

**Kawasaki Robot Controller
E Series**

**TCP/IP
Communication
Manual**

Robot

Kawasaki Heavy Industries, Ltd.

PREFACE

This manual gives instructions for using the 10BASE-T/100BASE-TX Ethernet-connected TCP/IP communication function with the E Series Controller.

This manual provides as much detailed information as possible on the standard operating methods for using this function. However, not every possible operation, condition or situation that should be avoided can be described in full. Therefore, should any unexplained questions or problems arise during robot operation, please contact Kawasaki Machine Systems. Refer to the contact information listed on the rear cover of this manual for the nearest Kawasaki Machine Systems office.

Read the E Controller Basic Manuals (including safety manual), delivered with the robot, without fail together with this manual. Do not perform any procedure described herein until the contents of this manual are fully understood.

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1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damages, and/or problems relating to industrial property rights as a result of using the system.
 2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
 3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
 4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
 5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different site or sold off to a different user, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.
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SYMBOLS

The items that require special attention in this manual are designated with the following symbols.

Ensure proper and safe operation of the robot and prevent physical injury or property damage by complying with the safety matters given in the boxes with these symbols.



DANGER

Failure to comply with indicated matters can result in imminent injury or death.



WARNING

Failure to comply with indicated matters may possibly lead to injury or death.



CAUTION

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation and maintenance.



WARNING

- 1. The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Should any unexplained questions or problems arise, please contact Kawasaki Machine Systems.**
- 2. Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the safety manual, all pertinent laws, regulations and related materials as well as all the safety explanation described in each chapter, and prepare safety measures suitable for actual work.**

CONTENT

| | |
|------------------------------------------------------------------------------|----|
| Preface..... | 1 |
| Symbols..... | 2 |
| | |
| 1.0 Overview of Ethernet-connected TCP/IP Communication | 5 |
| 1.1 Remote Terminal Function..... | 5 |
| 1.2 Socket Communication Function..... | 5 |
| 1.2.1 TCP Communication Instructions..... | 6 |
| 1.2.2 UDP Communication Instructions..... | 7 |
| 1.3 Support Specifications for TCP/IP Communication..... | 8 |
| | |
| 2.0 Ethernet Network Configuration and Connection with Robot Controller..... | 9 |
| 2.1 Direct Connection without Hub..... | 9 |
| 2.2 Network Connection with Hub..... | 10 |
| | |
| 3.0 Setting IP Address and Confirming Connection..... | 11 |
| 3.1 Setting IP Address and Subnet Mask | 11 |
| 3.2 Checking Connection to the Network..... | 13 |
| | |
| 4.0 Using KCwinTCP/KRterm Remote Terminal Function..... | 15 |
| 4.1 What is KCwinTCP/KRterm? | 15 |
| 4.2 System Requirements..... | 15 |
| 4.3 Installing Software and Registering Robot IP Address..... | 16 |
| 4.3.1 Installing KCwinTCP and Registering Robot IP Address | 16 |
| 4.3.2 Installing KRterm and Registering Robot IP Address | 17 |
| 4.4 Operating KCwinTCP/KRterm | 18 |
| 4.4.1 Daily Operations | 18 |
| 4.4.2 Menu | 20 |
| 4.4.2.1 File(F)..... | 20 |
| 4.4.2.2 Com(munication) (C)..... | 21 |
| 4.4.2.3 View (V)..... | 24 |
| 4.4.2.4 Help (H) | 24 |
| 4.4.3 Vertical/ Horizontal Scroll Bar..... | 24 |
| 4.4.4 Title Display | 25 |
| 4.5 Notes and Restrictions | 25 |
| 4.6 To Avoid Saving/Loading of Mistaken Robot Data..... | 26 |

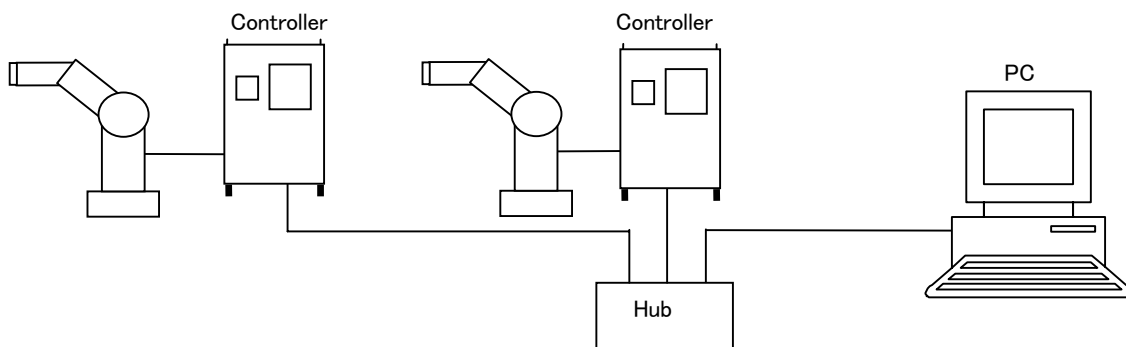
| | | |
|-------|--------------------------------------------------------------|----|
| 5.0 | Data Communication Instructions in UDP | 28 |
| 5.1 | Communication Errors in UDP_SENDTO and UDP_RECVFROM | 33 |
| 6.0 | Data Communication Instructions in TCP | 34 |
| 6.1 | Communication Errors in Socket Communication | 49 |
| 6.2 | Sample Program Using Socket Communication Instructions | 51 |
| 6.2.1 | When Robot is the Server-Side | 51 |
| 6.2.2 | When Robot is the Client-Side | 54 |
| 7.0 | Error Message | 56 |

1.0 OVERVIEW OF ETHERNET-CONNECTED TCP/IP COMMUNICATION

To use the functions below, create an Ethernet network as shown in the diagram below by connecting Ethernet port on main CPU board and external devices (e.g. PC) using 10BASE-T/100BASE-TX cable.

Remote terminal function

Socket communication function



1.1 REMOTE TERMINAL FUNCTION

By installing KCwinTCP/KRterm, software provided by Kawasaki, in a Windows computer, operations such as entering AS monitor commands from PC are made possible via Ethernet-connected TCP/IP communication in addition to the RS232 communication (standard feature).

1.2 SOCKET COMMUNICATION FUNCTION

This communication function provides commands based on socket interface in TCP/IP communication enabling data communication between robot controller and other devices.

Two types of communication commands are provided:

1. TCP communication instructions
2. UDP communication instructions

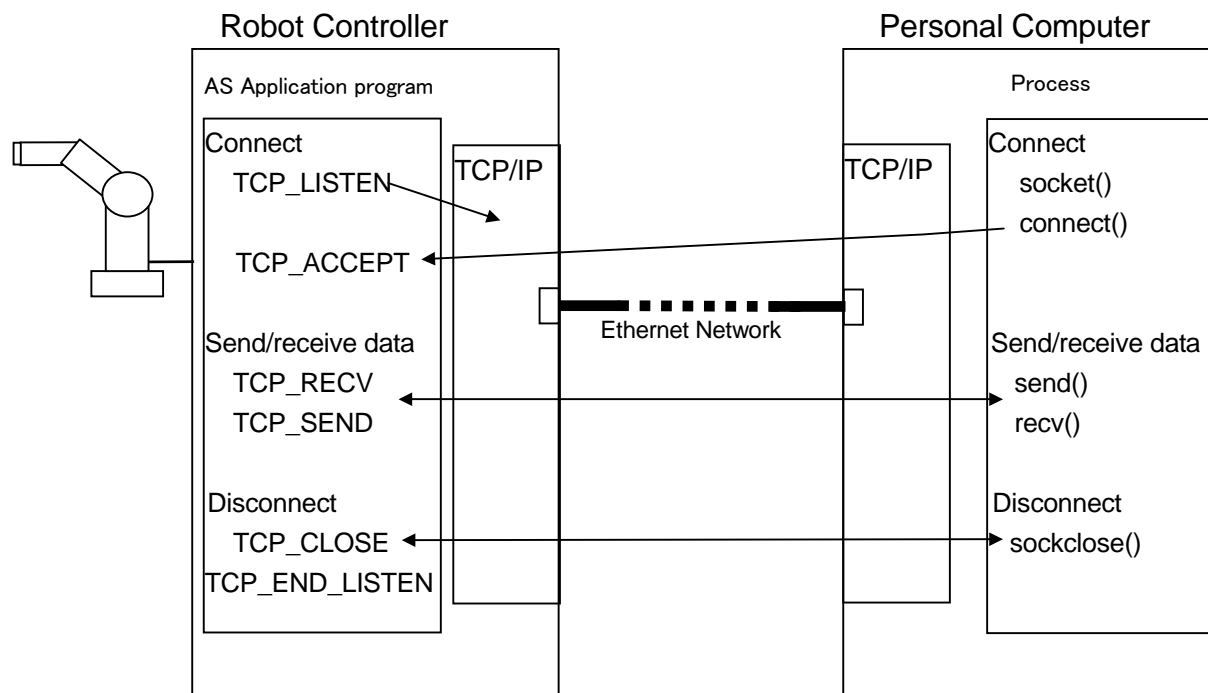
In TCP communication, data is automatically re-sent when communication errors occur. It is used in applications where certainty of the communication is important. In UDP communication, data is not re-sent after an error. It is used when speed is important.

1.2.1 TCP COMMUNICATION INSTRUCTIONS

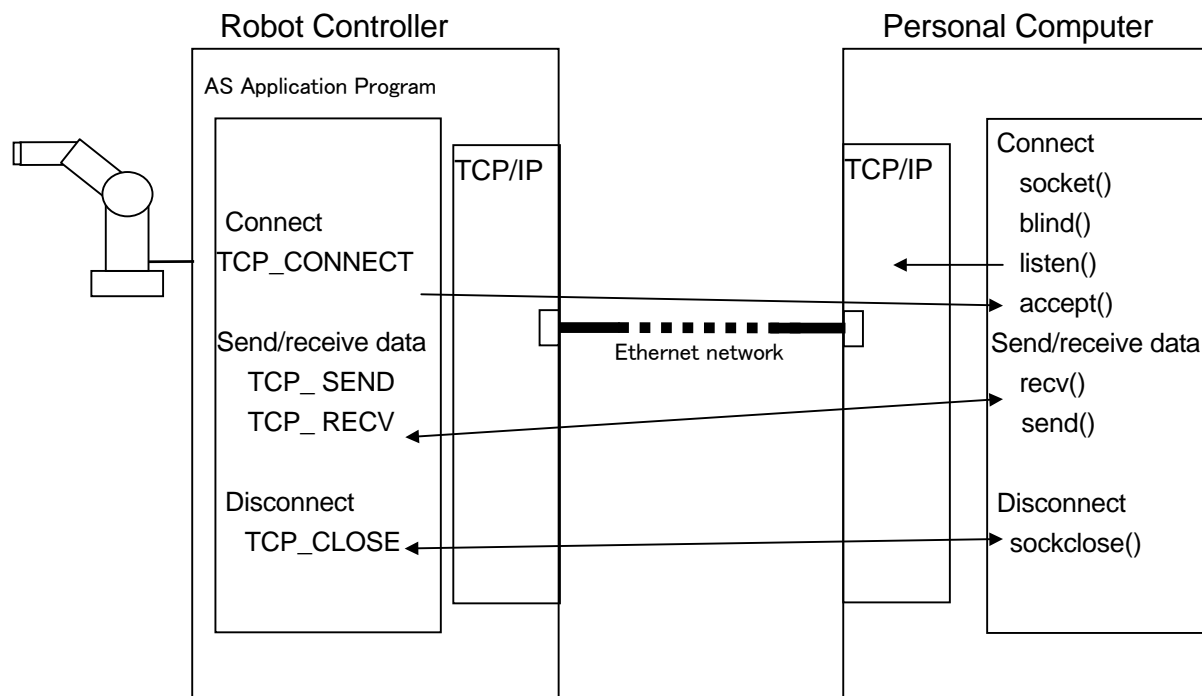
Available TCP communication instructions:

- | | |
|-----------------|--------------------------------------------------|
| •TCP_LISTEN | Creates socket and waits for connection requests |
| •TCP_ACCEPT | Checks if connection request is received |
| •TCP_CONNECT | Creates a socket and sends connection request |
| •TCP_SEND | Sends data string |
| •TCP_RECV | Receives data string |
| •TCP_CLOSE | Aborts socket communication |
| •TCP_END_LISTEN | Ends waiting for connection request |

Example: Robot as server

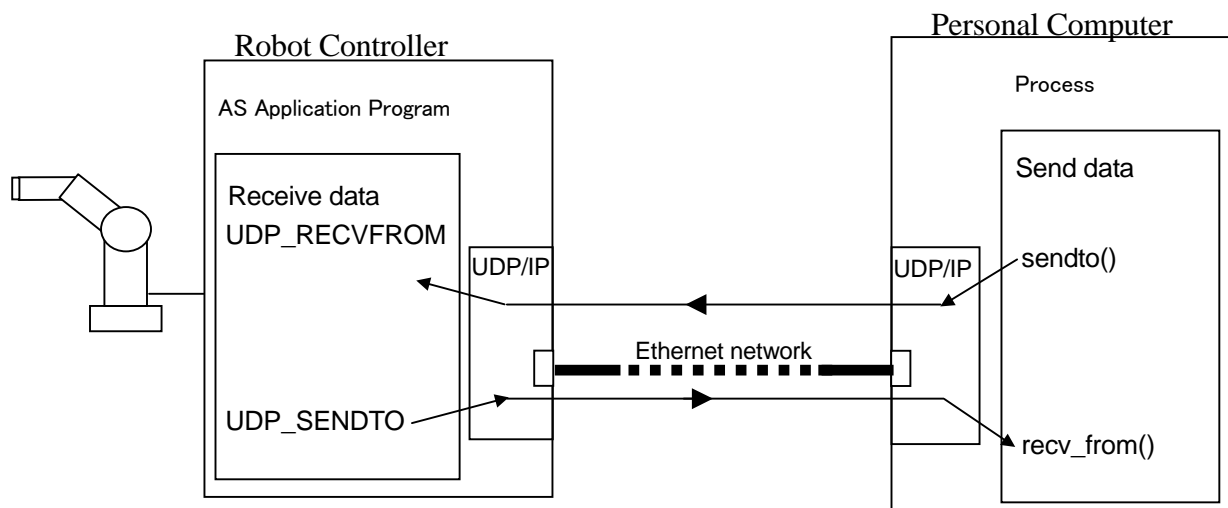


Example: Robot as client



1.2.2 UDP COMMUNICATION INSTRUCTIONS

There are two UDP communication instructions: UDP_SENDTO (sends data) and UDP_RECVFROM (receives data).



1.3 SUPPORT SPECIFICATIONS FOR TCP/IP COMMUNICATION

1. 10BASE-T/100BASE-TX Ethernet
2. Network connection transmission rate: 10Mbps/100Mbps
3. Connected using RJ045 Connector
4. Protocols: IP, ARP, RARP, ICMP, TCP, UDP, TELNET (Server)

2.0 ETHERNET NETWORK CONFIGURATION AND CONNECTION WITH ROBOT CONTROLLER

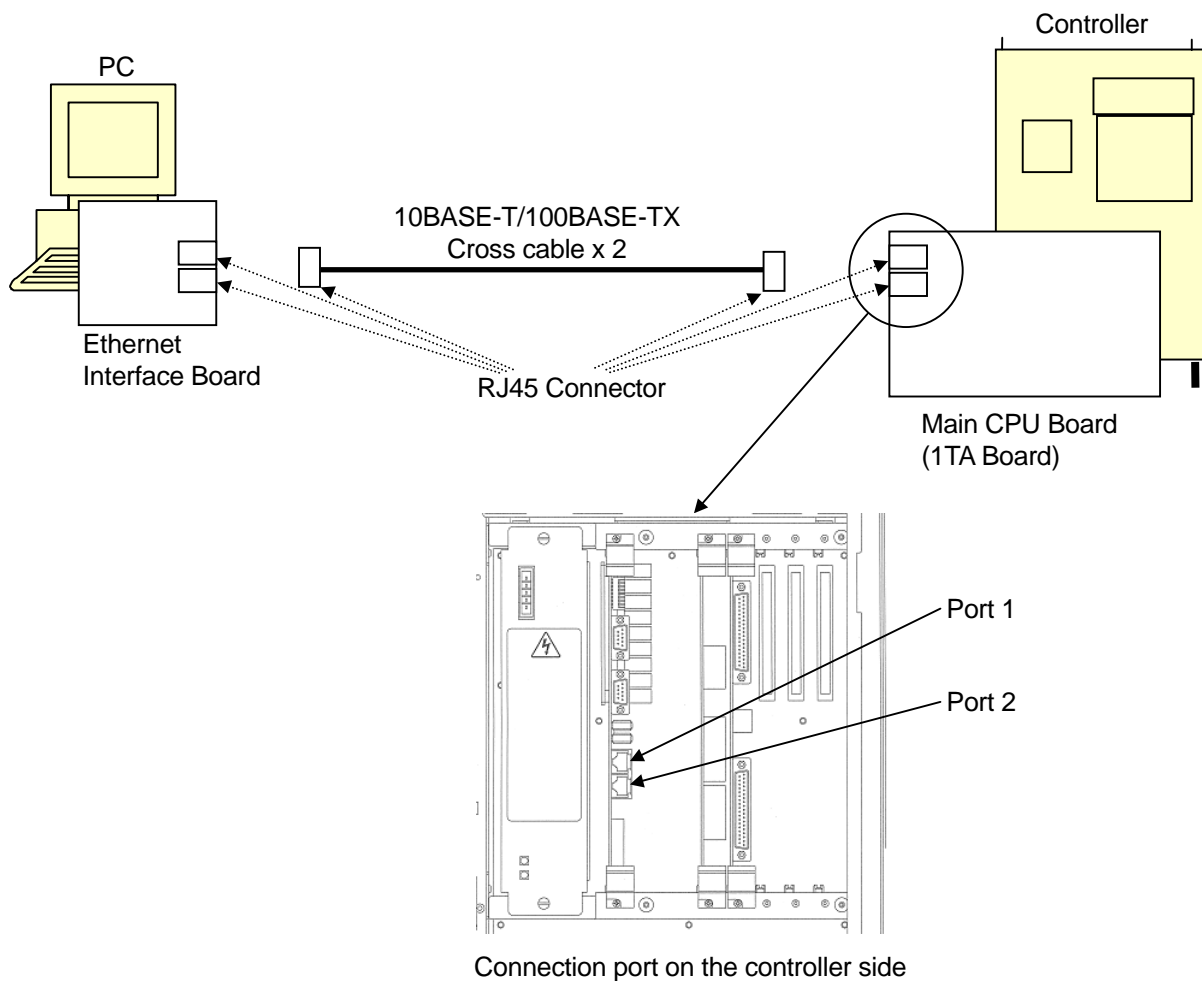
This section explains how an Ethernet network is created using an example of connecting a PC (external computer) with a robot controller.

The PC can be connected with the robot controller in two ways:

1. Connection of two controllers to one computer without using a hub
2. Connection of two or more computer systems (including robot controllers) using Ethernet via a hub.

2.1 DIRECT CONNECTION WITHOUT HUB

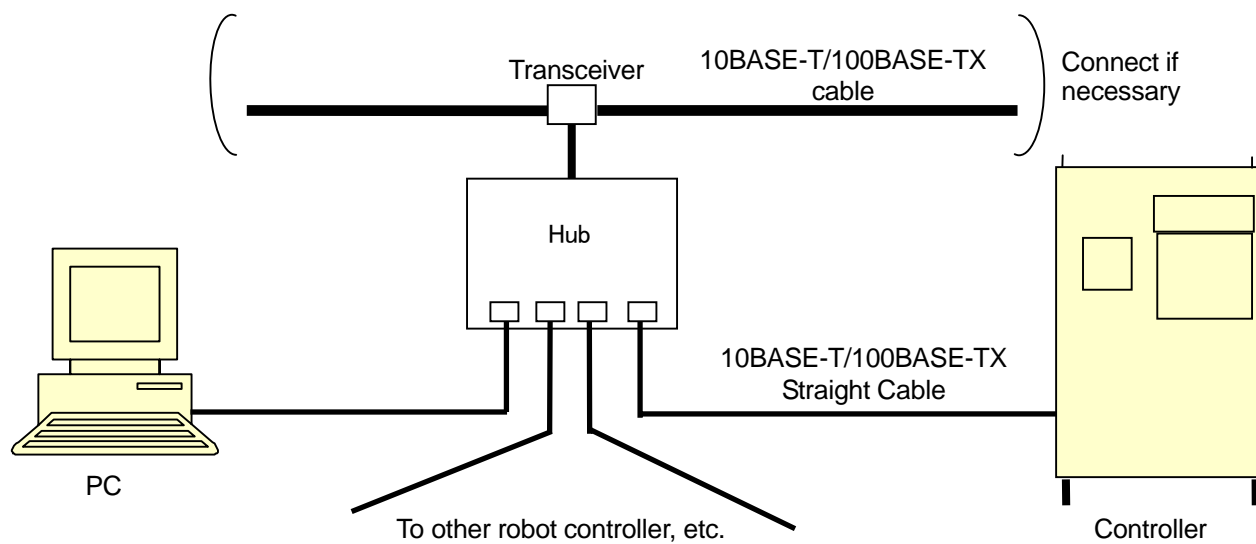
This diagram shows connection without hub.



In this case, use 10BASE-T/100BASE-TX cross cable for connecting.

2.2 NETWORK CONNECTION WITH HUB

This diagram shows the network using a hub connected with 10BASE-T/100BASE-TX.



In this case, use 10BASE-T/100BASE-TX straight cable for connecting.

3.0 SETTING IP ADDRESS AND CONFIRMING CONNECTION

To set the IP address and confirm connection, the robot controller and a Windows-based PC have to be connected to the network. After connecting the hardware, an IP address for the robot controller must be set on the network in order to use the TCP/IP communication function.

3.1 SETTING IP ADDRESS AND SUBNET MASK

Register the IP address and the subnet mask for the controller before using the TCP/IP communication function.

To set the IP address and subnet mask, execute NETCONF monitor command via teach pendant or a KCwin/KCwinTCP/KRterm remote terminal screen on a RS232C-connected PC.

The following example shows setting procedure for the port 1.

Example

>NETCONF

IP address = 192.168.0.2

Change ? (If not, press RETURN only)

123.123.123.123

IP address = 123.123.123.123

Change ? (If not, press RETURN only)

Host name =

Change ? (If not, press RETURN only)

KAWASAKI

Host name = KAWASAKI

Change ? (If not, press RETURN only)

Subnet mask = 255.255.240.0

Change ? (If not, press RETURN only)

255.255.255.0

Subnet mask= 255.255.255.0

Change ? (If not, press RETURN only)

Gateway IP = 0.0.0.0

Change ? (If not, press RETURN only)

255.255.255.0

Gateway IP = 255.255.255.0

Change ? (If not, press RETURN only)

DNS server 1 IP = 0.0.0.0

Change ? (If not, press RETURN only)

123.123.123.1

DNS server 1 IP = 123.123.123.1

Change ? (If not, press RETURN only)

DNS server 2 IP = 0.0.0.0

Change ? (If not, press RETURN only)

123.123.123.2

DNS server 2 IP = 123.123.123.2

Change ? (If not, press RETURN only)

Domain name =

Change ? (If not, press RETURN only)

kawasaki_robot

Domain name = kawasaki_robot

Change ? (If not, press RETURN only)

MAC address = 00:09:0f:00:ff:01

(W1018)Turn control power ON/OFF to change network setting.

>

For setting for the port 2, input NETCONF 2: instead of NETCONF.

IP address can be set via teach pendant. See the Operation Manual for setting the IP address via TP (Auxiliary function 0812 Network Setting).

After registering the IP address, reboot the robot controller by turning control power OFF → ON.

3.2 CHECKING CONNECTION TO THE NETWORK

Once Ethernet-connected interface for the robot controller is opened and properly started, connect a Windows PC to the same network and confirm the connection using the ping command in MS-DOS Prompt screen. Before checking with ping command, the Windows PC needs to be set for Ethernet connection (register IP address and subnet mask) and rebooted.

1. Open MS-DOS Prompt screen in a Windows PC.
2. In MS-DOS Prompt screen, enter:

```
>ping IP_address
```

IP_address is the IP address of the robot controller to be connected. If the connection is functioning properly, the following message appears.

Example C:>ping 001.002.003.004
Pinging 001.002.003.004 with 32 bytes of data:
Reply from 001.002.003.004: bytes=32 time=53ms TTL=64
Reply from 001.002.003.004: bytes=32 time=5ms TTL=64
Reply from 001.002.003.004: bytes=32 time=24ms TTL=64
Reply from 001.002.003.004: bytes=32 time=11ms TTL=64
Ping statistics for 001.002.003.004:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
Minimum = 5ms, Maximum = 53ms, Average = 23ms

If the connection is not properly established, error messages such as timeout error will be displayed.

Example C:>ping 001.002.003.005
Pinging 001.002.003.005 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.
Ping statistics for 001.002.003.005:
Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
Minimum = 0ms, Maximum = 0ms, Average = 0ms

This error can occur due to following causes. Check and correct the error and retry until connection is successful.

1. The power for hub is not ON.
2. The network cable connector is faulty or not connected correctly.
3. Incorrect cable is used.
4. IP address setting for the robot is not correct.

Generally, there are LEDs on the hub or Ethernet connection interface devices. The signal status can be checked by these LEDs. Use this information for troubleshooting when connection does not succeed.

4.0 USING KCWINTCP/KRTERM REMOTE TERMINAL FUNCTION

KCwinTCP/KRterm have Ethernet-connected remote terminal function. When installed on Windows PC, both software allow remote operation of robots from PC. Before terminal operation, it is necessary to identify which robot to be used by its IP address. When the robot is successfully connected, terminal operations such as entering monitor commands are possible. After the necessary operations are finished, end the connection using the designated instructions.

Only three PCs can be connected to one controller at a time. In other words, when the controller is connected to three PCs, remote terminal operations from other PC are not possible until that connection is terminated.

Instructions for operating the KCwinTCP/KRterm remote terminal function are explained below.

4.1 WHAT IS KCWINTCP/KRTERM?

KCwinTCP/KRterm is terminal software for the Kawasaki robot controller. When this software is installed on a PC and the PC is connected to controller by Ethernet connection, the following operations are possible by TCP/IP communication.

- AS monitor command input from PC
- Saving/loading controller memory contents to/from PC
- etc.

4.2 SYSTEM REQUIREMENTS

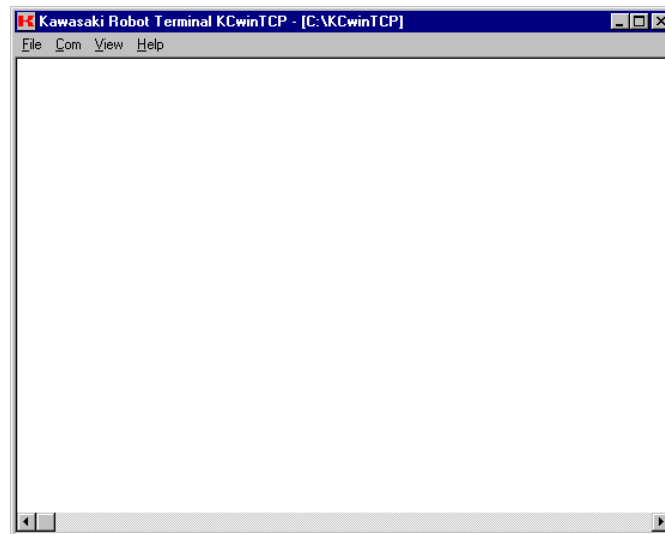
| | |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hardware | PC with CPU of 80486 or more, and operating with Microsoft Windows. |
| OS | KCwinTCP) Microsoft Windows 95/98/NT4.0/2000/XP KRterm) Microsoft Windows 2000/XP/Vista |
| Confirmed operation models* | KCwinTCP) Toshiba Personal Computer Dynabook Satellite 2520 (Windows98) Compaq Armada 1500C (Windows98) IBM ThinkPad 365X (Windows95) KRterm) DELL Inspiron 8000 (Windows2000) Lenovo ThinkCentre (WindowXP) Gateway GT5228J (Windows Vista) |

NOTE* Kawasaki is not responsible for use of KCwinTCP on unconfirmed hardware/OS.

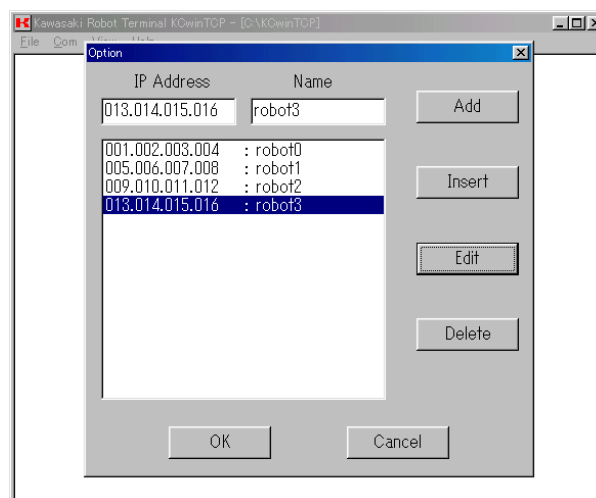
4.3 INSTALLING SOFTWARE AND REGISTERING ROBOT IP ADDRESS

4.3.1 INSTALLING KCWINTCP AND REGISTERING ROBOT IP ADDRESS

Install (copy) KCwinTCP provided by Kawasaki in the desired directory of your Windows PC. After installing, double-click on the KCwinTCP icon. KCwinTCP starts and the window below appears.



Register the robot controllers to be connected. Select [Com]→[Options] from the menu bar.



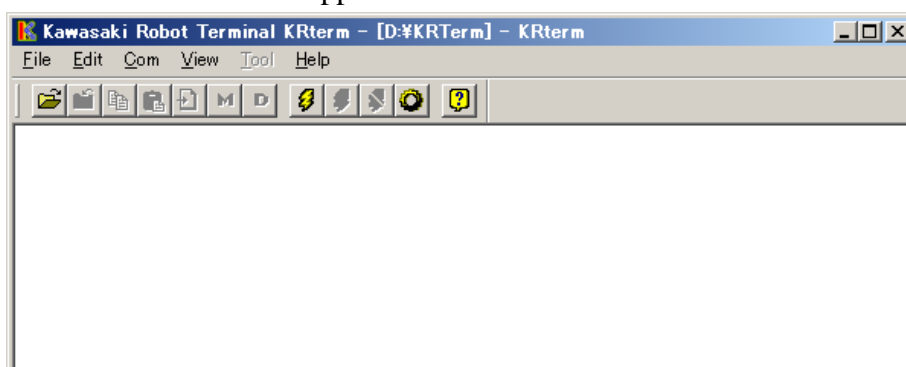
In the window that appears, enter the IP address and the name for the robot controllers on the network and click <OK>. (Several registrations are available.)

4.3.2 INSTALLING KRTERM AND REGISTERING ROBOT IP ADDRESS

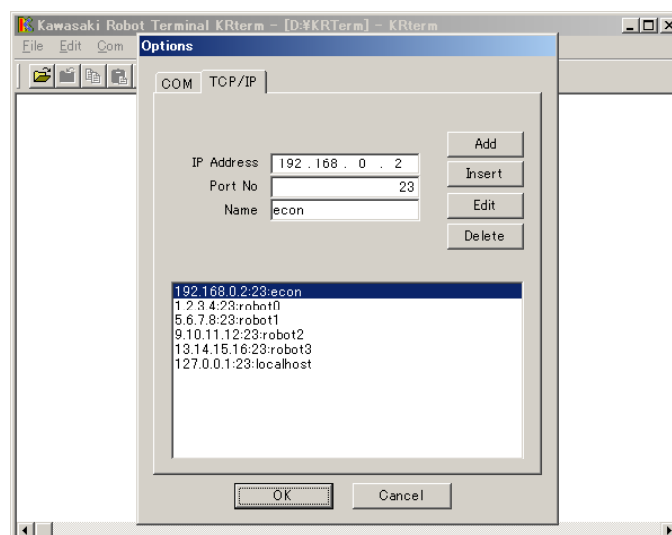
Install (copy) KRterm software (setupJ.exe) provided by Kawasaki in the desired directory of your Windows PC. After that, follow the instructions of installer.



After installation is complete, select KRterm icon with your mouse and double-click it. Then KRterm starts and window screen appears.



Register the robot controllers to be connected. Select [Com]→[Options] from the menu bar. In the window that appears, enter the IP address and the name for the robot controllers on the network and click <OK>.



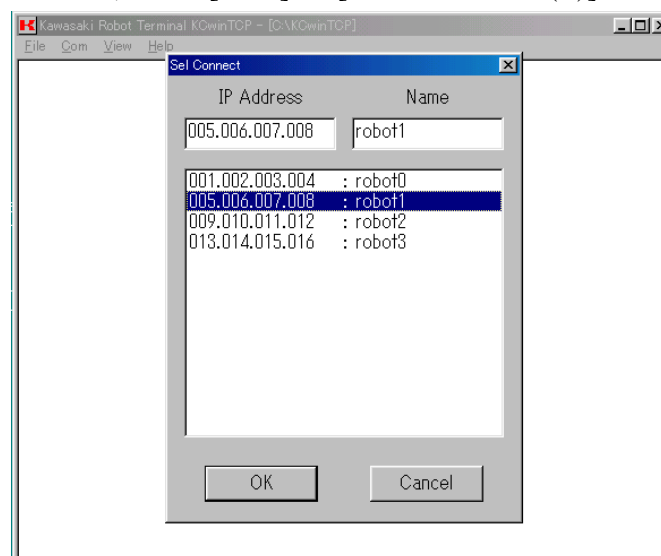
4.4 OPERATING KCWINTCP/KRTERM

4.4.1 DAILY OPERATIONS

1. Turn ON the controller. Do not initialize the controller. TELNET server function starts and the controller is now waiting for connection from client PC.

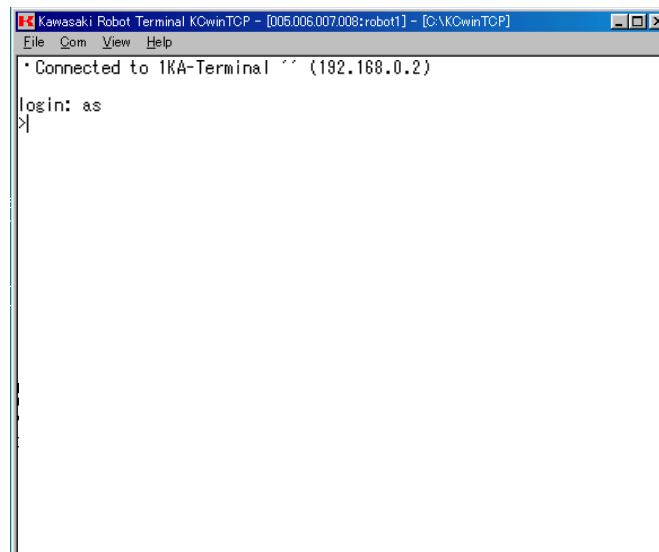
2. Start KCwinTCP/KRterm

Double-click on the KCwinTCP/KRterm icon. KCwinTCP/KRterm starts and a window appears. In this window, select [Com] → [Sel Connection (E)] from the menu bar.



Select the IP address of the robot to be connected using the cursor keys. Click <OK>.

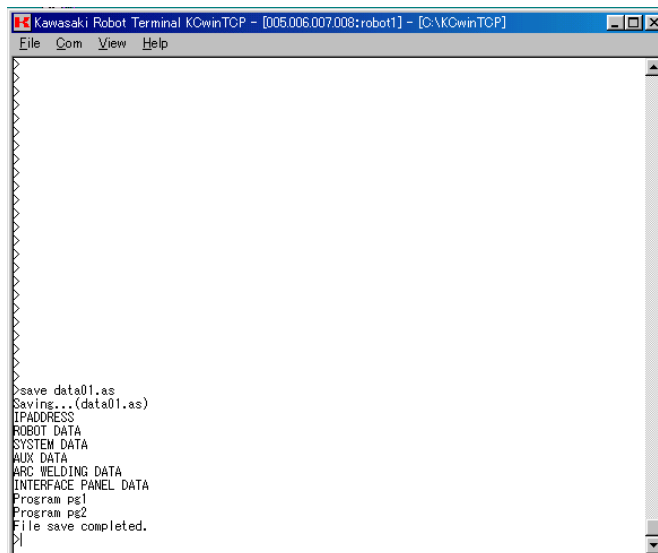
PC tries to connect with the specified IP address. When the connection is successfully established, login: appears following several other messages. Enter “as” after this message, and the robot will return a prompt.



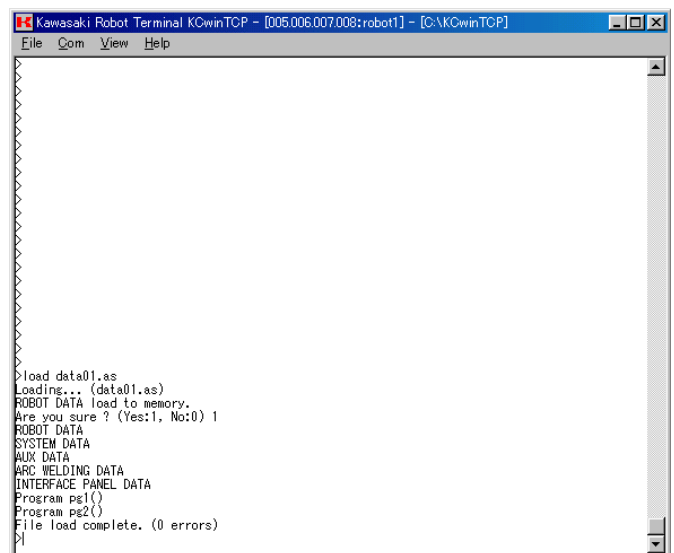
Now, AS monitor commands can be entered from the PC.

When uploading or downloading teach data between PC and controller, enter SAVE/LOAD monitor commands the same as in AS terminal.

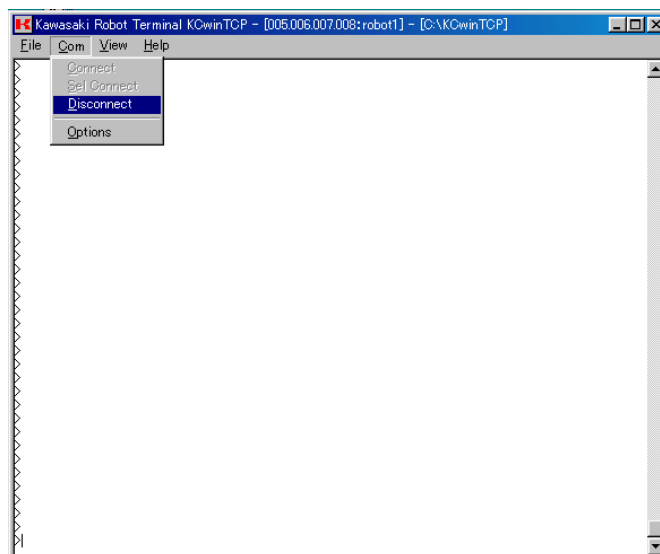
▪ When executing SAVE command



When executing LOAD command



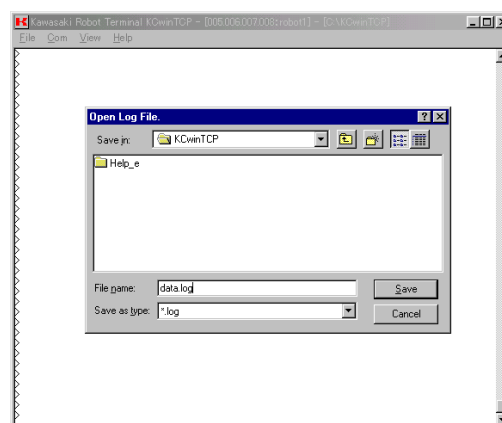
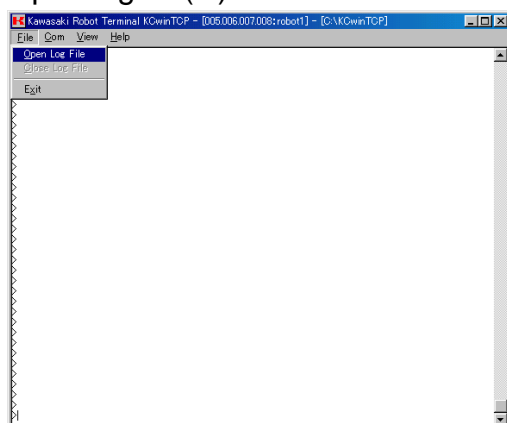
After all operations are finished, abort the connection. Select [Communication] → [Disconnect] from the menu bar.



4.4.2 MENU

4.4.2.1 FILE(F)

Open log file(O)



To save the characters displayed on screen as a log file, specify a file as above. (Default for extension log files is .log.)

Close log file(C)

Ends logging.

Exit(X)

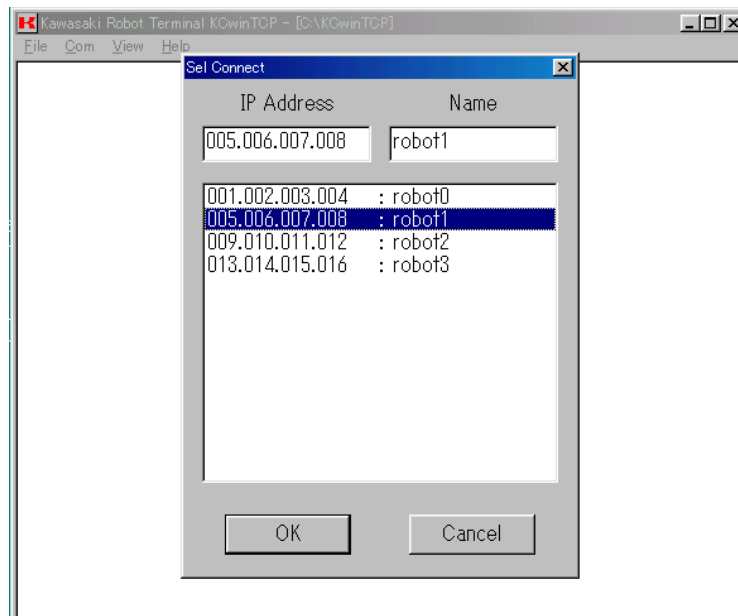
Terminates KCwinTCP/KRterm.

4.4.2.2 COM(MUNICATION) (C)

Connect(C)

Establishes connection with the robot whose IP address and port number were last used.

Sel(ect) Connect(ion)(E)



The IP addresses registered in [Options (O)] or [Sel. connect] are displayed in a list. Select the desired IP address and click <OK> to establish connection with that robot.

<OK>

Connects with the selected IP address.

<Cancel>

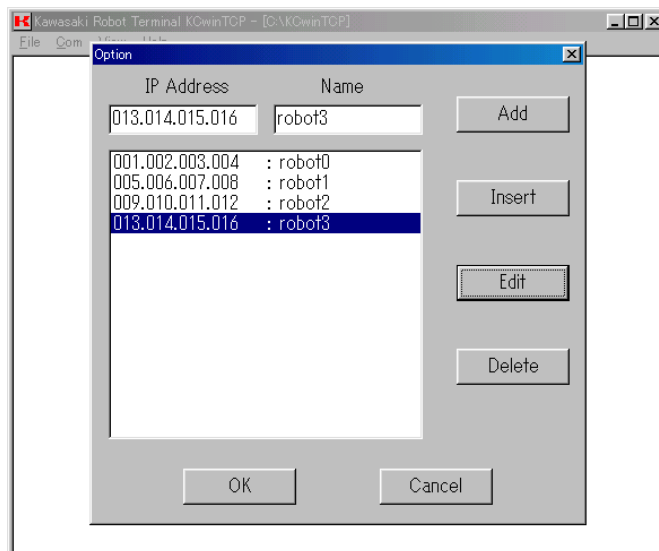
Terminates without making any connections.

Disconnect (D)

Terminates connection.

Options (O) (Only KCwinTCP displays this.)

Registers the IP address and names of the robots on the network. Maximum of 256 robots can be registered.



IP address

Enter the IP address of the robot to be connected.

Name

Enter the name (nickname) of the robot to be connected.

<Add>

Adds the entered IP address and name to the list.

<Insert>

Inserts the IP address and name above the cursor.

<Edit>

Overwrites the selected IP address and name with new contents.

<Delete>

Deletes the selected IP address and name from the list.

<OK>

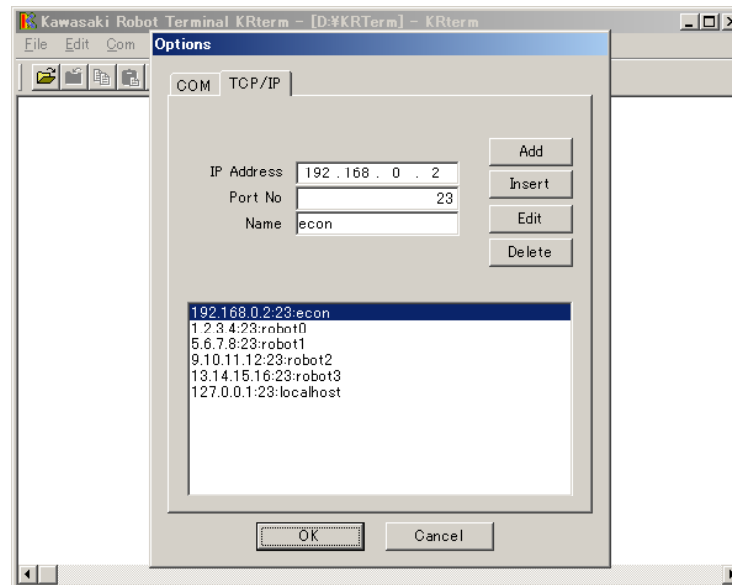
Overwrites contents and puts in effects all changes made to KCWINTCP.INI and terminates the Option screen.

<Cancel>

Terminates the screen without saving the changed contents. (KCWINTCP.INI is not overwritten.)

Options (O) (Only KRterm displays this.)

Registers the IP address and names of the robots on the network. Maximum of 256 robots can be registered.



IP address

Enter the IP address of the robot to be connected.

Port number

Port No.23 (to connect TELNET) is input by default.

Name

Enter the name (nickname) of the robot to be connected.

<Add>

Adds the entered IP address and name to the list.

<Insert>

Inserts the IP address and name above the cursor.

<Edit>

Overwrites the selected IP address and name with new contents.

<Delete>

Deletes the selected IP address and name from the list.

<OK>

Overwrites contents and puts in effects all changes made to KRterm.INI and terminates the Option screen.

<Cancel>

Terminates the screen without saving the changed contents. (KRterm.INI is not overwritten.)

4.4.2.3 VIEW (V)

Font (F)

Selects the font of the characters used on the screen.

Screen (W)

Set a number of scroll buffer and colors of screen background and text.

4.4.2.4 HELP (H)

Contents (C)

Opens the table of contents for KCwinTCP/KRterm operation instructions.

About KCwin (A)

Displays KCwinTCP/KRterm version information.

4.4.3 VERTICAL/ HORIZONTAL SCROLL BAR

The vertical scroll bar appears when the data exceeds the number of rows in the screen.

Maximum of 200 for KCwinTCP and 1000 for KRterm rows can be displayed using the scroll bar.

4.4.4 TITLE DISPLAY

The following information is shown on the title bar.

Example



[192.168.29.128:econ]

The current client is shown in the format [client IP address: name]. When no connection is established, nothing is displayed here.

[D:¥KRterm]

If only the file name is specified in AS language LOAD/SAVE command, the data will be saved/ loaded to/ from this directory. The directory can be changed through Menu→[File(F)] →[Set current folder(S)].

[Logging]

This is displayed while the screen data is being saved to the log file.

4.5 NOTES AND RESTRICTIONS

When connection is aborted during an execution of a monitor command, that command (e.g. EDIT) should first be terminated in the robot controller using ABORT.

Do not disconnect from the PC side until the command has been executed. If you have disconnected by mistake, immediately re-connect and check if that command was executed properly.

When the connection is aborted from the robot side (i.e. the OS displays a disconnection message), KCwinTCP/KRterm automatically cuts off connection. If it does not cut off automatically, manually disconnect KCwinTCP/KRterm.

AS commands FDIRECTORY, FDELETE, FORMAT are not supported in KCwinTCP/KRterm (Use Windows Explorer to perform such operations.)

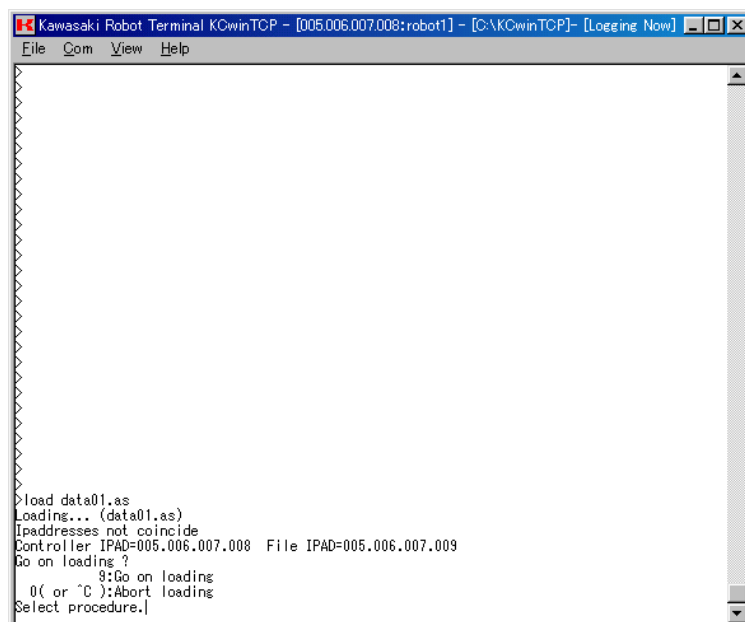
4.6 TO AVOID SAVING/LOADING OF MISTAKEN ROBOT DATA

Because more than one robot is connected to the network, there is the chance that a wrong robot data may be loaded to the robot. Also, data from a wrong robot may overwrite a saved file.

To avoid this, KCwinTCP/KRterm checks if the data is correct before loading. At the beginning of the data, the IP address data is stored when saving the file. (See line starting with .NETCONF below).

```
*****
.
*=== AS GROUP ===      : ASE_010000008 2009/04/06 16:11
*USER IF AS            : UASE010000008 2009/04/06 16:11
*USER IF TP            : UTPE010000008 2009/04/06 16:11
*ARM CONTROL AS        : AASE010000008 2009/04/06 16:11
*USER IF AS MESSAGE FILE : MASE0000008JP 2009/04/06 15:59
*USER IF TP MESSAGE FILE : MTPE0000008JP 2009/04/06 15:57
*ARM DATA FILE        : ARME010000008 2009/04/06 16:11
*KERNEL                : _KNL000000000 2000/00/00
*DRIVER                : _DRV100800000 2008/11/11
*=== SERVO GROUP ===   : SVE_080000007 2009/02/06 17:08
*ARM CONTROL SERVO      : ASVE080000007 2009/02/06 17:03
*SERVO DATA FILE       : ASPE080000007 2009/02/06 17:04
*ARM CONTROL SERVO FPGA : ASFE080000005 2008/12/08 13:28
*   [Shipment setting data]
*There is no Shipment setting data.
*****
.NETCONF      192.168.0.2,"KAWASAKI",255.255.255.0,255.255.255.0,0.0.0.0,0.0.0.0," "
.NETCONF2     192.168.11.2,255.255.255.0,0.0.0.0
.ROBOTDATA1
ZROBOT.TYPE   10  21   6   1      -571   RS020N-A001 ( 2009-04-06 16:40 )
ZSYSTEM       1   5   1      -106
ZLINEAR       0   0   0   0   0   0   0  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1
179
CONT_CODE     701      -10516
ZZERO         268428834 268435247 268432164 268434514 268429628 268427819 268435456
268435456 268435456 268435456 268435456 268435456 268435456 268435456 268435456
268435456 268435456 268435456 537238861
```

KCwinTCP/KRterm checks if the IP address in the line beginning with .NETCONF is the same as the IP address of the controller. If they are not the same, KCwinTCP/KRterm asks whether loading should be continued or not. Check if the data is correct and enter 9 to continue, and 0 to terminate.



5.0 DATA COMMUNICATION INSTRUCTIONS IN UDP

The following instructions enable data communication between robot controller and computer system via Ethernet UDP/IP.

UDP_SENDTO Program Instruction to send data

Sends the specified character string data based on UDP/IP. This instruction creates socket, sends data and closes the socket in one sequence.

UDP_RECVFROM Program Instruction to receive data

Receives and stores data in the specified character string array based on UDP/IP. This instruction creates socket, receives data and closes the socket in one sequence.

Example

Keyword




Parameter



UDP_SENDTO variable for returned value, IP address array variable, ...

Parameters marked with can be omitted.

Always enter a space between the keyword and the first parameter.

 represents the Enter (Return) key in the examples.

Program Instruction

UDP_SENDTO variable for returned value, IP address array variable,
port number, character string variable array for sending data,
number of elements, **timeout**

Function

Sends data string based on UDP protocol. The data to be sent is specified in a character string variable array. This instruction creates socket, sends data and closes socket in one sequence. If communication error occurs, the error code is stored in the returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 5.1 for details on communication error codes.

IP address array variable

- Specifies the first element of the array variable storing the IP address of the destination computer system. The IP address is stored in 8 bits increments to each element of the array variable.
- Data beyond 0 - 255 is regarded as error. The first data must be between 0 - 247, if not an error occurs.

Port number

- Specifies the port number that indicates the channel of the other end of the connection (process). The socket is bound to this port number.
- Acceptable range is 8192 - 65535, otherwise error occurs.

Character string variable array for sending data

- Specifies the first element of the character string array that stores the data to be sent.
- Array elements are sent in order from first to last.
- Change the data to be sent into character string format. Numeric data can be sent once transformed into character string format. Ensure the encoding format is consistent with that in the recipient (big endian/little endian, etc.).

- The maximum amount of data that can be sent in execution of one instruction is 1472 bytes.

Number of elements

- Specifies the number of elements to send in the character string variable array.
- These array elements are sent to the recipient in order of index number.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. Default is 1 second.
- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

Example

Increasing the count whenever robot operation is performed.

```
.PROGRAM pg1
:
Motion instructions
:
count = count + 1
$cnt[0]=$ENCODE(/D,count)
CALL send(.$cnt[])
.END
```

Sending the number of motions robot performed.

```
.PROGRAM send(.$cnt[])
UDP_SENDTO ret,ip[0],49152,.$cnt[0],1,2
IF ret<>0 THEN
TYPE "ERROR!"
HALT
END
.END
```

Program Instruction

UDP_RECVFROM variable for returned value, port number,
character string variable array for received data, number of elements,
timeout, IP address array variable, Max. number of bytes

Function

Receives and stores data in the character string variable array based on UDP protocol. This instruction creates socket, receives data, and closes socket in one sequence. If a communication error occurs, the error code is stored in the returned value storage variable, and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 5.1 for details on communication error codes.

Port number

- Specifies the port number that indicates the channel of the other end of the connection (process). The socket is bound to this port number.
- Acceptable range is 8192 – 65535, otherwise error occurs.

Character string variable array for received data

- Specifies the first element of the character string variable array that stores the received data.
- Data is received as continuous character data of 1 byte each. When receiving numeric data (transformed into character string data), ensure the encoding format is consistent with the sender (big endian/ little endian, data segmentation etc).
- The maximum amount of data that can be received in one instruction is 1472 bytes.

Number of elements

- Sets the variable to substitute the number of elements in the received character string variable array.
- Should be specified as a variable.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. The default setting is 1 second.
- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

IP address array variable

- Specifies the first element of the array variable to store the IP address of the node that sent the data. The 32 bits in the IP address is divided into 4 elements with 8 bits each, and each element is stored in the array elements in the specified array.

Maximum number of bytes

- Specifies the maximum number of bytes that can be stored in an element of the character string variable array.
- Acceptable range is 1 – 255, otherwise error occurs. Default setting is 255 bytes.

Example

```
Robot activated by value .start_flg.
.PROGRAM pg1
CALL rcv(.start_flg)
IF .start_flg == 1 THEN
:
Motion instructions
:
END
.END

Operating the robot based on operations received from another robot
.PROGRAM rcv(.start_flg)
UDP_RECVFROM ret,49152,$cnt[0],p,1,ip[0],255
IF ret<>0 THEN
TYPE "ERROR!"
HALT
END
num = VAL($cnt[0])
IF num%10 == 0 THEN
.start_flg = 1
ELSE
.start_flg = 0
END
.END
```

5.1 COMMUNICATION ERRORS IN UDP_SENDTO AND UDP_RECVFROM

| Code | Error message | Description | Countermeasure |
|-------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E4019 | TCPIP) Socket open failure. CODE=XX Dst.IP=XX.XX.XX.XX | Failed to open socket when executing UDP_SENDTO/UDP_RECVFROM. Too many sockets may have been opened. Or, parameter error e.g. wrong IP address. | Do not execute too many of this instruction. Fix incorrect parameter. CODE shows the SUB error code of TCP/IP package. |
| E4020 | TCPIP) Socket close failure. CODE=XX Dst.IP=XX.XX.XX.XX | Failed to close socket when executing UDP_SENDTO/UDP_RECVFROM. Possible problem along Ethernet or at other end of connection. | Check for problems in node at the other end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |
| E4021 | TCPIP)Communication Error. CODE=XX Dst.IP=XX.XX.XX.XX | Communication error during execution of UDP_SENDTO/UDP_RECVFROM. Possible problem along Ethernet or at other end of connection. | Check for problems in node at the other end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |
| E4022 | TCPIP)Too Long Message. | Tried to send data longer than the limit while executing UDP_SENDTO/UDP_RECVFROM. | Fix data to be within limit size and re-try the program. |
| E4023 | TCPIP)Cannot reach the Host | Could not connect with the host when executing UDP_SENDTO/UDP_RECVFROM. There is no host with this IP address on the network. Port number or IP address may be wrong. Or, possible problem along Ethernet or at other end of connection. | Check if port number or IP address is correct and correct it if it is wrong. Check for problems in node at the other end of connection or in the connection line. Fix accordingly. |
| E4024 | TCPIP)Communication Time Out. Dst.IP=XX.XX.XX.XX | Timeout occurred during execution of UDP_SENDTO/UDP_RECVFROM. Possible problem along Ethernet or at other end of connection. | Check for problems in node at the other end of connection or in the connection line. Fix accordingly. |
| E4025 | TCPIP)Connection aborted. | Connection was aborted while executing UDP_SENDTO/UDP_RECVFROM. Possible problem along Ethernet or at other end of connection. | Check for problems in node at the other end of connection or in the connection line. Fix accordingly. |
| E4026 | TCPIP)No Buffer Space. | Communication error occurred during execution of UDP_SENDTO/UDP_RECVFROM. TCP/IP system resource (queue, buffer) may be lacking. Or, possible problem along Ethernet or at other end of connection. | Stop some TCP/IP applications working at the same time. Reboot the controller. |
| E4027 | TCPIP)Bad Socket. | Could not connect when executing UDP_SENDTO/UDP_RECVFROM. Port number or IP address may be wrong. Or, possible problem along Ethernet or at other end of connection. | Check port number or IP address and correct if necessary. Check for problems in node at the other end of connection or in the connection line. Fix accordingly. |

6.0 DATA COMMUNICATION INSTRUCTIONS IN TCP

The following program instructions are provided to allow data transmission between robot controller and other computer systems via Ethernet TCP.

TCP_LISTENProgram Instruction to start waiting for connection request (used by server-side to start communication service)

Creates socket, binds it to the specified port number and waits for connection request to the socket. This is used when robot controller is used as the server.

Check if connection request is received using the below **TCP_ACCEPT** instruction.

TCP_ACCEPTProgram Instruction to check connection request (used by server-side to start communication service)

Checks if the specified port has received connection request for socket communication. This instruction is completed when the specified port receives connection request.

Use **TCP_ACCEPT** after creating a socket using **TCP_LISTEN**. After connection is confirmed by this command, use the **TCP_SEND** and **TCP_RECV** instructions below to send/ receive data.

TCP_CONNECTProgram Instruction to request connection (Used by client-side to start communication service)

Creates socket and binds it to the specified port number. Then, connection request for socket communication is send to the specified node, and connection is established. Use **TCP_CONNECT** when robot is the client.

After connecting via **TCP_CONNECT**, use **TCP_SEND** and **TCP_RECV** instructions to send/ receive data to/ from the server.

TCP_SEND Program Instruction to send data

Sends the specified character string data based on TCP protocol.

Use **TCP_SEND** after connecting via **TCP_ACCEPT** or **TCP_CONNECT** instructions.

TCP_RECV Program Instruction to receive data

Receives data and stores them in the specified character string variable based on TCP protocol.

Use **TCP_RECV** after connecting via **TCP_ACCEPT** or **TCP_CONNECT** instructions.

TCP_CLOSE Program Instruction to abort connection (Used to terminate communication service)

Closes the current socket connection. To close sockets created by TCP_LISTEN instruction, use TCP_END_LISTEN instruction below.

TCP_END_LISTEN Program Instruction to abort connection

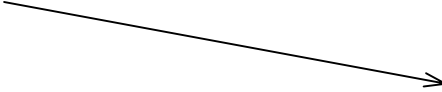
Closes socket currently waiting for connection request. To close sockets that are already connected, use the above TCP_CLOSE instruction.

Example

Keyword




Parameter



TCP_ACCEPT variable for returned value, port number, timeout, ...

Parameters marked with can be omitted.

Always enter a space between the keyword and first parameter.

 represents the Enter (Return) key in the examples.

Program Instruction

TCP_LISTEN variable for returned value, port number

Function

Program Instruction to start waiting for connection request (used by server-side to start communication service)

Creates socket, binds it to the specified port number, and waits for connection request to that socket. If communication error occurs during execution, the error code is stored in the returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Port number

- Specifies the port number that indicates the channel of the other end of the connection. The socket is bound to this port number.
- Acceptable range is 8192 – 65535, otherwise error occurs.

Program Instruction

TCP_ACCEPT variable for returned value, port number, timeout,
client IP address array variable

Function

Program Instruction to check connection request (used by server-side to start communication service)

Checks if the connection request for socket communication has been received by the specified port, and if it has, establishes connection. Connection is completed when this instruction terminates normally. If communication error occurs during execution, the error code is stored in the specified returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Sets the variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Port number

- Specifies the port number that indicates the channel of the other end of the connection (process). The socket is bound to this port number.
- Acceptable range is 8192 – 65535, otherwise error occurs.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. Default is 1 second. Acceptable range is 0 - 60, otherwise error occurs. If not specified, 1 is assumed.
- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

Client IP address array variable

- Specifies array variable that stores the IP address of the client (32 bits) when successfully connected.
- The IP address is stored in 8 bit increments to each element in the array variable in order

starting from the start of the IP address.

Example

IP address is stored in the array variable elements ipa[0] through ipa[3], when the connection is established with computer “192.168.0.3”.

ipa[0] : 192

ipa[1] : 168

ipa[2] : 0

ipa[3] : 3

Program Instruction

TCP_CONNECT variable for returned value, port number,
server IP address array variable, timeout

Function

Program Instruction to request connection (Used by client-side to start communication service)

Creates socket and binds to the specified port number. Then, connection request is sent to the specified node, and connection is established. The node is determined by the IP address of the server.

If communication error occurs during execution, the error code is stored in the returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication error occurs (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Port number

- Specifies the port number that indicates the channel of the other end of the connection (process). The socket is bound to this port number.
- Acceptable range is 8192 – 65535, otherwise error occurs.

Server IP address array variable

- Specifies array variable that stores the IP address of the server (32 bits) when successfully connected.
- The IP address is stored in 8 bit increments to each element in the array variable in order from the start of the IP address.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. Default is 1 second. Acceptable range is 0 - 60, otherwise error occurs. If not specified, 1 is assumed.

- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

Example

IP address is stored in the array variable elements ipa[0] through ipa [3], when the connection is established with computer “192.168.0.3”.

ipa[0] : 192

ipa[1] : 168

ipa[2] : 0

ipa[3] : 3

Program Instruction

TCP_SEND variable for returned value, socket ID number,
character string variable array for sending data, number of elements,
timeout

Function

Program Instruction to send data

Sends data based on TCP protocol. The data to be sent is specified as character string variable array.

If communication error occurs, the error code is stored in the returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Sets variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Socket ID number

- Specifies the socket ID number obtained by TCP_ACCEPT or TCP_CONNECT instructions.

Character string variable array for sending data

- Specifies the first element of the character string array that stores the data to be sent.
- Array elements are sent in order from first to last.
- Change the data to be sent into character string variable. Numeric data can be sent once transformed into character string format. Ensure that the encoding format is consistent with the recipient (big endian/little endian, etc.).
- The maximum amount of data that can be sent in execution of one instruction is 4096 bytes.

Number of elements

- Specifies the number of elements to send in the character string variable array.
- The specified number of elements are sent to the recipient in order of index number.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. Default is 1 second. Acceptable range is 0 - 60, otherwise error occurs. If not specified, 1 is assumed.
- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

Program Instruction

TCP_RECV variable for returned value, socket ID number,
character string variable array for received data, number of elements,
timeout, max. number of characters

Function

Program instruction to receive data

Receives data based on TCP protocol, and stores it in the specified character string variable array.

If communication error occurs, the error code is stored in the returned value storage variable and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Socket ID number

- Specifies the socket ID number obtained by TCP_ACCEPT or TCP_CONNECT instruction.

Received data storage character string variable array

- Specifies the first element of the character string variable array that stores the received data.
- Data is received as continuous character data of 1 byte each. When receiving numeric data (transformed into character string data), ensure that the encoding format is consistent with the sender (big endian/ little endian, data segmentation etc).
- The maximum amount of data that can be received in one instruction is 4096 bytes.

Number of elements

- Sets the variable to substitute the number of elements in the received character string variable array.
- Should be specified as a variable.

Timeout

- Specifies the time (seconds) to wait before outputting timeout error when connection is not established. Default is 1 second. Acceptable range is 0 - 60, otherwise error occurs. If not specified, 1 is assumed.
- When a timeout error occurs, the error code is stored in the returned value storage variable.
- Timeout error does not stop AS program execution.

Maximum number of characters

- Specifies the maximum number of bytes stored in an element of the character string variable array.
- Acceptable range is 1 – 255, otherwise error occurs.
- Default setting is 255 bytes.

Example

When character string “abcdefghijklmnopqrstuvwxyz” is received, this data is stored in array elements \$recv_dt[0] through \$recv_dt[3] of the received data storage character string variable array as shown below. The number of elements is specified as “rcv_cnt”, and the maximum number of characters in the element is specified as 10.

```
$recv_dt[0]: "abcdefghij"  
$recv_dt[1]: "klmnopqrst"  
$recv_dt[2]: "vwxyz"  
rcv_cnt      : 3
```

Program Instruction

TCP_CLOSE variable for returned value, socket ID number

Function

Program Instruction to abort connection (Used to terminate communication service)

Cuts off connection for socket communication and closes socket. If communication error occurs, the error code is stored in the returned value storage variable, and program execution does not stop.

When TCP_CLOSE execution is stopped by communication error etc., the connection may not be completely disconnected. In this case, execute TCP_CLOSE instruction again. This will internally shutdown (force CLOSE) the connection.

Parameter

Variable for returned value

- Sets variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Socket ID number

- Specifies the socket ID number obtained by TCP_ACCEPT or TCP_CONNECT instruction.

Program Instruction

TCP_END_LISTEN variable for returned value, port number

Function

Program Instruction to abort connection

Ends waiting for connection request on the socket specified by TCP_LISTEN and closes that socket. If communication error occurs, the error code is stored in the returned value storage variable, and program execution does not stop.

Parameter

Variable for returned value

- Specifies variable that stores the execution results.
- 0 is stored when execution completes normally.
- Error code is stored when communication error occurs. However, program execution does not halt at communication error.
- Error code is not stored when non-communication errors occur (e.g. parameter error). In this case, the program execution results in error and stops.
- See 6.1 for details on communication error codes.

Port number

- Specifies the socket currently waiting for connection request (socket specified in TCP_LISTEN instruction).

Program Instruction

TCP_STATUS **variable for returned value, port number , socket-ID-array, error-code-array, sub-error-code-array, IP_address-array**

Function

Stores to the specified array variables, the status of the sockets used in the TCP communication instructions. Data are stored in order of sockets ID No., as controlled within the robot controller. The data with the same array number in each parameter are data from same socket. When there is an error in the parameter, the program execution stops.

Parameter

Returned value storage variable

- Stores the number of sockets used.
- The data is not stored when there is an error in the parameter.

Port#-array

- Stores the port numbers of the sockets used.
- Only stores data generated by TCP_LISTEN, TCP_CONNECT instructions. The data for the socket generated by TCP_ACCEPT instruction is stored as 0.

Socket-ID-array

- Stores the socket ID of the socket in use.

Error-code-array

- Stores the error codes for the communication errors that occurred recently.
- These may include internal controller TCP/IP error codes not explained in 6.10.

Sub-error-code-array

- Stores the description codes for the error codes.
- SUB error codes for TCP/IP package

IP_address-array

- Stores the IP address of the connected device in character string.

Example: 192.168.0.1

- Only stores data generated by TCP_ACCEPT, TCP_CONNECT instructions. The data for the socket generated by TCP_LISTEN instruction is stored as "0.0.0.0".

Example

| Port number | Socket ID | Error code | Description code | IP Address |
|-------------|-----------|------------|------------------|--------------------------------------------------|
| 8192 | 1 | 0 | 0 | 0;Socket generated by TCP_LISTEN |
| 0 | 2 | 0 | 0 | 192.168.0.2 ;Socket generated by TCP_ACCEPT |
| 49152 | 3 | 0 | 0 | 192.168.0.5 ;Socket generated by TCP_CONNECT |
| 49153 | 4 | -21670 | 90 | 192.168.0.4 ;Example of a socket in error status |

When the following instructions are excuted in the above condition, the data is stored as below.

TCP_STATUS sock_cnt,port_no[0],sock_id[0],err_cd[0],sub_cd[0],\$ip_adrs[0]

```

sock_cnt      : 4
port_no[0]    : 8192
port_no[1]    : 0
port_no[2]    : 49152
port_no[3]    : 49153
sock_id[0]    : 1
sock_id[1]    : 2
sock_id[2]    : 3
sock_id[3]    : 4
err_cd[0]     : 0
err_cd[1]     : 0
err_cd[2]     : 0
err_cd[3]     : -21670
sub_cd[0]     : 0
sub_cd[1]     : 0
sub_cd[2]     : 0
sub_cd[3]     : 90
$ip_adrs[0]   : 0.0.0.0
$ip_adrs[1]   : 192.168.0.2
$ip_adrs[2]   : 192.168.0.5
$ip_adrs[3]   : 192.168.0.4

```

6.1 COMMUNICATION ERRORS IN SOCKET COMMUNICATION

The following errors may be detected during execution of socket communication instructions, but will not stop the execution of the program*. All errors are recorded in the error log.

NOTE* Program execution halts if error occurs when the controller is in the middle of processing TCP_ACCEPT.

| Code | Error message | Description | Countermeasure |
|-------|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E4019 | TCPIP) Socket open failure. CODE=XX Dst.IP=XX.XX.XX.X X | Failed to open socket when executing TCP_LISTEN/TCP_CONNECT. Too many sockets may have been opened. Or, parameter error e.g. wrong IP address. | Do not execute too many of this instruction. Fix incorrect parameter. CODE shows the SUB error code of TCP/IP package. |
| E4020 | TCPIP) Socket close failure. CODE=XX Dst.IP=XX.XX.XX.X X | Failed to close socket when executing TCP_CLOSE/TCP_END_LISTEN. Possible problem along Ethernet or at the other end of connection. | Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |
| E4021 | TCPIP)Communication Error. CODE=XX Dst.IP=XX.XX.XX.X X | Communication error during execution of TCP_SEND/TCP_RECV. Possible problem along Ethernet or at the other end of connection. | Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |
| E4022 | TCPIP)Too Long Message. | Tried to send data longer than the limit while executing TCP_SEND. | Fix data so the size is within limit size and re-try the program. |
| E4023 | TCPIP)Cannot reach the Host | Could not connect with the host when executing TCP_CONNECT. There is no host with this IP address on the network. Port number or IP address may be wrong. Possible problem along Ethernet or at the other end of connection. | Check if port number or IP address is correct and correct if necessary. Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. |
| E4024 | TCPIP)Communication Time Out. Dst.IP=XX.XX.XX.X X | Timeout occurred during execution of instructions based on TCP. Possible problem along Ethernet or at the other end of connection. | Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. |
| E4025 | TCPIP)Connection aborted. | Connection was aborted while executing TCP_CONNECT/TCP_SEND/TCP_RECV/TCP_ACCEPT. Possible problem along Ethernet or at the other end of connection. | Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. |
| E4026 | TCPIP)No Buffer Space. | Communication error occurred during execution of TCP_SEND/TCP_RECV. TCP/IP system source (queue, buffer) may be lacking. Or, possible problem along Ethernet or at the other end of connection. | Abort some TCP/IP applications working at the same time. Reboot the controller. |
| E4027 | TCPIP)Bad Socket. | Could not connect when executing TCP_CONNECT. Port number or IP address may be wrong. Possible problem along Ethernet or at the other end of connection. | Check port number or IP address and correct if necessary. Check for problems in the node at the other end of connection or in the connection line. Fix accordingly. |
| E4056 | TCP)This port is not in LISTEN (SOCK). | Failed to open socket when executing TCP_ACCEPT. Or failed to close socket when executing TCP_END_LISTEN. May have specified socket not created by TCP_LISTEN. | Check if port number and correct if necessary. |

| Code | Error message | Description | Countermeasure |
|-------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| E4057 | TCP)Illegal Socket ID | Communication error occurred during execution of TCP_SEND/TCP_RECV. Or, failed to close socket when executing TCP_CLOSE/TCP_END_LISTEN. May have specified socket ID number or port number of socket not created. Or, the order of program execution is wrong. | Check socket ID number or port number and correct if necessary. Check order of program execution, and correct if necessary. |
| E4055 | TCP)Cannot create a socket. | Failed to open socket when executing TCP_LISTEN/TCP_CONNECT. Too many sockets are opened. Or, the same port is used too many times. | Avoid executing too many instructions at a time. Correct parameter. Close port previously used via TCP_CLOSE/TCP_END_LISTEN before using it again. |

6.2 SAMPLE PROGRAM USING SOCKET COMMUNICATION INSTRUCTIONS

6.2.1 WHEN ROBOT IS THE SERVER-SIDE

```
.PROGRAM main()           ;Communication main program
port = 49152
max_length = 255
tout_open = 60
tout_rec = 60
CALL open_socket           ;Connecting communication
IF sock_id < 0 THEN
    GOTO exit_end
END
text_id = 0
tout = 60
eret = 0
rret = 0
$sdata[1] = "001"
CALL send(eret,$sdata[1]) ;Instructing processing 1
IF eret < 0 THEN
    PRINT "CODE 001 ERROR END code=",eret
    GOTO exit
END
CALL recv                  ;Receiving the result of processing 1
IF rret < 0 THEN
    PRINT "CODE 001 RECV ERROR END code=",rret
    GOTO exit
END
eret = 0
$sdata[1] = "002"
CALL send(eret,$sdata[1]) ;Instructing processing 2
IF eret < 0 THEN
    PRINT "CODE 002 ERROR END code=",eret
    GOTO exit
END
CALL recv                  ;Receiving the result of processing 2
IF rret < 0 THEN
    PRINT "CODE 002 RECV ERROR END code=",rret
    GOTO exit
END
exit:
CALL close_socket          ;Closing communication
exit_end:
.END
```

```

.PROGRAM open_socket() ;Starting communication
    er_count = 0
listen:
    TCP_LISTEN retl,port
    IF retl<0 THEN
        IF er_count >= 5 THEN
            PRINT "Connection with PC is failed (LISTEN). Program is stopped."
            sock_id = -1
            goto exit
        ELSE
            er_count = er_count+1
            PRINT "TCP_LISTEN error=",retl," error count=",er_count
            GOTO listen
        END
    ELSE
        PRINT "TCP_LISTEN OK ",retl
    END
    er_count = 0
accept:
    TCP_ACCEPT sock_id,port,tout_open,ip[1]
    IF sock_id<0 THEN
        IF er_count >= 5 THEN
            PRINT "Connection with PC is failed (ACCEPT). Program is stopped."
            TCP_END_LISTEN ret,port
            sock_id = -1
        ELSE
            er_count = er_count+1
            PRINT "TCP_ACCEPT error id=",sock_id," error count=",er_count
            GOTO accept
        END
    ELSE
        PRINT "TCP_ACCEPT OK id=",sock_id
    END
exit:
.END
.PROGRAM send(.ret,.$data) ;Communication Sending data
    $send_buf[1] = .$data
    buf_n = 1
    .ret = 1
    TCP_SEND sret,sock_id,$send_buf[1],buf_n,tout
    IF sret < 0 THEN
        .ret = -1
        PRINT "TCP_SEND error in SEND",sret
    ELSE
        PRINT "TCP_SEND OK in SEND",sret
    END
.END
.PROGRAM recv() ;Communication Receiving data
    .num=0
    TCP_RECV rret,sock_id,$recv_buf[1],.num,tout_rec,max_length
    IF rret < 0 THEN
        PRINT "TCP_RECV error in RECV",rret
        $recv_buf[1]="000"
    ELSE
        IF .num > 0 THEN
            PRINT "TCP_RECV OK in RECV",rret
        ELSE
            $recv_buf[1]="000"
        END
    END
.END

```

```
.PROGRAM close_socket() ;Closing communication
TCP_CLOSE ret,sock_id      ;Normal socket closure
IF ret < 0 THEN
    PRINT "TCP_CLOSE error ERROE=(",ret," ) ",$ERROR(ret)
    TCP_CLOSE ret1,sock_id  ;Forced closure of socket (shutdown)
    IF ret1 < 0 THEN
        PRINT "TCP_CLOSE error id=",sock_id
    END
ELSE
    PRINT "TCP_CLOSE OK id=",sock_id
END
TCP_END_LISTEN ret,port
IF ret < 0 THEN
    PRINT "TCP_CLOSE error id=",sock_id
ELSE
    PRINT "TCP_CLOSE OK id=",sock_id
END
.END
```

6.2.2 WHEN ROBOT IS THE CLIENT-SIDE

```

.PROGRAM main()           ;Communication main program
port = 49152
ip[1] = 192
ip[2] = 168
ip[3] = 0
ip[4] = 2
max_length = 255
tout_open = 60
tout_rec = 60
eret = 0
ret = 0
CALL open_socket           ;Connecting communication
IF sock_id < 0 THEN
    GOTO exit_end
END
text_id = 0
tout = 60
WHILE (1) DO
    ret = 0
    CALL recv              ;Receiving instruction data from PC
    IF ret < 0 THEN
        PRINT "Communication error code=",ret
        GOTO exit
    ELSE
        CASE ret OF
            VALUE 0:
                text_id = val($mid($recv_buf[1],1,3)) ;Taking in instruction number
            ANY :
                END
        END
    END
    IF text_id > 0 THEN
        CALL com_test      ;Processing of each instruction
        IF eret < 0 THEN
            goto exit
        END
    END
END
END
exit:
CALL close_socket          ;Disconnecting communication
exit_end:
.END
.PROGRAM com_test()      ;Processing per separate instruction data
CASE text_id OF
    VALUE 0: ;No instructions
        GOTO break_exit
    VALUE 1: ;Instructing processing 1
        ;Separate processing
    VALUE 2: ;Instructing processing 2
        ;Separate processing
    VALUE 3: ;Instructing processing 3
        ;Separate processing
    any :
        GOTO break_exit
END
$send_buf[1] = $recv_buf[1] + " OK"
CALL send(eret,$send_buf[1]) ;Sending end processing
break_exit:
.END

```

```

.PROGRAM open_socket() ;Starting communication
    .er_count =0
connect:
    TCP_CONNECT sock_id,port,ip[1],tout_open
    IF sock_id<0 THEN
        IF .er_count >= 5 THEN
            PRINT "Connection with PC failed. Program is stopped."
        ELSE
            .er_count = .er_count+1
            PRINT "TCP_CONNECT error id=",sock_id," error count=",.er_count
            GOTO connect
        END
    ELSE
        PRINT "TCP_CONNECT OK id=",sock_id
    END
.END

.PROGRAM recv() ;Communication Receiving data
    .num=0
    TCP_RECV ret,sock_id,$recv_buf[1],.num,tout_rec,max_length
    IF ret < 0 THEN
        PRINT "TCP_RECV error in RECV",ret
        $recv_buf[1]="000"
    ELSE
        IF .num > 0 THEN
            PRINT "TCP_RECV OK in RECV",ret
        ELSE
            $recv_buf[1]="000"
        END
    END
.END

.PROGRAM send(.ret,$data) ;Communication Sending data
    $send_buf[1] = .data
    buf_n = 1
    .ret = 1
send_rt:
    TCP_SEND sret,sock_id,$send_buf[1],buf_n,tout
    IF sret < 0 THEN
        .ret = -1
        PRINT "TCP_SEND error in SEND",sret
    ELSE
        PRINT "TCP_SEND OK in SEND",sret
    END
.END

.PROGRAM close_socket() ;Closing communication
    TCP_CLOSE ret,sock_id ;Normal socket closure
    IF ret < 0 THEN
        PRINT "TCP_CLOSE error ERROE=(",ret," ) ",$ERROR(ret)
        TCP_CLOSE ret1,sock_id ;Forced closure of socket (shutdown)
        IF ret1 < 0 THEN
            PRINT "TCP_CLOSE error id=",sock_id
        END
    ELSE
        PRINT "TCP_CLOSE OK id=",sock_id
    END
.END

```


7.0 ERROR MESSAGE

| Code | Error Message | Description | Countermeasure |
|-------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E4013 | TELNET) SEND error. CODE=XX | Error occurred when sending data by TCP/IP. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4014 | TELNET) RECV error. CODE=XX | Error occurred when receiving data by TCP/IP. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4015 | TELNET) IAC receive error. CODE=XX | Error occurred when receiving data by TCP/IP. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. Check the KCwinTCP/KRterm in the PC at other end of connection. |
| E4016 | TELNET) Close failure. CODE=XX | Error occurred in LISTEN/ACCEPT function in TCP/IP, and attempt to close the socket failed. TCP/IP system resources (queue, buffer) may be lacking. Or, possible problem along communication line, or in node at other end of connection. | Stop some TCP/IP applications working at the same time. Reboot the controller. CODE shows the SUB error code of TCP/IP package. |
| E4017 | TELNET) Main socket close failure. CODE=XX | Error occurred in LISTEN/ACCEPT function in TCP/IP, and tried to close the main socket but could not. TCP/IP system source (queue, buffer) may be lacking. Or, possible problem along communication line, or in node at other end of connection. | Stop some TCP/IP applications working at the same time. Reboot the controller. CODE shows the SUB error code of TCP/IP package. |
| E4018 | TELNET) System error. CODE=XX | The parameter in IPADDRESS command is wrong. | Set the parameter in IPADDRESS correctly. CODE shows the SUB error code of TCP/IP package. |
| E4019 | TCPIP) Socket open failure. CODE=XX Dst.IP=XX.XX.XX.XX | Failed to open socket when executing UDP_SENDTO/UDP_RECVFROM/TCP_LISTEN/TCP_CONNECT. Too many sockets may have been opened. Or, parameter error e.g. wrong IP address. | Do not execute too many of this instruction. Fix incorrect parameter. CODE shows the SUB error code of TCP/IP package. |
| E4020 | TCPIP) Socket close failure. CODE=XX Dst.IP=XX.XX.XX.XX | Failed to close socket when executing UDP_SENDTO/UDP_RECVFROM/TCP_CLOSE/TCP_END_LISTEN. There may be problem with the Ethernet or at the other end of the connection. | Check for problems in node at end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |
| E4021 | TCPIP)Communication Error. CODE=XX Dst.IP=XX.XX.XX.XX | Communication error during execution of UDP_SENDTO/UDP_RECVFROM/TCP_SEND/TCP_RECV. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. CODE shows the SUB error code of TCP/IP package. |

| | | | |
|-------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| E4022 | TCPIP)Too Long Message. | Tried to send data longer than the limit while executing UDP_SENDTO/UDP_RECVFROM/TCP_SEND. | Fix data so the size is within limit size and re-try the program. |
| E4023 | TCPIP)Cannot reach the Host. | Could not connect with the host when executing UDP_SENDTO/UDP_RECVFROM/TCP_CONNECT. There is no host with this IP address on the network. Port number or IP address may be wrong. Possible problem along communication line, or connection was aborted or closed. | Check port number or IP address and correct if necessary. Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4024 | TCPIP)Communication Time Out. Dst.IP=XX.XX.XX.XX | Timeout occurred during execution of instructions based on TCP. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4025 | TCPIP)Connection aborted. | Connection was aborted while executing UDP_SENDTO/UDP_RECVFROM/TCP_CONNECT/TCP_SEND/TCP_RECV/TCP_ACCEPT. Possible problem along communication line, or connection was aborted or closed. | Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4026 | TCPIP)No Buffer Space. | Communication error occurred during execution of UDP_SENDTO/UDP_RECVFROM/TCP_SEND/TCP_RECV. TCP/IP system source (queue, buffer) may be lacking. Or, possible problem along communication line, or connection was aborted or closed. | Stop some TCP/IP applications working at the same time. Reboot the controller. |
| E4027 | TCPIP)Bad Socket. | Could not connect when executing UDP_SENDTO/UDP_RECVFROM/TCP_CONNECT. Port number or IP address may be wrong. Possible problem along communication line, or connection was aborted or closed. | Check port number or IP address correct if necessary. Check for problems in node at end of connection or in the connection line. Fix accordingly. |
| E4056 | TCP)This port is not in LISTEN (SOCK). | Failed to open socket when executing TCP_ACCEPT. Or failed to close socket when executing TCP_END_LISTEN. May have specified socket not created by TCP_LISTEN. | Check port number and correct if necessary. |
| E4057 | TCP)Illegal Socket ID | Communication error occurred during execution of TCP_SEND/TCP_RECV. Or, failed to close socket when executing TCP_CLOSE/TCP_END_LISTEN. May have specified socket ID number or port number of socket not created. Or, the order of program execution is wrong. | Check socket ID number or port number and correct if necessary. Check order of program execution, and correct if necessary. |
| E4055 | TCP)Cannot create a socket. | Failed to open socket when executing TCP_LISTEN/TCP_CONNECT. Too many sockets are opened. Or, the same port is used too many times. | Avoid executing too many instructions at a time. Correct parameter. Close port previously used using TCP_CLOSE/TCP_END_LISTEN before using it again. |



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