OMRON

CK3M/CK5M-series

Programmable Multi-Axis Controller

Hardware
User's Manual

CK5M-CPU1□1
CK3M-CPU1□1
CK3W-PD048
CK3W-AX1313□/-AX1414□/-AX1515□/-AX2323□
CK3W-MD71□0
CK3W-AD□100
CK3W-ECS300
CK3W-GC□□00
CK3W-EXM01/-EXS02
CK5W-EXS01

Programmable Multi-Axis Controller

O036-E1-12

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  C:\DeltaTau\PowerPMAC\Compilers\opt\

Introduction

Thank you for purchasing the CK3M/CK5M-series Programmable Multi-Axis Controller (hereinafter, it may be abbreviated as “Motion Controller”).
This manual contains information necessary for using the CK3M/CK5M-series Programmable Multi-Axis Controller. Please read this manual and make sure you understand the functionality and performance of the product before you attempt to use it in a control system.
Keep this manual in a safe place where it will be available for reference during operation.

Intended Audience

This manual is intended for the following personnel, who must also have knowledge of electrical systems (electrical engineers or the equivalent).

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

Applicable Products

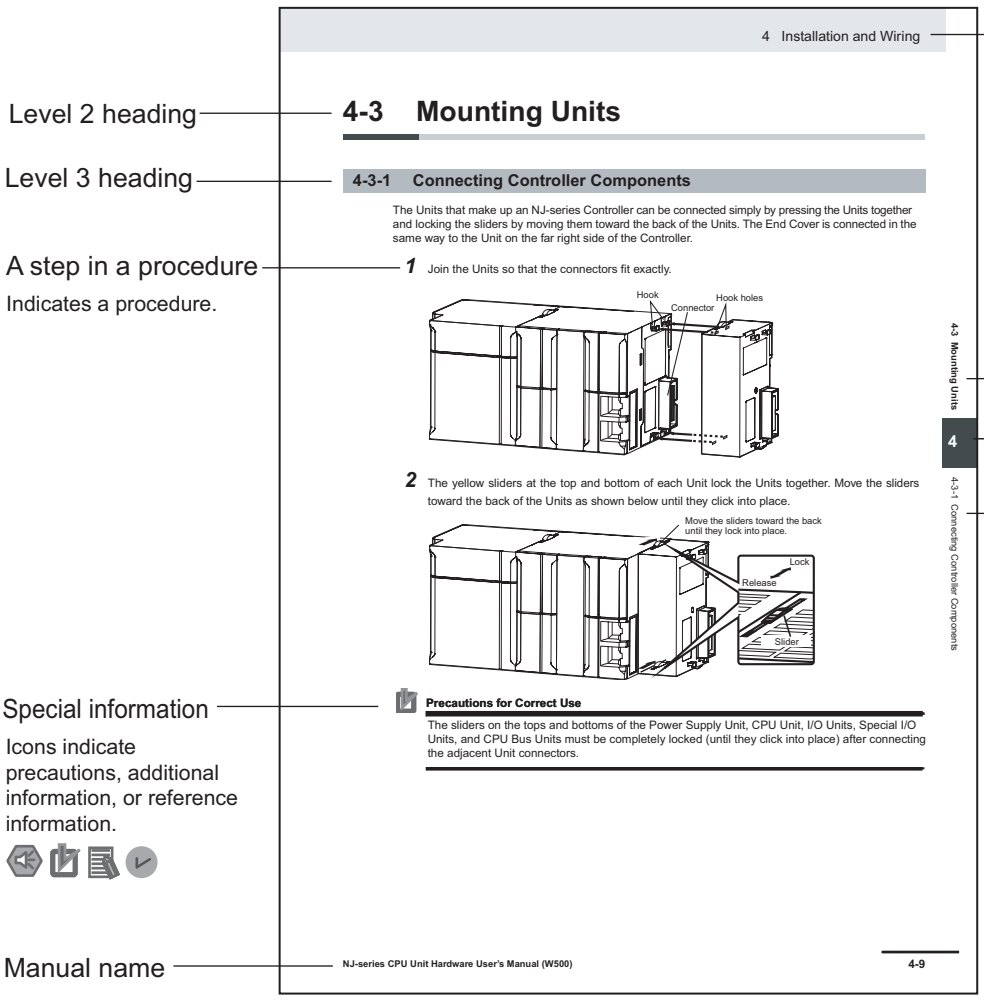
This manual covers the following products.

- CK3M/CK5M-series Programmable Multi-Axis Controller
  CK5M-CPU1□1
  CK3M-CPU1□1
  CK3W-PD048
  CK3W-AX1313□/-AX1414□/-AX1515□/-AX2323□
  CK3W-MD71□0
  CK3W-AD□100
  CK3W-ECS300
  CK3W-GC□□00
  CK3W-EXM01/-EXS02
  CK5W-EXS01

Manual Structure

Page Structure

The following page structure is used in this manual.



Note This illustration is provided only as a sample. It may not literally appear in this manual.

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure correct operation and performance.

Additional Information

Additional information to read as required.
This information is provided to increase understanding and make operation easier.

Sections in this Manual

1 Introduction to Motion Controllers
2 System Configuration
3 Configuration Units
4 Installation
5 Wiring
6 Troubleshooting
7 Inspection and Maintenance
A Appendices
I Index

CONTENTS

Introduction 1
Intended Audience 1
Applicable Products 1

Manual Structure 2
Page Structure 2
Special Information 3

Sections in this Manual 5

Terms and Conditions Agreement 11
Warranty, Limitations of Liability 11
Application Considerations 12
Disclaimers 12
Statement of Security Responsibilities for Assumed Use Cases and Against Threats 13

Safety Precautions 14
Definition of Precautionary Information 14
Symbols 14
WARNING 15
Cautions 19

Precautions for Safe Use 20

Precautions for Correct Use 25

Regulations and Standards 27
Conformance to EU Directives 27
Condition for Compliance with EU Directives 27
Conformance to UL and CSA Standards 28
Conformance to KC Certification 28

Versions 29
Checking Versions 29

Related Manuals 31

Terminology 32

Revision History 33

Section 1 Introduction to Motion Controllers

1-1 Features and System Configuration 1-2
1-1-1 Motion Controller Features 1-2
1-1-2 Introduction to the System Configurations 1-2
1-1-3 Support Software 1-4
1-2 Operating Procedure 1-6

Section 2 System Configuration

2-1 Basic Configuration 2-2
2-1-1 CK□W Unit Configuration 2-2
2-1-2 EtherCAT Network Configuration 2-5
2-2 Connecting to the Power PMAC IDE 2-6
2-3 Ethernet Network Configuration 2-7

Section 3 Configuration Units

3-1 CPU Unit 3-3
3-1-1 Models and Specifications 3-3
3-1-2 Part Names and Functions 3-7
3-1-3 Operation Status Indicators 3-8
3-1-4 Watchdog Output Terminal Block 3-9
3-1-5 USB Memory Device 3-10
3-2 Power Supply Unit 3-12
3-2-1 Models and Specifications 3-12
3-2-2 Part Names and Functions 3-13
3-3 Axis Interface Unit 3-14
3-3-1 Models and Specifications 3-14
3-3-2 Part Names and Functions 3-16
3-3-3 Operation Status Indicators 3-17
3-3-4 Address Switch Setting 3-18
3-3-5 Encoder Connector Specifications 3-18
3-3-6 Encoder Loss Detection 3-24
3-3-7 Pulse Input Timing Specifications for Digital Quadrature Encoder 3-25
3-3-8 Input Specifications for Sinusoidal Encoder 3-27
3-3-9 OutFlag Function 3-29
3-3-10 Amplifier Connector Specifications 3-30
3-3-11 DA Output Method 3-33
3-3-12 DirectPWM Output Method 3-35
3-3-13 Flag Connection Terminal Block Specifications 3-35
3-3-14 General Digital I/O Connection Terminal Block Specifications 3-40
3-4 Digital I/O Unit 3-47
3-4-1 Models and Specifications 3-47
3-4-2 Part Names and Functions 3-51
3-4-3 Operation Indicators 3-52
3-4-4 Address Switch Setting 3-52
3-4-5 Terminal Arrangement 3-53
3-4-6 I/O Data 3-54
3-5 Analog Input Unit 3-56
3-5-1 Models and Specifications 3-56
3-5-2 Part Names and Functions 3-57
3-5-3 Operation Indicators 3-58
3-5-4 Address Switch Setting 3-58
3-5-5 Terminal Arrangement 3-59
3-5-6 Analog Input Data 3-60
3-5-7 Input Filter 3-61
3-6 Encoder Input Unit 3-63
3-6-1 Models and Specifications 3-63
3-6-2 Part Names and Functions 3-65
3-6-3 Operation Indicators 3-65
3-6-4 Address Switch Setting 3-65
3-6-5 Terminal Arrangement 3-66
3-6-6 Software Settings 3-66
3-7 Laser Interface Unit 3-68
3-7-1 Models and Specifications 3-68

3-7-2 Part Names and Functions....3-72
3-7-3 Operation Indicators....3-73
3-7-4 Address Switch Setting....3-73
3-7-5 Terminal Arrangement....3-74
3-7-6 XY2-100 Interface....3-74
3-7-7 SL2-100 Interface....3-78
3-7-8 PWM Output Function....3-82
3-7-9 TCR Output Function....3-84
3-7-10 Software Settings....3-86

3-8 Expansion Master Unit and Expansion Slave Unit....3-89
3-8-1 Models and Specifications....3-89
3-8-2 Part Names and Functions....3-90
3-8-3 Operation Indicators....3-92
3-8-4 System Configuration....3-92

Section 4 Installation

4-1 Processing at Power ON and Power OFF....4-2
4-1-1 Power ON Operation....4-2
4-1-2 Power OFF Operation....4-2

4-2 Fail-safe Circuits....4-4

4-3 Unit Installation....4-6
4-3-1 Installation in a Control Panel....4-6
4-3-2 Connection Between Units....4-10
4-3-3 Mounting to DIN Track....4-11
4-3-4 DIN Track and Accessories....4-13
4-3-5 Assembled Appearance and Dimensions....4-14

4-4 Control Panel Installation....4-20
4-4-1 Temperature....4-20
4-4-2 Humidity....4-21
4-4-3 Vibration and Shock....4-22
4-4-4 Atmosphere....4-22
4-4-5 Electrical Environment....4-22
4-4-6 Grounding....4-27

Section 5 Wiring

5-1 Power Supply Wiring....5-2
5-1-1 Power Supply Unit CK3W-PD048....5-2
5-1-2 Power Supply Used....5-2
5-1-3 Applicable Wires....5-2
5-1-4 Grounding....5-3
5-1-5 Required Tools....5-4
5-1-6 Connecting Ferrules....5-4
5-1-7 Connecting Twisted Wires/Solid Wires....5-4
5-1-8 Removing Wires....5-5

5-2 CPU Unit Wiring....5-7
5-2-1 Laying the EtherCAT Network....5-7
5-2-2 Laying the Ethernet Network....5-12
5-2-3 Watchdog Timer Output Wiring....5-14
5-2-4 USB Memory Device Connection....5-17

5-3 Axis Interface Unit Wiring....5-18
5-3-1 Encoder Connector Wiring....5-18
5-3-2 Amplifier Connector Wiring....5-24
5-3-3 Flag Terminal Block/General I/O Terminal Block Wiring....5-26

5-4 Digital I/O Unit Wiring....5-33
5-4-1 Wiring the Terminals....5-33

5-4-2 Precautions When Connecting a Two-wire DC Sensor 5-36
5-4-3 Precautions When Connecting to Digital Output 5-38
5-5 Analog Input Unit Wiring 5-40
5-5-1 Wiring the Terminals 5-40
5-6 Encoder Input Unit 5-44
5-6-1 Encoder Connector Wiring 5-44
5-6-2 Dedicated Cable 5-44
5-7 Laser Interface Unit 5-46
5-7-1 Galvo Scanner Connector Wiring 5-46
5-7-2 Laser Connector Wiring 5-48
5-8 Expansion Master Unit and Expansion Slave Unit Wiring 5-50

Section 6 Troubleshooting

6-1 Types of Errors 6-2
6-2 Using the Indicators to Check Errors 6-3
6-2-1 Indicator Types 6-3
6-2-2 Procedure for Identifying Errors 6-3
6-3 Troubleshooting for Errors 6-5
6-3-1 Fatal Errors in the CPU Unit 6-5
6-3-2 Non-fatal Errors in the CPU Unit 6-6
6-3-3 Initialization of CPU Unit Using USB Memory 6-9
6-4 Sys.Status Register 6-10
6-4-1 Sys.Status Register List 6-10
6-4-2 Details of Flags 6-11
6-5 EtherNet/IP Connection Status Codes and Troubleshooting 6-21

Section 7 Inspection and Maintenance

7-1 Cleaning and Inspection 7-2
7-1-1 Cleaning 7-2
7-1-2 Periodic Inspections 7-2
7-2 Maintenance Procedures 7-4
7-2-1 Unit Replacement Precautions 7-4
7-2-2 Backup 7-4
7-2-3 Unit Replacement 7-4

Appendices

A-1 General Specifications A-3
A-2 Dimensions A-4
A-2-1 CPU Unit A-4
A-2-2 Power Supply Unit A-5
A-2-3 Axis Interface Unit A-5
A-2-4 CK3W-MD and CK3W-AD Units A-6
A-2-5 CK3W-ECS and CK3W-GC Units A-7
A-2-6 Expansion Master Unit and Expansion Slave Unit A-8
A-2-7 End Cover A-9
A-3 Restrictions on Using the NX-series EtherCAT Coupler Unit A-10
A-4 OMRON Servo Drive Connection Example A-11
A-5 Version Information A-12
A-6 How to Read the Lot Number A-13

A-7 Supported CIP Objects A-14
A-7-1 Identity Object (Class ID: 01 Hex) A-14
A-7-2 Assembly Object (Class ID: 04 Hex) A-15
A-7-3 TCP/IP Interface Object (Class ID: F5 Hex) A-16
A-7-4 Ethernet Link Object (Class ID: F6 Hex) A-17

A-8 Software Reference of Encoder Input Unit A-21
A-8-1 Gate3[i].SerialEncCtrl (Serial Encoder Control) A-21
A-8-2 Gate3[i].Chan[j].SerialEncEna (Serial Encoder Enable) A-24
A-8-3 Gate3[i].Chan[j].SerialEncCmd (Serial Encoder Command) A-24
A-8-4 Gate3[i].Chan[j].SerialEncDataA (Serial Encoder Data A) A-27
A-8-5 Gate3[i].Chan[j].SerialEncDataB (Serial Encoder Data B) A-28
A-8-6 Gate3[i].Chan[0].Status (Internal Memory Error Detection) A-31

A-9 Software Reference of Laser Interface Unit A-33
A-9-1 Gate3[i].SerialEncCtrl (Control Register) A-33
A-9-2 Gate3[i].Chan[j].DAC[0] (Setting of Command Position and Control Command) A-34
A-9-3 Gate3[i].Chan[j].DAC[1] (Setting of Command Position Compensation Value) A-35
A-9-4 Gate3[i].Chan[j].SerialEncDataA (Command Position after Interpolation, Reception Data) A-35
A-9-5 Gate3[i].Chan[j].SerialEncDataB (Status Data) A-36
A-9-6 Gate3[i].Chan[0].CompA (PWM Output Setting) A-38
A-9-7 Gate3[i].Chan[1].CompA (PWM Output Delay Setting) A-38
A-9-8 Gate3[i].Chan[2].CompA (PWM Output Pulse Count) A-38
A-9-9 Gate3[i].Chan[0].CompB (TCR Output Command Distance Setting) A-39
A-9-10 Gate3[i].Chan[1].CompB (TCR Output Comparison Table Setting) A-39
A-9-11 Gate3[i].Chan[2].CompB (TCR Output Control Register) A-39
A-9-12 Gate3[i].Chan[3].CompB (TCR Output Status Register) A-40
A-9-13 Gate3[i].Chan[0].Status (Internal Memory Error Detection) A-40

Index

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Safety Precautions

Definition of Precautionary Information

In this manual, precautions are shown with the following indications and symbols to ensure the safe use of the CK3M/CK5M-series Programmable Multi-Axis Controller.
The safety precautions that are provided are extremely important for safety. Always read and heed the information provided in all safety precautions.
The following notation is used.

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ Caution	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Symbols

	The circle and slash symbol indicates operations that you must not do. The specific operation is shown in the circle and explained in text. This example indicates that disassembly is prohibited.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for electric shock.
	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a general precaution.
	The filled circle symbol indicates operations that you must do. The specific operation is shown in the circle and explained in text. This example shows a general precaution for something that you must do.

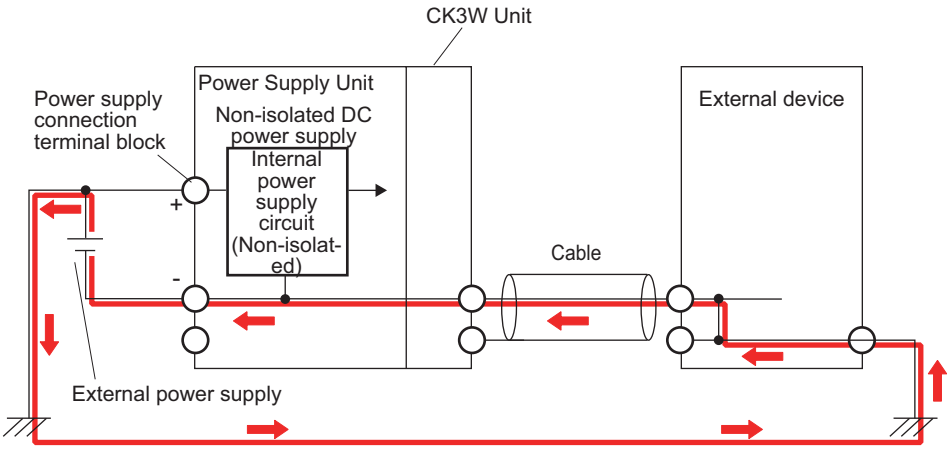
WARNING

⚠ WARNING

Wiring

Connect this Controller correctly to the servo amplifier, encoder, limit sensors, Galvo Scanner, and laser according to the instructions in this manual. Not doing so may cause the motor to run away, etc., resulting in serious accidents.

For the Power Supply Unit or any other power supply connected to peripheral devices, connect the 0-V side to ground, or do not ground them at all.
Depending on how devices connected to the non-insulated circuit are grounded, the power supply may be short-circuited.
Never ground the 24-V side of the power supply, as shown in the following figure.



During Power Supply

Do not attempt to take any Unit apart.
In particular, high-voltage parts are present in the Power Supply Unit while power is supplied or immediately after power is turned OFF. Touching any of these parts may result in electric shock. There are sharp parts inside the Unit that may cause injury.

Fail-safe Measures

Provide safety measures in external circuits to ensure safety in the system if an abnormality occurs due to malfunction of the system or due to other external factors affecting operation. Not doing so may result in serious accidents due to incorrect operation.
Emergency stop circuits, interlock circuits, limit circuits, and similar safety measures must be provided in external control circuits.

You must take fail-safe measures to ensure safety in the event of incorrect, missing, or abnormal signals caused by broken signal lines, momentary power interruptions, or other causes.

The UPS used enables normal operation to continue for a certain period of time if a momentary power interruption occurs. This means that the CK3M-series Controller may receive incorrect signals from external devices that are also affected by the power interruption. Accordingly, take suitable actions, such as establishing external fail-safe measures and interlock conditions, to monitor the power supply voltage of the external device as required.

Unintended outputs may occur if an error occurs in internal data of the Controller. As a countermeasure for these problems, external safety measures must be provided to ensure safe operation of the system.

The Controller will turn OFF all outputs of output units in the following cases and the slaves will operate according to the settings in the slaves.

- If a power supply error occurs
- If the connected power supply is faulty
- If a CPU Unit error (watchdog timer error) or CPU Unit reset occurs
- If a major fault level Controller error occurs
- While the Controller is on standby until RUN mode is entered after the power is turned ON
- If a system initialization error occurs

External safety measures must be provided to ensure safe operation of the system in such cases.

The outputs may remain ON or OFF due to welding or burning of the output relays or destruction of the output transistors. As a countermeasure for these problems, external safety measures must be provided to ensure safe operation of the system.

To ensure safe use of the Controller, correctly make the limit settings for the position, speed, acceleration, jerk, current, and following error, as well as the encoder loss detection.

For devices that move in a vertical direction, use a motor brake to prevent them from falling down when the servo control is stopped.

Downloading

Always confirm safety at the destination before you transfer a user program, configuration data, or setup data from the Power PMAC IDE.
The devices or machines may perform unexpected operation regardless of the operating mode of the Controller.

After you transfer the user program, the Controller is restarted and communications with the EtherCAT slaves are cut off. During that period, the slave outputs behave according to the slave specifications.
The time that communications are cut off depends on the EtherCAT network configuration.
Before you transfer the user program, confirm that the system will not be adversely affected.

Test Run

Before you start a Test Run, make sure that the operation parameters are set correctly.

Actual Operation

Check the user program, servo algorithm, data, and parameter settings for proper execution before you use them for actual operation.

Security Measures

Anti-virus protection

Install the latest commercial-quality antivirus software on the computer connected to the control system and maintain to keep the software up-to-date.

Security measures to prevent unauthorized access

Take the following measures to prevent unauthorized access to our products.

- Install physical controls so that only authorized personnel can access control systems and equipment.
- Reduce connections to control systems and equipment via networks to prevent access from untrusted devices.
- Install firewalls to shut down unused communications ports and limit communications hosts and isolate control systems and equipment from the IT network.
- Use a virtual private network (VPN) for remote access to control systems and equipment.
- Adopt multifactor authentication to devices with remote access to control systems and equipment.
- Set strong passwords and change them frequently.
- Scan virus to ensure safety of USB drives or other external storages before connecting them to control systems and equipment.

Data input and output protection

Validate backups and ranges to cope with unintentional modification of input/output data to control systems and equipment.

- Checking the scope of data
- Checking validity of backups and preparing data for restore in case of falsification and abnormalities
- Safety design, such as emergency shutdown and fail-soft operation in case of data tampering and abnormalities

Data recovery

Backup data and keep the data up-to-date periodically to prepare for data loss.

When using an intranet environment through a global address, connecting to a SCADA or an unauthorized terminal such as an HMI or to an unauthorized server may result in network security issues such as spoofing and tampering. You must take sufficient measures such as restricting access to the terminal, using a terminal equipped with a secure function, and locking the installation area by yourself.

When constructing an intranet, communication failure may occur due to cable disconnection or the influence of unauthorized network equipment. Take adequate measures, such as restricting physical access to network devices, by means such as locking the installation area.	
When using a device equipped with the SD Memory Card function, there is a security risk that a third party may acquire, alter, or replace the files and data in the removable media by removing the removable media or unmounting the removable media. Please take sufficient measures, such as restricting physical access to the Controller or taking appropriate management measures for removable media, by means of locking the installation area, entrance management, etc., by yourself.	

Cautions

⚠ Caution

Design

To control the motor safely and correctly, the servo algorithm design and gain setting work must be performed by engineers who understand control theories and the specifications of this product.

Create a program to verify the network is in cable redundancy before you enable it.
If such a program is not created, the cable may no longer be redundant due to disconnection on the ring topology without any notice.
Use the status variable *ECAT[i].RedundantLineBreak* to verify the network is in cable redundancy.

Test Run

When you perform a test run, take fail-safe measures and run the motor at a sufficiently low speed to ensure safety.

Downloading

Before you download a project written in C language, execute the re-initialization command ($$$***).

If you download a validated program to a different product, check the operation of the program again on the product because it may have different settings.

Precautions for Safe Use

Transporting

- Do not drop any Unit or subject it to abnormal vibration or shock. Doing so may result in Unit malfunction or burning.

Mounting

- Be sure that the terminal blocks, connectors, and other items with locking devices are correctly locked into place before use.
- When connecting the Power Supply Unit, CPU Unit, and CK□W Unit, connect the units together, then slide the sliders on the top and bottom until they click into place, and lock securely.
- Always mount an end cover for use. Note that if an end cover is not mounted, the Unit may not function satisfactorily.
- The number of CK□W Units connected to the CPU Unit must be within the specified range.

Installation

- Always connect to a ground of 100 Ω or less when installing the Units.
- For DIN Track installation, correctly follow the instructions in this manual.

Wiring

- Follow the instructions in this manual to correctly perform terminal block and connector wiring and insertion.
  Double-check all wiring and connector insertion before turning ON the power supply.
- If the external power supply to a digital output or a slave has polarity, connect it with the correct polarity.
  If the polarity is reversed, current may flow in the reverse direction and damage the connected devices regardless of the operation of the Controller.
- Before you connect a computer to the Controller, disconnect the power supply plug of the computer from the AC outlet.
  Also, if the computer has an FG terminal, connect it such that the FG terminal has the same electrical potential as the FG on the product.
  A difference in electrical potential between the computer and the Controller may cause a failure or malfunction.
- Do not pull on the cables or bend the cables beyond their natural limit.
- Do not place heavy objects on top of the cables or other wiring lines. Doing so may break the cables.
- Always use power supply wires with sufficient wire diameters to prevent voltage drop and burning.
  Make sure that the current capacity of the wire is sufficient. Otherwise, excessive heat may be generated.

When cross-wiring terminals, the total current for all the terminals will flow in the wire. When wiring cross-overs, make sure that the current capacity of each of the wires is not exceeded.

- Do not allow wire clippings, shavings, or other foreign material to enter the Controller. Otherwise, Controller burning, failure, or malfunctions may occur.
  Cover the Controller or take other suitable countermeasures, in particular when carrying out wiring work.
- To ensure safe use of the functions of the CK□W Units, observe the following points when wiring to avoid the effects of the noise.
  a) Use twisted-pair shielded wire for the encoder connection lines, amplifier connection lines, analog input lines, Galvo Scanner connection lines, and laser connection lines.
  b) Wire the encoder connection lines, amplifier connection lines, analog input lines, Galvo Scanner connection lines, and laser connection lines separately from the AC power lines, motor power lines, and other power lines, and do not insert into the same duct.
  c) If there are noise effects from power supply lines when using the same power supply to power an electrical welder or an electric discharge machine, or there is a high-frequency source nearby, insert a noise filter into the power supply input section.

Power Supply Design

- In the system, only use a power supply within the rated supply capacity range specified in this manual.
- Install external breakers and take other safety measures against short-circuiting and overcurrents in external wiring.
- Do not apply voltages to the Input Units in excess of the rated input voltage.
- Do not apply voltages or connect loads to the Output Units in excess of the maximum switching capacity.

Turning ON the Power Supply

- It takes approximately several tens of seconds to enter RUN mode after the power supply is turned ON. During that time, outputs will be OFF or the values will be as according to settings in the Unit or slaves. Also, external communications will not be able to be performed. Implement fail-safe circuits so that external devices do not operate incorrectly.
- Surge current occurs when the power supply is turned ON. When selecting fuses or breakers for external circuits, consider the above precaution and allow sufficient margin in shut-off performance. Refer to this user's manual for surge current specifications.
- Configure the external circuits so that the power supply to the digital output turns ON only after the power supply to the Controller has turned ON.
  If the power supply to the Controller is turned ON after the digital output power supply, the digital output may suddenly malfunction when the power supply is turned ON to the Controller.

Actual Operation

- Build a program such that the Sys.Status flag is constantly monitored and safe operations are taken if any errors occur.

Turning OFF the Power Supply

- Do not turn OFF the power supply or remove the USB memory device while the Controller is accessing the USB memory device. Data may become corrupted, and the Controller will not operate correctly if it uses corrupted data.
- Always turn OFF the power supply before you attempt any of the following.
  a) Mounting or removing the Units
  b) Assembling the Units
  c) Setting rotary switches
  d) Connecting cables or wiring the system
  e) Connecting or disconnecting the terminal blocks or connectors
- Do not disconnect the cable or turn OFF the power supply to the product when downloading data or programs from the Support Software. You may be unable to download the correct data, which could result in malfunctions.
- Do not turn OFF the power supply to the Controller while the built-in flash memory is being written. Data may become corrupted, and the Controller may not operate correctly.

Operation

Confirm that no adverse effects will occur in the system before you attempt any of the following.

- Changing the operating mode of the Controller (including changing operation mode setting when power is turned ON)
- Changing the user program or settings
- Changing set values or present values

EtherCAT Communications

- Make sure that the communications distance, number of nodes connected, and method of connection for EtherCAT are within specifications.
  Do not connect EtherCAT communications to EtherNet/IP, a standard in-house LAN, or other networks. An overload may cause the network to fail or malfunction.
- If the **Fail-soft Operation Setting** parameter is set to **Stop**, process data communications will stop for all the slaves when an EtherCAT communications error is detected in a slave. For this reason, if Servo Drives are connected, the Servos for all axes will be turned OFF. At that time, the Servo Drive will operate according to the Servo Drive specifications. Make sure that the **Fail-soft Operation** parameter setting results in safe operation when a device error occurs.
- If noise occurs or an EtherCAT slave is disconnected from the network, any current communications frames may be lost. If frames are lost, slave I/O data is not communicated, and unintended operation may occur. The slave outputs will behave according to the slave specifications. For details, refer to the manual for the slave.
- When an EtherCAT slave is disconnected or disabled, communications will stop and control of the outputs will be lost not only for the disconnected slave, but for all slaves connected after it. Confirm that the system will not be adversely affected before you disconnect or disable a slave.
- You cannot use standard Ethernet hubs or repeater hubs with EtherCAT communications. If you use one of these, a major fault level error or other error may occur.

- EtherCAT communications are not always established immediately after the power supply is turned ON. Use the system-defined variables and the EtherCAT Coupler Unit device variables in the user program to confirm that I/O data communications are established before attempting control operations.
- If you need to disconnect the cable from an EtherCAT slave during operation, first reset the EtherCAT and EtherCAT slaves that are connected after it to the Init state, then disconnect the EtherCAT slave.
- For EtherCAT and EtherNet, use the connection methods and cables that are specified in this manual. Otherwise, communications may be faulty.
- Make sure that all of the slaves to be restored are participating in the network before you reset the EtherCAT Master Function Module. If any slave is not participating in the network when any of these errors is reset, the EtherCAT Master Function Module may access a slave with a different node address than the specified node address, or the error may not be reset correctly.
- There is a time lag between the moment when this Controller sends a command value to the EtherCAT type Servo Drive and the moment when it receives the feedback value. Perform servo control taking this time lag into consideration.
- When the cable connected to the third-party slave on the ring topology is disconnected or the power supply is disconnected, the frame being communicated may be lost. If the frame is lost, the input or output data of the slave will not be transmitted, and unintended operation may occur.
  Before connecting a third-party slave on the ring topology, check the followings.
  a) Connect and disconnect the communication cable connected to the OUT port of the third-party slave several times, and check the status change of *ECAT[i].RedundantLineBreak* and *ECAT[i].RedundantLineFixed* will only occur.
  b) Connect and disconnect the communication cable connected to the IN port of the third-party slave several times, and check the status change of *ECAT[i].RedundantLineBreak* and *ECAT[i].RedundantLineFixed* will only occur.
  c) Turn the power OFF and ON of the third-party slave, and check that other slaves are not in any errors.

EtherNet/IP Communications

- Unexpected operation may result if inappropriate data link tables are set. Even if appropriate data link tables have been set, confirm that the controlled system will not be adversely affected before you transfer the data link tables. The data links start automatically after the data link tables are transferred.
- If EtherNet/IP tag data links (cyclic communications) are used with a repeating hub, the communications load on the network will increase. This will increase collisions and may prevent stable communications. Do not use repeating hubs on networks where tag data links are used. Use an Ethernet switch instead.
- Make sure to use the communications distance, number of nodes connected, and method of connection for EtherNet/IP within specifications. Do not connect EtherNet/IP communications to EtherCAT or other networks. An overload may cause the network to fail or malfunction.

Motion Control

- The motor is stopped if communications are interrupted between the Power PMAC IDE and the Controller during a Test Run. Connect the communications cable securely and confirm that the system will not be adversely affected before you perform a Test Run.
- EtherCAT communications are not always established immediately after the power supply is turned ON. Use the system-defined variables in the user program to confirm that communications are established before attempting control operations.
- When you create a servo algorithm, take fail-safe measures in the user program which includes the servo algorithm.

Unit Replacement

- Make sure that the required data, including the user program, configurations, settings, and variables, is transferred to the Controller that was replaced and to externally connected devices before restarting operation.

Upgrading the Power PMAC IDE

- After you upgrade a project file created with an older version of the Power PMAC IDE for use with a newer version of Power PMAC IDE, perform a test run before use to check that the project file was upgraded correctly.

Maintenance

- Do not attempt to disassemble, repair, or modify the Controller. Doing so may result in a malfunction or fire.
- Do not use corrosive chemicals to clean the Controller. Doing so may result in a failure or malfunction of the Controller.
- Dispose of the product according to local ordinances as they apply.

Precautions for Correct Use

Storage and Installation

- Follow the instructions in this manual to correctly perform installation.
- Do not operate or store the Controller in the following locations. Doing so may result in burning, in operation stopping, or in malfunction.
  a) Locations subject to direct sunlight
  b) Locations subject to temperatures or humidity outside the range specified in the specifications
  c) Locations subject to condensation as the result of severe changes in temperature
  d) Locations subject to corrosive or flammable gases
  e) Locations subject to dust (especially iron dust) or salts
  f) Locations subject to exposure to water, oil, or chemicals
  g) Locations subject to shock or vibration
- Take appropriate and sufficient countermeasures when installing the Controller in the following locations.
  a) Locations subject to strong, high-frequency noise
  b) Locations subject to static electricity or other forms of noise
  c) Locations subject to strong electromagnetic fields
  d) Locations subject to possible exposure to radioactivity
  e) Locations close to power lines
- Before touching a Unit, be sure to first touch a grounded metallic object in order to discharge any static build-up.
- Install the Controller away from sources of heat and ensure proper ventilation. Not doing so may result in malfunction, in operation stopping, or in burning.
- Use the CK3W-EXS02 for the Expansion Slave Unit farthest from the CPU Rack.
  When the CK5W-EXS01 is used, the signal becomes unstable, which may cause a malfunction.

Wiring

- Use the rated power supply voltage for the products.
- Follow the instructions in this manuals for the length and impedance of the cable used.

Task Settings

- If a Task Period Exceeded error occurs, shorten the programs to fit in the task period or increase the setting of the task period.

During Operation

- Do not disconnect the communications cable while the system is running. Doing so may result in a failure or malfunction of the system.

Motion Control

- Do not download motion control settings during a Test Run.

EtherCAT Communications

- Set the Servo Drives to stop operation if an error occurs in EtherCAT communications between the Controller and a Servo Drive.
- Always use the specified EtherCAT slave cables. If you use any other cable, the EtherCAT master or the EtherCAT slaves may detect an error and one of the following may occur.
  a) Continuous refreshing of process data communications will not be possible.
  b) Continuous refreshing of process data communications will not end during the set cycle.
- Wiring slaves incorrectly in the ring topology to connect IN ports or OUT ports may cause message and process data communication to stop. Make sure that the wiring of all slaves is correct.
- If synchronous slaves exist in the network configuration when a slave outside the ring topology is disconnected or disconnected, the cable redundant is temporarily disabled due to the DC synchronization correction process.

USB Devices

- Always use USB memory devices that comply with the USB standards.

Regulations and Standards

Conformance to EU Directives

Applicable Directives

- EMC Directives

Concepts

● EMC Directives

OMRON devices that comply with EU Directives also conform to the related EMC standards so that they can be more easily built into other devices or the overall machine. The actual products have been checked for conformity to EMC standards.*1

Whether the products conform to the standards in the system used by the customer, however, must be checked by the customer. EMC-related performance of the OMRON devices that comply with EU Directives will vary depending on the configuration, wiring, and other conditions of the equipment or control panel on which the OMRON devices are installed. The customer must, therefore, perform the final check to confirm that devices and the overall machine conform to EMC standards.

*1. Applicable EMC (Electromagnetic Compatibility) standards are as follows: EMS (Electromagnetic Susceptibility): EN61326 EMI (Electromagnetic Interference): EN61326 (Radiated emission: 10-m regulations).

● Conformance to EU Directives

The CK□M-series Unit complies with EU directives. To ensure that the machine or device in which the Controllers are used complies with EU Directives, the following precautions must be observed.

- Be sure to install the CK□M-series Units in the control panel.
- You must use double or reinforced insulation power supply for the DC power supplies that are connected as the Unit power supplies for the CK□M-series Units.
  We recommend that you use the OMRON S8VK-S series DC Power Supplies. EMC standard compliance was confirmed for the recommended Power Supplies.
- The CK□M-series Units that comply with EU Directives also conform to the Common Emission Standard (EN61326). Radiated emission characteristics (10 m regulations) may vary depending on the configuration of the control panel used, other devices connected to the control panel, wiring, and other conditions.
  You must therefore confirm that the overall machine or equipment in which the CK□M-series Units are used complies with EU Directives.
- This is a Class A product (for industrial environments). In a residential environment, it may cause radio interference. If radio interference occurs, the user may be required to take appropriate measures.

Condition for Compliance with EU Directives

The immunity test conditions for the CK□M-series Analog Input Unit are as follows.

Unit type	Overall accuracy
Analog Input Unit	+6%/-6%

To connect an Analog Input Unit, use 2-core twisted-pair shielded wire. Note that compliance was confirmed with the shielded wire grounded at both ends.

Conformance to UL and CSA Standards

The CK□M-series Controller conforms to UL and CSA standards.
For how to make your machine or device compliant with these standards, refer to the *INSTRUCTION SHEET* included with the product.
The *INSTRUCTION SHEET* provides usage conditions to make it compliant with the standards.

Conformance to KC Certification

When you use this product in South Korea, observe the following precautions.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

This product meets the electromagnetic compatibility requirements for business use. There is a risk of radio interference when this product is used in home.

Versions

PMAC firmware revisions are used to manage the motion control firmware in CK□M-series CPU Units.
The PMAC firmware revision is updated each time there is a change in motion control firmware. Even when two CPU Units have the same model number, they will have functional or performance differences if they have different PMAC firmware revisions.

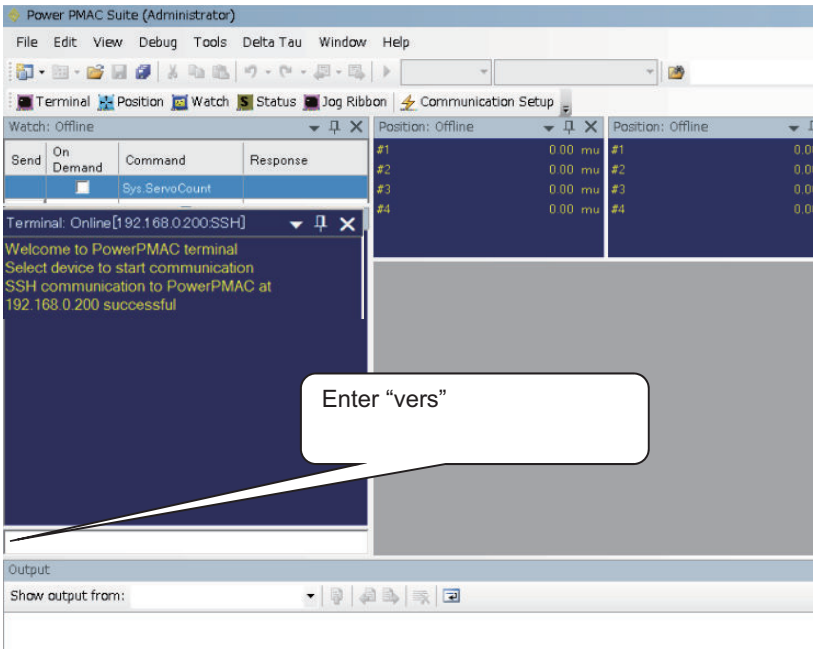
Checking Versions

You can check the PMAC firmware revision in Power PMAC IDE.

Checking with Power PMAC IDE

1 Connect the CK□M-series CPU Unit and Power PMAC IDE online.

2 Input*vers*to the terminal window.



The firmware revision is displayed on the command line.

The following table shows the main function supported by each firmware revision.

Firmware revision	Main supported function
2.4.0	CK3M-series CPU Unit initial version
2.6.0	EtherNet/IP target function
2.7.0	EtherCAT ring wiring
2.8.0	Enhanced security, support of OPC UA/MQTT

Refer to *FIRMWARE UPDATE HISTORY* in the *Power PMAC Software Reference Manual (Cat. No. O015)* for details of the supported functions.

Related Manuals

The following manuals are related. Use these manuals for reference. Contact your OMRON representative for information on how to procure these manuals.

Manual name	Cat. No.	Application	Description
CK3M/CK5M-series Programmable Multi-Axis Controller Hardware User's Manual	O036	Learning the basic specifications of the CK3M/CK5M-series Programmable Multi-Axis Controller including introductory information, design, installation, and maintenance. Mainly hardware information is provided.	An introduction to the entire CK3M/CK5M-series system is provided along with the following information. • Features and system configuration • Introduction • Part Names and Functions • General specifications • Installation and wiring • Maintenance and inspection
Power PMAC User's Manual	O014	Learning the features and usage examples of the Motion Controller.	The following information is provided on the Motion Controller. • Basic functions • Setup examples • Programming examples
Power PMAC Software Reference Manual	O015	Learning how to program the Motion Controller.	The following information is provided on the Motion Controller. • Details of commands • Details of data structure
Power PMAC IDE User Manual	O016	Learning how to operate Power PMAC IDE, the integrated development environment of the Controller.	Describes the operating procedures of Power PMAC IDE, and examples of how to start the system.
Power PMAC-NC-16 Quick Start Manual	O017	Briefly understanding the basic usage of Power PMAC-NC16.	Describes the Quick setup procedure to run Power PMAC-NC16 on a desktop PC by showing some examples.
Power PMAC-NC16 .ini Configuration Manual	O018	Configuring an application for CNC devices by using Power PMAC-NC16.	Describes how to set up*PowerPmacNC.ini*, the setup data file to be loaded when Power PMAC-NC16 starts.
Power PMAC-NC16 Software User Manual	O019	Learning about usage and features of Power PMAC-NC16, Support Software required to use the Controller for CNC devices.	The following information is provided on Power PMAC-NC16. • How to use the software • Features included in the software • Features that can be customized
Power PMAC-NC16 Mill G-Code Manual	O020	Creating programs for CNC devices by using Power PMAC-NC16.	Describes the basic G-code set that can be used for Power PMAC-NC16, and relevant instructions.

Terminology

Term	Description
PMAC	The acronym for Programmable Multi-Axis Controller.
Motion control	Motion control can achieve intended operation by providing a target value to the axis to be controlled, or by controlling state transitions.
Axis	A functional unit within the Motion Control Function Module. An axis is assigned to the drive mechanism in an external Servo Drive, etc.
NC	The acronym for Computerized Numerical Control. A method to numerically control machining processes in production by using computers. CNC has been further automatized over conventional numerical control machine tools (NC machine tools).
G-code	A type of language used to create NC programs.
CPU	Central Processing Unit. Hardware that executes instructions from computer programs.
Modbus/TCP	A protocol used for the Modbus communications on TCP/IP.
EtherCAT	The acronym for Ethernet for Control Automation Technology. EtherCAT is the real-time Ethernet protocol standards.
ENI file	ENI is the acronym for EtherCAT Network Information. The ENI file contains the network configuration information related to EtherCAT slaves.
ESI file	ESI is the acronym for EtherCAT Slave Information. The ESI file contains information unique to the EtherCAT slaves in XML format.
PMAC3 Style DSPGate3 IC	Motion control IC developed by the U.S. company Delta Tau Data Systems, Inc.
Gate3 index	IC index for PMAC3 Style DSPGate3 IC. Gate3 index is set with the DIP switch of the Unit. If index is *i*, the CPU Unit accesses the CK3W Unit with Gate3[i] data structure.
DirectPWM	A Servo Drive interface unique to Delta Tau Data Systems, Inc.
FilteredPWM	Method for creating analog output by smoothing the PWM pulse.
TrueDAC	Method for creating analog output using a DA converter.
Serial encoder	An encoder that uses communications to perform data transfer.
Digital quadrature encoder	A type of encoder that outputs pulse signals.
Sinusoidal encoder	A type of encoder that outputs SIN/COS waveforms at 1 Vpp.
Encoder loss detection function	Function that detects if encoder is not connected.
Hall sensor	A sensor that detects the rotor position of the motor by detecting the magnetic field.
Galvo Scanner	A Galvo Scanner device that moves the laser in various directions by adjusting the mirror angle.
TCR function	An abbreviation for *Trigger output by Commanded distance for Rapid processing*. Function for outputting the laser ON/OFF signal according to the command distance of laser trajectory.
CIP	An abbreviation for Common Industrial Protocol. An industrial standard protocol used for networks such as EtherNet/IP and DeviceNet.
EDS	An abbreviation for Electronic Data Sheet. A text file that contains the EtherNet/IP slave setting information.
Originator	A node that makes a request for opening a connection when a tag data link connection is opened in an EtherNet/IP network.
Target	A node that receives a request for opening a connection when a tag data link connection is opened in an EtherNet/IP network.
RPI	An abbreviation for Requested Packet Interval. Represents a data refresh period set for each connection between originators and targets on an EtherNet/IP network.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.

Revision code	Date	Revised content
01	July 2018	Original production
02	July 2019	• Made changes accompanying the addition of CK3W-AX1313□/-AX2323□/-MD71□0/-AD□100/-EXM01/-EXS02 Units. • Corrected mistakes.
03	July 2019	Corrected mistakes.
04	August 2020	• Made changes accompanying the addition of EtherNet/IP functions. • Corrected mistakes.
05	May 2021	• Made changes accompanying the addition of CK3W-ECS300 and CK3W-GC□□00 Units. • Corrected mistakes.
06	October 2021	Corrected mistakes.
07	December 2021	Corrected mistakes.
08	July 2022	Made changes accompanying the upgrade of CPU Unit's PMAC firmware revision.
09	September 2022	Revisions for adding safety precautions regarding security.
10	January 2023	Made changes accompanying the addition of CK5M-CPU1□1 and CK5W-EXS01 Units.
11	April 2025	Made changes accompanying the enhanced security and the support of OPC UA/MQTT.
12	July 2025	Corrected mistakes.

1

Introduction to Motion Controllers

This section describes the features, system configuration, and usage procedure of the CK3M/CK5M-series Programmable Multi-Axis Controller.

1-1 Features and System Configuration 1-2
1-1-1 Motion Controller Features 1-2
1-1-2 Introduction to the System Configurations 1-2
1-1-3 Support Software 1-4
1-2 Operating Procedure 1-6

1-1 Features and System Configuration

This section describes the features and basic system configuration of the CK3M/CK5M-series Programmable Multi-Axis Controller and Support Software.

1-1-1 Motion Controller Features

Fast Multi-Axis Control

The Motion Controller uses the *Programmable Multi Axis Controller*, developed by Delta Tau Data Systems, Inc. (hereinafter referred to as “Delta Tau”), a manufacturer specializing in motion controllers. This enables control of a maximum of 32 axes of an analog input type or DirectPWM type Servo Drive (when using eight CK3W-AX□□□□□□ Units and an Expansion Rack) at high speeds using the Axis Interface Unit.

Constructing Systems with Greater Flexibility

Programs for the Motion Controller can be written in G-code, C language, or Programmable Multi-Axis Controller specific language.
G-codes can be used after describing the operation of each G-code in the language dedicated to the Programmable Multi Axis Controller. The support software Power PMAC-NC provides sample programs for these G-codes.
This function design flexibility allows you to create functions that are optimized for your equipment. Various EtherCAT-compatible products such as image sensors and I/O as well as motion controls can be connected, allowing you to construct original systems to suit the equipment.

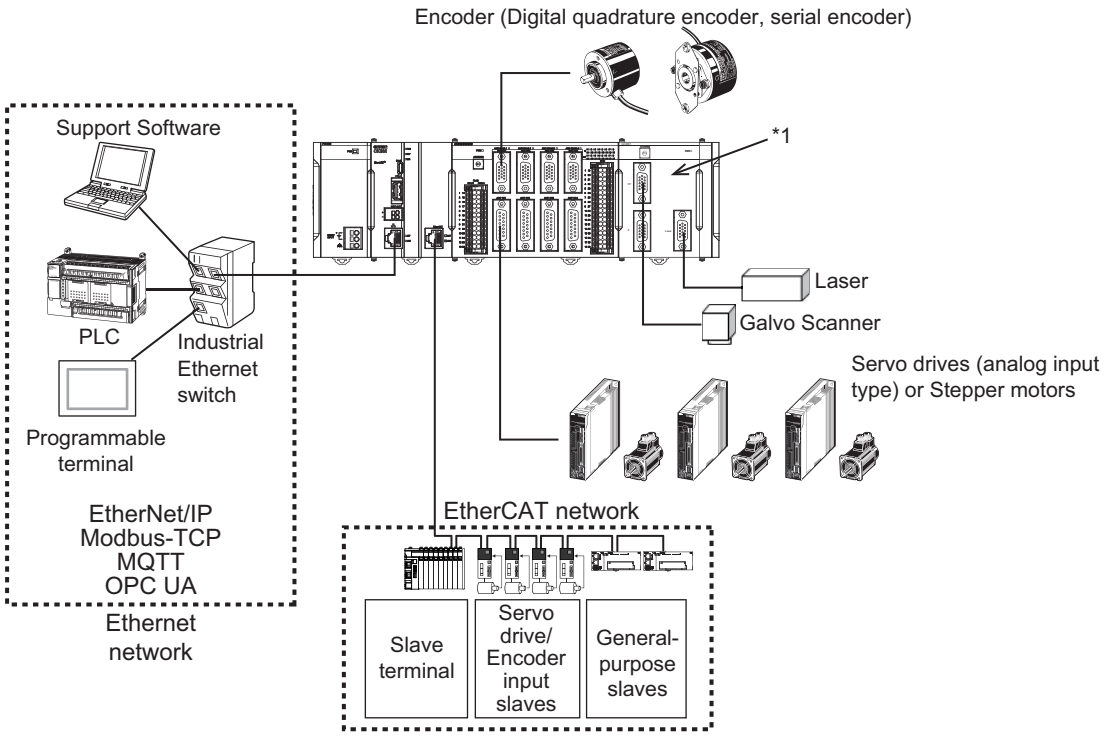
Compactness

The Controller is compact and has less wiring due to the use of the EtherCAT network, which helps to downsize devices.

1-1-2 Introduction to the System Configurations

The Motion Controller supports the following system configurations.
The basic configurations include the CK3W Unit configuration, EtherCAT network configuration, Ethernet network configuration, and Support Software.

Basic Configuration



*1. You will need this Unit when you use the Galvo Scanner.

● CK3W Unit Configuration

Up to four CK3W Units (or up to two CK3W-AX Units) can be connected to the CPU Unit.

Unit type	Model
Axis Interface Unit	CK3W-AX1313□/-AX1414□/-AX1515□/-AX2323□
Digital I/O Unit	CK3W-MD71□0
Analog Input Unit	CK3W-AD□100
Encoder Input Unit	CK3W-ECS300
Laser Interface Unit	CK3W-GC□□00

In addition to the CPU Rack, an Expansion Rack can be used to install additional CK3W Units. Up to one Expansion Rack can be added for the CK3M CPU Unit, and up to three Expansion Racks can be added for the CK5M CPU Unit.
You can add up to four CK3W Units (or up to two CK3W-AX Units) on each Expansion Rack.

By connecting an analog input type or DirectPWM type Servo Drive to a CK3W-AX Unit, high-speed axis control is enabled.
One CK3W-AX Unit controls up to four axes.
With the Expansion Rack, one CK5M CPU Unit can connect up to eight CK3W-AX Units and control a maximum of 32 axes in total.
With the Expansion Rack, one CK3M CPU Unit can connect up to four CK3W-AX Units and control a maximum of 16 axes in total.
A digital quadrature encoder, serial encoder, or sinusoidal encoder may be connected to the CK3W-AX Units as encoder input for feedback. The CK3W-AX Units have general digital I/O with 16-point input and 16-point output.

You can achieve highly accurate laser machining with the Galvo Scanner and the stage synchronized by connecting the Galvo Scanner and laser to the CK3W-GC Unit, and connecting the stage to the AX Unit.

● EtherCAT Network Configuration

By using the EtherCAT master communications port on the CPU Unit, EtherCAT slaves such as servo drives, inverters, machine vision systems, digital and analog I/O, and other general-purpose slaves can be connected.
The CPU Unit also supports connections with EtherCAT Slave Terminals. The EtherCAT Slave Terminal helps you to save space and construct flexible systems using a broad range of NX Units. However, when OMRON NX-series EtherCAT Coupler Units are used for the EtherCAT Slave Terminal, there are restrictions on the models and unit versions of EtherCAT Coupler Units that can be connected.
Refer to *A-3 Restrictions on Using the NX-series EtherCAT Coupler Unit* on page A-10 for details.

● Ethernet Network Configuration

The Ethernet communications port on the CPU Unit supports the EtherNet/IP protocol. It can be connected to devices such as PLCs and programmable terminals that support the EtherNet/IP protocol.
The Ethernet communications port can also be used for Modbus-TCP communications.
EtherNet/IP communications support targets only, so originators are required for the communications. If the originator in use is an NJ/NX-series CPU Unit, refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)* for details.
CPU Unit connection settings are required for EtherNet/IP communications. Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.

● Support Software

Connect a computer with the Support Software installed to the Motion Controller via the Ethernet network.
Refer to *1-1-3 Support Software* on page 1-4 for details of the Support Software.

1-1-3 Support Software

The following table shows the Support Software used to configure, monitor, program, and debug the Motion Controller.

Configuration software	Application	How to Procure
Power PMAC IDE[*1]	This computer software is used to configure the Motion Controller, create user programs, and debug the programs.	This is free software. [*2]

Configuration software		Application	How to Procure
Power PMAC-NC16	**Power PMAC-NC16 SDK**	This computer software is used to control machine tools and CNC machines with the Motion Controller. Use this software to customize HMI screens. The product contains extension source codes for customization.	This is non-free software. *2
	Power PMAC-NC16 Runtime	This computer software is used to control machine tools and CNC machines with the Motion Controller. Use this software when you do not customize HMI screens.	This is non-free software. *2

*1. Use Power PMAC IDE Ver.4 or a higher version. Refer to *A-5 Version Information* on page A-12 for details.
*2. Contact your OMRON representative for information on how to procure.

1-2 Operating Procedure

This section describes the procedure to construct a motion control system by using the Motion Controller.

No.	Step		Description	Reference
1	Preparation for work	Check for specification compatibility	Check compatibility with specifications of each Unit. • General specifications • Mounting direction	*A-1 General Specifications* on page A-3
		Selection of peripheral devices	Select peripheral devices to be used with the Motion Controller.	
		Preparation of Support Software	Procure and install the Support Software required for the system.	*1-1-3 Support Software* on page 1-4
2	Mounting and wiring of the Motion Controller	Mounting	Mount the Motion Controller. • Connecting adjacent Units • Mounting to DIN Track	*4-3 Unit Installation* on page 4-6
		Address switch setting	Set the address switches for the CK3W Units.	*3-3-4 Address Switch Setting* on page 3-18
		Wiring	Perform Motion Controller wiring.	*Section 5 Wiring* on page 5-1
3	Settings and wiring of the EtherCAT slave hardware*1	Node address settings	Use the hardware switches on all of the EtherCAT slaves in the network to set the node addresses.	Refer to the manual for the EtherCAT slave.
		Mounting	Mount EtherCAT slaves.	Refer to the manual for the EtherCAT slave.
		Wiring	Wire EtherCAT slaves. • Wiring of the unit power supply • I/O wiring	Refer to the manual for the EtherCAT slave.
4	Installing EtherCAT Communications Cables*1		Perform wiring for the EtherCAT communications cables.	*5-2-1 Laying the EtherCAT Network* on page 5-7
5	Turn ON the power supply to EtherCAT slaves.		Turn on the power to the devices configuring the system.	
6	Construction of the EtherCAT network*1	Installation of ESI files	Install the ESI files of EtherCAT slaves to be connected.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details. For information on the ESI file, refer to the manual for the EtherCAT slave.
		EtherCAT slave settings	Configure the EtherCAT communications settings. Then, create an ENI file used to download the configured settings to the Motion Controller.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.
		Activation of the EtherCAT network	Use Power PMAC IDE to download the ENI file to the Motion Controller. Make sure that the ENI file has been correctly downloaded, and then activate the EtherCAT network.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.

No.	Step		Description	Reference
7	Construction of the EtherNet/IP network*2	Settings of the originator device	Configure the originator device settings.	For details, refer to the manual for the originator device. Refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)* when the NJ/NX Series is used.
		Settings of the connection	Configure the connection settings.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.
8	Preparation for setting the Motion Controller	Creation of a new project	Connect the computer with the Support Software installed to the Motion Controller, and then start Power PMAC IDE and create a new project.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.
		Initialization of the Controller	Use Power PMAC IDE to initialize the Motion Controller.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.
9	Settings of the Motion Controller operation	Motor settings	Use Power PMAC IDE to set the motor operations for the Motion Controller.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.
		Programming	Create user programs on Power PMAC IDE.	Refer to the *Power PMAC User's Manual (Cat. No. O014)* and the *Power PMAC Software Reference Manual (Cat. No. O015)* for details.
10	Transferring project data and checking the operation		Transfer the created project data and check that operations work as expected.	Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.

*1. When you are using CK3M-CPU101, no setting is required.

*2. Perform settings only when EtherNet/IP is used.

2

System Configuration

This section describes the system configuration of the CK3M/CK5M-series Programmable Multi-Axis Controller.

2-1 Basic Configuration 2-2
2-1-1 CK□W Unit Configuration 2-2
2-1-2 EtherCAT Network Configuration 2-5
2-2 Connecting to the Power PMAC IDE 2-6
2-3 Ethernet Network Configuration 2-7

2-1 Basic Configuration

A Motion Controller supports the following two types of configurations.

- Basic Configuration
  The basic configurations include the CPU Unit and the Configuration Units that are controlled directly by the CPU Unit. There are two basic configurations.
  a) CK3W Unit Configuration
  b) EtherCAT network configuration
- Other Network Configuration
  This is the configuration of the system that is connected to the CPU Unit's built-in Ethernet port.

Basic System Configurations

● CK3W Unit Configuration

The CPU Rack is configured with CK3W Units.
In addition to the CPU Rack, an Expansion Rack can be used to install additional CK3W Units.
Motion control is enabled by connecting a DirectPWM type Servo Drive, an analog input type Servo Drive, or a stepper motor to the Axis Interface Unit.

● EtherCAT Network Configuration

The CK□M series CPU Unit can be connected to an EtherCAT network.
Motion control is enabled by connecting an EtherCAT type Servo Drive to the CPU Unit.

2-1-1 CK□W Unit Configuration

The following shows the configuration of CK□W Units.

CPU Rack

The CK3W Unit configuration in the CPU Rack consists of a Power Supply Unit, CPU Unit, CK3W-AX Unit, CK3W-MD Unit, CK3W-AD Unit, CK3W-ECS Unit, CK3W-GC Unit, and End Cover.
Up to four CK3W Units (or up to two CK3W-AX Units) can be connected to the CPU Unit.

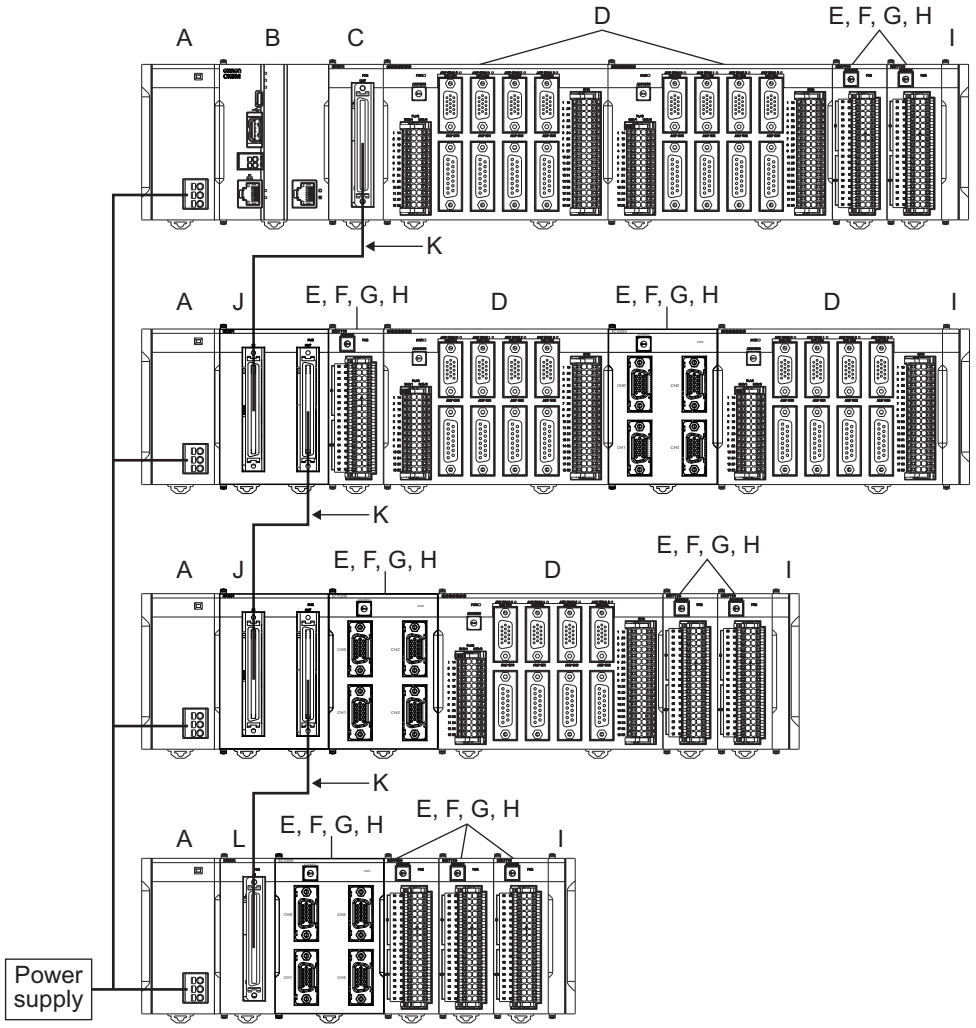
Expansion Rack

Up to one Expansion Rack can be added for the CK3M CPU Unit, and up to three Expansion Racks can be added for the CK5M CPU Unit.
To connect an Expansion Rack, use the Expansion Master Unit (CK3W-EXM01) and Expansion Slave Unit (CK5W-EXS01, CK3W-EXS02).
Up to four CK3W Units (or up to two CK3W-AX Units) can be installed to the Expansion Rack.
Connect the Expansion Master Unit (CK3W-EXM01) to the immediate right side of the CPU Unit. Connect the Expansion Slave Unit (CK5W-EXS01, CK3W-EXS02) to the immediate right side of the Power Supply Unit.

Unless the Expansion Master Unit (CK3W-EXM01) is connected adjacent to the right side of the CPU Unit, the Sys.Status register CK3WConfigErr becomes “5”.

Use the CK3W-EXS02 for the Expansion Slave Unit farthest from the CPU Rack, and the CK5W-EXS01 for the Expansion Slave Unit located in the middle.
The CK5W-EXS01 can only be used with the CK5M CPU Unit. It can not be used with the CK3M CPU Unit.

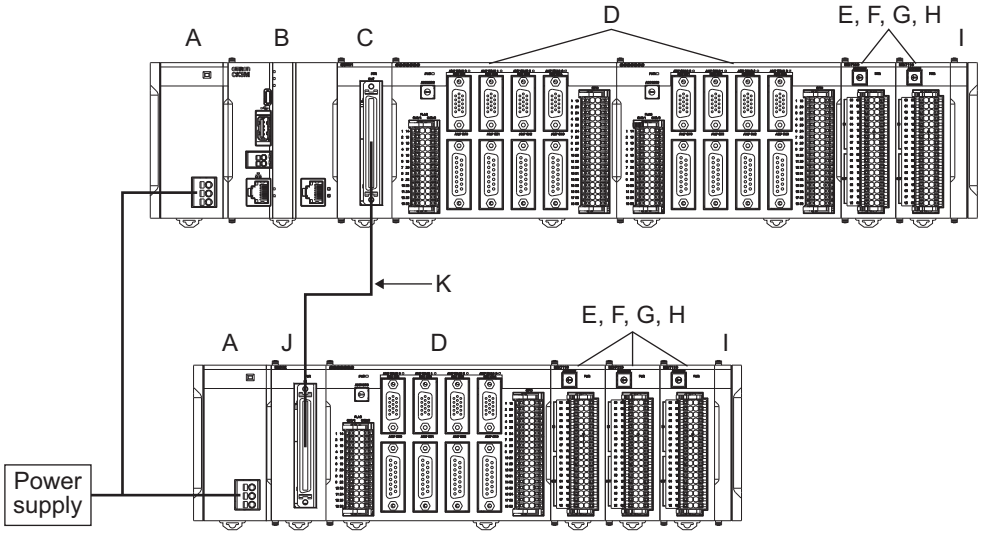
● For CK5M CPU Unit



Letter	Configuration	Remarks
A	Power Supply Unit	Input the 24 V power source. Always wire the CPU Rack and Expansion Rack to the same power supply.
B	CK5M-series CPU Unit	This is the Unit at the center of the motion control, which executes the motion program.
C	CK3W-EXM01	Expansion Master Unit. Connect this Unit to the immediate right side of the CPU Unit in the Expansion Rack.
D	CK3W-AX Unit	Axis Interface Unit. For axis control, connect this to a Servo Drive and encoder.
E	CK3W-MD Unit	Digital I/O Unit. You can add 16 digital inputs and 16 digital outputs.
F	CK3W-AD Unit	Analog Input Unit. You can add 4 or 8 voltage inputs.
G	CK3W-ECS Unit	Encoder Input Unit. You can connect four channels of the serial encoder.

Letter	Configuration	Remarks
H	CK3W-GC Unit	Laser Interface Unit. You can connect the Galvo Scanner compatible with the interface of XY2-100 or SL2-100.
I	End Cover	Must be connected to the right end of the CPU Rack and Expansion Rack. The CPU Unit and the Expansion Slave Unit are each provided with one End Cover.
J	CK5W-EXS01	Expansion Slave Unit. Use this in the Expansion Rack located in the middle. Connect this Unit to the immediate right side of the Power Supply Unit. This unit can only be used with the CK5M CPU Unit. It can not be used with the CK3M CPU Unit.
K	Expansion cable	Use this cable to connect the Expansion Master Unit and Expansion Slave Unit. The cable length is 30 cm. Be sure to use the CK3W-CAX03A (30 cm) cable.
L	CK3W-EXS02	Expansion Slave Unit. Use this for the Expansion Rack farthest from the CPU Rack. Connect this Unit to the immediate right side of the Power Supply Unit.

● For CK3M CPU Unit

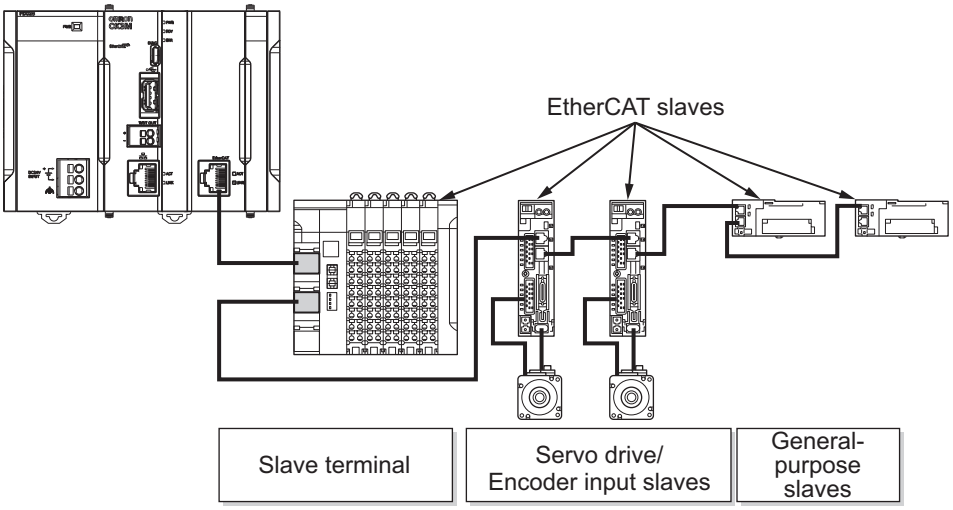


Letter	Configuration	Remarks
A	Power Supply Unit	Input the 24 V power source. Always wire the CPU Rack and Expansion Rack to the same power supply.
B	CK3M-series CPU Unit	This is the Unit at the center of the motion control, which executes the motion program.
C	CK3W-EXM01	Expansion Master Unit. Connect this Unit to the immediate right side of the CPU Unit in the Expansion Rack.
D	CK3W-AX Unit	Axis Interface Unit. For axis control, connect this to a Servo Drive and encoder.
E	CK3W-MD Unit	Digital I/O Unit. You can add 16 digital inputs and 16 digital outputs.
F	CK3W-AD Unit	Analog Input Unit. You can add 4 or 8 voltage inputs.
G	CK3W-ECS Unit	Encoder Input Unit. You can connect four channels of the serial encoder.
H	CK3W-GC Unit	Laser Interface Unit. You can connect the Galvo Scanner compatible with the interface of XY2-100 or SL2-100.
I	End Cover	Must be connected to the right end of the CPU Rack and Expansion Rack. The CPU Unit and the Expansion Slave Unit are each provided with one End Cover.

Letter	Configuration	Remarks
J	CK3W-EXS02	Expansion Slave Unit. Use this for the Expansion Rack farthest from the CPU Rack. Connect this Unit to the immediate right side of the Power Supply Unit.
K	Expansion cable	Use this cable to connect the Expansion Master Unit and Expansion Slave Unit. The cable length is 30 cm. Be sure to use the CK3W-CAX03A (30 cm) cable.

2-1-2 EtherCAT Network Configuration

The EtherCAT network configuration consists of a Power Supply Unit, CPU Unit, End Cover, and EtherCAT slaves.
Use the built-in EtherCAT port on the CK□M-series CPU Unit to connect EtherCAT slaves.



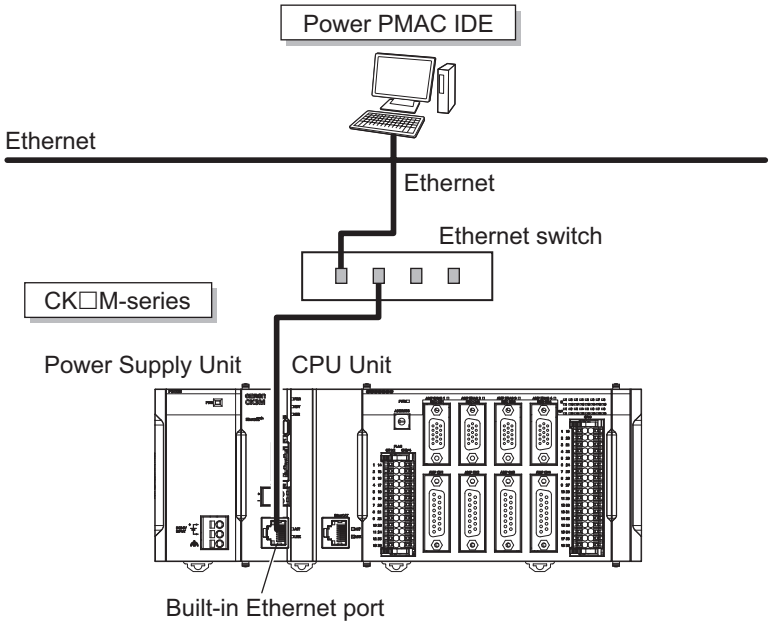
EtherCAT is synchronized with the servo cycle of the CK□M-series CPU Unit. This enables acquisition of the I/O data of slave terminals that are synchronized with the servo cycle.
Refer to *A-3 Restrictions on Using the NX-series EtherCAT Coupler Unit* on page A-10 for information on using the NX-series EtherCAT Coupler Unit.

Precautions for Correct Use

- Before you connect a slave from another manufacturer, refer to the relevant manual and be sure to check its operation.
- EtherCAT setup software that is provided by other manufacturers cannot be connected to CK□M-series CPU Units.
- When you use the CK3W-GC Unit, select **Bus Shift (Reference Clock controlled by EtherCAT Master Time)** for the Distributed Clock setting of EtherCAT.
  If you select **Master Shift (EtherCAT Master Time controlled by Reference Clock)**, the Galvo Scanner and the TCR function may not operate as intended.

2-2 Connecting to the Power PMAC IDE

Connect the CK□M-series CPU Unit and the Power PMAC IDE through Ethernet.



Precautions for Correct Use

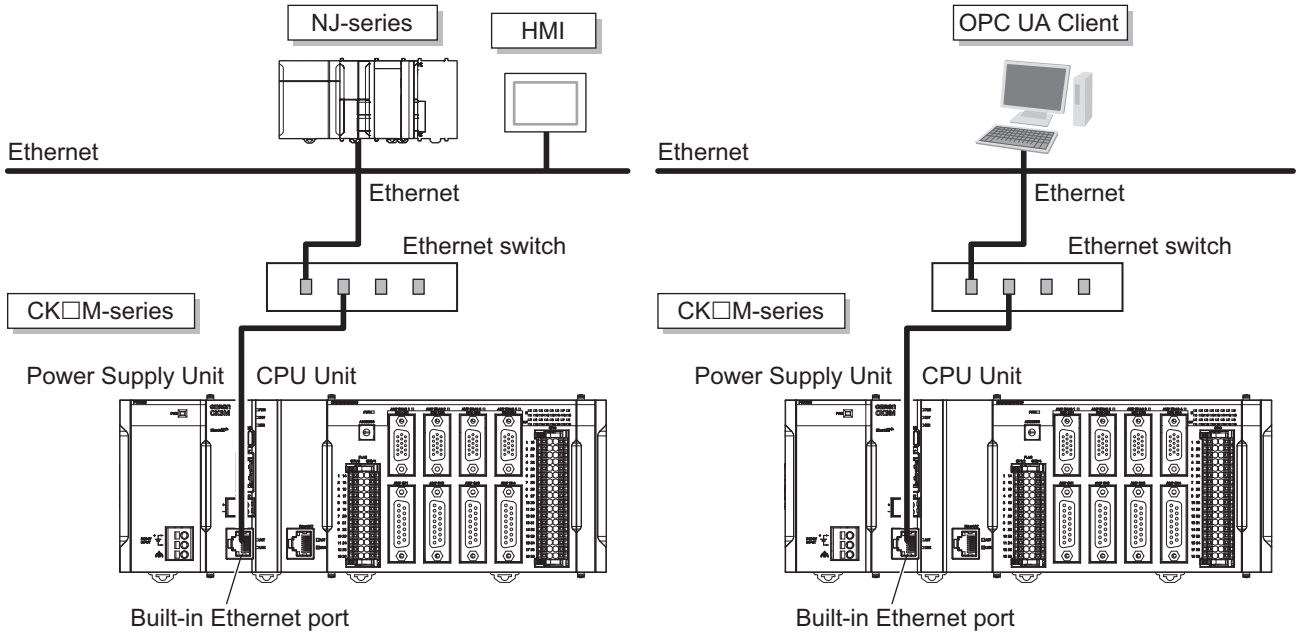
- Use Power PMAC IDE Ver.4 or a higher version. Refer to *A-5 Version Information* on page A-12 for details.
- To use the CPU Unit with PMAC firmware revision Ver.2.7 or later, use Power PMAC IDE Ver.4.5.2 or higher.
- To use the CPU Unit with PMAC firmware revision Ver.2.8 or later, use Power PMAC IDE Ver.4.6.4 or higher.

2-3 Ethernet Network Configuration

The Ethernet communication port of the CK□M-series CPU Unit supports EtherNet/IP, Modbus-TCP, OPC UA and MQTT protocols.
It can be connected to devices such as PLCs and programmable terminals that support the EtherNet/IP protocol or the Modbus-TCP protocol.

EtherNet/IP communications support targets only, so originators are required for the communications. If the originator in use is an NJ/NX-series CPU Unit, refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)* for details.
CPU Unit connection settings are required for EtherNet/IP communications. Refer to the *Power PMAC IDE User Manual (Cat. No. O016)* for details.

OPC UA and MQTT can be connected to the Ethernet communication port of the CPU Unit and can read and write variables in the CPU Unit using OPC UA communication or MQTT communication.



3

Configuration Units

This section describes the configuration units of the CK3M/CK5M-series Programmable Multi-Axis Controller.

3-1 CPU Unit 3-3
- 3-1-1 Models and Specifications 3-3
- 3-1-2 Part Names and Functions 3-7
- 3-1-3 Operation Status Indicators 3-8
- 3-1-4 Watchdog Output Terminal Block 3-9
- 3-1-5 USB Memory Device 3-10

3-2 Power Supply Unit 3-12
- 3-2-1 Models and Specifications 3-12
- 3-2-2 Part Names and Functions 3-13

3-3 Axis Interface Unit 3-14
- 3-3-1 Models and Specifications 3-14
- 3-3-2 Part Names and Functions 3-16
- 3-3-3 Operation Status Indicators 3-17
- 3-3-4 Address Switch Setting 3-18
- 3-3-5 Encoder Connector Specifications 3-18
- 3-3-6 Encoder Loss Detection 3-24
- 3-3-7 Pulse Input Timing Specifications for Digital Quadrature Encoder 3-25
- 3-3-8 Input Specifications for Sinusoidal Encoder 3-27
- 3-3-9 OutFlag Function 3-29
- 3-3-10 Amplifier Connector Specifications 3-30
- 3-3-11 DA Output Method 3-33
- 3-3-12 DirectPWM Output Method 3-35
- 3-3-13 Flag Connection Terminal Block Specifications 3-35
- 3-3-14 General Digital I/O Connection Terminal Block Specifications 3-40

3-4 Digital I/O Unit 3-47
- 3-4-1 Models and Specifications 3-47
- 3-4-2 Part Names and Functions 3-51
- 3-4-3 Operation Indicators 3-52
- 3-4-4 Address Switch Setting 3-52
- 3-4-5 Terminal Arrangement 3-53
- 3-4-6 I/O Data 3-54

3-5 Analog Input Unit 3-56
- 3-5-1 Models and Specifications 3-56
- 3-5-2 Part Names and Functions 3-57
- 3-5-3 Operation Indicators 3-58
- 3-5-4 Address Switch Setting 3-58
- 3-5-5 Terminal Arrangement 3-59

3-5-6 Analog Input Data 3-60
3-5-7 Input Filter 3-61

3-6 Encoder Input Unit 3-63
3-6-1 Models and Specifications 3-63
3-6-2 Part Names and Functions 3-65
3-6-3 Operation Indicators 3-65
3-6-4 Address Switch Setting 3-65
3-6-5 Terminal Arrangement 3-66
3-6-6 Software Settings 3-66

3-7 Laser Interface Unit 3-68
3-7-1 Models and Specifications 3-68
3-7-2 Part Names and Functions 3-72
3-7-3 Operation Indicators 3-73
3-7-4 Address Switch Setting 3-73
3-7-5 Terminal Arrangement 3-74
3-7-6 XY2-100 Interface 3-74
3-7-7 SL2-100 Interface 3-78
3-7-8 PWM Output Function 3-82
3-7-9 TCR Output Function 3-84
3-7-10 Software Settings 3-86

3-8 Expansion Master Unit and Expansion Slave Unit 3-89
3-8-1 Models and Specifications 3-89
3-8-2 Part Names and Functions 3-90
3-8-3 Operation Indicators 3-92
3-8-4 System Configuration 3-92

3-1 CPU Unit

This section describes the models and major specifications of the CK□M-series CPU Units.

3-1-1 Models and Specifications

Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model	CPU Unit	Memory capacity	EtherCAT port	Maximum number of controlled axes at EtherCAT port
CPU Unit	CK3M-CPU101	Dual core 1GHz	RAM: 1 GB Built-In Flash Memory: 2 GB *1	None	---
	CK3M-CPU111	Dual core 1GHz	RAM: 1 GB Built-In Flash Memory: 2 GB *1	EtherCAT: 1 port (DC sync)	4 axes
	CK3M-CPU121	Dual core 1GHz	RAM: 1 GB Built-In Flash Memory: 2 GB *1	EtherCAT: 1 port (DC sync)	8 axes
	CK5M-CPU131	Quad core 1.6GHz	RAM: 2 GB Built-in flash memory: 4 GB	EtherCAT: 1 port (DC sync)	16 axes
	CK5M-CPU141	Quad core 1.6GHz	RAM: 2 GB Built-in flash memory: 4 GB	EtherCAT: 1 port (DC sync)	32 axes

*1. For PMAC firmware revision 2.7 or earlier of the CPU Unit, the size of Built-In Flash memory is 1 GB.

Performance Specifications

The performance specifications are shown below.

Item	CK3M-CPU101	CK3M-CPU111	CK3M-CPU121	CK5M-CPU131	CK5M-CPU141
Memory	Main memory: 1 GB Built-In Flash Memory: 2 GB *1			Main memory: 2 GB Built-In Flash Memory: 4 GB	
Number of connectable CK3W Units (when using Expansion Rack)	8 Units max. Or 4 CK3W-AX Units max.			16 Units max. Or 8 CK3W-AX Units max.	
External connection terminals	No EtherCAT	For EtherCAT communications RJ45 × 1 (Shield supported)			
	For Ethernet communications RJ45 × 1 (Shield supported)				
	USB port For external memory connection, USB 2.0 host × 1 Type A				

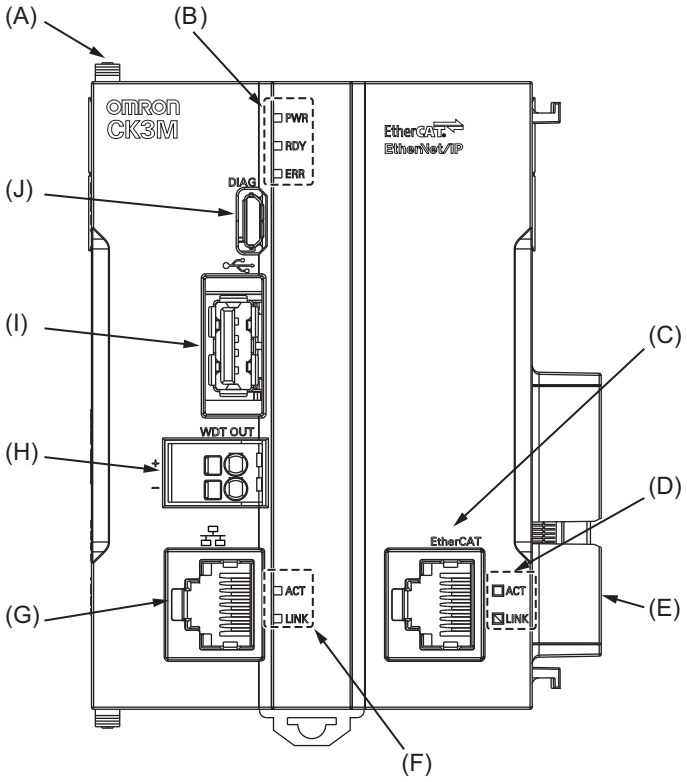
Item			CK3M-CPU101	CK3M-CPU111	CK3M-CPU121	CK5M-CPU131	CK5M-CPU141
Motion control	**CK3W-AX Unit**	**Maximum number of controlled axes**	16 axes (when using four CK3W-AX Units)			32 axes (when using eight CK3W-AX Unit Units)	
		Control method	Speed and torque control using analog output Stepper motor control using pulse output Commutation control using DirectPWM output				
	EtherCAT	**Maximum number of controlled axes**	None	4 axes	8 axes	16 axes	32 axes
		Communications cycle		250 µs min.		62.5µs min.	
		Control method		Issuing control commands using EtherCAT			
EtherCAT communications specifications	**Communications protocol**		None	EtherCAT protocol			
	Baud rate			100 Mbps			
	Physical layer			100BASE-TX (IEEE 802.3)			
	Topology			Line, daisy chain, branching, and ring*2			
	Transmission media			Twisted-pair cable of category 5 or higher (double-shielded cable with aluminum tape and braiding)			
	Transmission distance			Distance between nodes: 100 m or less			
	Maximum number of slaves			32		64	
	Range of node addresses that can be set			1 to 32		1 to 64	
Ethernet communications specifications	**Baud rate**		100 Mbps			1 Gbps/100 Mbps	
	Physical layer		100BASE-TX (IEEE 802.3)			1000BASE-T 100BASE-TX (IEEE 802.3)	
	Frame length		1,514 bytes max.				
	Media access method		CSMA/CD				
	Modulation		Baseband				
	Topology		Star				
	Transmission media		Twisted-pair cable of category 5, 5e, or higher (shielded cable)*3				
	Maximum transmission distance between Ethernet switch and node		100 m				
	Maximum number of cascade connections		There are no restrictions if an Ethernet switch is used.				

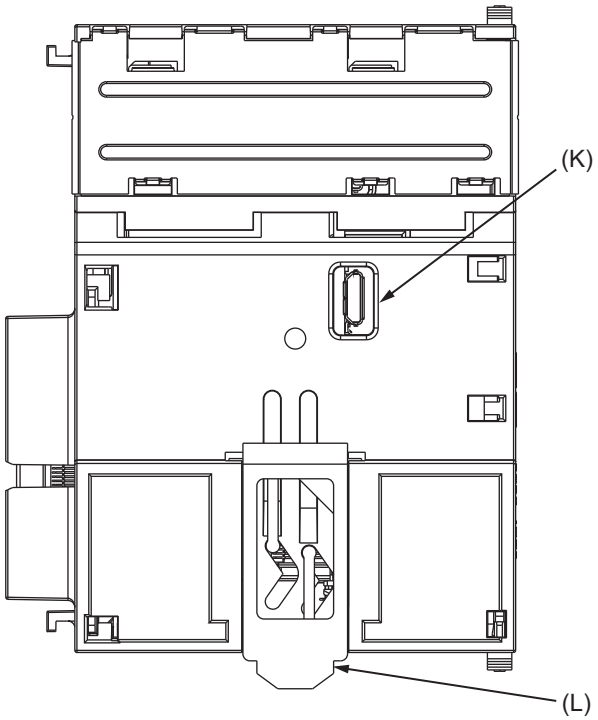
Item			CK3M-CPU101	CK3M-CPU111	CK3M-CPU121	CK5M-CPU131	CK5M-CPU141
	EtherNet/IP tag data link (cyclic communications)*4	Number of connections	32				
		Requested packet interval (RPI)	1 to 1,000 ms (0.5 ms units)				
		Allowed communications bandwidth per Unit	3,200 pps*5			12,000 pps*5	
		IO connection size	Input: 504 bytes max. Output: 504 bytes max.				
	EtherNet/IP CIP message service*4	UCMM (unconnected message)	Number of servers that can perform communications simultaneously: 32				
	EtherNet/IP conformance test		CT17 compliant			CT18 compliant	
	OPC UA *6	Connection port	The OPC UA server can be used simultaneously with the CPU unit's Ethernet communication.				
		OPC UA function	Server function				
		Transport Category	HTTPS UA-Binary UA-TCP UA-SC UA-Binary				
		Support profile model	Core 2017 Server Facet Embedded 2017 UA Server Profile Embedded DataChange Subscription Server Facet Event Subscription Server Facet Micro Embedded Device 2017 Server Standard 2017 Server Facet Standard DataChange Subscription 2017 Server Facet				
		Default endpoint port	opc.tcp://[IP address]: [port No.]/ The default URL is as follows: opc.tcp://192.168.0.200:4840/				
		Maximum number of clients (secure channels)	10				
		Maximum number of subscriptions	200				
		Maximum number of monitoring variables per server	3,000				
		Public variables	Pointer Variables (M), Global Variables(P), EtherCAT IO Data Variables(Ecat[].Io[].Data)				

Item			CK3M-CPU101	CK3M-CPU111	CK3M-CPU121	CK5M-CPU131	CK5M-CPU141
		Security Policy Mode	The security method can be specified from the following (multiple specifications possible) • Both signature and encryption are required: SignAndEncrypt Signature and encryption algorithm Signature and encryption algorithms: Basic256Sha256/ Basic256/ Basic128Rsa15 (multiple specifications possible) • Only signature required: Sign Signature algorithm Signature algorithm: Basic256Sha256/ Basic256/ Basic128Rsa15 (multiple specifications possible) • Neither signature nor encryption required				
		Application Authentication Method	X.509				
		User Authentication Method	The following settings are possible • Username/Password • Deny list				
USB port	**Physical layer**		USB 2.0 compliant, type A connector. Output voltage: 5 V, 0.5 A max.				
	Transmission distance		3 m max.				
Current consumption			5 VDC: 7.2 W max. (including End Cover)	5 VDC: 7.8 W max. (including End Cover)		5 VDC: 7.2 W max, 24 VDC: 3.3 W max. (including End Cover)	
Dimensions (height × depth × width)			90(H)/80(D)/63.2(W)				
Weight (including End Cover)			220 g max.	230 g max.		250 g max.	

*1. For PMAC firmware revision 2.7 or earlier of the CPU Unit, the size of Built-In Flash memory is 1 GB.
*2. A ring topology is available for CPU Units with PMAC firmware revision version 2.7.0 or later.
*3. Be sure to use a shielded cable for EtherNet/IP communications.
When you are using communication at 1 Gbps, be sure to use a cable of category 5e or higher.
*4. EtherNet/IP is available only for targets and not available for originators. EtherNet/IP is available only for CPU Units with PMAC firmware revision version 2.6.0 or later whose date of production is September 8th, 2020 or later (Lot number 08920 and later). Use Power PMAC IDE Ver.4.4.1 or a later version.
*5. Represents Packet Per Second and indicates the number of sent or received packets that can be processed in a second.
*6. The OPC UA function is available for CPU Units with PMAC firmware revision version 2.8.1 or later.

3-1-2 Part Names and Functions





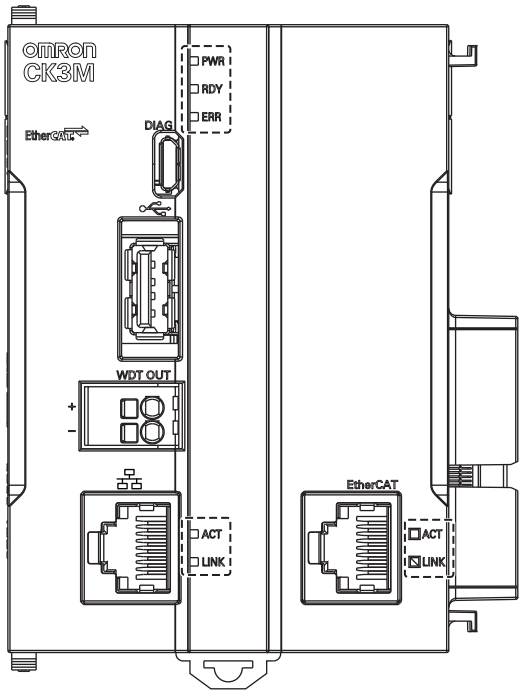
Letter	Name	Function
A	Slider	Holds the Units together.
B	CPU Unit operation indicators	Shows the operation status of the CPU Unit using multiple indicators.
C	EtherCAT communications connector	Connects to an EtherCAT network communications cable.

Letter	Name	Function
D	EtherCAT communications port operation indicators	Shows the operation status of EtherCAT.
E	Unit connector	Connector that connects to the Unit.
F	Ethernet communications port operation indicators	Shows the operation status of Ethernet.
G	Ethernet communications connector	Connects to an Ethernet network communications cable.
H	Watchdog output terminal block	Normally in ON state, and switches to OFF when watchdog is activated.
I	USB 2.0 connector	USB 2.0 interface connector. Connects the USB memory.
J	USB connector for maintenance	Do not use.
K	USB connector for maintenance	Do not use.
L	DIN Track mounting hook	Used to mount the Unit to a DIN Track.

3-1-3 Operation Status Indicators

CPU Unit Operation Status Indicators

The CPU Unit is equipped with indicators to show the current operations status.



● CPU Unit Status Indicators

The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	Lit.	Power is supplied to the Unit.
		Not lit.	Power is not supplied to the Unit.

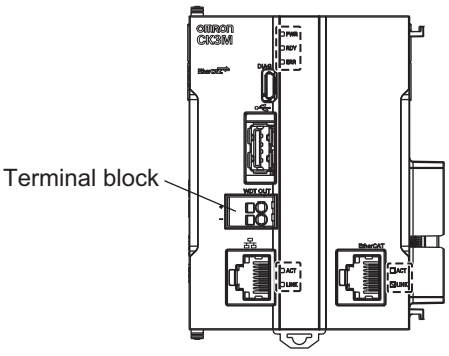
Indicator name	Color	Status	Description
RDY	Green	Lit.	Power is supplied to the Unit, and the Unit is in operation-ready status.
		Not lit.	Power is not supplied to the Unit, or initial processing is in progress.
ERR	Red	Lit.	Watchdog error or another hardware error
		Not lit.	The Unit is operating normally.
ECAT LINK	Orange	Lit.	The EtherCAT link is established.
		Not lit.	The EtherCAT link is not established.
ECAT ACT	Yellow	Lit.	The EtherCAT link is established.
		Flashing	Data communications are in progress after the EtherCAT link is established. Flashes every time data is sent or received.
		Not lit.	The EtherCAT link is not established.
Ethernet LINK	Green/ Orange	Lit in green.*1	The Ethernet link at 1 Gbps is established.
		Lit in orange.	The Ethernet link at 100 Mbps is established.
		Not lit.	The Ethernet link is not established.
Ethernet ACT	Yellow	Lit.	The Ethernet link is established.
		Flashing	Data communications are in progress after the Ethernet link is established. Flashes every time data is sent or received.
		Not lit.	The Ethernet link is not established.

*1. The indicator lights green only on the CK5M CPU Unit.

3-1-4 Watchdog Output Terminal Block

The Watchdog Output Terminal Block is described below.

Terminal Arrangement



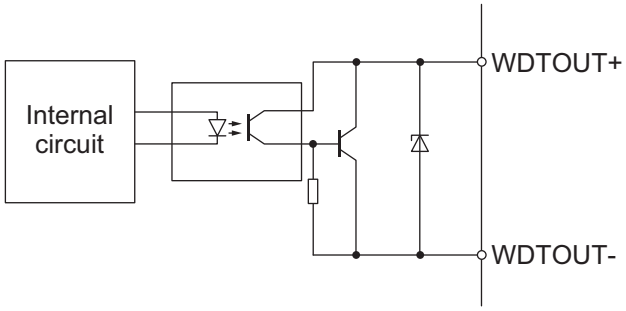
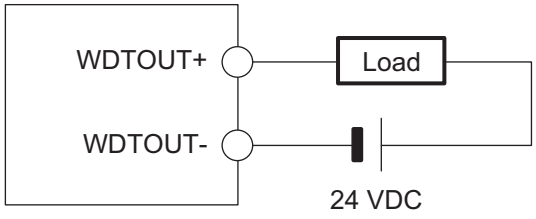
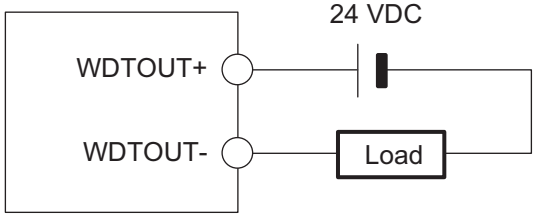
Abbreviation	Signal name
+	WDTOUT+
-	WDTOUT-

Output Status

In normal operation, it is ON, and at other times it is OFF.

Status	Output
When unit power is OFF	OFF
During normal operation	ON
When hardware watchdog error occurs	OFF
When software watchdog error occurs	OFF

Output Specifications

Item	Specification
Rated voltage	24 VDC
Operating load voltage range	20.4 to 26.4 VDC
Maximum load current	0.1 A
Leakage current	0.1 mA max.
Residual voltage	1.5 V max.
ON/OFF response time	10 ms max./10 ms max.
Isolation method	Photocoupler isolation
Circuit configuration	
Terminal connection diagram	NPN type  PNP type 

3-1-5 USB Memory Device

You can use a USB memory device for the following applications.

- Saving relevant data
- Initializing the CPU Unit

The following shows details of the recommended USB memory devices.
OMRON is not responsible for the operation of any other USB memory devices.

Recommended USB memories	Description
FZ-MEM2G	OMRON USB memory device (2 GB)

3-2 Power Supply Unit

This section describes the model and major specifications of the Power Supply Unit.

3-2-1 Models and Specifications

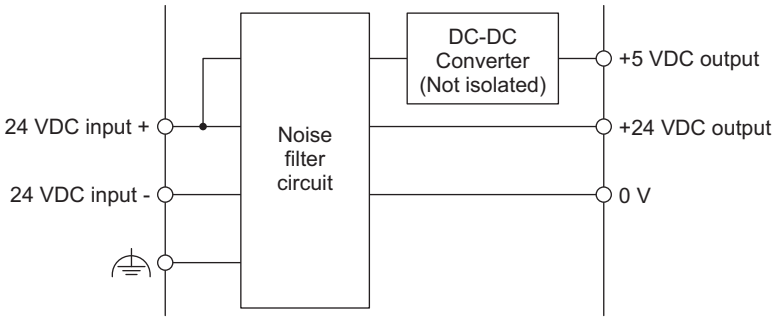
Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model	Specification
Power Supply Unit	CK3W-PD048	Rated output voltage: 5 VDC/24 VDC Maximum output power: 5 VDC 23 W, 24 VDC 55 W

Specifications

The specifications are shown below.

Item	Specification
Power supply voltage	24 VDC
Allowable power supply voltage range	20.4 to 26.4 VDC
Power consumption	101.7 W max.
Rated output voltage	5 VDC/24 VDC
Maximum output power*1	5 VDC 23 W 24 VDC 55 W
Isolation method	Not isolated
Circuit configuration	
Weight	130 g max.
Dimensions (height × depth × width)	90(H)/80(D)/45(W)

*1. Internal components in the Power Supply Unit may deteriorate or be damaged if the Power Supply Unit is used for an extended period of time exceeding the power supply output capacity or used when the outputs are shorted.

Recommended Power Supplies

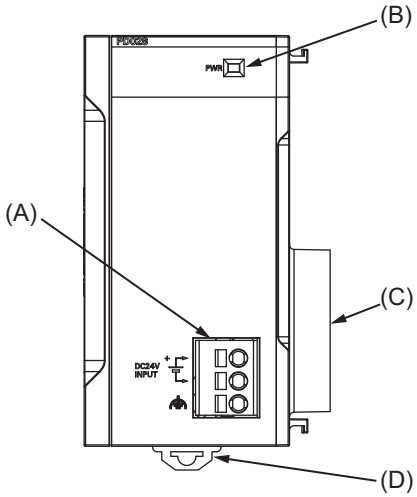
Use a SELV power supply that meets the following conditions.

- Has overcurrent protection.

• Has double or reinforced insulation between the input and output.

Recommended Power Supplies: S8VK-S series (manufactured by OMRON)

3-2-2 Part Names and Functions



Letter	Name	Function
A	Power supply connection terminal block	Connects the power supply.
B	Power supply status indicator	Lights when 5 V is output from the Power Supply Unit.
C	CPU Unit connector	Connector that connects to the CPU Unit.
D	DIN Track mounting hook	Used to mount the Unit to a DIN Track.

3-3 Axis Interface Unit

This section describes the models and major specifications of the Axis Interface Units.

3-3-1 Models and Specifications

Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model	Amplifier interface	Encoder interface	FLAG input, general digital input/ output type
Axis Interface Unit	CK3W-AX1313N	DirectPWM output	Digital quadrature encoder/Serial encoder	NPN type
	CK3W-AX1414N	DA output (FilteredPWM)		
	CK3W-AX1515N	DA output (TrueDAC)		
	CK3W-AX2323N	DirectPWM output	Sinusoidal encoder/ Serial encoder	
	CK3W-AX1313P	DirectPWM output	Digital quadrature encoder/Serial encoder	PNP type
	CK3W-AX1414P	DA output (FilteredPWM)		
	CK3W-AX1515P	DA output (TrueDAC)		
	CK3W-AX2323P	DirectPWM output	Sinusoidal encoder/ Serial encoder	

Axis Interface Unit Specifications

The main specifications for axis interface are given below.

- **CK3W-AX1414□/-AX1515□**

Item		Specification (CK3W-)			
		AX1414N	AX1414P	AX1515N	AX1515P
Address setting range		0 to F			
Number of channels		4 channels/Unit			
Encoder power supply output		5 VDC 500 mA/channel or less However, the total output current of each Unit is 1 A or less.			
Digital quadrature encoder input	Input form	Line receiver input			
	Maximum response frequency	Phases A, B, and C: 10 MHz			
Serial encoder input	Supported protocol	Contact your OMRON representative for information on the support protocols.			
Digital Hall sensor		4 points/channel (U, V, W, T)			
OUTFlagB output		1 point/channel			

Item		Specification (CK3W-)			
		AX1414N	AX1414P	AX1515N	AX1515P
Analog output	Method	FilteredPWM type		TrueDAC type	
	Number of points	1 point/channel		2 points/channel	
	Output range	Between DACA+/DACB+ and DACA-/DACB-: -20 to 20 V Between DACA+/DACB+ and AGND: -10 to 10 V			
Pulse output	Output form	Line driver output			
	Output method	Pulse output + directional output, or phase difference output			
	Maximum output frequency	10 MHz			
Amp enable output		1 point/channel			
Fault input		1 point/channel			
Flags	Digital input	4 points/channel (HOME, PLIM, NLIM, USER)			
	Digital output	1 point/channel (EQU)			
General digital I/O	Number of points	16 inputs, 16 outputs			
	Internal common	NPN	PNP	NPN	PNP
Power consumption		5 VDC: 4.5 W max. 24 VDC: 10.8 W max.		5 VDC: 4.5 W max. 24 VDC: 12.5 W max.	
Dimensions (height × depth × width)		90(H)/80(D)/130(W)			
Weight		520 g max.			

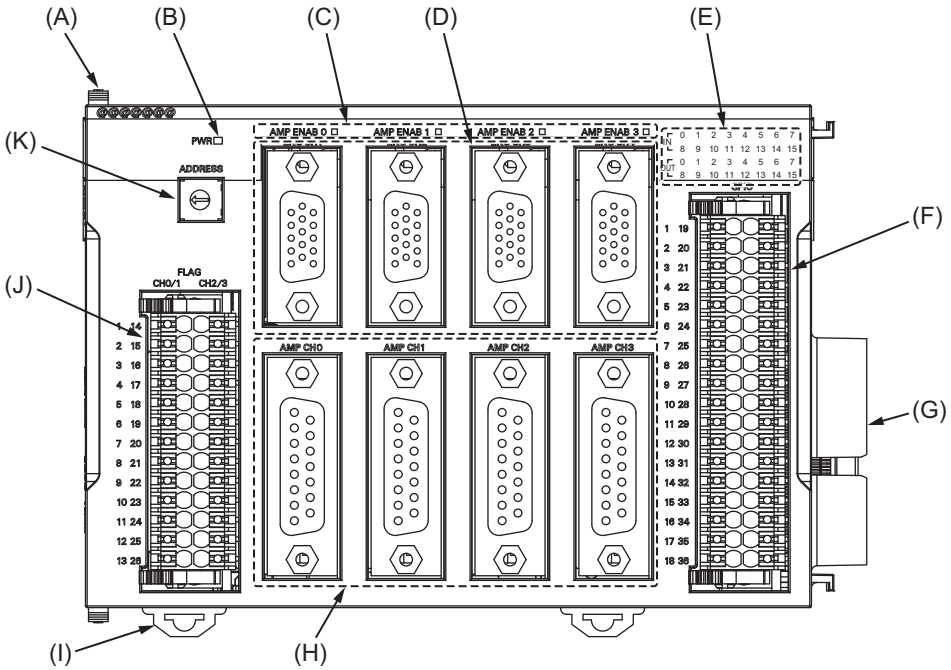
● CK3W-AX1313□/-AX2323□

Item		Specification (CK3W-)			
		AX1313N	AX1313P	AX2323N	AX2323P
Address setting range		0 to F			
Number of channels		4 channels/Unit			
Encoder power supply output		5 VDC 500 mA/channel or less However, the total output current of each Unit is 1 A or less.			
Digital quadrature encoder input	Input form	Line receiver input		---	
	Maximum response frequency	Phases A, B, and C: 10 MHz			
Serial encoder input	Supported protocol	Contact your OMRON representative for information on the support protocols.			
Sinusoidal encoder input	Input signal	---		1-Vpp SIN/COS signal	
	Maximum input frequency			2 MHz	
Digital Hall sensor		4 points/channel (U, V, W, T)			
DirectPWM output		Amplifier interface unique to Delta Tau			
Amp enable output		1 point/channel (built into DirectPWM)			
Fault input		1 point/channel (built into DirectPWM)			
Flags	Digital input	4 points/channel (HOME, PLIM, NLIM, USER)			
	Digital output	1 point/channel (EQU)			

Item		Specification (CK3W-)			
		AX1313N	AX1313P	AX2323N	AX2323P
General digital I/O	Number of points	16 inputs, 16 outputs			
	Internal common	NPN	PNP	NPN	PNP
Power consumption		5 VDC: 3.4 W max. 24 VDC: 12.5 W max.		5 VDC: 3.0 W max. 24 VDC: 13.1 W max.	
Dimensions (height × depth × width)		90(H)/80(D)/130(W)			
Weight		480 g max.			490 g max.

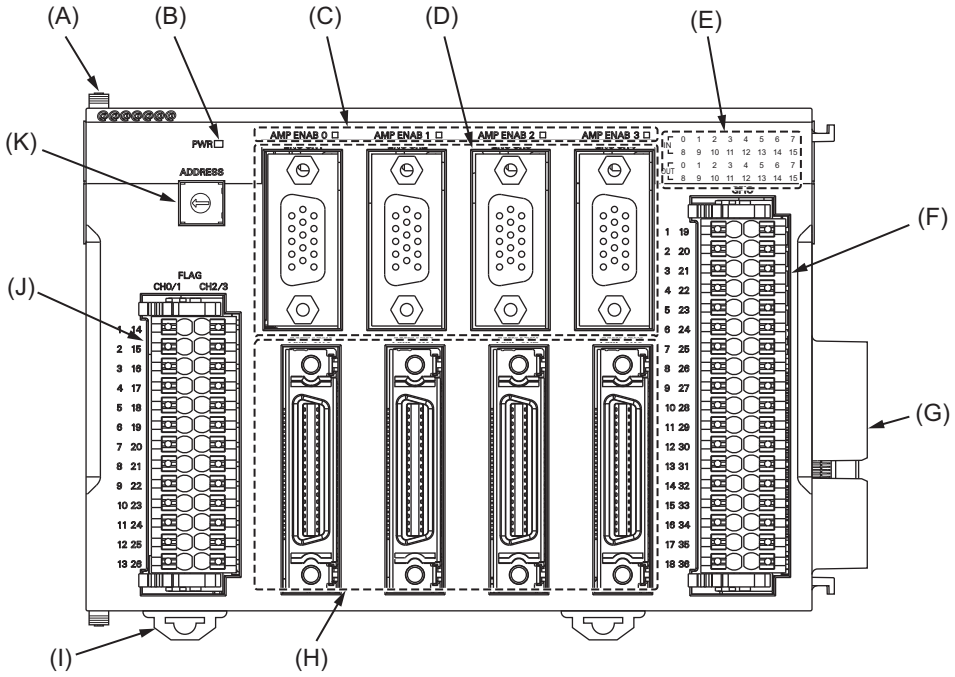
3-3-2 Part Names and Functions

CK3W-AX1414□/-AX1515□



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Amp enable status indicator	Shows the Amp enable status.
D	Encoder connector	Connects the encoder.
E	General digital input/output status indicator	Shows the general digital input/output status.
F	General digital I/O connection terminal block	Connects the general digital input/output.
G	Unit connector	Connector that connects to the Unit.
H	Amplifier connector	Connects the amplifier.
I	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
J	Flag connection terminal block	Connects the HOME/PLIM/NLIM/USER inputs and EQU output.
K	Address switch	Sets the Gate3 Index.

CK3W-AX1313□/-AX2323□



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Amp enable status indicator	Shows the Amp enable status.
D	Encoder connector	Connects the encoder.
E	General digital input/output status indicator	Shows the general digital input/output status.
F	General digital I/O connection terminal block	Connects the general digital input/output.
G	Unit connector	Connector that connects to the Unit.
H	Amplifier connector	Connects the amplifier.
I	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
J	Flag connection terminal block	Connects the HOME/PLIM/NLIM/USER inputs and EQU output.
K	Address switch	Sets the Gate3 Index.

3-3-3 Operation Status Indicators

The LED indicators show the unit operating status of the Axis Interface Unit.
The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	Lit.	Power is supplied.
		Not lit.	Power is not being supplied.
AMP ENAB0 to 3	Yellow	Lit.	Command values output to Servo Drive.
		Not lit.	Command values not output to Servo Drive.
IN 0 to 15	Yellow	Lit.	The input contact is ON.
		Not lit.	The input contact is OFF.
OUT 0 to 15	Yellow	Lit.	The output contact is ON.
		Not lit.	The output contact is OFF.

3-3-4 Address Switch Setting

This Unit is equipped with an IC that has the same interface as a PMAC3 style DSPGate3 IC.
Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the PMAC3 style DSPGate3 IC.

The address switch settings are used to set the Gate3 Index.
The setting range is from 0 to F. (Factory setting: 0)

Address switch setting	Power PMAC "Gate3" Index
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

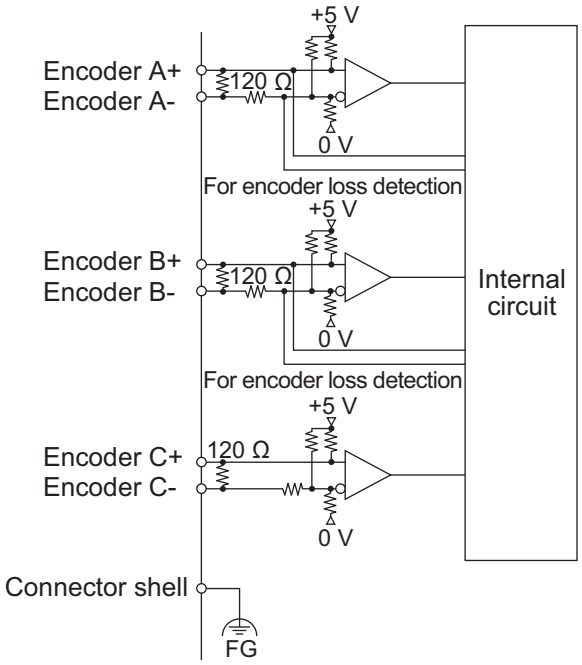
For example, if the address switch setting is *0*, the Gate3 Index becomes *0*.
In this case, this Unit is accessed with a Gate3[0] data structure.
Make sure that the address switch settings of Units do not overlap.
If they overlap, the Sys.Status register CK3WConfigErr becomes *7*.
Refer to *6-4 Sys.Status Register* on page 6-10 for Sys.Status.

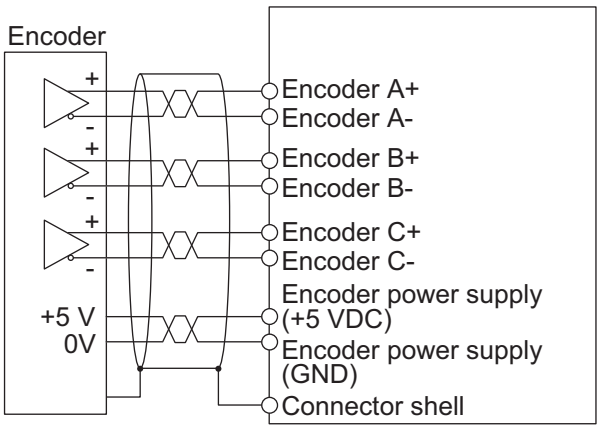
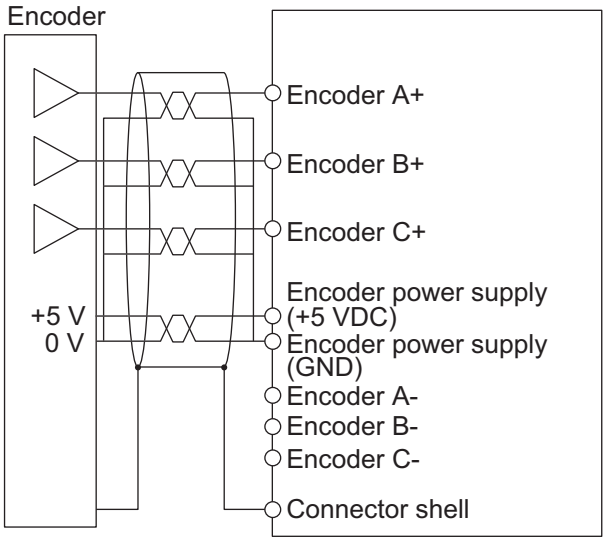
One CK3W Unit in the system supplies servo clock and phase clock signals to all the other Units.
The supply-source CK3W Unit must be installed to the CPU Rack.
Connect the Unit with the smallest address value to the CPU Rack because, by default, it is the supply source of clock signals.
You may specify the Unit with a desired address as the clock supply source by setting the register.
If the Unit that serves as the clock supply source is connected to the Expansion Rack, an error occurs because the CPU Unit cannot recognize clock signals.
If this error occurs, the Sys.Status register Sys.NoClocks becomes *1*.

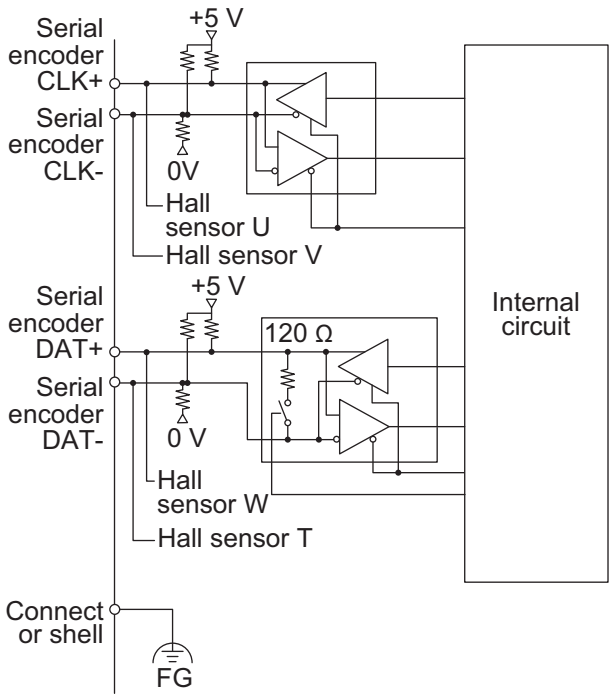
3-3-5 Encoder Connector Specifications

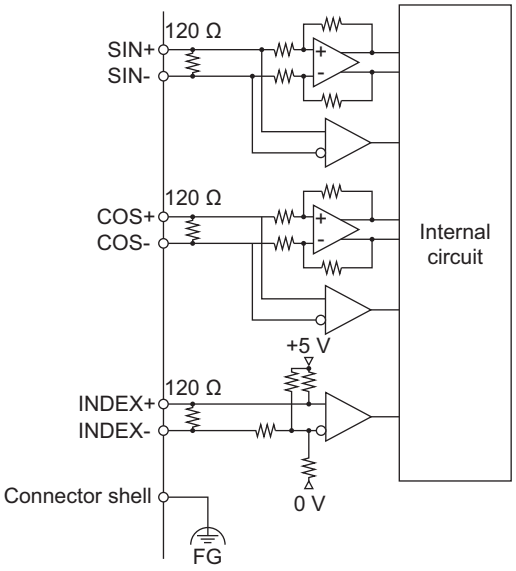
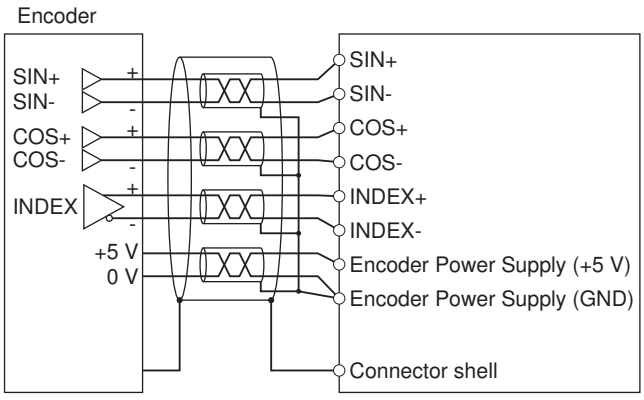
The electrical specifications for the encoder connector are as follows.

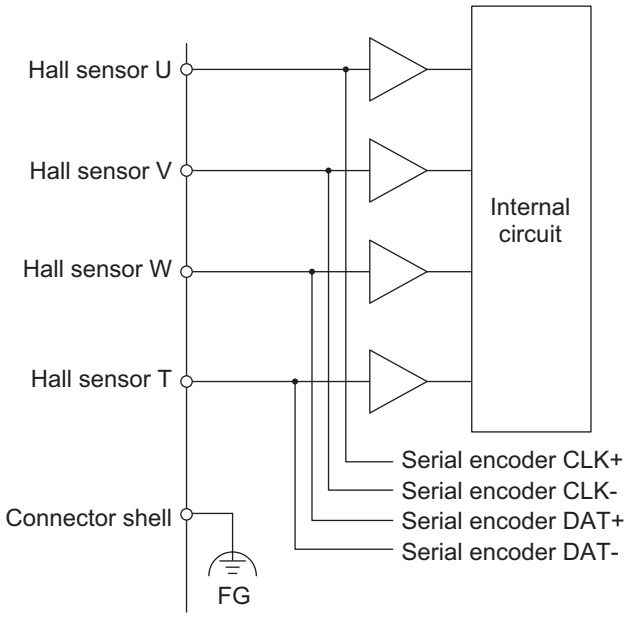
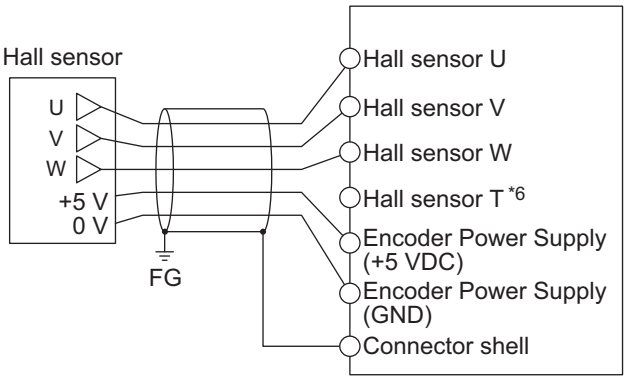
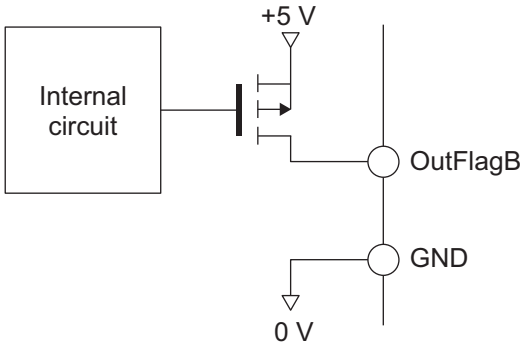
For the connector arrangement of the encoder connector, refer to *5-3-1 Encoder Connector Wiring* on page 5-18.

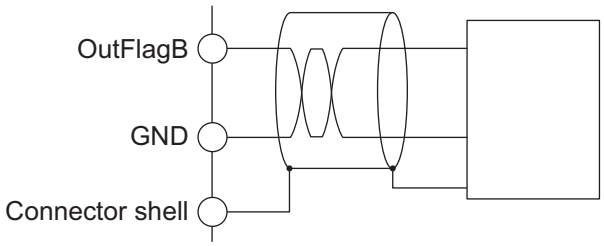
Isolation method		Not isolated (between internal circuit and encoder circuit)
Encoder power supply output	**Rated output voltage**	5 VDC
	Output voltage range	4.9 to 5.25 VDC (5 VDC +5%/-2%)
	Maximum output current	500 mA/channel or less However, the total output current of each Unit is 1 A or less.
Digital quadrature encoder input[*1]	**Input form**	Line receiver input (differential or single-ended input)
	Counting unit	Pulse
	Input voltage	Differential input: EIA standard RS-422A line driver levels Single-ended input[*2]: ON voltage 3.0 V or more, OFF voltage 1.0 V or less
	Maximum input voltage	Differential input: EIA standard RS-422A line driver levels Single-ended input: -0.3 to 6.0 VDC
	Maximum response frequency	Phases A, B, and C: 10 MHz
	Encoder loss detection	Differential input: Detectable With single-ended input: Detection disabled
	Circuit configuration	

	Terminal connection diagram	With differential input  With single-ended input  With single-ended input, use twisted-pair wire to improve noise resistance, and pair the respective signals of encoder A+, B+, C+ with GND.
Serial encoder input	**Supported protocol**	Contact your OMRON representative for information on the support protocols.
	Clock output	EIA standard RS-422A line driver levels
	Data I/O	EIA standard RS-485 line driver/receiver level

	Circuit configuration	

Sinusoidal encoder input*3	**Input form**	Line receiver input + AD conversion
	Number of inputs	2 points/channel (SIN signal, COS signal)
	Maximum rated input voltage	0 to Encoder Power Supply (+5 V) Encoder Power Supply as GND reference
	Allowable differential input voltage range	0.6 to 1.35 Vpp
	Allowable input voltage range	0 to 4.0 V Encoder Power Supply as GND reference
	Maximum input frequency	2 MHz*4
	AD converter resolution	16 bits
	Maximum cable length	20 m
	Circuit configuration	
	Terminal connection diagram	To reduce the effects of the noise, we recommend that you use a double-shielded cable and connect the inner shields to the Encoder Power Supply (GND) pin and the outer shield to the connector shell. 
Digital Hall sensor*5	**ON Voltage**	3.0 VDC min.
	OFF Voltage	0.9 VDC max.
	Maximum input rating	-0.3 to 6.0 VDC

	Circuit configuration	
	Terminal connection diagram	
OutFlagB output specifications*7	**Output signal**	1 point/channel
	Rated output voltage	5 VDC
	Maximum load current when ON	5 mA
	Residual voltage when ON	0.4 V max.
	Isolation method	Not isolated from internal circuit
	Circuit configuration	

	Connection diagram	
		 For the GND, use an encoder power source (GND).

*1. This function is available with the CK3W-AX1313□/-AX1414□/-AX1515□ Units.
*2. With single-ended input, only a voltage output type encoder can be connected. Open collector type encoders cannot be connected.
*3. This function is available with the CK3W-AX2323□ Units.
*4. The maximum input frequency in normal specification is 2 MHz, however, you can use the connector with frequency up to 8 MHz in the following conditions.
- Set Gate3[i].EncClockDiv=1 to use with the input frequency of 2 MHz or higher.
  Set Gate3[i].EncClockDiv=3 (Default) to use with the maximum input frequency of 2 MHz or lower.
- A temporary error of four counts in the integer part (Position fluctuation) may occur periodically with the input frequency of 1.5 MHz or higher, however, the errors are not accumulated.
  The error does not occur with the frequency of 1.5 MHz or lower and the position is output normally.
  Use with the frequency of 2 MHz or lower when the temporary error during operation is an issue.
- Gate3[i].Chan[j].SosError may occur with the frequency of 2 MHz or higher.
  Use a user program to check the encoder loss detection using Gate3[i].Chan[j].SumOfSquares and without using Gate3[i].Chan[j].SosError.
  When you set Gate3[i].Chan[j].SumOfSquares, set the threshold value to half of the value of Gate3[i].Chan[j].SumOfSquares when operated with the maximum input frequency.

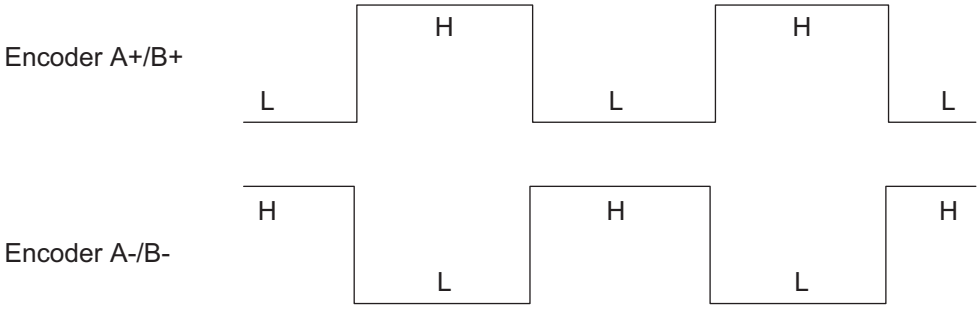
*5. A Hall sensor is a sensor that detects the rotor position of the motor by detecting the magnetic field. This is normally used to check the position when the power is turned ON.
*6. HALL T is not normally used, however, it can be used as a general 5V digital input.
*7. This output function is available with the CK3W-AX1414□/1515□ Units.

3-3-6 Encoder Loss Detection

Encoder Loss Detection in Digital Quadrature Encoder

Encoder loss detection is a function for detecting the encoder detachment. It can detect the encoder loss, and stop the motor.

In the differential input for the digital quadrature encoder, when a correct signal arrives in encoder A +/A-, encoder B+/B-, if the signal level is H in one side, the signal level of the other side is always L.



You can detect the encoder loss by setting a circuit so that both signals turn H or L when the encoder is not connected.

Encoder A+/B+	Encoder A-/B-	Encoder loss detection
H	L	Normal
L	H	Normal
H	H	Detects loss
L	L	Detects loss

If loss is detected, the value of *Gate3[i].Chan[j].LossStatus* becomes 1.
Motor[x].EncLossCount adds 1 to the count when encoder loss is detected, and subtracts 1 when encoder loss is not detected.
However, the minimum value of *Motor[x].EncLossCount* is 0, and it will never become a negative value.
You can set the motor to stop if *Motor[x].EncLossCount* exceeds the value set in the *Motor[x].EncLossLimit*. However, in a pulse input state, mis-detection of encoder loss may occur. Therefore, when you use the function to stop the motor at encoder loss, take the possibility of mis-detection during pulse input into consideration, and set the *Motor[x].EncLossLimit* register to *40* or more.

Precautions for Correct Use

If the digital quadrature encoder is used with single-ended input, you cannot use encoder loss detection since the encoder loss may be detected even if the encoder is connected correctly. When using the Encoder loss detection function, connect the GND of the encoder wiring.

Encoder Loss Detection in Sinusoidal Encoder

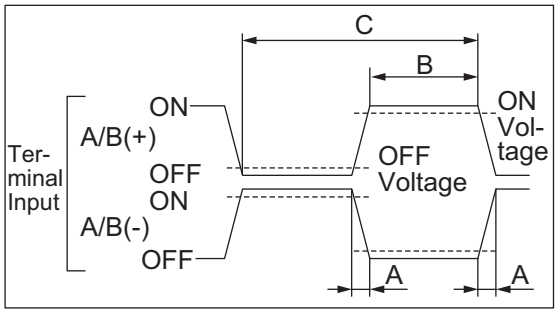
Normally, the sum of SIN squared and COS squared is always a constant value.
The sinusoidal encoder detects encoder loss by checking the sum of SIN squared and COS squared.
If loss is detected, the value of Gate3[i].Chan[j].SosError becomes 1.

3-3-7 Pulse Input Timing Specifications for Digital Quadrature Encoder

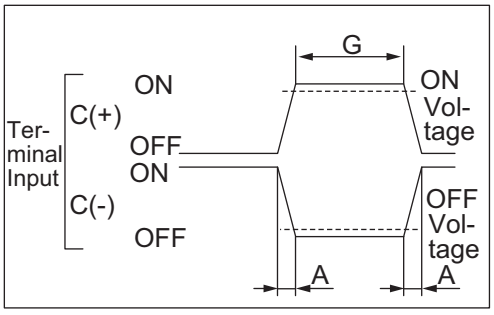
There are two types of input methods, differential input and single-ended input, for the digital quadrature encoder.
The respective pulse input timing specifications are given below.

With Differential Input

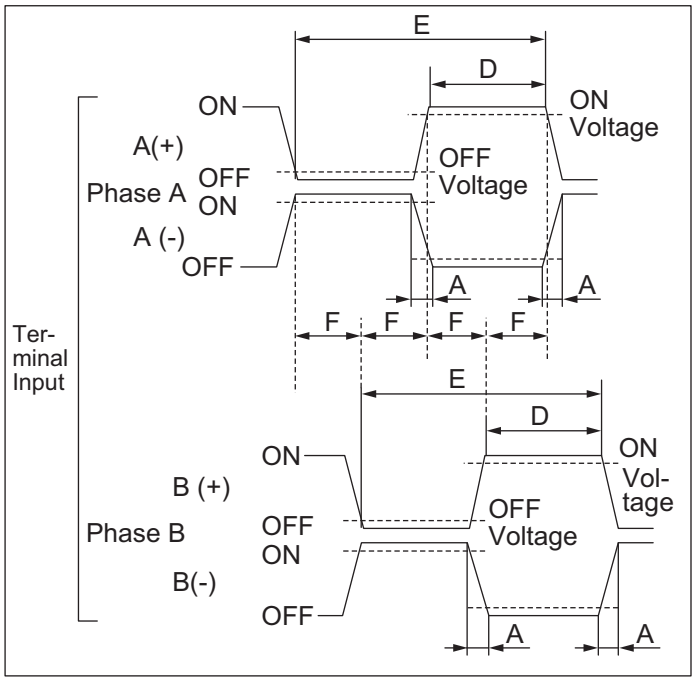
Encoder input (Phases A & B)
Input pulse duty = 50%



Encoder input (Phase C)



Relationship between Phase A and Phase B for Phase Differential Pulse Inputs

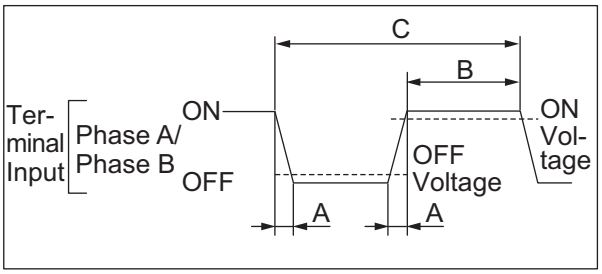


Timing conditions (with 10 MHz input)						
A	**B**	**C**	**D**	**E**	**F**	**G**
< 2.5 ns	> 50 ns	> 100 ns	> 50 ns	> 100 ns	> 25 ns	> 50 ns

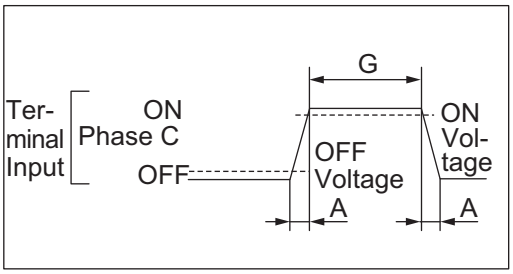
(With *Gate3[i].EncClockDiv = 0 : 100MHz* setting)

Single-Ended Input

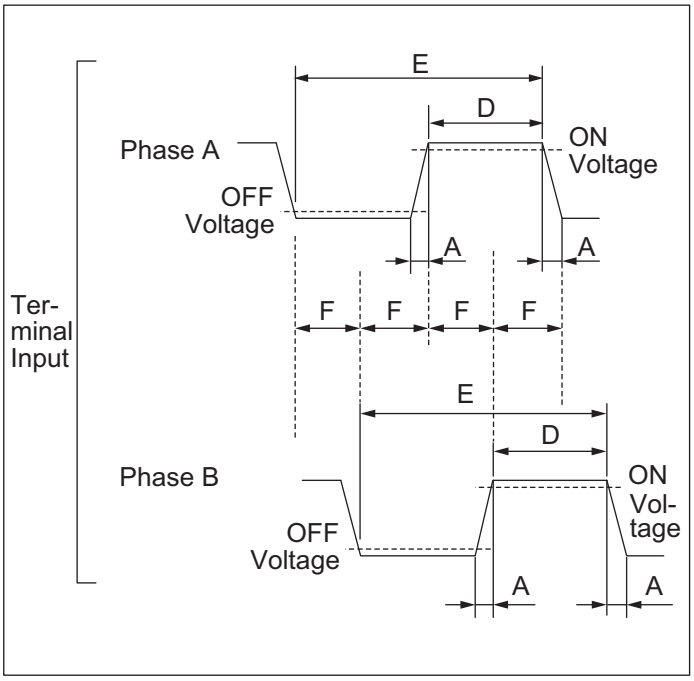
Encoder input (Phases A & B)
Input pulse duty = 50%



Encoder input (Phase C)



Relationship between Phase A and Phase B for Phase Differential Pulse Inputs



Timing conditions (with 10 MHz input)						
A	**B**	**C**	**D**	**E**	**F**	**G**
< 2.5 ns	> 50 ns	> 100 ns	> 50 ns	> 100 ns	> 25 ns	> 50 ns

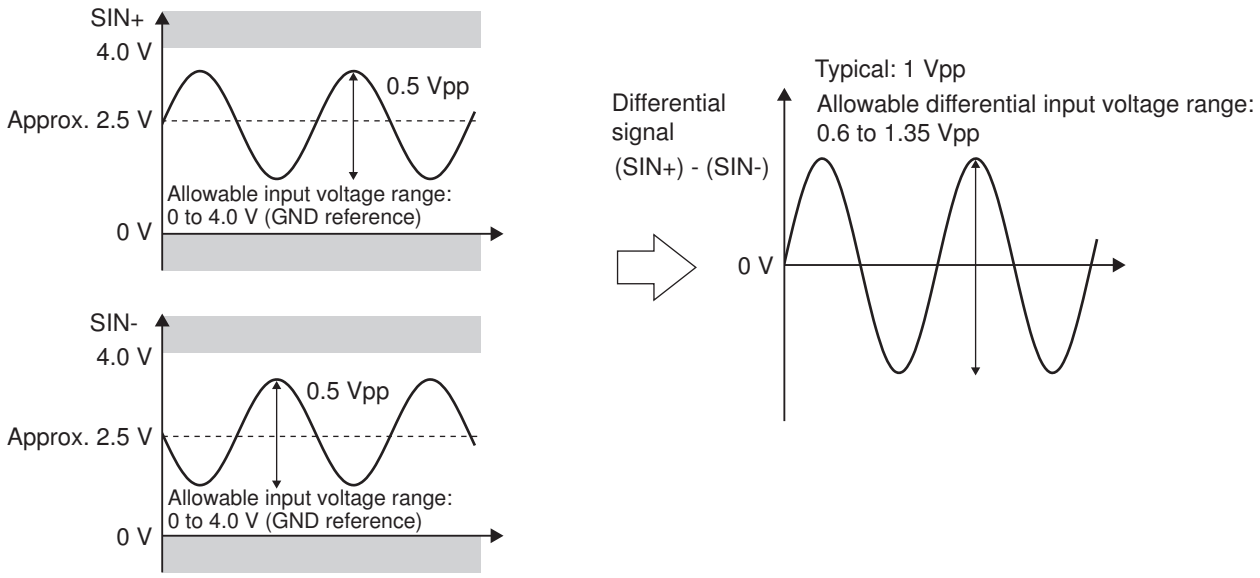
(With *Gate3[i].EncClockDiv = 0: 100MHz* setting)

3-3-8 Input Specifications for Sinusoidal Encoder

This section describes the input specifications for the sinusoidal encoder.

Input Waveform

For the sinusoidal encoder, input a sinusoidal differential signal with an amplitude of 1 Vpp between SIN+ and SIN-.
With GND as the reference voltage, the SIN+ waveform has an amplitude of 0.5 Vpp with the center line at approximately 2.5 V, whereas the waveform is inverted for SIN-.

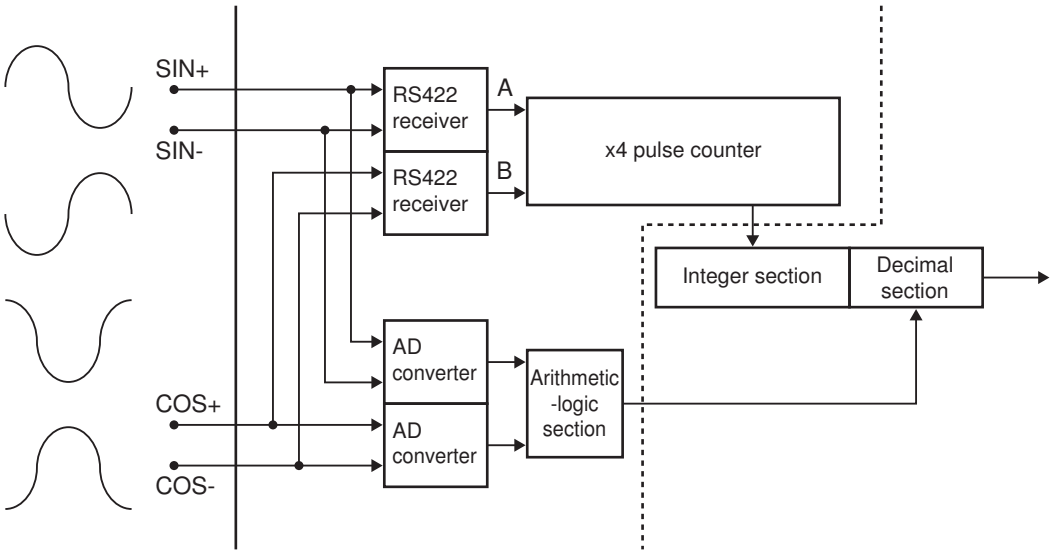


Between COS+ and COS-, input a waveform with a phase shift of +90° or -90° from the sinusoidal wave.

Make sure that the SIN and COS differential signals are within the range of 0.6 to 1.35 V. Also, make sure that the SIN+, SIN-, COS+, and COS- signals are within the range of 0 to 4.0 V relative to the GND reference.
The encoder may not convert the input signal correctly if it is out of the specified range.

Data Processing

SIN and COS signals are input to both the RS-422 receivers and the AD converters. The RS-422 receivers count the number of pulses with the x4 pulse counter and capture data at the timing of the servo clock.
The AD converters obtain analog data at the timing of the servo clock and perform an arctangent operation to determine the sinusoidal phase for the obtained analog data.
By combining these two types of data, it is possible to generate high-accuracy position data.



To read values from the sinusoidal encoder correctly, the following register settings are required. These register settings are the default.

Gate3[i].EncClockDiv = 3
Gate3[i].AdcEncClockDiv = 3
Gate3[i].AdcEncCtrl = $3FFFC000
Gate3[i].AdcEncDelay = 0
Gate3[i].AdcEncHeaderBits = 0
Gate3[i].AdcEncStrobe = $3FFFC0
Gate3[i].AdcEncUtoS = 0

3-3-9 OutFlag Function

The OutFlagB to D functions can be used to perform settings for the encoder.
The details for the functions are described below.

OutFlagB Function

This function can be used with the CK3W-AX1414□/1515□ Unit.

● Applications

Use this function as a signal to connect with the SEN signal that is necessary to acquire the absolute encoder value when connecting with the OMRON G5-series Servo Drives with General-purpose Pulse Train or Analog Inputs.

● Details on the Function

You can switch the output transistor state of the 15-pin of the encoder connector by manipulating the *Gate3[i].Chan[j].OutFlagB* register.

Register value	Output transistor status
0 (Default)	OFF
1	ON

OutFlagC Function

● Applications

Use this function when a servo clock signal must be output externally for synchronization with other devices.

● Details on the Function

You can switch the serial encoder CLK+/- signal to the servo clock signal by manipulating the *Gate3[i].Chan[j].OutFlagC* register.

Register value	Signal level
0 (Default)	Serial encoder CLK+/- signal
1	Servo clock +/- signal

OutFlagD Function

● Applications

When connecting with the OMRON G5-series Servo Drives with General-purpose Pulse Train or Analog Inputs, the encoder A+/- terminal and the serial encoder DAT+/- terminal are short circuited and used to enable obtaining the absolute encoder value sent from the Servo Drive.
Use this function to disable the terminating resistance of the serial encoder DAT+/- terminal, because the terminating resistances of the short-circuited encoder A+/- terminal and the serial encoder DAT +/- terminal overlap.

● Details on the Function

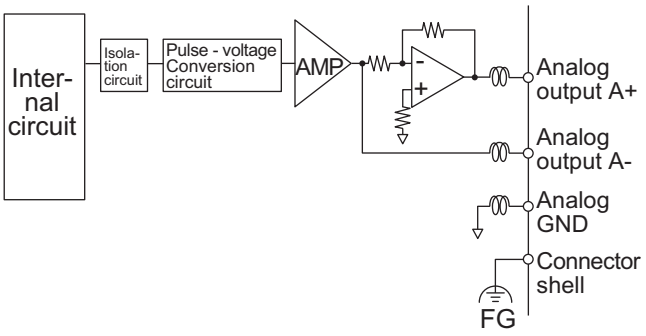
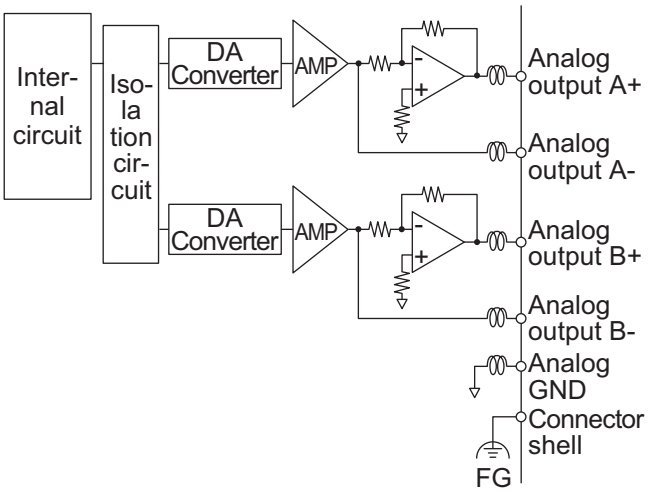
You can enable or disable the terminating resistance of the serial encoder DAT+/- terminal as shown in the table below by setting the *Gate3[i].Chan[j].OutFlagD* register and the *Gate3[i].Chan[j].SerialEncEna* register, which is for switching between enabling and disabling the serial encoder.

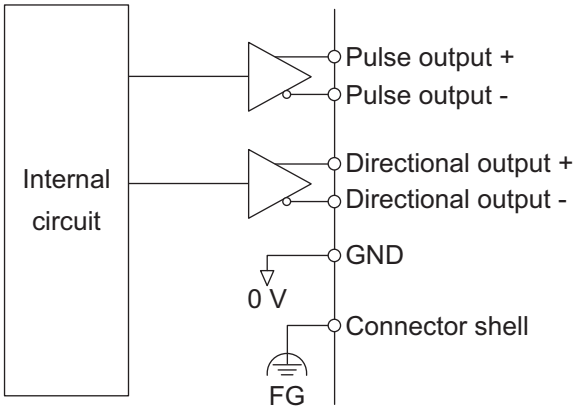
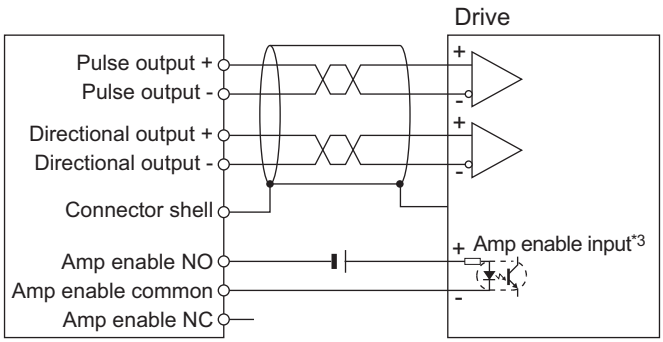
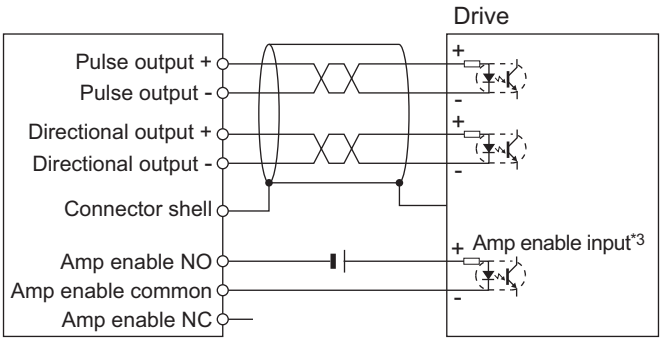
Gate3[i].Chan[j].OutFlagD	Gate3[i].Chan[j].SerialEncEna	Terminating resistance
0 (Default)	0 (Default)	Disabled
	1	Enabled
1	0	Disabled
	1	Disabled

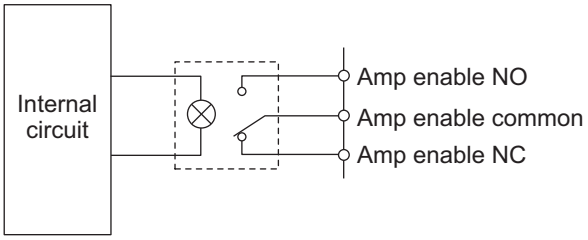
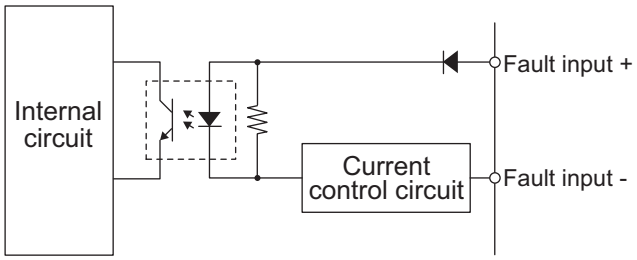
3-3-10 Amplifier Connector Specifications

This section describes the connector arrangement and electrical specifications for the amplifier connector.
For the connector arrangement of the amplifier connector, refer to *5-3-2 Amplifier Connector Wiring* on page 5-24.

Analog output (FilteredPWM type)	**Number of outputs**	1 point/channel
	Output method	Between DACA+ and DACA-: Differential output Between DACA+ and AGND: Single-ended output
	Output range	Between DACA+ and DACA-: -20 to 20V *1 Between DACA+ and AGND: -10 to 10V
	Allowable load resistance	5 kΩ min.
	Output impedance	0.5 Ω or less
	Resolution	Refer to *3-3-11 DA Output Method* on page 3-33.
	Isolation method	Isolation by Digital Isolator (between analog output and internal circuit)

	Circuit configuration	
Analog output (TrueDAC type)*2	**Number of outputs**	2 points/channel
	Output method	Between DACA+/DACB+ and DACA-/DACB-: Differential output Between DACA+/DACB+ and AGND: Single-ended output
	Output range	Between DACA+/DACB+ and DACA-/DACB-: -20 to 20 V *1 Between DACA+/DACB+ and AGND: -10 to 10V
	Allowable load resistance	5 kΩ min.
	Output impedance	0.5 Ω or less
	Resolution	1/65535 (full scale)
	Isolation method	Isolation by Digital Isolator (between analog output and internal circuit)
	Circuit configuration	
DirectPWM output	**Communications method**	Controller-Servo Drive interface unique to Delta Tau
	Connectable amplifier	Contact your OMRON representative.
	Output form	Line driver output
	Input form	Line driver input
	Isolation method	Not isolated from internal circuit
	Cables	For connection with an amplifier, be sure to use the following cables. • CK3W-CAAD009A (0.9 m) • CK3W-CAAD018A (1.8 m) • CK3W-CAAD036A (3.6 m)

Pulse output*3	**Output signal**	Output: 2 points/channel
	Pulse output method	Pulse output + directional output, or phase difference output
	Pulse output form	Line driver output
	Output voltage	EIA standard RS-422A line driver levels
	Maximum output frequency	10 MHz
	Cable length	10 m max.
	Isolation method	Not isolated from internal circuit
	Circuit configuration	
	Terminal connection diagram	Connection with a Drive with line receiver input  Connection with a Drive with 5-VDC photocoupler input *5 
Amp enable output*3	**Number of outputs**	1 point/channel
	Output method	Relay output (N.O. + N.C.)
	Maximum switching capacity	24 VDC/0.5 A

	Minimum switching capacity	5 VDC, 1 mA
	Relay service life	100,000 operations
	ON/OFF response time	10 ms max./10 ms max.
	Isolation method	Isolation by Relay (between amp enable output and internal circuit)
	Circuit configuration	
Fault input*3	**Number of inputs**	1 point/channel
	Rated input voltage	5 to 24 VDC
	Maximum input voltage	26.4 VDC
	Input current	7 mA typical (24 VDC)
	ON voltage/ON current	3 VDC min./1 mA min.
	OFF current	0.1 mA max.
	ON/OFF response time	20 µs min./400 µs max.
	Isolation method	Isolation by Photocoupler (between fault input and internal circuit)
	Circuit configuration	

*1. In DACA-, the reversed voltage of the DACA+ is output. In other words, when DACA+ = +10 V, then DACA- = -10 V. In this case, between DACA+ and DACA-, a 20 V potential difference is generated. The same applies to DACB+/DACB-.

*2. When using CK3W-AX1515□, set Gate3[i].DacClockDiv = 3 to 5.

*3. Available with the CK3W-AX1414□/1515□ Units.

*4. Pulses may be output unintendedly during the initial state and startup.
Be sure to connect the amplifier enable NO output to the amplifier enable input on the amplifier side to prevent motor malfunction.
Some amplifiers may have an amplifier disable input instead of an amplifier enable input. In that case, connect it to the amplifier enable NC.
The above wiring is an example, so please wire according to the manual of the amplifier.

*5. For connection with a Servo Drive with 5-VDC photocoupler input, only CK3W-AX1414□/-AX1515□ Units whose date of production is July 1, 2019 or later (Lot number 01719K and later) are available.
Refer to *A-6 How to Read the Lot Number* on page A-13 for the lot number.

3-3-11 DA Output Method

The following two methods are available for DA output.

- FilteredPWM
- TrueDAC

This section describes each of the methods.

FilteredPWM

This is a method for creating analog output by smoothing the PWM pulse.
The relationship between the set value and output voltage is shown below.

Set value	Voltage between analog output + and analog output -	Voltage between analog output + and analog GND
-16384	-20 V	-10 V
0	0 V	0 V
16383	+20 V	+10 V

PWM frequency is determined by the formula below.

$$f_{PWM} = \frac{PwmFreqMult+1}{2} f_{IntPhase}$$

f_{PWM} : PWM frequency
PwmFreqMult : Value set at Gate3[i].Chan[j].PwmFreqMult (Setting range: 0 to 7)
$f_{IntPhase}$: Internal phase clock frequency (Set at Gate3[i].PhaseFreq)

In addition, while the setting is between -16384 and 16383, the actual effective resolution can be calculated as follows.
$300000 \div f_{PWM}$ (kHz)

Since this is a method for smoothing out the PWM pulse, the higher the PWM frequency, the smaller the ripple, but the resolution also declines. To adequately reduce the ripple, set the PWM frequency to 30 kHz or more.
If the PWM frequency is set to 30 kHz, from the above formula, the full-scale effective resolution is a 10000 resolution.

TrueDAC

This is a method for creating analog output using a DA converter.
The relationship between the set value and output voltage is shown below.

Set value	Voltage between analog output + and analog output -	Voltage between analog output + and analog GND
-32768	-20 V	-10 V
0	0 V	0 V
32767	+20 V	+10 V

In TrueDAC, the setting range and effective resolution are the same.

3-3-12 DirectPWM Output Method

DirectPWM is a Servo Drive interface unique to Delta Tau, and only DirectPWM-compatible Servo Drives can be connected to this interface.
Contact your OMRON representative for information on DirectPWM-compatible Servo Drives.

DirectPWM allows the Motion Controller to directly send motor current commands to Servo Drives and monitor the actual motor current.
Because the Motion Controller directly sends motor current commands and monitors the motor current, high-speed precision motion control is enabled.

To use the DirectPWM output, the following settings are required.
These register settings are the default.

Gate3[i].AdcAmpClockDiv = 5
Gate3[i].AdcAmpStrobe = $FFFFFC
Gate3[i].AdcAmpDelay = 0
Gate3[i].AdcAmpHeaderBits = 2

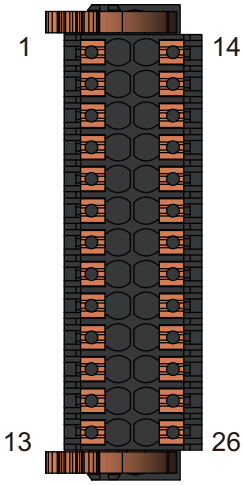
Additionally, set the phase clock frequency and the PWM frequency for each channel to 40 KHz or less.

3-3-13 Flag Connection Terminal Block Specifications

This section describes the terminal arrangement and electrical specifications of the flag connection terminal block.

Terminal Arrangement

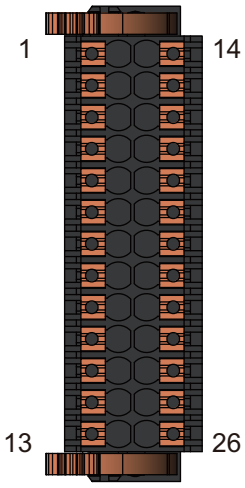
● **NPN Type**



No.	Signal		No.	Signal (4ch type)
1	EQU0		14	EQU2
2	EQU1		15	EQU3
3	COM_EQU		16	COM_EQU
4	HOME0		17	HOME2
5	PLIM0		18	PLIM2
6	NLIM0		19	NLIM2
7	USER0		20	USER2
8	V_FLAG0		21	V_FLAG2
9	HOME1		22	HOME3
10	PLIM1		23	PLIM3
11	NLIM1		24	NLIM3
12	USER1		25	USER3
13	V_FLAG1		26	V_FLAG3

Signal	Signal name	
EQUn	Position comparison output	Output
COM_EQU	Position comparison output (Common)	Common
HOMEn	Zero Position Detection Flag	Input
PLIMn	Positive Limit Flag	Input
NLIMn	Negative Limit Flag	Input
USERn	General-purpose Flag	Input
V_FLAGn	Flag (Common)	Common

● PNP Type



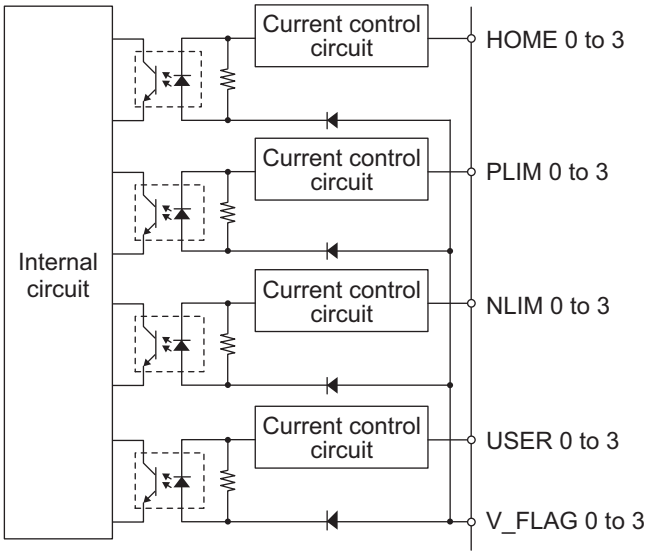
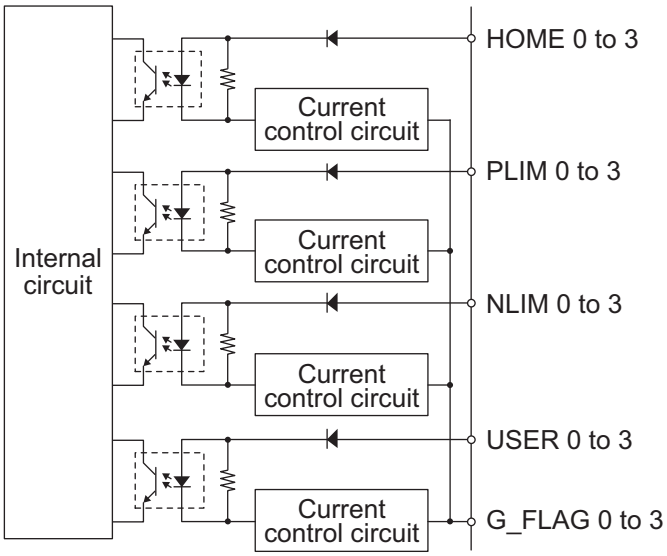
No.	Signal		No.	Signal (4ch type)
1	EQU0		14	EQU2
2	EQU1		15	EQU3
3	COM_EQU		16	COM_EQU
4	HOME0		17	HOME2
5	PLIM0		18	PLIM2
6	NLIM0		19	NLIM2
7	USER0		20	USER2
8	G_FLAG0		21	G_FLAG2
9	HOME1		22	HOME3
10	PLIM1		23	PLIM3
11	NLIM1		24	NLIM3
12	USER1		25	USER3
13	G_FLAG1		26	G_FLAG3

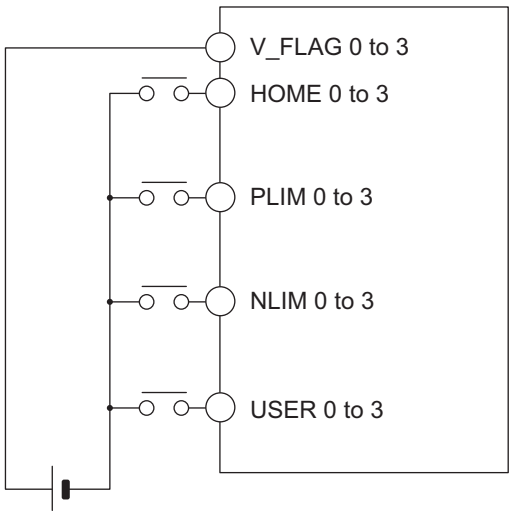
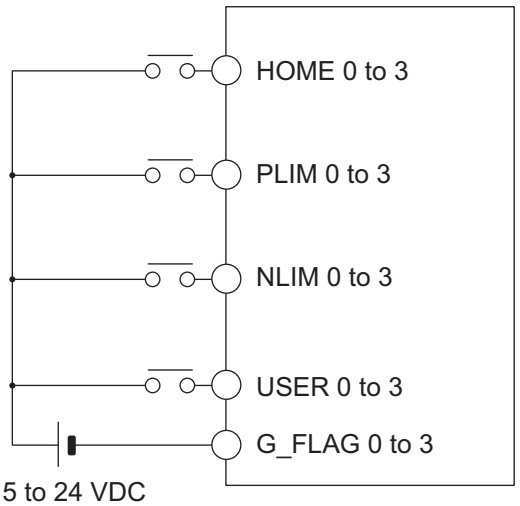
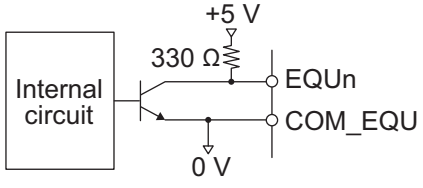
Signal	Signal name	
EQUn	Position comparison output	Output
COM_EQU	Position comparison output (Common)	Common
HOMEn	Zero Position Detection Flag	Input
PLIMn	Positive Limit Flag	Input
NLIMn	Negative Limit Flag	Input
USERn	General-purpose Flag	Input
G_FLAGn	Flag (Common)	Common

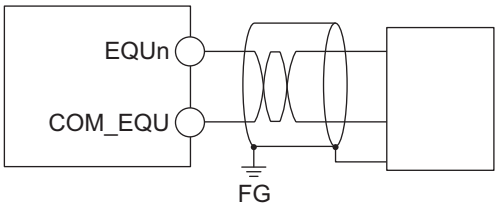
Electrical Specifications of Flag Connection Terminal Block

This section describes the electrical specifications for the flag connection terminal block.

Digital Input Specifications	**Input signal**	HOME, PLIM, NLIM, USER/Channel
	Rated input voltage	5 to 24 VDC
	Maximum input voltage	26.4 VDC
	Input current	HOME, PLIM, NLIM: 7.0 mA typical (24 VDC) USER: 9.3 mA typical (24 VDC)
	ON voltage/ON current	3 VDC min. / 1 mA min.
	OFF voltage/OFF current *1	1.0 VDC max. / 0.1 mA max.
	ON/OFF response time	HOME, PLIM, NLIM: 20 μs max./400 μs max. USER: 20 μs max./20 μs max.
	Isolation method	Isolation by Photocoupler (between input and internal circuit)

	Circuit configuration	NPN type  PNP type 

	Connection diagram	NPN type  5 to 24 VDC
		PNP type  5 to 24 VDC
Digital Output Specifications	**Output signal**	EQU/Channel
	Rated output voltage	5 VDC
	Maximum load current when ON	35 mA
	Residual voltage when ON	0.4 V max.
	Isolation method	Internal circuits and not isolated
	Circuit configuration	

	Connection diagram *2	

*1. Since the OFF current is small, connection to the two-wire sensor may not be successful. Refer to *Precautions When Connecting a Two-wire DC Sensor* on page 5-30 for information on using the two-wire sensor.

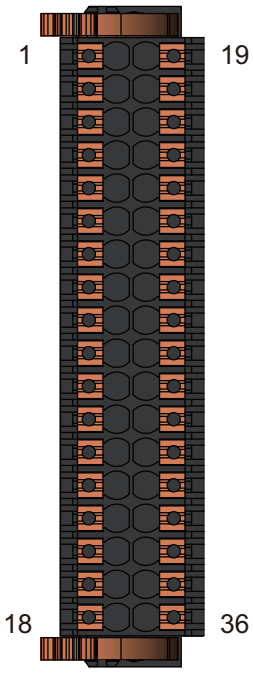
*2. For high-speed output, we recommend the use of shielded wiring.

3-3-14 General Digital I/O Connection Terminal Block Specifications

This section describes the terminal arrangement and electrical specifications of the general digital I/O connection terminal block.

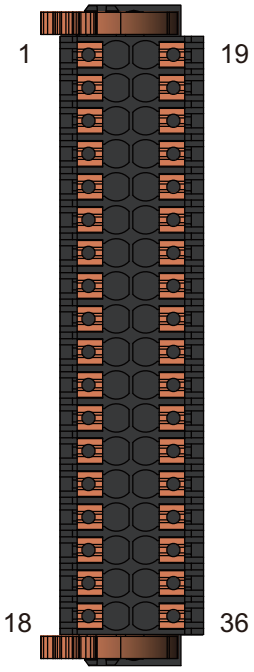
Terminal Arrangement

- **NPN Type**



No.	Signal		No.	Signal
1	IN00		19	IN08
2	IN01		20	IN09
3	IN02		21	IN10
4	IN03		22	IN11
5	IN04		23	IN12
6	IN05		24	IN13
7	IN06		25	IN14
8	IN07		26	IN15
9	V1		27	V1
10	OUT00		28	OUT08
11	OUT01		29	OUT09
12	OUT02		30	OUT10
13	OUT03		31	OUT11
14	OUT04		32	OUT12
15	OUT05		33	OUT13
16	OUT06		34	OUT14
17	OUT07		35	OUT15
18	V2		36	G2

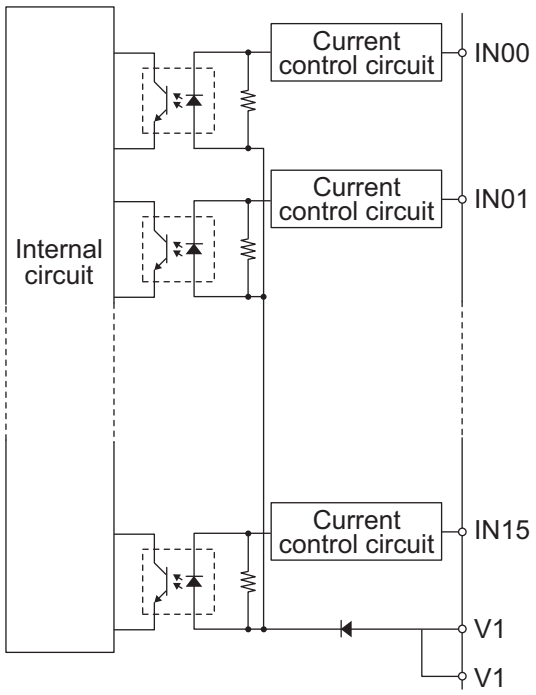
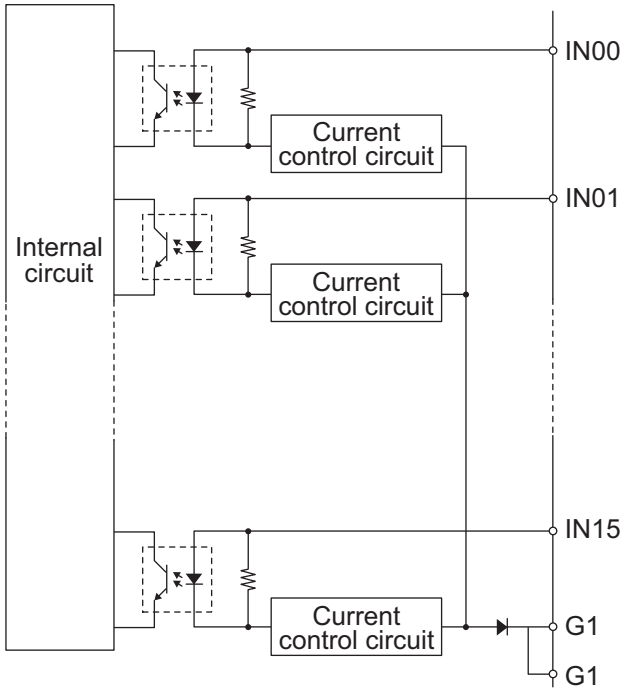
● PNP Type

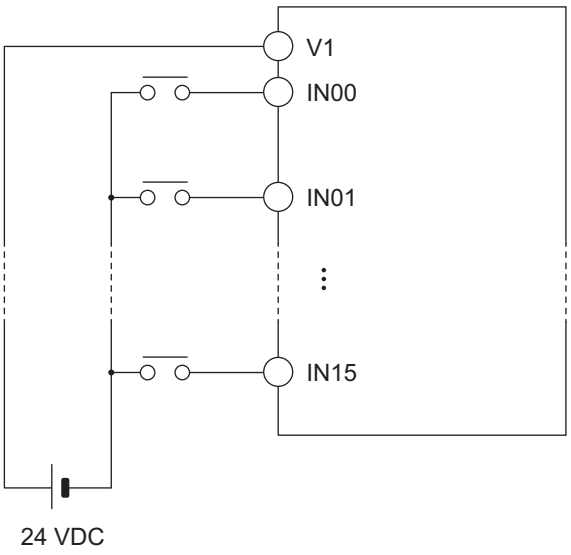
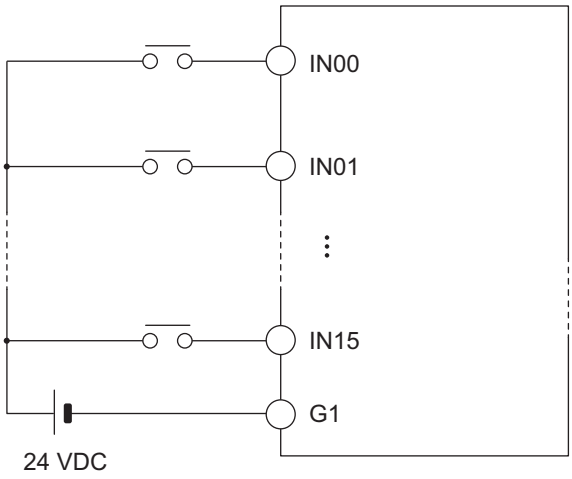


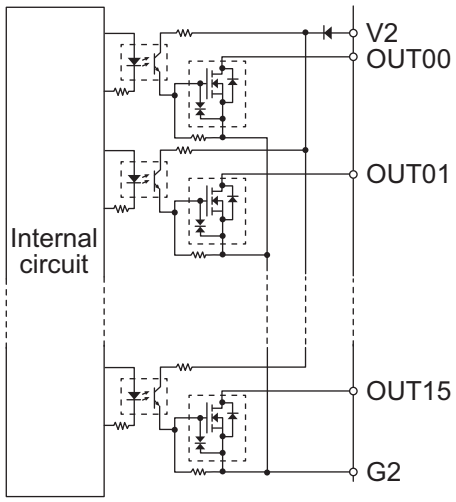
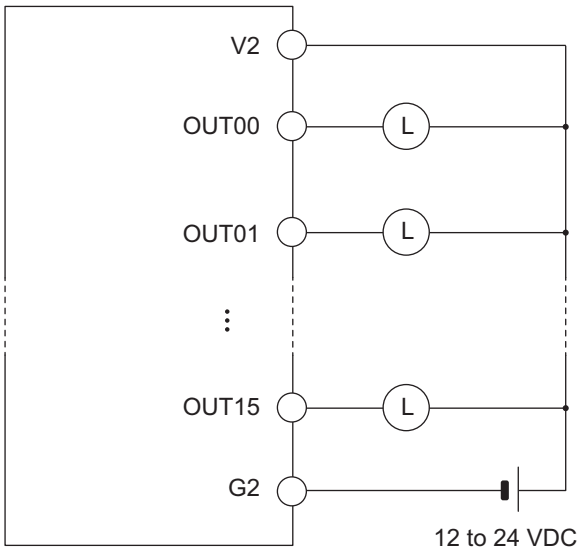
No.	Signal		No.	Signal
1	IN00		19	IN08
2	IN01		20	IN09
3	IN02		21	IN10
4	IN03		22	IN11
5	IN04		23	IN12
6	IN05		24	IN13
7	IN06		25	IN14
8	IN07		26	IN15
9	G1		27	G1
10	OUT00		28	OUT08
11	OUT01		29	OUT09
12	OUT02		30	OUT10
13	OUT03		31	OUT11
14	OUT04		32	OUT12
15	OUT05		33	OUT13
16	OUT06		34	OUT14
17	OUT07		35	OUT15
18	V2		36	G2

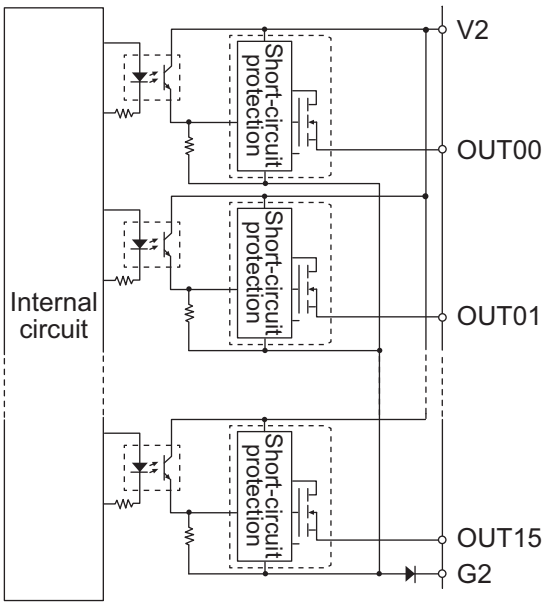
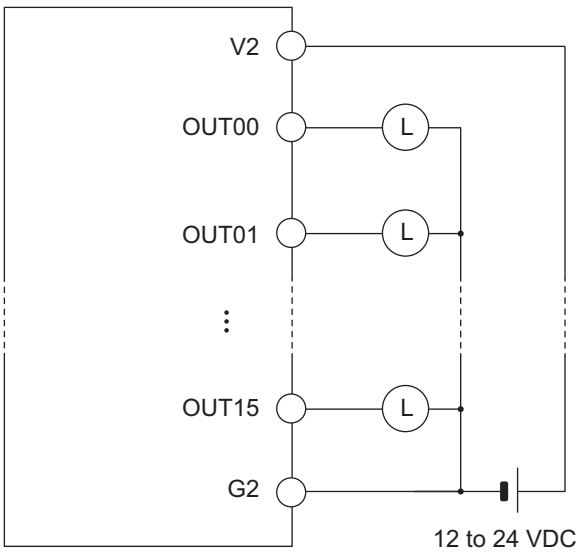
Electrical Specifications of General Digital I/O Connection Terminal Block

General digital input (NPN/PNP)	**Number of inputs**	16 points
	Rated input voltage	24 VDC
	Maximum input voltage	26.4 VDC
	Input current	3.9 mA typical (24 VDC)
	ON voltage/ON current	15 VDC min./3 mA min.
	OFF voltage/OFF current	5 VDC max./1 mA max.
	ON/OFF response time	20 μs max./400 μs max.
	Isolation method	Isolation by Photocoupler (between input and internal circuit)

	Circuit configuration	NPN type  PNP type 

	Connection diagram	NPN type 
		PNP type 
General digital output (NPN)	**Internal common**	NPN
	Rated voltage	12 to 24 VDC
	Current consumption	40 mA max.
	Operating load voltage range	10.2 to 26.4 VDC
	Maximum load current	0.5 A/point, 2 A/Unit
	Maximum inrush current	4.0 A/point, 10 ms max.
	Leakage current	0.1 mA max.
	Residual voltage	1.0 V max.
	ON/OFF response time	0.1 ms max./0.8 ms max.
	Isolation method	Isolation by Photocoupler (between output and internal circuit)
	Load short-circuit prevention	Not provided

	Circuit configuration	
	Connection diagram	NPN type 
General digital output (PNP)	**Internal common**	PNP
	Rated voltage	12 to 24 VDC
	Current consumption	80 mA max.
	Operating load voltage range	10.2 to 26.4 VDC
	Maximum load current	0.5 A/point, 2 A/Unit
	Maximum inrush current	4.0 A/point, 10 ms max.
	Leakage current	0.1 mA max.
	Current voltage	1.0 V max.
	ON/OFF response time	0.1 ms max./0.8 ms max.
	Isolation method	Isolation by Photocoupler (between output and internal circuit)
	Load short-circuit prevention	Provided

	Circuit configuration	
	Connection diagram	PNP type 

3-4 Digital I/O Unit

This section describes the Digital I/O Unit.

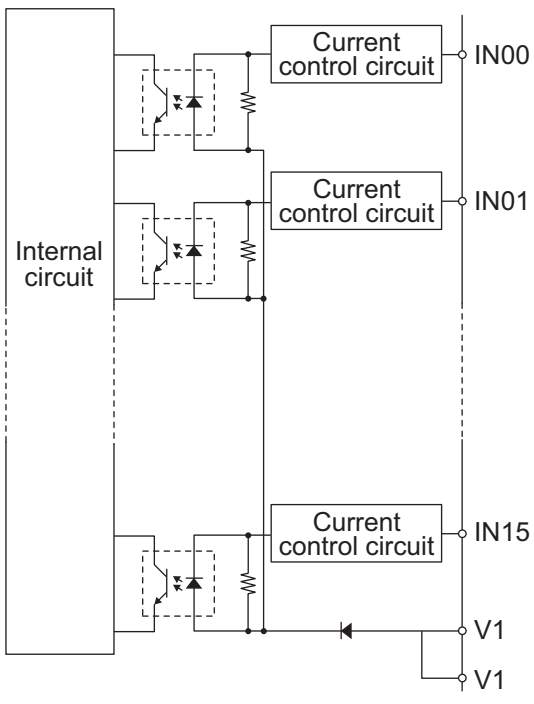
3-4-1 Models and Specifications

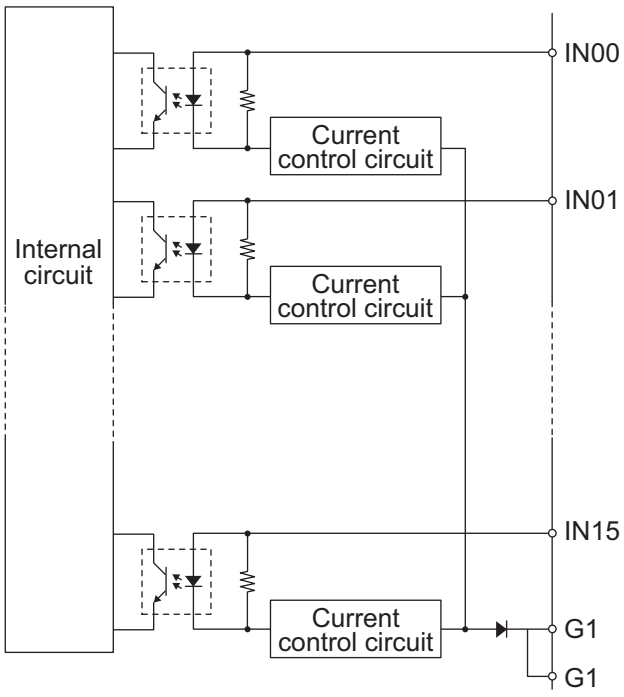
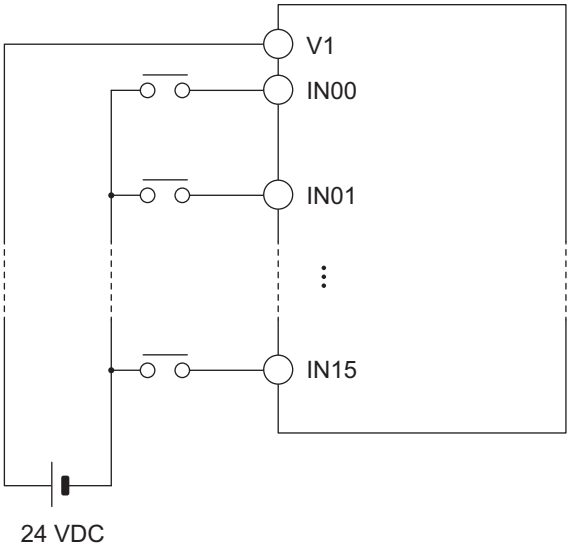
Models and Outline of Specifications

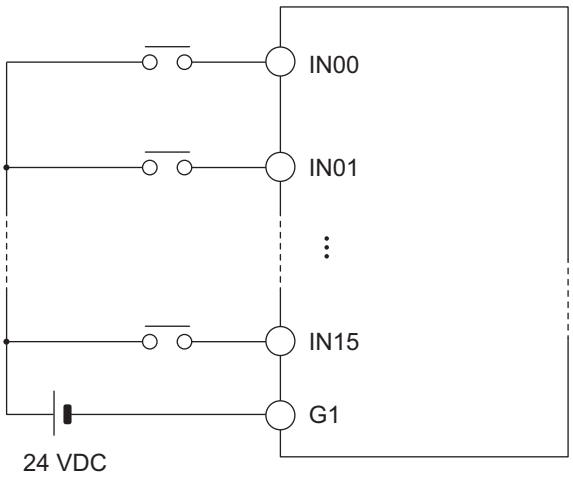
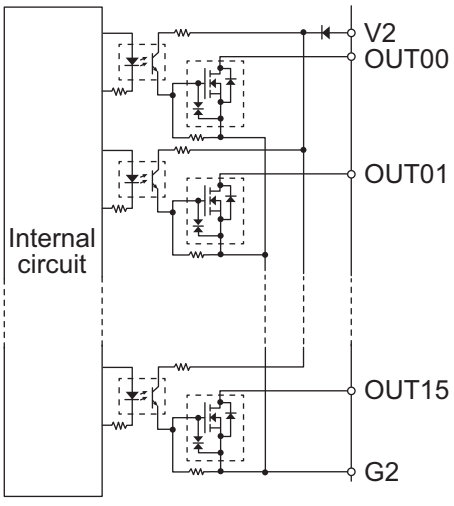
The models and outline of specifications are given below.

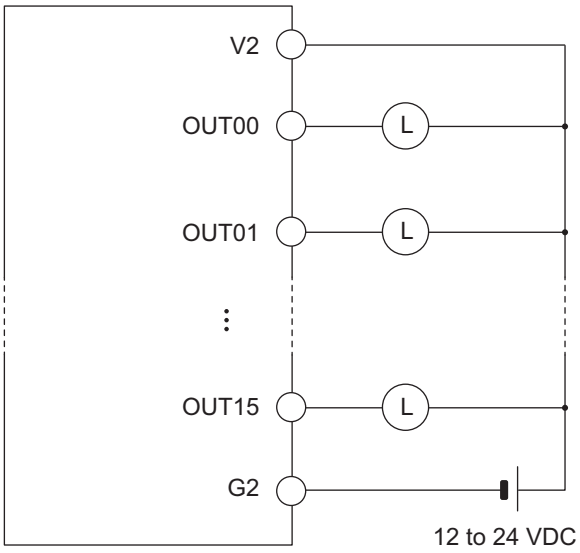
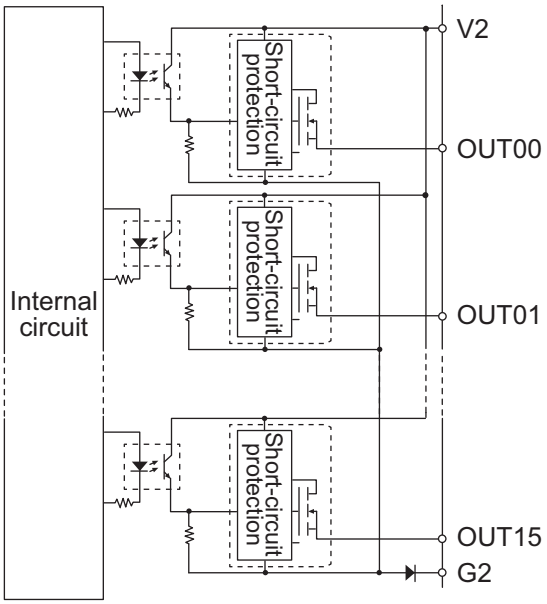
Unit type	Model	Number of inputs	Number of outputs	I/O type
Digital I/O Unit	CK3W-MD7110	16 points	16 points	NPN
	CK3W-MD7120	16 points	16 points	PNP

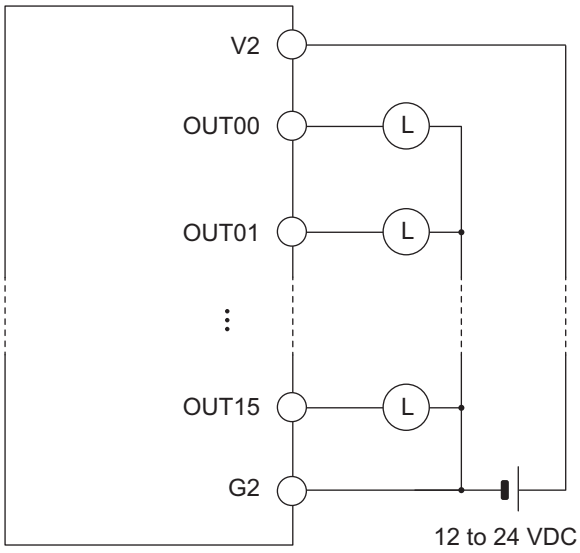
Specifications

Digital input (NPN/PNP)	**Number of inputs**	16 points
	Rated input voltage	24 VDC
	Maximum input voltage	26.4 VDC
	Input current	3.9 mA typical (24 VDC)
	ON voltage/ON current	15 VDC min./3 mA min.
	OFF voltage/OFF current	5 VDC max./1 mA max.
	ON/OFF response time	20 μs max./400 μs max.
	Isolation method	Isolation by Photocoupler (between input and internal circuit)
	Circuit configuration	NPN type 

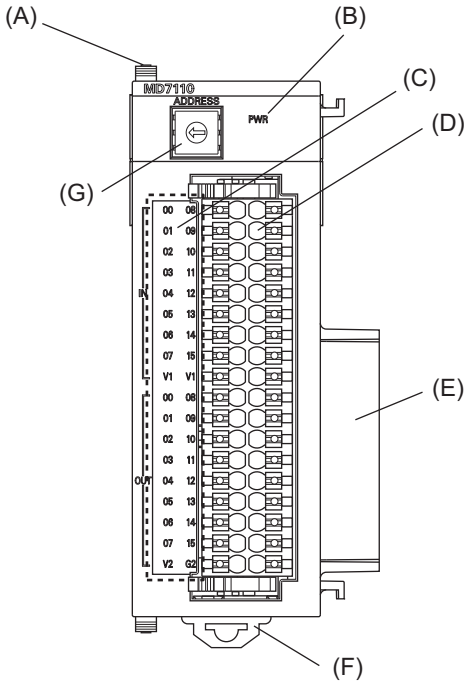
		PNP type 
	Connection diagram	NPN type 

		PNP type 
Digital output (NPN)	**Internal common**	NPN
	Rated voltage	12 to 24 VDC
	Current consumption	40 mA max.
	Operating load voltage range	10.2 to 26.4 VDC
	Maximum load current	0.5 A/point, 2 A/Unit
	Maximum inrush current	4.0 A/point, 10 ms max.
	Leakage current	0.1 mA max.
	Residual voltage	1.0 V max.
	ON/OFF response time	0.1 ms max./0.8 ms max.
	Isolation method	Isolation by Photocoupler (between output and internal circuit)
	Load short-circuit prevention	Not provided
	Circuit configuration	

	Connection diagram	
Digital output (PNP)	**Internal common**	PNP
	Rated voltage	12 to 24 VDC
	Current consumption	80 mA max.
	Operating load voltage range	10.2 to 26.4 VDC
	Maximum load current	0.5 A/point, 2 A/Unit
	Maximum inrush current	4.0 A/point, 10 ms max.
	Leakage current	0.1 mA max.
	Residual voltage	1.0 V max.
	ON/OFF response time	0.1 ms max./0.8 ms max.
	Isolation method	Isolation by Photocoupler (between output and internal circuit)
	Load short-circuit prevention	Provided
	Circuit configuration	

	Connection diagram	
Power consumption		5 V: 1.0 W max.
Dimensions (height × depth × width)		90(H)/80(D)/31.6(W)
Weight		150 g max.

3-4-2 Part Names and Functions



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Digital input/output status indicator	Shows the digital input/output status.
D	Terminal block	Connects the digital input/output.
E	Unit connector	Connector that connects to the Unit.
F	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
G	Address switch	Sets the Gate3 Index.

3-4-3 Operation Indicators

The LED indicators show the unit operating status of the Digital I/O Unit.
The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	ON	Power is supplied.
		OFF	Power is not being supplied.
IN 0 to 15	Yellow	ON	The input contact is ON.
		OFF	The input contact is OFF.
OUT 0 to 15	Yellow	ON	The output contact is ON.
		OFF	The output contact is OFF.

3-4-4 Address Switch Setting

This Unit is equipped with an IC that has the same interface as a PMAC3 style DSPGate3 IC.
Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the PMAC3 style DSPGate3 IC.

The address switch settings are used to set the Gate3 Index.
The setting range is from 0 to F. (Factory setting: 0)

Address switch setting	Power PMAC "Gate3" Index
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

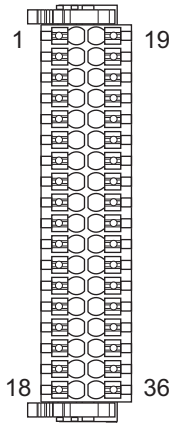
For example, if the address switch setting is *0*, the Gate3 Index becomes *0*.
In this case, this Unit is accessed with a Gate3[0] data structure.
Make sure that the address switch settings of Units do not overlap.
If they overlap, the Sys.Status register CK3WConfigErr becomes *7*.
Refer to *6-4 Sys.Status Register* on page 6-10 for Sys.Status.

One CK3W Unit in the system supplies servo clock and phase clock signals to all the other Units.
The supply-source CK3W Unit must be installed to the CPU Rack.
Connect the Unit with the smallest address value to the CPU Rack because, by default, it is the supply source of clock signals.
You may specify the Unit with a desired address as the clock supply source by setting the register.
If the Unit that serves as the clock supply source is connected to the Expansion Rack, an error occurs because the CPU Unit cannot recognize clock signals.
If this error occurs, the Sys.Status register Sys.NoClocks becomes *1*.

3-4-5 Terminal Arrangement

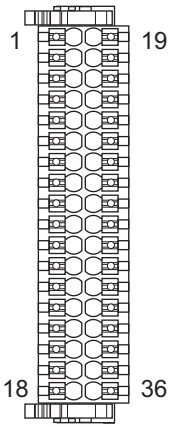
This section describes the terminal arrangement of the digital I/O connection terminal block.

CK3W-MD7110



No.	Signal		No.	Signal
1	IN00		19	IN08
2	IN01		20	IN09
3	IN02		21	IN10
4	IN03		22	IN11
5	IN04		23	IN12
6	IN05		24	IN13
7	IN06		25	IN14
8	IN07		26	IN15
9	V1		27	V1
10	OUT00		28	OUT08
11	OUT01		29	OUT09
12	OUT02		30	OUT10
13	OUT03		31	OUT11
14	OUT04		32	OUT12
15	OUT05		33	OUT13
16	OUT06		34	OUT14
17	OUT07		35	OUT15
18	V2		36	G2

CK3W-MD7120



No.	Signal		No.	Signal
1	IN00		19	IN08
2	IN01		20	IN09
3	IN02		21	IN10
4	IN03		22	IN11
5	IN04		23	IN12
6	IN05		24	IN13
7	IN06		25	IN14
8	IN07		26	IN15
9	G1		27	G1
10	OUT00		28	OUT08
11	OUT01		29	OUT09
12	OUT02		30	OUT10
13	OUT03		31	OUT11
14	OUT04		32	OUT12
15	OUT05		33	OUT13
16	OUT06		34	OUT14
17	OUT07		35	OUT15
18	V2		36	G2

3-4-6 I/O Data

The CPU Unit can access I/O data via the *Gate3[i].GpioData[0]* register.

Input data is stored in each bit of the register as shown below.

Input	Register
IN0	Gate3[i].GpioData[0].0
IN1	Gate3[i].GpioData[0].1
IN2	Gate3[i].GpioData[0].2
IN3	Gate3[i].GpioData[0].3
IN4	Gate3[i].GpioData[0].4
IN5	Gate3[i].GpioData[0].5
IN6	Gate3[i].GpioData[0].6

Input	Register
IN7	Gate3[i].GpioData[0].7
IN8	Gate3[i].GpioData[0].8
IN9	Gate3[i].GpioData[0].9
IN10	Gate3[i].GpioData[0].10
IN11	Gate3[i].GpioData[0].11
IN12	Gate3[i].GpioData[0].12
IN13	Gate3[i].GpioData[0].13
IN14	Gate3[i].GpioData[0].14
IN15	Gate3[i].GpioData[0].15

Output data is stored in each bit of the register as shown below.

Output	Register
OUT0	Gate3[i].GpioData[0].16
OUT1	Gate3[i].GpioData[0].17
OUT2	Gate3[i].GpioData[0].18
OUT3	Gate3[i].GpioData[0].19
OUT4	Gate3[i].GpioData[0].20
OUT5	Gate3[i].GpioData[0].21
OUT6	Gate3[i].GpioData[0].22
OUT7	Gate3[i].GpioData[0].23
OUT8	Gate3[i].GpioData[0].24
OUT9	Gate3[i].GpioData[0].25
OUT10	Gate3[i].GpioData[0].26
OUT11	Gate3[i].GpioData[0].27
OUT12	Gate3[i].GpioData[0].28
OUT13	Gate3[i].GpioData[0].29
OUT14	Gate3[i].GpioData[0].30
OUT15	Gate3[i].GpioData[0].31

To capture the I/O data correctly, the following register settings are required.
These register settings are the default.

Gate3[i].GpioDir[0] = $FFFF0000
Gate3[i].GpioPol[0] = $00000000
Gate3[i].GpioCtrl[0] = $00000000

3-5 Analog Input Unit

This section describes the Analog Input Unit.

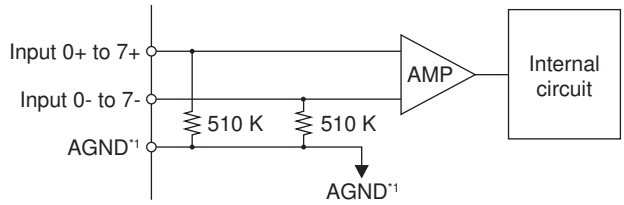
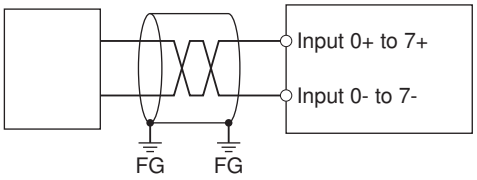
3-5-1 Models and Specifications

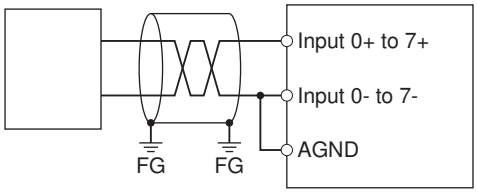
Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model	Number of inputs	Input range
Analog Input Unit	CK3W-AD2100	4 points	-10 to 10 V
	CK3W-AD3100	8 points	-10 to 10 V

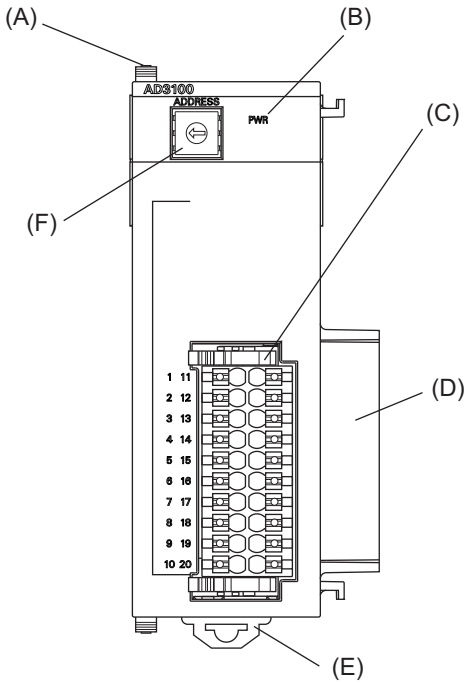
Specifications

Analog input	**Input method**	Differential or single-ended input *1
	Input range	-10 to 10 V
	Absolute maximum rating	±12 V (GND reference)
	Input impedance	1 MΩ min.
	Resolution	1/65116 (full scale)
	Accuracy (25°C)	±1.0%FS
	Effect of temperature	±0.018%FS/°C
	Isolation method	Between input and internal circuit: Power supply = Transformer, Signal = Digital isolator (Not isolated between inputs)
	Circuit configuration	 AGND: Analog circuit GND
	Terminal connection diagram	For differential input 

		For single-ended input  • If any of Input 0- to Input 7- is single ended input, apply a short-circuit between the input and AGND. • Use a shielded cable and ground at both ends of the cable.
Power consumption		CK3W-AD3100: 5 V 0.9 W max., 24 V 2.0 W max. CK3W-AD2100: 5 V 0.9 W max., 24 V 1.4 W max.
Dimensions (height × depth × width)		90(H)/80(D)/31.6(W)
Weight		CK3W-AD3100: 140 g max. CK3W-AD2100: 120 g max.

*1. Differential input and single-ended input can be mixed in a Unit.

3-5-2 Part Names and Functions



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Terminal block	Connects the analog input.
D	Unit connector	Connector that connects to the Unit.
E	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
F	Address switch	Sets the Gate3 Index.

3-5-3 Operation Indicators

The LED indicator shows the unit operating status of the Analog Input Unit.
The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	ON	Power is supplied.
		OFF	Power is not being supplied.

3-5-4 Address Switch Setting

This Unit is equipped with an IC that has the same interface as a PMAC3 style DSPGate3 IC.
Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the PMAC3 style DSPGate3 IC.

The address switch settings are used to set the Gate3 Index.
The setting range is from 0 to F. (Factory setting: 0)

Address switch setting	Power PMAC "Gate3" Index
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

For example, if the address switch setting is *0*, the Gate3 Index becomes *0*.
In this case, this Unit is accessed with a Gate3[0] data structure.
Make sure that the address switch settings of Units do not overlap.
If they overlap, the Sys.Status register CK3WConfigErr becomes *7*.
Refer to *6-4 Sys.Status Register* on page 6-10 for Sys.Status.

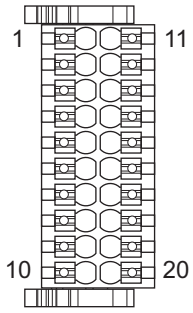
One CK3W Unit in the system supplies servo clock and phase clock signals to all the other Units.
The supply-source CK3W Unit must be installed to the CPU Rack.

Connect the Unit with the smallest address value to the CPU Rack because, by default, it is the supply source of clock signals.
You may specify the Unit with a desired address as the clock supply source by setting the register.
If the Unit that serves as the clock supply source is connected to the Expansion Rack, an error occurs because the CPU Unit cannot recognize clock signals.
If this error occurs, the Sys.Status register Sys.NoClocks becomes *1*.

3-5-5 Terminal Arrangement

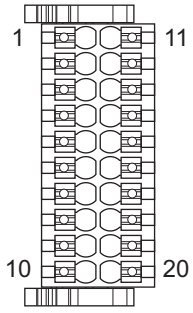
This section describes the terminal arrangement of the analog input connection terminal block.

CK3W-AD2100



No.	Signal		No.	Signal
1	AIN0+		11	AIN0-
2	AIN1+		12	AIN1-
3	AIN2+		13	AIN2-
4	AIN3+		14	AIN3-
5	AGND		15	AGND
6	NC		16	NC
7	NC		17	NC
8	NC		18	NC
9	NC		19	NC
10	AGND		20	AGND

CK3W-AD3100

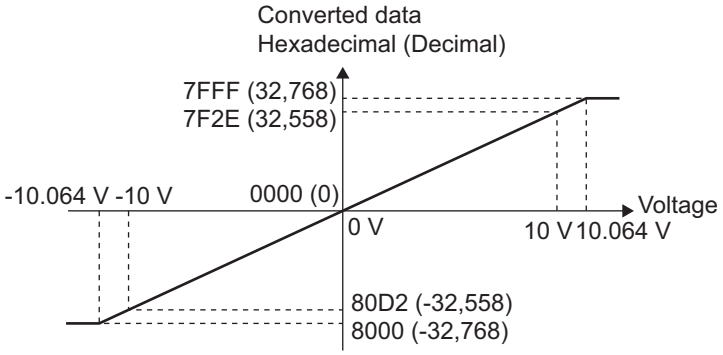


No.	Signal		No.	Signal
1	AIN0+		11	AIN0-
2	AIN1+		12	AIN1-
3	AIN2+		13	AIN2-
4	AIN3+		14	AIN3-
5	AGND		15	AGND
6	AIN4+		16	AIN4-
7	AIN5+		17	AIN5-
8	AIN6+		18	AIN6-
9	AIN7+		19	AIN7-
10	AGND		20	AGND

3-5-6 Analog Input Data

This section describes the correspondence between input analog signals and analog input data.

The graph shows that a voltage between -10 to 10 V is converted to data between 80D2 and 7F2E hex (-32,558 to 32,558).
When a negative voltage is input, it is expressed as the two's complement (hexadecimal).



Analog input data is stored in the upper 16 bits of the following register.

To use a register value, divide it by 2^{16} by using the program.

Input	Register	Bit position
AIN0	Gate3[i].Chan[0].ADCAmp[0]	[31:16]
AIN1	Gate3[i].Chan[0].ADCAmp[1]	[31:16]
AIN2	Gate3[i].Chan[0].ADCAmp[2]	[31:16]
AIN3	Gate3[i].Chan[0].ADCAmp[3]	[31:16]
AIN4	Gate3[i].Chan[1].ADCAmp[0]	[31:16]
AIN5	Gate3[i].Chan[1].ADCAmp[1]	[31:16]
AIN6	Gate3[i].Chan[1].ADCAmp[2]	[31:16]
AIN7	Gate3[i].Chan[1].ADCAmp[3]	[31:16]

The following table shows the conversion timing of analog input.

Input	Conversion timing
AIN0, AIN1, AIN4, AIN5	At the rising edge of the phase clock
AIN2, AIN3, AIN6, AIN7	At the falling edge of the phase clock

Note that the conversion timing of AIN0, AIN1, AIN4, AIN5 and that of AIN2, AIN3, AIN6, AIN7 are not the same.

To capture analog input data correctly, the following register settings are required.
These register settings are the default.

Gate3[i].AdcAmpClockDiv = 5 or 4 (5 by default)
Gate3[i].AdcAmpCtrl = $FFFFFC01
Gate3[i].AdcAmpDelay = 0
Gate3[i].AdcAmpHeaderBits = 1
Gate3[i].AdcAmpStrobe = $FFFFFC
Gate3[i].AdcAmpUtoS = 0
Gate3[i].GpioCtrl = $00000000
Gate3[i].GpioDir[0] = $0000FFFF
Gate3[i].GpioPol[0] = $00000000

3-5-7 Input Filter

The Analog Input Unit incorporates a hardware filter.
You can select the filter cut-off frequency from among 24.5 kHz, 12.2 kHz, 4.3 kHz, and 3.2 kHz and switch the frequency among them by setting the *Gate3[i].GpioData[0]* register as shown below.

Input	Input filter cut-off frequency (kHz)	Setting
AIN0	3.2 (Default)	Gate3[i].GpioData[0].0=0, Gate3[i].GpioData[0].1=0
	4.3	Gate3[i].GpioData[0].0=1, Gate3[i].GpioData[0].1=0
	12.2	Gate3[i].GpioData[0].0=0, Gate3[i].GpioData[0].1=1
	24.5	Gate3[i].GpioData[0].0=1, Gate3[i].GpioData[0].1=1
AIN1	3.2 (Default)	Gate3[i].GpioData[0].2=0, Gate3[i].GpioData[0].3=0
	4.3	Gate3[i].GpioData[0].2=1, Gate3[i].GpioData[0].3=0
	12.2	Gate3[i].GpioData[0].2=0, Gate3[i].GpioData[0].3=1
	24.5	Gate3[i].GpioData[0].2=1, Gate3[i].GpioData[0].3=1
AIN2	3.2 (Default)	Gate3[i].GpioData[0].4=0, Gate3[i].GpioData[0].5=0
	4.3	Gate3[i].GpioData[0].4=1, Gate3[i].GpioData[0].5=0
	12.2	Gate3[i].GpioData[0].4=0, Gate3[i].GpioData[0].5=1
	24.5	Gate3[i].GpioData[0].4=1, Gate3[i].GpioData[0].5=1
AIN3	3.2 (Default)	Gate3[i].GpioData[0].6=0, Gate3[i].GpioData[0].7=0
	4.3	Gate3[i].GpioData[0].6=1, Gate3[i].GpioData[0].7=0
	12.2	Gate3[i].GpioData[0].6=0, Gate3[i].GpioData[0].7=1
	24.5	Gate3[i].GpioData[0].6=1, Gate3[i].GpioData[0].7=1
AIN4	3.2 (Default)	Gate3[i].GpioData[0].8=0, Gate3[i].GpioData[0].9=0
	4.3	Gate3[i].GpioData[0].8=1, Gate3[i].GpioData[0].9=0
	12.2	Gate3[i].GpioData[0].8=0, Gate3[i].GpioData[0].9=1
	24.5	Gate3[i].GpioData[0].8=1, Gate3[i].GpioData[0].9=1
AIN5	3.2 (Default)	Gate3[i].GpioData[0].10=0, Gate3[i].GpioData[0].11=0
	4.3	Gate3[i].GpioData[0].10=1, Gate3[i].GpioData[0].11=0
	12.2	Gate3[i].GpioData[0].10=0, Gate3[i].GpioData[0].11=1
	24.5	Gate3[i].GpioData[0].10=1, Gate3[i].GpioData[0].11=1

Input	Input filter cut-off frequency (kHz)	Setting
AIN6	3.2 (Default)	Gate3[i].GpioData[0].12=0, Gate3[i].GpioData[0].13=0
	4.3	Gate3[i].GpioData[0].12=1, Gate3[i].GpioData[0].13=0
	12.2	Gate3[i].GpioData[0].12=0, Gate3[i].GpioData[0].13=1
	24.5	Gate3[i].GpioData[0].12=1, Gate3[i].GpioData[0].13=1
AIN7	3.2 (Default)	Gate3[i].GpioData[0].14=0, Gate3[i].GpioData[0].15=0
	4.3	Gate3[i].GpioData[0].14=1, Gate3[i].GpioData[0].15=0
	12.2	Gate3[i].GpioData[0].14=0, Gate3[i].GpioData[0].15=1
	24.5	Gate3[i].GpioData[0].14=1, Gate3[i].GpioData[0].15=1

3-6 Encoder Input Unit

This section describes the Serial Encoder Input Unit.

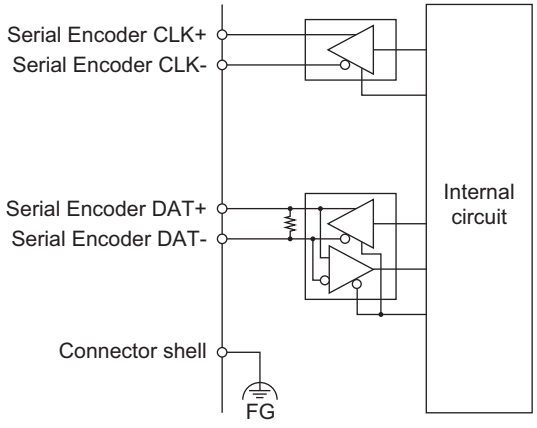
3-6-1 Models and Specifications

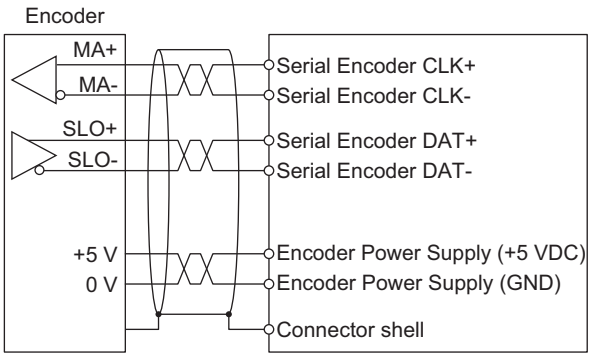
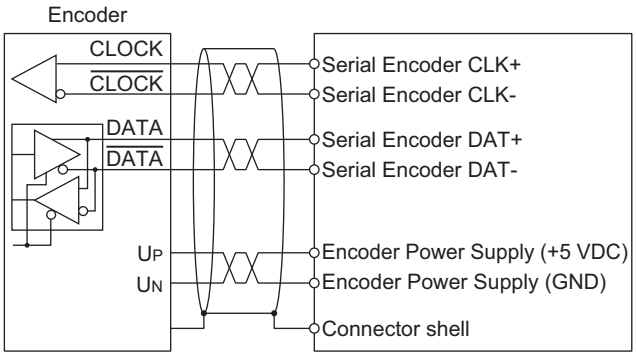
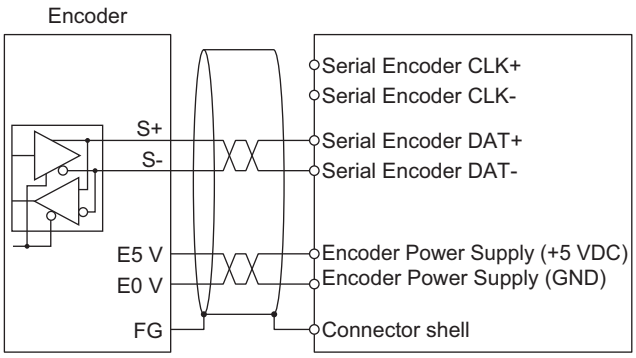
Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model	Encoder type	Number of channels
Encoder Input Unit	CK3W-ECS300	Serial encoder	4 channels

Specifications

Encoder power supply output	**Rated output voltage**	5 VDC
	Output voltage range	4.9 to 5.25 VDC (5 VDC +5%/-2%)
	Maximum output current	500 mA/channel or less However, the total output current of each Unit is 1 A or less.
Serial encoder input	**Supported protocol**	BiSS-C, Endat2.2, and R88M-1L□/-1M□ Motor built-in encoder
	Clock output[*1]	EIA standard RS-422A line driver level
	Data I/O	EIA standard RS-485 line driver/receiver level
	Maximum baud rate[*2]	BiSS-C: 2 MHz Endat2.2: 2 MHz
	Maximum transmission distance[*3]	BiSS-C (Baud rate: Transmission distance) 250 kHz: 95 m 1 MHz: 20 m 2 MHz: 8 m
		Endat2.2 (Baud rate: Transmission distance) 500 kHz: 100 m 1 MHz: 45 m 2 MHz: 10 m
		R88M-1L□/-1M□ Motor built-in encoder: 50 m
	Isolation method	Not isolated (between internal circuit and encoder circuit)
	Circuit configuration	

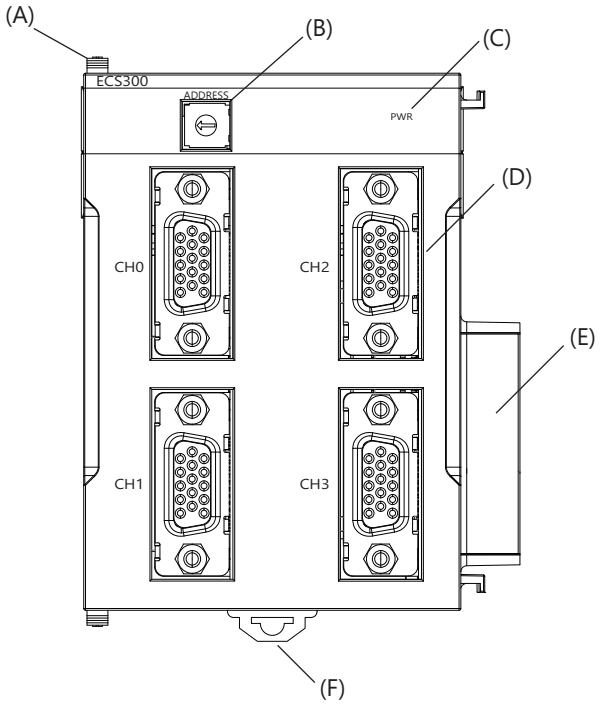
	Terminal connection diagram	BiSS-C  Endat2.2  R88M-1L□/-1M□ Motor built-in encoder 
Power consumption		5 V 0.6 W max. 24 V 6.8 W max.
Dimensions (height × depth × width)		90(H)/80(D)/63.2(W)
Weight		200 g max.

*1. When you use a reset command ($$$) to reset the Unit, the clock output will stop.

*2. For the R88M-1L□/-1M□ Motor built-in encoder, you cannot set a baud rate.

*3. The function of propagation delay compensation for Endat and BiSS-C is not available with the CK3W-ECS Units.

3-6-2 Part Names and Functions



Letter	Name	Function
A	Slider	Holds the Units together.
B	Address switch	Sets the Gate3 Index.
C	Power supply status indicator	Shows the power supply status.
D	Encoder connector	Connects the encoder.
E	Unit connector	Connector that connects to the Unit.
F	DIN Track mounting hook	Used to mount the Unit to a DIN Track.

3-6-3 Operation Indicators

The LED indicator shows the unit operating status of the Encoder Input Unit.
The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	ON	Power is supplied.
		OFF	Power is not being supplied.

3-6-4 Address Switch Setting

This Unit is equipped with an IC that has the same interface as a PMAC3 style DSPGate3 IC.
Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the PMAC3 style DSPGate3 IC.

The address switch settings are used to set the Gate3 Index.
The setting range is from 0 to F. (Factory setting: 0)

Address switch setting	Power PMAC "Gate3" Index
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

For example, if the address switch setting is *0*, the Gate3 Index becomes *0*.
In this case, this Unit is accessed with a Gate3[0] data structure.
Make sure that the address switch settings of Units do not overlap.
If they overlap, the Sys.Status register CK3WConfigErr becomes *7*.
Refer to *6-4 Sys.Status Register* on page 6-10 for Sys.Status.

One CK3W Unit in the system supplies servo clock and phase clock signals to all the other Units.
The supply-source CK3W Unit must be installed to the CPU Rack.
Connect the Unit with the smallest address value to the CPU Rack because, by default, it is the supply source of clock signals.
You may specify the Unit with a desired address as the clock supply source by setting the register.
If the Unit that serves as the clock supply source is connected to the Expansion Rack, an error occurs because the CPU Unit cannot recognize clock signals.
If this error occurs, the Sys.Status register Sys.NoClocks becomes *1*.

3-6-5 Terminal Arrangement

For the connector arrangement of the encoder connector, refer to *5-6-1 Encoder Connector Wiring* on page 5-44.

3-6-6 Software Settings

Use the following register settings for the software settings of the Encoder Input Unit.

The register settings here are different from the definitions descried in the *Power PMAC Software Reference Manual (Cat. No. O015)*.
Refer to *A-8 Software Reference of Encoder Input Unit* on page A-21 for detailed specifications.

Power PMAC Saved Data Structure Elements	
Gate3[i].SerialEncCtrl	Serial encoder control register
Gate3[i].Chan[0].SerialEncEna	Serial encoder enable Ch0
Gate3[i].Chan[1].SerialEncEna	Serial encoder enable Ch1
Gate3[i].Chan[2].SerialEncEna	Serial encoder enable Ch2
Gate3[i].Chan[3].SerialEncEna	Serial encoder enable Ch3
Gate3[i].Chan[0].SerialEncCmd	Serial encoder command register Ch0
Gate3[i].Chan[1].SerialEncCmd	Serial encoder command register Ch1
Gate3[i].Chan[2].SerialEncCmd	Serial encoder command register Ch2
Gate3[i].Chan[3].SerialEncCmd	Serial encoder command register Ch3
Power PMAC Status Data Structure Elements	
Gate3[i].Chan[0].SerialEncDataA	Serial encoder data register A Ch0
Gate3[i].Chan[0].SerialEncDataB	Serial encoder data register B Ch0
Gate3[i].Chan[1].SerialEncDataA	Serial encoder data register A Ch1
Gate3[i].Chan[1].SerialEncDataB	Serial encoder data register B Ch1
Gate3[i].Chan[2].SerialEncDataA	Serial encoder data register A Ch2
Gate3[i].Chan[2].SerialEncDataB	Serial encoder data register B Ch2
Gate3[i].Chan[3].SerialEncDataA	Serial encoder data register A Ch3
Gate3[i].Chan[3].SerialEncDataB	Serial encoder data register B Ch3
Gate3[i].Chan[0].Status	Internal memory error detection

Precautions for Correct Use

Make sure that the following settings of the CK3W-ECS Unit are the same as those of the supply-source Unit of servo clocks and phase clocks.
- Gate3[i].PhaseFreq
- Gate3[i].ServoClockDiv

Furthermore, in order to match internal phase clocks with external phase clocks, the CK3W-ECS Unit and the clock supply-source Unit should have the following setting.
- Gate3[i].PhaseClockDiv = 0
- Gate3[i].PhaseClockMulti = 0

If you make a different setting, data of the encoder may become an unexpected value.

3-7 Laser Interface Unit

This section describes the Laser Interface Unit.

3-7-1 Models and Specifications

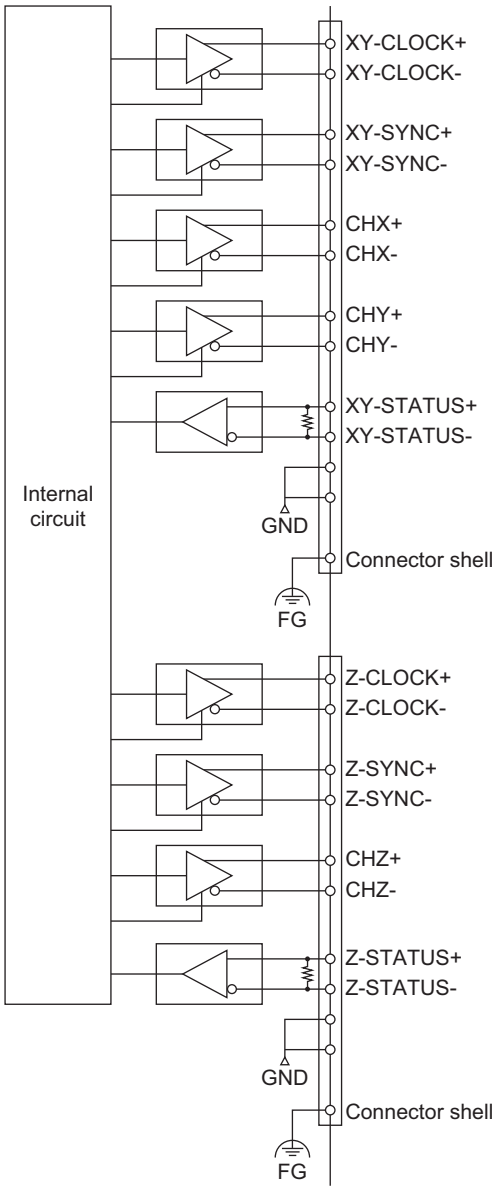
Models and Outline of Specifications

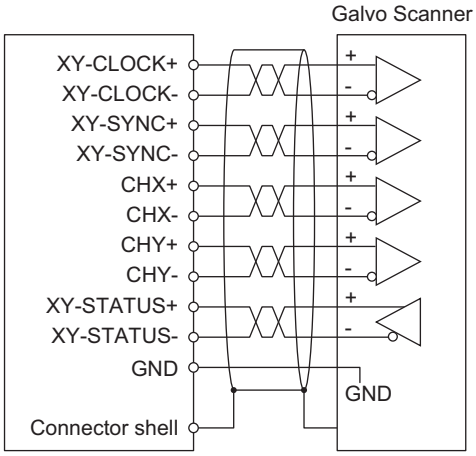
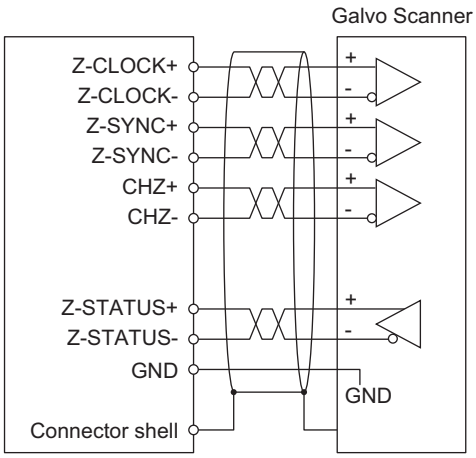
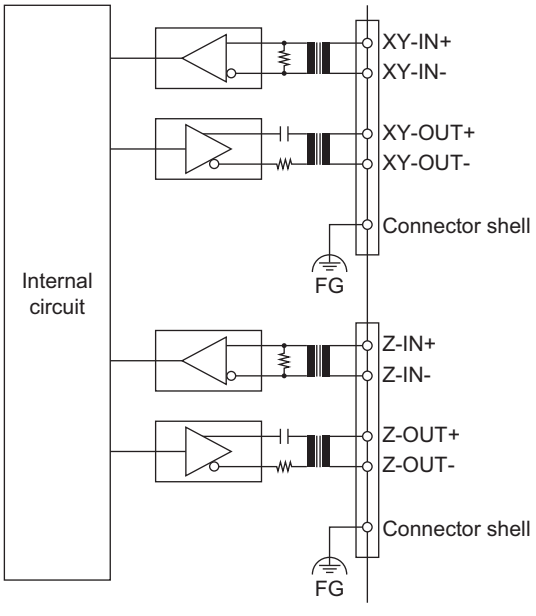
The models and outline of specifications are given below.

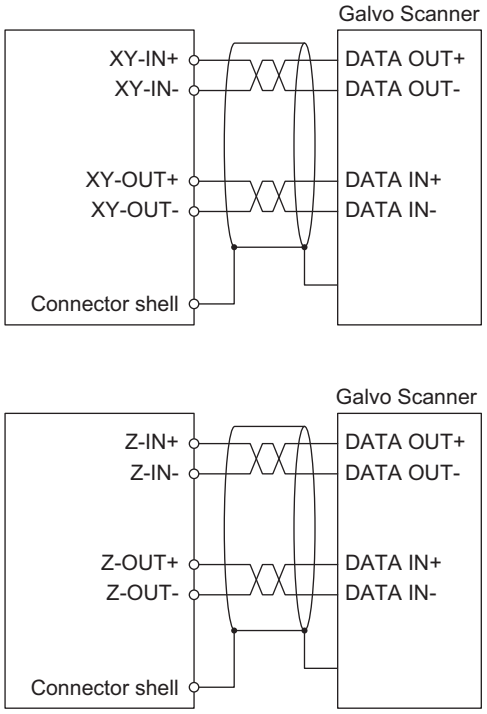
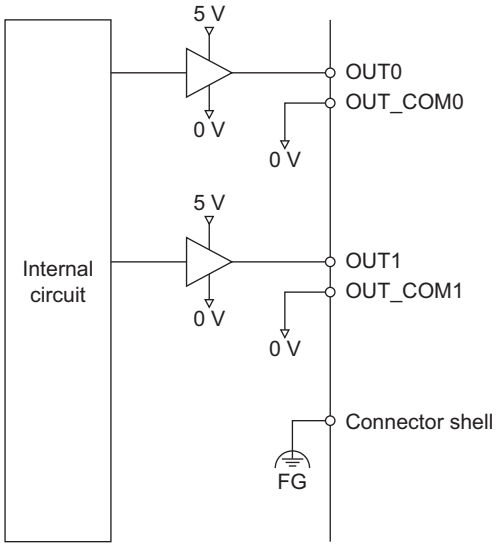
Unit type	Model	Communications method	Laser output
Laser Interface Unit	CK3W-GC1100	XY2-100	PWM output
	CK3W-GC1200		PWM output, TCR output
	CK3W-GC2100	SL2-100	PWM output
	CK3W-GC2200		PWM output, TCR output

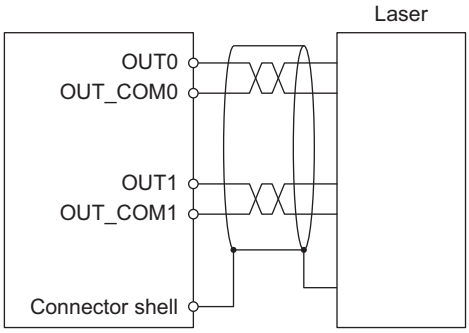
Specifications

XY2-100 Interface	**Data length*1**	16 bits, 18 bits, or 20 bits
	Clock output frequency	2 MHz
	Data refresh period	10 μs
	Maximum transmission distance	10 m
	Isolation method	Not isolated (between internal circuit and XY2-100 circuit)

	Circuit configuration	

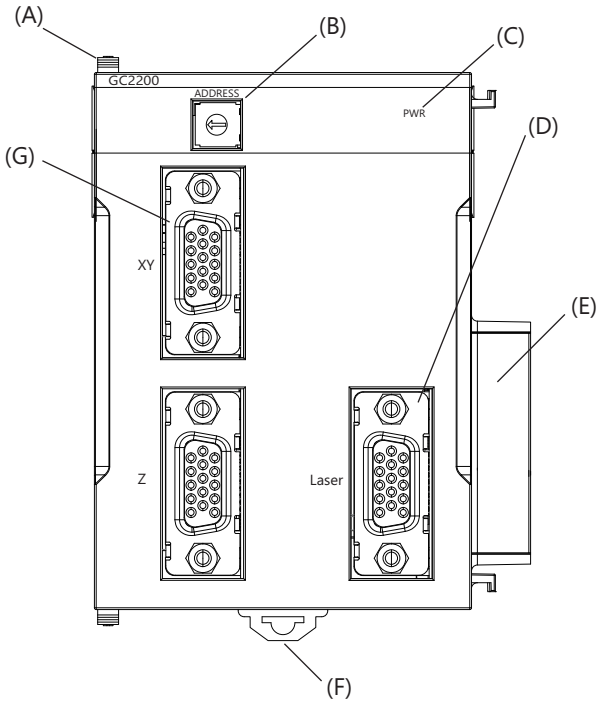
	Terminal connection diagram	 
SL2-100 Interface	**Data length**	20 bits
	Maximum transmission distance	25 m
	Cable impedance	110 Ω
	Isolation method	Isolation by pulse transformer (between internal circuit and SL2-100 circuit)
	Circuit configuration	

	Terminal connection diagram	
Laser output	**Number of points**	CK3W-GC□100: 1 point (OUT0: PWM output) CK3W-GC□200: 2 points (OUT0: PWM output, OUT1: TCR output)
	Rated voltage	5 VDC
	Maximum output current	20 mA
	Output voltage (for H output)	3.8 V min.
	Output voltage (for L output)	0.55 V max.
	Response time	100 ns max.
	Maximum transmission distance	25 m
	Isolation method	Not isolated (between internal circuit and laser output circuit)
	Circuit configuration	 *2

	Terminal connection diagram	 *3
Power consumption		CK3W-GC1□00: 5 V 0.6 W max., 24 V 1.9 W max. CK3W-GC2□00: 5 V 0.6 W max., 24 V 1.0 W max.
Dimensions (height × depth × width)		90(H)/80(D)/63.2(W)
Weight		190 g max.

*1. It is 16 bits for the XY2-100 Interface in general.
*2. The CK3W-GC□100 Units do not have the OUT1 circuit.
*3. The CK3W-GC□100 Units do not need the OUT1 wiring.

3-7-2 Part Names and Functions



Letter	Name	Function
A	Slider	Holds the Units together.
B	Address switch	Sets the Gate3 Index.
C	Power supply status indicator	Shows the power supply status.
D	Laser connector	Connects the laser.
E	Unit connector	Connector that connects to the Unit.
F	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
G	Galvo Scanner connector	Connects the Galvo Scanner.

3-7-3 Operation Indicators

The LED indicators show the unit operating status of the Laser Interface Unit.
The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	ON	Power is supplied.
		OFF	Power is not being supplied.

3-7-4 Address Switch Setting

This Unit is equipped with an IC that has the same interface as a PMAC3 style DSPGate3 IC.
Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the PMAC3 style DSPGate3 IC.

The address switch settings are used to set the Gate3 Index.
The setting range is from 0 to F. (Factory setting: 0)

Address switch setting	Power PMAC "Gate3" Index
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

For example, if the address switch setting is *0*, the Gate3 Index becomes *0*.
In this case, this Unit is accessed with a Gate3[0] data structure.
Make sure that the address switch settings of Units do not overlap.
If they overlap, the Sys.Status register CK3WConfigErr becomes *7*.
Refer to *6-4 Sys.Status Register* on page 6-10 for Sys.Status.

One CK3W Unit in the system supplies servo clock and phase clock signals to all the other Units.
The supply-source CK3W Unit must be installed to the CPU Rack.

Connect the Unit with the smallest address value to the CPU Rack because, by default, it is the supply source of clock signals.
You may specify the Unit with a desired address as the clock supply source by setting the register.
If the Unit that serves as the clock supply source is connected to the Expansion Rack, an error occurs because the CPU Unit cannot recognize clock signals.
If this error occurs, the Sys.Status register Sys.NoClocks becomes *1*.

3-7-5 Terminal Arrangement

For the connector arrangement of the Galvo Scanner connector and the laser connector, refer to *5-7-1 Galvo Scanner Connector Wiring* on page 5-46 and *5-7-2 Laser Connector Wiring* on page 5-48.

3-7-6 XY2-100 Interface

The XY2-100 Interface establishes communications for connecting the Galvo Scanner and the Controller.
This section describes the functions of the XY2-100 Interface.

Signal Descriptions

The XY2-100 Interface carries the XY-axis and the Z-axis signals that move the Galvo Scanner respectively in the vertical and horizontal directions and in the height direction.

Name	Function
XY-CLOCK/ Z-CLOCK	A clock signal for communications, and data is sent or received in synchronization with this clock. The frequency of this clock is 2 MHz, at which it is sent continuously. Since a single data is sent or received at 20-clock intervals, data is refreshed every 10 μs.
XY-SYNC/ Z-SYNC	A signal for frame synchronization.
CHX/ CHY/ CHZ	Command position data to be sent to the Galvo Scanner. You can use the setting to select 16-bit, 18-bit, or 20-bit data length. When the setting is 16 bits or 18 bits, add parity bits to frames. You can change the setting to choose even or odd parity.
XY-STATUS/ Z-STATUS	From the Galvo Scanner, 16-bit status data and parity are sent to the CK3W-GC Unit. You need to use a user program to determine whether the parity is correct.

Data Format of Command Position

A command position is 24-bit data.
To set the command position, use Gate3[i].Chan[j].DAC[0] [31:08].
You can select a data format of the command position by setting ModeSel (Gate3[i].SerialEncCtrl [14:15]).
The data ranges from -2^{23} to 2^{23}.
Data to be sent to the Galvo Scanner is limited to the command position (integer part).
The command position (fractional part) is used to improve the accuracy of linear interpolation.

● ModeSel = 00 (16-Bit Data)

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Command position (integer part) 16 bits																Command position (fractional part) 8 bits							

● ModeSel = 01 (18-Bit Data)

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Command position (integer part) 18 bits																		Command position (fractional part) 6 bits					

● ModeSel = 10 (20-Bit Data)

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Command position (integer part) 20 bits																				Command position (fractional part) 4 bits			

Linear Interpolation of Command Position

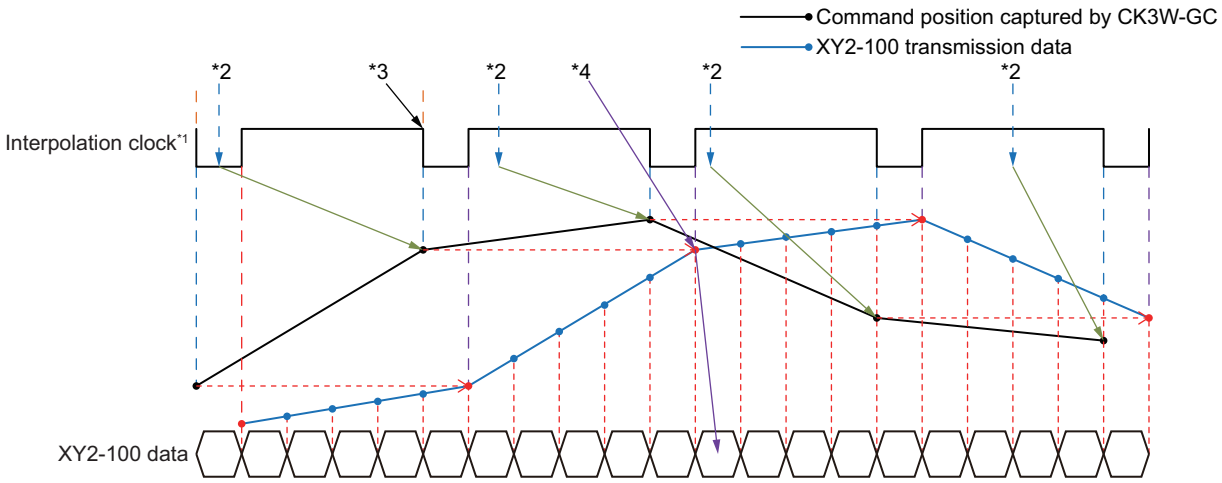
The XY2-100 Interface sends data every 10 μs.
However, since the CPU Unit writes a command position in the CK3W-GC Unit in synchronization with a phase or a servo clock, generally the command position data from the CPU Unit can only be refreshed in a cycle longer than 10 μs.
For this reason, the command position from CPU is applied linear interpolation and it is sent to the Galvo Scanner as the data of XY2-100.
For the clock that determines an interpolation cycle, you can select a servo clock or a phase clock by setting ClockSel (Gate3[i].SerialEncCtrl [17]).
The ClockSel setting should be the same as a setting of the clock that controls the motor of PMAC (bit 3 of Motor[x].PhaseCtrl).

A command position is applied linear interpolation in synchronous mode or asynchronous mode.
You can select synchronous mode or asynchronous mode by setting Sync (Gate3[i].SerialEncCtrl [16]).

● Operation in Synchronous Mode

In this mode ensure that the interpolation clock (Phase or Servo) period is set to an integer multiple of 10 μs. Also, make sure that the interpolation clock period is 1 ms or less.

The CK3W-GC Unit captures a command position at the falling edge of an interpolation clock, and sends that command position in an XY2-100 transmission cycle at the rising edge of the interpolation clock after next.
As the XY2-100 data between interpolation clocks, the value calculated by linear interpolation is sent.
You can match the command position from the CPU Unit with the shape of XY2-100 data by using this mode.



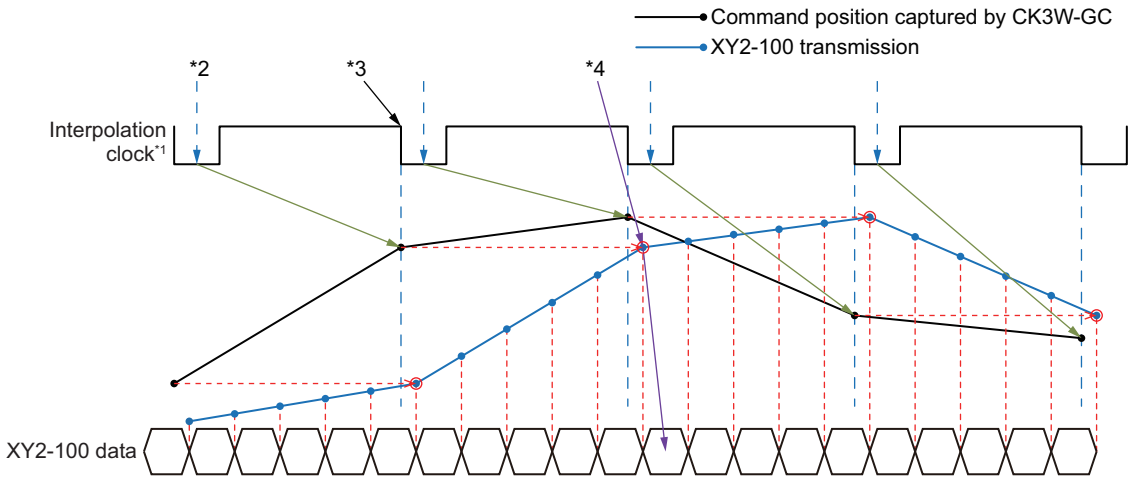
*1. ClockSel = 0: Servo clock
ClockSel = 1: Phase clock
*2. Command position writing from CPU Unit
*3. Command position capturing by CK3W-GC Unit
*4. The command position captured by the CK3W-GC Unit becomes the XY2-100 transmission data at the rising edge of the interpolation clock after next.

Precautions for Correct Use

When you set synchronous mode for linear interpolation of a command position, set a multiple of 10 μs to the phase or servo cycle set for an interpolation clock.
If it is not set correctly, the Galvo Scanner may not operate as intended.

● Operation in Asynchronous Mode

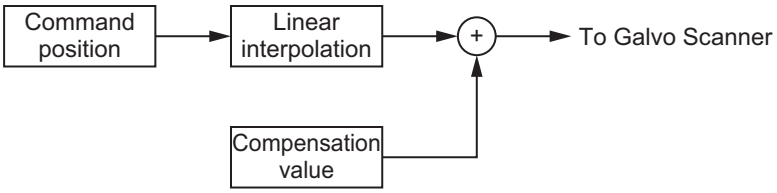
You can set any value to the interpolation clock (Phase or Servo) period.
The CK3W-GC Unit captures a command position at the falling edge of an interpolation clock, and sends that command position in an XY2-100 transmission cycle at the falling edge of the next interpolation clock.
As the XY2-100 data between interpolation clocks, the value calculated by linear interpolation is sent.
In asynchronous mode, the interpolation may not be linear interpolation in calculation. If you always need to use linear interpolation, use synchronous mode.
Although using this mode causes an error between the command position from the CPU Unit and the shape of XY2-100 data, you can set any value to the phase or the servo cycle.



*1. ClockSel = 0: Servo clock
ClockSel = 1: Phase clock
*2. Command position writing from CPU Unit
*3. Command position capturing by CK3W-GC Unit
*4. The command position captured by the CK3W-GC Unit becomes the XY2-100 transmission data at the falling edge of the next interpolation clock.

Compensation of Command Position Function

This is a function that adds the compensation value set using Gate3[i].Chan[j].Dac[1] to the command position after linear interpolation and sends it from XY2-100.



Data format of the compensation value is the same as that of the command position.
Data to be sent to the Galvo Scanner is limited to the command position (integer part).
If adding a positive compensation value causes transmission data to overflow, it is limited to the upper limit.
Conversely, if adding a negative compensation value causes transmission data to underflow, it is limited to the lower limit.

A compensation value is 24-bit data.
You can select a data format of the command position by setting ModeSel (Gate3[i].SerialEncCtrl [14:15]).

● ModeSel = 00 (16-Bit Data)

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Compensation value (integer part) 16 bits																Compensation value (fractional part) 8 bits							

● **ModeSel = 01 (18-Bit Data)**

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Compensation value (integer part) 18 bits																		Compensation value (fractional part) 6 bits					

● **ModeSel = 10 (20-Bit Data)**

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Compensation value (integer part) 20 bits																				Compensation value (fractional part) 4 bits			

Status Data

When you send a command position to the Galvo Scanner, the status data will be sent from the Galvo Scanner to the CK3W-GC Unit.
For details on the status data, refer to the Galvo Scanner specifications.
Parity bits are added to the status data.
In order to check that communications are in progress successfully, use a user program to check whether the parity is correct.

3-7-7 SL2-100 Interface

The SL2-100 Interface establishes communications for connecting the Galvo Scanner of SCANLAB GmbH and the Controller.
This section describes the functions of the SL2-100 Interface.

Signal Descriptions

The SL2-100 Interface carries the XY-axis and the Z-axis signals that move the Galvo Scanner respectively in the vertical and horizontal directions and in the height direction.

Name	Function
XY-OUT/ Z-OUT	Data to be sent to the Galvo Scanner. The data length is 20 bits for X, Y, and Z each. Additionally, you can set the type of data to be received from the Galvo Scanner by sending a control command.
XY-IN/ Z-IN	Data to be received from the Galvo Scanner. Receives the data set by the control command. The data length is 20 bits for X, Y, and Z each.

Data Format of Command Position

A command position is 24-bit data.
To set the command position, use Gate3[i].Chan[j].DAC[0] [31:08] when Control Bit (Gate3[i].SerialEncCtrl [15:13]) is 001.
Data format is as follows.

The data range is from -2^{23} to 2^{23}.
Data to be sent to the Galvo Scanner is limited to the command position (integer part).
The command position (fractional part) is used to improve the accuracy of linear interpolation.

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Command position (integer part) 20 bits																				Command position (fractional part) 4 bits			

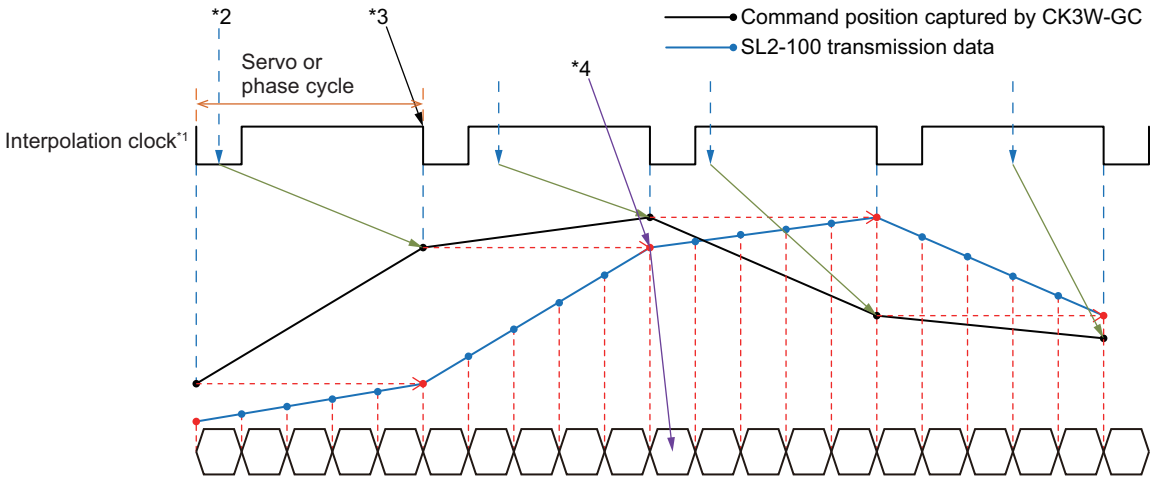
Linear Interpolation of Command Position

The SL2-100 Interface sends data every 10 µs.
However, since the CPU Unit writes a command position in the CK3W-GC Unit in synchronization with a phase or a servo clock, generally the command position data from the CPU Unit can only be refreshed in a cycle longer than 10 µs.
For this reason, the command position from CPU is applied linear interpolation and it is sent to the Galvo Scanner as the data of SL2-100.
For the clock that determines an interpolation cycle, you can select a servo clock or a phase clock by setting ClockSel (Gate3[i].SerialEncCtrl [17]).
The ClockSel setting should be the same as a setting of the clock that controls the motor of PMAC (bit 3 of Motor[x].PhaseCtrl).
Additionally, you can select rising edge or falling edge by setting EdgeSel (Gate3[i].SerialEncCtrl [12]).

A command position is applied linear interpolation in synchronous mode or asynchronous mode.
You can select synchronous mode or asynchronous mode by setting Sync (Gate3[i].SerialEncCtrl [16]).

● Operation in Synchronous Mode

In this mode ensure that the interpolation clock (Phase or Servo) period is set to an integer multiple of 10 µs.
The CK3W-GC Unit captures a command position at the falling edge (rising edge) of an interpolation clock, and sends that command position in an SL2-100 transmission cycle at the falling edge (rising edge) of the next interpolation clock.
As the SL2-100 data between interpolation clocks, the value calculated by linear interpolation is sent.
You can match the command position from the CPU Unit with the shape of SL2-100 data by using this mode.



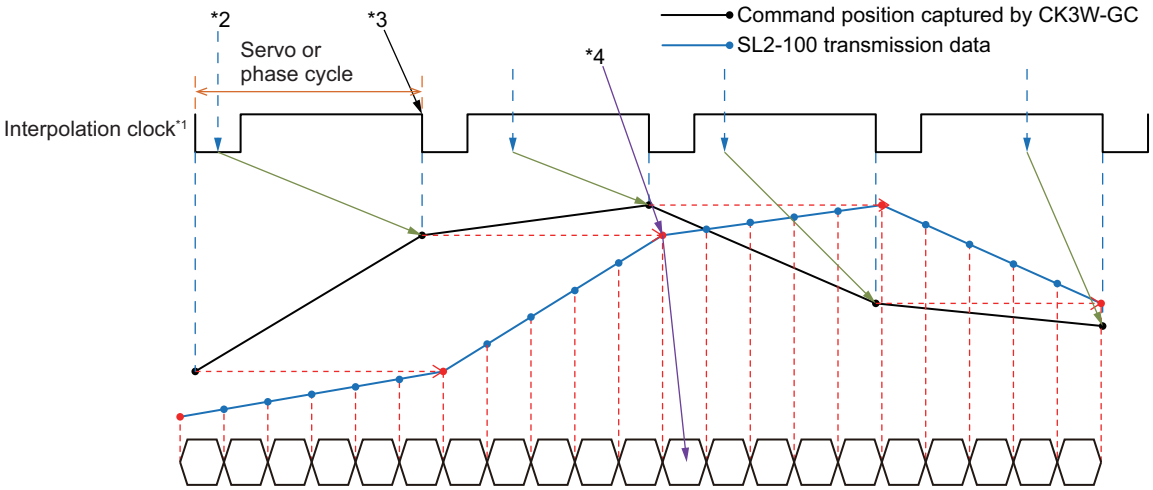
*1. ClockSel = 0: Servo clock
ClockSel = 1: Phase clock
*2. Command position writing from CPU Unit
*3. Command position capturing by CK3W-GC Unit
EdgeSel = 0: Falling edge
EdgeSel = 1: Rising edge
*4. The command position captured by the CK3W-GC Unit becomes the SL2-100 transmission data at the falling edge (rising edge) of the next interpolation clock.
EdgeSel = 0: Falling edge
EdgeSel = 1: Rising edge

Precautions for Correct Use

When you set synchronous mode for linear interpolation of a command position, set a multiple of 10 μs to the phase or servo cycle set for an interpolation clock.
If it is not set correctly, the Galvo Scanner may not operate as intended.

● Operation in Asynchronous Mode

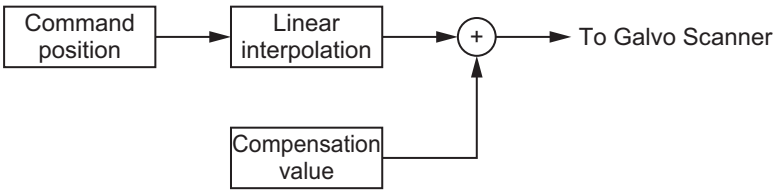
You can set any value to the interpolation clock (Phase or Servo) period.
The CK3W-GC Unit captures a command position at the falling edge (rising edge) of an interpolation clock, and sends that command position in an SL2-100 transmission cycle at the falling edge (rising edge) of the next interpolation clock.
As the SL2-100 data between interpolation clocks, the value calculated by linear interpolation is sent.
In asynchronous mode, the interpolation may not be linear interpolation in calculation. If you always need to use linear interpolation, use synchronous mode.
Although using this mode causes an error between the command position from the CPU Unit and the shape of SL2-100 data, you can set any value to the phase or the servo cycle.



*1. ClockSel = 0: Servo clock
ClockSel = 1: Phase clock
*2. Command position writing from CPU Unit
*3. Command position capturing by CK3W-GC Unit
EdgeSel = 0: Falling edge
EdgeSel = 1: Rising edge
*4. The command position captured by the CK3W-GC Unit becomes the SL2-100 transmission data at the falling edge (rising edge) of the next interpolation clock.
EdgeSel = 0: Falling edge
EdgeSel = 1: Rising edge

Compensation of Command Position Function

This is a function that adds the compensation value set using Gate3[i].Chan[j].Dac[1] to the command position after linear interpolation and sends it from SL2-100.



Data format of the compensation value is the same as that of the command position.
Data to be sent to the Galvo Scanner is limited to the command position (integer part).
If adding a positive compensation value causes transmission data to overflow, it is limited to the upper limit.
Conversely, if adding a negative compensation value causes transmission data to underflow, it is limited to the lower limit.

A compensation value is the following 24-bit data.

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Compensation value (integer part) 20 bits																				Compensation value (fractional part) 4 bits			

Sending Command to Galvo Scanner

You can send a command to the Galvo Scanner by setting Control Bit (Gate3[i].SerialEncCtrl [15:13]) = 111. The command only supports iDRIVE® compatible Galvo Scanner of SCANLAB GmbH.
The command has two parameters: CodeH and CodeL.
For details on the command, refer to the manual for the Galvo Scanner.
Use Gate3[i].Chan[j].Dac[0] to set a command.
Data format in which to send a command is as follows.

	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Command position	Code-H								Code-L								Always set 0.							

For Code-H in the data format, reverse the most significant bit of CodeH specified by the Galvo Scanner, and store it in there.
For example, when CodeH of the Galvo Scanner is *05*, set *85* to Code-H.
In Code-L, store CodeL specified by the Galvo Scanner as it is.
The read data specified by a command is stored in Gate3[i].Chan[j].SerialEncDataA.
Once it is specified by the command, this status will be retained, therefore, even if you set Control Bit = 100 after that, the read data will continue.

For example, when you send an actual current position to the CK3W-GC Unit from the iDRIVE® compatible Galvo Scanner of SCANLAB GmbH, the control command will be *$850100* because of CodeH = 05 and CodeL = 01.
Gate3[i].Chan[j].Dac[0] needs to be set using decimal notation. Therefore, for the control command *$850100*, set Gate3[i].Chan[j].Dac[0]=-2063532032.

3-7-8 PWM Output Function

PWM output is used for controlling the output of the laser light source.
You can set frequency, duty, pulse count, and delay time.
This section describes the functions of the PWM output.

Signal Descriptions

The PWM output is output from the OUT0 terminal.

Frequency Setting

The PWM frequency is set by the formula below, on the basis of PWMPeriod (Gate3[i].Chan[0].CompA[23:12]).

$$f_{PWM}(kHz) = \frac{10^5}{16 \times PWMPeriod}$$

The setting range of PWMPeriod is from 2 to 4095, and the frequency can be set in the range from 1,526 Hz to 3.125 MHz.

The following shows examples of settings.

PWMPeriod	PWM Frequency (kHz)
3125 ($C35)	2
1250 ($4E2)	5
625 ($271)	10
312 ($138)	20
125 ($07D)	50

Duty Setting

The PWM duty is set by the formula below, on the basis of DutyCycle (Gate3[i].Chan[0].CompA[11:0]).

$$\text{Positive Duty Cycle}(\%) = \frac{DutyCycle}{4096} \times 100$$

The setting range of DutyCycle is from 0 to 4095, however, if you set 4095, the duty will be 100%.

Pulse Count Setting

PulseCount (Gate3[i].Chan[2].CompA[19:8]) is used to set the pulse count of PWM.
PulseCount is subtracted by one every time one pulse is output.
Reading this register allows you to read the remaining pulse count to be output.
The setting range of PulseCount is from 0 to 4095, however, if you set 4095, PWM pulses will be output continuously.

Delay Setting

DelayUnit (Gate3[i].Chan[1].CompA [31:20]), Delay (Gate3[i].Chan[1].CompA [16:8]), and ClockSel (Gate3[i].SerialEncCtrl [17]) are used to set the delay of PWM.

When you set the pulse count of PWM, PWM is then started with a time delay set using DelayUnit and Delay from the rising edge timing of the clock set using ClockSel.

The delay time is calculated by the formula below.

$$\text{Delay Time(ns)} = [(Delay+3)] \times [(DelayUnits+2) \times 10]$$

The setting range of DelayUnit is from 0 to 4094. You cannot set 4095.
The setting range of Delay is from 0 to 511.

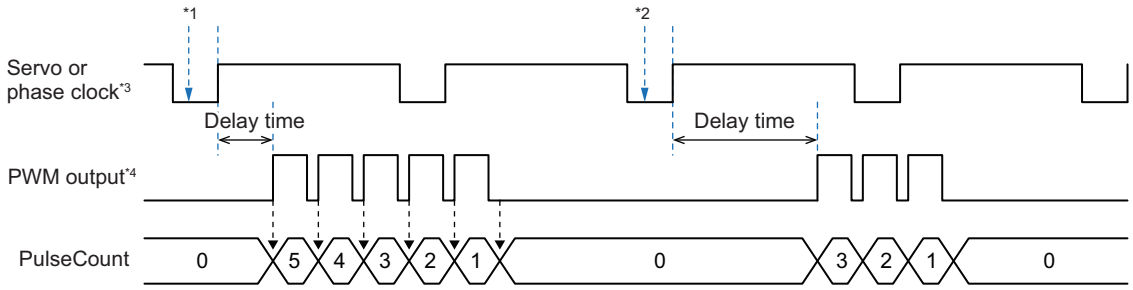
Configure DelayUnit to satisfy the following condition.
This setting may not operate correctly if the following condition is not satisfied.

Phase clock cycle × 0.2 - 100 ns > (DelayUnits + 2) × 10 (ns)

Be sure to wait for the previously set pulse output to complete before setting DelayUnit and Delay.

If you set DelayUnit and Delay before the previously set pulse output is completed, the expected pulses may not be output.
In the delay time, jitter of ±[(DelayUnits + 2) × 10 + 30] (ns) occurs. When you set DelayUnit, take the jitter into consideration.

The following shows examples of pulse output settings.



*1. Write Delay, DelayUnit, and PulseCount = 5 from the CPU Unit.
*2. Write Delay, DelayUnit, and PulseCount = 3 from the CPU Unit.
*3. ClockSel = 0: Servo clock
ClockSel = 1: Phase clock
*4. PWMPeriod and DutyCycle are used to set the pulse frequency and duty.

3-7-9 TCR Output Function

This function is available with the CK3W-GC□200 Units only. It is not available with the CK3W-GC □100 Units.
The TCR (Trigger output by Commanded distance for Rapid processing) output is a function for controlling ON/OFF of the laser light source according to the distance of laser trajectory.
The CPU Unit writes command distance in the CK3W-GC Unit for each phase or servo cycle, and the CK3W-GC Unit applies linear interpolation to the command distance.
The CK3W-GC Unit can set up to 4095 comparison values on a table.
The output is switched ON/OFF by comparing this comparison table with the command distance that was applied linear interpolation.
The laser light source can be turned ON/OFF according to the distance by using this output for controlling ON/OFF of the laser.

Signal Descriptions

TCR is output from the OUT1 terminal.

Linear Interpolation of Command Distance

Use Gate3[i].Chan[0].CompB to set command distance for each phase or servo cycle from the CPU Unit.
The command distance is applied linear interpolation, because it is only refreshed in a phase or a servo cycle.
To set an interpolation clock, use CompClkSel (Gate3[i].Chan[2].CompB[29]).
For the interpolation clock, select the same clock as a writing cycle from the CPU Unit.

When you set the command distance, make sure that it does not decrease if CompareEnable (Gate3[i].Chan[2].CompB[31]) is *1*. If it decreases, a linear interpolation will not be made correctly. When you decrease the command distance, set CompareEnable to *0*.

Setting of Comparison Table

Gate3[i].Chan[1].CompB, TableWritePointer(Gate3[i].Chan[3].CompB[23:12]), and TableClear(Gate3[i].Chan[2].CompB[30]) are used to set the comparison table.
When you write a comparison value in Gate3[i].Chan[1].CompB with the comparison table empty, it will be written in the buffer 0 (CompareTable[0]), and TableWritePointer will increase from 0 to 1.
Then, when you write a comparison value in Gate3[i].Chan[1].CompB, it will be written in the buffer 1 (CompareTable[1]), and TableWritePointer will increase from 1 to 2.
When TableWritePointer is 4095, this means that you have written comparison values in all buffers, so you can write no more values.

When you set the comparison table, make sure that the number increases. If it does not increase, a comparison will not be made correctly.
To write in the comparison table, be sure to set CompareEnable (Gate3[i].Chan[2].CompB[31]) to *0*. If CompareEnable is *1*, nothing will be written in the comparison table.

Buffer number	Comparison value
0	CompareTable [0]
1	CompareTable [1]
2	Empty
:	:
4092	Empty
4093	Empty
4094	Empty

Even if you set CompareEnable to *0*, the comparison table will not be cleared.
You can empty the comparison table by using TableClear to clear all buffers on the comparison table.
To clear the comparison table, be sure to set CompareEnable to *0* beforehand.
If you read Gate3[i].Chan[1].CompB, it will return a value on the comparison table where you are making a comparison now.

Execution of Comparison

CompareEnable(Gate3[i].Chan[2].CompB[31]) and ComparePointer(Gate3[i].Chan[3].CompB[11:0]) are used to execute comparison.

Writing 1 in CompareEnable will start comparison.
First, a comparison between Comparetable[0] and the linearly interpolated command distance is made.
A comparison output starts at 0.
When the linearly interpolated command distance has become larger than Comparetable[0], the comparison output will be reversed and the comparison value will change to Comparetable[1].
Next, a comparison between Comparetable[1] and the linearly interpolated command distance is made, and a comparison is made with Comparetable[n] in turn.

ComparePointer shows the buffer number where a comparison is made now.

When all the comparison is complete and the next buffer is empty, the last comparison output will be retained.

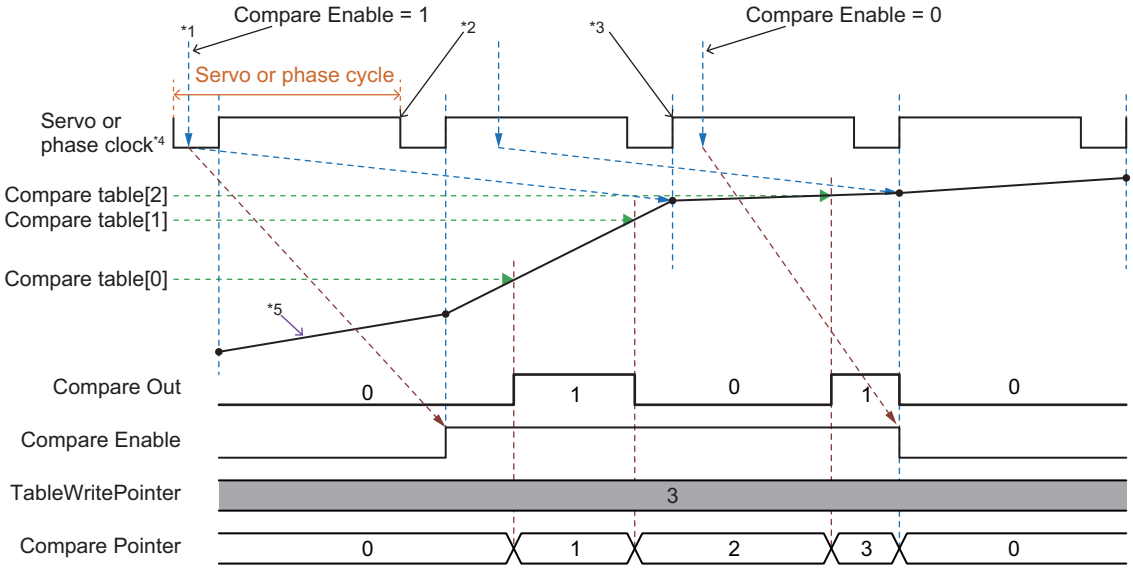
You can determine whether the comparison is complete by checking that ComparePointer is the same as TableWritePointer.
Setting CompareEnable to 0 will stop the comparison and reset the comparison output to 0.
Then, setting CompareEnable to 1 will start a comparison again from Comparetable[0].

Setting of Comparison Output

CompOutPol(Gate3[i].Chan[2].CompB[25]) sets the polarity of a comparison output.
For CompOutPol = 0, OUT1 outputs 5 V with a comparison output = 1.
For CompOutPol = 1, OUT1 outputs 0 V with a comparison output = 1.

You can forcibly set a comparison output by using CompOutWrite (Gate3[i].Chan[2].CompB[27:26]).
This is a 2-bit register, where the lower bit is write enable and the higher bit is the preset value of a CompOut signal.
CompOutWrite is always enabled regardless of CompareEnable.
CompOut (Gate3[i].Chan[3].CompB [31]) allows you to check the status of a comparison output.

The following shows examples of operation of the TCR output function.



*1. Writing from CPU Unit
*2. Capturing by CK3W-GC Unit
*3. The CK3W-GC Unit performs a linear interpolation so that the captured command distance may be reached at the rising edge of the interpolation clock after next.
*4. CompClockSel = 0: Servo clock
CompClockSel = 1: Phase clock
*5. Command distance after linear interpolation

3-7-10 Software Settings

Use the following register settings for the software settings of the Laser Interface Unit.

The register settings here are different from the definitions descried in the *Power PMAC Software Reference Manual (Cat. No. O015)*.
Refer to *A-9 Software Reference of Laser Interface Unit* on page A-33 for detailed specifications.

XY2-100 Interface	
Power PMAC Saved Data Structure Elements	
Gate3[i].SerialEncCtrl	Control register
Power PMAC Non-Saved Data Structure Elements	
Gate3[i].Chan[0].Dac[0]	X-axis command position
Gate3[i].Chan[1].Dac[0]	Y-axis command position
Gate3[i].Chan[2].Dac[0]	Z-axis command position
Gate3[i].Chan[0].Dac[1]	X-axis compensation value
Gate3[i].Chan[1].Dac[1]	Y-axis compensation value
Gate3[i].Chan[2].Dac[1]	Z-axis compensation value
Power PMAC Status Data Structure Elements	
Gate3[i].Chan[0].SerialEncDataA	X-axis command position after interpolation
Gate3[i].Chan[1].SerialEncDataA	Y-axis command position after interpolation
Gate3[i].Chan[2].SerialEncDataA	Z-axis command position after interpolation
Gate3[i].Chan[0].SerialEncDataB	XY-axis status
Gate3[i].Chan[2].SerialEncDataB	Z-axis status
SL2-100 Interface	
Power PMAC Saved Data Structure Elements	
Gate3[i].SerialEncCtrl	Control register
Power PMAC Non-Saved Data Structure Elements	
Gate3[i].Chan[0].Dac[0]	X-axis command position
Gate3[i].Chan[1].Dac[0]	Y-axis command position
Gate3[i].Chan[2].Dac[0]	Z-axis command position
Gate3[i].Chan[0].Dac[1]	X-axis compensation value
Gate3[i].Chan[1].Dac[1]	Y-axis compensation value
Gate3[i].Chan[2].Dac[1]	Z-axis compensation value
Power PMAC Status Data Structure Elements	
Gate3[i].Chan[0].SerialEncDataA	X-axis reception data
Gate3[i].Chan[1].SerialEncDataA	Y-axis reception data
Gate3[i].Chan[2].SerialEncDataA	Z-axis reception data
Gate3[i].Chan[0].SerialEncDataB	X-axis status
Gate3[i].Chan[1].SerialEncDataB	Y-axis status
Gate3[i].Chan[2].SerialEncDataB	Z-axis status
PWM output	
Power PMAC Saved Data Structure Elements	
Gate3[i].SerialEncCtrl	Control register
Power PMAC Non-Saved Data Structure Elements	
Gate3[i].Chan[0].CompA	PWM setting
Gate3[i].Chan[1].CompA	Delay setting
Gate3[i].Chan[2].CompA	Pulse count
TCR output	
Power PMAC Non-Saved Data Structure Elements	
Gate3[i].Chan[0].CompB	Command distance

	Gate3[i].Chan[1].CompB	Comparison table setting
	Gate3[i].Chan[2].CompB	Control register
	Gate3[i].Chan[3].CompB	Status register
Internal memory error detection		
Power PMAC Status Data Structure Elements		
	Gate3[i].Chan[0].Status	Internal memory error detection

Precautions for Correct Use

- Make sure that the following settings of the CK3W-GC Unit are the same as those of the supply-source Unit of servo clocks and phase clocks.
  Gate3[i].PhaseFreq
  Gate3[i].ServoClockDiv
  Furthermore, in order to match internal phase clocks with external phase clocks, the CK3W-GC Unit and the clock supply-source Unit should have the following setting.
  Gate3[i].PhaseClockDiv = 0
  Gate3[i].PhaseClockMult = 0
  If they have a different setting, the Galvo Scanner and the TCR function may not operate as intended.
- When you use EtherCAT on the system equipped with the CK3W-GC Unit, select **Bus Shift (Reference Clock controlled by EtherCAT Master Time)** for the Distributed Clock setting of EtherCAT.
  If you select **Master Shift (EtherCAT Master Time controlled by Reference Clock)**, the Galvo Scanner and the TCR function may not operate as intended.

3-8 Expansion Master Unit and Expansion Slave Unit

This section describes the Expansion Master Unit and the Expansion Slave Unit.

3-8-1 Models and Specifications

Models and Outline of Specifications

The models and outline of specifications are given below.

Unit type	Model
Expansion Master Unit	CK3W-EXM01
Expansion Slave Unit	CK5W-EXS01*1
	CK3W-EXS02

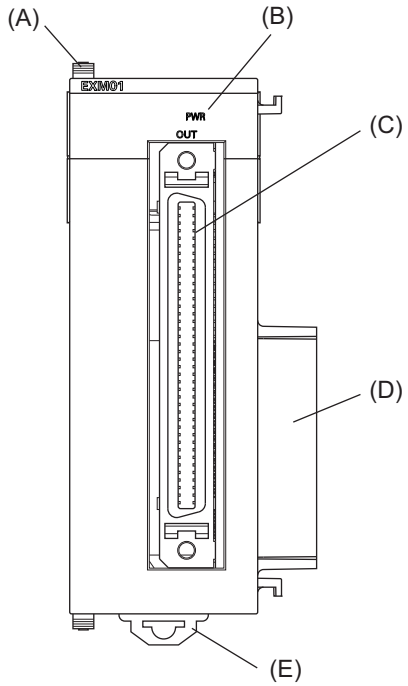
*1. The CK5W-EXS01 can only be used with the CK5M CPU Unit. It can not be used with the CK3M CPU Unit.

Specifications

Expansion cable	For connection between the Expansion Master Unit and the Expansion Slave Unit, be sure to use the following cable. CK3W-CAX003A (0.3 m)
Power consumption	CK3W-EXM01: 5 V 0.4 W max. CK5W-EXS01: 5 V 0.2 W max. CK3W-EXS02: 5 V 0.2 W max.
Dimensions (height × depth × width)	CK3W-EXM01/-EXS02: 90(H)/80(D)/31.6(W) CK5W-EXS01: 90(H)/80(D)/63.2(W)
Weight	CK3W-EXM01: 100 g max. CK5W-EXS01: 220 g max. (including End Cover) CK3W-EXS02: 130 g max. (including End Cover)

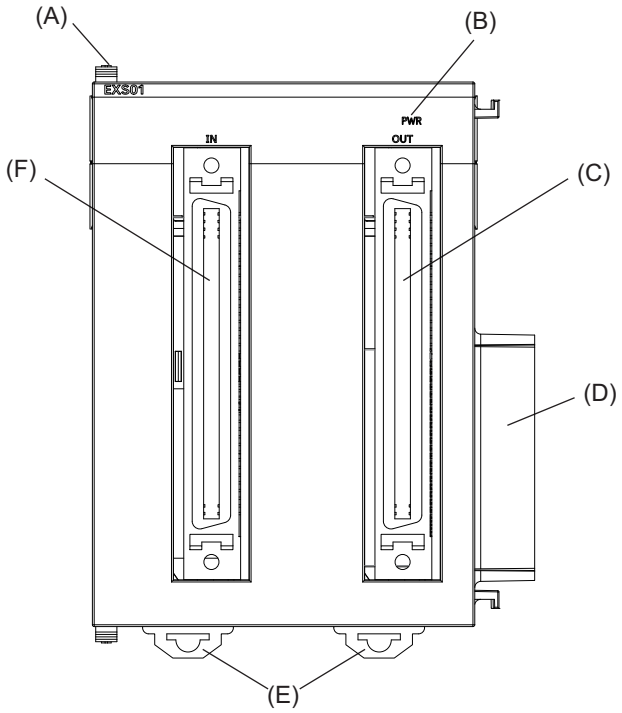
3-8-2 Part Names and Functions

CK3W-EXM01



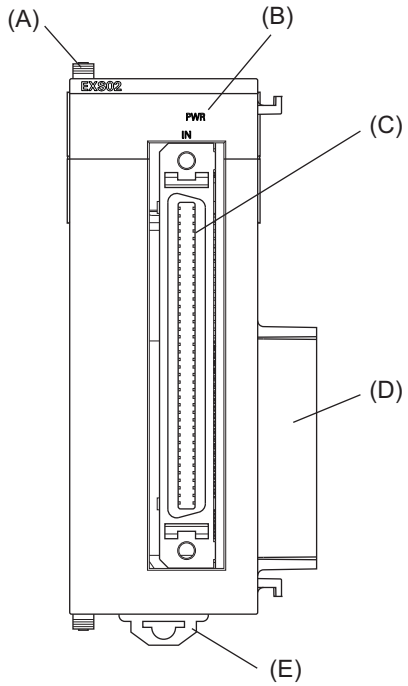
Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Expansion connector (OUT)	Connector that connects to the expansion connector (IN) on the Expansion Slave Unit.
D	Unit connector	Connector that connects to the Unit.
E	DIN Track mounting hook	Used to mount the Unit to a DIN Track.

CK5W-EXS01



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Expansion connector (OUT)	Connector that connects to the expansion connector (IN) on the Expansion Slave Unit.
D	Unit connector	Connector that connects to the Unit.
E	DIN Track mounting hook	Used to mount the Unit to a DIN Track.
F	Expansion connector (IN)	Connector that connects to the expansion connector (OUT) on the Expansion Master Unit or the Expansion Slave Unit.

CK3W-EXS02



Letter	Name	Function
A	Slider	Holds the Units together.
B	Power supply status indicator	Shows the power supply status.
C	Expansion connector (IN)	Connector that connects to the expansion connector (OUT) on the Expansion Master Unit or the Expansion Slave Unit.
D	Unit connector	Connector that connects to the Unit.
E	DIN Track mounting hook	Used to mount the Unit to a DIN Track.

3-8-3 Operation Indicators

Each LED indicator shows the unit operating status of the Expansion Master Unit or Expansion Slave Unit.

The operating statuses corresponding to the colors and statuses of the indicators are shown below.

Indicator name	Color	Status	Description
PWR	Green	ON	Power is supplied.
		OFF	Power is not being supplied.

3-8-4 System Configuration

You can use the Expansion Master Unit and the Expansion Slave Unit to connect an Expansion Rack to the CPU Unit.

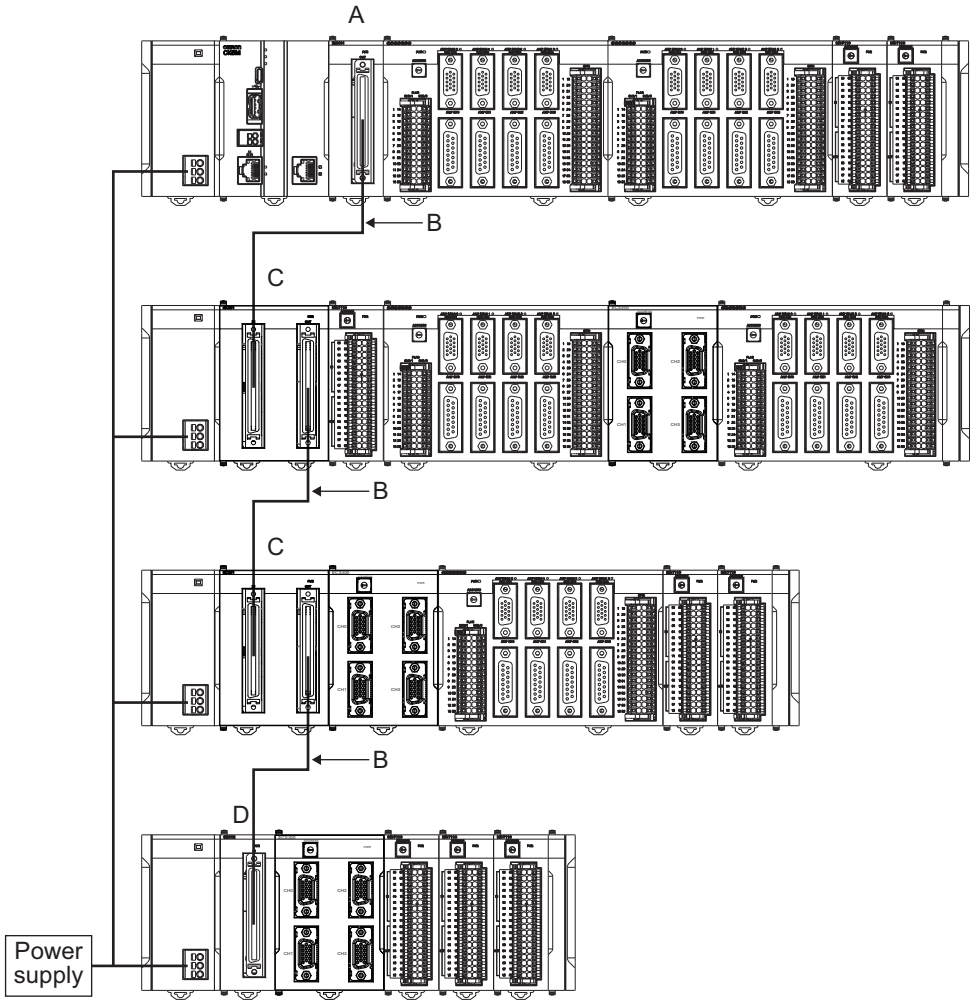
Up to one Expansion Rack can be added for the CK3M CPU Unit, and up to three Expansion Racks can be added for the CK5M CPU Unit.

Up to four CK3W Units (or up to two CK3W-AX Units) can be installed to the Expansion Rack.

Connect the Expansion Master Unit to the immediate right side of the CPU Unit. Connect the Expansion Slave Unit to the immediate right side of the Power Supply Unit.

Use the CK3W-EXS02 for the Expansion Slave Unit farthest from the CPU Rack, and the CK5W-EXS01 for the Expansion Slave Unit located in the middle.
The CK5W-EXS01 can only be used with the CK5M CPU Unit. It can not be used with the CK3M CPU Unit.

● For CK5M CPU Unit



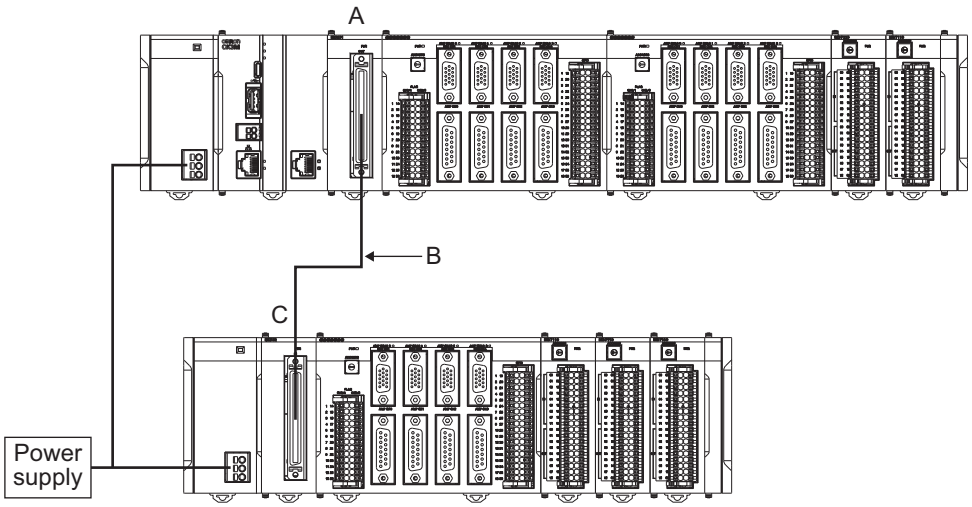
Letter	Name	Model
A	Expansion Master Unit	CK3W-EXM01
B	Expansion cable	CK3W-CAX003A
C	Expansion Slave Unit	CK5W-EXS01*1
D	Expansion Slave Unit	CK3W-EXS02

*1. The CK5W-EXS01 can only be used with the CK5M CPU Unit. It can not be used with the CK3M CPU Unit.

Precautions for Correct Use

Use the CK3W-EXS02 for the Expansion Slave Unit farthest from the CPU Rack.
When the CK5W-EXS01 is used, the signal becomes unstable, which may cause a malfunction.

● For CK3M CPU Unit



Letter	Name	Model
A	Expansion Master Unit	CK3W-EXM01
B	Expansion cable	CK3W-CAX003A
C	Expansion Slave Unit	CK3W-EXS02

4

Installation

This section describes precautions for installation and installation location of the CK3M/CK5M-series Programmable Multi-Axis Controller.

4-1 Processing at Power ON and Power OFF 4-2
4-1-1 Power ON Operation 4-2
4-1-2 Power OFF Operation 4-2
4-2 Fail-safe Circuits 4-4
4-3 Unit Installation 4-6
4-3-1 Installation in a Control Panel 4-6
4-3-2 Connection Between Units 4-10
4-3-3 Mounting to DIN Track 4-11
4-3-4 DIN Track and Accessories 4-13
4-3-5 Assembled Appearance and Dimensions 4-14
4-4 Control Panel Installation 4-20
4-4-1 Temperature 4-20
4-4-2 Humidity 4-21
4-4-3 Vibration and Shock 4-22
4-4-4 Atmosphere 4-22
4-4-5 Electrical Environment 4-22
4-4-6 Grounding 4-27

4-1 Processing at Power ON and Power OFF

4-1-1 Power ON Operation

Once the power supply to the Power Supply Unit starts, the Motion Controller enters the program operation ready status after the following time elapses.
In addition, when the Unit is in the operation-ready status, the RDY LED lights up.

● CPU Unit Startup Time at Power ON

A CK5M CPU Unit starts up in approximately 20 to 40 seconds and a CK3M CPU Unit starts up in 40 to 60 seconds.
Since the startup time is affected by the slave/unit configuration, confirm it on an actual device.

4-1-2 Power OFF Operation

This section describes how to perform the power OFF operation if a user program attempts to write data to the USB memory, or if the user program is to be downloaded to the built-in flash memory.

Writing to the USB Memory

If the power is interrupted while a user program is writing data to the USB memory, the data may be corrupted.
Confirm that no data is being written before you turn OFF the power supply.

Downloading to the Built-In Flash Memory

When you download a user program from the Power PMAC IDE, the data is once stored in the CPU cache before it is saved into the CPU Unit.
This means that, if you turn OFF the power supply immediately after starting the save operation, the CPU Unit cannot complete the transfer of the data from the cache to the built-in flash memory, which may result in a save operation failure or corruption of the saved data.

If the data is corrupted, issue a re-initialization command ($$$***) from the Power PMAC IDE, and download the program again.
If the CPU Unit fails to connect to the Power PMAC IDE, refer to *6-3-3 Initialization of CPU Unit Using USB Memory* on page 6-9 and implement initialization.

● Procedure to Download to the Built-in Flash Memory

Use the following procedure to download the user program to the built-in flash memory.
The procedure can be used for any firmware revision of the PMAC firmware.

1 Download the user program from the Power PMAC IDE.

2 At the Power PMAC IDE terminal, execute the **save** command.

3 Establish an SSH connection, and execute the **sync** command from the terminal that you connected to.

4 Wait for at least 5 seconds and turn OFF the power supply.

● Procedure to Download to the Built-in Flash Memory (Version 2.5 or Later)

For PMAC firmware revision version 2.5 or later, you can also use the following procedure to store the user program into the built-in flash memory.

1 Download the user program from the Power PMAC IDE.

2 At the Power PMAC IDE terminal, enter **Sys.SyncSave=1**.

3 At the Power PMAC IDE terminal, execute the **save** command.
Wait until the save completed notification is displayed on the Power PMAC IDE.

4 At the Power PMAC IDE terminal, enter **Sys.SyncSave=0**.

5 Wait for at least 5 seconds and turn OFF the power supply.

4-2 Fail-safe Circuits

⚠ WARNING

Provide safety measures in external circuits to ensure safety in the system if an abnormality occurs due to malfunction of the system due to other external factors affecting operation. Not doing so may result in serious accidents due to incorrect operation.

- Emergency stop circuits, interlock circuits, limit circuits, and similar safety measures must be provided in external control circuits.
- You must take fail-safe measures to ensure safety in the event of incorrect, missing, or abnormal signals caused by broken signal lines, momentary power interruptions, or other causes.
- The use of an Uninterruptible Power Supply (UPS) allows normal operation to continue even if a momentary power interruption occurs, possibly resulting in the reception of an erroneous signal from an external device affected by the momentary power failure. Take external fail-safe measures. Where necessary, monitor the power supply voltage on the system for external devices and use it as an interlock condition.
- Unintended behavior may occur if an error occurs in the internal memory of the product. As a countermeasure for these problems, external safety measures must be provided to ensure safe operation of the system.
- The Controller will turn OFF all outputs from Output Units in the following cases. The slaves will operate according to the settings in the slaves.
  a) If a power supply error occurs
  b) If the power supply connection becomes faulty
  c) If a CPU Unit error (watchdog timer error) or CPU Unit reset occurs
  d) If a major fault level Controller error occurs
  e) While the Controller is on standby until RUN mode is entered after the power is turned ON
  f) If a system initialization error occurs

As a countermeasure for these problems, external safety measures must be provided to ensure safe operation of the system.

- The outputs may remain ON or OFF due to welding or burning of the output relays or destruction of the output transistors. As a countermeasure for these problems, external safety measures must be provided to ensure safe operation of the system.
- To ensure safe use of the Controller, correctly make the limit settings for the position, speed, acceleration, jerk, current, and following error, as well as the encoder loss detection.
- For devices that move in a vertical direction, use a motor brake to prevent them from falling down when the servo control is stopped.

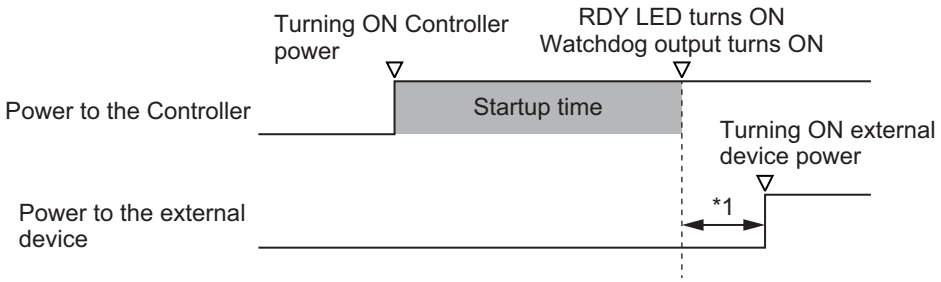
Power-on Order

If the power to the external device is turned ON before the start of the Controller is completed, DA output or pulse output may be output momentarily during the startup of the Controller, and the external device may malfunction.

To avoid malfunction of the external device, configure the external circuit so that the power of the external device is turned ON after waiting for 2 seconds or more after the start of the Controller is completed.

A CK5M CPU Unit starts up in approximately 20 to 40 seconds and a CK3M CPU Unit starts up in 40 to 60 seconds.

The Controller startup time varies depending on the slave and unit configuration, so check with the device to be used and take sufficient margin for the waiting time for turning ON the power to the external device.



*1. After starting the Controller, wait at least 2 seconds before turning ON the power to the external device. Take sufficient margin for the wait time.

4-3 Unit Installation

This section describes the installation of the CK□M-series Unit.

Precautions for Safe Use

Always turn OFF the power supply to the Controller before attempting any of the following.
- Attaching or removing the Units
- Assembling the Units
- Setting rotary switches
- Connecting cables or wiring the system
- Connecting or disconnecting the terminal blocks or connectors.

The built-in power supply of the CPU Unit may continue to supply power after the power supply is turned OFF. The POWER indicator remains lit as long as power is supplied. Make sure that the POWER indicator is not lit before you perform any of the above operations.

Precautions for Correct Use

- Follow the instructions in this manual to correctly perform installation.
- Do not operate or store the Units in the following locations. Doing so may result in burning, in operation stopping, or in malfunction.
  a) Locations subject to direct sunlight
  b) Locations subject to temperatures or humidity outside the range specified in the specifications
  c) Locations subject to condensation as the result of severe changes in temperature
  d) Locations subject to corrosive or flammable gases
  e) Locations subject to dust (especially iron dust) or salts
  f) Locations subject to exposure to water, oil, or chemicals
  g) Locations subject to shock or vibration
- Take appropriate and sufficient countermeasures if the Units are installed in the following locations.
  a) Locations subject to strong, high-frequency noise
  b) Locations subject to static electricity or other forms of noise
  c) Locations subject to strong electromagnetic fields
  d) Locations subject to possible exposure to radioactivity
  e) Locations close to power lines

4-3-1 Installation in a Control Panel

Installation in Cabinets or Control Panels

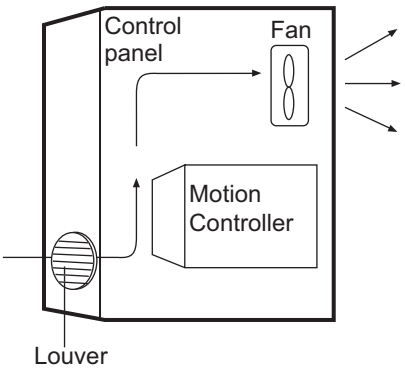
Please consider operability, maintainability, and environmental resistance when installing the CK□M-series Units in the cabinet or the control panel.

● Consideration for Ambient Temperature

The operating ambient temperature of the CK□M-series Controller must be within the range from 0 to 55 °C.

When necessary, take the following measures to maintain the proper temperature.
- Provide enough space for good air flow.
- Do not install the Controller above equipment that generates a large amount of heat such as heaters, transformers, or high-capacity resistors.

- If the ambient temperature exceeds 55 °C, install a cooling fan or air conditioner.

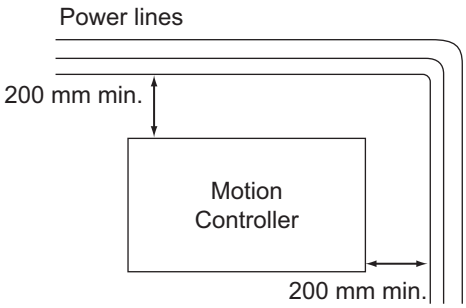


● Accessibility for Operation and Maintenance

- To ensure safe access for operation and maintenance, separate the Controller as much as possible from high-voltage equipment and power machinery.
- It will be easy to operate the Controller if it is mounted at a height of 1.0 to 1.6 m above the floor.

● Improving Noise Resistance

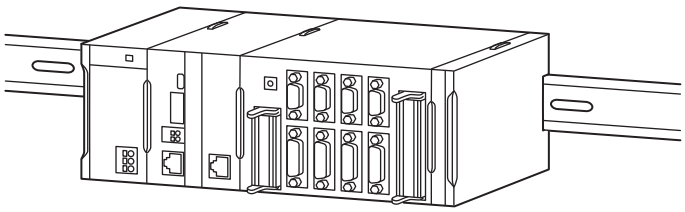
- Do not mount the Controller in a control panel containing high-voltage equipment.
- Install the Controller at least 200 mm away from power lines.



- Ground the mounting plate between the Controller and the mounting surface.

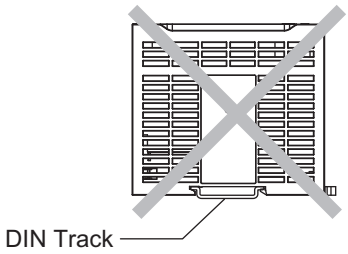
● Controller Orientation

- Each Rack must be mounted in the following position to provide proper cooling. This position is called an upright position.

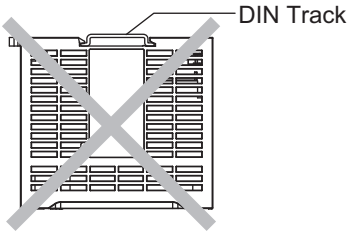


- Do not install a Rack in any of the following positions.

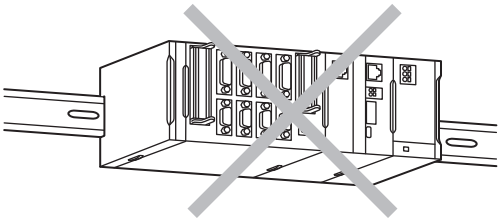
Mounting with the DIN Track on the Bottom



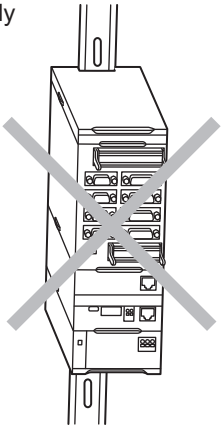
Mounting with the DIN Track on the Top



Mounting with the Rack Upside Down



Mounting with the DIN Track Installed Vertically

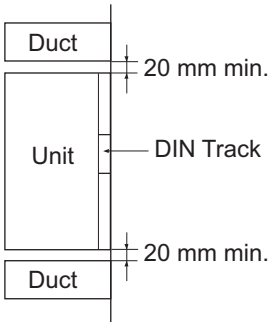


Additional Information

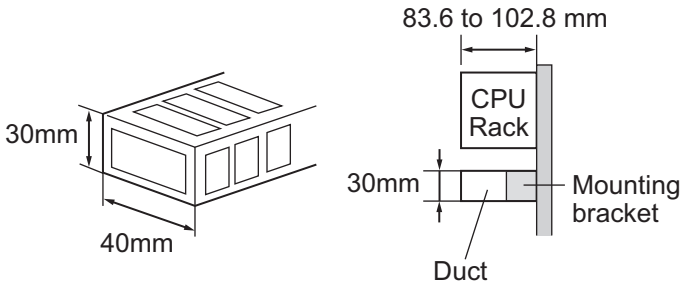
A Controller must be mounted on a DIN Track. It cannot be mounted with screws.

● Wiring Ducts

Whenever possible, route I/O wiring through wiring ducts.
Install mounting bracket so that it is easy to fish wire through the duct. It is handy to have the duct at the same height as the CPU Rack.

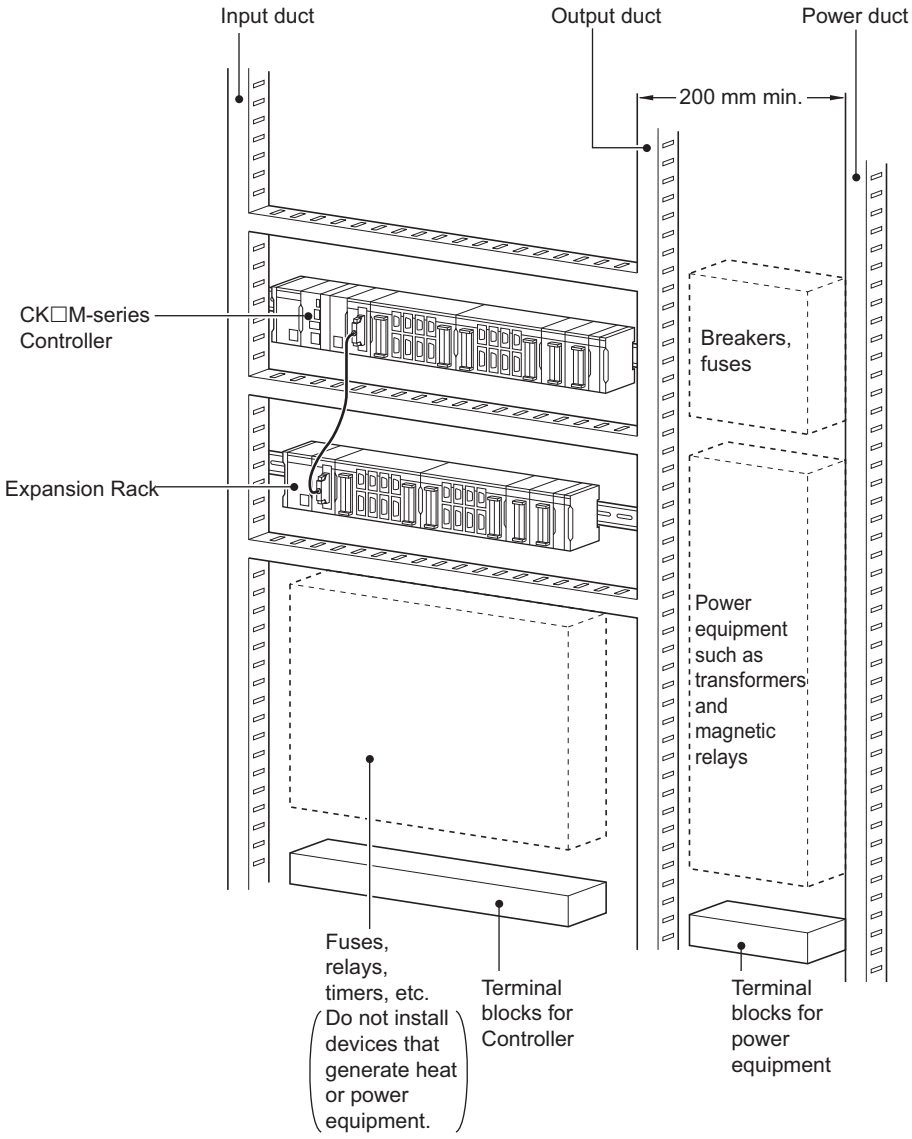


● Wiring Duct Example



● Routing Wiring Ducts

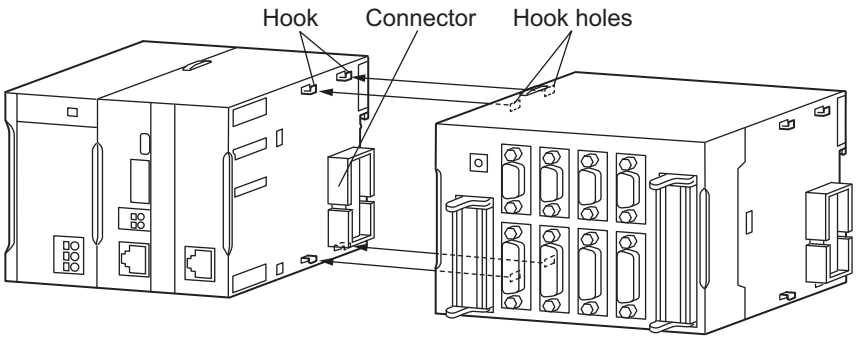
Install the wiring ducts at least 20 mm away from the tops of the Rack and any other objects (e.g., ceiling, wiring ducts, structural supports, devices, etc.) to provide enough space for air circulation and replacement of Units.



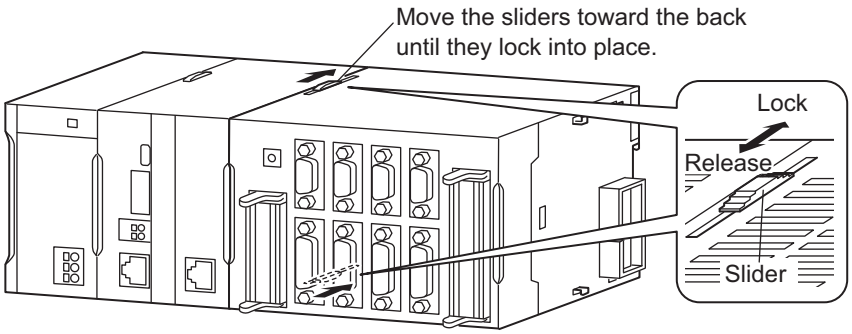
4-3-2 Connection Between Units

The Units that make up a CK3M-series Controller can be connected simply by pressing the Units together and locking the sliders by moving them toward the back of the Units. The End Cover is connected in the same way to the Unit on the far right side of the Controller.

1 Join the Units so that the connectors fit exactly.



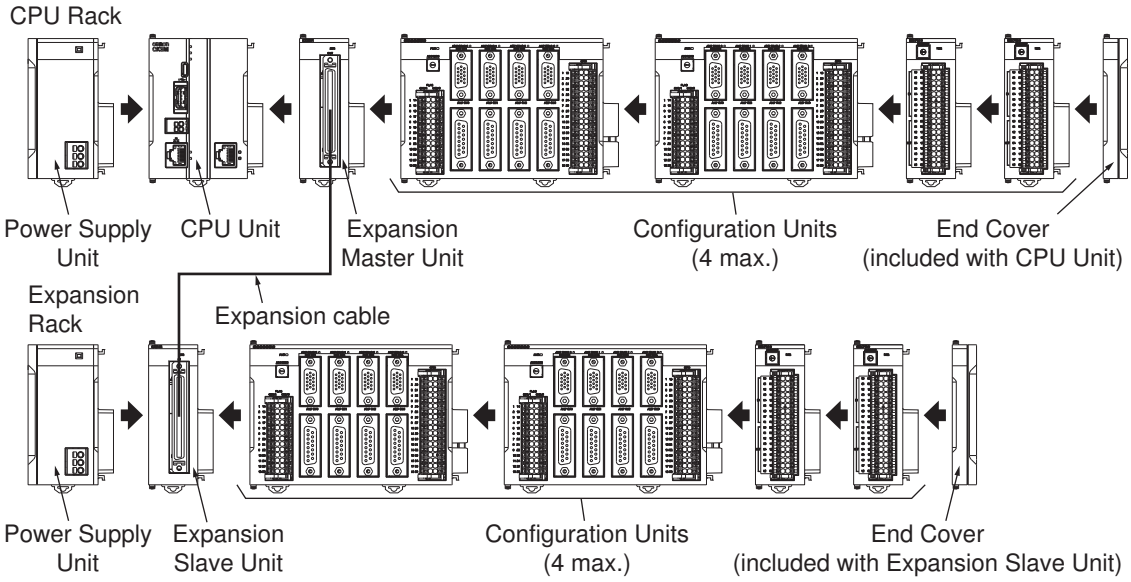
2 The yellow sliders at the top and bottom of each Unit lock the Units together. Move the sliders toward the back of the Units as shown below until they click into place.



Precautions for Safe Use

The sliders on the top and bottom of the CK□W Unit must be completely locked (until they click into place) after connecting the adjacent Unit connectors.

3 Attach the End Cover to the Unit on the far right side of the Rack.



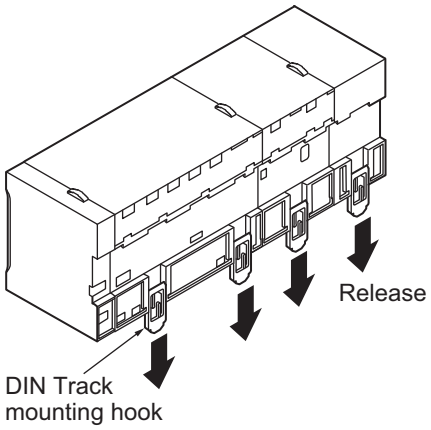
Precautions for Correct Use

- Always turn OFF the power supply before connecting Units to each other.
- During maintenance, always turn OFF the power supply to the entire system before replacing a Unit.
- You can connect up to four CK3W Units (or up to two CK3W-AX Units) to each of the CPU Rack and Expansion Rack. If you connect more than that number, the *Sys.CK3WConfigErr Flag* goes ON.
  Operation will continue even with the *Sys.CK3WConfigErr Flag* ON.

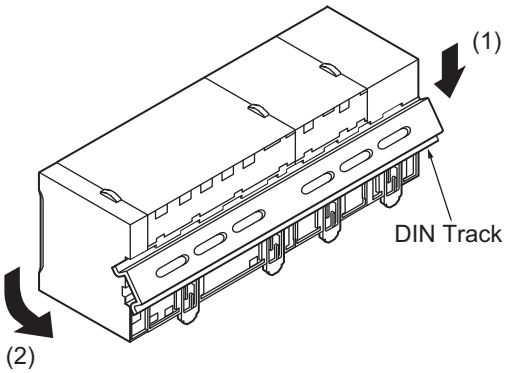
4-3-3 Mounting to DIN Track

Mount the CK□M-series Controller on the DIN Track.

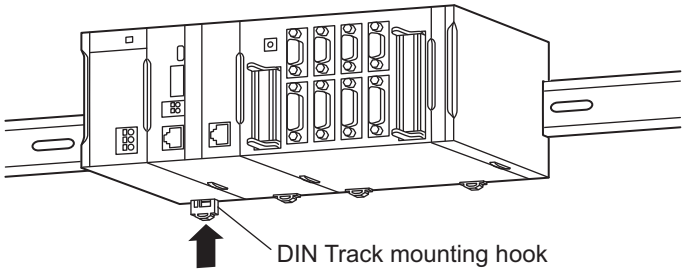
1 Release the DIN Track mounting hooks on the backs of the Units.



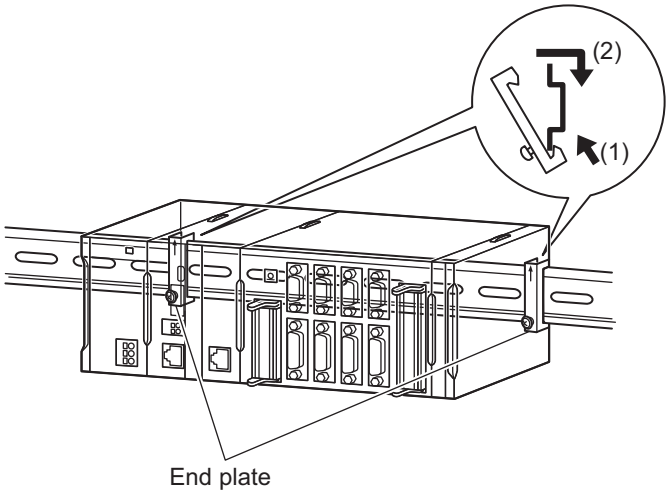
2 To mount, hook on the DIN Track from above (1), and insert into the back (2).



3 Lock all the DIN Track mounting hooks.



4 Install a DIN Track End Plate on each end of the Controller.
To mount an End Plate, hook from the underside (1), hook to the upper side, and then pull downward (2).
Then tighten the screw to lock the End Plate in place.



Precautions for Safe Use

Always turn OFF the power supply to the Controller before attempting any of the following.
- Mounting or removing the Units.
- Assembling the Units.
- Setting rotary switches.
- Connecting cables or wiring the system.
- Connecting or disconnecting the terminal blocks or connectors.

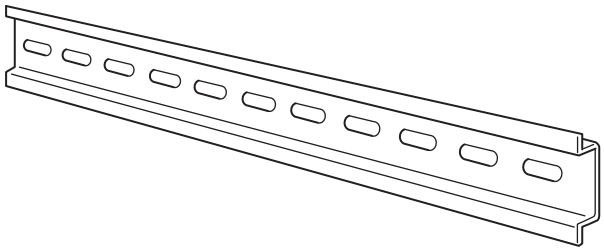
Additional Information

To remove Units, perform the steps above in reverse order.

4-3-4 DIN Track and Accessories

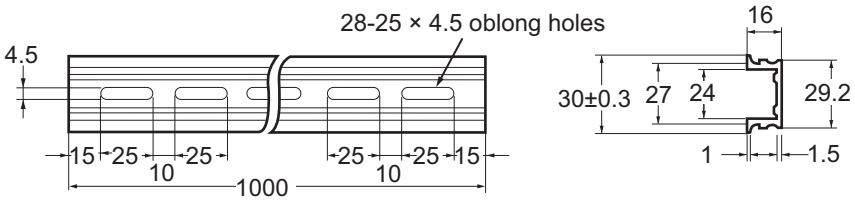
Mount the CK□M-series Controller on the DIN Track.
Secure each DIN Track inside a control panel with at least three screws.

DIN Tracks

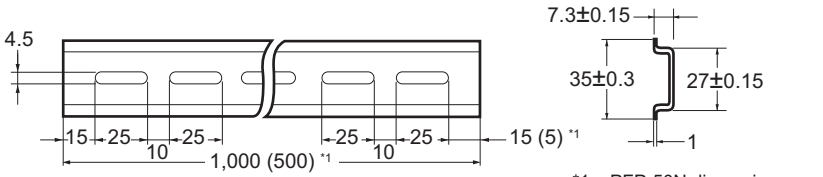


Secure the DIN Track to the control panel using M4 screws separated by 210 mm (3 holes) or less and using at least 3 screws. The tightening torque is 1.2 N·m.

- **PFP-100N2**



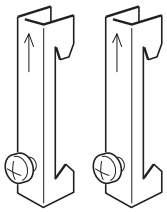
- **PFP-100N/50N**



*1. PFP-50N dimensions are given in parentheses.

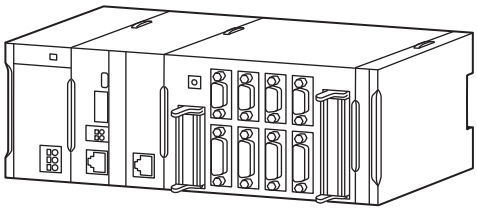
DIN Track End Plates

PFP-M (2 required)



4-3-5 Assembled Appearance and Dimensions

The figure below shows the CK□M-series Units connected to each other. An End Cover is connected to the right end.



Dimensions

● Power Supply Unit

Model	Unit width (mm)
CK3W-PD048	45

● CPU Unit

Model	Unit width (mm)
CK5M-CPU131	63.2
CK5M-CPU141	
CK3M-CPU101	
CK3M-CPU111	
CK3M-CPU121	

● End Cover

Model	Unit width (mm)
CK3W-TER11	15.6

● Axis Interface Unit

Model	Unit width (mm)
CK3W-AX1313N	130
CK3W-AX1414N	
CK3W-AX1515N	
CK3W-AX2323N	
CK3W-AX1313P	
CK3W-AX1414P	
CK3W-AX1515P	
CK3W-AX2323P	

● Digital I/O Unit and Analog Input Unit

Model	Unit width (mm)
CK3W-MD7110	31.6
CK3W-MD7120	
CK3W-AD2100	
CK3W-AD3100	

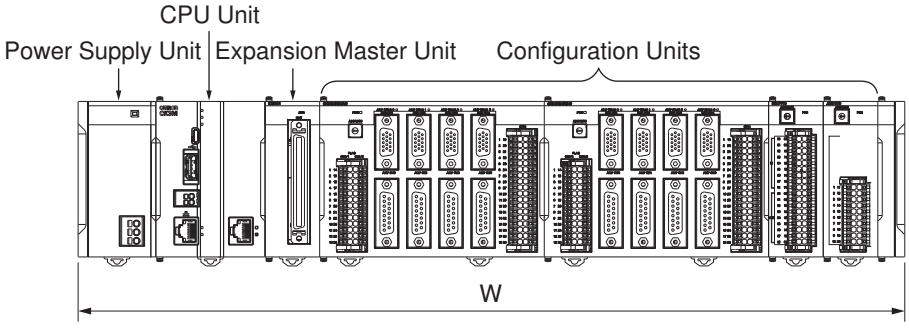
● Encoder Input Unit and Laser Interface Unit

Model	Unit width (mm)
CK3W-ECS300	63.2
CK3W-GC1100	
CK3W-GC1200	
CK3W-GC2100	
CK3W-GC2200	

● Expansion Master Unit and Expansion Slave Unit

Model	Unit width (mm)
CK3W-EXM01	31.6
CK5W-EXS01	63.2
CK3W-EXS02	31.6

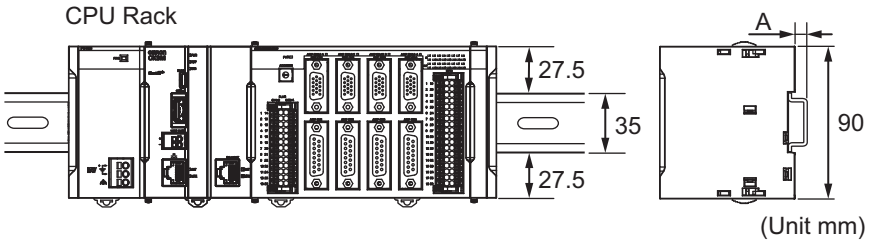
● Design Example for Width W



Name	Model	Unit width (mm)	Qty	Subtotal unit width (mm)
Power Supply Unit	CK3W-PD048	45	1	45
CPU Unit	CK3M-CPU101	63.2	1	63.2

Name	Model	Unit width (mm)	Qty	Subtotal unit width (mm)
Expansion Master Unit	CK3W-EXM01	31.6	1	31.6
Axis Interface Unit	CK3W-AX1414N	130	2	260
Digital I/O Unit	CK3W-MD7110	31.6	1	31.6
Analog Input Unit	CK3W-AD2100	31.6	1	31.6
End Cover	CK3W-TER11	15.6	1	15.6
Total W = 45 + 63.2 + 31.6 + 130 × 2 + 31.6 + 31.6 + 15.6				478.6

Installation Dimensions

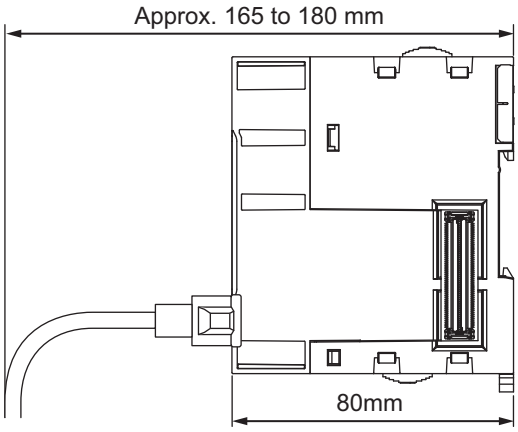


DIN Track	A (mm)
PFP-100N2	16
PFP-100N	7.3
PFP-50N	7.3

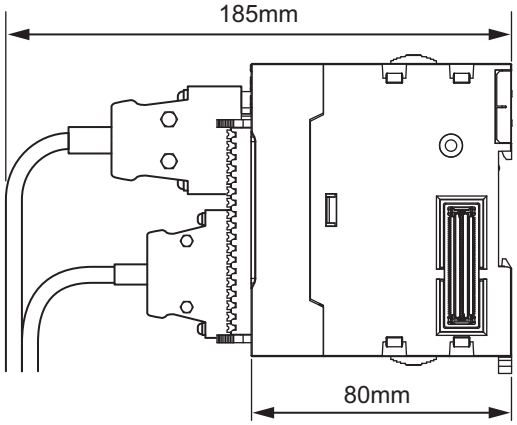
Installation Height

The mounting height of the CK□M-series Controller is 80.0 mm.
When cables are connected (such as a connecting cable to Support Software, an encoder connection cable, or an amplifier connection cable, etc.), however, even greater height is required. Allow sufficient depth in the control panel containing the Controller.

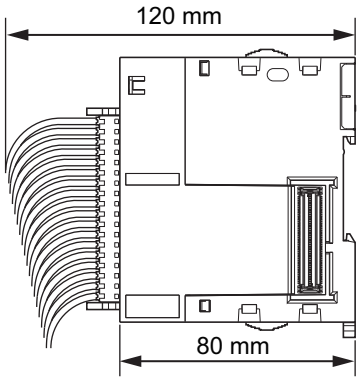
● CK□M-series CPU Unit



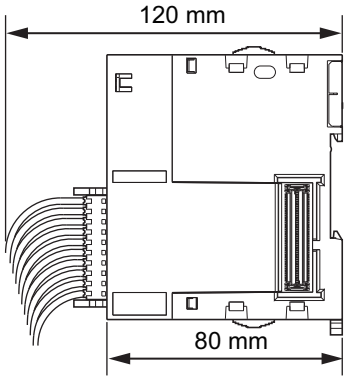
● CK3W-AX Unit



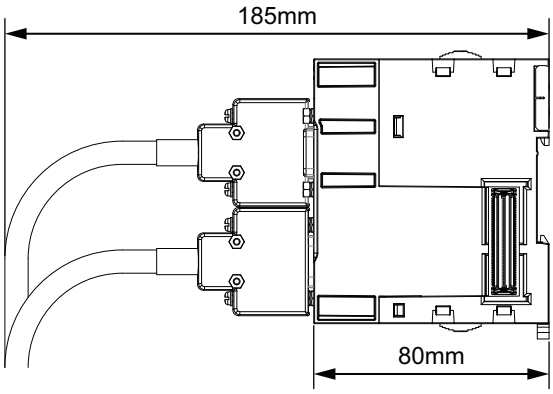
● CK3W-MD Unit



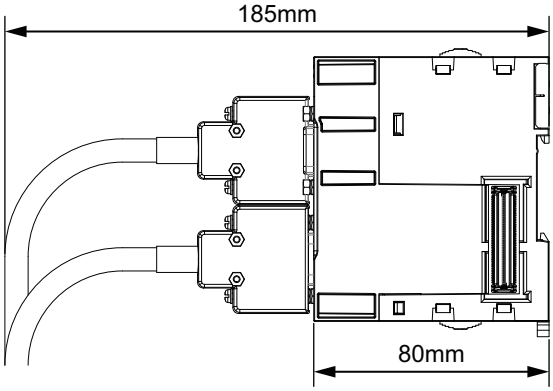
● CK3W-AD Unit



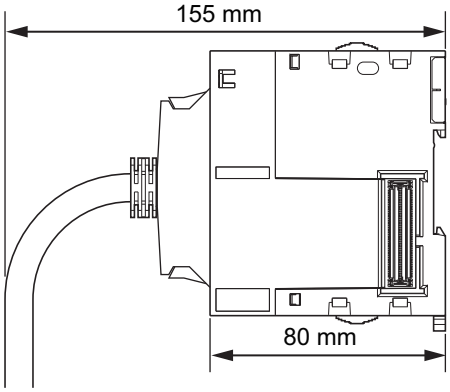
● **CK3W-ECS Unit**



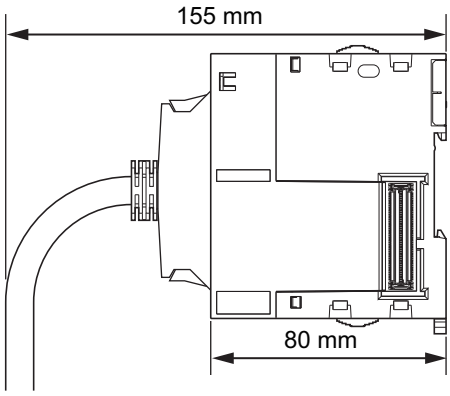
● **CK3W-GC Unit**



● **CK3W-EXM01 and CK3W-EXS02**



● **CK5W-EXS01**



4-4 Control Panel Installation

To ensure system reliability and safety, the system must be designed and configured according to the installation environment (temperature, humidity, vibration, shock, corrosive gases, overcurrent, noise, etc.).

4-4-1 Temperature

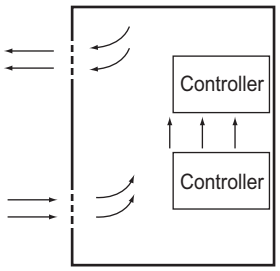
Panels have been reduced in size due to space-saving and miniaturization in devices and systems, and the temperature inside the panel may be at least 10 to 15°C higher than outside the panel. Implement the following measures against overheating at the installation site and in the panel, and allow a sufficient margin for the temperature before use.

High Temperatures

Use the following cooling methods as required, taking into account the ambient temperature and the amount of heating inside the panel.

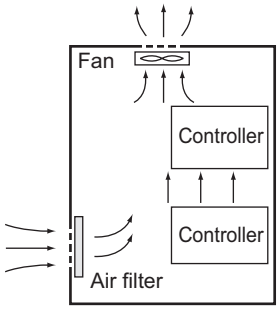
● Natural Cooling

- Natural cooling relies on natural ventilation through slits in the panel, rather than using cooling devices such as fans or coolers. When using this method, observe the following points.
- Do not install the Controller at the top of the panel, where hot air tends to stagnate.
- To provide ventilation space above and below the Controller, leave sufficient distance from other devices, wiring ducts, etc.
- Do not mount the Units in the wrong direction (e.g., vertically or upside down). Doing so may cause abnormal heating in the Controller.
- Do not install the Controller directly above any heat-generating equipment, such as heaters, transformers, and devices with high resistance.
- Do not install the Controller in a location exposed to direct sunlight.



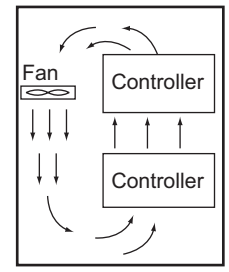
Natural Cooling

● **Forced Ventilation (by Fan at Top of Panel)**



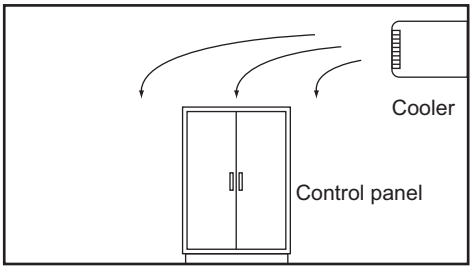
Forced Ventilation Method

● **Forced Air Circulation (by Fan in Closed Panel)**



Forced Air Circulation

● **Room Cooling (Cooling the Entire Room Where the Control Panel Is Located)**



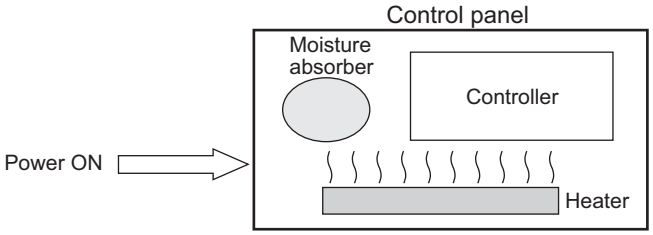
Room Cooling

Low Temperatures

The Controller may not start normally if the temperature is below 0°C when the power is turned ON. Maintain an air temperature of at least approximately 5°C inside the panel, by implementing measures such as installing a low-capacity space heater in the panel.
Alternatively, leave the Controller power ON to keep the Controller warm.

4-4-2 Humidity

Rapid temperature changes can cause condensation to occur, resulting in malfunctioning due to short-circuiting.
When there is a possibility of this occurring, take measures against condensation, such as leaving the Controller power ON at night or installing a heater in the control panel to keep it warmer.



Examples of Measures against Condensation

4-4-3 Vibration and Shock

The Controller is tested for conformity with the sine wave vibration test method (IEC 60068-2-6) and the shock test method (IEC 60068-2-27) of the Environmental Testing for Electrotechnical Products. It is designed so that malfunctioning will not occur within the specifications for vibration and shock. If, however, the Controller is to be used in a location in which it will be directly subjected to regular vibration or shock, then implement the following countermeasures:

- Separate the control panel from the source of the vibration or shock.
  Or secure the Controller and the panel with rubber padding to prevent vibration.
- Make the building or the floor vibration-resistant.
- To prevent shock when other devices in the panel such as electromagnetic contactors operate, secure either the source of the shock or the Controller with rubber padding.

4-4-4 Atmosphere

Using the Controller in any of the following locations can cause defective contact with connectors and corrosion of components. Implement countermeasures such as purging the air as required.

- In locations exposed to dust, dirt, salt, metal powder, soot, or organic solvents, use a panel with an airtight structure. Be careful of temperature increases inside the panel.
- In locations exposed to corrosive gas, purge the air inside the panel to clear the gas and then pressurize the inside of the panel to prevent gas from entering from outside.
- In locations where flammable gas is present, either use an explosion-protected construction or do not use the Controller.

4-4-5 Electrical Environment

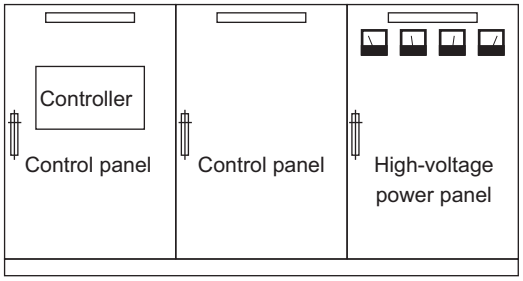
When installing or wiring devices, make sure that there will be no danger to people and that noise will not interfere with electrical signals.

Controller Installation Location

Install separately the Controller from high-voltage (600 V or higher) and power devices to ensure safe operation and maintenance. Install the Controller as far away as possible in case of unavoidable circumstances.

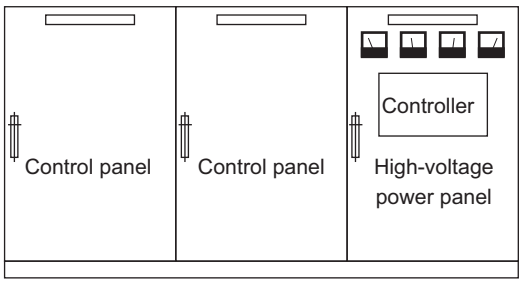
Example of Recommended Equipment Arrangement

OK



Example of Poor Equipment Arrangement

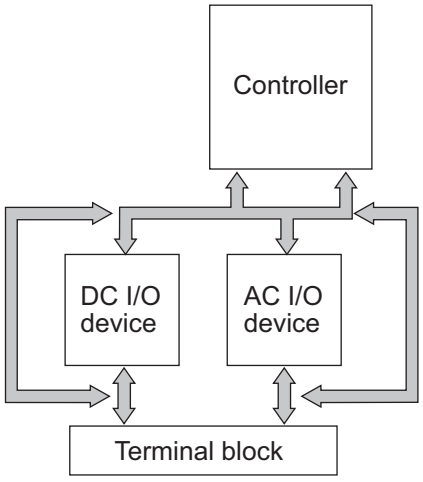
NG



Examples of Equipment Arrangement in Panel with High-voltage Devices

Arrangement of Controller and Units

The coils and contacts in electromagnetic contacts and relays in an external circuit are sources of noise. Do not install them close to the Controller. Locate them at least 100 mm away from the Controller.



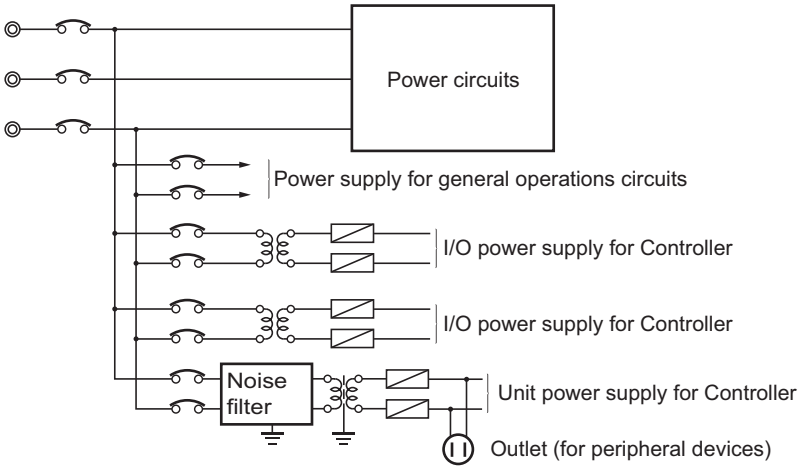
Example of Arrangement in Panel

Wire Layout for the Power Supply System

Observe the following points when wiring the power supply system.

- Separate the Controller power supply from the I/O device power supply and install a noise filter near the Controller power supply feed section.

- Use an isolating transformer to significantly reduce noise between the Controller and the ground. Install the isolating transformer between the Controller power supply and the noise filter, and do not ground the secondary coil of the transformer.
- Keep the wiring between the transformer and the Controller as short as possible, twist the wires well, and keep the wiring separate from high-voltage and power lines.

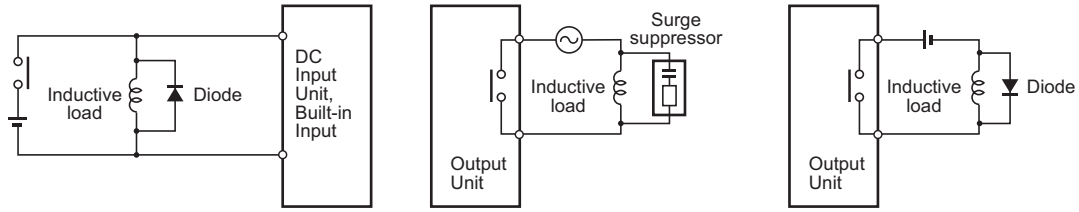


Power Supply System Diagram

Wiring External I/O Signal Lines

Observe the following points when wiring external I/O signal lines.

- To absorb reverse electromotive force when an inductive load is connected to an output signal, connect a surge suppressor near the inductive load in an AC circuit, or connect a diode near the inductive load in a DC circuit.



Connect a diode in a DC circuit.

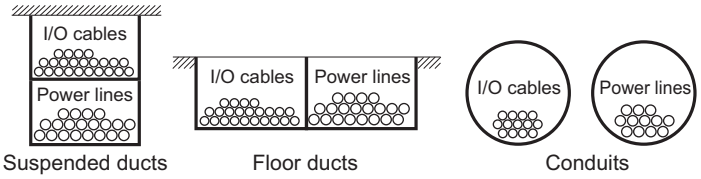
Connect a surge suppressor in an AC circuit.

Connect a diode in a DC circuit.

Input Signal Noise Countermeasures

Output Signal Noise Countermeasures

- Never bundle output signal lines with high-voltage or power lines, and do not route them in close proximity or parallel to such lines.
  If output signal lines must be routed in close proximity to such lines, place them in separate ducts or conduits. Be sure to ground the ducts or conduits.



Suspended ducts

Floor ducts

Conduits

I/O Cable Arrangement

- If the signal lines and power lines cannot be routed in separate ducts, use shielded cable. Connect the shield to the ground terminal at the Controller, and leave it unconnected at the input device.
- Wire the lines so that common impedance does not occur.
  Such wiring will increase the number of wires, so use common return circuits.
  Use thick wires with sufficient allowance for the return circuits, and bundle them with lines of the same signal level.
- For long I/O lines, wire the input and output signal lines separately.
- Use twisted-pair wires for pilot lamps (and particularly lamps with filaments).
- Use countermeasures, such as CR surge absorbers and diodes, for input device and output load device noise sources, as required.

External Wiring

Wiring, and noise countermeasures in particular, are based on experience, and it is necessary to closely manage wiring based on experience and information in the manuals.

● Wiring Routes

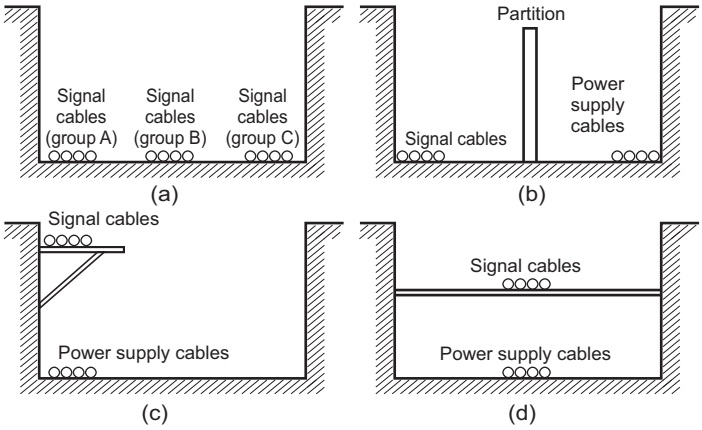
Each of the following combinations includes different signal types, properties, or levels. They will cause the signal-to-noise ratio to drop due to factors such as electrical induction. As a general rule when wiring, either use separate cables or separate wiring routes for these items. Future maintenance operations and changes to the system will also be made easier by carefully organizing the wiring from the start.

- Power lines and signal lines
- Input signals and output signals
- Analog signals and digital signals
- High-level signals and low-level signals
- Communications lines and power lines
- DC signals and AC signals
- High-frequency devices (such as Inverters) and signal lines (communications)

● Wiring

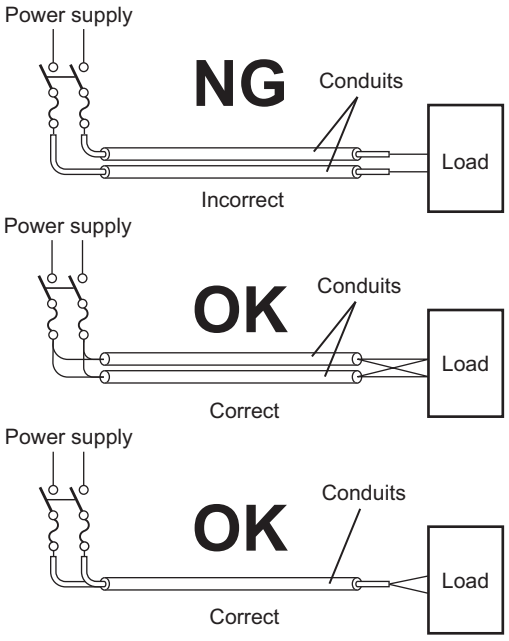
Observe the following points when wiring power supply and signal cables.

- When routing signal cables with differing characteristics through the same duct, always keep them separated.
- As much as possible, avoid routing multiple power supply lines through the same duct.
  If it cannot be avoided, then construct a partition between them in the duct and ground the partition.



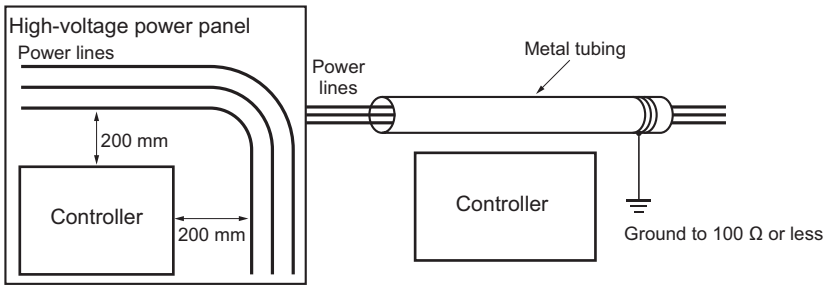
Partitioning Methods for Signal and Power Supply Cables

- To avoid overheating the conduits when using conduits for wiring, do not place wires for a single circuit in separate conduits.



Parallel Wiring (Single Phase)

- Power cables and signal cables adversely affect each other. Do not wire them in parallel.
- Noise induction may occur if the Controller is installed in a panel that includes high-voltage devices. Wire and install them as far apart as possible. (Refer to *Controller Installation Location* on page 4-22.)
- Either install the Controller a minimum of 200 mm away from high-voltage lines or power lines, or place the high-voltage lines or power lines in metal tubing and completely ground the metal tubing to 100 Ω or less.



Example: Separating Controller from Power Lines

● Other Precautions

- Digital I/O Units have both plus and minus commons, so pay attention to the polarity when wiring.

4-4-6 Grounding

This section describes the earthing methods and precautions.

Considerations for Earthing Methods

Local potential fluctuations due to lightning or noise from power devices will cause potential fluctuations between ground terminals of devices. This potential fluctuation may result in device malfunction or damage. To prevent this, it is necessary to suppress the occurrence of a difference in electrical potential between ground terminals of devices. You need to consider the earthing methods to achieve this objective

The recommended earthing methods for each usage condition are given in the following table.

Specifications of communications cables for EtherCAT and Ethernet	Earthing methods			
	Equipotential bonding system	Star earthing		Daisy Chain
		Connecting devices and noise sources to separate earth electrodes	Connecting devices and noise sources to a common earth electrode	
The cable shield connected to the connector hood at both ends of the communications cable	Recommended	Recommended	Not recommended	Not recommended

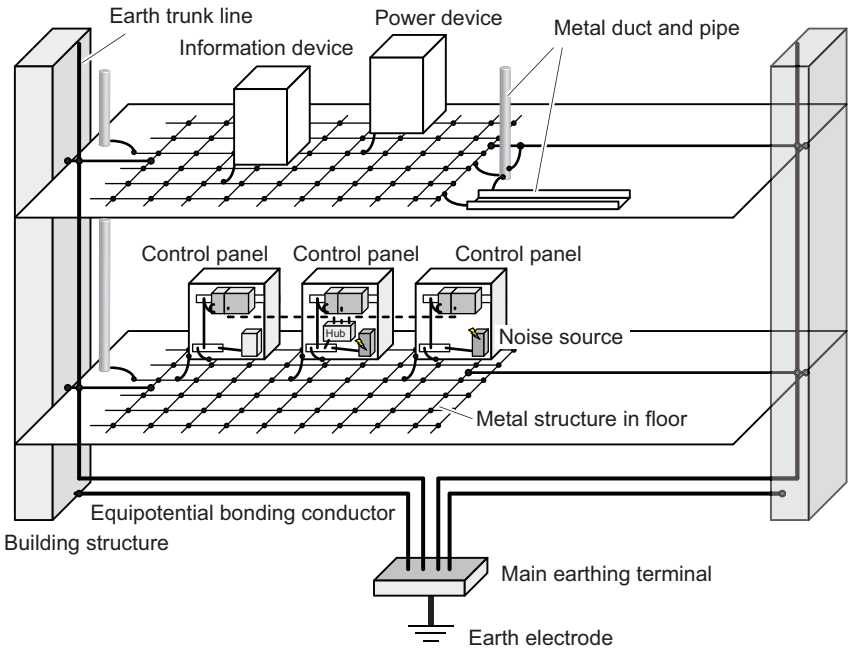
Additional Information

- In countries or regions where earthing methods are regulated, you must comply with the regulations. Refer to the applicable local and national ordinances of the place where you install the system, or other international laws and regulations.
- When using Ethernet switches, ask the Ethernet switch manufacturer for information about the environmental resistance of the Ethernet switches to be used, the grounding between Ethernet switches, and the specifications of cables.

● Equipotential Bonding System

Equipotential bonding is an earthing method in which steel frames and building structures, metal ducts and pipes, and metal structures in floors are connected together and make connections to the earth trunk line to achieve a uniform potential everywhere across the entire building. We recommend this earthing method.

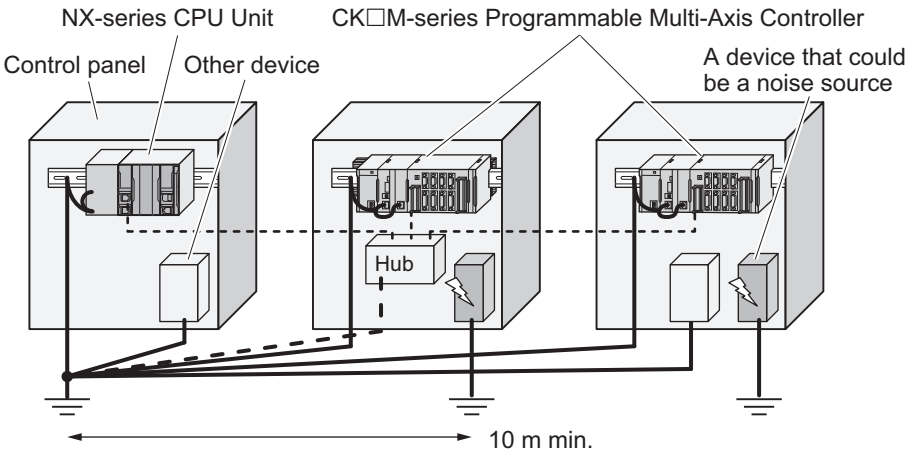
The following figure shows an example of an equipotential bonding system.
Connect the main earthing terminal and building structures together with equipotential bonding conductors and embed the mesh ground line in each floor.
Connect the ground line of each control panel to the equipotential bonding system.



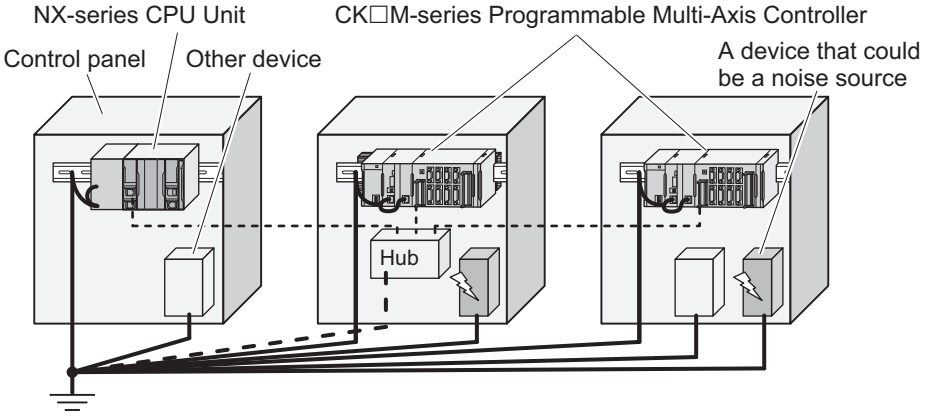
● Star Earthing

If the earthing method used for the building is not equipotential bonding or the earthing system is unknown, choose (a) from the earthing methods given below.

a. Installation method by connecting devices and noise sources to separate earth electrodes
   This is an earthing method to separately ground an earth electrode of the device that is connected with a communications cable or other devices and an earth electrode of a high-power device that could be a noise source, such as a motor or inverter. Each earth electrode must be ground to 100 Ω or less.
   Connect the ground lines of the device that is connected with a communications cable and other devices as a bundle to a single earth electrode. Be sure that the earth electrode is separated by a minimum of 10 m from any other earth electrode of a device that could be a noise source.

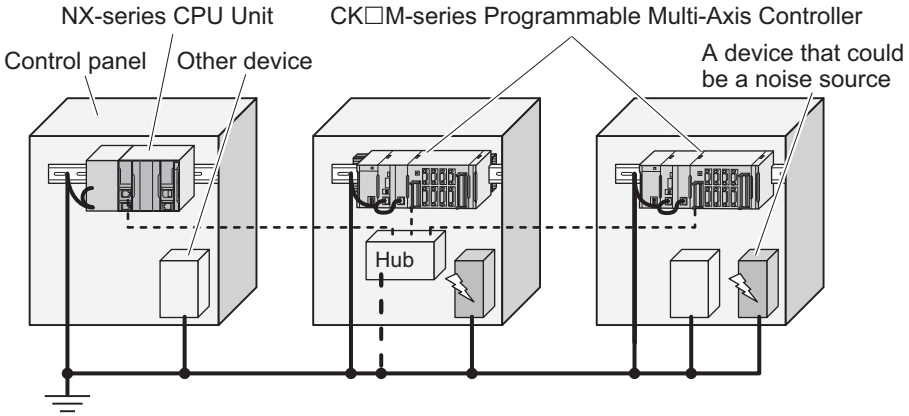


b. Installation method by connecting devices and noise sources to a common earth electrode
This is an earthing method to connect the device that is connected with a communications cable, other devices, and a device that could be a noise source, to a common earth electrode.
This earthing method is not recommended, because the device that is a potential noise source may interfere electromagnetically with other devices.



● Daisy Chain

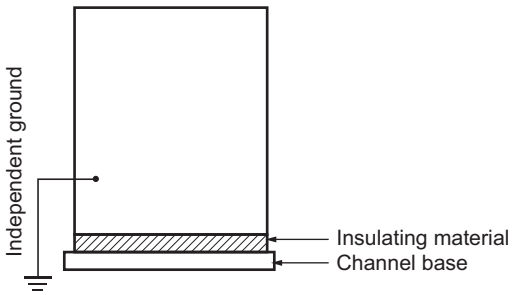
This is an earthing method to connect the device that is connected with a communications cable, other devices, and a device that could be a noise source using a daisy-chain topology to a common earth electrode.
This earthing method is not recommended because the device that could be a noise source may interfere electromagnetically with other devices.



Precautions for Grounding

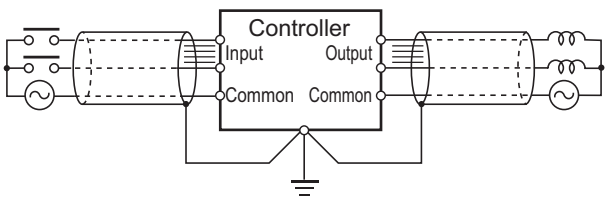
● General Precautions

- To prevent electrical shock, do not connect devices to ground poles (or steel frames) with non-equalized potential to which multiple devices are connected.
- Use a ground pole as close to the Controller as possible and keep the ground line as short as possible.
- If the same ground is used for both the signal lines and the enclosure, isolate the channel base (a metal plate inside a grounded control panel) with an insulating material.



Example: Insulating and Grounding an Enclosure

- If high-frequency equipment is present, then ground not only the high-frequency equipment but also the panel itself in which the Controller is housed.
- As shown in the following diagram, when using shielded cable for I/O wiring, connect the shield near the Controller to the enclosure ground terminal.
  Follow the instructions in the Communications Unit manual for preparing shielded communications cables.



Shielded Cable Ground

● Controller Ground Terminals

The Controller has the following ground terminal.

Grounding type	Symbol	Connection
Functional Grounding		Ground this terminal when power supply noise causes malfunctioning.

When the functional ground terminal is correctly grounded, it is generally effective in suppressing power supply common noise. Occasionally, however, grounding this terminal will result in picking up more noise, so be careful when using it.

5

Wiring

This section describes the wiring method for the CK3M/CK5M-series Programmable Multi-Axis Controller.

5-1 Power Supply Wiring 5-2
5-1-1 Power Supply Unit CK3W-PD048 5-2
5-1-2 Power Supply Used 5-2
5-1-3 Applicable Wires 5-2
5-1-4 Grounding 5-3
5-1-5 Required Tools 5-4
5-1-6 Connecting Ferrules 5-4
5-1-7 Connecting Twisted Wires/Solid Wires 5-4
5-1-8 Removing Wires 5-5

5-2 CPU Unit Wiring 5-7
5-2-1 Laying the EtherCAT Network 5-7
5-2-2 Laying the Ethernet Network 5-12
5-2-3 Watchdog Timer Output Wiring 5-14
5-2-4 USB Memory Device Connection 5-17

5-3 Axis Interface Unit Wiring 5-18
5-3-1 Encoder Connector Wiring 5-18
5-3-2 Amplifier Connector Wiring 5-24
5-3-3 Flag Terminal Block/General I/O Terminal Block Wiring 5-26

5-4 Digital I/O Unit Wiring 5-33
5-4-1 Wiring the Terminals 5-33
5-4-2 Precautions When Connecting a Two-wire DC Sensor 5-36
5-4-3 Precautions When Connecting to Digital Output 5-38

5-5 Analog Input Unit Wiring 5-40
5-5-1 Wiring the Terminals 5-40

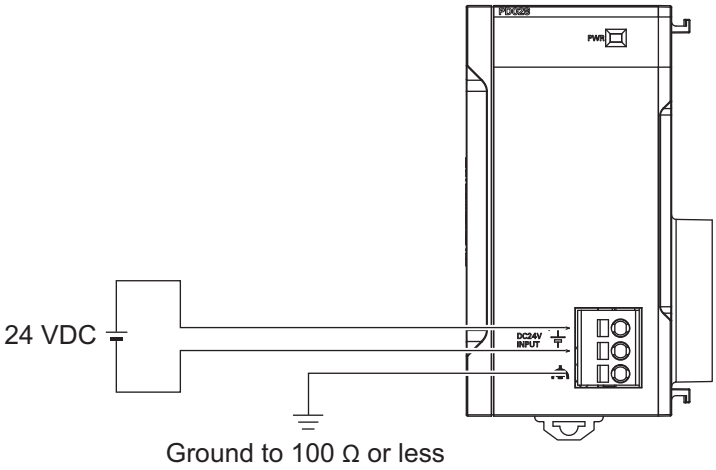
5-6 Encoder Input Unit 5-44
5-6-1 Encoder Connector Wiring 5-44
5-6-2 Dedicated Cable 5-44

5-7 Laser Interface Unit 5-46
5-7-1 Galvo Scanner Connector Wiring 5-46
5-7-2 Laser Connector Wiring 5-48

5-8 Expansion Master Unit and Expansion Slave Unit Wiring 5-50

5-1 Power Supply Wiring

5-1-1 Power Supply Unit CK3W-PD048



5-1-2 Power Supply Used

24 VDC power is supplied to the Unit power supply terminals (+, -). The power supply voltage range for the Unit power supplies is as follows.

Model	Power supply voltage range
CK3W-PD048	20.4 to 26.4 VDC

For the Unit power supply, use an SELV power supply with overcurrent protection.
An SELV power supply refers to a power supply with double or reinforced insulation between input and output, and with an output voltage of 30 V rms with a 42.4-V peak or an output voltage of 60 VDC max.
We recommend the following power supply.

Recommended Power Supply	Manufacturer
S8VK-S series	OMRON

Precautions for Correct Use

Always wire the CPU Rack and Expansion Rack to the same power supply.

5-1-3 Applicable Wires

The wires that you can connect to the terminal block are twisted wires, solid wires, and ferrules that are attached to the twisted wires. The following section describes the dimensions and processing methods for applicable wires.

Using Ferrules

If you use ferrules, attach the twisted wires to them.
Observe the application instructions for your ferrules for the wire stripping length when attaching ferrules.
Always use plated one-pin ferrules. Do not use unplated ferrules or two-pin ferrules.

The applicable ferrules, wires, and crimping tools are listed in the following table.

Manufacturer	Ferrule model	Applicable wire (mm^2 (AWG))	Crimping Tool (applicable wire size given in parentheses)
Phoenix Contact	AI0,25-8	0.25 (#24)	Phoenix Contact CRIMPFOX 6 (0.25 to 6 mm^2, AWG24 to 10)
	AI0,5-8	0.5 (#20)	
	AI0,75-8	0.75 (#18)	
	AI1,0-8	1.0 (#18)	
	AI1,5-8	1.5 (#16)	
Weidmüller	H0.25/12	0.25 (#24)	Weidmüller PZ6 Roto (0.14 to 6 mm^2, AWG26 to 10)
	H0.34/12	0.34 (#22)	
	H0.5/14	0.5 (#20)	
	H0.75/14	0.75 (#18)	
	H1.0/14	1.0 (#18)	
	H1.5/14	1.5 (#16)	

Using Twisted or Solid Wires

Wire type	Conductor cross-sectional area	Conductor length (stripping length)
Solid wire	0.2 to 4 mm^2	8 mm
Twisted wire	0.2 to 2.5 mm^2	8 mm

5-1-4 Grounding

The type of ground terminal on the Power Supply Unit is a functional ground terminal.
A functional ground terminal takes protective measures for device and system functions, including prevention of noises from external sources, and prevention of noises from devices or equipment that may have harmful effects on other devices or equipment.

- Ground to 100 Ω or less, and when possible use a separate ground from those of other devices.
- If using an independent ground is not possible, then use a common ground. Connect to the ground pole of the other device.
- Never use a common ground particularly with a motor, inverter, or other type of high-power equipment. Use an independent ground so that the devices do not affect each other.
- To reduce the risk of receiving an electric shock, do not connect devices to ground poles to which multiple devices are connected.
- Use a ground pole as close to the Power Supply Unit as possible and keep the ground line as short as possible.

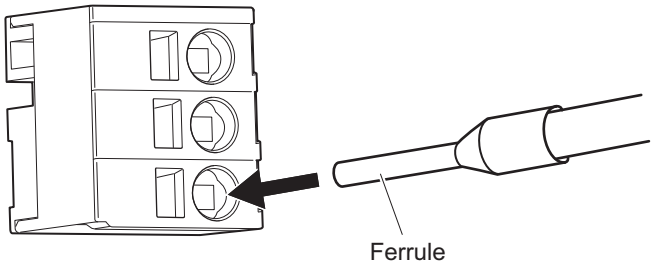
5-1-5 Required Tools

Use a flat-blade screwdriver to remove wires.
The recommended screw driver is as follows.

Model	Manufacturer
SZF 0-0,4X2,5	Phoenix Contact

5-1-6 Connecting Ferrules

Insert the ferrule straight into the terminal hole.
It is not necessary to press a flat-blade screwdriver into the release hole.

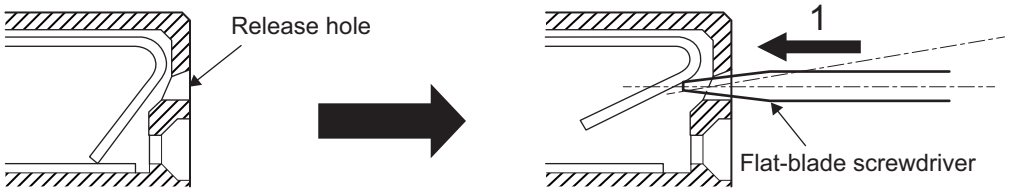


After you make a connection, make sure that the ferrule is securely connected to the terminal block.

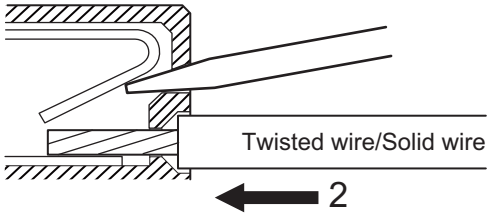
5-1-7 Connecting Twisted Wires/Solid Wires

Use the following procedure to connect the twisted wires or solid wires to the terminal block.

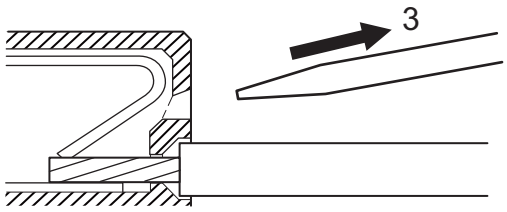
1 Press a flat-blade screwdriver straight into the release hole.
If you press in the screwdriver correctly, you will feel the spring in the release hole, and the screw driver will begin to incline.



2 Leave the flat-blade screwdriver pressed into the release hole and insert the twisted wire or the solid wire into the terminal hole.
Insert the twisted wire or the solid wire until the stripped portion is no longer visible to prevent shorting.



3 Remove the flat-blade screwdriver from the release hole.



After you make a connection, make sure that the twisted wire or the solid wire is securely connected to the terminal block.

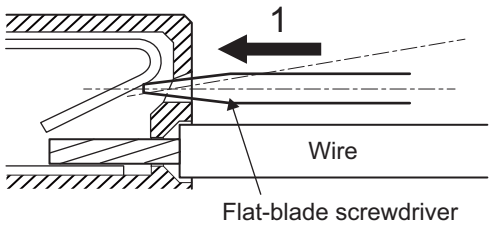
Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cable.

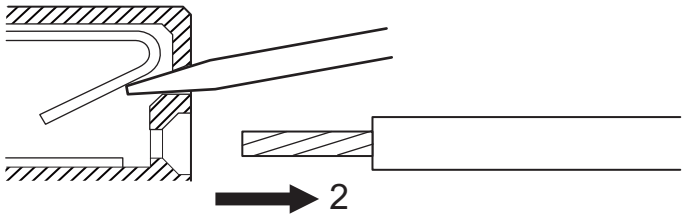
5-1-8 Removing Wires

Use the following procedure to remove the wires from the terminal block.
The removal method is the same for ferrules, twisted wires, and solid wires.

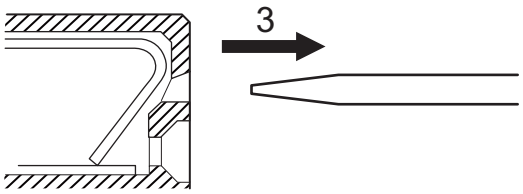
1 Press a flat-blade screwdriver straight into the release hole.
If you press in the screwdriver correctly, you will feel the spring in the release hole, and the screw driver will begin to incline.



2 Leave the flat-blade screwdriver pressed into the release hole and pull out the wire.



3 Remove the flat-blade screwdriver from the release hole.



Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cable.

5-2 CPU Unit Wiring

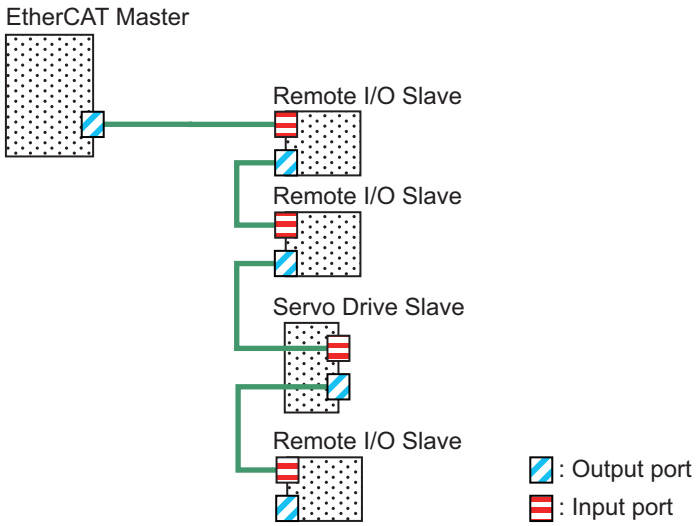
5-2-1 Laying the EtherCAT Network

This section describes how to install EtherCAT networks.

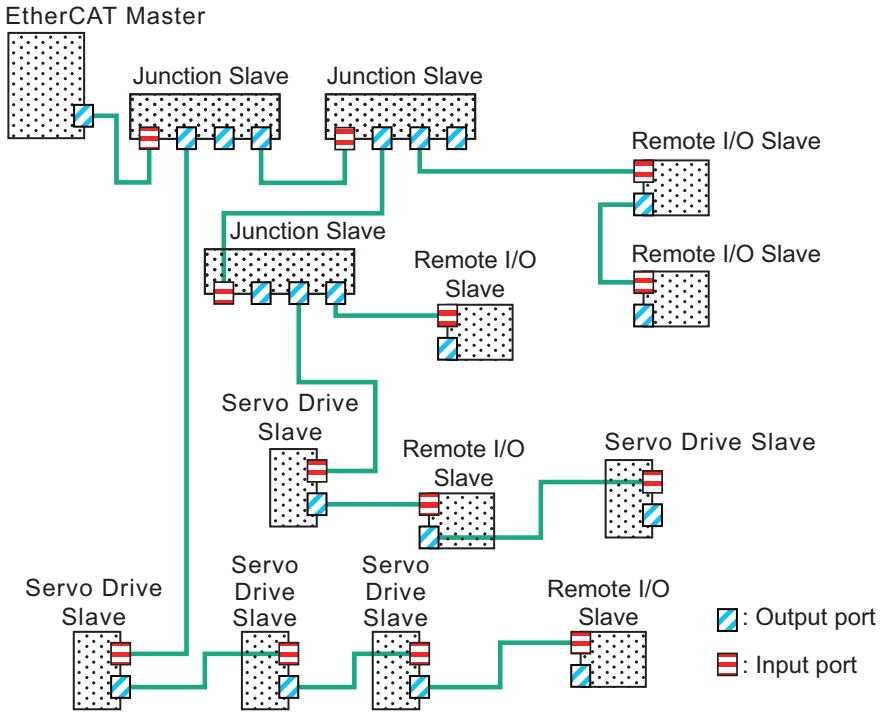
Supported Network Topologies

The EtherCAT port of the Motion Controller enables daisy chain connection without branching and branching using Junction Slaves. In addition, the ring wiring using Junction Slaves is available for CPU Units with PMAC firmware revision version 2.7.0 or later.
Examples of topology without branching, with branching (Junction Slaves), and ring wiring are shown below.

● No Branching



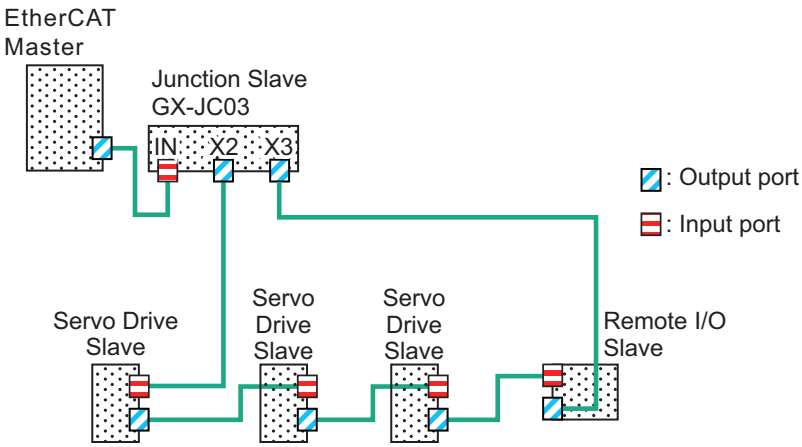
● Branching



● Ring Wiring

A configuration example of the ring wiring is shown below.

Refer to the *Power PMAC User's Manual (Cat. No. O014)* for the setting and usage of ring wiring.



Installation Precautions

Basic precautions for the installation of EtherCAT networks are provided below.

● Precautions when Installing a Network

- When you install an EtherCAT network, take sufficient safety precautions and follow the standards and specifications. (Refer to "JIS X 5252" or to electrical facility technical references.)
  An expert who is well trained in safety measures, standards, and specifications should be asked to perform the installation.
- Do not install EtherCAT network equipment near sources of noise.

If the network must be installed in an area subject to noise, take steps to address the noise, such as placing equipment in metal cases.

● Precautions when Installing Communications Cables

- Check the following items on the communications cables that are used in the network.
  a) Are there any breaks?
  b) Are there any shorts?
  c) Are there any connector problems?
- When you connect the cable to the communications connectors on devices, firmly insert the communications cable connector until it locks in place.
- Do not lay the communications cables together with high-voltage lines.
- Do not lay the communications cable near devices that generate noise.
- Do not lay the communications cables in locations subject to high temperatures or high humidity.
- Do not lay the communications cables in locations subject to excessive dirt and dust or to oil mist or other contaminants.
- There are limitations on the bending radius of communications cables. Check the specifications of the communications cable for the bending radius.

Installing EtherCAT Communications Cables

Ethernet communications cables and connectors are used to connect the EtherCAT port of the CPU Unit with EtherCAT slaves.
Use a straight, shielded twisted-pair cable (double shielding with aluminum tape and braiding) of Ethernet category 5 (100BASE-TX) or higher.
The following products are recommended.

● Cable with Connectors

The table below lists 4-pair cables with 26 AWG conductors.

Product name	Manufacturer	Cable length (m) *1	Model	Contact information
Cable with Connectors on Both Ends (RJ45/RJ45) Standard RJ45 connector type	OMRON Corporation	0.3	XS6W-6LSZH8SS30CM-Y *2	OMRON Customer Service Center
		0.5	XS6W-6LSZH8SS50CM-Y *2	
		1	XS6W-6LSZH8SS100CM-Y *2	
		10	XS6W-6LSZH8SS1000CM-Y *2	

*1. For the latest list of the Cables, refer to the *Industrial Ethernet Connectors Catalog (Cat. No. G019)*.
*2. The Cables are single-shielded, but the communications and noise characteristics are ensured to satisfy the standard values.

The table below lists 2-pair cables with 22 AWG conductors.

Product name	Manufacturer	Cable length (m) *1	Model	Contact information
Cable with Connectors on Both Ends (RJ45/RJ45) Rugged RJ45 connector type	OMRON Corporation	0.3	XS5W-T421-AMD-K	OMRON Customer Service Center
		0.5	XS5W-T421-BMD-K	
		1	XS5W-T421-CMD-K	
		2	XS5W-T421-DMD-K	
		5	XS5W-T421-GMD-K	
		10	XS5W-T421-JMD-K	
Cable with Plugs on Both Ends (M12/M12) Shield Strengthening Connector cable M12/Smartclick connector type	OMRON Corporation	0.5	XS5W-T421-BM2-SS	
		1	XS5W-T421-CM2-SS	
		2	XS5W-T421-DM2-SS	
		3	XS5W-T421-EM2-SS	
		5	XS5W-T421-GM2-SS	
		10	XS5W-T421-JM2-SS	
Cable with Plugs on Both Ends (M12/RJ45) Shield Strengthening Connector cable M12/Smartclick connector type Rugged RJ45 connector type	OMRON Corporation	0.5	XS5W-T421-BMC-SS	
		1	XS5W-T421-CMC-SS	
		2	XS5W-T421-DMC-SS	
		3	XS5W-T421-EMC-SS	
		5	XS5W-T421-GMC-SS	
		10	XS5W-T421-JMC-SS	

*1. For the latest list of the Cables, refer to the *Industrial Ethernet Connectors Catalog* (Cat. No. G019).

● Cables and Connectors

The table below lists 4-pair cables with 24 AWG conductors and connectors.

Product name	Manufacturer	Model	Contact information
Cables	Hitachi Metals, Ltd.	NETSTAR-C5E SAB 0.5 × 4P *1	Planning Department, Kanetsu Co., Ltd.
	Kuramo Electric Co., Ltd.	KETH-SB *1	Kuramo Electric Co., Ltd.
	JMACS Japan Co., Ltd.	IETP-SB *1	JMACS Japan Co., Ltd.
RJ45 Connectors	Panduit Corporation	MPS588 *1	Panduit Corporation US Headquarters Osaka Branch Office

*1. We recommend that you use combinations of the above cables and connectors.

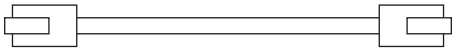
The table below lists 2-pair cables with 22 AWG conductors and connectors.

Product name	Manufacturer	Model	Contact information
Cables	Kuramo Electric Co., Ltd.	KETH-PSB-OMR *1	Kuramo Electric Co., Ltd.
	JMACS Japan Co., Ltd.	PNET/B *1	JMACS Japan Co., Ltd.
RJ45 Assembly Connectors	OMRON Corporation	XS6G-T421-1 *1	OMRON Customer Service Center

*1. We recommend that you use combinations of the above cables and connectors.

● Attaching the Connectors to the Cable and Pin Assignments

Use straight wiring to attach the connectors to the communications cable, as shown below.



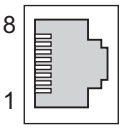
Pin No.	Wire color	Wire color	Pin No.
1	White-Green	White-Green	1
2	Green	Green	2
3	White-Orange	White-Orange	3
4	Blue	Blue	4
5	White-Blue	White-Blue	5
6	Orange	Orange	6
7	White-Brown	White-Brown	7
8	Brown	Brown	8
Hood	Shield	Shield	Hood

Note 1. Connect the cable shield to the connector hood at both ends of the cable.
Note 2. There are two connection methods for Ethernet: T568A and T568B. The T568A connection method is shown above, but the T568B connection method can also be used.

The connector specifications are as follows.

Item	Specification
Electrical characteristics	Conforms to IEEE 802.3 standards.
Connector structure	RJ45 8-pin modular connector (Conforms to ISO 8877)

The pin assignments are as follows.



Pin No.	Signal name	Abbreviation	Signal direction
1	Transmission data +	TD+	Output
2	Transmission data −	TD−	Output
3	Reception data +	RD+	Input
4	Not used.	---	---
5	Not used.	---	---
6	Reception data −	RD−	Input
7	Not used.	---	---

Pin No.	Signal name	Abbreviation	Signal direction
8	Not used.	---	---
Hood	Frame ground	FG	---

5-2-2 Laying the Ethernet Network

Installation Precautions

Basic precautions for the installation of Ethernet networks are provided below.

● Precautions when Installing a Network

- When you install an Ethernet network, take sufficient safety precautions and follow the standards and specifications. (Refer to "JIS X 5252" or to electrical facility technical references.)
  An expert who is well trained in safety measures, standards, and specifications should be asked to perform the installation.
- Do not install Ethernet network equipment near sources of noise.
  If the network must be installed in an area subject to noise, take steps to address the noise, such as placing equipment in metal cases.

● Precautions when Installing Communications Cables

- Check the following items on the communications cables that are used in the network.
  a) Are there any breaks?
  b) Are there any shorts?
  c) Are there any connector problems?
- When you connect the cable to the communications connectors on devices, firmly insert the communications cable connector until it locks in place.
- Do not lay the communications cables together with high-voltage lines.
- Do not lay the communications cable near devices that generate noise.
- Do not lay the communications cables in locations subject to high temperatures or high humidity.
- Do not lay the communications cables in locations subject to excessive dirt and dust or to oil mist or other contaminants.
- There are limitations on the bending radius of communications cables. Check the specifications of the communications cable for the bending radius.

Installing Ethernet Networks

The following products are recommended as devices to be used to configure an Ethernet network.

● Ethernet Switches

Manufacturer	Model	Description
OMRON	W4S1-05D	Packet priority control (QoS): EtherNet/IP control data priority Ethernet standard: IEEE 802.3 10Base-T, 100Base-TX Auto-negotiation: Supported Broadcast storm detection function: Supported Number of ports: 5

Manufacturer	Model	Description
Cisco Systems, Inc.	Consult the manufacturer. http://www.cisco.com/	
Contec USA, Inc.	Consult the manufacturer. http://www.contec.com/	
Phoenix Contact USA	Consult the manufacturer. https://www.phoenixcontact.com	

● Twisted-pair Cables and Connectors

Applicable EtherNet/IP communications cables and connectors vary depending on the used baud rate.

For 100Base-TX and 10Base-T, use an STP (shielded twisted-pair) cable of category 5 or higher. You can use either straight or cross cable.

For 1000Base-T, use an STP (shielded twisted-pair) cable (double shielding with aluminum tape and braiding) of category 5e or higher. You can use either straight or cross cable.

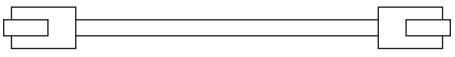
Cabling materials used for EtherNet/IP communication cables are shown in the table below. "100Base-TX" in the "Product" column of the table below indicates that either 100Base-TX or 10Base-T can be used.

Product			Manufacturer	Model
For 1000Base-T and 100Base-TX	Size and conductor pairs: AWG24 × 4 pairs *1	Cable	Hitachi Metals, Ltd.	NETSTAR-C5E SAB 0.5 × 4P CP
			Kuramo Electric Co.	KETH-SB
			JMACS Japan Co., Ltd.	IETP-SB
		RJ45 Connectors	Panduit Corporation	MPS588
For 100Base-TX	Size and conductor pairs: AWG22 × 2 pairs*1	Cable	Kuramo Electric Co., Ltd.	KETH-PSB-OMR
			JMACS Japan Co., Ltd.	PNET/B
		RJ45 Assembly Connectors	OMRON	XS6G-T421-1

*1. We recommend that you use cables and connectors in above combinations.

● Attaching the Connectors to the Cable and Pin Assignments

Use straight wiring to attach the connectors to the communications cable, as shown below.



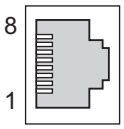
Pin No.	Wire color	Wire color	Pin No.
1	White-Green	White-Green	1
2	Green	Green	2
3	White-Orange	White-Orange	3
4	Blue	Blue	4
5	White-Blue	White-Blue	5
6	Orange	Orange	6
7	White-Brown	White-Brown	7
8	Brown	Brown	8
Hood	Shield	Shield	Hood

Note 1. Connect the cable shield to the connector hood at both ends of the cable.
Note 2. There are two connection methods for Ethernet: T568A and T568B. The T568A connection method is shown above, but the T568B connection method can also be used.

The connector specifications are as follows.

Item	Specification
Electrical characteristics	Conforms to IEEE 802.3 standards.
Connector structure	RJ45 8-pin modular connector (Conforms to ISO 8877)

The pin assignments are as follows.



Pin No.	100BASE-TX			1000BASE-T		
	Signal name	Abbreviation	Signal direction	Signal name	Abbreviation	Signal direction
1	Transmission data +	TD+	Output	Communication data DA +	BI_DA+	Input/output
2	Transmission data −	TD−	Output	Communication data DA-	BI_DA-	Input/output
3	Reception data +	RD+	Input	Communication data DB +	BI_DB+	Input/output
4	Not used.	---	---	Communication data DC +	BI_DC+	Input/output
5	Not used.	---	---	Communication data DC-	BI_DC-	Input/output
6	Reception data −	RD−	Input	Communication data DB-	BI_DB-	Input/output
7	Not used.	---	---	Communication data DD +	BI_DD+	Input/output
8	Not used.	---	---	Communication data DD-	BI_DD-	Input/output
Hood	Frame ground	FG	---	Frame ground	FG	---

5-2-3 Watchdog Timer Output Wiring

Applicable Wires

The wires that you can connect to the terminal block are twisted wires, solid wires, and ferrules that are attached to the twisted wires. The following section describes the dimensions and processing methods for applicable wires.

● Using Ferrules

If you use ferrules, attach the twisted wires to them.
Observe the application instructions for your ferrules for the wire stripping length when attaching ferrules.
Always use plated one-pin ferrules. Do not use unplated ferrules or two-pin ferrules.

The applicable ferrules, wires, and crimping tools are listed in the following table.

Manufacturer	Ferrule model	Applicable wire (mm^2 (AWG))	Crimping Tool (applicable wire size given in parentheses)
Phoenix Contact	AI0,25-8	0.25 (#24)	Phoenix Contact CRIMPFOX 6 (0.25 to 6 mm^2, AWG24 to 10)
	AI0,5-8	0.5 (#20)	
	AI0,75-8	0.75 (#18)	
Weidmüller	H0.25/12	0.25 (#24)	Weidmüller PZ6 Roto (0.14 to 6 mm^2, AWG26 to 10)
	H0.34/12	0.34 (#22)	
	H0.5/14	0.5 (#20)	
	H0.75/14	0.75 (#18)	

● Using Twisted or Solid Wires

Wire type	Conductor cross-sectional area	Conductor length (stripping length)
Solid wire	0.2 to 1.5 mm^2	8 mm
Twisted wire		

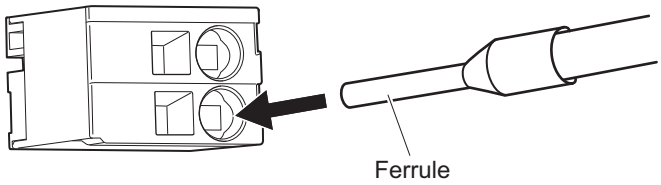
Required Tools

Use a flat-blade screwdriver to remove wires.
The recommended screw driver is as follows.

Model	Manufacturer
SZF 0-0,4X2,5	Phoenix Contact

Connecting Ferrules

Insert the ferrule straight into the terminal hole.
It is not necessary to press a flat-blade screwdriver into the release hole.

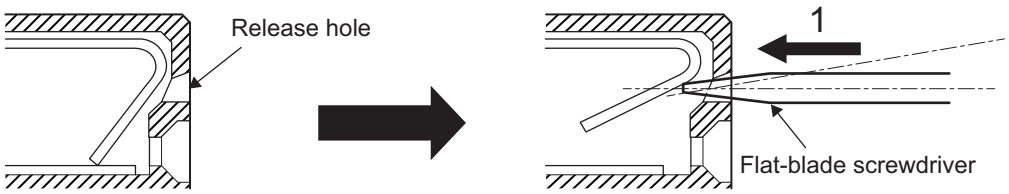


After you make a connection, make sure that the ferrule is securely connected to the terminal block.

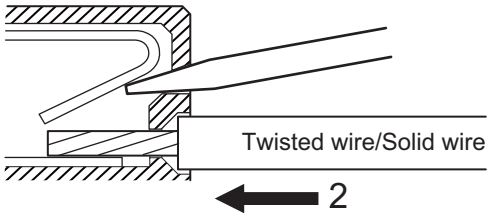
Connecting Twisted Wires/Solid Wires

Use the following procedure to connect the twisted wires or solid wires to the terminal block.

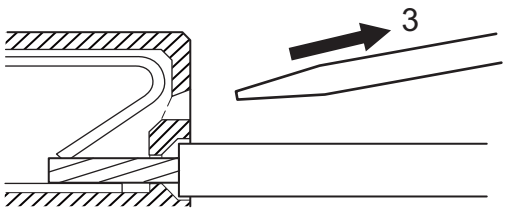
1 Press a flat-blade screwdriver straight into the release hole.
If you press in the screwdriver correctly, you will feel the spring in the release hole, and the screw driver will begin to incline.



2 Leave the flat-blade screwdriver pressed into the release hole and insert the twisted wire or the solid wire into the terminal hole.
Insert the twisted wire or the solid wire until the stripped portion is no longer visible to prevent shorting.



3 Remove the flat-blade screwdriver from the release hole.



After you make a connection, make sure that the twisted wire or the solid wire is securely connected to the terminal block.

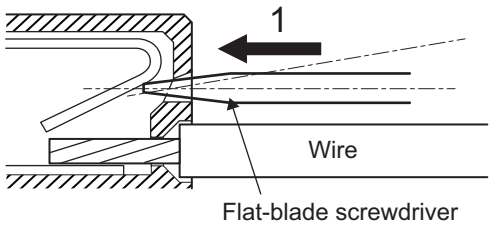
Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cable.

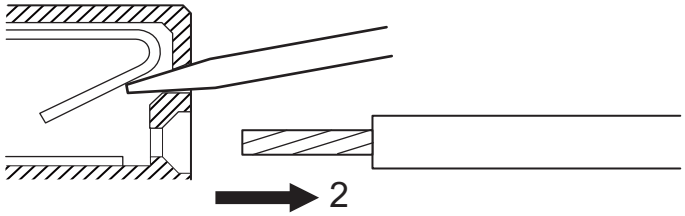
Removing Wires

Use the following procedure to remove the wires from the terminal block.
The removal method is the same for ferrules, twisted wires, and solid wires.

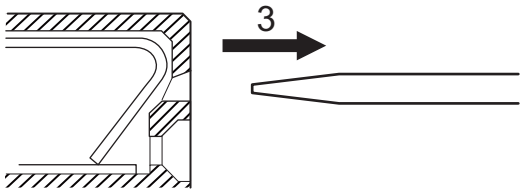
1 Press a flat-blade screwdriver straight into the release hole.
If you press in the screwdriver correctly, you will feel the spring in the release hole, and the screw driver will begin to incline.



2 Leave the flat-blade screwdriver pressed into the release hole and pull out the wire.



3 Remove the flat-blade screwdriver from the release hole.



Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cable.

5-2-4 USB Memory Device Connection

Connect a USB memory device to the USB host port (Type A) on the CPU Unit to save relevant data. Refer to *3-1-5 USB Memory Device* on page 3-10 for information on the recommended USB memory devices.

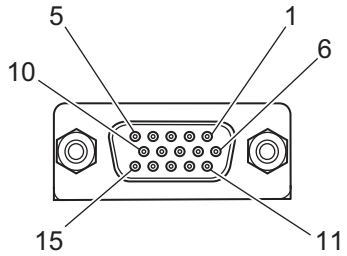
5-3 Axis Interface Unit Wiring

5-3-1 Encoder Connector Wiring

Connector Arrangement for Digital Quadrature Encoder

This section describes the connector arrangement for the CK3W-AX1313□/-AX1414□/-AX1515□ Units.

The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



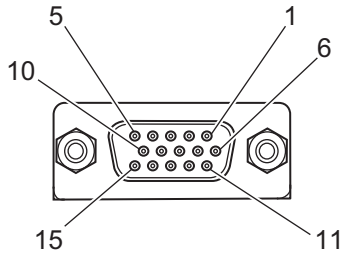
Pin No.	Symbol	Digital Quadrature Encoder + UVW signal		Serial Encoder		Digital Quadrature Encoder + Serial Encoder	
1	CHA	Encoder A+	Input	Not wired	-	Encoder A+	Input
2	CHB	Encoder B+	Input	Not wired	-	Encoder B+	Input
3	CHC	Encoder C+	Input	Not wired	-	Encoder C+	Input
4	CHU	Hall sensor U	Input	Serial Encoder CLK+	Output	Serial Encoder CLK+	Output
5	CHW	Hall sensor W	Input	Serial Encoder DAT+	Input / Output	Serial Encoder DAT+	Input / Output
6	CHA/	Encoder A-	Input	Not wired	-	Encoder A-	Input
7	CHB/	Encoder B-	Input	Not wired	-	Encoder B-	Input
8	CHC/	Encoder C-	Input	Not wired	-	Encoder C-	Input
9	CHV	Hall sensor V	Input	Serial Encoder CLK-	Output	Serial Encoder CLK-	Output
10	CHT	Hall sensor T	Input	Serial Encoder DAT-	Input / Output	Serial Encoder DAT-	Input / Output
11	ENCPWR	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output
12	ENCPWR	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output
13	GND	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output
14	GND	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output

Pin No.	Symbol	Digital Quadrature Encoder + UVW signal		Serial Encoder		Digital Quadrature Encoder + Serial Encoder	
15	OutFlagB*1	OutFlagB	Output	OutFlagB	Output	OutFlagB	Output
Shell	SHELL	Shield		Shield		Shield	

*1. The OutFlagB output function is not available with the CK3W-AX1313□ Units.

Connector Arrangement for Sinusoidal Encoder

This section describes the connector arrangement for the CK3W-AX2323□ Units.
The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



Pin No.	Symbol	Sinusoidal encoder + UVW signal		Serial Encoder + UVW signal		Sinusoidal encoder + Serial Encoder	
1	SIN	SIN+	Input	Not wired	-	SIN+	Input
2	COS	COS+	Input	Not wired	-	COS+	Input
3	INDEX	INDEX+	Input	Not wired	-	INDEX+	Input
4	CHU	Hall sensor U	Input	Serial Encoder CLK+	Output	Serial Encoder CLK+	Output
5	CHW	Hall sensor W	Input	Serial Encoder DAT+	Input / Output	Serial Encoder DAT+	Input / Output
6	SIN/	SIN-	Input	Not wired	-	SIN-	Input
7	COS/	COS-	Input	Not wired	-	COS-	Input
8	INDEX/	INDEX-	Input	Not wired	-	INDEX-	Input
9	CHV	Hall sensor V	Input	Serial Encoder CLK-	Output	Serial Encoder CLK-	Output
10	CHT	Hall sensor T	Input	Serial Encoder DAT-	Input / Output	Serial Encoder DAT-	Input / Output
11	ENCPWR	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output
12	ENCPWR	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output	Encoder Power Supply (+5 VDC)	Output
13	GND	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output
14	GND	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output	Encoder Power Supply (GND)	Output
15	NC	Not wired	-	Not wired	-	Not wired	-
Shell	SHELL	Shield		Shield		Shield	

Precautions for Correct Use

Do not connect a digital quadrature encoder to a CK3W-AX2323□ Unit. If you connect a digital quadrature encoder, the Unit may be damaged.

Dedicated Cable

The dedicated cables for wiring to the encoder connector are provided as an option.
The encoder connection side has discrete wires. Perform wiring to match the encoder specifications.

The cable models are as shown below.

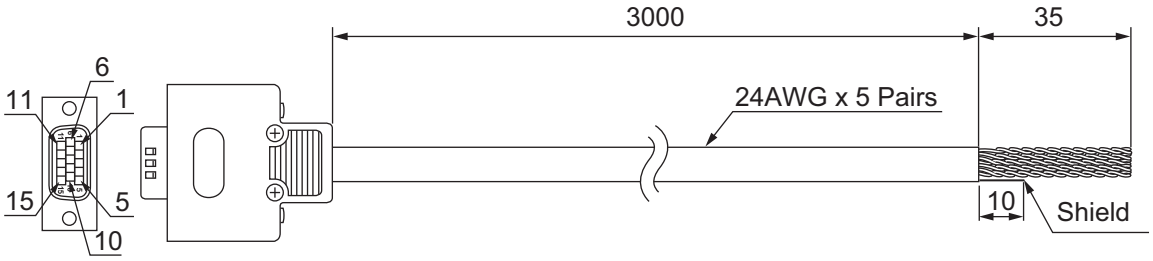
Type	Model	Length
For Digital Quadrature Encoder	CK3W-CAED03A	3 m
For Sinusoidal Encoder	CK3W-CAEA03A	3 m
For Serial Encoder	CK3W-CAES03A	3 m
For “Digital Quadrature Encoder + UVW Signal” or “Digital Quadrature Encoder + Serial Encoder”	CK3W-CAEW03A	3 m
For “Sinusoidal Encoder + UVW Signal” or “Sinusoidal Encoder + Serial Encoder”	CK3W-CAEAW03A	3 m

Additional Information

You may use a self-made cable.
When you create a self-made cable, use the following cable to block the effects of noise.

- Use a twisted-pair shielded cable for digital quadrature encoder, serial encoder, or UVW signal connection.
- Use a shielded twisted-pair cable with an overall shield and pair shields for sinusoidal encoder connection.

● For Digital Quadrature Encoder



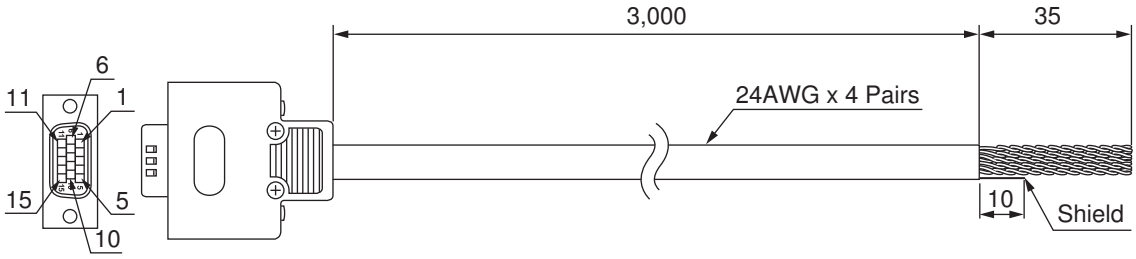
Type	Pin No.	Cable color	Mark	Signal
Pair 1	11	Blue	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Red	Encoder Power Supply (GND)
Pair 2	1, 5*1	Pink	Black	Encoder A+ Serial Encoder DAT+
	6, 10*1	Pink	Red	Encoder A- Serial Encoder DAT-
Pair 3	2	Green	Black	Encoder B+
	7	Green	Red	Encoder B-
Pair 4	3	Orange	Black	Encoder C+
	8	Orange	Red	Encoder C-

Type	Pin No.	Cable color	Mark	Signal
Pair 5	15	Gray	Black	OutFlagB
	14	Gray	Red	GND

*1. In order to make a connection with the OMRON G5-series Servo Drive R88D-KT□□□, Pin 1 and Pin 5, and Pin 6 and Pin 10 are short-circuited inside the connector.
You can also connect a normal digital quadrature encoder which does not use serial encoder DAT by disabling the serial encoder. To disable the serial encoder, set Gate3[i].Chan[j].SerialEncEna=0.

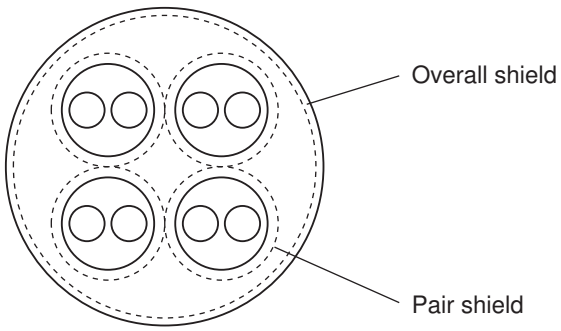
Note The cable shield is connected to the connector shell of the encoder connector.
When using this cable, set to *OutFlagD = 1* to disable the serial encoder DAT terminating resistance.

● For Sinusoidal Encoder

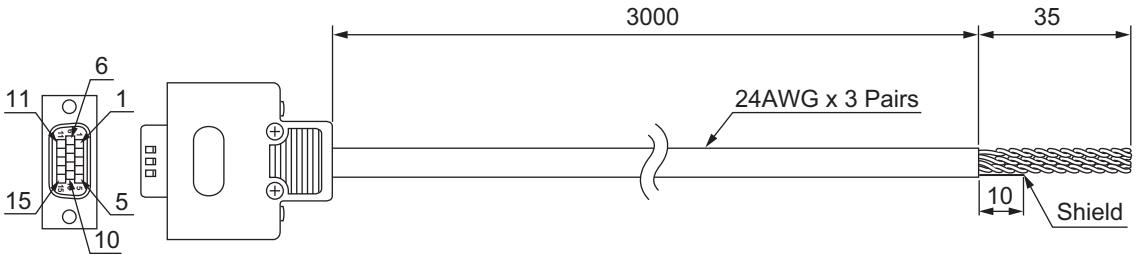


Type	Pin No.	Cable color	Signal
Pair 1	11	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Encoder Power Supply (GND)
Pair 2	1	Black	SIN+
	6	Red	SIN-
Pair 3	2	Black	COS+
	7	White	COS-
Pair 4	3	Black	INDEX+
	8	Green	INDEX-

Note The cable shield consists of an overall shield and pair shields.
The overall shield is connected to the connector shell of the encoder connector.
The pair shields are connected to the Encoder Power Supply (GND) pin.



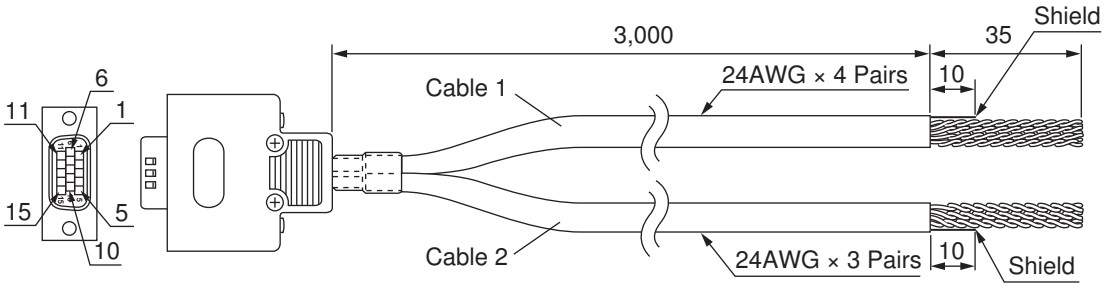
● For Serial Encoder



Type	Pin No.	Cable color	Mark	Signal
Pair 1	11	Blue	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Red	Encoder Power Supply (GND)
Pair 2	4	Pink	Black	Encoder CLK+
	9	Pink	Red	Encoder CLK-
Pair 3	5	Green	Black	Serial Encoder DAT+
	10	Green	Red	Serial Encoder DAT-

Note The cable shield is connected to the connector shell of the encoder connector.

● For "Digital Quadrature Encoder + UVW Signal" or "Digital Quadrature Encoder + Serial Encoder"



Cable 1

Type	Pin No.	Cable color	Mark	Signal
Pair 1	11	Blue	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Red	Encoder Power Supply (GND)
Pair 2	1	Pink	Black	Encoder A+
	6	Pink	Red	Encoder A-
Pair 3	2	Green	Black	Encoder B+
	7	Green	Red	Encoder B-
Pair 4	3	Orange	Black	Encoder C+
	8	Orange	Red	Encoder C-

Note The cable shield is connected to the connector shell of the encoder connector.

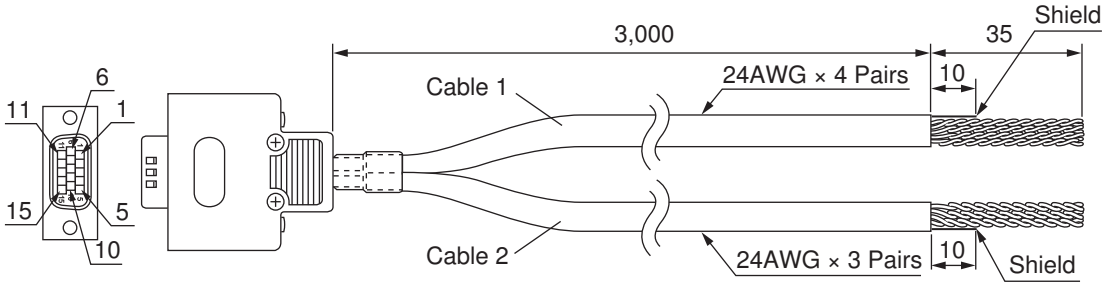
Cable 2

Type	Pin No.	Cable color	Mark	Signal	
				U, V, W	Serial Encoder
Pair 1	12	Blue	Black	Encoder Power Supply (+5 VDC)	
	14	Blue	Red	Encoder Power Supply (GND)	

Type	Pin No.	Cable color	Mark	Signal	
				U, V, W	Serial Encoder
Pair 2	4	Pink	Black	Hall sensor U	Serial Encoder CLK+
	9	Pink	Red	Hall sensor V	Serial Encoder CLK-
Pair 3	5	Green	Black	Hall sensor W	Serial Encoder DAT+
	10	Green	Red	Hall sensor T	Serial Encoder DAT-

Note The cable shield is connected to the connector shell of the encoder connector.

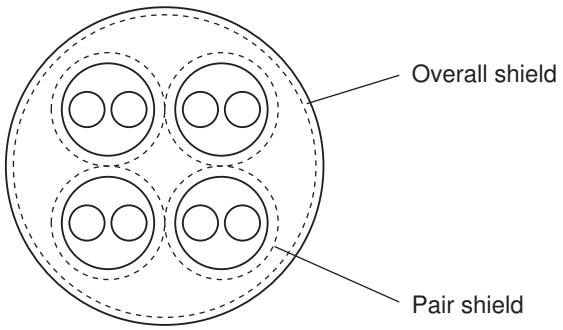
● For "Sinusoidal Encoder + UVW Signal" or "Sinusoidal Encoder + Serial Encoder"



Cable 1

Type	Pin No.	Cable color	Signal
Pair 1	11	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Encoder Power Supply (GND)
Pair 2	1	Black	SIN+
	6	Red	SIN-
Pair 3	2	Black	COS+
	7	White	COS-
Pair 4	3	Black	INDEX+
	8	Green	INDEX-

Note The cable shield consists of an overall shield and pair shields.
The overall shield is connected to the connector shell of the encoder connector.
The pair shields are connected to the Encoder Power Supply (GND) pin.



Cable 2

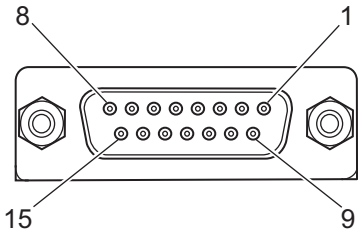
Type	Pin No.	Cable color	Signal	
			U, V, W	Serial Encoder
Pair 1	12	Blue	Encoder Power Supply (+5 VDC)	
	14	White	Encoder Power Supply (GND)	
Pair 2	4	Black	Hall sensor U	Serial Encoder CLK+
	9	Green	Hall sensor V	Serial Encoder CLK-
Pair 3	5	Yellow	Hall sensor W	Serial Encoder DAT+
	10	Brown	Hall sensor T	Serial Encoder DAT-

Note The cable shield is connected to the connector shell of the encoder connector.

5-3-2 Amplifier Connector Wiring

Connector Arrangement of FilteredPWM/TrueDAC Type Amplifier Connector

This section describes the connector arrangement for the CK3W-AX1414□/-AX1515□ Units.
The Unit side connector is a D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



Pin No.	Symbol	During analog output		During pulse output	
1	DACA+	Analog output A+	Output	Not wired	-
2	DACB+	Analog output B+ *1	Output	Not wired	-
3	AGND	Analog GND	Common	Not wired	-
4	FAULT+	Fault input +	Input	Fault input +	Input
5	PULSE+	Not wired	-	Pulse output +	Output
6	DIR+	Not wired	-	Directional output +	Output
7	AE_NO	Amp enable NO	Output	Amp enable NO	Output
8	AE_NC	Amp enable NC	Output	Amp enable NC	Output
9	DACA-	Analog output A-	Output	Not wired	-
10	DACB-	Analog output B- *1	Output	Not wired	-
11	FAULT-	Fault input -	Input	Fault input -	Input
12	PULSE-	Not wired	-	Pulse output -	Output
13	DIR-	Not wired	-	Directional output -	Output
14	GND	Not wired	-	GND	Common
15	AE_COM	Amp enable Common	Common	Amp enable Common	Common
Shell	SHELL	Shield		Shield	

*1. In the FilteredPWM type, there is no analog output B.

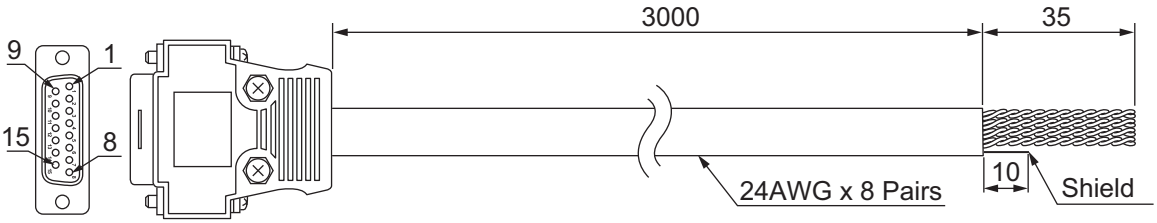
Dedicated Cable

● For FilteredPWM/TrueDAC type

This section describes the cable used for the CK3W-AX1414□/-AX1515□ Units.
The dedicated cable for wiring to the FilteredPWM/TrueDAC type amplifier connector is provided as an option.
The amplifier connection side has discrete wires. Wire in accordance with the Servo Drive specifications.

The cable model is as shown below.

Type	Model	Length
For FilteredPWM/TrueDAC type	CK3W-CAA03A	3 m



Type	Pin No.	Cable color	Mark	Signal
Pair 1	1	Blue	Black 1 dot	Analog output A+
	9	Blue	Red 1 dot	Analog output A-
Pair 2	2	Pink	Black 1 dot	Analog output B+
	10	Pink	Red 1 dot	Analog output B-
Pair 3	3*1	Green	Black 1 dot	Analog GND
	3*1	Green	Red 1 dot	Analog GND
Pair 4	5	Orange	Black 1 dot	Pulse output +
	12	Orange	Red 1 dot	Pulse output -
Pair 5	6	Gray	Black 1 dot	Directional output +
	13	Gray	Red 1 dot	Directional output -
Pair 6	4	Blue	Black 2 dot	Fault input +
	11	Blue	Red 2 dot	Fault input -
Pair 7	7	Pink	Black 2 dot	Amp enable NO
	15*1	Pink	Red 2 dot	Amp enable common
Pair 8	8	Green	Black 2 dot	Amp enable NC
	15*1	Green	Red 2 dot	Amp enable common

*1. Pin numbers 3 and 15 have two cables connected to one pin.

Note 1. The cable shield is connected to the connector shell of the amplifier connector.
Note 2. No GND signal (pin number: 14) is connected to this cable. If the amplifier connected to the pulse output requires a GND signal, make your own cable.

Additional Information

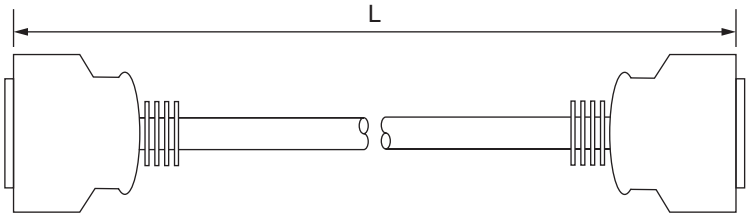
You may use a self-made cable.
When you create a self-made cable, use a shielded twisted-pair cable to block the effects of noise.

● For DirectPWM type

This section describes cables used for the CK3W-AX1313□/-AX2323□ Units.
Be sure to use the following cables for the DirectPWM type amplifier connector.

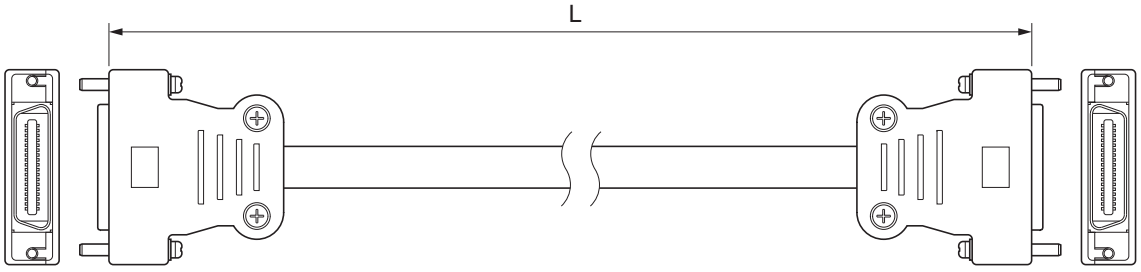
When connecting to the CK3A-G3□□L, use the following one-touch mounting type cable.

Type	Model	Name	Length (L)
For DirectPWM type	200-602739-036x	CABPWM-2	0.9 m
	200-602739-072x	CABPWM-4	1.8 m
	200-602739-144x	CABPWM-6	3.6 m



When connecting to other servo amplifiers, use the one-touch mounting type cable listed above or the screw mounting type cable listed below. When using it, check the connection conditions on the servo amplifier side before proceeding.

Type	Model	Length (L)
For DirectPWM type	CK3W-CAAD009A	0.9 m
	CK3W-CAAD018A	1.8 m
	CK3W-CAAD036A	3.6 m



5-3-3 Flag Terminal Block/General I/O Terminal Block Wiring

This section describes the wiring for the flag connection terminal block and the general digital I/O connection terminal block.

Wiring the Terminals

● Applicable Wires

The wires that you can connect to the terminal block are twisted wires, solid wires, and ferrules that are attached to the twisted wires. The following section describes the dimensions and processing methods for applicable wires.

Using Ferrules

If you use ferrules, attach the twisted wires to them.

Observe the application instructions for your ferrules for the wire stripping length when attaching ferrules.

Always use plated one-pin ferrules. Do not use unplated ferrules or two-pin ferrules.

The applicable ferrules, wires, and crimping tools are listed in the following table.

Manufacturer	Ferrule model	Applicable wire (mm^2 (AWG))	Crimping Tool (applicable wire size given in parentheses)
Phoenix Contact	AI0,5-10	0.5 (#20)	Phoenix Contact CRIMPFOX 6 (0.25 to 6 mm^2, AWG24 to 10)
	AI0,75-10	0.75 (#18)	
	AI1,0-10	1.0 (#18)	
	AI1,5-10	1.5 (#16)	
Weidmüller	H0.5/16	0.5 (#20)	Weidmüller PZ6 Roto (0.14 to 6 mm^2, AWG26 to 10)
	H0.75/16	0.75 (#18)	
	H1.0/16	1.0 (#18)	
	H1.5/16	1.5 (#16)	

Using Twisted or Solid Wires

Wire type	Conductor cross-sectional area	Conductor length (stripping length)
Solid wire	0.14 to 1.5 mm^2	10 mm
Twisted wire		

● Required Tools

Use a flat-blade screwdriver to remove wires.

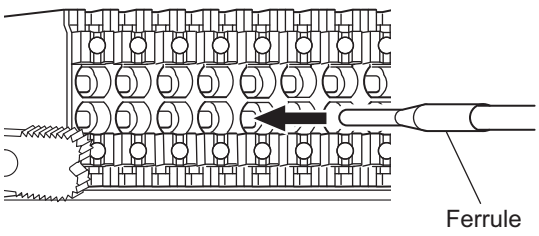
The recommended screw driver is as follows.

Model	Manufacturer
SZF 0-0,4X2,5	Phoenix Contact

● Connecting Ferrules

Insert the ferrule straight into the terminal hole.

It is not necessary to press a flat-blade screwdriver against the release button.

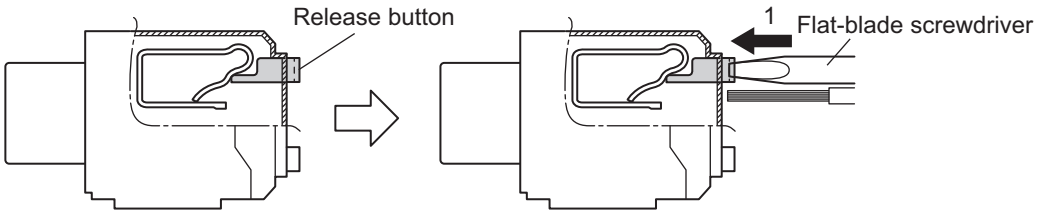


After you make a connection, make sure that the ferrule is securely connected to the terminal block.

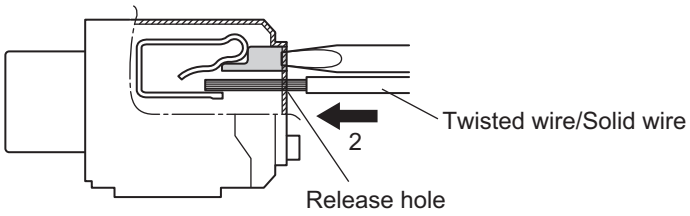
● Connecting Twisted Wires/Solid Wires

Use the following procedure to connect the twisted wires or solid wires to the terminal block.

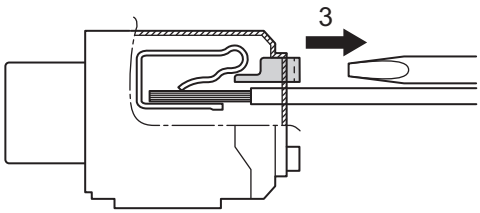
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and insert the twisted wire or the solid wire into the terminal hole.
Insert the twisted wire or the solid wire until the stripped portion is no longer visible, to prevent shorting.



3 Pull the flat-blade screwdriver away from the release button.



After you make a connection, make sure that the twisted wire or the solid wire is securely connected to the terminal block.

Precautions for Safe Use

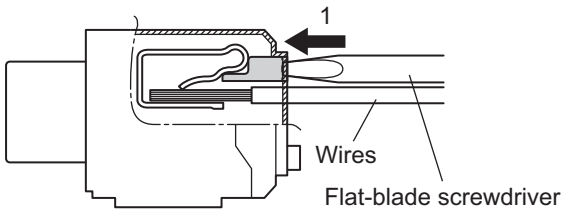
- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

● Removing Wires

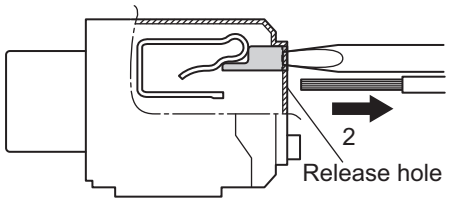
Use the following procedure to remove the wires from the terminal block.
The removal method is the same for ferrules, twisted wires, and solid wires.

If wires are secured firmly to the terminal block, release them first.

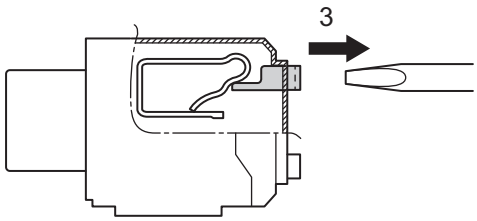
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and pull out the wire from the terminal hole.



3 Pull the flat-blade screwdriver away from the release button.



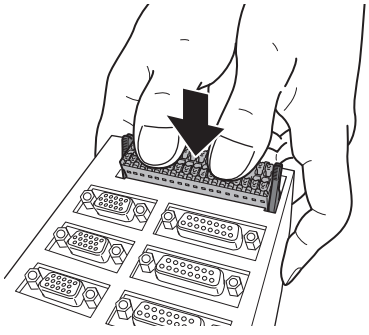
Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

● Installing a Terminal Block

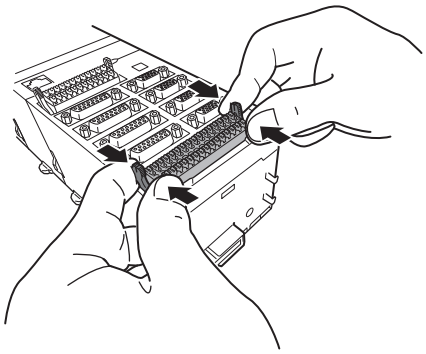
Insert the terminal block into the main body, and press hard to click the terminal block into place on the Unit.

After you mount the terminal block, make sure that it is fixed to the Unit.



● Removing a Terminal Block

Drop the lock levers on both sides of the terminal block at the same time to remove the terminal block.



Precautions When Connecting a Two-wire DC Sensor

When a two-wire sensor is used with a general digital input and a flag input, check that the following conditions are met.
Failure to meet these conditions may result in operating errors.

● Relation between ON voltage of the general digital input / flag input and sensor residual voltage

$V_{ON} \leq V_{CC} - V_R$

V_{ON}: ON voltage of general digital input and flag input

V_{CC}: Input voltage of general digital input and flag input

V_R: Output residual voltage of sensor

● Relation between input current to the general digital input / flag input and sensor control output (load current)

$I_{OUT}\,(min) \leq I_{ON} \leq I_{OUT}\,(max)$

Precautions for Correct Use

The general digital input and flag input are constant current type input.
For constant current type input, the input current does not increase linearly with the input voltage.
If you gradually raise the input voltage, once the input current reaches I_{ON}, the input current does not increase and remains roughly constant even when the input voltage is raised.

When I_{ON} is smaller than I_{OUT} (min), connect a bleeder resistor R. The bleeder resistor constant can be calculated as follows:

$R \leq (V_{CC} - V_R) / (I_{OUT}\,(min) - I_{ON})$

Power W of bleeder resistor $\geq (V_{CC} - V_R)^2 / R \times 4$ [allowable margin]

V_{CC}: Input voltage of general digital input and flag input

V_R: Output residual voltage of sensor

I_{ON}: Input current of general digital input and flag input

I_{OUT}: Sensor control output (load current)

● Relation between OFF current of the general digital input / flag input and sensor leakage current

The general digital input and flag input cannot detect sensor output OFF unless the following conditions are satisfied:

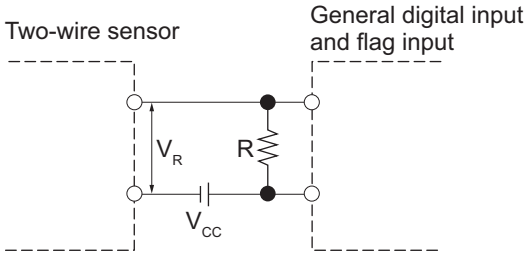
$I_{OFF} \geq I_{leak}$

When I_{leak} is greater than I_{OFF}, connect a bleeder resistor R.

Use the following equation to calculate the bleeder resistance constant.

$R \leq (V_{OFF} / I_{OFF}) \times V_{OFF} / (I_{leak} \times (V_{OFF} / I_{OFF}) - V_{OFF})$

Power W of bleeder resistor $\geq (V_{CC} - V_R)^2 / R \times 4$ [allowable margin]



V_{CC}: Power supply voltage

V_{ON}: ON voltage of general digital input and flag input

V_{OFF}: OFF voltage of general digital input and flag input

I_{ON}: ON current of general digital input and flag input

I_{OFF}: OFF current of general digital input and flag input

V_R: Output residual voltage of sensor

I_{OUT}: Sensor control output (load current)

I_{leak}: Sensor leakage current

R: Bleeder resistor

● Precautions for Sensor Inrush Current

An incorrect input may occur due to sensor inrush current if a sensor is turned ON after the Unit has started up to the point where inputs are possible.

Determine the time required for sensor operation to stabilize after the sensor is turned ON and take appropriate measures, such as inserting an ON delay into the application program after turning ON the sensor.

Precautions When Connecting to General Digital Output

● Output Short-circuit Protection

If a load connected to the output terminals is short-circuited, output components and printed circuit boards may be damaged.

When you use a NPN type output that does not include the load short-circuit protection, incorporate a protective fuse in the output. Use a fuse with a capacity of protection, around twice the rated output.

● Precautions for Inrush Current

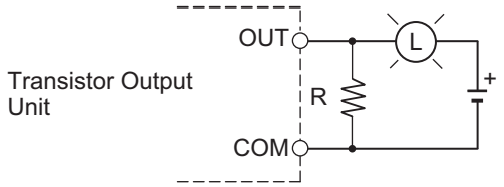
When you use general digital output, steps must be taken to avoid damage to the output transistor when connecting a load with a high inrush current such as an incandescent lamp.
Use either of the following methods to reduce the inrush current.

In countermeasure 1, the current consumption from the I/O power supply is increased although the voltage supplied to the load L is not decreased.
In countermeasure 2, the voltage supplied to the load L is decreased although the current consumption from the I/O power supply is not increased.
Select the appropriate countermeasures according to the operating conditions.

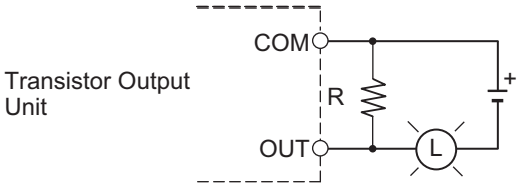
Countermeasure 1

Draw about 1/3 of the rated current consumed by the load.

NPN type



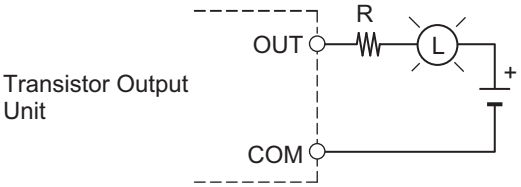
PNP type



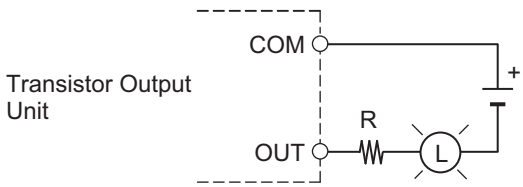
Countermeasure 2

Mount a limiting resistor.

NPN type



PNP type



5-4 Digital I/O Unit Wiring

This section describes the wiring for the digital I/O connection terminal block.

5-4-1 Wiring the Terminals

Applicable Wires

The wires that you can connect to the terminal block are twisted wires, solid wires, and ferrules that are attached to the twisted wires. The following section describes the dimensions and processing methods for applicable wires.

● Using Ferrules

If you use ferrules, attach the twisted wires to them.
Observe the application instructions for your ferrules for the wire stripping length when attaching ferrules.
Always use plated one-pin ferrules. Do not use unplated ferrules or two-pin ferrules.

The applicable ferrules, wires, and crimping tools are listed in the following table.

Manufacturer	Ferrule model	Applicable wire (mm^2 (AWG))	Crimping Tool (applicable wire size given in parentheses)
Phoenix Contact	AI0,5-10	0.5 (#20)	Phoenix Contact CRIMPFOX 6 (0.25 to 6 mm^2, AWG24 to 10)
	AI0,75-10	0.75 (#18)	
	AI1,0-10	1.0 (#18)	
	AI1,5-10	1.5 (#16)	
Weidmüller	H0.5/16	0.5 (#20)	Weidmüller PZ6 Roto (0.14 to 6 mm^2, AWG26 to 10)
	H0.75/16	0.75 (#18)	
	H1.0/16	1.0 (#18)	
	H1.5/16	1.5 (#16)	

● Using Twisted or Solid Wires

Wire type	Conductor cross-sectional area	Conductor length (stripping length)
Solid wire	0.14 to 1.5 mm^2	10 mm
Twisted wire		

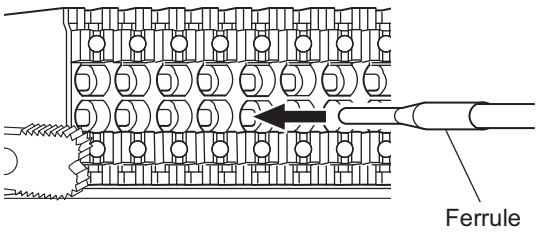
Required Tools

Use a flat-blade screwdriver to remove wires.
The recommended screw driver is as follows.

Model	Manufacturer
SZF 0-0,4X2,5	Phoenix Contact

Connecting Ferrules

Insert the ferrule straight into the terminal hole.
It is not necessary to press a flat-blade screwdriver against the release button.

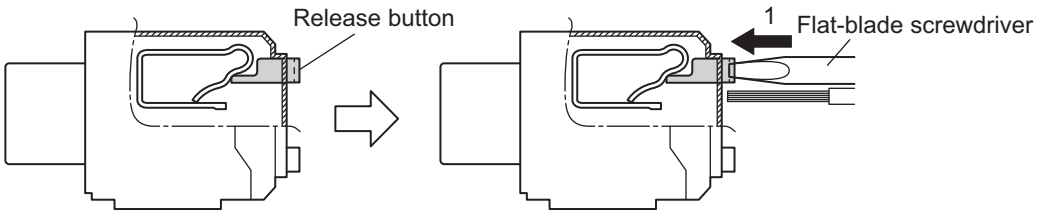


After you make a connection, make sure that the ferrule is securely connected to the terminal block.

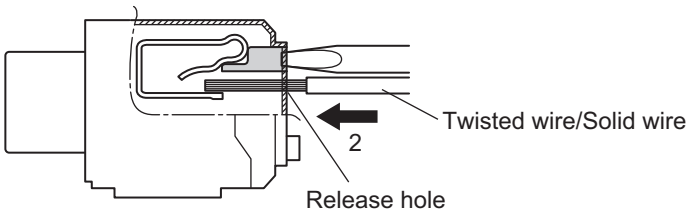
Connecting Twisted Wires/Solid Wires

Use the following procedure to connect the twisted wires or solid wires to the terminal block.

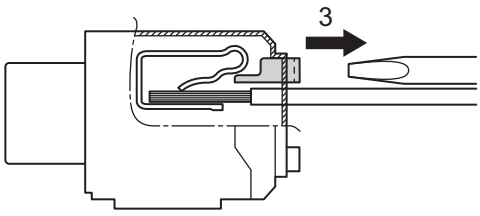
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and insert the twisted wire or the solid wire into the terminal hole.
Insert the twisted wire or the solid wire until the stripped portion is no longer visible, to prevent shorting.



3 Pull the flat-blade screwdriver away from the release button.



After you make a connection, make sure that the twisted wire or the solid wire is securely connected to the terminal block.

Precautions for Safe Use

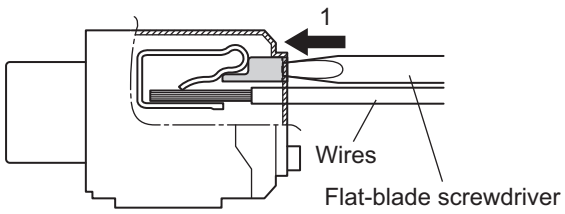
- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

Removing Wires

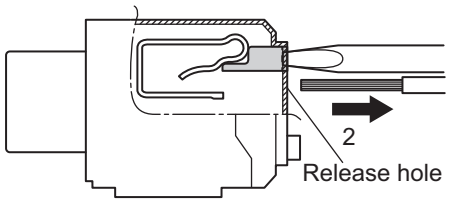
Use the following procedure to remove the wires from the terminal block.
The removal method is the same for ferrules, twisted wires, and solid wires.

If wires are secured firmly to the terminal block, release them first.

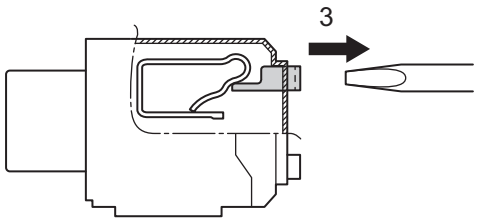
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and pull out the wire from the terminal hole.



3 Pull the flat-blade screwdriver away from the release button.



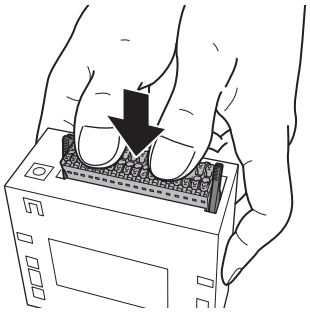
Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

Installing a Terminal Block

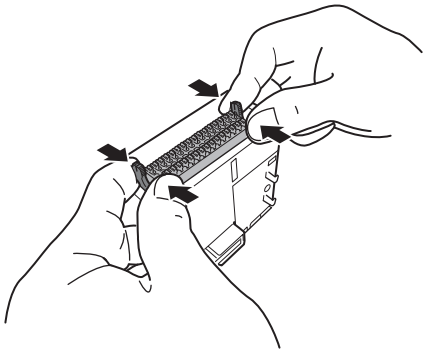
Insert the terminal block into the main body, and press hard to click the terminal block into place on the Unit.

After you mount the terminal block, make sure that it is fixed to the Unit.



Removing a Terminal Block

Drop the lock levers on both sides of the terminal block at the same time to remove the terminal block.



5-4-2 Precautions When Connecting a Two-wire DC Sensor

When a two-wire sensor is used with a digital input, check that the following conditions are met. Failure to meet these conditions may result in operating errors.

Relation between ON Voltage of the Digital Input and Sensor Residual Voltage

$V_{ON} \leq V_{CC} - V_R$

V_{ON}: ON voltage of digital input

V_{CC}: Input voltage of digital input

V_R: Output residual voltage of sensor

Relation between Input Current to the Digital Input and Sensor Control Output (Load Current)

I_{OUT} (min) ≤ I_{ON} ≤ I_{OUT} (max)

Precautions for Correct Use

The digital input is constant current type input.
For constant current type input, the input current does not increase linearly with the input voltage.
If you gradually raise the input voltage, once the input current reaches I_{ON}, the input current does not increase and remains roughly constant even when the input voltage is raised.

When I_{ON} is smaller than I_{OUT} (min), connect a bleeder resistor R. The bleeder resistor constant can be calculated as follows:

$R \leq (V_{CC} - V_R) / (I_{OUT}\text{ (min)} - I_{ON})$

Power W of bleeder resistor ≥ $(V_{CC} - V_R)^2 / R \times 4$ [allowable margin]

V_{CC}: Input voltage of digital input
V_R: Output residual voltage of sensor
I_{ON}: Input current of digital input
I_{OUT}: Sensor control output (load current)

Relation between OFF Current of the Digital Input and Sensor Leakage Current

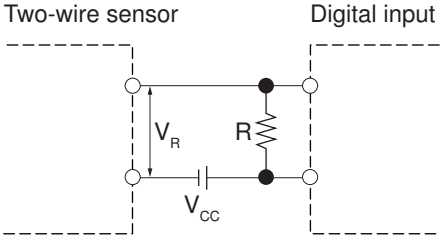
The digital input cannot detect sensor output OFF unless the following conditions are satisfied:

$I_{OFF} \geq I_{leak}$

When I_{leak} is greater than I_{OFF}, connect a bleeder resistor R.
Use the following equation to calculate the bleeder resistance constant.

$R \leq (V_{OFF} / I_{OFF}) \times V_{OFF} / (I_{leak} \times (V_{OFF} / I_{OFF}) - V_{OFF})$

Power W of bleeder resistor ≥ $(V_{CC} - V_R)^2 / R \times 4$ [allowable margin]



V_{CC}: Power supply voltage V_R: Output residual voltage of sensor

V_{ON}: ON voltage of digital input
V_{OFF}: OFF voltage of digital input
I_{ON}: ON current of digital input
I_{OFF}: OFF current of digital input
I_{OUT}: Sensor control output (load current)
I_{leak}: Sensor leakage current
R: Bleeder resistor

Precautions for Sensor Inrush Current

An incorrect input may occur due to sensor inrush current if a sensor is turned ON after the Unit has started up to the point where inputs are possible.
Determine the time required for sensor operation to stabilize after the sensor is turned ON and take appropriate measures, such as inserting an ON delay into the application program after turning ON the sensor.

5-4-3 Precautions When Connecting to Digital Output

Output Short-circuit Protection

If a load connected to the output terminals is short-circuited, output components and printed circuit boards may be damaged.
When you use a NPN type output that does not include the load short-circuit protection, incorporate a protective fuse in the output. Use a fuse with a capacity of protection, around twice the rated output.

Precautions for Inrush Current

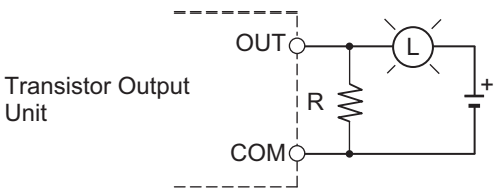
When you use general digital output, steps must be taken to avoid damage to the output transistor when connecting a load with a high inrush current such as an incandescent lamp.
Use either of the following methods to reduce the inrush current.

In countermeasure 1, the current consumption from the I/O power supply is increased although the voltage supplied to the load L is not decreased.
In countermeasure 2, the voltage supplied to the load L is decreased although the current consumption from the I/O power supply is not increased.
Select the appropriate countermeasures according to the operating conditions.

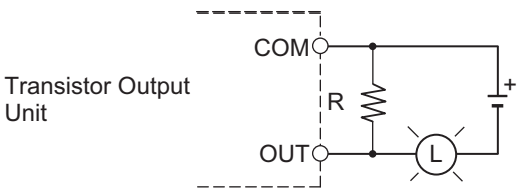
● Countermeasure 1

Draw about 1/3 of the rated current consumed by the load.

NPN type



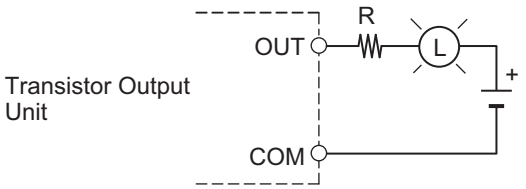
PNP type



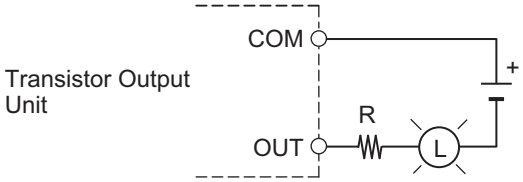
● Countermeasure 2

Mount a limiting resistor.

NPN type



PNP type



5-5 Analog Input Unit Wiring

This section describes the wiring for the analog input connection terminal block.

5-5-1 Wiring the Terminals

Applicable Wires

The wires that you can connect to the terminal block are twisted wires, solid wires, and ferrules that are attached to the twisted wires. The following section describes the dimensions and processing methods for applicable wires.

● Using Ferrules

If you use ferrules, attach the twisted wires to them.
Observe the application instructions for your ferrules for the wire stripping length when attaching ferrules.
Always use plated one-pin ferrules. Do not use unplated ferrules or two-pin ferrules.

The applicable ferrules, wires, and crimping tools are listed in the following table.

Manufacturer	Ferrule model	Applicable wire (mm^2 (AWG))	Crimping Tool (applicable wire size given in parentheses)
Phoenix Contact	AI0,5-10	0.5 (#20)	Phoenix Contact CRIMPFOX 6 (0.25 to 6 mm^2, AWG24 to 10)
	AI0,75-10	0.75 (#18)	
	AI1,0-10	1.0 (#18)	
	AI1,5-10	1.5 (#16)	
Weidmüller	H0.5/16	0.5 (#20)	Weidmüller PZ6 Roto (0.14 to 6 mm^2, AWG26 to 10)
	H0.75/16	0.75 (#18)	
	H1.0/16	1.0 (#18)	
	H1.5/16	1.5 (#16)	

● Using Twisted or Solid Wires

Wire type	Conductor cross-sectional area	Conductor length (stripping length)
Solid wire	0.14 to 1.5 mm^2	10 mm
Twisted wire		

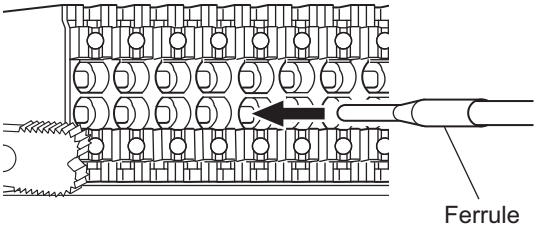
Required Tools

Use a flat-blade screwdriver to remove wires.
The recommended screw driver is as follows.

Model	Manufacturer
SZF 0-0,4X2,5	Phoenix Contact

Connecting Ferrules

Insert the ferrule straight into the terminal hole.
It is not necessary to press a flat-blade screwdriver against the release button.

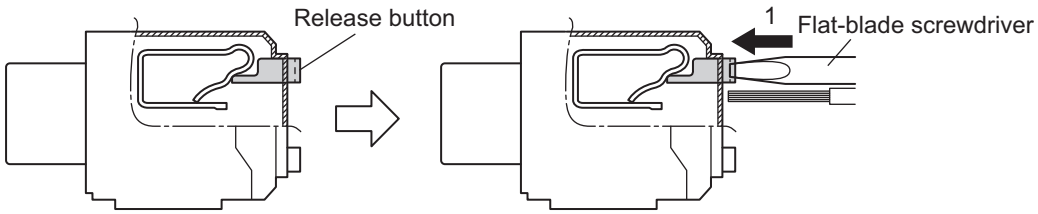


After you make a connection, make sure that the ferrule is securely connected to the terminal block.

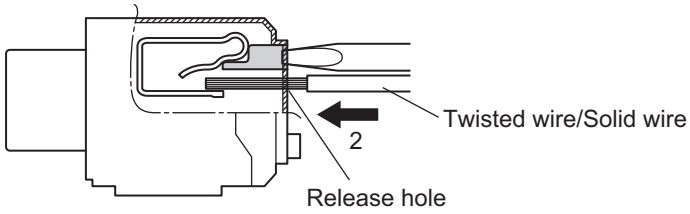
Connecting Twisted Wires/Solid Wires

Use the following procedure to connect the twisted wires or solid wires to the terminal block.

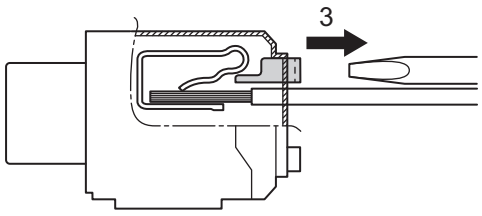
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and insert the twisted wire or the solid wire into the terminal hole.
Insert the twisted wire or the solid wire until the stripped portion is no longer visible, to prevent shorting.



3 Pull the flat-blade screwdriver away from the release button.



After you make a connection, make sure that the twisted wire or the solid wire is securely connected to the terminal block.

Precautions for Safe Use

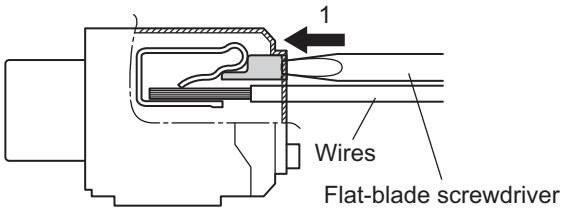
- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

Removing Wires

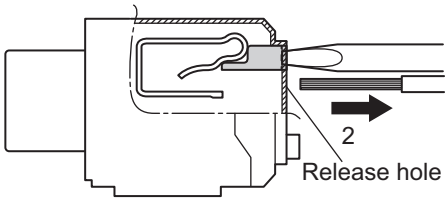
Use the following procedure to remove the wires from the terminal block.
The removal method is the same for ferrules, twisted wires, and solid wires.

If wires are secured firmly to the terminal block, release them first.

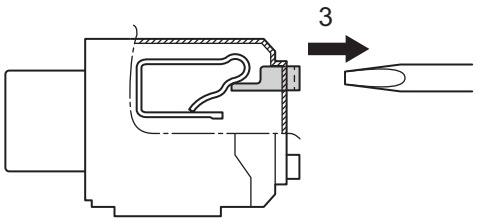
1 Press a flat-blade screwdriver straight against the release button from the terminal block front.



2 Leave the flat-blade screwdriver pressed against the release button and pull out the wire from the terminal hole.



3 Pull the flat-blade screwdriver away from the release button.



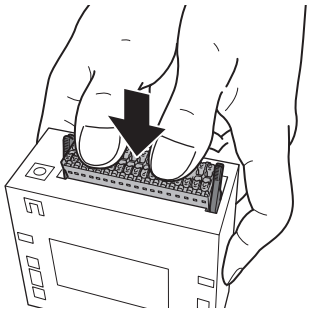
Precautions for Safe Use

- Make sure that all wiring is correct.
- Do not bend the cable forcibly. Doing so may break the cables.

Installing a Terminal Block

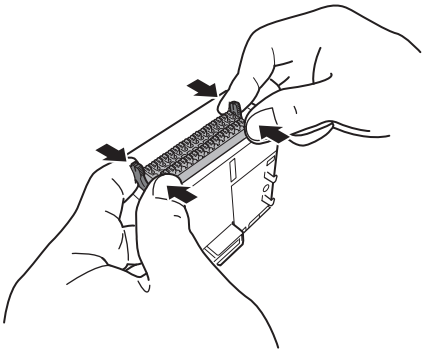
Insert the terminal block into the main body, and press hard to click the terminal block into place on the Unit.

After you mount the terminal block, make sure that it is fixed to the Unit.



Removing a Terminal Block

Drop the lock levers on both sides of the terminal block at the same time to remove the terminal block.

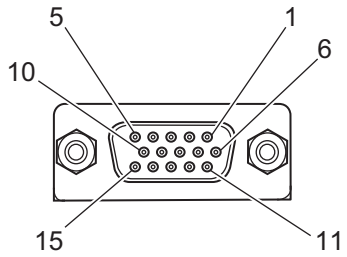


5-6 Encoder Input Unit

This section describes the wiring for the Serial Encoder Input Unit.

5-6-1 Encoder Connector Wiring

The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



Pin No.	Symbol	Serial Encoder	
1	NC	Not wired	-
2	NC	Not wired	-
3	NC	Not wired	-
4	CLK+	Serial Encoder CLK+	Output
5	DATA+	Serial Encoder DAT+	Input/Output
6	NC	Not wired	-
7	NC	Not wired	-
8	NC	Not wired	-
9	CLK-	Serial Encoder CLK-	Output
10	DATA-	Serial Encoder DAT-	Input/Output
11	ENCPWR	Encoder Power Supply (+5 VDC)	Output
12	ENCPWR	Encoder Power Supply (+5 VDC)	Output
13	GND	Encoder Power Supply (GND)	Output
14	GND	Encoder Power Supply (GND)	Output
15	NC	Not wired	-
Shell	SHELL	Shield	

5-6-2 Dedicated Cable

The dedicated cables for wiring to the encoder connector are provided as an option.
The encoder connection side has discrete wires.
Perform wiring to match the encoder specifications.

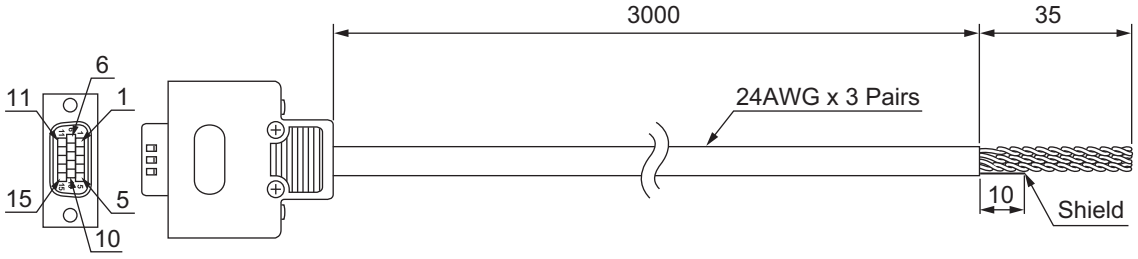
The cable model is as shown below.

Type	Model	Length
For Serial Encoder	CK3W-CAES03A	3 m

Additional Information

You may use a self-made cable.
When you create a self-made cable, use a shielded twisted-pair cable to block the effects of noise.

For Serial Encoder



Type	Pin No.	Cable color	Mark	Signal
Pair 1	11	Blue	Black	Encoder Power Supply (+5 VDC)
	13	Blue	Red	Encoder Power Supply (GND)
Pair 2	4	Pink	Black	Encoder CLK+
	9	Pink	Red	Encoder CLK-
Pair 3	5	Green	Black	Serial Encoder DAT+
	10	Green	Red	Serial Encoder DAT-

Note The cable shield is connected to the connector shell of the encoder connector.

5-7 Laser Interface Unit

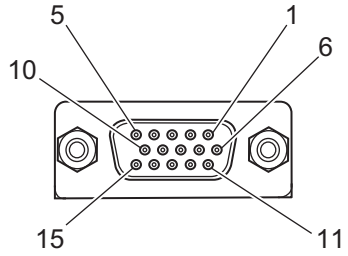
This section describes the wiring for the Laser Interface Unit.

5-7-1 Galvo Scanner Connector Wiring

The XY2-100 Interface connector wiring, SL2-100 Interface connector wiring, and dedicated cables are described below.

XY2-100 Interface Wiring

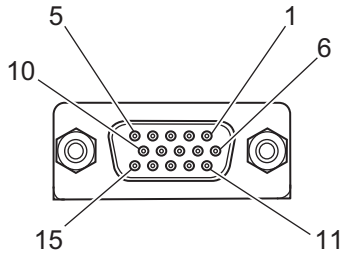
The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



Pin No.	XY		Z	
	Signal	Input/Output	Signal	Input/Output
1	CHX+	Output	CHZ+	Output
2	CHY+	Output	NC	-
3	XY-SYNC+	Output	Z-SYNC+	Output
4	XY-CLOCK+	Output	Z-CLOCK+	Output
5	XY-STATUS+	Input	Z-STATUS+	Input
6	CHX-	Output	CHZ-	Output
7	CHY-	Output	NC	-
8	XY-SYNC-	Output	Z-SYNC-	Output
9	XY-CLOCK-	Output	Z-CLOCK-	Output
10	XY-STATUS-	Input	Z-STATUS-	Input
11	NC	-	NC	-
12	NC	-	NC	-
13	GND	Common	GND	Common
14	GND	Common	GND	Common
15	NC	-	NC	-
Shell	Shield		Shield	

SL2-100 Interface Wiring

The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



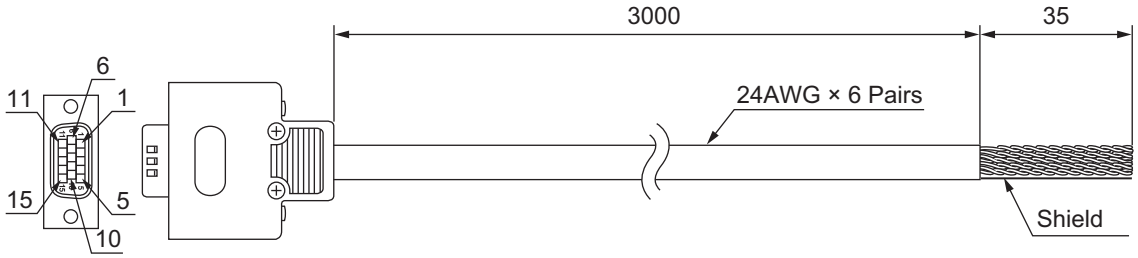
Pin No.	XY		Z	
	Signal	Input/Output	Signal	Input/Output
1	XY-IN+	Input	Z-IN+	Input
2	XY-OUT+	Output	Z-OUT+	Output
3	NC	-	NC	-
4	NC	-	NC	-
5	NC	-	NC	-
6	XY-IN-	Input	Z-IN-	Input
7	XY-OUT-	Output	Z-OUT-	Output
8	NC	-	NC	-
9	NC	-	NC	-
10	NC	-	NC	-
11	NC	-	NC	-
12	NC	-	NC	-
13	NC	-	NC	-
14	NC	-	NC	-
15	NC	-	NC	-
Shell	Shield		Shield	

Dedicated Cable

The dedicated cable for wiring to the Galvo Scanner connector is provided as an option.
The Galvo Scanner connection side has discrete wires.
Perform wiring to match the Galvo Scanner specifications.

The cable model is as shown below.

Type	Model	Length
For Galvo Scanner	CK3W-CAG03A	3 m



Type	Pin No.	Cable color	Tag*1	Signal			
				XY2-100		SL2-100	
				XY	Z	XY	Z
Pair 1	13	Blue	13	GND	GND	Not wired	Not wired
	14	White	14	GND	GND	Not wired	Not wired
Pair 2	1	Yellow	1	CHX+	CHZ+	XY-IN+	Z-IN+
	6	White	6	CHX-	CHZ-	XY-IN-	Z-IN-
Pair 3	2	Green	2	CHY+	Not wired	XY-OUT+	Z-OUT+
	7	White	7	CHY-	Not wired	XY-OUT-	Z-OUT-
Pair 4	3	Red	3	XY-SYNC+	Z-SYNC+	Not wired	Not wired
	8	White	8	XY-SYNC-	Z-SYNC-	Not wired	Not wired
Pair 5	4	Purple	4	XY-CLOCK+	Z-CLOCK+	Not wired	Not wired
	9	White	9	XY-CLOCK-	Z-CLOCK-	Not wired	Not wired
Pair 6	5	Blue	5	XY-STATUS+	Z-STATUS+	Not wired	Not wired
	10	Brown	10	XY-STATUS-	Z-STATUS-	Not wired	Not wired

*1. For the purpose of identification, each line has the tag that shows a pin No.

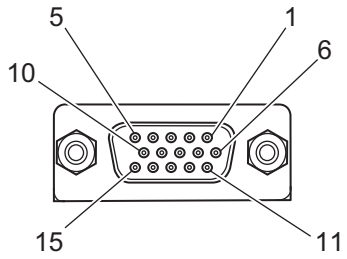
Note The cable shield is connected to the connector shell of the encoder connector.

Additional Information

You may use a self-made cable.
When you create a self-made cable, use a shielded twisted-pair cable to block the effects of noise.

5-7-2 Laser Connector Wiring

The Unit side connector is a high-density D-sub 15-pin female connector (MIL-C-24308 compliant, lock screw #4-40 UNC).



Pin No.	XY	
	Signal	Input/Output
1	NC	-
2	NC	-
3	NC	-
4	OUT0*1	Output
5	OUT1*1 *2	Output
6	NC	-
7	NC	-
8	NC	-
9	OUT_COM0*1	Output

Pin No.	XY	
	Signal	Input/Output
10	OUT_COM1*1 *2	Output
11	NC	-
12	NC	-
13	NC	-
14	NC	-
15	NC	-
Shell	Shield	

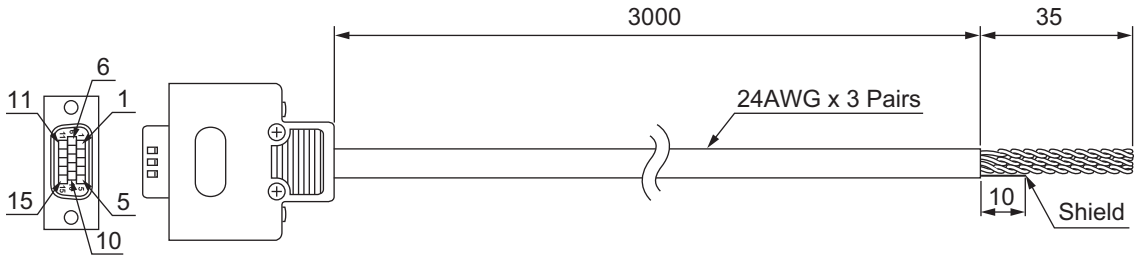
*1. OUT0 is PWM output, and OUT1 is TCR output.
*2. OUT1 is available with the CK3W-GC□200 Units only.

Dedicated Cable

The dedicated cable for wiring to the laser connector is provided as an option.
The laser connection side has discrete wires.
Perform wiring to match the laser specifications.

The cable model is as shown below.

Type	Model	Length
For laser connection	CK3W-CAES03A	3 m



Type	Pin No.	Cable color	Mark	Signal
Pair 1	11	Blue	Black	Not wired
	13	Blue	Red	Not wired
Pair 2	4	Pink	Black	OUT0*1
	9	Pink	Red	OUT_COM0*1 *2
Pair 3	5	Green	Black	OUT1*1
	10	Green	Red	OUT_COM1*1 *2

*1. OUT0 is PWM output, and OUT1 is TCR output.
*2. OUT1 is available with the CK3W-GC□200 Units only.

Note The cable shield is connected to the connector shell of the encoder connector.

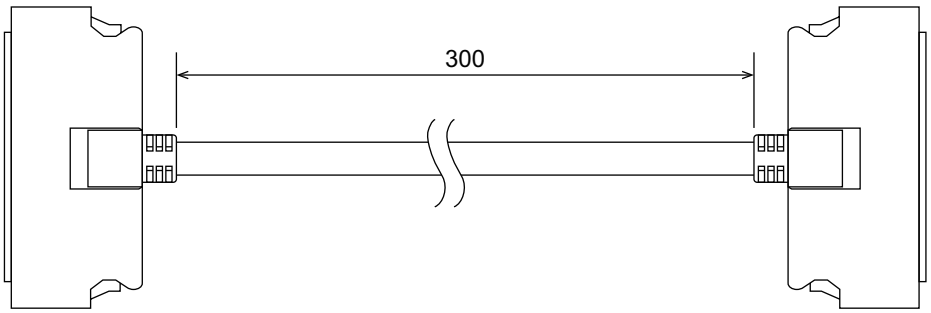
Additional Information

You may use a self-made cable.
When you create a self-made cable, use a shielded twisted-pair cable to block the effects of noise.

5-8 Expansion Master Unit and Expansion Slave Unit Wiring

For connection between the Expansion Master Unit and the Expansion Slave Unit, be sure to use the following expansion cable.

Type	Model	Length
Expansion cable	CK3W-CAX003A	0.3 m



6

Troubleshooting

This section describes the procedures for checking errors that may occur during operation of the CK3M/CK5M-series Programmable Multi-Axis Controller and taking corrective actions for the errors.

6-1 Types of Errors 6-2

6-2 Using the Indicators to Check Errors 6-3

6-2-1 Indicator Types 6-3

6-2-2 Procedure for Identifying Errors 6-3

6-3 Troubleshooting for Errors 6-5

6-3-1 Fatal Errors in the CPU Unit 6-5

6-3-2 Non-fatal Errors in the CPU Unit 6-6

6-3-3 Initialization of CPU Unit Using USB Memory 6-9

6-4 Sys.Status Register 6-10

6-4-1 Sys.Status Register List 6-10

6-4-2 Details of Flags 6-11

6-5 EtherNet/IP Connection Status Codes and Troubleshooting 6-21

6-1 Types of Errors

The errors in the Motion Controller are classified into the following two major categories.

- Fatal errors in the CPU Unit
  Errors that occurred as the result of the CPU Unit operation stopping.
- Non-fatal errors in the CPU Unit
  Errors that can be detected and managed by the CPU Unit itself that is still operating.

6-2 Using the Indicators to Check Errors

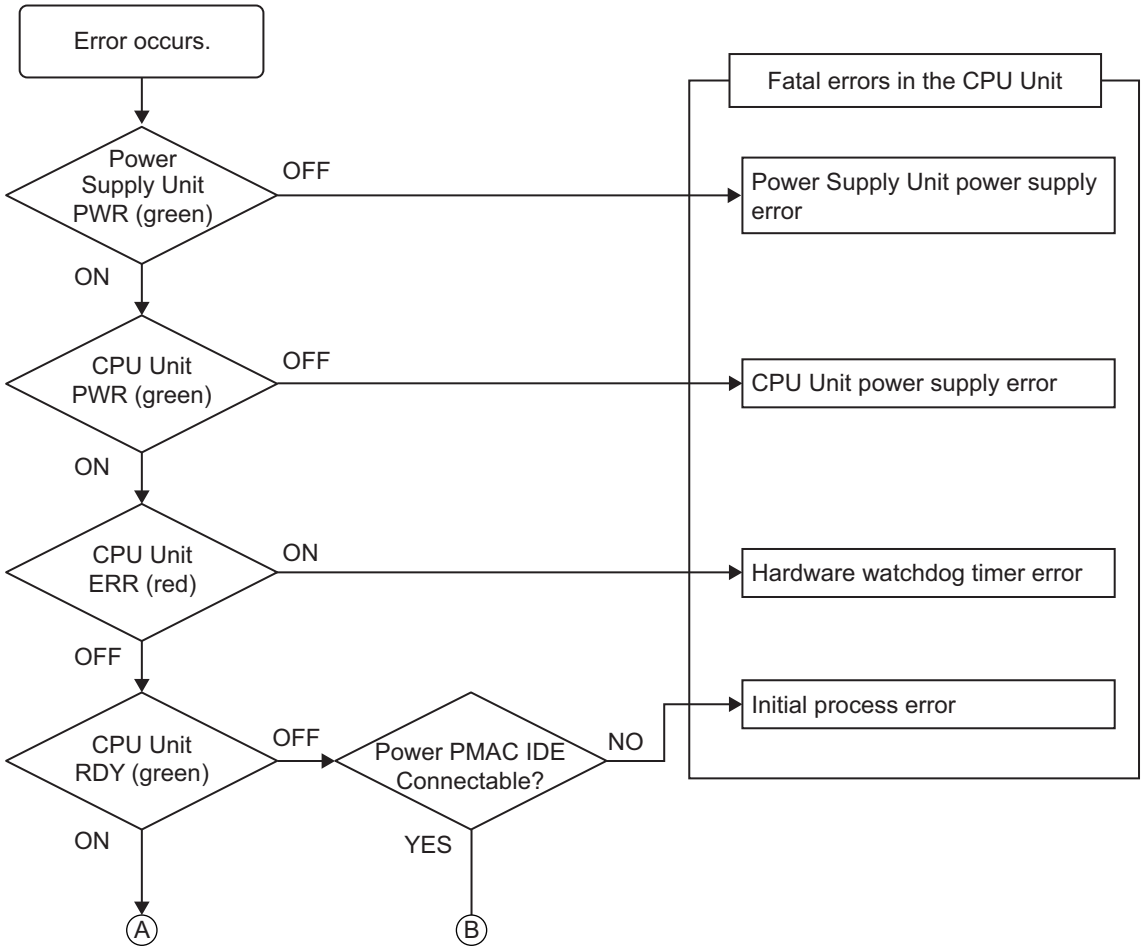
6-2-1 Indicator Types

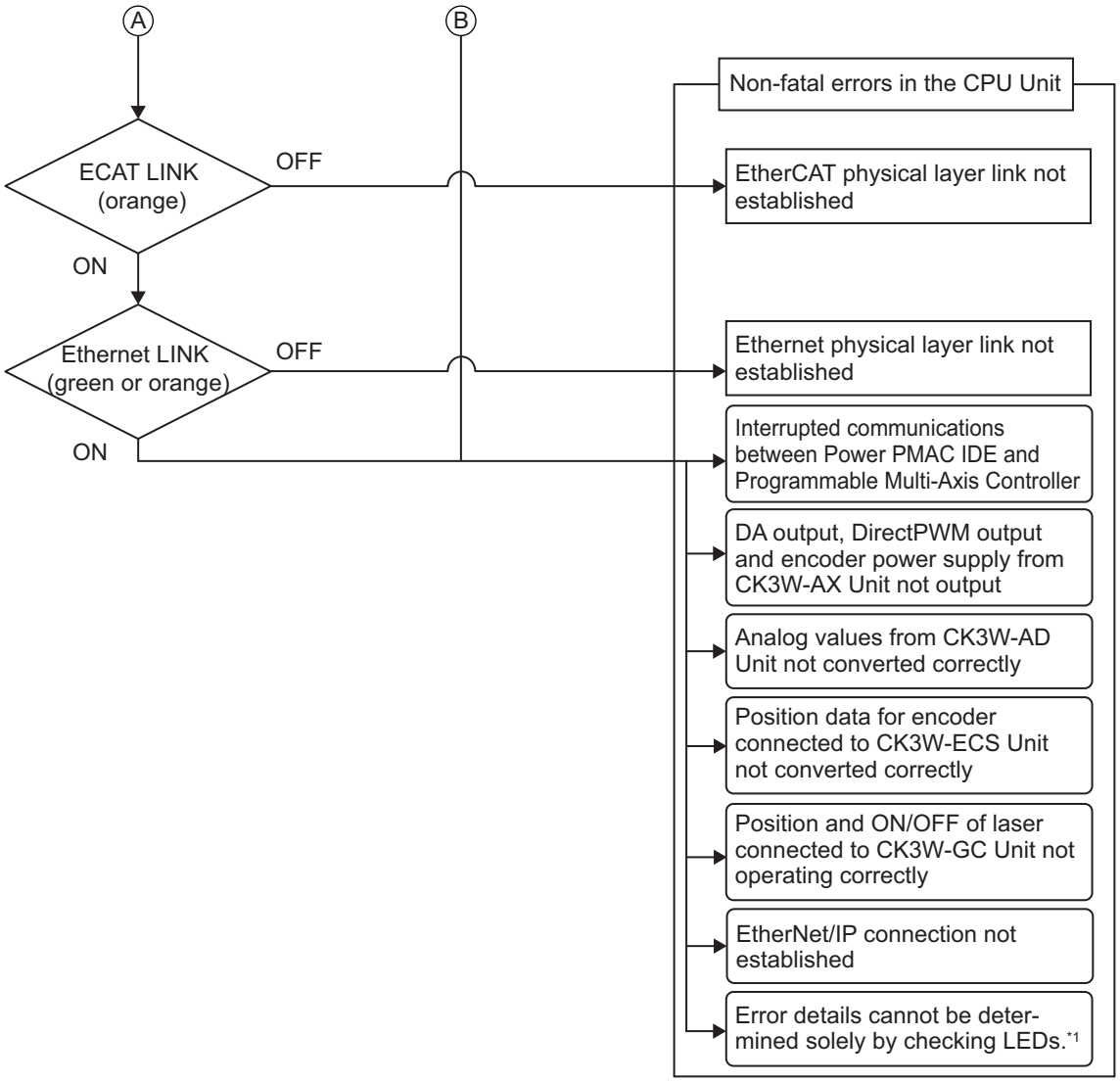
TheMotion Controllerindicators used for error checks and their functions are as shown below.

Unit	Indicator name	Description
Power Supply Unit	PWR	Shows that power is being supplied to the Unit.
CPU Unit	PWR	Shows the CPU Unit internal power status.
	RDY	Shows whether the CPU Unit is in operation-ready status.
	ERR	Shows the CPU Unit watchdog timer error status.
	ECAT LINK	Shows the link status of EtherCAT communications.
	ECAT ACT	Shows the data communications status of EtherCAT communications.
	Ethernet LINK	Shows the link status of Ethernet communications.
	Ethernet ACT	Shows the data communications status of Ethernet communications.
CK□W Unit	PWR	Shows the Unit internal power status.

6-2-2 Procedure for Identifying Errors

When an error occurs in the Motion Controller, check the indicators with the following flowchart to first identify if either a "non-fatal error in the CPU Unit" or a "fatal error in the CPU Unit" has occurred.





*1. For the details of errors that cannot be determined solely by checking the indicators, check the Sys.Status register.
Refer to *6-4-1 Sys.Status Register List* on page 6-10 for the Sys.Status flag.

6-3 Troubleshooting for Errors

6-3-1 Fatal Errors in the CPU Unit

For fatal errors in the CPU Unit, take the following corrective actions depending on the nature of the error.

Description	Cause	Corrective action
Power Supply Unit power supply error	Power is not supplied to the Power Supply Unit	Check the following items and adequately supply power to the unit. • Is the power turned on? • Is the power cable wired correctly? • Is the power cable free of damage?
	Input voltage is out of allowable range	Check the following items and adjust the voltage so that it falls within the allowable range. • Is the power supply voltage within the specified range? • Is the capacity of the power supply sufficient? • Is the power supply failing?
	Output current of the power supplied to the encoder exceeds the maximum current capacity	Check the following items and adjust the voltage so that it does not exceed the maximum current capacity. • Does encoder current consumption exceed the maximum current capacity? • Is the encoder connector wiring connected correctly? • Has the encoder cable short-circuited? • Is the encoder failing?
	Power supply error of mounted unit	Remove the connected Units one by one, and if the error is eliminated, replace that Unit.
	The number of connected Units exceeds the maximum capacity	Check whether the connected Units exceed the maximum connectable number. The maximum connectable number is 2 CK3W-AX Units.
	Power Supply Unit failure	If the error persists even after you make the above corrections, replace the Power Supply Unit.
CPU Unit power supply error	Connection error between the Power Supply Unit and the CPU Unit	Make sure that the Power Supply Unit and the CPU Unit are connected correctly.
	CPU Unit or Power Supply Unit failure	If the error persists even after you make the above corrections, replace the CPU Unit or the Power Supply Unit.

Description	Cause	Corrective action
Hardware watchdog timer error	Unit disconnection during operations	Make sure that the Units are connected correctly.
	Illegal user program	Refer to *6-3-3 Initialization of CPU Unit Using USB Memory* on page 6-9, and execute re-initialization.
	Ingress of conductive object	If there is conductive material nearby, blow air through the CPU Unit.
	Noise	If the error did not result from the above causes, cycle the power to the Controller and see if that resets the error. If the error occurs frequently, check the FG and power supply lines to see if noise is entering on them. Implement noise countermeasures as required.
	CPU Unit failure	If the error persists even after you make the above corrections, replace the CPU Unit.
Initial process error	Ingress of conductive object	If there is conductive material nearby, blow air through the CPU Unit.
	Noise	If the error did not result from the above causes, cycle the power to the Controller and see if that resets the error. If the error occurs frequently, check noise entry paths such as the FG and the power supply lines and implement noise countermeasures as required.
	CPU Unit failure	If the error persists even after you make the above corrections, replace the CPU Unit.

6-3-2 Non-fatal Errors in the CPU Unit

For non-fatal errors in the CPU Unit, take the following corrective actions depending on the nature of the error.

Description	Cause	Corrective action
EtherCAT physical layer link not established	The Ethernet cable used for EtherCAT communications is broken or the specified cable is not being used.	If the Ethernet cable is broken or if the specified cable is not being used, replace the cable.
	Disconnected connector on the Ethernet cable used for EtherCAT communications, contact failure, or part failure	Reconnect the connector and check to ensure it is mated correctly.
	Power is not supplied to the first slave connected to the CPU Unit.	Supply power to the slave.
	Failure of slave within EtherCAT network configuration	Replace the slave.
	Noise	Check noise entry paths, and implement noise-related countermeasures as required.
	CPU Unit failure	Replace the CPU Unit.

Description	Cause	Corrective action
Ethernet physical layer link not established	The Ethernet cable used for Ethernet communications is broken or the specified cable is not being used.	If the Ethernet cable is broken or if the specified cable is not being used, replace the cable.
	Disconnected connector on the Ethernet cable used for Ethernet communications, contact failure, or part failure	Reconnect the connector and check to ensure it is mated correctly.
	Power is not supplied to the Ethernet switch connected to the CPU Unit.	Supply power to the Ethernet switch.
	Failure of device within Ethernet network configuration	Replace the device.
	Noise	Check noise entry paths, and implement noise-related countermeasures as required.
	CPU Unit failure	Replace the CPU Unit.
Interrupted communications between Power PMAC IDE and CPU Unit	Communications interruption, due to disconnection and reconnection of the Ethernet cable used for Ethernet communication between Power PMAC IDE and the CPU Unit while communication was being established	If communications are interrupted between Power PMAC IDE and the CPU Unit with Ethernet communications established, communications cannot be reestablished simply by rectifying the problem that interrupted the communications. To reestablish the communications, you need to click**Communication Setup**in Power PMAC IDE and restart communications.
	Communications interruption due to power to Ethernet switch between Power PMAC IDE and CPU Unit being turned OFF → ON while communications were being established	
	Communications interruption due to power to CPU Unit being turned OFF → ON while communications were being established	
	Temporary communications interruption due to noise	Check noise entry paths, and implement noise-related countermeasures as required. Then reestablish communications between Power PMAC IDE and the CPU Unit. To reestablish the communications, you need to restart Power PMAC IDE or reestablish the communications by using Power PMAC IDE.
EtherNet/IP connection not established	If the originator in use is an NJ/NX-series CPU Unit, you can use Network Configurator to identify the cause and corrective action. Refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)*, *16-2 Checking Status with the Network Configurator* for details. Refer to *6-5 EtherNet/IP Connection Status Codes and Troubleshooting* on page 6-21 for error codes detected by the CK□M.	

Description	Cause	Corrective action
DA output, DirectPWM output and encoder power supply fromCK3W-AX Unitnot output	Power Supply Unit other than CK3W-PD048 is being used.	Check the Power Supply Unit model.
	CK3W-AX Unit failure	Replace the CK3W-AX Unit.
	Internal 24 V power is not being input to the CK3W-AX Unit due to a failure of the Unit to its left.	Replace the Unit to the left of this Unit.
Position data for encoder connected toCK3W-AX Unitnot converted correctly	The wiring is incorrect.	Check that the wiring is correct.
	The connected device is faulty.	Replace the connected device.
	The settings are incorrect.	Correct the settings.
	Input waveforms are not within the specified range.	Review the connected device and wiring so that input waveforms are within the specified range.
	The frequency of the input signal is not within the specified range.	Adjust the frequency to within the specified range.
	CK3W-AX Unitfailure	Replace theCK3W-AX Unit.
Analog values from CK3W-AD Unit not converted correctly	The wiring is incorrect.	Check that the wiring is correct.
	Power Supply Unit other than CK3W-PD048 is being used.	Check the Power Supply Unit model.
	CK3W-AD Unit failure	Replace the CK3W-AD Unit.
	Internal 24 V power is not being input to the CK3W-AD Unit due to a failure of a Unit to its left.	Replace the Unit to the left of this Unit.
Position data for encoder connected to CK3W-ECS Unit not converted correctly	The wiring is incorrect.	Check that the wiring is correct.
	The settings are incorrect.	Correct the settings.
	The cable is out of specification.	Make sure that the followings are within specifications. • Length • Wire type (twisted-pair and shielded)
	The connected device is faulty.	Replace the connected device.
	The cable is broken.	Replace the cable.
	An internal memory error has occurred.	When Gate3[i].Chan[0].Status[26] is 1, this is a temporary error in the internal memory. Cycle the power supply.
	CK3W-ECS Unit failure	Replace the CK3W-ECS Unit.
	Internal 24 V power is not being input to the CK3W-ECS Unit due to a failure of a Unit to its left.	Replace the Unit to the left of this Unit.
Position and ON/OFF of laser connected to CK3W-GC Unit not operating correctly	The wiring is incorrect.	Check that the wiring is correct.
	The settings are incorrect.	Correct the settings.
	The cable is out of specification.	Make sure that the followings are within specifications. • Length • Wire type (twisted-pair and shielded)
	The connected device is faulty.	Replace the connected device.
	The cable is broken.	Replace the cable.

Description	Cause	Corrective action
	An internal memory error has occurred.	When Gate3[i].Chan[0].Status[26] is 1, this is a temporary error in the internal memory. Cycle the power supply.
	CK3W-GC Unit failure	Replace the CK3W-GC Unit.
	Internal 24 V power is not being input to the CK3W-GC Unit due to a failure of a Unit to its left.	Replace the Unit to the left of this Unit.

6-3-3 Initialization of CPU Unit Using USB Memory

If the CPU Unit fails to connect to the Power PMAC IDE, you can use a USB memory to initialize the CPU Unit to the factory state.

Use the following procedure to carry out this process.

1 USB memory preparation
Prepare a blank USB memory formatted in FAT32. The recommended USB memory is listed in *3-1-5 USB Memory Device* on page 3-10.

2 Folder creation
Use a computer to create an empty folder named *PowerPmacFactoryReset* on the USB memory root.

3 With the power OFF, mount the above USB memory to the CPU Unit.

4 When the power to the CPU Unit is turned ON, the CPU Unit will be initialized to the factory default.

5 Connect the Power PMAC IDE, and issue a save command.

6 Turn the power OFF, and remove the USB memory.

6-4 Sys.Status Register

6-4-1 Sys.Status Register List

If an error cannot be identified with indicators, confirm the error status in the Sys.Status register.
If an error occurs during operation, check the Sys.Status register with the user program and take suitable action to avoid dangerous operation.
The Sys.Status register is not saved in the built-in flash memory, so it is deleted if the power goes OFF.
Sys.status can be checked on the Power PMAC IDE; select **Status**–**Global Status** on it.

The Sys.Status register is 32-bit data consisting of the following bits.

Bit	Name	Description
16-31	-	
15	CK3WHWChange	The CK3W hardware configuration was changed during operation.
14	CK3WConfigErr(bit2)	There is an error in the CK3W hardware configuration.
13	CK3WConfigErr(bit1)	
12	CK3WConfigErr(bit0)	
11	FlashSizeErr	The user program size exceeds the built-in flash memory capacity.
10	BufSizeErr	The buffer size exceeds the built-in RAM capacity.
9	AbortAll	In stop status after *Abort all* input
8	NoClocks	Cannot detect a phase clock or a servo clock.
7	Default	Factory default
6	FileConfigErr	System file setting error
5	HWChangeErr	After the save, the hardware configuration was changed.
4	ConfigLoadErr	Error in saved settings
3	ProjectLoadErr	User Project File Read Error
2	PwrOnFault	Read error when power is turned ON or during reset (bit 3 to 6 logical OR)
1	WDTFault (bit 1)	Real-time interruption software watchdog timer error
0	WDTFault (bit 0)	Background software watchdog timer error

6-4-2 Details of Flags

● CK3WHWChange

Register name	Sys.CK3WHWChange		
Description	The CK3W hardware configuration was changed during operation.		
Range	0 to 1		
Details	Checks if there were any changes in the configurations of the connected CK3W Unit and End Cover during operation. 0: No changes in hardware configurations during operation 1: Changes in hardware configurations during operation		
Detection timing	Continuous		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operation continues		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	The CK3W Unit address switch was changed during operation.	Check if there were any changes in the address switch.	None
	The CK3W Unit or End Cover was disconnected during operation.	Make sure that the Units are installed correctly.	None
	Contamination with conductive object	If there is conductive material nearby, blow air through the Unit.	Do not perform any metal work in the vicinity of the control panel. Make sure that the work environment is free of dirt and dust. Then close the control panel.
	Noise • Data corruption in bus signals • Malfunction of bus interface circuit	If the error occurs even after making the above correction, check noise entry paths such as the FG and the power supply lines and implement noise countermeasures as required.	Implement noise countermeasures.
	The CPU Unit or the CK3W Unit has failed • Internal bus contact failure	If this error persists even after you make the above two corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● CK3WConfigErr

Register name	Sys.CK3WConfigErr		
Description	There is an error in the CK3W hardware configuration.		
Range	0 to 7		
Details	Checks that there are no errors in the configurations of the connected CK3W Unit and End Cover. 0: No hardware configuration error 1: No End Cover 2: Five or more CK3W Units are installed to the CPU Rack or Expansion Rack, except for the Expansion Master Unit and Expansion Slave Unit. 3. Seventeen or more CK3W Units are installed to the CPU Unit, except for the Expansion Master Unit and Expansion Slave Unit. 4: Three or more Axis Interface Units are installed to the CPU Rack or Expansion Rack. 5: The Expansion Master Unit is not installed adjacent to the right side of the CPU Unit. 6. Four or more Expansion Racks are connected to the CPU Rack. 7: Address switches overlap. When an error occurs, the Unit number counted from the CPU Unit at which the error was detected is written to the Sys.CK3WConfigCount register. However, the CK3W-EXS02 (Expansion Slave Unit) is excluded from the count. If Sys.CK3WConfigCount is “0”, it shows that an error was detected in the CPU Unit. If Sys.CK3WConfigCount is “1”, it shows that an error was detected in the Unit installed next to the CPU Unit.		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operation continues		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	No End Cover	Attach an End Cover	None
	Seventeen or more CK3W Units are installed to the CPU Unit, except for the Expansion Master Unit and Expansion Slave Unit.	Keep the number of CK3W Units connected to the CPU Unit to 16 or less.	None
	Three or more CK3W-AX Units are connected to the CPU Rack or Expansion Rack.	Reduce the number of CK3W-AX Units connected to two or less.	None
	The CK3W Unit address switch value is used more than once.	Set a unique address to prevent duplication of the address switch value.	None
	Five or more CK3W Units are installed to the CPU Rack or Expansion Rack, except for the Expansion Master Unit and Expansion Slave Unit.	Reduce the number of CK3W Units connected to four or less in each rack.	None
	The Expansion Master Unit is not installed adjacent to the right side of the CPU Unit.	Install the Expansion Master Unit adjacent to the right side of the CPU Unit.	None

	Four or more Expansion Racks are connected to the CPU Rack.	Keep the number of Expansion Racks connected to the CPU Rack to 3 or less.	None
	Contamination with conductive object	If there is conductive material nearby, blow air through the Unit.	Do not perform any metal work in the vicinity of the control panel. Make sure that the work environment is free of dirt and dust. Then close the control panel.
	Noise • Data corruption in bus signals • Malfunction of bus interface circuit	If the error occurs even after making the above correction, check noise entry paths such as the FG and the power supply lines and implement noise countermeasures as required.	Implement noise countermeasures.
	The CPU Unit or the CK3W Unit has failed • The internal bus is disconnected.	If this error persists even after you make the above two corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● FlashSizeErr

Register name	Sys.FlashSizeErr		
Description	The user program size exceeds the built-in flash memory capacity.		
Range	0 to 1		
Details	0: No error 1: The user program size exceeds the built-in flash memory capacity.		
Detection timing	When save command is issued		
Recovery	Re-issue save command.		
Effects	Save command is invalidated.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	The user program size is too large.	Reduce the size of the user program. Or, delete the backup file.	None
Precautions/ Remarks	None		

● BufSizeErr

Register name	Sys.BufSizeErr		
Description	The buffer size set in the user program exceeds the built-in RAM capacity.		
Range	0 to 1		
Details	0: No error 1: Buffer size exceeds the built-in RAM capacity.		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	The buffer size is changed to the default value.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	The buffer size set in the user program is too large.	Reduce the buffer size.	None
Precautions/ Remarks	None		

● AbortAll

Register name	Sys.AbortAll		
Description	Stop by *Abort all* input		
Range	0 to 1		
Details	0: No stop by *Abort all* input 1: Stopped by *Abort all* input, or stopped in the past by *Abort all* input.		
Detection timing	With *Abort all* input		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operation continues		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	Abort all was input.	None	None
Precautions/ Remarks	None		

● NoClocks

Register name	Sys.NoClocks		
Description	Cannot detect a phase clock or a servo clock.		
Range	0 to 1		
Details	0: No error 1: Cannot detect a phase clock or a servo clock.		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Cannot enable the motor.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	The clock-related register is overwritten by the user program.	If the error no longer occurs after the re-initialization command ($$$***) is executed, review the user program.	None
	A Unit that supplies servo clock and phase clock signals is installed to the Expansion Rack.	Install the Unit that supplies clock signals to the CPU Rack.	None
	The CPU Unit or the CK3W Unit has failed	If this error persists even after you make the above corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● Default

Register name	Sys.Default		
Description	Initialized to the factory default setting.		
Range	0 to 1		
Details	0: No error 1: Cases below • In the factory default state, or initialized to the factory default state by a re-initialization command ($$$***). • Configuration changed after save command was issued.		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operation continues		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	Re-initialization command ($$$***) was issued.	None	None
	HWChangeErr or *ConfigLoadErr* occurred.	Check the corrective action for each error.	None
Precautions/ Remarks	None		

● FileConfigErr

Register name	Sys.FileConfigErr		
Description	System file setting error		
Range	0 to 1		
Details	0: No error 1: System file setting error		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operate with default settings.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	System file settings are incorrect.	If the re-initialization command ($$$***) is executed, and the error no longer occurs, review the user program.	None
	The CPU Unit or the CK3W Unit has failed	If this error persists even after you make the above corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● HWChangeErr

Register name	Sys.HWChangeErr		
Description	After the save, the hardware configuration was changed.		
Range	0 to 1		
Details	0: No change in hardware configuration. 1: After the save, the hardware configuration was changed.		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operate with default settings.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	After the save, the Unit configuration or address switch was changed.	Check the Unit configuration or address switch. When changing the Unit configuration or address switch, change the settings to match the new configuration, and issue a save command. If the Unit configuration or address switch has not changed, implement the following measures.	None
	Contamination with conductive object	If there is conductive material nearby, blow air through the Unit.	Do not perform any metal work in the vicinity of the control panel. Make sure that the work environment is free of dirt and dust. Then close the control panel.
	Noise • Data corruption in bus signals • Malfunction of bus interface circuit	If the error occurs even after making the above correction, check noise entry paths such as the FG and the power supply lines and implement noise countermeasures as required.	Implement noise countermeasures.
	The CPU Unit or the CK3W Unit has failed	If this error persists even after you make the above corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● ConfigLoadErr

Register name	Sys.ConfigLoadErr		
Description	Read error in saved settings		
Range	0 to 1		
Details	0: No error 1: System file setting error		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, or issue reset command ($$$)		
Effects	Operate with default settings.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	Settings are incorrect.	If the re-initialization command ($$$***) is executed, and the error no longer occurs, review the settings.	None
	The CPU Unit or the CK3W Unit has failed	If this error persists even after you make the above corrections, replace the CPU Unit or the CK3W Unit.	None
Precautions/ Remarks	None		

● ProjectLoadErr

Register name	Sys.ProjectLoadErr		
Description	User Project File Read Error		
Range	0 to 1		
Details	0: No error 1: User Project File Read Error		
Detection timing	When power is turned ON or the Controller is reset.		
Recovery	Cycle the power supply, issue reset command ($$$), or download the project		
Effects	Operate with default settings.		
Cause and correction	**Cause (Assumed cause)**	**Correction**	**Prevention**
	The project file is corrupted.	After executing the re-initialization command ($$$***), download the project file again.	If the unit power supply is turned OFF while saving the project file, the project file may be corrupted. Do not turn OFF the power supply while saving.
	An illegal project file was downloaded.	Identify the cause from the output window, and make corrections to the project file. After the corrections, execute the re-initialization command ($$$***), and download the project file again.	None
	CPU Unit failure	If this error persists even after you make the above corrections, replace the CPU Unit.	None
Precautions/ Remarks	None		

● PwrOnFault

To know whether the error has occurred when the power is turned ON or at reset with one bit, the value in PwrOnFault becomes 1 when any of Sys.FileConfigErr, Sys.HWChangeErr, Sys.ConfigLoadErr, or Sys.ProjectLoadErr is "1".

● WDTFault

<table>
<tr><td>Register name</td><td colspan="3">Sys.WDTFault</td></tr>
<tr><td>Description</td><td colspan="3">Software Watchdog Timer ErrorStatus</td></tr>
<tr><td>Range</td><td colspan="3">0 to 3</td></tr>
<tr><td>Details</td><td colspan="3">Sys.WDTFault shows the software watchdog timer operation status with 2-bit data.
Bit0: Background software watchdog timer error
0: No background watchdog timer error has occurred.
1: Background watchdog timer error has occurred.
Bit1: Real-time interruption software watchdog timer error
0: No real-time interruption watchdog timer error has occurred.
1: Real-time interruption watchdog timer error has occurred.

Refer to the Power PMAC User's Manual (Cat. No. O014) for details of the software watchdog timer.</td></tr>
<tr><td>Detection timing</td><td colspan="3">During operation</td></tr>
<tr><td>Recovery</td><td colspan="3">Cycle the power supply, issue reset command ($$$) or re-initialization command ($$$***)</td></tr>
<tr><td>Effects</td><td colspan="3">User program: Stops
Hardware: Enters reset state</td></tr>
<tr><td rowspan="3">Cause and correction</td><td>Cause (Assumed cause)</td><td>Correction</td><td>Prevention</td></tr>
<tr><td>Background software watchdog timer error occurred.
• Real-time interruption process took too long, and the background process could not be implemented at the interval set in the Sys.WDTReset register.</td><td>• Review the user program.
• Review the Sys.WDTReset register value.</td><td>None</td></tr>
<tr><td>Real-time interruption software watchdog timer error generated.
• Real-time interruption process could not be implemented at the interval set in the Sys.BgWDTReset register.</td><td>• Review the user program.
• Review the Sys.BgWDTReset register value.</td><td>None</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="3">None</td></tr>
</table>

6-5 EtherNet/IP Connection Status Codes and Troubleshooting

This section describes how to identify the cause of an error by the connection status of the tag data link and how to troubleshoot the error when the originator is an NJ/NX-series CPU Unit. The connection status can be monitored by the device monitor function of the Network Configurator. Refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)* for details of how to start Network Configurator and the device monitor function.

Connection status		Error cause		Corrective action example
General Status (hex)	Additional Status (hex)			
00	0000	Normal status code	The connection has been opened and the tag data link is communicating normally.	-
01	0106	Duplicate consumers	Attempted to open multiple connections for single-consumer data.	If you change the scanner while a tag data link is established, restart the PMAC.
01	0112	Error code returned from target	The RPI value is invalid.	If a single connection is connected to multiple originators, check if the RPI values are not different.
01	0114	Error code returned from target	The Vendor ID and Product Code did not match when the connection was opened.	Check if the originator did not specify a target device model that was different from the model of the target device actually connected.
01	0115	Error code returned from target	The Device Type did not match when opening connection.	Check if the originator did not specify a target device model that was different from the model of the target device actually connected.
01	0116	Error code returned from target	The Major/Minor Revisions did not match when opening connection.	Check if the revision in the EDS file in use matches the revision of the device.
01	0117	Error code returned from target	The tag set specified in the connection's target variables does not exist.	Check that the tag settings are correct with the EtherNet/IP setting tool.
01	011A	Error code returned from target	The number of connections is more than 32.	Does not occur. *1
01	0127	Error code returned from target	The connection size is different between the originator and target.	Check if the connection size of the target matches the connection size of the originator.
01	0128			
01	012F	Error code returned from target	The application path is different between the originator and target.	Check that the setting values for the target variable and originator variable are correct with the EtherNet/IP setting tool.

Connection status		Error cause		Corrective action example
General Status (hex)	Additional Status (hex)			
01	0203	Error code generated by originator	The connection timed out.	Timeout of tag data link communication from the target occurred. Check the power supply to and cable wiring of the devices on the path including the target and switch. If the cause is a decrease in performance due to heavy load, review the performance design by increasing the timeout value, RPI, or etc.
01	0204	Error code generated by originator	The connection open process timed out.	The target did not respond. Check the power supply to and cable wiring of the devices on the path including the target and switch.
01	0302	Error code generated by originator or returned from target	The overall communication of EtherNet/IP configuration exceeds the tag data link allowable communication bandwidth (pps).	Review the EtherNet/IP settings so that pps does not exceed the limit.

*1. If the number of connections is more than 32, *Tag Data Link Timeout* will occur repeatedly. If the controller log contains repetitive *Tag Data Link Timeout* records, check if the number of connections is appropriate.

7

Inspection and Maintenance

This section describes the procedures for the cleaning, inspection, and maintenance of the CK3M/CK5M-series Programmable Multi-Axis Controller.

7-1 Cleaning and Inspection 7-2
7-1-1 Cleaning 7-2
7-1-2 Periodic Inspections 7-2
7-2 Maintenance Procedures 7-4
7-2-1 Unit Replacement Precautions 7-4
7-2-2 Backup 7-4
7-2-3 Unit Replacement 7-4

7-1 Cleaning and Inspection

This section describes daily maintenance and the cleaning and inspection methods.
In order to use the functions of the Motion Controller in the best condition, please perform daily or regular inspections.

7-1-1 Cleaning

Perform the following cleaning procedures periodically to ensure the Motion Controller is maintained in the best operating condition. Always turn OFF the power supply to the Motion Controller before performing the cleaning procedures.

- Wipe off the dust or dirt on the front, top, or bottom of the Unit with a dry, soft cloth when doing daily cleaning.
- If dust or dirt remains even after wiping with a soft, dry cloth, wipe over with a cloth that has been wet with a sufficiently diluted detergent (2%) and wrung dry.
- Smudges may remain on the Unit from rubber, vinyl, or tape that was left on for a long time. Remove the smudges when cleaning.

Precautions for Correct Use

Never use volatile solvents, such as paint thinner, benzene, or chemical wipes.

7-1-2 Periodic Inspections

Since Motion Controller elements can deteriorate under improper environmental conditions, periodic inspections are required to ensure that the required conditions are being maintained.
Inspection is recommended at least once every six months to a year, but more frequent inspections may be necessary depending on the ambient environment.
Take immediate steps to correct the situation if any of the conditions in the following table are not met.

Inspection item	Inspection details	Criteria	Correction
External power supply	Check for voltage fluctuations at the power supply terminals.	The voltage must be within the allowable voltage fluctuation range.	Use a voltage tester to check the power supply at the terminals. Take necessary steps to bring voltage of the supplied power to within the allowable voltage fluctuation range.
Ambient environment	Check the ambient temperature. *1	0 to 55 °C	Use a thermometer to check the temperature and ensure that the ambient temperature remains within the allowed range of 0 to 55 °C.
	Check the ambient humidity. *2	Relative humidity must be 10% to 95% with no condensation.	Use a hygrometer to check the humidity and ensure that the ambient operating humidity remains between 10% and 90%. Make sure that condensation does not occur due to rapid changes in temperature.
	Check that the Controller is not in direct sunlight.	Not in direct sunlight	Protect the Controller if necessary.

Inspection item	Inspection details	Criteria	Correction
	Check for accumulation of dirt, dust, salt, metal powder, etc.	No accumulation	Clean and protect the Controller if necessary.
	Check for water, oil, or chemical sprays hitting the Controller.	No spray	Clean and protect the Controller if necessary.
	Check for corrosive or flammable gases in the area of the Controller.	No corrosive or flammable gases	Check by smell or use a sensor.
	Check the level of vibration or shock.	Vibration resistance and shock resistance must be within specifications.	Install cushioning or shock absorbing equipment if necessary.
	Check for noise sources near the Controller.	No significant noise sources	Either separate the Controller and noise source or protect the Controller.
Installation and wiring	Check that cable connectors are fully inserted and locked.	No looseness	Fully insert and lock the connectors.
	Check that the connectors for each Unit are fully inserted and locked.	No looseness	Press the connectors together completely and lock them with the sliders.
	Check for damaged external wiring cables.	No visible damage	Check visually and replace cables if necessary.

*1. If using a control panel, the temperature inside the control panel is the ambient temperature.
*2. If using a control panel, the humidity inside the control panel is the ambient humidity.

Tools Required for Inspections

● Required Tools

- Flat-blade screwdriver
- Phillips screwdriver
- Voltage tester or digital multimeter
- Industrial alcohol and pure cotton cloth
- Antistatic gas duster

● Tools Required Occasionally

- Oscilloscope
- Thermometer and hygrometer

7-2 Maintenance Procedures

This section describes the procedures to back up the data in the CPU Unit and to replace the Unit.
Use Power PMAC IDE Ver.4.0 or a higher version.

7-2-1 Unit Replacement Precautions

If you find any faulty Units during inspection, replace the Unit according to the following points.

- Do not replace a Unit until the power is turned OFF.
- After replacement, check the new Unit to ensure that there are no errors.
- If you return a faulty unit for repair, describe the problem in as much detail as possible, enclose this description with the Unit, and request repairs.

7-2-2 Backup

Store the project file and the EtherCAT ENI file so that the data can be restored when a failure or other problems occur.
If you are not using EtherCAT, saving the ENI file is not necessary.

7-2-3 Unit Replacement

Procedure to Replace a CPU Unit

The following describes the basic replacement procedure for the CPU Unit.

No.	Step	Description	Reference
1	Turn OFF power to the devices	Turn OFF power to the Motion Controller. Take measures to ensure that there are no effects on the peripheral devices, and then turn OFF power to the Motion Controller.	-
2	Disconnect cables	Disconnect the cables connected to the CPU Unit.	-
3	Replace the CPU Unit	Replace the CPU Unit with a new Unit, connect the cables, and turn ON power to the Motion Controller and EtherCAT equipment.	-
4	Connect with IDE	Connect the CPU Unit and the Power PMAC IDE online through Ethernet.	-
5	Initialize	In the terminal window, input the re-initialization command ($$$***), and initialize the CPU Unit.	-
6	Read the EtherCAT ENI file	In Power PMAC IDE, click **Delta Tau** – **Tools** – **System Setup** – **Master[0] Deactivated** in order. Click the **Browse** button, and read the backed-up ENI file into Power PMAC IDE.	Only when using EtherCAT
7	Write the EtherCAT ENI file	Click the **Download ENI file** button, and write the ENI file to the CPU Unit.	Only when using EtherCAT
8	Read the project file	Read out the backed-up project file in Power PMAC IDE.	The EtherNet/IP settings are contained in the project file.

No.	Step	Description	Reference
9	Write the project file	Right-click the project name, click **Build and Download All Programs**, and write the project file to the CPU Unit.	-
10	Execute save	In the terminal window, input the save command, and save the program in the built-in flash memory.	-
11	Execute reset	In the terminal window, input the reset command *$$$*, and reset the CPU Unit.	-

Procedure to Replace a CK3W Unit

The following describes the replacement procedure for a CK3W Unit.

No.	Step	Description	Reference
1	Turn OFF power to the devices	Take measures to ensure that there are no effects on the peripheral devices, and then turn OFF power to the Motion Controller.	-
2	Disconnect cables	Disconnect the cables connected to the CK3W Unit.	-
3	Set the address switch	Set the address switch of the new Unit to the same setting as that of the previous Unit.	-
4	Replace the CK3W Unit	Replace with the new Unit, connect the cables, and turn ON power to the Motion Controller.	-

Procedure to Replace an EtherCAT Slave

If you use EtherCAT, use the following procedure to replace an EtherCAT slave.

No.	Step	Description	Reference
1	Turn OFF power to the devices	Take measures to ensure that there are no effects on the peripheral devices, and then turn OFF power to the Motion Controller and all EtherCAT slaves.	-
2	Replace the EtherCAT Slave	For the EtherCAT slave replacement method, refer to the relevant manuals for each slave. Replace with a new Unit, turn ON power to the EtherCAT slave, and then turn ON power to the Motion Controller.	Refer to the manual for each EtherCAT slave for details.

A

Appendices

The appendices provide the general specifications, the Unit dimensions, and restrictions on using the OMRON EtherCAT Coupler Unit.

A-1 General Specifications A-3

A-2 Dimensions A-4

A-2-1 CPU Unit A-4
A-2-2 Power Supply Unit A-5
A-2-3 Axis Interface Unit A-5
A-2-4 CK3W-MD and CK3W-AD Units A-6
A-2-5 CK3W-ECS and CK3W-GC Units A-7
A-2-6 Expansion Master Unit and Expansion Slave Unit A-8
A-2-7 End Cover A-9

A-3 Restrictions on Using the NX-series EtherCAT Coupler Unit A-10

A-4 OMRON Servo Drive Connection Example A-11

A-5 Version Information A-12

A-6 How to Read the Lot Number A-13

A-7 Supported CIP Objects A-14

A-7-1 Identity Object (Class ID: 01 Hex) A-14
A-7-2 Assembly Object (Class ID: 04 Hex) A-15
A-7-3 TCP/IP Interface Object (Class ID: F5 Hex) A-16
A-7-4 Ethernet Link Object (Class ID: F6 Hex) A-17

A-8 Software Reference of Encoder Input Unit A-21

A-8-1 Gate3[i].SerialEncCtrl (Serial Encoder Control) A-21
A-8-2 Gate3[i].Chan[j].SerialEncEna (Serial Encoder Enable) A-24
A-8-3 Gate3[i].Chan[j].SerialEncCmd (Serial Encoder Command) A-24
A-8-4 Gate3[i].Chan[j].SerialEncDataA (Serial Encoder Data A) A-27
A-8-5 Gate3[i].Chan[j].SerialEncDataB (Serial Encoder Data B) A-28
A-8-6 Gate3[i].Chan[0].Status (Internal Memory Error Detection) A-31

A-9 Software Reference of Laser Interface Unit A-33

A-9-1 Gate3[i].SerialEncCtrl (Control Register) A-33
A-9-2 Gate3[i].Chan[j].DAC[0] (Setting of Command Position and Control Command) A-34
A-9-3 Gate3[i].Chan[j].DAC[1] (Setting of Command Position Compensation Value) A-35
A-9-4 Gate3[i].Chan[j].SerialEncDataA (Command Position after Interpolation, Reception Data) A-35
A-9-5 Gate3[i].Chan[j].SerialEncDataB (Status Data) A-36

A-9-6 Gate3[i].Chan[0].CompA (PWM Output Setting) A-38
A-9-7 Gate3[i].Chan[1].CompA (PWM Output Delay Setting) A-38
A-9-8 Gate3[i].Chan[2].CompA (PWM Output Pulse Count) A-38
A-9-9 Gate3[i].Chan[0].CompB (TCR Output Command Distance Setting) A-39
A-9-10 Gate3[i].Chan[1].CompB (TCR Output Comparison Table Setting) A-39
A-9-11 Gate3[i].Chan[2].CompB (TCR Output Control Register) A-39
A-9-12 Gate3[i].Chan[3].CompB (TCR Output Status Register) A-40
A-9-13 Gate3[i].Chan[0].Status (Internal Memory Error Detection) A-40

A-1 General Specifications

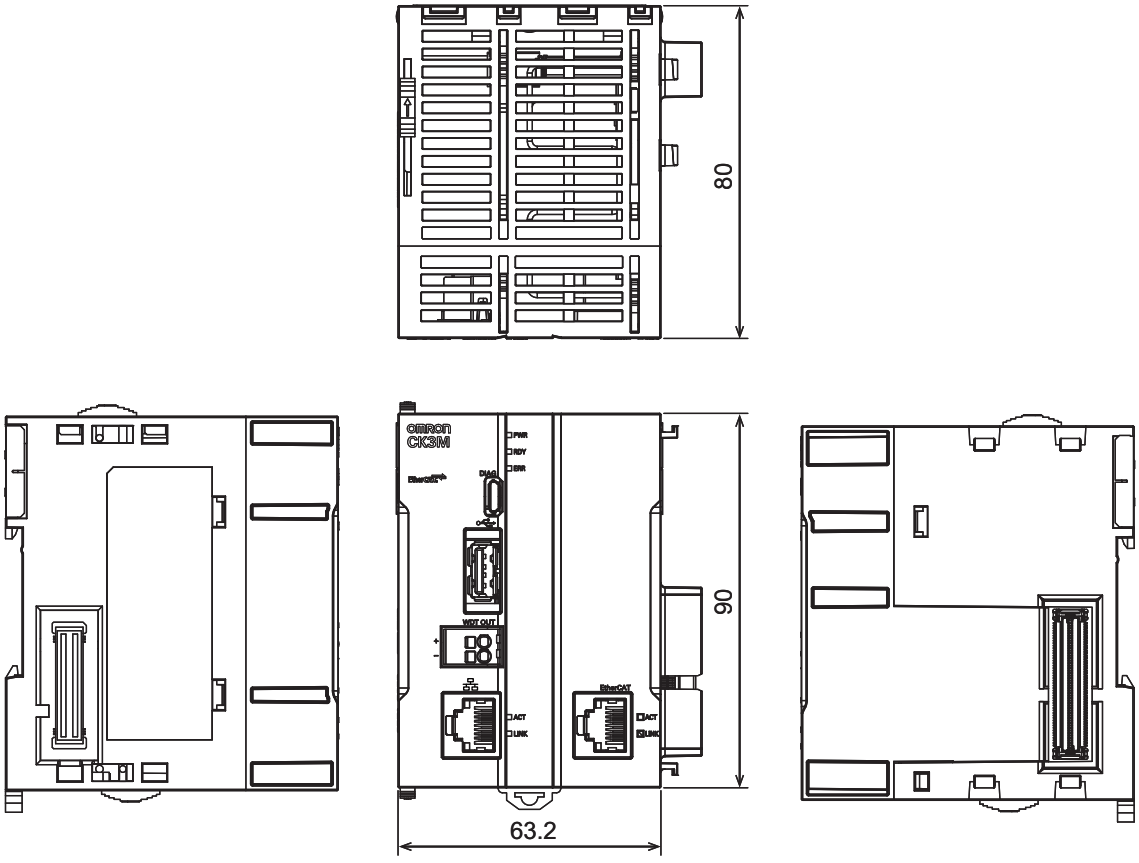
This section describes the Motion Controller specifications.

Item		Specification
Enclosure		Mounted in a panel
Grounding Method		Ground to less than 100 Ω.
Operating Environment	**Ambient Operating Temperature**	0 to 55 °C
	Ambient Operating Humidity	10% to 95% (with no condensation or icing)
	Atmosphere	Must be free of corrosive gases.
	Ambient Storage Temperature	-25 to 70 °C (with no condensation or icing)
	Vibration Resistance	Conforms to IEC 60068-2-6. 5 to 8.4 Hz with 3.5-mm amplitude, 8.4 to 150 Hz, acceleration of 9.8 m/s^2 100 min each in X, Y, and Z directions (10 sweeps of 10 min each = 100 min total)
	Shock Resistance	Conforms to IEC 60068-2-27. 147 m/s^2, 3 times each in X, Y, and Z directions
Insulation Resistance		20 MΩ min. between isolated circuits (at 100 VDC)
Dielectric Strength		510 VAC between isolated circuits for 1 minute with a leakage current of 5 mA max.
Applicable Standards		cULus, EU: EN 61326, RCM, KC

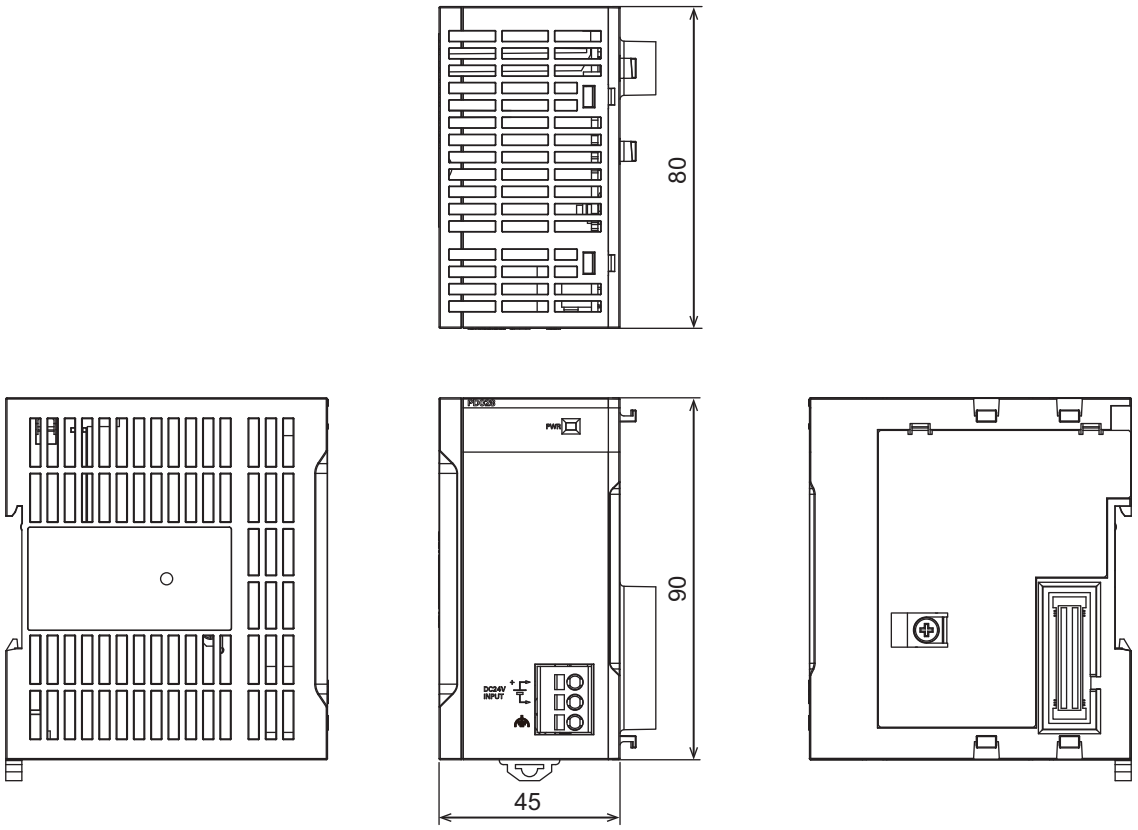
A-2 Dimensions

Dimensions are shown below. The unit of dimension is millimeters.

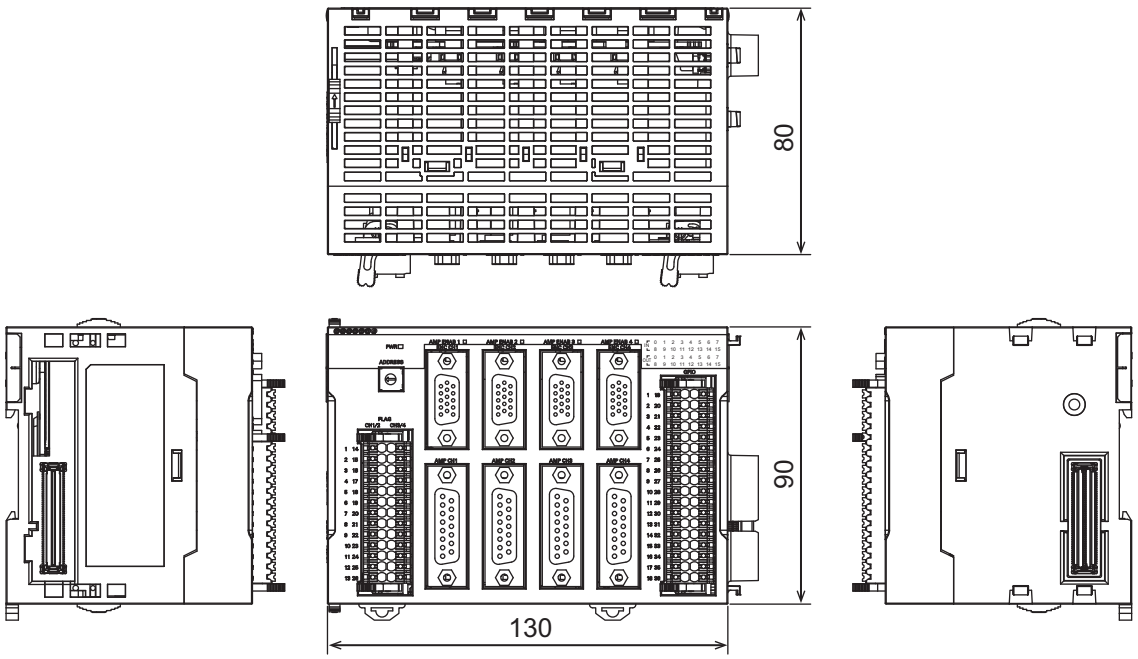
A-2-1 CPU Unit



A-2-2 Power Supply Unit

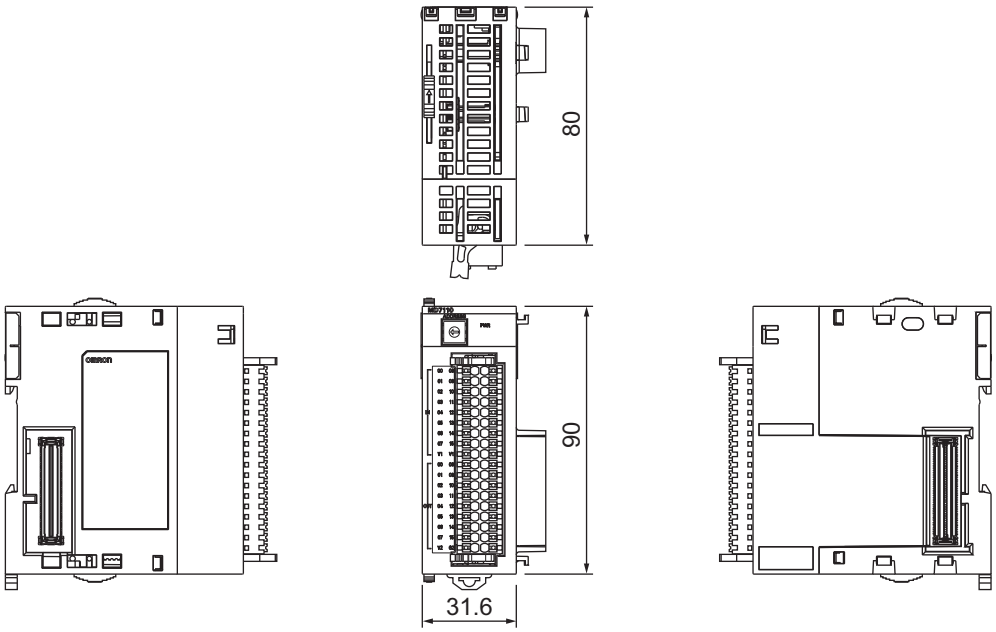


A-2-3 Axis Interface Unit

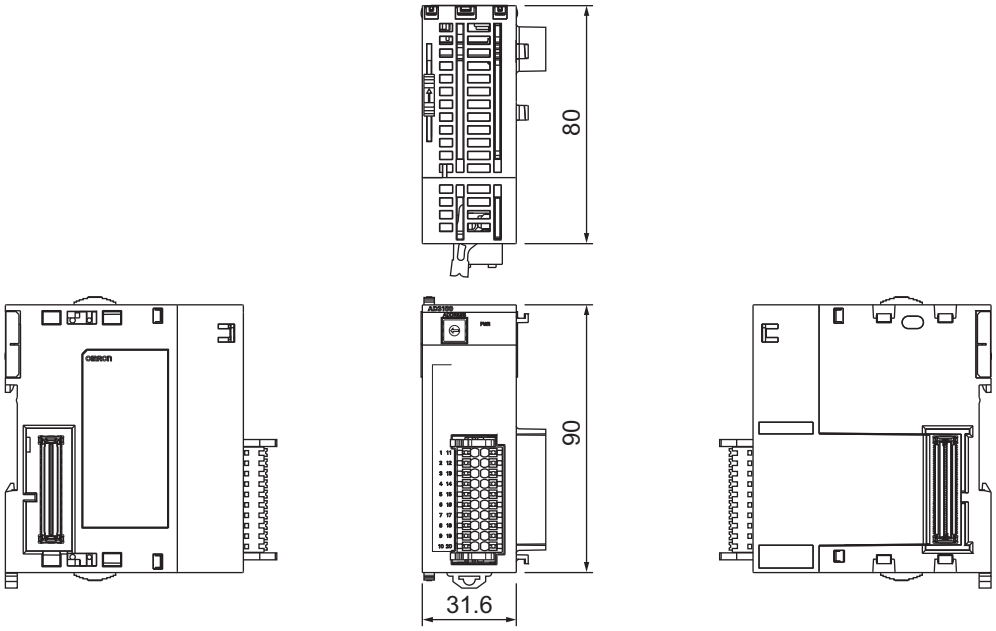


A-2-4 CK3W-MD and CK3W-AD Units

CK3W-MD Unit

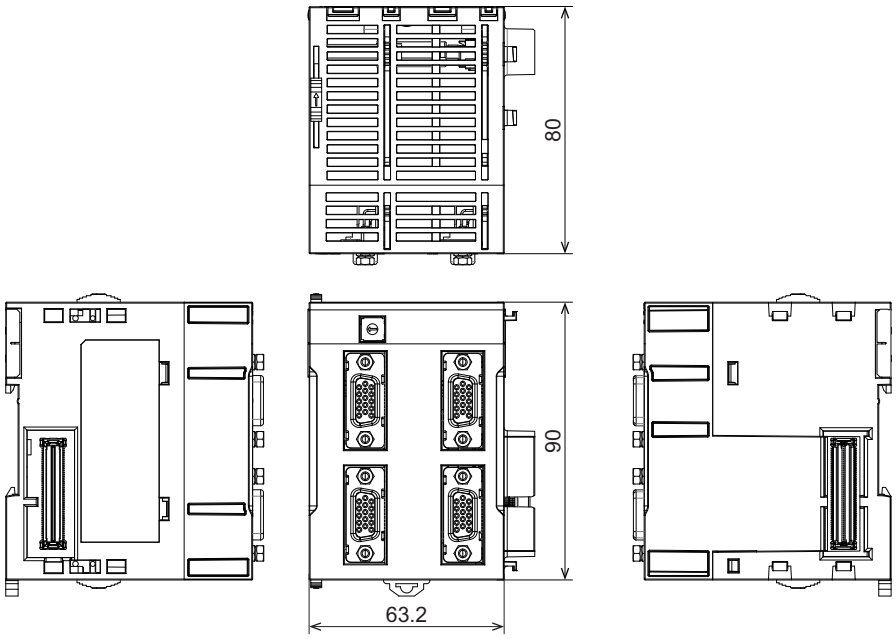


CK3W-AD Unit

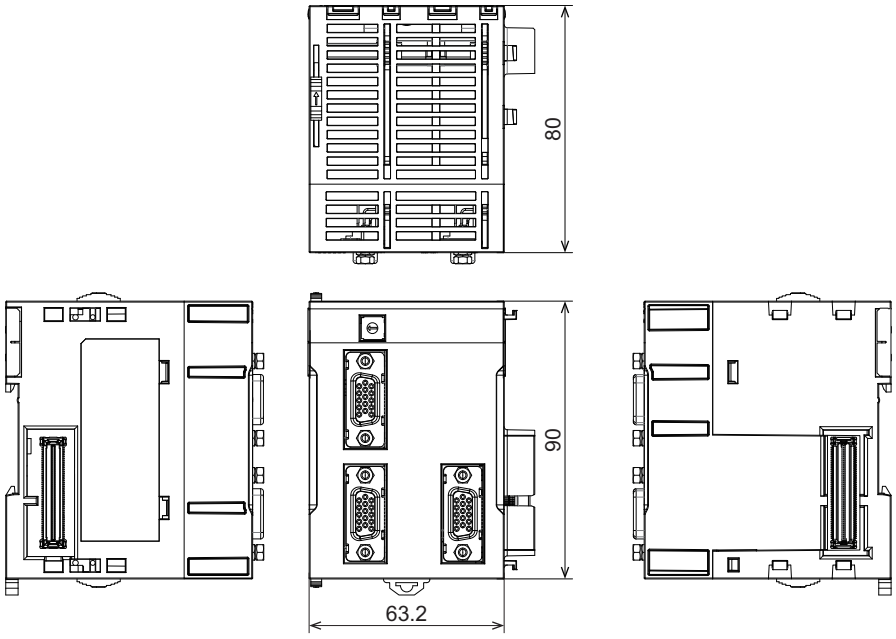


A-2-5 CK3W-ECS and CK3W-GC Units

CK3W-ECS Unit

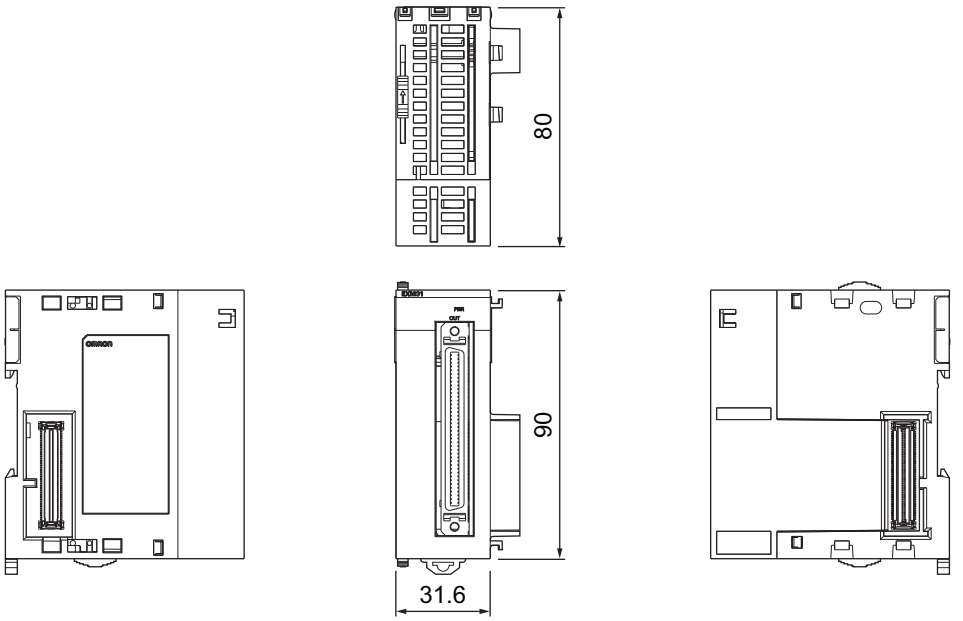


CK3W-GC Unit



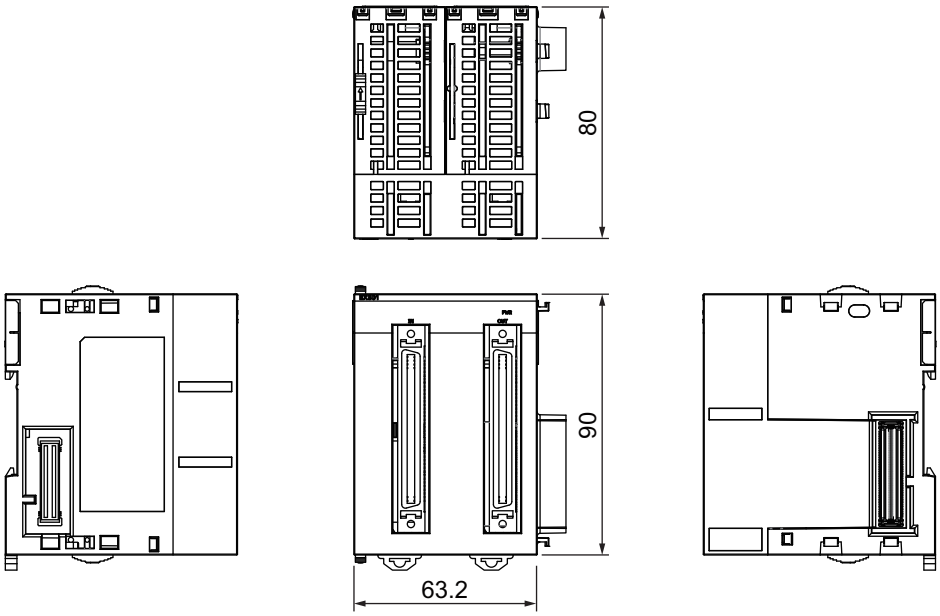
A-2-6 Expansion Master Unit and Expansion Slave Unit

Expansion Master Unit

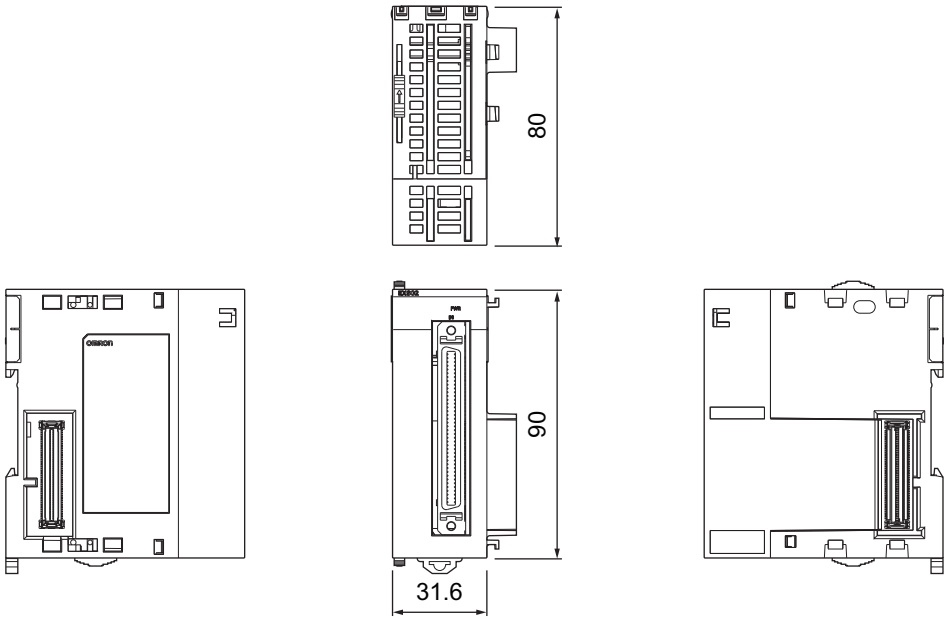


Expansion Slave Unit

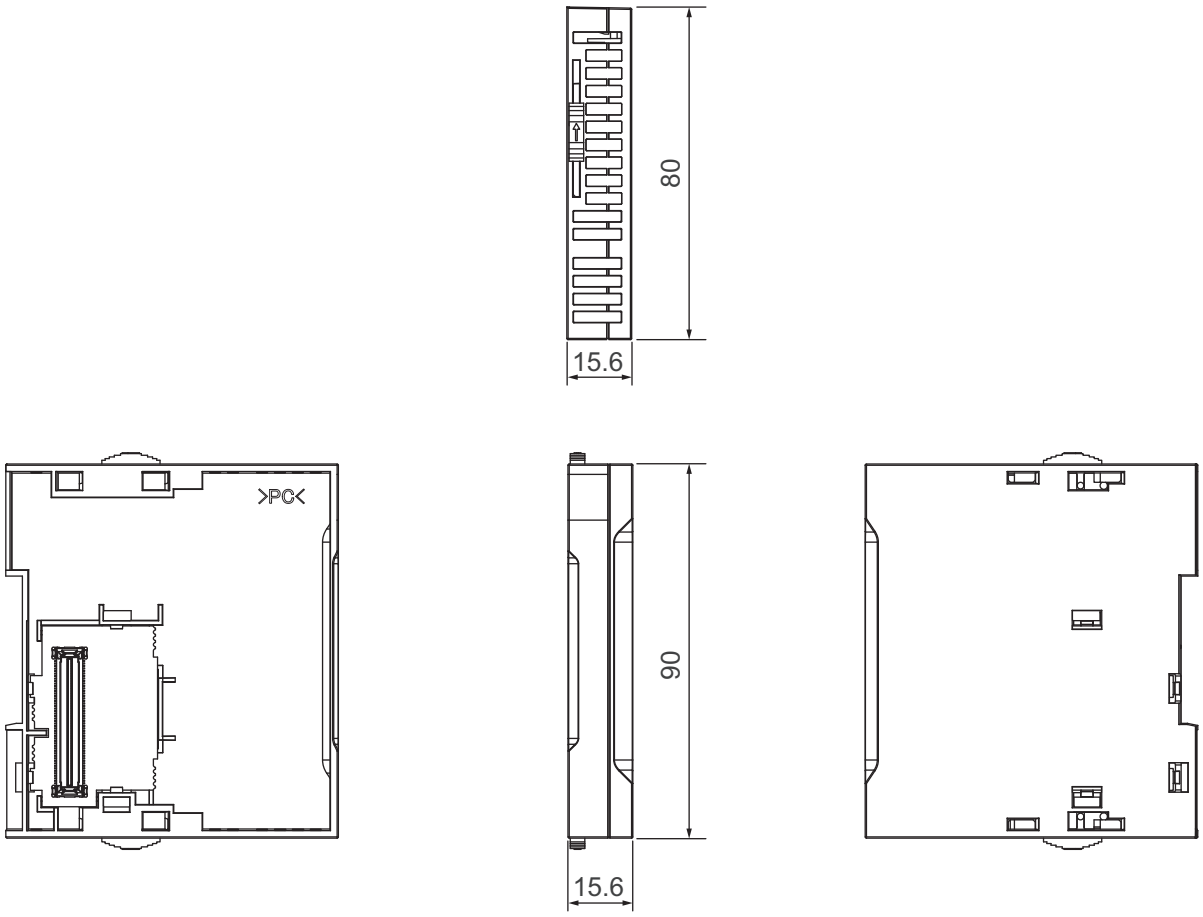
- **CK5W-EXS01**



● **CK3W-EXS02**



A-2-7 End Cover



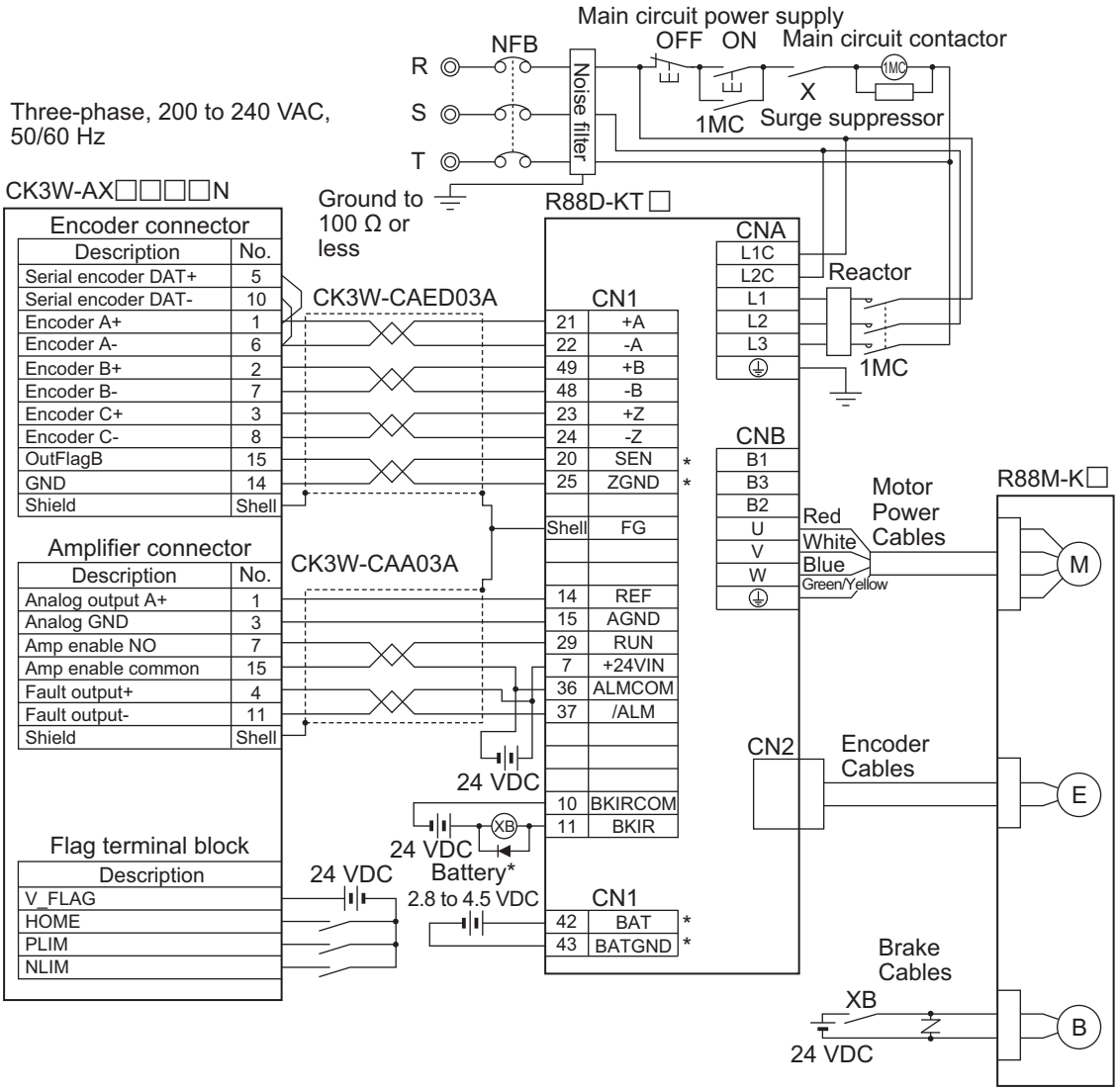
A-3 Restrictions on Using the NX-series EtherCAT Coupler Unit

When OMRON NX-series EtherCAT Coupler Units are used as slaves with the CPU Unit as the EtherCAT master, the following models and unit versions of EtherCAT Coupler Units can be connected.

Model	Unit version	Connectable/Unconnectable
NX-ECC203	Ver.1.4 or later	Connectable
	Ver.1.3 or earlier	Unconnectable
NX-ECC202	All versions	
NX-ECC201	All versions	

A-4 OMRON Servo Drive Connection Example

This section shows an example of a connection between a CK3W-AX1414□ or CK3W-AX1515□ Unit and an OMRON G5-series Servo Drive R88D-KT□□□.



Note 1. The terminal and wiring marked with * are used when an absolute encoder is used. When an incremental encoder is used, the wiring marked with * is not necessary.

Note 2. Do not connect the signal wires that are not used.

A-5 Version Information

This section provides version information that you need to know when connecting a CK3W Unit to a CPU Unit and Power PMAC IDE.
The table below specifies the correspondence between each CK3W Unit and the versions of CPU Unit and Power PMAC IDE.

Be sure to use the version combinations listed in the table below.

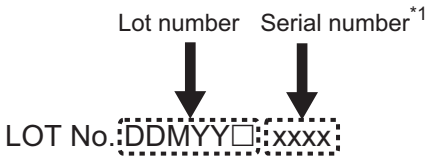
CK3W Unit	Supported version	
	CPU Unit's PMAC firmware revision	Power PMAC IDE version
CK3W-AX1414□/-AX1515□	All versions supported	Ver. 4.2 or higher
CK3W-AX1313□/-AX2323□	Ver. 2.5.2 or later	Ver. 4.3 or higher
CK3W-MD7110/-MD7120	Ver. 2.5.2 or later	Ver. 4.3 or higher
CK3W-AD2100/-AD3100	Ver. 2.5.2 or later	Ver. 4.3 or higher
CK3W-EXM01/-EXS02	Ver. 2.5.2 or later	Ver. 4.3 or higher
CK3W-ECS300	Ver. 2.6.1 or later	Ver. 4.5 or higher
CK3W-GC1□00/ -GC2□00	Ver. 2.6.1 or later	Ver. 4.5 or higher

Precautions for Correct Use

- Use the following versions of Power PMAC IDE, depending on the model of the CPU Unit.
  a) For a CK5M CPU Unit, use Power PMAC IDE Ver. 4.6.1 or higher.
  b) For a CK3M CPU Unit, use Power PMAC IDE Ver. 4 or higher.
- To use the CPU Unit with PMAC firmware revision Ver.2.7 or later, use Power PMAC IDE Ver.4.5.2 or higher.
- To use the CPU Unit with PMAC firmware revision Ver.2.8 or later, use Power PMAC IDE Ver.4.6.4 or higher.

A-6 How to Read the Lot Number

Lot number is printed on the side of the Unit.
The table below shows how to read the lot number.



*1. Serial numbers are given to the product manufactured from September 2022.

Symbol	Description
DD	Day of production: 1 to 31
M	Month of production: 1 to 9, X (October), Y (November), Z (December)
YY	Year of production: Last two digits of the year
□	OMRON's control number

A-7 Supported CIP Objects

The types of CIP objects supported in EtherNet/IP are as shown below.

Object name	Function	Reference
Identity object	Retrieves the product information of the CK3M/CK5M.	*A-7-1 Identity Object (Class ID: 01 Hex)* on page A-14
Assembly object	Joins the I/O data of the CK3M/CK5M.	*A-7-2 Assembly Object (Class ID: 04 Hex)* on page A-15
TCP/IP interface object	Configures the TCP/IP interface.	*A-7-3 TCP/IP Interface Object (Class ID: F5 Hex)* on page A-16
Ethernet link object	Retrieves various information on the Ethernet link.	*A-7-4 Ethernet Link Object (Class ID: F6 Hex)* on page A-17

A-7-1 Identity Object (Class ID: 01 Hex)

The Identity object is intended to retrieve the product information of the CK3M/CK5M.

Service Code

Service code (hex)	Parameter name	Description	Supported services	
			Classes	Instances
01	Get_Attribute_All	Reads the values of all attributes.	Supported	Supported
05	Reset	0: Restart	Not supported	Supported
0E	Get_Attribute_Single	Reads the value of the specified attribute.	Supported	Supported

Class ID and Instance ID

The class ID and instance ID are as shown below.

ID type	Value (hex)
Class ID	01
Instance ID	01

Attribute ID

The attribute IDs for instances are as shown below.

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
01	Vendor ID	Vendor ID	Read	UINT	002F (always)
02	Device Type	Device type	Read	UINT	000E (always)
03	Product Code	Product code	Read	UINT	*1
04	Revision	CIP revision	Read	Struct	---
	Major Revision	Major revision	Read	USINT	01
	Minor Revision	Minor revision	Read	USINT	02
05	Status	Status	Read	WORD	*2

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
06	Serial Number	Serial number	Read	UDINT	Set value
07	Product Name	Product name	Read	SHORT_STRING	Set value

*1. Product code

Model	Product code (hex)
CK5M-CPU131	0BEF
CK5M-CPU141	0BF0
CK3M-CPU101	0BE2
CK3M-CPU111	0BE3
CK3M-CPU121	0BE4

*2. Status

Status	Value (hex)
The I/O connection is not established	0000
The I/O connection is established in RunMode	0060
The I/O connection is established in IdleMode	0070

A-7-2 Assembly Object (Class ID: 04 Hex)

The Assembly object is intended to join the I/O data of the CK3M/CK5M.

Service Code

Service code (hex)	Parameter name	Description	Supported services	
			Classes	Instances
0E	Get_Attribute_Single	Reads the value of the specified attribute.	Supported	Supported
10	Set_Attribute_Single	Writes the value of the specified attribute.	Not supported	Supported

Class ID and Instance ID

The class ID and instance ID are as shown below.

ID type	Value (hex)
Class ID	04
Instance ID	ED: Listen Only Heartbeat Assembly EE: Input Only Heartbeat Assembly 300, 304, 308 to 37C (in 4 increments): Output Assembly 301, 305, 309 to 37D (in 4 increments): Input Assembly

Attribute ID

The attribute IDs for instances are as shown below.

● Attribute ID for Output Assembly

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
03	Data	Output data	Read and write	ARRAY of BYTE	0 to 504 byte data
04	Size	Output data size	Read	UINT	0 to 1F8

● Attribute ID for Input Assembly

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
03	Data	Input data	Read and write	ARRAY of BYTE	0 to 504 byte data
04	Size	Input data size	Read	UINT	0 to 1F8

A-7-3 TCP/IP Interface Object (Class ID: F5 Hex)

The TCP/IP Interface object is intended to configure the TCP/IP interface.

Service Code

Service code (hex)	Parameter name	Description	Supported services	
			Classes	Instances
01	Get_Attribute_All	Reads the values of all attributes.	Supported	Supported
0E	Get_Attribute_Single	Reads the value of the specified attribute.	Supported	Supported
10	Set_Attribute_Single	Writes the value of the specified attribute.	Not supported	Supported

Class ID and Instance ID

The class ID and instance ID are as shown below.

ID type	Value (hex)
Class ID	F5
Instance ID	01

Attribute ID

The attribute IDs for instances are as shown below.

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
01	Status	IP address setting status of the interface	Read	DWORD	00000001 (always)
02	Configuration Capability	Controller configurations and setup that can be set to the interface.	Read	DWORD	00000000 (always)
03	Configuration Control	Sets the method to used to set the IP address when the interface starts.	Read	DWORD	00000000 (always)

Attribute ID (hex)	Parameter name		Description	Attribute	Data type	Value (hex)
04	Physical Link Object		Path to the physical link object	Read	Struct	---
		Path Size	Path size	Read	UINT	0002 (always)
		Path	Fixed path	Read	Padded EPATH	20F62401 (always)
05	Interface Configuration		Interface configuration	Read	Struct	---
		IP Address	IP address	Read	UDINT	Set value
		Network Mask	Subnet mask	Read	UDINT	Set value
		Gateway Address	Default gateway	Read	UDINT	Set value
		Name Server	Primary name server	Read	UDINT	Set value
		Name Server 2	Secondary name server	Read	UDINT	Set value
		Domain Name	Domain name	Read	STRING	Set value
06	Host Name		Host name	Read	STRING	Set value
08	TTL Value		TTL value	Read	UINT	01 (always)
09	Mcast Config		Multicast configuration	Read	Struct	---
		Alloc Control	Multicast address allocation method	Read	USINT	00 (always)
		Reserved	Reserved	Read	USINT	00 (always)
		Num Mcast	Number of multicast addresses	Read	UINT	01 (always)
		Mcast Start Addr	Start multicast addresses	Read	UDINT	Set value
0D	Encapsulation Inactivity Timeout		Encapsulation inactivity timeout time	Read and write	UINT	Set value (120 seconds by default)

A-7-4 Ethernet Link Object (Class ID: F6 Hex)

The Ethernet link object is intended to retrieve various information on the Ethernet link.

Service Code

Service code (hex)	Parameter name	Description	Supported services	
			Classes	Instances
01	Get_Attribute_All	Reads the values of all attributes.	Supported	Supported
0E	Get_Attribute_Single	Reads the value of the specified attribute.	Supported	Supported
4C	Get_and_Clear	Specifies attribute 4, 5, 12, or 13 and resets the attribute to 0.	Not supported	Supported

Class ID and Instance ID

The class ID and instance ID are as shown below.

ID Type	Value (hex)
Class ID	F6

ID Type	Value (hex)
Instance ID	01

Attribute ID

The attribute IDs for instances are as shown below.

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
01	Interface Speed	Gives the baud rate for the interface.	Read	UDINT	Current value
02	Interface Flags	Gives the status of the interface.	Read	DWORD	*1
03	Physical Address	Gives the MAC address of the interface.	Read	ARRAY OF USINT	Current value of the MAC address
04	Interface Counters	Path to the physical link object	Read	Struct	---
	In Octets	The number of octets received through the interface.	Read	UDINT	Current value
	In Unicast Packets	The number of unicast packets received through the interface.	Read	UDINT	Current value
	In NonUnicast Packets	The number of packets besides unicast packets received through the interface.	Read	UDINT	Current value
	In Discards	The number of packets discarded after received by the interface	Read	UDINT	Current value
	In Errors	The number of incoming packets that had errors.	Read	UDINT	Current value
	In Unknown Protos	The number of incoming packets that were of an unknown protocol.	Read	UDINT	0 (always)
	Out Octets	The number of octets sent through the interface.	Read	UDINT	Current value
	Out Unicast Packets	The number of unicast packets sent through the interface.	Read	UDINT	Current value
	Out NonUnicast Packets	The number of packets besides unicast packets sent through the interface.	Read	UDINT	Current value
	Out Discards	The number of discarded sent packets.	Read	UDINT	Current value
	Out Errors	The number of sent packets that had errors.	Read	UDINT	Current value
05	Media Counters	Media counters for communications ports	Read	Struct	---
	Alignment Errors	Number of frames received that were not octets in length.	Read	UDINT	Current value
	FCS Errors	Number of frames received that did not pass the FCS check.	Read	UDINT	Current value
	Single Collisions	Number of frames sent successfully with only one collision.	Read	UDINT	Current value
	Multiple Collisions	Number of frames sent successfully with two or more collisions.	Read	UDINT	Current value

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
	SQE Test Errors	Number of times a SQE test error message was generated.	Read	UDINT	0 (always)
	Deferred Transmissions	The number of frames for which the first attempt to send was delayed because the media was busy.	Read	UDINT	Current value
	Late Collisions	The number of collisions detected in packets that were sent after 512 bit times.	Read	UDINT	Current value
	Excessive Collisions	The number of frames that failed to be sent because of excessive collisions.	Read	UDINT	Current value
	MAC Transmit Errors	The number of frames that failed to be sent due to an internal MAC sublayer transmission error.	Read	UDINT	Current value
	Carrier Sense Errors	The number of times the carrier sense condition was lost.	Read	UDINT	Current value
	Frame Too Longs	The number of frames received that exceeded the maximum allowed frame size.	Read	UDINT	Current value
	MAC Receive Errors	The number of frames that could not be received through the interface due to an internal MAC sublayer reception error.	Read	UDINT	Current value
07	Interface Type	Interface type	Read	USINT	02 (always)
0B	Interface Control	List of settings supported by the interface	Read	Struct	---
	Capability Bits	Settings supported by the interface	Read	DWORD	*2
	Speed/Duplex Array Count	The number of interface speed/duplex lists	Read	USINT	00 (always)
0C	HC Interface Counters	Counters related to packet transmission and reception on high capacity interfaces	Read	Struct	---
	HCInOctets	The number of octets received through the interface. This counter is the 64-bit edition of In Octets.	Read	ULINT	Current value
	HCInUnicastPkts	The number of unicast packets received through the interface. This counter is the 64-bit edition of In Unicast Packets.	Read	ULINT	Current value
	HCInMulticastPkts	The number of multicast packets received through the interface.	Read	ULINT	Current value
	HCInBroadcastPkts	The number of broadcast packets received through the interface.	Read	ULINT	Current value
	HCOutOctets	The number of octets sent through the interface. This counter is the 64-bit edition of Out Octets.	Read	ULINT	Current value
	HCOutUnicastPkts	The number of unicast packets sent through the interface. This counter is the 64-bit edition of Out Unicast Packets.	Read	ULINT	Current value
	HCOutMulticastPkts	The number of multicast packets sent through the interface.	Read	ULINT	Current value
	HCOutBroadcastPkts	The number of broadcast packets sent through the interface.	Read	ULINT	Current value

Attribute ID (hex)	Parameter name	Description	Attribute	Data type	Value (hex)
0D	HC Media Counters	High capacity media counters for communications ports	Read	Struct	---
	HCStatsAlignmentErrors	The number of frames received that were not octets in length. This counter is the 64-bit edition of Alignment Errors.	Read	ULINT	Current value
	HCStatsFCSErrors	The number of frames received that did not pass the FCS check. This counter is the 64-bit edition of FCS Errors.	Read	ULINT	Current value
	HCStatsInternalMacTransmitErrors	The number of frames that failed to be sent due to a MAC sublayer transmission error. This counter is the 64-bit edition of MAC Transmit Errors.	Read	ULINT	Current value
	HCStatsFrameTooLongs	The number of frames received that exceeded the maximum allowed frame size. This counter is the 64-bit edition of Frame Too Long.	Read	ULINT	Current value
	HCStatsInternalMacReceiveErrors	The number of frames that could not be received through the interface due to a MAC sublayer reception error. This counter is the 64-bit edition of MAC Receive Errors.	Read	ULINT	Current value
	HCStatsSymbolErrors	The number of frames that could not be received through the interface due to an internal MAC sublayer symbol error.	Read	ULINT	Current value

*1. Details on Interface Flags

Bit	Name	Description
0	Link Status	FALSE: The link is down. TRUE: The link is up.
1	Half/Full Duplex	FALSE: Half duplex TRUE: Full duplex
2-4	Negotiation Status	00 hex: Auto-negotiation is in progress. 01 hex: Auto-negotiation and speed detection failed. 02 hex: Auto-negotiation failed, but speed detection succeeded. 03 hex: Speed and duplex mode negotiation succeeded. 04 hex: Auto-negotiation was not attempted.

*2. Details on Capability Bits

Bit	Name	Description
0	Manual Setting Requirement Reset	Always FALSE
1	Auto-negotiate	Always TRUE
2	Auto-MDIX	Always TRUE
3	Manual Speed/Duplex	Always FALSE

A-8 Software Reference of Encoder Input Unit

This section describes register settings of the Encoder Input Unit.
The register settings here are different from the definitions descried in the *Power PMAC Software Reference Manual (Cat. No. O015)*.

A-8-1 Gate3[i].SerialEncCtrl (Serial Encoder Control)

Description	Serial encoder control register
Default	$0F400000

This register is write-protected, so you cannot change it unless you write a key value in Gate3[i].WpKey.
You can reset the write protection automatically in the script environment by writing the key value in Sys.WpKey.

The setting of this register depends on the serial encoder protocol.

For BiSS-C

Bit	Name	Function
31 to 24	SerialClockMDiv	Division factor of the serial clock
23 to 20	SerialClockNDiv	Division factor (exponent) of the serial clock
19 to 18	Reserve	Always set 0.
17	SerialTrigClockSel	Selection of a serial trigger clock Set which clock to do encoder reading on, phase or servo. 0: Phase clock 1: Servo clock
16	SerialTrigEdgeSel	Selection of a serial trigger clock edge Set which edge to start encoder reading at, the rising edge or falling edge of the clock. 0: Rising edge 1: Falling edge
15 to 08	SerialTrigDelay	Setting of a delay from the serial trigger clock edge Set the delay time between clock edge and encoder reading. The unit is an intermediate clock (SER_Clock) cycle. The setting range is from 0 to 255.
07 to 00	SerialProtocol	Serial encoder protocol setting For BiSS-C, set it to $0B.

BiSS-C clock frequency is determined by the formula below.

$$\text{Clock frequency (MHz)} = \frac{100}{(M+1) \times 2^{N}}$$

M = SerialClockMDiv
N = SerialClockNDiv

The intermediate clock (SER_Clock) to be used in internal processing is also the same as the clock frequency.
The following shows examples of the clock frequency settings to be used in BiSS-C.

Clock frequency	SerialClockMDiv	SerialClockNDiv
2 MHz	49 ($31)	0
1 MHz	99 ($63)	0
500 kHz	99 ($63)	1

The following shows examples of general settings.

```
SerialClockMDiv:    = $31    // Serial clock frequency = 2 MHz
SerialClockNDiv:    = 0      // Serial clock frequency = 2 MHz
SerialTrigClockSel: = 0      // Phase clock cycle used
SerialTrigEdgeSel:  = 0      // Rising edge used
SerialTrigDelay:    = 0      // Delay set to 0
SerialProtocol:     = $0B    // BiSS-C selected
```

For Endat2.2

Bit	Name	Function
31 to 24	SerialClockMDiv	Division factor of the serial clock
23 to 20	SerialClockNDiv	Division factor (exponent) of the serial clock
19 to 18	Reserve	Always set 0.
17	SerialTrigClockSel	Selection of a serial trigger clock Set which clock to do encoder reading on, phase or servo. 0: Phase clock 1: Servo clock
16	SerialTrigEdgeSel	Selection of a serial trigger clock edge Set which edge to start encoder reading at, the rising edge or falling edge of the clock. 0: Rising edge 1: Falling edge
15 to 08	SerialTrigDelay	Setting of a delay from the serial trigger clock edge Set the delay time between clock edge and encoder reading. The unit is an intermediate clock (SER_Clock) cycle. The setting range is from 0 to 255.
07 to 00	SerialProtocol	Serial encoder protocol setting For Endat2.2, set it to $03.

Endat2.2 clock frequency is determined by the formula below.

$$\text{Clock frequency (MHz)} = \frac{4}{(M+1) \times 2^N}$$

M = SerialClockMDiv
N = SerialClockNDiv

The intermediate clock (SER_Clock) to be used in internal processing is determined by the formula below.

$$SER_Clock\ (MHz) = \frac{100}{(M+1)\times 2^{N}}$$

M = SerialClockMDiv
N = SerialClockNDiv

The following shows examples of the clock frequency settings to be used in Endat2.2.

Clock frequency	SerialClockMDiv	SerialClockNDiv
2 MHz	1 ($01)	0
1 MHz	3 ($03)	0
500 kHz	7 ($07)	0
100 kHz	39 ($27)	0

The following shows examples of general settings.

```
SerialClockMDiv:     = $01    // Serial clock frequency = 2 MHz
SerialClockNDiv:     = 0      // Serial clock frequency = 2 MHz
SerialTrigClockSel: = 0       // Phase clock cycle used
SerialTrigEdgeSel:  = 0       // Rising edge used
SerialTrigDelay:     = 0      // Delay set to 0
SerialProtocol:      = $03    // Endat2.2 selected
```

For R88M-1L□/-1M□ Motor Built-in Encoder

Bit	Name	Function
31 to 18	Reserve	Always set 0.
17	SerialTrigClock-Sel	Selection of a serial trigger clock Set which clock to do encoder reading on, phase or servo. 0: Phase clock 1: Servo clock
16	SerialTrigEdge-Sel	Selection of a serial trigger clock edge SetSet which edge to start encoder reading at, the rising edge or falling edge of the clock. 0: Rising edge 1: Falling edge
15 to 08	SerialTrigDelay	Setting of a delay from the serial trigger clock edge Set the delay time between clock edge and encoder reading. The unit is an intermediate clock (SER_Clock) cycle. The setting range is from 0 to 255.
07 to 00	SerialProtocol	Serial encoder protocol setting Set $0E for R88M-1L□/-1M□ Motor built-in encoder.

For R88M-1L□/-1M□ Motor built-in encoder, you do not need to set clock frequency.
The frequency of intermediate clock (SER_Clock) is 100MHz.

The following shows examples of general settings.

```
SerialTrigClockSel: = 0       // Phase clock cycle used
SerialTrigEdgeSel:  = 0       // Rising edge used
SerialTrigDelay:     = 0      // Delay set to 0
SerialProtocol:      = $0E    // R88M-1L/-1M Motor built-in encoder selected
```

A-8-2 Gate3[i].Chan[j].SerialEncEna (Serial Encoder Enable)

Description	Serial encoder enable
Default	0

This register is write-protected, so you cannot change it unless you write a key value in Gate3[i].WpKey.
You can reset the write protection automatically in the script environment by writing the key value in Sys.WpKey.

Gate3[i].Chan[j].SerialEncEna controls whether to enable the serial encoder.

1: Serial encoder enable
0: Serial encoder disable

Gate3[i].Chan[j].SerialEncEna shows the bit 20 of Gate3[i].Chan[j].InCtrl.
For this reason, you can also set it from Gate3[i].Chan[j].InCtrl.

Precautions for Correct Use

Gate3[i].Chan[j].SerialEncEna is **Serial encoder disable** by default.
Set it to **Serial encoder enable** before use.

A-8-3 Gate3[i].Chan[j].SerialEncCmd (Serial Encoder Command)

Description	Command control of serial encoder
Default	$00000000

The setting of this register depends on the serial encoder protocol.

For BiSS-C

Bit	Name	Function
31 to 24	Reserve	Always set 0.
23 to 16	CRC_MASK	CRC polynomial expression setting Set the CRC polynomial expression of the frame to be sent from the encoder. $M_7X^8 + M_6X^7 + M_5X^6 + M_4X^5 + M_3X^4 + M_2X^3 + M_1X^2 + M_0X^1 + 1$ M_n = CRC_MASK[n] For example, when the CRC polynomial expression of the encoder is $X^6 + X^1 + 1$, set CRC_MASK[7:0] = 00100001 = $21.
15 to 14	Reserve	Always set 0.
13	SerialEncTrig-Mode	Serial trigger mode (continuous or one-shot) setting Set whether to sample the encoder repeatedly or sample it only once. For continuous sampling, it is sampled for each clock (phase or servo) to be set using Gate3[i].SerialEncCtrl. 0: Continuous sampling 1: One-shot sampling

Bit	Name	Function
12	SerialEncTrigEna	Serial trigger enable Set whether to sample the encoder. When SerialEncTrigMode is continuous sampling, it is sampled continuously during SerialEncTrigEna = 1. When SerialEncTrigMode is one-shot sampling, it is sampled only once at SerialEncTrigEna = 1. When sampling is done, SerialEncTrigEna will be 0 automatically. 0: Serial encoder trigger disable 1: Serial encoder trigger enable
11	Reserve	Always set 0.
10	SerialEncData-Ready	Serial reception status read 0: Reception in progress 1: Reception done This bit is read-only and writing is disabled.
09 to 06	SerialEncStatus-Bits [3:0]	Number of status data bits setting Set the number of bits of the status data to be sent from the encoder. The valid setting range is from 0 to 6 (0000 to 0110).
05 to 00	SerialEncNumBits	Number of encoder data bits setting Set the number of bits of the position data to be sent from the encoder. The valid setting range is from 12 to 40 (001100 to 101000).

The following shows examples of general settings.

```
CRC Mask:            = $21                  // When CRC polynomial expression is x6
+ x1 + 1
SerialEncTrigMode:   = 0                    // Continuous sampling
SerialEncTrigEna:    = 1                    // Serial encoder trigger enable
SerialEncDataReady:  = 0                    // Read-only and writing is disable
SerialEncStatusBits: = Depending on encoder    // Set according to encoder specific
ations
SerialEncNumBits:    = Depending on encoder    // Set according to encoder specific
ations
```

For Endat2.2

Bit	Name	Function
31	Reserve	Always set 0.
30 to 24	MRS_Code	Set the type of additional data to be sent from the Endat2.2 encoder. This product supports the following three MRS Codes of additional data. • 1000010 – Position data 2 Word 1 (LSB) • 1000011 – Position data 2 Word 2 (LSB) • 1000100 – Position data 2 Word 3 (MSB) Gate3[i].Chan[j].SerialEncDataB can read the set additional data. The MRS Codes can be set when the Command Code is “111000”. Set 0 when the Command Code is “000111”, “101010”, or “101101”.
23 to 22	Reserve	Always set 0.

Bit	Name	Function
21 to 16	Command_Code	Set the Command Code to send to the Endat encoder. This product supports the following four Command Codes. 000111 – Position data read 101010 – Encoder reset 111000 – Position data and additional data read 101101 – Position data and additional data read, encoder reset
15 to 14	Reserve	Always set 0.
13	SerialEncTrigMode	Serial trigger mode (continuous or one-shot) setting Set whether to sample the encoder repeatedly or sample it only once. For continuous sampling, it is sampled for each clock (phase or servo) to be set using Gate3[i].SerialEncCtrl. 0: Continuous sampling 1: One-shot sampling
12	SerialEncTrigEna	Serial trigger enable Set whether to sample the encoder. When SerialEncTrigMode is continuous sampling, it is sampled continuously during SerialEncTrigEna = 1. When SerialEncTrigMode is one-shot sampling, it is sampled only once at SerialEncTrigEna = 1. When sampling is done, SerialEncTrigEna will be 0 automatically. 0: Serial encoder trigger disable 1: Serial encoder trigger enable
11	Reserve	Always set 0.
10	SerialEncDataReady	Serial reception status read 0: Reception in progress 1: Reception done This bit is read-only and writing is disabled.
09 to 06	Reserve	Always set 0.
05 to 00	SerialEncNumBits	Number of encoder data bits setting Set the number of bits of the position data to be sent from the encoder. The valid setting range is from 12 to 40 (001100 to 101000).

The following shows examples of general settings.

```
MRS Code:            = 0000000            // Additional data not set
Command Code:        = 000111             // Position data read
SerialEncTrigMode:   = 0                  // Continuous sampling
SerialEncTrigEna:    = 1                  // Serial encoder trigger enable
SerialEncDataReady:  = 0                  // Read-only and writing is disable
SerialEncStatusBits: = Depending on encoder    // Set according to encoder specific
ations
SerialEncNumBits:    = Depending on encoder    // Set according to encoder specific
ations
```

For R88M-1L□/-1M□ Motor Built-in Encoder

Bit	Name	Function
31 to 16	Command Code	Set the Command Code to send to the encoder. This product supports the following four Command Codes. • $0000 – Position data read (multi-turn 16 bits, single-turn 23 bits) • $00D8 – Position data (single-turn 23 bits) and error code read • $0040 – Error code clear*1 • $0048 – Multi-turn clear*1
15 to 14	Reserve	Always set 0.
13	SerialEnc-TrigMode	Serial trigger mode (continuous or one-shot) setting Set whether to sample the encoder repeatedly or sample it only once. For continuous sampling, it is sampled for each clock (phase or servo) to be set using Gate3[i].SerialEncCtrl. 0: Continuous sampling 1: One-shot sampling
12	SerialEncTri-gEna	Serial trigger enable Set whether to sample the encoder. When SerialEncTrigMode is continuous sampling, it is sampled continuously during SerialEncTrigEna = 1. When SerialEncTrigMode is one-shot sampling, it is sampled only once at SerialEncTrigEna = 1. When sampling is done, SerialEncTrigEna will be 0 automatically. 0: Serial encoder trigger disable 1: Serial encoder trigger enable
11	Reserve	Always set 0.
10	SerialEnc-DataReady	Serial reception status read 0: Reception in progress 1: Reception done This bit is read-only and writing is disabled.
09 to 00	Reserve	Always set 0.

*1. When you clear error codes or clear multi-turn, set **SerialEncTrigMode** to **One-shot sampling**, and send the *Command Code* to the encoder 8 times.

The following shows examples of general settings.

```
Command Code:        = $0000    // Position data read
SerialEncTrigMode:   = 0        // Continuous sampling
SerialEncTrigEna:    = 1        // Serial encoder trigger enable
SerialEncDataReady:  = 0        // Read-only and writing is disable
```

A-8-4 Gate3[i].Chan[j].SerialEncDataA (Serial Encoder Data A)

Description	Position data of serial encoder

This register is read-only. Writing is disabled.

The setting of this register depends on the serial encoder protocol.

For BiSS-C

Gate3[i].Chan[j].SerialEncDataA is used to read lower 32 bits of position data.

Bit	Name	Function
31 to 0	Position data	Lower 32 bits of position data

For Endat2.2

Gate3[i].Chan[j].SerialEncDataA is used to read lower 32 bits of position data.

Bit	Name	Function
31 to 0	Position data	Lower 32 bits of position data

For R88M-1L□/-1M□ Motor Built-in Encoder

Gate3[i].Chan[j].SerialEncDataA is used to read lower 9 bits of multi-turn data and 23 bits of single-turn position data.

Bit	Name	Function
31 to 23	Multi-turn position data	Lower 9 bits of multi-turn position data
22 to 0	Single-turn position data	Single-turn position data

A-8-5 Gate3[i].Chan[j].SerialEncDataB (Serial Encoder Data B)

Description	Position data, status data, etc. for the serial encoder

This register is read-only. Writing is disabled.
The setting of this register depends on the serial encoder protocol.

For BiSS-C

Gate3[i].Chan[j].SerialEncDataB is used to read a communications error, status, and upper 8 bits of position data.

Bit	Name	Function
31	Timeout error	Shows the status of the timeout error. 0: No error 1: Timeout error
30	CRC error	Shows the status of the CRC error. 0: No error 1: CRC error
29 to 24	Status information	Shows the status information sent from the encoder. For details on the status, refer to the encoder specifications.
23 to 8	Reserve	
0 to 7	Position data	Upper 8 bits of position data

For Endat2.2

The meaning of Gate3[i].Chan[j].SerialEncDataB changes according to the Command Code setting.

● For Command Code = 000111 or 101010

Bit	Name	Function
31	Timeout error	Shows the status of the timeout error. 0: No error 1: Timeout error
30	CRC error	Shows the status of the CRC error. 0: No error 1: CRC error
29	Error bit	Shows the error bit sent from the encoder. For details on the error bit, refer to the encoder specifications.
28 to 8	Reserve	
0 to 7	Position data	Upper 8 bits of position data

● For Command Code = 111000 or 101101

In this Command Code, a frame is divided into two, position data and additional data 1, therefore, there are two CRC errors. Additionally, for the error bit, it is possible to show two bits.

Bit	Name	Function
31	Timeout error	Shows the status of the timeout error. 0: No error 1: Timeout error
30	CRC error P	Shows the status of the CRC error of position data frame. 0: No error 1: CRC error
29	CRC error 1	Shows the status of the CRC error of additional data 1 frame. 0: No error 1: CRC error
28	Reserve	
27	Error bit 1	Shows the error bit 1 sent from the encoder. For details on the error bit 1, refer to the encoder specifications.
26	Error bit 2	Shows the error bit 2 sent from the encoder. For details on the error bit 2, refer to the encoder specifications.
25 to 24	Reserve	
23	WRN	Shows the WRN bit sent from the encoder. For details on the WRN bit, refer to the encoder specifications.
22	RM	Shows the RM bit sent from the encoder. For details on the RM bit, refer to the encoder specifications.
21	Busy	Shows the Busy bit sent from the encoder. For details on the Busy bit, refer to the encoder specifications.
20 to 16	MRS Acknowl-edge	Shows the MRS code set in the encoder. Check that it is the same as the sent MRS code, and then read additional data.
0 to 15	Additional data	The additional data set in MRS code is stored.

For R88M-1L□/-1M□ Motor Built-in Encoder

Gate3[i].Chan[j].SerialEncDataB is used to read a communications error, additional data, and upper 7 bits of multi-turn position data.

Bit	Name	Function
31	Timeout error	Shows the status of the timeout error. 0: No error 1: Timeout error
30	CRC error	Shows the status of the CRC error. 0: No error 1: CRC error
29 to 24	Reserve	
23 to 8	Additional data	Data to be displayed varies with the Command Code. • For Command Code = $00D8 Shows the error code. *1 • For Command Code = $0000, $0040, or $0044 Shows the status. *2
7	Reserve	
0 to 6	Multi-turn position data	Upper 7 bits of multi-turn position data

*1. Check the error code and take appropriate measures.
For solutions, refer to *Solutions to Error Codes* on page A-30 below.
After you implement measures, cycle the power supply or clear status.

*2. Status represents the information that summarizes error codes. For details, refer to *Status* on page A-31.

● Solutions to Error Codes

Bit	Name	Function	Cause	Corrective action
15	Counter code error	The encoder detected a one-rotation counter error.	Excess noise has occurred.	Implement noise countermeasures. If the error occurs even after the noise countermeasures are implemented, replace the motor because the Servomotor failed.
			Failure due to vibration, shock, condensation, foreign material, etc.	
11 to 14	Reserve			
10	Counter increment error	The encoder detected a one-rotation counter error.	Excess noise has occurred.	Implement noise countermeasures. If the error occurs even after the noise countermeasures are implemented, replace the motor because the Servomotor failed.
			Failure due to vibration, shock, condensation, foreign material, etc.	
9	Motor overheat error	The encoder detected the temperature that exceeded the protection level of motor.	The temperature is high around the motor.	Adjust the temperature around the motor to within the operating temperature range.
			The motor is overloaded	Adjust the motor load rate to within the specified range.
			Encoder failure	If the error persists, replace the motor.
7 to 8	Maintenance information	This is not used.		
6	Absolute position detection error	The encoder detected a multi-rotation counter error.	An error was detected in the multi-rotation detecting area of the encoder	After cycling the power supply, clear multi-turn.
			Excess noise has occurred.	Implement noise countermeasures. If the error persists, replace the motor.

Bit	Name	Function	Cause	Corrective action
5	One-rotation counter error	The encoder detected a one-rotation counter error.	Excess noise has occurred.	Implement noise countermeasures. If the error occurs even after the noise countermeasures are implemented, replace the motor because the Servomotor failed.
			Failure due to vibration, shock, condensation, foreign material, etc.	
4	Encoder memory error	The encoder detected a non-volatile memory error.	False detection due to a data read error caused by excess noise	If the error occurs even after you cycle the power supply, replace the motor because the encoder failed.
			Non-volatile memory failure	
3	Overspeed error	The encoder detected the overspeed.	External forces are rotating the motor.	If external forces are rotating the motor, you should keep the external forces away.
			Encoder failure and false detection	If the problem persists, replace the motor because the encoder is out of order.
2	Reserve			
1	Absolute encoder multi-rotation counter error	The encoder detected a multi-rotation counter error.	A temporary error occurred in the encoder multi-rotation detection function due to vibration, shock, or condensation	Use the Unit as it is if this error ceased after you improved the operating environment. If the error occurs again, replace the motor.
			Encoder failure	
0	Maintenance information	This is not used.		

● Status

Status summarizes error codes and displays them in bits.

Bit	Description
15 to 4	Reserve
3	Shows the status of *Motor overheat error* in error codes.
2	When any of the following error codes becomes 1, this bit will be 1. • Counter code error • Counter increment error • Absolute position detection error • One-rotation counter error • Encoder memory error • Overspeed error • Absolute encoder multi-rotation counter error
1 to 0	Maintenance information

A-8-6 Gate3[i].Chan[0].Status (Internal Memory Error Detection)

Description	Internal memory error detection

This register is read-only. Writing is disabled.

It can detect a memory error inside the Unit.
The errors are classified into the following two types.

Each error is removed by cycling the power supply.
Use a user program to monitor this register, and cycle the power supply when an error occurs.

Bit	Name	Function
31 to 28	Reserve	
27	Minor error	Detects a minor error in the internal memory. 0: No minor error found in internal memory 1: A minor error found in internal memory Even if a minor error occurs, operation will continue.
26	Fatal error	Detects a fatal error in the internal memory. 0: No fatal error found in internal memory 1: A fatal error found in internal memory Even if a fatal error occurs, communications with the serial encoder will not stop.
25 to 00	Reserve	

A-9 Software Reference of Laser Interface Unit

This section describes register settings of the Laser Interface Unit.
These register settings are different from the definitions descried in the *Power PMAC Software Reference Manual (Cat. No. O015)*.

A-9-1 Gate3[i].SerialEncCtrl (Control Register)

Description	Control register
Default	$00000000

This register is write-protected, so you cannot change it unless you write a key value in Gate3[i].WpKey.
You can reset the write protection automatically in the script environment by writing the key value in Sys.WpKey.

The setting of this register depends on XY2-100 and SL2-100.

For CK3W-GC1□00 Units (XY2-100)

Bit	Name	Function
31 to 20	Reserve	Always set 0.
19	TxEnable	XY2-100 data send enable 0: XY2-100 output stop 1: XY2-100 output enable
18	Parity	Set the send parity. 0: Even parity 1: Odd parity
17	ClockSel	Set the clock to use for the linear interpolation of XY2-100 and the delay time of PWM output. 0: Servo clock 1: Phase clock
16	Sync	Set the synchronous or asynchronous mode for linear interpolation. 0: Asynchronous mode 1: Synchronous mode
15 to 14	ModeSel	Select a data format of the position command. 00: 16-bit data format 01: 18-bit data format 10: 20-bit data format 11: Setting prohibited
13 to 0	Reserve	Always set 0.

For CK3W-GC2□00 Units (SL2-100)

Bit	Name	Function
31 to 20	Reserve	Always set 0.

Bit	Name	Function
19	TxEnable	SL2-100 data send enable 0: SL2-100 output stop 1: SL2-100 output enable
18	Reserve	Always set 0.
17	ClockSel	Set the clock to use for the linear interpolation of SL2-100 and the delay time of PWM output. 0: Servo clock 1: Phase clock
16	Sync	Set the synchronous or asynchronous mode for linear interpolation. 0: Asynchronous mode 1: Synchronous mode
15 to 13	Control Bits	Set the type of transmission data. *1 001: Command position 111: Control command
12	EdgeSel	Set the clock edge to use for linear interpolation. 0: Falling edge 1: Rising edge
11	Tx Valid	Enable or disable transmission data. 0: Transmission data disable 1: Transmission data enable
10 to 0	Reserve	Always set 0.

*1. Always set 001 or 111.

A-9-2 Gate3[i].Chan[j].DAC[0] (Setting of Command Position and Control Command)

Description	Setting of command position and control command
Default	0

Depending on the channel, this setting varies as follows.

Register	Description
Gate3[i].Chan[0].Dac[0]	X-axis setting
Gate3[i].Chan[1].Dac[0]	Y-axis setting
Gate3[i].Chan[2].Dac[0]	Z-axis setting

Note Gate3[i].Chan[3].Dac[0] is not used.

The setting of this register depends on XY2-100 and SL2-100.

Precautions for Correct Use

This register does not support hexadecimal notation such as $00000000 to $FFFFFFFF. Use decimal notation for setting.

For CK3W-GC1□00 Units (XY2-100)

Bit	Name	Function
31 to 08	Command position	Write a command position in the CK3W-GC Unit from the CPU Unit. Data format of the command position is determined by ModeSel. The setting range is from -2^{23} to 2^{23}.

Bit	Name	Function
07 to 00	Reserve	Always set 0.

For CK3W-GC2□00 Units (SL2-100)

Bit	Name	Function
31 to 08	Command position or control command*1	This data depends on the setting of Control Bit as follows. • Control Bit = 001: Command position • Control Bit = 111: Control command The setting range of command position is from $-2^{23}-1$ to $2^{23}-1$.
07 to 00	Reserve	Always set 0.

*1. For details on the Command position and the control command, refer to *3-7-7 SL2-100 Interface* on page 3-78.

Precautions for Correct Use

Since this register cannot use hexadecimal numbers, use decimal numbers even when you set control commands.

A-9-3 Gate3[i].Chan[j].DAC[1] (Setting of Command Position Compensation Value)

Description	Setting of command position compensation value
Default	0

Depending on the channel, this setting varies as follows.

Register	Description
Gate3[i].Chan[0].Dac[1]	X-axis setting
Gate3[i].Chan[1].Dac[1]	Y-axis setting
Gate3[i].Chan[2].Dac[1]	Z-axis setting

Note Gate3[i].Chan[3].Dac[1] is not used.

Precautions for Correct Use

This register does not support hexadecimal notation such as $00000000 to $FFFFFFFF. Use decimal notation for setting.

Bit	Name	Function
31 to 08	Command position compensation value	Write a command position compensation value in the CK3W-GC Unit from the CPU Unit. Data format is determined by ModeSel. The setting range is from $-2^{23}-1$ to $2^{23}-1$.
07 to 00	Reserve	Always set 0.

A-9-4 Gate3[i].Chan[j].SerialEncDataA (Command Position after Interpolation, Reception Data)

Description	Command position after interpolation, and reception data based on control command

Default	$00000000

Depending on the channel, this setting varies as follows.

Register	Description
Gate3[i].Chan[0].SerialEncDataA	X-axis setting
Gate3[i].Chan[1].SerialEncDataA	Y-axis setting
Gate3[i].Chan[2].SerialEncDataA	Z-axis setting

Note Gate3[i].Chan[3].SerialEncDataA is not used.

This register is read-only. Writing is disabled.
The setting of this register depends on XY2-100 and SL2-100.

For CK3W-GC1□00 Units (XY2-100)

Bit	Name	Function
31 to 08	Command position after linear interpolation	Stores the command position data that was applied linear interpolation. *1 The command position data that was applied linear interpolation is refreshed every 10 μs. This data is the value before a compensation of command position is made. Data format is determined by ModeSel.
07 to 00	Reserve	Always set 0.

*1. Stores the data before a compensation of command position is made.

For CK3W-GC2□00 Units (SL2-100)

Bit	Name	Function
31 to 08	Reception data based on control command	Receives the reception data set by the control command.
07 to 00	Reserve	Always set 0.

A-9-5 Gate3[i].Chan[j].SerialEncDataB (Status Data)

Description	Status data of the Galvo Scanner
Default	$00000000

This register is read-only. Writing is disabled.
The setting of this register depends on XY2-100 and SL2-100.

For CK3W-GC1□00 Units (XY2-100)

Depending on the channel, this setting varies as follows.

Register	Description
Gate3[i].Chan[0].SerialEncDataB	XY-axis status
Gate3[i].Chan[2].SerialEncDataB	Z-axis status

Note Gate3[i].Chan[1].SerialEncDataB and Gate3[i].Chan[3].SerialEncDataB are not used.

Bit	Name	Function
31 to 13	Status	Stores the status data sent from the Galvo Scanner. For details on the status data, refer to the manual for the Galvo Scanner.
12	Status Parity	Stores the parity bits added to the status data. Use a user program to check that the parity is correct.
11 to 00	Reserve	Always set 0.

For CK3W-GC2□00 Units (SL2-100)

Depending on the channel, this setting varies as follows.

Register	Description
Gate3[i].Chan[0].SerialEncDataB	X-axis status
Gate3[i].Chan[1].SerialEncDataB	Y-axis status
Gate3[i].Chan[2].SerialEncDataB	Z-axis status

Note Gate3[i].Chan[3].SerialEncDataB is not used.

Bit	Name	Function
31	TxRx_Error	Detects an error in communications with the Galvo Scanner. 0: Communications normal 1: Communications abnormal*1
30	Power_OK	Shows the status of the internal power supply voltage of the Galvo Scanner. 0: Internal power supply voltage abnormal in the Galvo Scanner 1: Internal power supply voltage normal in the Galvo Scanner If any internal power supply voltage error is found, follow the manual for the Galvo Scanner to remove it.
29	Temp_OK	Shows the status of the internal temperature of the Galvo Scanner. 0: Internal temperature abnormal in the Galvo Scanner 1: Internal temperature normal in the Galvo Scanner If any internal temperature error is found, follow the manual for the Galvo Scanner to remove it.
28	Position_Ack	Shows whether the error in the position data of the Galvo Scanner is within the standard range. *2 0: The error in the position data of the Galvo Scanner is outside the standard range. 1: The error in the position data of the Galvo Scanner is within the standard range.
27	Data for maintenance	Used for maintenance.
26 to 14	Reserve	Always set 0.
13 to 8	Data for maintenance	Used for maintenance.
7 to 0	Number of frames received	Counts the number of frames received by the CK3W-GC Unit. Since a frame comes every 10 μs, you can confirm that the reception data is coming when you check that this data is counting up.

*1. Depending on the timing of starting communications with the Galvo Scanner, TxRx_Error may turn ON in the detection of the first frame.
Do not use a user program to check the error that may occur at the start of communications.

*2. For the standard ranges, refer to the Galvo Scanner specifications.

A-9-6 Gate3[i].Chan[0].CompA (PWM Output Setting)

Description	PWM output setting
Default	$00000000

Bit	Name	Function
31 to 20	DutyCycle	Set the duty in the H period of PWM output by the formula below. $\text{Duty (\%)} = \frac{DutyCycle}{4096} \times 100$ The setting range is from 0 to 4095. However, if you set DutyCycle = 4095, the duty will be 100%.
19 to 08	PWMPeriod	Set the PWM frequency by the formula below. $f_{PWM}\text{(kHz)} = \frac{10^5}{16 \times PWMPeriod}$ The setting range is from 2 to 4095. The PWM frequency can be set in the range from 1,526 Hz to 3.125 MHz.
07 to 00	Reserve	Always set 0.

A-9-7 Gate3[i].Chan[1].CompA (PWM Output Delay Setting)

Description	PWM output delay setting
Default	$00000000

Bit	Name	Function
31 to 20	DelayUnit	Set a delay unit in 10 ns increments. The setting range is from 0 to 4094. *1*2
19 to 17	Reserve	Always set 0.
16 to 08	Delay	When you set the pulse count of PWM, PWM is then started with a time delay calculated by the formula below from the rising edge of the clock set using ClockSel. $\text{Delay Time(ns)} = [(Delay+3)] \times [(DelayUnits+2) \times 10]$ The setting range is from 0 to 511.
07 to 00	Reserve	Always set 0.

*1. Do not set 4095.

*2. Configure DelayUnit to satisfy the following condition.
This setting may not operate correctly if the following condition is not satisfied.
Phase clock cycle × 0.2 - 100 ns > (DelayUnits + 2) × 10 (ns)

A-9-8 Gate3[i].Chan[2].CompA (PWM Output Pulse Count)

Description	PWM output pulse count
Default	$00000000

Bit	Name	Function
31 to 20	Reserve	Always set 0.

Bit	Name	Function
19 to 08	Pulse-Count	Set the pulse count to output. When one pulse is output, a value of this register will be subtracted by one. Reading this register will return the number of the remaining PWM pulses to be output. When the value is 0, no PWM pulse will be sent. You will find that the pulse output is done by monitoring this register. The setting range is from 0 to 4095. When a value of this register is set at the maximum value (4095), PWM pulses will be output continuously without subtracting this register.
07 to 00	Reserve	Always set 0.

A-9-9 Gate3[i].Chan[0].CompB (TCR Output Command Distance Setting)

Description	TCR output command distance setting
Default	$00000000

This register is valid for the CK3W-GC□200 Units only.

Bit	Name	Function
31 to 0	CommandDistance	Write command distance in a phase or a servo cycle from the CPU Unit. *1 The setting range is from 0 to 2^{32}-1.

*1. Refer to *3-7-9 TCR Output Function* on page 3-84 for details.

A-9-10 Gate3[i].Chan[1].CompB (TCR Output Comparison Table Setting)

Description	TCR output comparison table setting
Default	$00000000

This register is valid for the CK3W-GC□200 Units only.

Bit	Name	Function
31 to 0	CompareValue	Write a comparison value from the CPU Unit. *1 When you read this, it will return a value on the comparison table where you are making a comparison now. The setting range is from 0 to 2^{32}-1.

*1. Refer to *3-7-9 TCR Output Function* on page 3-84 for details.

A-9-11 Gate3[i].Chan[2].CompB (TCR Output Control Register)

Description	TCR output control register
Default	$00000000

This register is valid for the CK3W-GC□200 Units only.

Bit	Name	Function
31	CompareEnable	Set whether to execute or stop the comparison function. 0: Comparison stop 1: Comparison execute
30	ClearTable	Setting this bit to 1 will clear the comparison table. Reading this bit will always result in 0. Before you clear the table, be sure to set CompareEnable to 0.

Bit	Name	Function
29	CompClkSel	Select an interpolation clock. 0: Servo clock 1: Phase clock To change this setting, be sure to set CompareEnable to 0 beforehand. Also, make sure that the interpolation clock period is 1 ms or less.
28	Reserve	Always set 0.
27 to 26	CompOut-Write	This is a 2-bit register, which allows you to forcibly set a comparison output. The lower bit is write enable, and the higher bit sets the status of a comparison output. 01: A comparison output is forcibly set to 0. 11: A comparison output is forcibly set to 1. Writing 00 or 10 will reset the forced output.
25	CompOutPol	Set the status of an OUT1 terminal output to a comparison output. 0: With comparison output = 1, OUT1 terminal = H (5 V output) With comparison output = 0, OUT1 terminal = L (0 V output) 1: With comparison output = 1, OUT1 terminal = L (0 V output) With comparison output = 0, OUT1 terminal = H (5 V output)
24 to 00	Reserve	Always set 0.

A-9-12 Gate3[i].Chan[3].CompB (TCR Output Status Register)

Description	TCR output status register

This register is valid for the CK3W-GC□200 Units only.
This register is read-only. Writing is disabled.

Bit	Name	Function
31	CompOut	Shows the OUT1 terminal status. 0: OUT1 terminal = L (0 V output) 1: OUT1 terminal = H (5 V output)
30 to 24	Reserve	
23 to 12	TableWrite-Pointer	Shows the buffer number to be written next on the comparison table. When this data is *n*, buffers on the comparison table are empty from n to 4094. When this data is *0*, all buffers are empty. When this data is *4095*, all buffers are used and you can write no more comparison values.
11 to 0	Compare-Pointer	A buffer number on the comparison table with which the comparison is being executed now. When this data is *n*, the comparison value of buffer n is valid. When Compare Enable is *0*, this data will be *0*. The comparison is done when ComparePointer is the same as TableWritePointer.

A-9-13 Gate3[i].Chan[0].Status (Internal Memory Error Detection)

Description	Internal memory error detection

This register is read-only. Writing is disabled.

It can detect a memory error inside the Unit.
The errors are classified into the following two types.
Each error is removed by cycling the power supply.

Use a user program to monitor this register, and cycle the power supply when an error occurs.

Bit	Name	Function
31 to 28	Reserve	
27	Minor error	Detects a minor error in the internal memory. 0: No minor error found in internal memory 1: A minor error found in internal memory Even if a minor error occurs, operation will continue.
26	Fatal error	Detects a fatal error in the internal memory. 0: No fatal error found in internal memory 1: A fatal error found in internal memory If a fatal error occurs, XY2-100 and SL2-100 communications will stop, and OUT0 terminal and OUT1 terminal outputs will be set to L (0 V output).
25 to 00	Reserve	

I

Index

Index

A

Applicable Wires..... 5-2, 5-14, 5-26, 5-33, 5-40

B

Basic Configuration..... 1-3, 2-2

C

Cleaning..... 7-2
CPU Rack..... 2-2
CPU Unit..... 3-3
Crimping Tool..... 5-3, 5-15, 5-27, 5-33, 5-40

D

Daisy chain..... 4-29
Daisy Chain..... 4-27
DIN Track..... 4-13
DIN Track End Plates..... 4-13

E

Earthing Methods..... 4-27
ECAT ACT..... 3-9
ECAT LINK..... 3-9
Equipotential bonding system..... 4-27, 4-28
ERR..... 3-9
EtherCAT communications connector..... 3-7
EtherCAT communications port operation indicators..... 3-8
EtherCAT Network Configuration..... 2-5
Ethernet ACT..... 3-9
Ethernet communications connector..... 3-8
Ethernet communications port operation indicators..... 3-8
Ethernet LINK..... 3-9
Ethernet Network Configuration..... 2-7

F

Ferrule..... 5-3, 5-14, 5-26, 5-33, 5-40
Functional Grounding..... 4-31

G

Grounding..... 4-27, 5-3
grounding to 100 Ω or less..... 5-3

I

Initialization of CPU Unit..... 6-9
Installation Dimensions..... 4-16
Installation height..... 4-16
Installation in cabinets or control panels..... 4-6

M

Modbus-TCP communications..... 1-4

N

network topology..... 5-7

O

Operating Procedure..... 1-6
Output Specifications..... 3-10
Output Status..... 3-9

P

Performance Specifications..... 3-3
Power PMAC IDE..... 1-4
Power PMAC-NC16 Runtime..... 1-5
Power PMAC-NC16 SDK..... 1-5
Power Supply Unit..... 3-12
PWR..... 3-8

R

RDY..... 3-9
Recommended Power Supplies..... 3-12
recommended screwdriver..... 5-4, 5-15, 5-27, 5-33, 5-40
Recommended USB memoryRecommended USB memory..
..... 3-10

S

Slider..... 3-7
Solid Wires. 5-3, 5-4, 5-15, 5-26, 5-27, 5-33, 5-34, 5-40, 5-41
Star earthing..... 4-27, 4-28
Support Software..... 1-4

T

Twisted Wires.....
..... 5-3, 5-4, 5-15, 5-26, 5-27, 5-33, 5-34, 5-40, 5-41
twisted-pair cable..... 5-9

U

Unit connector..... 3-8
USB 2.0 connector..... 3-8
USB connector for maintenance..... 3-8

W

Watchdog output terminal block..... 3-8, 3-9
Wiring Ducts..... 4-8

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