

PLC System Maintenance

This course is for PLC system users to solve minor errors and restore the system promptly.

Introduction**Purpose of the course**

This course is for PLC system users to solve minor errors and restore the system promptly.

This course is designed for the following users who have basic knowledge of the PLC.

- Users who will design a PLC system
- Users who will maintain equipment in the factory

Goals of this course are shown below.

- To select products and design systems that do not cause errors
- To understand the necessity of the periodic inspections and practice the inspections
- To diagnose an error primarily for solving a fault promptly

This course describes the overview of PLCs before the main subject.

The contents of this course are as follows.

Chapter 1 - PLC

Overview of PLCs

Chapter 2 - Maintenance

Maintenance of the PLC system

Chapter 3 - Modules and countermeasures

Detailed countermeasures corresponding to the module types

Chapter 4 - Support system

Support systems of Mitsubishi Electric for the PLC system maintenance

Final Test

Pass grade: 60% or higher

Introduction**How to use this e-Learning tool**

Go to the next page		Go to the next page.
Back to the previous page		Back to the previous page.
Move to the desired page		"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning		Exit the learning.

Introduction**Cautions for use****Safety precautions**

When you learn based on using actual products, please carefully read the safety precautions in the corresponding manuals.

Chapter 1 Programmable logic controller (PLC)

Introduction

A PLC is an equipment that automates factory operations. Mitsubishi PLC improves factory productivity with its reliable hardware and intuitive software operation.

Since first released in 1971, Mitsubishi PLC has built up its reputation as a highly reliable industrial automation controller.

Some of its reliable characteristics are as follow.

- Robust and fault-tolerant against an immediate power failure unlike personal computers with hard disc
- Operative in a wider temperature range than home electrical appliances
- Long-term and stable operation ensured with strictly selected components
- Long-time stable supply without frequent model change
- Optimized control program allowing easier programming and maintenance

--- Note on the stable operation ---

Stable operation is described by the RAS computer system stability index.

RAS stands for Reliability, Availability, and Serviceability. PLCs are industrial electrical products that support RAS if they do not fail easily, withstand long-time operation and easy to be maintained.



1.1

Building block

The MELSEC iQ-R Series PLCs were released in 2014.

The MELSEC iQ-R Series is a building block type PLC incorporated new technologies and inherited design concepts from the MELSEC Series.

The building block type PLC is a modular-based configuration system.

Each module has its own function and can be replaced one by one.

The building block type has the following advantages.

- Functions can be added in modules according to the system size
- When a system similar to the existing system is created, functions can be replaced in modules according to the control system type
- Faulty modules can be easily replaced

The building block type PLC is suitable for future expansion, extension of control functions and easy exchange of modules.



Chapter 2 Maintenance

Introduction

A brief description of proper PLC maintenance, where maintenance means to maintain PLC's safety and operation condition.

2.1 Necessity of maintenance

Maintenance is required to improve the operating rate of the system.

Improving the operating rate means to extend normal system operating time, and shorten system downtime due to failures. Since PLC automates a system, unexpected PLC failure hinders the automated operation.

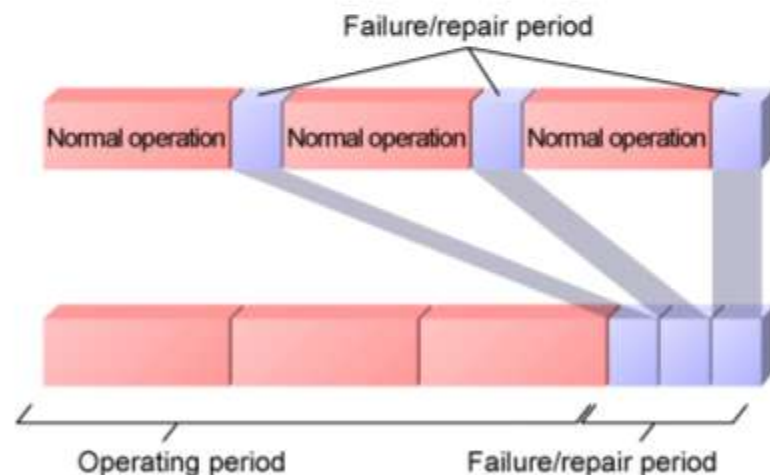
Operating rate = Operating period / (Operating period + Failure period)

Long **[Operating period]** indicates that the PLC does not fail easily.

[Operating period] is shortened by the limited life components or accidental failures.

Short **[Failure period]** indicates that the operation is less interrupted.

The following pages describe the situations in which maintenance is required.



2.2

Life and maintenance of the system

The entire product life cycle must be considered when determining the maintenance required in each stage.

Life-cycle of the system

Maintenance must be considered early in the development planning stage.

Selecting fragile components or the fragile system specification affects the life of the system.

In general, troubles often occur at the startup of the system. Therefore, solving the troubles at the startup leads to the stable operation.

After the troubles are identified, the system can operate normally, however, a failure can occur due to the life-time of the components.

If the whole system gets old, replace the system.

The maintenance is required not only after the startup of the system. The maintenance is required corresponding to the situation.



2.3

Improving the operating rate

Let's go back to the operation period and failure/repair period.

Operating rate = Operating period / (Operating period + Failure period)

This calculation formula shows that extending the operating period and shortening the failure/repair period are needed for improving the operating rate.



In particular,

How to extend the operating period of the system

- Select reliable products → Select the products with long operating time
- Design a system which does not fail easily → Extend the product lifetime
- Protect PLCs from failures → Decrease detrimental effects on the system

How to shorten the period from the failure to restoration of the system

- Detect the failure in advance and replace the products
→ Inform the maintenance personnel of the failure as soon as possible
- Minimize the failure period → Restore the system quickly

The following pages describe the contents to be considered in each design step.

2.4

Extending the operating period

How to extend the operating period

- Select reliable products → Select the products with long operating time
- Design a system which does not fail easily → Maintain the product life-time
- Protect PLCs from accidental failures → Decrease detrimental effects on the system

Using the products with long life-time

PLCs are reliable products designed for industrial use.

Selected components (e.g. long life capacitor etc...) enables PLCs long-time stable operation.

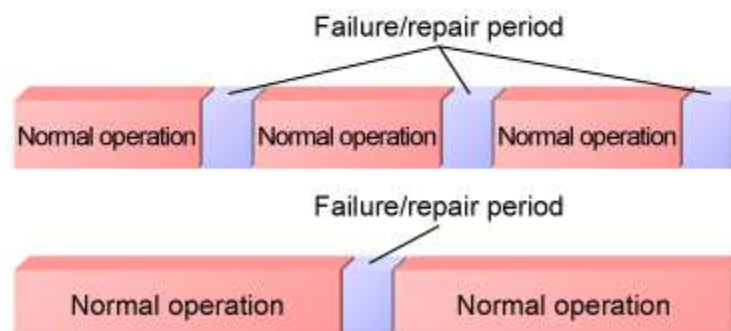
Even though the same control functions as those with PLCs can be configured with other low-cost measures such as personal computers, the reliability is completely different.

Protecting PLCs from accidental failures

PLCs are composed by vulnerable electrical components.

Therefore, excluding the elements which cause detrimental effects prevents accidental failure.

- Design method considering the lifetime of the electrical components to use PLCs for a long time
 - Product life time
 - Rating and derating
- Design method considering adverse effects to PLCs to protect PLCs
 - Countermeasures against noise
 - Countermeasures in installation environment



2.4.1

Lifetime

This page briefly describes the limited life components which can shorten the normal operation period.

Limited life components of PLCs are shown below.

The detailed description is given in each section.

- Aluminum electrolytic capacitor
- Battery
- Relay
- Fuse

The ways of using these limited life components for a long time are described in the next page.



Capacitor



Battery



Relay



Fuse

2.4.2

Rating and derating

All electrical components have rated operating conditions (voltage, current, etc.) specified by their respective manufacturers. Mitsubishi PLC modules are designed to operate normally under the rated operating condition according to the product specifications.

However, electrical components may sometimes operate beyond the absolute maximum rating. For an example, overcurrent inevitably flows in inductive loads, such as a motor and solenoid, where a counter-electromotive force is generated.

Absolute maximum rating is an operating condition below which product can withstand without damage.

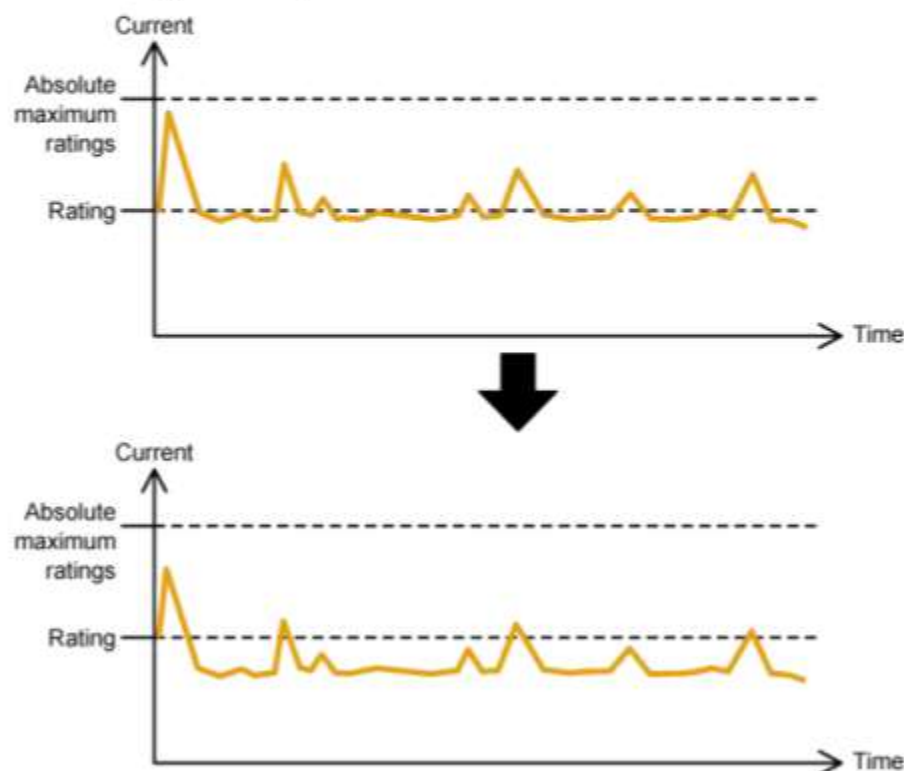
Let's say a component is rated 2A at 40° C and has absolute maximum rating of 5A 1s, this indicates that transient overcurrent up to 5A is permitted for 1 second.

If an electrical component frequently operates close to the absolute maximum rating, it may become damaged over time and breakdowns easily even if it returned to the rated operating condition.

Derating is an idea for preventing failures by operating components below the rated condition within tolerance limit. It means that the output level is decreased. Derating prolongs the lifetime of the component even if it operates with occasional transient overcurrent.

Max. load current	0.1A/point, 2A/common
Max. inrush current	0.7A 10ms or less

The description of noise, which is one of the causes of errors is given in the next page.



2.4.3

Countermeasures against noise

As mentioned in the previous page, operating at the rated condition means guaranteeing the operation and keeping the lifetime.

Exceeding the rating may cause unexpected operation without any breakdown.

The electrical signals causing the unexpected operation are called noise.

The general countermeasures against noise are the following.

- Avoid noise transfer between devices
- Not to apply the noise to other devices

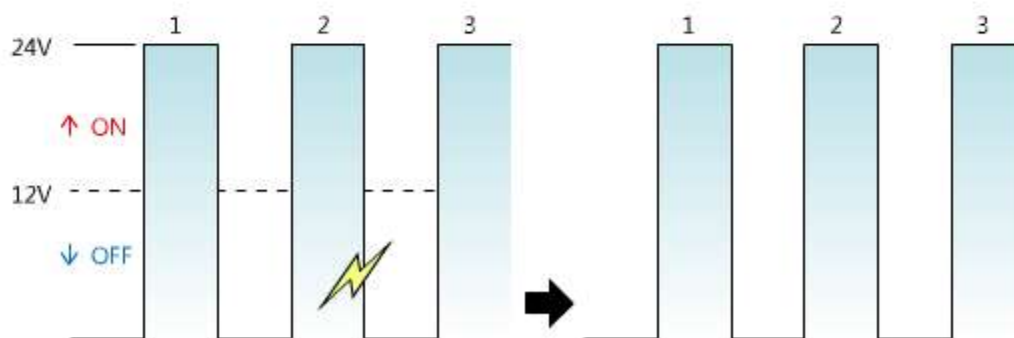
There are too many kinds of countermeasures against noise to be described here.

Please understand that the noise may make the operation of the PLC system unstable.

Factory-automation devices including PLCs control inputs and outputs using 24VDC or 100VAC to improve the noise immunity. A momentary drop in 5V, caused by noise, significantly affects the signal of 5VDC but not 24VDC.

Precautions on the grounding and wiring, which are the basic countermeasures against the noise, are described in section 2.4.9 and 2.4.10.

The descriptions of the installation environment are given in the next page.

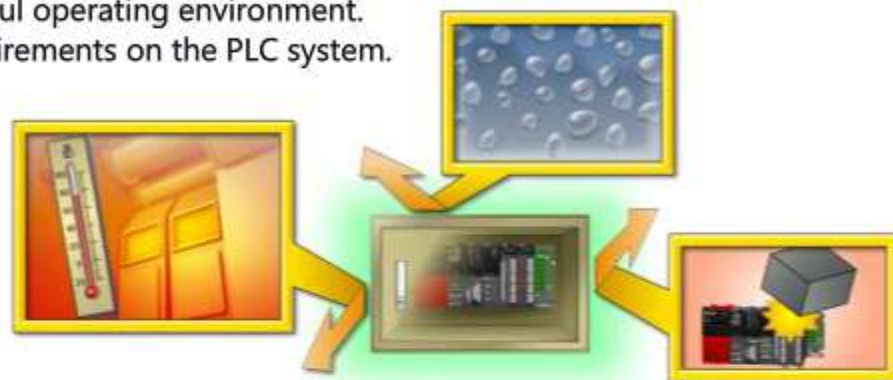


2.4.4

Countermeasures in installation environment

In general, the PLC system is installed in the metal box which is called control panel. A control panel protects the PLC system from potentially harmful operating environment. However, at the same time, it impose certain specification requirements on the PLC system.

- Ambient temperature range
- Atmosphere, ambient humidity range and condensation
- Vibration and shock



Item	Specification					
Operating ambient temperature	0 to 55°C					
	0 to 60°C (when an extended temperature range base unit is used)					
Storage ambient temperature	-25 to 75°C					
Operating ambient humidity	5 to 95%RH, non-condensing					
Storage ambient humidity	5 to 95%RH, non-condensing					
Vibration resistance	Compliant with JIS B 3502 and IEC 61131-2		Frequency	Constant acceleration	Half amplitude	No. of sweeps
		Under intermittent vibration	5 to 9Hz	—	3.5mm	10 times each in X, Y, and Z directions
			9 to 150Hz	9.8m/s ²	—	
		Under continuous vibration	5 to 9Hz	—	1.75mm	—
			9 to 150Hz	4.9m/s ²	—	
Shock resistance	Compliant with JIS B 3502 and IEC 61131-2 (147m/s ² , 3 times each in X, Y, and Z directions)					
Operating atmosphere	No corrosive gas					

2.4.5

Ambient temperature

PLC is composed of various electronic components. (e.g. semiconductors)

Ambient temperature has a big impact on the lifetime of a semiconductor. When the ambient temperature rises 10C°, the lifetime of the aluminum electrolytic capacitor halves.

Ambient temperature range

The permissible temperature of semiconductors is described briefly in the following.

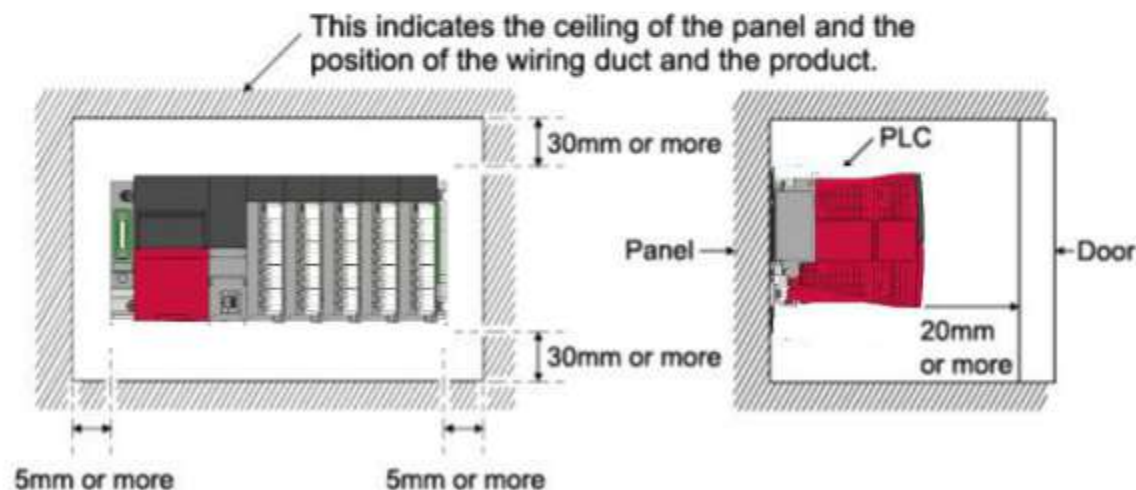
$$\text{Ambient temperature} + \text{Temperature rise} < \text{Permissible semiconductor temperature}$$

Therefore, low ambient temperature allows more temperature rise in the semiconductor.

Mitsubishi PLCs are designed to operate with self-cooling to avoid the operation error caused by the failure of a fan. Configure the wiring with space tolerance and make room around the PLC system since other heat source may exist in the control panel.

Detail values are described in manuals.

Example



Item	Specification
Operating ambient temperature	0 to 55°C
	0 to 60°C (when an extended temperature range base unit is used)
Storage ambient temperature	-25 to 75°C

2.4.5

Ambient temperature

Before designing the panel layout, the temperature tolerance must be determined based on expected ambient temperature rise. The ambient temperature rise can be estimated by the emitted heat, which is calculated based on the consumed power.

- Assume the power conversion efficiency of the power supply module to be 70%. Then, the remaining 30% is dissipated as heat.
- Electric power is the product of voltage and current. Based on the current usage at 5V as described in the product specification, power consumption can be determined.

$$T = W / (U \cdot A) [^{\circ}\text{C}]$$

T: Ambient temperature rise [degree]

W: Power consumption [W]

A: Internal wall surface area of a panel [m^2]

U: Overall heat transfer coefficient [$\text{W}/(\text{m}^2 \cdot \text{K})$]

U = 6 when uniform ambient temperature is assumed

U = 4 when convection is considered

Then, check that the ambient temperature + T is lower than 55°C (60°C when an extended temperature range base unit is used), which is the upper limit of the ambient temperature.

When the calculation result is higher than the allowable temperature, lower the temperature with forced cooling such as a fan.

Or, use an air-conditioner for the sealed control panel.

Item	Specification
Operating ambient temperature	0 to 55°C
	0 to 60°C (when an extended temperature range base unit is used)
Storage ambient temperature	-25 to 75°C



2.4.6

Atmosphere and ambient temperature range

Atmosphere means the ambient air condition of the PLC system, such as the corrosive gas, combustible gas, powder, and splash.

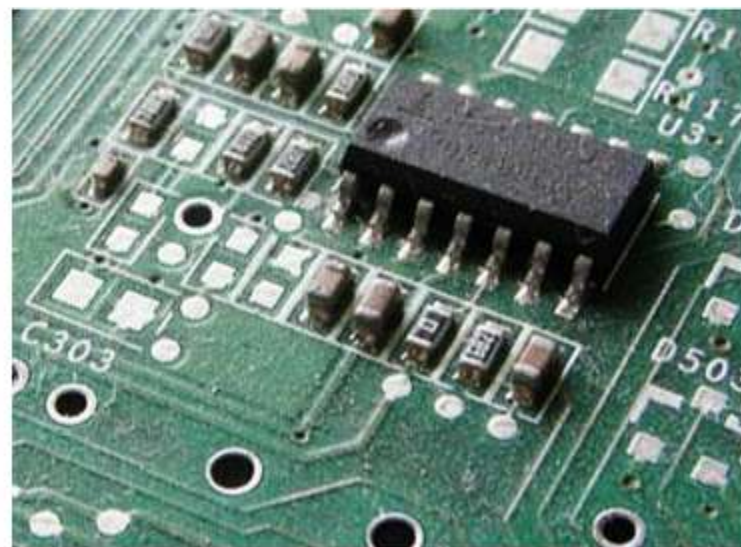
Corrosive gas ruptures solder connections and PCB patterns, which causes operation error.

With dew condensation or an increase in humidity, powders or droplets stuck to the LSI pins increase the possibility of electric leakage and leads to the unstable operation or failure.

At too low humidity, the static electricity can be generated, which can cause a malfunction. Furthermore, semiconductors can be damaged.

Against these environments above, take measures such as using a sealed control panel and separating the control panel from these environments.

Item	Specification
Operating ambient humidity	5 to 95%RH, non-condensing
Storage ambient humidity	5 to 95%RH, non-condensing
Operating atmosphere	No corrosive gas



2.4.7

Vibration and shock

Shock damage is caused by instantaneous acceleration.

Vibration damage is caused by continuous acceleration.

Both damages can break the components and interrupt the module operation.

To prevent the shock, carry the modules to the installation location packed in the package.

To minimize the vibration of the modules, take measures as follows.

- Fix the DIN rail securely
- Fix the PLC module to the base by using the fixing screws with specified torque securely
- Configure the structure by using damping rubber to prevent the direct vibrations from the motors and others

Item	Specification					
Vibration resistance	Compliant with JIS B 3502 and IEC 61131-2		Frequency	Constant acceleration	Half amplitude	No. of sweeps
		Under intermittent vibration	5 to 9Hz	—	3.5mm	10 times each in X, Y, and Z directions
			9 to 150Hz	9.8m/s ²	—	
		Under continuous vibration	5 to 9Hz	—	1.75mm	—
			9 to 150Hz	4.9m/s ²	—	
Shock resistance	Compliant with JIS B 3502 and IEC 61131-2 (147m/s ² , 3 times each in X, Y, and Z directions)					

2.4.8

Grounding

Grounding should be performed before installing the control panel. Grounding should be performed systematically. The following shows the terms related to grounding.

Independent grounding

Devices which consume large current such as motors are the noise sources. Though the electric potential of the ground bar is 0V, the motor side receives the electric potential of the noise. When the grounding wire is branched at the half length, the ground wire connected to the PLC receives half electric potential of the noise electric potential. Therefore, independent grounding is recommended for avoiding the effect of the noise source to the PLC system.

Two ground terminals

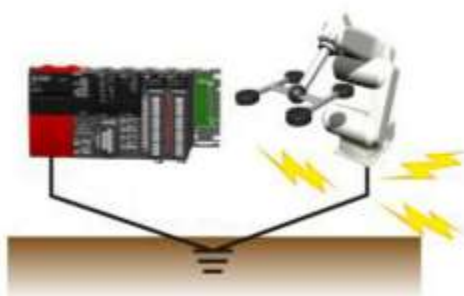
Ground the LG terminal of the power supply module to remove the noise and to make AC power supply stable. The FG terminal must be grounded to remove the noise of the whole PLC system since it is the standard of the electric potential of the whole PLC system.

Grounding should be performed as stated below.

- Independent grounding should be performed for best results
- For grounding, use wires of 2mm² or thicker
- Shorten the distance between the grounding point and the ground terminals as much as possible



(1) Independent grounding....Best



(2) Shared grounding....Good



(3) Common grounding....Not allowed

2.4.9

Wiring

Wiring includes the following.

Power cables

The main power supply of the processing machinery, the motor drive power supply, and the inverter drive power supply are included.

In general, they can be the noise source since large current with high voltage flows through them.

Communication cables

Communication cables are easily affected by power cables since the signals which transmit through the communication cables are weak.

Separate the communication cables from the power cables whenever possible. (e.g. putting the cables in different ducts.) Using optical fiber cables is effective in eliminating noise since electricity does not flow through those cables.

I/O signal cables

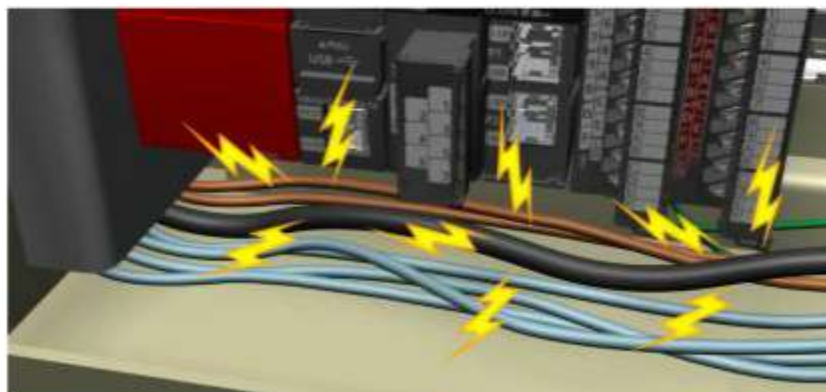
The inductance increases in I/O signal cables according to the length. When the wiring is long, the I/O signals might not be recognized as signals.

Do not make the wiring unnecessarily long.

Select the network according to the conditions.

So far, the knowledge to maintain the normal operation period has been described.

The following pages describe the measures to shorten the failure period after the operation of the system is started.



2.5

Shortening the failure period

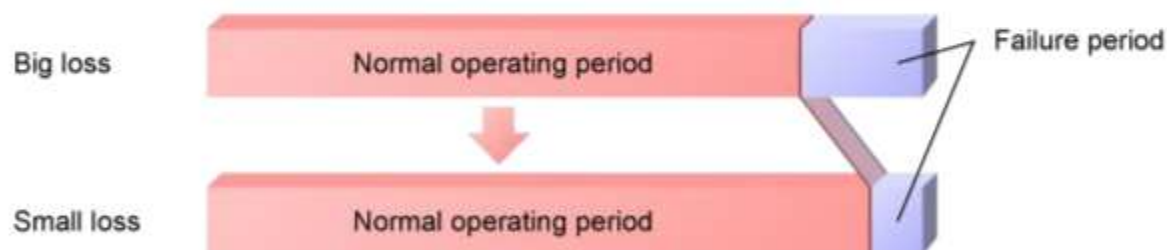
How to shorten the failure period

- Detect the failure in advance and replace the products
- Minimize the failure period

For example,

- Replace the module before the lifetime to prevent any failure
 - Prepare spare parts near the system
 - Prepare the specifications to be referred in case of a failure
 - Use modules equipped with the failure diagnosis function, and replace as required
 - Display not only the error, but also the solution
 - Notify the failure to the maintenance personnel as soon as possible
- The failure rate can be decreased
 - The failure parts can be replaced quickly
 - The trouble can be found easily
 - The trouble can be found easily
 - Troubles can be solved quickly
 - Troubles can be solved quickly

The detailed methods are described from here.



2.5.1

Maintenance plan

Taking measures after a trouble occurred needs more time than taking measures expecting the trouble. Taking measures without any expectation may make the situation worse.

Time to solve the trouble means the system stop time. At the production site where the system stop time affects the productivity directly, the system stop time maybe a business issue.

To prevent such situations, consider the following.

- **Preventive maintenance** to prevent troubles
- **Corrective maintenance** to solve troubles quickly

The preventive maintenance includes the following contents.

- Selection of reliable products
- Proper system designing
- **Periodic inspection to capture unusual situations**
- **Replacement of the product before its life-cycle ends**

The **corrective maintenance** includes the following contents.

- Understanding of the flow (procedure) for the troubleshooting (to solve the problem)
- Storage and easy search of specifications
- Display of the corrective measures
- Record of the maintenance
- Management of the control program versions

These are described from here.



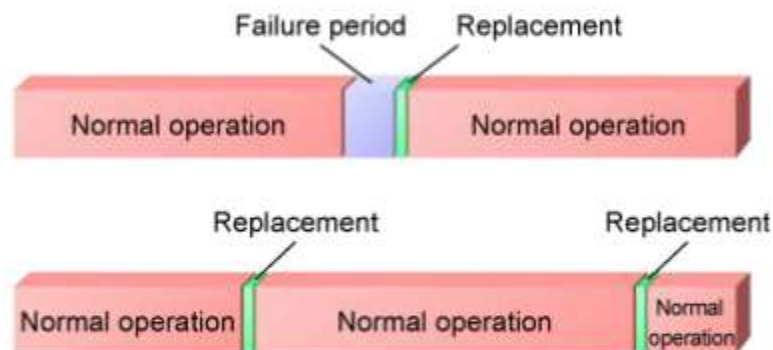
2.5.2

Preventive maintenance

The preventive maintenance includes the following contents.

- Product selection with no failure occurrence
- Maintenance-considered design
- Periodic inspection not to miss unusual situations
- Replacement of the products before the lifetime ends

These are described from here.



2.5.3

Manufacturer selection

Consider maintenance when selecting the manufacturer.

FA products cannot be selected only because of low price like home electrical appliances.

Consider the following points for the selection.

Long-time stable supply

Unlike home electric appliances and personal computers, programmable controllers require long-time stable operation.

In the FA environment where the long-time stable operation is required, the frequent model change interrupts the reliable use.

Withstand environment characteristics

If there is no noise, devices will operate normally. However it is typical for the FA environment to have a lot of noise sources. To operate the devices in such environment, select products which satisfy the proper noise tests, which also do not influence other devices.

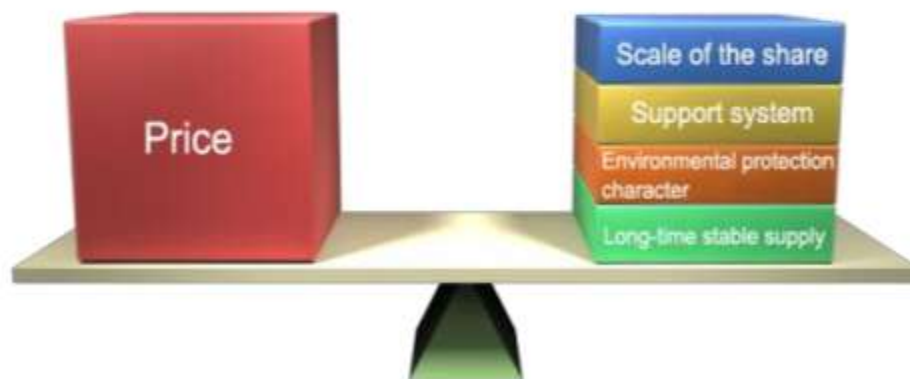
Support system

Even though the product price is low, a bad support system increases the entire cost.

Recent years, the development of overseas factories has been increasing and the overseas support is the important element related to the quick system restoration.

Scale of the share

The larger the share of the market is, the more consultants and information are available.



2.5.4

Maintenance-considered design

Clarified countermeasures

PLC's or manufacturer's error codes do not often provide enough information for operators. Use HMIs (GOTs) to indicate the measures to be taken by operators according to specified system.

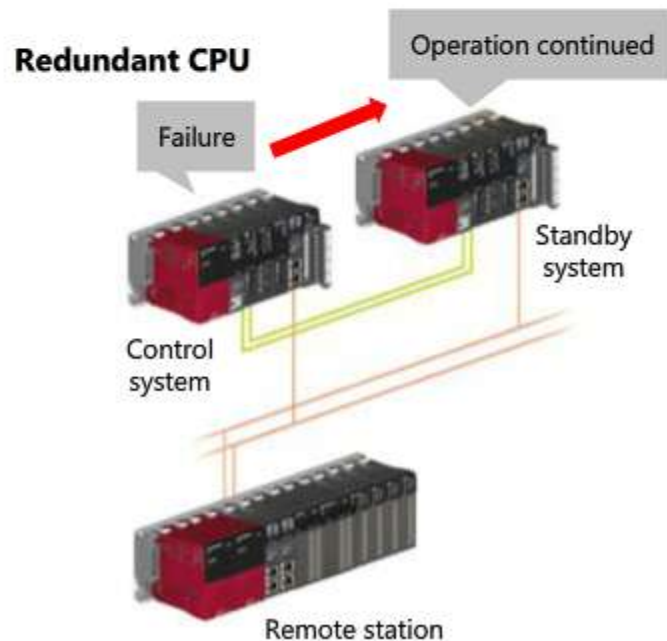
Design of systems in which partial failures do not affect the whole system

Configure the system where two PLC CPUs are used to avoid failures (redundant system). If one CPU stops due to failure, the other will control the system instead.

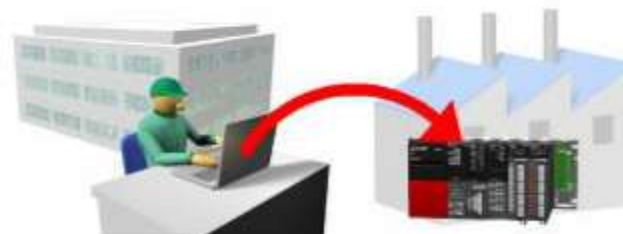
Use the redundant when a system stop creates a big loss.

Remote maintenance solution

Maintenance can also be performed from a remote location via the Internet. Remote maintenance can help in fast system restoration.



Remote maintenance



Periodic inspection

Weigh the labor of the periodic inspection against the damage caused by the trouble.

- Diagnose the error by using the engineering software and take corrective measures according to the error.
For the procedures of the corrective measures, refer to the troubleshooting in the end of the module's users' manual.

- The solderless terminal is fixed by stress of metal.

Since long-time operation may loosen the terminal, retighten the terminal with the specified torque.

Daily inspection

No	Item	Description
23	Tightening the screw terminal block with the specified torque	Check: ☐
24	Warning of the battery	Check: ☐
25	Dust existence	Check: ☐
26	Module error display	Check: ☐
27	Error message (code) (time)	[] [/ / , : :]
28	Detail error information	
29	Other error history	
	Saving the error history	Check: ☐ (File name: .csv)
30	LED/LED status	MODE : On (Color:—) Flashing Off RUN : On (Color:—) Flashing Off ERR : On (Color:—) Flashing Off USER : On (Color:—) Flashing Off BAT : On (Color:—) Flashing Off BOOT : On (Color:—) Flashing Off
31	Connection with peripheral device	RS232 : Allowed Not allowed

2.5.6 Periodic replacement

As described in "2.3.1 Lifetime", specific components have limited lifetime. To shorten the failure period, take proper countermeasures.

Countermeasure examples (from the shortest downtime to the longest)

- (1) Replace the module periodically
- (2) Replace the product with the spare when the product fails
- (3) When the module fails, purchase the corresponding module and replace it

This section explains about (1) in more detail.

Understand the module specifications including the limited lifetime parts, and replace the modules systematically.

For the proper replacement timing, refer to the Technical bulletin "For the safety use of MELSEC PLC".

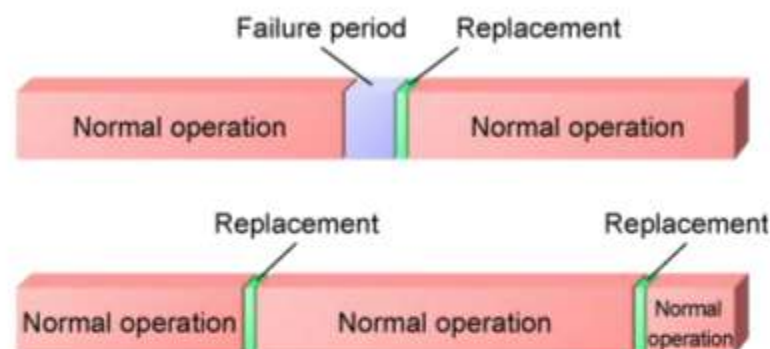
In addition, consider the possible discontinuation of the PLC series in the future.

Mitsubishi Electric PLCs have been supplied stably for a long time. This stability in supply is something unavailable with personal computers.

At the same time, user-friendly and technologically advanced products have been supplied.

Consider introducing new products when a large change such as a layout change of the factory is needed.

Mitsubishi Electric introduces new products systematically and helps in the smooth replacement by announcing the discontinuation of products well in advance and by providing replacement assistance.



2.5.7 Storage and easy search of specifications

To shorten the time of failures, the following points are important.

- Keep the specifications organized
- Store the specifications near the system
- Sort out the specifications so that necessary information can be easily obtained

Using GOTs, which are Mitsubishi Electric HMIs, necessary information can be stored and displayed.

For example, displaying troubleshooting manual with error codes helps solve problem quickly.



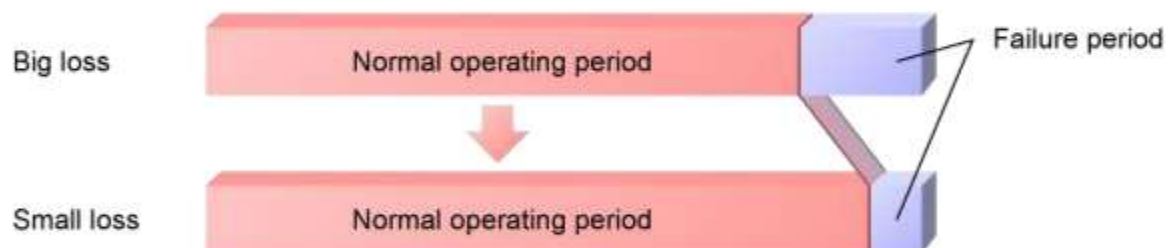
2.6

Corrective maintenance

The corrective maintenance includes the following contents.

- Understanding procedure of the troubleshooting
- Display of the corrective measures
- Record of the maintenance
- Management of the control programs versions

These are described next.



2.6.1

Troubleshooting

The troubleshooting is described in the PLC module manuals.

By answering the questions, you can acquire how to deal with a problem.

Preparing the troubleshooting corresponding to the module used in the PLC system in advance can shorten the time to solve problems.

Example)

3 Troubleshooting by Symptom

If any function of the CPU module does not operate as designed, perform troubleshooting by checking the following items. If the ERROR LED or USER LED is on or flashing, eliminate the error cause using the engineering tool.

When the POWER LED of the power supply module turns off

When the POWER LED of the power supply module turns off, check the following items.

Check item	Action
The power supply module is not mounted on the base unit properly.	Remove the power supply module from the base unit, and mount it back on the base unit. Then, restore power to the system.
The READY LED of the CPU module is on.	The power supply module has failed. Replace the power supply module.
Power supply voltage is not appropriate.	Supply power voltage within the specified range. (LJ1 MELSEC iQ-R Module Configuration Manual)
The internal current consumption within the entire system exceeded the rated output current of the power supply module.	Review the system configuration so that the internal current consumption does not exceed the rated output current. (LJ1 MELSEC iQ-R Module Configuration Manual)
The POWER LED turns on when power is restored to the system after all modules, except the power supply module, have been removed.	One of the modules except the power supply module has failed. Repeatedly supply power to the system, returning the modules to the system one by one. The last module mounted immediately before the POWER LED turns off has failed. Replace the corresponding module.

If the POWER LED of the power supply module does not turn on even after the items above are checked and the actions are taken, the possible cause is a hardware failure of the power supply module. Please consult your local Mitsubishi representative.

When the READY LED of the CPU module turns off

When the READY LED of the CPU module turns off, check the following items.

Check item	Action
The CPU module is not mounted on the main base unit properly.	Remove the CPU module from the main base unit, and mount it back on the main base unit.
The READY LED of another module is on.	A major error has occurred in the CPU module. Replace the CPU module.
The READY LED turns on when the power supply module is replaced and the power is restored to the system. (Check the LED status after the power supply module on the extension base unit is also replaced.)	The power supply module before the replacement has failed. Replace the power supply module.
The READY LED does not turn on even after the power supply module is replaced and the power is restored to the system. (Check the LED status after the power supply module on the extension base unit is also replaced.)	One of the modules except the power supply module has failed. Repeatedly supply power to the system, returning the modules to the system one by one. The last module mounted immediately before the READY LED turns off has failed. Replace the corresponding module.

2.6.3

Record of the maintenance

Record the failure occurred once after it is solved.

Recording the failure provides the following advantages.

- The time to solve the same failure will be shortened
- Records provide the trend of the failure and help pursue the root cause

Example of the maintenance record list

Device name/Panel name	☐		
Module model name	☐	Model name	Serial number
Detailed event	☐	Version	
		• LED status (on, off, dimly on, flashing, occasionally on, or momentary on) • Error code/error step • CPU error history/detailed error • Special relay/resister	
Occurrence stages	☐	☐ Startup ☐ Others ☐ Operating period ☐ In operation () ()	• Operation start timing, occurrence timing, installation of the periphery facilities and remodeling construction
Occurrence timing	☐	☐ Startup ☐ Random ☐ Program when changing ☐ Others() ☐ When turning on the power supply ☐ When operating ()	• Writing during RUN
Occurrence frequency	☐	☐ Always ☐ () times when doing () ☐ Others () ☐ Only () times	
Restoration method	☐	☐ Resetting the power supply ☐ Replacing the module ☐ Starting the system again ☐ Pressing the reset switch ☐ Modifying the wire ☐ Others ()	
Configuration diagram	☐	Attached sheet	• The product information list is saved by the system monitor of GX Works3 for MELSEC iQ-R Series
Data saving	☐	☐ Parameter + program ☐ Positioning data File name ☐ Device ☐ Protocol analyzer () ☐ HMI screen data ☐ MX SHEET () ☐ Special module data ☐ () ()	• Permission of the customer is necessary
			• Background of the failure • Error of other devices • Companion

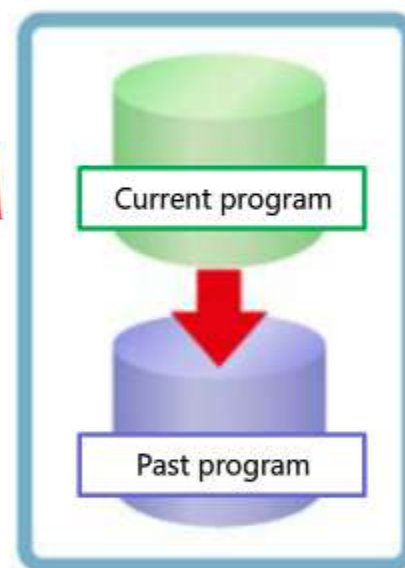
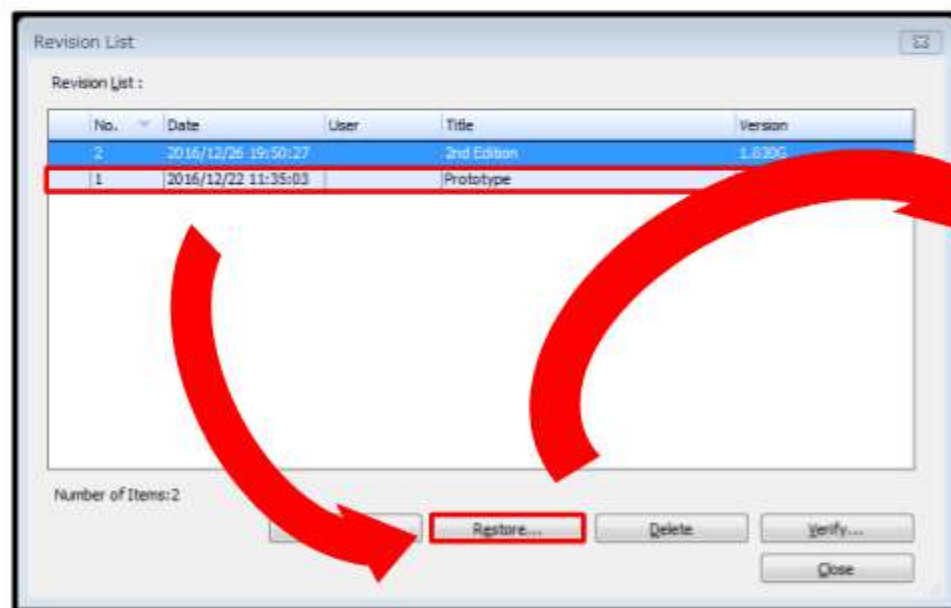
2.6.4

Management of the control programs versions

Modifying a program in a project may cause a malfunction even after it is debugged.

If a system fails with a modified program in a project, consider operating temporarily with the previous project where the system operated normally.

Thus, it is important to provide easy access to previous versions of PLC projects.



2.6.5

Pursuing the cause

The failure occurred once may occur again.

When a failure occurs, do not just restore the operation by turning the power OFF-ON or by a reset. Instead, pursue the cause of the failure and prepare a countermeasure.

The convenient functions for such cases are the GOT fault history, module diagnostics, CSV output, etc.

Fault history

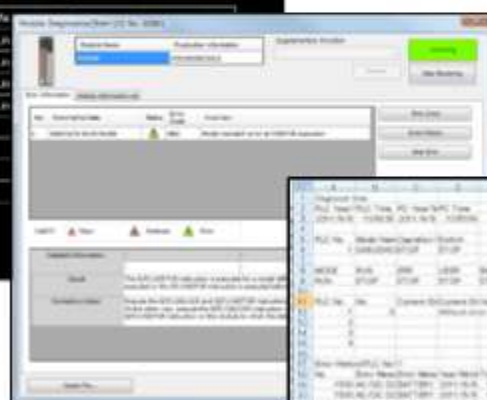
Preparing the measure against a previous failure is one of the ways to shorten the downtime.

GOT fault history

Alarm history screen

Incident date	Time	Message
07/12/26	00:00:00	LI
07/12/26	00:00:10	LI
07/12/26	00:10:00	LI
07/12/26	00:10:00	LI

Module diagnostics



CSV output

The screenshot shows a CSV file with multiple columns including 'Incident Date', 'Time', 'PLC No.', 'Module No.', 'Module Name', 'Status', 'Action', and 'Comment'. The data is organized into several sections, providing a comprehensive log of system events and diagnostics.

2.7

Replacement

Replacing modules

In some cases stopping the production may damage all the products.

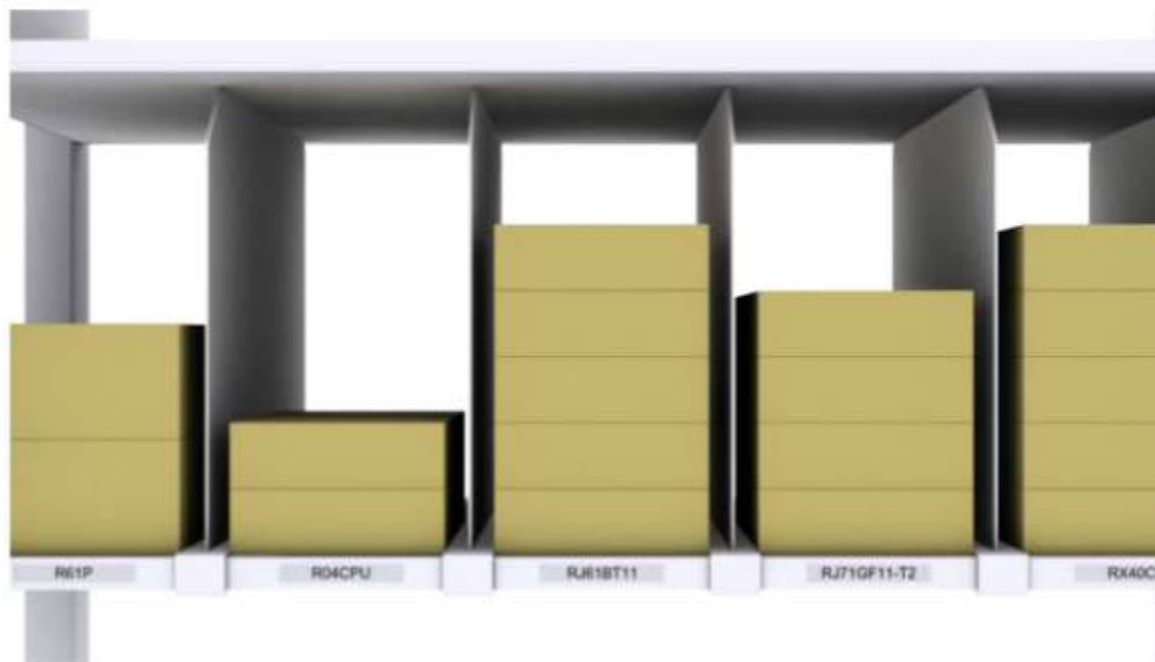
In such a system, the faulty module has to be replaced before pursuing the root cause of the failure.

For such cases, preparing spares is important.

Switching signals

Sometimes it is good to reserve some of the terminals in the output module. Then in case of emergency it is possible to switch the terminals and rewrite the program.

However, when a module itself breaks, the module must be replaced.



Chapter 3 Modules and countermeasures

Introduction

This chapter describes the detailed countermeasures corresponding to the module types.

3.1 Precautions of module and parts in use

This section describes the methods to maintain the normal operation period and to shorten the failure period.

The Useful Life of Basic PLCs.

The useful life means the period when device satisfies the prescribed function and performance. The useful time of MELSEC PLCs is basically ten years.

However, modules with limited life components, such as aluminum electrolytic capacitors, should be replaced every five years.

A relay's lifetime is dependent on the frequency of use, and a transistor, which is said to have semi-permanent lifetime, is also affected by the frequency of use. If such components are frequently used above the rated operating condition, their useful life may be shortened.

The following pages describe components installed in modules and precautions.

3.2

Power supply

The power supply module decreases the 100VAC or 220VAC commercial power supply to 5VDC which PLC modules use.

The rated current capacity of the power supply module must be higher than the total current consumption of all modules (including PLC CPUs). Choose the power supply module that satisfies the condition. The rated current of the power supply module is indicated on each power supply module.

If required, install additional power supply module to the extension base to make up the current capacity.

To maintain the normal operation period, perform derating.

To get a direct current, the power supply module has the aluminum electrolytic capacitor, which is a limited life component. If the capacity of the aluminum electrolytic capacitor is decreased due to its lifetime, its function to smooth the current (to make direct current) reduces. It increases the possibility to interfere with the operation of the whole system. System becomes to be easily affected by noises or the capacitor does not function.

To shorten the failure period, countermeasures are required. For example, replace the aluminum electrolytic capacitor before its life-cycle ends.

Power supply module



Aluminum electrolytic capacitor

3.2.1

Aluminum electrolytic capacitor lifetime

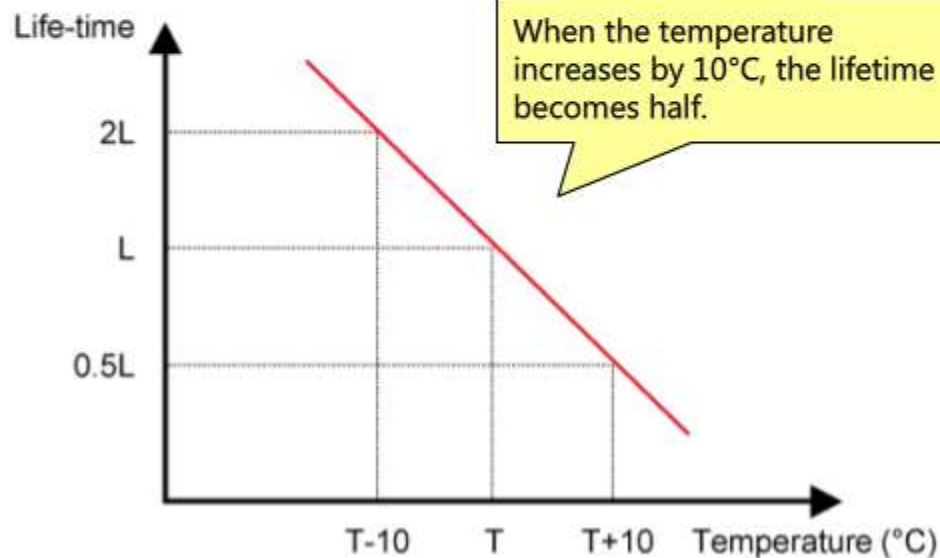
This section describes briefly the limited life components in the power supply module.

Aluminum electrolytic capacitor

Temperature rise accelerates a chemical change inside, which shortens the lifetime. Therefore, the temperature management is important.

The main function of the capacitor is to store electricity, which is often the noise source.

When the capacitor's lifetime reaches to its end, its ability to store electricity (ability to take out noise) decreases. In this condition, noise-related malfunctions are more likely to occur.



3.3

PLC CPU

The CPU module of PLC is the brain of the PLC system.

The PLC system is controlled according to the control program written in the CPU module.

There are basically two memory types to keep the programs in the CPU module: RAM and ROM.

The data in the RAM is lost by power-off. (CPU module keeps RAM data using a battery.)

The data in the ROM is not lost even by power-off and is not easily rewritten.

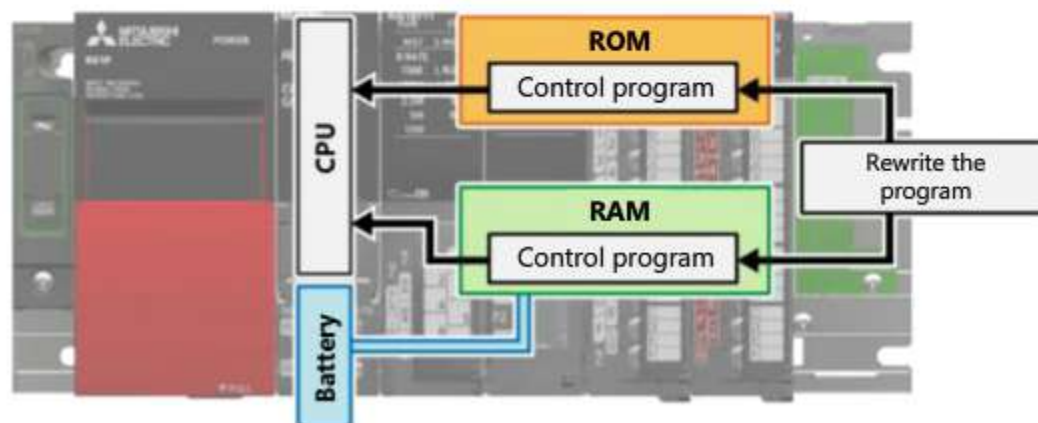
Save programs and parameters to the RAM when corrections are needed frequently (ex. system is started up).

When the program operates stably and does not require frequent changes, store it to the ROM.

Even when the main power supply is switched off, the CPU module maintains the programs, device data and clock data in the RAM using the battery as a power supply.

Before the battery is completely consumed, the corresponding warning will be displayed on the PLC's LED indicator. After seeing the warning, replace the battery as soon as possible.

Consider purchasing spare batteries, and store batteries in a low humidity condition.



3.4

Output module

There are two types of output modules: Semiconductor type and Contact type.

Semiconductor type

- Transistor output type
- Triac output type

The semiconductor has a certain electric power loss, which increases with current.

The lost electric power turns into heat, which could inversely affect the semiconductor's operation.

Therefore, some semiconductor type output modules have common current restrictions.

The conduction intervals and the number of simultaneously-conducted points should be also considered as they determine the generated heat amount.

Perform derating when designing a system which will work in a noisy environment and/or with inductive load.

RY41NT2P transistor output module	
Item	Specifications
Number of output points	32 points
Rated load voltage	12/24VDC (allowable voltage range: 10.2 to 28.8VDC)
Maximum load current	0.2A/point, Pilot Duty, 2A/common
Maximum inrush current	Current is to be limited by the overload protection function.

Example of when the common current restriction (abstracted from a manual)

3.4

Output module

Contact type

Relay output type

When an inductive load is controlled by relay outputs, the inrush current flows to the relay contacts. To maintain the normal operation period of a relay-type output module, take the following measures.

- Use a module with higher rated current (higher than what is normally required)
- Install a device that suppresses inrush current to the inrush-current-generating area (suppression of surge)
- Replace the module before the lifetime reaches its end

Take the following countermeasures to shorten the failure period of semiconductor and relay type output modules.

- Use the output modules of the same type even when all the points are not used so that the spares can be the same
- Set marking tubes and others to signal lines to clarify the wire connection
- Receive signals at the terminal block to clarify the destination of the wire

RY10R2 contact output module		
Item		Specifications
Number of output points		16 points
Rated switching voltage/current		24VDC 2A (resistive load)/point, 8A/common 240VAC 2A (COS ϕ = 1)/point, 8A/common
Minimum switching load		5VDC, 1mA
Maximum switching load		264VAC 125VDC
Response time	OFF → ON	10ms or less
	ON → OFF	12ms or less
Life	Mechanical	20 million times or more
	Electrical	2.5 * Relay life (contact switching life)
Maximum switching frequency		3600 times/hour

Example of the description of the rated current (abstracted from a manual)

3.4.1

Relay lifetime

This section describes briefly the limited life components used in relay output modules.

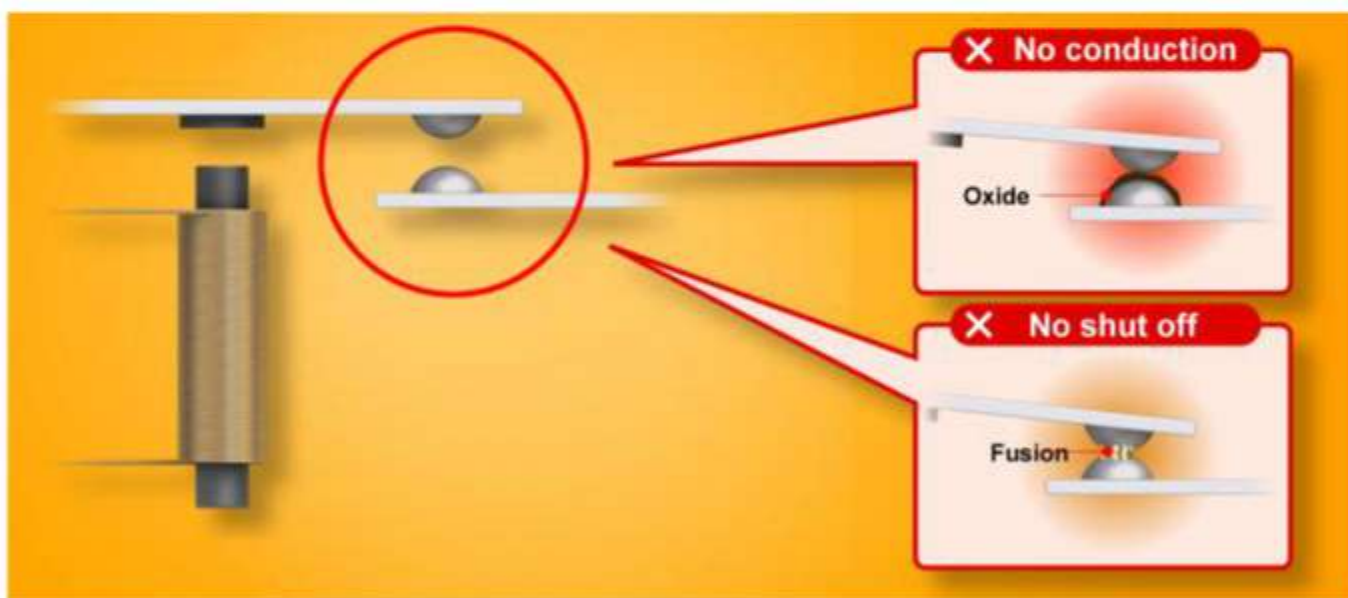
Relay

Relays have electric contacts and mechanical structures to drive the contacts. Each of them has a limited lifetime. Even though the normal current of the contact satisfies the rating, the transitive (momentary) current exceeds far beyond the rated current and may cause the following problems.

- The contact part is melted and cannot be separated (fusion)
- The contacts oxidized by sparks occurred in the area becomes non-conductive

Since relays are fixed to modules, the relays themselves cannot be replaced.

The reasons above indicate that the transistor or triac output type should be used for frequent open and close operations.



3.4.2

Fuse lifetime

This section describes briefly the limited life components which are in some of the output modules.

Fuse

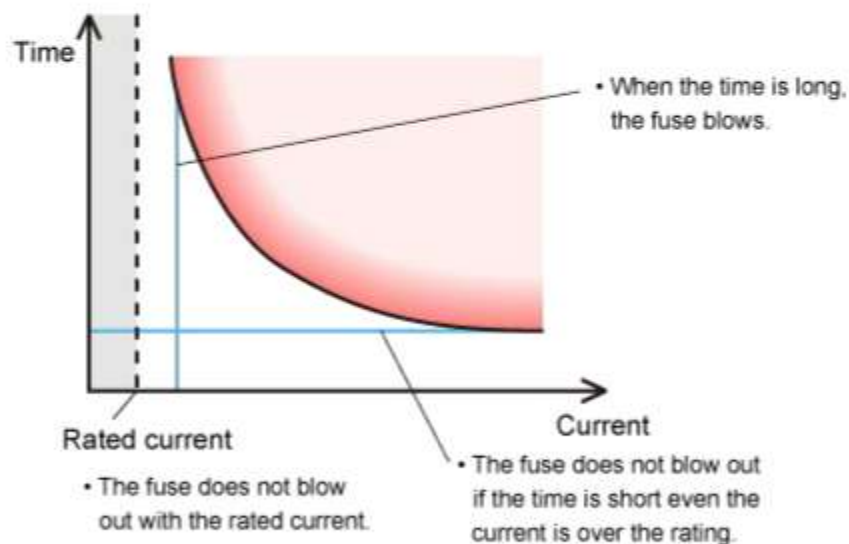
A fuse is a device in which metal with comparatively low melting point melts due to the current exceeding the rating to interrupt the circuit.

If the metal is fatigued due to the current exceeding the rating, the circuit may be interrupted even in a normal status.

Design the system so that the fuse does not blow. If the fuse blows out, replace the module.

The fuse is a protection mechanism. Therefore, the blowout of the fuse indicates that there is a cause which leads to the blowout.

Before replacing the module, the cause needs to be removed.



3.5

Input module

There are, in general, the following input module types.

- 1) 24VDC input type
- 2) 100VAC input type
- 3) 5VDC input type

The heat generated by internal resistors of a module may cause the module and the surrounding devices to malfunction. Because of this, the heat must be controlled by limiting the resistance in a module.

For 32-point/64-point input modules, the number of points through which current can simultaneously flow are limited to keep the resistance to a certain level. Such limitation, of course, is not necessary if current only flows instantaneously. The conduction intervals and the number of simultaneously-conducted points must be considered as they determine the generated heat amount and the normal operating period.

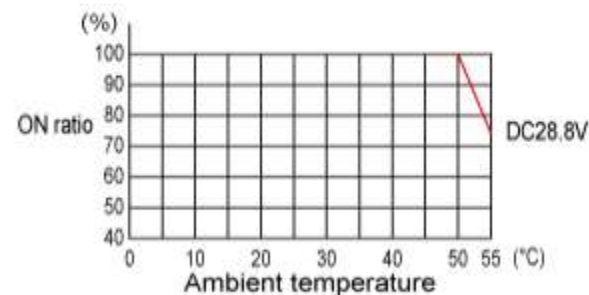
As shown right, when a 28.8VDC is input to the input module with the 24VDC rating in the ambient temperature of 55°C, some points stay OFF, or the ON status of some points are not continuous.

To turn ON all the required points, take one of the following measures:

- Reduce the number of required points
- Lower the required voltage
- Configure a system that does not require points to be continuously ON
- Lower the ambient temperature

To shorten the failure period, the following countermeasures can be considered.

- Prepare spares: Use the input modules of the same type even when all the points are not used
- Set marking tubes to signal lines to clarify the wire connection
- Receive signals at the terminal block to clarify the destination of the wire



Chapter 4 Support system

Warranty

Check carefully the warranty information, such as the range and period of the free-warranty, and safety precautions in the manual etc.

Products and service

Mitsubishi Electric has been the leader in the factory automation business in Japan with its quality-focused products including PLCs. Many customers choose Mitsubishi for its outstanding product reliability and attentive after-sales service.

Mitsubishi products comply with many overseas standards. Also, the support centers located in major countries worldwide deliver the same service as in Japan to support customers in every aspect.

4.1

International service network

Please contact the overseas FA centers.

The FA center is the key station for the local information, and the local staffs support customers.

The FA center and local agencies cooperate with each other to provide services.



1 Japan, Head office

2 China Shanghai

3 China Beijing

4 China Tianjin

5 China Guangzhou

6 Taiwan Taichung

7 Taiwan Taipei

8 Korea

9 ASEAN

10 Thailand

11 Indonesia

12 Vietnam Hanoi

13 Vietnam Ho Chi Minh

14 India Pune

15 India Gurgaon

16 India Bangalore

17 India Chennai

18 India Ahmedabad

19 North America

20 Mexico

21 Brazil

22 Brazil Votorantim

23 Europe

24 Germany

25 UK

26 Czech Republic

27 Italy

28 Russia

29 Turkey

4.2**Telephone technical consultation**

Mitsubishi Electric prepares the telephone consultation for the problem the customer cannot solve.

Contact the local FA center.

- What is the symptom of the problem?
- Does the problem occur frequently or did it occur for the first time?
- What was done before the problem occurred?
- What is the system configuration?
- How long has the system been operated?
- What has been done after the problem occurred?
- Did anything change by the corrective action?
- Is there any error code?

Test**Final Test**

Now that you have completed all of the lessons of the **PLC System Maintenance** Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.

There are a total of 7 questions (16 items) in this Final Test.

You can take the final test as many times as you like.

How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct answers : **7**

Total questions : **7**

Percentage : **100%**

To pass the test, you have to answer **60%** of the questions correct.

Proceed

Review

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

Test**Final Test 1**

✓ Select the correct description to increase the operating rate. (Select one description.)

- ☐ Lengthen the normal operating period and failure period.
- ☐ Shorten the normal operating period and failure period.
- ☐ Shorten the normal operating period and lengthen the failure period.
- ✓ ☒ Lengthen the normal operating period and shorten the failure period.

Back

Test**Final Test 2**

Select the most suitable description when selecting the PLC manufacturer. (Select one description.)

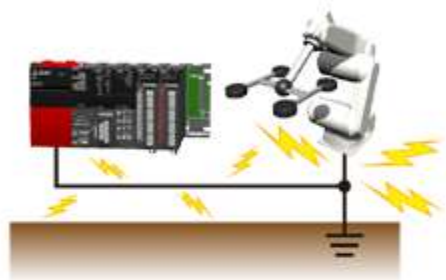
- ☐ The PLCs should be as cheap as possible to lower the cost of the whole facility.
- ☐ The PLCs with frequent model changes are generally technologically advanced and suitable for plant facilities.
- ☒ The long-time stable supply, stable operation, interchangeability, and market share must be considered.

Back

Test

Final Test 3

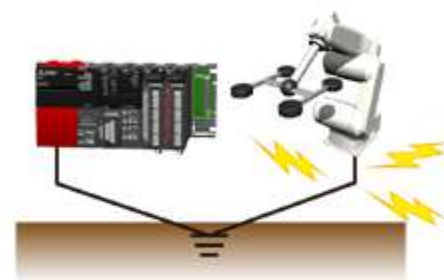
✓ Select the best grounding method. (Select one method.)



☐ Common grounding



☒ Independent grounding



☐ Shared grounding

Back

Test

Final Test 4



Select the correct description related to the derating. (Select one description.)

- ☒ For long-time stable operation, design the system well below the rating.
- ☐ Semiconductors used in PLCs are permanent devices. They can be used without any worries even at high temperatures.
- ☐ The PLC system should be used in high humidity because the vapor formed in high humidity cools down the system.
- ☐ Installing PLCs in a control panel without any gaps increases the heat conductivity and improves the cooling effect.

Back

Test

Final Test 5



 Select the correct description related to the maintenance. (Select two descriptions.)

- ☐ Even though the design is rough, a proper inspection protects the PLC system from failures.
-   Maintenance must be considered during the system design stage.
- ☐ If the PLC system is not designed for direct contact with human, an inspection is unnecessary.
-   The maintenance in a broad sense includes the manufacturer selection.
- ☐ Keep using a PLC as long as it operates even though the production of the series is discontinued.

Back

Test

Final Test 6

✓ Complete the following sentences about atmosphere.

Atmosphere indicates the status of around the PLC system.

Corrosive gases corrode . Corrosive gases, which damage lead wires and printed circuit board patterns, will eventually cause a malfunction.

With dew condensation or an increase in humidity, powders or stuck to the LSI pins increase the possibility of and leads to the unstable operation or failure.

At too low , the can be generated, which can cause a malfunction. Therefore, the possibility that the semiconductors get damaged increases, which leads to a malfunction.

Back

Test

Final Test 7

✓ Complete the following sentences about the method to shorten the failure period.

- * Replace before the lifetime reaches its end, or a failure occurs.
✓
- * Keep spare parts near the system.
✓
- * Keep the specification to easily identify the faulty point.
✓
- * Replace the product before a failure occurs in a product with the fault diagnosis function.
✓
- * Display clearly not only the error, but also the countermeasure.
✓

Back

Test**Test Score**

You have completed the Final Test. Your results are as follows.
To end the Final Test, proceed to the next page.

Correct answers : **7**

Total questions : **7**

Percentage : **100%**

Proceed

Review

Congratulations. You passed the test.

You have completed the **PLC System Maintenance** Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.

You can review the course as many times as you want.

Review

Close