YAMAHA

YAMAHA MOTOR CO., LTD.

YAMAHA NETWORK BOARD

SRCD/SRCP
ERCX/SRCX/DRCX

Ethernet

User's Manual

ENGLISH **E**

E74-Ver. 3.07

INTRODUCTION

Thank you for purchasing the Ethernet unit for the YAMAHA single-axis/dual-axis robot controllers SRCP/SRCD/ERCX/SRCX/DRCX series.

This is an optional unit to allow connecting YAMAHA single-axis/dual-axis robot controllers SRCP/SRCD/ERCX/SRCX/DRCX series (hereafter called "controller") to the widely used Ethernet which is a de facto standard for office equipment network.

This manual describes typical examples for taking safety measures, installing wiring, making machine settings and operating the machine to ensure that the Ethernet unit is used safely and effectively. Be sure to read this manual before use. Even after reading this manual, keep it in a safe, easily accessible location so it can be referred to whenever needed. When moving this unit, always make sure this manual accompanies it, and make sure that the person who will actually use this Ethernet unit reads this manual thoroughly.

This manual only contains information involving the Ethernet unit. Please refer to the controller user's manual for information about basic controller operation and programming, etc.
The TPB screen displays in this manual are for the DRCX series dual-axis robot controller screens and so may differ somewhat from the SRCP/SRCD/ERCX/SRCX series single-axis robot controller screens. Please note that this will cause no problem with controller or Ethernet unit functions.

⚠CAUTION

- **The contents of this manual may be changed in advance without prior notice.**
- **Every effort was made to ensure the contents of this manual are complete, however please contact us if errors, ambiguities or possible trouble points are found.**
- **This manual does not constitute a warranty of industrial rights or other rights nor a concession of utility rights. Further, no responsibility whatsoever is accepted for problems arising from use of the information contents listed in this manual.**
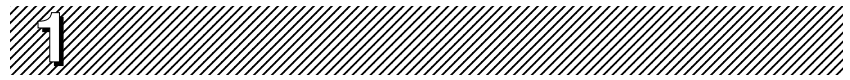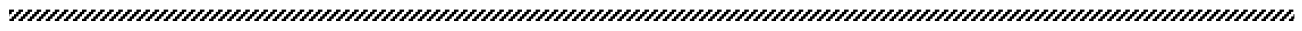
MEMO

Contents

MEMO

CHAPTER 1

Cautions To Ensure Safety

1-1   Basic safety points

Besides reading this instruction manual and the controller user's manual, also be sure to handle the equipment correctly while paying sufficient attention to safety.
Points regarding safety in this instruction manual only list items involving this product. Please refer to the controller instruction manual for information regarding safety when using this unit with the controller.
It is not possible to detail all safety items within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation.

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks. Failure to take necessary safety measures or mishandling due to not following the instruction in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Important caution points in this manual are from hereon indicated by the term:

⚠ **CAUTION**

1-2   System design safety points

⚠ **CAUTION**

Ethernet communications protocol specifications do not guarantee real-time operation. So relying only on the Ethernet in situations such as robot emergency stop can be extremely dangerous. Install safety interlock circuits using the emergency stop terminal in the parallel I/O of the controller to ensure quick and effective emergency stops.

⚠ **CAUTION**

To find the current status of the network system and controller when communication errors occur on the Ethernet system, refer beforehand to this manual and the instruction manual for equipment used by the other party. Also install safety interlock circuit so that systems including a controller will function reliably and safely when communication errors occur.

⚠ **CAUTION**

Do not bundle control lines or communication cables together or in close contact with main circuit or motor/actuator lines. As a general rule, maintain a gap of at least 100mm. Noise in signal lines may cause faulty operation.

1-3   Installation and wiring safety points

⚠CAUTION

Always cut off all power to the controller and the overall system before attempting installation or wiring jobs. This will prevent possible electrical shocks.
After the controller has been on for a while, some points in the controller may be extremely hot or remain at high voltages. After cutting off the power when installing or removing the unit, wait at least 5 minutes before starting work.

⚠CAUTION

Always uses the system specifications as listed in the controller instruction manual during installation or wiring work on the controller. Attempting to use other than these system specifications might cause electrical shocks, fire, faulty operation, product damage or deteriorated performance.

⚠CAUTION

Securely install the connectors into the unit, and when wiring the connectors, make the crimp, contact or solder connections correctly, using the tool specified by the manufacturer. Poor connections will cause faulty operation.

⚠CAUTION

When installing the unit, be careful not to directly touch any electronic components (except DIP switches) or parts conducting electrical current.

⚠CAUTION

Make sure that foreign matter such as wiring debris or dust does not penetrate into the controller.

⚠CAUTION

Always store network cable inside cable ducts or clamp them securely in place. Otherwise, excessive play or movement, or mistakenly pulling on the cable may damage the unit or cables, or poor cable contact may lead to faulty operation.

⚠CAUTION

When detaching the cable, remove by holding the connector itself and not by tugging on the cable. Otherwise, removing by pulling on the cable itself may damage the unit or cables, or poor cable contact may lead to faulty operation.

1-4   Start-up and maintenance safety points

⚠ CAUTION

Never attempt to disassemble the robot or controller. When a robot or controller component must be repaired or replaced, contact us for details on how to perform the servicing.

⚠ CAUTION

Always cut off all power to the controller and the overall system before attempting maintenance or servicing. This will prevent possible electrical shocks.
After the controller has been on for a while, some points in the controller may be extremely hot or remain at high voltages. After cutting off the power when installing or removing the unit, wait at least 5 minutes before starting work.

⚠ CAUTION

Do not touch the terminals (or pins) while power is still applied to the unit. This may cause electrical shocks or faulty operation.

1-5   Precautions when disposing of the unit

⚠ CAUTION

This product must be properly handled as industrial waste when its disposal is required.

4

1-6   Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:
(1) After 18 months (one and a half year) have elapsed from the date of shipment
(2) After one year has elapsed from the date of installation
(3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:
(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
2) Troubles caused by procedures prohibited in this manual.
3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
4) Use of any other than genuine parts and specified grease and lubricants.
5) Incorrect or inadequate maintenance and inspection.
6) Repairs by other than authorized dealers.

YAMAHA MOTOR CO., LTD. MAKES NO OTHER EXPRESS OR IMPLIED WAR-
RANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY
OR FITNESS FOR ANY PARTICULAR PURPOSE. THE WARRANTY SET FORTH
ABOVE IS EXCLUSIVE AND IS IN LIEU OF ALL EXPRESSED OR IMPLIED
WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY, FITNESS
FOR A PARTICULAR PURPOSE, OR WARRANTIES ARISING FROM A COURSE
OF DEALING OR USAGE OF TRADE.
YAMAHA MOTOR CO., LTD. SOLE LIABILITY SHALL BE FOR THE DELIVERY
OF THE EQUIPMENT AND YAMAHA MOTOR CO., LTD. SHALL NOT BE LI-
ABLE FOR ANY CONSEQUENTIAL DAMAGES (WHETHER ARISING FROM
CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY). YAMAHA
MOTOR CO., LTD. MAKES NO WARRANTY WHATSOEVER WITH REGARD TO
ACCESSORIES OR PARTS NOT SUPPLIED BY YAMAHA MOTOR CO., LTD.

CHAPTER 2
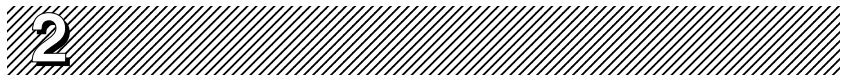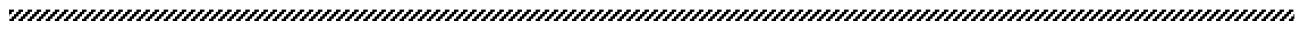
Ethernet Unit

2-1   Ethernet unit features

Ethernet is the network most commonly used by office equipment today. This Ethernet unit is an optional device for connecting to controllers over the Ethernet.
The communications protocol utilizes TCP/IP which is a standard Internet protocol so PCs and business computers with Internet access or equipment incorporating TCP/IP protocols can easily exchange data with the controller.

Main features of this Ethernet unit are as follows:

- ■ The controller can be connected to the Ethernet system using this unit. The unit fits directly inside the controller and so does not require any extra installation space.
- ■ The Ethernet unit uses 10BASE-T specifications, so UTP cables (unshielded twisted-pair cables) or STP cables (shielded twisted-pair cables) can be used. This makes cable and wiring installation really easy.
- ■ Several controllers can be connected on the same network so information can be processed in one batch from a designated PC.
- ■ Utilizing a HUB having 10BASE-2 or 10BASE-5 connectors, controllers can be accessed even from offices located away from the factory. Using the Internet allows accessing even controllers in remote locations.
- ■ The controller operates as a TELNET (socket) server, which can easily be accessed from PCs used as TELNET terminals. (Windows PCs incorporate a TELNET terminal called TELNET.EXE as standard equipment.)

  Ethernet unit commands are the same as those handled through RS-232C, so even first-time users will find it easy to use.

If information such as network settings on the PC or for detailed information on other equipment is needed, refer to that particular user's manual or product instruction manual. For information on operating the YAMAHA controller or robot programming, refer to the controller user's manual.

* Ethernet is a registered trademark of the Xerox Corporation (USA).

2-2 How data is exchanged

The following is a brief explanation to help understand how information is exchanged over the Ethernet with the other devices, such as between the controller and PC.

In the communications method called TCP/IP, an IP address is assigned to each device connected on the network. The IP address is a number unique to each device and serves to identify that device. In the communications process, the IP address of the controller must first be specified to make connection. After making the connection, the actual data is exchanged between the devices and when finished the connection is terminated.

The controllers equipped with the Ethernet unit operate as a server and constantly await a connection request from the client (other party's device such as a PC). Specific actions are then carried out when a request arrives from a client. So the controller cannot connect to another server on its own.

Device such as PC is the client, connects to server and issues commands to perform specified actions.
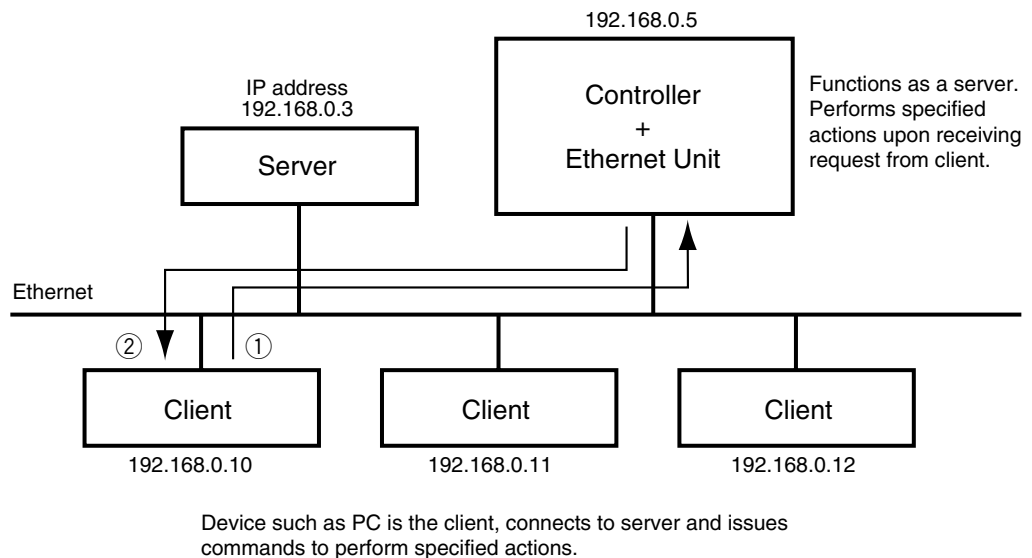
① Specify the IP address of controller to exchange data with and make the connection. (Above example shows the client 192.168.0.10 has specified the controller 192.168.0.5 and made a connection.)

② After making the connection, the controller runs a specific series of actions according to instructions from the client.

Ⓜ Ⓔ Ⓜ Ⓞ

During multitasking by the client, several robots can be simultaneously connected to one client unit.
Only one client can make a simultaneous connection to one controller unit.
Settings such as of the IP address and subnet are made from the TPB.

2-3   How to connect to Ethernet

The Ethernet unit employs 10BASE-T specifications, so the controller connects by a cable to the HUB.
Use UTP cables (unshielded twisted-pair cables) or STP cables (shielded twisted-pair cables) for category 3 or higher, with straight-through wiring specifications.
To connect to the Ethernet, insert the cable with modular jack into the modular connector on the controller until you hear a click. Insert the other end of the cable into the modular connector on the HUB.
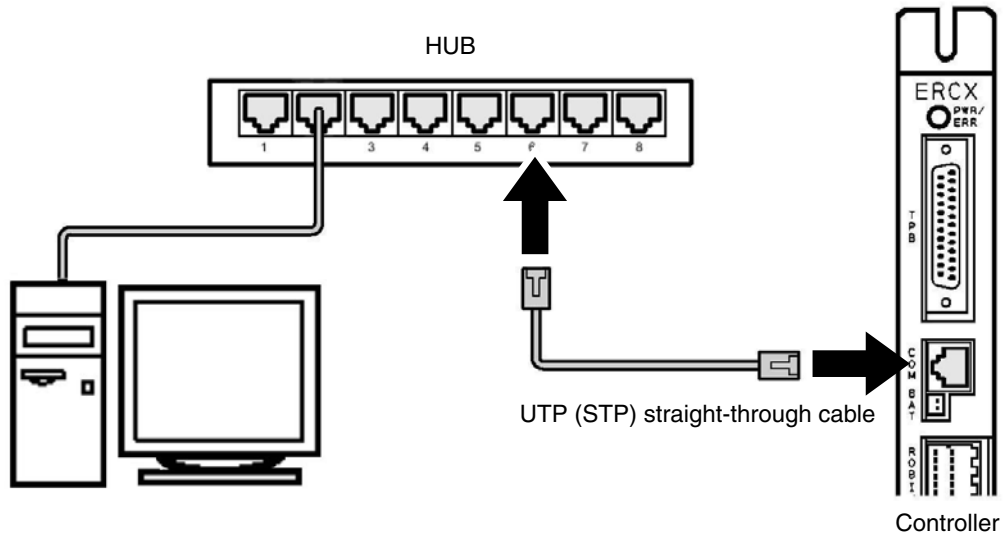

Fig. 2-1 Connecting to Ethernet

⚠CAUTION

We use an FL HUB (made by Phoenix Contact) to check operation. Using this HUB is recommended if constructing your own system.
HUBs generally available on the market are not designed for use in locations such as factories, some HUBs are vulnerable to external noise. Please acknowledge beforehand that operation cannot be guaranteed if other types of HUBs are used. Always be sure to use a HUB with high noise resistance when connecting to the controller.

⚠CAUTION

The maximum cable length between the HUB and controller is 100 meters.
Before connecting the HUB and controller always refer to the instruction manuals for the device used by the other party and peripheral equipment such as the HUB. If the HUB communication mode can be set manually, then set to 10Mbps/Half Duplex.

MEMO
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━

Using a straight-through cable is recommended when connecting to the other party's device by way of the HUB. You can connect directly to the other party's device without the HUB by using a crossover cable but communication may sometimes not be possible due to the type of LAN adapter used by other party's device.

2-4   Making system settings for the controller (server)

A minimum of IP address, subnet mask and gateway settings must be made so that the controller will be correctly identified and acknowledged on Ethernet.
These settings are made from the TPB and enabled after the controller is restarted.

2-4-1   Validating the Ethernet unit

Before the Ethernet unit can be used, it must first be set as follows, to allow it to be identified by the controller.

1) Press **F3** (SYS) on the initial menu screen.

```
[MENU]

select menu


1EDIT2OPRT3SYS 4MON
```

2) Press **F4** (next) to switch the function display and then press **F2** (OPT).

```
[SYS]

select menu


1SAFE2OPT 3UTL 4next
```

3) Press **F1** (DEV).

```
[SYS-OPT]

select menu


1DEV 2MAC 3VER 4next
```

4) The current Ethernet unit identity status appears on the display.
Using the number keypad, enter "1" to make the Ethernet unit identifiable from the controller or enter "0" to prevent it being identified from the controller, and then press the ➡ key.

```
[SYS-OPT-DEV]

Ethernet= 0

0:invalid 1:valid
```

5) The screen returns to the previous display in step 4.

```
[SYS-OPT-DEV]

Ethernet= 1

0:invalid 1:valid
```

2-4-2   Setting the IP address

This following explains how to set the IP address.
The IP address is a number unique to each device and identifies that device from among many other devices connected on the network. The IP address of one device must not be the same number as another device so use caution when setting the IP address.

1) Press [F3] (SYS) on the initial menu screen.

```
[MENU]

select menu



1EDIT2OPRT3SYS 4MON
```

2) Press [F4] (next) to switch the function display and then press [F2] (OPT).

```
[SYS]

select menu



1SAFE2OPT 3UTL 4next
```

3) Press [F4] (next) again and then press [F1] (IP).

```
[SYS-OPT]

select menu



1IP  2MASK3GWAY4next
```

4) The currently set IP address is now displayed. To change it, enter the new IP address with the number pad keys. (To move the cursor to right and left between periods, use the [⇞] or [⇟] keys.)
When completely finished making the new IP address entry, press the ➡ key.

```
[SYS-OPT-IP]

IP address

= 192.168.  0.  2
```

5) The screen returns to the previous display in step 4.

```
[SYS-OPT-IP]

IP address

= 133.210.201.100
```

⚠**CAUTION**

When connecting the controller on an already existing network, always check with the network supervisor before making IP address, subnet mask and gateway settings.

🅼🅴🅼🅾

The IP address is separated into network address and host address sections. The network address section is extracted from the IP address by AND processing with the subnet mask. The remaining portion is the host address section. Devices belonging to the same network must all be set to have the same network address. The host address, however, should be different for every device and set so that no two devices have the same number. The first and the last host address numbers are reserved for the system so be sure not to set these as the IP address.

When the IP address for example is 192.168.0.10 and the subnet mask is 255.255.255.0, the network address section is found to be 192.168.0 and the host address section to be 10 by means of AND processing with the subnet mask. In this case, the network address section of all other devices belonging to that network must all be 192.168.0. The host address section of those other devices on the other hand, must be set to a number other than 10. The number 0 and 255 are reserved, so do not use them for setting the host address.

So when a device having an IP address of 192.168.0.10 and a subnet mask of 255.255.255.0 belongs to a particular network and you want to add another device to that network, then you would assign IP addresses from among 192.168.0.1 to 192.168.0.9 and 192.168.0.11 to 192.168.0.254.

🅼🅴🅼🅾

The Ethernet unit is not usable with IP address auto-acquisition functions such as DHCP and BOOTP. You must set the IP address manually.

2-4-3 Setting the subnet mask

This following explains how to set the subnet mask.
The subnet mask is a numerical address used to subdivide the network into smaller parts.

1) Press ⌗F3⌗ (SYS) on the initial menu screen.

```
[MENU]

select menu



1EDIT2OPRT3SYS 4MON
```

2) Press ⌗F4⌗ (next) to switch the function display and then press ⌗F2⌗ (OPT).

```
[SYS]

select menu



1SAFE2OPT 3UTL 4next
```

3) Press ⌗F4⌗ (next) again and then press ⌗F2⌗(MASK).

```
[SYS-OPT]

select menu



1IP  2MASK3GWAY4next
```

4) The currently set subnet mask is now displayed. To change it, enter the new subnet mask with the number pad keys. (To move the cursor to right and left between periods, use the ⌗⌗ or ⌗⌗ keys.)
    When completely finished making the subnet mask entries, press the ➡ key.

```
[SYS-OPT-MASK]

subnet mask

= 255.255.255.  0

```

5) The screen returns to the previous display in step 4.

```
[SYS-OPT-MASK]

subnet mask

= 255.255.255.240

```

⚠CAUTION

When connecting the controller on an already existing network, always check with the network supervisor before making IP address, subnet mask and gateway settings.

2-4-4　Setting the gateway

The following explains how to set the gateway. Basically this is specifying the router IP address. The router is a device relaying information from a certain network to a different network when two or more networks are present.

1) Press ☐F3 (SYS) on the initial menu screen.

```
[MENU]

select menu


1EDIT2OPRT3SYS 4MON
```

2) Press ☐F4 (next) to switch the function display and then press ☐F2 (OPT).

```
[SYS]

select menu


1SAFE2OPT 3UTL 4next
```

3) Press ☐F4 (next) again and then press ☐F3 (GWAY).

```
[SYS-OPT]

select menu


1IP  2MASK3GWAY4next
```

4) The currently set gateway is now displayed. To change it, enter the new gateway with the number pad keys. (To move the cursor to right and left between periods, use the ☐ or ☐ keys.)
When completely finished making the gateway entry, press the ➡ key.

```
[SYS-OPT-GWAY]

gateway

= 192.168.  0.  1
```

5) The screen returns to the previous display in step 4.

```
[SYS-OPT-GWAY]

gateway

= 133.210.201.  1
```

15

⚠CAUTION

Any appropriate gateway address can be used as long as the network is not connected to other networks. (However, use an IP address that has not yet been assigned to other devices.)

When connecting the controller on an already existing network, always check with the network supervisor before making IP address, subnet mask and gateway settings.

The Ethernet unit uses a private address as the IP address default setting. This default value cannot be used as is on the Internet. So when connecting to the Internet, always be sure to change the IP address of the controller to a global address.

2-5   Making the PC settings (client)

The settings for the device (PC) are also essential for correctly exchanging information with the controller. A basic method for setting a computer using Windows 98 is described below. If using a device having a different OS (operating system) or TCP/IP protocols, refer to the user's manual for that device for information on how to make the settings.

* Windows is a registered trademark of the Microsoft Corporation (USA).

2-5-1   Setting the TCP/IP protocol

A brief description of setting the TCP/IP protocol for Windows 98 is given below. See the First Step Guide in Windows 98 for more detailed information. Some changes in the settings may be needed to match the user's network.

1) Click the "Start" button, point to "Settings", and then select "Control Panel".
2) Double-click the "Network" icon within the "Control Panel".
3) Under the "Configuration" tab screen, look inside "The following network components are installed" list, and check that "Client for Microsoft Networks" and "TCP/IP" are present. (When there is more than one network adapter, the "TCP/IP → Currently used network adapter" is displayed.) If missing from this list, then add "Client for Microsoft Networks" and "TCP/IP" by using step 7 below.

4) Double-click "TCP/IP" to display the Properties.

5) On the "IP Address" tab screen, set the IP address and the subnet mask. Enter the PC subnet mask and IP address here.

17
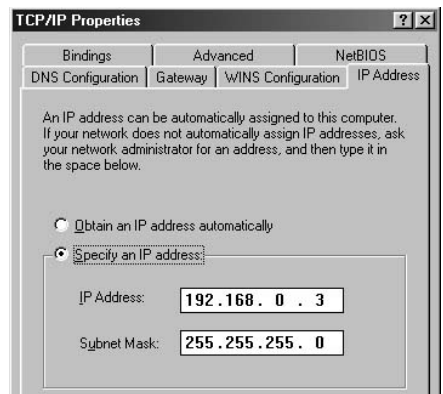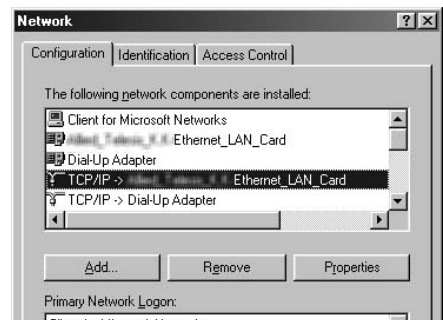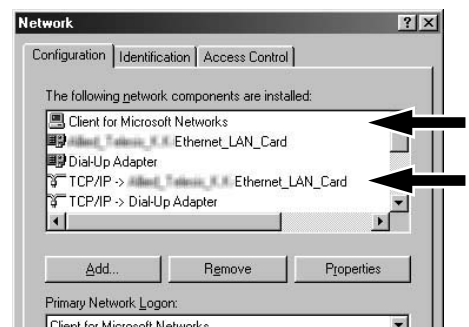
6) Set the gateway under the "Gateway" tab screen. Enter the IP address of the router serving as the gateway and then click the "Add" button. When finished making the settings, click the "OK" button a few times and a message appears asking if it is okay to restart the PC. Click the "OK" button to restart. The settings you made are enabled once the PC restarts.
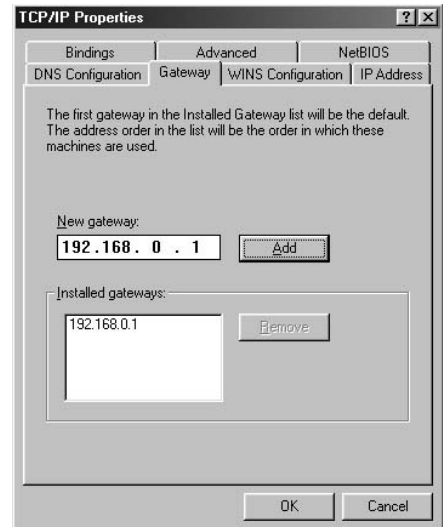
7) If "Client for Microsoft Networks" and "TCP/IP" were missing in step 3 above, click the "Add" button to add them to "The following network components are installed" list.
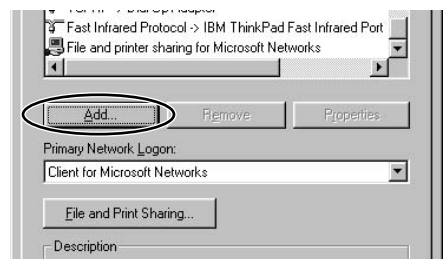
8) Double-click "Client" to add "Client for Microsoft Networks".
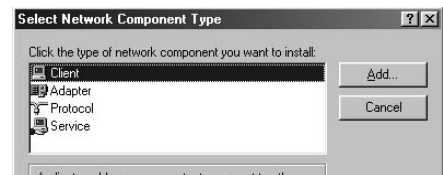
9) In the "Manufacturers" box, select "Microsoft" and in the "Network Clients" box, select "Client for Microsoft Networks" and click the "OK" button.
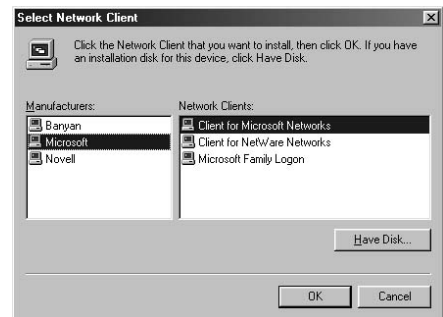
10) Double-click "Protocol" to add "TCP/IP".
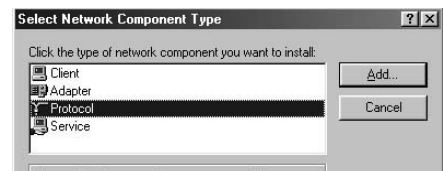
11) In the "Manufacturers" box, select "Microsoft" and in the "Network Protocols" box, select "TCP/IP" and click the "OK" button.

18
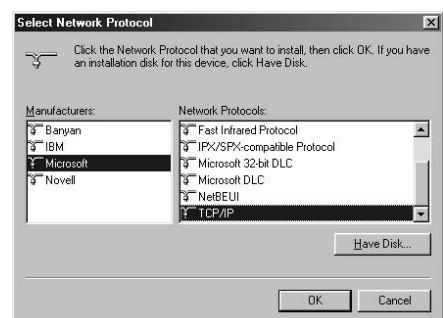
2-6   Checking the connection with "ping"

Once you are finished with the network settings, make a check with "ping" to confirm that you can send and receive data normally. Here, "ping" is a network diagnostic tool incorporated into the OS as a standard feature. A simple description of how to use "ping" incorporated into Windows 98 is described below so refer to it when needed. If using "ping" while incorporated into another OS or TCP/IP protocol, then consult the instruction manual for that particular device.

1)   Click the "Start" button, point to "Programs," and then select "MS-DOS Prompt" to open the MS-DOS window.
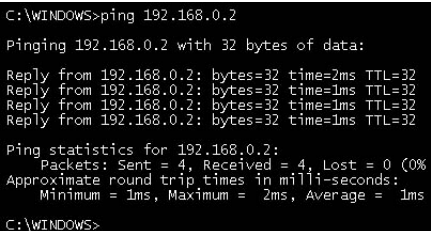
2)   Run the ping command.
      You will see a cursor at C:\WINDOWS> on the screen. Enter,
          ping xxx.xxx.xxx.xxx
      and press the Enter key.
      In the xxx.xxx.xxx.xxx portion, enter the controller IP address.
      The address for the controller in the figure on the right (middle) is 192.168.0.2. This example shows normal communication status.
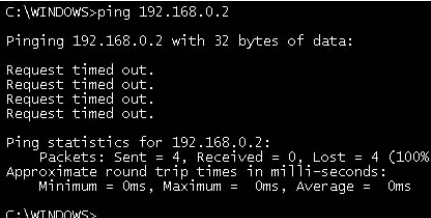
3)   The right (bottom) figure shows normal communication has not been established. If this happens, recheck the network device and settings, and eliminate the trouble.

19

2-7 Using TELNET

Communicating by TELNET (remote operation) allows loading and editing point or program data and operating the robot just the same if connected through an RS-232C port.
Commands are easy to understand because they are identical to RS-232C communication commands.

2-7-1 Difference between TELNET and RS-232C communications

TELNET and RS-232C both perform the same processing. However, they use different communication formats. This means that one format might not match your own particular system needs or objectives, so you should get a good understanding of their different features before incorporating them into your system.

TELNET
 • Easily connects to different types of systems. Can handle one versus multiple device communications.
 • Allows remote communications since it connects between separate systems.
 • Basically not usable for real-time processing since real-time operation is not guaranteed.

RS-232C
 • Basically handles one party to one party (or device) communications.
 • Designed for communications between devices in close proximity.
 • Operates largely to real-time specifications.

Ethernet communications protocol specifications do not guarantee real-time operation. So relying only on the Ethernet in situations such as robot emergency stop can be extremely dangerous. Install safety interlock circuits using the emergency stop terminal in the parallel I/O of the controller to ensure quick and effective emergency stops.

2-8 TELNET dedicated parameters

To ensure reliable TELNET communications that match customer system settings, the Ethernet unit can be used with TELNET dedicated parameters explained in this section.

2-8-1 TELNET dedicated parameters: Setup method 1

To set up TELNET dedicated parameters, use the procedure below. (User name and password settings are not included.)

1) Press ⌑F3⌑ (SYS) on the initial menu screen.

```
[MENU]
select menu


1EDIT2OPRT3SYS 4MON
```

2) Press ⌑F4⌑ (next) to switch the function display and then press ⌑F2⌑ (OPT).

```
[SYS]
select menu


1SAFE2OPT 3UTL 4next
```

3) Press ⌑F4⌑ (next) a few times until the parameter you want to set appears, and then press that function key.

```
[SYS-OPT]
select menu


1PORT2ECHO3TOUT4next
```

4) The currently set data now appears. To change this setting, enter the figure you want with the number pad keys. When finished, press the ➾ key.

```
[SYS-OPT-PORT]
port No
= 23
range 0→65535
```

5) The screen returns to the previous display in step 4).

```
[SYS-OPT-PORT]
port No
= 3000
range 0→65535
```

2-8-2   TELNET dedicated parameters: Setup method 2

To set the user name and password for login, use the procedure below.

1)   Perform step 1 through step 3 in "2-8-1 TELNET dedicated parameters: Setup method 1".

2)   Select **F1** (LIN) to display the submenu. Press **F1** (CHEK) to set whether or not to make the LOGIN check. Press **F2** (USER) to set the user name. Press **F3** (PASS) to set the password.

```
[SYS-OPT-LIN]

select menu


1CHEK2USER3PASS
```

3)   If you selected **F2** (USER) or **F3** (PASS) in step 2, then a screen appears showing the currently set user name and password on the 3rd line.

```
[SYS-OPT-LIN-USER]

login user

= USER

ABCDEFGHIJKLMNOPQRST
```

4)   To change the current user name and password, select and enter one character at a time from the letters in the 4th line.
To enter those characters, use the ⌨ or ⌨ keys to move the cursor to the character you want, and then press the ➡ key.
If you enter the wrong character, you can erase it by pressing the **BS** key.
When finished entering the characters, press the **ESC** key.

```
[SYS-OPT-LIN-USER]

login user

= DRCX1

xyz0123456789!"#$%&'
```

*You can enter from 1 though 8 characters.

5)   A check message next appears, so press **F1** (yes) to enter the new setting.
To abort any changes you made, press the **F2** (no) key.

```
[SYS-OPT-LIN-USER]

data set OK?


1yes 2no
```

6)   The screen returns to the previous display in step 3.

```
[SYS-OPT-LIN-USER]

login user

= DRCX1

ABCDEFGHIJKLMNOPQRST
```

2-8-3   Description of TELNET dedicated parameters

■ PORT (TCP port No.)
Use this parameter to set the TCP port No. of the controller.
The port No. set here is specified along the IP address when the client connects to the controller.

Input range   : 0 to 65535
Default value   : 23 (TELNET port)

* If any value other than 23 (TELNET port) is specified then negotiation with the TELNET protocol is impossible. (Switches to ordinary socket communication.)
* Using a port No. other than the well-known ports (0 to 1023) is advised when changing the port.
* After changing the setting, restart the controller to enable the settings you made.

■ ECHO (echoback)
Use this parameter to select whether or not to send back (echoback) to the client, the same characters that the client sent to the controller.

Input range   : 0 or 1
Meaning   : 0 :No echoback
                       1 : Echoback
Default value   : 1

■ TOUT (communication timeout)
Using this parameter allows cutting the TELNET connection if data is not sent or received from the client or controller within a certain amount of time.
Set the number of minutes after which the TELNET communication will be cut.
Setting "0" (zero) here voids the timeout check and there is no timeout to cut the TELNET connection.

Input range   : 0 to 255 (minutes)
Default value   : 10

■ IDLE (no-reply timeout)
If no-reply at all has come back from the client, a packet (Keep Alive packet) can be sent at fixed intervals to verify if the other party is present. This parameter sets the time intervals between transmissions in seconds.
If the no-reply state continues for (IDLEx3) a certain period (default is 15 seconds), then an error has occurred and TELNET communication is cut.
Setting "0" (zero) here prevents sending a Keep Alive packet and the connection with the client is not cut even if the no-reply state continues.

Input range   : 0 to 255 (seconds)
Default value   : 5

* The Keep-Alive packet is issued automatically by the controller. This packet has no effect on data sent and received by the user.

■ LIN-CHEK (Login check)

Use this parameter to set whether or not to check the connection while the client is connected to the controller.

If making a login check is selected here, then always make the user name and the password check when connected to the controller. In this case, the client cannot connect to the controller if data stored within the controller does not match data sent from the client. However, if the login check is not selected here, then no check of the connection is made and communication is possible right away.

Input range   : 0 or 1
Meaning   : 0: No login check
                       1: Login check
Default value   : 1

■ LIN-USER (Login user name)

Use this parameter to set the user name when making the login check.

When the login check is used, the user name set here must entered so the client can connect to the controller.

Characters that can be input are alphabet letters A to Z, a to z, numbers 0 to 9, and symbols ! " # $ % & ' (*) + - . : = ? @ [\] _ ` {|} (All regular pitch letters.)

Input range   : 1 to 8 characters
Default value   : USER

■ LIN-PASS (Login password)

Use this parameter to set the password when making the login check.

When the login check is used, the password set here must entered so the client can connect to the controller.

Characters that can be input are alphabet letters A to Z, a to z, numbers 0 to 9, and symbols ! " # $ % & ' (*) + - . : = ? @ [\] _ ` {|} (All regular pitch letters.)

Input range   : 1 to 8 characters
Default value   : PASSWORD

■ LOUT (Logout processing)

Robot operation can stop automatically when the client terminates the connection with the controller.

Input range   : 0 or 1
Meaning   : 0: Continue robot operation
                       1: Stop robot operation
Default value   : 0

 * If the TELNET connection is cutoff due to an error, then robot operation stops automatically regardless of the above settings.

2-9 TELENET communication commands

2-9-1 Communication command specifications

TELNET communication commands are broadly classified into two types.
One type is commands that instruct the Ethernet unit to process the command task. The other type is robot control commands to access the controller and perform sophisticated processing. These robot control commands are further subdivided into the following four categories.

• Ethernet unit control commands
• Robot control commands 　　　1. Robot language 　　　2. Data handling 　　　3. Utilities 　　　4. Special codes

Communication command format for robot control commands except special codes is as follows.

@<operation code> 　　[Operand 1>][,<operand2>][,<operand 3>•••]c/f l/f

■ Basically, the Ethernet unit control commands and Robot control commands begin with the start code '@' (=40H) and run when a statement with the last line ending with the code c/r (=0DH) 1/f (=0AH) is sent to the controller. The robot control command always begins with a start code but start codes are sometimes not required in some Ethernet unit control commands. One exception to this is the special codes in robot control commands. These do not require a start code and c/r l/f.

■ A communication command is basically composed of an operation code and an operand. Depending on the command statement, either no operand or multiple operands are used.
Items in [ ] (brackets) can be omitted.

■ The character codes used are the JIS8 unit system codes (ASCII codes with katakana characters added). Input characters can be upper case or lower case.

■ One or more space must be inserted between the operation code and the operand.

■ Items in < > marks should be specified by the user. Check the description of each communication command and enter the appropriate data.

■ When two or more operands are entered, insert a comma (,) between them. (There are exceptions.)

2-9-2　Ethernet unit control commands

These commands instruct the Ethernet unit to process the command task. Unlike the robot control commands described later on, the Ethernet unit control commands may not require a start code '@' (=40H) at the beginning of the command.

(1) LOGOUT
BYE

This command terminates TELNET communication. The LOGOUT and the BYE commands have the same results. Always issue one of these commands when terminating communication.

Cutting off communications without using these commands causes an error to be issued and halts robot operation.

Transmission example　　: LOGOUT c/r l/f ....Terminates　TELNET communication.

(2) VER

This command shows the Ethernet unit version.

Transmission example　　: VER c/r l/f
Response example　　　　: Version_1.01 c/r l/f

(3) @ETHER ECHO <echo status>

Selects the Ethernet status.

Echo status　　　　　　: 1 signifies using echoback. 0 signifies no echoback.
Transmission example　　: @ETHER_ECHO_0 c/r l/f .. Sets to "no echoback".
Response example　　　　: OK c/r l/f

(4) @?ETHER ECHO

Reads out the echoback status.

Transmission example　　: @?ETHER_ECHO_0 c/r l/f
Response example　　　　: 0 c/r l/f .... Echobackstatusis "no
　　　　　　　　　　　　　OK c/r l/f   echoback".

///

2-9-3　Robot control commands

Robot control commands access the controller and perform sophisticated processing. Command specifications are identical to RS-232C communication commands. Refer to the "Communication Command Description" in the controller instruction manual for further information.

2-10 Making a connection with TELNET.EXE

A typical Windows PC has a TELNET terminal called TELNET.EXE as standard equipment. The following briefly explains how to make a connection using TELNET.EXE. Preconditions are a controller IP address of 192.168.0.2, a port No. of 23, and all other dedicated TELNET parameters at their default values.

1) Click the "Start" button and select "Run" to open the file name input window. Enter "telnet" here and then press the "OK" button.

2) The telnet.exe now starts up, so select "Remote System" from the Connect" menu.

3) A menu screen for choosing the connection destination now appears. Enter the controller IP address in the Host Name box and enter the controller port No. in the Port box. When finished, click the "Connect" button.
   * In this example, 192.168.0.2 is entered in the Host Name box. There is no need to enter anything in the Port box (Here, "telnet" signifies Port No. 23.)

4) The PC now connects to the controller and the login check is made. Enter the user name here.
   * In the example shown here, type in "USER" and press the Enter key. If set to "no login check", no password message appears following this message.

5) Next, enter the password. The characters you enter appear as asterisks (*) on the screen.
   * In the example shown here, type in "PASSWORD" and press the Enter key.
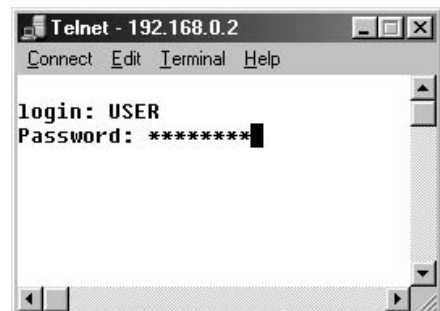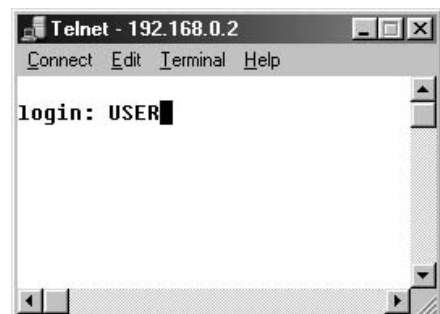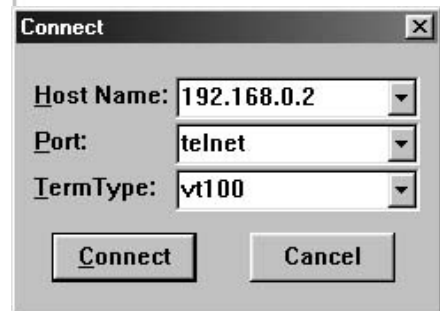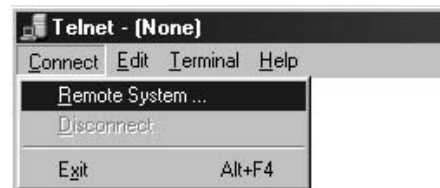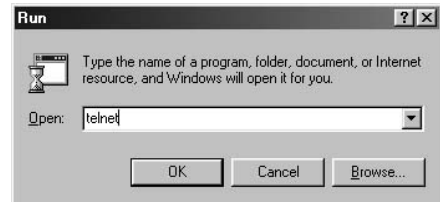
6) An OK message appears on the screen when the login check ends normally.
From now on, commands and messages can be exchanged with the robot.

```
Telnet - 192.168.0.2                _ □ ✕
Connect  Edit  Terminal  Help

login: USER
Password: ********
OK
█
```

7) When the task or job is complete, enter the LOGOUT or BYE command to cancel the connection with the controller and press the Enter key.

```
Telnet - 192.168.0.2                _ □ ✕
Connect  Edit  Terminal  Help
@?ROBOT
20/20
OK
@?POS 0
100.00,0.00
OK
@?P100,101
P100=0.00,0.00
P101=50.00,50.00
OK
LOGOUT█
```
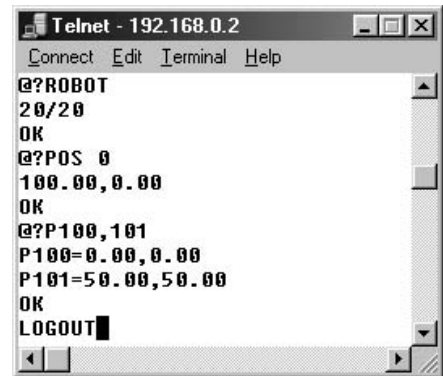
8) A message appears announcing the connection has been terminated.
Click the "OK" button and the screen returns to that in step 2.

```
Telnet                              ✕

Connection to host lost.

        OK
```

MEMO

▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬ ▬

If you want to simultaneously control several controllers, start up TELNET.EXE as many times as needed.

2-11   Other operating tasks

2-11-1   Displaying the MAC address

Use the following procedure to display the MAC address of the Ethernet unit.

1) Press [F3] (SYS) on the initial menu screen.

```
[MENU]

select menu


1EDIT2OPRT3SYS 4MON
```

2) Press [F4] (next) to switch the function display and then press [F2] (OPT).

```
[SYS]

select menu


1SAFE2OPT 3UTL 4next
```

3) Press [F2] (MAC).

```
[SYS-OPT]

select menu


1DEV 2MAC 3VER 4next
```

4) The MAC address appears on the screen. Press (ESC) to return to the previous screen.

```
[SYS-OPT-MAC]

MAC address

= 00-04-C6-00-01-1F
```

2-11-2   Displaying the version of the Ethernet unit

1)   Press F3 (SYS) on the initial screen.

```
[MENU]

select menu


1EDIT2OPRT3SYS 4MON
```

2)   Press F4 (next) to switch the function
display and then press F2 (OPT).

```
[SYS]

select menu


1SAFE2OPT 3UTL 4next
```

3)   Press F3 (VER).

```
[SYS-OPT]

select menu


1DEV 2MAC 3VER 4next
```

4)   The version of the Ethernet unit now ap-
pears on the screen.
Press ESC to return to the previous
screen.

```
[SYS-OPT-VER]

unit version

= 1.01
```

2-12 Message List

2-12-1 Error messages

The following error messages involving the Ethernet system have been added.

ERROR MESSAGE No. 38	Message	net link error
	Cause	• TELNET connection terminated due to error. • A TELNET dedicated parameter is set so as to stop operation during logout processing.
	Solution	• To end the TELNET communication use a LOGOUT or BYE command. • Make setting with a TELNET dedicated parameter so as to continue operation during logout processing.

2-12-2 Telnet message list

	Message	login:
	Meaning	Request for entry of login user name.
	Response	Enter user name.
	Message	Password:
	Meaning	Request for entry of login password.
	Response	Enter login password.
	Message	login incorrect.
	Meaning	Error was found during login check.
	Response	Enter the correct user name and password.
	Message	TELNET is disconnected!!
	Meaning	Login check was made 3 times but errors were found so connection was cutoff.
	Response	Enter the correct user name and password.
	Message	telnet is already used!!
	Meaning	A TELNET connection has already been made.
	Response	Limit the number of simultaneous logins to 1.
	Message	timeout.
	Meaning	Continuous communication time exceeded the time set on the TELNET parameter timeout (time).
	Response	Set a larger timeout (time) on the TELNET parameter so communication time does not exceed the timeout.

2-13   Troubleshooting

When problems occur, then troubleshoot as needed by using the following information as a guide. Be sure to always also refer to sections on "Troubleshooting" in the controller user's manual as well as the instruction manual for the other party's equipment such as PCs or HUB peripheral devices. If taking the troubleshooting steps listed there does not eliminate the problem, then quickly contact your local YAMAHA sales dealer.

No.	Symptom	Probable causes	Checkpoints	Action
1	Cannot make TELNET connection. (Using "ping" only results in a timeout.)		• Disconnect the controller from the network and connect the PC instead. (Use a PC capable of a good connection with the network. Make the same IP address, subnet mask and gateway settings as used on the controller.) Now try running "ping" from the client while setup as above, and check for a response.	• If timeouts still occur when connected this way (using PC instead of controller), then the problem is on the client side or in the HUB peripheral device. (Check probable causes 1 through 6.) • If a replay comes back normally, then the problem is in the controller, so check probable causes 7 through 8.
		1) Ethernet cable defects, poor connection, or wrong specs.	• Check if securely attached to the modular connector. • Check for a disconnection (or break) in the cable or a miswire. • Check if the straight-through cable or crossover cable are being used for the wrong connection. • Try replacing the cables.	• Insert in firmly until a click noise is heard. • Correct the wiring if a miswire is found. Replace the cable if a break in the wiring is found. • Use a straight-through cable between the HUB and controller. Use a crossover cable if connecting directly to the other party's device. • If operation returns to normal, then the problem is in the cables. Replace the cable.
		2) Defective HUB or wrong settings	• Try changing to another port. • Check if the communication mode is manually set to other than 10Mbps/Half Duplex. • Try another HUB	• If operation returns to normal then the port is defective, so do not use that port. • When setting the HUB communication mode manually, then set it to 10Mbps/Half Duplex. • If operation returns to normal then the HUB is defective, so replace the HUB.
		3) Router is defective or wrong settings	• Check the router settings. • Try substituting with another router.	• Redo the router settings. • If operation returns to normal then the router is defective so replace the router.
		4) Network adapter used by the client is defective or the settings on the client side are wrong.	• Check the network settings on the client side. • Try substituting with another network adapter on the client side.	• Redo the network settings on the client side. • If operation returns to normal then the network adapter is defective so replace the adapter.
		5) Network traffic (communication data load) is too heavy.	• Check if the traffic load is appropriate.	• Change the network structure to get a smaller traffic load.
		6) Ethernet cable is too close to a noise source such as motor cables.	• Check how and where the Ethernet cables are installed.	• Separate the Ethernet cable from potential noise sources.

No.	Symptom	Probable causes	Checkpoints	Action
		7) Wrong IP address, subnet mask or gateway settings on controller.	• Check the settings after referring to "2-4-2 Setting the IP address" p. 10, "2-4-3 Setting the subnet mask" p. 12, and "2-4-4 Setting the gateway" p. 13.	• Redo the IP address, subnet mask and gateway settings correctly. Then turn on the controller power again.
		8) Ethernet unit is defective	• Try substituting the Ethernet unit.	• If operation returns to normal, then the Ethernet unit is probably defective, so replace the Ethernet unit.
2	Cannot make TELNET connection or cannot terminate the TELNET connection right away. (ping reply is normal).	1) Wrong IP address used during Telnet connection	• Check that the IP address of the controller you are attempting to connect with is correct.	• Enter the correct IP address.
		2) Wrong Port No. used during TELNET connection.	• Check that the port No. of the controller you are attempting to connect with is correct.	• Enter the correct IP address.
		3) The controller is already logged in with another TELNET terminal.	• When connected, the message "telnet is already used!" appears.	• Await termination of current TELNET connection.
		4) Alarm issued to controller.	• Alarm message appears when connected. • Connect the TPB and check for an alarm. • Status led is lit up in red.	• Troubleshoot according to the type of alarm.
		5) IP address is the same as another network device.	• Check if the IP address and MAC address have a correct match by using the "arp" command incorporated in the OS. • Check all devices on the network to find if the same IP address is being used.	• If the IP address and MAC address do not match each other, then the IP address is wrong, so try redoing the settings. • If found to be the same as another device, change the setting.
		6) Network traffic (communication data load) is too heavy.	• Check if the traffic load is appropriate.	• Change the network structure to get a smaller traffic load.
3	An OK does not come back after login, or no replay comes back even after issuing a command. (Some unit control commands are useable such as LOGOUT or BYE.)	1) Ethernet unit is not enabled and not identified (recognized) by controller.	• See "2-4-1 Enabling the Ethernet Unit" (p. 9) and check if the Ethernet Unit is enabled.	• Enable the Ethernet unit and turn on the power to the controller again.
		2) I/O custom command input signal is set ON.	• Check the I/O signal (Check on the sequencer monitor, etc.) • Communication error is issued when TPB is connected to controller.	• Always use a pulse input for the custom command input.
		3) Commands such as origin return, axis movement commands, or data write commands are being run from I/O or RS/232C.	• Reply comes back after axis movement or writing data.	• When issuing TELNET commands, do not run commands from the I/O or RS-232C.

No.	Symptom	Probable causes	Checkpoints	Action
4	Program stops by itself during automatic operation.	1) TELNET communication cuts off by itself without a LOGOUT or BYE command being issued.		• Always use a LOGOUT or BYE command to terminate a TELNET communication.
		2) TELNET parameter was set to stop operation during logout.	• Check the TELNET parameter to find if it was set to stop operation during logout.	• Reset the parameter so operation continues during logout.
		3) Communication status continues for a fixed period and then cuts off automatically at timeout.	• Check the TELNET parameter to find if communication status is longer than the time set for timeout.	• Set so communication time does not exceed the timeout limit. Otherwise increase the communication timeout period or disable the timeout function.
		4) No-response status continues for a fixed period versus the keep-alive packet and then cuts off automatically at timeout.	• Check if a cable is detached or power supply for the HUB or other equipment is off. • Check if operating problems are occurring in devices such as the HUB due to noise, etc. • Too short of a period was set for the no-response timeout period.	• Check the network and repair/restore any problem locations. • Replace a device having operating errors with another device. • Set the no-response timeout period to match the network structure and traffic conditions. Or disable the timeout function.
		5) Ethernet unit is defective.	• Try substituting with another Ethernet unit.	• If operation returns to normal, then the Ethernet unit is defective so replace it.

34

2-14   Specifications

2-14-1   Ethernet unit specifications

Spec item ╲ Model	Ethernet unit
Applicable controllers	SRCP/SRCD/ERCX/SRCX/DRCX series controllers
Network specs	Conforms to Ethernet (IEEE802.3)
Baud rate	10Mbps (10BASE-T)
Connector	RJ-45 connector (octal modular connector) 1 port
Cable	UTP (unshielded twisted-pair) cable for category 3 or higher, or STP (shielded twisted-pair) cable
Maximum cable length	100 meters (between HUB and controller)
Communication mode	Half Duplex
Network protocol	Application layer : TELNET Transport layer : TCP Network layer : IP, ICMP, ARP Data link layer : CSMA/CD Physical layer : 10BASE-T
Number of simultaneous logins	1
IP address setting	From TPB
Monitor LED [*1]	Run, Collision, Link, Transmit, Receive

[*1] The upper lid of the controller must be removed to monitor the LED.

> NOTE: The product external appearance and specifications are subject to change without prior notice for purposes of improvements or other factors.

⚠ **CAUTION**

We use an FL HUB (made by Phoenix Contact) to check operation. Using this HUB is recommended if constructing your own system.
HUBs generally available on the market are not designed for use in locations such as factories, so some HUBs are vulnerable to external noise. Please acknowledge beforehand that operation cannot be guaranteed if other types of HUBs are used. Always be sure to use a HUB with high noise resistance when connecting to the controller.

2-14-2　Modular connector

The pin layout for the modular connector used in the Ethernet unit is shown below.
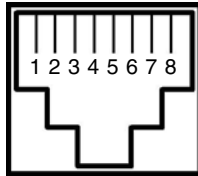
Pin No	Signal name
1	TD+
2	TD-
3	RD+
4	N.C
5	N.C
6	RD-
7	N.C
8	N.C

*Pins 4, 5, 7, 8 are not used.

2-14-3 UTP (STP) cable

The Ethernet cables are standardized by ANSI/TIA/EIA568A. To avoid miswiring and malfunction, we recommend using cables conforming to this standard. When using 10BASE-T cables, it must have transmission characteristics of category 3 or higher.

■ Straight-through cable

Use this cable to connect the HUB to the controller and other party's device.

Between T-568A

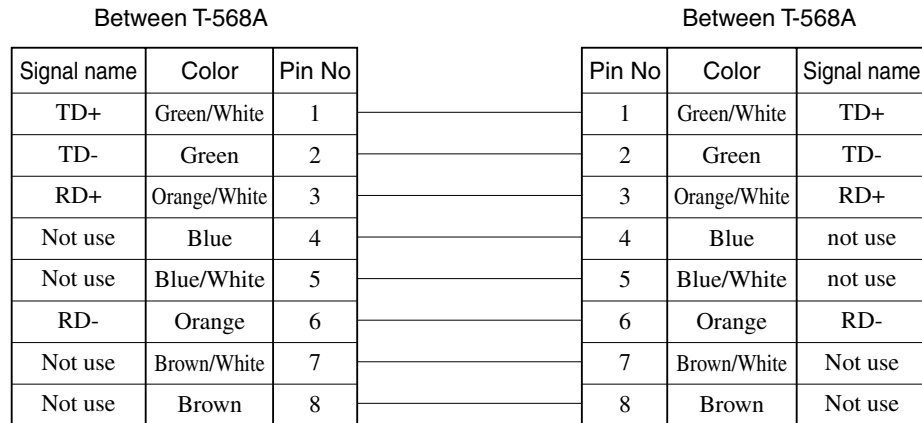| Signal name	Color	Pin No
TD+	Green/White	1
TD-	Green	2
RD+	Orange/White	3
Not use	Blue	4
Not use	Blue/White	5
RD-	Orange	6
Not use	Brown/White	7
Not use	Brown	8

Between T-568A

Pin No	Color	Signal name
1	Green/White	TD+
2	Green	TD-
3	Orange/White	RD+
4	Blue	not use
5	Blue/White	not use
6	Orange	RD-
7	Brown/White	Not use
8	Brown	Not use

* Pins 4, 5, 7, 8 are not used for 10BASE-T.
* Straight-through cable also connects between T-568B and T-568B.

■ Crossover cable

Use this cable to connect the controller directly with other party's device. This cable is also used to connect HUBs in cascade(when HUBs have a cascade port).

Between T-568A

Signal name	Color	Pin No
TD+	Green/White	1
TD-	Green	2
RD+	Orange/White	3
Not use	Blue	4
Not use	Blue/White	5
RD-	Orange	6
Not use	Brown/White	7
Not use	Brown	8

Between T-568B

Pin No	Color	Signal name
1	Orange/White	TD+
2	Orange	TD-
3	Green/White	RD+
4	Blue	not use
5	Blue/White	not use
6	Green	RD-
7	Brown/White	Not use
8	Brown	Not use
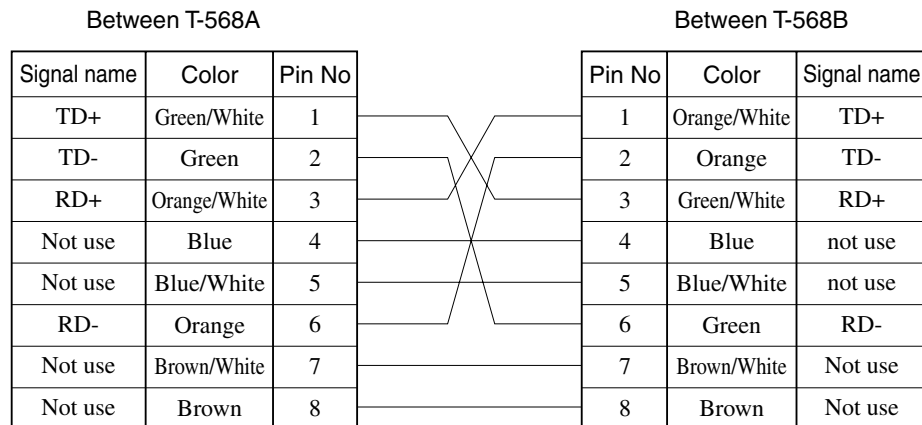
* Pins 4, 5, 7, 8 are not used for 10BASE-T.

2-15   Supplement
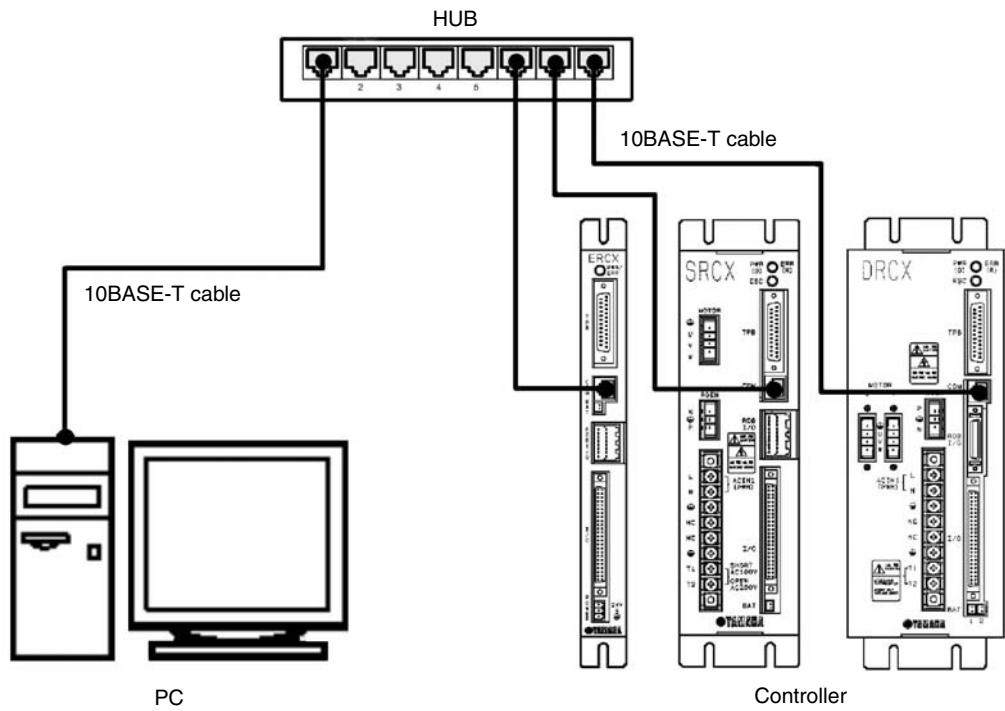
2-15-1   Typical network systems

How a particular user builds up a network system depends on factors such as the scale of the network.

■ Example 1
In this example, several controllers are operated from one PC using one HUB.

System setup example

	IP address	Subnet mask	Gateway
PC	192.168.0.2	255.255.255.0	192.168.0.1
Controller 1	192.168.0.3	255.255.255.0	192.168.0.1
Controller 2	192.168.0.4	255.255.255.0	192.168.0.1
Controller 3	192.168.0.5	255.255.255.0	192.168.0.1

■ Example 2

In this example, many controllers are operated with the HUBs connected in cascade.
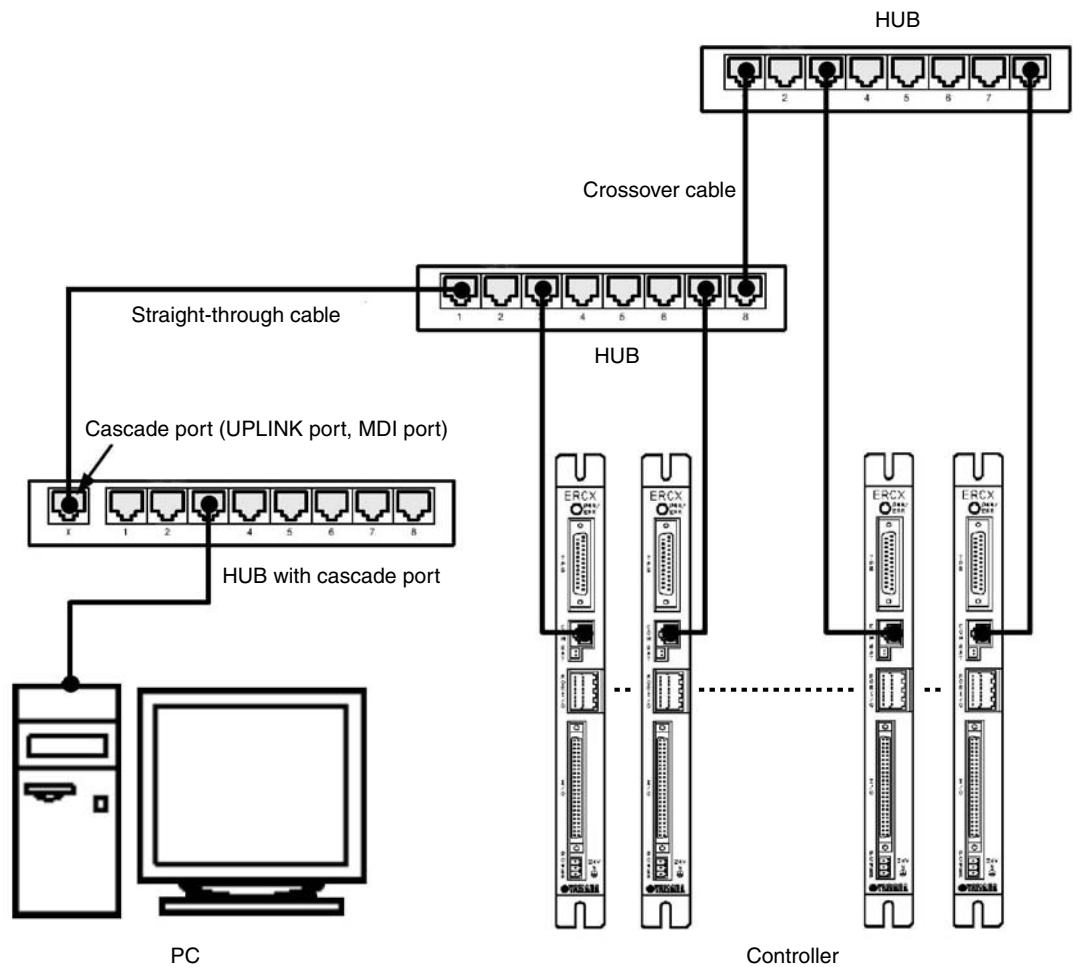
* The cascade port, also sometimes called an UPLINK port or MDI port is used when connecting multiple HUBs in cascade. Straight-through cables are used to connect the cascade ports of the HUBs together. However, crossover cables are used when connecting HUBs not having cascade ports or when making cascade connections without using cascade ports.
* A maximum of 4 HUB units can be connected in cascade.
* The same type network can also be built up by stacking HUBs together using so-called stackable HUBs. In this case, Multiple HUBs connected in a stack are seen as just one large HUB by the network so there is no limit on the number of HUB units that can be stacked.
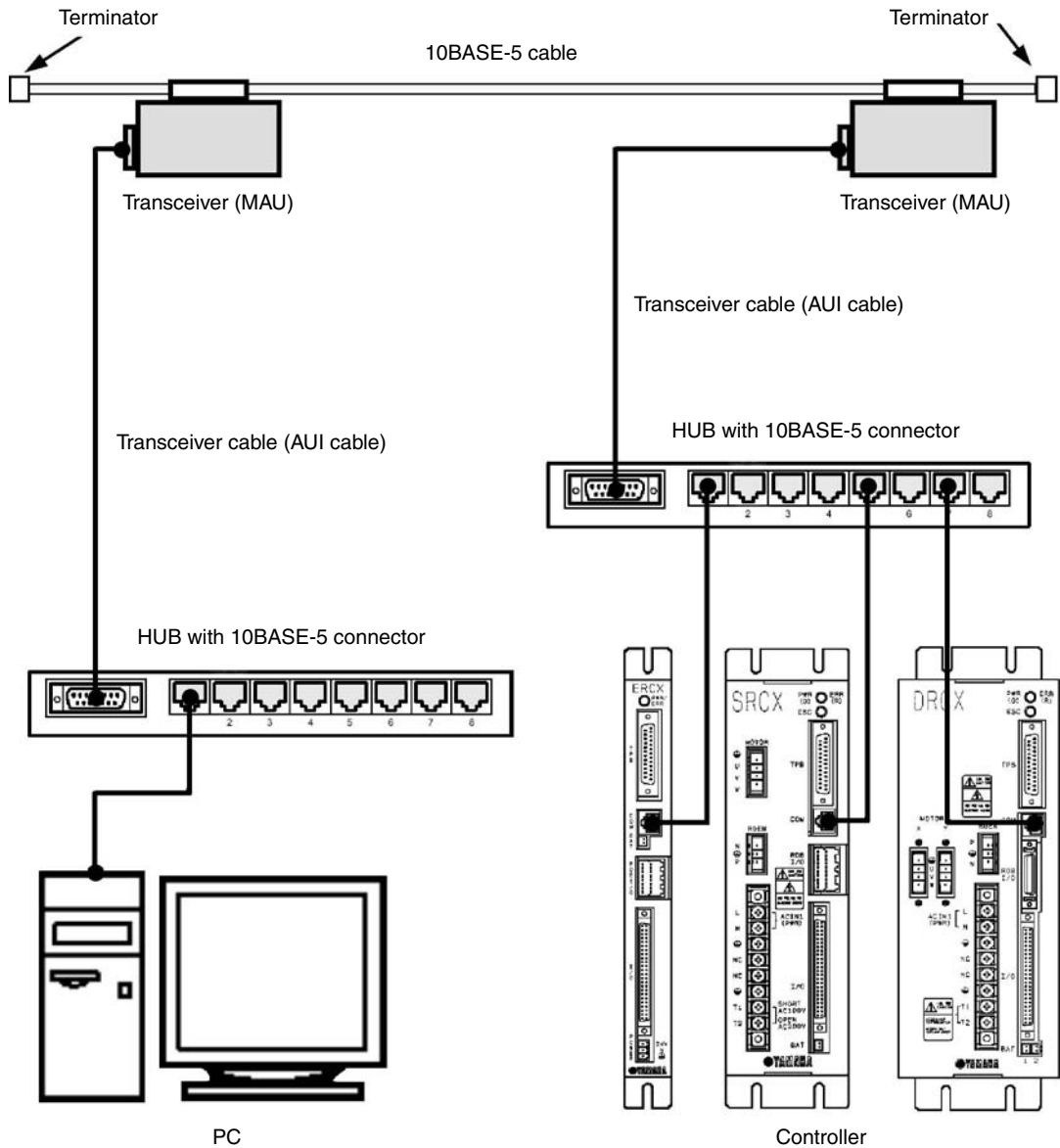
System setup example

	IP address	Subnet mask	Gateway
PC	192.168.0.2	255.255.255.0	192.168.0.1
Controller 1	192.168.0.3	255.255.255.0	192.168.0.1
Controller 2	192.168.0.4	255.255.255.0	192.168.0.1
:	:	:	:
Controller 9	192.168.0.11	255.255.255.0	192.168.0.1
Controller 10	192.168.0.12	255.255.255.0	192.168.0.1

■ Example 3

In this example, the control PC and the controllers are separated from each other.

* The 10BASE-5 cable has a maximum length of 500 meters. However, this distance can be extended to a maximum of 2.5 kilometers by connecting cables together and using repeaters, etc.

System setup example

	IP address	Subnet mask	Gateway
PC	192.168.0.2	255.255.255.0	192.168.0.1
Controller 1	192.168.0.3	255.255.255.0	192.168.0.1
Controller 2	192.168.0.4	255.255.255.0	192.168.0.1
Controller 3	192.168.0.5	255.255.255.0	192.168.0.1

■ Example 4

In this example, a dial-up router is used to operate a controller in a remote location over an ISDN line.
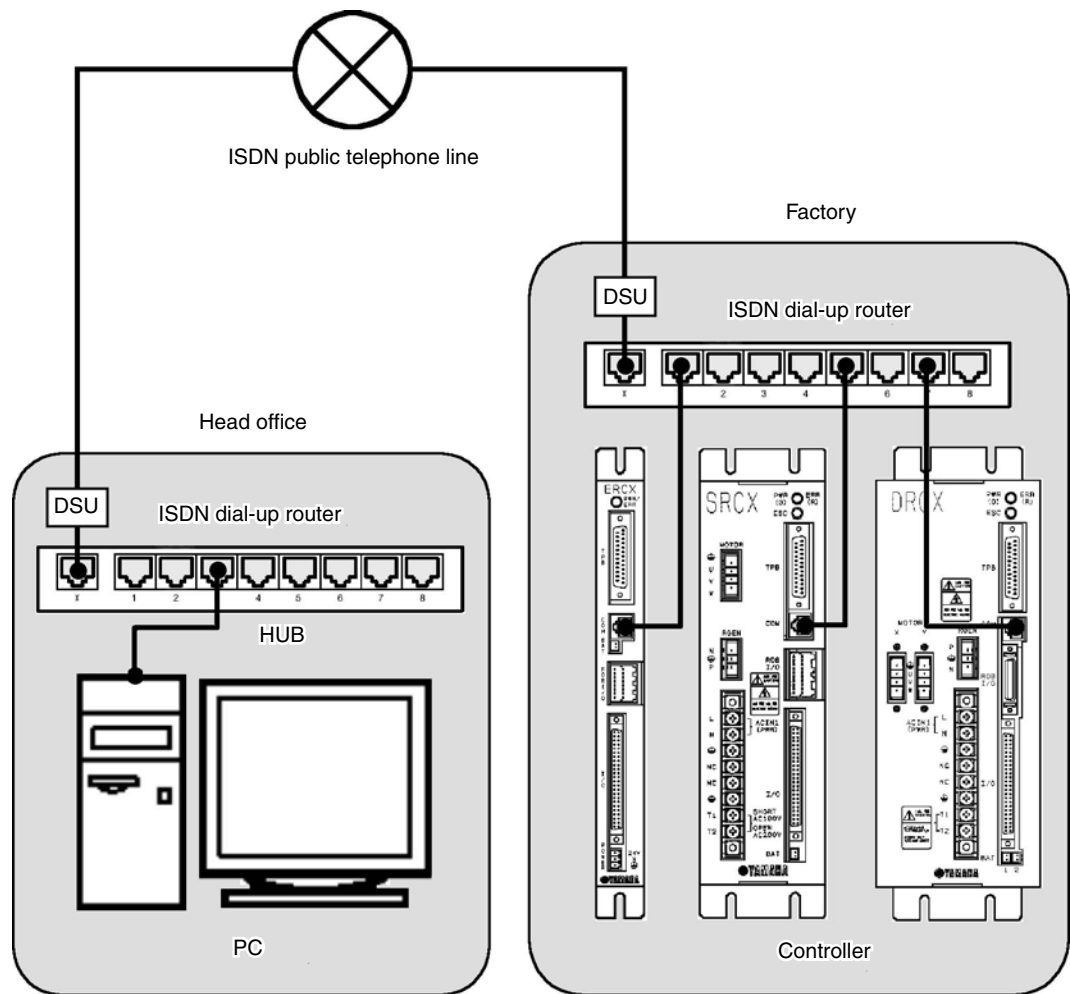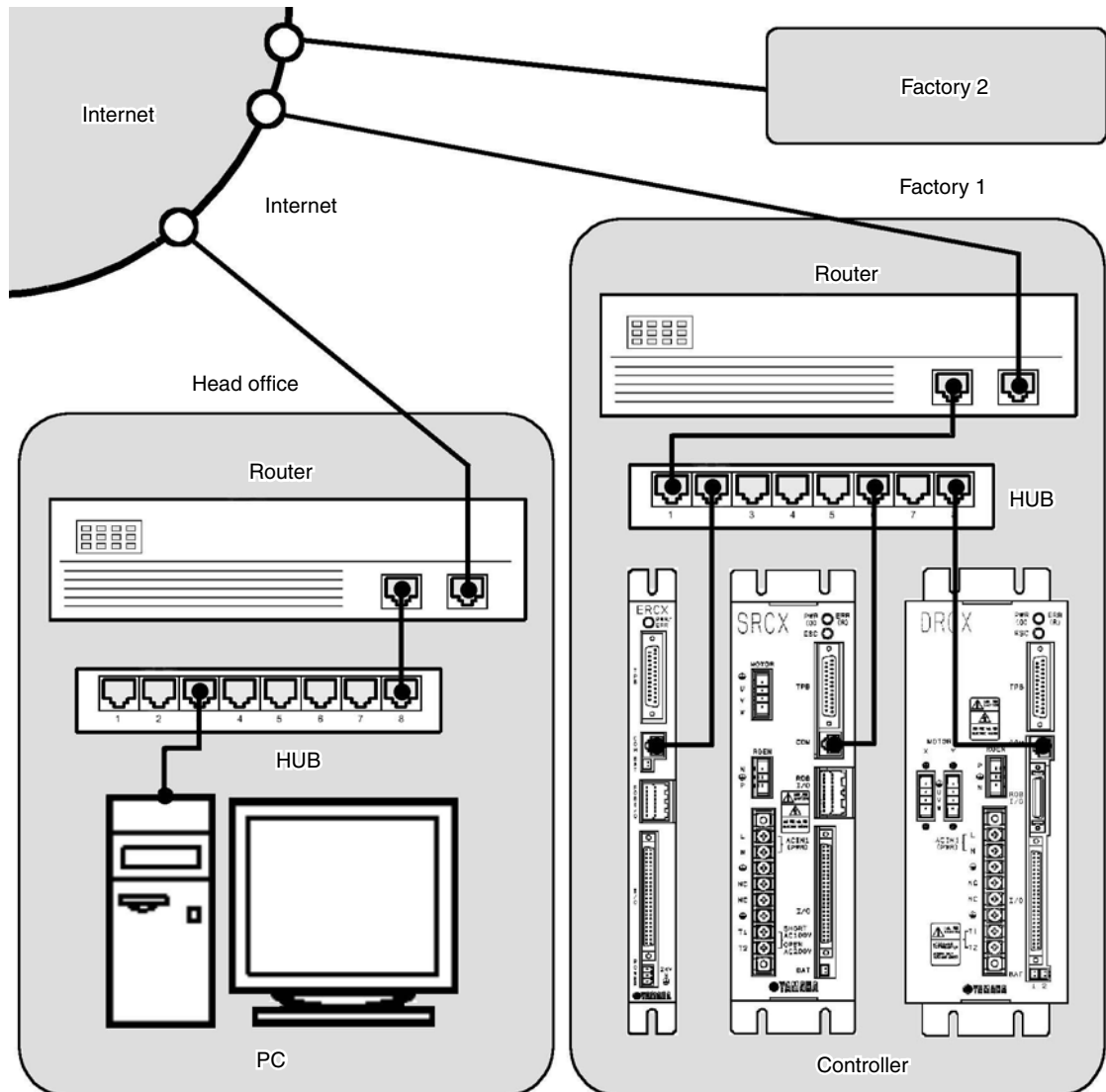

System setup example
(Head office network: 192.168.0.0/24, Factory network 192.168.1.0/24)

	IP address	Subnet mask	Gateway
Head office router	192.168.0.1	255.255.255.0	
PC	192.168.0.2	255.255.255.0	192.168.0.1
Factory router	192.168.1.1	255.255.255.0	
Controller 1	192.168.1.2	255.255.255.0	192.168.1.1
Controller 2	192.168.1.3	255.255.255.0	192.168.1.1
Controller 3	192.168.1.4	255.255.255.0	192.168.1.1

* The dial-up router must be set so that data destined for 192.168.0.0/24 is sent to the head office, and data destined for 192.168.1.0/24 is sent to the factory.

■ Example 5

In this example, a controller in a remote location is centrally managed over the Internet.

Use of a firewall (defense mechanism to keep out intruders) is recommended to maintain security.

System setup example

	IP address	Subnet mask	Gateway
Head office router	133.215.0.1	255.255.255.0	
PC	133.215.0.2	255.255.255.0	133.215.0.1
Factory 1 router	133.215.1.1	255.255.255.0	
Controller 1	133.215.1.2	255.255.255.0	133.215.1.1
Factory 2 router	133.215.2.1	255.255.255.0	
Controller 1	133.215.2.2	255.255.255.0	133.215.2.1

* Routers must be set to match system conditions.
* To make a connection over the Internet, a global address must be set in the IP address.
* Use of identical addresses is not allowed so customers must not use the addresses set in the above example.
 Always use the customer's own unique address. NIC (in Japan, JPNIC) handles the assigning and management of addresses.

42

2-15-2 Description of terminology

■ TCP/IP (Transmission Control Protocol/Internet Protocol)

TCP/IP is a general term for a group of standard protocols for carrying out communications over the Internet centering around TCP and IP protocols. Computers and PCs capable of accessing the Internet all use TCP/IP protocols.

The Ethernet unit contains TCP, IP, ICMP, ARP and TELNET protocols.
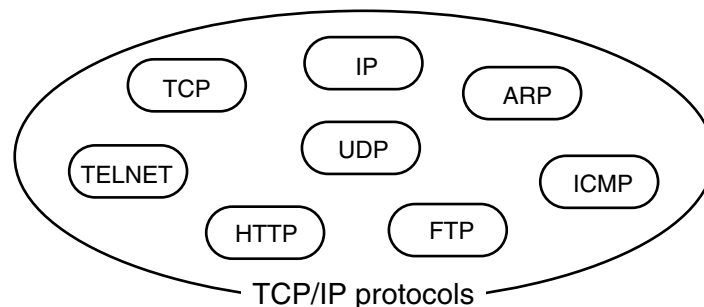
TCP/IP protocols

* The protocols making up TCP/IP are also comprised of many protocols other than those shown in the figure on the left. Protocols are a set of conventions (or rules) that must be mutually complied with so that controllers and PCs can communicate with the other party.

■ Ethernet

The Ethernet is basically one type of standard for network system hardware. Ethernet is a network invented by the Xerox Corporation (USA) in the early 1970's and currently forms an international standard known as IEE802.3. The Ethernet physically consists of cable types such as 10BASE-2, 10BASE-5, and 10BASE-T that differ from each other in terms of maximum cable length and the maximum number of connections. The Ethernet unit uses cables conforming to 10BASE-T specifications. Besides TCP/IP, the protocols most commonly used on the Internet are NetBEUI and IPX/SPX, etc.

Another feature of the Ethernet is the use of CSMA/CD as a data transmission method (see below).

■ CSMA/CD (Carrier Sense Multiple Access with Collision Detection)

CSMA/CD is a method of sending signals, developed by combining a CSMA data transmission method with a transmission error handling method called CD.

CSMA refers to joint use of one transmission cable by many devices connected over a network. CSMA is therefore a method for checking network status beforehand and then transmitting the data after verifying that transmission is possible.

CD is a method for handling data collisions that occur on the network. In this method, when a data collision (conflict) occurs, that data is re-transmitted after a randomly selected time period has elapsed.

Many devices can be connected to the Ethernet by using these CSMA/CD methods. However, performance cannot be guaranteed in real-time because of transmission standby (time awaiting transmission) and retransmissions.
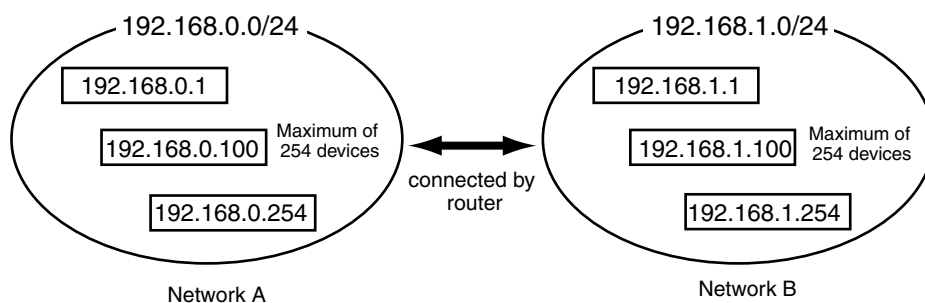
■ IP address

The IP address is a unique number assigned to each device to identify that device on the network and prevent the same number from being used by different devices. (More accurately, an IP address is assigned to each network interface, since once PC may sometimes be installed with multiple network interfaces.) In a TCP/IP protocol, the data transmit source and destination are specified by this IP address. The IP address consists of 32 bits (4 bytes) so can be expressed with this number without changes, however it is normally expressed as a decimal number separated by periods (.) at each byte (in other words, four sets of numbers separated by periods). An IP address of 0xC0A80002, for example, is normally expressed as 192.168.0.2

The IP address is actually comprised of 2 address sections. One section is the network address. The network address is the address of the network itself. The other section is the host address section. The host address is an address for identifying each device on that network. The IP address, as shown below, uses the first through the Nth bits as the network address, and the N+1 bit through 32nd bit as the host address. (The value of N is determined by the subnet mask.)

	1	N N+1	32
IP address	Network address section	Host address section	
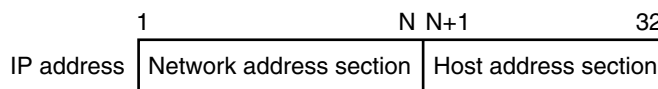
In an IP address of 192.168.0.2, for example, if the N value (network length) is 24 bits, then the network address section is 192.168.0, and the host address section is 2. Generally, in a network address, the host address section is 0 and the network length is listed behind the address. In the above example, this would be shown as 192.168.0.0/24.

One network can be connected with as many devices as there are addresses to identify them. However, host address bits having all zeroes (0), or all ones (1) are reserved and so cannot be used. In the above example, though the host address can identify 256 devices, the numbers 0 and 255 cannot be used so the maximum number of devices that can actually be connected is 254.

Network A — 192.168.0.0/24: 192.168.0.1, 192.168.0.100 (Maximum of 254 devices), 192.168.0.254

connected by router

Network B — 192.168.1.0/24: 192.168.1.1, 192.168.1.100 (Maximum of 254 devices), 192.168.1.254

Any company (organization) can freely select a host address but when attempting to connect their network to the Internet, that company (organization) cannot select the network address on their own. An application to acquire a network address must be made to the NIC (in Japan, JPNIC). If connecting one's network to the Internet is not necessary, then any company can freely select a network address, as well as a host address.

If there is no need to connect to the Internet, then use of the following addresses is allowed.

10.0.0.0 through 10.255.255.255 (1 unit of class A)
172.16.0.0 through 172.31.255.255 (16 units of class B)
192.168.0.0 through 192.168.255.255 (256 units of class C)

An address acquired by making application to NIC on the other hand is referred to as a global address.

■ Subnet mask

The subnet mask is used to separate the IP address into a network address section and a host address section. The network address bit is set to 1, and the host address bit is set to 0.

The subnet mask, just like the IP address is expressed as a decimal number of 32 bits (4 bytes) with each byte separated by a period (or four sets of numbers separated by periods). So if the subnet mask is 255.255.255.0, then the network address section is 24 bits.

A company (organization) is generally assigned only one network address when applying to the NIC for an IP address. The company making the application falls within one of classes A, B or C depending on the scale of the company. Class B for example, has a network length of 16 bits and can be assigned a network allowing connection of up to 65533 devices. However, unless changes are made, this network cannot efficiently perform the required managing and processing tasks. So such a network is normally set with subnet masks to divide it into an appropriate number of smaller networks. When a class B network for example, is set with a subnet mask of 255.255.255.0, a total of 256 settings can be made allowing up to 254 devices to be connected.

■ MAC address (Media access control address)

The MAC address, also called the Ethernet address is a hardware type identification number (6 bytes) set in each network interface. The MAC address is set in each device during the manufacturing stage and therefore does not have to be set by the user.

Each device in the Ethernet system is identified by means of this MAC address. In other words, the IP address is automatically converted to a MAC address, even when communicating by means of a TCP/IP protocol.

Basically the user does not normally have to even be aware of the MAC address. However, if there are communication problems, then the interrelation of the IP address and MAC address can be checked to find out if the cause of the problem is overlapping (identical) IP addresses.

■ HUB

A HUB is a device used for connecting devices such as PCs by way of a 10BASE-T network. The HUB has multiple ports that allow connecting modular jacks and twisted pair cables fitted with these modular jacks connect to the HUB from each device.

The HUB may have different type connectors depending on whether the HUB is for 10BASE-2 or 10BASE-5. Various types of networks can be constructed by means of these HUBs.

■ Router

The router is a device for mutually connecting networks together. The router is controlled based on a sophisticated process. The router sends data with an external destination from an internal network to an external network, and sends data received from an external network, to an internal network. Designated data is discarded in a filtering process to help maintain network safety.

The router IP address is set as the gateway address in each network device. This setting allows data to be correctly sent and received by each device on the network.

Revision record

Manual version	Issue date	Description
Ver. 3.01	Nov. 2003	English manual Ver. 3.01 is based on Japanese manual Ver. 3.01.
Ver. 3.02	Dec. 2005	English manual Ver. 3.02 is based on Japanese manual Ver. 3.02.
Ver. 3.03	Feb. 2006	English manual Ver. 3.03 is based on Japanese manual Ver. 3.04.
Ver. 3.04	Aug. 2006	English manual Ver. 3.04 is based on Japanese manual Ver. 3.05.
Ver. 3.05	May 2007	English manual Ver. 3.05 is based on Japanese manual Ver. 3.05.
Ver. 3.06	Sep. 2007	English manual Ver. 3.06 is based on Japanese manual Ver. 3.06.
Ver. 3.07	Dec. 2007	English manual Ver. 3.07 is based on Japanese manual Ver. 3.07.