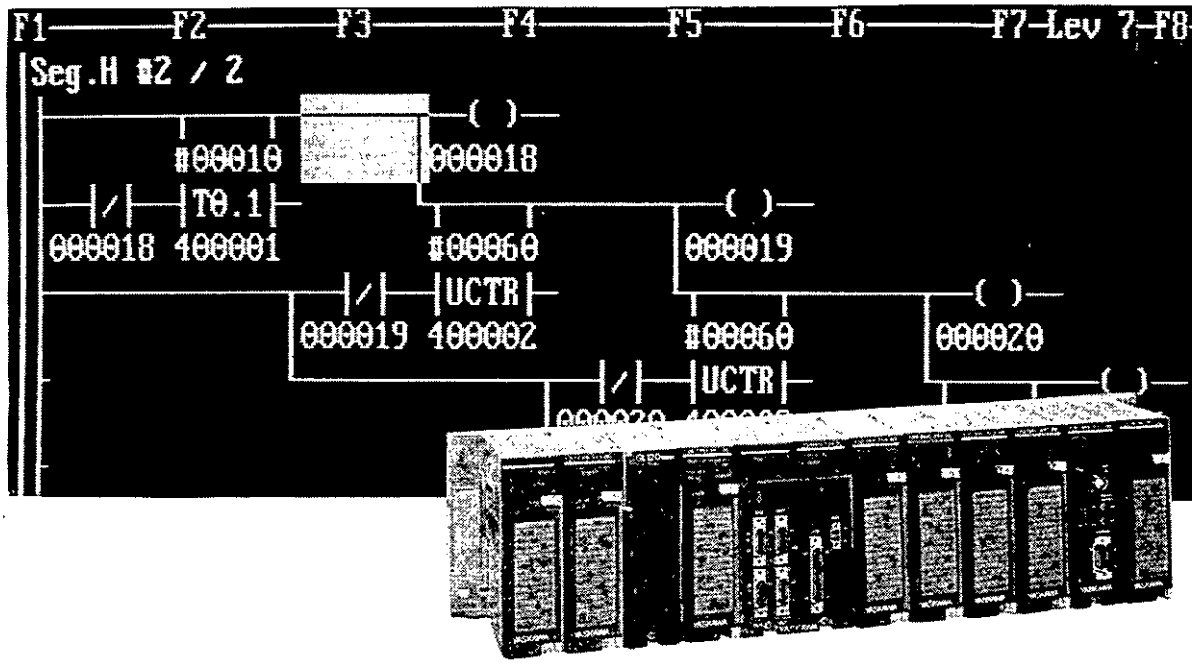
MEMOCON GL120, GL130

# COAXIAL REMOTE I/O SYSTEM

# USER'S MANUAL




YASKAWA

MANUAL NO. SIEZ-C825-70.8C

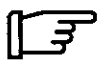
# Manual Contents

This manual describes specifications and applications of the JAMSC-120CRD13100 Remote I/O Driver Module and the JAMSC-120CRR13100 Remote I/O Receiver Module. These Modules are used to create Coaxial Remote I/O Systems for MEMOCON GL120 and GL130 Programmable Controllers.

Please read this manual carefully and be sure you understand the information provided before attempting to design, install, or operate a Remote I/O System.

# Visual Aids

The following aids are used to indicate certain types of information for easier reference.



Indicates references for additional information.

IMPORTANT — Indicates important information that should be memorized.

◀EXAMPLE▶ — Indicates application examples.


Indicates supplemental information.

◗SUMMARY — Indicates a summary of the important points of explanations.

**Note** — Indicates inputs, operations, and other information required for correct operation but that will not cause damage to the device.


Indicates definitions of terms used in the manual.

# NOTICE

The following conventions are used to indicate precautions in this manual. Failure to heed precautions provided in this manual can result in injury to people or damage to the products.

⚠ **WARNING** Indicates precautions that, if not heeded, could possibly result in loss of life or serious injury.

⚠ **Caution** Indicates precautions that, if not heeded, could result in relatively serious or minor injury, damage to the product, or faulty operation.

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# CONTENTS

# Introduction and Precautions

# 1



This chapter gives precautions and warnings concerning the use of this product and the manual. **You must read this chapter before reading the rest of the manual or using the product.**

# 1.1 Overview of Manual

- This manual describes how to use the Coaxial Remote I/O Modules. Read this manual carefully to ensure the proper use of the Remote I/O Modules. Also, keep this manual in a safe place so that it can be used whenever necessary.

- The following Coaxial Remote I/O Modules are discussed in this manual.

  JAMSC-120CRD13100 Remote I/O Driver Module

  JAMSC-120CRR13100 Remote I/O Receiver Module

- Refer to the following manuals for related Peripheral Devices and Modules.

| Manual | Manual number | Contents |
|---|---|---|
| MEMOCON GL120, GL130 Hardware User's Manual | SIEZ-C825-20.1 | Describes the functions, specifications, and handling methods of GL120 and GL130 hardware. |
| MEMOCON GL120, GL130 Software User's Manual Volume 1 | SIEZ-C825-20.11 | Describes the operating principles and I/O allocation of GL120 and GL130. |
| MEMOCON GL120, GL130 Software User's Manual Volume 2 | SIEZ-C825-20.12 | Describes the expansion instructions and the floating-point instructions of the GL120 or GL130 system. |
| MEMOCON Micro, GL120, GL130 MEMOBUS User's Manual | SIEZ-C825-70.13 | Describes the functions, and handling methods of MEMOBUS system. |
| MEMOCON GL120, GL130 COM Instructions User's Manual | SIEZ-C825-70.14 | Describes COM instructions, their functions and application methods. |
| MEMOCON Micro, GL120, GL130 Programing Panel P120 (MEMOSOFT) User's Manual | SIEZ-C825-60.7 | Describes the functions, specifications, and usage of the Programming Panel P120 (with built-in MEMOSOFT). |
| MEMOCON Micro, GL120, GL130 MEMOSOFT for DOS User's Manual | SIEZ-C825-60.10 | Describes functions and operating methods of the MEMOSOFT for DOS. |

- Thoroughly check the specifications and conditions or restrictions of the product before use.

# 1.2 Precautions

This section outlines general precautions that apply to using this manual and the product. You must read this section first before reading the remainder of the manual.





## 1.2.1 Safety Precautions

- MEMOCON was not designed or manufactured for use in devices or systems that concern people's lives. Users who intend to use the product described in this manual for special purposes such as devices or systems relating to transportation, medical, space aviation, atomic power control, or underwater use must contact Yaskawa Electric Corporation beforehand.

- This product has been manufactured under strict quality control guidelines. However, if this product is to be installed in any location in which a failure of MEMOCON involves a life and death situation or in a facility where failure may cause a serious accident, safety devices MUST be installed to minimize the likelihood of any accident.

## 1.2.2 General Precautions

- The diagrams and photographs provided in this manual are typical examples only and may be different from the product that is supplied.

- The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

- Contact your Yaskawa representative or a Yaskawa office listed on the back of this manual to order a new manual whenever this manual is damaged or lost. Please provide the document number listed on the front cover of this manual when ordering.

- Contact your Yaskawa representative or a Yaskawa office listed on the back of this manual to order new nameplates whenever a nameplate becomes worn or damaged.

- Yaskawa cannot make any quality guarantee for products which have been modified. Yaskawa assumes no responsibility for any injury or damage caused by a modified product.

## 1.2.3 Installation Precautions

Abide by the following precautions when installing MEMOCON systems.

⚠**Caution** The installation environment must meet the environmental conditions given in the product catalog and manuals. Using the MEMOCON in environments subject to high temperatures, high humidity, excessive dust, corrosive gases, vibration, or shock can lead to electrical shock, fire, or faulty operation. Do not use the MEMOCON in the following locations.

- Locations subject to direct sunlight or ambient temperatures not between 0 and 60 °C.
- Locations subject to relative humidity in excess of 95%, rapid changes in humidity, or condensation.
- Locations subject to corrosive or flammable gas.
- Locations that would subject the MEMOCON to direct vibration or shock.
- Locations subject to contact with water, oil, chemicals, etc.

⚠**Caution** Install the MEMOCON as described in this product manual. Improper installation can cause product failure, malfunctions, or Modules or other components to fall off.

⚠**Caution** Do not allow wire clippings or other foreign matter to enter the MEMOCON. Foreign matter can cause fires, product failure, or malfunctions.

## 1.2.4 Wiring Precautions

⚠ **Caution** Wiring must be performed by qualified personnel.

Mistakes in wiring can cause fires, product failure, or malfunctions.

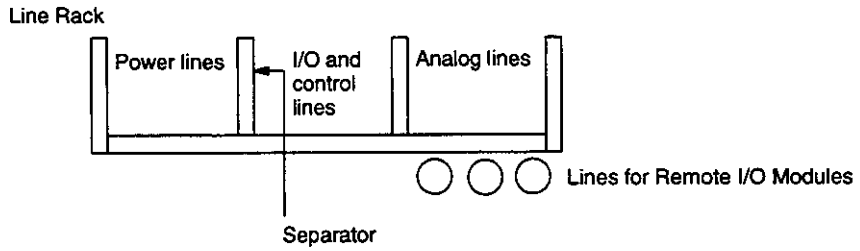
- Insert the interface cables properly.

Insert the connectors of the various interface cables that are to be connected to MEMOCON into the communication ports and attach them properly. Improper insertion of interface cables may cause operational errors in the MEMOCON.

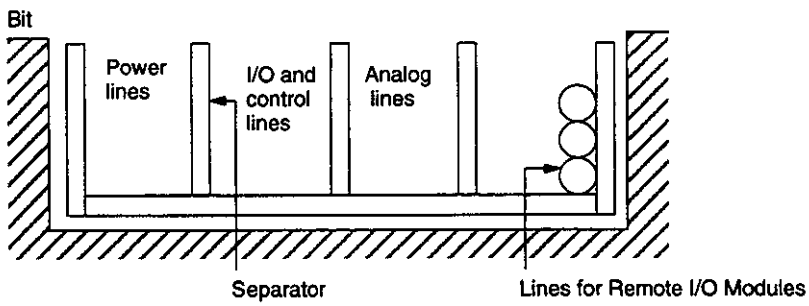
- Separate wiring properly.

I/O lines connecting the MEMOCON to external devices must be selected based on the following considerations: mechanical strength, resistance to noise, wiring distance, signal voltage, etc.

I/O lines must be separated from power lines both within and outside of the control panel to minimize the affects of noise. Faulty operation can result if I/O lines are not sufficiently separated from power lines.




When wiring Remote I/O Module cables outside of the control panel, place them in a duct or conduit by themselves to minimize the affects of noise. Faulty operation can result if MEMOBUS lines are not sufficiently insolated.



## 1.2.5 Application Safety Precautions

**⚠WARNING** Do not touch terminals while the power is ON.

Touching live terminals may cause electric shock.

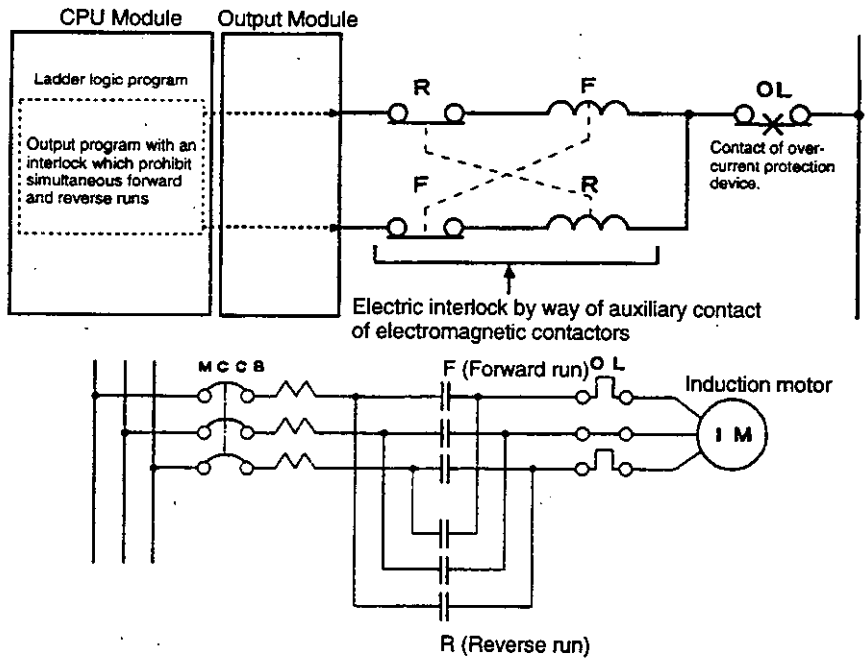
**⚠WARNING** Externally connect emergency stop, interlock circuits, and other switches to the MEMOCON.

**External Interlocks for the GL120 and GL130**

Externally connect an interlock to the GL120 and GL130 if there is any chance that GL120 and GL130 failure could result in bodily harm or equipment damage.

Always use an external interlock system as shown in the following example when reciprocal operations (e.g., forward and reverse directions) are being performed with a motor.

An interlock is generally programmed in the GL120/GL130 to ensure that forward and reverse signals are not simultaneously output. An external interlock circuit must also be provided using the auxiliary contacts of electromagnetic contactors.




**⚠WARNING** Operations such as RUN, STOP, forced output, and program changes during operation must be carried out with care. Operational errors may damage the machine or cause accidents.

## 1.2.6 Maintenance

Do not attempt to disassemble or modify the MEMOCON in any way. Doing so can cause fires, product failure, or malfunctions.

Make sure that equipment power is turned OFF before mounting or removing the MEMOCON Modules.

⚠ **WARNING** Turn OFF the power supply before installing or removing a Remote I/O Driver Module. Otherwise, an electric shock, an operation error, or a fault may occur.

# 1.3 Using this Manual

This manual is written for those who already have a basic knowledge of MEMOCON PLCs. We recommend reading the *MEMOCON GL120, GL130 Hardware User's Manual* before attempting to read this manual.

- **Meaning of Basic Terms**

  In this manual, the following terms indicate the meanings as described below, unless otherwise specified.

  - **Remote I/O = Remote I/O System**
  - **I/O = Input and Output**
  - **PLC = Programmable (Logic) Controller**
  - **PP = Programming Panel**

- **Description of Technical Terms**

  The bold technical terms in this manual are briefly explained in the **Glossary** provided at the bottom of the page. An example is shown below.


**Glossary**

The following types of terms are described.

- Specific sequence control terms required for explanation of functions.
- Terms that are specific to programmable controllers and electronic devices.

# Outline of Remote I/O and System Configuration

# 2

This chapter outlines the Remote I/O Systems and their system configurations.

# 2.1 What is Remote I/O?

This section describes remote I/O.



## 2.1.1 Remote I/O Outline

1) Remote I/O is a communications system for installing I/O services to remote locations.

2) Remote I/O consists of a Remote I/O Driver Module and a Remote I/O Receiver Module, which respectively function as a master station and a slave station of a remote communications line.

3) A Remote I/O Receiver Module has one communications port (MEMOBUS port). By connecting a P120 Programing Panel or a personal computer to this MEMOBUS port, programming and monitoring for the CPU Module are enabled.

## 2.1.2 Remote I/O Features

1) All 120-series I/O Modules can be used on remote stations.

2) Enhanced monitor functions can be used to monitor the status of the I/O Modules, error counts, and other status.

3) Data can be transmitted up to 1 km by altering the cable type and the baud rate.

4) Remote operation is possible from a MEMOBUS port using a Programming Panel.

5) Easy communications are possible with ASCII devices by using the MEMOBUS port as a master port and by using COMR instructions.

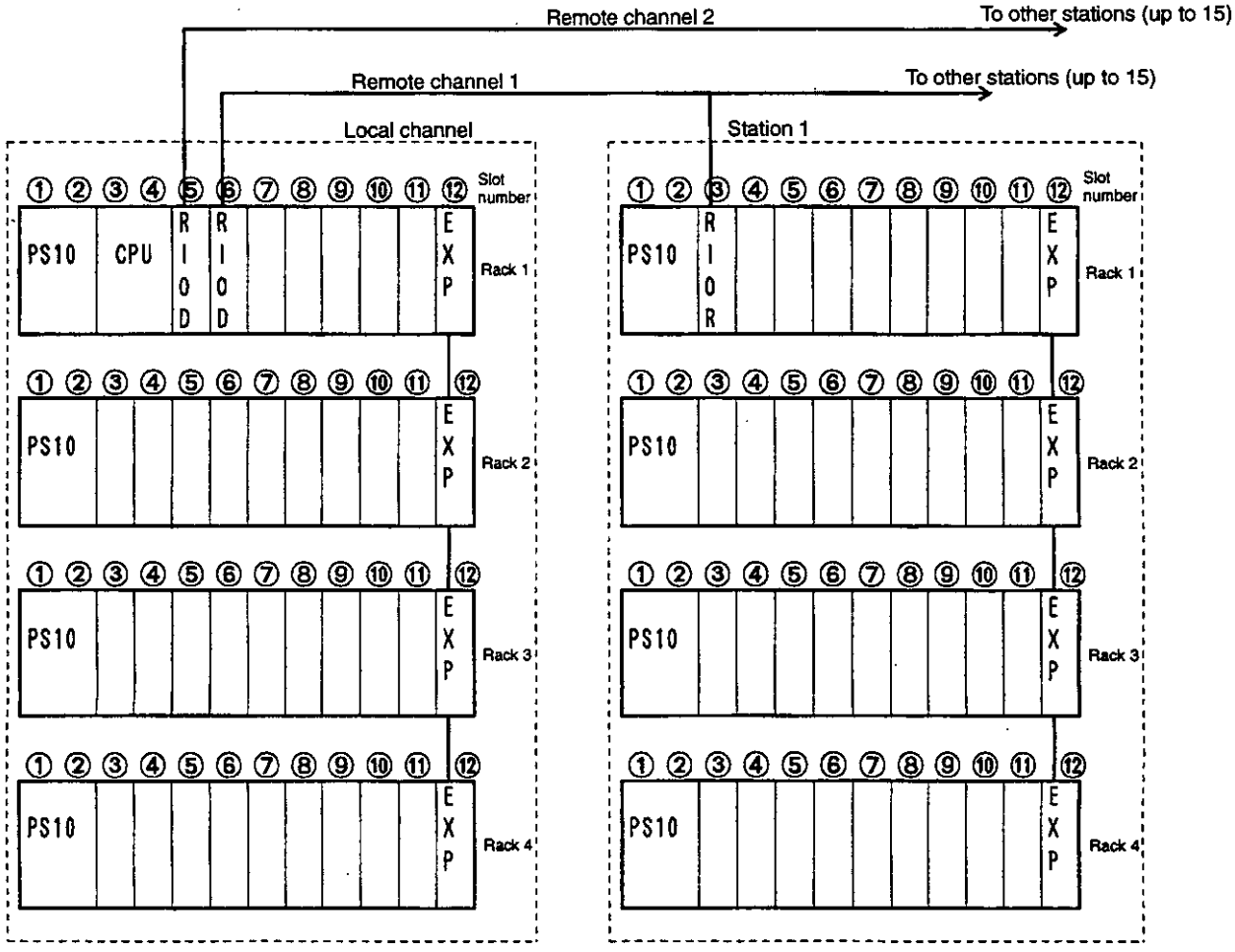
# 2.2 System Configuration

This section describes the system configuration of Remote I/O and definition of the I/O section.



## 2.2.1 System Configuration

1) *Figure 2.1* illustrates the system configuration of Remote I/O.

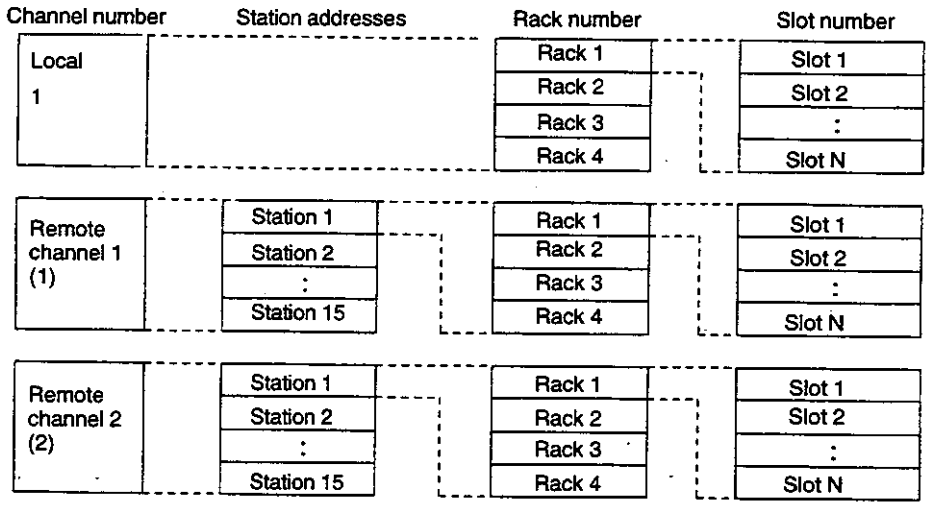



PS10: Power Supply Module
CPU: CPU Module
EXP: Expander Module
RIOD: Remote I/O Driver Module
RIOR: Remote I/O Receiver Module

**Figure 2.1 System Configuration Diagram**

## 2.2.2 I/O Configuration

1) *Figure 2.2* illustrates the I/O configuration.




**Note** N indicates the number of slots determined by the Mounting Base (see *Table 2.1*).

**Figure 2.2 I/O Configuration**

## 2.2.3 Number of I/O Allocation Points

1) *Table 2.1* lists the numbers of I/O points that can be allocated in the GL120 and GL130. *Table 2.2* shows the relationship between the Mounting Base and the number of slots.

**Table 2.1 Configuration of Allocatable I/O**

| Item | | GL120 | GL130 |
|---|---|---|---|
| Number of I/O points | Digital I/O | Up to 1024 points | Up to 4096 points |
| | Register I/O | Up to 512 registers (1 register = 16 bits) | |
| Local channel | Number of racks | Up to 4 | |
| | Number of slots | Up to 16/rack (See note.) | |
| Remote channels | Number of stations | Up to 15 stations/channel | |
| | Number of racks | Up to 4/station | |
| | Number of slots | Up to 16/rack (See note.) | |

**Note** The maximum number of slots is determined by the Mounting Base.

**Table 2.2 Mounting Base Slots**

| Mounting Base | Number of Slots |
|---|---|
| JRMSI-120XBP00600 | 6 |
| JRMSI-120XBP01000 | 10 |
| JRMSI-120XBP01200 | 12 |
| JRMSI-120XBP01600 | 16 |

## 2.2.4 Definition of I/O Sections

### 1) Local Channel

The local channel includes all the I/O Modules installed on the Mounting Base where the CPU Module is installed plus all of the I/O Modules installed on other Mounting Bases connected with Rack-to-rack Cables via I/O Expander Modules (model: JAMSC-120CBE37000).

I/O Expander Modules are located at the right end of the Mounting Base. (Mounting Base: JRMSI-120XBP0□□00, where □□ indicates the number of slots; Rack-to-rack Cable: JZMSZ-120W0100-□□, where □□ indicates the cable length.)

### 2) Remote Channels

A remote channel includes all of the I/O connected by a Remote Cable from a Remote I/O Driver Module (model: JAMSC-120CRD13100). Up to two Remote I/O Driver Modules can be installed on the GL120 and GL130 and each Module is identified as either remote channel 1 or remote channel 2. Remote channel numbers are set with a switch on the Remote I/O Driver Modules.

### 3) Remote Stations

A remote station includes all of the I/O Modules installed on a Mounting Base with a Remote I/O Receiver Module (model: JAMSC-120CRR13100) and all the I/O Modules installed on other Mounting Bases connected with Rack-to-rack Cables via I/O Expander Modules. I/O Expander Modules are located at the right end of the Mounting Base. Up to 15 (from 1 to 15) station addresses can be assigned to remote stations for identification. The same station address cannot be assigned more than once within a remote channel. Station addresses are set using the rotary switches on Remote I/O Receiver Modules. The numbers set by the rotary switches must be the same as the station addresses.

### 4) Racks

A rack includes all of the I/O Modules installed on one Mounting Base. Rack numbers from 1 to 4 are assigned to the racks. Rack numbers are set by a selection switch (0 to 3) on the I/O Expander Module.

### 5) Slots

A slot is one of a number of connectors for the various types of Modules that can be installed on a Mounting Base. Mounting Bases of 6, 10, 12, and 16 slots are available. A CPU Module, PS10 Module, or MC20 Module occupies two slots.

# 2.3 I/O Allocation for Remote Channels

This section describes the I/O allocation for remote channels.



## 2.3.1 I/O References

1) Basically speaking, I/O is allocated for the remote channel in the same way as for the local channel; however, a remote channel number and a station address are included with the I/O allocation. Therefore, when allocating I/O for a remote channel, specification of a channel number and a station address is required.

2) The concept for a station is the same as for the local channel. The contents of remote channel I/O allocations are the same as for the local channel and consists of an I/O reference number, module type, and I/O data format.

3) The specification of I/O references is the same as for the local channel.

## 2.3.2 Module Types

The specification of the module types is the same as for the local channel except for the following restrictions.

**Note** The number of I/O points that can be allocated to one station for a remote channel is restricted as follows:

- Number of input bytes = (Total number of digital input points) ÷ 8 + (Total number of input registers) x 2 ≤ 512 bytes

- Number of output bytes = (Total number of digital output points) ÷ 8 + (Total number of output registers) x 2 ≤ 512 bytes

## 2.3.3 I/O Data Format

1) The format of I/O data specifies the structure used to exchange I/O data with the I/O references that are allocated. In the actual I/O allocation operation, the format of I/O data is specified in a zoom operation.

**2) Specification of Bit Sequence**

Two types of settings are available for specification of the bit sequence, MSB and LSB. With MSB, the first I/O reference is assigned to the smallest input number. With LSB, the first I/O reference is assigned to the largest input number. The factory setting is for MSB for digital I/O. For register I/O, the factory setting is for LSB.

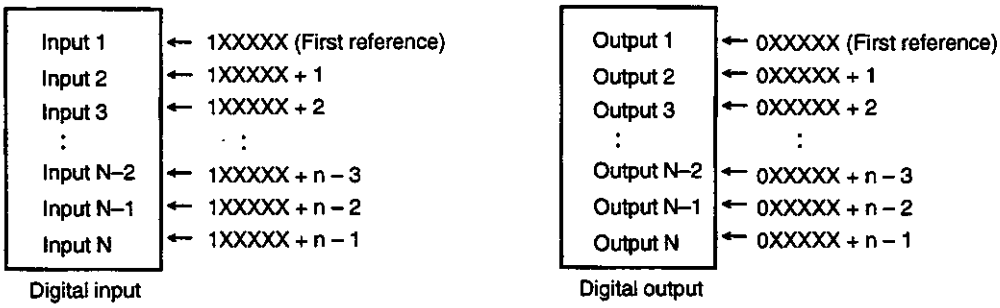



**Figure 2.3 Digital I/O Data Format with Bit Sequence Specification = MSB**

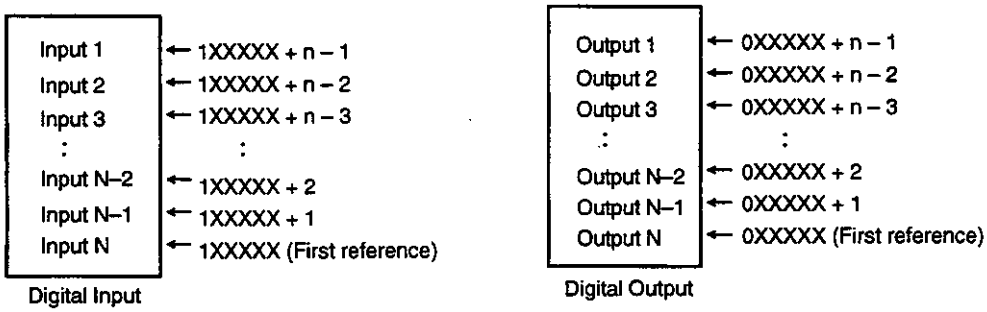



**Figure 2.4 Digital I/O Data Format with Bit Sequence Specification = LSB**

### 3) Specification of BIN/BCD for the Input and Output Data

BIN or BCD must be specified as the I/O data type for register I/O references. The factor setting is for BIN. *Figure 2.5* gives an example.

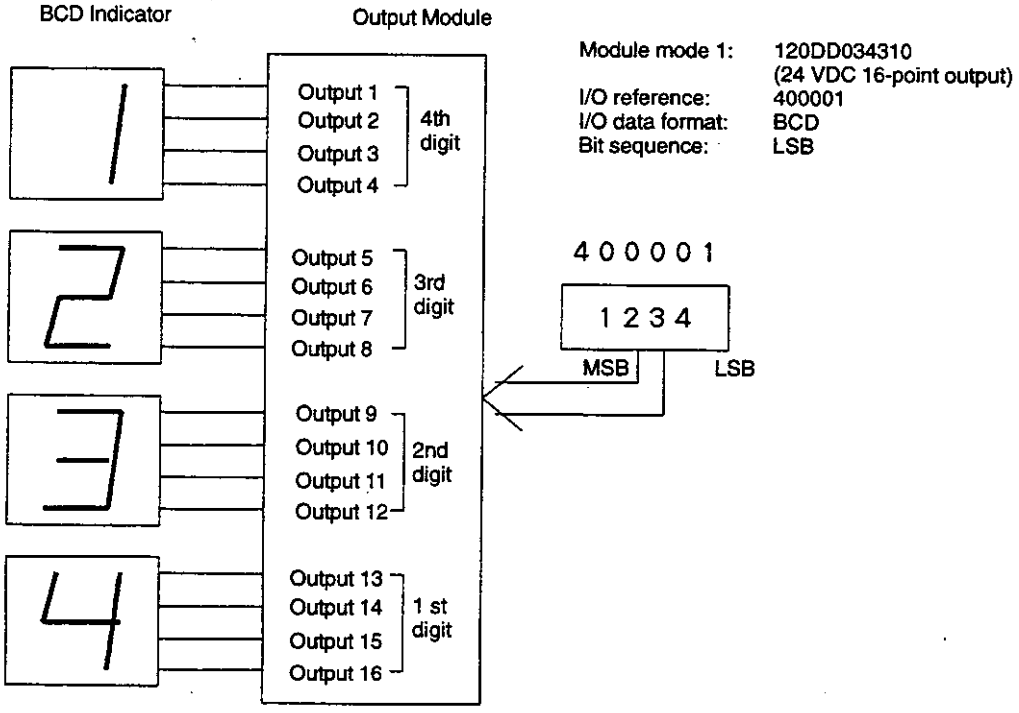



**Figure 2.5 BCD Output**

### 4) Service Scan Specification

Two service scan modes are available, normal and high-speed. The service scan specification is significant when the high-speed segment is used. That is, if high speed is specified for I/O Modules, they will be serviced before the high-speed ladder logic segment is solved. The I/O Modules that are synchronized with high-speed scan are called high-speed segment I/O. The high-speed segment specification is made separately for each station for remote channels. The factory setting for the mode is for the normal service scan.

### 5) Selecting Timeout Output Treatment

When a CPU Module changes from a RUN state to a halt state, the treatment of output data can be selected. Either the status just before entering the halt state or a set status can be output.

### 6) Setting Timeout Output Data

The data to be output when the CPU Module is halted must be specified when a set status is selected for timeout outputs. The data to be specified here is the image of the PC reference data. The data is converted and the output is based on the bit sequence that was set.

## 2.3.4 Example of Remote Channel Allocations

*Figure 2.6* shows an example of the I/O Module layout for a remote channel and *Table 2.3* shows an example of the I/O allocations.

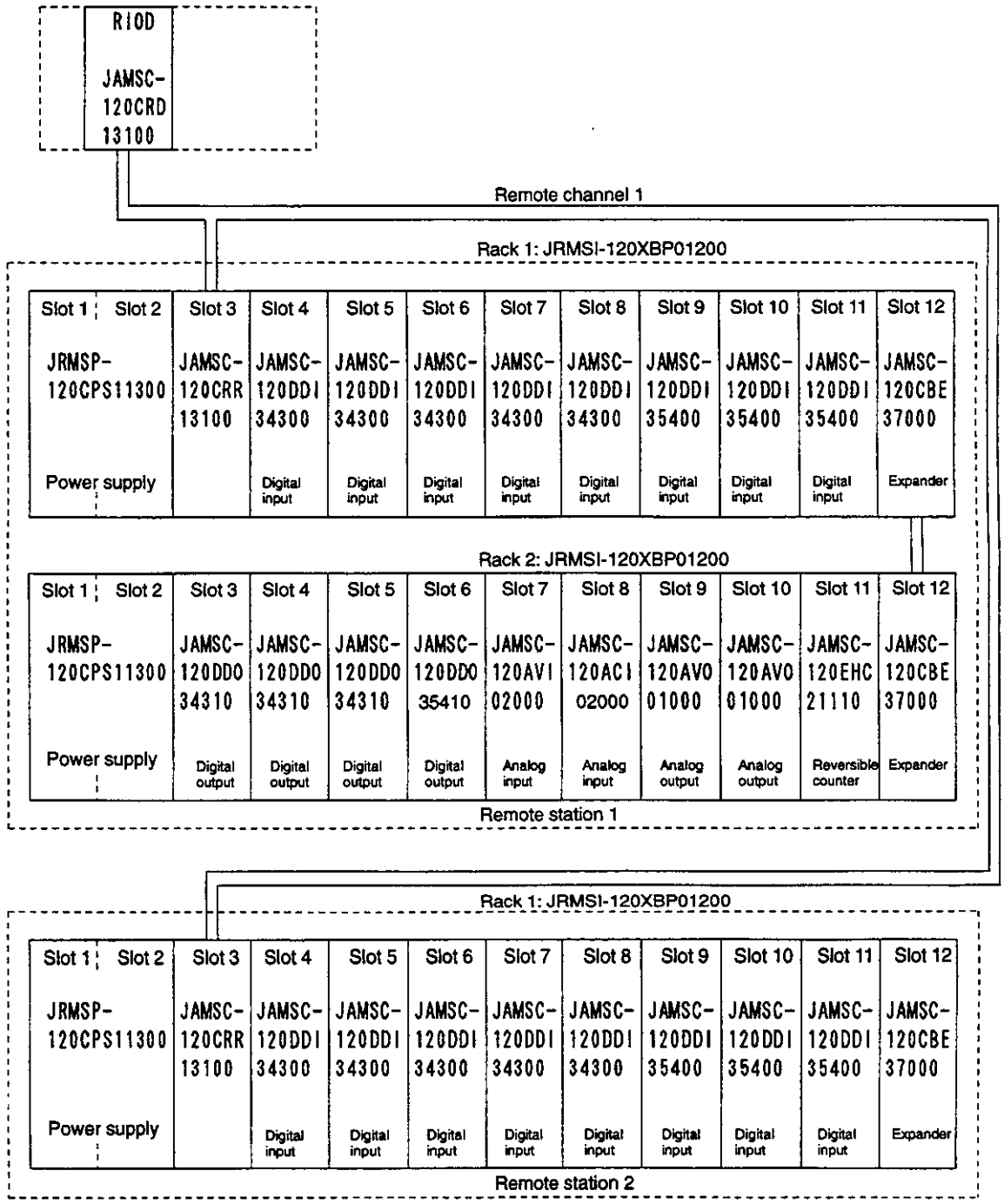



**Figure 2.6 Example of I/O Module Layout**

**Table 2.3 Example of Remote I/O Assignment**

| Remote Channel Number | I/O Allocations | | | Module Type | I/O Reference Number | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Digital Inputs | | Register Inputs | | Digital Outputs | | Register Outputs | |
| | ST. Address | Rack Number | Slot Number | | Reference | Number of Points | Reference | Number of Points | Reference | Number of Points | Reference | Number of Points |
| 1 | 1 | 1 | 1 | Power Supply Module | | | | | | | | |
| | | | 2 | | | | | | | | | |
| | | | 3 | Remote I/O Receiver | | | | | | | | |
| | | | 4 | 120DDI34300 | 100001 | 16 | | | | | | |
| | | | 5 | 120DDI34300 | 100017 | 16 | | | | | | |
| | | | 6 | 120DDI34300 | 100033 | 16 | | | | | | |
| | | | 7 | 120DDI34300 | 100049 | 16 | | | | | | |
| | | | 8 | 120DDI34300 | 100065 | 16 | | | | | | |
| | | | 9 | 120DDI35400 | 100081 | 32 | | | | | | |
| | | | 10 | 120DDI35400 | 100113 | 32 | | | | | | |
| | | | 11 | 120DDI35400 | 100145 | 32 | | | | | | |
| | | | 12 | Expander Module | | | | | | | | |
| | | 2 | 1 | Power Supply Module | | | | | | | | |
| | | | 2 | | | | | | | | | |
| | | | 3 | 120DDO34310 | | | | | 000001 | 16 | | |
| | | | 4 | 120DDO34310 | | | | | 000017 | 16 | | |
| | | | 5 | 120DDO34310 | | | | | 000033 | 16 | | |
| | | | 6 | 120DDO35410 | | | | | 000049 | 32 | | |
| | | | 7 | 120AVI02000 | | | 300001 | 4 | | | | |
| | | | 8 | 120ACI02000 | | | 300005 | 4 | | | | |
| | | | 9 | 120AVO01000 | | | | | | | 400001 | 2 |
| | | | 10 | 120ACO01000 | | | | | | | 400003 | 2 |
| | | | 11 | 120EHC21110 | 100177 | 16 | 300009 | 4 | 000081 | 16 | 400005 | 4 |
| | | | 12 | Expander Module | | | | | | | | |
| 1 | 2 | 1 | 1 | Power Supply Module | | | | | | | | |
| | | | 2 | | | | | | | | | |
| | | | 3 | Remote I/O Receiver | | | | | | | | |
| | | | 4 | 120DDI34300 | 100193 | 16 | | | | | | |
| | | | 5 | 120DDI34300 | 100209 | 16 | | | | | | |
| | | | 6 | 120DDI34300 | 100225 | 16 | | | | | | |
| | | | 7 | 120DDI34300 | 100241 | 16 | | | | | | |
| | | | 8 | 120DDI34300 | 100257 | 16 | | | | | | |
| | | | 9 | 120DDI35400 | 100273 | 32 | | | | | | |
| | | | 10 | 120DDI35400 | 100305 | 32 | | | | | | |
| | | | 11 | 120DDI35400 | 100337 | 32 | | | | | | |
| | | | 12 | Expander Module | | | | | | | | |

ST. address: Station addresses

**Note** I/O allocation is not required for Power Supply Modules, Remote I/O Receiver Modules, I/O Expander Modules, and empty slots. Refer to the *MEMOSOFT for DOS User's Manual* (manual No. SIEZ-C825-60.10) for the allocation.

# Names and Functions of Remote I/O Components

# 3

This chapter describes the names and functions of the components used to create Remote I/O Systems.

# 3.1 Remote I/O Driver Module

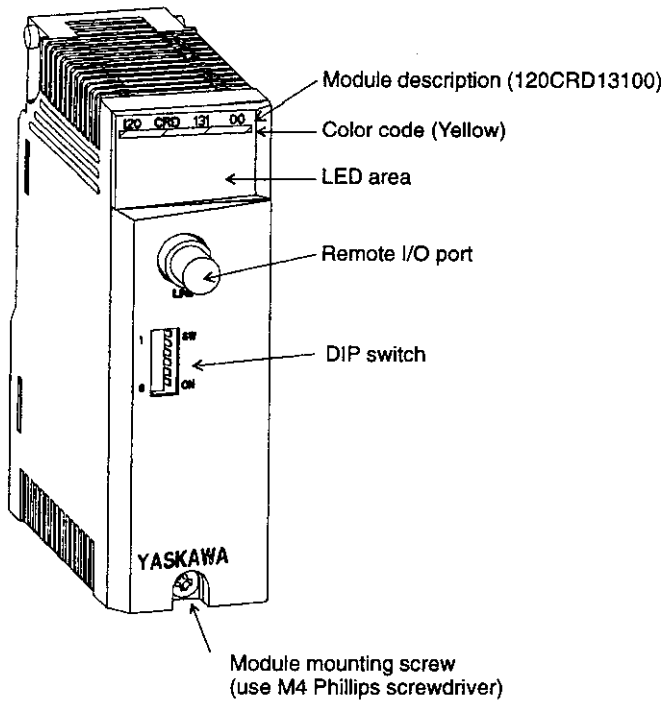
This section describes the names and functions of the components of the Remote I/O Driver Module.



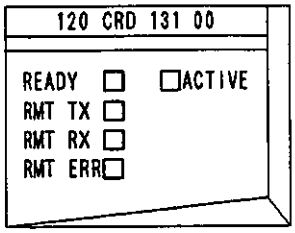
## 3.1.1 Components

The names of the components of the Remote I/O Driver Module are shown below.

Model: JAMSC-120CRD13100



Indicator Panel




| Indicator (Color) | Meaning |
|---|---|
| READY (green) | Lit when the Remote I/O Driver Module is operating normally. |
| ACTIVE (green) | Lit when Remote I/O Driver Module is processing I/O. |
| RMT TX (green) | Lit when data is transmitted from the Remote I/O communications port. |
| RMT RX (green) | Lit when data is received from the Remote I/O communications port. |
| RMT ERR (red) | Stays lit for about 10 ms when a transmission error occurs on the Remote I/O communications port. |

Status errors are indicated by the following displays.

| Error | LED Display |
|---|---|
| | **READY Indicator OFF and RMT ERR Indicator Flashes** |
| ROM error | The RMT ERR indicator flashes repeatedly. |
| RAM error | The RMT ERR indicator flashes twice and goes off for 1 second. |
| Common memory error | The RMT ERR indicator flashes three times and goes off for 1 second. |
| Watchdog error | The RMT ERR indicator flashes four times and goes off for 1 second. |

## 3.1.2 Functions

### 1) Remote I/O Port

A Remote I/O System is configured with coaxial cable to provide the Remote I/O Driver Module and Remote I/O Receiver Modules with a Remote I/O port for mutual transmission of data.

### 2) DIP Switch

a) Use the DIP switch at the front of each Remote I/O Driver Module and Remote I/O Receiver Module to set the baud rate and channel number. The switch can be set either before or after the Modules are installed. The state of the switches are loaded and stored when power is turned ON.

### b) Remote I/O Driver Module DIP Switch

| Pin No. | Setting | | |
|---|---|---|---|
| 1 | ON | Self-diagnostic mode | |
| | OFF | Remote mode (Set to OFF.) | |
| 2 | ON | 2000 I/O mode (for future use) | |
| | OFF | 120 I/O mode | |
| 3 | ON | Used as the Master for channel 2. | |
| | OFF | Used as the Master for channel 1. | |
| 4 | Not used. | | |
| 5 & 6 | **5** | **6** | **Baud Rate** |
| | ON | ON | 4 Mbps |
| | ON | OFF | 2 Mbps |
| | OFF | ON | 1 Mbps |
| | OFF | OFF | 0.5 Mbps |

**Note** (1) Set the same baud rate for the Remote I/O Driver Modules and Remote I/O Receiver Modules.

(2) If a pin setting is changed after the power supply is turned ON, turn OFF the power supply and restart the Driver Module again.

# 3.2 Remote I/O Receiver Module

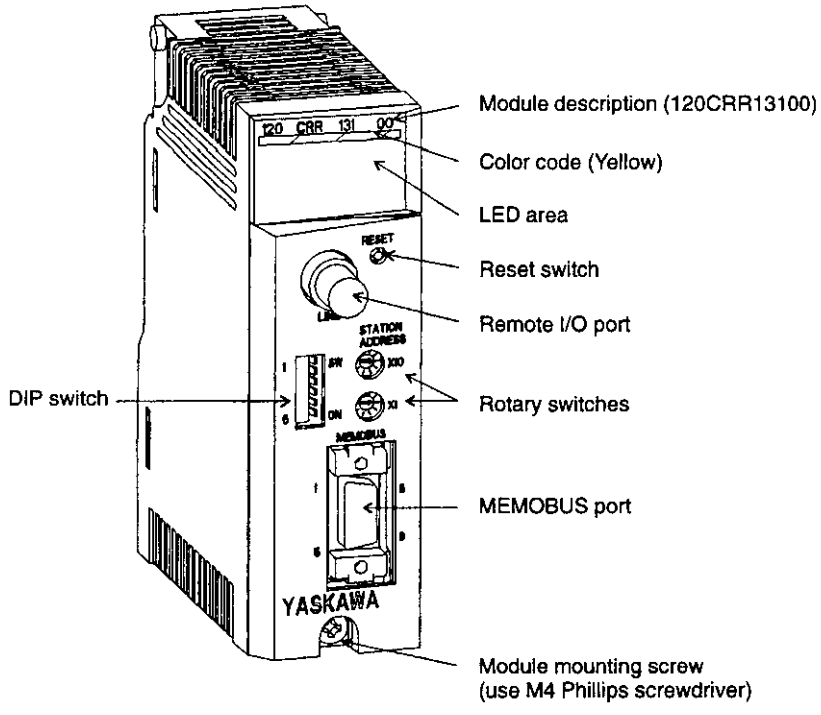
This section describes the components of a Remote I/O Receiver Module.



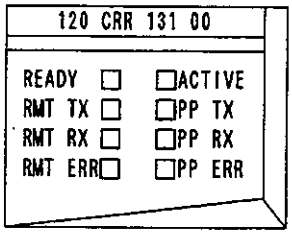
## 3.2.1 Components

The component names for the Remote I/O Receiver Module are shown below.

Model: JAMSC-120CRR13100



Indicator Panel




| Indicator (Color) | Meaning |
|---|---|
| READY (green) | Lit when the Remote I/O Driver Module is operating normally. |
| ACTIVE (green) | Lit when the Remote I/O Driver Module is processing I/O. |
| RMT TX (green) | Lit when data is transmitted from the Remote I/O communications port. |
| RMT RX (green) | Lit when data is received from the Remote I/O communications port. |
| RMT ERR (red) | Stays lit for about 10 ms when a transmission error occurs in the Remote I/O communications port. |
| PP TX (green) | Lit when data is sent from the MEMOBUS port. |
| PP RX (green) | Lit when data is received from the MEMOBUS port. |
| PP ERR (red) | Lit when a MEMOBUS port transmission error occurs. |

Status errors are indicated by the following displays.

| Error | LED Display |
|---|---|
| | **READY Indicator OFF and RMT ERR Indicator Flashes** |
| ROM error | The RMT ERR indicator flashes repeatedly. |
| RAM error | The RMT ERR indicator flashes twice and goes off for 1 second. |
| ASIC error | The RMT ERR indicator flashes three times and goes off for 1 second. |
| Watchdog error | The RMT ERR indicator flashes four times and goes off for 1 second. |

## 3.2.2 Functions

### 1) Remote I/O Port

A Remote I/O System is configured with coaxial cable so that the Remote I/O Driver Module and Remote I/O Receiver Modules have a signal path for mutual transmission of data.

### 2) MEMOBUS Port

a) A Remote I/O Receiver Module has one MEMOBUS port. A MEMOBUS master device (Programming Panel, ACGC, etc.) can be connected to this port.

b) Remote operations are possible via the remote functions of the Programming Panel. When using the remote functions of the Programming Panel, change the protocol for the MEMOSOFT communications parameters to Remote MEMOBUS.

c) The element status function cannot be used when the remote functions of the Programming Panel are used.

d) A MEMOBUS slave device (CRT, printer, etc.) can be connected via the COMR instruction. Refer to the *COM Instructions User's Manual* (manual No. SIEZ-C825-70.14) for details.

e) Use the DIP switch or MEMOSOFT to set communication parameters. See item *4) DIP Switch* for details.

### 3) System Configuration of a MEMOBUS Port and the COMR Instruction

MEMOBUS master communications via the Remote I/O Driver Module and Remote I/O Receiver Modules are achieved with the COMR instruction. An example of system configuration for the COMR instruction is shown below.

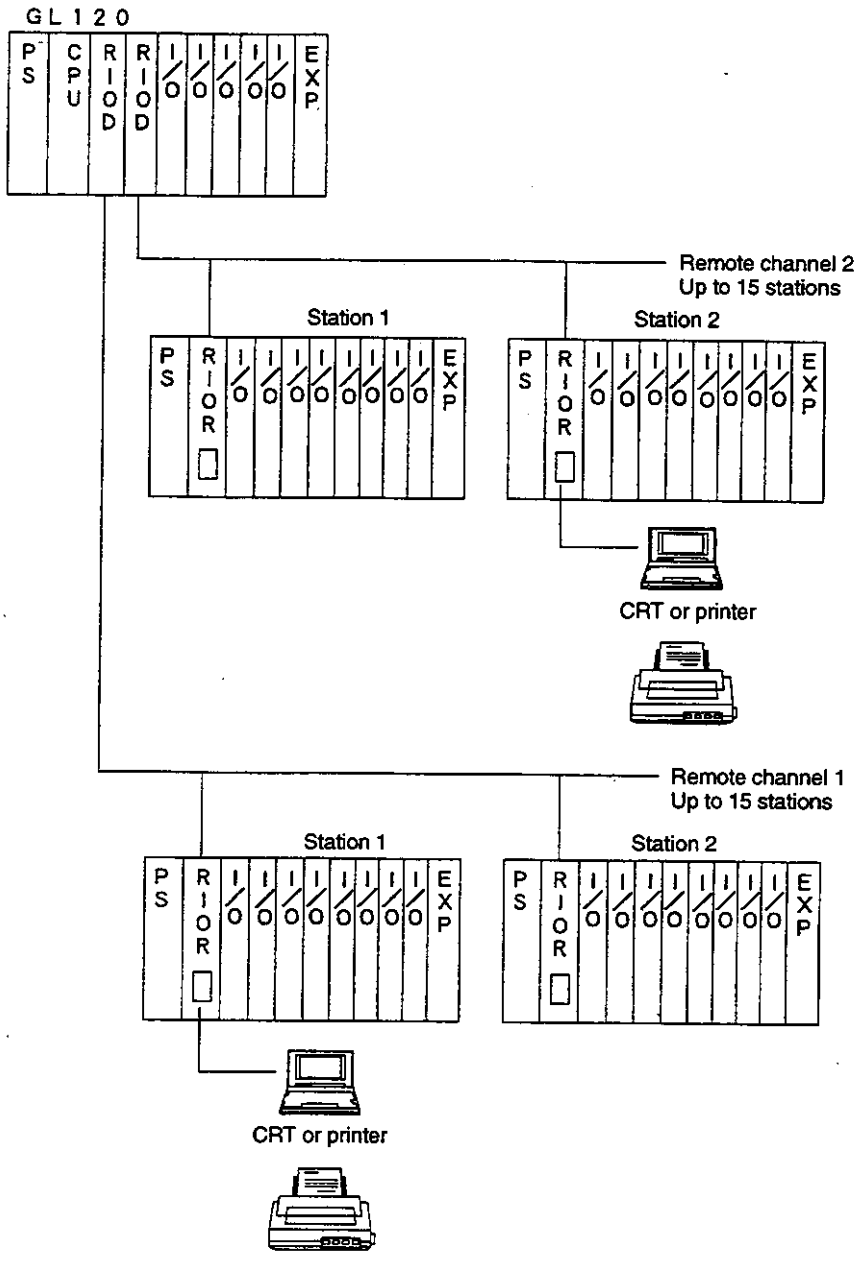



**Figure 3.1 System Configuration for the COMR Instruction**

### 4) DIP Switch

a) Use the DIP switch on the front of each Remote I/O Driver Module and Remote I/O Receiver Module to set the baud rate and channel number. The switch can be set either before or after the Modules are installed. The state of the switches are loaded and stored when power is turned ON.

#### b) Remote I/O Receiver Module DIP Switch Settings

| Pin No. | Setting | | |
|---|---|---|---|
| 1 | ON | Self-diagnostic mode | |
| | OFF | Remote mode (Set to OFF.) | |
| 2 | ON | Master communications invalid (COMR instruction cannot be used.) | |
| | OFF | Master communications valid | |
| 3 | ON | Transparent mode (for master) | |
| | OFF | MEMOBUS mode (for master) | |
| 4 | ON | Default communication parameters | |
| | OFF | Memory communication parameters | |
| 5 & 6 | **5** | **6** | **Baud Rate** |
| | ON | ON | 4 Mbps |
| | ON | OFF | 2 Mbps |
| | OFF | ON | 1 Mbps |
| | OFF | OFF | 0.5 Mbps |

**Note** (1) The baud rate must be the same between the Remote I/O Driver Module and Remote I/O Receiver Modules.

(2) If a pin setting is changed after the power supply is turned ON, restart the Receiver Module by pressing the reset switch or turn ON the power supply again.

#### c) MEMOBUS Port DIP Switch Setting for Communication Parameters

| Pin No. | Setting | Communication Parameter |
|---|---|---|
| 4 | ON | Default communication parameters* |
| | OFF | Memory communication parameters |

*Default communication parameters are given in the following table.

| Item | Specification |
|---|---|
| Baud rate | 9,600 bps |
| Parity | Even parity |
| Stop bits | 1 |
| Communication mode | RTU |

d) When memory communication parameters are specified, the communication parameters set using the MEMOSOFT are used. Communication parameters can be

changed at any time. However, for stations for which I/O allocations have not been performed, changing the communication parameters takes up to about 150 seconds.

e) The following values are set for memory communication parameters using the MEMOSOFT. Select Configuration –> Setting –> Ports from the MEMOSOFT menu.

| Item | Specification |
|---|---|
| Baud rate | 1,200/1,800 /2,000/2,400/3,600 /4,800 /7,200/9,600/19,200 bps |
| Parity | One of the following: No parity check, even parity or odd parity |
| Stop bit | 1 or 2 |
| Communication mode | RTU or ASCII |

**Note** (1) Only one MEMOBUS master device can connected to a port for each channel.

(2) Communication parameters can be changed any time. However, for stations for which I/O allocations have not been performed, changing the communication parameters takes up to about 150 seconds.

**5) Rotary Switches: STATION ADDRESS**

For a Remote I/O System, up to 15 stations each can be installed for channel 1 and channel 2. Therefore, each remote station must have a specific local station address. Set the addresses using the rotary switches on the front of the Remote I/O Receiver Module.

**Note** (1) Numbers from 1 to 15 (two decimal digits) can be set. The same station address cannot be set more than once within the same channel.

(2) To change an address after turning ON the power supply, restart the Module by pressing the reset switch.

(3) Use a value between 1 and 15 for the station address. If any other number is set, the Module will not function correctly.

**6) Reset Switch**

A reset switch is provided on the front of a Remote I/O Receiver Module. Pressing the reset switch initializes a Module. Use this switch when DIP switch or rotary switch settings have been changed or when errors occur. Press the switch with a pointed object (mechanical pencil, etc.) to reset the Module.

# Remote I/O Specifications

# 4

This chapter provides the specification of the various components of a Remote I/O System.

# 4.1 Remote I/O Specifications

This section provides general, Module, performance, transmission path, and functional specifications of Remote I/O Systems.



## 4.1.1 General Specifications

The general specifications of Remote I/O Driver Modules and Remote I/O Receiver Modules are given in the following table.

| Item | | Specifications |
|---|---|---|
| Physical environment | Ambient operating temperature | 0 to 60 °C |
| | Ambient storage temperature | –25 to 85 °C |
| | Ambient operating humidity | 30% to 95% RH (with no condensation) |
| | Ambient storage humidity | 5% to 95% RH (with no condensation) |
| | Pollution level | Pollution level 1 conforming to JIS B3501. |
| | Atmosphere | No corrosive gas. |
| | Operating altitude | 2000 m max. |
| Mechanical operating conditions | Vibration resistance | Complies with JISB3502<br>10 to 57 Hz: Single amplitude 0.075 mm<br>57 to 150 Hz: Fixed acceleration 9.8 $m/s^2$ (1 G)<br>10 sweep cycles in directions X, Y, and Z.<br>(Sweep time: 1 octave/min) |
| | Shock resistance | Complies with JISB3502<br>Acceleration peak value: 147 $m/s^2$ (15 G)<br>Usage time: 11 ms<br>Shock direction: Twice in directions ±X, ±Y, and ±Z. |
| Electrical operating conditions | Noise immunity | Noise voltage: 1,500 V, Noise width: 100 ns/1 µs, Rise time: 1 ns (Noise applied to the AC power supply by a noise simulator) |
| Installation condition | Cooling method | Self-cooling |

## 4.1.2 Module Specifications

1) The following table gives the specifications of a Remote I/O Driver Module.

| Item | Specifications |
|---|---|
| Model no. | JAMSC-120CRD13100 |
| Function | Required when installing an I/O section in a remote location. This Module functions as a master station of a Remote I/O System. |
| Status indicators | READY: Module normal<br>RMT TX: Remote transmission in progress<br>RMT RX: Remote reception in progress<br>RMT ERR: Remote communications error<br>ACTIVE: BUS ASIC normal |
| Switches | Set items such as the baud rate. |
| Maximum transmission distance | 1 km (however, depends on the baud rate and the cable) |
| Internal current consumption | 800 mA at 5 VDC |
| Installation base | CPU Mounting Base |
| External dimensions | 40.34 x 130 x 103.85 mm (W x H x D) |
| Approximate mass | 300 g |
| Hot swapping (Removal/Insertion under power) | Not permitted. |

2) The following table gives the specifications of a Remote I/O Receiver Module.

| Item | Specifications |
|---|---|
| Model no. | JAMSC-120CRR13100 |
| Function | Required when installing an I/O section in a remote location. This Module functions as a slave station of a Remote I/O System. |
| Status indicators | READY: Module normal<br>RMT TX: Remote transmission in progress<br>RMT RX: Remote reception in progress<br>RMT ERR: Remote communications error<br>ACTIVE: BUS ASIC normal<br>PP TX: MEMOBUS port transmission in progress<br>PP RX: MEMOBUS port reception in progress<br>PP ERR: MEMOBUS port communications error |
| Switches | Set items such as baud rate and station address. |
| Internal current consumption | 800 mA at 5 VDC |
| Installation base | I/O Rack |
| External dimensions | 40.34 x 130 x 103.85 mm (W x H x D) |
| Approximate mass | 300 g |
| Hot swapping (Removal/Insertion under power) | Permitted |

## 4.1.3 Communication Specifications

1) The following table gives the specifications of a Remote I/O port.

| Item | Specifications |
|---|---|
| Topology (communication network) | Bus |
| Media access control method | Multi-drop (1:n communications) |
| Media (Transmission medium) | Coaxial cable (75 Ω) |
| Modulation method | Base band |
| Encoding method | Manchester code |
| Baud rate | Choose from 0.5/1/2/4 Mbps |
| Transmission distance | Transmission distance varies according to the baud rate and specifications of coaxial cable. If, for example, the baud rate is 4 Mbps and 12C-5AF Coaxial Cable is used; it is possible to transmit up to 1 km max. |
| Number of stations | 15 max. (Up to 15 Remote I/O Receiver Modules are connectable.) |
| Error Measures (RAS) | Automatic parallel off and malfunctioning station recovery |
| Synchronization method | Frame |
| Communications format | Comforms to HDLC. |
| Insulation method | Pulse transformer |
| Connector | BNC connector |

2) The following table gives the specifications of the MEMOBUS port of a Remote I/O Receiver Module.

### a) MEMOBUS Port Specifications

| Item | Specifications |
|---|---|
| Communications method | Half-duplex stop-start synchronization |
| Transmission levels | Conform to RS-232C |
| Protocol | MEMOBUS protocol or any other protocol |
| Baud rate | 19,200/9,600/7,200/4,800/3,600/2,400/2,000/1,800/1,200 bps |
| Communications mode | RTU mode or ASCII mode |
| Data format | The following data format is used between master and slaves, between master and modems, and between modems and slaves:<br>1) Data bit length: 8 (RTU mode) or 7 (ASCII mode)<br>2) Parity check: Yes or No<br>3) Parity: Odd or even<br>4) Stop bits: 1 or 2 |
| Transmission distance | 15 m (Can be extended to 4.5 km maximum by using Yaskawa modem.) |
| Transmission error detection | CRC-16 (RTU mode) or LRC (ASCII mode) |
| Connector | D-sub connector (9-pin, female) |

**b) MEMOBUS Port Connector Pin Assignment**

| Pin | Signal Name |
|---|---|
| 1 | FG |
| 2 | TXD (Transmission data) |
| 3 | RXD (Reception data) |
| 4 | RTS (Request to send) |
| 5 | CTS (Clear to send) |
| 6 | DSR (Data set ready) |
| 7 | SGND (Signal ground) |
| 8 | – |
| 9 | DTR (Data terminal ready) |

## 4.1.4 Functional Specifications

**1) Number of I/O Points**

a) The number of I/O points is restricted at each station. The number of I/O points that can be installed depends upon the number of physical slots and the capacity of the I/O allocation memory of the CPU. The following table gives the specifications for I/O point capacity.

| Item | Specifications |
|---|---|
| Number I/O points per system | GL120<br>Digital inputs + Digital outputs ≤ 1024 bits<br>Register input + Register output ≤ 512 sets (1 set = 16 bits) |
| | GL130<br>Digital inputs + Digital outputs ≤ 4096 bits<br>Input registers + Output registers ≤ 512 registers (1 register= 16 bits) |
| Number I/O points per station | Number of input bytes ≤ 512 bytes<br>Number of output bytes ≤ 512 bytes<br>Registers: N x 2 bytes (decimal places truncated).<br>Digital bits: (M + 7)/ 8 bytes<br>(N: Number of registers, M: Number of digital bits) |
| I/O allocation memory | GL120: 11K words<br>GL130: 14K words |


**I/O allocation memory**

The I/O allocation memory is a table that includes allocations to local stations. When the header section and checksum section (TCOP header: 3 words; station describer: 6 words; Checksum: 1 word) are equivalent to 15 stations x 2, a maximum of 190 words are used. The remaining memory is used by I/O Modules. The average memory space used by one Module is 10 words.

# 4.2 Setting Baud Rate

This section describes the setting of the baud rate of Remote I/O Driver Modules and Remote I/O Receiver Modules.



## 4.2.1 Remote I/O Driver Modules

Set the baud rate using the DIP switch on the front of the Remote I/O Driver Module.

**DIP Switch of a Remote I/O Driver Module**

| Pin No. | Pin No. | | |
|---|---|---|---|
| 1 | ON | Self-diagnostic mode | |
| | OFF | Remote mode (must be set to OFF) | |
| 2 | ON | 2000 I/O mode (for future use) | |
| | OFF | 120 I/O mode | |
| 3 | ON | Used as channel 2. | |
| | OFF | Used as channel 1. | |
| 4 | Not used. | | |
| 5 & 6 | **5** | **6** | **Baud Rate** |
| | ON | ON | 4 Mbps |
| | ON | OFF | 2 Mbps |
| | OFF | ON | 1 Mbps |
| | OFF | OFF | 0.5 Mbps |

**Note** (1) The baud rate of the Remote I/O Driver Module and Remote I/O Receiver Modules must be the same.

(2) If a pin setting is changed for the baud rate after power is turned ON, turn OFF the power supply and restart the Remote I/O Driver Module.

## 4.2.2 Remote I/O Receiver Modules

Set the baud rate using the DIP switch on the front of a Remote I/O Receiver Module.

**DIP Switch on a Remote I/O Receiver Module**

| Pin No. | Pin No. | | |
|---|---|---|---|
| 1 | ON | Self-diagnostic mode | |
| | OFF | Remote mode (must be set to OFF) | |
| 2 | ON | Master communications invalid (COMR instruction cannot be used). | |
| | OFF | Master communications valid (COMR instruction can be used). | |
| 3 | ON | Transparent mode (for master) | |
| | OFF | MEMOBUS Mode (for master) | |
| 3 | ON | Default communication parameter | |
| | OFF | Memory communication parameter | |
| 5 & 6 | **5** | **6** | **Baud Rate** |
| | ON | ON | 4 Mbps |
| | ON | OFF | 2 Mbps |
| | OFF | ON | 1 Mbps |
| | OFF | OFF | 0.5 Mbps |

**Note** (1) The baud rate of the Remote I/O Driver Module and Remote I/O Receiver Modules must be the same.

(2) If a pin setting is changed for the baud rate after power is turned ON, press the reset switch and restart the Remote I/O Receiver Module.

# 4.3 Transmission Distance

This section describes how to calculate the transmission distance of a Remote I/O transmission path.



## 4.3.1 Calculation Method

The distance of a Remote I/O transmission path varies according to the number of Remote I/O Receiver Modules that are connected and the type of coaxial cables used. The calculation method is shown below.

$L = PL/Pa$ (km)

Where, $PL = Pdr - Pm - Pt - Psn$
$= Pdr - 4.0 - 1.0 - Psn$ (dB)

$Pdr = Pd - Pr + Px$
$= 19.4$ (dB) $+ Px$

L: Transmission distance (km)
PL: Allowable dissipation of the coaxial cable (dB)
Pa: Signal attenuation of the coaxial cable (dB/km)
Pdr: Transmission/reception level difference (dB)
Pm: Noise margin (dB)
Pt: Power supply temperature fluctuation (dB)
Psn: Module insertion loss (dB)
Pd: Transmission level = 68.9 (dB)
Pr: Reception level = 49.5 (dB)
Px: Compensation (depends on the baud rate) =
−3.4 dB/4 MHz, −2.4 dB/2 MHz,−1.9 dB/1 MHz, −1.4 dB/0.5 MHz

**1) Coaxial Cable Allowable Loss: PL**

| Baud Rate (Mbps) | Transmission/ Reception Level Difference Pdr (dB) | Coaxial Cable Allowable Loss: PL (dB) | | |
|---|---|---|---|---|
| | | PL | n=1 (Receivers) | n=15 (Receivers) |
| 4 | 16.0 | PL (4) = 11.0 − Psn (4) | 10.78 dB | 9.24 dB |
| 2 | 17.0 | PL (2) = 12.0 − Psn (2) | 11.76 dB | 10.08 dB |
| 1 | 17.5 | PL (1) = 12.5 − Psn (1) | 12.22 dB | 10.26 dB |
| 0.5 | 18.0 | PL (0.5) = 13.0 − Psn (0.5) | 12.66 dB | 10.28 dB |

**2) Module Insertion Loss: Psn**

| Baud Rate (Mbps) | Module Insertion Loss: Psn (dB) | | |
|---|---|---|---|
| | Ps | n=9 | n=15 |
| 4 | 0.11 (dB/unit) | 1.1 dB | 1.76 dB |
| 2 | 0.12 (dB/unit) | 1.2 dB | 1.92 dB |
| 1 | 0.14 (dB/unit) | 1.4 dB | 2.24 dB |
| 0.5 | 0.17 (dB/unit) | 1.7 dB | 2.72 dB |

Psn = Ps x (n+1)
Where n = Number of Remote I/O Receiver Modules and 1 = Remote I/O Driver Module

**3) Coaxial Cable Signal Attenuation: Pa**

| Cable (Manufactured by Fujikura, Ltd.) | Signal Attenuation: Pa (dB/km) | | | |
|---|---|---|---|---|
| | 0.5 MHz | 1 MHz | 2 MHz | 4 MHz |
| 3C-2V, 3C-2V (Cu, Fe) ZV | 9.0 | 13.8 | 20.0 | 28.8 |
| 5C-2V, 5C-2V (Cu, Fe) ZV | 5.1 | 8.8 | 12.7 | 18.4 |
| 5C-FB, 5C-FB (Cu, Fe) ZV | 4.8 | 7.4 | 10.5 | 14.0 |
| 7C-FB, 7C-FB (Cu, Fe) ZV | 4.2 | 5.8 | 7.6 | 10.0 |
| 7C-FL, 7C-FL (Cu, Fe) ZV | 2.9 | 4.4 | 6.4 | 9.3 |
| 12C-5AF, 12C-5AF (Cu, Fe) ZV | 1.46 | 2.2 | 3.2 | 4.5 |

Signal attenuation: Pa is the value determined by multiplying the standard value by 1.15.

4

## 4.3.2 Maximum Transmission Distance

The maximum transmission distance (Lmax) is given in the following table under the conditions: Remote I/O Receiver Modules n=15 Modules and internal panel cable length (3C-2V) = 50 m or less.

Maximum transmission distance:

Lmax = Internal panel cable length + Panel-to-panel cable length

**Example of Lmax (n=15 Modules)**

| Baud Rate (Mbps) | Length of Coaxial Cable (km) | | | | Maximum Transmission Distance: Lmax (km) |
|---|---|---|---|---|---|
| | 3C-2V | 5C-2V | 7C-FL | 12C-5AF | |
| 4 | 0.05 | 0.42 | 0 | 0 | 0.47 |
| | 0.05 | 0.05 | 0 | 1.29 | 1.39 |
| | 0.05 | 0 | 0.83 | 0 | 0.88 |
| 2 | 0.05 | 0.71 | 0 | 0 | 0.76 |
| | 0.05 | 0.05 | 0 | 2.27 | 2.37 |
| | 0.05 | 0 | 1.41 | 0 | 1.46 |
| 1 | 0.05 | 1.03 | 0 | 0 | 1.08 |
| | 0.05 | 0.05 | 0 | 3.35 | 3.45 |
| | 0.05 | 0 | 2.16 | 0 | 2.21 |

# I/O Servicing and Scan Time

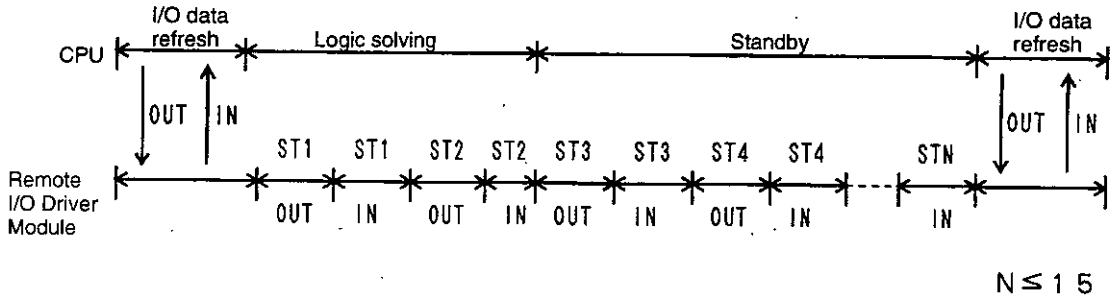
# 5

This chapter describes the relationship between I/O servicing and the scan time.

## 5.1 Logic Solving and I/O Processing

1) With the GL120 or GL130, logic is solved by the CPU Module and I/O is processed by a Remote I/O Driver simultaneously. Therefore, a delay occurs until the input signal from an Input Module is transmitted to a CPU Module or a the result of solving logic (output signal) by the CPU Module is transmitted to an external device connected to an Output Module.

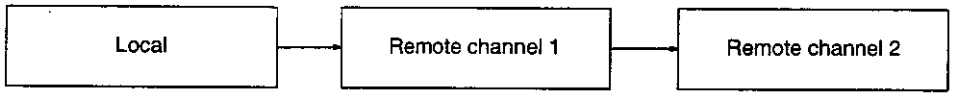
2) The relationship between logic solving by a CPU Module and I/O processing by a Remote I/O Driver Module is shown below.



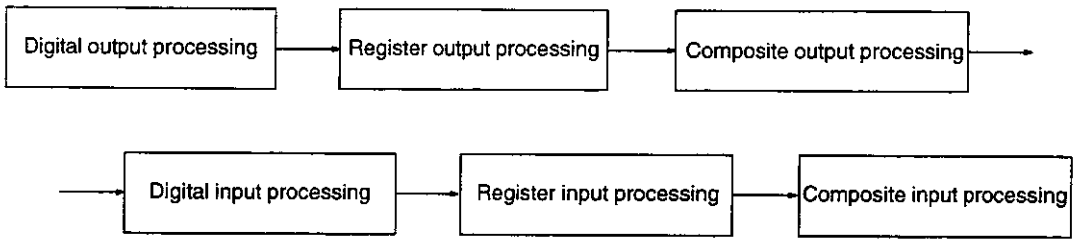

N≤15

## 5.2 I/O Processing Sequence

1) I/O processing services are performed in the following sequence: local channel, remote channel 1, and then remote channel 2.



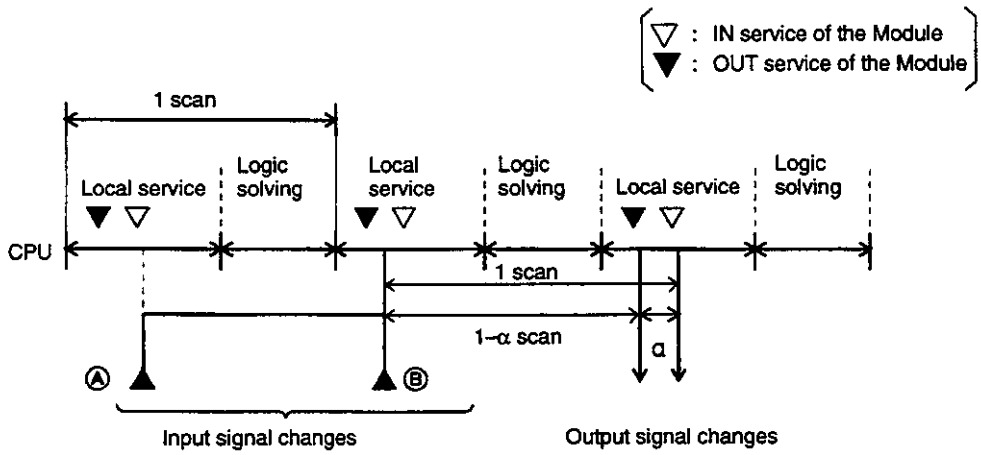

2) For each remote channel, servicing is performed in order of the station addresses (1 to 15) in the following sequence.



# 5.3 Delay of I/O Signals

A delay occurs from the time when a change occurs in an input signal to the time when the CPU Module recognizes the change, solves the logic, and the result appears as an output signal.

**1) Local Channel**




**a) Change of Input Signal –> CPU: 0 to 1 Scan**

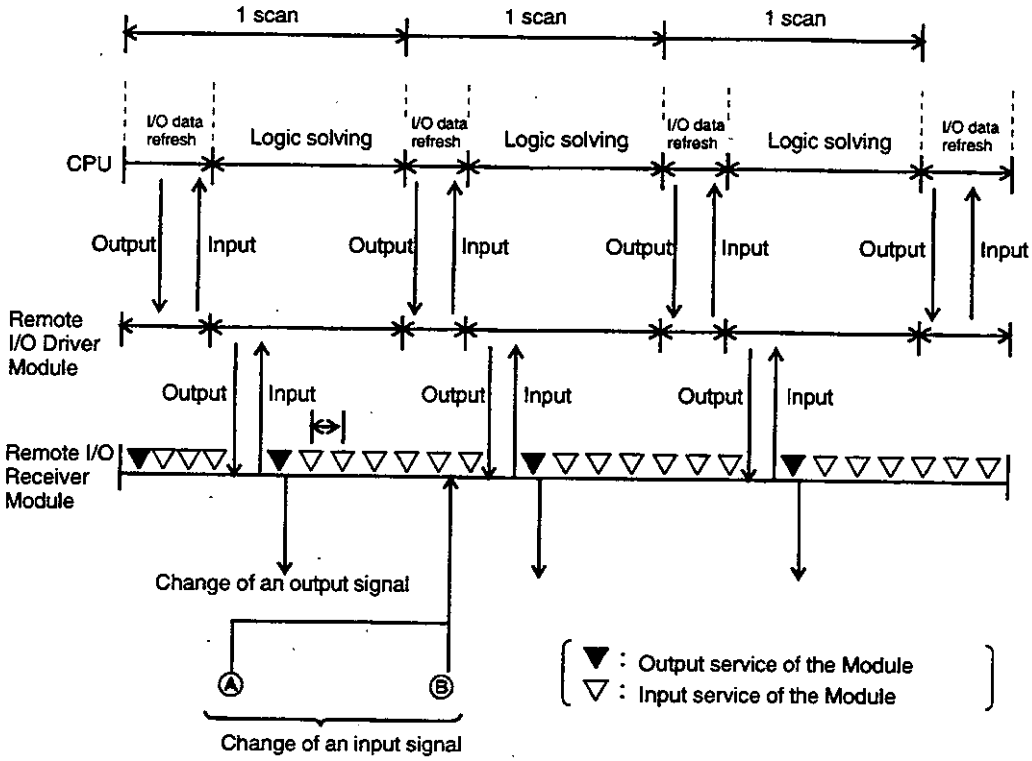
Time required for a change of an input signal to be input to the CPU through an Input Module is shown above. When a change of an input signal occurs near (A), the maximum delay is one scan, however, if a change occurs near (B), the delay will be minimal.

**b) CPU –> Change of Output Signal: 1 – α Scan**

This time is shown above as α, the value of α depends on the I/O allocation. This is the time required from when a CPU Module starts to solve logic until the result appears as an output signal through an Output Module.

c) A time of (1 scan – α) to (2 scan – α) is thus required from a change in an input signal to the result appearing as an output signal. However, α varies according to the I/O allocation.

### 2) Remote I/O Channels




a) The input servicing of the Remote I/O Receiver Modules varies depending on the number of Input Modules; however, scanning occurs between 1 ms to 7 ms.

**b) Change in Input Signal –> Remote I/O Receiver Module: 1 Scan or Less**

This is the time required for a change in an input signal to be input to a Remote I/O Receiver Module through an Input Module. As shown above, when a change in an input signal occurs near (A) in the diagram, a delay of one scan occurs. When a change occurs near (B) in the diagram, the delay will be minimal.

**c) Remote I/O Receiver Module –> Remote I/O Driver Module –> CPU: 1 Scan**

**d) CPU –> Remote I/O Driver Module: 1 Scan**

**e) Remote I/O Driver Module –> Receiver –> Change in Output: 1 Scan or Less**

f) Therefore, 2 to 4 scan times are required for a change in an input signal to be output as an output signal.

# 5.4 I/O Processing Time

1) The I/O processing time in GL120 or GL130 can be calculated using the following equation.

I/O processing time = Local I/O processing time + Optional Module processing time + Remote I/O processing time

When no I/O Modules are allocated, the I/O processing time will be 0 if an Optional Module is not used.

2) Local I/O processing time = Input overhead + Output overhead + Total Input Module time + Total input byte time + Total Output Module time + Total output byte time

| Item | GL120 (μs) | GL130 (μs) |
|---|---|---|
| Input overhead | 67 | 100 |
| Output overhead | 56 | 91 |
| Overhead per Input Module | 83 (96) | 72 (88) |
| Transmission time per input byte | 20 (24) | 15 (19) |
| Overhead per Output Module | 91 (105) | 75 (91) |
| Transmission time per output byte | 10 (14) | 8 (12) |

**Note** Values in parentheses are for when Modules are installed in two to four racks.

◀EXAMPLE▶ Local I/O processing time will be as follows when two 24-VDC 32-point Modules are used on rack 1 for both input and output with the GL120 or GL130:

Local I/O processing time = 67 + 56 + 83 x 2 + 20 x 8 + 91 x 2 +10 x 8 = 711 (μs)

3) The following table lists I/O processing times of Optional Modules.

**I/O Processing Time of Optional Modules**

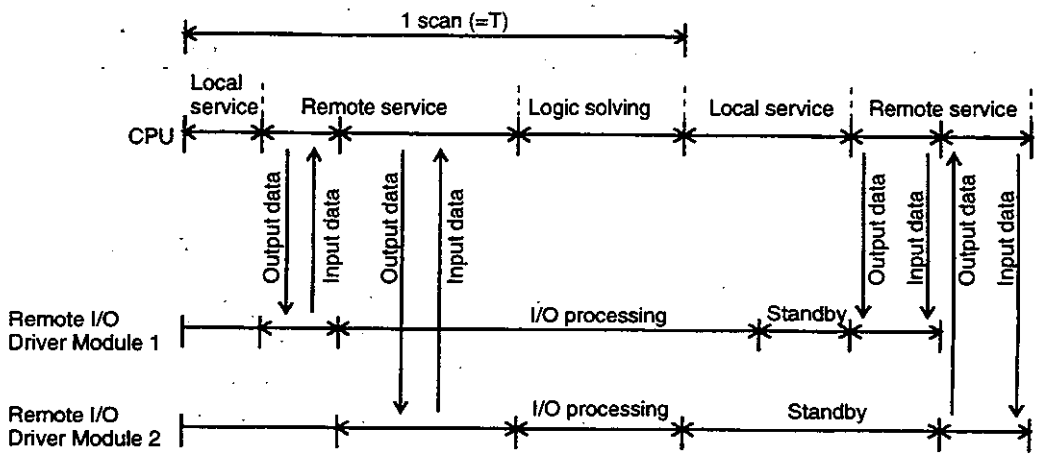
| Name | Abbreviation | Model No. | GL120 I/O processing time (μs) | GL130 I/O processing time (μs) |
|---|---|---|---|---|
| Remote I/O Driver Module | R10D-COAX | JAMSC-120CRD13100 | 363 | 310 |
| MEMOBUS Module (RS-232) | MEMOBUS-232 | JAMSC-120NOM26100 | 2900±300 | 3000±330 |
| MEMOBUS Module (RS-422) | MEMOBUS-422 | JAMSC-120NOM27100 | 2900±300 | 3000±330 |
| PC Link Module (See note.) | PC LINK-COAX | JAMSC-120NFB23100 | 7400±1800+α | 3000±1000+β |
| 4-axis Motion Module | MC20 | JAMSC-120MMB10400 | 1870 | 1497 |
| 1-axis Motion Module | MC10 | JAMSC-120MMB10100 | | |

**Note** The processing time for the following data items is added to the PC Link Module.

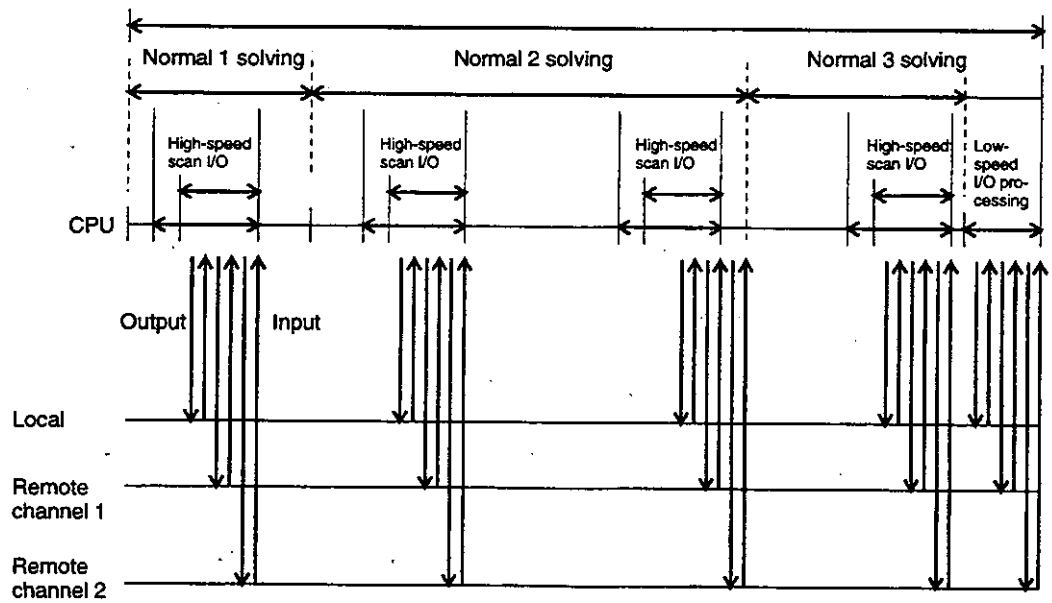
| Item | Processing Time for Number of GL120 Data Items (μs) | Processing Time for Number of GL130 Data Items (μs) |
|---|---|---|
| Link input processing time | 3650 + 0.4 x No. of input words | 3500 + 0.23 x No. of input words |
| Number of link output processing times | 4260 + 1.42 x No. of output words | 140 + 1.95 x No. of output words |
| Processing time for the number of link data items | α = input + output | β = input + output |

### 4) Processing Time of Remote I/O

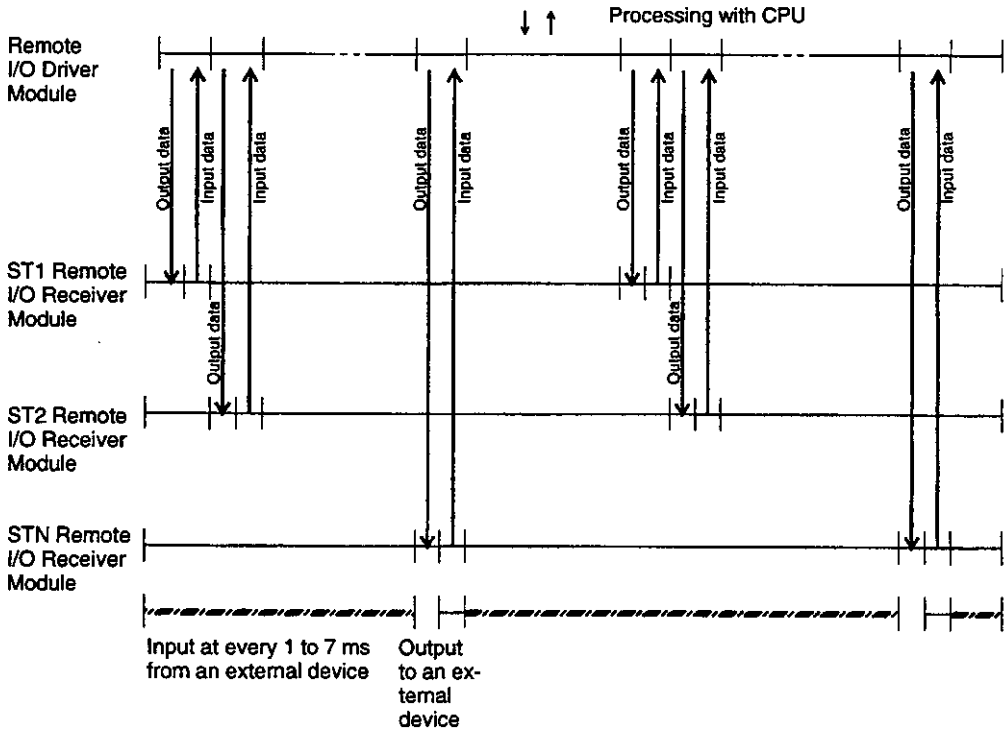
a) When remote I/O is connected, the relationship of data exchange between a Remote I/O Driver Module and the CPU Module is as follows:




### b) High-speed Scan (Normally Segments 1, 2, or 3)



### c) Remote I/O Station I/O Timing




5

# Installation and Connection of Remote I/O

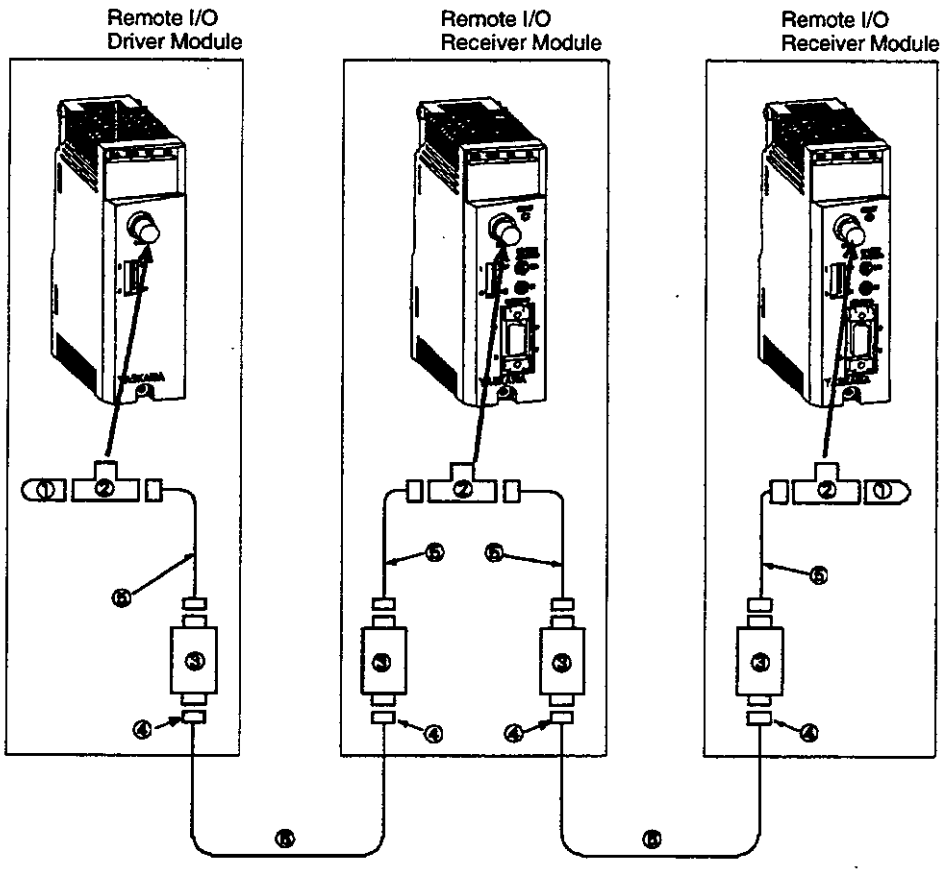
# 6

This chapter describes the procedures for installing and connecting a Remote I/O System.

# 6.1 Configuration of Remote I/O Transmission Paths

1) The configuration of Remote I/O transmission paths is illustrated below. A Remote I/O transmission path consists of coaxial cables and coaxial connectors. As illustrated, the Remote I/O Driver Module does not necessarily have to be installed as an end station of the transmission path. Coaxial cables can be internal panel wiring cables or panel-to-panel wiring cables.

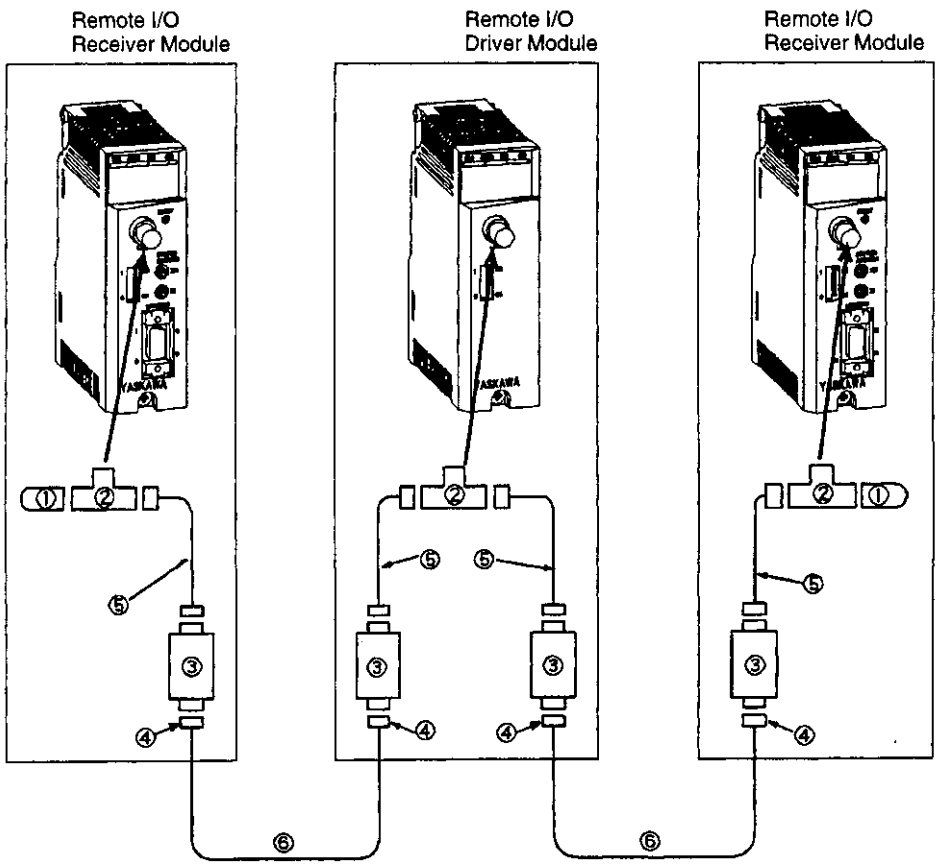
**a) Remote I/O Driver Module Installed at End of Transmission Path**



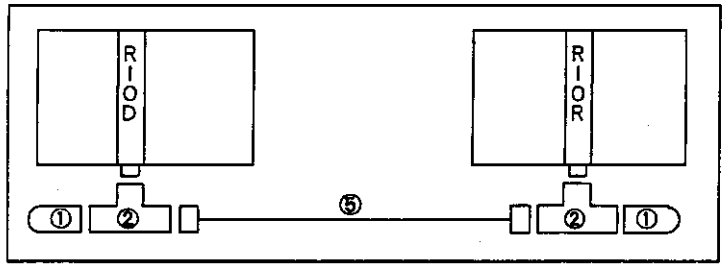
| No. | Name | Model No. | Remarks |
|---|---|---|---|
| 1 | Terminator (75 Ω) | 221629-5 | Used at the end station of a transmission path. |
| 2 | T-adaptor | 413592-2 | Used to connect a coaxial cable used as the terminal at a BNC Connector to a Module intended as a station. |
| 3 | Conversion Adapter | T-0298 | Used to connect a coaxial cable used as the terminal at a BNC Connector to an F-connector coaxial cable. |
| 4 | F-connector | F-5FB | Used as the terminal for a trunk-line coaxial cable. |
| 5 | W60 Cable | JZMSZ-W60-□<br>W60-1: 2.0 m<br>W60-2: 3.0 m<br>W60-3: 5.0 m | Used as a branch cable (for internal panel wiring).<br>A BNC Connector is used at each end of the cable. |
| 6 | Panel-to-panel coaxial cable (See note) | 5C, 7C, 11C, 12C etc. | Select the appropriate cable according to the connection distance. |

**Note** The W61 Cable, which can be used as a trunk line (panel-to-panel wiring), with an F-connector at both ends, is also available from Yaskawa.

### b) Remote I/O Receiver Module Panels Installed at Ends of Transmission Path



### c) Remote I/O Driver and Receiver Modules Installed in Same Panel




| No. | Name | Model No. | Remarks |
|---|---|---|---|
| 1 | Terminator (75 Ω) | 221629-5 | Used at the end station of a transmission path. |
| 2 | T-adaptor | 413592-2 | Used to connect a coaxial cable used as the terminal at a BNC Connector to a Module intended as a station. |
| 3 | Conversion Adapter. | T-0298 | Used to connect a coaxial cable used as the terminal at a BNC Connector to an F-connector coaxial cable. |
| 4 | F-connector | F-5FB | Used as the terminal for a trunk-line coaxial cable. |
| 5 | W60 Cable | JZMSZ-W60-□<br>W60-1: 2.0 m<br>W60-2: 3.0 m<br>W60-3: 5.0 m | Used as a branch cable (for internal panel wiring).<br>A BNC Connector is used at each end of the cable. |
| 6 | Panel-to-panel coaxial cable (See note) | 5C, 7C, 11C, 12C etc. | Select the appropriate cable according to the connection distance. |

**Note** The W61 Cable, which can be used as a trunk line (panel-to-panel wiring), with an F-connector at both ends, is also available from Yaskawa.

# 6.2 Internal Panel Wiring

This section describes internal panel wiring.



## 6.2.1 Cables

### 1) Yaskawa Standard Coaxial Cables1

Use the same coaxial cables as for Remote I/O Systems. The following table shows the models and specifications of Yaskawa standard coaxial cables.

#### a) W1000 Cable

| Model No. | Cable Length | Cable Used | Remarks |
|---|---|---|---|
| JZMSZ-W1000-02 | 2 m | 3C-2V (in-panel) | BNC Connectors at both ends |
| JZMSZ-W1000-03 | 3 m | | |
| JZMSZ-W1000-05 | 5 m | | |

#### b) W60 Cable

| Model No. | Cable Length | Cable Used | Remarks |
|---|---|---|---|
| JZMSZ-W60-1 | 2 m | 3C-2V (in-panel) | BNC Connectors at both ends |
| JZMSZ-W60-2 | 3 m | | |
| JZMSZ-W60-3 | 5 m | | |

#### c) W61 Cable

| Model No. | Cable Length | Cable Used | Remarks |
|---|---|---|---|
| JZMSZ-W61-1 | 2 m | 5C-FB (panel to panel) | F-connectors (F-5FB) at both ends<br>Gold-plated contacts |
| JZMSZ-W61-2 | 5 m | | |
| JZMSZ-W61-3 | 10 m | | |

### 2) Other Coaxial Cables

The table below shows the models and specifications of coaxial cables manufactured by Fujikura, Ltd.

| Model (Fujikura, Ltd.) | Electrostatic and Magnetic Shield | Application | Conditions | Signal Attenuation: Pas (dB/km) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 0.5 MHz | 1 MHz | 2 MHz | 4 MHz |
| 3C-2V | Not provided | In-panel | Special duct | 9.0 | 12.0 | 17.0 | 25.0 |
| 3C-2V (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |
| 5C-2V | Not provided | Panel-to-panel | Special duct | 5.1 | 7.6 | 11.0 | 16.0 |
| 5C-2V (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |
| 5C-FB | Not provided | Panel-to-panel | Special duct | 4.8 | 7.4 | 10.5 | 14.0 |
| 5C-FB (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |
| 7C-FB | Not provided | Panel-to-panel | Special duct | 4.2 | 5.8 | 7.6 | 10.0 |
| 7C-FB (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |
| 7C-FL | Not provided | Panel-to-panel | Special duct | 2.9 | 3.8 | 5.6 | 8.1 |
| 7C-FL (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |
| 12C-5AF | Not provided | Panel-to-panel | Special duct | 1.46 | 2.2 | 3.2 | 4.5 |
| 12C-5AF (Cu, Fe) ZV | Provided | | Low voltage duct | | | | |

**Note** (a) Coaxial cables equivalent to the above can be applicable.

(b) Signal attenuation: Pas (dB/km) shows typical values.

### 3) Coaxial Connectors

The following table shows the models and specifications of coaxial connectors.

| Connector | Name | Model | Abbreviation | Remarks | Manufacturer |
|---|---|---|---|---|---|
| Connection | BNC Connector | BNC-P-3-Ni-CAu | BNC-P-3 | For 3C-2V, Gold-plated contacts | Daiichi Electronic Inc. |
| | F-connector | FSPW-5-Ni-CAu | | For 5C-2V, Gold-plated contacts | Fujikura, Ltd. |
| | | F-5FB | | For 5C-FB, Gold-plated contacts | Fujikura, Ltd. |
| | | FSPW-7-Ni-CAu | | For 7C-FL, Gold-plated contacts | Fujikura, Ltd. |
| | | F-7FB | | For 7C-FB, Gold-plated contacts | Fujikura, Ltd. |
| | Fitting Connector | FT-12C-2.9-TC31 | | For 12C-5AF, Gold-plated contacts | Fujikura, Ltd. |
| | | FT-7C-FL | | For 7C-FB, Gold-plated contacts | Fujikura, Ltd. |
| Branching | T-connector | 413592-2 | | For connection and branching | AMP |
| Conversion | Conversion Adapter | T-0298 | | For conversion of BNC and F-connectors | Yaskawa Electric Corp. |
| | Conversion Connector | FTR-FJ | | For conversion of Fitting and F-connectors | Fujikura, Ltd. |
| Junction | Junction Connector | F-A | | For joining F-connectors to each other | Fujikura, Ltd. |
| | | FI-A | | For connecting Fitting Connectors to each other | Fujikura, Ltd. |
| Termination | Terminator | 221629-5 | | For termination of ends of transmission path | AMP |

**Note** (a) All of the above connectors have a connection loss of 0 dB.

(b) Waterproof and insulate the junctions of the coaxial cable (e.g., wrap with self sealing tape).

(c) See *6.5 Grounding* for information on grounding.

### 4) MEMOBUS Cables

MEMOBUS cables are RS-232C cables used for connecting a Programming Panel, ACGC, or host computer to the MEMOBUS port. Yaskawa provides the standard cables shown below.

| Type | Name | Abbreviation | Model No. | Description | Length |
|---|---|---|---|---|---|
| MEMOBUS cable | W0200 Cable | W0200-03 | JZMSZ-120W0200-03 | 1) Used to connect a personal computer made by NEC (PC-98) to the MEMOBUS port.<br>2) D-SUB connector (25-pin, male) on the personal computer end. | 2.5 m |
| | | W0200-15 | JZMSZ-120W0200-15 | | 15.0 m |
| | W0201 Cable | W0201-03 | JZMSZ-120W0201-03 | 1) Used to connect a personal computer made by NEC (PC-98) to the MEMOBUS port.<br>2) Half-pitch connector (MDR 14-pin, one-touch lock, straight) on the personal computer end. | 2.5 m |
| | | W0201-15 | JZMSZ-120W0201-15 | | 15.0 m |
| | W0202 Cable | W0202-03 | JZMSZ-120W0202-03 | 1) Used to connect a DOS personal computer to the MEMOBUS port.<br>2) D-SUB connector (9-pin, female) on the personal computer end. | 2.5 m |
| | | W0202-15 | JZMSZ-120W0202-15 | | 15.0 m |
| | W0203 Cable | W0203-03 | JZMSZ-120W0203-03 | 1) Used to connect a Programming Panel (P120) to the MEMOBUS port.<br>2) D-SUB connector (9-pin, female). | 2.5 m |
| | | W0203-15 | JZMSZ-120W0203-15 | | 15.0 m |
| | W0204 Cable | W0204-05 | JZMSZ-120W0204-05 | 1) Used to connect an FA monitor (ACGC4200) to the MEMOBUS port. | 5.0 m |
| | | W0204-10 | JZMSZ-120W0204-10 | | 10.0 m |
| | | W0204-15 | JZMSZ-120W0204-15 | | 15.0 m |
| | W0205 Cable | W0205-01 | JZMSZ-120W0205-01 | Used to connect a 2000-series J2078 Modem to the MEMOBUS port of a CPU Module or a MEMOBUS Module (RS-232). | 1.0 m |
| | | W0205-03 | JZMSZ-120W0205-03 | | 3.0 m |
| | | W0205-05 | JZMSZ-120W0205-05 | | 5.0 m |
| | W0206 Cable | W0206-01 | JZMSZ-120W0206-01 | Used to connect a readily available AX/2400C modem to the MEMOBUS port of a CPU Module or a MEMOBUS Module (RS-232). | 1.0 m |
| | | W0206-03 | JZMSZ-120W0206-03 | | 3.0 m |
| | | W0206-05 | JZMSZ-120W0206-05 | | 5.0 m |
| | W0240 Cable | W0240-01 | JZMSZ-120W0240-01 | 1) Used to connect a 2000-series J2078 Modem to the RS-232C port of a personal computer made by NEC (PC-98).<br>2) D-SUB connector (25-pin, male) on the personal computer end. | 1.0 m |
| | | W0240-03 | JZMSZ-120W0240-03 | | 3.0 m |
| | | W0240-05 | JZMSZ-120W0240-05 | | 5.0 m |
| | W0241 Cable | W0241-01 | JZMSZ-120W0241-01 | 1) Used to connect a 2000-series J2078 Modem to the RS-232C port of a personal computer operating on DOS.<br>2) D-SUB connector (9-pin, female) on the personal computer end. | 1.0 m |
| | | W0241-03 | JZMSZ-120W0241-03 | | 3.0 m |
| | | W0241-05 | JZMSZ-120W0241-05 | | 5.0 m |

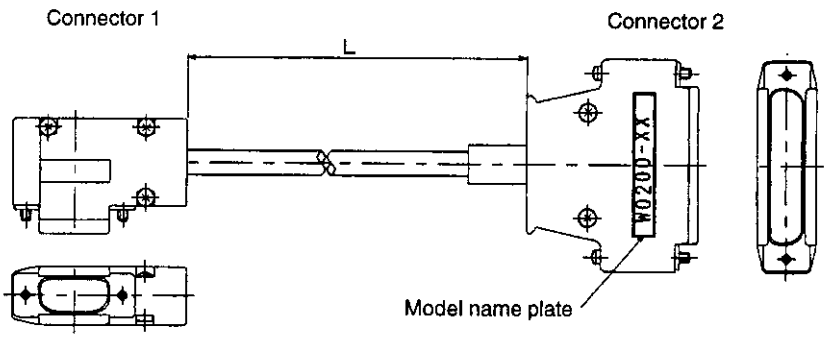
Details of MEMOBUS Cable specifications, external dimensions, and connection diagrams are given on the following pages.

### a) W0200 Cable

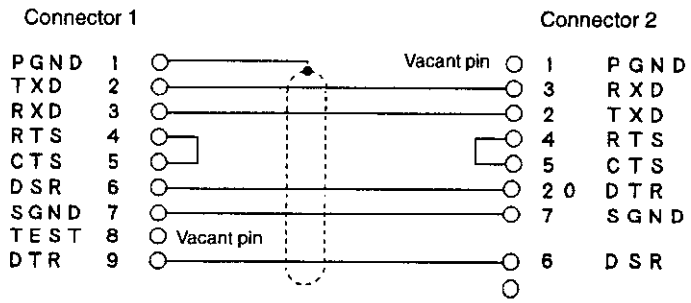
#### (1) Specifications

| Item | Specifications | |
|---|---|---|
| Model Name | W0200-03 | W0200-15 |
| Model No. | JZMSZ-120W0200-03 | JZMSZ-120W0200-15 |
| Length (L) | 2.5 m | 15.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-43250-02 (D8A) (DDK) | |

#### (2) Dimensions




#### (3) Connection Diagram



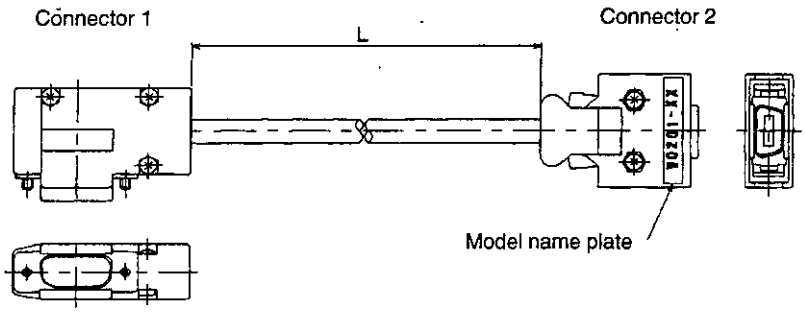

Cable size: 0.13 mm$^2$ (AWG26)

### b) W0201 Cable

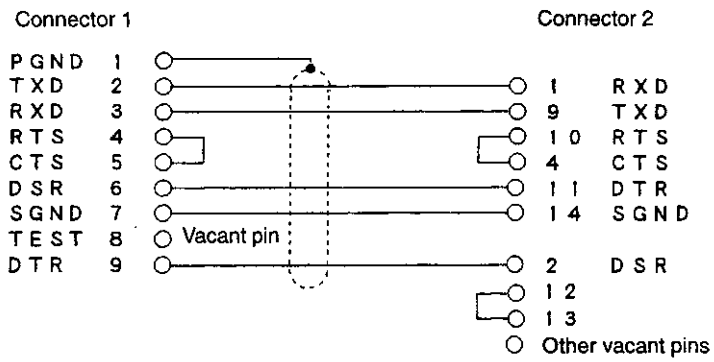
#### (1) Specifications

| Item | Specifications | |
|---|---|---|
| Model Name | W0201-03 | W0201-15 |
| Model No. | JZMSZ-120W0201-03 | JZMSZ-120W0201-15 |
| Length (L) | 2.5 m | 15.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | |
| Connector Specifications | 17JE-23090-02 (D90B) (DDK) + Plug: 10114-3000VE (3M)<br>Shield kit: 103144-42F0-008 (3M) | |

#### (2) Dimensions




#### (3) Connection Diagram



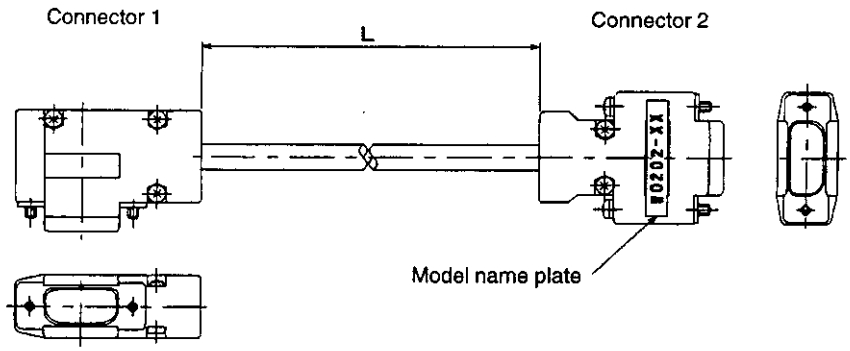

Cable size: 0.13 mm$^2$ (AWG26)

### c) W0202 Cable

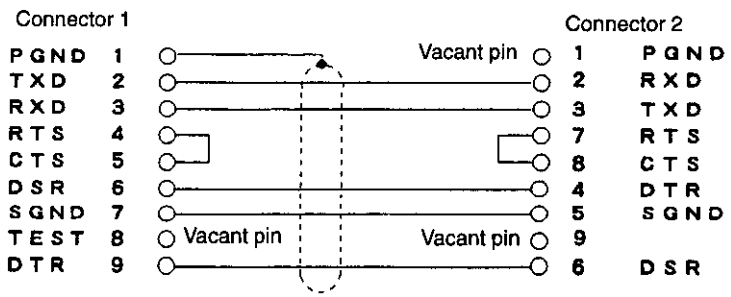
#### (1) Specifications

| Item | Specifications | |
|---|---|---|
| Model Name | W0202-03 | W0202-15 |
| Model No. | JZMSZ-120W0202-03 | JZMSZ-120W0202-15 |
| Length (L) | 2.5 m | 15.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-13090-02 (D8C) (DDK) | |

#### (2) Dimensions




#### (3) Connection Diagram



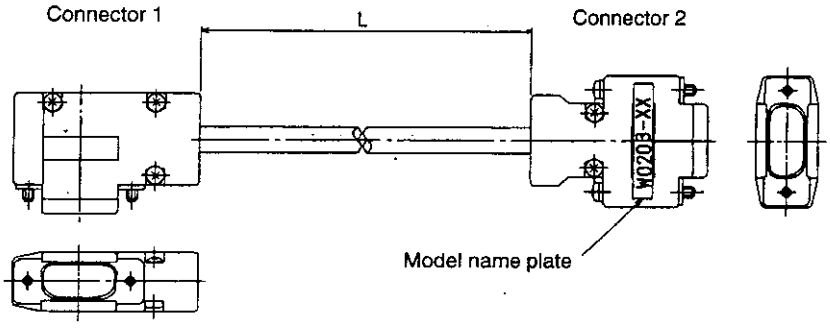

Cable size: 0.13 mm$^2$ (AWG26)

### d) W0203 Cable

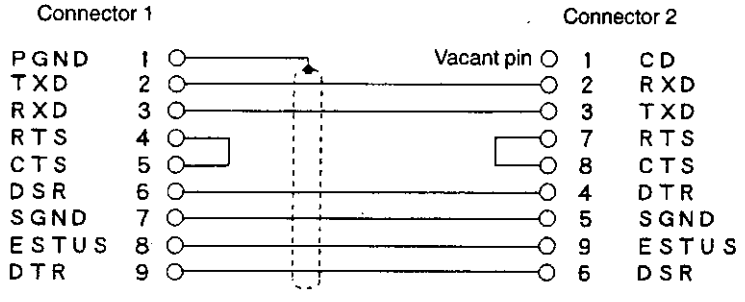
#### (1) Specifications

| Item | Specifications | |
|---|---|---|
| Model Name | W0203-03 | W0203-15 |
| Model No. | JZMSZ-120W0203-03 | JZMSZ-120W0203-15 |
| Length (L) | 2.5 m | 15.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-13090-02 (D8C) (DDK) | |

#### (2) Dimensions




#### (3) Connection Diagram



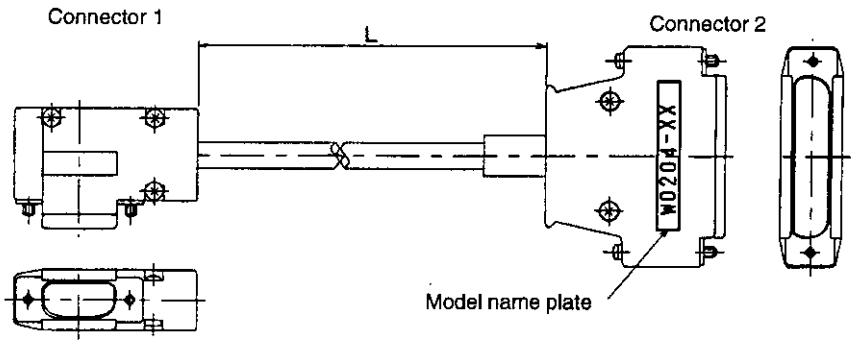

Cable size: 0.13 mm$^2$ (AWG26)

### e) W0204 Cable

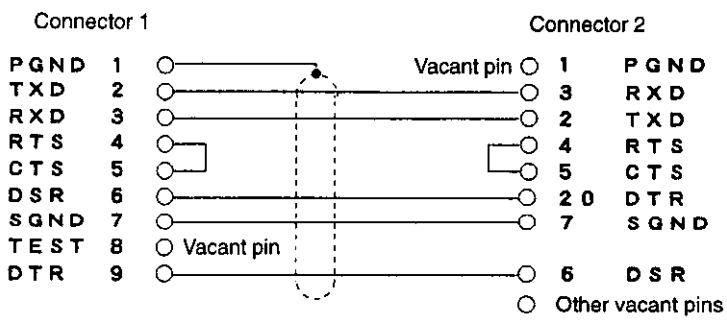
#### (1) Specifications

| Item | Specifications | | |
|---|---|---|---|
| Model Name | W0204-05 | W0204-10 | W0204-15 |
| Model No. | JZMSZ-120W0204-05 | JZMSZ-120W0204-10 | JZMSZ-120W0204-15 |
| Length (L) | 5.0 m | 10.0 m | 15.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-33250-02 (D8B) (DDK) | | |

#### (2) Dimensions




#### (3) Connection Diagram



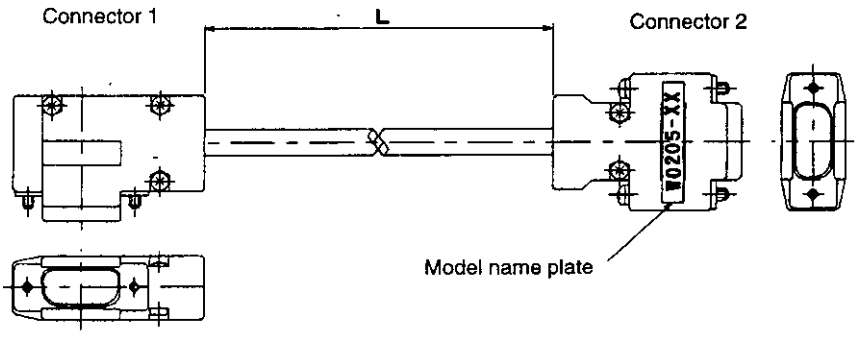

Cable size: 0.13 mm$^2$ (AWG26)

### f) W0205 Cable

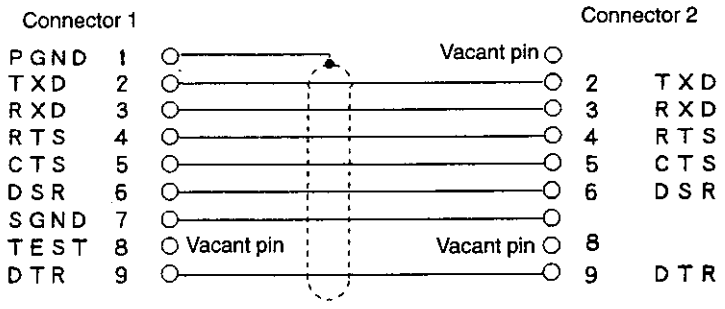
#### (1) Specifications

| Item | Specifications | | |
|---|---|---|---|
| Model Name | W0205-01 | W0205-03 | W0205-05 |
| Model No. | JZMSZ-120W0205-01 | JZMSZ-120W0205-03 | JZMSZ-120W0205-05 |
| Length (L) | 1.0 m | 3.0 m | 5.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-23090-02 (D8B) (DDK) | | |

#### (2) Dimensions




#### (3) Connection Diagram



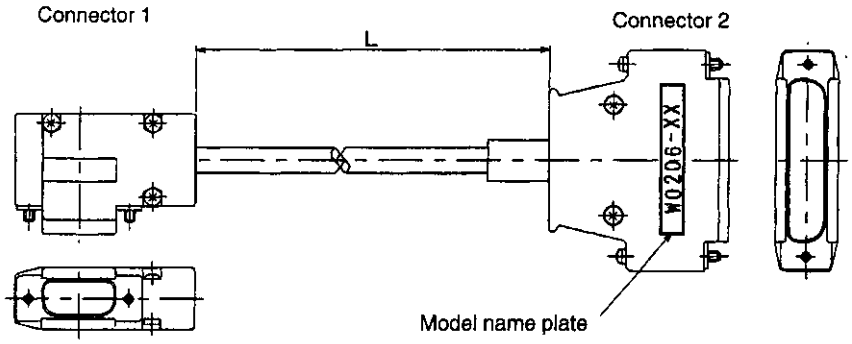

Cable size: 0.13 mm$^2$ (AWG26)

### g) W0206 Cable

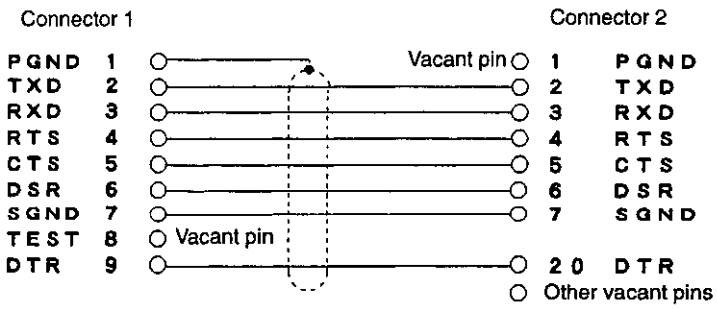
#### (1) Specifications

| Item | Specifications | | |
|---|---|---|---|
| Model Name | W0206-01 | W0206-03 | W0206-05 |
| Model No. | JZMSZ-120W0206-01 | JZMSZ-120W0206-03 | JZMSZ-120W0206-05 |
| Length (L) | 1.0 m | 3.0 m | 5.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D90B)<br>Connector 2: 17JE-43250-02 (D8C) (DDK) | | |

#### (2) Dimensions




#### (3) Connection Diagram



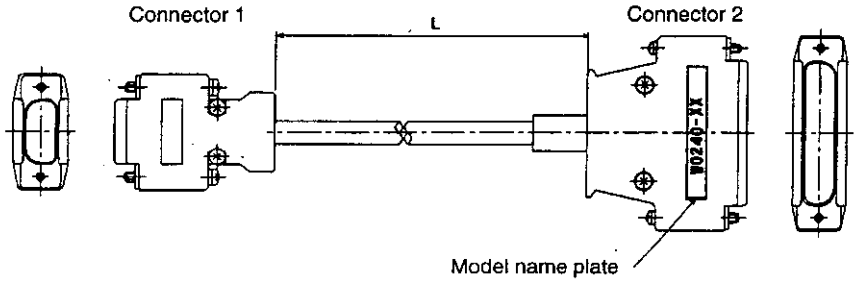

Cable size: 0.13 mm$^2$ (AWG26)

### h) W0240 Cable

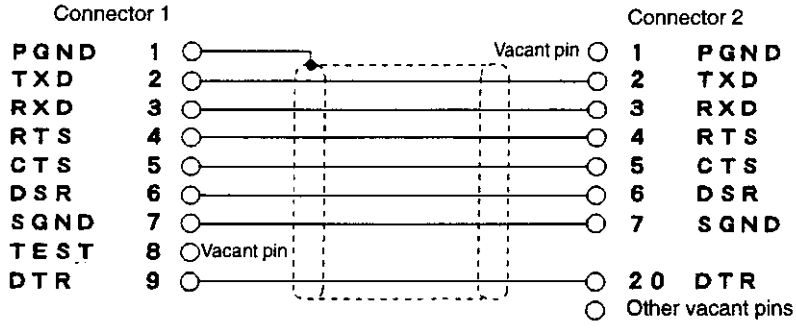
#### (1) Specifications

| Item | Specifications | | |
|---|---|---|---|
| Model Name | W0240-01 | W0240-03 | W0240-05 |
| Model No. | JZMSZ-120W0240-01 | JZMSZ-120W0240-03 | JZMSZ-120W0240-05 |
| Length (L) | 1.0 m | 3.0 m | 5.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D8B)<br>Connector 2: 17JE-43250-02 (D8A) (DDK) | | |

#### (2) Dimensions




#### (3) Connected Diagram



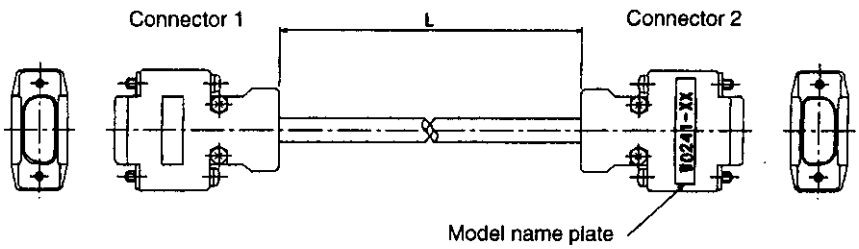

Cable size: 0.13 mm$^2$ (AWG26)

### i) W0241 Cable

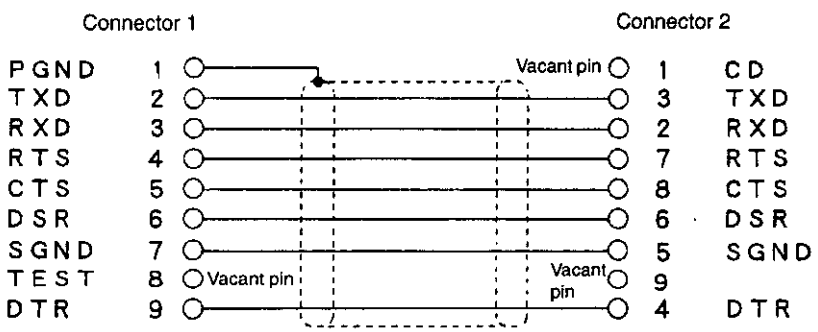
#### (1) Specifications

| Item | Specifications | | |
|---|---|---|---|
| Model Name | W0241-01 | W0241-03 | W0241-05 |
| Model No. | JZMSZ-120W0241-01 | JZMSZ-120W0241-03 | JZMSZ-120W0241-05 |
| Length (L) | 1.0 m | 3.0 m | 5.0 m |
| Cable Specifications | 9-core shielded cable, UL2921, 0.13 mm$^2$ (AWG26) | | |
| Connector Specifications | Connector 1: 17JE-23090-02 (D8B)<br>Connector 2: 17JE-13090-02 (D8C) (DDK) | | |

#### (2) Dimensions




#### (3) Connection Diagram




Cable size: 0.13 mm$^2$ (AWG26)

### 1) JZMSZ-120W0200 and JZMSZ-120W0204 Connections

| Pin# | Remote I/O Receiver Module | Direction | Pin# | Personal Computer Made by NEC (PC-98) D-SUB 25-pin Connector |
|---|---|---|---|---|
| | Signal Name | | | Signal Name |
| 1 | PGND (protective ground) | | 1 | PGND (protective ground) (vacant) |
| 2 | TXD (transmission data) | → | 3 | RXD (reception data) |
| 3 | RXD (reception data) | ← | 2 | TXD (transmission data) |
| 4 | RTS (request to send) | → | 4 | RTS (request to send) |
| 5 | CTS (clear to send) | ← | 5 | CTS (clear to send) |
| 6 | DSR (data set ready) | → | 20 | DTR (data terminal ready) |
| 7 | SGND (signal ground) | ↔ | 7 | SGND (signal ground) |
| 8 | Vacant | | | |
| 9 | DTR (data terminal ready) | ← | 6 | DSR (data set ready) |

### 2) JZMSZ-120W0201 Connections

| Pin# | Remote I/O Receiver Module | Direction | Pin# | Personal Computer Made by NEC (PC-98) Half-pitch Connector |
|---|---|---|---|---|
| | Signal Name | | | Signal Name |
| 1 | PGND (protective ground) | | | |
| 2 | TXD (transmission data) | → | 1 | RXD (reception data) |
| 3 | RXD (reception data) | ← | 9 | TXD (transmission data) |
| 4 | RTS (request to send) | → | 10 | RTS (request to send) |
| 5 | CTS (clear to send) | ← | 4 | CTS (clear to send) |
| 6 | DSR (data set ready) | → | 11 | DTR (data terminal ready) |
| 7 | SGND (signal ground) | ↔ | 14 | SGND (signal ground) |
| 8 | Vacant | | | |
| 9 | DTR (data terminal ready) | ← | 2 | DSR (data set ready) |
| | | | 12 | RSEN |
| | | | 13 | SGND (signal ground) |

### 3) JZMSZ-120W0202 Connections

| Pin# | Remote I/O Receiver Module | Direction | Pin# | IBM-PC D-SUB 9-pin Connector |
|---|---|---|---|---|
| | Signal Name | | | Signal Name |
| 1 | PGND (protective ground) | | 1 | PGND (protective ground) (vacant) |
| 2 | TXD (transmission data) | → | 2 | RXD (reception data) |
| 3 | RXD (reception data) | ← | 3 | TXD (transmission data) |
| 4 | RTS (request to send) | → | 7 | RTS (request to send) |
| 5 | CTS (clear to send) | ← | 8 | CTS (clear to send) |
| 6 | DSR (data set ready) | → | 4 | DTR (data terminal ready) |
| 7 | SGND (signal ground) | ↔ | 5 | SGND (signal ground) |
| 8 | Vacant | | 9 | (vacant) |
| 9 | DTR (data terminal ready) | ← | 6 | DSR (data set ready) |

#### 4) JZMSZ-120W0203 Connections

| Pin# | Remote I/O Receiver Module | Direction | Pin# | P120 D-SUB 9-pin Connector |
|---|---|---|---|---|
| | Signal Name | | | Signal Name |
| 1 | PGND (protective ground) | ← | 1 | CD (vacant) |
| 2 | TXD (transmission data) | → | 2 | RXD (reception data) |
| 3 | RXD (reception data) | ← | 3 | TXD (transmission data) |
| 4 | RTS (request to send) | → | 7 | RTS (request to send) |
| 5 | CTS (clear to send) | ← | 8 | CTS (clear to send) |
| 6 | DSR (data set ready) | → | 4 | DTR (data terminal ready) |
| 7 | SGND (signal ground) | → | 5 | SGND (signal ground) |
| 8 | ESTUS (element status) | → | 9 | ESTUS (element status) |
| 9 | DTR (data terminal ready) | ← | 6 | DSR (data set ready) |

**Note** When using the remote functions of the Programming Console, the element status monitoring function cannot be used.

## 6.2.2 Connections between Devices

*Figure 6.1* shows the connections between the Remote I/O Driver Module and a Remote I/O Receiver Module and the use of the Conversion Adapter between these Modules.

1) Connect a T-adapter to the BNC Connector (LINE) on the front panel.

2) Connect the BNC Connector at one end of the coaxial cable to the T-adapter and the BNC Connector at the other end of the cable to the BNC receptacle on the Conversion Adapter.

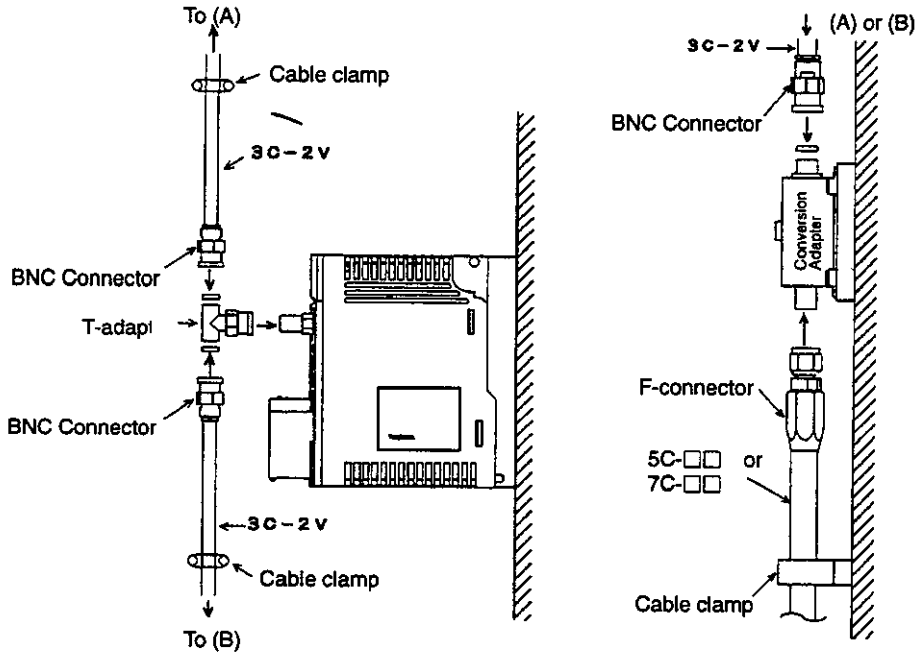



**Figure 6.1 Device Connections**

## 6.2.3 Shield Treatment

For shielded coaxial cables, ground the shield at one point (ground resistance: 100 Ω max). See *6.5 Grounding* for details.

## 6.2.4 Separating of Coaxial Cables from Other Cables

**1) Separation from Low-voltage Cables**

Keep coaxial cables at least 100 mm away from low-voltage cables. Alternatively, use coaxial cables shielded with copper or iron (hereafter referred to as shielded coaxial cables). The coaxial cable should be housed in metal conduit or a metal duct.

**2) Separation from Operation Circuit Cables**

Keep shielded coaxial cables at least 100 mm away from operation circuit cables. Alternatively, shield the operation circuit cables.

**3) Separation from Main Circuit Cables**

Keep shielded coaxial cables away from main circuit cables as shown in *Table 6.1*. Alternatively, shield the main circuit cables.

**Table 6.1 Recommended Distances between Shielded Coaxial Cable and Main Circuit Cable**

| Main Circuit | Recommended Distance |
|---|---|
| 125 V, 10 A | 300 mm or more |
| 250 V, 50 A | 450 mm or more |
| 440 V, 200 A | 600 mm or more |
| 3 kV to 6 kV, 800 A | 1,200 mm or more |

# 6.3 Indoor Panel-to-Panel Wiring

This section describes indoor panel-to-panel wiring.



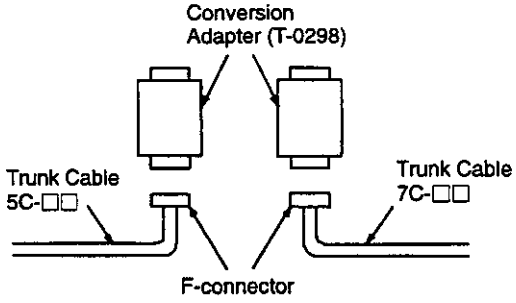
## 6.3.1 Connection between Devices

1) For Coaxial Cables 5C-□□ and 7C-□□, use F-connectors to connect to Conversion Adapters.

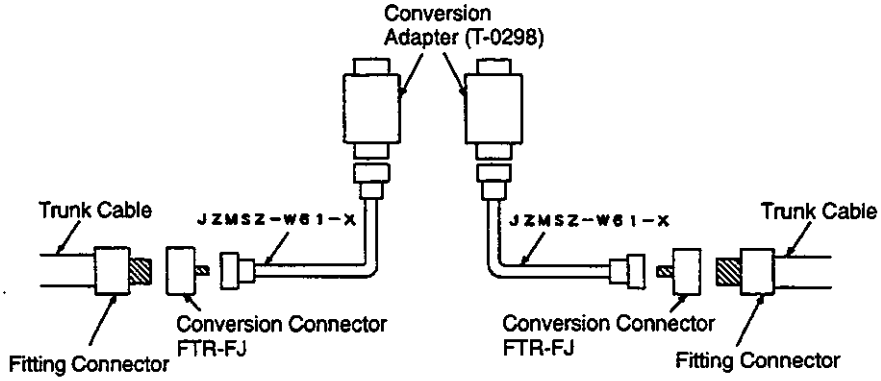
2) For trunk Coaxial Cables 11C-4AF and 12C-5AF, first connect to smaller Coaxial Cables 5C-□□ and 7C-□□ with Conversion Connectors, then connect these cables to Conversion Adapters with F-connectors.

3) Use Junction Connectors to connect trunk Coaxial Cables of the same size.

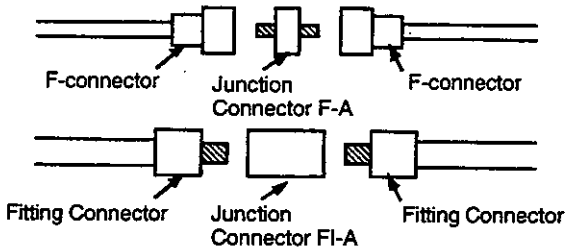
**a) Connection of 5C - □□ and 7C - □□**




**b) Connection using Large Size Connectors**



**c) Connecting between Coaxial Cables**




## 6.3.2 Shield Treatment

For shielded coaxial cables, ground the shield at one point (ground resistance: 100 Ω max). See *6.5 Grounding* for details.

## 6.3.3 Separating Coaxial Cables from Other Cables

**1) Shielded Coaxial Cables**

Accommodate the shielded coaxial cable in a low-voltage circuit duct separated from general operation circuit duct as shown in *Figure 6.2 (a)*. If the low-voltage circuit and general operation circuits are in the same duct, separate them by at least 100 mm, then place the shielded coaxial cable on the low-voltage circuit side as shown in *Figure 6.2 (b)*.

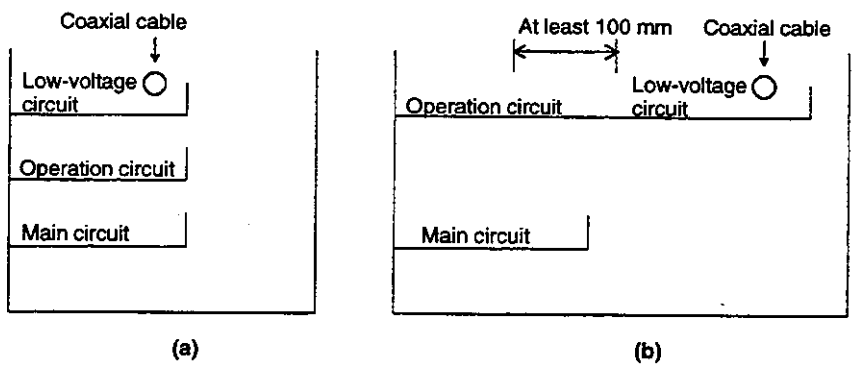



**Figure 6.2 Separating Wire Ducts**

2) Use a fitted duct cover that does not leave a gap between the duct and the cover.

| Main Circuit | Recommended Distance |
|---|---|
| 125 V, 10 A | 300 mm or more |
| 250 V, 50 A | 450 mm or more |
| 440 V, 200 A | 600 mm or more |
| 3 kV to 6 kV, 800 A | 1,200 mm or more |

### 3) Unshielded Coaxial Cables

Coaxial Cables must be run individually in metal conduit or metal duct as shown in figures *6.3.* Ground both ends of the metal conduit or duct and at as many points as necessary. Coaxial Cables 11C-4AF and 12C-5AF are difficult to run in conduit since they are inflexible. Run them individually in metal ducts. See *Figure 6.3 (b) and (d).*

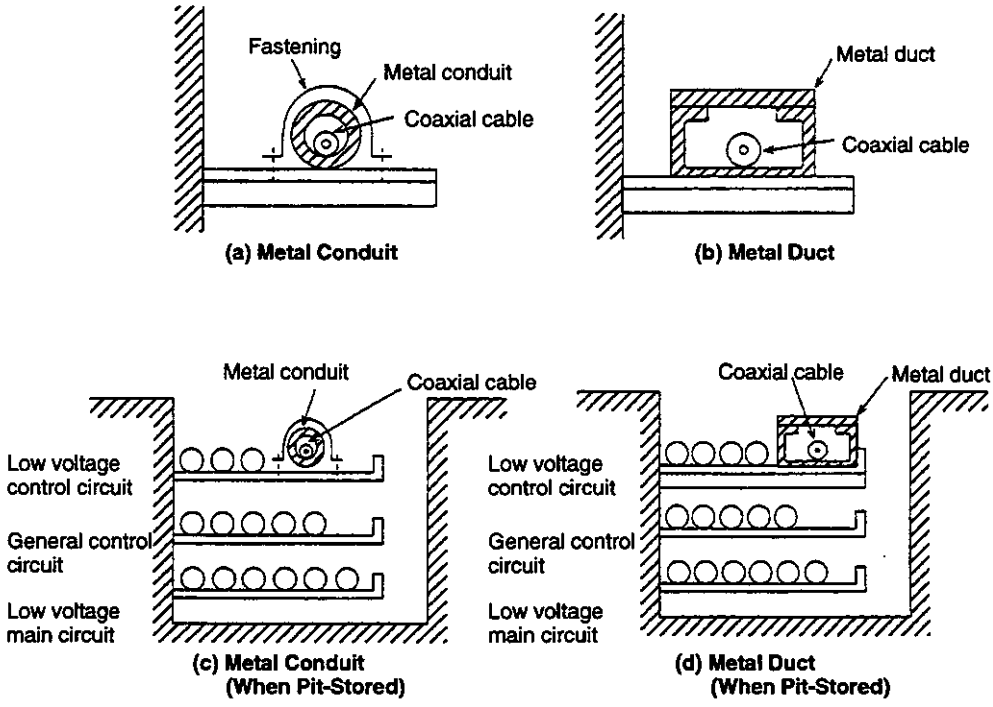



**Figure 6.3 Coaxial Cable Installation**

### 4) Bending Coaxial Cables

Use the following guidelines when bending coaxial cables: For 5C-□□ and 7C-□□, the bending radius must be 10 times or more of the finished bend diameter; For 11C-4AF and 12C-5AF, 20 times or more. (See *Figures 6.4 and 6.5.*) Use flexible metal conduit for bending so that the metal conduits can contact each other. In this case, the bending radius must be 20 times or more of the finished bend diameter for 5C-□□ and 7C-□□. (See *Figure 6.5.*)

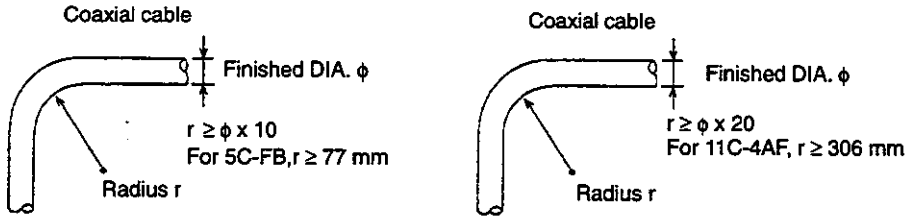



**Figure 6.4 Cable Bending**

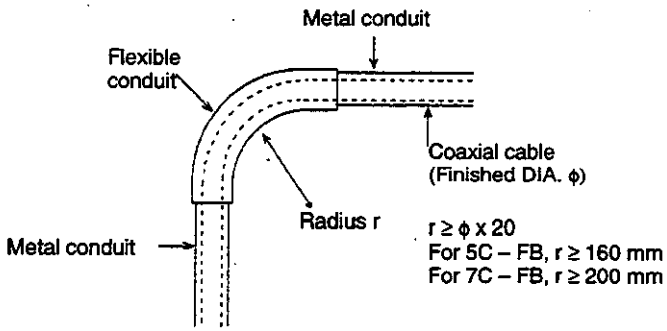



**Figure 6.5 Metal Conduit Bending**

### a) Minimum Cable Bending Radius

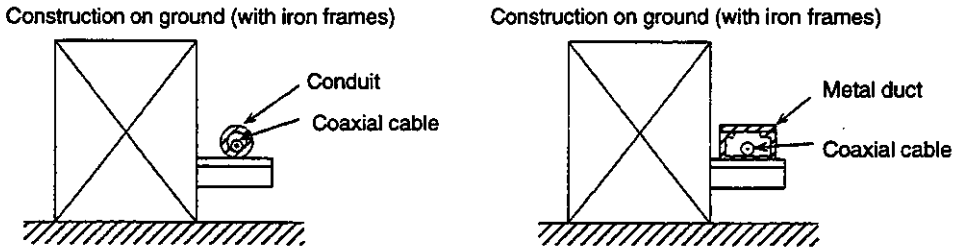
| Model (Made by Fujikura, Ltd.) | Finished Diameter in mm | Minimum Bending Radius in mm (formula) |
|---|---|---|
| 3C-2V | 5.6 | 56 (r = ϕ x 10) |
| 3C-2V (Cu, Fe) ZV | 8.6 | 86 (r = ϕ x 10) |
| 5C-2V | 7.5 | 75 (r = ϕ x 10) |
| 5C-2V (Cu, Fe) ZV | 12.0 | 120 (r = ϕ x 10) |
| 5C-FB | 7.7 | 77 (r = ϕ x 10) |
| 5C-FB (Cu, Fe) ZV | 12.0 | 120 (r = ϕ x 10) |
| 7C-FB | 10.0 | 100 (r = ϕ x 10) |
| 7C-FB (Cu, Fe) ZV | 13.0 | 130 (r = ϕ x 10) |
| 7C-FL | 10.0 | 100 (r = ϕ x 10) |
| 7C-FL (Cu, Fe) ZV | 14.5 | 145 (r = ϕ x 10) |
| 11C-4AF | 15.3 | 306 (r = ϕ x 20) |
| 11C-4AF (Cu, Fe) ZV | 18.3 | 366 (r = ϕ x 20) |
| 12C-5AF | 15.3 | 306 (r = ϕ x 20) |
| 12C-5AF (Cu, Fe) ZV | 20.0 | 400 (r = ϕ x 20) |

# 6.4 Outdoor Panel-to-Panel Wiring

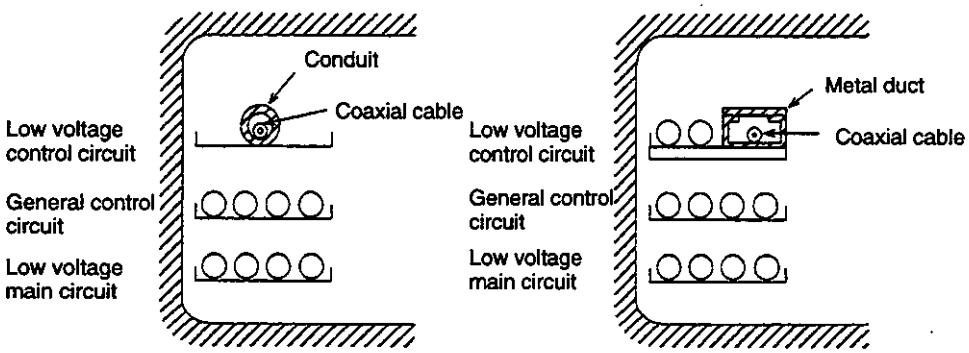
This section describes outdoor panel-to-panel wiring.

The procedures for laying coaxial cables are basically the same as those described in *6.3 Indoor Panel-to-Panel Wiring*, but note the following differences.

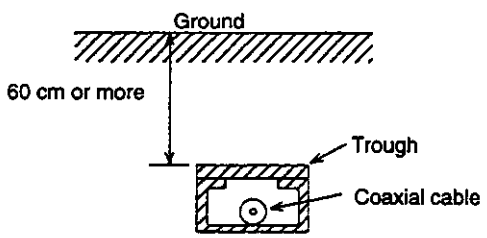
1) For outdoor wiring, always lay coaxial cables along above ground structures (steel frames). If no such structures are available, accommodate the cables in an underground pit or tunnel or bury the cables in the ground.




**(a) Construction on Ground**




**(b) Underground Pit or Tunnel**




**(c) Burying in the Ground**

2) Do not route bare coaxial cables overhead. The cables may receive noise induced from airborne radio waves and cause transmission errors. Since the GL120, GL130 Remote I/O System is not protected from lightning, the equipment may also be damaged by lightning strikes.

3) Coaxial cable expands and contracts with temperatures. The thermal expansion coefficient of coaxial cables is about 0.005% per degree (°C). For example, a coaxial cable of 500 m expands 25 cm when the temperature increases 10 °C. Normally, this extent of expansion can be compensated through the entire cable route. When coaxial cables are routed through an above ground structure, however, changes in the cable length may not be compensated because of large temperature fluctuations. Therefore, let the coaxial cable have some play at the inlet and outlet of each metal conduit so that changes in the cable length can be compensated.

4) If water is trapped in a metal conduit or duct and freezes in winter, it applies mechanical stress to the coaxial cable. To prevent this, drill drain holes in the metal conduit or duct.

# 6.5 Grounding

This section describes grounding methods.



## 6.5.1 Grounding Methods

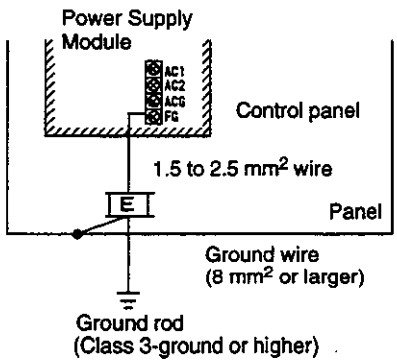
### 1) Procedure

#### a) Installing Equipment

The Mounting Base on which each Module of the GL120 or GL130 is installed must be mounted on an integrated steel base (frame). Always leave coaxial connectors above the electrical ground.

#### b) Ground Wire

Mount a ground terminal (E) in the control panel and connect the terminal to the cabinet of the control panel. Also, connect the ground terminal to the FG terminal on the Power Supply Module. For the ground wire between the ground terminal and the ground plate, use a ground wire of at least 8 $mm^2$ (AWG8) and also make the wire as short as possible. If the distance between the ground terminal and the ground plate is long, use a thicker ground wire so that the sum of the ground resistance and the ground wire resistance is less than100 Ω.




#### c) Ground Plate

The ground plate should be as close to the GL120 or GL130 control panel as possible and kept at least 15 meters away from the ground plates of other high-voltage control panels (Group B in *Table 6.2* below). The ground resistance must be less than100 Ω.

#### d) Sharing Ground

Basically, a GL120 or GL130 should have its own ground. If a GL120 or GL130 must share the ground wire and ground plate with other control panels, use the following information as guidelines.

**Table 6.2 Sharing Ground Wire and Ground Plate**

| | |
|---|---|
| Shared Use Permitted (Group A Panel) | Computer panels, instrumentation control panels, I/O relay panels, general control circuit panels, etc. |
| Shared Use NOT Permitted (Group B Panel) | High-voltage main circuit panels, large-capacity thyristor panels, etc. |

## 6.5.2 Shielded Coaxial Cables

Ground the shield of the shielded coaxial cable at one point only. The figure below shows examples of grounding shielded coaxial cables (Sa, Sb, Sc, and Sd: relay terminals).

**1) Sb and Sc Connected**

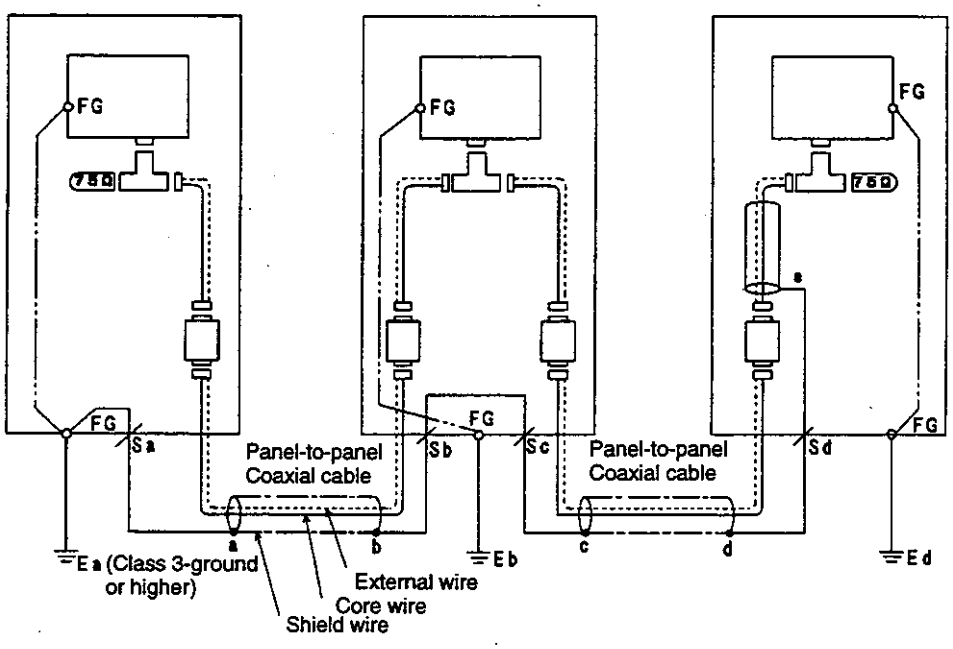
Ground the shield at point Ea or Ed in the figure.

**2) Shield Not Groundable at Point Ea or Ed**

Sa and Sc can be grounded at point Eb.

**3) Shielded Coaxial Cable Inside a Panel**

Connect point e on the shield to point d on the shield of the panel-to-panel shielded coaxial cable via relay terminal Sd.




## 6.5.3 Metal Conduits and Metal Ducts

Always ground both ends of a metal conduit or duct. Each metal conduit or duct should be grounded at as many points as possible.

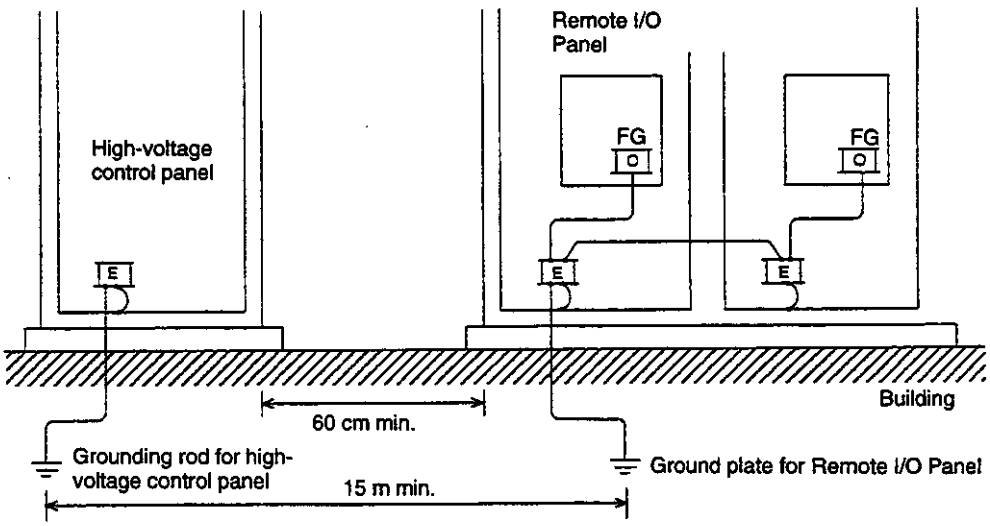
# 6.6 Installation of Control Panel

This section describes the method of installing a control panel.

Follow the procedure described below when installing a control panel (referred to as a Remote I/O Panel) for the GL120 or GL130, a Remove I/O Driver Module, or a Remove I/O Receiver Module.

### 1) Separating Remote I/O Panels from High-voltage Control Panels

Do not install a Remote I/O Panel and a high-voltage control panel (Group B in the *Table 6.2*) side by side. If a Remote I/O Panel must be installed near a high-voltage control panel, always keep the Remote I/O Panel at least 60 cm away from the high-voltage control panel. Likewise, keep the ground wire at least 60 cm away from that of the high-voltage control panel and keep the ground plate at least 15 m away from that of the high-voltage control panel.



### 2) Installing Remote I/O Panels and Other Control Panels Side by Side

Remote I/O Panels and Group A control panels can be installed side by side. In this case, these control panels are electrically connected to each other through the channel base. To further ensure safe grounding, connect the ground terminals (E) of these control panels with a ground wire of at least 8 $mm^2$ as shown in the figure below. Then, connect one of the ground terminals to the ground plate.

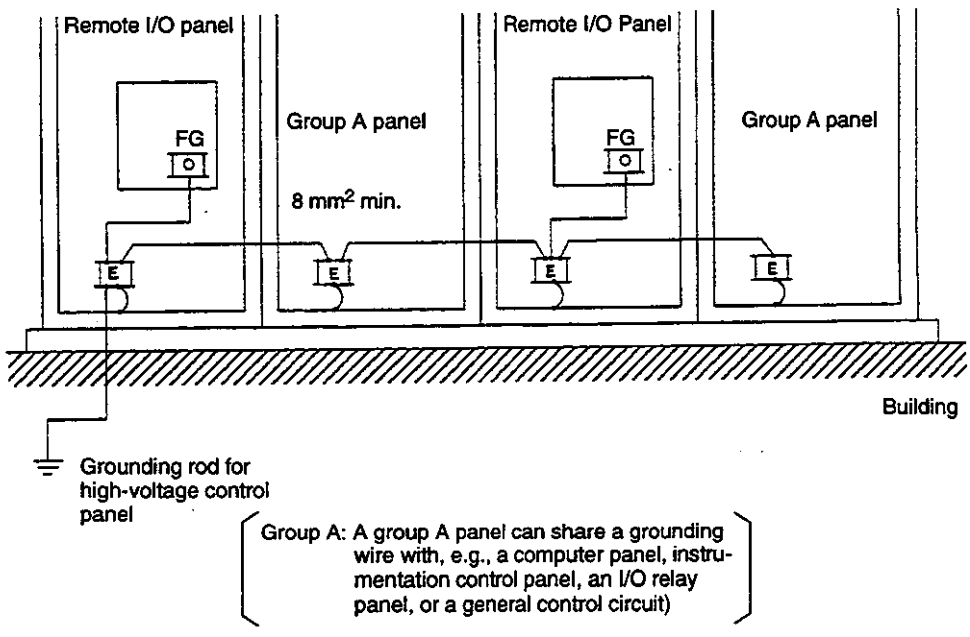



**Figure 6.6 Separation from Group A Panels**

### 3) Insulating Remote I/O Panels

When a Remote I/O Panel is installed in a steel-frame building, it is grounded through the building. This will not normally cause a problem. However, if a Remote I/O Panel is installed near a high-voltage control panel, a ground current from the high-voltage control panel will cause ground noise at the Remote I/O Panel. To prevent this, insulate the Remote I/O Panel from the building as shown in the figure below. Then, connect the ground terminal (E) of the Remote I/O Panel to its own ground plate.

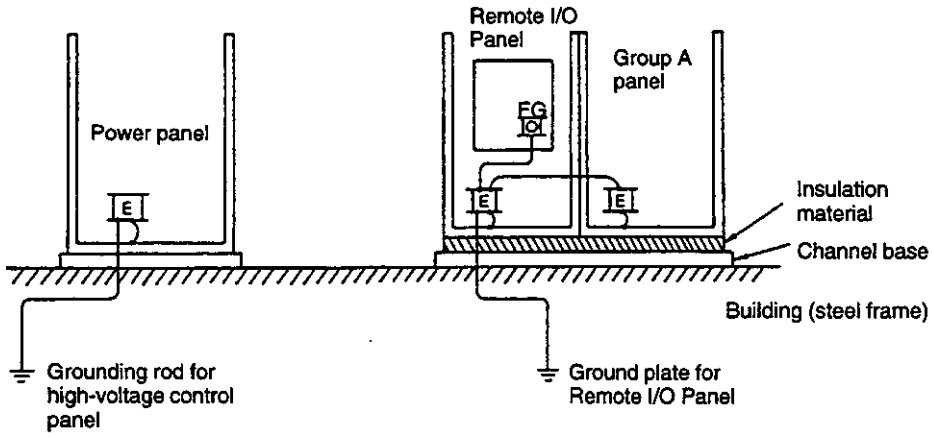



**Figure 6.7 Remote I/O Panel Insulation**

# Remote I/O Setup and Maintenance

# 7

This chapter describes the setup and troubleshooting of Remote I/O Systems.

# 7.1 Remote I/O Setup

This section describes troubleshooting and setting up of the Remote I/O transmission path.



## 7.1.1 Checklist for Remote I/O Transmission Path

1) Have the BNC Connectors and F Connectors been locked and tightened properly?

2) Are the coaxial cable long enough?

3) Are the coaxial cables and connectors connected according to specifications?

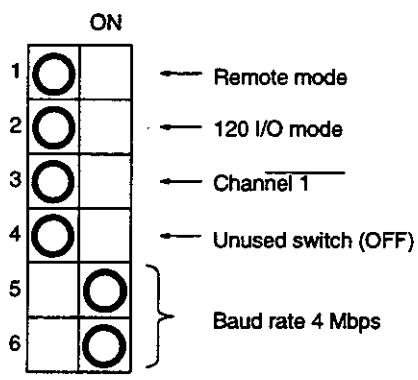
4) Is a terminator (75Ω) installed at each end of the transmission path?

5) Is wiring separated properly from the main circuits (power lines) and the control circuits?

6) Has grounding been done correctly? In particular, is the shield of the shielded coaxial cable grounded at a single point on the entire transmission path?

## 7.1.2 DIP Switches Settings

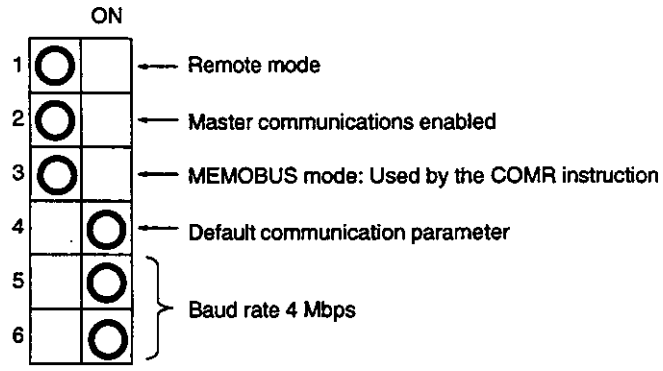
◀EXAMPLE▶ 1) Remote I/O Driver Module DIP switch settings are as follows:




**Note** (1) Set the same baud rate between the Remote I/O Driver Module and Remote I/O Receiver Modules.

(2) If a setting is changed after turning ON the power supply, press the reset switch or turn the power supply off and on.

◀EXAMPLE▶ 2) Remote I/O Receiver Module DIP switch settings are as follows:




**Note** (1) Set the same baud rate between the Remote I/O Driver Module and Remote I/O Receiver Modules.

(2) If a setting is changed after turning ON the power supply, press the reset switch or turn the power supply off and on.

3) To select the memory communication parameter, turn OFF DIP switch pin 4. To set different values from the default values, turn ON DIP switch pin 4 and set the desired parameters from the MEMOSOFT. Select Configuration –> Setting –> Ports from the MEMOSOFT menus.

| Item | Specification |
|---|---|
| Baud rate | 1,200/1,800/2,000/2,400/3,600/4,800/7,200/9,600*/19,200 bps |
| Parity | One of the following: No parity check; even parity*; odd parity |
| Stop bits | 1* or 2 |
| Transmission mode | RTU* or ASCII |

*Default values.

**Note** (1) Only one port can be connected to a MEMOBUS master device per channel.

(2) Communication parameters can be changed any time. However, for a station without I/O allocations, a port parameter change may take up to 150 seconds.

## 7.1.3 I/O Allocations

1) Select Configuration –> Map –> I/O Map from the MEMOSOFT menus.

2) Set an I/O reference, a Module type, and an I/O data format. In particular, check thoroughly that the reference is not duplicated, i.e., has not already been used.

3) Refer to the following manuals for further information on I/O allocations.

- *MEMOCON GL120, GL130 Software User's Manual Volume 1*: SIEZ-C825-20.11
- *MEMOCON Micro GL120, GL130 P120 Programming Panel User's Manual*: SIEZ-C825-60.7
- *MEMOSOFT for DOS User's Manual*: SIEZ-C825-60.10

# 7.2 Maintenance

This section describes troubleshooting.



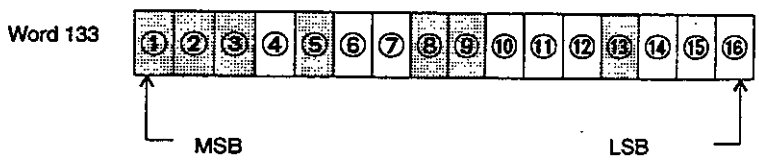
## 7.2.1 Fault Detection

**1) Monitoring by a Remote Station Status Table**

a) Status information for various Modules can be read using the STAT instruction.

b) Status words from 133 to 162 (for 30 stations) for remote channels are described.

◀EXAMPLE▶ Status word 133 contains the status of station 1 of remote channel 1 as follows (same for 134 to 162);




| Bit Number | Name | Meaning When Bit Is Set to "1" |
|---|---|---|
| 1 | Communications error or no remote station response | A communications error occurred between a Remote I/O Driver Module and a Remote I/O Receiver Module. Alternatively, no response is sent from a remote station. |
| 2 | Allocated data fault | The data that was allocated contains an abnormality. |
| 3 | Output data length error | The output data length sent from the Remote I/O Driver Module is abnormal. |
| 5 | MEMOBUS port communication parameter fault | The communication parameter of the MEMOBUS port of the Remote I/O Receiver Module is abnormal. |
| 8 | ASIC fault | The bus control ASIC is abnormal. |
| 9 | Allocation request | No data is allocated to the remote station. |
| 13 | I/O service timeout error | No I/O service was performed within a certain period. |

c) See the *GL120, GL130 Software User's Manual Volume 2* (Manual No. SIEZ-C825-20.12) for details.

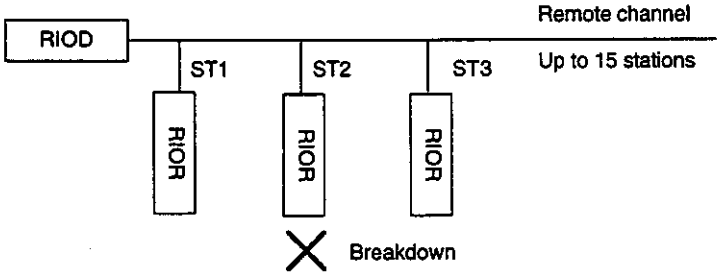
### 2) Detection of Faulty Stations

a) The Remote I/O Driver Module performs a scan service for Remote I/O Receiver Modules. If no response is sent or an abnormality is detected, the related bit of the remote station status table of the CPU is set to "1."

b) When an abnormality is detected over five scans consecutively, the input signal for the station is set to "0."

c) Other non-faulty Remote I/O Receiver Modules are serviced normally.

d) Station #2 is faulty in the following example. Status word 134 is set to 8000H.



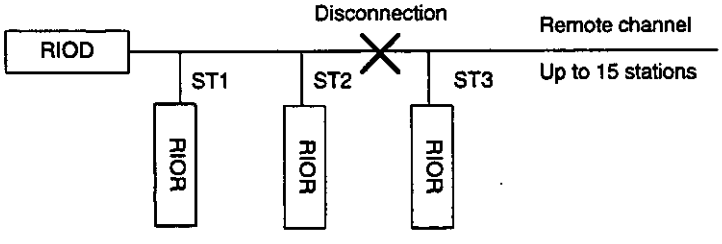

RIOD: Remote I/O Driver Module
RIOR: Remote I/O Receiver Module
ST1: Station number 1

### 3) Break in the Transmission Path

a) Since one side of a terminator will be lost by disconnection, normal transmission of all the Remote I/O Receiver Modules is not guaranteed.

b) Since the Remote I/O Driver Module performs a scan services for all the Remote I/O Receiver Modules, I/O operation is performed for only those Remote I/O Receiver Modules that issue a normal response.

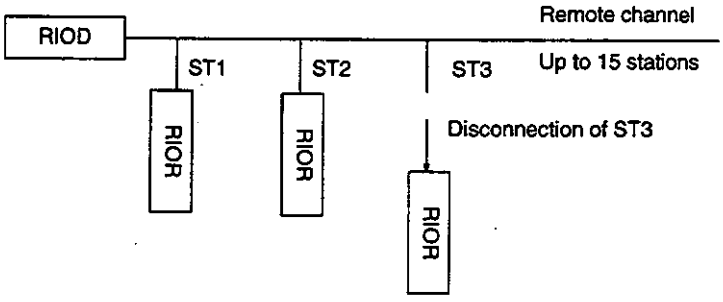
c) **Example of a Break in the Transmission Path**



**4) Disconnection from the Transmission Path**

a) Since no response is sent from a disconnected Remote I/O Receiver Module, the station is assumed to be faulty.

b) **Example of Disconnection from the Transmission Path**



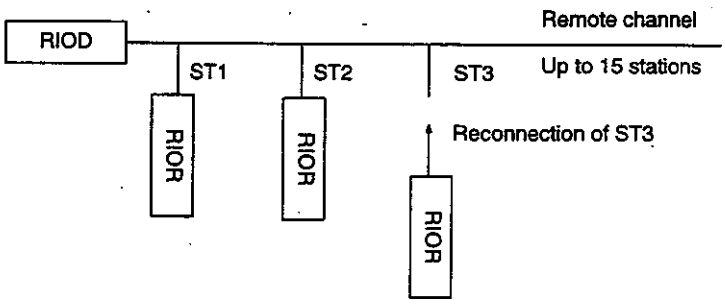

**5) Reconnection to a Transmission Path**

a) In the first service after reconnection, the I/O allocation is requested from the Remote I/O Receiver Module.

b) Normal operation starts after I/O allocation information is sent to Remote I/O Receiver Module from the Remote I/O Driver Module.

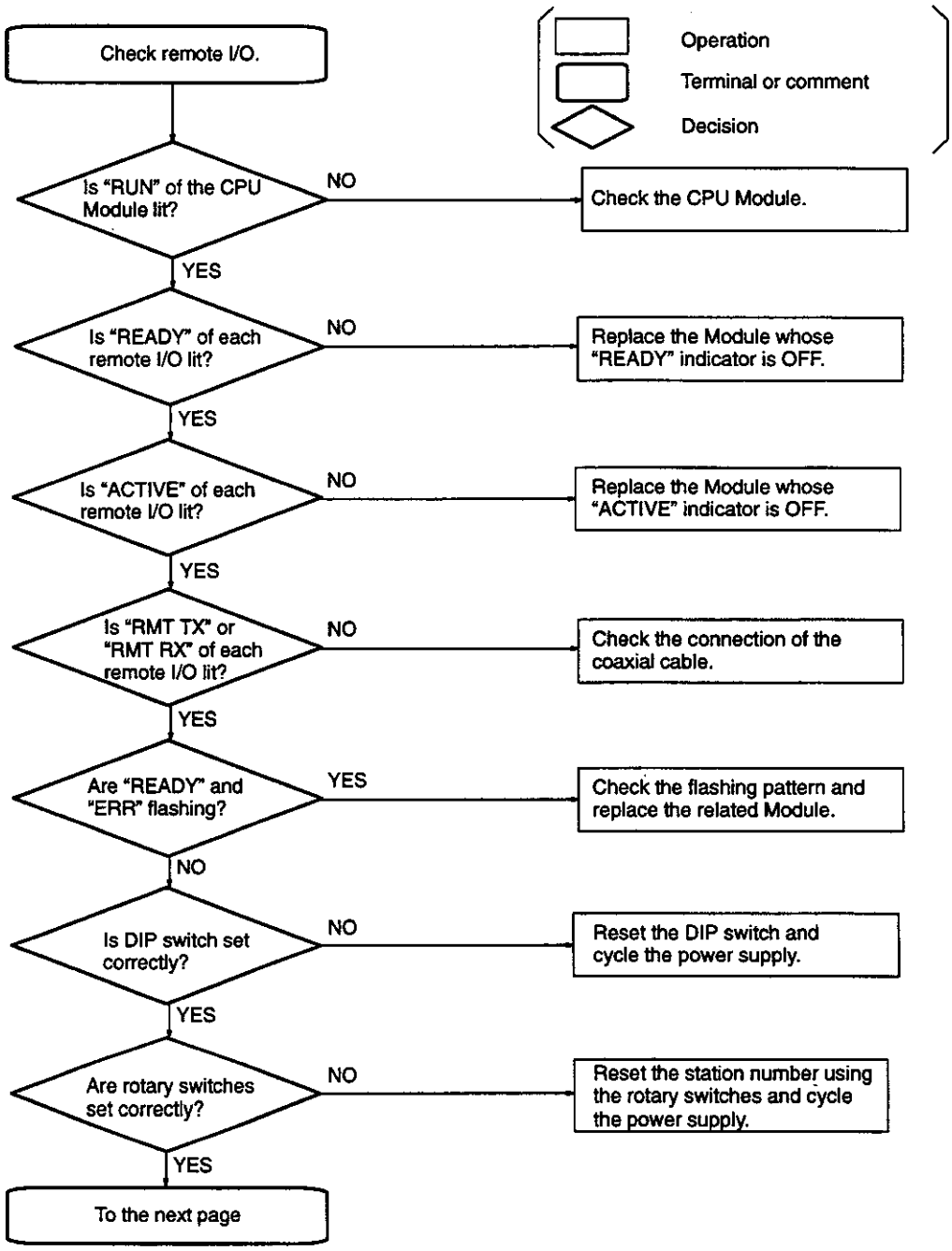
c) The same operation is also performed when the Remote I/O Receiver Module reset switch is pressed.

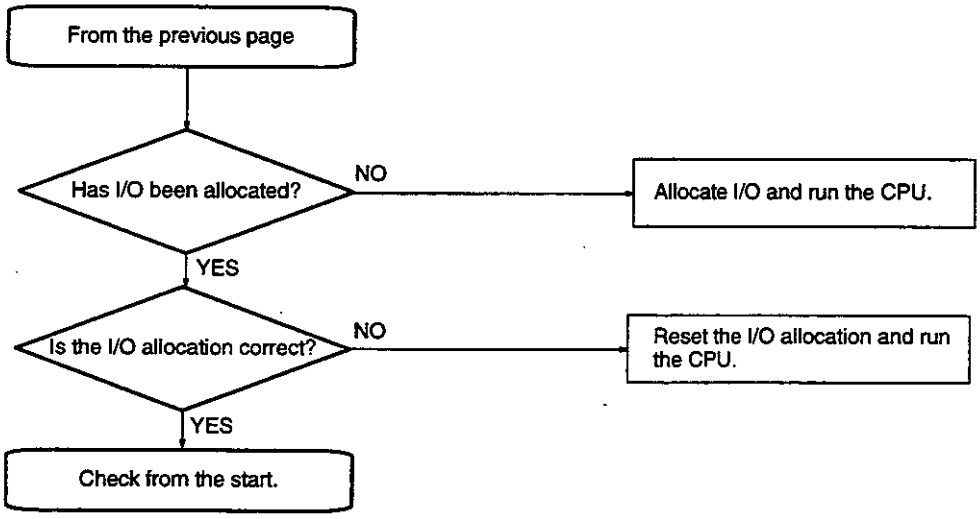
d) **Example of Reconnection to a Transmission Path**



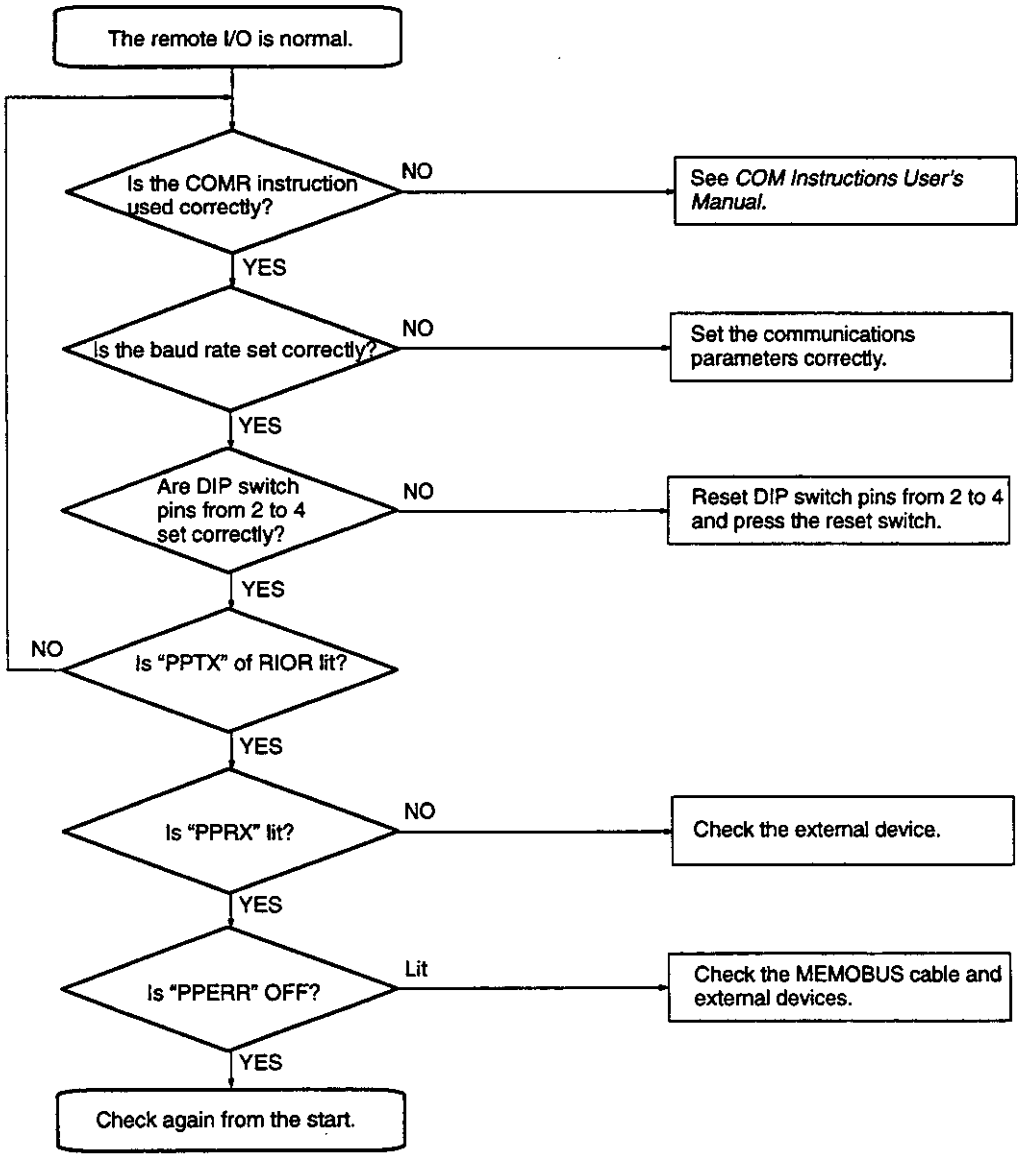
## 7.2.2 Fault Checking Procedure

### 1) Checking Remote I/O Faults




From the previous page
Has I/O been allocated?
NO
Allocate I/O and run the CPU.
YES
Is the I/O allocation correct?
NO
Reset the I/O allocation and run the CPU.
YES
Check from the start.

## 2) Checking Remote I/O Receiver Module MEMOBUS Port Failures



# Appendix A

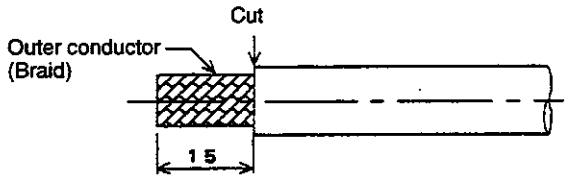
## Coaxial Cable Connector Installation Procedures



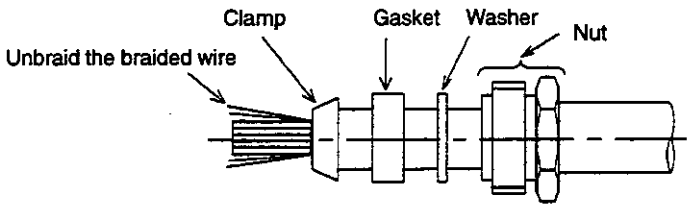
This appendix describes the installation procedures for BNC Connectors, F-connectors, and Fitting Connectors.

# A.1 BNC Connector Installation

1) Remove the sheath to 15 mm from the cable end. Use a cutter knife or pipe cutter (IFV1638).




2) Sequentially insert nut, washer, gasket, and clamp onto the coaxial cable.

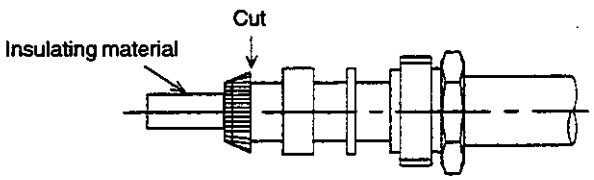



**Note** a) Place the nut, washer, and gasket over the sheath.

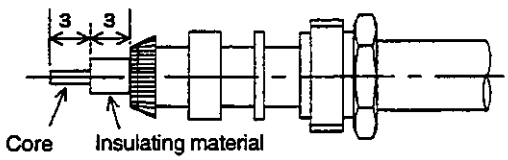
b) Place the clamp over the braided wire until it reaches the sheath cut surface.

c) After placing the clamp, unbraid the braided wire.

3) Turn back the braided wires along the clamp taper, and cut them to the same dimension as the taper.

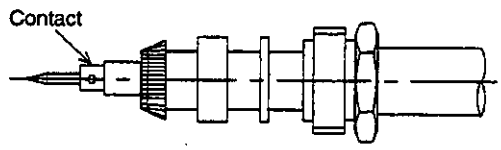



4) Remove the insulating material, leaving about 3 mm, to expose the core. Cut the core end, so that the bare core is 3 mm long.




**Note** Be careful not to damage the core.

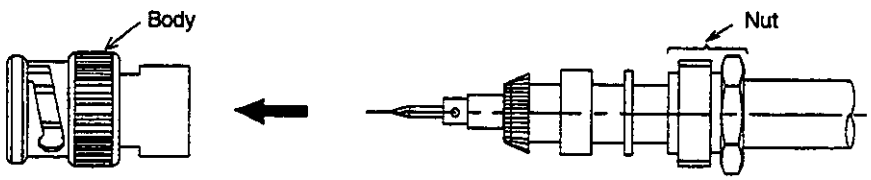
5) Pass the core through the contact, and solder.




**Note** a) Solder quickly, being careful not to deform the insulating material.

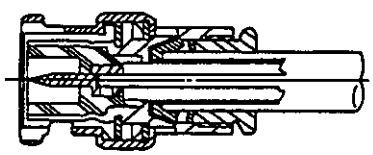
b) Do not permit the solder to form a lump or a gap between the contact and insulating material.

6) Insert the contact into the body.




**Note** Insert the contact into the body to the end.

7) Using a wrench, turn the nut to tighten the body. This completes connector installation.

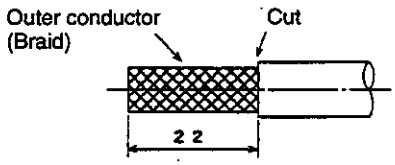


# A.2 F-connector Installation

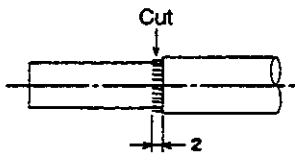
The example given below is for a 5C-2V cable.

1) Prepare the ends of coaxial cable, using a cutter knife or pipe cutter (IFV1638).

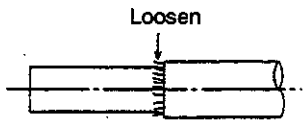
a) Remove the sheath to 22 mm from the cable end.



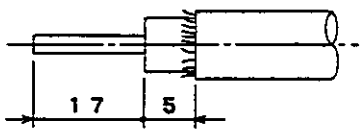

b) Using nippers, remove braided wires, leaving them about 2 mm long.




c) Loosen the braided wires.

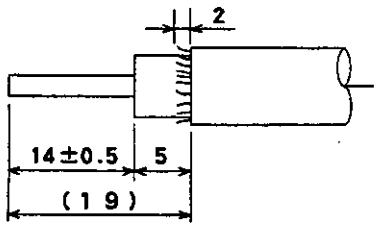



d) Pull out the insulating material 17 mm from the end.




**Note** Be sure not to damage the core.

e) Cut the core end, and adjust the bare core to 14 ± 0.5 mm.

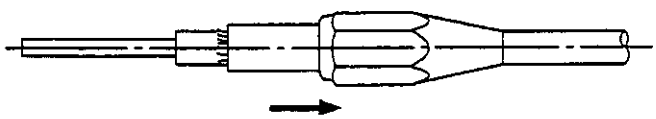



**Note** a) The bare core must be 14 ± 0.5 mm.

b) Leave aluminum foil about 5 mm.

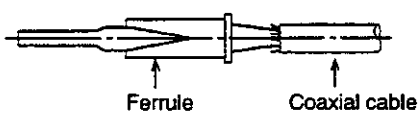
c) Leave the braided wires loose.

2) Insert the F-connector nut into the coaxial cable.



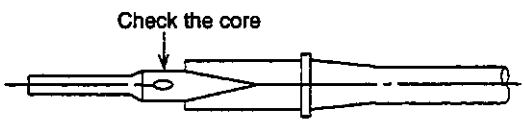
3) Press a ferrule into the coaxial cable.

a) Insert the cable end into the ferrule.



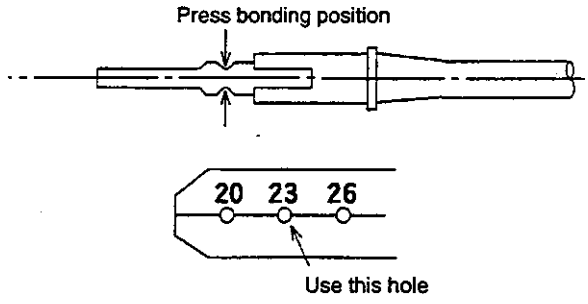

**Note** During insertion, be careful not to turn up the aluminum foil.

b) Check through the contact window to make sure that the core is correctly inserted into the contact.



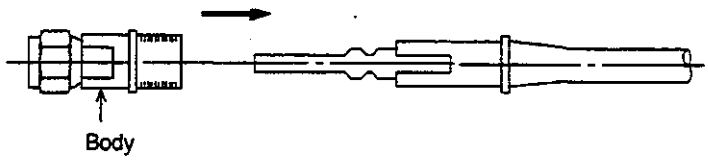
4) Press to bond the ferrule contact.

For press bonding, use an crimping tool (FC-1, DIA 23 mm, made by Fujikura, Ltd.). The press bonding position is at the contact window.

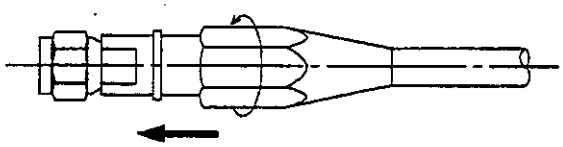



**Note** Be careful not to bend the contact.

5) Insert the body into the ferrule.




6) Using a wrench, tighten the nut until the rubber gasket is completely hidden. This completes the connector installation.

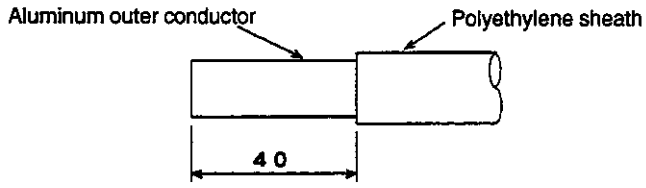


**Note** Fix the body with a wrench or an adjustable spanner (12 mm width across flat) and turn the nut for tightening with a wrench or an adjustable spanner (14 mm width across flat).

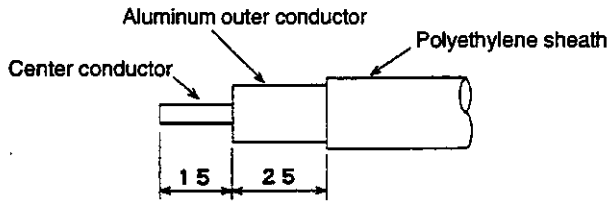
# A.3 Fitting Connector Installation

1) Prepare the ends of a coaxial cable, using a cutter knife or pipe cutter (IFV1638).

a) Remove the sheath to 40 mm from the cable end.

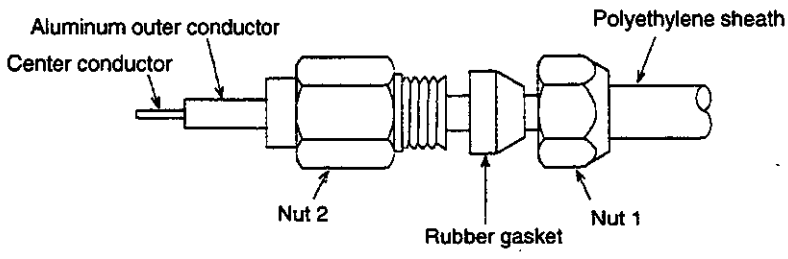



b) Remove the aluminum outer conductor and insulating material to 15 mm from the cable end.

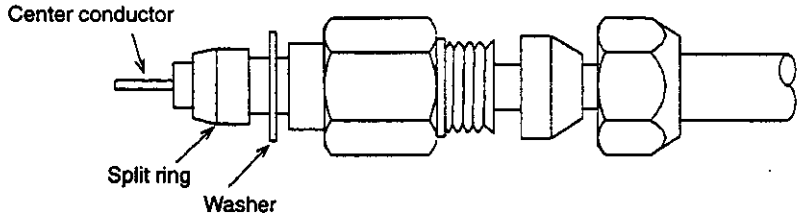



**Note** Be careful not to bend or damage the center conductor.

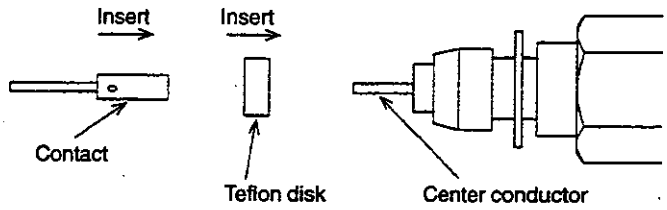
2) Sequentially insert nut, rubber gasket, and nut 2 onto the coaxial cable.



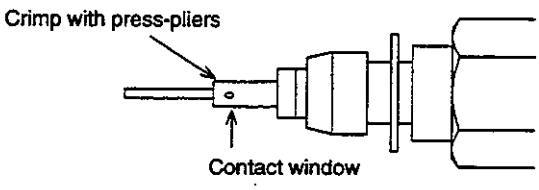

3) Insert washer and split ring onto the aluminum outer conductor.



4) Sequentially insert the Teflon disk and contact onto the center conductor.

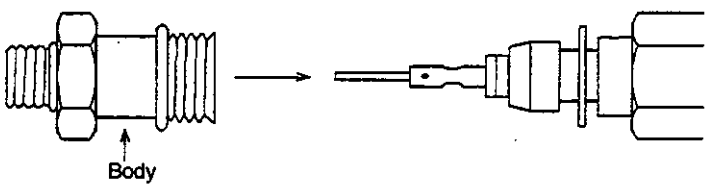



5) Press to bond the contact, using 9.5 mm coaxial-cable press-pliers.

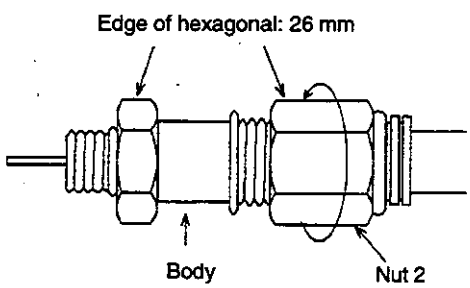



**Note** Check through the contact window to make sure that the contact is inserted.

6) Insert the contact into the body.

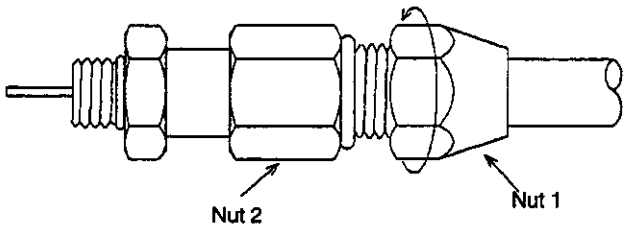



7) Tighten the body and nut 2.




**Note** Fully insert the body and tighten nut 2.

8) Tighten nut 1. This completes the connector installation.




**Note** Secure nut 2, then turn to tighten nut 1.

# A.4 Tool List

### Coaxial Cable Stripper CST

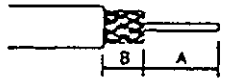
Manufacturer: Nihon Weidmuller Co., Ltd.

**Table A.1 Coaxial Cable Stripper**

| **Specifications** | | |
|---|---|---|
| Length | 100 mm | |
| Mass | 65 g | |
| Height | 42 mm | |
| Width | 26 mm | |
| **Sheath Trim** | | |
| Coaxial Cable | 2.5 to 8 mm Dia | |
| | RG58, 59, 62, 71, 174, 187, 188 | |
| **Order Data** | | |
| Type | No. | Sheath Trim (Refer to the following diagram) |
| Coaxial Cable Stripper CST | 903050 | |
| Screw Holder | 903206 | |
| Blade Cassette (Gray) | 903205 | Approx. 3.9 mm (B) |
| Blade Cassette (Red) | 903204 | Approx. 6 mm (B) |
| Blade Cassette (Yellow) | 903203 | Approx. 12 mm (B) |
| Blade Cassette (Blue) | 903202 | Approx. 6.5 mm (B) |
| Blade Cassette (Brown) | 903201 | Approx. 7.5 mm+ Approx. 3.5 mm (C+B) |
| Blade Cassette (Green) | 903200 | Approx. 7.1 mm + Approx. 5.1 mm (C+B) |

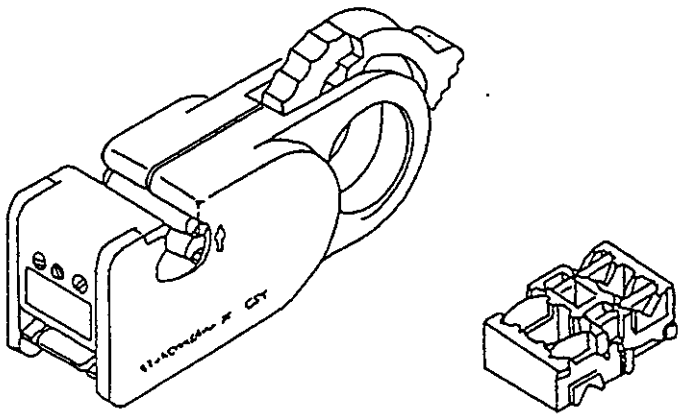
### Sheath Trimming Dimensions

Blade Cassette:
Gray/Red/Yellow/Blue




Blade Cassette:
Green/Brown

Coaxial cable stripper cannot be used for the cable type 7C, 7C2V, 11C, and 12C.



Coaxial cable stripper　　Blade cassette

**Figure A.1 Coaxial Cable Stripper and Blade Cassette**

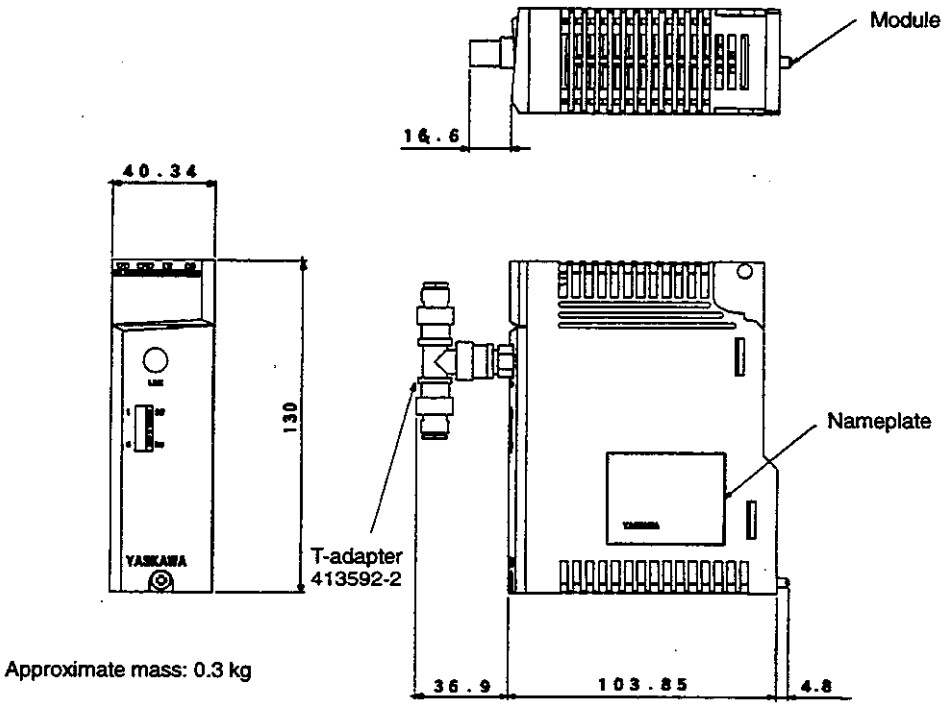
# Appendix B

## Remote I/O Module External Dimensions

This appendix shows external dimensions of Remote I/O Modules and related products.

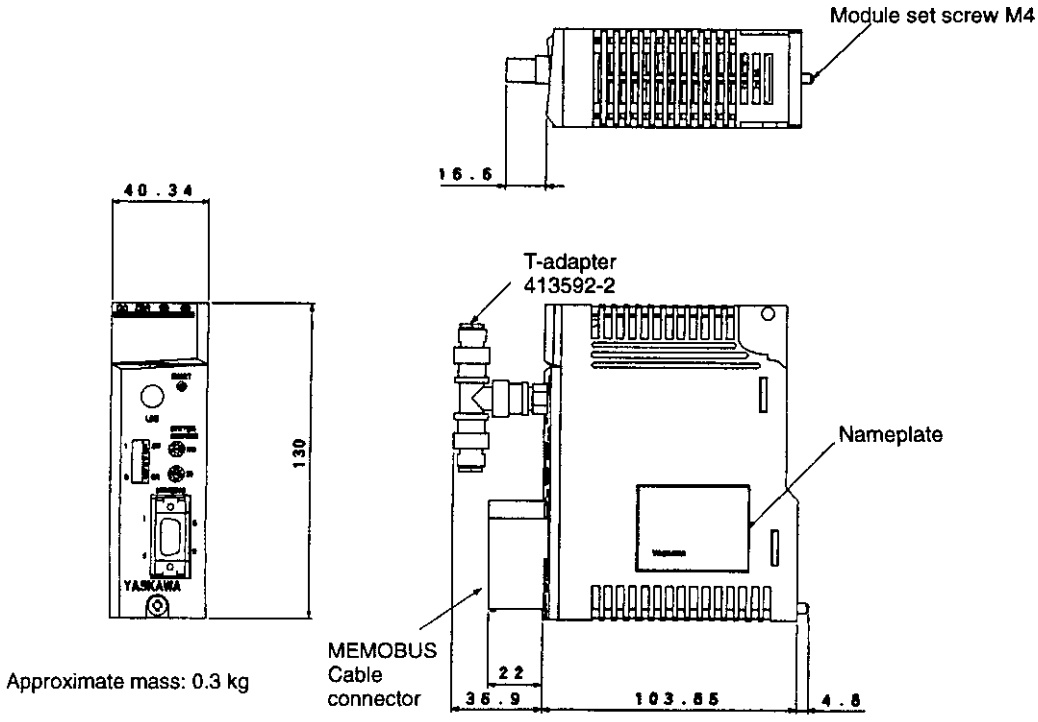
# B.1 Remote I/O Module External Dimensions in mm

### 1) Remote I/O Driver Module (JAMSC-120CRD13100)



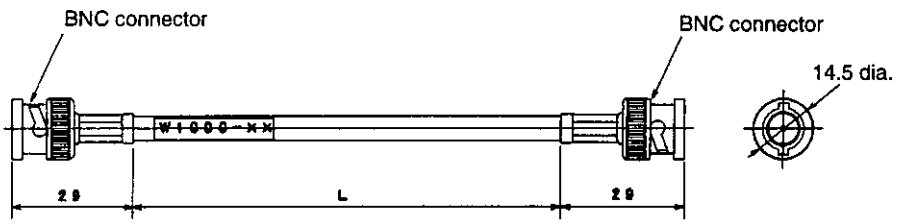

Approximate mass: 0.3 kg

### 2) Remote I/O Receiver Module (JAMSC-120CRR13100)



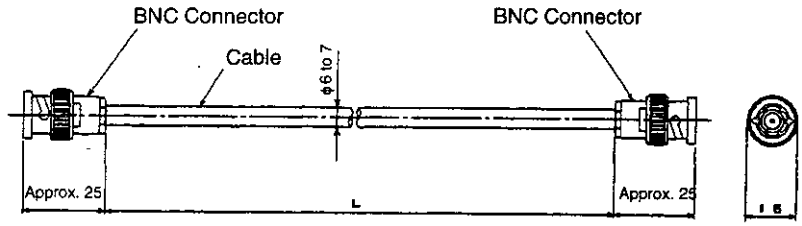

Approximate mass: 0.3 kg

### 3) W1000 Cable (JZMSZ-W1000-□)



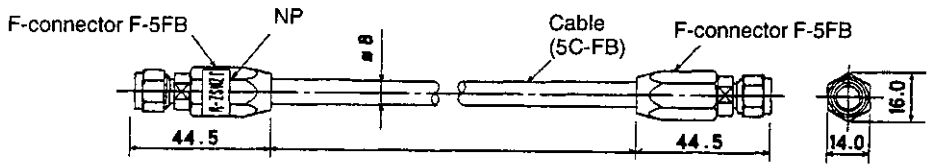

| Type | Length (L) | Approximate Mass |
|---|---|---|
| JZMSZ-W1000-02 | 2,000 mm | 0.3 kg |
| JZMSZ-W1000-03 | 3,000 mm | 0.4 kg |
| JZMSZ-W1000-05 | 5,000 mm | 0.5 kg |

### 4) W60 Cable (JZMSZ-W60-□)



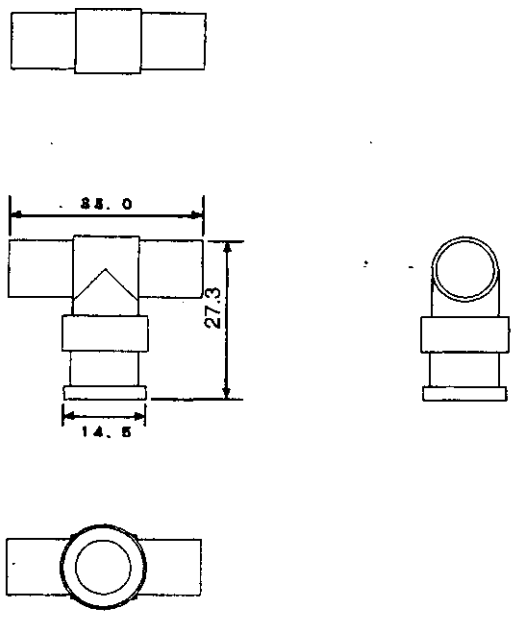

| Type | Length (L) | Approximate Mass |
|---|---|---|
| JZMSZ-W60-1 | 2,000 mm | 0.3 kg |
| JZMSZ-W60-2 | 3,000 mm | 0.4 kg |
| JZMSZ-W60-3 | 5,000 mm | 0.5 kg |

### 5) W61 Cable (JZMSZ-W61-□)

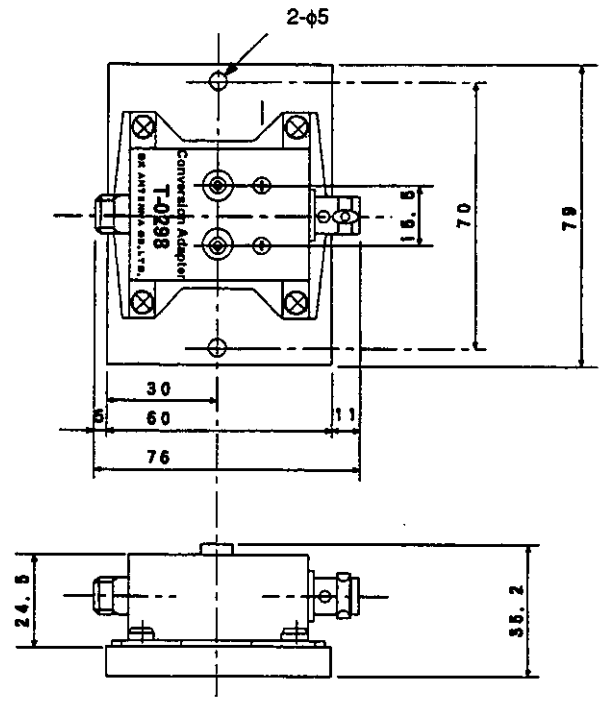



| Type | Length (L) | Approximate Mass |
|---|---|---|
| JZMSZ-W61-1 | 2,000 mm | 0.3 kg |
| JZMSZ-W61-2 | 5,000 mm | 0.5 kg |
| JZMSZ-W61-3 | 10,000 mm | 0.8 kg |

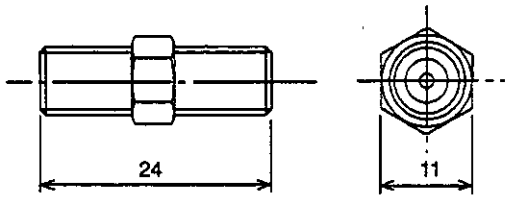
### 6) T-adapter (413592-2)



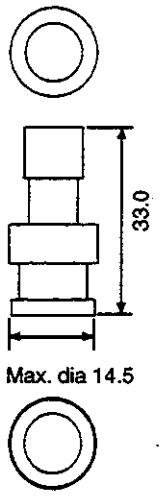
### 7) Conversion Adapter (T-0298)




### 8) Junction Connector (F-A)

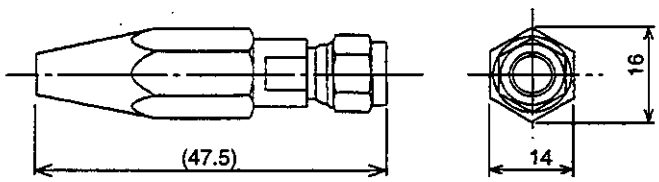


### 9) Terminator (221629-5)




Resistance: 75 Ω

### 10) F-connector (F-7FB)



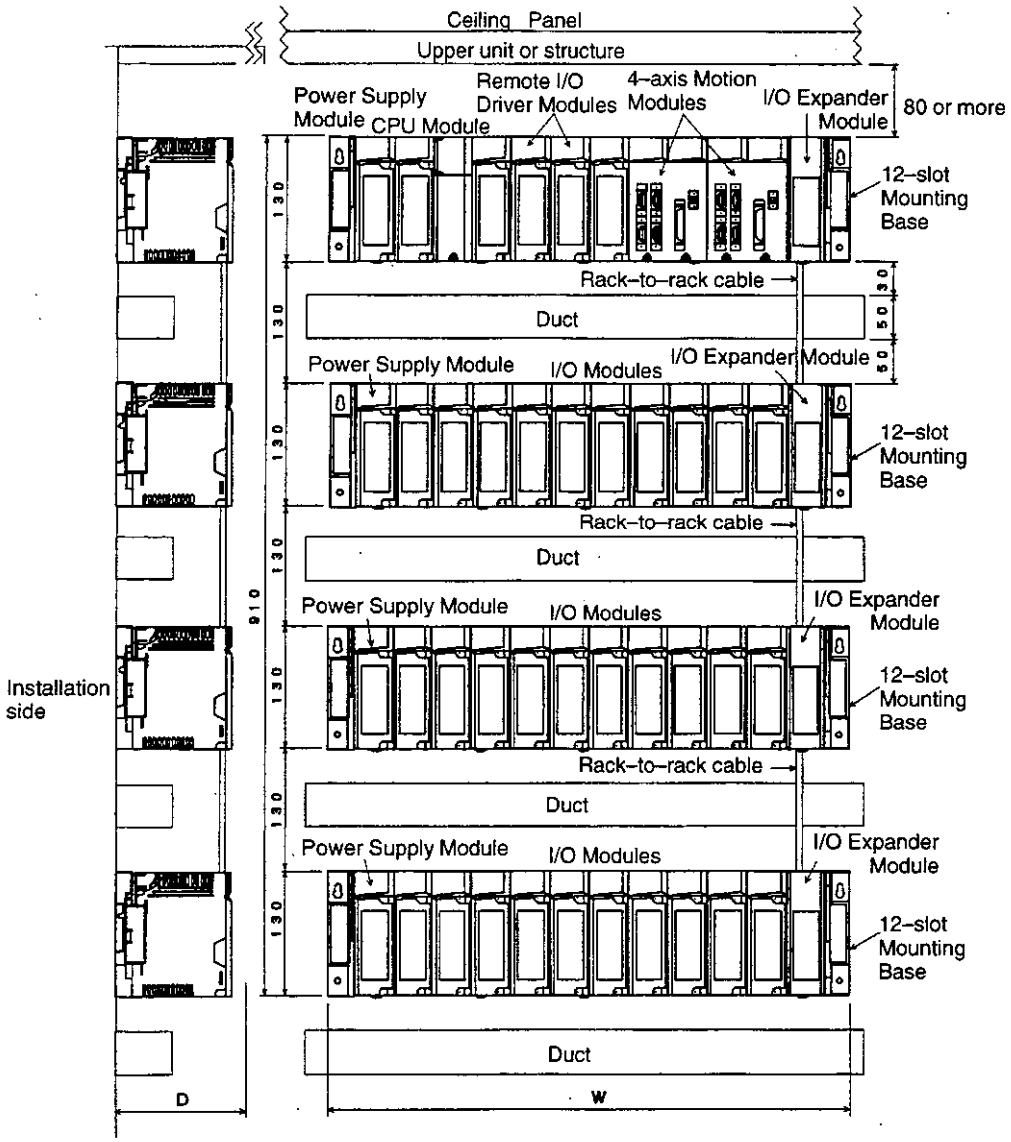
# Appendix C

## Remote I/O Panel Arrangement and Drilling Dimensions

This appendix provides examples of internal panel arrangements and drilling dimensions.

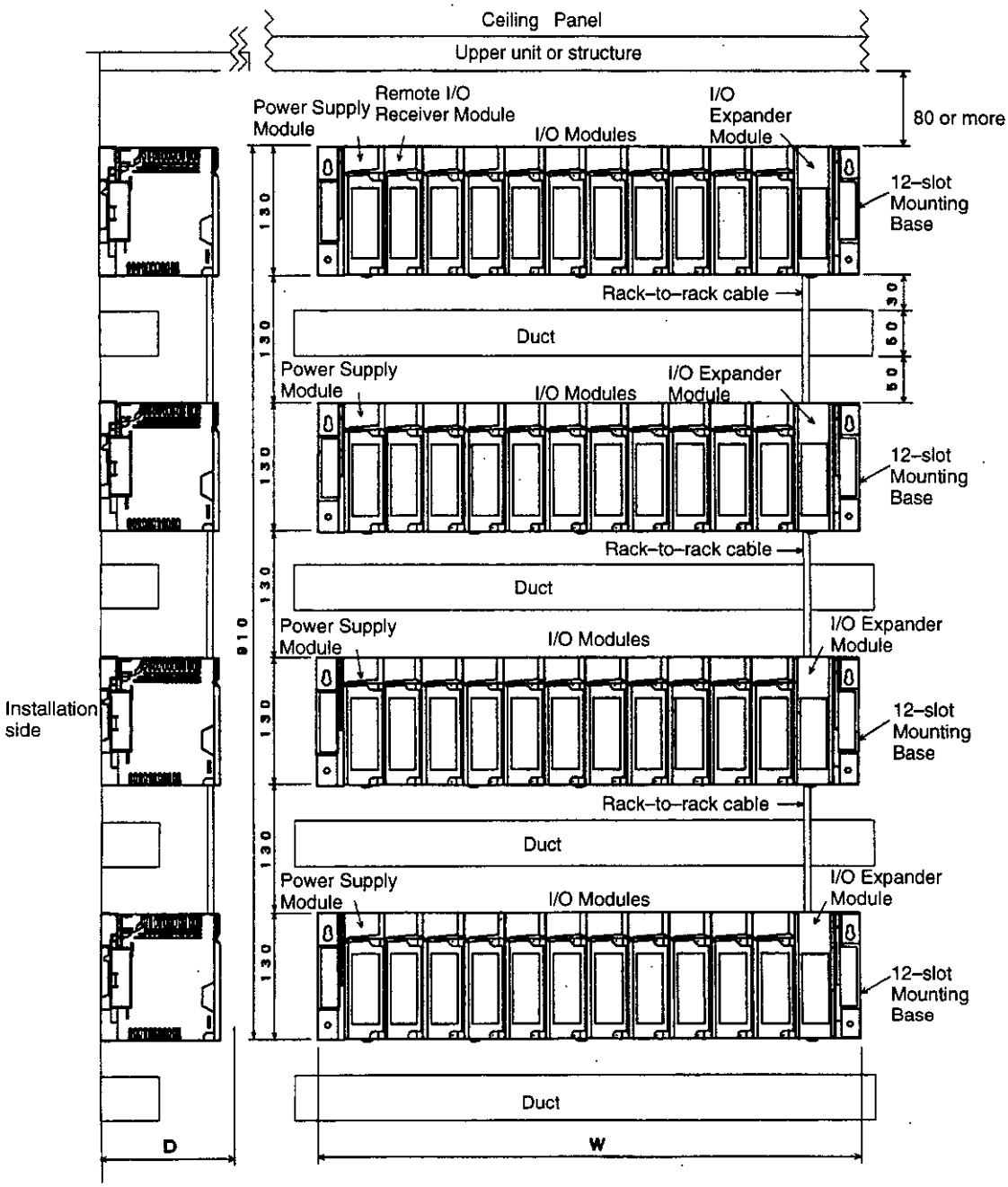
# C.1 Internal Arrangement of a Remote I/O Panel and Drilling Dimensions in mm

### 1) Local Channel Configuration




| No. of Slots | Dimension W |
|---|---|
| 6 | 300 mm |
| 8 | 380 mm |
| 10 | 460 mm |
| 12 | 540 mm |
| 16 | 710 mm |

## 2) Remote Channel Configuration




| No. of Slots | Dimension W |
|---|---|
| 6 | 300 mm |
| 8 | 380 mm |
| 10 | 460 mm |
| 12 | 540 mm |
| 16 | 710 mm |

**Note** 1) Provide a gap of 80 mm or more between the Module and the structure above it for better air flow and easier replacement.

2) The installation side of the Mounting Base has been metal-plated for improved noise suppression. Ensure that there is conductivity between the Mounting Base and the installation board on the panel.

3) For dimension D (maximum required size), check the required size in the external diagram of each Module that is to be connected to the panel.

# INDEX

## Symbols



## Numbers



## A



## B



## C

## D



## E



## F



## G

## H



## I



## J



## L

# M



# N



# O

## P



## R

## S



## T

## U



## V



## W



## Y

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