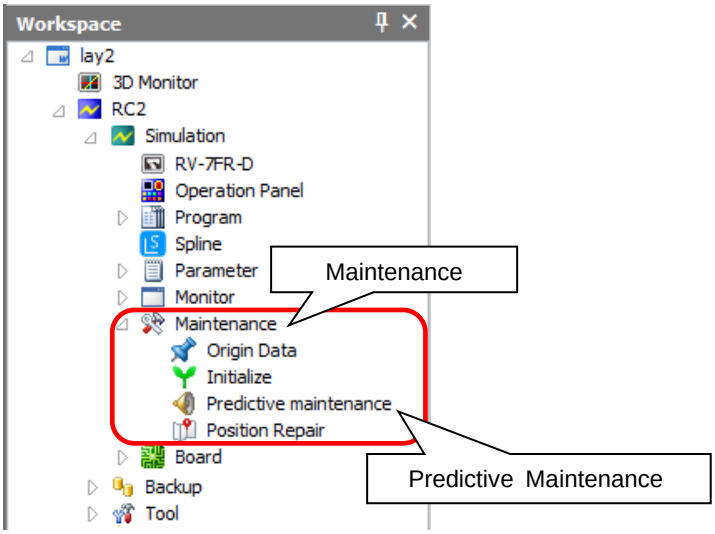


Set the "PMENA" parameter for each project.

4 Check that the predictive maintenance function is enabled.

1) Change the operation mode to <Simulation>.
   If parameter setting in Step 3 is performed using <Simulation>, start up Simulation once again. (The "PMENA" parameter requires rebooting.)

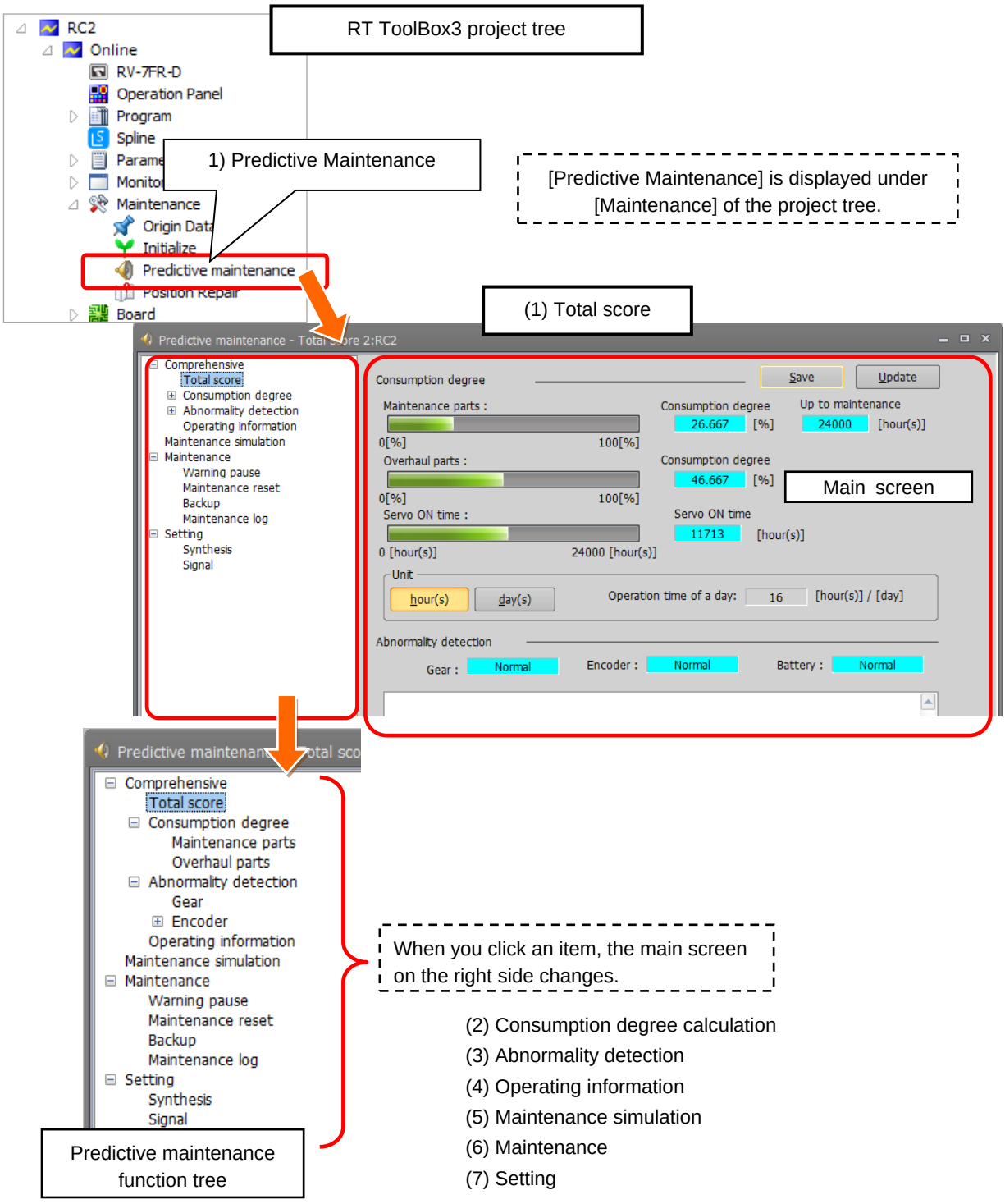
2) From the project tree, expand [Maintenance] and check that [Predictive Maintenance] is displayed.



<< MEMO >>

4. Basic screen structure

This screen displays the status of reduction gear, the encoder, and battery (normal, warning, abnormalities), and the total evaluation result of the consumption degree calculation function.



1) From the RT ToolBox3 project tree, when you double-click [Maintenance] - [Predictive Maintenance], the predictive maintenance function starts and the Total Score screen appears.
2) In the Total Score screen, the predictive maintenance function tree is displayed on the left side and the main screen on the right side.
3) When you click the + mark in the predictive maintenance function tree, menus of the predictive maintenance function appear.
4) When you click an item on the predictive maintenance function tree, the main screen on the right changes.

(1) Total score

This screen displays the total evaluation result of the abnormality detection function and consumption degree calculation function, and maintenance messages.

For details, refer to "5. Total score".

(2) Consumption degree calculation

The screen indicates the consumption degree of each part and each joint axis of maintenance parts and overhaul parts calculated by the consumption degree calculation function.

For details, refer to "6 Consumption degree calculation function".

(3) Abnormality detection function

The screen that displays the score of reduction gear and the encoder calculated by the abnormality detection function.

Log data for 365 days is also displayed. The status of reduction gear and each joint axis of the encoder are indicated as well.

For function details, refer to "7 Abnormality detection function".

(4) Operating information

The screen that displays the integration time and accumulation count from the time when the previous overhaul was carried out.

• Integration Time [hours]: Power ON Time, Servo ON Time, Operation Time, Actual Operation Time

• Accumulation Count [times] : Servo ON Count, Motor Cumulative Rotation Count

For details, refer to "8 Operating information. ".

(5) Maintenance simulation

Using the real machine (online) or simulations on RT ToolBox3, this function estimates the parts replacement time or the recommended maintenance time when specific motion patterns (robot programs) are repeated.

For details, refer to "9 Maintenance simulation".

(6) Maintenance

This menu is used to specify pause of warning occurrence/signal output, and reset the consumption degree of maintenance parts and overhaul parts, backup, restore, and checking of the maintenance log.

For details, refer to “11 Maintenance".

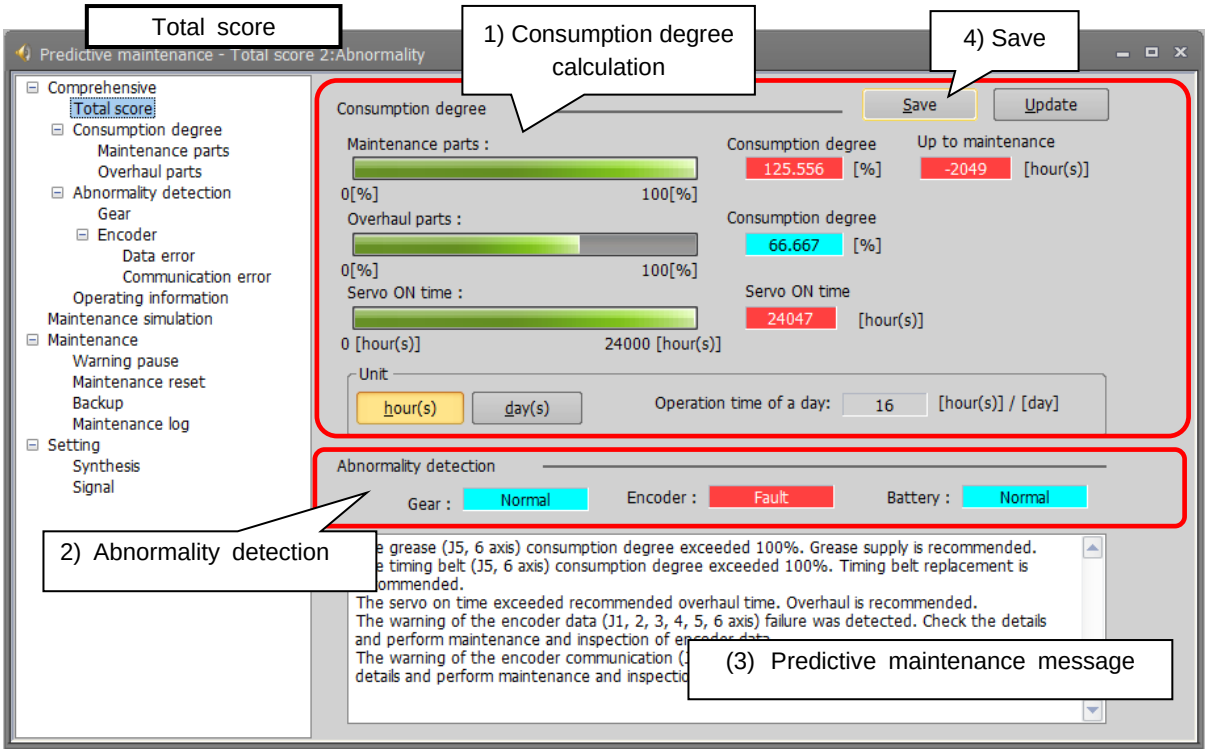
(7) Setting

This menu is used to set the preventive maintenance function including the presence of warning occurrence, signal output and its occurrence intervals, specify the detection level, and set dedicated input/output signals.

For details, refer to “3.2.1 Setting how to notify”.

5. Total score

This screen displays the status of reduction gear, the encoder, and battery (normal, warning, abnormalities), and the total evaluation result of the consumption degree calculation function.



(1) Consumption degree calculation

The Consumption Degree area indicates the total score (Consumption Degree [%] and Up to Maintenance) of maintenance parts (grease, timing belt), and the total score (Consumption Degree [%]) of overhaul parts (reduction gear, bearing, ball screw, ball spline), and the accumulated servo ON time since the previous overhaul time.

Consumption degree [%] is displayed based on the recommended maintenance time of each part as 100 [%].

You can check details of each part and joint axis on the Consumption Degree screen.

(Refer to "6 Consumption degree calculation function ".)

■Maintenance parts and overhaul parts

Classification	Target parts	Display description
Maintenance parts	Grease, timing belt	Consumption degree [%], remaining time up to the recommended maintenance time The remaining time of each joint axis of maintenance parts is calculated and Consumption Degree [%] and Up to Maintenance [h] of the part (joint axis) having the least remaining time to the recommended maintenance time is displayed.
Overhaul parts	Reduction gear, bearing, ball screw/ball spline	Consumption degree [%] The remaining time of each joint axis is individually calculated and the consumption degree [%] of the part (joint axis) having the least remaining time is used.

When the consumption status comes close to or exceeds the notification day you specified, check the content of the predictive maintenance message displayed at the bottom of the screen and details of each part/each joint axis on the Consumption Degree screen and take measures.

For predictive maintenance message and measures, refer to "10. When consumption occurred/abnormality detected, 10.1Consumption Degree".

(2) Abnormality detection

This area of the screen indicates the score status obtained using the abnormality detection function. The display also includes the status (normal, fault) of reduction gear, the status (normal, fault) of the encoder, and the status (normal, warning, fault) of the battery.
You can check details of each joint axis on the Abnormality Detection screen.
(Refer to "7 Abnormality detection function".)

If " Warning " or "Fault" is indicated, check the content of the predictive maintenance message displayed at the bottom of the screen and details of each part/each joint axis on the Abnormality Detection screen and take measures.
For predictive maintenance message and measures, refer to "10. When consumption occurred/abnormality detected, 10.2 Abnormality detection".

[Note] About abnormality detection

Abnormalities could be detected due to the following factors.

1) The setting of the detection level has no margin or the setting value is not appropriate.

2) Due to operating environment.
- The robot installation location or robot motion was changed.
- Effect of vibration around the robot or electric noise.

If the above factors are not considered as the cause, check the change in the score of the log on the Abnormality Detection screen or the current status from the oscillograph.

(3) Predictive maintenance message

When the consumption status of the target part exceeds the notification day you specified, or the score exceeds the detection level, the predictive maintenance message according to the status is displayed; check the message content and take measures.
For predictive maintenance messages and measures, refer to "10. When consumption occurred/abnormality detected".

(4) Save

"Save" button in the total score window exports all predictive maintenance data as a CSV file.
The log data of the score calculated by the abnormality detection function, and operation data are included.

Storage destination：[Folder for workspace]¥[Project name]¥Maintenance¥PMLog

File name：[TotalDataYYYYMMDD-HHMMSS].csv

(The storage destination and the folder name can be changed.)

6. Consumption degree calculation function

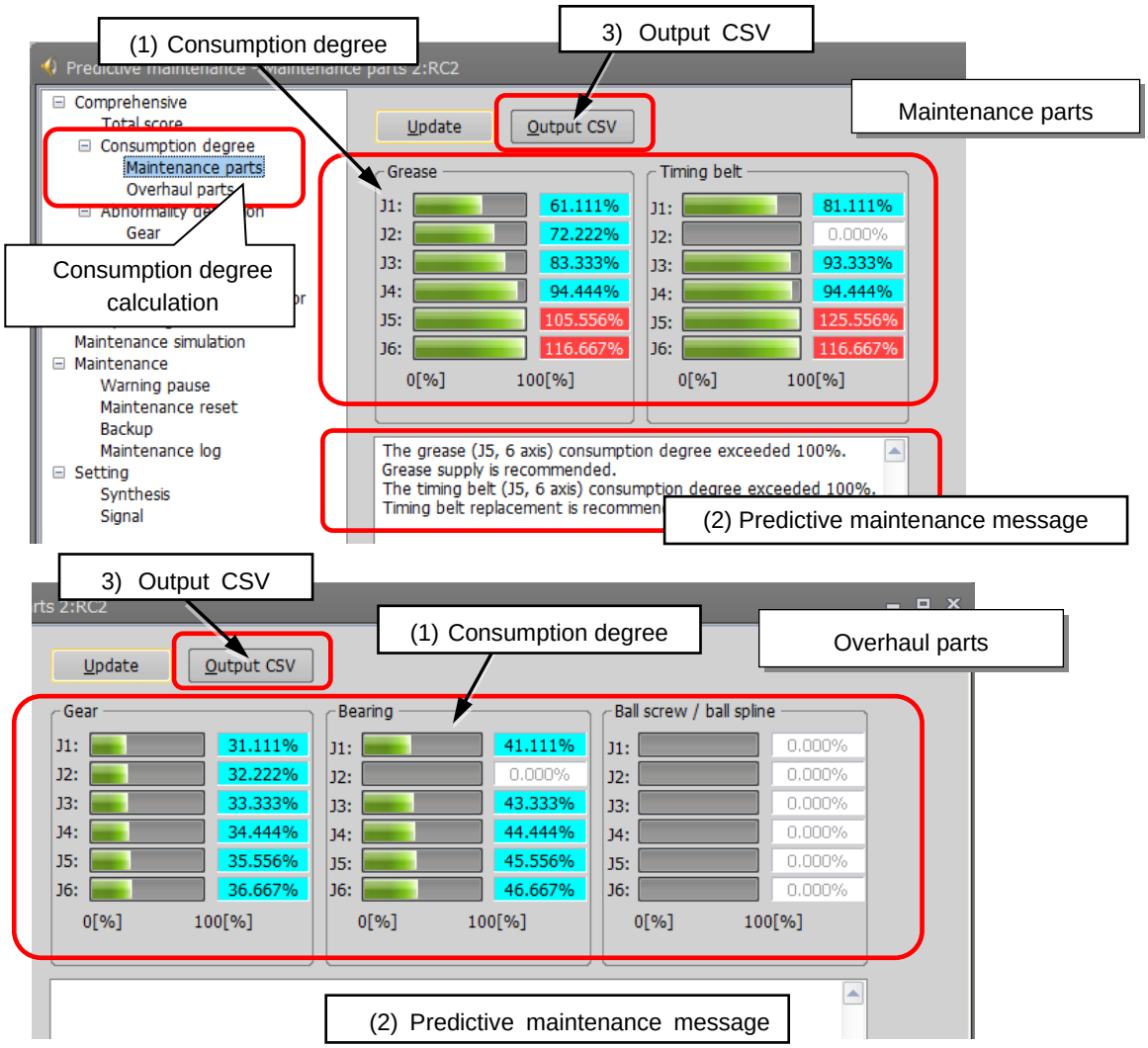
This function calculates the consumption degree [%] of robot components based on the actual operating status (motor speed, load status, and others), and calculates the period up to maintenance/inspection or overhaul.

The screen indicates the consumption degree of each joint axis of maintenance parts and overhaul parts calculated by the consumption degree calculation function.
The current status of maintenance parts (grease, timing belt) and overhaul parts (reduction gear, bearing, ball screw/ball spline) is displayed, separately in two screens. Also, the current status is displayed as the predictive maintenance message.

■Maintenance parts and overhaul parts

Maintenance parts	Grease, timing belt
Overhaul parts	Reduction gear, bearing, ball screw/ball spline

1) Start predictive maintenance.
2) Click [Total Score] - [Consumption Degree] to expend the menu.
3) When you select "Maintenance Parts" or "Overhaul Parts", the consumption degree of each part of the target axis and each joint axis is displayed.



(1) Consumption degree

This area of the screen indicates the consumption degree of each part of the target axis and each joint axis in a graph and numeric value [%].
(For target axis, refer to "2.1.4 Target models/target axes".)

(2) Predictive maintenance message

This field displays predictive maintenance messages according to the part status.
When the remaining time exceeds the notification day, an appropriate predictive maintenance message is displayed; check the message content and take measures. For predictive maintenance message and measures, refer to "10. When consumption occurred/abnormality detected 10.1 Consumption Degree ".

(3) Output CSV

Exports data of the consumption degree displayed in the window as a CSV file.
Storage destination and the file name of the CSV file

Storage destination：[Folder for workspace]¥[Project name]¥Maintenance¥PMLog

File name：[ConsumptionDataYYYYMMDD-HHMMSS].csv

(The storage destination and the folder name can be changed.)

⚠ Caution

[About calculation of the consumption degree]

- The consumption degree of each part is calculated on the assumption that the robot is used in the environment (ambient temperature, humidity) within the specification scope described in the instruction manual (standard specifications).
- The consumption degree of each part is used as a reference value for supporting the maintenance and inspection schedule calculated based on the robot operating status. It does not guarantee the service life of the robot.
- Irrespective of the consumption degree, carry out daily inspection and periodic maintenance and inspection described in the instruction manual (Standard Specifications Manual, Robot Arm Setup & Maintenance).
- When the servo ON time exceeds the specified time (24,000 hours) or the consumption degree exceeds the warning remaining number of days, we recommend you perform overhaul of the robot arm.
- Reset operation of the consumption degree of each part must not be executed except during maintenance or part replacement.
- For the total score of maintenance parts and overhaul parts, the value of the part among all joint axes having the least remaining time (Up to Maintenance) to the recommended maintenance time is output, respectively. For that reason, the consumption degree of the total score could be smaller than the maximum consumption degree value of each part.
- The remaining time is a reference value calculated based on the operating status of the robot from the previous maintenance time. Also, the remaining time is when you use the robot in the same way as before.
  Therefore, if operation is changed, the remaining time may increase or decrease.
- For the axis with multiple parts of one type, the part that wears the fastest in terms of design is the subject for the calculation. It is recommended to perform maintenance on the peripheral parts at the same time as the part replacement.

Caution

[About the robot controller]

- When using this function by upgrading from a non-compatible controller software version to a compatible controller software version, the consumption degree during the period of the non-compatible software version is not added up, thus the result of consumption degree calculation function cannot be the correct value
- The consumption degree of the robot arm is saved in the robot controller, thus it is necessary to use the correct combination of the robot arm and robot controller.
  To replace the robot arm or robot controller only, perform backup/restore of predictive maintenance information to migrate the predictive maintenance information.
  (For backup/restore, refer to "11.3 Backup and restore".)

Caution

Depending on the operating status at startup, correct results may not be obtained at the beginning due to fluctuations until sufficient data is accumulated.

Caution

Correctly set hand work conditions (weight, center of gravity, shape) actually used. If the settings differ from the actual robot settings, the consumption degree cannot be calculated correctly.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions.
For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Caution

When the predictive maintenance function is valid, the maintenance forecast is not displayed and warning signals of maintenance forecast are not output. When the information is reset by the predictive maintenance function or maintenance forecast, the information in the other function is reset as well.

<<MEMO>>

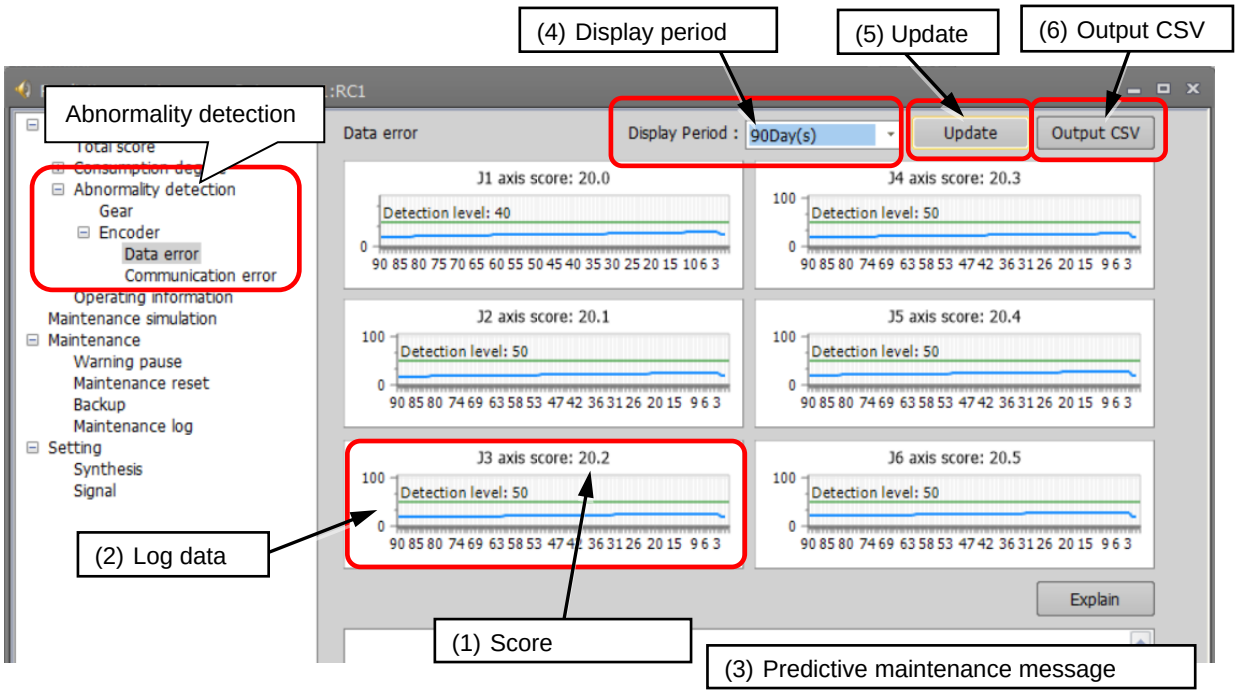
7. Abnormality detection function

This function detects abnormalities or deterioration of robot reduction gear components early.
Before the robot exhibits behavior that is a sign of an abnormality, the function can detect reduction gear or encoder abnormalities.

The screen that indicates the score calculated by the abnormality detection function.
The display also includes the current score of the reduction gear including reduction gears, encoder data abnormality, and encoder communication abnormality.
Log data for 365 days is also displayed.

When the score exceeds the detection level, the reduction gear is assumed to be abnormal and an error (warning) occurs or that effect is notified by the dedicated output signal. Also, the current status is displayed as the predictive maintenance message.

1) Start predictive maintenance.
2) Click [Total Score] - [Abnormality Detection] to expand the menu.
3) When you select "Reduction gear", "Encoder - Data Error", or "Encoder - Communication Error", the current score and log data are displayed. You can specify the display period of log data in the upper part of the screen.



(1) Score

Indicates the score of each joint axis. The value is the current value.

(2) Log data

Displays log data of the maximum value of score of each joint axis for the past 365 days.
The indicated value is the maximum value of a day.

- You can specify the display period using the "Display Period" field of the upper part of the screen. Non target axes are not displayed.
- The color of the graph differs depending on the score.
  The color is blue when the latest value of the score is normal. When the value exceeds the detection level, the color is red (detection level is green).
- For the display range of the horizontal axis of the graph, 1 is displayed on the right end as the current day and the left side is old data.
  If the log data does not exist for the number of display days, the graph is displayed left justified.

(3) Predictive maintenance message

This field displays predictive maintenance messages according to the part status.
When an abnormality is detected, an appropriate predictive maintenance message is displayed; check the message content and take measures.
For predictive maintenance messages and measures, refer to "10. When consumption occurred/abnormality detected 10.2 Abnormality detection".

(4) Display period

You can specify the display period of log data displayed on the screen.
1 year (365 days) | 3 months (90 days) | 1 month (30 days) | 1 week (7 days)

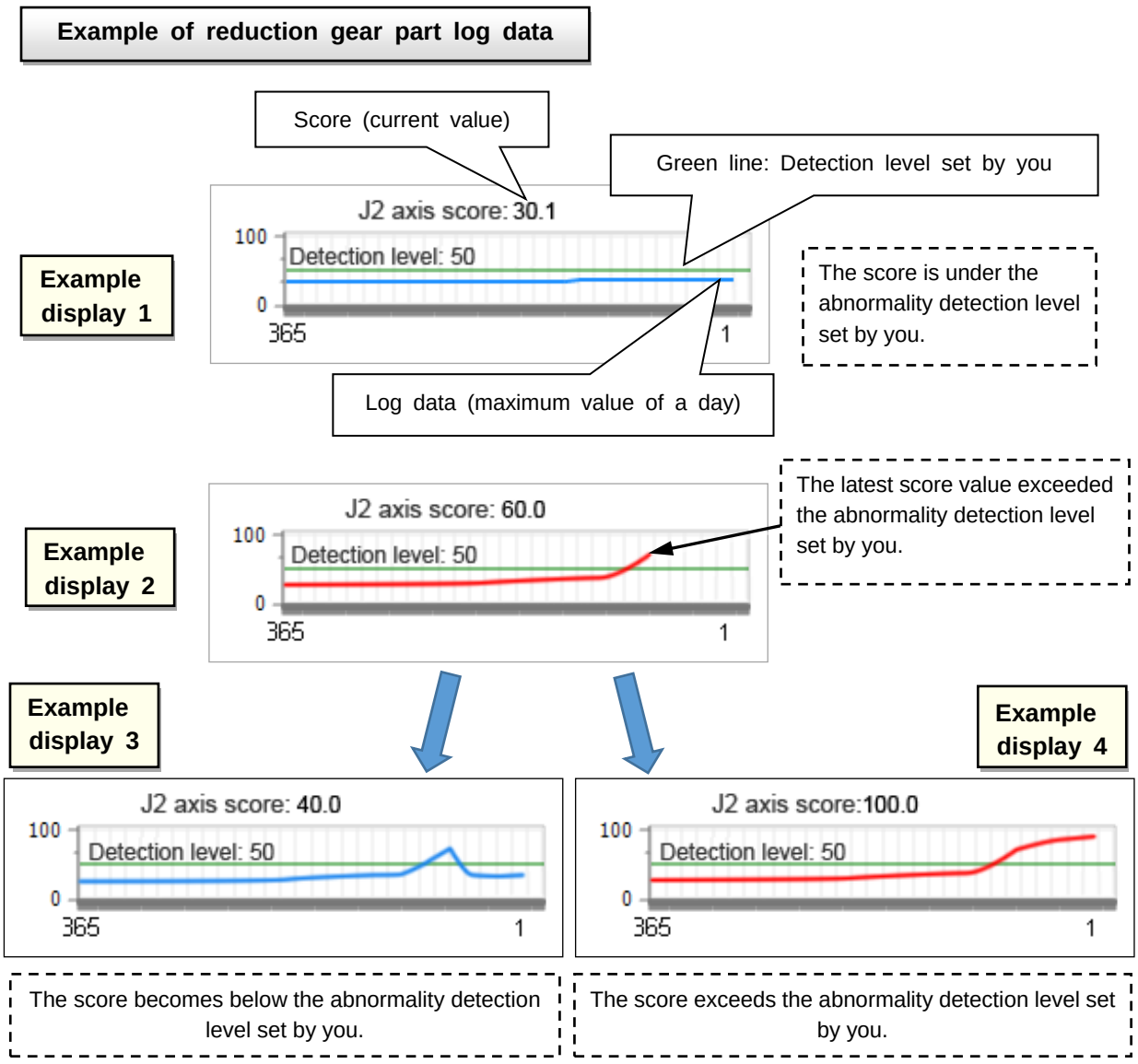
(5) Update

Updates the screen display.

(6) Output CSV

Output the graph data displayed on the screen (date and score) in the CSV format.

* Storage destination and file name of the CSV file
  Storage destination: [Folder for workspace]¥[Project name]¥Maintenance¥PMLog
  File name: [DetectionDataYYYYMMD-HHMMSS].csv



Caution

- The score output by the reduction gear abnormality detection function is calculated based on motor feedback data and is a reference value for detecting abnormalities that leads to a failure. It does not guarantee to certainly detect abnormalities before part failure. Also, this score targets aged deterioration of the robot.

Caution

- Since the score of the reduction gear abnormality detection varies depending on the operating speed and operation conditions such as the hand load by the hand and the workpiece, set the detection level according to the actual operating conditions.

  If the operating conditions such as the workpiece, the hand, and the operation program are changed, review the setting of the detection level. If the setting of the detection level is not appropriate, abnormalities may not be detected or mis-detection may occur.

Caution

- When there is a vibration source outside the robot arm or robot operation is hindered by an external cable, and others. Abnormalities or deterioration of parts may not be diagnosed correctly.

Caution

Set the conditions (weight, center of gravity, and shape) of the actual hand and the workpiece to be used correctly. If the settings differ from the actual robot conditions, mis-detection may occur or abnormalities may not be detected.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions.
For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Caution

The reduction gear abnormality detection function may detect failure of driving parts other than the reduction gear, such as the bearing and the timing belt. In addition, the score of the axis without abnormality may also change.

Caution

The reduction gear abnormality detection function calculates when the motor is operating at a motor speed of 500 rpm or faster.
The score is not calculated for axes operating at less than 500 rpm.
The operation speed can be checked using the oscillograph of RT ToolBox3 or the monitoring function.
(For the starting method for the oscillograph, refer to "Checking scores with the real-time monitor oscillograph" and for the starting method for the monitor function, refer to "How to check the motor speed with the RT ToolBox3 monitor function".)

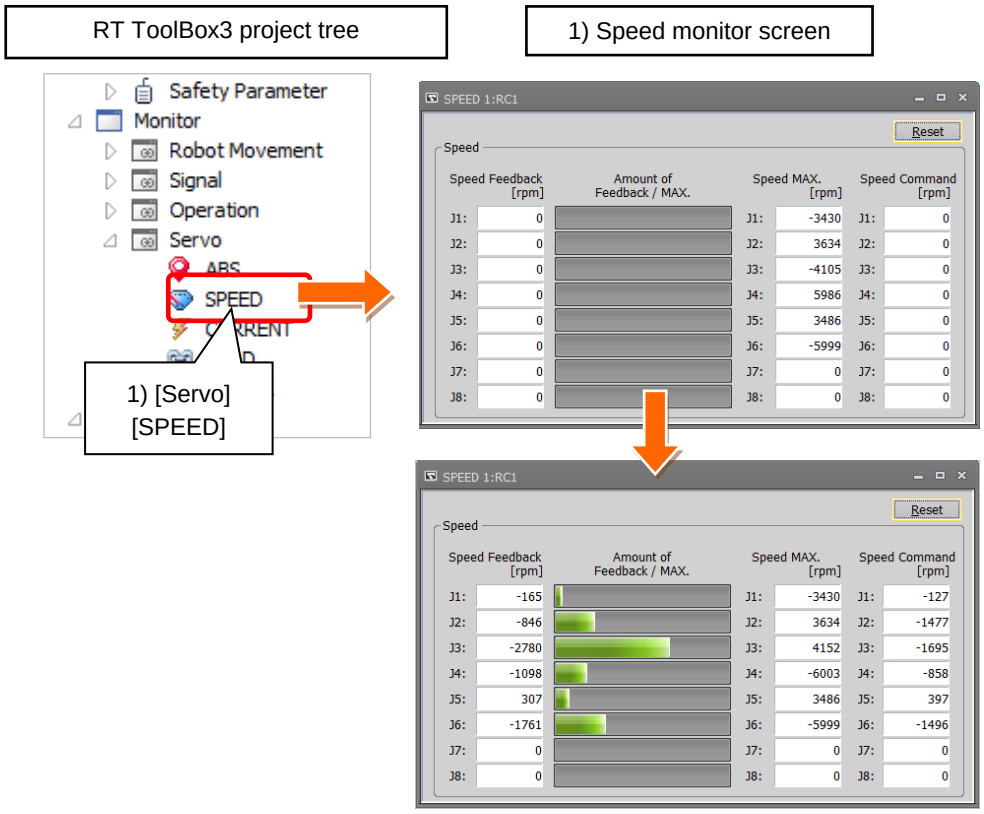
Caution

The score may fluctuate depending on changes in the ambient temperature.
To ensure that the score does not fluctuate during detection, use the robot in an environment which has a stable temperature. Review the detection level settings if the ambient temperature changes.

■How to check the motor speed with the RT ToolBox3 monitor function

1) From the RT ToolBox3 project tree, click [Monitor] - [Servo] and then double-click [Speed] to display the [SPEED] screen.

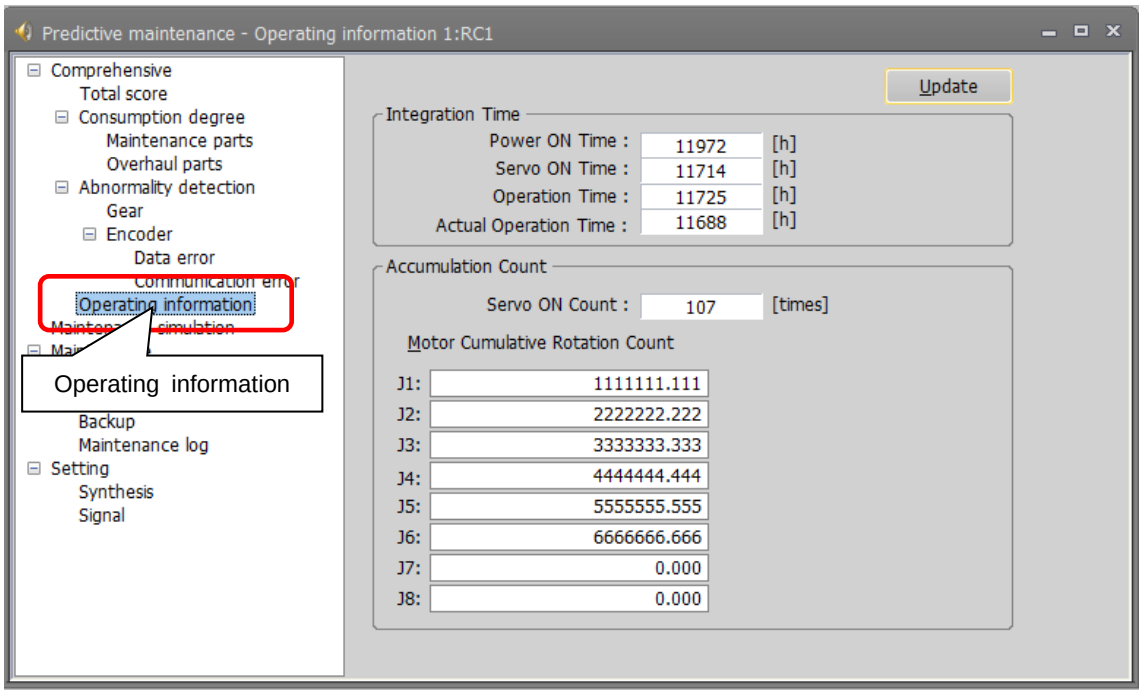
2) You can monitor data related to the speed of each axis motor of the robot in action.



8. Operating information

The Operating Information screen is used to manage and display the integration time and accumulation count from the time when the previous overhaul was carried out.
The integration time and accumulation count data are reset when "Reset operation at overhaul implementation" is performed.

1) Start predictive maintenance.
2) Click [Total Score] to expand the menu.
3) When you select [Operating Information], the integration time and accumulation count are indicated on the main screen.



■Data that can be monitored

Classification	Data	Unit
Integration Time	Power ON Time (duration of robot controller power ON)	[h] hours
	Servo ON Time (duration of servo ON)	[h] hours
	Operation Time (duration of robot program execution)	[h] hours
	Actual Operation Time (duration of actual robot arm operation)	[h] hours
Accumulation Count	Servo ON Count (robot)	[times]
	Motor Cumulative Rotation Count (for robot, each joint axis)	[r] (rotation)

<< MEMO >>

9. Maintenance simulation

This function estimates the parts replacement time or the recommended maintenance time when a specific motion pattern (robot program) is repeated using a real machine (online) or simulations on RT ToolBox3.

Maintenance simulation estimates the following items.

1) Number of years up to the time of replenishing grease
2) Number of years up to the time of timing belt replacement
3) Recommended number of years up to the recommended maintenance time for overhauling parts
(Of reduction gear, bearing, ball screw, and ball spline, the part for which there is the shortest number of years of maintenance)

There are two types of estimation methods, "Program operation" and "1 Cycle operation".
For the real machine (online), estimation is possible using "Program operation", and for simulation, in addition to "Program operation", "1 Cycle operation" can also be used.

- 1 Cycle operation: Specify the start line and end line of the robot program to estimate the parts replacement/ the recommended maintenance time based on its 1 cycle operation pattern.
  Because 1 cycle can be accurately specified on a robot program, it is possible to more accurately estimate the number of years when 1 cycle operation is repeated than when using Program operation.
  The estimation result of the number of years is from the brand new robot state.
- Program operation: While running a robot program automatically, the parts replacement/the recommended time is estimated based on the operation pattern from when the start button is pressed to when the end button is pressed.
  Accurate 1 cycle (start line and end line) cannot be specified but Program operation is used when it is difficult to specify 1 cycle on the program, such as when the program uses external signals.
  The estimation result for a real machine (online) is the number of years from the current consumption degree of the robot. The estimation result for simulation is the number of years from the brand new robot state.

Operation mode	Estimation method	Number of years estimated
Real machine (online)	Program operation	The number of years from the current consumption degree of the robot.
Simulation	1 Cycle operation, Program operation	The number of years from the brand new robot state.

[Note] In order to use Maintenance Simulation in the simulation mode of RT ToolBox3, the function code and parameter of the MELFA Smart Plus card need to be set.
For the setting method, refer to “3.3 Setting of maintenance simulation”.

⚠ Caution

When RT ToolBox3 mini is used, simulation on RT ToolBox3 cannot be used.

The recommended number of years up to the replacement/maintenance time output by this function is the value calculated when the specified operation is repeated. Also, the result may vary depending on the performance of the personal computer used and the load status. The actual time changes depending on the actual operating status or load status of the robot.
Use as reference values for planning of maintenance and inspection.

Correctly set hand work conditions (weight, center of gravity, shape) actually used. If the settings differ from the actual robot settings, the consumption degree cannot be calculated correctly.
Use parameters HNDDAT* and WRKDAT* to set hand work conditions and use Loadset commands to specify hand work conditions. For details of hand work condition setting, refer to the separate "Instruction Manual/Detailed Explanations of Functions and Operations".

Do not use M_TIMER(8) while programming. This function uses M_TIMER(8) for the estimation of parts replacement time and maintenance time. If M_TIMER(8) is used while programming, the number of years of replacement and maintenance cannot be estimated accurately.

After changing to M_TIMER(1) to M_TIMER(7), perform the maintenance simulation.

9.1. "1 Cycle" operation

This operation is performed in the simulation mode of the RT ToolBox3.
Specify the start line and end line of the robot program to estimate the parts replacement/ the recommended maintenance time based on its 1 Cycle operation pattern.

[Note] When an actual machine is connected, the "1 Cycle" button and the “Program“ button are not displayed.

Note on 1 Cycle operation

(1) For command line that waits for signals to be input or robot status changes, use a comment to set the stop time.

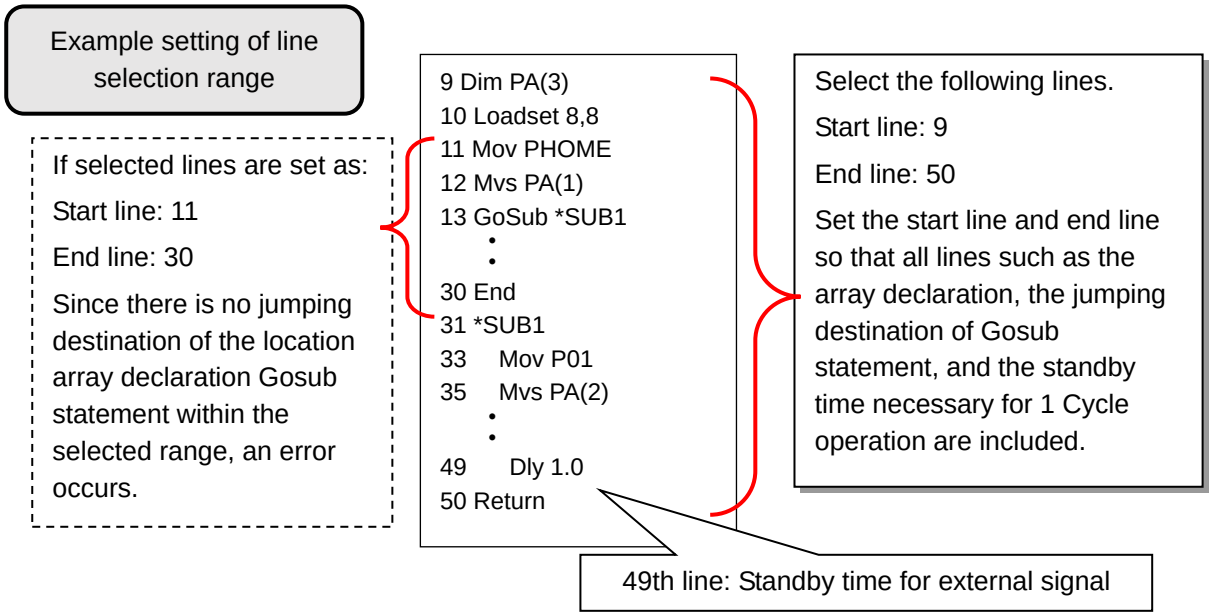
For a program waiting for input of signal from outside or change of the robot status variable, comment out that portion and instead set a stop time (assumed) and specify the start line and end line including that line.

(2) Use a program with no infinite loop.

A program that executes an infinite loop does not give the correct calculation result.
Check that the program is not an infinite loop in a FOR or GOTO statement.

(3) Include all instructions required for 1 cycle in the line selection range.

When selecting the start line and end line of a program, specify line numbers in such a way that all instructions such as jump destinations of Gosub or hand word settings required for the robot to perform 1 cycle operation are included in the range.
When sending/receiving external signals, temporarily set the stop time as a substitute for the signal sending/receiving time and specify the line numbers including that line.
Example) If there is no jumping destination of a sub routine within the selected range, an error (jumping destination does not exist) occurs and the maintenance simulation cannot be executed.



(4) About robot program "ESTPROG.prg"

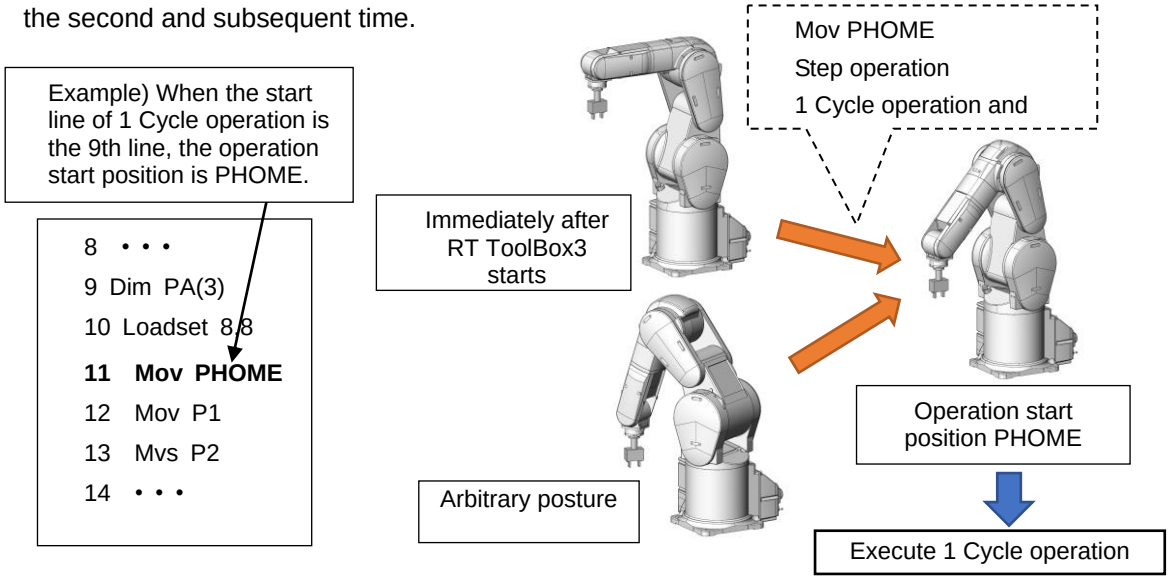
When executing 1 cycle operation, "ESTPROG" is displayed as the robot program on the operating panel. This is a program that is automatically generated when 1 cycle operation is executed. After 1 cycle operation, you can delete this program if it is unnecessary.

1 Move the current position of the robot to the robot operation start position of 1 Cycle operation.

If the current position of the robot is not at the start position of 1 Cycle operation, if 1 Cycle operation starts, the robot moves to the operation start position first. Since that operation is included in the calculation by the maintenance simulation, calculation cannot give the correct 1 Cycle operation result.

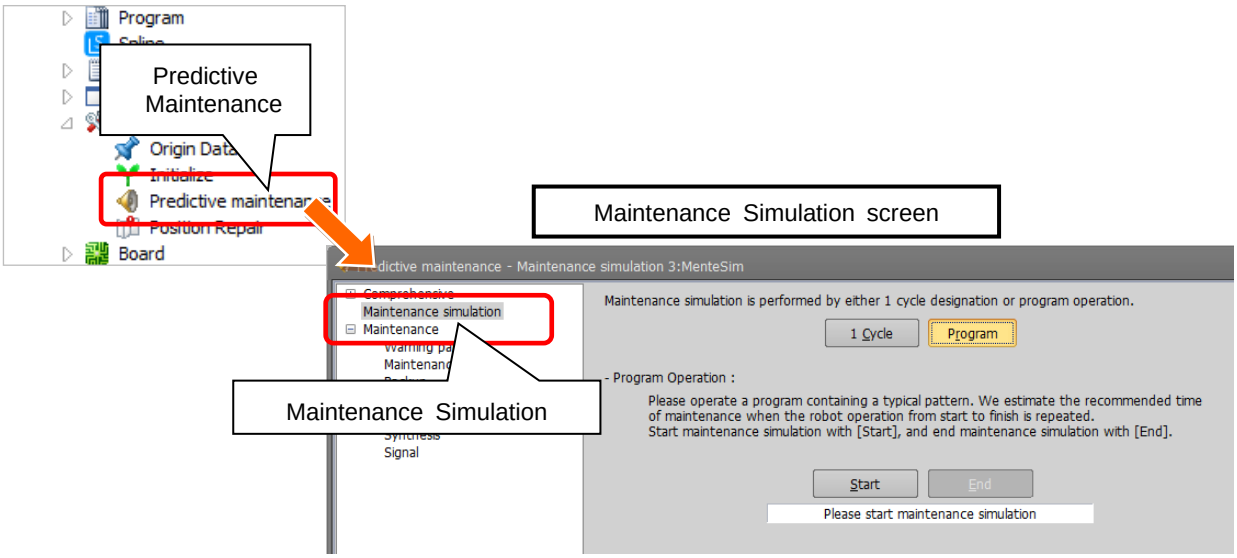
Immediately after starting RT ToolBox3, when performing 1 Cycle operation after the robot is changed to an arbitrary posture using the JOG operation or the program is paused while running, move the current position of the robot to the start position of 1 Cycle operation. Example moving methods of the current position of the robot are described below.

- Use direct execution to move the robot to the operation start position.
- Use step operation to execute up to the start line of 1 Cycle operation.
- Execute 1 Cycle operation once (Step 2 to Step 7) and use the maintenance simulation results of the second and subsequent time.



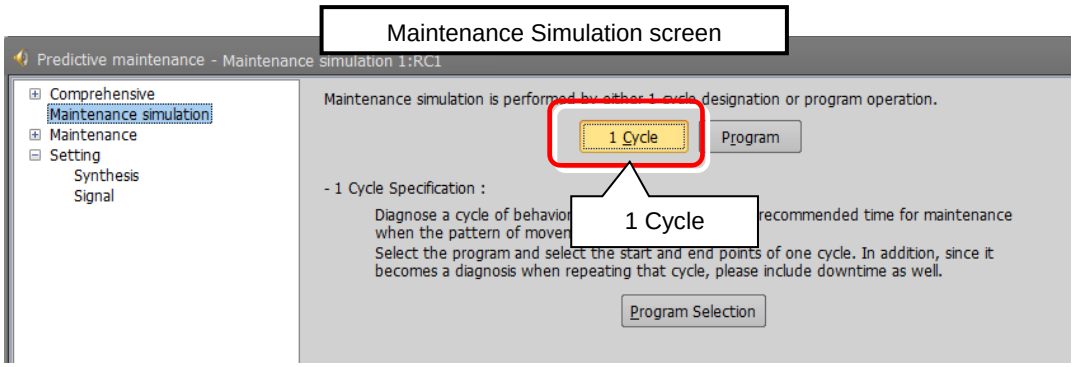
2 Open the Maintenance Simulation screen.

1) Start RT ToolBox3 where the MELFA Smart Plus card function code is set.
2) Open the RT ToolBox3 project using <Simulation>.
3) From the RT ToolBox3 project tree, click [Maintenance] - [Predictive Maintenance].
4) From the predictive maintenance tree, select [Maintenance Simulation].



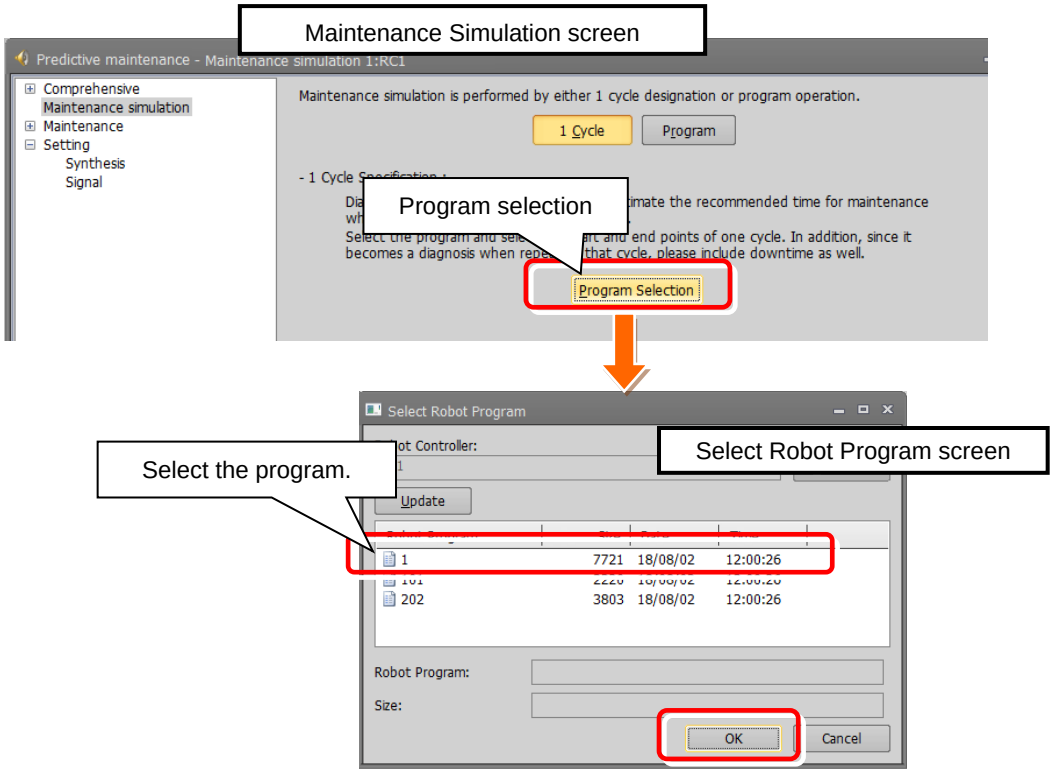
3 Select "1 Cycle".

1) Select "1 Cycle" on the Maintenance Simulation screen.

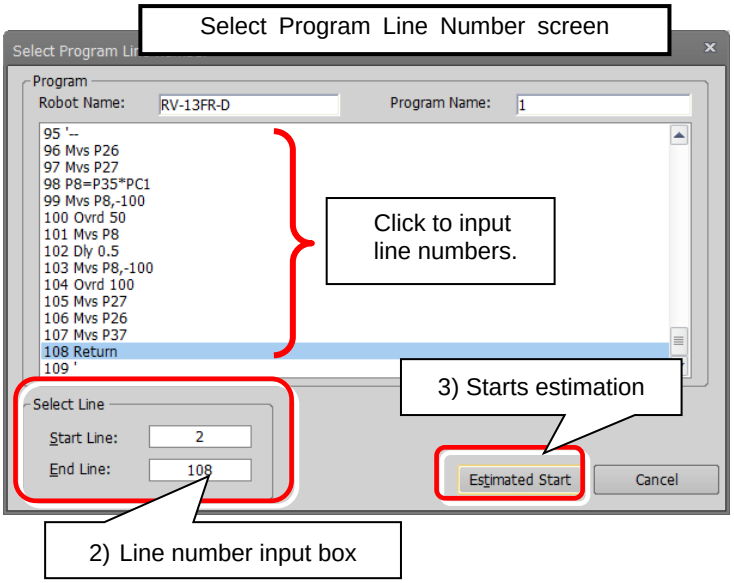


4 Select the execution program.

1) Click [Program Selection] on the Maintenance Simulation screen.
2) The "Select Robot Program" screen opens; select the program to run the simulation and click the "OK" button.



5 Select the start line and end line of the program.



1) The Select Program Line Number screen appears.
2) Select the start line and end line.

<Selection method>
Enter the line number in the input box at the right side of Start Line and End Line.
Also, when you click a program line, that line number is entered in the input box.

3) Clicking the "Estimated Start" button starts the maintenance simulation.

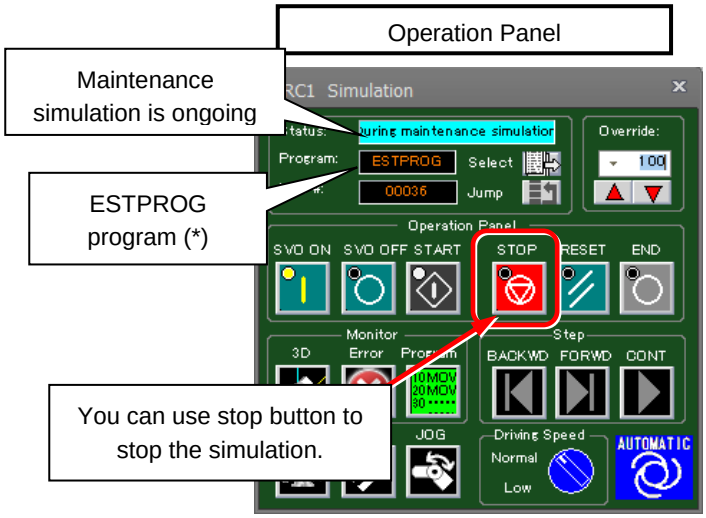
(*1) If the start line number is greater than the end line number, an error message is displayed.
(*2) If an error occurred while the maintenance simulation is running, an error message is displayed. After resetting the error, execute Step 1 to adjust the robot posture to the start posture and then execute again from Step 3.

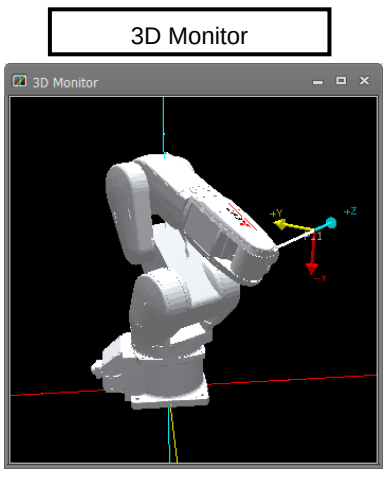
Caution Include all instructions required for 1 Cycle operation in the line selection range. (Refer to "Note on 1 Cycle operation".)

6 Robot program is executed.

1) The status of the operating panel indicates "During maintenance simulation", and the robot program is indicated as "ESTPROG(*)", and 1 cycle from the start line and end line specified on the Select Program Line Number screen is executed. You can check operation of the robot on the 3D monitor.
2) To stop the maintenance simulation halfway through, press the "STOP" button on the operating panel. The running program stops and the maintenance simulation is stopped.

(*) The program that is automatically generated when 1 Cycle operation is executed. After 1 cycle operation, you can delete this program if it is unnecessary.





7 The simulation results are displayed.

The simulation results are displayed when operation from the start line to end line specified in Step 5 is repeated.

1) When program operation ends, the maintenance simulation results are displayed.
   The displayed results are estimated results based on the value of "Operation Time of a Day" and "Working Days in a Month".

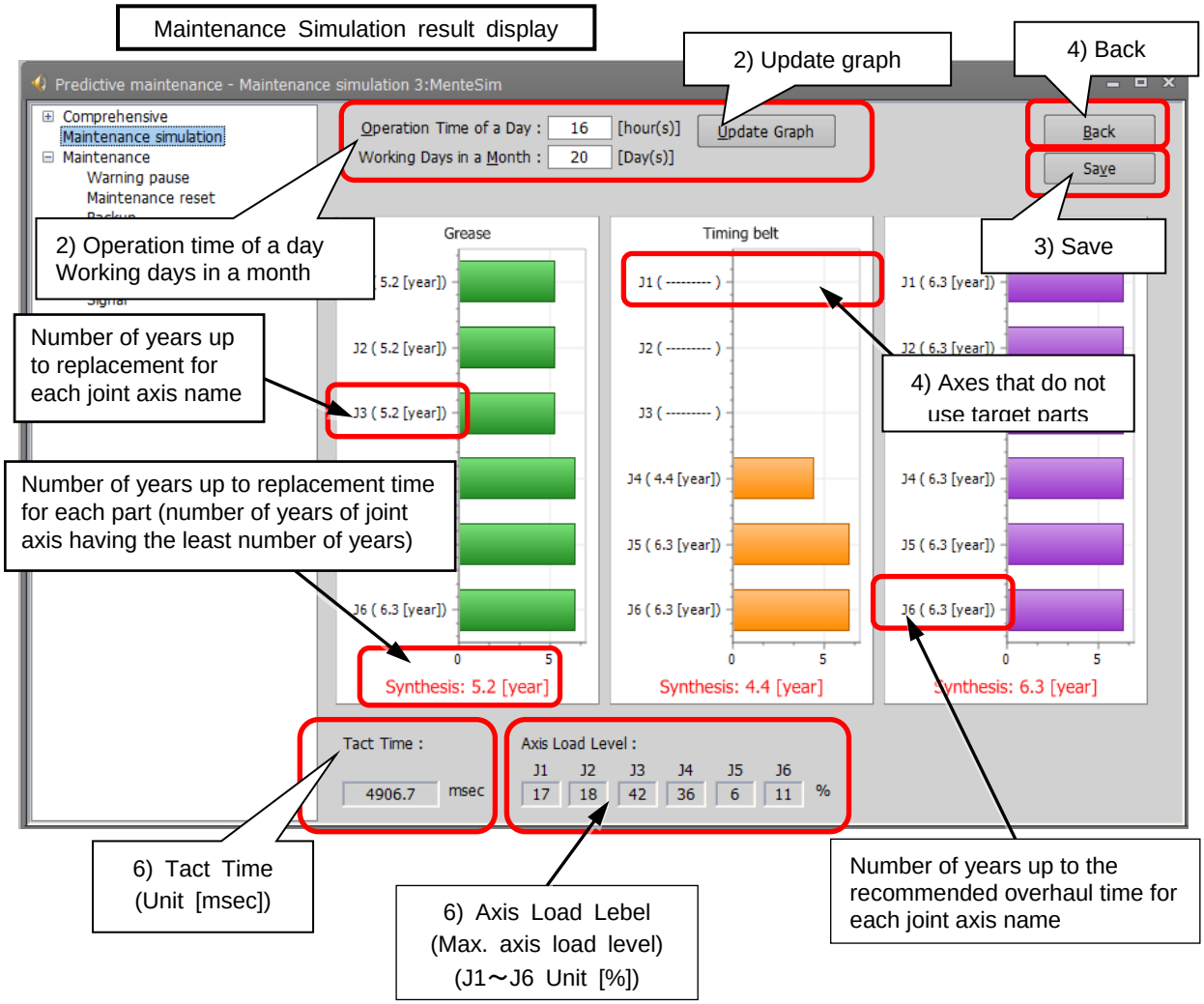
2) After changing the value of "Operation Time of a Day" and "Working Days in a Month", click the "Update Graph" button. The simulation results recalculated by the changed conditions are displayed.

3) When you click the “Save” button ,output maintenance simulation results in the CSV format.
   *Storage destination and file name of the CSV file
   Storage destination: [Folder for workspace]¥[Project name]¥Maintenance¥PMLog
   File name: [SimulationDataYYYYMMD-HHMMSS].csv

4) Click the "Retry" button to return to the initial screen of maintenance simulation.

5) The graph and the number of years are not displayed for joint axes that do not use the target parts.

6) The operation time (unit: msec) of "1 Cycle operation" and the axis load level (unit: %) are displayed.



The number of years up to the replacement time of grease and the timing belt are displayed. Also, for overhaul parts, of the reduction gear, bearing, ball screw/ball spline, the number of years of the part having the least years are displayed for each joint axis.

⚠Caution

[Tact time calculation]

- The calculated tact time varies with the performance and load status of the computer used and will not completely match the actual robot operating time (tact time).
- Use this function as a rough yardstick for tact time study.
  Under correct conditions, the results of tact time calculation with this software have an error of about ±3% compared to the actual robot operating time (tact time).

⚠Caution

[Axis load level calculation]

- The axis load level numerically expresses the motor load.
- The robot will generate an overload error and stops protecting the motor when the axis load level exceeds 100%.The calculated axis load level assumes multiple iterations of the same operation.

  However, be aware that stop will not occur in simulation even if the load level exceeds 100%.
- There is a possibility that continuous operation will not be possible in an actual robot when the calculated axis load level is high. You should lower the operation frequency with the Dly command, and lower operation speed and the acceleration with the Accel and the Ovrd commands, etc. Changing the operation point may lower the operation point.
- Complete agreement with the calculated axis load level cannot be guaranteed because the axis load level of an actual robot is influenced in robot individual differences, the ambient temperature, the condition of the robot, etc. Use this function as a rough yardstick for studying robot movement.

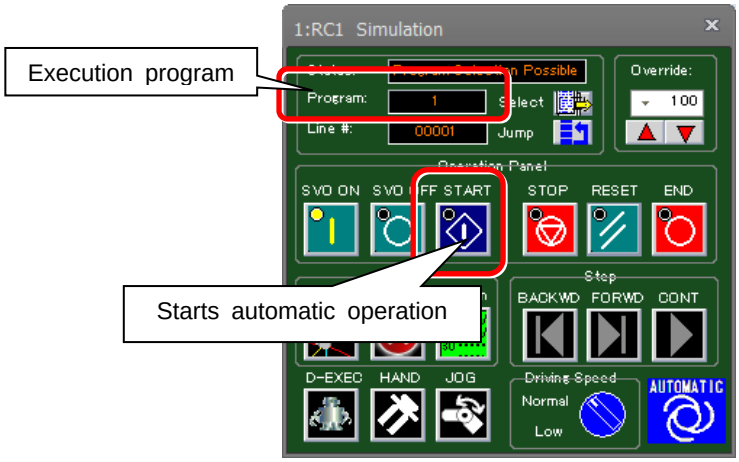
9.2. Program operation

Run a program online or in the simulation mode of RT ToolBox3.

While running a robot program automatically, the pats replacement/ the recommended maintenance time is estimated for operation from when the start button is pressed to when the end button is pressed is repeated.

1 Perform automatic operation for the program.

1) Automatically run the program that performs maintenance simulation.

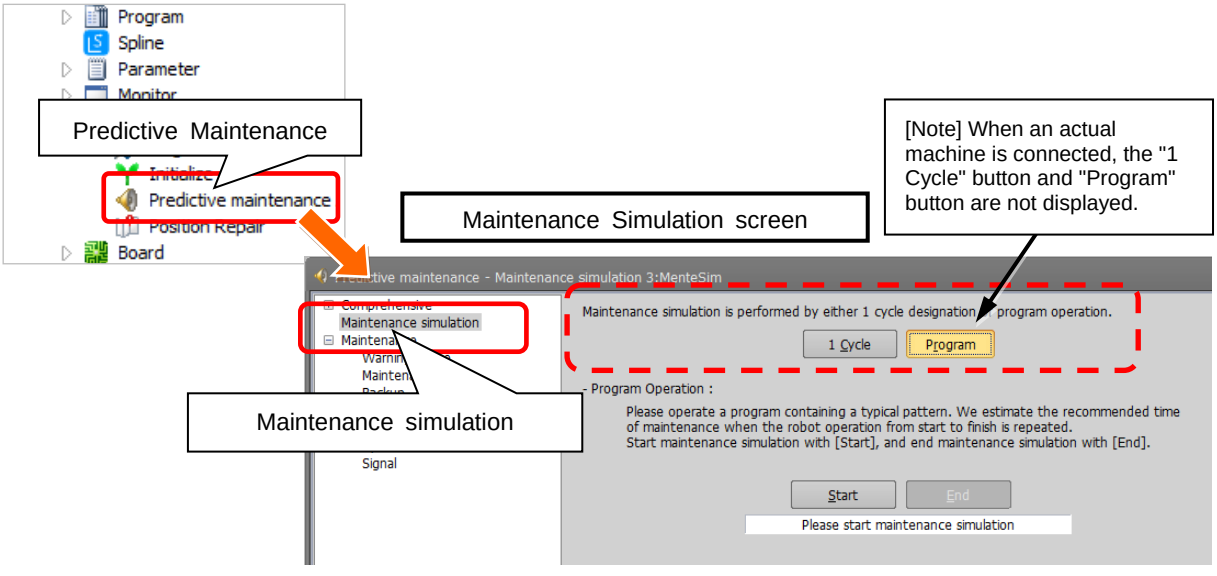


2 Open the Maintenance Simulation screen.

1) While automatically running the program that performs maintenance simulation, from the RT ToolBox3 project tree, click [Maintenance] - [Predictive Maintenance] to start.

2) From the predictive maintenance tree, select [Maintenance Simulation].

[Note] When an actual machine is connected, the "1 Cycle" button and "Program" button are not displayed.

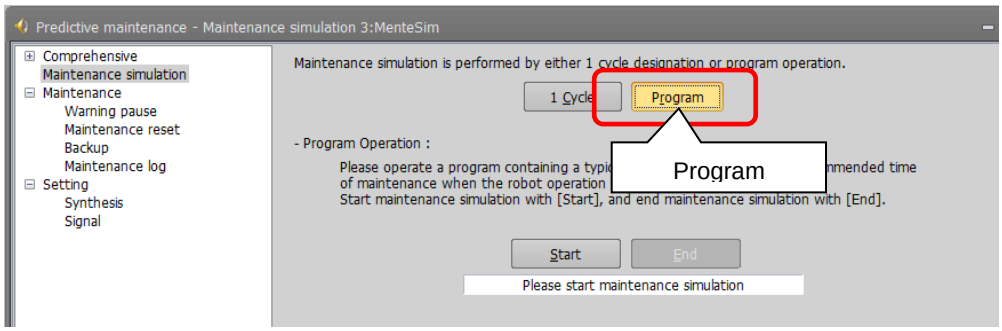


3 Select the "Program" for the estimation method. (Simulation only)

1) When running a program in simulation mode, select "Program" on the Maintenance Simulation screen.

[Note] When an actual machine is connected, the "1 Cycle" button and "Program" button are not displayed.

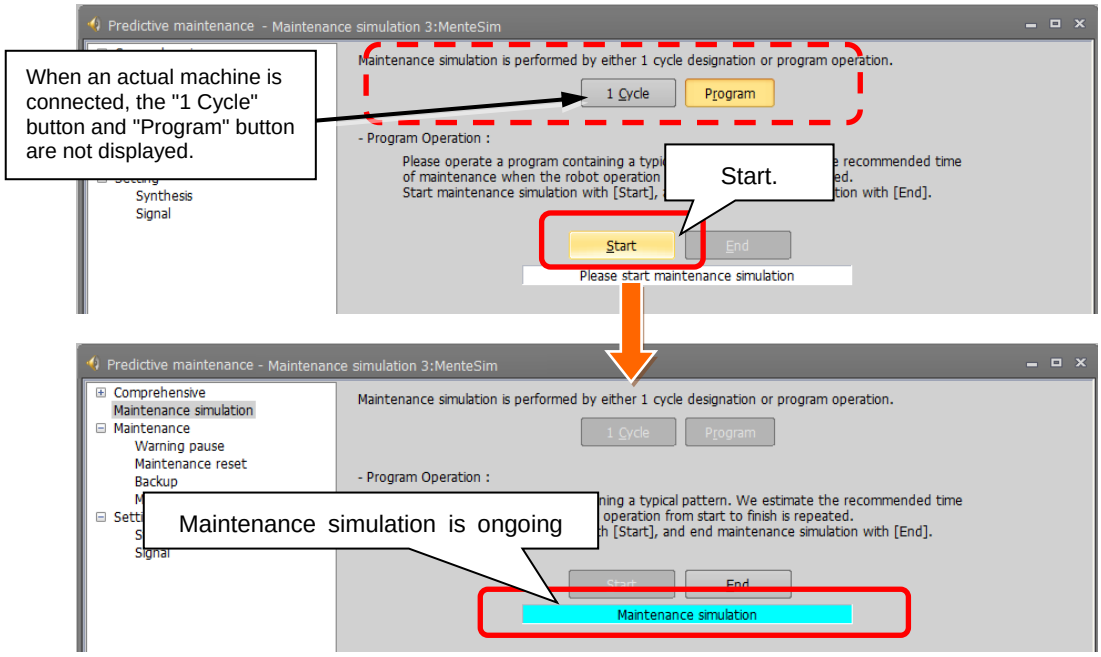
Maintenance Simulation screen



4 Start maintenance simulation.

1) Clicking the "Start" button on the Maintenance Simulation screen starts maintenance simulation. During simulation, a "During maintenance simulation" message is displayed under the Start button.

Maintenance Simulation screen



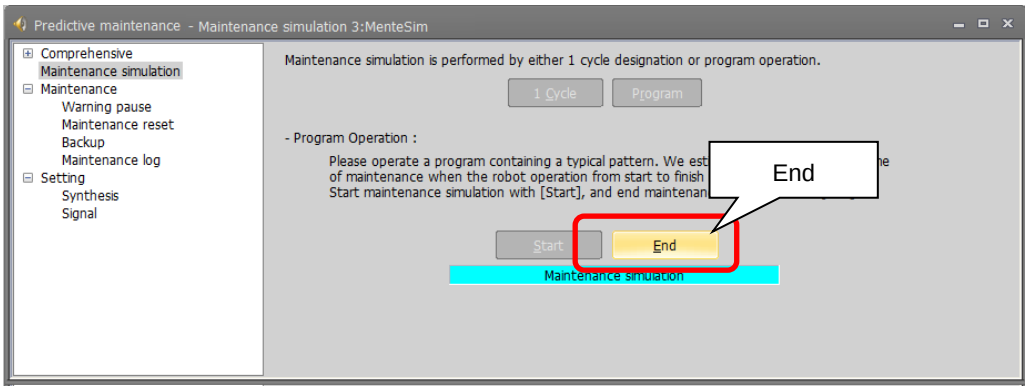
On the operation panel, "Operating" is displayed for Status and the currently running program name is displayed for Program.

In case of simulation mode, robot motion can be checked on the 3D monitor.

5 End the maintenance simulation.

1) When a series of operations for performing maintenance simulation have been executed, click the "End" button on the Maintenance Simulation screen.
The maintenance simulation ends and the Maintenance Simulation result screen appears.
(Even though the "End" button is clicked, the robot continues operation.)

Maintenance Simulation screen



6 The simulation results are displayed.

The maintenance simulation result displayed is when the operation from clicking the "Start" button in Step 4 to clicking the "End" button in Step 5 is repeated.

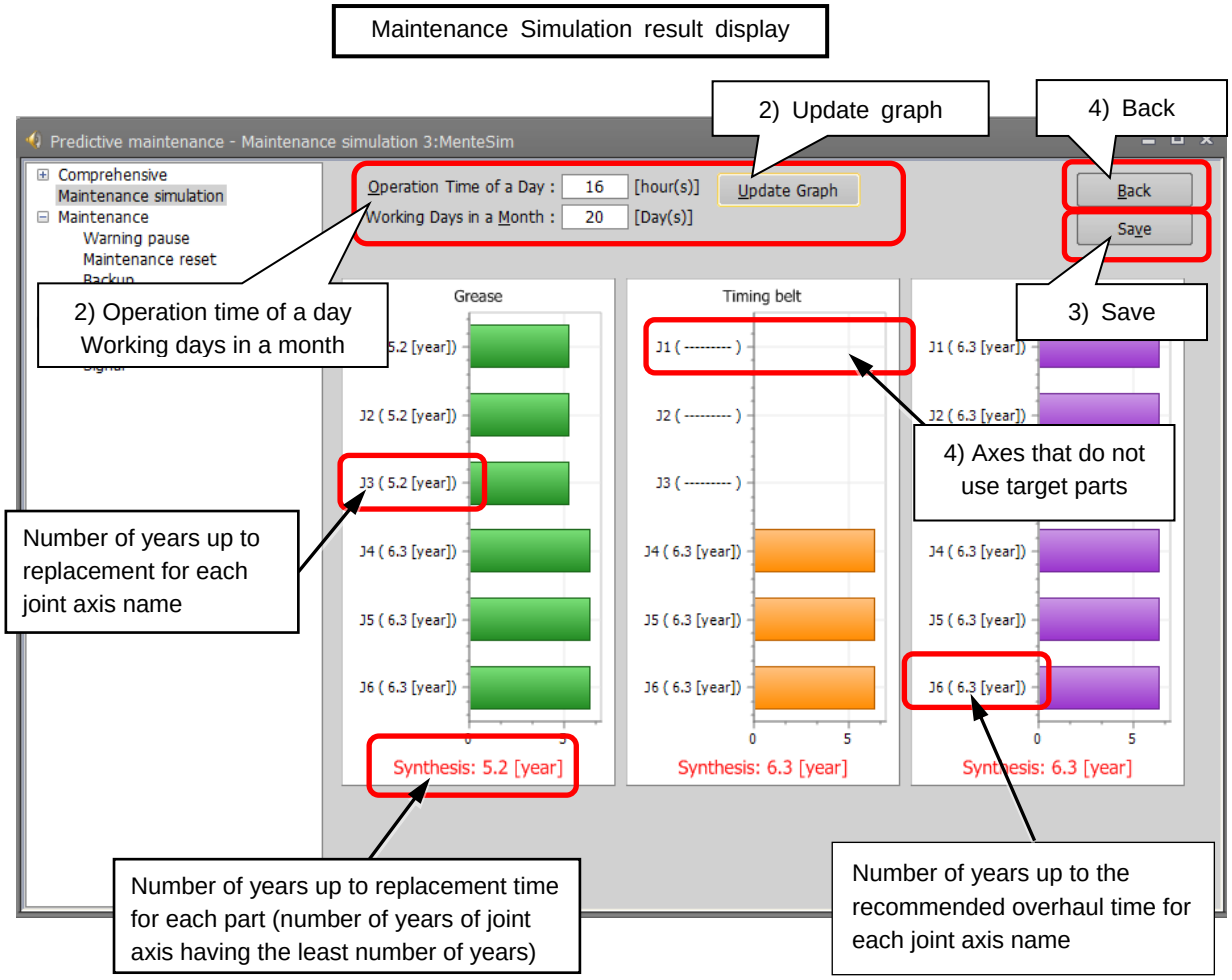
1) When program operation ends, the maintenance simulation results are displayed.
   The displayed results are estimated results based on the value of "Operation Time of a Day" and "Working Days in a Month".

2) After changing the value of "Operation Time of a Day" and "Working Days in a Month", click the "Update Graph" button. The simulation results recalculated by the changed conditions are displayed.

3) When you click the “Save” button ,output maintenance simulation results in the CSV format.
   *Storage destination and file name of the CSV file
   Storage destination: [Folder for workspace]¥[Project name]¥Maintenance¥PMLog
   File name: [SimulationDataYYYYMMD-HHMMSS].csv

4) Click the "Retry" button to return to the initial screen of maintenance simulation.

5) The graph and the number of years are not displayed for joint axes that do not use the target parts.



The number of years up to the replacement time of grease and the timing belt are displayed. Also, for overhaul parts, of the reduction gear, bearing, ball screw/ball spline, the number of years of the part having the least years are displayed for each joint axis.

10. When consumption occurred/abnormality detected

When the consumption status of the target part exceeded the notification day you specified or when the score of the abnormality detection exceeded the detection level, an error number and error message corresponding to the status are displayed. Predictive maintenance message is also displayed in the maintenance message field on the RT ToolBox3 Predictive maintenance screen.

This section explains the content and measures corresponding to each error number and predictive maintenance message; take measures corresponding to the error number and predictive maintenance message given.

For other error numbers, refer to “16. Troubleshooting” and the separate "Troubleshooting in CR800 Series Controller Instruction Manual".

[CAUTION]
For a warning that occurred due to parts consumption, even though the warning signal output is reset, the RT ToolBox3 predictive maintenance message continues to be displayed if the consumption status or abnormal status is unchanged.

10.1. Consumption Degree

10.1.1. Maintenance parts

(1) Grease (* n in the table indicates the axis numbers (1 to 6).)

Error number	C.712n
Error message	Grease replenishment period
RT ToolBox3 predictive maintenance message	The grease (Jn axis) consumption degree exceeded the warning number of days remaining. Please check the details and prepare for grease supply.
Measures	Replenish grease. After that, reset the consumption degree. For details of the grease and replenishing procedure, refer to "5. Maintenance and Inspection" in the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance". For reset method, refer to "11.2 Maintenance Reset".

Error number	C.712n
Error message	Grease replenishment period
RT ToolBox3 predictive maintenance message	The grease (Jn axis) consumption degree exceeded 100%. Grease supply is recommended.
Measures	Replenish grease. After that, reset the consumption degree. For details of the grease and replenishing procedure, refer to "5. Maintenance and Inspection" in the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance". For reset method, refer to "11.2 Maintenance Reset".

(2) Timing belt

Error number	C.713n
Error message	Timing belt replacement period
RT ToolBox3 predictive maintenance message	The timing belt (Jn axis) consumption degree exceeded the warning number of days remaining. Please check the details and prepare for timing belt replacement.
Measures	Replace the timing belt. After that, reset the consumption degree. For details of the timing belt and replacement procedure, refer to "5. Maintenance and Inspection" in the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance". For reset method, refer to "11.2 Maintenance Reset"..

Error number	C.713n
Error message	Timing belt replacement period
RT ToolBox3 predictive maintenance message	The timing belt (Jn axis) consumption degree exceeded 100%. Timing belt replacement is recommended.
Measures	Replace the timing belt. After that, reset the consumption degree. For details of the timing belt and replacement procedure, refer to "5. Maintenance and Inspection" in the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance". For reset method, refer to "11.2 Maintenance Reset".

10.1.2. Overhaul parts

(1) Reduction gear (* n in the table indicates the axis numbers (1 to 6).

Error number	C.714n
Error message	Overhaul period (decelerator)
RT ToolBox3 predictive maintenance message	The gear (Jn axis) consumption degree exceeded the warning number of days remaining. Please check the details and prepare for overhaul.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. When overhaul is performed, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Error number	C.714n
Error message	Overhaul period (decelerator)
RT ToolBox3 predictive maintenance message	The gear (Jn axis) consumption degree exceeded 100%. Overhaul is recommended.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, perform reset. For reset method, refer to "11.2 Maintenance Reset".

(2) Bearing

Error number	C.715n
Error message	Overhaul period (bearing)
RT ToolBox3 predictive maintenance message	The bearing (Jn axis) consumption degree exceeded the warning number of days remaining. Please check the details and prepare for overhaul.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. When overhaul is performed, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Error number	C.715n
Error message	Overhaul period (bearing)
RT ToolBox3 predictive maintenance message	The bearing (Jn axis) consumption degree exceeded 100%. Overhaul is recommended.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, perform reset. For reset method, refer to "11.2 Maintenance Reset".

(3) Ball screw

Error number	C.716n
Error message	Overhaul period (ball screw)
RT ToolBox3 predictive maintenance message	The ball screw (Jn axis) consumption degree exceeded the warning number of days remaining. Please check the details and prepare for overhaul.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, reset the consumption degree. For reset method, refer to "11.2 Maintenance Reset".

Error number	C.716n
Error message	Overhaul period (ball screw)
RT ToolBox3 predictive maintenance message	The ball screw (Jn axis) consumption degree exceeded 100%. Overhaul is recommended.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, reset the consumption degree. For reset method, refer to "11.2 Maintenance Reset".

10.1.3. Servo ON time

(* n in the table indicates the axis numbers (1 to 6).

Error number	C.7110
Error message	Overhaul period (servo on time)
RT ToolBox3 predictive maintenance message	The servo on time exceeded the warning number of days remaining. Please check the details and prepare for overhaul.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Error number	C.7110
Error message	Overhaul period (servo on time)
RT ToolBox3 predictive maintenance message	The servo on time exceeded recommended overhaul time. Overhaul is recommended.
Measures	Perform overhaul of the robot body. For selection of replacement parts and overhaul implementation timing, consult with our service affiliated company. After overhaul, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Caution When the servo ON time exceeds the specified time (24,000 hours) or the consumption degree exceeds the warning remaining number of days, we recommend you perform overhaul of the robot arm.

10.2. Abnormality detection

10.2.1. Reduction gear

(* n in the table indicates the axis numbers (1 to 6).)

Error number	C.717n
Error message	Abnormality detection (reduction gear)
RT ToolBox3 predictive maintenance message	The warning of the reduction gear (Jn axis) failure was detected. Check the details and perform maintenance and inspection of reduction gear.
Measures	Immediately perform inspection or replacement of the reduction gear.Note1 For inspection/replacement of parts, consult with our service affiliated company. If you replace a part, perform reset. For reset method, refer to "11.2 Maintenance Reset".

10.2.2. Encoder

Error number	C.718n
Error message	Abnormality detection (encoder data)
RT ToolBox3 predictive maintenance message	The warning of the encorder data (Jn axis) failure was detected. Check the details and perform maintenance and inspection of encorder data.
Measures	Immediately perform inspection or replacement of the motor/wiring. Note1 For inspection/replacement of parts, consult with our service affiliated company. If you replace a part, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Error number	C.719n
Error message	Abnormality detection (encoder com.)
RT ToolBox3 predictive maintenance message	The warning of the encorder communication (Jn axis) failure was detected. Check the details and perform maintenance and inspection of encorder communication.
Measures	Immediately perform inspection or replacement of the motor/wiring. Note1 For inspection/replacement of parts, consult with our service affiliated company. If you replace a part, perform reset. For reset method, refer to "11.2 Maintenance Reset".

Note 1) About abnormality detection

Abnormalities could be detected due to the following factors.

1) The setting of the detection level has no margin or the setting value is not appropriate.
2) Due to operating environment.
   • The robot installation location or robot motion was changed.
   • Effect of vibration around the robot or electric noise.

If the above factors are not considered as the cause, check the change in the score of the log on the Abnormality Detection screen or the current status from the oscillograph.

10.2.3. Battery

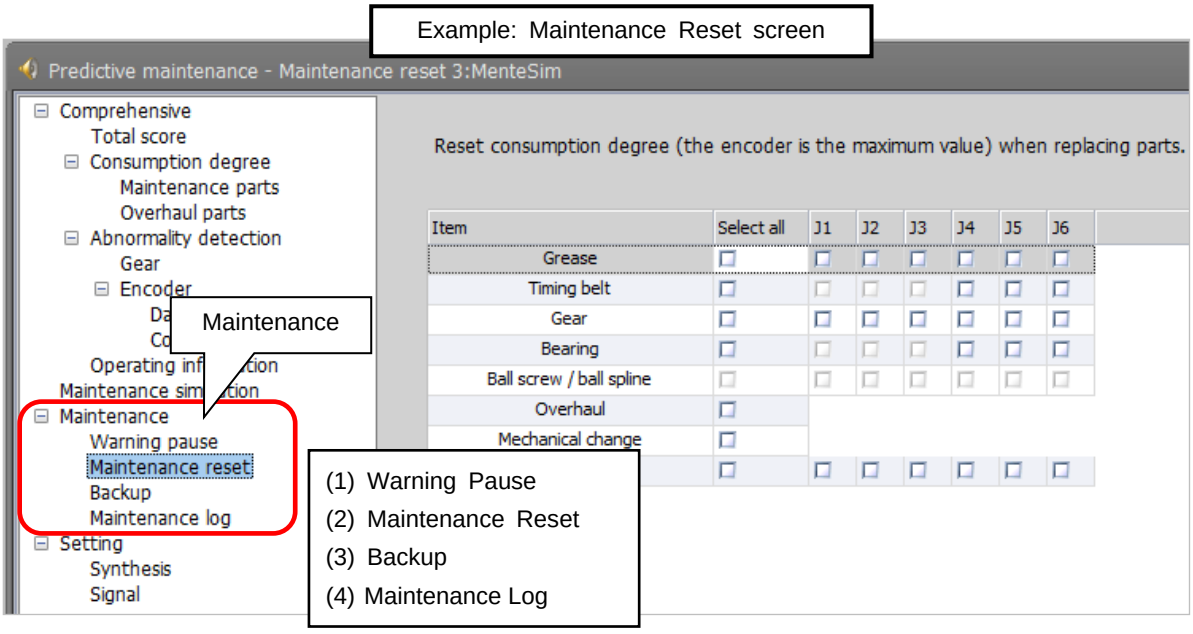
Error number	C.7510
Error message	Battery voltage low (robot)
RT ToolBox3 predictive maintenance message	Battery voltage is low. Early battery replacement is recommended.
Measures	Replace the battery as soon as possible. For the battery replacement procedure and home position setting procedure, refer to the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance".

Error number	C.7500
Error message	No battery voltage (robot)
RT ToolBox3 predictive maintenance message	Battery voltage outage detected. Please replace the battery immediately. If the power is turned on again without replacing the battery, the absolute position data of the encoder may be lost.
Measures	Replace the battery as soon as possible. When the home position has been lost, perform the home position setting. For the battery replacement procedure and home position setting procedure, refer to the separate volume, "Instruction Manual/Robot Arm Setup & Maintenance".

11. Maintenance

On the maintenance screen, you can reset the consumption degree, or can specify backup/restore and pausing of warning occurrence/warning signal output during maintenance. In addition, you can check the maintenance log.

1) Start predictive maintenance.
2) Click [Maintenance] to expand the menu; the maintenance functions are displayed.
3) Click [Warning Pause], [Maintenance Reset], [Backup], or [Maintenance Log], to switch the main screen.



1) Warning Pause : Displays the warning occurred/list of warning signals being output. Specify pausing of notifications (alarm, dedicated output signal).

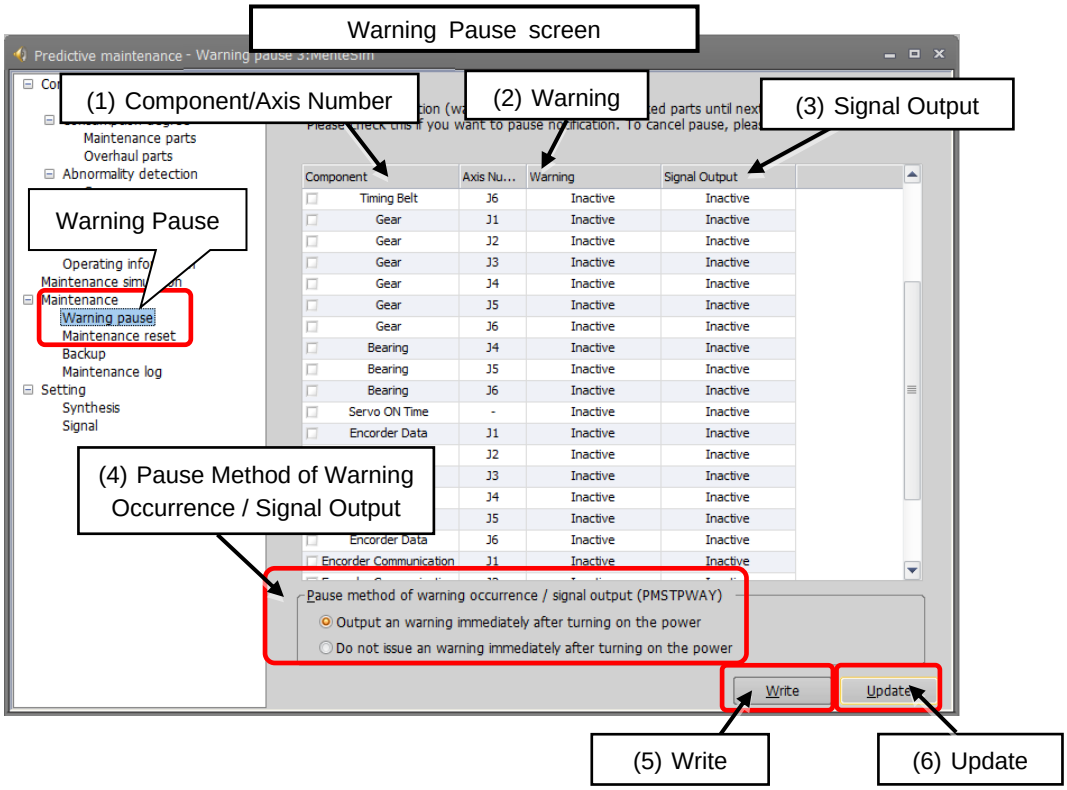
2) Maintenance Reset : Resets (clears) the accumulation data related to consumption degree and score.

3) Backup : Performs backup/restore when migrating the predictive maintenance data to a different controller.

4) Maintenance Log : Displays the maintenance log recorded during executing maintenance reset.

11.1. Warning Pause

Displays the list of warning and warning signals that are occurring or paused.
Usually, the alarm of consumption degree calculation is notified at the intervals you set.
If you desire to stop notification (alarm, dedicated output signal), you can temporarily disable at this stage.
Note that the alarm of abnormality detection cannot be reset while it exceeds the notification level.



1) Component/Axis Number:
Indicates the parts and axes currently under warning.

2) Warning:
Indicates either occurring or pause.
Select this check box to pause. Deselect this check box to cancel pause.

3) Signal Output:
Indicates either occurring or pause.
Select this check box to pause. Deselect this check box to cancel pause.

4) Pause Method of Warning Occurrence / Signal Output:
Set the pause method of warning occurrence.

5) Write:
Writes the content of the selected item.
You can temporarily disable notification related to consumption degree calculation until part replacement (reset of consumption degree).
You can also temporarily disable notification related to abnormality detection.

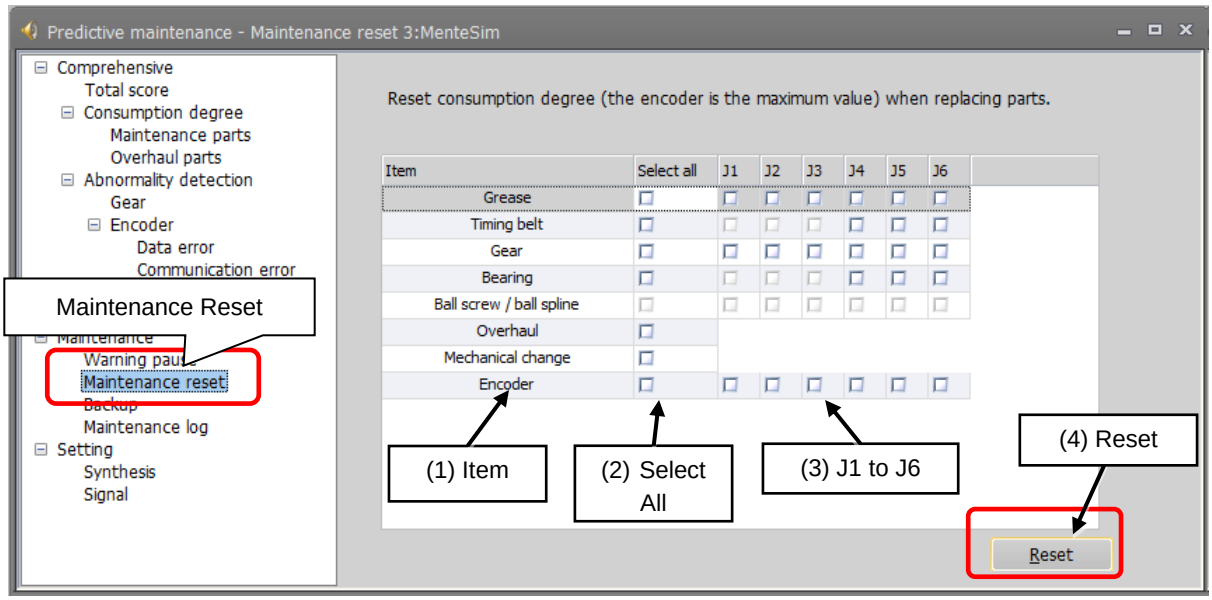
6) Update:
Updates the screen display.

Caution Even though you set pause of warning occurrence or signal output, already occurred warnings and warning signals are not reset.
Use the error reset operation from the teaching pendant or inputting error reset signal (ERRRESET) to reset those warnings and signals.

11.2. Maintenance Reset

When part replacement, grease replenishing, or overhaul was performed, the information of the axes for which maintenance was performed accumulated in the controller needs to be reset.

On the Maintenance Reset screen, you can reset the information held by the controller such as the consumption degrees calculated by the consumption degree calculation function or the information related to score calculated by the abnormality detection function.



1) Item: Displays parts subject to reset.

2) Select All: Selecting this check box selects all [J1] to [J6] check boxes on the right field.

3) J1 to J6: Depending on the robot type, non-target axes are not selected.

4) Reset: Resets the consumption degree of the items you have selected.

Item	Implementation timing	Reset target
Grease	At grease replenishing	• Accumulated data for consumption degree calculation of the specified joint axis • Score of the reduction gear abnormality detection of the specified joint axis Note 1)
Timing belt	At part replacement	
Reduction gear		
Bearing		
Ball screw/ball spline		
Overhaul	At overhaul	• Accumulated data of all parts, operating information (integration time and accumulation count) • Score of abnormality detection of all parts
Mechanism replacement	At replacement of robot body	
Encoder	At replacement of motor	Score of the encoder abnormality detection of the specified joint axis (Encoder data, Encoder communication)

Note 1) Since the averaging filter is used for the score of the reduction gear abnormality detection, the score is reset at maintenance reset (part replacement). Once the robot starts operating, the value gradually becomes the converged value.

Caution

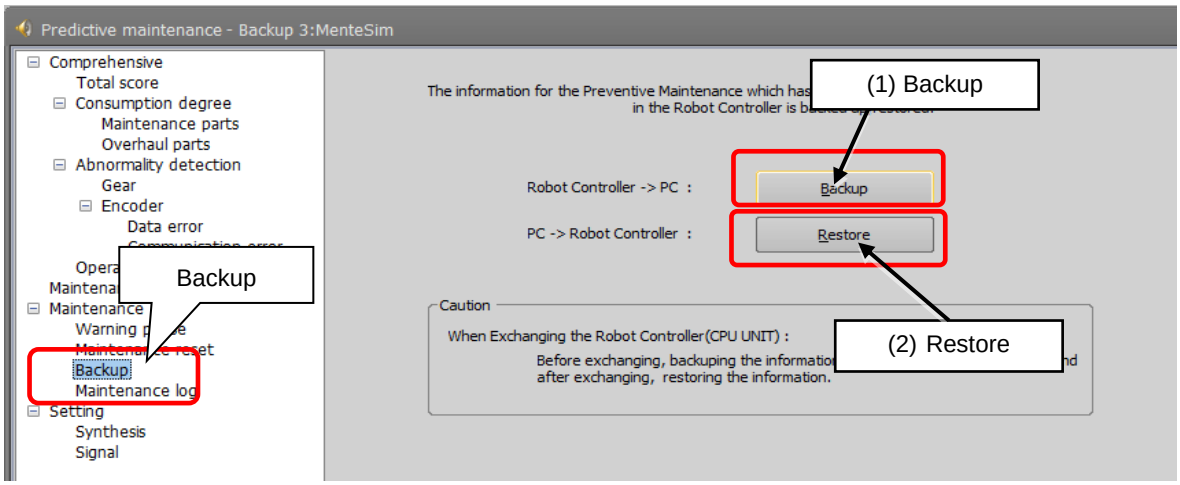
- Once maintenance reset is executed, the accumulated data before that cannot be restored.
- Perform maintenance reset only when maintenance such as part replacement, grease replenishing, overhaul was carried out.

11.3. Backup and restore

You can back up or restore predictive maintenance information held in the controller.

To replace the robot body or robot controller only, you need to perform backup/restore of the predictive maintenance information to migrate the predictive maintenance information.
For backup/restore of the predictive maintenance information, click [Maintenance] - [Backup] of the predictive maintenance function.

- Replacing the robot controller
  When replacing the controller, back up the predictive maintenance information from the previous controller and restore it in the new controller.
- Exchanging the combination of robot controller and mechanism (between the same models)
  When exchanging the combination of controller and mechanism between the same models, before implementation, back up the predictive maintenance information of the respective controllers and after implementation restore the information to the replaced controllers.



1) Backup: Save the predictive maintenance information in the robot controller to a file on a personal computer.

2) Restore: Transfer the information backed up on the personal computer to the robot controller.

Caution

- The predictive maintenance information of the robot body is saved in the robot controller; it is necessary to use the correct combination of the robot body and robot controller.
  To replace the robot body or robot controller only, perform backup/restore of predictive maintenance information to migrate the predictive maintenance information.
- In order to prevent writing backup data to a different robot, an error (H.7101) occurs when the serial number of the robot is different from the backup data value when restoring.
- When the serial number of the connected robot was changed, an error (H.7100) is output upon power on to notify that effect in order to prevent the occurrence of unmatched predictive maintenance information when exchanging robot.
- When there is no backup data, all consumption degrees can be reset by performing mechanism replacement of maintenance reset. However, in that case, the consumption degree calculation result cannot be the correct value. (Refer to "11.2 Maintenance Reset".)
- After replacing the robot controller, if you did not restore the predictive maintenance information or if you restored it a long time after backup was performed, the consumption degree calculation result cannot be the correct value.
- Perform backup/restore between robot controllers having the same software version. If the version is different, there is a possibility an error may occur when restoring.

11.3.1. Backup (robot → personal computer)

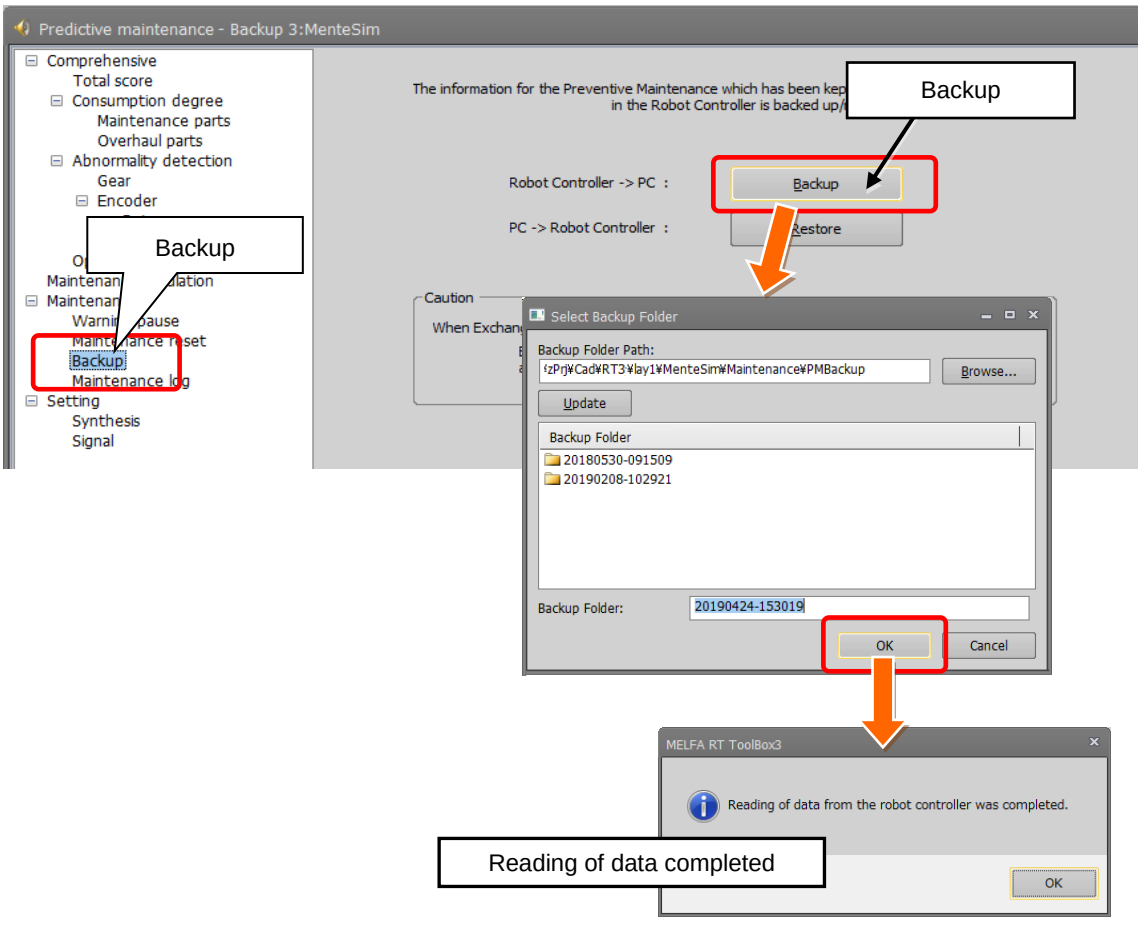
Save the predictive maintenance information in the robot controller to a file on a personal computer.

When clicking the [Backup] button, a time stamp folder (folder name: "YYmmdd-HHMMSS") is automatically created in the [Maintenance] - [PMBackup] folder directly under the project and the backup data is saved in that folder. Backup (robot □ personal computer)

The following describes how to back up predictive maintenance information.

1 Create a backup file for predictive maintenance information.

1) Start predictive maintenance.
2) Click [Maintenance] - [Backup].
3) When you click Backup on the main screen, the “Select Backup Folder” screen opens, and click the "OK" button.
   Storage destination and the folder name of the backup data
   Storage destination：[Folder for workspace]¥[Project name]¥Maintenance¥PMLog
   Folder name：[YYYYMMDD-HHMMSS]
   (The storage destination and the folder name can be changed.)
4) After a while, a message indicating the end of data read is displayed.



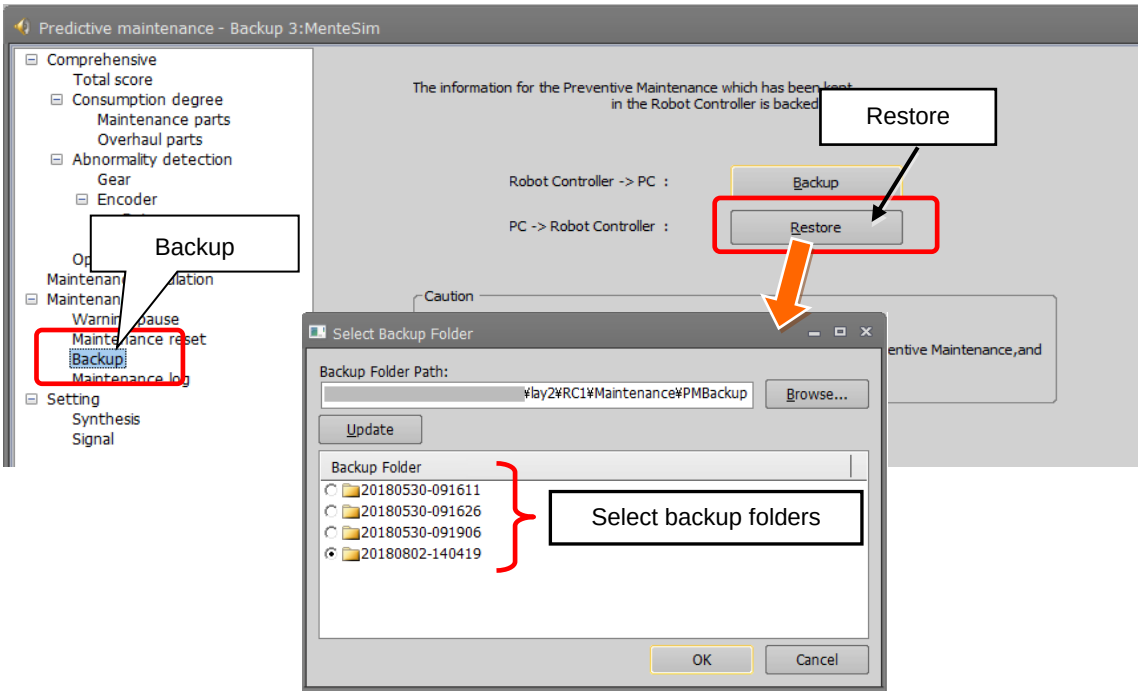
11.3.2. Restore (personal computer → robot)

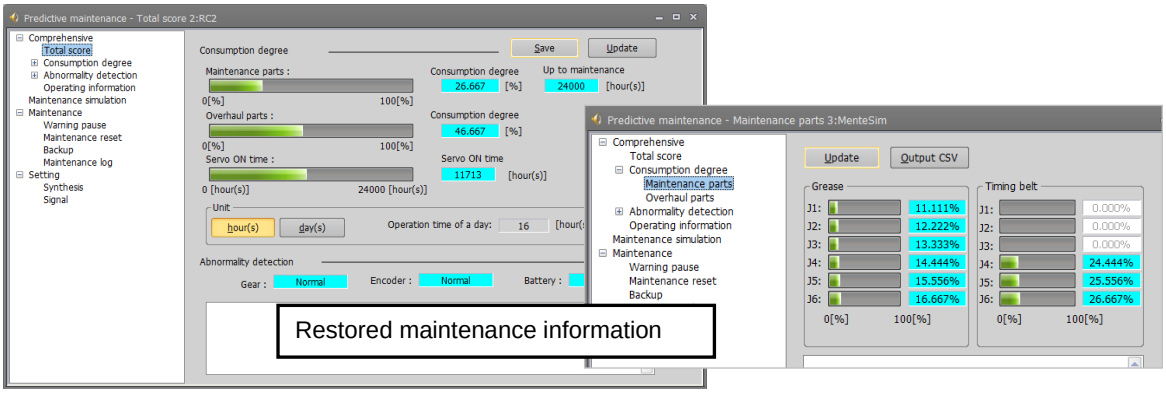
Transfer the information backed up on the personal computer to the robot controller.
To restore predictive maintenance information, from the folder selection dialog box, select the folder you wish to restore.
If there is missing backup data, an error message is displayed and restore is interrupted.

The following describes how to restore predictive maintenance information.

1 Restore predictive maintenance information.

1) Start predictive maintenance.
2) Click [Maintenance] - [Backup].
3) When "Restore" is clicked on the main screen, the "Select Backup Folder" appears.
4) Use the "Browse" button to specify the location of the backup folder.
5) The backup folder is displayed on the screen; select the folders you wish to restore and then press the [OK] button.
6) From the tree on the left side, when you select Total Score, Abnormality Detection, Consumption Degree, or other predictive maintenance functions, the restored information is displayed on the main screen.





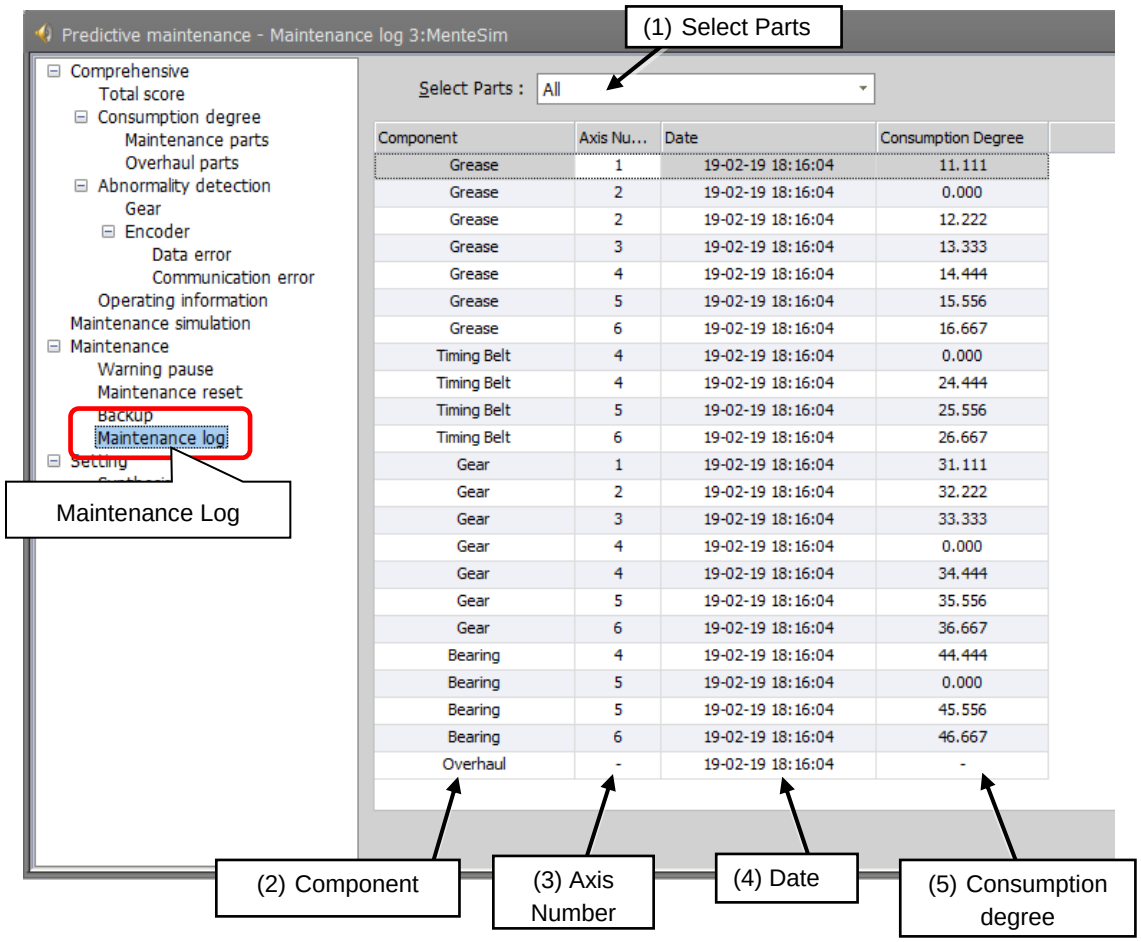
11.4. Maintenance Log

Display the recorded maintenance log.

11.4.1. Maintenance Log screen

The predictive maintenance function stores 10 maintenance log items of the past.
Upon executing maintenance reset, item, date & time, consumption degree [%] and accumulation count are recorded.
On the Maintenance Log screen, the recorded log is displayed.

Log targets: Grease, timing belt, reduction gear, bearing, ball screw, overhaul



1) Select Parts
Select items for which a log is displayed.
(All, Grease, Timing Belt, Gear, Bearing, Ball Screw, Overhaul)

2) Component
Items selected in the Select Parts field are displayed. A maximum of 10 log items are displayed for each axis.

3) Axis Number
Displays the target axes. Displays "-" for overhaul.

4) Date
Displays the reset date & time.

5) Consumption degree
Displays consumption degree [%] at the time of reset.

11.4.2. Data to be recorded in the maintenance log

After performing grease replenishing, timing belt replacement, or robot overhaul, upon resetting the consumption degree of each part, the reset date & time, consumption degree [%] at the time of reset, and reset count are recorded in the maintenance log.

Log type	Record target	Log save count	Type of data log to be recorded
Grease	For each joint axis	For 10 times	Reset date & time, consumption degree [%] at the time of reset
Timing belt			
Reduction gear			
Bearing			
Ball screw Ball spline			
Overhaul	Robot		Reset date & time, servo ON time [h] at the time of reset Note1)
Reset (implementation) count Note1)	For each joint axis	–	Grease, timing belt, reduction gear, bearing, ball screw/ball spline, overhaul

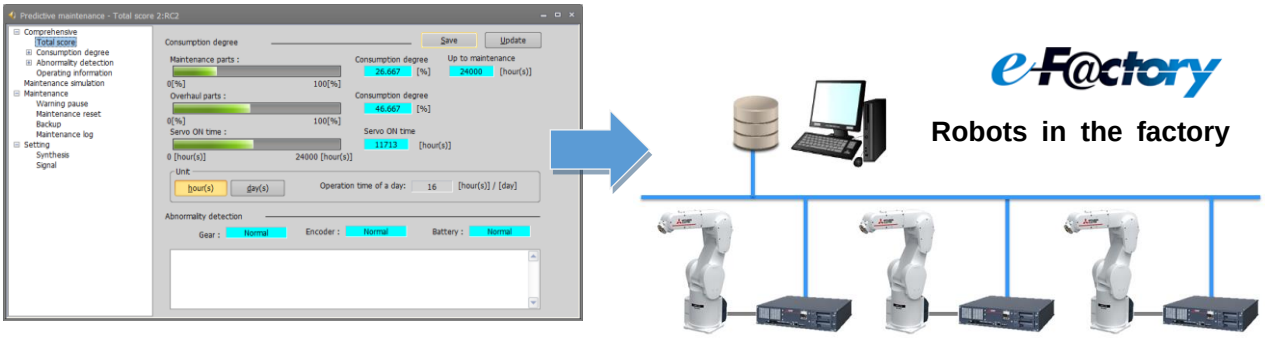
Note 1) You can check them by robot (system) status variables or parameters.

- The maintenance log of each part and the implementation log of overhaul are recorded.
- When the log save count is exceeded, the old log data is deleted first.
- In case the predictive maintenance function is disabled, a log is also recorded when reset is performed with the maintenance forecast.

<< MEMO >>

12. Batch management of maintenance information

Explains how to collectively manage maintenance information of the entire production line with the host system.



12.1. Functional overview

Maintenance information used in the predictive maintenance function is compatible with the data output in communication protocol MelfaRXM.ocx, SLMP.

By using this function to collectively manage the maintenance information of the entire production line in a host system, it is easier to plan maintenance schedules and carry out maintenance activities for the entire production line.

Use the following means to output predictive maintenance data so the maintenance information of each robot in your factory can be collectively managed. (For data to be output, refer to “12.2 Output data”.)

Communication protocol	Details	Data acquisition method
MelfaRXM.ocx	This is ActiveX control that communicates with the robot controller used when you create application software to communicate with the robot controller. The instruction manual is included in the following folder in the CD-ROM of RT ToolBox3 (Standard Version/Pro Version). Communication Middleware (MelfaRXM.ocx) Manual: [Utility¥MelfaRXM¥Doc¥MelfaRxMJ.pdf]	Specify by the dedicated request ID using the RequestService function.
SLMP	This is a common protocol for inter-application communication. Reading/writing of robot controller devices can be performed from a compatible programmable controller, personal computer or HMI (Human Machine Interface), and other devices via Ethernet. For details, refer to the following instruction manual. Separate volume, "Instruction Manual Ethernet Function".	Allocate status variables to D device (parameters DDEVVL01 to DDEVVL32)

12.2. Output data

Output data	Target	Unit	Robot status variable	Parameter
Basic data	Robot body serial number	Character string	C_RBSerial	RBSERIAL
	Power ON time	h (hours)	M_PowOnTime	TIMPOWON
	Servo ON time	h (hours)	M_SrvOnTime	TIMSRVON
	Operation time	h (hours)	M_PrgTime	TIMPRG
	Actual operation time	h (hours)	M_MovTime	TIMMOV
	Servo ON count	Times	M_SrvOnNum	NUMSRVON
	Motor cumulative rotation count	Rotation	M_MtRotNum	NUMMTROT
Consumption degree	Mechanism total (maintenance parts)	%	M_PMCsmMnt	CSMPMMNT
	Mechanism total (overhaul parts)	%	M_PMCsmOH	CSMPMOH
	Grease	%	M_PMCsmGrs	CSMPMGRS
	Timing belt	%	M_PMCsmBlt	CSMPMBLT
	Reduction gear	%	M_PMCsmDec	CSMPMDEC
	Bearing	%	M_PMCsmBrg	CSMPMBRG
	Ball screw Ball spline	%	M_PMCsmBss	CSMPMBSS
Remaining time	Mechanism total (maintenance parts)	h (hours)	M_PMRmnMnt	RMNPMMNT
	Servo ON time (At overhaul implementation)	h (hours)	M_PMRmnSrv	RMNPMSRV
Consumption status	Mechanism total (maintenance parts)	−	M_PMStsMnt	STSPMMNT
	Mechanism total (overhaul parts)	−	M_PMStsOH	STSPMOH
	Grease	−	M_PMStsGrs	STSPMGRS
	Timing belt	−	M_PMStsBlt	STSPMBLT
	Reduction gear	−	M_PMStsDec	STSPMDEC
	Bearing	−	M_PMStsBrg	STSPMBRG
	Ball screw Ball spline	−	M_PMStsBss	STSPMBSS
	Servo ON time (At overhaul implementation)	−	M_PMStsSrv	STSPMSRV
Notification pause status	Grease	−	M_PMRptGrs	RPTPMGRS
	Timing belt	−	M_PMRptBlt	RPTPMBLT
	Reduction gear	−	M_PMRptDec	RPTPMDEC
	Bearing	−	M_PMRptBrg	RPTPMBRG
	Ball screw Ball spline	−	M_PMRptBss	RPTPMBSS
	Servo ON time (At overhaul implementation)	−	M_PMRptSrv	RPTPMSRV

Output data	Target	Unit	Robot status variable	Parameter
Maintenance Log	Specify data to get	−	−	LOGPMNO
	Grease	Piece	M_PMLogGrs	−
		Character string	C_PMLogGrs	LOGPMGRS
	Timing belt	Piece	M_PMLogBlt	−
		Character string	C_PMLogBlt	LOGPMBLT
	Reduction gear	Piece	M_PMLogDec	−
		Character string	C_PMLogDec	LOGPMDEC
	Bearing	Piece	M_PMLogBrg	−
		Character string	C_PMLogBrg	LOGPMBRG
	Ball screw Ball spline	Piece	M_PMLogBss	−
		Character string	C_PMLogBss	LOGPMBSS
	Overhaul	Piece	M_PMLogOH	−
		Character string	C_PMLogOH	LOGPMOH
Score	Reduction gear	−	M_PMScrDrv	SCRPMDRV
	Encoder data abnormality	−	M_PMScrEnc1	SCRPMEN1
	Encoder communication abnormality	−	M_PMScrEnc2	SCRPMEN2
Abnormality detection status	Reduction gear	−	M_PMStsDrv	STSPMDRV
	Encoder data abnormality	−	M_PMStsEnc1	STSPMEN1
	Encoder communication abnormality	−	M_PMStsEnc2	STSPMEN2
	Battery voltage status	−	M_PMStsBat	STSPMBAT
Notification method of abnormality detection Pause status	Reduction gear	−	M_PMRptDrv	RPTPMDRV
	Encoder data abnormality	−	M_PMRptEnc1	RPTPMEN1
	Encoder communication abnormality	−	M_PMRptEnc2	RPTPMEN2
Abnormality detection log data	Specify data to get	−	−	LOGPMDAY
	Reduction gear	Piece	M_PMLogScr	−
		−	M_PMLogD	LOGPMDRV
	Encoder data abnormality	Piece	M_PMLogScr	−
		−	M_PMLogE1	LOGPMEN1
	Encoder communication abnormality	Piece	M_PMLogScr	−
		−	M_PMLogE2	LOGPMEN2
Abnormality detection Detection level	Reduction gear	−	M_PMWngDrv	PMWNGDRV
	Encoder data abnormality	−	M_PMWngEnc1	PMWNGEN1
	Encoder communication abnormality	−	M_PMWngEnc2	PMWNGNE2

12.3. Request ID (MelfaRXM.ocx) specified by RequestService

You can get robot status variables and parameter values related to the predictive maintenance function using the existing request ID.

ID value	Function name
212	Get variable value
301	Get parameter value (consider open level)
302	Write parameter value

13. Robot (system) status variables

13.1. Robot (system) status variable list

13.1.1. Consumption degree calculation function

*1) Attributes in the table, R: Read only
*2) Mechanism No. .....1 to 3, Specifies a mechanism number corresponding to the multitask processing function

<Serial number>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
C_RBSerial	Mechanism No. (1 to 3) *2)	Robot body serial number	R	Character string type	100
C_RCSerial	None	Controller serial number	R	Character string type	101

<Operating information>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PowOnTime	None	Power ON time	R	Integer type,Time	102
M_SrvOnTime	None	Servo ON time	R	Integer type,Time	103
M_PrgTime	None	Operation time	R	Integer type,Time	104
M_MovTime	None	Actual operation time	R	Integer type,Time	105
M_SrvOnNum	None	Servo ON count	R	Integer type	106
M_MtRotNum	Axis No.(1 to 8)	Motor cumulative rotation count	R	Double-precision real number type	107

<Maintenance log>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMLogGrs	Axis No.(1 to 8)	Maintenance count (grease)	R	Integer type	108
M_PMLogBlt	Axis No.(1 to 8)	Maintenance count (timing belt)	R	Integer type	109
M_PMLogDec	Axis No.(1 to 8)	Maintenance count (reduction gear)	R	Integer type	110
M_PMLogBrg	Axis No.(1 to 8)	Maintenance count (bearing)	R	Integer type	111
M_PMLogBss	Axis No.(1 to 8)	Maintenance count (ball screw/ball spline)	R	Integer type	112
M_PMLogOH	None	Maintenance count (overhaul (servo ON time))	R	Integer type	113
C_PMLogGrs	Axis No.(1 to 8) Log No.(1 to 10)	Maintenance log (grease)	R	Character string type	114
C_PMLogBlt	Axis No.(1 to 8) Log No.(1 to 10)	Maintenance log (timing belt)	R	Character string type	115
C_PMLogDec	Axis No.(1 to 8) Log No.(1 to 10)	Maintenance log (reduction gear)	R	Character string type	116
C_PMLogBrg	Axis No.(1 to 8) Log No.(1 to 10)	Maintenance log (bearing)	R	Character string type	117
C_PMLogBss	Axis No.(1 to 8) Log No.(1 to 10)	Maintenance log (ball screw/ball spline)	R	Character string type	118
C_PMLogOH	Log No.(1 to 10)	Maintenance log (overhaul (servo ON time))	R	Character string type	119

<Consumption degree>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMCsmMnt	None	Consumption degree (mechanism total (maintenance parts))	R	Single-precision real number type, %	120
M_PMCsmOH	None	Consumption degree (mechanism total (overhaul parts))	R	Single-precision real number type, %	121
M_PMCsmGrs	Axis No.(1 to 8)	Consumption degree (grease)	R	Single-precision real number type, %	122
M_PMCsmBlt	Axis No.(1 to 8)	Consumption degree (timing belt)	R	Single-precision real number type, %	123
M_PMCsmDec	Axis No.(1 to 8)	Consumption degree (reduction gear)	R	Single-precision real number type, %	124
M_PMCsmBrg	Axis No.(1 to 8)	Consumption degree (bearing)	R	Single-precision real number type, %	125
M_PMCsmBss	Axis No.(1 to 8)	Consumption degree (ball screw/ball spline)	R	Single-precision real number type, %	126
M_PMRmnMnt	None	Remaining time (mechanism total (maintenance parts))	R	Integer type,Time	127
M_PMRmnSrv	None	Remaining time (servo ON time)	R	Integer type,Time	128

<Consumption status>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMStsMnt	None	Consumption status (mechanism total (maintenance parts))	R	Integer type	129
M_PMStsOH	None	Consumption status (mechanism total (overhaul parts))	R	Integer type	130
M_PMStsGrs	Axis No.(1 to 8)	Consumption status (grease)	R	Integer type	131
M_PMStsBlt	Axis No.(1 to 8)	Consumption status (timing belt)	R	Integer type	132
M_PMStsDec	Axis No.(1 to 8)	Consumption status (reduction gear)	R	Integer type	133
M_PMStsBrg	Axis No.(1 to 8)	Consumption status (bearing)	R	Integer type	134
M_PMStsBss	Axis No.(1 to 8)	Consumption status (ball screw/ball spline)	R	Integer type	135
M_PMStsSrv	None	Consumption status (servo ON time)	R	Integer type	136

<Notification>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMRptGrs	Axis No.(1 to 8)	Notification pause status (grease)	R	Integer type	137
M_PMRptBlt	Axis No.(1 to 8)	Notification pause status (timing belt)	R	Integer type	138
M_PMRptDec	Axis No.(1 to 8)	Notification pause status (reduction gear)	R	Integer type	139
M_PMRptBrg	Axis No.(1 to 8)	Notification pause status (bearing)	R	Integer type	140
M_PMRptBss	Axis No.(1 to 8)	Notification pause status (ball screw/ball spline)	R	Integer type	141
M_PMRptSrv	None	Notification pause status (servo ON time)	R	Integer type	142

13.1.2. Abnormality detection function

*1) Attributes in the table, R: Read only

<Abnormality detection log>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMLogScr	None	Log data count of abnormality detection log	R	Integer type	143
M_PMLogD	Log No.(1 to 365) Axis No.(1 to 9)	Abnormality detection log data (reduction gear)	R	Single-precision real number type	144
M_PMLogE1	Log No.(1 to 365) Axis No.(1 to 9)	Abnormality detection log data (encoder data abnormality)	R	Single-precision real number type	145
M_PMLogE2	Log No.(1 to 365) Axis No.(1 to 9)	Abnormality detection log data (encoder communication abnormality)	R	Single-precision real number type	146

<Score>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMScrDrv	Axis No.(1 to 8)	Score (reduction gear)	R	Single-precision real number type	147
M_PMScrEnc1	Axis No.(1 to 8)	Score (encoder data abnormality)	R	Single-precision real number type	148
M_PMScrEnc2	Axis No.(1 to 8)	Score (encoder communication abnormality)	R	Single-precision real number type	149

<Abnormality detection status>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMStsDrv	Axis No.(1 to 8)	Abnormality detection status (reduction gear)	R	Integer type	150
M_PMStsEnc1	Axis No.(1 to 8)	Abnormality detection status (encoder data abnormality)	R	Integer type	151
M_PMStsEnc2	Axis No.(1 to 8)	Abnormality detection status (encoder communication abnormality)	R	Integer type	152
M_PMStsBat	None	Abnormality detection status (battery voltage status)	R	Integer type	153

<Notification>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMRptDrv	Axis No.(1 to 8)	Notification pause status (reduction gear)	R	Integer type	154
M_PMRptEnc1	Axis No.(1 to 8)	Notification pause status (encoder data abnormality)	R	Integer type	155
M_PMRptEnc2	Axis No.(1 to 8)	Notification pause status (encoder communication abnormality)	R	Integer type	156

<Detection level>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_PMWngDrv	Axis No.(1 to 8)	Detection level (reduction gear abnormality detection)	R	Integer type	157
M_PMWngEnc1	Axis No.(1 to 8)	Detection level (encoder data abnormality detection)	R	Integer type	158
M_PMWngEnc2	Axis No.(1 to 8)	Detection level (encoder communication abnormality detection)	R	Integer type	159

13.1.3. MELFA Smart Plus

<MELFA Smart Plus card>

Variable name	Array designation	Details	Attribute *1)	Data type, Unit	Page
M_SmartPlus*2)	1	MELFA Smart Plus function usage status	R	Integer type	—
C_SmartPlus*2)	1	MELFA Smart Plus function name	R	Character string type	—

*1) Attributes in the table, R: Read only

*2) For the Robot (system) status variable of MELFA Smart Plus card, refer to the separate volume, "Instruction Manual/MELFA Smart Plus".

13.2. Consumption degree calculation function

13.2.1. Serial number

C_RBSerial: Robot body serial number

[Function]

Returns the serial number of the robot body.

[Format]

Example) <String variable> = C_RBSerial(<Mechanism number>)

[Terminology]

<String variable> Specify the string variable to assign.

<Mechanism number> Set the mechanism number. (1 to 3)
When omitted, 1 is used.

[Sample]

1 C1$ = C_RBSerial(1) 'The serial number of the robot body (mechanism 1) is set in C1$.

[Explanation]

(1) Returns the serial number of the robot body registered in the "RBSERIAL" parameter.
(2) This variable is read only.

[Related system status variables]

C_RCSerial

C_RCSerial: Controller serial number

[Function]

Returns the serial number of the robot controller.

[Format]

Example) <String variable> = C_RCSerial

[Terminology]

<String variable>	Specify the string variable to assign.

[Sample]

```
1 C1$ = C_RCSerial      'The serial number of the robot controller is set in C1$.
```

[Explanation]

(1) Returns the serial number of the robot controller.
(2) This variable is read only.

[Related system status variables]

C_RBSerial

13.2.2. Operating information

M_PowOnTime: Power ON time

[Function]

Returns the cumulative time of power supply ON of robot controller from a last overhaul. [hour]

[Format]

Example) <Numeric variable> = M_PowOnTime

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PowOnTime 'The cumulative time of power ON of the robot controller is set in M1.
```

[Explanation]

(1) Returns the cumulative time of power ON of the robot controller.
The cumulative time is the time from when the previous overhaul was carried out.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_SrvOnTime: Servo ON time

[Function]

Returns the cumulative time of servo ON of the robot body from a last overhaul. [hour]

[Format]

Example) <Numeric variable> = M_SrvOnTime

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_SrvOnTime   'The cumulative servo ON time of the robot body (mechanism 1) is set in M1.
```

[Explanation]

(1) Returns the cumulative time of servo ON of the robot body (mechanism 1).
The cumulative time is the time from when the previous overhaul was carried out.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_PrgTime: Operation time

[Function]

Returns the cumulative time of the operating time of the robot controller from a last overhaul. [hour]

[Format]

Example) <Numeric variable> = M_PrgTime

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PrgTime          'The operation time of the robot controller is set in M1.
```

[Explanation]

(1) Returns the operation time of the robot controller.
The operation time is the time from when the previous overhaul was carried out.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_MovTime: Actual operation time

[Function]

Returns the cumulative time of the moving time of the robot body from a last overhaul. [hour]

[Format]

Example) <Numeric variable> = M_MovTime

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_MovTime      'The actual operation time of the robot body (mechanism 1) is set in M1.
```

[Explanation]

(1) Returns the actual operation time of the robot body (mechanism 1).
The actual operation time is the time from when the previous overhaul was carried out.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_SrvOnNum: Servo ON count

[Function]

Returns the cumulative count of the servo ON of the robot body from a last overhaul.

[Format]

Example) <Numeric variable> = M_SrvOnNum

[Terminology]

<Numeric variable>　Specify the joint type variable to assign.

[Sample]

```
1 M1 = M_SrvOnNum    'The servo ON count of the robot body (mechanism 1) is set in M1.
```

[Explanation]

(1) Returns the servo ON count of the robot body (mechanism 1).
The count is the accumulation count from when the previous overhaul was carried out.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_MtRotNum: Motor cumulative rotation count

[Function]

Returns the cumulative number of rotations of the motor of the robot body from a last overhaul of the specified axis.

[Format]

```
Example) <Numeric variable> = M_MtRotNum(<Axis number>)
```

[Terminology]

<Numeric variable>	Specify the joint type variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_MtRotNum(1)          'The motor cumulative rotation count of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the motor cumulative rotation count of the robot body (mechanism 1).
The rotation count is the accumulation count from when the previous overhaul was carried out.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

13.2.3. Maintenance Log

M_PMLogGrs: Maintenance count (grease)

[Function]

Returns the maintenance count (reset count) of the grease of the specified axis.

[Format]

Example) <Numeric variable> = M_PMLogGrs(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMLogGrs(1)          'The maintenance count of the grease for the J1 axis is set in M1.
```

[Explanation]

(1) Returns the maintenance count (reset count) of the grease for the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

[Related system status variables]

C_PMLogGrs

M_PMLogBlt: Maintenance count (timing belt)

[Function]

Returns the maintenance count (reset count) of the timing belt of the specified axis.

[Format]

Example) <Numeric variable> = M_PMLogBlt(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMLogBlt(1) 'The maintenance count of timing belt for the J1 axis is set in M1.
```

[Explanation]

(1) Returns the maintenance count (reset count) of timing belt of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

[Related system status variables]

C_PMLogBlt

M_PMLogDec: Maintenance count (reduction gear)

[Function]

Returns the maintenance count (reset count) of the decelerator of the specified axis.

[Format]

Example) <Numeric variable> = M_PMLogDec(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMLogDec(1)          'The maintenance count of the reduction gear for the J1 axis is set in M1.
```

[Explanation]

(1) Returns the maintenance count (reset count) of the reduction gear of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

[Related system status variables]

C_PMLogDec

M_PMLogBrg: Maintenance count (bearing)

[Function]

Returns the maintenance count (reset count) of the bearing of the specified axis.

[Format]

Example) <Numeric variable> = M_PMLogBrg(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMLogBrg(1)          'The maintenance count of the bearing of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the maintenance count (reset count) of the bearing of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

[Related system status variables]

C_PMLogBrg

M_PMLogBss: Maintenance count (ball screw/ball spline)

[Function]

Returns the maintenance count (reset count) of the ball screw / ball spline of the specified axis.

[Format]

Example) <Numeric variable> = M_PMLogBss(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

1 M1 = M_PMLogBss(3)	The maintenance count of the ball screw of the J3 axis is set in 'M1.

[Explanation]

(1) Returns the maintenance count (reset count) of the ball screw/ball spline of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

[Related system status variables]

C_PMLogBss

M_PMLogOH: Maintenance count (overhaul (servo ON time))

[Function]

Returns the maintenance count (reset count) of the overhaul.

[Format]

Example) <Numeric variable> = M_PMLogOH

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMLogOH    'The maintenance count of overhaul is set in M1.
```

[Explanation]

(1) Returns the maintenance count (reset count) of overhaul for the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

[Related system status variables]

C_PMLogOH

C_PMLogGrs: Maintenance log (grease)

[Function]

Returns the maintenance log data (the reset date and time, the consumption degree when resetting) of the grease.

[Format]

Example) <String variable> = C_PMLogGrs(<Log number>, <Axis number>)

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

[Sample]

```
1 C1$ = C_PMLogGrs(1,1)                    'The maintenance log of the grease is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, consumption degree at the time of reset) of the grease for the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1.000" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Consumption degree [%] at the time of reset>" when the predictive/preventive maintenance function is enabled.

<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,80.000"

(5) Returns "----/--/--,--:--:--,0.000" when there is no log data specified by <Log number>.

(6) Returns "----/--/--,--:--:--,0.000" when a nonexistence axis is specified in <Axis number>.

[Related system status variables]

M_PMLogGrs

C_PMLogBlt: Maintenance log (timing belt)

[Function]

Returns the maintenance log data (the reset date and time, the consumption degree when resetting) of the timing belt.

[Format]

```
Example) <String variable> = C_PMLogBlt(<Log number>, <Axis number>)
```

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

[Sample]

```
1 C1$ = C_PMLogBlt(1,1)                    'The maintenance log of the timing belt is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, consumption degree at the time of reset) of the timing belt of the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1.000" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Consumption degree [%] at the time of reset>" when the predictive/preventive maintenance function is enabled.

<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,80.000"

(5) Returns "----/--/--,--:--:--,0.000" when there is no log data specified by <Log number>.

(6) Returns "----/--/--,--:--:--,0.000" when a nonexistence axis is specified in <Axis number>.

[Related system status variables]

M_PMLogBlt

C_PMLogDec: Maintenance log (reduction gear)

[Function]

Returns the maintenance log data (the reset date and time, the consumption degree when resetting) of the decelerator.

[Format]

```
Example) <String variable> = C_PMLogDec(<Log number>, <Axis number>)
```

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

[Sample]

```
1 C1$ = C_PMLogDec(1,1)                    'The maintenance log of the reduction gear is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, consumption degree at the time of reset) of the reduction gear for the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1.000" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Consumption degree [%] at the time of reset>" when the predictive/preventive maintenance function is enabled.
<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,80.000"

(5) Returns "----/--/--,--:--:--,0.000" when there is no log data specified by <Log number>.

(6) Returns "----/--/--,--:--:--,0.000" when a nonexistence axis is specified in <Axis number>.

[Related system status variables]

M_PMLogDec

C_PMLogBrg: Maintenance log (bearing)

[Function]

Returns the maintenance log data (the reset date and time, the consumption degree when resetting) of the bearing.

[Format]

```
Example) <String variable> = C_PMLogBrg(<Log number>, <Axis number>)
```

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

[Sample]

```
1 C1$ = C_PMLogBrg(1,1)                    'The maintenance log of the bearing is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, consumption degree at the time of reset) of the bearing of the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1.000" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Consumption degree [%] at the time of reset>" when the predictive/preventive maintenance function is enabled.
<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,80.000"

(5) Returns "----/--/--,--:--:--,0.000" when there is no log data specified by <Log number>.

(6) Returns "----/--/--,--:--:--,0.000" when a nonexistence axis is specified in <Axis number>.

[Related system status variables]

M_PMLogBrg

C_PMLogBss: Maintenance log (ball screw/ball spline)

[Function]

Returns the maintenance log data (the reset date and time, the consumption degree when resetting) of the ball screw / ball spline.

[Format]

```
Example) <String variable> = C_PMLogBss(<Log number>, <Axis number>)
```

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

[Sample]

```
1 C1$ = C_PMLogBss(1,3)        'The maintenance log of the ball screw of the J3 axis is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, consumption degree at the time of reset) of the ball screw/ball spline of the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1.000" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Consumption degree [%] at the time of reset>" when the predictive/preventive maintenance function is enabled.
<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,80.000"

(5) Returns "----/--/--,--:--:--,0.000" when there is no log data specified by <Log number>.

(6) Returns "----/--/--,--:--:--,0.000" when a nonexistence axis is specified in <Axis number>.

[Related system status variables]

M_PMLogBss

C_PMLogOH: Maintenance log (overhaul (servo ON time))

[Function]

Returns the maintenance log data (the reset date and time, the cumulative time of servo ON when resetting) of the overhaul.

[Format]

```
Example) <String variable> = C_PMLogOH(<Log number>)
```

[Terminology]

<String variable> Specify the string variable to assign.

<Log number> Specify the log number to get. (1 to 10)

The greater the number, the older the log data.

To get the last reset date & time, specify "1".

When omitted, 1 is used.

[Sample]

```
1 C1$ = C_PMLogOH(1)                    'The maintenance log of overhaul is set in C1$.
```

[Explanation]

(1) Returns the maintenance log data (reset date & time, servo ON time at the time of reset) of overhaul for the robot body (mechanism 1).

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "<Date>, <Time>, <Servo ON time [h] at the time of reset>" when the predictive/preventive maintenance function is enabled.
<Date> is output in "YYYY/MM/DD" format, and <Time> in "hh:mm:ss" format.
Example : "2018/02/01,12:00:00,24000"

(5) Returns "----/--/--,--:--:--,0" when there is no log data specified by <Log number>.

[Related system status variables]

M_PMLogOH

13.2.4. Consumption degree

M_PMCsmMnt: Consumption degree (mechanism total (maintenance parts))

[Function]

Returns the overall consumption degree of the maintenance part (grease and timing belt). [%]

[Format]

Example) <Numeric variable> = M_PMCsmMnt

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMCsmMnt  'The overall consumption degree of the maintenance parts is set in M1.
```

[Explanation]

(1) Returns the overall consumption degree of the maintenance parts (grease, timing belt) of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

[Related system status variables]

M_PMCsmGrs / M_PMCsmBlt

M_PMCsmOH: Consumption degree (mechanism total (overhaul parts))

[Function]

Returns the overall consumption degree of the overhaul part (decelerator, bearing and ball screw / ball spline). [%]

[Format]

Example) <Numeric variable> = M_PMCsmOH

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMCsmOH   'The overall consumption degree of the overhaul parts is set in M1.
```

[Explanation]

(1) Returns the overall consumption degree of the parts (reduction gear, bearing, ball screw, ball spline) requiring overhaul of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

[Related system status variables]

M_PMCsmDec / M_PMCsmBrg / M_PMCsmBss

M_PMCsmGrs: Consumption degree (grease)

[Function]

Returns the consumption degree of the grease of the specified axis. [%]

[Format]

Example) <Numeric variable> = M_PMCsmGrs(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMCsmGrs(1)                'The consumption degree of the grease for the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption degree (unit: %) of the grease of each joint axis of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" for joint axes that do not require grease replenishing.

M_PMCsmBlt: Consumption degree (timing belt)

[Function]

Returns the consumption degree of the timing belt of the specified axis. [%]

[Format]

```
Example) <Numeric variable> = M_PMCsmBlt(<Axis number>)
```

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)
When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMCsmBlt(1)          'The consumption degree of the timing belt of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption degree (unit: %) of the timing belt of each joint axis of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" when the joint axis does not have the target parts.

M_PMCsmDec: Consumption degree (reduction gear)

[Function]

Returns the consumption degree of the decelerator of the specified axis. [%]

[Format]

Example) <Numeric variable> = M_PMCsmDec(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMCsmDec(1)          'The consumption degree of the reduction gear of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption degree (unit: %) of the reduction gear of each joint axis of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" when the joint axis does not have the target parts.

M_PMCsmBrg: Consumption degree (bearing)

[Function]

Returns the consumption degree of the bearing of the specified axis. [%]

[Format]

Example) <Numeric variable> = M_PMCsmBrg(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMCsmBrg(1)          'The consumption degree of the bearing of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption degree (unit: %) of the bearing of each joint axis of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" when the joint axis does not have the target parts.

M_PMCsmBss: Consumption degree (ball screw/ball spline)

[Function]

Returns the consumption degree of the ball screw / ball spline of the specified axis. [%]

[Format]

Example) <Numeric variable> = M_PMCsmBss(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)
When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMCsmBss(3)          'The consumption degree of the ball screw of the J3 axis is set in M1.
```

[Explanation]

(1) Returns the consumption degree (unit: %) of the ball screw/ball spline of each joint axis of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" when the joint axis does not have the target parts.

M_PMRmnMnt: Remaining time (mechanism total (maintenance parts))

[Function]

Returns the remaining time until maintenance of the maintenance part (grease and timing belt). [hour]

[Format]

```
Example) <Numeric variable> = M_PMRmnMnt
```

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMRmnMnt  'The remaining time up to the maintenance of the maintenance part is set in M1.
```

[Explanation]

(1) Returns the remaining time up to the maintenance of the maintenance parts (grease, timing belt) of the robot body (mechanism 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_PMRmnSrv: Remaining time (servo ON time)

[Function]

Returns the remaining time until specified time of an overhaul of the cumulative time of servo ON. [hour]

[Format]

Example) <Numeric variable> = M_PMRmnSrv

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMRmnSrv  'The remaining time up to overhaul of the overhaul part is set in M1.
```

[Explanation]

(1) Returns the remaining time of the cumulative servo ON time to reach the specified overhaul time.
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

13.2.5. Consumption status

M_PMStsMnt: Consumption status (mechanism total (maintenance parts))

[Function]

Returns the consumption status of the maintenance part (grease and timing belt).

[Format]

Example) <Numeric variable> = M_PMStsMnt

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMCsmMnt  'The overall consumption degree of the maintenance parts is set in M1.
```

[Explanation]

(1) Returns the consumption status of the maintenance part (grease, timing belt) of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) Specify the warning occurrence remaining time using the "PMWNGDAY" parameter.

(3) This variable is read only.

(4) Returns "-1" when the predictive/preventive maintenance function is disabled.

[Related system status variables]

M_PMCsmGrs / M_PMCsmBlt

M_PMStsOH: Consumption status (mechanism total (overhaul parts))

[Function]

Returns the consumption status of the overhaul part (decelerator, bearing and ball screw / ball spline).

[Format]

Example) <Numeric variable> = M_PMStsOH

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMStsOH    'The consumption status of the overhaul part is set in M1.
```

[Explanation]

(1) Returns the consumption status of the maintenance part (grease, timing belt) requiring overhaul of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) Specify the warning occurrence remaining time using the "PMWRGDAY" parameter.

(3) This variable is read only.

(4) Returns "-1" when the predictive/preventive maintenance function is disabled.

M_PMStsGrs: Consumption status (grease)

[Function]

Returns the consumption status of grease of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsGrs(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsGrs(1) 'The consumption status of the grease for the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption status of the grease of each joint axis of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) Returns "0" for joint axes that do not require grease replenishing.

M_PMStsBlt: Consumption status (timing belt)

[Function]

Returns the consumption status of timing belt of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsBlt(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsBlt(1)  'The consumption status of the timing belt of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption status of the timing belt of each joint axis of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMStsDec: Consumption status (reduction gear)

[Function]

Returns the consumption status of decelerator of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsDec(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsDec(1)          'The consumption status of the reduction gear of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption status of the reduction gear of each joint axis of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMStsBrg: Consumption status (bearing)

[Function]

Returns the consumption status of bearing of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsBrg(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)
When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsBrg(1) 'The consumption status of the bearing of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the consumption status of the bearing of each joint axis of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMStsBss: Consumption status (ball screw/ball spline)

[Function]

Returns the consumption status of ball screw / ball spline of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsBss(<Axis number>)

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis to get the cumulative rotation count. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsBss(3)'The consumption status of the ball screw of the J3 axis is set in M1.
```

[Explanation]

(1) Returns the consumption status of the ball screw/ball spline of each joint axis of the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMStsSrv: Consumption status (servo ON time)

[Function]

Returns the arrival status to the specified time of an overhaul of the cumulative time of servo ON.

[Format]

Example) <Numeric variable> = M_PMStsSrv

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMStsSrv     'The arrival status to the specified overhaul time is set in M1.
```

[Explanation]

(1) Returns the arrival status of the cumulative servo ON time to the specified overhaul time for the robot body (mechanism 1).
0 : The remaining time exceeded the warning occurrence remaining time.
1 : The remaining time is less than the warning occurrence remaining time, exceeded 0 [h].
2 : The remaining time is 0 [h] or less.

(2) This variable is read only.

(3) Returns "-1" for all axes when the predictive/preventive maintenance function is disabled.

13.2.6. Notification

M_PMRptGrs: Notification pause status (grease)

[Function]

Returns the stop status of warning / signal output, of grease consumption of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptGrs<Axis number>

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis for which to get a log. (1 to 6)
When omitted, 1 is used.

[Sample]

1 M1 = M_PMRptGrs(1) 'The notification method of the grease consumption of the J1 axis is set in M1.

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to grease consumption of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)
(2) This variable is read only.
(3) Returns "-1" when the predictive/preventive maintenance function is disabled.
(4) Returns "0" when the joint axis does not exist.
(5) Returns "0" for joint axes that do not require grease replenishing.

M_PMRptBlt: Notification pause status (timing belt)

[Function]

Returns the stop status of warning / signal output, of timing belt consumption of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptBlt<Axis number>

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMRptBlt(1)      'The notification method of the timing belt consumption of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to timing belt consumption of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptDec: Notification pause status (reduction gear)

[Function]

Returns the stop status of warning / signal output, of decelerator consumption of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptDec<Axis number>

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMRptDec(1)      'The notification method of the reduction gear consumption of the J1 axis
                          is set in M1.
```

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to reduction gear consumption of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "0" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptBrg: Notification pause status (bearing)

[Function]

Returns the stop status of warning / signal output, of bearing consumption of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptBrg<Axis number>

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMRptBrg(1)     'The notification method of bearing consumption of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to bearing consumption of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptBss: Consumption status (ball screw/ball spline)

[Function]

Returns the stop status of warning / signal output, of ball screw / ball spline consumption of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptBss<Axis number>

[Terminology]

<Numeric variable>	Specify the numeric variable to assign.
<Axis number>	Specify the joint axis for which to get a log. (1 to 6) When omitted, 1 is used.

[Sample]

1 M1 = M_PMRptBss(3) 'The notification method of ball screw consumption of the J3 axis is set in M1.

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to ball screw/ball spline consumption of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptSrv: Notification pause status (servo ON time)

[Function]

Returns the stop status of warning / signal output, of arrival status to the specified time of an overhaul of the cumulative time of servo ON.

[Format]

Example) <Numeric variable> = M_PMRptSrv

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMRptSrv    'The arrival notification method to the specified overhaul time is set in M1.
```

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, of arrival status to the specified time of an overhaul of the cumulative time of servo ON of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive/preventive maintenance function is disabled.

13.3. Abnormality detection function

13.3.1. Abnormality detection log

M_PMLogScr: Log data count of abnormality detection log

[Function]

Returns the number of log data of the abnormality detection log (the reduction gear and encoder).

[Format]

Example) <Numeric variable> = M_PMLogScr

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMLogScr    'The log data count of abnormality detection log is set in M1.
```

[Explanation]

(1) Returns the log data count of the reduction gear including the reduction gear of the robot body (mechanism 1) and encoder abnormality detection log.
(2) This variable is read only.
(3) Returns “-1” when the predictive maintenance function is disabled.

[Related system status variables]

C_PMLogDrv / C_PMLogEnc1 / C_PMLogEnc2

M_PMLogD : Abnormality detection log data (reduction gear)

[Function]

Returns the score from the abnormality detection log (reduction gear) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMLogDrv(<Log number>, <Axis number>)

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Log number> Specify the number of the log to retrieve. (1 to 365)

The greater the number, the older the log data.

1: Retrieves today's maximum score value.

2 to 365: Retrieves the maximum score value from [specified value - 1] days ago.

(Example: When "5" is set, the command retrieves the score from 4 days ago.)

<Axis Number> Specify the joint axis to retrieve the data from. (1 to 9)

1 to 8: Retrieves the joint axis data of the abnormality detection log (reduction gear).

9: Retrieves the date of log data.

[Examples]

```
1 M1 = M_PMLogDrv(1,1)     'Today's data of the abnormality detection log (reduction gear) for Axis J1 is
                             set in M1.
2 M2 = M_PMLogDrv(1,9)     'Today's date is set in M2.
```

[Comments]

(1) Returns the score from the abnormality detection log of the robot's reduction gear (mechanism 1).
(2) This variable is read-only.
(3) Returns "-1" when the predictive maintenance function is disabled.
(4) Returns the following numeric value from the abnormality detection log data (reduction gear) with the combination of <Log number> and <Axis number> when the predictive maintenance function is enabled.
* When <Axis number> = 9 is specified, the command retrieves the date (displays [YYMMDD]).

Examples:
<Log number> = 1, <Axis number> = 1: 80.505 (Displays today's score for the J1 axis reduction gear)
<Log number> = 2, <Axis number> = 1: 80.455 (Displays the score of the previous day for the J1 axis reduction gear)
<Log number> = 1, <Axis number> = 9: 190130 (For example if today is January 30, 2019.)
<Log number> = 2, <Axis number> = 9: 190129 (For example if the previous day is January 29, 2019.)

(5) Returns "0" when there is no log data of the date specified in <Log number>.
(6) The log data of the score for a nonexistent joint axis is "0".
(7) The score value is today's maximum value.
(8) When maintenance reset (other than the encoder) is performed, today's maximum score value is the one after reset.
(9) Log data (log number, date, srore) will not be updated on non-working days.

[Related system status variables]

M_PMLogScr / M_PMScrDrv

M_PMLogE1: Abnormality detection log data (encoder data abnormality)

[Function]

Returns the score from the abnormality detection log data (encoder data abnormality) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMLogEnc1(<Log number>, <Axis number>)

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Log number> Specify the number of the log to retrieve. (1 to 365)

The greater the number, the older the log data.
1: Retrieves today's maximum score value.
2 to 365: Retrieves the maximum score value from [specified value - 1] days ago.
(Example: When "5" is set, the command retrieves the score from 4 days ago.)

<Axis Number> Specify the joint axis to retrieve the data from. (1 to 9)

1 to 8: Retrieves the joint axis data of the abnormality detection log (encoder data abnormality).
9: Retrieves the date of log data.

[Examples]

1) M1 = M_PMLogEnc1(1,1) 'Today's data of the abnormality detection log (encoder data abnormality) for Axis J1 is set in M1.
2) M2 = M_PMLogEnc1(1,9) 'Today's date is set in M2.

[Comments]

(1) Returns the score from the abnormality detection log of the robot's encoder data abnormality. (mechanism 1).
(2) This variable is read-only.
(3) Returns "-1" when the predictive maintenance function is disabled.
(4) Returns the following numeric value from the abnormality detection log data (encoder data abnormality) with the combination of <Log number> and <Axis number> when the predictive maintenance function is enabled.
* When <Axis number> = 9 is specified, the command retrieves the date (displays [YYMMDD]).

Examples:
<Log number> = 1, <Axis number> = 1: 80.905 (Displays today's score for the J1 axis encoder data abnormality)
<Log number> = 2, <Axis number> = 1: 80.555 (Displays the score of the previous day for the J1 axis encoder data abnormality)
<Log number> = 1, <Axis number> = 9: 190130 (For example if today is January 30, 2019.)
<Log number> = 2, <Axis number> = 9: 190129 (For example if the previous day is January 29, 2019.)

(5) Returns "0" when there is no log data of the date specified in <Log number>.
(6) The score of a nonexistent joint axis is "0".
(7) The score value is today's maximum value.
(8) When maintenance reset (encoder) is performed, today's maximum score value is the one after reset.
(9) Log data (log number, date, srore) will not be updated on non-working days.

[Related system status variables]

M_PMLogScr / M_PMScrEnc1

M_PMLogE2: Abnormality detection log data (encoder communication abnormality)

[Function]

Returns the score from the abnormality detection log (encoder communication abnormality) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMLogEnc2(<Log number>, <Axis number>)

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Log number> Specify the number of the log to retrieve. (1 to 365)

The greater the number, the older the log data.

1: Retrieves today's maximum score value.

2 to 365: Retrieves the maximum score value from [specified value - 1] days ago.

(Example: When "5" is set, the command retrieves the score from 4 days ago.)

<Axis Number> Specify the joint axis to retrieve the data from. (1 to 9)

1 to 8: Retrieves the joint axis data of the abnormality detection log (encoder data communication abnormality).

9: Retrieves the date of log data.

[Examples]

1) M1 = M_PMLogEnc2(1,1) 'The data of abnormality detection log (encoder communication abnormality) for Axis J1 is set in M1.

2) M2 = M PMLogEnc2(1,9) 'Today's date is set in M2.

[Comments]

(1) Returns the score from the abnormality detection log of the robot's encoder communication abnormality. (mechanism 1).

(2) This variable is read-only.

(3) Returns "-1" when the predictive maintenance function is disabled.

(4) Returns the following numeric value from the abnormality detection log data (encoder communication abnormality) with the combination of <Log number> and <Axis number> when the predictive maintenance function is enabled.

* When <Axis number> = 9 is specified, the command retrieves the date (displays [YYMMDD]).

Examples:

<Log number> = 1, <Axis number> = 1: 80.505 (Displays today's score for the J1 axis encoder communication abnormality)

<Log number> = 2, <Axis number> = 1: 80.555 (Displays the score of the previous day for the J1 axis encoder communication abnormality)

<Log number> = 1, <Axis number> = 9: 190130 (For example if today is January 30, 2019.)

<Log number> = 2, <Axis number> = 9: 190129 (For example if the previous day is January 29, 2019.)

(5) Returns "0" when there is no log data of the date specified in <Log number>.

(6) The score of a nonexistent joint axis is "0".

(7) The score value is today's maximum value.

(8) When maintenance reset (encoder) is performed, today's maximum score value is the one after reset.

(9) Log data (log number, date, srore) will not be updated on non-working days.

[Related system status variables]

M_PMLogScr / M_PMScrEnc2

13.3.2. Score

M_PMScrDrv: Score (reduction gear)

[Function]

Returns the score of reduction gear of the specified axis.

[Format]

Example) <Numeric variable> = M_PMScrDrv(<Axis numbe>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMScrDrv(1)'The score of the reduction gear of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the score of the reduction gear including the reduction gear of each joint axis of the robot body (mechanical 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) Returns "0" when the joint axis does not have the target parts.

[Related system status variables]

M_PMLogScr / C_PMLogDrv

M_PMScrEnc1: Score (encoder data abnormality)

[Function]

Returns the score of encoder data error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMScrEnc1(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)
When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMScrEnc1(1)   'The score of the encoder data abnormality of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the score of encoder data abnormality of each joint axis of the robot body (mechanical 1).
(2) This variable is read only.
(3) Returns "-1" when the predictive maintenance function is disabled.
(4) Returns "0" when a nonexistent axis is specified in <Axis number>.
(5) The score value is the worst value from the time of the previous maintenance.
The worst value is retained until maintenance reset (for the encoder) of the target axis is performed.

[Related system status variables]

M_PMLogScr / C_PMLogEnc1

M_PMScrEnc2: Score (encoder communication abnormality)

[Function]

Returns the score of encoder communication error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMScrEnc2(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMScrEnc2(1)    'The score of encoder communication abnormality of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the score of encoder communication abnormality of each joint axis of the robot body (mechanical 1).

(2) This variable is read only.

(3) Returns "-1" when the predictive maintenance function is disabled.

(4) Returns "0" when a nonexistent axis is specified in <Axis number>.

(5) The score value is the worst value from the time of the previous maintenance.
The worst value is retained until maintenance reset (for the encoder) of the target axis is performed.

[Related system status variables]

M_PMLogScr / C_PMLogEnc2

13.3.3. Abnormality detection status

M_PMStsDrv: Abnormality detection status (reduction gear)

[Function]

Returns the abnormality detection status of reduction gear of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsDrv(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsDrv(1) 'The abnormality detection status of the reduction gear of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the abnormality detection status of the reduction gear including the reduction gear of each joint axis of the robot body (mechanical 1).
0 : The score is 0 or greater, less than the detection level
1 : The score is at the detection level or higher

(2) The abnormality detection status is retained once it exceeds the detection level until it is powered on or maintenance reset (other than the encoder) of the target axis is performed.

(3) The detection level can be specified by the "PMWNGDRV" parameter.

(4) This variable is read only.

(5) Returns "-1" when the predictive maintenance function is disabled.

(6) Returns "0" when a nonexistent axis is specified in <Axis number>.

(7) Returns "0" when the joint axis does not have the target parts.

[Related system status variables]

M_PMScrDrv

M_PMStsEnc1: Abnormality detection status (encoder data abnormality)

[Function]

Returns the abnormality detection status of encoder data error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsEnc1(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsEnc1(1)    'The abnormality detection status of encoder data abnormality of the J1 axis
                          is set in M1.
```

[Explanation]

(1) Returns the abnormality detection status of the reduction gear of each joint axis of the robot body (mechanical 1).
0 : The score is 0 or greater, less than the detection level
1 : The score is at the detection level or higher

(2) The abnormality detection status is retained once it exceeds the detection level until maintenance reset (for the encoder) of the target axis is performed.

(3) The detection level can be specified by the "PMWNGEN1" parameter.

(4) This variable is read only.

(5) Returns "-1" when the predictive maintenance function is disabled.

(6) Returns "0" when a nonexistent axis is specified in <Axis number>.

(7) Returns "0" when the joint axis does not have the target parts.

[Related system status variables]

M_PMScrEnc1

M_PMStsEnc2: Abnormality detection status (encoder communication abnormality)

[Function]

Returns the abnormality detection status of encoder communication error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMStsEnc2(<Axis number>)

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to get the cumulative rotation count. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMStsEnc2(1)    'The abnormality detection status of the encoder communication
                          abnormality of the J1 axis is set in M1.
```

[Explanation]

(1) Returns the abnormality detection status of the reduction gear of each joint axis of the robot body (mechanical 1).
0 : The score is 0 or greater, less than the detection level
1 : The score is at the detection level or higher

(2) The abnormality detection status is retained once it exceeds the detection level until maintenance reset (for the encoder) of the target axis is performed.

(3) The detection level can be specified by the "PMWNGEN2" parameter.

(4) This variable is read only.

(5) Returns "-1" when the predictive maintenance function is disabled.

(6) Returns "0" when a nonexistent axis is specified in <Axis number>.

(7) Returns "0" when the joint axis does not have the target parts.

[Related system status variables]

M_PMScrEnc2

M_PMStsBat: Abnormality detection status (battery voltage status)

[Function]

Returns the abnormality detection status of battery voltage.

[Format]

Example) <Numeric variable> = M_PMStsBat

[Terminology]

<Numeric variable>　Specify the numeric variable to assign.

[Sample]

```
1 M1 = M_PMStsBat     'The battery voltage status is set in M1.
```

[Explanation]

(1) Returns the battery voltage status of the robot body (mechanism 1).
0: Normal
1: Battery voltage low
2: Battery has run out

(2) This variable is read only.

(3) Returns "-1" when the predictive maintenance function is disabled.

13.3.4. Notification

M_PMRptDrv: Notification pause status (reduction gear)

[Function]

Returns the stop status of warning / signal output, of abnormality detection of reduction gear of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptDrv<Axis number>

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

When omitted, 1 is used.

[Sample]

```
1 M1 = M_PMRptDrv(1)    'The notification method of abnormality detection of the reduction gear of the
                         J1 axis is set in M1.
```

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to abnormality detection of the reduction gear including the reduction gear of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptEnc1: Notification pause status (encoder data abnormality)

[Function]

Returns the stop status of warning / signal output, of abnormality detection of encoder data error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptEnc1<Axis number>

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

When omitted, 1 is used.

[Sample]

1 M1 = M_PMRptEnc1(1) 'The notification method of abnormality detection of the J1 axis is set in M1.

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to abnormality detection of encoder data abnormality of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

M_PMRptEnc2: Notification pause status (encoder communication abnormality)

[Function]

Returns the stop status of warning / signal output, of abnormality detection of encoder communication error of the specified axis.

[Format]

Example) <Numeric variable> = M_PMRptEnc2<Axis number>

[Terminology]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis for which to get a log. (1 to 6)

When omitted, 1 is used.

[Sample]

1 M1 = M_PMRptEnc2(1) 'The notification method of abnormality detection of the J1 axis is set in M1.

[Explanation]

(1) Returns the pause status of warning occurrence/warning signal output, which occurs due to abnormality detection of encoder communication abnormality of the joint axis specified in <Axis number> of the robot body (mechanism 1). (1/0 = Enable/Disable)

(2) This variable is read only.

(3) Returns "-1" when the predictive maintenance function is disabled.

(4) Returns "0" when the joint axis does not exist.

(5) Returns "0" when the joint axis does not have the target parts.

13.3.5. Detection level

M_PMWngDrv : Detection level (reduction gear abnormality detection)

[Function]

Returns the detection level (reduction gear abnormality detection) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMWngDrv<Axis number>

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to retrieve the detection level (reduction gear abnormality detection) from. (1 to 6)

When omitted, 1 is used.

[Example]

```
M1 = M_PMWngDrv(1)    'The detection level (reduction gear abnormality detection) of Axis J1 is set in M1.
```

[Comments]

(1) Returns the detection level (reduction gear abnormality detection) of the joint axis specified in <Axis number> for the robot (mechanism 1).

(2) This variable is read-only.

M_PMWngEnc1 : Detection level (encoder data abnormality detection)

[Function]

Returns the detection level (encoder data abnormality detection) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMWngEnc1<Axis number>

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to retrieve the detection level (encoder data abnormality detection) from. (1 to 6) When omitted, 1 is used.

[Example]

```
M1 = M_PMWngEnc1(1)     'The detection level (encoder data abnormality detection) of Axis J1 is
                         set in M1.
```

[Comments]

(1) Returns the detection level (encoder data abnormality detection) of the joint axis specified in <Axis number> for the robot (mechanism 1).

(2) This variable is read-only.

M_PMWngEnc2 : Detection level (encoder communication abnormality detection)

[Function]

Returns the detection level (encoder communication abnormality detection) of the specified axis.

[Syntax]

Example) <Numeric variable> = M_PMWngEnc2<Axis number>

[Term]

<Numeric variable> Specify the numeric variable to assign.

<Axis number> Specify the joint axis to retrieve the detection level (encoder communication abnormality detection) from. (1 to 6)

When omitted, 1 is used.

[Example]

```
M1 = M_PMWngEnc2(1)     'The detection level (encoder communication abnormality
                         detection) of Axis J1 is set in M1.
```

[Comments]

(1) Returns the detection level (encoder communication abnormality detection) of the joint axis specified in <Axis number> for the robot (mechanism 1).

(2) This variable is read-only.

14. Parameter

14.1. Common to predictive maintenance functions

(*1 Attributes in the table, R: Read only, W: Write only, R/W: Read/write)

Parameter	Parameter name	Number of elements	Details explanation	Factory setting	Attribute *1)
Pause method of warning occurrence	PMSTPWAY	Integer 1	Specify the pause method of warning occurrence or warning signal output of the predictive/preventive maintenance function. Specify the behavior of the predictive/preventive maintenance function when warning occurrence or warning signal output is paused. 1: Pause until maintenance (occurs only once when power is input). (Warning occurs or a warning signal is output once immediately after power input and pause continues after reset.) 2: Pause until maintenance (stops as well when power is input)	1	R/W
Predictive/preventive maintenance function enable/disable switching	PMENA	Integer 1	Specify enable/disable of the predictive/preventive maintenance function. This parameter is used when a customer who uses the "MELFA Smart Plus Card Pack" disables the predictive/preventive maintenance function in order to continue using the maintenance forecast.	0	R/W
Predictive maintenance function enable/disable status	MSPPMENB	Integer 1	You can check whether or not the predictive maintenance function is enabled. (Read only) 1: Enable 0: Disable		R
Version management of predictive/preventive maintenance function	PMVER	Character string	Manages the version of the predictive/preventive maintenance function.		R

14.2. Consumption degree calculation function

14.2.1. Setting parameters

(*1 Attributes in the table, R: Read only, W: Write only, R/W: Read/write)

Parameter	Parameter name	Number of elements	Details explanation	Factory setting	Attribute *1)
Warning remaining number of days and operation time of a day	PMWNGDAY	Integer 2	Specify the warning remaining number of days and operation time of a day of the predictive/preventive maintenance function. ■Element 1 Specify the remaining number of days (remaining recommended maintenance time) to issue a warning by the predictive/preventive maintenance function. Unit: [day] Setting range: 0 or higher ■Element 2 Specify the operation time of a day used by the predictive/preventive maintenance function. Unit: [h] (time) Setting range: 1 to 24 * The warning remaining number of days is calculated by Element 1 x Element 2.	(30, 16)	R/W
Notification interval of part consumption	PMWNGTI	Integer 1	Specify the notification interval of part consumption of the predictive/preventive maintenance function. Specify the interval (hours) to issue a warning by the predictive/preventive maintenance function. After warning/signal output is reset, warning does not occur until the specified hours elapses. Unit: [h] (time) Setting range: 1 to 24	6	R/W

Parameter	Parameter name	Number of elements	Details explanation	Factory setting	Attribute *1)
Notification method of maintenance part consumption	PMRPTMNT	Integer 2	Specify the notification method of the predictive/preventive maintenance function. (Maintenance part consumption) Specify the behavior when the warning occurrence detection level by the predictive/preventive maintenance function exceeded the remaining time (remaining recommended maintenance time) of the maintenance parts. Element 1: Issues warning/does not issue warning (1/0) Element 2: Outputs/does not output dedicated signals (1/0)	0, 0	R/W
Notification method of overhaul part consumption	PMRPTOH	Integer 2	Specify the notification method of the predictive/preventive maintenance function. (Overhaul part consumption) Specify the behavior when the warning occurrence detection level by the predictive/preventive maintenance function exceeded the remaining time (remaining recommended maintenance time) of the part requiring overhaul. Element 1: Issues warning/does not issue warning (1/0) Element 2: Outputs/does not output dedicated signals (1/0)	0, 0	R/W

14.2.2. Data acquisition parameters

The following operations are possible using the data acquisition parameters of the consumption degree calculation function.

Get the integration time and accumulation count from the previous overhaul. (Total)
Get the consumption degree [%] of the target part. (Total/for each joint axis)
Get the remaining time [h] to the recommended maintenance time of the target part. (Total/for each joint axis)

(*1 Attributes in the table, R: Read only, W: Write only, R/W: Read/write)

<Integration time>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Power ON time from the previous overhaul	TIMPOWON	Integer 1	Power ON time from the previous overhaul * "-1" when the predictive/preventive maintenance function is disabled.	R
Servo ON time from the previous overhaul	TIMSRVON	Integer 1	Servo ON time from the previous overhaul * "-1" when the predictive/preventive maintenance function is disabled.	R
Operation time from the previous overhaul	TIMPRG	Integer 1	Operation time from the previous overhaul * "-1" when the predictive/preventive maintenance function is disabled.	R
Actual operation time from the previous overhaul	TIMMOV	Integer 1	Actual operation time from the previous overhaul * "-1" when the predictive/preventive maintenance function is disabled.	R

<Accumulation count>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Servo ON count from the previous overhaul	NUMSRVON	Integer 1	Servo ON count from the previous overhaul * "-1" when the predictive/preventive maintenance function is disabled.	R
Servo ON time from the previous overhaul	NUMMTROT	Real number 8	Motor cumulative rotation count from the previous overhaul (up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R

<Getting consumption degree>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Consumption degree of the predictive/preventive maintenance function (mechanism total (maintenance parts))	CSMPMMNT	Real number 1	Consumption degree of the predictive/preventive maintenance function (mechanism total (maintenance parts)) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled.	R
Consumption degree of the predictive/preventive maintenance function (mechanism total (overhaul parts))	CSMPMOH	Real number 1	Consumption degree of the predictive/preventive maintenance function (mechanism total (overhaul parts)) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled.	R

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Consumption degree of the predictive/preventive maintenance function (grease)	CSMPMGRS	Real number 8	Consumption degree of the predictive/preventive maintenance function (grease) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R
Consumption degree of the predictive/preventive maintenance function (timing belt)	CSMPMBLT	Real number 8	Consumption degree of the predictive/preventive maintenance function (timing belt) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R
Consumption degree of the predictive/preventive maintenance function (reduction gear)	CSMPMDEC	Real number 8	Consumption degree of the predictive/preventive maintenance function (reduction gear) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R
Consumption degree of the predictive/preventive maintenance function (bearing)	CSMPMBRG	Real number 8	Consumption degree of the predictive/preventive maintenance function (bearing) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R
Consumption degree of the predictive/preventive maintenance function (ball screw/ball spline)	CSMPMBSS	Real number 8	Consumption degree of the predictive/preventive maintenance function (ball screw/ball spline) (Up to three decimal places) * "-1" when the predictive/preventive maintenance function is disabled, and "0" when the axis does not exist.	R

<Getting remaining time>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Remaining time of the predictive/preventive maintenance function (mechanism total (maintenance parts))	RMNPMMNT	Integer 1	Remaining time of the predictive/preventive maintenance function (mechanism total (maintenance parts)) * "-1" when the predictive/preventive maintenance function is disabled.	R
Remaining time of the predictive/preventive maintenance function (servo ON time (at overhaul implementation))	RMNPMSRV	Integer 1	Remaining time of the predictive/preventive maintenance function (servo ON time (at overhaul implementation)) * "-1" when the predictive/preventive maintenance function is disabled.	R

<Getting consumption status>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Consumption status of the predictive/preventive maintenance function (mechanism total (maintenance parts))	STSPMMNT	Integer 1	Consumption status of the predictive/preventive maintenance function (mechanism total (maintenance parts)) -1: The predictive/preventive maintenance function is disabled 0: The remaining time exceeded the warning occurrence remaining time. 1: The remaining time is less than the warning occurrence remaining time, exceeded 0 [h]. 2: The remaining time is 0 [h] or less.	R
Consumption status of the predictive/preventive maintenance function (mechanism total (overhaul parts))	STSPMOH	Integer 1	Consumption status of the predictive/preventive maintenance function (mechanism total (overhaul parts)) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT).	R
Consumption status of the predictive/preventive maintenance function (grease)	STSPMGRS	Integer 8	Consumption status of the predictive/predictive/preventive maintenance function (grease) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT). * "0" when the axis does not exist.	R
Consumption status of the predictive/preventive maintenance function (timing belt)	STSPMBLT	Integer 8	Consumption status of the predictive/preventive maintenance function (timing belt) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT). * "0" when the axis does not exist.	R
Consumption status of the predictive/preventive maintenance function (reduction gear)	STSPMDEC	Integer 8	Consumption status of the predictive/preventive maintenance function (reduction gear) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT). * "0" when the axis does not exist.	R
Consumption status of the predictive/preventive maintenance function (bearing)	STSPMBRG	Integer 8	Consumption status of the predictive/preventive maintenance function (bearing) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT). * "0" when the axis does not exist.	R
Consumption status of the predictive/preventive maintenance function (ball screw/ball spline)	STSPMBSS	Integer 8	Consumption status of the predictive/preventive maintenance function (ball screw/ball spline) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT). * "0" when the axis does not exist.	R

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Consumption status of the predictive/preventive maintenance function (servo ON time (at overhaul implementation))	STSPMSRV	Integer 1	Consumption status of the predictive/preventive maintenance function (servo ON time (at overhaul implementation)) The meaning of the value is the same as that of the mechanism total (maintenance parts) (STSPMMNT).	R

14.2.3. Operation parameters

The following operations are possible using the parameters for operation of the consumption degree calculation function.

Reset consumption degree reset of the target part. (For each joint axis)
Pause occurrence of warnings until consumption degree reset of the target part. (For each joint axis)
Get the consumption degree warning occurrence status or pause status of the target part. (For each joint axis)
Get the maintenance log data of the target part. (For each joint axis)
(*1 Attributes in the table, R: Read only, W: Write only, R/W: Read/write)

<Consumption degree reset>

<table>
<tr><th>Parameter</th><th>Parameter name</th><th>Number of elements</th><th>Details explanation</th><th>Attribute *1)</th></tr>
<tr><td>Consumption degree (grease) accumulated data reset</td><td>RSTPMGRS</td><td>Integer 1</td><td>Resets accumulated data related to the consumption degree (grease) of the predictive/preventive maintenance function. (When the specified axis is under pause of warning occurrence, the pause status is canceled at the same time.)
In order to prevent mis-operation, the value upon reading is [-1] (out of setting range).
<table>
<tr><th>Value</th><th>Read</th><th>Writing</th></tr>
<tr><td>0</td><td>－</td><td>Resets all axes</td></tr>
<tr><td>1 to 6</td><td>－</td><td>Resets the specified axis number only</td></tr>
<tr><td>Other</td><td>－</td><td>C.7081(04000) : Out of range
C.7081(03000) : Other than numeric value</td></tr>
</table>
</td><td>W</td></tr>
<tr><td>Consumption degree (timing belt) accumulated data reset</td><td>RSTPMBLT</td><td>Integer 1</td><td>Resets accumulated data related to the consumption degree (timing belt) of the predictive/preventive maintenance function.
* The meaning of reading and writing is the same as that of grease (RSTPMGRS).</td><td>W</td></tr>
<tr><td>Consumption degree (reduction gear) accumulated data reset</td><td>RSTPMDEC</td><td>Integer 1</td><td>Resets accumulated data related to the consumption degree (reduction gear) of the predictive/preventive maintenance function.
* The meaning of reading and writing is the same as that of grease (RSTPMGRS).</td><td>W</td></tr>
<tr><td>Consumption degree (bearing) accumulated data reset</td><td>RSTPMBRG</td><td>Integer 1</td><td>Resets accumulated data related to the consumption degree (bearing) of the predictive/preventive maintenance function.
* The meaning of reading and writing is the same as that of grease (RSTPMGRS).</td><td>W</td></tr>
<tr><td>Consumption degree (ball screw/ball spline) accumulated data reset</td><td>RSTPMBSS</td><td>Integer 1</td><td>Resets accumulated data related to the consumption degree (ball screw/ball spline) of the predictive/preventive maintenance function.
* The meaning of reading and writing is the same as that of grease (RSTPMGRS).</td><td>W</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Parameter name</th><th>Number of elements</th><th>Details explanation</th><th>Attribute *1)</th></tr>
<tr><td>Operating information (integration time, accumulation count) total accumulated data reset</td><td>RSTPMOH</td><td>Integer 1</td><td>Resets total accumulated data related to the operating information (integration time, accumulation count) of the predictive/preventive maintenance function. (Used at the time of overhaul.)
In order to prevent mis-operation, the value upon reading is [-1] (out of setting range).
<table>
<tr><th>Value</th><th>Read</th><th>Writing</th></tr>
<tr><td>1</td><td>－</td><td>Reset</td></tr>
<tr><td>Other</td><td>－</td><td>C.7081(04000) : Out of range
C.7081(03000) : Other than numeric value</td></tr>
</table></td><td>W</td></tr>
<tr><td>Consumption degree, operating information (integration time, accumulation count) total accumulated data reset</td><td>RSTPMNEW</td><td>Integer 1</td><td>Resets total accumulated data related to the consumption degree and operating information (integration time, accumulation count) of the predictive/preventive maintenance function. (Used at the time of mechanism replacement.)
* The meaning of reading and writing is the same as that of overhaul (RSTPMOH).</td><td>W</td></tr>
</table>

<Pausing warning occurrence/signal output>

<table>
<tr><th>Parameter</th><th>Parameter name</th><th>Number of elements</th><th>Details explanation</th><th>Attribute *1)</th></tr>
<tr><td>Consumption degree (grease) of each joint axis
Specifying pause of warning occurrence/warning signal output</td><td>RPTPMGRS</td><td>Integer 8</td><td>Specifies pause of warning occurrence/warning signal output of the consumption degree (grease) of each joint axis.
<table>
<tr><th>Value</th><th>Read</th><th>Writing</th></tr>
<tr><td>-1</td><td>The predictive/preventive maintenance function is disabled</td><td>C.7081(04000) : Out of range</td></tr>
<tr><td>0</td><td>Pause disabled</td><td>Pause disabled</td></tr>
<tr><td>1</td><td>Pause enabled</td><td>Pause enabled</td></tr>
<tr><td>Other</td><td>－</td><td>C.7081(04000) : Out of range
C.7081(03000) : Other than numeric value</td></tr>
</table></td><td>R/W</td></tr>
<tr><td>Consumption degree (timing belt)
Specifying pause of warning occurrence/warning signal output</td><td>RPTPMBLT</td><td>Integer 8</td><td>Specifies pause of warning occurrence/warning signal output of the consumption degree (timing belt) of each joint axis.
* The meaning of reading and writing is the same as that of grease (RPTPMGRS).</td><td>R/W</td></tr>
</table>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Consumption degree (reduction gear) Specifying pause of warning occurrence/warning signal output	RPTPMDEC	Integer 8	Specifies pause of warning occurrence/warning signal output of the consumption degree (reduction gear) of each joint axis. * The meaning of reading and writing is the same as that of grease (RPTPMGRS).	R/W
Consumption degree (bearing) Specifying pause of warning occurrence/warning signal output	RPTPMBRG	Integer 8	Specifies pause of warning occurrence/warning signal output of the consumption degree (bearing) of each joint axis. * The meaning of reading and writing is the same as that of grease (RPTPMGRS).	R/W
Consumption degree (ball screw/ball spline) Specifying pause of warning occurrence/warning signal output	RPTPMBSS	Integer 8	Specifies pause of warning occurrence/warning signal output of the consumption degree (ball screw/ball spline) of each joint axis. * The meaning of reading and writing is the same as that of grease (RPTPMGRS).	R/W
Servo ON time (at overhaul implementation) Specifying pause of warning occurrence/warning signal output	RPTPMSRV	Integer 1	Specifies pause of warning occurrence/warning signal output of the servo ON time (at overhaul implementation). * The meaning of reading and writing is the same as that of grease (RPTPMGRS).	R/W

<Maintenance log>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Specifying data to get maintenance log	LOGPMNO	Integer 2	Specifies the data to get the maintenance log of the predictive/preventive maintenance function. It is possible to get specified data (log number, joint axis number) for each part using the following virtual parameters. Element 1: Log number of maintenance log (1 to 10) * The log number of the last reset date & time is "1". Element 2: Joint axis number of maintenance log (1 to 6) * When an out of range value is specified, "C.7081(04000): value is out of range", when a value other than numeric is specified, "C.7081(03000): value is out of range" is used.	R/W
Getting maintenance log data (grease)	LOGPMGRS	Character string 6	Gets maintenance log data (grease). Element 1: Log number (1 to 10) Element 2: Joint axis number (1 to 6) Element 3: Reset date (YYYY/MM/DD) Element 4: Reset time (hh: mm: ss) Element 5: Consumption degree [%] at reset (up to three decimal places) Element 6: Reset count [times] * If a log number with which there is no recorded data or nonexistent joint axis number is specified, the output becomes as follows: Element 3: "----/--/--" Element 4: "--:--:--" Element 5: 0.000 * If the predictive/preventive maintenance function is disabled, the output becomes as follows: Element 3: "" Element 4: "" Element 5: -1.000 Element 6: -1	R
Getting maintenance log (timing belt) data	LOGPMBLT	Character string 6	Gets maintenance log (timing belt) data. * The meaning of data is the same as that of the grease (LOGPMGRS).	R
Getting maintenance log (reduction gear) data	LOGPMDEC	Character string 6	Gets maintenance log (reduction gear) data. * The meaning of data is the same as that of the grease (LOGPMGRS).	R
Getting maintenance log (bearing) dat	LOGPMBRG	Character string 6	Gets maintenance log (bearing) data. * The meaning of data is the same as that of the grease (LOGPMGRS).	R
Getting maintenance log (ball screw/ball spline) data	LOGPMBSS	Character string 6	Gets maintenance log (ball screw/ball spline) data. * The meaning of data is the same as that of the grease (LOGPMGRS).	R

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Getting maintenance log (overhaul) data	LOGPMOH	Character string 6	Gets maintenance log (overhaul) data. Element 5: Servo ON time [h] at reset (integer) * If a log number with which there is no recorded data or nonexistent joint axis number is specified, the output becomes as follows: Element 5: 0 * If the predictive/preventive maintenance function is disabled, the output becomes as follows: Element 5: -1 * The meaning of data is the same as that of the grease (LOGPMGRS).	R

14.3. Abnormality detection function

14.3.1. Setting parameters

(*1 Attributes in the table, R: Read only, W: Write only, R/W: Read/write)

Parameter	Parameter name	Number of elements	Details explanation	Factory setting	Attribute *1)
Detection level (reduction gear abnormality detection)	PMWNGDRV	Integer 6	Specify the detection level of the predictive maintenance function (reduction gear abnormality detection). Specify the score which causes a warning by the predictive maintenance function for the reduction gear including the reduction gear of each joint axis. Setting range: -1 or higher *-1: When you set -1, detection is disabled * This parameter can be written while the program is in operation.	-1, -1, -1, -1, -1, -1, -1, -1	R/W
Detection level (encoder data abnormality detection)	PMWNGEN1	Integer 6	Specify the detection level of the predictive maintenance function (encoder data abnormality detection). Specify the score (encoder data abnormality) which causes a warning for the encoder of each joint axis to occur by the predictive maintenance function. Setting range: -1 to 100 *-1: When you set -1, detection is disabled * This parameter can be written while the program is in operation.	30, 30, 30, 30, 30, 30, 30, 30	R/W
Detection level (encoder communication abnormality detection)	PMWNGEN2	Integer 6	Specify the detection level of the predictive maintenance function (encoder communication abnormality detection). Specify the score (encoder communication abnormality) which causes a warning for the encoder of each joint axis to occur by the predictive maintenance function. Setting range: -1 to 100 *-1: When you set -1, detection is disabled * This parameter can be written while the program is in operation.	30, 30, 30, 30, 30, 30, 30, 30	R/W
Notification method of abnormality detection	PMRPTSCR	Integer 2	Specify the notification method of the predictive maintenance function (abnormality detection). Specify the behavior of the predictive maintenance function when the score exceeded the detection level. Element 1: Issues warning/does not issue warning (1/0) Element 2: Outputs/does not output dedicated signal (1/0)	0, 0	R/W

14.3.2. Data acquisition parameters

The following operations are possible using the data acquisition parameters of the abnormality detection function.

Get the score of the target part (For each joint axis)
Get the abnormal status of the target part (For each joint axis)

(*1 Attributes in the table ... R: Read only, W: Write only, R/W: Read/write)

<Getting score>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Score (reduction gear abnormality detection)	SCRPMDRV	Real number 8	Score of the predictive maintenance function (reduction gear abnormality detection) (Up to three decimal places) * "-1" when the predictive maintenance function is disabled, and "0" when the axis does not exist.	R
Score (encoder data abnormality detection)	SCRPMEN1	Real number 8	Score of the predictive maintenance function (encoder data abnormality detection) (Up to three decimal places) * "-1" when the predictive maintenance function is disabled, and "0" when the axis does not exist.	R
Score (encoder communication abnormality detection)	SCRPMEN2	Real number 8	Score of the predictive maintenance function (encoder communication abnormality detection) (Up to three decimal places) * "-1" when the predictive maintenance function is disabled, and "0" when the axis does not exist.	R

<Getting abnormal status>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Abnormality detection status (reduction gear)	STSPMDRV	Integer 8	Abnormality detection status of the predictive maintenance function (reduction gear) -1: The predictive maintenance function is disabled 0: The score is 0 or greater, less than the warning occurence level 1: The score is at the detection level or higher * "0" when the axis does not exist.	R
Abnormality detection status (encoder data abnormality)	STSPMEN1	Integer 8	Abnormality detection status of the predictive maintenance function (encoder data abnormality) -1: The predictive maintenance function is disabled 0: The score is 0 or greater, less than the detection level 1: The score is at the detection level or higher * "0" when the axis does not exist.	R
Abnormality detection status (encoder communication abnormality)	STSPMEN2	Integer 8	Abnormality detection status of the predictive maintenance function (encoder communication abnormality) -1: The predictive maintenance function is disabled 0: The score is 0 or greater, less than the detection level 1: The score is at the detection level or higher * "0" when the axis does not exist.	R

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Abnormality detection status (battery voltage)	STSPMBAT	Integer 1	Abnormality detection status of the predictive maintenance function (battery voltage) -1: The predictive maintenance function is disabled 0: Normal 1: Battery voltage low 2: Battery voltage has run out	R

14.3.3. Operation parameters

The following operations are possible using the operation parameters of the abnormality detection function.

Score maximum value reset (encoder data abnormality, encoder communication abnormality) (For each joint axis)
Pauses occurrence of a warning until maintenance of the target part. (For each joint axis)
Gets the warning occurrence status or pause status of the target part. (For each joint axis)
Gets the abnormality detection log data of the target part. (For each joint axis)
(*1 Attributes in the table ... R: Read only, W: Write only, R/W: Read/write)

<Score maximum value reset>

<table>
<tr><th>Parameter</th><th>Parameter name</th><th>Number of elements</th><th>Details explanation</th><th>Attribute *1)</th></tr>
<tr><td>Score maximum value reset</td><td>RSTPMENC</td><td>Integer 1</td><td>Resets the maximum value data related to the score (encoder data abnormality, encoder communication abnormality) of the predictive maintenance function.
In order to prevent mis-operation, the value upon reading is [-1] (out of setting range).
(When the specified axis is under pause of warning occurrence, the pause status is canceled at the same time.)
<table>
<tr><th>Value</th><th>Read</th><th>Writing</th></tr>
<tr><td>0</td><td>－</td><td>Resets all axes</td></tr>
<tr><td>1 to 6</td><td>－</td><td>Resets the specified axis number only</td></tr>
<tr><td>Other</td><td>－</td><td>C.7081(04000): Out of range
C.7081(03000): Other than numeric value</td></tr>
</table>
</td><td>W</td></tr>
</table>

<Pausing warning occurrence/signal output>

<table>
<tr><th>Parameter</th><th>Parameter name</th><th>Number of elements</th><th>Details explanation</th><th>Attribute *1)</th></tr>
<tr><td>Reduction gear abnormality detection
Specifying pause of warning occurrence/
signal output</td><td>RPTPMDRV</td><td>Integer 8</td><td>Specify pause of warning occurrence/warning signal output of the abnormality detection (reduction gear) of each joint axis.
<table>
<tr><th>Value</th><th>Read</th><th>Writing</th></tr>
<tr><td>-1</td><td>The predictive maintenance function is disabled</td><td>C.7081(04000): Out of range</td></tr>
<tr><td>0</td><td>Pause disabled</td><td>Pause disabled</td></tr>
<tr><td>1</td><td>Pause enabled</td><td>Pause enabled</td></tr>
<tr><td>Other</td><td>－</td><td>C.7081(04000): Out of range
C.7081(03000): Other than numeric value</td></tr>
</table>
</td><td>R/W</td></tr>
</table>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Encoder data abnormality detection Pause of warning occurrence/ signal output	RPTPMEN1	Integer 8	Specify pause of warning occurrence/warning signal output of the abnormality detection (encoder data abnormality) of each joint axis. * The meaning of reading and writing is the same as that of the reduction gear (RPTPMDRV).	R/W
Encoder communication abnormality detection Specifying warning occurrence/ signal output pause	RPTPMEN2	Integer 8	Specify pause of warning occurrence/warning signal output of the abnormality detection (encoder communication abnormality) of each joint axis. * The meaning of reading and writing is the same as that of the reduction gear (RPTPMDRV).	R/W

<Abnormality detection log>

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Specifying data to get abnormal detection log	LOGPMDAY	Integer 1	Specify the data to get the abnormality detection log of the predictive maintenance function. It is possible to get specified data (log number, joint axis number) for each part using the following virtual parameters. Element 1: Log number of abnormal detection log (1 to 365) * Gets the data of [Log no. - 1] days before. * When "1" is specified, the data of the day is obtained. * Log data (log number, date, srore) will not be updated on non-working days. When an out of range value is specified, "C.7081(04000): value is out of range", when a value other than numeric is specified, "C.7081(03000) : value is out of range" is used.	R/W

Parameter	Parameter name	Number of elements	Details explanation	Attribute *1)
Getting abnormality detection log (reduction gear) data	LOGPMDRV	Character string 10	Gets the abnormality detection log (reduction gear) data. Element 1: Log number (1 to 365) Element 2: Date (YYYY/MM/DD) Element 3: The maximum score value of the specified day (J1 axis) (Up to three decimal places) Element 4: The maximum score value of the specified day (J2 axis) (Up to three decimal places) Element 5: The maximum score value of the specified day (J3 axis) (Up to three decimal places) Element 6: The maximum score value of the specified day (J4 axis) (Up to three decimal places) Element 7: The maximum score value of the specified day (J5 axis) (Up to three decimal places) Element 8: The maximum score value of the specified day (J6 axis) (Up to three decimal places) Element 9: The maximum score value of the specified day (J7 axis) (Up to three decimal places) Element 10: The maximum score value of the specified day (J8 axis) (Up to three decimal places) * If a log number with which there is no recorded data or nonexistent joint axis number is specified, the output becomes as follows: Element 2: "----/--/--" Element 3 to 10: 0.000 * If the predictive maintenance function is disabled, the output becomes as follows: Element 2: "" Element 3 to 10: -1.000	R
Getting abnormality detection log data (encoder data abnormality)	LOGPMEN1	Character string 10	Gets abnormality detection log data (encoder data abnormality). * The meaning of the data is the same as that of the reduction gear (LOGPMDRV).	R
Getting abnormality detection log data (encoder communication abnormality)	LOGPMEN2	Character string 10	Gets abnormality detection log data (encoder communication abnormality). * The meaning of the data is the same as that of the reduction gear (LOGPMDRV).	R

15. Dedicated input/output signals

This section describes dedicated input/output signals related to the predictive maintenance function.

To use those signals, from the Predictive Maintenance screen, click the [Setting] - [Signal] screen and assign a signal number to the respective parameter. (Note 1)
For the setting procedure for signal numbers, refer to "3 Startup and initial settings, 3.2.3 Setting signals".

For details on dedicated input/output signals, refer to the separate volume, "CR800 Series Controller INSTRUCTION MANUAL Detailed explanations of functions and operations".

Note 1) Set the signal numbers according to the system to be used. The range of values that can be set in the parameters are 0 to 255, 2000 to 5071, 6000 to 8047, and 10000 to 18191.

15.1. Consumption degree calculation function

It is possible to check the status with dedicated output signals in case the remaining time up to the recommended replacement/maintenance time of each part or the remaining time up to the specified overhaul time exceeded the warning occurrence detection level specified by the "PMWNGDAY" parameter. Also, you can reset the consumption degree [%] of the predictive maintenance function using a dedicated input signal.

Caution

- If the predictive maintenance function is disabled, the output is always OFF.
- For parts for each joint axis, if even one of the axes exceeds the warning occurrence detection level, the signal becomes ON.
- In case of maintenance part (grease, timing belt), the signal is output only when the PMRPTMNT parameter's Element 2 is ON (output), and if the predictive maintenance function is disabled, the signal is always OFF.
- In case of an overhaul part (reduction gear, bearing, ball screw, ball spline) and servo ON time, the signal is output only when the PMRPTOH parameter's Element 2 is ON (output), and if the predictive maintenance function is disabled, the signal is always OFF.

<Dedicated warning output>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMSIGMNT	Input	–	–	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (maintenance part) Outputs the effect that the remaining time (remaining recommended maintenance time) of the mechanism total (maintenance parts) exceeded the warning occurrence detection level.	―	-1	-1
PMSIGOH	Input	–	–	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (overhaul part) Outputs the effect that the remaining time (remaining recommended maintenance time) of the mechanism total (overhaul parts) exceeded the warning occurrence detection level.	–	-1	-1

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMSIGGRS	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (grease) Outputs the effect that the remaining time (remaining recommended maintenance time) of the grease exceeded the warning occurrence detection level.	−	-1	-1
PMSIGBLT	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (timing belt) Outputs the effect that the remaining time (remaining recommended maintenance time) of the timing belt exceeded the warning occurrence detection level.	−	-1	-1
PMSIGDEC	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (decelerator) Outputs the effect that the remaining time (remaining recommended maintenance time) of the reduction gear exceeded the warning occurrence detection level.	−	-1	-1
PMSIGBRG	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (bearing) Outputs the effect that the remaining time (remaining recommended maintenance time) of the bearing exceeded the warning occurrence detection level.	−	-1	-1
PMSIGBSS	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (ball screw/ball spline) Outputs the effect that the remaining time (remaining recommended maintenance time) of the ball screw/ball spline exceeded the warning occurrence detection level.	−	-1	-1
PMSIGSRV	Input	−	−	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive/preventive maintenance (servo on time) Outputs that the servo ON time reached the overhaul implementation time.	−	-1	-1

<Consumption degree reset>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMRSTGRS	Input	Consumption degree reset of predictive/preventive maintenance (grease) Resets the grease consumption degree information. * The reset target axis is specified in IODATA or DIODATA using the axis bit pattern.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTBLT	Input	Consumption degree reset of predictive/preventive maintenance (timing belt) Resets the timing belt consumption degree information. * The reset target axis is specified in IODATA or DIODATA using the axis bit pattern.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTDEC	Input	Consumption degree reset of predictive/preventive maintenance (decelerator) Resets the reduction gear consumption degree information. * The reset target axis is specified in IODATA or DIODATA using the axis bit pattern.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTBRG	Input	Consumption degree reset of predictive/preventive maintenance (bearing) Resets the bearing consumption degree information. * The reset target axis is specified in IODATA or DIODATA using the axis bit pattern.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTBSS	Input	Consumption degree reset of predictive/preventive maintenance (ball screw/ball spline) Resets the ball screw/ball spline consumption degree information. * The reset target axis is specified in IODATA or DIODATA using the axis bit pattern.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTOH	Input	Consumption degree reset of predictive/preventive maintenance (overhaul) Resets the consumption degree information and operating information (integration time/accumulation count) of all parts. * The reset target axis is all axes.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1
PMRSTNEW	Input	Consumption degree reset of predictive/preventive maintenance (replace to new robot) Resets the consumption degree information and operating information (integration time/accumulation count) of all parts. * The reset target axis is all axes.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1

<Pausing warning occurrence/signal output>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMSTPGRS	Input	Pause of warning and warning signal output (grease) * The pause target axis is specified in IODATA or DIODATA using the axis bit pattern. Pause of unspecified axes is canceled.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPBLT	Input	Pause of warning and warning signal output (timing belt) * The pause target axis is specified in IODATA or DIODATA using the axis bit pattern. Pause of unspecified axes is canceled.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPDEC	Input	Pause of warning and warning signal output (decelerator) * The pause target axis is specified in IODATA or DIODATA using the axis bit pattern. Pause of unspecified axes is canceled.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPBRG	Input	Pause of warning and warning signal output (bearing) * The pause target axis is specified in IODATA or DIODATA using the axis bit pattern. Pause of unspecified axes is canceled.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPBSS	Input	Pause of warning and warning signal output (ball screw/ball spline) * The pause target axis is specified in IODATA or DIODATA using the axis bit pattern. Pause of unspecified axes is canceled.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPSRV	Input	Pause of warning and warning signal output (servo on time) * Enable/disable of pause is specified by bit0 of IODATA or DIODATA.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1

15.2. Abnormality detection function

This function allows you to check the abnormality detection status using dedicated output signals. (Use parameters to specify the detection level or presence of signal output.)

⚠ Caution

- The signal changes only when Element 2 of the PMRPTSCR parameter is "1" (output).
- If the predictive maintenance function is disabled, the output is always OFF.
- For parts for each joint axis, if even one of the axes exceeds the warning occurrence detection level, the signal becomes ON.

<Dedicated warning output>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMSIGDRV	Input	–	–	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive maintenance (reduction gear abnormality detection) Outputs the effect that the score of the reduction gear exceeded the detection level. * The detection level is specified by the PMWNGDRV parameter.	–	-1	-1
PMSIGEN1	Input	–	–	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive maintenance (encoder data abnormality detection) Outputs the effect that the score of the encoder data abnormality exceeded the detection level. * The detection level is specified by the PMWNGEN1 parameter.	–	-1	-1
PMSIGEN2	Input	–	–	-1 (No meaning),	-1 (No meaning),
	Output	Maintenance warning of predictive maintenance (encoder communication abnormality detection) Outputs the effect that the score of the encoder communication abnormality exceeded the detection level. * The detection level is specified by the PMWNGEN2 parameter.	–	-1	-1

<Reset>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMRSTENC	Input	Status information reset of the abnormality detection of predictive maintenance.(encoder) Resets the abnormality detection status information of the encoder. * The axis bit pattern is specified by the IODATA or DIODATA parameter.	–	-1,	-1,
	Output	Outputs the reset completion.	–	-1	-1

<Pausing warning occurrence/signal output>

Parameter name	Category	Function	Signal level	Signal number at factory default	
				CR800-R/Q	CR800-D
PMSTPDRV	Input	Pause of warning and warning signal output (reduction gear abnormality detection) * The axis bit pattern is specified by the IODATA or DIODATA parameter.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPEN1	Input	Pause of warning and warning signal output (encoder data abnormality detection) * The axis bit pattern is specified by the IODATA or DIODATA parameter.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1
PMSTPEN2	Input	Pause of warning and warning signal output (encoder communication abnormality detection) * The axis bit pattern is specified by the IODATA or DIODATA parameter.	–	-1,	-1,
	Output	Outputs the completion of pause specification change.	–	-1	-1

16. Troubleshooting

16.1. Error number list

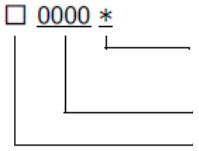
This section describes the cause and countermeasure to take for the error numbers when errors related to the predictive maintenance function occurs. In event of an error, refer to this chapter and take appropriate action.

For other error numbers described in this chapter, refer to the separate volume, "Troubleshooting in CR800 Series Controller Instruction Manual".

When an error occurs, the ERROR LED in front of the robot controller lights up or flashes.

ERROR LED status	Description
On	Low-level error, or warning occurred.
Flashing	High-level error occurred.
Off	Normal operation.

The meaning of the error numbers is explained below.



- Errors marked with an * are those required for power reset.
  Take action according to the countermeasures given.
- The error type is indicated by a four-digit number.
- There are 3 types of errors.
  H:High-level error.....Servo turns off.
  L:Low-level error.....Operation stops.
  C:Warning.....Operation continues.

- "n" indicated in the last one digit of the error number is the robot axis number.
  Example) Motor overcurrent error of H0931J1 axis.

16.1.1. Common to predictive maintenance functions

Functions such as consumption degree calculation of the predictive maintenance function assume that the same controller and the same mechanism are used.

When the serial number of the connected robot was changed, the error (H.7100) is output to notify that effect upon power ON in order to prevent reliability of the predictive maintenance function from decreasing after exchanging the robot or robot controller.

Also, in order to prevent writing backup data to a different robot, the error (H.7101) occurs when attempting restoration if the serial number of the robot body is different from the backup data value, and restoration cannot be performed.

Also, in case the backed up data format has been changed as a result of version upgrade of the robot controller and it is attempted to write the old format data, error H.7102 is output to notify that effect.

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
H.7100	00000	Error message	Robot arm serial number mismatch (preventive maintenance)
		Cause	Robot arm that connection was replaced
		Measures	Execute restoration of predictive/preventive maintenance data, or reset
H.7101	00000	Error message	Backup serial number mismatch
		Cause	Robot arm and backup data are the different serial number
		Measures	Please use the backup data matching robot arm
H.7102	00n00 (n is the mechanism number	Error message	Backup file version is different
		Cause	Predictive/preventive maintenance function backup file version mismatch
		Measures	Please select the backup file of the corresponding version

16.1.2. Consumption degree calculation function

In case the remaining time up to the recommended replacement/maintenance time of each part or the remaining time up to the specified overhaul time exceeded the remaining time of warning occurrence specified by the "PMWNGDAY" parameter, or the setting of the dedicated output signal is incorrect, the following warnings will occur.
However, warning occurrence is limited to those permitted by the "PMRPTMNT" parameter for maintenance parts (grease, timing belt) and to those permitted by the "PMRPTOH" parameter for overhaul parts (reduction gear, bearing, ball screw, ball splicer).

* For details of countermeasures when error number C.7110, C.712n, C.713n, C.714n, C.715n, or C.716n occurs, refer to "10. When consumption occurred/abnormality detected".

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
C.7110	00X00 X = Mechanism number	Error message	Overhaul period (servo on time)
		Cause	The servo on time has entered the overhaul recommendation period
		Measures	Execution of an overhaul of a robot arm is recommended
C.712n (n indicates the axis numbers (1 to 6).)	00X00 X = Mechanism number	Error message	Grease replenishment period
		Cause	Grease consumption degree exceeded the warning level
		Measures	Please replenish grease and reset consumption degree
C.713n (n indicates the axis numbers (1 to 6).)	00X00 X = Mechanism number	Error message	Timing belt replacement period
		Cause	Timing belt consumption degree exceeded the warning level
		Measures	Please replace timing belt and reset consumption degree
C.714n (n indicates the axis numbers (1 to 6).)	00X00 X = Mechanism number	Error message	Overhaul period (decelerator)
		Cause	Decelerator consumption degree exceeded the warning level
		Measures	Execution of an overhaul of a robot arm is recommended
C.715n (n indicates the axis numbers (1 to 6).)	00X00 X = Mechanism number	Error message	Overhaul period (bearing)
		Cause	Bearing consumption degree exceeded the warning level
		Measures	Execution of an overhaul of a robot arm is recommended
C.716n (n indicates the axis numbers (1 to 6).)	00X00 X = Mechanism number	Error message	Overhaul period (ball screw)
		Cause	Ball screw consumption degree exceeded the warning level
		Measures	Execution of an overhaul of a robot arm is recommended
H.6640	99000	Error message	Illegal parameter (PMSIGMNT)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGOH)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
H.6640	99000	Error message	Illegal parameter (PMSIGGRS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGBLT)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGDEC)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGBRG)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGBSS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGSRV)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTGRS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTBLT)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTDEC)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTBRG)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTBSS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTOH)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
H.6640	99000	Error message	Illegal parameter (PMRSTNEW)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPGRS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPBLT)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPDEC)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPBRG)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPBSS)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPSRV)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter

16.1.3. Abnormality detection function

If the score exceeded the detection level specified by the parameter "PMWNGDRV", "PMWNGEN1", or "PMWNGEN2", or if the setting of the dedicated output signal is incorrect, the following warnings will occur. However, the score warning is limited to those permitted to occur by the "PMRPTSCR" parameter.

Caution "Score" used for judgment of warning occurrence is not the maximum score value of a day but is instead the real time value.

For details of countermeasures when error number C.717n, C.718n, or C.719n occurs, refer to "10. When consumption occurred/abnormality detected".

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
C.717n (n indicates the axis numbers (1 to 6).)	00XYY X = Mechanism number	Error message	Abnormality detection (reducion gear)
		Cause	The sign of failure of reduction gear was detected
		Measures	Inspection and replacement of reduction gear is recommended
C.718n (n indicates the axis numbers (1 to 6).)	00XYY X = Mechanism number	Error message	Abnormality detection (encoder data)
		Cause	The sign of failure of encoder was detected
		Measures	Inspection and replacement of motor and wiring is recommended
C.719n (n indicates the axis numbers (1 to 6).)	00XYY X = Mechanism number	Error message	Abnormality detection (encoder com.)
		Cause	The sign of failure of encoder was detected
		Measures	Inspection and replacement of motor and wiring is recommended
H.6640	99000	Error message	Illegal parameter (PMSIGDRV)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGEN1)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSIGEN2)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMRSTENC)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPDRV)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter

Error number		Causes of the error and its countermeasures	
Upper four digits	Lower five digits		
H.6640	99000	Error message	Illegal parameter (PMSTPEN1)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
		Error message	Illegal parameter (PMSTPEN2)
		Cause	The parameter setting is illegal
		Measures	Correct the parameter
C.7500	00000	Error message	No battery voltage (robot)
		Cause	The battery is spent.
		Measures	Replace the battery and set the origin. For more information about the replacement procedure, refer to the separate volumes, "Instruction Manual/Robot Arm Setup to Maintenance".
C.7510	00000	Error message	Battery voltage low (robot)
		Cause	The battery will be spent soon.
		Measures	Replace the battery. For more information about the replacement procedure, refer to the separate volumes, "Instruction Manual/Robot Arm Setup to Maintenance".

16.1.4. MELFA Smart Plus card

Indicates the error number related to the MELFA Smart Plus card.

Error number	Error cause and measures	
L3780	Error message	Cannot use the MELFA Smart Plus.
	Cause	Invalid MELFA Smart Plus.
	Measures	Check the MELFA Smart Plus card or parameter.
L3781	Error message	Cannot use the MELFA Smart Plus.
	Cause	Invalid MELFA Smart Plus.
	Measures	Check the MELFA Smart Plus card or parameter.
L3782	Error message	There're MELFA Smart Plus Cards.
	Cause	Multiple MELFA Smart Plus cards are installed.
	Measures	Turn off controller and pull unnecessary MELFA Smart Plus card.

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Apr., 2019 MEE Printed in Japan on recycled paper.