YAMAHA
YAMAHA MOTOR CO., LTD.

YAMAHA NETWORK BOARD RCX series

Ethernet

User's Manual

ENGLISH E

E94-Ver. 1.04

INTRODUCTION

Our thanks for your purchase of this Ethernet unit for use with YAMAHA RCX series robot controllers.

This is an optional unit to allow connecting YAMAHA RCX series robot controllers 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 and programming manual for information on basic robot controller operation and programming.

NOTE

- 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

General Contents

MEMO

Chapter 1 Cautions To Ensure Safety

1-1 Basic safety points

Besides reading this 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 manual only list items involving this product. Please refer to the controller user's 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 SAFETY connector of the robot controller to ensure quick and effective emergency stops.

⚠ ***CAUTION***

To find the current status of the network system and robot 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 robot 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 user's manual during installation or wiring work on the robot 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 robot 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.

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.

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MEMO

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 YAMAHA robot 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 robot controller.

Main features of this Ethernet unit for RCX series robot controllers are as follows:

- The RCX series robot controllers 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, robot controllers can be accessed even from offices located away from the factory. Using the Internet allows accessing even robot controllers in remote locations.
- The robot 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 robot controller and robot programming, refer to the controller user's manual and programming manual.

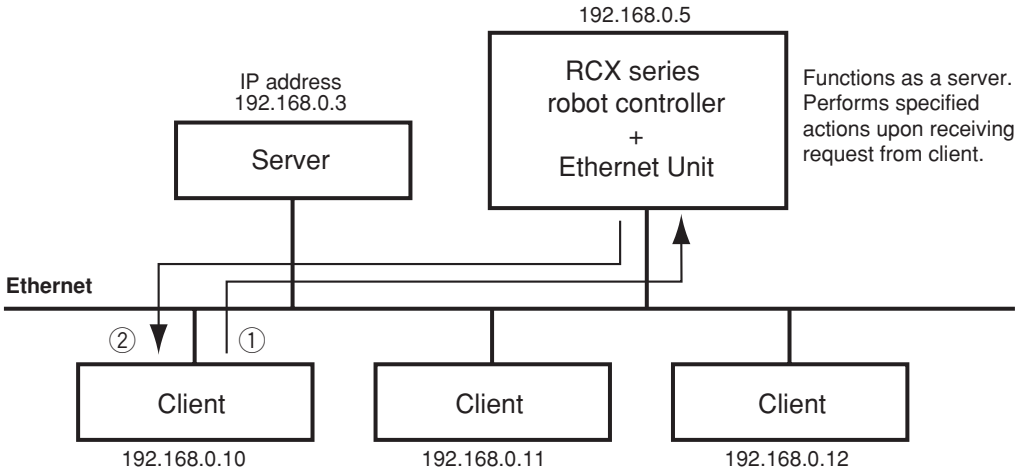
* Ethernet is a registered trademark of the Xerox Corporation (USA).

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 robot 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 robot 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 RCX series robot 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 robot controller does not 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 robot controller to exchange data with and make the connection. (Above example shows the client 192.168.0.10 has specified the robot controller 192.168.0.5 and made a connection.)

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

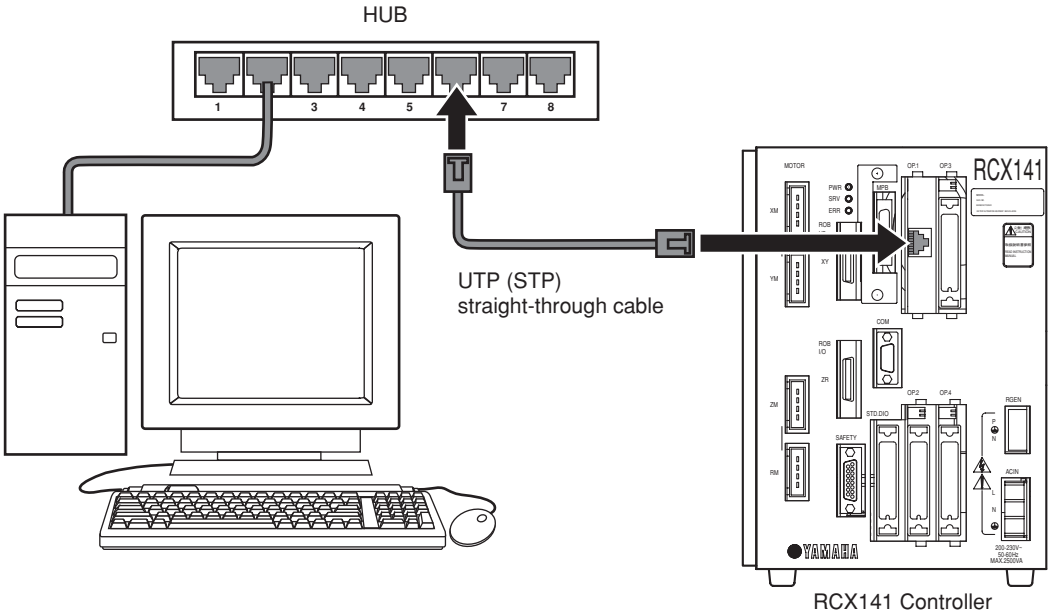
NOTE

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 robot controller unit.
Settings such as of the IP address and subnet are made from the MPB (or the RPB when using the RCX221/222).

2-3 How to connect to Ethernet

The Ethernet unit for RCX series employs 10BASE-T specifications, so the robot 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, 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.

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.

NOTE

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)

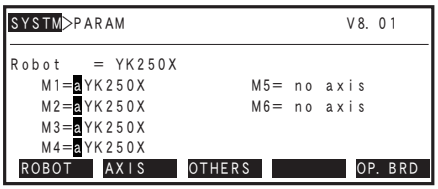
A minimum of IP address, subnet mask and gateway settings must be made so that the robot controller will be correctly identified and acknowledged on Ethernet.
These settings are made from the MPB (or the RPB when using the RCX221/222). The following sections explain the procedures using the MPB.
The settings will be enabled after restarting the controller.

2-4-1 Validating the Ethernet unit

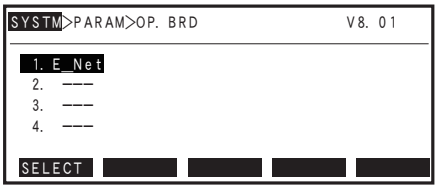
To use the Ethernet, the Ethernet board must first be enabled by setting the parameter.

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

2) Press [F5] (OP. BRD).

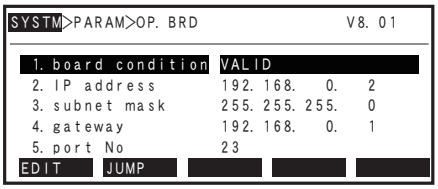


3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



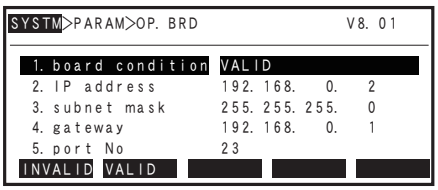
4) The current Ethernet unit identity status appears on the display.

   With the cursor positioned on the "1. board condition" ("1. board function" for RCX221/222), press [F1] (EDIT).



5) Press [F2] (VALID) to make the Ethernet identifiable from the controller.

   If making it unidentified from the controller, press [F1] (INVALID).



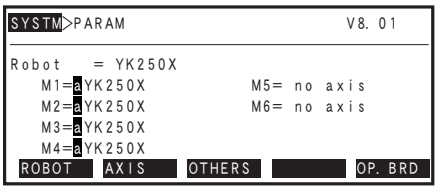
6) To end the setting, press [ESC]. To continue setting another parameter, use the [↑] [↓] keys to select the parameter.

2-4-2 Setting the IP address

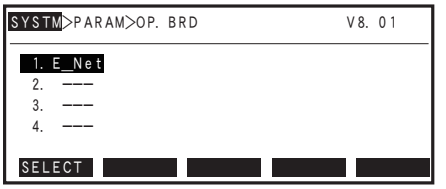
The following explains how to set the IP address.
The IP address is a number unique to each device and identifies that device from among many other devices connected on the network. The IP address of one device must not be the same number as another device so use caution when setting the IP address.

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

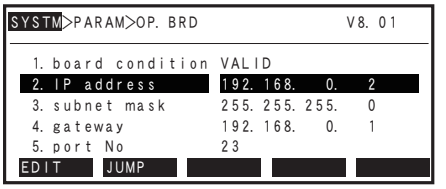
2) Press [F5] (OP. BRD).



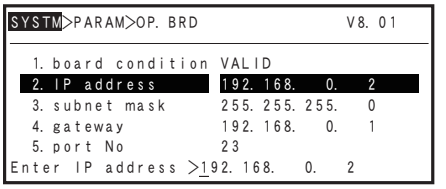
3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



4) Press the [↓] key once to select "2. IP address" and press [F1] (EDIT).



5) The currently set IP address appears.
To change it, enter the new IP address with the [0] to [9] keys. Enter the exact number including periods (.).
After changing the setting, press [⇔].



6) To end the setting, press [ESC]. To continue setting another parameter, use the [↑] [↓] keys to select the parameter.

⚠ ***CAUTION***
All changes to the IP address, subnet mask and gateway settings will be enabled after restarting the robot controller. When connecting the robot controller on an already existing network, always check with the network supervisor before making IP address, subnet mask and gateway settings.

NOTE

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.

NOTE

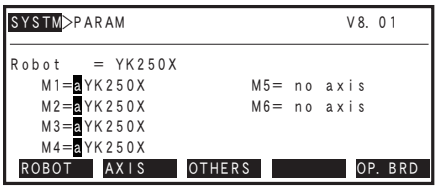
The Ethernet unit for RCX series is not usable with IP address auto acquisition functions such as DHCP and BOOTP. You must set the IP address manually.

2-4-3 Setting the subnet mask

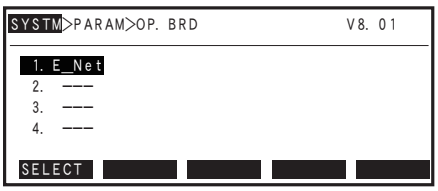
The following explains how to set the subnet mask.
The subnet mask is a numerical address used to subdivide the network into smaller parts.

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

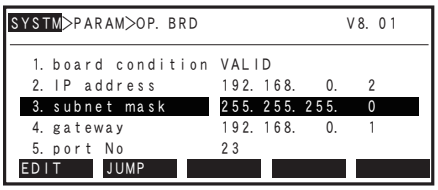
2) Press [F5] (OP. BRD).



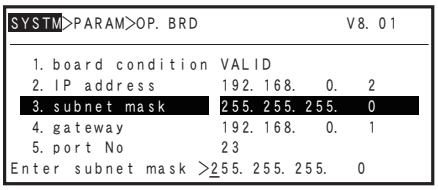
3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



4) Press the [↓] key twice to select "3. subnet mask" and then press [F1] (EDIT).



5) The currently set subnet mask appears.
To change it, enter the new subnet mask with the [0] to [9] keys. Enter the exact number including periods (.).
After changing the setting, press [⇒].



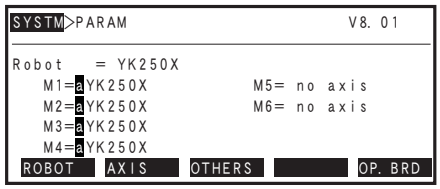
6) To end the setting, press [ESC]. To continue setting another parameter, use the [↑] [↓] keys to select the parameter.

2-4-4 Setting the gateway

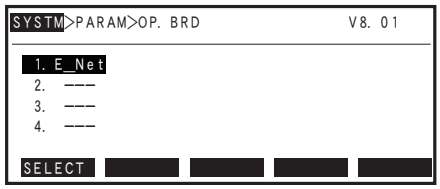
The following explains how to set the gateway. Basically this is specifying the router IP address. The router is a device relaying information from a certain network to a different network when two or more networks are present.

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

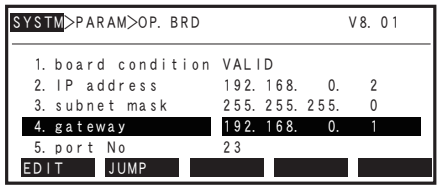
2) Press [F5] (OP. BRD).



3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



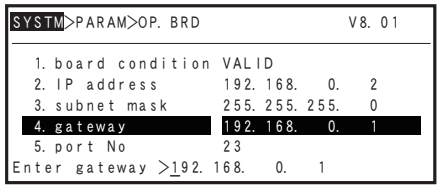
4) Press the [↓] key three times to select "4. gateway " and then press [F1] (EDIT).



5) The currently set gateway appears.

To change it, enter the new gateway with the [0] to [9] keys. Enter the exact number including periods (.).

After changing the setting, press [⇨].



6) To end the setting, press [ESC]. To continue setting another parameter, use the [↑] [↓] keys to select the parameter.

⚠ ***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 robot controller on an already existing network, always check with the network supervisor before making IP address, subnet mask and gateway settings.
The Ethernet unit for RCX series 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 robot 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 robot controller. A basic method for setting a computer using Windows XP 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

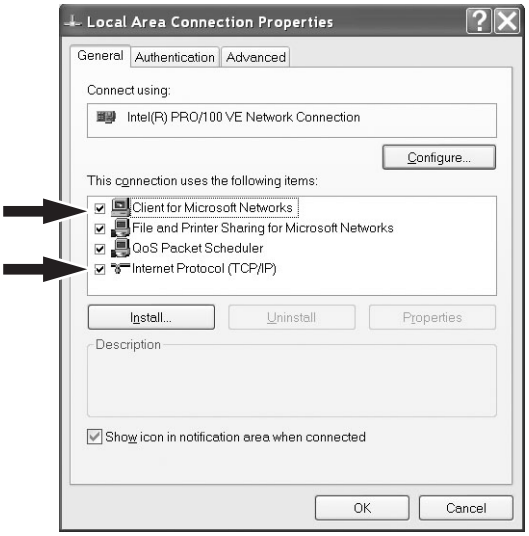
A brief description of setting the TCP/IP protocol for Windows XP is given below. See the First Step Guide in Windows XP for more detailed information. Some changes in the settings may be needed to match the user's network.

1) Open "Control Panel".

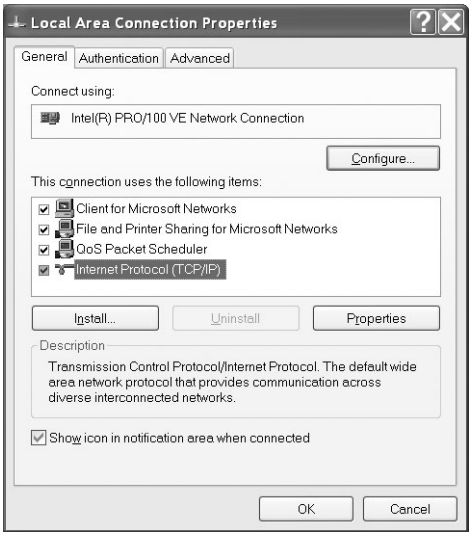
2) Double-click "Network connections" icon in "Control Panel".

3) In the "Network connection" window, right-click on "Local Area Connection" to open "Properties".

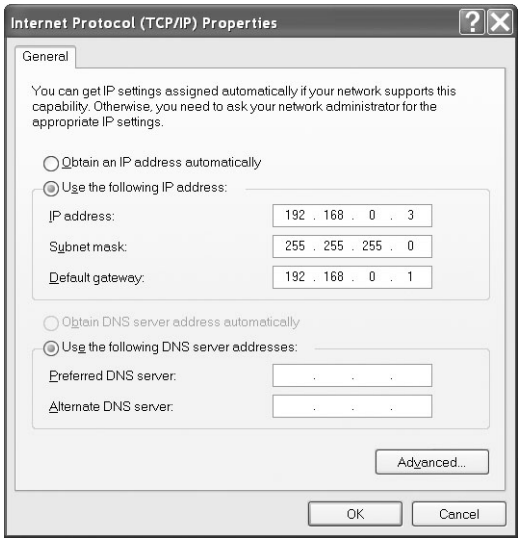
4) Check that "Client for Microsoft Networks" and "Internet Protocol (TCP/IP)" are listed on the "General" tab.



5) Select "Internet Protocol (TCP/IP)" and press the "Properties" button.



6) In the "Internet Protocol (TCP/IP) Properties" dialog box, set the PC's IP address, subnet mask, and gateway to match the status of use. Also set the DNS server to match the status of use.

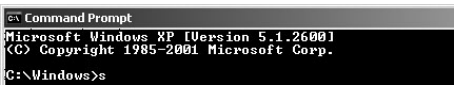


7) Click OK to close the setup screen.

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 XP 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.

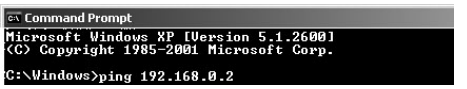
1) Click the "Start" button, point to "All Programs", and select "Accessories" - "Command Prompt" to open the "Command Prompt" screen.



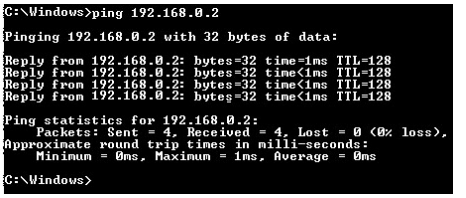
2) Run the ping command.

   Following the command prompt ">", enter "ping xxx.xxx.xxx.xxx" and press the Enter key.

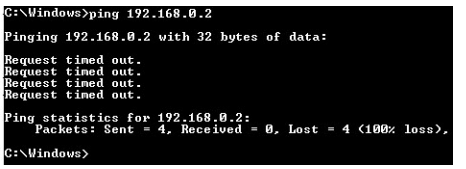
   In the "ping xxx.xxx.xxx.xxx" portion, enter the IP address of the robot controller.



3) The screen on the right shows an example that normal communication is established.



4) The screen on the right shows an example that normal communication is not established. If this happens, recheck the network device and settings, and eliminate the trouble.



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 SAFETY connector of the robot 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 for RCX series can be used with TELNET dedicated parameters explained in this section.

2-8-1 Parameter description

To use TELNET communications, the following parameters should be set as needed.
Each parameter can be set in "SYSTEM > PARAM > OP. BRD" mode. See "2-8-2 Setting the parameters" for how to set the parameters.

■ TCP port No.

Use this parameter to set the TCP port No. of the robot controller.

The port No. set here is specified along with the IP address when the client connects to the robot controller.

MPB/RPB display	5. port No
Input range	0 to 65535
Default value	23 (TELNET port)

* If any value other than the TELNET port (23) is specified, then negotiation with the TELNET protocol is not attempted. (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 change.

■ 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 robot controller.

MPB/RPB display	6. echoback
Input range	F1 : Invalid F2 : Valid
Default value	Valid

■ Communication timeout

The TELNET connection can be disconnected if data is not sent or received from the client or robot controller within a certain amount of time.

Use this parameter to set the amount of that time (minutes). Setting to "0" (zero) voids the timeout check and there is no timeout to disconnect the TELNET connection.

MPB/RPB display	7. timeout [min]
Input range	0 to 255 (minutes)
Default value	10

■ LOGIN check

Use this parameter to set whether or not to perform a login check when a client attempts to connect to the robot controller.

When the login check is enabled, the user name and password are always checked when the client attempts to connect to the robot controller. The client cannot connect the robot controller unless the user name and password sent from the client match the data stored in the robot controller. When the login check is disabled, the client can connect to the robot controller without a login check and communication is possible right away.

MPB/RPB display	8. login check
Input range	F1 : Invalid F2 : Valid
Default value	Valid

■ LOGIN user name

Use this parameter to set the login user name.

When the login check is enabled, the client must enter the user name specified here to connect to the robot controller.

MPB/RPB display	9. login user
Input range	1 to 8 characters <Usable characters> Alphabets : A to Z Numbers : 0 to 9 Symbols : ! " # $ % & ' ( ) + = . : ; – ? @ | { } _ ~ < > * , ^ [ ] /
Default value	USER

■ LOGIN password

Use this parameter to set the login password.

When the login check is enabled, the client must enter the password specified here to connect to the robot controller.

MPB/RPB display	10. login password
Input range	1 to 8 characters <Usable characters> Alphabets : A to Z Numbers : 0 to 9 Symbols : ! " # $ % & ' ( ) + = . : ; – ? @ | { } _ ~ < > * , ^ [ ] /
Default value	PASSWORD

■ LOGOUT processing

This parameter sets whether to stop the robot automatically or to continue the robot operation when the client disconnects from the robot controller.

MPB/RPB display	11. logout
Input range	F1 : CONT. (Continues robot operation.) F2 : Stop (Stops robot operation.)
Default value	Stop

* If TELNET connection is cut off due to an error, the robot operation stops automatically regardless of the above setting.

■ No-response timeout

If no-response has come back from the client, packets (keep-alive packets) can be sent at fixed time intervals to verify if the other party is present. This parameter sets the time interval between transmissions of these packets.

If no-response state continues for a specified time (setting time × 3 [Default is 15 seconds]), then the robot controller determines that an error has occurred and automatically cuts the TELNET connection. Setting to "0" (zero) will not send keep-alive packets so the connection with the client is not automatically cut even if no-response state continues.

MPB/RPB display	12. keep-alive [sec]
Input range	0 to 255 (seconds)
Default setting	5

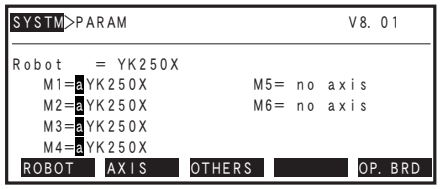
* Depending on the network, response time may be longer and an apparent "no-response" error detected. If this happens, change the setting as needed. (Internet, etc.)

* The controller automatically sends keep-alive packets. These packets do not affect the user transmit/receive data.

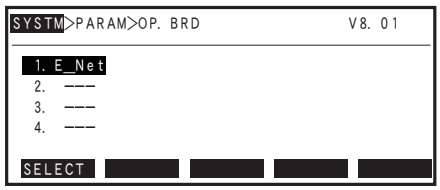
2-8-2 Setting the parameters

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

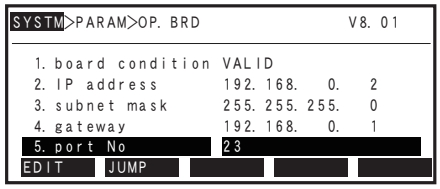
2) Press [F5] (OP. BRD).



3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



4) Use the [↑] [↓] keys to select the parameter to be changed, and press [F1] (EDIT).



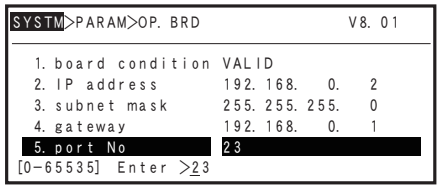
5) The setting method slightly differs according to the parameter to be changed.

<Setting method 1>

Enter the number with the [0] to [9] keys and then press [⇒].

Applicable parameters

5. port No
7. timeout [min]
12. keep-alive [sec]

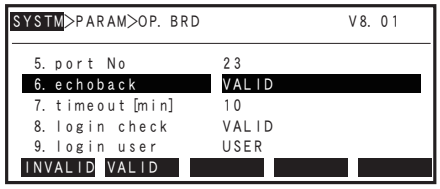


<Setting method 2>

Enter the desired setting with [F1] or [F2].

Applicable parameters

6. echoback
8. login check
11. logout

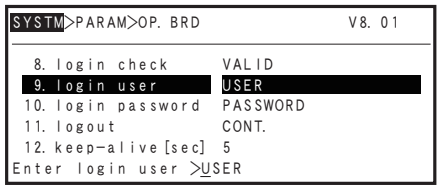


<Setting method 3>

Enter the setting with the [0] to [9], [A] to [Z] and symbol keys, and then press [⇒].

Applicable parameters

9. login user
10. login password



6) To end the setting, press [ESC]. To continue setting another parameter, use the [↑] [↓] keys to select the parameter.

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 robot controller and perform sophisticated processing. These robot control commands are further subdivided into the following 5 categories.

- Ethernet unit control commands
- Robot control commands
  1. Key operation
  2. Utilities
  3. Data handling
  4. Robot language
  5. Control codes

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

```
@ [ ] <online command> [<_command option>] <termination code>
```

Items in brackets [ ] can be omitted.

@ ..... start code (=40h)

_ ..... blank

<online command> ..... Refer to programming manual.

<_command option> ..... Refer to programming manual.

<termination code> ..... CR (=0Dh) code, or CRLF (=0Dh + 0Ah) code

■ Robot control commands begin with the start code '@' (=40h) and run when a statement with the last line ending with the termination code, CR (=0Dh) code or CRLF (=0Dh + 0Ah) code, is sent to the controller. As exceptions, control codes do not require a start code and termination code.

Ethernet unit control commands do not require a start code, but the last line must end with a termination code.

		Start code '@' (=40h)	Termination code CR (=0Dh) code or CRLF (=0Dh + 0Ah) code
Ethernet unit control commands		Not required	Required
Robot control commands	Other than control codes	Required	Required
	Control codes	Not required	Not required

■ One line must be within 80 characters except for the terminal code (CR (=0Dh) code or CRLF (=0Dh + 0Ah) code).

■ A communication command is basically composed of an <online command> and an <_command option>. Depending on the command statement, no <_command option> is used or multiple <_command options> are used.

■ The character codes used are the JIS8 unit system codes (ASCII codes with katakana characters added). See the controller user's manual for the character code tables.

■ One or more space must be inserted between <online command> and <_command option>.

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

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 do 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 echoback".
OK c/r l/f

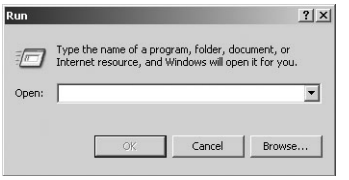
2-9-3 Robot control commands

Robot control commands access the controller and perform sophisticated processing. Command specifications are identical to RS-232C communication commands. See the programming manual for details on each command.

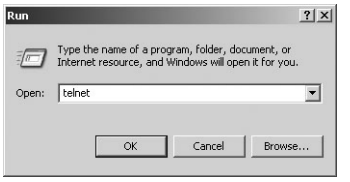
2-10 Making a connection with TELNET.EXE

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 robot 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 dialog box.

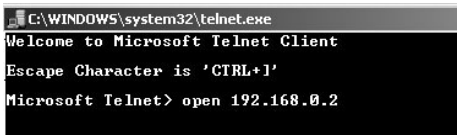


2) Enter "telnet" in the edit box and then press the "OK" button.



3) The telnet.exe now starts up. Enter "open xxx.xxx.xxx.xxx" following the prompt (>) and then press the Enter key.

   In the "xxx.xxx.xxx.xxx" portion, enter the IP address of the robot controller.



4) Connection is made to the robot controller and a login check begins.

   Enter the user name here and then press the Enter key.

   * If the login check is disabled by the robot parameter, then this user name request message and the subsequent password message do not appear.

5) Next, enter the password.

   At this point, the password characters you entered are displayed as asterisks (*) on the screen.

   After entering the password, press the Enter key.

6) An OK message appears on the screen when the login check ends normally.

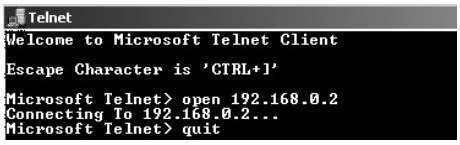
   From now on, commands and messages can be exchanged with the robot.

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

8) A message appears indicating the connection has been disconnected.

Click any key to return to the screen in step 3.

9) To end the telnet.exe, enter "QUIT" following the prompt (>) and press the Enter key.



NOTE

If you want to simultaneously control two or more robot controllers, start up TELNET.EXE as many times as needed.

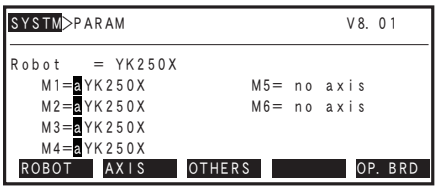
2-11 Other operating tasks

2-11-1 Displaying the MAC address

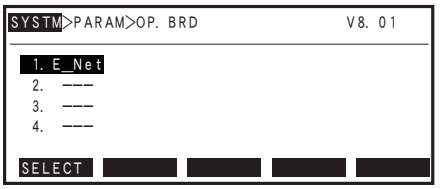
Use the following procedure to display the MAC address of the Ethernet unit for RCX series robot controllers.

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

2) Press [F5] (OP. BRD).

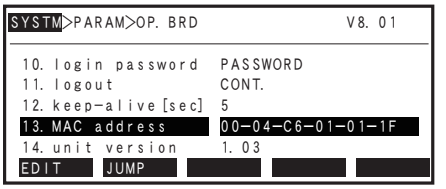


3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



4) Select "13. MAC address" with the the [↑] [↓] keys and press [F1] (EDIT).

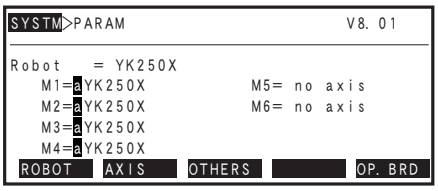
* The MAC address cannot be changed.



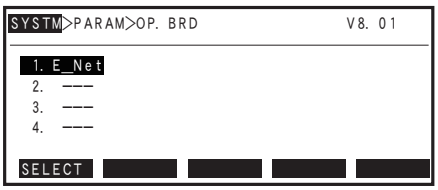
2-11-2 Displaying the version of the Ethernet unit

1) Press [F1] (PARAM) in "SYSTEM" mode to enter "SYSTEM>PARAM" mode.

2) Press [F5] (OP. BRD).

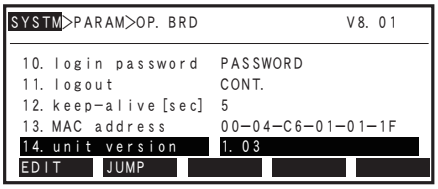


3) Select the number for "E_Net" with the [↑] [↓] keys and press [F1] (SELECT).



4) Select "14. unit version" with the the [↑] [↓] keys and press [F1] (EDIT).

* The Ethernet unit version number cannot be changed.



2-12 Message List

2-12-1 Error messages

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

12.41 : EtherNet link error

Code : &H0C29

Meaning/Cause : TELNET connection is disconnected.

a. Cable is broken or connector is disconnected.
b. Communication with the client was off for more than the time specified by the "13. timeout [min]" parameter for Ethernet.
c. Logout processing was performed because the "11. logout" parameter for Ethernet is set to "Stop".
d. There was no response from the client even when keep-alive packets were sent.
e. The LOGOUT or BYE command was not used to end the TELNET communication.

Action :
1. Connect the cable and/or connector securely.
2. Communicate at least once within the time specified by the "7. timeout [min]" parameter, or set that parameter to "0" to disable the timeout.
3. To prevent this error at logout, set the "11. logout" parameter to "CONT.".
4. Check if the client is in response to keep-alive packets, or set the "12. keep-alive [sec]" parameter to "0" to stop sending out keep-alive packets.
5. Use the LOGOUT or BYE command to end the TELNET communication.

12.42 : EtherNet hardware error

Code : &H0C2A

Meaning/Cause : The Ethernet unit is broken.

Action : Replace the Ethernet unit.

2-12-2 Telnet message list

login:

Meaning : Request for entry of login user name.
Action : Enter user name.

Password:

Meaning : Request for entry of login password.
Action : Enter login password.

login incorrect:

Meaning : Error was found during login check.
Action : Enter the correct user name and password.

TELNET is disconnected!!

Meaning : Login check resulted in errors 3 times in succession, so connection was disconnected automatically.
Action : Enter the correct user name and password.

TELNET is disconnected!!

Meaning : TELNET has already been connected.
Action : Limit the number of simultaneous logins to 1.

timeout.

Meaning : No-communication state continued beyond the time specified by the TELNET communication timeout parameter.
Action : Set the TELNET communication timeout parameter to a longer time so that no-communication state does not exceed the timeout period.

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 by referring to "2-4-2 Setting the IP address", "2-4-3 Setting the subnet mask", and "2-4-4 Setting the gateway".	• 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 robot 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 robot controller you are attempting to connect with is correct.	• Enter the correct IP address.
		3) Robot control 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 MPB or RPB 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 Validating the Ethernet unit" 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 MPB or RPB 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.

2-14 Specifications

2-14-1 Ethernet unit specifications

Spec item \ Model	Ethernet unit
Applicable controllers	RCX 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 MPB or RPB
Monitor LED	Run, Collision, Link, Transmit, Receive

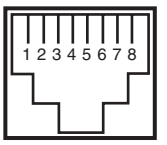
NOTE: The product external appearance and specifications are subject to change without prior notice for purposes of improvements or other factors.

⚠ ***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.

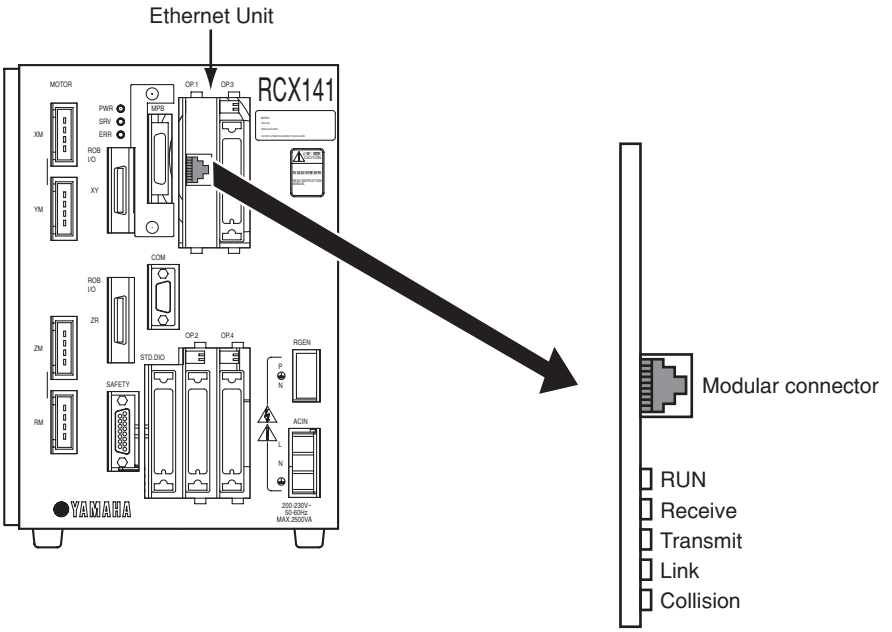
2-14-2 Modular connector

The pin layout for the modular connector used in the Ethernet unit for RCX series 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 robot controller and other party's device.

Between T-568A				Between T-568A	
Signal name	Color	Pin No	Pin No	Color	Signal name
TD+	Green/White	1	1	Green/White	TD+
TD-	Green	2	2	Green	TD-
RD+	Orange/White	3	3	Orange/White	RD+
Not use	Blue	4	4	Blue	not use
Not use	Blue/White	5	5	Blue/White	not use
RD-	Orange	6	6	Orange	RD-
Not use	Brown/White	7	7	Brown/White	Not use
Not use	Brown	8	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 robot 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				Between T-568B	
Signal name	Color	Pin No	Pin No	Color	Signal name
TD+	Green/White	1	1	Orange/White	TD+
TD-	Green	2	2	Orange	TD-
RD+	Orange/White	3	3	Green/White	RD+
Not use	Blue	4	4	Blue	not use
Not use	Blue/White	5	5	Blue/White	not use
RD-	Orange	6	6	Green	RD-
Not use	Brown/White	7	7	Brown/White	Not use
Not use	Brown	8	8	Brown	Not use

* Pins 4, 5, 7, 8 are not used for 10BASE-T.

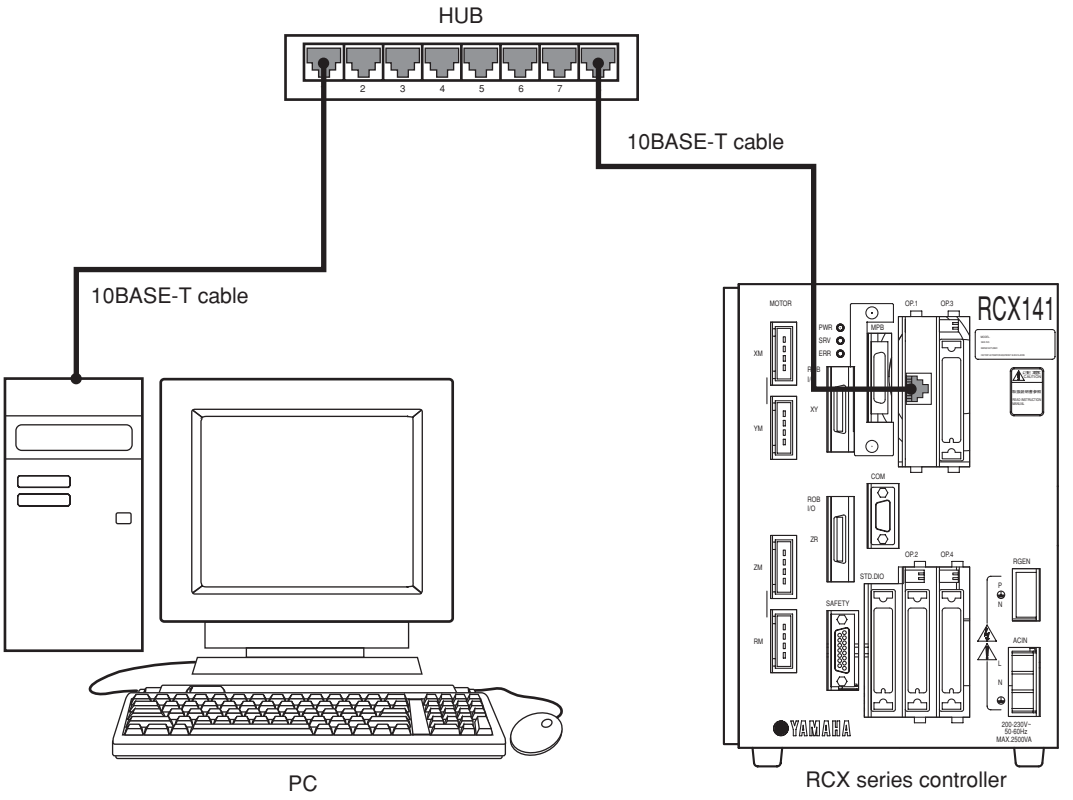
2-15 Supplement

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.

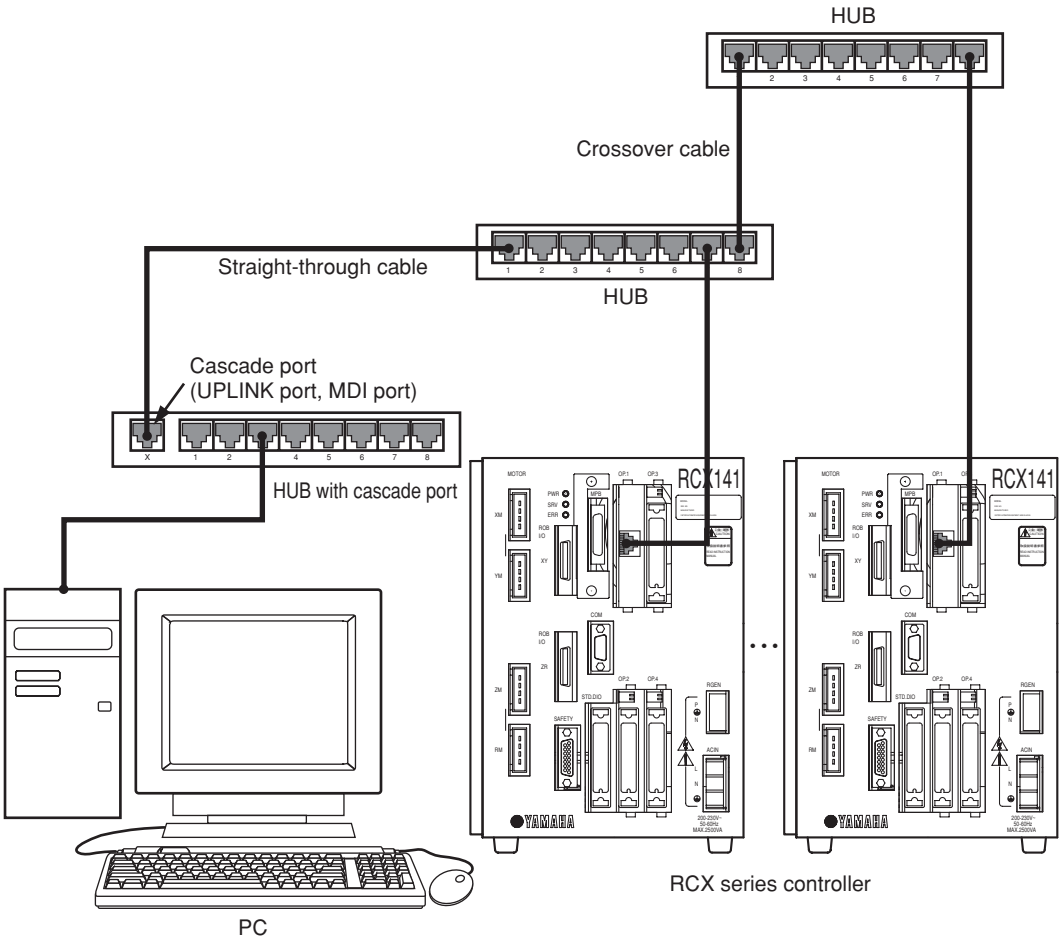


System setup example

	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.



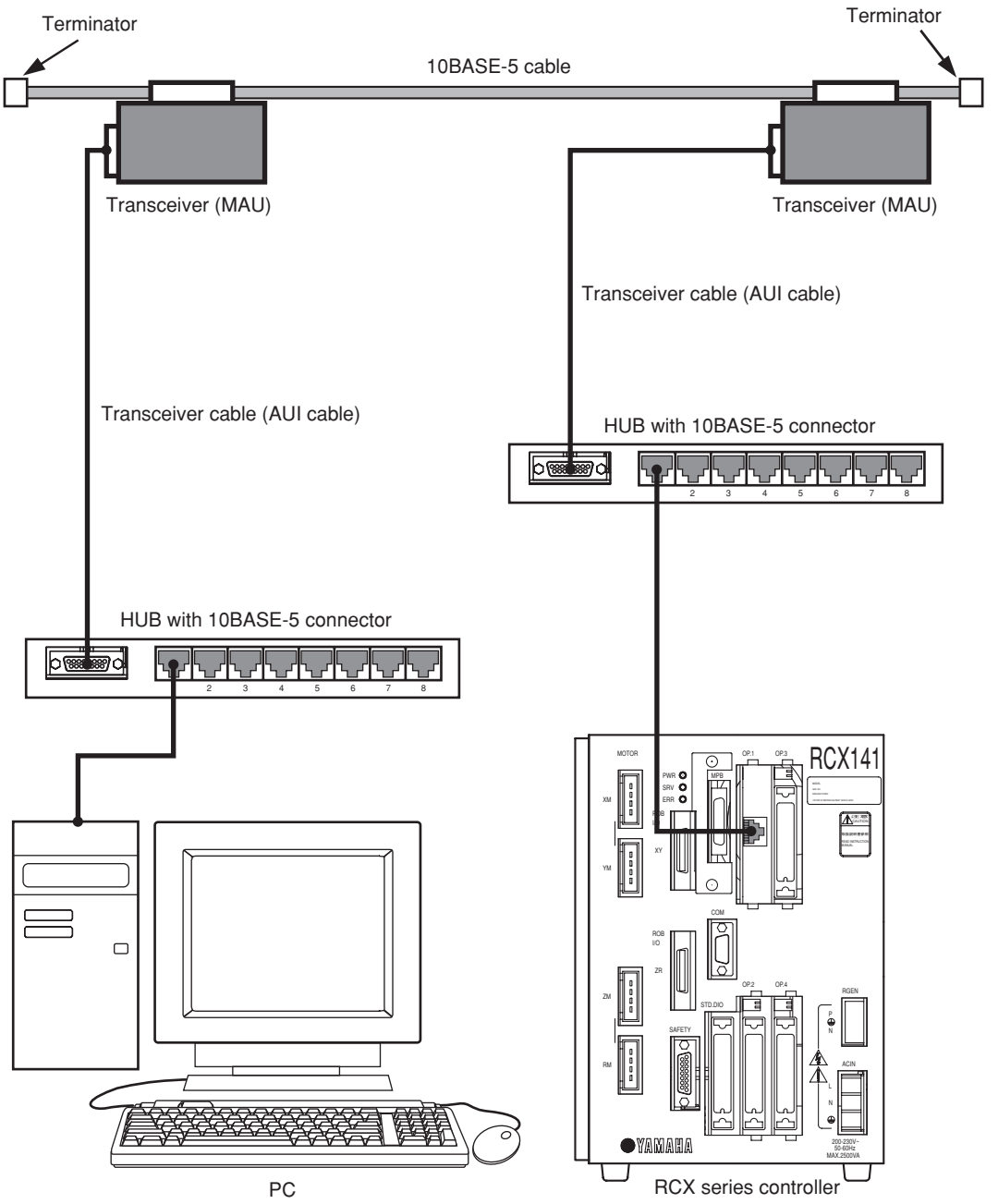
* The cascade port, also sometimes called an UPLINK port or MDI port is used when connecting multiple HUBs in cascade. Straight-through cables are used to connect the cascade ports of the HUBs together. However, crossover cables are used when connecting HUBs not having cascade ports or when making cascade 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.



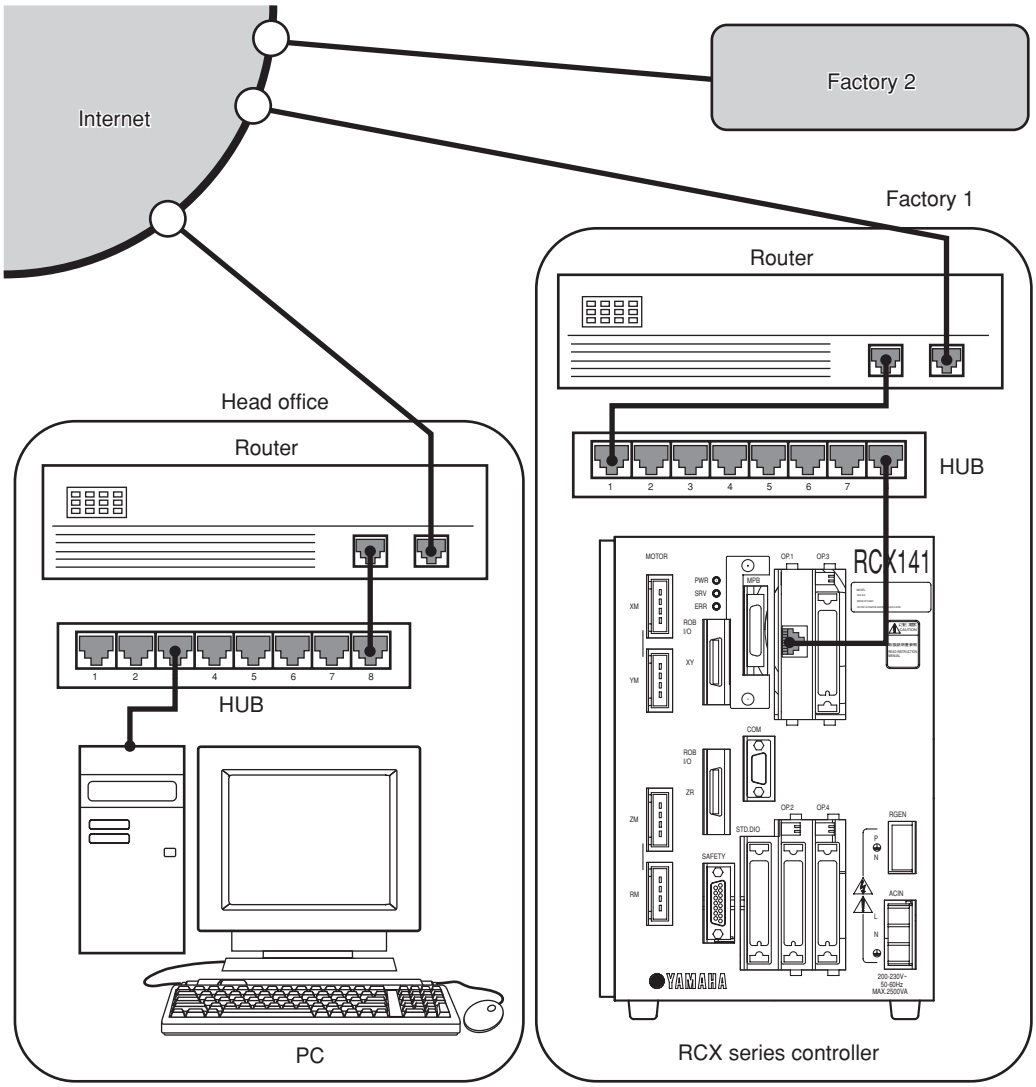
* The 10BASE-5 cable has a maximum length of 500 meters. However, this distance can be extended to a maximum of 2.5 kilometers by connecting cables together and using repeaters, etc.

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 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

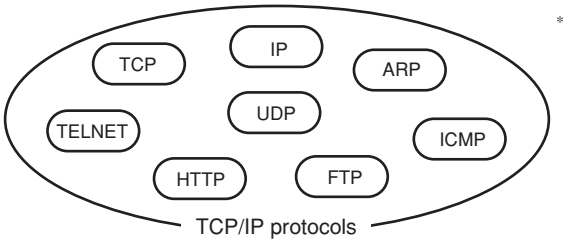
* Routers must be set to match system conditions.
* To make a connection over the Internet, a global address must be set in the IP address.
* Use of identical addresses is not allowed so customers must not use the addresses set in the above example.
  Always use the customer's own unique address. NIC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

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 for RCX series contains TCP, IP, ICMP, ARP and TELNET protocols among 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 transmission cable types such as maximum cable length and the maximum number of connections. The Ethernet unit for RCX series 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.

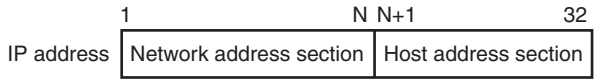
CD is a method for handling data collisions that occur on the network. In this method, when a data collision (conflict) occurs, that data is re-transmitted after a randomly selected time period has elapsed.

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

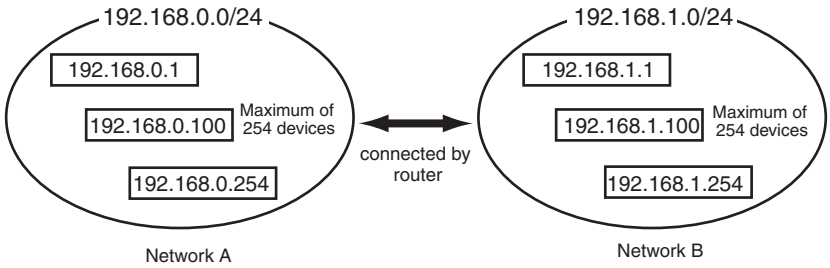
The IP address is a unique number assigned to each device to identify that device on the network and prevent the same number from being used by different devices. (More accurately, an IP address is assigned to each network interface, since once PC may sometimes be installed with multiple network interfaces.) 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.)



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.



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.

MEMO

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User's Manual

YAMAHA Robot Controller

RCX series

Ethernet network board

Sep. 2007
Ver. 1.04
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