Preliminary version

HITACHI PROGRAMMABLE CONTROLLER

HIDIC MICRO-EH

APPLICATION MANUAL

NJI-350B (X)

WARNING

To ensure that the equipment described by this manual. As well as all equipment connected to and used with it, operate satisfactorily and safely, all applicable local and national codes that apply to installing and operating the equipment must be followed. Since codes can vary geographically and can change with time, it is the user's responsibility to determine which standard and codes apply, and to comply with them.

FAILURE TO COMPLY WITH APPLICABLE CODES AND STANDARDS CAN RESULT IN DAMAGE TO EQUIPMENT AND / OR SERIOUS INJURY TO PERSONNEL.
INSTALL EMERGENCY POWER STOP SWITCH WHICH OPERATES INDEPENDENTLY OF THE PROGRAMMABLE CONTROLLER TO PROTECT THE EQUIPMENT AND / OR PERSONNEL IN CASE OF THE CONTROLLER MALFUNCTION.

Personnel who are to install and operate the equipment should carefully study this manual and any others referred to by it prior to installation and / or operation of the equipment. Hitachi, Ltd. constantly strives to improve its products, and the equipment and the manual(s) that describe it may be different from those already in your possession.

If you have any questions regarding the installation and operation of the equipment, or if more information is desired, contact your local Authorized Distributor or Hitachi, Ltd.

IMPORTANT

THIS EQUIPMENT GENERATES, USES, AND CAN RADIATE RADIO FREQUENCY ENERGY AND, IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE INTERFERENCE TO RADIO COMMUNICATIONS. AS TEMPORARILY PERMITTED BY REGULATION, IT HAS NOT BEEN TESTED FOR COMPLIANCE WITH THE LIMITS FOR CLASS A COMPUTING DEVICES PURSUANT TO SUBPART J OF PART 15 OF FCC RULES, WHICH ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST SUCH INTERFERENCE.

OPERATION OF THIS EQUIPMENT IN A RESIDENTIAL AREA IS LIKELY TO CAUSE INTERFERENCE IN WHICH CASE THE USER, AT HIS OWN EXPENSE, WILL BE REQUIRED TO TAKE WHATEVER MEASURES MAY BE REQUIRED TO CORRECT THE INTERFERENCE.

LIMITED WARRANTY AND IMITATION OF LIABILITY

Hitachi, Ltd. (Hitachi) warrants to the original purchaser that the programmable controller (PLC) manufactured by Hitachi is free from defects in material and workmanship under normal use and service. The obligation of Hitachi under this warranty shall be limited to the repair or exchange of any part or parts which may prove defective under normal use and service within eighteen (18) months from the date of manufacture or twelve (12) months from the date of installation by the original purchaser which ever occurs first, such defect to be disclosed to the satisfaction of Hitachi after examination by Hitachi of the allegedly defective part or parts. This warranty in expressly in lieu of all other warranties expressed or implied including the warranties of merchantability and fitness for use and of all other obligations or liabilities and Hitachi neither assumes, nor authorizes any other person to assume for Hitachi, any other liability in connection with the sale of this PLC. This warranty shall not apply to this PLC or any part hereof which has been subject to accident, negligence, alteration, abuse, or misuse. Hitachi makes no warranty whatsoever in respect to accessories or parts not supplied by Hitachi. The term "original purchaser", as used in this warranty, shall be deemed to mean that person for whom the PLC in originally installed.

In no event, whether as a result of breach of contract, warranty, tort (including negligence) or otherwise, shall Hitachi or its suppliers be liable for any special, consequential, incidental or penal damages Including, but not limited to, loss of profit or revenues, loss of use of the products or any associated equipment, damage to associated equipment, cost of capital, cost of substitute products, facilities, services or replacement power, down time costs, or claims of original purchaser's customers for such damages.

To obtain warranty service, return the product to your distributor, or send it with a description of the problem, proof of purchase, post paid, insured, and in a suitable package to:

Quality Assurance Dep.
Hitachi Industrial Equipment Systems Co., Ltd.
46-1, Ooaza-Tomioka Nakajo-machi
Kitakanbara-gun, Niigata-ken
959-2608 JAPAN

The information and/or drawings set forth in this document and all rights in and to inventions disclosed herein and patents which might be granted thereon disclosing or employing and the materials, techniques or apparatus described herein are the exclusive property of Hitachi, Ltd.

No copies of the information or drawings shall be made without the prior consent of Hitachi, Ltd.

Hitachi, Ltd. provides customer assistance in varied technical areas. Since Hitachi does not posses full access to data concerning all of the uses and applications of customer‘s products, responsibility is assumed by Hitachi neither for customer product design nor for any infringements of patents or rights of others which may result from Hitachi assistance.

The specifications and descriptions contained in this manual were accurate at the time they were approved for printing. Since Hitachi, Ltd. Incorporated constantly strives to improve all its products, we reserve the right to make changes to equipment and/or manuals at any time without notice and without incurring any obligation other than as noted in this manual.

Hitachi, Ltd. assumes no responsibility for errors that may appear in this manual.

As the product works with user program and Hitachi, Ltd. cannot test all combination of user program components, it is assumed that a bug or bugs may happen unintentionally. If it is happened: please inform the fact to Hitachi, Ltd. or its representative. Hitachi will try to find the reason as much as possible and inform the countermeasure when obtained.

Nevertheless Hitachi, Ltd. intends to make products with enough reliability, the product has possibility to be damaged at any time. Therefore personnel who are to install and operate the equipment has to prepare with the counter-measure such as power off switch can be operated independently of the controller. Otherwise, it can result in damage to equipment and/or serious injury to personnel.

Safety Precautions

Read this manual and attached documents thoroughly before installing and operating this unit, and performing maintenance or inspection of this unit in order to use the unit correctly. Be sure to use this unit after acquiring adequate knowledge of the unit, all safety information, and all precautionary information. Also, be sure to deliver this manual to the person in charge of maintenance.
Safety caution items are classified as "Danger" and "Caution" in this document.

DANGER : Cases in which, if handled incorrectly, a dangerous situation may occur, resulting in possible death or severe injury.

CAUTION : Cases in which, if handled incorrectly, a dangerous situation may occur, resulting in possible minor to medium injury to the body, or only mechanical failure.

However, depending on the situation, items marked with **CAUTION** may result in major accidents.

Both of these items contain important safety information, so be sure to follow them closely.

Icons for prohibited items and required items are shown below:

: Indicates a prohibited item (item that cannot be performed). For example, when open flames are prohibited, is shown.

: Indicates a required item (item that must be performed). For example, when grounding must be performed, is shown.

1. Installation

CAUTION
• Use this product in an environment as described in the catalogue and this document. If this product is used in an environment subject to high temperature, high humidity, excessive dust, corrosive gases, vibration or shock, it may result in an electric shock, fire or malfunction. • Installation this product according to the instructions in this manual. If installation is not performed correctly, it may result in falling, malfunction, or an operational error of the unit. • Never allow foreign objects such as wire chips to enter the unit. They may cause a fire, malfunction, or failure.

2. Wiring

REQUIRED

- Always perform grounding (FE terminal).
  If grounding is not performed, there is a risk of an electric shock or malfunction.

⚠ CAUTION

- Connect a power supply that meets the rating.
  If a power supply that does not meet the rating is connected, it may result in a fire.

- Any wiring operation should only be performed by a qualified technician.
  If wiring is performed incorrectly, it may result in a fire, failure, or electric shock.

3. Precautions When Using the Unit

DANGER

- Never touch the terminals while the power is on.
  There is a risk of an electric shock.

- Configure the emergency stop circuit, interlock circuit and other related circuits external to the programmable controller (referred to as the PLC in this document).
  Otherwise, a failure in the PLC may damage the equipment or result in a serious accident.
  Never interlock the unit with the external load via the relay drive power supply of the relay output module.

⚠ CAUTION

- Before performing program change, forced output, run, stop and other operations while the unit is in operation, be sure to check the validity of the applicable operation and safety.
  An operation error may damage the equipment or result in a serious accident.

- Be sure to power on the unit according to the designated power-on sequence.
  Otherwise, an erroneous operation may damage the equipment or result in a serious accident.

4. Maintenance

DANGER
• Never connect the ⊕ and ⊖ of the battery in reverse. Also, never charge, disassemble, heat, place in fire, or short circuit the battery. There is a risk of an explosion or fire.

PROHIBITED
• Never disassemble or modify the unit. These actions may result in a fire, malfunction, or failure.

CAUTION
• Be sure to turn off the power supply before removing or attaching the module/unit. Otherwise, it may result in an electric shock, malfunction, or failure.

Revision History

No.	Description of Revision	Date of Revision	Manual Number
1	Appendix-1 Instruction Support FUN92 to 96 of H-4010 ○ -> ×. Appendix-2 Task code H28 Corrected explanation of Timer counter number.	2000/11	NJI-350 (X)
2	Postscript of battery error detection. (3.2 chapters item number 26, 15 chapters (4)) Correct a description of digital filter . (8.7 chapters) Addition of appendix 3.	2000/12	NJI-350A (X)
3	28 points expansion units added. Analog expansion module added. Circuit diagram added in chapter 3 FUN 5, TRNS/RECV command added in chapter 5.	2003/10	NJI-350B (X)

Table of Contents

MEMO

Chapter 1 Features

1. Multifunctional all-in-one type PLC
   The MICRO-EH is a multifunctional all-in-one type PLC that contains all necessary parts—a power supply and CPU parts as well as I/O units--within one unit.
   Three sizes of PLCs are available: 10, 14, and 28 points. A type with 23 points plus three points of analog I/O having the same size as the 28-point PLC is also available. Moreover, for PLCs with more than 14 points, it is possible to install additional 14 or 28 point expansion units up to four units. Thus, the MICRO-EH can control a wide range of systems from small to medium size.

2. Simplified positioning by counter inputs and pulse train outputs
   The function of inputs/outputs can be selected from four modes. By selecting a mode, inputs/outputs that are used as normal inputs/outputs can be set as counter inputs and pulse train outputs. Through a combination of these special inputs/outputs, it is possible to control positioning without using special modules.

3. Simplified instrument system by analog integration
   For the 23-point PLC, there are two points of analog input and one point of analog output for which both current and voltage can be selected. High performance analog channels, with a resolution of 12 bits and an overall accuracy of ±1 % or less, can be used without requiring special settings of the channels; thus, a simplified instrument system can easily be implemented.

4. Superior upward compatibility
   The MICRO-EH has been developed as a part of the EH/H series family.
   Debugging and programming can be performed using the same concept as for the EH/H series.
   In addition, the MICRO-EH software property can effectively be applied to the EH/H series for future system expansion.

5. Easy maintenance through removable terminal blocks and installation on a DIN rail
   All models of the MICRO-EH series support the DIN rail so that the PLC can easily be mounted and dismounted. In addition, the I/O section of the 14-point PLC or more utilizes a removable terminal block. Thus, erroneous and faulty wiring that may occur when connecting to external devices can be reduced.

6. Remote maintenance through modem connection
   Communication with remote sites can be performed via dial-up line by connecting a modem to port 1 on the 14-point PLC or more of the MICRO-EH series. It is possible to monitor and manage remote systems from an office or monitor room.

7. Easily adjustable potentiometer
   The 14-point PLC or more of the MICRO-EH series supports two potentiometers.
   By using these potentiometers, it is possible to rewrite internal output values in real-time by one driver without using peripheral devices. Since the resolution of the potentiometer is 10 bits, it is possible to set any value from 0 to 3FFH. To obtain stable analog values of the potentiometers, it is possible to sample 1 to 40 analog values of the potentiometers and average them.

8. Maintaining programs without a battery
   It is possible to retain user programs in case of out-of battery or no battery, since FLASH memory is used as the backup memory for the user programs. However, a battery is necessary for data memory backup. (See the Notes in Chapter 7.1 for a list of precautionary details.)

9. Support for various programming languages
   The MICRO-EH supports “Pro-H,” the programming software that allows creating programs in five programming languages regulated in IEC1131-3. This means that customers who have learned languages other than Ladder can easily create programs with this programming software.

10. Compliant with overseas specifications as standard
    All types of MICRO-EH PLCs have obtained the CE mark, C-TICK and UL. Therefore, systems in which these PLCs are installed can be exported without requiring any modification.

MEMO

Chapter 2   System Overview

This chapter describes the system configuration of the MICRO-EH.
The MICRO-EH is an all-in-one type programmable controller, and has the following system configuration.

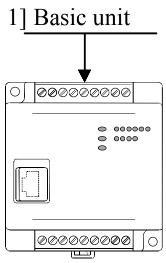


Figure 2.1 10-point type system configuration diagram

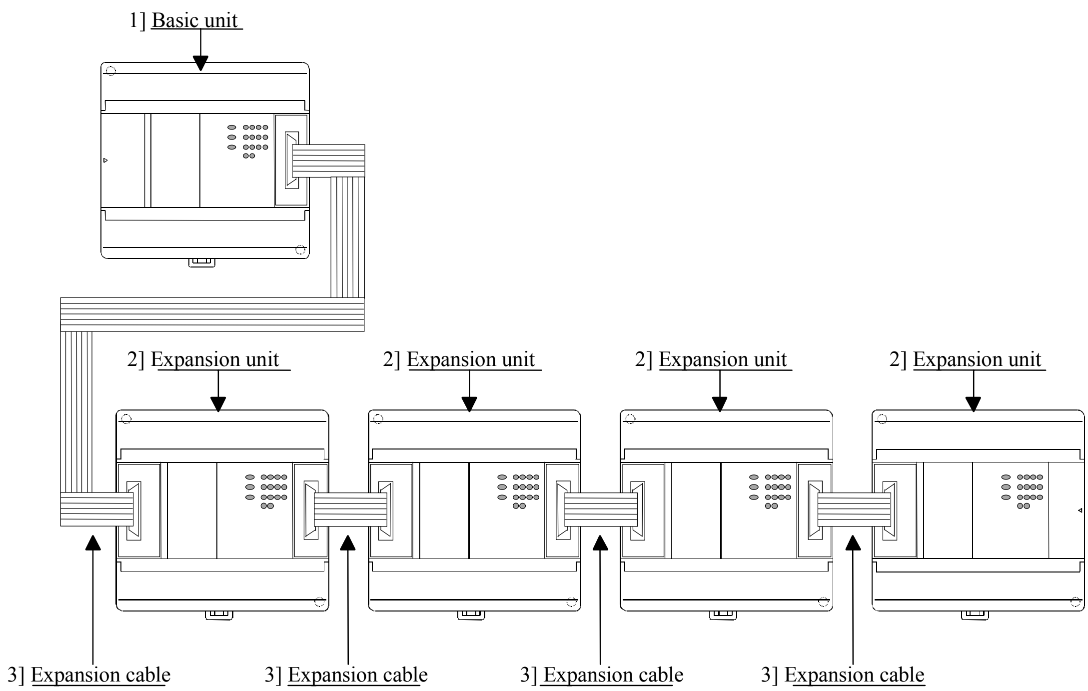


Figure 2.2 14-point type system configuration diagram

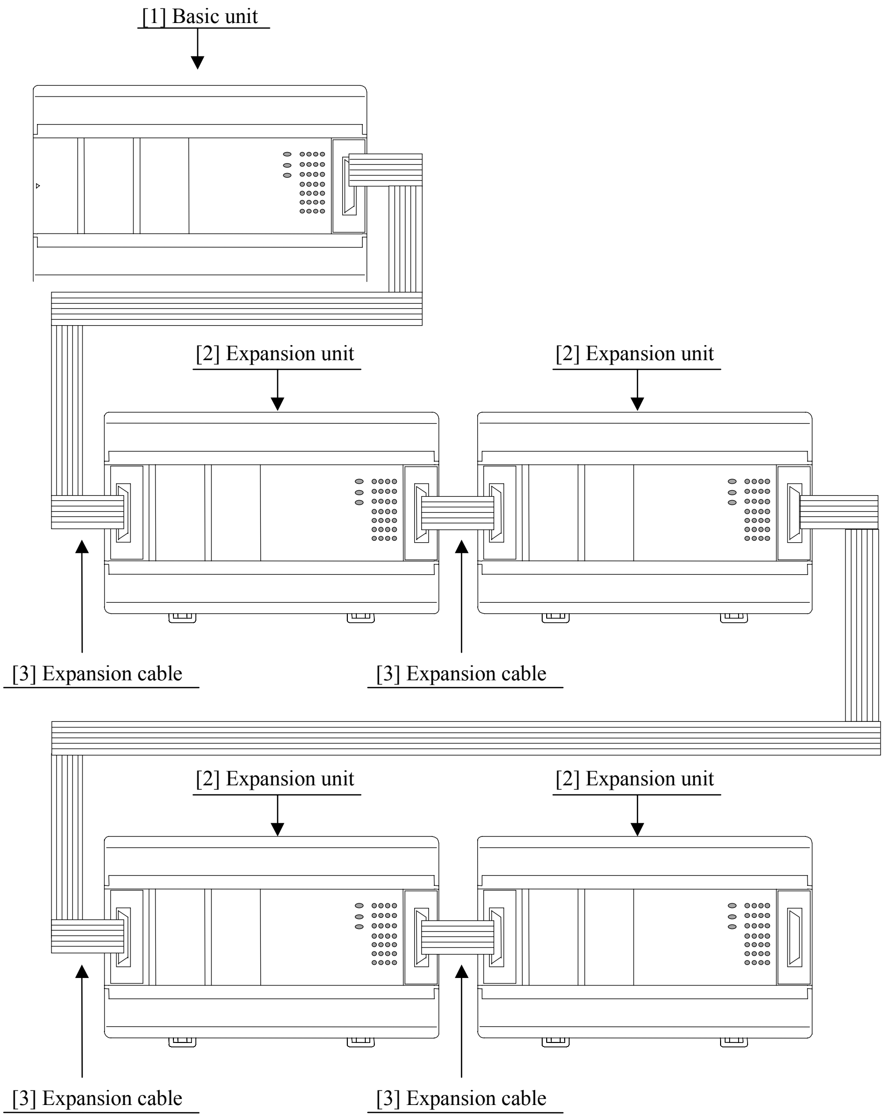


Figure 2.3 23,28-point type system configuration diagram

No restriction for combination of 14,23,28 points, and basic/expansion unit.
14 points basic unit can handle any type of expansion units, and 23/28 points basic unit as well.

No.	Device name	Description
1]	Basic unit	Calculates, imports inputs, and controls outputs according to the contents of user programs.
2]	Expansion unit	14 points digital unit, 4 in/2 out analog unit
3]	Expansion cable	Cable for connecting the basic unit and expansion unit, or between expansion units.

Chapter 3 Function and Performance Specifications

3.1 General Specifications

<table>
<tr><th>Item</th><th colspan="2">Specification</th></tr>
<tr><td>Power supply type</td><td>AC</td><td>DC</td></tr>
<tr><td>Power voltage</td><td>100/110/120 V AC (50/60 Hz),
200/220/240 V AC (50/60 Hz)</td><td>24 V DC</td></tr>
<tr><td>Power voltage fluctuation range</td><td>85 to 264 V AC wide range</td><td>19.2 to 30 V DC</td></tr>
<tr><td>Current consumption</td><td colspan="2">Please refer to 4.7, “Weights and Power Consumption.”</td></tr>
<tr><td>Allowable momentary power failure</td><td>85 to 100 V AC: For a momentary power failure of less than 10 ms, operation continues
100 to 264 V AC: For a momentary power failure of less than 20 ms, operation continues</td><td>19.2 to 30 V DC: For a momentary power failure of less than 10 ms, operation continues</td></tr>
<tr><td>Operating ambient temp.</td><td colspan="2">0 to 55 °C</td></tr>
<tr><td>Storage ambient temp.</td><td colspan="2">-10 to 75 °C</td></tr>
<tr><td>Operating ambient humidity</td><td colspan="2">5 to 95 % RH (no condensation)</td></tr>
<tr><td>Storage ambient humidity</td><td colspan="2">5 to 95 % RH (no condensation)</td></tr>
<tr><td>Vibration proof</td><td colspan="2">Conforms to JIS C 0911</td></tr>
<tr><td>Noise resistance</td><td colspan="2">○ Noise voltage 1,500 Vpp Noise pulse width 100 ns, 1 µs
(Noise created by the noise simulator is applied across the power supply module's input terminals. This is determined by our measuring method.)
○ Based on NEMA ICS 3-304
○ Static noise: 3,000 V at metal exposed area
○ Conforms with EN50081-2 and EN50082-2</td></tr>
<tr><td>Supported standards</td><td colspan="2">Conforms with UL, CE markings and C-TICK</td></tr>
<tr><td>Insulation resistance</td><td colspan="2">20 MΩ or more between the AC external terminal and the protection earth (PE) terminal (based on 500 V DC mega)</td></tr>
<tr><td>Dielectric withstand voltage</td><td colspan="2">1,500 V AC for one minute between the AC external terminal and the protection earth (PE) terminal</td></tr>
<tr><td>Grounding</td><td colspan="2">Class D dedicated grounding (grounded by a power supply module)</td></tr>
<tr><td>Environment used</td><td colspan="2">No corrosive gases and no excessive dirt</td></tr>
<tr><td>Structure</td><td colspan="2">Attached on an open wall</td></tr>
<tr><td>Cooling</td><td colspan="2">Natural air cooling</td></tr>
</table>

3.2 Function Specifications

The functions available in the MICRO-EH are described in the table below.

No.	Item	Description
1	Basic functions	The following functions can be executed when constructing a system using the PLC. 1] An input signal is received from the control object, operations are performed according to the contents of the program created by the user and the results are output as an output signal. Also, operation results and progress information can be retained in the internal output area. 2] Power is supplied to the main module, system starts to run, and the operation described above is performed continuously until the power is shut down or the system stops running. 3] The information retained internally can be extracted by a device connected externally or can be set in other information. Also, this information is initialized at the time the system starts running, but it can also be retained depending on the user settings. 4] Operating status can be confirmed with the LED display of each unit or with an external device that has been connected.
2	Setting and display	The following have been provided for the user to set or confirm various types of operation status: 1] DIP switch (basic unit) This specifies the CPU communication function setting and operation mode, etc. (except for 10-point type) 2] RUN switch (basic unit) It can instruct to run and stop. (external input for 10-point type) 3] LED display (basic unit and expansion unit) Indicates the power system status, operating status and I/O operation status. 4] Communication connector (basic unit) This can connect external devices using RS-232C, RS-485, RS-422. (only the 23-point and 28-point types with RS-485, RS-422) 5] Expansion connector (basic unit and expansion unit) This allows installation of additional input/output. (except for 10-point type) 6] Terminal block (basic unit and expansion unit) This performs the connections for supplying power, and for handling signals with the control object.
3	Number of I/O points	The number of points that can be controlled with respect to the control object is as follows: 1] External inputs/outputs The number of points that can be use for external inputs/outputs differs depending on the basic unit. The 10-point type cannot expand the inputs/outputs. For the 14-point, 23-point and 28-point types, a maximum of 4 expansion units can be connected. The I/O numbers for inputs are indicated by X, WX, DX and outputs are indicated by Y, WY, DY. 2] Internal outputs These are areas for temporarily storing information. The I/O numbers include M, WM, DM, R, WR, DR. 3] A timer counter is provided internally. 4] Array (corresponding to a substitution statement only) An array of I/O numbers can be expressed by enclosing by parentheses.
4	User program memory	The program in which the control contents have been described can be stored. This FLASH memory resides in the basic unit. 1] The contents of this memory will be maintained even if the power is shut off. Because of this, it is necessary to initialize the memory since it may have undefined after the unit is purchased. 2] Programming is done using peripheral units such as programming software (LADDER EDITOR) for the H-series programmable controllers. 3] The instructions that can be used are those designated by the H-series ladder. See the list of instructions for details. 4] A battery is not required to retain the contents of the user program. Always save the created programs to a floppy disk just in case an unexpected problem occurs.

No.	Item	Description
5	Control method	With the PLC, the user programs are converted in batch at operation startup, and the programs after conversion will be executed in order as they are read one by one. 1] The method used for data I/O is that after the I/O data (information) is scanned (execution from the head of the program to the end), it is updated in group. If refresh of external I/O is required during scanning (refresh method), use the refresh instruction. 2] Apart from the program that will be normally executed, a periodic scan program which interrupts the normal program at a fixed time intervals and is executed, can be created. The time intervals are 10 ms, 20 ms and 40 ms. 3] The user programs are executed from the head of the program to the end, and are once again repeated after performing the system processing that updates the lapsed timer value, refreshes I/O, and performs communication with peripheral units.
6	Run/stop control	Running and stopping the PLC is normally performed by the user. 1] Turn on the RUN switch to start operation for the 14-point type or higher. Turn this switch off to stop operation. For the 10-point type, turn on the RUN input terminal to start operation. Turn it off to stop operation. 2] The start and stop operations can be performed with designated external inputs or internal outputs by designating the operation control inputs with a programming unit. 3] Apart from the operation described above, if a malfunction is detected in the system while it is running, operation stops and the outputs are aborted (OFF). 4] If the power is shut off and then turned back on while the system is running, operation starts. When the power shuts off, turn off the power to the PLC, then shut off the external input power. When turning the power back on, turn on the external input power before turning on the power to the PLC. 5] When starting operation, do so after clearing internal information which is not designated for storage during power failure. When stopping operation, leave the internal information as is, turn off the outputs and then stop the operation. 6] When the power has been cut off for longer than the time allowed for the momentary power failure, then depending on the system load status, either operation continues or the system perceives that a power shut off has occurred and restarts operation. To resume operation securely, have the power remain off for 1 minute or longer.
7	Operation parameters	Each type of condition for operating the PLC can be set. The possible settings for operation when an error occurs are provided below. 1] Operation may be continued when I/O information does not match. 2] Overload check time can be set. The initial value is 100 ms and the module stops when the time for one scan takes longer than the set overload check time. (overload error) 3] Operation may be continued when an overload error occurs. 4] When a power failure (power shutoff) occurs, the internal output area for retaining information and the timer counter range can be designated. And, the setting below is possible. 1] The name of the user program can be registered. 2] A password can be set up so that the third party cannot reference the program. 3] It is necessary to register the type of I/O module used as an I/O assignment table. In order to create this I/O assignment table, the types of I/O modules that are connected can be read.
8	Change while in operation	A part of a program can be modified during operation. 1] If a modification is made with a programming unit and a change is performed while in operation, the user program in the CPU is changed and the altered program is switched internally at the end of scanning, and operation continues with the new program. 2] When a control instruction is included in the modification to the program, make the changes after first performing the control instruction change procedure in the programming unit to check for safety. 3] Until operation starts to continue with the new program, a pause [halt period] occurs when the module does not run. External input information is not being received during this time, so leave a sufficient time for executing a change while in operation.

No.	Item	Description
9	Forced set/reset	Forced set and forced reset of the designated I/O can be performed from the programming unit connected to the CPU module.
10	Forced output	Output can be forced with respect to the designated I/O number from the programming unit connected to the CPU module. For I/O that is not designated, outputs are shut off.
11	Calendar clock function (only for 23- and 28-point types)	23-point and 28-point types have the calendar clock function. 1] The year, month, date, day of the week, hour, minute and second can be set. 2] There is a function for making adjustments in 30-second units. 3] When a battery is not installed, the calendar clock information is not retained when power goes off. The calendar clock must be reset. (The battery is an optional. Purchase separately.)
12	Dedicated port	This is a communication port with dedicated protocol for the H-series. The communication command called the task code is defined in the port. 1] A programming unit can be connected. (However, the command language programmer PGM-CHH and the portable graph programmer PGM-GPH cannot be used.) 2] Port 1 and port 2 can be used as dedicated ports. Transmission speed, etc. can be switched using the DIP switch. (Port 2 is supported only by the 23-point and 28-point type models.)
13	General purpose port	General purpose port function is supported from software version H0130 (WRF051=H0130) or newer. This function enables serial communication to any standard devices like bar code reader by using TRNS/RECV command in user program.
14	Modem control	A modem can be used to connect externally. It becomes operable when data receives from the external media, and task code communication can afterward be performed. Port 1 can be assigned for this function by switching the DIP switch. (The 10-point type is not supported.)
15	Self-diagnosis	Self-diagnostic tests for the following items are performed: 1] Microcomputer check 2] System program area check 3] Memory check 4] User program check 5] Internal output area check 6] Mounted I/O check
16	Abnormal handling	When a problem occurs, the error code that indicates the error description is output to special internal output WRF000 as a hexadecimal value. Also, errors are notified to the external devices through the OK LED. If the error level is high, the CPU stops operation, but depending on the error, the operation may be continued using the user settings. If multiple errors occur, the error code with higher error severity is set. The detailed information is also set to the special internal output. Also, this information is always recorded in the power failure memory, so the information can be referenced even after the power is cut off. (However, a battery is required.) The clearing of the error information can be conducted by turning on R7EC.
17	Task code	By combining individual task codes, the following functions can be achieved by the programs in the host computer: 1] CPU control (RUN/STOP control of CPU, occupy/release, CPU status read, etc.) 2] I/O control (various types of monitoring) 3] Memory write (all clear, batch transfer, etc.) 4] Memory read (reading of programs, etc.) 5] Response (various responses from CPU)
18	Instruction	Programming can be performed for various purposes and usage by combining Ladder and the instruction language.
19	High-speed counter	The external input of the basic unit can be used as a high-speed counter by specifying it as a counter input. The following can be set. 1] Single-phase counter, 2 channels 2] Single-phase counter, 4 channels (For the 10-point type, it is single-phase, 3 channels.) 3] Two-phase counter 1 channel, single-phase counter 1 channel (For the 10-point type, it is two-phase, 1 channel.) The functions include a count operation (up/down, leading/trailing), coincidence output control, preset by preloaded input, and count value reading by strobe input.

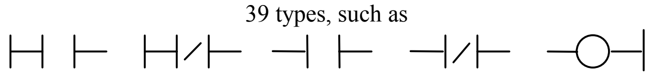
No.	Item	Description
20	Interrupt input	The external input of the basic unit can be specified for interrupt input. With the interrupt input, the corresponding interrupt program can be executed.
21	PWM output	The external output of the basic unit can be specified for pulse width modulated output. In this case, pulses are output at the specified frequency with a duty between 0 and 100 %. A maximum of 4 points, including the pulse array output, can be set.
22	Pulse train output	The external output of the basic unit can be specified for pulse output. In this case, pulses are output at the specified frequency with a duty between 30 and 70 %. A maximum of four points, including the pulse output, can be set.
23	Analogue input	The analogue input function is available in the 23-point type and analog exp. unit. The resolution is 12 bits and it can be used by either selecting a current input between 0 and 20 mA or a voltage input between 0 and 10 V.
24	Analogue output	The analogue output function is available in the 23-point type and analog exp. unit. The resolution is 12 bits and it can be used by either selecting a current output between 0 and 20 mA or a voltage output between 0 and 10 V.
25	Potentiometer	14-point, 23-point, and 28-point types have two potentiometers, with which setting values etc. can be changed without using the programming units.
26	Battery	A dedicated battery can be installed in the 23-point and 28-point types so that data in the data memory can be maintained even when the power supply to the main unit is shut off. In addition, the data of the calendar clock in the 23-point and 28-poins types can be maintained. The battery is an optional (model EH-MBAT). Please refer to Chapter 15 (4) Life of the battery.

Note: There are functions supported by H series that are not supported by this PLC (debug, trace, force, and simulation functions).

3.3 Performance Specifications

3.3.1 Calculation Specifications

The calculation specifications of the PLC are described below.

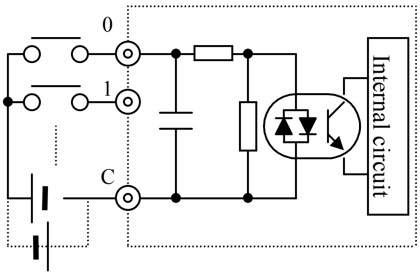
<table>
<tr><td rowspan="2">Model</td><td colspan="3">Name</td><td>10-point type</td><td>14-point type</td><td colspan="2">23/28-point type</td></tr>
<tr><td colspan="3">Type</td><td>EH-D10DT
EH-D10DTP
EH-D10DR</td><td>EH-D14DT
EH-D14DTP
EH-A14DR
EH-D14DR
EH-A14AS</td><td>EH-A23DRP
EH-A23DRT
EH-D23DRP</td><td>EH-D28DT
EH-D28DTP
EH-A28DRP
EH-A28DRT
EH-A28DR
EH-D28DRP
EH-D28DRT
EH-D28DR
EH-A28AS</td></tr>
<tr><td rowspan="5">Control specifications</td><td colspan="3">CPU</td><td colspan="4">32-bit RISC processor</td></tr>
<tr><td colspan="3">Processing system</td><td colspan="4">Stored program cyclic system</td></tr>
<tr><td rowspan="2">Processing speed</td><td colspan="2">Basic instructions</td><td colspan="4">0.9 μs / instruction</td></tr>
<tr><td colspan="2">Application instructions</td><td colspan="4">Several 10 μs / instruction</td></tr>
<tr><td colspan="3">User program memory</td><td colspan="4">3 k steps max. (FLASH memory)</td></tr>
<tr><td rowspan="4">Operation processing specifications</td><td rowspan="2">Instruction language</td><td colspan="2">Basic instructions</td><td colspan="4">39 types such as LD, LDI, AND, ANI, OR, ORI, ANB, ORB, OUT, MPS, MRD, MPP, etc.</td></tr>
<tr><td colspan="2">Arithmetic instructions
Application instructions</td><td colspan="4">62 types (arithmetic, application, control, FUN command etc.)</td></tr>
<tr><td rowspan="2">Ladder</td><td colspan="2">Basic instructions</td><td colspan="4">39 types, such as
</td></tr>
<tr><td colspan="2">Arithmetic instructions
Application instructions</td><td colspan="4">62 types (arithmetic, application, control, FUN command etc.)</td></tr>
<tr><td rowspan="11">I/O processing specifications</td><td rowspan="2">External I/O</td><td colspan="2">I/O processing system</td><td colspan="4">Refresh processing</td></tr>
<tr><td colspan="2">Maximum number of points</td><td>10 points</td><td>126 points</td><td>135 points</td><td>140 points</td></tr>
<tr><td rowspan="5">Internal output</td><td colspan="2">Bit</td><td colspan="4">1,984 points (R0 to R7BF)</td></tr>
<tr><td colspan="2">Word</td><td colspan="4">4,096 words (WR0 to WRFFF)</td></tr>
<tr><td rowspan="2">Special</td><td>Bit</td><td colspan="4">64 points (R7C0 to R7FF)</td></tr>
<tr><td>Word</td><td colspan="4">512 words (WRF000 to WRF1FF)</td></tr>
<tr><td colspan="2">Bit/word shared</td><td colspan="4">16,384 points, 1,024 words (M0 to M3FFF, WM0 to WM3FF)</td></tr>
<tr><td rowspan="3">Timer counter</td><td colspan="2">Number of points</td><td colspan="4">256 points (TD + CU) *1</td></tr>
<tr><td colspan="2">Timer set value</td><td colspan="4">0 to 65,535, timer base 0.01 s, 0.1 s, 1 s (0.01s has maximum 64 points *2)</td></tr>
<tr><td colspan="2">Counter set value</td><td colspan="4">1 to 65,535 times</td></tr>
<tr><td colspan="3">Edge detection</td><td colspan="4">512 points (DIF0 to DIF511: Decimal)
+ 512 points (DFN0 to DFN511: Decimal)</td></tr>
<tr><td rowspan="2">Peripheral equipment</td><td colspan="3">Program system</td><td colspan="4">Instruction language, ladder diagram</td></tr>
<tr><td colspan="3">Peripheral unit</td><td colspan="4">Programming software
(LADDER EDITOR DOS version/Windows® version, Pro-H)
Instruction language programmer and form graphic display programmer cannot be used.</td></tr>
<tr><td>Maintenance functions</td><td colspan="3">Self-diagnosis</td><td colspan="4">PLC error (LED display): Microcomputer error, watchdog timer error, memory error, program error, system ROM/RAM error, scan time monitoring, battery voltage low detection, etc.</td></tr>
</table>

*1: The same numbers cannot be used with the timer counter.
*2: Only timers numbered 0 to 63 can use 0.01 s for their timer base.

3.3.2 Input Specifications

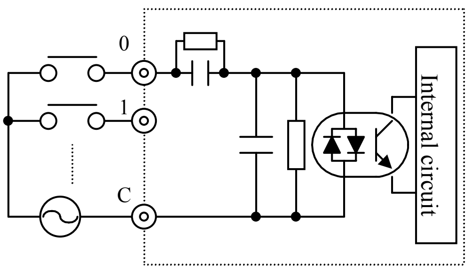
The input circuit consists of DC input and AC input, with the following specifications.

(1) DC input

Item		Specification	Circuit diagram
Input voltage		24 V DC	
Allowable input voltage range		0 to 30 V DC	
Input impedance		Approx. 2.8 kΩ	
Input current		7.5 mA typical	
Operating voltage	ON voltage	15 V DC (min) / 4.5 mA (max)	
	OFF voltage	5 V DC (max) / 1.5 mA (max)	
Input lag	OFF → ON	Basic unit : 0.5 to 20 ms (configurable) Exp. unit : 0.5 ms or less	
	ON → OFF	Basic unit : 0.5 to 20 ms (configurable) Exp. unit : 0.5 ms or less	
Number of input points		See Chapter 4	
Number of common		See Chapter 4	
Polarity		None	
Insulation system		Photocoupler insulation	
Input display		LED (green)	
External connection		10-point type: fixed type terminal block 14-, 23-, 28-point types: Removable type screw terminal block (M3)	

*1: Common terminals are separated each other.

(2) AC input

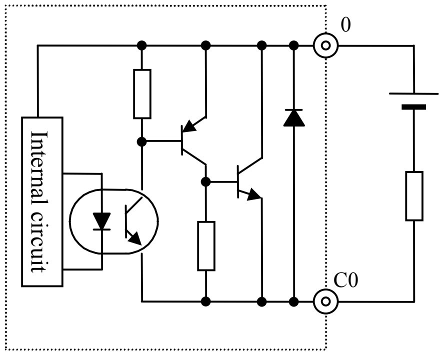
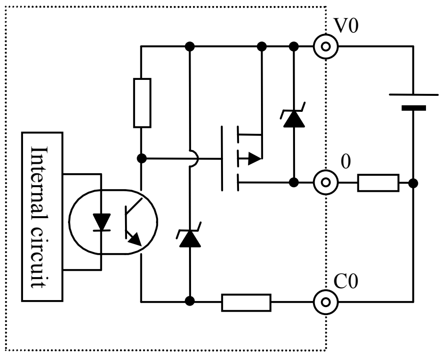
Item		Specification	Circuit diagram
Input voltage		100 to 120 V AC	
Allowable input voltage range		85 to 132 V AC 50 -5 % to 60 +5 % Hz	
Input impedance		Approx. 14.6 kΩ (60 Hz) Approx. 17.6 kΩ (50 Hz)	
Input current		Approx. 7 mA RMS (100 V AC/60 Hz)	
Operating voltage	ON voltage	80 V AC (min.) 4.5 mA	
	OFF voltage	30 V AC (max.) 2 mA	
Input lag	OFF → ON	25 ms (max.) *1	
	ON → OFF	30 ms (max.) *1	
Number of input points		See Chapter 4.	
Number of common		See Chapter 4.	
Polarity		None	
Insulation system		Photocoupler insulation	
Input display		LED (green)	
External connection		14-, 28-point types: Removable type screw terminal block (M3)	

*1: Delay by hardware only. Delay by digital filter (software filter) 0.5 to 20 ms is not included.
*2: Common terminals are separated each other.

3.3.3 Output Specifications

(1) DC output

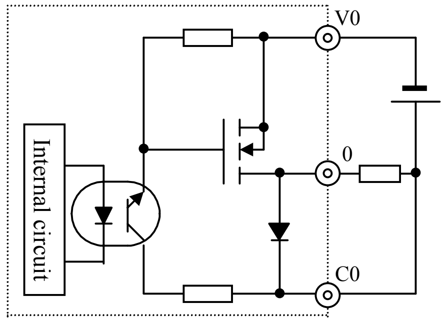
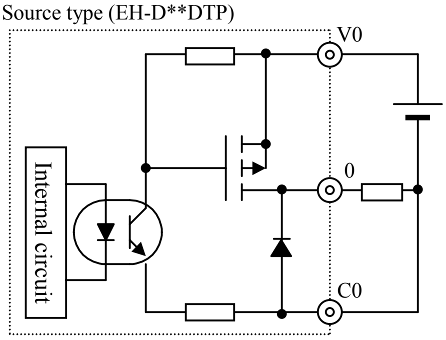
(**Y100** of EH-*23DRP/A23DRT/*28DRP/*28DRT)

Item		Specification		Circuit diagram
Type		EH-A23DRT EH-*28DRT	EH-*23DRP EH-*28DRP	Sink type (23/28DRT)  Source type (23/28DRP) 
Y100 output specifications		Transistor output (sink type)	Transistor output (source type)	
Rated load voltage		24 / 12 / 5 V DC 24 V DC +20 %, -80 %		
Minimum switching current		1 mA		
Leak current		0.1 mA (max)		
Maximum load current	1 circuit	0.75 A 24 V DC 0.5 A 12 V DC 0.25 A 5 V DC		
	1 common	0.75 A		
Output response time	OFF → ON	0.1 ms (max) 24 V DC 0.2 A		
	ON → OFF	0.1 ms (max) 24 V DC 0.2 A		
Number of output points		1		
Number of common		1		
Surge removing circuit		None		
Fuse		None		
Insulation system		Photocoupler insulation		
Output display		LED (green)		
External connection		Removable type screw terminal block (M3)		
External power supply *1 to V terminal		Not necessary	30 to 16 V DC	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)		
Output voltage drop		0.3 V DC (max)		

*1: It is necessary to supply 16 to 30 V DC between the V and C terminals externally for the source type.
The sink type operates by load power supply only. See "4.6 Terminal Layout and Wiring" for the details.

(2) DC output: LCDC-Low Current

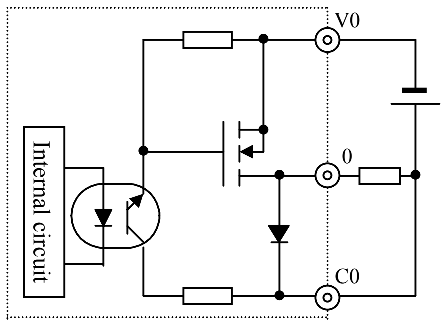
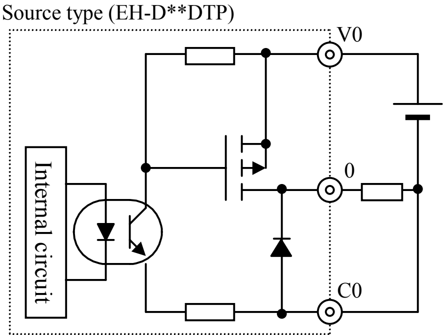
(All points of EH-D10DT/DTP, **Y102-Y105** of EH-D14DT/DTP, **Y102-Y109** of EH-D28DT/DTP, **Y*018-Y*021** of EH-D14EDT/D14EDTP)

Item		Specification	Circuit diagram
Output specification		Transistor output	Sink type (EH-D**DT)  Source type (EH-D**DTP) 
Rated load voltage		24/12 V DC (+10 %, -15 %)	
Minimum switching current		1 mA	
Leak current		0.1 mA (max)	
Maximum load current	1 circuit	0.75 A 24 V DC 0.5 A 12 V DC	
	1 common	3 A	
Output response time	OFF → ON	0.1 ms (max) 24 V DC 0.2A	
	ON → OFF	0.1 ms (max) 24 V DC 0.2A	
Number of output points		See Chapter 4.	
Number of common		See Chapter 4.	
Surge removing circuit		None	
Fuse		None	
Insulation system		Photocoupler insulation	
Output display		LED (green)	
External connection		Removable type screw terminal block (M3)	
Externally supplied power *1		30 to 12 V DC	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	
Output voltage drop		0.3 V DC (max)	

*1: It is necessary to supply 12 to 30 V DC between the V and C terminals externally. See "4.6 Terminal Layout and Wiring."

(3) DC output: HCDC-High Current

(**Y100**,**Y101** of EH-D14DT/DTP, **Y100, Y101, Y110, and Y111** of EH-D28DT/DTP, **Y*016, Y*017** of EH-D14EDT/D14EDTP)

Item		Specification	Circuit diagram
Output specification		Transistor output	Sink type (EH-D**DT)  Source type (EH-D**DTP) 
Rated load voltage		24/12 V DC (+10 %, -15 %)	
Minimum switching current		1 mA	
Leak current		0.1 mA (max)	
Maximum load current	1 circuit	1A 24 V DC	
	1 common	3 A	
Output response time	OFF → ON	0.1 ms (max) 24 V DC 0.2A	
	ON → OFF	0.1 ms (max) 24 V DC 0.2A	
Number of output points		See Chapter 4.	
Number of common		See Chapter 4.	
Surge removing circuit		None	
Fuse		None	
Insulation system		Photocoupler insulation	
Output display		LED (green)	
External connection		Removable type screw terminal block (M3)	
Externally supplied power *1		30 to 12 V DC	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	
Output voltage drop		0.3 V DC (max)	

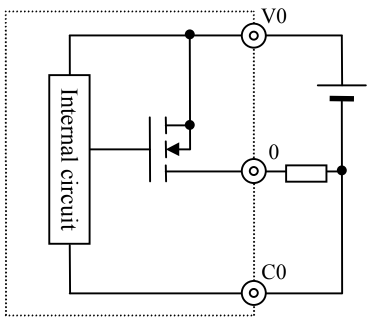
*1: It is necessary to supply 12 to 30 V DC between the V and C terminals externally. See "4.6 Terminal Layout and Wiring."

(4) DC output (ESCP type): HCDC-High Current

(**Y100,Y101** of EH-D14DTPS, **Y100-Y103** of D28DTPS)
Y*016,Y*017 of EH-EDTPS, **Y*019** of EH-D28EDTPS)

Item		Specification	Circuit diagram
Output specification		Transistor output	
Rated load voltage		24/12 V DC (+10 %, -15 %)	
Minimum switching current		10 mA	
Leak current		0.1 mA (max)	
Maximum load current	1 circuit	1 A	
	1 common	3 A	
Output response time	OFF → ON	0.05 ms (max) 24 V DC 0.2A	
	ON → OFF	0.05 ms (max) 24 V DC 0.2A	
Number of output points		See Chapter 4.	
Number of common		See Chapter 4.	
Surge removing circuit		None	
Fuse		None	
Insulation system		Photocoupler insulation	
Output display		LED (green)	
External connection		Removable type screw terminal block (M3)	
Externally supplied power *1		30 to 12 V DC	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	
Output voltage drop		0.3 V DC (max)	

Source type (EH-D**DTPS)



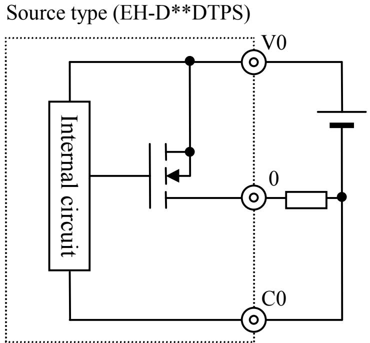
*1: It is necessary to supply 12 to 30 V DC between the V and C terminals externally. See “4.6 Terminal Layout and Wiring.”

(5) DC output (ESCP type): LCDC-Low Current

(**Y102-Y105** of EH-D14DTPS, **Y104-Y111** of EH-D28DTPS
Y*018-Y*021 of EH-D14EDTPS, **Y*020-Y*027** of EH-D28EDTPS)

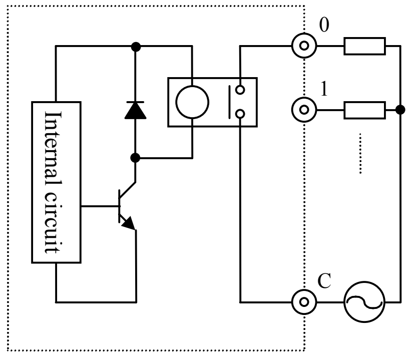
Item		Specification	Circuit diagram
Output specification		Transistor output	
Rated load voltage		24/12 V DC (+10 %, -15 %)	
Minimum switching current		10 mA	
Leak current		0.1 mA (max)	
Maximum load current	1 circuit	0.7 A	
	1 common	3 A	
Output response time	OFF → ON	0.5 ms (max) 24 V DC 0.2A	
	ON → OFF	0.5 ms (max) 24 V DC 0.2A	
Number of output points		See Chapter 4.	
Number of common		See Chapter 4.	
Surge removing circuit		None	
Fuse		None	
Insulation system		Photocoupler insulation	
Output display		LED (green)	
External connection		Removable type screw terminal block (M3)	
Externally supplied power *1		30 to 12 V DC	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	
Output voltage drop		0.3 V DC (max)	

Source type (EH-D**DTPS)



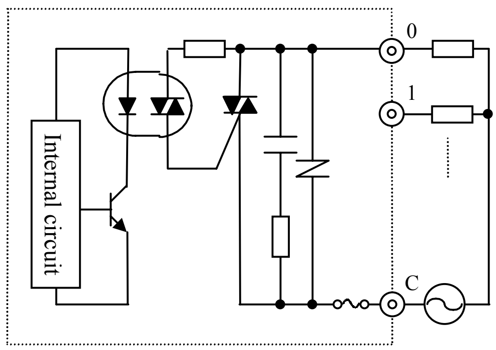
*1: It is necessary to supply 12 to 30 V DC between the V and C terminals externally. See “4.6 Terminal Layout and Wiring.”

(6) Relay output

Item		Specification	Circuit diagram
Rated load voltage		5 to 250 V AC, 5 to 30 V DC	
Minimum switching current		1 mA	
Maximum load current	1 circuit	2 A (24 V DC, 240 V AC)	
	1 common	5 A	
Output response time	OFF → ON	15 ms (max)	
	ON → OFF	15 ms (max)	
Number of output points		See Chapter 4.	
Number of common		See Chapter 4.	
Surge removing circuit		None	
Fuse		None	
Insulation system		Relay insulation	
Output display		LED (green)	
External connection		Removable type screw terminal block (M3)	
Externally supplied power (for driving the relays)		Not necessary	
Contact life *1		20,000,000 times (mechanical) 200,000 times (electrical: 2 A)	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	

*1: Refer to the Life curve of relay contacts in Chapter 10 for the details.

(7) AC output (SSR)

Item		Specification	Circuit diagram
Output specification		Triac output	
Rated voltage		100/240 V AC	
Output voltage		100 –15 % to 240 +10 % V AC 50 –5 % to 60 +5 % Hz	
Maximum load current	1 circuit	0.5 A 240 V AC	
	1 common	2 A	
Minimum load current		100 mA	
Maximum leakage current		1.8 mA 115 V AC(max) 3.5 mA 230 V AC(max)	
Maximum inrush current		5 A (at 1 cycle or less)/point 10 A (at 1 cycle or less)/common	
Maximum delay time	Off → On	1 ms or less	
	On → Off	1 ms + 1/2 cycle or less	
Output common		See Chapter 4.	
Polarity		See Chapter 4.	
Insulation system		Phototriac insulation	
Fuse *2		Used	
Surge removing circuit		Sunabar circuit + varistor	
External connection		Removable terminal block	
Voltage drop		1.5 V RMS (max)	
Insulation		1500 V or more (external-internal) 500 V or more (external-external)	

*2: It is necessary to repair the module if the load short-circuits and causes the fuse to melt.
Note that the fuse cannot be replaced by users.

3.3.4 High-Speed Counter Specifications

		Single phase	Two phase
Available input		X0, X2, X4, X6	X0 and X2 in pair
Input voltage	ON	15 V	
	OFF	5 V	
Count pulse width		100 µs	
Maximum count frequency		10 kHz each channel	
Count register		16 bits	
Coincidence output		Allowed	
On/Off-preset		Allowed	
Upper/lower limit setting		Not allowed	
Preload/strobe		Allowed	

Since 10 points type does not have input X6, counter channel is up to 3 ch.

3.3.5 PWM Output/Pulse Train Output Specifications

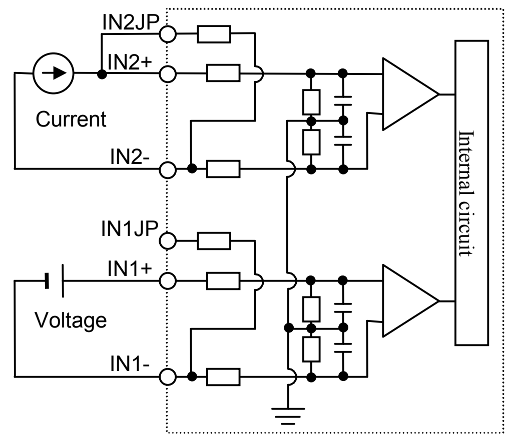
	23-point and 28-point type Relay Output	10/14/28-point Transistor Output
Available outputs	Y100 (optional)	Y100-Y103 (optional)
Load voltage	5/12/24 V	12/24 V
Minimum load current	1 mA	
PWM max. output frequency *1	2 kHz total channels	
Pulse train max. output frequency *1	5 kHz total channels	
Pulse acceleration/deceleration	By FUN 151.	

*1: Relay outputs cannot keep up with high frequencies; these outputs should be used at the operating frequency upon confirmation.

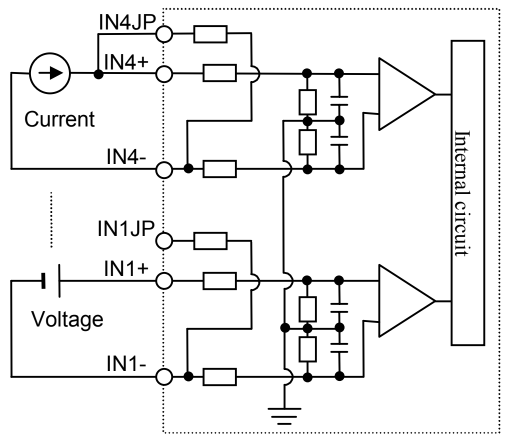
3.3.6 Analogue Input Specifications

Module type	23 points module	Analog exp. unit
Input channel	WX30, WX31	WX u01 - WX u04 (u : unit number)
Input range	0-10 V (10.24V max.)	0-10V (10.24V max.)
		-10 to +10V (±10.24V max.)
	0-20 mA (20.48 mA max.)	0-20 mA (20.48 mA max.)
	-	4-20 mA (20.38 mA max.)
Resolution	12 bits	
Accuracy	±1 % of full scale	
Linearity	Max. +/-3 units	
Current input impedance	Approx. 249 Ω	
Voltage input impedance	Approx. 100 kΩ	Approx. 200 kΩ
Input delay time	20 ms	
Channel to internal circuit insulation	Not insulated	Insulated
Channel-to-channel insulation	Not insulated	

Circuit diagram (23 points type)



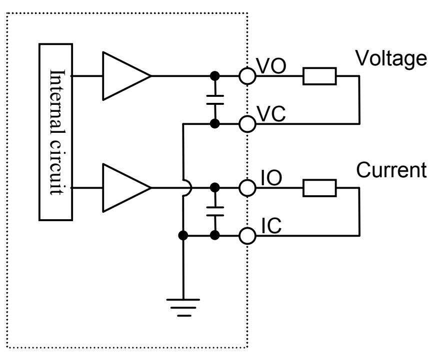
Circuit diagram (Analog expansion unit)



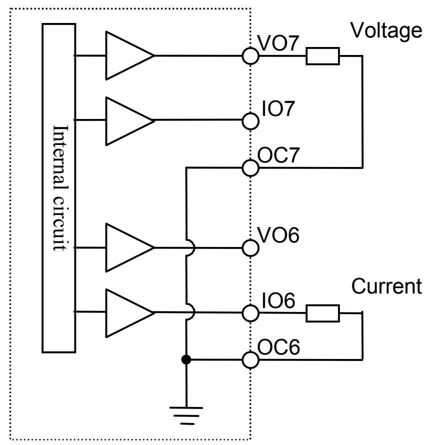
3.3.7 Analogue Output Specifications

Module type	23 points type module	Analog exp. unit
Output channel	WY40	WY u06, WY u07 (u : unit number)
Output range	0-10V (10.24V max.)	0-10V (10.24V max.)
	0-20mA (20.48mA max.)	0-20mA (20.48mA max.)
		4-20mA (20.38mA max.)
Resolution	12 bits	
Accuracy	±1 % of full scale	
Current output Allowable load Output allowable capacity Output allowable inductance	10 to 500 Ω Maximum 2000 pF Maximum 1 H	
Voltage output Allowable load Output allowable impedance	Maximum 10 kΩ Maximum 1 μF	

Circuit diagram (23 points type)



Circuit diagram (Analog expansion unit)



3.3.8 Potentiometer Analogue Input Specifications

Number of potentiometer inputs	2
Stored in	Ch.1 : WRF03E, Ch.2 WRF03F
Input range	0-1023 (H0-H3FF)
Resolution	10 bits
Input filter	By user settings

3.3.9 Interrupt Input Specifications

Input that can be used		X1, X3, X5, X7 (by user settings)
Input voltage	ON	15 V
	OFF	5 V

3.3.10 Backup

(1) Battery
Data memory (retentive area) can be kept by EH-MBAT battery as below.

Battery life time (total power off time) [Hr] *	
Guaranteed value (Min.) @55°C	Actual value (Max.) @25°C
9,000	18,000

* Battery life time has been changed since Oct. 2002 production (MFG NO.02Jxx) due to hardware modification.

Battery can be mounted inside of front cover.
Battery is available only for 23-point and 28-point types.
If the calendar clock function is used with the 23-point or 28-point type, be sure to use the battery.

(2) Capacitor
14-point type: Data can be kept for 72 hours (at 25 °C) by the capacitor.
23 and 28-point types: Data can be kept for 24 hours (at 25 °C) by the capacitor.

Please note that data memory of 10 point type cannot be retained.

3.3.11 Expansion

- Up to 4 times of expansion units can be installed.
- 14 points and 28 points digital units, and 4ch. input / 2 ch. output analog expansion units available.
- A cable with a length of up to 1 m can be used to connect between units.
- The total extension cable length can be up to 2 m (from the basic unit to the expansion unit at the end).
- The 10-point type unit cannot be expanded.

3.3.12 Clock Function

23-point and 28-point types have calendar function. This can be operated either by internal output area or task code.
* 10-point and 14-point types do not have this function.

(1) Reading the clock data
By turning on the read request (R7F8), the clock data is read out in the reading value area (WRF01B to WRF01F).

(2) Writing the clock data
By turning on the write request (R7F9), the clock data stored in writing value area (WRF01B to WRF01F) is written to the current data area (WRF00B to WRF00F). If the data is wrong, error flag (R7BF) will turn on. If data is right, clock data will be written and writing flag R7FB will turn off.

(3) Adjusting the clock data ± 30 seconds
By turning on the ± 30 seconds adjustment request (R7FA), one of the following operations is performed depending on the second value:

- If the second digits are 00 to 29, the second digits are set to 00.
- If the second digits are 30 to 59, the minute is incremented by 1 and the second digits are set to 00.

(4) Special internal output definitions

- Operation bits

I/O number	Name	Description
R7F8	Request to read calendar and clock data	Calendar and clock data is read out to WRF01B-F01F.
R7F9	Request to write calendar and clock data	Calendar and clock data in WRF01B-F01F is written to the current data in WRF00B-F00F.
R7FA	Clock ± 30 seconds adjustment request	Sets the second digits of the RTC to 00.
R7FB	Calendar and clock setting data error	Turns on when the setting data is abnormal.

- Current data monitor area : Current data of the clock given always (all BCD data).

I/O number	Name	Description
WRF00B	Year	4-digit year [yyyy]
WRF00C	Month and date	[mmdd]
WRF00D	Day of the week	0 to 6 : Sunday to Saturday
WRF00E	Hour and minute	[hhmm] (24-hour system).
WRF00F	Second	[00ss]

- Reading/writing area : Clock data to be read or written.
(All BCD data)

I/O number	Name	Description
WRF01B	Year	4-digit year [yyyy]
WRF01C	Month and date	[mmdd]
WRF01D	Day of the week	0 to 6 : Sunday to Saturday
WRF01E	Hour and minute	[hhmm] (24-hour system).
WRF01F	Second	[00ss]

Note 1: The day of the week data is expressed as follows.
0: Sunday, 1: Monday, 2: Tuesday, 3: Wednesday, 4: Thursday, 5: Friday, 6: Saturday

3.3.13 Power Supply for Sensor

The 24 V terminal at the input terminal part can supply current to external equipment (not for all units).
If this terminal is used as the power supply for the input part of this unit, the remaining can be used as power supply for the sensors.
The following current (I) can be supplied as power supply for the sensors.

(1) EH-*14*** (14-point type basic unit)
EH-*14E*** (14-point type extension unit)

I = 350 mA – (7.5 mA x number of input points that are turned on at the same time)

(2) EH-A28DR* (28-point type basic unit)
EH-A23DR*** (23-point type basic unit)

I = 280 mA – (7.5 mA x number of input points that are turned on at the same time)

Chapter 4 Product lineup and wiring

4.1 Product lineup

(1) Basic units

Table 4.1 Product lineup list

Type	Specifications	I/O assignment symbol
EH-D10DT	DC power, DC input × 6, Transistor (sink) output × 4	X48/Y32/empty16
EH-D10DTP	DC power, DC input × 6, Transistor (source) output × 4	X48/Y32/empty16
EH-D10DR	DC power, DC input × 6, Relay output × 4	X48/Y32/empty16
EH-D14DT	DC power, DC input × 8, Transistor (sink) output × 6	X48/Y32/empty16
EH-D14DTP	DC power, DC input × 8, Transistor (source) output × 6	X48/Y32/empty16
EH-A14DR	AC power, DC input × 8, Relay output × 6	X48/Y32/empty16
EH-D14DR	DC power, DC input × 8, Relay output × 6	X48/Y32/empty16
EH-A14AS	AC power, AC input × 8, SSR output × 6	X48/Y32/empty16
EH-D23DRP	DC power, DC input × 13, Relay output × 9, Transistor output (source) × 1, Analog input × 2, Analog output × 1	X48/Y32/ empty16/WX4/WY4
EH-A23DRT	AC power, DC input × 13, Relay output × 9, Transistor output (sink) × 1, Analog input × 2, Analog output × 1	X48/Y32/ empty16/WX4/WY4
EH-A23DRP	AC power, DC input × 13, Relay output × 9, Transistor output (source) × 1, Analog input × 2, Analog output × 1	X48/Y32/ empty16/WX4/WY4
EH-D28DT	DC power, DC input × 16, Transistor (sink) output × 12	X48/Y32/empty16
EH-D28DTP	DC power, DC input × 16, Transistor (source) output × 12	X48/Y32/empty16
EH-D28DTPS	DC power, DC input × 16, Transistor (source) output (ESCP) × 12	X48/Y32/empty16
EH-D28DRT	DC power, DC input × 16, Relay output × 11, Transistor output (sink) × 1	X48/Y32/empty16
EH-D28DRP	DC power, DC input × 16, Relay output × 11, Transistor output (source) × 1	X48/Y32/empty16
EH-A28DRT	AC power, DC input × 16, Relay output × 11, Transistor output (sink) × 1	X48/Y32/empty16
EH-A28DRP	AC power, DC input × 16, Relay output × 11, Transistor output (source) × 1	X48/Y32/empty16
EH-A28DR	AC power, DC input × 16, Relay output × 12	X48/Y32/empty16
EH-A28AS	AC power, AC input × 16, SSR output × 12	X48/Y32/empty16
EH-D14EDT	Expansion unit, DC power, DC input × 8, Transistor (sink) output × 6	B1/1
EH-D14EDTP	Expansion unit, DC power, DC input × 8, Transistor (source) output × 6	B1/1
EH-D14EDTPS	Expansion unit, DC power, DC input × 8, Transistor (source) output (ESCP) × 6	B1/1
EH-D14EDR	Expansion unit, DC power, DC input × 8, Relay output × 6	B1/1
EH-A14EDR	Expansion unit, AC power, DC input × 8, Relay output × 6	B1/1
EH-D28EDT	Expansion unit, DC power, DC input × 16, Transistor (sink) output × 12	B1/1
EH-D28EDTPS	Expansion unit, DC power, DC input × 16, Transistor (source) output (ESCP) × 12	B1/1
EH-D28EDR	Expansion unit, DC power, DC input × 16, Relay output × 12	B1/1
EH-A28EDR	Expansion unit, AC power, DC input × 16, Relay output × 12	B1/1
EH-D6EAN	Expansion unit, DC power, Analog input × 4, Analog output × 2	FUN 0
EH-A6EAN	Expansion unit, AC power, Analog input × 4, Analog output × 2	FUN 0

Each digit in the type name has the following meaning:

EH - D 28 □ D T P

[None]: Sink, T: Sink, P: Source (except in the cases of relay output and SSR output)

R: Relay output, T: Transistor (DC) output, S: SSR (AC) output

D: DC input, A: AC input

[None]: Basic unit, E: Expansion unit

10: 10-point type, 14: 14-point type, 23: 23-point type, 28: 28-point type

A: AC power supply type, D: DC power supply type

(2) Peripheral Units

Table 4.2 List of peripheral units

Product	Form	Specification	Remarks
Graphic input device support software	HL-GPCL	Ladder diagram/Instruction language editor LADDER EDITOR (for GPCL)	
	HL-PC3	Ladder diagram/Instruction language editor LADDER EDITOR (for PC98 series) with CPU connection cable	
	HL-AT3E	Ladder diagram/Instruction language editor LADDER EDITOR (for PC/AT compatible personal computer)	
	HLW-PC3	Ladder diagram/Instruction language editor LADDER EDITOR (for Windows® 95/NT 4.0)	
	HLW-PC3E	Ladder diagram/Instruction language editor LADDER EDITOR (for Windows® 95/98/NT 4.0)	
	Pro-H	HITACHI H-series PLC Programming Software According to IEC 61131-3 (for Windows® 95/98/NT 4.0)	

Note: HI-LADDER (attached to the GPCL01H) may also be used.
However, HL-GPCL and HI-LADDER cannot be used for the 10-point type.

(3) Connection Cables

Table 4.3 List of connection cables

Product	Form	Specification	Remarks
Cable for connecting basic unit and expansion unit	EH-MCB10	Length: 1 m (basic unit–exp. unit, exp. unit - exp. unit)	Total 2 m
	EH-MCB05	Length: 0.5 m (basic unit–exp. unit, exp. unit - exp. unit)	Total 2 m
	EH-MCB01	Length: 0.1 m (basic unit–exp. unit, exp. unit - exp. unit)	Total 2 m
Conversion cable for connecting peripheral units	EH-RS05	Length: 0.5 m	*
Peripheral equipment	GPCB02H	Length: 2 m, between CPU and graphic input unit	
	GPCB05H	Length: 5 m, between CPU and graphic input unit	
	GPCB15H	Length: 15 m, between CPU and graphic input unit	
	CBPGB	Length: 2 m, between graphic input unit and printer	
	LP100	Length: 2 m, between graphic input unit and kanji printer	
	KBADPTH	Length: 15 m, between graphic input unit and JIS keyboard	
	PCCB02H	Length: 2 m, between CPU and PC98 series	**
	WPCB02H	Length: 2 m, between CPU and PC98 series (25-pin)	**
	WVCB02H	Length: 2 m, between CPU and DOS/V (9-pin)	**
	EH-VCB02	Length: 2 m, between CPU (8P modular terminal) and DOS/V (9-pin)	

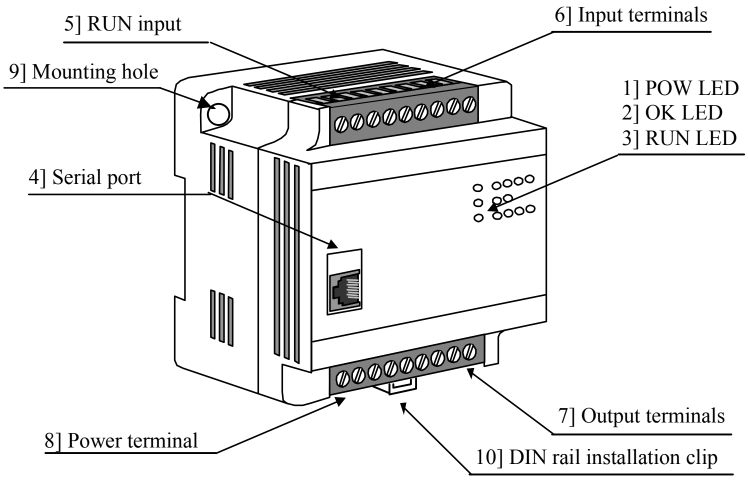
*: Required when connecting the MICRO-EH with PC98, IBM PC/AT compatible PC or other system using one of the cables marked with **.

(4) Others

Model	Usage	Remarks
EH-MBAT	Lithium battery	

4.2 10-Point Basic Unit

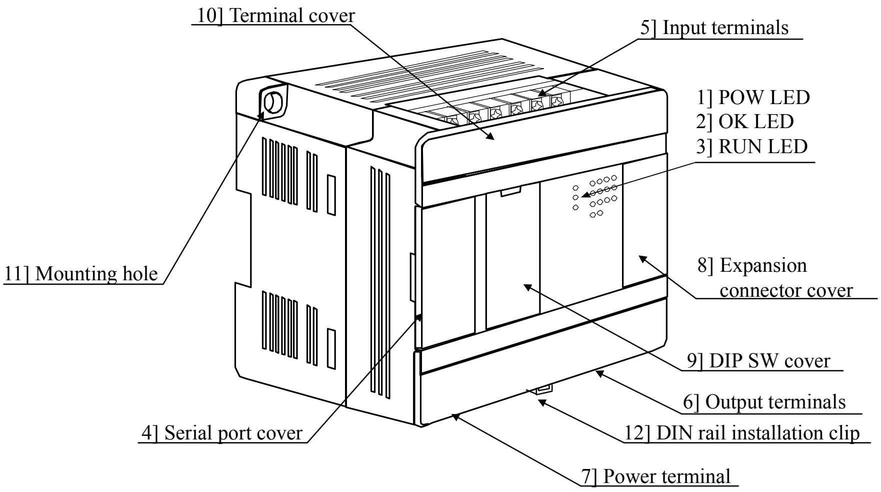
Name and function of each part	Type	EH-D10DT, EH-D10DTP, EH-D10DR

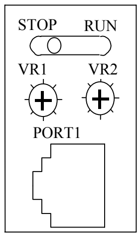
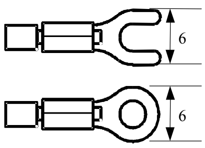


No.	Item	Detailed explanation	Remarks
Explanation of operation		Operations are performed according to the contents of the program created by the user. The programming unit connected to the CPU module communication port writes and reads the user programs. Memory is installed inside the CPU module in which the user programs and internal output information are stored.	
1]	POW LED	Lighting when the power is supplied.	
2]	OK LED	Lighting at normal operation.	See Chapter 12.
3]	RUN LED	Lighting at RUN status.	
4]	Serial port 1	Serial port for connecting the peripheral units. Communication speed is fixed as 4800 bps. The communication specification is set to port 1.	See Chapter 11.
5]	RUN input	External input to control the PLC's RUN/STOP. When 24 V DC is loaded to the RUN terminal and common terminal (C), the PLC is set to the RUN state.	See Chapter 10.
6]	Input terminals	Terminals for wiring the external input units. One piece of AWG14 to AWG22 (2.1 to 0.36 mm^2) or two pieces of AWG16 to AWG22 (1.3 to 0.36 mm^2) per terminal may be wired.	See Chapter 10.
7]	Output terminals	Terminals for connecting the external load. The wiring specification is the same as for the input terminals.	See Chapter 10.
8]	Power terminal	Terminal for connecting the power supply. The wiring specification is the same as for the input terminals.	See Chapter 10.
9]	Mounting hole	Used when installing the PLC directly on a board with screws	See Chapter 10.
10]	DIN rail installation clip	Used when installing the PLC on a DIN rail	See Chapter 10.

4.3 14-Point Basic Unit

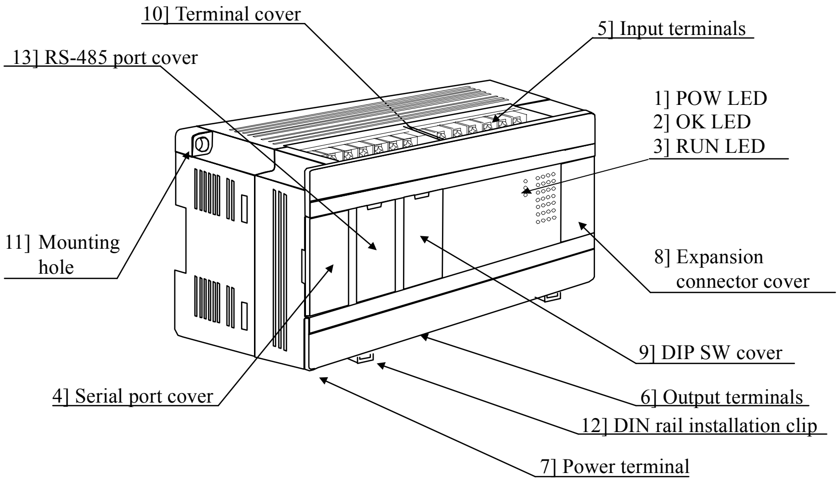
Name and function of each part	Type	EH-*14***

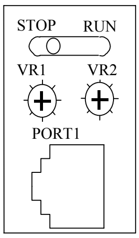
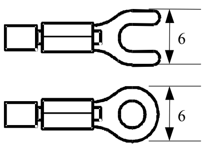


No.	Item	Detailed explanation	Remarks
Explanation of operation		Operations are performed according to the contents of the program created by the user. The programming unit connected to the CPU module communication port writes and reads the user programs. Memory is installed inside the CPU module in which the user programs and internal output information are stored.	
1]	POW LED	Lighting when the power is supplied.	
2]	OK LED	Lighting at normal operation.	See Chapter 12.
3]	RUN LED	Lighting at RUN status.	
4]	Serial port cover	Cover for the connector for connecting peripheral units and the RUN switch. When the cover is opened, the RUN switch, potentiometers (VR), and RS-232C serial port 1 (PORT 1) can be used. The communication specification is set to port 1. 	See Chapters 8 and 11.
5]	Input terminals	Terminals for wiring the external input units. Recommended terminals are shown in the figure to the right. One piece of AWG14 to AWG22 (2.1 to 0.36 mm^2) or two pieces of AWG16 to AWG22 (1.3 to 0.36 mm^2) per terminal may be wired. 	See Chapter 10. (Make sure that the terminals will not disengage due to loose screws.) (Recommended)
6]	Output terminals	Terminals for connecting the external load. The wiring specification is the same as for the input terminals.	See Chapter 10.
7]	Power terminal	Terminal for connecting the power supply. The wiring specification is the same as for the input terminals.	See Chapter 10.
8]	Expansion cover	Cover for the expansion connector	See Chapter 10.
9]	DIP SW cover	Cover for the DIP switches When the cover is opened, the DIP switches are exposed. These DIP switches are used to set the communication speed of serial port 1 and the modem connection.	See Chapter 11.
10]	Terminal cover	Cover for terminals	
11]	Mounting hole	Used when installing the PLC with screws	See Chapter 10.
12]	DIN rail installation clip	Used when installing the PLC on a DIN rail	See Chapter 10.

4.4 23-Point and 28-Point Basic Unit

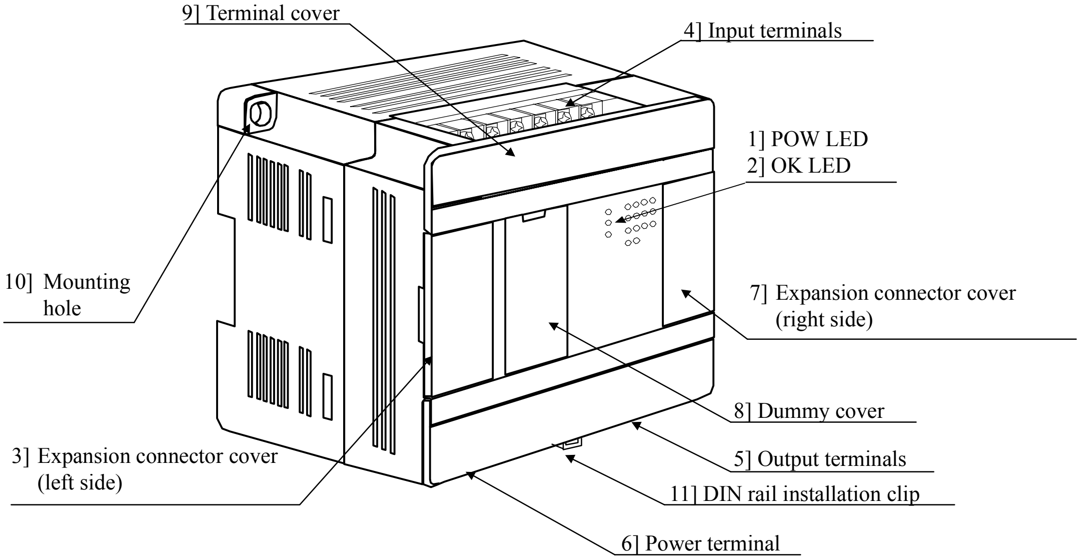
Name and function of each part	Type	
		EH-*23***
		EH-*28***



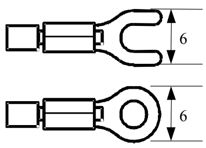
No.	Item	Detailed explanation	Remarks
Explanation of operation		Operations are performed according to the contents of the program created by the user. The programming unit connected to the CPU module communication port writes and reads the user programs. Memory is installed inside the CPU module in which the user programs and internal output information are stored.	
1]	POW LED	Lighting when the power is supplied.	
2]	OK LED	Lighting at normal operation.	See Chapter 12.
3]	RUN LED	Lighting at RUN status.	
4]	Serial port cover	Cover for the connector for connecting peripheral units and the RUN switch. When the cover is opened, the RUN switch, potentiometers (VR), and RS-232C serial port 1 (PORT 1) can be used. The communication specification is set to port 1. 	See Chapters 8 and 11.
5]	Input terminals	Terminals for wiring the external input units. Recommended terminals are shown in the figure to the right. One piece of AWG14 to AWG22 (2.1 to 0.36 mm^2) or two pieces of AWG16 to AWG22 (1.3 to 0.36 mm^2) per terminal may be wired. 	See Chapter 10. (Make sure that the terminals will not disengage due to loose screws.) (Recommended)
6]	Output terminals	Terminals for connecting the external load. The wiring specification is the same as for the input terminals.	See Chapter 10.
7]	Power terminal	Terminal for connecting the power supply. The wiring specification is the same as for the input terminals.	See Chapter 10.
8]	Expansion cover	Cover for the expansion connector	See Chapter 10.
9]	DIP SW cover	Cover for the DIP switches and the backup battery storage unit. When the cover is opened, the DIP switches are exposed. These DIP switches are used to set the communication speed of serial port 1 and the modem connection.	See Chapter 11.
10]	Terminal cover	Cover for terminals	
11]	Mounting hole	Used when installing the PLC with screws	See Chapter 10.
12]	DIN rail installation clip	Used when installing the PLC on a DIN rail	See Chapter 10.
13]	RS-485 port cover	Cover for RS-485 port. It is connected with a D sub 15-pin female connector. The communication specification is set to port 2.	See Chapter 11.

4.5 Expansion Unit

Name and function of each part	Type	
		EH-*14ED** (same dimension as 14 pts. basic unit)
		EH-*28ED** (same dimension as 28 pts. basic unit)
		EH-*6EAN (same dimension as 14 pts. basic unit)



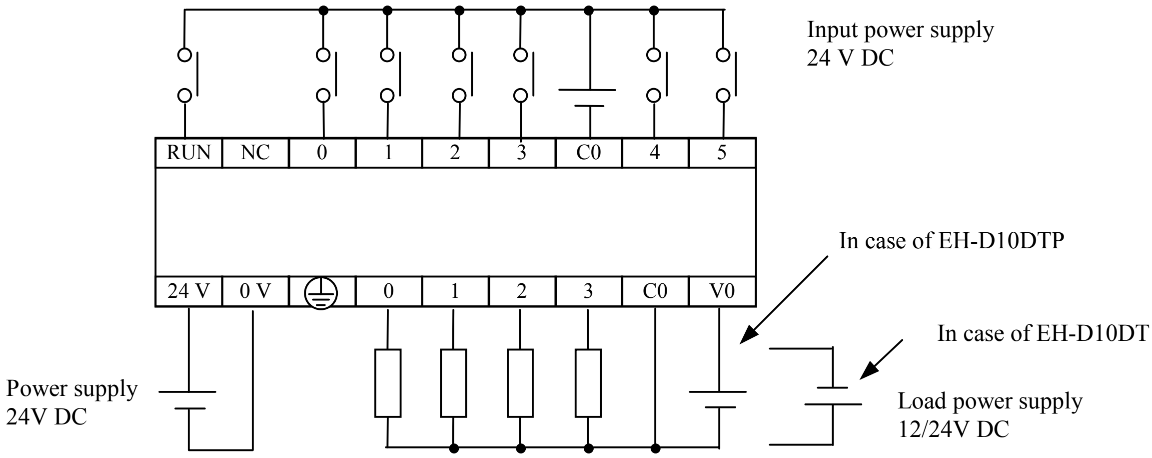
Above picture is 14 points module

No.	Item	Detailed explanation	Remarks
Explanation of operation		Operations are performed according to the contents of the program created by the user. The programming unit connected to the CPU module communication port writes and reads the user program. Memory is installed inside the CPU module in which the user program and internal output information are stored.	
1]	POW LED	Lighting when the power is supplied.	
2]	OK LED	Lighting at normal operation.	
3]	Expansion cover (Left side)	Cover for expansion connector Used when connecting to the expansion cable from the front unit.	See Chapter 10.
4]	Input terminals	Terminals for wiring the external input units. Recommended terminals are shown in the figure to the right. One piece of AWG14 to AWG22 (2.1 to 0.36 mm^2) or two pieces of AWG16 to AWG22 (1.3 to 0.36 mm^2) per terminal may be wired. 	See Chapter 10. (Make sure that the terminals will not disengage due to loose screws.) (Recommended)
5]	Output terminals	Terminals for connecting the external load. The wiring specification is the same as for the input terminals.	See Chapter 10.
6]	Power terminal	Terminal for connecting the power supply. The wiring specification is the same as for the input terminals.	See Chapter 10.
7]	Expansion cover (Right side)	Cover for expansion connector Used when connecting to the next unit.	See Chapter 10.
8]	Dummy cover	Cover used as a dummy.	
9]	Terminal cover	Cover for terminals	
10]	Mounting hole	Used when installing the PLC with screws	See Chapter 10.
11]	DIN rail installation clip	Used when installing the PLC on a DIN rail	See Chapter 10.

4.6 Terminal Layout and Wiring

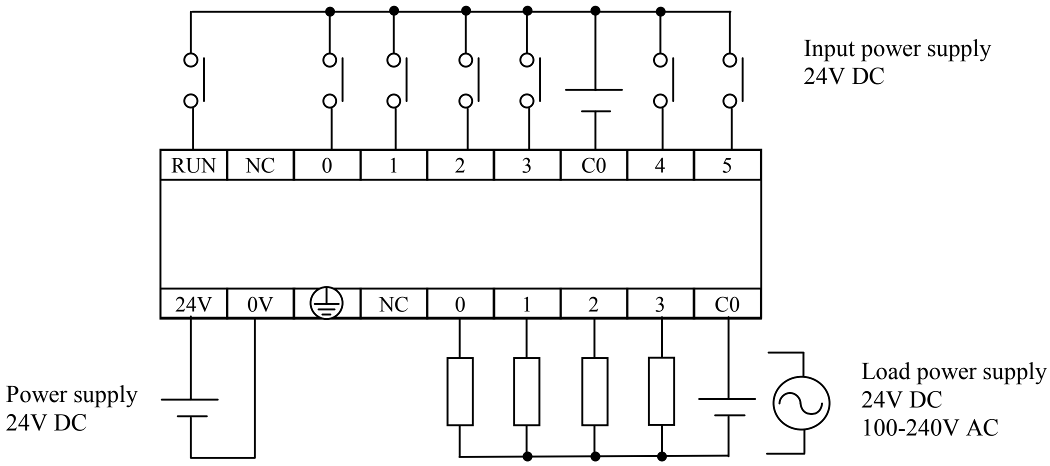
10-point type
EH-D10DT, EH-D10DTP

* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.

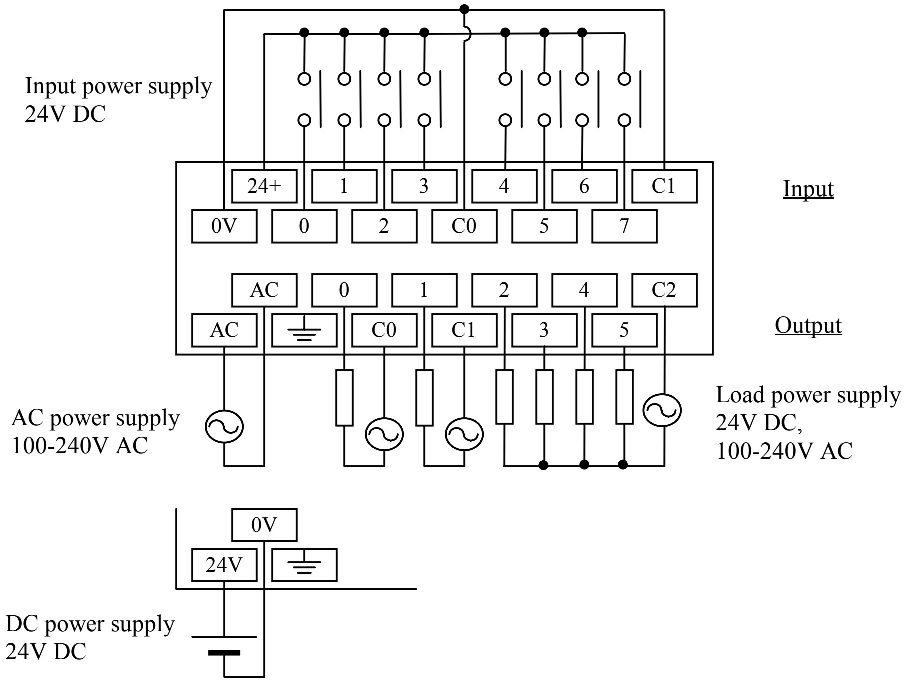


EH-D10DR

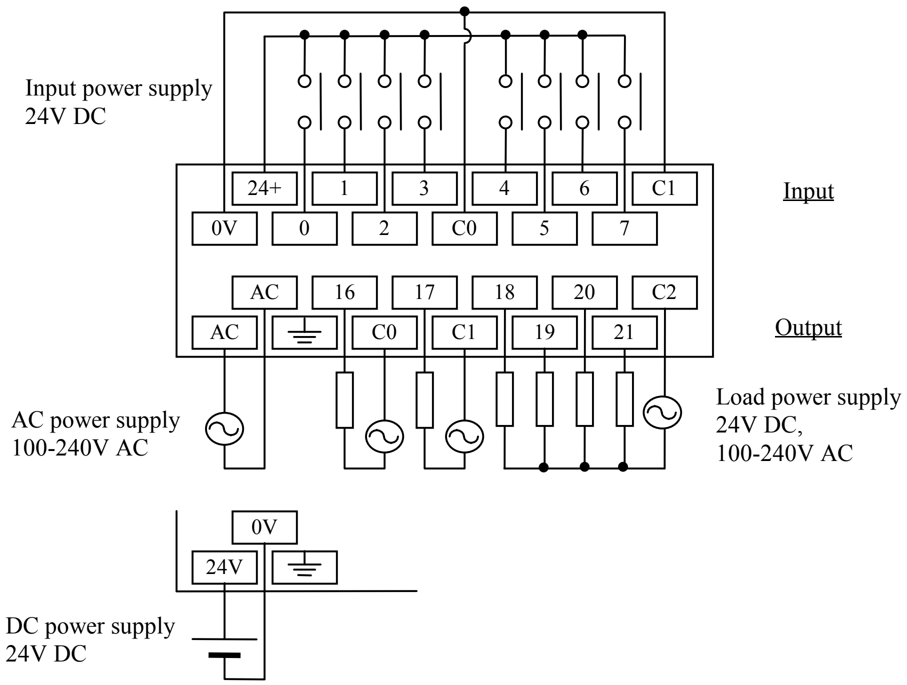
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



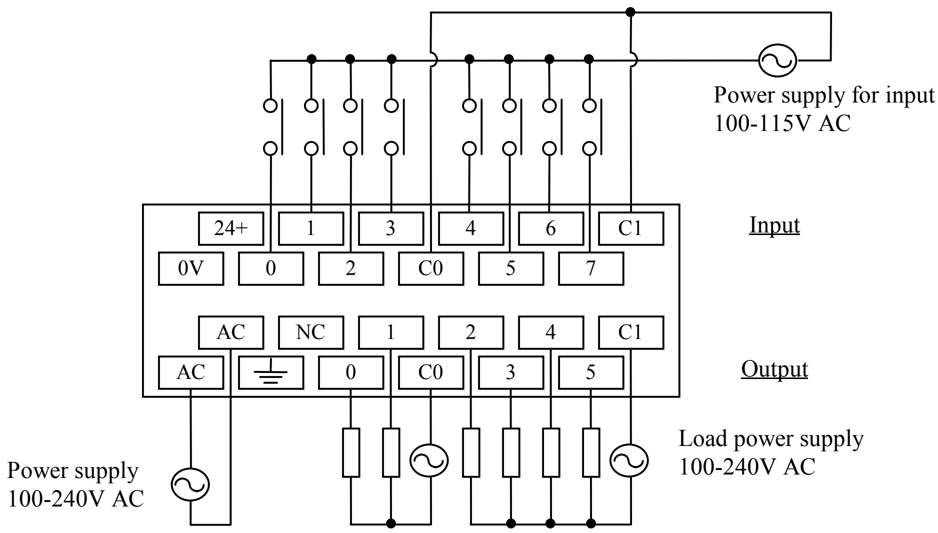
14-point type
EH-A14DR, EH-D14DR
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



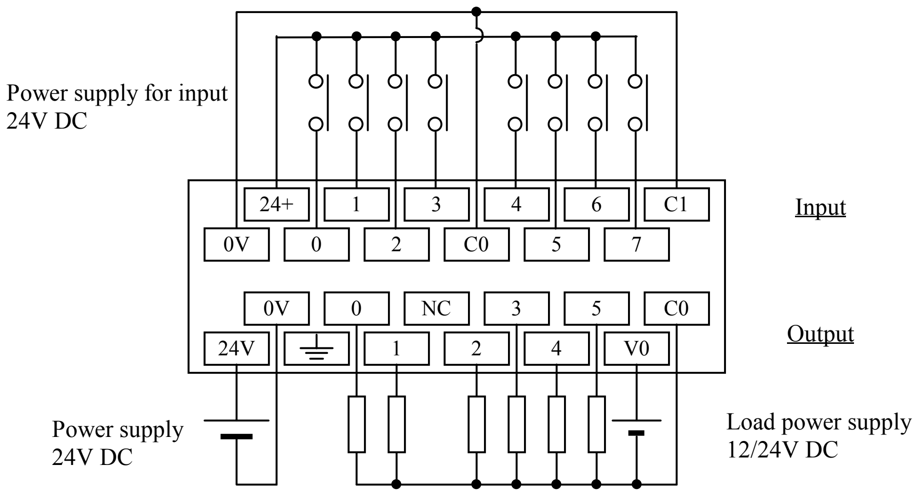
EH-A14EDR, EH-D14EDR
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



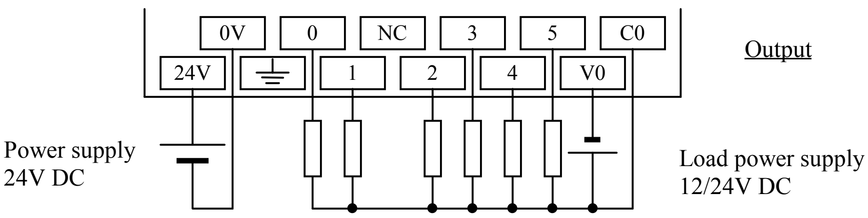
EH-A14AS



EH-D14DTP
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.

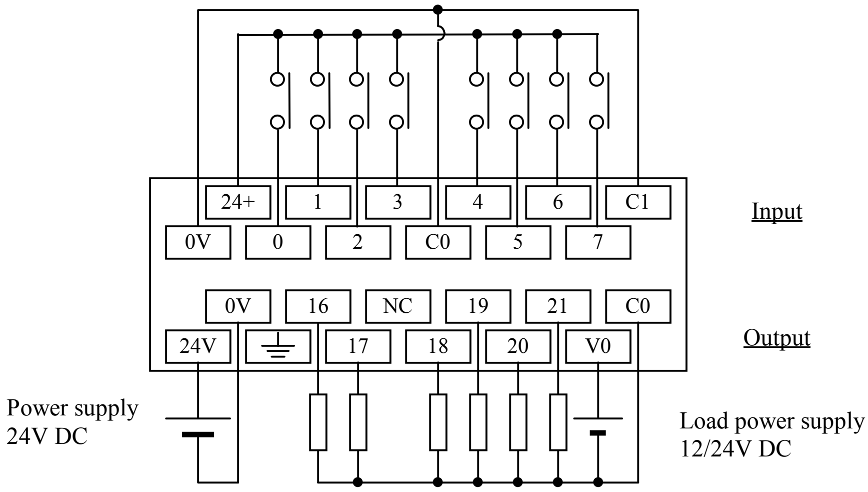


EH-D14DT
(The input wiring is the same as EH-D14DTP.)



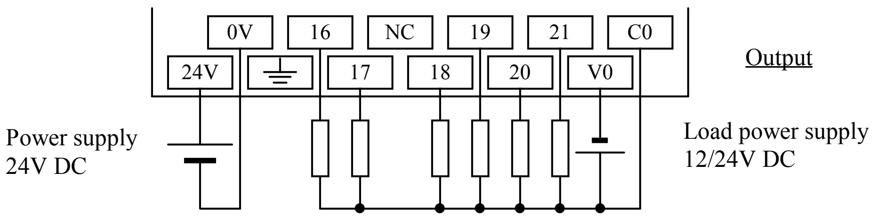
EH-D14EDTP

* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.

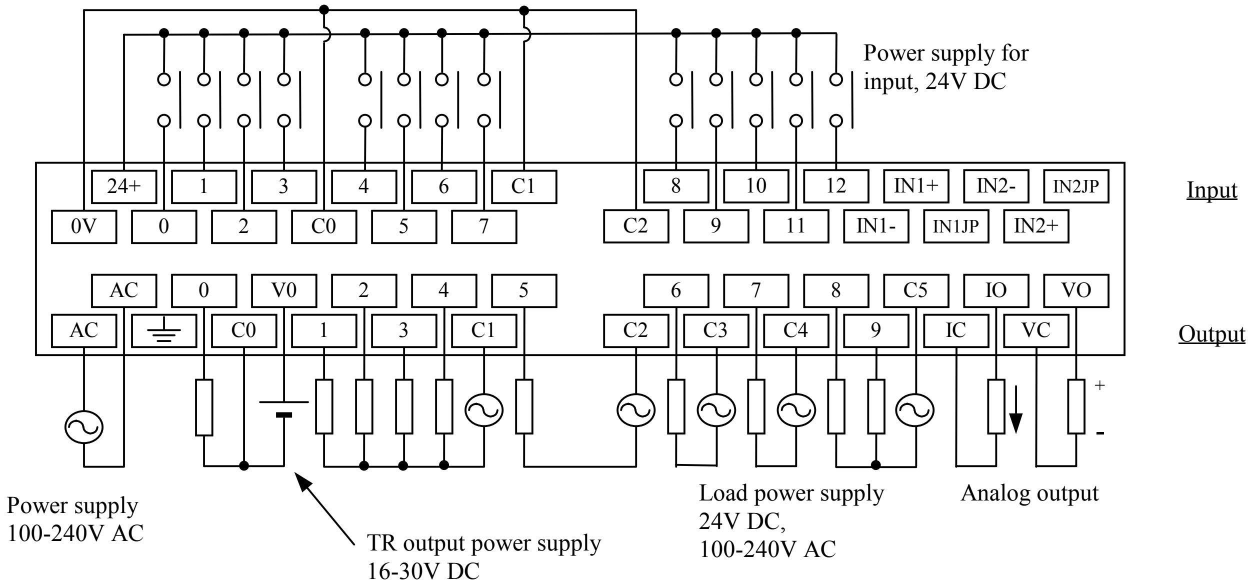


EH-D14EDT

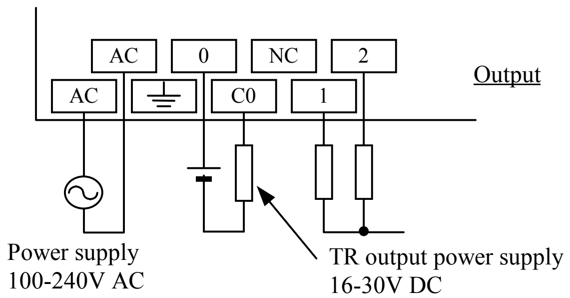
(The input wiring is the same as EH-D14EDTP.)



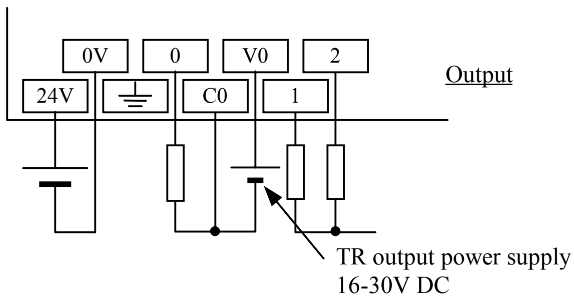
23-point type
EH-A23DRP
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



EH-A23DRT
(The input wiring is the same as EH-A23DRP.)



EH-D23DRP

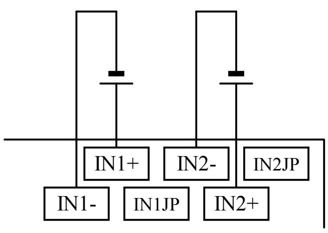


In case of analog current input, please set the following value in **WRF06E**.

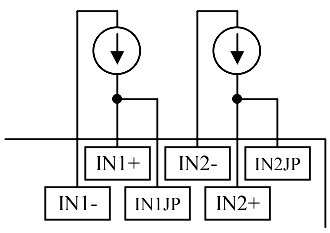
WRF06E	ch-0	ch-1
H0000	Voltage	Voltage
H4000	Voltage	Current
H8000	Current	Voltage
HC000	Current	Current

Please refer to Chapter 8-9.

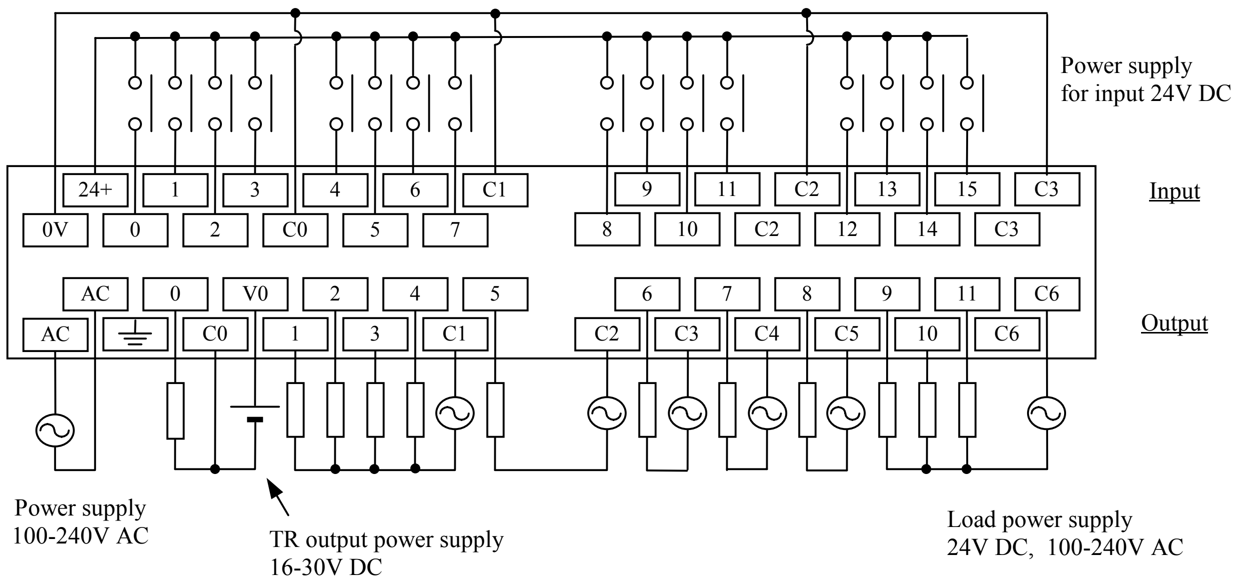
Analog voltage input



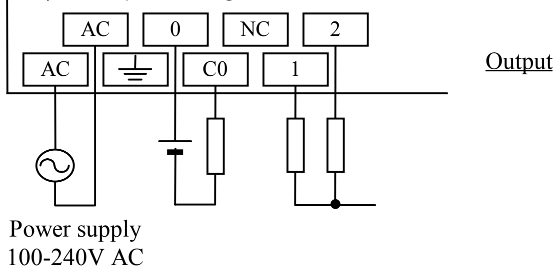
Analog current input



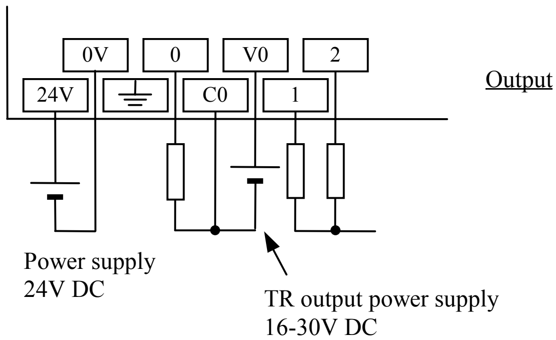
28-point type
EH-A28DRP
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



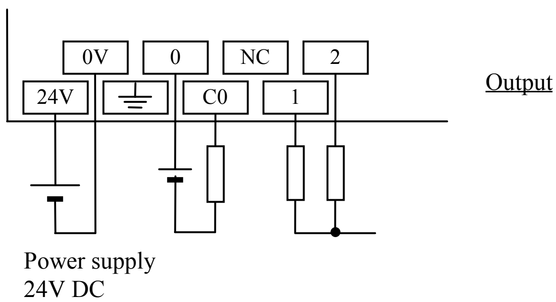
EH-A28DRT
(The input wiring is the same as EH-A28DRP.)



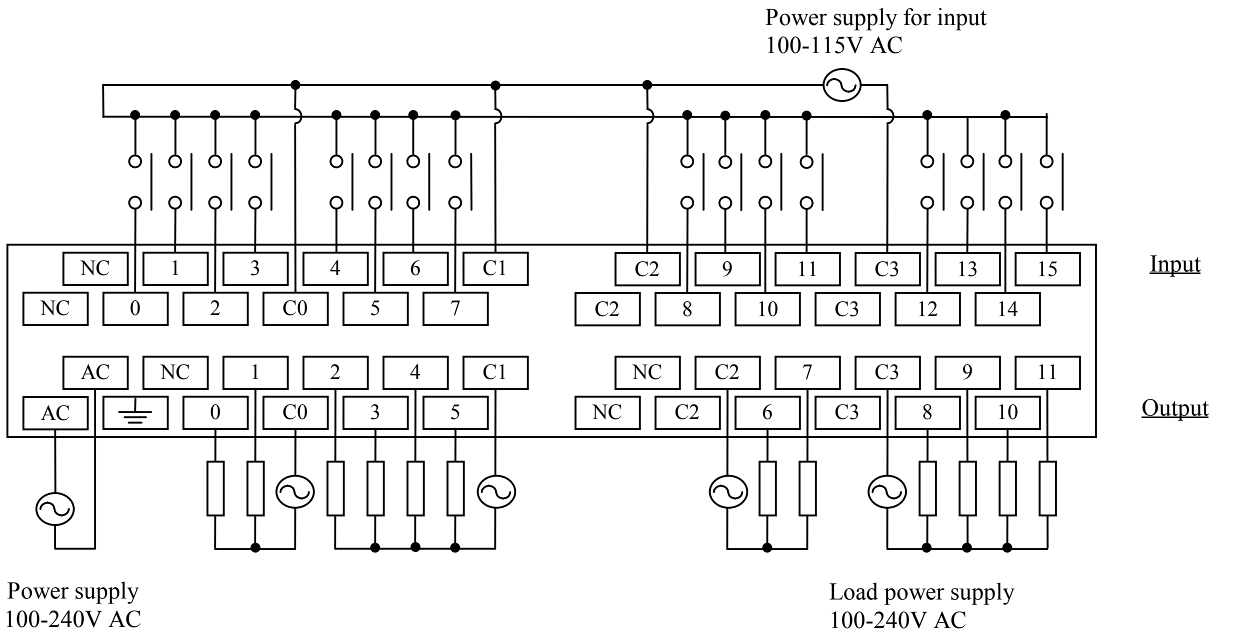
EH-D28DRP
(The input wiring is the same as EH-A28DRP.)



EH-D28DRT
(The input wiring is the same as EH-A28DRP.)

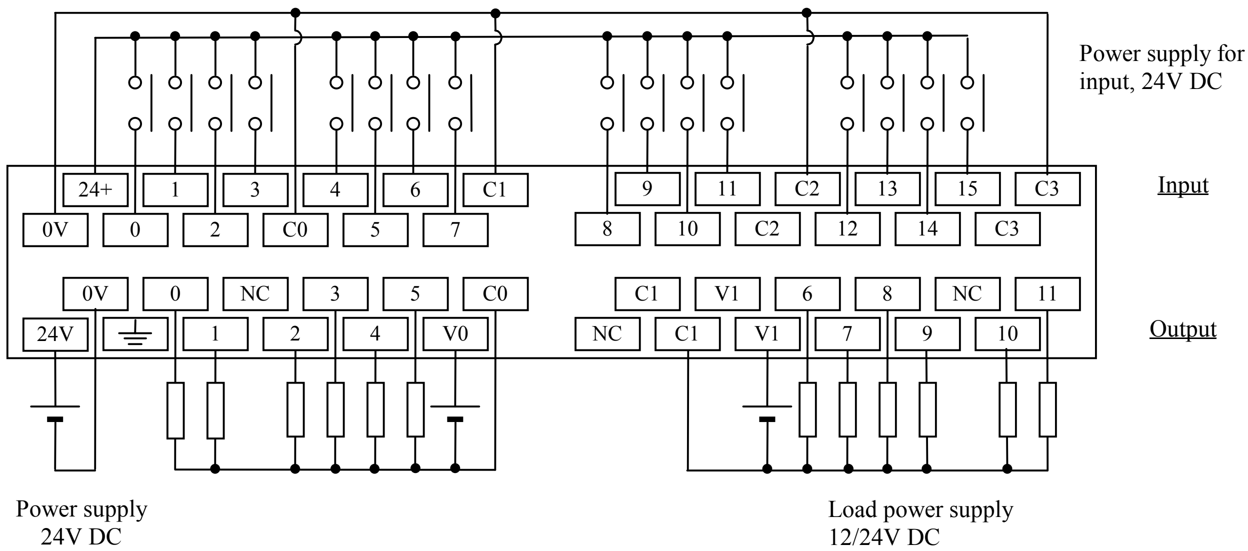


EH-A28AS



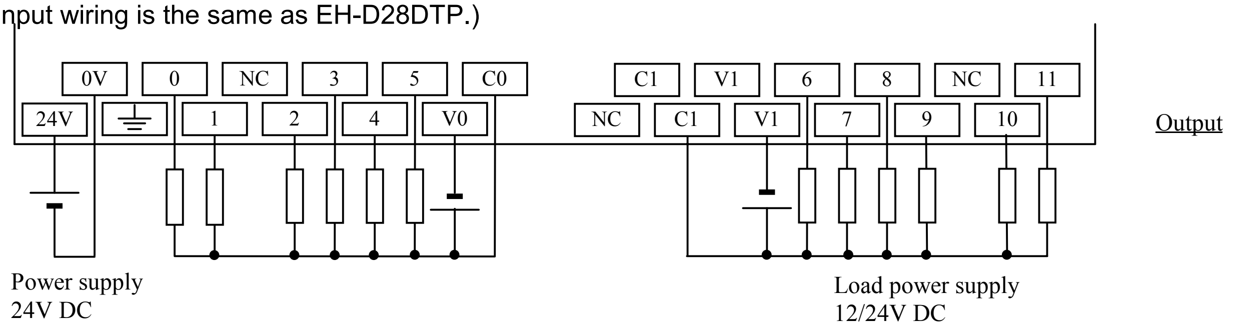
EH-D28DTP

* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



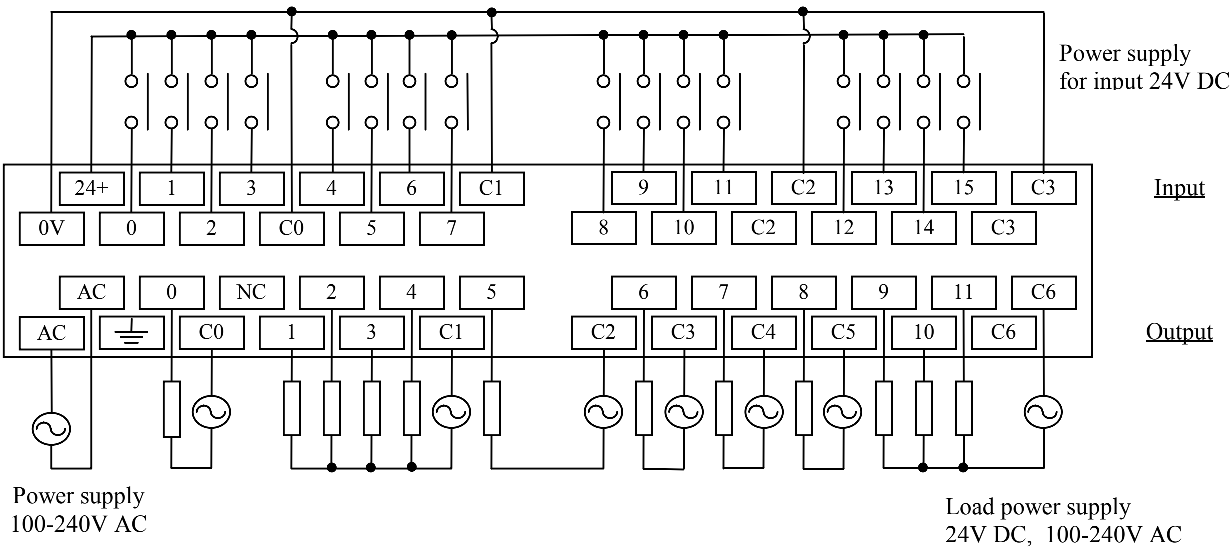
EH-D28DT

(The input wiring is the same as EH-D28DTP.)



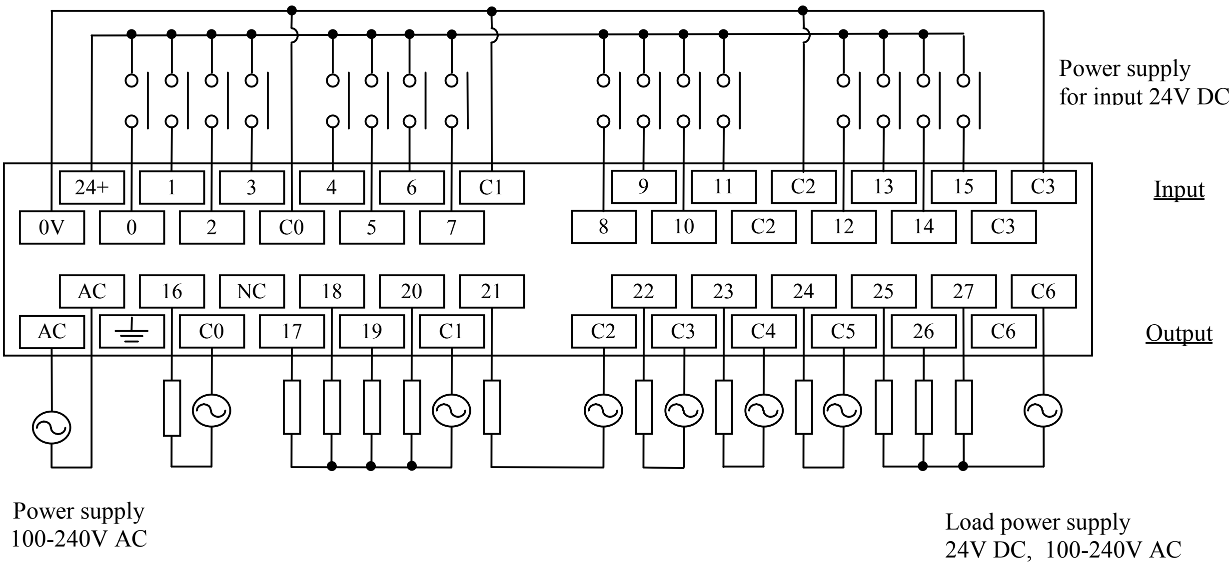
EH-A28DR

* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.

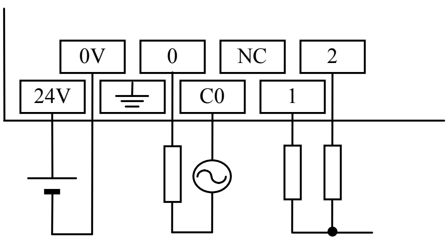


EH-A28EDR

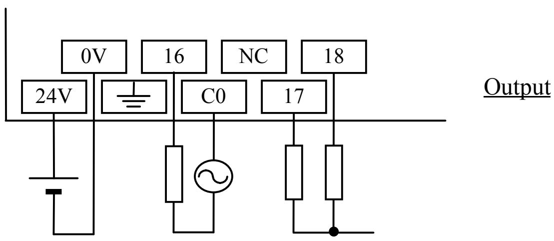
* Since the DC input is bidirectional, it is possible to reverse the polarity of the power supply.



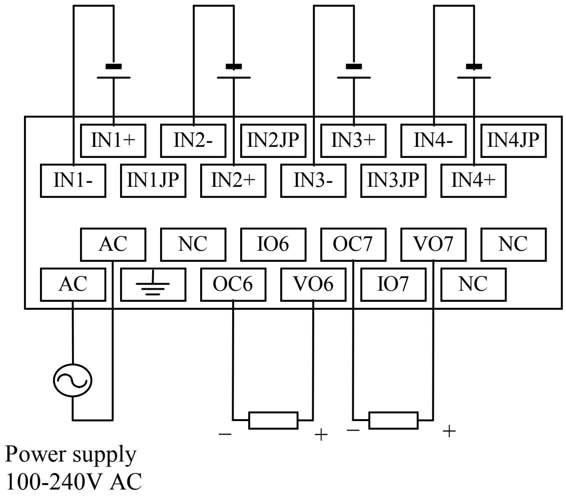
EH-D28DR



EH-D28EDR



Analog expansion unit
EH-A6EAN (Example of voltage input and voltage output)

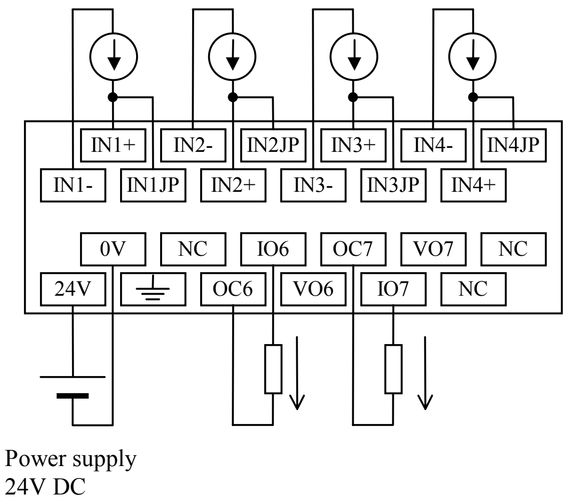


Voltage input × 4

Input and output can be configured as voltage or current independently.

Voltage output × 2

EH-D6EAN (Example of current input and current output)



Current input × 4

Input and output can be configured as voltage or current independently.

Current output × 2

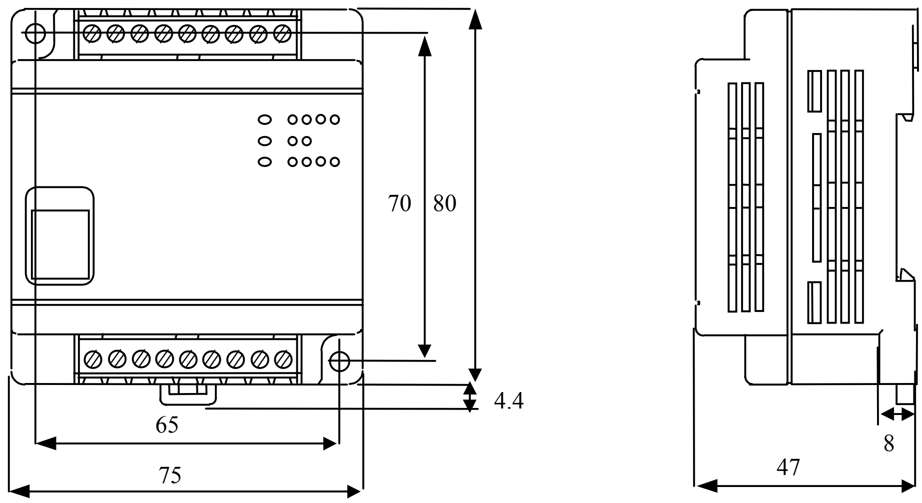
4.7 Weights and Power Consumption

Type	Weight (g)	Power consumption (A)						Remarks
		100V AC		264V AC		24V DC		
		Normal	Rush	Normal	Rush	Normal	Rush	
EH-D10DT/DTP/DR	200	-	-	-	-	0.12	0.6	
EH-D14DT/DTP/DTPS	300	-	-	-	-	0.16	0.6	
EH-A14DR	400	0.1	15	0.06	40	-	-	
EH-D14DR	300	-	-	-	-	0.16	0.6	
EH-A14AS	380	0.1	15	0.06	40	-	-	
EH-A23DRP/DRT	600	0.2	15	0.06	40	-	-	
EH-D23DRP	500	-	-	-	-	0.2	0.6	
EH-D28DT/DTP/DTPS	500	-	-	-	-	0.2	0.6	
EH-A28DRP/DRT	600	0.1	15	0.06	40	-	-	
EH-A28DR	600	0.2	15	0.06	40	-	-	
EH-D28DRP/DRT	500	-	-	-	-	0.3	0.6	
EH-D28DR	500	-	-	-	-	0.3	0.6	
EH-A28AS	600	0.2	15	0.06	40	-	-	
EH-D14EDT/EDTP/EDTPS	300	-	-	-	-	0.16	0.6	
EH-A14EDR	400	0.1	15	0.06	40	-	-	
EH-D14EDR	300	-	-	-	-	0.16	0.6	
EH-D28EDT/EDTPS	500	-	-	-	-	0.2	0.6	
EH-A28EDR	600	0.2	15	0.06	40	-	-	
EH-D28EDR	500	-	-	-	-	0.3	0.6	
EH-A6EAN	400	0.1	15	0.06	40	-	-	
EH-D6EAN	300	-	-	-	-	0.16	0.6	

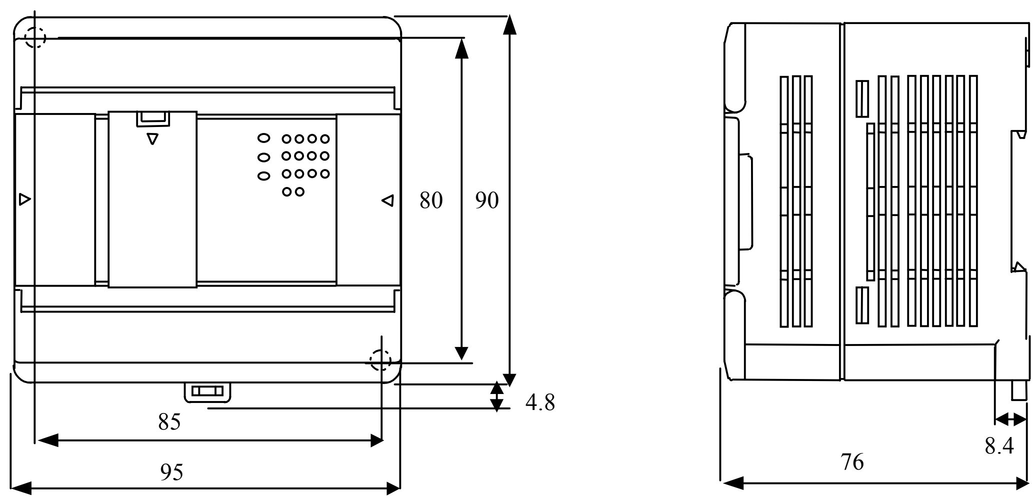
4.8 Exterior Dimensions

(1) 10-point type

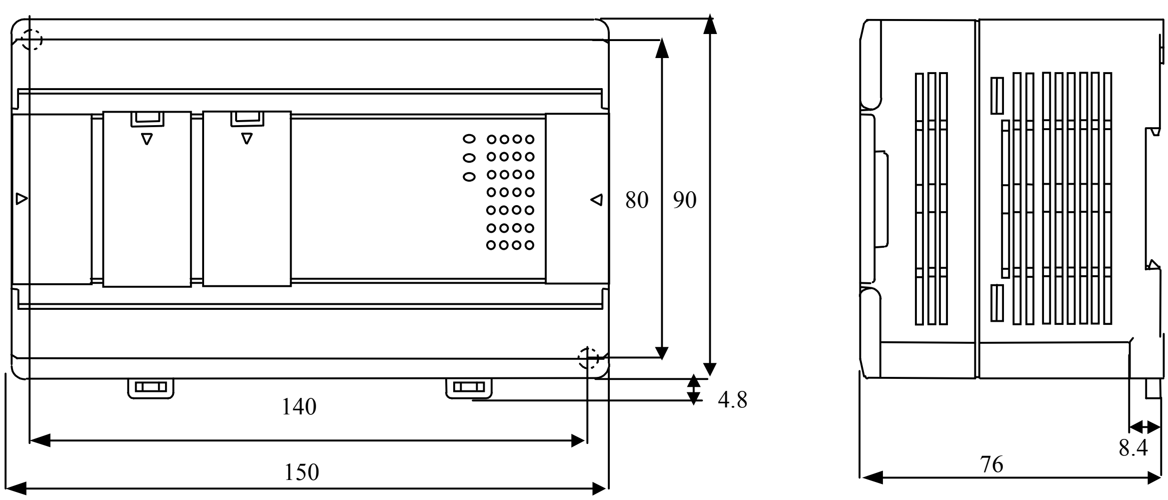
(Unit : mm)



(2) 14-point type, 14-point expansion unit, Analog expansion unit



(3) 23-point, 28-point types and 28-point expansion



MEMO

Chapter 5 Instruction Specifications

5.1 Instruction Classifications

The instructions used with the MICRO-EH are classified as shown in the following table.

Table 5.1 Instruction classification table

No.	Instruction classification	Description	Type
1	Basic instructions	Sequence	21
		Timer/counter	6
		Relational box	8
2	Arithmetic instructions	Substitution (array variable)	1
		Mathematical operations	10
		Logical operations	3
		Relational expression	8
3	Application instructions	Bit operation	3
		Shift/rotate	8
		Transfer	3
		Negation/Two's complement/Sign	3
		Conversion	4
		Application: BCU, SWAP, UNIT, DIST	4
4	Control instructions	END, JMP, CAL, FOR, NEXT, RTS, RTI, LBL, SB, INT, CEND, CJMP	12
5	Transfer instructions	TRNS 0, RECV 0	2
6	FUN instructions	Refresh, high-speed counter, PMW, pulse, comments	18

5.2 List of Instructions

[Legend]
Condition codes

DER	Data error (special internal output R7F4) Set to “1” as a data error when the I/O number is exceeded or when the BCD was abnormal data, etc. When there is no data error, it is set to “0.”
ERR	Error (special internal output R7F3) Set to “1” when an error is generated when a control instruction and a special instruction are executed. The error code is set in WRF015. When there are no errors, the previous status is maintained.
SD	Shift data (special internal output R7F2) Performs shift-in of the contents of SD by the SHR or SHL instruction.
V	Over flow (special internal output R7F1) Indicates that a digit overflow has occurred and the signed data range is exceeded as a result of signed data operations.
C	Carry (special internal output R7F0) Indicates the contents of digit increase due to addition, digit decrease due to subtraction, and shift-out due to shifting.
●	Maintains the previous status.
1]	Set to “1” when there is an error in operation results. The previous status is maintained if there is no error.
↕	Changes according to the operation result.

Processing time: This indicates the instruction processing time.
The displayed value is an average. It varies depending on the parameter and data count with the instructions used.
See the details on the instruction specifications for details.

The following lists the instructions.

1. Basic instructions (sequence instructions)

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (µs) MICRO-EH	Steps	Remarks
Sequence instructions	1		LD	Logical operation start	Indicates the commencement of a-contact operation.	X, Y R0 to R7BF M0 to M3FFF TD, SS, CU, CT Timer: 0 to 255 Counter: 0 to 255 DIF0 to DIF511 DFN0 to DFN511	●	●	●	●	●	0.9	1	
	2		LDI	Logical negation operation start	Indicates the commencement of b-contact operation.									
	3		AND	Logical AND	Indicates a-contact series connection.							0.8		
	4		ANI	Logical NAND	Indicates b-contact series connection.									
	5		OR	Logical OR	Indicates a-contact parallel connection.		●	●	●	●	●	0.9	2	
	6		ORI	Logical NOR	Indicates b-contact parallel connection.									
	7		NOT	Logical NOT	Reverses all operation results up to that point.	None	●	●	●	●	●	0.8	2	
	8	DIF	AND DIF	Leading edge detection	Indicates detection of the input rise.	DIF0 to DIF511 (Decimal)	●	●	●	●	●	1.0	3 4	Number overlap not allowed
		DIF	OR DIF											
	9	DFN	AND DFN	Trailing edge detection	Indicates detection of the input fall.	DFN0 to DFN511 (Decimal)	●	●	●	●	●	1.2	3 4	Number overlap not allowed
		DFN	OR DFN											
	10		OUT	I/O output	Indicates an output coil.	X, Y R0 to R7BF M0 to M3FFF TD, SS, CU, CTU, CTD, CL Timer: 0 to 255 Counter: 0 to 255	●	●	●	●	●	1.0	1	
	11	SET	SET	I/O set	Indicates set output.	X, Y R0 to R7BF M0 to M3FFF	●	●	●	●	●	0.9	1	
	12	RES	RES	I/O reset	Indicates reset output.									
	13	MCS	MCS	Set master control	Indicates master control set operation.	MCS0 to MCS49	●	●	●	●	●	0.7	3	Number overlap allowed
	14	MCR	MCR	Reset master control	Indicates master control reset operation.	MCR0 to MCR49	●	●	●	●	●	0.7	2	Number overlap allowed

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4	R7F3	R7F2	R7F1	R7F0	Process time (μ s)	Steps	Remarks
							DER	ERR	SD	V	C	MICRO-EH		
Sequence instructions	15	MPS	MPS	Operation result push	Stores the previous operation result.	None	●	●	●	●	●	—	0	
	16	MRD	MRD	Operation result read	Reads the stored operation result and continues operation.									
	17	MPP	MPP	Operation result pull	Reads the stored operation result, continues operation and clears the stored result.									
	18		ANB	Logical block serial connection	Indicates serial connection between two logical blocks.	None	●	●	●	●	●	—	0	
	19		ORB	Logical block parallel connection	Indicates parallel connection between two logical blocks.	None						0.7	1	
	20		[ ]	Processing box start and end	Indicates start and end of a process box.	None	●	●	●	●	●	0.6	3	
	21		( )	Relational box start and end	Indicates start and end of a comparison box.	None	●	●	●	●	●	0.8	0	

2. Basic instructions (timer, counter)

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4	R7F3	R7F2	R7F1	R7F0	Process time (μ s)	Steps	Remarks
							DER	ERR	SD	V	C	MICRO-EH		
Timer	22	TD	OUT TD	On delay timer	Indicates an on delay timer operation.	TD0 to TD255 When 0.01 s, it is possible to use until 0 to 63.	●	●	●	●	●	1.4	5	Number overlap not allowed
	23	SS	OUT SS	Single shot	Indicates a single shot operation.	SS0 to SS255 When 0.01 s, it is possible to use 0 to 63.	●	●	●	●	●	1.4	5	
Counter	24	CU	OUT CU	Counter	Indicates a counter operation.	CU0 to CU255	●	●	●	●	●	1.4	5	
	25	CTU	OUT CTU	Up of up/down counter	Indicates an up operation of up-down counter.	CTU0 to CTU255	●	●	●	●	●	1.4	5	
	26	CTD	OUT CTD	Down of up/down counter	Indicates a down operation of up-down counter.	CTD0 to CTD255	●	●	●	●	●	1.4	3	
	27	CL	OUT CL	Counter clear	Indicates a clear operation for CU, RCU, CTU, CTD and WDT.	CL0 to CL255	●	●	●	●	●	0.9	1	

3. Basic instructions (relational box)

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Relational box	28	s1 == s2	LD (s1== s2)	= Relational box	When s1 = s2: Continuity When s1 ≠ s2: Noncontinuity	[Word] WX, WY, WR, WM, Timer Counter [Double word] DX, DY, DR, DM Constant	●	●	●	●	●	27	5 6 7 8	*1 *2 Upper case: W Lower case: DW
		s1 == s2	AND (s1== s2)									35		
		s1 == s2	OR (s1== s2)											
	29	s1 S== s2	LD (s1 S== s2)	Signed = Relational box	When s1 = s2: Continuity When s1 ≠ s2: Noncontinuity s1 and s2 are compared as signed 32-bit binary.	DX, DY, DR, DM Constant	●	●	●	●	●	35	5 6 7 8	*2
		s1 S== s2	AND (s1 S== s2)											
		s1 S== s2	OR (s1 S== s2)											
	30	s1 <> s2	LD (s1< >s2)	<> Relational box	When s1 = s2: Noncontinuity When s1 ≠ s2: Continuity	[Word] WX, WY, WR, WM, Timer Counter [Double word] DX, DY, DR, DM Constant	●	●	●	●	●	26.8	5 6 7 8	*1 *2 Upper case: W Lower case: DW
		s1 <> s2	AND (s1< >s2)									34.5		
		s1 <> s2	OR (s1< >s2)											
	31	s1 S<> s2	LD (s1 S<> s2)	Signed <> Relational box	When s1 = s2: Noncontinuity When s1 ≠ s2: Continuity s1 and s2 are compared as signed 32-bit binary.	DX, DY, DR, DM Constant	●	●	●	●	●	34.5	5 6 7 8	*2
		s1 S<> s2	AND (s1 S<> s2)											
		s1 S<> s2	OR (s1 S<> s2)											

*1: In the case of word, it requires five steps for LD (s1□s2) and AND (s1□s2), and six steps for OR (s1□s2).

*2: In the case of double word, for LD (s1□s2) and AND (s1□s2), it requires five steps when the combination of s1 and s2 is I/O and I/O, six steps when the combination is either I/O and constant or constant and I/O, and seven steps when the combination is constant and constant. For OR (s1□s2), one step is added respectively.

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4	R7F3	R7F2	R7F1	R7F0	Process time (μ s)	Steps	Remarks
							DER	ERR	SD	V	C	MICRO-EH		
Relational box	32	s1 < s2	LD (s1< s2)	< Relational box	When s1 < s2: Continuity When s1 ≥ s2: Noncontinuity	[Word] WX, WY, WR, WM, Timer Counter [Double word] DX, DY, DR, DM Constant	●	●	●	●	●	26.8	5 6 7 8	*1 *2 Upper case: W
		s1 < s2	AND (s1< s2)									37.5		Lower case: DW
		s1 < s2	OR (s1< s2)											
	33	s1 S< s2	LD (s1 S< s2)	Signed < Relational box	When s1 < s2: Continuity When s1 ≥ s2: Noncontinuity s1 and s2 are compared as signed 32-bit binary.	DX, DY, DR, DM Constant	●	●	●	●	●	37.5	5 6 7 8	*2
		s1 S< s2	AND (s1 S< s2)											
		s1 S< s2	OR (s1 S< s2)											
	34	s1 <= s2	LD (s1 <= s2)	<= Relational box	When s1 ≤ s2: Noncontinuity When s1 > s2: Continuity	[Word] WX, WY, WR, WM, Timer Counter [Double word] DX, DY, DR, DM Constant	●	●	●	●	●	26.8	5 6 7 8	*1 *2 Upper case: W
		s1 <= s2	AND (s1 <= s2)									42		Lower case: DW
		s1 <= s2	OR (s1 <= s2)											
	35	s1 S<= s2	LD (s1 S<= s2)	Signed <= Relational box	When s1 ≤ s2: Continuity When s1 > s2: Noncontinuity s1 and s2 are compared as signed 32-bit binary.	DX, DY, DR, DM Constant	●	●	●	●	●	37.5	5 6 7 8	*2
		s1 S<= s2	AND (s1 S<= s2)											
		s1 S<= s2	OR (s1 S<= s2)											

*1: In the case of word, it requires five steps for LD (s1□s2) and AND (s1□s2), and six steps for OR (s1□s2).

*2: In the case of double word, for LD (s1□s2) and AND (s1□s2), it requires five steps when the combination of s1 and s2 is I/O and I/O, six steps when the combination is either I/O and constant or constant and I/O, and seven steps when the combination is constant and constant. For OR (s1□s2), one step is added respectively.

4. Arithmetic instructions

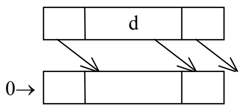
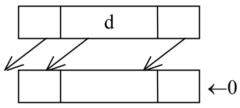
Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Substitution statement	1	d=s		Substitution statement	d ← s	[Bit] d: Y, R, M s: X, Y, R, M, Constant	↕	●	●	●	●	32	3	I/O: I/O
												74	4	I/O: Array
												52	4	Array: I/O
												92	5	Array: Array
						[Word] d: WY, WR, WM, Timer · Counter s: WX, WY, WR, WM, Timer · Counter, Constant	↕	●	●	●	●	27	3	I/O: I/O
												66	4	I/O: Array
												53	4	Array: I/O
												99	5	Array: Array
						[Double word] d: DY, DR, DM s: DX, DY, DR, DM, Constant * Array variables can be used.	↕	●	●	●	●	35	4	I/O: I/O
												86	4	I/O: Array
												71	5	Array: I/O
												120	5	Array: Array
Mathematical operation	2	d=s1+s2		Binary addition	d ← s1+s2	[Word] d: WY, WR, WM s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: DY, DR, DM s1, s2: DX, DY, DR, DM, Constant	●	●	●	↕	↕	45 61	4 6	Upper case: W Lower case: DW
	3	d=s1 B+ s2		BCD addition	d ← s1+s2		↕	●	●	●	↕	115 177	4 6	Upper case: W Lower case: DW
	4	d=s1 - s2		Binary subtraction	d ← s1 - s2		●	●	●	↕	↕	41 58	4 6	Upper case: W Lower case: DW
	5	d=s1 B - s2		BCD subtraction	d ← s1 - s2		↕	●	●	●	↕	104 163	4 6	Upper case: W Lower case: DW
	6	d=s1 x s2		Binary multiplication	d ← s1 x s2		↕	●	●	●	●	43 112	4 6	Upper case: W Lower case: DW
	7	d=s1 B x s2		BCD multiplication	d ← s1 x s2		↕	●	●	●	●	164 447	4 6	Upper case: W Lower case: DW
	8	d=s1 S x s2		Signed binary multiplication	d ← s1 x s2	[Double word] d: DY, DR, DM s1, s2: DX, DY, DR, DM, Constant	↕	●	●	●	●	143	6	
	9	d=s1 / s2		Binary division	[Word] d ← s1 / s2 WRF016 ← s1 mod s2 [Double word] d ← s1 / s2 DRF016 ← s1 mod s2	[Word] d: WY, WR, WM s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: DY, DR,, DM s1, s2: DX, DY, DR, DM, Constant	↕	●	●	●	●	55 110	4 6	Upper case: W Lower case: DW
	10	d=s1 B/ s2		BCD division								152 253	4 6	Upper case: W Lower case: DW
	11	d=s1 S/ s2		Signed binary division		[Double word] d: DY, DR, DM s1, s2: DX, DY, DR, DM, Constant	↕	●	●	↕	●	101	6	

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Logic operation	12	d=s1 OR s2		Logical OR	d ← s1+s2	[Bit] d: Y, R, M s1, s2: X, Y, R, M [Word] d: WY, WR, WM, Timer Counter s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: DY, DR, DM s1, s2: DX, DY, DR, DM, Constant	●	●	●	●	●	62 33 86	4 4 6	Upper case: B Middle case: W Lower case: DW
	13	d=s1 AND s2		Logical AND	d ← s1 · s2		●	●	●	●	●	46 36 49	4 4 6	Upper case: B Middle case: W Lower case: DW
	14	d=s1 XOR s2		Exclusive OR	d ← s1 ⊕ s2		●	●	●	●	●	42 33 66	4 4 6	Upper case: B Middle case: W Lower case: DW
Relational expression	15	d=s1 == s2		= Relational expression	When s1 = s2, d ← 1 When s1 ≠ s2, d ← 0	[Word] d: Y, R, M s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant	●	●	●	●	●	60 48	4 6	Upper case: W Lower case: DW
	16	d=s1 S== s2		Signed = Relational expression	When s1 = s2, d ← 1 When s1 ≠ s2, d ← 0 s1 and s2 are compared as signed 32-bit binary.	[Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant						108	6	
	17	d=s1<>s2		<> Relational expression	When s1 = s2, d ← 0 When s1 ≠ s2, d ← 1	[Word] d: Y, R, M s1, s2: WX, WY, WR, WM, Timer · Counter, Constant [Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant	●	●	●	●	●	60 46	4 6	Upper case: W Lower case: DW
	18	d=s1 S<> s2		Signed <> Relational expression	When s1 = s2, d ← 0 When s1 ≠ s2, d ← 1 s1 and s2 are compared as signed 32-bit binary.	[Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant						48	6	
	19	d=s1<s2		< Relational expression	When s1 < s2, d ← 1 When s1 ≥ s2, d ← 0	[Word] d: Y, R, M s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant	●	●	●	●	●	40 70	4 6	Upper case: W Lower case: DW
	20	d=s1 S< s2		Signed < Relational expression	When s1 < s2, d ← 1 When s1 ≥ s2, d ← 0 s1 and s2 are compared as signed 32-bit binary.	[Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant						50	6	

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Relational expression	21	d=s1 <= s2		≤ Relational expression	When s1 < s2, d ← 1 When s1 ≥ s2, d ← 0	[Word] d: Y, R, M s1, s2: WX, WY, WR, WM, Timer Counter, Constant [Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant	●	●	●	●	●	40 71	4 6	Upper case: W Lower case: DW
	22	d=s1 S<= s2		Signed ≤ Relational expression	When s1 ≤ s2, d ← 1 When s1 > s2, d ← 0 s1 and s2 are compared as signed 32-bit binary.	[Double word] d: Y, R, M s1, s2: DX, DY, DR, DM, Constant						50	6	

5. Application instructions

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Bit operations	1	BSET(d, n)		Bit set	n 0 d [1] Sets 1 to bit n.	[Word] d: WY, WR, WM, TC n(0-15): WX, WY, WR, WM, TC, Constant	●	●	●	●	●	26 35	3 3	Upper case: W Lower case: DW
	2	BRES(d, n)		Bit reset	n 0 d [0] Sets 0 to bit n.		●	●	●	●	●	29 38	3 3	Upper case: W Lower case: DW
	3	BTS(d, n)		Bit test	n 0 d [ ] → C Acquires the value in bit n to C (R7F0).	[Double word] d: DY, DR, DM n(0-31): WX, WY, WR, WM, TC, Constant	●	●	●	●	↕	31 38	3 3	Upper case: W Lower case: DW
Shift/rotate	4	SHR(d, n)		Shift right	SD → d → C Shifts right by n bits.	[Word] d: WY, WR, WM, TC n: WX, WY, WR, WM, TC, Constant	●	●	●	●	↕	38 46	3 3	Upper case: W Lower case: DW
	5	SHL(d, n)		Shift left	C ← d ← SD Shifts left by n bits.		●	●	●	●	↕	38 46	3 3	Upper case: W Lower case: DW
	6	ROR(d, n)		Rotate right	d → C Rotates right by n bits.	[Double word] d: DY, DR, DM n: WX, WY, WR, WM, TC, Constant *C: R7F0 SD: R7F2	●	●	●	●	↕	47 75	3 3	Upper case: W Lower case: DW
	7	ROL(d, n)		Rotate left	C ← d Rotates left by n bits.		●	●	●	●	↕	46 54	3 3	Upper case: W Lower case: DW
	8	LSR(d, n)		Logical shift right	0 → d → C Shifts right by n bits.		●	●	●	●	↕	36 45	3 3	Upper case: W Lower case: DW
	9	LSL(d, n)		Logical shift left	C ← d ← 0 Shifts left by n bits.		●	●	●	●	↕	36 45	3 3	Upper case: W Lower case: DW

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Shift/rotate	10	BSR(d, n)		BCD shift right	 Shifts BCD to right by n digits.	[Word] d: WY, WR, WM, TC n: WX, WY, WR, WM, TC, Constant	●	●	●	●	●	32 40	3 3	Upper case: W Lower case: DW
	11	BSL(d, n)		BCD shift left	 Shifts BCD to left by n digits.	[Double word] d: DY, DR, DM n: WX, WY, WR, WM, TC, constant	●	●	●	●	●	32 39	3 3	Upper case: W Lower case: DW
Transfer	12	MOV(d, s, n)		Block transfer	Transfers (copies) n bits (or words) of data from I/O number s to the n bit (or word) range from I/O number s.	[Bit] d, s: R, M n(0-255): WX, WY, WR, WM, TC, Constant [Word] d, s: WR, WM n(0-255):WX, WY, WR, WM, TC, Constant	↕	●	●	●	●	153 124	4 4	*3 Upper case: B Lower case: W
	13	COPY(d, s, n)		Copy	Copies the bit (or word) data of I/O number s to the n bit (or word) range from I/O number d.	[Bit] d: R, M s: X, Y, R, M, Constant n(0-255): WX, WY, WR, WM, TC, Constant [Word] d: WR, WM s, n(0-255): WX, WY, WR, WM, TC, Constant	↕	●	●	●	●	80 73	4 4	*3 Upper case: B Lower case: W
Negation / Two's complement / Sign	14	XCG(d1, d2, n)		Block exchange	Exchanges the n bit (or word) range from I/O number d1 and the n bit (or word) range from I/O number d2.	[Bit] d1, d2: R, M n(0-255): WX, WY, WR, WM, TC, Constant [Word] d: WR, WM n(0-255): WX, WY, WR, WM, TC, Constant	↕	●	●	●	●	139 120	4 4	*3 Upper case: B Lower case: W
	15	NOT(d)		Reverse	Reverses the bit for the I/O number d value.	[Bit] Y, R, M [Word] WY, WR, WM [Double word] DY, DR, DM	●	●	●	●	●	27 22 28	2 2 2	Upper case: B Middle case: W Lower case: DW
	16	NEG(d)		Two's complement	Stores two's complement of the value stored in I/O number d, in d.	[Word] WY, WR, WM [Double word] DY, DR, DM	●	●	●	●	●	22 29	2 2	Upper case: W Lower case: DW
	17	ABS(d, s)		Absolute value	Stores the absolute value of s in d, and the sign value of s in carry (R7F0). (0: Positive, 1: Negative)	[Word] d: WY, WR, WM s: WX, WY, WR, WM, TC, Constant [Double word] d: DY, DR, DM s: DX, DY, DR, DM, Constant	●	●	●	●	↕	30 41	3 4	Upper case: W Lower case: DW

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Conversion	18	BCD(d, s)		Binary → BCD conversion	Converts the value of s into BCD and stores it in I/O number d. If the value of s is an error, DER (R 7F4) = 1 is set.	[Word] d: WY, WR, WM s: WX, WY, WR, WM, TC, Constant	↕	●	●	●	●	79 89	3 4	Upper case: W Lower case: DW
	19	BIN(d, s)		BCD → Binary conversion	Converts the value of s into binary and stores it in I/O number d. If the value of s is an error, DER (R 7F4) = 1 is set.	[Double word] d: DY, DR, DM s: DX, DY, DR, DM, Constant	↕	●	●	●	●	49 75	3 4	Upper case: W Lower case: DW
	20	DECO(d, s, n)		Decode	Decodes the value indicated by the least significant n bits of s, and sets the bit that corresponds to the decoding result of the bit row starting from I/O number d, to 1.	d: R, M s: WX, WY, WR, WM, TC, Constant n: Constant(1-8)	↕	●	●	●	●	105	4	*3
	21	ENCO(d, s, n)		Encode	Encodes the bit location in which 1 is set within the bit row, which starts with I/O number s and lasts for the amount of nth power of 2, and stores it in I/O number d. If multiple bits that contain 1 exist, the one with the upper bit locations will be encoded.	d: WY, WR, WM s: R, M n: Constant(1-8)	↕	●	●	●	↕	128	4	*3

*3: Processing time when n=1.

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Application instruction	22	BCU(d, s)		Bit count	Among the contents of s (word, double-word), stores the number of bits that are set to 1 in I/O number d.	[Word] d: WY, WR, WM s: WX, WY, WR, WM, TC, Constant [Double word] d: WY, WR, WM s: DX, DY, DR, DM, Constant	●	●	●	●	●	33 42	3 4	Upper case: W Lower case: DW
	23	SWAP(d)		Swap	Swaps the upper 8 bits and the lower 8 bits of the value (word) for I/O number d.	d: WY, WR, WM	●	●	●	●	●	25	2	
	24	UNIT(d, s, n)		Unit	Stores the lower 4 bit values of the n words starting with s in the lower 4 bits each of d (word).	d: WY, WR, WM s: WR, WM n: Constant(0-4)	↕	●	●	●	●	100	4	*4
	25	DIST(d, s, n)		Distribute	Extracts the value of s (word) in 4 bit units from the least significant bits, and sets them in the lower 4 bits of each word starting with I/O number d (word). The upper bits are set to 0.	d: WR, WM s: WX, WY, WR, WM, TC, Constant n: Constant(0-4)	↕	●	●	●	●	87	4	*4

*4: Processing time when n = 1

6. Control instructions

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Control	1	END		Normal scan end	Indicates the end of a normal scan.	None	●	●	●	●	●	714	1	
	2	CEND(s)		Scan conditional end	Re-executes normal scan from the beginning of the normal scan when s=1, while the next instruction is executed when s=0.	s: X, Y, R, M	●	●	●	●	●	5 707 32	2 2	*5 *6
	3	JMP n		Unconditio-nal jump	Jumps to LBL n of the same No. n.	n: Constant(0-255)	●	1]	●	●	●			
	4	CJMP n (s)		Conditional jump	When s=1, jumps to the LBL n of the same No.; when s=0, executes the next instruction.	n: Constant(0-255) s: X, Y, R, M	●	1]	●	●	●	3 32	3	*5 *6
	5	LBL n		Label	Indicates the jump destination of JMP or CJMP of the same No.	n: Constant(0-255)	●	●	●	●	●	0.5	1	
	6	FOR n (s)		FOR	When s=0, jumps to the location after the NEXT n of the same No.; when s is not 0, executes the next instruction.	n: Constant(0-49) s: WY, WR, WM	●	1]	●	●	●	33	3	
	7	NEXT n		NEXT	Subtracts 1 from the s value of the FOR n of the same No. and jumps to FOR n.	n: Constant(0-49)	●	1]	●	●	●	38	2	
	8	CAL n		Call subroutine	Executes the SB n subroutine of the same No. n.	n: Constant(0-99)	●	1]	●	●	●	24	2	
	9	SB n		Start subroutine	Indicates the start of No. n subroutine.	n: Constant(0-99)	●	1]	●	●	●	0.5	1	
	10	RTS		RETURN SUBROUTIN	Returns from subroutine.	None	●	●	●	●	●	25	1	
	11	INT n		Start interrupt scan	Indicates the start of No. n interrupt scan.	n: Constant(0-2, 16-19, 20-27)	●	●	●	●	●	0.5	1	
	12	RTI		RETURN INTERRUPT	Returns from interrupt scan.	None	●	●	●	●	●	0.5	1	

7. Transfer instructions

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
Transfer inst.	1	TRNS 0		General purpose port communica-tion command	Data sending and receiving (optional)	d: WY10 s: WR, WM t: R, M	↕	●	●	●	●	80	3	
	2	RECV 0			Data receiving and sending (optional)	d: WX0 s: WR, WM t: R, M	↕	●	●	●	●	80	3	

8. FUN instructions

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
FUN instructions	1	FUN 5 (s)		General purpose port switching	Port type switching from dedicated port to general purpose port	s: WR,WM	↕	●	●	●	●	114	3	
	2	FUN 80 (s) (ALREF (s))		I/O refresh (all points)	Refreshes all external I/O ranges.	s: WR,WM	↕	●	●	●	●	432	3	
	3	FUN 81 (s) (IOREF (s))		I/O refresh (I/O /link designation)	Refreshes only the input range, output range or link range.	s: WR,WM	↕	●	●	●	●	244	3	

Classification	Item number	Ladder symbol	Instruction symbol	Instruction name	Process descriptions	I/O types used	R7F4 DER	R7F3 ERR	R7F2 SD	R7F1 V	R7F0 C	Process time (μ s) MICRO-EH	Steps	Remarks
FUN instructions	4	FUN 82 (s) (SLREF (s))		I/O refresh (any slot)	Refreshes the I/O at the designated slot.	s: WR, WM	↕	●	●	●	●	311	3	
	5	FUN 140 (s)		High-speed counter operation control	Performs the starting and stopping of the count operation of the specified counter.	s: WR, WM	↕	●	●	●	●	147	3	
	6	FUN 141 (s)		High-speed counter coincidence output control	Performs the enabling and disabling of the coincidence output of the specified counter.	s: WR, WM	↕	●	●	●	●	138	3	
	7	FUN 142 (s)		High-speed counter up-count / down-count control	This controls the up-count/down-count of the specified counter. (Single-phase counters only)	s: WR, WM	↕	●	●	●	●	156	3	
	8	FUN 143 (s)		High-speed counter current value replacement	The counter value of the specified counter number will be replaced by the data stored in the replacement value storage area.	s: WR, WM s+1: WR, WM	↕	●	●	●	●	175	3	
	9	FUN 144 (s)		High-speed counter current value reading	This function reads the count value of the specified counter number and writes it to the current value storage range	s: WR, WM s+1: WR, WM	↕	●	●	●	●	132	3	
	10	FUN 145 (s)		High-speed counter current value clear	Clears the count value of the specified counter number.	s: WR, WM	↕	●	●	●	●	157	3	
	11	FUN 146 (s)		High-speed counter preset	The on-preset value and off-preset value will be set according to the preset specifications in respect to the specified counter number.	s: WR, WM s+1: WR, WM s+2: WR, WM	↕	●	●	●	●	162	3	
	12	FUN 147 (s)		PWM operation control	Starts PWM output of the specified PWM output number.	s: WR, WM	↕	●	●	●	●	135	3	
	13	FUN 148 (s)		PWM Frequency on-duty changes	Sets the frequency value and the on-duty value of the PWM output number specified by the on-duty value and the specified frequency value.	s: WR, WM s+1: WR, WM s+2: WR, WM	↕	●	●	●	●	173	3	
	14	FUN 149 (s)		Pulse output control	Starts pulse output of the specified pulse number and the output is stopped when the specified number of pulses are output.	s: WR, WM	↕	●	●	●	●	149	3	
	15	FUN 150 (s)		Pulse frequency output setting changes	Pulse output is commenced at the specified frequency. Output is stopped when the number of pulses specified have been output.	s: WR, WM s+1: WR, WM s+2: WR, WM	↕	●	●	●	●	217	3	
	16	FUN 151 (s)		Pulse output with acceleration/ deceleration	Divides the time band and frequency into 10 levels and performs acceleration/deceleration.	s: WR, WM s+1: WR, WM s+2: WR, WM s+3: WR, WM s+4: WR, WM	↕	●	●	●	●	919	3	
	17	FUN 254 (s) (BOXC (s))		BOX comment	No processing is performed in the CPU.	s: WR, WM	●	●	●	●	●	—	3	
	18	FUN 255 (s) (MEMC (s))		Memo comment	No processing is performed in the CPU.		●	●	●	●	●	—	3	

5.3 Instruction Specification Details

(1) Basic instructions	
(2) Arithmetic instructions	
(3) Application instructions	
(4) Control instructions	
(5) Transfer instructions	
(6) FUN instructions	

Item number	Basic instructions-1, 2	Name	Logical operation start (LD, LDI)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.9	←	
	●	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
LD n LDI n	—	1

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	I/O number	O	O	O	O									

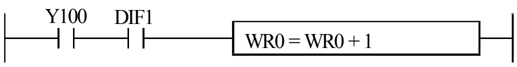
Function

LD n: Starts the a-contact logical operation. Enters the continuity state when input is on.

LDI n: Starts the b-contact logical operation. Enters the continuity state when input is off.

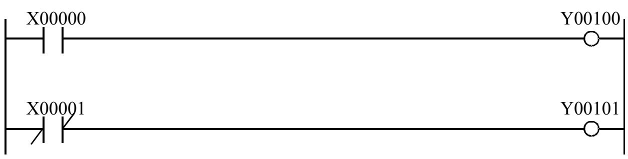
Notes

- Edge detection (DIF, DFN) cannot be used in respect to LDI.
- Pay close attention if the external output is to be monitored when counter input (coincidence output), PWM output or pulse output is set with the PI/O function.



Y100 will not change while monitored. It will remain the same value previously set using functions such as set/reset.
For example, if Y100 is off, the Y100 status will not change while being monitored and WRO will also remain unchanged.

Program example




```
LD    X00000
OUT   Y00100

LDI   X00001
OUT   Y00101
```

Program description

- When input X00000 is on, output Y00100 is on; when off, the output is off.
- When input X00001 is off, output Y00101 is on; when on, the output is off.

Item number	Basic instructions-3, 4	Name	Contact serial connection (AND, ANI)

Ladder format	Condition code					Processing time (μs)		Remark
n ─┤ ├─ / n ─┤/├─	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.8	←	
	●	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
AND n ANI n	—	1

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	I/O number	○	○	○	○									

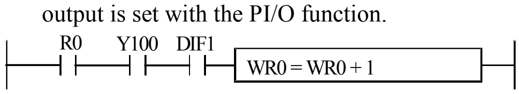
Function

AND n: Obtains AND of the previous operation result and the a-contact operation.

ANI n: Obtains AND of the previous operation result and the b-contact operation.

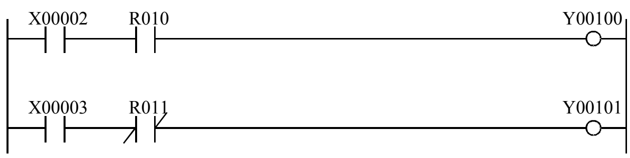
Notes

- Edge detection (DIF, DFN) cannot be used in respect to ANI.
- Pay close attention if the external output is to be monitored when counter input (coincidence output), PWM output, or pulse output is set with the PI/O function.



Y100 will not change when monitored. It will remain the same value previously set using functions such as set/reset.
For example, if Y100 is off, the Y100 status will not change while being monitored and WRO will also remain unchanged.

Program example




```
LD    X00002
AND   R010
OUT   Y00100

LD    X00003
ANI   R011
OUT   Y00101
```

Program description

- When input X00002 and R010 are both on, output Y00100 is on and all others are off.
- When input X00003 is on and R011 is off, output Y00101 is on and all others are off.

Item number	Basic instructions-5, 6	Name	Contact parallel connection (OR, ORI)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.9	←	
	●	●	●	●	●			

Instruction format		Number of steps	
		Condition	Steps
OR	n	—	2
ORI	n		

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	I/O number	○	○	○	○									

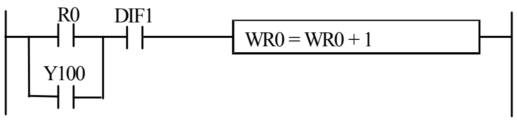
Function

OR n: Obtains OR of the previous operation result and the a-contact operation.

ORI n: Obtains OR of the previous operation result and the b-contact operation.

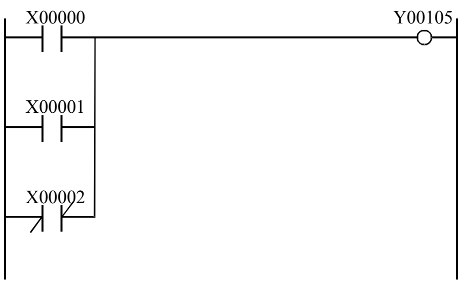
Notes

- Edge detection (DIF, DFN) cannot be used in respect to ORI.
- Pay close attention if the external output is to be monitored when counter input (coincidence output), PWM output, or pulse output is set with the PI/O function.



Y100 will not change when monitored. It will remain the same value previously set using functions such as set/reset.
For example, if Y100 is off, the Y100 status will not change while being monitored and WRO will also remain unchanged.

Program example

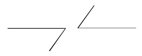



```
LD    X00000
OR    X00001
ORI   X00002
OUT   Y00105
```

Program description

- When X00000 is on, X00001 is on, or X00002 is off, the operation is “1” and Y00105 turns on.

Item number	Basic instructions-7	Name	Negation (NOT)

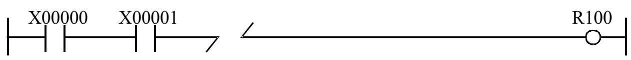
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.8	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
NOT	Condition			Steps				
	—			2				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function

- Reverses the operation result obtained up to that point.

Program example

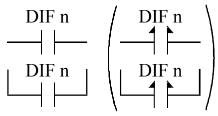



```
LD    X00000
AND   X00001
NOT
OUT   R100
```

Program description

- When input X00000 and input X00001 are both on, the operation is “1,” but due to , the calculation turns into “0” and R100 turns off.
- In all other cases, R100 turns on.

Item number	Basic instructions-8	Name	Leading edge detection (AND DIF, OR DIF)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.0	←	
	●	●	●	●	●			

Instruction format	Number of steps	
AND DIF n OR DIF n	Condition	Steps
	AND DIF n	3
	OR DIF n	4

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Number												○	0 to 511 (Decimal)

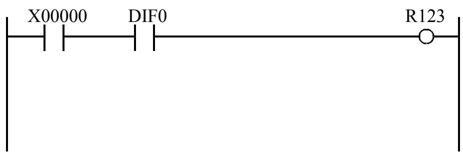
Function

- Detects the rise of an input signal and retains the operation result only for one scan.
  ( ) indicates the display when the Ladder Editor is used.

Notes

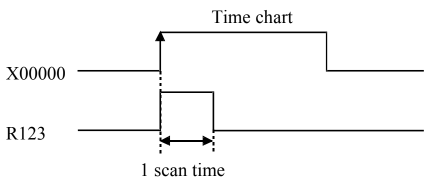
- DIF number may not be overlapped. (However, no error is generated even if overlapped numbers are used.)
- DIF cannot use the b contact.

Program example




```
LD    X00000
AND   DIF0
OUT   R123
```

Program description



- Upon leading of X00000 on, R123 turns on only for one scan.
- If b-contact is used for X00000, operation will be the same as the a-contact DFN operation.

Item number	Basic instructions-9	Name	Trailing edge detection (AND DFN, OR DFN)

Ladder format	Condition code					Processing time (μs)		Remark
DFN n (DFN n) / DFN n (DFN n)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.0	←	
	●	●	●	●	●			
Instruction format	**Number of steps**							
AND DFN n OR DFN n	Condition			Steps				
	AND DFN n			3				
	OR DFN n			4				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Number												○	0 to 511 (Decimal)

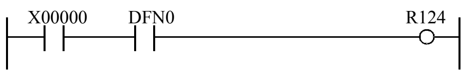
Function

- Detects the fall of an input signal and retains the operation result only for one scan.
  ( ) indicates the display when the Ladder Editor is used.

Notes

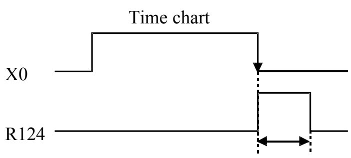
- DFN number may not be overlapped. (However, no error is generated even if overlapped numbers are used.)
- DFN cannot use the b contact.

Program example



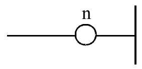

```
LD    X00000
AND   DFN0
OUT   R124
```

Program description



- Upon a fall of X00000, R124 turns on only for one scan.
- If b-contact is used for X00000, operation will be the same as the a-contact DIF operation.

Item number	Basic instructions-10	Name	Coil output (OUT)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.0	←	
	●	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
OUT n	—	1

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	I/O number		○	○	○									

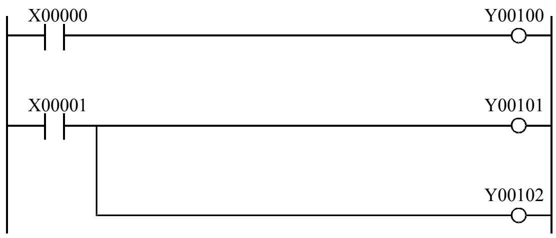
Function

- Switches on the coil when the operation result obtained up to that point is “1.”
- Switches off the coil when the operation result obtained up to that point is “0.”

Notes

- L becomes the internal output when link modules are not used.

Program example



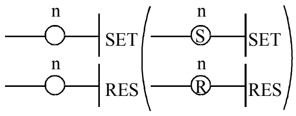

```
LD    X00000
OUT   Y00100

LD    X00001
OUT   Y00101
OUT   Y00102
```

Program description

- When input X00000 is on, the operation is “1” and Y00100 turns on.
- When input X00001 is on, the operation is “1,” and Y00101 and Y00102 turn on.

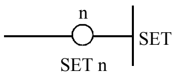
Item number	Basic instructions-11, 12	Name	Set/reset coil output (SET, RES)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case: SET Lower case: RES
	DER	ERR	SD	V	C	0.9	←	
	●	●	●	●	●			

Instruction format	Number of steps: Condition	Number of steps: Steps	Average	Maximum
SET n RES n	—	1	0.9	←

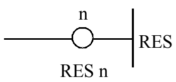
Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	I/O number		○	○										

Function



Switches on the device when the operation result obtained up to that point is “1.”

The device that is switched on will not be switched off even if the operation result is “0.”



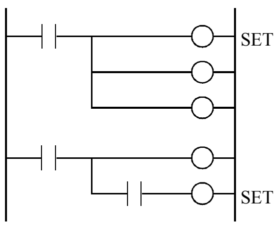
Switches off the device when the operation result obtained up to that point is “1.”

( ) indicates the display when the Ladder Editor is used.

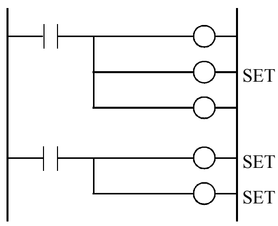
Notes

- When a set/reset coil is used on a multi-layer coil, it must be set to the highest level or an arbitrary contact must be entered immediately before the use.

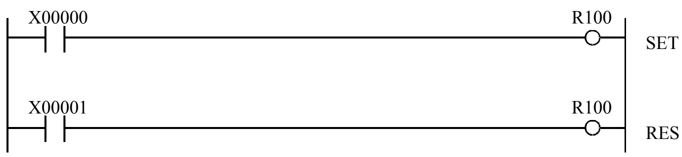
Example of OK



Example of NG



Program example

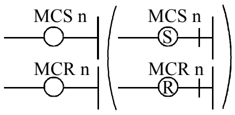



```
LD    X00000
SET   R100
LD    X00001
RES   R100
```

Program description

- When input X00000 turns on, output R100 turns on. Even if X00000 turns off, R100 remains on.
- When input X00001 turns on, output R100 turns off.
- When input X00000 and X00001 both turn on, the one executed later than the other during programming takes a higher priority.

Item number	Basic instructions-13, 14	Name	Set (start)/reset (cancel) master control (MCS, MCR)		

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case: MCS Lower case: MCR
	DER	ERR	SD	V	C	0.7	←	
	●	●	●	●	●			
Instruction format	Number of steps							
MCS n MCR n	Condition			Steps		0.7	←	
	MCS n			3				
	MCR n			2				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DL, DM		
n	Number												○	0 to 49 (Decimal)

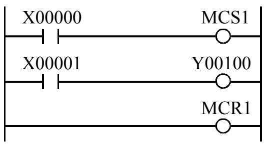
Function

- Controls the input to the circuit sandwiched by the master control set (MCS n) and reset (MCR n).
  (An AND operation is performed with respect to each input and MCS.)
- The master control can be used up to eight layers.
  ( ) indicates the display when the Ladder Editor is used.

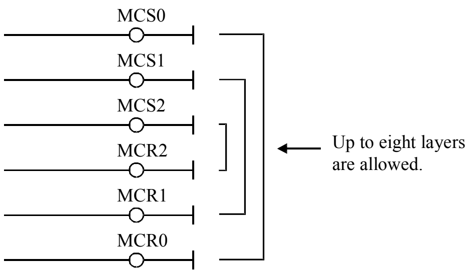
Notes

- Always use the master control MCS and MCR in pairs.

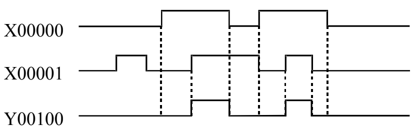
Program example




```
LD    X00000
MCS1
LD    X00001
OUT   Y00100
MCR1
```



Program description



- When input X00000 is on, the circuits surrounded by MCS and MCR obeys input X00001, and output Y00100 turns on/off.
- When input X00000 is off, the circuits surrounded by MCS and MCR are independent of input X00001, and output Y00100 turns off.

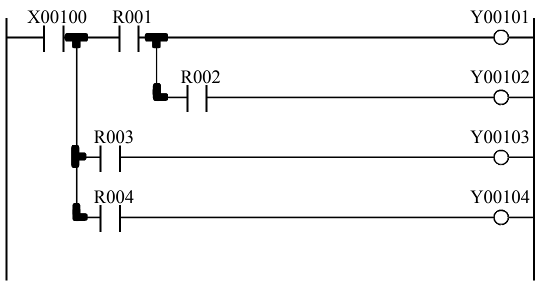
Item number	Basic instructions-15, 16, 17	Name	Save/read/clear operation result (Branching of ladder)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
Save Read Clear	DER	ERR	SD	V	C	—	—	
	●	●	●	●	●			

Instruction format		Number of steps	
		Condition	Steps
MPS	Save	—	0
MRD	Read		
MPP	Clear		

Usable I/O		Bit: X	Y	R, M	TD, SS, CU, CT	Word: WX	WY	WR, WM	TC	Double word: DX	DY	DR, DM	Constant	Other

Function




```
LD   X00100
MPS
AND  R001
MPS
OUT  Y00101
MPP
AND  R002
OUT  Y00102
MRD
AND  R003
OUT  Y00103
MPP
AND  R004
OUT  Y00104
```

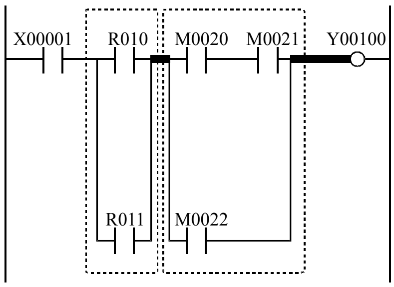
- MPS stores the previous operation result. (Push)
- MRD reads the results stored by the MPS and continues operation.
- MPP reads the results stored previously by the MPS and continues operation, then clears the results after operation. (Pull)

Item number	Basic instructions-18	Name	Logical block serial connection (ANB)

Ladder format	Condition code					Processing time (μs)		Remark
(See Function column)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	—	—	
	●	●	●	●	●			
Instruction format	Number of steps							
ANB	Condition			Steps				
	—			0				

Usable I/O	Bit				Word				Double word			Constant	Other
	X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function




```
LD   X00001
LD   R010
OR   R011
ANB
LD   M0020
AND  M0021
OR   M0022
ANB
OUT  Y00100
```

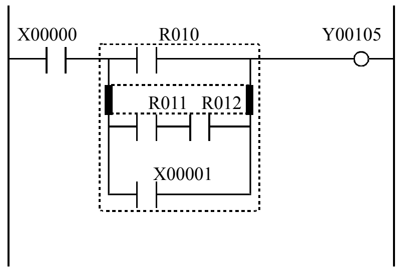
This instruction is used to perform AND operation with respect to the logical operation blocks (dotted line area).

Item number	Basic instructions-19	Name	Logical block parallel connection (ORB)

<table>
<tr><td rowspan="3">Ladder format</td><td colspan="5">Condition code</td><td colspan="2">Processing time (μs)</td><td rowspan="2">Remark</td></tr>
<tr><td>R7F4</td><td>R7F3</td><td>R7F2</td><td>R7F1</td><td>R7F0</td><td>Average</td><td>Maximum</td></tr>
<tr><td>DER</td><td>ERR</td><td>SD</td><td>V</td><td>C</td><td rowspan="5">0.7</td><td rowspan="5">—</td><td rowspan="5"></td></tr>
<tr><td>(See Function column)</td><td>●</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><td>Instruction format</td><td colspan="5">Number of steps</td></tr>
<tr><td rowspan="2">ORB</td><td colspan="3">Condition</td><td colspan="2">Steps</td></tr>
<tr><td colspan="3">—</td><td colspan="2">1</td></tr>
</table>

<table>
<tr><td rowspan="3" colspan="2">Usable I/O</td><td colspan="4">Bit</td><td colspan="4">Word</td><td colspan="3">Double word</td><td rowspan="3">Constant</td><td rowspan="3">Other</td></tr>
<tr><td rowspan="2">X</td><td rowspan="2">Y</td><td>R,</td><td>TD, SS,</td><td rowspan="2">WX</td><td rowspan="2">WY</td><td>WR,</td><td rowspan="2">TC</td><td rowspan="2">DX</td><td rowspan="2">DY</td><td>DR,</td></tr>
<tr><td>M</td><td>CU, CT</td><td>WM</td><td>DM</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

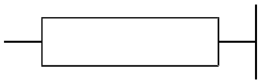
Function




```
LD   X00000
LD   R010
LD   R011
AND  R012
ORB
OR   X00001
ANB
OUT  Y00105
```

This instruction is used to perform OR operation with respect to the logical operation blocks (dotted line area).

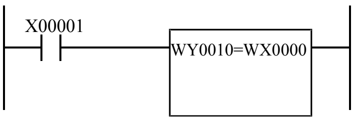
Item number	Basic instructions-20	Name	Processing box start and end (PROCESSING BOX)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.6	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
[ ]	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function

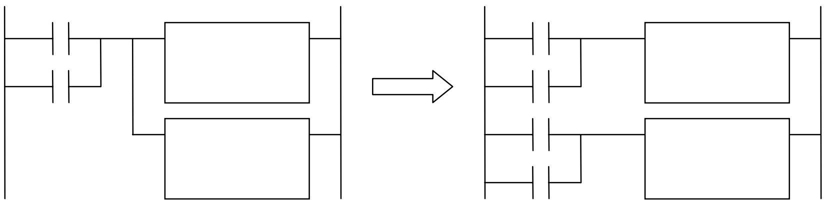
- Indicates the start and end of the processing box.



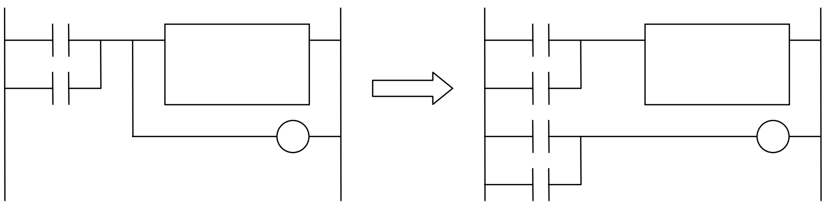

```
LD   X00001
[
WY0010=WX0000
]
```

- In the above example, the operation inside the processing box will be executed when input X00001 is on.

Parallel connection of processing box or coil is not allowed.



Not allowed Allowed



Not allowed Allowed

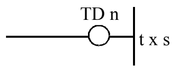
Item number	Basic instructions-21	Name	Relational box start and end (RELATIONAL BOX)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.8	—	
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps				
( )	—			0				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function

- Indicates the start and end of the relational box.

Item number	Basic instructions-22	Name	On delay timer (ON DELAY TIMER)				
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.4	—	
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition		Steps					
OUT TD n t s	—		5					

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	Timer number												○	0 to 255 (Decimal)
t	Time base													.01s, .1s, 1s
s	Set value					○	○	○					○	1 to 65535 (Decimal)

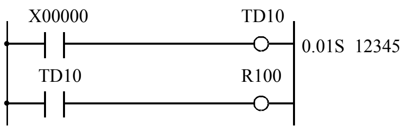
Function

- The progress value is updated when the startup condition is on, and the coil turns on when the progress value is greater than or equal to the set value.
- If the startup condition is turned off, the progress value is cleared and the coil turns off.
- The progress value is set in TC n and does not exceed 65535 (decimal).
- If the progress value is updated during RUN, the operation will be performed using the new progress value at that point.
- If an I/O is set for the set value, the set value can be changed during operation by changing the I/O value, since the set values are updated during each scan.

Notes

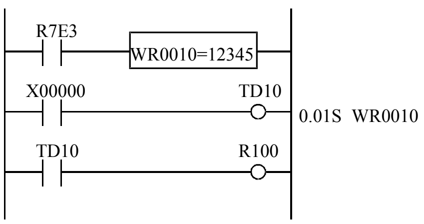
- The .01s time base can only be used for timer numbers 0 to 63 (64 points).
- The .1 s and 1 s time bases can be used for all timer numbers (0 to 255).
- A maximum of 256 points can be used for the timers TD, SS, CU, CTU and CTD in total.
  However, the same area as the counter is used. The timer numbers and counter numbers may not be overlapped.

Program example




```
LD    X00000
OUT   TD10  0.01S  12345
LD    TD10
OUT   R100
```

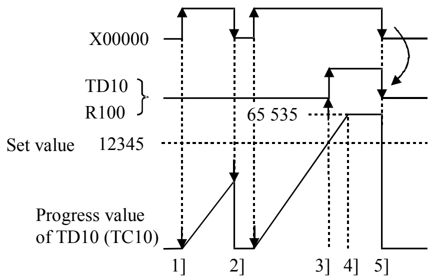
- An example of a word I/O being used as the set value for the circuit shown above.




```
LD    R7E3
[
WR0010=12345
]
LD    X00000
OUT   TD10  0.01S  WR0010
LD    TD10
OUT   R100
```

Program description

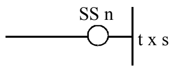
[Time chart]



1] When input X00000 turns on, TD progress value is updated.
2] When input X00000 turns off, the TD progress value is cleared.
3] TD10 turns on when progress value ≧ set value.
4] While X00000 is on, the progress value increases, but will not increase exceeding 65535.
5] When X00000 turns off, TD10 also turns off and the progress value is cleared.

- Example using word I/O as the set value
  When RUN is commenced, the set value is set to the word I/O.
  Or, the word I/O for the set value is designated to store in the power failure memory.

Item number	Basic instructions-23	Name	Single shot (SINGLE SHOT)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.4	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition		Steps					
OUT SS n t s	—		5					

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, WDT, MS, TMR, CU, RCU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	Timer number												○	0 to 255 (Decimal)
t	Time base													.01s, .1s, 1s
s	Set value					○	○	○					○	1 to 65535 (Decimal)

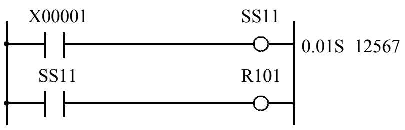
Function

- Detects the leading edge of the startup condition, starts updating progress values, and turns on the coil.
- The coils turns off when the progress value is greater than or equal to the set value. If a leading edge is detected while the progress value is less than the set value, the progress value is set to 0 and the counter is reset.
- The progress value is set in TC n and does not exceed 65535 (decimal).
- If the progress value is updated during RUN, the operation will be performed using the new progress value at that point.
- If an I/O is set for the set value, the set value can be changed during operation by changing the I/O value, since the set values are updated during each scan.

Notes

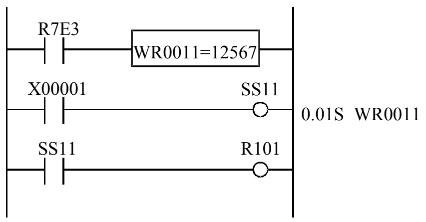
- The .01 s time base can only be used for timer numbers 0 to 63 (64 points).
- The .1 s and 1s time bases can be used for all timer numbers (0 to 255).
- A maximum of 256 points can be used for the timers TD, SS, CU, CTU and CTD in total.
  However, the same area as the counter is used. Timer number and counter number may not be overlapped.
- Since the startup condition of a single shot is edge detection, the condition for one scan cannot be detected during the first scan after RUN starts.

Program example




```
LD     X00001
OUT    SS11  0.01S  12567
LD     SS11
OUT    R101
```

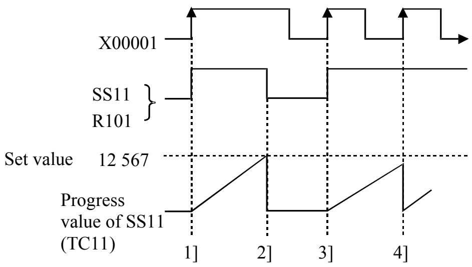
- An example of a word I/O being used as the set value for the circuit shown above.




```
LD     R7E3
[
WR0011=12567
]
LD     X00001
OUT    SS11  0.01S  WR0011
LD     SS11
OUT    R101
```

Program description

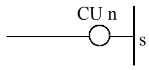
[Time chart]



1] The progress value is updated and SS11 turns on at the leading edge of X00001.
2] SS11 turns off when set value ≧ progress value.
X00001 is turned on at this time, but the single shot startup conditions are ignored because it uses edge trigger.
3] SS11 is turned on at the leading edge of X00001 again, and the progress value is updated.
4] When the leading edge of X00001 is detected while the progress value does not reach the set value, the single shot timer is triggered again and the progress value returns to 0, then starts increasing. The SS11 remains on.

- Example using word I/O as the set value
  When RUN is commenced, the set value is set to the word I/O.
  Or, the word I/O for the set value is designated to store in the power failure memory.

Item number	Basic instructions-24	Name	Counter (COUNTER)

Ladder format	Condition code					Processing time (µs)		Remark
 CU n, s	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	1.4	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition		Steps					
OUT CU n s	—		5					

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Counter number												○	0 to 255 (Decimal)
s	Set value					○	○	○					○	1 to 65535 (Decimal)

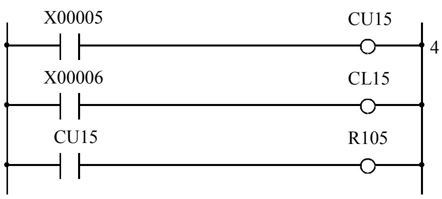
Function

- Increments the progress value by 1 each time the leading edge of the startup condition is detected, and switches on the coil when the progress value is greater than or equal to the set value. The coil that is switched on turns off when the counter clear CL n is switched on, and the progress value is cleared to 0.
- The progress value is set in TC n and does not exceed 65535 (decimal).
- If the progress value is updated while the system is running, the operation will be performed using the new progress value at that point.
- If an I/O is set for the set value, the set value can be changed during operation by changing the I/O value, since the set values are updated during each scan.

Notes

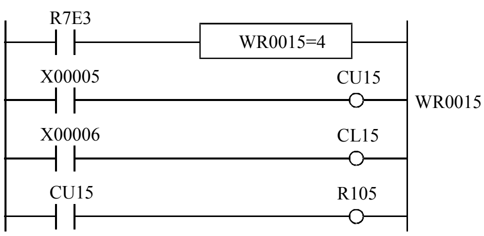
- A maximum of 256 points can be used for the timers and counters TD, SS, CU, CTU and CTD in total.
- The timer numbers and counter numbers can not be overlapped.
- While the counter clear CL n is on, the rise of startup condition is ignored.
- Since the startup condition of the counter is edge detection, the condition for one scan can not be detected during the first scan after RUN starts.
- If the set value is set to 0, it is regarded as a coil that is always on and controlled by the CL n.

Program example




```
LD    X00005
OUT   CU15  4
LD    X00006
OUT   CL15
LD    CU15
OUT   R105
```

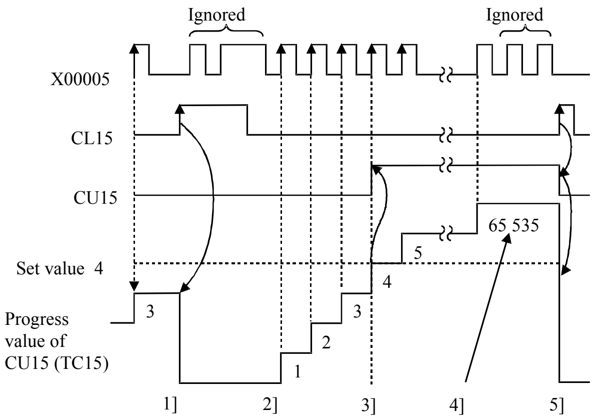
- An example of a word I/O being used as the set value for the circuit shown above.




```
LD    R7E3
[
WR0015=4
]
LD    X00005
OUT   CU15  WR0015
LD    X00006
OUT   CL15
LD    CU15
OUT   R105
```

Program description

[Time chart]

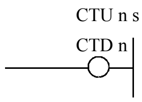


1] The progress value (count) is cleared to 0 by the counter clear (CL15). While the counter clear is on, the progress value will not be updated.
2] The progress value is updated at the leading edge of X00005.
3] Counter coil (CU15) is turned on since the progress value ≧ set value.
4] The count value will not exceed 65535 (decimal).
5] The progress value and counter coil are cleared by counter clear (CL15).

- The clear is performed under the conditions set immediately prior to the execution of the counter coil instruction.

- Example using word I/O as the set value
  When RUN is commenced, the set value is set to the word I/O.
  Or, the word I/O for the set value is designated to store in the power failure memory.

Item number	Basic instructions-25, 26	Name	Up (CTU n) and down (CTD n) of up/down counter (UP/DOWN COUNTER)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case: CTU Lower case: CTD
	DER	ERR	SD	V	C	1.4	—	
	●	●	●	●	●			
Instruction format	Number of steps							
OUT CTU n s OUT CTD n	Condition			Steps		1.4	—	
	CTU			5				
	CTD			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Counter number												○	0 to 255 (Decimal)
s	Set value					○	○	○					○	1 to 65535 (Decimal)

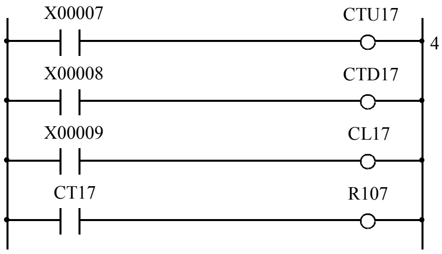
Function

- For the UP counter, increments the progress value by 1 each time the leading edge of the startup condition is detected, while it decrements the progress value by 1 for the DOWN counter. The coil switches on when the progress value is greater than or equal to the set value and switches off when the progress value is less than the set value. When the counter clear CL n switches on, the progress value is cleared to 0 and the coil switches off.
- The progress value is set in TC n, and the value will be in the range of 0 to 65535 (decimal).
- If the progress value is updated during RUN, the operation will be performed using the new progress value at that point.
- If an I/O is set for the set value, the set value can be changed during operation by changing the I/O value, since the set values are updated during each scan.

Notes

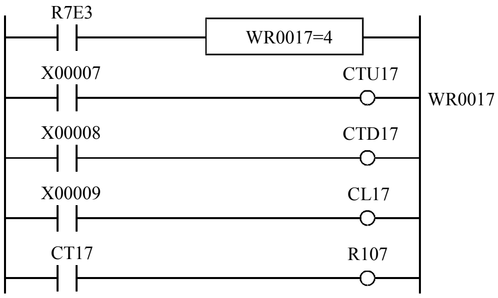
- A maximum of 256 points can be used for the timers and counters TD, SS, CU, CTU and CTD in total.
- The timer numbers and counter numbers cannot be overlapped.
- The numbers for the UP coil and DOWN coil must be the same.
- While the counter clear CL n is on, the rise of startup condition is ignored.
- Since the startup condition of the counter is edge detection, the condition for one scan may not be detected during the first scan after RUN starts.
- If the set value is set to “0”, it is regarded as a coil that is always on and controlled by the CL n.

Program example




```
LD    X00007
OUT   CTU17 4
LD    X00008
OUT   CTD17
LD    X00009
OUT   CL17
LD    CT17
OUT   R107
```

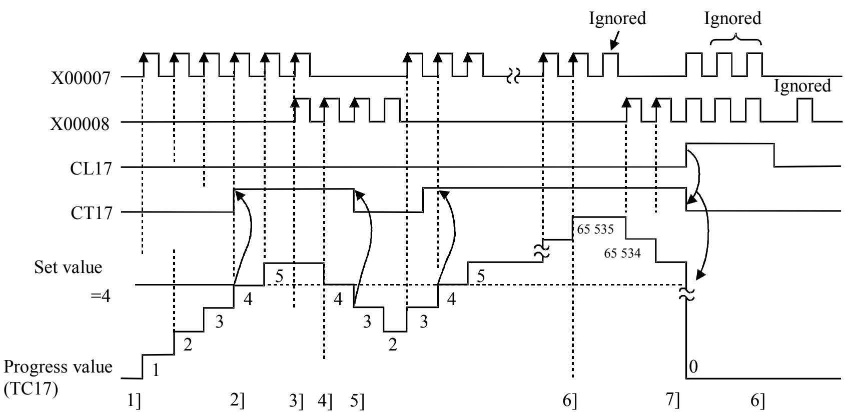
- An example of a word I/O being used as the set value for the circuit shown above.




```
LD    R7E3
[
WR0017=4
]
LD    X00007
OUT   CTU17  WR0017
LD    X00008
OUT   CTD17
LD    X00009
OUT   CL17
LD    CT17
OUT   R107
```

Program description

[Time chart]

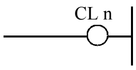


1] The progress value (count value) is up-counted at the leading edge of X00007.
2] The counter coil (CT17) is turned on when the progress value ≧ set value.
3] When the up-coil and down-coil startup conditions turn on simultaneously, the progress value does not change.
4] The progress value is down-counted at the leading edge of X00008.
5] The counter coil turns off when set value > progress value.

6] The progress value will not exceed 65535 (decimal). Also, it will not be below 0.
7] When the counter clear (CL17) turns on, the progress value and the counter coil are cleared. The progress value is not updated while the counter clear is on.

- The clear is performed under the conditions set immediately before execution of the counter coil instruction.
- Example using the word I/O as the set value
  When RUN is commenced, the set value is set to word I/O.
  Or, the word I/O for the set value is designated to store in the power failure memory.

Item number	Basic instructions-27	Name	Counter clear (COUNTER CLEAR)

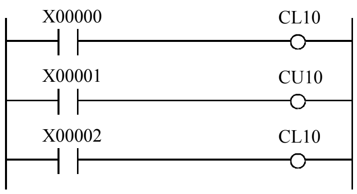
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	0.9	—	
	●	●	●	●	●			
Instruction format	Number of steps							
OUT CL n s	Condition			Steps				
	—			1				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Counter number												○	0 to 255 (Decimal)

Function

- Clears the progress values of the integral timer and switches off the timer coil.
- In the case of WDT, the time monitor check is performed (see WDT for details).
- In the case of counters, the progress value is cleared and the counter coil is switched off.
- The clearing operation is conducted immediately before execution of the counter or timer coil instruction indicated by the clear coil.

Example:



1) When X00000 is turned on, the CL10 immediately prior to CU10, and CU10 is cleared.
2) Even if X00002 turns on, if X00001 is off, the CL10 is turned off by the circuit before CU10 is executed. Thus, the CU10 will not be cleared.

Notes

- The same number should be used for the timer number and counter number.

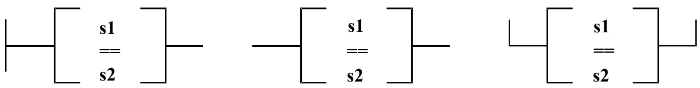
Item number	Basic instructions-28	Name	=Relational box (=RELATIONAL BOX)

Ladder format	Condition code					Processing time (μs)		Remark
(See Function column)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case: W Lower case: DW
	DER	ERR	SD	V	C	27	40	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition	Steps				35	50	
LD (s1 == s2) AND (s1 == s2) OR (s1 == s2)	Word	(See Notes)						
	Double word	(See Notes)						

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
s1	Relational number 1					○	○	○	○	○	○	○	○	
s2	Relational number 2					○	○	○	○	○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as unsigned numbers, and
  if s1 is equals to s2, it enters the continuity status (on) and
  if s1 is not equal to s2, enters the noncontinuity status (off).
- When s1 and s2 are words: 0 to 65535 (decimal) or H0000 to HFFFF (hexadecimal)
  When s1 and s2 are double words: 0 to 4294967295 (decimal) or H00000000 to HFFFFFFFF (hexadecimal)

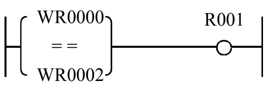
Notes

[Number of steps]

Word	
LD (s1 == s2)	5 steps
AND (s1 == s2)	5 steps
OR (s1 == s2)	6 steps

Double word		LD, AND (s1==s2)	OR (s1==s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (WR0000 == WR0002)
OUT   R001
```

Program description

- When WR0000 = WR0002, R001 turns on.

Item number	Basic instructions-29	Name	Signed = Relational box (SIGNED = RELATIONAL BOX)

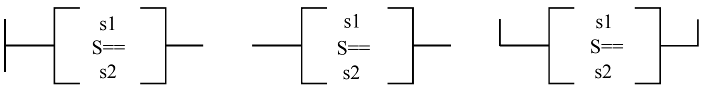
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
(See Function column)	DER	ERR	SD	V	C	35	50	
	●	●	●	●	●			

Command format	Number of steps: Condition	Steps
LD (s1 S== s2) AND (s1 S== s2) OR (s1 S== s2)	Double word	(See Cautionary notes)

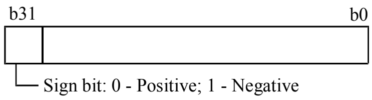
Usable I/O		Bit: X	Bit: Y	Bit: R, L, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
s1	Relational number 1									○	○	○	○	
s2	Relational number 2									○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as signed double-word numbers, and if s1 is equals to s2, it enters the continuity status (on) and if s1 is not equal to s2, enters the noncontinuity status(off).
- s1, s2 – 2147483648 to + 2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

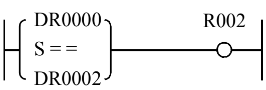


Cautionary notes

[Number of steps]

Double word		LD, AND (s1S==s2)	OR (s1S==s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (DR0000 S== DR0002)
OUT   R002
```

Program description

- When DR0000 = DR0002, R002 turns on (signed).

Item number	Basic instructions-30	Name	<> Relational box (<> RELATIONAL BOX)

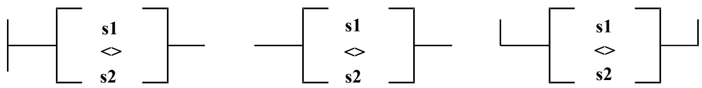
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
(See Function column)	DER	ERR	SD	V	C	26.8	40	Upper case: W Lower case: DW
	●	●	●	●	●			

Instruction format	Number of steps		Processing time (μs)		Remark
	Condition	Steps	Average	Maximum	
LD (s1 <> s2) AND (s1 <> s2) OR (s1 <> s2)	Word	(See Notes)	34.5	50	
	Double word	(See Notes)			

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s1	Relational number 1					○	○	○	○	○	○	○	○	
s2	Relational number 2					○	○	○	○	○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as unsigned numbers, and
  if s1 is equals to s2, it enters the noncontinuity status (off) and
  if s1 is not equal to s2, enters the continuity status (on).
- When s1 and s2 are words: 0 to 65535 (decimal) or H0000 to HFFFF (hexadecimal)
  When s1 and s2 are double words: 0 to 4294967295 (decimal) or H00000000 to HFFFFFFFF (hexadecimal)

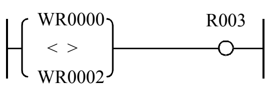
Notes

[Number of steps]

Word		
LD	(s1 <> s2)	5 steps
AND	(s1 <> s2)	5 steps
OR	(s1 <> s2)	6 steps

Double word		LD, AND (s1<>s2)	OR (s1<>s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (WR0000 < > WR0002)
OUT   R003
```

Program description

- When WR0000 ≠ WR0002, R003 turns on.

Item number	Basic instructions-31	Name	Signed <> Relational box (SIGNED <> RELATIONAL BOX)

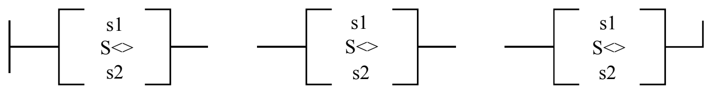
Ladder format	Condition code					Processing time (μs)		Remark
(See Function column)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	34.5	50	
	●	●	●	●	●			

Command format	Number of steps	
	Condition	Steps
LD (s1 S<> s2) AND (s1 S<> s2) OR (s1 S<> s2)	Double word	(See Cautionary notes)

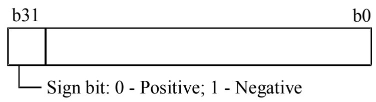
Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, L, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s1	Relational number 1									○	○	○	○	
s2	Relational number 2									○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as signed double-word numbers, and if s1 is equals to s2, it enters the noncontinuity status (off) and if s1 is not equal to s2, enters the continuity status (on).
- s1, s2 – 2147483648 to + 2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

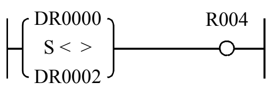


Cautionary notes

[Number of steps]

Double word		LD, AND (s1S<>s2)	OR (s1S<>s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (DR0000 S < > DR0002)
OUT   R004
```

Program description

- When DR0000 ≠ DR0002, R004 turns on (signed).

Item number	Basic instructions-32	Name	<Relational box (<RELATIONAL BOX)

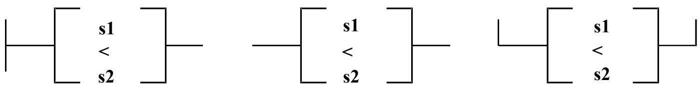
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
(See Function column)	DER	ERR	SD	V	C	26.8	40	Upper case: W Lower case: DW
	●	●	●	●	●			

Instruction format	Number of steps		Processing time (μs)	
	Condition	Steps	Average	Maximum
LD (s1 < s2) AND (s1 < s2) OR (s1 < s2)	Word	(See Notes)	37.5	52
	Double word	(See Notes)		

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s1	Relational number 1					○	○	○	○	○	○	○	○	
s2	Relational number 2					○	○	○	○	○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as unsigned numbers, and
  if s1 is less than s2, it enters the continuity status (on) and
  if s1 is greater than or equal to s2, enters the noncontinuity status (off).
- When s1 and s2 are words: 0 to 65535 (decimal) or H0000 to HFFFF (hexadecimal)
  When s1 and s2 are double words: 0 to 4294967295 (decimal) or H00000000 to HFFFFFFFF (hexadecimal)

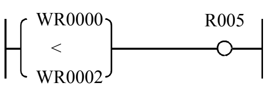
Notes

[Number of steps]

Word	
LD (s1 < s2)	5 steps
AND (s1 < s2)	5 steps
OR (s1 < s2)	6 steps

Double word		LD, AND (s1<s2)	OR (s1<s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD   (WR0000 < WR0002)
OUT  R007
```

Program description

- When WR0000 < WR0002, R005 turns on.

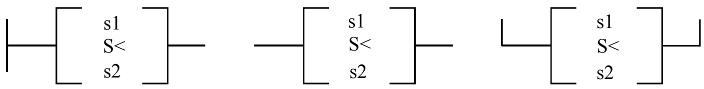
Item number	Basic instructions-33	Name	Signed<Relational box (SIGNED < RELATIONAL BOX)

<table>
<tr><th>Ladder format</th><th colspan="5">Condition code</th><th colspan="2">Processing time (μs)</th><th>Remark</th></tr>
<tr><td rowspan="3">(See Function column)</td><td>R7F4</td><td>R7F3</td><td>R7F2</td><td>R7F1</td><td>R7F0</td><td>Average</td><td>Maximum</td><td rowspan="6"></td></tr>
<tr><td>DER</td><td>ERR</td><td>SD</td><td>V</td><td>C</td><td rowspan="5">37.5</td><td rowspan="5">53</td></tr>
<tr><td>●</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><th>Command format</th><th colspan="5">Number of steps</th></tr>
<tr><td rowspan="2">LD (s1 S< s2)
AND (s1 S< s2)
OR (s1 S< s2)</td><th colspan="2">Condition</th><th colspan="3">Steps</th></tr>
<tr><td colspan="2">Double word</td><td colspan="3">(See Cautionary notes)</td></tr>
</table>

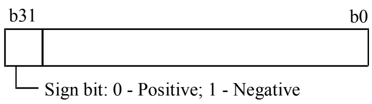
<table>
<tr><th colspan="2" rowspan="2">Usable I/O</th><th colspan="4">Bit</th><th colspan="4">Word</th><th colspan="3">Double word</th><th rowspan="2">Constant</th><th rowspan="2">Other</th></tr>
<tr><th>X</th><th>Y</th><th>R, L, M</th><th>TD, SS, CU, CT</th><th>WX</th><th>WY</th><th>WR, WM</th><th>TC</th><th>DX</th><th>DY</th><th>DR, DM</th></tr>
<tr><td>s1</td><td>Relational number 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>○</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td>s2</td><td>Relational number 2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>○</td><td>○</td><td>○</td><td>○</td><td></td></tr>
</table>

Function

[Ladder format]



- Compares s1 and s2 as signed double-word numbers, and if s1 is less than s2, it enters the continuity status (on) and if s1 is greater than or equal to s2, enters the noncontinuity status (off).
- s1, s2 – 2147483648 to + 2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

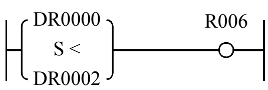


Cautionary notes

[Number of steps]

Double word		LD, AND (s1S<s2)	OR (s1S<s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (DR0000 S< DR0002)
OUT   R006
```

Program description

- When DR0000 < DR0002, R006 turns on (signed).

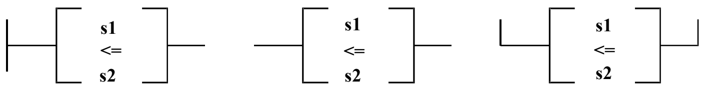
Item number	Basic instructions-34	Name	≤ Relational box (≤ RELATIONAL BOX)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
(See Function column)	DER	ERR	SD	V	C	26.8	40	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition		Steps					
LD (s1 <= s2) AND (s1 <= s2) OR (s1 <= s2)	Word		(See Notes)			42	52	
	Double word		(See Notes)					

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s1	Relational number 1					○	○	○	○	○	○	○	○	
s2	Relational number 2					○	○	○	○	○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as unsigned numbers, and
  if s1 is less than or equal to s2, it enters the continuity status (on) and
  if s1 is greater than s2, it enters the noncontinuity status (off).
- When s1 and s2 are words: 0 to 65535 (decimal) or H0000 to HFFFF (hexadecimal)
  When s1 and s2 are double words: 0 to 4294967295 (decimal) or H00000000 to HFFFFFFFF (hexadecimal)

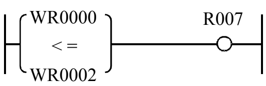
Notes

[Number of steps]

Word		
LD	(s1 <= s2)	5 steps
AND	(s1 <= s2)	5 steps
OR	(s1 <= s2)	6 steps

Double word		LD, AND (s1<=s2)	OR (s1<=s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (WR0000 <= WR0002)
OUT   R007
```

Program description

- When WR0000 ≤ WR0002, R007 turns on.

Item number	Basic instructions-35	Name	Signed ≤ Relational box (SIGNED ≤ RELATINAL BOX)

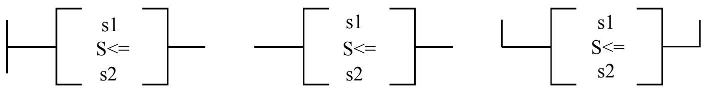
Ladder format	Condition code					Processing time (μs)		Remark
(See Function column)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	37.5	53	
	●	●	●	●	●			

Command format	Number of steps	
	Condition	Steps
LD (s1 S<= s2) AND (s1 S<= s2) OR (s1 S<= s2)	Double word	(See Cautionary notes)

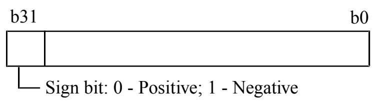
Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, L, M	TD, SS, WDT, MS, TMR, CU, RCU, CT	WX	WY	WR, WL, WM	TC	DX	DY	DR, DL, DM		
s1	Relational number 1									○	○	○	○	
s2	Relational number 2									○	○	○	○	

Function

[Ladder format]



- Compares s1 and s2 as signed double-word numbers, and if s1 is less than or equal to s2, it enters the continuity status (on) and if s1 is greater than s2, it enters the noncontinuity status (off).
- s1, s2 – 2147483648 to + 2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

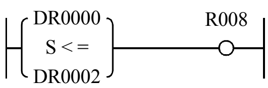


Cautionary notes

[Number of steps]

Double word		LD, AND (s1S<=s2)	OR (s1S<=s2)
I/O	I/O	5 steps	6 steps
I/O	Constant	6 steps	7 steps
Constant	I/O	6 steps	7 steps
Constant	Constant	7 steps	8 steps

Program example




```
LD    (DR0000 S<= DR0002)
OUT   R008
```

Program description

- When DR0000 ≦ DR0002, R008 turns on (signed).

Item number	Arithmetic instructions-1	Name	Substitution statement (ASSIGNMENT STATEMENT)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s	DER	ERR	SD	V	C	(See following table)		
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
d = s	(See Notes)	

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	Substitution destination		○	○			○	○	○		○	○		
s	Substitution source	○	○	○		○	○	○	○	○	○	○	○	
( )	Index value					○	○	○						

Function

- Substitutes the content of s into d.
- It is possible to use array variables for d and s.
- When d is a word, the constant is 0 to 65535 or – 32768 to + 32767 (decimal)
  H0000 to HFFFF or H8000 to H7FFF (hexadecimal)
  When d is a double word, the constant is 0 to 4294967295 or -2147483648 to +2147483647 (decimal)
  H00000000 to HFFFFFFFF or H80000000 to H7FFFFFFF

Notes

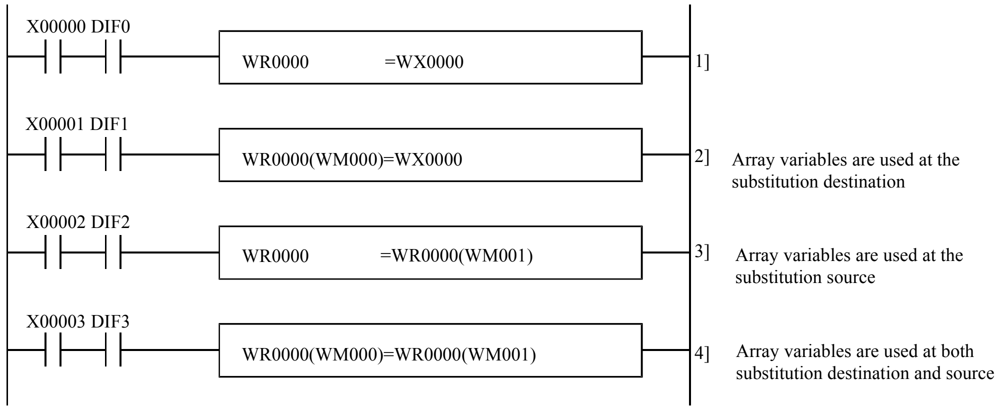
- When using an array variable, DER is set to 1 if the usable I/O number exceeds the maximum value, and DER is reset to “0” if it is normal.
- The combinations of d and s are as follows:

d	s
Bit	Bit
Word	Word
Double word	Double word

- Step numbers and processing time are as follows:

d	s	Number of steps ( ) indicates DW	Processing time (μs) Bit	Processing time (μs) Word	Processing time (μs) Double word
I/O	I/O	3 (4)	32	27	35
I/O	Array	4	74	66	86
Array	I/O	4 (5)	52	53	71
Array	Array	5	92	99	120

Program example



Program description

1] The value of WX0000 is substituted into WR0000 at the leading edge of input X00000.
2] The value of WX0000 is substituted into the WR number designated by WR0000 + WM000 at the leading edge of input X00001.
   1) When WM000 = H0010, it holds the same meaning as WR0010 = WX0000.
3] The word number of the I/O advanced by the amount designated by WR0000 + WM001 due to the I/O assignment is substituted into WR0000 at the leading edge of input X00002.
   1) When WM001 = H0010, it hods the same meaning as WR0000 = WR0010.
4] The I/O value designated by WR0000 + WM001 at the leading edge of input X00003 is substituted into the I/O of the value designated by WR0000 + WM000.
   Example) When WM000 = H0010 and WM001 = H0015, it holds the same meaning as WR0010 = WR0015.

Item number	Arithmetic instructions-2	Name	Binary addition (BINARY ADDITION)

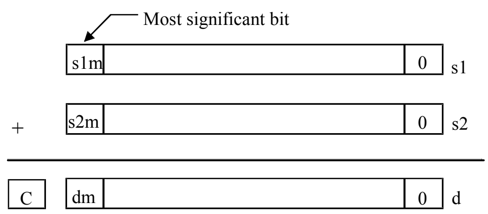
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 + s2	DER	ERR	SD	V	C	45	—	Upper case: W Lower case: DW
	●	●	●	↕	↕			
Instruction format	Number of steps							
	Condition		Steps			61	—	
d = s1 + s2	Word		4					
	Double word		6					

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination						○	○	○		○	○		
s1	Augend					○	○	○	○	○	○	○	○	
s2	Addend					○	○	○	○	○	○	○	○	

Function

- Adds s1 and s2 as the binary data, and substitutes the result into d as the binary data.
- The C flag is set to "0" if the operation result is within the range of H0000 to HFFFF for word and H00000000 to HFFFFFFFF for double word. Otherwise, It is set to "1."
  $C = s1m \cdot s2m + s1m \cdot \overline{dm} + s2m \cdot \overline{dm}$
- The V flag is set to "1" if the operation result is meaningless as signed binary data, and "0" if it is meaningful.

s1	s2	d	V
Positive	Positive	Positive	0
Positive	Positive	Negative	1
Positive	Negative	Positive/Negative	0
Negative	Positive	Negative/Positive	0
Negative	Negative	Positive	1
Negative	Negative	Negative	0



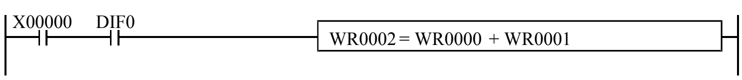
$V = s1m \cdot s2m \cdot \overline{dm} + \overline{s1m} \cdot \overline{s2m} \cdot dm$

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD    X00000
AND   DIF0
[
WR0002 = WR0000 + WR0001
]
```

Program description

- The sum of WR0000 and WR0001values is substituted into WR0002 at the leading edge of input X00000.

Item number	Arithmetic instructions-3	Name	BCD addition (BCD ADDITION)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 B+ s2	DER	ERR	SD	V	C	115	—	Upper case: W Lower case: DW
	↕	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
d = s1 B+ s2	Word			4		177	—	
	Double word			6				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination						○	○	○		○	○		
s1	Augend					○	○	○	○	○	○	○	○	
s2	Addend					○	○	○	○	○	○	○	○	

Function

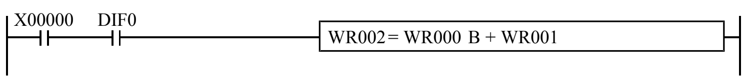
- Adds s1 and s2 as the BCD data, and stores the result in d as the BCD data.
- The C flag is set to "1" if there is a digit increase, and "0" if not.
- The DER flag is set to "1" if the operation result s1 and s2 are invalid as the BCD data. If so, operation is not performed and the C flag retains the previous state without outputting to d. If the s1 and s2 are valid as the BCD data, the DER is set to "0."
- When s1, s2 are words: 0000 to 9999 (BCD)
- When s1, s2 are double words: 00000000 to 99999999 (BCD)

Notes

- The combinations of d, s1 and s2 are as follows.

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD      X00000
AND     DIF0
[
WR002 = WR000 B+ WR001
]
```

Program description

- The sum of WR000 and WR001 values is substituted into WR002 as the BCD data at the leading edge of input X00000.

Item number	Arithmetic instructions-4	Name	Binary subtraction (BINARY SUBTRACTION)

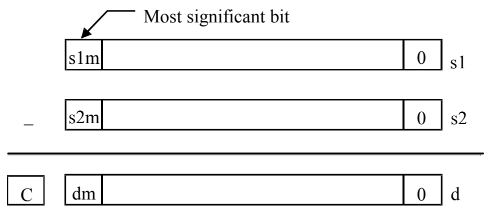
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 – s2	DER	ERR	SD	V	C	41	—	Upper case: W Lower case: DW
	●	●	●	↕	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
d = s1 – s2	Word			4		58	—	
	Double word			6				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination						○	○	○		○	○		
s1	Minuend					○	○	○	○	○	○	○	○	
s2	Subtrahend					○	○	○	○	○	○	○	○	

Function

- Subtracts s2 from s1 as the binary data, and substitutes the result into d as the binary data.
- The C flag is set to “1” if there is a digit decrease, and “0” if not.
  $C = \overline{s1m} \cdot s2m + \overline{s1m} \cdot dm + s2m \cdot dm$
- The V flag is set to “1” if the operation result is a meaningless signed-binary data, and “0” if it has meaning.

s1	s2	d	V
Positive	Positive	Positive/Negative	0
Negative	Negative	Positive/Negative	0
Positive	Negative	Positive	0
Positive	Negative	Negative	1
Negative	Positive	Positive	1
Negative	Positive	Negative	0



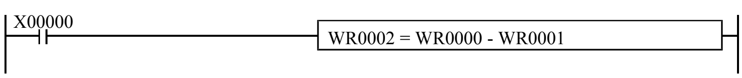
$V = \overline{s1m} \cdot s2m \cdot dm + s1m \cdot \overline{s2m} \cdot \overline{dm}$

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD  X00000
[
WR0002 = WR0000 - WR0001
]
```

Program description

- When input X00000 is on, the difference between WR0000 value and WR0001 value is substituted into WR0002.

Item number	Arithmetic instructions-5	Name	BCD subtraction (BCD SUBTRACTION)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 B– s2	DER	ERR	SD	V	C	104	—	Upper case: W Lower case: DW
	↕	●	●	●	↕			

Instruction format	Number of steps				
	Condition	Steps			
d = s1 B– s2	Word	4	163	—	
	Double word	6			

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, WDT, MS, TMR, CU, RCU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination						○	○	○		○	○		
s1	Minuend					○	○	○	○	○	○	○	○	
s2	Subtrahend					○	○	○	○	○	○	○	○	

Function

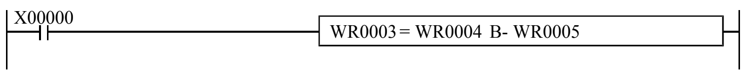
- Subtracts s2 from s1 as the BCD data, and substitutes the result into d as the BCD data.
- The C flag is set to "1" if there is a digit decrease, and "0" if not.
- The DER flag is set to "1" if s1 or s2 is not a valid BCD data. If so, operation is not performed and the C flag retains the previous state without outputting to d. If the s1 and s2 are valid BCD data, the DER is set to "0."

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00000
[
WR0003 = WR0004 B- WR0005
]
```

Program description

- When input X00000 is on, the difference between WR0004 value and WR0005 value is substituted into WR0003 as BCD data.

Item number	Arithmetic instructions-6	Name	Binary multiplication (BINARY MULTIPLICATION)

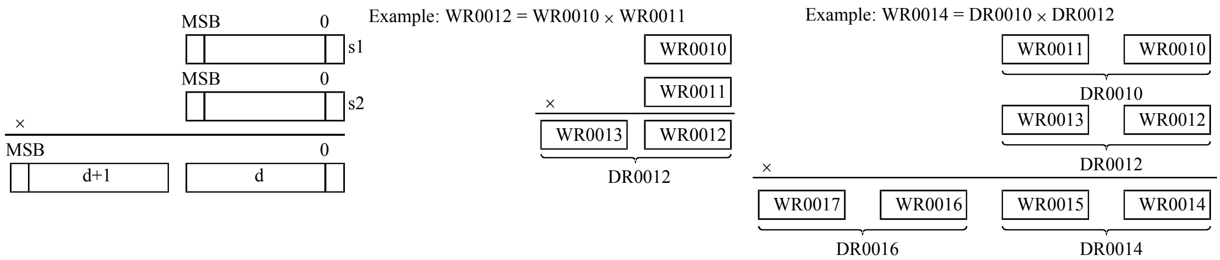
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 × s2	DER	ERR	SD	V	C	43	—	Upper case: W Lower case: DW
	↕	●	●	●	●			

Instruction format	Number of steps		Processing time (μs) Average	Processing time (μs) Maximum
	Condition	Steps		
d = s1 × s2	Word	4	112	—
	Double word	6		

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination						○	○	○		○	○		
s1	Multiplicand					○	○	○	○	○	○	○	○	
s2	Multiplier					○	○	○	○	○	○	○	○	

Function

- Multiplies s1 and s2 as the binary data, and substitutes the result into d+1 (upper digit) and d (lower digit) in binary.
- The DER flag is set to "1" if d+1 exceeds the usable I/O range (in this case only the lower word is substituted), and "0" when it does not exceed.



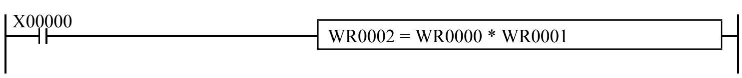
Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

- Since the operation results are always substituted into d and d + 1, note that the word or double-word at d + 1 is not used as the I/O of others.

Program example




```
LD   X00000
[
WR0002 = WR0000 * WR0001
]
```

Program description

- When input X00000 is on, the product of WR0000 value and WR0001 value is substituted into WR0002.

d = s1 x s2

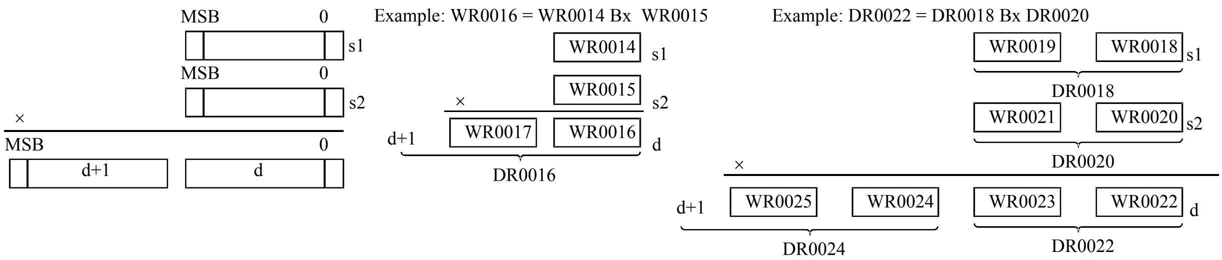
Item number	Arithmetic instructions-7	Name	BCD multiplication (BCD MULTIPLICATION)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 B× s2	DER	ERR	SD	V	C	164	—	Upper case: W Lower case: DW
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
d = s1 B× s2	Word			4		447	—	
	Double word			6				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination						○	○	○		○	○		
s1	Multiplicand					○	○	○	○	○	○	○	○	
s2	Multiplier					○	○	○	○	○	○	○	○	

Function

- Multiplies s1 and s2 as the BCD data, and substitutes the result into d+1 (upper digit) and d (lower digit) as the BCD data.
- The DER flag is set to “1” if s1 or s2 is an invalid BCD data. In this case, the operation is not performed. Also, if d+1 exceeds the usable I/O range, the DER flag is set to “1” and only the lower digit word is substituted. The DER flag is set to “0” if s1 and s2 are valid BCD data and d+1 is within the usable I/O range.



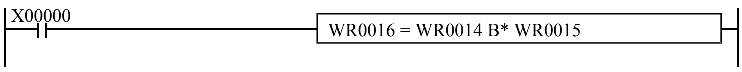
Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

- Since the operation results are always substituted into d and d + 1, note that the word or double-word at d + 1 is not used as the I/O of others.

Program example




```
LD   X00000
[
WR0016 = WR0014 B * WR0015
]
```

Program description

- When input X00000 is on, the product of WR0014 value and WR0015 value is substituted into WR0016 as the BCD data.

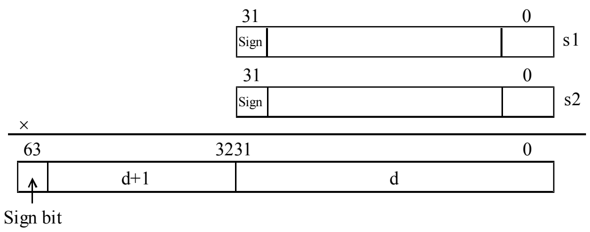
Item number	Arithmetic instructions-8	Name	Signed binary multiplication (SIGNED BINARY MULTIPLICATION)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S× s2	DER	ERR	SD	V	C	143	—	
	↕	●	●	●	●			
Command format	**Number of steps**							
	Condition		Steps					
d = s1 S× s2	Double word		6					

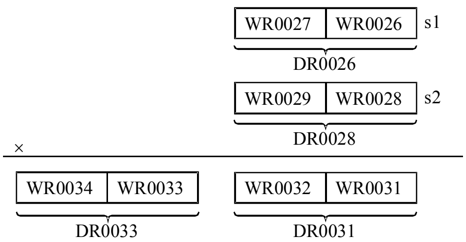
Usable I/O		Bit: X	Bit: Y	Bit: R, L, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination										○	○		
s1	Multiplicand									○	○	○	○	
s2	Multiplier									○	○	○	○	

Function

- Multiplies s1 and s2 as signed binary data, and substitutes the result into d+1 (upper digit) and d (lower digit) as signed binary.
- The DER flag is 1 if d+1 exceeds the usable I/O range (in this case only the lower digit word is substituted), and 0 when it does not.



Example) D R0031 = DR0026 S × DR0028



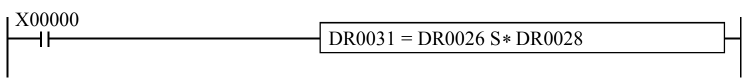
The sign of the operation result is entered in the most significant bit.

- s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

Cautionary notes

- The operation result is always assigned to d and d+1. Be sure not to use word or double word d+1 as the I/O of other functions.

Program example




```
LD      X00000
[
DR0031 = DR0026 S∗DR0028
]
```

Program description

- When input X00000 turns on, the product of the values in DR0026 and DR0028 is substituted into DR0031 as signed binary data.

Item number	Arithmetic instructions-9	Name	Binary division (BINARY DIVISION)

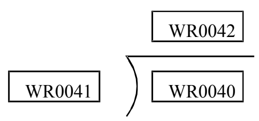
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 / s2	DER	ERR	SD	V	C	55	—	Upper case: W Lower case: DW
	↕	●	●	●	●			
Instruction format	Number of steps							
d = s1 / s2	Condition			Steps		110	—	
	Word			4				
	Double word			6				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination						○	○	○		○	○		
s1	Dividend					○	○	○	○	○	○	○	○	
s2	Divisor					○	○	○	○	○	○	○	○	

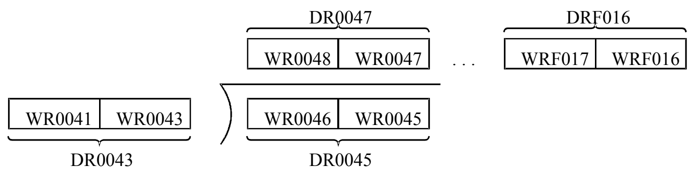
Function

- Divides s1 by s2 as the binary data and substitutes the quotient into d in binary. The remainder is set in the special internal output WRF016 (DRF016 in the case of double word).
- The DER flag is set to "1" if s2 is "0," and the operation is not performed. As long as s2 is not set to "0", the flag is set to "0" and the operation is performed.

Example: WR0042 = WR0040/WR0041



Example: DR0047 = DR0045/DR0043

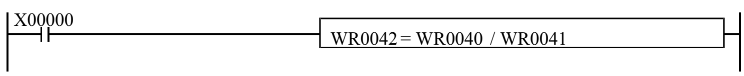


Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00000
[
WR0042 = WR0040 / WR0041
]
```

Program description

- When input X00000 is on, the value of WR0040 is divided by the value of WR0041, then substituted into WR0042. The remainder is substituted into special internal output WRF016.

Item number	Arithmetic instructions-10	Name	BCD division

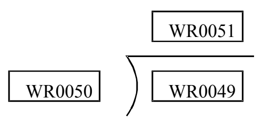
Ladder format	Condition code					Processing time (μs)		Remark
d = s1 B/ s2	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case: W Lower case: DW
	DER	ERR	SD	V	C	152	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
d = s1 B/ s2	Condition			Steps		253	—	
	Words			4				
	Double word			6				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination						○	○	○		○	○		
s1	Dividend					○	○	○	○	○	○	○	○	
s2	Divisor					○	○	○	○	○	○	○	○	

Function

- Divides s1 by s2 as the BCD data, and substitutes the quotient into d in the BCD data. The remainder is set in the special internal output WRF016 (DRF016 in the case of double word).
- The DER flag is set to "1" if s1 or s2 is an invalid BCD data or when s2 is set to "0". In this case the operation is not performed. If both s1 and s2 are valid BCD data and s2 is not set to "0," the operation is performed.

Example: WR0051 = WR0049 B/ WR0050



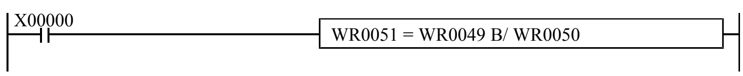
- When s1, s2 are words: 0000 to 9999 (BCD)
- When s1, s2 are double words: 00000000 to 99999999 (BCD)

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00000
[
WR0051 = WR0049 B/ WR0050
]
```

Program description

- When input X00000 is on, the value of WR0049 is divided by the value of WR0050, then substituted into WR0051 as the BCD data.
  The reminder is substituted into WRF016 as the BCD data.

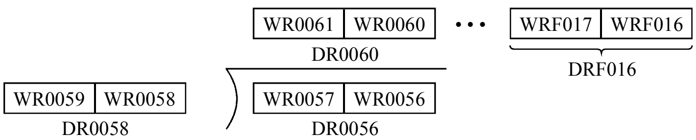
Item number	Arithmetic instructions-11			Name	Signed binary division			
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S/ s2	DER	ERR	SD	V	C	101	—	
	↕	●	●	↕	●			
Command format	Number of steps							
	Condition		Steps					
d = s1 S/ s2	Double word		6					

Usable I/O		Bit: X	Bit: Y	Bit: R, L, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination										○	○		
s1	Dividend									○	○	○	○	
s2	Divisor									○	○	○	○	

Function

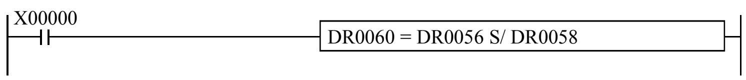
- Divides s1 by s2 as signed binary data, and substitutes the quotient into d in signed binary data. The remainder is set in the special internal output DRF016 signed binary data.
- The DER flag is 1 if s2 is 0, and the operation is not performed. As long as s2 is not 0, it is 0 and the operation is performed.
- The V flag is 1 when the quotient is a positive value and exceeds H7FFFFFFF. Otherwise, it is 0.

Eexample) DR0060 = DR0056 S/ DR0058



- s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

Program example




```
LD   X00000
[
DR0060 = DR0056 S/ DR0058
]
```

Program description

- When input X00000 turns on, the value of DR0056 is divided by the value in DR0058, then substituted into DR0060 as signed binary data. The remainder is substituted into special internal output DRF016 as signed binary data.

Item number	Arithmetic instructions-12	Name	Logical OR

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 OR s2	DER	ERR	SD	V	C	62	—	Upper case: B Middle case: W Lower case: DW
	●	●	●	●	●			
Instruction format	**Number of steps**					33	—	
	Condition		Steps					
d = s1 OR s2	Bit, word		4			86	—	
	Double word		6					

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○			○	○	○		○	○		
s1	Comparand	○	○	○		○	○	○	○	○	○	○	○	
s2	Relational number	○	○	○		○	○	○	○	○	○	○	○	

Function

- Obtains OR of s1 and s2, and substitutes the result into d.

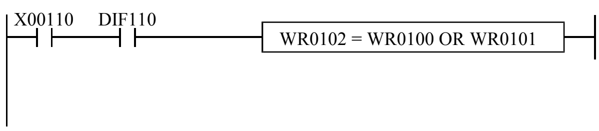
s1	s2	d
0	0	0
0	1	1
1	0	1
1	1	1

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Bit	Bit
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00110
AND  DIF110
[
WR0102=WR0100 OR WR0101
]
```

Program description

- At the leading edge of X00110, the OR of WR0100 and WR0101 is set in WR0102.

WR0100 = H1234	When ⇨	WR0100 = 0001001000110100
WR0101 = H5678		WR0101 = 0101011001111000
WR0102 = H567C		WR0102 = 0101011001111100

Item number	Arithmetic instructions-13	Name	Logical AND

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 AND s2	DER	ERR	SD	V	C	46	—	Upper case: B
	●	●	●	●	●			Middle case: W
Instruction format	**Number of steps**					36	—	Lower case: DW
	Condition			Steps				
d = s1 AND s2	Bit, word			4		49	—	
	Double word			6				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○			○	○	○		○	○		
s1	Comparand	○	○	○		○	○	○	○	○	○	○	○	
s2	Relational number	○	○	○		○	○	○	○	○	○	○	○	

Function

- Obtains AND of s1 and s2, and substitutes the result into d.

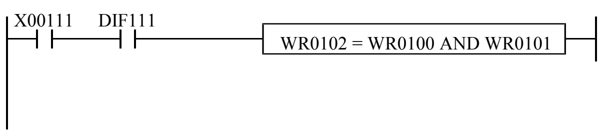
s1	s2	d
0	0	0
0	1	0
1	0	0
1	1	1

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Bit	Bit
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00111
AND  DIF111
[
WR0102=WR0100 AND WR0101
]
```

Program description

- At the leading edge of X00111, the AND of WR0100 and WR0101 is set in WR0102.

WR0100 = H1234
WR0101 = H5678
WR0102 = H1230

When ⇨

WR0100 = 0001001000110100
WR0101 = 0101011001111000
WR0102 = 0001001000110000

Item number	Arithmetic instructions-14	Name	Exclusive OR

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 XOR s2	DER	ERR	SD	V	C	42	—	Upper case: B
	●	●	●	●	●			Middle case: W
Instruction format	**Number of steps**					33	—	Lower case: DW
	Condition		Steps					
d = s1 XOR s2	Bit, word		4			66	—	
	Double word		6					

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination		○	○			○	○	○		○	○		
s1	Comparand	○	○	○		○	○	○	○	○	○	○	○	
s2	Relational number	○	○	○		○	○	○	○	○	○	○	○	

Function

- Obtains exclusive OR (XOR) of s1 and s2, and substitutes the result into d.

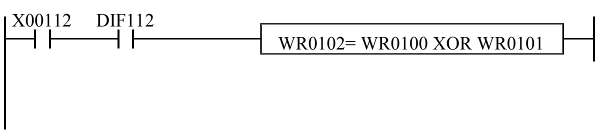
s1	s2	d
0	0	0
0	1	1
1	0	1
1	1	0

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Bit	Bit
Word	Word	Word
Double word	Double word	Double word

Program example




```
LD   X00112
AND  DIF112
[
WR0102=WR0100 XOR WR0101
]
```

Program description

- At the leading edge of X00112, the XOR of WR0100 and WR0101 is set in WR0102.

```
WR0100 = H1234              WR0100 = 0001001000110100
WR0101 = H5678    When ⇨    WR0101 = 0101011001111000
WR0102 = H444C              WR0102 = 0100010001001100
```

Item number	Arithmetic instructions-15	Name	= Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 == s2	DER	ERR	SD	V	C	60	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
d = s1 == s2	s is a word			4		48	—	
	s is a double word			6				

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	Substitution destination		○	○										
s1	Comparand					○	○	○	○	○	○	○	○	
s2	Relational number					○	○	○	○	○	○	○	○	

Function

- Substitutes "1" when s1 is equal to s2 and otherwise "0" into d, assuming s1 and s2 as binary data.

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Word	Word
Bit	Double word	Double word

Program example

M0000 = WX0000 = = WX0001

[
M0000 = WX0000 = = WX0001
]

Program description

- When WX0000 = WX0001, M0000 is set to "1." Otherwise, M0000 is reset to "0."

Item number	Arithmetic instructions-16	Name	Signed = Relational expression

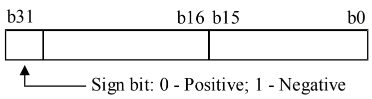
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S== s2	DER	ERR	SD	V	C	108	—	
	●	●	●	●	●			
Command format	**Number of steps**							
	Condition			Steps				
d = s1 S== s2	s is a double word			6				

Usable I/O		Bit: X	Bit: Y	Bit: R, L, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination		○	○										
s1	Comparand									○	○	○	○	
s2	Relational number									○	○	○	○	

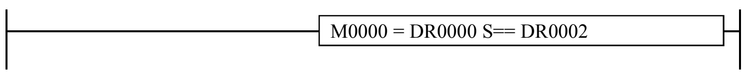
Function

- Substitutes 1 when s1 is equal to s2 and otherwise 0 into d, assuming s1 and s2 as signed binary data.
- s1 and s2 are both signed binary data. When the most significant bit is 0, the value is positive; when the most significant bit is 1, the value is negative.

  s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)



Program example



[
M0000 = DR0000 S== DR0002
]

Program description

- When the values of DR0000 and DR0002 are equal, 1 is set in M0000. Otherwise, M0000 is reset to 0.

d = s1 S== s2

d = s1 <> s2

Item number	Arithmetic instructions-17	Name	<> Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
d = s1 <> s2	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	60	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
d = s1 <> s2	Condition			Steps		46	—	
	s is a word			4				
	s is a double Word			6				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Substitution destination		○	○										
s1	Comparand					○	○	○	○	○	○	○	○	
s2	Relational number					○	○	○	○	○	○	○	○	

Function

- Substitutes 1 when s1 is not equal to s2 and otherwise 0 into d, assuming s1 and s2 as binary data.

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Word	Word
Bit	Double word	Double word

Program example

Y00000= WR0000 < > WR0001

[
Y00000= WR0000 < > WR0001
]

Program description

- When WR0000 ≠ WR0001, "1" is set in Y00000. Otherwise, Y00000 is reset to "0."

Item number	Arithmetic instructions-18	Name	Signed <> Relational expression

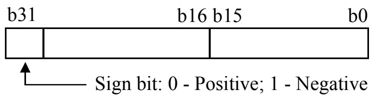
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S<> s2	DER	ERR	SD	V	C	48	—	
	●	●	●	●	●			

Command format	Number of steps	
	Condition	Steps
d = s1 S<> s2	s is a double word	6

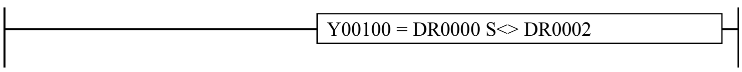
Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, L, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○										
s1	Comparand									○	○	○	○	
s2	Relational number									○	○	○	○	

Function

- Substitutes 1 when s1 is not equal to s2 and otherwise 0 into d, assuming s1 and s2 as signed binary data.
- s1 and s2 are both signed binary data. When the most significant bit is 0, the value is positive; when the most significant bit is 1, the value is negative.
  s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)



Program example



[
Y00100 = DR0000 S<> DR0002
]

Program description

- When the values of DR0000 and DR0002 are not equal, Y00100 is turned on. Otherwise, Y00100 is turned off.

Item number	Arithmetic instructions-19	Name	< Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 < s2	DER	ERR	SD	V	C	40	—	Upper case: W Lower case: DW
	●	●	●	●	●			

Instruction format	Number of steps		Processing time (μs) Average	Maximum
	Condition	Steps		
d = s1 < s2	s is a word	4	70	—
	s is a double word	6		

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○										
s1	Comparand					○	○	○	○	○	○	○	○	
s2	Relational number					○	○	○	○	○	○	○	○	

Function

- Substitutes "1" when s1 is less than s2 and otherwise "0" into d, assuming s1 and s2 as binary data.

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Word	Word
Bit	Double word	Double word

Program example

```
|----[ R0 = TC100 < TC101 ]----|
```

[
R0 = TC100 < TC101
]

Program description

- When TC100 < TC101, R0 is set to "1." Otherwise, R0 is reset to "0."
  (TC n is the progress value of the no. n timer or counter.)

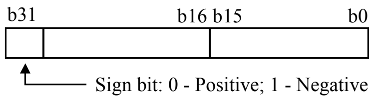
Item number	Arithmetic instructions-20	Name	Signed < Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S< s2	DER	ERR	SD	V	C	50	—	
	●	●	●	●	●			
Command format	**Number of steps**							
	Condition			Steps				
d = s1 S< s2	s is a double word			6				

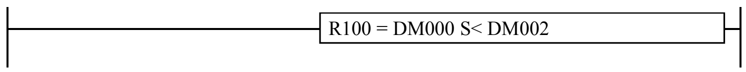
Usable I/O		Bit X	Bit Y	Bit R, L, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	Substitution destination		○	○										
s1	Comparand									○	○	○	○	
s2	Relational number									○	○	○	○	

Function

- Substitutes 1 when s1 is less than s2 and otherwise 0 into d, assuming s1 and s2 as signed binary data.
- s1 and s2 are both signed binary data. When the most significant bit is 0, the value is positive; when the most significant bit is 1, the value is negative.
  s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)



Program example



[
R100 = DM000 S< DM002
]

Program description

- When the value in DM000 is less than the value in DM002, 1 is set in R100. Otherwise, R100 is reset to 0.

d = s1 <= s2

Item number	Arithmetic instructions-21	Name	≤ Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 <= s2	DER	ERR	SD	V	C	40	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps		71	—	
d = s1 <= s2	s is a word			4				
	s is a double word			6				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○										
s1	Comparand					○	○	○	○	○	○	○	○	
s2	Relational number					○	○	○	○	○	○	○	○	

Function

- Substitutes “1” when s1 is less than or equal to s2 and otherwise “0” into d, assuming s1 and s2 as binary data.

Notes

- The combinations of d, s1 and s2 are as follows:

d	s1	s2
Bit	Word	Word
Bit	Double word	Double word

Program example

Y00001 = WR10 <= WR100

[
Y00001 = WR10 <= WR100
]

Program description

- When WR10 ≦ WR100, Y00001 is set to “1.” Otherwise, Y00001 is reset to “0.”

Item number	Arithmetic instructions-22	Name	Signed ≤ Relational expression

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
d = s1 S<= s2	DER	ERR	SD	V	C	50	—	
	●	●	●	●	●			

Command format	Number of steps	
	Condition	Steps
d = s1 S<= s2	s is a double word	6

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, L, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Substitution destination		○	○										
s1	Comparand									○	○	○	○	
s2	Relational number									○	○	○	○	

Function

- Substitutes 1 when s1 is less than or equal to s2 and otherwise 0 into d, assuming s1 and s2 as signed binary data.
- s1 and s2 are both signed binary data. When the most significant bit is 0, the value is positive; when the most significant bit is 1, the value is negative.

  s1, s2 – 2147483648 to +2147483647 (decimal)
  H80000000 to H7FFFFFFF (hexadecimal)

b31 b16 b15 b0

Sign bit: 0 - Positive; 1 - Negative

Program example

```
|----------------[ Y00100 = DR10 S<= DR100 ]-|
```

[
Y00100 = DR10 S<= DR100
]

Program description

- When the value in DR10 is less than or equal the value in DR100, Y00100 is turned on. Otherwise, Y00100 is turned off.

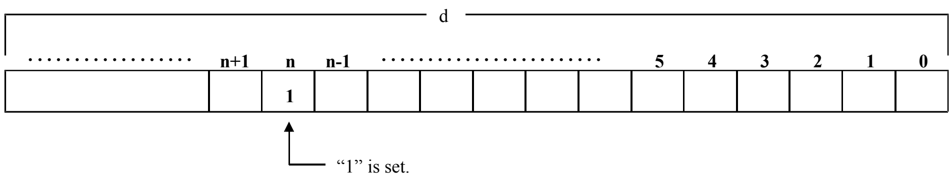
Item number	Application instructions-1	Name	Bit set

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BSET (d, n)	DER	ERR	SD	V	C	26	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps				
BSET (d, n)				3		35	—	

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to be set the bit						○	○	○		○	○		
n	Bit location to be set					○	○	○	○				○	The constant is set in decimal.

Function

- Sets the nth bit in the I/O (word or double word) specified by d to "1."
- Other bit contents are unaltered.



If d is a word: Designates the bit location depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the bit location depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

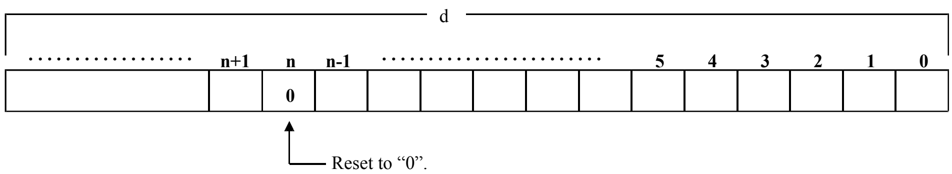
Item number	Application instructions-2	Name	Bit reset

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BRES (d, n)	DER	ERR	SD	V	C	29	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps				
BRES (d, n)				3		38	—	

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to be set the bit						○	○	○		○	○		
n	Bit location to be reset					○	○	○	○				○	The constant is set in decimal.

Function

- Sets the nth bit in the I/O (word or double word) specified by d to "0."
- Other bit contents are unaltered.



If d is a word: Designates the bit location depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the bit location depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

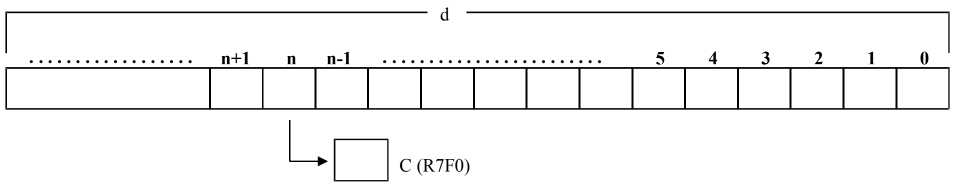
Item number	Application instructions-3	Name	Bit test

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BTS (d, n)	DER	ERR	SD	V	C	31	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
BTS (d, n)				3		38	—	

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	I/O to be tested						○	○	○		○	○		
n	Bit location to be tested					○	○	○	○				○	The constant is set in decimal.

Function

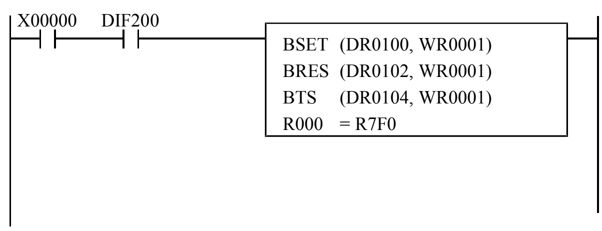
- Checks the contents of the nth bit of the I/O (word or double word) specified by d, and if the result is “1,” '1' is set to C (R7F0). If the result is “0,” C (R7F0) is reset to “0.”
- The contents of d remains unaltered.



If d is a word: Designates the bit location depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as “0.”)
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the bit location depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as “0.”)
The n (constant) can be set to 0 to 31 (decimal).

Program example




```
LD   X00000
AND  DIF200
[
BSET (DR0100, WR0001)
BRES (DR0102, WR0001)
BTS  (DR0104, WR0001)
R000 = R7F0
]
```

Program description

When WR0001 = H1234 at the leading edge of X00000 (WR0001 = $0001001000\underbrace{110100}_{\text{20 (decimal)}}$)

If DR0100 = H00000000, DR0102 = HFFFFFFFF and DR0104 = H5555AAAA are set, the 20th bit of DR0100 is set to “1” by the BSET at the leading edge of X00000.

```
          b31 —— b20 ———————— b0
DR0100=00000000000000000000000000000000
                  ↑
           This bit is set to “1.”
```

Also, the 20th bit of DR0102 is reset to “0” by BRES.

```
          b31 —— b20 ———————— b0
DR0102=11111111111111111111111111111111
                  ↑
           This bit is set to “0.”
```

Also, the 20th bit of DR0104 is checked by BTS.

```
          b31 —— b20 ———————— b0
DR0104=01010101010101011010101010101010
                  ↑
              This bit is checked.
           Since the 20th bit is “1,” C (R7F0) = “1” is set.
```

Item number	Application instructions-4	Name	Shift right

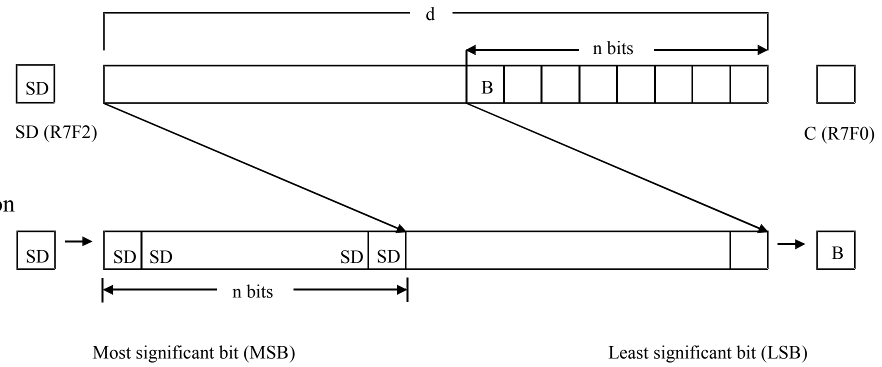
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
SHR (d, n)	DER	ERR	SD	V	C	38	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
SHR (d, n)				3		46	—	

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	I/O to be shifted						○	○	○		○	○		
n	Number of bits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the right (toward the lower digits) by n bits.
- Sets n bits of SD (R7F2) contents starting with the most significant bit.
- Sets the content of the nth bit from the least significant bit in C (R7F0).

Before execution



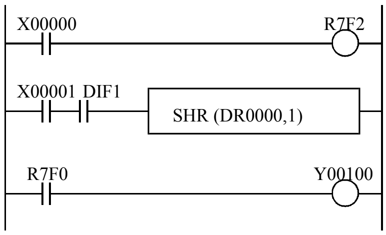
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the shifting is not performed. The previous state is retained in C.

Program example



X00000 ..... Defective unit input To SD

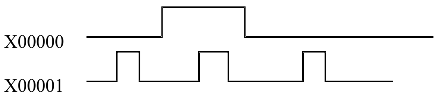
X00001 ..... Conveyor movement

Y00001 ..... Defective unit output Carry

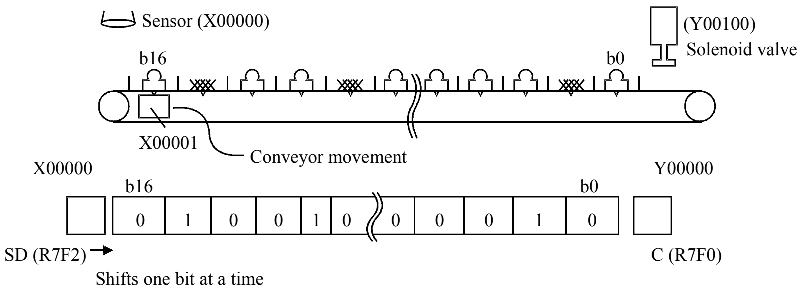
```
LD    X00000
OUT   R7F2
LD    X00001
AND   DIF1
[
SHR   (DR0000,1)
]
LD    R7F0
OUT   Y00100
```

Program description

- There exists a conveyor that has 16 stands and is moving to the right.
- Each time the conveyor moves one stand to the right, a pulse input enters X1.
- There is a sensor on the left end of the conveyor, and when a defective unit is placed on the conveyor, X00000 turns on. X00000 (sensor input) and X00001 (conveyor movement) signals are as follows:



- As the conveyor moves to the right, the data is also shifted one bit at a time, and when data exits to the carry (on the right end of the conveyor), the (Y00100) solenoid valve turns on and rejects the defective unit.



Item number	Application instructions-5	Name	Shift left

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
SHL (d, n)	DER	ERR	SD	V	C	38	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
SHL (d, n)				3		46	—	

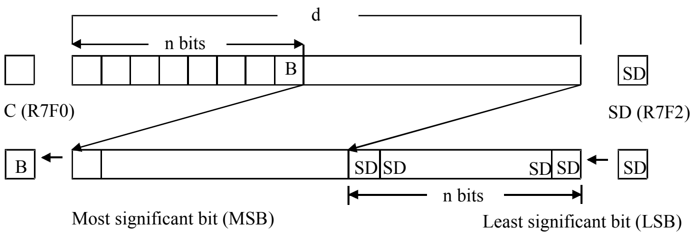
Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	I/O to be shifted						○	○	○		○	○		
n	Number of bits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the left (toward the upper digits) by n bits.
- Sets n bits of SD (R7F2) contents starting with the least significant bit.
- Sets the content of the nth bit from the most significant bit in C (R7F0).

Before execution

After execution



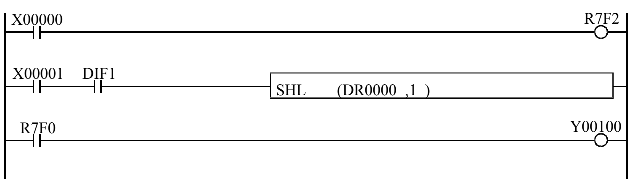
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the shifting is not performed. The previous state is retained in C.

Program example




```
LD    X00000
OUT   R7F2
LD    X00001
AND   DIF1
[
SHL   (DR0000,1)
]
LD    R7F0
OUT   Y00100
```

Program description

- The R7F2 value is determined by the on/off of X00000.
- The content of DR0000 is shifted to the left by one bit when X00001 rises.
  At this time, the value of R7F2 is set in b0 and the value of b31 (b15 of WR1) in R7F0.
- The Y00100 turns on/off depending on the b31 value of DR0000 (b15 of WR1) prior to the shift.

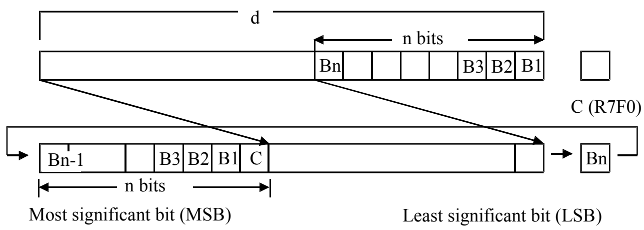
Item number	Application instructions-6	Name	Rotate right

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
ROR (d, n)	DER	ERR	SD	V	C	47	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	Number of steps							
	Condition			Steps				
ROR (d, n)				3		75	—	

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	I/O to be rotated						○	○	○		○	○		
n	Number of bits to be rotated					○	○	○	○				○	The constant is set in decimal.

Function

- Rotates the contents of d to the right (toward the lower digits) by n bits.
- The content of the least significant bit is input to C (R7F0) while the content of C (R7F0) is input to the most significant bit. This is repeated n times.
- The content of C (R7F0) is set in the nth bit from the most significant bit.
- The content of the nth bit from the least significant bit is set in C (R7F0).



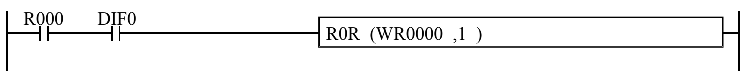
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.") The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.") The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the rotation is not performed. The previous state is retained in C.

Program example




```
LD    R000
AND   DIF0
[
ROR   (WR0000,1)
]
```

Program description

- When R000 rises, WR0000 is shifted to the right by one bit.
  At this time, the value of the least significant bit, b0, is set in R7F0, and the value of R7F0 immediately prior to the shift is set in the most significant bit, b15.

Item number	Application instructions-7	Name	Rotate left

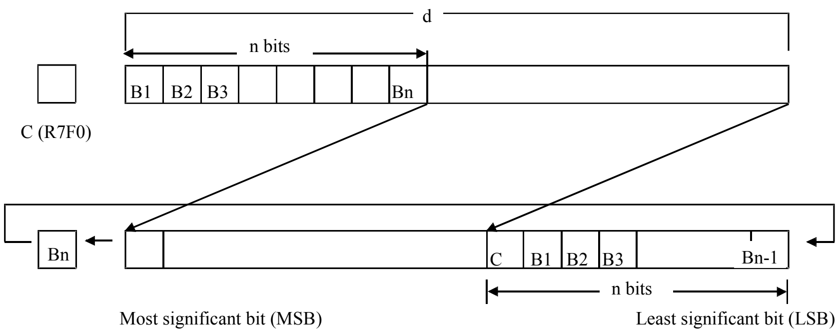
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
ROL (d, n)	DER	ERR	SD	V	C	46	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
ROL (d, n)				3		54	—	

Usable I/O		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM	Constant	Other
		Bit				Word				Double word				
d	I/O to be rotated						○	○	○		○	○		
n	Number of bits to be rotated					○	○	○	○				○	The constant is set in decimal.

Function

- Rotates the contents of d to the left (toward the upper digits) by n bits.
- The content of C (R7F0) is set in the nth bit from the least significant bit.
- The content of the nth bit from the least significant bit is set in C (R7F0).

Before execution



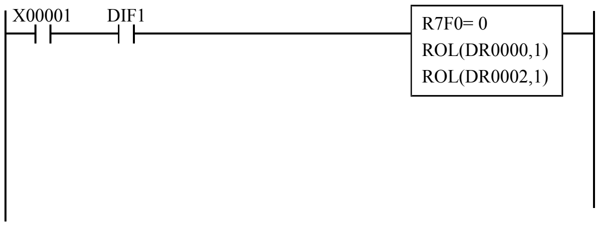
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.") The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.") The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the rotation is not performed. The previous state is retained in C.

Program example

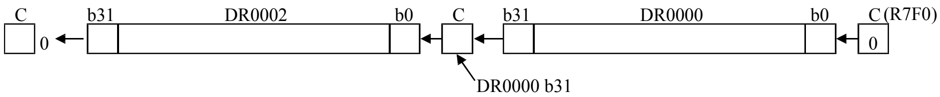



```
LD     X00001
AND    DIF1
[
R7F0   = 0
ROL    (DR0000,1)
ROL    (DR0002,1)
]
```

Program description

- When X00001 rises, the 64-bit data is shifted one bit at a time.
  The space after the shift is filled with "0."

Overall movement



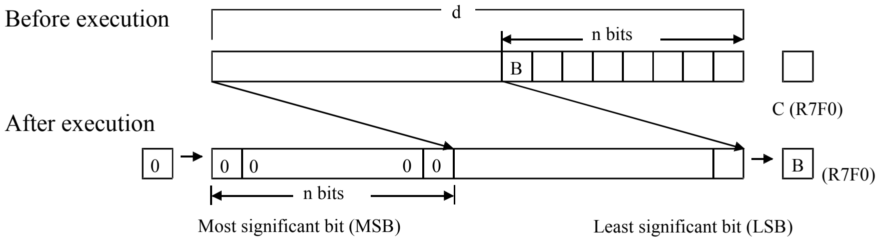
Item number	Application instructions-8	Name	Logical shift right

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
LSR (d, n)	DER	ERR	SD	V	C	36	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
LSR (d, n)				3		45	—	

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	I/O to be shifted						○	○	○		○	○		
n	Number of bits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the right (toward the lower digits) by n bits.
- "0" is set from the most significant bit to the nth bit.
- The content of the nth bit from the least significant bit is set in C (R7F0).



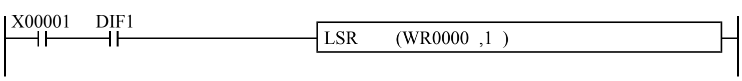
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the shifting is not performed. The previous state is retained in C.

Program example




```
LD    X00001
AND   DIF1
[
LSR   (WR0000 ,1)
]
```

Program description

- When X00001 rises, the content of WR0000 is shifted to the right by one bit.
  At this time, "0" is set in b15 and the value of b0 immediately prior to the shift is set in R7F0.

LSR (d, n)

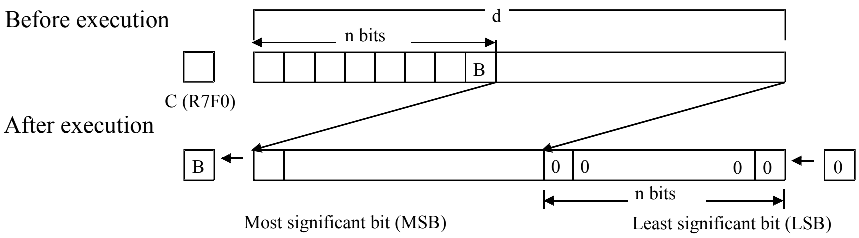
Item number	Application instructions-9	Name	Logical shift left

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
LSL (d, n)	DER	ERR	SD	V	C	36	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
LSL (d, n)				3		45	—	

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to be shifted						○	○	○		○	○		
n	Number of bits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the left (toward the upper digits) by n bits.
- "0" is set from the least significant bit to the nth bit.
- The content of the nth bit from the most significant bit is set in C (R7F0).



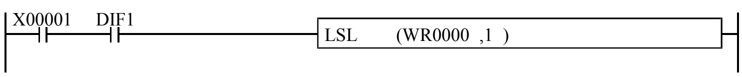
If d is a word: Designates the shift amount, depending on the contents (0 to 15) of the lower 4 bits (b3 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 15 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 31) of the lower 5 bits (b4 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 31 (decimal).

Notes

- If n is equal to "0," the shifting is not performed. The previous state is retained in C.

Program example




```
LD     X00001
AND    DIF1
[
LSL    (WR0000 ,1)
]
```

Program description

- When X00001 rises, the content of WR0000 is shifted to the left by one bit.
  At this time, "0" is set in b0 and the value of b15 immediately prior to the shift is set in R7F0.

LSL (d, n)

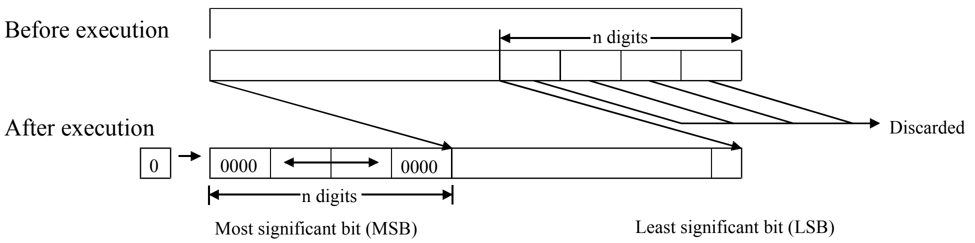
Item number	Application instructions-10	Name	BCD shift right

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BSR (d, n)	DER	ERR	SD	V	C	32	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
BSR (d, n)				3		40	—	

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	I/O to be shifted						○	○	○		○	○		
n	Number of digits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the right (toward the lower digits) by n digits (1 digit is equivalent to 4 bits).
- "0" is set from the most significant bit to the nth digit.
- The digits from least significant bit to the nth digit are discarded.



If d is a word: Designates the shift amount, depending on the contents (0 to 3) of the lower 2 bits (b1, b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 3 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 7) of the lower 3 bits (b2 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as "0.")
The n (constant) can be set to 0 to 7 (decimal).

Notes

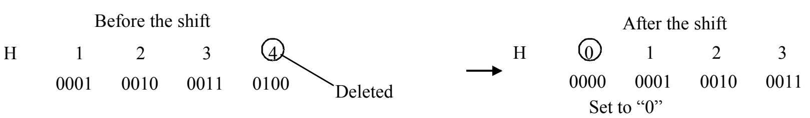
- If n is equal to "0," the shifting is not performed.

Program example


```
LD    X00001
AND   DIF1
[
BSR   (WR0000 ,1)
]
```

Program description

- When X00001 rises, the content of WR0000 is regarded as BCD code and shifted to the right by four bits.
  At this time, the values in the lower 4 bits (b3 to b0) are deleted and "0000" is set in the upper four bits (b12 to b15).



BSR (d, n)

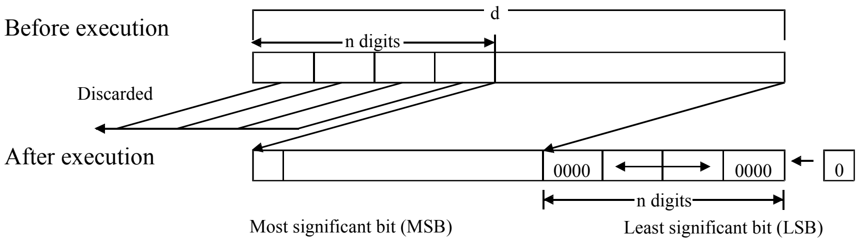
Item number	Application instructions-11	Name	BCD shift left

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BSL (d, n)	DER	ERR	SD	V	C	32	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
BSL (d, n)				3		39	—	

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	I/O to be shifted						○	○	○		○	○		
n	Number of digits to be shifted					○	○	○	○				○	The constant is set in decimal.

Function

- Shifts the contents of d to the left (toward the upper digits) by n digits (one digit is equivalent to 4 bits).
- “0” is set from the least significant bit to the nth digit.
- The digits from the most significant bit to the nth digit are discarded.



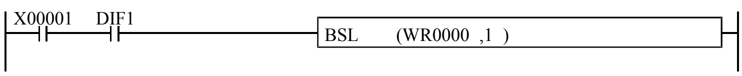
If d is a word: Designates the shift amount, depending on the contents (0 to 3) of the lower 2 bits (b1, b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as “0.”)
The n (constant) can be set to 0 to 3 (decimal).

If d is a double word: Designates the shift amount, depending on the contents (0 to 7) of the lower 3 bits (b2 to b0) of n (WX, WY, WR, WM, TC). (Upper bits are ignored and considered as “0.”)
The n (constant) can be set to 0 to 7 (decimal).

Notes

- If n is equal to “0,” the shifting is not performed.

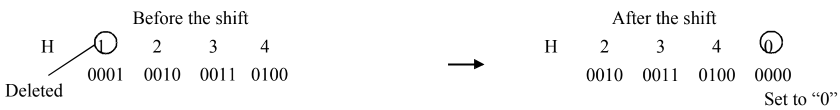
Program example




```
LD    X00001
AND   DIF1
[
BSL   (WR0000 ,1)
]
```

Program description

- When X00001 rises, the content of WR0000 is regarded as BCD code and shifted to the left by four bits.
  At this time, the data of the lower four bits are deleted and “0000” is set in the upper four bits.



BSL (d, n)

Item number	Application instructions-12	Name	Block transfer (MOVE)

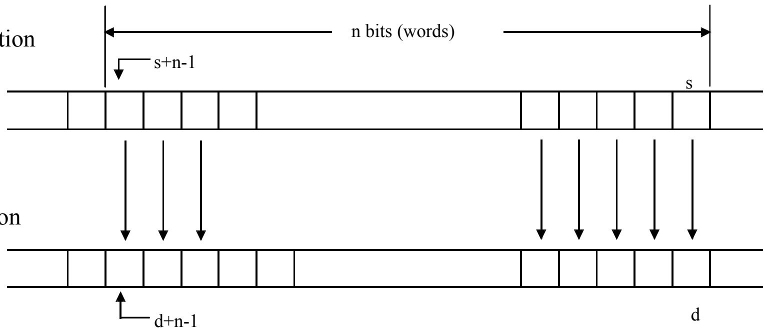
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
MOV (d, s, n)	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
MOV (d, s, n)				4				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Transfer destination head I/O			○				○						
s	Transfer source head I/O			○				○						
n	Number of bits (words) to be transferred					○	○	○	○				○	The constant is set in decimal.

Function

- Transfers n bits (words) between s and s + n – 1 to d + n – 1.
- The values between s and s + n – 1 are retained. However, if the transfer source and transfer destination ranges overlap, the transferred values will be used.

Before execution



After execution

If n is a word: The contents (0 to 255) of the lower 8 bits (b7 to b0) of n (WX, WY, WR, WM, TC) are set to the number of bits (words) to be transferred.

If n is a constant: 0 to 255 (decimal) can be designated for the number of bits (words) to be transferred.

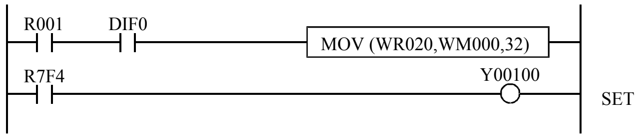
Notes

- Use this instruction so that d + n – 1 and s + n – 1 do not exceed the I/O range (R7BF, M3FFF, WRFFF, and WM3FF). If the I/O range is exceeded, DER is equal to '1' and the transfer is performed to the maximum range.
- If n is equal to “0,” the block transfer is not performed and DER (R7F4) will be set to “0.”

n	Processing time (μs) (Average)	
	Bit	Word
1	153	124
16	165	154
32	166	197
64	175	282
128	199	430
255	226	780

Program example

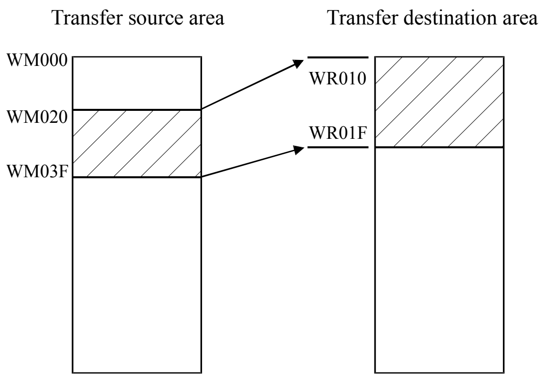
- The data in WM000 to WM01F is transferred to the area WR020 to WR03F.




```
LD    R001
AND   DIF0
[
MOV   (WR020,WM000,32)
]
LD    R7F4
SET   Y00100
```

Program description

- 32 words of data are transferred.



Item number	Application instructions-13	Name	Copy

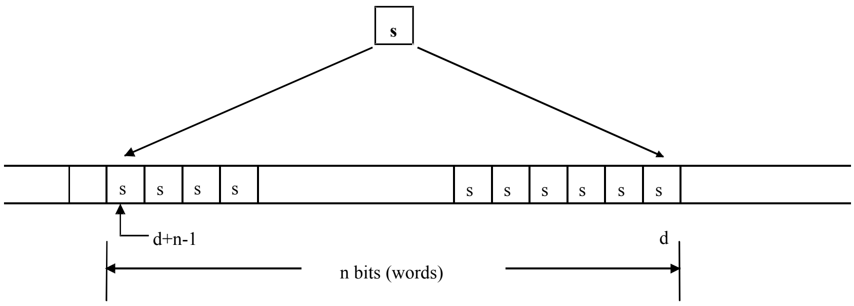
Ladder format	Condition code					Processing time (μs)		Remark
COPY (d, s, n)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
COPY (d, s, n)		4

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Copy destination head I/O			○				○						
s	Copy source head I/O	○	○	○		○	○	○	○				○	
n	Number of bits (words) to be copied					○	○	○	○				○	The constant is set in decimal.

Function

- The value of s (bit, word) is copied from d to d + n - 1.
- The value of s is retained.
- A bit is copied to bits and a word is copied to words.



If n is a word: The contents (0 to 255) of the lower 8 bits (b7 to b0) of n (WX, WY, WR, WM, TC) are set to the number of bits (words) to be copied.

If n is a constant: 0 to 255 (decimal) can be designated for the number of bits (words) to be copied.

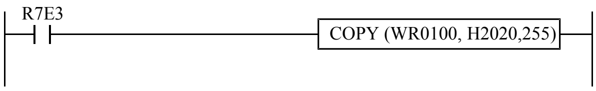
Notes

- Use this instruction so that d + n - 1 does not exceed the I/O range (R7BF, M3FFF, WRFFF, and WM3FF). If it exceeds the I/O range, DER is equal to '1' and transfers to the maximum range.
- If n is equal to “0,” the block copy is not be performed and DER (R7F4) will be set to “0.”

n	Processing time (μs) (Average)	
	Bit	Word
1	80	73
16	83	114
32	83	148
64	88	224
128	95	381
255	109	785

Program example

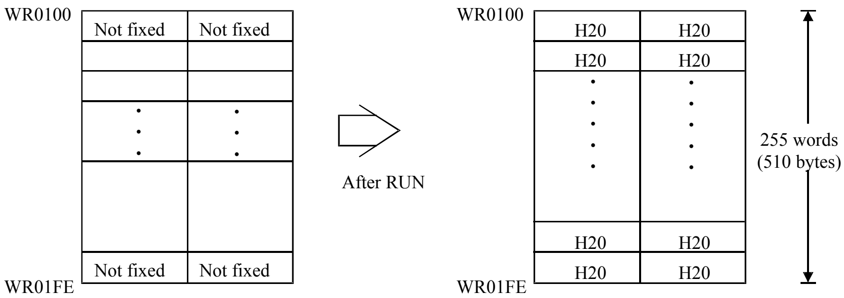
The default value (H2020) is set in the range of WR0100 to WR01FE.




```
LD   R7E3
[
COPY (WR0100, H2020, 255)
]
```

Program description

WR0100 to WR01FE is considered as the communication data area and is filled with space code (H20) as the default value during the first scan after RUN starts.
R7E3: The first scan ON after RUN



Item number	Application instructions-14	Name	Block exchange (EXCHANGE)

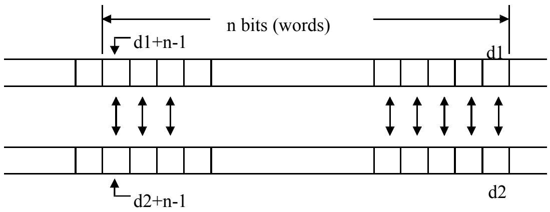
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
XCG (d1, d2, n)	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
XCG (d1, d2, n)		4

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d1	Exchange destination head I/O			○				○						
d2	Exchange source head I/O			○				○						
n	Number of bits (words) to be exchanged					○	○	○	○				○	The constant is set in decimal.

Function

- Exchanges the contents of the n bits from d1 to d1 + n - 1 and the contents between d2 and d2 + n - 1.
- Bits are exchanged with bits and words are exchanged with words.



If n is a word: The contents (0 to 255) of the lower 8 bits (b7 to b0) of n (WX, WY, WR, WM, TC) are set to the number of bits (words) to be exchanged.

If n is a constant: 0 to 255 (decimal) can be designated for the number of bits (words) to be exchanged.

Notes

- Use this instruction so that d1 + n – 1 and d2 + n - 1 do not exceed the I/O range (R7BF, M3FFF, WRFFF, and WM3FF). If they exceeds the I/O range, DER is equal to '1' and the exchange is performed up to the maximum range with respect to the smaller number of bits (words) specified in d1 and d2.
- If n is equal to "0," the block exchange is not performed and DER (R7F4) will be set to "0."

Program example


```
LD      X00001
AND DIF1
[
XCG    (WM000, WM100, 256)
]
```

Program description

- When X00001 rises, the contents of WM000 to WM0FF are exchanged with the contents of WM100 to WM1FF.

n	Processing time (μs) (Average)	
	Bit	Word
1	139	120
16	338	159
32	528	207
64	918	284
128	1899	449
255	3695	779

Item number	Application instructions-15	Name	NOT

Ladder format	Condition code					Processing time (μs)		Remark
NOT (d)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	27	—	Upper case: B
	●	●	●	●	●			
Instruction format	Number of steps					22	—	Middle case: W
	Condition			Steps				
NOT (d)				2		28	—	Lower case: DW

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to be reversed		○	○			○	○			○	○		

Function

- Reverses the contents of d.

Before execution

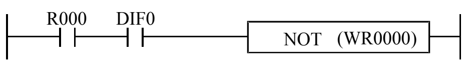
1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1

After execution

Notes

- Use edge trigger as the startup condition for this instruction.

Program example




```
LD   R000
AND  DIF0
[
NOT  WR0000
]
```

Program description

- When R000 rises, the content of WR0000 is reversed.
  Example) If WR0000 is H1234, WR0000 = HEDCB after the instruction is executed;
  WR0000 = H1234 when executed again

NOT (d)

NEG (d)

Item number	Application instructions-16	Name	Two's complement (NEGATE)					
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
NEG (d)	DER	ERR	SD	V	C	22	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps				
NEG (d)				2		29	—	

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to take complement						○	○			○	○		

Function

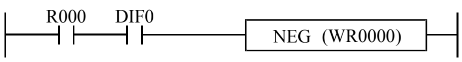
- Calculates two's complements of d (Reverses each bit contained in d and adds "1." However, C (R7F0) remains unchanged).

Before execution	1	1	0	0	1	1	0	0	0	0	0	1	1	0	1	0
	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
	0	0	1	1	0	0	1	1	1	1	1	0	0	1	0	1
+																1
After execution	0	0	1	1	0	0	1	1	1	1	1	0	0	1	1	0

Notes

- Use edge trigger as the startup condition for this instruction.

Program example




```
LD    R000
AND   DIF0
[
NEG   WR0000
]
```

Program description

- When R000 rises, 2's complement of the content of WR0000 is obtained.
  Example) If WR0000 is H1234, WR0000 = HEDCC after the instruction is executed;
  WR0000 = H1234 when executed again

Item number	Application instructions-17	Name	Absolute value

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
ABS (d, s)	DER	ERR	SD	V	C	30	—	Upper case: W Lower case: DW
	●	●	●	●	↕			
Instruction format	**Number of steps**							
	Condition			Steps				
ABS (d, s)	Word			3		4	—	
	Double word			4				

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	I/O after absolute value is taken						○	○			○	○		
s	I/O before absolute value is taken					○	○	○	○	○	○	○	○	

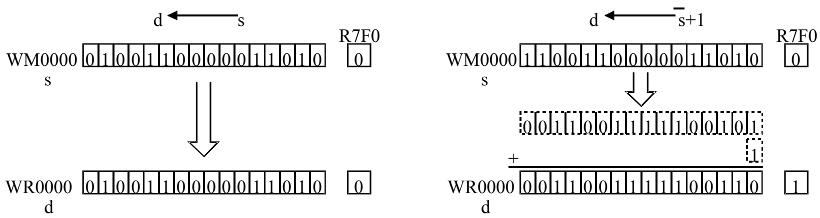
Function

- Given s is signed, set the absolute value of s in d.
- If s is positive or 0: The content of s is set to d. C (R7F0) is set to “0.”
- If s is negative: Two's complements of the contents of s are set in d. C (R7F0) is set to “1.”
- Perform with d and s as both words or both double words.

Example:

(When the value of WM is positive or 0)
WM0000 = H4C1A

(When the value of WM is negative)
WM0000 = HCC1A



- When s is a word: 0 to 32767 (decimal) correspond to H000 to H7FFF (hexadecimal).
  –32768 to –1(decimal) correspond to H8000 to HFFFF (hexadecimal).
- When s is a double word: 0 to 2147483647 (decimal) correspond to H00000000 to H7FFFFFFF (hexadecimal).
  –2147483648 to –1 (decimal) correspond to H80000000 to HFFFFFFFF (hexadecimal).

Notes

- Use edge trigger as the startup condition for this instruction.

Item number	Application instructions-18	Name	Binary → BCD conversion

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BCD (d, s)	DER	ERR	SD	V	C			Upper case: W
	↕	●	●	●	●	79	—	Lower case: DW
Instruction format	**Number of steps**							
	Condition			Steps				
BCD (d, s)	Word			3		89	—	
	Double word			4				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O after conversion (BCD)						○	○			○	○		
s	I/O before conversion (BIN)					○	○	○	○	○	○	○	○	

Function

- The result of the content conversion of s from binary to BCD is output to d.
- If the conversion result of s exceeds the number of BCD data digits in d, DER (R7F4) is set to '1' and the instruction will not be executed.
  If s is a word: set s so that H0000 ≦ s ≦ H270F (0 to 9999).
  If s is a double word: set s so that H00000000 ≦ s ≦ H5F5E0FF (0 to 99999999).

Before execution s

1				B				4				F			
0	0	0	1	1	0	1	1	0	1	0	0	1	1	1	1

(Binary)
1B4FH=6991

After execution d

6				9				9				1			
0	1	1	0	1	0	0	1	1	0	0	1	0	0	0	1

(BCD)

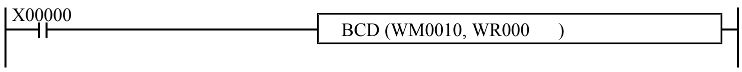
Combinations of d and s.

d	s
Word	Word
Double word	Double word

Notes

- If a data error occurred, the previous contents of d are retained.

Program example




```
LD    X00000
[
BCD   (WM0010, WR000)
]
```

Program description

- When X00000 turns on, the content of WR000 is converted from binary to BCD and output to WM0010.
  WR000 H1B4F
  After conversion
  WM0010 H6691

Item number	Application instructions-19	Name	BCD → Binary conversion

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BIN (d, s)	DER	ERR	SD	V	C	49	—	Upper case: W Lower case: DW
	↕	●	●	●	●			

Instruction format	Number of steps		Processing time (μs)		Remark
	Condition	Steps	Average	Maximum	
BIN (d, s)	Word	3	75	—	
	Double word	4			

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
d	I/O after conversion (BIN)						○	○			○	○		
s	I/O before conversion (BCD)					○	○	○	○	○	○	○	○	

Function

- The result of the content conversion of s from BCD to binary is output to d.
- If the contents of s are not BCD data (if A through F is included in the data), DER (R7F4) is set to '1' and the conversion will not be executed (d remains unchanged).

Before execution s

6				9				9				1				
0	1	1	0	1	0	0	1	1	0	0	1	0	0	0	1	(BCD)

After execution d

1				B				4				F				
0	0	0	1	1	0	1	1	0	1	0	0	1	1	1	1	(Binary)

Combinations of d and s.

d	s
Word	Word
Double word	Double word

Notes

- If a data error occurred, the previous contents of d are retained.

Program example


```
LD X00000
[
BIN (WM0010, WR000)
]
```

Program description

- When X00000 turns on, the content of WR000 is converted from BCD to binary and output.

WR000 H6691

After conversion

WM0010 H1B4F

BIN (d, s)

Item number	Application instructions-20	Name	Decode

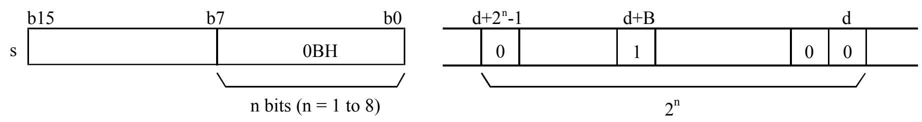
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
DECO (d, s, n)	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
DECO (d, s, n)		4

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Decode destination head I/O			○										
s	Word I/O to be decoded					○	○	○	○				○	
n	Number of bits to be decoded												○	1 to 8 (decimal)

Function

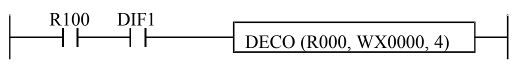
- Decodes the lower n bits of s to 2^n and outputs '1' to the decoded bits in the bit rows between d and $d + 2^n - 1$ (where n = 1 to 8). Note that the value "0" is output for bits other than the decoded bits in the bit row $d + 2^n - 1$.
- If n is "0," the instruction will not be executed, and the contents of d to $d + 2^n - 1$ remain unchanged.



Notes

- Use this instruction so that $d + 2^n - 1$ does not exceed the I/O range (R7BF and M3FFF). If it exceeds the I/O range, DER is equal to '1' and the decoding is performed at the maximum range starting from d.
- Use 1 to 8 for n.

Program example




```
LD    R100
AND   DIF1
[
DECO (R000, WX0000, 4)
]
```

Program description

- When WX0000 = H000F, R00F, which is the 15th bit from R000 among the bits indicated by the lower four bit values of WX0000, is set to "1" upon leading of R100.

n	Processing time (μs)	
	Average	Maximum
1	105	–
2	115	–
3	195	–
4	195	–
5	317	–
6	481	–
7	829	–
8	1586	–

Item number	Application instructions-21	Name	Encode

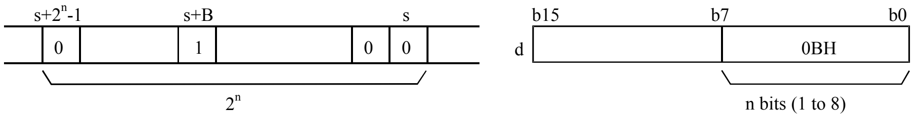
Ladder format	Condition code					Processing time (μs)		Remark
ENCO (d, s, n)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	↕			

Instruction format	Number of steps	
	Condition	Steps
ENCO (d, s, n)		4

Usable I/O		Bit: X	Y	R, M	TD, SS, CU, CT	Word: WX	WY	WR, WM	TC	Double word: DX	DY	DR, DM	Constant	Other
d	Decode destination head I/O						○	○						
s	Word I/O to be encoded			○										
n	Number of bits to be encoded												○	1 to 8 (decimal)

Function

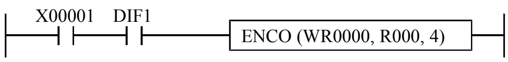
- Encodes the bit location 2^n in the range between s and s + 2^n – 1 where the bit is “1,” and outputs the result to d (n = 1 to 8). Upper bits (16-n) of d are set to “0.”
- If n is “0,” the instruction will not be executed and the contents of d retain the original values.
- If there are more than one bits that are set to “1” between s and s + 2^n – 1, the upper bit location will be encoded.
- If all the bits from s to s + 2^n – 1 are '0', '0' is output to d, and C (R7F0) is equal to '1.' In other cases, C (R7F0) is set to '0.'



Notes

- Use this instruction so that s + 2^n– 1 does not exceed the I/O range (R7BF and M3FFF). If it exceeds the I/O range, DER is set to '1' and the encoding is performed at the maximum range starting from s.
- Use 1 to 8 for n.

Program example




```
LD    X00001
AND   DIF1
[
ENCO (WR0000, R000, 4)
]
```

Program description

- Upon the leading of X00001, the most significant bit that is set to “1” is detected within the row of bits R000 to R00F (2^4 –1 = 15 bits), and a four-bit binary number is set in the word I/O of d.
  Example) If “1” is set in the 7th and 6th bits of R000 to R00F, H0007 is set in WR0000.

n	Processing time (μs)	
	Average	Maximum
1	128	–
2	128	–
3	128	–
4	187	–
5	126	–
6	126	–
7	126	–
8	126	–

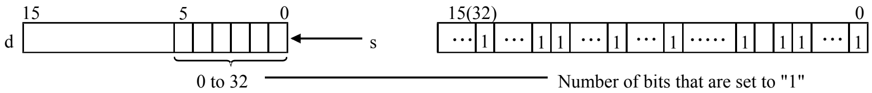
Item number	Application instructions-22	Name	Bit count

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
BCU (d, s)	DER	ERR	SD	V	C	33	—	Upper case: W Lower case: DW
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
BCU (d, s)	Word			3		42	—	
	Double word			4				

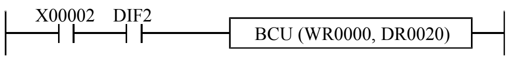
Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Number of bits set to 1						○	○						
s	I/O that counts the bits set to 1					○	○	○	○	○	○	○	○	

Function

- Of the contents of s (16 bits for word and 32 bits for double word), the number of bits that are set to "1" are output to d (0 to 32).



Program example




```
LD     X00002
AND    DIF2
[
BCU    (WR0000, DR0020)
]
```

Program description

- At the leading edge of X00002, the number of bits that are set to "1" among the data input to DR0020 is counted, and set to WR0000.
  Example)

In the case of

```
         ┌─A─┐┌─7─┐┌─1─┐┌─4─┐┌─F─┐┌─1─┐┌─5─┐┌─3─┐
DR0020 = 1010 0111 0001 0100 1111 0001 0101 0011
```

the number of bits set to "1" is 16 (decimal).
Therefore, the result is WR0000 = H0010.

Item number	Application instructions-23	Name	Swap

Ladder format	Condition code					Processing time (μs)		Remark
SWAP (d)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	25	—	
	●	●	●	●	●			
Instruction format	Number of steps							
	Condition			Steps				
SWAP (d)				2				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	I/O to be exchanged						○	○						

Function

- Swaps the upper 8 bits and lower 8 bits contained in d.

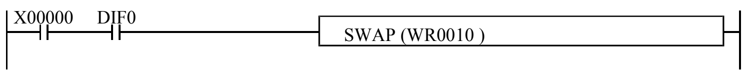
(Before execution) d | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |

(After execution) d | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |

Notes

- Use edge trigger as the startup condition for this instruction.

Program example




```
LD     X00000
AND    DIF0
[
SWAP (WR0010)
]
```

Program description

- The upper and lower bits of WR0010 are swapped at the leading edge of X00000, and are stored in WR0010.
  WR0010 H1234 Before execution
  WR0010 H3412 After execution

Note: Since a scan is executed when there is no leading edge DIF0, the upper and lower bits of WR0010 are swapped every time a scan is executed.

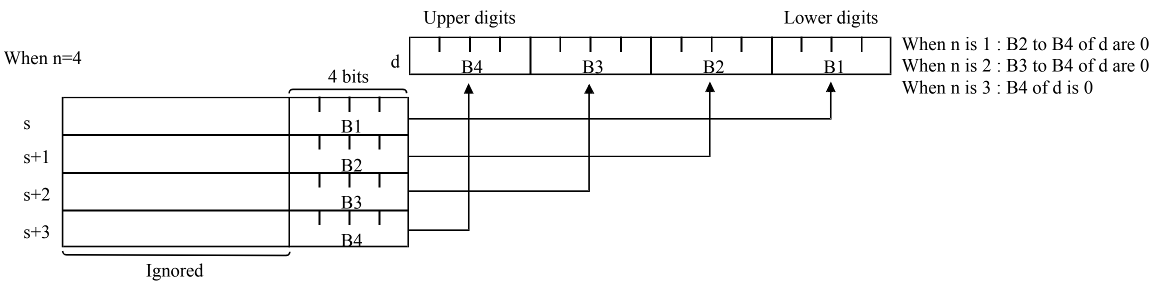
Item number	Application instructions-24	Name	Unit

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
UNIT (d, s, n)	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
UNIT (d, s, n)				4				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
d	Unity result write destination I/O						○	○						
s	Unity destination head I/O							○						
n	Numbers of words to be united												○	n=0 to 4

Function

- Sets the values in the lower four bits of each of the n (1 to 4) words starting from s to the lower four bits of each word in d.
- If n is 1 to 3, the bits not set in d will be "0."
- The data stored in s to s + n – 1 will be retained even if UNIT is executed.
- Use this instruction so that s + n - 1 does not exceed the I/O range (WRFFF and WM3FF). If it exceeds the I/O range, DER is equal to '1' and the lower four bits within the range between s and I/O will be set in d.

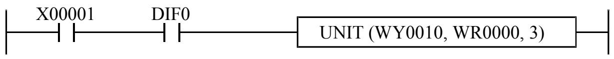


Notes

- When n=0, it is not executed.
- When n>5, it is not executed.

n	Processing time (μs) Average	Maximum
0	75	–
1	100	–
2	103	–
3	106	–
4	109	–

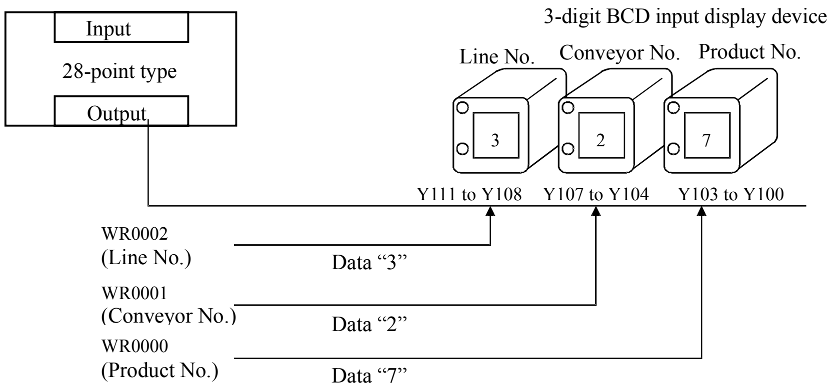
Program example




```
LD     X00001
AND    DIF0
[
UNIT   (WY0010, WR0000, 3)
]
```

Program description

A 3-digit BCD input display device is connected to the WY0010, and each digit displays WR0000 to WR0002 data independently. (Only the lower four bits are considered the valid data for WR0000 to WR0002.)



Item number	Application instructions-25	Name	Distribute

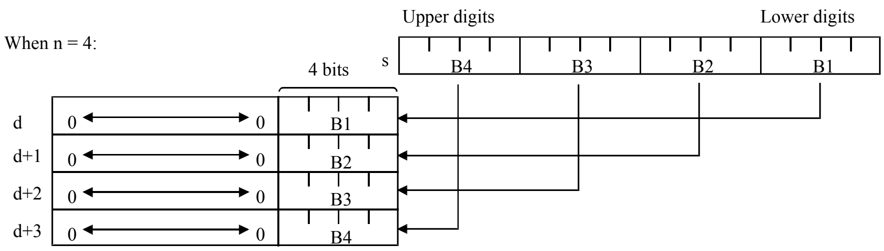
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
DIST (d, s, n)	DER	ERR	SD	V	C	As per the table below.		
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
DIST (d, s, n)		4

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Distribution result write destination head I/O							○						
s	I/O to be distributed					○	○	○	○				○	
n	Number of words to be distributed												○	n=0 to 4

Function

- Distributes s into four bit sections and sets to the lower four bits of the n words starting from d.
- The upper 12 bits of the range d to d + n – 1 will be "0."
- The value of s will be retained even if DIST is executed.
- Use this instruction so that d + n - 1 does not exceed the I/O range (WRFFF and WM3FF). If it exceeds the I/O range, DER is equal to '1' and the distribution data for s will be set in the lower four bits within the range between d and the I/O.

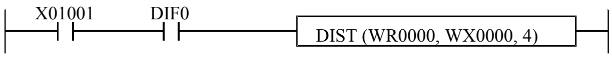


Notes

- When n=0, it is not executed.

n	Processing time (μs)	
	Average	Maximum
0	62	–
1	87	–
2	90	–
3	92	–
4	94	–

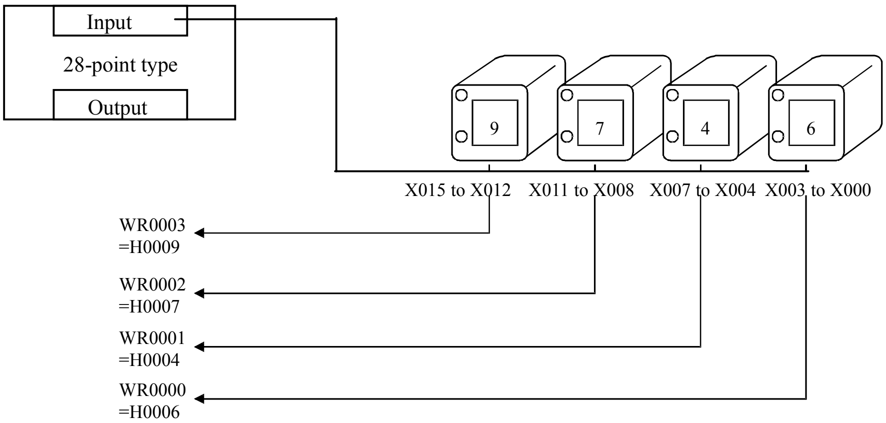
Program example




```
LD      X00001
AND     DIF0
[
DIST    (WR0000, WX0000, 4)
]
```

Program description

A 4-bit 4-digit Digit switch is connected to the WX0000, and the data for each digit is stored in WR0000 to WR0003 as independent data.



Item number	Control instructions-1	Name	Normal scan end

<table>
<tr><th rowspan="2">Ladder format</th><th colspan="5">Condition code</th><th colspan="2">Processing time (μs)</th><th rowspan="2">Remark</th></tr>
<tr><td>R7F4</td><td>R7F3</td><td>R7F2</td><td>R7F1</td><td>R7F0</td><td>Average</td><td>Maximum</td></tr>
<tr><td rowspan="2">END</td><td>DER</td><td>ERR</td><td>SD</td><td>V</td><td>C</td><td rowspan="5">714</td><td rowspan="5">—</td><td rowspan="5"></td></tr>
<tr><td>●</td><td>●</td><td>●</td><td>●</td><td>●</td></tr>
<tr><th>Instruction format</th><th colspan="5">Number of steps</th></tr>
<tr><td rowspan="2">END</td><th colspan="3">Condition</th><th colspan="2">Steps</th></tr>
<tr><td colspan="3"></td><td colspan="2">1</td></tr>
</table>

<table>
<tr><th rowspan="2" colspan="2">Usable I/O</th><th colspan="4">Bit</th><th colspan="4">Word</th><th colspan="3">Double word</th><th rowspan="2">Constant</th><th rowspan="2">Other</th></tr>
<tr><td>X</td><td>Y</td><td>R, M</td><td>TD, SS, CU, CT</td><td>WX</td><td>WY</td><td>WR, WM</td><td>TC</td><td>DX</td><td>DY</td><td>DR, DM</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Function

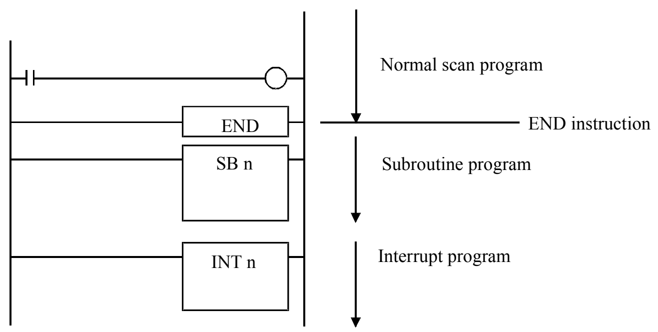
- Indicates the end of a normal scan program. (The execution of this instruction returns to the beginning of the program, and a normal scan is executed.)
- This instruction is not required when there are no subroutine programs or interrupt scan programs.
- If there is a subroutine program or interrupting program, write this instruction at the end of the normal scan program.
- This instruction is used only once in a program. Do not use any startup conditions with this instruction.

Notes

- The END instruction is checked prior to the execution, and if there is an error, the following error codes are set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0010	There is no END instruction.
		H0022	There are two or more END instructions.
		H0032	A startup condition is used with the END instruction.

Instruction for use



Item number	Control instructions-2	Name	Scan conditional end

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	Upper case : Conditions do not meet Lower case : Conditions meet
CEND (s)	DER	ERR	SD	V	C			
	●	●	●	●	●	5	—	
Instruction format	**Number of steps**							
	Condition			Steps				
CEND (s)				2		707	—	

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Scan end condition	○	○	○										

Function

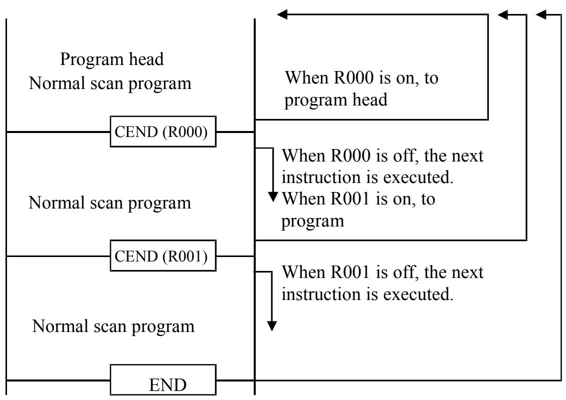
- If the scan end condition (s) is on, the execution of this instruction returns to the head of the scan program and executes the program.
- If (s) is off, the next instruction is executed.
- This instruction can only be used in normal scan programs, and can be used as many times as desired.
- This instruction can specify a startup condition. In this case, if the startup condition and (s) are both on, this instruction is executed.

Notes

- The CEND instruction is checked prior to the execution, and if there is an error, the following error codes are set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0023	The CEND instruction is found after the END instruction.

Instruction for use



JMP n

Item number	Control instructions-3	Name	Unconditional jump (JUMP)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
JMP n	DER	ERR	SD	V	C	32	—	
	●	1]	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
JMP n		2

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Code number												O	0 to 255 (Decimal)

Function

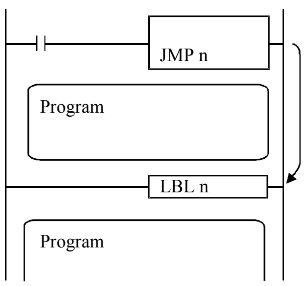
- If the startup condition of JMP n switches on, the control jumps the program from this instruction to the LBL n of the same code number. Always use JMP n and LBL n in pairs.
- If the startup condition is not established, the next instruction will be executed.
- To set this instruction in conjunction with other instructions in the same arithmetic-operation box, insert this instruction at the end of the box.
- The JMP n instruction is valid only within the same scan program. (A jump to a subroutine or interrupt scan cannot be performed from a normal scan, nor vice versa.)
- Nesting of JMP n instructions is possible, but note so that an overload error does not occur.

Notes

- This instruction is checked prior to the execution, and if there is an error, the following error codes are set in the special internal outputs R7F3 and WRF015. In this case, jump is not performed and the next instruction will be executed.

Special internal output		Error code	Error description
R7F3=1	WRF015	H0015	There is no LBL n.
		H0040	A jump is attempted to a different program area.

Instruction for use



- When the startup condition turns on, it jumps to LBL n.
- If there is a timer within the program it jumped to, the progress value is updated, but since instructions are not executed, output will not be turned on even if the ON conditions are met.

Item number	Control instructions-4	Name	Conditional jump

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
CJMP n (s)	DER	ERR	SD	V	C	3	—	Upper case : Conditions do not meet
	●	1]	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
CJMP n (s)				3		32	—	Lower case : Conditions meet

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Code number												○	0 to 255 (Decimal)
s	Jump condition	○	○	○										

Function

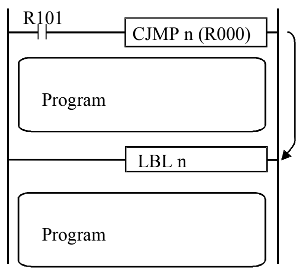
- If the jump condition (s) of CJMP n(s) switches on, the control jumps the program from this instruction to the LBL n of the same code number. Always use CJMP n(s) and LBL n in pairs.
- If the startup or jump condition is not established, the next instruction will be executed.
- To set this instruction in conjunction with other instructions in the same arithmetic-operation box, caution must be used because the jump takes place without performing the operations specified after the instruction.
- The CJMP n(s) instruction is valid only within the same scan program. (A jump to a subroutine or interrupt scan cannot be performed from a normal scan, nor vice versa.)
- Nesting of CJMP n(s) instructions is possible, but note so that an overload error does not occur.

Notes

- This instruction is checked prior to the execution, and if there is an error, the following error codes are set in the special internal outputs R7F3 and WRF015. In this case, jump is not performed and the next instruction will be executed.

Special internal output		Error code	Error description
R7F3=1	WRF015	H0015	There is no LBL n.
		H0040	A jump is attempted to a different program area.

Instruction for use

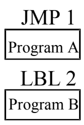


- When the startup condition and the R000 jump condition bit I/O are both on, it jumps to LBL n.
- If there is a timer within the program it jumped to, the progress value is updated, but since instructions are not executed, output will not be turned on even if the ON conditions are met.

CJMP n (s)

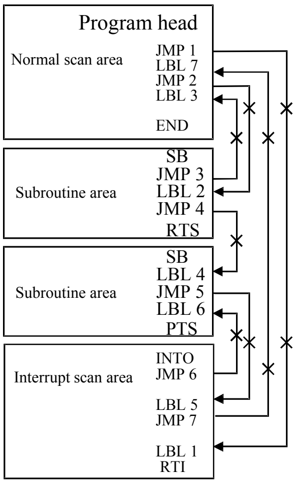
Syntax of JMP, CJMP

1] LBL n with the same code number as the code number n of the JMP instruction is required.



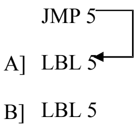
- If JMP 1 is executed when there is no LBL 1, an LBL undefined error occurs. JMP 1 will do nothing and execute the next processing of program A.

2] Jump is not permitted to outside the area in which the JMP instruction resides.



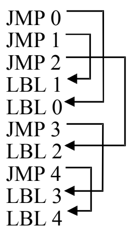
- When the JMP 1 instruction is executed, since LBL 1 is not in the normal scan area, a "jump outside the area" error will be generated. The JMP 1 instruction will do nothing and execute the next processing of program.
- JMP 2 to JMP 7 perform similar processing.

3] Code number n of the JMP instruction and the LBL n with the same code number may not be overlapped.

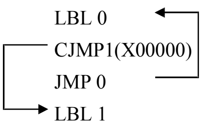


- In the pre-operation process, the label instructions A] and B] have 5 as the code numbers, so a duplicate definition error will occur.

4] Nesting of JMP instructions is allowed.

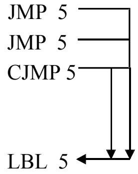


5] The JMP instruction can jump to a location before the instruction itself.

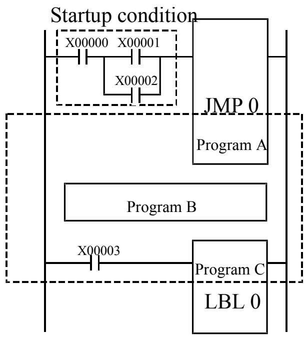


- JMP 0 will jump to LBL 0, which is a location before the JMP instruction.
- When input X00000 turns on, the loop between LBL 0 and JMP 0 is escaped by jumping from CJMP 1 (X00000) to LBL 1.
- If there is no instruction as CJMP 1 (X00000) to escape from the loop, the loop from LBL 0 to JMP 0 will continue endlessly.

6] An overlap of JMP instructions with the same code number is valid.



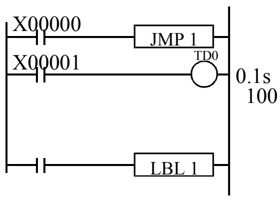
7] A startup condition can be programmed with respect to JMP instructions.



- If a jump is performed from JMP 0 to LBL 0, programs A, B and C will not be executed.

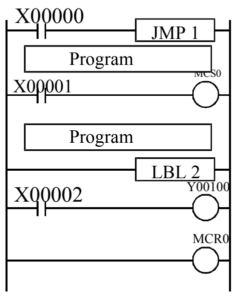
8] The CJMP instruction also follows the same syntax as 1] through 7].

Note 1: When a JMP instruction jumps to LBL, the status of each I/O between JMP and LBL is retained. However, the timer progress value will be updated.



- If X00000 turns on after X00001 turns on, the progress value of TD0 will be updated even if a jump is performed from JMP 1 to LBL 1. If X00000 remains on, TD0 will not turn on even if its progress value exceeds 100.

Note 2: If the JMP instruction is used in conjunction with the MCS or MCR instruction, the following actions will result, so exercise caution when programming.



- When JMP 2 does not jump, Y00100 will turn on when X00001 and X00002 are both on.
- When JMP 2 does jump, if X00000 is on, Y00100 will follow the on/off of X00002 regardless of the on/off of X00001.

Note 3: Do not create a circuit that jumps to outside from between MCS and MCR.

Item number	Control instructions-5	Name	Label

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
LBL n	DER	ERR	SD	V	C	0.5	—	
	●	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
LBL n		1

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Code number												○	0 to 255 (Decimal)

Function

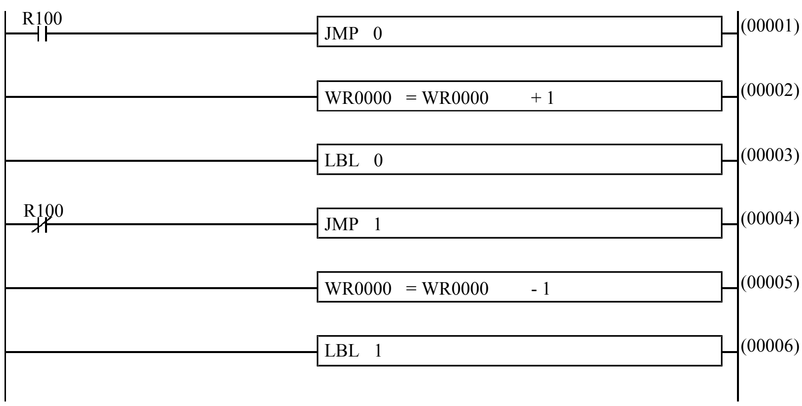
- This instruction indicates the destination of the jump when the JMP n or CJMP n instruction is executed (n is always used in pairs).
- The n in the LBL n cannot be used multiple times in the same program.
- This instruction itself does not perform any operation.
- Even if a startup condition is used with LBL n, it will be ignored.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0001	Duplicate definition of LBL

Instruction for use



- When R100 is on, JMP 0 will be executed but JMP 1 will not be executed.
  Therefore, the content of WR0000 will decrement by one during each scan.
- When R100 is off, JMP 0 will not be executed but JMP 1 will be executed.
  Therefore, the content of WR0000 will increment by one during each scan.

Item number	Control instructions-6	Name	FOR

Ladder format	Condition code					Processing time (μs)		Remark
FOR n (s)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	33	—	
	●	1]	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FOR n (s)				3				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	Code number												○	0 to 49 (Decimal)
s	Number of times repeated						○	○						

Function

- Jumps from the NEXT n of the same code number to this instruction.
- If the number of times repeated (s) is greater than 0, the instruction following the FOR n (s) is executed.
- If the number of times repeated (s) is equal to 0, it jumps to the instruction following the NEXT n.
- Use FOR n (s) and NEXT n in pairs. Also, place the NEXT n after FOR n.
- The FOR n (s) may not be used more than once.
- Use the FOR n (s) and NEXT n in the same program area. (It is not allowed to include FOR n (s) in the normal scan and NEXT n in the subroutine area.)
- The FOR n (s) to NEXT n nesting can be made up to five levels.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0001	Duplicate definition of FOR

- If an error is generated during the execution of the instruction, an error code will be set in the special internal outputs R7F3 and WRF015, and the following program will be executed.

Special internal output		Error code	Error description
R7F3=1	WRF015	H0017	NEXT undefined
		H0043	FOR to NEXT error
		H0044	Area error for NEXT
		H0045	FOR to NEXT nesting error
		H0046	FOR nesting overflow

Instruction for use

- For the instruction instruction, see NEXT n.

Item number	Control instructions-7	Name	NEXT

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
NEXT n	DER	ERR	SD	V	C	38	—	
	●	1]	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
NEXT n		2

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Code number												O	0 to 49 (Decimal)

Function

- Subtracts 1 from the number of times repeated (s) for the FORn (s) instruction of the same code number, then jumps to FORn (s).

Notes

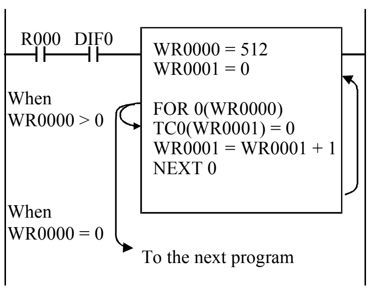
- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0003	Duplicate definition of NEXT

- If an error is generated during the execution of the instruction, an error code will be set in the special internal outputs R7F3 and WRF015, and the following program will be executed.

Special internal output		Error code	Error description
R7F3=1	WRF015	H0016	FOR undefined
		H0046	FOR nesting overflow

Instruction for use

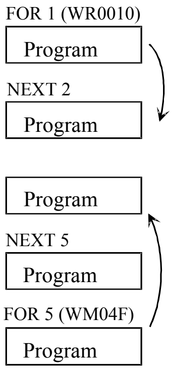


- When R000 is turned on, the progress value (TC n) of the timer or counter is cleared with 0 for 512 points.
- Once the FOR to NEXT starts, the instruction keeps executing until (s) is "0."
- FOR0 (WR0000) performs instructions after TC0 (WR0001) = 0 while WR0000>0, subtracts "1" from WR0000 at NEXT0, then jumps to FOR0 (WR0000).
- FOR0 (WR0000) jumps to the next instruction within the current box upon WR0000 = 0.

NEXT n

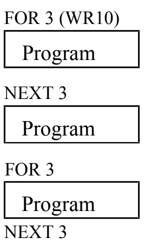
Syntax of FOR to NEXT

1] A NEXT instruction with the same code number as the code number n of the FOR instruction is required after the FOR instruction.



- NEXT undefined error
  The NEXT instruction with respect to the FOR instruction does not exist within the user program.
- FOR undefined error
  The FOR instruction does not exist before the NEXT instruction.
- NEXT to FOR error
  The NEXT instruction exists before the FOR instruction.

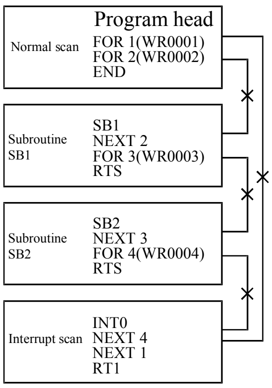
2] An overlap of FOR and NEXT instructions with the same code number n is not allowed.



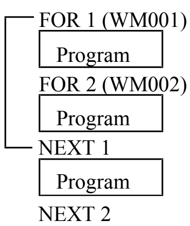
- FOR duplicate-definition error
  A FOR instruction with the same code number n is programmed.
- NEXT duplicate-definition error
  A NEXT instruction with the same code number n is programmed.

Note: FOR and NEXT duplicate-definition errors will occur during operation pre-processing.

3] FOR and NEXT must be within the same area.



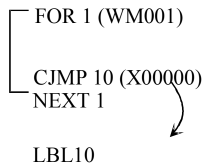
4] Use FOR to NEXT as a nest.



FOR 1(WM001) to NEXT 1 will execute normally.

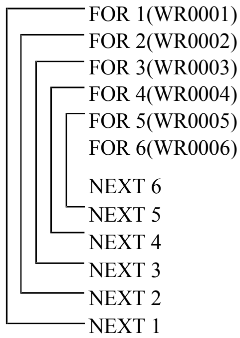
- Nesting error
  When WM002=0
  Since FOR 1(WM001) to NEXT 1 is prioritized, jump will not be performed over NEXT 1 from FOR 2 to NEXT 2. At this time, NEXT 2 generates a FOR 2 undefined error.
  When WM002 ≠ 0
  FOR 2 will not do anything. Therefore, NEXT 2 will generate a FOR 2 undefined error.

5] It is possible to escape from a FOR to NEXT loop using a jump instruction.



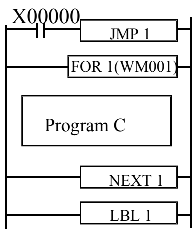
The FOR 1 to NEXT 1 loop is escaped when X00000 turns on before the loop has been repeated for the set number of repeats (content of WM001).

6] FOR to NEXT may be nested up to 5 levels. When a subroutine is included, the FOR to NEXT within the subroutine is counted.



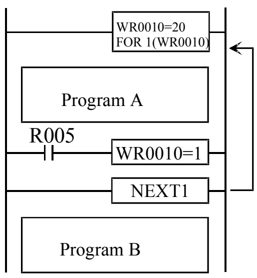
- Nesting overflow error

7] Do not include a startup condition between FOR and NEXT. If a startup condition is required, create a circuit as shown below:



[Operation description]
When X00000 is off, program C is repeatedly executed for the number of WM 1 times.
When X00000 is on, program C is not executed since a jump is performed from JMP 1 to LBL 1.

8] The number of repeats may be modified within the program.



The content of WR0010 decrements by 1 and a jump is performed to FOR 1 (WR0010).

- When R005 is off
  Program B is executed after program A is repeated 20 times.
- When R005 is on
  The repeat counter WR0010 changes to 1, and since the NEXT 1 processing subtracts 1 from it, the content of WR0010 becomes 0. Therefore, the repeating of program A is terminated and program B is execute

Item number	Control instructions-8	Name	Call subroutine

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
CAL n	DER	ERR	SD	V	C	24	—	
	●	1]	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
CAL n		2

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	Code number												O	0 to 99 (Decimal)

Function

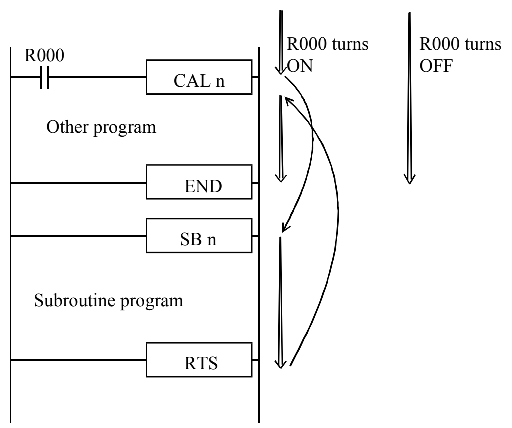
- If the startup condition of CAL n is on, this instructions executes the subroutine program (the program sandwiched by SB n and RTS) of the same code number.
- If the startup condition is off, the next program is executed.
- Up to 5 levels of CAL (nesting) for another subroutine can be performed within a subroutine.
- It is possible to call a subroutine from within an interrupt scan program.

Notes

- If an error is generated during the execution of the instruction, an error code will be set in the special internal outputs R7F3 and WRF015, and the following program will be executed.

Special internal output		Error code	Error description
R7F3=1	WRF015	H0013	SB undefined
		H0041	Nesting error

Instruction for use



- When R000 is on, a subroutine program is executed by CAL n. After the execution, the program is re-executed from the code following the CAL n.
- When R000 is off, the subroutine program is not executed, and the next program is executed.

Item number	Control instructions-9	Name	Start subroutine program

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
SB n	DER	ERR	SD	V	C	0.5	—	
	●	1]	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
SB n		1

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
n	Code number												O	0 to 99 (Decimal)

Function

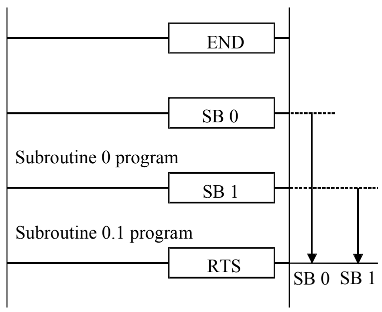
- This instruction indicates the start of a subroutine program (processing is not performed).
- The n in the SB n cannot be used more than once in the same program.
- Even if a startup condition is used for SB n, it will be ignored.
- Always use SB n and RTS in pairs.
- Code the SB n to RTS subroutine program after the END instruction.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0004	Duplicate definition of SB
		H0013	SB undefined

Instruction for use



- When CAL 0 is executed, SB 0 to RTS is executed as a subroutine.
- When CAL 1 is executed, SB 1 to RTS is executed as a subroutine.

SB n

Item number	Control instructions-10	Name	End of subroutine program (RETURN SUBROUTINE)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
RTS	DER	ERR	SD	V	C	25	—	
	●	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
RTS		1

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function

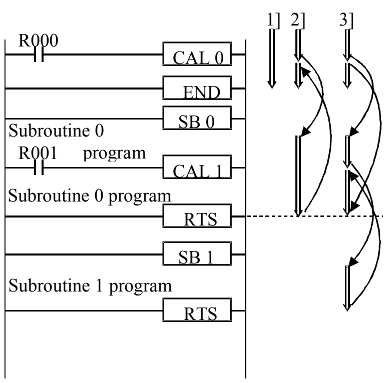
- This instruction declares the end of a subroutine program.
- When this instruction is executed, the program is resumed starting from the line following the CAL n instruction that called the subroutine.
- Do not set a startup condition with this instruction.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0011	SB undefined
		H0020	SB area error
		H0030	RTS startup condition error

Instruction for use



1] The program is executed when R000 and R001 are both off
2] The program is executed when R000 is on and R001 is off
CAL 0 is executed, then the subroutine 0 program is executed.
CAL 1 is not executed, the subroutine 0 program is terminated and the execution is returned to the code following the CAL 0.
3] The program is executed when R000 and R001 are both on
CAL 0 is executed, then the subroutine 0 program is executed.
CAL 1 is executed, then the subroutine 1 program is executed.
The subroutine 1 program is completed and execution is returned to the code following the CAL 1.
The subroutine 0 program is completed and execution is returned to the code following the CAL 0.

Item number	Control instructions-11	Name	Start interrupt scan program (INTERRUPT)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
INT n	DER	ERR	SD	V	C	0.5	—	
	●	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
INT n				1				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
n	Interrupt priority												○	0 to 2 , 16 to 19, 20 to 27 (Decimal)

Function

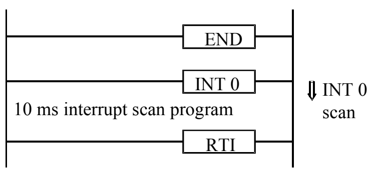
- This instruction declares the start of an interrupt scan program.
- n = 0 to 2 indicates a periodical interrupt scan. n = 16 to 19 indicates interrupt input. n = 20 to 27 indicates an interrupt scan when the counter input exceeds the preset value.
- It is set to the 10 ms periodic scan when n = 0, 20 ms periodic scan when n = 1, and 40 ms periodic interrupt scan when n = 2.
- The smaller the number n, the higher the interrupt priority.
- Always use INT n and RTI in pairs.
- Even if a startup condition is used for INT n, it will be ignored.
- Code the INT n to RTI subroutine program after the END instruction.
- The n in INT n cannot be used more than once within the same program.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0005	Duplicate definition of INT
		H0014	INT undefined

Instruction for use



- The program between INT0 and RTI is started and executed every 10 ms.

Item number	Control instructions-12	Name	End interrupt scan program (RETURN INTERRUPT)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
RTI	DER	ERR	SD	V	C			
	●	●	●	●	●	0.5	—	
Instruction format	**Number of steps**							
	Condition			Steps				
RTI				1				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		

Function

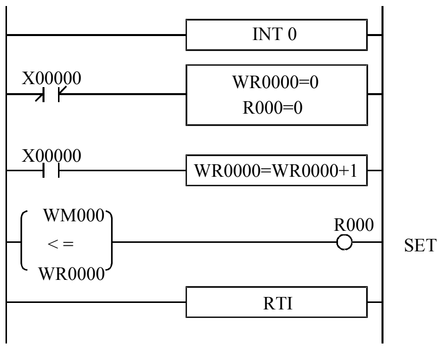
- This instruction declares the end of an interrupt scan program.
- When this program is executed, the processing is returned to the program that was executing before the interrupt scan was performed.
- Do not set a startup condition with this instruction.

Notes

- This instruction is checked prior to execution, and when there is an error, the following error code is set in the special internal output WRF001. Also, the CPU error code '34' is set to special internal output WRF000.

CPU error code	Special internal output	Error code	Error description
34	WRF001	H0012	RTI undefined
		H0021	RTI area error
		H0031	RTI startup condition error

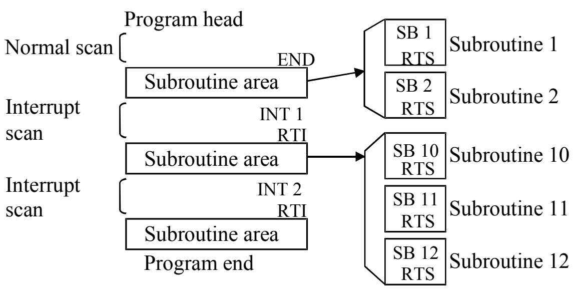
Instruction for use



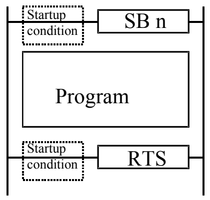
- A 0.01s timer is created using 10 ms interval interrupt.
- WM000, WR0000 and R000 are used for the set value, progress value and timer coil, respectively.
- When X00000 is off, the progress value and timer coil are cleared.
- When X00000 is on, the progress value increments by 1 every 10 ms.
- The timer coil is turned on upon WM000 is less than or equal to WR0000.

Syntax of SB n, RTS, INT n and RTI

1] A subroutine can be programmed between a normal scan and interrupt scan, between two interrupt scans, or after the final interrupt scan.

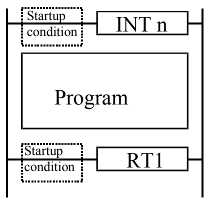


2] Program the subroutine start (SB n) and subroutine end (RTS) instructions without specifying startup conditions.

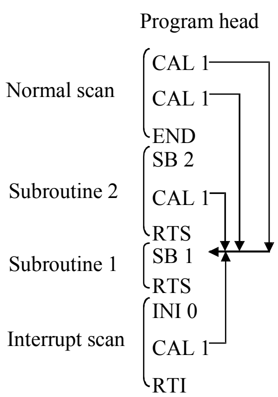


- The RTS startup condition error will occur during operation pre-processing.

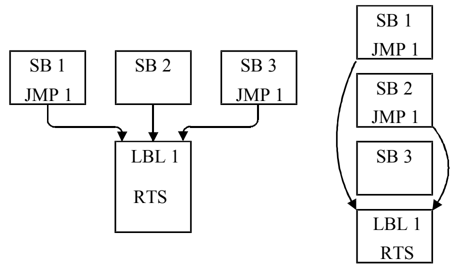
3] Program the interrupt scan start (INT n) and scan complete (RTI) instructions without specifying startup conditions.



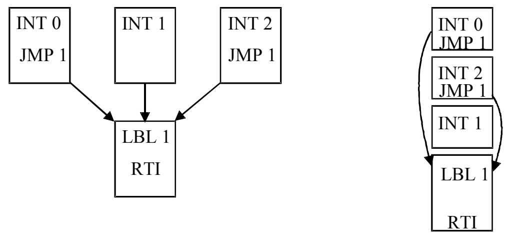
4] The same subroutine can be called from a normal scan, interrupt scan or subroutine.



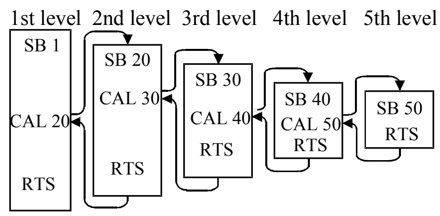
5] It is also possible to program a subroutine with multiple entry points and one exit.

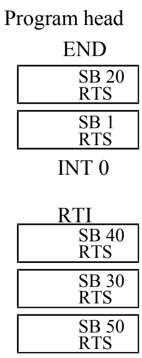


6] It is also possible to program a interrupt scan with many entry points and one exit.



7] Nesting of subroutines is allowed up to 5 levels.





(1) As shown to the left, the subroutine program order and nesting order have no relationship.

Item number	Transfer command-1	Name	General purpose port communication command

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
TRNS 0 (d, s, t)	DER	ERR	SD	V	C	80	2,078	
	↕	●	●	●	●			
Command format	**Number of steps**							
	Condition			Steps				
TRNS 0 (d, s, t)	-			5				

Usable I/O		Bit: X	Bit: Y	Bit: R, L, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Others
d	Dummy						○							
s	Parameter area							○						s to s+14
t	Communication control			○										t to t+11

Function

(1) This is a command to send data via general purpose port. It is also possible to receive data after data sending.

(2) Parameter "d" is dummy. Assign WY10. (Actual data in Y100 to Y115 is not influenced.)

(3) Parameter "s" is starting address of parameter table for communication setting.

(4) Parameter "t" is starting address of bit table for communication control.

(5) "s" parameter

s	[0] Return code
s+1	[1] System area (Do not use this area.)
s+3	[2] Timeout
s+4	[3] Address of sending area
s+6	[4] Reserve area for data sending (word)
s+7	[5] Address of receiving area
s+9	[6] Reserve area for data receiving (word)
s+A	[7] Receiving data length (byte)
s+B	[8] Start code
s+C	[9] End code
s+D	[10] Communication speed
s+E	[11] Communication format

(shaded) : Access forbidden

(blank) : User setting area

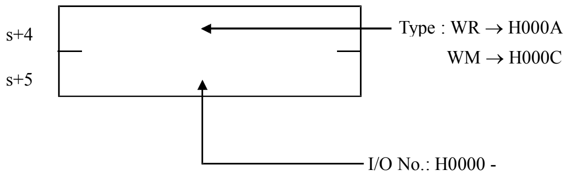
[0] Return code : Result of TRNS 0 command is set in lower 8 bits.
Completed 0
Error ≠ 0

[1] System area : This area is used by system (CPU) while TRNS 0 operation. It is not allowed for users to use this area.

⚠ If this area is written, CPU might stop operation due to system error.

[2] Timeout : Timeout setting from command executed to completed.
=0 : Timeout disabled
≠0 : Timeout enabled [×10ms]
Max. HFFFF

[3] Address of sending area :
Address number and address type are configured in 2 words as below.



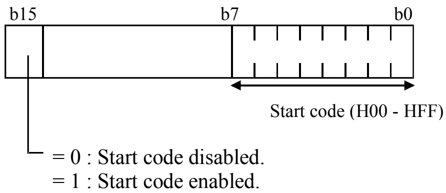
[4] Reserved data size for data sending. : This is not actual data size but reserved size. Set it by "Word".

[5] Address of receiving area :
Address number and address type are configured in 2 words as below.
(Data format is as same as sending area.)

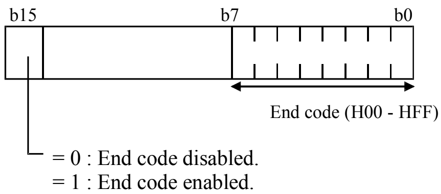
[6] Reserved data size for data receiving. : This is not actual data size but reserved size. Set it by "Word".

[7]*1 Receiving data length :
If receiving data is found by data length, set this parameter by "Byte". The maximum size is 1,024 byte. If data is more than 1,024 bytes or reserved area, TRNS command fails with DER="1".

[8]*1 Start code :
If receiving data is found by start code, set this parameter.



[9]*1 End code :
If receiving data is found by end code, set this parameter.



[10] Communication speed :

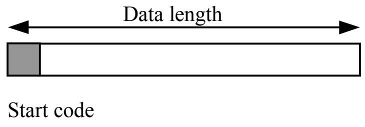
Baud rate	Value
300 bps	H0000
600 bps	H0001
1,200 bps	H0002
2,400 bps	H0003
4,800 bps	H0004
9,600 bps	H0005
19,200 bps	H0006
38,400 bps	H0007
57,600 bps	H0008

[11] Communication format

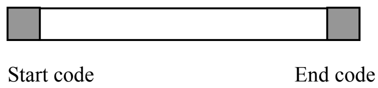
Format	Value
7 bits, even parity, 2 stop	H0000
7 bits, odd parity, 2 stop	H0001
7 bits, even parity, 1 stop	H0002
7 bits, odd parity, 1 stop	H0003
8 bits, non parity, 2 stop	H0004
8 bits, non parity, 1 stop	H0005
8 bits, even parity, 1 stop	H0006
8 bits, odd parity, 1 stop	H0007

*1 Received data is defined by either of following 4 ways depending on setting in [7] s+A to [9] s+C.

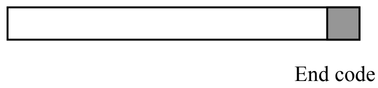
(a) Start code and data size*2
s+A : Data length (Byte)
s+B : H80□□ (□□=Start code)
s+C : H0000



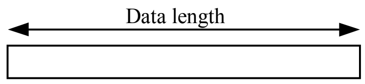
(b) Start and end code *2
s+A : H0000
s+B : H80□□ (□□=Start code)
s+C : H80□□ (□□=End code)



(c) End code
s+A : H0000
s+B : H0000
s+C : H80□□ (□□=End code)

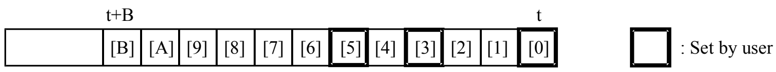


(d) Data length
s+A : Data length (Byte)
s+B : H0000
s+C : H0000



*2 In case of start code used, CPU can fail to receive due to buffer size full if data with wrong start code is sent.

(6) "t" parameter



[0] Execution bit:
Set "1" by user program to send data. This bit is reset after communication completed.

[1] Communication completed :
This bit is set "1" when communication completed without error, and reset at communication starting.

[2] Communication failed :
This bit is set "1" when communication fails, and reset at communication starting.

[3] Initialize :
Set "1" by user program to initialize TRNS 0 command. If this bit is on while communication, the communication is forced to be stopped.

[4] Initialize completed :
This bit is set "1" when initializing completed without error. Initialize bit [3] is reset at this timing.

[5] Receive enabled :
Set "1" by user program if CPU needs to receive data after data sending. This bit is reset after communication completed.

[6] Parity error flag :
This bit is set "1" when parity error detected.

[7] Framing error :
This bit is set "1" when framing error detected.

[8] Overrun error :
This bit is set "1" when overrun error detected.

TRNS 0 (d, s, t)

[9] Timeout :
This bit is set "1" when timeout detected.

[A] Input buffer full :
This bit is set "1" when input buffer full

[B] Conflict error :
This bit is set "1" when TRNS 0 or RECV 0 commands are duplicated.

Bit [6] to [B] is reset at initializing and TRNS 0 executed.

(7) Sending/receiving data format

Set sending data as follows, and Receiving data is set as follows.

[1] Sending/receiving data byte is even.

Sending/Receiving data byte (N)	
1st byte	2nd byte
3rd byte	4th byte
5th byte	6th byte
7th byte	8th byte
…	
N-1th byte	Nth byte

[2] Sending/receiving data byte is odd.

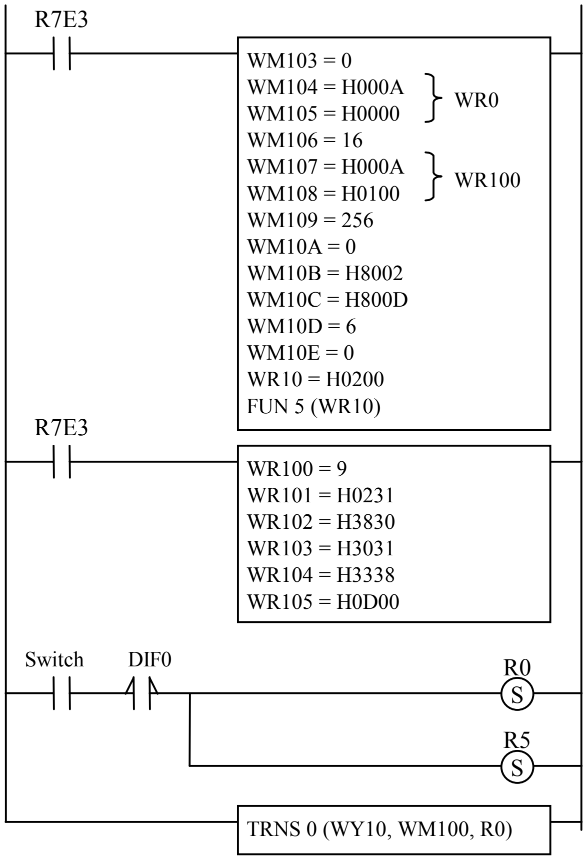
Sending/Receiving byte (N)	
1st byte	2nd byte
3rd byte	4th byte
5th byte	6th byte
7th byte	8th byte
…	
N-2th byte	N-1th byte
Nth byte	(ignored)

Reserve area for data sending/receiving

Caution

- Be sure to switch port type at first from dedicated port to general purpose port by FUN 5 command in user program.
- If CPU receives data by RECV command after data sending, received data could be failed depending on timing. In such a case, TRNS command with "receive enabled" is recommended.
- No contact nor condition is allowed to use with TRNS 0 command.
- Be sure to set [0] Execution bit high in 2nd scan or later. (Not in 1st scan)
- If parameter setting is wrong, error code H52 (TRNS/RECV command error) is set in WRF000 in some cases.
- ER signal is set on in the following condition.
  Communication executed properly.
- ER signal is set off in the following condition.
  - Initialized bit being set "1" while communication.
  - CPU status changed RUN→STOP→RUN while communication
  - Timeout while communication.
  - s, t parameters overwritten and range error while communication.

Sample program



R7E3 : 1st scan ON
Timeout = 0

Reserve area for data sending :
16 words from WR0

Reserve area for data receiving :
256 words from WR100

Data receiving definition
Start code : H02, End code : H0D

Communication speed : 19.2k bps
Format : 7 bits, even, 2 stop

Port 2 configured as general purpose port.

Sent data : 9 bytes
Inverter (SJ300/L300P) command
FWD RUN for station No.18
02 31 38 30 30 31 33 38 0D
(STX 18 00 1 38 CR) [38=BCC]

When the switch is ON, execution bit R0 is ON, and data is sent out from CPU port.

R5 enables data receiving from the other device.

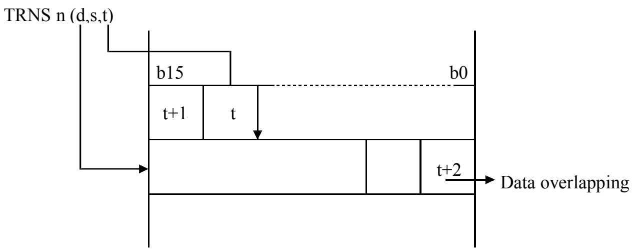
Description

TRNS 0 parameter and sent data are configured at 1st scan by R7E3 contact.
When the switch is ON, execution bit R0 is ON, and data is sent out from CPU port.

TRNS/RECV command return code table

Return code	Name	Description	Countermeasure
H00	Completed properly	Operation completed without error	-
H21	Range error	Parameter "s" and "t" is out of available I/O range.	Set right value.
H22	Reserve area for sending setting error	Parameter setting is wrong.	
H23	Reserve area for sending range error	Parameter is out of available I/O range.	
H24	Reserve area for receiving setting error	Parameter setting is wrong.	
H25	Reserve area for receiving range error	Parameter is out of available I/O range.	
H26	Sending data error	Configured sending data length is beyond reserve area	
H27	Receiving data error	Configured receiving data length is beyond reserve area	
H28	Area overlapping error *2	Parameter s, t, or reserve area is overlapped.	
H30	Timeout *1	Communication is not completed within configured time.	Set longer timeout or check the program.
H40	Receiving area over *3	Received data is beyond reserved area	Configure bigger size
H41	Parity error *4	Parity error detected	Check wiring and data format.
H42	Framing error *4	Framing error detected	
H43	Overrun error detected	Overrun error detected	
H44	Conflict error	TRNS 0/RECV 0 duplicated	Execute one by one
H45	Parameter error	Baud rate or format setting is wrong	Set right value.
H46	Port type error	Port type is not general purpose port.	Configure general purpose port.

*2 Area overlapping error (H28) is not detected in the following case.



If starting area of "s" parameter and "t" parameter is overlapped, error code H21 can be set instead of H28.

*3 Received data is stored as long as reserved area. (1,024 bytes)

*4 Data is not guaranteed.

TRNS 0 (d, s, t)

Item number	Transfer command-2	Name	General purpose port communication command					
Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
RECV 0 (d, s, t)	DER	ERR	SD	V	C			
	↕	●	●	●	●			
Command format	Number of steps					80	2,064	
	Condition			Steps				
RECV 0 (d, s, t)	-			5				

Usable I/O		Bit				Word				Double word			Constant	Others
		X	Y	R, L, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
d	Dummy					○								
s	Parameter area							○						s to s+14
t	Communication control			○										t to t+11

Function

(1) This is a command to send data via general purpose port. It is also possible to receive data after data sending.

(2) Parameter "d" is dummy. Assign WX0. (Actual data in X00 to X15 is not influenced.)

(3) Parameter "s" is starting address of parameter table for communication setting.

(4) Parameter "t" is starting address of bit table for communication control.

(5) "s" parameter

s	[0] Return code
s+1	[1] System area (Do not use this area.)
s+3	[2] Timeout
s+4	[3] Address of sending area
s+6	[4] Reserve area for data sending (word)
s+7	[5] Address of receiving area
s+9	[6] Reserve area for data receiving (word)
s+A	[7] Receiving data length (byte)
s+B	[8] Start code
s+C	[9] End code
s+D	[10] Communication speed
s+E	[11] Communication format

(shaded) : Access forbidden

(blank) : User setting area

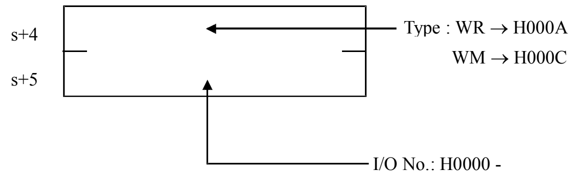
[0] Return code : Result of RECV 0 command is set in lower 8 bits.
Completed 0
Error ≠ 0

[1] System area : This area is used by system (CPU) while RECV 0 operation. It is not allowed for users to use this area.

⚠ If this area is written, CPU might stop operation due to system error.

[2] Timeout : Timeout setting from command executed to completed.
=0 : Timeout disabled
≠0 : Timeout enabled [×10ms]
Max. HFFFF

[3] Address of sending area :
Address number and address type are configured in 2 words as below.



[4] Reserved data size for data sending. : This is not actual data size but reserved size. Set it by "Word".

[5] Address of receiving area :
Address number and address type are configured in 2 words as below.
(Data format is as same as sending area.)

[6] Reserved data size for data receiving. : This is not actual data size but reserved size. Set it by "Word".

[7][*1] Receiving data length :
If receiving data is found by data length, set this parameter by "Byte". The maximum size is 1,024 byte. If data is more than 1,024 bytes or reserved area, RECV command fails with DER="1".

[8][*1] Start code :
If receiving data is found by start code, set this parameter. (See TRNS command)

[9][*1] End code :
If receiving data is found by end code, set this parameter. (See TRNS command)

[10] Communication speed (See TRNS command)

[11] Communication format (See TRNS command)

*1 Received data is defined by either of following 4 ways depending on setting in [7] s+A to [9] s+C.

*2 In case of start code used, CPU can fail to receive due to buffer size full if data with wrong start code is sent.

(6) "t" parameter

	t+B											t
	[B]	[A]	[9]	[8]	[7]	[6]	[5]	[4]	[3]	[2]	[1]	[0]

☐ : Set by user

[0] Execution bit:
Set "1" by user program to send data. This bit is reset after communication completed.

[1] Communication completed :
This bit is set "1" when communication completed without error, and reset at communication starting.

[2] Communication failed :
This bit is set "1" when communication fails, and reset at communication starting.

[3] Initialize :
Set "1" by user program to initialize RECV 0 command. If this bit is on while communication, the communication is forced to be stopped.

[4] Initialize completed :
This bit is set "1" when initializing completed without error. Initialize bit [3] is reset at this timing.

[5] Send enabled :
Set "1" by user program if CPU needs to send data after data receiving. This bit is reset after communication completed.

[6] Parity error flag :
This bit is set "1" when parity error detected.

[7] Framing error :
This bit is set "1" when framing error detected.

[8] Overrun error :
This bit is set "1" when overrun error detected.

[9] Timeout :
This bit is set "1" when timeout detected.

[A] Input buffer full :
This bit is set "1" when input buffer full

[B] Conflict error :
This bit is set "1" when TRNS 0 or RECV 0 commands are duplicated.

Bit [6] to [B] is reset at initializing and RECV 0 executed.

(7) Sending/receiving data format (See TRNS 0 command)

Caution

- Be sure to switch port type at first from dedicated port to general purpose port by FUN 5 command in user program.
- If CPU receives data by RECV command after data sending, sent data could be failed depending on timing. In such a case, RECV command with "send enabled" is recommended.
- No contact nor condition is allowed to use with RECV 0 command.
- Be sure to set [0] Execution bit high in 2^{nd} scan or later. (Not in 1^{st} scan)
- If parameter setting is wrong, error code H52 (TRNS/RECV command error) is set in WRF000 in some cases.
- ER signal is set on in the following condition.
  Communication executed properly.
- ER signal is set off in the following condition.
  - Initialized bit being set "1" while communication.
  - CPU status changed RUN→STOP→RUN while communication
  - Timeout while communication.
  - s, t parameters overwritten and range error while communication.

Item number	FUN instructions-1	Name	General purpose port switching

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 5 (s)	DER	ERR	SD	V	C	114	-	
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 5 (s)	—	3

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument							○						
s+1	(system area)							○						
s+2	(system area)							○						

Function

This command is to switch dedicated port (programming port) to general purpose port.

S	Port number	Current setting
S+1	System area	
S+2	System area	

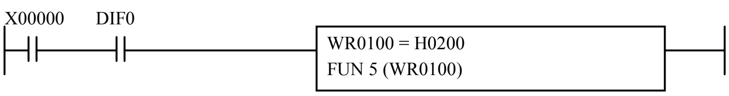
Port number
H01 : Port 1
H02 : Port 2
* Error with the other values

Current setting
H00 : Dedicated port (Programming port)
H01 : Port 1 is general purpose port
H02 : Port 2 is general purpose port

Notes

- General purpose port can be configured only one port. If either port is configured general purpose port, FUN 5 command for the other port is ignored with DER=1.
- General purpose works only when CPU is in RUN mode. When CPU status is in STOP, the port is automatically switched back to dedicated port (programming port).
- It is impossible to switch from general purpose to dedicated port while CPU is in RUN status.
- FUN 5 does not work if port 1 is configured as modem mode.

Program example




```
LD    X00000
AND   DIF0
[
WR0100 = H0200
FUN 5 (WR0100)
]
```

Program description

Port 2 is switched to general purpose port at rising edge of X0000 input.

Item number	FUN instructions-2	Name	I/O refresh (All points)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 80 (s)	DER	ERR	SD	V	C	432	—	
* (ALREF (s))	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 80 (s) * (ALREF (s))	—	3

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (dummy)							○						

Function

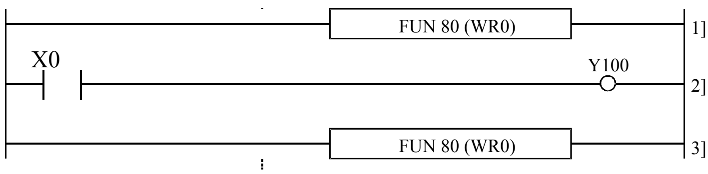
- This instruction performs I/O refresh of all data in the external I/Os (including link area) during scanning.

* ( ) indicates the display when the Ladder Editor is used.

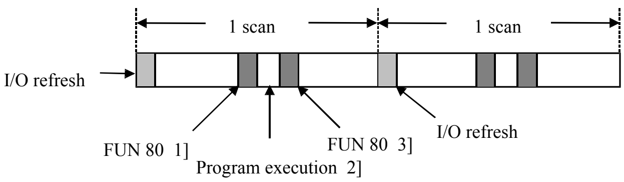
Notes

- This instruction performs I/O refresh of all external I/Os.
  If refresh of certain area is to be performed, use FUN81 or FUN82.
- If the argument s exceeds the maximum I/O number, DER is set to “1” and no processing will be performed.
- Assign argument s as a one-word dummy. The I/O specified for argument s (WR and WM) will not be affected.

Program example



Program description



Item number	FUN instructions-3	Name	I/O refresh (Input/output)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 81 (s)	DER	ERR	SD	V	C	244	—	
* (IOREF (s))	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 81 (s) * (IOREF (s))	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Type							○						

Function

s [Input type] H00: Input refresh
H01: Output refresh

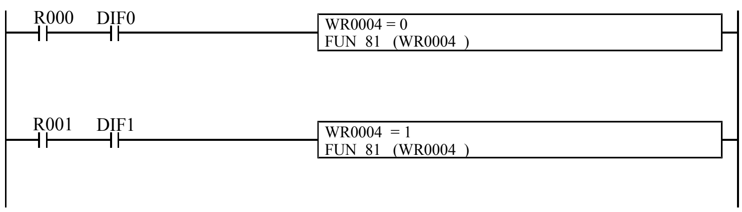
- Depending on the I/O type of the area specified by s, refresh is performed with respect to I/O modules only, output modules only.
- Refresh is performed by each slot assignment according to the I/O assignment.
- If the refresh processing is completed normally, DER is set to '0.'

* ( ) indicates the display when the Ladder Editor is used.

Notes

- If the I/O type is other than H00 or H01, DER is set to "1" and no processing will be performed.
- If the argument s exceeds the maximum I/O number, DER is set to "1" and no processing will be performed.

Program example




```
LD      R000
AND     DIF0
[
WR0004 = 0
FUN 81  (WR0004)
]
LD      R001
AND     DIF1
[
WR0004 = 1
FUN 81  (WR0004)
]
```

Program description

- Upon leading of R000, the input module is refreshed.
- Upon leading of R001, the output module is refreshed.

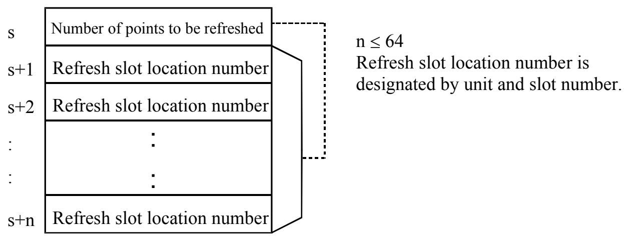
Item number	FUN instructions-4	Name	I/O Refresh (slot)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 82 (s) * (SLREF (s))	DER	ERR	SD	V	C	311	—	
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 82 (s) * (SLREF (s))	—	3

Usable I/O		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM	Constant	Other
s	Number of points							○						
s+1 and beyond	Slot location number							○						Designate the slot location.

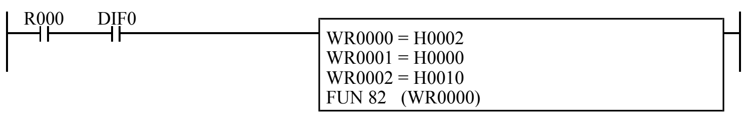
Function



- Performs refresh of the designated module for the number of points specified by s, starting with area s+1.
- Refresh is performed by slot.
- The slot location numbers stored in areas s+1 and subsequent are designated by the unit number and slot number.
- The maximum number of points to be refreshed (n) is 64 points. The points exceeding 64 points are not refreshed.
- If refresh processing is completed normally, DER is set to “0.”

* ( ) indicates the display when the Ladder Editor is used.

Program example




```
LD       R000
AND      DIF0
[
WR0000  = H0002
WR0001  = H0000
WR0002  = H0010
FUN82    (WR0000)
]
```

Program description

- Upon leading of R000, the two slots designated after WR0001 (unit 0, slot 0) and (unit 1, slot 0) are refreshed.

FUN 82 (s)

Notes

- Set the unit number (0 to 3) and slot number (0 to 1) after s+1. For other set values, DER is set to “1” and that slot will not be processed.
- If there is no I/O assignment to the designated slot, DER is set to “1” and that slot will not be processed.
- If the number of s+n points exceeds the maximum I/O number, DER is set to “1” and no processing will be performed.
- If the number of points exceeds 64, DER is set to “1” and the points exceeding 64 will not be processed (refresh will be performed for up to 64 points).

Slot location number

The slot locations are designated using the unit number and slot number.
The unit number and slot number are set as follows in one word units:

b15	b12	b7	b3 b0
0 to 0	0 to 0	Unit number	Slot number

FUN 82 (s)

Item number	FUN instructions-5	Name	High-speed Counter Operation Control

Ladder format	Condition code					Processing time (μs)		Remark
FUN 140 (s)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	147	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 140 (s)	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (Counter number, operation control value)							○						

Function

	15 … 8	7 … 0
S	Counter number	Operation instruction

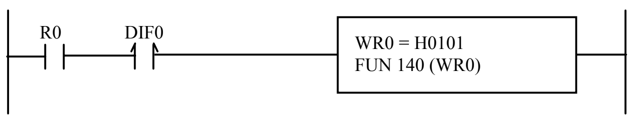
Counter number: H01 to H04
Operation instruction: H00 – Stop, H01 – Start

- Performs the starting and stopping of the count operation for the specified counter.

Notes

- If a value other than H01 to H04 is specified for the counter number and the operation instruction is set to a value other than H00 or H01, DER will be set to "1" and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to "1" and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to "1" and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- This instruction is only used to start and stop the counter operation. Other counter settings will not be changed.
- The counter operation will start after the power is turned back on even if the power is turned off when the count operation is stopped by this instruction. The operation of the high-speed counter will be stopped only when this instruction specifies the stop instruction.
- The counter operation will continue when the CPU operation is stopped.
- When the count operation stops, the progress value update also stops. When starting the count operation, the progress value is cleared and then the operation starts.

Program example




```
LD    R0
AND   DIF0
[
WR0   = H101
FUN   140 ( WR0 )
]
```

Program description

- Prior to starting a counter operation, various settings required for the counter operation are reflected in the special internal outputs, and the PI/O function setting flag (R7F5) is turned on while the CPU is being stopped.
  For details on the special internal output settings, see Chapter 8.
  Starts the counter No. 1 operation.

Item number	FUN instructions-6	Name	High-speed Counter Coincidence Output Control

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 141 (s)	DER	ERR	SD	V	C	138	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 141 (s)	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (Counter number, output instruction)							○						

Function

	15 … 8	7 … 0
S	Counter number	Operation instruction

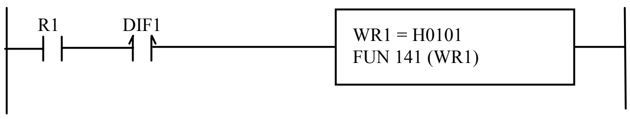
Counter number: H01 to H04
Output instruction: H00 – Coincidence output disable,
H01 – Coincidence output able

- Performs the enabling and disabling of the coincidence output for the specified counter.
- Output is turned off when the coincidence output disabling instruction is issued while coincidence output is being performed (while coincidence output is on).

Notes

- If a value other than H01 to H04 is specified for the counter number and the output instruction is set to a value other than H00 or H01, DER will be set to "1" and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to "1" and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to "1" and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- This instruction is only used to enable and disable the coincidence output. Other counter settings will not be changed and it will not affect the count operation.
- When coincidence output is enabled by this instruction when the coincidence conditions are already established, coincidence output will be turned on when the instruction is issued.
- The control contents of this instruction will be reflected in the output control flag (R7FC to R7FF) of the corresponding counter number.
- When the CPU is not operating, the counter coincidence output continues/stops according to the setting of the special internal output (output selection at R7DC stop).

Program example




```
LD    R1
AND   DIF1
[
WR1   = H101
FUN   141 ( WR1 )
]
```

Program description

- Sets the coincidence output validity for the counter No. 1.
  Because the counter coincidence output Yxxx cannot be used in the ladder program (including the monitor, etc.), do not use it for the coil such as a contact.

Item number	FUN instructions-7	Name	High-speed Counter Up-Count/Down-count Control (Single phase counter only)

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 142 (s)	DER	ERR	SD	V	C	156	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 142 (s)	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (Counter number, Up/Down instruction)							○						

Function

S	15 … 8	7 … 0
	Counter number	Up/Down instruction

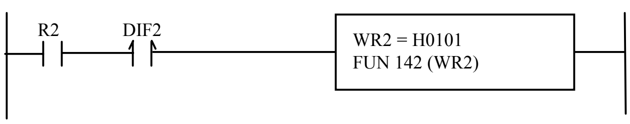
Counter number: H01 to H04
Up/down instruction: H00 – Up-count, H01 – Down-count

- This controls the up-count/down-count of the specified counter.
- Up-count and down-count control can be performed during the count operation.

Notes

- If a value other than H01 to H04 is specified for the counter number and the up/down instruction is set to a value other than H00 or H01, DER will be set to “1”and no processing will be performed.
- If the specified counter number is set to a function other than single-phase counter, DER will be set to “1” and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to “1” and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to “1” and no processing will be performed.
- This instruction is only used to control the up-count and down-count. Other counter settings will not be changed and it will not affect the count operation.
- The control contents of this instruction will be reflected in bits 11 to 8 of the special internal output WRF07E of the corresponding counter number.

Program example




```
LD   R2
AND  DIF2
[
WR2  = H101
FUN  142 ( WR2 )
]
```

Program description

- Switches the counter operation of the counter No. 1 to down count.
  The count edges (leading/trailing) will follow the specification of the special internal output (WRF07E).

Item number	FUN instructions-8	Name	High-speed Counter Current Value Replacement

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 143 (s)	DER	ERR	SD	V	C	175	—	
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 143 (s)	—	3

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (counter number)							○						
s+1	Argument (Replacement value storage area)							○						

Function

	15 … 8	7 … 0
S	Counter number	* *
S + 1	Replacement value storage area	

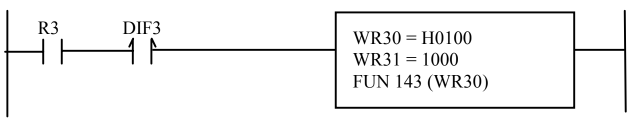
Counter number: H01 to H04
**: Disable area

- The counter value of the specified counter number will be replaced by the data stored in the replacement value storage area.

Notes

- If a value other than H01 to H04 is specified for the counter number, DER will be set to "1" and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to "1"and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to "1" and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- This instruction is only used to rewrite the count value. Other counter settings will not be changed and will not affect the count operation.
- If the range for S exceeds the valid range of the I/O, DER will be set to "1" and no processing will be performed.

Program example




```
LD     R3
AND    DIF3
[
WR30  = H100
WR31  = 1000
FUN    143 (WR30)
]
```

Program description

- Rewrite the count value of the counter No. 1 to 1000.

FUN 143 (s)

Item number	FUN instructions-9	Name	High-speed counter current value reading

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 144 (s)	DER	ERR	SD	V	C	132	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition		Steps					
FUN 144 (s)	—		3					

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
s	Argument (counter number)							○						
s+1	Argument (Current value storage area)							○						

Function

	15 ... 8	7 ... 0
S	Counter number	* *
S + 1	Current value storage area	

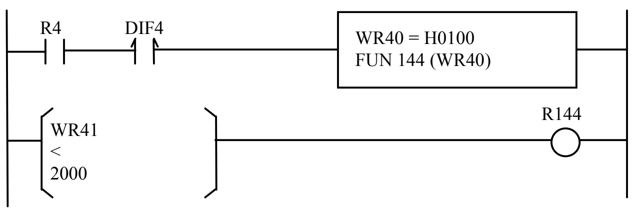
Counter number: H01 to H04
**: Disable area

- This function reads the count value of the specified counter number and writes it to the current value storage area.

Notes

- If a value other than H01 to H04 is specified for the counter number, DER will be set to "1" and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to "1"and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to "1" and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- This instruction is only used to read the count value. Other counter settings will not be changed and it will not affect the count operation.
- The execution of this instruction will not change WRF07A to WRF07D (strobe area) and WRF056 (strobe complete flag).
- <u>If the range for S exceeds the valid range of the I/O, DER will be set to "1" and no processing will be performed.</u>

Program example




```
LD     R4
AND    DIF4
[
WR40  = H100
FUN    144 ( WR40 )
]

LD     (WR41 < 2000)
OUT    R144
```

Program description

- Load the count value of the counter No. 1 to WR41.
  If the count value of the counter No. 1 is less than 2000, R144 is turned on.

FUN 144 (s)

Item number	FUN instructions-10	Name	High-speed counter current value clear

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 145 (s)	DER	ERR	SD	V	C	157	—	
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 145 (s)	—	3

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (counter number)							○						

Function

	15 8	7 0
S	Counter number	* *

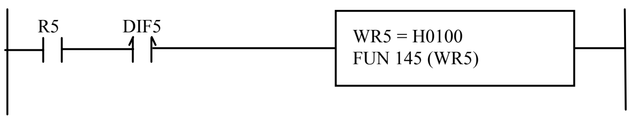
Counter number: H01 to H04
**: Disable area

- The output value will be changed according to the output condition (on-preset value, off-preset value settings) if the count value of the specified counter number is cleared and coincidence output is possible.

Notes

- If a value other than H01 to H04 is specified for the counter number, DER will be set to "1" and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to "1" and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to "1" and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- This instruction is used only to clear the count value. Other counter settings will not be changed and it will not affect the count operation.

Program example




```
LD    R5
AND   DIF5
[
WR5   = H100
FUN   145 ( WR5 )
]
```

Program description

- The count value of the counter No. 1 is cleared.

Item number	FUN instructions-11	Name	High-speed counter preset

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 146 (s)	DER	ERR	SD	V	C	162	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 146 (s)	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (counter number, preset specification)							○						
s+1	Argument (on-preset value)							○						
s+2	Argument (off-preset value)							○						

Function

	15 — 8	7 — 0
S	Counter number	Preset specification
S + 1	On-preset specification	
S + 2	Off-preset specification	

Counter number: H01 to H04

Preset specification:
H00 – Specification of on-preset value and off-preset value
H01 – Specification of on-preset value only
H02 – Specification of off-preset value only

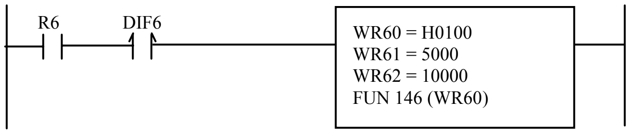
- The on-preset value and off-preset value will be set according to the preset specifications for the specified counter number.
- The coincidence output value will remain unchanged even when coincidence output is possible.

Notes

- If a value other than H01 to H04 is specified for the counter number and a value other than H00 to H02 is set for the preset specification, DER will be set to “1” and no processing will be performed.
- Since Counter 4 is invalid when a 10-point CPU is used, if Counter 4 is specified, DER will be set to “1” and no processing will be performed.
- If the specified counter number is set to a function other than a corresponding external I/O counter (single-phase counter, two-phase counter), DER will be set to “1” and no processing will be performed.
- The specified preset value will be checked using the criteria shown below. If an error occurs, DER will be set to “1” and no processing will be performed.
  If there is no error, the bit respective to the setting error detail information WRF057 will be set to “0” and releases the operation disabled status.
  1] When the preset specification is 00H
     If S+1 (on-preset) and S+2 (off-preset) values are equal, and error is generated.
  2] When the preset specification is 01H
     If S+1 (on-preset) and the off-preset value of WRF076 to WRF079 are equal, an error is generated.
  3] When the preset specification is 02H
     If S+2 (on-preset) and the off-preset value of WRF072 to WRF075 are equal, an error is generated.
- This instruction is used only to set the on-preset value and off-preset value. Other counter settings will not be changed and it will not affect the count operation.
- The settings made using the instruction will be reflected in the special internal output (WRF072 to WRF075 and WRF076 to WRF078). However, it is not reflected if DER becomes equal to “1.”
- <u>If the range for S exceeds the valid range of the I/O, DER will be set to “1” and no processing will be performed.</u>

FUN 146 (s)

Program example




```
LD     R6
AND    DIF6
[
WR60   = H100
WR61   = 5000
WR62   = 10000
FUN    146 ( WR60 )
]
```

Program description

- Sets both the on-preset value and off-preset value in the counter No. 1.
  Sets 5000 for the on-preset value and 10000 for the off-preset value.

Item number	FUN instructions-12	Name	PWM operation control

Ladder format	Condition code					Processing time (μs)		Remark
FUN 147 (s)	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
	DER	ERR	SD	V	C	135	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 147 (s)	—			3				

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
s	Argument (PWM output number)							○						

Function

	15	8	7	0
S	PWM output number		Operation instruction	

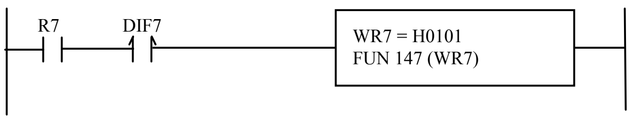
PWM output number: H01 to H04
Operation instruction: H00 – Stop, H01 - Start

- Starts/stops the PWM output of the specified PWM output number.

Notes

- If a value other than H01 to H04 is specified as the PWM output number, DER will be set to "1" and no processing will be performed.
- If the external I/O corresponding to the PWM output number is set to a function other than PWM output, DER will be set to "1" and no processing will be performed.
- If PWM output is activated with this instruction, the output control flag (R7FC to R7FF) corresponding to the specified PWM output number will turn on and off.
- The PWM output operation does not stop, even when CPU operation is stopped.
- When the CPU is not operating, the PWM output continues/stops according to the setting of the special internal output (output selection at R7DC stop).

Program example




```
LD    R7
AND   DIF7
[
WR7   = H101
FUN   147 ( WR7 )
]
```

Program description

- Prior to starting a PWM output operation, various settings required for the PWM output operation are reflected in the special internal outputs, and the PI/O function setting flag (R7F5) is turned on while the CPU is being stopped.
  For details on the special internal output settings, see Chapter 8.
  Starts the PWM output No. 1 (Y100) operation.

FUN 147 (s)

Item number	FUN instructions-13	Name	PWM Frequency on-duty changes

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 148 (s)	DER	ERR	SD	V	C	173	—	
	↕	●	●	●	●			

Instruction format	Number of steps	
	Condition	Steps
FUN 148 (s)	—	3

Usable I/O		Bit: X	Bit: Y	Bit: R, M	Bit: TD, SS, CU, CT	Word: WX	Word: WY	Word: WR, WM	Word: TC	Double word: DX	Double word: DY	Double word: DR, DM	Constant	Other
s	Argument (PWM output number)							○						
s+1	Argument (Frequency value)							○						
s+2	Argument (On-duty value)							○						

Function

	15 … 8	7 … 0
S	PWM number	**
S + 1	Frequency values	
S + 2	On-duty value	

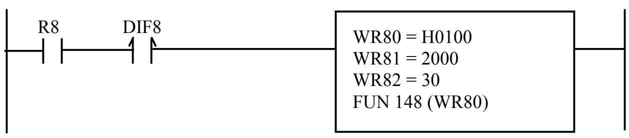
PWM output number: H01 to H04
**: Disable area
Frequency: 10 to 2000 (Hz)
*: If the frequency value is set to less than 10 Hz, it is internally changed to 10 Hz. The S parameter is also rewritten.
On-duty value:
With auto correction – Depends on the frequency used.
Without auto correction – 0 to 100 (%)
Auto correction is executed when the value corresponding to the CPU model is specified in WRF06B.
Caution: There will be a slight error even if correction setting is performed

- Sets the frequency value and on-duty value of the PWM output number specified by the on-duty value and the specified frequency value.
- Sets the frequency value in Hz.
  Example: To set a frequency of 1 kHz, set 1000 (H3B8) as internal output.
- Sets the on-duty value in %.
  Example: To set an on-duty of 80 %, set 80 (H50) as internal output.
- When the on-duty is set to be auto-corrected, the effective range of the on-duty is calculated using the following expressions.
  On-duty lower limit value (%) = Hardware delay time (μs) x Frequency used (Hz) x 10^{-4}
  On-duty upper limit value (%) = 100 – Hardware delay time (μs) x Frequency used (Hz) x 10^{-4}
  If the CPU model is EH-***DRP and the PWM output is 2 kHz,
  On-duty lower limit value = $50 \times 2000 \times 10^{-4} = 10$ %
  On-duty upper limit value = $100 - (50 \times 2000 \times 10^{-4}) = 90$ %
  Thus, the effective range of the on-duty will be 10 % to 90 %.

Notes

- If a value other than H01 to H04 is specified as the PWM output number, and if the on-duty value is outside the effective range, DER will be set to “1” and no processing will be performed.
- If the external I/O corresponding to the PWM output number is set to a function other than PWM output, DER will be set to “1” and no processing will be performed.
- The settings made using the instruction will be reflected in the special internal output (WRF072 to WRF075 and WRF076 to WRF079). However, it is not reflected if DER becomes equal to “1.”
- The minimum frequency that can be supported is 10 kHz. If a frequency value smaller than 10 kHz is specified, it will be changed to 10 kHz internally by the system.
- The maximum frequency that can be supported is 2 kHz. Do not set to more than 2 kHz. Operation above 2 kHz is not guaranteed.
- <u>If the range for S exceeds the valid range of the I/O, DER will be set to “1” and no processing will be performed.</u>

Program example




```
LD     R8
AND    DIF8
[
WR80  = H100
WR81  = 2000
WR82  = 30
FUN    148 ( WR80 )
]
```

Program description

- Sets both the frequency and on-duty value of the PWM output No. 1 (Y100).
  Sets 2000 (Hz) for the frequency and 30 (%) for the on-duty value.

Item number	FUN instructions-14	Name	Pulse output control

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 149 (s)	DER	ERR	SD	V	C	149	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 149 (s)	—			3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (Pulse output number)							○						

Function

S

15	0
Pulse output number	Operation instruction

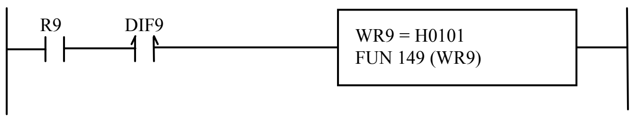
Pulse output number: H01 to H04
Operation instruction: H00 – Stop,
H01 - Start

- Starts pulse output of the specified pulse number and the output is stopped once the specified number of pulses are output.

Notes

- If the pulse output number is set to a value other than H01 to H04 and the pulse output number is set to "0," DER will be set to "1"and no processing will be performed.
- If the external I/O corresponding to the pulse output number is set to a function other than pulse output, DER will be set to "1"and no processing will be performed.
- If the specified counter number is unable to make an output (PI/O function setting result by R7F5), DER will be set to "1" and no processing will be performed.
- The pulse that is output with this instruction will be a pulse having a duty of 30 to 50 %. (To output a pulse having a duty ratio of 50 %, set the value corresponding to the CPU model in the special internal output WRF06B, by referring to Section 8.1.4.)
- When pulse output is commenced with this instruction, the output control flag (R7FC to R7FF) that corresponds to the pulse output number will turn on while the pulse is output. It will turn off when the specified number of pulses have been output.
- When the CPU is not operating, the pulse output continues/stops according to the setting of the special internal output (output selection at R7DC stop).
- This instruction does not have an acceleration/deceleration function.
- Only pulse output stop operation can be executed for the I/O that is outputting a pulse with the acceleration/deceleration function.
- If this instruction is executed while the backup memory is being written (R7EF=1), DER will be set to "1" and no processing will be performed.
- The backup memory will not be written during pulse output. Be extremely careful when you change a program during RUN.

Program example




```
LD    R9
AND   DIF9
[
WR9   = H101
FUN   149 ( WR9 )
]
```

Program description

- Prior to starting a pulse output operation, various settings required for the pulse output operation are reflected in the special internal outputs, and the PI/O function setting flag (R7F5) is turned on while the CPU is being stopped.
  For more details on the special internal output settings, see Chapter 8.
  Starts the pulse output No. 1 (Y100) operation.

FUN 149 (s)

Item number	FUN instructions-15	Name	Pulse frequency output setting changes

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 150 (s)	DER	ERR	SD	V	C	217	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 150 (s)	—			3				

Usable I/O		Bit X	Bit Y	Bit R, M	Bit TD, SS, CU, CT	Word WX	Word WY	Word WR, WM	Word TC	Double word DX	Double word DY	Double word DR, DM	Constant	Other
s	Argument (Pulse number)							○						
s+1	Argument (Frequency value)							○						
s+2	Argument (Number of output pulses)							○						

Function

	15	0
S	Pulse output number	Change specification
S + 1	Frequency value	
S + 2	Number of pulse output	

Pulse output number: H01 to H04
Change specification: H00: Sets the frequency value and number of pulse output,
H01: Sets the frequency value only,
H02: Sets the number of pulse output
Frequency: 10 to 5000 (Hz)
* The maximum frequency of 5000 Hz represents the total of all pulse output frequencies.
* If the frequency value is set to less than 10 Hz, it is internally changed to 10 Hz. The S parameter is also rewritten.
Number of output pulses: H0000 – HFFFF (0 to 65535)

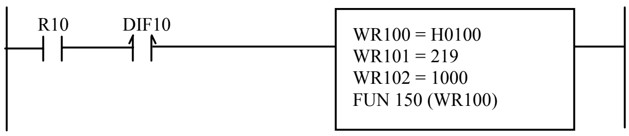
Auto correction is executed when the value corresponding to the CPU model is specified in WRF06B.
Caution: There will be a slight error even if correction setting is performed.

- Pulse output is commenced at the specified frequency. Output is stopped once the number of pulses specified have been output.
- Sets the frequency value in Hz.
  Example: To set a frequency of 3 kHz, set 3000 (HBB8) as internal output.
- Sets the count for the number of output pulses.
  Example: To set output of 10,000, set 10,000 (H2710) as internal output.

Notes

- If the pulse output number is set to a value other than H01 to H04, DER will be set to “1”and no processing will be performed.
- If the external I/O corresponding to the pulse output number is set to a function other than pulse output, DER will be set to “1”and no processing will be performed.
- The minimum frequency that can be supported is 10 kHz. If a frequency value smaller than 10 kHz is specified, it will be changed to 10 kHz internally by the system.
- If the specified frequency value is greater than 5 kHz, or even when it is 5 kHz or less, and if the total sum with other set pulse output frequencies becomes greater than 5 kHz, DER will be set to “1” and no processing will be performed.
- If the specified frequency value is 5 kHz or less, and the total sum with other set pulse output frequencies is also 5 kHz or less, the bit corresponding to the setting error detail WRF057 will be set to “0” and the operation enable state becomes active.
- The settings by this instruction will be reflected in the special internal output (WRF072 to WRF075 and WRF07A to WRF07D).
- If the range for S exceeds the valid range of the I/O, DER will be set to “1” and no processing will be performed.
- If the pulse output number is set to “0,” pulse output will not be performed even when the pulse output start (R7FC to R7FF is set to “1” or FUN149) is set.
- If this instruction is executed for the I/O that is outputting a pulse with the acceleration/deceleration function, DER will be set to “1” and no processing will be performed.

Program example




```
LD      R10
AND     DIF10
[
WR100   = H100
WR101   = 219
WR102   = 1000
FUN     150 ( WR100 )
]
```

Program description

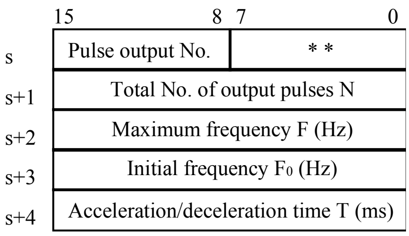
- Sets both the frequency and pulse output count of the pulse output No. 1 (Y100).
  Sets 500 (Hz) for the frequency and 3,000 for the number of pulse outputs.

Item number	FUN instructions-16	Name	Pulse output with acceleration/deceleration

Ladder format	Condition code					Processing time (μs)		Remark
	R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 151 (s)	DER	ERR	SD	V	C	919	—	
	↕	●	●	●	●			
Instruction format	**Number of steps**							
	Condition			Steps				
FUN 151 (s)								

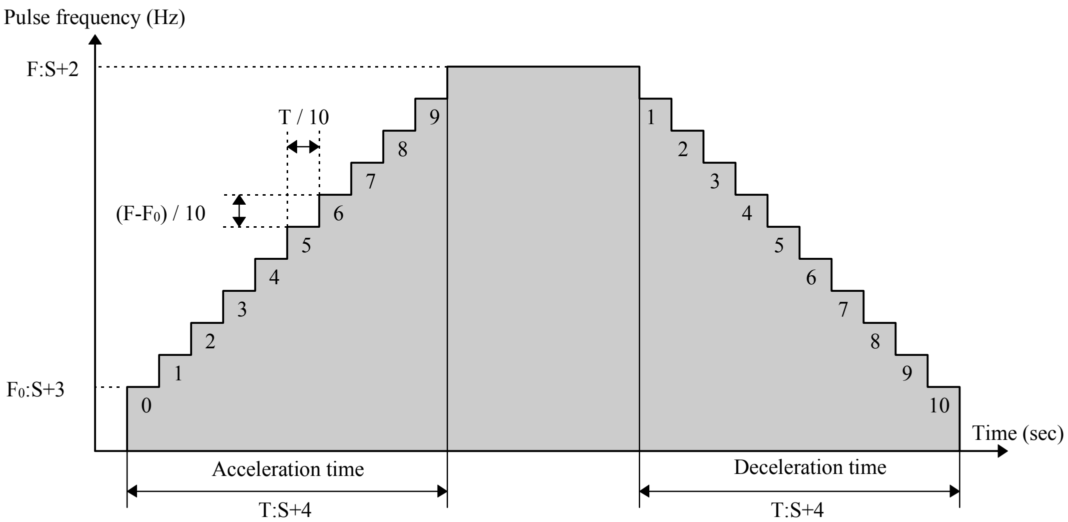
Usable I/O		X	Y	R, L, M	TD, SS, WDT, MS, TMR, CU, RCU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM	Constant	Other
		Bit				Word				Double word				
s	Pulse output No.							○						
s+1	Total No. of output pulses							○						
s+2	Maximum frequency (Hz)							○						
s+3	Initial frequency (Hz)							○						
s+4	Acceleration/deceleration time (ms)							○						

Function



Pulse output No.:	H01 to H04
**:	Invalid area
Total No. of output pulses:	H0000 to HFFFF (0 to 65535)
Maximum frequency (Hz):	HA to H1388 (10 to 5000)
Initial frequency (Hz):	HA to H1388 (10 to 5000)
Acceleration/deceleration time (ms):	H0000 to HFFFF (0 to 65535)

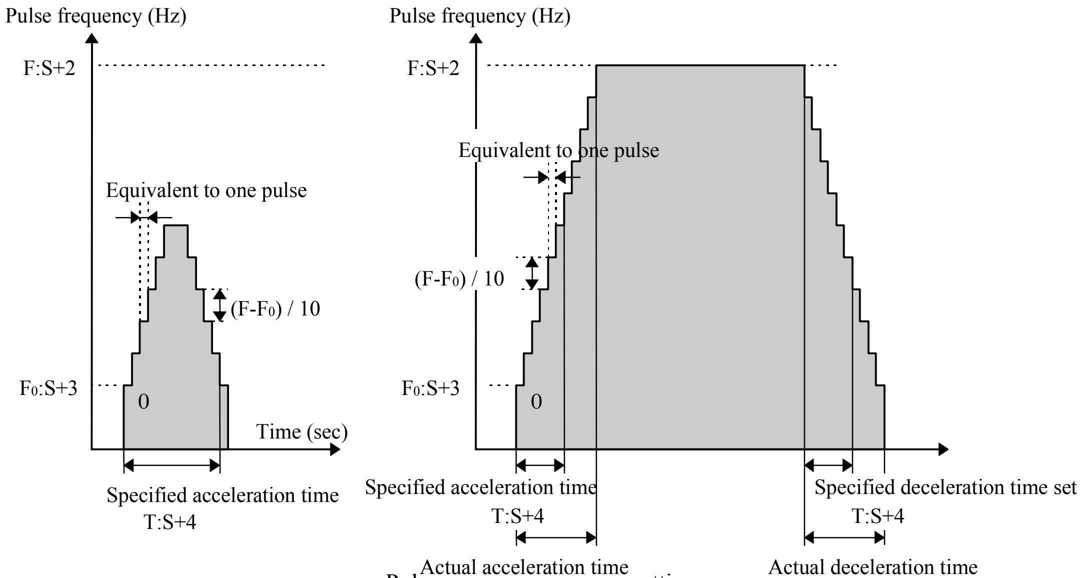
This instruction outputs pulses with the acceleration/deceleration function.
It outputs pulses from the pulse output terminal set with the pulse output number s until the total number of output pulses set with s+1 is reached.
Since the output of pulses starts from the one having the frequency set with s+3, set the parameters so that the stepping motor and other devices will not become out of tune.
Acceleration is performed at the acceleration time set with s+4 in 10 steps until the maximum frequency set with s+2 is reached.
Deceleration is performed at the deceleration time set with s+4 until the total number of output pulses set with s+1 is reached.
The ratio of frequency change for the deceleration is the same as for the acceleration.



FUN 151 (s)

Notes

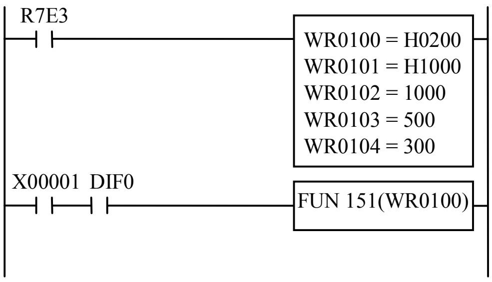
When this instruction is executed, the maximum frequency is stored in the special internal output's pulse output frequency (WRF072 to WFR075), and the number of output pulses is stored in the special internal output's number of output pulses (WRF07A to WRF07D) respectively.
This instruction will not be executed if the specified pulse output is generating pulse output.
If the output that corresponds to the specified pulse output number has not been set for pulse output, DER will be set to "1" and pulse output will not be generated.
If the total of the frequency set with this instruction and the frequency set for another pulse output exceeds 5 kHz, DER will be set to "1" and pulse output will not be generated.
If the maximum frequency is larger than the initial frequency, DER will be set to "1" and pulse output will not be generated.
If the same value is specified for the maximum frequency and initial frequency, pulses will be output for the number of pulses set with the maximum cycle without acceleration/deceleration.
If the maximum frequency and initial frequency are set to a value smaller than 10 Hz, the specified values will be changed to 10 Hz by the system.
If the total number of output pulses is small, deceleration will be performed without accelerating up to the maximum frequency. In this case, the specified acceleration/deceleration time will not be used as the acceleration/deceleration time; it will be accelerated (or decelerated) for each pulse.
For the acceleration/deceleration time, set a value equal to or larger than (1 / maximum frequency + 1 / initial frequency) x 5. If an acceleration/deceleration time smaller than this value is specified, the specified acceleration/deceleration will not be set.
Acceleration and deceleration are performed in 10 steps, and at least one or more pulses are always output. Thus, if a small initial frequency value is specified, an error in the acceleration/deceleration time will become large.



Pulse output at abnormal setting

- If this instruction is executed while the backup memory is being written (R7EF=1), DER will be set to "1" and no processing will be performed.
- The backup memory will not be written during pulse output. Be extremely careful when you change a program during RUN.

Program example




```
LD      R7E3
[
WR0100 = H0200
WR0101 = H1000
WR0102 = 1000
WR0103 = 500
WR0104 = 300
]
LD      X00001
AND     DIF0
[
FUN 151 (WR0100)
]
```

Program description

Sets the required parameters in the special internal outputs at the first scan after RUN start.
At the leading edge of X00001, pulses are output starting from Y101 using the following settings: acceleration/deceleration time of 300 (Hz), initial frequency of 500 (Hz), maximum frequency of 1000 (Hz), and number of output pulses of 4,096 pulses.

Item number	FUN instructions-17				Name	BOX comment								
Ladder format		Condition code					Processing time (μs)		Remark
		R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 254 (s) * (BOXC (s))		DER	ERR	SD	V	C	—	—	
		●	●	●	●	●			
Instruction format		Number of steps							
		Condition			Steps				
FUN 254 (s) * (BOXC (s))					3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (dummy constant)							○						

Function

- This instruction does not perform any operations. It is used to print comments on the right side of the calculation box in conjunction with the Ladder Editor.
- A comment can contain a maximum of 32 characters.

* ( ) indicates the display when the Ladder Editor is used.

Item number	FUN instructions-18				Name	Memo comment								
Ladder format		Condition code					Processing time (μs)		Remark
		R7F4	R7F3	R7F2	R7F1	R7F0	Average	Maximum	
FUN 255 (s) * (MEMC (s))		DER	ERR	SD	V	C	—	—	
		●	●	●	●	●			
Instruction format		Number of steps							
		Condition			Steps				
FUN 255 (s) * (MEMC (s))					3				

Usable I/O		Bit				Word				Double word			Constant	Other
		X	Y	R, M	TD, SS, CU, CT	WX	WY	WR, WM	TC	DX	DY	DR, DM		
s	Argument (dummy constant)							○						

Function

- This instruction does not perform any operations. It is used to print comments on the right side of the calculation box in conjunction with the Ladder Editor.
- A comment can contain a maximum of one screen (66 characters × 16 lines).

* ( ) indicates the display when the Ladder Editor is used.

Chapter 6 I/O Specifications

Table 6.1 lists the input/output classifications and input/output point types that can be used with the MICRO-EH

Table 6.1 Usable I/O classifications and point types

Item		Function	Symbol	Size	10/16	Name	10-point type Number of points	14-point type Number of points	23-point type Number of points	28-point type Number of points
1	External I/O*	External I/O	X	B	10	Bit external input	6 points	8 points	13 points	16 points
			WX	W	16	Word external input	1 word	1 word	1 word	2 words
			DX	D	16	Double-word external input				
			Y	B	10	Bit external output	4 points	6 points	10 points	12 points
			WY	W	16	Word external output	1 word	1 word	1 word	1 word
			DY	D	16	Double-word external output				
		Analog input	WX	W	16	Analog input	-	-	2 words	-
		Analog output	WY	W	16	Analog output	-	-	1 word	-
		Counter input	X	B	10	High-speed counter input	3 points total	4 points total	4 points total	4 points total
		Interrupt input	X	B	10	Interrupt input				
		Counter output	Y	B	10	High-speed counter synchronized output	3 points	4 points	4 points	4 points
		Pulse/PWM output	Y	B	10	Pulse output PWM output	3 point	4 points	4 point	4 points
2	Internal I/O	Bit	R	B	16	Bit internal output	1984 points			
			R	B	16	Bit special internal output	64 points			
		Word	WR	W	16	Word internal output	4096 words			
			DR	D	16	Double-word internal output				
			WR	W	16	Word special internal output	512 words			
			DR	D	16	D.-word special internal output				
		Sharing of bit / word	M	B	16	Bit internal output	16384 points			
			WM	W	16	Word internal output	1024 words			
			DM	D	16	Double-word internal output				
3	Others	Edge detection	DIF	B	10	Rising edge	512 points			
			DFN	B	10	Falling edge	512 points			
		Master control	MCS	B	10	Master control set	50 points			
			MCR	B	10	Master control reset				
		Timer counter	TD	B	10	On delay timer	Timer 256 points (0.01 s timer has only 0 to 63) Counter 256 points (The same area as the timer is used.) (The same timer counter number cannot be used more than once.)			
			SS	B	10	Single-shot timer				
			CU	B	10	Up counter				
			CTU	B	10	Up-down counter up input				
			CTD	B	10	Up-down counter down input				
			CL	B	10	Clear progress value				

*: The external I/O, counter I/O, interrupt input, pulse/PWM outputs use the same area by specifying the operation I/O operation mode (WRF070). See Chapter 8 for further information.

Note: The MICRO-EH does not support CPU link area (L/WL).

Note: B and W in the Size column represent bit and word (16 bits), respectively.

6.1 I/O Assignment

I/O assignment and I/O address are listed below.

Table 6.2 I/O assignment and I/O address

Type		I/O assignment	10-point type	14-point type	23-point type	28-point type
Basic	Digital	Slot 0 : X48	X0-5	X0-7	X0-12	X0-15
		Slot 1 : Y32	Y100-103	Y100-105	Y100-109	Y100-111
		Slot 2 : Empty	-	-	-	-
	Analog	Slot 3 : X4W	-	-	WX30-31	-
		Slot 4 : Y4W	-	-	WY40	-
Exp.1	Digital	Unit 1 / Slot 0 : B1/1	-	X1000-1007 / 1015 (14 / 28 pts.)		
			-	Y1016-1021 / 1027 (14 / 28 pts.)		
	Analog	Unit 1 / Slot 0 : FUN0	-	WX101-104 (WX100 is for command function under development)		
			-	WY106-107 (WY105 is for command function under development)		
Exp.2	Digital	Unit 2 / Slot 0 : B1/1	-	X2000-2007 / 2015 (14 / 28 pts.)		
			-	Y2016-2021 / 2027 (14 / 28 pts.)		
	Analog	Unit 2 / Slot 0 : FUN0	-	WX201-204 (WX200 is for command function under development)		
			-	WY206-207 (WY205 is for command function under development)		
Exp.3	Digital	Unit 3 / Slot 0 : B1/1	-	X3000-3007 / 3015 (14 / 28 pts.)		
			-	Y3016-3021 / 3027 (14 / 28 pts.)		
	Analog	Unit 3 / Slot 0 : FUN0	-	WX301-304 (WX300 is for command function under development)		
			-	WY306-307 (WY305 is for command function under development)		
Exp.4	Digital	Unit 4 / Slot 0 : B1/1	-	X4000-4007 / 4015 (14 / 28 pts.)		
			-	Y4016-4021 / 4027 (14 / 28 pts.)		
	Analog	Unit 4 / Slot 0 : FUN0	-	WX401-404 (WX400 is for command function under development)		
			-	WY406-407 (WY405 is for command function under development)		

6.2 External I/O Numbers

When starting an operation of the MICRO-EH, a user program is executed (scanned) after the input refresh processing (receiving external input data) is performed. Operations are performed according to the contents of the user program, and the next input refresh processing and output refresh processing (operation results are reflected in the external output) are performed. After that, the next user program is executed (scanned). This series of operations is continually repeated until the operation is stopped or until a problem occurs in which the operation can no longer continue.
When the operation is stopped or if a problem interrupting the operation occurs, the CPU performs output refresh processing making all output data as off data and then stops the operation, regardless of the execution status of the user program.
Figure 6.1 shows a diagram outlining this series of operations.

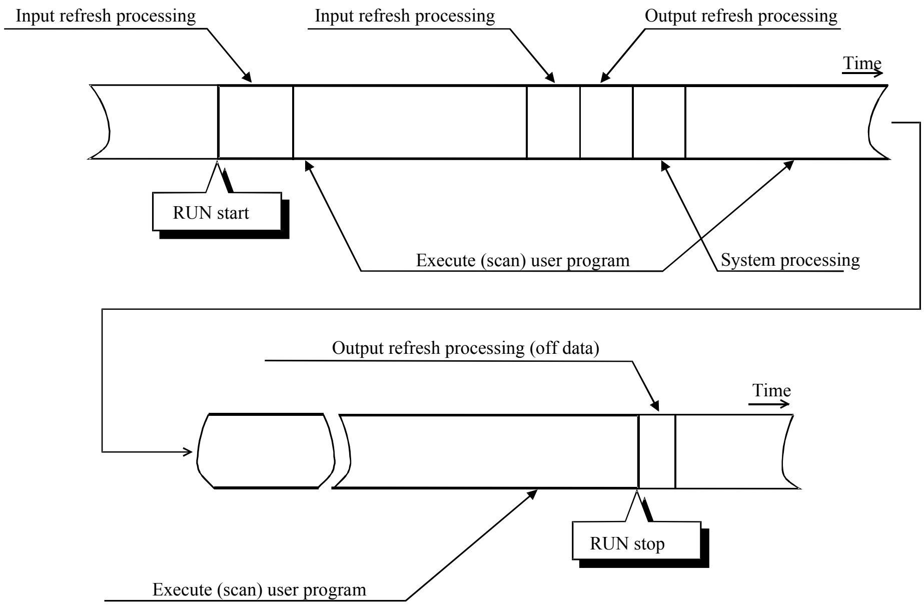


Figure 6.1 Overview of user program execution and refresh processing

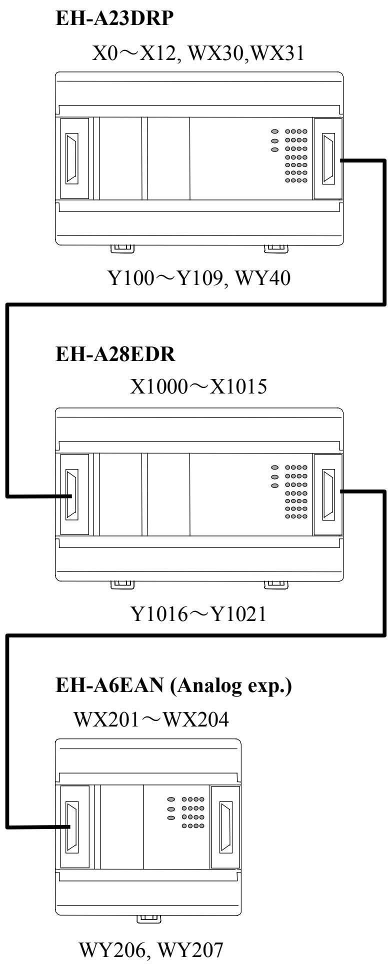
The user programs are executed in sequence, normally beginning with the program in the beginning of the scan area till the last program, or until the END instruction. Then, I/O data is refreshed prior to the execution of the next user program.
As shown above, external I/O data is updated in batch mode in the refresh processing after the user program is executed.
If it is necessary to update (refresh) the I/O data while the user program is being executed, use the refresh instruction.
When designing a system, take into account the above refresh operation from when the input data is received and operated until output data is obtained.

The following explains the external I/O assignment. The external I/O numbers for the MICRO-EH system are expressed with the following conventions.

Table 6.6 List of external I/O classification and data type

Classification	I/O classification	Data type	Remarks
X	External input	Bit type	Corresponds to the signal of each terminal block.
WX		Word type (16-bit)	Data in the range 0 to 15 is batch processed. 16-bit synchronicity guaranteed.
DX		Double-word type (32-bit)	Two word data are batch expressed. Lower 16-bit and upper 16-bit synchronicity are not guaranteed.
Y	External output	Bit type	Corresponds to the signal of each terminal block.
WY		Word type (16-bit)	Data in the range 0 to 15 is batch processed. 16-bit synchronicity guaranteed.
DY		Double-word type (32-bit)	Two word data are expressed as one batch. Lower 16-bit and upper 16-bit synchronicity are not guaranteed.

Table 6.7 List of I/O number conventions for external I/O

<table>
<tr><th>Data type</th><th>Numbering convention</th><th>Example</th></tr>
<tr><td>Bit type (basic)</td><td>X □ □ □□ ← Input
Y □ □ □□ ← Output
Bit number
Slot number (X:0 Y:1)
Unit number (0)</td><td rowspan="3">
</td></tr>
<tr><td>Bit type (expansion)</td><td>X □ □ □□ ← Input
Y □ □ □□ ← Output
Bit number
(X:00-07/15 Y:16-21/27)
Slot number (0)
Unit number (1-4)</td></tr>
<tr><td>Word type (basic/expansion)</td><td>WX □ □ □
WY □ □ □
Word number
Slot number
Unit number (1-4)</td></tr>
</table>

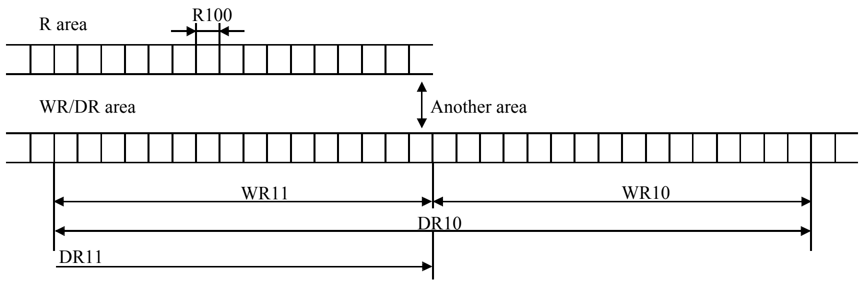
6.3 Internal Output Numbers

Memory is available as an internal output area in the CPU module. There are three areas: bit dedicated area (R), word dedicated area (WR), and bit/word shared area (M/WM).

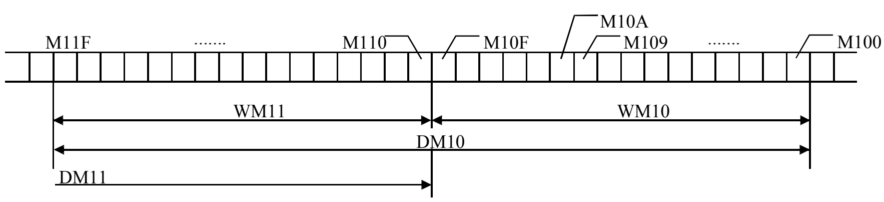
Table 6.8 List of I/O number conventions for external I/O

Data type	Numbering convention		Example
Bit-dedicated type		R□□□ Normal area H000 to H7BF Special area H7C0 to H7FF Both are expressed as hexadecimals.	R0 R105 R23C R7E7
Word dedicated type	<Word>	WR□□□□ Normal area H0000 to Special area HF000 to Both are expressed as hexadecimals.	WR0 WR11 WR123 WRF004
	<Double word>	DR□□□□ Normal area H0000 to Special area HF000 to Both are expressed as hexadecimals. Expresses WR for 2 words in continuation.	DR0 DR11 DR123 DRF004
Bit/word shared type	<Bit>	M □□□□ H0000~	M0 M11 M123
	<Word>	WM□□□ H000~ M120F M1200 WM120	WM0 WM11 WM123
	<Double word>	DM□□□□ H0000 to Expresses as hexadecimals. Expresses DM for 2 words in continuation.	DM0 DM11 DM234

- Internal outputs R, WR and DR are completely separate areas. Bit-based operations cannot be performed in the WR.
  (Example) Relationships among R100, WR10, and DR10



- Because internal outputs M, WM and DM share the same area, bit-based operations are allowed.
  (Example) Relationships among M100, WM10, and DM10



Chapter 7 Programming

7.1 Memory Size and Memory Assignment

Table 7.1. Lists the programming specifications for the MICRO-EH.

Table 7.1 Programming specifications

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>10/14-point type</th><th>23/28-point type</th></tr>
<tr><td>1</td><td colspan="2">Program size</td><td colspan="2">3 k steps (3072 steps)</td></tr>
<tr><td>2</td><td colspan="2">Instruction size</td><td colspan="2">32 bits/1 step</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Memory specification</td><td>SRAM</td><td>Backup with a battery is not possible since a battery cannot be installed.</td><td>Backup is possible by installing the battery.</td></tr>
<tr><td>FLASH</td><td colspan="2">Backup using flash memory is possible.</td></tr>
<tr><td>4</td><td colspan="2">Programming language</td><td colspan="2">H-series ladder/instruction language</td></tr>
<tr><td>5</td><td colspan="2">Program creation</td><td colspan="2">Created with H-series programming devices</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Program modification</td><td>During STOP</td><td colspan="2">Can be done as desired from the programming devices.</td></tr>
<tr><td>During RUN</td><td colspan="2">Can be done using the modify during RUN operation (except control instructions). Control instructions can be changed with special operations. *1
(When a change is made during RUN, control operation stops while the program is being modified.).</td></tr>
<tr><td>7</td><td colspan="2">Program protection</td><td colspan="2">Programs can only be modified when write is enabled. (The enable status is automatically controlled by the programming device).</td></tr>
<tr><td>8</td><td colspan="2">Password</td><td colspan="2">A password can be set from the programming device (the program cannot be displayed when setting the password. The programs can be downloaded to the programming device).</td></tr>
<tr><td>9</td><td colspan="2">Check function</td><td colspan="2">A sum check function for the program is always executing. An address check with the I/O assignment table is executed when RUN operation starts.</td></tr>
<tr><td>10</td><td colspan="2">Program name</td><td colspan="2">The program names are set from the programming device and stored along with the programs.</td></tr>
</table>

*1: Refer to the peripheral unit manual for details.

Notes:

- Comment data that has been created with the peripheral unit is not stored in the CPU.
- Save the user programs to a floppy disk or other media for backup.
- If a program exceeding 3072 steps is created by setting 4 K steps in the LADDER EDITOR, no error occurs in the LADDER EDITOR, but a “writing outside memory range” error will occur when writing the program to the CPU.
- Unlike the conventional H series, the MICRO-EH series backup user programs in the FLASH memory.
  In order to shorten the program transfer time, the user programs are transferred once to the operation execution memory, at which point the transfer is completed. The backup to the FLASH memory is performed afterward; therefore, be sure to turn off the power to the main unit after approximately two minutes have passed since the program transfer. If the power is turned off within two minutes, a user memory error (31H) may occur. Note that the transfer completion to the FLASH memory can be confirmed by the special internal output (R7EF).

7.2 Programming Devices

The following methods are used to create the user programs.

Table 7.2 Programming methods

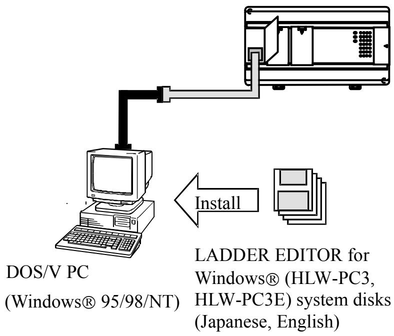
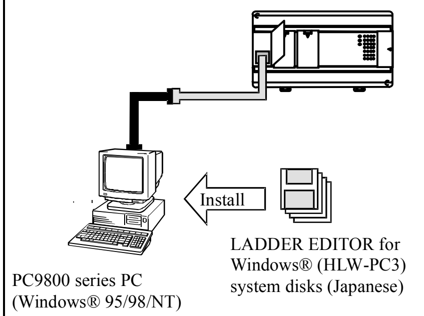
No.	Programming device used	Concept of operation	Remarks
1	Personal computer software (LADDER EDITOR, etc.)	[For off-line/on-line operation] Creates an I/O assignment table, inputs the program to be created, and transfers the program to the CPU in online mode. [For direct operation] As each program is entered one by one, it is directly written to the CPU. Change operation can be performed during RUN operation. Note: This mode is not available for Windows® version. [During on-direct operation] When programs are input one by one, the input programs are written into the CPU's memory and personal computer's memory. Change operation can be performed during RUN operation. Note: To enter the on-direct mode, match the contents in the CPU's memory and personal computer's memory.	• I/O assignment information can be read. • Initialize the CPU when starting up for the first time after the unit is unpacked or when a battery error occurs.
2	Dedicated programming console (GPCL01H, etc.)	[For off-line/on-line operation] Creates an I/O assignment table, inputs the program to be created, and transfers the program to the CPU in online mode. [For direct operation] As each program is entered one by one, it is directly written to the CPU. Change operation can be performed during RUN operation. Note: This mode is not available for Windows® version. [During on-direct operation] On-direct operation cannot be performed.	

Portable graphic programmers and instruction language programmers can not be used.

7.3 Programming Methods

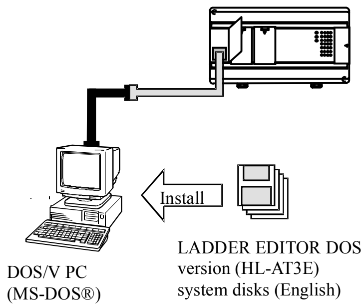
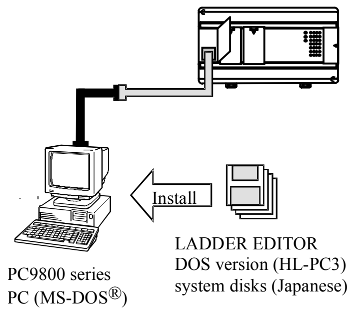
The following shows the system configuration using a personal computer and the procedures for creating a user program using personal computer software. Please note that cables differ depending on the personal computer and software used.

Table 7.3 System configuration using a personal computer

No.	Personal computer software used	DOS/V PC	PC9800 series personal computer
1	LADDER EDITOR (Windows® version)		

Item	DOS/V PC		PC9800 series personal computer
CPU setting	Specify H-302.		
Memory assignment	Specify RAM-04H (4 K memory).		
Cable (MICRO-EH side)	EH-RS05	EH-VCB02	EH-RS05
Cable (personal computer side)	WVCB02H		WPCB02H

Port	Type	DIP SW	1	2	3	4		PC9800 series
Port 1 *1, *2	10-point type	There are no DIP switches (fixed to 4800 bps).						
	14/23/28-point type	Status	ON	OFF	ON	OFF	38.4 kbps	Same as left
			ON	OFF	OFF	OFF	19.2 kbps	
			OFF	OFF	ON	OFF	9600 bps	
			OFF	OFF	OFF	OFF	4800 bps	
Port 2	10/14-point type	Port 2 does not exist.						
	23/28-point type	Cannot be connected with the above configuration since the RS-422/485 are used (RS-232C/422 converters are required.) Set the transmission speed in the special internal output (WRF03D).						

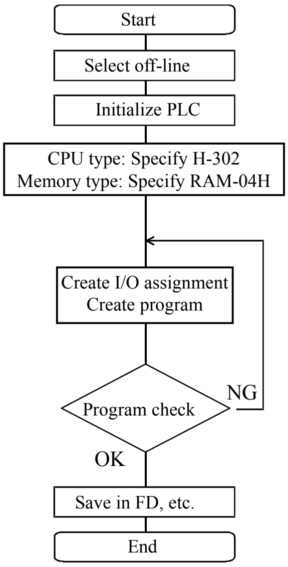
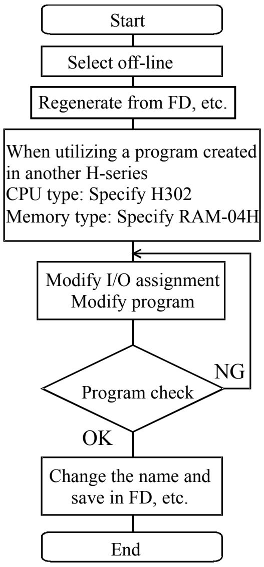
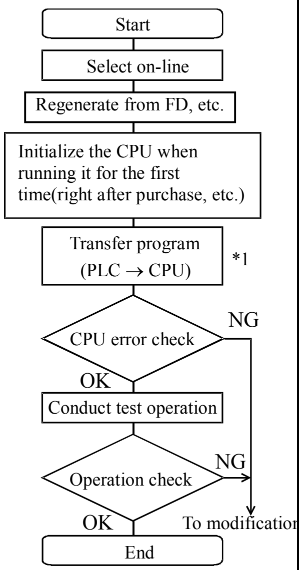
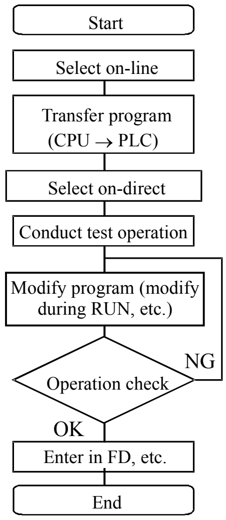
No.	Personal computer software used	DOS/V PC	PC9800 series personal computer
2	LADDER EDITOR (DOS version)		

Item	DOS/V PC	PC9800 series personal computer
CPU setting	Specify H-302.	
Memory assignment	Specify RAM-04H (4 k memory).	
Cable (MICRO-EH side)	EH-VCB02	EH-RS05
Cable (personal computer side)		PCCB02H

Port	Type	DIPSW	1	2	3	4		PC9800 series
Port 1 *1, *2	10-point type	There are no DIP switches (fixed to 4800 bps).						
	14/23/28-point type	Status	OFF	OFF	OFF	OFF	4800 bps	Same as left
Port 2	10/14-point type	Port 2 does not exist.						
	23/28-point type	Cannot be connected with the above configuration since the RS-422/485 are used (RS-232C/422 converters are required.) Set the transmission speed in the special internal output (WRF03D).						

*1: Settings of the port 1 can be changed when the DR signal is off. When the DR signal is on, the setting is fixed.
*2: Set the port 1 to the transmission control procedure 1 by the special internal output (WRF01A). (The default is the transmission control procedure 1.)
Note: Refer to the manual of the applicable software on how to install and operate each software (LADDER EDITOR).

Table 7.4 List of procedures for creating a program

Item	Create new program	Modify	Test operation, adjustment	
	Off-line	Off-line	On-line	On-direct
Out-line of opera-ting procedure				
Situation	When creating a new program	When modifying a program	When transferring a created program to the CPU for the first time	When modifying a program during test operation
Point	A program can be created without executing MICRO-EH.	When using a program that was used in another H-series, specify H-302 as the CPU type.	When performing CPU error check, make sure the I/O assignment matches the loaded module. (The loading read function can be used to match them forcibly.)	To enter the on-direct mode, match the contents in the CPU's memory and personal computer's memory. The modified contents will be reflected in both the computer memory and CPU memory.

*1: Set the flow size to 0 for memory assignment.
If a program transfer is performed by specifying the flow size, the message "Cannot execute: Operation error" is displayed, and a peripheral unit remain as WRITE occupied. In this case, either cancel the occupy state from LADDER EDITOR of the peripheral unit or by re-entering the CPU power.

The user program is managed in circuit units. One circuit can describe nine contact points (a-type contact point or b-type contact point) and seven coils as shown in the figure below.

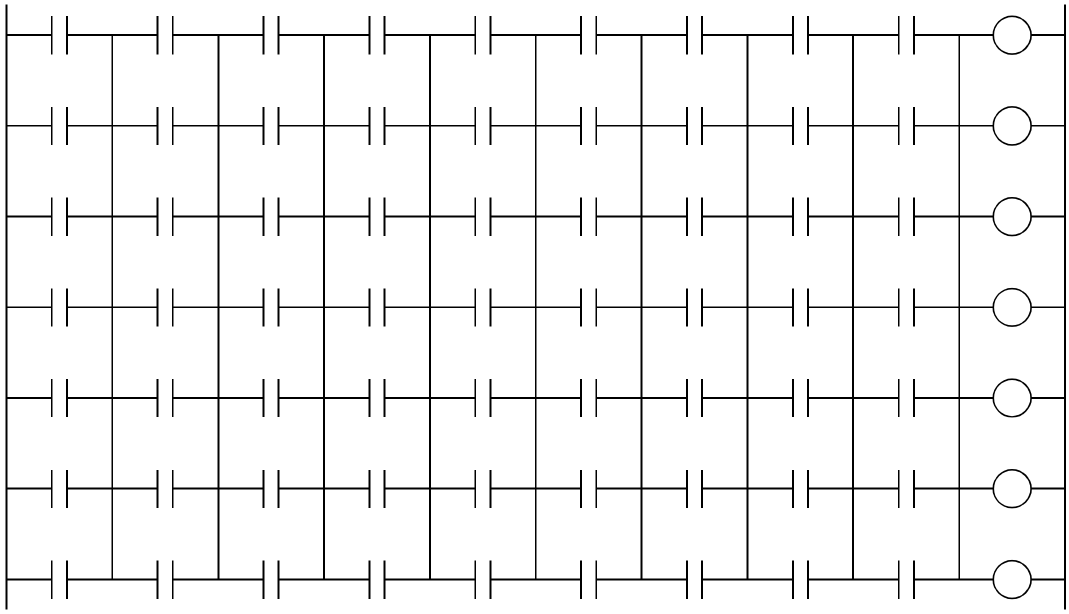


Figure 7.1 Size of one circuit

Or, one relational box can be described using the width of three contact points. The relational box can be considered as an a-type contact point that turns on when the conditions in the box are established (Figure 7.2).

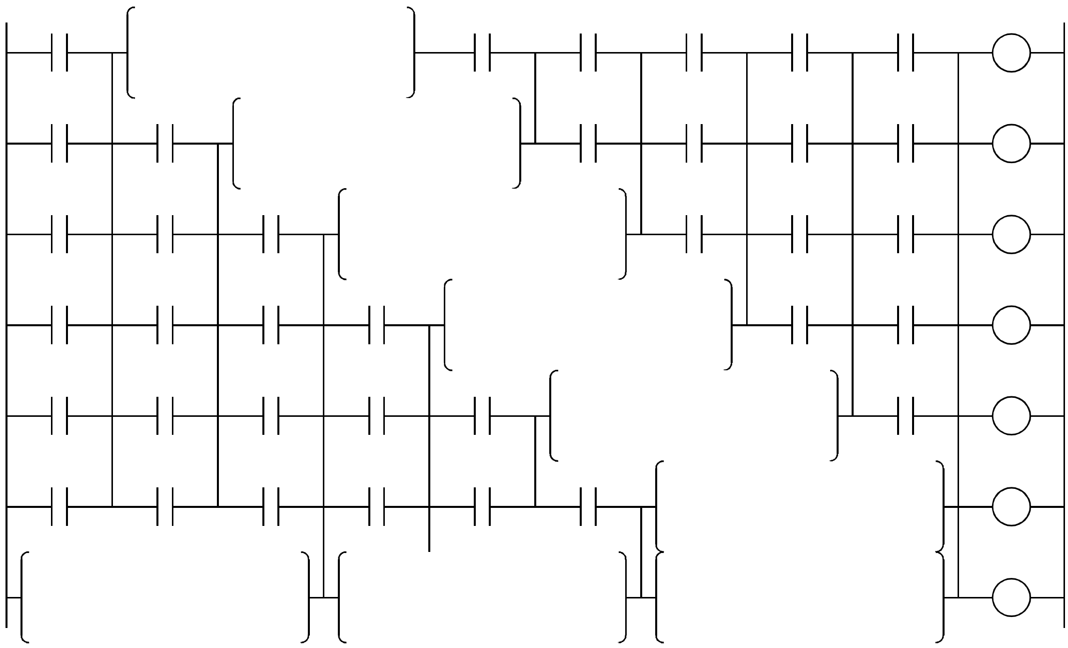


Figure 7.2 Example when using a relational box

In addition, if loop symbols are used, a circuit containing up to 57 contact points and one coil can be entered within seven lines.
However, an OR circuit cannot be input after a loop.

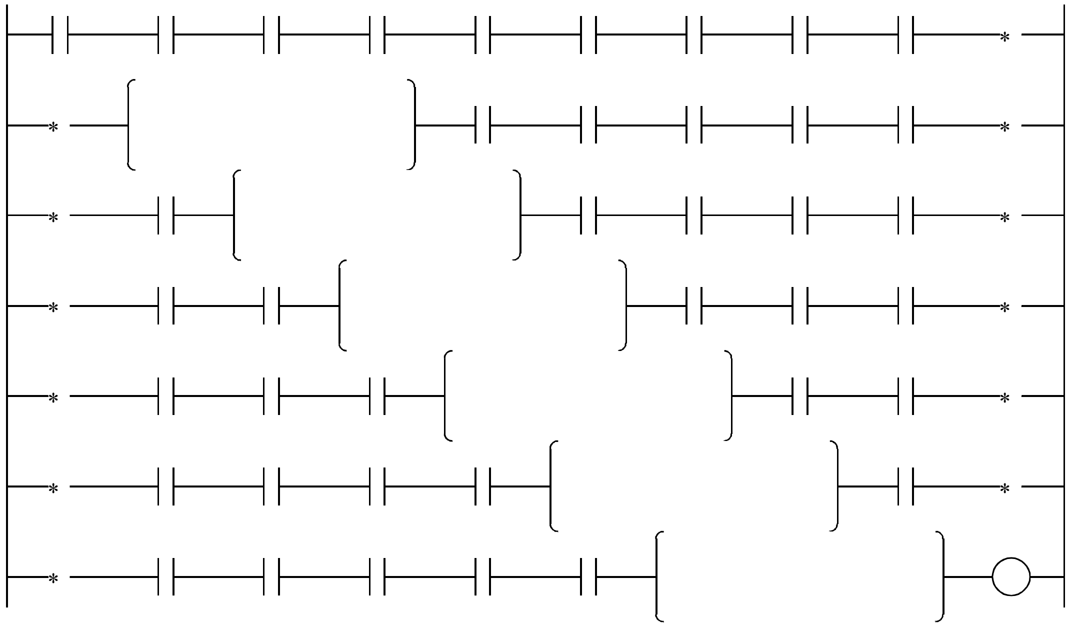


Figure 7.3 Example when using loop symbols

A processing box can be placed at the coil position. The processing instructions, application instructions, control instructions, transfer instruction and fun instructions can be described in a processing box. A maximum of 19 instructions can be described in one processing box. The processing box is executed when the conditions in the contact section to be connected directly in advance is established. The processing box is not executed if the condition is not established.
See the chapter on the “Instruction Specifications” for details on each instruction.

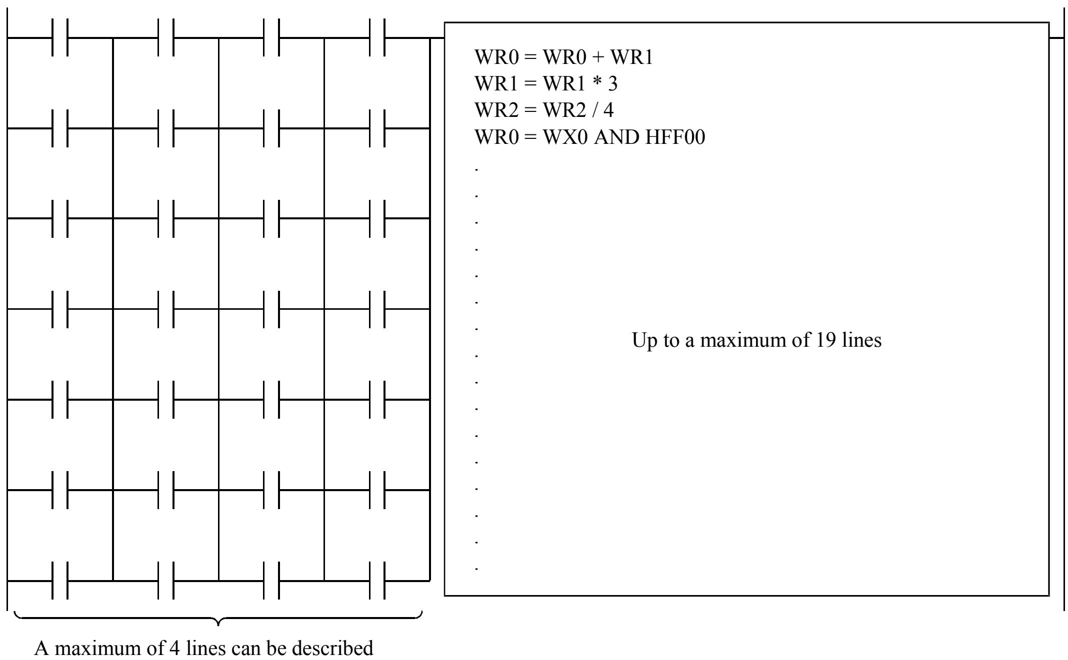


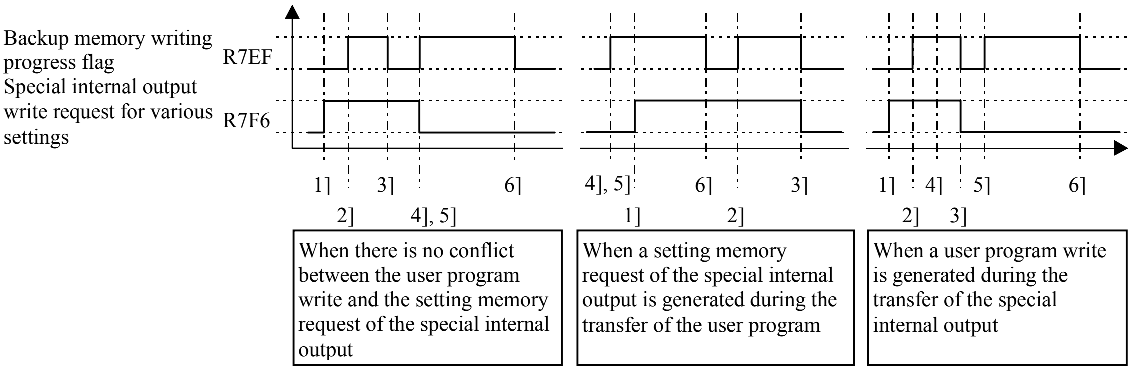
Figure 7.4 Example when using a processing box

Note: For the LADDER EDITOR for Windows®, a processing box can be displayed in one contact point width, so a circuit of nine contact points and one processing box can be entered.
For more details, refer to the user's manual for the LADDER EDITOR for Windows®.

7.4 Program Transfer

The MICRO-EH stores the user programs written from the peripheral units in the execution memory (RAM). Then, it transfers the user programs to the FLASH memory (backup memory) utilizing the idle time of the MPU in the internal area of the MICRO-EH. This is performed regardless of operation status of the CPU. Therefore, the programs may not be written into the backup memory (FLASH memory) even though the peripheral units display that program transfer has been completed. If the power is turned off before the programs are written to the FLASH memory, the customer's programs may be lost.
In order to prevent such crisis, it is necessary to monitor the Backup Memory Writing Progress Flag (R7EF) after the programs are transferred. When this bit special internal output is ON, it indicates that the data (programs, etc.) are being transferred to the backup memory. When is it OFF, it indicates that the data is not being written to the backup memory. Turning off the power after making sure that the Backup Memory Writing Progress Flag (R7EF) turns off after the program is transferred from the peripheral unit to the MICRO-EH will ensure that the program is backed up properly. (The transfer to the backup memory takes approximately two minutes.)
If a new program is written from a peripheral unit while a user program is being transferred to the backup memory (FLASH memory), the user program transfer to the backup memory will be stopped and the new program will be transferred to the backup memory. Therefore, the program that is stored in the backup memory will be the program that is written last.

In addition to the user programs, the settings to be stored in the special internal outputs can be transferred to the backup memory. The transfer of the special internal outputs for various settings (Note 1) can be executed by turning ON the Memory Request for Various Settings Flag (R7F6). As with the transfer of the user programs, the Backup Memory Writing Progress Flag (R7EF) will be turned ON during this transfer.
Figure 7.5 below shows the operation of the Backup Memory Writing Progress Flag (R7EF) during the backup of the special internal output for various settings and the backup of the user programs. Note that when one is being transferred, the next transfer will not start until the current transfer is complete.



1] R7F6 ON due to forced set or reset
2] Special internal output transfer start for various settings
3] Special internal output transfer end for various settings
4] Write from the peripheral unit is complete.
5] User program transfer start
6] User program transfer end

Figure 7.5 Operation of the bit special internal output when backup memory is being accessed

Note:
- The backup memory cannot be written during pulse output. If a program is changed during RUN with respect to the CPU during pulse output, turn off the power supply approximately two minutes after pulse output stops.
- Pulses cannot be output while the backup memory is being written. Commence pulse output once again after the Backup Memory Writing Progress Flag turns off.

Note 1) The following lists the special internal outputs for various settings that can be transferred to the backup memory by the Memory Request for Various Settings Flag (R7F6).

Table 7.5 List of special internal outputs that can be stored

No.	Special internal output that can be stored	Function	
1	WRF01A	Dedicated port 1	Communication settings
2	WRF03C	Dedicated port 1	Modem timeout time
3	WRF03D	Dedicated port 2	Communication settings
4	WRF06B	Pulse/PWM automatic correction settings	
5	WRF06C	Potentiometer 1	Filtering time
6	WRF06D	Potentiometer 2	Filtering time
7	WRF06E	Analog input type selection	
8	WRF06F	Phase counting mode	
9	WRF070	I/O operation mode	
10	WRF071	I/O detailed function settings	
11	WRF072	Output frequency On-preset value	
12	WRF073		
13	WRF074		
14	WRF075		
15	WRF076	On-duty value Off-preset value	
16	WRF077		
17	WRF078		
18	WRF079		
19	WRF07A	Pre-load value Pulse output value	
20	WRF07B		
21	WRF07C		
22	WRF07D		
23	WRF07E	Input edge	
24	WRF07F	Input filtering time	

Chapter 8 High-speed counter, PWM / Pulse train output and Analogue I/O

The MICRO-EH operates in four operation modes. By selecting the proper operation mode, input/output points can be assigned to the counter input, interrupt input, pulse output, and PWM output functions, instead of the normal input/output function.
The 14-point type model or higher are equipped with two potentiometers. The values of internal outputs can be changed externally using these potentiometers, without peripheral units.
The 23-point type model is equipped with two points of analogue input and one point of analogue output.
This chapter explains how to set various functions mentioned above, together with simple usage examples.

8.1 Input/Output Function

The normal input/output points can not only be used as they are, but can also be assigned special functions. In order to assign these special functions, it is necessary to select the right operation mode; the following briefly explains the procedure for selecting the operation modes. Refer to the section corresponding to each item for the details.

8.1.1 Initial Setting for Special Input/Output Function

Figure 8.1 shows a flowchart for the setting procedures.
First, select an operation mode. There are 5 operation modes, mode 0 to 3 and 10. By selecting an operation mode the input number to be used for high-speed counter input and the type of counter is determined, along with the output number for the corresponding output.
Next, the desired input/output function for each point of input/output should be selected, because the function assigned to input/output varies depending on the operation mode selected.
Lastly, set the operating conditions for each input/output function selected.
Furthermore, performing the settings mentioned above does not in itself make the settings valid for the actual operation. The settings become valid only after turning on the special internal output for individual setting (R7F5). After making the settings valid, it is possible to make changes for each function using the special internal output for individual setting.
Turning the special internal output (R7F6) on also stores the settings performed above in the FLASH memory. From the next time the power supply is turned on, the settings stored in the FLASH memory are automatically read; it is not necessary to perform the settings every time.

1] Set the operation mode

Set the number 0 to 3 corresponding to the mode you want to set in WRF070.
Refer to Table 8.1 for the details of each mode.
Note 1) If nothing is set, the settings stored in the FLASH memory become valid.
Note 2) If a number larger than 4 is set, mode 0 will be selected.
Note 3) After the settings are stored in the FLASH memory, it is not necessary to perform the settings after step 1] from the next time.

2] Set input/output terminal

Set the function of each input/output terminal in WRF071.
Refer to the section about detailed function settings for the details.
Note 4) If nothing is set, the initial value will become 0.

3] Set the operating conditions for each function

Set the operating conditions for each function in WRF072 to WRF07E.
Refer to the section about detailed operating condition settings for the details.
Note 5) If nothing is set, the initial value will become 0.

4] Make the settings valid

The settings performed in steps 1] to 3] become valid by turning R7F5 on.
Note 6) The settings performed in steps 1] to 3] do not become valid unless R7F5 is turned on while output is turned off.
Moreover, if R7F5 is turned on while the CPU is running, the settings do not become valid even though R7F5 is turned on. The settings become valid at the point when the CPU is stopped.

5] Change individual setting

6] Store the settings in the memory.

The settings performed in steps 1] to 3] are stored in the FLASH memory by turning R7F6 on.
It is not necessary to perform the settings again when the power supply is turned on for the next time.
Note 7) If R7F6 is not turned on, the settings will be changed to the ones stored in the FLASH memory when the power supply is turned on for the next time (if nothing is stored in the FLASH memory, the initial values will be set).
Note 8) When the CPU is operating, the settings are not stored in the FLASH memory by turning R7F6 on.
Note 9) R7EF turns on while the settings are transferred to the FLASH memory. If the power supply to the main unit is turned off while R7EF is on, the settings are not properly stored in the FLASH memory; there is a possibility that the parameter settings are initialized when the power supply is turned on for the next time.

Figure 8.1 Flow of operation mode setting procedure

8.1.2 Operation Mode

Select one mode from the 5 modes shown in Table 8.1 (mode 10 described in following pages.) and set the mode number in the special internal output WRF070 when the CPU is in STOP status.

*1: If parameter in WRF070 is not saved by R7F6, the value will be 0 at the next power on.
*2: The operation mode setting can be changed only when CPU is in STOP status.

Each input and output terminal setting is configured in WRF071.

Table 8.1 Operation mode list

<table>
<tr><th></th><th>Mode 0</th><th>Mode 1</th><th colspan="2">Mode 2</th><th colspan="2">Mode 3</th></tr>
<tr><td></td><td>Standard</td><td>Single-phase counter ×2</td><td colspan="2">Single-phase counter ×4</td><td colspan="2">2-phase counter ×1,
Single-phase counter ×1</td></tr>
<tr><td>X0</td><td>Standard input</td><td>Counter input 1</td><td colspan="2">Counter input 1</td><td colspan="2">Counter input 1A</td></tr>
<tr><td rowspan="3">X1</td><td>Standard input</td><td>Counter preload 1</td><td colspan="2">Counter preload 1</td><td colspan="2">Counter preload 1</td></tr>
<tr><td>Interrupt input 1</td><td>Counter strobe 1</td><td colspan="2">Counter strobe 1</td><td colspan="2">Counter strobe 1</td></tr>
<tr><td></td><td>Standard input [*6]</td><td colspan="2">Standard input [*6]</td><td colspan="2">Standard input [*6]</td></tr>
<tr><td>X2</td><td>Standard input</td><td>Counter input 2</td><td colspan="2">Counter input 2</td><td colspan="2">Counter input 1B</td></tr>
<tr><td rowspan="3">X3</td><td>Standard input</td><td>Counter preload 2</td><td colspan="2">Counter preload 2</td><td colspan="2">Counter input (marker) 1Z</td></tr>
<tr><td>Interrupt input 2</td><td>Counter strobe 2</td><td colspan="2">Counter strobe 2</td><td colspan="2"></td></tr>
<tr><td></td><td>Standard input [*6]</td><td colspan="2">Standard input [*6]</td><td colspan="2"></td></tr>
<tr><td>X4</td><td>Standard input</td><td>Standard input</td><td colspan="2">Counter input 3</td><td colspan="2">Standard input</td></tr>
<tr><td rowspan="3">X5</td><td>Standard input</td><td>Standard input</td><td colspan="2">Counter preload 3</td><td colspan="2">Standard input</td></tr>
<tr><td>Interrupt input 3</td><td>Interrupt input 3</td><td colspan="2">Counter strobe 3</td><td colspan="2">Interrupt input 3</td></tr>
<tr><td></td><td>Standard input [*6]</td><td colspan="2">Standard input [*6]</td><td colspan="2"></td></tr>
<tr><td>X6</td><td>Standard input [*3]</td><td>Standard input [*3]</td><td colspan="2">Counter input 4 [*3]</td><td colspan="2">Counter input 4 [*3]</td></tr>
<tr><td rowspan="3">X7</td><td>Standard input [*3]</td><td>Standard input [*3]</td><td colspan="2">Counter preload 4 [*3]</td><td colspan="2">Counter preload 4 [*3]</td></tr>
<tr><td>Interrupt input 4 [*3]</td><td>Interrupt input 4 [*3]</td><td colspan="2">Counter strobe 4 [*3]</td><td colspan="2">Counter strobe 4 [*3]</td></tr>
<tr><td></td><td>Standard input [*6]</td><td colspan="2">Standard input [*6]</td><td colspan="2">Standard input [*6]</td></tr>
<tr><td rowspan="3">Y100</td><td>Standard output</td><td>Counter output 1</td><td colspan="2">Counter output 1</td><td colspan="2">Counter output 1</td></tr>
<tr><td>PWM output 1</td><td>Standard output [*6]</td><td colspan="2">Standard output [*6]</td><td colspan="2">Standard output [*6]</td></tr>
<tr><td>Pulse output 1</td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td rowspan="3">Y101</td><td>Standard output</td><td>Counter output 2</td><td colspan="2">Counter output 2</td><td colspan="2">Standard output</td></tr>
<tr><td>PWM output 2 [*5]</td><td>Standard output [*6]</td><td colspan="2">Standard output [*6]</td><td colspan="2">PWM output 2 [*5]</td></tr>
<tr><td>Pulse output 2 [*5]</td><td></td><td colspan="2"></td><td colspan="2">Pulse output 2 [*5]</td></tr>
<tr><td rowspan="3">Y102</td><td>Standard output</td><td>Standard output</td><td colspan="2">Counter output 3</td><td colspan="2">Standard output</td></tr>
<tr><td>PWM output 3 [*5]</td><td>PWM output 3 [*5]</td><td colspan="2">Standard output [*6]</td><td colspan="2">PWM output 3 [*5]</td></tr>
<tr><td>Pulse output 3 [*5]</td><td>Pulse output 3 [*5]</td><td colspan="2"></td><td colspan="2">Pulse output 3 [*5]</td></tr>
<tr><td rowspan="3">Y103</td><td>Standard output</td><td>Standard output</td><td>Counter output 4 [*4]</td><td>Standard output</td><td>Counter output 4 [*4]</td><td>Standard output</td></tr>
<tr><td>PWM output 4 [*5]</td><td>PWM output 4 [*5]</td><td>Std. output [*6]</td><td>PWM out 4 [*5]</td><td>Std. output [*6]</td><td>PWM out 4 [*5]</td></tr>
<tr><td>Pulse output 4 [*5]</td><td>Pulse output 4 [*5]</td><td></td><td>Pulse out 4 [*5]</td><td></td><td>Pulse out 4 [*5]</td></tr>
</table>

*3: Modes 0 to 3 can be set regardless of the type of CPU however, note that the 10-point type does not have X6 and X7.
*4: It is only possible to select either Standard output, PWM output, or pulse output for the 10- point type CPU. (A counter corresponding output cannot be set because there is no counter input that can correspond to it.)
*5: It is possible to set for the relay output type, but the expected output waveform cannot be obtained. Moreover, care must be taken because it may cause an relay error.
*6: This assignment is supported by Ver.1.11 (WRF051=H0111) or newer.

8.1.3 Input/Output Setting

Configure each I/O setting in the special internal output (WRF071) and make it effective by setting R7F5 ON in CPU STOP status. This information is normally reset at every power on, but this can be saved in the FLASH memory by setting R7F5 ON after that.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF071:	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 8.2 Special internal output for setting detailed function

Mode 0

Name	Bit	Value	Bit	Value	Function
X0	-	-	-	-	Standard input (Fixed)
X1	a	0	b	0	Standard input
				1	Interrupt input
X2	-	-	-	-	Standard input (Fixed)
X3	c	0	d	0	Standard input
				1	Interrupt input
X4	-	-	-	-	Standard input (Fixed)
X5	e	0	f	0	Standard input
				1	Interrupt input
X6	-	-	-	-	Standard input (Fixed)
X7	g	0	h	0	Standard input
				1	Interrupt input

Name	Bit	Value	Bit	Value	Function
Y100	i	0	j	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-
Y101	k	0	l	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-
Y102	m	0	n	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-
Y103	o	0	p	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-

Mode 1

Name	Bit	Value	Bit	Value	Function
X0	-	-	-	-	Counter input (Fixed)
X1	a	0	b	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X2	-	-	-	-	Counter input (Fixed)
X3	c	0	d	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X4	-	-	-	-	Standard input (Fixed)
X5	e	0	f	0	Standard input
				1	Interrupt input
X6	-	-	-	-	Standard input (Fixed)
X7	g	0	h	0	Standard input
				1	Interrupt input

Name	Bit	Value	Bit	Value	Function
Y100	i	0	j	0	Counter output
				1	Standard output *1
		1		0	
				1	
Y101	k	0	l	0	Counter output
				1	Standard output *1
		1		0	
				1	
Y102	m	0	n	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-
Y103	o	0	p	0	Standard output
				1	PWM output
		1		0	Pulse output
				1	-

*1 : Supported by software version.1.11 or newer.

Mode 2

Name	Bit	Value	Bit	Value	Function
X0	-	-	-	-	Counter input (Fixed)
X1	a	0	b	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X2	—	—	—	—	Counter input (Fixed)
X3	c	0	d	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X4	—	—	—	—	Counter input (Fixed)
X5	e	0	f	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X6	—	—	—	—	Counter input (Fixed)
X7	g	0	h	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1

Name	Bit	Value	Bit	Value	Function	
Y100	i	0	j	0	Counter output	
				1	Standard output *1	
		1		0		
				1		
Y101	k	0	l	0	Counter output	
				1	Standard output *1	
		1		0		
				1		
Y102	m	0	n	0	Counter output	
				1	Standard output *1	
		1		0		
				1		
Y103	o	0	p	0	Counter output	Std. output *2
				1	Standard output *1	PWM output *2
		1		0		Pulse output *2
				1		

*1 : Supported by software version 1.11 or newer.
*2 : Configuration for 10 point type.

Mode 3

Name	Bit	Value	Bit	Value	Function
X0	—	—	—	—	2 phase Counter 1A (Fixed)
X1	a	0	b	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1
X2	—	—	—	—	2 phase counter 1B (Fixed)
X3	c	0	d	0	Counter input 1Z (Fixed)
X4	—	—	—	—	Standard input (Fixed)
X5	e	0	f	0	Standard input
				1	Interrupt input
X6	—	—	—	—	Counter input (Fixed)
X7	g	0	h	0	Counter preload
				1	Counter strobe
		1		0	Standard input *1

Name	Bit	Value	Bit	Value	Function	
Y100	i	0	j	0	Counter output	
				1	Standard output *1	
		1		0		
				1		
Y101	k	0	l	0	Standard output	
				1	PWM output	
		1		0	Pulse output	
				1	-	
Y102	m	0	n	0	Standard output	
				1	PWM output	
		1		0	Pulse output	
				1	-	
Y103	o	0	p	0	Counter output	Standard output *2
				1	Standard output *1	PWM output *2
		1		0		Pulse output *2
				1		-

*1 : Supported by software version 1.11 or newer.
*2 : Configuration of 10 point type.

8.1.4 Input/Output Setting (Mode 10)

Mode 10 had been added since Ver. 01.13. I/O assignment of mode 10 is very flexible as follows.

Parameter setting is compatible with existing mode 0 to 3 except for WRF071. Operation of FUN command (FUN 140 - 150) is same for all the mode 0 to 10.

■ Outline

Input and output are configured in every group as below.

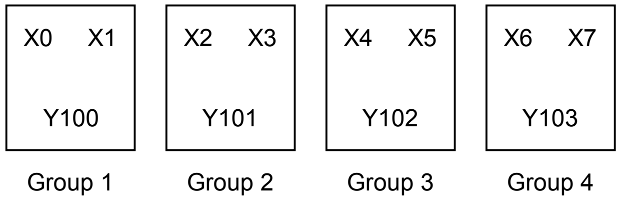


Fig. 8.4 Group of mode 10

■ Mode setting

Set "H10" to the special internal output WRF070.

■ In/output setting

Set parameter according to the following table to the special internal output WRF071.

Bit :	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF071 :	Group 1				Group 2				Group 3				Group 4			
Default :	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 8.5 Bit table of WRF071

Select one of below combinations and set in WRF071 for every group.

Fig. 8.2 Parameter for in/output setting

Parameter	X0 / 2 / 4 / 6	X1 / 3 / 5 / 7	Y100/101/102/103
H 0	Standard input	Standard input	Standard output
H 1			PWM output
H 2			Pulse output
H 3		Interrupt input	Standard output
H 4			PWM output
H 5			Pulse output
H 6	Counter input	Standard input	Standard output
H 7			Counter output
H 8		Preload input	Standard output
H 9			Counter output
H A		Strobe input	Standard output
H B			Counter output
Others	Standard input	Standard input	Standard output

Since 10 points type does not have input X6 and X7, possible value for group 4 is 0 to 2.

■ Example

Group	Function			Value
1	X0 : Standard input	X1 : Standard input	Y100 : Pulse output 1	➔ H2
2	X2 : Counter 2	X3 :Preload input 2	Y101 : Standard output	➔ H8
3	X4 : Counter 3	X5 : Standard input	Y102 : Counter output 3	➔ H7
4	X6 : Standard input	X7 : Interrupt input 4	Y103 : Standard output	➔ H3

➔ WRF071 = H2873

8.1.5 Special Output Operation in CPU STOP Status

Generally the counter output, PWM output and pulse output are not generated if the CPU is in the STOP state. To output these outputs when the CPU is in the STOP state, turn on the special internal output R7DC. By turning on the special internal output R7DC for controlling the special outputs in the STOP state, the operation of the special outputs at the time of test operation can be checked, and the outputs that are independent of the RUN and STOP states of the CPU can be output. Note that the R7DC is set to 0 when the power is turned on. Also, if the output control flag (R7FC to R7FF) is turned on while the CPU is in the STOP state and the R7DC is off, the output flag is turned off by the system.

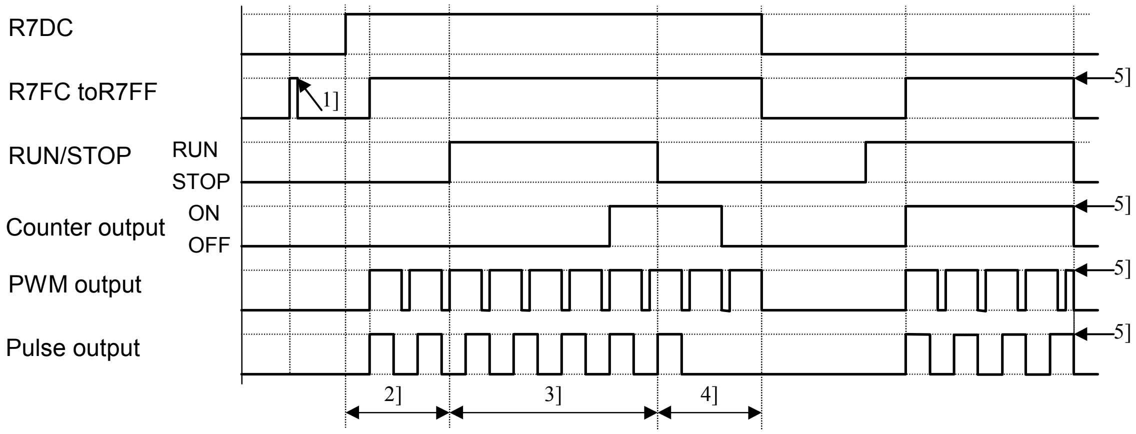


Figure 8.4 Operation of special outputs when the CPU is in the RUN/STOP states

1] When the R7DC is off, the output control flag is turned off by the system.
2] When the R7DC is on, the corresponding special output turns on by turning on the output control flag.
  * The counter output of the counter turns on when the condition is satisfied.
3] The special outputs turn on and off according to the user program.
4] The special outputs are being output while the output condition is satisfied or the R7DC is on.
5] The special outputs turn on and off according to the RUN/STOP states of the CPU. The output control flag is turned off by the system when the CPU operation stops.
  * The special outputs continue to be output as long as the CPU operation continues, even if an error has occurred when the operation is set to be continued when I/O assignments do not match or when a congestion error occurs.

8.1.6 Pulse / PWM Output adjustment

The transistor output that generates the pulse output and PWM output contains a hardware delay time. This delay time affects the on-duty significantly as the frequency increases. In addition, this delay time is slightly different depending on the CPU model. By setting the value that corresponds to the CPU model in the special internal output WRF06B for setting the PWM/pulse output correction, both the PWM output and pulse output with no load in the system can be corrected.
Caution: There will be a slight error even if correction setting is performed.
These special internal outputs are stored in the FLASH memory by turning on the various setting write request (R7F6). Once the setting is stored in the FLASH memory, it is not necessary to make the setting again when the power is turned on next time.

WRF06B:	Setting value indicating the CPU model

Figure 8.3 Special internal outputs for setting PWM/pulse output correction

CPU model	Setting value	Remark
EH-***DTP	H0001	
EH-***DT	H0002	
EH-***DRP	H0003	
EH-***DRT	H0004	
Other than above	Other than above	No correction

Note: *** changes depending on the CPU.

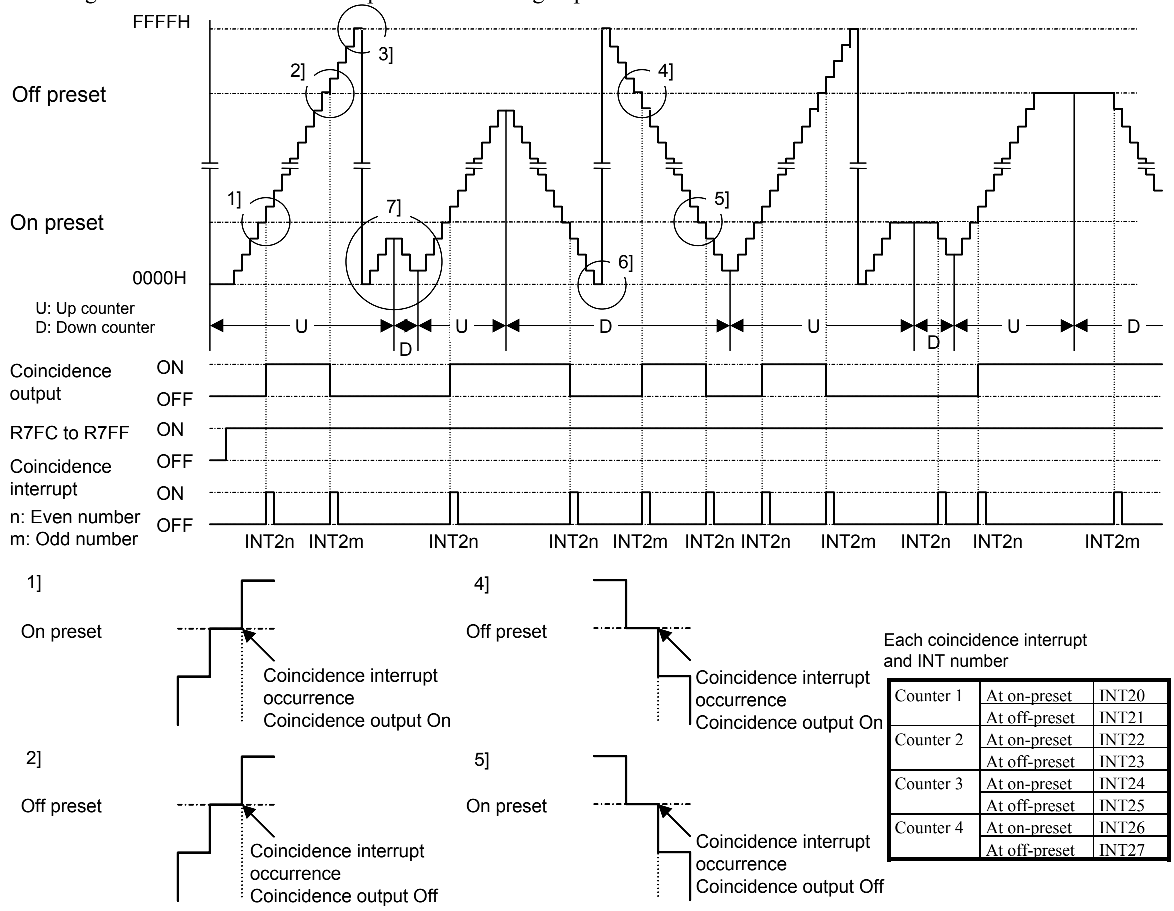
8.2 High-Speed Counter (Single-Phase)

The high-speed counter settings are stored in the special internal outputs (WRF070 to 7E). It is only possible to perform the setting through the special internal output (WRF071) when the CPU is stopped and the output is turned off. Once all the input/output settings are completed, the settings of each counter can be changed using the special internal outputs for individual setting (WRF058 to 5B), regardless of whether the CPU is operating or stopped. In addition, the settings can be changed by a program using the FUN instruction (FUN140 to 142, and 146). Refer to the chapter about the FUN instruction for information about how to use the FUN instruction for setting.

8.2.1 Operation of Single-Phase Counter

(1) Basic operation

Figure 8.5 describes the basic operation of the high-speed counter.



Counter 1	At on-preset	INT20
	At off-preset	INT21
Counter 2	At on-preset	INT22
	At off-preset	INT23
Counter 3	At on-preset	INT24
	At off-preset	INT25
Counter 4	At on-preset	INT26
	At off-preset	INT27

Figure 8.5 Basic operation of high-speed counter (single-phase)

Up counter

1] The counter output turns on* when the current counter value becomes larger than the on-preset value. The interrupt process (INT2n) starts up if an interrupt program is used in the running user program.

2] The counter output turns off when the current counter value becomes larger than the off-preset value. The interrupt process (INT2m) starts up if an interrupt program is used in the running user program.

3] The counter values wrap around in a ring. That is, the current counter value goes back to 0h when one more pulse is counted after the maximum value (FFFFH) is reached.

Down counter

4] The counter output turns on* when the current counter value becomes smaller than the off-preset value. The interrupt process (INT2m) starts up if an interrupt program is used in the running user program.

5] The counter output turns off when the current counter value becomes smaller than the on-preset value. The interrupt process (INT2n) starts up if an interrupt program is used in the running user program.

6] The counter values wrap around in a ring. That is, the current counter value becomes FFFFH when one more pulse is counted after the minimum value (0H) is reached. Note also that the initial value of the counter is 0H, and the value reaches FFFFH after the first pulse is counted after the start of operation.

Others

7] The user program can switch from using a counter as an up counter to a down counter, as well as from a down counter to an up counter while the counter is operating (using FUN142).

* The counter output does not turn on unless the control output flag (R7FC to R7FF) is turned on.

(2) Preload input operation

When a preload signal is entered, the current counter value is reset to the preload value.
The counter output is controlled only when the on-preset value or off-preset value is exceeded by the progress of the counter value. Because of this, the counter output maintains its status before the preload input when the on-preset or off-preset value is exceeded due to the preload value (when jumping from the Off area to the On area, or vice versa). Also, the status of the counter output is reflected in the data memory at the timing of the refresh process. Therefore, it should be noted that the status monitored by peripheral units, etc. and the actual output status may be different (by a delay of one scan).

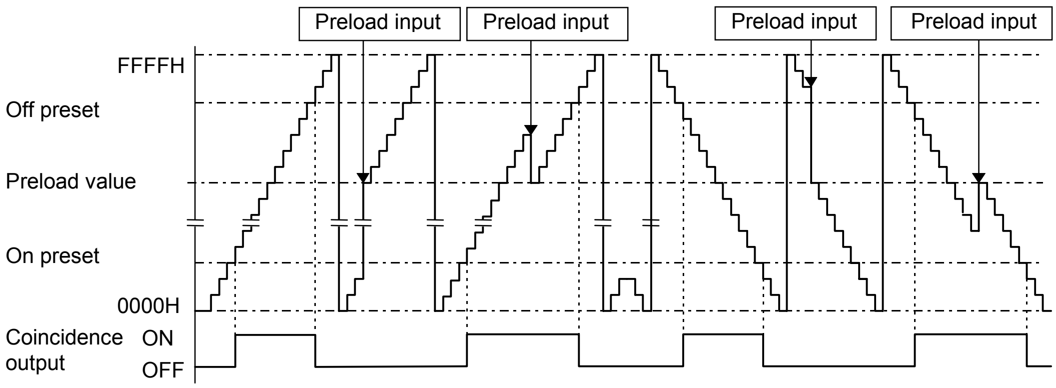


Figure 8.6 Preload input operation of high-speed counter (single-phase)

(3) Strobe input operation

When a strobe signal is entered, the current counter progress value is stored in the strobe storage area (WRF07A to 7D) of the special internal output.

(4) Current value clear instruction operation

When the current value clear instruction (FUN144) is executed, the current counter value is reset (cleared) to zero.
The counter output is controlled only when the on-preset value or off-preset value is exceeded by the progress of the counter value. Because of this, the counter output maintains its status before the execution of the current value clear instruction when either the on-preset or off-preset value is exceeded due to the execution of the current value clear instruction (when jumping from the Off area to the On area, or vice versa).

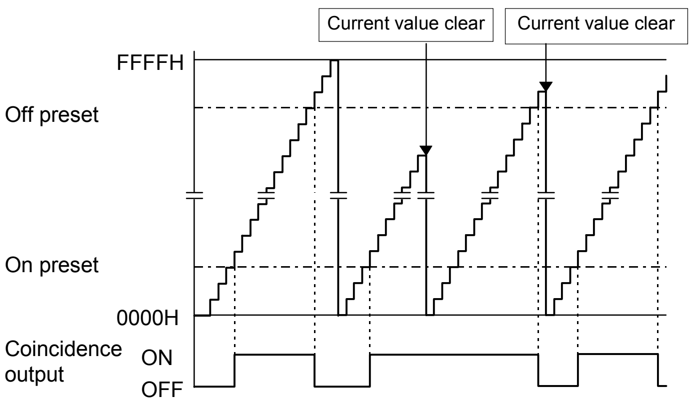


Figure 8.7 Current value clear instruction operation of high-speed counter (single-phase)

8.2.2 Setting of Single-Phase Counter

If either one of operation modes 1, 2, or 3 is selected, the single-phase counter should be set using the special internal output (WRF072 to WRF07E). In order to make the contents of the various settings valid, it is necessary to turn on the special internal output R7F5. The settings can be changed using the FUN instruction during the CPU operation (some settings cannot be changed, however.)

(1) Setting the counter input

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF07E:	a	b	c	d	e	f	g	h	Not used							
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 8.8 Special internal output for setting counter input

	Bit	Setting value	Count edge	Bit	Setting value	Count operation
Counter 1	a	0	Rising edge	e	0	Up count operation *1
		1	Falling edge		1	Down count operation *1
Counter 2	b	0	Rising edge	f	0	Up count operation *1
		1	Falling edge		1	Down count operation *1
Counter 3	c	0	Rising edge	g	0	Up count operation *1
		1	Falling edge		1	Down count operation *1
Counter 4	d	0	Rising edge	h	0	Up count operation *1
		1	Falling edge		1	Down count operation *1

*1 Can also be made valid by executing FUN142.
In case of mode 1, the settings for counter 3 and 4 are ignored.
In case of mode 3, the settings for counter 1 to 3 are ignored.

(2) Setting the on-preset value
Set the count value at which the counter output is turned on (the on-preset value) for every counter used. Any value in the range from 0 to FFFFH (0 to 65, 535) can be set. If the on-preset value is set to the same value as the off-preset value, the counter will not perform any counting operation (see (5)).

WRF072:	On-preset value for counter 1
WRF073:	On-preset value for counter 2
WRF074:	On-preset value for counter 3
WRF075:	On-preset value for counter 4

Figure 8.9 Special internal outputs for setting the on-preset values

In case of mode 1, WRF074 and WRF075 are used to set the frequency for the PWM/pulse outputs.
In case of mode 3, WRF073 and WRF074 are used to set the frequency for the PWM/pulse outputs.

(3) Setting the off-preset value
Set the count value at which the counter output is turned off (the off-preset value) for every counter used. Any value in the range from 0 to FFFFH (0 to 65, 535) can be set. If the off-preset value is set to the same value as the on-preset value, or larger than the on-preset value, the counter will not perform any counting (see (5).).

WRF076:	Off-preset value for counter 1
WRF077:	Off-preset value for counter 2
WRF078:	Off-preset value for counter 3
WRF079:	Off-preset value for counter 4

Figure 8.10 Special internal outputs for setting off-preset values

In case of mode 1, WRF078 and WRF079 are used to set the on-duty for the PWM/pulse outputs.
In case of mode 4, WRF077 and WRF078 are used to set the on-duty for the PWM/pulse outputs.

(4) Setting the counter preload

When preloading is used, the value to be preloaded should be set for each counter used. Any value in the range from 0 to FFFFH (0 to 65,535) can be set.

WRF07A:	Preload value for counter 1
WRF07B:	Preload value for counter 2
WRF07C:	Preload value for counter 3
WRF07D:	Preload value for counter 4

Figure 8.11 Special internal outputs for setting the preload values

This special internal output becomes valid immediately after the setting.
In case of mode 1, WRF07C and WRF07D are used to set the number of pulse outputs.
In case of mode 4, WRF07B and WRF07B are used to set the number of pulse outputs.

(5) At abnormal setting

If the on-preset and off-preset settings contain the same values for one or more counters when the PI/O function setting flag (R7F5) is turned on, the corresponding bit in the error display special internal output turns on and the counters with error settings do not perform any counting. (It does not count even if a counter input is entered.) In addition, the setting abnormal flag (R7F7) turns on.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF057:	a	Not used							b	c	d	e	f	g	h	i

Figure 8.12 Special internal output for setting error display

Bit	Description of abnormality	Related terminal
a	Total pulse frequency abnormality	Y100 to Y103
b	Pulse 4 frequency abnormality	Y103
c	Pulse 3 frequency abnormality	Y102
d	Pulse 2 frequency abnormality	Y101
e	Pulse 1 frequency abnormality	Y100
f	Counter 4 preset value abnormality	X6
g	Counter 3 preset value abnormality	X4
h	Counter 2 preset value abnormality	X2
i	Counter 1 preset value abnormality	X0

(6) Individual counter setting

The on-preset and off-preset values can be changed for each counter by the special internal outputs for individual setting regardless of whether the CPU is operating or stopped. Turn on the corresponding bit in the following special internal outputs when only the on-preset or the off-preset value should be changed for a certain counter input. (To change both settings at the same time, set the "H3" in the corresponding special internal outputs for individual setting.)
Moreover, when the specified on-preset and off-preset values are the same, the corresponding bit of the error display special internal output is turned on and operation is performed using the preset value before the setting. (The set value for the special internal output also returns to the preset value before the setting was made)

		15 … 2	1	0
WRF058:	Counter 1	Not used	a	b
WRF059:	Counter 2	Not used	a	b
WRF05A:	Counter 3	Not used	a	b
WRF05B:	Counter 4	Not used	a	b

Figure 8.13 Special internal outputs for individual counter setting

Bit	Description
a	Off-preset change request
b	On-preset change request

In case of mode 1, WRF05A and WRF05B are used to set individual PWM/pulse outputs.
In case of mode 4, WRF059 and WRF05A are used to set individual PWM/pulse outputs.

8.3 High-Speed Counter (Two-Phase Counter)

When operation mode 3 is selected, two-phase counters can be used. Four kinds of phase counting modes are available for two-phase counters.
The settings of the two-phase counters are stored in the special internal outputs (WRF06F to 72, 76, 7A, and 7E). It is only possible to perform the settings through the special internal output (WRF071) when the CPU is stopped and the output is turned off. Once all the input/output settings are completed, the setting of each counter can be changed using the special internal outputs for individual setting (WRF058), regardless of whether the CPU is operating or stopped. In addition, the setting can be changed by a program using the FUN instruction (FUN140 to 142, and 146). Refer to the chapter about the FUN instruction for information about how to use the FUN instruction for setting.

8.3.1 Operation of Two-Phase Counters

The phase counting mode settings are stored in the special internal output (WRF06F). The operation of the counter values is the same as for a single-phase counter and likewise wrap around from 0000H to FFFFH. In case of an up counter, the count value becomes 0000H if one more pulse is input while the current count value is FFFFH. In case of a down counter, the count value becomes FFFFH if one more pulse is input while the current count value is 0000H. Moreover, the preload input operation, strobe input operation, and executing operation of the current value clear instruction are run in the same manner as for a single-phase counter. The status of the counter output is stored in the data memory at the timing of the refresh process. Therefore, it should be noted that the status monitored by peripheral units, etc. and the actual output status may be different (by a delay of one scan).

(1) Phase counting mode 0

The counter counts up when input 1A is ahead of input 1B, and down when input 1A is lagging behind input 1B.

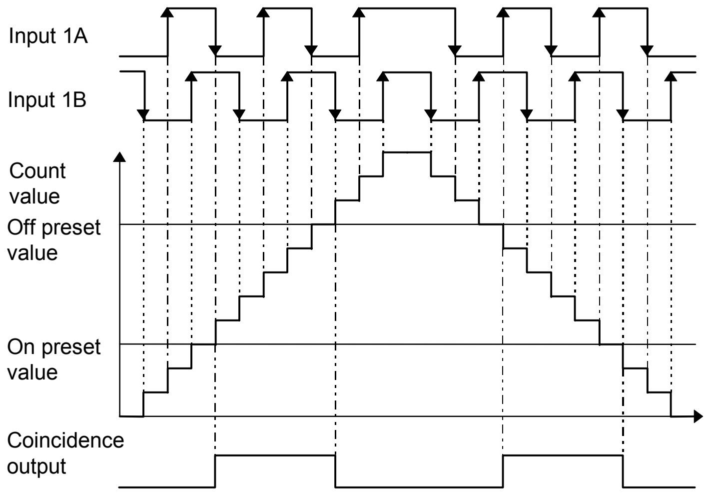


Figure 8.14 Counting operation of phase counting mode 0

Input 1A	Input 1B	Operation
1 (High)	↑ (Rising edge)	Up count
0 (Low)	↓ (Falling edge)	
↓ (Falling edge)	1 (High)	
↑ (Rising edge)	0 (Low)	
0 (Low)	↑ (Rising edge)	Down count
1 (High)	↓ (Falling edge)	
↓ (Falling edge)	0 (Low)	
↑ (Rising edge)	1 (High)	

(2) Phase counting mode 1

In this mode the counter counts at the rising edge of input 1A. At this point, if input 1B is 0 (Low) it counts up, and if input 1B is 1 (High) it counts down.

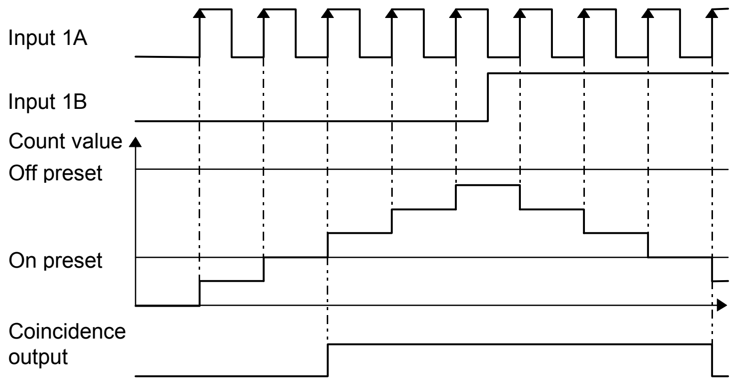


Figure 8.15 Counting operation of phase counting mode 1

Input 1A	Input 1B	Operation
1 (High)	↑ (Rising edge)	Do not count
0 (Low)	↓ (Falling edge)	
↓ (Falling edge)	1 (High)	
↑ (Rising edge)	0 (Low)	Up count
0 (Low)	↑ (Rising edge)	Do not count
1 (High)	↓ (Falling edge)	
↓ (Falling edge)	0 (Low)	
↑ (Rising edge)	1 (High)	Down count

(3) Phase counting mode 2

In this mode, if input 1B is 0 (Low) at the rising edge of input 1A the counter counts up, and if input 1A is 0 (Low) at the rising edge of input 1B, the counter counts down.

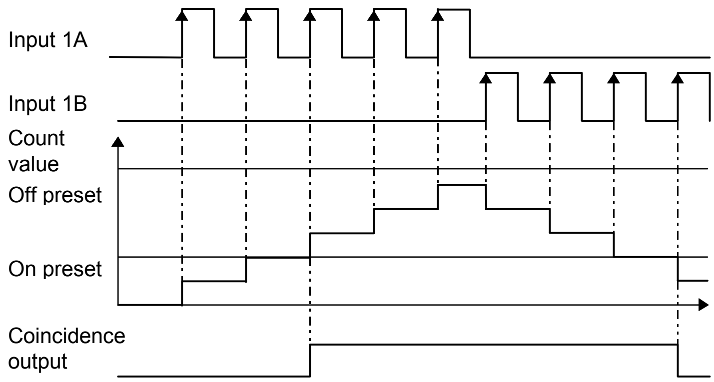


Figure 8.16 Counting operation of phase counting mode 2

Input 1A	Input 1B	Operation
1 (High)	↑ (Rising edge)	Do not count
0 (Low)	↓ (Falling edge)	
↓ (Falling edge)	1 (High)	
↑ (Rising edge)	0 (Low)	Up count
0 (Low)	↑ (Rising edge)	Down count
1 (High)	↓ (Falling edge)	Do not count
↓ (Falling edge)	0 (Low)	
↑ (Rising edge)	1 (High)	

(4) Phase counting mode 3

In this mode the counter counts at the rising and falling edge of input 1B. It counts up when input 1A is more ahead of input 1B, and down when input 1A is lagging behind input 1B.

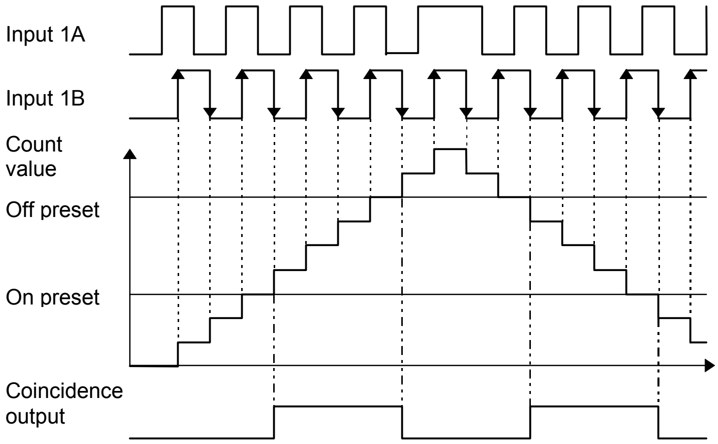


Figure 8.17 Counting operation of phase counting mode 3

Input 1A	Input 1B	Operation
1 (High)	↑ (Rising edge)	Up count
0 (Low)	↓ (Falling edge)	
↓ (Falling edge)	1 (High)	Do not count
↑ (Rising edge)	0 (Low)	
0 (Low)	↑ (Rising edge)	Down count
1 (High)	↓ (Falling edge)	
↓ (Falling edge)	0 (Low)	Do not count
↑ (Rising edge)	1 (High)	

(5) Clear input operation (common to all the phase counting modes)

The count value is cleared at the rising edge of input 1Z. As an example, the clear operation of phase counting mode 4 is shown in Figure 8.18. (The clear operation works identically for all four phase counting modes.)

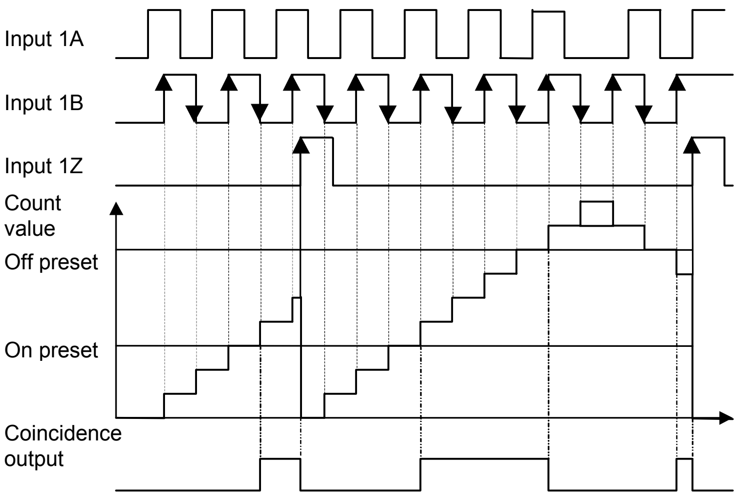


Figure 8.18 Count value clear operation (phase counting mode 4)

8.3.2 Setting of Two-Phase Counter

The setting of the two-phase counters are stored in the special internal outputs (WRF072 to WRF07E).

(1) Phase counting mode

Set the phase counting mode (0-3) in WRF06E. Please see the chapter 8.3.1 about phase counting mode.

WRF06F:	Phase counting mode

Figure 8.19 Special internal output for phase counting mode

(2) Setting the on-preset value

Set the count value (the on-preset value) at which the counter output is turned on (or off). Any value in the range from 0 to FFFFH (0 to 65, 535) can be set. If the on-preset value is set to the same value as the off-preset value, or smaller than the off-preset value, the counter will not perform any counting (see (4).).

WRF072:	On-preset value for two-phase counter

Figure 8.20 Special internal output for setting the on-preset value

(3) Setting the off-preset value

Set the count value (the off-preset value) at which the counter output is turned off (or on). Any value in the range from 0 to FFFFH (0 to 65, 535) can be set. If the off-preset value is set to the same value as the on-preset value, or larger than the on-preset value, the counter will not perform any counting (see (4).).

WRF076:	Off-preset value for two-phase counter

Figure 8.21 Special internal output for setting the off-preset value

(4) Setting the counter preload

When preloading is used, the value to be preloaded should be set for each counter used. Any value in the range from 0 to FFFFH (0 to 65, 535) can be set.

WRF07A:	Preload value for two-phase counter

Figure 8.22 Special internal output for setting the preload value

This special internal output becomes valid immediately after the setting.

(5) Diagnostic error

If the on-preset and off-preset settings contain the same values for one or more counters when the PI/O function setting flag (R7F5) is turned on, the corresponding bit in the abnormality display special internal output turns on and the counters with abnormal settings do not perform any counting. (It does not count even if a counter input is entered.) In addition, the setting abnormal flag (R7F7) turns on.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF057:	a	Not used							b	c	d	e	f	g	h	I

Figure 8.23 Special internal output for input/output function abnormality

Bit	Description of abnormality	Related terminal
a	Total pulse frequency abnormality	Y100 to Y103
b	Pulse 4 frequency abnormality	Y103
c	Pulse 3 frequency abnormality	Y102
d	Pulse 2 frequency abnormality	Y101
e	Pulse 1 frequency abnormality	Y100
f	Counter 4 preset value abnormality	X6
g	Counter 3 preset value abnormality	-
h	Counter 2 preset value abnormality	-
i	Two-phase counter 1 preset value abnormality	X0 to X3

(5) Individual counter setting

The on-preset and off-preset values can be changed for each two-phase counter by the special internal output for individual setting (WRF058) regardless of whether the CPU is operating or stopped. Turn on the corresponding bit in the following special internal outputs when only the on-preset or the off-preset value should be changed for a two-phase counter. (To change both settings at the same time, set the "H3" in the corresponding special internal outputs for individual setting.)
Moreover, when the specified on-preset and off-preset values are the same, the corresponding bit of the error display special internal output is turned on and operation is performed using the preset value before the setting. (The set value for the special internal output also returns to the preset value before the setting was made)

		15 – 2	1	0
WRF058:	Two-phase counter	Not used	a	b

Figure 8.24 Special internal output for individual setting of counter setting values

Bit	Description
a	Off-preset change request
b	On-preset change request

8.4 PWM Output

A PWM output can be set as an output by setting the operation mode and output terminal. By setting an output to a PWM output, a pulse with a duty ratio in the range that corresponds to the specified frequency can be output.

8.4.1 Operation of PWM Output

The PWM output settings are stored in the special internal outputs. It is only possible to perform the settings through the special internal output when the CPU is stopped and the output is turned off. Once all the input/output settings are completed, the setting of each PWM output can be changed using the special internal outputs for individual setting, regardless of whether the CPU is operating or stopped. In addition, the settings can be changed by a program using the FUN instruction (FUN148). See the chapter about the FUN instruction for information about how to use the FUN instruction for setting.

(1) Basic operation

The special internal outputs R7FC to R7FF are used to control the output. When these special internal outputs are turned on, a pulse is output at the frequency and the on-duty set in the special internal outputs (WRF072 to 79). When the special internal output for output control is turned off, the PWM output is also turned off. The special internal outputs R7FC to R7FF correspond to PWM outputs 1 to 4 (Y100 to Y103); for example, if R7FD is turned on, a pulse train is output from PWM output 2 (Y101). The on/off status of the PWM outputs is not stored in the data memory. Therefore, the status of the terminals used for PWM output monitored by peripheral units, etc. may be different from the actual status of the PWM output terminals.
When a fatal or serious error occurs in the CPU, there will be no output. The output is also stopped if a fatal or serious error occurs in the CPU during output.

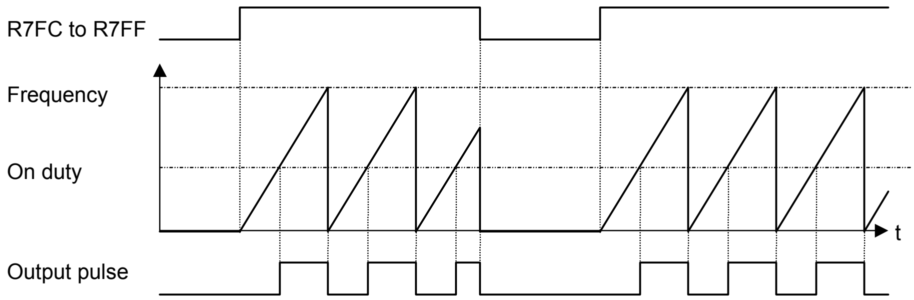


Figure 8.25 Basic operation of PWM output

(2) Operation when setting values are changed

The settings of each PWM output (frequency and on-duty) can be changed by the FUN instruction or the special internal outputs (WRF072 to 79) regardless of whether the CPU is operating or stopped.

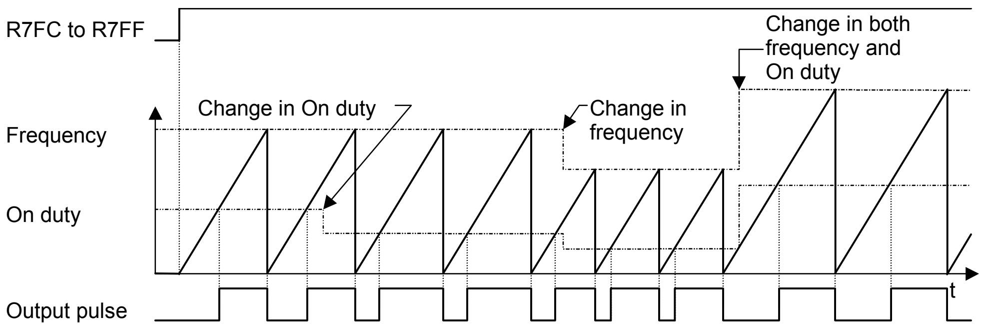


Figure 8.26 Operation of PWM output when setting values are changed.

(3) Operation at abnormal settings

The PWM output is not output if the on-duty is set to a value other than the range in use. However, the FUN instruction does not execute setting change when the setting value is abnormal.

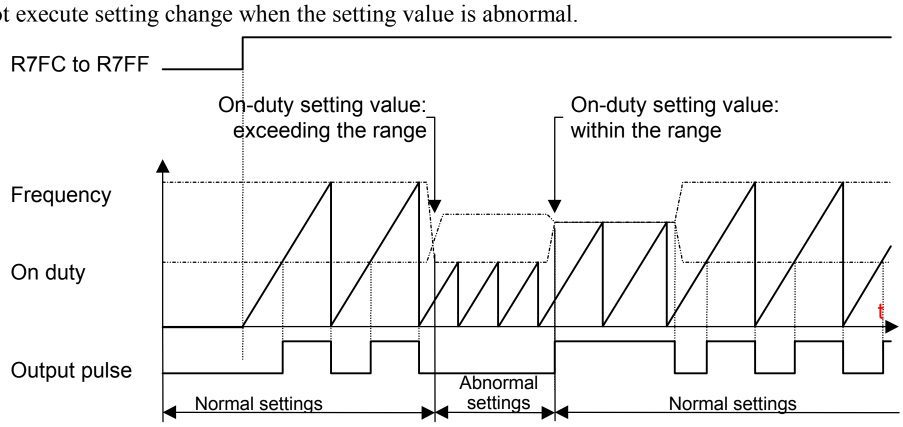


Figure 8.27 Operation of PWM output at abnormal settings

8.4.2 Setting the PWM Output

The settings of the PWM output operation are stored in the special internal outputs (WRF072 to WRF079).

(1) Setting the PWM output frequency

Set the frequency of output pulse for each PWM output to be used in special internal outputs. The setting values must be 10 to 2000 (HA to H7D0). If the frequency value is set to less than 10 Hz, it is changed to 10 Hz by the system.
It should be noted that the maximum frequency of the PWM output is 2 kHz. Even if a value larger than the maximum frequency is set, an error flag, etc. will not be output, so be careful not to set a frequency that exceeds 2 kHz.
(Example) If the output frequency is 1 kHz, set “1000” (H3E8) in the special internal outputs.

WRF072:	Output frequency for PWM output 1
WRF073:	Output frequency for PWM output 2
WRF074:	Output frequency for PWM output 3
WRF075:	Output frequency for PWM output 4

Figure 8.28 Special internal outputs for setting the PWM output frequency

In case of mode 1, WRF072 and WRF073 are used to set the on-preset value of a counter.
In case of mode 4, WRF072 and WRF075 are used to set the on-preset value of a counter.

(2) Setting the PWM output on-duty value

Set the on-duty value in the corresponding special internal output for each PWM output to be used. The setting values are 0 to 100 (H0 to H64) when the auto correction of on-duty values is not performed. If an on-duty value exceeding this range is specified, PWM outputs will not be generated. When performing auto correction, the range of on-duty values that can be set differs depending on the frequency and CPU mode to be set. For more details on the auto correction, see Section 8.1.5. When a function other than PWM is assigned, this setting is not necessary.
(Example) If the on-duty value is 70 %, set “70” (H46) in the special internal outputs.

WRF076:	On-duty value for PWM output 1
WRF077:	On-duty value for PWM output 2
WRF078:	On-duty value for PWM output 3
WRF079:	On-duty value for PWM output 4

Figure 8.29 Special internal outputs for setting PWM output on-duty

In case of mode 1, WRF076 and WRF077 are used to set the off-preset value of a counter.
In case of mode 4, WRF076 and WRF079 are used to set the off-preset value of a counter.

(3) Effective range of PWM output on-duty values

When correcting on-duty values by setting the value that corresponds to the CPU model in the special internal output (WRF06B) for setting PWM/pulse output correction, the effective range of the on-duty values differs depending on the frequency and CPU model to be used. The effective range of the on-duty values is calculated from the following expressions. For the hardware delay time in the expressions, see Table 6.2.
Caution: There will be a slight error even if correction setting is performed.

On-duty lower limit value (%) = Hardware delay time (μs) x Frequency used (Hz) x 10^{-4}
On-duty upper limit value (%) = 100 - Hardware delay time (μs) x Frequency used (Hz) x 10^{-4}

Table 8.2 Transistor output delay time for each CPU model

CPU model	Hardware delay time (TYP)	Remark
EH-***DTP	50 μs	
EH-***DT	70 μs	
EH-***DRP	75 μs	
EH-***DRT	25 μs	

Example: If the CPU model is EH-***DRP and the PWM output is 2 kHz,
On-duty lower limit value = 50 x 2000 x 10^{-4} = 10 %
On-duty upper limit value = 100 - (50 x 2000 x 10^{-4}) = 90 %
Thus, the effective range of on-duty values will be 10 % to 90 %.

If correction is not performed (0 is set in WRF06B), on-duty values can be set in the range of 0 to 100 %. However, caution must be exercised since there will be an error for the period of transistor output delay time between the specified on-duty and the on-duty that is actually output.

(4) Setting abnormality

When the PI/O function setting flag (R7F5) is turned on, and a value exceeding the effective range of on-duty values is set for the on-duty setting value of each PWM output (WFR076 to WRF079), PWM outputs will not be generated.
(Example of incorrect setting) PWM output 2 kHz
On-duty setting value (WRF076) - 95

(5) Individual PWM output setting

The frequency and on-duty can be set for each PWM output by the special internal outputs regardless of whether the CPU is operating or stopped. By setting “H1” in the special internal outputs listed below, it is changed to the frequencies set in the special internal outputs (WRF072 to WFR075) and the on-duty values set in the special internal outputs (WRF076 to WFR079). When changing the setting, if any of the on-duty setting values (WRF076 to WRF079) for PWM outputs is set to a value exceeding the effective range, PWM outputs will not be generated.

		15 … 2 1	0
WRF058:	PWM output 1	Not used	a
WRF059:	PWM output 2	Not used	a
WRF05A:	PWM output 3	Not used	a
WRF05B:	PWM output 4	Not used	a

Figure 8.30 Special internal outputs for setting individual PWM outputs

Bit	Description
a	PWM output: individual setting value change request

8.5 Pulse Train Output

A pulse output can be assigned to an output by setting an output terminal. By setting an output to pulse output, a specified number of consecutive pulses with a duty ratio of 30 to 70 % can be output. ((To output a pulse having a duty ratio of 50 %, set the value corresponding to the CPU model in the special internal output WRF06B, by referring to Section 8.1.4.) A minimum of 10 Hz to a maximum of 5 kHz can be specified as frequency values. (The maximum frequency of 5 kHz represents the total of all pulse output frequencies.)

8.5.1 Operation of Pulse Output

The settings of the pulse outputs are stored in the special internal outputs. It is only possible to perform the settings through the special internal output when the CPU is stopped and the output is turned off. Once all the input/output settings are completed, the setting of each chain output can be changed using the special internal outputs for individual setting, regardless of whether the CPU is operating or stopped. In addition, by using the FUN instruction, settings can be changed by a program (FUN150), or pulse outputs with the acceleration/deceleration function can be generated (FUN151). Refer to the chapter about the FUN instruction for information about how to use the FUN instruction for setting.

(1) Basic operation

The special internal outputs R7FC to R7FF are used to control the output. When these special internal outputs are turned on, a pulse train is output at the frequency set in the special internal outputs (WRF072 to 7D) for the set number of pulses. After the set number of pulses is output, the special internal outputs R7FC to R7FF for output control are turned off by the system. The special internal outputs R7FC to R7FF correspond to pulse outputs 1 to 4 (Y100 to Y103); for example, if R7FD is turned on, a pulse is output from pulse output 2 (Y101). If peripheral units, etc. forcefully turn these special internal outputs off, the pulse output is turned off even if the set number of pulses has not yet been output. The on/off status of the PWM output is not stored in the data memory. Therefore, the status of the terminals used for pulse output monitored by peripheral units, etc. may be different from the actual status of the pulse output terminals.
When a fatal or serious error occurs in the CPU, there will be no output. The output is also stopped if a fatal or serious error occurs to the CPU during output.
In addition, pulses are not output while the backup memory is being written (R7EF=1). Therefore, care should be taken when handling the pulse output immediately after a program transfer or after a program change while running.

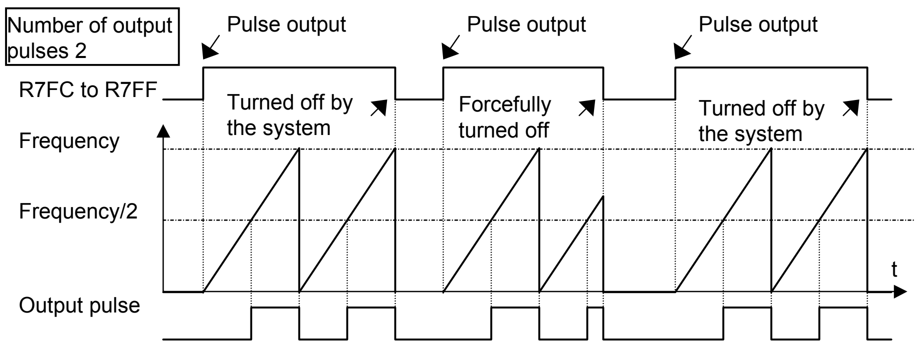


Figure 8.31 Basic operation of pulse output

(2) Operation when setting values are changed

The settings of the pulse outputs (frequency and number of output pulses) can be changed by the FUN instruction or the special internal outputs (WRF072 to 7D) regardless of whether the CPU is operating or stopped. If the settings are made during the execution of a program in such way that the total frequency of all the pulse outputs exceeds 5 kHz, the frequency settings will not be changed. Also, the corresponding bit in the abnormality display special internal output is turned on, and the output will continue to operate at the previously set frequency. (The setting value of the special internal output also returns to the value set before the abnormal setting was made.)

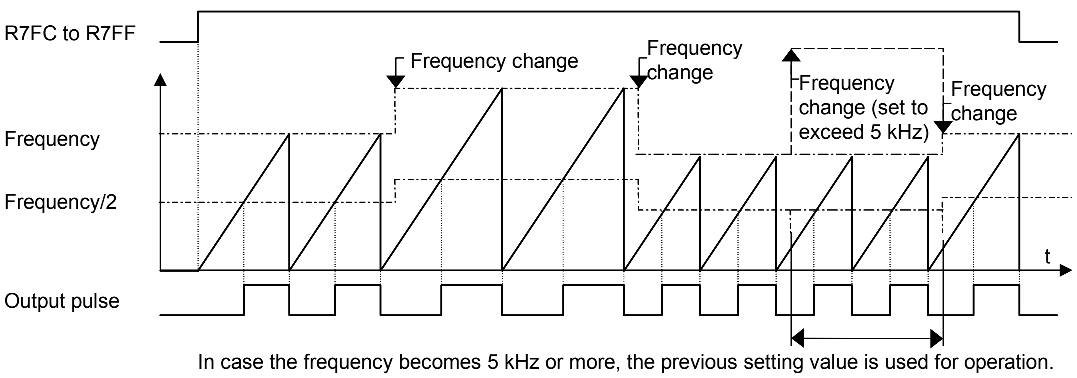


Figure 8.32 Operation when the pulse output frequency is changed

To change the number of output pulses, the following operation will be performed:

1] When the number of pulses is to be changed to a value larger than the number of pulses currently being output, pulses will be output until the number of newly changed pulses is reached, and then the pulse output stops.
2] When the number of pulses is to be changed to a value smaller than the number of pulses currently being output, the pulse output stops when the current number of pulses is reached.

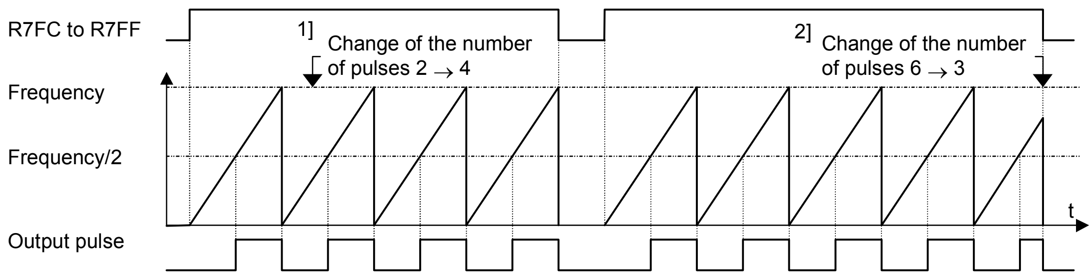


Figure 8.33 Operation for changing the number of pulse output

8.5.2 Setting of Pulse Output

The settings of the pulse outputs are stored in the special internal outputs (WRF072 to WRF07D).

(1) Setting the pulse output frequency

Set the frequency of the output pulse for each pulse output to be used in all of the special internal outputs shown below. The setting values are 10 to 5000 (HA to H1388). If a value less than 10 Hz is set, it is internally changed to 10 Hz by the system. When setting the frequencies, make sure that the total value of all pulse output frequencies stays within 5 kHz.

(Example 1) Assuming there is one point of pulse output and the output frequency is 5 kHz:
Setting value = 5000 (H1388)

(Example 2) Assuming there are three points of pulse output and the output frequencies are 1 kHz, 1 kHz, and 3 kHz, respectively (the settings should be made so that the sum of the output frequencies set for each of the pulse outputs becomes 5 kHz or less.):
Setting value = 1000 (H3E8)
Setting value = 1000 (H3E8)
Setting value = 3000 (HBB8)

WRF072:	Output frequency for pulse output 1
WRF073:	Output frequency for pulse output 2
WRF074:	Output frequency for pulse output 3
WRF075:	Output frequency for pulse output 4

Figure 8.34 Special internal outputs for setting output frequencies

In case of mode 1, WRF072 and WRF073 are used for setting the on-preset value of a counter.
In case of mode 4, WRF072 and WRF075 are used for setting the on-preset value of a counter.

(3) Setting the number of output pulses

Set the number of output pulses for each pulse output used. The setting values are 0 to 65535 (H0 to HFFFF). If the number of output pulses is set to “0,” no pulses will be output.

WRF07A:	Number of output pulses for pulse output 1
WRF07B:	Number of output pulses for pulse output 2
WRF07C:	Number of output pulses for pulse output 3
WRF07D:	Number of output pulses for pulse output 4

Figure 8.35 Special internal outputs for setting number of output pulses

In case of mode 1, WRF07A and WRF07B are used for setting the preload strobe value.
In case of mode 4, WRF07A and WRF07D are used for setting the preload strobe value.

(4) At setting abnormality

If the sum of the frequencies of the pulse outputs is set to exceed 5 k when the PI/O function setting flag (R7F5) is turned on, the bit for the total pulse frequency abnormality in the error display special internal output turns on, and none of the pulse outputs are output. In addition, individual setting of pulse outputs cannot be performed when the bit for the total pulse frequency abnormality is turned on.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF057:	a	Not used							b	c	d	e	f	g	h	i

Figure 8.36 Special internal output for input/output function abnormality

Bit	Description of abnormality	Related terminal
a	Total pulse frequency abnormality	Y100 to Y103
b	Pulse 4 frequency abnormality	Y103
c	Pulse 3 frequency abnormality	Y102
d	Pulse 2 frequency abnormality	Y101
e	Pulse 1 frequency abnormality	Y100
f	Counter 4 preset value abnormality	X6
g	Counter 3 preset value abnormality	X4
h	Counter 2 preset value abnormality	X2
i	Counter 1 preset value abnormality	X0

(5) Individual setting of pulse outputs

It is possible to set the frequency and number of output pulses for each pulse output by the special internal outputs for individual setting, regardless of whether the CPU is operating or stopped. Turn on the corresponding bit in the following special internal outputs when only the pulse frequency or number of output pulses should be changed.

If the total of frequencies exceeds 5 kHz as a result of performing individual setting of pulse outputs for pulse outputs that are working normally, the bit for the error display special internal output that corresponds to the changed pulse output will turn on, and that pulse output will work at the frequency before the setting change. (The value set in the special internal output also returns to the previous value before the setting was made.)

		15 ... 2	1	0
WRF058:	Pulse output 1	Not used	a	b
WRF059:	Pulse output 2	Not used	a	b
WRF05A:	Pulse output 3	Not used	a	b
WRF05B:	Pulse output 4	Not used	a	b

Figure 8.37 Special internal outputs for setting individual pulse outputs

Bit	Description
a	Number of output pulse change request
b	Output pulse frequency change request

8.6 Interrupt Input

When either operation mode 0, 1, or 3 is selected, it is possible to assign an interrupt input to X1, X3, X5, and X7 by the special internal output (WRF07F). (The 10-point type CPU does not have X7.) It is only possible to set them by the special internal output under the conditions where the CPU is stopped and the output is off.
When an interrupt input is entered, an interrupt process determined by a user program starts up. The INT numbers corresponding to the interrupt inputs are listed in Table 8.2. See the chapter about the instruction specifications for the interrupt input processing.

Table 8.3 Interrupt input – correspondence table

Interrupt input	Terminal	INT No.
Interrupt input 1	X1	INT16
Interrupt input 2	X3	INT17
Interrupt input 3	X5	INT18
Interrupt input 4	X7	INT19

8.7 Digital Filter

The input can set digital filter functions (when assigned normal input functions in X0 to X7 with operation mode 0, 1, or 3, be set to the input too). The sampling number of the digital filter is stored in the special internal output (WRF07F). The sampling number is set in 0.5ms unit (0 to 40, i.e., 0 to 20ms). When the value 0 is set, there is no filter, and when 41 or more is set, it is treated as a sampling number of 40 (20ms). This special internal output is stored in the FLASH memory by turning on the various setting write requests (R7F6). Once the setting is stored in the FLASH memory, it is not necessary to make the setting again when the power is turned on next time.
The input status is maintained in the buffer for the maximum sampling number. When the input status is read, the status for the past set number of sampling numbers is looked up, and if there was no change, that status is read. If there were changes, the status before the change is read.

WRF07F:	Input sampling number

Figure 8.38 Special internal output for setting normal input sampling number

The above-mentioned setting is stored immediately upon the completion of the setting. Moreover, it is invalid for inputs assigned to counter input.

8.8 Potentiometers

CPUs other than of the 10-point type are equipped with two potentiometers. Through the use of these potentiometers, it becomes possible to change values in the special internal outputs from the outside using a tool that looks like a screwdriver. The resolution is 10 bits, so it is possible to adjust the values from 0 to 3FFH (1 to 1,023).
The potentiometers are found under the cover on the left side of the main unit. The value becomes larger when the dial is turned clockwise and smaller when turned counterclockwise. In addition, this value is always stored in the special internal output, regardless of whether the CPU is operating or stopped.

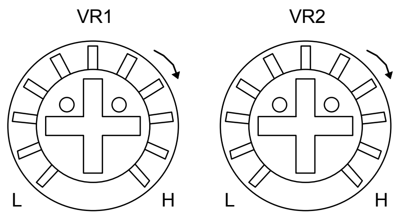


Figure 8.39 Potentiometers

(1) Values of the potentiometers

The values entered by means of the potentiometers are stored in the following special internal outputs.

WRF03E:	Potentiometer 1 input value
WRF03F:	Potentiometer 2 input value

Figure 8.40 Potentiometer input value storage special internal output

(2) Setting a filter for the potentiometer

The input values of the potentiometers fluctuate depending on the operating environment of the main unit etc. If the ratio of fluctuation is to be reduced, a sampling number can be set in the following special internal output. Once the sampling number is set, the average of the data obtained in the time period determined by the sampling number calculated by internal processing is set in WRF03E and WRF03F.
The sampling number can be set between 0 and 40 (0 to 28H). If 0 is set, the data without average is stored in WRF03E and WRF03F. If a value greater than 41 is set, the sampling number is treated as 40.

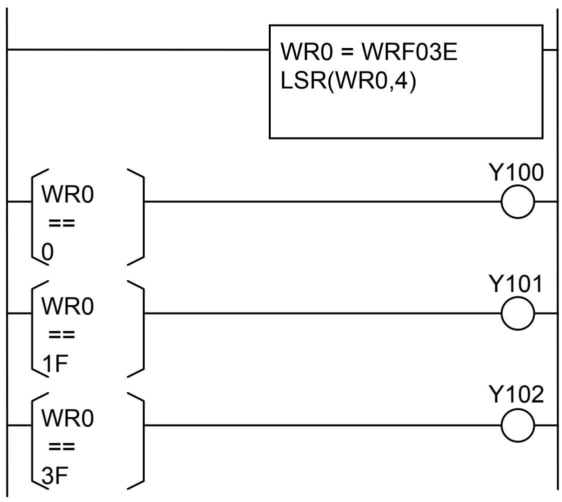
WRF06C:	Potentiometer 1 data sampling number
WRF06D:	Potentiometer 2 data sampling number

Figure 8.41 Special internal output for setting input data sampling number

This special internal output is stored in the FLASH memory by turning on various setting write requests (R7F6). Once it is stored in the memory, it is not necessary to set the value again when the power is turned on for the next time.

(3) Example

The following shows a simple ladder program using the potentiometers:



1] Always substitute the value of potentiometer 1 to WR0.
2] Delete the lower four bits of WR0 (because lower four bits are more prone to error due to changes in resistance caused by temperature, etc.)

3] If WR0 is “0,” Y100 is turned on.

4] If WR0 is 1F, Y101 is turned on.

5] If WR0 is 3F, Y102 is turned on.

By turning potentiometer 1, one of flags Y100 to Y102 turns on.

8.9 Analogue Input

The 23-point type CPU is equipped with two points of analogue input. The input to these two points can be set to voltage input or current input individually. The setting of current or voltage input is made in the special internal output WRF06E. This special internal output is stored in the FLASH memory by turning on various setting write requests (R7F6). Once it is stored in the memory, it is not necessary to set the value again when the power is turned on for the next time.

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF06E:	a	b	Not used													
Initial value:	0	0														

Figure 8.42 Special internal output for selecting the analogue type

WRF06E Setting value	Function	
	Analogue CH0 (Bit a)	Analogue CH1 (Bit b)
C000H	Current input	Current input
8000H	Current input	Voltage input
4000H	Voltage input	Current input
0000H	Voltage input	Voltage input

Please note that the external wiring is different for voltage input and current input. See the section regarding analogue system wiring for the details.
Through the above-mentioned settings, the input data of channel 0 is stored in WX 30 and the input data of channel 1 is stored in WX31. The correspondence between analogue data and digital data is shown in the figure 8.40 (divide 0 to 10 V and 0 to 20 mA in 0 to 4000). The voltage data is converted to 0.0025 [V] per 1H and the current data is converted to 0.005 [mA] per 1H. Therefore, the value ranges that can be measured from the output channel are 0 to 10.2375 [V] for voltage data and 0 to 20.475 [mA] for current data, respectively.

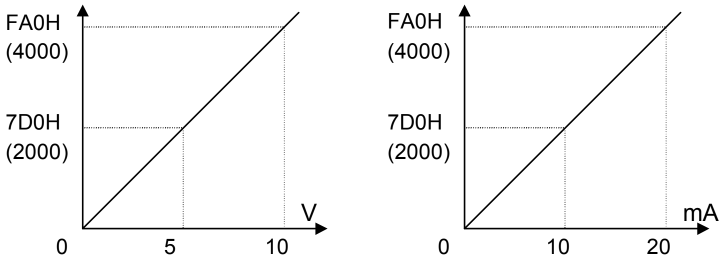


Figure 8.43 Correspondence diagrams of digital and analogue input

(Example)
If analogue input channel 0 is set to voltage input and the analogue input channel 1 is set to current input, and 3V and 14mA are applied respectively, 4B0H (1200) is stored in WX30 and AF0H (2800) is stored in WX31.

8.10 Analogue Output

The 23-point type CPU is equipped with one point of analogue output. In analogue output, digital values set at WY40 are converted to analogue output, and then output. Switching between voltage output/current output is performed by external wiring; analogue voltage outputs are output when connected to a voltage output terminal, and analogue current output when connected to a current output terminal.
The correspondence between analogue data and digital data is shown in the figure 8.41 (divide 0 to 10 V and 0 to 20 mA in 0 to 4000). The voltage data is converted to 0.0025 [V] per 1H and the current data is converted to 0.005 [mA] per 1H. Therefore, the values that can be output from the output channel are 0 to 10.2375 [V] for voltage data and 0 to 20.475 [mA] for current data, respectively.

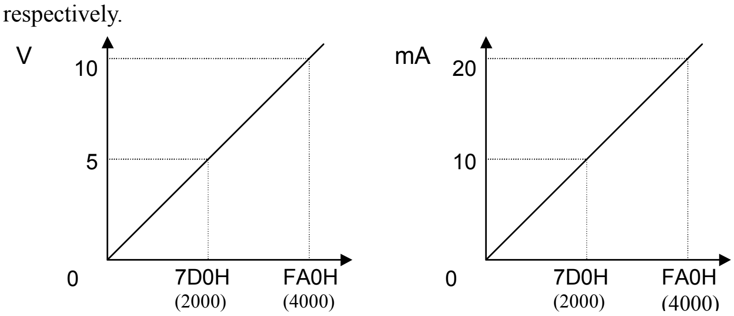


Figure 8.44 Correspondence diagrams of digital and analogue output

(Example)
If 5F0H (1520) is set in WY40, 3.8 V is output from the analogue voltage output terminal. When reconnected to the analogue current output terminal, 7.6 mA is output. Please note that if connected to both terminals by mistake, the correct output value will not be output.

8.11 Analogue Expansion unit

Analogue expansion module has 4 ch. of analog input and 2 ch. of analog output, which is configured by dip switches.

■ Range setting

Analogue input range setting (Common for all input channels.)

Sw1	Sw2	Range	Remarks
off	off	0 - 10V	Default setting
off	**ON**	0 - ±10V	
ON	off	0 - 20mA	
ON	**ON**	4 - 20mA	

Analogue output range setting (Common for all output channels.)

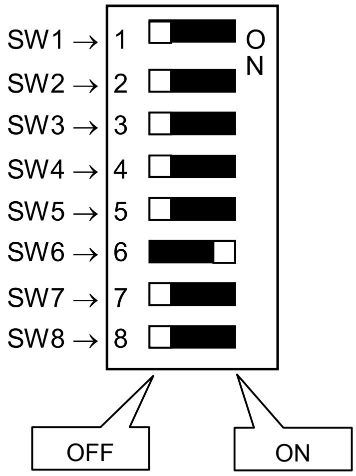
Sw3	Sw4	Range	Remarks
off	off	0 - 10V	Default setting
off	**ON**		
ON	off	0 - 20mA	
ON	**ON**	4 - 20mA	

Conversino mode

Sw6	Conversion mode	Remarks
off	4,096 (H0FFF)	
ON	4,000 (H0FA0)	Default setting

Sw5,7,8 : Set off always.

Dip switch
(Default setting)



Caution : Set dip switch while power off.

■ I/O assignment, data table

I/O assignment = "**FUN 0**"

WX u00	System area	Do not use this area.
WX u01	Ch.1 Input data	Data in lower 12 bits.
WX u02	Ch.2 Input data	Always 0 in higher 4 bits.
WX u03	Ch.3 Input data	0000H - 0FFFH
WX u04	Ch.4 Input data	
WY u05	System area	Do not use this area.
WY u06	Ch.6 Output data	Data to be written in lower 12 bits.
WY u07	Ch.7 Output data	0000H -0FFFH

u : Unit number (1 - 4)

Example : Unit 1, Input ch.2 → WX102   Unit 4, Output ch.7 → WY407

■ In/output data table

0 - 10V / 0 - 20mA / 4 - 20mA

	Mode 4000	Mode 4096
0V / 0mA / 4mA	0	0
5V / 10mA / 12mA	H07D0 (2000)	H07FF (2047)
10V / 20mA / 20mA	H0FA0 (4000)	H0FFF (4095)

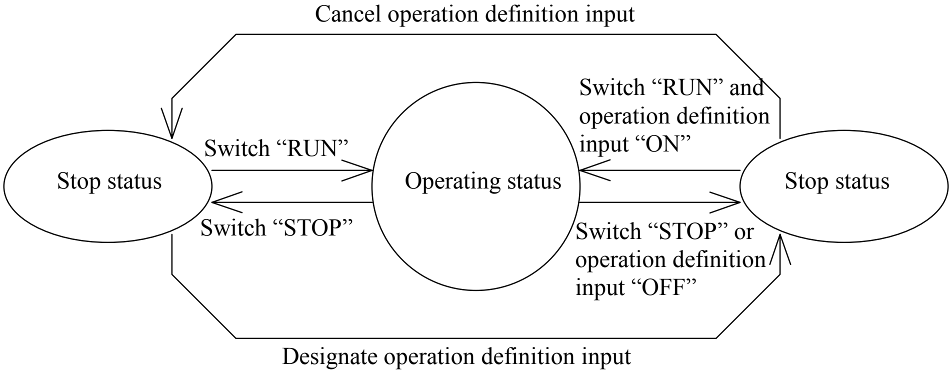
-10 - +10V (only for analog input)

	Mode 4000	Mode 4096
-10V	H0830 (-2000) *	H0800 (-2048) *
0V	0	0
+10V	H07D0 (2000)	H07FF (2047)

* 2's complement

Chapter 9 PLC Operation

The operating status and stop status of the MICRO-EH can be switched through various types of operations. This feature is shown in Figure 9.1.



Caution
The MICRO-EH cannot handle a REMOTE specification. A 10-point type CPU becomes the RUN mode when the RUN input is On.

Figure 9.1 Transitional diagram between operating and stop statuses

The MICRO-EH can be operated or stopped under the conditions as shown in Figure 9.1. If an error is detected during operation or stop, output is shut off, an error is displayed and the MICRO-EH stops. There are fatal error, serious error, minor error and warning. The operating status for each error is listed in Table 9.1.

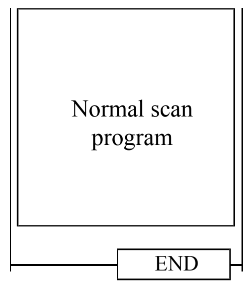
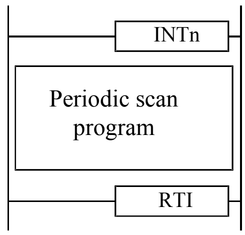
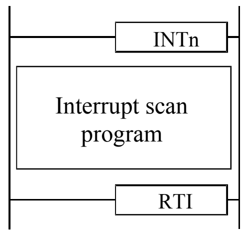
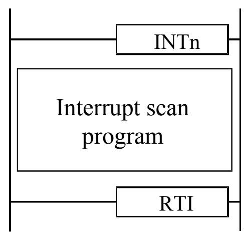
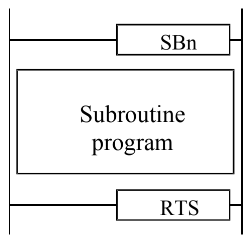
Table 9.1 Description of each error and operating status

Classification	Description	Run/Stop
Fatal error	This indicates there is a fatal and unrecoverable error, such as a power supply problem, microcomputer error, system ROM error, system RAM error and system path error.	Stops
Serious error	This indicates there is an error such as data memory problem, system program problem, user memory problem, user memory size error, syntax/assembler error, etc., which may cause a malfunction if operation is continued.	Stops
Minor error	These are errors such as I/O information verify error, remote problem, congestion error, excessively assigned I/O points, etc. The operation may be continued when a continue operation is set by the user programs.	Stops (continued operation is possible if specified)
Warning	These are problems such as a transfer error, backup memory write problem, etc. where it is possible to continue the operation.	Operation continues

9.1 RUN Start

When the MICRO-EH switches to the operating state, the user program is executed in sequence from the beginning. The user programs consist of a normal scan program and periodical scan program. In addition to these programs, there is a subroutine area defined as a subroutine.

Table 9.2 Program classification

No.	Program classification	Description	Expression
1	Normal scan program	This is the program that is normally executed. When the program has been executed to the END instruction, execution starts again from the beginning. Congestion error is monitored according to the congestion check time set by the user. It is monitored from the beginning of the program to the END instruction. When it is specified to continue during congestion (R7C0), the operation continues even if a congestion error occurs.	
2	Periodical scan program	This program is executed periodically at intervals of 10 ms, 20 ms, or 40 ms. INT0: Every 10 ms INT1: Every 20 ms INT2: Every 40 ms Each execution cycle time becomes a congestion error monitoring time. When it is specified to continue during congestion (R7C1), the periodical scan program is suspended during operation.	Described in the area after the END instruction.  n = 0, 1, 2
3	Interrupt scan program	When there is an input to the input terminal assigned to the interrupt input, the interrupt program (INT16 to INT19) corresponding to that input starts up. If another interrupt caused by the same factor occurs during the execution of the interrupt program, a congestion error occurs. When the operation continuation at a congestion error (R7C2) is specified, the same interrupt scan program is run from the beginning again.	Described in the area after the END instruction  n = 16 to 19
		If the counter value exceeds the preset value, a corresponding interrupt program (INT20 to INT27) starts up according to the counter number.	Described in the area after the END instruction  n = 20 to 27
4	Subroutine	This is a program called by the CALL instruction.	Described in the area after the END instruction  n = 0 to 99

Each program is executed in the order of the priority shown in Figure 9.2. Each program is executed while monitoring the execution time of each program area. If the monitored time exceeds the specified time, this causes a congestion error and operation stops. When continued operation has been specified, operation continues.
The timing for scan execution is shown in Figure 9.2. System processing is performed at set periods (every 5 ms), followed by communication system processing. *1 The maximum execution time of communication system processing equals the duration of time until the next periodical system processing is started. If the communication system processing ends before the maximum execution time is up, execution of scan processing is started upon completion of the communication system processing. When the next periodical processing is executed, scanning is performed until the next periodical processing is executed.

*1: Communication system processing is executed every 10 ms.
*2: The execution of scan processing starts after the communication system processing is completed.

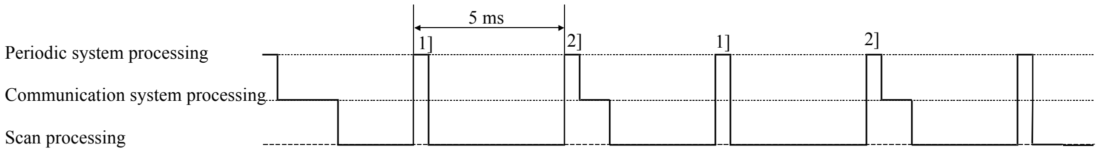


Figure 9.2 Relationship between system processing and scanning

Note: Processing 1 takes extremely short period of time as compared with Processing 2. Therefore, in the following diagram Processing 1 is omitted in order to avoid complexity.

As shown in Figure 9.3, scan processing is done while periodical scanning is performed. Periodical scanning is processed at the point when switching to normal scan. Periodical scans are performed at intervals of every 10 ms, 20 ms, or 40 ms. In terms of priority of execution, 10 ms scans have the highest priority. Use the refresh instruction when you wish to perform data processing for the external I/O (X, Y) in the periodical scan.
Update processing of timer progress value is performed as a part of system processing.

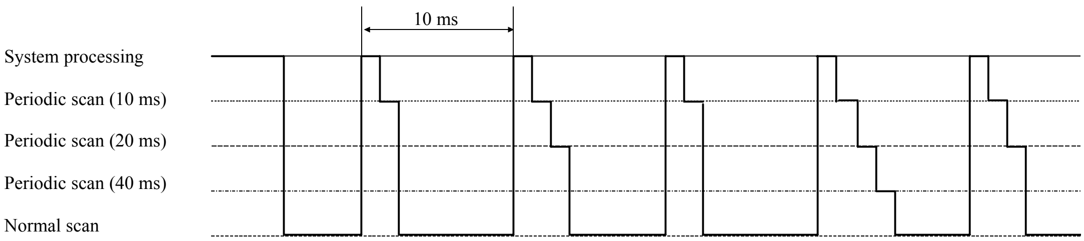


Figure 9.3 Scan execution timing

9.1.1 Normal Scan

(1) Definition and operation

The normal scan refers to the calculations and execution of the ladder/instruction language program (excluding interrupt programs) until the END scan processing caused by the END instruction or the execution of programs written in Pro-H. The time required for one scan, from the beginning of a normal scan program to the END scan processing, is called the normal scan time.

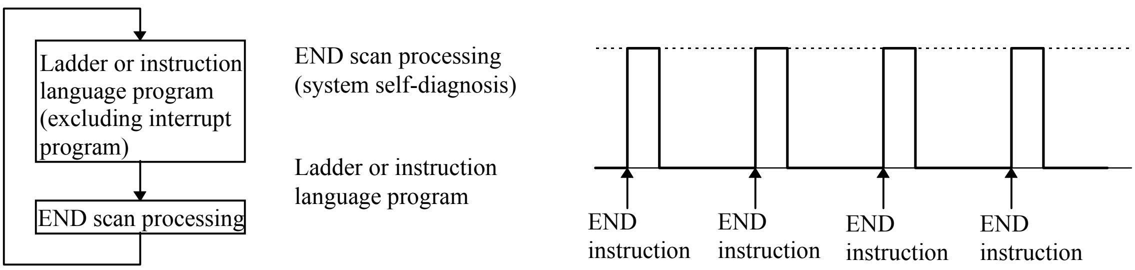


Figure 9.4 Operation of normal scan

(2) Causes of congestion errors at normal scan

Congestion errors may occur at normal scan because of the following three possible reasons. In particular when using a periodical scan program and an interrupt scan program together, care must be taken to create the program in such a way that the total scan time does not exceed the congestion check time.

(a) When only a normal scan program is used
The scan time exceeded the congestion check time because the time required for one scan was too long.

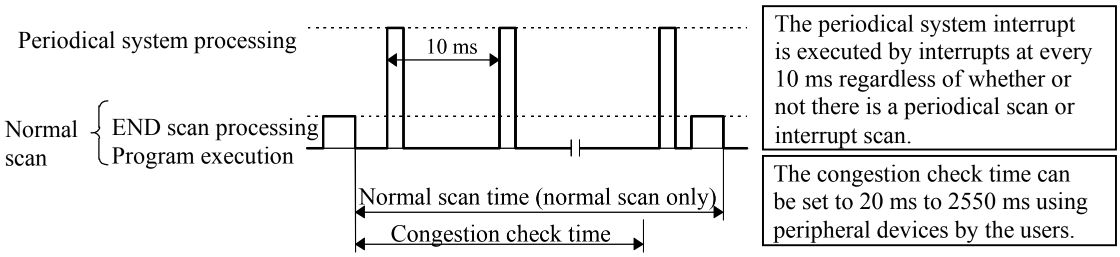


Figure 9.5 Congestion error at normal scan (a)

(b) When both a normal scan program and a periodical scan program are used
The congestion check time was exceeded because the periodical scan program was executed and the normal scan time became longer.

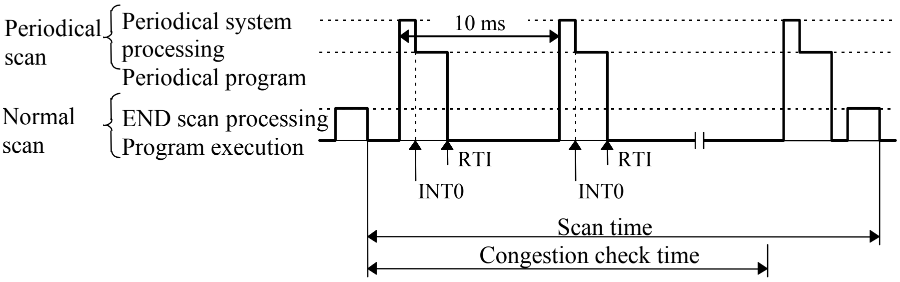


Figure 9.6 Congestion error at normal scan (b)

(c) When both a normal scan program and an interrupt scan program are used
The congestion check time was exceeded because the interrupt scan program was executed due to an interrupt input and the normal scan time became longer.

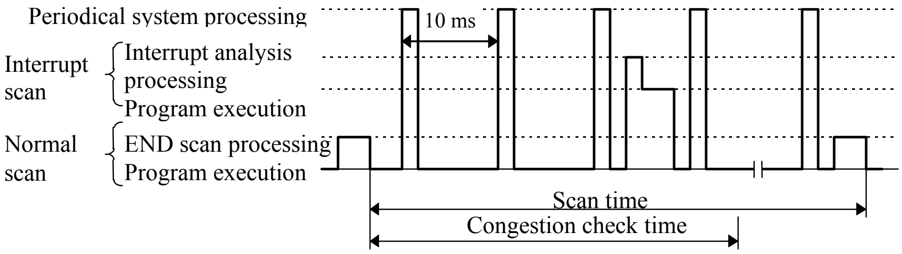


Figure 9.7 Congestion error at normal scan (c)

(3) Continuation of operation after a congestion error occurred

When the special internal output bit R7C0, which specifies whether the operation should continue after a congestion error occurred, is turned on, the normal scan executes the scan until the end regardless of the congestion check time, and after executing the END scan processing, executes the normal scan from the beginning again.

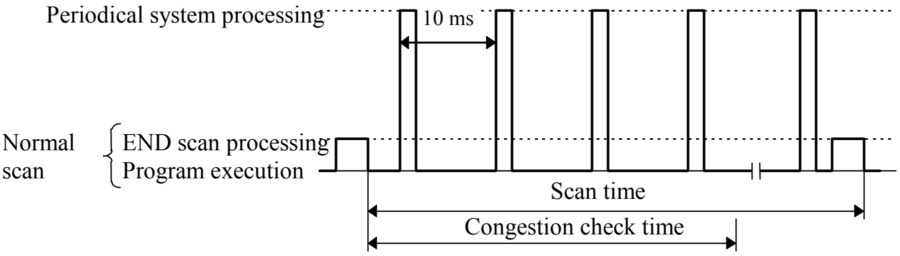


Figure 9.8 Operation when operation continuation at congestion error is set

However, note that this setting does not stop the execution of the scan when a congestion error occurred even when an infinite loop is formed within the normal scan by the JMP instruction.

9.1.2 Periodical Scan

(1) Definition and operation

This scan executes interrupt programs (periodical scan programs) while the CPU is operating with a fixed cycle time (10 ms, 20 ms, or 40 ms) specified by the users.
Enter the periodical scan program to be executed between instructions INT0 and RT1 if it should be started up with a 10 ms cycle time, and between INT1 and RT1 if it should be started up with a 20 ms cycle time.
The periodical system processing is executed every 10 ms regardless of whether or not there is a periodical scan program.

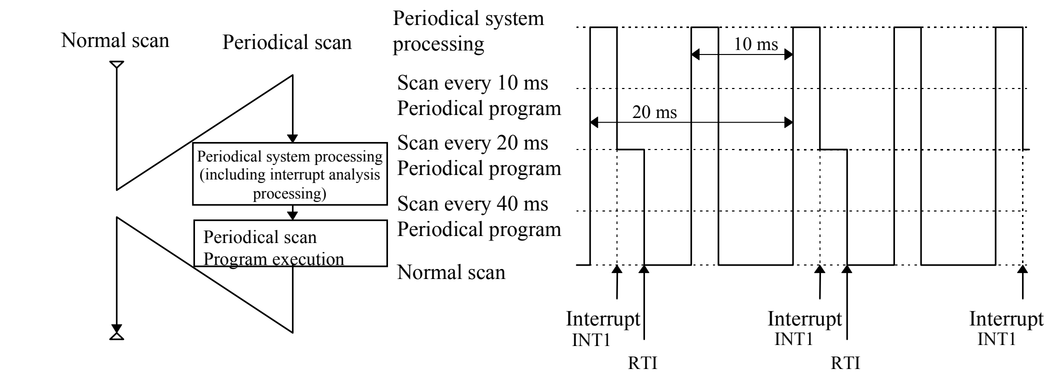


Figure 9.9 Operation of periodical scan (in case of INT1)

(2) Causes of congestion errors at periodical scan

If there are periodical scans at every 10 ms as well as scans at every 20 ms or 40 ms, a congestion error occurs and the scan is stopped if the periodical scan at 10 ms is started up again before all the periodical scans are completed (i.e., the periodical system processing at INT0 to INT2 does not end within 10 ms).

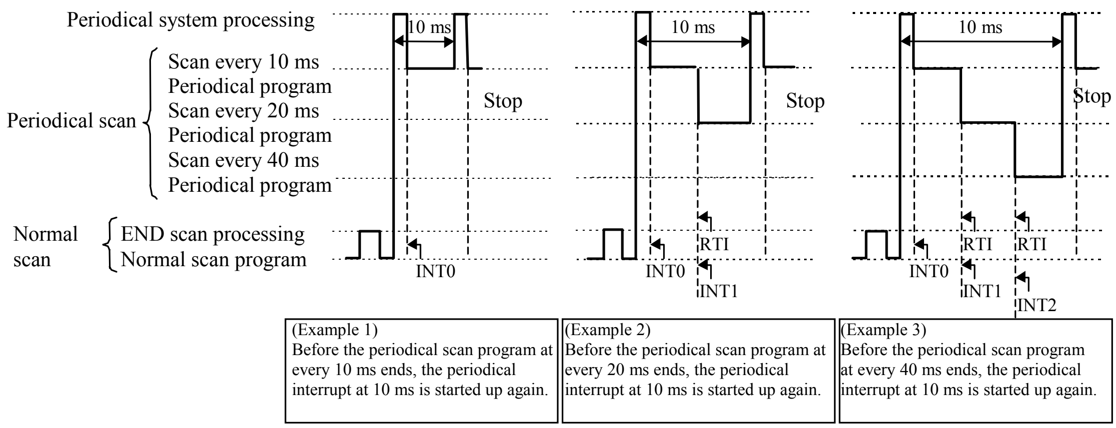


Figure 9.10 Congestion error at periodical scan (10 ms)

Similarly, when executing with a periodical scan at every 20 ms or with a combination of periodical scans at every 20 ms and 40 ms, a congestion error occurs if the periodical scan at 20 ms is started up again before all the periodical scans are completed (i.e., the periodical system processing at INT1 to INT2 does not end within 20 ms). Finally, when using a periodical scan at every 40 ms, a congestion error occurs if the periodical scan at 40 ms is started up again before all the periodical scans are completed (i.e., the periodical system processing at INT2 does not end within 40 ms).

(3) Continuation of operation after a congestion error
If a congestion error occurs when the special internal output bit R7C1, which specifies whether the operation should continue after a congestion error, is turned on, the execution of the periodical scan is stopped and the periodical scan is executed from the beginning again. If the operation continuation specification for the normal scan is Off when this happens, the scan stops as a congestion error at a normal scan. If the operation continuation specification for the normal scan is On, only the periodical scan continues to be executed in the event of a periodical congestion error. Care must be taken because the normal scan is not executed under this condition.

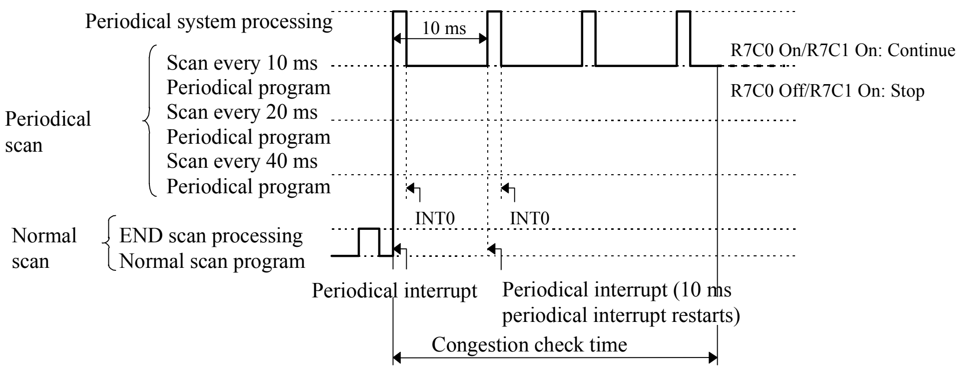


Figure 9.11 Operation when operation continuation at congestion error is set

9.1.3 Interrupt Scan

(1) Definition and operation
If there is an input to an input terminal assigned to an interrupt input, or there is an input to an input terminal assigned to a counter input and the current counter value exceeds the preset value while the CPU is operating, interrupt programs (interrupt scan) corresponding to them are started up. An interrupt scan caused by an interrupt input executes interrupt programs from INT16 to19 to RTI instructions. An interrupt scan due to a corresponding interrupt caused by the counter current value executes the interrupt programs from INT20 to INT27 to RTI instruction.
If an interrupt caused by another factor is input during the execution of an interrupt scan, the next interrupt scan is started up at the point when the interrupt scan being executed is completed. Also, if two or more interrupts are input during the execution of an interrupt scan, the interrupt scans are started up in order from the smallest INT number at the point when the interrupt scan being executed is completed.

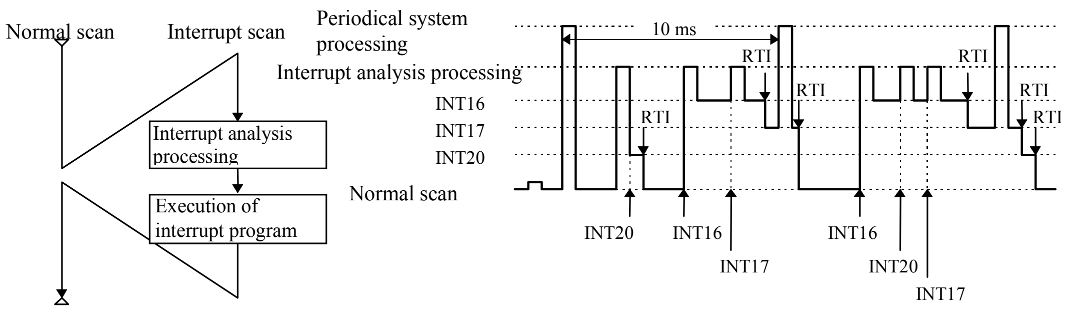


Figure 9.12 Operation of interrupt scan

(2) Causes of congestion errors at interrupt scan
An interrupt scan congestion error occurs during the interrupt scan processing when an interrupt of the same number is entered again.
In addition, a normal scan congestion error occurs if interrupt inputs are frequently entered because a normal scan cannot be executed.

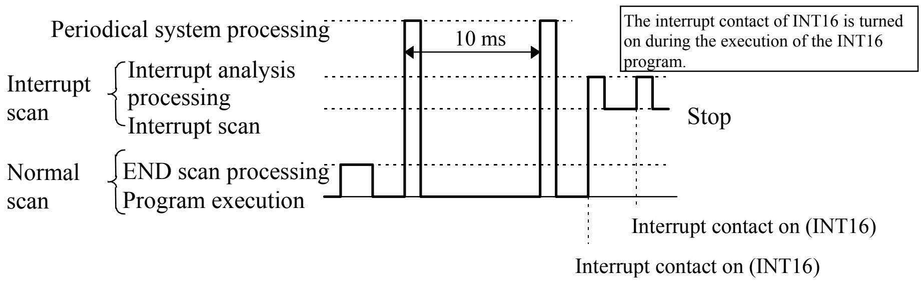


Figure 9.13 Operation of interrupt scan

(3) Continuation of operation after a congestion error occurred

If an interrupt scan congestion error occurs when the special internal output bit R7C2, which specifies whether the operation should continue after a congestion error, is turned on, the interrupt scan is started anew and the scan is executed from the beginning again. Therefore, if the operation continuation specification of the normal scan is Off under the conditions where interrupt inputs are frequently entered from the external source, this scan is stopped as a normal scan congestion error. If the operation continuation specification of the normal scan is On, only interrupt scans are continuously executed depending on the condition of the interrupt congestion error. Care must be taken because normal scans are not executed under this condition.

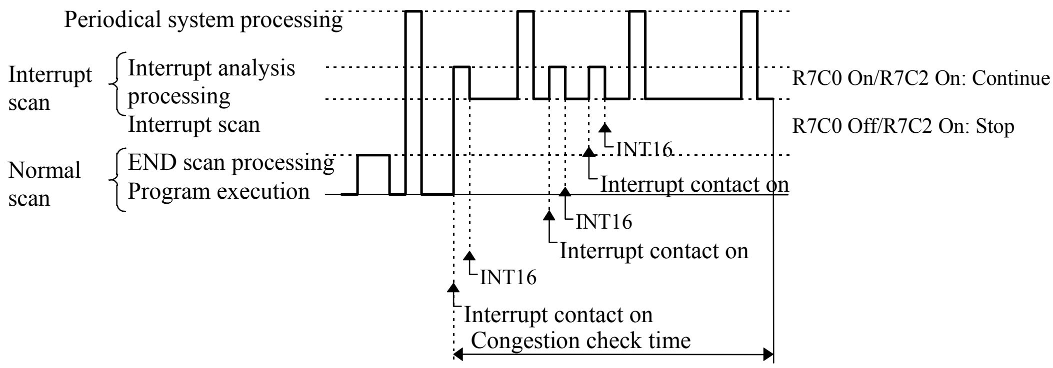
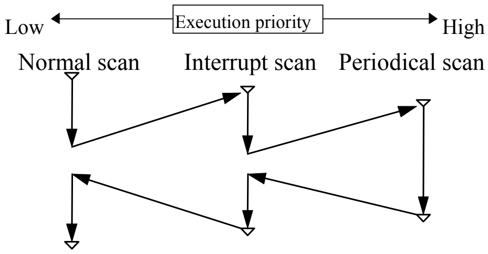


Figure 9.14 Operation when operation continuation at congestion error is set

9.1.4 Relationship of Each Scan Type

When three types of scan occur at the same time, scan is executed in the order of periodical scan, then interrupt scan, and then normal scan.



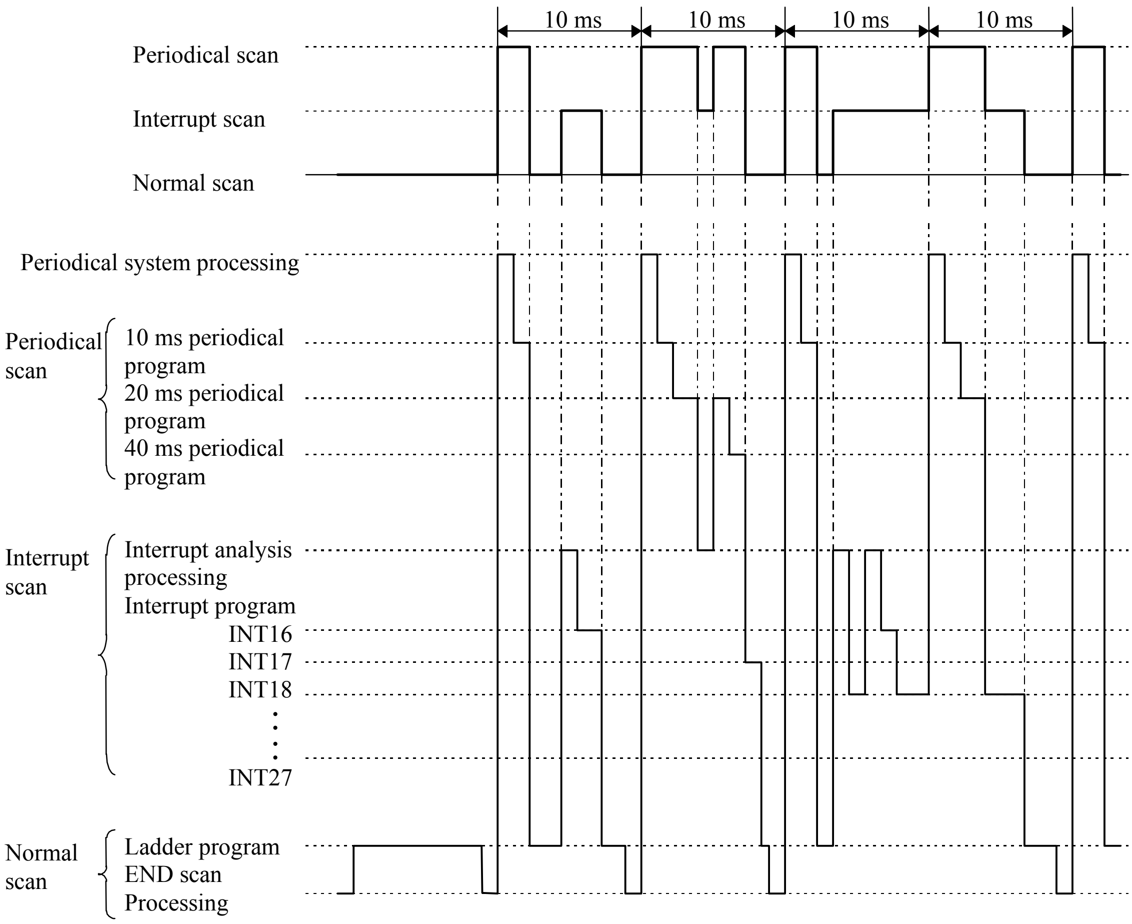


Figure 9.15 Relational diagram of scan operation

Table 9.3 List of interrupt label

Interrupt label	Cause of startup	Interrupt label	Cause of startup
INT0	Interrupt every 10 ms	INT20	Counter 1 on-preset match
INT1	Interrupt every 20 ms	INT21	Counter 1 off-preset match
INT2	Interrupt every 40 ms	INT22	Counter 2 on-preset match
INT16	Interrupt of interrupt input 1	INT23	Counter 2 off-preset match
INT17	Interrupt of interrupt input 2	INT24	Counter 3 on-preset match
INT18	Interrupt of interrupt input 3	INT25	Counter 3 off-preset match
INT19	Interrupt of interrupt input 4	INT26	Counter 4 on-preset match
		INT27	Counter 4 off-preset match

9.2 Online Change in RUN

The user programs can be modified during operation while retaining the output status as is. This is called the “program change while running” function. To modify the user programs, special programming software or programmer is required. Refer to the individual manuals on the operation.
Program change while running cannot be executed in the following situations. Perform this operation after satisfying the conditions.

Table 9.4 Conditions for performing program change while running

No	Conditions under which program change while running cannot be performed	Specific situation	How to satisfy the conditions
1	When READ-occupying	Other programming device is connected.	Change other programming devices to off-line.
2		When a personal computer or panel, etc. is connected and monitoring is being executed.	Change the personal computer or panel to off-line. (When monitoring, it is convenient to use the occupancy unnecessary task code.)
3	END instruction is not executed.	A program that runs in an infinite loop is being executed.	Correct the program so that it does not run in an infinite loop.
4	Attempted to modify a program that includes control instructions.	Performing program change while running for a circuit containing a control instruction may cause operation to stop depending on the type of the program modification error.	An explanation of how to perform program change while running for a circuit that contains a control instruction is given in the programming software manual.
5	A password has been set.	A program protected by a password cannot be modified.	Execute after having the system administrator remove the password.

(When the CPU is stopped, the update is executed without displaying a message confirming program change while running.)

The MICRO-EH operation when the user program is changed in RUN is shown below.

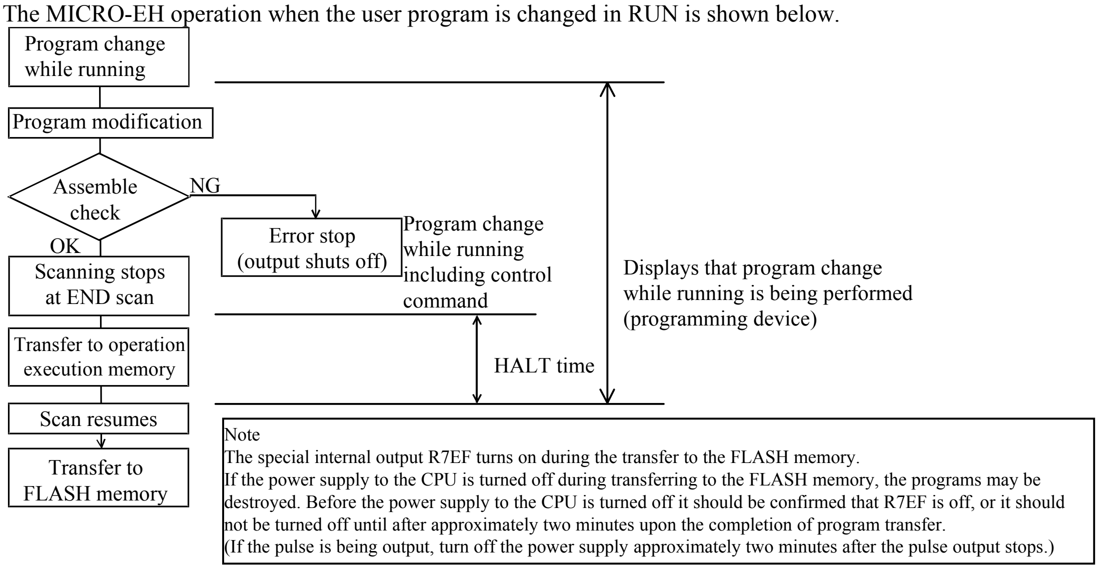


Figure 9.16 Internal processing for program change while running

Transfer to the FLASH memory

Unlike the conventional H/EH series, the MICRO-EH transfers its user program to the FLASH memory, the backup memory, during the idle time of the CPU processing. Because of this, when the transfer to the operation execution memory is completed, the peripheral unit displays that the transfer is complete. However, the transfer to the FLASH memory is not completed at this stage. If the power supply to the CPU (especially CPUs without battery or CPUs whose data maintenance guarantee time is over) is turned off at this status, a user memory error (31H) occurs when the power supply to the main unit is turned back on. Therefore, it should be confirmed that the FLASH memory writing flag (R7EF) is off before the power supply to the main unit is turned off, or it should not be turned off until after approximately two minutes upon the completion of program transfer. (During pulse output, programs are not transferred to the FLASH memory until the pulse output is stopped. If the pulse is being output, turn off the power supply approximately two minutes after the pulse output stops.)

CPU HALT time

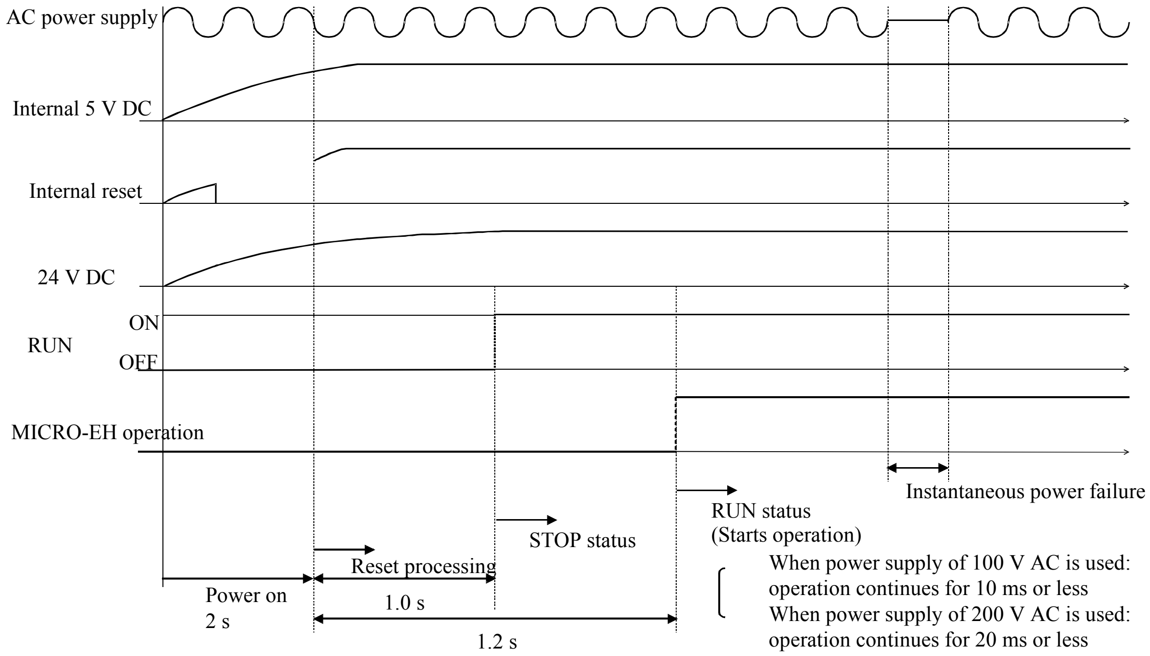
When performing program change while running, the program to be written to the CPU is checked if there are no errors, then the CPU is halted temporarily (RUN $\rightarrow$ HALT).
The program of the modified area is written to the CPU while it is halted, and the CPU is set to operate (HALT $\rightarrow$ RUN) again.
At this time, the following equation shows the approximate time the CPU is halted (it is not necessarily the maximum value).

HALT time (ms) = 45 $\times$ Program capacity (k steps) + 20

An example of a calculation of the HALT time for the MICRO-EH using the above equation is 155 ms.

9.3 Instantaneous Power Failure

The following shows operation when the power supply to the MICRO-EH shuts off.



(1) Powering on

The MICRO-EH starts operations after a maximum of 3.5 seconds have elapsed after power-up. If the power for input module is not completely started when the operation is commenced, the input that is supposed to be on will be received as Off and operation proceeds, so make sure that the power for I/O module is completely turned on before operation is commenced.

Note: When extending with a CPU larger than 14-point type, turn on the power supply for both base and extension sides at the same time.

(2) Instantaneous power failure actions

(a) When 100 VAC is supplied
Operation is continued during instantaneous power failures that last less than 10 ms.

(b) When 200 VAC is supplied
Operation is continued during instantaneous power failure that last less than 20 ms.

Note: Make arrangement so that the power for input module is supplied while the CPU continues its operation. If the power is not supplied, the CPU will perform operation assuming the input data as Off. Exercise caution especially when performing operation that changes the contents of the power failure memory using input signals, since the contents of the power failure memory may have been altered unintentionally due to an instantaneous power failure.

9.4 Operation Parameter

The settings of “parameters,” which are required to perform tasks such as creating programs, transferring programs to the CPU, are performed. The setting contents are explained below.

Item	Function	Description	When to use the function
1	Password	○ Register a password to a program in the four-digit hexadecimal format. The program with a password will not allow program operation nor changes unless the correct password is entered, so please exercise caution. Note: The user will not be able to reset the password when it is forgotten, so exercise extreme caution when accessing a password. Password is not set at the time of shipment.	Use to protect the confidentiality of the programs.
2	CPU type	○ Set the CPU name used to perform programming. Set the CPU type to “H-302” for MICRO-EH.	Always perform these settings when programming.
3	Memory assignment	○ Set the memory capacity. Set the memory type to “RAM-04H” for MICRO-EH.	Always perform these settings when programming. The number of program steps that can be input is 3072.
4	Operating parameters	○ Operation control Perform these settings when controlling the running and stopping of the operation using a specific I/O. If this is not set, operation will start automatically by setting the RUN switch (or the RUN terminal) to “RUN.” ○ Congestion check time Set this when you wish to stop the CPU operation when the set maximum processing time for a normal scan is exceeded. When this setting is not made, this is automatically set to initial value 100 ms. ○ Operating mode at problem occurrence Set this when you wish to continue the CPU operation when the error generated by the CPU is minor.	Set according to the user's operation purposes.
5	I/O assignment	○ This sets the I/O assignment information of the CPU. It is convenient to use the MICRO-EH's I/O assignment copy function.	Always perform these settings when programming.
6	Program name	Set the program name using a maximum of 16 alphanumeric characters. The set program names can be written into the CPU along with the program, which will facilitate the program verification and management.	Set this to facilitate program verification and management.
7	Power failure memory*	This sets the range in which the data in a specified area in the CPU is to be stored upon CPU power off or when commencing RUN. Settings for R, WR, WM, TD, DIF, DFN are possible.	Set this when there is data you wish to maintain when operation is stopped. The special internal output data is unconditionally saved for power failure by the I/O number.

*: 10-point type CPU does not have the power failure memory function. Even though it is possible to set a power failure memory area from a peripheral unit, the values that are stored here will not be persistent; **do not set this function.**
Moreover, 14-point type CPU can maintain power failure memory only up to 72 hours. Note that non-persistent values will be stored if the power supply to the main unit is not turned on after these hours have passed. 23- and 28-point CPUs without a battery can maintain power failure memory for only up to 30 minutes. The data can be retained for approximately two months by installing a battery.

9.5 Test Operation

(1) Verification of interlock
Verify performance of the interlock in case of unexpected incidents.
Create ladders such as an emergency stop circuit, protective circuit and interlock circuit outside the program controller. For the relay output module, however, do not control the relay drive power supply to interlock with the external loads.

(2) Operation without load
Before actually operating the loads in the system, test the program only and verify its operation.
Always perform this if there may damage the other party's equipment due to unexpected operation caused by program errors or other problems.

(3) Operation using actual loads
Supply power to the external input and external output to verify the actions.

9.6 Forced Set/Reset

It is possible to forcefully set/reset data to specified I/O points using peripheral units, regardless of whether the CPU is operating or stopped. Refer to the manuals for the peripheral units for how to set/reset forcefully.
Please note that for the special internal outputs related to operation modes, forcefully setting/resetting only the corresponding special internal output does not enforce the change in the operation mode. For example, when the frequency of a pulse output should be changed, the frequency will not be changed by just setting the desirable frequency in WRF072, the special internal output for setting pulse frequency. See Chapter 8, where the setting of the PI/O function is explained in detail.

9.7 Forced Output

It is possible to use peripheral units to specify single outputs for forced output while the CPU is stopped. Refer to the manuals for the peripheral units for how to output forcefully.
Table 9.5 lists the differences between the forced set/reset and forced output.

Table 9.5 Differences between forced set/reset and forced output

	Forced set/reset	Forced output
I/O types that can be used	X,Y,M,R,TD,SS,CU, CT,WX,WY, WM,WR, TC,DX,DY,DM,DR	Y,WY,DY
CPU status in which the function can be used	During RUN and being stopped	Being stopped
Function	Changes the data in the area that stores the CPU calculation result to a specified value.	Turns only one specified external output (one point or one data) on/off while the CPU is being stopped. All other outputs are turned off.
Application	For checking when setting/changing power failure memory area data at troubles.	For checking the wiring for external output.

Note:
1] The actual external output status and the external output information stored internally in the CPU may be different when the CPU is stopped. At this point, if a forced set/reset is performed to the external output, the external output information stored internally in the CPU is output from other external output. Thus, the forced output function can be used in order to check the wiring for the external output.
2] Only I/O points assigned by the I/O assignment written in the CPU can be set for external input and external output I/O numbers.

Chapter 10   PLC Installation, Mounting, Wiring

10.1 Installation

(1) Installation location and environment
  (a) When installing the MICRO-EH, use the unit under the environment within the general specification.
  (b) Mount the PLC onto a metal plate.
  (c) Install the PLC in a suitable enclosure such as a cabinet that opens with a key, tool, etc.

(2) Installing the unit
  (a) Precautions when installing the unit
    1] When installing the base unit, fix it securely with screws in 2 places (M4, length 20 mm or more) or DIN rail.
    2] To use the unit within the ambient temperature range,
      a) Allow ample space for air circulation. (50 mm or more at top and bottom, 10 mm or more to the left and right)
      b) Avoid installing the unit directly above equipment that generates significant heat (heater, transformer, large-capacity resistance, etc.)
      c) When the ambient temperature reaches more than 55 °C, install a fan or cooler to lower the temperature to below 55 °C.
    3] Avoid mounting inside a panel where high-voltage equipment is installed.
    4] Install 200 mm or more away from high-voltage lines or power lines.
    5] Avoid upside down, vertical or horizontal mounting.

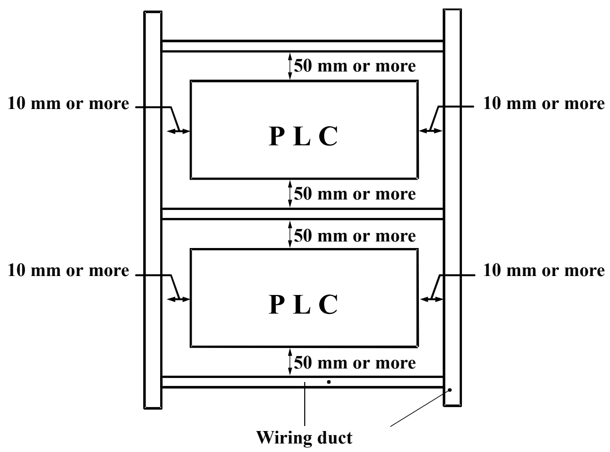


Figure 10.1 Mounting clearances

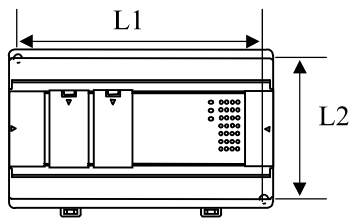


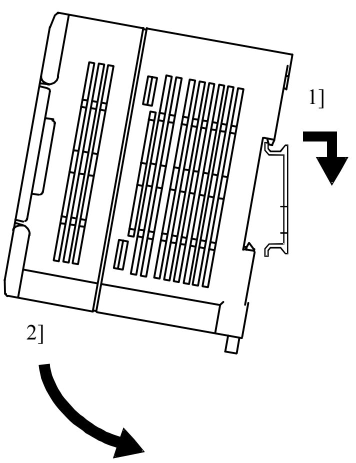
Figure 10.2 External dimensions

Dimensional table

Unit	L1	L2
10-point	65	70
14-point (basic, exp.)	85	80
23, 28-point (basic, exp.)	140	80

Unit: mm

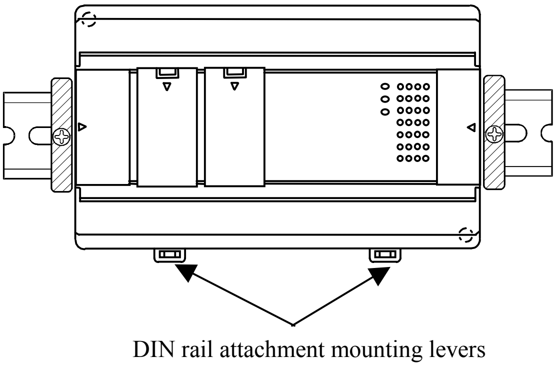
(b) Mounting to a DIN rail
Attaching to a DIN rail



1] Hook the claw (top side) attached to the back of the unit to the DIN rail.
2] Press the unit into the DIN rail until it clicks.

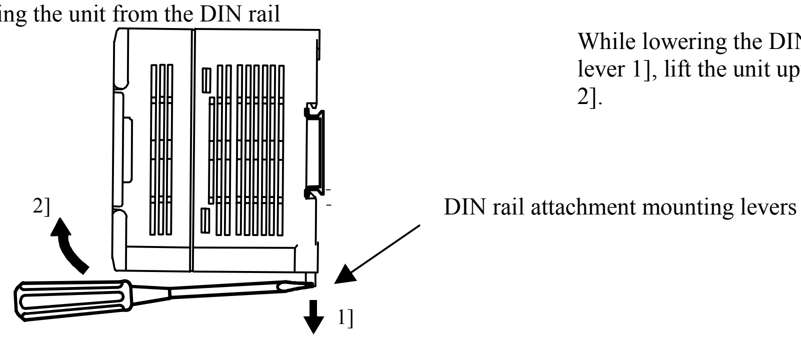
Note: After installation, check to make sure the base unit is securely fixed.

Securing the unit



Secure the unit by installing DIN rail fixing brackets from both sides. (The product may move out of place if not secured with the fixing brackets.)

Removing the unit from the DIN rail



While lowering the DIN rail attachment mounting lever 1], lift the unit upward to remove as shown by 2].

10.2 Wiring

(1) Separation of the power system

The power supplies include power for the MICRO-EH main unit/power for the I/O signals/power for general equipment. These power supplies should be wired from separate systems as much as possible.
When these power supplies are supplied from one main power source, separate the wiring with a transformer or similar device, so that each power supply is a separate system.

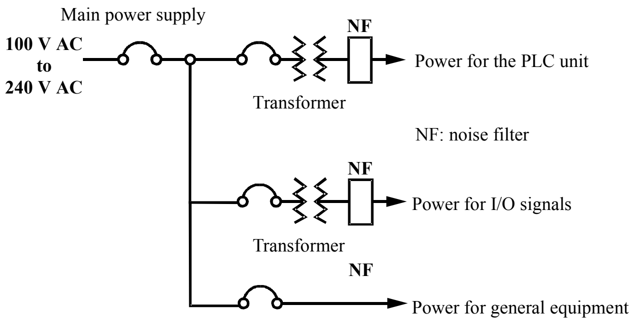


Figure 10.3 Example of power system diagram

(2) Regarding fail safe

1] Construct an interlock circuit external to the MICRO-EH.
When the MICRO-EH's power is turned on or off, the inputs/outputs of the MICRO-EH may not temporarily operate normally due to the time lag of the power supply of the MICRO-EH's main unit, the external power supply of the MICRO-EH's expansion unit, and the external power supply (especially DC power supply) for the MICRO-EH's I/O signals, as well as the difference in their startup times.
Thus, either turn on the power to the expansion unit first, or turn on the power to both the base unit and expansion unit simultaneously. Also, be sure to turn on the external power supply (especially DC power supply) for the MICRO-EH's I/O signals before turning on the MICRO-EH.
Additionally, a problem in the external power supply or a malfunction in the MICRO-EH's main unit may cause abnormal operations. To prevent such problems from causing abnormal operations of the entire system, and from the viewpoint of creating a fail-safe mechanism, construct such circuits as an emergency stop circuit, protective circuit and interlock circuit external to the MICRO-EH for the sections that may result in mechanical damage or accident if abnormal operations occur.

2] Install a lightning arrester
To prevent damage to the equipment as a result of being struck by lightning, it is recommended that a lightning arrester be installed for each MICRO-EH's power supply circuit.
The MICRO-EH detects a power failure from a voltage drop in the internal 5 VDC power supply. For this reason, when the load in the unit's internal 5 VDC system is light, 5 VDC is retained for a long period of time and operations may continue for more than 100 ms. Thus, when an AC input unit is used, an off-delay timer for coordinating with the internal 5 VDC system is required to avoid erroneous input since the AC input signal turns off more quickly than the internal 5 VDC system.

(3) Wiring to the power module

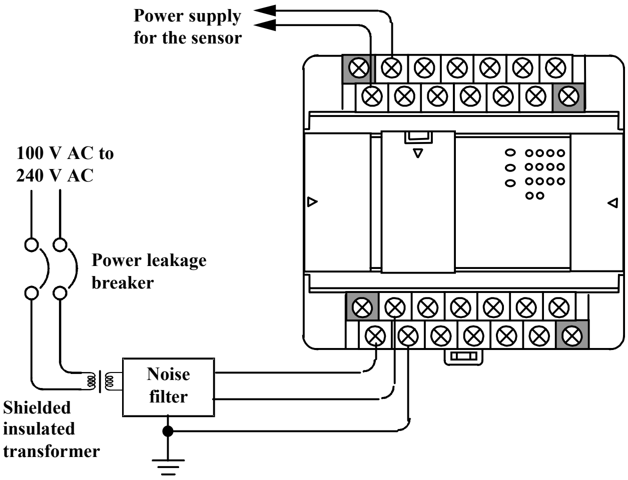


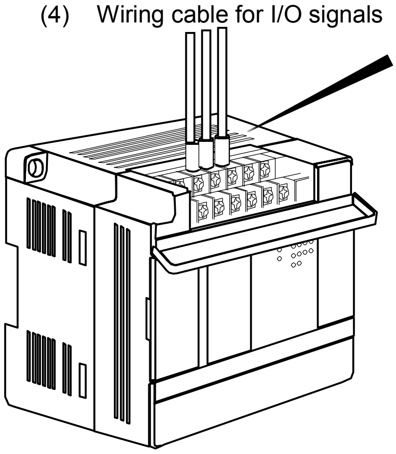
Figure 10.4 Power supply wiring diagram

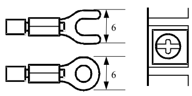
(a) For power supply wiring, use a cable of 2 mm^2 or more to prevent a voltage drop from occurring.
(b) For the function ground terminal (PE terminal), use a cable of 2 mm^2 or more and provide Class D grounding (100 Ω or less). The appropriate length for the ground cable is within 20 m.
  1] Instrumentation panel and relay panel grounding may be shared.
  2] Avoid grounding shared with equipment that may generate noise such as high-frequency heating furnace, large-scaled power panel (several kW or more), thyristor exchanger, electric welders, etc.
  3] Connect a noise filter (NF) to the power cable.
(c) Tighten the terminal screws within the torque range as shown below.

Unit	Screw	Clamping torque
10-point	M2.5	0.3 to 0.4 N·m
14, 23, 28-point, expansion	M3.0	0.5 to 0.6 N·m

(d) Use the same power supply system for the basic and expansion units.

(4) Wiring cable for I/O signals





Tighten each terminal screw using a torque of the specified torque range.
When using a crimp terminal, use one with an outer diameter of 6 mm or less.
Use only up to two crimp terminals in the same terminal. Avoid clamping down more than three at the same time.
Only one piece of cable can be wired per terminal if the cable type is between AWG14 and AWG22 (cable thickness ranging between 2.1 mm^2 and 0.36 mm^2), but two pieces can be wired if the cable type is between AWG16 and AWG22 (between 1.3 mm^2 and 0.36 mm^2).

(5) Wiring to the input terminals

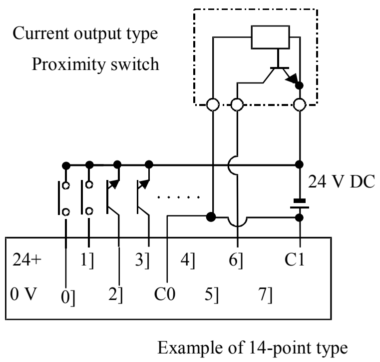
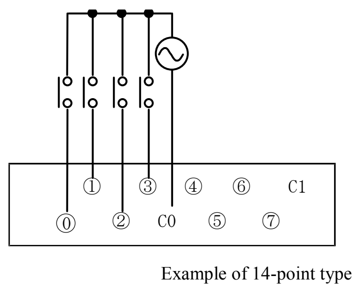
DC input	AC input
	

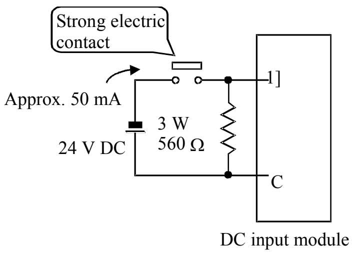
Figure 10.5 Input wiring

(a) DC input

1] When all input terminals (X0, X1, ...) and the common terminal (C) are loaded with 24 VDC, the input becomes ON status, and approximately 7.5 mA of current flows to the external input contacts.

2] For sensors such as a proximity switch or photoelectric switch, current output type (transistor open collector) can be connected directly. For voltage-output-type sensors, connect them to the input terminal after first going through the transistor.

3] Take measures to prevent faulty contact in a strong electric contact.



The current that flows to a contact when external contacts are closed is approximately 7.5 mA. If a strong electric contact must be used, add resistance as shown in the diagram at left and supply sufficient current to the contact to prevent a faulty contact.

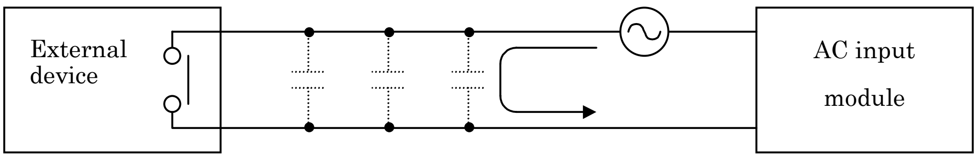
4] Limit the wiring length within 30 m.

5] Multiple number of common terminals located at each input section are not connected internally. Make the connections externally as needed.

6] <u>There are no RUN and STOP switches for the 10-point type. Connect with the RUN input terminal according to the above connection procedure so that RUN and STOP can be performed. Operation cannot be performed unless this connection is done.</u>

(b) AC input

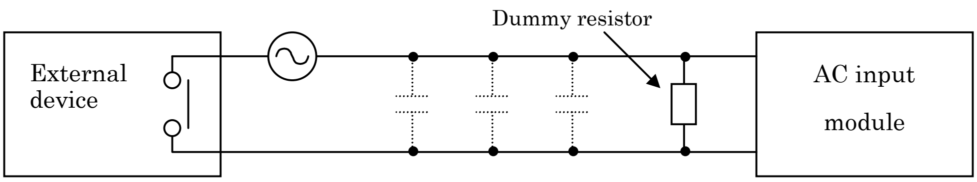
In case of AC input module, input voltage may exist if input wiring is long although no device drives. This phenomenon is caused from leakage current due to floating capacitance between lines.



The countermeasures are [1] or [2] as follows. This voltage due to electrostatic coupling must be half of max. OFF voltage or less.

[1] To install dummy resistor in parallel so that impedance of input module is lower.

[2] To replace power supply at drive (external device) side.



(6) Wiring to the output terminals

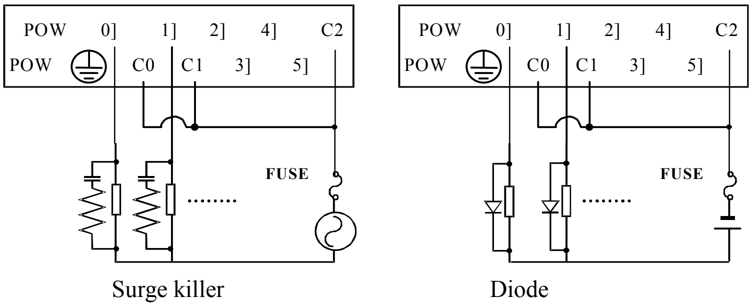
Item	Relay output EH-*XXDR**
External wiring	

Figure 10.6 Relay output wiring

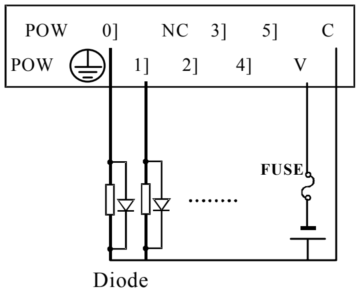
Item	Transistor output (sink type) (EH-*XXDT**)
External wiring	

Figure 10.7 Transistor output wiring

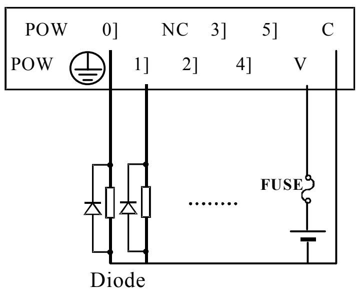
Item	Transistor output (source type) (EH- XXDTP**)
External wiring	

Figure 10.8 Transistor output wiring

(a) Wiring to the relay output terminals

1] Life of relay contacts

Life curve of relay contacts

Figure 1 Life characteristics (125 V AC)

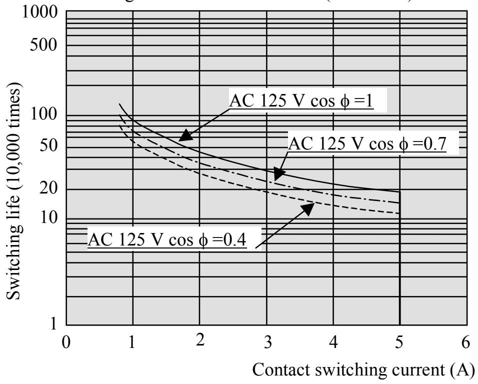


Figure 2 Life characteristics (250 V AC)

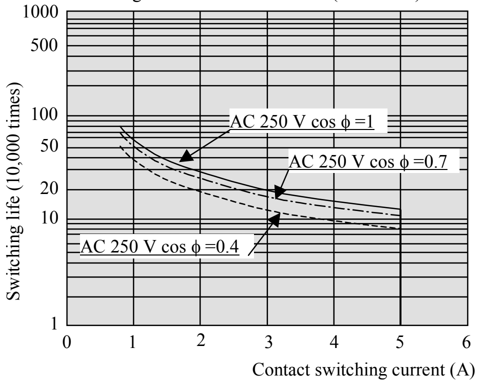
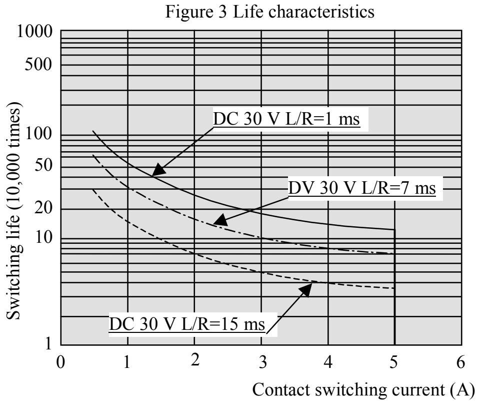


Figure 3 Life characteristics



Life of the contact is almost in squared reverse proportion to the current, so be aware that interrupting rush current or directly driving the condenser load will drastically reduce the life of the relay.
When switching is made with high frequency, use a transistor output module.

2] Surge killer
For inductive load, connect a surge killer (condenser 0.1 μF, + resistance of approx. 100 Ω) in parallel to the load. Also, for DC load, connect a flywheel diode.

3] Fuse
A built-in fuse is not used in this module. Install a 6 A fuse in the common to prevent the external wiring from burning out.
For the independent contact output section, install a 2A fuse per circuit.

(b) Wiring to the transistor output terminals

4] Flywheel diode
For inductive load, connect a flywheel diode in parallel.

5] V and C terminals
Always connect a V terminal and C (common) terminal. If the module is used without connecting these terminals, the internal flywheel diode may not function and the module may malfunction or break down.

6] Fuse
There is no built-in fuse to prevent external wiring burning. Therefore, it is recommended that a fuse be installed externally to prevent the external wiring from burning out. (This does not protect the internal transistor elements.) If the external load is short-circuited, please contact us for repair.

(7) Wiring to the unit terminals

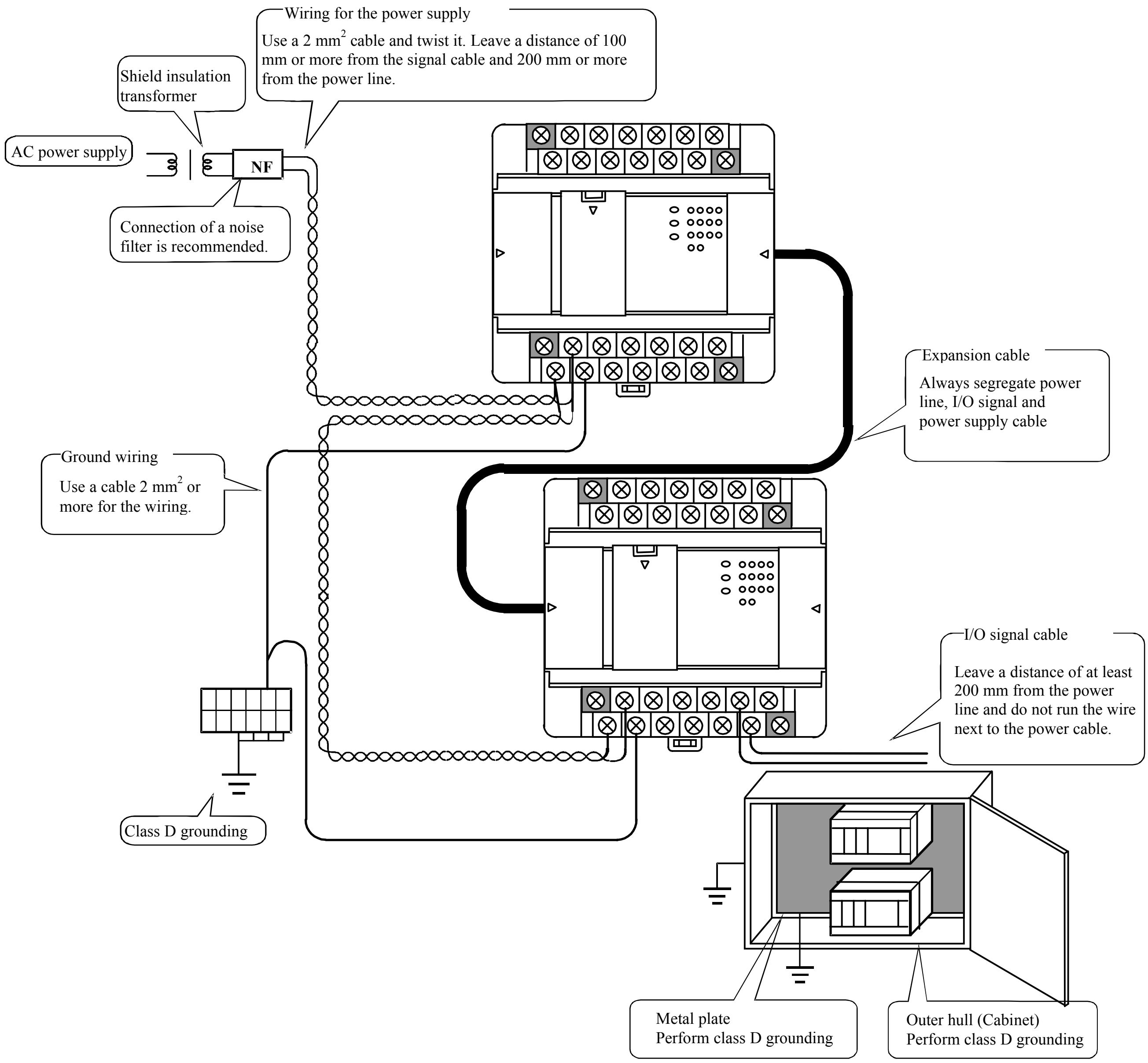


Figure 10.9 Example of wiring

(8) Wiring to the analog I/O terminals

- Do not apply the voltage that exceeds the rated input voltage to the analog input terminals. In addition, do not allow the current that exceeds the rated input current to flow into the analog input terminals. If a power supply that is different from the specified power supply is connected, the product may be damaged or burned out.
- For the channels that do not use the analog input terminals, be sure to short-circuit the analog input terminals before using such channels.
- For the external wiring to the analog I/O terminals, use a shielded cable and make routing different from other power lines with different voltages and signal lines. In addition, ground one end of the shield cable. However, grounding both ends or open ends may have better effect than grounding one end of the shield cable, depending on the noise environment in which the equipment is used. Use the appropriate grounding method accordingly.
- Place AC power supply lines, signal lines and data lines in separate pipes.
- Wire signal lines and data lines as close as possible to a grounded surface such as a cabinet and metal bar.

Chapter 11 Communication Specifications

11.1 Port function

Port function of MICRO-EH is shown in Table 11.1.

Table 11.1 Communication port specification

Port type		RS-232C			RS-422/485				
		Dedicated port		General purpose port	Dedicated port				General purpose port
		Transmission procedure 1	Trans. proce-dure 2		Transmission procedure 1		Transmission procedure 2		
					Without St. No. (1:1)	With St. No. (1:N)	Without St. No. (1:1)	With St. No. (1:N)	
Connected devices		Programming device, PC, modem, HMI	PC, etc.	PC, etc.	Programming device, PC, HMI	PC, etc.	PC, etc.	PC, etc.	PC, etc.
Port 1	All modules	✓	✓	✓*	-	-	-	-	-
Port 2	23,28 pts. module	-	-	-	✓	✓	✓	✓	✓*

* Supported by software version 1.30 (WRF051=H0130) or newer.

11.2 Port 1

Specification of port 1 is shown below.

Table 11.1 Port 1 specification

Item	Specification		
Communication speed*	Dedicated (programming) port	Modem mode	General purpose port
	4800, 9600, 19.2k, 38.4k bps	2400, 4800, 9600, 19.2 k, 38.4k, 57.6 k bps	300, 600, 1200, 2400, 4800, 9600, 19.2k, 38.4k, 57.6k bps
Communication system	Half duplex		
Synchronization	Asynchronous		
Startup system	One-sided startup using the host side command		
Transmission system	Serial transmission (bit serial transmission)		
Transmission code	ASCII		Configured by user
Transmission code configuration	ASCII: 7-bit data, 1 start, 1 stop, even parity Start bit (1 bit) Parity bit (1 bit) Stop bit (1 bit) 2^0 2^1 … 2^6 P Data (7 bits) (even parity)		Configured by user
Data sending sequence	Sent out from the lowest bit		
Error control	Vertical parity check, checksum, overrun check, framing check		
Transmission unit	Message unit (variable length)		
Max. message length	1,024 bytes (including control characters)		
Control procedure	H-series dedicated procedure (hi-protocol) Standard protocol (transmission control procedure 1), Simplified protocol (transmission control procedure 2)		Configured by user
Interface	RS-232C (maximum cable length: 15 m)		
Connector	8P modular connector (RJ45)		

* : Handy programmers are not available with MICRO-EH.
* : GPCL01H is not available with 10 points type as communication speed is fixed as 4,800 bps.
* : If host sends NAK command, the next message must be sent after 10 ms interval.

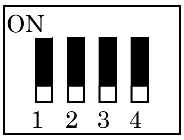
(1) Port 1 settings

Port 1 is configured by combination of DIP switch and special register (WRF01A).

DIP switch can be set when cable is not connected (DR signal is off). Switch configuration is set at cable connected (DR is high).

Value in WRF01A is saved in FLASH memory when writing flag (R7F6) is turned on. If saved in FLASH memory, it is not necessary to set again at the next power up.

[Caution] If transmission procedure 2 is configured and saved in FLASH memory once, peripheral device/application which supports procedure 1 such as LADDER EDITOR can not be connected.



Port type		DIP switch 1	2	3	4	WRF01A	Remarks
Dedicated port	38.4 kbps	**ON**	off	**ON**	off	H0000 : Transmission procedure 1 H8000 : Transmission procedure 2	
	19.2 kbps	**ON**	off	off	off		
	9600 bps	off	off	**ON**	off		
	4800 bps	off	off	off	off		Default
Dedicated port via modem	4800 bps	off	**ON**	off	off	H0000 : Prcd. 1 / H8000 : Prcd. 2	H0*** : Procedure 1 H8*** : Procedure 2
	9600 bps					H0100 : Prcd. 1 / H8100 : Prcd. 2	
	19.2 k bps					H0200 : Prcd. 1 / H8200 : Prcd. 2	
	38.4 k bps					H0300 : Prcd. 1 / H8300 : Prcd. 2	
	57.6 k bps					H0400 : Prcd. 1 / H8400 : Prcd. 2	
	2400 bps					H0500 : Prcd. 1 / H8500 : Prcd. 2	
General purpose port		Port switching by **FUN5 command,** Baud rate by **TRNS/RECV command**					

* Due to no DIP switch equipped, 10 points type does not support modem function.
* +12V is supplied from pin 4 if DIP switch is ON.
* General purpose port is supported by software version 0130 (WRF051=H0130) or newer.

(2) Port 1 hardware

The circuit diagram of port 1 and the signal list are shown in Figure 11.2 and Table 11.3 respectively.

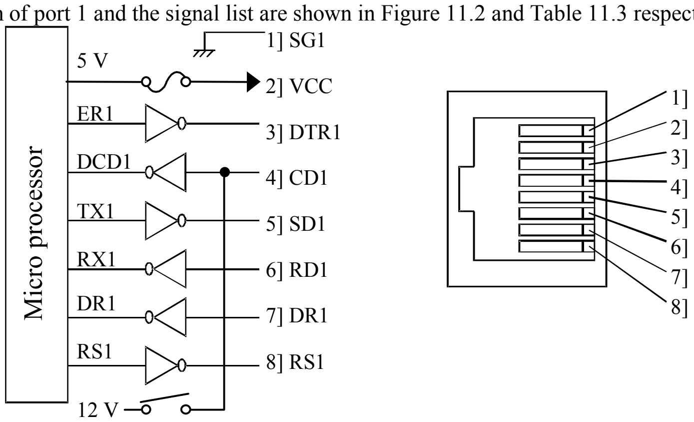


Figure 11.2 Circuit diagram and pin numbers for port 1

Table 11.3 List of port 1 signals

Pin No.	Signal abbreviation	Direction CPU ⇔ Host	Meaning
1]	SG1	← →	Signal ground
2]	VCC	→	5 V DC is supplied. (Protective fuse is connected.)
3]	DTR1 (ER)	→	Communication enabled signal. When it is high, communication is possible.
4]	CD1 (DCD)	→	12V is output when DIP switch 1 is on.
5]	SD1 (TXD)	→	Data sent by the CPU
6]	RD1 (RXD)	←	Data received by the CPU
7]	DR1 (DSR)	←	Peripheral units connected signal. When it is high, peripheral device is connected.
8]	RS1 (RTS)	→	Transmission request signal. When it is high, CPU is ready to receive data.

11.3 Port 2

The specifications of port 2 are listed in Table 11.4. 1:n station communication by the high protocol is possible with port 2. By creating and including a control procedure based on the high protocol on the personal computer which will become the host, it becomes possible to control a maximum of 32 stations from one host. The systems can thus be configured in several ways.

Table 11.4 Port 2 specifications

Item	Specification	
	Dedicated (programming) port	General purpose port
Communication speed	4800, 9600, 19.2 k, 38.4 k bps	300, 600, 1200, 2400, 4800, 9600, 19.2 k, 38.4 k, 57.6 k bps
Communication system	Half duplex	
Synchronization	Asynchronous	
Startup system	One-sided startup using the host side command	
Transmission system	Serial transmission (bit serial transmission)	
Transmission code, configuration	ASCII: 7-bit data, 1 start, 1 stop, even parity	Configured by user
Transmission code outgoing sequence	Sent out from the lowest bit in character units	
Error control	Vertical parity check, checksum, overrun check, framing check	
Transmission unit	Message unit (variable length)	
Maximum message length	503 bytes (including control characters) Note: 505 bytes when the station number is used.	1,024 bytes
Control procedure	H-series dedicated procedure (h-protocol) Standard protocol (transmission control procedure 1), Simplified protocol (transmission control procedure 2)	Configured by user
Interface	RS-422/485 (maximum cable length: 250 m)	
Connector	CPU side: 15-pin D-sub Cable side: a cable equivalent to 17JE-23150-02(D8B) (DDK Co., Ltd.) is recommended (D-SUB fitting screw M3 × 0.5)	

(1) Setting port 2

Port 2 is configured by special register WRF03D. The settings can be changed even when port 2 is communicating. The highest bit (b15) of WRF03D is setting bit.

If station number mode is used, make sure to set the station number from 0 to 31 in BCD code.
Value in WRF03D is saved in FLASH memory when writing flag (R7F6) is turned on. If saved in FLASH memory, it is not necessary to set again at the next power up.

(Example) Transmission control procedure 2, communication speed 19.2 kbps, and station number 28.
➔ WRF03D = HE228 After the setting is completed, WRF03D is changed to H6228. (b15 cleared)

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
WRF03D:	a	b	c	0			d					e				
Initial value:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 11.3 Special internal output for setting port 2

Field	Setting value	Content	Note
a	0	Setting completed	After the setting is completed, the system changes this bit to 0.
	1	Setting change request	Set this bit to 1 when changing the setting.
b	0	Transmission control procedure 1	
	1	Transmission control procedure 2	
c	0	Without station number	
	1	With station number	
d	0	Transmission speed 4800 bps	Setting of bits 8 to 12 H0000
	1	9600 bps	H0001
	2	19.2 kbps	H0010
	3	38.4 kbps	H0011
	Other than above	4800 bps	
e	0 ~ 31	Station number *	Set by BCD.

* Communication speed of general purpose port is configured in TRNS/RECV command. Value in WRF03D is ignored.

(2) 1:n station communication on RS-485

When station number mode is used on RS-485, termination command (NAK FF) from host/PC can conflict with reply from CPU, and CPU can fail to receive this command. Pay attention to this possibility at using this command.

(3) Port 2 hardware

The circuit diagram of port 2 and the signal list are shown in Figure 11.4 and Table 11.6 respectively.

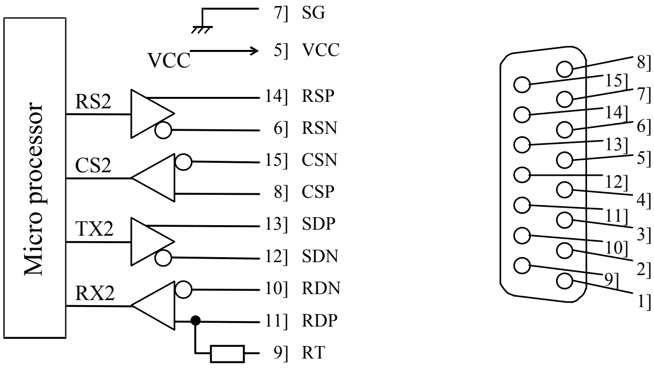


Figure 11.4 Circuit diagram and pin numbers for port 2

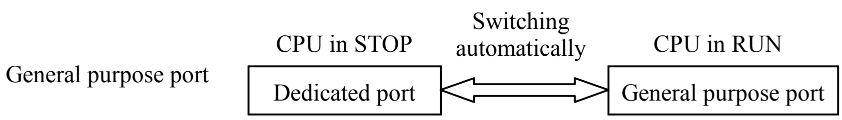
Table 11.6 List of port 2 signals

Pin No.	Signal abbreviation	Direction CPU ⇔ Host	Meaning
1]	NC		Not used
2]	NC		Not used
3]	NC		Not used
4]	NC		Not used
5]	Vcc	→	5 V DC is supplied.
6]	RSN	→	Transmission request signal. When it is high low, CPU is ready to receive data..
7]	SG	—	Signal ground
8]	CSP	←	Receive enabled signal. When it is high, connected device is ready to receive data.
9]	RT		Terminating resistor (120Ω). Connect to pin 10 if necessary.
10]	RDN	←	Data received by the CPU -
11]	RDP	←	Data received by the CPU +
12]	SDN	→	Data sent by the CPU -
13]	SDP	→	Data sent by the CPU +
14]	RSP	→	Transmission request signal. When it is high level, CPU is ready to receive data.
15]	CSN	←	Receive enabled signal. When it is low, connected device is ready to receive data.

11.4 General purpose port (Port 1,2)

General purpose port can be configured either port 1 or port 2 by FUN 5 command in user program. General purpose port enables serial communication to devices like bar code reader by TRNS/RECV command in user program.
Even if configured, the port works as general purpose port only CPU is in RUN status. Port is changed back to dedicated port when CPU is in STOP status.

* General purpose port is supported by software version 1.30 (WRF051=H0130) or newer.



11.5 Modem Control Function

The 14-point or higher MICRO-EH is equipped with a modem control function. The modem control function can be operated using task codes. To use this function, it is necessary to set No.2 of the DIP SW.
For details on the communication specifications, see Table 11.1, "Specifications of port 1."
* The 10-point type CPU does not have this function.
Connecting two operating modems may be difficult if there is a significant difference between them in terms of communication speeds. Thus, use the models having the same communication speed.

11.5.1 Configuration

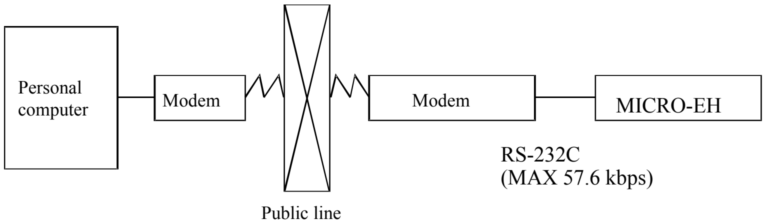


Figure 11.5 Modem connection configuration diagram

Table 11.7 List of port 1 signals when a modem is connected

Pin No.	Signal abbreviation	Direction CPU / Host	Meaning
1]	SG1	—	Signal ground
2]	CD1	←	Carrier receive in-progress notification signal Connected to CD in the modem.
3]	ER1	→	Communication enabled signal of the terminal
4]	ER2	→	Not used
5]	SD1	→	Data sent by the CPU Connected to SD in the modem.
6]	RD1	←	Data received by the CPU Connected to RD in the modem.
7]	DR1	←	Communication enabled signal of the modem Connected to DR in the modem.
8]	RS1	→	Transmission request signal Connected to RS in the modem.

11.5.2 AT Commands

The AT commands are used to make various modem settings, and are set from the host computer. The MICRO-EH issues the AT commands automatically for initial setting. Other than this, the AT commands are not used.
Refer to instruction manual or other documents furnished by modem manufacturers for details on the AT commands.
In AT commands, an instruction sent to the modem from the host is called a "command," and the character string in response to the "command" returned to the host from the modem is called a "result code."
AT commands always begin with the character string "AT," and a return code is input at the end of the command. However, A/ is excluded. The command that follows the "AT" can have multiple inputs in a single line.

Example)

A	T	&C	1	&S	0	P	2	CR	LF

- A T: AT commands
- &C 1: CD signals: Follows the carrier signals generated by the opposite device
- &S 0: DR signals: Always On
- P 2: 20 pps (pulse setting)

(1) Format

1] AT command format

A	T	command parameter command parameter · · · ·	CR	LF

2] Result code format

CR	LF	Result code (word)	CR	LF

Result code (number)	CR	LF

(2) List of commands (extract)

1] AT commands

Command	Function overview	Example
AT	Automatically recognizes data format	—
A/	Re-executes the response directly preceding	—
ATA	Forced reception	
ATDmm	Dial	ATD12345678
ATEn	Command echo (echo back a text string entered to modem) 0: No 1: Yes	ATE0
ATHn	Line ON/OFF 0: On hook (disconnect) 1: Off hook	ATH0 ATH1
ATPn	Pulse (dial) setting 0, 1: 10 pps 2 : 20 pps	ATP0, ATP1 ATP2
ATQn	Result code setting 0: Yes 1: No	ATQ0
ATT	Tone (push) setting	ATT
ATSn = X	Sets S register value.	ATS0 = 0
ATVn	Result code display format 0: Number 1: Word	ATV0 ATV1
AT&Cn	CD signal control 0: Always on 1: Depends on the carrier of counter-party modem	AT&C0 AT&C1
AT&Dn	ER signal control 0: Always on 2: Turning from on to off during communication disconnects line 3: Turning from on to off resets the software	AT&D0 AT&D2 AT&D3
AT&Sn	DR signal 0: Always on 1: Depends on sequence 2: Depends on CD signal	AT&S0 AT&S1 AT&S2
AT&Rn	RI(CI) signal control 0: Turns on from calling start until communication begins 1: Turns on from calling start until communication ends 2: Turns on/off in synchronization with the call signal	AT&R0 AT&R1 AT&R2

2] S register

S register	Set value	Function
S0	0 no automatic reception 1 to 255	Setting for automatic reception/reception ring count
S2	0 to 127 (43 [+])	Escape code setting
S3	0 to 127 (13 [CR])	CR code setting
S4	0 to 127 (10 [LF])	LF code setting

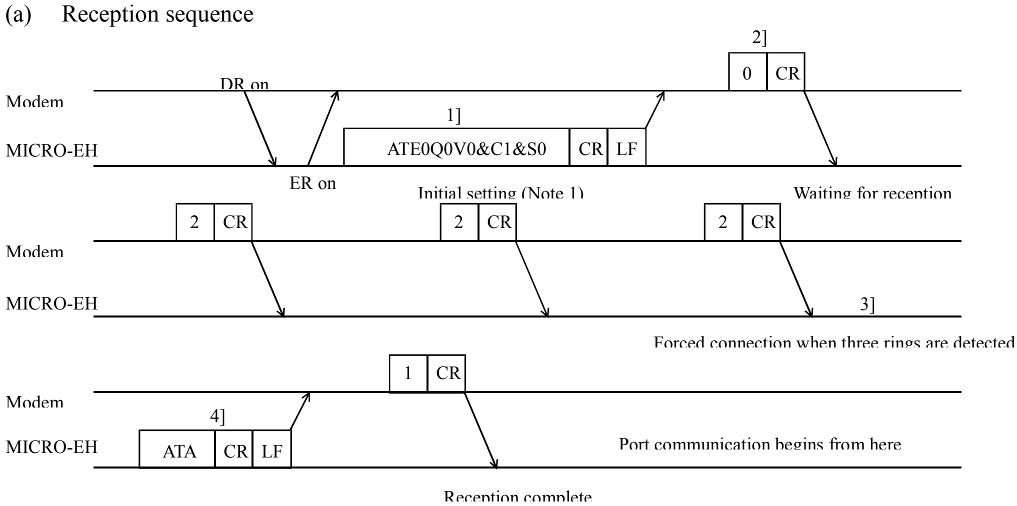
3] Result codes

Number format	Word format	Meaning
0	OK	Normal execution
1	CONNECT	Connection complete
2	RING	Reception detected
3	NO CARRIER	Line disconnected
4	ERROR	Command error
5	CONNECT 1200	1200 bps connection
6	NO DIAL TONE	Cannot hear dial tone
7	BUSY	Busy signal detected
8	NO ANSWER	No tone heard
10	CONNECT 2400	2400 bps connection
11	CONNECT 4800	4800 bps connection
12	CONNECT 9600	9600 bps connection
13	CONNECT 14400	14400 bps connection

(3) Sequence

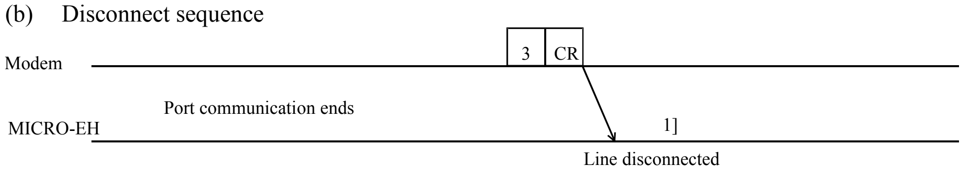
An example of a communication sequence using the Omron-made modem ME3314A is given below.

(a) Reception sequence



1] The PLC issues the AT command that performs the initial setting of the modem.
2] If initial setting is OK, the modem returns "0."
3] The PLC detects the result code "2" three times while in the reception wait state.
4] It connects the modem.

(b) Disconnect sequence



1] The PLC disconnects the line when the result code "3" is returned from the modem.

Note 1: Since the modem initial setup sets only minimal items from the MICRO-EH side, connect a personal computer and perform necessary settings before making the connection. (Set the DR signal to always on.) Moreover, do not change the following initial settings.

Contents of the initial settings

Command echo:	None
Result code:	Yes
Display format of result code:	Numerical format

Note 2: The modem timeout (WRF03C) stored in the special internal output refers to the time from data transmission from the MICRO-EH to the data reception from the opposite station (STX, ENQ, NAK). Normally, this special internal output should be set to "0000" (default) or "H8000" (no timeout). Set the timeout only when it is especially necessary to monitor the reception time from the opposite station. When a timeout is detected, the MICRO-EH cuts off the line. When setting the timeout, set the time in the ** part of H80. The unit is * seconds (hexadecimal).

Note 3: Before actually cutting off the line, issue the task code of the line cut off request (HIC--see Appendix 2, "Task code list" for details) from the host side.

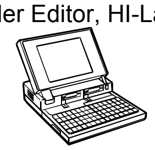
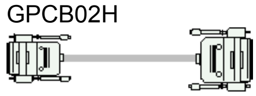
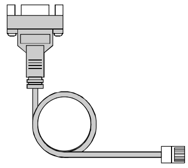
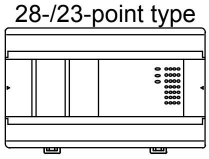
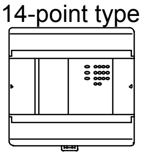
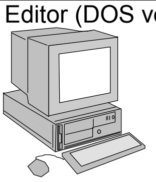
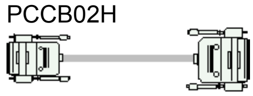
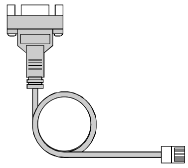
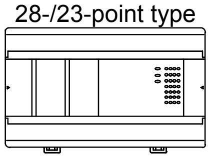
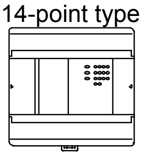
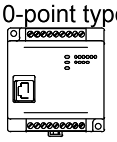
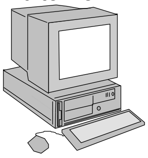
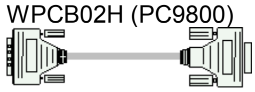
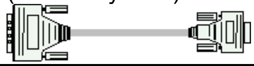
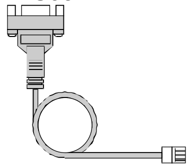
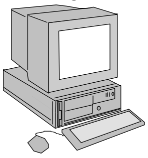
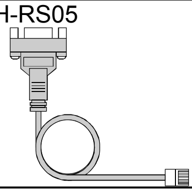
11.6 Connecting to the Ports

The following shows some examples of connections between port 1 and 2 and peripheral units. When creating a connection cable, check it thoroughly in advance according to what the purpose of its use is.

11.6.1 Port 1

Port 1 of the MICRO-EH is a communication port that uses the RS-232C protocol as interface. It is also a dedicated port with which to perform communication by the H series dedicated procedure (high protocol). Table 11.8 lists the types of peripheral units and cables that can be connected to port 1.

Table 11.8 Peripheral unit connection configuration

Peripheral unit	Cable		CPU type
GPCL01H (Ladder Editor, HI-Ladder) 	GPCB02H 	EH-RS05 	28-/23-point type  14-point type 
Ladder Editor (DOS version) 	PCCB02H 	EH-RS05 	28-/23-point type  14-point type  10-point type 
Ladder Editor for Windows® 	WPCB02H (PC9800)  WVCB02H (DOS/V system) 	EH-RS05 	
	EH-VCB02 (DOS/V system) 		
Pro-H 	WVCB02H 	EH-RS05 	
	EH-VCB02 		

*1: Set the DIP switches to 19.2 kbps when connecting to a GPCL01H.
*2: Adjust the DIP switch settings to the speed with which to communicate when connecting a LADDER EDITOR or Pro-H. (The speed is fixed at 4800 bps for 10-point type CPU.)

11.6.2 Port 2

Port 2 of the MICRO-EH is a communication port that uses either the RS-422 or RS-485 protocol as interface. It is also a dedicated port with which to perform communication by the H series dedicated procedure (high protocol), which allows 1:n station communication. Figure 11.6 and 11.7 show examples of port 2 connections for 1:n station communication. Moreover, the connection for communicating 1:1 is performed by connecting only the first CPU in the figure below.

(1) In case of RS-422

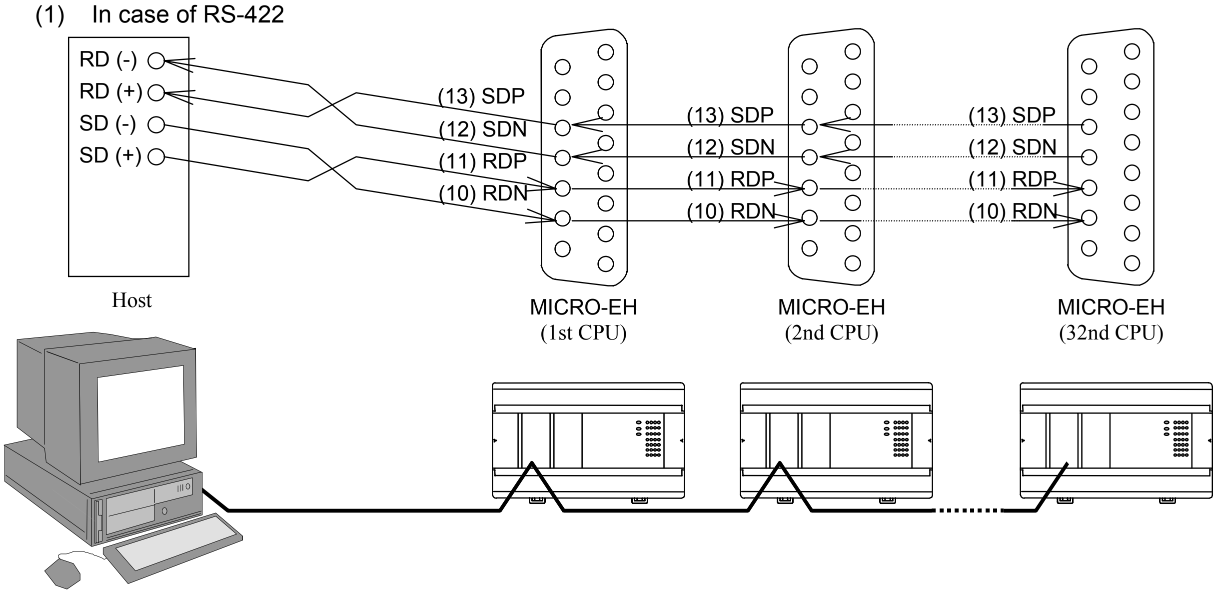


Figure 11.6 Connection for 1:n station communication by RS-422

(2) In case of RS-485

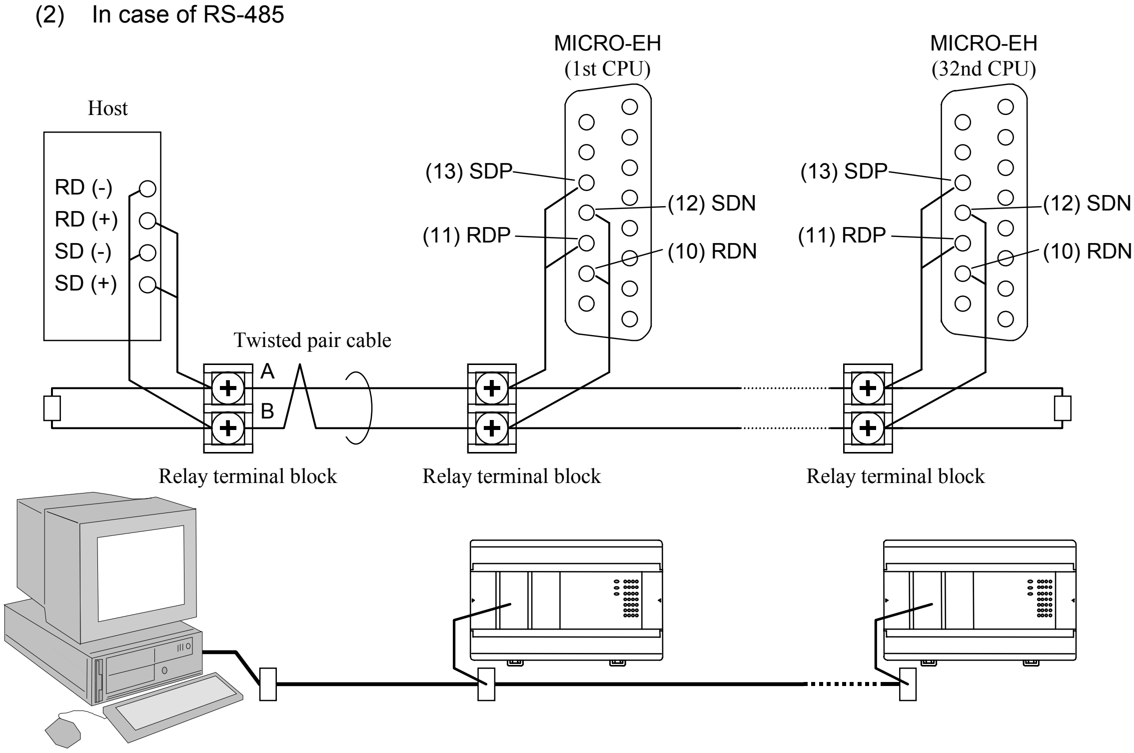


Figure 11.7 Connection for 1:n station communication by RS-485

MEMO

Chapter 12 Error Code List and Special Internal Outputs

12.1 Error Codes

The table below indicates the self-diagnostic error codes. (See Chapter 13, “Troubleshooting” about corrective actions.) Error codes are output as hexadecimal values to the special internal output WRF000. (This special internal output is saved during power failure, and is retained even when the causes of the error are eliminated. Also, when multiple errors occur, the most fatal error in the error classification is stored.)

Note: LED examples The occurrence of a flashing pattern other than the following means a micro computer error. However, an error code is not reflected in the special internal output in this case.

○ : ON ● : OFF ◕ : Flashing (1 s ON, 1 s OFF) ◑ : Flashing (500 ms ON, 500 ms OFF) ◔ : Flashing (250 ms ON, 250 ms OFF)

Error code	Error name [detection timing]	Classifi -cation	Description	RUN LED	OK LED	Ope- ration	Related special internal output	
							Bit	Word
11	System ROM error [at power ON]	Fatal error	The system ROM has a checksum error or cannot be read Error in built-in ROM/FLASH)	●	●	Stop	—	—
12	System RAM error [at power ON]	Fatal error	The system RAM cannot be read and/or written properly	●	●	Stop	—	—
13	Micro computer error [always checking]	Fatal error	Address error interrupt, undefined instruction interrupt occurred in the micro computer	●	●	Stop	R7C8	—
—	Reset processing in progress [at power ON]	—	CPU is being reset.	●	●	Stop	—	—
1F	System program error [always checking]	Fatal error	System program in FLASH memory has a checksum error	●	◔	Stop	—	—
23	Undefined instruction [at starting RUN]	Serious error	Error is detected when an attempt is made to execute a user program instruction that cannot be decoded (undefined instruction)	●	◑	Stop	R7C9	—
27	Data memory error [at power ON and initializing CPU]	Serious error	Data memory cannot be read/written properly.	●	◑	Stop	—	—
31	User memory error [at power ON and during RUN]	Serious error	A checksum error is detected in user memory.	●	◑	Stop	R7CA	—
33	User memory size error [at starting RUN]	Serious error	User program capacity set by the parameter is other than 280 HEX.	●	◑	Stop	R7CC	—
34	Grammar/assemble error [at starting RUN and online change in RUN]	Serious error	There is a grammatical error in user program.	●	◑	Stop	R7D4	WRF001
41	I/O configuration error [always checking]	Minor error	• I/O assignment information and actual loading of module do not match • Assignment is made for expansion level 5 or greater. • There exists assignment of 5 slots or greater.	*1	◕	Stop *2	R7CD	WRF002
44	Overload error (normal scan) [at END processing]	Minor error	Execution time for normal scan exceeded the overload check time set by the parameter.	*1	◕	Stop *2	R7D1	—
45	Overload error (periodical scan) [periodical processing]	Minor error	Execution time for periodical scan exceeded the execution period.	*1	◕	Stop *2	R7D2	—
46	Overload error (interrupt scan) [during interrupt processing]	Minor error	An interrupt of the same cause occurred during interrupt scan	*1	◕	Stop *2	R7D3	—

Error code	Error name [detection timing]	Classifi -cation	Description	RUN LED	OK LED	Ope-ration	Related special internal output	
							Bit	Word
5F	Backup memory error [at program downloading and special I/O function setting is requested]	Warning	Data cannot be written to the backup memory.	*1	◕	Run	—	—
61	Port 1 transmission error (parity) [when transmitting]	Warning	Parity error was detected during transmission.	*1	○	Run	—	—
62	Port 1 transmission error (framing/overrun) [when transmitting]	Warning	Framing error or overrun error was detected during transmission.	*1	○	Run	—	—
63	Port 1 transmission error (time out) [when transmitting]	Warning	Time out error was detected during transmission.	*1	○	Run	—	—
64	Port 1 transmission error (protocol error) [when transmitting]	Warning	Protocol (transmission procedure) error was detected during transmission.	*1	○	Runs	—	—
65	Port 1 transmission error (BCC error) [when transmitting]	Warning	Checksum error was detected during transmission.	*1	○	Run	—	—
67	Port 2 transmission error (parity) [when transmitting]	Warning	Parity error was detected during transmission.	*1	○	Run	—	—
68	Port 2 transmission error (framing/overrun) [when transmitting]	Warning	Framing error or overrun error was detected during transmission.	*1	○	Run	—	—
69	Port 2 transmission error (time out) [when transmitting]	Warning	Time out error was detected during transmission.	*1	○	Run	—	—
6A	Port 2 transmission error (protocol error) [when transmitting]	Warning	Protocol (transmission procedure) error was detected during transmission.	*1	○	Run	—	—
6B	Port 2 transmission error (BCC error) [when transmitting]	Warning	Checksum error was detected during transmission.	*1	○	Run	—	—
71 *3	Battery error (data memory) [always checking]	Warning	• Battery voltage dropped below the specified value • Battery not installed	*1	◕	Run	R7D9	—
72 *4	Instantaneous power failure detection [always checking]	Warning	Instantaneous power failure detected.	*1	◕	Run	R7CF R7DA	—
94	Port 1 No modem response [when modem is connected]	Warning	There is no response with the AT command.	*1		Run	—	—

*1: Depends on the CPU's operating state. The RUN LED is lit while the CPU is in operation; the RUN LED is unlit while the CPU is not in operation.
*2: Depending on the settings of the operating parameters from the peripherals, the operation may be continued even when an error occurs.
*3: Although batteries cannot be mounted on the 10- or 14-point type, battery errors are monitored by the system. Set R7EE to OFF prior to the use.
*4: Supported by software version 1.11 (WRF051=H0111) or newer.

How to Clear the CPU Error Code:
Set 1 to the Special Internal Output R7EC.

12.2 Syntax and Assembler Error Codes

The following describes the syntax and Assembler error codes. The error codes are output as hexadecimal values to the internal output WRF001. The syntax and Assembler error checks are performed at the time of RUN startup.

Error code	Error item	Description of error	Corrective action
H0001	Duplicate definition of LBL	There are 2 or more LBL instructions with the same number in the program	Limit the LBL instruction that has 2 or more of the same number to 1.
H0002	Duplicate definition of FOR	There are 2 or more FOR instructions with the same number in the program	Limit the FOR instruction that has 2 or more of the same number to 1.
H0003	Duplicate definition of NEXT	There are 2 or more NEXT instructions with the same number in the program	Limit the NEXT instruction that has 2 or more of the same number to 1.
H0004	Duplicate definition of SB	There are 2 or more SB instructions with the same number in the program	Limit the SB instruction that has 2 or more of the same number to 1.
H0005	Duplicate definition of INT	There are 2 or more INT instructions with the same number in the program	Limit the INT instruction that has 2 or more of the same number to 1.
H0010	END undefined	There is no END instruction prior to the INT or SB instructions	Define the END instruction before the INT or SB instruction.
H0011	RTS undefined	There is no RTS instruction corresponding to the SB instruction	Define the RTS instruction after the SB instruction.
H0012	RTI undefined	There is no RTI instruction corresponding to the INT instruction	Define the RTI instruction after the INT instruction.
H0013	SB undefined	There is no SB instruction corresponding to the RTS instruction	Define the SB instruction before the RTS instruction.
H0014	INT undefined	There is no INT instruction corresponding to the RTI instruction	Define the INT instruction before the RTI instruction.
H0020	RTS area error	There is the RTS instruction in the normal scan area or interrupt scan program area	Define the RTS instruction within the subroutine area.
H0021	RTI area error	There is the RTI instruction in the normal scan area or subroutine program area	Define the RTI instruction within the interrupt scan area.
H0022	END area error	There is the END instruction in the interrupt scan program area or subroutine program area	Define the END instruction at the end of the normal scan area.
H0023	CEND area error	There is the CEND instruction in the interrupt scan program area or subroutine program area	Define the CEND instruction within the normal scan area.
H0030	RTS start condition error	There is a startup condition in the processing box that includes the RTS instruction	Delete the startup condition of the processing box.
H0031	RTI start condition error	There is a startup condition in the processing box that includes the RTI instruction	Delete the startup condition of the processing box.
H0032	END start condition error	There is a startup condition in the processing box that includes the END instruction	Delete the startup condition of the processing box.

Syntax and Assembler error checks by the task code
The undefined contents of the syntax, Assembler and operation error codes will be checked.
However, error codes will not be set in WRF001

12.3 Operation Error Codes

If an error occurs when a control instruction is executed, “1” is set in the operation error (ERR) special internal output “R7F3” and an error code (hexadecimal) indicating the description of the error is set in WRF015.
To clear the operation errors to zeros, execute “R7F3=0” using a forced setting from a program or peripheral unit. To clear the error codes to zeros, execute “WRF015=0” using a forced setting from a program or peripheral unit.

Error code	Error name	Description of error	Originating instruction
H0013	SB undefined	SBn instruction corresponding to the instruction number n in the CALn instruction is not programmed	CAL
H0015	LBL undefined	LBLn instruction corresponding to the instruction number n in the JMPn and CJMPn instructions is not programmed	JMP CJMP
H0016	FOR undefined	FORn instruction corresponding to the instruction number n in the NEXTn instruction is not programmed	NEXT
H0017	NEXT undefined	NEXTn instruction corresponding to the instruction number n in the FORn instruction is not programmed	FOR
H0040	LBL area error	LBLn instruction corresponding to the instruction number n in the JMPn and CJMPn instructions is not programmed in the same program area	JMP CJMP
H0041	CAL nesting overflow	There are more than 6 levels of subroutine nesting	CAL
H0042	CAL undefined	RTS instruction was executed without executing the CAL instruction	RTS
H0043	FOR to NEXT error	There is a NEXTn with the same instruction number n prior to the FORn instruction	FOR
H0044	NEXT area error	There is no NEXTn instruction with the same instruction number n as the FORn instruction in the same program area	FOR
H0045	FOR to NEXT nesting overflow	The FORn and NEXTn instructions are not nested	FOR
H0046	FOR nesting overflow	There are more than 6 nesting levels of FOR to NEXT	FOR NEXT

12.4 Bit Special Internal Output Area

The MICRO-EH has a special internal output area for performing status display and various other settings. The special internal output area is constantly backed up in case of power failure.
The following lists the definitions of the bit special internal output area (R7C0 to R7FF).

No.	Name	Meaning	Description	Setting condition	Resetting condition
R7C0	Ignore scan time error (normal scan)	0: Stop operation 1: Continue operation	Designates continue/stop running when a normal scan overload error occurs	Set by user	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7C1	Ignore scan time error (cyclic scan)	0: Stop operation 1: Continue operation	Designates continue/stop running when a periodic-scan overload error occurs		
R7C2	Ignore scan time error (interrupt scan)	0: Stop operation 1: Continue operation	Designates continue/stop running when an interrupt-scan overload error occurs		
R7C3	Undefined	Do not use.			
R7C4	Undefined	Do not use.			
R7C5	Undefined	Do not use.			
R7C6	Undefined	Do not use.			
R7C7	On line change in RUN	0: On line changed not allowed. 1: On line changed allowed.	Designates whether online change in RUN is allowed in user program	Set by user	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7C8	Serious error flag	0: Normal 1: Abnormal	Indicates whether there is an abnormal in the microcomputer (Address error, undefined instruction)	Set by the system	
R7C9	Microcomputer error	0: Normal 1: Abnormal	Indicates whether there is an abnormal in the microcomputer (Computation error)		
R7CA	User memory error	0: Normal 1: Abnormal	Indicates whether there is an abnormal in user memory		
R7CB	Undefined	Do not use.			
R7CC	Memory size over	0: Normal 1: Abnormal	Indicates whether the capacity set by the parameter exceeds loaded memory capacity	Set by the system	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7CD	I/O configuration error	0: Normal 1: Unmatched	Indicates whether I/O assignment and loading are matched (Mismatched information output to WRF002)		
R7CE	Undefined	Do not use.			
R7CF *1	Operation mode for instantaneous power failure	0: Hold 1: Reset (same start up operation as normal power on.)		Set by the system	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7D0	Undefined	Do not use.			
R7D1	Scan time error (normal scan)	0: Normal 1: Scan time over	Indicates whether the normal scan execution time has exceeded the designated time	Set by the system	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7D2	Scan time error (cyclic scan)	0: Normal 1: Scan time over	Indicates whether the periodic scan was completed within cycle time		
R7D3	Scan time error (interrupt scan)	0: Normal 1: Scan time over	Indicates whether an interrupt of the same factor occurred during interrupt scan execution.		
R7D4	Grammar/assemble error	0: Normal 1: Error	Indicates whether there is a grammar error in user program (Detailed information output to WRF001)		
R7D5	Blown fuse detection	0: Normal 1: Error	Indicates whether or not a fuse connected to the second pin (see Chapter 11) of serial port 1 has blown out.	Set by the system	Cleared by the system
R7D6	Undefined	Do not use.			

*1: Supported by software version 1.11 (WRF051=H0111) or newer.

No.	Name	Meaning	Description	Setting condition	Resetting condition
R7D7	Undefined	Do not use.			
R7D8	Undefined	Do not use.			
R7D9	Battery error	0: Normal 1: Abnormal	Indicates whether battery voltage is low	Set by the system	Cleared by the system *2
R7DA *1	Instantaneous power failure detection	0: Not detected 1: Instantaneous power failure detected.		Set by the system	Cleared by user, Cleared when retentive area is cleared, or the CPU is initialized.
R7DB	Self-diagnostic error	0: Normal 1: Error	Indicates whether there is a self-diagnostic error (Detailed information output to WRF000)	Set by the system	
R7DC	Output mode	0: Stops output 1: Continues output	Operation mode at CPU stop for PWM output, pulse output and counter coincidence output.	Set by user	
R7DD	Undefined	Do not use.			
R7DE	Undefined	Do not use.			
R7DF	Undefined	Do not use.			
R7E0	Key switch location (STOP)	0: at RUN position 1: at STOP position		Set by the system	Cleared by the system
R7E1	Undefined	Do not use.			
R7E2	Key switch location (RUN)	0: at STOP position 1: at RUN position		Set by the system	Cleared by the system
R7E3	1^{st} scan ON after RUN	1: 1^{st} scan after RUN	ON only at the 1^{st} scan.		
R7E4	Always ON	1: Always	Always ON regardless of CPU status		Cannot be cleared.
R7E5	0.02 second clock	0: 0.01 seconds 1: 0.01 seconds			Cleared by the system
R7E6	0.1 second clock	0: 0.05 seconds 1: 0.05 seconds			
R7E7	1.0 second clock	0: 0.5 seconds 1: 0.5 seconds			
R7E8	CPU Occupation	0: Unoccupied 1: Occupied	Indicates CPU occupation status from the peripheral unit		
R7E9	RUN prohibited	0: Operation allowed 1: Operation prohibited	Indicates whether it is operation prohibited status		
R7EA	Executing a online change in RUN	1: Being executed	Indicates whether operation is temporarily stopped (output hold) due to online change in RUN		

*1: Supported by software version 1.11 (WRF051=H0111) or newer.
*2: The battery error (R7D9) will turn off when the error cause is eliminated by replacing the battery, etc.

No.	Name	Meaning	Description	Setting condition	Resetting condition
R7EB	Clear retentive area	1: Clear retentive area		Set by user	Cleared by the system
R7EC	Clear error code	1: Clear error code in WRF000 to F00A, R7C8 to 7DE			
R7ED	Undefined	Do not use.			
R7EE	Battery error detection enable/disable	1: Detection enabled 0: Detection disabled	Be sure to set if battery is used.	Set by user	Cleared by user, or when retentive area is cleared, or the CPU is initialized.
R7EF	Backup memory writing execution flag	1: Being written		Set by the system *3	Cleared by the system
R7F0	Carry flag (CY)	0: No carry 1: Carry	Indicates whether there is a carryover from the operation result		
R7F1	Overflow flag (V)	0: No overflow 1: Overflow	Indicates whether there is overflow in the operation result		
R7F2	Shift data (SD)	0: Shift data “0” 1: Shift data “1”	Designates the shift data used in shift instructions, etc.	Set by user	Cleared by user
R7F3	Operation error (ERR)	0: Normal 1: Error	Indicates whether there is an operation error when operation is executed	Set by the system	Cleared by the system
R7F4	Data error (DER)	0: Normal 1: Error	Indicates whether there is a data error when operation is being executed.		
R7F5	Special I/O function setting flag	1: Request to set	For counter, PWM and pulse train	Set by user	
R7F6	Special I/O parameters to write in FLASH *4	1: Request to write	For counter, PWM and pulse train		
R7F7	Special I/O parameter error	0: Normal 1: Error	Indicates the results of the special I/O parameter settings.	Set by the system	
R7F8	Calendar, clock read request	1: Request to read	Read the present values of calendar, clock and set in WRF01B to WRF01F	Set by user	
R7F9	Calendar, clock setting request	1: Request to write	Set the data set in WRF01B to WRF01F in the calendar and clock		
R7FA	Clock ± 30 second adjustment request	1: Request adjustment	When second data (WRF00F) is 0 to 29, it becomes 0 seconds and when it is 30 to 59, +1 minute is added and second data becomes 0		
R7FB	Calendar and clock set data error	0: Normal 1: Error	Indicates whether there is an error in calendar and clock set data	Set by the system	
R7FC	Output control 1	0: Output disabled 1: Output enabled	Sets the enabling and disabling when Y100 through Y103 is used as PWM output, pulse output, and counter coincidence output.	Set by user	Cleared by user (Cleared by the system in case of pulse output)
R7FD	Output control 2				
R7FE	Output control 3				
R7FF	Output control 4				

*3: Cleared by system even when Set by user.
*4: The word special internal output that can be written using this function is shown in Table 12.1 on the following page.

Table 12.1 List of special internal outputs that can be stored

No.	Special internal output that can be stored	Function
1	WRF01A	Dedicated port 1 Communication settings
2	WRF03C	Dedicated port 1 Modem timeout time
3	WRF03D	Dedicated port 2 Communication settings
4	WRF06B	Pulse and PWM auto correction setting
5	WRF06C	Potentiometer 1 Filtering time
6	WRF06D	Potentiometer 2 Filtering time
7	WRF06E	Analog input type selection
8	WRF06F	Phase counting mode
9	WRF070	I/O operation mode
10	WRF071	I/O detailed function settings
11	WRF072	Output frequency On-preset value
12	WRF073	
13	WRF074	
14	WRF075	
15	WRF076	On-duty value Off-preset value
16	WRF077	
17	WRF078	
18	WRF079	
19	WRF07A	Pre-load value Pulse output value
20	WRF07B	
21	WRF07C	
22	WRF07D	
23	WRF07E	Input edge
24	WRF07F	Input filtering time

12.5 Word Special Internal Output Area

The following lists the definitions of the word special internal output area (WRF000 to WRF1FF).

No.	Name	Storage data	Description	Setting condition	Resetting condition
WRF000	Self-diagnosis error code	Error code (Hexadecimal)		Set by the system	Cleared by user
WRF001	Syntax/Assembler error details	Syntax/Assembler error code (Hexadecimal)	Error code for user program Syntax/Assembler error is stored		
WRF002	Further information of I/O configuration error	Mismatched slot number	Bits 15–12: 0, bits 11–8: a, bits 7–4: b, bits 3–0: 0 a: Unit number (0 to 5) b: Slot number (0 to F)		
WRF003-F00A	Undefined	Do not use.			
WRF00B	Calendar and clock present value (4 digit BCD)	Year	4 digit year [yyyy]	Set by the system	Always displayed
WRF00C		Month / date	[mm dd]		
WRF00D		Day of the week	Sunday: 0000 to Saturday: 0006		
WRF00E		Hour / minute	[hh mm] (24-hour system)		
WRF00F		Seconds	[00 ss]		
WRF010	Scan time (maximum value)	Max. scan time × 10 ms		Set by the system	Cleared by the system (in the RUN starts)
WRF011	Scan time (present value)	Current scan time × 10 ms			
WRF012	Scan time (minimum value)	Min. scan time × 10 ms. (HFFFF at 1st scan)			
WRF013	CPU status	Bits 15–12: Unused, bits 11–8: a, bit 7: b, bit 6: c, bit 5: d, bit 4: e, bit 3: f, bit 2: g, bit 1: h, bit 0: i a: CPU type (0011), b: Battery error (1=error, 0=no error), c: Not used, d-g: Not used (Fixed to 0), h: Halt (1=executing, 0=not executing), i: CPU operation (1=RUN, 0=STOP)			Always displayed
WRF014	Word internal output capacity	Number of words for word internal output (WR) = H1000			Always displayed
WRF015	Operation error code	Operation error code			Cleared by user
WRF016	Division remainder register (low word)	Remainder data when division instruction executed			
WRF017	Division remainder register (high word)	Remainder data when division instruction executed (Used only at double word operation)			
WRF018-F019	Undefined	Do not use.			
WRF01A	Setting of Com. port 1	Bit 15: a, bit 14: b, bit 13: c, bits 12–8: d, bits 7–0: Unused a: Transmission control procedures (0- Standard, 1-Simplified) b-c: Not used d: Baud rate during modem connection = 00000: 4800 bps, = 00001: 9600 bps, = 00010: 19.2 kbps = 00011: 38.4 kbps, = 00100: 57.6 kbps, = 00101: 2400 bps = 4800 bps for other than the above		Set by user	Cleared by user
WRF01B	Reading or writing register for calendar and clock (4 digit BCD) Use with R7F8 or R7F9	Year	4 digit year [yyyy]	Set by system or user	Cleared by user
WRF01C		Month / date	[mm dd]		
WRF01D		Day of the week	Sunday: 0000 to Saturday: 0006		
WRF01E		Hour / minute	[hh mm] (24-hour system)		
WRF01F		Seconds	[00 ss]		
WRF020 to F03B	Undefined	Do not use.			

No.	Name	Storage data / Description	Setting condition	Resetting condition
WRF03C	Port 1 Modem timeout time	15 8 7 0 [a | Not used | Modem timeout time] a: Whether or not settings are present 0=No setting 1=Setting is present Modem timeout time: 1 second increments (set with hexadecimal value) 0=No timeout monitoring	Set by user	Cleared by user
WRF03D	Port 2 Communication settings	15 14 13 12 8 7 0 [a | b | c | d | Station number] a: Setting bit 1=Set Set to 0 by the system after setting is complete. b: Transmission control procedures 0=Standard, 1=Simplified c: Whether or not station numbers are present 0=No station numbers, 1=Station numbers are present d: Baud rate settings = 00000: 4800 bps, = 00001: 9600 bps, = 00010: 19.2 kbps = 00011: 38.4 kbps, = 4800 bps if other than the above Station numbers: 2 digits from 00 through 31 of BCD Set to 31 for values outside the range	Set by user	Cleared by user
WRF03E	Potentiometer input 1	0 - 1023	Set by user	Cleared by user
WRF03F	Potentiometer input 2	0 - 1023	Set by user	Cleared by user
WRF040 to F042	Occupied member registration area 1	Occupied port number a: 0=Not occupied, 1=Read-occupied, 2=Write-occupied b: Loop number c: Unit number d: Module number e: Port number 15 8 7 0 [a | Fixed to 0] [b | c] [d | e]	Set by the system	Cleared by the system
WRF043 to F045	Occupied member registration area 2			
WRF046 to F048	Occupied member registration area 3			
WRF049 to F04B	Occupied member registration area 4			
WRF04C to F04F	Undefined	Do not use.		
WRF050	System ROM version	System software version in internal ROM	Set by the system	-
WRF051	System ROM version	System software version in external FLASH memory		
WRF052	Undefined	Do not use.		
WRF053	Undefined	Do not use.		
WRF054	Power on timer	Power on time [sec.] (low word)	Set by the system	-
WRF055	Power on timer	Power on time [sec.] (high word)		
WRF057	Detailed information of counter setting errors	15 14 8 7 6 5 4 3 2 1 0 [a | Not used | b | c | d | e | f | g | h | i] a: Error in pulse frequency total b: Pulse 4 frequency c: Pulse 3 frequency d: Pulse 2 frequency e: Pulse 1 frequency f: Counter 4 preset g: Counter 3 preset h: Counter 2 preset i: Counter 1 preset 0=Normal, 1=Error	Set by the system	Cleared by the system

No.	Name	Stored data	Description	Setting condition	Resetting condition
WRF057	Detailed information of counter setting errors		15 14 … 8 7 6 5 4 3 2 1 0 | a | Not used | b | c | d | e | f | g | h | i | a: Error in pulse frequency total b: Pulse 4 frequency c: Pulse 3 frequency d: Pulse 2 frequency e: Pulse 1 frequency f: Counter 4 preset g: Counter 3 preset h: Counter 2 preset i: Counter 1 preset 0=Normal, 1=Error	Set by the system	Cleared by the system
WRF058	PI/O function individual setting request 1 *		15 … 2 1 0 | Not used | a | b | a: Output number (during pulse setting) Off-preset (during counter setting) b: On-preset (during counter setting) Frequency (during pulse setting), frequency, on-duty (during PWM setting) 0=No changes, 1=Change request	Set by user	Cleared by the system
WRF059	PI/O function individual setting request 2 *		15 … 2 1 0 | Not used | a | b | a: Output number (during pulse setting) Off-preset (during counter setting) b: On-preset (during counter setting) Frequency (during pulse setting), frequency, on-duty (during PWM setting) 0=No changes, 1=Change request	Set by user	Cleared by the system
WRF05A	PI/O function individual setting request 3 *		15 … 2 1 0 | Not used | a | b | a: Output number (during pulse setting) Off-preset (during counter setting) b: On-preset (during counter setting) Frequency (during pulse setting), frequency, on-duty (during PWM setting) 0=No changes, 1=Change request	Set by user	Cleared by the system
WRF05B	PI/O function individual setting request 4 *		15 … 2 1 0 | Not used | a | b | a: Output number (during pulse setting) Off-preset (during counter setting) b: On-preset (during counter setting) Frequency (during pulse setting), frequency, on-duty (during PWM setting) 0=No changes, 1=Change request	Set by user	Cleared by the system
WRF05D to F06A	Undefined	Do not use.			

No.	Name	Stored data	Description	Setting condition	Resetting condition
WRF06B	Pulse and PWM output auto correction setting	01: For EH-***DTP 02: For EH-***DT 03: For EH-***DRP 04: For EH-***DRT	The output waveforms of the pulses and PWM are automatically corrected by setting the value corresponding to the CPU model.	Set by user	Cleared by user
WRF06C	Potentiometer CH1	Sampling number: 0 to 40.			
WRF06D	Potentiometer CH2				
WRF06E	Analog input type selection	15 14 13 … 0 | a | b | Not used | Selects whether the analog input is voltage or current. a: Analog 1 selection 0=Voltage 1=Current b: Analog 2 selection 0=Voltage 1=Current			
WRF06F	Counting mode of 2-phase counter	00: Mode 0 01: Mode 1 02: Mode 2 03: Mode 3			
WRF070	I/O operation mode	H00: Mode 0 H01: Mode 1 H02: Mode 2 H03: Mode 3 H10: Mode 10			
WRF071	I/O detailed function settings	I/O assignment for counter, PWM and pulse train output			
WRF072 to F075	Output frequency, On-preset value	Frequency setting value, on-preset setting value			
WRF076 to F079	On-duty value, Off-preset value	On-duty setting value, off-preset setting value			
WRF07A to F07D	Pre-load value, Pulse output value	Counter pre-load value or pulse output value			
WRF07E	Input edge	Counter input edge setting value			
WRF07F	Input filtering time	Filter time ×0.5 ms, up to 40 (=20ms)			
WRF080 to F19F	Undefined	Do not use.			

*: See Chapter 8 for more details.

Chapter 13 Troubleshooting

13.1 Error Display and Actions

The display locations of errors detected by individual device in the MICRO-EH system are shown in Figure 13.1. When an error occurs, take an action according to the error code list.

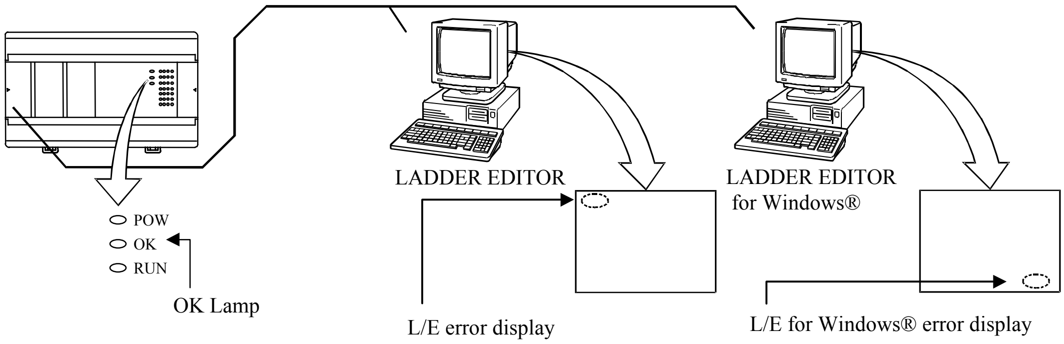


Figure 13.1 Error display locations of the MICRO-EH

(1) Error display

(a) Error display on the main unit
The MICRO-EH will perform self-diagnostic tests using the microcomputer, and when there is an error the contents are indicated in the combination of lit/flashing/not lit of the OK and RUN lamps located in the front of the main unit. See the error code list and action in Chapter 12, for the detailed error codes and actions.

(b) Programmer error display
Error codes encountered during program device operation, such as duplicate definition error, undefined error, operation error, program over, etc., will be displayed on the programming device. For detailed error codes, refer to the error code list in the programming device manual.

(c) GPCL error display
The error detected by the CPU during the GPCL operation is displayed at the bottom left of the screen. For the details of error codes, see the list of error codes in the GPCL manual.

(d) Setting in the special internal output
An error code is set in the special internal output area (such as WRF000). The smaller the error code value, the more serious the error is. When two or more errors occur, the smaller number is set. For example, if “71” (battery error) and “31” (user memory error) occur simultaneously, “31” is set. If the levels are the same, the cause code generated last will be displayed.
The clearing of error special internal output is performed by setting the special internal output R7EC to “1.” The R7EC can be set to “1” either by connecting the programming device or by including a subprogram that sets the R7EC using external input within the program. (If turning R7EC on by the program, always set it on after the error cause has been verified. However, if R7EC is turned on by a program that would generate a congestion error, the system may clear the error cause and rerun after detecting a congestion error.)
Note: Error codes are set in hexadecimal values. Verify error codes by setting the monitor to hexadecimal display.

The following shows the range of the special internal output that is cleared when R7EC is set to "1."

No.	Bit special internal output
R7C8	Fatal error flag
9	Microcomputer error
A	User memory error
B	(Undefined)
C	Memory size over
D	I/O verify mismatch
E	(Undefined)
R7CF	(Undefined)
R7D0	(Undefined)
1	Congestion error (normal scan)
2	Congestion error (periodical scan)
3	Congestion error (interrupt scan)
4	Syntax/assembler error
5	(Undefined)
6	(Undefined)
7	(Undefined)
8	(Undefined)
9	Battery error
A	(Undefined)
R7DB	Self-diagnostic error

No.	Word special internal output
WRF000	Self-diagnostic error code
1	Syntax/assembler error details
2	I/O verify mismatch details

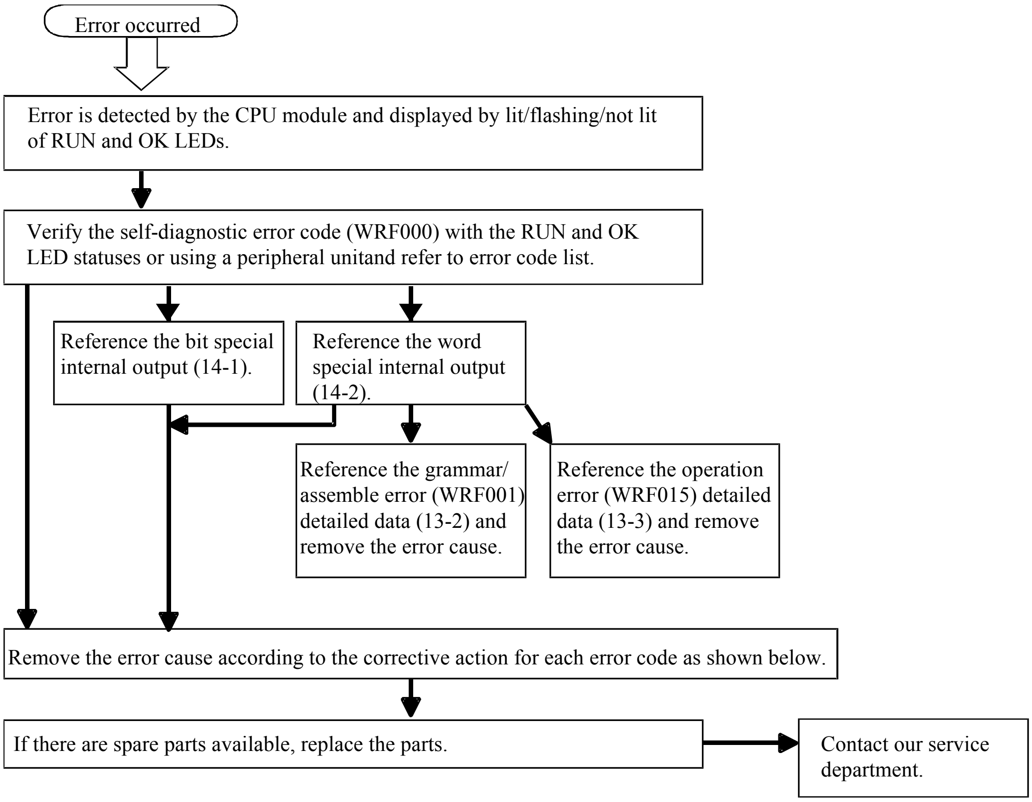
When all of the special internal output data cannot be cleared during program execution, refer to the self-diagnostic error code list and clear only the corresponding error flags by using forced set of the programmer or peripheral unit.

Caution

If the internal output for a self-diagnostic error R7DB (WRF000) is used as a system error for the stop condition of CPU RUN, the R7DB may be turned on even with an error of the warning level (battery error, etc.), causing the CPU to stop. Therefore, do not use the internal output of the self-diagnostic error as a condition for stopping the CPU.

(2) Corrective actions when an error occurred

The process flow when an error occurred is shown below.



Error code	Error name	Corrective action
11	System ROM error	Restart the power. If the same error occurs, it is a hardware error in the CPU module, so replace the CPU module with a spare. Make sure that there are no machines, etc. that generate excessive noise near MCRO-EH. Note: The 1x error cannot be verified since peripheral units cannot be connected until the system starts up after powering on again.
12	System RAM error	
13	Microcomputer error	
1F	System program error	
23	Undefined instruction	
27	Data memory error	
—	Power shut-off, power supply error	Check the power supply voltage of the basic unit and expansion unit.
31	User memory error	The contents of the user program is destroyed. Perform initialization and transfer the program again. This is displayed when the machine is stored with a worn-out battery or without battery for a long period of time.
33	User memory size error	This may be displayed when the contents of the memory within the basic unit is unstable. If the same error occurs after initialization, replace the basic unit with a new one.
34	Syntax/assembler error	There is a syntax/assembler error in the user program. Verify the program and I/O assignment.
41	I/O information verification error	Check the I/O assignment. Check the expansion cable connection.
44	Congestion error (normal scan)	Change the program so that the scan time of the user program is less or change the congestion check time.
45	Congestion error (periodic scan)	Change the program so that the periodic interrupt program execution time is less.
46	Congestion error (interrupt scan)	Perform interlock externally to that the same interrupt will not occur during interrupt processing. Change the program so that the execution time of the interrupt program is short.
5F	Backup memory error	There is a possibility that the FLASH memory cannot be written to. Reset the power after the user program is read and saved to the peripheral units.

Error code	Error name	Corrective action
61	Port 1 transmission error (parity)	Check the connection of the connector cable. Check the settings such as the transmission speed. Check to see if there are any sources of noise near the cable.
62	Port 1 transmission error (framing/overrun)	
63	Port 1 transmission error (timeout)	Check the connection of the connector cable. Check to see if there are any sources of noise near the cable. Verify the protocol specification, examine the host computer processing and correct any errors.
64	Port 1 transmission error (protocol error)	
65	Port 1 transmission error (BCC error)	
67	Port 2 transmission error (parity)	Check the connection of the connector cable. Check the settings such as the transmission speed. Check to see if there are any sources of noise near the cable.
68	Port 2 transmission error (framing/overrun)	
69	Port 2 transmission error (timeout)	Check the connection of the connector cable. Check to see if there are any sources of noise near the cable. Verify the protocol specification, examine the host computer processing and correct any errors.
6A	Port 2 transmission error (protocol error)	
6B	Port 2 transmission error (BCC error)	
71	Battery error	Replace the battery with a new one. Verify the connection of the battery connector.
91	Port 1 Modem no response	Verify the connection with battery. Replace the modem with a new one.

Perform the following procedures to erase the error display.

(a) When the basic unit is being stopped
Turn the basic unit RUN switch (or RUN terminal) to “STOP,” then to “RUN” again.
If the cause of the error has been corrected, the OK lamp is lit. However, the error information remains in the error special internal output, which stores the CPU error types and details. (This makes it possible to analyze the error after recovery.) To reset the error information, perform the procedures shown in (b) or turn ON the special internal output (R7EB) of the power failure memory clear on the peripheral units.

(b) When the CPU is still running (RUN)
Set the special internal output R7EC to “1” to clear the OK lamp indicator and the error internal output.

13.2 Checklist when Abnormality Occurred

If an error occurs in the MICRO-EH system, check the following items. If there are no problems in the following items, contact our service department.

(a) Power supply related items
- Is the power voltage correct? (85 to 264 V AC)
- Are there any warps in the power supply waveform?
- Are there any excessive noises in the power supply?
- Is power supplied for all basic and expansion units?

(b) CPU related items
- Are the initial settings (CPU initialization, I/O assignment, parameter settings, etc.) proper?
- Are there any error codes that are output to the special internal output?
- Is the RUN switch (or RUN terminal) in the proper location?
- Are batteries mounted properly? Is the battery life still remaining? (23/28-point types only)

(c) Input module related items
- Is the input voltage within the specifications for the internal section?
- Is there any noise or chattering in the input?
- Do the I/O assignment numbers in the program match?
- Is the wiring done properly?

(d) Output module related items
- Do the module and the load power supply type (DC/AC) match?
- Do the load voltage and current match the specification of the output section?
- Is there any noise or chattering in the output waveform?
- Is the wiring done properly?
- Do the I/O assignment numbers in the program match?
- Are there any unintentional overlaps in the output numbers?

(e) Wiring related items
- Is the wiring between the expansions mixed up with other wires?
- Are the power supply wiring and I/O cables separated?
- Are there any foreign substances in the connector of the basic/expansion units?

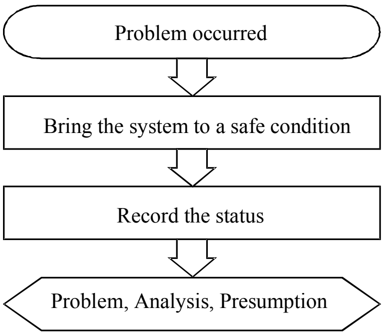
Cautions

(a) When returning the unit for repair, please notify us of the malfunctioning conditions in as much detail as possible (including error codes, malfunctioning I/O bit number, will not turn on or off, etc.).

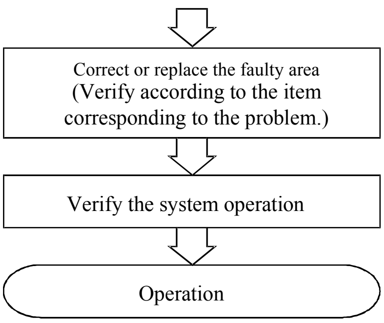
(b) The tools and devices necessary for troubleshooting are briefly as follows:
Phillips/flathead drivers, digital multimeter, tester, oscilloscope (necessary depending on the case) etc.

13.3 Procedures to Solve Abnormality

The following shows the processing flow when a problem has occurred:

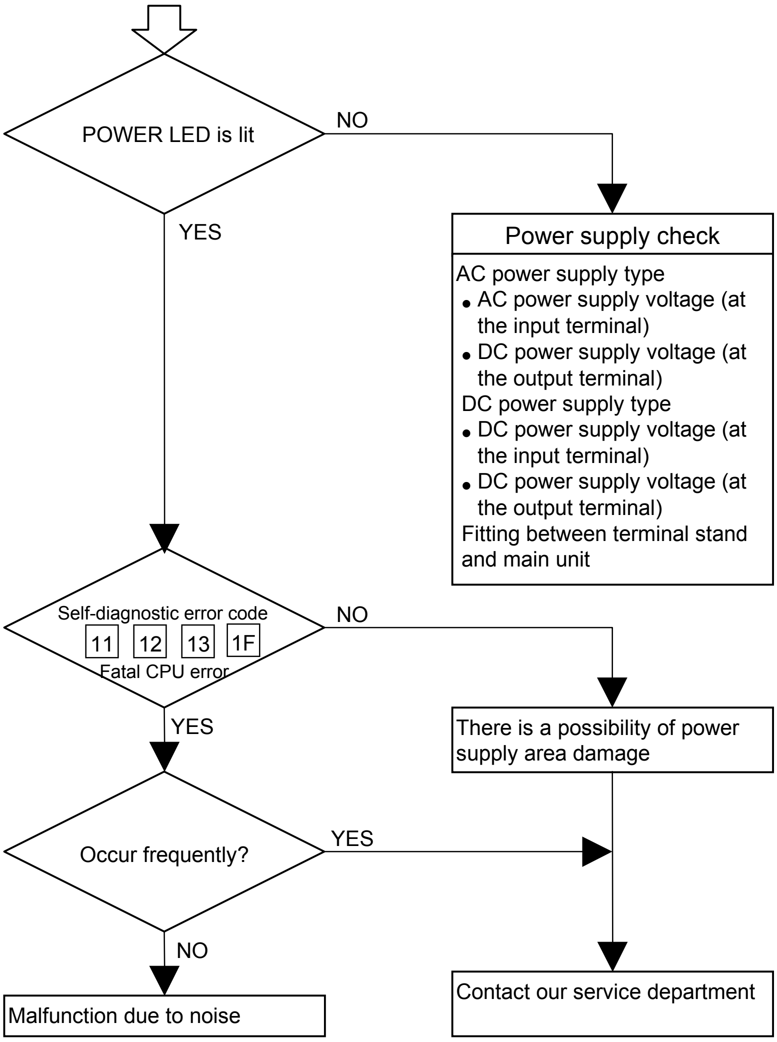


Major problems	Verification points	Typical causes of problem	Reference item
PLC will not start	Power LED, CPU error code	Power supply problem, power shut-off, insufficient power supply capacity, fatal CPU error	(a)
Will not operate (will not RUN)	CPU error code, CPU LED, Internal output of error	I/O assignment problem, incorrect parameter settings, incorrect user program, syntax error, operating conditions not established, write-occupied status	(b)
Operation stopped (RUN stopped)	Power LED, CPU LED, CPU error code	Power supply problem, expansion power supply problem/shut-off, CPU problem, memory problem	(c)
Erroneous input, no input (abnormal operation)	CPU LED, I/O LED Monitoring by peripheral units	User program timings, input power supply, bad connection, problem in input area, I/O inductive noise	(d)
Counter input does not operate	Input LED, special internal output setting	Input power supply, bad connection, problem in input area, I/O inductive noise, operating mode setting error	(e)
Output error, no output (abnormal operation)	CPU LED, I/O LED, Monitoring by peripheral units, Forced setting	User programming, bad connection, problem in output area, I/O inductive noise	(f)
PWM pulse output does not operate	Output LED, special internal output setting	Bad connection, problem in output area, I/O inductive noise, operating mode setting error	(g)
Peripheral unit problem	CPU error code, fuse, peripheral units	Fatal CPU error, peripheral unit problem, peripheral unit setting error, cable problem, broken fuse	(h)



(a) PLC will not start

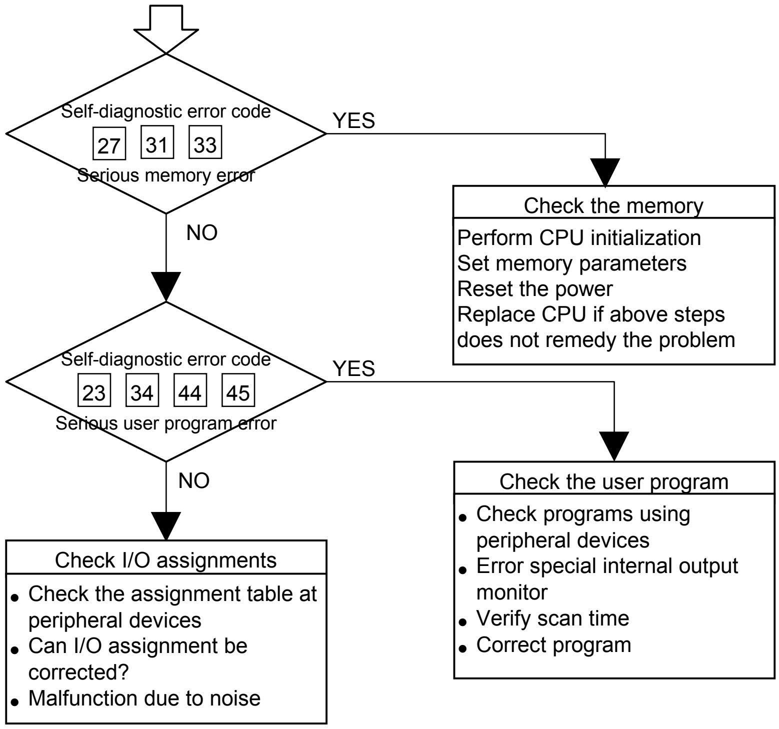
[The CPU OK LED does not turn off even when power is started, nor peripheral units cannot be connected on-line.]



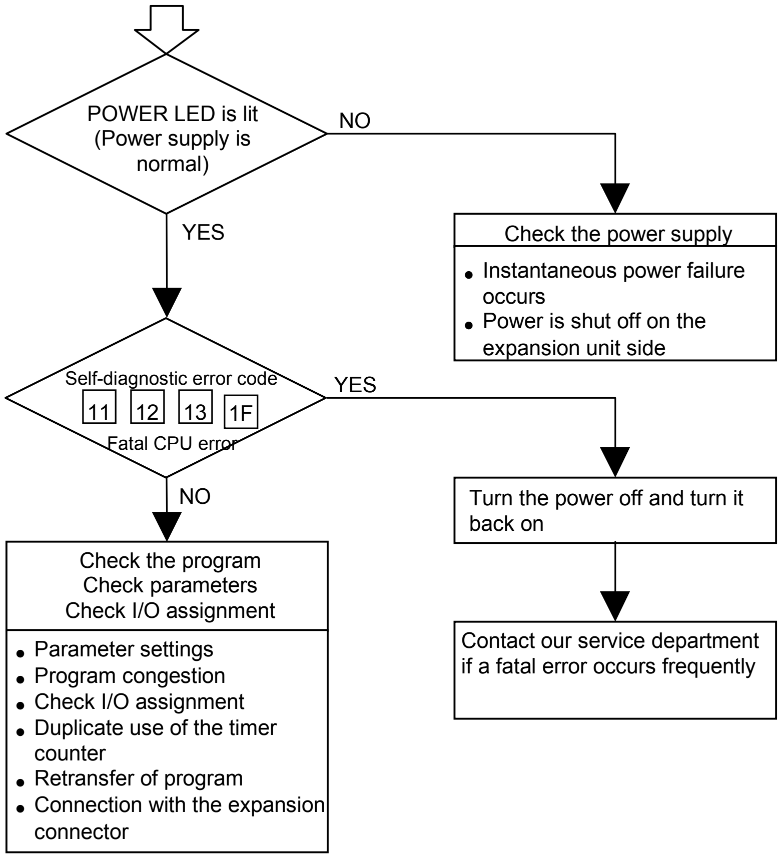
(b) Will not operate (will not run)
Even if the PLC operation conditions are met, the CPU does not operate (the RUN LED does not turn on) and remains stopped. However, the peripheral units go on-line.

Caution

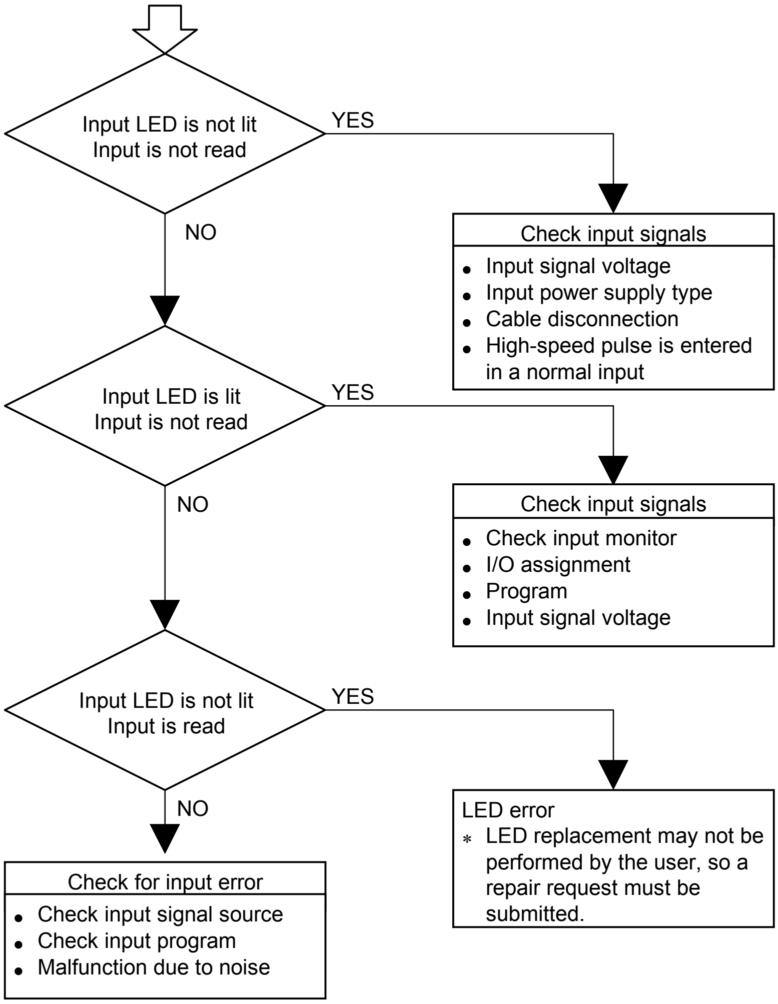
If the CPU is WRITE-occupied, the CPU will not run even if the RUN switch is switched from “STOP” to “RUN.” The CPU starts running by pressing the GRS key after peripheral units are connected.



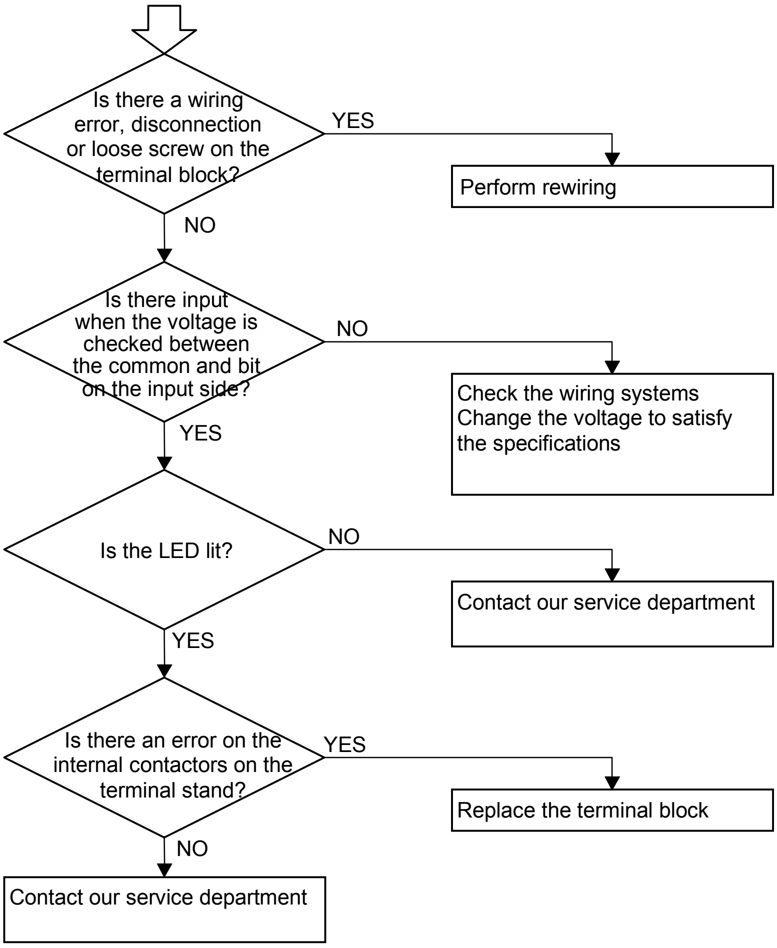
(c) Operation stopped (RUN stopped)
[During normal operation, the CPU suddenly stops (the RUN LED turns off).]



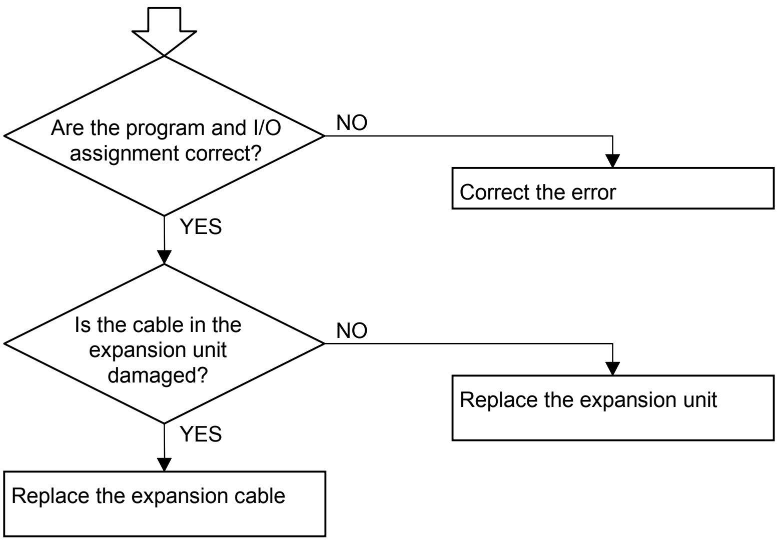
(d) Wrong input at input module or no input (operation problem)
[The CPU runs, but the input data is not correct.]



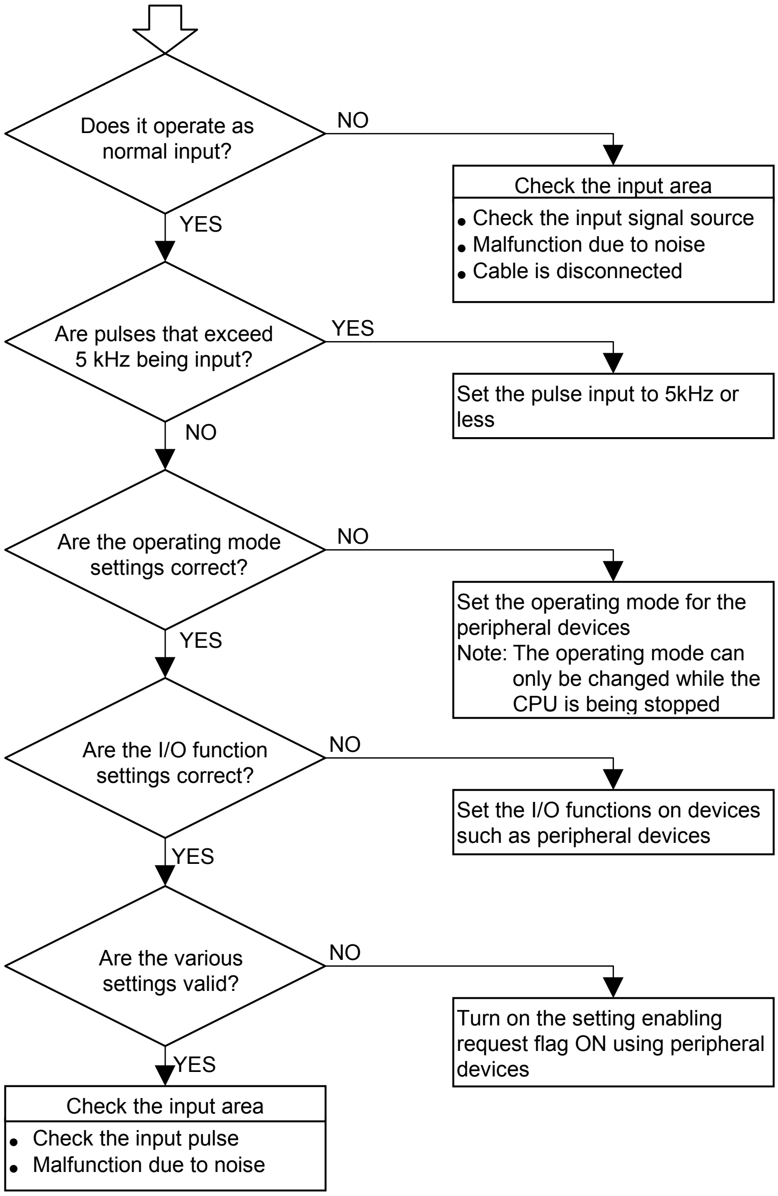
[Data cannot be entered.]



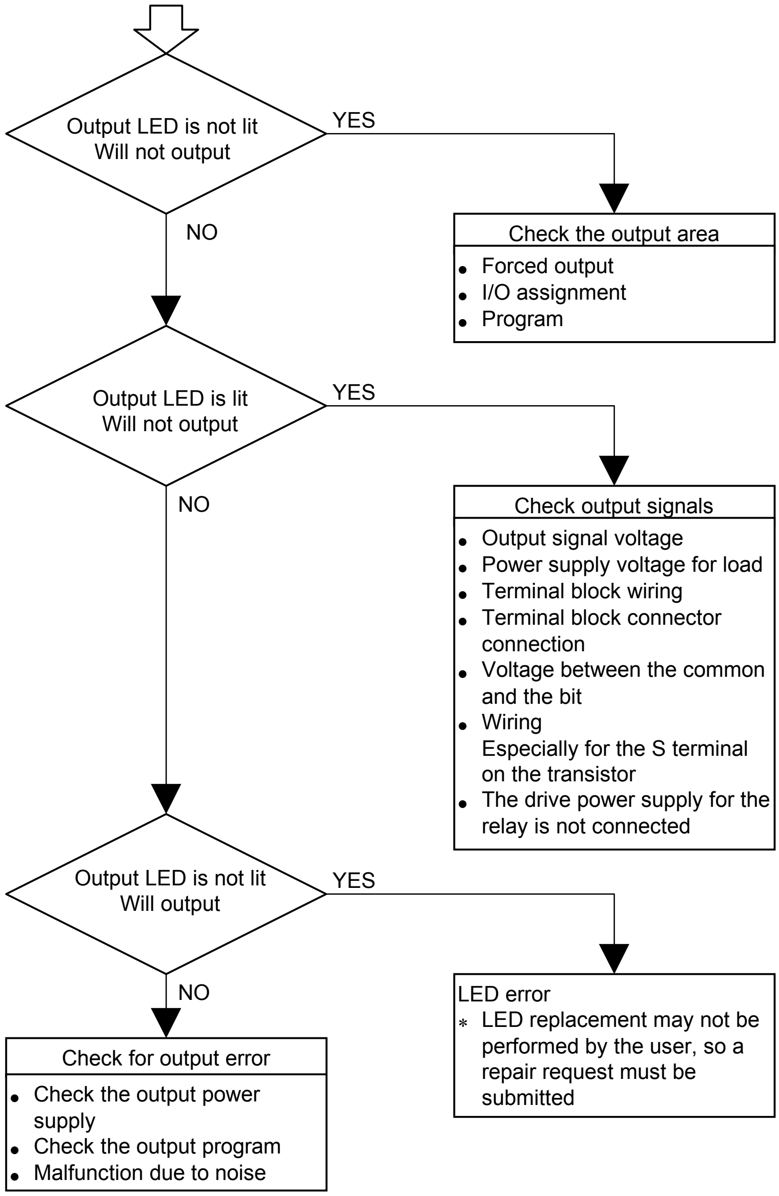
[I/O assignment error is generated, but data is read.]



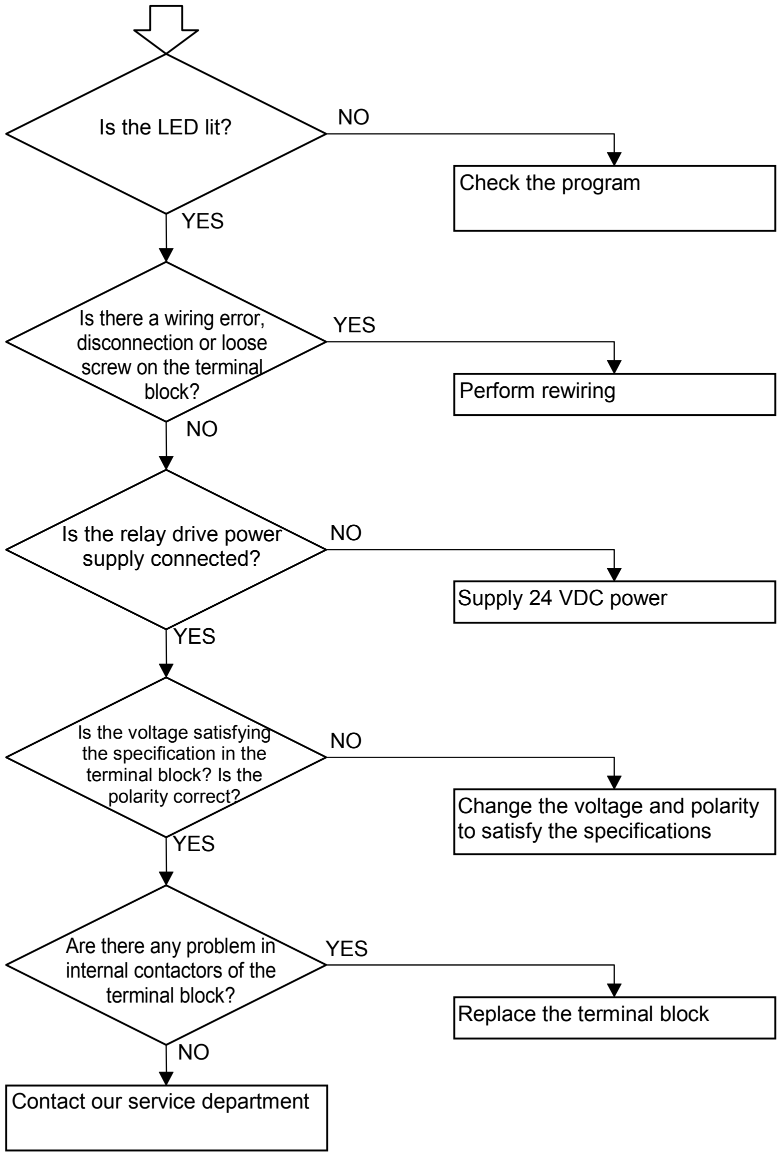
(e) The counter input does not function
[The CPU operates, but the input data is incorrect]



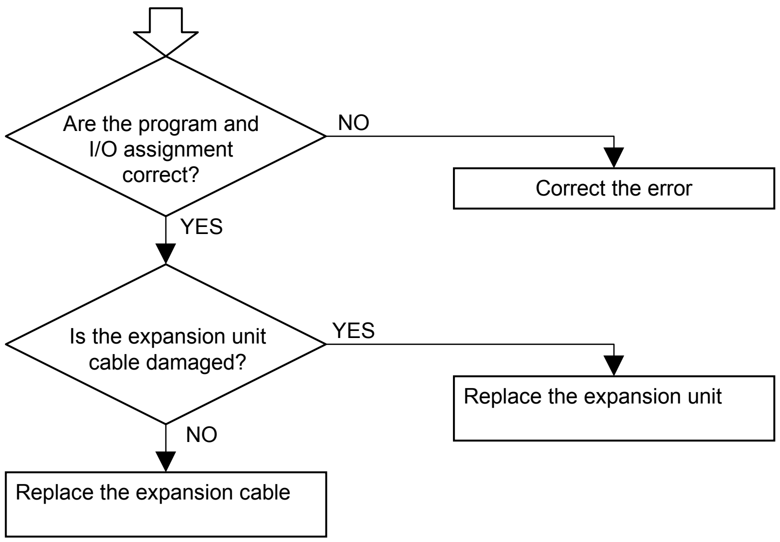
(f) Wrong output from output module or output module will not output (operation problem)
[The CPU operates, but output signals are not correct.]



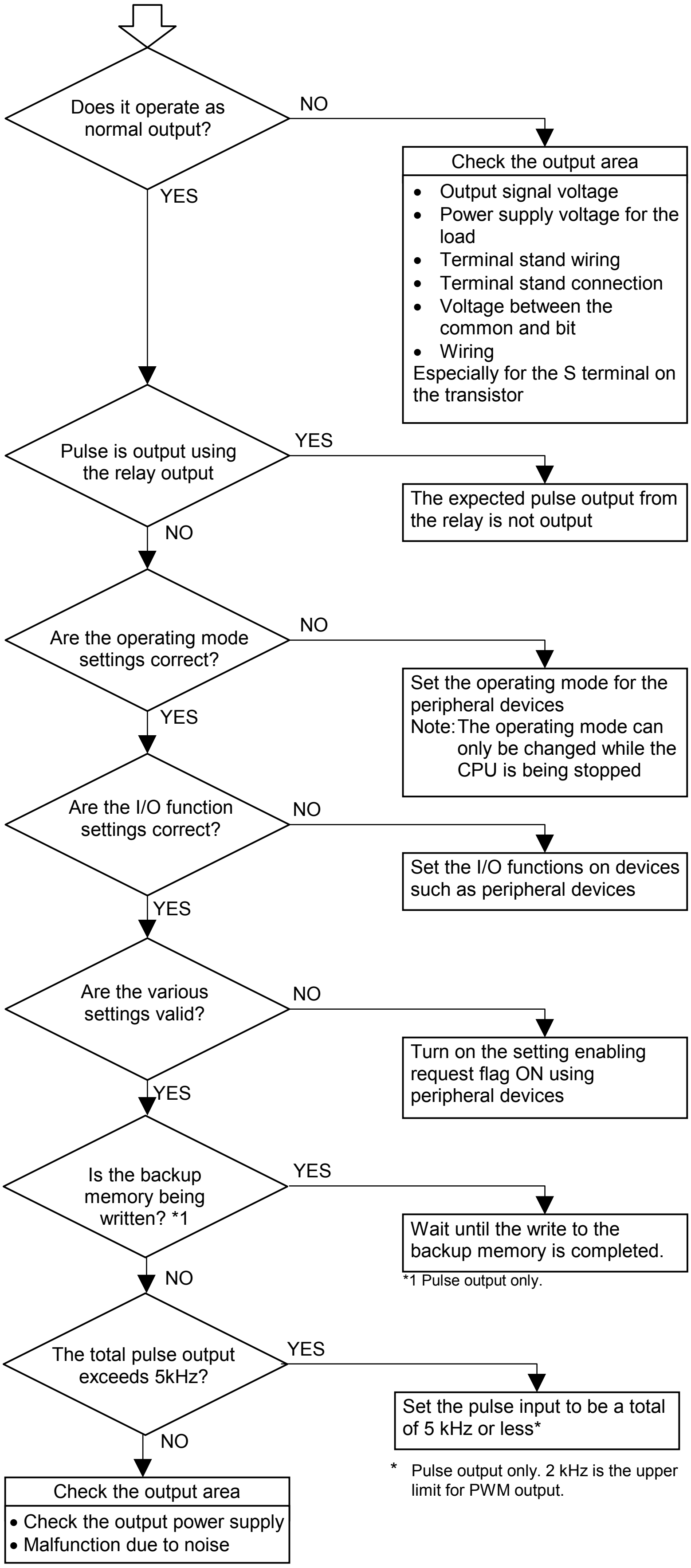
[The CPU operates, but output signals are not detected.]



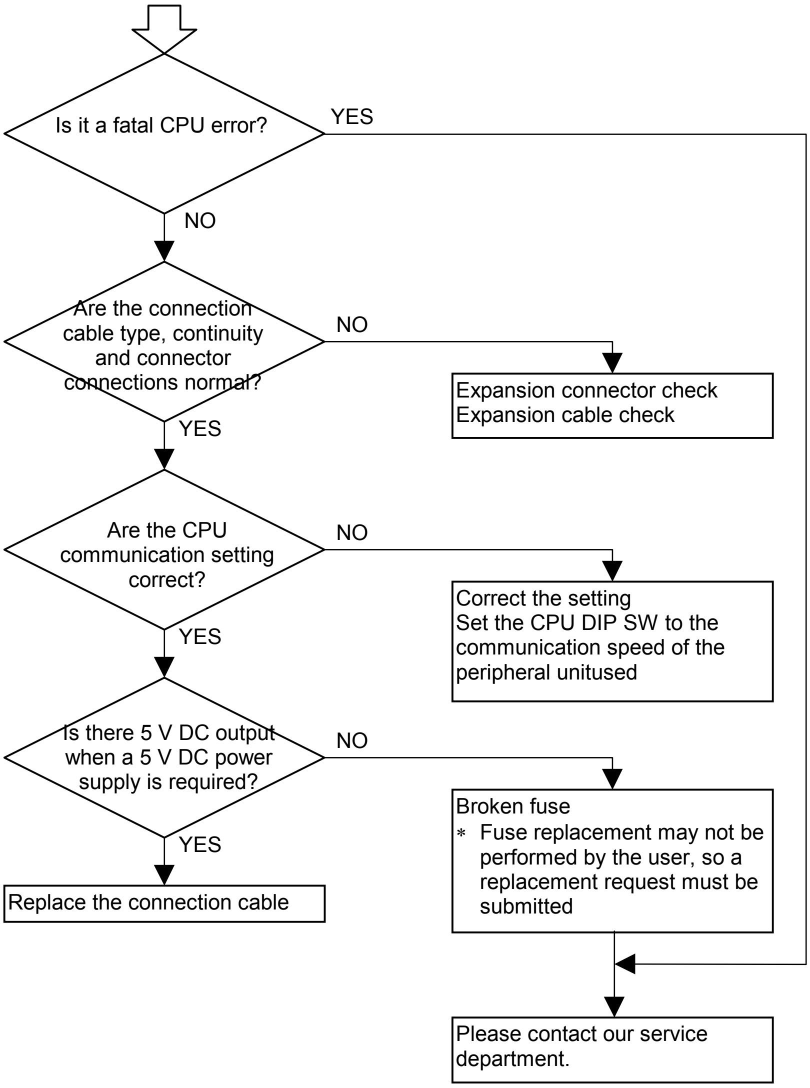
[I/O assignment error occurred, but output is normal.]



(g) [The PWM and pulse output does not operate
The CPU operates, but the pulse output and PWM output are not correct]



(h) Peripheral units problem
[Peripheral units cannot be connected.]



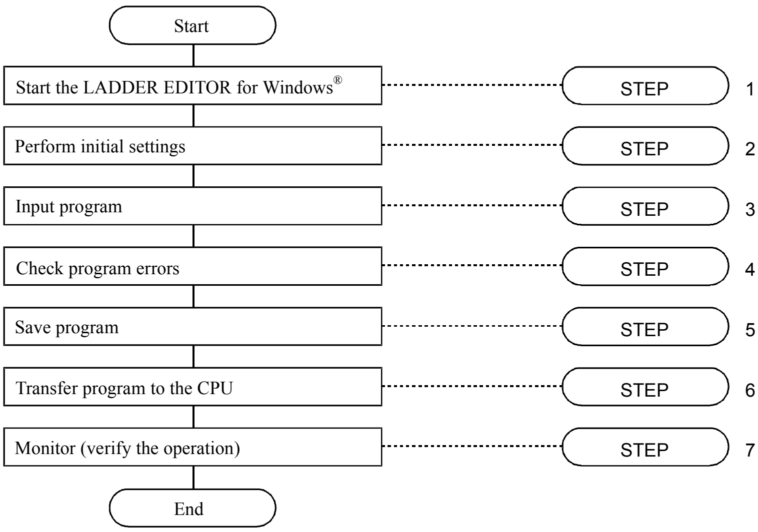
Chapter 14 Operation Examples

To understand the basic operation of the MICRO-EH, this chapter explains samples of operations such as inputting simple programs and verifying operations.
The following programming devices can be used:

	Peripheral unit name	Form
1	H series ladder diagram instruction language software LADDER EDITOR	HL-PC3 HL-AT3E
2	H series ladder diagram instruction language software LADDER EDITOR for Windows® version	HLW-PC3 HLW-PC3E

* Graphic input device (format: GPCL01H) can be used except on-direct mode.

(1) Operation verification procedures
An operation is verified according to the following procedures:

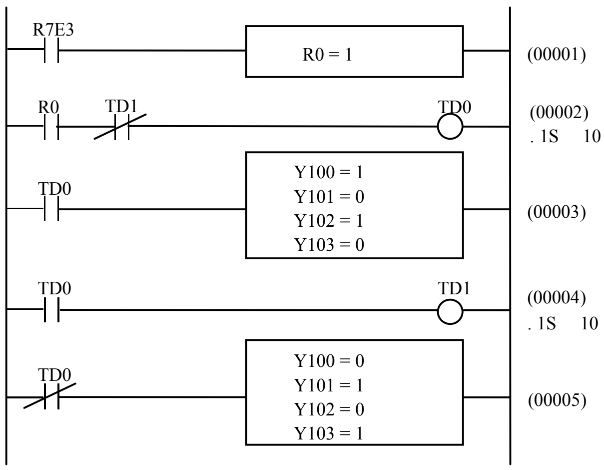


A personal computer and LADDER EDITOR for Windows® are used as the peripheral units in the example. For details, refer to the user's manual for each peripheral unit.

(2) Detailed operation example
The following explains an operation example using the module and sample program from step 1.

CPU: 14-point type
Slot 0: Bit point X48
Slot 1: Bit point Y32
Slot 2: 16 vacant points
Input/output operating mode: Mode 0
(WRF070 = 0, default value)

Operation of program
Turn Y100 and Y 102 on and Y101 and Y103 off and vice versa, alternating at one second intervals.



STEP 1 Starting the LADDER EDITOR for Windows®

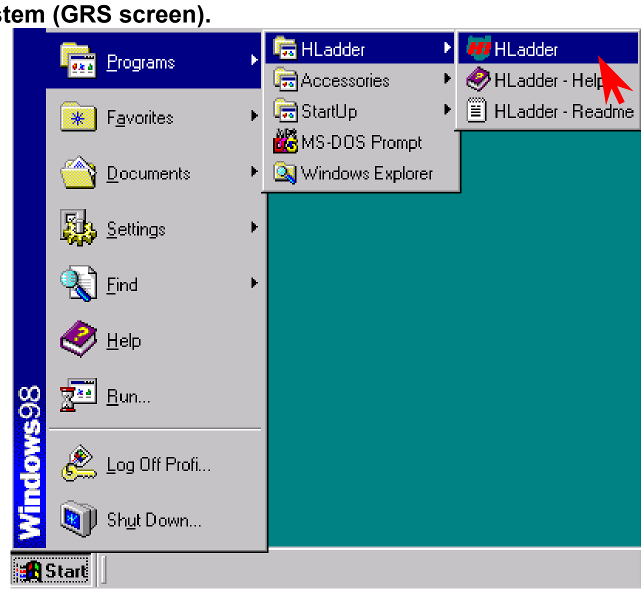
1. Start the personal computer.

Start the personal computer.

2. Start the LADDER EDITOR for Windows® system (GRS screen).

From the Start menu of Windows®, click **[Program]** → **[Hladder]** → **[Hladder].**
As LADDER EDITOR for Windows® is started, the GRS screen is displayed.

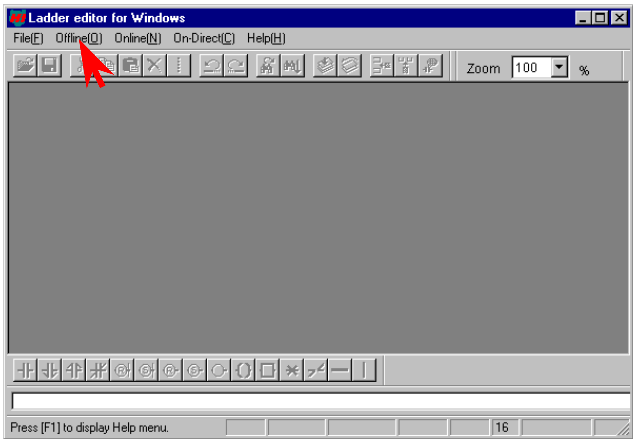
Startup



3. Switching to Offline mode.

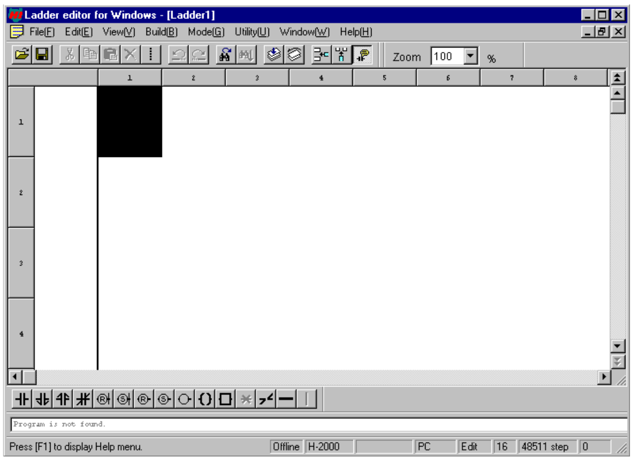
Click **[Offline]** in the Menu bar.

GRS screen



The Read/Edit screen is displayed.

Mode switching



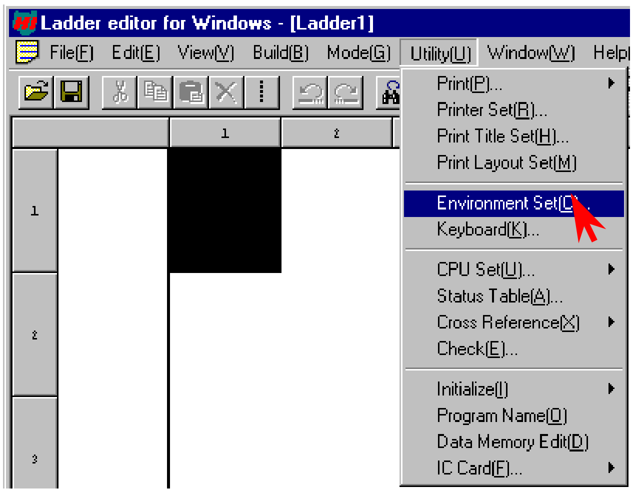
STEP 2 Initialization

Settings for the CPU type, memory type and I/O assignment are performed.

1. Setting the CPU type

Click **[Utility]** → **[Environment Settings]** in the Menu bar.

Pull-down menu

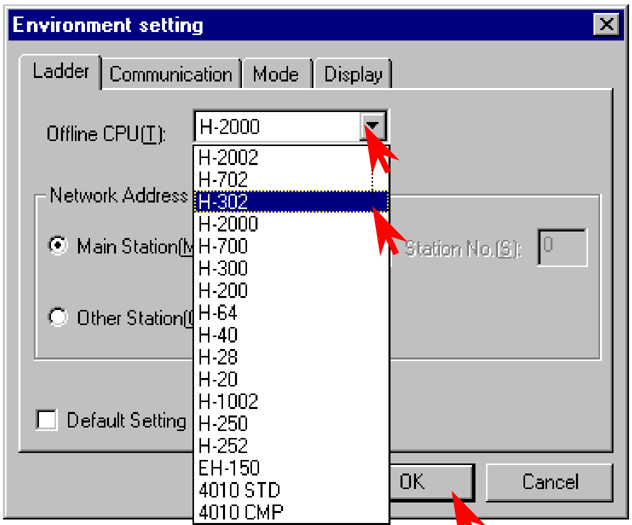


The Environment Setting dialogue box is displayed.

Specify the CPU type from the Ladder tag.

- Click the ▼ of the Offline CPU field to show the available CPU types in the pull-down display. Select the CPU type.
- Click the **[OK]** button.

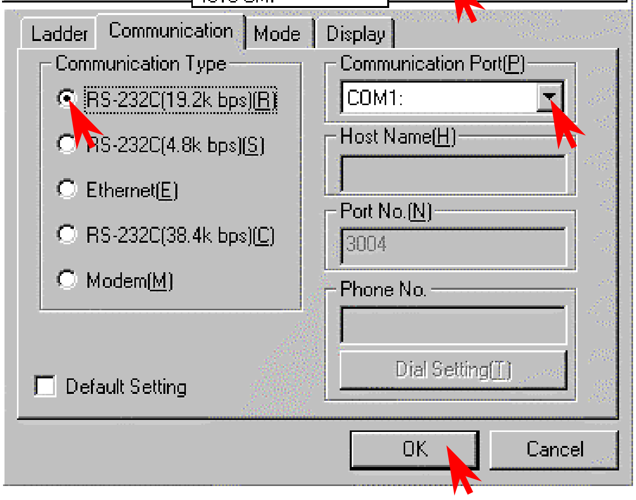
Pull-down display of CPU types



Specify the transmission speed from the Communication tag.

- Select the transmission speed set with the DIP switches of the MICRO-EH main unit (in case of the 10-point type CPU, the transmission speed is fixed at 4800 bps).
- Specify the communication port.
- Click the **[OK]** button.

Pull-down display of CPU types

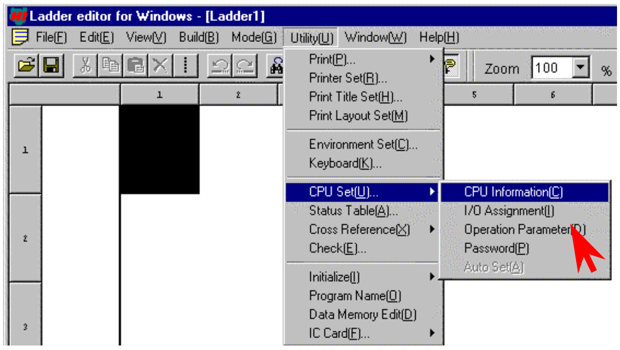


Select "H-302" for the CPU type setting.

2. Setting the memory type

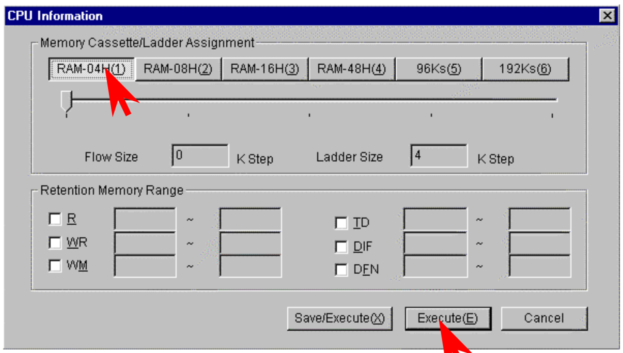
Click **[Utility]** → **[CPU Setting]** → **[CPU Information]** in the Menu bar.
The CPU Information dialogue box is displayed.

Pull-down menu



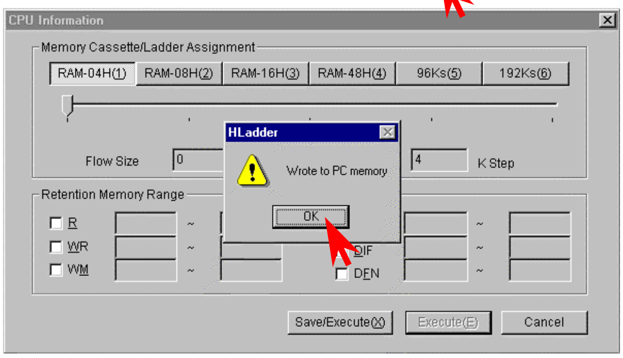
- Click the Memory Cassette/Ladder Assign button and select the memory cassette size.
- Click **[Execute]** or the **[Memory/Execute]** button.

CPU Information dialogue box



- Click the [OK] button in the confirmation dialogue box.

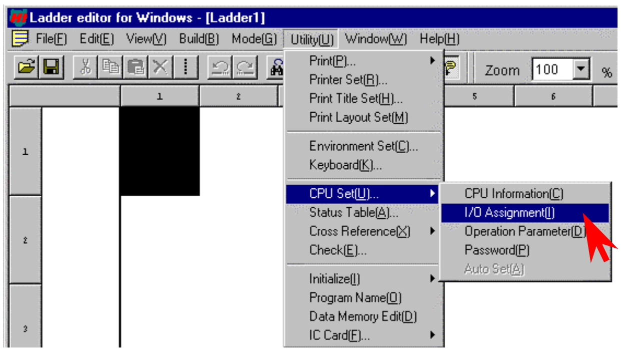
Set the memory cassette size to RAM-04H.
[Execute]: Save to the PC memory
[Memory/Execute]: Save to the PC memory and Window registry.



3. Assigning I/O

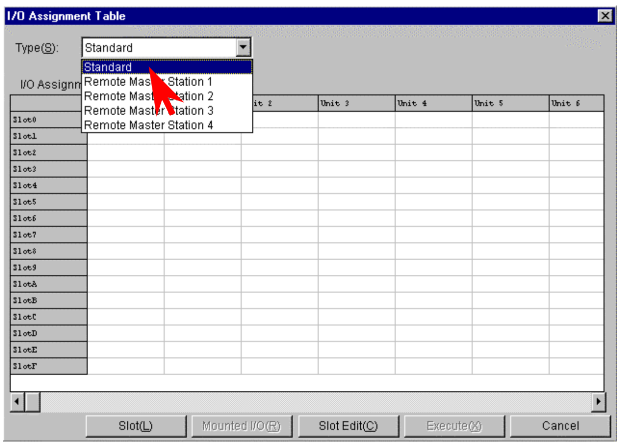
Click **[Utility]** → **[CPU Setting]** → **[I/O Assign]** in the Menu bar.

Pull-down menu



The I/O Assign List dialogue box is displayed.
Click the ▼ of the Types field and select **[Standard]** from the pull-down display.

I/O Assign List dialogue box



There are two setting methods for the subsequent procedures.

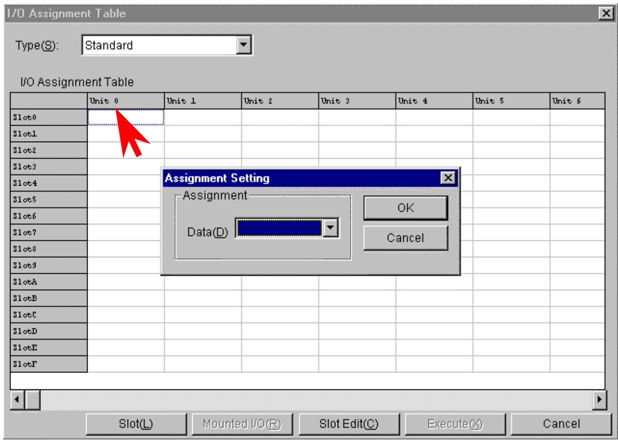
- From the I/O Assign List
- From the I/O Assign List → Slot Setting Status

[Setting from the I/O Assign List]

1] Double-click the cell for the unit number and slot number to be set.

The Assignment Setting dialogue box is displayed.

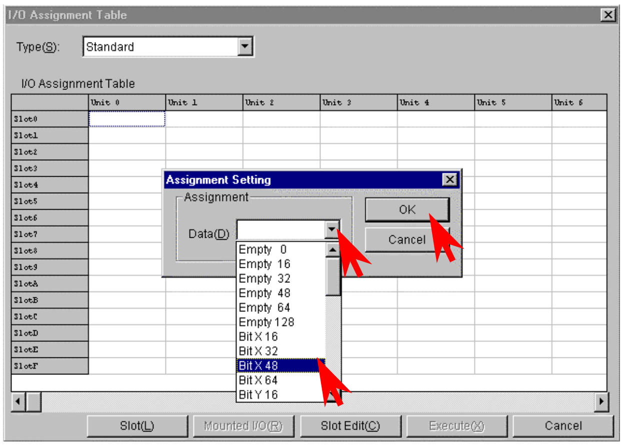
The Assignment Setting dialogue box



2] Click the ▼ of the data and select I/O type from the pull-down display.

3] Click the **[OK]** button to close the Assignment Setting dialogue box.

Setting of I/O type

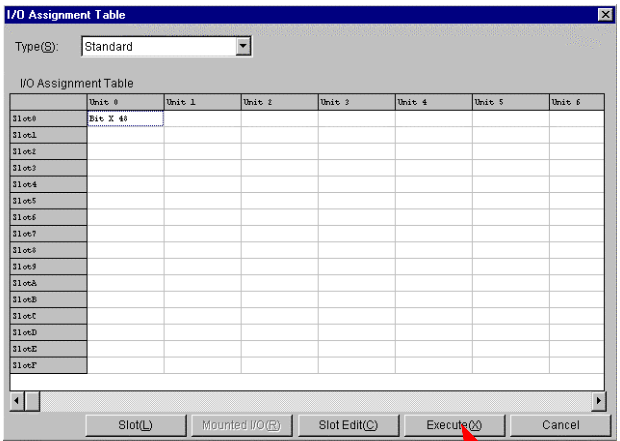


In the same way, repeat steps 1] to 3] to assign X48 and 16 vacant points to Slot 1 and 2 respectively.

If a wrong value has been entered, the slot is left blank by assigning [Vacant 0] and is treated as though nothing is assigned to it.

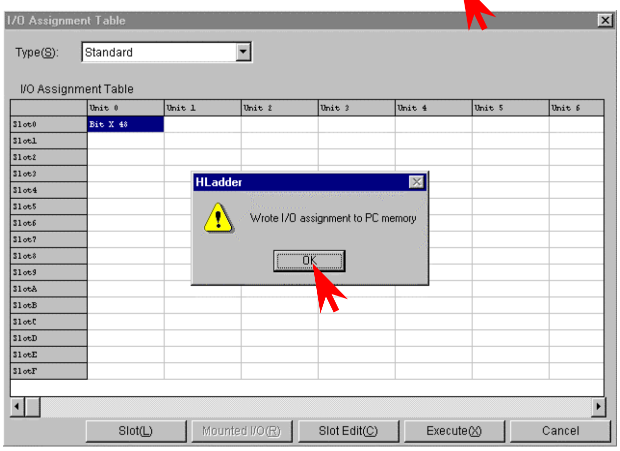
4] Click the **[Execute]** button.

The information assigned to the PC memory is written.



5] Click the **[OK]** button in the confirmation dialogue box to close the I/O Assignment List dialogue box.

Confirmation dialogue box



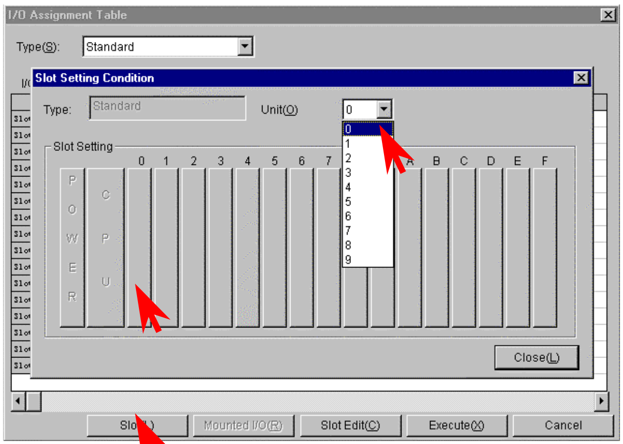
[Setting from the Slot Setting Status]

Click the **[Slot]** button to display the Slot Setting Status dialogue box.

1] Click the ▼ of the unit and select the unit number from the pull-down display.

2] Click the button of the slot number to be set.

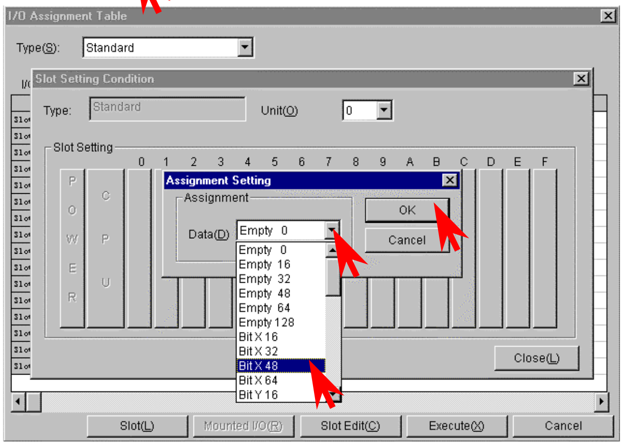
Slot Setting Status dialogue box



3] Click the ▼ of the data and select the I/O type from the pull-down display.

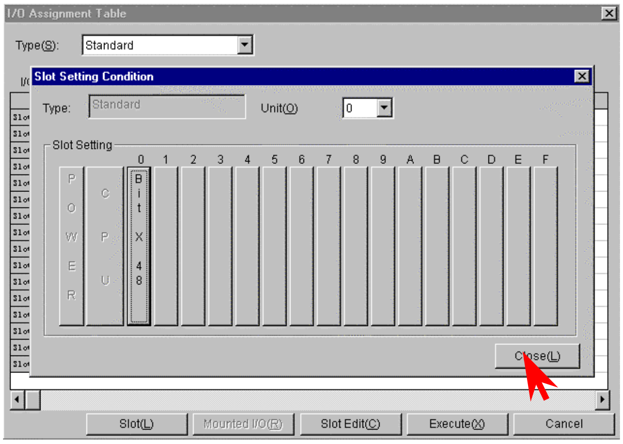
4] Click the **[OK]** button and close the Assignment Setting dialogue box.

Specification of I/O type



In the same way, repeat the steps 1] and 2] to 4] to set other unit and slot numbers in order to perform I/O assignment according to the unit to be used.
In this example, X48 and 16 vacant points are assigned to slots 1 and 2 respectively.

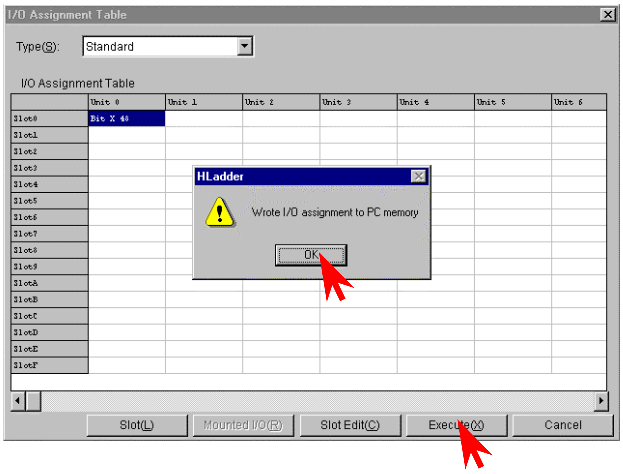
5] Click the **[Close]** button to close the Slot Setting Status dialogue box.
Enter the I/O assignment set in the Slot Setting Status into the I/O Assignment List.



6] Click the **[Execute]** button to write the assigned information to the PC memory.

7] Click the **[OK]** button in the confirmation dialogue box to close the I/O Assignment List dialogue box.

Confirmation dialogue box



For online mode, it is possible to read the I/O mounted on the CPU by the "Mount" button. For details, refer to the "Reading Mounted I/O" of the programming device.

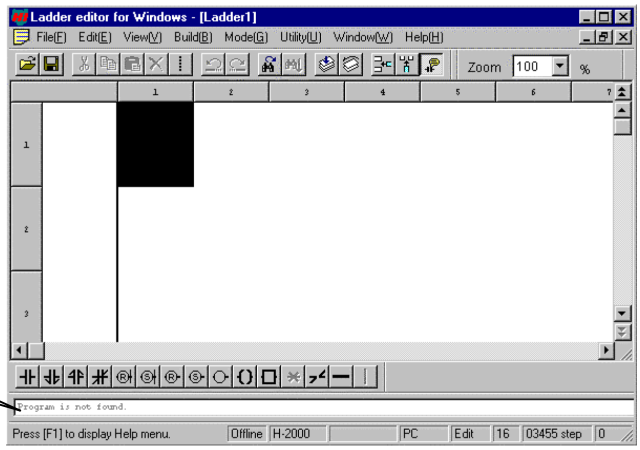
STEP 3 Program Input

1. Input a program.

At first, the output window displays "there is no program" in the bottom left of the Read/Edit screen.
The cursor ■, which indicates the program input position, is placed at the top left of the screen.

Read/Edit screen

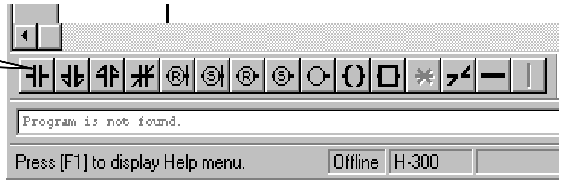
Output window



[Input procedure of ladder program]
Repeat steps 1] to 4] to proceed with symbol input. The usual operations found in other Windows applications, such as cut, copy, paste, and move, can be performed on already input symbols.

1] Specify the input position. (Move the cursor ■ by clicking the mouse or the arrow keys.)
2] Click symbols in the Symbol bar.

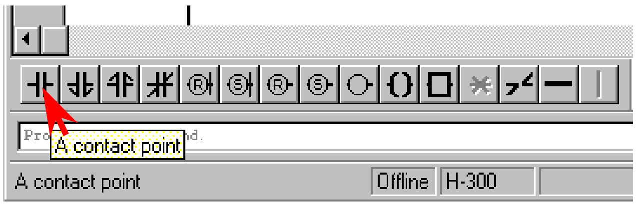
Symbol bar



3] Input the desired function (I/O, comparison expression, arithmetic expression) in the dialogue box for the symbol displayed.
4] Click the **[OK]** button in the dialogue box.

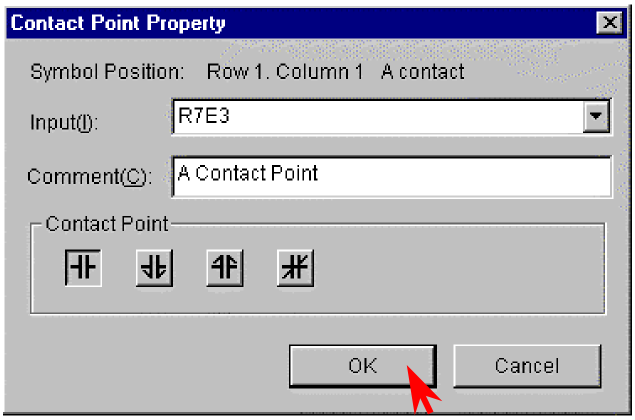
[Example of entering a contact]
1] Begin from the cursor position at the top left.
2] Click the symbol for contact A.
The dialogue box for contacts is displayed.

Symbol selection



3] Enter "R7E3" as the I/O No. in the Input field. (I/O No. (half-width alpha-numeric input) can be entered by the keyboard only, or by selecting the initial letter(s) from the pull-down menu of ▼ and by typing the rest.)
Enter a proper comment.

Contact property

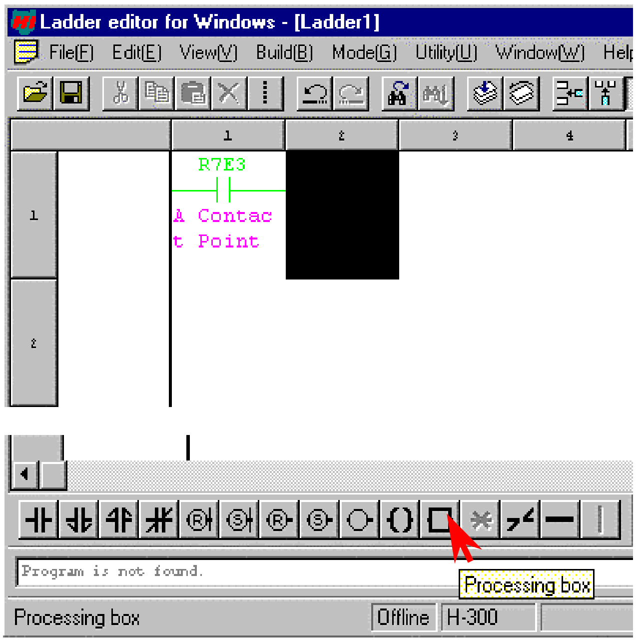


4] Click the **[OK]** button.
The dialogue closes.

When the dialogue box closes, the symbol is displayed in the Read/Edit screen and the cursor shifts.

Display of symbol

The comment is displayed under the symbol.



[Example of entering a Processing Box]

1] The specification of the input position can be omitted when entering symbols into the same circuit as the contact above.

2] Click the symbol for Processing Box.

Symbol selection

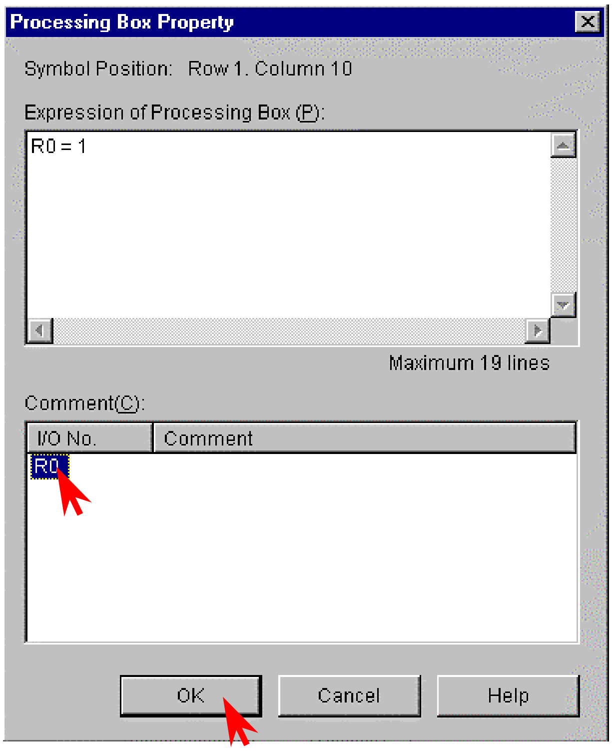
The cursor moves to the far-right portion of the screen automatically.
The dialogue box for the processing box symbol is displayed.

3] Input arithmetic expressions in the Expression in Processing Box text field.

Multiple lines (a maximum of 19) can be input by including line breaks

Processing Box properties

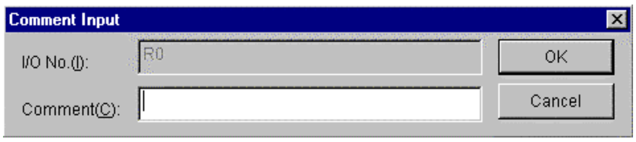
The comment for the I/O No. written to the Processing Box is displayed by clicking the Comment column.
If there are no comments, only the I/O No. is displayed.



Always enter a space before and after “=“.

- The Comment Input dialogue box is displayed by double-clicking the I/O No. displayed in the Comment column.
- Input a comment and click the **[OK]** button.

Comment Input dialogue box



4] Click the **[OK]** button in the Processing Box.

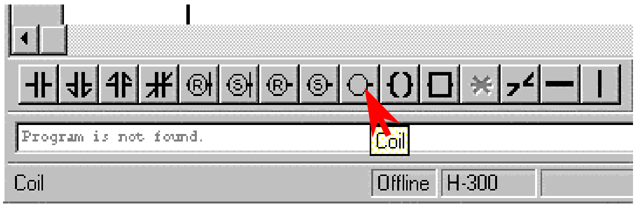
The input of the horizontal line symbol, which connects between symbols, may be omitted. (Symbols are connected by horizontal lines by the automatic wiring function at circuit write.)

[Example of entering a timer]

1] Specify the input position, or omit the specification if entering it in the same circuit.

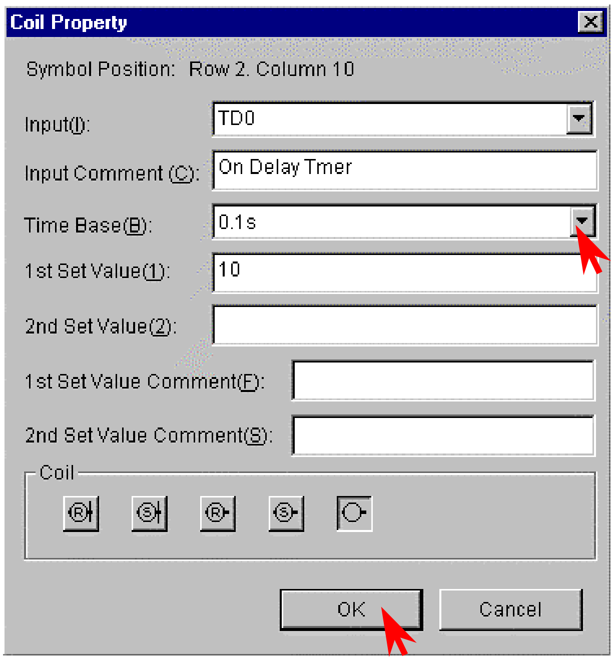
2] Click the symbol for coil.
When the specification of the input position is omitted, the cursor automatically moves to the far-right portion of the screen.

Symbol selection



3] Input I/O No., time base, and the first setting value.

Coil property



The following initials of various I/O numbers can be selected from the pull-down display of the Input field:

R, L, M, Y, TD, SS, WDT, MS, TMR, CU, RCU, CTU, CTD, CL

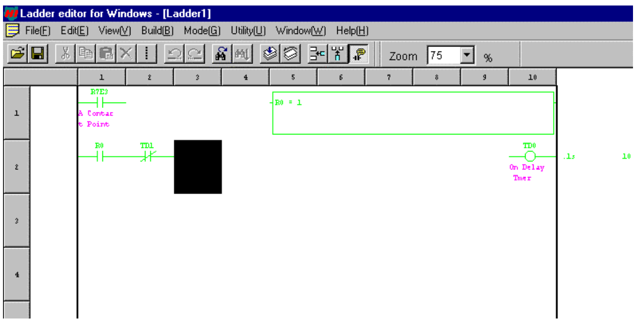
Input values in the necessary items, such as the time base, the first setting value, and second setting value, according to the I/O No.

(Example) Coil
It is only necessary to enter values in the Input and Comment items.

4] Click the **[OK]** button to display the symbol at the cursor at the far-right portion of the circuit.

Symbols whose input positions for coils, arithmetic expressions, etc. are determined are automatically flushed to the right.

Display of symbols



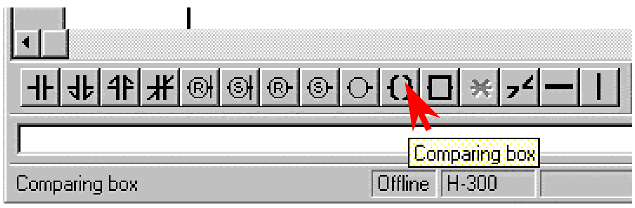
After displaying the coil, the cursor moves to the top of the next circuit.

[Example of entering a Comparison Box]

1] Specify the input position

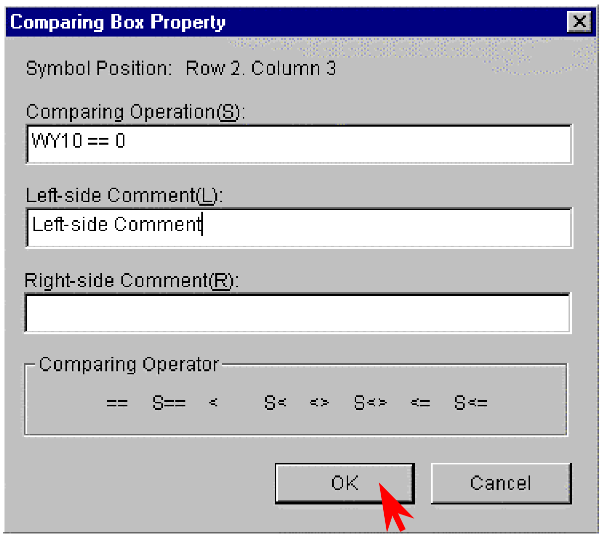
2] Click the symbol for Comparison Box.

Symbol selection



3] Input comparison expression and comment.
4] Click the **[OK]** button.

Comparison Box property

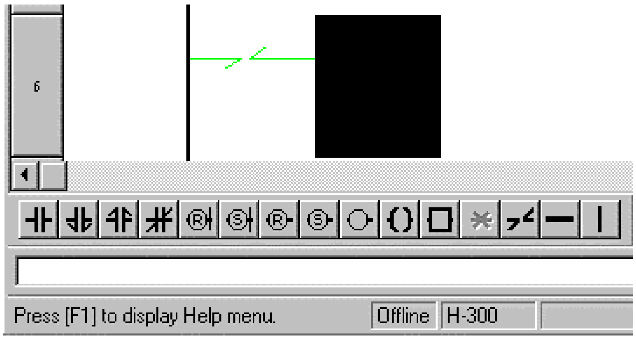


The comment input is valid only for I/O numbers. In this example, entering a comment for the value on the right side of the expression will not generate a comment.

Always enter a space between an I/O number and comparison operator (in this case, between "WY10" and "= ="), as well as between a comparison operator and comparison data ("= =" and "0").

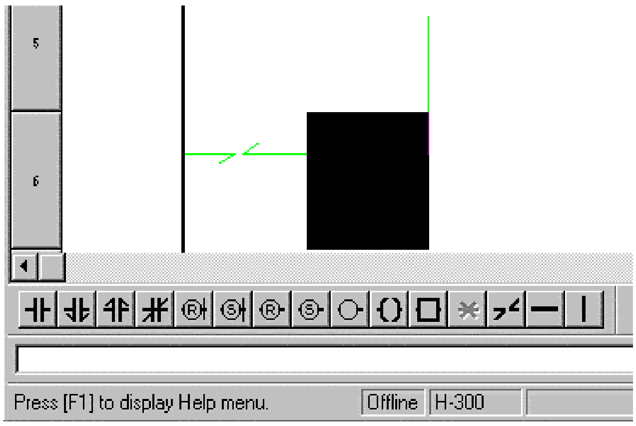
[Example of entering a Knot]
1] Specify the input position.
2] Click the symbol for Knot.
The symbol is displayed and the cursor moves to the right.

Display of symbols



[Example of entering a Vertical Line]
1] Specify the input position.
2] Click the symbol for Vertical Line.
The symbol is displayed on the right side of the cursor.
The cursor does not move.

Display of symbol



In case of the Horizontal Line symbol, the cursor does move to the right after displaying the symbol, in the same way as in the Knot symbol.

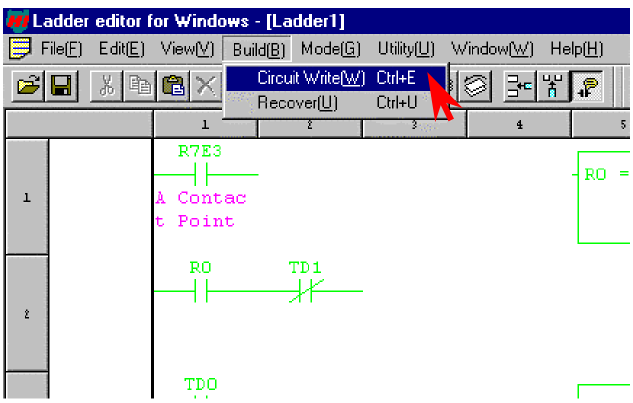
2. Writing to the program memory

Perform a "circuit write" operation by either of the following methods in order to write the circuit to the program memory.

1] Click **[Build]** → **[Circuit write]** in the Menu bar.

2] Click the **[circuit write]** icon  in the tool bar.

Circuit write operation

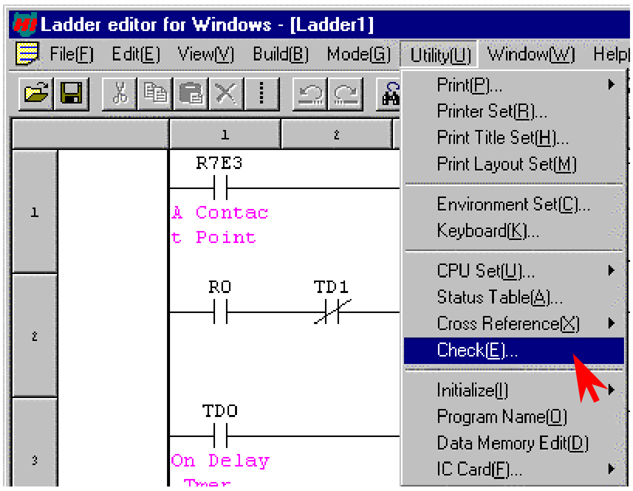


STEP 4 Checking Program Errors

Check to see if the program in the memory is correct.

Click **[Utility]** → **[Check]** in the Menu bar.
The Check dialogue box is displayed.

Pull-down menu

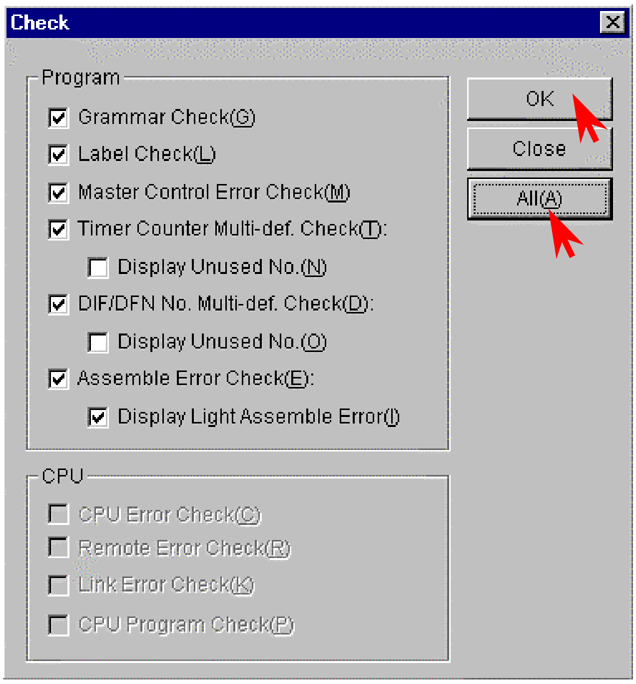


- Click the **[All items]** or the individual check column to specify the items to be checked.
- Click the **[Execute]** button.

The Check Result dialogue box is displayed.

Check dialogue box

The checking of the CPU can be specified at online mode.

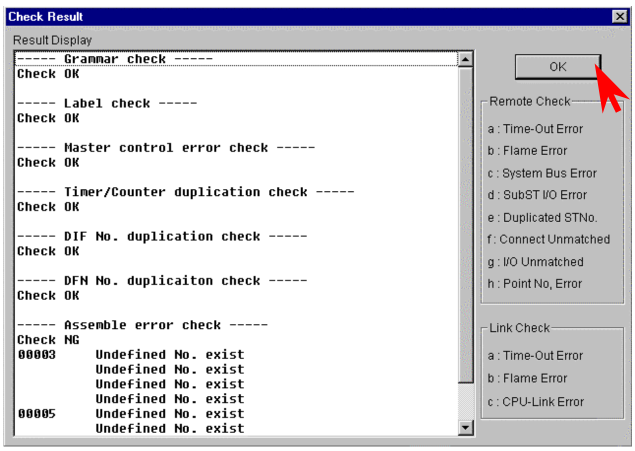


- Click the **[OK]** button.

The Check Result dialogue box closes.

Check Result dialogue box

(Note)
For example, if the I/O assignment of bit Y32 is missing for unit 1, WY10 of the sample is treated as undefined; the error is displayed as in the figure to the right.



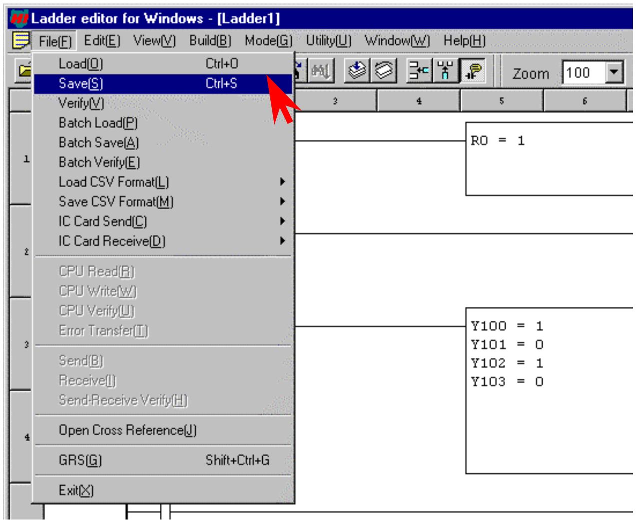
If there are any errors, correct the errors of the program before check the program again.

STEP 5 Saving the Program

Save the program and comment that has been created to a floppy disk.

Click **[File]** → **[Record]** in the Menu bar, the Record icon, or **[File]** → **[Batch Record]**.
The dialogue for Record or Batch Record is displayed.

Pull-down menu

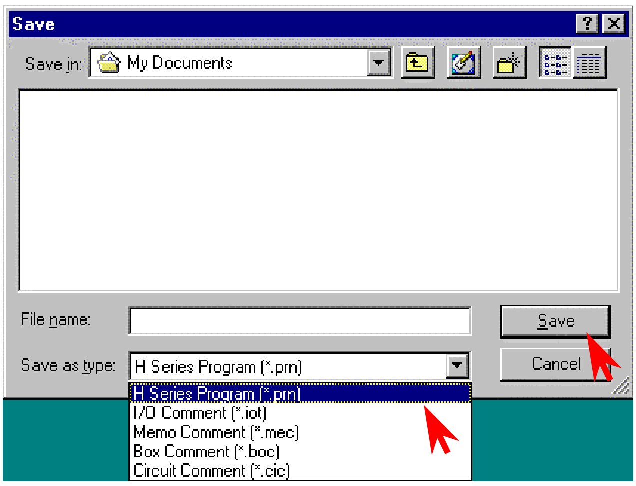


Record: Specify the file type and save.
Batch Record: Saves a program and all the comment files.

Record dialogue box:
Specify the directory to save in, file name, and file type.
Batch Record dialogue box:
Specify the place to save and file name.

Click the **[Save]** button to save.

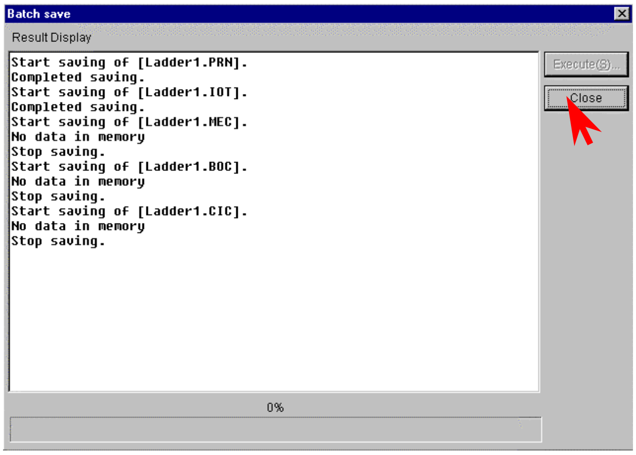
Record dialogue box



File name extensions are not necessary to input.

Record and Batch Record display the results of the save operations for one file and five files respectively.
The figure to the left shows an example of a result display for the Batch Record.

Batch Record Result dialogue box



STEP 6 Program Transfer to CPU

Write the program that has been input, to the CPU. However, verify the following:

- The CPU and the personal computer connection cable are properly connected.
- The CPU power is on.
- CPU mode switch is set to "STOP."

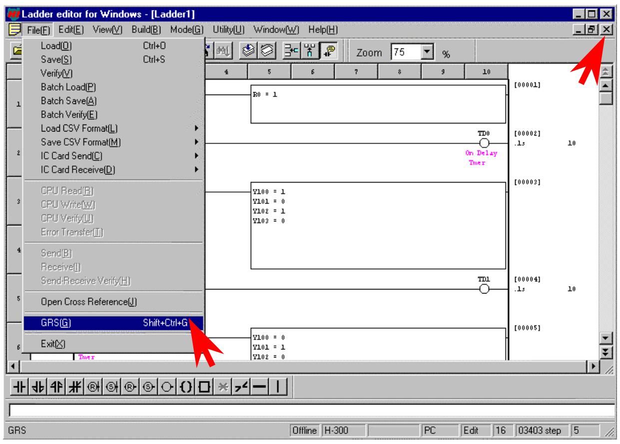
1. Switching to online mode.

Move to the GRS screen from the offline mode.
This can be done in two ways.

1] Click **[File]** → **[GRS]** in the Menu bar.

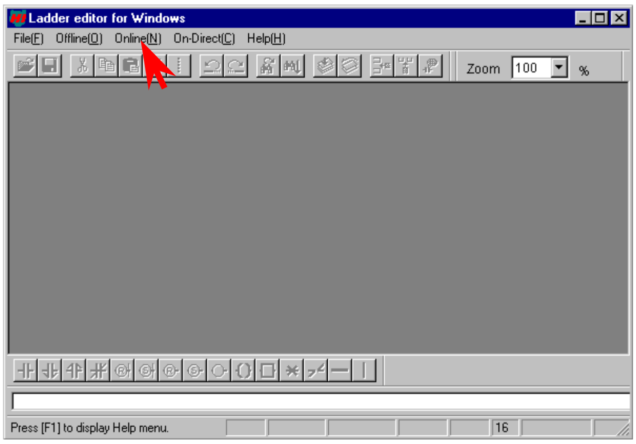
2] Click (lower button) on the upper right of the screen.

GRS screen



In the GRS screen, click the **[Online]** item in the Menu bar.
The Read/Edit screen of the online mode is displayed.

GRS screen

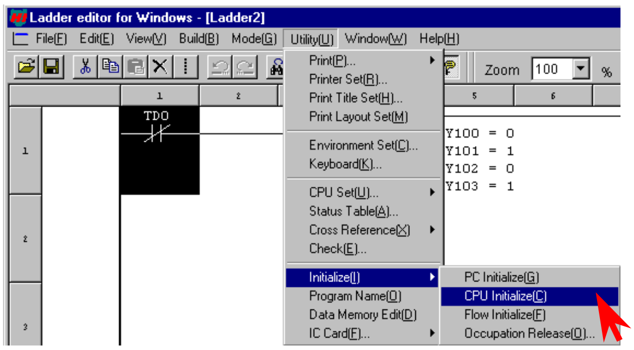


Note: Verify again that the DIP switches are set to the transmission speed selected in the Environment Setting in step 2. (For the 10-point type, it is fixed to 4800 bps.)

2. Initializing the CPU

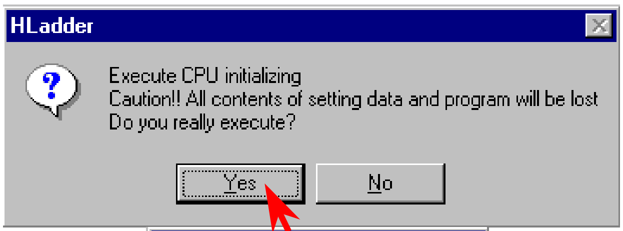
Click **[Utility]** → **[Initialize]** → **[CPU initialize]** in the Menu bar.

Pull-down menu

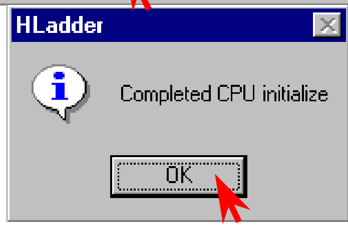


Note: Please note that programs etc. in the personal computer will be erased if [PC initialize] is selected.

The Confirmation dialogue box is displayed; click the **[Yes]** button and start the CPU initialization.



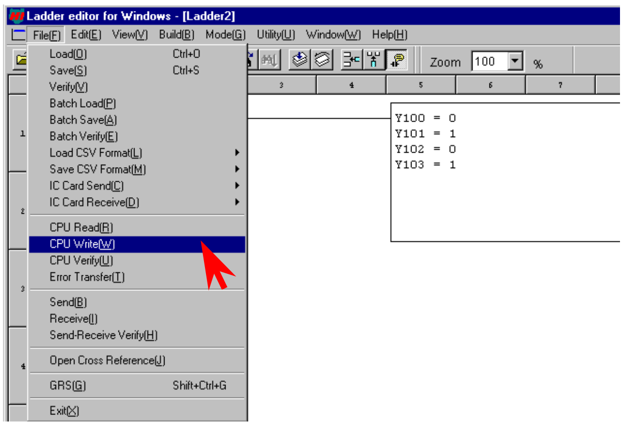
The Exit dialogue box is displayed; click the **[OK]** button to close the dialogue.



3. Transferring to the CPU

Click **[File]** → **[CPU write]** in the Menu bar.

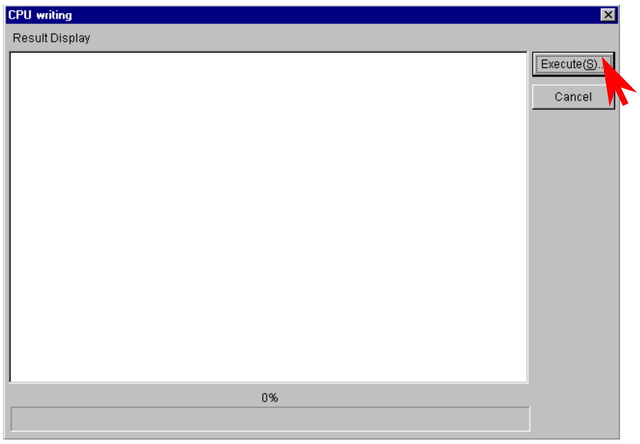
Pull-down menu



Program transfer
CPU Read: PC (personal computer) ← CPU
CPU Write: PC (personal computer) → CPU

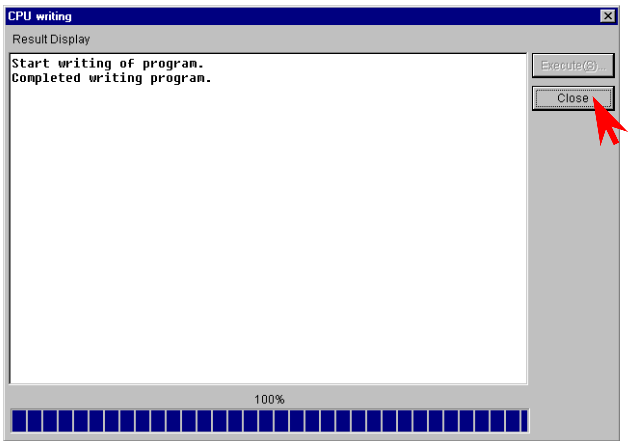
The CPU Write dialogue box is displayed.
Click the **[Execute]** button.

CPU write dialogue box



When the writing is completed, the result is displayed.
Click the **[Close]** button to close the dialogue box.

Display of write result

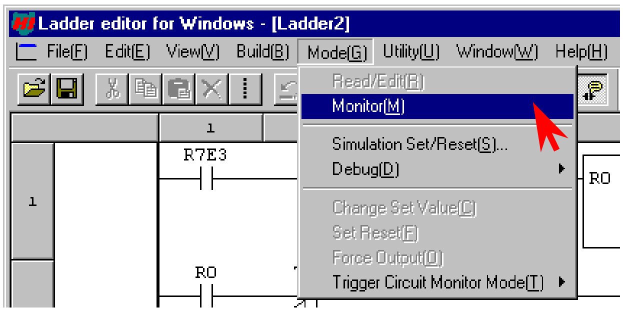


STEP 7 Monitoring (Verifying the Operation)

Monitor the program execution status in the CPU.

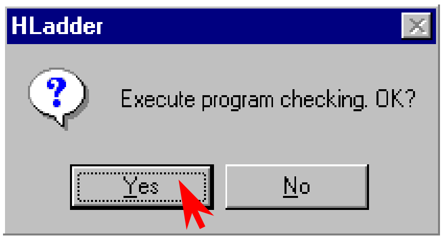
[Circuit monitor]
Click **[Mode]** → **[Monitor]** in the Menu bar.

Pull-down menu



The Confirmation dialogue box for the program match check between PC and the CPU is displayed.
Click the **[Yes]** button.

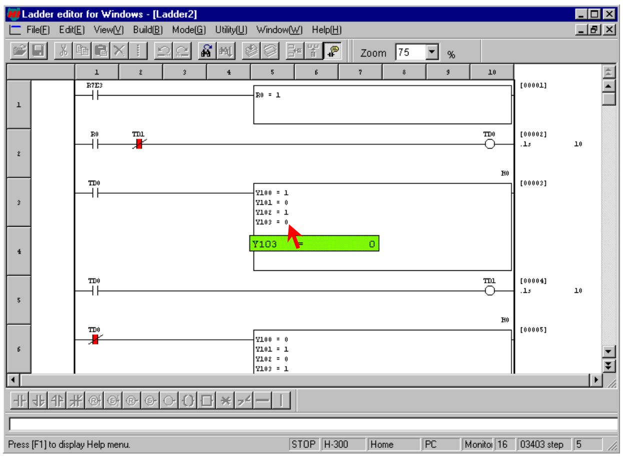
Match check



Set the CPU's RUN switch to “RUN” to begin the CPU operation.

The on/off status of the contact, timer, and current counter value are displayed.

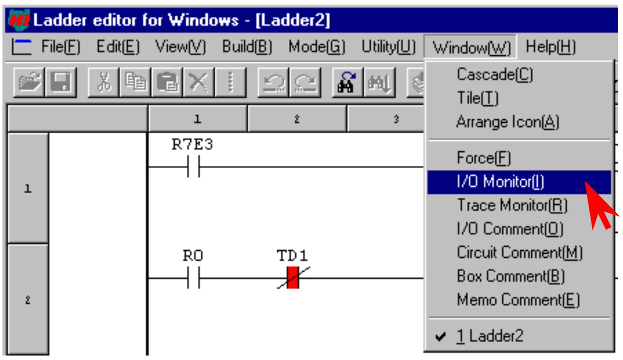
Display of circuit monitor



To monitor and display the current value and progress value, select comparison expression, arithmetic box, and coil (timer, counter, etc.) with the mouse arrow.

[I/O monitor]
The I/O monitor can be operated while in monitor mode.
Click **[Window]** → **[I/O Monitor]** in the Menu bar.
The I/O Monitor dialogue box is displayed.

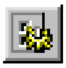
Pull-down menu

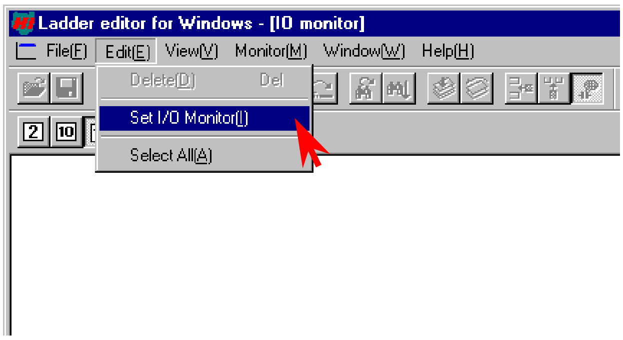


The I/O Monitor dialogue box is displayed on the Read/Edit screen at its maximum size.

The I/O monitor can be specified in the following two ways.

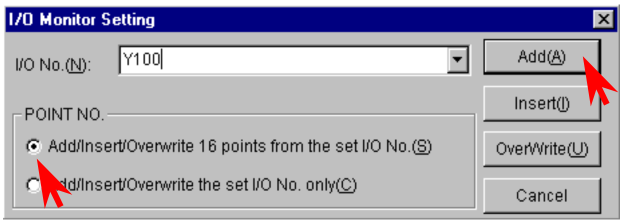
1] Click **[Edit]** → **[I/O monitor setting]** in the Menu bar.

2] Click the  icon in the Symbol bar.



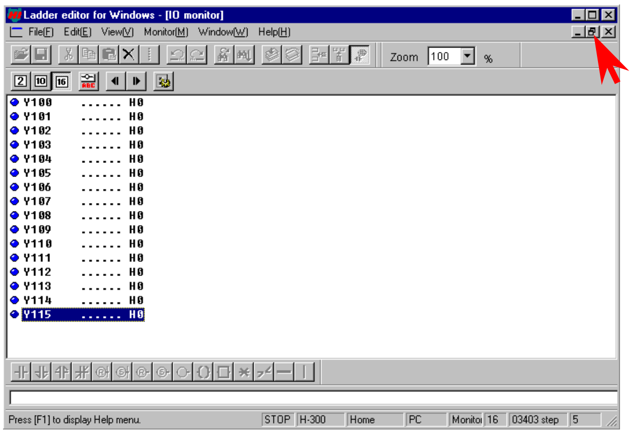
I/O Monitor dialogue box

- Enter the starting I/O No.
- Click the number of points to be monitored.
- Click on either the **[Add]**, **[Insert]**, or **[Overwrite]** buttons.



I/O Monitor Setting dialogue box

Monitor and display 16 points from Y100.



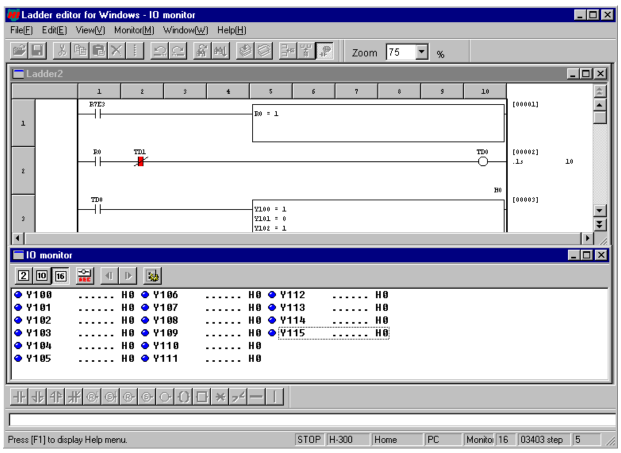
I/O monitor

The I/O monitor can display up to 64 I/O points (up to 64 including words/double-words).

Click the I/O No. being I/O monitored and click **[Edit]** → **[Delete]** to delete it from the monitor.

The display size of the I/O Monitor dialogue box can be changed by clicking .

Both the circuit monitor in the Read/Edit screen and the I/O Monitor can be displayed by making their display sizes smaller to check the operation.



Display of circuit and I/O monitor

Chapter 15 Daily and Periodic Inspections

In order to use the functions of the MICRO-EH in the optimal conditions and maintain the system to operate normally, it is essential to conduct daily and periodic inspections.

(1) Daily inspection

Verify the following items while the system is running.

Table 15.1 Items for daily inspection

Item	LED display	Normal status	Main cause of error
Unit LED display *1	POW	Lighting	Power supply error, etc.
	RUN	Lighting (in RUN status)	When not lit: Microcomputer malfunction, memory error, etc. When flashing: Syntax error, congestion error, etc.
	OK	Lighting	When not lit: Microcomputer malfunction, memory error, etc. When flashing: Battery error *2

*1: The MICRO-EH indicates the error contents using the combination of lit/flashing/not lit status of OK and RUN lamps. For details, see the error code list in Chapter 12.

*2: If the power supply for the basic unit is left turned off without replacing the battery after the OK lamp was flashing, the memory contents may be destroyed. Exercise caution when the system power is turned off for a long period of time, since this error may not have been detected and the memory contents may have already been destroyed.

(2) Periodic inspection

Turn off the power for the external I/O circuit and check the following items once every six months.

Table 15.2 Items for periodic inspection

Part	Item	Check criteria	Remarks
Programming device to CPU	Check operation of programming device	Must be able to be connected online. All switches and display lamps work normally.	
Power supply	Check for voltage fluctuations	85 to 264 V AC	Tester
I/O module	Output relay life	Electrical life 200,000 times Mechanical life 20 million times	See the relay contact life curve (Chapter 10).
	LED	Turns on/off correctly	
	External power voltage	Within the specification for each I/O	See the I/O specifications (Chapter 6).
Battery (Lithium battery)	Check voltage and life	Is the OK lamp flashing? Check to see if it has been less than 2 months since the last exchange.	
Installation and connecting areas	(1) All modules are securely fixed (2) All connectors fit snugly (3) All screws are tightened (4) Damage and deterioration of each cable	There should be no problem.	Tighten Check insertion Tighten Visual check
Ambient environment	(1) Temperature (2) Humidity (3) Other	0 to 55 °C 5 to 95 % RH (no condensation) No dust, foreign matter, vibration	-
Spare parts	Check number of parts, storage condition	There should be no problem.	-
Program	Check program contents	Compare the contents of the latest program saved and CPU contents, and make sure they match.	Check both master and backup.

(3) Life of the power module

Numbers of electrolytic condensers are used in the power module. Electrolytic condensers have a lifetime and it is believed that the life is reduced by half when the ambient temperature rises 10 °C.
When stocking spare parts, the standard for consideration is that the power module has a life of approximately five years when used at the rated ambient temperature (30 °C). Also, to extend the life of the module, consider the air circulation around the module and ambient temperature when installing it.

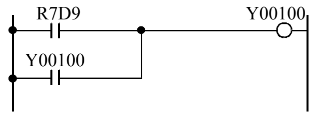
(4) Life of the battery

- The battery life time is shown below.

Battery life time (total power off time) [Hr] *	
Guaranteed value (Min.) @55°C	Actual value (Max.) @25°C
9,000	18,000

* Battery life time has been changed since Oct. 2002 production (MFG NO.02Jxx) due to hardware modification.

- The battery life can be determined by checking for the flashing of the OK lamp.
- The battery life time flag is in the bit special internal output “R7D9.”
  An example of a circuit using “R7D9” is shown below.



The battery error can be output to external output Y00100 by using the ladder shown to the left.

* R7EE is a bit to enable battery error detection. Be sure to set R7EE if battery is used.

Figure 15.1 Battery error detection circuit

- The self-diagnostic error code “71” indicates that the battery is not loaded or that it has reached its life.
- Exchange the battery every two years even if it is still functional.
- Use the battery within one year after purchase.

(5) How to replace the battery

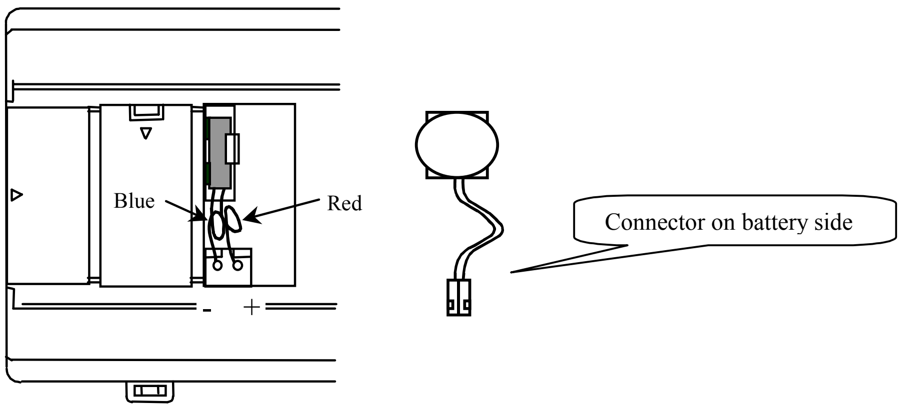


Figure 15.2 Replacing battery

1] Prepare a new battery (EH-MBAT).
2] Replace the battery while the power supply to the basic base is turned on.
3] Remove the old lithium battery from the battery case.
4] Insert the new battery and connect the cable to the CPU module.
Insert it so that the red lead is ⊕, and the black lead is ⊖.
5] Fold the excess lead and store it in the lead storage space.
(If excess lead is not stored properly, the wire may get caught on the front cover and be severed.)
* When exchanging while the basic unit power turned off, perform steps 4], 5] and 6], in less than 30 minute.

Caution on handling the battery

Be careful when replacing the battery, since incorrect replacement may cause the battery to explode. Use EH-MBAT for new batteries.

Batteries that have been replaced should be individually placed in a suitable plastic bag (to prevent shorting) and a disposal company should be requested to dispose of them.

At this time, do not short the batteries, throw them in a fire, dismantle them, exert external force, expose them to water, charge them or cut the lead wires since doing so leads to the risk that the batteries will ignite, explode or burn up.

Appendix 1   H-Series Instruction Support Comparison Chart

[Basic instructions and sequence instructions]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	LD	Start logical operation	○	○	○	○	○	○	○	○	○
2	LDI	Start logical NOT operation	○	○	○	○	○	○	○	○	○
3	AND	Logical AND	○	○	○	○	○	○	○	○	○
4	ANI	Logical AND not	○	○	○	○	○	○	○	○	○
5	OR	Logical OR	○	○	○	○	○	○	○	○	○
6	ORI	Logical OR not	○	○	○	○	○	○	○	○	○
7	NOT	Logical NOT	○	○	○	○	○	○	○	○	○
8	AND DIF	Detect rising edge	○	○	○	○	○	○	○	○	○
9	OR DIF	Detect rising edge	○	○	○	○	○	○	○	○	○
10	AND DFN	Detect falling edge	○	○	○	○	○	○	○	○	○
11	OR DFN	Detect falling edge	○	○	○	○	○	○	○	○	○
12	OUT	Output I/O	○	○	○	○	○	○	○	○	○
13	SET	Set I/O	○	○	○	○	○	○	○	○	○
14	RES	Reset I/O	○	○	○	○	○	○	○	○	○
15	MCS	Start master control	○	○	○	○	○	○	○	○	○
16	MCR	Cancel master control	○	○	○	○	○	○	○	○	○
17	MPS	Push operation result	○	○	○	○	○	○	○	○	○
18	MRD	Read operation result	○	○	○	○	○	○	○	○	○
19	MPP	Pull operation result	○	○	○	○	○	○	○	○	○
20	ANB	Connect logical block in serial	○	○	○	○	○	○	○	○	○
21	ORB	Connect logical block in parallel	○	○	○	○	○	○	○	○	○
22	[ ]	Start and end processing box	○	○	○	○	○	○	○	○	○
23	( )	Start and end relational box	○	○	○	○	○	○	○	○	○

[Basic instructions and timers/counters]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	OUT TD	On-delay timer	○	○	○	○	○	○	○	○	○
2	OUT SS	Single shot	○	○	○	○	○	○	○	○	○
3	OUT MS	Mono stable timer	×	○	×	×	○	○	○	○	○
4	OUT TMR	Integral timer	×	○	×	×	○	○	○	○	○
5	OUT WDT	Watchdog timer	×	○	×	×	○	○	○	○	○
6	OUT CU	Counter	○	○	○	○	○	○	○	○	○
7	OUT RCU	Ring counter	×	○	×	×	○	○	○	○	○
8	OUT CTU	Up-down counter up	○	○	○	○	○	○	○	○	○
9	OUT CTD	Up-down counter down	○	○	○	○	○	○	○	○	○
10	OUT CL	Clear counter	○	○	○	○	○	○	○	○	○

[Basic instructions and comparison boxes]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	LD (s1 == s2)	= comparison box	○	○	○	○	○	○	○	○	○
2	AND (s1 == s2)	= comparison box	○	○	○	○	○	○	○	○	○
3	OR (s1 == s2)	= comparison box	○	○	○	○	○	○	○	○	○
4	LD (s1 S== s2)	Signed = comparison box	○	○	×	×	○	○	○	○	○
5	AND (s1 S== s2)	Signed = comparison box	○	○	×	×	○	○	○	○	○
6	OR (s1 S== s2)	Signed = comparison box	○	○	×	×	○	○	○	○	○
7	LD (s1 < > s2)	< > comparison box	○	○	○	○	○	○	○	○	○
8	AND (s1 < > s2)	< > comparison box	○	○	○	○	○	○	○	○	○
9	OR (s1 < > s2)	< > comparison box	○	○	○	○	○	○	○	○	○
10	LD (s1 S< > s2)	Signed < > comparison box	○	○	×	×	○	○	○	○	○
11	AND (s1 S< > s2)	Signed < > comparison box	○	○	×	×	○	○	○	○	○
12	OR (s1 S< > s2)	Signed < > comparison box	○	○	×	×	○	○	○	○	○
13	LD (s1 < s2)	< comparison box	○	○	○	○	○	○	○	○	○
14	AND (s1 < s2)	< comparison box	○	○	○	○	○	○	○	○	○
15	OR (s1 < s2)	< comparison box	○	○	○	○	○	○	○	○	○
16	LD (s1 S< s2)	Signed < comparison box	○	○	×	×	○	○	○	○	○
17	AND (s1 S< s2)	Signed < comparison box	○	○	×	×	○	○	○	○	○
18	OR (s1 S< s2)	Signed < comparison box	○	○	×	×	○	○	○	○	○
19	LD (s1 <= s2)	<= comparison box	○	○	○	○	○	○	○	○	○
20	AND (s1 <= s2)	<= comparison box	○	○	○	○	○	○	○	○	○
21	OR (s1 <= s2)	<= comparison box	○	○	○	○	○	○	○	○	○
22	LD (s1 S<= s2)	Signed <= comparison box	○	○	×	×	○	○	○	○	○
23	AND (s1 S<= s2)	Signed <= comparison box	○	○	×	×	○	○	○	○	○
24	OR (s1 S<= s2)	Signed <= comparison box	○	○	×	×	○	○	○	○	○

[Arithmetic instructions]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	d = s	Assignment statement	○	○	○	○	○	○	○	○	○
2	d = s1 + s2	Binary addition	○	○	○	○	○	○	○	○	○
3	d = s1 B+ s2	BCD addition	○	○	○	○	○	○	○	○	○
4	d = s1 – s2	Binary subtraction	○	○	○	○	○	○	○	○	○
5	d = s1 B– s2	BCD subtraction	○	○	○	○	○	○	○	○	○
6	d = s1 × s2	Binary multiplication	○	○	○	○	○	○	○	○	○
7	d = s1 B× s2	BCD multiplication	○	○	○	○	○	○	○	○	○
8	d = s1 S× s2	Signed binary multiplication	○	○	×	×	○	○	○	○	○
9	d = s1 / s2	Binary division	○	○	○	○	○	○	○	○	○
10	d = s1 B/ s2	BCD division	○	○	○	○	○	○	○	○	○
11	d = s1 S/ s2	Signed binary division	○	○	×	×	○	○	○	○	○
12	d = s1 OR s2	Logical OR	○	○	○	○	○	○	○	○	○
13	d = s1 AND s2	Logical AND	○	○	○	○	○	○	○	○	○
14	d = s1 XOR s2	Exclusive OR	○	○	○	○	○	○	○	○	○
15	d = s1 == s2	= comparison expression	○	○	○	○	○	○	○	○	○
16	d = s1 S== s2	Signed = comparison expression	○	○	×	×	○	○	○	○	○
17	d = s1 < > s2	≠ comparison expression	○	○	○	○	○	○	○	○	○
18	d = s1 S< > s2	Signed ≠ comparison expression	○	○	×	×	○	○	○	○	○
19	d = s1 < s2	< comparison expression	○	○	○	○	○	○	○	○	○
20	d = s1 S< s2	Signed < comparison expression	○	○	×	×	○	○	○	○	○
21	d = s1 <= s2	≤ comparison expression	○	○	○	○	○	○	○	○	○
22	d = s1 S<= s2	Signed ≤ comparison expression	○	○	×	×	○	○	○	○	○

[Application instructions] (1/2)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	BSET (d, n)	Bit set	○	○	○	○	○	○	○	○	○
2	BRES (d, n)	Bit reset	○	○	○	○	○	○	○	○	○
3	BTS (d, n)	Bit test	○	○	○	○	○	○	○	○	○
4	SHR (d, n)	Shift right	○	○	○	○	○	○	○	○	○
5	SHL (d, n)	Shift left	○	○	○	○	○	○	○	○	○
6	ROR (d, n)	Rotate right	○	○	○	○	○	○	○	○	○
7	ROL (d, n)	Rotate left	○	○	○	○	○	○	○	○	○
8	LSR (d, n)	Logical shift right	○	○	○	○	○	○	○	○	○
9	LSL (d, n)	Logical shift left	○	○	○	○	○	○	○	○	○
10	BSR (d, n)	BCD shift right	○	○	○	○	○	○	○	○	○
11	BSL (d, n)	BCD shift left	○	○	○	○	○	○	○	○	○
12	WSHR (d, n)	Batch shift right	×	○	×	×	○	○	○	○	○
13	WSHL (d, n)	Batch shift left	×	○	×	×	○	○	○	○	○
14	WBSR (d, n)	Batch BCD shift right	×	○	×	×	○	○	○	○	○
15	WBSL (d, n)	Batch BCD shift left	×	○	×	×	○	○	○	○	○
16	MOV (d, s, n)	Block transfer	○	○	×	×	○	○	○	○	○
17	COPY (d, s, n)	Copy	○	○	×	×	○	○	○	○	○

[Application instructions] (2/2)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
18	XCG (d, d2, n)	Block exchange	○	○	×	×	○	○	○	○	○
19	NOT (d)	Reverse	○	○	○	○	○	○	○	○	○
20	NEG (d)	Two's complement	○	○	○	○	○	○	○	○	○
21	ABS (d, s)	Absolute value	○	○	○	○	○	○	○	○	○
22	SGET (d, s)	Sign addition	×	○	×	×	○	○	○	○	○
23	EXT (d, s)	Sign expansion	×	○	×	×	○	○	○	○	○
24	BCD (d, s)	Binary → BCD conversion	○	○	○	○	○	○	○	○	○
25	BIN (d, s)	BCD → Binary conversion	○	○	○	○	○	○	○	○	○
26	DECO (d, s, n)	Decode	○	○	○	○	○	○	○	○	○
27	ENCO (d, s, n)	Encode	○	○	○	○	○	○	○	○	○
28	SEG (d, s)	7 segment decode	×	○	×	×	○	○	○	○	○
29	SQR (d, s)	Square root	×	○	×	×	○	○	○	○	○
30	BCU (d, s)	Bit count	○	○	○	○	○	○	○	○	○
31	SWAP (d)	Swap	○	○	○	○	○	○	○	○	○
32	FIFIT (P, n)	Initialize FIFO	×	○	×	×	○	○	○	○	○
33	FIFWR (P, s)	Write FIFO	×	○	×	×	○	○	○	○	○
34	FIFRD (P, d)	Read FIFO	×	○	×	×	○	○	○	○	○
35	UNIT (d, s, n)	Unit	○	○	○	○	○	○	○	○	○
36	DIST (d, s, n)	Distribute	○	○	○	○	○	○	○	○	○
37	ADRIO (d, s)	Convert I/O address	×	○	×	×	×	○	○	○	○

[Control instructions]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	END	End normal scan	○	○	○	○	○	○	○	○	○
2	CEND (s)	End scan condition	○	○	○	○	○	○	○	○	○
3	JMP n	Unconditional jump	○	○	○	○	○	○	○	○	○
4	CJMP n (s)	Conditional jump	○	○	○	○	○	○	○	○	○
5	RSRV n	Reserve	×	×	×	×	×	×	○	○	○
6	FREE	Free reserve	×	×	×	×	×	×	○	○	○
7	LBL n	Label	○	○	○	○	○	○	○	○	○
8	FOR n (s)	For	○	○	×	×	○	○	○	○	○
9	NEXT n	Next	○	○	×	×	○	○	○	○	○
10	CAL n	Call subroutine	○	○	○	○	○	○	○	○	○
11	SB n	Start subroutine program	○	○	○	○	○	○	○	○	○
12	RTS	Return subroutine	○	○	○	○	○	○	○	○	○
13	START n	Start basic task	×	×	×	×	×	×	○	○	○
14	INT n	Start interrupt scan program	○	○	○	○	○	○	○	○	○
15	RTI	Return interrupt	○	○	○	○	○	○	○	○	○

[High-function module transfer instructions]

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	TRNS 0 (d, s, t)	General-purpose port transmission instruction	O*	O	×	×	×	×	×	O	O
2	RECV 0 (d, s, t)	General-purpose port reception instruction	O*	O	×	×	×	×	×	O	O
3	TRNS 1 (d, s, t)	Data transmission/reception instruction for SIO, CLOCK	×	×	×	×	×	O	×	O	O
4	QTRNS1 (d, s, t)	High-speed data transmission/reception instruction for SIO, CLOCK	×	×	×	×	×	×	×	O	O
5	TRNS 2 (d, s, t)	Data transmission/reception instruction for ASCII	×	×	×	×	×	×	×	O	O
6	QTRNS2 (d, s, t)	High-speed data transmission/reception instruction for ASCII	×	×	×	×	×	×	×	O	O
7	TRNS 3 (d, s, t)	Data transmission instruction for POSIT-H	×	×	×	×	×	×	×	O	O
8	QTRNS3 (d, s, t)	High-speed data transmission instruction for POSIT-H	×	×	×	×	×	×	×	O	O
9	RECV 3 (d, s, t)	Data reception instruction for POSIT-H	×	×	×	×	×	×	×	O	O
10	TRNS 4 (d, s, t)	Data transmission/reception instruction for POSIT-2H, POSITA2H	×	×	×	×	×	O	×	O	O
11	QTRNS 4 (d, s, t)	High-speed data transmission/reception instruction for POSIT-2H, POSITA2H	×	×	×	×	×	×	×	O	O
12	TRNS 5 (d, s, t)	Data transmission/reception instruction for XCU-001H	×	×	×	×	×	×	×	O	O
13	TRNS 6 (d, s, t)	Data transmission/reception instruction for XCU-232H	×	×	×	×	×	×	×	O	O

* Supported by software version 1.30 (WRF051=H0130) or newer.

[FUN instructions] (1/5)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
1	FUN 0 (s) (PIDIT (s))	PID operation initialization	×	O	×	×	×	O	×	O	O
2	FUN 1 (s) (PIDOP (s))	PID operation execution control	×	O	×	×	×	O	×	O	O
3	FUN 2 (s) (PIDCL (s))	PID operation execution	×	O	×	×	×	O	×	O	O
4	FUN 4 (s) (IFR (s))	Process stepping	×	O	×	×	×	×	×	×	O
5	FUN 5 (s)	General purpose port switching	O	×	×	×	×	×	×	×	×
6	FUN 10 (s) (SIN (s))	SIN function calculation	×	O	×	×	×	O	×	O	O
7	FUN 11 (s) (COS (s))	COS function calculation	×	O	×	×	×	O	×	O	O
8	FUN 12 (s) (TAN (s))	TAN function calculation	×	O	×	×	×	O	×	O	O
9	FUN 13 (s) (ASIN (s))	ARC SIN function calculation	×	O	×	×	×	O	×	O	O
10	FUN 14 (s) (ACOS (s))	ARC COS function calculation	×	O	×	×	×	O	×	O	O
11	FUN 15 (s) (ATAN (s))	ARC TAN function calculation	×	O	×	×	×	O	×	O	O
12	FUN 20 (s) (DSRCH (s))	Data search	×	×	×	×	×	O	×	O	O
13	FUN 21 (s) (TSRCH (s))	Table search	×	×	×	×	×	O	×	O	O
14	FUN 30 (s) (BINDA (s))	Binary → decimal ASCII conversion (16 bits)	×	×	×	×	×	O	×	O	O
15	FUN 31 (s) (DBINDA (s))	Binary → decimal ASCII conversion (32 bits)	×	×	×	×	×	O	×	O	O

[FUN instructions] (2/5)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
16	FUN 32 (s) (BINHA (s))	Binary → hexadecimal ASCII conversion (16 bits)	×	×	×	×	×	○	×	○	○
17	FUN 33 (s) (DBINHA (s))	Binary → hexadecimal ASCII conversion (32 bits)	×	×	×	×	×	○	×	○	○
18	FUN 34 (s) (BCDDA (s))	BCD → decimal ASCII conversion (16 bits)	×	×	×	×	×	○	×	○	○
19	FUN 35 (s) (DBCDDA (s))	BCD → decimal ASCII conversion (32 bits)	×	×	×	×	×	○	×	○	○
20	FUN 36 (s) (DABIN (s))	Unsigned 5 digit Decimal ASCII → binary conversion	×	×	×	×	×	○	×	○	○
21	FUN 37 (s) (DDABIN (s))	Signed 10 digit Decimal ASCII → binary conversion	×	×	×	×	×	○	×	○	○
22	FUN 38 (s) (HABIN (s))	4-digit hexadecimal ASCII → binary conversion	×	×	×	×	×	○	×	○	○
23	FUN 39 (s) (DHABIN (s))	8-digit hexadecimal ASCII → binary conversion	×	×	×	×	×	○	×	○	○
24	FUN 40 (s) (DABCD (s))	4-digit decimal ASCII → BCD conversion	×	×	×	×	×	○	×	○	○
25	FUN 41 (s) (DDABCD (s))	8-digit decimal ASCII → BCD conversion	×	×	×	×	×	○	×	○	○
26	FUN 42 (s) (ASC (s))	Hexadecimal binary → ASCII conversion (digit designation)	×	×	×	×	×	○	×	○	○
27	FUN 43 (s) (HEX (s))	Hexadecimal ASCII → binary conversion (digit designation)	×	×	×	×	×	○	×	○	○
28	FUN 44 (s) (ASDD (s))	Unit character strings	×	×	×	×	×	○	×	○	○
29	FUN 45 (s) (SCMP (s))	Compare character strings	×	×	×	×	×	○	×	○	○
30	FUN 46 (s) (WTOB (s))	Word → byte conversion	×	×	×	×	×	○	×	○	○
31	FUN 47 (s) (WTOW (s))	Byte → word conversion	×	×	×	×	×	○	×	○	○
32	FUN 48 (s) (BSHR (s))	Shift byte unit to right	×	×	×	×	×	○	×	○	○
33	FUN 49 (s) (BSHL (s))	Shift byte unit to left	×	×	×	×	×	○	×	○	○
34	FUN 50 (s) (TRSET (s))	Set sampling trace	×	×	×	×	×	○	×	○	○
35	FUN 51 (s) (TRACE (s))	Execute sampling trace	×	×	×	×	×	○	×	○	○
36	FUN 52 (s) (TRRES (s))	Reset sampling trace	×	×	×	×	×	○	×	○	○
37	FUN 60 (s) (BSQR (s))	Binary square root	×	×	×	×	×	○	×	○	○
38	FUN 61 (s) (PGEN (s))	Dynamic scan pulse	×	×	×	×	×	○	×	○	○
39	FUN 70 (s)	Set high-speed counter mode	×	×	○	×	×	×	×	×	×
40	FUN 71 (s)	Read high-speed counter progress value	×	×	○	×	×	×	×	×	×
41	FUN 72 (s)	Write high-speed counter progress value	×	×	○	×	×	×	×	×	×
42	FUN 73 (s)	Read high-speed counter set value	×	×	○	×	×	×	×	×	×
43	FUN 74 (s)	Write high-speed counter set value	×	×	○	×	×	×	×	×	×
44	FUN 80 (s) (ALREF (s))	Refresh I/O (all points)	○	○	×	×	×	○	×	×	○

[FUN instructions] (3/5)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
45	FUN 81 (s) (IORREF (s))	Refresh I/O (input/output designation)	O	O	×	×	×	O	×	×	O
46	FUN 82 (s) (SLREL (s))	Refresh I/O refresh (any slot)	O	O	×	×	×	O	×	×	O
47	FUN 90 (ETDIT)	Expansion timer initial setting	×	×	×	×	×	×	×	×	O
48	FUN 91 (ETD)	Expansion timer execution	×	×	×	×	×	×	×	×	O
49	FUN 92 (ECUIT)	Expansion counter/up-down counter initial setting	×	×	×	×	×	×	×	×	×
50	FUN 93 (ECU)	Expansion counter execution	×	×	×	×	×	×	×	×	×
51	FUN 94 (ECTU)	Expansion up-down counter up execution	×	×	×	×	×	×	×	×	×
52	FUN 95 (ECTD)	Expansion up-down counter down execution	×	×	×	×	×	×	×	×	×
53	FUN 96 (ECL)	Clear expansion counter	×	×	×	×	×	×	×	×	×
54	FUN 97 (WNRED)	Read expansion link area	×	×	×	×	×	×	×	×	O
55	FUN 98 (WNWRT)	Write expansion link area	×	×	×	×	×	×	×	×	O
56	FUN 100 (INT)	Floating decimal point operation (real number → integer (word) conversion)	×	O	×	×	×	×	×	×	O
57	FUN 101 (INTD)	Floating decimal point operation (real number → integer (double word) conversion)	×	O	×	×	×	×	×	×	O
58	FUN 102 (FLOAT)	Floating decimal point operation (integer (word) → real number conversion)	×	O	×	×	×	×	×	×	O
59	FUN 103 (FLOATD)	Floating decimal point operation (integer (double word) → real number conversion)	×	O	×	×	×	×	×	×	O
60	FUN 104 (FADD)	Floating decimal point operation (addition)	×	O	×	×	×	×	×	×	O
61	FUN 105 (FSUB)	Floating decimal point operation (subtraction)	×	O	×	×	×	×	×	×	O
62	FUN 106 (FMUL)	Floating decimal point operation (multiplication)	×	O	×	×	×	×	×	×	O
63	FUN 107 (FDIV)	Floating decimal point operation (division)	×	O	×	×	×	×	×	×	O
64	FUN 108 (FRAD)	Floating decimal point operation (angle → radian conversion)	×	O	×	×	×	×	×	×	O
65	FUN 109 (FDEG)	Floating decimal point operation (radian → angle conversion)	×	O	×	×	×	×	×	×	O
66	FUN 110 (FSIN)	Floating decimal point operation (SIN)	×	O	×	×	×	×	×	×	O
67	FUN 111 (FCOS)	Floating decimal point operation (COS)	×	O	×	×	×	×	×	×	O
68	FUN 112 (FTAN)	Floating decimal point operation (TAN)	×	O	×	×	×	×	×	×	O
69	FUN 113 (FASIN)	Floating decimal point operation (ARC SIN)	×	O	×	×	×	×	×	×	O
70	FUN 114 (FACOS)	Floating decimal point operation (ARC COS)	×	O	×	×	×	×	×	×	O

[FUN instructions] (4/5)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
71	FUN 115 (FATAN)	Floating decimal point operation (ARC TAN)	×	O	×	×	×	×	×	×	O
72	FUN 116 (FSQR)	Floating decimal point operation (square root)	×	O	×	×	×	×	×	×	O
73	FUN 117 (FEXP)	Floating decimal point operation (exponent)	×	O	×	×	×	×	×	×	O
74	FUN 118 (FLOG)	Floating decimal point operation (natural logarithm)	×	O	×	×	×	×	×	×	O
75	FUN 120 (INDXD)	Index setting (argument d)	×	×	×	×	×	×	×	×	O
76	FUN 121 (INDXS)	Index setting (argument s)	×	×	×	×	×	×	×	×	O
77	FUN 122 (INDXC)	Cancel index	×	×	×	×	×	×	×	×	O
78	FUN 123 (INC)	Increment (INC)	×	×	×	×	×	×	×	×	O
79	FUN 124 (INCD)	Double word increment (DINC)	×	×	×	×	×	×	×	×	O
80	FUN 125 (DEC)	Decrement (DEC)	×	×	×	×	×	×	×	×	O
81	FUN 126 (DECD)	Double word decrement (DECD)	×	×	×	×	×	×	×	×	O
82	FUN 127 (BITTOW)	Expand bit data to word data	×	×	×	×	×	×	×	×	O
83	FUN 128 (WTOBIT)	Expand word data to bit data	×	×	×	×	×	×	×	×	O
84	FUN 130 (FBINI)	Set file memory block	×	×	×	×	×	×	×	×	O
85	FUN 131 (FBMOV)	Transfer file memory block	×	×	×	×	×	×	×	×	O
86	FUN 132 (FBCHG)	Exchange file memory block	×	×	×	×	×	×	×	×	O
87	FUN 133 (FWRED)	Read file memory word unit	×	×	×	×	×	×	×	×	O
88	FUN 134 (FWWRT)	Write file memory word unit	×	×	×	×	×	×	×	×	O
89	FUN 135 (FRED)	Read file memory byte unit	×	×	×	×	×	×	×	×	O
90	FUN 136 (FWRT)	Write file memory byte unit	×	×	×	×	×	×	×	×	O
91	FUN 140 (s)	High-speed counter operation control	O	×	×	×	×	×	×	×	×
92	FUN 141 (s)	High-speed counter coincident output control	O	×	×	×	×	×	×	×	×
93	FUN 142 (s)	High-speed counter up/down control	O	×	×	×	×	×	×	×	×
94	FUN 143 (s)	Rewrite current high-speed counter value	O	×	×	×	×	×	×	×	×
95	FUN 144 (s)	Read current high-speed counter value	O	×	×	×	×	×	×	×	×
96	FUN 145 (s)	Clear current high-speed counter value	O	×	×	×	×	×	×	×	×

[FUN instructions] (5/5)

No.	Instruction format	Instruction name	MICRO-EH	EH-150	H-64 ~ H-20	H-200	H-250	H-252	H-2000 H-700 H-300	H-2002 H-1002 H-702 H-302	H-4010
97	FUN 146 (s)	Preset high-speed counter	○	×	×	×	×	×	×	×	×
98	FUN 147 (s)	PWM operation control	○	×	×	×	×	×	×	×	×
99	FUN 148 (s)	Change PWM frequency on-duty	○	×	×	×	×	×	×	×	×
100	FUN 149 (s)	Pulse output control	○	×	×	×	×	×	×	×	×
101	FUN 150 (s)	Change number of pulse frequency output setting	○	×	×	×	×	×	×	×	×
102	FUN 151 (s)	Pulse output with acceleration/deceleration	○	×	×	×	×	×	×	×	×
103	FUN 210 (s) (LOGIT (s))	Initial setting for data logging	×	○	×	×	×	×	×	×	×
104	FUN 211 (s) (LOGWRT (s))	Write log data	×	○	×	×	×	×	×	×	×
105	FUN 212 (s) (LOGCLR (s))	Clear log data	×	○	×	×	×	×	×	×	×
106	FUN 213 (s) (LOGRED (s))	Read log data	×	○	×	×	×	×	×	×	×
107	FUN 254 (s) (BOXC (s))	BOX comment	○	○	○	○	○	○	○	○	○
108	FUN 255 (s) (MEMC (s))	Memo comment	○	○	○	○	○	○	○	○	○

Supported command for EH-150 depends on CPU types. Please read EH-150 application manual for further information.

Appendix 2 Standards

MICRO-EH products are global products designed and manufactured for use throughout the world. They should be installed and used in conformance with product-specific guidelines as well as the following agency approvals and standards.

Item	Standards	
Industrial Control Equipment[Safety]	UL 508 CSA C22.2 no 142-M1987	Certification by Underwriters Laboratories for selected modules
Hazardous Locations[Safety] Class I, Div II, A,B,C,D	UL 1604 CSA C22.2 No142-M1987	Certification by Underwriters Laboratories for selected modules
European EMC Directive	IEC 61131-2 (2003)	Emission, Immunity
European Low Voltage Directive	IEC 61131-2 (1994)	
Australia C-tick mark	AS/AZN CISPR11 (2002)	

Warning:

Explosion hazard – substitution of componets may impair suitability for class I, division 2"
Do not replace modules unless power has been switched off or the area is known to be non-hazardous.
Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.