WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi4aHL071001FMEN3

Hi4a Controller Function Manual

HRLadder

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

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1 Overview

The description in this manual is based on HRLadder v2.12 build 1.

1.1. Background Knowledge

For better understanding of this manual, users must have the following background knowledge.

- Usage of Hyundai Hi4, Hi4a or Hi5 Robot Controller
- Understanding of PLC application
- Embedded PLC application of Hyundai Robot Controller
  Refer to the “Embedded PLC of Function MANUAL”

1.2. About HRLadder

HRLadder is a software for editing a ladder and for monitoring of the embedded PLC of Hyundai Robot Controller. The controllers supported are Hi4, Hi4a and Hi5.

HRLadder is performed in PC Window environment, and provides a convenient and simple user interface.
Table 1-1 shows main functions provided by HRLadder.

Table 1-1 Main Functions of HRLadder

Ladder Editing	Available to edit a ladder diagram for Hyundai Robot Controller, and save it in a disk in the file format for the Controller.
Syntax Check	Checking a syntax of ladder diagram completed its writing and editing, and finding out the positions of error.
Download	Available to transmit the ladder working of HRLadder to Hyundai Robot Controller by using a communication function.
Upload	Available to load the ladder working of Hyundai Robot Controller to HRLadder by using a communication function.
PLC Monitoring	When the embedded PLC of Hyundai Robot Controller is in operation, all the real-time status of current relay are checkable.

1.3. Feasible Environment of HRLadder

Table 1-2 Feasible Environment of HRLadder

Hardware	Pentium level PC recommended	
Operation System	MS Window 95/98/2000/NT/XP	
Video	Above 1024x768, 256 color recommended	
Robot Controller	Above Hi4 Main S/W Version 10.00-15 required (Latest version of Hi4a and Hi5 controller recommended)	
Others	For the use of RS-232C (refer to 1.4)	1 Extra COM serial port for PC (or USB-Serial converter) RS-232C Cable
	For the use of Ethernet (refer to 1.5)	PC side – Ethernet function When using Hi4, exclusive Ethernet card is required

1.4. How to Connect RS-232C Cable

With RS-232C or Ethernet, uploading, downloading, or monitoring of ladder file is available.

- For the use of RS-232C :
  Use the RS-232C cable connected as shown in the figure 1.1. The left figure shows how to connect to cabinet of Hi4a controller, and the right one shows how to connect to main board directly.

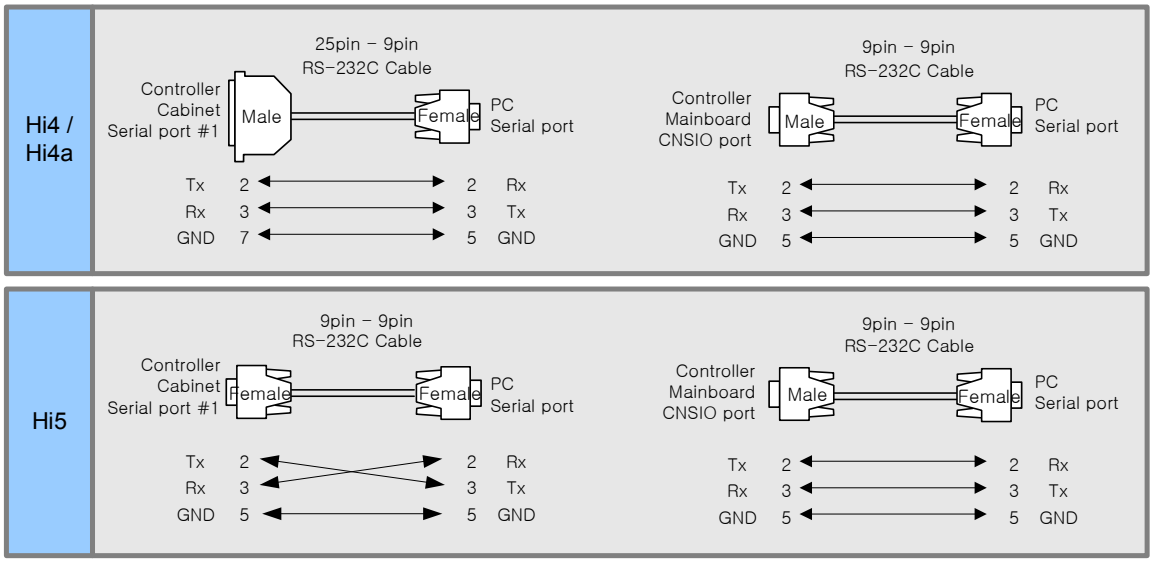


Fig. 1.1 Connection of RS-232C Cable for HRLadder

1.5. How to Configurate Ethernet Environment

With RS-232C or Ethernet*, uploading, downloading, or monitoring of ladder file is available.

- For the use of Ethernet :
  When controller is not connected to HUB, connect PC to Controller by using Ethernet UTP cable of 1:1 cross type as shown in the figure 1.2.
  (For Hi4 controller, Ethernet function is not installed as default and exclusive Ether card must be installed on the main board as shown in Fig. 1.2.)

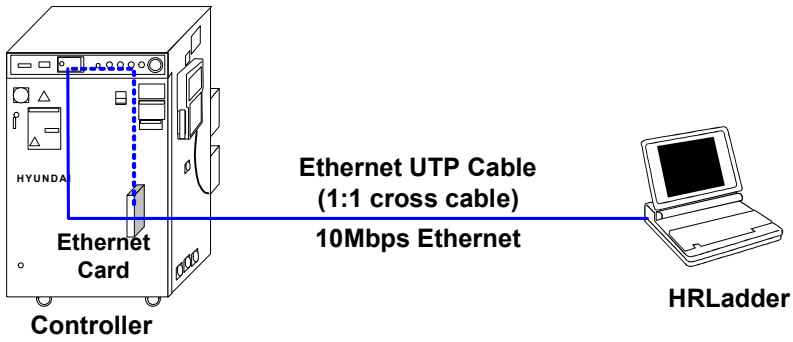


Fig. 1.2 Connection of Ethernet (using a 1:1 cross cable)

When Controller is connected to HUB, connect PC to the same HUB by using Ethernet UTP cable of direct type as shown in the figure 1.3.

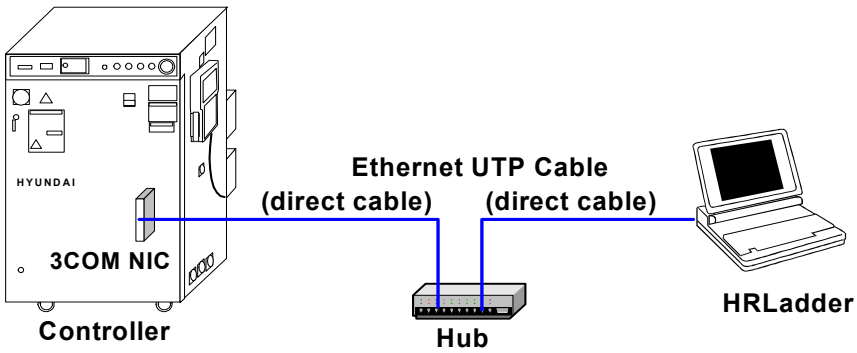


Fig. 1.3 Connection of Ethernet (using a direct cable and HUB)

* In case of BD411 mainboard, PCMCIA type Ethernet card (3COM 3XE539ET-AP) must be installed, while BD412 mainboard has built-in Ethernet port.

Ethernet UTP cable, in case of direct cable, is available in the market. The wiring method to create the 1:1 cross cable is as shown in Fig. 1.4.

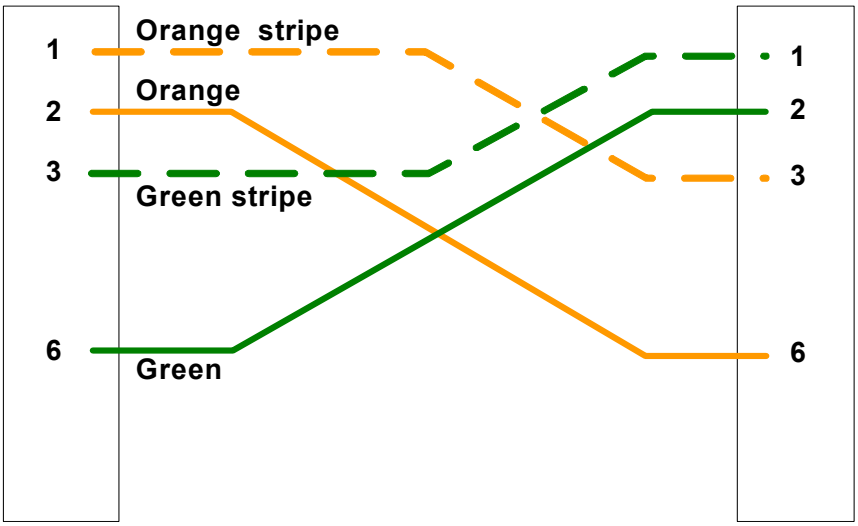


Fig. 1.4 Connecting Method of 1:1 cross Cable

2

Installation & Start of HRLadder

2.1. Installation of HRLadder

(1) Insert HRLadder CD into a CD drive.

(2) Open a installing directory for HRLadder in explorer, and execute “setup.bat”.

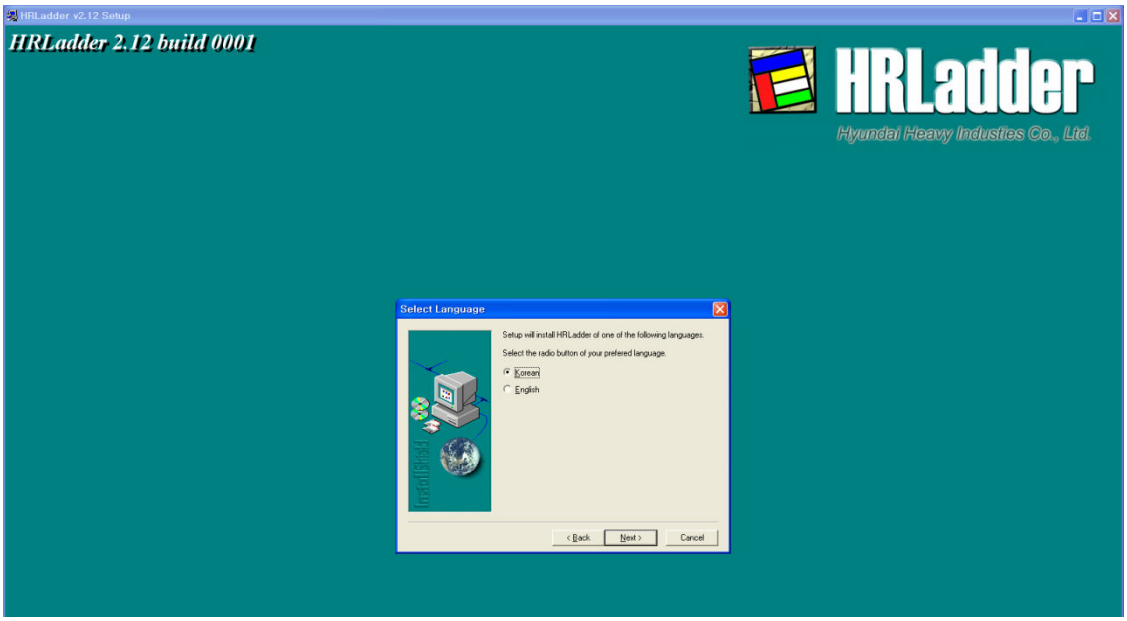


Fig. 2.1 HRLadder Installing Screen

(3) In the screen as figure 2.1, select a language to use (Korean or English), and click “Next>” button.

(4) Read the license carefully, and click “Yes” button.

(5) Select a directory to install, and click “Next>” button.

(6) Select a directory to install the folder name of program, and click “Next>” button.

(7) As shown in the figure 2.2, click “Finish” button when the dialog box indicating the completion of installation is popped up.

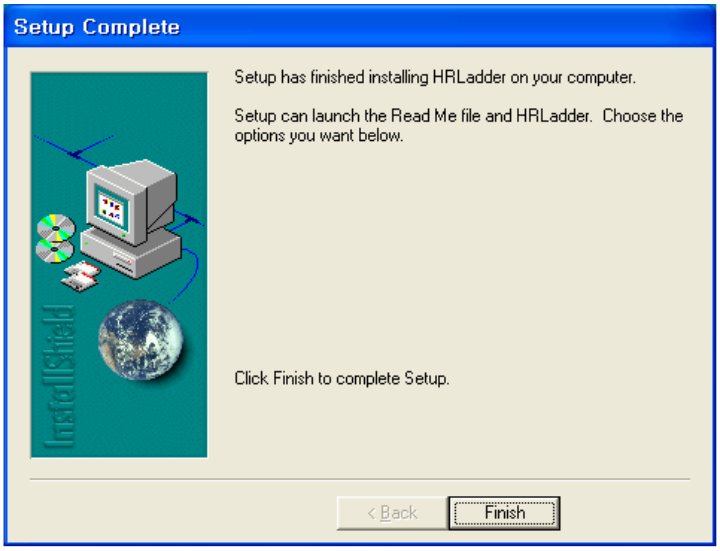


Fig. 2.2 Installation Complete Dialog Box

2.2. Start of HRLadder

To execute the HRLadder, press Start button, and click HRLadder in the 『program - HRLadder』 folder or double-click HRLadder icon in the desktop as shown in the figure 2.3.

Fig. 2.3 HRLadder Icon

2.3. License Input

To use HRLadder officially, license key number proper to the innate No. of PC with S/W should be input. When there is no input license number in the initial stage of HRLadder installation, it would operate as trial version. If the dialog box is popped up every time HRLadder is executed as shown in the figure 2.4, it indicates a trial version.

Fig. 2.4 Trial version message box

In this case, the ladder diagram is restricted by 1000 pixel for the vertical size in its editing (unavailable to edit longer even with a reduced screen). Thus, it may be used only for evaluating the HRLadder software. The way to make the HRLadder official is as follows.

Select 『Tool – License』 input menu. Such dialog box as the figure 2.5 will be displayed.

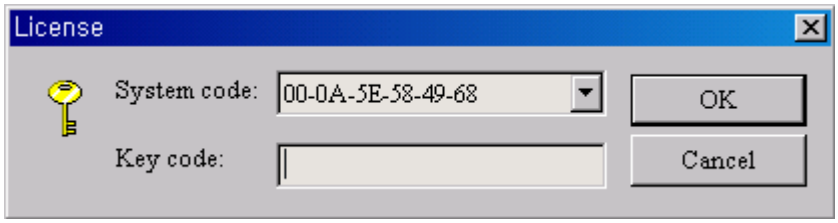


Fig. 2.5 Dialog Box for License Input

The figure of 6 byte written in the system code is a proper data of the installed PC. When purchasing a license of HRLadder from a supplier, deliver this number.
(This system code is MAC address of Ethernet card in PC. Without Ethernet card, official version of HRLadder cannot be used.)

Supplier will inform the user of the key code for the delivered number. Be sure to write down this number, and input the number to the key code section before pressing OK button as shown in the figure 2.6.

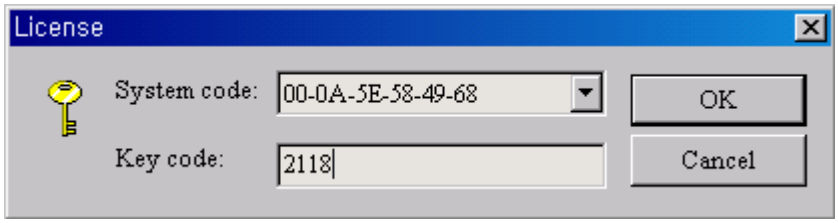


Fig. 2.6 Key Code Input

Re-run HRLadder after finishing it. Here, if the dialog box indicating a trial version is not showed up, it means that a correct key code is input and an official version is operating.
In the official version, ladder diagram editing is available without limit.

Once the key code is input, it is not necessary to re-input even when re-running HRLadder, upgrading the version or re-installing. However, the input key code will be lost if HRLadder in uninstalled from PC or in case of re-installation of operation system and format. Thus, in this case, the key code should be re-input when re-installing. Be sure to write down the key code and keep it well.

If the PC has multiple Ethernet cards, or has devices like Bluetooth, modem, several system codes could be listed as shown in the figure 2.7.

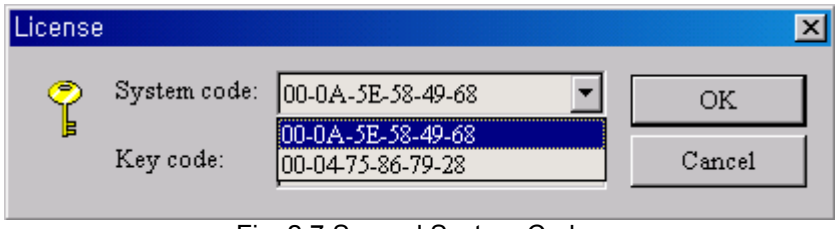


Fig. 2.7 Several System Codes

2.4. Project Management

Let's practice how to configurate the project of HRLadder.

(1) Run the HRLadder program.

(2) Select 『File- New』 in the menu. The screen like the figure 2.8 is displayed.
HPPrj is for creating a new project file(extension .HPP), and HRLadd is for creating a new ladder file(extension .LAD). Several ladder files are managed for one project in a hierarchical order.

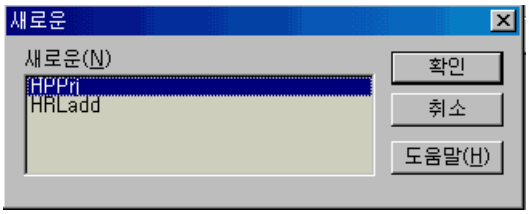


Fig. 2.8 Dialog Box of New File

(3) Select HPPrj and press "OK" button. I/O Map Window and Workspace Window for monitoring as shown in the figure 2.9. This Workspace is a space for registering the ladder file names to manage in a project.

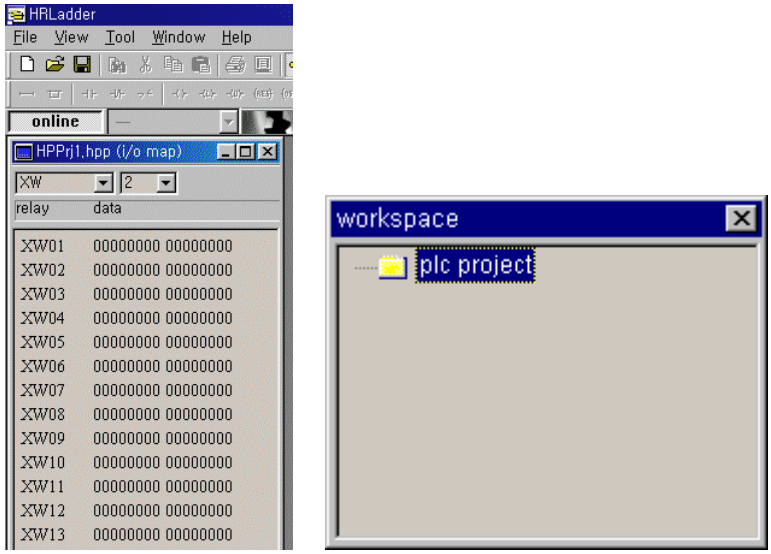


Fig. 2.9 Monitoring Window and Empty Workspace Window

(4) Select 『File - Save』, and save the project as a proper name. (In this example, a name of 'XY project.hpp' is used.)

(5) Again, select 『File – New』 in a menu, and at this time, select HRLadd and press Confirm button. When a ladder editing window is showed up, select 『File - Save』 and save the ladder file as a proper name.
Repeat the process to make and save some more ladder files.
(In this example, a name of 'L103.lad', 'L104.lad' is used.)

(6) Select a 'plc project' folder of empty workspace window, and press the right button of mouse, and then the pop-up menu will be displayed as shown in the figure 2.10.

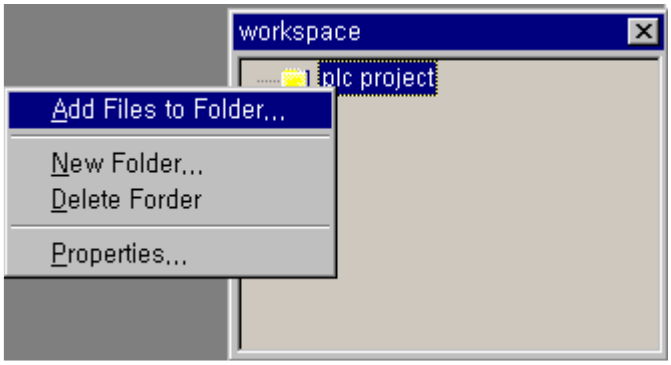


Fig. 2.10 Files Addition to Folder in Task Window

(7) When selecting "Add Files to Folder…", a dialog box to select files is displayed. Select files to add, and click "Open" button as shown in the figure 2.11. If clicking it with Ctrl key pressed, several files may be selected together.

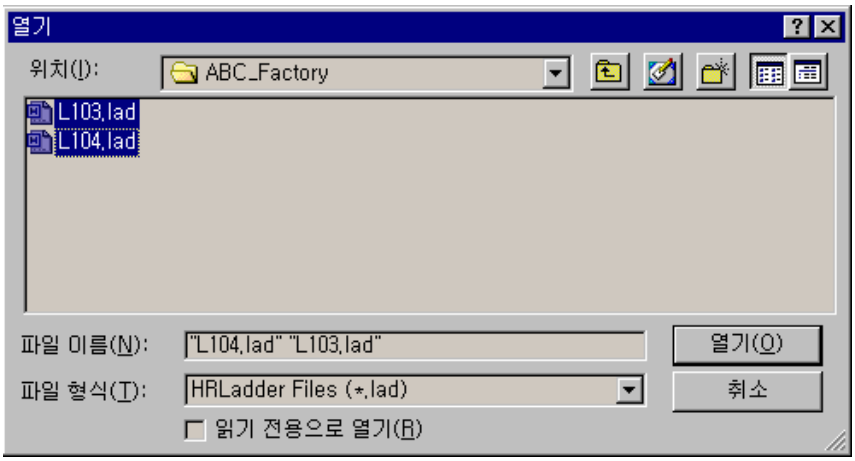


Fig. 2.11 Selecting Files to Add

(8) The corresponding names of files will be showed up in the lower side of plc project in workspace window. Again, click the right button of mouse, and select "New Folder…" as shown in the figure 2.12.

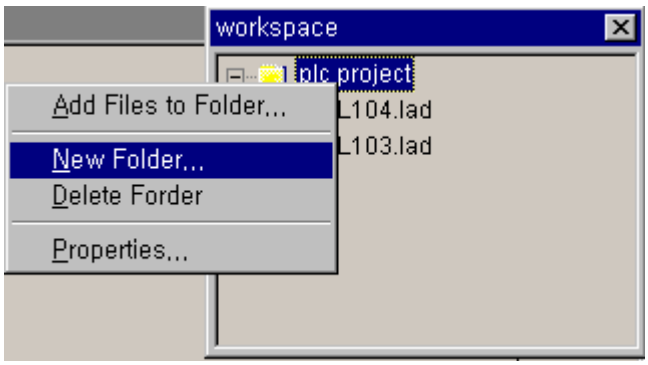


Fig. 2.12 New Folder

(9) When the dialog box of new folder is displayed as shown in the figure 2.13, input a proper folder name.(In this example, a name of 'FLR' is used.)
As shown in the figure 2.14, the name of newly-made folder will be displayed in workspace window.

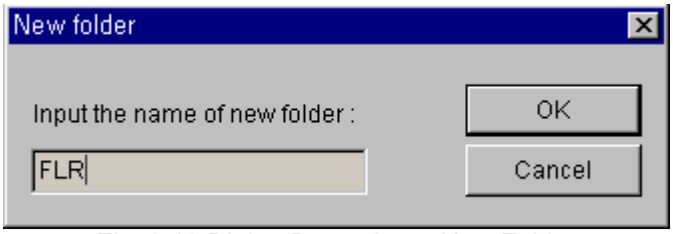


Fig. 2.13 Dialog Box to Input New Folder

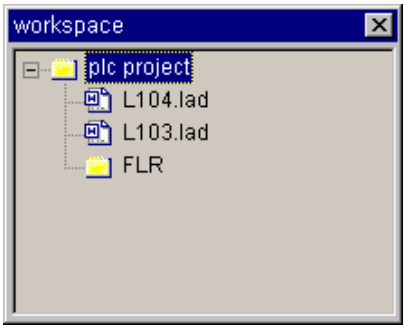


Fig. 2.14 Newly-made Folder

(10) Let's make 2 more ladder files as explained above.
(In this example, a name of 'FLR202.lad', 'FLR201.lad' is used.)

(11) Add the ladder file made as explained above to the new folder name. Finally, it will be like the figure 2.15.

Folders and ladder files can have sub-node continuously in a hierarchical order. Take note that making a folder in workspace window does not mean that actual window OS folders are made. These folders are only data structures managed by the project files of HRLadder on their own.

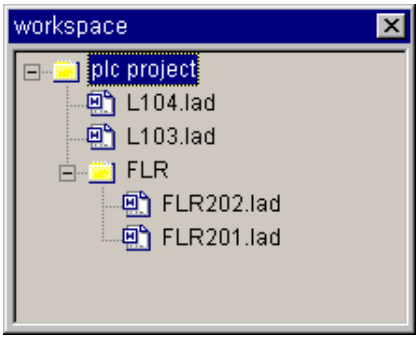


Fig. 2.15 Added ladder files in a hierarchical order

3

Editing of Ladder Diagram

3.1. Basic Editing

The editing method for ladder working is explained here. Follow the instructions.

(1) Make a project and ladder file as explained in the previous chapter.

(2) Start with an empty ladder document open with only one Rung as shown in the figure 3.1.

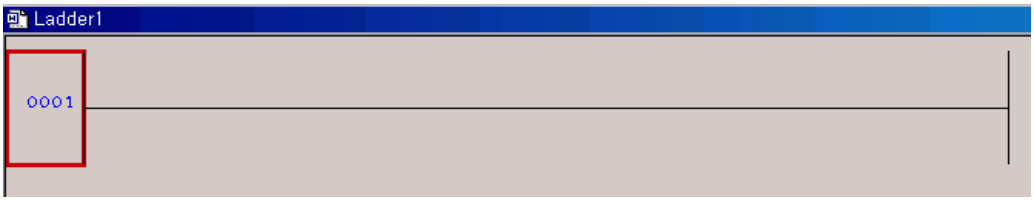


Fig. 3.1 Empty Ladder Document

Red square in the left of Rung is a selection box indicating that it is selected. You can select Rung or the instruction with clicking the left button of mouse. 0001 means Rung No, and it increases by 1 as Rung is added.

(3) Select XIC (eXamine If Closed) in the instruction tool bar as shown in the figure 3.2.

Fig. 3.2 XIC of Instruction Tool Bar

XIC symbol will be inserted as the initial instruction of selected Rung as shown in the figure 3.3.

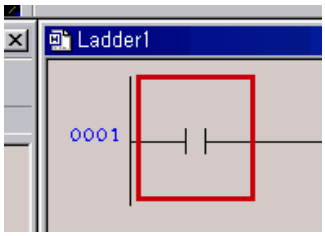


Fig. 3.3 XIC Symbol Insertion

(4) Double-click the symbol or hit Enter key while selecting the symbol. An edit box to input a tag(operand) will be displayed. Input the relay name of X1 as shown in the figure 3.4. (Small letter input will be automatically transformed to capital letter.)

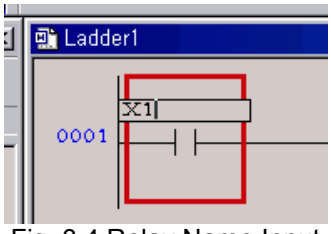


Fig. 3.4 Relay Name Input

If pressing Enter key, input including the operand of instruction will be completed. The Incorrect relay name will be displayed in red color.)

(5) Select the instruction OTE (OuTput Energize) in the instruction tool bar as shown in the figure 3.5.

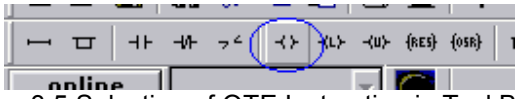


Fig. 3.5 Selection of OTE Instruction in Tool Bar

OTE will be inserted as the next instruction of selected instruction. Like XIC, double-click the symbol or hit Enter key to open the editing box, and input Y1 as operand, and then hit Enter key. Now, it will be like the figure 3.6. (Output instruction is arranged in the end of right side Rung.)

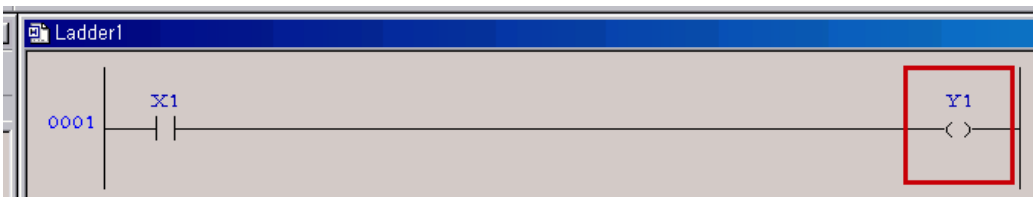


Fig. 3.6 XIC, OTE Input Result

(6) Now, Rung 1 is completed. When this ladder working is executed, Y1 signal will be controlled according to X1 signal.

Click Rung button in the instruction tool bar as shown in the figure 3.7. A new Rung will be added to the location below the current Rung as shown in the figure 3.8.

Fig. 3.7 Click Rung Button in Tool Bar

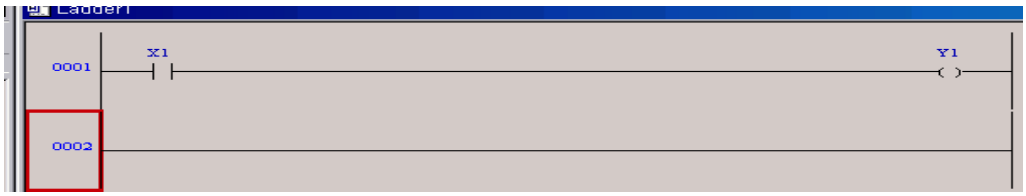


Fig. 3.8 Addition of New Rung

3.2. Branch Editing

How to insert a branch into Rung and edit it is explained here. Follow the instructions.

(1) Let's begin with the condition like the figure 3.9.

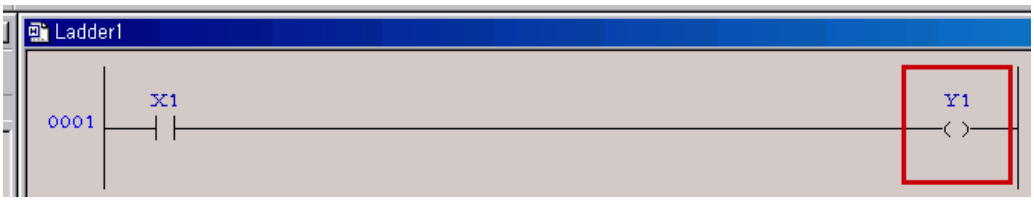


Fig. 3.9 Beginning State of Branch Editing

(2) Select a branch in tool bar as shown in the figure 3.10. The branch is inserted into Rung as shown in the figure 3.11.

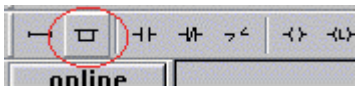


Fig. 3.10 Selecting Branch in Tool Bar

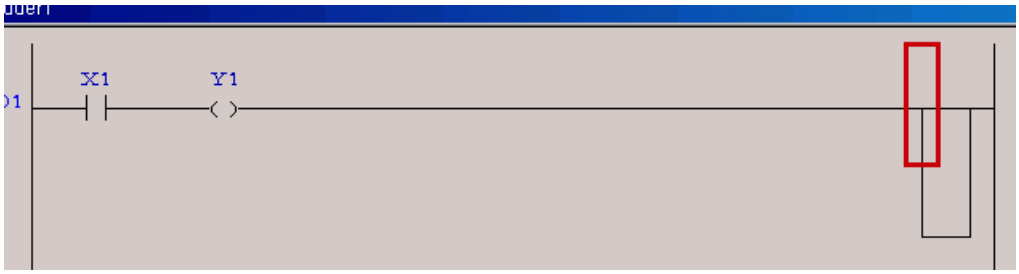


Fig. 3.11 Inserted Branch

(3) Let's move Y1(OTE) to the inside of branch. There are 2 ways. One is to drag and move Y1, and the other one is to drag an end of branch and move it between X1 and Y1. Let's apply the first method. If dragging Y1 with a left button of mouse, yellow squares are showed up in the position where Y1 can be moved. Place a cursor in the preferred position, and then the corresponding square will turn red as shown in the figure 3.12. Here, release the left button of mouse.

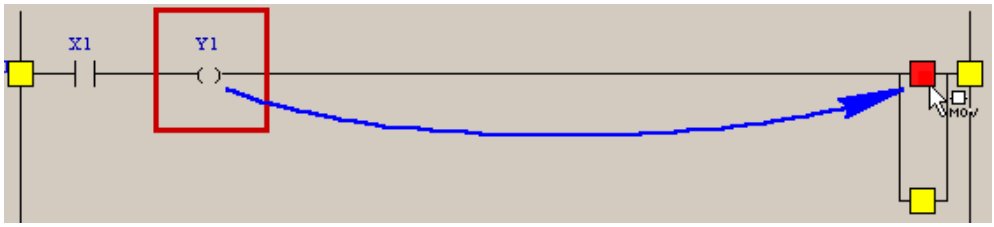


Fig. 3.12 Dragging an instruction with mouse

(4) Y1 is moved inside of branch as shown in the figure 3.13.

Fig. 3.13 Instruction moved inside of branch

(5) The second method is similar to the first one. Just drag the left end of branch with left button of mouse, and place it in your preferred location.

(6) The way to insert an instruction on a branch is the same as the one to insert it into Rung. Place the selection box in your preferred location, and click the instruction, and then it will be inserted into the right side of selection box as shown in the figure 3.14.

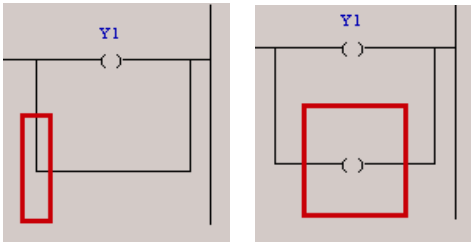


Fig. 3.14 Instruction insertion on branch

(7) Branch can be linked continuously to the branch.

(8) Place the selection box on the branch, and click Branch button in the instruction tool bar as shown in the figure 3.15.

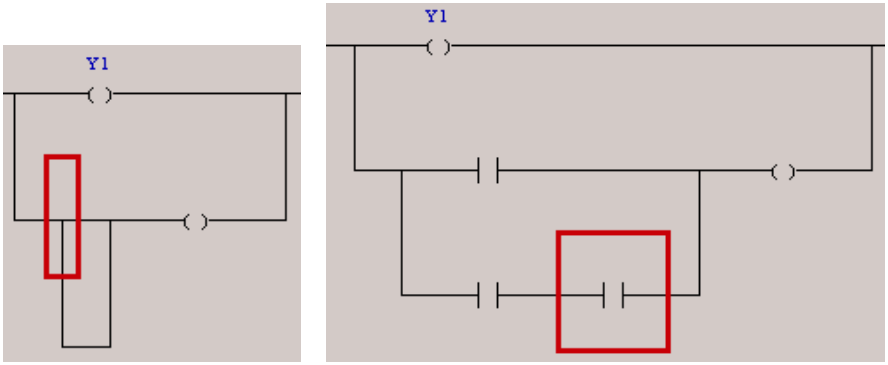


Fig. 3.15 Link branch to branch

(9) There is no limit on the number of branches to link in a hierarchical order.

3.3. Delete, Cut, Copy, Paste, Undo

(1) You can select desired Rung or instruction by clicking them with left button of mouse.

(2) If clicking the left button of mouse with [Ctrl] key pressed, several instructions of several rungs can be simultaneously selected as shown in the figure 3.16. However, instructions should be in the same Branch level of same Rung. In addition, rungs cannot be selected with instructions or branches together. When selecting several rungs, all the selected instructions for deleting/cutting/copying are applied.

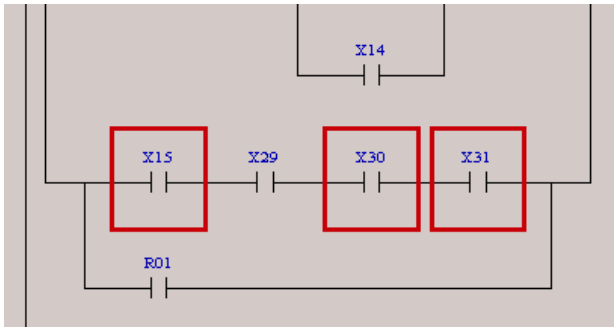


Fig. 3.16 Simultaneous selection of several instructions or rungs

(3) If selecting the edge of branch as shown in the figure 3.17, branch, sub-branch, and included instructions are all applied.

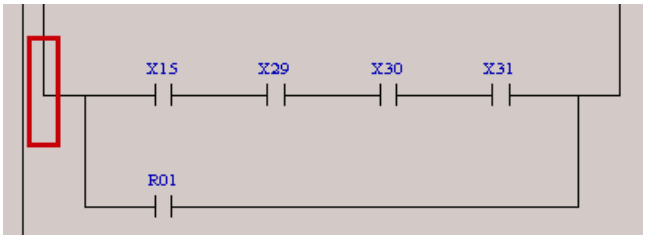


Fig. 3.17 Selection of Entire Branch

(4) If pressing [Del] key, the selected instructions, or selected Rung or branch is deleted.

(5) If pressing [Ctrl+X] key or clicking button, the selected instructions, or selected Rung or branch is deleted and moved to clip board.

(6) If pressing [Ctrl+C] key or clicking button, the selected instructions, or selected Rung or branch is copied into clip board.

(7) If pressing [Ctrl+V] key or clicking button, the existing instructions in clip board, or Rung or branch is pasted onto the right side of selected position.

(8) If pressing [Ctrl+Z] key or clicking button, the operations done just before is canceled.

(9) If pressing [Ctrl+Y] key or clicking button, the operations canceled just before is re-done.

3.4. Types of Tag

Of the relay index, 1 bit data can be input and displayed as one of the three types; 1 bit, 8 bit, and 16 bit.
Refer to I/O configuration table. In most cases, 8 bit type has a suffix of 'B'(Byte), and 16 bit type has a suffix of 'W'(word) in the name of relay type. But in case of 1 bit type does not have a suffix.

For example, like the table 3-1, in case of X relay, 8 bit is called XB, 16 bit is XW, and 1 bit is X. All of these have an index at the end of their titles.

Data consists of X1~X8 is XB1, and data consists of X1~X16 or XB1~XB2 is XW1.

Table 3-1 Relations between X, XB, and XW

	← Higher															Lower →
1bit	X16	X15	X14	X13	X12	X11	X10	X9	X8	X7	X6	X5	X4	X3	X2	X1
8bit	XB2								XB1							
16bit	XW1															

For example of X12, it can be input as the 3 types as shown in the table 3-2. All of these 3 expressions mean the same data bit.

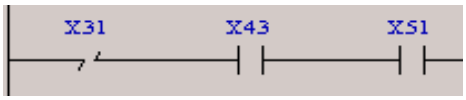
Table 3-2 Types of X12

1bit type	X12	12^{th} X bit
8bit type	XB2/4	4th bit out of the 2nd XB byte
16bit type	XW1/12	12th bit out of the 1st XW word

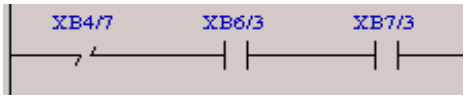
For one more example, X31 and XB4/7, XW2/15 are all the same.

HRLadder has a function that selects one of the 3 types and show it to ladder diagram. Each time 『View - “to the type of x bit tag”』 menu is selected, or  button is pressed in the tool bar, the expression type is circulating to 1bit → 8bit → 16bit as shown in the figure 3.18.

1 bit type



8 bit type



16 bit type

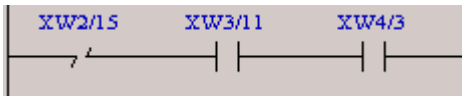


Fig. 3.18 Tag type of 1, 8, 16 bit

If users input the tag, it is always input as changed to the current expression type. For example, when the current mode is 16bit expression type, and the tag of an instruction is input as X51, it will be immediately changed to XW4/3 and be input.

3.5. Comment & Relay Description Table

A comment can be attached for each relay, and the inputted relay comments can be edited in the relay description table.

(1) Double click the upper position of the relay you want to edit the comment with left button of mouse. An edit box for comment input appears as shown in the figure 3.19.

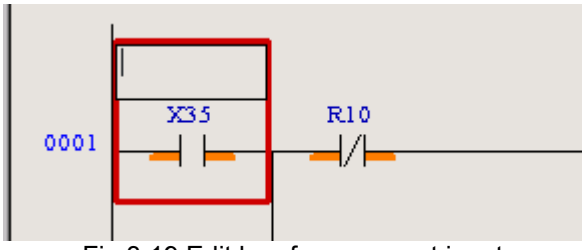


Fig 3.19 Edit box for comment input

(2) If inputting a comment and press Enter, the comment is displayed as shown in figure 3.20.

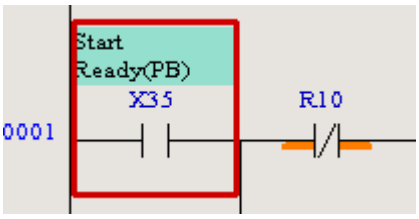


Fig 3.20 Instruction that a comment is inputted

(3) When you press the SHIFT+ENTER key while entering the comment, you can enter the return character to change the row as shown in Fig. 3.21.

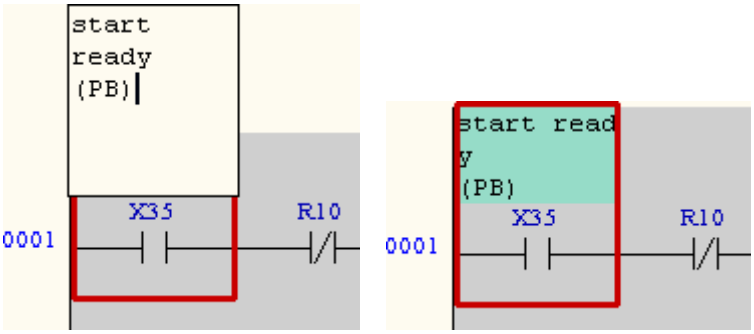


Fig. 3.21 Changing the row with return character

(4) In case of box type instruction, you can input a comment by double-clicking upper side of rectangular as shown in figure 3.22.

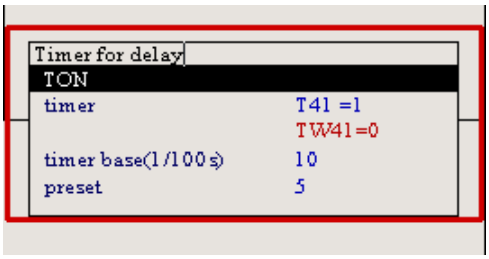


Fig 3.22 Inputting a comment of box type instruction

(5) You can attach a comment for rungs. As shown in figure 3.23, double-click the rung number, input in the edit box, and press Enter.

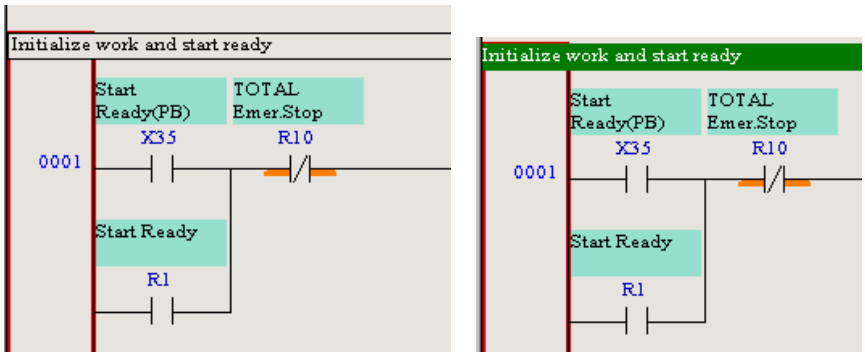


Fig 3.23 Inputting a comment of a rung

(6) The comment informations are stored not in ladder file but in project file, and are managed integratedly. That is, inputted relay comments are applied to all ladder files together. If you want to store comments not in project file but in ladder file, open the option dialog box with 『Tool – Option』 and check the “Store inst. comments in LAD file” entry as shown in figure 3.24. If storing comments in a ladder file, by uploading/downloading from/to controller, the comments informations come to be moved, too.

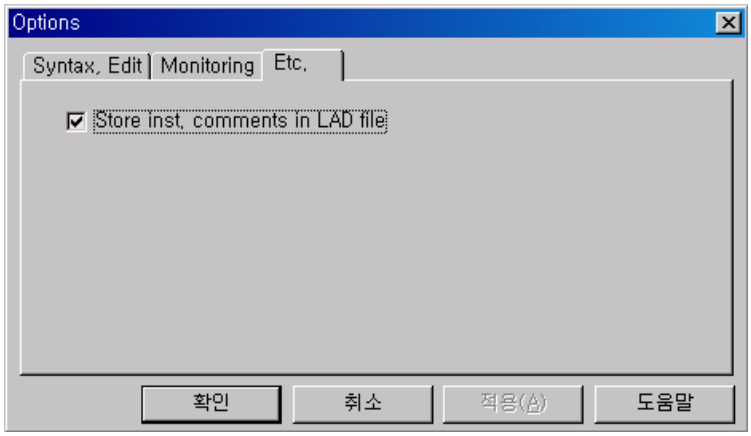


Fig 3.24 Tool - Option dialog box

(7) In the main menu, if selecting 『View – Relay Description Table』 or click  button, the relay description table appears. Fig 3.25 shows an example of relay description table. In upper side, the relay type names like X, Y, DI, DO, exist as tab. If clicking each tab, corresponding type's relay comments are displayed, and if clicking ALL tab, all the relay comments are displayed.

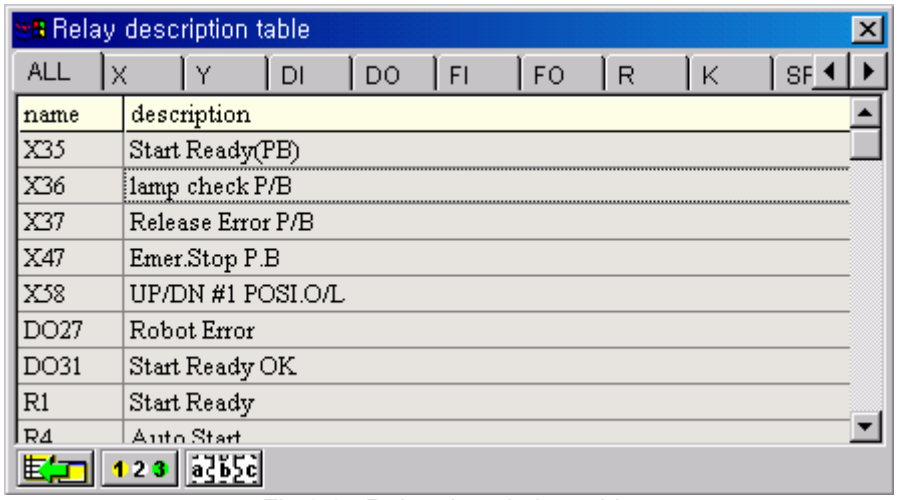


Fig 3.25 Relay description table

(8) If double-clicking specific row, you can edit the relay name or comments of corresponding row as shown in figure 3.26.

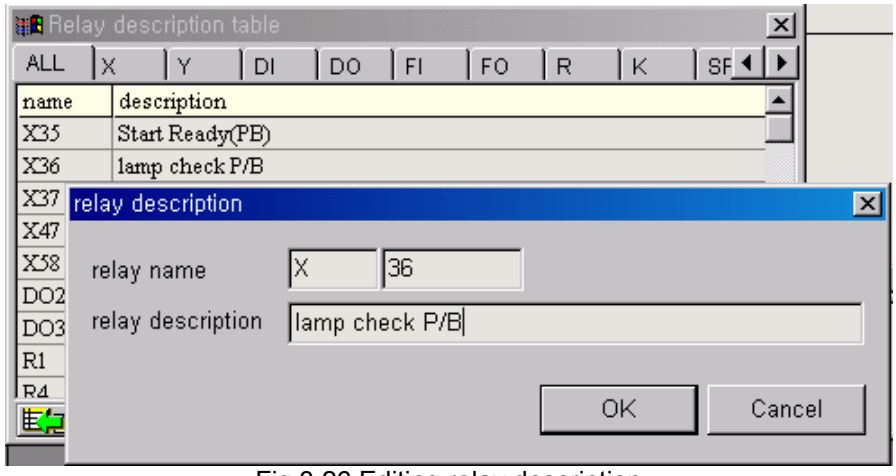
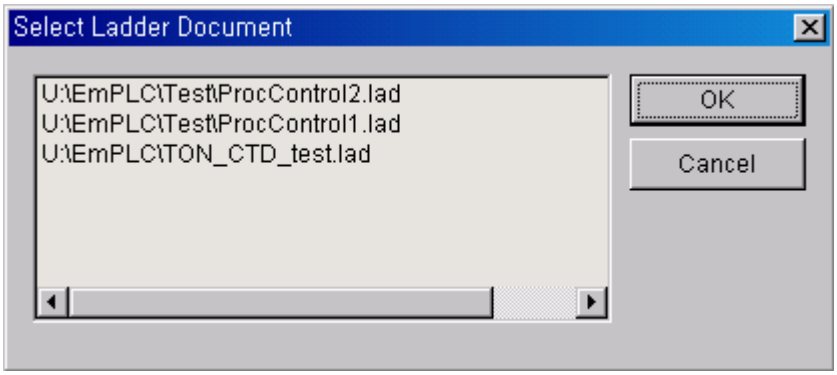
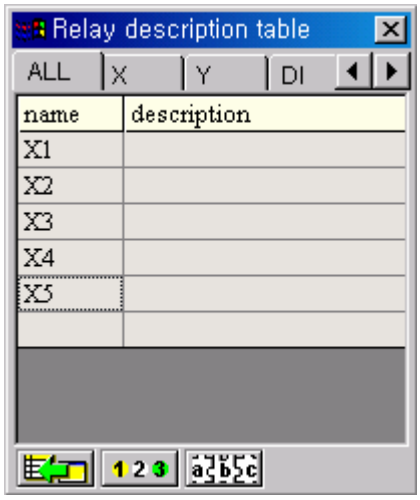


Fig 3.26 Editing relay description

(9) There are three buttons on bottom of relay description table. Each role is as explained in table 3-3.

Table 3-3 The function of relay description table's buttons

Import from ladder file 	When comment informations are stored in a ladder file, and the informations have to be imported, firstly open the ladder file as a window and click this button.  The dialog box displaying currently opened ladder files appears as shown in upper figure. If selecting the file you want and pressing OK button, the selected ladder file's comment informations are copied to the project and displayed in the relay description table.
Automatic increment 	For example, in relay description table, if selecting the item of X1 and clicking this button, whenever you click this button, the relay items are automatically inputted increasing the relay index to the below rows like X2, X3, X4… 
Sort 	Clicking this button sorts the relays in forward order, and one more clicking sorts the relays in backward order.

(10) The relay description table can be stored in a text file. Select 『File - Export Relay Description…』 while selecting project window, and input a filename and click Save button. The storing format is simple one in which relay name and description is separated with tab character as shown in figure 3.27.

Fig 3.27 Relay description table stored in text file

(11) This kind of text files can be opened in Microsoft Excel as shown in figure 3.28.

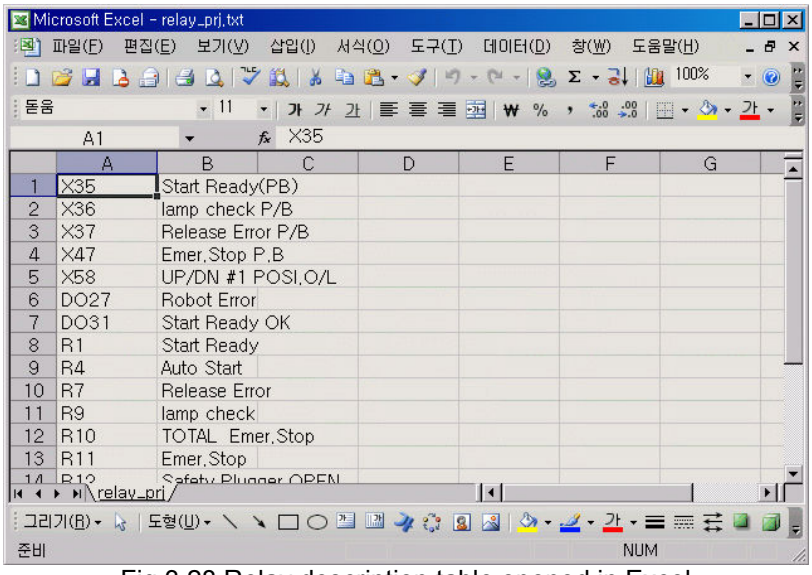


Fig 3.28 Relay description table opened in Excel

(12) On the contrary, a relay description table created in Excel can be stored in form of text file (separating with tab), and the text file can be imported into the project by selecting 『File – Importing Relay Description…』 .

3.6. Find & Replace

This function is to search the whole ladder diagram in order to find out a specified string or to replace the searched string with a different one. If selecting 『Edit - Find & Replace』 menu or clicking button in the tool bar, or pressing “Ctrl + F” key, the Search & Replace dialog box will be displayed as shown in the figure 3.28.

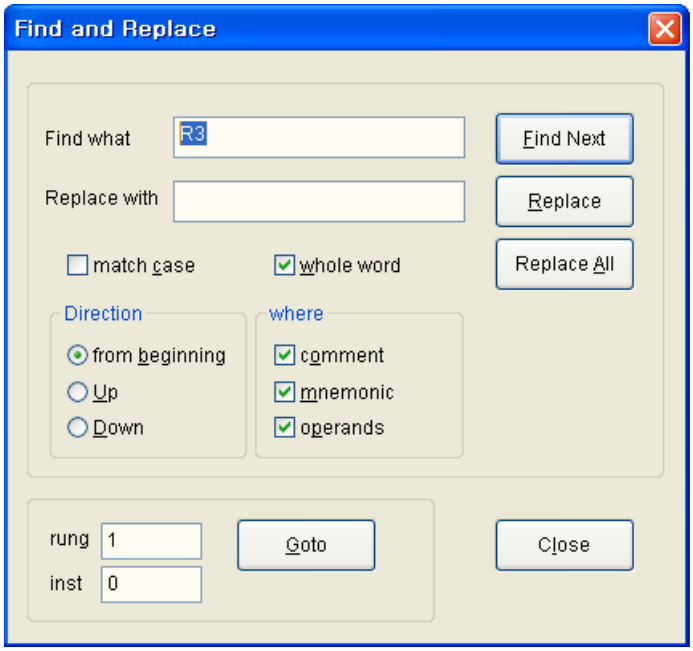


Fig. 3.29 Dialog Box for Find & Replace

In the table 3-4, each part of dialog box is explained.

Table 3-4 Each Part of Search & Replace Dialog Box

Find what	Input the string to search.
Replace with	Input the new string to replace with the searched string. Input only when replacing. You may leave it empty when searching only.
Find Next	Search for the next target string following the current location of cursor, and move the cursor to the string.
Replace	After replacing a string in the current location of cursor, move the cursor to the next location.
Replace All	Search all the ladder diagram from the current location of cursor to the end, and replace all the searched strings at a time.
match case	Select whether you compare the strings without discriminating between capital and small letter in searching.
Direction	When you select from the beginning, it will search from the beginning of the ladder diagram to search in “down” direction. If selecting a “down”, searching will be done in the right direction first and then keep on going down to the below rung. If selecting an “up”, searching will be done in the left direction first and then keep on going up to the above rung.
where	Select a subject to search. Searching is available for a subject sorted in comments, mnemonics, or operands. However, replacing is not available for the mnemonic.
rung/inst/Goto	Input rung and instruction No. and press Goto button, then the cursor will move to the target location. For example, if you intend to search the 5^{th} instruction in the 30^{th} rungs, input 30 to rung, 5 to inst, and press Goto button. If you intend to search Rung, then input 0 for the instruction No.
Close	Close the Search & Replace dialog box.

3.7. Syntax Check

This function is to check if the written ladder diagram has any errors in syntax.
Activate the ladder diagram window to check(activated state with clicking in a mouse).

Select 『Tool – Syntax Check』 menu or click  button in the tool bar.
As shown in the figure 3.30, the result of syntax check is output in the lower screen of result window. Errors are composed of the rung/inst format of error position and the error details.

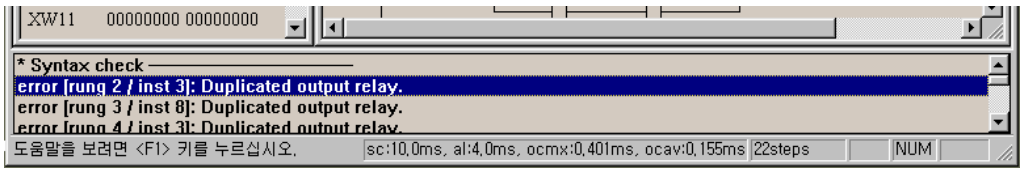


Fig. 3.30 Syntax Check of Result Window

Double-click the error items, and the cursor will move to the location of error. Mostly, errors are occurred by an incorrect relay name or an inappropriate combination of relay as the operand of corresponding instruction, or by a relay index deviated from the range. For example, in the figure 3.31, a syntax error occurs because DO7 input as a source b operand is a bit relay.

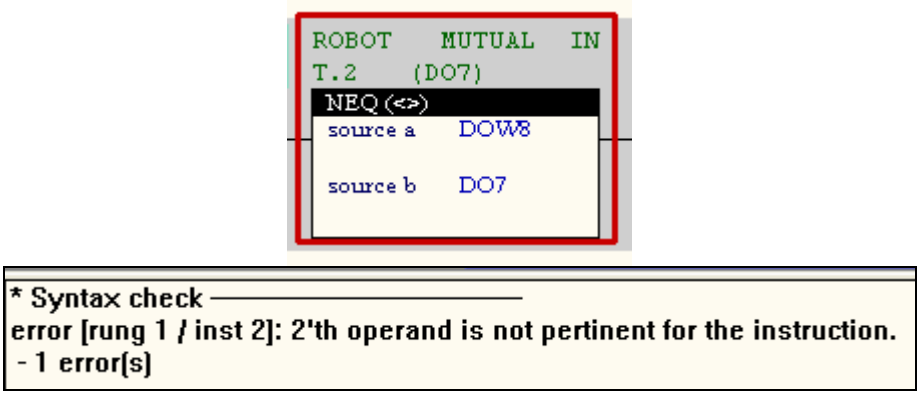


Fig. 3.31 Example of Syntax Error

When using 1 relay with more than 2 times output, it is considered to be a syntax error. However, this double output can be allowable in a syntax check. If selecting 『Tool – Option』, a dialog box is displayed like the figure 3.32. Here, check the 『Permit duplicated output』 item.

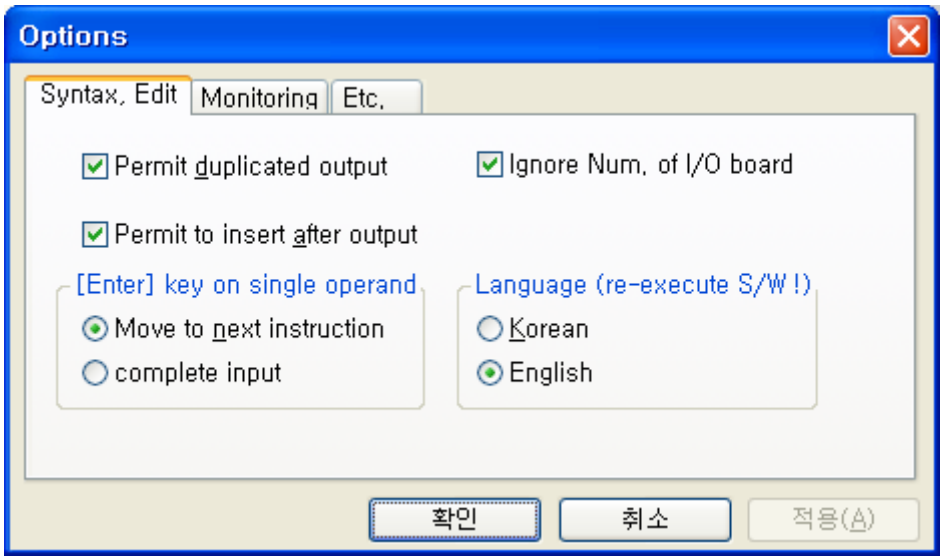


Fig. 3.32 Dialog Box for Option

4

Communication Setup

4.1. RS-232C Communication Setup

If you intend to upload/download of ladder and do monitoring with RS-232C, select RS-232C as the communication mode first.

Click  button in the tool bar or select 『Tool - Option』 in the menu, and the option dialog box will be displayed as shown in the figure 4.1.

Fig. 4.1 Option Dialog Box

In the option dialog box, press  button after pressing the monitoring tab, and click OK button to close the dialog box. And the communication mode will be selected as RS-232C.

And then, RS-232C parameters should be set up.
If clicking  button in the tool bar or selecting 『Tool – Comm Setup』 in the menu, a dialog box for RS-232C communication setup will be displayed as shown in the figure 4.2.

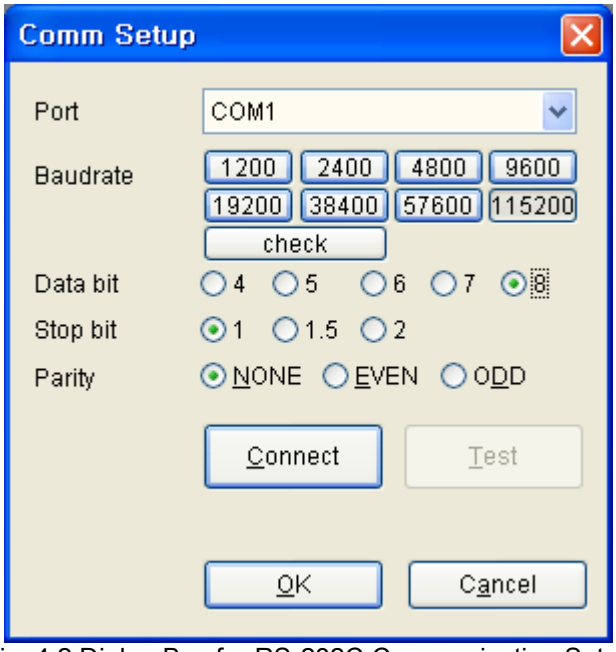


Fig. 4.2 Dialog Box for RS-232C Communication Setup

Parameters are available to change only when 

button is OFF in the dialog box for RS-232C communication setup(that is, disconnected). Thus, if it is ON, click it to turn off.

Select a communication port connected with RS-232C cable to PC, and set up the transmitting speed to be identical with Controller. Set up the data bit, stop bit, parity with Controller as shown in the figure 4-2.
The right part of dialog box is for Ethernet of Hi3TB Controller, so leave as it is.
Click OK button, and the set value will be applied and the dialog box will be closed.

The set communication port and transmitting speed will be displayed in PLC control bar as shown in the figure 4.3.

Fig. 4.3 Display of Communication Port and Transmit Speed in PLC Control Bar

4.2. RS-232C Communication Troubleshooting

When you have a problem related to RS-232C communication, follow the troubleshooting flowchart shown in Fig. 4.4.

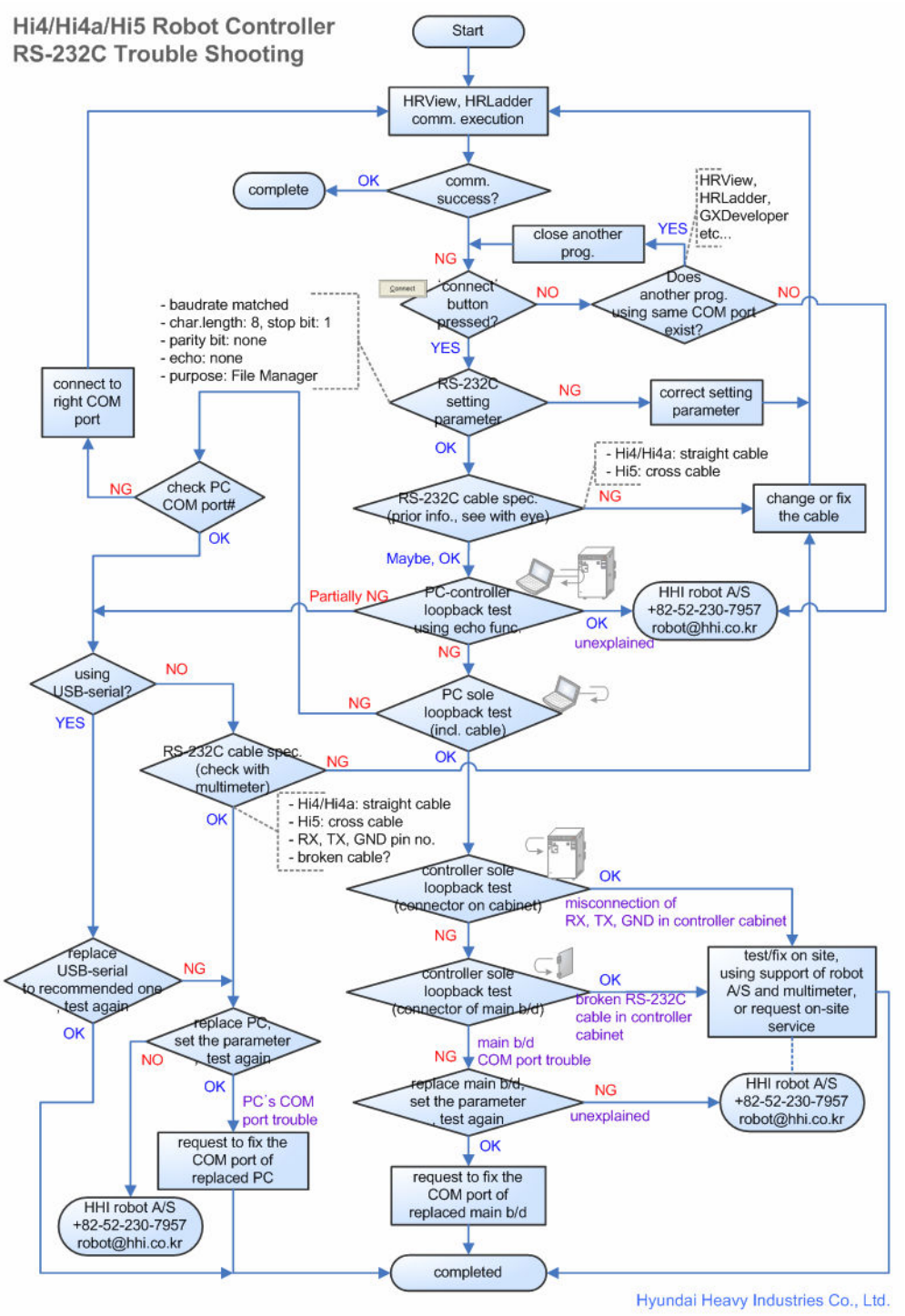


Fig. 4.4 RS-232C troubleshooting flowchart

■ Loop back test method on PC side

To test whether the RS-232C connection is normal, first open the communication setting dialog box and press the Connection (C) button to connect the communication.

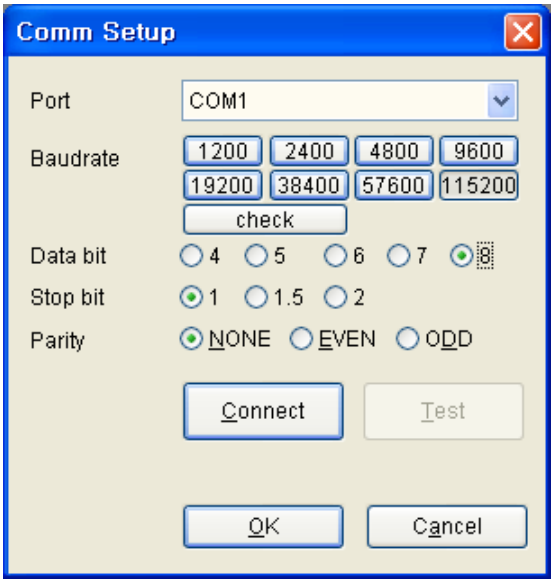


Fig. 4.5 Option dialog box

When you press the Test (T) button, RS-232C communication test dialog box opens as shown in Fig. 4.6.

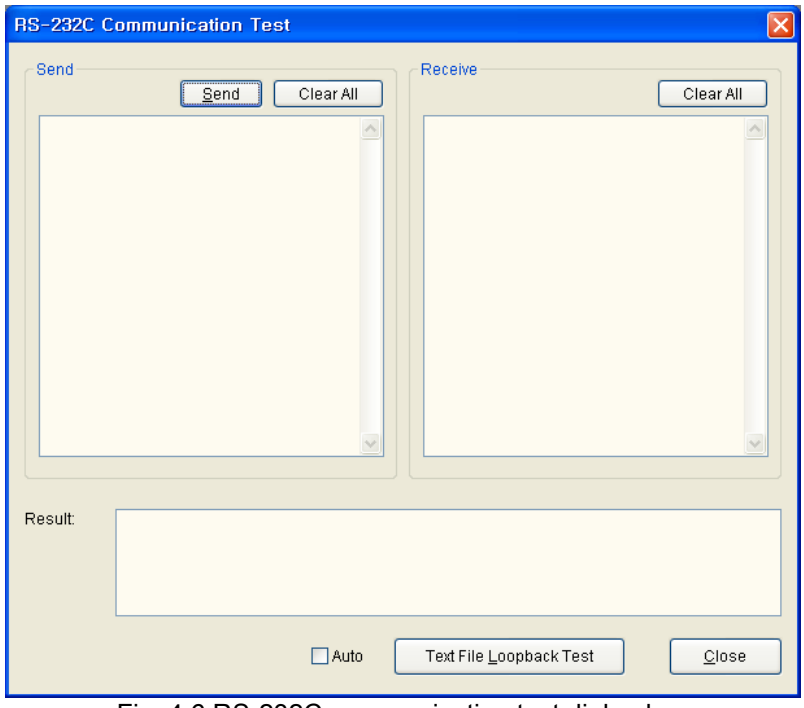


Fig. 4.6 RS-232C communication test dialog box

Table 4-1 Each part of RS-232C communication test dialog box

Send group box	**Send button**	This sends the text entered in the transmission edit box to RS-232C. (It sends only 500 byte of the front part.)
	Delete all button	This deletes all the text in the transmission edit box.
	Edit box	This is the area to record the text to send. This displays the text to send during text file loop back test.
Receive group box	**Delete all button**	This deletes all the text in the reception edit box.
	Edit box	This displays the text received from RS-232C.
Test result edit box		This displays the result of text file loop back test. This displays the send/received byte, whether they are equal, location and text where not equal etc.
Auto checkbox		Select whether to automatically repeat the text file loop back test.
Text file loop back test button		This executes the text file loop back test. It reads the long text data from the internal text file and sends it to RS-232C. Then the sent and received bytes are compared for comparison test. Sent and received data is displayed in each edit box.
Close button		Close the RS-232C communication test dialog box

The method of how to check whether the selected COM port of the PC serial port is operating normally is as follows. First short circuit the No. 2 and 3 pin of the connector on the cable installed for the COM port of the PC as shown in Fig. 4.7.

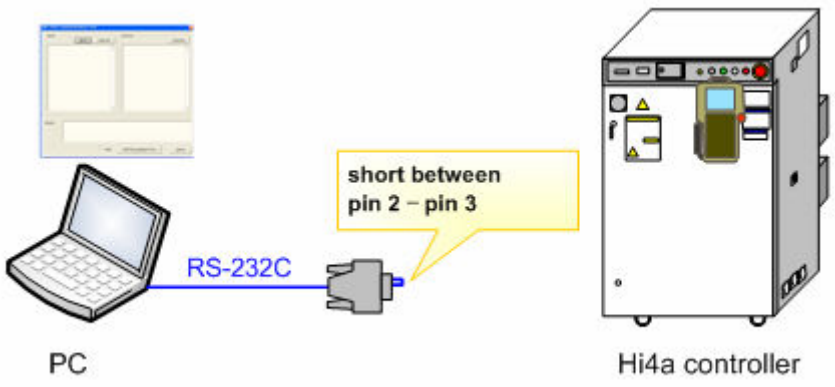


Fig. 4.7 Short circuit between No. 2 and 3 pin

When you press the text file loop back test button, the internal text file is sent/received to display the content in the edit box. When this is displayed as shown in Fig. 4.8, it is normal.

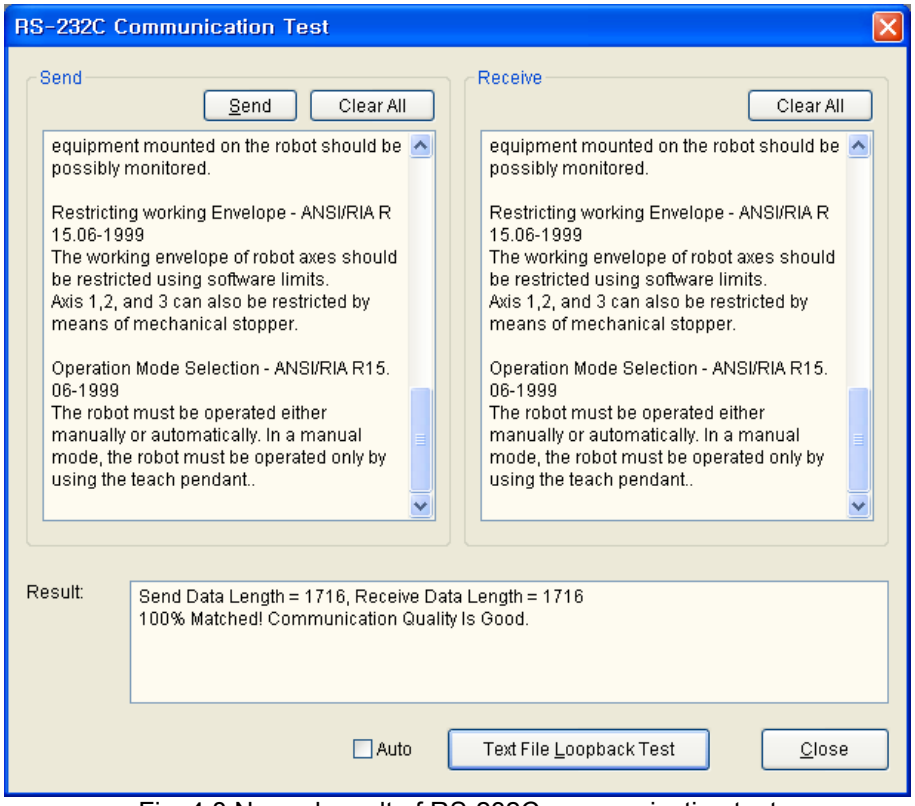


Fig. 4.8 Normal result of RS-232C communication test

The conclusion of the test result is as shown in Table 4-2.

Table 4-2 Result and conclusion of text file loop back test

Result	Conclusion (Estimated causes)
The data received in the reception edit box is displayed as it is and the test result displays “100% Matched!”.	Operation of COM port of PC is normal
No data displayed in the edit box of the receive side.	- Cable disconnected. - Incorrect connection of cable to another COM port of the PC. - PC COM port problem - No. 2 and 3 are not short circuited. - Setting error or defect of USB-Serial product (during use)
Unlike the received data in the edit box, partially corrupted text is displayed.	- Send/Receive function of the COM port of the PC is partially defective. Check whether there is a problem with the H/W. - Defect or performance deterioration of USB-Serial product (during use)

The method of checking whether the serial communication connection with the robot controller is normal is as follows. First, connect the COM port of the PC and the robot controller with the serial communication cable as shown in Fig. 4.9.

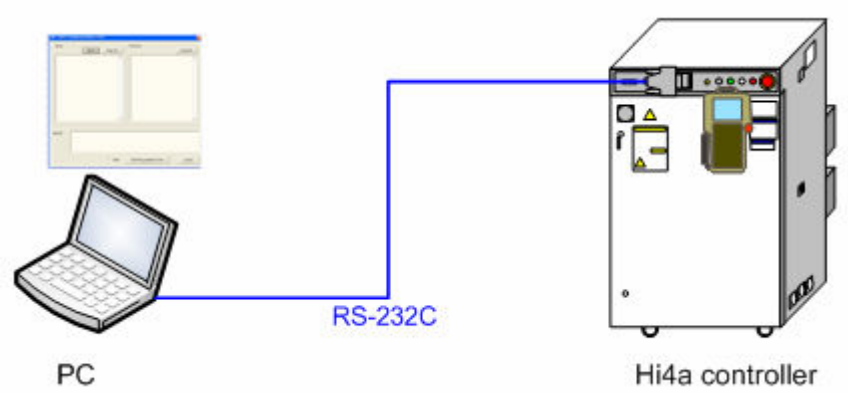


Fig. 4.9 PC - Checking the serial communication between the PC and the robot

Select [PF2: System] – 2: Control parameter – 2: Serial ports – 3: Serial port #1 (or, 4: Serial port #2) screen from the teach pendant of the robot controller and align the communication parameter with the PC side. Set the Echo to <Enable> as shown in Fig. 4.10.

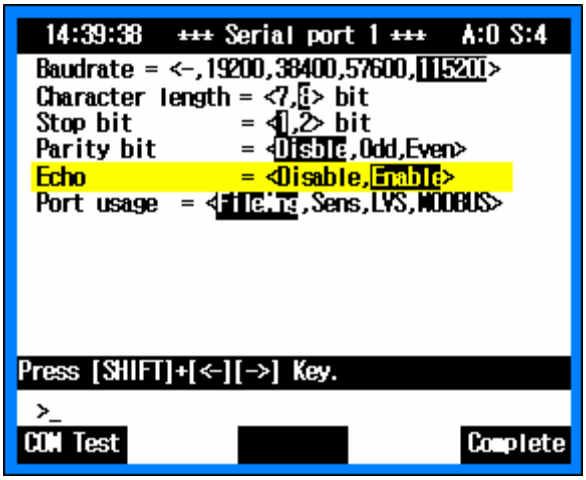


Fig. 4.10 Setting the echo of the communication parameter

When you press the text file loop back test button, the internal text file will be sent/received and the content will be displayed on the edit box. The conclusion is as shown in Table 4-3.

Table 4-3 Result and conclusion of text file loop back test

Result	Conclusion (Estimated causes)
The data received in the reception edit box is displayed as it is and the test result displays “100% Matched!”.	Connection of serial communication between the robot controller and PC is normal.
No data displayed in the edit box of the receive side.	(When the loop back test of the PC side is normal,) - Incorrect connection of RX and TX of the cable. - The cable is incorrectly connected to another COM port of the robot controller. - COM port problem of robot controller. - Serial cable disconnection inside the robot controller cabinet.
Unlike the received data in the edit box, partially corrupted text is displayed.	(When the loop back test of the PC side is normal,) - Send/Receive function of the COM port of the PC is partially defective. Check whether there is a problem with the H/W.

Reset the echo setting on the touch pendent serial port screen after the test, and the reset to <Disable>.

■ How to execute the loop back test on the controller side

(This function is supported from the Hi4a main S/W version v20.03-10.)

Enter the [PF2: System] – 2: Controller parameter – 2: Serial ports – 3: Serial port #1 (or, 4: Serial port #2) screen from the touch pendent of the robot controller, and press the [PF1: COM test].

As shown in the direction on the screen, short circuit the No. 2 and 3 pin of RS-232C of the controller cabinet as shown in Fig. 4.11.

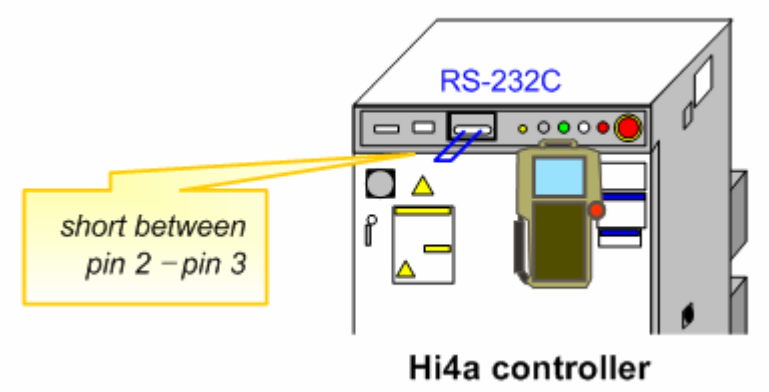


Fig. 4.11 RS-232C loopback of the controller cabinet shorted

When you press the [SET] key and see the message shown in Fig. 4.12, it is normal.

Fig. 4.12 Normal result of RS-232C communication test

In case of an error, a message saying “Communication error: Move to next step.” is displayed. Short circuit the No. 2 and 3 pin of the RS-232C terminal of the main board as shown in Fig. 4.13.

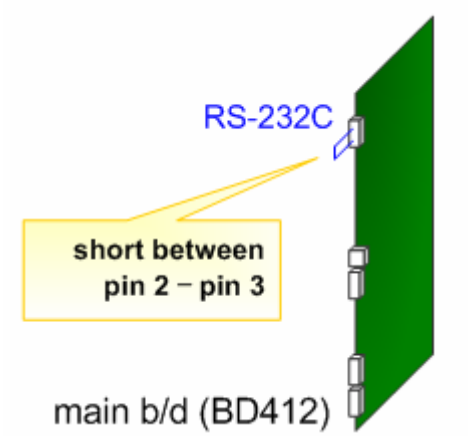


Fig. 4.13 RS-232C loopback of the main board shorted

When you press the [SET] key and see the message displayed in Fig. 4.14, there is no issue with the main board. In this case, check the cable disconnection within the board connected to the main board from the RS-232C inside the controller cabinet.

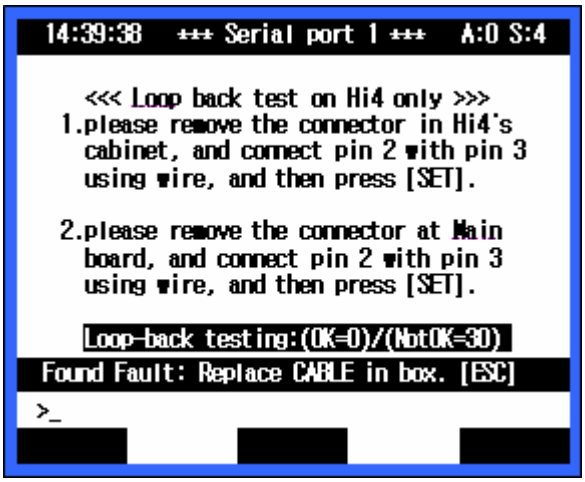


Fig. 4.14 Result when the RS-232C of the main board normally functions

When you press the [SET] key and see the message displayed in Fig. 4.15, there is an issue with the main board. In this case, replace the main board.

Fig. 4.15 Result when the RS-232C of the main board abnormally functions

4.3. Ethernet Communication Setup

If you intend to upload/download the ladder and do monitoring with Ethernet, Ethernet should be selected as the communication mode first.

Click  button in the tool bar or select 『Tool - Option』 in the menu, and the option dialog box will be displayed as shown in the figure 4.16.

Fig. 4.16 Option Dialog Box

In the option dialog box, press  button after pressing the monitoring tab, and click OK button to close the dialog box. And the communication mode will be selected as Ethernet.

And then, parameters such as IP address of Ethernet and port No. should be set up. If clicking  button in the tool bar or selecting 『Tool – Comm Setup』 in the menu, a dialog box for Ethernet setup will be displayed as shown in the figure 4.17.

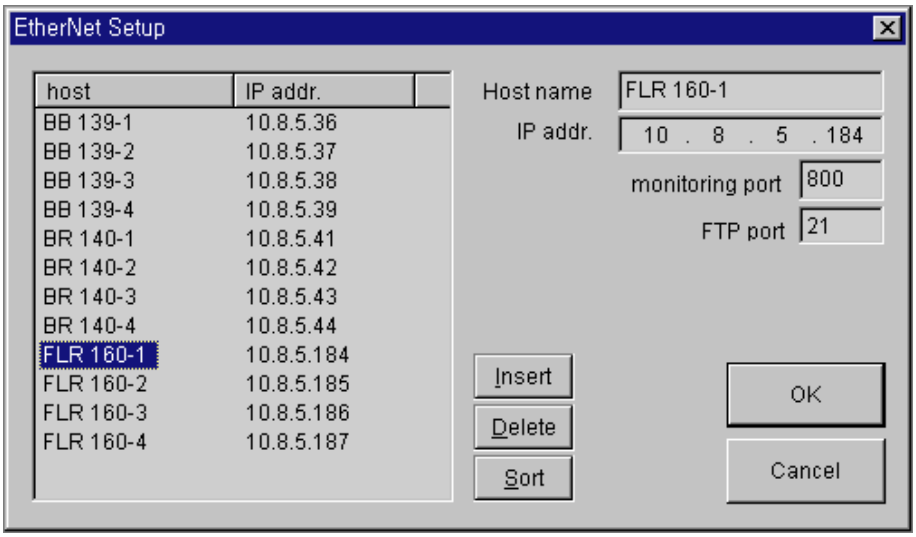


Fig. 4.17 Dialog Box for Ethernet Setup

First, in this dialog box, register the Hi4a controllers frequently connected. The registration procedure is as follows.

Input the host name(Hi4a controller name or number) and IP address in the right section, and input the value of monitoring port(default value is 800) and FTP port(default value is 21) (If possible, match HRLadder and Hi4a Controller with 800 and 21 respectively because port value should avoid a collision with other services. Because the Hi5 controller uses a different communication method from FTP method, you do not need to set the port.

Click Insert button after the input, and the new input is added to the list on the left.
Repeat this process to write a list of Hi4a Controllers.

To delete 1 item in the list, select the target item and click Delete button.

To sort the list items in order like 123, ABC, click Sort button.

To modify the input items of list, select the item and change to a preferred value in the right section, and then select the other item to reflect the changed item.

Click OK button after selecting a preferred item in the list, and the corresponding item will be selected as a host to connect and the dialog box will be closed. Here, the written list is saved as a text file of ENetSetup.dat in the directory where HRLadder execute file is located.

Fig 4.18 is the example of ENetSetup.dat file opened with NotePad.

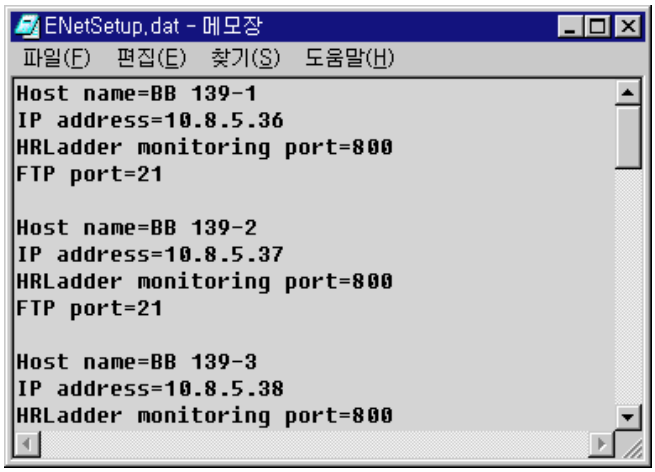


Fig. 4.18 Example of ENetSetup.dat File

The item name and its IP address selected in the dialog box for Ethernet setup is displayed in PLC control bar as shown in the figure 4.19. This is the host to connect.

Fig. 4.19 Display of Host Name & IP Address in PLC Control Bar

5

File Upload•Download

5.1. Download

This function is to transmit the ladder diagram completed in its writing or modifying to the embedded PLC of Controller.

When downloading the ladder diagram, HRLadder and embedded PLC should be connected as the state of online. Check [online] button in PLC control bar, press the button to be online if it is not.

Syntax check is automatically executed for the ladder diagram during download. If an syntax error is detected, download won't be performed, instead the error details will be displayed in result window.

If there is no syntax error, click Download button in the tool bar, or perform a download with 『Tool – Download』 menu or Hotkey [Ctrl+F5].

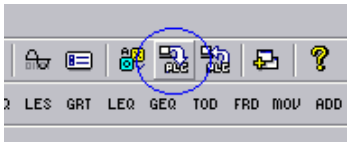


Fig. 5.1 Download Button in Tool Bar

If the embedded PLC is stopped, that is in the state of STOP or remote STOP as shown in the figure 5.2, downloading is immediately performed.

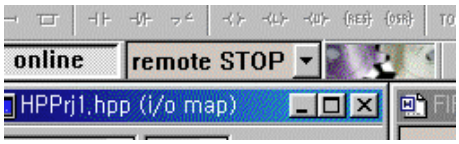


Fig. 5.2 PLC STOP

If it is in the state of run instead of STOP, that is RUN or remote RUN, the dialog box will be displayed as shown in the figure 5.3.

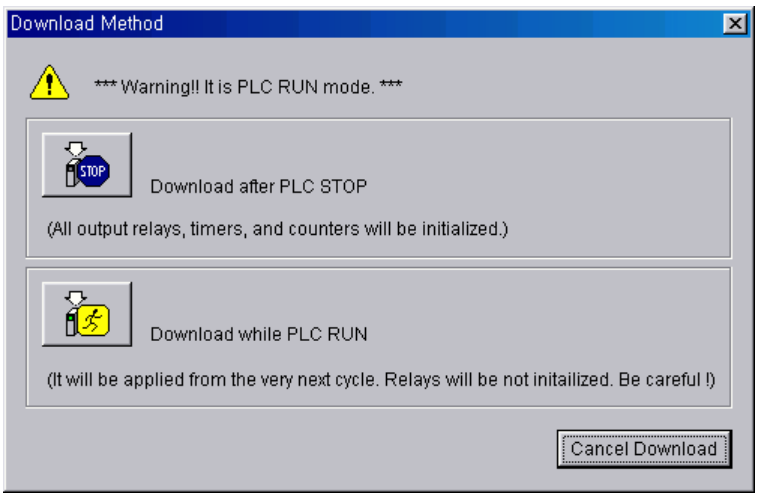


Fig. 5.3 Dialog Box for Download Type Selecting

If selecting [Download after PLC STOP], the embedded PLC in the state of remote RUN will be automatically changed to remote STOP , and then downloading will be performed. (if it is RUN, error message is displayed because remote conversion of mode is not available.) The downloaded ladder working starts operating in the initialized state of output contact point, timer, and counter because the embedded PLC is stopped.

Be careful of dropping accident when disconnecting a signal.

If selecting [Download during PLC RUN], downloading will be performed in the state of embedded PLC RUN. However, newly downloaded PLC ladder file is applied to the next PLC cycle.

Output contact points, timers, and counters don't be initialized. Thus, take note whether the remained relay values can be managed in the logical structure of changed ladder without any problems.

Download during PLC RUN function is not supported for the main board version 10.00-16 and less of the Hi4a controller, and instead the dialog box will be output as shown in the figure 5.4.

Fig. 5.4 Unsupported Message on Main Board Version

Success message output as shown in the figure 5.5 indicates downloading is completed. The downloaded ladder diagram is saved as a file of ROBOT.LD0 in the robot controller, and operated in a RUN mode.

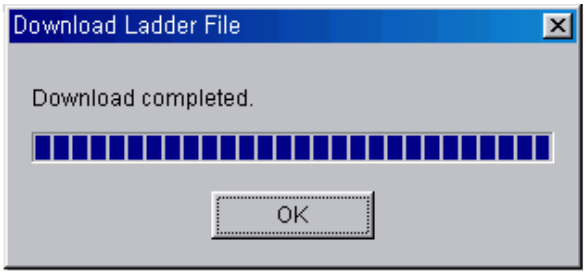


Fig. 5.5 Download Success Message

5.2. Upload

This function is to open the embedded PLC ladder file of robot controller, ROBOT.LD0, after receiving it with HRLadder.

When uploading the ladder diagram as shown in the figure 5.6, HRLadder and embedded PLC should be connected as the state of online. Check online button in PLC control bar, press the button to be online if it is not.

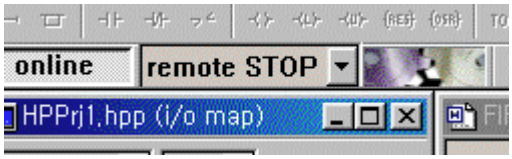


Fig. 5.6 online status Check

Click Upload button in the tool bar as shown in the figure 5.7, or perform an upload with 『Tool – Upload』 menu or [Ctrl+F6].

Fig. 5.7 Upload Button in Tool Bar

Success message output indicates uploading is completed. The uploaded ladder diagram is opened as a file of Noname.lad in HRLadder.

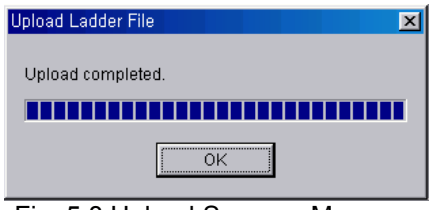


Fig. 5.8 Upload Success Message

5.3. Comparison

This is the function to check whether the ladder file of the current ladder window is the same as the ladder file downloaded to internal PLC (or other ladder file within the PC).

Click on the [Compare] tool button from the toolbar or select the 『Tools – Compare』 menu to upload the ladder file from the internal PLC to compare with the currently selected ladder window.

When the files are the same, the following icon as shown in Fig. 5.9 on the top right will be displayed.

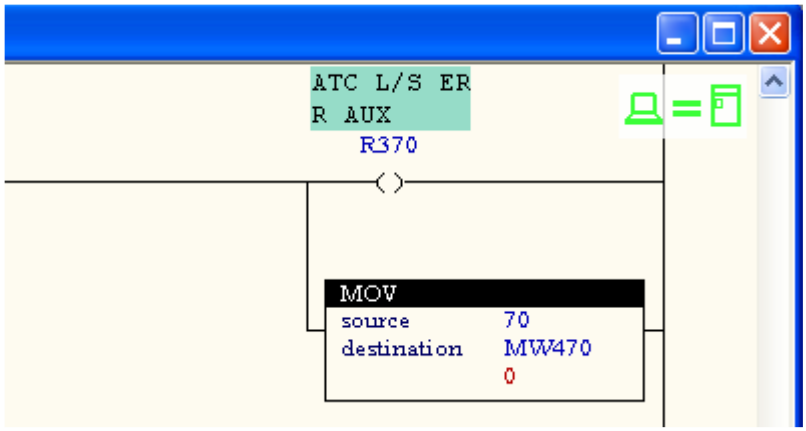


Fig. 5.9 Icon when the files are the same based on the comparison

When the files are different, the icon as shown in Fig. 5.10 is displayed.

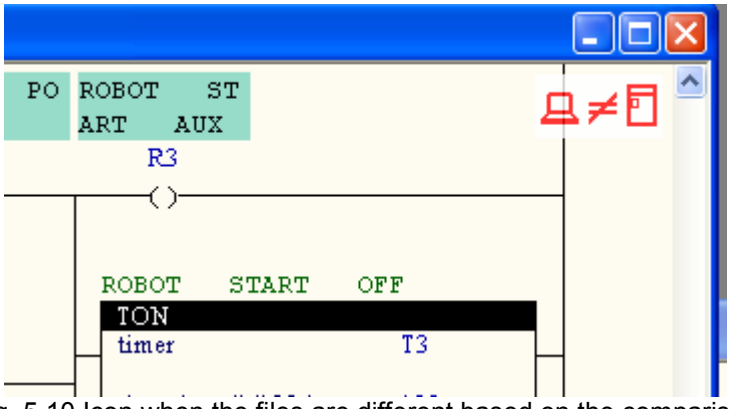


Fig. 5.10 Icon when the files are different based on the comparison

(Use the checksum of the ladder file during the PLC RUN to continue the comparison in real time and the icon to display that they are different will always be displayed.)

To check which location is different in detail select the 『Tools – Detail comparison』 menu. When the dialog box as shown in Fig. 5.11 is displayed, click on the [Run comparison] button to check the details of the result.
(You can designate the file within the PC from comparison target B to make the comparison.)

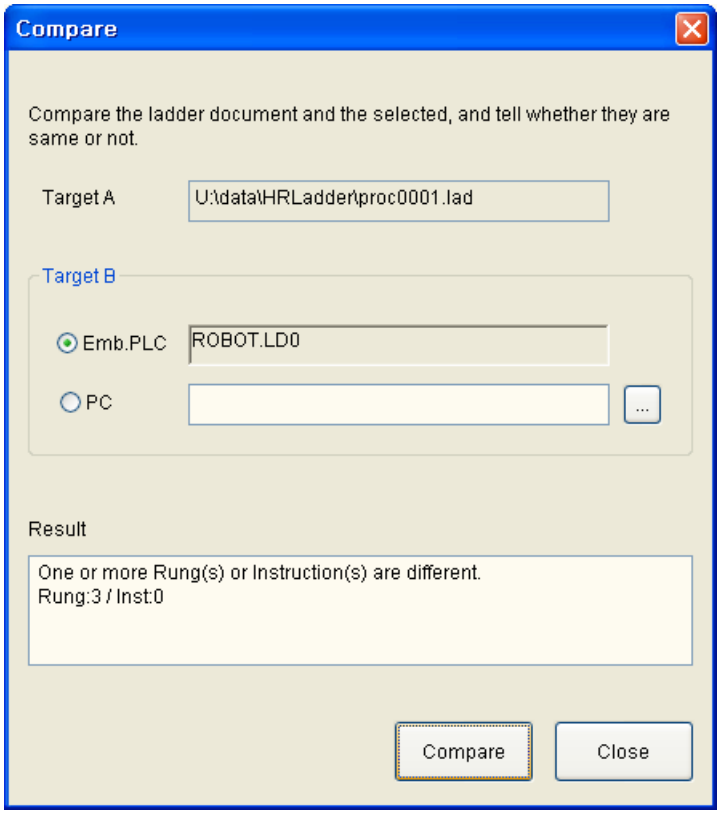


Fig. 5.11 Detail comparison result

6
Monitoring

6.1. PLC Monitoring

This function is to monitor the current relay value of embedded PLC in robot controller using HRLadder.
The project file (*.hpp) should be opened as shown in the figure 6.1. Make a new project file by the 『File – New』 instruction, or open the existing project file by the 『File – Open』 instruction.

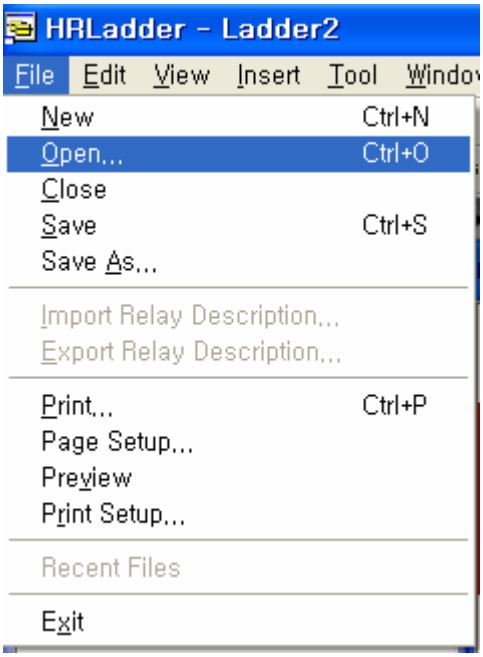


Fig. 6.1 Open Project File

If pressing Online button, a cogwheel picture will move in the PLC control bar. The movement of this picture indicates monitoring is normally performed. Table 6-1 describes the meaning of monitoring picture.

Table 6-1 Pictures of Monitoring status

Picture	Meaning
 separated cogwheel	Communication is offline
 stopped red cogwheel	Communication is online. Communication error.
 rotating cogwheel	Communication is online .Normal communication.

If you intend to make it Offline, press online button once again .

PLC mode list box located in the right side of Online button displays the current PLC mode, and is used for a remote control. There are 6 status in PLC mode as shown in the table 6-2.

Table 6-2 Status of PLC mode list box

PLC Mode	Meanings
STOP	Ladder operation is stopped. Mode is convertible only with controller T/P.
RUN	Ladder operation is in operation. Mode is convertible only with controller T/P.
Remote STOP	Ladder operation is stopped. Remote conversion to Remote-RUN is available with HRLadder.
Remote RUN	Ladder operation is in operation. Remote conversion to Remote-STOP is available with HRLadder.
PLC OFF	Embedded PLC is OFF. (Hi4a controller dip s/w No.5 OFF)
NO LAD	No ladder diagram in the embedded PLC.

For example, if embedded PLC is in the state of remote RUN or remote STOP, mode is remotely convertible with the drop down list box in HRLadder as shown in the figure 6.2.

Fig. 6.2 Remote Conversion of Mode with Drop Down List Box

In other cases, remote conversion is not available. The list box of PLC status, like the figure 6.3, shows only the current status, and does not allow users to operate it.

Fig. 6.3 Drop Down List unavailable remote conversion

Like the figure 6.4, open the dropdown list box of relay types in the upper side of monitoring window and select a type, the corresponding relay value is displayed.

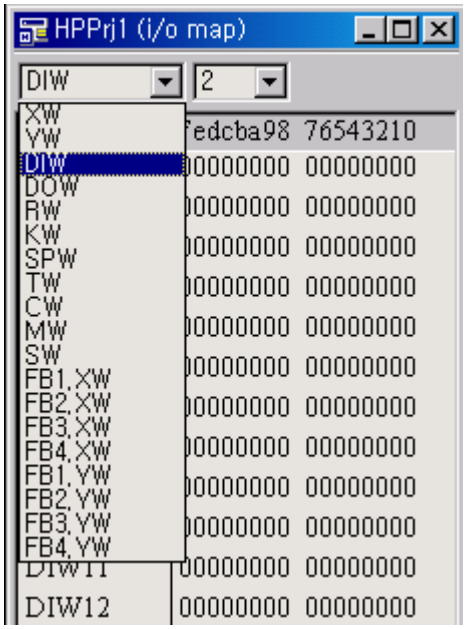


Fig. 6.4 Selecting a relay type for monitoring

Like the figure 6.5, open the dropdown list box of bit types in the upper side of monitoring window to select a proper bit for relay value. There are 3 choices among binary, decimal, and hexadecimal.

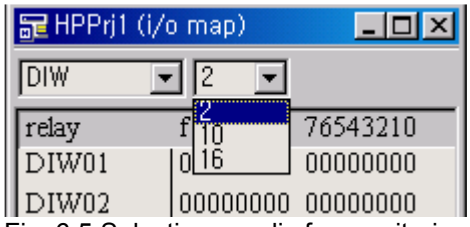


Fig. 6.5 Selecting a radix for monitoring

If you intend to see several types of relay simultaneously, open the several windows at the same time.

If selecting 『Window – New Window』 item in the main menu, one more monitoring window will be displayed. Arrange the location and size of window with a mouse as shown in the figure 6.6, and set up a dropdown list box of relay types.

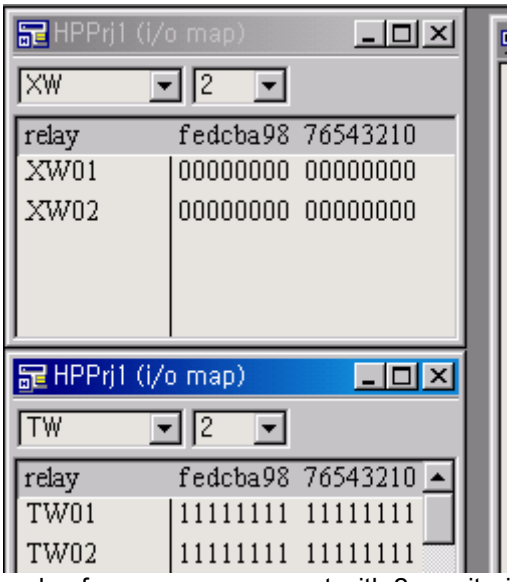


Fig. 6.6 Example of proper arrangement with 2 monitoring windows

When the internal PLC is in RUN condition and the ladder diagram is the same as that from the file downloaded from the internal PLC in monitoring situation, In the symbol of ladder diagram, relay status is displayed while monitoring is in operation. Symbols of DO18, DO17, DO21 are displayed as a short and thick horizontal lines as shown in the figure 6.7, and it means an activated status. The symbol of DO21 is XIO(B Contacting point), and it means DO21 signal is OFF.

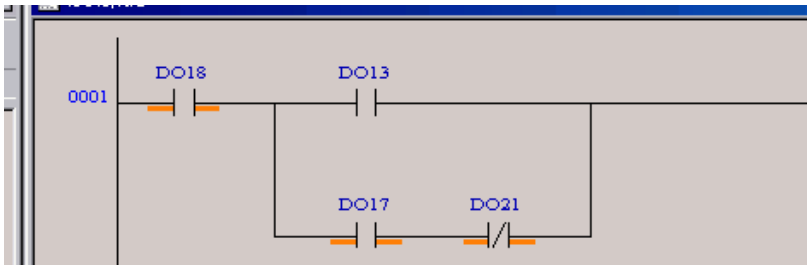


Fig. 6.7 Relay Status Display of Ladder Diagram Symbol

In case of box type instruction, current relay value is displayed below the operand with purple colored characters, as shown in the figure 6.8.

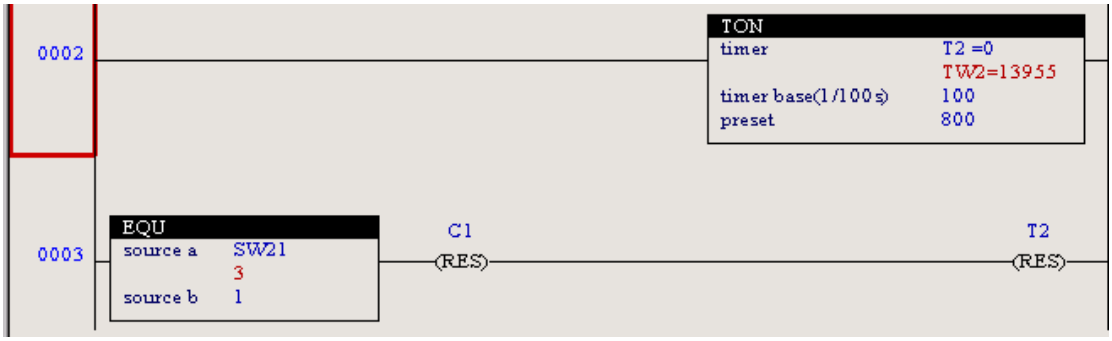


Fig 6.8 Relay Status Display of Box Type Instruction

If the internal PLC is in STOP condition, the monitoring value of the operand is not displayed. Also if the ladder diagram is different from that of the file downloaded from the internal PLC, Fig. 6.9 on the top right side of the ladder window will be displayed, and the monitoring value of the operand is not displayed. That is, for the ladder currently being run, you must analyze the operation of the ladder while looking at the monitoring value of the operand.
(When only the notes are different, the ladder files are considered the same.)

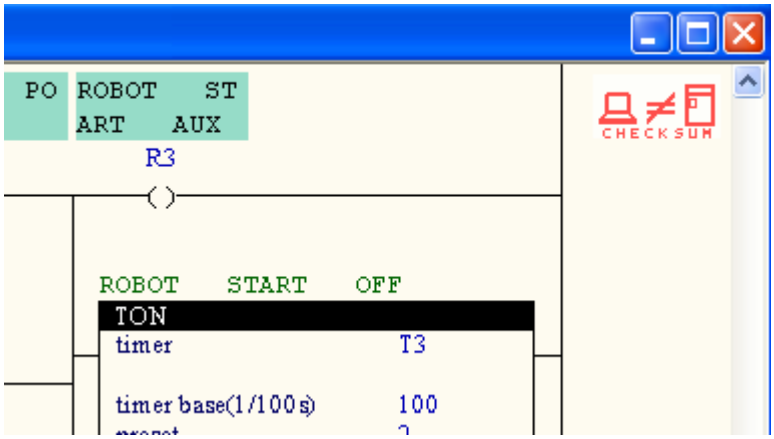


Fig. 6.9 Icon to display that the ladder files are different

After clicking on the different checksum icon on the top right side of the ladder window, click on 'Yes' on the message box as shown in Fig. 6.10 to force display the monitoring value.

Fig. 6.10 Whether it is selected to force display the operand value

HRLadder continuously receives an enormous volume of monitoring data from Controller through communication cable. Thus, you may feel the updating speed of monitoring data is dissatisfactory. For speeding up, increase the baud rate in RS-232C setup. (Controller setup should be changed as well.)

Another way to speed up is to set up the rest, other than some relays that monitoring is required, not to have a monitoring. Select 『Tool – Option』 menu, and a dialog box will be displayed as shown in the figure 6.11. HRLadder performs monitoring only for the relay checked in the check box. Remove a check for the relays that do not require a monitoring. With a removal of bulky relays such as RX, KW, TW, CW, DMW, or SMW, the speed would be considerably increased. In case of CW, DMW, or SMW, restrict the number of data in the edit box located in the right side of check box to increase communication speed.

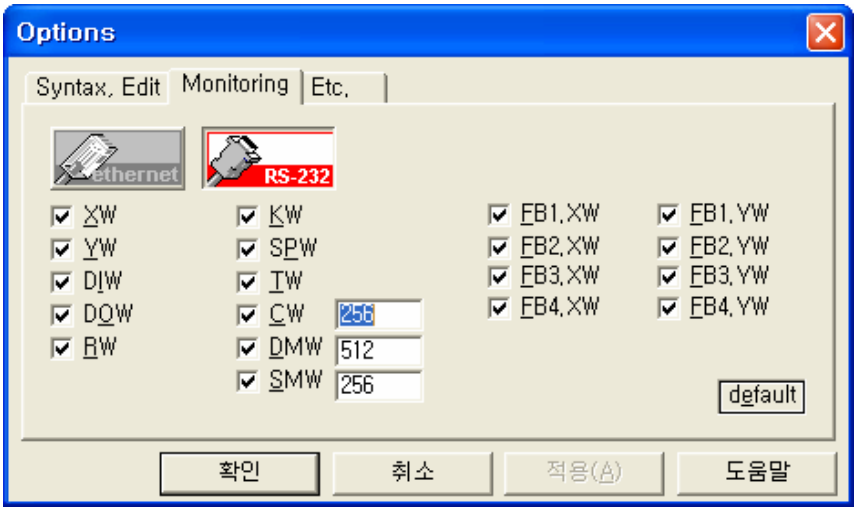


Fig. 6.11 Selection of Relay Range for Monitoring

6.2. Status Bar Information

Like the figure 6.12, some information on the operating status of embedded PLC is provided in status bar located in the lower side of HRLadder. (This information is displayed only when the embedded PLC is the status of RUN or remote RUN.) Its meaning is described in the table 6-3.

Fig. 6.12 Information on Operating Status of Embedded PLC in Status Bar

Table 6-3 Meanings of Embedded PLC Operation Status Information in Status Bar

scan time	Period of Entire Ladder Operation
occu (occupation)	Ration occupied within the unit of 10ms
n steps	The Number of Steps(Instructions) for Entire Ladder Work.

The unit for period is 10ms. As shown in the Table 6-4, scan time increases by 10ms each time it exceeds 10ms. Approximately 1300 steps take 20ms. (In case of mainboard S/W version 10.07-32)

Table 6-4 Relations Between Ladder Procesing Time and its Cycle

(Ladder Processing Time) < 10ms	Laddering operates once every 10ms repeatedly.
10ms < (Ladder Processing Time) < 20ms	Laddering operates once every 20ms repeatedly.
20ms < (Ladder Processing Time) < 30ms	Laddering operates once every 30ms repeatedly.
….	……

Some PLC products just ignore the excess of instructions without executing, when their ladder diagram is so big that it exceeds the specified scan time. It is called a fixed scan time type.
The Embedded PLC is a variable scan time type, which increases the scan time by 10ms, when its ladder diagram is so big that it exceeds the specified scan time.

The concept of occu. is described in the figure 6.13. It is an example that laddering takes more than 10ms. Thus, scan time becomes 20ms. The occu. value, 40%, indicates that scan time has more than enough to reach 30ms.

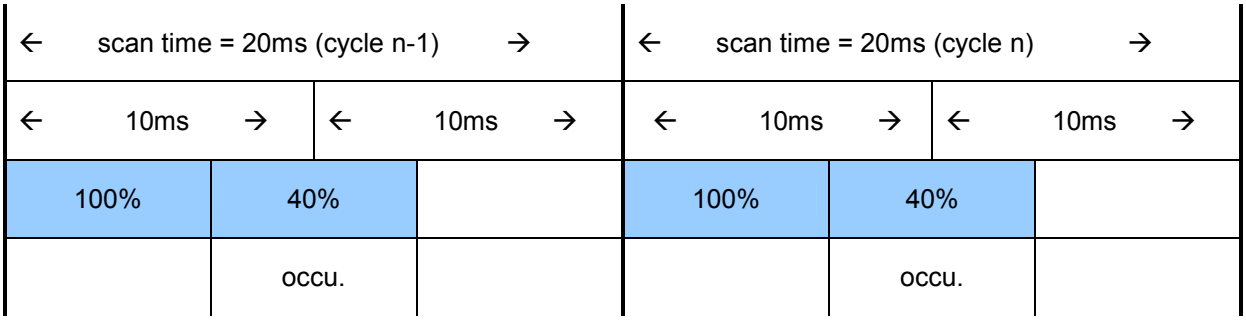


Fig 6.13 Example of occu. Concept

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