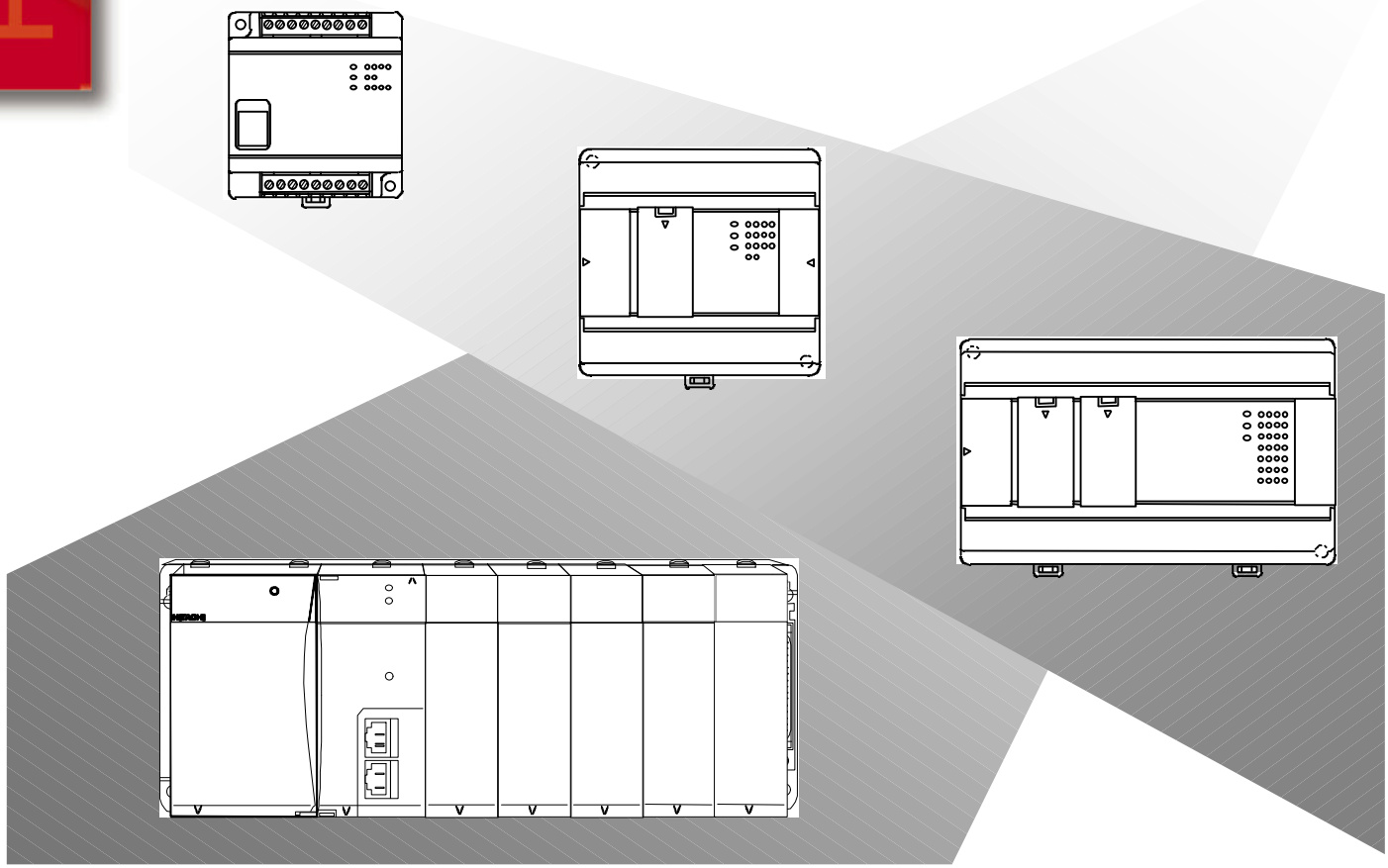
Getting Started

Hitachi PLC



Powerful Hitachi PLC

Programming Compatibility

Programming is fully compatible from the smallest PLC (MICRO-EH) to the biggest one (Big-H series).

2 communication ports

2 communication ports can be used flexibly as programming, HMI communication and general purpose port for bar code reader or intelligent sensors or scales.

(Note : MICRO-EH does not support the general purpose port.)

Easy programming

Hitachi provides two different programming software.

1) Pro-H : IEC61131-3 standard, Multiprogramming languages.

2) LADDER EDITOR for Windows : Easy ladder programming editor

(The both in one CD package)

High speed micro processor

EH-150 and MICRO-EH has a 32 bits RISC microprocessor called “Super H”.

Compact size

The compact PLC has more capabilities with high reliability, and saves more space and cost.

Open network

EH-150 series has Profibus DP master/slave modules and DeviceNet master/slave modules, which will increase application range.

Flexible product line up

Digital I/O (normal / high density), analog I/O (V, I, PT100/1000), high speed counter, positioning, several communication modules are available.

Solution for total automation system

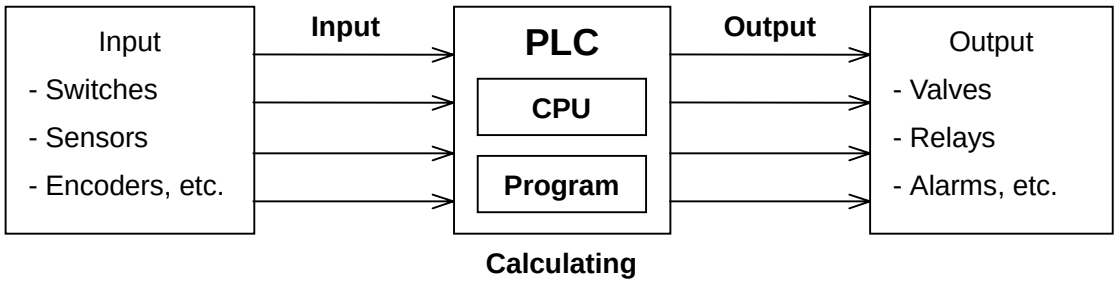
Hitachi provides many options besides PLC as follows.

- Operator panel **EH-HMI** series
- Remote I/O system **EH-RIO** series
- Frequency inverters **L/SJ100** and **L300P/SJ300** series.

1. Introduction

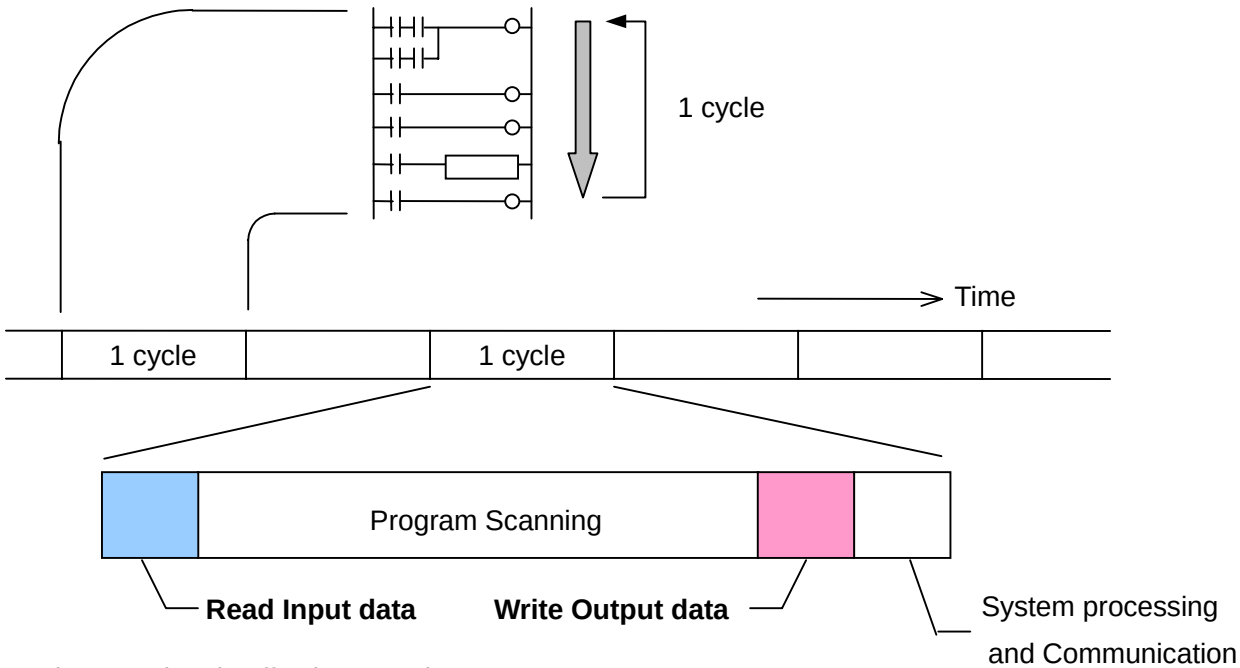
What is a PLC?

"PLC" stands for Programmable Logic Controller. PLC is an industrial controller, which enables the control of many devices and signals easily and flexibly. The PLC is "Programmable" by PC or hand held programming unit. The PLC's basically work in 3 steps : reading input data, calculating in the CPU and writing output data according to user program in the PLC.



How it works?

The PLC has a CPU. The CPU executes (scans) a user program. When the CPU reaches the end of the program, the CPU will return to the program top and execute again, this process is continuous. In every cycle, input data is read, and output data is written once each.



Input and output data is effective once in a scan.

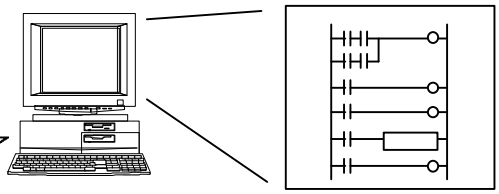
This is called "**Refresh Processing**".

* Scan time (cycle time) depends on your program. (Normally 5 to 30ms.)

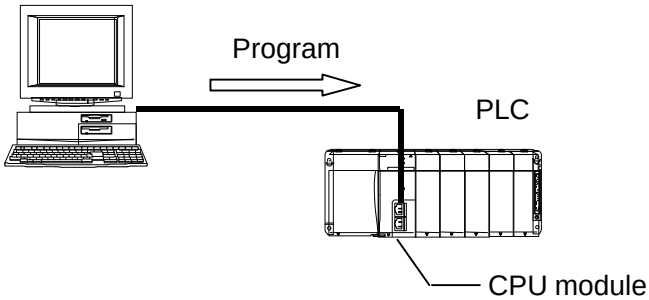
Basic flow

Programming on PC

Programming software required (see page 1)

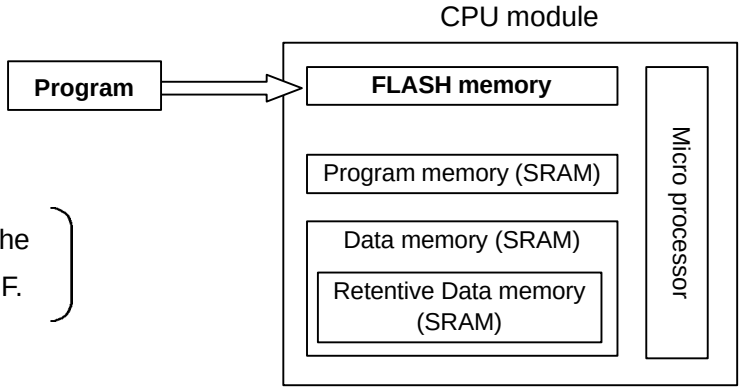


Download from PC to CPU

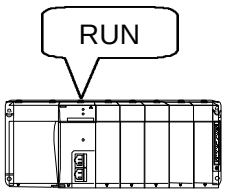


The program is stored in FLASH memory of CPU

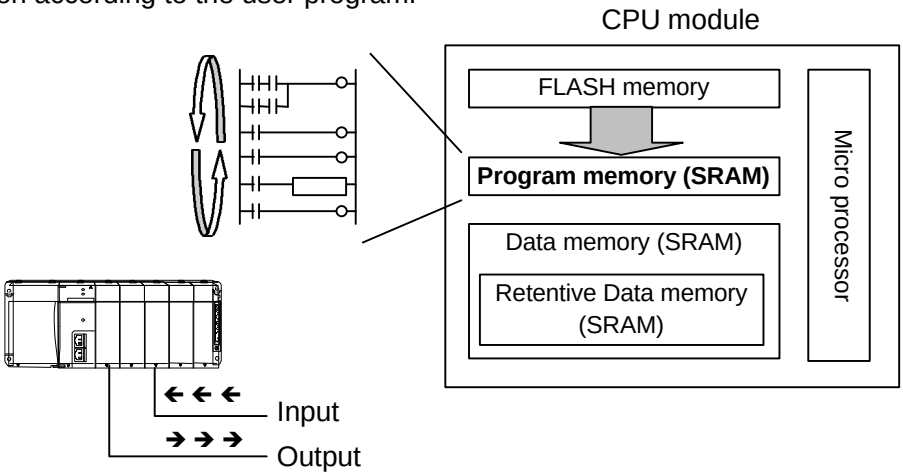
FLASH memory keeps the program after power OFF.



Start the PLC by PC or RUN switch on the PLC



PLC starts operation according to the user program.

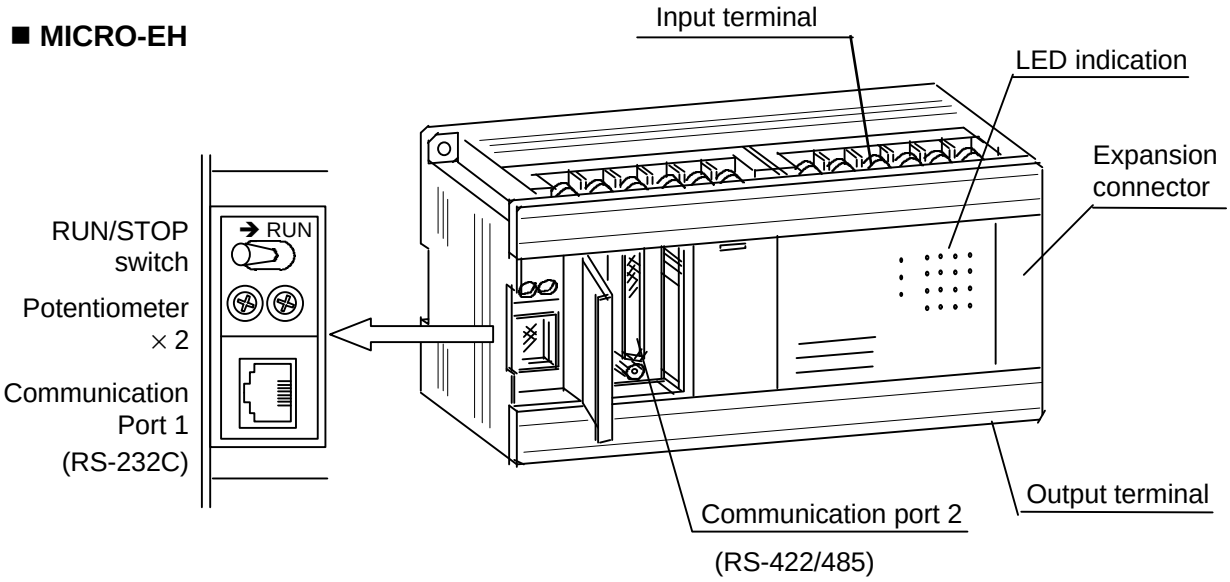


2. Hitachi PLC

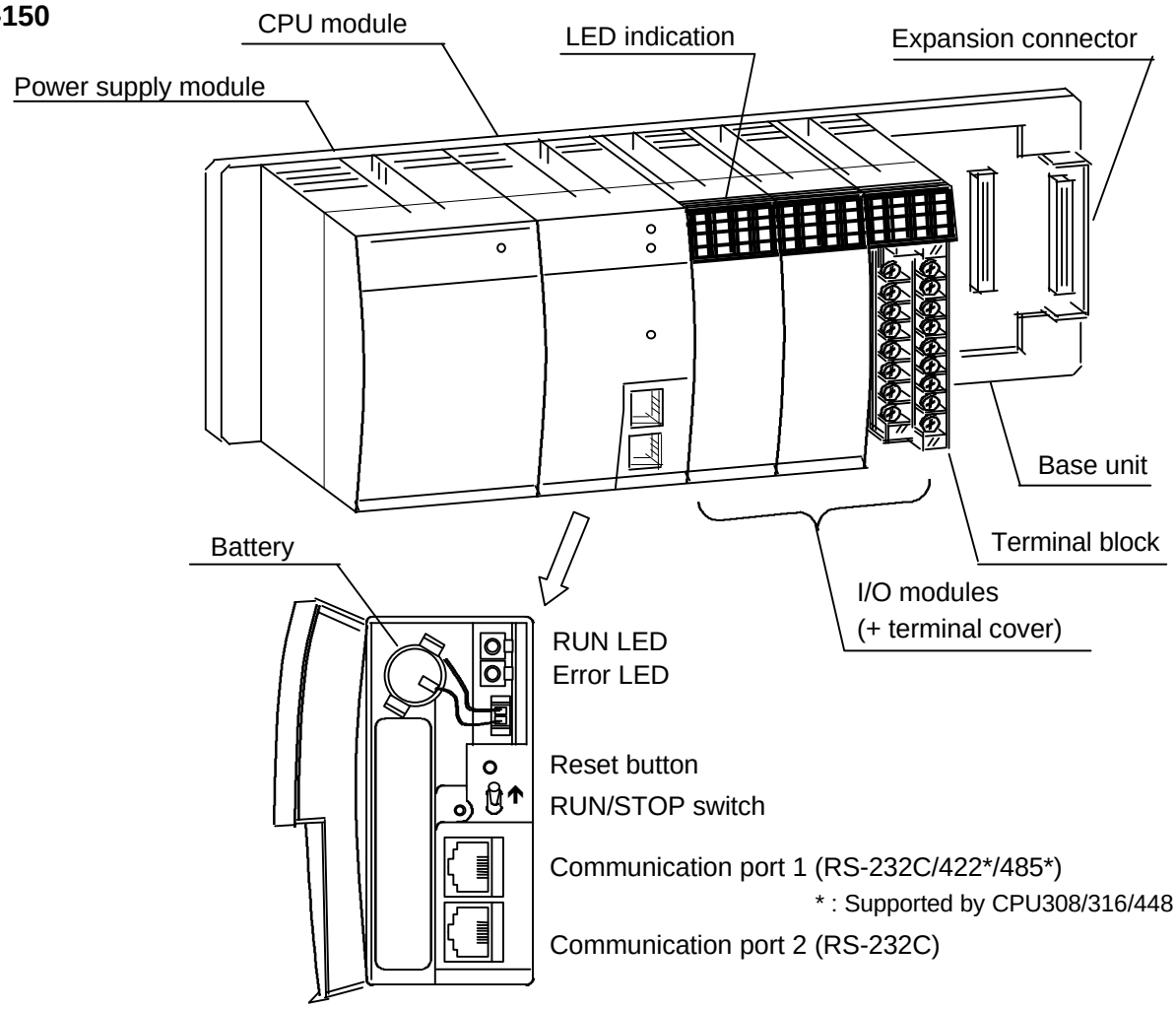
System design

Hitachi has a compact type PLC “MICRO-EH” and modular type PLC “EH-150”.

■ **MICRO-EH**



■ **EH-150**

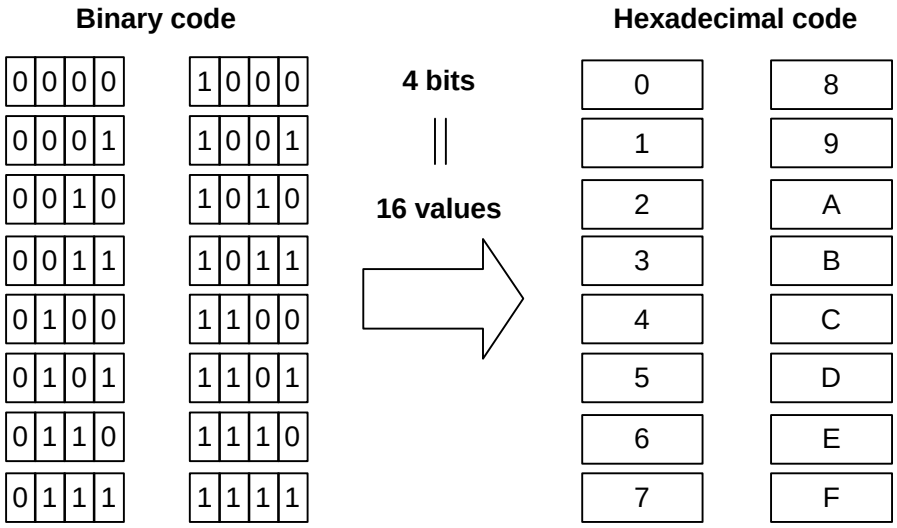


Binary, decimal and hexadecimal code

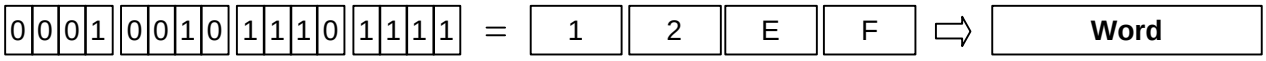
Before going into the Hitachi PLC details, it is important to understand the numbering system of the PLC. Electric devices like PLC's can handle only digital data. The minimum unit of digital data is a "bit". 1 bit has two states, 0 or 1.

0 or 1

4 bits can give us 16 different values because of 2^4 as below left.



Since 4 bits of data is not easy to handle, the data is translated to hexadecimal code 0 to F as above right. One hexadecimal code (= 4 bits) can express 16 different values.
4 hexadecimal codes have 65,535 values (= 16^4). This unit (4 hexadecimal codes = 16 bits) is called as "**Word**". Normally Hitachi PLC handles binary data and word data.



This is a comparison table of one "**Word**" in binary, decimal and hexadecimal expressions.

2	10	16	2	10	16
0000 0000 0000 0000	0	H 0000	0000 0000 0011 1111	63	H 003F
0000 0000 0000 0001	1	H 0001	0000 0000 0100 0000	64	H 0040
0000 0000 0000 0010	2	H 0002			
0000 0000 0000 0011	3	H 0003	0000 0000 1111 1111	255	H 00FF
0000 0000 0000 0100	4	H 0004	0000 0001 0000 0000	256	H 0100
0000 0000 0000 0101	5	H 0005			
0000 0000 0000 0110	6	H 0006	0000 0011 1111 1111	1023	H 03FF
0000 0000 0000 0111	7	H 0007	0000 0100 0000 0000	1024	H 0400
0000 0000 0000 1000	8	H 0008			
0000 0000 0000 1001	9	H 0009	0000 0111 1111 1111	2047	H 07FF
0000 0000 0000 1010	10	H 000A	0000 1000 0000 0000	2048	H 0800
0000 0000 0000 1011	11	H 000B			
0000 0000 0000 1100	12	H 000C	0000 1111 1111 1111	4095	H 0FFF
0000 0000 0000 1101	13	H 000D	0001 0000 0000 0000	4096	H 1000
0000 0000 0000 1110	14	H 000E			
0000 0000 0000 1111	15	H 000F	0111 1111 1111 1111	32767	H 7FFF
0000 0000 0001 0000	16	H 0010	1000 0000 0000 0000	32768	H 8000
0000 0000 0001 1111	31	H 001F	1111 1111 1111 1111	65535	H FFFF
0000 0000 0010 0000	32	H 0020			

I/O data types

Hitachi PLC's handles the following I/O.

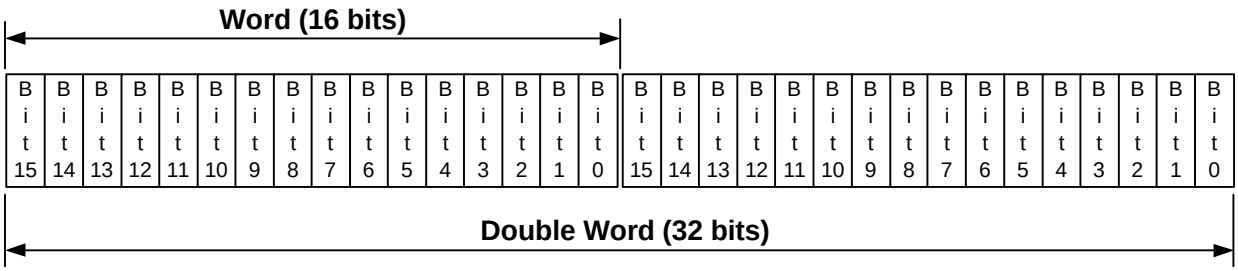
		Bit (for Digital data, etc)	Word (for Analog data, etc)	Double Word
External I/Os	Input	X □□□□ [**D**]	WX □□□ [H]	DX □□□ [H]
	Output	Y □□□□ [**D**]	WY □□□ [H]	DY □□□ [H]
Internal I/Os	Normal memory	R □□□□ [H]	WR □□□ [H]	DR □□□ [H]
	Shared memory	M □□□□ [H]	WM □□□ [H]	DM □□□ [H]
	Link memory	L □□□□ [H]	WL □□□ [H]	DL □□□ [H]
	Timer (TD,SS, etc.)	TD □□□ [**D**]	-	-
	Counter (CU, etc.)	CU □□□ [**D**]	-	-
	Edge detection ↑	DIF □□□ [**D**]	-	-
	Edge detection ↓	DFN □□□ [**D**]	-	-

Note : [D] ... Decimal (ex. 00,01,...,09,10,...,15,16,17,18,19,20,21,...)

[H] ... Hexadecimal (ex. 00,01,...,09,0A,0B,...0F,10,11,...1F,20,21,...)

■ Bit, Word and Double Word

Double Word consists of 2 Words, and 1 Word consists of 16 bits as below.

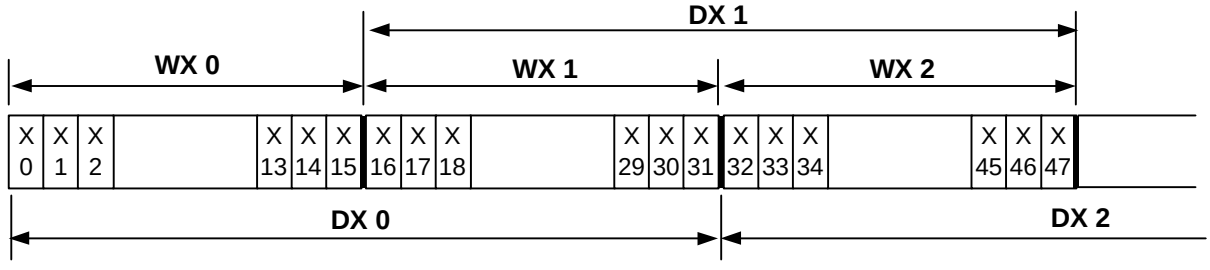


Example : WR 0 = H'1234, WR 1 = H'5678 ➔ DR 0 = H'5678 1234
WR 1 WR 0

■ External I/O

External I/Os (**X, Y, WX, WY, etc.**) are direct addresses for each digital input/output module or analog input/output module. Please note bit I/Os X and Y are decimal expression.

(WX/WY can be used as access command or data for high function modules like the counter module.)

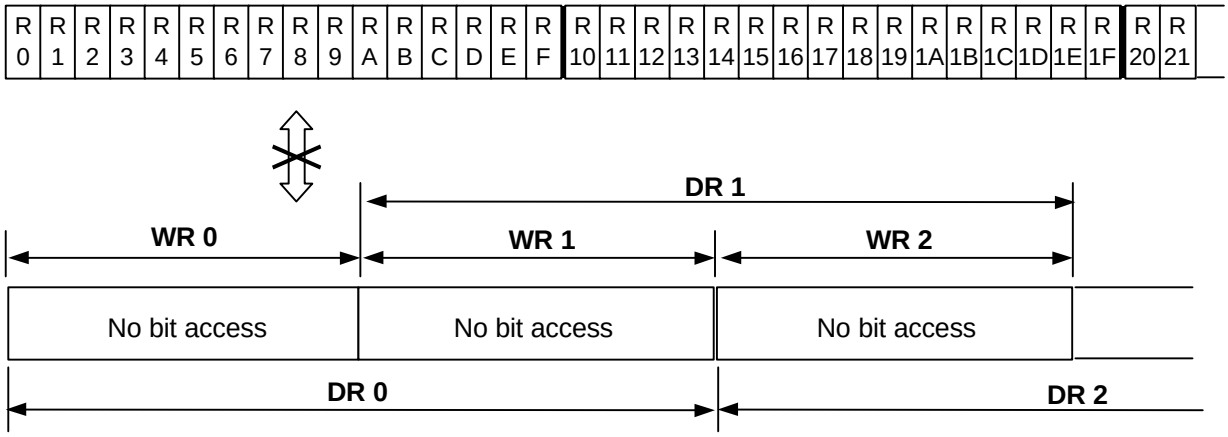


■ **Internal I/O**

Internal I/O (**R, WR, M, WM, etc.**) means **data memory**. This data memory area can be read or written freely for flags, parameters, set point values or calculation depending on your program.

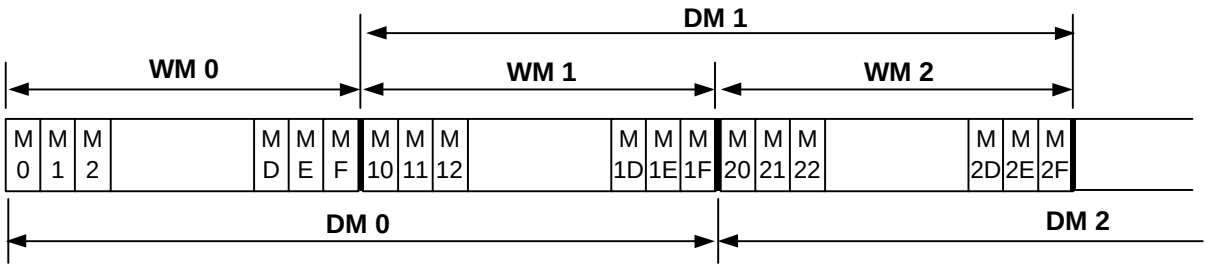
[R, WR]

Note : "R" and "WR/DR" are physically separated memory areas.



[M, L]

Note : "M", "WM" and "DM" are in one common memory area. (L/WL/DL as well.)



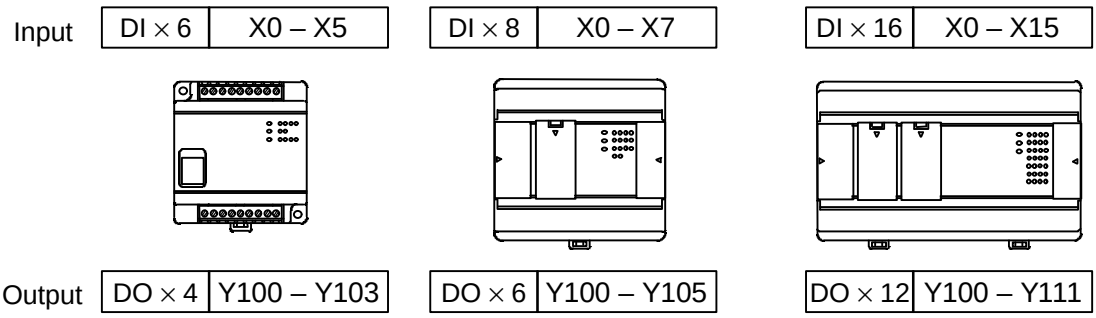
Note : "L" is available only for the LINK module

* Refer to the chapter "Programming" for further information about TD, CU, DIF and DFN.

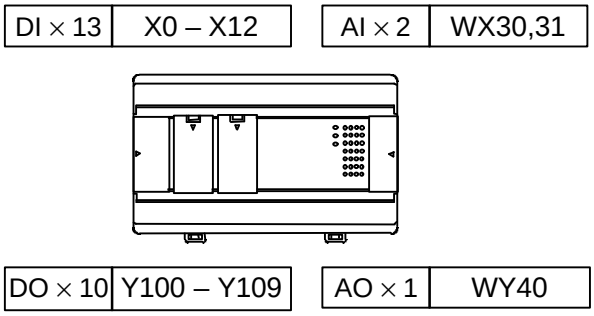
I/O address of MICRO-EH

The I/O address of MICRO-EH is fixed.

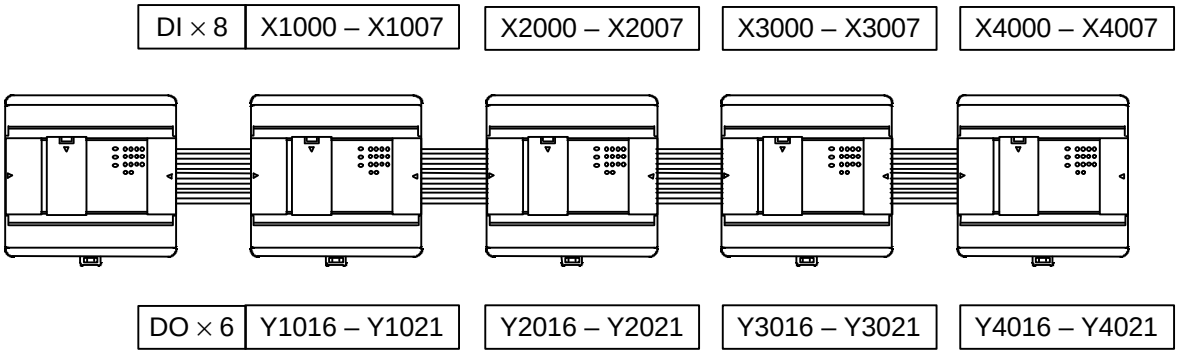
■ **10/14/28 points**



■ **23 points**



■ **Expansion units**



DI : Digital Input
DO : Digital Output
AI : Analog Input
AO : Analog Output

I/O address of EH-150

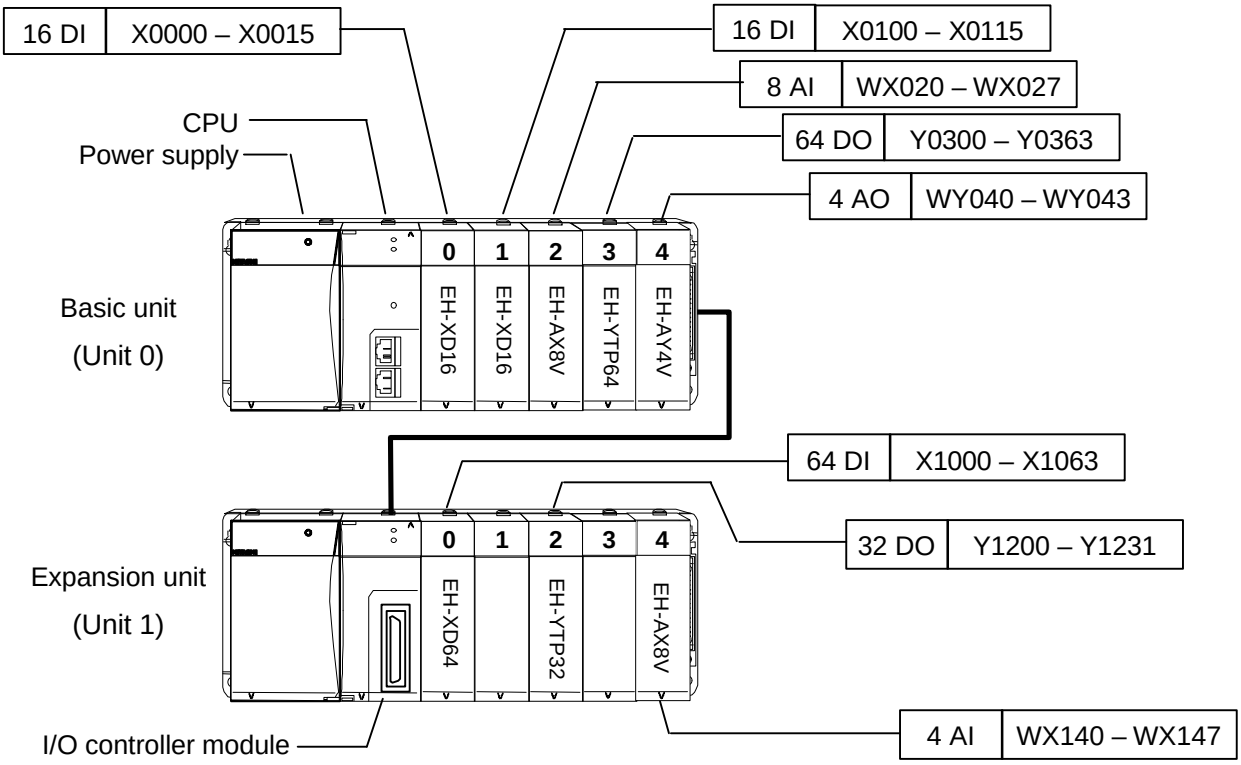
The I/O address of EH-150 depends on the module location and I/O type.

[Bit] X□ □ □□

- Bit number (decimal)
- Slot number (0 - 7)
- Unit number (0 - 1)
- I/O type

[Word] WX□ □ □

- Word number
- Slot number (0 - 7)
- Unit number (0 - 1)
- I/O type



* 16 DI : 16 points Digital Input module, 4 AO : 4 channels Analog Output module

Hexadecimal expression

As mentioned above, each hexadecimal code can be expressed as 4 bits.

0 : 0000	4 : 0100	8 : 1000	C : 1100
1 : 0001	5 : 0101	9 : 1001	D : 1101
2 : 0010	6 : 0110	A : 1010	E : 1110
3 : 0011	7 : 0111	B : 1011	F : 1111

Since one word (WX, WY, WM, etc.) consists of 16 bits (X, Y, M, etc.), the relation between WX/WY and X/Y is as follows. (“H” stands for hexadecimal.)

```
                        X15          X8  X7          X0
WX 0  =  H1234  =  0001  0010  0011  0100

                        Y15          Y8  Y7          Y0
WY 5  =  H00FF  =  0000  0000  1111  1111
```

3. Technical specifications

	MICRO-EH 10/14/23,28	EH-150				
		CPU104	CPU208	CPU308	CPU316	CPU448
General specification						
Speed of Binary command	0.9μs	1.0μs				0.1μs
Memory size	3 kstep	4 kstep	8 kstep	8 kstep	16 kstep	48 kstep
I/O points	10/70/84	512	1,024			
Exp. unit	Up to 4	-	1			
Commands	98					152
PID	-			✓		
Clock	✓ *1	-	✓			
Port 1	RS-232C			RS-232C/422/485		
Port 2	RS-422/485 *1	RS-232C				
Memory board	(planned)	-		✓ (optional)		
Modem	✓	-	✓			
Internal memory						
R	1984 bits (R0 – R7BF)					
WR	4,096 word (WR0 – FFF)		8,192 w. (WR0 – 1FFF)	17,408 w. (WR0 – 43FF)	22,528 w. (WR0 – 57FF)	50,176 w. (WR0 – C3FF)
M, WM	16,384 points = 1,024 w. (M0 – 3FFF = WM0 – 3FF)					
L, WL	-	16,384 points ×2 = 1,024 w. ×2 (L0 – 3FFF = WM0 – 3FF, L10000 – 13FFF = WL1000 – 13FF				
Special R	64 points (R7C0 – 7FF (see below)					
Special WR	512 words (WRF000 – F1FF) (see below)					
Timer (TD)/ counter (CU) points	256 points (TD + CU) 0.01s : 64 pts.	512 points (TD + CU) *2 (TD : up to 256 points, 0.01s base TD : up to 64 points.)				
TD /CU setting value	TD : 65,535 with 0.01, 0.1 or 1 sec. time base CU : 65,535 times					
Edge detect	512 points (DIF0 - 511) / 512 points (DFN0 - 511)					

*1 : Only 23, 28 points module.

*2 : (TD) is up to 256 (TD0 - 255), and counter (CU) is up to 511 (CU0 - 511) for EH-150 series. TD number is not allowed to use same as CU number, and vice versa.

Special internal registers R, WR

The special internal registers are some flags, diagnostic information and parameter setting area to operate the PLC easily and flexibly. The following list is a part of this area and error code in WRF000.

Address	Description	Set by	Reset by
R7E3	ON while the first scan	CPU	CPU
R7E4	Always ON	CPU	CPU
R7E5	0.02s clock (0.01s ON, 0.01s OFF)	CPU	CPU
R7E6	0.1s clock (0.05s ON, 0.05s OFF)	CPU	CPU
R7E7	1s clock (0.5s ON, 0.5s OFF)	CPU	CPU
R7EC	Clear error code	user	CPU
WRF000	Error code (See right table.)	CPU	user
WRF00B – 00F	Calendar	CPU	-
WRF010 – 012	Scan time (max. / current / min.)	CPU	CPU
WRF01B – 01F	Calendar to read/write	user	user
WRF050	ROM version	CPU	CPU
WRF051	FLASH ROM version	CPU	CPU

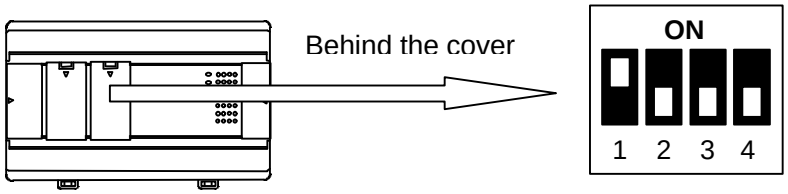
Error code in WRF000	
H13	micro processor error
H33	memory size error
H34	program (syntax) error
H41	I/O configuration error
H44	scan time error (normal scan)
H45	scan time error (periodic scan)
H71	Battery low

4. Setting up

Baud rate for PLC

■ MICRO-EH

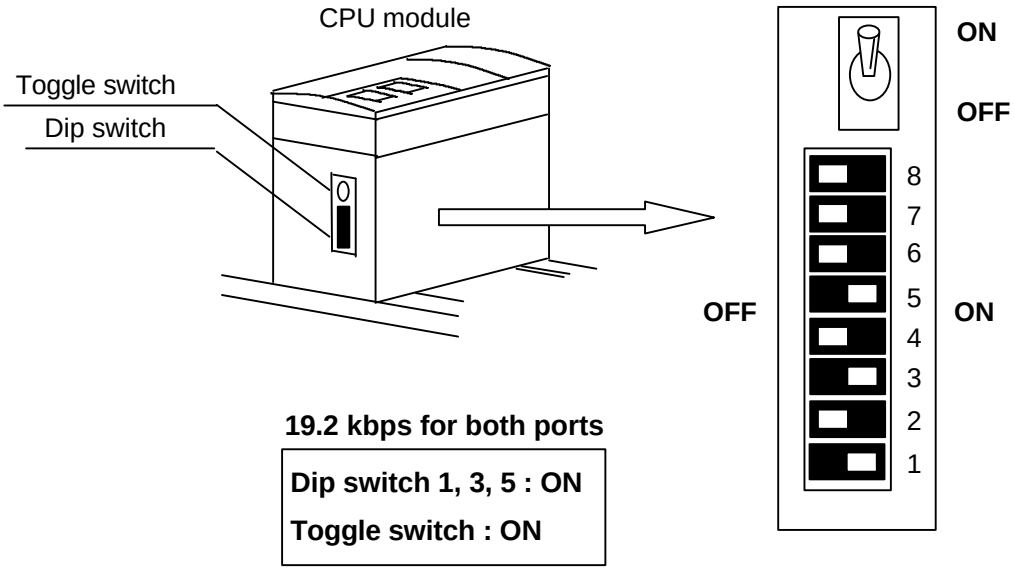
Configure baud rate for communication port 1 and 2. For normal use, set the dip switch 1 ON. The port 1 will then be available for programming with 19.2kbps.



Port No.	Communication type / baud rate		Dip switch				WRF01A	WRF03D
			1	2	3	4		
Port 1 RS-232C Dedicated port (Programming / HMI)	Standard	38.4 kbps	ON	-	ON	-	-	-
		19.2 kbps	**ON**	-	-	-	-	-
		9600 bps	-	-	ON	-	-	-
		4800 bps	-	-	-	-	-	-
	Modem mode	4800 bps	-	ON	-	-	H0000	-
		9600 bps	-	ON	-	-	H0100	-
		19.2 kbps	-	ON	-	-	H0200	-
		38.4 kbps	-	ON	-	-	H0300	-
		57.6 kbps	-	ON	-	-	H0400	-
		2400 bps	-	ON	-	-	H0500	-
Port 2 RS422/485 Dedicated port (Programming / HMI)	Standard	4800 bps	-	-	-	-	-	H8000
		9600 bps	-	-	-	-	-	H8100
		19.2 kbps	-	-	-	-	-	H8200
		38.4 kbps	-	-	-	-	-	H8300
	Multidrop	4800 bps	-	-	-	-	-	HA0xx
		9600 bps	-	-	-	-	-	HA1xx
		19.2 kbps	-	-	-	-	-	HA2xx
		38.4 kbps	-	-	-	-	-	HA3xx

■ EH-150

Configure baud rate for communication port 1 and 2. For normal use, set the dip switch 1, 3, 5 all ON, and the toggle switch ON. Both ports will then be available for programming with 19.2kbps.



19.2 kbps for both ports

Dip switch 1, 3, 5 : ON

Toggle switch : ON

Dip switch and toggle switch configuration

RUN/STOP Mode	Remote	SW 1 : ON		
	RUN switch	SW 1 : OFF		
Port 1	Dedicated port (Programming / HMI)	SW 5 : ON	4,800 bps	SW 3, 4 : ON, ON
			9,600 bps	SW 3, 4 : OFF, ON
			19,200 bps	SW 3, 4 : ON, OFF
			38,400 bps	SW 3, 4 : OFF, OFF
	General purpose port	SW 5 : OFF	Modem mode	SW 2 : ON
			Normal mode	SW 2 : OFF
Port 2	Dedicated port (Programming / HMI)		4,800 bps	SW 6, T : OFF, OFF
			9,600 bps	SW 6, T : ON, OFF
			19,200 bps	SW 6, T : OFF, ON
			38,400 bps	SW 6, T : ON, ON

SW1-6 = Dip switch, SW T = Toggle switch

Baud rate for PC (Programming software)

The baud rate setting procedure depends on the programming software.

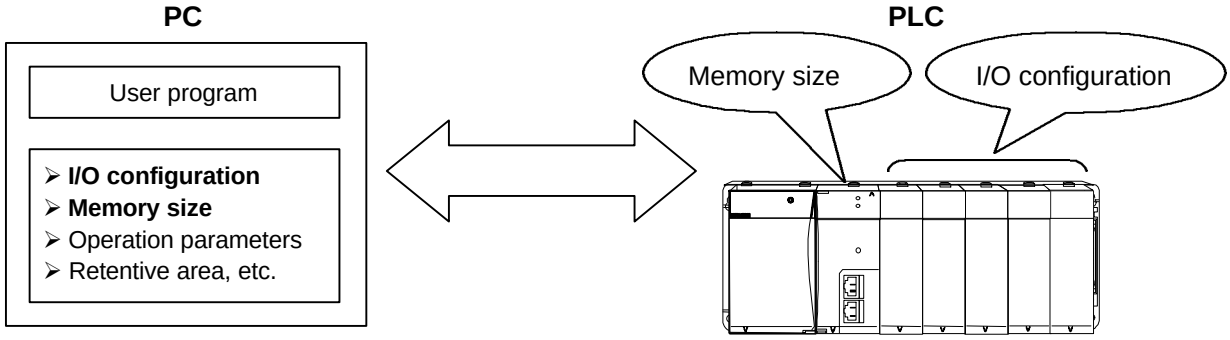
Pro-H	Right mouse click on “Resource” - [Setting] – [Communication]
Ladder Editor for Win.	[Utility] – [Environment] – [Communication]

5. Configuration

The user program is up/downloaded from/to the PLC as described above.

Besides the user program, several other pieces of important information are up/downloaded from/to the PLC together with user program. Ensure the following settings are configured correctly.

The "**I/O configuration**" and "**Memory size**" in the PC program must be same as the actual I/O configuration and memory size in the PLC.



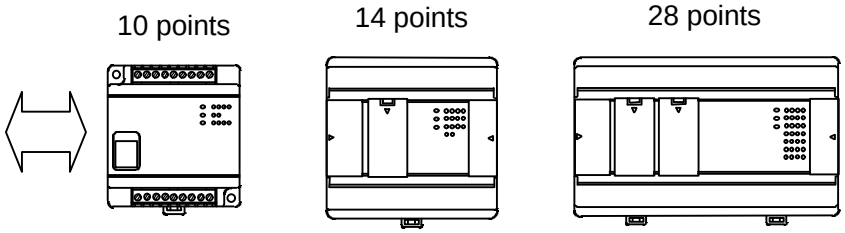
I/O configuration

■ **MICRO-EH**

The I/O configuration of MICRO-EH is fixed for each model. This table can be read out from the PLC when on-line.

10, 14, 28 points basic module

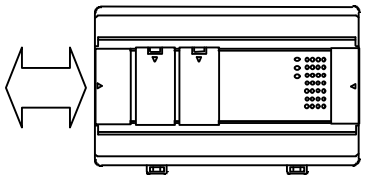
	Unit 0	Unit 1
Slot 0	X48	
Slot 1	Y32	
Slot 2		
Slot 3		
Slot 4		



I/O configuration of 10,14 and 28 points module is fixed (X48, Y32).

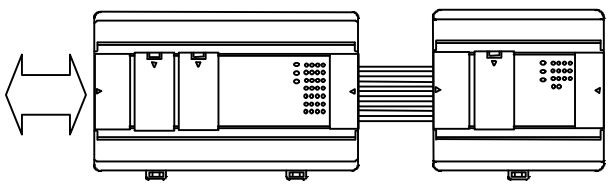
23 points basic module

	Unit 0	Unit 1
Slot 0	X48	
Slot 1	Y32	
Slot 2	Empty 16	
Slot 3	**WX 4**	
Slot 4	**WY 4**	



Expansion module

	Unit 0	**Unit 1**
Slot 0	X48	**B1/1**
Slot 1	Y32	
Slot 2		
Slot 3		
Slot 4		

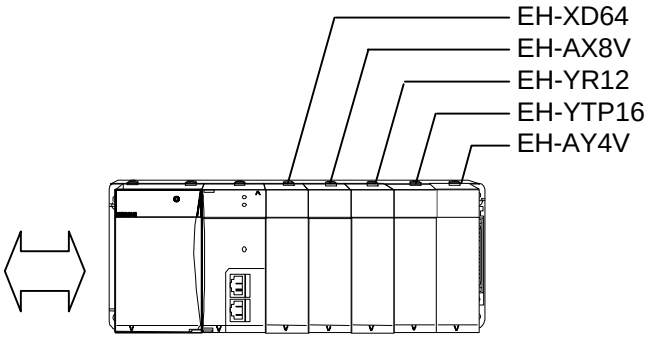


■ EH-150

Since the module configuration of EH-150 depends on the user, the I/O configuration table (module configuration table) must be declared in the PC. This table can be read out from PLC when on-line.

[I/O configuration table in PC]

	Unit 0	Unit 1
Slot 0	X64	
Slot 1	WX 8	
Slot 2	Y16	
Slot 3	Y16	
Slot 4	WY4	
Slot 5		
Slot 6		
Slot 7		



Note : The assignment of a 12 point relay module is “Y16”.

Note : Each module has its own I/O assignment. Please refer to the application manual for further information.

Note : If the downloaded I/O configuration table does not accord with the actual I/O configuration, the PLC will not start. However the programming software has a special option setting, which allows the PLC to work with the wrong I/O configuration.

Memory size

Configure memory size in programming software accordingly. The memory size can be read out from PLC when on-line as well as the I/O configuration.

MICRO-EH	all models	3 k step (4 k step*)
EH-150	EH-CPU104	4 k step
	EH-CPU208	8 k step
	EH-CPU308	8 k step
	EH-CPU316	16 k step
	EH-CPU448	48 k step

*Note : Actual memory size of MICRO-EH is 3 k step however, the configuration on PC should be **4 k step**.

On programming software

This setting is configured in the following way depending on programming software.

I/O configuration

Pro-H	Double click on “Resource configuration”- [I/O Configuration]
Ladder Editor for Win.	[Utility] - [CPU setting] - [I/O assignment]

Memory size

Pro-H	Double click on “Resource configuration” - [Memory Allocation]
Ladder Editor for Win.	[Utility] - [CPU setting] - [CPU information]

Operation parameters

Several optional parameters are available. Configure if necessary.

Operation parameters	**Default**	**Enable**
RUN input	Disable	Set the address
Max. scan time	100 ms	Set the time
Operation mode in wrong I/O configuration	STOP	RUN
Operation mode in expansion unit error	STOP	RUN
Operation mode in remote unit error	STOP	RUN
LINK area range	Disable	Set the range
etc.		

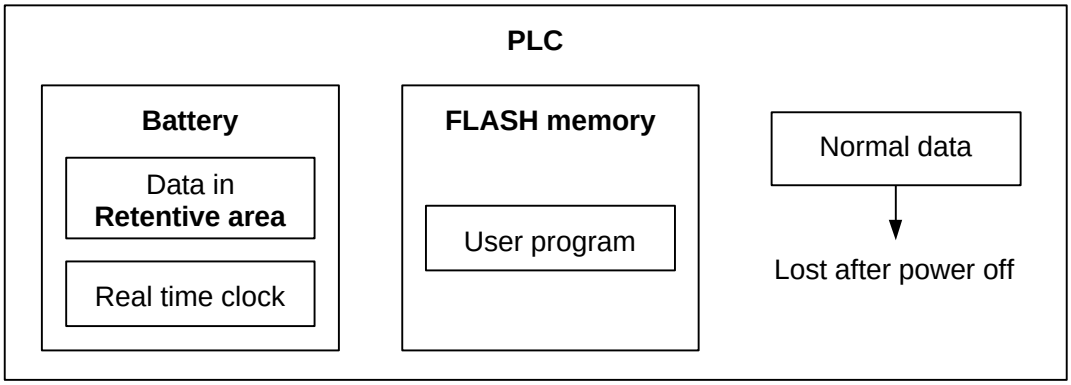
If the “Operation mode in wrong I/O configuration” is enabled, CPU can work without actual I/O modules, which is useful for debugging or testing.

On programming software

Pro-H	Double click on “Resource configuration”- [Operation parameters]
Ladder Editor for Win.	[Utility] - [CPU setting] - [Operation parameters]

Retentive area

Internal memory R, WR, WM, TD can be configured as “Retentive area”, which will be kept by a battery after power off. The battery keeps data not only in the retentive area, but also the real time clock. User program is kept in FLASH memory, which does not require battery back up.



On programming software

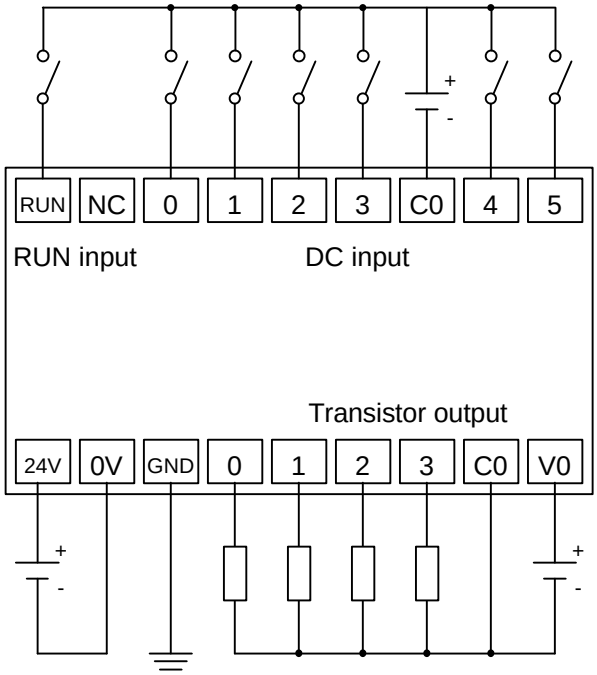
Pro-H	Double click on “Resource configuration”- [Memory allocation]
Ladder Editor for Win.	[Utility] - [CPU setting] - [CPU information]

6. Wiring

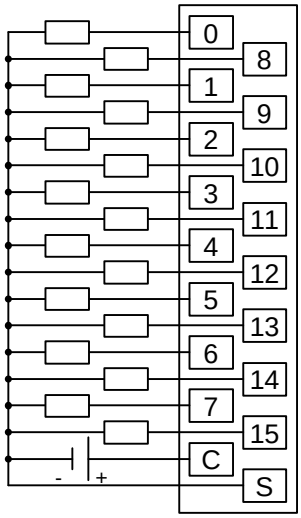
Wiring diagram for some modules are shown below. Implement wiring based on these drawings for other MICRO-EH also. Each I/O module for EH-150 has a wiring label at the terminal block.

Note : All DC inputs can be connected as either positive or negative logic.

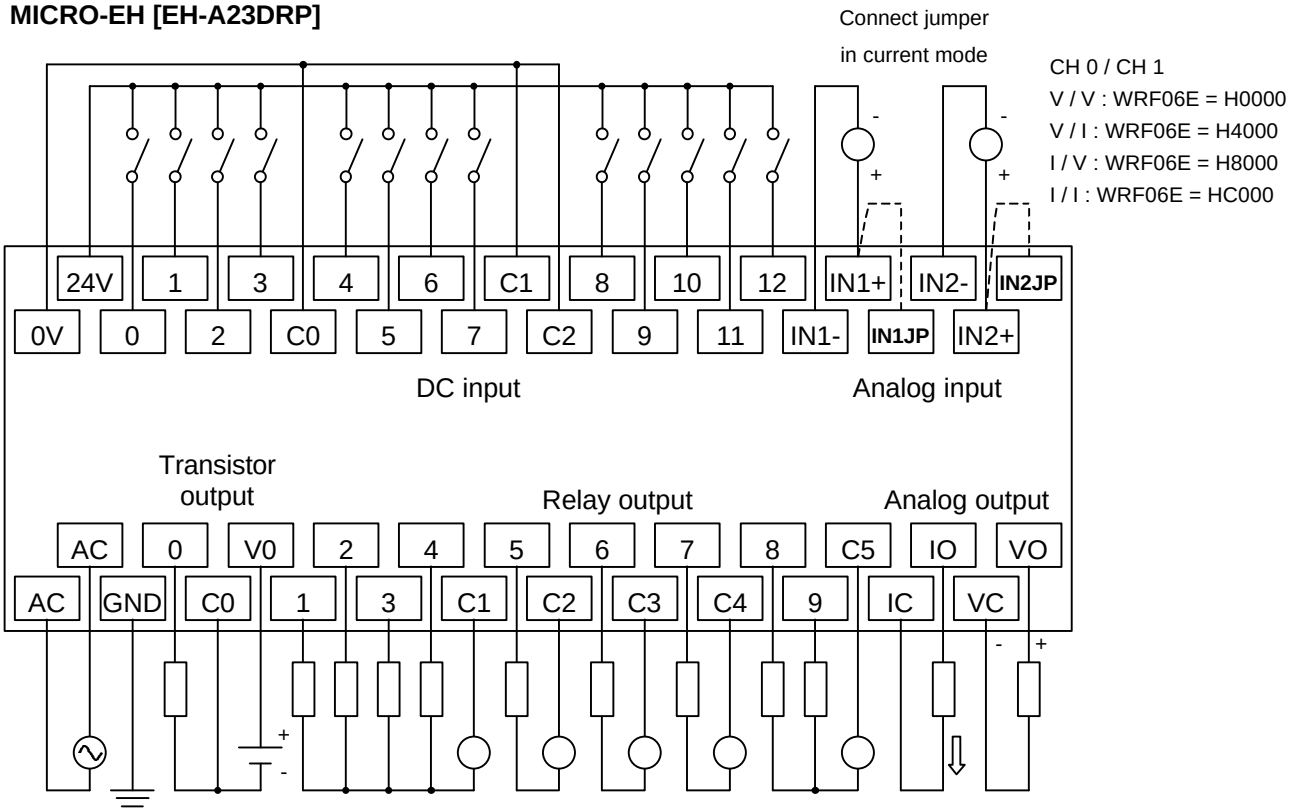
MICRO-EH [EH-D10DTP]



EH-150 [EH-YTP16]



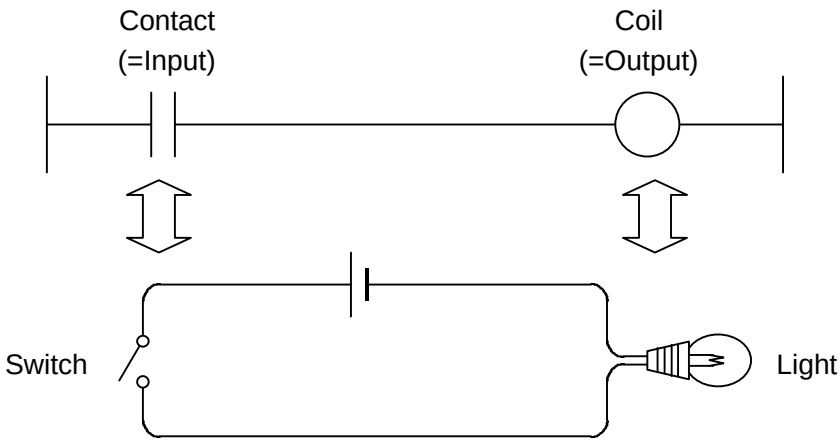
MICRO-EH [EH-A23DRP]



7. Programming

One of the most popular and basic programming language is “ladder” (LD), however SFC or FBD is becoming very popular. In this chapter, LD is introduced for easy understanding.

The simplest LD circuit consists of one contact and one coil as below.

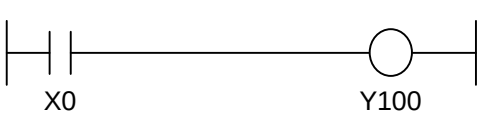


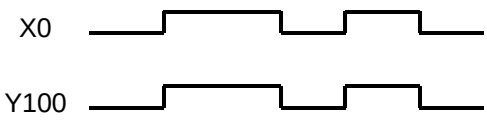
In this picture, while the switch is ON, the light is ON.
This LD circuit is almost the same meaning as the above picture. The “contact” is condition for the coil to be ON, and the “coil” is the result.
Basically input “X” is used for the contact, and output “Y” is used for the coil. The internal I/Os “R”, “M” can be used for both cases depending on your program. (Y can work as a contact.)

Hitachi PLC handles the following I/O types.

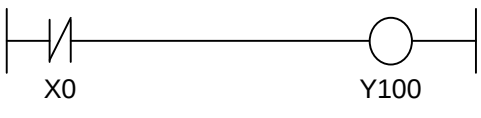
⊣⊢	A contact (Normally open)	—○—	Normal coil
⊣/⊢	B contact (Normally close)	—(S)— —(R)—	Set / Reset coil (MCS / MCR coil available)
⊣↑⊢	Edge detection (Low ➔ High)	—○— TD	Timer (Other timers ; SS, MS, TMR, WDT available)
⊣↓⊢	Edge detection (High ➔ Low)	—○— CU	Counter (Other counters ; RCU, CTU, CTD, CL available)
⊣/⊢	NOT		

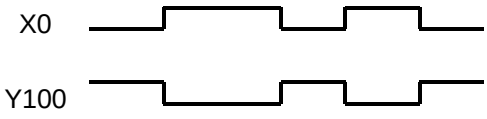
A Contact / Coil



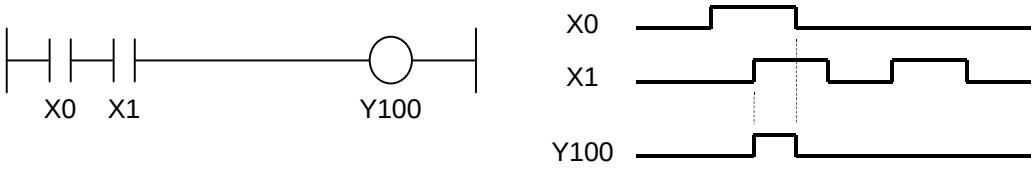


B Contact / Coil

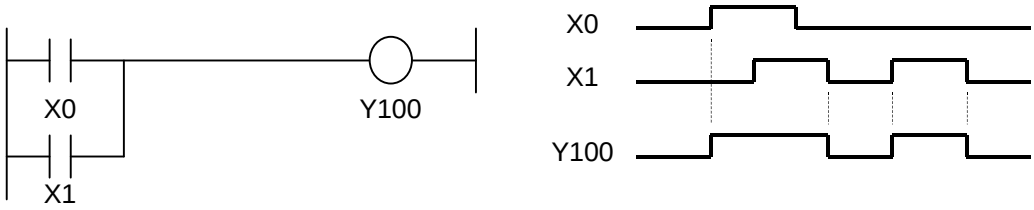




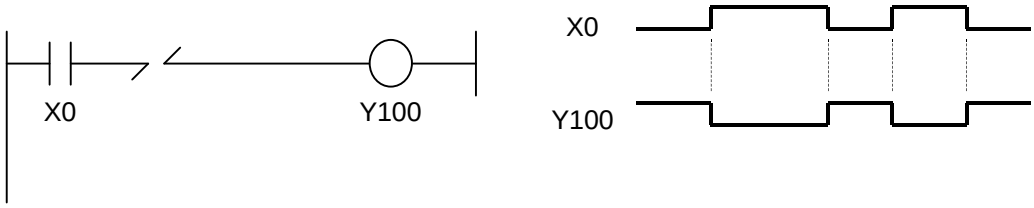
AND



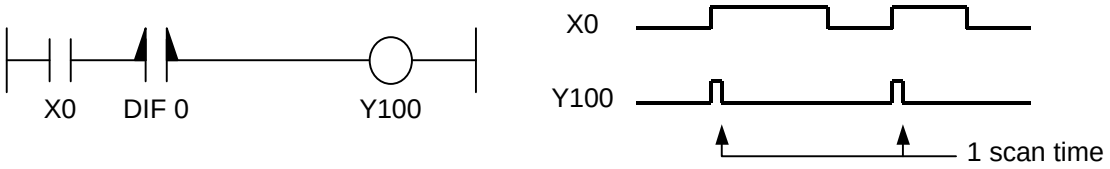
OR



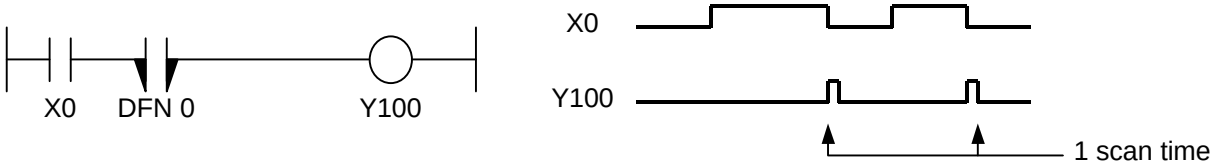
NOT



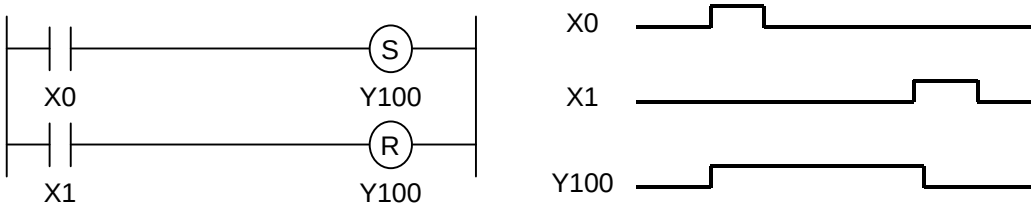
Edge detection (↑) : DIF



Edge detection (↓) : DFN



Set/Reset coil



Internal memory R, M can be used instead of X and Y.

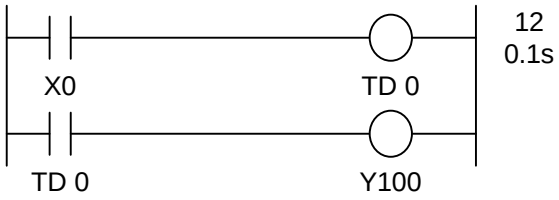
De Morgan's Laws

NOT (**A** AND **B**) = (NOT **A**) OR (NOT **B**) ⇔ $\overline{\mathbf{A} \times \mathbf{B}} = \overline{\mathbf{A}} + \overline{\mathbf{B}}$

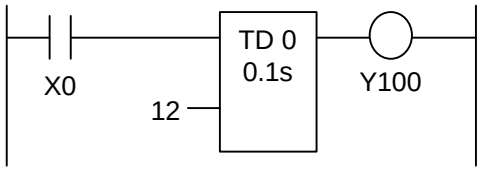
NOT (**A** OR **B**) = (NOT **A**) AND (NOT **B**) ⇔ $\overline{\mathbf{A} + \mathbf{B}} = \overline{\mathbf{A}} \times \overline{\mathbf{B}}$

ON delay timer : TD

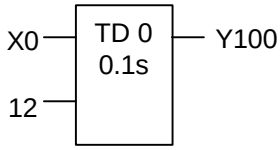
■ **LADDER EDITOR**

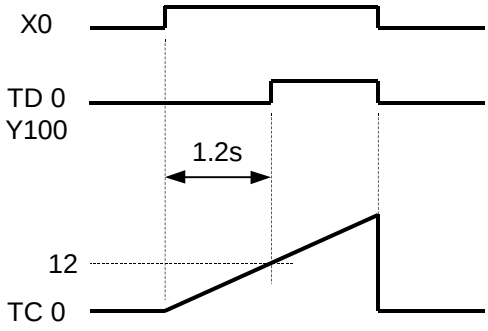


■ **Pro-H (LD)**



■ **Pro-H (FBD)**

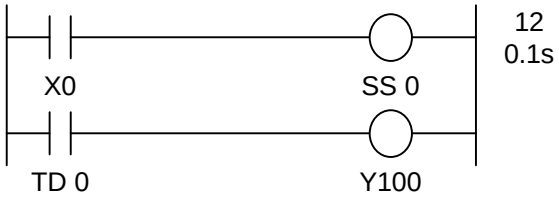




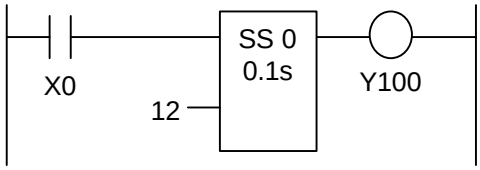
* TC is a word data counting 0 up to 65,535.

Single Shot timer : SS

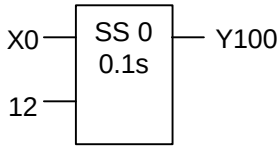
■ **LADDER EDITOR**

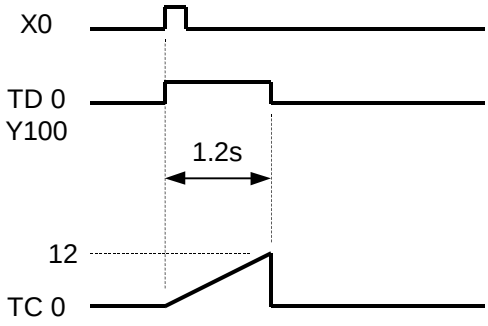


■ **Pro-H (LD)**



■ **Pro-H (FBD)**



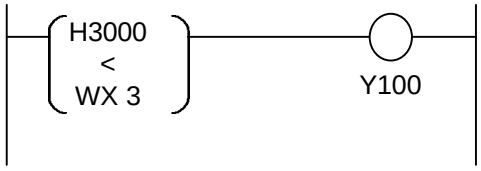


* TC is a word data counting 0 up to 65,535.

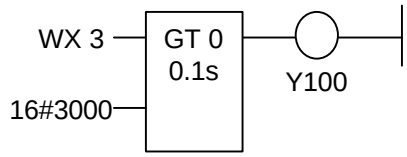
Note : MICRO-EH supports above 2 timers only.
Note : EH-150 supports Mono-stable timer “MS”, integral timer “TMR” and Watch dog timer “WDT” besides above ones.

Comparison box

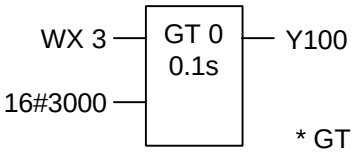
■ **LADDER EDITOR**



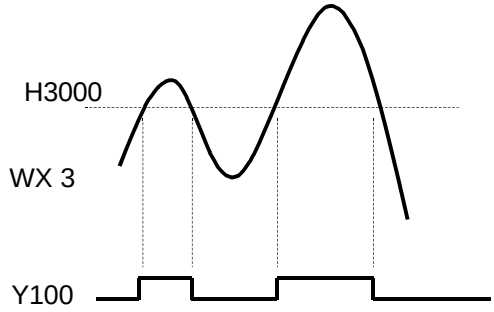
■ **Pro-H (LD)**



■ **Pro-H (FBD)**

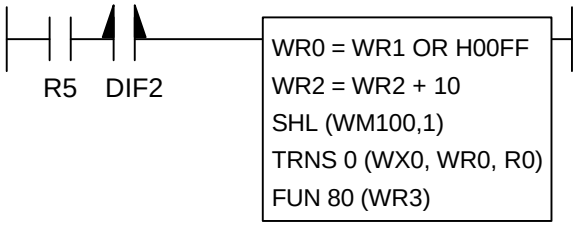


* GT : Greater Than



While WX 3 exceeds H3000, Y100 is ON.

Inline box



Up to 19 lines

Many commands are available

Basic commands : 35 ~
Arithmetical commands : 22 ~
Application commands : 25 ~
Control commands : 12 ~
Special function commands : 16 ~