FBs-PLC User's Manual II【Advanced Application】

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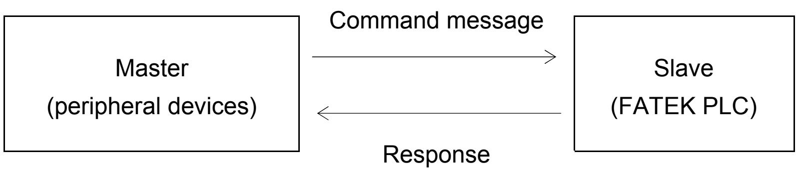
Appendix 1　FATEK Communication Protocol

This Protocol is each communication port of FATEK PLC to communicate with the peripherals under standard mode. Any peripherals that want to communicate with FATEK PLC model have to meet the rules, not only the hardware connection but also the software parameter setting. Besides, the message format also has to be the same with this protocol so that the PLC can respond normally.

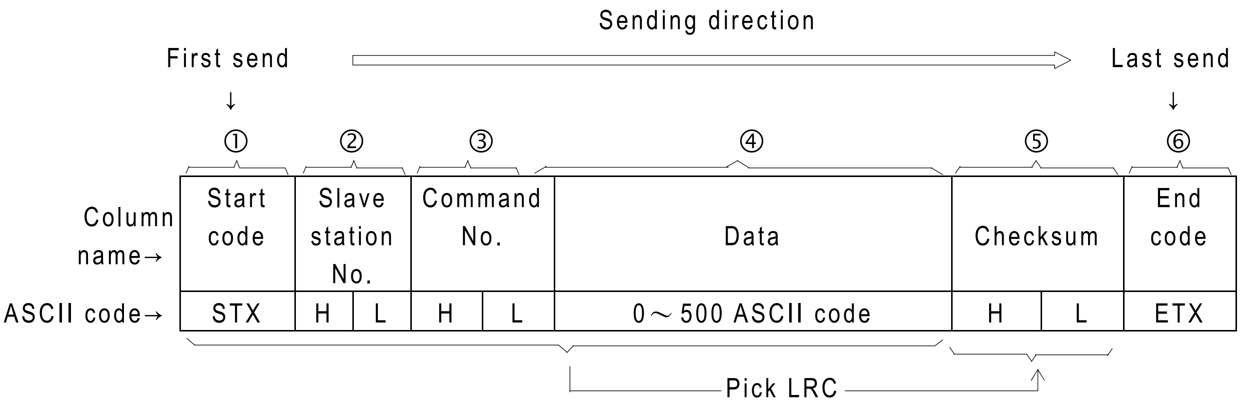
1.1　Master and Slave Definition and Communication

FATEK PLC is defined as slaves in the communication with peripheral devices that are always defined as masters when communicate with FATEK PLC. All the peripheral devices send the message when communicate with FATEK PLC and its respond when receive the message from masters.



1.2　The Communication Message Format of FATEK PLC

There are 6 data columns in the FATEK PLC communication format including command (master) and response (slave) message.



①Start code（STX）：The hexadecimal code of the STX in ASCII code is 02H. The start characters are all STX in command and response message. The receiving site can determine the data start code with STX.

②The station No. of slave ：The station numbers are hexadecimal two-number value. There is only master station and are 255 slave stations in the PLC communication frame. Every slave station has the only number from 1～FEH.（if the station No. is 0, it means the master can send command to all slaves）When the master want to send command to one or all（station No.=0）it accords the station No. assignment. The slave will send its own station No. when it send response message to master.

Remark：	The default value of station No. for PLC is all 1. The station No. can not be amended in the net, it can be changed or amended through FP-08 or WinProladder.

③ Command code ：The command No. is two numbers of hexadecimal systems. It is the action which the master wants slave to execute. For example, to read or write the status of discrete, force setting, run, stop… The command No. which is received from master is also included in response message when slave send the response message.

④ Data information ：The data information contains 0（no data）～500 ASCII character. The data in this column is to assign the address or value for reading or writing. The beginning of this data information contains the error code in the response message. In normal condition（no error happened）the error code must be 0（30H）in the beginning and then follow the responding status or value in the response message. When error happened, it will be the error code instead of 0（30H）and it will not follow the data information.

⑤ Checksum ：Checksum check the hexadecimal value of ASCII code in the previous ①～④ columns and produce one checksum value in one byte length (two hexadecimal value 00～FF）with "LRC (Longitudinal Redundancy Check)" method. This message will be checked with the same way at the receiving side when the message is received. When the two check values are the same, it means the data transferred correctly. If the two check values are different, there are some error happened. The calculation of LRC method is to add all the hexadecimal value (8 bits length) of ASCII code and ignore to carry the number to keep the check value at 8 bits length.

⑥ End code（ETX）：The hexadecimal code of EXT code of ASCII is 03H. The EXT code of either command or response is all ETX. When the receiving side receive the ETX code, it means the data transmission terminated and start to process command or data.

1.3 The Communication Error Code of FATEK PLC

If the error happened in OS command, address, value area of software operation or hardware problem will cause the slave system can not process the command comes from master system. If there is error happened, slave system will respond the message to master system. No matter what command code or data the master system sends, the format of responding message is all the same. Including the required start code (STX), end code (ETX) and checksum value, the command code and station No. will be sent back to master system. The slave system will judge what kind of the error and respond the error code to master system.

● Following table is the response format of communication error of FATEK PLC：

Error code	Description
0	Error free
2	Illegal value.
4	Illegal format, or communication command can not execute.
5	Can not run（Ladder Checksum error when run PLC）
6	Can not run（PLC ID≠Ladder ID when run PLC）
7	Can not run（Snytax check error when run PLC）
9	Can not run（Function not supported）
A	Illegal address

1.4 The Function Description of Communication Command

In this section only focus on communication command code and explain the command message of master and the response format of slave.（only perform the examples in success）

1.4.1 The Classification and Assignment of Components

The main function of PLC communication is to read and write the status or value inside PLC components. Concerning the discrete and register which are available for read and write and address assignment are as following table：

Component	Symbol	Name	Discrete address（5 characters）	16 bits register address（6 characters）	32 bits register address（7 characters）
The status of discrete	X	Input discrete	X0000～X9999	WX0000～WX9984	DWX0000～DWX9968
	Y	Output relay	Y0000～Y9999	WY0000～WY9984	DWY0000～DWY9968
	M	Internal relay	M0000～M9999	WM0000～WM9984	DWM0000～DWM9968
	S	Step relay	S0000～S9999	WS0000～WS9984	DWS0000～DWS9968
	T	Timer discrete	T0000～T9999	WT0000～WT9984	DWT0000～DWT9968
	C	Counter discrete	C0000～C9999	WC0000～WC9984	DWC0000～DWC9968
The data of register	TMR	Timer register	-	RT0000～RT9999	DRT0000～DRT9998
	CTR	Counter register	-	RC0000～RC9999	DRC0000～DRC9998
	HR	Data register	-	R00000～R65535	DR00000～DR65534
	DR	Data register	-	D00000～D65535	DD00000～DD65534
	FR	File register	-	F00000～F65535	DF00000～DF65534

- The discrete status（X，Y，M，S）can combine 16 or 32 continuous status as the 16-bit or 32-bit register, such as the above table WX△△△△ or DWX△△△△, but △△△△ should be multiple of 8.

- It needs 5 characters when assign the discrete address and 6 characters when assign the 16-bit register address and 7 characters to assign the 32-bit register address.

- The address boundary of components in above table is the largest for FATEK PLC. Users should notice the valid address and attribution of each PLC components.（ex. The boundary for X、Y address is 0000～0255; for S is 0000～0999 of FBE-PLC） If exceed the boundary of valid address, PLC will reply error code "A" (illegal address), and will not execute that command.

1.4.2 The Description of Communication Command

- The description of communication command：

Command code	Function description	Message length can be processed during one scan	Remark
40	The gist read the system status of PLC	-	
41	Control RUN/STOP of PLC	-	
42	Single discrete control	1 point	
43	The status reading of ENABLE/DISABLE of continuous discrete	1～256 points	
44	The status reading of continuous discrete	1～256 points	
45	Write the status to continuous discrete	1～256 points	
46	Read the data from continuous registers	1～64 Words	
47	Write to continuous registers	1～64 Words	
48	Mixed read the random discrete status of register data	1～64 points or Words	
49	Mixed write the random discrete status of register data	1～32 points or Words	
4E	Loop back testing	0～256 characters	
53	The detail read the system status of PLC	-	

1： The message of discrete status is represented by one character (1 means ON, 0 means OFF) and the data of 16-bit register uses 4 characters to represent the value of one WORD（0000H～FFFFH）

2： The data of 32-bit register is DW（two continuous Words）, it has to use 8 characters to represent its data. If the component is 32-bit register, the component has to be treated as 2W. For example, in command code 46 and 47, they can process 64 16-bit components and only process 32 32-bit components.

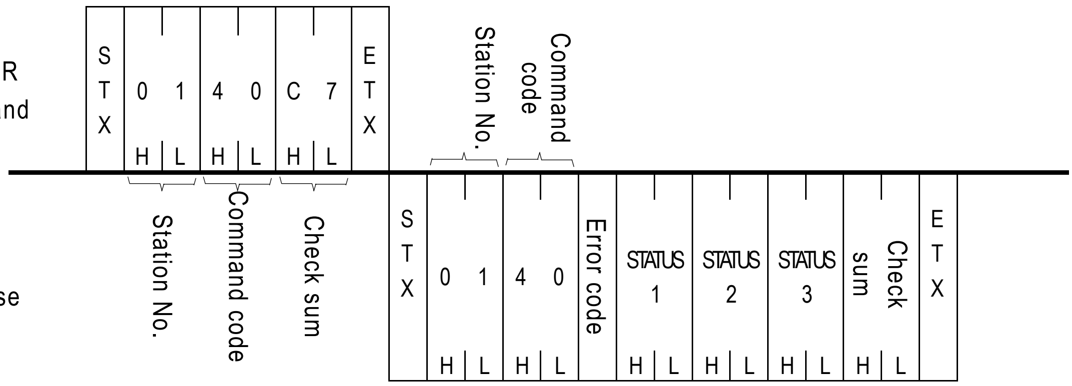
3： In the command code 48 and 49, the message length is the total of discrete and word. They can not exceed 64W(command 48) and 32W(command 49). As increase one point, its total words will decrease one word. It is the same in the other hand. Because the message length of 32-bit component uses 2 words, it will be less 2 words or point when increase one 32-bit component. For example, the message length of command 48 is 1～64W. If it read 20 32-bit components, its message will occupy 40 words and remain 24W available for discrete or 16-bit register. In this example, command code can read 44 components（20 32-bit components and 24discrete or 16-bit components） in one communication.

4： The operation (read and write) of continuous discrete or register is not only one component and the numbers are continuous so that you don't need to assign their components number during your assignment. You just only need to appoint the start number and how many components (N). Its operating object can only being one of discrete or register and can not be operated randomly.

5： The random operating objects can read or write several discrete and register. As their number is not continuous, you have to appoint their number and allow operating discrete and register randomly.

● Command code 40（Read the system status of PLC）

Format



STATUS 1：

H				L			
B7	B6	B5	B4	B3	B2	B1	B0

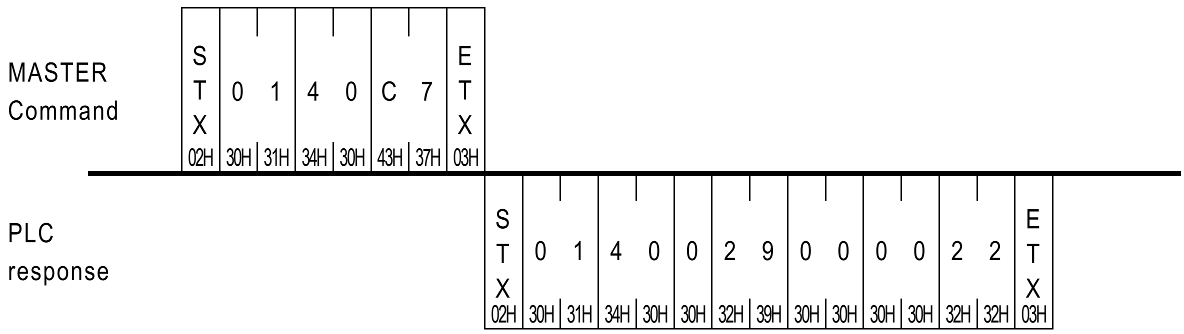
- B0：RUN/STOP
- B2：Ladder checksum error/NORMAL
- B3：USE MEMORY PACK/NOT USE
- B4：WDT Timeout/NORMAL
- B5：SET ID/NOT SET ID
- B6：EMERGENCY STOP/NORMAL
- B7：0（RESERVE FOR FUTURE）

STATUS 2：(LADDER program capacity)　Reserved

STATUS 3：　0（RESERVE FOR FUTURE）

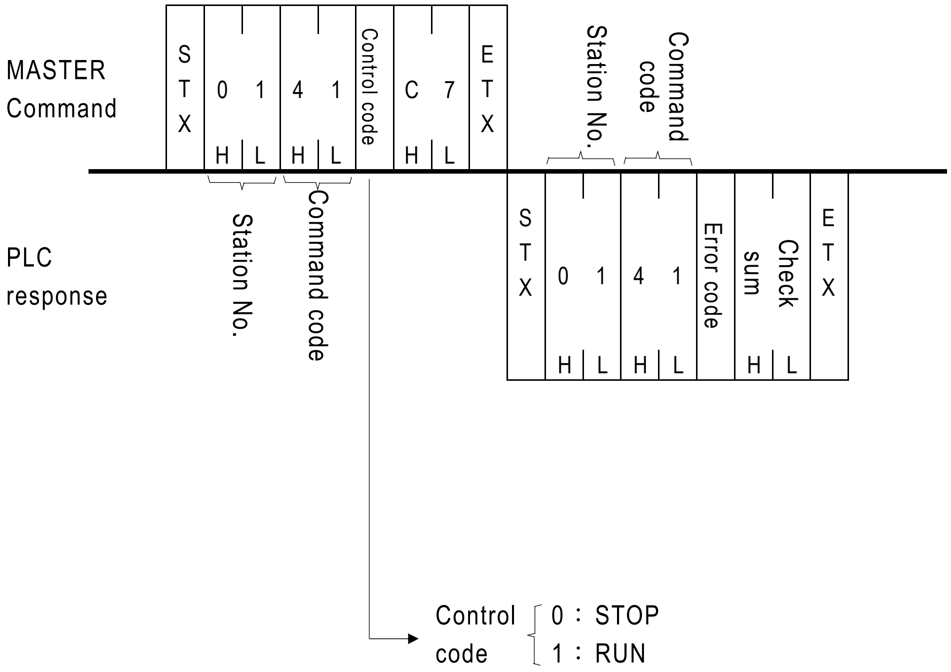
Ex.

If the PLC is equipped with MEMORY PACK and ID is set in both PLC and MEMORY PACK and PLC status is “RUN” under normal condition, the system status of PLC which MASTER read will be as following:（B5,B3, and B0 are 1 and the other are all 0 that the STATUS is 29H）。



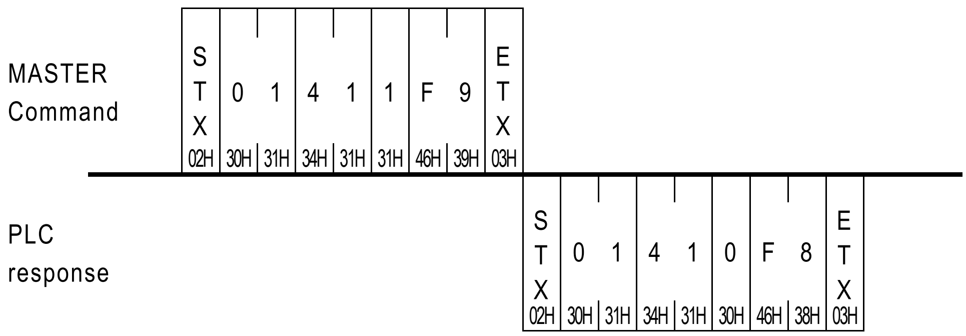
● Command code 41（Control the PLC RUN/STOP）

Format



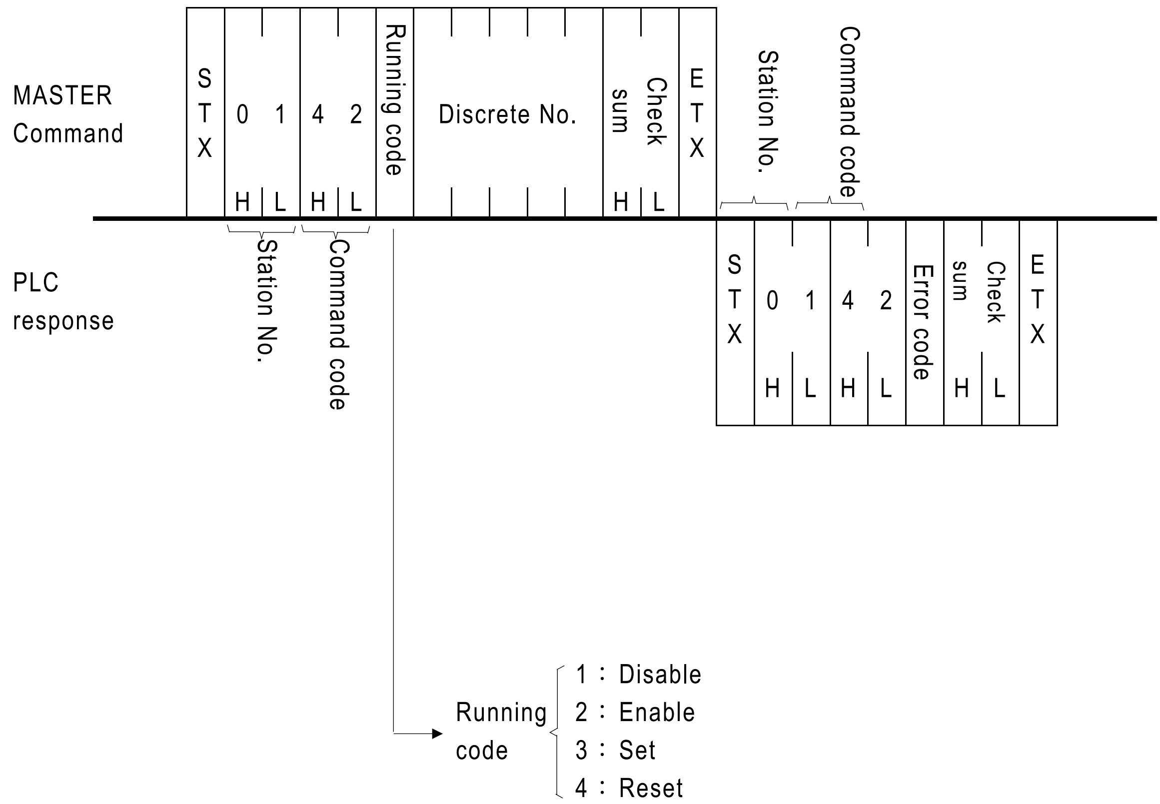
Ex.

Turn on PLC to “RUN”

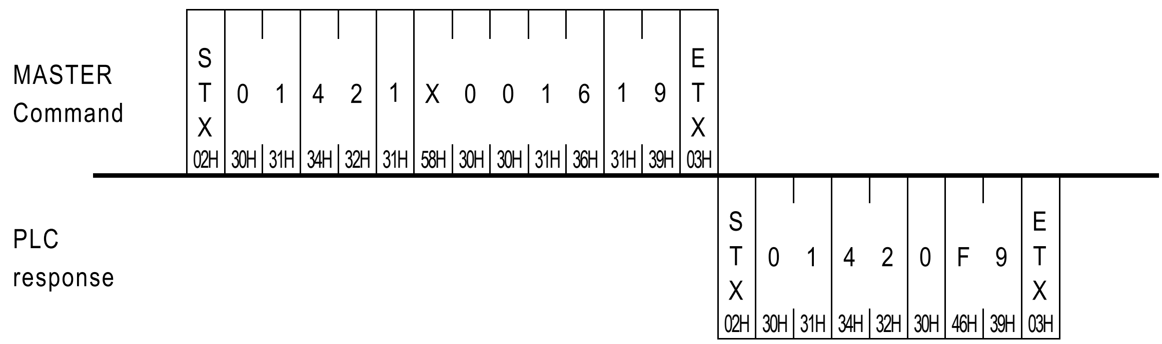


● Command code 42（Single discrete control）

Format This command can control the appointed discrete to do ENABLE, DISABLE, SET, RESET four activities.



Ex. The following communication format is the example to DISABLE the discrete X16.



● Command code 43（The status reading of ENABLE/DISABLE of continuous discrete）

Format

Use this command to read the ENABLE/DISABLE status of continuous adding discrete.

MASTER Command

STX	0	1	4	3	Number N	Start No.	Check sum		ETX
	H	L	H	L			H	L	
	Station No.		Command code						

PLC response

STX	0	1	4	3	Error code	Status 0	Status 1	. . . .	Status N	Check sum		ETX
	H	L	H	L						H	L	
	Station No.		Command code									

Number N：The range of Hex value of two number can be 1≤N≤256（When N=00H it equals to 256）

Ex.

If Y10，Y12，Y16 of the continuous 7 discrete, Y10～Y16 are DISABLE and the others are all ENABLE, the PLC status of this command reading is as following.

MASTER Command

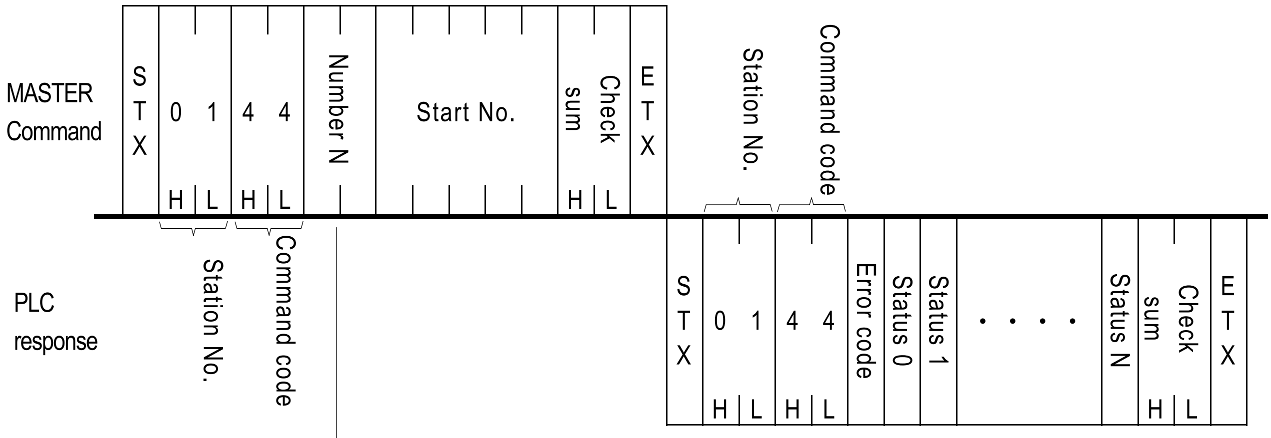
STX	0	1	4	3	0	7	Y	0	0	1	0	4	B	ETX
02H	30H	31H	34H	33H	30H	37H	59H	30H	30H	31H	30H	34H	42H	03H

PLC response

STX	0	1	4	3	0	1	0	1	0	0	0	1	4	D	ETX
02H	30H	31H	34H	33H	30H	31H	30H	31H	30H	30H	30H	31H	34H	44H	03H

● Command code 44（The status reading of continuous discrete）

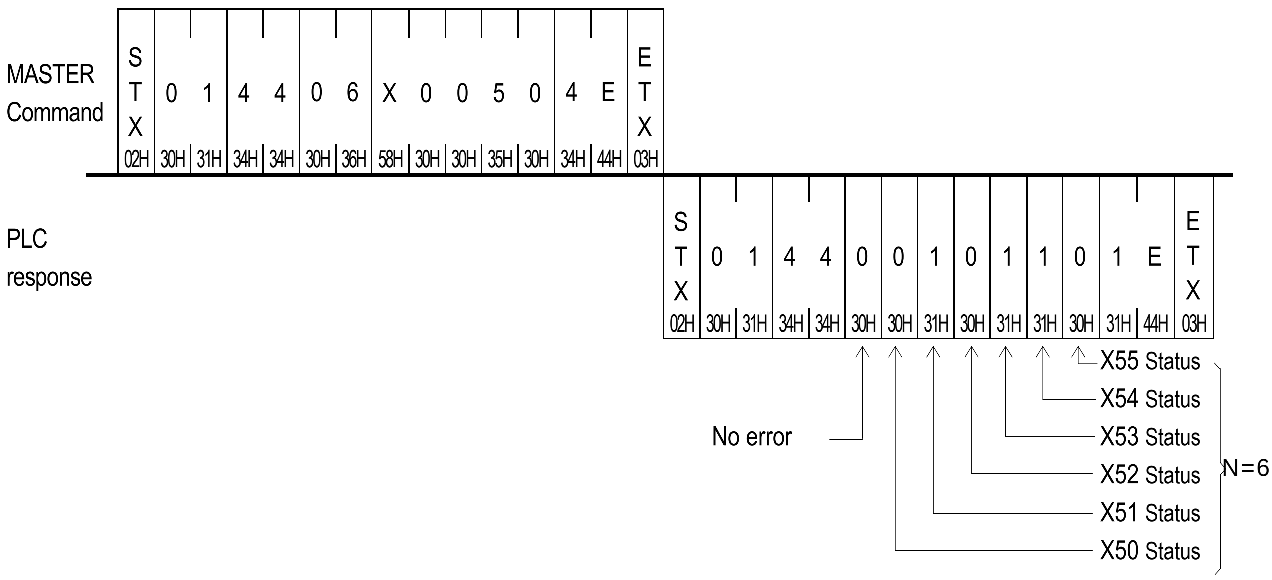
Format



Number N： The range of Hex value of two numbers can be 1≤N≤256（When N=00H, is equals to 256）

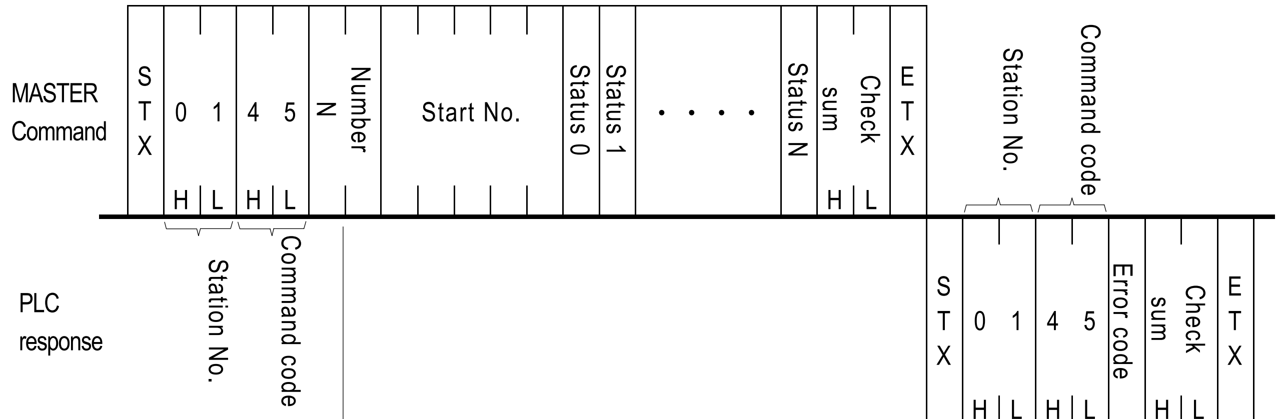
Ex.

If the status of X50, X52, X55 are all 0 and X51, X53, X54 are all 1, following is the status of reading the continuous 6 inputs（X50～X55）



●Command code 45（Write the status to continuous discrete）

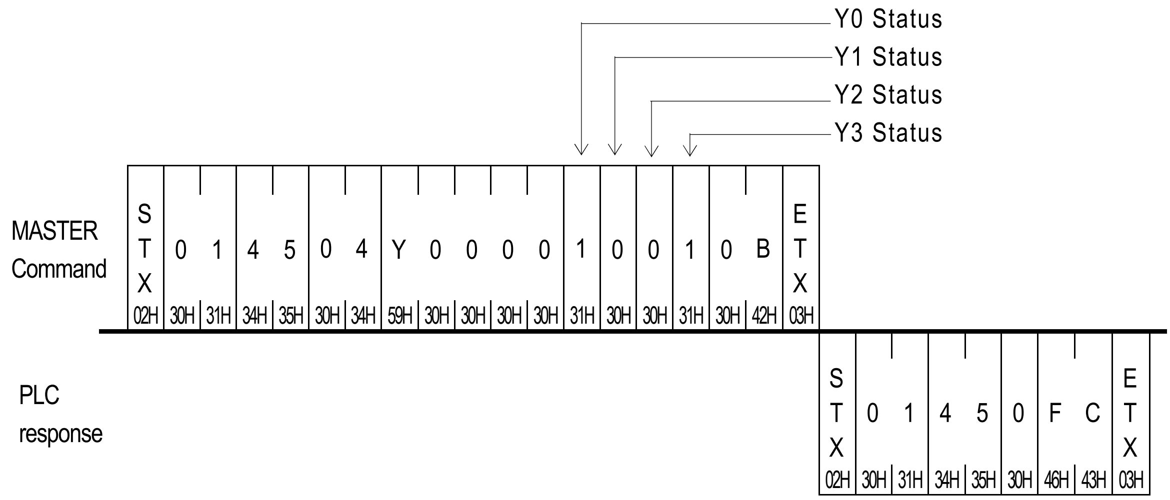
Format



Number N： The range of Hex value of two numbers can be 1≤N≤256（When N=00H it equals to256）

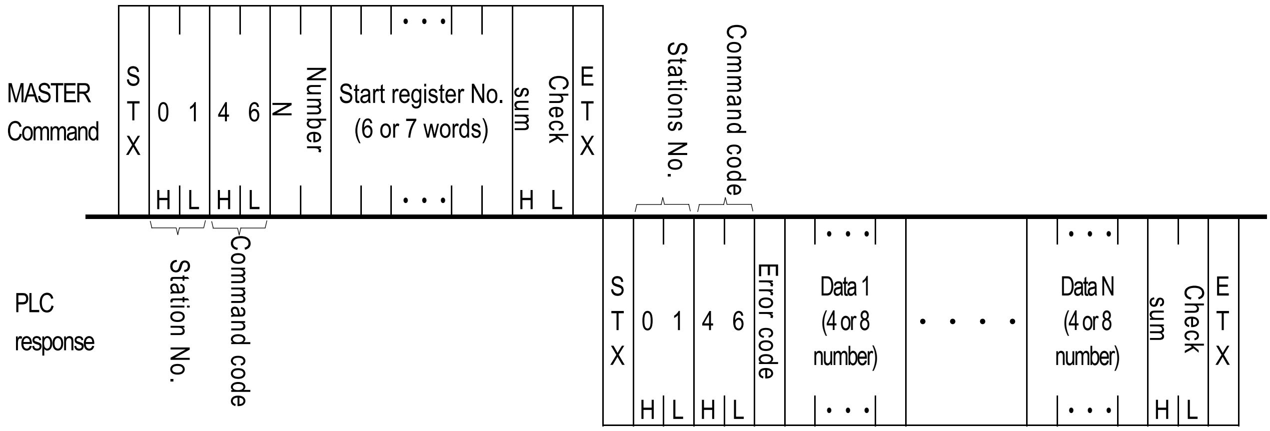
Ex.

Write the status to continuous 4 outputs（Y0～Y3）, Y0 and Y3 are 1, Y1 and Y2 are 0.



●Command code 46（Read the data from continuous registers）

Format



- Number N consists of Hex value of two numbers, its range can be 01H～40H or 20H（32-bit component）
- The number of 16-bit register contains 6 characters and the Hex value of its data contains 4 characters. （It can be shown as 0000H～FFFFH）
- The number of 32-bit register contains 7 characters and the Hex value of its data contains 8 characters.（It can be shown as 00000000H～FFFFFFFFH）

Ex. Read the data of continuous 3 16-bit registers and start with R12.（R12，R13，R14）

MASTER Command

STX	0	1	4	6	0	3	R	0	0	0	1	2	7	5	ETX
02H	30H	31H	34H	36H	30H	33H	52H	30H	30H	30H	31H	32H	37H	35H	03H

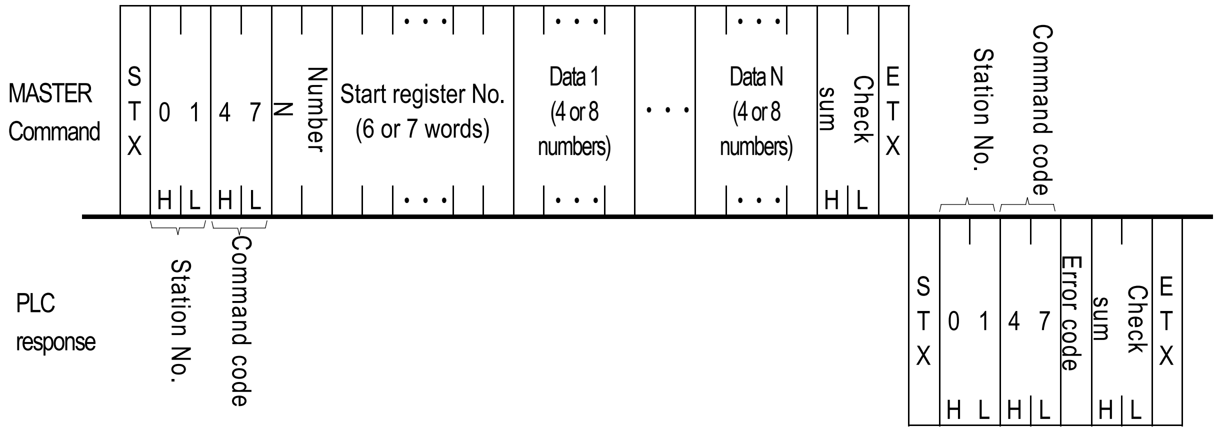
PLC response

STX	0	1	4	6	0	1	0	A	5	7	F	C	4	0	0	0	1	8	9	ETX
02H	30H	31H	34H	36H	30H	31H	30H	41H	35H	37H	46H	43H	34H	30H	30H	30H	31H	38H	39H	03H
						The data of R12				The data of R13				The data of R14						

- Refer to the above example, the PLC responds as R12=10A5H, R13=7FC4H, R14=0001H

● Command code 47 (Write to continuous registers)

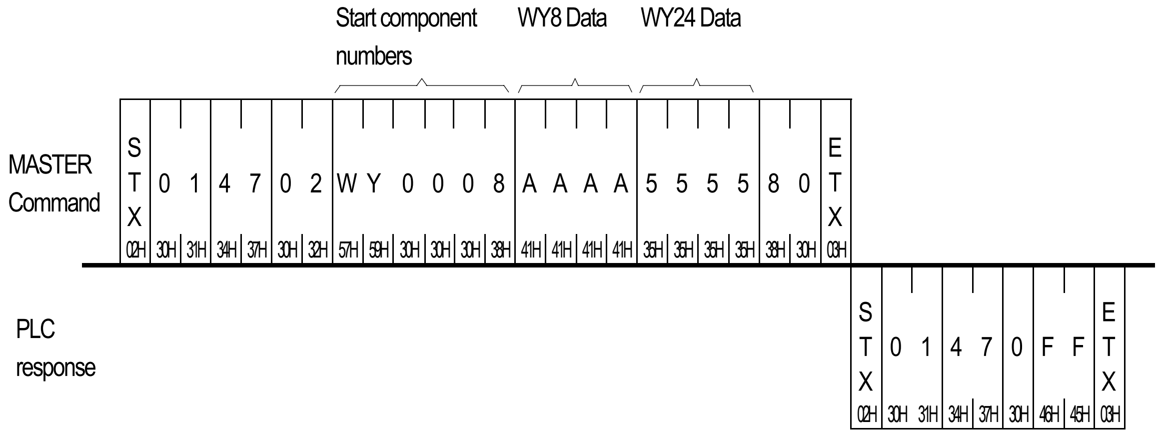
Format



- Number N consists of Hex value of two numbers, its range can be 01H～40H or 20H (32-bit component)
- The number of 16-bit register contains 6 characters and the Hex value of its data contains 4 characters. (It can be shown as 0000H～FFFFH)
- The number of 32-bit register contains 7 characters and the Hex value of its data contains 8 characters. (It can be shown as 00000000H～FFFFFFFFH)

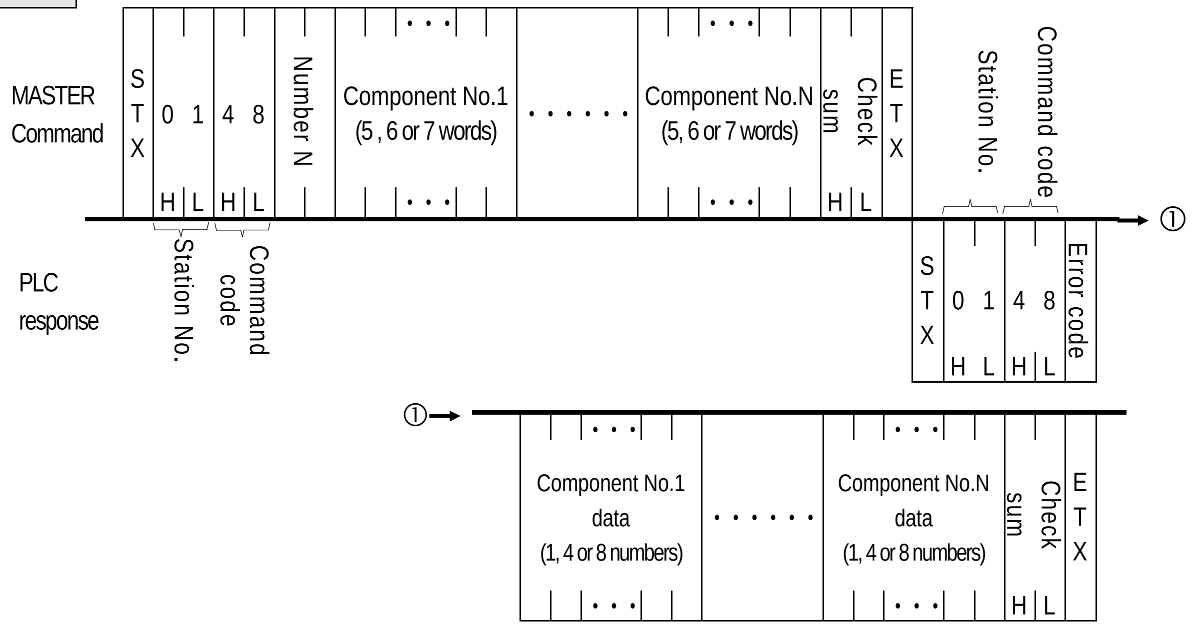
Ex.

Input AAAAH to the 16-bit register WY8 and input 5555H to WY24. This is the format of input data to continuous register because WY8 and WY24 are continuous.



●Command code 48（Mixed read the random discrete status or register data）

Format



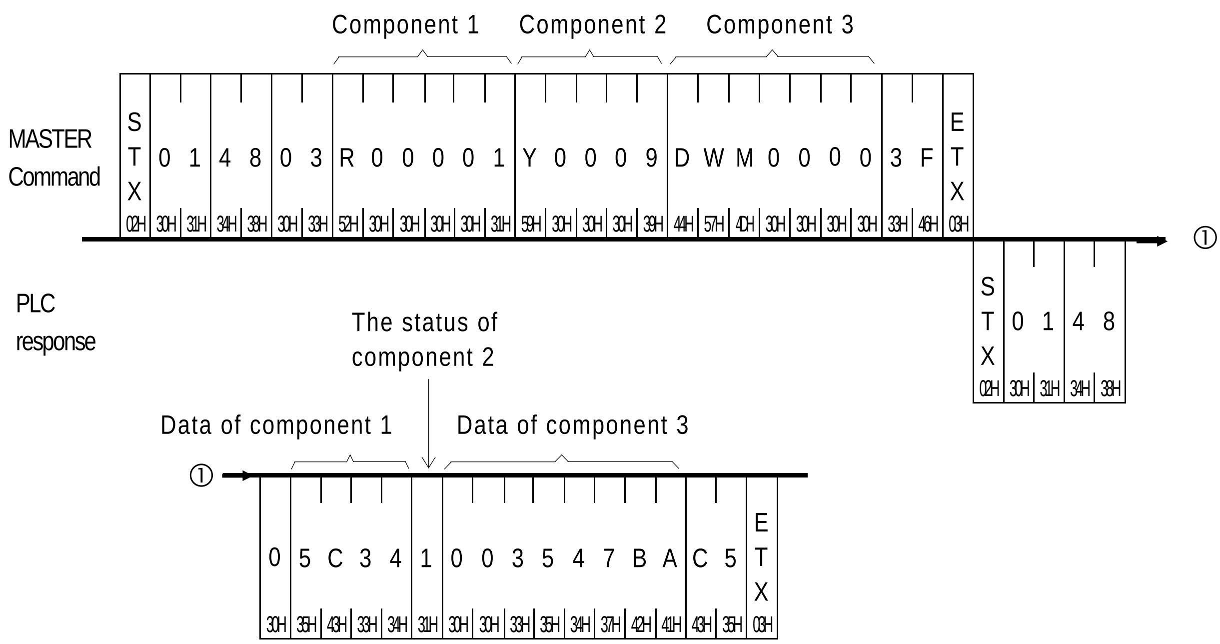
●Number N consists of Hex value of two numbers, it means the total numbers of components. Its range can be 01H ～40H.（Refer to the item 3）

●If the component is discrete, its number can only be 5 characters and status response can only be one number （1 or 0）

●If the component is 16-bit register, its number can be 6 characters and data response is Hex value of 4 characters.

●If the component is 32-bit register, its number can be 7 characters and data response is Hex value of 8 characters.

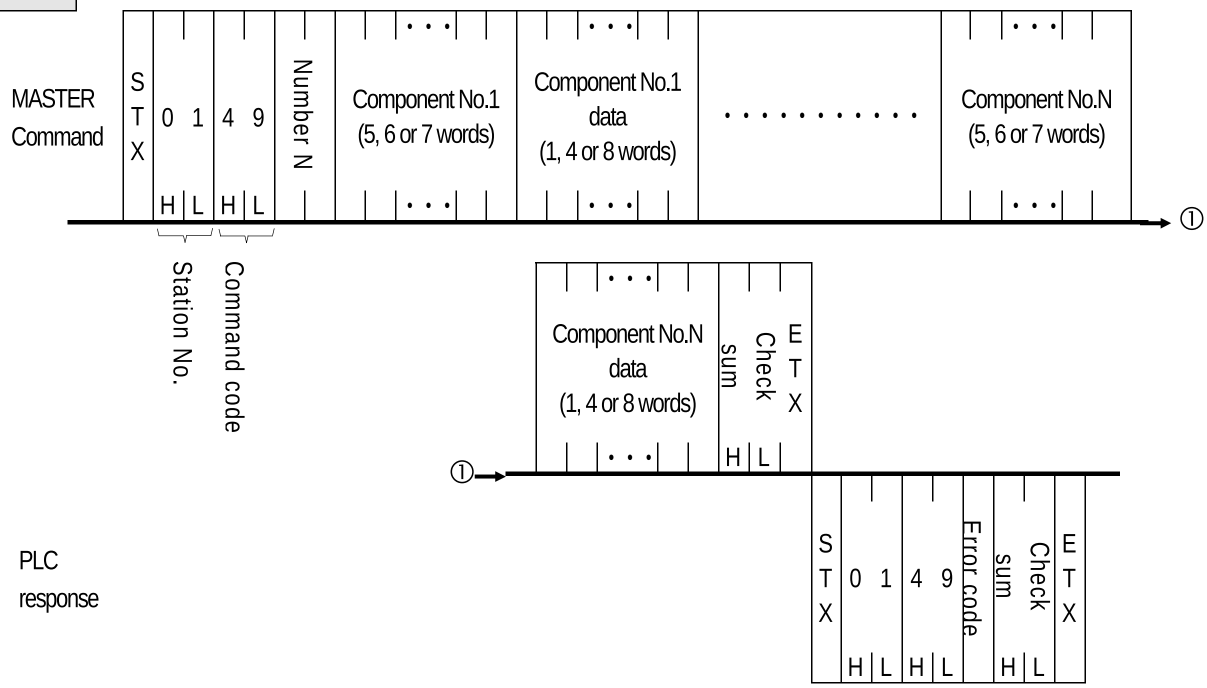
Ex. Read the status and data of R1，Y9 and DWM0（i.e. M31～M0）



●In the above example, R1=5C34H and Y9 status is 1（〝ON〞），DWM0=3547BAH

● Command code 49（Mixed write the random discrete status or register data）

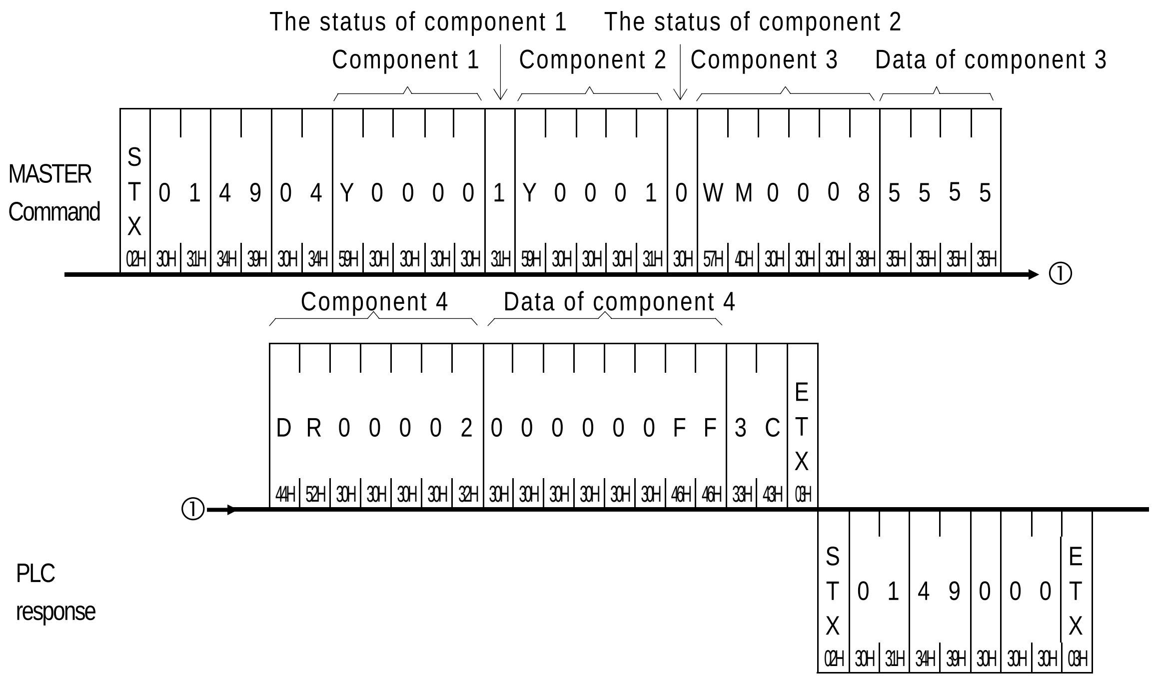
Format



- Number N consists of Hex value of two numbers, it means the total numbers of write to components. Its range can be 01H～40H.（Refer to the item 3）
- If the component is discrete, its number can only be 5 characters and status response can only be one number（0 or 1）
- If the component is 16-bit register, its number can be 6 characters and data response is Hex value of 4 characters.
- If the component is 32-bit register, its number can be 7 characters and data response is Hex value of 8 characters.

Ex.

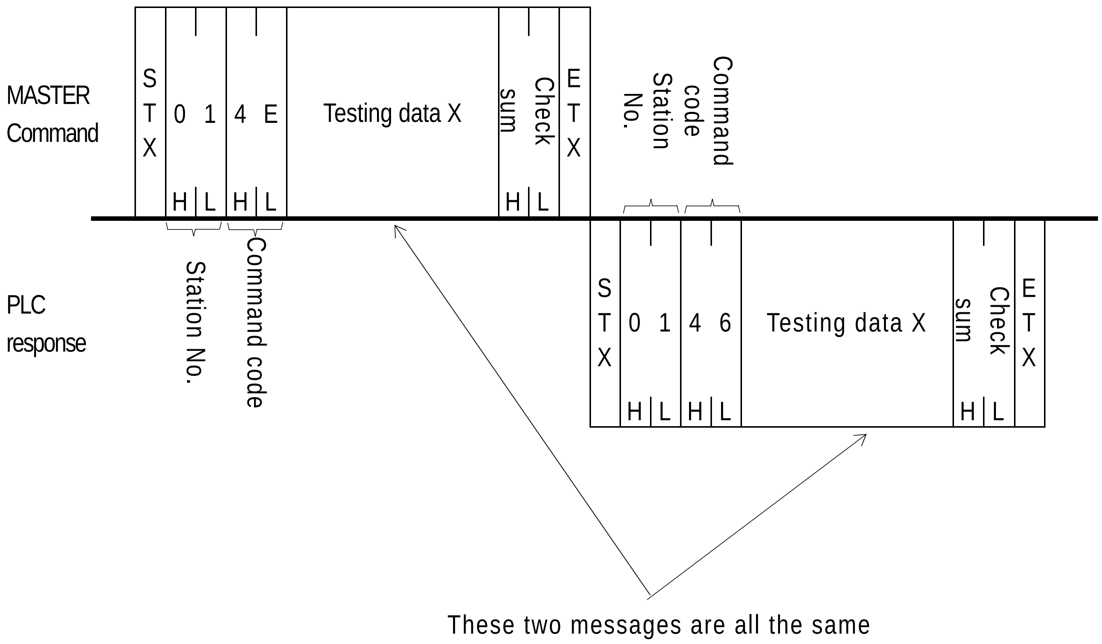
Set the status of Y0 at 1, Y1 at 0, 16-bit register WM8 at 5555H, 32-bit register DR2 at FFH.



● Command code 4E（Loop back testing）

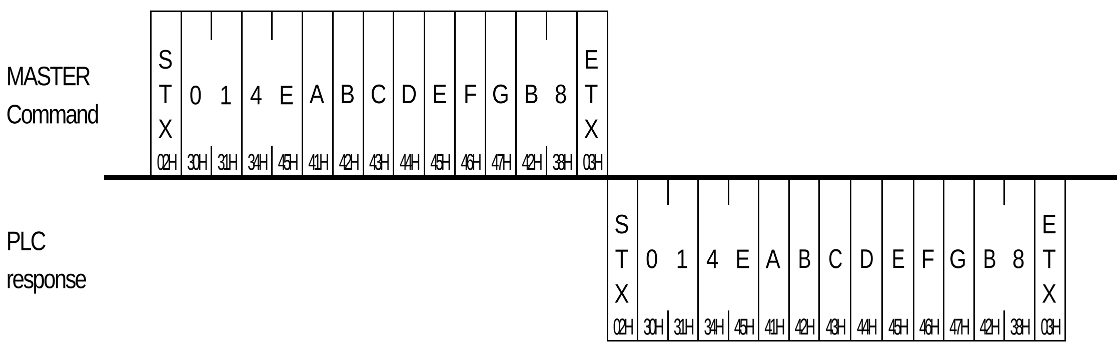
Format

This command makes PLC respond all test data back to Master. It is only for testing the communication condition between Master and PLC and it will not influence the PLC function.



Ex.

Use this command to send the data 〝ABCDEFG〞 from Master to PLC to rest weather the PLC respond normally.



● Command code 53（Read the detailed system status of PLC）

Format

MASTER Command

STX	Station No. (H)	Station No. (L)	Command code (H)	Command code (L)	Checksum (H)	Checksum (L)	ETX
STX	0	1	5	3	C	B	ETX

PLC response

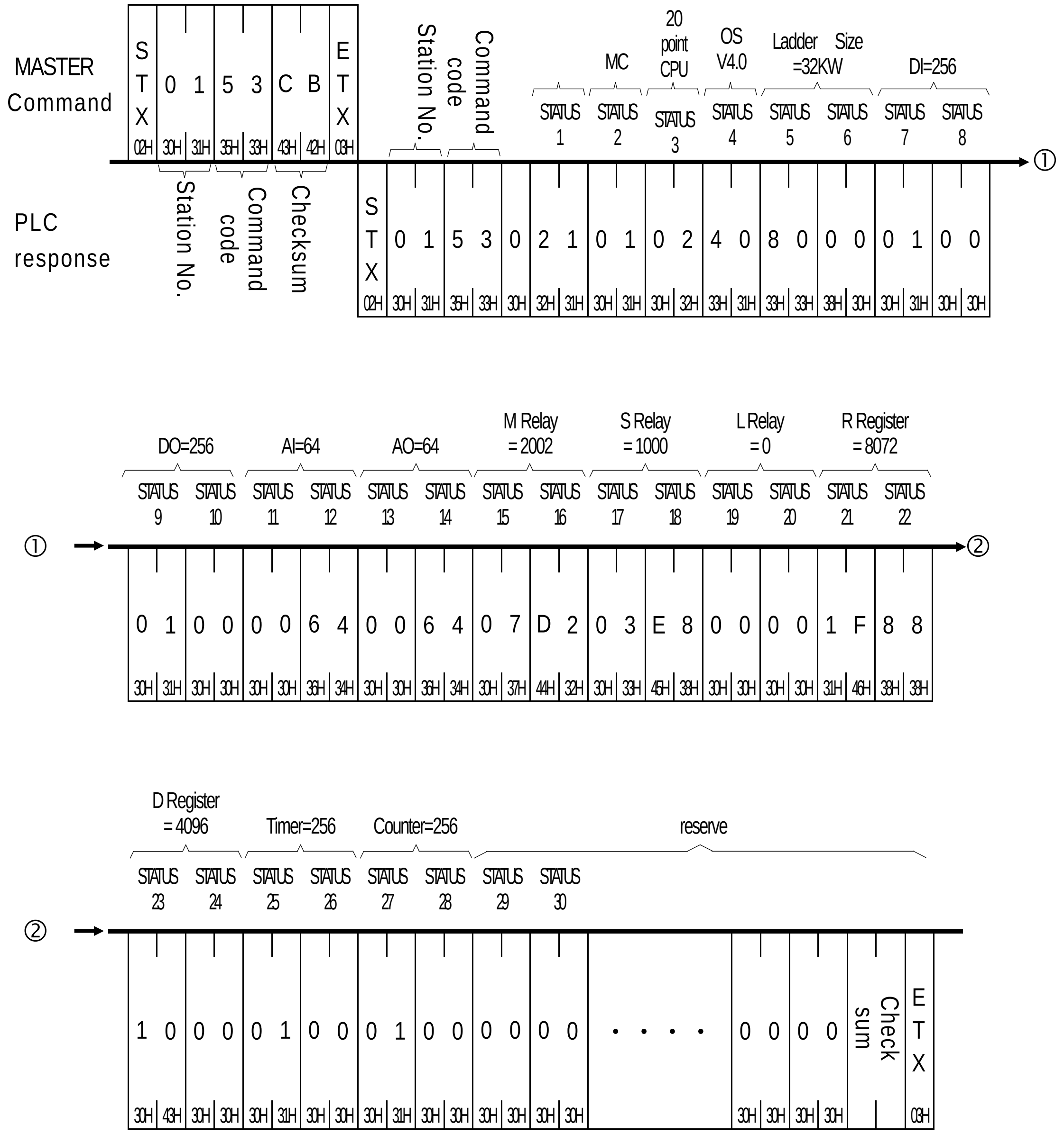
STX	Station No. (H)	Station No. (L)	Command code (H)	Command code (L)	Checksum	STATUS 1 (H L)	STATUS 2 (H L)	STATUS 3 (H L)	STATUS 4 (H L)	STATUS 5 (H L)	STATUS 6 (H L)	·········	STATUS 64 (H L)	Check sum (H L)	ETX
STX	0	1	5	3								·········			ETX

STATUS 1	B0：RUN/STOP B1：Battery Low/Normal B2：Ladder checksum error/Normal B3：Use MEMORY PACK/Not use B4：WDT Time out/Normal B5：ID setting/Not set ID B6：Urgent stop/Normal B7：(reserve for future use)
STATUS 2	Types of Main unit 00H:MA 01H:MC Other values: retain
STATUS 3	I/O points of main unit 00H:10 points 01H:14 points 02H:20 points · ·
STATUS 4	OS Version of PLC 40H：V4.0X 41H：V4.1X • •
STATUS 5	Ladder Size Hi-Byte
STATUS 6	Ladder Size Lo-Byte
STATUS 7	Discrete input Hi-Byte
STATUS 8	Discrete input Lo-Byte
STATUS 9	Discrete output Hi-Byte
STATUS 10	Discrete output Lo-Byte
STATUS 11	Analog input Hi-Byte
STATUS 12	Analog input Lo-Byte
STATUS 13	Analog output Hi-Byte
STATUS 14	Analog output Lo-Byte

STATUS 15	M Relay Hi-Byte
STATUS 16	M Relay Lo-Byte
STATUS 17	S Relay Hi-Byte
STATUS 18	S Relay Lo-Byte
STATUS 19	L Relay Hi-Byte
STATUS 20	L Relay Lo-Byte
STATUS 21	R Register Hi-Byte
STATUS 22	R Register Lo-Byte
STATUS 23	D Register Hi-Byte
STATUS 24	D Register Lo-Byte
STATUS 25	Timer Hi-byte
STATUS 26	Timer Lo-byte
STATUS 27	Counter Hi-Byte
STATUS 28	Counter Lo-Byte
STATUS 29	
•	•
•	•
•	•
•	•
•	•
•	•
STATUS 64	

● Command code 53 (Read the detailed system status of PLC)

Ex. If the type of PLC is FBs-20MC, OS version is 4.0x, program capacity is 32K words, without MEMORY PACK, and ID setting, all the status are normal and in RUN model, then the result of reading the system status is as following：



Appendix 2　PWMDA Analog Output Module

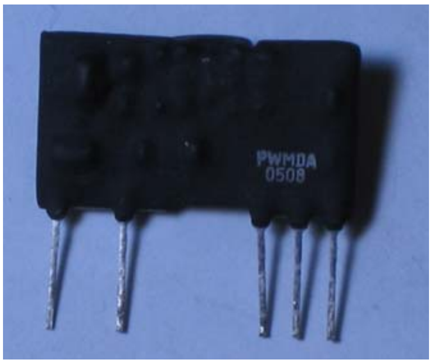
Although FBs Series main unit has been provide analog output module, but allow for the customer who only one point analog output demand. FATEK Automation created the simple and easy analog output module(PWMDA) which to fit various application.

FBs PWMDA Using the theorem of pulse width modulation, cooperate to peripheral output circuit, and then it can transform the different width of digital signal pulse to corresponding analog output voltage(0～10V).

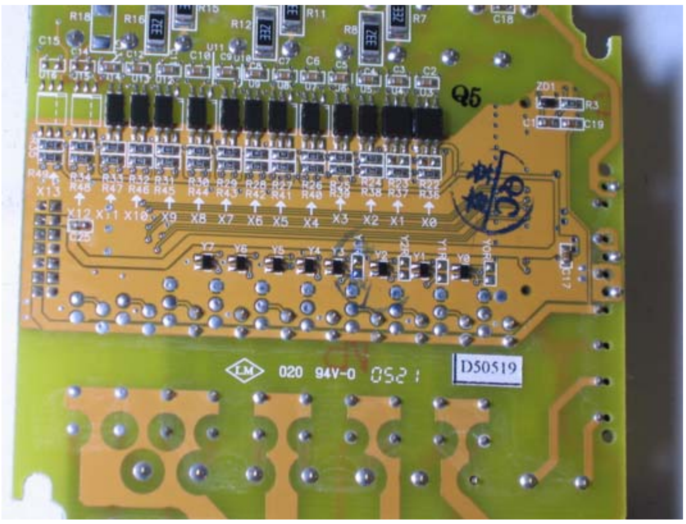
If you want to use PWMDA then you must purchase the PWMDA component form FATEK Automation, and replace to transistor output (the step of replace output component, please refer to chapter 1.1). After finish the component change procedure. Using high speed pulse width modulation instruction (FUN139) to send analog voltage.

1.1 PWMDA Component Installation

FBs-PLC PWMDA component only can be installed in high speed output(Y0、Y2..), because it must match up with FUN139. The shape of PWMDA component and change method shows in below **:**

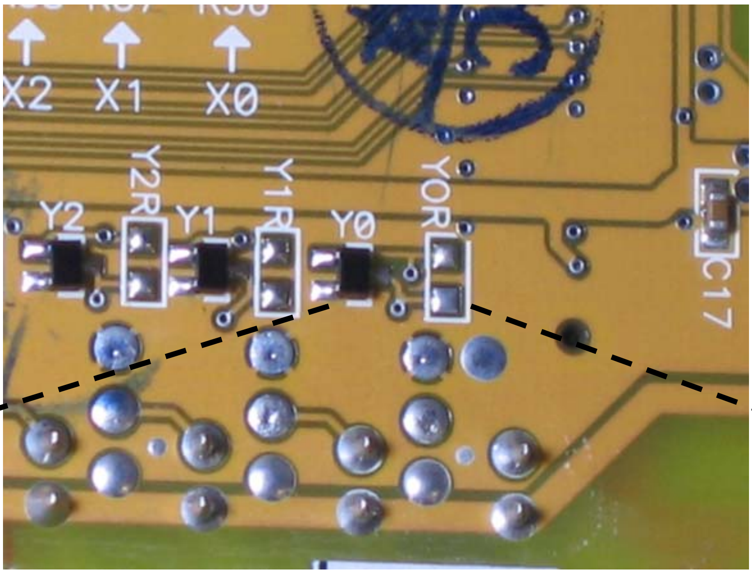


1. If the output component(Y0) were TR(J)-H originally, then remove TR(J)-H directly. And replace to PWMDA component to finish change procedure.
2. If the output component(Y0) were Relay, TR(J), or TR(J)-M originally, then you not only to remove driver transistor (DTC123E), but also to install a SMD resistance(100Ω) in Y0R position.



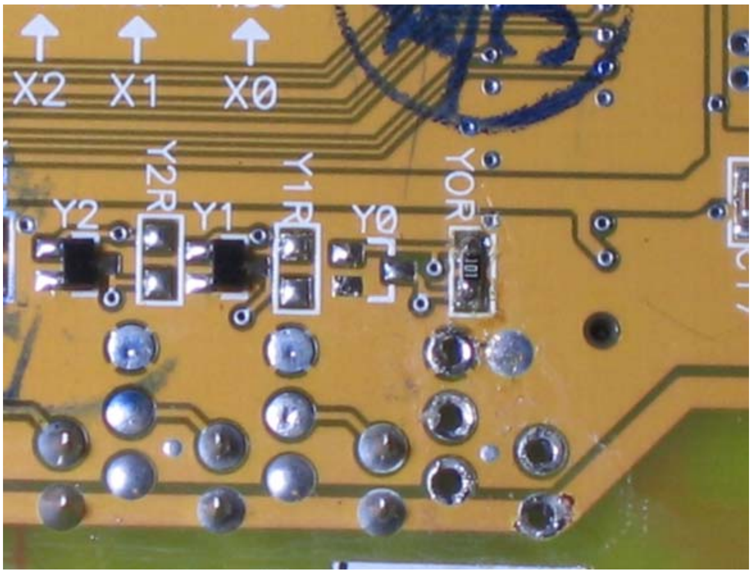
Opening the cover of PLC, take I/O board out and turn it over

Removed drive transistor DTC123E.



Installed the SMD resistance(100Ω) in Y0R position.

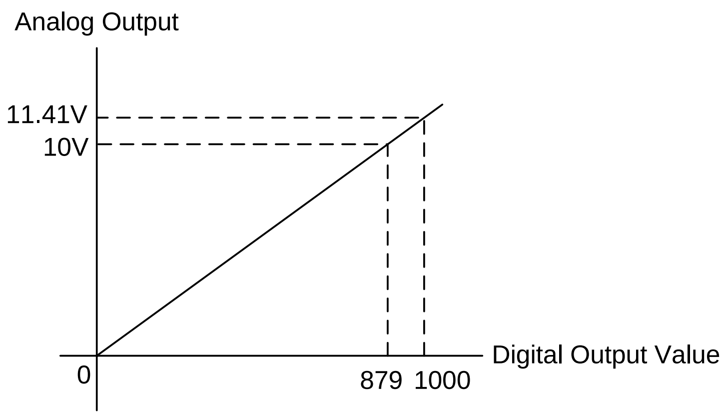
Before PWMDA component change



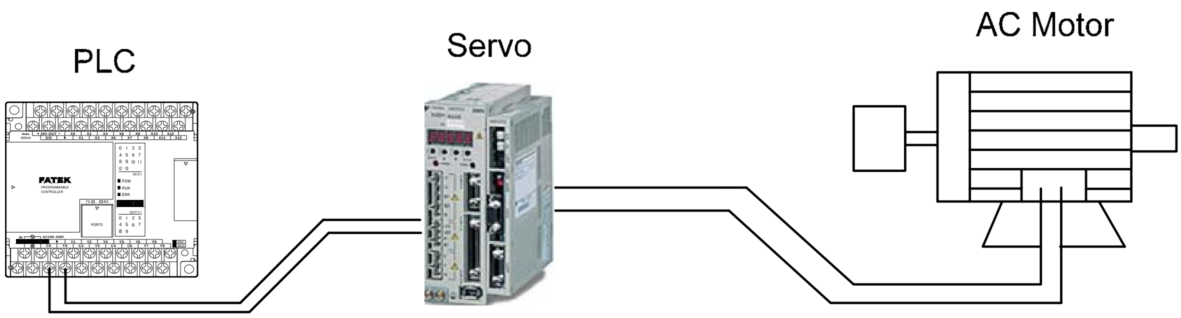
After PWMDA component change

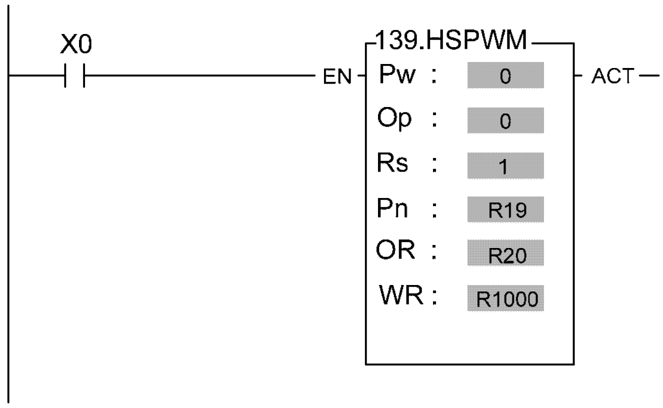
⚠ Caution
When Y0 has been finished PWMDA component change, then Y1 won't be used anymore (because they used the same common ground). After component changed, please pasting the serials number stickers in correct position for recognized easily.

1.2 Specifications of PWMDA

Items	Specifications	Remark
Span of Analog Output	DC 0～10V	
Digital output value	0～1000	
Resolution	10mV(10V/1000)	
Output resistance	1K	
Minimum loading（≥10V output）	5.2K	
D/A conversion time	＜50mS	
Performance curve		

Application Example





Pw **:** High speed pulse width modulation (pulse width modulation →analog voltage) output point(0=Y0, 1=Y2,…)

Op **:** Output polarity；= 0：Digital output value = 0, Vo=0V；Digital output value = 1000, Vo=10V.

= 1：Digital output value = 0, Vo=10V；Digital output value =1000, Vo=0V.

Rs **:** Resolution；1=1/1000 (0.1%)。

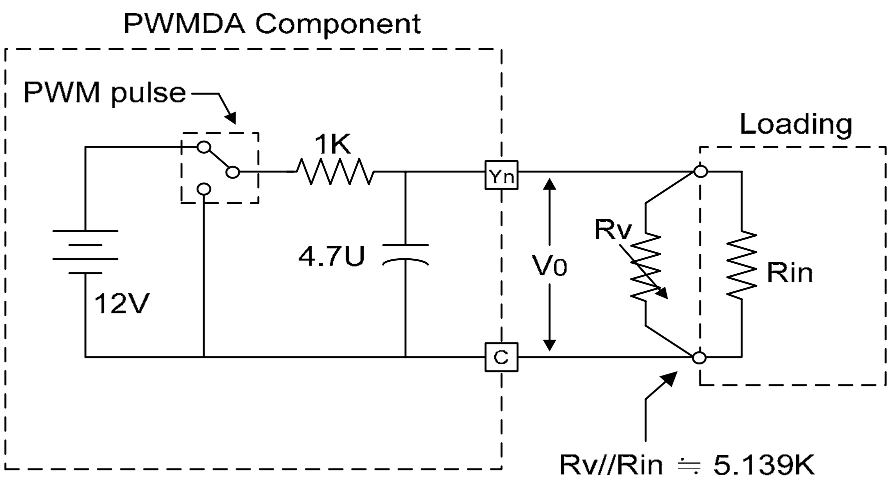
Pn **:** Setting of output frequency(0~255). Suggesting to set as 1(output frequency = 9.2KHz).

OR **:** Output pulse width setting register(0~1000)**………**digital output value.

WR **:** Working register, it can't repeat in use.

※ For detail illustration of FUN139, please refer to FBs user's manual I(Instruction Chapter).

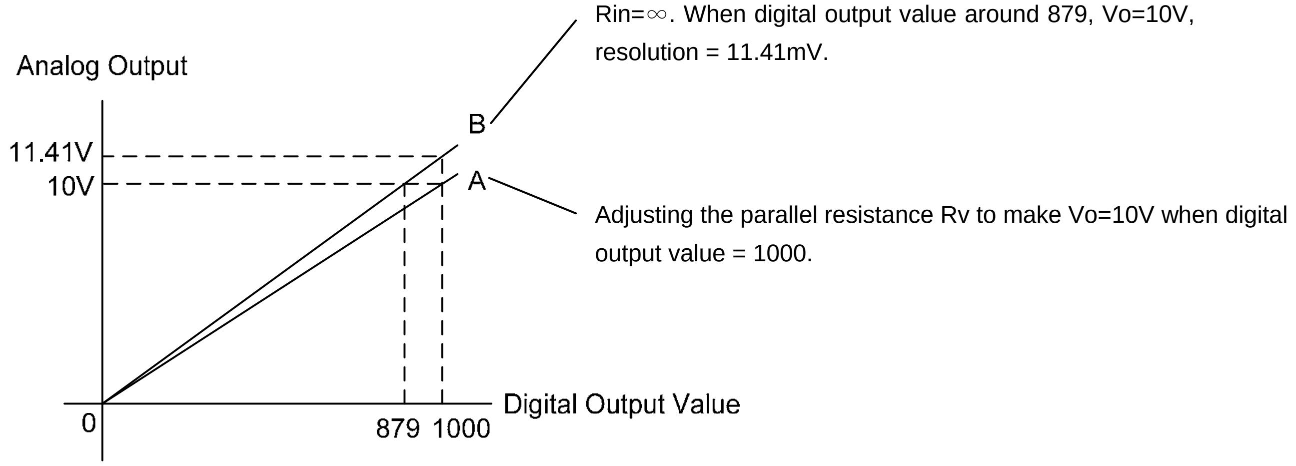
PWMDA hardware diagram & resolution adjustment indication：



PWMDA hardware diagram

- Adjust through hardware **:** Firstly setting digital output value as 1000, then to adjust parallel resistance(Rv) to make Vo = 10V.(see curve A in below chart).

- Adjust through software **:** Firstly setting digital output value as 1000. If Vo≥ 10V then to reduce digital output value until Vo = 10V(see curve B in below chart).



Chapter 9　FBs-PLC Interrupt Function

9.1　The Principle and the Structure of Interrupt Function

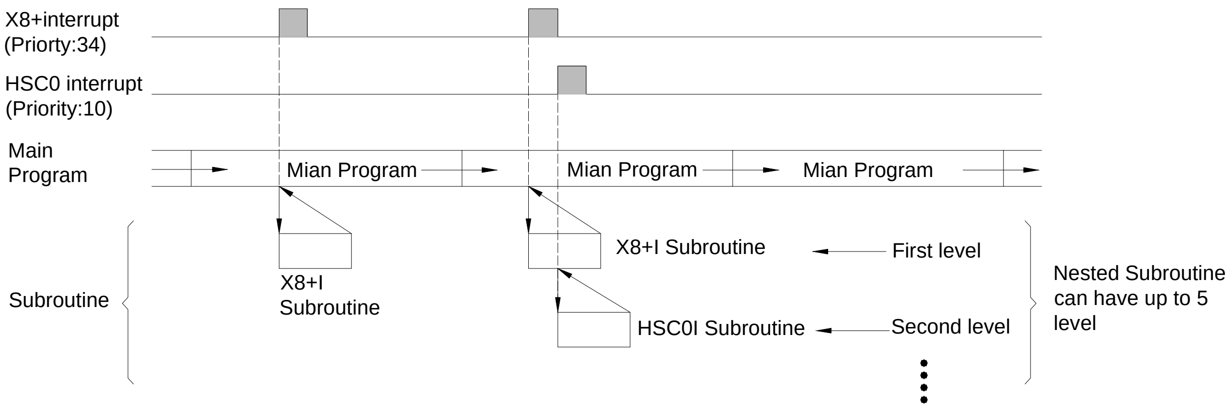
There are many jobs that FBs-PLC needs to carry out. For example, there are 20K words user's program need to be solved, 512 points of I/O status need to be captured or updated, 5 communication ports need to be serviced, and etc. However, jobs can only be executed one at a time as there is merely one CPU available. Therefore, PLC service one job after another in sequence until all the jobs are executed once. Then, it will return to the first job to repeat the same cycle. The time interval of each execution is called the "scan time" of PLC. The CPU execution speed is extremely fast in comparison with human response. As far as human feeling is concerned, PLC almost completes all jobs at the same time when PLC can normally complete the foregoing huge workload within tens of milliseconds (ms). Hence, it can meet the requirements of the most practical control cases.

In most application cases, the control method described above is very much sufficient. But for some applications that require a high-speed response (such as positioning control), a delay in scan time will certainly mean an increase in error. Under the circumstances, only applying the "Interrupt" function can achieve the precision requirement.

The so-called "Interrupt" means the interrupt request to the CPU during normal scan cycle when an immediate response is required. After receiving such request, the CPU will promptly stop all scanning work to prioritize to perform and complete the corresponding service work before return (the so-called "Return from Interrupt" or RTI) to where interrupt occurred and resume the interrupted scanning work.

The service work needed to carry out while interrupt occurred is called Interrupt Service Routine, which is a subroutine consisted by a series of ladder codes. It is placed in the subroutine area and begin with the LBL instruction with reserved label name (please refer to Section 9.3). Since it is placed in the subroutine area, it will not be executed in a normal PLC scanning cycle (PLC only constantly scans the main program area but not the subroutine area).

In normal case, the CPU can promptly execute the corresponding interrupt routine within hundreds of micro-seconds when an interrupt occurred. When there are more than one interrupt occurred at the same time (e.g. FBs-PLC has 49 interrupts source), only the interrupt with highest priority can be executed. All the other interrupt routines need to wait until it became the highest priority among the pending interrupts. Consequently, a response delay of hundreds of microseconds, or even few milliseconds, may be caused. Hence, in a multiple interrupt inputs structure, an interrupt priority is given to each interrupt in accordance with its importance. In case another interrupt request is made when the PLC is carrying out the interrupt service routine for an interrupt request that has a higher priority than the new interrupt request, the CPU will wait until the execution of the subroutine is completed before accepting the new interrupt request. However, if the priority of the new interrupt request is higher than the one being executed, the CPU will stop the running of the current interrupt service routine immediately to execute the interrupt service routine with a higher priority. After completing the execution, the CPU will return to the previously interrupted service routine with a lower priority to continue the incomplete work. This kind of interrupt in an interrupt execution is called the "Nested Interrupt". FBs-PLC can have up to 5 levels of nested interrupts. The diagram below shows the examples of single interrupts and nested interrupt:

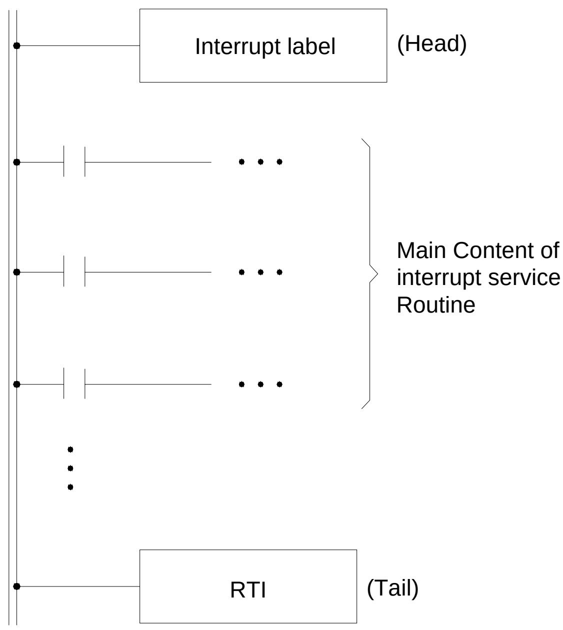


9.2 Structure and Application of Interrupt Service Routine

Although both “Interrupt” and “Call” are having subroutines, but the calling methods (to jump to subroutine for execution) are different. When the CALL command [FUN67] is executed by “Call” in the main program, the CPU will execute the subroutine with the label name designated by the CALL command. The CPU will return to the main program after the RTS (Return from Subroutine) command is executed.

The calling of “Interrupt” is triggered by, instead of using software commands, the hardware interrupt signal to the CPU. The CPU will identify the source of the interrupt and jump automatically to the “Interrupt Service Routine” with the label name of the interrupt in the subroutine for execution. It will return to the main program after the RTI (Return from Interrupt) command is executed. Therefore, there is no ladder code relevant to interrupt in the main program area.

As mentioned before, interrupt service routine must be placed in the sub program area. The structure is shown as the diagram on the right where a “head”, a “tail” and the main body of the service routine are included. The “head” is the “interrupt label name” of the interrupt (to be discussed in the next section). The “tail” is the RTI command [FUN69], to tell the CPU that the interrupt subroutine is ended and it should jump to the place where were interrupted, please refers to FUN69 (RTI) instruction. In between the “head” and the “tail” is the main body of the interrupt service routine used to tell the CPU what control actions should be executed when interrupt occurs.



The power line for subroutine is indicated by double lines to differentiate from the power line for the main program (single line) for easy reading.

9.3 Interrupt Source, Label and Priority for FBs-PLC

As described in the last section, every "Interrupt Service Routine" should have a unique "Interrupt Label". There are 49 corresponding "Interrupt Labels" for interrupts, namely "Interrupt Reserve Words", cab be used in the sub program area of FBs-PLC. These labels are dedicated to the interrupt routines hence cannot use for normal subroutine or jump target.

The "Interrupt Label" (Interrupt Reserve Words) are all suffix with an "I" letter. For examples, the interrupt label for high-speed counter HSC0 should be "HSC0I" and the interrupt label for X0+ should be "X0+I". The "Interrupt Labels" and their priorities for the 49 FBs-PLC interrupt sources of FBs-PLC are shown as below.

The following table is the interrupt sources and their label names. To compatible with previous versions of programming tool, besides HSC/HST, the label names in old versions are also enlisted (label name with parenthesis). The new label names are prefer than old while in usage (HSTAI, 1MSI~100MSI, X0+I~X15-I are prior in using).

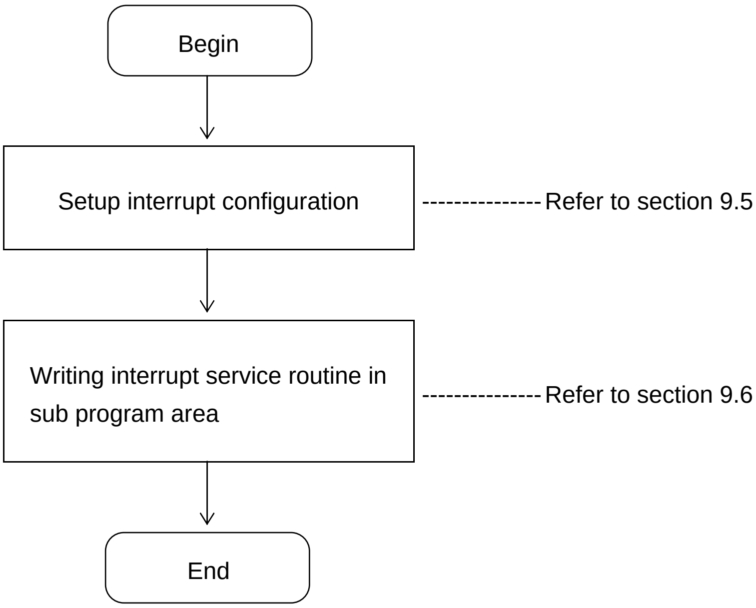
(The priority of interrupt is inversely proportional to the value of priority)

Interrupt Source	Priority	Interrupt Label	Condition for Interrupt	Note
High Speed Timer	1	HSTAI (ATMRI)	Timing from HSTA to（CV=PV）	No interrupt when act as a cyclic timer
Internal Time Base	2	1MSI (1MS)	One interrupt every 1mS	One kind of time base interrupt is allowed at a time (please refer to Section 9.5.2). Therefore, the actual number of interrupts is 42.
	3	2MSI (2MS)	One interrupt every 2mS	
	4	3MSI (3MS)	One interrupt every 3mS	
	5	4MSI (4MS)	One interrupt every 4mS	
	6	5MSI (5MS)	One interrupt every 5mS	
	7	10MSI (10MS)	One interrupt every 10mS	
	8	50MSI (50MS)	One interrupt every 50mS	
	9	100MSI (100MS)	One interrupt every 100mS	
HSC ／ HST	10	HSC0I/HST0I	Counting/Timing from HSC0/HST0 to (CV=PV)	HSC0~HSC3 are labeled as HSC0I~HSC3I when configured as high speed counter; and are labeled as HST0I~HST3I for high speed timer.
	11	HSC1I/HST1I	Counting/Timing from HSC1/HST1 to (CV=PV)	
	12	HSC2I/HST2I	Counting/Timing from HSC2/HST2 to (CV=PV)	
	13	HSC3I/HST3I	Counting/Timing from HSC3/HST3 to (CV=PV)	
PSO	14	PSO0I	Pulse output of PSO0 completed	
	15	PSO1I	Pulse output of PSO1 completed	
	16	PSO2I	Pulse output of PSO2 completed	
	17	PSO3I	Pulse output of PSO3 completed	

Interrupt Source	Priority	Interrupt Label		Condition for Interrupt	Note
Interrupt from External Hardware Input or Software High-Speed Timer	18	X0+I (INT0)	HSC4I ∫ HSC7I	Interrupt when 0→1 (↑) of X0	The counter input and control input of the software high speed counter HSC4 ～ HSC7 which were implemented by the interrupt function can be designated as any one input of X0～X15. Therefore, the interrupt priority of the software high speed counter depends on the input it utilized.
	19	X0–I (INT0–)		Interrupt when 1→0 (↓) of X0	
	20	X1+I (INT1)		Interrupt when 0→1 (↑) of X1	
	21	X1–I (INT1–)		Interrupt when 1→0 (↓) of X1	
	22	X2+I (INT2)		Interrupt when 0→1 (↑) of X2	
	23	X2–I (INT2–)		Interrupt when 1→0 (↓) of X2	
	24	X3+I (INT3)		Interrupt when 0→1 (↑) of X3	
	25	X3–I (INT3–)		Interrupt when 1→0 (↓) of X3	
	26	X4+I (INT4)		Interrupt when 0→1 (↑) of X4	
	27	X4–I (INT4–)		Interrupt when 1→0 (↓) of X4	
	28	X5+I (INT5)		Interrupt when 0→1 (↑) of X5	
	29	X5–I (INT5–)		Interrupt when 1→0 (↓) of X5	
	30	X6+I (INT6)		Interrupt when 0→1 (↑) of X6	
	31	X6–I (INT6–)		Interrupt when 1→0 (↓) of X6	
	32	X7+I (INT7)		Interrupt when 0→1 (↑) of X7	
	33	X7–I (INT7–)		Interrupt when 1→0 (↓) of X7	
	34	X8+I (INT8)		Interrupt when 0→1 (↑) of X8	
	35	X8–I (INT8–)		Interrupt when 1→0 (↓) of X8	
	36	X9+I (INT9)		Interrupt when 0→1 (↑) of X9	
	37	X9–I (INT9–)		Interrupt when 1→0 (↓) of X9	
	38	X10+I (INT10)		Interrupt when 0→1 (↑) of X10	
	39	X10–I (INT10–)		Interrupt when 1→0 (↓) of X10	
	40	X11+I (INT11)		Interrupt when 0→1 (↑) of X11	
	41	X11–I (INT11–)		Interrupt when 1→0 (↓) of X11	
	42	X12+I (INT12)		Interrupt when 0→1 (↑) of X12	
	43	X12–I (INT12–)		Interrupt when 1→0 (↓) of X12	
	44	X13+I (INT13)		Interrupt when 0→1 (↑) of X13	
	45	X13–I (INT13–)		Interrupt when 1→0 (↓) of X13	
	46	X14+I (INT14)		Interrupt when 0→1 (↑) of X14	
	47	X14–I (INT14–)		Interrupt when 1→0 (↓) of X14	
	48	X15+I (INT15)		Interrupt when 0→1 (↑) of X15	
	49	X15–I (INT15–)		Interrupt when 1→0 (↓) of X15	

9.4 How to Use Interrupt of FBs-PLC

The applications of interrupt in internal timing, external input, HSC/HST or PSO are similar. Since the applications of HSC/HST and PSO have been described in other chapters/sections, only examples of internal timing and external input will be described in this section.



9.5 Interrupt Configuration

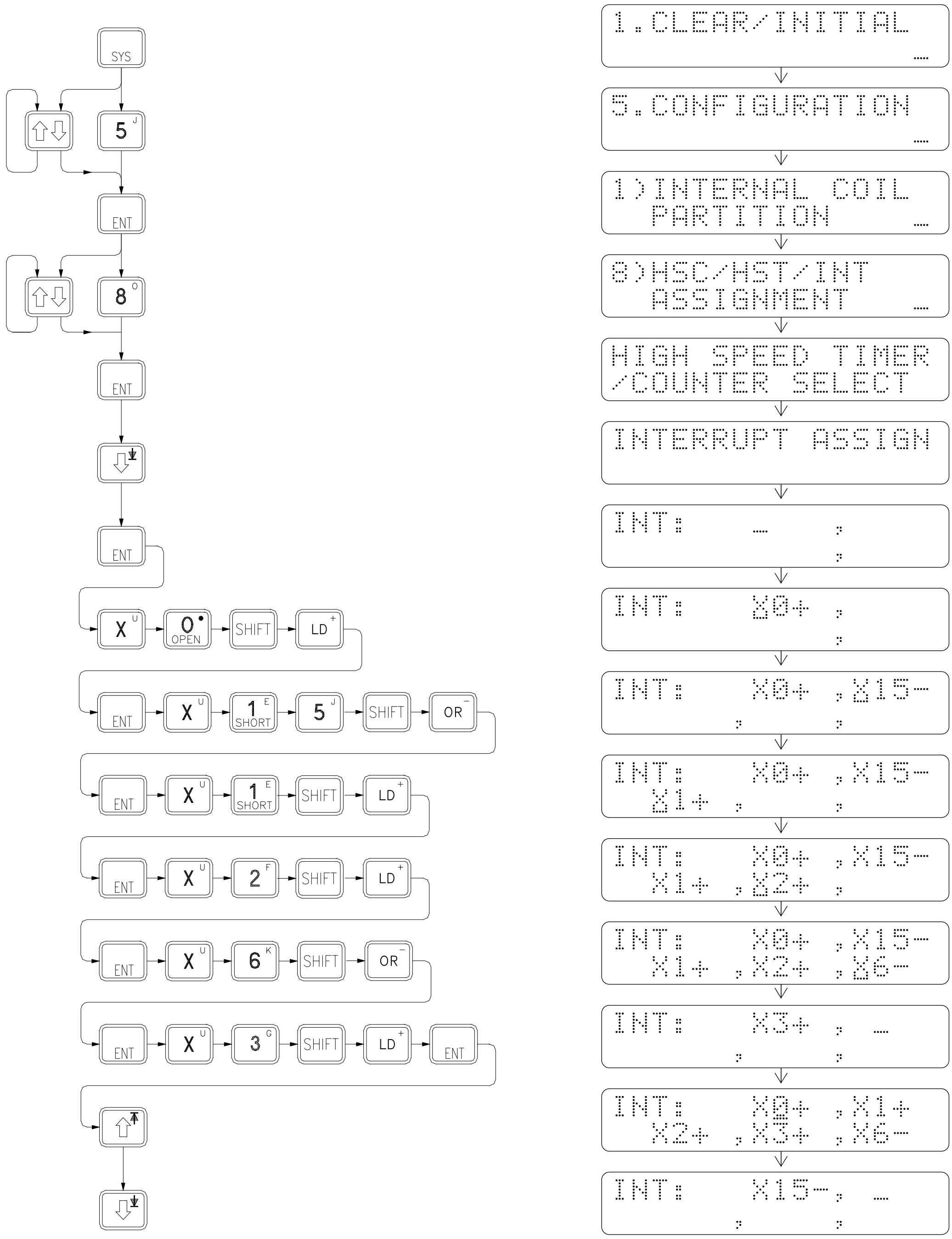
In fact, interrupt configuration is simply to determine whether the application of a certain interrupt is to be used or not.

Interrupt configuration can be divided into configuration relevant to I/O or irrelevant to I/O two categories. HSTA, HSC/HST, PSO and external interrupt are all relevant to I/O and should be performed by the configuration function of programming tool, WinProladder or FP-08. The programming tool will automatically enable the interrupt of the device once it is configured.

The configuration of internal time base interrupt (1MSI~100MSI), which is irrelevant to I/O, need not to be configured. As long as the time base interrupt reserved words, which is placed in front of the interrupt service subroutine, appears in the sub program area, it imply the interrupt has been planned. If more than one such interrupts appear, can use low byte, B0~B7, of the special register R4162 to control the interrupt of 1MSI~100MSI to be executed or not.

9.5.1 Interrupt Configuration Through the Operation of FP-08

【Keypad Operation】 【LCD Display】



- External interrupt shares the 16 high-speed input points, X0~X15, with HSC and SPD instructions. Therefore, the number of the input points used by HSC or SPD cannot configure for external interrupt.

  Note: SPD instruction can only uses X0~X7 8 input points for average speed detection.

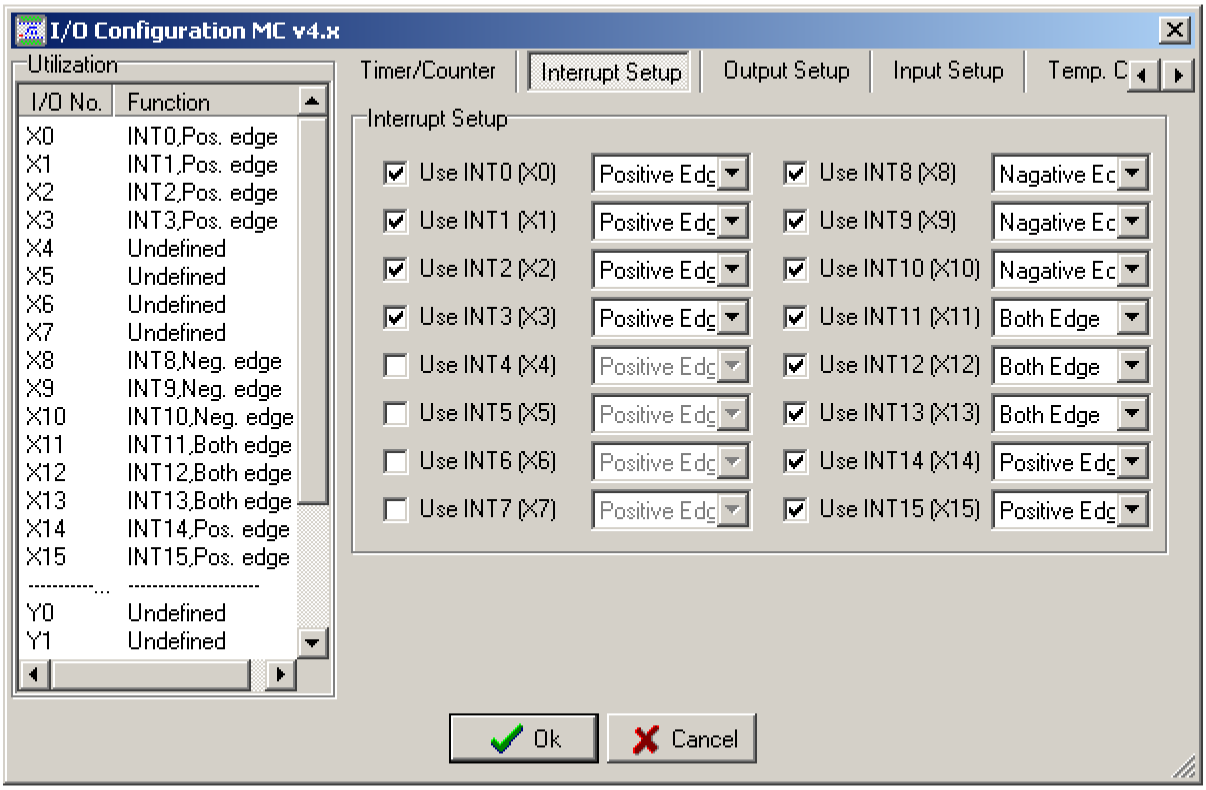
- Once the interrupt configuration is determined, it cannot be changed in PLC RUN. But the EN command [FUN145] and DIS command [FUN146] provided by FBs-PLC can dynamically enable/disable the operation of interrupt of external, HSC and HSTA in PLC RUN. Please refer to the description of the two instructions.

9.5.2 Interrupt Configuration Through the Operation of WinProladder

Click the item “I/O Configuration” which in Project Windows **:**

Project name
- System Configuration
  - I/O Configuration → Select “Interrupt Setup”

When “Interrupt Setup” windows appear, then you can choose the Interrupt which you want.



9.5.3 Internal Time Base Interrupt Configuration by R4162

When the internal time base interrupt reserved words (8 kinds, 1MSI~100MSI) appears in the sub program area, it imply that the designated interrupt has been planned and can be masked by using the 8 bits of the low byte in the register R4162 as shown in below:

R4162:	B7	B6	B5	B4	B3	B2	B1	B0
	100MS	50MS	10MS	5MS	4MS	3MS	2MS	1MS

- When bit status =0: Enable the time base interrupt (not masked)
- When bit status =1: Disable the time base interrupt (masked)

- Among B0~B7, if more than one of the bits is 0, FBs-PLC will enable the one with the smallest time base and disable the others. If the content of R4162 is 00H, then all time base interrupts will not be masked. However, if 1 MS and 2MS~100MS time base interrupt subroutine are all appeared in subprogram area, only the 1MS time base interrupt will be executed, and the others will not be executed.
- It is with great flexibility since the user can dynamically change the time base or pause or enable the interrupt by using the ladder program to change the value of R4162 at any time in PLC RUN.
- The default of R4162 is 0; it represents that 1MS~100MS time base interrupt are not been masked. As long as any one of time base interrupt processing subroutine exists in the sub program area, it will be executed periodically.
- Since a considerable CPU time is required for execution of every interrupt, the smaller the interrupt time base, the more interrupts required and the longer CPU time occupied. Therefore, application should be made only when necessary to avoid degradation of CPU performance.

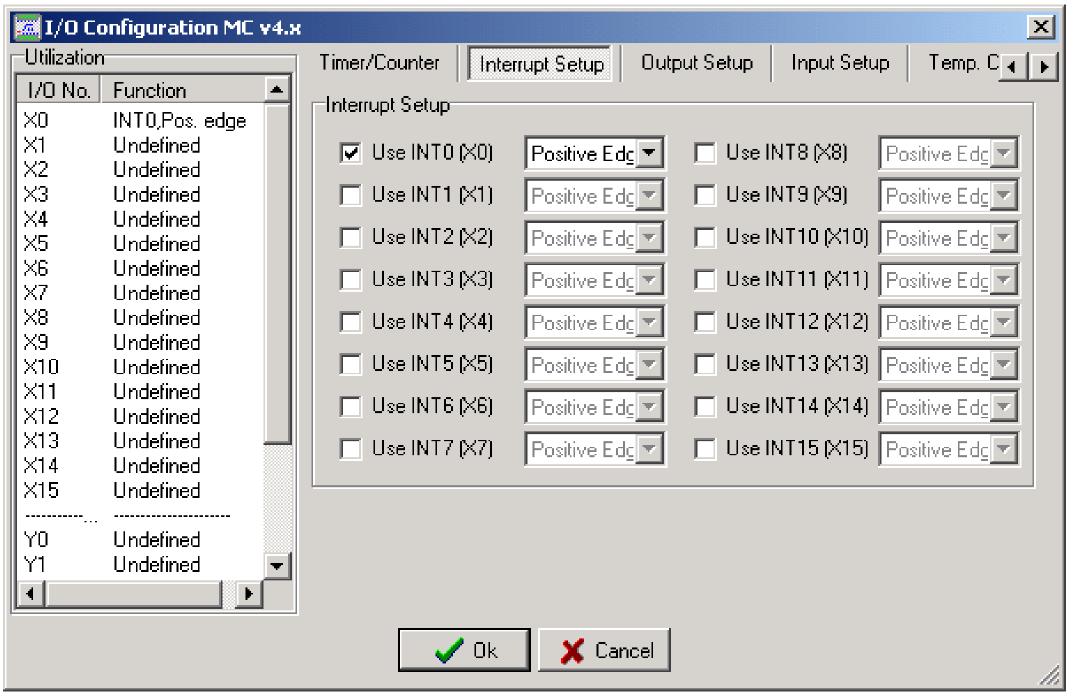
9.6 Examples of Interrupt Routine

Example 1 Precision position control by positioning switch .(Configure X0 as the positive edge interrupt input)

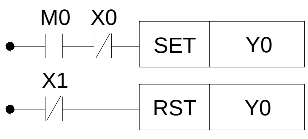
X0 : Position Sensor

X1 : Emergency Stop

Y0：Power motor

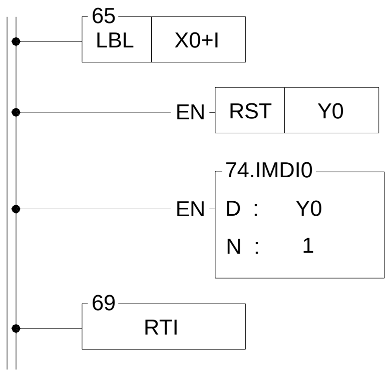


【Main program】



• M0 (start) changes from 0→1, the motor is ON.

【Subroutine】



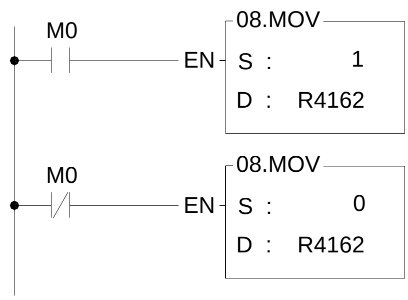
• When the sensor, X0, detects the arriving of positioning location, i.e. X0 change from 0→1, the hardware will automatically execute the interrupt subroutine

• As motor Y0 changes to 0, it stops the motor immediately.
• Output Y0 immediately to reduce delay caused by scan time

• It must employ immediate input/output instruction in the interrupt subroutine to meet the real time high speed precision control requirement.

Example 2 1MS Internal Time base Interrupt

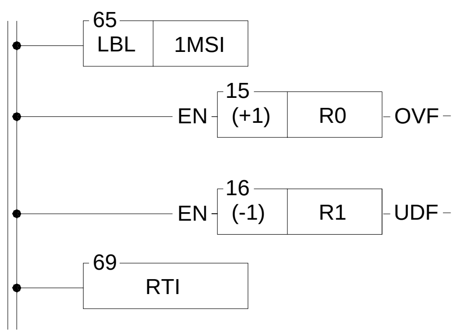
【Main program】



• When M0=1, 1MS timing interrupt is disabled
(1MS timing interrupt being masked)

• When M0=0, 1MS timing interrupt is enabled

【Subroutine】



• After 1MS time base interrupt is started, the system will automatically execute the interrupt subroutine every 1MS

• R0 is used as the up counting cyclic timer for every 1MS time base

• R1 is used as the down counting cyclic timer for every 1MS time base

9.7 Capture Input and Digital Filter

In many high-speed application, you can set interrupt input to prevent signal lose. Besides, you can set Captured Input to capture the transient input signal less than one PLC scan time. The method to set Capture Input is very easy.

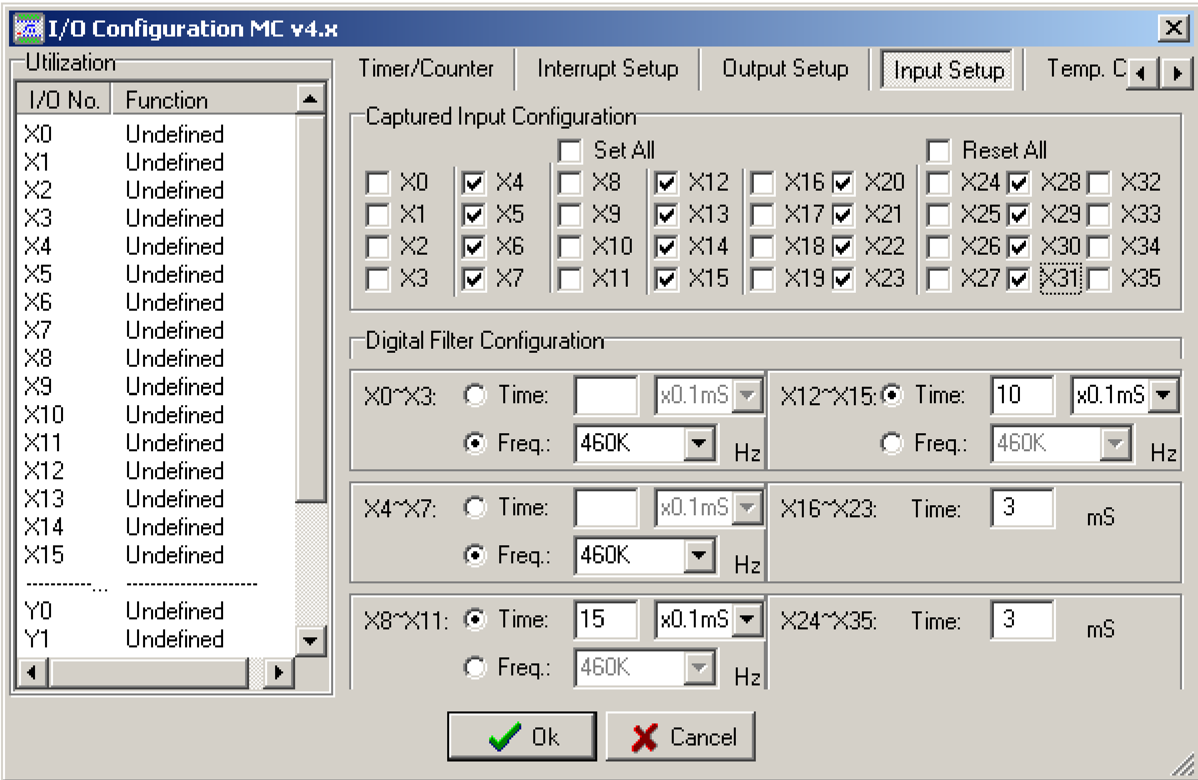
Click the item “I/O Configuration” which in Project Windows :

Project name

  System Configuration

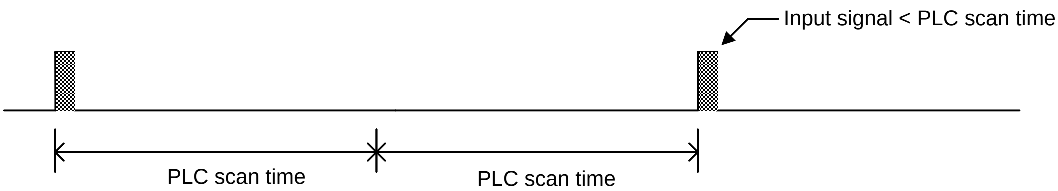
    I/O Configuration → Select “Input Setup”

When “Input Setup” windows appear, then you can choose the Capture Input point which you want.



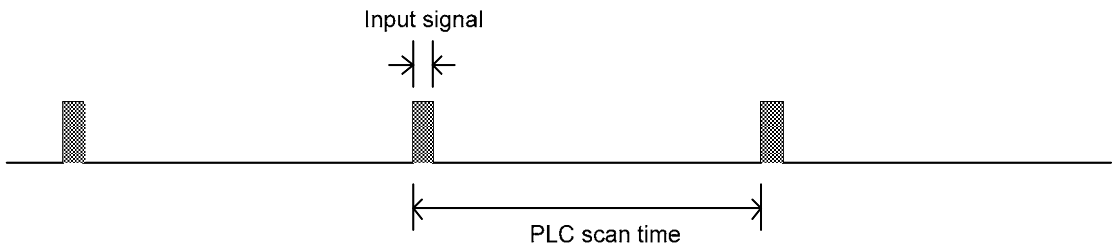
Example_1

When the input is configured as the captured input and used for counting application, it is necessary that the input signal period must be greater than 2 scan time for correct counting. For example the input frequency is 50Hz, then the scan time of PLC must be less than 10mS for counting without loss.



Example_2

The captured input can get the input signal which duration is less than 1 scan time of PLC.

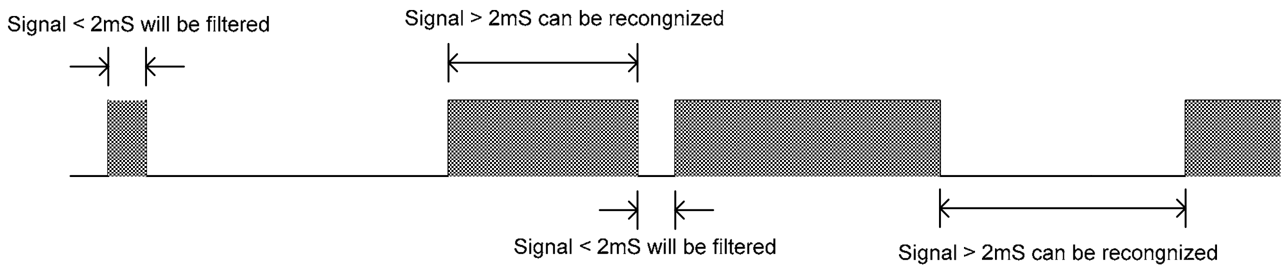


The FBs series PLC main unit supports the captured input function as mentioned above, except this, it also supplies the digital filtering function for digital inputs X0~X35. There are 6 groups of digital inputs { (X0~X3)、(X4~X7)、(X8~X11)、(X12~X15)、(X16~X23)、(X24~X35) } for filtering setting.

There are 2 methods for digital filtering, one is the frequency domain, the other is the time domain. The filtering setting for upper four groups of digital inputs (X0~X15) can be either frequency domain or time domain; while in frequency domain, it supports the range of 14KHz～1.8MHz in total 8 selections; while in time domain, it supports the range of 1~15 ×1mS or 1~15×0.1mS selections. The last two groups of digital inputs (X16~X35) only supports the time domain, and the selections are 1~15×1mS.

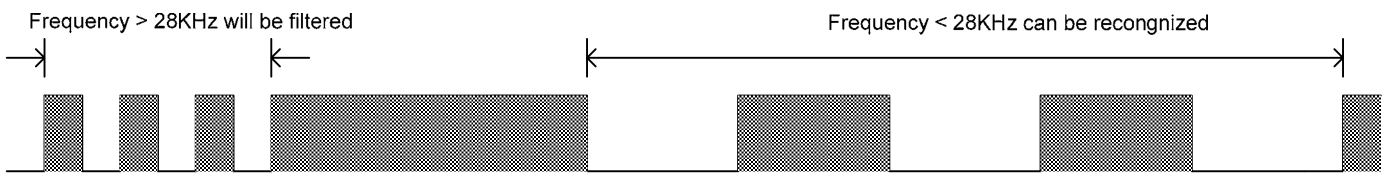
Example 1

When the filtering time is 2mS, if the ON or OFF duration is less than 2mS, it will lose the ON or OFF signal.



Example 2

When the filtering frequency is 28KHz, if the input frequency is greater than 28KHz, it will lose the input signal.



Chapter 10　FBs-PLC High-Speed Counter and Timer

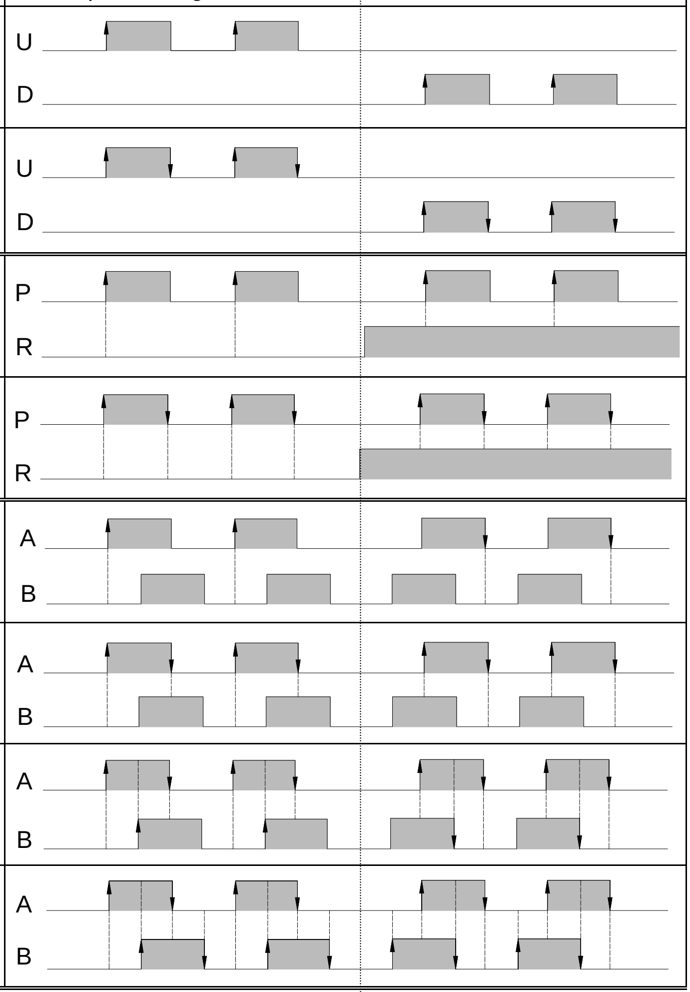
10.1　FBs-PLC High-Speed Counter

The counting frequency of an ordinary PLC's software counter can only reach tens of Hz (depending on the scan time). If the frequency of input signal is higher than that, it is necessary to utilize high-speed counter (HSC), otherwise loss count or even out of counting may occur. There are usually two types of HSC implemented for PLC. The hardware high-speed counter (HHSC) employed special hardware circuit and the software high-speed counter (SHSC) which when counting signal changes state will interrupt CPU to perform the increment/decrement counting operation. FBs-PLC provides up to 4 HHSCs (in SoC chips) and 4 SHSCs. All of them are all 32-bit high speed counter.

10.1.1　Counting Modes of FBs-PLC High-Speed Counter

As shown in the table below, each of the four FBs-PLC HHSCs and SHSCs provides 8 and 3, respectively, kind of counting modes to choose from:

Counting Mode			HHSC (HSC0～HSC3)	SHSC (HSC4～HSC7)	Counting Waveform	
					Up Counting（+1）	Down Counting（–1）
Up-down pulse	MD 0	U/D	○	○		
	MD 1	U/D×2	○			
Pulse-direction	MD 2	P/R	○	○		
	MD 3	P/R×2	○			
AB phase	MD 4	A/B	○	○		
	MD 5	A/B×2	○			
	MD 6	A/B×3	○			
	MD 7	A/B×4	○			

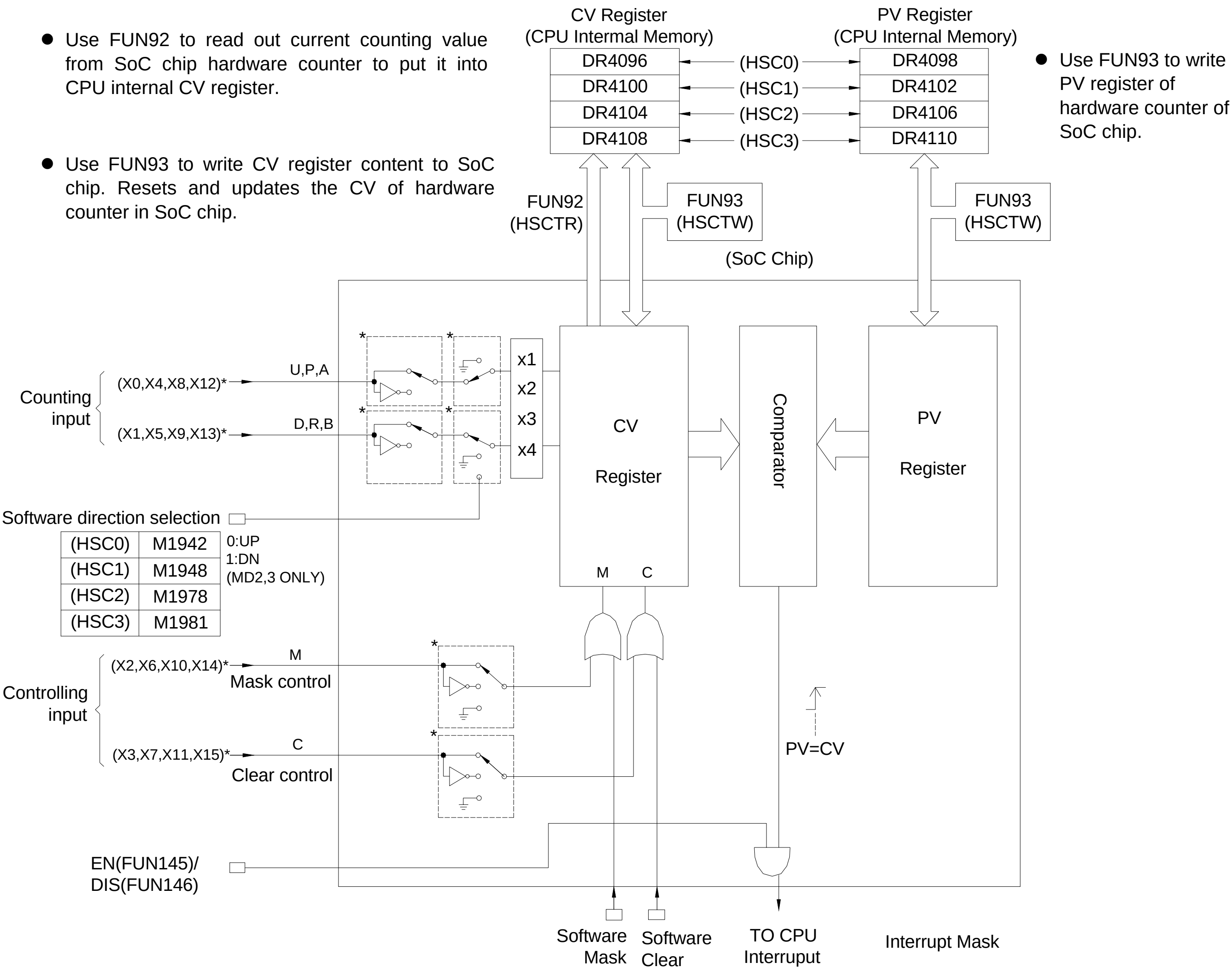


• The up/down arrow (↑ , ↓) on the positive/negative edge in the waveform represents where counting (+1 or –1) occurs.

10.2 System Architecture of FBs-PLC High-Speed Counter

The diagrams below are the system architecture for FBs-PLC HHSC and SHSC where each one of them has multi-purpose input and counting functions. Some of the functions are built-in (such as CV register number, PV register number, interrupt label and relay number for software MASK, CLEAR and direction selection) that user need not to assign for configuration. However, some functions, with a "*" marked in the diagrams below, must use the programming tool to configure the HSC (such as HSC application selection, counting mode, application of each function input, inverse polarity and appointment of corresponding input point number Xn) etc. For detailed structure and operation of the 8 kind of counting modes that assigned in configuration, please refer to section 10.2.1~10.2.3 for explanation.

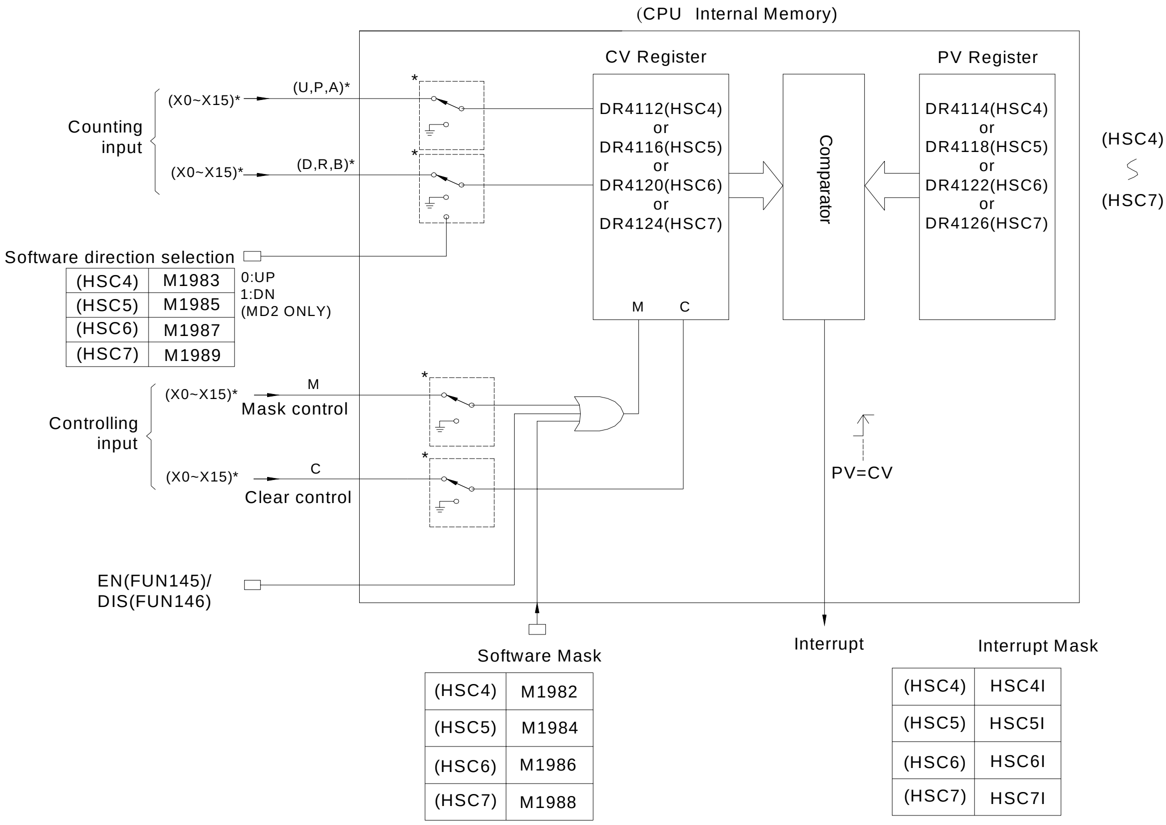
Note: CV (Current Value); PV (Preset Value).



	Software Mask	Software Clear
(HSC0)	M1940	M1941
(HSC1)	M1946	M1947
(HSC2)	M1976	M1977
(HSC3)	M1979	M1980

	Interrupt Mask
(HSC0)	HSC0I
(HSC1)	HSC1I
(HSC2)	HSC2I
(HSC3)	HSC3I

System Architecture of HHSC（HSC0～HSC3）



System Architecture of SHSC（HSC4～HSC7）

- All control signals of HHSC and SHSC are default as Active High (i.e. Status =1 for active and 0 for non-active). In order to cooperate with the sensor's polarity, the HHSC counting inputs (U, D, P, R, A and B) and control inputs (M and C) can be selected for polarity inverse.

- By default when the MASK control signal, M is 1, the HSC counting pulse will be masked without any counting being performed and all HSC internal status (such as CV and PV) will remain unchanged. The HSC will function normally only when M returns to "0". Some sensors have Enable outputs which function is on the contrary to MASK. Counters will not count when Enable = 0 and can only start functioning when Enable = 1. Then, function of inverse polarity input of MASK can be selected to cooperate with the sensors having Enable output.

- When the CLEAR control signal, C is 1, the HSC internal CV register will be cleared to 0 and no counting will be performed. The HSC will start counting from 0 when C returns to 0. Ladder program can also directly clear the CV register (DR4112, DR4116, DR4120, and DR4124), so as to clear the current counting value to 0.

- The four sets of FBs-PLC HHSC are located in the SoC chips where the CV or the PV registers the user can't access directly. What the user can access are the CV registers (DR4096～DR4110) located in the CPU internal memory. Ideally, the contents of CV and PV registers in the chips should be updated simultaneously with the CV and PV registers in the CPU internal memory. However, to keep the correspondence between the two must be loaded or read by the CPU when they, in fact, belong to two different hardware circuits. It is necessary to use FUN93 to load the CV and the PV registers inside the CPU to the respective CV and PV registers (to allow HHSC to start counting from this initial value. Then, FUN92 can be used to read back the counting value of the HHSC CV register in the chips to the CV register in the CPU (i.e. the CV register in the CPU has the bi-direction function). Since read can only be carried out when FUN92 is executed (so-called "sampling" reading), it might result in difference between the HHSC CV value in the chips and the CV value in the CPU, the deviation will getting greater especially when the counting frequency is high.

- When the counting frequency is not high or the demand for positioning precision is not so much, using FUN92 in the main program to read the current counting value and then incorporate comparator instruction is adequate for a simple counting positioning control.

- When the demand for positioning precision is higher, or in the multi-zone count setting control, it may use the FUN92 to read the current counting value while in the time base interrupt routine and incorporate compare instruction to perform more precise counting positioning control.

- As the demand for positioning precision is extremely high, it must use the preset interrupt function of hardware counter. The preset value can load by FUN93 into the PV register of HHSC in the chipset. When CV value of HHSC reaches this preset value, the hardware comparator in the HHSC will send interrupt to CPU at the very moment CV=PV, and jump to interrupt subroutine to do real time control or procession.

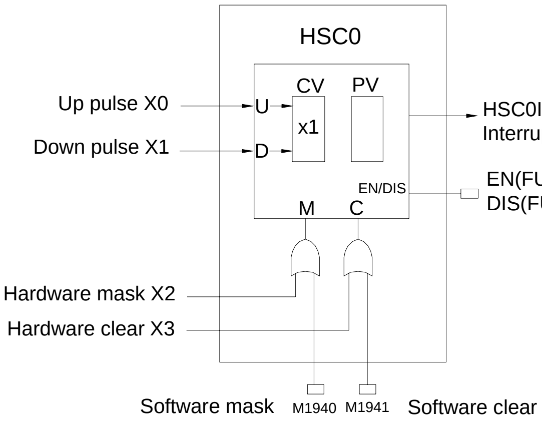
- SHSC, on the other hand, uses the interrupt method to request an interrupt signal to the CPU when the counting input is on the rising edge. Then, the CPU will determine whether it should decrease or increase the internal CV register (since the CV register itself in the CPU is a SHSC CV register, no FUN92 or FUN93 is required). Each time when CV is updated, if the CPU find that it is equal to the PV register value, the CPU will jump immediately to the corresponding SHSC interrupt service routine for processing. Whenever there has a change in SHSC counting or control input can cause the CPU to be interrupted. The higher the counting frequency, the more of CPU time will be occupied. The CPU responding time will be considerably increased or even Watchdog time-out will be caused to force the PLC to stop operating. Therefore, it is preferred to use HHSC first; if it needs to use SHSC, the sum of all FBs-PLC SHSC input frequencies should not exceed 5KHz.

- None of the special relay controls, such as software MASK, CLEAR and direction control, is real time. This means that although MASK, CLEAR or direction change has been set during routine scanning, the signal will only be transmitted to HSC when I/O updating is under way after the completion of routine scanning. Hence, it is not suitable for the real time control in HSC operation (which should be mainly used for initial setting before HSC operation). Should real time control be required, please use hardware to control input or apply the FUN145(EN), FUN146(DIS), FUN92(HSCTR), and FUN93(HSCTW) etc. instructions for control.

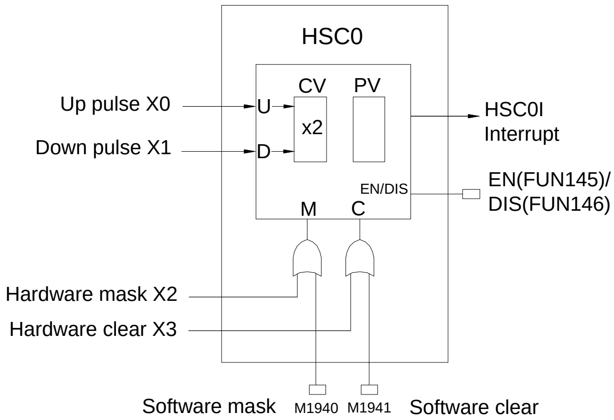
- Every HSC is equipped with the functions, ENable(FUN145) and DISable(FUN146), when SHSC is disabled, it will stop counting and without the interrupt function ; when HHSC is disabled, the counting still works but the interrupt function being disabled.

10.2.1 The Up/Down Pulse Input Mode of High-Speed Counter (MD0，MD1)

The up/down pulse input of high-speed counter has up counting pulse input (U) and down counting pulse input (D) that are independent to each other without any phase relationship. Each of them will +1 (U) or –1 (D) on the CV value when the rising edge of the pulse input occurs (both positive and negative edge for MD1). This also applies when the rising (or falling) edge of the U and D pulse occur simultaneously (it will offset with each other). Both of the two modes have the built-in software MASK and CLEAR (CLEAR is not available for SHSC) control functions, when the control function are not in use should keep the status (such as M1940 and M1941) as “0”. Apart from the built-in software MASK and CLEAR, the controls of hardware MASK and CLEAR can also be configured. The MASK control is first performed by the OR operation of the hardware and software control, then the result is send to the HSC MASK control M, and so does CLEAR. Taking HSC0 as an example, the function schematic diagrams for MD0 and MD1 configured separately are shown as below.

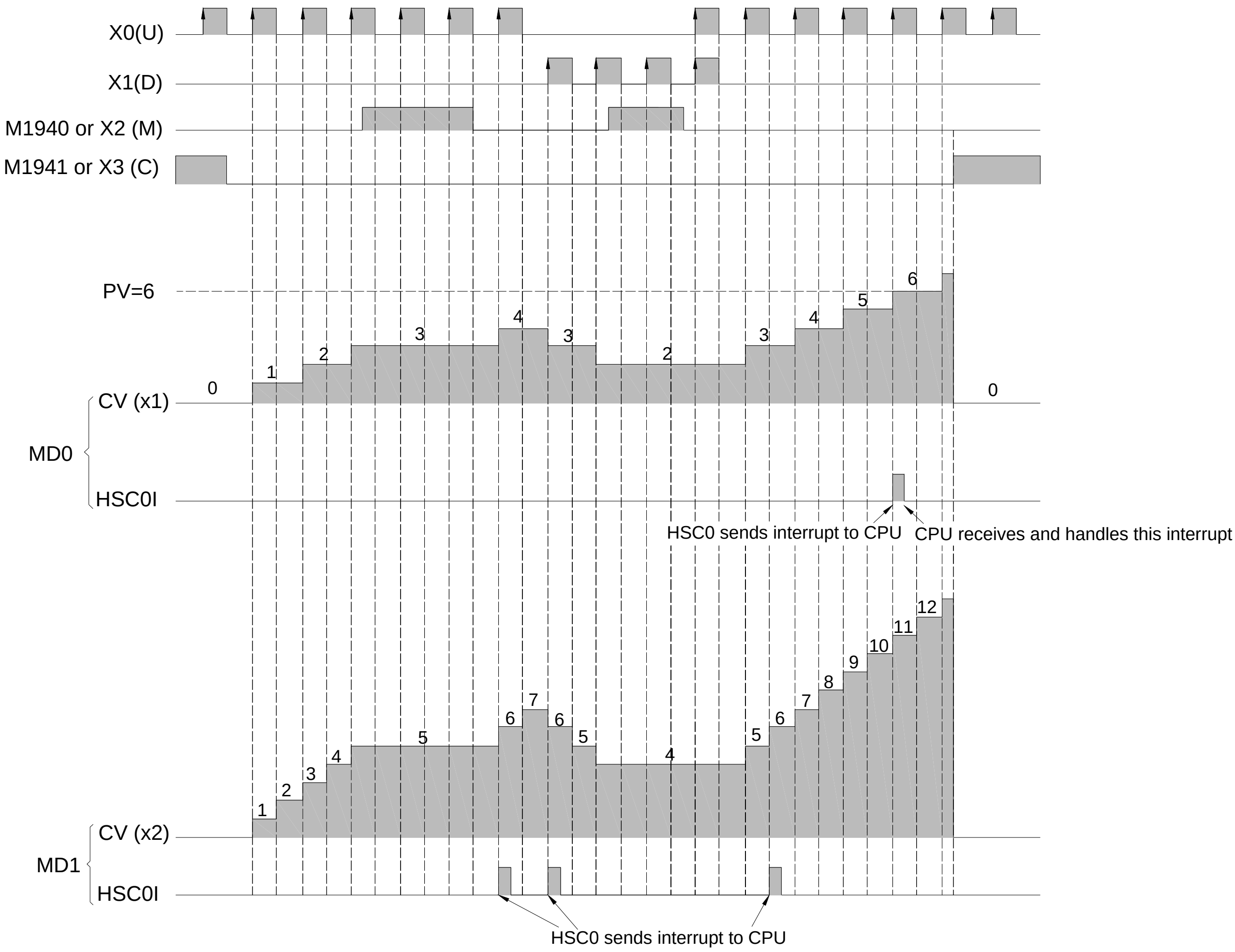


MD0（U/D）



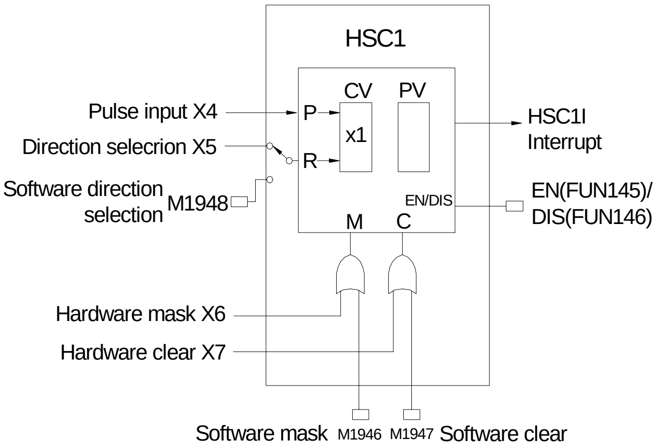
MD1（U/D×2）(HHSC Only)

The Waveforms of the HSC, which is configured as up/down pulse input mode, and PV value is preset to 6:

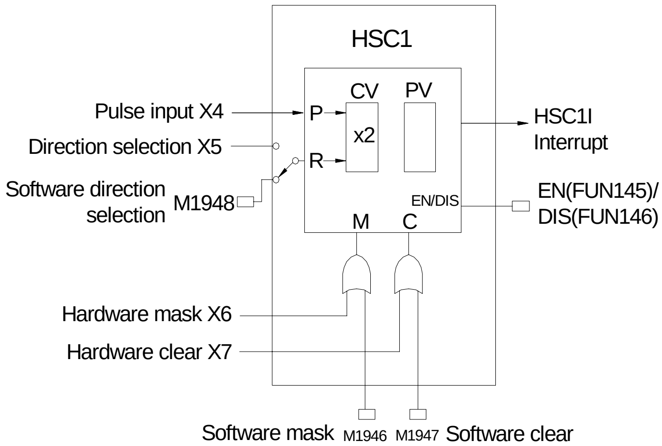


10.2.2 Pulse/Direction Input Mode of High-Speed Counter (MD2, MD3)

The pulse-direction input mode high-speed counter only has one counting pulse input P (pulse). It requires another direction input R (Direction) to decide whether the CV value should +1 (R=0) or –1 (R=1) when the rising edge (both rising and falling edges for MD3) of counting pulse arrives. The same applies to counting of MD2 and MD3 except that MD2 only counts on the rising edge (+1 or –1) and MD3 counts on both rising and falling edges of PS pulse (twice the counts of MD2). These two modes have built-in software MASK, software CLEAR (SHSC does not have clear). When control function is not in use, it must keep the status (such as M1946 and M1947 in this example) to be 0. Apart from the built-in software MASK and CLEAR, the controls of hardware MASK and CLEAR can also be configured. The MASK control is first performed by the OR operation of the hardware and software control, then the result is send to the HSC MASK control M, and so does CLEAR. The function schematic diagrams of HSC1 configured individually for MD2 and MD3 are shown as below.



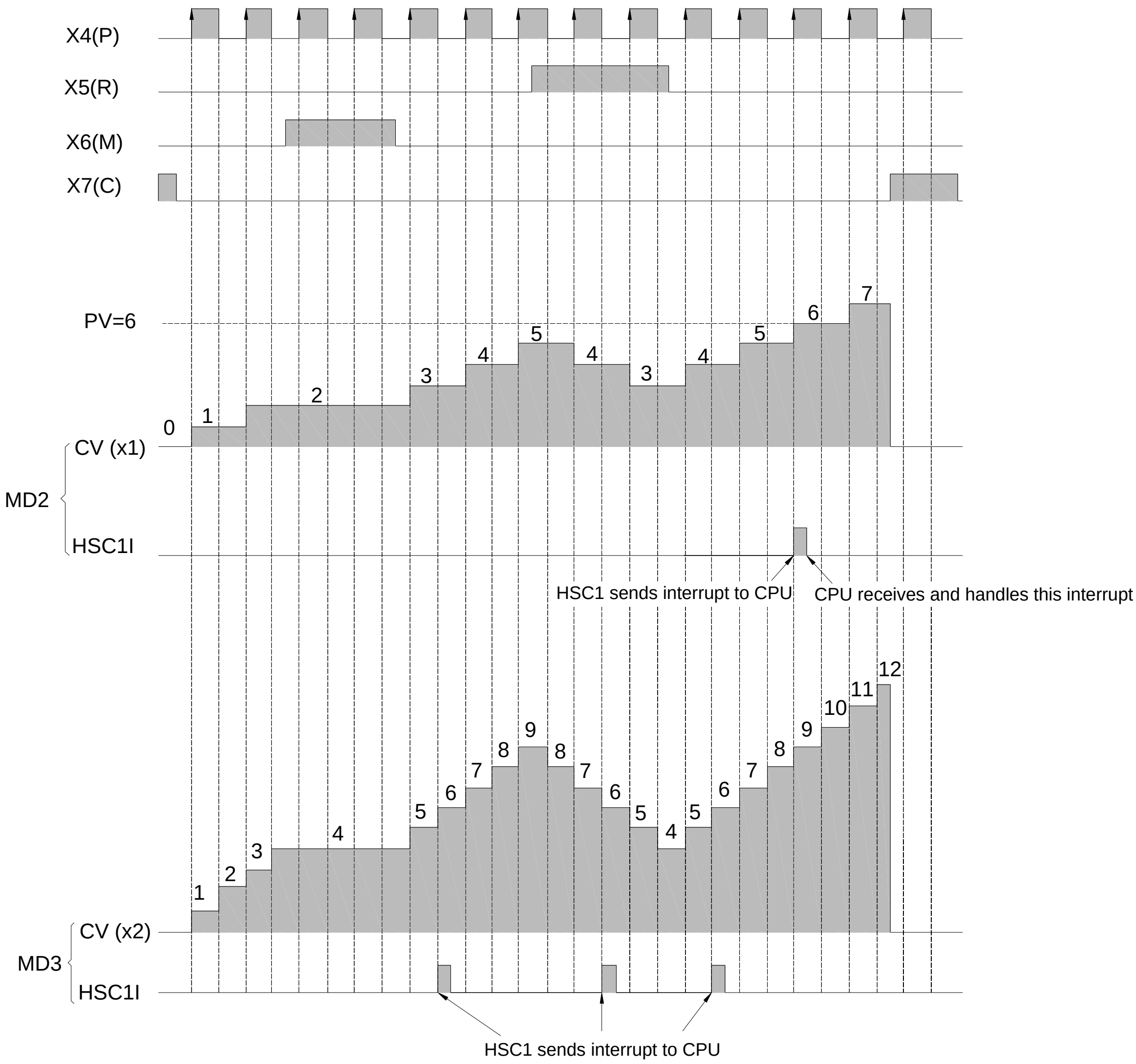
MD2（P/R）



MD3（P/R×2）（HHSC Only）

Direction selection of MD2 and MD3 HHSC, for HSC or SHSC, can be come from the external inputs (such as X5 in this example) or the special relay in CPU (such as M1948 in this example) to reduce the usage of external input points.

The diagram below is the waveform diagram for the relationship between counting and control of the two HSC. In this example the PV value is to 6.



10.2.3 AB Phase Input Mode of High-Speed Counter (MD4,MD5,MD6,MD7)

The AB phase high-speed counter is equipped with phase A and phase B pulse input with counting value +1 or –1, depending on the phase relationship between the two, i.e. the related counting of the two phases. If phase A is ahead of phase B, the CV value should be +1, else, the CV value should be –1. The counting of the four modes, MD4 (A/B), MD5 (A/B×2), MD6 (A/B×3) and MD7 (A/B×4), of AB phase HSC are similar. Their differences are:

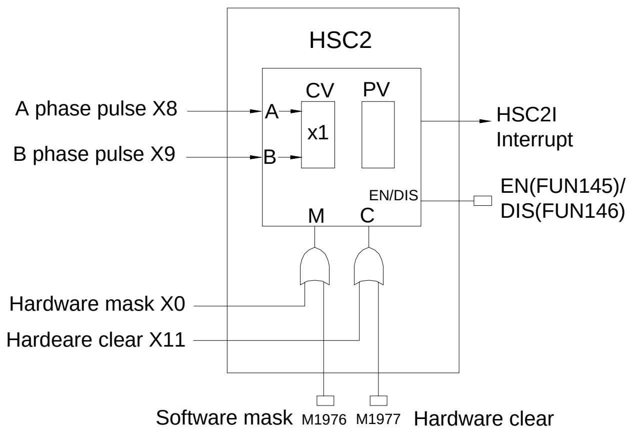
① MD4 (A/B) : The rising edge of A is +1 when A is ahead of B and the falling edge of A is –1 when A is behind B.

② MD5 (A/B×2): The rising and falling edges of A are +1 when A is ahead of B, and –1 when A is behind B (twice the counts of MD4).

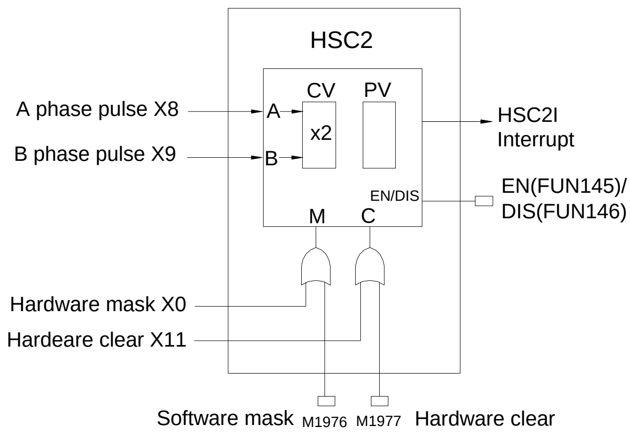
③ MD6 (A/B×3): The rising and falling edges of A and rising edge of B are +1 when A is ahead of B. The rising and falling edges of A and the falling edge of B are –1 when A is behind B (three times the counts of MD4).

④ MD7 (A/B×4): The rising and falling edges of A and B are +1 when A is ahead of B and the rising and falling edges of A and B are –1 when A is behind B (four times the counts of MD4).

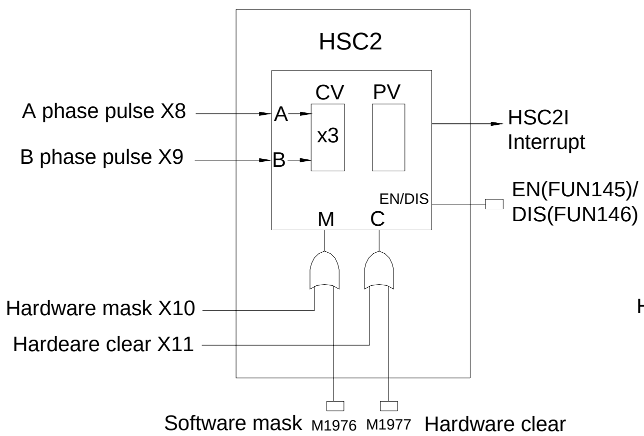
Other MD4～MD7 HSC modes also have built-in software MASK, software CLEAR (SHSC does not have clear). When control function is not in use, it must keep the status (such as M1946 and M1947 in this example) to be 0. Apart from the built-in software MASK and CLEAR, the controls of hardware MASK and CLEAR can also be configured. The MASK control is first performed by the OR operation of the hardware and software control, then the result is send to the HSC MASK control M, and so does CLEAR. The function schematic diagrams of HSC2 for the four MD4~MD7 HSC modes are shown as below.



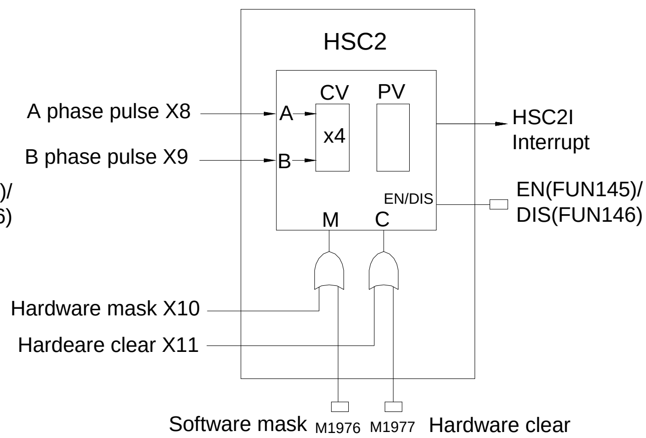
MD4（A/B）



MD5（A/B×2）(HHSC Only)

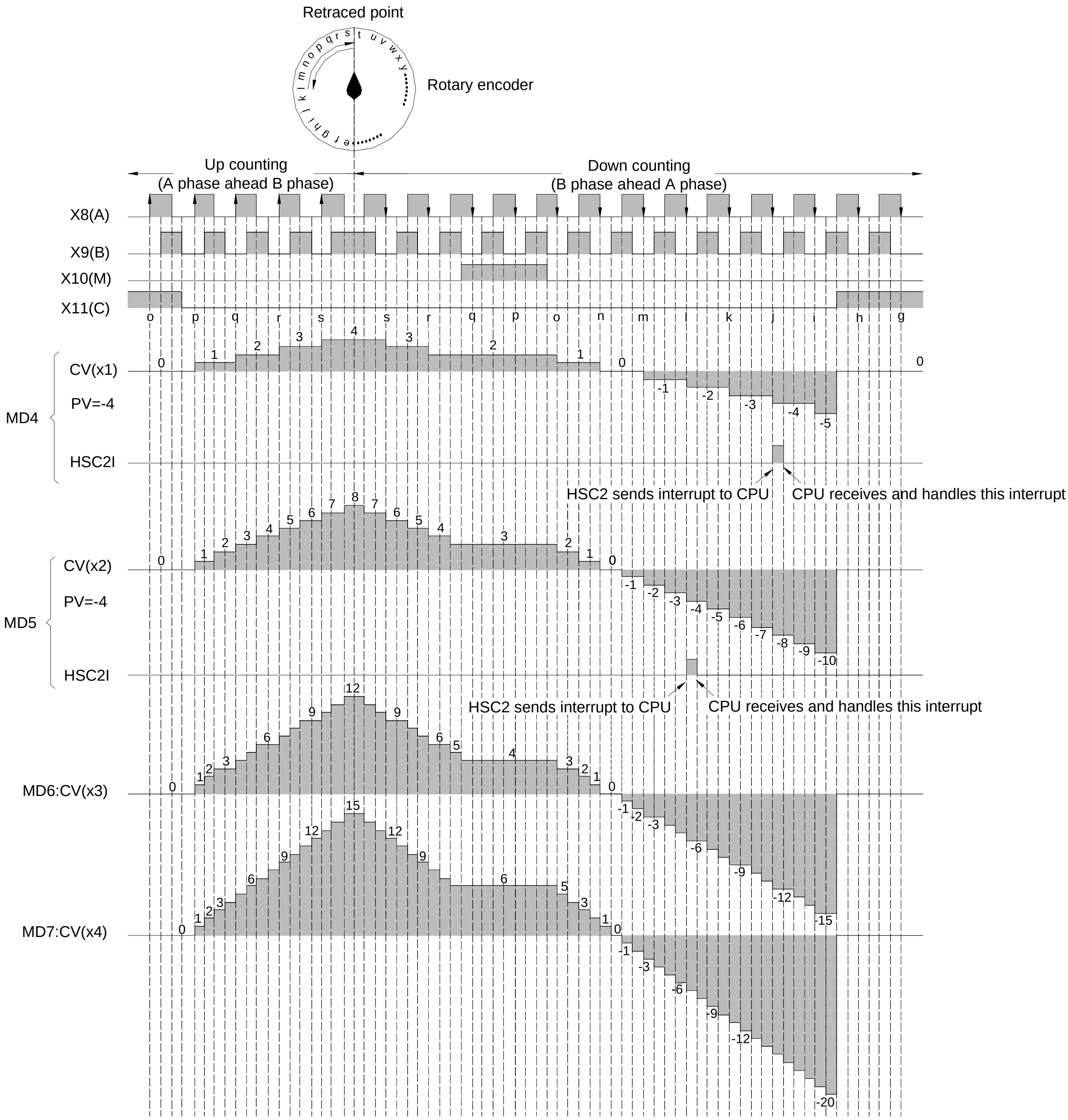


MD6（A/B×3）(HHSC Only)



MD7（A/B×4）(HHSC Only)

The diagram below is the waveform diagram for the relationship between counting and control of the four HSC modes in this example when the PV value is set as at -4.



10.3 Procedure for FBs-PLC High-Speed Counter Application

Start

↓

● Configure HSC counting mode and respective input (by FP-08 or WinProladder)	1.Please refer to Section 10.2 for respective HSC counting modes and principles. 2.Please refer to Section 10.4 for setting examples.
● Complete hardware wiring according to the previous input assignment	1.Please refer to “Digital Input Circuit” in Chapter 6 “Hardware Manual” for hardware wiring.
● Set HSC initial CV value and interrupt PV value in the main program	1.If the HSC is HHSC, it is necessary to apply FUN93 to load it into the HHSC CV and PV in the SoC chip. 2.Please refer to Section 10.5 for program examples.
● Write necessary handling procedures to be taken during interrupt and condition for next interrupt in sub program area	1.Please refer to Section 9.1 for subroutine structure. 2.Please refer to Section 10.5 “Actual Examples” for program examples.
● Start the operation	Please refer to Section 10.5 for program examples and description.

↓

End

10.4 HSC/HST Configuration

10.4.1 HSC/HST Configuration (Using FP-08)

The screen of FP-08 will be taken as an example to describe HSC Configuration in this section. The HSC Configuration, in sequence, includes the following 5 items:

① Select assignment for HSC/HST (only HHSC provides this item selection function). Proceed to next item if selection is HSC. No other items are required if configured as HST.

② Assign respective HSC counting modes (MD0～MD7). After keying in the mode number, FP-08 will automatically display the HSC counting and control input names of the mode and reserve space for users to key in the external input point number Xn. The blank mode field indicates the HSC is not in use.

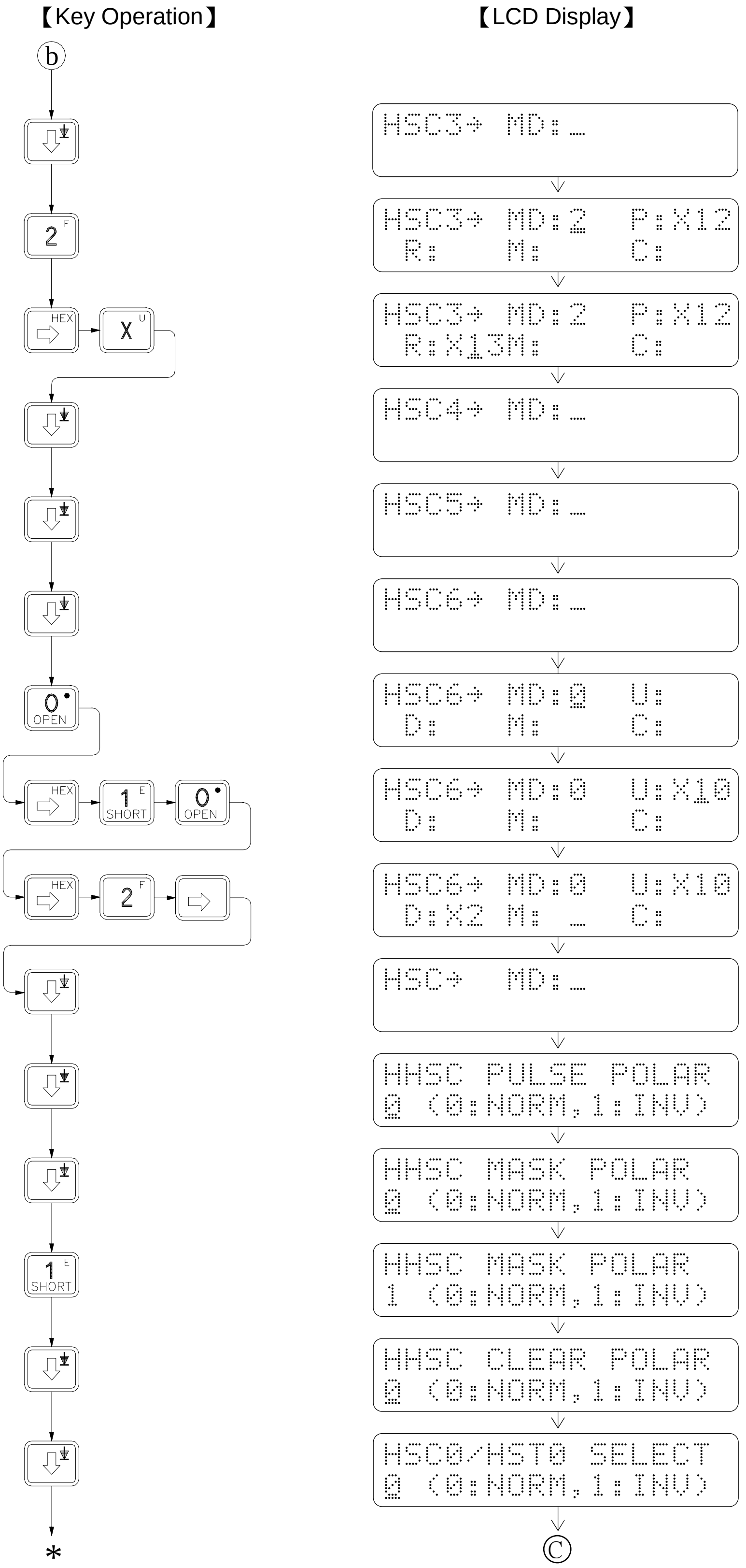
③ Determine whether the respective counting inputs (U, D, P, R, A and B) and control inputs (M and C) are to be applied or not (reserve the space if not in use and fill in the Xn value if it is to be applied. As respective Xn input values of HHSC are fixed, it requires only to key in alphabet “X” and FP-08 will automatically make up the preset number n).

④ Select whether the polarity of each HHSC counting input (U, D, P, R, A and B) is inverse or not, so as to match the polarity of the encoder (0: Not inverse, 1: Inverse. Preset as 0).

⑤ Select whether the polarity of each HHSC control input (M and C) is inverse or not, so as to match the polarity of the encoder (0: Not inverse, 1: Inverse. Preset as 0).

Examples applying FP-08 to perform the above mentioned ①~⑤ configurations

【Key Operation】	【LCD Display】	
SYS	1.CLEAR/INITIAL _	
5 J	5.CONFIGURATION _	
ENT	1)INTERNAL COIL PARTITON	
8 O	8)HSC/HST/INT ASSIGNMENT	
ENT	HIGH SPEED TIMER /COUNTER SELECT	
ENT	Ⓒ → HSC0/HST0 SELECT 0 (0:HSC,1:HST)	• HSC0 is preset as HSC
↓	HSC1/HST1 SELECT 0 (0:HSC,1:HST)	• HSC1 is preset as HSC
1 E SHORT	HSC1/HST1 SELECT 1 (0:HSC,1:HST)	• HSC1 is used as a high-speed counter HST1
↓	HSC2/HST2 SELECT 0 (0:HSC,1:HST)	• HSC2 is preset as HSC
↓	HSC3/HST3 SELECT 0	• HSC3 is preset as HSC
↓	HSC0→ MD:_	• MD field is blank indicating that HSC0 is not in use
↓	HSC2→ MD:_	• There is no need to configured HSC1 as it has been set to HST (No Display). • MD field of HSC2 is blank indicating MD is not in use
7 N	HSC2→ MD:7 A:X8 B:X9 M: C:	*• After 7 is keyed in, the respective MD7 input names will be displayed and the preset values for A and B (X8 and X9) will be filled automatically
HEX → X U	HSC2→ MD:7 A:X8 B:X9 M:X10 C:	• If MASK is required, just key in X and it will automatically fills number 10
ⓐ	ⓑ	



- Key in 2 and the preset number of P will be filled automatically
- Move the cursor to R and key in "X", it will immediately change to X13 and change it to be hardware direction control
- HSC4 is not in use
- HSC5 is not in use
- HSC6 is set as MD0 and respective input names of MD0 SHSC will be displayed automatically
- Assign X10 as the up counting pulse "U" for HSC6
- Assign X2 as the down counting pulse "D" for HSC6
- HSC7 is not in use
- All counting inputs of every HHSC(HSC0～HSC3)are preset as non-inverse
- All MASK controls of HHSC are preset as non-inverse
- Change all MASK inputs of HHSC to inverse (i.e. the MASK function becomes ENable)
- All CLEAR controls of HHSC are preset as non-inverse
- Complete configuration and return to the initial screen display (HSC0/HST0 Item Selection)

- Input value modification can be made by directly key in the new value to overwrite. Use CLR key to delete any input value, if required.
- A blank field (without any value input) indicates the application of the HSC or the input is not required.
- "pulse" in the previous example represents the "Counting Input", i.e. U and D, P and R or A and B, of HHSC.
- "POLAR" represents "POLARITY", i.e. selection of inverse or non-inverse.

- The input point for respective HHSC counting and control inputs are fixed. Therefore, in the “Configuration Examples” of the previous example, it needs only to key in “X” for each HHSC input to indicate that the input is to be applied and FP-08 or WinProladder will automatically make up the preset number for X, to which no change will be allowed. The user may assign respective SHSC counting or control inputs between X0~X15 freely. Hence, it is necessary to key in both the “X” and the number n for SHSC input point number to make it complete.

10.4.2 HSC/HST Configuration (Using WinProladder)

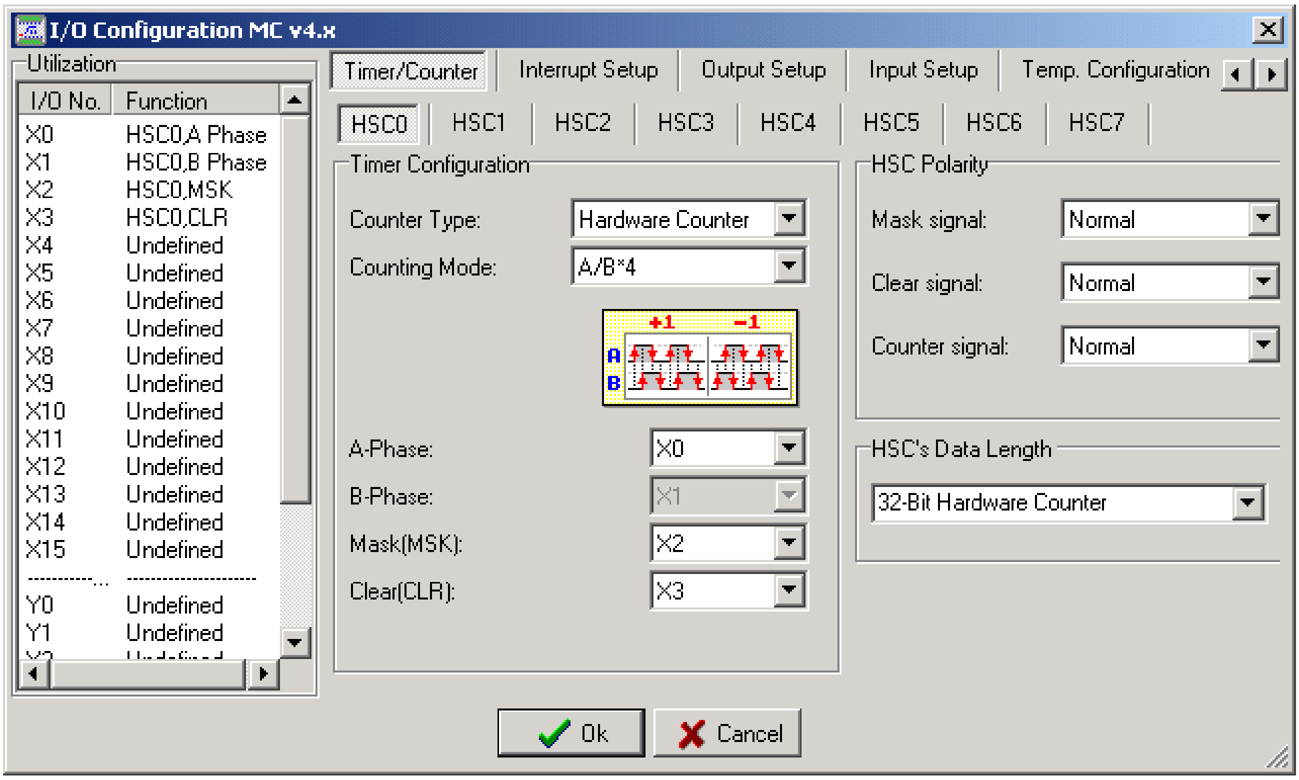
Click the item “I/O Configuration” which in Project Windows :

Project name

System Configuration

I/O Configuration → Select “Timer/Counter”

When “Timer/Counter” window appear then you can choose the Timer or Counter which you want.



---《Timer/Counter Configuration》---

【 Counter Type 】: It can select Hardware Counter or Hardware Timer.

【 Counting Mode 】: It can select the Counting Mode(Example: U/D、P/R、A/B……)

【 A-Phase 】: Select the up pulse input signal. If the Mode is P/R Counting Mode ,and this item will be “PLS”; If the Mode is U/D Counting Mode ,and this item will be “UP”.

【 B-Phase 】: Select the down pulse input signal. If the Mode is P/R Counting Mode ,and this item will be “DIR”; If the Mode is U/D Counting Mode ,and this item will be “DN”.

【 Mask[MSK] 】: It can select Mask input.

【 Clear[CLR] 】**:** It can select Clear input.

---《HSC Polarity》area ---

【 Mask signal 】**:** Determining Mask signal is positive or negative.

【 Clear signal 】**:** Determining Clear signal is positive or negative.

【 Counter signal 】**:** Determining Counter signal is positive or negative.

---《HSC's Data Length》area ---

It can choose 32-bit Hardware Counter mode or 16-bit Timer + 16-bit Counter mode. 32-bit Hardware Counter mode means using two register to record the Counting value. The 16-bit Timer + 16-bit Counter mode means using one register to record Counting value and the other register will be cyclic Timer.

All preset or selectable input point numbers, software MASK, software CLEAR, direction selection and other related numbers of HHSC and SHSC are summarized in the table below:

Type / Signal Allowed		MA/MC/MN							
		HHSC				SHSC			
		HSC0	HSC1	HSC2	HSC3	HSC4	HSC5	HSC6	HSC7
CV Register		DR4096	DR4100	DR4104	DR4108	DR4112	DR4116	DR4120	DR4124
PV Register		DR4098	DR4102	DR4106	DR4110	DR4114	DR4118	DR4122	DR4126
Counting Input	U,P or A	X0	X1/X4	X4/X5/X8	X5/X12	X0～X15	X0～X15	X0～X15	X0～X15
	D,R or B	X1	X5	X9	X13	X0～X15*	X0～X15*	X0～X15*	X0～X15*
Control Input	Mask	X2	X6	X10	X14	X0～X15	X0～X15	X0～X15	X0～X15
	Clear	X3	X7	X11	X15	X0～X15	X0～X15	X0～X15	X0～X15
Software MASK Relay		M1940	M1946	M1976	M1979	M1982	M1984	M1986	M1988
Software CLEAR Relay		M1941	M1947	M1977	M1980	Clear the Current Value Register directly			
Software Direction Selection(MD2,3 Only)		M1942	M1948	M1978	M1981	M1983	M1985	M1987	M1989
Interrupt Subroutine Label		HSC0I	HSC1I	HSC2I	HSC3I	HSC4I	HSC5I	HSC6I	HSC7I

* When SHSC works in MD2(P/R), direction chose by special relay M1983、M1985、M1987 and M1989.

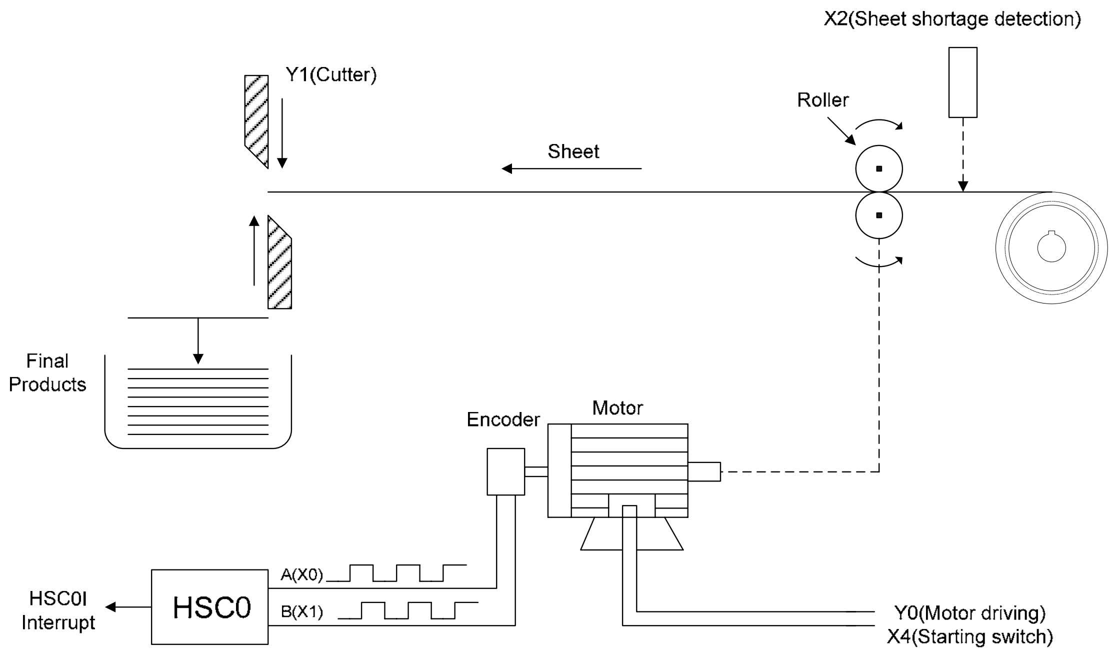
- When working in A-B Mode(HHSC as MD4～MD7、SHSC as MD4), whose A/B input must be used in pair, as X8 and X9.(even number is A-Phase and odd number is B-Phase)
- The input point of X0~X15 in the table above can only be assigned once (i.e. used as one function), which can't repeat to be used.

- FBs-MN's frequency can reach up to 460 KHz.(single phase and AB phase)
- FBs-MC's frequency can reach up to 100 KHz. (single phase and AB phase)
- FBs-MA's frequency can reach up to 20KHz (single phase), and 10KHz (double phase).
- The total input frequencies of SHSC can't be exceed 8 KHz; the higher the frequency, the more it occupy the system (CPU) time, and the scanning duration will be extended abruptly.
- MA only support SHSC.

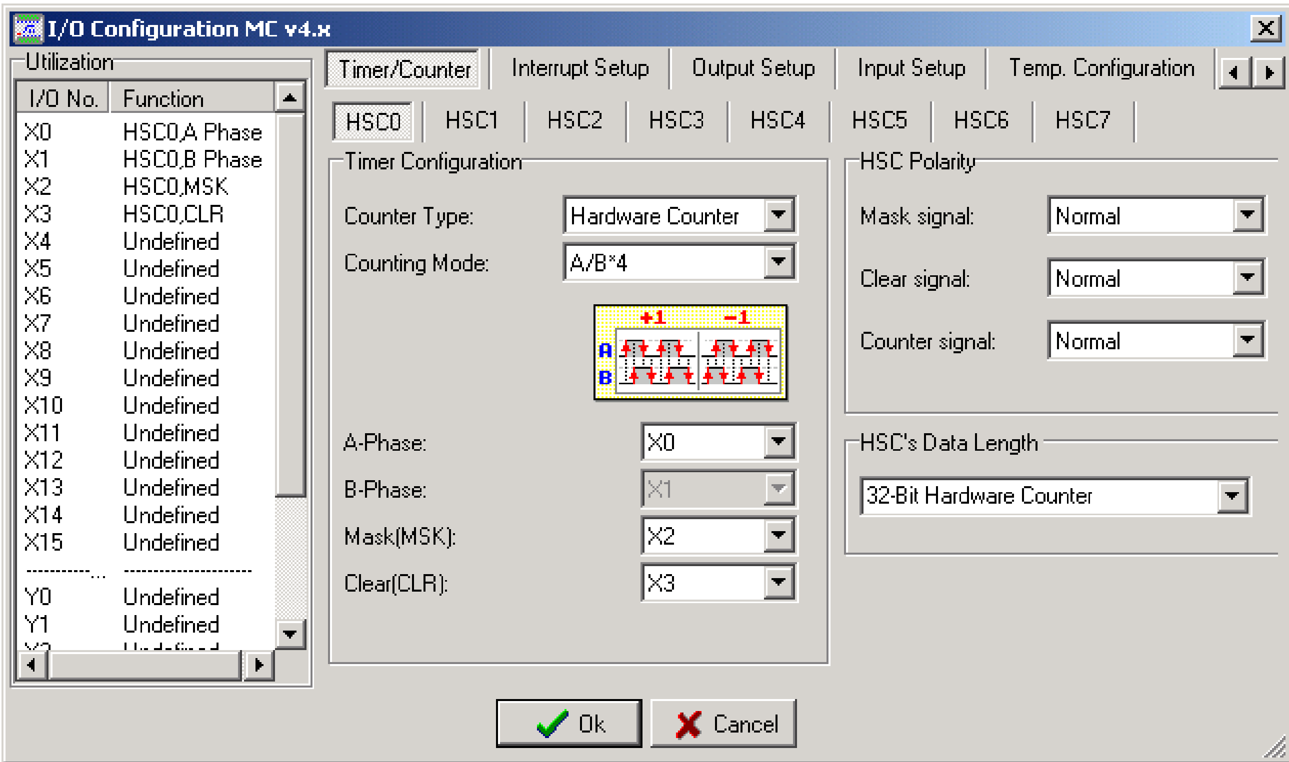
10.5 Examples for Application of High-Speed Counter

Example 1 This example uses high-speed counter for equal-length cutting control.

Mechanism

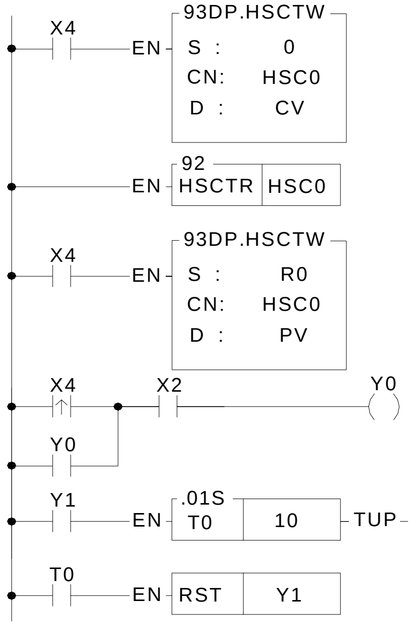


HSC configuration (Just set HSC0 to MD7 and complete the configuration)



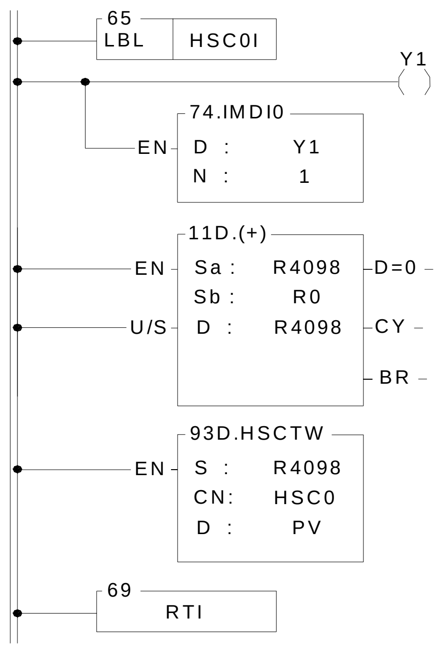
Control program

【Main Program】



- Use FUN 93 to write the contents of the current value register into the CV register of HSC0 in the SoC chip
  CN =0 indicates HSC0
  D =0 indicates CV
- Use FUN 92 to read the counting value of the HSC0 CV register in the SoC chip (store into DR4096)
- Store the counting of cutting length DR0 into DR4098 and use FUN93 to store the value into the PV register of HSC0 in the SoC chip
  CN =0 indicates HSC0
  D =1 indicates PV
- Start the motor
- Turn the cutter Y1 ON for 0.1 second

【Subroutine】



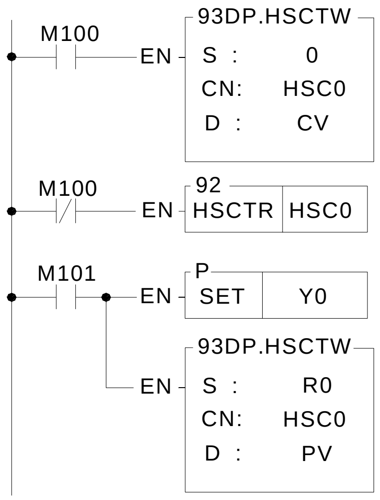
- When HSC0 CV=PV in the SoC chip, the hardware will automatically execute the interrupt subroutine labeled HSC0I
- When counting is up, turn Y1 ON (to cut materials)
- Output Y1 immediately to reduce the error caused by scan time
- Calculate new cutting position and load HSC0 PV

【Description】

1. The main program will initialize the HSC0 CV (CV=0) in advance and move the cropping length (DR0) to the HSC0 PV before starts Y0 to turn on the motor for material conveying.
2. When CV reaches PV, the length of R0 is added to the PV before being reloaded into HSC0 PV.
3. When all materials are rolled out, the material shortage detector X2 will be ON and stop the motor.

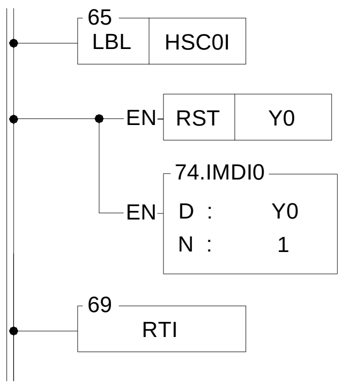
Example 2 Example of high speed counting up action processed by Interrupt

【Main Program】



- Employ FUN93 to write the content of current value register into the CV of HSC0 in SoC chip (reset)
  CN =0, represents HSC0
  D =0, represents CV
- Employ FUN92 to read out the current counting value of HSC0 in SoC chip, and store it into the CV register (DR4096)
  CN=0, represents HSC0
- As M101 change from 0→1, start Y0 ON (begin to operate)
- Employ FUN93 to write the content of preset register into HSC0 PV in SoC chip, which serves as setting value of counting up interrupt
  CN=0, represents HSC0
  D =1, represents PV

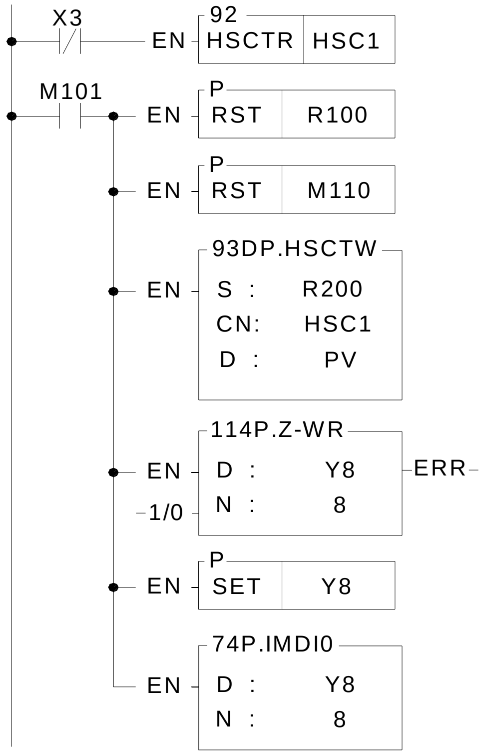
【Subroutine】



- Hardware high speed counter #0 interrupt label
- When time up, it sets Y0 OFF (stop)
- Let Y0 out immediately, so as to stop promptly (otherwise Y0 will have a scan time output delay)

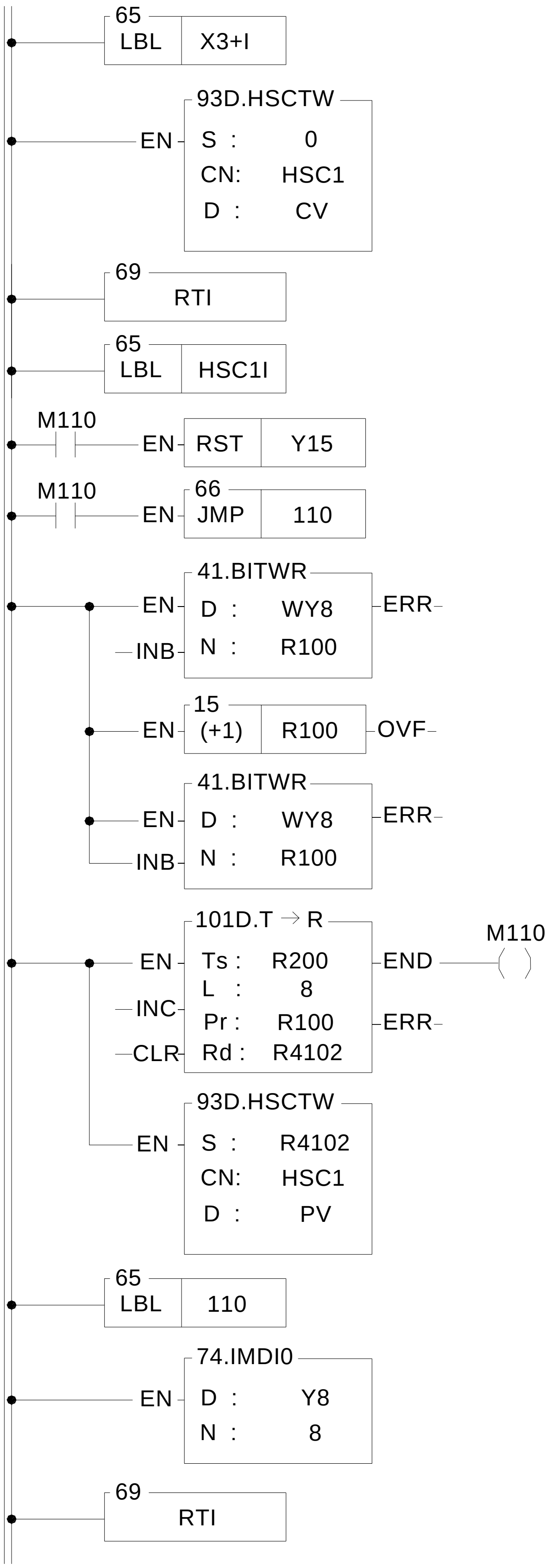
Example 3 Example of Immediate response of multi-zone high speed counting up by Interrupt Processing

【Main program】



- Employ FUN92 to read out the current value of HSC1 in SoC chip, and store it into current value register DR4100
  CN =1, represents HSC1
- As M101 change from 0→1, clears the pointer register to 0
- Clears the flag of the last zone to be OFF
- Employ FUN93 to write preset register content into HSC1 PV in SoC chip, which serve as counting up setting value.
  CN =1, represents HSC1
  D =1, represents PV
- Clear Y8～Y15 to be OFF
- Set Y8 ON, it represents that it is at the zone 0 currently
- Set Y8～Y15 output t immediately

【Subroutine】



- Label name for the X3 rising edge interrupt service subroutine of X3+1 (it must assign X3 to be the rising edge interrupt input)
- When X3 changes from 0→1,employ FUN93 to write the current register content to the HSC1 CV in SoC chip (reset).
  CN = 1, represents HSC1
  D = 1, represents CV
- Labeled as HSC1I hardware high speed counter interrupt service subroutine.
- Turn Y15 OFF when the last zone finished.
- Make the previous zone output OFF
- Set the pointer point to the next zone
- Set the output of next zone to be ON
- Move the counting value of next zone (beginning from DR200 pointer pointed register) to the preset register DR4102
- When it's the last zone, the M110 is ON
- Employ the FUN93 to write the preset value into the HSC1 PV in the SoC chip, which serves as counting up interrupt setting point.
  CN =1, represents HSC1
  D =1, represents PV
- Y8～Y15 output transmitting immediately

10.6 FBs-PLC High-Speed Timer

The minimum timing unit (time base) of an ordinary PLC can only reach 1mS, on which the deviation in scan time should also be added. Therefore, it is necessary to apply high-speed timer (HST) if a more precise timing (e.g. using timer to cooperate with HSC for frequency measurement) is required.

FBs-PLC is built in a high-speed timer (HSTA) with a time base of 16-bits/0.1mS and, as described previously, four 32-bit high-speed counters (HSC0~HSC3) of HHSC that can work as the high speed timer (HST0~HST3) with a time base of 32-bit/0.1mS for using. Thus, FBs-PLC can have up to five high-speed timers. As HSC and INT, all HST can be enabled or disabled (default as enable) by the instructions EN (FUN145) and DIS (FUN146). HSTA and HST0~HST3 are respectively described as below.

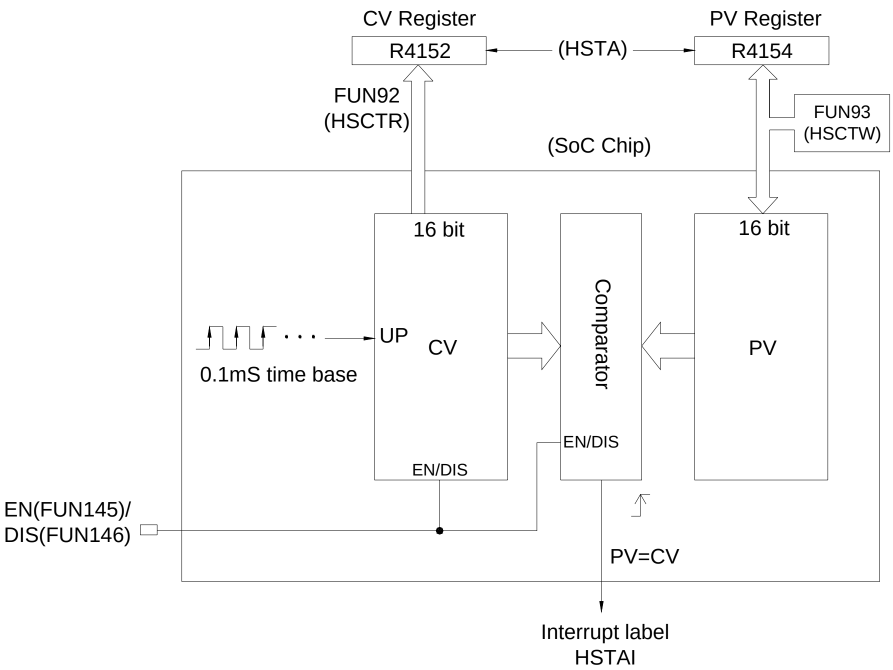
The finest time base for most of the ordinary PLC is 10mS. Though some PLC may have HST with a time base of 1mS. When deviations in the PLC scan time is taken into consideration (e.g. if the scan time is 10mS when the time base is 1mS, the total deviation still exceeds 10mS), the figure of 1mS becomes meaningless. Therefore, these PLCs can’t be applied in high precision timing. FBs-PLC, having a time base of 0.1mS, has no deviation in scan time for its time up is sent out by interrupt to provide a precision 100 times better than ordinary PLCs’ timer application and can be used for many applications demanding precision timing.

10.6.1 HSTA High-Speed Timer

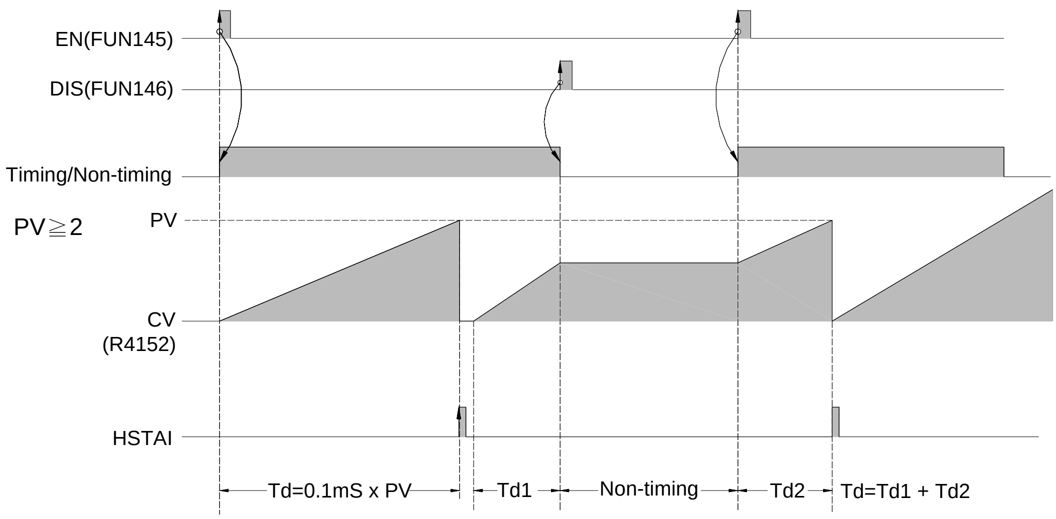
HSTA is a 16-bit hardware timer built in the SoC chip. As HHSC, it must use the instruction FUN93 (HSCTW) to load the PV to the HSTA PV in the chip, and with the instruction FUN92 (HSCTR) to read for CV. HSTA can be used as a timer having two different functions. FBs-PLC will use it as a general 16-bit delay timer when PV $\geq$2 and as a 32-bit cyclic timer when PV=0.

A. HSTA 16-bit high-speed delay timer (Timely interrupt timer)

After HSTA starts timing, the delay timer will delay for a time of PVx0.1mS before sending an interrupt out. When PV>0, HSTA served as a delay timer which is 16-bit and its PV value can be set as 0002H~FFFFH. i.e. the delay time can be set as 0.2mS~6.5535 seconds. Except that having a more precise time base and being able to send an interrupt out immediately at time-up to provide a much higher timing precision, the applications of HSTA are the same as an ordinary delay timer. The diagram below is the structure diagram for HSTA being used as a delay timer. Please refer to Section 10.6.3 “Program Examples” for detailed function and application.

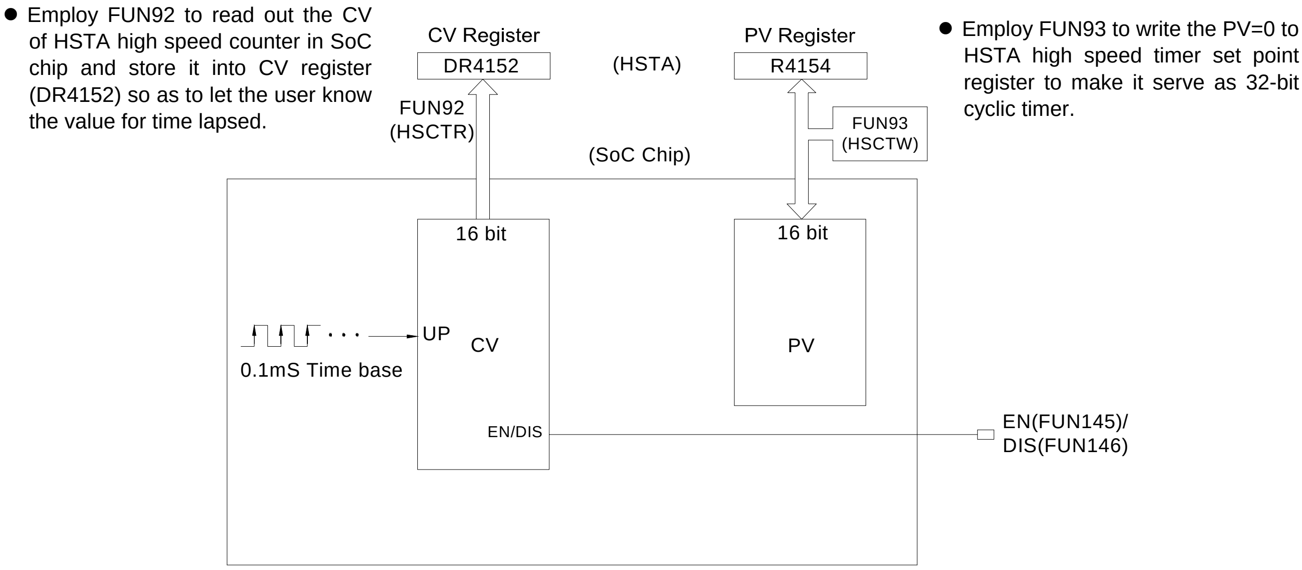


- Apply FUN93 to write the PV into preset register of HSTA high speed timer in SoC chip, which serves as timely interrupt timer (for every set point of timer it perform once the timely interrupt subroutine with label name of “HSTAI”).



B. HSTA 32-bit high-speed cyclic timer

The so-called “Cyclic Timer” is a timer that add 1 to its current value for every fixed interval and will persistently carry out up counting cyclic timing. Its CV value will cycle around as 0, 1, 2, ··· 2147483647, 2147483648, 2147483649, ······ 4294967295, 0, 1, 2, ··· (as the time base is 0.1mS, CV value x 0.1mS will be its accumulative time). In fact, the cyclic timer is an up counting cyclic timing clock having a time base of 0.1mS that can operate endlessly and be used to read any two events at the time when they occurred and to calculate the time interval between the occurrence of the said two events. The Diagram B as shown below is the structure diagram for HSTA being used as a 32-bit cyclic timer. As shown in diagram, when cyclic timer PV=0, it will not send out the interrupt. To obtain the timing value, it is necessary to use FUN92 to access the CV value from the SoC chip and save it to the 32-bit CV register (DR4152) in the PLC. The typical application of the cyclic timer is for more precision of turning speed (RPM) detection under the circumstances when the change in turning speed (RPM) is huge or when it is extremely low. Please refer to Example of Section 10.6.3 for description.



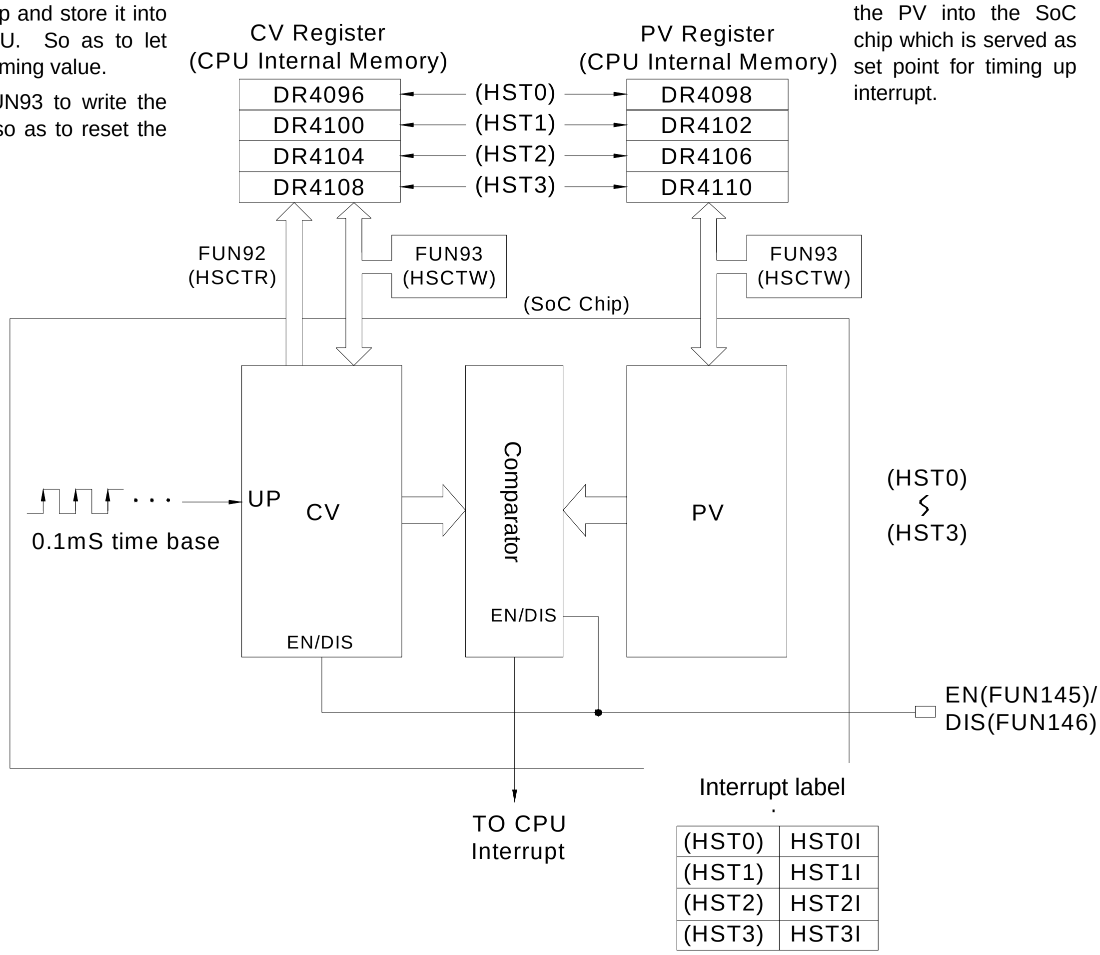
10.6.2 HST0～HST3 High-Speed Delay Timer

A. HST0~HST3 high-speed delay timer (Timely interrupt timer)

HHSC (HSC0~HSC3) can be configured as four 32-bit high-speed delay timers, HST0~HST3. They have the same functions and time base as a 16-bit HSTA delay timer except that HST0~HST3 are 32-bit to plan HHSC as HST only needs to select “1” in the HSC/HST Item Selection under Item 8 “HSC/HST/INT” of FP-08 or WinProladder “Configuration”. Please refer to the example (to configure HSC1 as HST1) in Section 10.4 “HSC/HST Configuration”. The diagram below is the function structure diagram for HHSC being planned as a HST. Its applications are the same as that of a 16-bit HSTA. Please refer to Section 10.6.4 “Program Examples”.

- Employ FUN92 to read out the current timing value in SoC chip and store it into the CV register of CPU. So as to let user know the current timing value.
- It may also employ FUN93 to write the CV into the SoC chip so as to reset the timing value.

- Apply FUN93 to write the PV into the SoC chip which is served as set point for timing up interrupt.

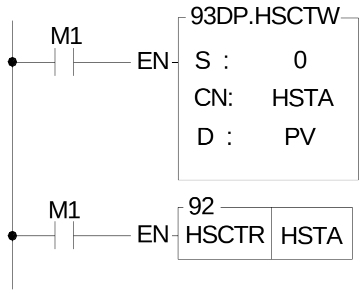


B. HST0~HST3 32-bit cyclic timer

According to demand, configured the HHSC(HSC0~HSC3) to be the 32-bit timers of HST0~HST3. For interval of every 0.1mS, the current timing value register in SoC chip will be increased by 1. User may use FUN92 instruction to read out the current timing value and store it into the CV registers (DR4096, DR4100, DR4104, and DR4108) of CPU. Therefore the content of CV register of CPU become 0, 1, 2, ……, 7FFFFFFFH, 80000000H, ……., FFFFFFFFH, 0, 1, …… etc. variation of values for 32-bit. With the timing calculation technique to count the interval between two events, it can obtain infinite number of 0.1mS 32-bit timers.

10.6.3 Examples for Application of High-Speed Timer HSTA

Example 1 HSTA serve as 32-bit cyclic timer

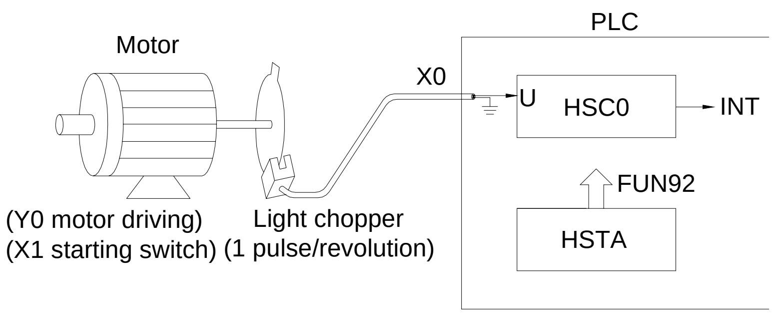


- Employ FUN93 to write the preset value into the HSTA PV in the SoC chip
  CN =4, represents HSTA
  D =1, represents PV
- Employ FUN 92 to read out the current timing value of HSTA in SoC chip and store it to DR4152
  (DR4152 value change from 0,1,2, ……,FFFFFFFF,0,1,2,……cyclic variation, the unit is 0.1mS)
- CN =4, represents HSTA

Example 2 Application example for cyclic timer

This example uses HSTA as a cyclic timer, cooperating with HSC0, to read the time interval for accumulation of 10 pulses and sending an interrupt out each time as 10 pulses are accumulated and, reciprocally, find out the required RPM (the number of pulses is fixed when the time varies).

Mechanism



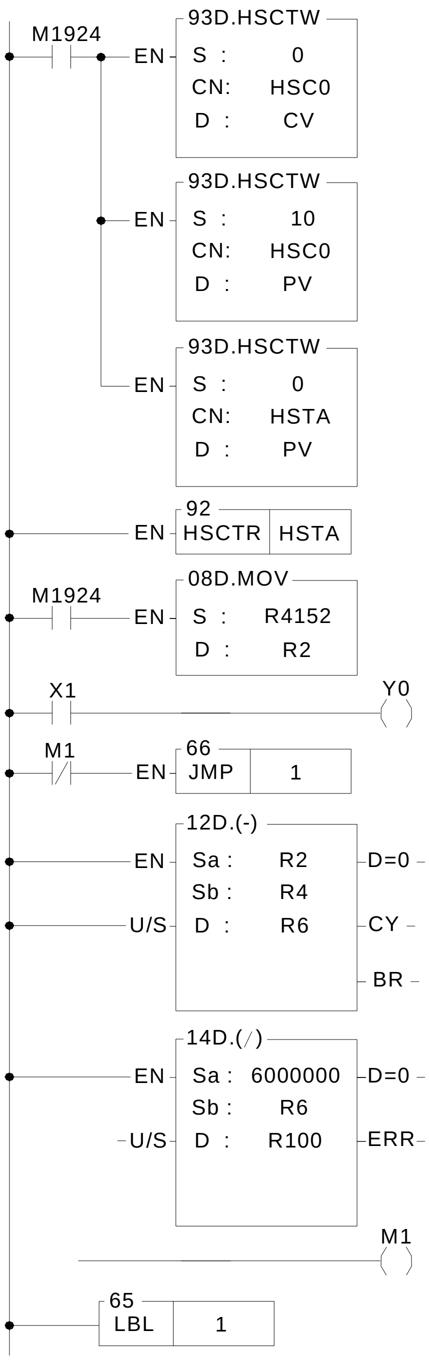
HSC and HST configuration

① As HSTA is built in, no configuration is required. Simply make PV =0 to make it as a 32-bit cyclic timer.

② To cooperate with the photo interrupter, set the HSC0 as an up counting counter having single input (MD0, but use only U input).

※ All other settings (polarity of counting and control inputs) are preset (non-inverse) and should not be changed.

【Main Program】

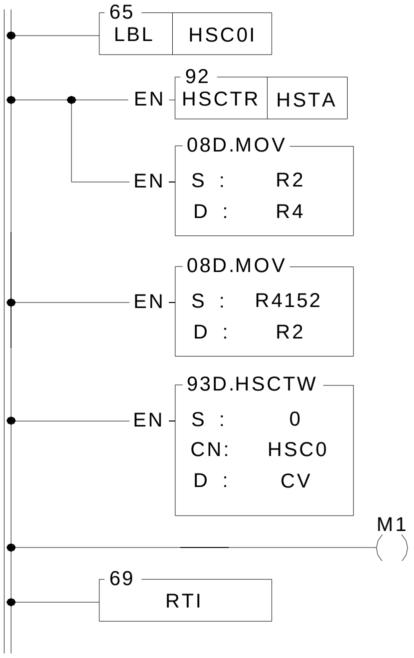


- Employ FUN93 to write current value 0 into the CV of HSC0 in SoC chip (reset)
  CN =0, represents HSC0
  D =0, represents CV
- Write 10 into the preset register in SoC chip, which acts as interrupt value for counting up;
  FUN93 CN=0 indicates HSC0 and D=1 indicates PV
- Write 0 into the preset register, and HSTA is configured as a 32-bit high-speed cyclic timer
  FUN93 CN=4 indicates HSTA and D=1 indicates PV
- Read the current timing value
- The initial value of HSTA CV register is stored to DR2
- Find interval for each HSC0 interrupt
- Rotating speed $= \frac{N}{\Delta T} \times 60$ RPM

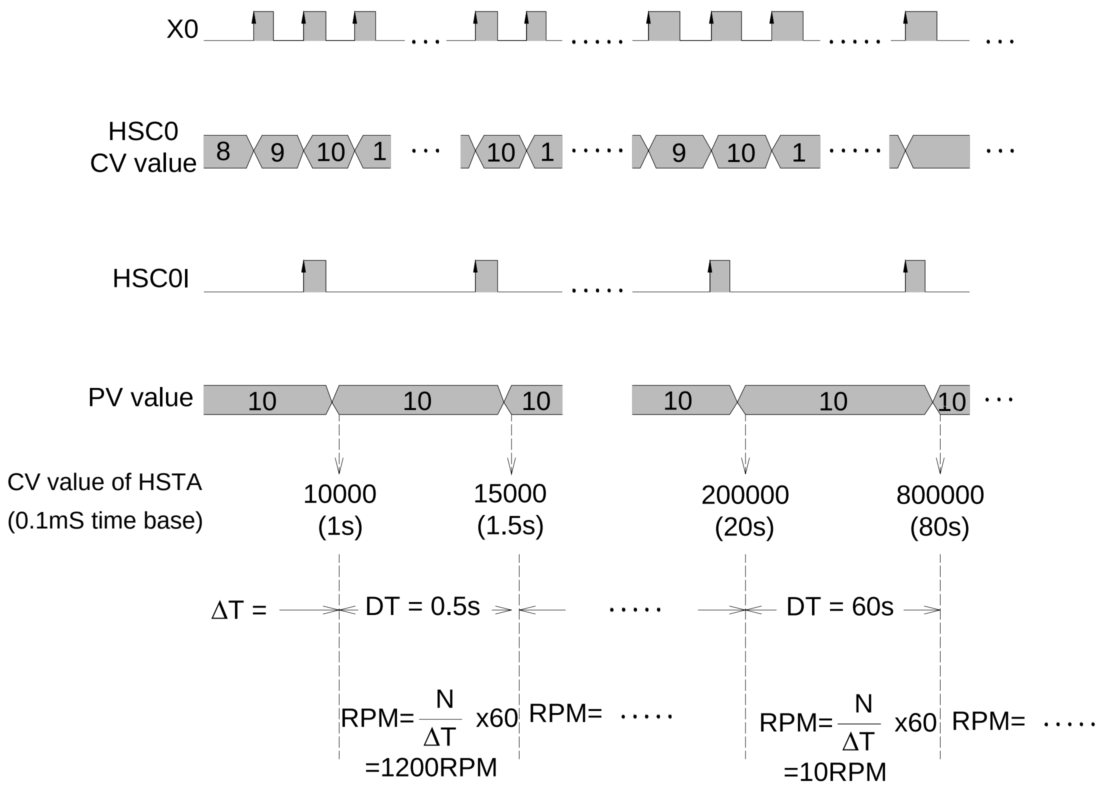
  N=10, $\Delta T = \Delta CV \times 0.1mS = \frac{(\text{currentCV} - \text{previousCV})}{10000S}$

  Therefore rotating speed $= \frac{6000000}{\Delta CV}$ RPM
- R100=RPM
- Clear the calculation flag of RPM

【Subroutine】

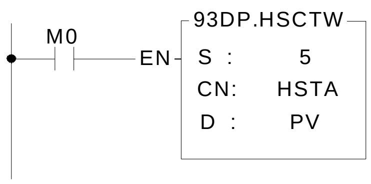


- Each time when HSC0 accumulates 10 pulses, the hardware will automatically run this interrupt subroutine
- Read the HSTA CV
- Reset the current value to 0
- M1=ON, RPM calculating flag



Example 3　HSTA serve as timely interrupt timer program

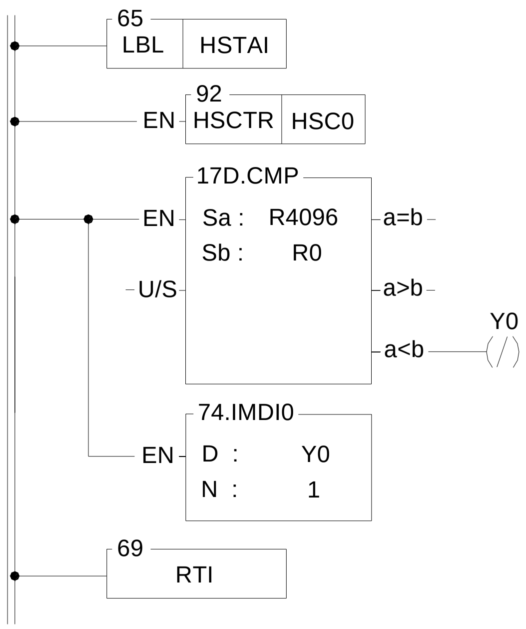
【Main Program】



- Set up the period of timely interrupt time. S=5 represents that it performs the interrupt service subroutine with the label name of HSTAI every 0.5mS.

- Employ FUN93 to write the preset value into HSTA PV in SoC chip, which serve as time up for interrupt preset value.
  CN =4, represents HSTA
  D =1, represents PV

【Subroutine】



- Interrupt service subroutine with the label name of HSTA.

- Read the current value of hardware high speed counter HSC0 once every 0.5mS.

- To tell whether the current counting value is greater than or equal to R0. if yes, then Y0 will be ON.

- Update output Y0 immediately, so as to reach the high speed output reaction
  (otherwise there will be introduced a delay in scan time)

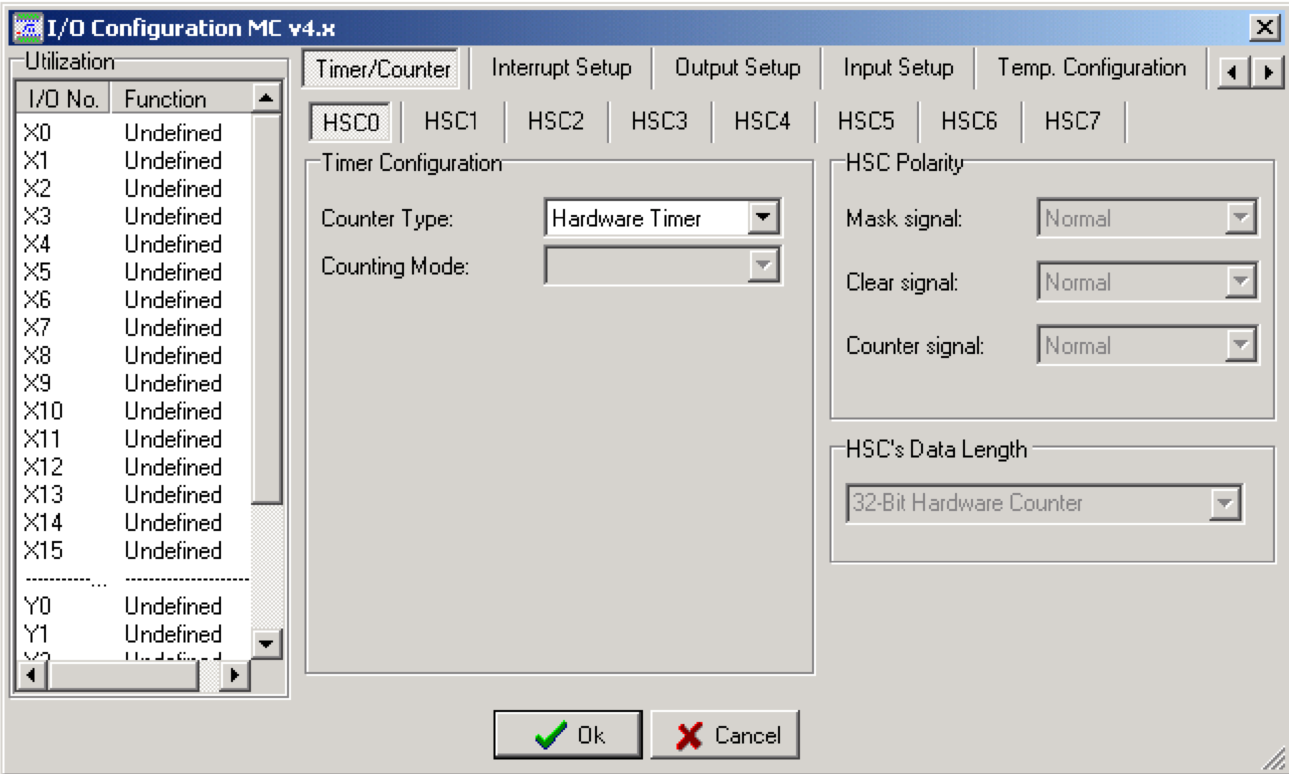
10.6.4 Examples for Application of High-Speed Timer HST0~HST3

HSC and HST configuration(Using WinProladder)

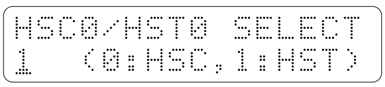
Click the item “I/O Configuration” which in Project Windows :

Project name
- System Configuration
  - I/O Configuration → Select “Timer/Counter”

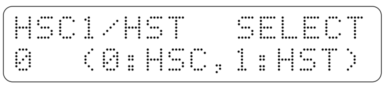
- When “Timer/Counter” windows appear, then you can choose the “Hardware Timer” in Counter Type item, then HHSC (Hardware High Speed Counter) can configure to be HHT.(Hardware High speed Timer)
- User don’t have to configure the HSTA, because the HSTA is default. Only you want HHSC(Hardware High Speed Counter) to be HHT.(Hardware High speed Timer) and you have to configure it.



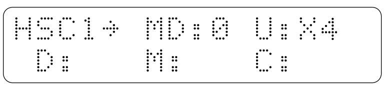
HSC and HST configuration(Using FP-08)



- HSC0 is set as HST0



- HSC1 is preset as HSC



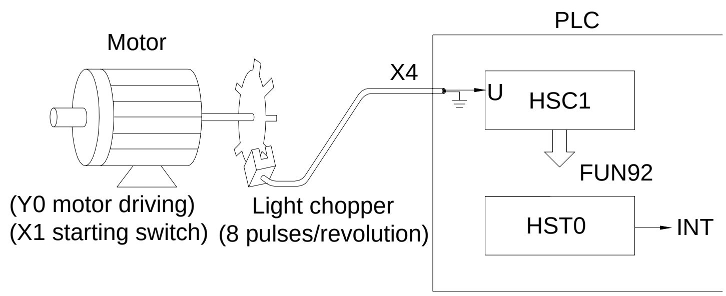
- HSC1 is set as MD0, an up counting counter with single input. Other inputs will not be used.

- All other settings (polarity of counting and control inputs) are default (Non-inverse) and should not be changed.

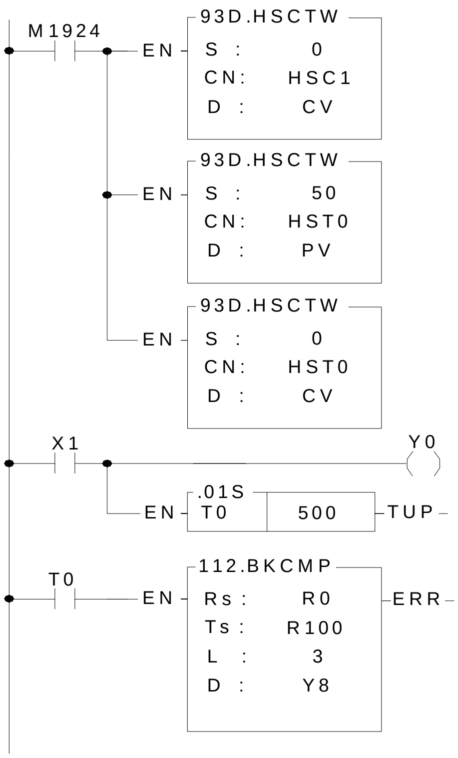
Example1 Application example for delay timer

This example configures HSC0 as a HST0 delay timer. At the same time, by connecting the high-speed counter HSC1 with a rotary motor of an automatic wood drilling machine and sending out an interrupt at a fixed period. Each time interrupt occur will read the counting value of the counter. Then, by comparing the change in speed between the number of the motor's rotation when no loading is applied (operating without drilling) and that when the drill head is pressing down (drilling), the change of the motor's RPM can be calculated. It is understood that resistance will be less and motor's RPM will be faster when the drill head is normal (sharp) than when the drill head is blunt. When the drill head is broken, it works like operating without drilling that no resistance exists and RPM is the fastest. Usually the difference in rotating speed among the three conditions is not significant and which cannot be sampled and detected by an ordinary timer having a more than tens of ms of deviation. However, applied with an HST having a time base of 0.1mS that incorporating interrupt, the drill head's status (normal, blunt or broken) can be detected and, thus, warning can be given or operation can be stopped in due time for drill head replacement.【The time is fixed and the number of pulses varies】

Mechanism

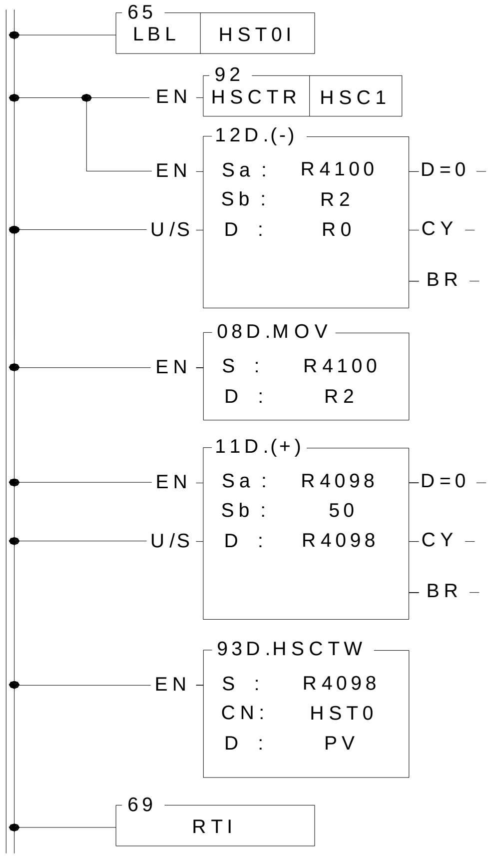


【Main Program】



- Employ FUN93 to reset current value register in SoC chip. FUN93 CN=1 indicates HSC1 and D=0 indicates CV
- HST0 PV value is set as 50, i.e. one interrupt every 5mS (50×0.1mS)
- The initial value of HST0 CV register is 0
- Use FUN112 to compare the drill head's RPM speed after starting the motor for 5 seconds
  R0: The number of HSC1 pulses obtained in every 5mS

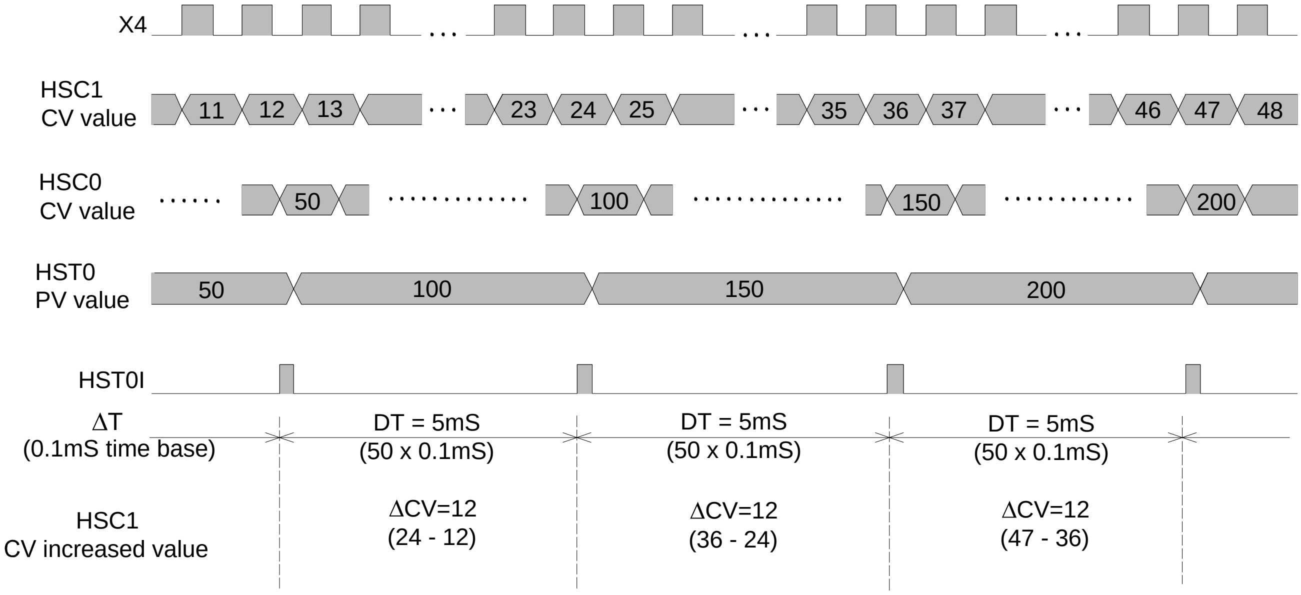
【Subroutine】

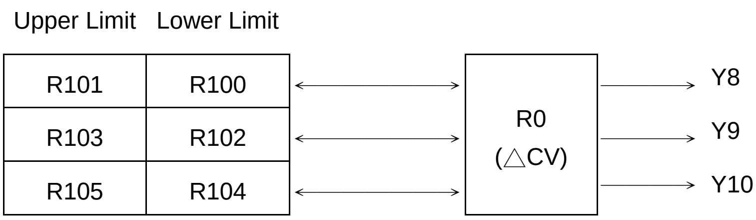


- The hardware will execute this subroutine once every 5mS
- Read the current counting value of HSC1 and put it into DR4100
- Find out the increment of HSC1 CV value in this 5mS interval and store the value into DR0
- Calculate the new HSC0 PV

【Description】

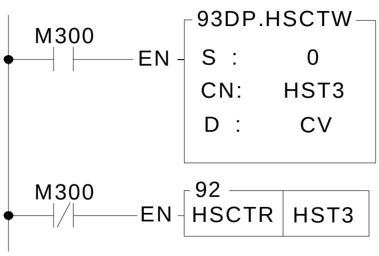
Supposed that the drill head's normal RPM is 18000rpm and the photo interrupter will generate 8 pulses in one revolution, then the frequency of the pin U of HSC1 is 18000/60×8=2400Hz, i.e. 12 pulses will be generated for every 5mS. Therefore, HST0 can be used to send an interrupt and read the HSC1 CV value every 5mS to get the RPM value.





※ Setting different upper and lower limits to category the RPM condition

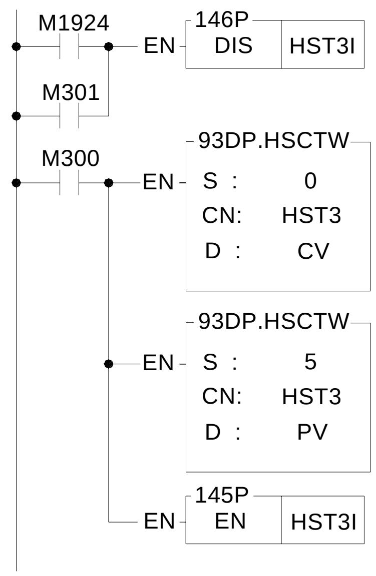
Example2 Hardware high speed timer HST3 serve as 32-bit cyclic timer



- As M300 change from 0→1, clear the current value register to 0
- Employ FUN 93 to write current value 0 into the HST3 CV (reset) in SoC chip
  CN =3, represents HST3
  D =0, represents CV
- Employ FUN92 to read out the current timing value of HST3 in SoC chip and store it into the current value register DR4108
  (DR4108 value cyclically changes from 0, 1, 2, ⋯⋯, FFFFFFFF, 0, 1, 2, ⋯⋯ the unit is 0.1mS)
  CN =3, represents HST3

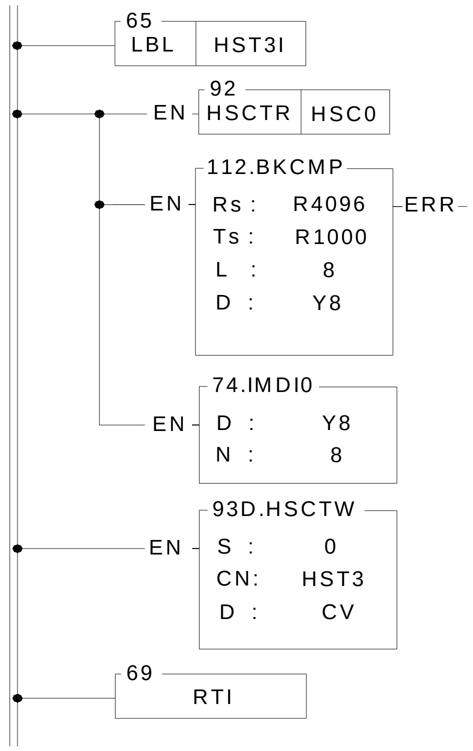
Example3 Hardware high speed timer HST3 serve as periodic interrupt timer

【Main Program】



- Turn on or M301 is ON, it prohibits the HST3 from sending periodic interrupt
- As M300 change from 0→1, clear the current register to 0
- Employ FUN93 to write current value 0 into the HST3 CV (reset) in SoC chip.
  CN =3, represents HST3; D=0, represents CV
- Set up periodic interrupt interval; PV=5 represent every 0.5mS perform once the interrupt service subroutine with label name of HST3I.
- Employ FUN93 to write the preset value into the HST3 PV in SoC chip, which serve as time up interrupt preset value.
  CN=3 represents HST3; D=1 represents PV
- Enable the HST3 interrupt

【Subroutine】



- Hardware high speed Interrupt service subroutine with the label name of HST3I.
- Read the current value of hardware high speed counter HSC0 once every 0.5mS.
- To tell which zone of the electronic drum does the current counting value fall, and set the corresponding output point to be ON.
- Update output Y8～Y15 immediately
- Employ FUN93 to reset current value register into the HST3 CV in SoC chip (reset).
  CN=3 represents HST3; D=0, represents CV

Chapter 11　The NC Positioning Control of FBs-PLC

People use ordinary motor to exercise positioning control in early stage; since the speed and precision demand was not so high then, it was enough to fulfill the demand. As the increasing of mechanical operation speed for the efficiency purpose, finished product quality standard, and precision demands are getting higher, the stopping position control of motor is no more what the ordinary motor is capable to do. The best solution for this problem is to adopt NC positioning controller which incorporate with stepping or servo motor to do the position control. In the past, the extremely high cost limited the prevailing of its usage; however, the technology advance and cost decreasing, which made the pricing affordable, had helped to increase the prevailing of usage gradually. To cope with this trend, the FBs-PLC integrated into its internal SoC chip the special NC positioning controller that is available on the market, therefore makes it free from the bothersome data transaction and linking procedure between PLC and special NC positioning controller. Furthermore, it greatly lowered the entire gadget cost hence provides the user the solution for a good bargain, high quality, simple, and convenient integrated NC positioning control with PLC.

11.1 The Methods of NC Positioning

The methods for controlling interface of PLC and stepping or servo driver are as follows:

- Giving command by way of digital I/O: Easy to use but less dexterity in application.
- Giving command by way of analogue output: Better dexterity in controlling reaction but it is with a higher cost and easy to be interfered by noise.
- Giving command by way of communication: There is no standard for communication protocol and it is confined in communication reaction thus constitutes a bottleneck for application.
- Giving command by way of high speed pulse: The cost is low and is easy to precisely controlled.

Of these methods, controlling stepping or servo driver with high speed pulse is more frequently used method. The main unit of PLC contains multi-axis high speed pulse output and hardware high speed counter, and it can provide easy using, designing for positioning program editing. Therefore it makes the related application even more convenient and comfortable.

Following two kinds are frequently used NC server system that constituted by PLC associates with servo drivers:

- Semi closed loop control

  The PLC is responsible for sending high speed pulse command to servo driver. The motion detector installed on servo motor will forward directly to server driver, closed loop reaches only to server driver and servo motor. The superior point is that the control is simple and the precision is satisfactory (which is suitable for most of the applications). The defect is that it can't fully reflect the actual shift amount after the transmission element; furthermore, the element being consumed, become aging, or has defect will not be able to be compensated nor checked to verify.

- Closed loop control

  The PLC is responsible for sending high speed pulse command to servo driver. In addition to that the shift detection signal installed on servo motor which will be forwarded directly to servo driver, the attached shifting detector installed after the transmission element can fully reflect the actual shift amount and forward it to the high speed counter that PLC contains. So as to make the control becomes more delicate, and help to avoid the defect of above mentioned semi closed loop.

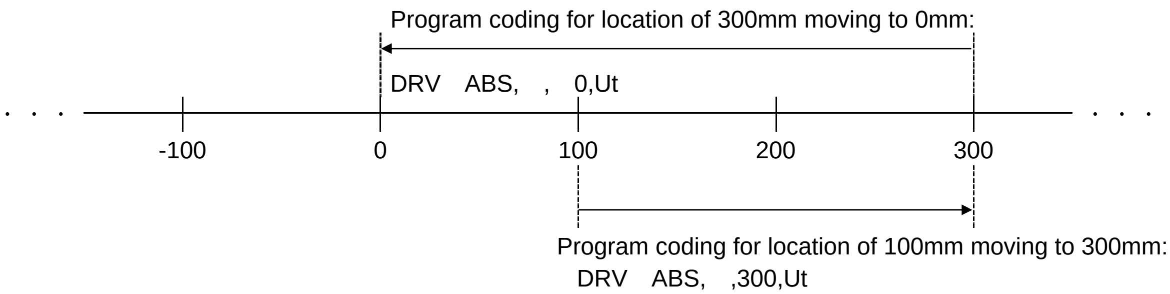
11.2 Absolute Coordinate and Relative Coordinate

The designation of moving distance can be assigned by absolute location (absolute coordinate positioning), or assigned by relative distance (relative coordinate positioning). And the DRV instruction is used to drive motor.

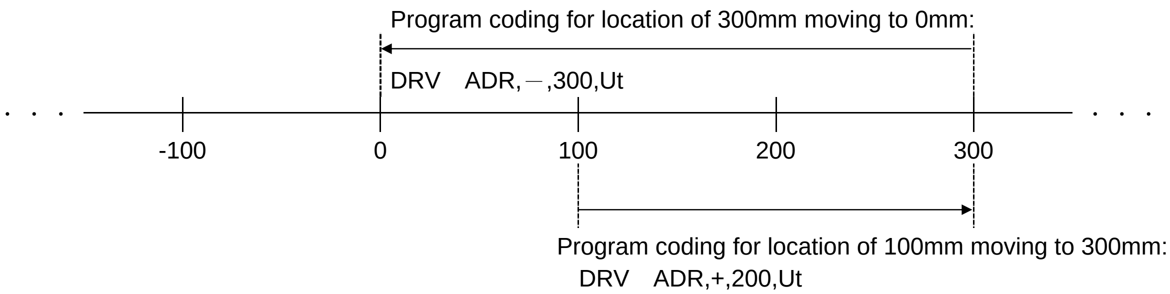
While marking the moving distance with absolute coordinate,
if it is located at 100mm at the present, for moving to 300 mm, the positioning instruction is : DRV ABS, ,300, Ut
if it is located at 300mm at the present, for moving to 0mm, the positioning instruction is : DRV ABS, , 0, Ut.

While marking the moving distance with relative coordinate,
if it is located at 100mm at the present, for moving to 300 mm, the positioning instruction is : DRV ADR, +, 200, Ut.
if it is located at 300mm at the present, for moving to 0mm, the positioning instruction is : DRV ADR, –, 300, Ut.

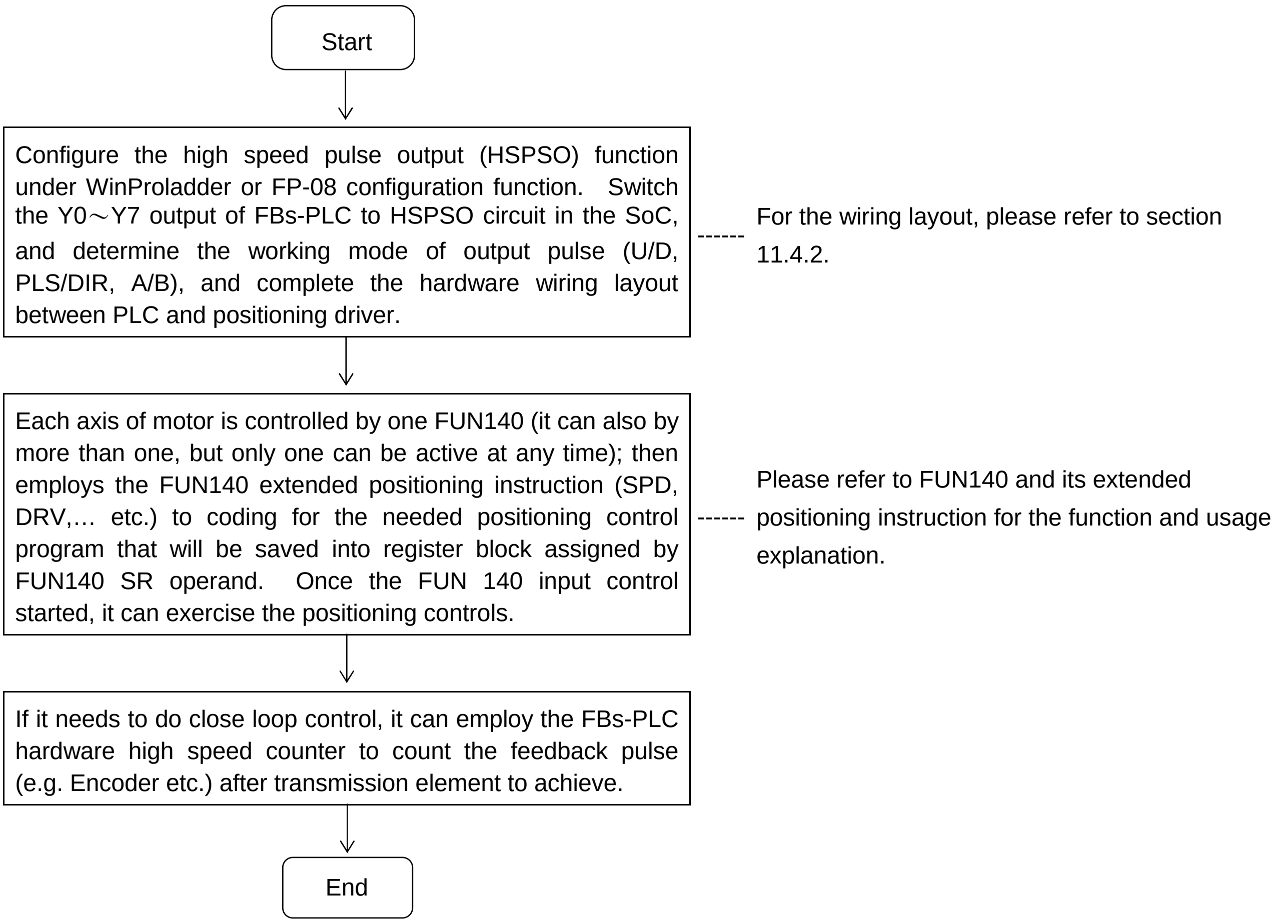
- Absolute coordinate labeling



- Relative coordinate labeling



11.3 Procedures of Using FBs-PLC Positioning Control



11.4 Explanation for the Positioning Control Hardware of FBs-PLC

11.4.1 Structure of Output Circuit of HSPSO

According to different main unit, it provides different frequency of output pulse, it includes 20KHz (Medium speed) of single ended transistor output model (FBs-xxMCT), and high speed differential output model (FBs-xxMNT) which can reach 920KHz (for single phase), two series of models.

High speed pulse output circuit share to use the Y0～Y7 exterior output of FBs-PLC. While it is not yet using the HSPSO function (haven't configured the PSO function under configuration function), the Y0～Y7 exterior output of FBs-PLC is corresponding to the Y0～Y7 status of internal output relay. When the HSPSO has been configured, the Y0～Y7 exterior output will switch directly to HSPSO output circuit within SoC, which has no relation with Y0～Y7 relay inside PLC.

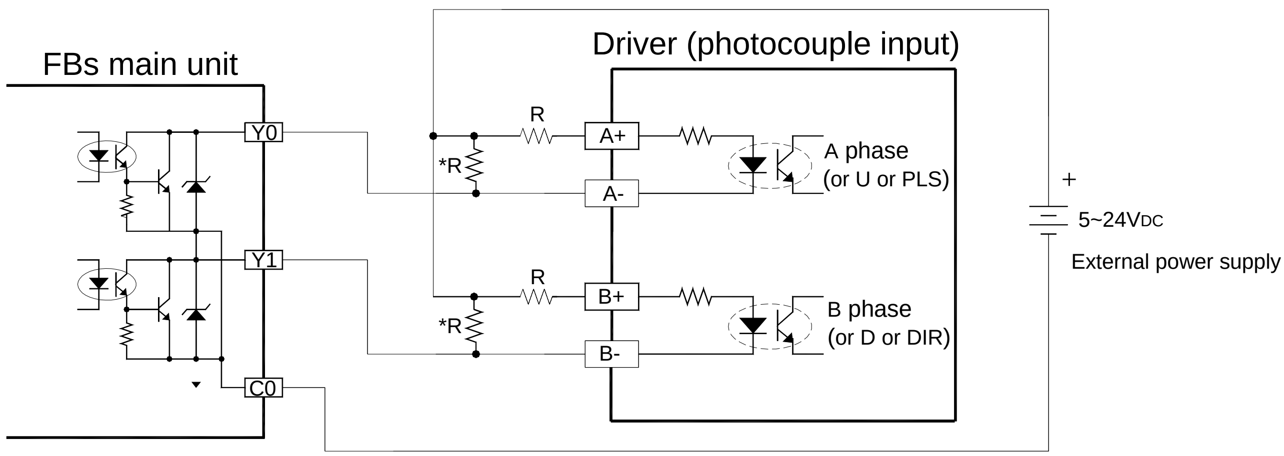
The following is the detailed signals list for respective axis output of main unit and the selectable output modes:

Axis No.	Exterior output	Output modes			
		U/D output	P/R output	A/B output	Single PLS output
PSO0	Y0 , Y1	Y0=U , Y1=D	Y0=P , Y1=R	Y0=A , Y1=B	Y0=PLS
PSO1	Y2 , Y3	Y2=U , Y3=D	Y2=P , Y3=R	Y2=A , Y3=B	Y2=PLS
PSO2	Y4 , Y5	Y4=U , Y5=D	Y4=P , Y5=R	Y4=A , Y5=B	Y4=PLS
PSO3	Y6 , Y7	Y6=U , Y7=D	Y6=P , Y7=R	Y6=A , Y7=B	Y6=PLS

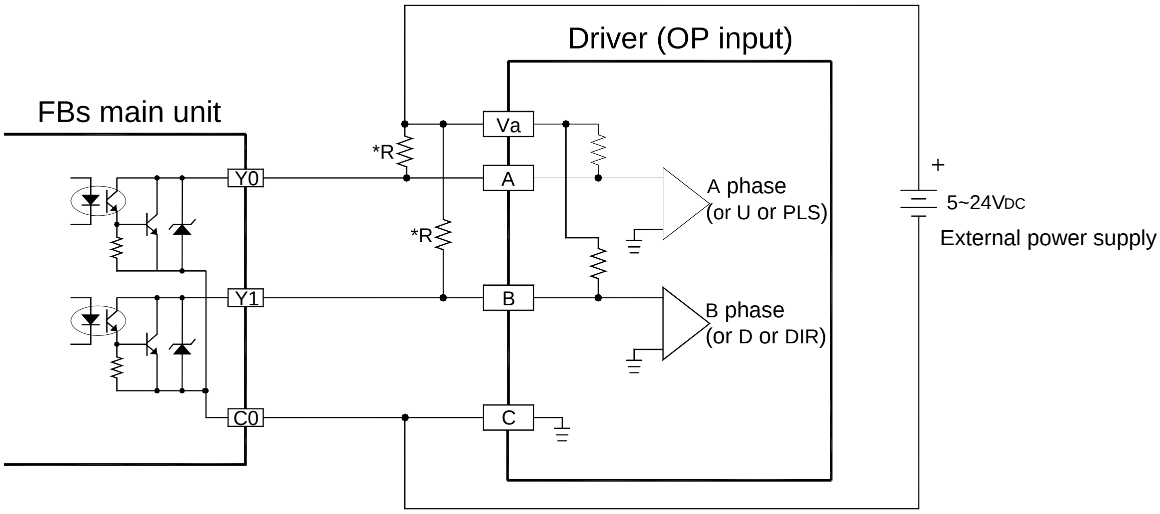
11.4.2 Hardware Wiring Layout for FBs-PLC Positioning Control

Take the 0th axis (PSO0) of FBs-XXMCT, FBs-XXMAT, and FBs-XXMNR(T) main unit for example, it is illustrated with diagrams as follows; the others are the same.

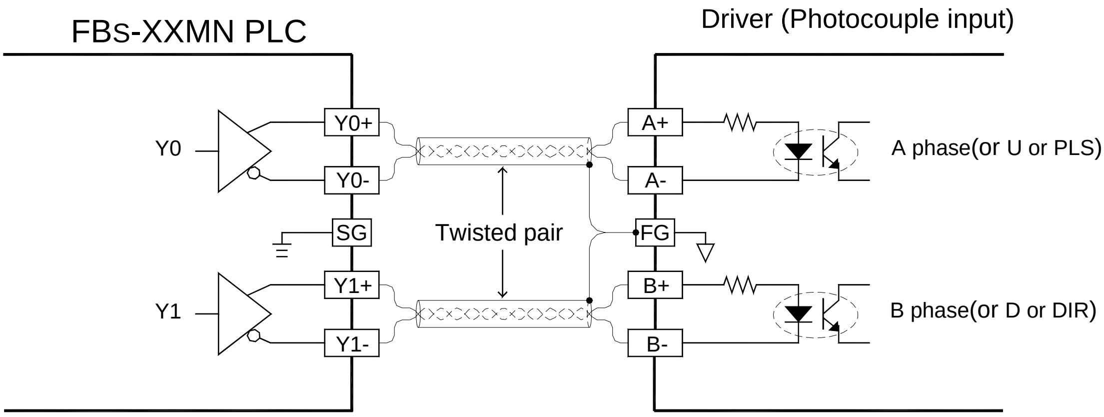
A, FBs-XXMCT , FBs-XXMAT single ended output wiring layout.

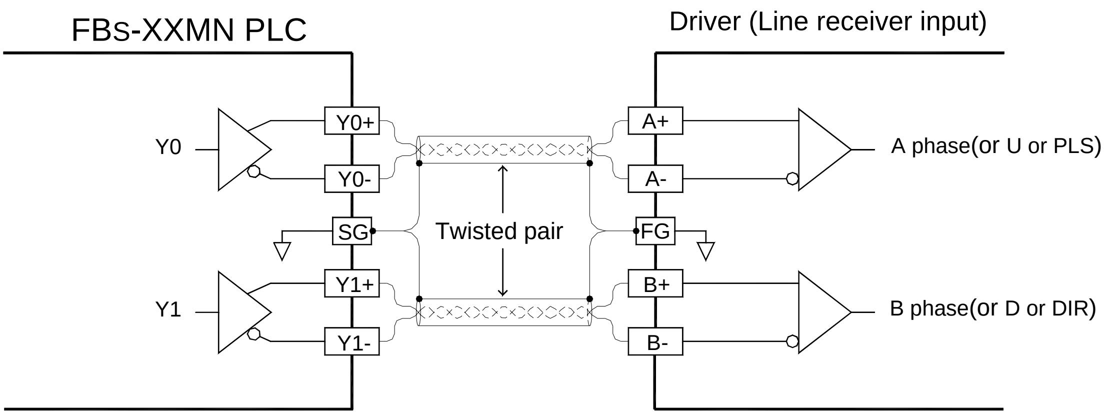


∗ Please refer to Hardware manual H7-6 for the usage of speed-up resistor "R".



B 、FBs-XXMNR(T) differential output wiring layout





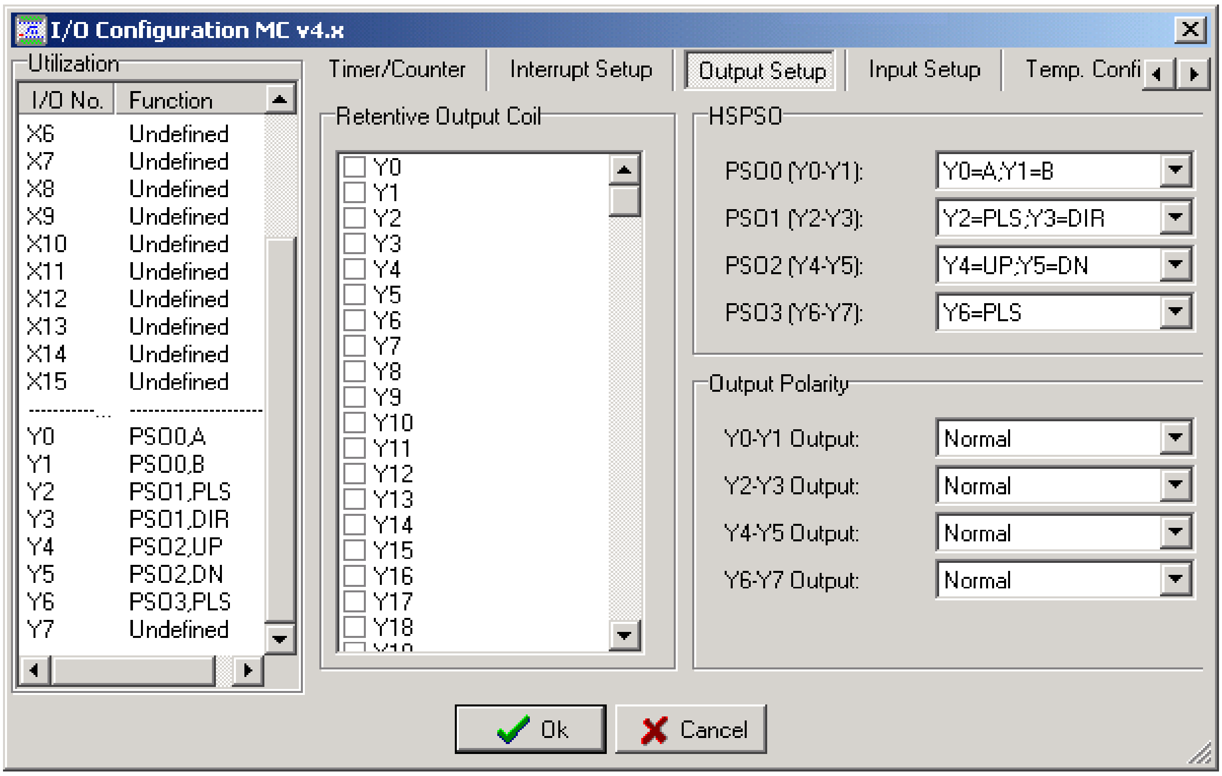
（For line receiver input, it must make PLC connect to FG of driver to eliminate common mode voltage）

Configuration of HSPSO with WinProladder

Click the "I/O Configuration" Item which in project windows :

Project name
System Configuration
I/O Configuration → select "Output Setup"

When "Output Setup" windows appear, then you can configure the Output type :



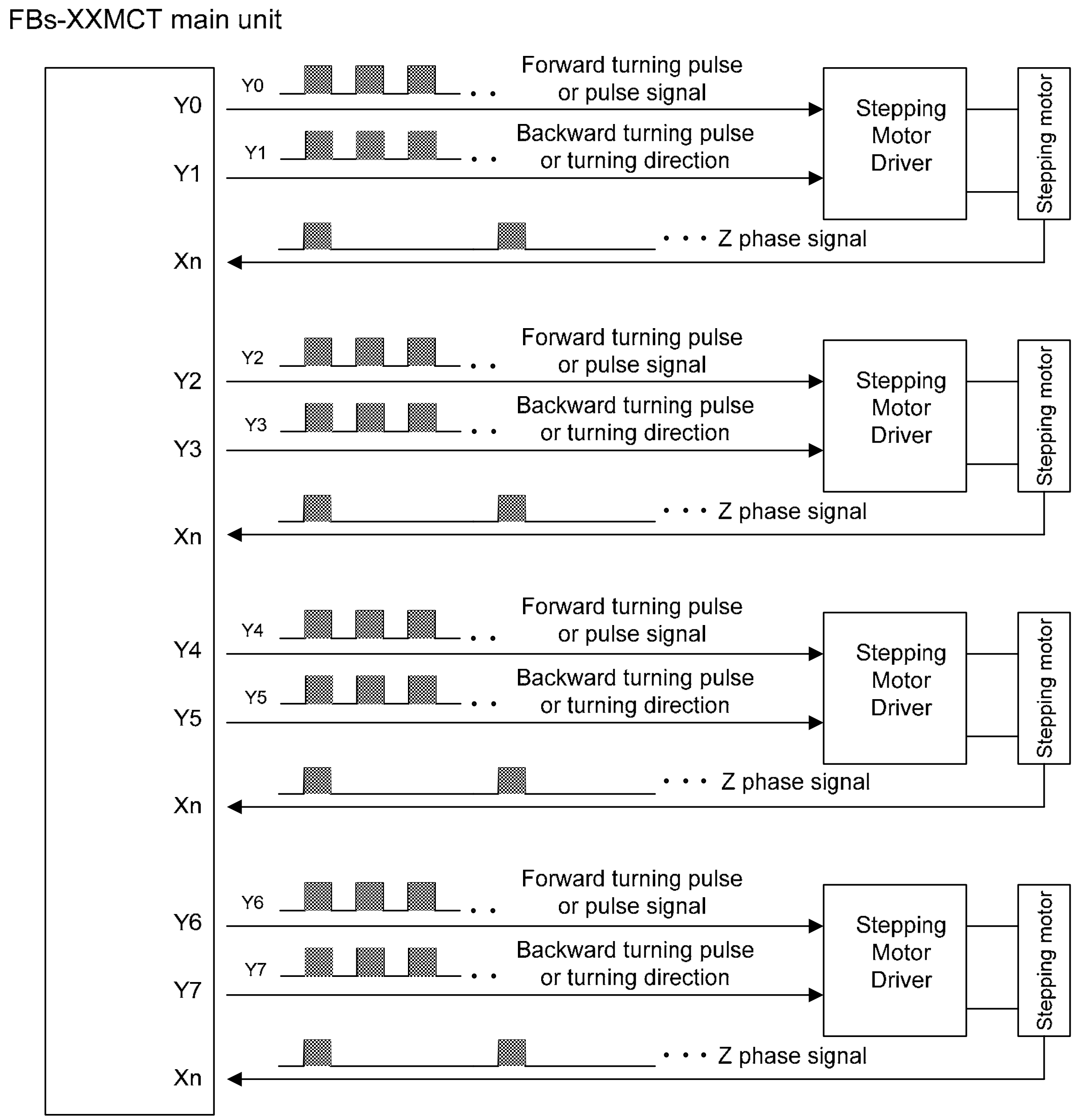
11.5 The Explanation for the Position Control Function of FBs-PLC

The position control function of FBs-PLC incorporates the dedicated NC position controller, which is available in the market, into the PLC. This makes the PLC and NC controller be able to share the same data block without the demand of complicated works like data exchange and synchronized controlling between these two systems. And it can still use the usual NC positioning control instruction (e.g. SPD , DRV,··· etc.).

One main unit can control up to 4 axes of their position control, and can drive multi axis simultaneously. However, it provides point to point positioning and speed control, but also it provides the linear interpolation function. When the system is applying for more than 4 axes, it can also employ CPU LINK function of FBs-PLC to attain control over more positioning actions.

The NC position control instruction for FBs-XXMCT、FBs-XXMN main units are identical to each other. The difference is only on the different circuit output, as previously revealed. Hereby we assume that FBs-XXMCT main unit is used in the control of stepping motor or server with lower speed, and FBs-XXMN main unit is used in high speed servo motor control. Consequently, we illustrate only with the connecting diagram of FBs-XXMCT main unit that driving stepping motor and the diagram of FBs-XXMN main unit that driving servo motor. Of course we can also use FBs-XXMCT main unit to drive servo motor or use FBs-XXMN main unit to drive stepping motor instead, they can still work perfectly, as long as its circuit structure (single ended or differential) and frequency can match.

11.5.1 Interface of Stepping Motor



- Stepping motor is designed to receive input pulse to attain to the control of desired angle or distance, therefore the turning angle and the input pulse count has a positive correlation ship, and the turning speed also depends on the input pulse frequency.

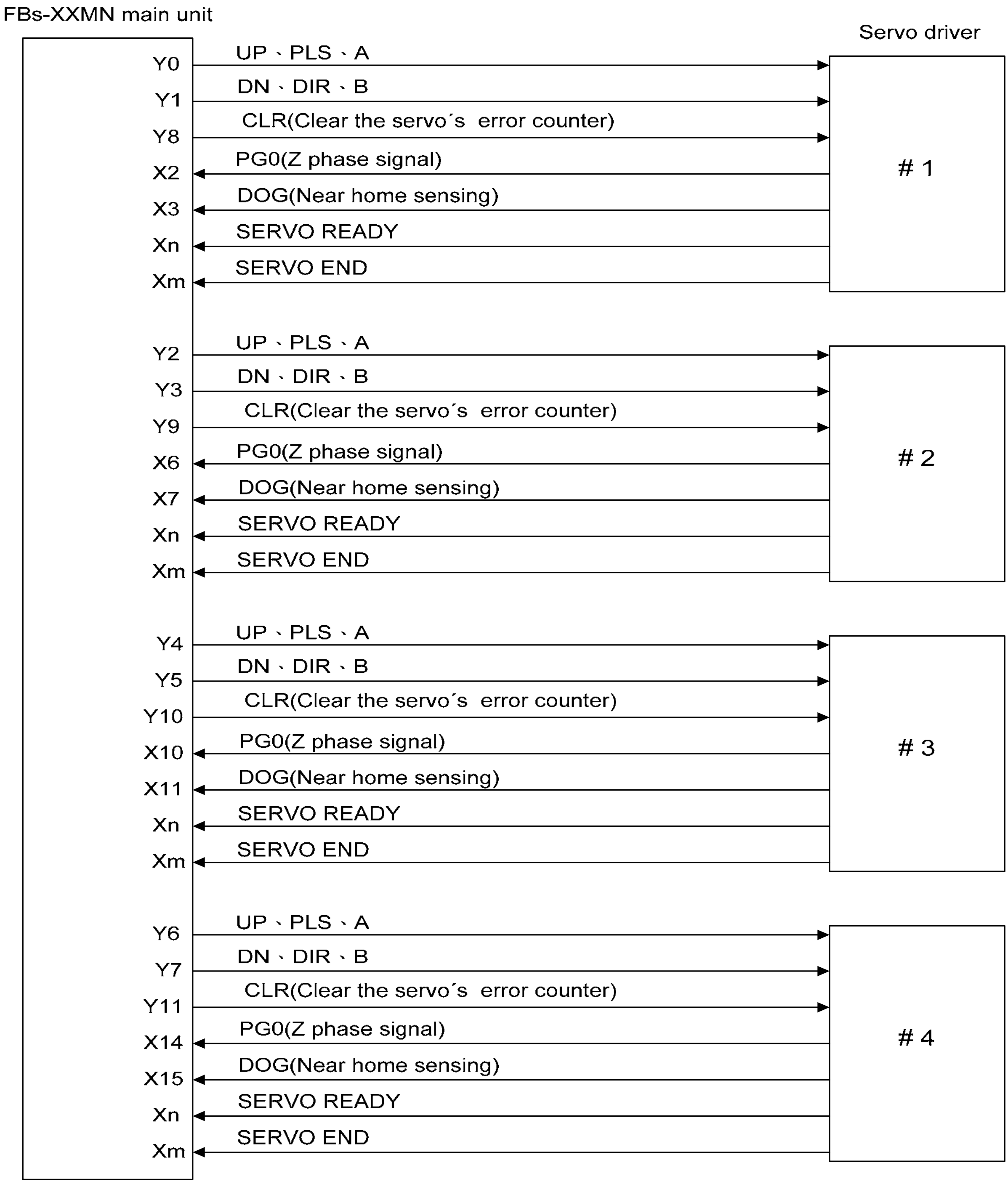
N (RPM) = 60 × f / n

n = 360 / θs

N : Revolving speed of motor (RPM)
f : Pulse frequency (PLS/Sec)
n : Pulse counts for motor to turn for a revolution (PLS/ Rev).
θs : Angle (Deg)

Phase	Basic pulse angle	FULL		HALF	
		Pulse angle	Pulse counts for turning one revolution	Pulse angle	Pulse counts for turning one revolution
5 phase	0.36°	0.36°	1000	0.18°	2000
	0.72°	0.72°	500	0.36°	1000
4 phase	0.90°	0.90°	400	0.45°	800
2 phase	1.80°	1.80°	200	0.90°	400

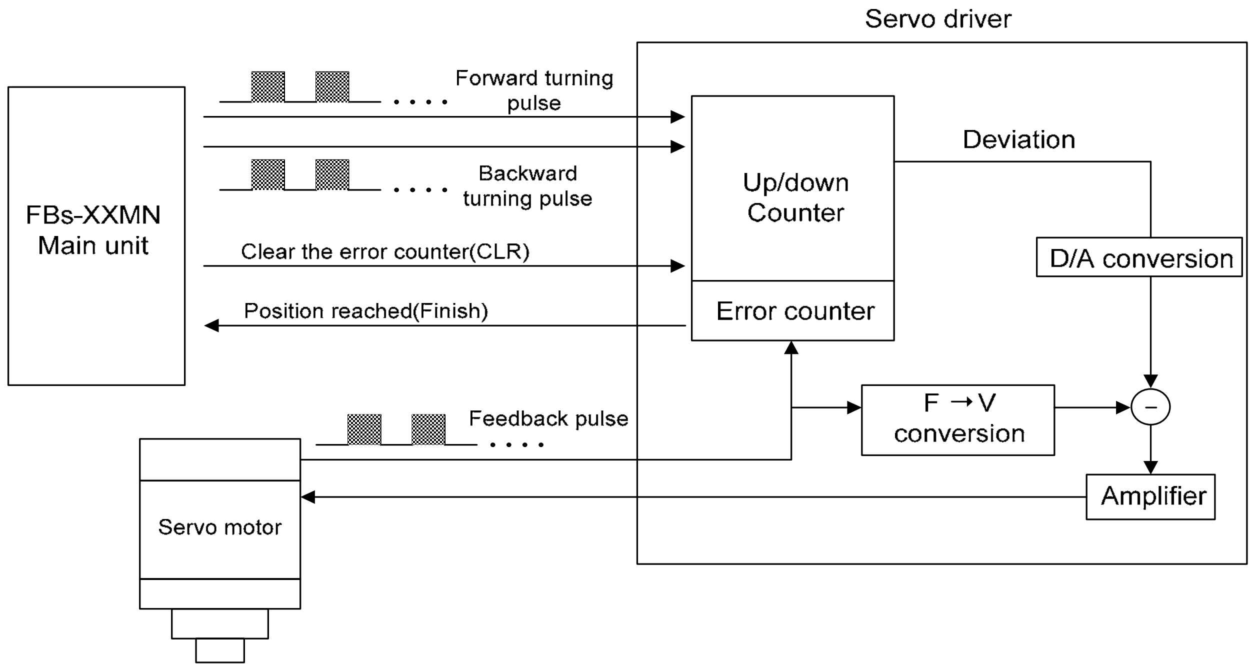
11.5.2 Interface of Servo Motor



※ Except that the Y0～Y7 of above diagram are for dedicated purpose, Y8～Y11 and respective inputs can be adjusted for using according to demand.

※ The left over travel, right over travel limit switches for safety detection also need to be connected to PLC to assure proper operation.

11.5.3 Working Diagram Illustration for Servo Motor



- The Encoder of servo motor feedback the shifting detection signal to servo driver. The driver gets the pulse frequency, and pulse count of input signal (pulse command), as well as the frequency and pulse count of feedback signal processed with internal error counter and frequency to voltage conversion circuit, and acquired the pulse and turning speed deviations. Using these operations to control the servo motor, so as to obtain a high speed, precise speed and positional closed-loop processing system.

- The revolving speed of servo motor depends on the pulse frequency of input signal; the turning stroke of motor is determined by pulse count.

- Generally speaking, the final control error deviation of servo motor is ±1 pulse.

11.6 Explanation of Function for NC Position Control Instruction

The NC position control of FBs-PLC has following four related instructions:

- FUN140 (HSPSO) high speed pulse output instruction, which includes following 9 extension positioning instructions:

1. SPD	4. DRVZ	7. EXT	Used for positioning program coding and stored to SR operand area of FUN140
2. DRV	5. WAIT	8. GOTO	
3. DRVC	6. ACT	9. MEND	

- FUN141 (MPARA) positioning parameter setting instruction

- FUN142 (PSOFF) enforcing pulse output stop instruction.

- FUN143 (PSCNV) converting the current pulse value to displaying value instruction.

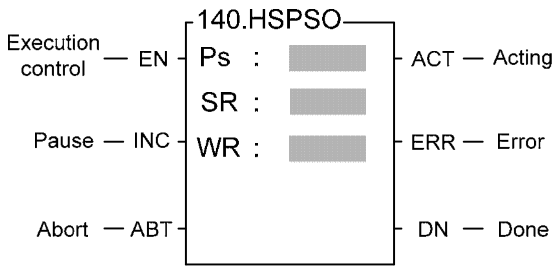
- FUN147（MHSPO）multi high speed pulse output instruction, which includes following 7 extension positioning instructions:

1. SPD	4. WAIT	7. MEND	Used for positioning program coding and stored to SR operand area of FUN147
2. LIN	5. EXT		
3. LINE	6. GOTO		

The following function explanations are for the above mentioned 5 instructions:

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

Ladder symbol



Ps: The set number of Pulse Output (0～3)

0:Y0 & Y1
1:Y2 & Y3
2:Y4 & Y5
3:Y6 & Y7

SR: Starting register for positioning program (example explanation)

WR: Starting register for instruction operation (example explanation). It controls 7 registers, which the other program cannot repeat in using.

Range / Ope-rand	HR	DR	ROR	K
	R0 | R3839	D0 | D3999	R5000 | R8071	
Ps				0～3
SR	○	○	○	
WR	○	○	○*	

Instruction Explanation

1. The NC positioning program of FUN140 (HSPSO) instruction is a program written and edited with text programming. We named every position point as a step (which includes output frequency, traveling distance, and transfer conditions). For one FUN140, it can be arranged with 250 steps of positioning points at the most, with every step of positioning point controlled by 9 registers.
2. The best benefit to store the positioning program into the registers is that in the case of association with MMI (Man Machine Interface) to operate settings, it may save and reload the positioning program via MMI when replacing the molds.
3. When execution control "EN"=1, if the other FUN140 instructions to control Ps0～3 are not active (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 will be ON), it will start to execute from the next step of positioning point (when goes to the last step, it will be restarted from the first step to perform); if Ps0～3 is controlled by other FUN140 instruction (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 would be OFF), this instruction will acquire the pulse output right of positioning control once the controlling FUN140 has released the control right.
4. When execution control input "EN" =0, it stops the pulse output immediately.
5. When output pause "PAU" =1 and execution control "EN" was 1 beforehand, it will pause the pulse output. When output pause "PAU" =0 and execution control is still 1, it will continue the unfinished pulse output.
6. When output abort "ABT"=1, it stops pulse output immediately. (When the execution control input "EN" becomes 1 next time, it will restart from the first step of positioning point to execute.)
7. While the pulse is in output transmitting, the output indication "ACT" is ON.
8. When there is execution error, the output indication "ERR" will be ON. (The error code is stored in the error code register.)
9. When each step of positioning point is complete, the output indication "DN" will be ON.

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

*** The working mode of Pulse Output must be set (without setting, Y0～Y7 will be treated as general output) to be one of U/D, P/R, or A/B mode, thus the Pulse Output may have a regular output.

U/D Mode : Y0 (Y2, Y4, Y6), it sends out upward counting pulse.
Y1 (Y3, Y5, Y7), it sends out downward counting pulse.

P/R Mode : Y0 (Y2, Y4, Y6), it sends the pulse out.
Y1 (Y3, Y5, Y7), it sends out the directional signal;
ON=upward counting, OFF= downward counting.

A/B Mode : Y0 (Y2, Y4, Y6), it sends out the phase A pulse.
Y1 (Y3, Y5, Y7), it sends out the phase B pulse.

- The output polarity for Pulse Output can select to be Normal ON or Normal OFF.

〔The interfaces for positioning control〕

M1991	ON : stop or pause FUN140, slow down and stop pulse output.
	OFF : stop or pause FUN140, stop pulse output immediately.
M1992	ON : Ps0 Ready
	OFF : Ps0 is in action
M1993	ON : Ps1 Ready
	OFF : Ps1 is in action
M1994	ON : Ps2 Ready
	OFF : Ps2 is in action
M1995	ON : Ps3 Ready
	OFF : Ps3 is in action
M1996	ON : Ps0 has finished the last step
M1997	ON : Ps1 has finished the last step
M1998	ON : Ps2 has finished the last step
M1999	ON : Ps3 has finished the last step

M2000 : ON, multi axes acting simultaneously (At the same scan, when execution control “EN”= 1of FUN140 instructions which control Ps0～3, their pulses output will be sent at the same time without any time lag).
: OFF, as the FUN140 for Ps0～3 starts, corresponding axis pulse output will be sent immediately; since the ladder program is executed in sequence, therefore even the FUN140 for Ps0～3 started at the same scan, there must be some time lag between them.

Ps No.	Current output frequency	Current pulse position	The remaining pulse counts to be transmitted	Error code
Ps0	DR4080	DR4088	DR4072	R4060
Ps1	DR4082	DR4090	DR4074	R4061
Ps2	DR4084	DR4092	DR4076	R4062
Ps3	DR4086	DR4094	DR4078	R4063

※ R4056 : When the value of low byte=5AH, it can be dynamically changed for its output frequency during the high speed pulse output transmitting at any time.

When the value of low byte is not 5AH, it can not be dynamically changed for its output frequency during the high speed pulse output transmitting.

The default value of R4056 is 0

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

R4064 **:** The step number (positioning point) which has been completed of Ps0.

R4065 **:** The step number (positioning point) which has been completed of Ps1.

R4066 **:** The step number (positioning point) which has been completed of Ps2.

R4067 **:** The step number (positioning point) which has been completed of Ps3.

- Format of positioning program:

  SR: Starting register of registers block which reserved to store positioning program, explained as follows:

SR	A55AH	The effective positioning program; its starting register must be A55AH
SR+1	Total steps	1～250
SR+2		The first positioning point (step) of positioning program (every step controlled by 9 registers).
SR+3		
SR+4		
SR+5		
SR+6		
SR+7		
SR+8		
SR+9		
SR+10		
⋮	⋮	
		The Nth step of positioning program.
SR+N×9+2		

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

- Explanation for working register of instruction operation:

WR is the starting register.

WR+0	Being executed or stopped step
WR+1	Working flag
WR+2	Controlled by system
WR+3	Controlled by system
WR+4	Controlled by system
WR+5	Controlled by system
WR+6	Controlled by system

WR+0 **:** If this instruction is in execution, the content of this register represents the step (1～N) being performed. if this instruction is not in execution, the content of this register represents the step where it stopped at present
When execution control "EN" =1, it will perform the next step, i.e. the current step plus 1 (if the current step is at the last step, it will restart to perform from the first step).
Before starting the execution control "EN" =1, the user can renew the content of WR+0 to determine starting from which step to perform (when the content of WR+0 =0, and execution control "EN" =1, it represents that the execution starts from the first step).

WR+1 **:** B0～B7, total steps

B8 = ON, output paused

B9 = ON, waiting for transfer condition

B10 = ON, endless output (the stroke operand of DRV command is set to be 0)

B12 = ON, pulse output transmitting (the status of output indicator "ACT")

B13 = ON, instruction execution error (the status of output indicator "ERR")

B14 = ON, finished being executed step (the status of output indicator "DN")

*** When step which has been completed, the output indication "DN" will turn ON and keep such status if suspending ; the user may turn OFF the status of "DN" by using the rising edge of output coil controlled by "DN" to clear the content of WR+1 register to be 0, and it can be attained.

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

Error indication	Error code	
R4060（Ps0）	0 : Error free	The possible error codes for FUN141 execution
R4061（Ps1）	1 : Parameter 0 error	
R4062（Ps2）	2 : Parameter 1 error	
R4063（Ps3）	3 : Parameter 2 error	
	4 : Parameter 3 error	
	5 : Parameter 4 error	
	6 Parameter 5 error	
	7 : Parameter 6 error	
	8 : Parameter 7 error	
	9 : Parameter 8 error	
	10 : Parameter 9 error	
	13 Parameter 12 error	
	15 Parameter 14 error	
	30 : Error of variable address for speed setting	The possible error codes for FUN140 execution
	31 : Error of setting value for speed setting	
	32 : Error of variable address for stroke setting	
	33 : Error of setting value for stroke setting	
	34 : Illegal positioning program	
	35 : Length error of total step	
	36 : Over the maximum step	
	37 : Limited frequency error	
	38 : Initiate/stop frequency error	
	39 : Over range of compensation value for movement	
	40 : Over range of moving stroke	
	41 : ABS positioning is not allowed within DRVC commands	
	42 : DRVC instruction not allow ABS addressing	
	50 : Illegal operation mode of DRVZ	
	51 : Illegal DOG input number	
	52 : Illegal PG0 input number	
	53 : Illegal CLR output number	
	60 : Illegal linear interpolation command	

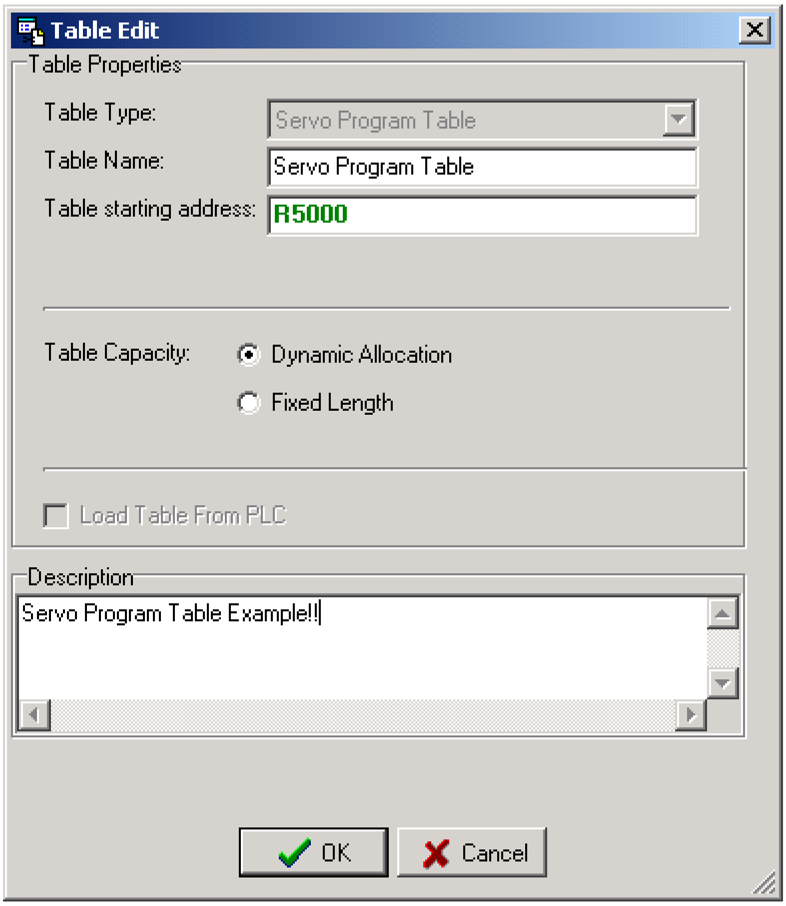
Note : The content of error indication register will keep the latest error code. Making sure that no more error to happen, you can clear the content of error indication register to be 0; as long as the content maintains at 0, it represents that there's no error happened.

Editing Servo Program Table with WinProladder

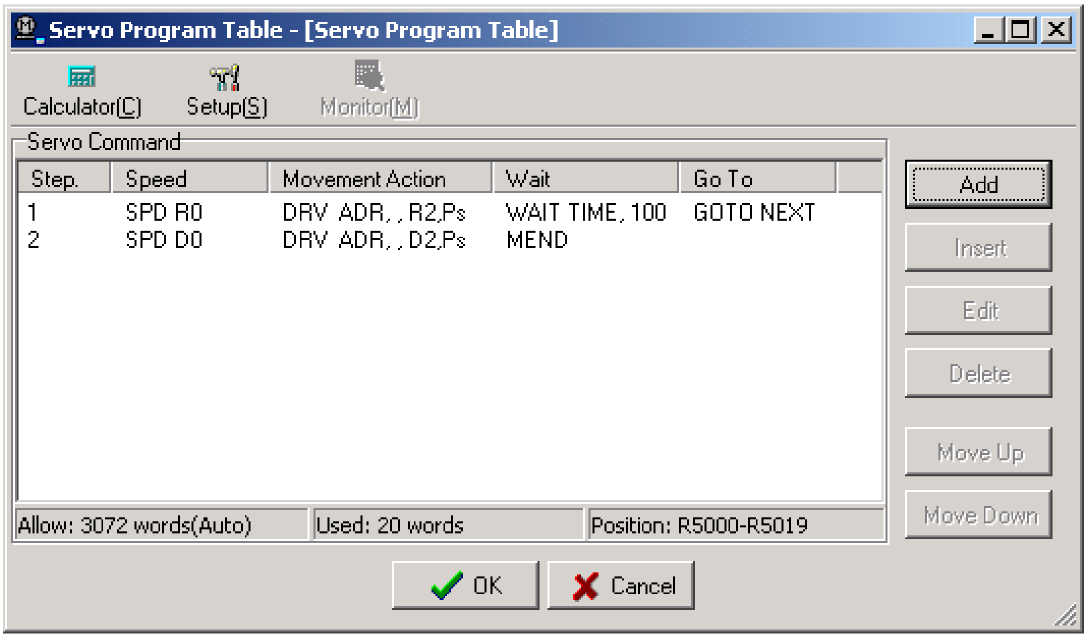
Click the "Servo Program Table" Item which in project windows :

Project name
- Table Edit
  - Servo Program Table → Click right button and select "New Table"

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO



- Table Type **:** It will be fixed to " Servo Program Table ".
- Table Name **:** For modify or debug, you can give a convenient name.
- Table Starting address **:** Enter the address which Starting register of Servo Program Table.

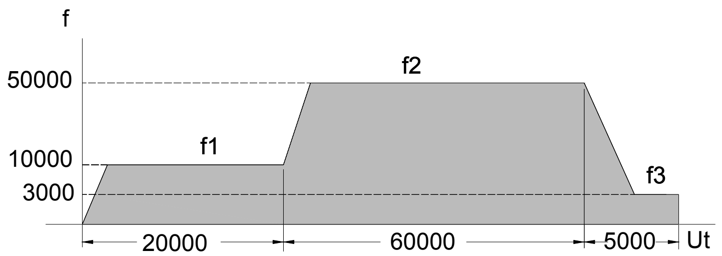


FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

- For easy programming and trouble shooting, the WinProladder provides the text editing environment to edit the motion program(servo program table) for FUN140 execution; Key in the complete FUN140 instruction first and then move the cursor to the position of it, pressing the hot key "Z", then comes the text editing environment. The user can create the new motion program or display the existed program under this friendly user interface operation.
- Extended positioning instructions are listed as follows:

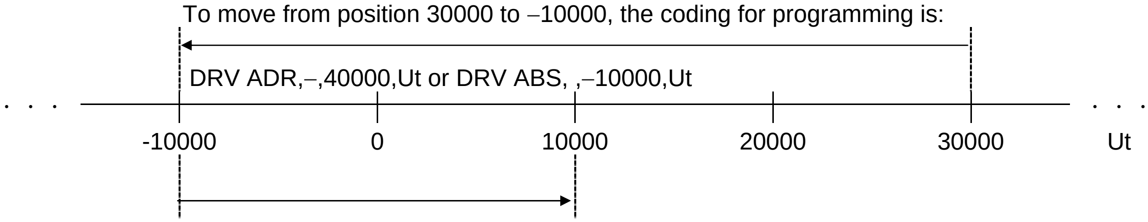
Instruction	Operand	Explanation
SPD	XXXXXX or Rxxxx or Dxxxx	• Moving speed in frequency or velocity (FUN141 Parameter_0=0 represents velocity; Parameter_0=1 or 2 for frequency; the system default is frequency). The operand can be input directly with constant or variable (Rxxxx, Dxxxx); when the operand is variable, it needs 2 registers, e.g. D10 represents D10 (Low Word) and D11 (High Word), which is the setting of frequency or velocity. • When selecting to use the velocity setting, the system will automatically convert the velocity setting to corresponding output frequency. • Output frequency range: 1≦output frequency≦921600 Hz. *** When the output frequency is 0, this instruction will wait until the setting value isn't 0 to execute the positioning pulse output.
DRV	ADR ，+ ，XXXXXXXX，Ut ADR ，+ ，XXXXXXXX，Ps ADR ，– ，XXXXXXXX，Ut ADR ，– ，XXXXXXXX，Ps ADR ， ， XXXXXXXX，Ut ADR ， ，–XXXXXXXX，Ut ADR ， ， XXXXXXXX，Ps ADR ， ，–XXXXXXXX，Ps ADR ，+ ，Rxxxx，Ut ADR ，+ ，Rxxxx，Ps ADR ，– ，Rxxxx，Ut ADR ，– ，Rxxxx，Ps ADR ， ，Rxxxx，Ut ADR ， ，Rxxxx，Ps ADR ，+ ，Dxxxx，Ut ADR ，+ ，Dxxxx，Ps ADR ，– ，Dxxxx，Ut ADR ，– ，Dxxxx，Ps ADR ， ，Dxxxx，Ut ADR ， ，Dxxxx，Ps ABS ， ， XXXXXXXX，Ut ABS ， ，–XXXXXXXX，Ut ABS ， ， XXXXXXXX，Ps ABS ， ，–XXXXXXXX，Ps ABS ， ，Rxxxx，Ut ABS ， ，Rxxxx，Ps ABS ， ，Dxxxx，Ut ABS ， ，Dxxxx，Ps	• Moving stroke setting in Ps or mm,Deg,Inch (When FUN141 Parameter_0=1, the setting stroke in Ut is Ps; Parameter_0=0 or 2, the setting stroke in Ut is mm, Deg, Inch; the system default for Ut is Ps). • When 4_th operand of DRV is Ut (not Ps) , according to parameter setting of 1, 2, 3 of FUN141, the system will convert the corresponding pulse count to output. •There are 4 operands to construct DRV instruction as follows: 1_st operand: coordinate selection. ADR or ABS: ADR, relative distance movement ABS, absolute position movement 2_nd operand: revolving direction selection (Valid for ADR only). '+' , forward or clockwise '–' , backward or counterclockwise ' ' ,direction is determined by the setting value (positive value: forward; negative value: backward) 3_rd operand: moving stroke setting XXXXXXXX: or –XXXXXXXX or Rxxxx or Dxxxx — It can directly input with constant or variable (Rxxxx, Dxxxx); it needs 2 registers when adopting the variable, e.g. R0 represents R0 (Low Word) and R1 (High Word) as the setting of moving stroke. *** When the setting of moving stroke is 0 and 1_st operand is ADR, it represents to revolve endless. Stroke setting range: –99999999 ≤ stroke setting ≤ 99999999 4_th operand: resolution of stroke setting Ut or Ps:for Ut, the resolution is one unit; (it is determined by parameter 0, 3 of FUN141); for Ps, the enforced resolution is one pulse.

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

Instruction	Operand	Explanation
DRVC	ADR，+，XXXXXXXX，Ut or or or or ABS，–， Rxxxx ，Ps or Dxxxx	The usage of DRVC and the operand explanation is the same as DRV's instruction. *** DRVC is used to do successive speed changing control (8 speeds at the most). *** Of the successive speed changing control, only the first DRVC instruction can use the absolute value coordinate for positioning. *** The revolution direction of DRVC can only be decided by '+' or '–'. *** The revolution direction only determined by the first DRVC of successive DRVC instructions; i.e. the successive speed changing control can only be the same direction. For example: successive 3 speed changing control 001 SPD 10000 * Pulse frequency = 10KHz. DRVC ADR，+，20000，Ut * Forward 20000 units. GOTO NEXT 002 SPD 50000 * Pulse frequency =50 KHz DRVC ADR，+，60000，Ut * Forward 60000 units. GOTO NEXT 003 SPD 3000 * Pulse frequency = 3KHz. DRV ADR，+，5000，Ut * Forward 5000 units. WAIT X0 * Wait until X0 ON to restart from the first step to execute. GOTO 1 Note: The number of DRVC instructions must be the number of successive speeds deducted by 1, i.e. the successive speed changing control must be ended with the DRV instruction. • The above mentioned example is for successive 3 speeds changing control, which used 2 DRVC instructions and the third must use DRV instruction. • Diagram illustration for the above mentioned example: 

Note: Comparison explanation between the relative coordinate positioning (ADR) and the absolute coordinate positioning (ABS)

To move from position 30000 to –10000, the coding for programming is:



To move from position –10000 to 10000, the coding for programming is:
DRV ADR,+,20000,Ut or DRV ABS, ,10000,Ut

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

Instruction	Operand	Explanation
WAIT	Time, XXXXX or Rxxxx or Dxxxx or X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	• When pulse output is complete, performing the wait instruction for going to the next step. There are 5 kind of operands that explained as follows: Time: The waiting time (the unit is 0.01 second), it can be directly input with constant or variable (Rxxxx or Dxxxx); when it is time up, performs the step that assigned by GOTO. X0～X255: Waiting until the input status is ON, it performs the step that assigned by GOTO. Y0～Y255:Waiting until the output status is ON, it performs the step that assigned by GOTO. M0～M1911: Waiting until the internal relay is ON, it performs the step that assigned by GOTO. S0～S999: Waiting until the step relay is ON, it performs the step that assigned by GOTO.
ACT	Time，XXXXX or Rxxxx or Dxxxx	• After the time to output pulses described by operand of ACT, it performs immediately the step that assigned by GOTO, i.e. after the pulse output for a certain time, it performs the next step immediately. The action time (the unit is 0.01 second) can be directly input with constant or variable (Rxxxx or Dxxxx); when the action time is up, it performs the step assigned by GOTO.
EXT	X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	• External trigger instruction; when it is in pulse output (the number of pulses sending is not complete yet), if the status of external trigger is ON, it will perform the step assigned by GOTO immediately. If the status of external trigger is still OFF when the pulse output has been complete, it is the same as WAIT instruction; waiting the trigger signal ON, then perform the step assigned by GOTO.
GOTO	NEXT or 1～N or Rxxxx or Dxxxx	• When matching the transfer condition of WAIT, ACT, EXT instruction, by using GOTO instruction to describe the step to be executed. NEXT: It represents to perform the next step. 1～N: To perform the described number of step. Rxxxx: The step to be performed is stored in register Rxxxx. Dxxxx: The step to be performed is stored in register Dxxxx.
MEND		The end of the positioning program.

FUN 140 HSPSO	High Speed Pulse Output (Including the extended positioning instruction)	FUN 140 HSPSO

- The coding for positioning programming **:**

First, it must complete the FUN140 instruction before the editing of positioning program, and assigned in FUN140 instruction the starting register of registers block to store positioning program. While editing the positioning program, it will store the newly edited positioning program to the assigned registers block; for every one positioning point (called as one step) edited, it is controlled by 9 registers. If there are N positioning points, it will be controlled by N $\times$ 9 + 2 registers in total.

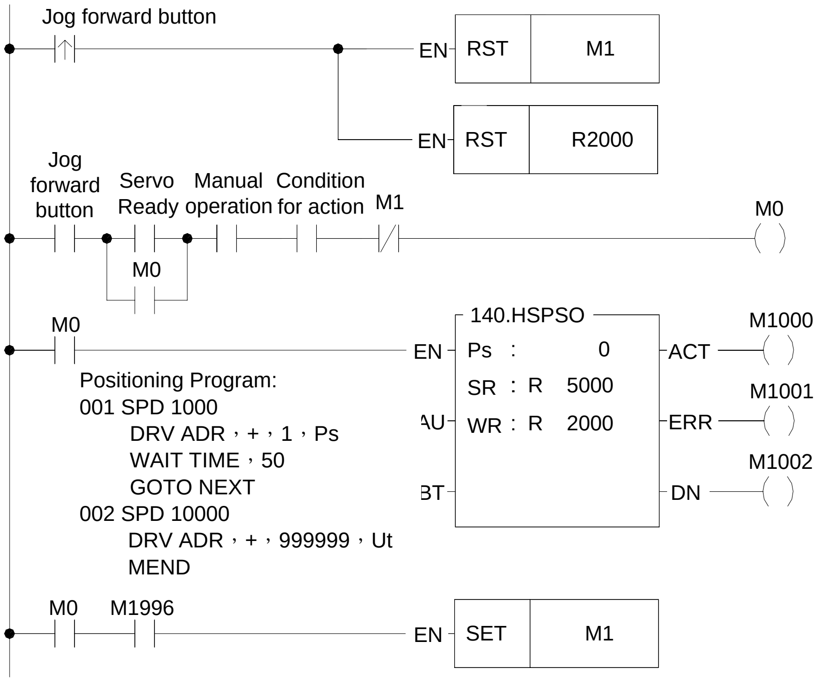
Note: The registers storing the positioning program can not be repeated in using!

- Format and example for the positioning program 1:

```
001 SPD    5000              ; Pulse frequency = 5KHz.
    DRV    ADR,+,10000,Ut    ; Moving forward 10000 units.
    WAIT   Time,100          ; Wait for 1 second.
    GOTO   NEXT              ; Perform the next step.
002 SPD    R1000             ; Pulse frequency is stored in DR1000 (R1001 and R1000).
    DRV    ADR,+,D100,Ut     ; Moving forward, the stroke is stored in DD100 (D101 and D100).
    WAIT   Time,R500         ; The waiting time is stored in R500.
    GOTO   NEXT              ; To perform the next step.
003 SPD    R1002             ; Pulse frequency is stored in DR1002 (R1003 and R1002).
    DRV    ADR,–,D102,Ut     ; Moving backward, the stroke is stored in DD102 (D103 and D102).
    EXT    X0                ; When external trigger X0 (slow down point) ON, it performs the next
    GOTO   NEXT              ; step immediately.
004 SPD    2000              ; Pulse frequency = 2KHz.
    DRV    ADR,–,R4072,Ps    ; Keep outputting the remain (stored in DR4072).
    WAIT   X1                : Wait until X1 ON,
    GOTO   1                 : Perform the first step.
```

Program example: Jog forward

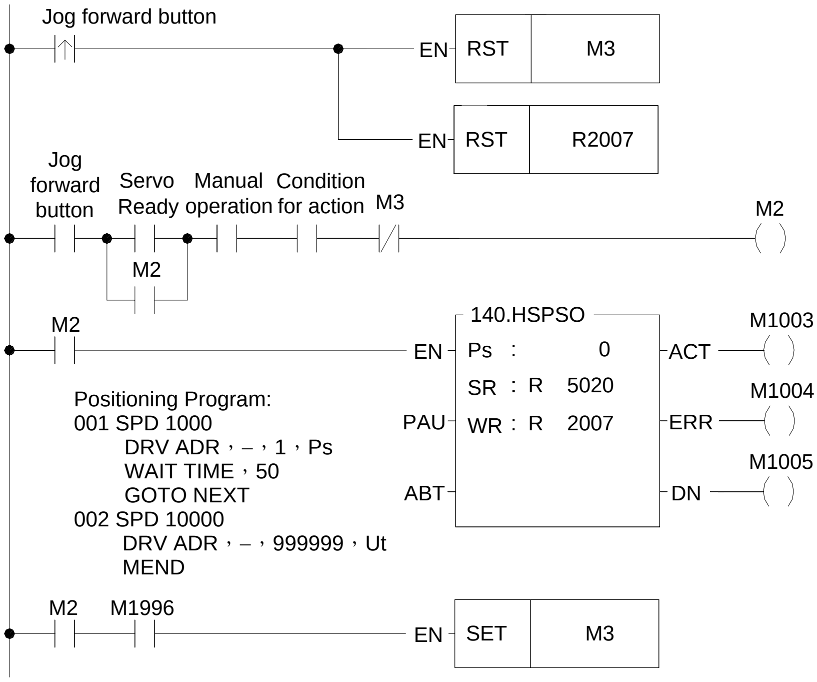
As the jog forward button has been pressed for less than 0.5 second (changeable), it sends out only one (changeable) pulse;
As the jog forward button has been pressed for more than 0.5 second (changeable), it continuously sends pulses out (the frequency is 10KHz, changeable), until the release of the jog forward button to stop the pulse transmitting; or it may be designed to send N pulses out at the most.



- Clear finish signal.
- Perform from the first step every time.
- When the last step been complete, set finish signal.

Program example: Jog Backward

As the jog backward button has been pressed for less than 0.5 second (changeable) it sends out only one (changeable) pulse;
As the jog backward button has been pressed for more than 0.5 second (changeable), it continuously sends pulses out (the frequency is 10KHz, changeable), until the release of the jog backward button to stop the pulse transmitting; or it may be designed to send N pulses out at the most.



- Clear finish signal.
- Perform from the first step every time.
- When the last step been complete, set finish signal.

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA

Ladder symbol

141.MPARA

Execution control — EN - Ps : - ERR —

SR :

Ps: The set number of Pulse Output (0～3).

SR: Starting register for parameter table, it has totally 18 parameters which controlled by 24 registers.

Range / Ope-rand	HR R0 | R3839	DR D0 | D3999	ROR R5000 | R8071	K
Ps				0～3
SR	○	○	○	

Instruction explanation

1. This instruction is not necessary if the system default for parameter value is matching what users need. However, if it needs to open the parameter value to do dynamic modification, this instruction is required.
2. This instruction incorporates with FUN140 for positioning control purpose, each axis can have one FUN140 instruction only.
3. Whether the execution control input “EN” = 0 or 1, anyway, this instruction will be performed.
4. When there is error in parameter value, the output indication “ERR” will be ON, and the error code is appeared in the error code register.

Explanation for the parameter table:

SR =Starting register of parameter table, suppose it is R2000.

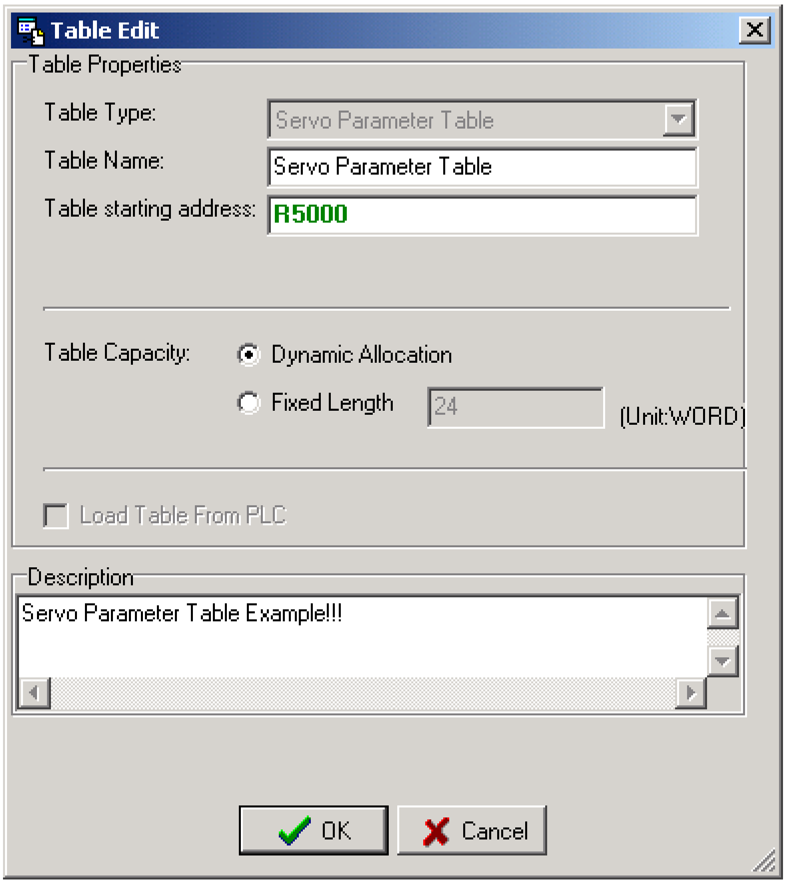
R2000	0～2	Parameter 0	System default =1
R2001	1～65535 Ps/Rev	Parameter 1	System default =2000
DR2002	1～999999 μM/Rev 1～999999 mDeg/Rev 1～999999×0.1 mInch/Rev	Parameter 2	System default =2000
R2004	0～3	Parameter 3	System default =2
DR2005	1～921600 Ps/Sec 1～153000	Parameter 4	System default =460000
DR2007	0～921600 Ps/Sec 1～153000	Parameter 5	System default =141
R2009	1～65535 Ps/Sec	Parameter 6	System default =1000
R2010	0～32767	Parameter 7	System default =0
R2011	0～30000	Parameter 8	System default =5000
R2012	0～1	Parameter 9	System default =0100H
R2013	-32768～32767	Parameter 10	System default =0
R2014	-32768～32767	Parameter 11	System default =0
R2015	0～30000	Parameter 12	System default =0
R2016	0～30000	Parameter 13	System default =500
DR2017	0～1999999	Parameter 14	System default =0
DR2019	00H~FFH	Parameter 15	System default =FFFFFFFFH
DR2021	-999999～999999	Parameter 16	System default =0
R2023	0～255	Parameter 17	System default =1

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA

Editing Servo Parameter Table with WinProladder

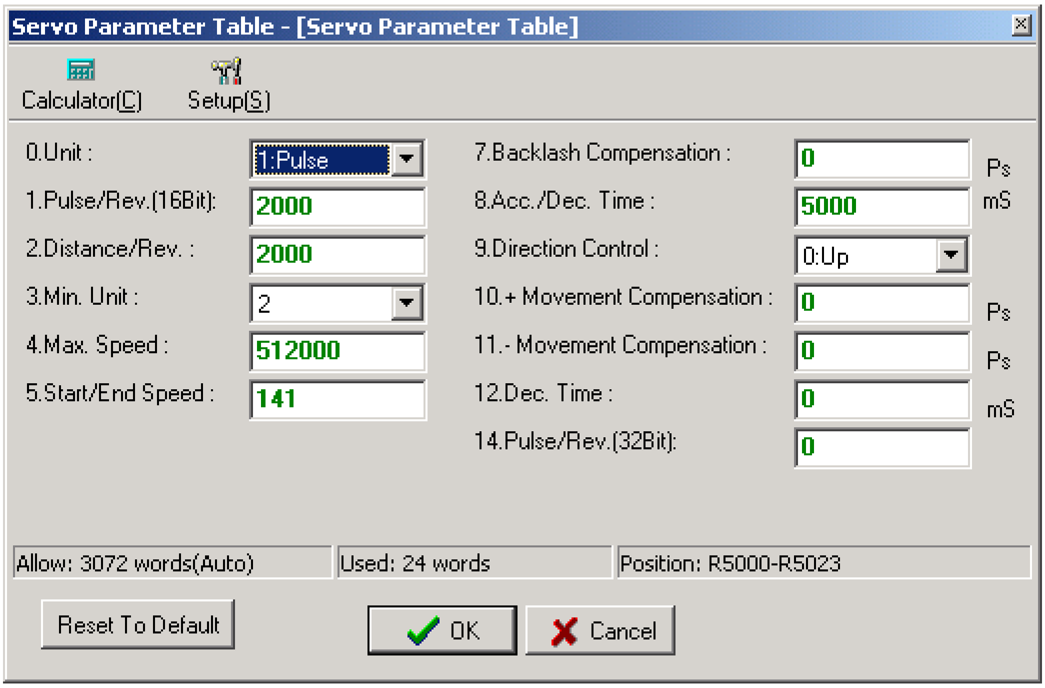
Click the “Servo Parameter Table” Item which in project windows :

Project name
  Table Edit
    Servo Parameter Table → Click right button and select “New Table”



- Table Type : It will be fixed to ” Servo Parameter Table ”.
- Table Name : For modify or debug, you can give a convenient name.
- Table Starting address : Enter the address which Starting register of Servo Parameter Table.

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA



Explanation for the parameter:

- Parameter 0: The setting of unit, its default is 1.
  - When the setting value is 0, the moving stroke and speed setting in the positioning program will all be assigned with the unit of mm, Deg, Inch, so called machine unit.
  - When the setting value is 1, the moving stroke and speed setting in the positioning program will all be assigned with the unit of Pulse, so called motor unit.
  - When the setting value is 2, the moving stroke setting in the positioning program will all be assigned with the unit of mm, Deg, Inch, and the speed setting will all be assigned with the unit of Pulse/Sec, which is called as compound unit.

Parameter 0, unit setting	"0" machine unit	"1" motor unit	"2" compound unit
Parameter 1, 2	Must be set	No need to set	Must be set
Parameter 3, 7, 10, 11	mm，Deg，Inch	Ps	mm，Deg，Inch
Parameter 4,5,6,15,16	Cm/Min，Deg/Min，Inch/Min	Ps/Sec	Ps/Sec

- Parameter 1: Pulse count/1-revolution, its default is 2000, i.e. 2000 Ps/Rev.
  - The pulse counts needed to turn the motor for one revolution
    A= 1～65535 (for value greater than 32767, it is set with unsigned decimal) Ps/Rev
  - When Parameter 14 = 0, Parameter 1 is the setting for Pulse /Rev
  - When Parameter 14 ≠ 0, Parameter 14 is the setting for Pulse/Rev

- Parameter 2: Movement/1 revolution, its default is 2000, i.e. 2000 Ps/Rev.
  - The movement while motor turning for one revolution.
    B=1～999999 μM/Rev
    1～999999 mDeg/Rev
    1～999999 × 0.1 mInch/Rev

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA

● Parameter 3: The resolution of moving stroke setting, its default is 2.

Parameter 0 / Parameter 3	Set value=0, machine unit; Set value=2, compound unit;			Set value=1 motor unit (Ps)
	mm	Deg	Inch	
Set value =0	×1	×1	×0.1	×1000
Set value =1	×0.1	×0.1	×0.01	×100
Set value =2	×0.01	×0.01	×0.001	×10
Set value =3	×0.001	×0.001	×0.0001	×1

● Parameter 4: The limited speed setting, its default is 460000, i.e. 460000 Ps/Sec.

- Motor and compound unit: 1～921600 Ps/Sec.
- Machine unit: 1～153000 (cm/Min, ×10 Deg/Min, Inch/Min).

However, the limited frequency can't be greater than921600 Ps/Sec.

$f\_max = (V\_max \times 1000 \times A) / (6 \times B) \leq 921600$ Ps/Sec

$f\_min \geq 1$ Ps/Sec

Note: A = Parameter 1, B =Parameter 2.

● Parameter 5: Initiate/Stop speed, the default = 141.

- Motor and compound unit: 1～921600 Ps/Sec.
- Machine unit: 1～15300 (cm/Min, ×10 Deg/Min, Inch/Min).

However, the limited frequency can't be greater than 921600 Ps/Sec.

●Parameter 6: Creep speed for machine zero return; the default is 1000.

Motor and compound unit: 1～65535 Ps/Sec

Machine unit: 1～15300 (cm/Min, ×10 Deg/Min, Inch/Min).

●Parameter 7: Backlash compensation, the default =0.

- Setting range: 0～32767 Ps.
- While backward traveling, the traveling distance will be added with this value automatically.

● Parameter 8: Acceleration/Deceleration time setting, the default = 5000, and the unit is mS.

- Setting range: 0～30000 mS.
- The setting value represents the time required to accelerate from idle state up to limited speed state or decelerate from the limited speed state down to the idle state.
- The acceleration/deceleration is constant slope depending on Parameter 4 / Parameter 8
- When Parameter 12 = 0, Parameter 8 is the deceleration time
- There will have the auto deceleration function for short stroke movement.

●Parameter 9: Rotation and zero return direction; the default is 0100H (Not used in linear interpolation mode)

	b15 — b8	b7 — b0
SR+12	Para 9-1	Para 9-0

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA

- Parameter 9-0: Rotation direction setting; the default is 0
  Setting value =0, the present value increases while in forward pulse output; the present value decreases while in backward pulse output.
  Setting value =1, the present value decreases while in forward pulse output; the present value increases while in backward pulse output.
- Parameter 9-1: Zero return direction setting; the default is 1
  Setting value =0, direction in which the present value increases.
  Setting value =1, direction in which the present value decreases.

● Parameter 10: Forward movement compensation, the default = 0.
- Setting range: –32768～32767 Ps.
- When it is in forward pulse output, it will automatically add with this value as the moving distance.

● Parameter 11: Backward movement compensation, the default =0.
- Setting range: –32768～32767 Ps.
- When it is in backward pulse output, it will automatically add with this value as the moving distance.

● Parameter 12: Deceleration time setting, the default =0, and the unit is mS.
- Setting range: 0～30000 mS.
- When Parameter 12 = 0, Parameter 8 is the deceleration time
- When Parameter 12 ≠ 0, Parameter 12 is the deceleration time

●Parameter 13: Interpolation time constant; the default is 500.
- Setting range: 0～30000 mS.
- Set the time required to achieve the speed specified by the program. (The initiate speed is always regarded as “0.)
- This parameter is valid while interpolation control.

●Parameter 14: Pulse count/1-revolution, the default = 0.
- The pulse counts needed to turn the motor for one revolution
- When Parameter 14 = 0, Parameter 1 is the setting for Pulse /Rev
- When Parameter 14 ≠ 0, Parameter 14 is the setting for Pulse/Rev

●Parameter 15: I/O control interface for DRVZ; the default is FFFFFFFFH

	b15　　　b8	b7　　　b0
SR+19	Para 15-1	Para 15-0
SR+20	Para 15-3	Para 15-2

- Parameter 15-0: Setting of DOG input (SR+19), it must be the input of the main unit
  b6~b0: Reference number of DOG input (0~15, it means X0~X15)
  b7=0: Contact A or Normal Open
  =1: Contact B or Normal Close
  b7~b0=FFH, without DOG input

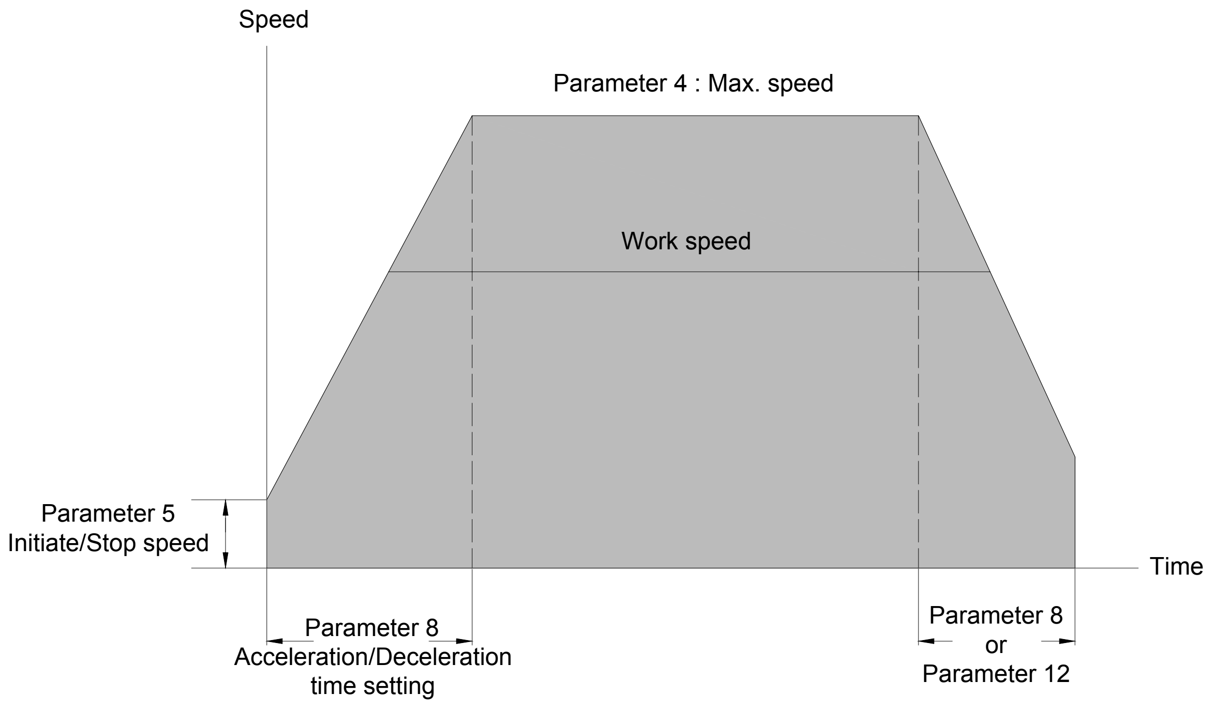
FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA

- Parameter 15-1: Setting of stroke limit input (SR+19)
  - b14~b8: Reference number of limit input (0~125, it means X0~X125)
  - b15 = 0 : Contact A or Normal Open
  - = 1 ; Contact B or Normal Close
  - b15~b8 = FFH, without limit input

- Parameter 15-2: Setting of PG0 signal input (SR+20), it must be the input of the main unit
  - b6~b0: Reference number of PG0 input (0~15, it means X0~X15)
  - b7= 0 : Start counting at front end of sensing DOG input
  - b7= 1 ; Start counting at rear end of sensing DOG input
  - b7~b0 = FFH, without PG0 input

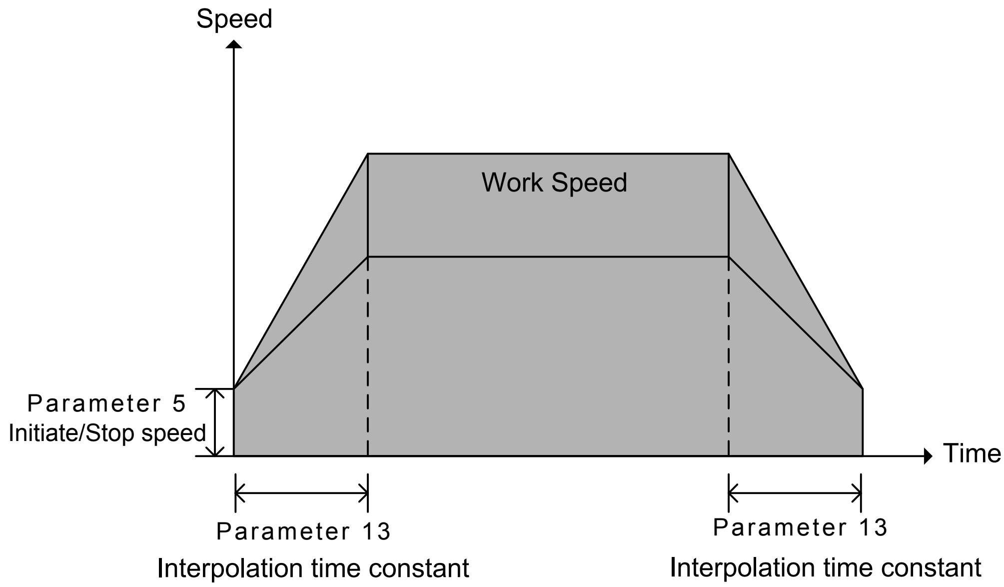
- Parameter 15-3: Setting of CLR signal output (SR+20), it must be the output of the main unit
  - b15~b8: Reference number of CLR output (0~23, it means Y0~Y23)
  - b15~b8 =FFH, without CLR output

- Parameter 16: Machine zero point address; the default is 0. Setting range: -999999 ~ 999999 Ps
- Parameter 17: Number of zero point signals (Sensing of PG0 input); the default is 1. Setting range : 0~255 count



. For reference with FUN140 instruction

FUN 141 MPARA	Instruction of Parameter Setting for Positioning Program	FUN 141 MPARA



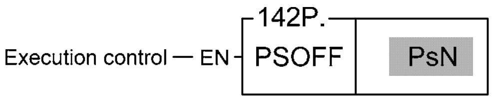
. For reference with FUN147 instruction

※ The parameter 13 of the axis with longest movement is used for acceleration and deceleration control for linear interpolation if each axis owns its own motion parameter table

※ Using the same motion parameter table (through FUN141 and give the same starting address of SR operand for each axis) for the simultaneous linear interpolation axes, it is the best way for multi-axis linear interpolation motion control

FUN 142 P PSOFF	Enforcing to Stop Pulse Output	FUN 142 P PSOFF

Ladder symbol

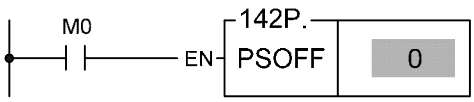


N: 0～3, enforces the assigned set number of Pulse Output to stop its output.

Instruction Explanation

1. When stop control "EN" =1, or changes from 0→1(P instruction), this instruction will enforce the assigned set number of Pulse Output to stop its output.
2. When applying in the process of return home , as the home has returned, it can immediately stop the pulse output by using this instruction, so as to make it stop at the same position every time when performing machine homing.

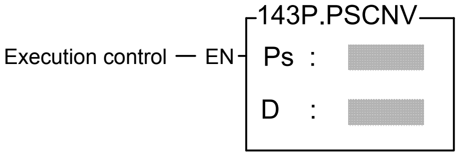
Program example



; When M0 changes from 0→1, it enforces the Ps0 to stop the pulse output.

FUN 143 P PSCNV	Converting the Current Pulse Value to the Displaying Value (mm, Deg, Inch, PS)	FUN 143 P PSCNV

Ladder symbol



Ps: 0～3; converting the assigned pulse position to mm (Deg, Inch, PS) which has the same unit as the set point, so as to make the current position displayed.

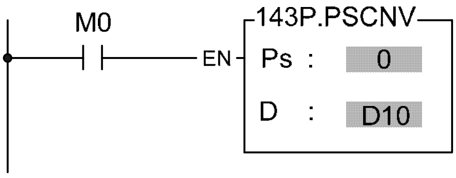
D: Registers that store the current position after conversion. It uses 2 registers, e.g. D10 represents D10 (Low Word) and D11 (High Word) two registers.

Range / Operand	HR R0 – R3839	DR D0 – D3999	ROR R5000 – R8071	K 2 – 256
Ps				0～3
D	○	○	○*	

Instruction Explanation

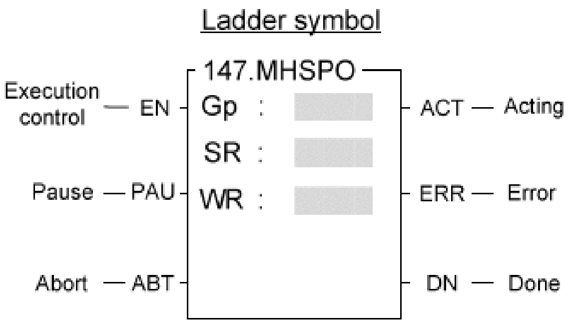
1. When execution control "EN" =1 or changes from 0→1(P instruction), this instruction will convert the assigned current pulse position (PS) to be the mm (or Deg, Inch, or PS) that has the same unit as the set value, so as to make current position displaying.
2. After the FUN140 and FUN 147 instructions have been performed, it will then be able to get the correct conversion value by executing this instruction.

Program Example



; When M0=1, it converts the current pulse position of Ps0 (DR4088) to the mm (or Deg or Inch or PS) that has the same unit as the set value, and store it into the DD10 to make the current position displaying.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO



Gp : Group number (0~1)

SR : Starting register for positioning program (example explanation)

WR : Starting register for instruction operation (example explanation). It controls 9 registers, which the other program cannot repeat in using.

Range / Operand	HR R0–R3839	DR D0–D3999	ROR R5000–R8071	K
Gp				0~1
SR	○	○	○	
WR	○	○	○*	

Instruction Explanation

1. The FUN147 (MHSPO) instruction is used to support the linear interpolation for multi-axis motion control, it consists of the motion program written and edited with tex programming. We named every position point as a step (which includes output frequency, traveling distance, and transfer conditions). Every step of positioning point owns 15 registers for coding.
2. The FUN147 (MHSPO) instruction can support up to 4 axes for simultaneous linear interpolation; or 2 sets of 2-axis linear interpolation (i.e. Gp0 = Axes Ps0 & Ps1 **;** Gp1 = Axes Ps2 & Ps3)
3. The best benefit to store the positioning program into the registers is that in the case of association with MMI (Man Machine Interface) to operate settings, it may save and reload the positioning program via MMI when replacing the molds.
4. When execution control "EN"=1, if the other FUN147/FUN140 instructions to control Ps0～3 are not active (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 will be ON), it will start to execute from the next step of positioning point (when goes to the last step, it will be restarted from the first step to perform); if Ps0～3 is controlled by other FUN147/FUN140 instruction (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 would be OFF), this instruction will acquire the pulse output right of positioning control once the controlling FUN147/FUN140 has released the control right.
5. When execution control input "EN" =0, it stops the pulse output immediately.
6. When output pause "PAU" =1 and execution control "EN" was 1 beforehand, it will pause the pulse output. When output pause "PAU" =0 and execution control is still 1, it will continue the unfinished pulse output.
7. When output abort "ABT"=1, it stops pulse output immediately. (When the execution control input "EN" becomes 1 next time, it will restart from the first step of positioning point to execute.)
8. While the pulse is in output transmitting, the output indication "ACT" is ON.
9. When there is execution error, the output indication "ERR" will be ON. (The error code is stored in the error code register.)
10. When each step of positioning point is complete, the output indication "DN" will be ON.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

*** The working mode of Pulse Output must be set (without setting, Y0～Y7 will be treated as general output) to be one of U/D, or A/B mode, thus the Pulse Output may have a regular output.

U/D mode : Y0 (Y2, Y4, Y6), it sends out upward counting pulse.
Y1 (Y3, Y5, Y7), it sends out downward counting pulse.

A/B mode : Y0 (Y2, Y4, Y6), it sends out the phase A pulse.
Y1 (Y3, Y5, Y7), it sends out the phase B pulse.

● The output polarity for Pulse Output can select to be Normal ON or Normal OFF.

【The interfaces for positioning control】

M1991	ON : Stop or pause FUN147, slow down then stop pulse output OFF : Stop or pause FUN147, stop pulse output immediately
M1992	ON : Ps0 is ready OFF : Ps0 is in action
M1993	ON : Ps1 is ready OFF : Ps1 is in action
M1994	ON : Ps2 is ready OFF : Ps2 is in action
M1995	ON : Ps3 is ready OFF : Ps3 is in action
M1934	ON : Gp0 has finished the last step
M1935	ON : Gp1 has finished the last step

DR4068	Gp0 vector speed
DR4070	Gp1 vector speed
D4060	Gp0 error code
D4061	Gp1 error code
D4062	The step number (positioning point) which has been completed of Gp0.
D4063	The step number (positioning point) which has been completed of Gp1.

Ps No.	Current output frequency	Current pulse position	The remaining pulse counts to be transmitted
Ps0	DR4080	DR4088	DR4072
Ps1	DR4082	DR4090	DR4074
Ps2	DR4084	DR4092	DR4076
Ps3	DR4086	DR4094	DR4078

※ FUN147 doesn't support dynamic change for its output frequency during the pulse transmitting.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

- Format of positioning program with linear interpolation：

SR：Starting register of registers block which reserved to store positioning program, explained as follows：

SR	A55CH	；The effective positioning program; its starting register must be A55CH
SR+1	Total steps	
SR+2		The first positioning point (step) of positioning program (every step owns 15 registers for coding).
SR+3		
• • • •	• • • •	
SR+14		
SR+15		
SR+16		
	⋮	
		The Nth step of positioning program.
SR+N×15+2		

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

● Explanation for working register of instruction operation :

WR is the starting of working registers.

WR+0	Being executed or stopped step
WR+1	Working flag
WR+2	Controlled by system
WR+3	Controlled by system
WR+4	Controlled by system
WR+5	Controlled by system
WR+6	Controlled by system
WR+7	Controlled by system
WR+8	Controlled by system

WR+0 **:** If this instruction is in execution, the content of this register represents the step (1～N) being performed. If this instruction is not in execution, the content of this register represents the step where it stopped at present

When execution control “EN” =1, it will perform the next step, i.e. the current step plus 1 (if the current step is at the last step, it will restart to perform from the first step).

Before starting the execution control “EN” =1, the user can renew the content of WR+0 to determine starting from which step to perform (when the content of WR+0 =0, and execution control “EN” =1, it represents that the execution starts from the first step).

WR+1 **:** B0～B7, total steps

B8 = ON, output paused

B9 = ON, waiting for transfer condition

B10 = ON, endless output

B12 = ON, pulse output transmitting (the status of output indicator “ACT”)

B13 = ON, instruction execution error (the status of output indicator “ERR”)

B14 = ON, finished being executed step (the status of output indicator “DN”)

*** When step which has been completed, the output indication “DN” will turn ON and keep such status if suspending ; the user may turn OFF the status of “DN” by using the rising edge of output coil controlled by "DN" to clear the content of WR+1 register to be 0, and it can be attained.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

Error indication	Error code		
R4060（Ps0）	0	：Error free	The possible error codes For FUN141 execution
R4061（Ps1）	1	：Parameter 0 error	
R4062（Ps2）	2	：Parameter 1 error	
R4063（Ps3）	3	：Parameter 2 error	
D4060（Gp0）	4	：Parameter 3 error	
D4061（Gp1）	5	：Parameter 4 error	
	6	：Parameter 5 error	
	7	：Parameter 6 error	
	8	：Parameter 7 error	
	9	：Parameter 8 error	
	10	：Parameter 9 error	
	13	：Parameter 12 error	
	14	：Parameter 13 error	
	15	：Parameter 14 error	
	30	：Error of variable address for speed setting	The possible error codes For FUN140 and FUN147 execution
	31	：Error of setting value for speed setting	
	32	：Error of variable address for stroke setting	
	33	：Error of setting value for stroke setting	
	34	：Illegal positioning program	
	35	：Length error of total step	
	36	：Over the maximum step	
	37	：Limited frequency error	
	38	：Initiate/stop frequency error	
	39	：Over range of compensation value for movement	
	40	：Over range of moving stroke	
	41	：ABS positioning is not allowed within DRVC commands	
	42	：DRVZ can't follow DRVC	
	50	：Illegal operation mod of DRVZ	
	51	：Illegal DOG input number	
	52	：Illegal PG0 input number	
	53	：Illegal CLR output number	
	60	：Illegal linear interpolation command	

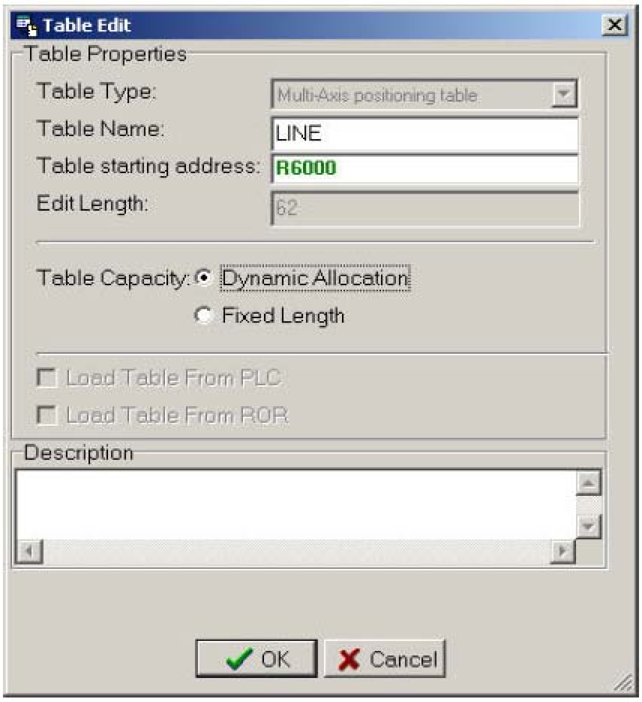
Note : The content of error indication register will keep the latest error code. Making sure that no more error to happen, you can clear the content of error indication register to be 0, and it still maintains the value at 0.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

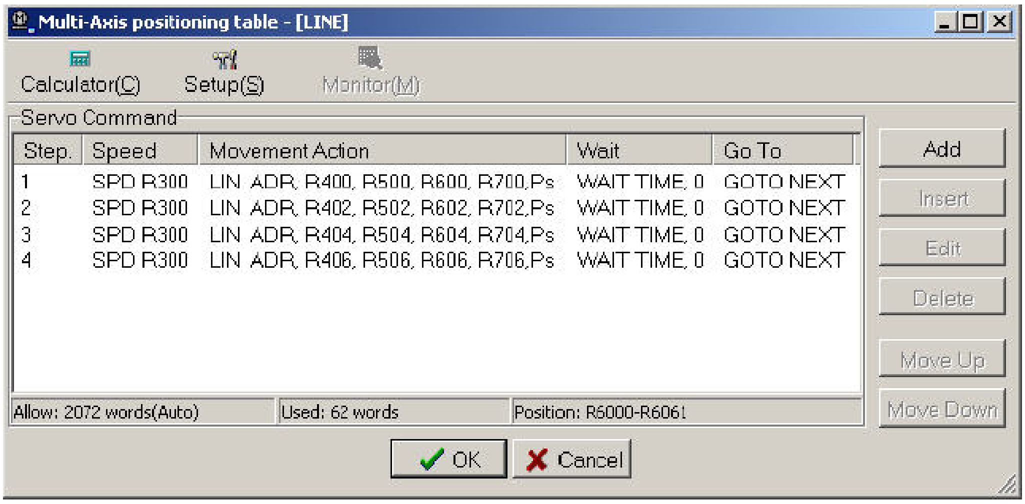
Editing Servo Program Table with WinProladder

Click the "Servo Program Table" item which in project window:

Project Name
└── Table Edit
 └── Servo Program Table → Click right button and select "New Table"



- Table Type: Multi-Axis positioning table
- Table Name: For modify or debug, you can give a convenient name.
- Table Starting address: Enter the address which Starting register



FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

- For easy programming and trouble shooting, the WinProladder provides the text editing environment to edit the motion program (servo program table) for FUN147 execution.
- Extended positioning instructions for linear interpolation are listed as follows:

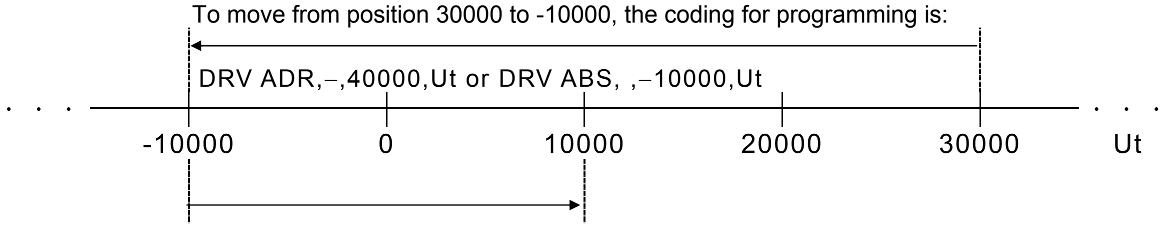
Instruction	Operand	Explanation
SPD	XXXXXX or Rxxxx or Dxxxx	• Setting of the vector speed for linear interpolation 1 ≦ setting value ≦ 1840000 • Moving speed in frequency or velocity (FUN141 Parameter_0=0 represents velocity; Parameter_0=1 or 2 for frequency; the system default is frequency). The operand can be input directly with constant or variable (Rxxxx, Dxxxx); when the operand is variable, it needs 2 registers, e.g. D10 represents D10 (Low Word) and D11 (High Word), which is the setting of frequency or velocity. • When selecting to use the velocity setting, the system will automatically convert the velocity setting to corresponding output frequency • The corresponding axis frequency for output will be calculate from the setting of the vector speed • Output frequency range: 1≦output frequency≦921600 Hz.
LIN	ADR，X，Y，Z，W，Ut or or ABS Ps Where, X：Stroke setting of Ps0 Y：Stroke setting of Ps1 Z：Stroke setting of Ps2 W：Stroke setting of Ps3	• Moving stroke setting in Ps or mm,Deg,Inch (When FUN141 Parameter_0=1, the setting stroke in Ut is Ps; Parameter_0=0 or 2, the setting stroke in Ut is mm, Deg, Inch; the system default for Ut is Ps). • When 6_th operand of LIN is Ut (not Ps) , according to the settings of parameter 1, 2, 3 of FUN141, the system will convert the corresponding pulse count to output. • There are 6 operands to construct LIN instruction as follows: 1_st operand: coordinate selection. ADR or ABS: ADR, relative distance movement ABS, absolute position movement 2_nd～5_th operands: moving stroke setting for each axis XXXXXXXX: or −XXXXXXXX or Rxxxx or Dxxxx — It can directly input with constant or variable (Rxxxx, Dxxxx); it needs 2 registers when adopting the variable, e.g. R0 represents R0 (Low Word) and R1 (High Word) as the setting of moving stroke. Positive setting value moves forward Negative setting value moves backward *** When the setting of moving stroke is 0 or in space and 1_st operand is ADR, it means no movement for this axis *** When the setting of moving stroke is in space and 1_st operand is ABS, it means no movement for this axis Maximum setting for one movement must be under ±1999999 Ps 6_th operand: resolution of stroke setting Ut or Ps: for Ut, the resolution is one unit (it is determined by parameter 0, 3 of FUN141); for Ps, the enforced resolution is one pulse.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

Instruction	Operand	Explanation
LINE	ADR，X，Y，Z，W，Ut or or ABS Ps Where, X：Stroke setting of Ps0 Y：Stroke setting of Ps1 Z：Stroke setting of Ps2 W：Stroke setting of Ps3	•LINE is used for linear interpolation in endless movement •There are 6 operands to construct LINE instruction as LIN's Description •The stroke setting for each axis means the output ratio between the active axes, the axis with longest movement is followed by others i.e. In LINE mode, if the stroke settings are 1000、500、300、0(In Ps), it means if Ps0 axis sends 1000Ps, then Ps1 and Ps2 will send 500Ps and 300Ps respectively. (Axis Ps3 doesn't work due to the setting value is 0). It will follow this ratio (1000/500/300/0) for pulse output until the FUN147 instruction is stopped or exists from the LINE mode.

Note: Comparison explanation between the relative coordinate positioning (ADR) and the absolute coordinate positioning (ABS)

To move from position 30000 to -10000, the coding for programming is:



To move from position–10000 to 10000, the coding for programming is:
DRV ADR,+,20000,Ut or DRV ABS, ,10000,Ut

Instruction	Operand	Explanation
WAIT	TIME，XXXXX or Rxxxx or Dxxxx or X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	• When pulse output is complete, performing the wait instruction to go to the assigned step. There are 5 kind of operands that explained as follows: Time: The waiting time (the unit is 0.01 second), it can be directly input with constant or variable (Rxxxx or Dxxxx); when it is time up, performs the step that assigned by GOTO. X0～X255: Waiting until the input status is ON, it performs the step that assigned by GOTO. Y0～Y255:Waiting until the output status is ON, it performs the step that assigned by GOTO. M0～M1911: Waiting until the internal relay is ON, it performs the step that assigned by GOTO. S0～S999: Waiting until the step relay is ON, it performs the step that assigned by GOTO.

FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

EXT	X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	•External trigger instruction; when it is in pulse output (the number of pulses sending is not complete yet), if the status of external trigger is ON, it will perform the step assigned by GOTO immediately. If the status of external trigger is still OFF when the pulse output has been complete, it is the same as WAIT instruction; waiting the trigger signal ON, then perform the step assigned by GOTO.
GOTO	NEXT or 1～N or Rxxxx or Dxxxx	• When matching the transfer condition of WAIT, ACT, EXT instruction, by using GOTO instruction to describe the step to be executed. NEXT: It represents to perform the next step. 1～N : To perform the described number of step Rxxxx: The step to be performed is stored in register Rxxxx Dxxxx: The step to be performed is stored in register Dxxxx
MEND		End of the positioning program.

- The editing for positioning programming with linear interpolation**:**

  First, it must complete the FUN147 instruction before the editing of positioning program, and assigned in FUN147 instruction the starting register of registers block to store positioning program. While editing the positioning program, it will store the newly edited positioning program to the assigned registers block; for every one positioning point (called as one step) edited, it owns 15 registers for coding. If there are N positioning points, it will be used by N × 15 + 2 registers in total.

  Note: The registers storing the positioning program can not be repeated in using!

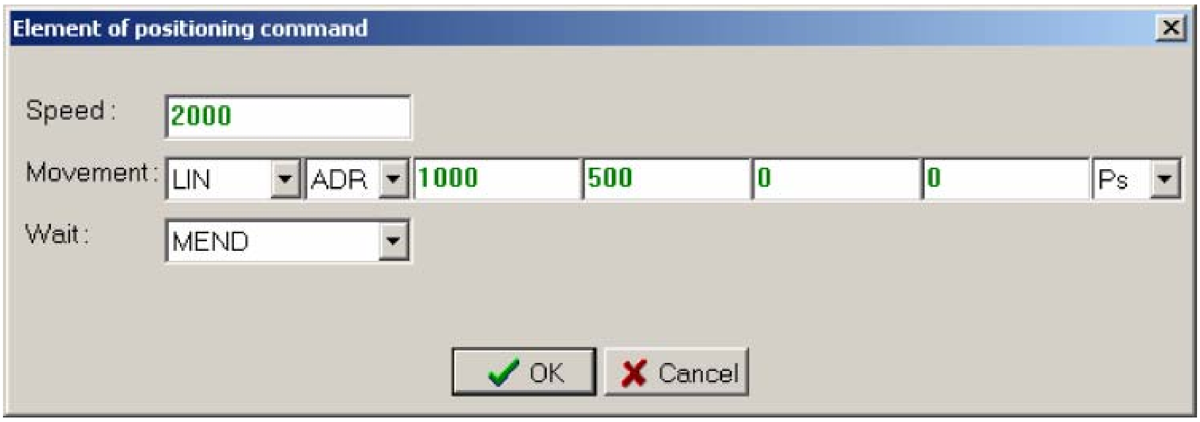
- Format and example for the positioning program with linear interpolation:

```
001 SPD     5000                        ; Vector speed is 5KHz
    LIN     ADR,500,400,300,200,Ut      ; Moving forward 500(Ps0)/400(Ps1)/300(Ps2)/200(Ps3) units
    WAIT    TIME,100                    ; Wait for 1second
    GOTO    NEXT                        ; Perform the next step
002 SPD     R1000                       ; Vector speed is stored in DR1000（R1001 and R1000）
    LIN     ADR,D100,D200, ,    ,Ut     ; Moving stroke is stored in DD100(Ps0) & DD200(Ps1)
    WAIT    TIME,R500                   ; The waiting time is stored in R500
    GOTO    NEXT                        ; To perform the next step
003 SPD     R1002                       ; Vector speed is stored in DR1002（R1003 and R1002）
    LIN     ADR,0,0,R300,R400,Ps        ; Moving stroke is stored in DR300(Ps2) & DR400(Ps3)
    WAIT    X0                          ; Wait until X0 ON
    GOTO    1                           ; Perform the first step
```

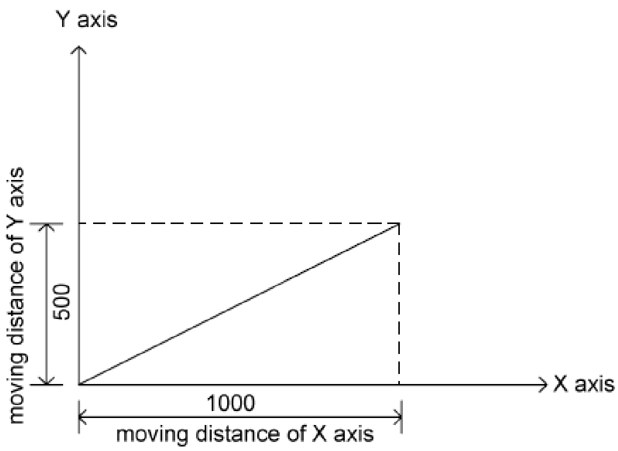
FUN147 MHSPO	Multi-Axis High Speed Pulse Output	FUN147 MHSPO

Example and figure for description

The positioning program with linear interpolation instruction as below:



It means the moving stroke setting for axis Ps0(X axis) is 1000 Ps, for axis Ps1(Y axis) is 500 Ps; both axes Ps2 and Ps3 are inactive due to the setting values are 0.



FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG

```
                 ┌148. MPG ──┐
Execution EN ────┤ Sc :      ├── ACT
                 │ Ps :      │
                 │ Fo :      │
                 │ Mr :      │
                 │ WR :      │
                 └───────────┘
```

Sc ： Source of high speed counter; 0~7
Ps ： Axis of pulse output; 0~3
Fo ： Setting of output speed (2 registers)
Mr ： Setting of multiplier (2 registers)
Mr+0： Multiplicand (Fa)
Mr+1： Dividend (Fb)
WR：Starting address of working registers, it needs 4 registers

＊ This instruction can be supported in PLC OS firmware V4.60 or late

Range / Operand	HR R0 ∣ R3839	ROR R5000 ∣ R8071	DR D0 ∣ D3999	K 16 bit
Sc	○	○	○	0~7
Ps	○	○	○	0~3
Fo	○	○	○	
Mr	○	○	○	
WR	○	○*	○	

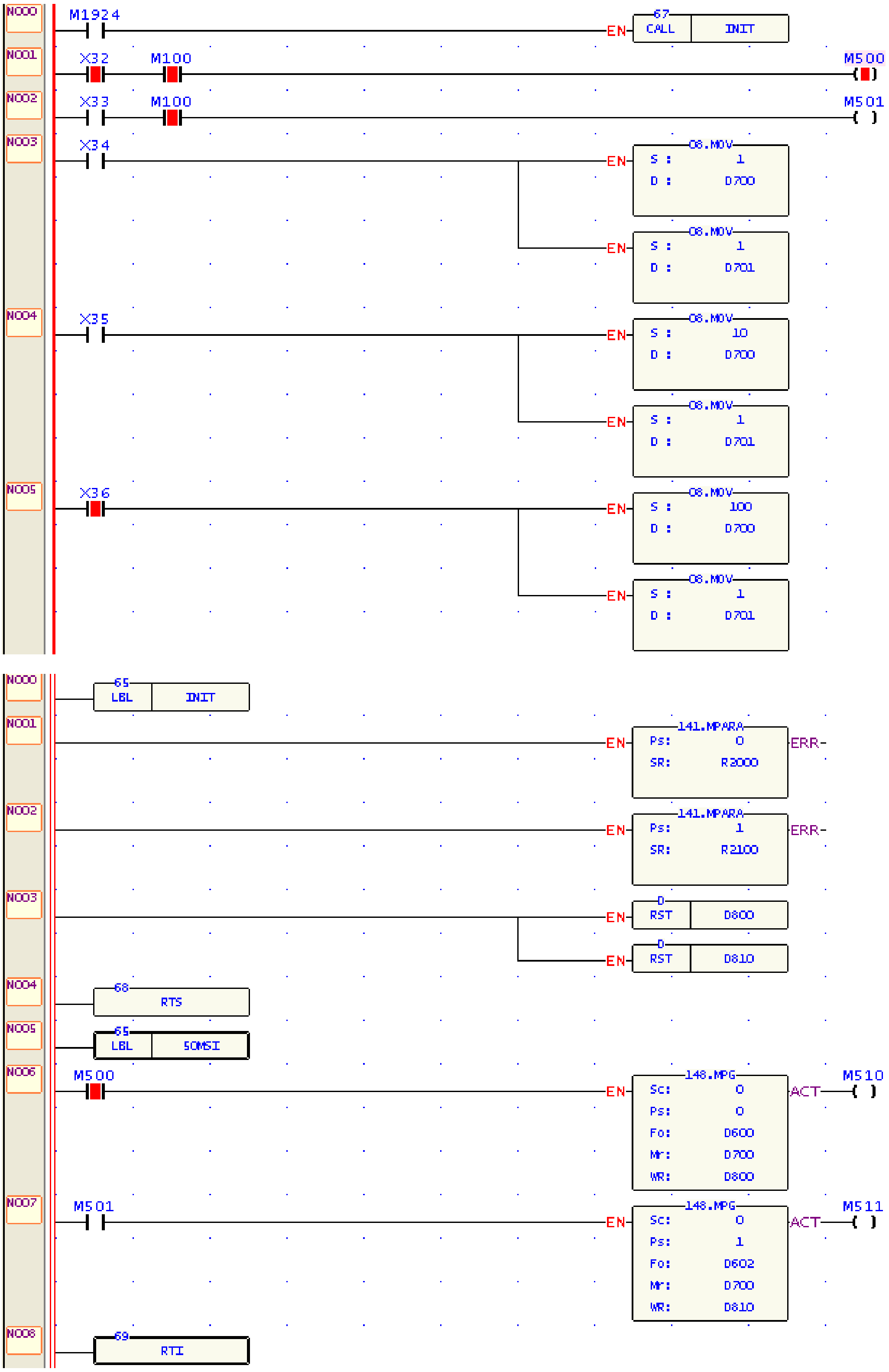
- Let this instruction be executed in 50mS fixed time interrupt service routine (50MSI)、or by using the 0.1mS high speed timer to generate 50mS fixed time interrupt service to have accurate repeat time to sample the pulse input from manual pulse generator. If it comes the input pulses, it will calculate the number of pulses needing to output according to the setting of multiplier (Mr+0 and Mr+1), and then outputs the pulse stream in the speed of setting (Fo) during this time interval.
  The setting of output speed (Fo) must be fast enough, and the acceleration / deceleration rate (Parameter 4 and parameter 8 of FUN141 instruction) must be sharp to guarantee it can complete the sending of pulse stream during the time interval if it is under high multiplier (100 or 200 times) situation.

- When execution 〝EN〞=1, this instruction will sample the pulse input from manual pulse generator by reading the current value of assigned high speed counter every time interval; it doesn't have any output if it doesn't have any input pulse; but If it senses the input pulses, it will calculate the number of pulses needing to output according to the setting of multiplier (Mr+0 and Mr+1), and then outputs the pulse stream in the speed of setting (Fo) during this time interval.
  Number of output pulses = (Number of input pulses × Fa) / Fb
- This instruction also under the control of hardware resource management; it wouldn't be executed if the hardware is occupied.
- The output indicator ACT=1 if it outputs the pulses; otherwise ACT=0.

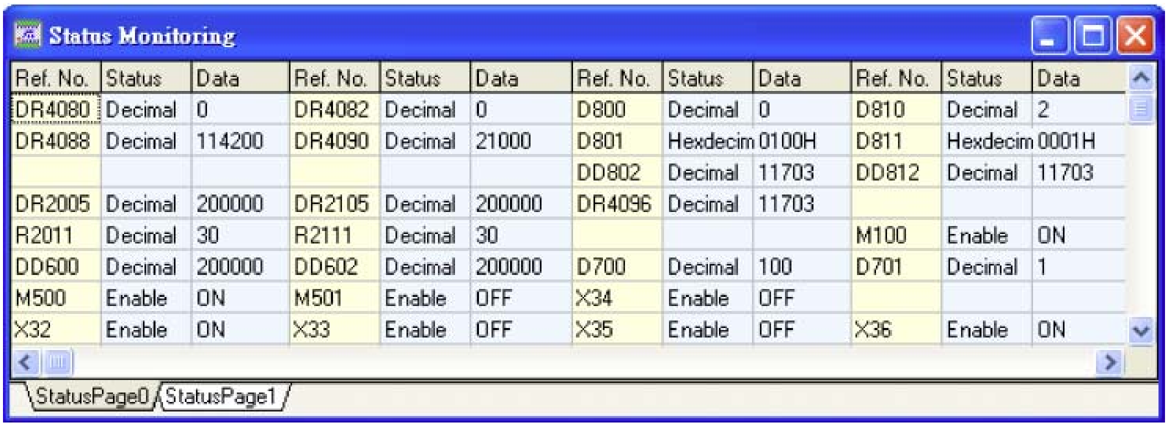
50mS		50mS
· Sample pulse input · Output pulse stream in the second of Fo	…	· Sample pulse input · Output pulse stream in the speed of Fo

FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG

Example 1:



FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG



Ref. No.	Status	Data	Ref. No.	Status	Data	Ref. No.	Status	Data	Ref. No.	Status	Data
DR4080	Decimal	0	DR4082	Decimal	0	D800	Decimal	0	D810	Decimal	2
DR4088	Decimal	114200	DR4090	Decimal	21000	D801	Hexdecim	0100H	D811	Hexdecim	0001H
						DD802	Decimal	11703	DD812	Decimal	11703
DR2005	Decimal	200000	DR2105	Decimal	200000	DR4096	Decimal	11703			
R2011	Decimal	30	R2111	Decimal	30				M100	Enable	ON
DD600	Decimal	200000	DD602	Decimal	200000	D700	Decimal	100	D701	Decimal	1
M500	Enable	ON	M501	Enable	OFF	X34	Enable	OFF			
X32	Enable	ON	X33	Enable	OFF	X35	Enable	OFF	X36	Enable	ON

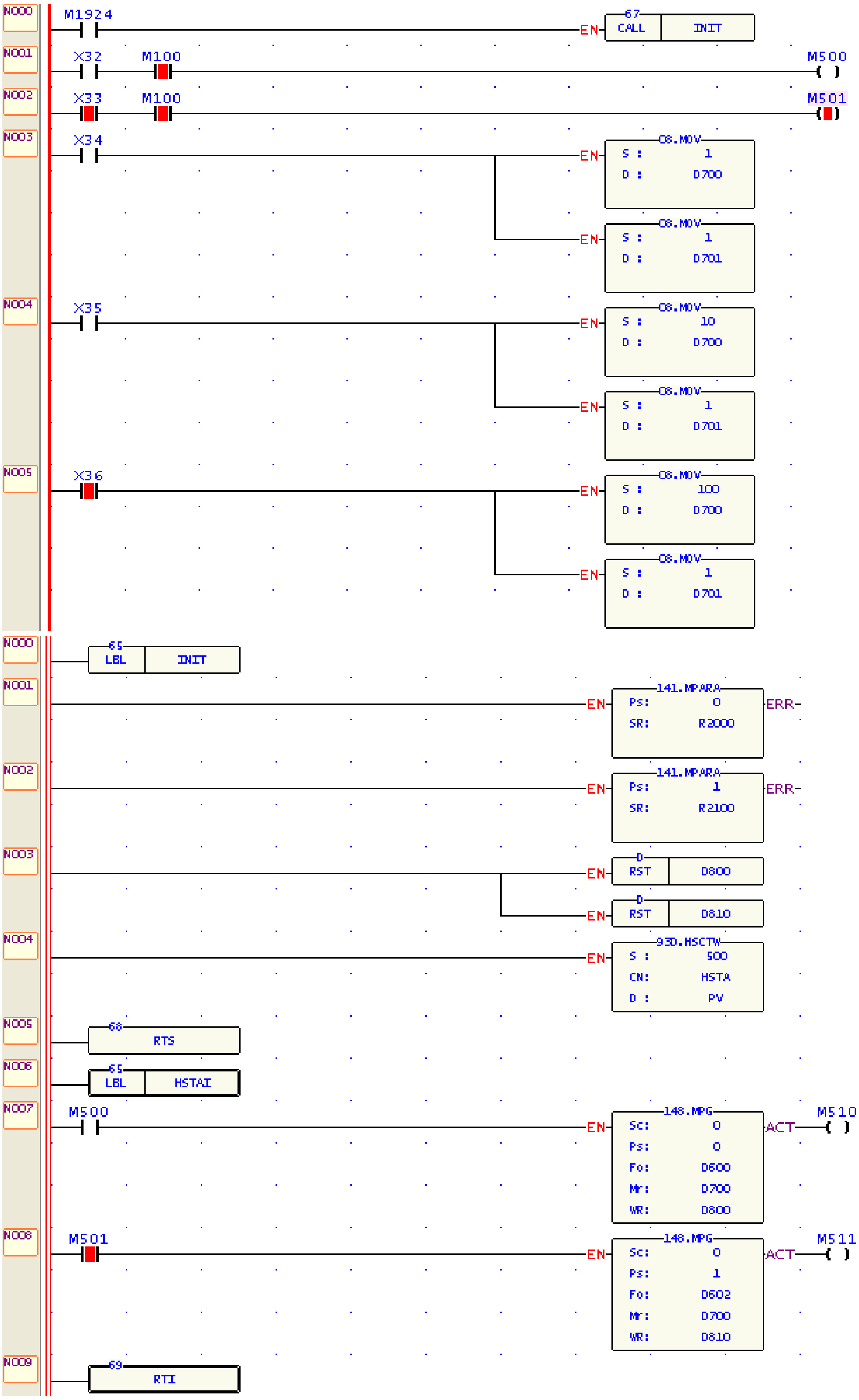
X32 ：Select axis 0(Ps0)
X33 ：Select axis 1 (Ps1)
X34 ：Multiplier = 1
X35 ：Multiplier = 10
X36 ：Multiplier = 100
M100：Enable / disable MPG activity
DR2005：Maximum speed of axis 0(Parameter 4 of FUN141)；200K Hz
R2011 ：Acc/Dec time of axis 0(Parameter 8 of FUN141)；30mS
DD600：Output speed of axis 0 for MPG; 200K Hz
DR2105： Maximum speed of axis 1 (Parameter 4 of FUN141) ; 200K Hz
R2111 ： Acc/Dec time of axis 1 (Parameter 8 of FUN141); 30mS
DD602： Output speed of axis 1 for MPG; 200K Hz

Description： Let the MPG instruction (FUN148) be executed in 50mS fixed time interrupt service routine (50MSI) to handle the MPG positioning of Ps0 and Ps1. When X32=1 and M100=1, it will handle the MPG positioning of Ps0; it will sample the pulse input from reading the current value of HSC0 every 50mS time interval; it doesn't have any output if it doesn't have any input pulse; but If it senses the input pulses, it will calculate the number of pulses needing to output according to the setting of multiplier (D700 and D701), and then outputs the pulse stream in the speed of setting (DD600) during this time interval.

.Number of output pulses = (Number of input pulses from HSC0 × D700) / D701

FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG

Example 2 :



FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG

Status Monitoring

Ref. No.	Status	Data	Ref. No.	Status	Data	Ref. No.	Status	Data	Ref. No.	Status	Data
DR4080	Decimal	0	DR4082	Decimal	0	D800	Decimal	0	D810	Decimal	2
DR4088	Decimal	114200	DR4090	Decimal	21000	D801	Hexdecim	0000H	D811	Hexdecim	0101H
						DD802	Decimal	11703	DD812	Decimal	11703
DR2005	Decimal	200000	DR2105	Decimal	200000	DR4096	Decimal	11703			
R2011	Decimal	30	R2111	Decimal	30				M100	Enable	ON
DD600	Decimal	200000	DD602	Decimal	200000	D700	Decimal	100	D701	Decimal	1
M500	Enable	OFF	M501	Enable	ON	X34	Enable	OFF			
X32	Enable	OFF	X33	Enable	ON	X35	Enable	OFF	X36	Enable	ON

StatusPage0 / StatusPage1

X32 ： Select axis 0 (Ps0)
X33 ： Select axis 1 (Ps1)
X34 ： Multiplier = 1
X35 ：Multiplier = 10
X36 ： Multiplier = 100
M100： Enable/disable MPG activity
DR2005： Maximum speed of axis 0 (Parameter 4 of FUN141) ; 200K Hz
R2011 ： Acc/Dec time of axis 0 (Parameter 8 of FUN141); 30mS
DD600： Output speed of axis 0 for MPG; 200K Hz
DR2105： Maximum speed of axis 1 (Parameter 4 of FUN141) ; 200K Hz
R2111 ： Acc/Dec time of axis 1 (Parameter 8 of FUN141); 30mS
DD602： Output speed of axis 1 for MPG; 200K Hz

Description： By using the 0.1mS high speed timer to generate 50mS fixed time interrupt service (HSTAII) to handle the MPG positioning of Ps0 and Ps1. When X33=1 and M100=1, it will handle the MPG positioning of Ps1; it will sample the pulse input from reading the current value of HSC0 every 50mS time interval; it doesn’t have any output if it doesn’t have any input pulse; but If it senses the input pulses, it will calculate the number of pulses needing to output according to the setting of multiplier (D700 and D701), and then outputs the pulse stream in the speed of setting (DD602) during this time interval.

.Number of output pulses = (Number of input pulses from HSC0 × D700) / D701

FUN148 MPG	Manual Pulse Generator For Positioning	FUN148 MPG

Manual Pulse Generator(FUN148，MPG) instruction supports most left/right limitation for positioning control

. High byte value of R4020 ≠ 55H, not support this function；

High byte value of R4020 = 55H, bits of low byte are used for most left/right limitation

R4020_ b15…b8=55H，

R4020_ b0=1，not allowed forward movement of Ps0

R4020_ b1=1，not allowed backward movement of Ps0

R4020_ b2=1，not allowed forward movement of Ps1

R4020_ b3=1，not allowed backward movement of Ps1

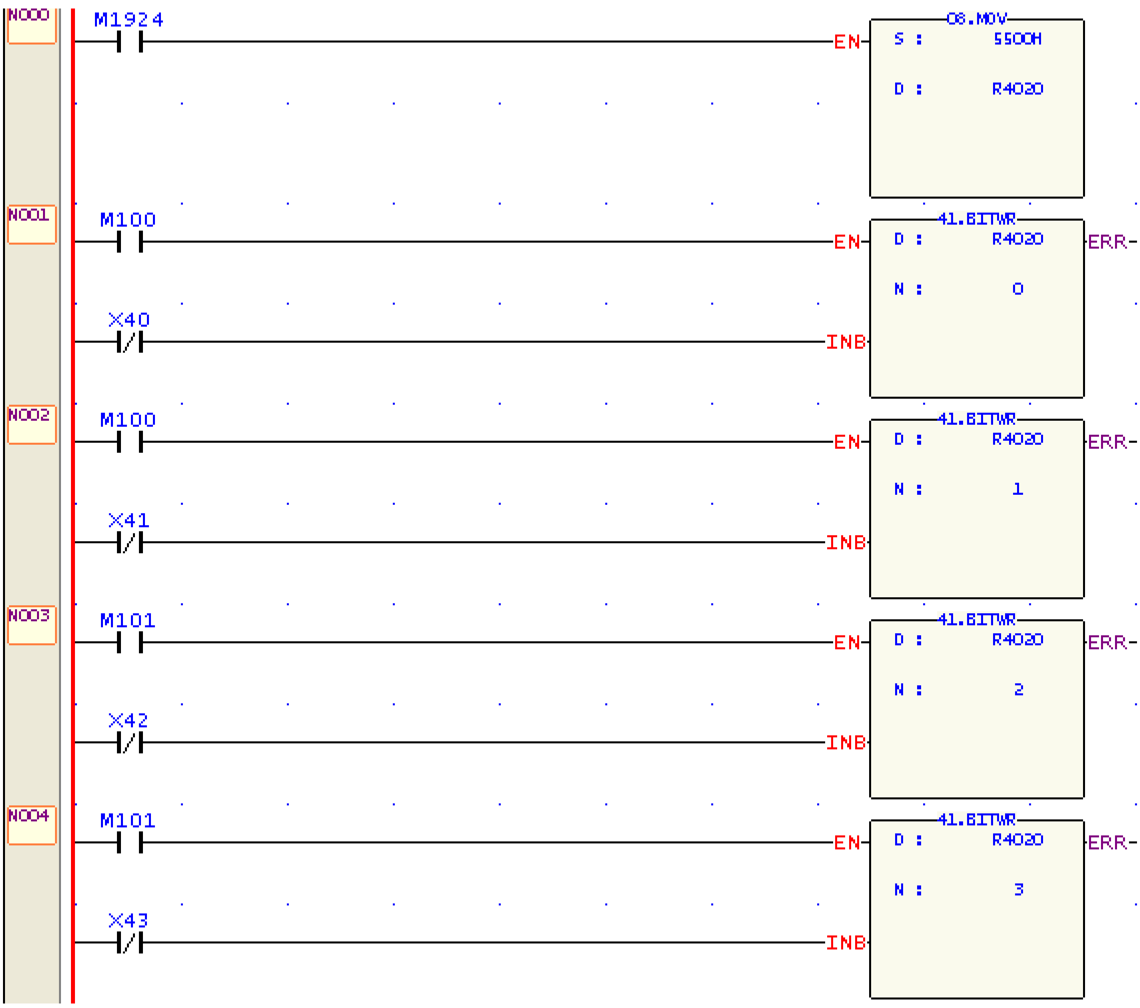
R4020_ b4=1，not allowed forward movement of Ps2

R4020_ b5=1，not allowed backward movement of Ps2

R4020_ b6=1，not allowed forward movement of Ps3

R4020_ b7=1，not allowed backward movement of Ps3

. Program example

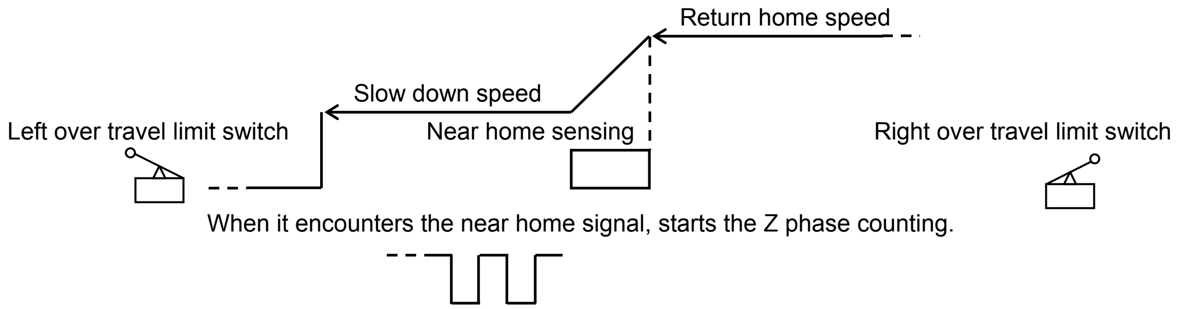


11.7 Machine Homing

The machine set which undertakes relative model Encoder as shifting detector usually need the reset action for the reference of positioning coordinate; we called this action as machine homing (seeking for zero reference).

The machine homing diagram for NC servo unit is as follows:

Method 1:



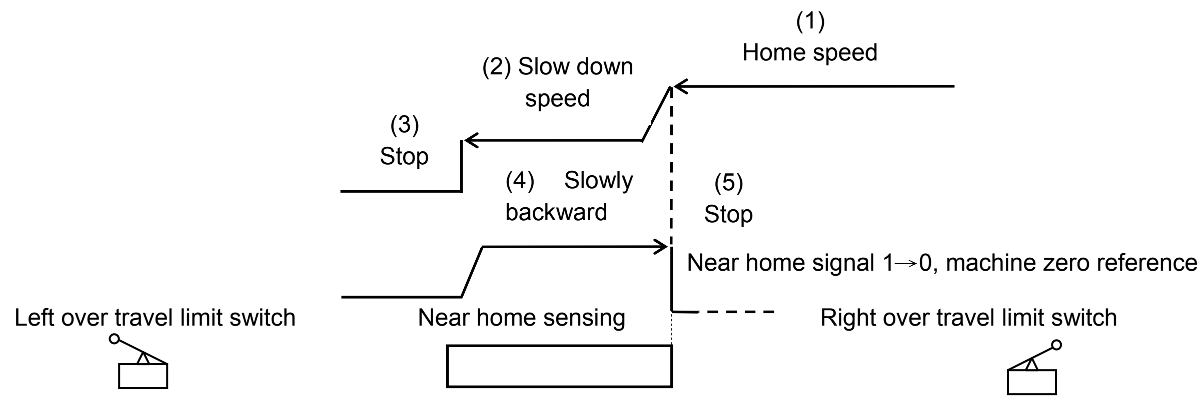
Z phase counting is up, the pulse output stops, then send out the CLR signal to clear the error counter of servo driver.

e.g.:

X3: Near home sensing input is configured as interrupt input; in the case of machine homing, it starts HSC4 to begin counting in X3+ interrupt service subroutine.

X2: Z phase counting input, it is configured as UP input of HSC4; the X2+ is prohibited to interrupt in regular time, when executing machine homing and X3 near home interrupt occurred, it starts HSC4 to begin Z phase counting. When HSC4 counting is up, it stops the pulse output, prohibit the X2+ interrupt, set home position to signal, and sends out the CLR signal to clear the error counter of servo driver. Please consult program example.

Method 2: According to application demand, it may slow down when encountering the near home sensor, while over the sensor a little far away, stop the pulse output, and then traveling slowly with backward direction; the very moment when it get out of near home sensor (the sensing signal changes from 1→0), it is treated as machine home. This program is simpler!



X3: Near home sensing input; it is configured as falling edge interrupt input.

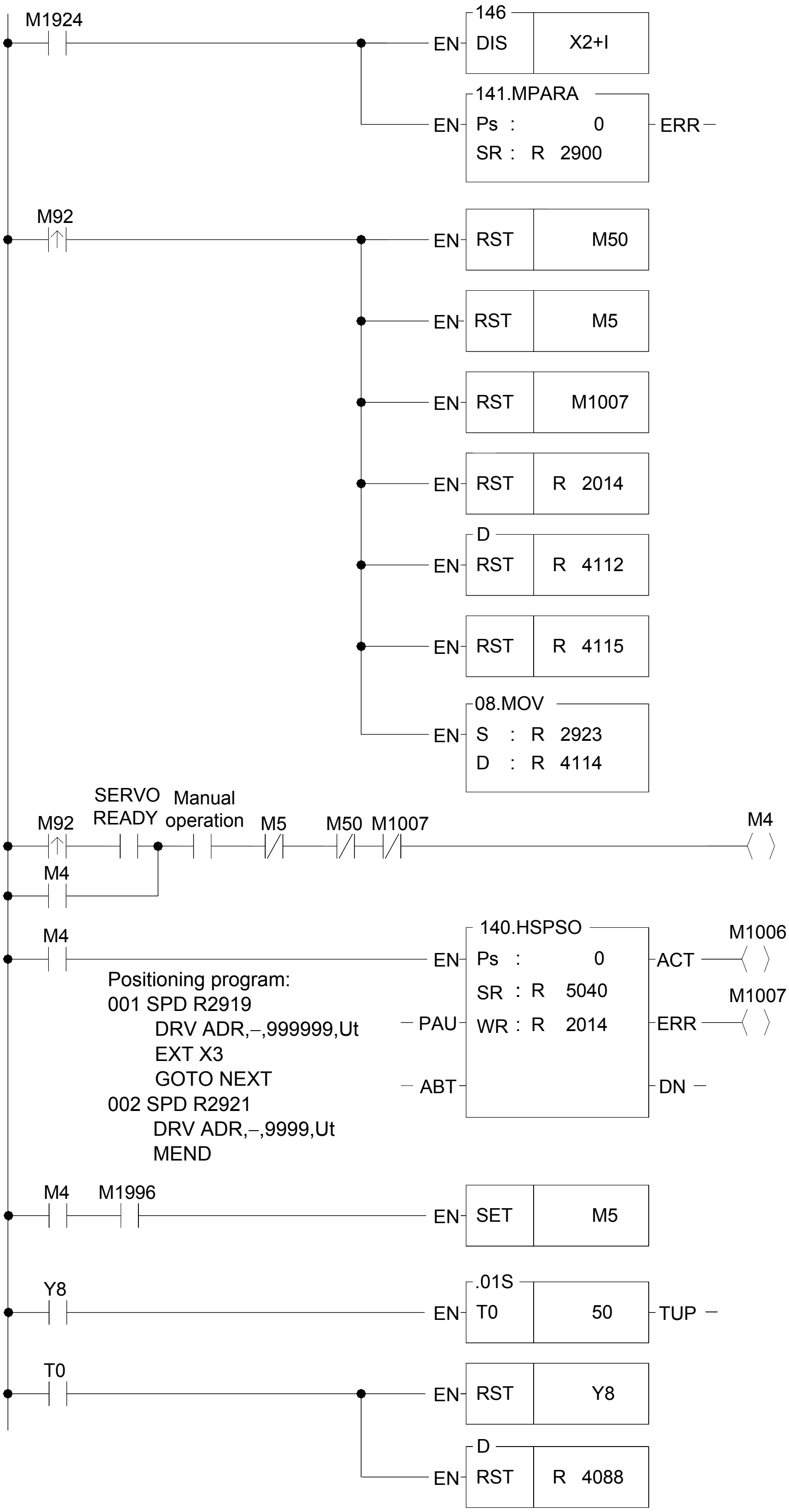
- Once encountering the near home sensor, it will enable X3 falling edge interrupt, and slow down to stop within the near home sensing range.
- Slowly backward traveling until the near home sensing signal changes from 1→0.
- When the near home sensing signal changes from 1→0, it performs the X3- interrupt service subroutine immediately.
- The X3- interrupt service subroutine: Stops the pulse output immediately, prohibits the X3- interrupt, sets home position to signal, and sends out CLR signal to clear the error counter of servo driver. (Please consult the example program.)

Program Example 1: Machine homing (method 1)

X2: Configured as the UP input of HSC4, and connected to Z phase input.

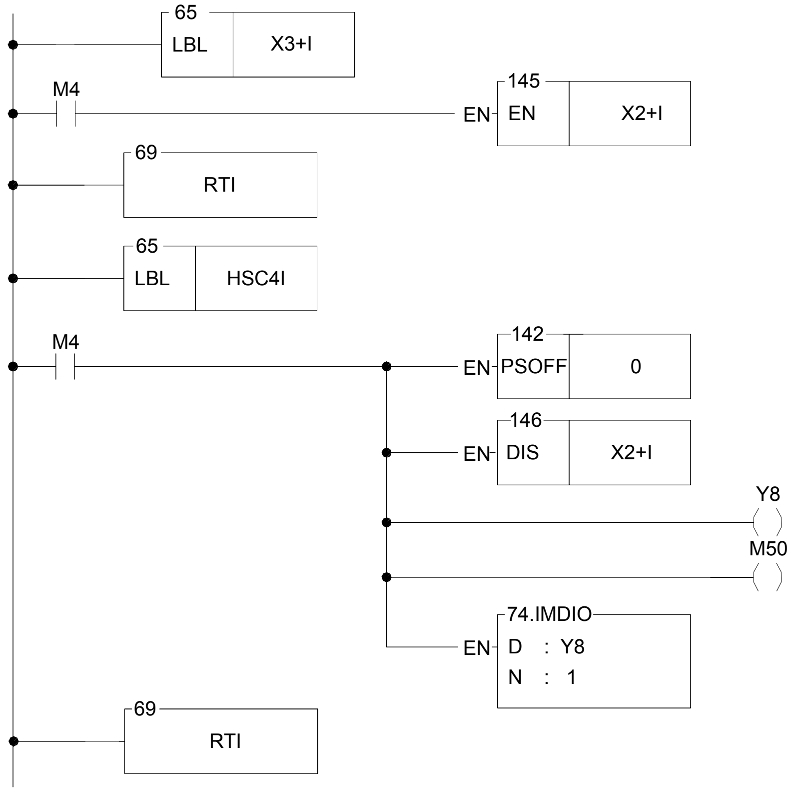
X3: Configured as the rising edge interrupt input, and connected to near home sensing input.

【Main Program】



- Prohibits X2+ interruption (HSC4 does not count)
- Parameter table R2900→R2923.
- Clears the homing completion signal.
- Clears the instruction completion signal for homing
- Clears the error signal.
- Clears the step pointer, it starts from the first step to execute.
- Clears the current value of HSC4.
- Clears the High Word of preset value for HSC4.
- Fill the preset value of HSC4 with the content of Parameter 17 of FUN141.
- Configure R5000～R5199 as the read only register (ROR) before programming, after then, when storing program, the Ladder program will automatically contains the positioning program.
- Homing instruction completed
- Signal for homing completion
- Fill the current PS registers with 0, while homing completed.
- Signal to clear error counter of servo driver -- Y8 is ON for 0.5 second.

【Sub Program】

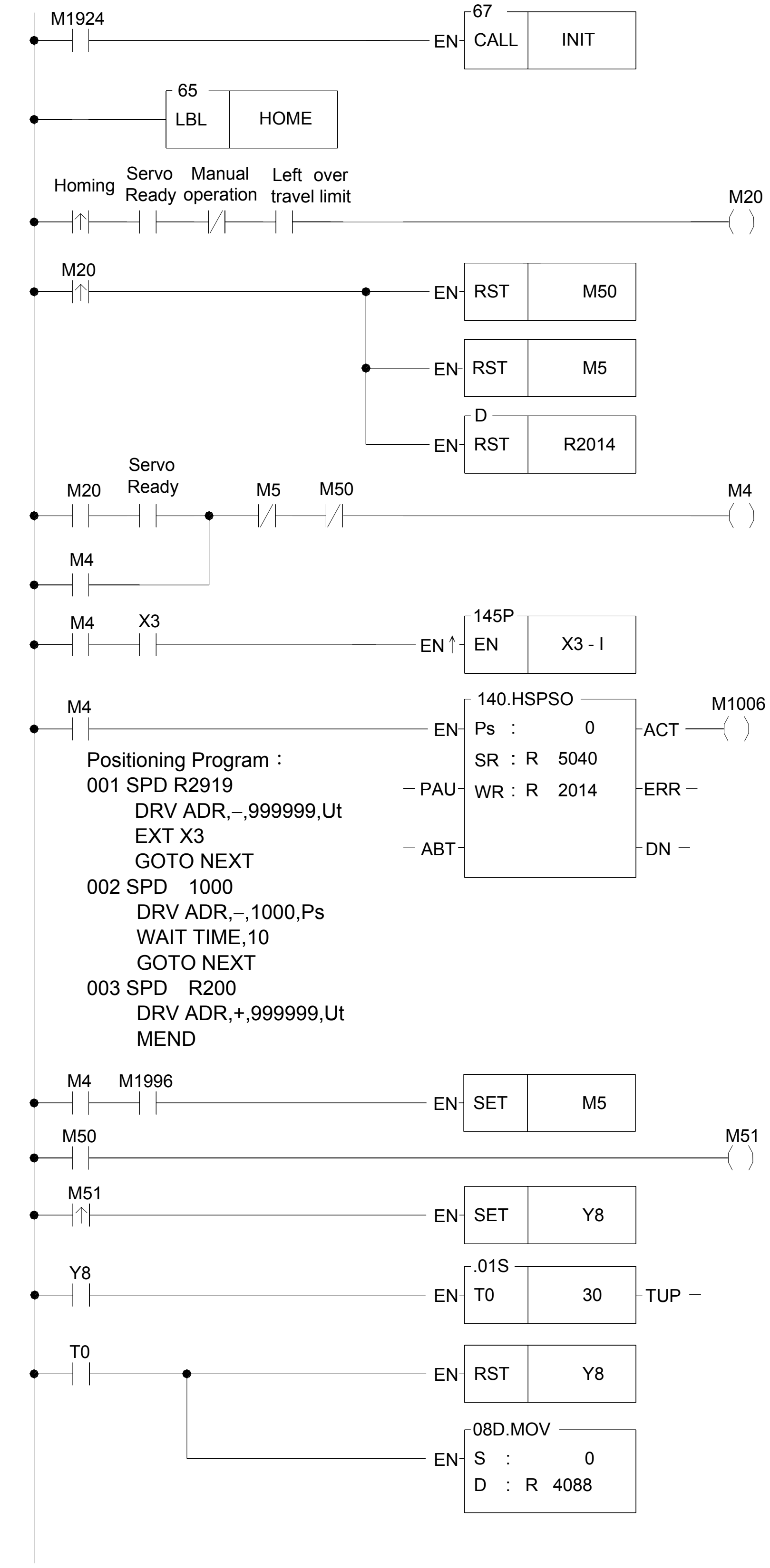


- X3 rising edge interrupt service subroutine.
- Enables HSC4 counting if homing.
- Interrupt service subroutine of HSC4 (Z phase counting is up)
- Stops pulse output immediately.
- Prohibits rising edge interrupt of X2.
- Output to clear error counter of servo driver.
- Sets the homing completion signal.
- Sends output immediately.

Program Example 2: Machine homing (method 2)

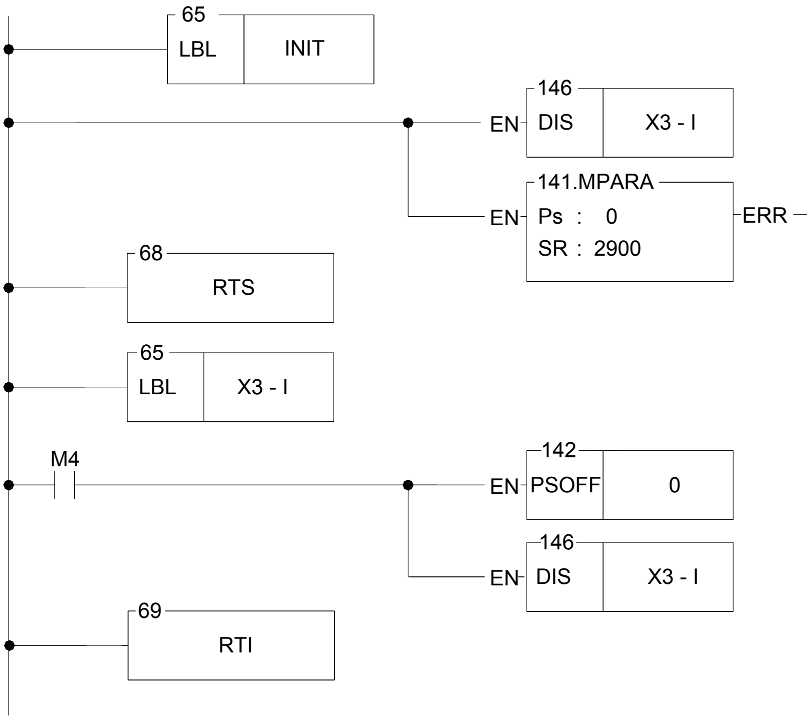
X3: Connected to near home sensing input, and configured as falling edge interrupt input.

【Main Program】



- Clears the homing completion signal.
- Clears the instruction completion signal for homing.
- Clears the step pointer, it starts from the first step to execute.
- Enable X3– (falling edge) interrupt.
- Configure R5000～R5199 to be the read only register (ROR) before programming, after then, when storing program, the Ladder program will automatically contains the positioning program.
- Homing instruction completed.
- Signal for homing completion.
- Output to clear error counter of servo driver -- Y8 is ON for 0.3 second.
- Fill the current PS registers with 0.

【Sub Program】



- Prohibits X3– interrupt
- Parameter table R2900～R2923
- X3 falling edge interrupt service subroutine.
- Stops pulse output immediately
- Prohibits X3– interrupt
- Sets the homing completion signal.

The above two machine homing examples are implemented by using Ladder program; although it is not difficult to understand, but it's a bit cumbersome to use, which might be inconvenient for users. Since FATEK is taking into account the customer's utility and convenience, we add machine zero return command (DRVZ) in high-speed pulse output instruction (FUN140), which provides 3 modes (MD0~MD2) of operation for different application requirement, of FBs series PLC system version (OS) V4.32 (including) or later versions.

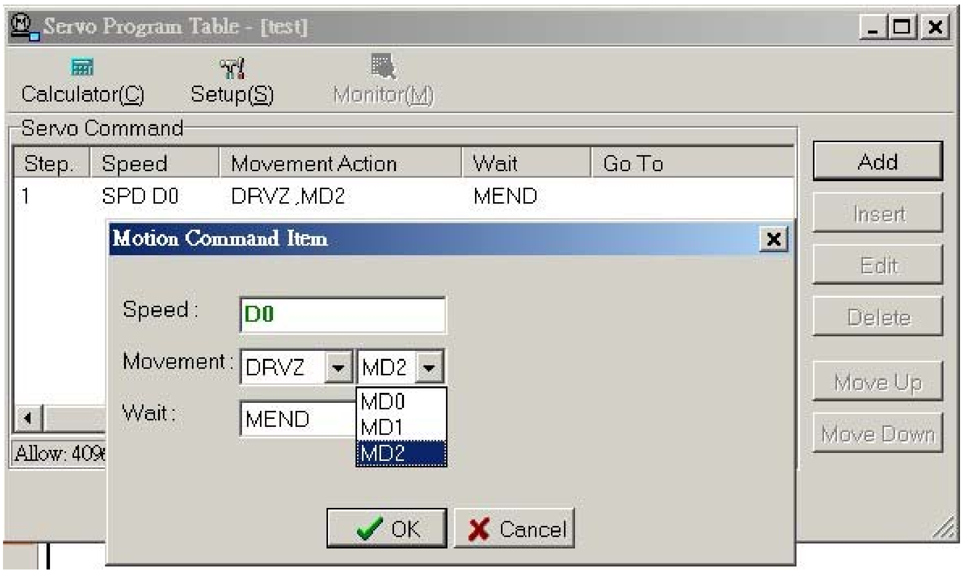
When using DRVZ command for machine homing, it should conjoining the FUN141 motion parameter's setting of machine zero related, it can be listed as below:

	DRVZ MD0	DRVZ MD1	DRVZ MD2
Parameter 6 (Creep speed)	Must be	Must be	Must be
Parameter 9-1 (Return direction)	Must be	Must be	Must be
Parameter 15-0 (DOG input)	Must be	Must be	Must be
Parameter 15-1 (Limit input)	Optional	Optional	Optional
Parameter 15-2 (PG0 input)	No need	No need	Must be
Parameter 15-3 (CLR output)	Optional	Optional	Optional
Parameter 16 (Zero point address)	Must be	Must be	Must be
Parameter 17 (No. of PG0 signal)	No need	No need	Must be

The FUN 140 instruction can't be executed for machine zero return while encountering the following situations with the error indications:

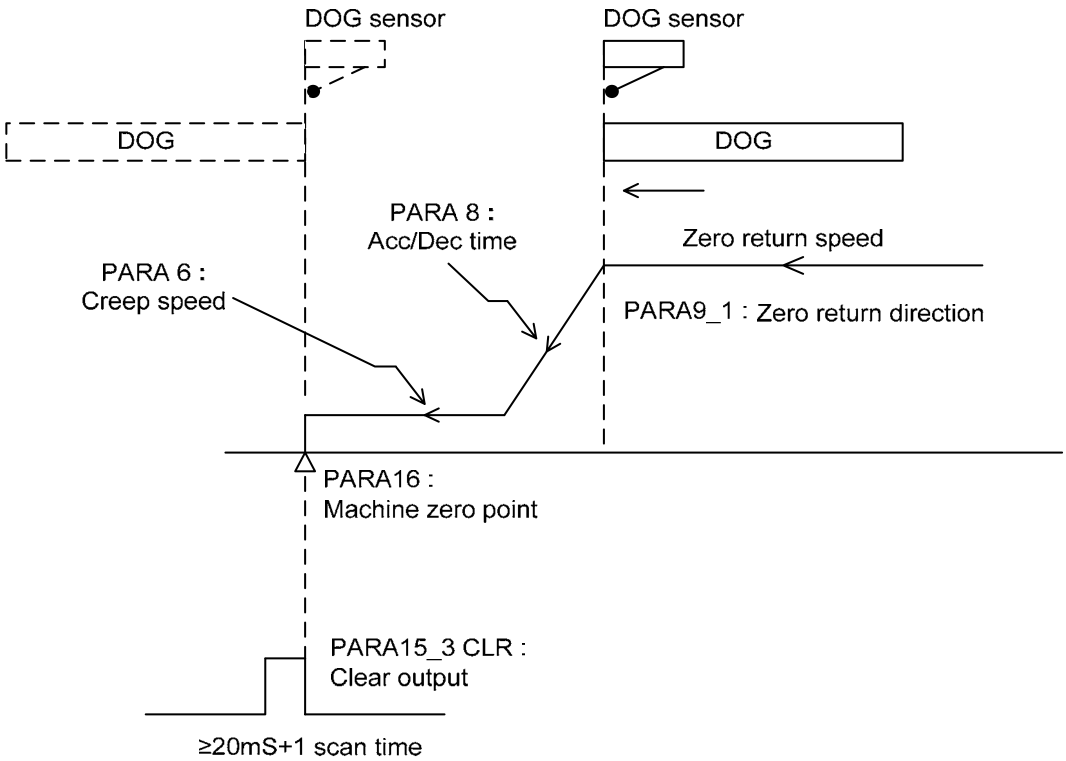
	Error Code	Explanation
R4060(PS0) R4061(PS1) R4062(PS2) R4063(PS3)	42	DRVZ can't follow DRVC
	50	Illegal operation mode of DRVZ
	51	Illegal DOG input
	52	Illegal PG0 input
	53	Illegal CLR output

The method of using DRVZ is same as the method of two modes (DRV and DRVC) of FUN140. To see the details please choose MD0~MD2 of Movement Action mode of the servo program table in the project window (See below).



Zero return (DRVZ) operation in detailed diagram description

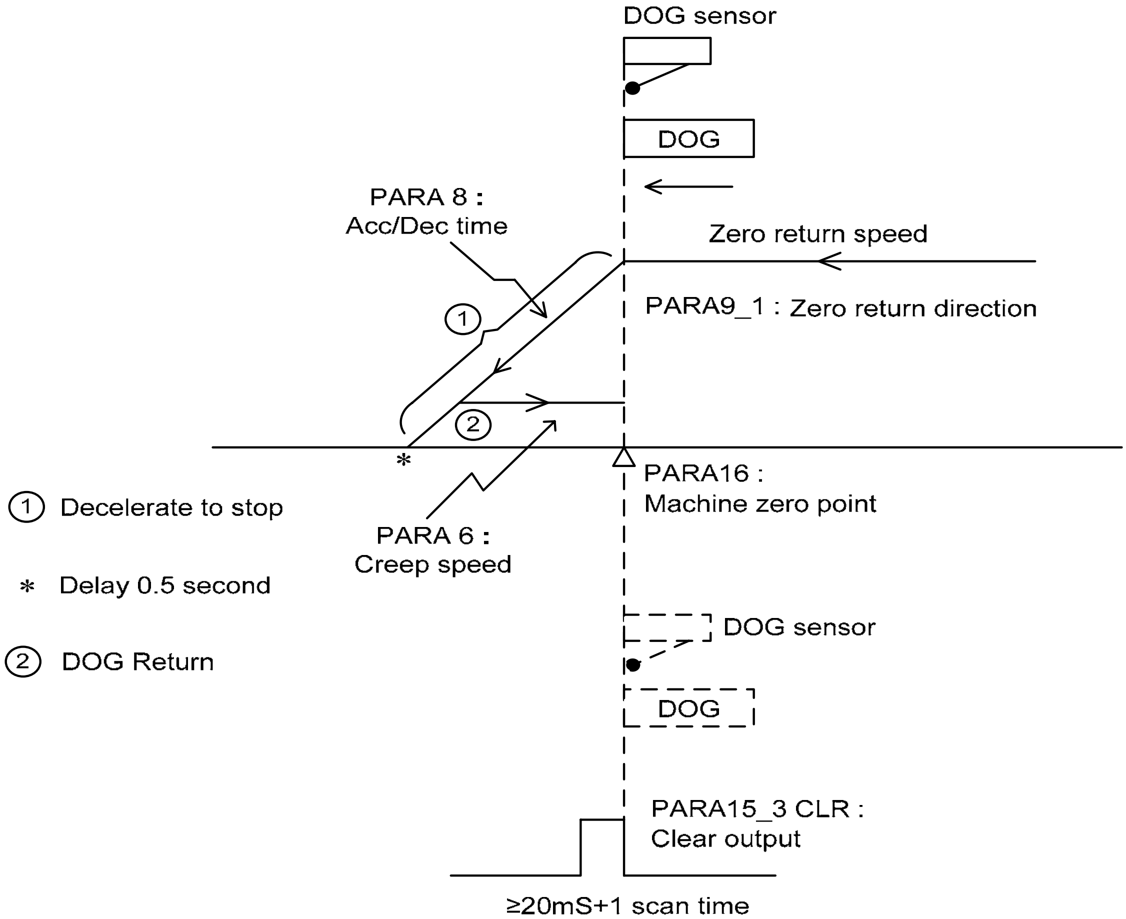
Mode 0



【Description】

1. Zero return starts behind the DOG sensor (Parameter 15_0)
   - a. Moving forward to zero direction in Zero Return Speed
   - b. Changing the moving speed by Creep Speed (Parameter 6) while sensing the dog sensor (Edge detection and interrupt processing
   - c. Keeping forward until leaving the dog sensor (Edge detection and interrupt processing), it is the zero home position
   - d. If it doesn't configure the CLR output (Parameter 15_3) for servo driver, the zero return process has been finished at step c.
   - e. If it has been configured the CLR output (Parameter 15_3) for servo driver, the zero return process will be finished after the CLR output with more than 20mS duration
2. Zero return starts at or in front of the DOG sensor (Parameter 15_0) + Stroke limit sensor (Parameter 15_1)
   - a. Moving forward to zero direction in zero return speed, there will stop moving while sensing the limit sensor
   - b. Moving backward in zero return speed and after leaving the dog sensor, it will drive the zero return procedures same as mentioned above 1.

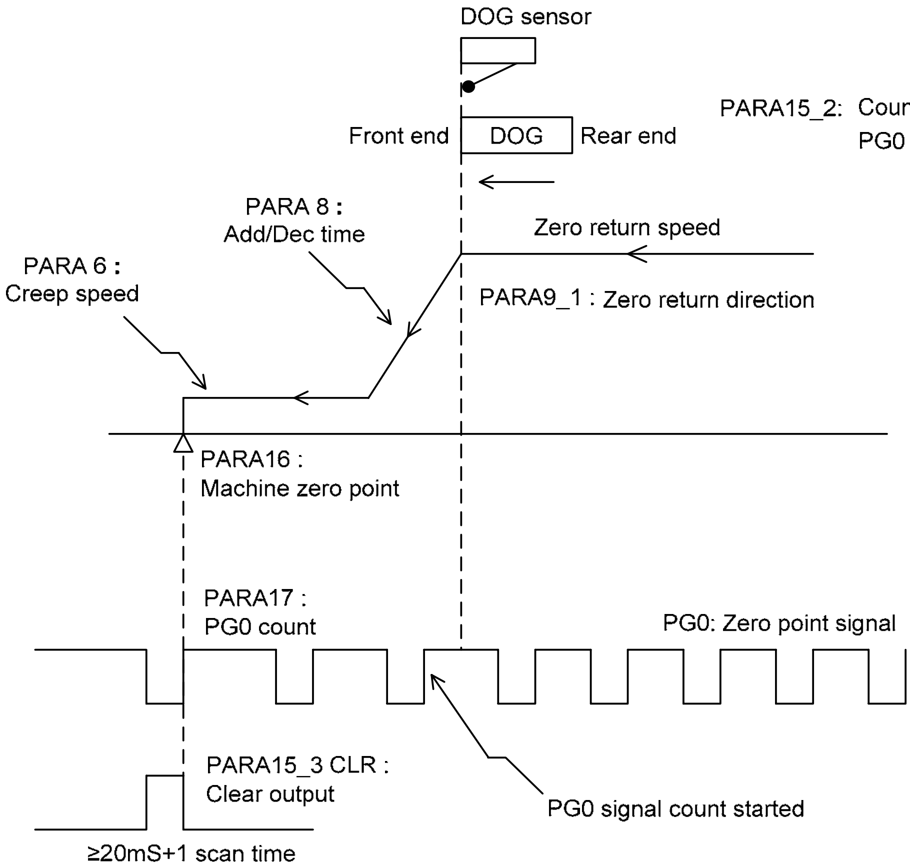
Mode 1



【Description】

1. Zero return starts behind the DOG sensor (Parameter 15_0)
   - a. Moving forward to zero direction in Zero Return Speed
   - b. Auto slow down to stop movement while sensing the dog sensor (Edge detection and interrupt processing)
   - c. Delay 0.5 second, then moving backward until leaving the dog sensor (Edge detection and interrupt processing), it is the zero home position
   - d. If it doesn't configure the CLR output (Parameter 15_3) for servo driver, the zero return process has been finished at step c
   - e. If it has been configured the CLR output (Parameter 15_3) for servo driver, the zero return process will be finished after the CLR output with more than 20mS duration
2. Zero return starts at or in front of the DOG sensor (Parameter 15_0) + Stroke limit sensor (Parameter 15_1)
   - a. Moving forward to zero direction in zero return speed, there will stop moving while sensing the limit sensor
   - b. Moving backward in zero return speed and after leaving the dog sensor, it will drive the zero return procedures same as mentioned above 1.

Mode 2 (Front edge counting)

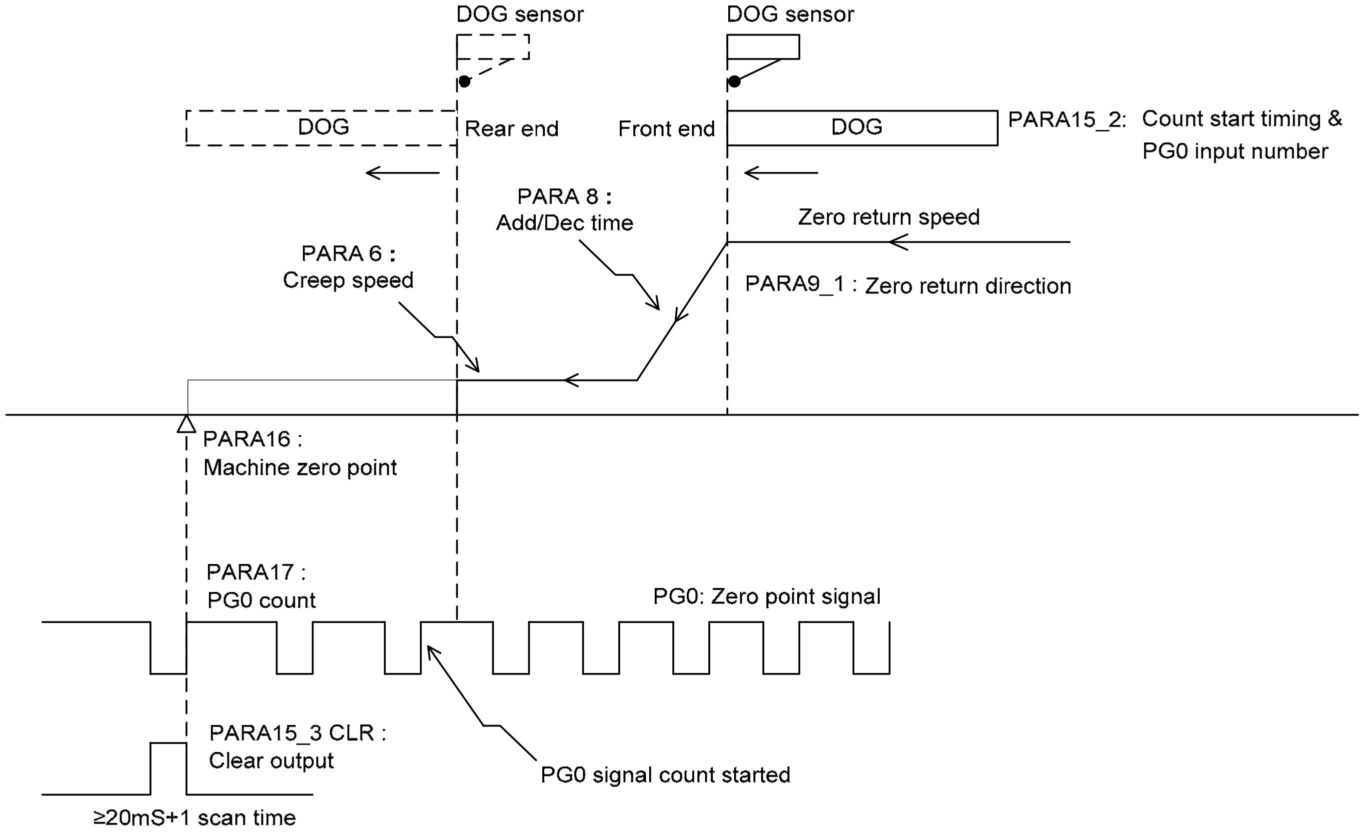


【Description】

1. Zero return starts behind the DOG sensor (Parameter 15_0)
   a. Moving forward to zero direction in Zero Return Speed
   b. Changing the moving speed by Creep Speed (Parameter 6) while sensing the dog sensor (Edge detection and interrupt processing), and start counting (Edge detection and interrupt processing) the PG0 signal (Parameter 15_2)
   c. While the counting value of PG0 signal is equal to the present value (Parameter 17), it is the zero home position
   d. If it doesn't configure the CLR output (Parameter 15_3) for servo driver, the zero return process has been finished at step c
   e. If it has been configured the CLR output (Parameter 15_3) for servo driver, the zero return process will be finished after the CLR output with more than 20mS duration
2. Zero return starts at or in front of the DOG sensor (Parameter 15_0) + Stroke limit sensor (Parameter 15_1)
   a. Moving forward to zero direction in zero return speed, there will stop moving while sensing the limit sensor
   b. Moving backward in zero return speed and after leaving the dog sensor, it will drive the zero return procedures same as mentioned above 1.

※ Working at this mode, it should be noticed to adjust the correct position of dog sensor to incorporate with PG0 signal to avoid one count PG0 error for zero return processing

Mode 2 (Rear edge counting)



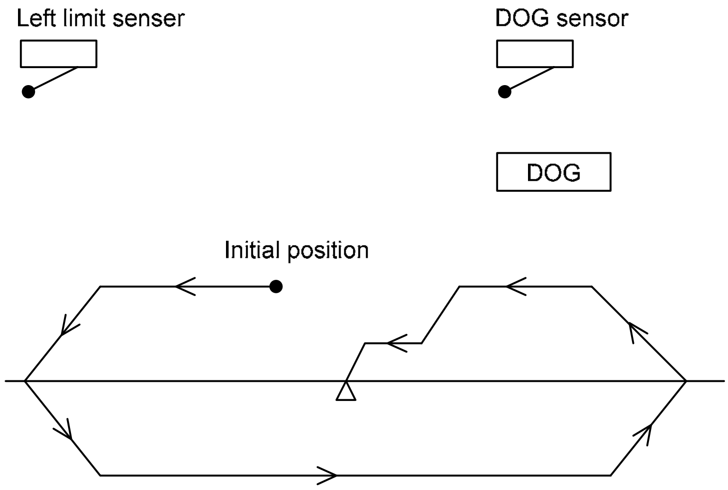
【Description】

1. Zero return starts behind the DOG sensor (Parameter 15_0)
   a. Moving forward to zero direction in Zero Return Speed
   b. Changing the moving speed by Creep Speed (Parameter 6) while sensing the dog sensor (Edge detection and interrupt processing); keeping forward and start counting (Edge detection and interrupt processing) the PG0 signal (Parameter 15_2) while leaving the dog sensor
   c. While the counting value of PG0 signal is equal to the present value (Parameter 17), it is the zero home position
   d. If it doesn't configure the CLR output (Parameter 15_3) for servo driver, the zero return process has been finished at step c
   e. If it has been configured the CLR output (Parameter 15_3) for servo driver, the zero return process will be finished after the CLR output with more than 20 mS duration
2. Zero return starts at or in front of the DOG sensor (Parameter 15_0) + Stroke limit sensor (Parameter 15_1)
   a. Moving forward to zero direction in zero return speed, there will stop moving while sensing the limit sensor
   b. Moving backward in zero return speed and after leaving the dog sensor, it will drive the zero return procedures same as mentioned above 1.

※Working at this mode, it should be noticed to adjust the correct position of dog sensor to incorporate with PG0 signal to avoid one count PG0 error of zero return processing

The above three homing completion modes assume that starting point is nearly the right side of DOG sensor. But when implementing homing action, the starting point is possible located after DOG sensor or exactly located on DOG sensor. The following diagram and description are interpreted the homing action of two locations:

Zero return starts at or in front of the DOG sensor



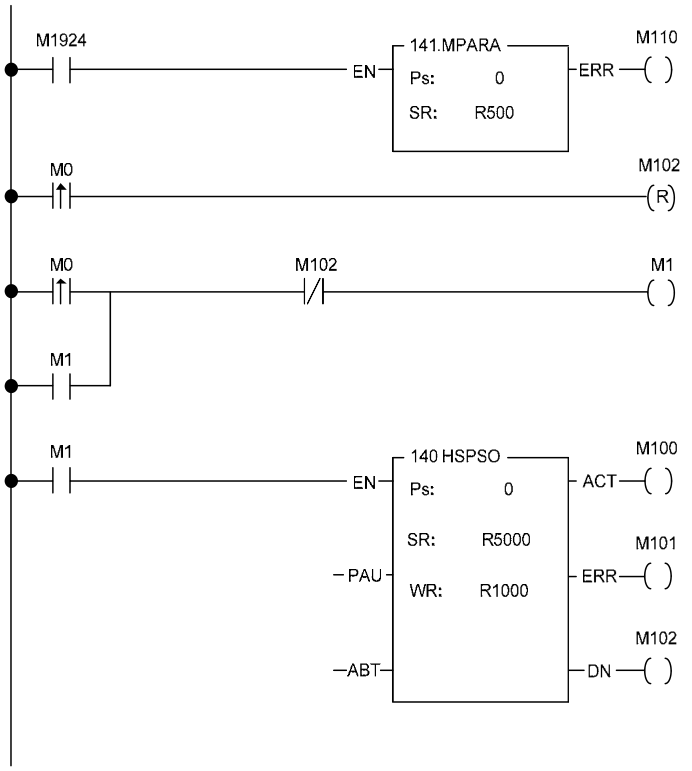
Steps

1. When homing operation has started, it moves toward the homing direction (Parameter 9_1) in zero return speed until strokes the switch of limit input point (Parameter 15_1).

2. When it strokes the limit input point (Parameter 15_1), it immediately moving backward to the homing direction until leave the DOG sensor (sensor signal from 1 → 0).

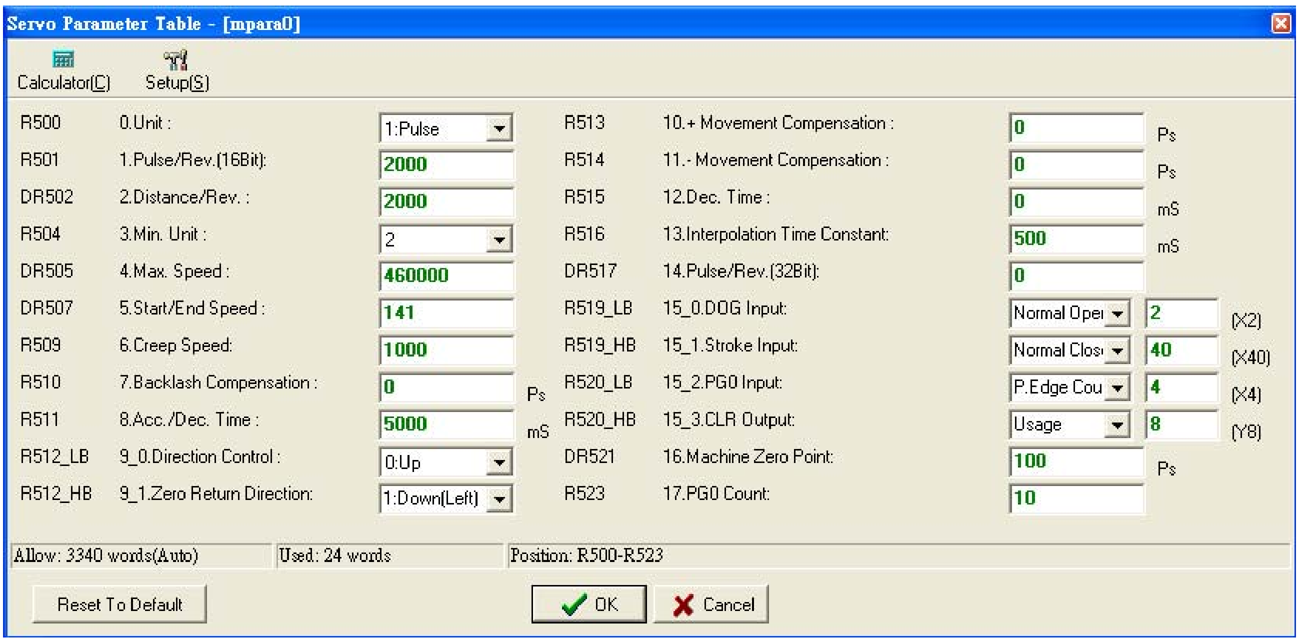
3. Upon completion of the Step 2, you can determine that the starting point has returned back to the right of DOG sensor, and then it will complete the homing operation as we set the homing mode (MD0~MD2) earlier.

Program Example 3 : Machine homing (by using Mode 2 of DRVZ command)



- M1924 initial/end pulse set the parameter of the servo parameter command into the system.
- Clears FUN140 homing completing signal.
- Homing operation has started.
- FUN140 operates DRVZ command.

Servo Parameter Table(FUN141) Setting



Servo Parameter Table - [mpara0]

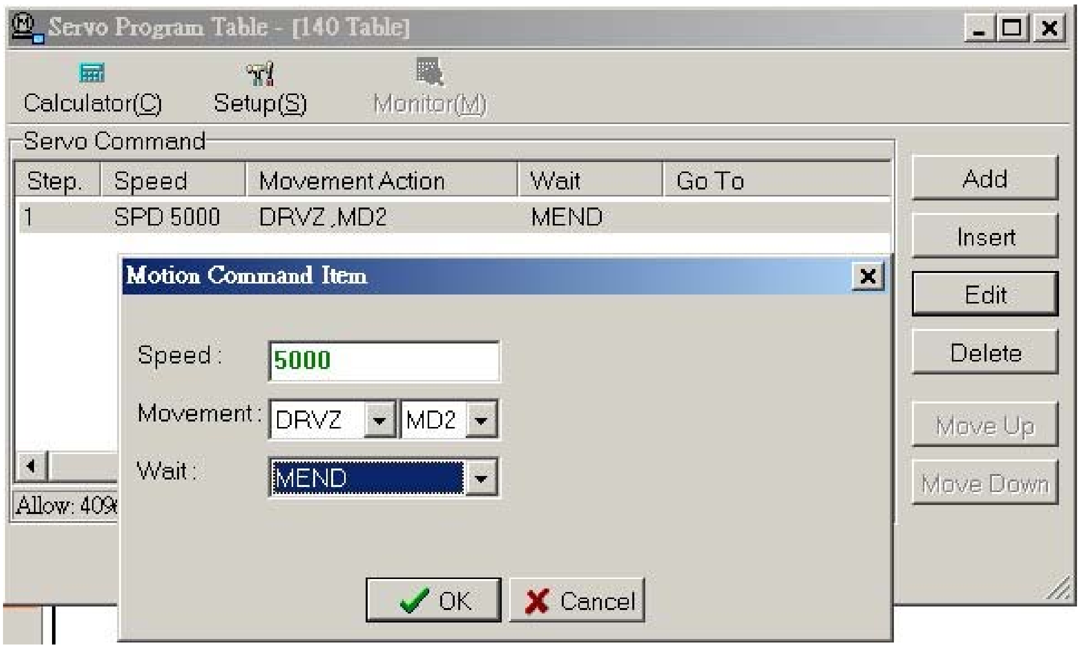
Calculator(C) Setup(S)

R500	0.Unit :	1:Pulse		R513	10.+ Movement Compensation :	0	Ps
R501	1.Pulse/Rev.(16Bit):	2000		R514	11.- Movement Compensation :	0	Ps
DR502	2.Distance/Rev. :	2000		R515	12.Dec. Time :	0	mS
R504	3.Min. Unit :	2		R516	13.Interpolation Time Constant:	500	mS
DR505	4.Max. Speed :	460000		DR517	14.Pulse/Rev.(32Bit):	0	
DR507	5.Start/End Speed :	141		R519_LB	15_0.DOG Input:	Normal Open / 2	(X2)
R509	6.Creep Speed:	1000		R519_HB	15_1.Stroke Input:	Normal Close / 40	(X40)
R510	7.Backlash Compensation :	0	Ps	R520_LB	15_2.PG0 Input:	P.Edge Cou / 4	(X4)
R511	8.Acc./Dec. Time :	5000	mS	R520_HB	15_3.CLR Output:	Usage / 8	(Y8)
R512_LB	9_0.Direction Control :	0:Up		DR521	16.Machine Zero Point:	100	Ps
R512_HB	9_1.Zero Return Direction:	1:Down(Left)		R523	17.PG0 Count:	10	

Allow: 3340 words(Auto) | Used: 24 words | Position: R500-R523

Reset To Default | OK | Cancel

Servo Program Table(FUN140) Setting



Program Description:

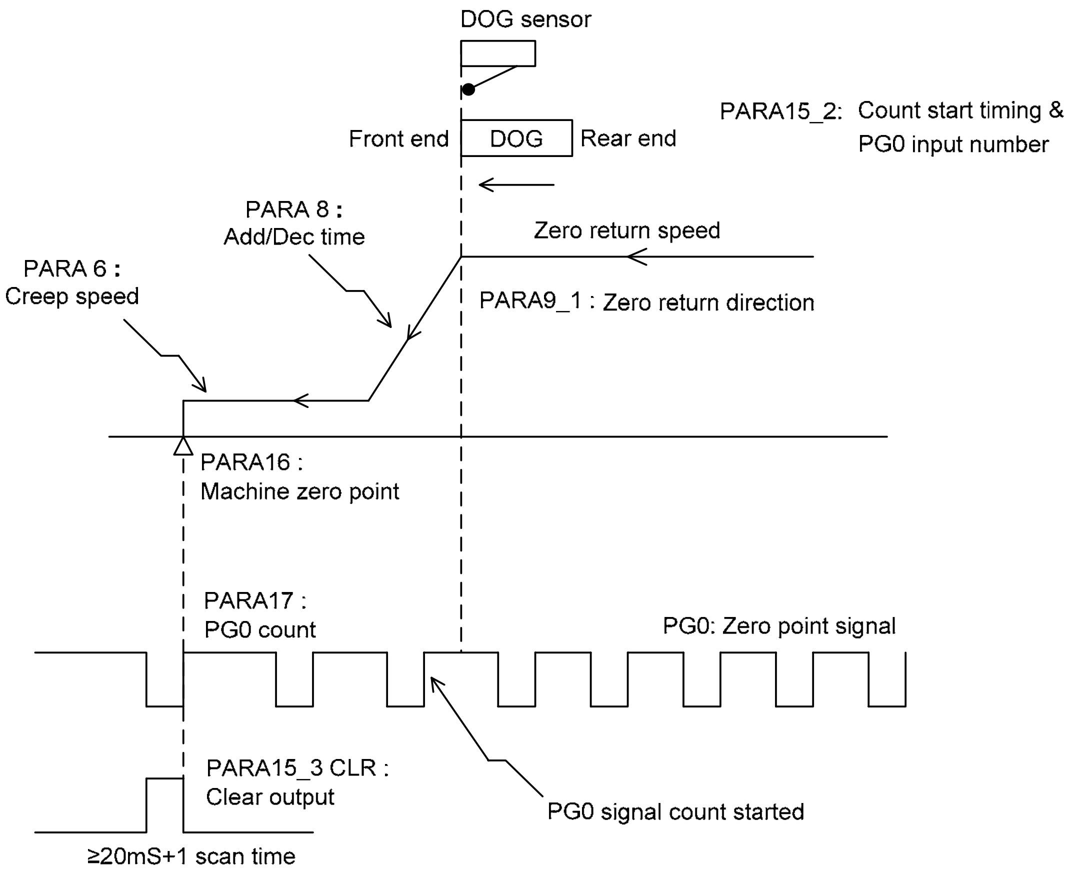
(1). When the program has been executed, the initial pulse (M1924) will set the starting address of servo parameters table.

(2). When M0 is from 0→1 (P instruction), the self-holding loop M1 has started and at the same time FUN140 homing operation has also started.

(3). According to FUN140 the servo program table setting, first the speed toward to homing return direction (left) is 5000 until it touches the DOG points (X2), it immediately drops the speed to 1000 and starts PG0 counting.

(4). When zero signal counting (X4) has reached its setting value 10, it finds the home position. Zero clear signal (Y8) sent to "ON" more than 20mS and as well as the machine zero position value, set to 100, moves to current register. (In this example we use 0 axis, then set the value 100 to DR4088), then the homing operation has completed.

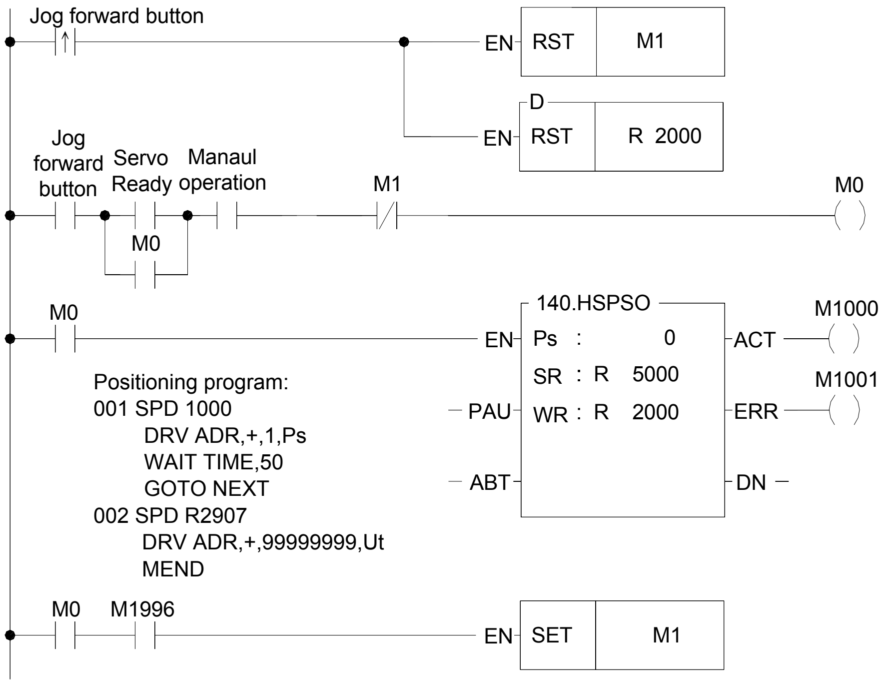
Diagram



※ When set the DOG point, it should be the input points (X0~X15) of main unit.

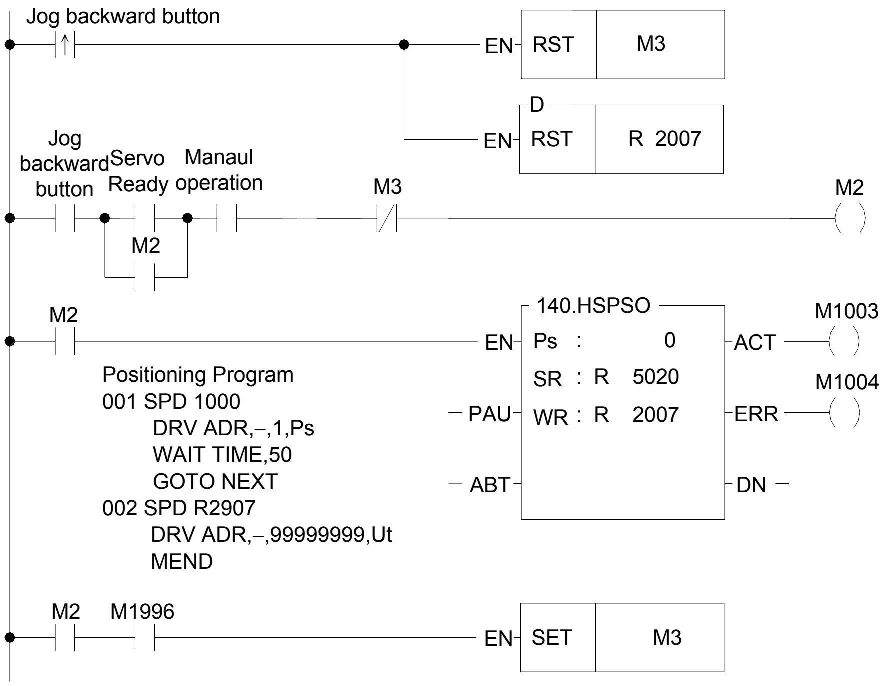
※ When the input DOG point has been set, it cannot be conflict with interrupt and high-speed counter, for example: if X0 has been set for DOG point, then X0 cannot be set to an interrupt input or high-speed counter.

Program Example 4: JOG Forward



- Clears the completion signal
- Starts from the first step every jog execution.
- As the execution of last step completed, it sets up the completion signal.

Program Example 5: JOG Backward



- Clears the completion signal.
- Starts from the first step every jog execution.
- As the execution of the last step completed, it sets up the completion signal.

Program Example 6: Step by step, One cycle, Continuous positioning control.

M93 : Start

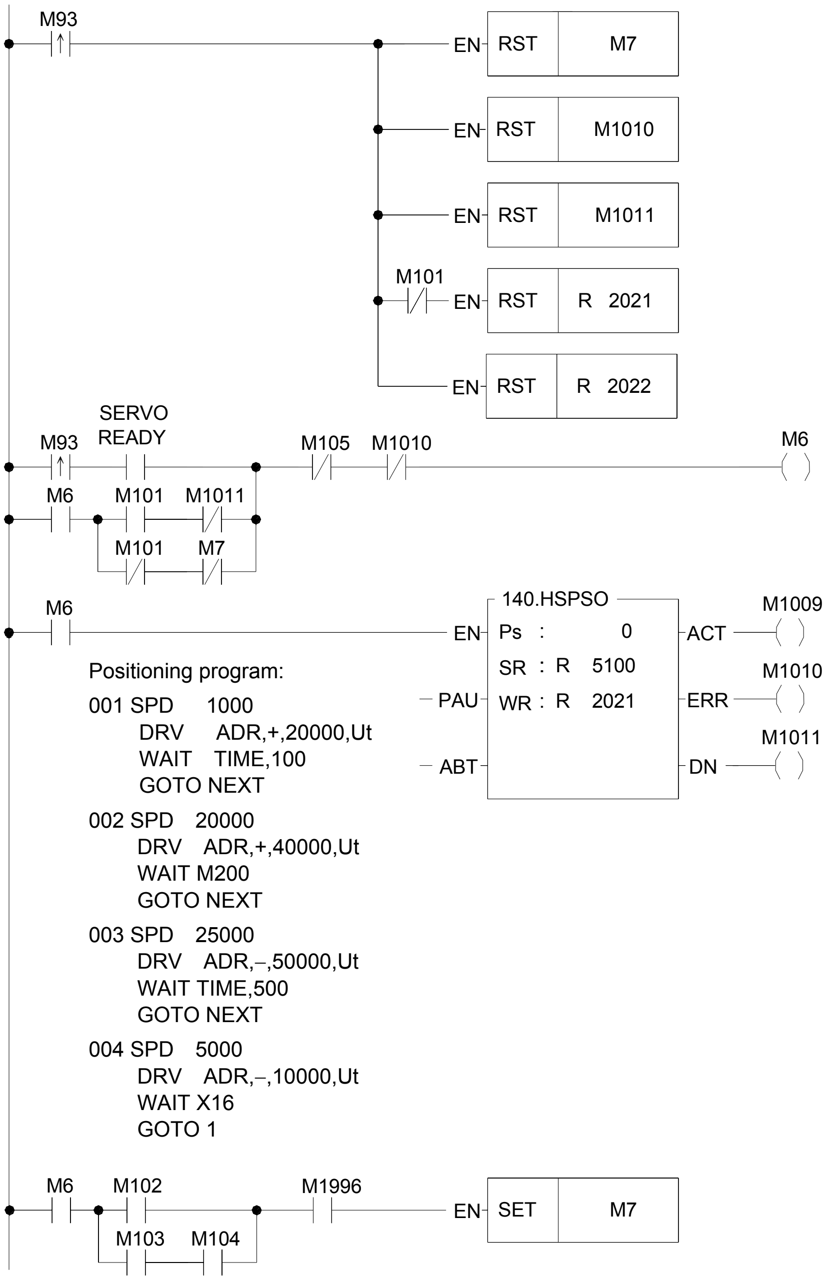
M101 : Step by step operation mode

M102 : One cycle operation mode

M103 : Continuous operation mode

M104 : Regular shut down.

M105 : Emergency stop.



- Clears shut down signal.
- Clears the error signal.
- Clears the step completion signal.
- Except step by step mode, the step pointer is cleared to be 0; it starts from the first step to execute.
- Clears being active bit of FUN140
- Set up the shut down signal.

Chapter 12 The Communication Function of FBs-PLC

The FBs-PLC main unit has been built in the communication port0 with optional USB or RS232 interface. If additional communication boards (CB) have been purchased, then it can increase to 2~3 communication interfaces (depending on the model of CB). If it is still not enough, communication modules can be added to expand the number of communication interfaces to 5 (PORT0~PORT4). There are three types of communication interfaces, RS232、RS485 or Ethernet, to choose from in both CB and CM. Among them, Port 0 is a permanent interface for FATEK communications interface, which is controlled by the CPU of the PLC, using FATEK “Standard communication driver” to manage the communication transactions of the Port, i.e. “FATEK communication protocol”. Any access to the Port must comply with the format of “FATEK communication protocol” to get responses from the PLC. This includes starting character, station no., command code, body, error check code, ending characters, etc.; for more details please refer to “Appendix 2: FATEK communication protocol”. WinProladder and numerous HMI and SCADA software are equipped with communication drivers complying with this communication protocol, therefore where the parameters on hardware interface and communications are consistent, communication connection can be established by just connecting the communication Port with the “Standard Interface”. If the communication driver with complying communication protocol is not available, besides writing its own commands complying with “FATEK communication protocol” to communicate with PLC, the commonly used industrial Modbus RTU/ASCII protocol can also be used to establish a connection with FBs-PLC. The factory setting and the PLC system initialization on Port 1 ~ Port 4 default to FATEK standard communication interface; though in order to meet the extensive application and requirements of communication connection, Port 1 ~ Port 4 provides FATEK standard communication interface, as well as providing easy communication commands that support powerful functions to allow users to compile their required communication application software through the Ladder diagram program, and easily achieve the aim of system integration and distributed monitoring. Further detail will be explained in subsequent chapters.

12.1 Functions and Applications of FBs-PLC Communication Ports

Besides the hardware interface distinction of USB, RS232,RS485 or Ethernet among the 5 COM ports of FBs-PLC, there are also 3 software interface types in terms of software interfaces. The table below shows the software interface types that can be configured on the 5 COM ports of FBs-PLC:

Available types / Software Interface	Communication Port					Notes
	Port0	Port1	Port2	Port3	Port4	
Standard Interface	○	○	○	○	○	Port controlled by CPU, using FATEK ”Standard communication driver” or Modbus communication driver, but Port0 does not support Modbus communication protocol.
Dedicated Modem interface		○				Port controlled by CPU, using the Modem driver + FATEK ”Standard communication driver” or Modbus communication driver.
Ladder diagram program controlled interface		○	○	○	○	Port controlled by users (Ladder diagram program)
Interface type configuration method	—	Register configure	PLC Auto configure	PLC Auto configure	PLC Auto configure	

- Standard Interface : Port0 ~ Port4 can all be configured into this type of interface (Port0 can only be this type of interface and only provides FATEK standard communication driver). Under this interface type, the Port is controlled by the standard communication driver of FBs-PLC (using FATEK communication protocol or Modbus RTU/ASCII communication protocol), hence called “standard interface”. To communication with the “Standard Interface”, the connection can only be established by complying with FATEK FB-PLC communication protocol or Modbus RTU/ASCII communication protocol.

※ Port0 doesn’t support ModBus communication protocol.

- Dedicated Modem Interface **:** Only Port1 can select this interface type. Under this interface type, Port1 is controlled by the built-in "MODEM driver" of FBs-PLC, in charge of telephone reception or dialing tasks, and then hand the connection over to FATEK standard communication driver after the connection is established, subsequent operation is the same as the "Standard interface" above.

- Ladder diagram Program controlled interface **:** Port1 ~ Port4 can all select this interface type. Under this interface type, the Port will be controlled by the user's Ladder diagram program instructions, such as FUN94, FUN150, FUN151, etc., hence users can gain control of the Port through the Ladder program.

The following sections will detail the functions and applications of the 5 Ports on FBs-PLC under each of the 3 different software interfaces.

＊ Port1 ~ Port4 communication parameter are default to **:**

Baud Rate: 9600 bps
Data Length: 7 Bits
Parity**:** Even
Stop Bit: 1 Bit

12.1.1 Communication Port 0 : USB or RS232 Interface

Functional specification

- USB interface complies with standard functional specification of USB1.1
- RS232 interface functional specification complies with the EIA RS232 standard, with 5 types of communication speeds 9600, 19200, 38400, 57600 and 115200 configurable**.**

Basic usage

- Besides providing the standard RS232 interface, models with USB interface are also provided since more and more notebook computers are using USB port to replace COM ports due to light weight and thickness considerations.
- The main purpose of Port0 is to provide a communication interface for program editing, so generally speaking it would be in passive receiving mode.

Extended usage

①Besides program editing, it can also connect to HMI, SCADA equipped with FATEK communication driver.

②Through conversion of interface signal into RS485 signal, connections can be made with RS485 interface peripherals, such as computers, WinProladder, HMI, SCADA, etc. or become a Slave of the FATEK CPU Link network.

12.1.2 Communication Port1～Port4 : RS232 or RS485 Serial Interface

Functional specification

- RS232 interface functional specification complies with the EIA RS232C standard, communication parameters are adjustable up to highest communication rate of 921.6Kbps. Factory setting and system initialization communication parameter is configured to the default communication parameter.
- RS485 interface functional specification complies with EIA RS485 standard.

Basic usage

There are 3 types of software interface are selectable as follows :

①Standard interface :

Connectable to peripherals with RS232 or RS485 interface, such as computer, WinProladder, HMI, SCADA, etc.

②Port1 dedicated modem interface :

It can actively or passively connect to remote computers or conduct auto information gathering, warning or anomaly reporting for remote servicing via MODEM.

③Ladder diagram Program controlled interface :

User can control Port1~Port4 through the ladder diagram instructions, such as FUN94 (ASCWR) command to take control of Port1 and connect to printers with RS232 hardware interface for Chinese/English report printing; FUN151 (CLINK) command takes control of Port1~Port4 to establish connection with FATEK CPU Link or peripherals with RS232 or RS485 interfaces; FUN150 (MBUS) command can turn Port1~Port4 into a master of Modbus RTU/ASCII communication protocol for connecting Slaves with this communication protocol.

④Port2 can provide FATEK high speed CPU Link function.

Extended usage

- Under Standard interface, act as the Slave for multi-drop FATEK RS485 or point to point RS232 CPU LINK network.
- Under Ladder diagram program controlled interface types, Port1~Port4 has the following functions:

  ①Use MD0 mode of FUN151 (CLINK) instruction to act as the master for FATEK CPU Link network.

  ②Use MD1 mode of FUN151 (CLINK) instruction to actively connect to intelligent peripherals equipped with this communication interface, such as other brands' PLC, servo driver, temperature controller, inverter, message display, etc.

  ③Use MD2 mode of FUN151 (CLINK) instruction for connection to receive the intelligent peripherals equipped with this communication interface, such as card readers, bar code readers, weighing scales, etc.

  ④Port2 can utilize MD3 mode of FUN151 (CLINK) instruction to act as the master for FATEK high speed CPU Link network.

  ⑤Use FUN150 (MBus) instruction to act as the Master for Modbus RTU/ASCII communication protocol to connect to peripherals with this communication protocol.

12.1.3 Ethernet Interface

Functional specification

- Comply with IEEE802.3 standard to provide 10Base T interface.

Basic usage

- Provide intranet or internet connectivity within the plant. It can connect to WinProladder, HMI, SCADA with Ethernet network interface and FATEK communications driver or Modbus driver.

Extended usage

- It can coordinate with MD0 mode of FUN151(CLINK) instruction to provide remote data acquisition through the Ethernet network between the PLC's. (＊Client Mode).

Note **:** For details on Client Mode of FBs-PLC network interface, please refer to the explanations in section 12.8.

12.2 How to Use FBs-PLC Communication Functions

Refer to the diagram in Section 2.2 "Combination of PLC and Peripheral Systems" in the "Hardware Manual" for the connection of FBs-PLC to the host computer, intelligent peripherals, and other PLCs.

Among Port0~Port4, only Port 2 provides real-time response function (real-time: data is processed immediately when received or sent without being affected by scan time.) and communicates with binary code (two times ASCII code). Other ports use ASCII code for communication in the standard mode and data will not be processed until the scan is complete and housekeeping is active. Thus, there will have the service delay because of the scan time. Port2 should be provided for each PLC to share data with each other via "FATEK high-speed CPU Link" (i.e., the MD3 mode of FUN151 (CLINK)) to meet the real time monitor requirements. Port0, Port1, Port3, Port4 should be used for intelligent peripherals, HMI, SCADA, and other non-real-time control applications for data collection and monitoring.

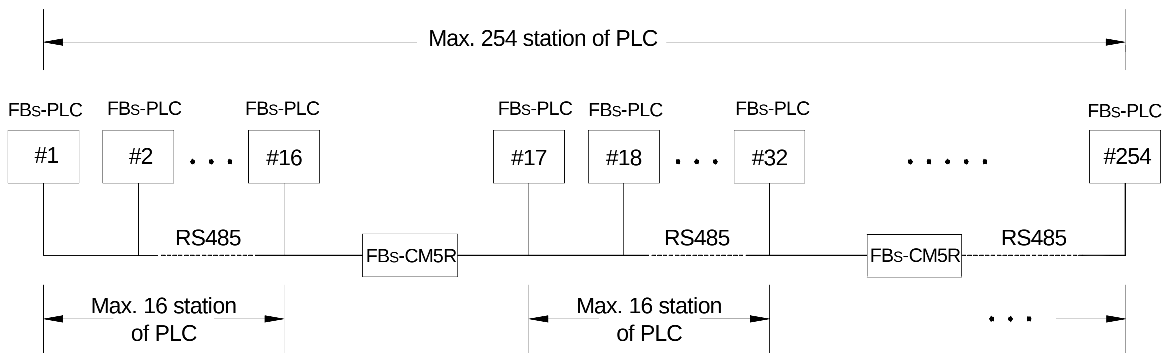
12.3 Hardware Wiring Notifications for RS485 Interface

In the FBs-PLC communication interfaces, RS232 provides only point to point connection function while RS485 provides connection for multiple stations. Its wiring distance should conform to the restriction specified in the EIA standard.

The principle that connection distance should be as short as possible and the station should be far away from high noise sources must be observed for hardware wiring. RS232 is for point to point connection with a shorter connection distance and the standard cable sold in the market or provided by FATEK is applicable. However, for high-speed RS485 network, communication quality is affected and operation might be seriously interfered with if the problems, such as high baud rate, long connection distance, high signal attenuation, multiple stations, bad grounding, high noise, terminating impedance mapping, and topology, are not solved appropriately. Please read the notes of hardware wiring for RS485 network at the end of this section carefully.

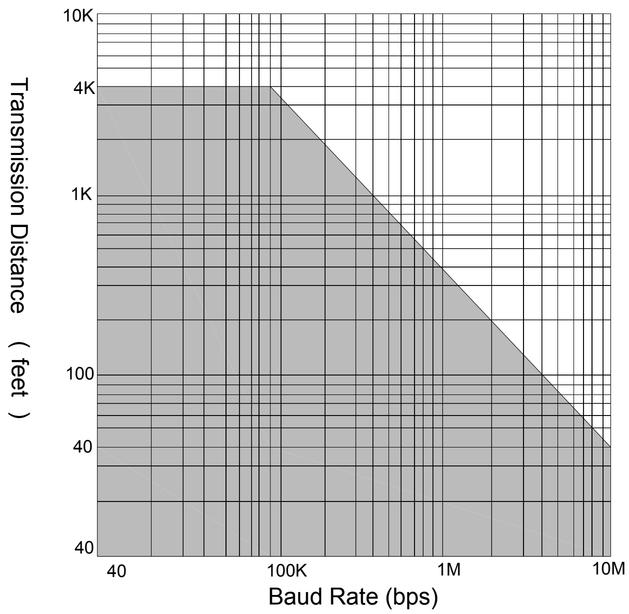
Limits on the number of stations

Though the number of FBs-PLC stations can be set up to 254, 16 stations are the maximum for hardware driving for RS485 interface. If more than 16 stations are required, a RS485 amplifier (FBs-CM5R) must be used. 16 additional stations can be assigned to one amplifier up to the max. 254 stations.



Limit on distance

The following diagram shows the relationship between the baud rate and transmission distance of RS485 standard interface.

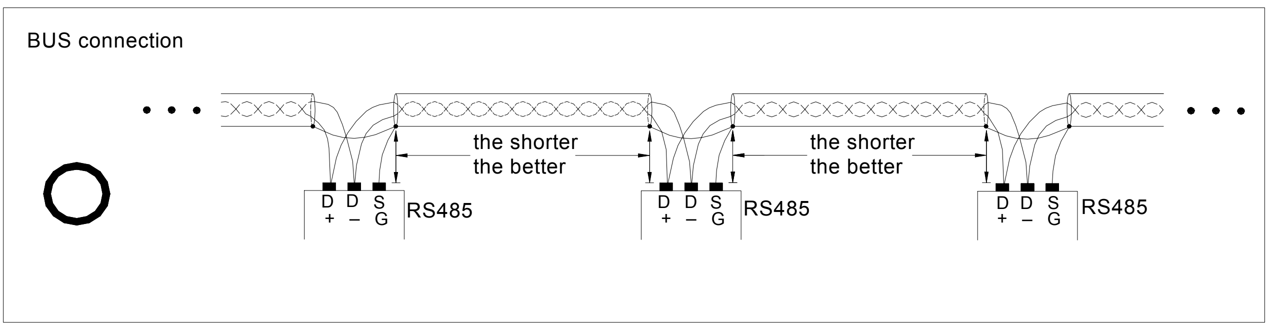


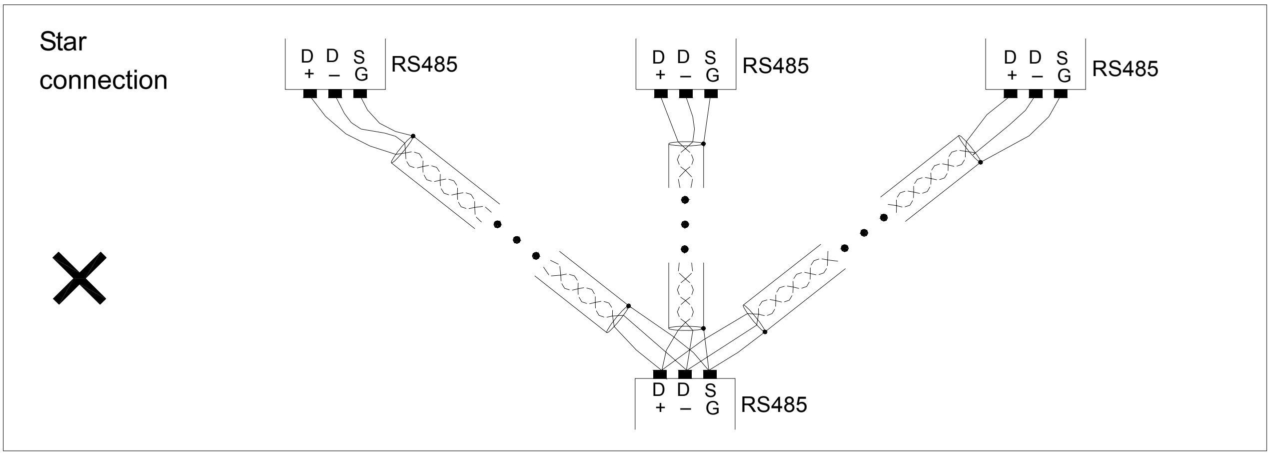
Cable

Use the shielded twisted pair cables for connection. Cable quality is an important factor to transmission signal. When the baud rate is high, low quality twisted pair (e.g., PVC twisted pair cables) will cause extremely high signal attenuation and considerably shorten the transmission distance. Its noise immunity is poorer. In a circumstance where the baud rate and noise is high, and the distance is long, use high quality twisted pair cables (such as Belden 9841 polyethylene twisted pair cables), Its dielectric loss can be 1000 times lesser than that of PVC twisted pair cable. But in a circumstance where the baud rate and noise are low, PVC twisted pair cable is an acceptable and economical alternative. If the transmission distance is too long to raise signal attenuation, use a RS485 amplifier (FBs-CM5R) to amplify signal.

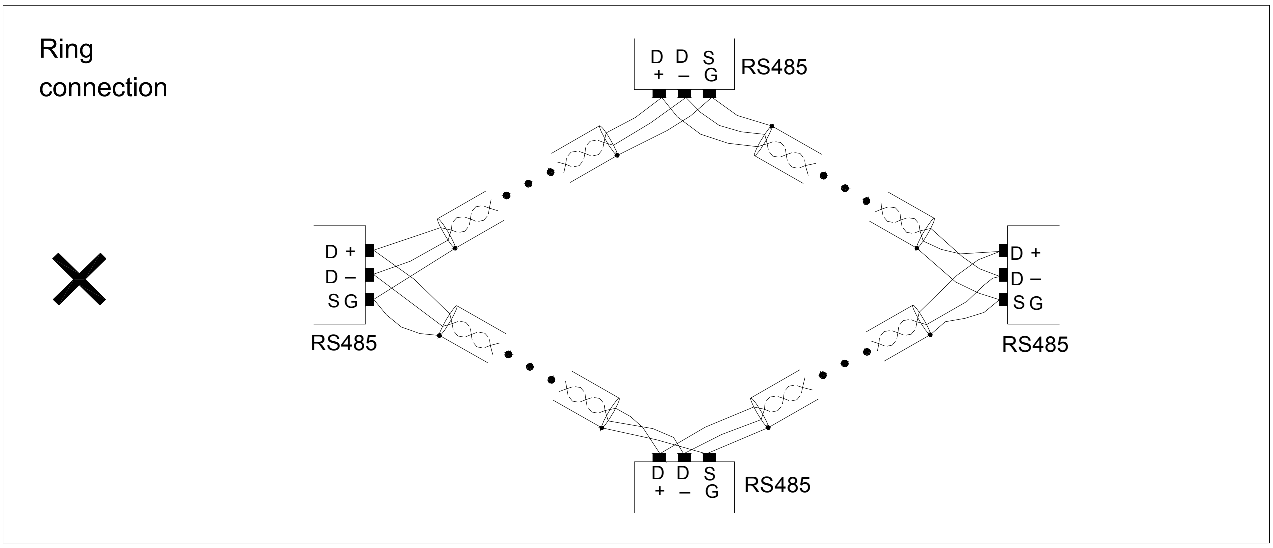
Topology

Topology is a graph structure of transmission connection. The topology of RS485 must be in a Bus structure. All cables must be connected from the first station to the second station, from the second station to the third station, …… to the last station. As shown in the following diagrams, both star and ring connections are not allowed. If FBs-CM5H is used, RS485 can be set to star connection, but ring connection is still not allowed.

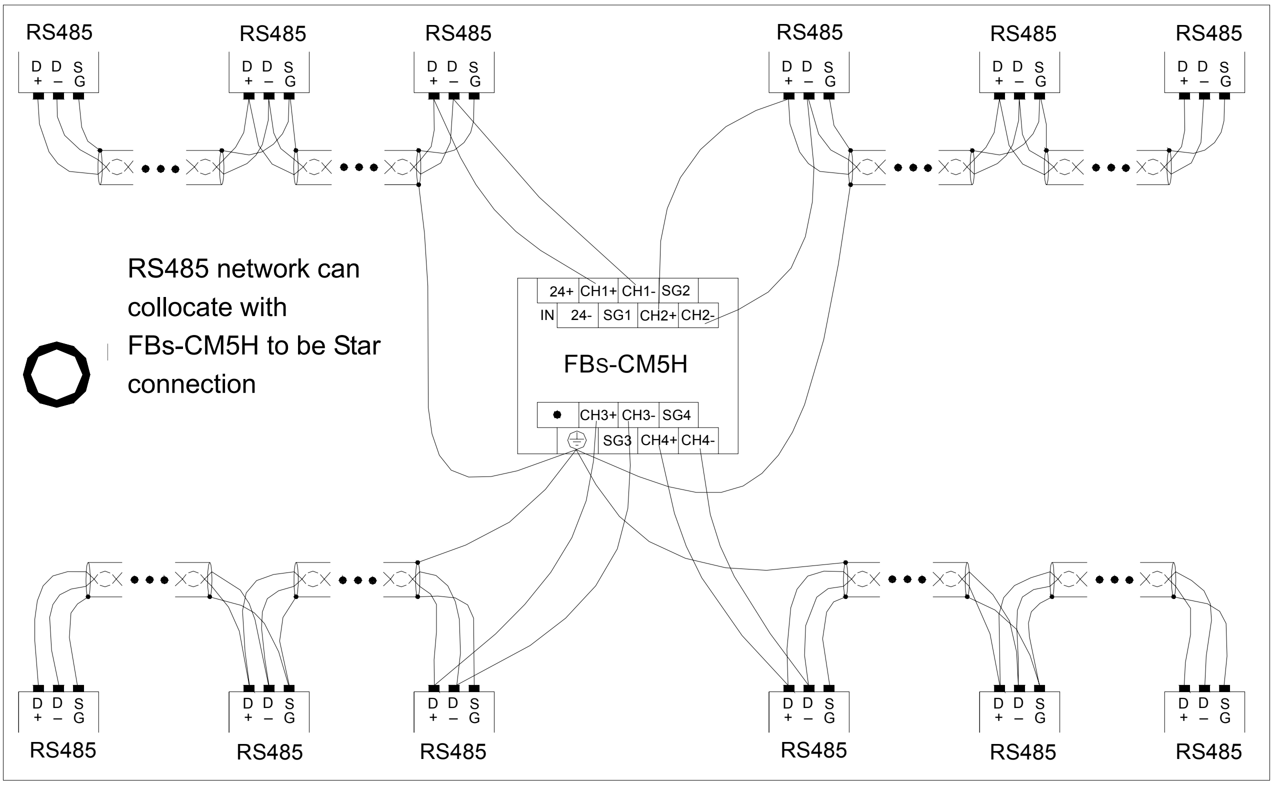




Star
connection
D D S
+ – G
RS485
RS485
RS485
RS485



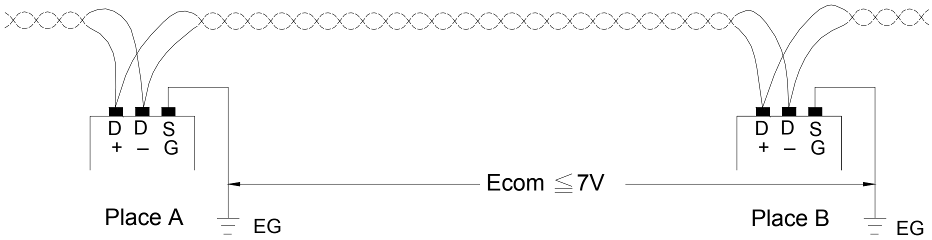
Ring
connection
D D S
+ – G
RS485
D +
D –
S G
RS485
RS485
RS485



RS485
D D S
+ – G
RS485 network can
collocate with
FBs-CM5H to be Star
connection
24+
CH1+
CH1-
SG2
IN
24-
SG1
CH2+
CH2-
FBs-CM5H
CH3+
CH3-
SG4
SG3
CH4+
CH4-

FG grounding

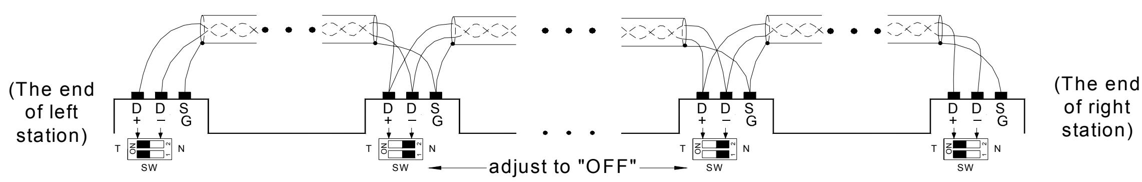
Though RS485 network can be connected with two cables, the connection is easily affected by noise. To improve communication quality, the ground potential difference (common mode voltage) between two stations should not exceed the max. allowable common mode voltage of the R485 transmission IC. 7V shall not be exceeded when FBs-PLC IC is used; otherwise, RS485 may not operate normally.



No matter how the ground potential is, we recommend using a twisted pair cable covered with shielding. The SG of each station is connected with the ground wire covered with shielding (similar to the above-mentioned ”topology”) to clear common mode voltage and provides the shortest circuit for signal transmission to improve the anti-noise capacity.

Terminating impedance

Different transmission cables have different characteristic impedance (the characteristic impedance of a twisted pair cable is approximately 120Ω). When the signal is transmitted to the terminating resistor of a cable, reflection and waveform distortion (either sinking or protruding) will be caused if the terminating impedance is different from its characteristic impedance. This distortion is not obvious when the cable is short but it will be more serious with longer cables. Finally, PLCs cannot transmit correctly and a terminating resistor should be installed to solve this problem. A 120Ω terminating resistor has been installed inside the FBs-PLC. When a terminating resistor is required to be added, open the cover and toggle the DIP switch to the “ON” position (DIP switch is set to “OFF” position by the factory). Terminating resistors can only be added to each PLC on the utmost left and right ends of the Bus. All the DIP switches between both end should be on the position “OFF”, or the driving power of RS485 may become insufficient. The diagram below shows the setting and application of terminating resistors:

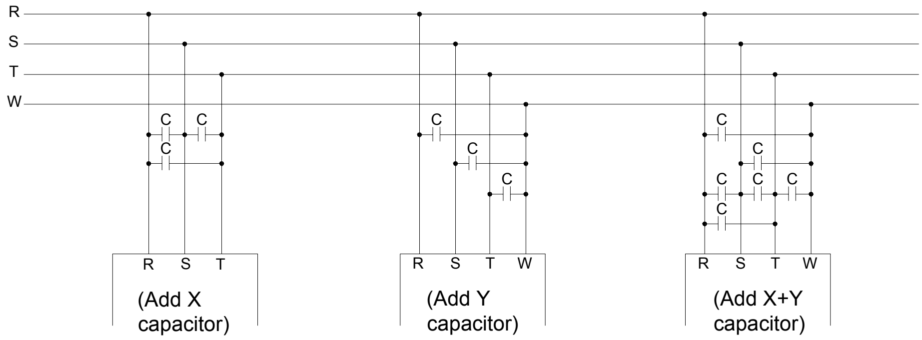


Should open the cover, adjust to “ON” for most left and right PLC units.

⚠ Caution
• The built-in RS485 terminating resistors of FBs-PLC is not only having impedance matching feature, but also having BIAS feature. When all the output drives are “OFF” (no output), the application must maintain the correct setting (at least one set to “ON”).

Strategies against noise

When wiring for RS485 network is implemented based on the described materials and rules or a 120Ω terminating resistor is added, most noise situations are eliminated. However, if noise cannot be eliminated, it means that there are strong noise sources near the RS485 network. Besides keeping cables far away from noise sources (e.g., electromagnetic valves, inverters, servo drivers, or other power units), the most effective way to solve the problem is to use noise suppression components. Refer to the description in Section 7.5 in the "Hardware Manual" for noise suppression of electromagnetic valves, relays and other devices with inductive load. The diagram below shows the noise suppression approaches for inverters, servo drivers, and other high-noise power units (i.e., add X capacitance or Y capacitance or X+Y capacitance).



C = 0.22μf~0.47μf／AC630V

⚠ Caution
• Hardware wiring for communication network and addition and removal of communication stations should be implemented with PLC disconnected. Don't work especially when PLC is running, or communication errors may occur to generate incorrect PLC output.

12.4 How to Use FBs-PLC Communication Ports

The requirements for communication are that (1) hardware interfaces and mechanisms, (2) communication parameters and (3) software interfaces (i.e. the protocol) of the receiver/ sender must be consistent. The same are applicable to PLC. After the above three fundamentals are meet, PLC will communicate with other PLCs or peripherals. The following will describe these three fundamentals.

12.4.1 Matching of Hardware Interfaces and Mechanisms

In order to meet the interface requirement of variety peripherals, the FBs-PLC provides USB, RS232, RS485 and Ethernet communication interfaces for choice. When install, care should be taken if the hardware interface is of the same type. Incorrect connection of different type of communication interface may cause the permanent hardware failure. Also please make sure that the signals of mating connector are all match. For example, TXD must connect to RXD, RTS (if any) should be connected to CTS. The interface of USB, RS232 and RS485 are described at bellow (Ethernet is described at section 12.8).

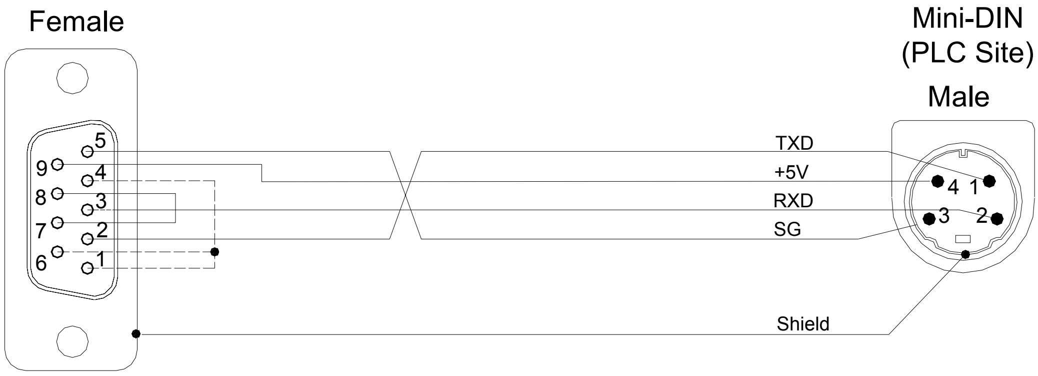
Port0 USB interface (built in)

The FBs-PLC equipped with port0 USB interface can be order by suffixed an U letter in the CPU model number. The port0 can only be acted as slave. Its connector is a standard USB B type connector. The user can use the standard USB A to USB B cable (can buy from FATEK, the product number is FBs-USBP0-180, please refer the description at below) to connect the PC and PLC.

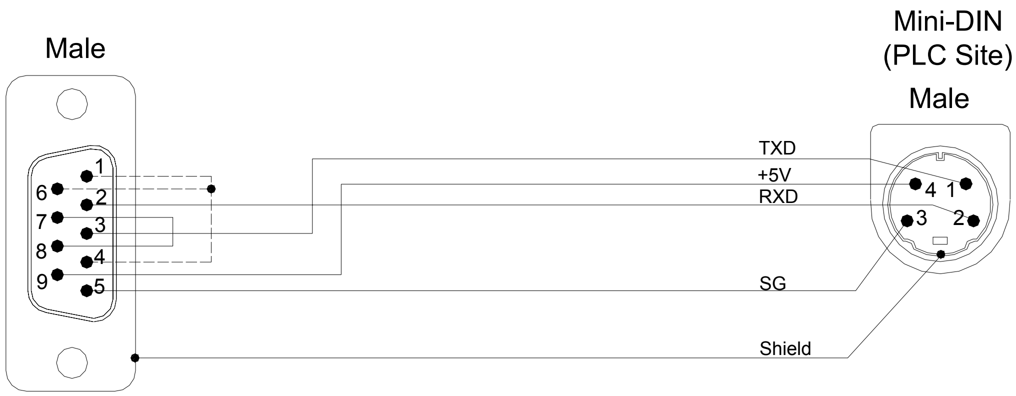
Port0 RS232 interface (built in)

The CPU model number with no U letter suffixed is a FBs-PLC that built in a port0 RS232 interface. The connector for port0 RS232 is a 4 pin Mini-DIN female connector. FATEK provides a dedicated connection cable that has a 9 Pin D-sub female connector at one end for the PC or peripherals to connect PLC port0 RS232. The wiring diagrams of port0 USB and RS232 connection cable are shown at below.

FBs-232P0-9F-150 (Mini-DIN male ⟶ 9 Pin D-sub female) :



FBs-232P0-9M-400 (Mini-DIN male ⟶ 9 Pin D-sub male) :



Model	Description
FBs-232P0-9F-150	MD4M to DB9F communication cable (FBs main unit Port 0 RS232 connect to standard DB9M), length 150cm
FBs-232P0-9M-400	MD4M to DB9M communication cable (FBs main unit Port 0 RS232 connect to DB9F), length 400cm
FBs-USBP0-180	Port0 USB cable (standard commercial USB A ⟷ B), 180cm long.

FBs – 232 P0 – 9 F – 150

FBs-Series product name

(connector specification) (connection distance) unit/cm

F: Female
M: Male

9: 9Pin D-sub

(Port on the PLC) → P0：Port0 (RS232)
P0：Port0 (USB)

(External Interface) → 232：RS232
USB：USB1.1

Port1~Port4 RS232 interface (expandable)

It can expand 1~2 communication port interface (according to the model number of CB) if purchase communication board (CB). The maximum expandable communication port is 4 (Port1~Port4) with extended CM modules.

Port1~Port4 is the default setting or default for PLC system initialization of FATEK standard communication interface. In order to provide the majority applications and needs of communication cable extension, Port1~Port4 is not only provide FATEK standard communication interface, but also provide powerful communication instructions. In this way, users allow to program their application communication through Ladder instructions which can easily achieve system integration and monitoring purposes.

The interface of communication board (CB) or communication module (CM) has RS232 or RS485 to choose.

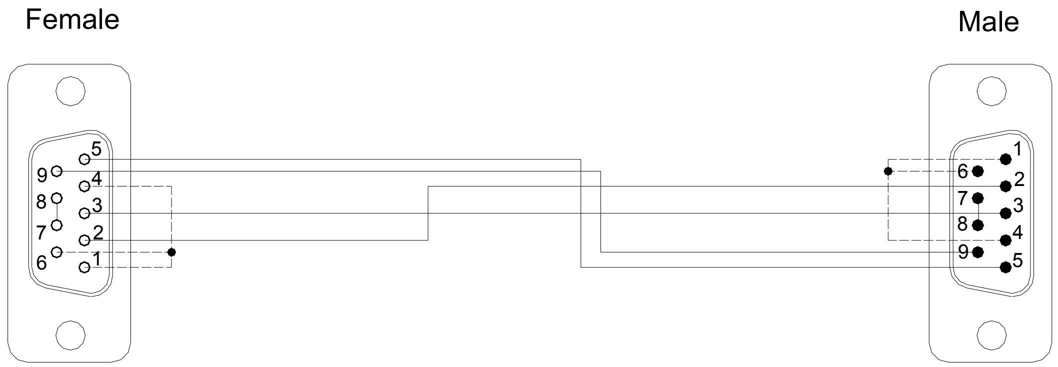
- RS232 interface

The communication port of Port1~Port4 can be utilized by installed the RS232 communication board (or module). Each communication board (or module) provides one or two standard RS232 9 Pin D-sub female connector(s). While application, the user can buy a standard 9 pin RS232 cable directly from computer store or follow the example diagram at below to DIY the cable.

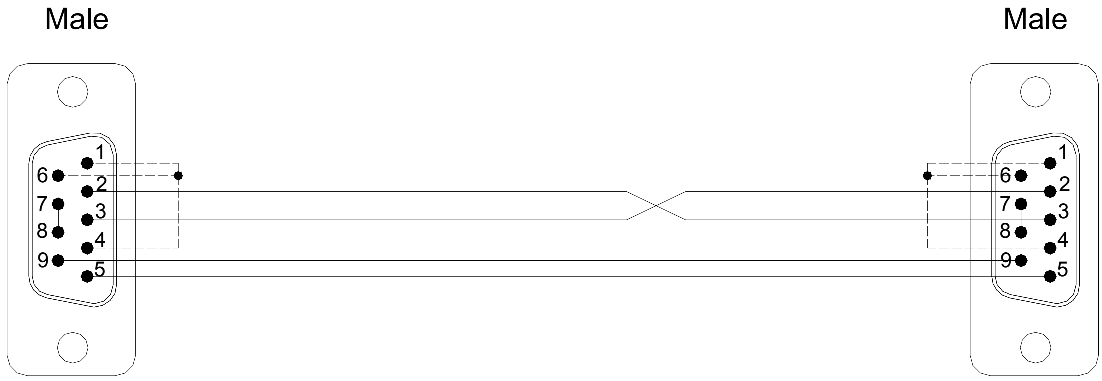
Connector Type \ Pin \ Signal Name		TXD	RXD	RTS	CTS	SG	DTR	DSR
9Pin D-sub	MALE	3	2	7	8	5	4	6
	FEMALE	2	3	8	7	5	6	4

port1、port2 usage only (RTS, CTS)　　FBs PLC Non-usage (DTR, DSR)

9P D-sub female ⟶ 9P D-sub male RS232 communication cable :



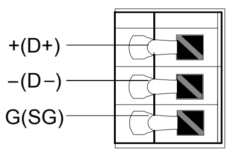
9P D-sub male ⟶ 9P D-sub male RS232 communication cable :



If you make RS232 cables by yourself and the definition of each pin is not clear, use a multimeter for measurement to determine TXD and RXD. 9 Pin connector: The pin 5 is SG; Measure the pin 2 (red probe) and the pin 5 (black probe) with a multimeter. If it is approximately −9V, it means that the pin 2 is the transmission pin; If it is approximately 0V, it means that the pin 2 is the receiving pin. Measure the pin 3 (red probe) and the pin 5 (black probe) by a multimeter. If it is approximately −9V, it means that the pin 3 is the transmission pin; If it is approximately 0V, it means that the pin 3 is the receiving pin.

Port1~Port4 RS485 interface (expandable)

The communication port of Port1~Port4 can be utilized by installed the RS485 communication board (or module). Each communication board (or module) provides one or two standard RS485 3-pin European plug-able terminal block. The pin assignment of connector(s) is show below.



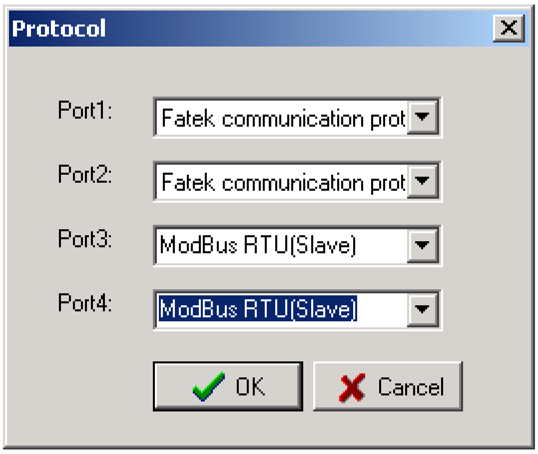
12.4.2 Selection and Setting of Communication Protocols

Besides offering the FATEK protocol by default, Port1~Port4 can be set to Modbus (Slave) protocol. The following shows the setting steps in the WinProladder :

Click the protocol: PLC

Setting

Protocol → a port can be set to Modbus RTU or FATEK Protocol:



Besides, you also can setting the communication protocol through special register.

- R4047 : Upper Byte = 55H, configure the communication port for Modbus RTU protocol.

  = Other values, Port1～4 don't support Modbus RTU protocol(The defaults are FATEK protocol)

  Lower Byte : Port assignment for Modbus RTU protocol.

Format as below :

Upper Byte	Lower Byte							
55H	b7	b6	b5	b4	b3	b2	b1	b0

b0, Reserved ;

b1=0, Port 1 acts as FATEK protocol.

=1, Port 1 acts as Modbus RTU protocol.

b2=0, Port 2 acts as FATEK protocol.

=1, Port 2 acts as Modbus RTU protocol.

b3=0, Port 3 acts as FATEK protocol.

=1, Port 3 acts as Modbus RTU protocol.

b4=0, Port 4 acts as FATEK protocol.

=1, Port 4 acts as Modbus RTU protocol.

-
-
-

b5～b7, Reserved

※ It allows to assign multiple ports for Modbus RTU protocol, where the corresponding bit must be 1.

For example：

R4047=5502H, Assign Port 1 as Modbus RTU protocol;
R4047=5504H, Assign Port 2 as Modbus RTU protocol;
R4047=5506H, Assign both Port 1 and Port 2 as Modbus RTU protocol;

Refer to：The rule for address mapping between Modbus and Fatek(Chapter 12).

Method 2 (FBs PLC OS V4.24 or later can support this method)

R4047：Upper Byte = 56H，configure the communication port of FATEK or Modbus RTU/ ASCII communication protocol
= other values, it doesn't work above function
(the default is FATEK communication protocol)

Lower Byte = Port1~4，FATEK/Modbus RTU/Modbus ASCII communication protocols

Format as below：

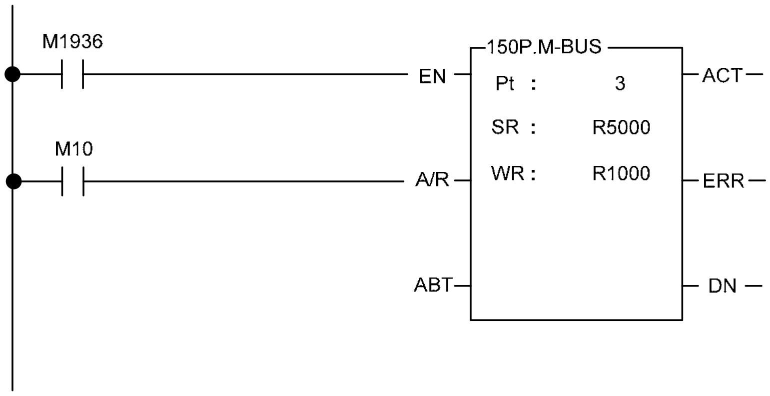
Upper Byte	Lower Byte							
56H	b7	b6	b5	b4	b3	b2	b1	b0

Bits	Value	Description
b1b0	0 or 1	Port1 works FATEK protocol
	2	Port1 works Modbus RTU protocol
	3	Port1 works Modbus ASCII protocol
b3b2	0 or 1	Port2 works FATEK protocol
	2	Port2 works Modbus RTU protocol
	3	Port2 works Modbus ASCII protocol
b5b4	0 or 1	Port3 works FATEK protocol
	2	Port3 works Modbus RTU protocol
	3	Port3 works Modbus ASCII protocol
b7b6	0 or 1	Port4 works FATEK protocol
	2	Port4 works Modbus RTU protocol
	3	Port4 works Modbus ASCII protocol

Port1～Port4 works the master of Modbus RTU/ASCII communication protocol

※ If PLC communication port is a Slave station of Modbus RTU/Modbus ASCII, please follow the use of above method to plan Modbus RTU/Modbus ASCII protocol interface.

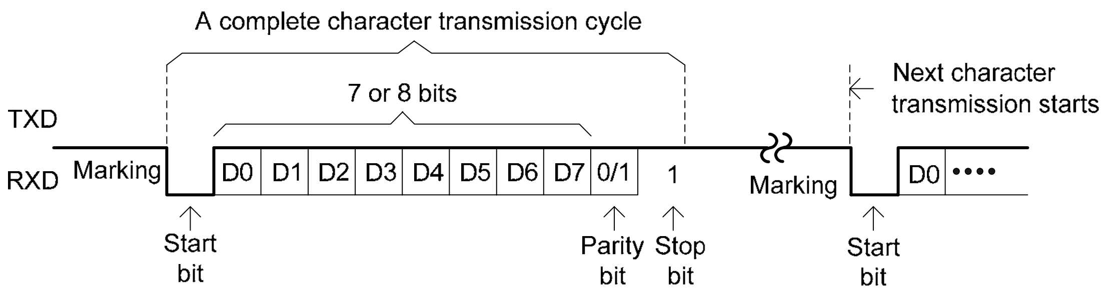
※ If PLC communication port is a Master station of Modbus RTU/Modbus ASCII, please follow FUN150 (M-BUS) instruction (refer to below diagram). Please refer to Chapter 13 for further details of FUN150 (M-BUS) instruction.



12.4.3 Settings for Communication Parameters

Communication parameters can be set up for each of the 5 FBs-PLC ports. When out of factory or communication parameters of Port 0~Port 4 are set to the same parameters of Port 0 before shipment or after system initialization. (See the table below.)

Baud Rate	9600 bps
Data Bit	7 Bits
Parity Check	Even
Stop Bit	1 Bit



Default communication parameters

Port	Register Setup	Default Value	Default Baud Rate	Other default Parameters
Port 0	R4050	5621H	9600 bps	7-bit Data, Even、1-bit Stop
Port 1	R4146	5621H	9600 bps	7-bit Data, Even、1-bit Stop
Port 2	R4158	5621H	9600 bps	7-bit Data, Even、1-bit Stop
Port 2 (High-speed)	R4161	5665H	153600 bps	8-bit Data, Even、1-bit Stop
Port 3	R4043	5621H	9600 bps	7-bit Data, Even、1-bit Stop
Port 4	R4044	5621H	9600 bps	7-bit Data, Even、1-bit Stop

※ When a port is set to Modbus RTU protocol, data bit is always 8-bit.
※ Port 1~Port 4 also provides Baud Rate settings for user-defined (1125 bps~1152000 bps).

※ Port 0 can be changed the baud rate only the other parameters are always 7-bit Data, Even, 1-bit Stop. Also, Port 0 supports FATEK communication protocol only.

Setup of port0~port4 communication parameters

56H	Communication Parameters

B_{15} B_8 B_7 B_0

Even/Odd Parity (B7)

0：Even Parity	
1：Odd Parity	

Data Bit (B6)

0：7 Bits	
1：8 Bits	※R4161 is only 8-bit.

Parity Check (B5)

0：None Parity	
1：With Parity	

Stop Bit (B4)

0：1 Bit	
1：2 Bits	

B7	B6	B5	B4	B3	B2	B1	B0

⇩

B3	B2	B1	B0	Value	Baud Rate
0	0	0	0	0	4800 bps
0	0	0	1	1	9600 bps
0	0	1	0	2	19200 bps
0	0	1	1	3	38400 bps
0	1	0	0	4	76800 bps
0	1	0	1	5	153600 bps
0	1	1	0	6	307200 bps
0	1	1	1	7	614400 bps
1	0	0	0	8	7200 bps
1	0	0	1	9	14400 bps
1	0	1	0	A	28800 bps
1	0	1	1	B	57600 bps
1	1	0	0	C	115200 bps
1	1	0	1	D	230400 bps
1	1	1	0	E	921600 bps
1	1	1	1	F	User-defined

※ R4161(PORT2) the high-speed baud rate must be greater than or equal 38400bps.

Port 1~Port 4 provides Baud Rate settings for user-defined (1125 bps~1152000 bps)

Formula

$$Baud\_Rate\_Div = \left(\frac{18432000}{Baud\_Rate}\right)-1 \qquad (15 \sim 16383)$$

$$Baud\_Rate = \left(\frac{18432000}{Baud\_Rate\_Div+1}\right) \qquad (1125 \text{ bps} \sim 1152000 \text{ bps})$$

Port	Register Setup	Formula
Port 1	D4000	$D4000 = \left(\frac{18432000}{Baud\_Rate}\right)-1$
Port 2	D4001	$D4001 = \left(\frac{18432000}{Baud\_Rate}\right)-1$
Port 3	D4002	$D4002 = \left(\frac{18432000}{Baud\_Rate}\right)-1$
Port 4	D4003	$D4003 = \left(\frac{18432000}{Baud\_Rate}\right)-1$

Example 1

If you want to set Port 1 Baud Rate to 1200 bps, then R4146 = 56XFH :

$$D4000 = \left(\frac{18432000}{1200}\right) - 1 = 15359$$

Example 2

If you want to set Port 2 Baud Rate to 256000 bps, then R4158 = 56XFH **:**

$$D4001 = \left(\frac{18432000}{25600}\right) - 1 = 71$$

Without station number checking for HMI or SCADA connecting

While PLC communicating with WinProladder or FP-08, it recognizes the FATEK's internal communication protocol.

While PLC communicating with Man Machine Interface (MMI) or Supervising software (SCADA), it recognizes the FATEK's external communication protocol.

Low byte of R4149 = 1, Port 0 without station number checking while FATEK's external communication protocol.
Low byte of R4155 = 1, Port 1 without station number checking while FATEK's external communication protocol.
High byte of R4155 = 1, Port 2 without station number checking while FATEK's external communication protocol.
Low byte of R4156 = 1, Port 3 without station number checking while FATEK's external communication protocol.
High byte of R4156 = 1, Port 4 without station number checking while FATEK's external communication protocol.

Reply delay time setting

As the PLC received a packet of addressed message and passed the error check, it would reply the message after the reply delay time period.

Low byte of R4040 **:** Port 0 reply delay time setting (Unit in mS).
High byte of R4040 **:** Port 1 reply delay time setting (Unit in mS).
Low byte of R4041 **:** Port 2 reply delay time setting (Unit in mS).
High byte of R4041 **:** Port 3 reply delay time setting (Unit in mS).
Low byte of R4042 **:** Port 4 reply delay time setting (Unit in mS).

Transmission delay time setting

While the communication port being used as the master of FATEK CPU LINK (FUN151) or Modbus RTU (FUN150) multidrop's network, it allows the user to set the transmission delay time to slow down the expiration of message frame.

High byte of R4147 **:** Port 1 transmission delay time setting (Unit in 10mS)
High byte of R4159 **:** Port 2 transmission delay time setting (Unit in 10mS)
High byte of R4045 **:** Port 3 transmission delay time setting (Unit in 10mS)
High byte of R4048 **:** Port 4 transmission delay time setting (Unit in 10mS)

Receive time-out span setting

While the communication port being used as the master of FATEK CPU LINK (FUN151) or Modbus RTU (FUN150) multidrop's network, it allows the user to set the receive time-out span to detect whether the slave station on line or not.

Low byte of R4147 **:** Port 1 receive time-out span setting (Unit in 10mS).
Low byte of R4159 **:** Port 1 receive time-out span setting (Unit in 10mS).
Low byte of R4045 **:** Port 1 receive time-out span setting (Unit in 10mS).
Low byte of R4048 **:** Port 1 receive time-out span setting (Unit in 10mS).

New message detection time interval setting

1. While the communication port being used as the master or slave of Modbus RTU protocol, the system will give the default time interval to identify each packet of receiving message, if the default works not well, the user can set this time interval through the high byte setting of R4148 and let M1956 be 1, to avoid the overlap of different packet of message frame.
   When M1956=1 **:** High Byte of R4148 is used to set the new message detection time interval for Port 1～Port 4 (Unit in mS)
2. While the communication port being used to communicate with the intelligent peripherals through the FUN151 convenient instruction, if the communication protocol without the end of text to separate each packet of message frame, it needs message detection time interval to identify the different packet. High byte of R4148 is used for this setting.
   High Byte of R4148：New message detection time interval setting for Port 1～Port 4 (Unit in mS).

Without station number checking for FATEK's internal communication protocol

While PLC communicating with WinProladder or FP-08, it recognizes the FATEK's internal communication protocol, the quick way to communicate with the PLC is to key in 255 as the station number for WinProladder to connect with the unsure station number of target.

Related internal relay

Port	Port Ready Indicator Relay	Finished Indicator Relay
Port1	M1960	M1961
Port2	M1962	M1963
Port3	M1936	M1937
Port4	M1938	M1939

12.4.4 Modem Interface Setting

As described in Section 12.1, the communication port of FBs-PLC has 3 types of software interface which the default setting of Port0 is "Standard Interface". However, Port1~Port4 have two interfaces, "Standard Interface" and "Ladder Diagram Program Controlled Interface", and the interface type is based on PLC's CPU of user's program setting (when user used communication controlled instruction FUN150 and FUN151, it will automatically set to "Ladder Diagram Program Controlled Interface"). Thus, within the 5 communication ports, only Port 1 needs register configuration. (To set the Dedicated Modem Interface)

High Byte of R4149 = 55H, Remote-Diagnosis/Remote-CPU-Link by way of Port 1 through Modem connection, it supports user program controlled dial up function.

= AAH, Remote diagnosis by way of Port 1 through Modem connection, it supports Passive receiving & Active dialing operation mode

= Other values, without above function

12.5 Description and Application of Software Interface Types

12.5.1 Standard Interface

The port with the standard interface is controlled by PLC CPU, and the communication transaction of the ports is controlled by FATEK "Standard Communication Driver" or "Modbus Communication Driver". All accesses to the port must be executed in the format of "FATEK-PLC Protocol" or "Modbus Communication Driver". FP-08, WinProladder software package, and many HMI and SCADA have communication drivers conforming to "FATEK-PLC Protocol", so linkage is built immediate when the "standard interface" port is connected and the hardware interface and communication parameters are consistent. When no such conforming communication driver is available, additional commands that conform to the format of "FATEK-PLC Protocol" or "Modbus Communication Driver" must be written for PLC communication.

12.5.2 Modem-Specific Interface

R4149 high byte = AAH means that Port 1 is set up to Modem-specific interface. Though CPU uses FATEK "Standard Communication Driver" or "Modbus Communication Driver" to control the communication transaction of Port 1, connection must be made via Modem. In other words, Port 1 is controlled by "Modem Driver" before communication starts, no matter whether active dialup or passive reception connection is concerned, and no access is allowed to PLC. The Modem Driver is only used for Modem connection and transfers the control of Port 1 to FATEK "Standard Communication Driver" when Modem is connected successfully, and Port 1 becomes the "standard interface". This section discusses the operation of Modem active dialup connection and passive reception connection.

With the Modem-specific interface, the PLC allows Port 1 to dial up a remote Modem actively or receive messages from a remote Modem passively depending on the setting of the internal phone number register (R4140~R4145). When connection of both machines is successful, transmission or reception of data is executed via the phone cable.

A. Passive reception mode

When no “effective phone number” is stored in the internal phone number register of the PLC (see B below), it will enter the passive reception mode and set up the Modem to the reception mode waiting for a remote Modem to dial up. When both machines connect successfully and the inbound signal is correct, the PLC host exits the reception mode immediately and runs into connection state. The remote Modem can fully control and access the PLC host. The PLC host checks the content of the phone number register only at the moment when the power of the PLC host or Modem is turned on (OFF→ON). Therefore, any change to R4140~R4145 (e.g. save or removal of a phone number) is only effective when the power of the PLC host or Modem is turned off and turned on again.

B. Active dialup mode

When an “effective phone number” is stored in the internal phone number register of the PLC host, it enters the active dialup mode at the moment when the power of the PLC host and Modem is turned on. In this mode, Port 1 can dialup a phone number in R4140~R4145 via Modem for connection to the remote Modem corresponding to this phone number. When both machines connect successfully, the PLC host exits the dialup mode and runs into connection state. The remote Modem can fully control and access the PLC host. If dialing fails, the PLC host executes the second dialing to a maximum of three redials (about 3 minutes). If the third redial fails, the PLC host exits the active dialup mode and enters the passive reception mode. It also sets up the Modem to the reception mode waiting for calls from a remote Modem.

Only the phone number that is stored in the Modem phone number register in the following format will be identified as effective by the PLC host. The phone number must be written hex-decimally. Only 0~9 and “E” are meaningful in the hexadecimal digits. “A” stands for dialing delay and is usually used for international calls or extensions of an automatic switchboard. (a “A” is about 2 seconds). “B” stands for “#”, and “C” stands form “*”. Among the effective digits, 0~9 is used for phone numbers, while “E” stands for the end of a phone number. Since each register has 4 hexadecimal digits, R4140~R4145 have 24 hexadecimal digits and maximum 23 digits, the end character “E” not counted, can be stored in R4140~R4145. Phone numbers are stored in order from digit 0 of R4140 to digit 3 of R4145. For example, the phone number 02-6237019 is stored in the following order:

Direction ←

R4145				R4144				R4143				R4142				R4141				R4140			
χ	χ	χ	χ	χ	χ	χ	χ	χ	χ	χ	χ	χ	χ	E	9	1	0	7	3	2	6	2	0
↑ Digit 3								↑ Digit 3						↑ End character						↑ Digit 3			↑ Digit 0

“χ”: Any value from 0 to F

2620H is stored in R4140, 1073H is stored in R4141,and XXE9H is stored in R4142. R4143~R4145 can be any value. Please note that the last digit of the phone number must be followed by the end character “E”. The PLC host will ignore the number (any value from 0 to F) behind “E”. Only the value 0~C is acceptable before “E”. Any other values will be regarded as ineffective.

If the telephone bill is paid by the service unit answering the call, no effect phone number should be stored in the internal Modem phone number register of the PLC host, so that it will enter the reception mode when turned on and the service unit will then call the client. If the phone bill is paid by the client, at least one effect phone number must be stored in the internal Modem phone number register of the PLC host, so that it will enter the dialup mode at the moment when the client turn on the power of the PLC host and Modem. Since the phone number of the service unit may change, the WinProladder package provides a phone number Write and Callback command. In this case, the client is not able to call the service unit with the old phone number. To solve this problem, the client may turn on the Modem and PLC host. When the PLC host fails converts to the reception mode after three failed dials (about 3 minutes), the service unit calls the client and imports its new phone number in the Modem phone number register of client's PLC host and sends a callback command. When receiving the callback command, the PLC host of the client enters the dialup mode immediately and calls the service unit with the imported new number. This application requests the service unit to call the client and pay the bill. However, the amount of the telephone bill is limited because it takes very short time for implementation of the Write and Callback command.

When executing the "Write and Callback" command and connecting to the host of the client successfully, WinProladder will take the old number back from the PLC host for reference (and for future use when write-back of the old number is required) before it writes the new number and executes callback. When the connection is not required any more, WinProladder will give a shutdown command automatically for disconnection.

12.5.3 Ladder Program Control Interface

This type of interface can be set up for Port1~Port4. The ladder program that are used to control the ports are FUN94 (ASCWR), FUN150 (M-BUS) and FUN151 (CLINK).

FUN94 (ASCWR) uses Port 1 as an output interface for ASCII files (transmission only) and sends messages to printers, computers, and other devices that receive messages with ASCII code. The typical application of this command is the connection to printers for Chinese/English reports. WinProladder provides the "ASCII File Editor" function. It converts the data to be edited or printed to ASCII files and stores them in PLC. Production reports, material request reports, and other reports are generated with the help of various dynamic data input during the operation of PLC. Refer to "ASCII File Output Applications" for more information.

FUN150 (M-BUS) controls Port 1~Port 4 and uses them as masters on the Modbus network. The ports can connect to Modbus peripherals (slaves) easily. Refer to the "Convenient instruction for Modbus RTU Master" below for more information.

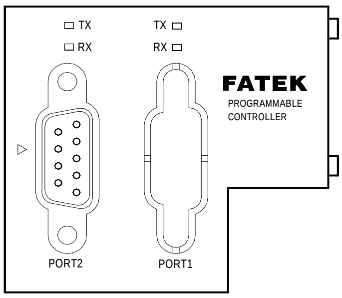
FUN151 (CLINK) controls Port 1~Port 4 and uses them for resource sharing among PLCs or connection to intelligent peripherals. FUN151 provides four operation modes. Refer to the "FBs-PLC CLINK Applications" below for more information.

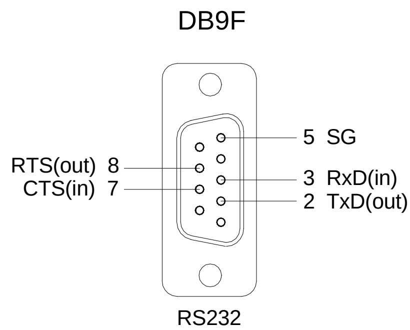
12.6 Communication Boards(CB)

The FBs-PLC main unit has been built in the communication port 0 , and it can increase the communication ports by purchasing the optional communication board. In response to varying application and demand, 6 types of specification have been designed to suit actual application of customers. In the model name of communication board and communication module, CB signifies Communication Board, CM signifies Communication Module, 2 signifies RS232 interface, 5 signifies RS485 interface, E signifies Ethernet interface. The specification and appearance of every communication board is as follows:

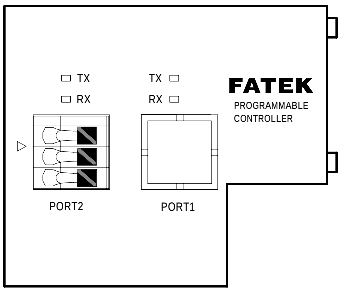
Model/Item		Specification
FBs-CB2		1 × RS232 COM Port (Port 2), with TX、RX indicators.
FBs-CB22		2 × RS232 COM Port (Port 1+Port 2), with TX、RX indicators.
FBs-CB5		1 × RS485 COM Port (Port 2), with TX、RX indicators.
FBs-CB55		2 × RS485 COM Port (Port 1+Port 2), with TX、RX indicators.
FBs-CB25		1 × RS232 COM Port (Port 1) + 1 x RS485 COM Port (Port 2), with TX、RX indicators.
FBs-CBE		1 × Ethernet COM Port (Port 2), with Link、TX、RX indicators.
RS232 specification	Mechanical	DB9F Standard Plug
	Electrical	EIA RS232 Standard Specification
RS485 specification	Mechanical	3-PIN European style movable terminal platform
	Electrical	EIA RS485 Standard Specification, built-in the terminator with the DIP switch setting.

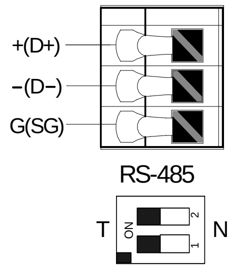
- 1 × RS232 COM Port〔FBs-CB2〕



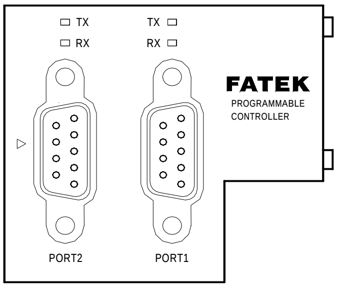


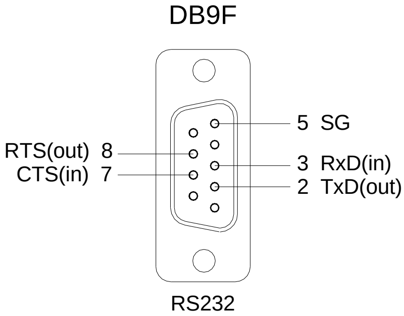
- 1 × RS485 COM Port 〔FBs-CB5〕



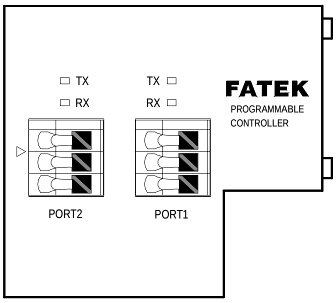


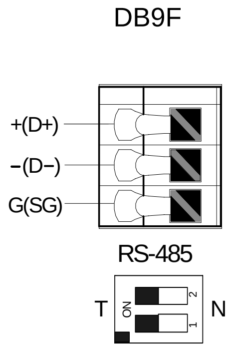
- 2 × RS232 COM Port 〔FBs-CB22〕



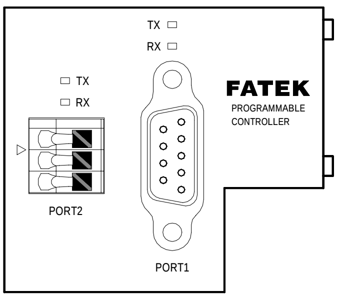


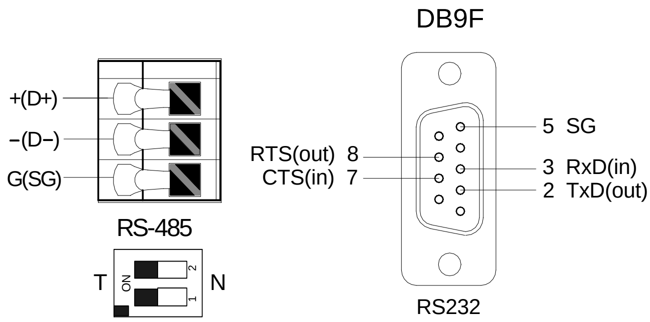
- 2 × RS485 COM Port 〔FBs-CB55〕



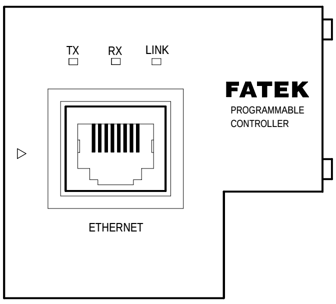


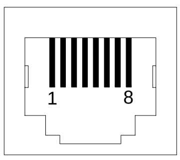
- 1 × RS232＋1 × RS485 COM Port 〔FBs-CB25〕





- 1 × Ethernet COM Port 〔FBs-CBE〕





Signal	RJ-45 Pin
TX+	1
TX-	2
RX+	3
RX-	6

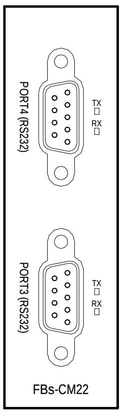
12.7 Communication Modules (CM)

For 3 communication ports application, we need the optional communication board, and we also need the extra communication module for 5 communication ports requirement. The naming system for CM is as described above. CM means communication module, 2 means RS232 interface, 5 means RS485 interface, E means Ethernet interface. The specifications and appearance of each CM is as follows:

Model / Item		Specifications
FBs-CM22		2 × RS232 COM Port (Port 3+Port 4), with TX、RX indicators.
FBs-CM55		2 × RS485 COM Port (Port 3+Port 4), with TX、RX indicators.
FBs-CM25		1 × RS232 COM Port (Port 3) + 1 × RS485 COM Port (Port 4), with TX,RX indicators.
FBs-CM25E		1 × RS232 COM Port (Port 3) + 1 × RS485 COM Port (Port 4) With Ethernet interface, with RUN, Link, TX, RX indicators.
FBs-CM55E		1 × RS485 COM Port (Port 3) + 1 × RS485 COM Port (Port 4) With Ethernet interface, with RUN、Link、TX、RX indicators.
FBs-CM25C		General purpose RS232 ⟷ RS485 converter, with RX indicators.
FBs-CM5R		General purpose RS485 amplifier, with RX indicators.
FBs-CM5H		General purpose 4-port RS485 Hub, with ACT, COLLISION indicators.
RS232 specification	Mechanical	DB9F Standard Plug
	Electrical	EIA RS232 Standard Specification
RS485 specification	Mechanical	3-PIN European style movable terminal
	Electrical	EIA RS485 Standard Specification, built-in the terminator with the DIP switch setting.
Ethernet specification	Mechanical	4-PIN European style movable terminal
	Electrical	10BaseT，IEEE 802.3 standard

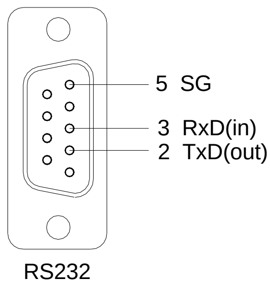
∗ MA main unit does not support expansion of communication modules, therefore it can only have up to three COM Ports

- 2 × RS232 COM Port



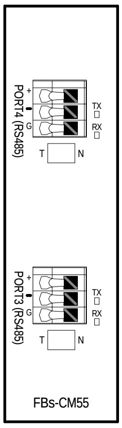
〔FBs-CM22〕

DB9F

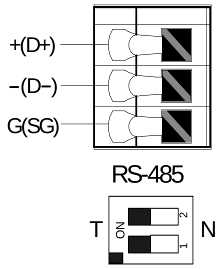


Pin assignment of the connector

- 2 × RS485 COM Port

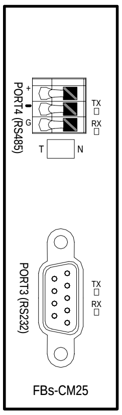


〔FBs-CM55〕

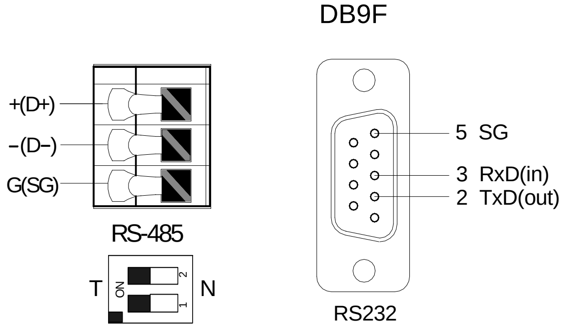


Pin assignment of the connector

- RS232＋RS485 COM Port

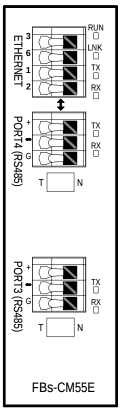


〔FBs-CM25〕

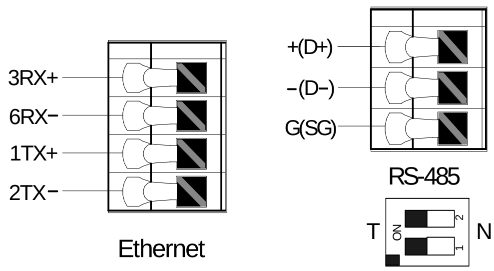


Pin assignment of the connector

- 2 × RS485 COM Port ＋ Ethernet

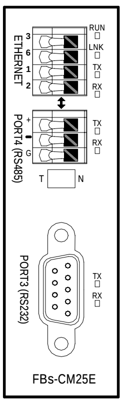


〔FBs-CM55E〕

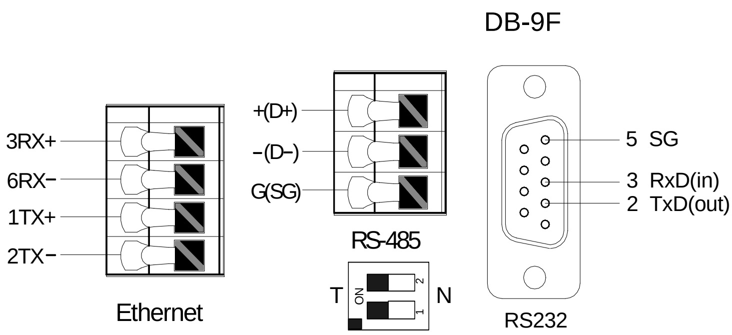


Pin assignment of the connector

- RS232 ＋ RS485 ＋ Ethernet

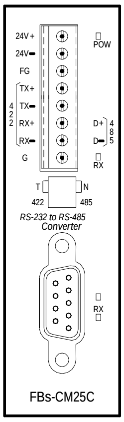


〔FBs-CM25E〕

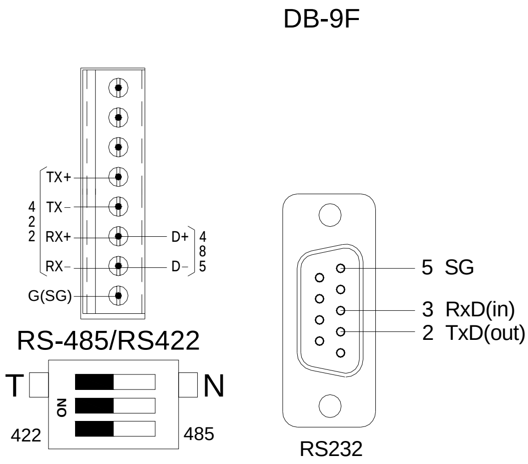


Pin assignment of the connector

- RS232 ↔ RS485 Converter

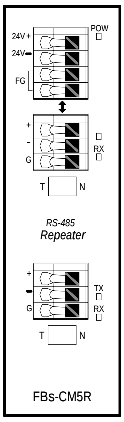


〔FBs-CM25C〕

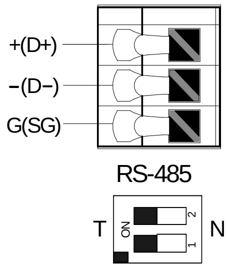


Pin assignment of the connector

- RS485 Repeater

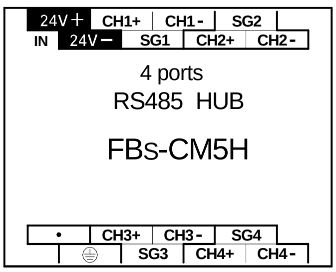


〔FBs-CM5R〕



Pin assignment of the connector

- RS485 HUB



〔FBs-CM5H〕

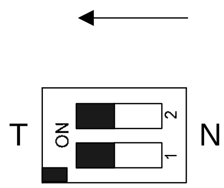
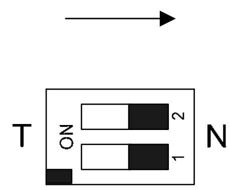
12.7.1 4-Port RS485 Central Hub (FBs-CM5H)

FBs-CM5H is the 4 ports RS485 central Hub. This module is not restricted to be used on FBs-PLC series products, and it can be used by the wide range application of RS485 communication interface. This product can function as a repeater, and it can support the star topology for wiring connection except the traditional RS485 bus topology. In addition, the ports are designed with opto-electric insulations to protect the system from disrupted current generated by the difference in earth current. Another feature is the direction change control utilizes automation to adjust in accordance with different data transfer rate and data format. Installation is easy and it can be directly fixed onto DIN-Rail or fixed with screws. For details of the wiring method for FBs-CM5H, please refer to chapter 12.3 (RS485 COM Port hardware wiring notes)

Indicators

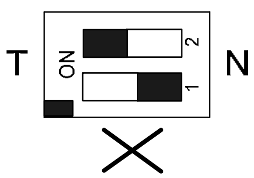
Indicator Name	Functional Description
POW	Power indicators. This indicator will light up when there is external power source.
ACTIVE	Four LED indicators represent the activities of the four ports. The ports with indicators on are active ports, and the others are passive ports. Messages on active port will appear on passive port.
COLLISION	Four LED indicators represent the signal collision status for the four ports. The ports with indicator on mean the signal transmitted online and the signal to be transmitted on the ports are inconsistent, which also mean there are other devices transmitting signal on the bus causing conflicts.

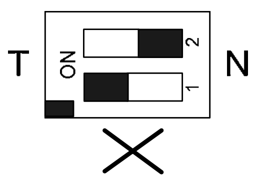
Setting for terminator

Port No.	Switch	Terminator ON	Terminator OFF
CH1	SW1	 Switch 1,2 are ON	 Switch 1 & 2 are OFF
CH2	SW2		
CH3	SW3		
CH4	SW4		

⚠Warning

- The DIP switch for terminator setting must be used with the 2 bits together (both “ON”, or both “OFF”), the two bits can not be inconsistent, otherwise it would cause bad or worsen communication.



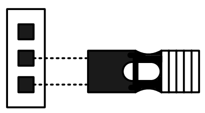


Working mode settings

1.Symmetrical mode： Function of every port is the same. Signal received by any one port would transmit to the other ports.

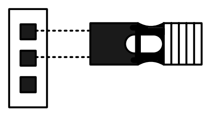
2.Asymmetrical mode： Port 1 is the master, and signals received by it will be transmitted to other ports, but signal received by port 2~4 would only transmit to port 1.

JP2



Asymmetrical mode

JP2

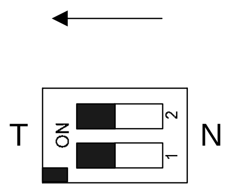
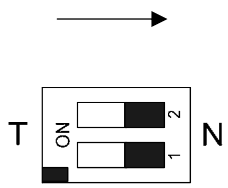


Symmetrical Mode

12.7.2 Isolated RS485 Repeater (FBs-CM5R)

FBs-CM5R is the universal RS485 repeater. This module is not restricted to be used in FBs-PLC series products only, it can also be used in wide range of RS485 interface application. The feature of this product is the opto-electric insulation design between the two RS485 ports, protecting system from disrupted current caused by difference in grounding potential. Installation is very convenient, just fix it directly onto DIN-Rail or screw it on.

Setting for terminator

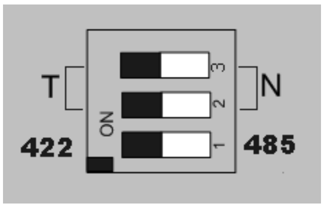
Terminator ON	Terminator OFF
	

12.7.3 Isolated RS232/RS485 Bi-Directional Signal Converter (FBs-CM25C)

FBs-CM25C is the interface signal converter between RS232 and RS485 network. This module is not limited to be used on FBs-PLC series products, it can be used as the universal converter between RS232 and RS485 interface. The feature of this product is the opto-electric insulation design between the two ports, protecting system from disrupted current caused by difference in grounding potential. Another feature is the direction change control utilizes automation to adjust in accordance with different data transfer rate and data format. Installation is very convenient, just fix it directly onto DIN-Rail or screw it on.

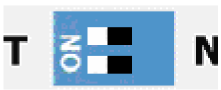
FBs-CM25C DIP Switch Setting

There have three DIP switches at front panel of FBs-CM25C (as the diagram shown below). User can select the RS485 or RS422 working mode by setting the DIP switches.

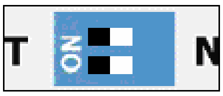


RS485 Terminator

If choose built-in termination resistor, please turn the switch to ON, the T position (turn to left).



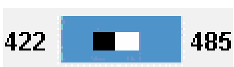
On the other hand, if choose no termination(OFF), then turn the switch to N position (turn to right).



RS485/RS422 Selection

When choose RS422 interface, please turn the switch to 422 position (turn to left).

When choose RS485 interface, please turn the switch to 485 position (turn to right).



12.8 FBs Ethernet Communication Module and Application

Network communication has far reaching applications and is helpful for the circulation of information. Though most of the software systems are designed for commercial use, the CIM application in the manufacturing industry and the ongoing development of the Internet speed the application of network communication in industries. In the circumstances, FATEK develops a series of Ethernet/Serial Port Bridge Module as a cost efficient and effective FBs-PLC network connection solution for customer.

The FBs-CBE module only provides connection of the Ethernet to FBs-PLC. Other modules (CM25E/CM55E) provide two serial ports Port 3 and Port 4 for communication applications. Port 4 is only used in conjunction with RS485 for Ethernet signal transformation, while Port 3 is used for other peripheral control purposes.

12.8.1 Specifications

12.8.1.1 Connector Specifications

Module	Port	Signal Type	Connector Type	Power Consumption*
FBs-CM25E	Port3	RS232	DB9 female	200mA
	Port4	RS485	European 3pin connector	
	Ethernet	10BaseT	European 4pin connector	
FBs-CM55E	Port3	RS485	European 3pin connector	200mA
	Port4	RS485	European 3pin connector	
	Ethernet	10BaseT	European 4pin connector	
FBs-CBE	Ethernet	10BaseT	RJ45	150mA

*： CPU 5V power source

12.8.1.2 Ethernet Specifications

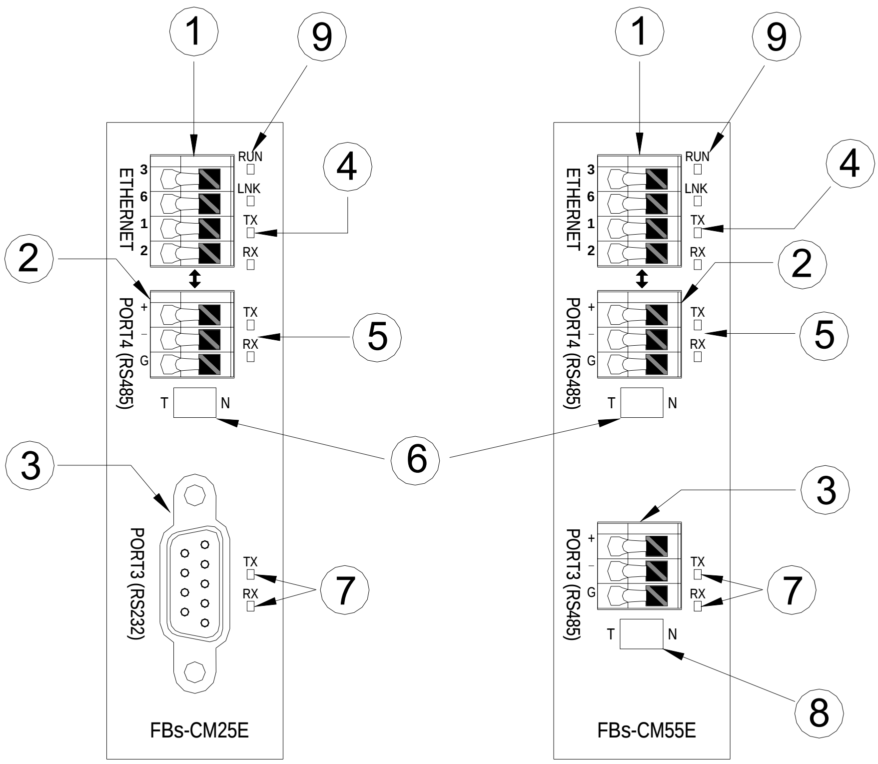
Feature	**Description**	
Network interface	10BaseT, IEEE 802.3	
Transmission Protocol	TCP,UDP, IP, ARP	
Application Protocol	Client Mode	FATEK UDP
	Server Mode	FATEK/TCP/UDP, Modbus/TCP
Status Indicator	Link status indicator(LINK), transmission status indicator(TX), receiving status indicator(RX)	

PLC port	CM25E/CM55E	Port4	
	CBE	Port1	Fatek server mode
		Port2	Fatek client mode or Modbus server mode
PLC baud rate	9600,19200,38400,57600,115200,230400(**CM25E/CM55E**)		
	115200(**CBE**)		

Feature	Description
Security	Use permitted IP for access control
Building tools	Windows Network Building Software
Application modes	Server and Client modes
Permitted IPs	10
Port mapping group size	18
TCP connections	Max. 8 connection at a time (only for the Server mode)

12.8.2 Appearance

12.8.2.1 CM25E and CM55E Appearance



① Ethernet connector **:** Instead of traditional RJ-45, European 4pin connector with excellent contact is used for the vibration environment of the machine.

② Port4 connector : For RS485 signal.

③ Port3 connector : For RS485 signal (FBs-CM55E) and RS232 signal (FBs-CM25E).

④ Ethernet status indicator :

LINK : ON indicates that normal connection.

RX : ON indicates that the module senses messages in the Ethernet.

TX : ON indicates that the module is sending messages to the Ethernet.

⑤ Port4 status indicator :

RX : ON indicates that Port 4 is receiving messages.

TX : ON indicates that the Port 4 is sending messages.

⑥ Port4 terminating resistor switch : This switch is used to control the connection of the terminating resistor in the module to Port 4 RS485 interface. T means with terminating resistor. N means Without terminating resistor.

⑦ Port3 status indicator :

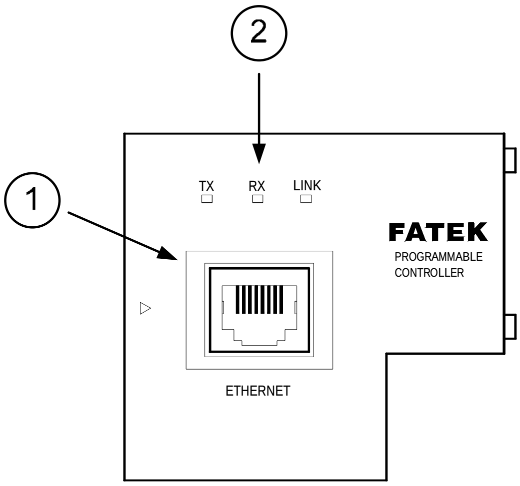
RX : ON indicates that Port 3 is receiving messages.

TX : ON indicates that the Port 3 is sending messages.

⑧ Port3 terminating resistor switch : This switch is used to control the connection of the terminating resistor in the module to Port 3 RS485 interface. T means With terminating resistor. N means Without terminating resistor.

⑨ Module status indicator (RUN) : Quick flashing indicates normal operation. Slow flashing indicates active setup.

12.8.2.2 CBE Appearance



① Ethernet connector: Standard RJ45 connector.

② Ethernet status indicator:

LINK: ON indicates normal connection.

RX: ON indicates that the module senses messages in the Ethernet.

TX: ON indicates that the module is sending messages to the Ethernet.

12.8.3 Serial Connector Function (Only CM25E/CM55E Provides)

Port3 connector

The signal level of Port3 connector is of RS232(CM25E) or RS485(CM55E). This port can be treated as a general communication port of FBs-PLC module and used for peripheral applications.

Port4 connector

The signal level of Port4 connector is of RS485(CM55E). The main function of this port is to couple the Ethernet signal to FBs-PLC module, this port also can be treated as a general communication port of FBs-PLC module and used for peripheral applications. Whenever the FBs-CMX5E module receive a data packet from the Ethernet interface, the same data packet also will appear at this port(Ethernet to serial port conversion). On the contrary, if a data packet is received at this port and the destination is due for network (by lookup mapping table), it will also appear at Ethernet network. Because the multi-drop characteristic of RS485 interface, install one FBs-CMX5E can provide more than one PLC to hook on Ethernet.

12.8.4 Transforming From Ethernet to Serial Communication

The operation principle of Ethernet serial converter is to take this module as interface and receive all the messages from network that intend to the PLCs managed by this module then convert it to the serial signal that can be accepted by PLC and transmit it thru port4. The operation is completely transparent, in other words, The FBs-PLC cannot distinguish the message is from local or network, the reply message is the same with normal RS232communication. When the FBs-CMX5E or FBs-CBE module(for clarity it will be referred as Ethernet module in following context) receives the reply message of PLC will pack the message into network data packet then send it to the network. It must emphasis here that the network environment is complicated and not adequate for real time data transfer and can be use mainly for monitoring but not for control. The main reason to use the network for factory communication is for its connectivity. The application, which required to access one processor at same time by multiple clients, previous was difficult to implement by RS232 and RS485 can now easily achieve by network solution.

12.8.5 Application Structure

Base on the different requirements of network application this module provides two operating modes –Server Mode and Client Mode.

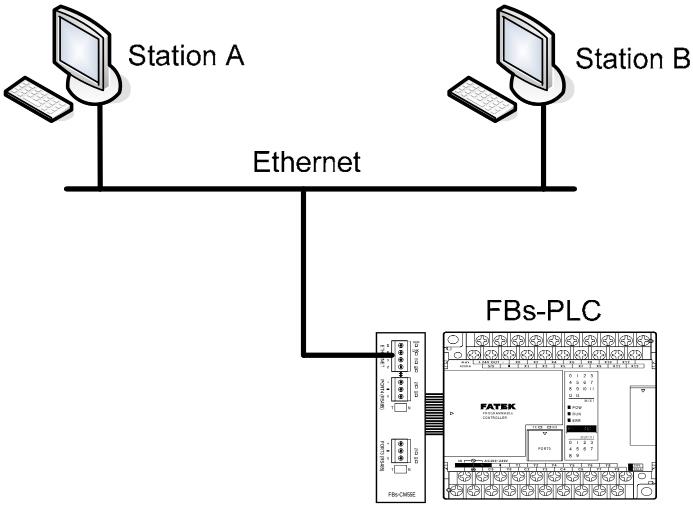
When operates at server mode, the Ethernet module will wait for the message coming from the network. After decode the received message it will send the message thru serial port to the PLC main unit. The reply message from the PLC will intercept by this module and packed into data packet then transmit to the network hence complete a server mode transaction.

When operates at client mode, the Ethernet module will wait for the message coming from the serial port. If the received message is for the PLC located at the remote site connected by network, the Ethernet module will pack the message into data packet for network transmission and send it to network. After send the message to network the Ethernet module will wait for the reply message coming from network, when it receives the reply message it will direct the message to serial port for PLC hence complete a client mode transaction. The network connection of Ethernet module depicted in the figures at following chapter, for clarity, will only be drawn by a direct link. Actually the network interface of the Ethernet module is 10BaseT, which should attach with Hub in order to connect with network.

12.8.5.1 Server Mode

When operates at server mode, the direct connected single PLC or the stations connected by RS485 (CM25E/CM55E) are all work at slave mode, which will wait for command message passively and reply the command. Follows are example of server mode application.

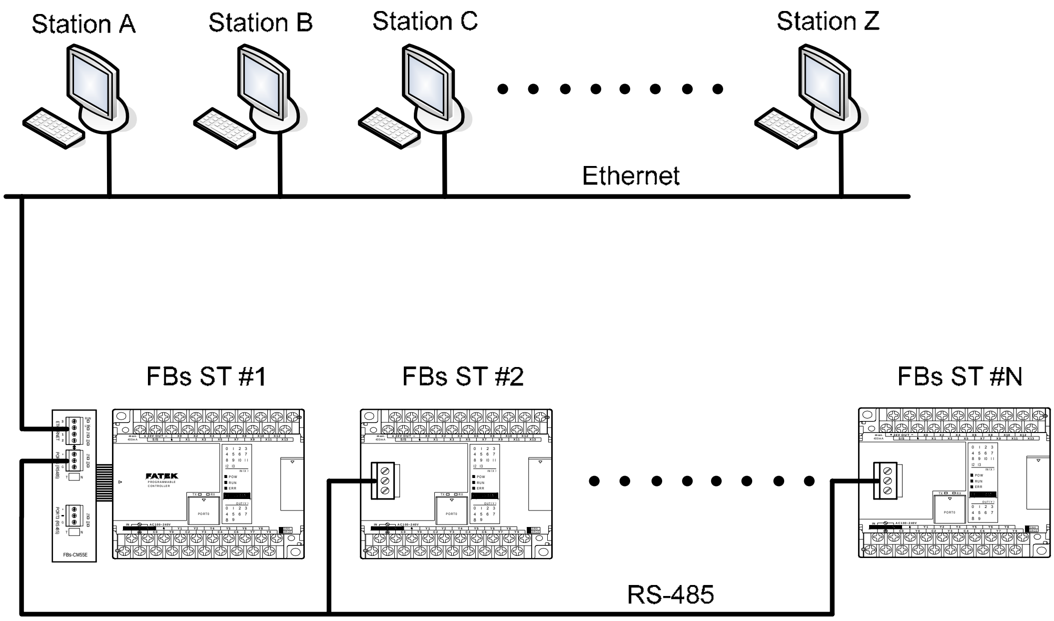
Single FBs-PLC connection



The example illustrate on above is the simplest server mode application. Work station A and work station B are master that can send the command message actively to FBs-PLC, Upon receiving the command message, Ethernet module will send the message thru the port4 to FBs-PLC. When there are more than one message intended to send to FBs-PLC, the Ethernet module will save the additional messages into the message queue then send it to FBs-PLC in orders (Must wait for the reply message before send the next command) therefore there will no conflicts.

When work at this mode, there is no need to write any program in PLC for operation.

Multiple PLC connection



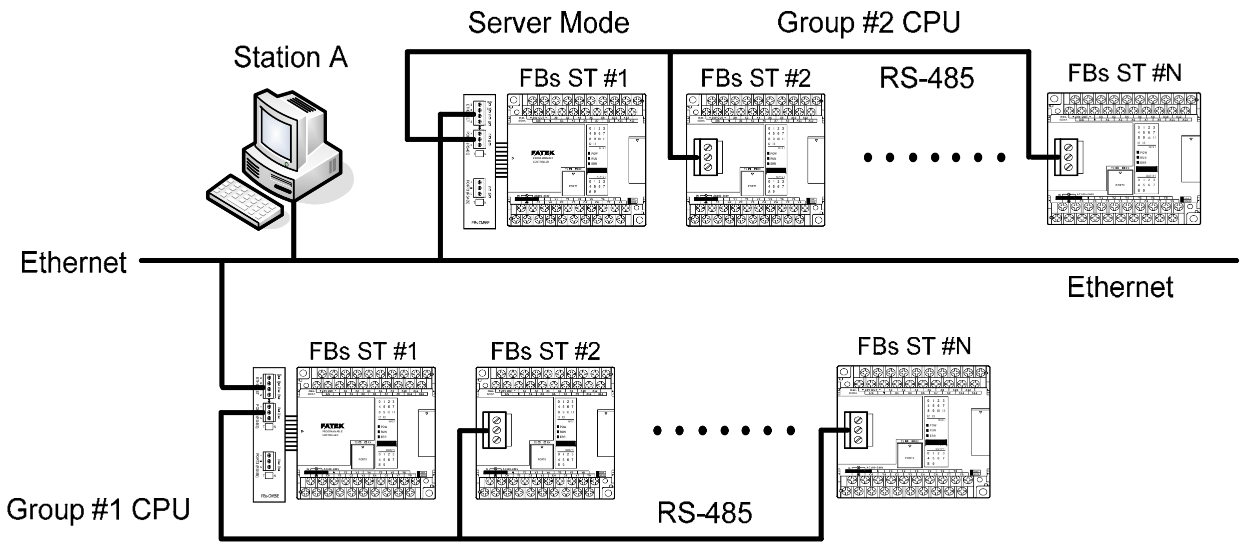
Under this application architecture, The PLCs connect the Ethernet module with the RS485 interface of port4. The work station A and work station B are master that can send the command message actively to FBs-PLC, Upon receiving the command message from the network, Ethernet module will re-send the message to FBs-PLC thru port4 interface. When the message appears at RS485 line, each PLC will compare the target station embed in message against its own station ID. If the result is true then it will reply according to the command message. The reply message will intercept by the Ethernet module and re-pack then send to the network. When there are more than one message intended to send to FBs-PLC, the Ethernet module will save the additional messages into the message queue then send it to FBs-PLC in orders (Must wait for the reply message before send the next command) therefore will not have conflicts. When work at this mode, there is no need to write any program in PLC for operation.

12.8.5.2 Client Mode

While work at client mode (CM25E/CM55E), the Ethernet module will wait the command message at port4. When it finds the message is for the PLC station located at remote site then it will pack the message according to the content of port mapping table and send it to the network. After that, Ethernet module will keep an eye on network for the reply message. Upon receiving the reply message, the Ethernet module will decode the message then send back to PLC thru serial port hence complete a client mode transaction. When work at this mode, the direct connected single PLC or the master station of PLC LINK connected by RS485 interface (CM25E/CM55E) are all operated at master mode, which means it use LINK instruction mode0 to send the command actively. The client mode also can be further divided into standard mode and virtual server mode. Explanation as follows.

Standard mode

When work at this mode, the master PLC connected with Ethernet module can use LINK instruction mode0 send the command message to other PLC. The target PLC that master PLC intend to command can be a local slave PLC connected by RS485 interface to master PLC or a PLC located at remote site with sever mode Ethernet connection. There is a “Station to network address translation table” in the Ethernet module when work at client mode. This table includes the information about the mapping of local station and remote station, the user should set this table according to the actual application deployment. While operation, the Ethernet module will constantly inspect the received message, if the station number in the message can be found in the translation table that means the message is going to route to network, the Ethernet module will first replace the station number in message according to the translation table then re-calculate and update the check sum of translated message and encapsulate it in network data packet and finally send it to the network. After received the reply message from network, the Ethernet module will perform the translation of message at the reverse order. First it will replace station number in message to the original station number and then re-calculate and update the check sum of message then send it to serial port. A standard client mode network application is shown as follows.



In the above figure, there are two groups of PLC. The PLCs in each group are linked together by RS485 interface and then attach to an Ethernet module for network accessibility. The station number 1 of group 1 is a master PLC, which not only can access the other PLCs of same group but also can access the PLCs of group 2 with the help of two Ethernet modules bridging. The Ethernet module attached to group 2 PLC is configured as server mode, which means all the PLCs covered by this module are work as slave PLC and wait for the command passively. It must emphasis that the PLCs under standard client mode Ethernet module can't access by other master devices thru network communication. The role of this kind of Ethernet module is very similar to Fire Wall. Only the messages from inside or the corresponding reply messages can be accepted by Ethernet module, other messages will be blocked. The security of client mode operation is very high. Based on the reason described above, the workstation A can only access the PLCs of group 2. It's noted that, from the view point of master PLC, the station number of station #2 of group 2 is not 2, otherwise it can't distinguish it from the local station of #2. This can be overcame by the introduction of translation table.

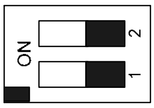
Virtual server mode

Though high security is the key feature of standard client mode, can't accessed by other devices thru network is also a drawback. To take the balance between the security and connectivity, the Ethernet module provides a virtual server mode to meet the both end. While working at this mode, the Ethernet module emulates a PLC with station number of 255. There are only R0~R1999 can be accessed of this virtual PLC. When the command message is for station 255, the Ethernet module will interpret the message and act upon that message; this is true for all the messages whether it comes from serial port or from network. The Ethernet module act as a medium, the status of PLCs can store in it for outside world access. The outside world can put the command status in it for PLCs access. The virtual server mode is an option for client working mode, which means while act as virtual server the master PLC still can access the slave PLCs that attached to network.

12.8.6 Hardware Installation

DIP switch setting …………Termination resistor installation(FBs-CM25E/CM55E)

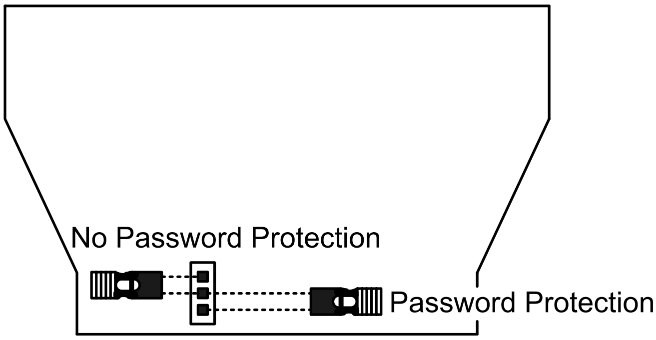
In order to meet the termination requirement of RS485 network, all Ethernet modules equip with a set of built-in termination resistor to ease the field installation. The termination function can be setup by the DIP switch seen from the front cover as follow.

T  N

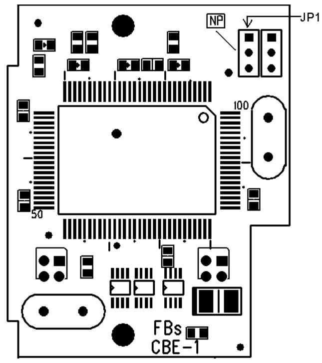
When both switches are at T position, it means termination resistor is in effective. When at N position means no termination resistor attached by this module. When implementation, there are only two modules that located at opposite far side need to terminated. Excessive termination will over load the whole network thus must be avoided.

Password protection setup

When the password has been entered (enabled), the user will be requested to enter a matched password each time when perform the configuration via configuration utility 'ether_cfg.exe'. In other words, in case the user forget the password then he/she no longer can modify the module's configuration. To prevent this situation from occurring, there also provides a jumper to disable the password protection temporary. This jumper can be accessed only when the module's plastic cover is removed. The relative location of jumper is depicted at follow **:**



CM-25E/CM-55E



CBE

When CM-25E, CM-55E or CBE the jumper cap of JP1 is at upper position (linked by white line), the password protection is disabled. The jumper cap should put in the lower position when under normal operation.

Cable wiring

Serial Port Connectors : Please refer to 12.8.9 for the Port3, Port4 signal description.

Network Connect : The connector type of FBs-CM25E/55E is Euro 4pin plug connector while FBs-CBE board is RJ-45. Please use the CAT5 UTP (un-shielded twisted pair) cable for network connection. The best recommendation is using the CAT5 STP(shielded twisted pair) cable

The wiring of cable to network connector is listed as below **:**

Signal	Line Color	European Pins	RJ-45 Pins	Direction
TX+	White orange	3	1	External ← PLC
TX-	Orange	4	2	External ← PLC
RX+	White green	1	3	External → PLC
RX-	Green	2	6	External → PLC

12.8.7 Software Setup

There is a accompany software "Ether_cfg.exe" to aid the configuration of Ethernet module. This software is a windows-based software and has following functions **:**

1. Basic module Information setup : Includes IP (Network address), gateway, netmask, baud rate, operating mode, module name, module description.

2. Security setup : Setup authorized IP. With this function, only the command message issue by the host with authorized IP can be accepted by Ethernet module. Hence can prevent the unintended access and keep the system secure. There are 10 set of IP group can be set. Each group can contain one or more consecutive IPs.

3. Local station to remote station mapping :

The operating of FBs-PLC networking is purely transparent. When access the remote slave PLC by executing the LINK instruction of mode0 and with the help of Ethernet module, the master PLC does not know the remote PLC is connected by network. In other words, the maximum number of slave station is still 254. When Ethernet module work at client mode, in order to translate the local station into remote station, must first setup the translation table. Considering the convenience for variety application, there are three methods can be used to setup the network configuration.

4. Setup by local area network :

This is the most convenient method for network configuration. When operating, the configuration software will scan all the Ethernet modules attached to the network. All the scanned Ethernet modules will be shown in the table on the screen with the regarded basic information. The user can pick the Ethernet module to be editing directly from the screen. Considering the security, we can set the password to prevent the unintended access.

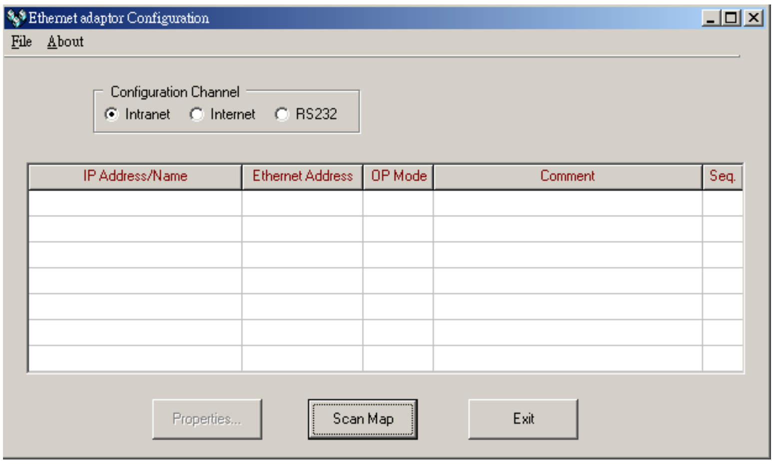
5. Setup by internet :

With this method can setup the network configuration thru Internet. Most often is used to setup the station mapping or authorized IP. While use this method, can only setup one Ethernet module at a time and must specify the IP address of Ethernet module to be edited. Considering the security, can set password to prevent the unintended access.

LAN configuration

Step 1 : Use the network cable to connect the Ethernet module and Hub.

Step 2 : Connect the PC to network and execute the software - ether_cfg.exe. Use the mouse click the 'Intranet' option in the 'Configuration Channel' group box, then the screen changes to

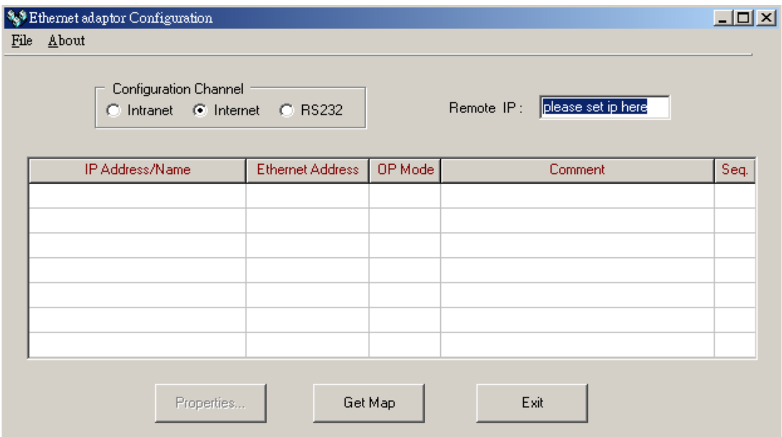


→ Click the 'Scan Map' button then start the scanning of Ethernet module. All the modules detected will be shown in the table.

Internet setup

Step 1 : Connect the Ethernet module and Hub with twisted Ethernet cable.

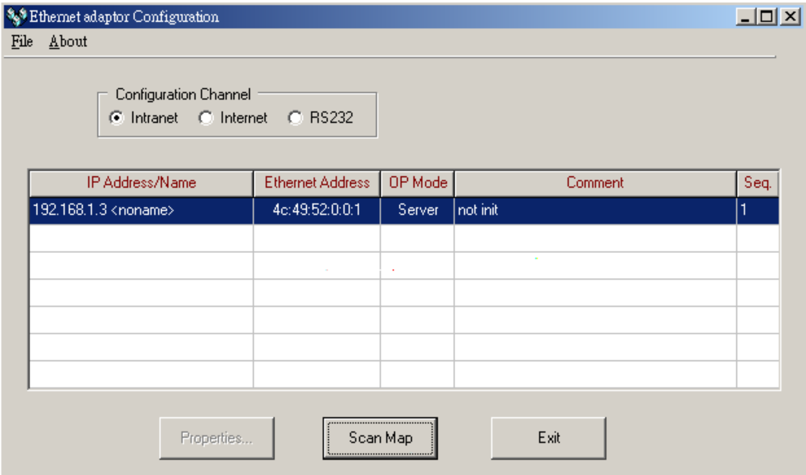
Step 2 : Connect the PC to network and execute the network configuration software - ether_cfg.exe. Use the mouse point to the 'Internet' option buttons within the 'Configuration Channel' group box and click it then the screen will be shown as below



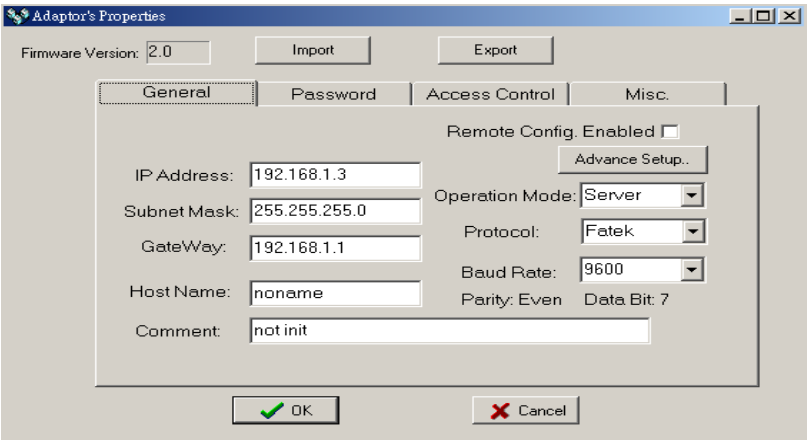
At this time can input the remote IP address of the Ethernet module desired for configuration. After click the 'Get Map' button, it will start to connect Ethernet module. When the connection is established will show the information regard the connected Ethernet module in the table at the middle of window.

Common data setup

Whenever the connection is established, it will show the information regard the connected Ethernet module in the table at the middle of window, no matter what the connection method is selected.



At that time, can double click the line where the desired Ethernet module is located or single click the line and click 'Properties..' button to perform the configuration. If password not setting or correct password were entered will show the screen as below



Follows are the description of each field shown in above **:**

1.Firmware Version : Denotes the software version of Ethernet module for configuration.

2.IP Address : IP address of Ethernet module for configuration.

3.Subnet Mask : Subnet mask of Ethernet module for configuration.

4.GateWay : The IP address of gateway for Ethernet module for configuration.

5.Host Name : For documentation, can be used to distinguish Ethernet module. At most can consist of 11 characters.

6.Comment : For documentation, can be used to distinguish Ethernet module. At most can consist of 21 characters.

7.Operation mode : Client or server mode selection.

8.Protocol : There are two communication protocols were supported in this module. **Modbus/TCP** or **Fatek**. **Modbus/TCP** can be choosed only when the operation mode is set to Server mode while the Fatek mode can be used in both modes.

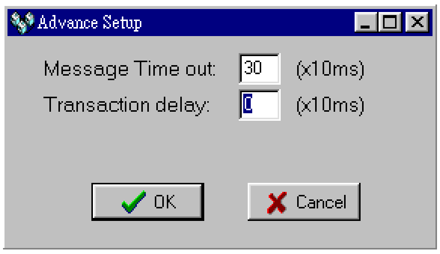
9.Baud Rate(CM25E/CM55E) : Communication speed between Ethernet module and PLC with 9600、19200、38400、57600、115200、230400 bps six options.

10.Remote Config. Enabled : For security, when this option is checked will allow the configuration thru the Internet. It must be checked when intent to configure the network configuration according to the method described in section5.3.4. It's strongly recommended to set the password when enable the remote configuration to prevent the leakage of security hole. Please leave this option un-checked if remote configuration is not necessary.

11.Import/Export button : Can use the Export function to save entire setup data of Ethernet module to file or use the Import function to retrieve the setup data stored in file to ease the editing job of configuration.

※ The contents enclose in the box at below can be skipped for the beginner.

Advance Setup : Advanced Setup: This setting can only need to be performed when at server mode, click 'Advance Setup' button to start setup and the screen will be shown **:**



Message Time Out : The time-out time for PLC, the default setting is 300ms. Ethernet module will wait for the same amount time of this field before the PLC can reply the command message.

Transaction delay : The minimal delay time for Ethernet module to send the next command message after it receives a reply message from PLC. The default setting is 0ms. This setting is used for the applications that connect multiple PLCs with diverse scan time by RS485.

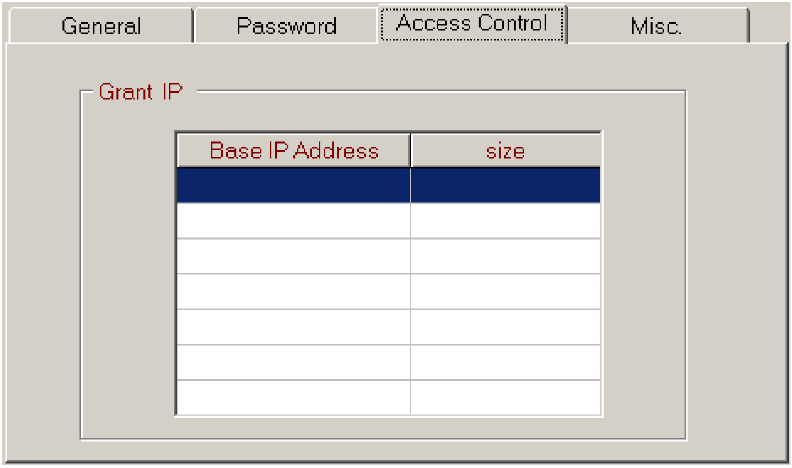
Security setup

For security of Ethernet module operation, besides the disable/enable control of remote configuration, also provides following measures to work with

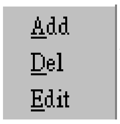
Password protection : Continues from last screen, click the 'Password' tab to set the password. The screen changes to

Please input the new password at 'New Password' and 'Confirm Password' edit field and click the 'Change' button to complete the setting of new password. Please click the 'Remove' button if password protection is not necessary.

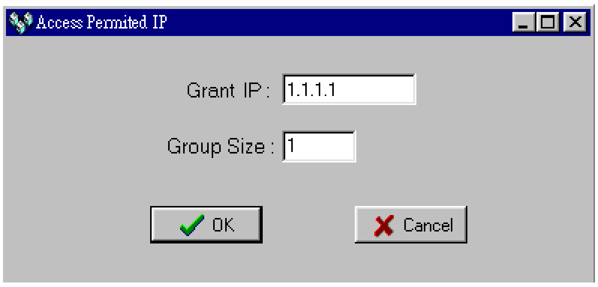
The setting of access right : Use the setting of authorized IP to prevent the illegal access of data. After click the 'Access Control' tab, the screen changes to



Move the cursor to the 'Grant IP' table and click the right mouse button then the screen will appear a pop-up menu as shown below **:**



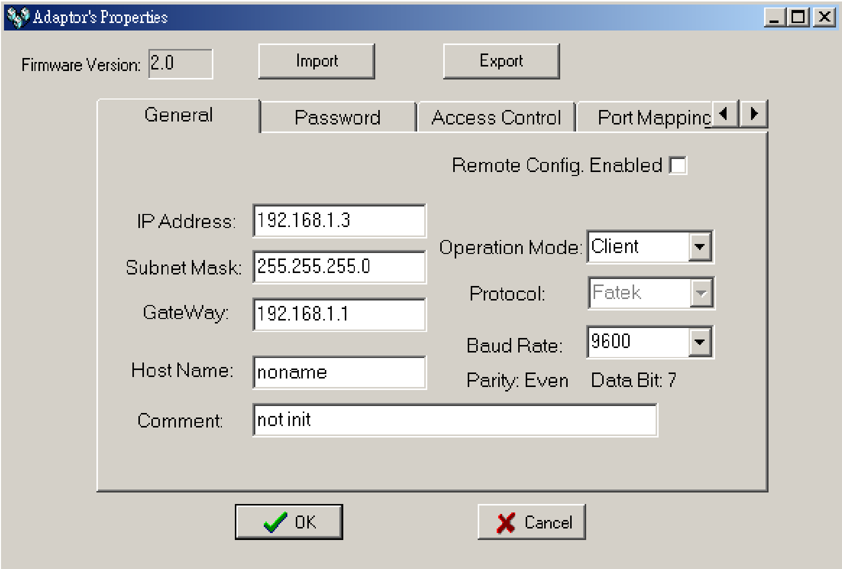
… … … Click 'Add' to add one set of authorized IP. Click 'Del' to delete a set of authorized IP. Click 'Edit' to modify an existed authorized IP data. After click the 'Add' function the screen changes to



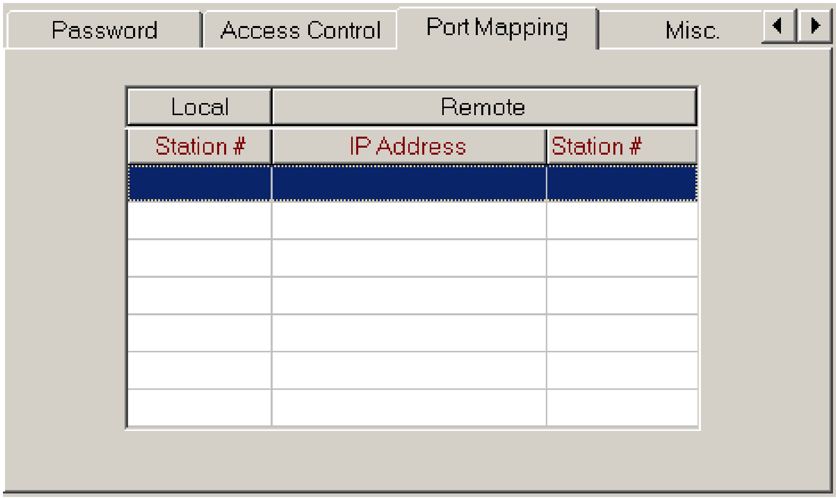
With this dialog to define a set of consecutive authorized IP addresses. Please input the first IP address of the consecutive IP addresses in the 'Grant IP' field and input the size of IP addresses in 'Group Size' filed

Port mapping setup

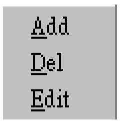
This setting can only need to perform when Ethernet module is work at client mode. When the working mode is set to client mode the basic configuration data page changes to



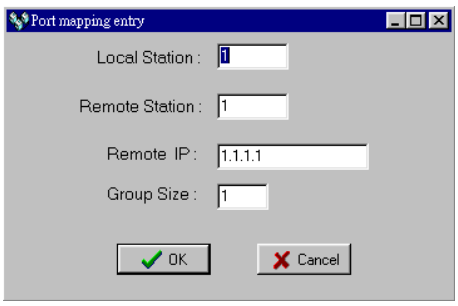
It has an additional ‘Port Mapping’ tab when compare with server mode, after click the ‘Port Mapping’ tab the screen changes to



Move the cursor to the table locating in the center of window then click the right mouse button then the screen appears a pop-up menu as shown below :



… … … Click ’Add’ to add one station mapping data. Click ’Del’ to delete a station mapping data. Click ‘Edit’ to modify an existed station mapping data. After click the ’Add’ command the screen changes to



Following are the description of each field shown in above :

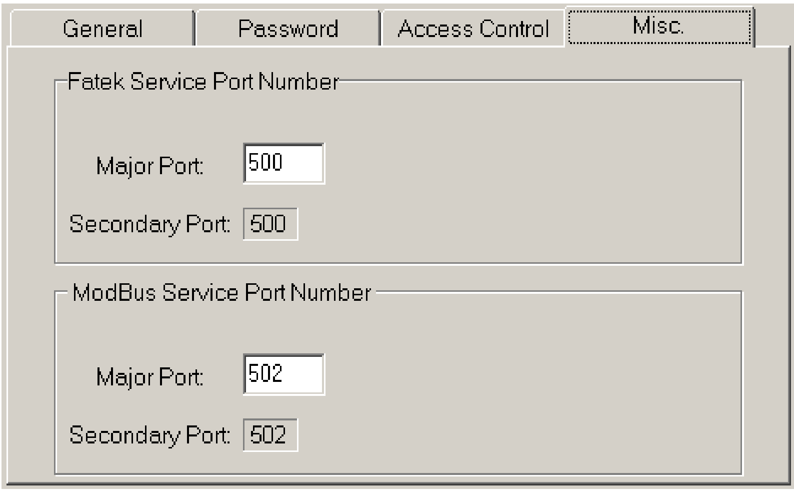
1.Local Station: The station number of local PLC.

2.Remote Station: The station number of remote PLC.

3.Remote IP: The IP address of Ethernet module connected by the remote PLC.

4.Group Size: With execute this dialog once can define a group of station mapping, for example, if we want to map the local PLC station number 20~29 to remote PLC station10~19 and the IP Address of remote Ethernet module is 192.168.1.3 then can set the Local Station to 20, Remote Station to 10, Group Size to 10, Remote IP to 192.168.1.3. The Ethernet module can provide at most 19 groups of station mapping.

Service port setup



The Ethernet module when work either in TCP or UDP server mode should be assigned a service port number for client access. The default port number for FBs series Ethernet module is port 500. If the user want to change the port number can click the 'MISC' tab and change the Major port field to desire port number. Second port field provides the UDP working mode the opportunity to have dual service port number, one is port 500 the other is port number appear in Major port field.

Update configuration

When finish the editing of configuration data, please click the 'OK' button of the "adaptor's properties" window to update the Ethernet module. When finish the update and without error, the screen will change to main window and ready for configuration of another Ethernet module.

12.8.8 Procedures to Change the Configuration

Now summarize the procedures to change the network configuration at below.

Step 1: Select a connection method. (LAN or Internet)

Step 2: Edit the basic data of the module.

Step 3: Set the password protection (optional).

Step 4: Setup the authorized IP (optional).

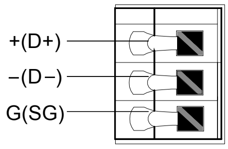
Step 5: Setup the mapping of local and remote station and IP address (Only client mode required).

12.8.9 Pin Assignments and Protocols

RS232 port pin assignments

Signal	Pins	Direction
RX	3	External→PLC
TX	2	External←PLC
GND	5	

RS485 port pin assignments



FATEK TCP/UDP communication protocol

The communication protocol of FATEK TCP/UDP embeds the FATEK serial communication message in the TCP or UDP data packet. The port number used to convey the FATEK TCP/UDP message is configurable (default is 500.)

Modbus/TCP communication protocol

The document of communication protocol of Modbus/TCP can be referenced at the web site http://www.Modbus.org . The port number used to convey the Modbus/TCP message is 502.

Through PLC register to set IP configuration (only CBE provides this function)

Although the IP address of Ethernet module can be set though Ethernet configuration software (Ether_cfg.exe), the IP of CBE module (version V5.4 or above) can also be set through register of PLC. The method is shown below:

D3990: = 4950H IP setting is decided from PLC register. If not same as this value, then decided from configure software.

When PLC decided configure, IP limit can only be C class, which is Netmask = 255.255.255.0

If IP is indicated as **A.B.C.D** , then Router is indicated as **A.B.C.R**

D3991 - A
D3992 - B
D3993 - C
D3994 - D
D3995 - R

When the value of A,B,C,D, or R is greater than 255 or when the value of D or R is 0, then is D3990, not 4950H.

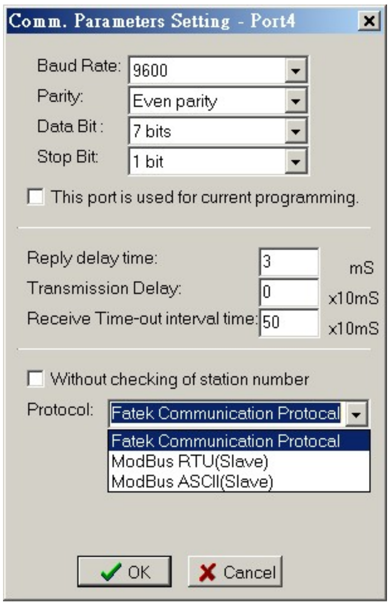
Setting example: Suppose IP has been set as 192.168.2.10 and router = 192.168.2.1, then the register setting is as below:

D3990 = 4950H. D3991 = 192. D3992 = 168. D3993 = 2. D3994 = 10. D3995 = 1.

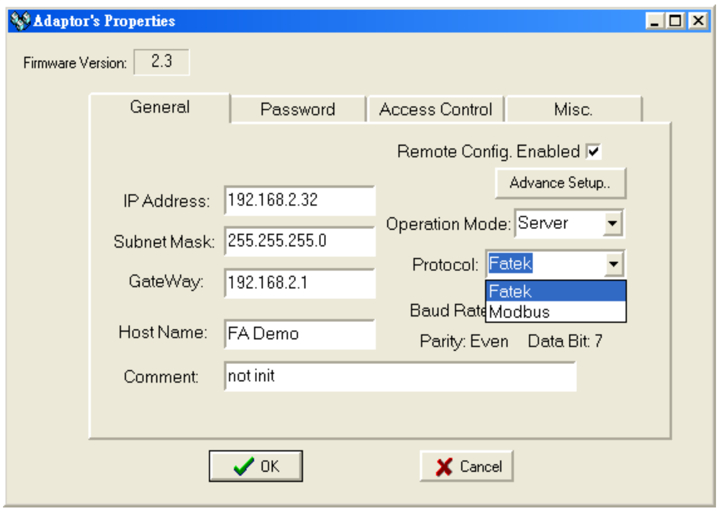
Notes

1. When using CM25E/55E Ethernet module and Modbus communication protocol, should remember to set the corresponding communication port (Port4) to Modbus communication protocol (CBE will automatically set) of main unit side (PLC side). In addition, in order to set working mode for Ethernet module and set Modbus for communication protocol, it should through FATEK Ethernet Configure Software (Ether_cfg.exe).
2. When CBE is planned as client mode, it is operated through Port2 of PLC. Therefore, the Pt parameter of CLINK instruction from the PLC should set to 2 (Port2) in order to operate normally. Otherwise, client mode only supports FATEK UDP application protocol.
3. When using FATEK Ethernet configuration software (Ether_cfg.ext) to do internet scanning Ethernet module, an if the indicator RX and TX flashed but didn't detected the module, please check the built-in firewall of PC (Windows XP) to see if it has turn off. If not, please do so and try again.

1. PLC Communication Port Setting



2. Ethernet Module Setting (Only for CM-25E/55E module)



Chapter 13 The Applications of FBs-PLC Communication Link

As previously revealed in Chapter 12 that the FBs-PLC can support the "Ladder Program Control Interface" communication function for the applications of multi-drop FATEK CPU Link network or connecting with the intelligent peripherals through Port 1～Port 4.

The connection of FBs-PLC can through CLINK(FUN151), besides it support Modbus communication interface, too. Port1～Port 4 can be Modbus communication protocol master station by FUN150 to connect with the Modbus slave peripherals.

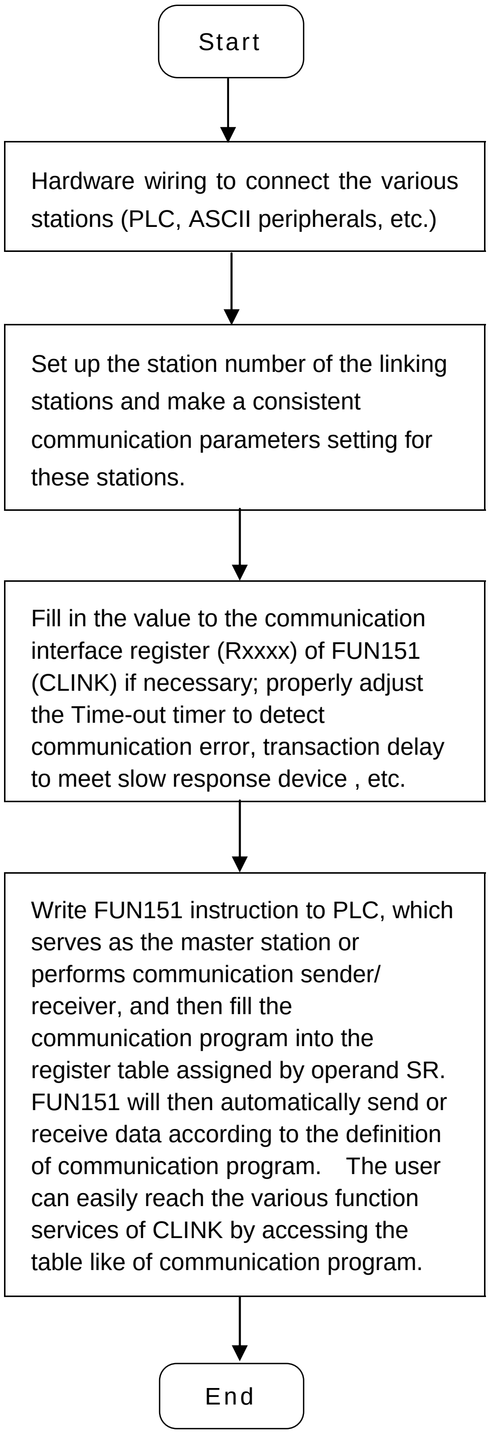
The RS-232 interface is for point to point connection, the RS485 interface is for long distance connection or multi-drop communication network

The FUN151 (CLINK) instruction provides MD0 to MD3 four kinds of instruction mode, that the MD3 mode is monopolized by Port 2 for "FATEK High Speed CPU Link Network" ， the others are for "Ordinary Communication Link". The following list enlisted the description for the difference on various instruction modes for the CLINK instruction

Category \ Item		Baud Rate	Data Bit	Transmitting code	Error detection	Command processing speed
FUN151 (CLINK)	High Speed LINK （MD3） * Port 2 only	38.4K bps	921.6K bps	8-bit	Binary code	CRC-16	Immediately
	Ordinary LINK （MD0～MD2） * Port 1～ Port 4	4.8K bps	921.6K bps	7-bit or 8-bit Adjustable	ASCII code	Checksum	Processing during Housekeeping
FUN150 (M-BUS)	Modbus Master	4.8K bps	921.6K bps	7bit/8bit	Binary code / ASCII Code	CRC-16 / Checksum	Processing when scan to FUN150 instruction

13.1 Application for FUN151 Instruction

13.1.1 Procedures for Usage



- Station number can be set to any one between 1 to 254 without replication.

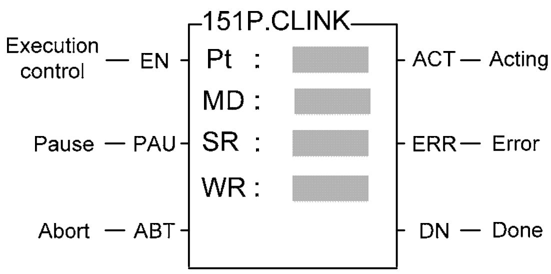
- For communication parameters, please refer to the description of "Communication Related Setting".

13.1.2 Explanation of Respective Modes and Application Program for FUN151

This section will base on the four instruction modes (MD0 to MD3) of FUN151 (CLINK) instruction to explain their usages, with respective practical application program examples.

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Ladder symbol



Pt : Assign the port, 1～4

MD : 0, serves as the master station of Fatek CPU Link (adopts Fatek communication protocol)

SR : Starting register of communication program (see example for its explanation)

WR : Starting register for instruction operation (see example for its explanation). It controls 8 registers, the other programs can not repeat in using.

Range / Operand	HR R0 ∣ R3839	ROR R5000 ∣ R8071	DR D0 ∣ D3999	K
Pt				1~4
MD				0
SR	○	○	○	
WR	○	○*	○	

Descriptions

1. FUN151 (CLINK) : MD 0, it makes PLC act as the master of FATEK CPU Link Network through Port 1~ 4.
2. The master PLC may connect with 254 slave stations through the RS485 interface.
3. Only the master PLC needs to use FUN151 instruction, the slave doesn't need.
4. It employs the program coding method or table filling method to plan for the data flow controls; i.e. from which one of the slave station to get which type of data and save them to the master PLC, or from the master PLC to write which type of data to the assigned slave station. It needs only seven registries to make definition; every seven registers define one packet of data transaction.
5. When execution control 〝EN〞 changes from 0→1 and both inputs “PAU” and “ABT” are 0, and if Port 1/2/3/4 hasn’t been controlled by other communication instructions [i.e. M1960 (Port1) / M1962 (Port2) / M1936 (Port3) / M1938 (Port4) = 1], this instruction will control the Port 1/2/3/4 immediately and set the M1960/M1962/M1936/M1938 to be 0 (which means it is being occupied), then going on a packet of data transaction immediately. If Port 1/2/3/4 has been controlled (M1960/M1962/M1936/M1938 = 0), then this instruction will enter into the standby status until the controlling communication instruction completes its transaction or pause/abort its operation to release the control right (M1960/M1962/M1936/M1938 =1), and then this instruction will become enactive, set M1960/M1962/M1936/M1938 to be 0, and going on the data transaction immediately.
6. While in transaction processing, if operation control “PAU” becomes 1, this instruction will release the control right (M1960/M1962/M1936/M1938 = 1) after this transaction. Next time, when this instruction takes over the transmission right again, it will restart from the next packet of data transaction.
7. While in transaction processing, if operation control “ABT” becomes 1, this instruction will abort this transaction immediately and release the control right (M1960/M1962/M1936/M1938 = 1). Next time, when this instruction takes over the transmission right again, it will restart from the first packet of data transaction.
8. While it is in the data transaction, the output indication “ACT” will be ON.
9. If there is error occurred when it finishes a packet of data transaction, the output indication “DN” & “ERR” will be ON.
10. If there is no error occurred when it finishes a packet of data transaction, the output indication “DN” will be ON.

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

【Interface Signals】

Dedicated Relays and Registers for corresponding port：

Signals \ Comm. Port	Port 1	Port 2	Port 3	Port 4
1. Port Ready Indicator	M1960	M1962	M1936	M1938
2. Port Finished Indicator	M1961	M1963	M1937	M1939
3. Port Communication Parameters	R4146	R4158	R4043	R4044
4. TX Delay & RX Time-out Span	R4147	R4159	R4045	R4048
5. Setting of RX Time-out Span	D4043			
6. Edge Trigger Execution	D4044			

1. Port Ready Indicator： This signal is generated from CPU.

ON, it represents that port is free and ready.

OFF, it represents that port is busy, data transaction is going.

2. Port Finished Indicator：This signal is generated from CPU.

When the communication program completed the last packet of data transaction, this signal will be ON for one scan time (for successive data transaction).

When the communication program completed the last packet of data transaction, this signal will be still ON (for single packet of data transmission)

3. Port Communication Parameters：

The register is for communication parameters setting of corresponding port. (please refer to the chapter of communication parameters setting)

4. TX Delay & RX Time-out Span：

The content of Low Byte defines the receive Time-out span of CLINK instruction; its unit is 0.01 second (the default is 50, which means 0.5 second). The CLINK instruction employs receive Time-out span to judge whether the slave station on line or not. When the master PLC sent out the read/write command to the slave station, the slave station didn't reply within this period means that there is abnormal event in communication called Time-out. When there are multi-drop linking, properly adjust this value (greater than 1 scan time of the slave station with the longest scan time) to shorten the communication response time among the active linking stations if there are many slave stations power off (The time-out cases will happen).

The content of High Byte defines the transmission delay time between two packets of data transaction for CLINK instruction; its unit is 0.01 second (the default is 0).

5. Setting of RX Time-out Span D4043：

	Port1	Port2	Port3	Port4
Setting of RX Time-out Span	Low byte of R4147	Low byte of R4159	Low byte of R4045	Low byte of R4048

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

D4043：Setting the time unit in 0.01 or 0.1 second for RX time-out detection

High Byte	Low Byte							
56H	b7	b6	b5	b4	b3	b2	b1	b0

High Byte of D4043 ≠56H (Hex), time unit is in 0.01 second.

High Byte of D4043 = 56H (Hex), Low Byte of D4043 defines the time unit;

b1=0, Time-out timer in 0.01 second (Port 1)
=1, Time-out timer in 0.1 second (Port 1)

b2=0, Time-out timer in 0.01 second (Port 2)
=1, Time-out timer in 0.1 second (Port 2)

b3=0, Time-out timer in 0.01 second (Port 3)
=1, Time-out timer in 0.1 second (Port 3)

b4=0, Time-out timer in 0.01 second (Port 4)
=1, Time-out timer in 0.1 second (Port 4)

For example, D4043=560AH, it means time unit in 0.1 second for Port 1 & 3; but in 0.01 second for Port 2 & 4

If low byte of R4147=50, it means Port 1 has 5 seconds for RX time-out detection;

If low byte of R4159=50, it means Port 2 has 0.5 seconds for RX time-out detection

6. Edge Trigger Execution D4044：

High byte of D4044=00H

Low byte of D4044：Setting to improve communication efficiency

High Byte	Low Byte							
00H	b7	b6	b5	b4	b3	b2	b1	b0

High Byte of D4044=00H (Hex), Low Byte of D4044 defines the communication port；

b1=0, Minimum 3 scan time to execute one communication transaction (Port 1)
=1, Minimum 2 scan time to execute one communication transaction (Port 1)

b2=0, same as the description of b1=0 (Port 2)
=1, same as the description of b1=1 (Port 2)

b3=0, same as the description of b1=0 (Port 3)
=1, same as the description of b1=1 (Port 3)

b4=0, Port 4 same as the description of b1=0 (Port 4)
=1, Port 4 same as the description of b1=1 (Port 4)

For example, D4044=0006H, it means 2 scan time minimum to execute one communication transaction for Port 1 & 2; but 3 scan time minimum for Port 3 & 4

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

High byte of D4044=56H

D4044：Setting of one edge trigger to execute one communication transaction or only one edge trigger then make continuous execution of communication transactions

High Byte	Low Byte							
56H	b7	b6	b5	b4	b3	b2	b1	b0

High Byte of D4044≠56H(Hex), one edge trigger to execute one communication transaction
High Byte of D4044=56H(Hex), Low Byte of D4044 defines the communication port：

b1=0, one edge trigger to execute one communication transaction (Port 1)
=1, only one edge trigger then make continuous execution of communication transaction (Port 1)

b2=0, same as the description of b1=0 (Port 2)
=1, same as the description of b1=1 (Port 2)

b3=0, same as the description of b1=0 (Port 3)
=1, sane as the description of b1=1 (Port 3)

b4=0, same as the description of b1=0 (Port 4)
=1, same as the description of b1=1 (Port 4)

For example, D4044=5618H, it means one edge trigger to execute one communication transaction for Port 1 & 2; but only one edge trigger then make continuous execution of communication transactions for Port 3 & 4

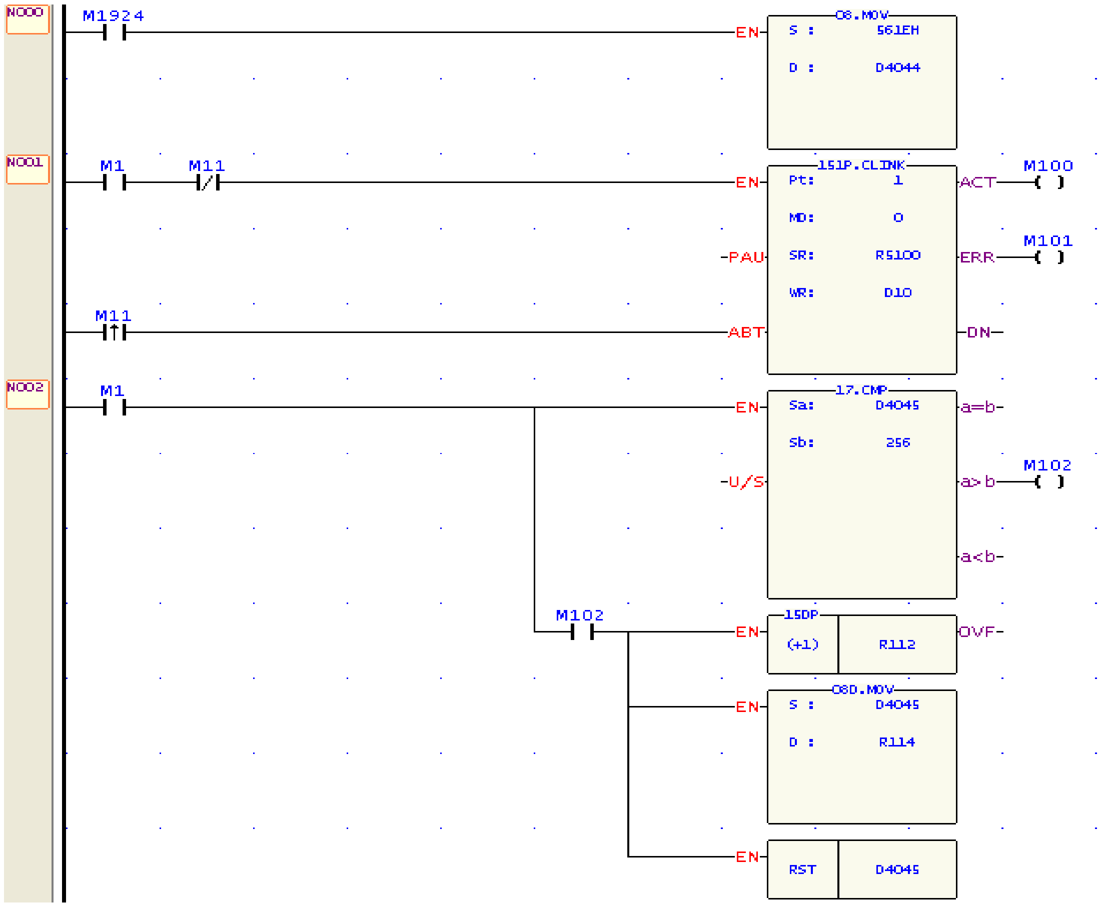
- WR+0 & WR+1 of communication instruction will tell the communication result for each communication transaction if it is one edge trigger to execute one communication transaction
- If it is only one edge trigger then make continuous execution of communication transactions, the following registers will tell the communication result:

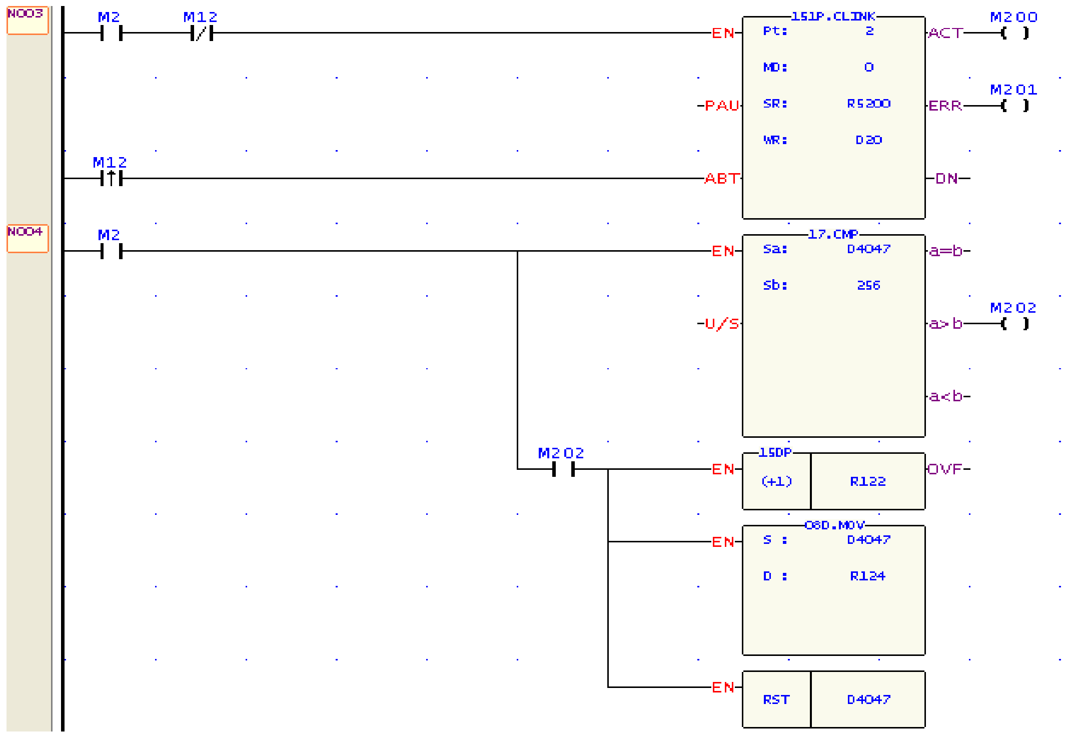
  D4045 & D4046 : Communication result of Port 1 (Same with above WR+0 & WR+1)
  D4047 & D4048 : Communication result of Port 2 (Same with above WR+0 & WR+1)
  D4049 & D4050 : Communication result of Port 3 (Same with above WR+0 & WR+1)
  D4051 & D4052 : Communication result of Port 4 (Same with above WR+0 & WR+1)

Let the control input ABT be ON if it wants to stop the communication transaction

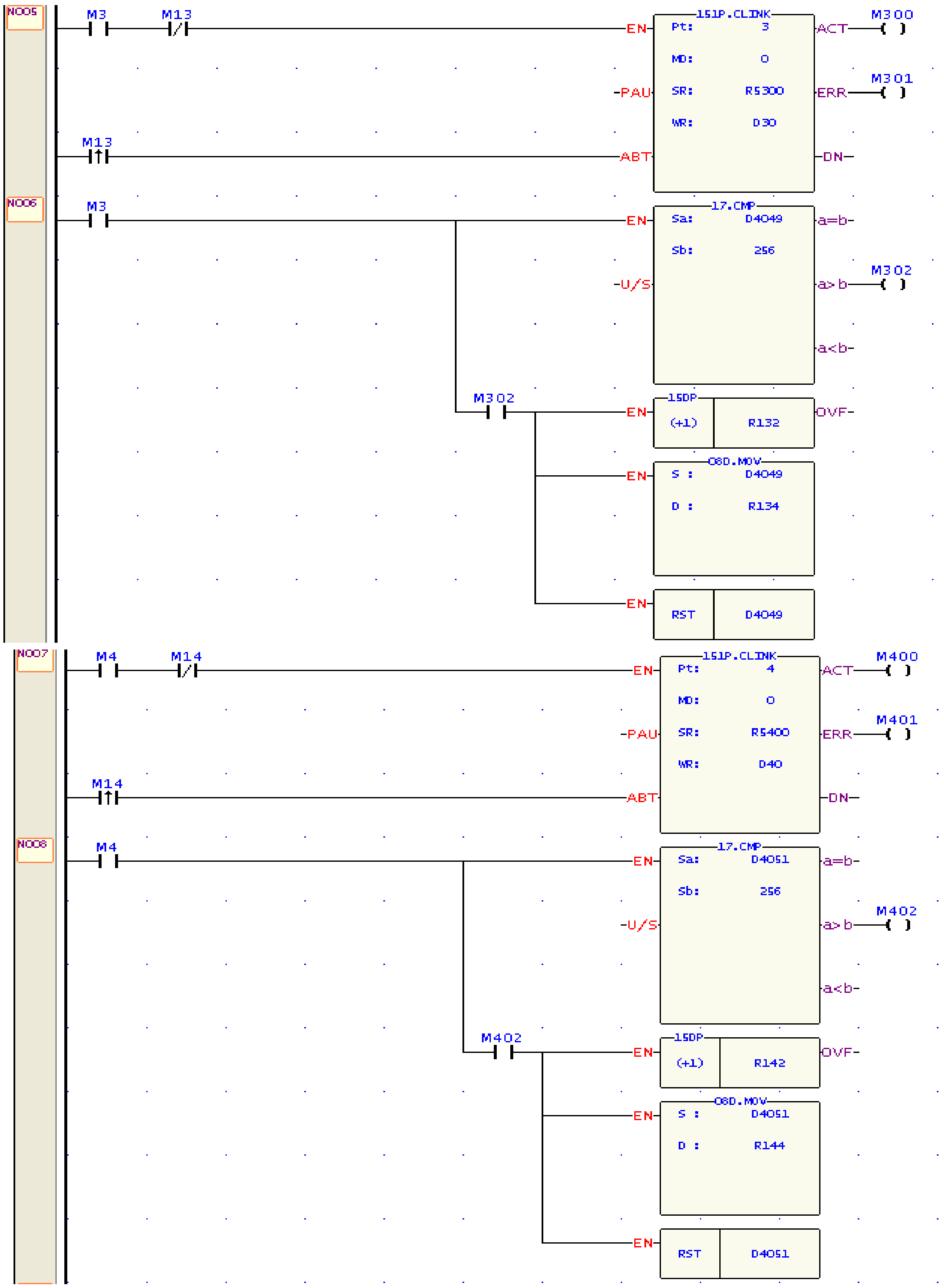
FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Sample program for one edge trigger to execute one communication transaction



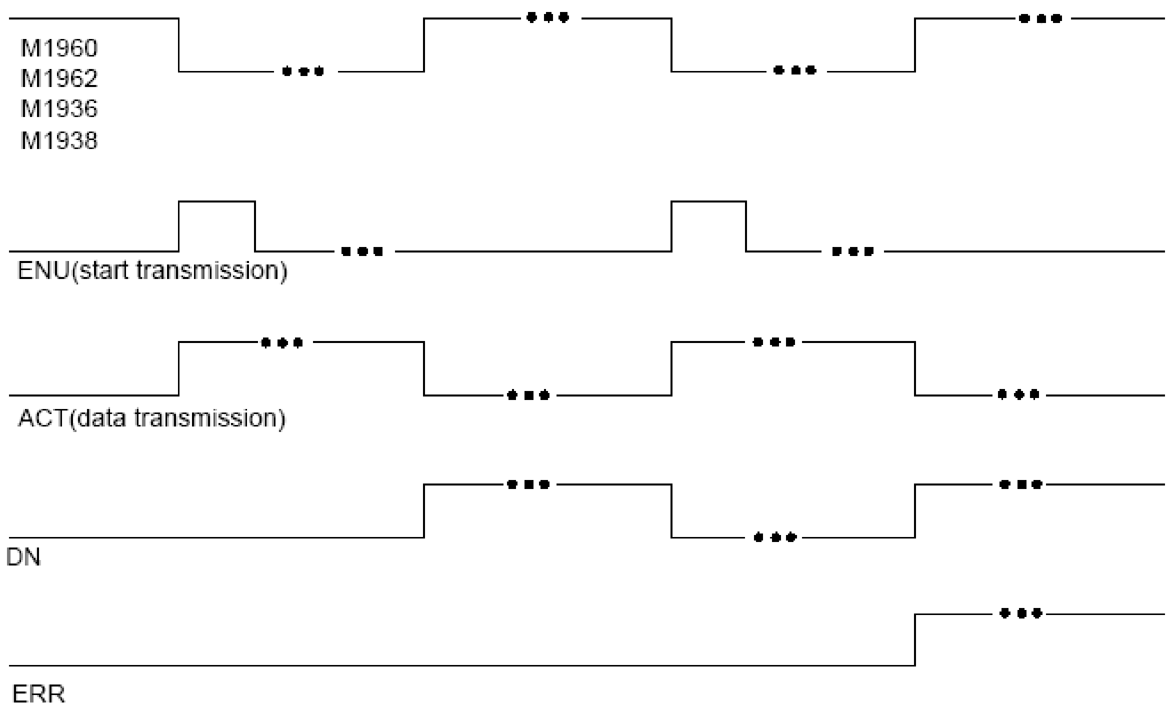


FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK



FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Waveform of Input and Output signals



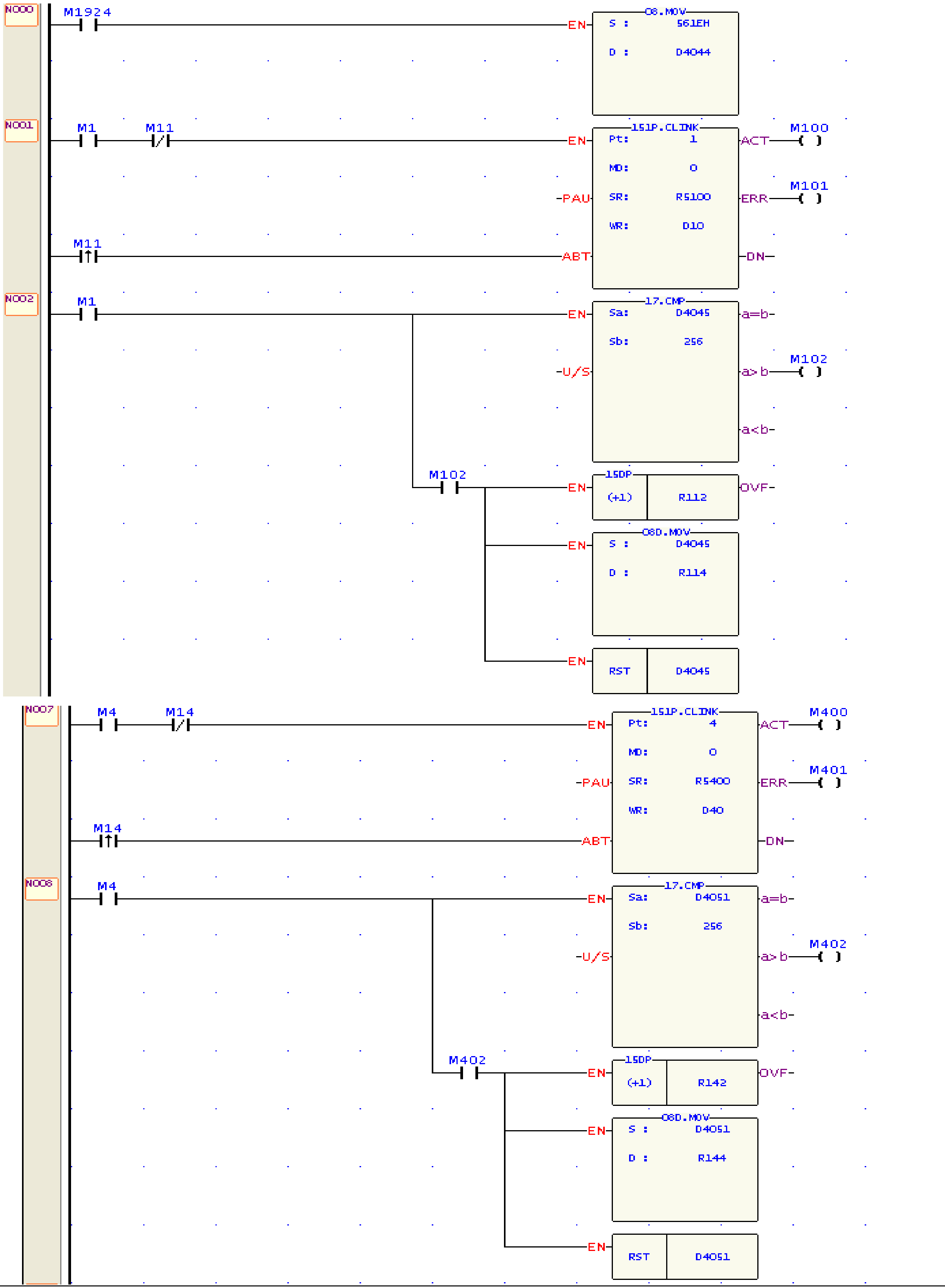
Note : 1. Only "DN" will be ON if one transaction finished without error.

2. "ERR" & "DN" will be ON at the same time if one transaction finished with error.

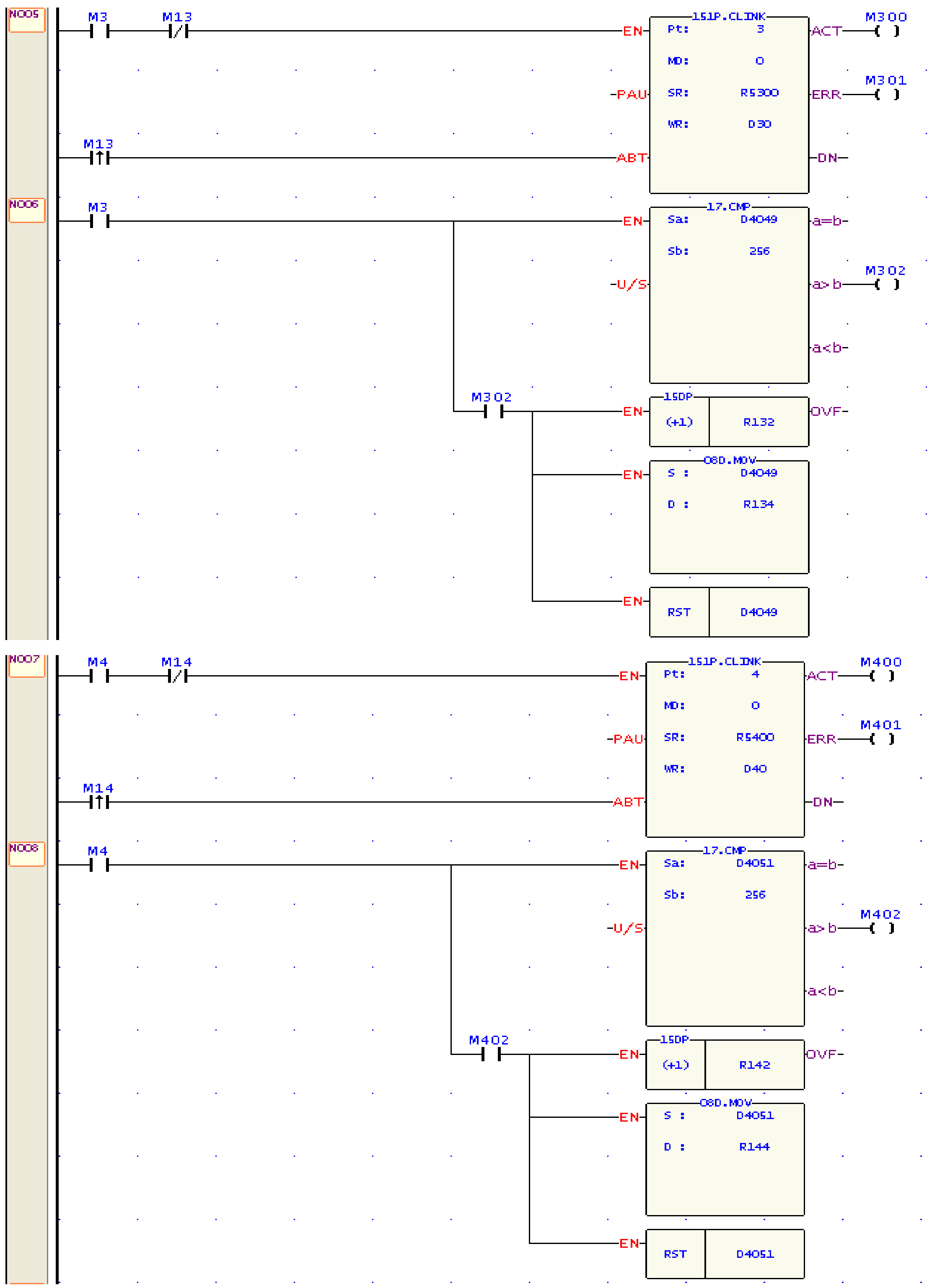
3. M1961/M1963/M1937/M1939 will be ON one scan time while the last packet of transaction finished.

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Sample program for only one edge trigger then make continuous execution of communication transactions

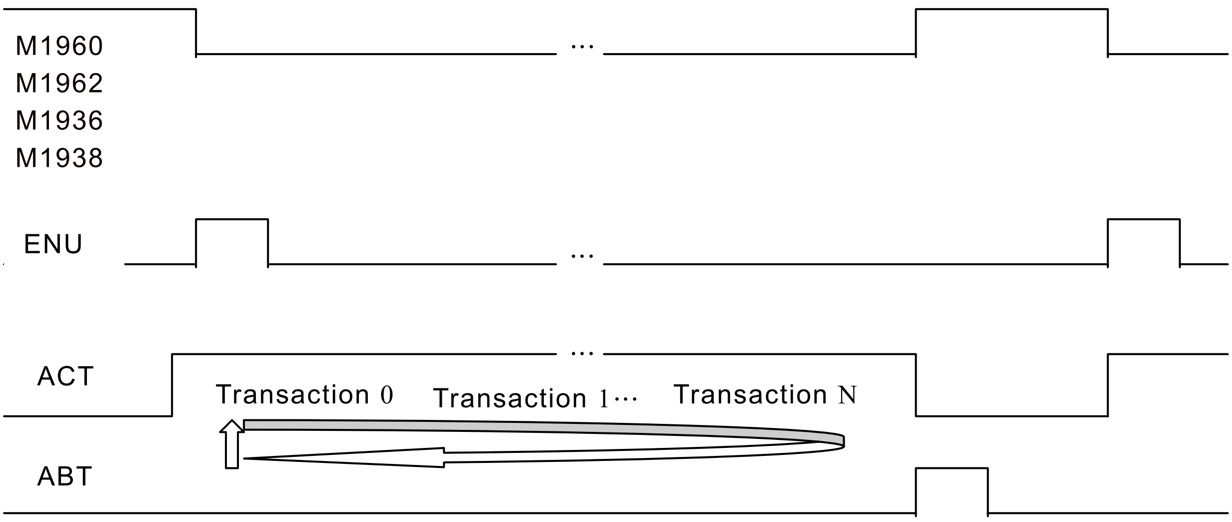


FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK



FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Waveform of input control and output indication

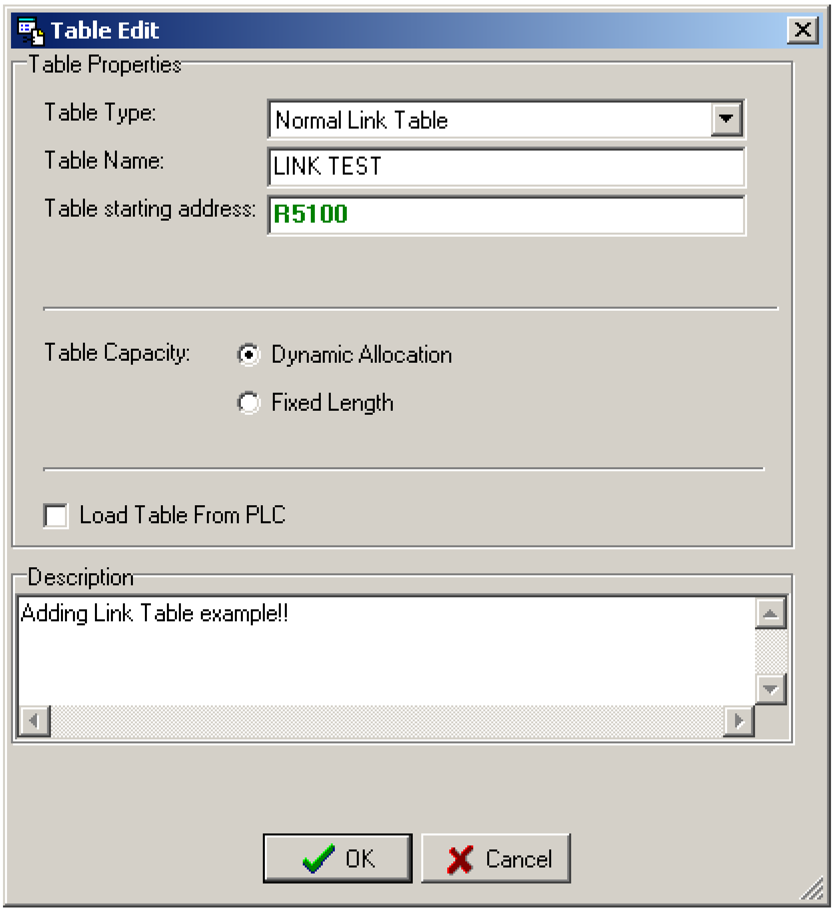


FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Editing Communication Table with WinProladder

Click the “Link Table” Item which in project windows :

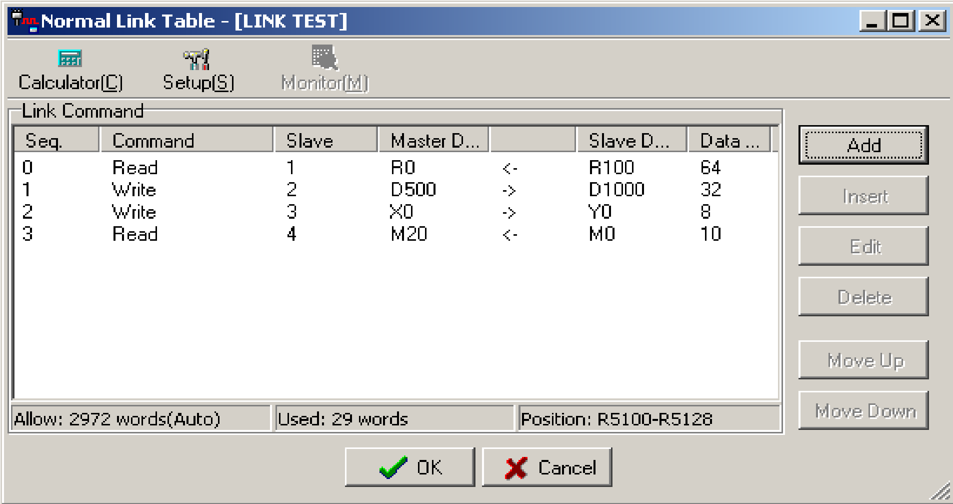
Project name
- Table Edit
  - Link Table → Click right button and select “New Link Table”



- Table Type : MD0 must be selected ”Normal Link Table”. ; MD3 must be selected ”High Speed Link Table”.
- Table Name : For modify or debug, you can give a convenient name.
- Table Starting address : Enter the address which is the starting register of communication table to store the data exchange list.

※ To make it easy to edit, read, and maintain the communication program, we have extended following related instructions under FUN150 and FUN151. The use method is take focus on FUN150 or FUN151, and press the hotkey “Z”. When “Table Edit” windows appear, then you can edit the communication table.

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK



Explanation for operand SR

SR： Starting register for communication program of CLINK instruction

SR+0	Total transactions	• Low Byte is valid; one transaction takes 7 registers to describe, which means 7 registers define a packet of data transaction.
SR+1	Slave station No. which is about to transact with	• Low Byte is valid, 0～254 (0 means that master PLC broadcasts the data to all slave PLC, the slave PLC does not reply).
SR+2	Command code	• Low Byte is valid; =1, means reading data from slave PLC; =2, means writing data to slave PLC.
SR+3	Data length of this transaction	• Low Byte is valid; the range is 1～64.
SR+4	Data type of Master PLC	• Low Byte is valid, and its range is 0 to 13; it defines the data type of master PLC (see next page).
SR+5	Starting reference of Master PLC	• Word is valid; it defines the starting address of data (master).
SR+6	Data type of slave PLC	• Low Byte is valid, and its range is 0 to 13; it defines the data type of slave PLC (see next page).
SR+7	Starting reference of Slave PLC	• Word is valid; it defines the starting address of data (slave).
SR+8	Slave station No. which is about to transact with	Description of the 2nd packet of transaction.
SR+9	Command Code	
SR+10	Data length of this transaction	
SR+11	Data type of Master PLC	
SR+12	Starting reference of Master PLC	
SR+13	Data type of slave PLC	
SR+14	Starting reference of Slave PLC	
	⋮	

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Master/Slave data type, code and reference number

Data code	Data type	Reference number
0	X (discrete input)	0～255
1	Y (discrete output)	0～255
2	M (internal relay M)	0～1911
3	S (step relay S)	0～999
4	T (timer contact)	0～255
5	C (counter contact)	0～255
6	WX (word of discrete input ,16 bits)	0～240, it must be the multiple of 8.
7	WY (word of discrete output ,16 bits)	0～240, it must be the multiple of 8.
8	WM (word of internal relay,16 bits)	0～1896, it must be the multiple of 8.
9	W S (word of step relay,16 bits)	0～984, it must be the multiple of 8.
10	TR (timer register)	0～255
11	CR (counter register)	0～199
12	R (data register Rxxxx)	0～3839
13	D (data register Dxxxx)	0～4095

Note : The data type for master and slave must be consistent. i.e. if the master station is any value between 0 to 5, the slave station must also be any value between 0 to 5; if the master station is any value between 6 to 13, the slave station must also be any value between 6 to 13.

Explanation for the operand WR of FUN151:MD0

	High Byte	Low Byte
WR+0	Result code	Transaction No.
WR+1	Station number	Command code
WR+2	For internal operation	
WR+3	For internal operation	
WR+4	For internal operation	
WR+5	For internal operation	
WR+6	For internal operation	
WR+7	For internal operation	

- Result code indicates the transaction result; 0= normal, other value =abnormal.
- Transaction No. indicates which one is in processing.
- Station number, the slave station No. which is in transaction.
  Command code
  =40H, reading system status from slave PLC.
  =44H, reading successive discrete status from slave PLC.
  =45H, writing successive discrete status to slave PLC.
  =46H, reading successive registers from slave PLC.
  =47H, writing successive registers to slave PLC.
- WR+4's b0=1, Port has been occupied and this instruction is waiting to acquire the transmission right for data transaction.
  b4=1 , This instruction is not first time performing.
  b12 , Output indication for "ACT"
  b13 , Output indication for "ERR".
  b14 , Output indication for "DN".

Result code: 0, this transaction is successful.
2, data length error (data length is 0 or greater than 64 in one transaction).
3, command code error (command code is greater than 2).
4, data type error (data type is greater than 13, please refer to data type code).
5, reference number error (please refer to reference number).
6, inconsistence in data type (e.g. master station is 0～5 while slave is 6～13).
A, no response from slave station (Time-out error).
B, communication error (received error data).

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

- For easy programming and trouble shooting, the WinProladder provides the table editing environment to edit the communication table of FUN151 instruction; Key in the complete FUN151 instruction first and then move the cursor to the position of it, depressing the "Z" key, now comes the table editing environment. The user can create the new communication table or display the existed table under this friendly user interface operation.

Communication Table for FUN151:MD0

Sequence No.	Command	Slave	Master Data	Slave Data	Length
0 ~ nnn	Read (=1) Write (=2)	Describing the station number of slave PLC which is about to transact with. Station number=0, The master PLC broadcasts the data to all slave PLCs and slave PLCs will not reply Station number=N, it means the station number of the slave PLC which is about to transact with the master PLC N=1~ 254	Describing the data type & reference number of this packet of transaction for the master PLC. X0 ~ X255 Y0 ~ Y255 M0 ~ M1911 S0 ~ S999 T0 ~ T255 C0 ~ C255 WX0 ~ WX240 WY0 ~ WY240 WM0 ~ WM1896 WS0 ~ WS984 TR0 ~ TR255 CR0 ~ CR199 R0 ~ R3839 D0 ~ D4095	Describing the data type & reference number of this packet of transaction for the slave PLC. X0 ~ X255 Y0 ~ Y255 M0 ~ M1911 S0 ~ S999 T0 ~ T255 C0 ~ C255 WX0 ~ WX240 WY0 ~ WY240 WM0 ~ WM1896 WS0 ~ WS984 TR0 ~ TR255 CR0 ~ CR199 R0 ~ R3839 D0 ~ D4095	Data length of this transaction. 1 ~ 64

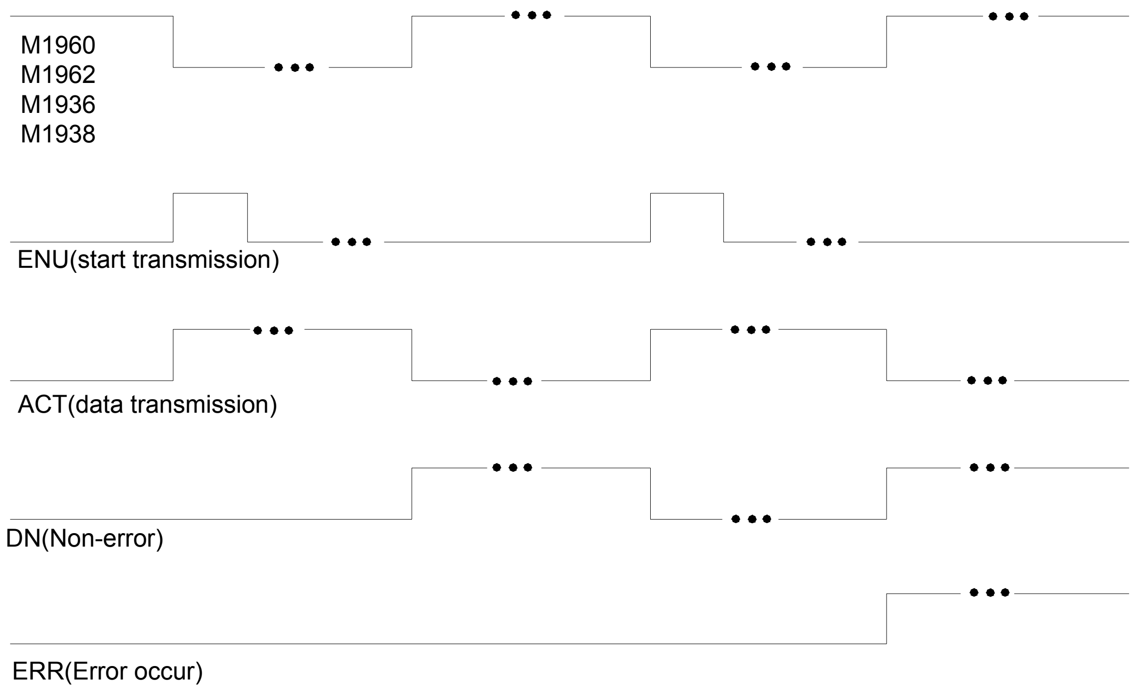
Explanation on program example

When execution control M1/M2/M3/M4 = ON, and corresponding port is not occupied by other communication instruction (M1960、M1962、M1936、M1938 = ON), CLINK instruction will start the data transaction. The M1960、M1962、M1936、M1938 is OFF during data transaction, and when the transaction is finished, the M1960、M1962、M1936、M1938 becomes ON. Employ the OFF↔ON change of M1960、M1962、M1936、M1938 (FUN151 execution control 〝ENU〞↑means starting) may automatically starts for every packet of data transaction successively (when the last packet of transaction is completed, it will automatically return to the first packet of transaction to obtain the automatic cycling transmission).

- Output Indicators： 〝ACT〞 ON：Transaction is in progress
  〝ERR〞 ON：Error occurred (Refer to the result code)
  〝DN〞 ON：One transaction finished

FUN151 CLINK	Convenient Instruction of FUN151: MD0 (Which makes PLC act as the master station in CPU LINK network through Port 1~4)	FUN151 CLINK

Waveform of Input and Output Signals



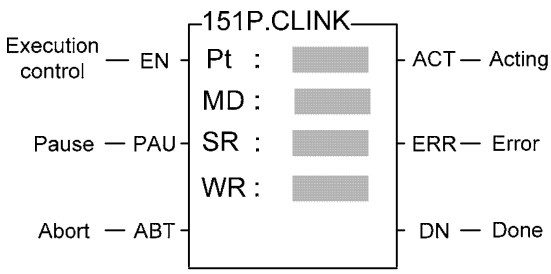
Note： 1. Only "DN" will be ON if one transaction finished without error.

2. "ERR" & "DN" will be ON at the same time if one transaction finished with error.

3. M1961/M1963/M1937/M1939 will be ON one scan time while the last packet of transaction finished.

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

Ladder symbol



Pt : Assign the port, 1～4

MD : 1, link with intelligent peripherals that equipped with communication interface

SR : Starting register for data transmission table

WR : Starting register for instruction operation (see example for explanation). It controls 8 registers, the other programs cannot repeat in use.

Range / Operand	HR R0 | R3839	ROR R5000 | R8071	DR D0 | D3999	K
Pt				1~4
MD				1
SR	○	○	○	
WR	○	○*	○	

Descriptions

1. FUN151:MD1, it makes PLC act as the communication sender to link with the intelligent peripherals that equipped with communication interface.
2. A master PLC may connect to multi sets of peripherals that have identical communication protocol through the RS-485 interface.
3. The communication protocol/format is written with LADDER program, which must be consistent with the linked peripherals.
4. When execution control 〝EN〞 changes from 0→1 and both inputs “PAU” and “ABT” are 0, and if Port 1/2/3/4 hasn’t been controlled by other communication instructions [i.e. M1960 (Port1) 、 M1962 (Port2) 、M1936 (Port3) 、 M1938 (Port4) = 1], this instruction will control the Port 1/2/3/4 immediately and set the M1960、M1962、M1936、M1938 to be 0 (which means it is being occupied), then going on a packet of data transaction immediately. If Port 1/2/3/4 has been controlled (M1960、M1962、M1936、M1938 = 0), then this instruction will enter into the standby status until the controlling communication instruction completes its transaction or pause/abort its operation to release the control right (M1960、M1962、M1936、M1938 =1), and then this instruction will become enactive, set M1960、M1962、M1936、M1938 to be 0, and going on the data transaction immediately.
5. During transaction, if the “PAU” input becomes 1, this instruction will pause and release the control right (set M1960、M1962、M1936、M1938 = 1) after it completed the transmission of the on-going data.
6. During transaction, if the “ABT” input becomes 1, this instruction will abort the transmission and release the control right immediately (set M1960/M1962/M1936/M1938 = 1).
7. While transaction is going, the output indication “ACT” will be ON.
8. When a packet of data transaction is finished (transmission finished or "transmit then receive" completed), if there is error occurred, the output indication “DN” & “ERR” will be ON.
9. When a packet of data transaction is finished (transmission finished or "transmit then receive" completed), if there is no error occurred, the output indication “DN” will be ON.

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

【Interface Signals】

Dedicated Relays and Registers for corresponding port :

Signals \ Comm Port	Port 1	Port 2	Port 3	Port 4
1. Port Ready Indicator	M1960	M1962	M1936	M1938
2. Port Finished Indicator	M1961	M1963	M1937	M1939
3. Port Communication Parameters	R4146	R4158	R4043	R4044
4. TX Delay & RX Time-out Span	R4147	R4159	R4045	R4048
5. Setting of RX Time-out Span	D4043			
6. Edge Trigger Execution	D4044			

1. Port Ready Indicator： This signal is generated from CPU.
ON, it represents that port is free and ready.
OFF, it represents that port is busy, data transaction is going.

2. Port Finished Indicator： This signal is generated from CPU.
ON, it means data transaction has been completed.

3. Port Communication Parameters :

The register is for communication parameters setting of corresponding. port. (please refer to the chapter of communication parameters setting).

4. TX Delay & RX Time-out Span：

The content of Low Byte defines the receive Time-out span of CLINK instruction; its unit is 0.01 second (the default is 50, which means 0.5 second).

The CLINK instruction employs receive Time-out span to judge whether the slave station on line or not. When the master PLC sent out the read/write command to the slave station, the slave station didn't reply within this period means that there is abnormal event in communication called Time-out. When there are multi-drop linking, properly adjust this value (greater than 1 scan time of the slave station with the longest scan time) to shorten the communication response time among the active linking stations if there are many slave stations power off (The time-out cases will happen).

The content of High Byte makes no sense at this mode.

5. Setting of RX Time-out Span: Please refer this chapter, page 13-4~13-5 for details

6. Edge Trigger Execution: Please refer this chapter, page 13-5~13-6 for details

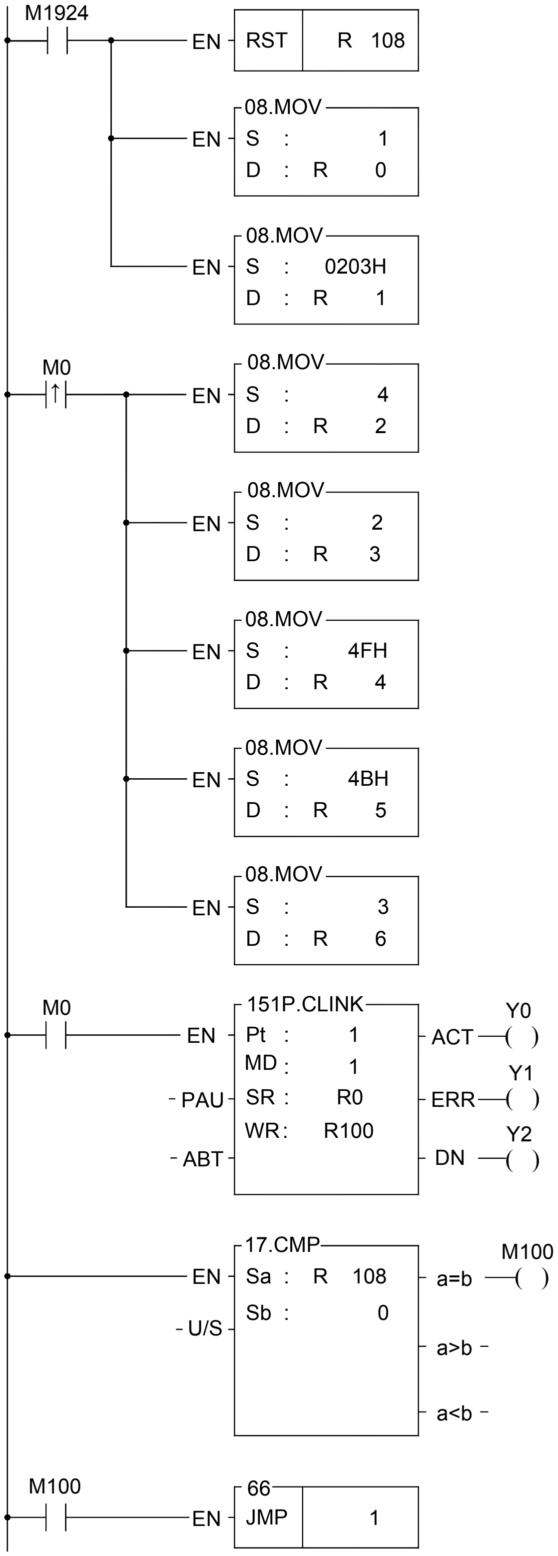
※When receiving message without ending code, and if M1956=1, then R4148 high byte of the received Time-out span setting is used to determine whether a data have been received or not, the unit is 0.001 second (default is 0CH, 12mS).

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

Program example for loop back test

PLC station A sends data to PLC station B (PLC station B sends the received original data back to the PLC station A, loopback test), and checks whether the responding message of PLC station B is the same as its original data that had sent out; therefore, it can do simple test on software and hardware of PLC Port1 whether it is normal and error free.

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

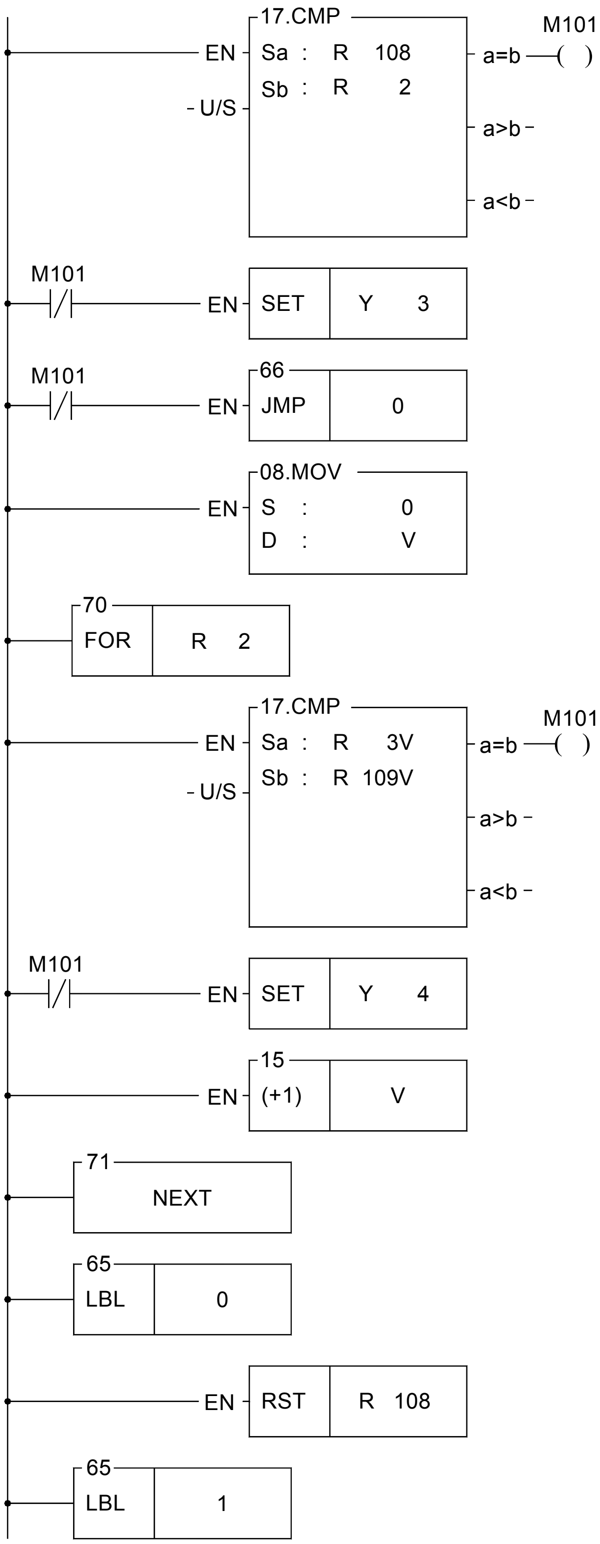


- Clears the received data length to be 0 (for "transmit" only, this instruction is not required).
- Setting of the operation mode:
  - Set to be "transmit then receive" mode (R0=1)
- Set the starting code (02H) and ending code (03H) for responding message in receiving. (without starting and ending codes, R1=0 can also receive regularly)
- Packing data to be transmitted:
- Set the transmitting data length (R2=N).
- Fills in the data that is to be transmitted:
  - Fill in data 1 (R3= ' STX ')
  - Fill in data 2 (R4= ' O ')
  - Fill in data 3 (R5= ' K ')
  - Fill in data 4 (R6= ' ETX ')
- When selecting "transmit then receive" mode, it employs the comparing instruction to judge whether the responding message from the counter partner is received; if it is received, then M100=OFF, and it will process the received data.
  (For " transmit" mode, this program is not required)

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

• The processing program for data received.

• For details of the data received, please refer to the explanation of following page.



• Compares the received data length and transmitted data length.

• When the length is inconsistent, it sets up the error indication.

• Clears the pointer V to be 0.

• Compares the consistency of all of the received data and transmitted data.

• Compares the received data and transmitted data one by one.

• When there is a data difference, set up the error indication.

• As the received data processed complete, clears the received data length to be 0, and gets ready to receive new data.

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

Explanation for the operand SR of FUN151: MD1

SR：Starting register of data transmission table

SR+0	Transmit only or Transmit then Receive	•Low byte is valid, =00H, transmit only, no response from the slave device =01H, transmit then receive the responding data (Receive only without err =81H, transmit then receive the responding data (Receive even with error)
SR+1	Starting & Ending code for receiving	• High byte : Start of text for receiving. Low byte : End of text for receiving.
SR+2	Length of Transmission	• The maximum length of data to be transmitted is 511
SR+3	Data 1	• Low byte is valid
SR+4	Data 2	• Low byte is valid
SR+5	Data 3	• Low byte is valid
SR+6	Data 4	• Low byte is valid
• • •		
	Data N	• Low byte is valid

Note 1： When selecting the transmit-only mode, the Starting /Ending code of receiving is meaningless.

2： When it is in the "transmit then receive" mode, before the starting of transmission, it must first to estimate the starting and ending code of responding message from communication partner and write them into the receiving starting/ending code register (e.g. SR+1=0203H, 02H stands for starting code and 03H for ending code), so as to ensure the correct message frame receiving. The communication protocol with starting/ending code makes the identifying of every packet of messages easy, and the communication program is simple and efficient.

3： When it is in the "transmit then receive" mode, fills the high byte of starting/ending code register with 0 if no starting code in responding message; if no ending code in responding message, fills 0 to the low byte of starting/ending code register. Adjusts the high byte of R4148 (message detection time interval) to judge whether a packet of data has been received completely; the unit is 0.001 second (the default is 0CH, 12mS).

FUN151 CLINK	Convenient Instruction of FUN151: MD1 (Which makes PLC act as the communication sender through Port 1~4)	FUN151 CLINK

The communication protocol without ending code depends on message detection time interval to tell whether it has received completely a packet of data (the setting of message detection time interval must be greater than the maximum response delay time between data bytes when communication partner is replying), thus it may ensure the receiving of the whole packet to be complete. Generally speaking, the data in transmitting is transmitted one byte after another continuously; therefore, if there is pause (greater than message detection time interval), it means the packet of message is transmitted completely.

Explanation for the operand WR of FUN151:MD1

	High Byte	Low Byte	
WR+0	Result code	0	• Result code =0, OK ; = other values, abnormal.
WR+1	For internal operation use		• Working registers for CLINK instruction
WR+2	For internal operation use		
WR+3	For internal operation use		
WR+4	For internal operation use		• WR+4 : b0=1, Pending b12= 〝ACT〞 output indication b13= 〝ERR〞 output indication b14= 〝DN〞 output indication
WR+5	For internal operation use		
WR+6	For internal operation use		
WR+7	For internal operation use		
WR+8	Total amount of data received		• The total amount of data byte being received (the register for received data length; it includes the starting and ending code).
WR+9	Data 1		• The first byte of data received (if there is the starting code, it is the starting code); High byte =0.
•	Data 2		• The second byte of data received; High byte =0.
•	Data 3		• The third byte of data received; High byte =0.
• •			
	Data N		• The N_th byte of data received (if there is the ending code, it is the ending code); High byte =0.

Result code **:** 0, transaction is successful.

2, data length error (the value is 0, or the packet of transaction is greater than 511)

A, no response from the slave

B, communication abnormal (received error data)

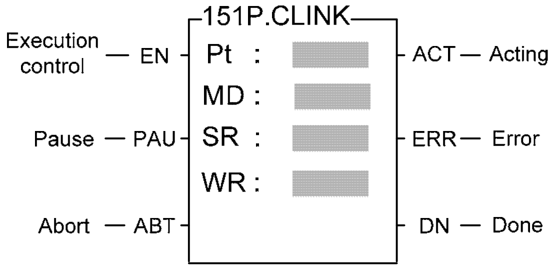
● Output Indicator **:** 〝ACT〞 ON：Transaction is in progress

〝ERR〞 ON：Error occurred

〝DN〞 ON：One transaction finished

FUN151 CLINK	Convenient Instruction of FUN151: MD2 (Which makes PLC act as the communication receiver through Port 1~4)	FUN151 CLINK

Ladder symbol



Pt : Assign the port, 1～4

MD : 2, PLC waiting to receive the message sent by intelligent peripherals

SR : Starting register for data transmission table

WR : Starting register for instruction operation (see example for explanation). It controls 8 registers, the other programs cannot repeat in use.

Operand \ Range	HR R0 ~ R3839	ROR R5000 ~ R8071	DR D0 ~ D3999	K
Pt				1~4
MD				2
SR	○	○	○	
WR	○	○*	○	

Descriptions

1. FUN151 : MD2 instruction provides Fatek PLC with ability to receive message sent by peripherals with communication interface at any time.

2. The communication protocol is written with LADDER program, which must be consistent to the peripheral device.

3. When execution control 〝EN〞 changes from 0→1 and both inputs “PAU” and “ABT” are 0, and if Port 1/2/3/4 hasn’t been controlled by other communication instructions [i.e. M1960 (Port1) 、 M1962 (Port2) 、 M1936 (Port3) 、 M1938 (Port4) = 1], this instruction will control the Port 1/2/3/4 immediately and set the M1960、M1962、M1936、M1938 to be 0 (which means it is being occupied). If Port 1/2/3/4 has been controlled (M1960、M1962、M1936、M1938 = 0), then this instruction will enter into the standby status until the controlling communication instruction completes its transaction or pause/abort its operation to release the control right, and then this instruction will become enactive.

4. When the input “PAU” or “ABT” becomes 1, it gives up the receiving immediately (M1960、M1962、M1936、M1938 = 1).

5. While it is in the receiving state, the output indication “ACT” is ON.

6. When a packet of data transaction finished (receive finished or receive then transmit completed), if there is error occurred, the output indication “DN” & “ERR” will be ON for one scan time.

7. When a packet of data transaction finished (receive finished or receive then transmit completed), if there is no error occurred, the output indication “DN” will be ON for one scan time.

FUN151 CLINK	Convenient Instruction of FUN151: MD2 (Which makes PLC act as the communication receiver through Port 1~4)	FUN151 CLINK

【Interface Signals】

Dedicated Relays and Registers for corresponding port：

Signals \ Comm Port	Port 1	Port 2	Port 3	Port 4
1. Port Ready Indicator	M1960	M1962	M1936	M1938
2. Port Finished Indicator	M1961	M1963	M1937	M1939
3. Port Communication Parameters	R4146	R4158	R4043	R4044
4. TX Delay & RX Time-out Span	R4147	R4159	R4045	R4048

1. Port Ready Indicator：This signal is generated from CPU.
ON, it represents that port is free and ready.
OFF, it represents that port is busy, data transaction is going.

2. Port Finished Indicator：This signal is generated from CPU.
ON, it means data transaction has been completed.

3. Port Communication Parameters :

The register is for communication parameters setting of corresponding. port. (please refer to the chapter of communication parameters setting).

4. TX Delay & RX Time-out Span：

The Low Byte defines the Time-out span of FUN151:MD2 instruction; its unit is 0.01 second (the default is 32H). When the PLC received the message and must respond to it (receive then transmit mode), but the LADDER program is unable to process and send out the responding message during this period of time, the CPU will give up response this time and automatically restore back to receiving state. When FUN151:MD2 is set to be "receive only" mode, this value is meaningless.

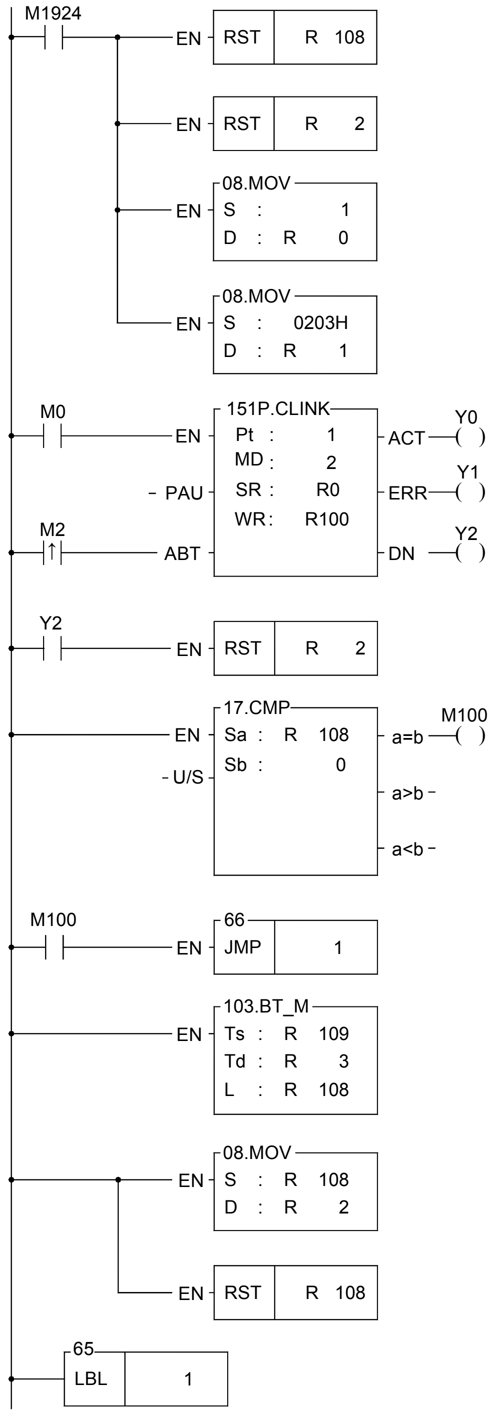
The content of High Byte makes no sense at this mode.

Note 1 : Once FUN151 : MD2 activated, it will stay in receiving state all the time; unless the input signal of PAU" or "ABT" becomes ON, then it will escape from receiving state and stop receiving and waiting for next time it will be activated again.

2 : When there is change on Starting/Ending code for receiving, it must make the input signal of PAU" or "ABT" becomes ON once, and re-activate the receive control "EN" from 0→1 to start message receiving

FUN151 CLINK	Convenient Instruction of FUN151: MD2 (Which makes PLC act as the communication receiver through Port 1~4)	FUN151 CLINK

Program example for loop back reply (This PLC station sends back the received data to the master, which had sent out the data)



Clears the received data length to be 0.

- Clears the transmitted data length to be 0. (for "receive' only, this program is not required).
- Sets up the operation mode:
  - Sets “receive then transmit” mode.
  - Sets up the starting code (02H) and ending code (03H) (R1=0, it will receive regularly even without the starting and ending code)
- When transmission complete, clears the transmitted data length to be 0 (for "receive" only mode, this instruction is not needed)
- While selecting "receive then transmit" mode, it employs the comparing instruction to tell whether a new packet of message is received; if it is, the M100=OFF and it will process the received data.
- Copy all of the received data to responding registers.
- R108 is the length of received data.
- After the received data processed, fills the received data length to be the sending back data length to start the responding transmission.
- Clears the received data length to be 0 (ready to receive new data).

FUN151 CLINK	Convenient Instruction of FUN151: MD2 (Which makes PLC act as the communication receiver through Port 1~4)	FUN151 CLINK

Explanation for the operand SR of FUN151: MD2

SR : Starting register of data reply table

SR+0	Receive only or Receive then Transmit	• Low Byte is valid, =00H, Receive only without error, no response from the PLC =01H, Receive only without error, then reply from the PLC =80H, Receive even with error, no response from the PLC =81H, Receive even with error, then reply from the PLC
SR+1	Starting/Ending code of receiving	• High Byte : Describing the starting code of receiving Low Byte : Describing the ending code of receiving.
	Length of reply data	• Maximum of length is 511. It will start to transmit the reply data as long as the length is not 0
	Reply data 1	• Low Byte is valid
SR+4	Reply data 2	• Low Byte is valid
•		
•		
•	Reply data N	• Low Byte is valid

Note 1 : When selecting the "receive only" mode, CPU fills the received data into the receiving registers and set the length after it has received a packet of message, and starts to receive the next packet of message immediately.

2 : When selecting the "receive then transmit" mode, CPU fills the received data into the receiving registers and set the length after it has received a packet of message; then it starts to wait for the reply data length which is not zero to start transmitting reply data (therefore when select this mode, it must control the reply data length to be zero before the reply data completely filled into the reply registers; when the reply data fills into the reply registers finished, it may then set the length of reply data).

3 : It must fills the starting code and ending code into the starting/ending code register before the starting of receiving (e.g. SR+1=0A0DH, 0AH stands for starting code and 0DH for ending code), so as to ensure it to be free from receiving error.
The communication protocol with starting/ending code makes the identifying of every packet of messages easy, and the communication program is simple and efficient.

4 : If the receiving message without starting code, fills the high byte of starting/ending code with 0; if the receiving message without ending code, fills the low byte of starting/ending code with 0. Adjusting High Byte of R4148 (new message detection time interval) to detect whether a packet of message has been received completely, the unit is 0.001 second (default is 0CH, 12 mS). The communication protocol without ending code depends on new message detection time interval to tell whether it has received completely for a packet of data (the setting of new message detection time interval must be greater than the maximum delay time between data bytes to be received), thus it may ensure the receiving of the whole packet to be completed. Generally speaking, the data in transmitting is transmitted one byte after another continuously; therefore, if there is pause (greater than new message detection time interval), it means that the packet of message is transmitted completely.

5 : When selecting "receive only" mode, if the receiving message has no ending code, the interval between every packet of data sent by the sender must be greater than the receiver's new message detection time interval, otherwise the receiver won't be able to distinguish between each packet of data correctly.

FUN151 CLINK	Convenient Instruction of FUN151: MD2 (Which makes PLC act as the communication receiver through Port 1~4)	FUN151 CLINK

Explanation for the operand WR of FUN151:MD2

	High Byte	Low Byte	
WR+0	Result code	0	Result code =0, OK ; = other values, abnormal.
WR+1	For internal operation use		• Working registers for CLINK instruction
WR+2	For internal operation use		
WR+3	For internal operation use		
WR+4	For internal operation use		• WR+4 : b0=1, Pending b12= 〝ACT〞 output indication b13= 〝ERR〞 output indication b14= 〝DN〞 output indication
WR+5	For internal operation use		
WR+6	For internal operation use		
WR+7	For internal operation use		
WR+8	Total amount of data received		• The total amount of data byte being received (the register for received data length; it includes the starting and ending code).
WR+9	Data 1		• The first byte of data received (if there is the starting code, it is the starting code); High byte =0.
•	Data 2		• The second byte of data received; High byte =0.
•			
•	Data N		• The N_th byte of data received (if there is the ending code, it is the ending code); High byte =0.

Note : When CPU received a packet of message, it filled the data to receiving registers and set up the received data length. Before the LADDER program starts to receive, you may clear the register of received data length to be 0; it means the receiving of a new packet of message when compared and found that the received data length is not zero. After the LADDER program gets the received data, it clears the received data length register to be 0. Just compare to see the received data length register is not zero means the receiving of a packet of new message, and so it may easily to process the receiving action.

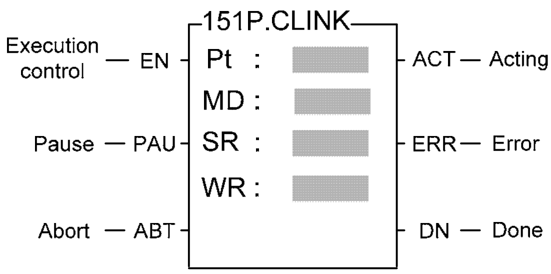
Result code : 0, data transaction is successful.
2, the data length is error (the value is 0, or the transaction is greater than 511)
A, unable to reply message within Time-out span ("receive then transmit" mode).
B, communication abnormal (received error data)

Output indication :

“ACT” ON : In receiving state
“ERR” ON : Error occurred in previous packet of transaction, it will be ON for a scan time
“DN” ON : The previous packet of transaction completed without error, ON for a scan time.

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of “Fatek high speed CPU Link network” through Port2)	FUN151 CLINK

Ladder symbol



Pt : Only port 2 is valid

MD : 3, serves as the master station of Fatek High Speed CPU Link network

SR : Starting register of communication program (see example for its explanation)

WR : Starting register for instruction operation (see example for its explanation). It controls 8 registers, the other programs can not repeat in using.

Operand \ Range	HR R0 ⏐ R3839	ROR R5000 ⏐ R8071	DR D0 ⏐ D3999	K
Pt				1~4
MD				3
SR	○	○	○	
WR	○	○*	○	

Descriptions

1. FUN151 : MD3, it provides high speed data sharing between Fatek's PLC (data response time will not be influenced by the scan time of PLC).
2. A master PLC can link with 254 slave PLCs at the most to share data through the RS-485 interface.
3. FUN151 : MD3 is required only by master PLC, not by the slave PLC.
4. The station number of master PLC must be No.1, or it should be assigned by R4054 register if which is not No.1 but need to be as the master.
5. The setting of M1958 for slave PLC must be ON (M1958 OFF is for non-high speed link), but it’s not necessary for master PLC.
6. In high speed linking, the maximum Baud Rate is 921.6K bps and minimum is 38.4K bps (adjustable); the data bit is fixed at 8 Bits. Data is transmitted with binary code (which is twice time as fast as ASCII Code), and the error checking is adopting CRC-16, which is more reliable than Checksum.
7. The principle of high speed linking data transmission is based upon the COMMON DATA MEMORY concept to design; e.g. as the master PLC sent out the content of R0 to R31, .the contents of R0～R31 for all the slave PLCs will be the same as the master’s; when slave PLC no.2 sent out the contents of R32～R47, the R32～R47 contents of master PLC and other slave PLCs will be the same as PLC station no.2’s, etc.
8. When PLC is in STOP mode, the Port 2 enters into the standard interface mode that it can connect to WinProladder, MMI, or graphic supervisor (the communication parameter is set by R4158).
9. It employs the program coding or table filling method to plan for data flow control; i.e. for what kind of data being sent from which PLC station to all the PLC on line, it takes only 7 registers (5 of which is being physically used, and 2 reserved) to define; every 7 registers define once communication transaction.
10. When execution control “EN” changes from 0→1 and both pause “PAU” and abort “ABT” are 0, this instruction will control Port 2 and set M1962 to be “0” (being controlled) and processing the data transaction immediately, suppose the Port 2 is not controlled by other communication instruction (M1962=1). If Port 2 is being controlled (M1962=0), this instruction will enter into wait state until the controlling instruction completes the transmission or pause/abort the operation to release the control right (M1962=1); then it enacts from wait state, engages in the transmitting transaction and sets M1962 to be “0”.

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of "Fatek high speed CPU Link network" through Port2)	FUN151 CLINK

11. When pause "PAU" or abort "ABT" of input is 1, it escapes from high speed data link immediately (M1962 ON).
12. Within the high speed linking, the output indication "ACT" is ON; Port 2 is occupied.
13. When there is error occurred while it is starting the high speed linking, the output indication "ERR" will be ON, and the high speed linking will not be performed.

【Interface signals】

M1958 : While in the PLC high speed data linking, slave PLC must set M1958 ON (not necessary for master PLC)
For non high speed data linking of PLC, the slave PLC must set M1958 OFF.

M1962 : The signal is generated from CPU.
ON represents the Port 2 is available.
OFF represents the Port 2 is occupied.

M1963 : The signal is generated from CPU.
When M1967 is ON (this signal is controlled by the user program) and after the last packet of communication transaction is completed, the CPU sets M1962 and M1963 ON, and the high speed data transmission will be stopped; it must control "ABT" (transmission abort) to be ON, and then restart execution control "EN↑" to change from 0→1 before the high speed linking can restart.
When M1967 is OFF (this signal is controlled by the user program), the high speed data transmission will automatically restart a new transmission from the first packet of communication transaction (M1962 and M1963 is keeping OFF state) after the last packet of communication transaction is completed.

M1967 : One-time or cycling control (controlled by the user program)
ON, one cycle, it will stop after the last packet of data transaction is performed completely.
OFF, successive cycles, it will restart from first packet of transaction when it has finished the last packet of transaction.

R4054 : It assigns the PLC station which is not no.1 to act as the master of high speed linking.

	High byte	Low byte	
R4054	55	Station number.	H

When the station number of the PLC is not number 1, fills its station number (low byte of R4055 stores the station number) into the low byte of R4054 and writes to high byte of R4054 with 55H, and then controls the execution control input "EN↑" from 0→1; even though the PLC station which is not no.1, it can still be the master station for high speed linking.

R4055 : When high byte of R4055 is not 55H,Low byte of R4055 shows the station number of PLC.
When high byte of R4055 is 55H,Low byte of R4055 defines the station number of PLC.

R4058 : Showing the station number of slave PLC which is abnormal while high speed linking (0: Represents normal; if many slave PLC were abnormal in the mean time, it is possible to see only one number; after the debugging of abnormal and clear R4058 to be 0 until the value of R4058 keeping to be 0, it will then network works normal). In communication transaction program or table, it must exist the case for slave station to send data to other stations then can the master PLC detect whether the slave station is online without error; if in the communication transaction program or table, there is only the master station sending data to slave stations, the master PLC can't detect whether slave PLC is on line without error. The user must employ programming skill to add abnormal detecting program to the master PLC and

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of “Fatek high speed CPU Link network” through Port2)	FUN151 CLINK

slave PLC to do the error checking (as a matter of fact, the program is very simple; just makes the PLC, which is sending data, to create an ON↔OFF variation signal. Once the receiving PLC does not detect the ON↔OFF variation signal in a period of time, it means that there is communication error).

R4059 **:** Error logging of abnormal slave PLC while high speed linking.

	High byte	Low byte	
R4059	Abnormal code	Abnormal count	H

Low byte **:** Abnormal count summation

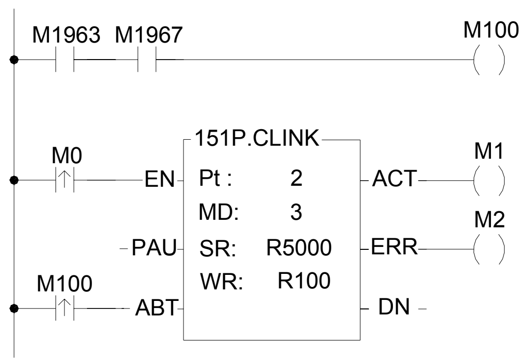
High byte **:** Abnormal code
OAH, No response from slave station
OBH, Error data
01H, Framing Error
02H, Over Run Error
04H, Parity Error
08H, CRC error

Explanation for the checking method for abnormal communication is the same as that for R4058.

R4160 **:** Port 2 Rx/Tx Time-out setting (in high speed linking). The system will base on the setting of R4161 communication parameter to produce pertaining set point if high byte of R4160 is not 56H, the user need not to set it. If high byte of R4160 is 56H, the low byte of R4160 is reserved for manual setting.

R4161 **:** Communication parameter setting register for Port 2 High Speed CPU Link.

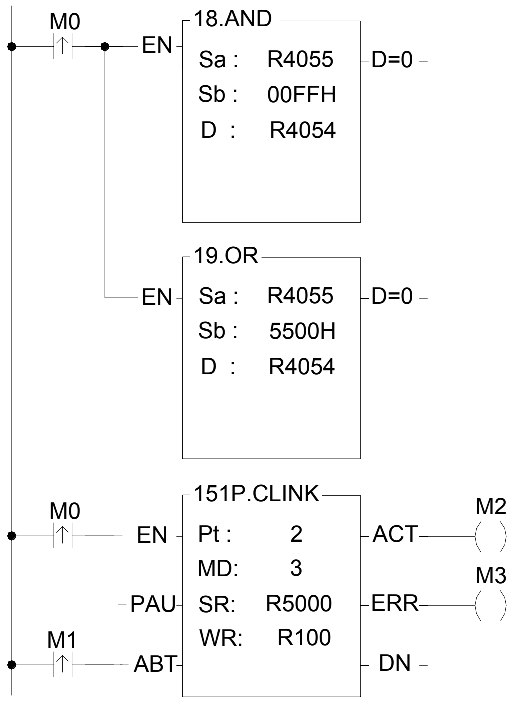
Program example 1 (PLC no. 1 serves as the master of high speed data linking)



- Planning R5000～R5199 to be ROR, the communication program will be stored together with LADDER program.
- When M1967 is ON, performs one cycle transmission. It must start the abortion, then restart M0 before it can perform high speed data link again.

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of "Fatek high speed CPU Link network" through Port2)	FUN151 CLINK

Program example 2 (PLC which station number is not no.1 serves as the master of high speed data linking.)



- Get PLC station number and write it into R4054
- Set the high byte for R4054 to be 55H
- Planning R5000～R5199 to be ROR, the communication program will be stored together with LADDER program.
- When ABT is not controlled, M1 instruction needs not to input.

Program example 3

The same machine sets or equipments (with same LADDER program) perform multi-station data collection or distributed control through RS-485 high speed linking.

The principle for high speed data linking is based on COMMON DATA MEMORY concept to design; while designing, it must devise a successive data block and evenly distributed to respective PLCs to do data exchange among PLCs. e.g.:

R1000～R1031**:** The data block of PLC no. 1 (through high speed linking, the other PLCs' content of R1000～R1031 become the same as that of PLC no.1).

R1032～R1063: The data block of PLC no. 2 (through high speed linking, the other PLCs' content of R1032～R1063 become the same as that of PLC no.2).

•　　　　　•

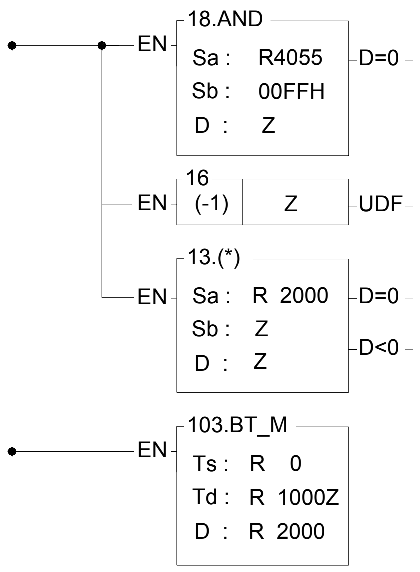
•　　　　　•

•　　　　　•

For example, get the production data (stored at R0～R31) from each machine set, and collectively gathering R1000～R1639 (suppose there are 20 sets linking) stored in master PLC through RS-485 high speed data linking; it needs merely the master PLC of high speed linking to connect to MMI or graphic supervisor, then it can monitor and store, for follow up processing, the production data of respective machine sets with real time effect.

Note **:** If it is simply for data collection and monitoring and no need to do real time control, employs the FUN151: MD0 can easily and concisely accomplish the assignment; when requiring real time control or supervisoring , it must employ FUN151: MD3 to accomplish a speedy, precisely controlling demand.

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of "Fatek high speed CPU Link network" through Port2)	FUN151 CLINK



- Get PLC station number and write it in pointer Z
- Station number deducts 1
- R2000 = Length of data to be sent from each station (e.g. 32)
- data length * (station number−1):
  Directing to the apportioned data block of this station.
- Move production data from respective stations to the apportioned data block of respective stations, and transmitting it to all other PLCs on line through high speed data linking.

Explanation for operand SR of FUN151: MD3

SR：Starting register for communication program of CLINK instruction

SR+0	Packets of data transaction	• Low Byte is valid. A packet of transmission demands 7 registers to describe; i.e. 7 registers define a packet of data.
SR+1	Station number to transmit	• Low Byte is valid. 1～254
SR+2	Command code	• Low Byte is valid, it can only be 4 (high speed linking command).
SR+3	Length of this packet of data	• Low Byte is valid. 1～32, defines the data length of one transaction.
SR+4	Data type	• Low Byte is valid. 12＝R; 13＝D.
SR+5	Data starting reference	• Word is valid. Defines starting number of working data.
SR+6	Reserved	• Code for data type: Data starting reference
SR+7	Reserved	12: R data register 0～3839 13: D data register 0～3999
SR+8	Station number to transmit	Describing for the 2_nd packet of transaction
SR+9	04	
•	Length of data	
•	Data type	
•	Data starting reference	
•	Reserved	
•	Reserved	

FUN151 CLINK	Convenient Instruction of FUN151: MD3 (PLC serve as the master of “Fatek high speed CPU Link network” through Port2)	FUN151 CLINK

Explanation for operand WR of FUN151:MD3

	High Byte	Low Byte
WR+0	Result code	
WR+1	For internal operation	
⋮		
WR+7	For internal operation	

Result code : 0 : Correct format
2 : Data length error (Length is 0 or greater than 32)
3 : Command code error (Command is not equal to 4)
4 : Data type error (Data type is not 12 nor 13)
5 : Data reference error

- For easy programming and trouble shooting, the WinProladder provides the table editing environment to edit the communication table of FUN151 instruction; Key in the complete FUN151 instruction first and then move the cursor to the position of it, depressing the "Z" key, now comes the table editing environment. The user can create the new communication table or display the existed table under this friendly user interface operation.

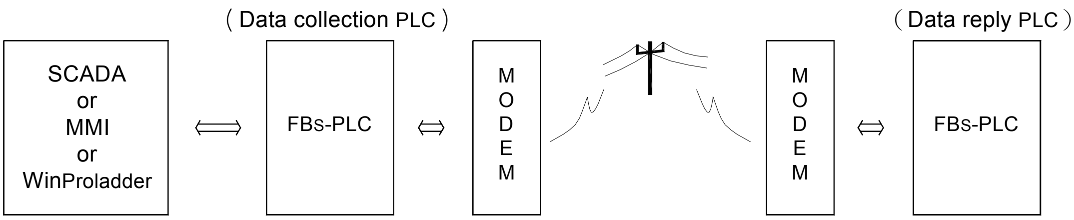
Communication Table for FUN151:MD3

※ Only Port 2 is valid for FUN151：MD 3

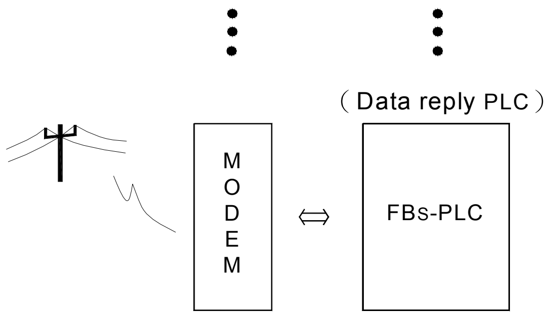
Sequence No.	Command	Station No.	Data	All Station	Length
0～nnn	High Speed Link (=4)	Station number to transmit the data 1～254	The data will be transmitted R0～R3839 D0～D3999	The data will be received R0～R3839 D0～D3999	Data length of this transaction 1～32

FUN151 CLINK	CPU Link by Way of Port 1 to Connect to Modem	FUN151 CLINK

- PLC can connect to MODEM through communication port 1, and by way of telecommunication network to link and share data with remote PLC. Its application is as follows :
  - · Perform automatic data collection from the remote end.
  - · Automatically report for alarm and abnormal conditions.
  - · Associate with current available graphic supervisor software or MMI etc. standard products to constitute a wide area network automatic monitoring system. It doesn't need to develop specific designing, so as to reduce the development risk and time limit.
- Hardware configuration, and setting :



Data collecting PLC :
· Don't need to store phone number within the CPU
· High Byte of R4149 = 55H (MODEM function)
Data reply PLC :
· High Byte of R4149 = 55H (MODEM function)
· R4140～R4145 sets the phone number for general data collecting PLC end (extension phone function allowed).
e.g. Phone number is 02-28082192, then
R4140=8220H, R4141=1280H, and R4142=0E29H.



If phone number is : 02-28082192 ext 100, then R4140=2A20H, R4141=2808H, R4142=A291H, R4143=AAAAH, R4144=001AH, R4145=000EH.

· Explanation: R4140～R4145 is telephone number register for dialing;
"E" is the ending character of phone number; "A" is the dial delaying character (usually the dialing of extension number or international long distance call can be reached by making use of dial delaying, the delayed time for a delaying character is based on MODEM setting, which is about 2 second). "B" stands for "#" character, and "C" stands for "*" character.

· It employs CLINK (FUN151:MD0) instruction to write data to the general data collecting PLC or to read data from general data collecting PLC (refer to FUN151:MD0 Instruction user guide).

*** The maximum communication Baud Rate can reach 115200 bps (both of the communication ends must be consistent in setting)

· Let the communication parameters be 8-bit and Non-parity will be better for almost Modem

FUN151 CLINK	CPU Link by Way of Port 1 to Connect to Modem	FUN151 CLINK

· The wiring of PLC communication port1 and MODEM：

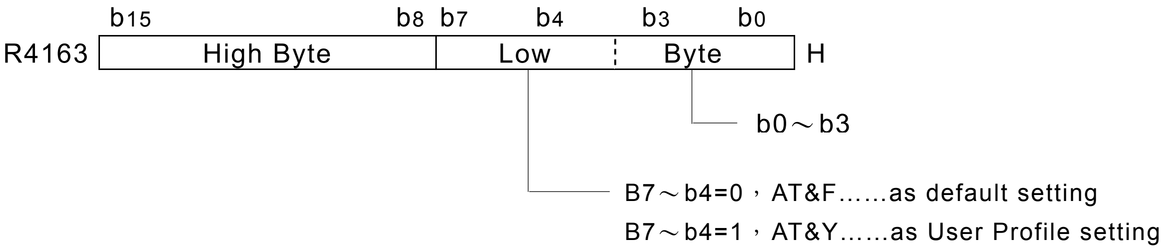
Fatek PLC （DB-9）		MODEM （DB-25）	
PIN 3：RXD	←——→	TXD	（PIN_3）
PIN 2：TXD	←——→	RXD	（PIN_2）
PIN 8：RTS	←——→	CTS	（PIN_4）
PIN 7：CTS	←——→	RTS	（PIN_5）
PIN 5：SG	←——→	SG	（PIN_7）
	┌	DSR	（PIN_6）
	└	DTR	（PIN_20）

MODEM dialing interface signal

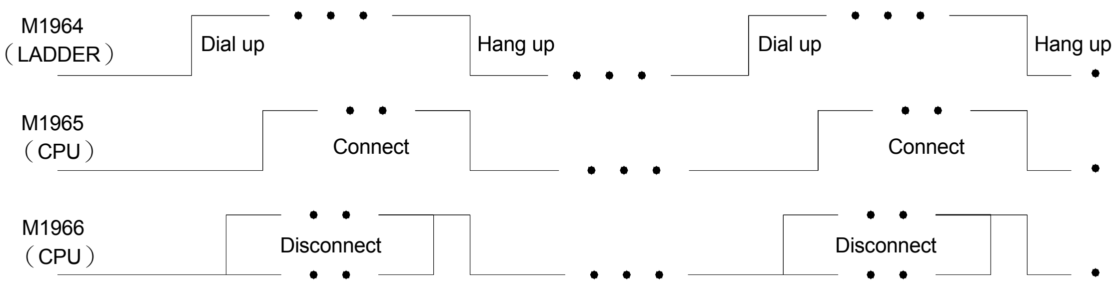
M1959 **:** OFF, dialing by “Tone” ;
ON, dialing by “Pulse”

M1964 **:** OFF→ON, dial up ;
ON→OFF, hang up

R4163 **:** The Low Byte of R4163 is used to control the application of X instruction while MODEM dialing.
=1, it does not detect dial tone nor busy tone while MODEM dialing.
=2, it detects only dial tone but does not detect busy tone while MODEM dialing.
=3, it dials directly without detecting dial tone, but will detect busy tone after MODEM dialing.
=4, it detects both dial tone and busy tone for MODEM dialing.
For other values, it works as 4; different country system needs to adjust the setting pertaining to the country.



The High Byte of R4163 is used to set the ring count for auto answer mode of Modem.



FUN151 CLINK	CPU Link by Way of Port 1 to Connect to Modem	FUN151 CLINK

Note 1 : Of M1965 and M1966, there will be only one ON, not both to be ON at the same time.

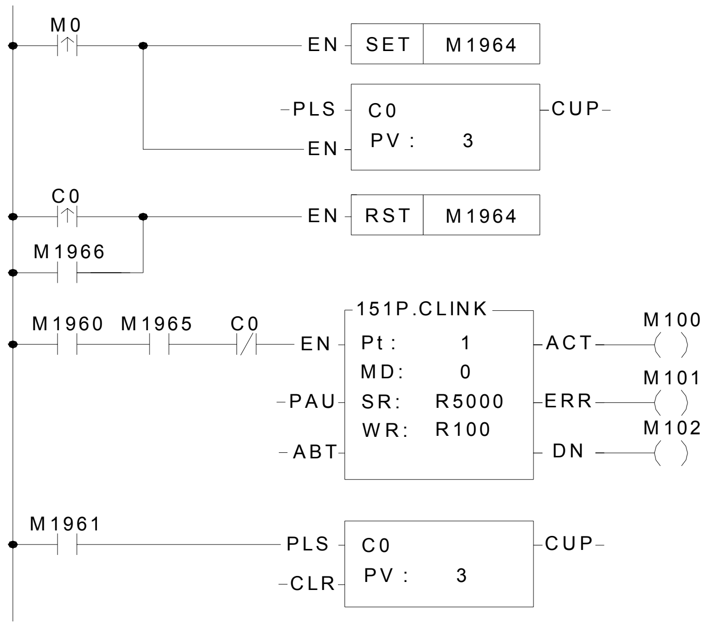
2 : The waiting time for dial connection is 1 minute; if unable to connect, it will redial twice (totally 3 times). If all of the dial connection tries failed, CPU will set M1966 to be ON (connection failed).

3 : When the quality of communication is not stable and easy to disconnect, you may employ the abnormal detecting function of CLINK instruction to control M1964 redials for connection (delay time of redial must be more than 10 seconds).

4 : When PLC change from RUN to STOP, the CPU will automatically change MODEM to be receiving state, which could accept the remote side dial connection.

5 : When PLC is not in dialing or MODEM connection states, CPU will automatically change MODEM to be receiving state, which could accept the remote side dial connection.

Program example



- When M0 changes from 0→1, dials up.
- Clears the transaction count.
- Hang up after transactions completed or connection failed.
- Planning R5000～R5199 to be ROR, the communication program will be stored together with LADDER program.
- Counting after all transactions completed

13.2 Application for FUN150(Modbus) Instruction

13.2.1 Procedures for Usage

Start

↓

Hardware wiring to connect the various stations (PLC, ASCII peripherals, etc.)

↓

Set up the station number of the linking stations and make a consistent communication parameters setting for these stations. ◦

- Station number can be set to any one between 1 to 254 without replication.

↓

Fill in the value to the communication interface register (Rxxxx) of FUN150 (Modbus) if necessary; properly adjust the Time_out timer to detect communication error, transaction delay to meet slow response device , etc.

- For communication parameters, please refer to the description of "Communication Related Setting".

↓

Write FUN150 instruction to PLC, which serves as the master station or performs communication sender/ receiver, and then fill the communication program into the register table assigned by operand SR. FUN150 will then automatically send or receive data according to the definition of communication program. The user can easily reach the various function services of Modbus by accessing the table like of communication program.

↓

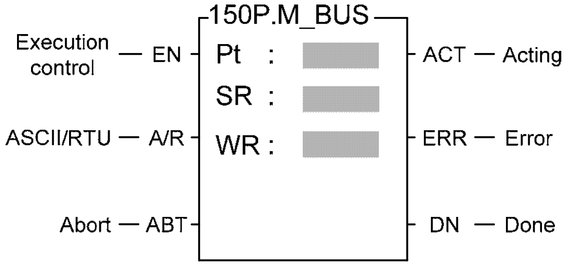
End

13.2.2 Explanation Application Program for FUN150

This section will instruction to explain FUN150(Modbus) usages, with respective practical application program examples.

FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master (Which makes PLC as the Modbus RTU/ASCII master through Port 1～4)	FUN150 M-BUS

Ladder symbol



Pt : 1～4，specify the communication port to work as the Modbus RTU master

SR : Starting register of communication program

WR : Starting register for instruction operation. It controls 8 registers，the other programs can not repeat in using.

Range / Ope-rand	HR	ROR	DR	K
	R0 | R3839	R5000 | R8071	D0 | D3999	
Pt				1～4
SR	○	○	○	
WR	○	○*	○	

Descriptions

1. FUN150 (M-BUS) instruction makes PLC act as Modbus RTU/ASCII master through Port 1～4, thus it is very easy to communicate with the intelligent peripheral with Modbus RTU/ASCII protocol.
2. The master PLC may connect with 247 slave stations through the RS485 interface.
3. Only the master PLC needs to use M-BUS instruction.
4. It employs the program coding method or table filling method to plan for the data flow controls; i.e. from which one of the slave station to get which type of data and save them to the master PLC, or from the master PLC to write which type of data to the assigned slave station. It needs only seven registries to make definition; every seven registers define one packet of data transaction.
5. When execution control 〝EN〞 changes from 0→1 and the input “ABT” is 0, and if Port 1/2/3/4 hasn’t been controlled by other communication instructions [i.e. M1960 (Port1)、 M1962 (Port2) 、 M1936 (Port3) 、 M1938 (Port4) = 1], this instruction will control the Port 1/2/3/4 immediately and set the M1960、M1962、M1936、M1938 to be 0 (which means it is being occupied), then going on a packet of data transaction immediately. If Port 1/2/3/4 has been controlled (M1960、M1962、M1936、M1938 = 0), then this instruction will enter into the standby status until the controlling communication instruction completes its transaction or pause/abort its operation to release the control right (M1960、M1962、M1936、M1938 =1), and then this instruction will become enactive, set M1960、M1962、M1936、M1938 to be 0, and going on the data transaction immediately.
6. While in transaction processing, if operation control “ABT” becomes 1, this instruction will abort this transaction immediately and release the control right (M1960、M1962、M1936、M1938 = 1). Next time, when this instruction takes over the transmission right again, it will restart from the first packet of data transaction.
7. While 〝A/R〞 =0，Modbus RTU protocol； 〝A/R〞 =1，Modbus ASCII protocol。
8. While it is in the data transaction, the output indication “ACT” will be ON.
9. If there is error occurred when it finishes a packet of data transaction, the output indication “DN” & “ERR” will be ON.
10. If there is no error occurred when it finishes a packet of data transaction, the output indication “DN” will be ON.

Note : Modbus ASCII Mode has been supported after OS Version 4.24 and later

FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master (Which makes PLC as the Modbus RTU/ASCII master through Port 1～4)	FUN150 M-BUS

【Interface Signals】

Dedicated Relays and Registers for corresponding port :

Signals \ Comm Port	Port 1	Port 2	Port 3	Port 4
1. Port Ready Indicator	M1960	M1962	M1936	M1938
2. Port Finished Indicator	M1961	M1963	M1937	M1939
3. Port Communication Parameters	R4146	R4158	R4043	R4044
4. TX Delay & RX Time-out Span	R4147	R4159	R4045	R4048
5. Setting of RX Time-out Span	D4043			
6. Edge Trigger Execution	D4044			

1. Port Ready Indicator：This signal is generated from CPU.

ON, it represents that port is free and ready.

OFF, it represents that port is busy, data transaction is going.

2. Port Finished Indicator : This signal is generated from CPU.

When the communication program completed the last packet of data transaction, this signal will be ON for one scan time (for successive data transaction).

When the communication program completed the last packet of data transaction, this signal will be still ON (for single packet of data transmission)

3. Port Communication Parameters :

The register is for communication parameters setting of corresponding port. (please refer to the chapter of communication parameters setting).

4. TX Delay & RX Time-out Span :

The content of Low Byte defines the receive time-out span of M-BUS instruction; its unit is 0.01 second (the default is 50, which means 0.5 second)
The M-BUS instruction employs receive time-out span to judge whether the slave station on line or not. When the master PLC sent out the read/write command to the slave station, the slave station didn't reply within this period means that there is abnormal event in communication called Time-out. When there are multi-drop linking, properly adjust this value (greater than 1 scan time of the slave station with the longest scan time) to shorten the communication response time among the active linking stations if there are many slave stations power off (The time-out cases will happen).

The content of High Byte defines the transmission delay time between two packets of data transaction for M-BUS instruction; its unit is 0.01 second (the default is 0).

For point to point link, this value can be set as 0 to shorten the communication transaction time and promote the communication efficiency. In the case of linking multi-drop and if the scan time of master PLC is far longer than any slave station, this value can also be set to 0 to shorten the communication transaction time and promote the communication efficiency. When there are multi-drops linking and the scan time of master PLC is close to that of slave station's, it must properly adjust this value (greater than 1 scan time of the slave station with the longest scan time) to reach the best, error-free communication quality

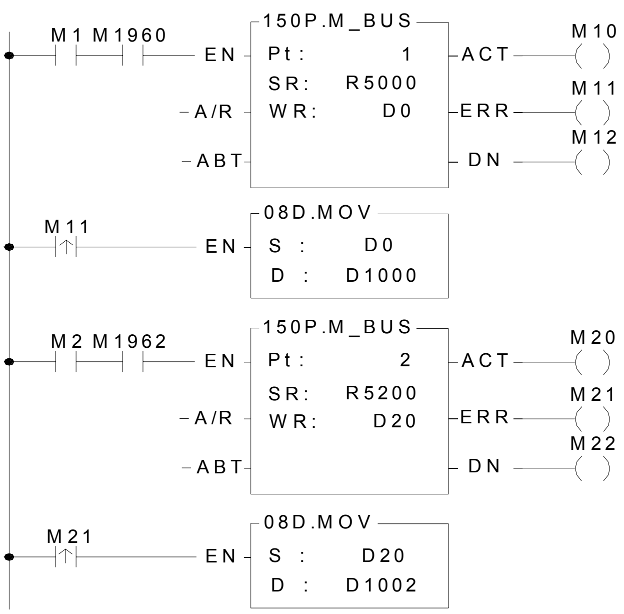
FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master （Which makes PLC as the Modbus RTU/ASCII master through Port 1～4）	FUN150 M-BUS

5. Setting of RX Time-out Span: Please refer this chapter, page 13-4~13-5 for details

6. Edge Trigger Execution: Please refer this chapter, page 13-5~13-6 for details

※When receiving message without ending code, and if M1956=1, then R4148 high byte of the received Time-out span setting is used to determine whether a data have been received or not, the unit is 0.001 second (default is 0CH, 12mS).

Program example（Automatic cycling transmission）



- Configure R5000～R5399 as the read only register (ROR) before programming, after then, when storing program, the ladder program will automatically contains the communication program .
- When there is communication error, gets and stores the error message to D1000 & D1001 would be helpful for error analysis or logging.

FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master （Which makes PLC as the Modbus RTU/ASCII master through Port 1～4）	FUN150 M-BUS

Explanation on program example

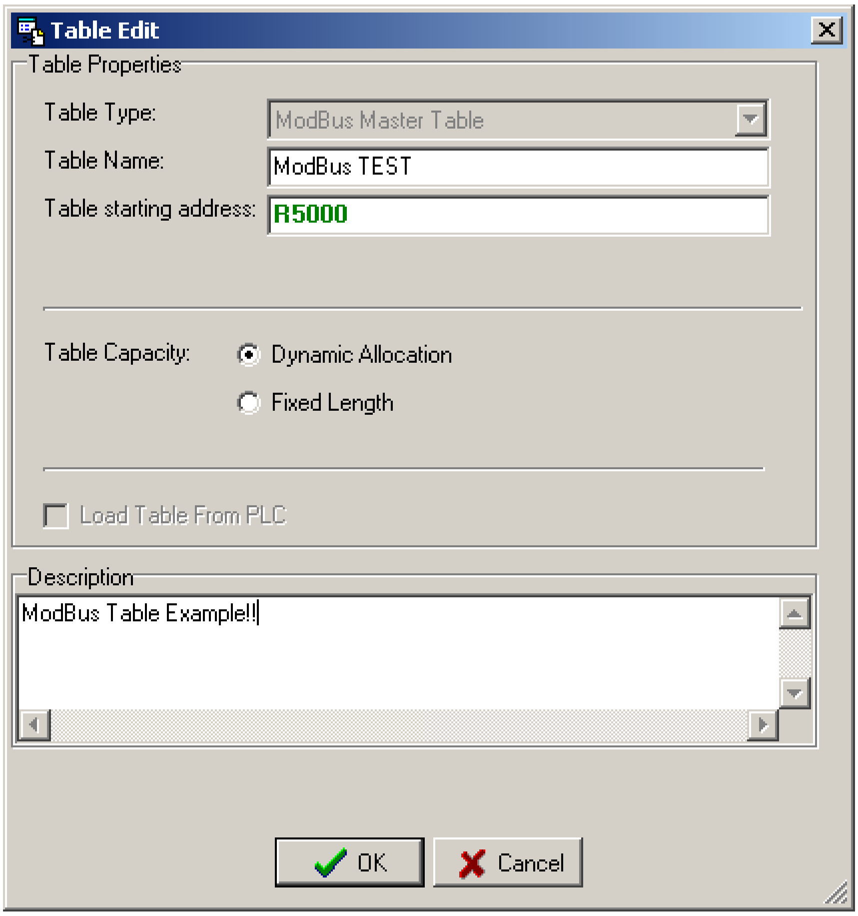
1. When execution control "EN" changes from 0→1, and Port 1 is not occupied by other communication instruction (M1960 ON), M-BUS instruction will start the data transaction. The M1960 is OFF during data transaction, and when the transaction is finished, the M1960 becomes ON. Employ the OFF←→ON change of M1960 (M-BUS execution control "EN" = 0→1 means starting) may automatically starts for every packet of data transaction successively (when the last packet of transaction is completed, it will automatically return to the first packet of transaction to obtain the automatic cycling transmission).

2. When execution control "EN" changes from 0→1, and Port 2 is not occupied by other communication instruction (M1962 ON), M-BUS instruction will start the data transaction. The M1962 is OFF during data transaction, and when the transaction is finished, the M1962 becomes ON. Employ the OFF←→ON change of M1962 (M-BUS execution control "EN" = 0→1 means starting) may automatically starts for every packet of data transaction successively (when the last packet of transaction is completed, it will automatically return to the first packet of transaction to obtain the automatic cycling transmission).

Editing Communication Table with WinProladder

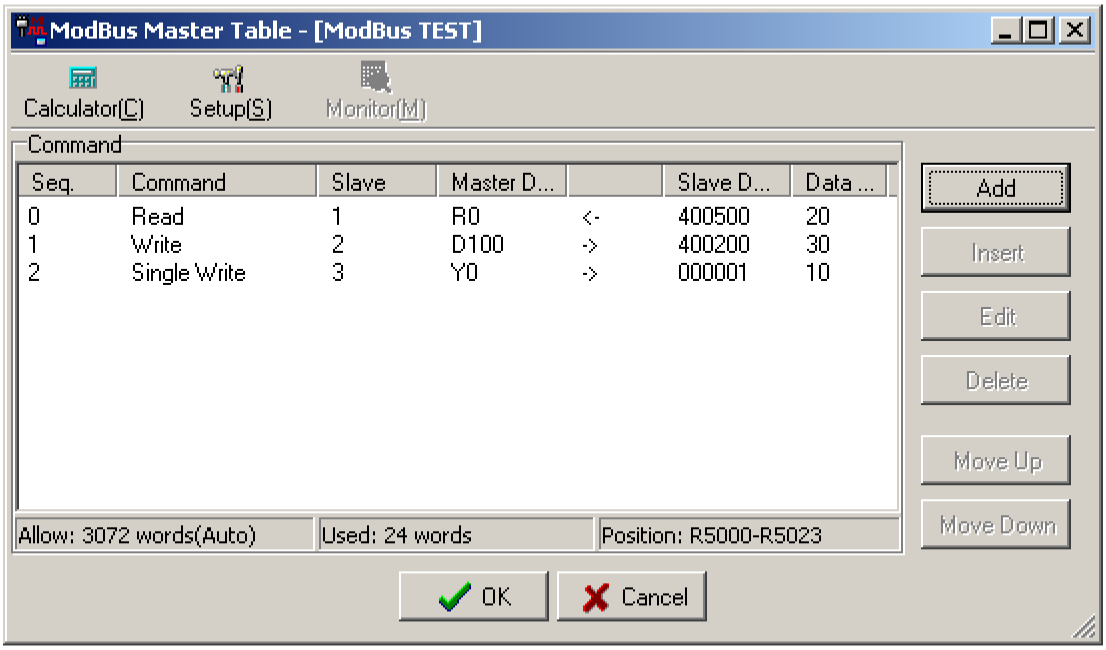
Click the "Modbus Master" Item which in project windows **:**

Project name
 └ Table Edit
  └ Modbus Master → Click right button and select "Add Modbus Master Table"



FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master （Which makes PLC as the Modbus RTU/ASCII master through Port 1～4）	FUN150 M-BUS

- Table Type **:** It will be fixed to ” Modbus Master Table ”.
- Table Name **:** For modify or debug, you can give a convenient name.
- Table Starting address **:** Enter the address which Starting register of communication Table



FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master （Which makes PLC as the Modbus RTU/ASCII master through Port 1～4）	FUN150 M-BUS

Starting register for communication program of M-BUS instruction

SR：Starting register for communication program of M-BUS instruction

SR+0	A5h	50h	• A550h，it means valid M-BUS program
SR+1	07h	Total transactions	• Low Byte : Total number of transactions，one transaction needs 7 registers to describe.
SR+2	Slave station No. Which is about to transact with		• Low Byte is valid, 0～247 (0 means that master PLC broadcasts the data to all slaves, the slaves do not reply).
SR+3	Command code		• Low Byte is valid ; =1, means "Read data from slave station" =2, means "Write multiple data to slave station" =3, means "Write single data to slave station"
SR+4	Data length of this transaction		• Low Byte is valid; the range is 1～125 (Reg.) or 1～255 (Discrete).
SR+5	Data type of Master PLC		• Low Byte is valid, and its range is 1～3 or 12～13; it defines the data type of master PLC (see next page).
SR+6	Starting reference of Master PLC		• Word is valid; it defines the starting address of data (master).
SR+7	Data type of slave station		• Low Byte is valid, and its range is 0 or 4; it defines the data type of slave station (see next page).
SR+8	Starting reference of Slave station		• Word is valid; it defines the starting address of data (slave).
SR+9	Slave station No. which is about to transact with		Description of the 2_nd packet of transaction
SR+10	Command code		
SR+11	Data length of this transaction		
SR+12	Data type of Master PLC		
SR+13	Starting reference of Master PLC		
SR+14	Data type of slave station		
SR+15	Starting reference of Slave station		
• • •			
SR+2+ n×7	Reserved		• N is the total number of transaction

FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master (Which makes PLC as the Modbus RTU/ASCII master through Port 1～4)	FUN150 M-BUS

- Data code, type and reference number of Master station (FATEK PLC)

Data code	Data type	Reference number
1	Y (Output Relay)	0～255
2	M (Internal M Relay)	0～1911
3	S (Step Relay)	0～999
12	R (Data Register Rxxxx)	0～3839
13	D (Data register Dxxxx)	0～3999

- Data code, type and reference number of Slave station (Modbus slave)

Data code	Data type	Reference number
0	Discrete Output	1～65535
4	Holding register	1～65535
1	Discrete Input (OS version 4.22↑)	1～65535
3	Input Register(OS version 4.22↑)	1～65535

- WR：Starting register for instruction operation of M-BUS (FUN150)

	High Byte	Low Byte
WR+0	Result code	Transaction No.
WR+1	Station number	Command code
WR+2	For internal working use	
WR +3	For internal working use	
WR+4	For internal working use	
WR+5	For internal working use	
WR+6	For internal working use	
WR+7	For internal working use	

- Result code indicates the transaction result; 0 means "Normal", other value means "Abnormal"
- Transaction No. indicates which one is in processing (begins from 0).
- Station number: the slave station No. which is in transaction.

  Command code =01H，read status of 0xxxxx from slave station
  =02H，read status of 1xxxxx from slave station
  =03H，read data of 4xxxxx from slave station
  =04H，read data of 3xxxxx from slave station
  =05H，force single coil to slave station
  =06H，preset single register to slave station
  =0FH，force multiple coils to slave station
  =10H，preset multiple registers to slave station
- WR+4 B0=1, Port has been occupied and this instruction is waiting to acquire the transmission right for data transaction
  B4=1, this instruction is not first time performing.
  B12, output indication for “ACT”
  B13, output indication for “ERR”
  B14, output indication for “DN”

Result code : 0, Transaction is successful.
2, Data length error (for length is 0 or over limit).
3, Command code error (Command code is 0 or greater than 3)
4, Data type error
5, Reference number error
6, Inconsistence in data type (e.g. master station is 1～3 while slave is 12～13).
7, Port error (Not Port 1～4)
8, Invalid communication table

FUN150 M-BUS	Convenient Instruction for Modbus RTU/ASCII Master (Which makes PLC as the Modbus RTU/ASCII master through Port 1～4)	FUN150 M-BUS

A, No response from slave station (Time-out error).
B, Communication error (received error data or exception reply).

- For easy programming and trouble shooting, the WinProladder provides the table editing environment to edit the communication table of FUN150 instruction; Key in the complete FUN150 instruction first and then move the cursor to the position of it, depressing the "Z" key, now comes the table editing environment. The user can create the new communication table or display the existed table under this friendly user interface operation.

M-BUS Communication Table

Sequence No.	Command	Slave	Data of Master	Data of Slave	Length
0～nnn	Read (=1) Write (=2) Write single (=3)	The station number of slave which is about to transact with Station No.=0, It means broadcasting, there will not any response from the slave Station No.=N, It means the station number of slave which is about to transact with; N=1～247	The data type of Master for this transaction Y0～Y255 M0～M1911 S0～S999 R0～R3839 D0～D3999	The data type of Slave for this transaction 000001～065535(read/write) 400001～465535(read/write) 100001～165535(read) 300001～365535(read)	Quantity of this While Register, 1～125 While Discrete, 1～255

※ WinProladder provides the user friendly table edit for M-BUS Master：

Sequence No.	Command	Slave	Data of Master		Data of Slave	Data length
0	Read	1～247	Y0～Y255	←	000001～065535	1～255
			M0～M1911	←	000001～065535	1～255
			S0～S999	←	000001～065535	1～255
			Y0～Y255	←	100001～165535	1～255
			M0～M1911	←	100001～165535	1～255
			S0～S999	←	100001～165535	1～255
			R0～R3839	←	400001～465535	1～125
			D0～D3999	←	400001～465535	1～125
			R0～R3839	←	300001～365535	1～125
			D0～D3999	←	300001～365535	1～125
1	Write	0～247	Y0～Y255	→	000001～065535	1～255
			M0～M1911	→	000001～065535	1～255
			S0～S999	→	000001～065535	1～255
			R0～R3839	→	400001～465535	1～125
			D0～D3999	→	400001～465535	1～125
2						
•						
•						

Modbus Slave	Address mapping between Modbus and Fatek (Port 1~4 works as the slave device through Modbus Communication Protocol)	Modbus Slave

- FBs-PLC can use FUN150 to be Modbus protocol Master, besides it also can be Modbus communication Slave by configuration(Port1～Port4, but Port0 fixed to Fatek communication protocol) then it can connect with the intelligent peripheral.
- See below for Modbus and Fatek data address mapping rules:

Mapping Rule

Modbus		Fatek
5 Code	0XXXX	Discrete elements of Ynnn、Xnnn、Mnnnn、Snnn、Tnnn、Cnnn
	4XXXX	Data Registers of Rnnnn、Dnnnn、Tnnn、Cnnn
6 Code	00XXXX	Discrete elements of Ynnn、Xnnn、Mnnnn、Snnn、Tnnn、Cnnn
	40XXXX	Data Registers of Rnnnn、Dnnnn、Tnnn、Cnnn

Available Range(5 Code)

Modbus	FATEK	Description
00001～00256	Y0～Y255	Discrete Output
01001～01256	X0～X255	Discrete Input
02001～04002	M0～M2001	Discrete M Relay
06001～07000	S0～S999	Discrete S Relay
09001～09256	T0～T255	Status of T0～T255
09501～09756	C0～C255	Status of C0～C255
40001～44168	R0～R4167	Holding Register
45001～45999	R5000～R5998	Holding Register or ROR
46001～48999	D0～D2998	Data Register
49001～49256	T0～T255	Current Value of T0～T255
49501～49700	C0～C199	Current Value of C0～C199(16-bit)
49701～49812	C200～C255	Current Value of C200～C255(32-bit)

Modbus Slave	Address mapping between Modbus and Fatek (Port 1~4 works as the slave device through Modbus Protocol)	Modbus Slave

Available Range(6 Code)

Modbus	FATEK	Description
000001～000256	Y0～Y255	Discrete Output
001001～001256	X0～X255	Discrete Input
002001～004002	M0～M2001	Discrete M Relay
006001～007000	S0～S999	Discrete S Relay
009001～009256	T0～T255	Status of T0～T255
009501～009756	C0～C255	Status of C0～C255
400001～404168	R0～R4167	Holding Register
405001～405999	R5000～R5998	Holding Register or ROR
406001～408999	D0～D2998	Data Register
409001～409256	T0～T255	Current Value of T0～T255
409501～409700	C0～C199	Current Value of C0～C199(16-bit)
409701～409812	C200～C255	Current Value of C200～C255(32-bit)

※※ Special Register and Relay Available Range

Modbus	FATEK	Description
02001～03912	M0～M1911	General purpose Internal Relay
03913～04002	M1912～M2001	Special Internal Relay
40001～43840	R0～R3839	General purpose Register
43841～43904	R3840～R3903	Analog or Numeric Input Register
43905～43968	R3904～R3967	Analog or Numeric Output Register
43969～44168	R3968～R4167	Special Register

Modbus Slave	Port 1~4 simulates the Modbus slave device	Modbus Slave

Add new address mapping for Modbus slave communication protocol; out of range access, the PLC will reply communication error

Register No.	Value	Description
R3968	=A55AH	New address mapping for Modbus slave communication protocol (Detailed as below)
	= Others	Existed address mapping for Modbus slave comm. protocol
R3969	0 ~ 65535	. Assign the starting address of discrete output of Modbus . 0 ~ 65535 : it means discrete output 000001 ~ 065536 . Apply to function code 01, 05, 15 of Modbus protocol
R3970	0 ~ 2001	. Assign the starting address of internal relay of FATEK . 0 ~ 2001 : it means internal relay M0 ~ M2001 . Apply to function code 01, 05, 15 of Modbus protocol
R3971	1 ~ 2001	. Assign the range of access both for discrete output (Modbus) and internal relay (FATEK) . 1 ~ 2001 : it means access range between 1 ~ 2001 point . It is the group R3969 ~ R3971 for mapping the discrete output (Modbus) and internal relay (FATEK) for access (R3968 should be A55AH)
R3972	0 ~ 65535	. Assign the starting address of discrete input of Modbus . 0 ~ 65535 : it means discrete input 100001 ~ 165536 . Apply to function code 02 of Modbus protocol
R3973	0 ~ 2001	. Assign the starting address of internal relay of FATEK . 0 ~ 2001 : it means internal relay M0 ~ M2001 . Apply to function code 02 of Modbus protocol
R3974	1 ~ 2001	. Assign the range of access both for discrete input (Modbus) and internal relay (FATEK) . 1 ~ 2001 : it means access range between 1 ~ 2001 point . It is the group R3972 ~ R3974 for mapping the discrete input (Modbus) and internal relay (FATEK) for access (Don't care R3968)
R3975	0 ~ 65535	. Assign the starting address of register input of Modbus . 0 ~ 65535 : it means register input 300001 ~ 365536 . Apply to function code 04 of Modbus protocol
R3976	0 ~ 3839	. Assign the starting address of R register of FATEK . 0 ~ 3839 : it means R register R0 ~ R3839 . Apply to function code 04 of Modbus protocol

Modbus Slave	Port 1~4 simulates the Modbus slave device	Modbus Slave

R3977	1 ~ 3840	. Assign the range of access both for register input (Modbus) and R register (FATEK) . 1 ~ 3840 : it means access range between 1 ~ 3840 word . It is the group R3975 ~ R3977 for mapping the register input (Modbus) and R register (FATEK) for access (Don't care R3968)
R3978	0 ~ 65535	. Assign the starting address of holding register of Modbus . 0 ~ 65535 : it means holding register 400001 ~ 465536 . Apply to function code 03, 06,16 of Modbus protocol
R3979	0 ~ 3839	. Assign the starting address of R register of FATEK . 0 ~ 3839 : it means R register R0 ~ R3839 . Apply to function code 03, 06,16 of Modbus protocol
R3980	1 ~ 3840	. Assign the range of access both for holding register (Modbus) and R register (FATEK) . 1 ~ 3840 : it means access range between 1 ~ 3840 word . It is the group R3978 ~ R3980 for mapping the holding register (Modbus) and R register (FATEK) for access (R3968 should be A55AH)

For example. R3968=A55AH, it means new address mapping for Modbus slave comm. protocol

R3969=0, R3970=1000, R3971=100: Mapping 000001 ~ 000100 (Modbus)
M1000~M1099 (FATEK)

R3972=10, R3973=1100, R3974=50: Mapping 100011 ~ 100060 (Modbus)
M1100 ~ M1149 (FATEK)

R3975=50, R3976=1000, R3977=10: Mapping 300051 ~ 300060 (Modbus)
R1000 ~ R1009 (FATEK)

R3978=100, R3979=2000, R3980=200: Mapping 400101 ~ 400300 (Modbus)
R2000 ~ R2199 (FATEK)

Modbus Slave	Configuration of Port 1~4 for working as the Modbus Protocol	Modbus Slave

● Port 1～4 support Modbus RTU/ASCII (Slave) communication protocol

. Method 1 (All OS versions of FBs PLC can support this method)

R4047 : Upper Byte = 55H，configure the communication port of Modbus RTU protocol

= Other values，Port 1～4 don't support Modbus RTU protocol (FATEK as the default)

Lower Byte : Port assignment for Modbus RTU protocol

Format as below :

Upper Byte	Lower Byte							
55	b7	b6	b5	b4	b3	b2	b1	b0

b0, Reserved ;

b1=0, Port 1 acts as FATEK protocol
=1, Port 1 acts as Modbus RTU protocol

b2=0, Port 2 acts as FATEK protocol
=1, Port 2 acts as Modbus RTU protocol

b3=0, Port 3 acts as FATEK protocol
=1, Port 3 acts as Modbus RTU protocol

b4=0, Port 4 acts as FATEK protocol
=1, Port 4 acts as Modbus RTU protocol

.
.
.

b7～b5, Reserved

※ It allows to assign multiple ports for Modbus RTU protocol，where the corresponding bit must be 1。

For example:

R4047=5502H, Assign Port 1 as Modbus RTU protocol ;

R4047=5504H, Assign Port 2 as Modbus RTU protocol ;

R4047=5506H, Assign both Port 1 & Port 2 as Modbus RTU protocol。

Modbus Slave	Configuration of Port 1~4 for working as the Modbus Protocol	Modbus Slave

. Method 2 (FBs PLC OS V4.24 or later can support this method)

R4047 : Upper Byte = 56H，configure the communication port of FATEK or Modbus RTU/ASCII communication protocol

= Other values，it doesn't work above function

Lower Byte : Port assignment for communication protocols

Format as below :

Upper Byte	Lower Byte							
56	b7	b6	b5	b4	b3	b2	b1	b0

Bits	Value	Description
b1b0	0 or1	Port 1 works FATEK protocol
	2	Port 1 works Modbus RTU protocol
	3	Port 1 works Modbus ASCII protocol
b3b2	0 or 1	Port 2 works FATEK protocol
	2	Port 2 works Modbus RTU protocol
	3	Port 2 works Modbus ASCII protocol
b5b4	0 or 1	Port 3 works FATEK protocol
	2	Port 3 works Modbus RTU protocol
	3	Port 3 works Modbus ASCII protocol
b7b6	0 or 1	Port 4 works FATEK protocol
	2	Port 4 works Modbus RTU protocol
	3	Port 4 works Modbus ASCII protocol

Chapter 14 Application of ASCII File Output Function

The FBs-PLC's ASCII file output function allows the PLC to directly drive ASCII output devices such as printers and terminals, and let them print or display English document data or display screens such as production reports, materials details and warning messages. For application of the ASCII file output function, it is necessary to edit, the ASCII file data to be output must be edited to fit the required format of the FBs-PLC FUN 94 (ASCWR) instruction. Then using this instruction, it will be sent out via port 1 to the ASCII output device connected with port 1.

14.1 Format of ASCII File Data

ASCII file data may be divided into fixed, unchanging background file data and dynamically changing variable data. The background file data may be in English characters, numerals, symbols, graphs, etc, and the variable data can only be printed out as binary, decimal, or hexadecimal numeric value data.

ASCII code is a byte length code, which has a total of 256 combinations. Of these, the first 128 (0-127) are fairly clearly defined and are used by most of the ASCII peripherals. For codes greater than 128 each manufacturer has different definitions and graphics and there are no uniform specifications. FBs-PLC designed the FUN 94 (ASCWR) instruction to be solely responsible for transmission, and not for editing. This work is done by the ASCII editor of the WinProladder software package. Below is the editing command format adopted by the WinProladder software package editor.

1. Basic command Symbols

- | / | Linefeed

A line slanting down from right to left means that no matter where the printing is up to, if this symbol is encountered, then the printing head or the terminal display will move to the beginning (the very left) of the next line and go on printing or displaying from that point. A series of "/" will create a succession of linefeeds (one "/" will cause one linefeed) .

- | \ | Pagefeed

A line slanting down from left to right means that when this symbol is encountered the printing head or the terminal display will move to the beginning (top left hand corner) of the next page, and continue printing or displaying from that point. A series of "\" will create a succession of pagefeeds. (One "\" will cause one pagefeed).

- | , | Comma

Used to separate statements in the file data. All the data included between two commas is a complete and executable statement (must not be used for beginning and end of file). Note that although the shape of a comma is the same as the shape of a single quotation mark, their positions are different (the comma is in a position near the center of the letter, while the single quotation mark is near the top right corner). The function meaning that they represent is completely different. Please refer to Item 2, background data format - statements.

- | END | File end

At the end of the ASCII file END is added to show that the ASCII file is finished.

2. Background Data Format

, $\underline{\text{M X}}$ $\underbrace{\text{N N}_1\text{ N N}_2\cdots\cdots\cdots}$, Repeat ASCII code（N）	or	, M X ' $\underbrace{\text{A B C D E F G H I J K}}$ ' , Repeat tangible ASCII code

- MX:
  Represents the number of repeats. M can be 1 to 999. The ASCWR instruction can send out M times successively all the hexadecimal ASCII code or tangible ASCII code data contained between X and the first comma (,). If there is no data after X (ie, the comma comes directly after X), then the ASCWR instruction will send out M successive space codes. If you only have to send out the ASCII code or the tangible ASCII code once, then MX can be discarded.

- ASCII code data format: This data format has an N two-digit hexadecimal value. Every two adjoining hexadecimal numerals starting from the right hand side of X will be regarded as an ASCII code. NN can be any ASCII code, including tangible or intangible ASCII code such as English characters, numeric symbols or control codes. However, its main use is as a special tangible code for control codes which cannot be represented by tangible character fonts or cannot find a font or symbol on the WinProladder ASCII editor. For tangible characters or symbols that can be directly represented on the ASCII editor by tangible keys, it should be more convenient to use the original printing out format. For example, if you want to print out the character "A", with the original printing method you can type A via the keyboard. But if you want to use ASCII code, you must check the table on which "A" is represented by 41 H, and then enter 41. It is obviously a lot less convenient.

- Original printing out tangible ASCII code data format: What is enclosed within two single quotation marks' ', can only be tangible ASCII code such as English characters, numerals, symbols, and graphics (characters that can be found on or input via the ASCII editor keyboard). The ASCWR instruction will faithfully print out all the characters that are contained in ' ', so if you need to print out a single quotation mark itself, you must have two successive single quotation marks. For example:

'I''M A BOY' will be printed out as I' M A BOY

If the graphics or symbols of the ASCII output device cannot be found on the ASCII editor keyboard, then you naturally are unable to do input using this format. In such a case you can check the ASCII code for that symbol or graphic, and use ASCII code to input and print out.

3. Variable Data Format

, "<u>8</u> <u>. 2</u> <u>R 0</u> <u>D</u>" ,

format code
variable register
digits after the decimal point
total number of variables printed out

A data statement within two double quotation marks " ", is used to specify the register address of variable data, and what format or format code it will be printed out .

- Total number of variables printed out: In this example, "8" are used to print out the reserved 8 digit columns of the variable (R0) numeric value (including negative signs). If the variable value is larger than the total number of printed out digits then the high digit will be cut out. If the number of digits is insufficient, the remaining positions will be occupied by spaces.

- Digits after the decimal point: The number of digits after the decimal point within the total number of digits of the variable. In this example, in a total number of 8 digits, there are 2 places after the decimal point. The decimal point symbol "." itself occupies one position so the integer will remain 5 digits.

- Variable register: Can be R, D,WX, WY, etc, of a 16-bit register, or DR,DD,DWX, DWY, etc, of a 32-bit register. The contents of these registers can be retrieved and printed out using the format and format code specified by the contents of " " .

- Format code: Can use hexadecimal H, decimal D or binary B format for printing out (when format code is not specified, it will be decimal - therefore D can be omitted).

This example assumes that the content value of R0 is -32768. In the 8.2 format, the print out result is

	−	3	2	7	.	6	8

If the format changes from 8.2 to 5.1 then the print out result changes to

2	7	6	.	8

14.2 Application Examples of ASCII File Output

The file data print out will start from the top left hand corner of each page. It will print from left to right with lines going from top to bottom (please refer to the format in the diagram below). When the final character in a line is reached (this varies according to the output device - a printer can have 80 characters or 132 characters), the printer will automatically jump to the start (left-hand side) of the next line. If it has not yet printed to the final character, but encounters the linefeed command (/) or the page feed command (\), then it will jump to the start of the next line or the next page, and start printing from that point.

Suppose that the production statistics table for the manufacturing division of a certain company has the following format. This can be used as an example to explain the editing and printing out of its ASCII file data.

```
←·················· 28 spaces···················· →  PRODUCTION REPORT
                                                      =================
←·······························52 spaces ····································································→DATE: 1/20/99

←··· ·16 spaces·· ·· →  TOTAL NUMBER            （A） :        1000 PCS
                        NUMBER OF YIELD         （B） :         983 PCS
                        NUMBER OF REPAIR        （C） :          17 PCS
                        STANDARD TIME           （D） :         8.5 MIN／PCS
                        TOTAL WORKING TIME      （E） :        8500 MIN
                        ACTUAL WORKING TIME     （F） :        9190 MIN
                        EFFICIENCY              （G） :        92.49 ％


←··· ··· ···  22 spaces··· ··· ···        →REMARK:   A×D＝E，E／F＝G
```

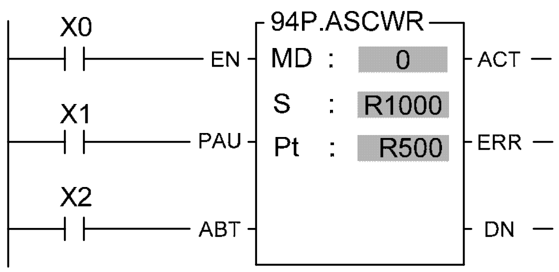
Before editing this file, you must first tell the file editor starting from which register within PLC the file to be edited shall be stored. When editing the file data, you must differentiate whether the file data to be edited (printed out) is fixed background data or variable data. The background data can be input using ASCII characters or symbol graphic of the original print out format (using what is contained inside ' '), or it can directly use the ASCII code of its character or symbol graphics. As for the variable data section, because it is stored in registers (so as long as the variable value changes, the print out numerical value will change with it), the print out message must contain the register number and print out format, such as number of characters, digits after the decimal point etc, as well as the format code that is used for the print out (contained inside " "). In the example in the table above, the year, month, day data and the total number (A) to efficiency (G) figures are all variable data. It assumes that the year, month, day data accesses the year, month, day registers (R4133 to R4131) within the real time clock register RTCR. R0 stores the total number (A), R1 stores the number of yield (B), etc, and R6 stores the efficiency (G) value. Below is the ASCII file data for this statistical table example:

```
///,28X,'PRODUCTION REPORT',/,28X,'==================', /,
52X,'Date:',"2R4132",'/',"2R4131",'/',"2R4133",//,16X,'TOTAL    NUMBER
(A) :',"10R0",' PCS',//,16X, 'NUMBER OF YIELD       (B) :' , "10R1",'
PCS',//,16X,'NUMBER TO REPAIR     (C) :',"10R2",' PCS',//,16X,'STANDARD TIME
(D) :',"10.1R3",' MIN/PCS',//,16X,'TOTAL WORKING    TIME (E) :',"10R4",'
MIN',//,16X,'ACTUAL WORKING TIME(F) :',"10R5",' MIN',//,16X,'EFFICIENCY
(G) :' ," 10.2R6",' %',/////,22X,'REMARK: AXD=E, E/F=G',END
```

* : In the above example ' ================== ' can be replaced by 18X'=' or 18X3D.

During the process of file output, when the output reaches variable data, the CPU will retrieve and do output with the numerical values at that time of the register whose address are contained within the " ". Therefore, if a variable is printed out both at the beginning and end of a file, a different numerical value may be obtained (when it has printed to halfway the register value changes).

After the file editing has been completed, the FUN94 instruction can be used to print out its background and dynamic data. If this file is edited (stored) starting from R1000, then when it is outputting, S must be specified as R1000 before there can be an accurate output, as seen in the program example in the diagram below left. Supposing that the numerical value of the variable register is as shown in the diagram below right, then when X1 and X2 are 0, and X0 goes from 0 to 1, this instruction will print out the statistical table from the previous page, from Port 1 of PLC.



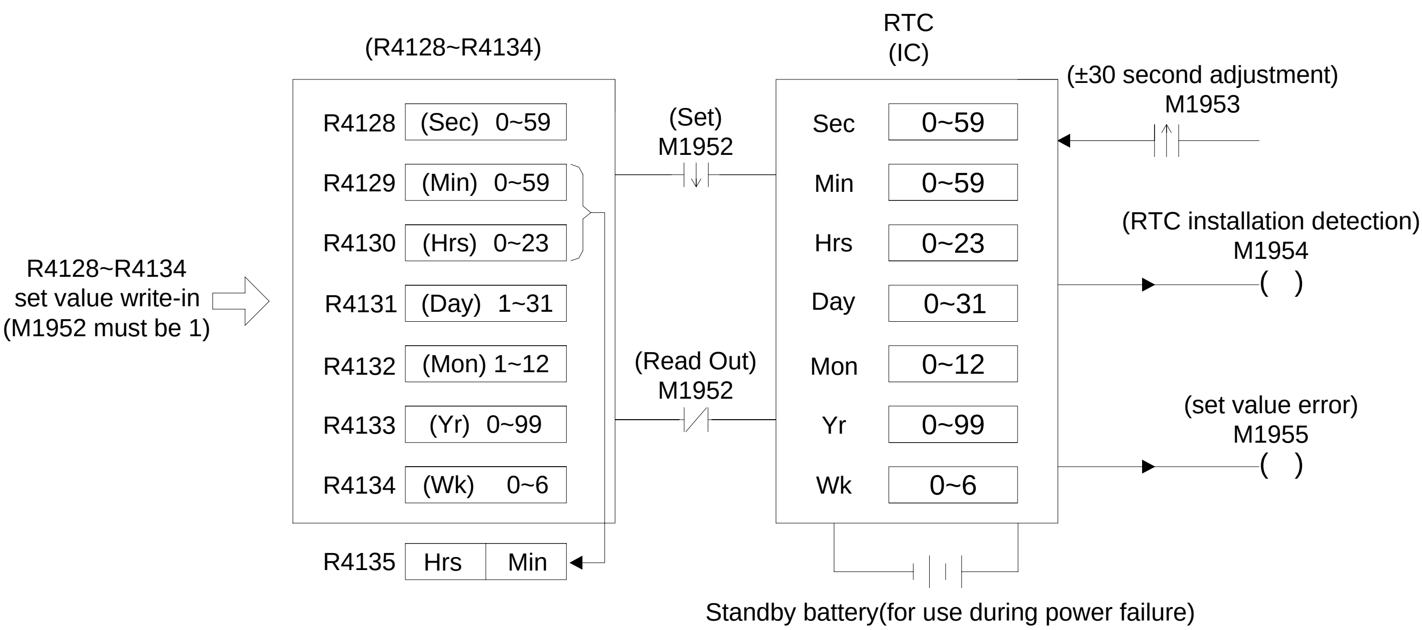
R4133	=82	R2	=17
R4132	=12	R3	=85
R4131	=00	R4	=8500
R0	=1000	R5	=9190
R1	=983	R6	=9249

Chapter 15 Real Time Clock （RTC）

A real time clock (RTC) has been built in the FBs-PLC's MC/MN main unit. No matter whether the PLC is switched on or off, the RTC will always keep accurate time. It provides 7 kinds of time value data-week, year, month, day, hour, minute and second. Users can take advantage of the real time clock to do 24 hour controls throughout the year (for example, businesses or factories can switch lights on and off at set times each day, control gate access, and do pre-cooling and pre-heating before business or operations begin). It can enable your control system to automatically coordinate with people's living schedules, and not only will it raise the level of automatic control, it will improve efficiency.

15.1 Correspondence Between RTC and the RTCR Within PLC

Within PLC, there are special purpose registers (RTCR) for storing the time values of the RTC. There are 8 RTCR registers in all, going from R4128 to R4135. R4128 to R4134 are used to store the 7 kinds of time values mentioned above, from weeks to seconds. Because in practical daily application, certain hour and minute time data is often used, we have specially merged the time values of the hour register (R4130) and minute register (R4129) within RTCR, and put them in R4135 high byte and low byte, so they can be accessed by the user. The diagram below shows the correspondence between RTC and the RTCR within PLC, as well as the control switch and status flag (M1952-M1955) related to RTC accessing.

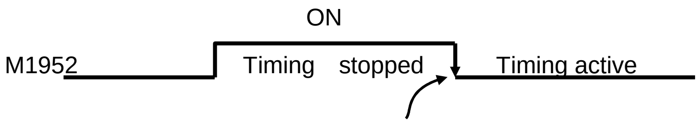


※D4053= 0，no RTC chip installed
= 1，RTC chip is HT1381
= 2，RTC chip is ISL1208
= 3，RTC chip is S35390A

15.2 RTC Access Control and Setting

Within PLC, R4128~R4134 registers have been allocated to store the time values of RTC, and this is of great convenience to the user. However, if you want to load the set values of R1428~R4134 into RTC or read out what is in RTC onto R1428~R4134, and tune the time value etc, then the setting must be done using the special relays (M1952 and M1953) for RTC access. Below is an explanation of the access and adjustment procedures, and the status flag relays.

1. RTC setting:
   The (R4128~R4134→RTC) setting action is only executed once at the moment that relay M1952 goes from 1→0 (falling edge).



At the moment when M1952 goes from 1 to 0, the set values of R4128 to R4134 within RTCR will be written into the corresponding hardware registers within RTC. After M1952 has returned to 0 the timing action will start. Also, with each scan, CPU will retrieve time values from RTC in the opposite direction and write them onto R4128~R4134.

Note: If you want to load the set values into RTC, you must first make M1952 as 1 and then load the set values into R4128~R4134. The loading of the set values into R4128~R4134 can be done via MOVE instruction. However, you must first halt the RTC read out (make M1952 as 1), otherwise the data that you just wrote into R4128~R4134 will immediately be overridden by the time data being read back from RTC in the opposite direction.

2. RTC read out (RTC→R4128~R4135):
   whenever the M1952 relay is 0 (RTC timing active). With every scan, CPU will take the time value data within RTC and move it to R4128~R4135. When it is 1, it will not read out. In this case R4128~R4135 can load in the set values and they won't be overridden.

3. ±30 second adjustment:
   At the moment that the status of relay M1953 goes 1, CPU will check the value of the second register (R4128) within RTC. If its value is between 0 and 29 seconds then it will be cleared to 0. If its value is between 30 and 59 seconds then besides being cleared to 0, the minute register (R4129) will be increased by 1 (ie, one minute will be added). This can be used to adjust your RTC time value.

4. M1954 RTC installation detecting flag:
   When RTC is fitted to the PLC, relay M1954 will be set as 1; otherwise it will be 0.

5. M1955 set value error flag:
   When the time value which is set to RTC's IC is illegal, then the error flag relay M1955 will be set as 1, and the setting action will not be executed.

Setting calendar with WinProladder

Click the “calendar” Item which in Tool bar **:**

PLC
└ Setting
  └ calendar → Click right button and select “New Table”

● 『PLC current time』**:** It is means current time of PLC in on-line situation. In the “Setup” frame, if “Apply PC time” item is chosen then current time of PC will display below, press “Update PLC time” button to write PC’s current time into PLC. But if “Apply PC time” item isn’t chosen you can modify the Date and Time by yourself. After you change the Date and Time, press “Update PLC time” button to write the Date and time into PLC’s calendar.

15.3 RTC Time Calibration

Real-time Clock is essential in many applications, but due to external temperature changes, the RTC crystal frequency will also change. Thus, the RTC is not as accurate as we expected!

The inaccuracy of Calendar (RTC) circuit in FBs main unit is from crystal frequency. The inaccuracy includes: manufacturing causes, crystal aging and working temperature changes caused by temperature frequency difference (as they are given the technical parameters of crystal products, usually several PPM to tens PPM).

When the crystal frequency is deviated from specific value in actual work, it is caused by time calibration. We must try to compensate the inaccuracy.

As the actual vibration frequency of the same nominal value of each crystal, which matches with a nominal value of capacitor, must fall within in a certain range. In addition, FBs series (D4053=3) provides a digital clock adjustment function. It can also change 32768Hz pulses/second, and then reached adjustment of the clock in which the PLC is to maintain high accuracy travel time. The related time adjustment register is D4054.

According to experimental experiences of time calibration (seconds/day), and then refer to the below table to find the corresponding error and makes correction. It is to improve timing accuracy.

The following table shows the error of seconds when a day goes. The time adjustment register (D4054) is to set the corresponding correction parameters, range is from -16.88 to +16.61 seconds.

Figure 1： Time calibration table when D4053=3

Rate (S/DAY)	Time adjustment register D4054	Rate (S/DAY)	Time adjustment register D4054	Rate (S/DAY)	Time adjustment register D4054	Rate (S/DAY)	Time adjustment register D4054
16.61	56FCH	4.55	562DH	-0.18	567FH	-4.82	5693H
16.35	567CH	4.46	56CDH	-0.26	56BFH	-4.91	5613H
16.09	56BCH	4.37	564DH	-0.35	563FH	-5.00	56E3H
15.83	563CH	4.28	568DH	-0.43	56DFH	-5.09	5663H
15.57	56DCH	4.19	560DH	-0.52	565FH	-5.18	56A3H
15.31	565CH	4.10	56F5H	-0.60	569FH	-5.27	5623H
15.05	569CH	4.01	5675H	-0.69	561FH	-5.36	56C3H
14.79	561CH	3.92	56B5H	-0.77	56EFH	-5.45	5643H
14.53	56ECH	3.83	5635H	-0.86	566FH	-5.54	5683H
14.27	566CH	3.74	56D5H	-0.94	56AFH	-5.62	5603H
14.01	56ACH	3.65	5655H	-1.03	562FH	-5.83	5656H
13.75	562CH	3.56	5695H	-1.11	56CFH	-6.09	5696H
13.49	56CCH	3.47	5615H	-1.20	564FH	-6.36	5616H
13.23	564CH	3.38	56E5H	-1.28	568FH	-6.62	56E6H
12.97	568CH	3.29	5665H	-1.37	560FH	-6.89	5666H
12.71	560CH	3.20	56A5H	-1.45	56F7H	-7.15	56A6H
12.45	56F4H	3.11	5625H	-1.54	5677H	-7.42	5626H
12.19	5674H	3.02	56C5H	-1.62	56B7H	-7.68	56C6H
11.93	56B4H	2.93	5645H	-1.71	5637H	-7.95	5646H
11.66	5634H	2.84	5685H	-1.79	56D7H	-8.21	5686H
11.39	56D4H	2.75	5605H	-1.88	5657H	-8.48	5606H
11.13	5654H	2.66	56F9H	-1.96	5697H	-8.74	56FAH
10.86	5694H	2.57	5679H	-2.05	5617H	-9.01	567AH
10.60	5614H	2.48	56B9H	-2.13	56E7H	-9.17	56BAH
10.33	56E4H	2.39	5639H	-2.22	5667H	-9.43	563AH
10.07	5664H	2.31	56D9H	-2.30	56A7H	-9.69	56DAH
9.80	56A4H	2.22	5659H	-2.39	5627H	-9.95	565AH
9.54	5624H	2.14	5699H	-2.48	56C7H	-10.21	569AH
9.27	56C4H	2.05	5618H	-2.57	5647H	-10.47	561AH
9.01	5644H	1.97	56E9H	-2.66	5687H	-10.73	56EAH
8.74	5684H	1.88	5669H	-2.75	5607H	-10.99	566AH

8.48	5604H	1.80	56A9H	-2.84	56FBH	-11.25	56AAH
8.21	56F8H	1.71	5629H	-2.93	567BH	-11.51	562AH
7.95	5678H	1.63	56C8H	-3.02	56BBH	-11.77	56CAH
7.68	56B8H	1.54	5649H	-3.11	563BH	-12.04	564AH
7.42	5638H	1.46	5689H	-3.20	56DBH	-12.30	568AH
7.15	56D8H	1.37	5609H	-3.29	565BH	-12.57	560AH
6.89	5658H	1.29	56F1H	-3.38	569BH	-12.83	56F2H
6.62	5698H	1.20	5671H	-3.47	561BH	-13.10	5672H
6.36	5618H	1.12	56B1H	-3.56	56EBH	-13.37	56B2H
6.09	56E8H	1.03	5631H	-3.65	566BH	-13.64	5632H
5.83	5668H	0.95	56D1H	-3.74	56ABH	-13.91	56D2H
5.56	56A8H	0.86	5651H	-3.83	562BH	-14.18	5652H
5.54	56FDH	0.77	5691H	-3.92	56CBH	-14.45	5692H
5.45	567DH	0.69	5611H	-4.01	564BH	-14.72	5612H
5.36	56BDH	0.60	56E1H	-4.10	568BH	-14.99	56E2H
5.27	563DH	0.52	5661H	-4.19	560BH	-15.26	5662H
5.18	56DDH	0.43	56A1H	-4.28	56F3H	-15.53	56A2H
5.09	565DH	0.35	5621H	-4.37	5673H	-15.80	5622H
5.00	569DH	0.26	56C1H	-4.46	56B3H	-16.07	56C2H
4.91	561DH	0.18	5641H	-4.55	5633H	-16.34	5642H
4.82	56EDH	0.09	5681H	-4.64	56D3H	-16.61	5682H
4.73	566DH	0	0000H	-4.73	5653H	-16.88	5602H
4.64	56ADH	-0.09	56FFH				

Note: The clock adjustment circuitry only adjusts time calibration. It does not adjust frequency of crystal itself, so there is no change in pulse output 32768Hz.

Examples of setting a range adjustment value

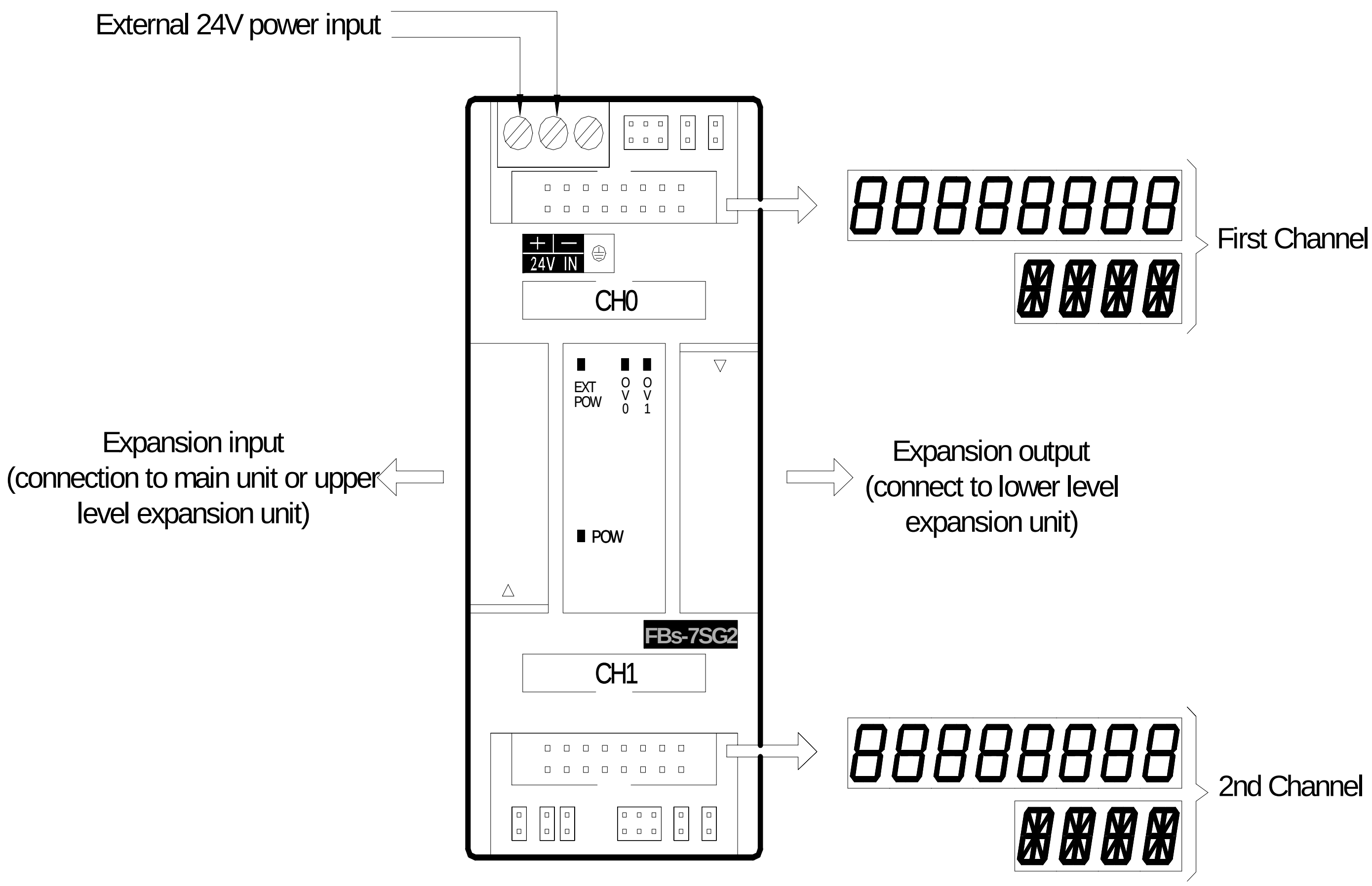
1. When PLC time calibration takes daily faster 3.38 seconds, the time calibration value is 3.38 seconds / day, Look-up the above table to adjust value = 56E5H
2. When PLC time calibration takes daily slower 5.62 seconds, the time calibration is -5.62 seconds / day, Look-up the above table to adjust value = 5603H

Chapter 16 7/16-Segment LED Display Module

16.1 FBs-7SG Overview

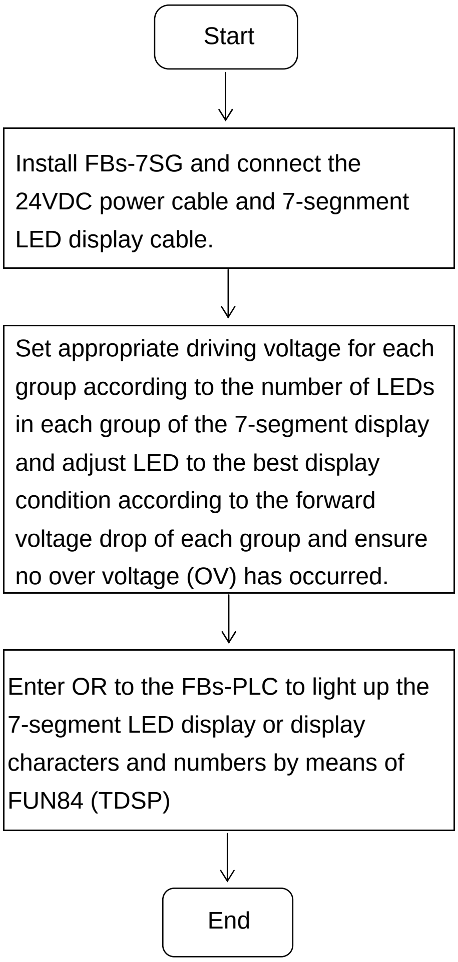
There two models in the FBs-7SG range: 7SG1 and 7SG2. Each of which has one or two 8-digit display driver ICs for driving eight or sixteen 7-segment LED displays using a common ground; or four or eight 16-segment LED displays. The drawing below is an example of FBs-7SG2.

Appearance



FBs-7SG has been equipped with an exclusive 7-segment LED display driver IC for multiplexing display of one to eight 7-segment or one to four 16-segment LED displays (one group). With one 16-core flat ribbon cable, users can display 8 digits (numbers) or 64 independent LED displays (8 LEDs for one digit, selectable between digital or LED display) or 4-digit character display. Every 7SG module will occupy three to eight output registers(OR) addresses (R3904 ～R3967) in the I/O address. Therefore, the PLC can control a maximum of 192 7-segnment displays or 64 16-segment displays or 1024 independent LED displays.

16.2 The Procedure of Using FBs-7SG Module



- See FBs-7SG Hardware Wiring, Section 16.4.1 for details. Refer to Section 16.4 for details about the circuit of 7-segment LED display
- See FBs-7SG Hardware Setup, Section 16.4.2 for details.
- See FUN84. TDSP Commands, Section 16.8 for details.

16.3 FBs-7SG I/O Address

Every FBs-7SG module will occupy three to eight output registers(OR) addresses (R3904~R3967) in the I/O address. In general, WinProladder will detect and calculate the actual I/O addresses occupied by the expansion modules installed on the system after connecting to the PLC. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming.

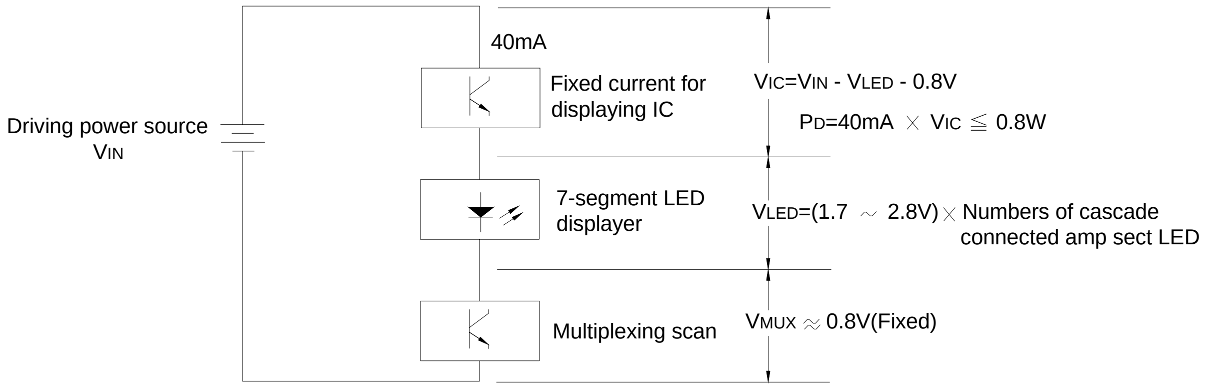
16.4 FBs-7SG Hardware Wiring and Setup

16.4.1 FBs-7SG Hardware Wiring

The hardware wiring diagram of FBs-7SG is shown above. In addition to the external 24V power, expansion module input and expansion module output, users will only need to connect the output to a 7-/16-segment LED display board with an 16-core FRC flat ribbon cable.

16.4.2 FBs-7SG Hardware Setup

The drawing below presents the output driver circuit of the internal display IC on FBs-7SG. General users will not need to calculate the voltage drop of LEDs. They will only need to adjust the voltage according to the jumper table below in order to prevent over voltage.

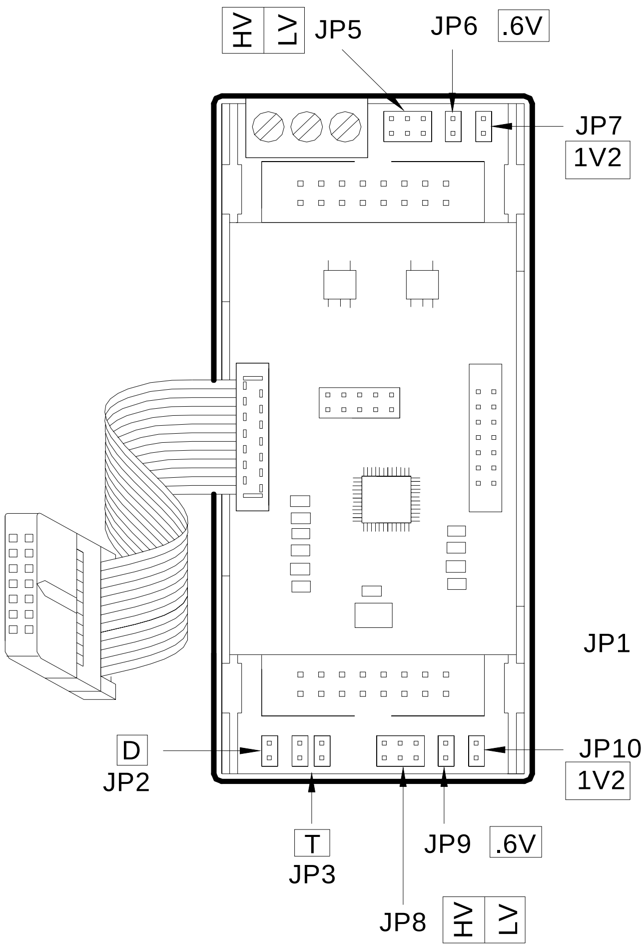


The power consumption will completely depend on the amount of voltage drop V_{IC} (P_D = 40mA × V_{IC}) connected to it because the IC current source is fixed at 40mA. As shown in the above diagram, $V_{IC} = V_{IN} - V_{LED} - 0.8V$, i.e. V_{IC} is affected by the driving current voltage V_{IN} and the forward voltage drop of the 7-segment display V_{LED}, because the safety power consumption of display IC at the severest ambient temperature condition must be controlled at or under 0.8W; i.e. V_{IC} must be smaller than 2V. If the V_{IC} is too low, the brightness of the LED will be reduced; if it is too high, it will result in incorrect display (LEDs that are not supposed to be lighted up will be lighted up) or display IC damage.

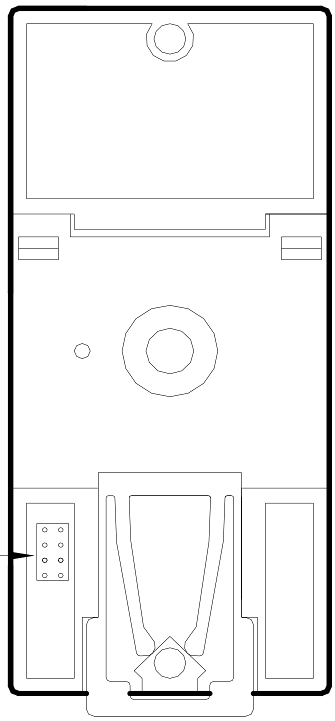
The forward voltage drop of LED is generally between 1.7V and 2.8V. Depending on the size of ordinary 7-segment or 16-segment LED displays, each segment (e.g. a-g) consists of one to five LEDs connected in series. While the range of forward voltage drop among segments will be from 1.7V to 14V, it will be impossible to drive different LED displays with a single voltage. In order to drive the majority 7-segment LED displays, FBs-7SG comes with four driving voltage options at 5V (low-voltage), 7.5V, 10V and 12.5V (high voltage for the last three options) and a fine tuning function at 0.6V-1.8V by means of the diodes and jumpers incorporated to them. In practice, the power supply can drive LEDs of different forward voltages and prevent display IC from blowing by limiting V_{IC} within 2V. The diagrams below show the high/low voltage setup (common) of LED on FBs-7SG, the high/low voltage driving options of displays and the jumper setting of forward voltage drop fine tuning, and its exaction location (as seen after opening the top cover of FBs-7SG).

In this section, we will show you how to obtain the optimal display of 7-/16-segment LED displays without blowing or shorten the life of the display IC by means of driving voltage (V_{IN}) setup, high/low voltage selection and forward voltage fine tuning.

FBs-7SG jumper location



Jumper Layout (open top cover)



Jumper Layout (back of module)

The jumper settings below are referred to FBs-7SG2, because they have covered those in FBs-7SG1.

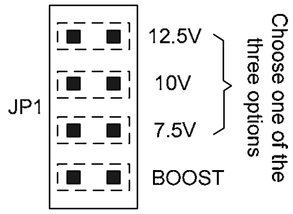
Attribute	Jumper	Function
Common	JP2	Decode (D closed)/Non-decode (D open) setting
	JP3	O.V. Test (T) or Normal (No Jumper) setting
	JP1	High Voltage (HV) selection (back of module)
CH0	JP5	High (HV)/Low (LV) voltage selection
	JP6	0.6V(0.6V) voltage drop fine tuning
	JP7	1.2V(1V2) voltage drop fine tuning
CH1	JP8	High (HV)/Low (LV) voltage selection
	JP9	0.6V(0.6V) voltage drop fine tuning
	JP10	1.2V(1V2) voltage drop fine tuning

FBs-7SG1

FBs-7SG2

JP5/JP8	JP1	JP7/JP10	JP6/JP9	LED Driving Voltage
LV	Inactive	Open	Open	2.4V
		Open	Short	3V
		Short	Open	3.6V
		Short	Short	4.2V
HV	7.5V	Open	Open	4.9V
		Open	Short	5.5V
		Short	Open	6.1V
		Short	Short	6.7V
	10V	Open	Open	7.4V
		Open	Short	8V
		Short	Open	8.6V
		Short	Short	9.2V
	12.5V	Open	Open	9.9V
		Open	Short	10.5V
		Short	Open	11.1V
		Short	Short	11.7V

Short JP5/JP8 with a jumper horizontally; place the jumper head onto the JP5/JP8.
JP1 is located at the back of the module. Turn module over for setup.



Short only one of the three options above. JP1 is effective only when HV is selected from JP5. When LV is selected from JP5, JP1 will be ineffective.

When BOOST is short, the driving voltage will be boosted by 5% to compensate circuit voltage drop. JP5 to JP7 are effective on CH0 and JP8-JP10 on CH1.

FBs-7SG module default jumper setting

Jumper Number	Default Jumper Setting	Note
JP1	Locating in third position(7.5V)	Setting as 7.5V mode
JP2	Plugging jumper	Setting as decode mode
JP3	Only plugging in bottom terminal (equal no Setting)	Don't do over voltage test(O.V.)
JP5	Locating in LV position	Setting as low voltage mode
JP6	Plugging jumper	Fine tuning 0.6V
JP7	No jumper	
JP8	Locating in LV position	Setting as low voltage mode
JP9	Plugging jumper	Fine tuning 0.6V
JP10	No jumper	

16.4.3 LED Driving Voltage Setup and Over-Voltage (OV) Inspection

Users must select the correct driving voltage according to the voltage requirements of LEDs of different sizes before applying the module. If the voltage is too low, the brightness of LEDs will be reduced. If the voltage is too high, the brightness of LEDs will be uneven. More importantly, the LED driver IC will be blown due to over-voltage (O.V.). Therefore, it is necessary to make sure that the CE intermittent voltage (V_{IC}) of the driver IC is below 2V to prevent an O.V. of the driver IC. Yet, it is difficult for users to measure the V_{IC} of driver IC in multiplexing. Therefore, FBs-7SG is equipped with an O.V. LED indicator to facilitate users to check if an OV occurs. The O.V. indicator is located next to the output socket on the panel labeled with O.V.

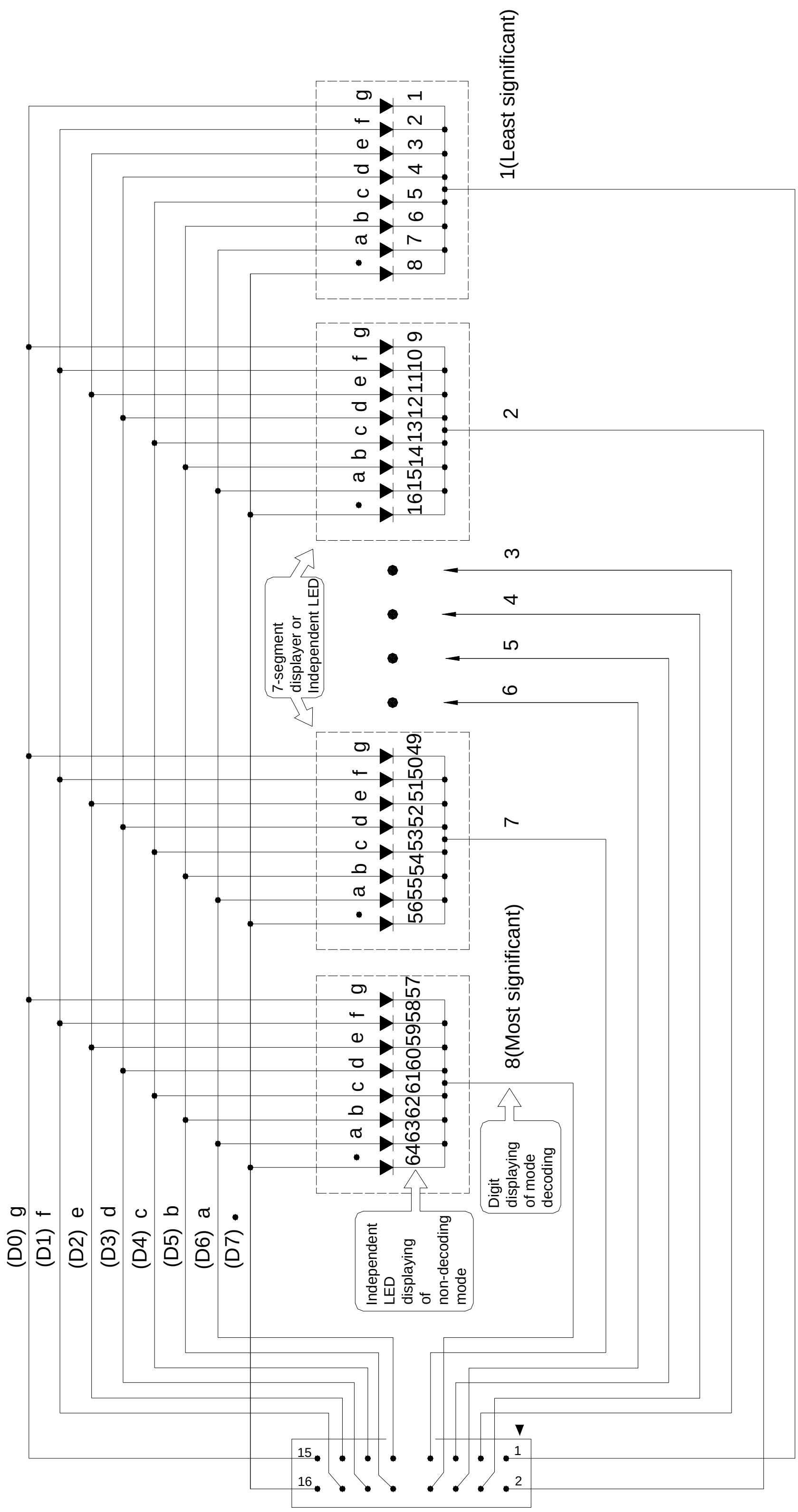
The result of the O.V. indicator is meaningful only when all segments (a total of 64, including the decimal point) are lighted up. If the O.V. indicator is out in this situation, it means there is no O.V. If the indicator is on, it means there is an O.V. (the indicator may blink or is on constantly if not all segments are lighted up, in this case, it is meaningless). If you want to perform a full segment test, set the TEST Jumper (JP3) to “T” (only when the PLC is OFF) on the lower left part of 7SG or use the convenient command (FUN84:TDSP) on 7SG by setting All Input-ON to “1” (PLC is in “RUN” mode) to light up all segments for an O.V. test.

The following examples show the LED of FBs-7SG module driving voltage setup and O.V. test procedures.

1. Set JP3 to “T”.
2. Start with LV and then adjust driving voltage to the required brightness or the O.V. indicator is on according to the jumper setting as shown in the table above. When the O.V. indicator is on, reduce voltage until the O.V. indicator is off. Please be noted that if the brightness is at its maximum level but it cannot meet the requirements, replace LEDs with higher efficiency.
3. Set JP3 back to ‘N” (normal position) or All Input-ON of FUN84:TDSP to “0”.

⚠ Caution
The 7-segment LED display of FBs-7SG is driven by the driver IC with a rated current ≒40mA. The power consumption depends on the V_{IC} of CE because the maximum power limit is only 0.7W/25°C, do not use module in O.V. condition to prevent the driver IC from blowing.

16.5 7-segment LED Display and Individual LED Display Circuits



The above diagram indicates the correct wiring (common ground) of the 7-segment LED display or independent LED display of FBs-7SG. Users may make their own display according to this circuit and layout and connect the display to any output socket on FBs-7SG with a 16-pin flat ribbon cable. We offer LED display boards and products in six different dimensions to meet the demands of users. The table below shows the range of our LED display boards and products.

Model	Specification
DBAN.8-nR	0.8" 4-digit 16-segment LED display, n means R(Red) 16-segment LED characters display installed, can be 1~4
DBAN2.3-nR	2.3" 4-digit 16-segment LED display, n means R(Red) 16-segment LED characters display installed, can be 1~4
DB.56-nR	0.56" 8-digit 7-segment LED display, n means R(Red) 7-segment LED characters display installed, can be 1~8
DB.8-nR	0.8" 8-digit 7-segment LED display , n means R(Red) 7-segment LED characters display installed, can be 1~8
DB2.3-nR	2.3" 8-digit 7-segment LED display, n means R(Red) 7-segment LED characters display installed, can be 1~8
DB4.0-nR	4.0" 4-digit 7-segment LED display , n means R(Red) 7-segment LED characters display installed, can be 1~4

※ Models inside parentheses are products equipped with LED display and ribbon cable socket.

Recommended pin settings

Model	HV/LV (JP5/JP8)	JP1	JP7/JP10	JP6/JP9	Driving Voltage
DBAN.8	LV		Open	Short	3V
DBAN2.3	HV	10V	Open	Open	7.4V
DB.56	LV		Open	Open	2.4V
DB.8	LV		Short	Open	3.6V
DB2.3	HV	10V	Short	Short	9.2V
DB4.0	HV	10V	Short	Open	8.6V

Users can adjust the pin settings tabulated above table on any FATEK standard products. If higher brightness is desired, users can fine-tune the driving voltage according to the jumper settings as shown above. Users must avoid over voltage (O.V.) of output (O.V. indicator will light up) in order not to blow the 7SG module.

Connector pin layout

Pin	Signal	Pin	Signal
1	DIG0	2	DIG1
3	DIG2	4	DIG3
5	DIG4	6	DIG5
7	DIG6	8	DIG7
9	a/D0	10	b/D1
11	c/D2	12	d/D3
13	e/D4	14	f/D5
15	g/D6	16	p/D7

There are two display output connectors on 7SG2, each can support 64 segments of LED display. When all segments are on, 8 segments will be scanned at a time for a total of 8 times.

DIG0-DIG7 as tabulated above refer to low active output signals (Sink or NPN output), only one signal will be active (multiplexing) at the same time to select a group of LEDs (8 segments). a/D0-p/D7 are source output signals (PNP) controlling the display of corresponding segments.

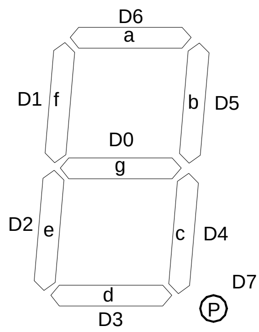
16.6 Decode Display and Non-Decode Display

① Non-decode display: (All segments are dimmed, controlled by user-defined applications independently)

A total of 8 ORs are equipped on FBs-7SG2 to control the display of 128 segments. Each segment is controlled by a corresponding bit. When the bit value is 1, the corresponding segment will light up. The correlations of each segment and OR is tabulated below. OR is the first output register that occupied by the module. Each OR will output signals twice, i.e. 1 bit of data (8 segments) each time. These data will be transferred to the corresponding outputs p/D7-a/D0.

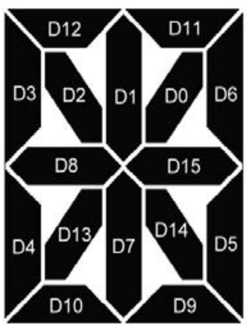
OR		D15~D8	D7~D0
CH0	OR+0	SEG15~SEG8	SEG7~SEG0
	OR+1	SEG31~SEG24	SEG23~SEG16
	OR+2	SEG47~SEG40	SEG39~SEG32
	OR+3	SEG63~SEG56	SEG63~SEG48
CH1	OR+4	SEG15~SEG8	SEG7~SEG0
	OR+5	SEG31~SEG24	SEG23~SEG16
	OR+6	SEG47~SEG40	SEG39~SEG32
	OR+7	SEG63~SEG56	SEG63~SEG48

7-segment LED correspondence



The digit on the farthest right of the display board (8 digits, max.) corresponds to outputs SEG0-SEG7; the next digit to the left corresponds to outputs SEG8-SEG15; the digit on the farthest left of the display board corresponds to outputs SEG63-SEG56. Each 7SG2 can drive sixteen 7-segment LED displays.

16-segment LED correspondence



Segments D0-D15 of the digit on the farthest right of the display board (4 digits, max.) correspond to outputs SEG0-SEG15 on 7SG2; the next digit to the left corresponds to outputs SEG16-SEG31; the digit on the farthest left of the display board corresponds to outputs SEG63-SEG48. Each 7SG2 can drive 8 16-segment LED displays.

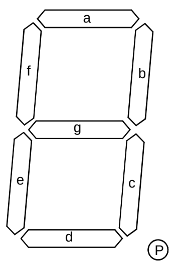
② **Decode Display :** Display data on the corresponding segments with default coding

In this mode, a total of 4 output registers(OR) are equipped on FBs-7SG2 to control the display of 8 digits of 7-segment LEDs. Each digit is controlled by 4 bits. The decimal point of an 8-digit number is controlled by the first output register. Each point is controlled by the corresponding bit. The correlations among the digits, decimal point and ORs are tabulated below. OR is the first output register that occupied by the module.

Attribute	OR	D15~D12	D11~D8	D7~D4	D3~D0	
Common	OR+0	P15~P8		P7~P0		
CH0	OR+1	DIG3	DIG2	DIG1	DIG0	1_st 8-digit
	OR+2	DIG7	DIG6	DIG5	DIG4	
CH1	OR+3	DIG3	DIG2	DIG1	DIG0	2_nd 8-digit
	OR+4	DIG7	DIG6	DIG5	DIG4	

OR0 controls the display of decimal point. When the value is "1", the corresponding decimal point will light up. OR1-OR4 control the display of 16-digit numbers. Each digit will be controlled by four corresponding bits. A total of 16 changes correspond to the following displays.

4-bit digital 7-segment LED decode and non-decode number displays

Nibble Value		7-segment LED display structure	Segment DIM (0) ON (1)							Number
Hexadecimal	Binary		a	b	c	d	e	f	g	
0	0000		1	1	1	1	1	1	0	0
1	0001		0	1	1	0	0	0	0	1
2	0010		1	1	0	1	1	0	1	2
3	0011		1	1	1	1	0	0	1	3
4	0100		0	1	1	0	0	1	1	4
5	0101		1	0	1	1	0	1	1	5
6	0110		1	0	1	1	1	1	1	6
7	0111		1	1	1	0	0	1	0	7
8	1000		1	1	1	1	1	1	1	8
9	1001		1	1	1	1	0	1	1	9
A	1010		0	0	0	0	0	0	1	-
B	1011		1	0	0	1	1	1	1	E
C	1100		0	1	1	0	1	1	1	H
D	1101		0	0	0	1	1	0	1	c
E	1110		0	0	0	1	1	1	1	t
F	1111		0	0	0	0	0	0	0	

ASCII Code and 16-segment number display cross-reference table

MSB / LSB	x000	x001	x010	x011	x100	x101	x110	x111
0000								
0001								
0010								
0011								
0100								
0101								
0110								
0111								
1000								
1001								
1010								
1011								
1100								
1101								
1110								
1111								

16.7 FBs-7SG Input Power Requirements and Consumption

FBs-7SG is equipped with a DC24V isolated power supply to convert an external 24V power input into power supply for use by the internal circuit and 7-segment LED display on FBs-7SG. The tolerance of input is DC24V±20%.

FBs-7SG consumes 2Wmax when idled. The consumption increases according to the number of 7-segments lighted up. The segment driving current of every display IC on FBs-7SG is 40mA. The driving current for displaying one digit using 8 segments consumes 320mA, and the maximum power consumption of a group is obtained as formulated below:

Pd = 320mA $\times$ V_{IN} (LED driving voltage) ÷ 0.8 (power efficiency) W

Total consumption = 2 + Pd $\times$ n（W）

For example, the total power consumption of FBs-7SG2 (output from both groups) at maximum power (V_{IN} = 12.5V, all 8 segments are on):

2W +（320mA $\times$ 12.5V ÷8 ）= 7W

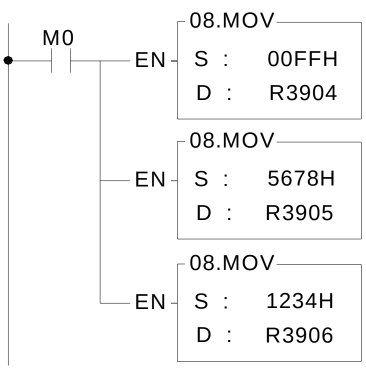
16.8 Controlling Display Contents with OR on FBs-7SG

There are two ways to light up an LED with FBs-7SG. In this section, we will introduce the method of how to light up a 7-segment number display by programming the OR output. In the next section, we will continue with displaying special symbols with FUN84. If displaying numbers with OR controls in decode mode, digits in front of a number will be displayed as 0.

If expansion modules are connected to the FBs PLC, these modules and the I/O address they occupied (see Chapter 12, WinProladder User’s Manual for details) will be displayed on the screen when WinProladder is connected to the PLC. If a FBs-7SG2 is connected to the FBs PLC, users will find in the project window that the system has automatically assigned the output address to FBs-7SG2 when WinProladder is connected to the PLC.

Program example 1 (Decode Display Mode)

Control of 8-digit 7-segment display with FBs-7SG1, with decimal point on. In this case, the FBs-7SG1 must be set to Decode Mode.



Description **:**

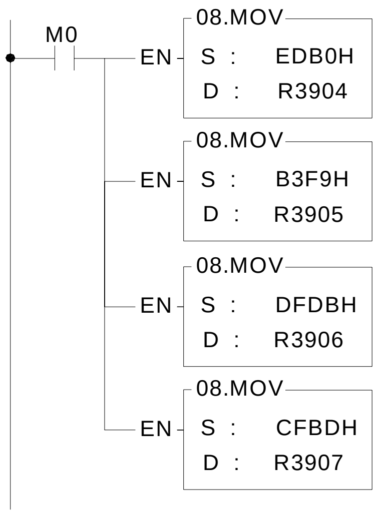
When M0=1, move the value to be output to the OR. As described above, OR+0 (R3904 in the example) controls the display of decimal point in decode mode; OR+1 (R3905 in the example) controls the display of the lower section of the four digits and OR+2 (R3906 in the example) the upper section of the four digits. The results are:

OR	Contents
R3904	00FFH
R3905	5678H
R3906	1234H

7-segment display contents **:** 1.2.3.4.5.6.7.8.

Program example 2 (Non-decode Display Mode)

Display numbers on the 8-digit 7-segment display with FBs-7SG1, with decimal point on. In this case, the FBs-7SG1 must be set to Non-decode Mode.



Description **:**

When M0=1, move the value to be output to the OR. As described above, OR+0 (R3904 in the example) controls the display of the first two digits, OR+1 (R3905 in the example) the third and fourth digits, OR+2 (R3906 in the example) the fifth and sixth digits, and OR+3(R3907 in the example) the last two digits. The results are:

OR	Contents
R3904	EDB0H
R3905	B3F9H
R3906	DFDBH
R3907	CFBDH

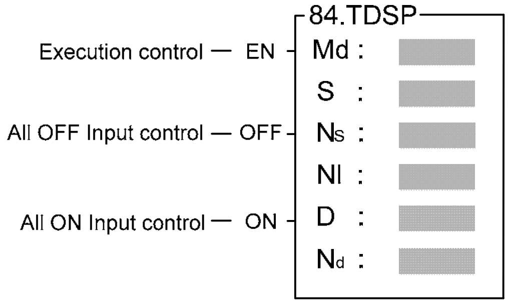
7-segment display contents **:** E.d.6.5.4.3.2.1.

16.9 FBs-7SG Output Commands FUN84: TDSP

The TDSP commands are described in the next page.

FUN84 TDSP	FBs-7SG Display Module Convenient Commands 7/16-segment display character and number display conversion	FUN84 TDSP

Ladder symbol



Md : Operation Mode, 0～3
S : Starting address of being converted characters
Ns : Start of source character, 0～63
Nl : Length of character, 1～64
D : Starting address to store the converted pattern
Nd : Start pointer while storing
S operand can be combined with V、Z、P0～P9 index registers for indirect addressing

Range / Oper-and	HR	OR	ROR	DR	K	Index
	R0 ∣ R3839	R3904 ∣ R3967	R5000 ∣ R8071	D0 ∣ D3999	Positive integer 16/32-bit	V、Z、P0～P9
Md					0～3	
S	○	○	○	○		○
Ns	○	○	○	○	0～63	
Nl	○	○	○	○	1～64	
D	○	○	○*	○		
Nd	○	○	○*	○	0～63	

- This convenient instruction is used to generate the corresponding display pattern for FBs series 7-segment or 16-segment display pannel under the control of FBs-7SG1 or FBs-7SG2 modules.

  When execution control "EN"=1, input "OFF"=0, and input "ON"= 0, this instruction will perform the display pattern conversion, where S is the starting address storing the being converted characters, Ns is the pointer to locate the starting character, Nl tells the length of being converted characters, and D is the starting address to store the converted result, Nd is the pointer to locate the start of storing.

  There are 4 kinds of operation mode as below:

  Md=0, display pattern conversion for 16-segment display; the source character is the 8-bit ASCII Code, the converted result is the 16-bit display pattern. By the control of M1990, it determines the display direction, where M1990=0, right to left display ; M1990=1, left to right display

  Md=1, Without leading zero display conversion for 16-segment display; the source character is the 8-bit ASCII Code, the converted result is the 16-bit display pattern without leading zero.

  Md=2, Non-decoded display pattern conversion for 7-segment display; the source character is the 4-bit nibble code, the converted result is the 8-bit display pattern.

  Md=3, Without leading zero display conversion for 7-segment decoded display; the source character is the 4-bit nibble code, the converted result is the 4-bit display pattern without leading zero.

  Byte 0 or Nibble 0 of S is the 1st displaying character, Byte 1 or Nibble 1 of S is the 2nd displaying character,⋯

  Ns operand is the pointer to tell where the displaying character starts

  Nl operand is the character quantity for conversion

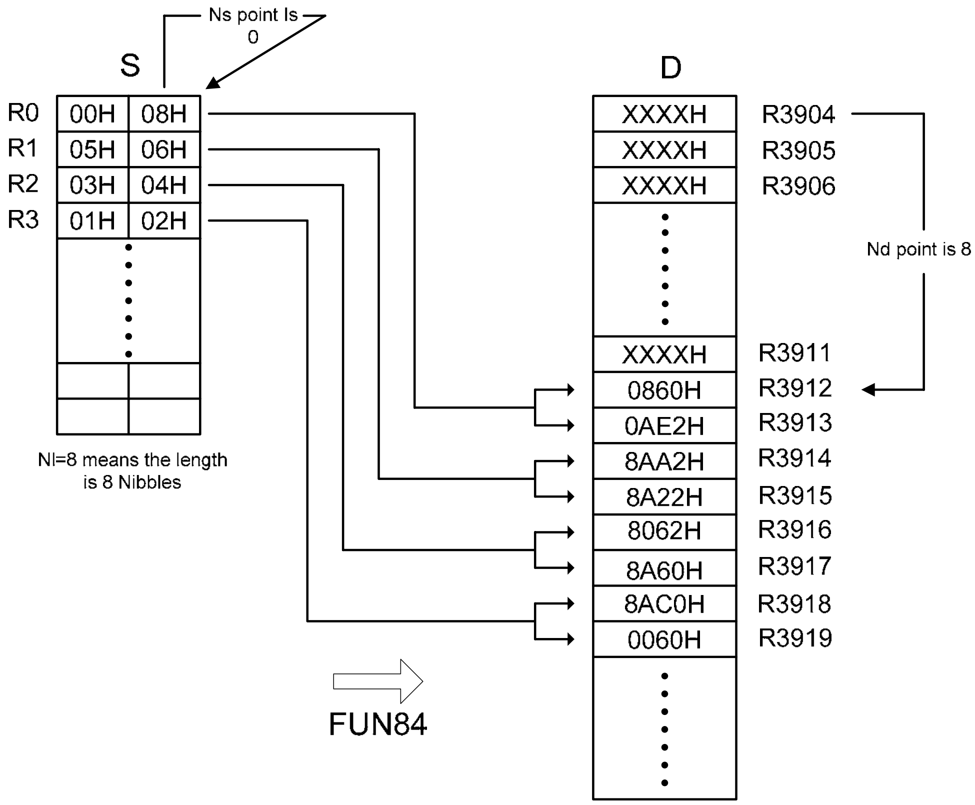
FUN84 TDSP	FBs-7SG Display Module Convenient Commands 7/16-segment display character and number display conversion	FUN84 TDSP

D operand is the starting address to store the converted display pattern; while Md=0 or 1, one source character of 8-bit ASCII code needs one 16-bit location to store the result; while Md=2, one source character of 4-bit nibble code needs one 8-bit location to store it; while Md=3, one source character of 4-bit nibble code needs one 4-bit location to store it.

Nd operand is the pointer to tell where is the start to store the converted pattern.

- When inputs "OFF"=1, "ON"=0, and "EN"=0/1, the D operand will be filled with the all OFF pattern according to the operation mode, the Nd pointer, and the quantity of Nl.
- When inputs "ON"=1, "OFF"=0/1, and "EN"=0/1, the D operand will be filled with the all ON pattern according to the operation mode, the Nd pointer, and the quantity of Nl.
- Data will be converted differently based on the selected mode. The description below is based on Example 2.

In Example 2, MD=1; S=R0; Ns=0; Nl=8; D=R3904; and Nd=8. Data conversion is presented below.



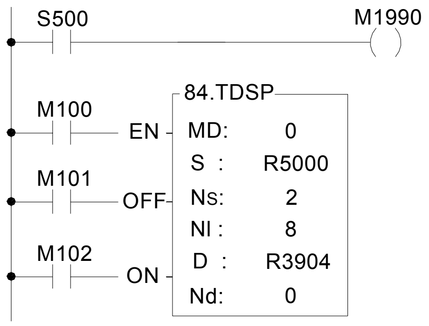
Example1

8-character of text display by using the FBs-7SG2 display module and 16-Segment display panels; for this application, the FBs-7SG2 module must be set to work at the non-decoded operation mode.

The WinProladder supports the "ASCII Table" editing for easy and convenient text message display; we can create one ASCII Table with the content ' WELCOME ' for testing, and we assign R5000 is the table starting address, then R5000～R5007 will have the following contents **:**

FUN84 TDSP	FBs-7SG Display Module Convenient Commands 7/16-segment display character and number display conversion	FUN84 TDSP

R5000=2027H (20H= ；27H=')
R5001=4557H (45H=E；57H=W)
R5002=434CH (43H=C；4CH=L)
R5003=4D4FH (4DH=M；4FH=O)
R5004=2045H (20H= ；45H=E)
R5005=2C27H (2CH=,；27H=')
R5006=4E45H (4EH=N；45H=E)
R5007=0044H (00H= ；44H=D)



Description： When M100=1, M101=0 and M102=0, the FUN84 will perform the display pattern conversion, where the source (S) begins from the R5000, the start pointer (Ns) is pointed to byte 2, and the quantity (Nl) is 8, it means the contents of R5001～R5004 are the displaying characters; the registers R3904～R3911 will store the converted pattern for text message displaying (D operand begins from R3904, Nd operand is pointed to word 0, Nl operand is 8 for quantity)

While M1990=1, the 16-segment panel will display "WELCOME " ;

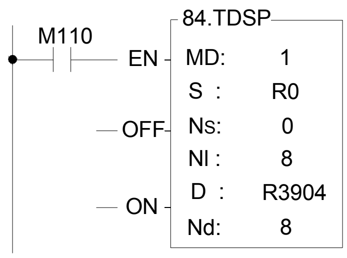
While M1990=0, the 16-segment panel will display " EMOCLEW".

When M101=1, M102=0, the registers R3904～R3911 will be filled with the all OFF pattern for displaying.

When M102=1, the registers R3904～R3911 will be filled with the all ON pattern for displaying.

Example2

8-character of display without the leading zero through the second FBs-7SG2 display module and 16-Segment display panels; for this application, the FBs-7SG2 module must be set to work at the non-decoded operation mode.



FUN84 TDSP	FBs-7SG Display Module Convenient Commands 7/16-segment display character and number display conversion	FUN84 TDSP

Description

When M110=1, the FUN84 will perform the display pattern conversion, where the source (S) begins from the R0, the start pointer (Ns) is pointed to byte 0, and the quantity (Nl) is 8, it means the contents of R0～R3 are the displaying characters; the registers R3912～R3919 will store the converted pattern for message displaying (D operand begins from R3904, Nd operand is pointed to word 8, Nl operand is 8 for quantity).

(1) R0=0008H
R1=0506H
R2=0304H
R3=0102H
Display on the 16-segment display : "12345608"

(2) R0=0708H
R1=0506H
R2=0000H
R3=0000H
Display on the 16-segment display : "   5678"

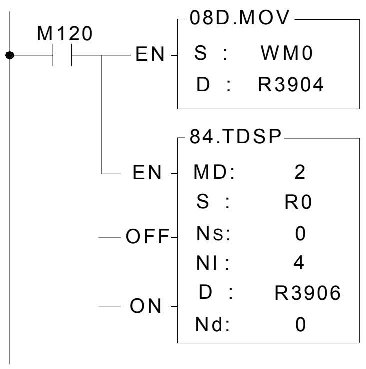
(3) R0=3738H
R1=3536H
R2=3334H
R3=3132H
Display on the 16-segment display : "12345678"

(4) R0=3038H
R1=3536H
R2=3334H
R3=3030H
Display on the 16-segment display : " 345608"

※ The I/O address of FBs-7SG2 in Example 2 must be at R3912~R3919 to ensure the correct display of the message/number (length=8); i.e. other digital or analog output modules may be connected in front of FBs-7SG2.

Example3

4-digit of numeric display and 32-point of external independent LED's display through the control of FBs-7SG1 display module and 4-digit of 7-segment display panel; also, it needs the extra circuit to control the 32-point of independent LED's display. For this application, the FBs-7SG1 module must be set to work at the non-decoded operation mode.

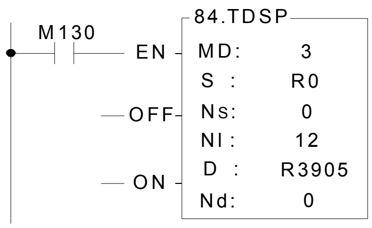


Description : When M120=1, the status of M0～M31 will be copied to the output registers R3904～R3905 to control the display of the 32-point of independent LEDs. The FUN84 also performs the display pattern conversion, where the source (S) begins from the R0, the start pointer (Ns) is pointed to nibble 0, and the quantity (Nl) is 4, it means nibble0～nibble3 of R0 are the displaying characters; the output registers R3906～R3907 will store the converted pattern for displaying (D operand begins from R3906, Nd operand is pointed to byte 0, Nl operand is 4 for quantity).

R0=1024H → The 7-segment panel will display "1024"

Example 4

12-digit of decoded numeric display without the leading zero through the control of FBs-7SG2 display module and 12-digit of 7-segment display panels. For this application, the FBs-7SG2 module must be set to work at the decoded operation mode.



Description：When M130=1, the FUN84 will perform the display pattern conversion, where the source (S) begins from the R0, the start pointer (Ns) is pointed to nibble 0, and the quantity (Nl) is 12, it means nibble0～nibble11 of R0～R2 are the displaying characters; the output registers R3905～R3907 will store the converted pattern for displaying (D operand begins from R3904, Nd operand is pointed to nibble 0, Nl operand is 12 for quantity).

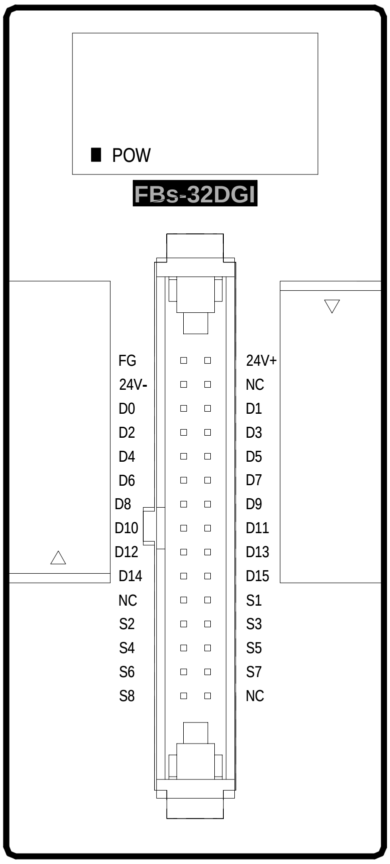
(1). R2=1234H, R1=5678H, R0=9000H
Display on the 7-segment display : "123456789000"

(2). R2=0000H, R1=5678H, R0=9000H
Display on the 7-segment display : "   56789000"

Chapter 17　Thumbwheel Switch Input Module

FBs-32DGI is a multiplex input module. One 32DGI module can support up to 32 digits thumbwheel switch or 128 discrete switch inputs. Thanks to the I/O control chip that incorporated in this module, the update rate of the input status is irrelevant to CPU scan time. The input refresh time of this module is mere 10 mS. Owing to the scan nature of PLC, though the multiplex input task is not performed by CPU, the over-all refresh time of this input module is still constrained by the CPU scan time if the scan time is larger than 10 mS.

Appearance

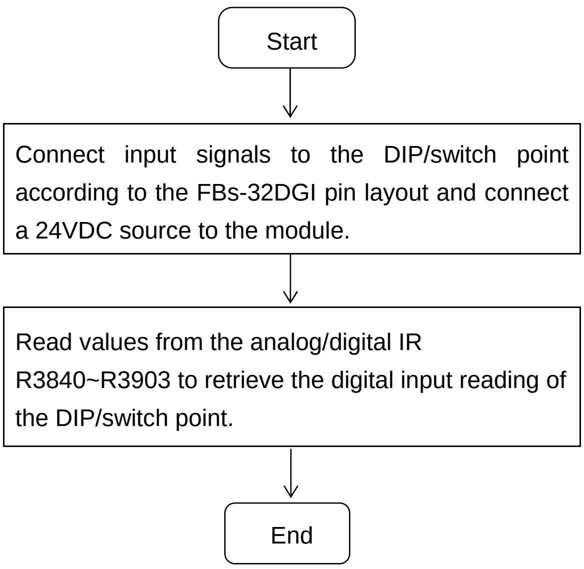


By using the multiplex input, users only need to connect the FBs-32DGI with 24 wires to achieve 32-digit inputs (or 128 switch points). While FBs-32DGI is only 4cm wide, it is a truly high-density, low-cost and labor-saving solution.

17.1 FBs-32DGI Specifications

Item	Specification	Remarks
Input points	32-digit DIP/128 independent switch points	
Occupied Resources	8 IRs	
Connector	30-pin boxed header	
Control signal	Column Output– 8 dots SINK (NPN) output Row Output– 16 dots SOURCE output	
Refresh rate	10mS	
Insulation	Transformer (power) and optical separation (contact signal)	
Status indicator	5V PWR LED indicator	
Power supply and consumption	24V-15%/+20%, 40mA	
Internal current	5V, 14mA	
Working temperature	0 - 60°C	
Storage temperature	20 - 80°C	
Dimensions	40(W)×90(H)×80(D) mm	

17.2 The Procedure of Using FBs-32DGI Module

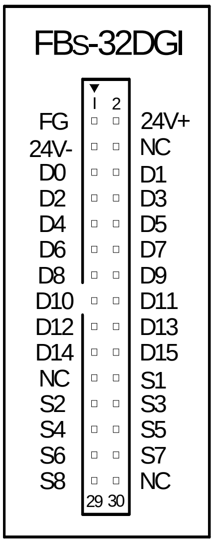


17.3 FBs-32DGI I/O Address

Each FBs-32DGI module occupies 8 IRs (R3840~R3903) for I/O address. In general, WinProladder will automatically detect and calculate the actual I/O address occupied by the module installed on the system after connecting to the PLC. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming.

17.4 FBs-32DGI Hardware Description

FBs-32DGI pin layout



[Aerial View]

Pin	Signal Name	Pin	Signal Name
1	FG	2	24V+(external)
3	24V-(external)	4	No Connection
5	D0	6	D1
7	D2	8	D3
9	D4	10	D5
11	D6	12	D7
13	D8	14	D9
15	D10	16	D11
17	D12	18	D13
19	D14	20	D15
21	No Connection	22	S1
23	S2	24	S3
25	S4	26	S5
27	S6	28	S7
29	S8	30	No Connection

The I/O control chip built in the module multiplexes the 32 digits of thumbwheel switch or 128 discrete switch inputs by eight times scan, each scan reads in 4 digits of thumbwheel switch or 16 discrete switch inputs. The input selection signals S1～S8 listed in the above table are all low active output signal(NPN output). The multiplex data input signals D0～D15 are sink type input signals. Each times of scan, data are read from D0～D15 inputs and stored in I/O control chip.

The status of 32 digits of thumbwheel switch or 128 discrete switch inputs are directly mapped to 8 input registers as shown in following table. The IR is the first input register allocated for corresponding module (IR's range is R3840~R3903).

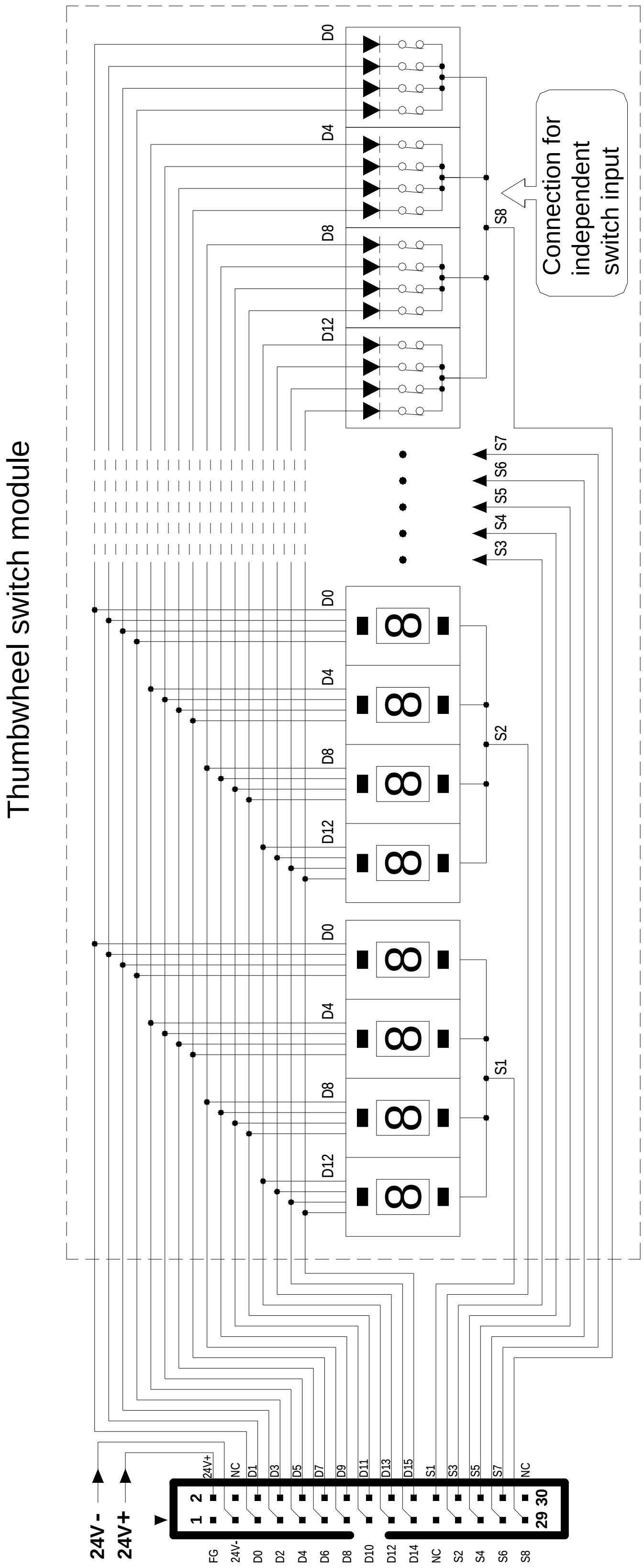
DIP switch input

IR	D15-D12	D11-D8	D7-D4	D3-D0
IR+0	DIG3	DIG2	DIG1	DIG0
IR+1	DIG7	DIG6	DIG5	DIG4
IR+2	DIG11	DIG10	DIG9	DIG8
IR+3	DIG15	DIG14	DIG13	DIG12
IR+4	DIG19	DIG18	DIG17	DIG16
IR+5	DIG23	DIG22	DIG21	DIG20
IR+6	DIG27	DIG26	DIG25	DIG24
IR+7	DIG31	DIG30	DIG29	DIG28

Single point switch input

IR	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
IR+0	I15	I14	I13	I12	I11	I10	I9	I8	I7	I6	I5	I4	I3	I2	I1	I0
IR+1	I31 - I16															
IR+2	I47 - I32															
IR+3	I63 - I48															
IR+4	I79- I64															
IR+5	I95 - I80															
IR+6	I111- I96															
IR+7	I127 - I112															

17.5 FBs-32DGI Input Circuit Diagram



Chapter 18　AIO Module

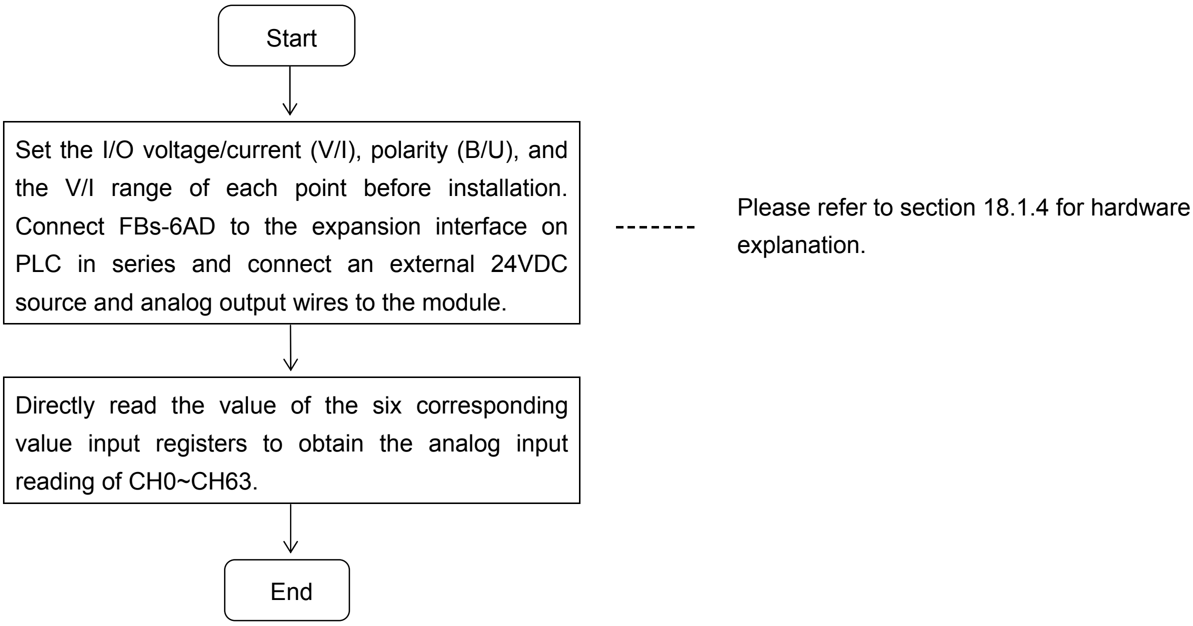
18.1　FBs-6AD Analog Input Module

FBs-6AD is one of the analog input modules of FATEK FBs series PLC. It provides 6 channels A/D input with 12 or 14 bits effective resolution.. Base on the different jumper settings it can measure the varieties of current or voltage signal. The reading value is represented by a 14-bit value no matter the effective resolution is set to 12 or 14 bits. In order to filter out the field noise imposed on the signal, it also provides the average of sample input function.

18.1.1　Specifications of FBs-6AD

<table>
<tr><th colspan="3">Item</th><th colspan="2">Specifications</th><th>Remark</th></tr>
<tr><td colspan="3">Total Channel</td><td colspan="2">6 Channel</td><td></td></tr>
<tr><td colspan="3">Digital Input Value</td><td colspan="2">–8192～+8191 or　0～16383(14 bits)
–2048～+2047 or　0～4095(12 bits)</td><td></td></tr>
<tr><td rowspan="4">Span Of Analog input</td><td rowspan="2">Bipolar*</td><td>10V*</td><td>*1.Voltage：–10～10V</td><td>5.Current：–20～20mA</td><td rowspan="4">*： It means the default setting</td></tr>
<tr><td>5V</td><td>2. Voltage：–5～5V</td><td>6. Current：–10～10mA</td></tr>
<tr><td rowspan="2">Unipolar</td><td>10V</td><td>3. Voltage：0～10V</td><td>7. Current：0～20mA</td></tr>
<tr><td>5V</td><td>4. Voltage：0～5V</td><td>8. Current：0～10mA</td></tr>
<tr><td colspan="3">Resolution</td><td colspan="2">14 or 12 bits</td><td></td></tr>
<tr><td colspan="3">Finest resolution</td><td colspan="2">Voltage：0.3mV
Current：0.61μA</td><td>= Analog input signal / 16383</td></tr>
<tr><td colspan="3">I/O Points Occupied</td><td colspan="2">6 IR(Input Register)</td><td></td></tr>
<tr><td colspan="3">Accuracy</td><td colspan="2">Within ±1% of full scale</td><td></td></tr>
<tr><td colspan="3">Conversion Time</td><td colspan="2">Updated each scan</td><td></td></tr>
<tr><td colspan="3">Maximum absolute input signal</td><td colspan="2">Voltage：±15V（max）
Current：±30mA（max）</td><td>It may cause the destruction to hardware if exceeds this value.</td></tr>
<tr><td colspan="3">Input resistance</td><td colspan="2">63.2KΩ（Voltage input）、250Ω（Current input）</td><td></td></tr>
<tr><td colspan="3">Isolation</td><td colspan="2">Transformer(Power) and photocouple(Signal)</td><td></td></tr>
<tr><td colspan="3">Indicator(s)</td><td colspan="2">5V PWR LED</td><td></td></tr>
<tr><td colspan="3">Supply Power</td><td colspan="2">24V-15%/+20%、2VA</td><td></td></tr>
<tr><td colspan="3">Internal Power Consumption</td><td colspan="2">5V、100mA</td><td></td></tr>
<tr><td colspan="3">Operating Temperature</td><td colspan="2">0 ~ 60 ℃</td><td></td></tr>
<tr><td colspan="3">Storage Temperature</td><td colspan="2">-20 ~ 80 ℃</td><td></td></tr>
<tr><td colspan="3">Dimensions</td><td colspan="2">40(W)x90(H)x80(D) mm</td><td></td></tr>
</table>

18.1.2 The Procedure of Using FBs-6AD Module



18.1.3 Address Allocation of FBs-PLC Analog Inputs

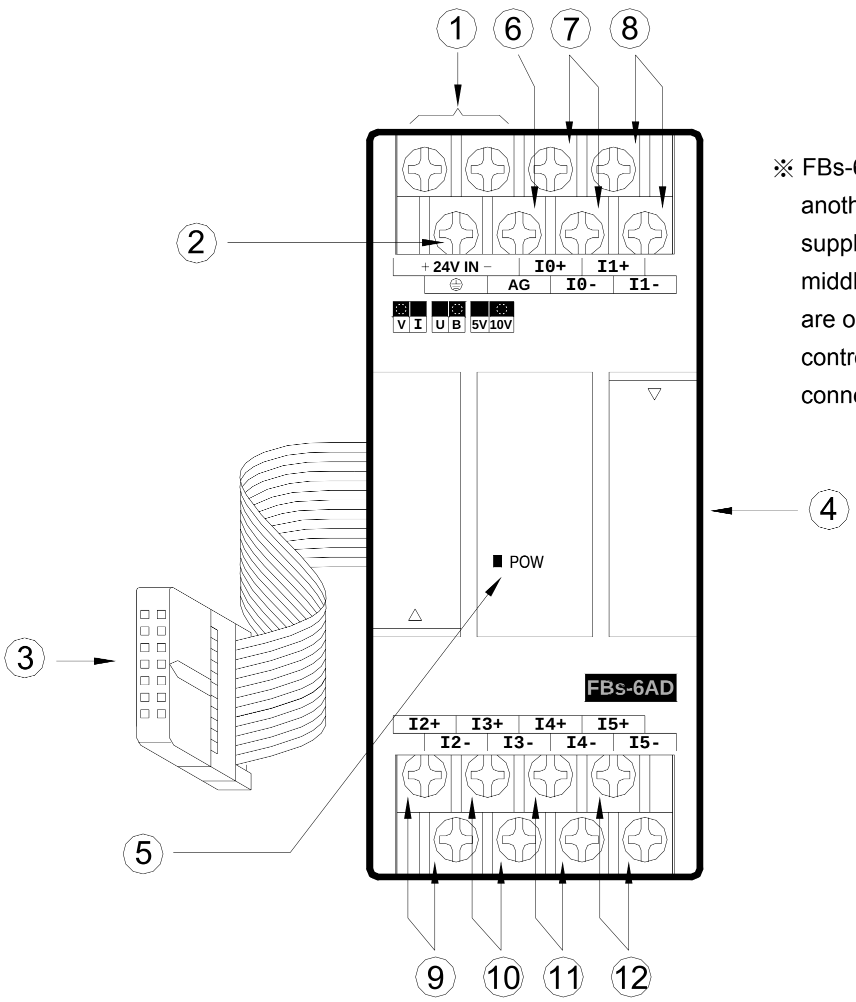
The I/O addressing of FBs-6AD inputs is beginning from the module closest to main unit, it is orderly numbered as CH0～CH5 (1st module), CH6～CH11 (2nd module), CH12～CH17 (3rd module)…… and increased with occurring order number, i.e. for each module, it adds with 6 and is totally 64 inputs from CH0～CH63, and they are corresponding to the respective internal analogue input register of PLC (so called as IR register) R3840～R3903 as listed in following table. After connecting FBs-6AD to the expansion interface on the PLC, FBs-PLC will automatically detect the number of AD points. WinProladder will automatically detect and calculate the IRs on the system after connecting to the PLC. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming.

Numeric Input Register（IR）	Content of IR (CH0～CH63) B_{15} B_{14} B_{13} B_{12} B_{11} B_{10} B_9 B_8 B_7 B_6 B_5 B_4 B_3 B_2 B_1 B_0	Input label Of FBs-6AD	
IR+0	14/12 bit ; 14-bit , B14~ B15= B13 ; 12-bit, B12~ B15= B11	CH0	FBs-6AD
IR +1	14/12 bit ; 14-bit , B14~ B15= B13 ; 12-bit, B12~ B15= B11	CH1	
IR +2	〃	CH2	
IR +3	〃	CH3	
IR +4	〃	CH4	
IR +5	〃	CH5	
IR +6	Depends on module type	CHX	
IR +7	Depends on module type	CHX	
IR +8	〃	CHX	
IR +9	〃	CHX	

⋮	⋮	⋮
R3896	〃	CHX
R3897	〃	CHX
R3898	〃	CHX
R3899	〃	CHX
R3900	〃	CHX
R3901	〃	CHX
R3902	Depends on module type	CHX
R3903	Depends on module type	CHX

Other Modules

18.1.4 FBs-6AD Hardware Description



Outlook of top view

※ FBs-6AD contains 3 PCBs overlapping one another. The lowest one is the power supply unit (isolated power supply). The middle one is the I/O board (connectors are on this layer). The upper one is the control board (control/expansion I/O connections) as described below.:

① External power input terminal ：Power supply of analogue circuit for FBs-6AD, the voltage can be 24VDC±20% and should be supplied with 4W of power at least.

② Protecting ground terminal：Connect to the shielding of the signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

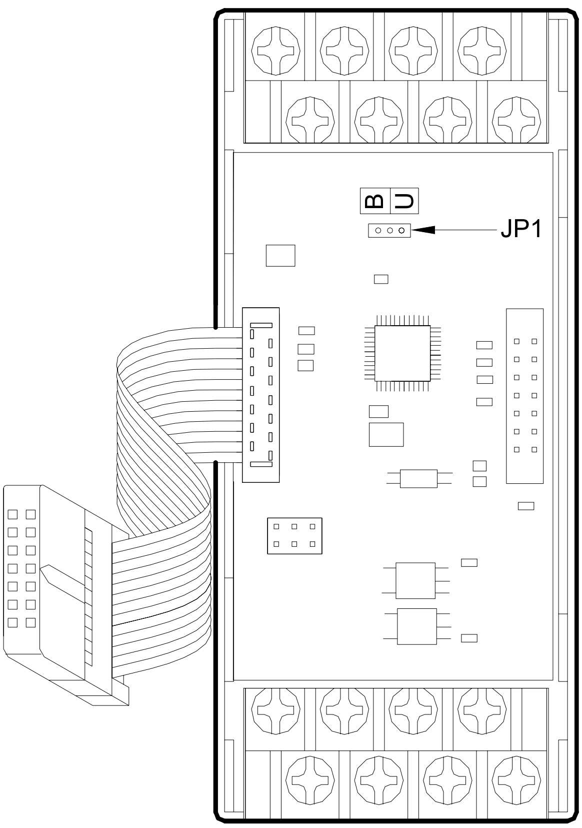
④ Expansion output connector：Provides the connection for next expansion unit.

⑤ Power indicator： It indicates whether the power supply at analogue circuit and external input power source are normal.

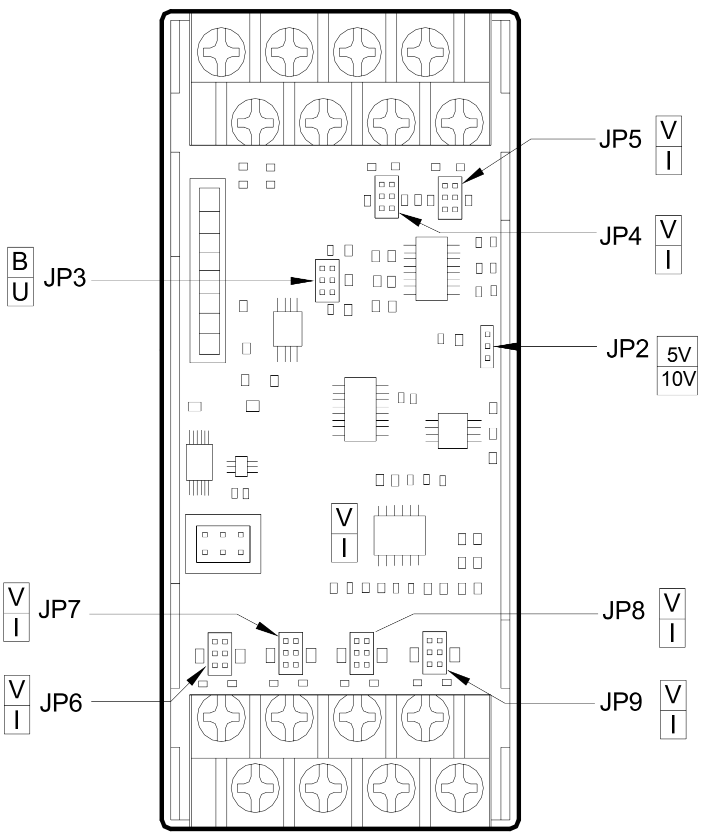
⑥ AG Ground：No connection is needed in general; except when the common mode signal is too high. See examples overleaf for details.

⑦～⑫：Input terminal of CH0～CH5.

18.1.4.1 FBs-6AD Hardware Jumper Setting



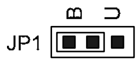
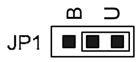
Pin layout in control board (open top cover)



Pin layout on I/O board (remove control board)

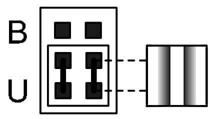
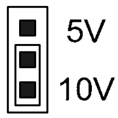
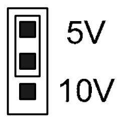
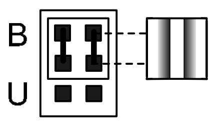
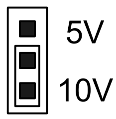
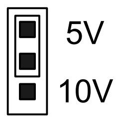
1. Input code format selection (JP1)

Users can select between unipolar and bipolar codes. The input range of unipolar codes and bipolar codes is 0~16383 and –8192~8191, respectively. The two extreme values of these formats correspond to the lowest and highest input signal values, respectively (see table below). For example, if the input signal type is set to -10V~ +10V, the unipolar code corresponding to the input is 8192 and the bipolar code corresponding to the input is 0 for 0V input. If the input is 10V, the unipolar code corresponding to the input is 16383 and the bipolar code corresponding to the input is 8191. In general, the input code format is selected according to the form of input signals; i.e. unipolar codes for unipolar input signals; and bipolar codes for bipolar input signals. In doing so, their correlations will become more heuristics. Unless it is necessary to make a deviation conversion through FUN33; otherwise, do not select bipolar codes for unipolar input signals (see FUN33 description for details). The format of input codes of all channels is selected from JP1. See above diagram for the location of JP1：

Input Code Format	JP1 Setting	Input Value Range	Corresponding Input Signals
Bipolar		-8192～8191	-10V～10V(-20mA～20mA) -5V～5V(-20mA～20mA) 0V～10V(0mA～20mA) 0V～5V(0mA～10mA)
Unipolar		0～16383	

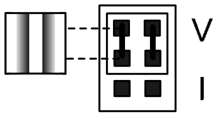
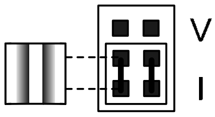
2. Input signal form setup (JP2&JP3)

Users can set the input signal form (voltage/current) of individual channels; except the polarity and amplitude which are common. The location of jumpers are tabulated below：

Signal Form	JP3 Setting	JP2 Setting
0～10V or 0～20mA		
0～5V or 0～10mA		
-10～+10V or -20～+20mA		
-5～+5V or -10mA～+10mA		

CH0~CH5 share the JP2 and JP3 jumper, therefore all channels must be of the same type that is one of the four types listed at above table. Only the current/voltage setting can be chosen arbitrary：

3. Voltage or current setting (JP4～JP9)

Signal Type	JP4(CH0) ～ JP9(CH5) Setting
Voltage	
Current	

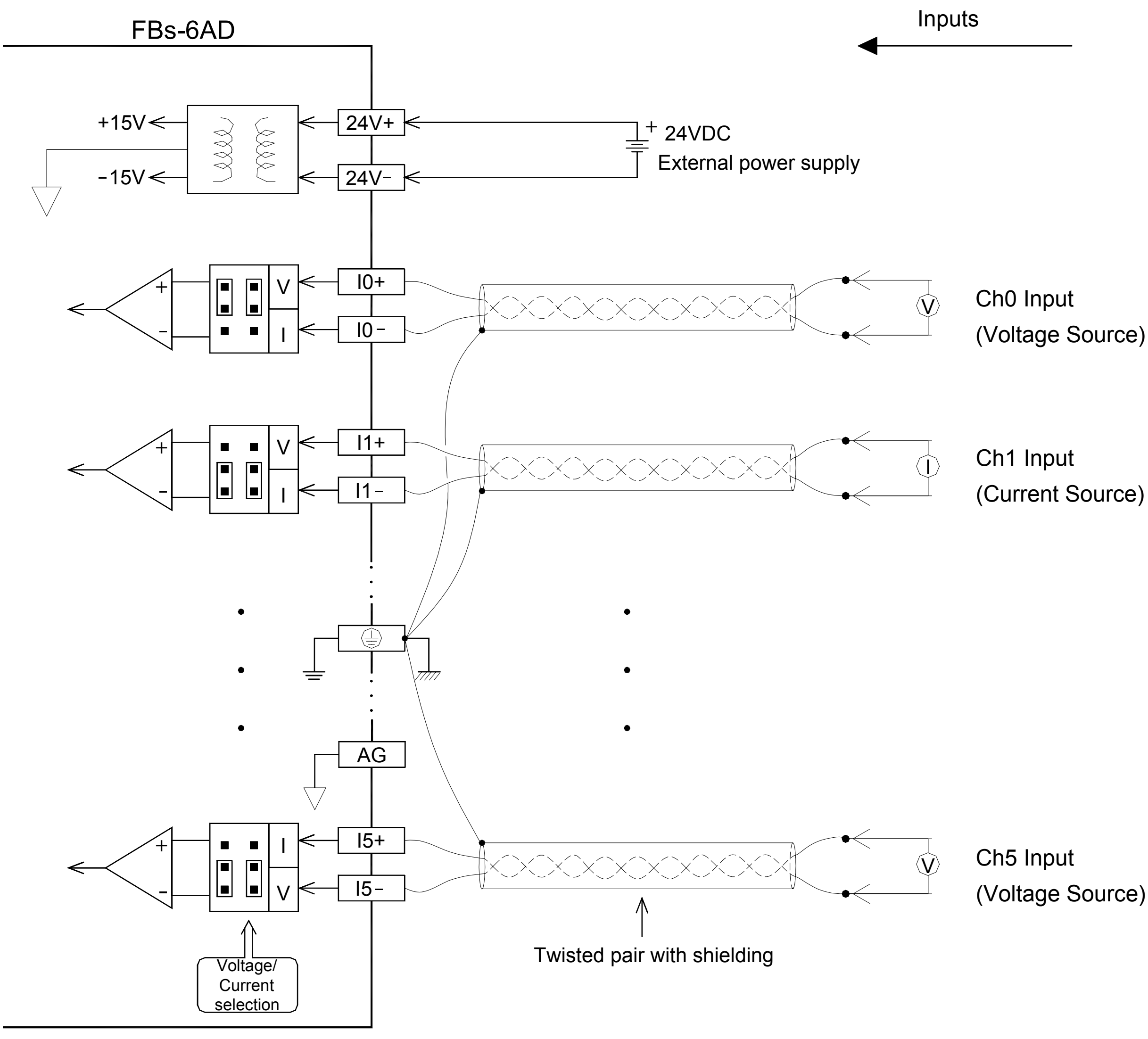
∗The default factory settings of 6AD analogue input module are：

Input code format → Bipolar(-8192~+8191)

Input signal type and range → Bipolar(-10V ~ +10V)

For those applications that require the setting differ than the above default setting should make some modifications of jumper position according to above tables. While application, besides the setting of jumper should be conducted, the AI module configuration of WinProladder also need to be performed.

18.1.5 FBs-6AD Input Circuit Diagram



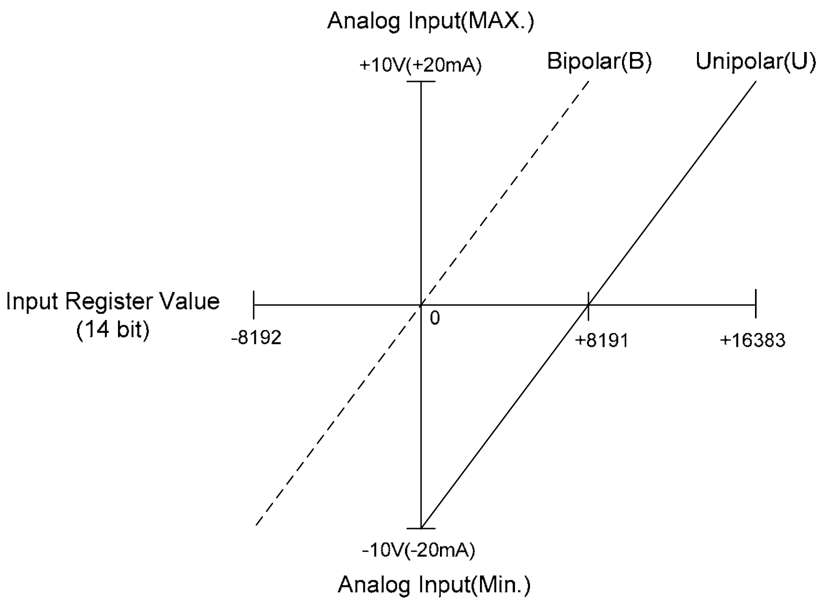
18.1.6 FBs-6AD Input Characteristics and Jumper Setting

Users can select the Input ranges of FBs-6AD from the jumpers described above, such as V/I, U/B (I/O codes), U/B (signal form), 5V/10V, etc. The Input signals conversion characteristics of these settings are illustrated below. Users can adjust different Input forms by coordinating the conversion curve with various V/I (voltage/current) Input settings. See Section 18.1.4 for details of V/I settings **:**

Diagram 1：Bipolar 10V（20mA）Span

Input Range	Voltage	−10V～10V	Jumper Setting	JP3 JP2 B U 5V 10V	————	JP1 B U
	Current	−20mA～20mA			--------	JP1 B U

14 bit input format



12 bit input format

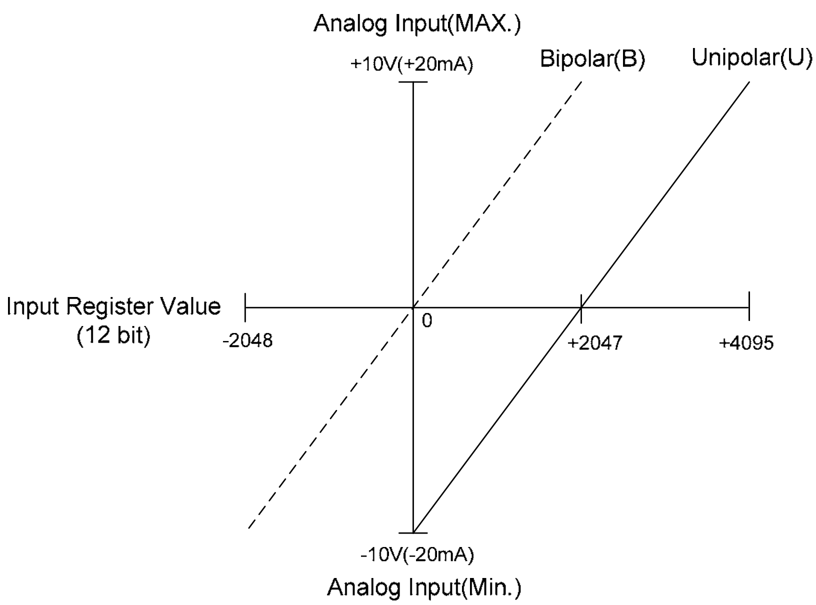
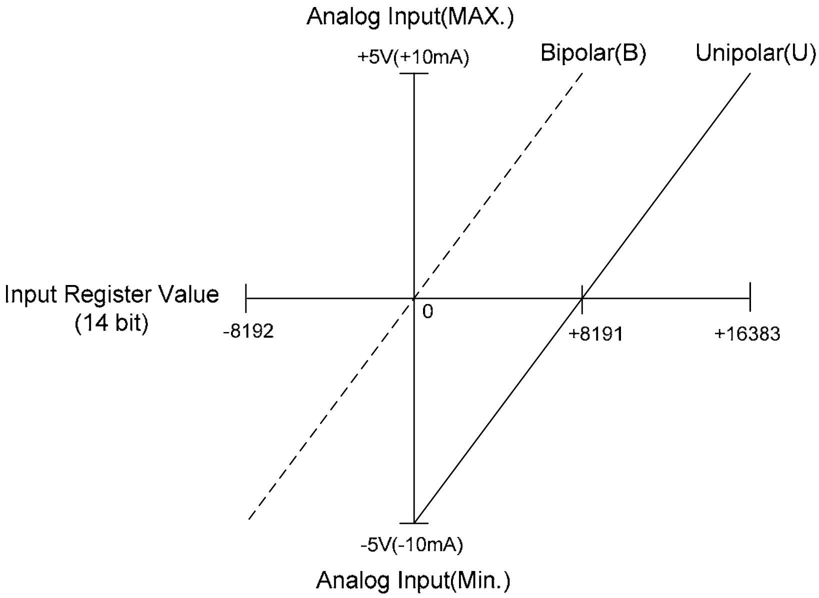


Diagram 2：Bipolar 5V（10mA）Span

Input Range	Voltage	−5V～5V	Jumper Setting	JP3 JP2 B 5V U 10V	————	JP1 B U
	Current	−10mA～10mA			--------	JP1 B U

14 bit input format



12 bit input format

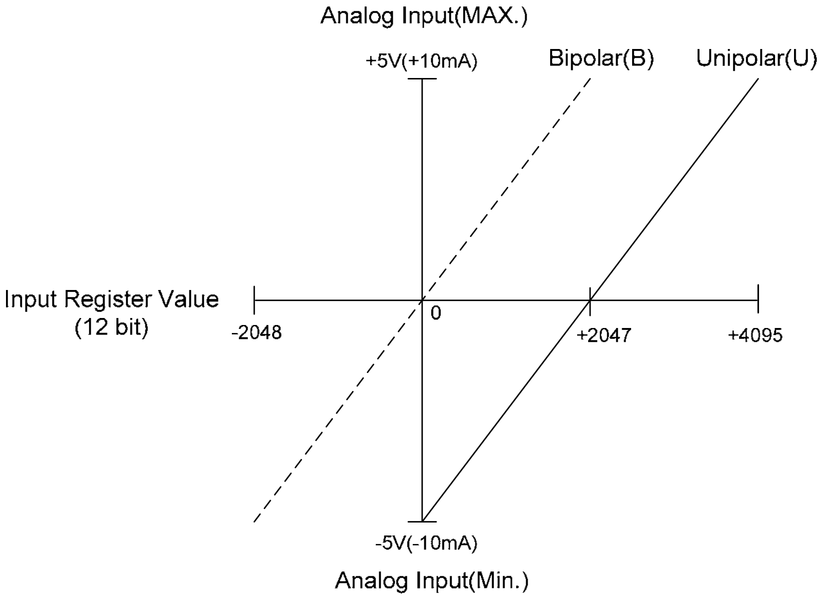
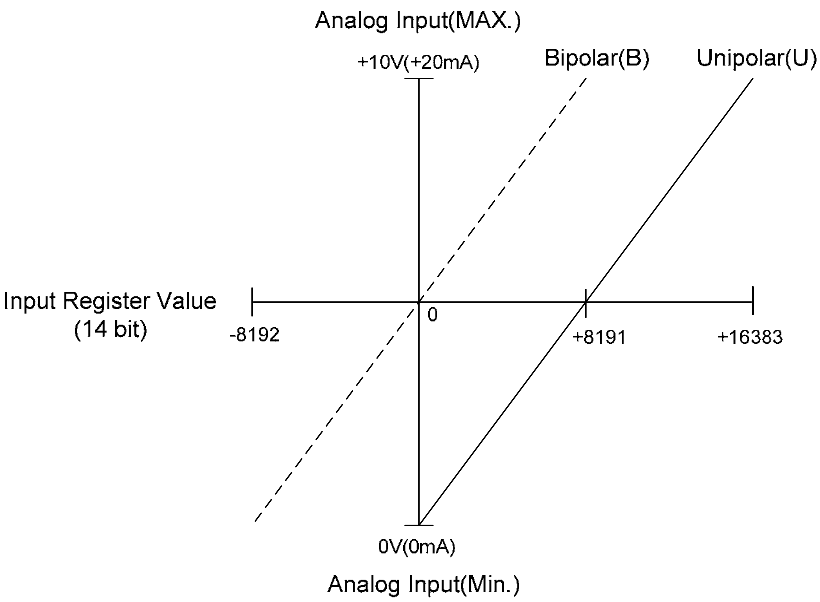


Diagram 3：Unipolar 10V（20mA）Span

Input Range	Voltage	0V～10V	Jumper Setting	JP3 JP2 B U 5V 10V	————	JP1 B U
	Current	0mA～20mA			- - - - - - - -	JP1 B U

14 bit input format



12 bit input format

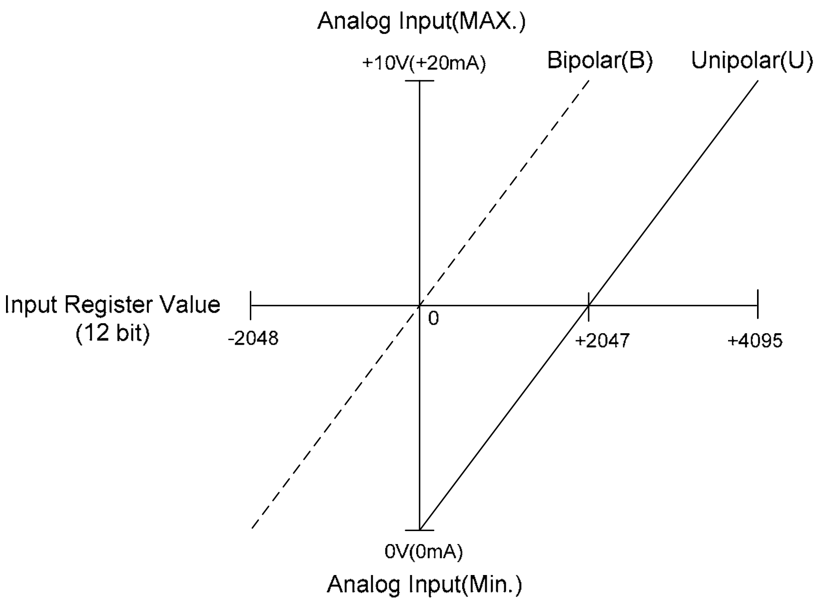
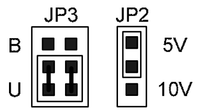
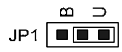
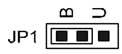
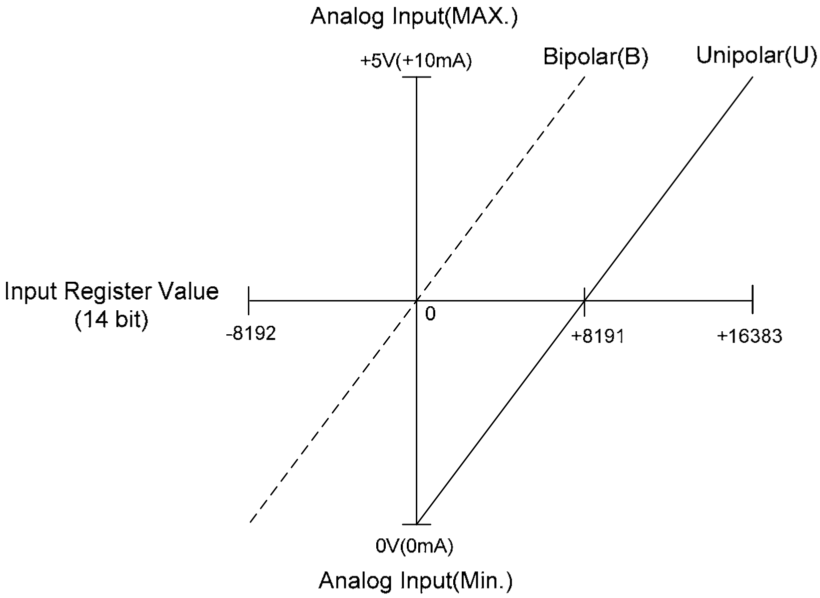


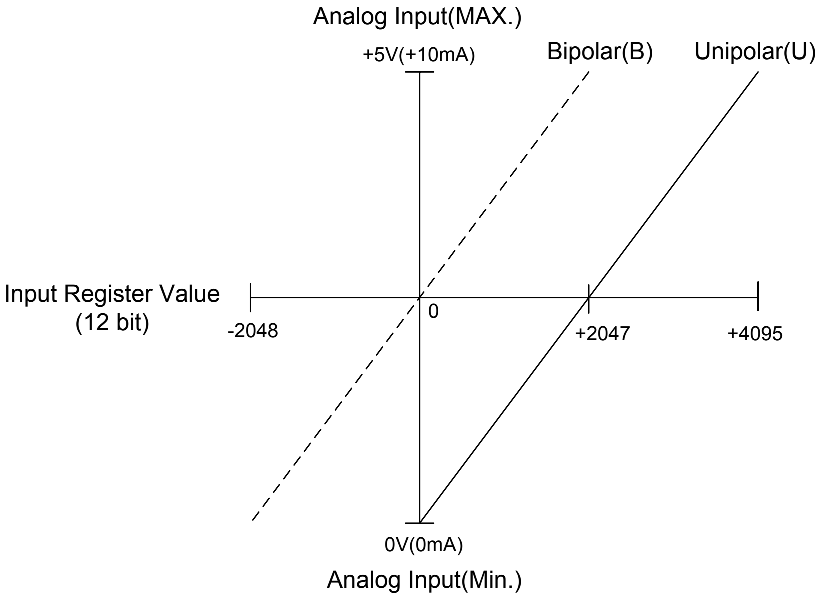
Diagram 4：Unipolar 5V（10mA）Span

Input Range	Voltage	0V～5V	Jumper Setting		————	
	Current	0mA～10mA			--------	

14 bit input format



12 bit input format



18.1.7 Configuration of Analog Input

For the analog input reading of FBs series PLC, there are 3 kinds of data formats used to represent the reading value in compliance with the variation of the external analog inputs. Also, it supports the average method to improve the drift of the reading value away from the noise interference or unstable original analog signal.

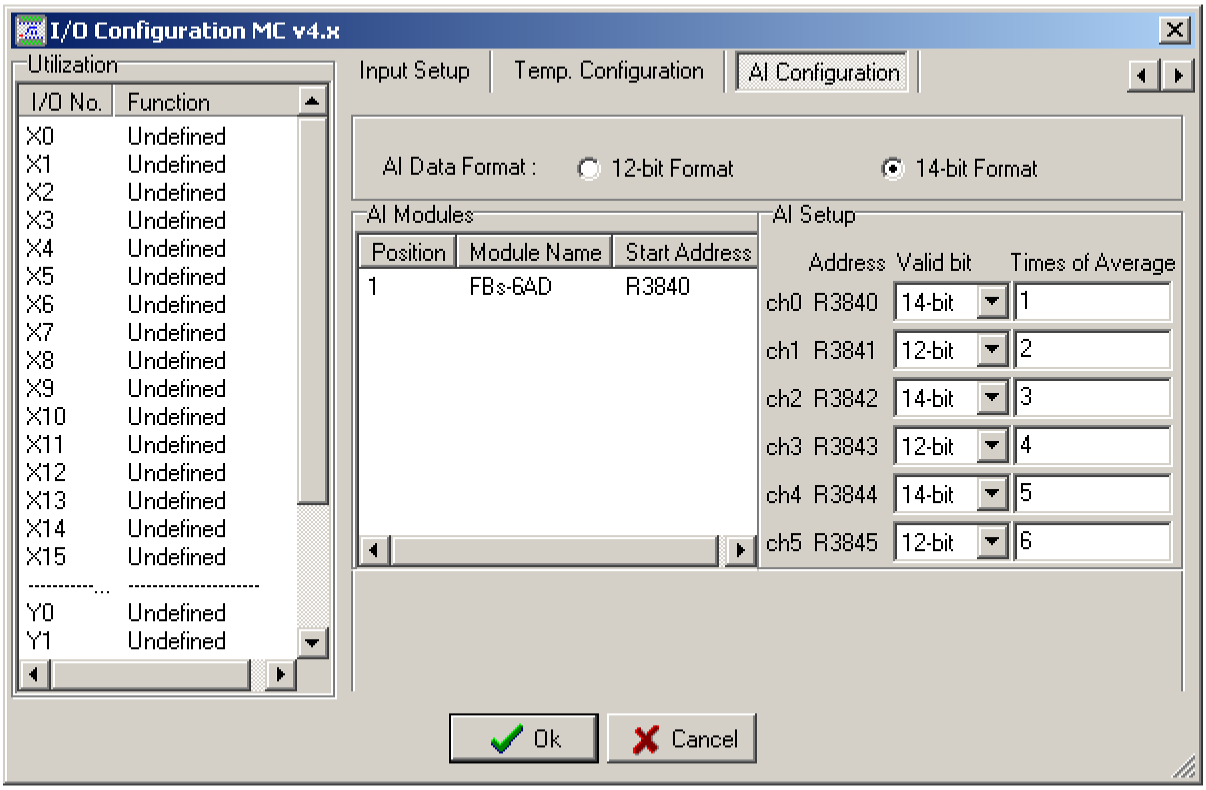
The WinProladder provides the friendly and convenient operation interface for the purpose of analog input configuration. There are "analog input data format", "valid bits", and "number of average" for settings.

The procedures for analog inputs configuration with WinProladder

Click the item "I/O Configuration" which in Project Windows :

Project name
System Configuration
I/O Configuration → Select "AI Configuration"

- If FBs main unit connects with AD Expansion nodule, then it will auto detect and allotted the system resource(IR).



Description of the configuration screen：

- AI Data Format ： All analog inputs can be assigned as 12-bit or 14-bit resolution of data format.

- AI Modules ： This window displays the information of installed analog input modules, click the selective module will bring the setting window for valid bits and times of average.

- AI Setup ： When the data format is 12-bit resolution, each channel of analog input can be allowed to set the times of average; When the data format is 14-bit resolution, each channel of analog input can be allowed to set the valid bits and times of average.

AI Data Format

- 12-bit resolution with sign representation (-2048～2047)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
B11	B11	B11	B11	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

∗ B11 = 0--------- Positive reading value
1--------- Negative reading value
∗ B15～B12 = B11

- 12-bit resolution without sign representation (0～4095)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	0	0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

- 14-bit but valid 12-bit resolution with sign representation (-8192～8188)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
B13	B13	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0	0

∗ B13 = 0--------- Positive reading value
1--------- Negative reading value
∗ B15～B14= B13 ; B1～B0= 0

∗ In this Data Format, because B1 and B0 are fixed 0 then value change by times of 4.

- 14-bit but valid 12-bit resolution without sign representation (0～16380)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0	0

∗In this Data Format, because B1 and B0 are fixed 0 then value change by time of 4.

● 14-bit resolution with sign representation (-8192～8191)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
B13	B13	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

∗ B13 = 0--------- Positive reading value
1--------- Negative reading value
∗ B15～B14= B13

● 14-bit resolution without sign representation (0～16383)：

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
0	0	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1

Relative registers of AI configuration

This introduction is for HMI or SCADA User, because they may modify through registers. Winproladerʼs User can ignore this introduction. When you configure Analog Input format with Winproladder, these value of registers will be finished.

Register	Content	Description
D4042	5612H	all analog inputs are the 12-bit resolution ; it is allowed to set times of average for each channel.
〃	5614H	all analog inputs are the 14-bit resolution ; it is allowed to set times of average for each channel.

Register	Content	Description
D4006	B0 = 0	AI channel 0 is valid 12-bit resolution.
	B0 = 1	AI channel 0 is valid 14-bit resolution.
〃	⋮	⋮
D4006	B15 = 0	AI channel 15 is valid 12-bit resolution.
	B15 = 1	AI channel 15 is valid 14-bit resolution.
D4007	B0 = 0	AI channel 16 is valid 12-bit resolution.
	B0 = 1	AI channel 16 is valid 14-bit resolution.
〃	⋮	⋮
D4007	B15 = 0	AI channel 31 is valid 12-bit resolution.
	B15 = 1	AI channel 31 is valid 14-bit resolution.

Register	Content	Description
D4008	B0 = 0	AI channel 32 is valid 12-bit resolution.
	B0 = 1	AI channel 32 is valid 14-bit resolution.
〃	⋮	⋮
D4008	B15 = 0	AI channel 47 is valid 12-bit resolution.
	B15 = 1	AI channel 47 is valid 14-bit resolution.
D4009	B0 = 0	AI channel 48 is valid 12-bit resolution.
	B0 = 1	AI channel 48 is valid 14-bit resolution.
〃	⋮	⋮
D4009	B15 = 0	AI channel 63 is valid 12-bit resolution.
	B15 = 1	AI channel 63 is valid 14-bit resolution.

Register	Content	Description
D4010	1～16	Low byte is used to define the times of average for AI channel 0.
	1～16	High byte is used to define the times of average for AI channel 1.
⋮	⋮	⋮
D4041	1～16	Low byte is used to define the times of average for AI channel 62.
	1～16	High byte is used to define the times of average for AI channel 63.

※ The default of AI data format is 14-bit resolution, valid 12-bit, and times of average is 1.

※ The legal setting value for times of average is 1～16, if it is not the value：

The default for times of average is 1 when it is valid 12-bit resolution.
The default for times of average is 8 when it is valid 14-bit resolution.

18.1.8 Tacking on the OFFSET Mode Input

For the process of input for signal source of offset mode (take 4～20mA input for example), the user can set A/D input range to be 0～20mA, convert the IR value to unipolar (0～16383), lessen the offset (4mA) value (16383x4/20=3276), then times the maximum input amount (20mA), and divide by the maximum span (4mA～20mA); and it can acquire the offset input conversion from 4mA～20mA reflect to 0～16383, the procedure is as follows：

a. Set the A/D input range of analogue input module to be 0～20mA.

b. Add the IR (R3840～R3903) value with * 8192 and then store it into register Rn (the value of Rn is 0～16383).

c. Deduct 3276 (16383x$\frac{4}{20}$) from value of register Rn, and store the calculated value back to register Rn; if the value is negative, clear the content of register Rn to 0 (the value of Rn is 0～13107).

d. The value of register Rn times 20 and then divide by 16 (Rn x $\frac{20}{16}$), and it will convert the 4mA～20mA input to range of 0～16383.

e. To sum up the items from a～d, the mathematical equation is as follows：

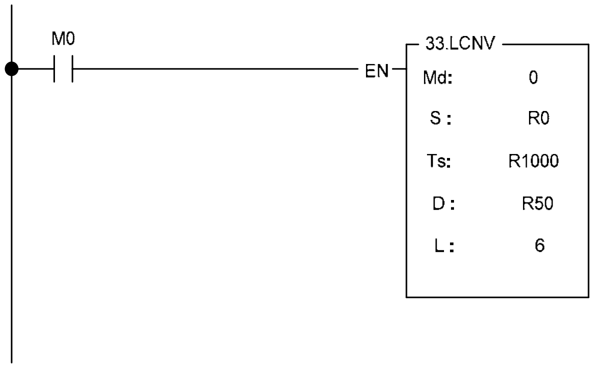
$$\text{Offset mode conversion value} = \left[IR+8192(\text{or } 0) - \left(16383\times\frac{4}{20} \right) \right] \times \frac{20}{16} \quad ; \text{ value is } 0 \sim 16383$$

※ Special to 4～20 mA Offset mode, you can use FUN32 to substitute for processing above, but another offset mode please refer to above processing.

* note：Step b “Add 8192” is means input code setting in bipolar mode(JP1 setting in position B). If input code setting in unipolar mode (JP1 setting in position U) then you don’t have to “Add 8192”.

Using Linear Conversion(FUN33) reading on 4～20mA OFFSET mode

Except using the above mathematical methods and FUN32 to read 4~20mA analog reading conversion, when the OS version is later than 4.08 (including), you may use linear conversion instruction (FUN33) to read 4~20mA conversion input parameters.



- When M0 is “ON”, it will continuous perform 6 registers of conversion starting from R0, where R1000 is the starting address of the table of the conversion parameters, and the corresponding values will be stored into R50～R55.

The converted result is in below:

	Ts
R1000	3276
R1001	16383
R1002	0
R1003	16383

	S			D
R0	0	⇨	R50	-4094
R1	3000		R51	-345
R2	6000		R52	3405
R3	9000		R53	7155
R4	12000		R54	10904
R5	16383		R55	16383

18.2 FBs-4DA/2DA Analog Output Module

FBs-4DA and FBs-2DA are two of the analog output modules of FATEK FBs series PLC. They provide 4 and 2 channels 14 bits D/A output respectively. Base on the different jumper settings it can provide varieties of current or voltage output signal. The output code can be configured as unipolar or bipolar which makes the relation of output code and real output signal more intuitive. For safety, the output signal will be automatically forced to zero(0V or 0mA) when the module is not serviced by CPU for 0.5 second.

18.2.1 Specifications of FBs-4DA/2DA

Item			Specifications	Remark
Total Channel			4 Channel（FBs-4DA）、2 Channel（FBs-2DA）	
Digital Output Value			–8192～+8191(Bipolar) or 0～16383(Unipolar)	*： It means the default setting
Span Of Analog output	Bipolar*	*10V	*1. Voltage：–10～10V 5. Current：–20～20mA	
		5V	2. Voltage：–5～5V 6. Current：–10～10mA	
	Unipolar	10V	3. Voltage：0～10V 7. Current：0～20mA	
		5V	4. Voltage：0～5V 8. Current：0～10mA	
Resolution			14 bits	
Finest resolution			0.3mV(Voltage)、0.61μA(Current)	
I/O Points Occupied			4(4DA) or 2(2DA) OR(Output register)	
Accuracy			Within ±1% of full scale	
Conversion Time			Updated each scan	
Maximum accommodation for resistance loading			Voltage：500Ω～1MΩ Current：0Ω～500Ω	The deviation will be enlarged if exceeding this range
Isolation			Transformer(Power) and photocouple(Signal)	
Indicator(s)			5V PWR LED	
Internal Power Consumption			5V、20mA	
Operating Temperature			0～60 ℃	
Storage Temperature			-20～80 ℃	
External power supply			24V-15%/+20%、120mA(4DA)、70mA(2DA)	
Dimensions			40(W)x90(H)x80(D) mm	

18.2.2 The Procedure of Using FBs-4DA/2DA Analog Output Module

Start

↓

Set the I/O voltage/current (V/I), polarity (B/U), and the V/I range of each point before installation. Connect FBs-4DA/2DA to the expansion interface on PLC in series and connect an external 24VDC source and analog output wires to the module. ------- Please refer to section 18.2.4 for hardware explanation.

↓

Directly fill the output value into the analogue output registers R3904～R3967 to acquire the corresponding analogue output span of CH0～CH63 from output module.

↓

End

18.2.3 Address Allocation of FBs-PLC Analog Outputs

FBs-4DA/2DA Provides 4 points of outputs(4DA) or 2 points of outputs(2DA). The I/O addressing of output is beginning from the module closest to main unit; it is orderly numbered as CH0～CH1 (1st module), CH2～CH3 (2nd module), CH4～CH5 (3rd module)‥‥‥ and increased with occurring order number, which reaches 64 points in total, and they are corresponding to the respective internal analogue output registers (so called OR register) R3904～R3967. User needs only to expand connecting FBs-DA modules through expansion interface, and main unit will automatically detect the quantity of the outputs and send out the value to corresponding output of each DA modules. The following table is detailed OR registers (R3904～R3967) corresponding to the expansion analogue outputs (CH0～CH63). WinProladder will automatically detect and calculate the ORs on the system after connecting to the PLC. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming.

I/O allocation of FBs-2DA

Numeric Output Register（OR）	Contents (CH0～CH63)		Output lable Of FBs-2DA	
	B_{15} B_{14}	B_{13} B_{12} B_{11} B_{10} B_9 B_8 B_7 B_6 B_5 B_4 B_3 B_2 B_1 B_0		
OR+0	＊ ＊	B_{13} CH0 output value B_0	CH0	FBs-2DA
OR+1	＊ ＊	CH1 output value	CH1	
OR+2	＊ ＊	CH2 output value	CH0	FBs-2DA
OR+3	＊ ＊	CH3 output value	CH1	
⋮	⋮	⋮	⋮	Other modules

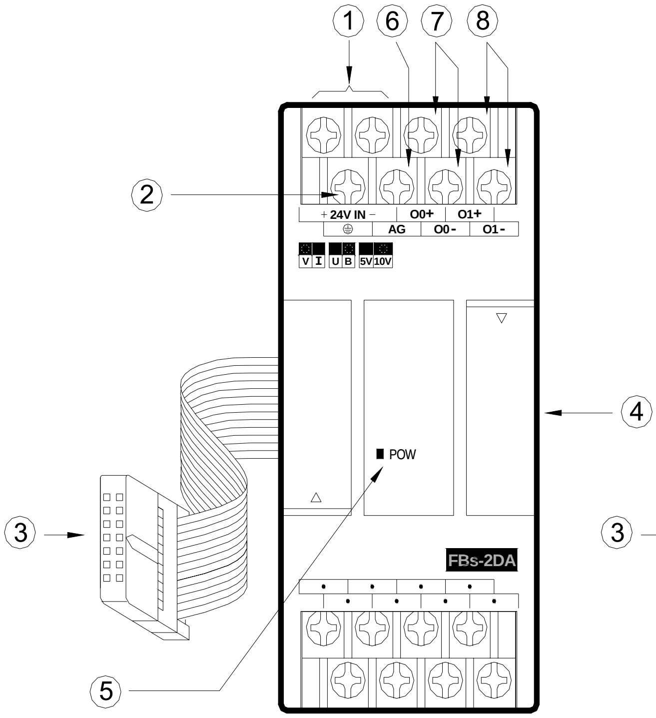
R3966	Depends on module type	CHX
R3967	Depends on module type	CHX

＊ ＊------------ Unipolar code output (0～16383)，B14、B15 = 00
Bipolar code output (-8192～8191)，B14、B15 = B13

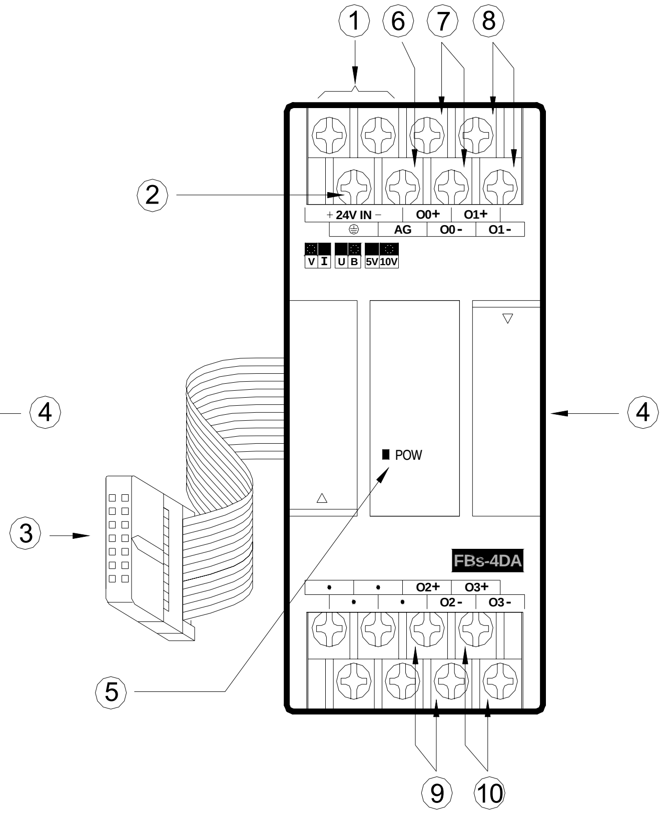
I/O allocation of FBs-4DA

Numeric Output Register（OR）	Contents (CH0～CH63)		Output lable Of FBs-4DA	
	B_{15} B_{14}	B_{13} B_{12} B_{11} B_{10} B_9 B_8 B_7 B_6 B_5 B_4 B_3 B_2 B_1 B_0		
OR+0	＊ ＊	B_{13} CH0 output value B_0	CH0	FBs-4DA
OR+1	＊ ＊	CH1 output value	CH1	
OR+2	＊ ＊	CH2 output value	CH2	
OR+3	＊ ＊	CH3 output value	CH3	
. . . .	. . . .	. . . .	. . . .	Other modules
R3964	Depends on module type		CHX	
R3965	Depends on module type		CHX	
R3966	Depends on module type		CHX	
R3967	Depends on module type		CHX	

18.2.4 FBs-2DA /4DA Hardware Description



FBS-2DA



FBS-4DA

① External power input terminal：Power supply of analogue circuit for this module, the voltage can be 24VDC±20% and should be supplied with 4W of power at least.

② Protecting ground terminal： Connect to the shielding signal cable.

③ Expansion input cable： It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector： Provides the connection for next expansion unit.

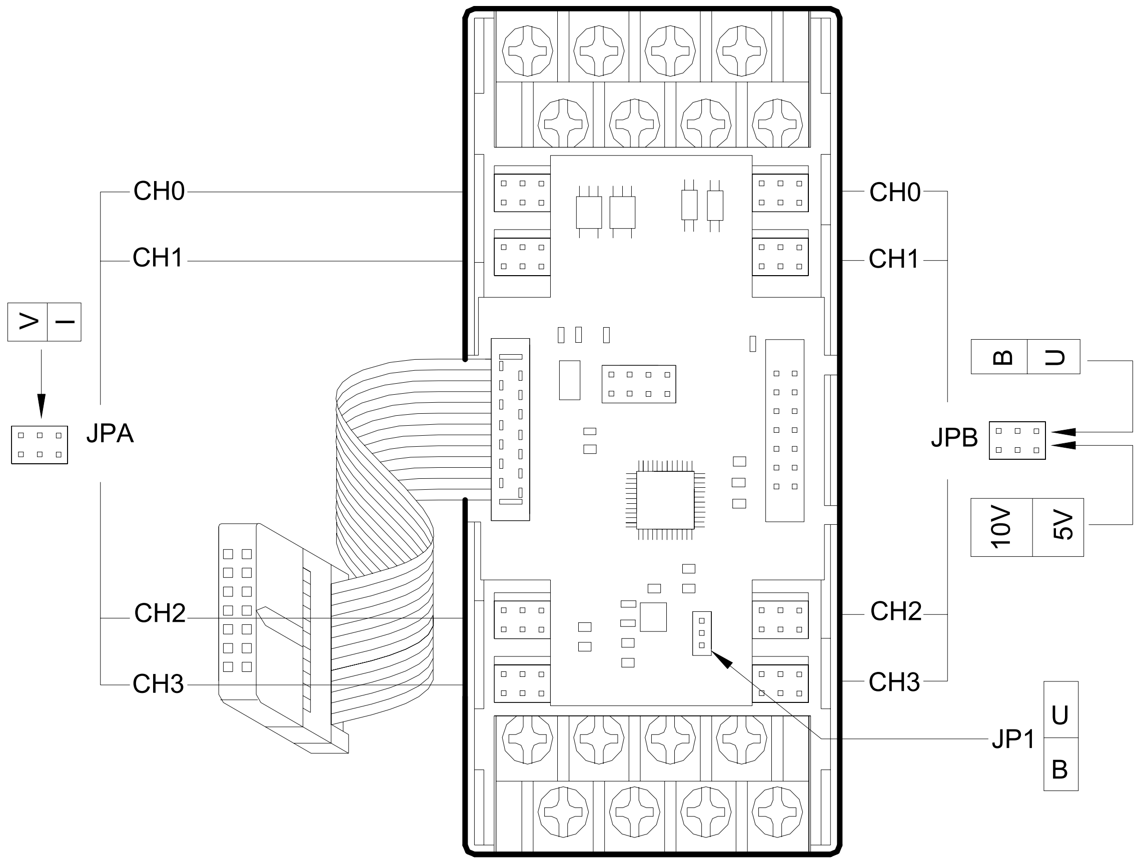
⑤ Power indicator： It indicates whether the power supply at analogue circuit and external input power source are normal.

⑥ AG Ground： No connection is needed in general; except when the common mode signal is too high. See examples overleaf for details.

⑦、⑧： Output terminal of CH0～CH1.

⑨、⑩： Output terminal of CH2～CH3.

18.2.4.1 FBs-4DA/2DA Hardware Jumper Setting



FBs-4DA/2DA Jumper location

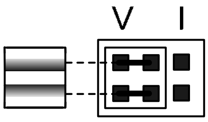
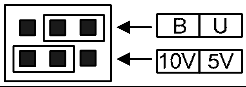
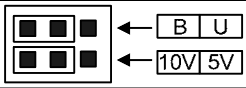
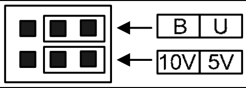
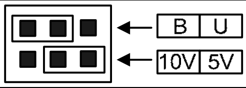
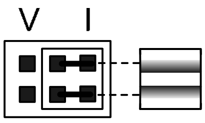
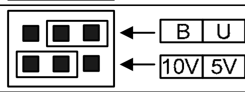
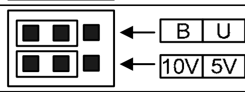
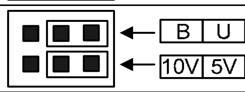
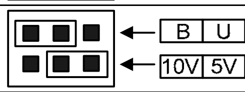
Output code format selection (JP1)

Users can select between unipolar and bipolar codes. The output range of unipolar codes and bipolar codes is 0~16383 and –8192~8191, respectively. The two extreme values of these formats correspond to the lowest and highest output signal values, respectively (see table below). In general, the output code format is selected according to the form of output signals; i.e. unipolar codes for unipolar output signals; and bipolar codes for bipolar output signals. In doing so, their correlations will become more heuristics. Yet, as the format of output code on all channels is selected from JP1, it is the user's choice to select unipolar or bipolar codes if both are used on different channels. See diagram above for location of JP1 **:**

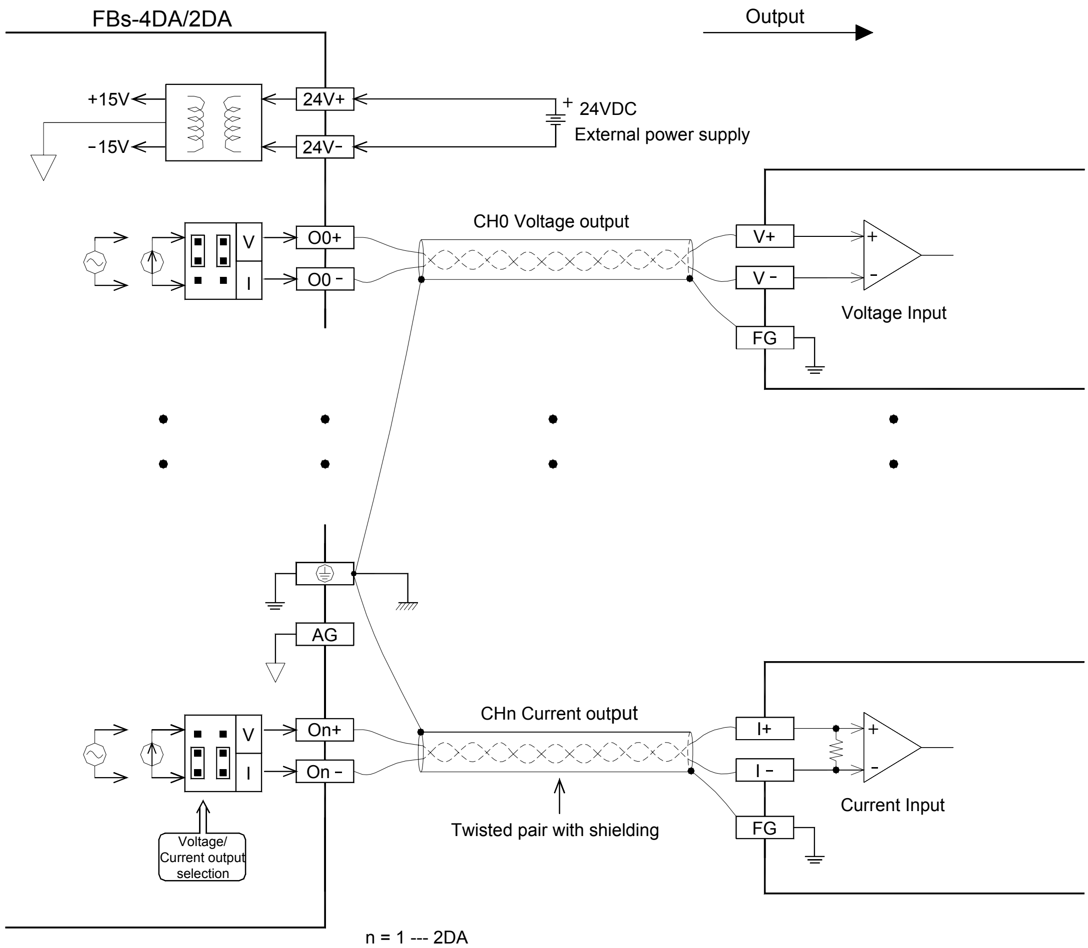
Output Code Format	JP1 Setting	Output Value Range	Corresponding Input Signals
Bipolar	JP1 U B	-8192～8191	-10V～10V(-20mA～20mA) -5V～5V(-10mA～10mA) 0V～10V(0mA～20mA) 0V～5V(0mA～10mA)
Unipolar	JP1 U B	0～16383	

Output signal form setup (JPA&JPB)

Users can set the output signal form (voltage/current) of individual channels; except the polarity and amplitude which are common.

Signal Form	JPA (voltage/current) Setting	JPB (polarity/amplitude) Setting
0V～10V		
-10V～10V		
0V～5V		
-5V～5V		
0mA～20mA		
-20mA～20mA		
0mA～10mA		
-10mA～10mA		

18.2.5 FBs-4DA/2DA Output Circuit Diagram



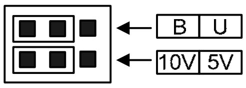
n = 1 --- 2DA

n = 3 --- 4DA

18.2.6 FBs-4DA/2DA Output Characteristics and Jumper Setting

Users can select the output ranges of FBs-4DA/2DA from the jumpers described above, such as V/I, U/B (I/O codes), U/B (signal form), 5V/10V, etc. The Output signals conversion characteristics of these settings are illustrated below. Users can adjust different Output forms by coordinating the conversion curve with various V/I (voltage/current) Output settings. See Section 18.2.4 for details of V/I settings **:**

Diagram 1：Bipolar 10V（20mA）Span

Output Range	Voltage	−10V～10V	Jumper Setting		————	JP1  U B
	Current	−20mA～20mA			- - - - - - - -	JP1  U B

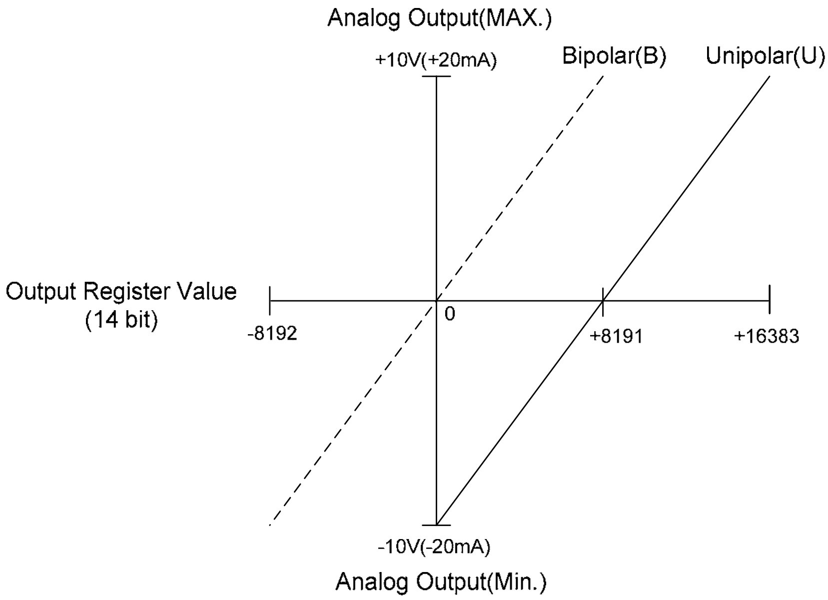
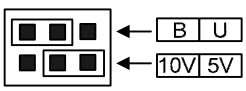
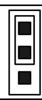


Diagram 2：Bipolar 5V（10mA）Span

Output Range	Voltage	−5V～5V	Jumper Setting		————	JP1  U B
	Current	−10mA～10mA			- - - - - - - -	JP1  U B

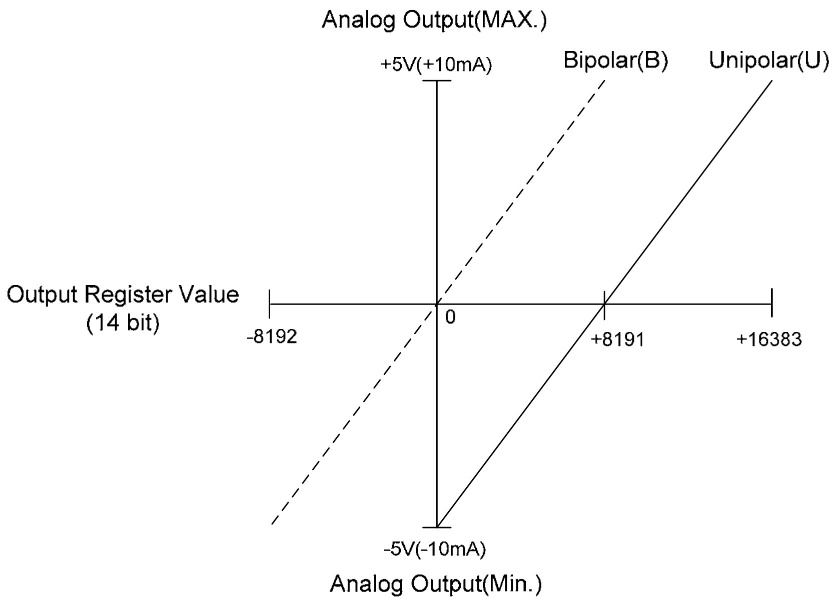


Diagram 3：Unipolar 10V（20mA）Span

Output Range	Voltage	0V～10V	Jumper Setting	B U / 10V 5V	———	JP1 U B
	Current	0mA～20mA			- - - - - - - -	JP1 U B

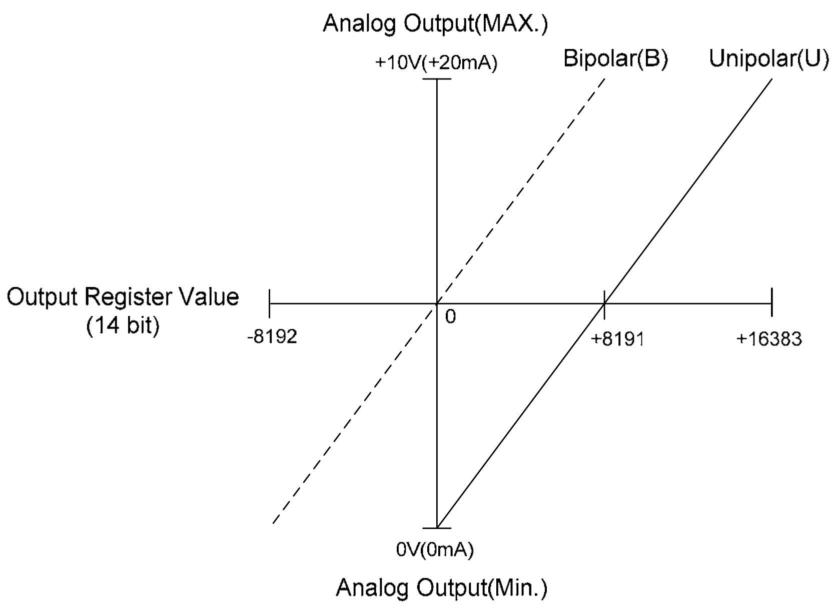
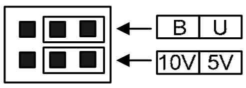
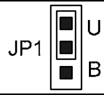
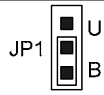
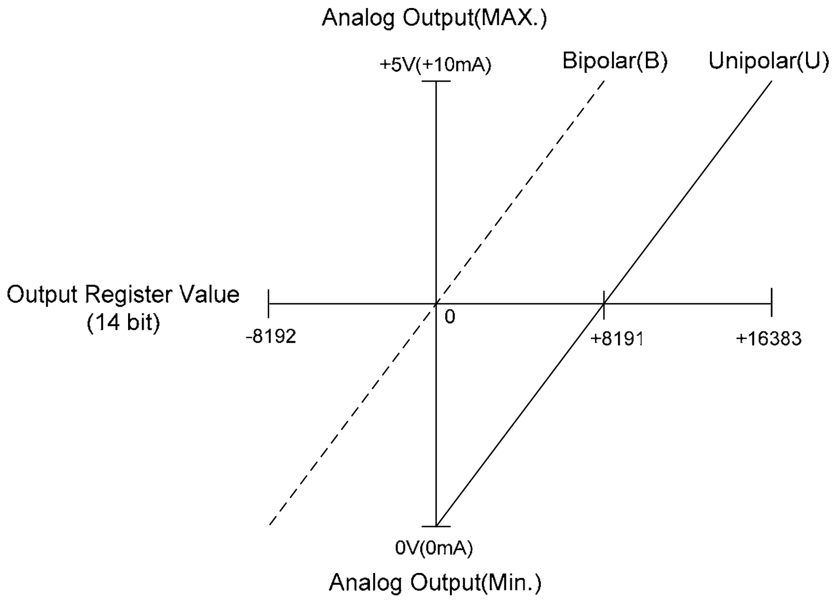


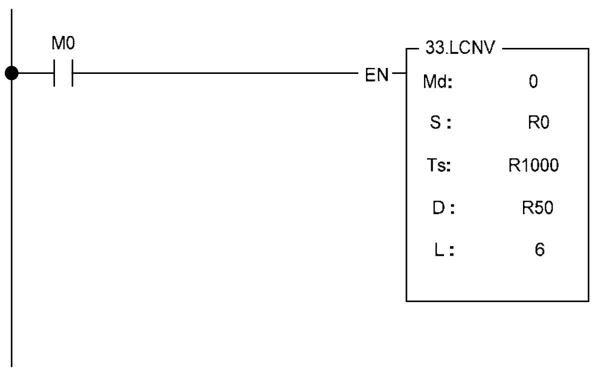
Diagram 4：Unipolar 5V（10mA）Span

Output Range	Voltage	0V～5V	Jumper Setting		————	
	Current	0mA～10mA			- - - - - - - -	



18.2.7 Tracking on the OFFSET Mode Output

For the process of output for signal source of offset mode (take 4~20mA output for example), when the OS version is later than 4.08 (including), you may use linear conversion instruction (FUN33) to read 4~20mA conversion output parameters.



• When M0 is “ON”, it will continuous perform 6 registers of conversion starting from R0, where R1000 is the starting address of the table of the conversion parameters, and the corresponding values will be stored into R50～R55.

The converted result is in below:

	Ts
R1000	0
R1001	16383
R1002	3276
R1003	16383

	S			D
R0	0	⇨	R50	3276
R1	3000		R51	5676
R2	6000		R52	8076
R3	9000		R53	10476
R4	12000		R54	12876
R5	16383		R55	16383

18.3 FBs-4A2D Analog Input/Output Module

FBs-4A2D is one of the analog I/O modules of FATEK FBs series PLC. For analog output it provides 2 channels of 14 bit D/A output. Base on the different jumper settings it can provide varieties of current or voltage output signal. The output code can be configured as unipolar or bipolar which makes the relation of output code and real output signal more intuitive. For safety, the output signal will be automatically forced to zero(0V or 0mA) when the module is not serviced by CPU for 0.5 second.

For analog input it provides 4 channels A/D input with 12 or 14 bits effective resolution. Base on the different jumper settings it can measure the varieties of current or voltage signal. The reading value is represented by a 14 bit value no matter the effective resolution is set to 12 or 14 bits The output code also can be configured as unipolar or bipolar which makes the relation of input code and real input signal more intuitive.. In order to filter out the field noise imposed on the signal, it also provides the average of sample input function.

18.3.1 Specifications of FBs-4A2D

Analog output specifications

Item			Specifications	Remark
Output Channel			2 Channel（2DA）	
Digital Output Value			−8192～+8191(Bipolar) or 0～16383(Unipolar)	*：It means the default setting
Span Of Analog output	Bipolar*	*10V	*1. Voltage：−10～10V 5. Current：−20～20mA	
		5V	2. Voltage：−5～5V 6. Current：−10～10mA	
	Unipolar	10V	3. Voltage：0～10V 7. Current：0～20mA	
		5V	4. Voltage：0～5V 8. Current：0～10mA	
Resolution			14 bits	
Finest resolution			0.3mV(Voltage)、0.61μA(Current)	
I/O Points Occupied			2 OR(Output register)	
Accuracy			Within ±1% of full scale	
Conversion Time			Updated each scan	
Maximum accommodation for resistance loading			Voltage：500Ω～1MΩ Current：0Ω～300Ω	The deviation will be enlarged if exceeding this range

Analog input specifications

Item			Specifications	Remark
Input Channel			4 Channel (4AD)	
Digital Input Value			−8192～+8191or 0～16383(14bit) −2048～+2047or 0～4095(12bit)	
Span Of Analog Input	Bipolar*	*10V	*1. Voltage：−10～10V 5. Current：−20～20mA	*：It means the default setting
		5V	2. Voltage：−5～5V 6. Current：−10～10mA	
	Unipolar	10V	3. Voltage：0～10V 7. Current：0～20mA	
		5V	4. Voltage：0～5V 8. Current：0～10mA	
Resolution			14 or 12 bit	

Finest resolution	Voltage：0.3mV Current：0.61μA	=Analog Input Signal/ 16383(rounded the third decimal place)
I/O Points Occupied	4 IR(Input register)	
Accuracy	Within ±1% of full scale	
Conversion Time	Updated each scan	
Maximum absolute input signal	Voltage：±15V（max） Current：±30mA（max）	It may cause the destruction to hardware if exceeds this value.
Input resistance	63.2KΩ（Voltage input）、250Ω（Current Input）	

General specifications

Isolation	Transformer(Power) and photocouple(Signal)	
Indicator(s)	5V PWR LED	
Internal Power Consumption	5V、100mA	
External power supply	24V-15%/+20%、100mA	
Operating Temperature	0 ~ 60 ℃	
Storage Temperature	-20 ~ 80 ℃	
Dimensions	40(W)x90(H)x80(D) mm	

18.3.2 The Procedure of Using FBs-4A2D Analog Input/Output Module

Start

↓

Set the I/O voltage/current (V/I), polarity (B/U), and the V/I range of each point before installation. Connect FBs-4A2D to the expansion interface on PLC in series and connect an external 24VDC source and analog output wires to the module. ------- Please refer to section 18.3.4 for hardware explanation.

↓

Analog Input : Directly read the value of the four corresponding IRs to obtain the analog input reading of CH0~CH3.

Analog Output : Directly fill the output value into the analogue output registers R3904～R3967 to acquire the corresponding analogue output span of CH0～CH1 from output module.

↓

End

18.3.3 Address Allocation of FBs-PLC Analog Inputs/Outputs

FBs-4A2D offers 4 AD points and 2 DA points. The AD points number starts from the one nearest to the PLC, the number in order is CH0~CH3 (module 1); CH4~CH7 (module 2); CH8~CH11 (module 3); etc, accumulates in serial; i.e. add 4 to each module, the total is 64 points (CH0~CH63) corresponding top the value IRs inside the PLC (R3840~R3903), respectively. In DA point numbering, from the one nearest to the PLC, the number runs from CH0 through to CH63 in serial, the total is 64 points corresponding top the value ORs inside the PLC (R3904~R3967), respectively. After connecting FBs-4A2D to the expansion interface on the PLC, FBs-PLC will automatically detect the number of AD/DA points. WinProladder will automatically detect and calculate the value IRs/ORs on the system after connecting to the PLC. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming (see I/O Number Configuration, Section 12.6, WinProladder User's Manual for details).

Address allocation of FBs-4A2D(Analog output)

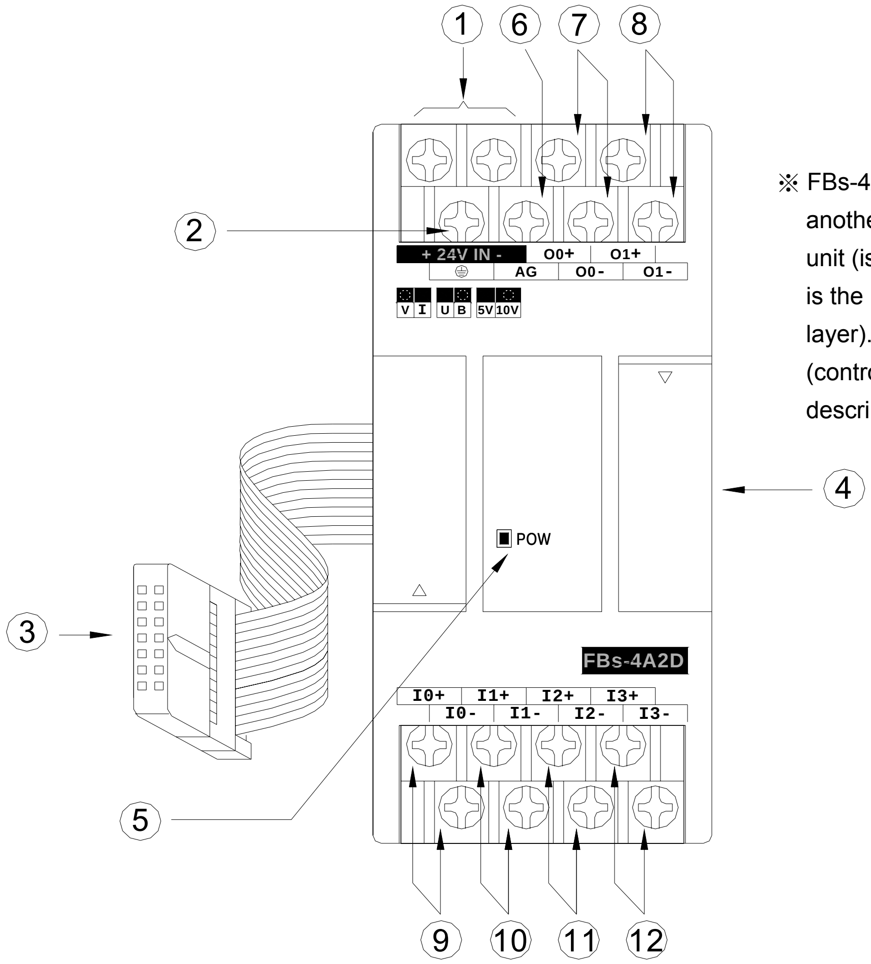
Numeric Output Register（OR）	Content of OR (CH0～CH63)		Output lable	
	B_{15} B_{14}	B_{13} B_{12} B_{11} B_{10} B_9 B_8 B_7 B_6 B_5 B_4 B_3 B_2 B_1 B_0		
OR+0	＊ ＊	B_{13} CH0 output value B_0	CH0	FBs-4A2D
OR+1	＊ ＊	CH1 output value	CH1	
OR+2	Depends on module type		CHX	Other modules
OR+3			CHX	
⋮	⋮	⋮	⋮	
R3966	Depends on module type		CHX	
R3967	Depends on module type		CHX	

＊ ＊ ------------ Unipolar code output (0～16383)，B14、B15 = 00
Bipolar code output (-8192～8191)，B14、B15 = B13

Address allocation of FBs-4A2D(Analog input)

Numeric Input Register（IR）	Content of IR (CH0～CH63) B15 B14 B13 B12 B11 B10 B9 B8 B7 B6 B5 B4 B3 B2 B1 B0	Input lable	
IR+0	14/12 bit ; 14-bit , B14~ B15= B13 ; 12-bit, B12~ B15= B11	CH0	FBs-4A2D
IR+1	14/12 bit ; 14-bit , B14~ B15= B13 ; 12-bit, B12~ B15= B11	CH1	
IR+2	〃	CH2	
IR+3	〃	CH3	
⋮	⋮	⋮	Other modules
R3900	Depends on module type	CHX	
R3901	Depends on module type	CHX	
R3902	〃	CHX	
R3903	〃	CHX	

18.3.4 FBs-4A2D Hardware Description



※ FBs-4A2D contains 3 PCBs overlapping one another. The lowest one is the power supply unit (isolated power supply). The middle one is the I/O board (connectors are on this layer). The upper one is the control board (control/expansion I/O connections) as described below.**:**

Outlook of top view

① External power input terminal ： Power supply of analogue circuit for this module, the voltage can be 24VDC±20% and should be supplied with 4W of power at least.

② Protecting ground terminal： Connect to the shielding of signal cable.

③ Expansion input cable： It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector： Provides the connection for next expansion unit.

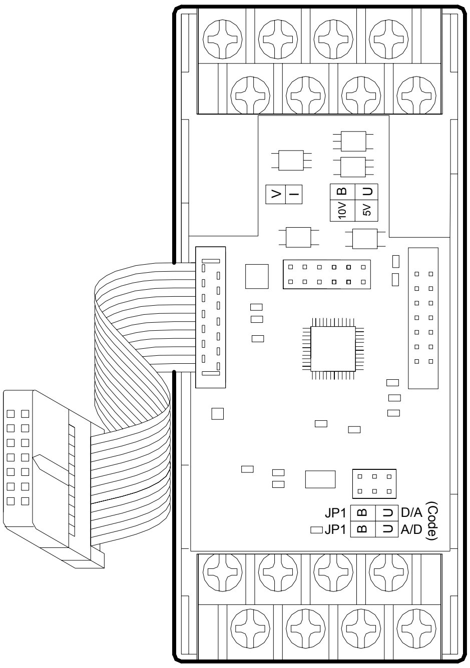
⑤ Power indicator： It indicates whether the power supply at analogue circuit and external input power source are normal.

⑥ AG Ground： No connection is needed in general; except when the common mode signal is too high. See examples overleaf for details.

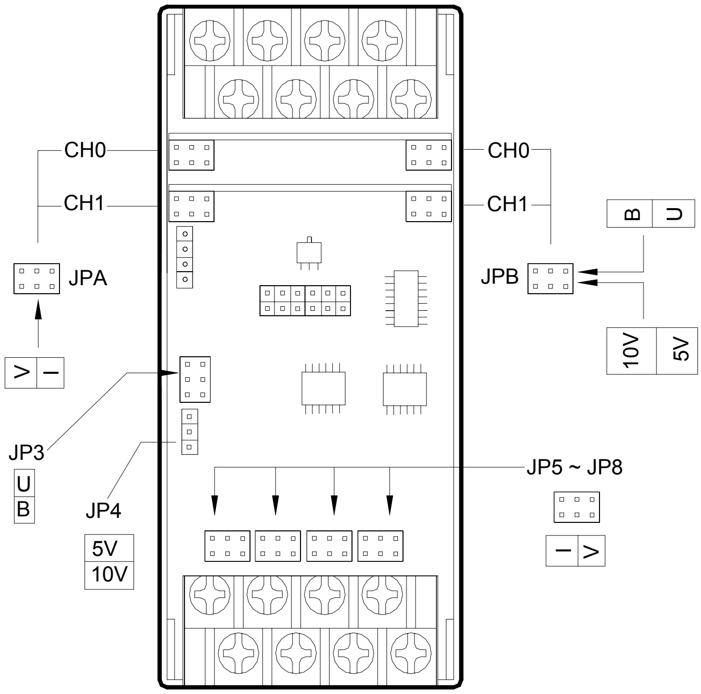
⑦、⑧： Output terminal of CH0～CH1.

⑨、⑫： Input terminal of CH0～CH3.

18.3.4.1 FBs-4A2D Hardware Jumper Setting



Pin Layout in Control Board (open top cover)

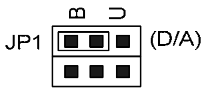
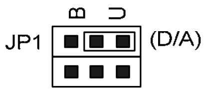


Pin Layout on I/O Board (Remove Control Board)

● (Analog output)

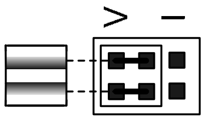
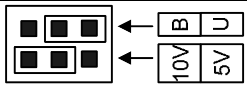
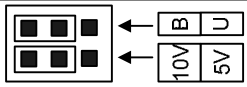
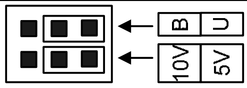
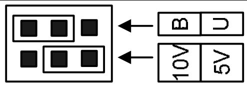
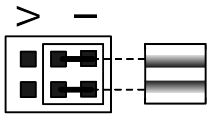
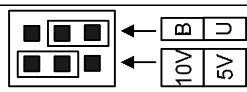
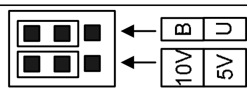
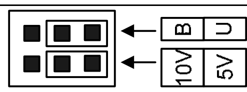
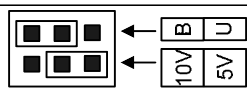
1. Output code format selection (JP1)

Users can select between unipolar and bipolar codes. The output range of unipolar codes and bipolar codes is 0~16383 and –8192~8191, respectively. The two extreme values of these formats correspond to the lowest and highest output signal values, respectively (see table below). In general, the output code format is selected according to the form of output signals; i.e. unipolar codes for unipolar output signals; and bipolar codes for bipolar output signals. In doing so, their correlations will become more heuristics. Yet, as the format of output code on all channels is selected from JP1, it is the user's choice to select unipolar or bipolar codes if both are used on different channels. See diagram above for location of JP1 :

Output Code Format	JP1 Setting	Output Value Range	Corresponding Input Signals
Bipolar		-8192～8191	-10V～10V(-20mA～20mA) -5V～5V(-10mA～10mA)
Unipolar		0～16383	0V～10V(0mA～20mA) 0V～5V(0mA～10mA)

2. Output signal form setup (JPA&JPB)

Users can set the output signal form (voltage/current) of individual channels; except the polarity and amplitude which are common.

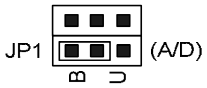
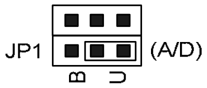
Signal Form	JPA (voltage/current) Setting	JPB (polarity/amplitude) Setting
0V～10V		
-10V～10V		
0V～5V		
-5V～5V		
0mA～20mA		
-20mA～20mA		
0mA～10mA		
-10mA～10mA		

● (Analog input)

1. Input code format selection (JP1)

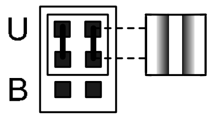
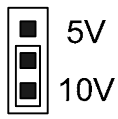
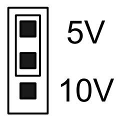
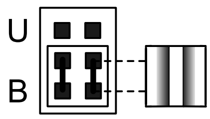
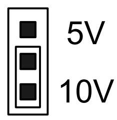
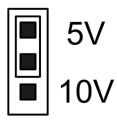
Users can select between unipolar and bipolar codes. The input range of unipolar codes and bipolar codes is 0~16383 and –8192~8191, respectively. The two extreme values of these formats correspond to the lowest and highest input signal values, respectively (see table below). For example, if the input signal type is set to -10V~ +10V, the unipolar code corresponding to the input is 8192 and the bipolar code corresponding to the input is 0 for 0V input. If the input is 10V, the unipolar code corresponding to the input is 16383 and the bipolar code corresponding to the input is 8191. In general, the input code format is selected according to the form of input signals; i.e. unipolar codes for unipolar input signals; and bipolar codes for bipolar input signals. In doing so, their correlations will become more heuristics. Unless it is

necessary to make a deviation conversion through FUN33; otherwise, do not select bipolar codes for unipolar input signals (see FUN33 description for details). The format of input codes of all channels is selected from JP1. See above diagram for the location of JP1：

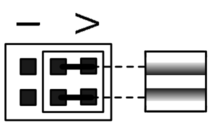
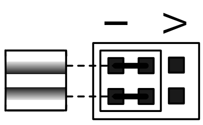
Input Code Format	JP1 Setting	Input Value Range	Corresponding Input Signals
Bipolar		-8192～8191	-10V～10V(-20mA～20mA) -5V～5V(-10mA～10mA) 0V～10V(0mA～20mA) 0V～5V(0mA～10mA)
Unipolar		0～16383	

2. Input signal form setup (JP3&JP4)

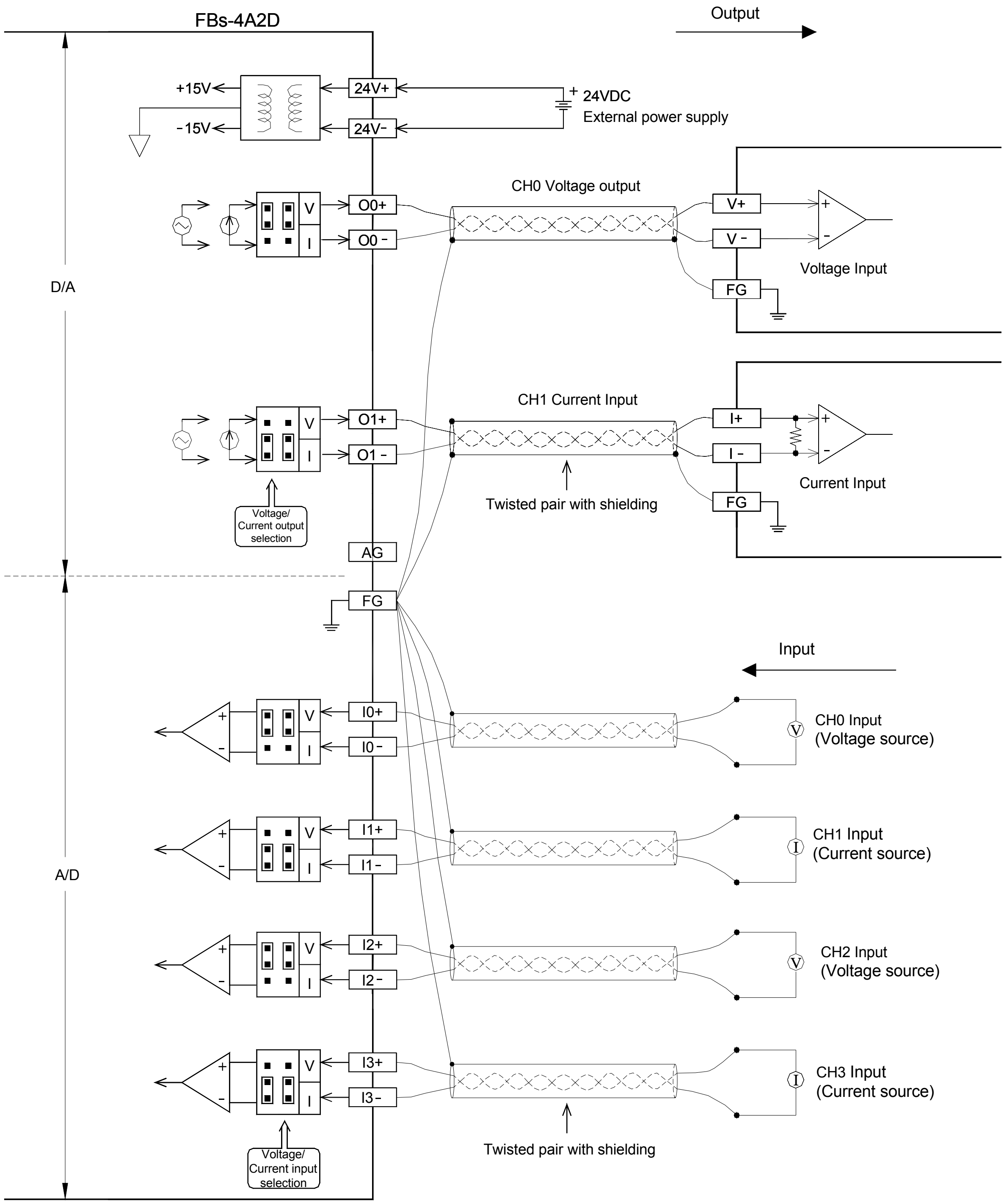
Users can set the input signal form (voltage/current) of individual channels; except the polarity and amplitude which are common. The location of jumpers are tabulated below：

Signal Form	JP3 Setting	JP4Setting
0～10V or 0～20mA		
0～5V or 0～10mA		
-10～+10V or -20～+20mA		
-5～+5V or -10mA～+10mA		

3. Voltage or current setting (JP5～JP8)

Signal Type	JP5(CH0) ～ JP8(CH3) Setting
Voltage	
Current	

18.3.5 FBs-4A2D Input/Output Circuit Diagram



18.3.6 FBs-4A2D Input/Output Characteristics

Users can select the I/O ranges of FBs-4A2D from the jumpers described above, such as V/I, U/B (I/O codes), U/B (signal form), 5V/10V, etc. The I/O conversion characteristics of these settings are illustrated below. Users can adjust different I/O forms by coordinating the conversion curve with various V/I (voltage/current) I/O settings. See Section 18.3.4 for details of V/I settings.

Chapter 19　Analog Input/Output Expansion Board

Since the main units, which have less than 14 points, of FBs Series does not provide right expansion module input/output interface, FATAK has developed a special series of analog expansion I/O boards for the units.　This series includes analog input expansion board (FBs-B4AD), analog output expansion board (FBs-B2DA), and analog I/O expansion board (FBs-B2A1D).　Thus, when customers using the main units have less than 14 points, they will be able to connect to the surrounding analog signals to achieve economic advantages of the application.　An introduction of three analog expansion boards is shown in the following:

FBs-B4AD is the analog input signal expansion board of FATEK FBs series PLC.　It provides 4 channels 12-bit analog input measurement signal (14-bit expression).　When applications occurred, it will be able to determine the location of wiring input or output signal type (voltage or current).

FBs-B2DA is the analog output signal expansion board of FATEK FBs series PLC.　It provides 2 channels 12-bit (14-bit expression) analog output signal.　When applications occurred, it will be able to determine the location of wiring input or output signal type (voltage or current). For safety, the output signal will be automatically forced to zero (0V or 0mA) when the modules is not serviced by CPU for 0.5 seconds.

FBs-B2A1D is the analog I/O signal expansion board.　It provides 1 channel 12-bit (14-bit expression) analog output signal and measurable 2 channels 12-bit (14-bit expression) analog input signal.　When applications occurred, it will be able to determine the location of wiring input or output signal type (voltage or current). For safety, the output signal will be automatically forced to zero (0V or 0mA) when the modules is not serviced by CPU for 0.5 seconds.

19.1　Specifications of FBs Analog Expansion Boards

FBs-B4AD Specifications

Item		Specifications	Remark
Input Point		4 points(4AD)	
Resolution		12-bit	
Numeric Expression		14 bits(0 ～ 16380)	
Finest Resolution		2.44mV(Voltage)、4.88μA(Current)	
I/O Points Occupied		4 Registers(D4072～D4075)	
Conversion Time		Updated each scan	
Span of Analog Input	Voltage	0～10V	
	Current	0～20mA	
Accuracy		Within ±1% of full scale	
Input Resistance		100KΩ(Voltage)、125Ω(Current)	
Internal Consumption		5V、100mA	
Working Temperature		0 ~ 60 ℃	
Storage Temperature		-20 ~ 80 ℃	

FBs-B2DA Specifications

Item		Specifications	Remark
Output Channel		2 channels (2DA)	
Resolution		12-bit	
Numeric Expression		14 bits(0 ～ 16380)	
Finest Resolution		2.44mV(Voltage)、4.88μA(Current)	
I/O Points Occupied		2 Registers(D4076～D4077)	
Conversion Time		Updated each scan	
Span of Analog Output	Voltage	0～10V	
	Current	0～20mA	
Accuracy		Within ±1% of full scale	
Internal Consumption		5V、120mA	
Working Temperature		0 ~ 60 ℃	
Storage Temperature		-20 ~ 80 ℃	

FBs-B2A1D Specifications

Detailed Analog Input Specifications			
Item		Specifications	Remark
Input Channel		2 channels(2AD)	
Resolution		12-bit	
Numeric Expression		14 bits(0 ～ 16380)	
Finest Resolution		2.44mV(Voltage)、4.88μA(Current)	
I/O Points Occupied		2 Registers (D4072～D4073)	
Conversion Time		Updated each scan	
Span of Analog Input	Voltage	0～10V	
	Current	0～20mA	
Accuracy		Within ±1% of full scale	
Detailed Analog Output Specifications			
Item		Specifications	Remark
Output Channel		1 channel(1DA)	
Resolution		12-bit	
Numeric Expression		14 bits(0 ～ 16380)	
Finest Resolution		2.44mV(Voltage)、4.88μA(Current)	
I/O Points Occupied		1 Register (D4076)	
Conversion Time		Updated each scan	
Span of Analog Output	Voltage	0～10V	
	Current	0～20mA	
Accuracy		Within ±1% of full scale	
Detailed Specifications of Common Parts			
Item		Specifications	Remark
Internal Consumption		5V、150mA	
Working Temperature		0 ~ 60 ℃	
Storage Temperature		-20 ~ 80 ℃	

19.2 The Procedure of Using FBs Analog Expansion Boards

Start

↓

There is considerable use of differences between FBs analog expansion board and analog expansion module. The signal type of FBs analog expansion board is not set to pin layout, it is set to wiring. This means that there is different pins fixed signal type. If you would like to use current or voltage, you would have to set to the correct pin wiring first. You cannot adjust pin layout afterword. ------- Please refer to section 19.4 for hardware explanation.

↓

Analog Input: Directly read the value of register to obtain the analog input reading.

Analog Output: Directly fill the output value into the output register to acquire the corresponding analog output voltage and current.

↓

End

19.3 Address Allocation of FBs Analog Expansion Boards

The address allocation of analog expansion board also has difference to FBs series analog expansion module. The occupied analog expansion board system resources is no longer numerical input register (IR register) R3840~R3903 or numerical output register (OR register) R3904~R3967, but a data register D4072~D4075 (analog input expansion board) or D4076~D4077 (analog output expansion board). The three types of analog expansion boards occupied the resources are listed in below.

Meanwhile, after WinProladder connect with PLC, it will automatically detect and configure the register. Users may refer to the I/O Module Number Configuration provided by WinProladder in order to find out the exact I/O address of each expansion module to facilitate programming.

I/O allocation of FBs-B4AD

Channel		Occupied I/O Resources
Analog Input	CH0	D4072 (0 ～ 16380)
	CH1	D4073 (0 ～ 16380)
	CH2	D4074 (0 ～ 16380)
	CH3	D4075 (0 ～ 16380)

I/O allocation of FBs-B2DA

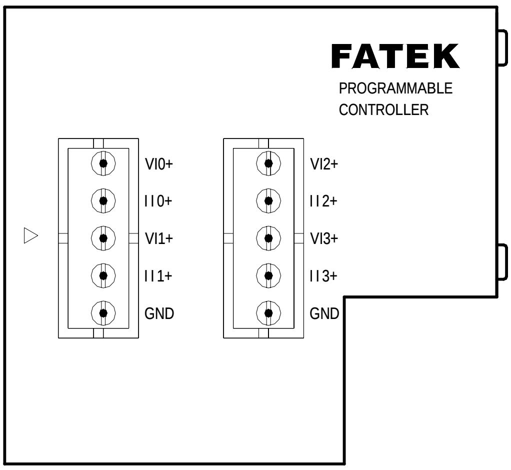
Channel		Occupied I/O Resources
Analog Output	CH0	D4076 (0 ～ 16380)
	CH1	D4077 (0 ～ 16380)

I/O allocation of FBs-B2A1D

Channel		Occupied I/O Resources
Analog Input	CH0	D4072 (0 ～ 16380)
	CH1	D4073 (0 ～ 16380)
Analog Output	CH0	D4076 (0 ～ 16380)

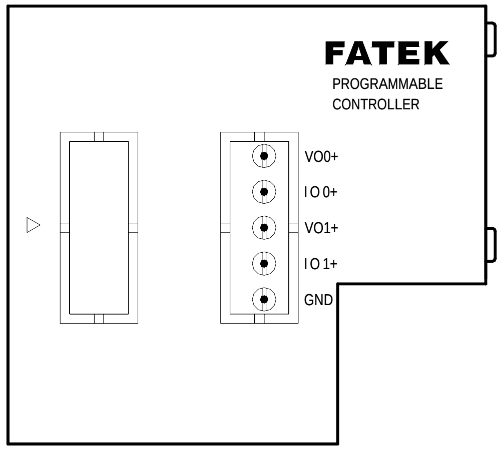
19.4 Hardware Description of FBs Analog Expansion Boards

FBs-B4AD outlook and top view



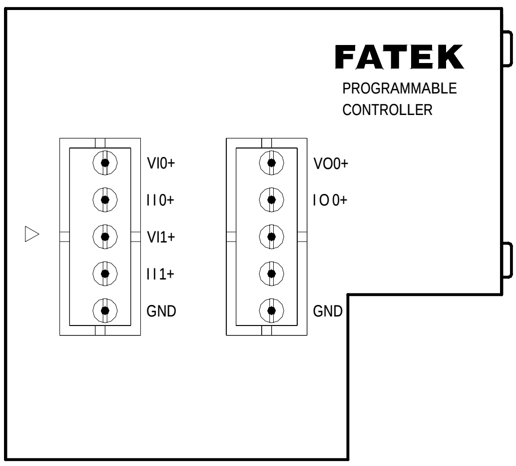
Pin Position	Explanation
VI0+	Channel 0 Analog Voltage Input
II0+	Channel 0 Analog Current Input
VI1+	Channel 1 Analog Voltage Input
II1+	Channel 1 Analog Current Input
VI2+	Channel 2 Analog Voltage Input
II2+	Channel 2 Analog Current Input
VI3+	Channel 3 Analog Voltage Input
II3+	Channel 3 Analog Current Input
GND	Ground Wire

FBs-B2DA outlook and top view



Pin Position	Explanation
VO0+	Channel 0 Analog Voltage Output
IO0+	Channel 0 Analog Current Output
VO1+	Channel 1 Analog Voltage Output
IO1+	Channel 1 Analog Current Output
GND	Ground Wire

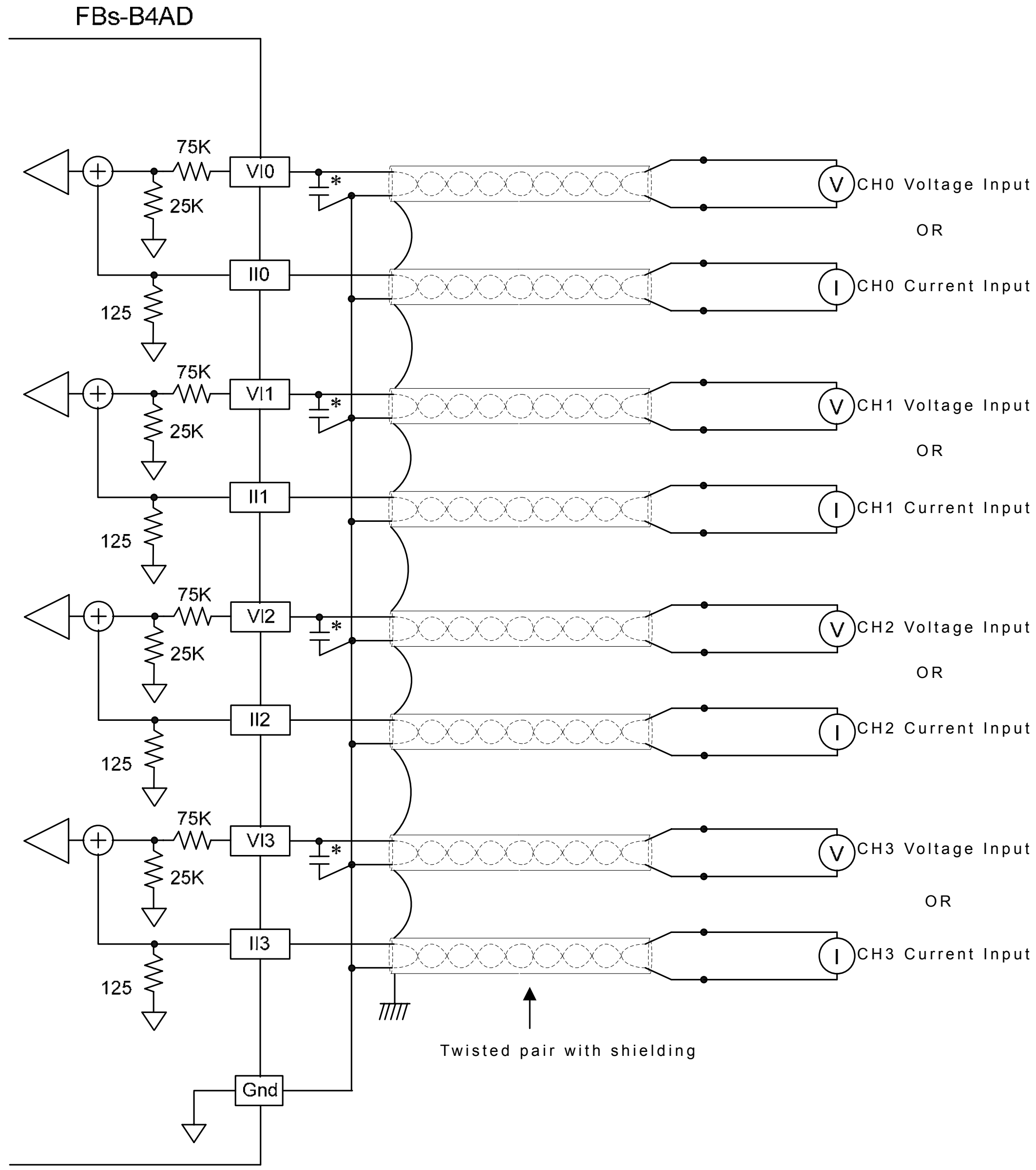
FBs-B2A1D outlook and top view



Pin Position	Explanation
VI0+	Channel 0 Analog Voltage Input
II0+	Channel 0 Analog Current Input
VI1+	Channel 1 Analog Voltage Input
II1+	Channel 1 Analog Current Input
GND	Ground Wire
VO0+	Channel 0 Analog Voltage Output
IO0+	Channel 0 Analog Current Output
GND	Ground Wire

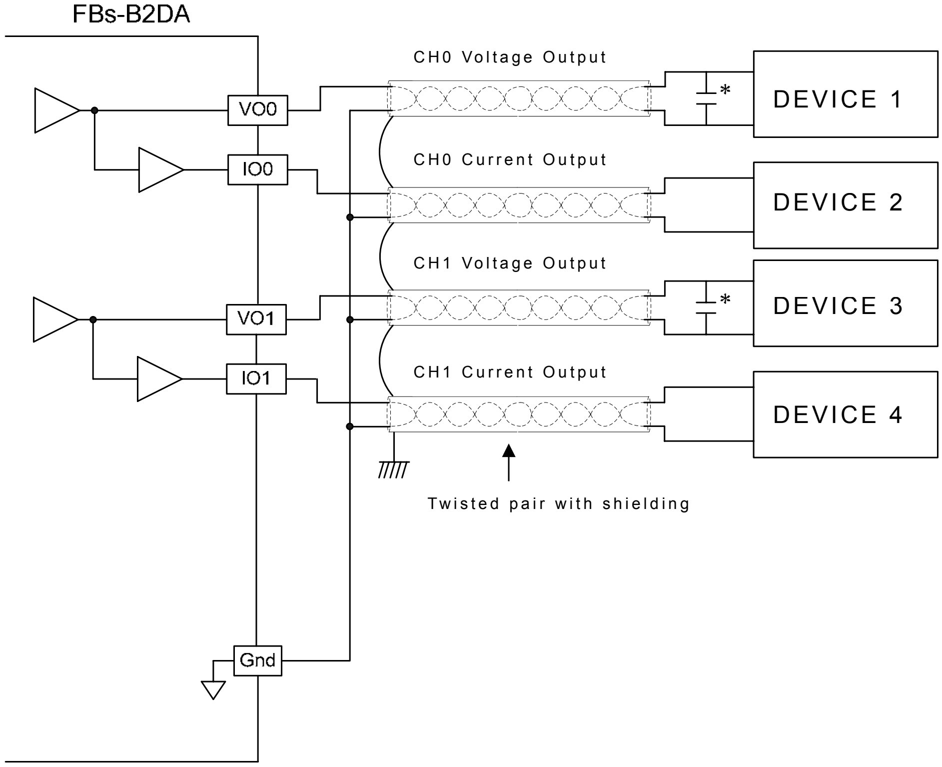
19.5 FBs Analog Expansion Boards I/O Circuit Diagram

19.5.1 FBs-B4AD Analog Input Circuit Diagram



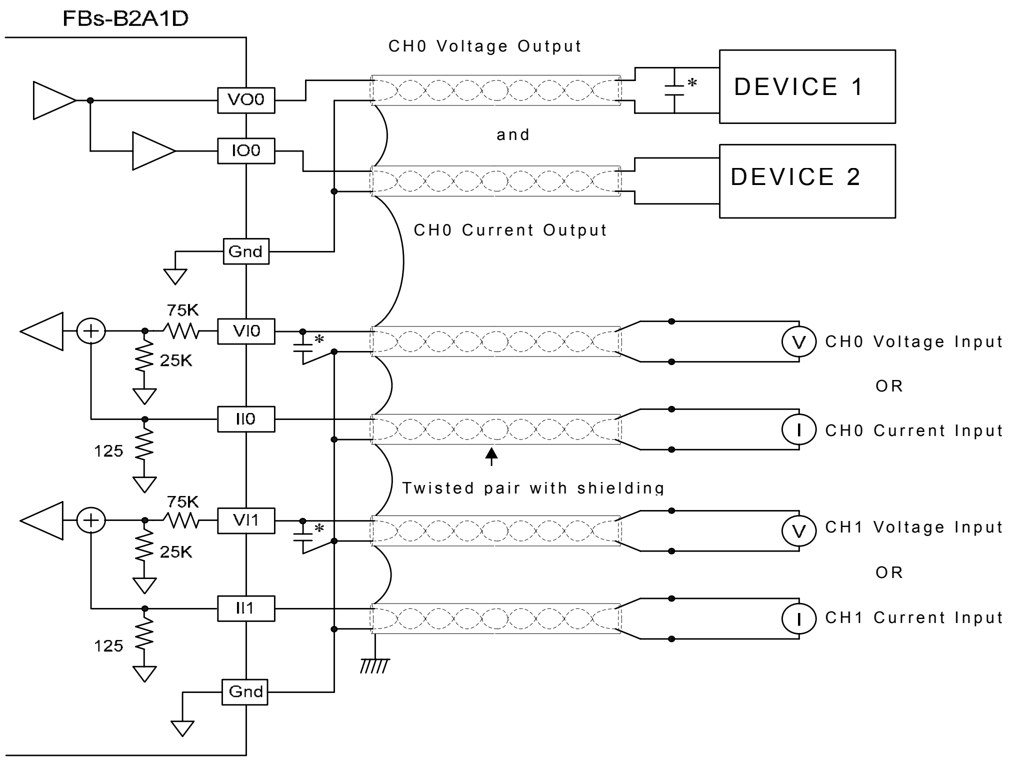
*0.1~0.47uF capacitor (to filter noise)………Advice to install, but not necessary!!

19.5.2 FBs-B2DA Analog Output Circuit Diagram



*0.1~0.47uF capacitor (to filter noise)………Advice to install, but not necessary!!

19.5.3 FBs-B2A1D Analog I/O Circuit Diagram



*0.1~0.47uF capacitor (to filter noise)………Advice to install, but not necessary!!

19.6 FBs Analog Expansion Board I/O Characteristics

The analog I/O conversion characteristics of these settings are illustrated below. Users can adjust different I/O forms by coordinating the conversion curve with various V/I (Voltage/Current) I/O settings.

Figure 1：Analog Input Characteristics Curve

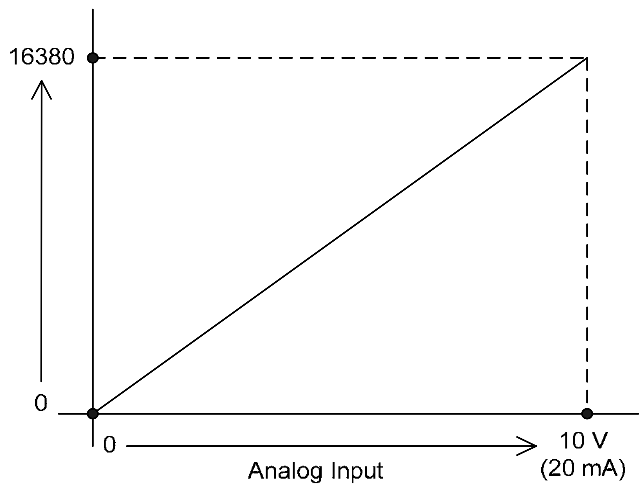
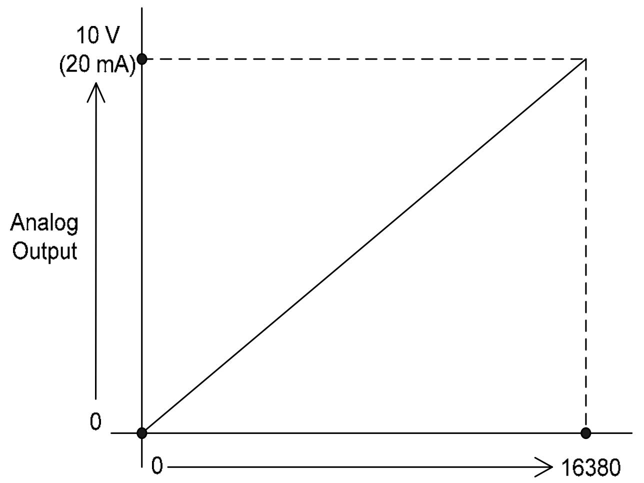


Figure 2：Analog Output Characteristics Curve



Chapter 20 Temperature Measurement of FBs-PLC and PID Control

FBs-PLC provides two kinds of temperature modules to meet the great temperature measurement applications. One kind of these modules are directly interfacing with the thermocouple, and the others are interfacing with the RTD sensor. The modules FBs-2TC/FBs-6TC/FBs-16TC support 2/6/16 temperature channels correspondingly to connect the J,K,T,E,N,B,R,S type of thermocouple. The modules FBs-6RTD/FBs-16RTD support 6/16 temperature channels correspondingly to connect the PT-100,PT-1000 type of RTD sensor. The total temperature inputs can be expanded up to 32 channels at the most.

By the time domain multiplexing design method, each temperature module occupies 1 point of register input and 8 points of digital output for I/O addressing. The update rate for temperature reading value can be set as normal (Update time is 4 second, the resolution is 0.1°) or fast (Update time is 2 second, the resolution is 1°).

The WinProladder provides the very user friendly table editing operation interface to configure the temperature measurement, for example, selecting the temperature module, type of sensor, and assign the registers to store the reading values… As to the temperature control, it has the convenient instruction FUN86(TPCTL) to perform the PID operation to control the heating or cooling of the temperature process.

20.1 Specifications of Temperature Measuring Modules of FBs-PLC

20.1.1 Thermocouple Input of FBs-PLC

Specifications / Items	Module		
	FBs-2TC	FBs-6TC	FBs-16TC
Number of input points	2 Points	6 Points	16 Points
Thermocouple type and temperature measurement range	J(−200～900°C) K(−190～1300°C) R(0～1800°C) S(0～1700°C) E(−190～1000°C) T(−190～380°C) B(350～1800°C) N(−200～1000°C)		
I/O Points Occupied	1 IR(Input Register)、8 DO(Discrete Output)		
Software Filter	Moving Average		
Average Samples	NO 1、2、4、8 Configurable		
Compensation	Built-in cold junction compensation		
Resolution	0.1°C		
Conversion Time	1 or 2 Sec.	2 or 4 Sec.	3 or 6 Sec.
Overall Precision	±(1%+1°C)		
Isolation	Transformer(Power) and photocouple(Signal) isolation (per-channel isolation)		
Internal Power Consumption	5V，32mA		5V，35mA
Power Input	24VDC-15%/+20%、2VA max		
Indicator(s)	5V PWR LED		
Operating Temperature	0～60 °C		
Storage Temperature	-20～80°C		
Dimensions	40(W)x90(H)x80(D) mm		90(W) x90(H) x80(D) mm

20.1.2 RTD Input of FBs-PLC

Specifications / Items	Module	
	FBs-6RTD	FBs-16RTD
Number of input points	6 Points	16 Points
RTD type and temperature measurement range	3-wire RTD sensor JIS(α=0.00392) or DIN(α=0.00385) Pt-100(−200～850°C) Pt-1000(−200～600°C)	
I/O Points Occupied	1 IR(Input Register)、8 DO(Discrete Output)	
Software Filter	Moving Average	
Average Samples	NO 1、2、4、8 Configurable	
Resolution	0.1°C	
Conversion Time	1 or 2 Sec.	2 or 4 Sec.
Overall Precision	±1%	
Isolation	Transformer(Power) and photocouple(Signal) isolation (per-channel isolation)	
Internal Power Consumption	5V，35mA	5V，35mA
Power Input	24VDC-15%/+20%、2VA max	
Indicator(s)	5V PWR LED	
Operating Temperature	0～60 °C	
Storage Temperature	-20～80°C	
Dimensions	40(W)x90(H)x80(D) mm	90(W) x90(H) x80(D)mm

20.1.3 NTC Temperature Input Module

Item / Specifications	Module
	FBs-6NTC
Input point	6 points
Sensor Type	2K, 5K, 10K, 20KΩ(@25℃)NTC sensor
I/O Address Occupied	1 IR (Input Register), 8 DO (Discrete Output)
Software Filter	Moving average
Average Samples	1、2、4、8、16 configurable
Resolution	0.1°C
Conversion Time	1 or 2 Sec.
Accuracy	±1%
Isolation	Transformer(Power) and photo-coupler(Signal)
Internal power consumption	5V，35mA
Supply power	24VDC-15%/+20%、2VA
Indicator(s)	5V PWR LED
Operating Temperature	0～60 °C
Storage Temperature	-20～80°C
Dimension	90(W) x90(H) x80(D)mm

20.2 The Procedure of Using FBs Temperature Module

20.2.1 Temperature Measurement Procedure

Start

↓

Connect Modules to the expansion interface on PLC in series and connect an external 24VDC source and temperature measure input wires. ------- Please refer to section 20.6 for setting and wiring.

↓

Executing the WinProladder and configure the configuration table address、Temperature register address and working register in “Temp. configuration” windows then you can read temperature value from register directly. ------- Please refer to section 20.3

↓

End

20.2.2 Closed Loop PID Temperature Control

Start

↓

Connect Modules to the expansion interface on PLC in series and connect an external 24VDC source and temperature measure input wires. ------- Please refer to section 20.6 for setting and wiring.

↓

Using convenient instruction of PID temperature control(FUN86) combine to “Temp. configuration” Table to get the current value of temperature and let it be as so called Process Variable (PV); after the calculation of software PID expression, it will respond the error with an output signal according to the setting of Set Point (SP),the error's integral and the rate of change of the process variable. Through the closed loop operation, the steady state of the process may be expected. ------- Please refer to FUN86 explanation of instructions and program example.

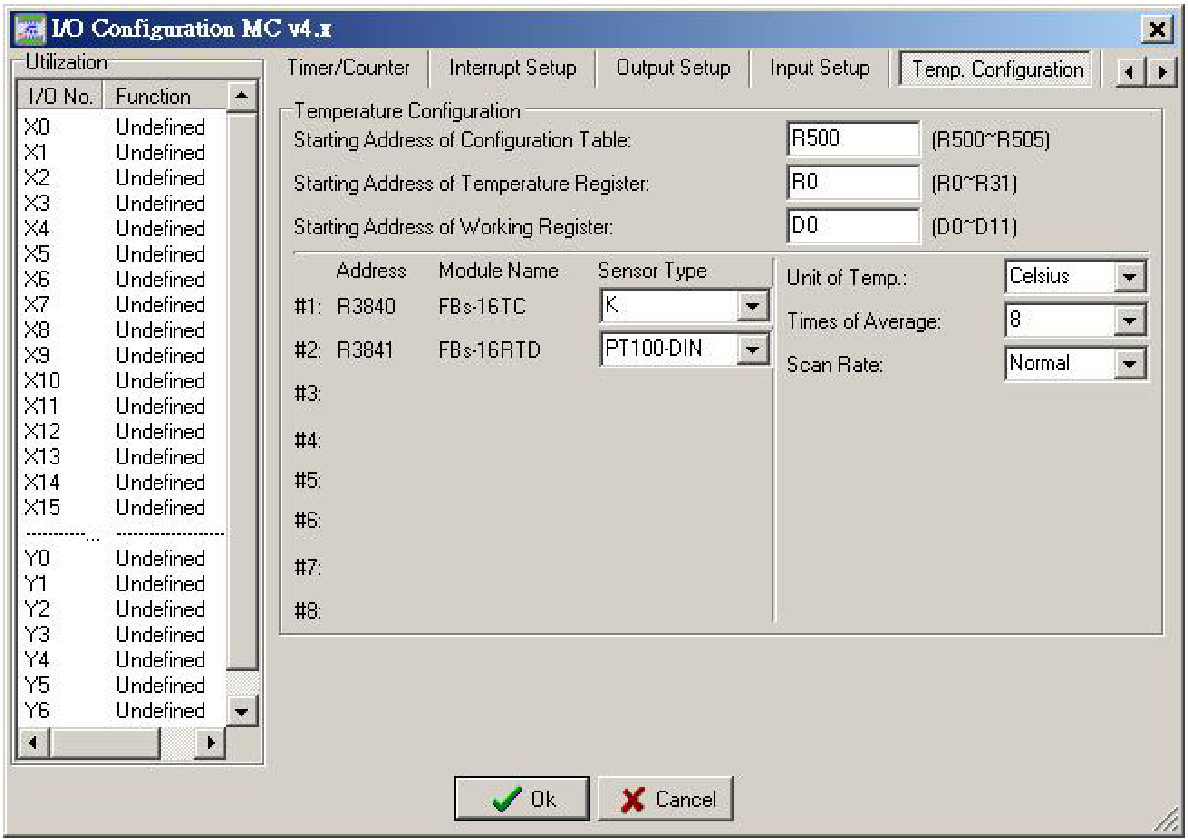
↓

End

20.3 The Procedures to Configure the Temperature Measurement

Click the item “I/O Configuration” which in Project Windows :

Project name
System Configuration
I/O Configuration → Select “Temp. Configuration”



1. 〔Starting Address of Configuration Table〕: Assign the starting of registers to store the temperature configuration table, there will allow the following inputs.
   a. Space (Without temperature configuration table)
   b. Rxxxx or Dxxxxx

   The configuration table will occupy 4+N of registers, where N is the number of modules.
   As shown the sample above, R5000~R5005 stores the table

2. 〔.Starting Address of Temp. Register〕: Assign the starting of registers to store the current temperature reading values, there will allow the following inputs, Rxxxx or Dxxxxx ; 1 channel of temperature occupies 1 register as shown the sample above, R0~R31 stores the reading values. The resolution of reading value is 0.1°.
   For example. R0=1234, it means 123.4°

3. 〔Starting Address of Working Register〕: Assign the starting of registers to reserve the working registers, there will allow the following inputs Rxxxx or Dxxxxx
   As shown the sample above, D0~D11 are the working registers

【Temperature module installation information and setup】

4.〔Module #1 ~ # 8〕: Display the name of the installed temperature module and the analog starting address of it's own, there are the following modules。

① 6TC (6 channels of thermocouple input)
② 6RTD (6 channels of RTD input)
③ 16TC (16 channels of thermocouple input)
④ 16RTD (16 channels of RTD input)
⑤ 2TC (2 channels of thermocouple input)
⑥ 6NTC (6 channels NTC temperature input)

※The Sensor Type field is used to assign and display the sensor type, the detail Sensor Type please refer to section 20.1

5.〔Unit of Temperature〕: Assign the unit of temperature, there have the following selections

① Celsius
② Fahrenheit

6.〔Times of Average〕: Assign the times of average for temperature measurement, there have the following selections, No / 2 / 4 / 8.

7.〔Scan Rate〕: Assign the update rate of temperature reading value, there will have the following selections : Normal (Update time is 4 second, the measurement resolution is 0.1°), Fast (Update time is 2 second, the measurement resolution is 1°). The resolution of reading value is always 0.1°.

20.3.1 The Internal Format of Temperature Configuration Table

This introduction is for trouble shooting or HMI or SCADA User, because they may modify through registers. Winproladder's User can ignore this introduction. When you configure temperature configuration table with Winproladder, these value of registers will be finished. When SR+0 = A556h, it means valid temperature configuration table. But if SR+0 = other values, it means invalid temperature configuration table.

Address	High Byte	Low Byte
SR + 0	A5H	56H
SR + 1	Quantity of temperature modules (1~8)	
SR + 2	Starting address of reading values	
SR + 3	Starting address of working registers	
SR + 4	Type of sensor (#1)	Module name (#1)
SR + 5	Type of sensor (#2)	Module name (#2)
SR + 6	Type of sensor (#3)	Module name (#3)
SR + 7	Type of sensor (#4)	Module name (#4)
SR + 8	Type of sensor (#5)	Module name (#5)
SR + 9	Type of sensor (#6)	Module name (#6)
⋮	⋮	⋮

※ The temperature configuration table occupies (4＋N) registers in total ; where N is the quantity of modules.

20.3.2 The Internal Format of Working Registers

Supposing the starting address is WR

Address	High Byte	Low Byte
WR+0	Execute Code	XXXXH
WR+1	Sensor abnormal indicator (Sensor 0 ～ Sensor 15)	
WR+2	Sensor abnormal indicator (Sensor 16 ～ Sensor 31)	
WR+3	Total amount of TP channel	Qty of Temperature Module
WR+4	Type of sensor of Module #1	D.O. of TP Module #1
WR+5	Channel No. of Module #1	A.I. of TP Module #1
WR+6	Reading start of Temperature Module #1	
WR+7	Current channel of Temperature Module #1	
· · ·	· · ·	
WR+(N×4)+0	Sensor of Module #N	D.O. of TP Module #N
WR+(N×4)+1	Channel No. of Module #N	A.I. of TP Module #N
WR+(N×4)+2	Reading start of Temperature Module #N	
WR+(N×4)+3	Current channel of Temperature Module #N	

Notes：

1. Lower byte of WR+0：Tells the mismatch between the configuration table & installed temperature board

b0=1，means module #1

·

·

·

b7=1，means module #8

2. Upper byte of WR+0：Execute Code

= 00H,Idle

= FFH,TP channel ＞ 32, w/o temperature measurement

= FEH, lower byte of WR+3 = 0 or ＞ 8, same as above

= 56H,already read all TP channels, measurement in progress

※ The working table occupies (N×4)＋4 registers in total ; where N is the quantity of modules

20.3.3 Description of Related Special Registers for Temperature Measurement

sensor's installation status

- R4010 : Each bit of R4010 to tell the status of the sensor's installation.

  Bit0=1 means that 1st point of temperature sensor is installed.

  Bit1=1 means that 2nd point of temperature sensor is installed.

  ·

  ·

  Bit15=1 means that 16th point of temperature sensor is installed.

  (The default of R4010 is FFFFH)

- R4011 : Each bit of R4011 to tell the status of the sensor's installation.

  Bit0=1 means that 17th point of temperature sensor is installed.

  Bit1=1 means that 18th point of temperature sensor is installed.

  .

  .

  Bit15=1 means that 32th point of temperature sensor is installed.

  (The default of R4011 is FFFFH)
- When the temperature sensor is installed (the corresponding bit of R4010 or R4011 must be 1), the system will perform the line broken detection to the sensor. If there is line broken happened to the sensor, there will have the warning and the line broken value will be displayed.
- When the temperature sensor is not installed (the corresponding bit of R4010 or R4011 must be 0), the system won't perform the line broken detection to the sensor and there will not have the warning; the temperature value will be displayed as 0.
- Depends on the sensor's installation, the ladder program may control the corresponding bit of R4010 and R4011 to perform or not to perform the line broken detection.

20.4 I/O Addressing of Temperature Module

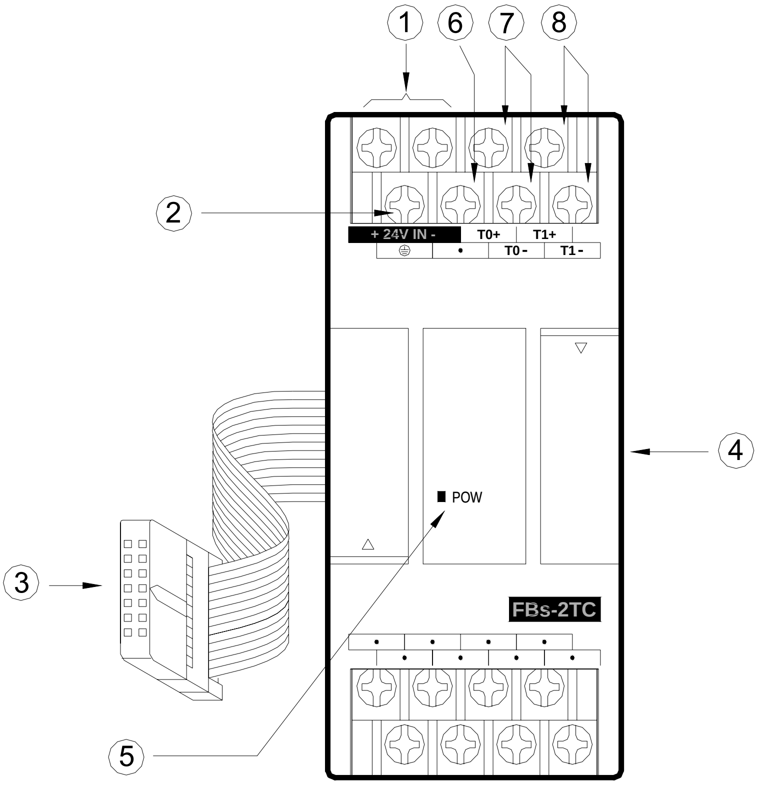
By the time domain multiplexing design method, each temperature module occupies 1 point of input register and 8 points of digital output for I/O addressing. For correct I/O access, the I/O addressing of extension modules following the temperature module must be added the I/O quantity which the corresponding module should have. The WinProladder provides the easy and convenient way to calculate the I/O address for the extension modules through the on-line "I/O Numbering" operation.

20.5 Temperature Modules Hardware Description

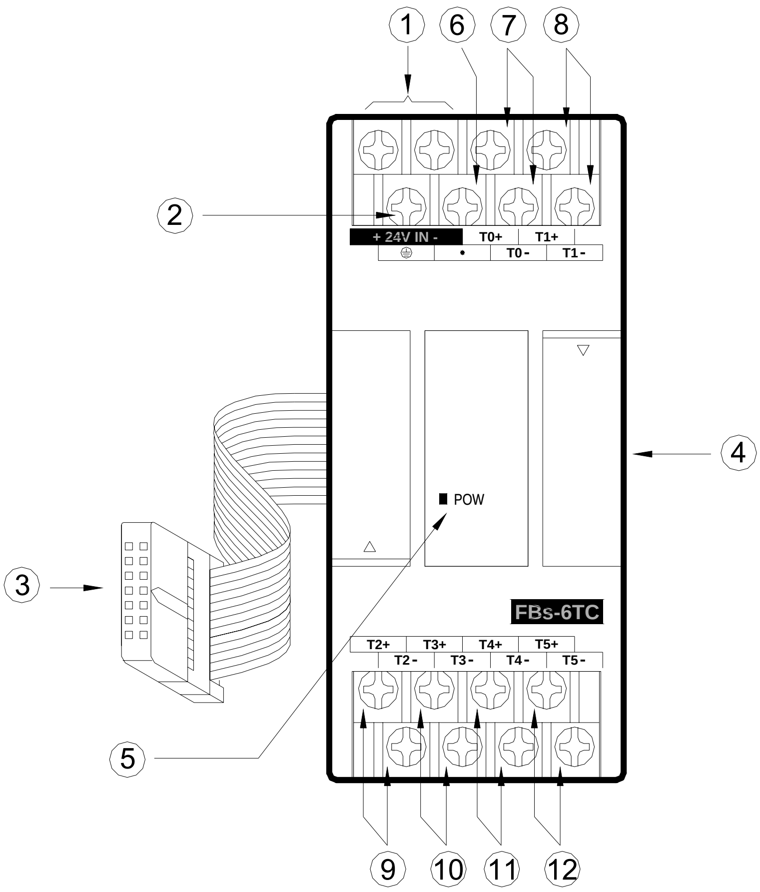
FBs-2TC, FBs-6TC, FBs-16TC, FBs-6RTD, FBs-16RTD, and FBs-6NTC Temperature modules contains 3 PCBs overlapping one another. The lowest one is the power supply unit (isolated power supply). The middle one is the I/O board (connectors are on this layer). The upper one is the control board (control/expansion I/O connections) as described below.:

20.5.1 FBs-2TC、6TC、16TC Outlook of Top View

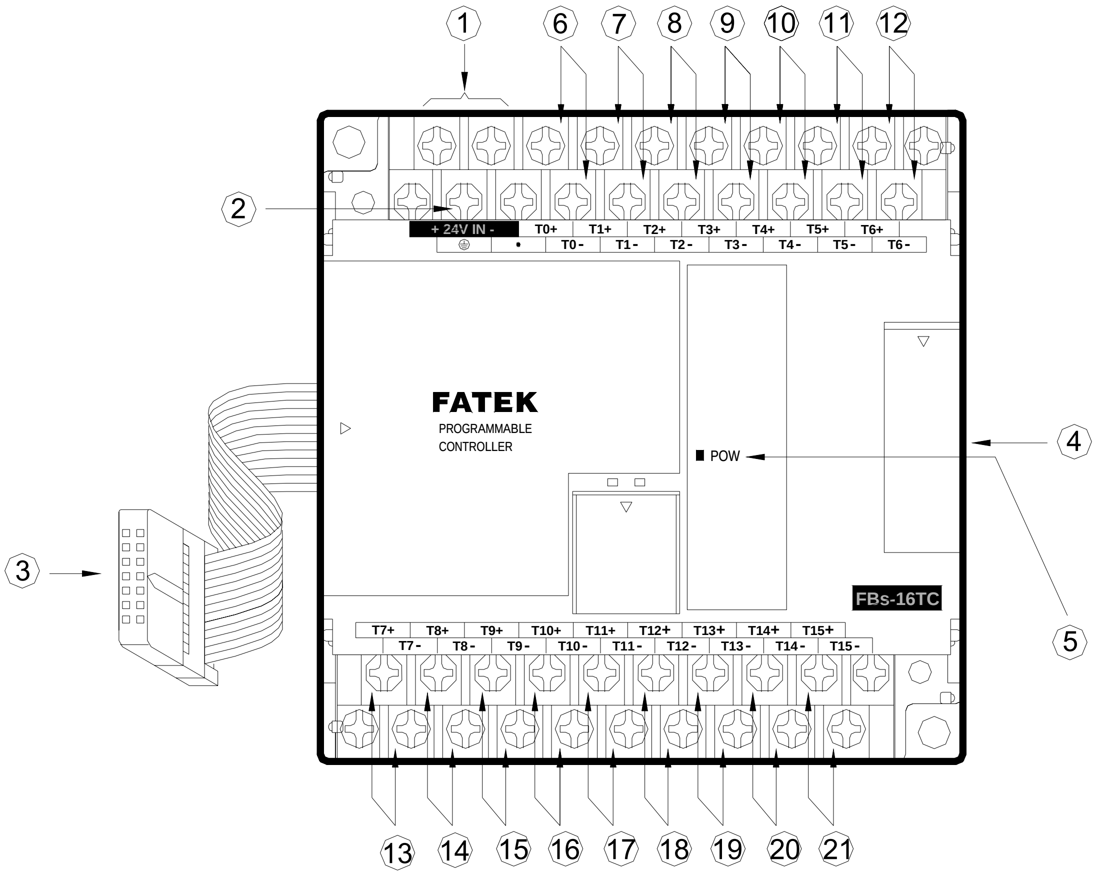
2TC


1
6
7
8
2
+ 24V IN -
T0+
T1+
T0 -
T1 -
4
POW
3
FBs-2TC
5

6TC


1
6
7
8
2
+ 24V IN -
T0+
T1+
T0 -
T1 -
4
POW
3
FBs-6TC
T2+
T3+
T4+
T5+
T2 -
T3 -
T4 -
T5 -
5
9
10
11
12

16TC



① External power input terminal： Power supply for analogue circuit of FBs-XXTC module, supply voltage is 24VDC±20%

② Protecting ground terminal：Connect to the shielding of signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector：Provides the connection for next expansion unit.

⑤ Power indicator：Indicates whether the power supply at analogue circuit and external input power source are normal.

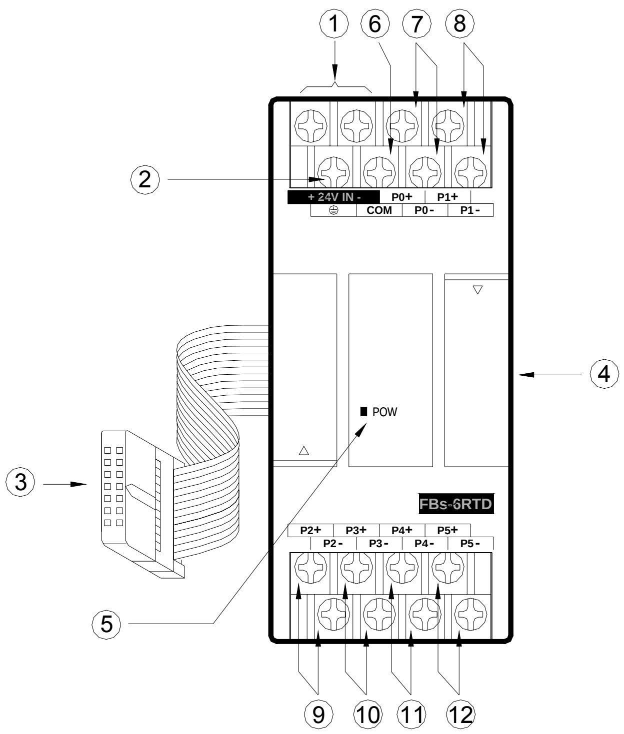
⑥ Input terminal for 1st TC input：The TC input of channel 0(T0+、T0-)

⑦ Input terminal for 2nd TC input：The TC input of channel 1(T1+、T1-)

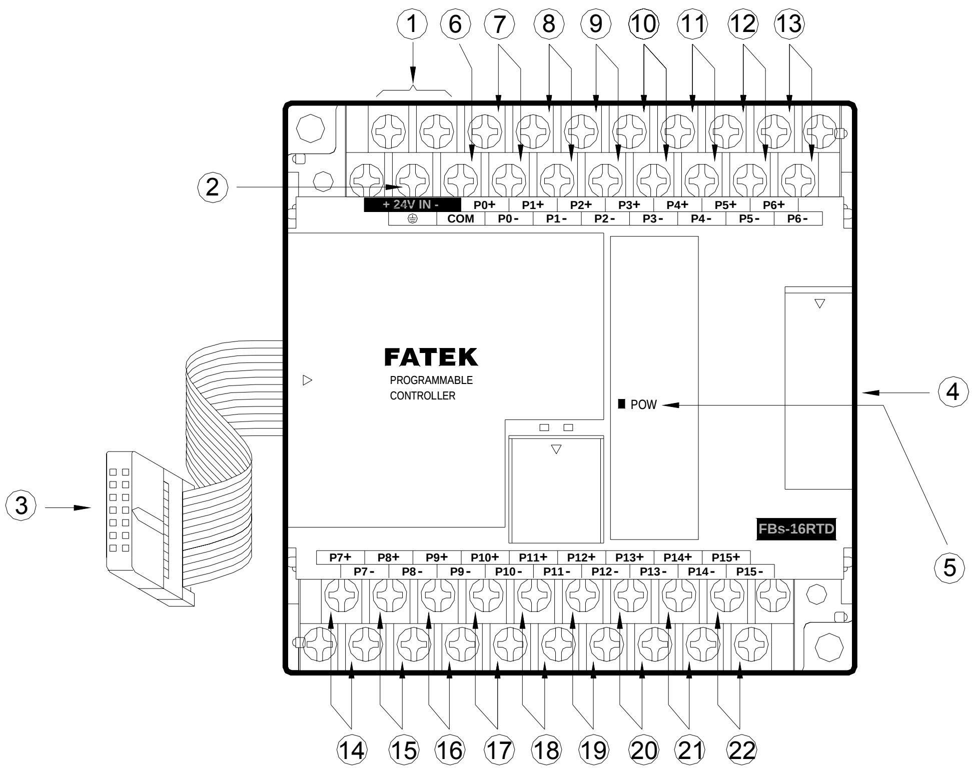
⑧～㉑ Input terminal for (3rd ～16th) TC input： The TC input of channel 2～channel 15(T2+、T2-～T15+、T15-)

20.5.2 FBs-6RTD、16 RTD Outlook of Top View

6RTD



16RTD



① External power input terminal ：Power supply for analogue circuit of FBs-XXRTD module, supply voltage is 24VDC±20%

② Protecting ground terminal：Connect to the shielding signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector：Provides the connection for next expansion unit.

⑤ Power indicator：Indicates whether the power supply at analogue circuit and external input power source are normal.

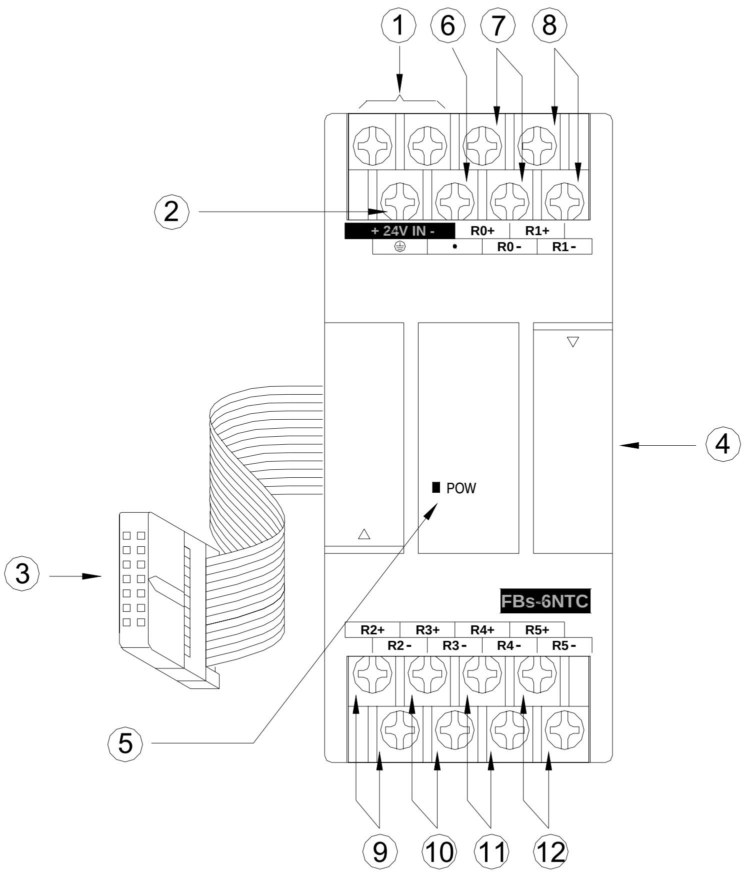
⑥ Common terminal for 3-wires RTD input： To connect to the common wire of each 3-wires RTD input.

⑦ Input terminal for 1st RTD input： The RTD input of channel 0(P0+、P0-)

⑧～㉒ Input terminal for (2nd ～16th) RTD input： The RTD input of channel 1～15 (P1+、P1-～P15+、P15-)

20.5.3 FBs-6NTC Outlook of Top View

6NTC



① External power input terminal: Power supply for analogue circuit of FBs-6NTC module, supply voltage is 24VDC±20%

② Protecting ground terminal: Connect to the shielding signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector: Provides the connection for next expansion unit.

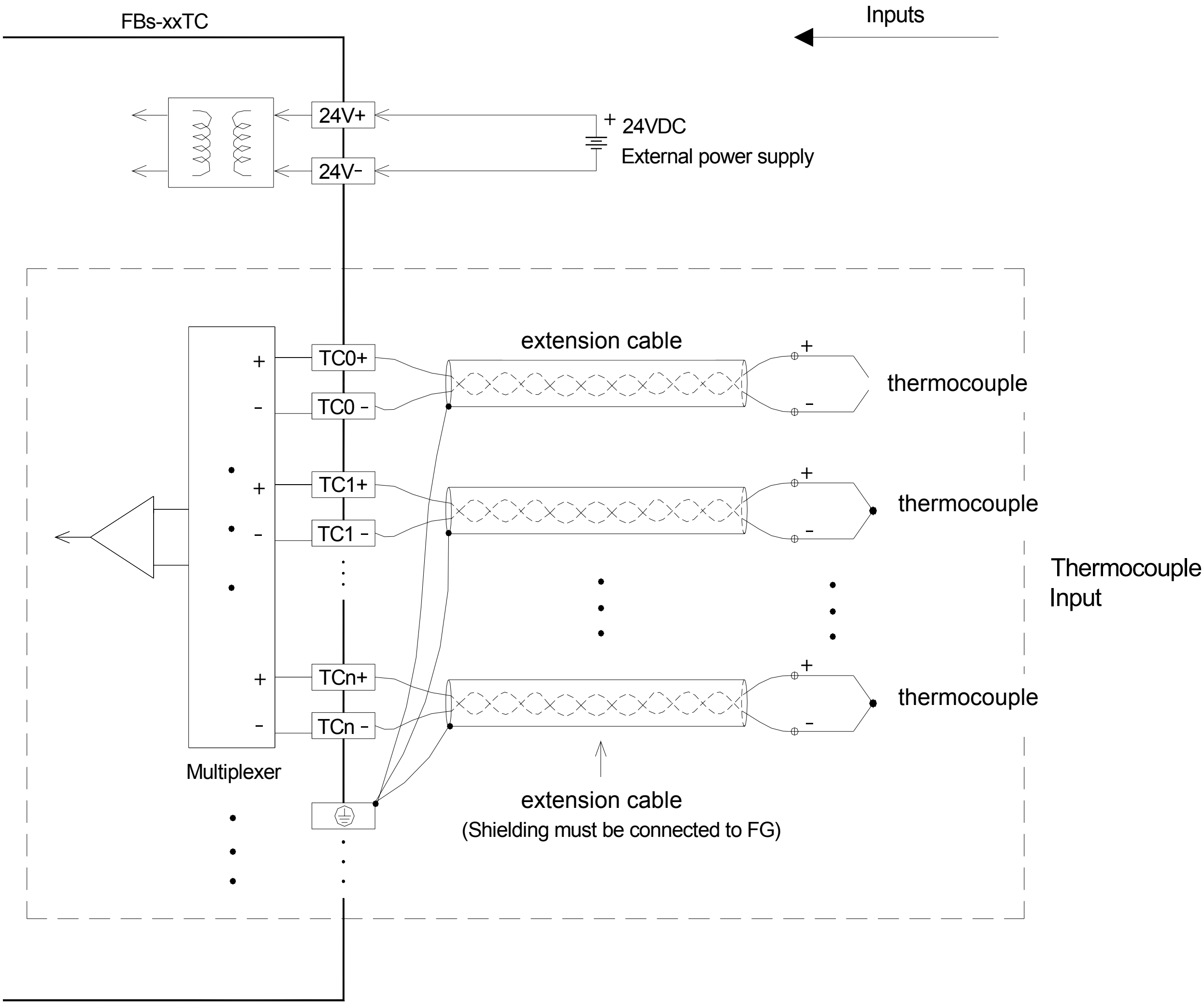
⑤ Power indicator：Indicates whether the power supply at analogue circuit and external input power source are normal.

⑥ Input terminal for 1st NTC input： The NTC input of channel 0(R0+、R0-)

⑦ Input terminal for (2nd ～6th) NTC input： The NTC input of channel 1～5 (R1+、R1- ～R5+、R5-)

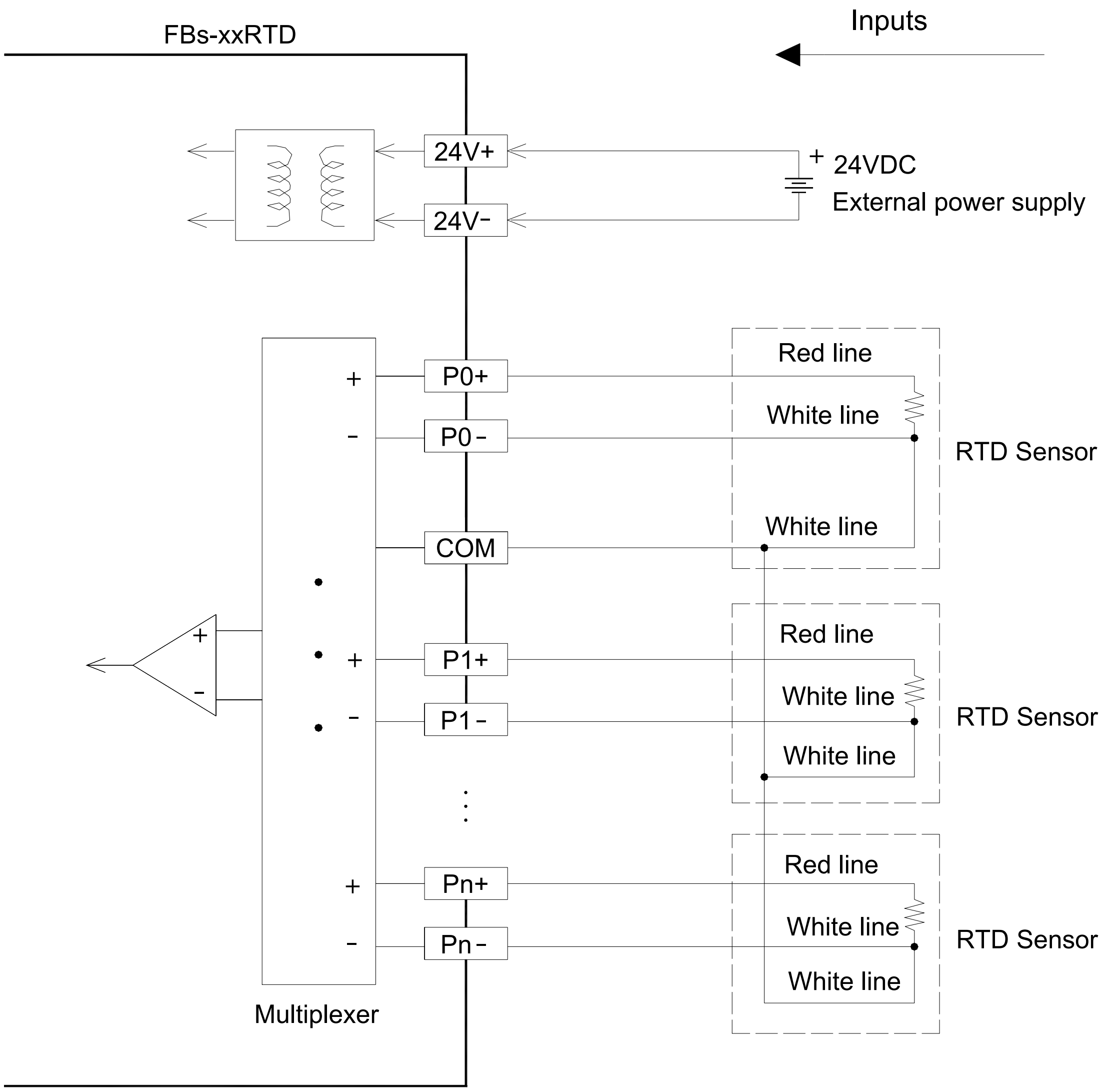
20.6 Wiring of the Temperature Modules

20.6.1 Wiring of the Thermocouple Input Module



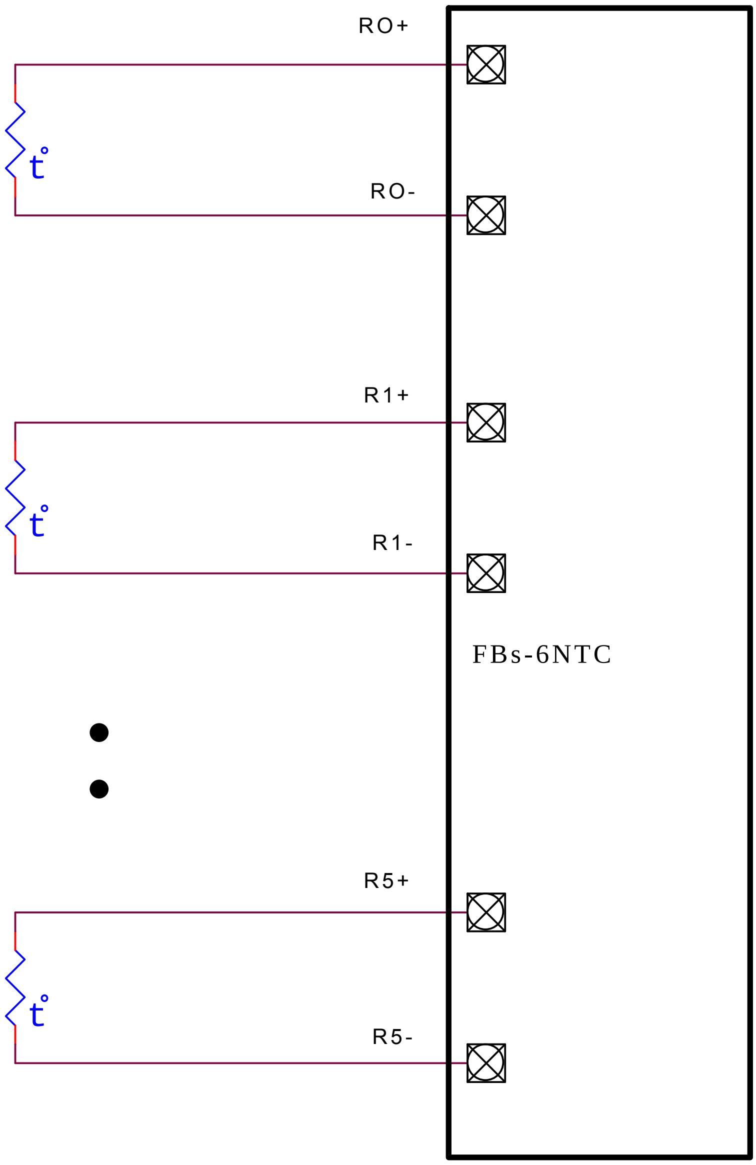
If it's FBs-6TC, n is 5
If it's FBs-16TC, n is 15

20.6.2 Wiring of the RTD Input Module



If it's FBs-6RTD, n is 5
If it's FBs-16RTD, n is 15

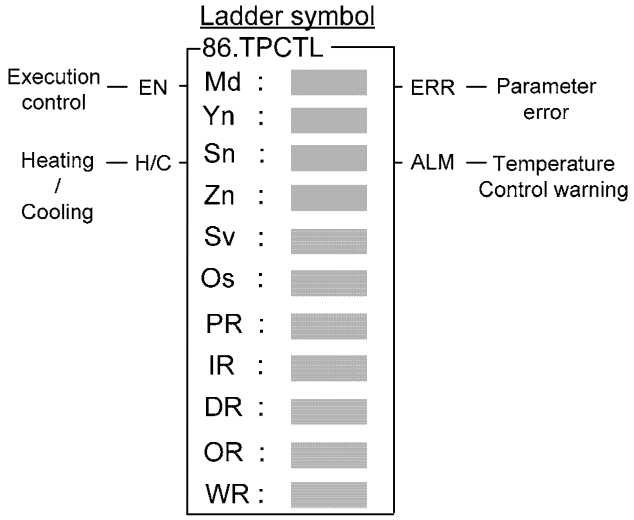
20.6.3 Wiring of the NTC Module



20.7 Instructions Explanation and Program Example for Temperature Measurement and PID Temperature Control of FBs-PLC

The followings are the instructions explanation and program example for temperature measurement and PID temperature control of FBs-PLC.

FUN86 TPCTL	Convenient Instruction of PID Temperature Control	FUN86 TPCTL



Range / Operand	Y (Y0 ∣ Y255)	HR (R0 ∣ R3839)	ROR (R5000 ∣ R8071)	DR (D0 ∣ D3999)	K
Md					0～1
Yn	○				
Sn					0～31
Zn					1～32
Sv		○	○*	○	
Os		○	○*	○	
PR		○	○*	○	
IR		○	○*	○	
DR		○	○*	○	
OR		○	○*	○	
WR		○	○*	○	

Md : Selection of PID method
=0, Modified minimum overshoot method
=1, Universal PID method

Yn : Starting address of PID ON/OFF output; it takes Zn points.

Sn : Starting point of PID control of this instruction; Sn = 0～31.

Zn : Number of the PID control of this instruction; 1≤ Zn ≤32 and 1 ≤ Sn+Zn ≤ 32

Sv : Starting register of the set point; it takes Zn registers. (Unit in 0.1°)

Os : Starting register of the in-zone offset; it takes Zn registers. (Unit in 0.1°)

PR : Starting register of the gain (Kc); it takes Zn registers.

IR : Starting register of integral tuning constant (Ki);it takes Zn registers.

DR : Starting register of derivative tuning constant (Td); it takes Zn registers.

OR : Starting register of the PID analog output; it takes Zn registers.

WR : Starting of working register for this instruction. It takes 9 registers and can't be repeated in using.

- By employing the temperature module and table editing method to get the current value of temperature and let it be as so called Process Variable (PV); after the calculation of software PID expression, it will respond the error with an output signal according to the setting of Set Point (SP),the error's integral and the rate of change of the process variable. Through the closed loop operation, the steady state of the process may be expected.
- Convert the output of PID calculation to be the time proportional on/off (PWM) output, and via transistor output to control the SSR for heating or cooling process; this is a good performance and very low cost solution.
- Through the analog output module (D/A module), the output of PID calculation may control the SCR or proportional valve to get more precise process control.

- Digitized PID expression is as follows:

$$M_n = [K_c \times E_n] + \sum_{0}^{n} [K_c \times K_i \times T_s \times E_n] + [K_c \times T_d \times (PV_n - PV_{n-1}) / T_s]$$

M_n : Output at time "n".
K_c : Gain (Range: 1～9999；Pb=1000 / Kc x0.1%, Unit in 0.1%)
K_i : Integral tuning constant (Range:0～9999, equivalent to 0.00～99.99 Repeat/Minute)
T_d : Derivative tuning constant (Range:0～9999, equivalent to 0.00～99.99 Minute)
PV_n : Process variable at time "n"
PV_{n-1} : Process variable when loop was last solved
E_n : Error at time "n" ; E= SP – PVn
T_s : Solution interval for PID calculation (Valid value are 10, 20, 40, 80,160, 320; the unit is in 0.1Sec)

Principle of PID parameter adjustment

- As the gain (Kc) adjustment getting larger, the larger the proportional contribution to the output. This can obtain a sensitive and rapid control reaction. However, when the gain is too large, it may cause oscillation. Do the best to adjust "Kc" larger (but not to the extent of making oscillation), which could increase the process reaction and reduce the steady state error.
- Integral item may be used to eliminate the steady state error. The larger the number (Ki, integral tuning constant, Ki=1/Ti), the larger the integral contribution to the output. When there is steady state error, adjust the "Ki" larger to decrease the error.
  When the "Ki" = 0, the integral item makes no contribution to the output.

For example **:** if the reset time is 5 minutes, Ki=1/Ti=100/5=20；It means integral tuning constant is 0.2 Repeat/Minute

- Derivative item may be used to make the process smoother and not too over shoot. The larger the number (Td, derivative tuning constant), the larger the derivative contribution to the output. When there is too over shoot, adjust the "Td" larger to decrease the amount of over shoot.
  When the "Td" = 0, the derivative item makes no contribution to the output.

For example **:** if the rate time is 1 minute, then the Td = 100; if the differential time is 2 minute, then the Td = 200.

- Properly adjust the PID parameters can obtain an excellent result for temperature control.
- The default solution interval for PID calculation is 4 seconds (Ts=40).
- The default of gain value (Kc) is 110, where Pb=1000/110×0.1%≒0.91%; the system full range is 1638°, it means the value SP－14.8° (1638×0.91≒14.8) will let PID operation enter proportional band control.
- The default of integral tuning constant is 17
- The default of derivative tuning constant is50, it means the rate time is 0.5 minutes (Td=50).
- When changing the PID solution interval, it may tune the parameters Kc, Ki, Td again.

Instruction guide

- FUN86 will be enabled after reading all temperature channels.
- When execution control "EN" = 1, it depends on the input status of H/C for PID operation to make heating (H/C=1) or cooling (H/C=0) control. The current values of measured temperature are through the multiplexing temperature module ; the set points of desired temperature are stored in the registers starting from Sv. With the calculation of software PID expression, it will respond the error with an output signal according to the setting of set point, the error's integral and the rate of change of the process variable. Convert the output of PID calculation to be the time proportional on/off (PWM) output, and via transistor output to control the SSR for heating or cooling process; where there is a good performance and very low cost solution. It may also apply the output of PID calculation (stored in registers starting from OR), by way of D/A analog output module, to control SCR or proportional valve, so as to get more precise process control.
- When the setting of Sn, Zn ($0 \leqslant Sn \leqslant 31$ and $1 \leqslant Zn \leqslant 32$, as well as $1 \leqslant Sn + Zn \leqslant 32$) comes error, this instruction will not be executed and the instruction output "ERR" will be ON.
- This instruction compares the current value with the set point to check whether the current temperature falls within deviation range (stored in register starting from Os). If it falls in the deviation range, it will set the in-zone bit of that point to be ON; if not, clear the in-zone bit of that point to be OFF, and make instruction output "ALM" to be ON.

- In the mean time, this instruction will also check whether highest temperature warning (the register for the set point of highest temperature warning is R4008). When successively scanning for ten times the current values of measured temperature are all higher than or equal to the highest warning set point, the warning bit will set to be ON and instruction output “ALM” will be ON. This can avoid the safety problem aroused from temperature out of control, in case the SSR or heating circuit becomes short.
- This instruction can also detect the unable to heat problem resulting from the SSR or heating circuit runs open, or the obsolete heating band. When output of temperature control turns to be large power (set in R4006 register) successively in a certain time (set in R4007 register), and can not make current temperature fall in desired range, the warning bit will set to be ON and instruction output “ALM” will be ON.
- WR: Starting of working register for this instruction. It takes 9 registers and can’t be repeated in using.
  The content of the two registers WR+0 and WR+1 indicating that whether the current temperature falls within the deviation range (stored in registers starting from Os). If it falls in the deviation range, the in-zone bit of that point will be set ON; if not, the in-zone bit of that point will be cleared OFF.
  Bit definition of WR+0 explained as follows:
  Bit0=1, it represents that the temperature of the Sn+0 point is in-zone…
  Bit15=1, it represents that the temperature of the Sn+15 point is in-zone.
  Bit definition of WR+1 explained as follows:
  Bit0=1, it represents that the temperature of the Sn+16 point is in-zone…
  Bit15=1, it represents that the temperature of Sn+31 point is in-zone.
  The content of the two registers WR+2 and WR+3 are the warning bit registers, they indiacte that whether there exists the highest temperature warning or heating circuit opened.
  Bit definition of WR+2 explained as follows:
  Bit0=1, it means that there exists the highest warning or heating circuit opened at the Sn+0 point...
  Bit15=1, it means that there exists the highest warning or heating circuit opened at the Sn+15 point.
  Bit definition of WR+11 explained as follows:
  Bit0=1, it means that there exists the highest warning or heating circuit opened at the Sn+16 point...
  Bit15=1 , it means that there exists the highest warning or heating circuit opened at the Sn+31 point.
  Registers of WR+4 ～ WR+8 are used by this instruction.
- It needs separate instructions to perform the heating or cooling control.

Specific registers related to FUN86

- R4003 = A55AH, starting address of temperature reading value is defined by R4004
  = Other values, starting address of temperature reading value is defined by temperature configuration screen
- R4004 = 10000～13839, is defines R0~R3839 is the starting address of temperature reading value as the process variables for PID control
  = 20000～23999, it defines D0~D3999 is the starting address of temperature reading value as the process variables for PID control
  = Other values, starting address of temperature reading value is defined by temperature configuration screen
- R4005 **:** The content of Low Byte to define the solution interval between PID calculation

  =0, perform the PID calculation every 1 seconds.
  =1, perform the PID calculation every 2 seconds.
  =2, perform the PID calculation every 4 seconds. (System default)
  =3, perform the PID calculation every 8 seconds.

=4, perform the PID calculation every 16 seconds.
≥5, perform the PID calculation every 32 seconds.

：The content of High Byte to define the cycle time of PID ON/OFF（PWM）output.=0，PWM cycle time is 1 seconds.
=1，PWM cycle time is 2 seconds. (System default)
=2，PWM cycle time is 4 seconds.
=3，PWM cycle time is 8 seconds.
=4，PWM cycle time is 16 seconds.
≥5，PWM cycle time is 32 seconds.

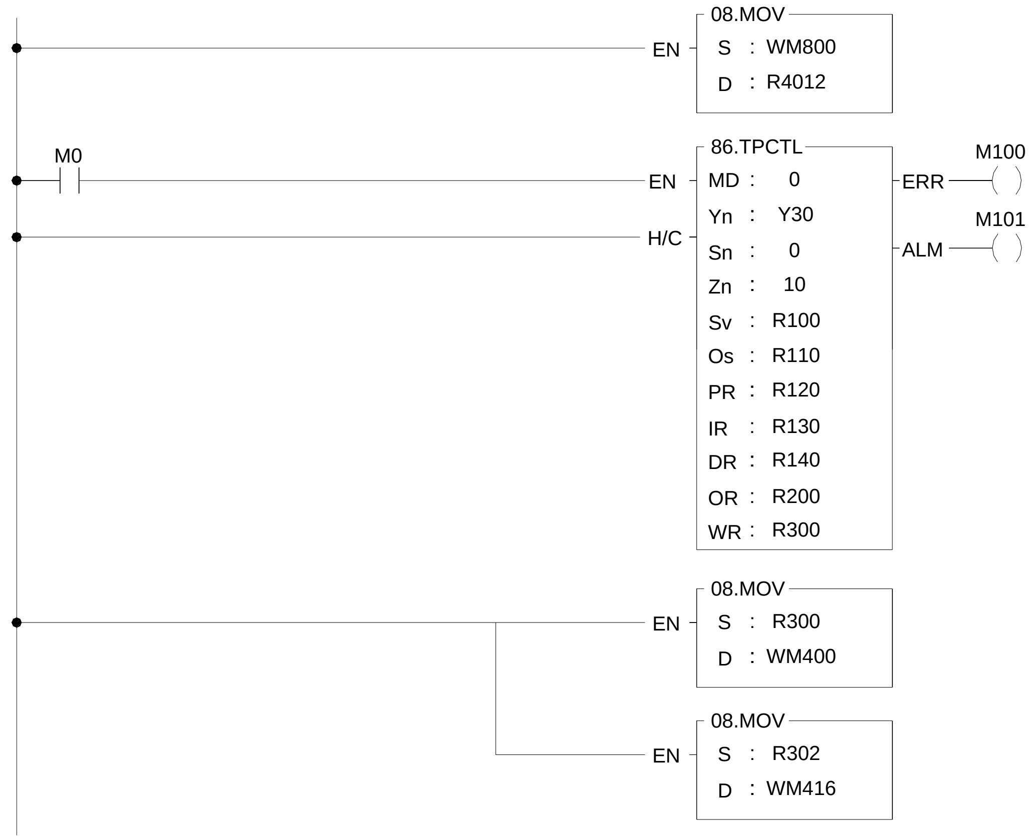
Note 1 **:** When changing the value of R4005, the execution control “EN” of FUN86 must be set at 0. The next time when execution control “EN” =1, it will base on the latest set point to perform the PID calculation.

Note 2 **:** The smaller the cycle time of PWM, the more even can it perform the heating. However, the error caused by the PLC scan time will also become greater. For the best control, it can base on the scan time of PLC to adjust the solution interval of PID calculation and the PWM cycle time.

- R4006：The setting point of large power output detection for SSR or heating circuit opened, or heating band obsolete. The unit is in % and the setting range falls in 80～100(%); system default is 90(%).
- R4007：The setting time to detect the continuing duration of large power output while SSR or heating circuit opened, or heating band obsolete. The unit is in second and the setting range falls in 60～65535 (seconds); system default is 600 (seconds).
- R4008：The setting point of highest temperature warning for SSR, or heating circuit short detection. The unit is in 0.1 degree and the setting range falls in 100～65535; system default is 3500 (Unit in 0.1°).
- R4012：Each bit of R4012 to tell the need of PID temperature control.
  Bit0=1 means that 1st point needs PID temperature control.
  Bit1=1 means that 2nd point needs PID temperature control.
  .
  .
  Bit15=1 means that 16th point needs PID temperature control.
  (The default of R4012 is FFFFH)
- R4013：Each bit of R4013 to tell the need of PID temperature control.
  Bit0=1 means that 17th point needs PID temperature control.
  Bit1=1 means that 18th point needs PID temperature control.
  .
  .
  Bit15=1 means that 32th point needs PID temperature control.
  (The default of R4013 is FFFFH)

- While execution control “EN”=1 and the corresponding bit of PID control of that point is ON (corresponding bit of R4012 or R4013 must be 1), the FUN86 instruction will perform the PID operation and respond to the calculation with the output signal.
- While execution control “EN”=1 and the corresponding bit of PID control of that point is OFF (corresponding bit of R4012 or R4013 must be 0), the FUN86 will not perform the PID operation and the output of that point will be OFF.
- The ladder program may control the corresponding bit of R4012 and R4013 to tell the FUN86 to perform or not to perform the PID control, and it needs only one FUN86 instruction.

Program example



Description

- The status of M800～M815 are controlled by the MMI or external inputs to tell which temperature channel needs PID control; if the corresponding bit is ON, it means yes; if the bit is OFF, it means no PID control.
- When M0=ON, it will perform the PID heating control of 10 (Zn=10) channels from channel 0 (Sn=0) to channel 9.
- Y30 ～ Y39 : PID ON/OFF (PWM) output; they must be the transistor outputs.
- R100～R109 : Registers of set point (Unit in 0.1°).
- R110～R119 : Registers of deviation zone (Unit in 0.1°), it determines whether the temperature falls into setting range.

  E.g. Set point is 2000 (200.0°) and deviation zone is 50 (5.0°), then

  1950 (195.0°) ≦ Current value ≦ 2050 (205.0°) means the temperature is in zone.
- R120～R129 : Setting point of gain .
- R130～R139 : Setting point of integral tuning constant .
- R140～R149 : Setting point of derivative tuning constant .
- R200～R209 : Output of PID calculation (Value from 0～16383).
- R300～R308 : Working registers, they can't be repeated in use.
- When the setting of Sn, Zn comes error, this instruction will not be executed and output M100 will be ON.

- When one of the temperatures is not in zone, or there exists highest temperature warning or heating abnormal, the output M101 will be ON.

Note **:** When performing the instruction FUN86 of the first time, the system will automatically assign the default value of gain (Kc), integral tuning constant (Ki), and derivative tuning constant (Td) for each channel. They can be changed while application tuning.

- M400～M409 : The temperature in zone indicators.
- M416～M425 : To tell the highest temperature warning or heating abnormal channel.

Chapter 21 Analog Input and Temperature Measurement Combination Module

In response to actual needs of user applications, FBs-PLC provides an economical combination of temperature and analog input module measurement. In short, it is to integrate single temperature module and the characteristics of analog input module. Therefore, the setup and operation methods for single temperature module and analog input module are exactly the same, except the number of channels can be measured is different. Both 2A4TC and 2A4RTD modules have offered 2 channels analog input and 4 channels temperature measurement capability. The difference is that 2A4TC is using thermocouple to measure temperature, while the 2ARTD4 is using RTD sensor to measure temperature. There are 8 types of thermocouple to choose: J、K、T、E、N、B、R、S; And there are only two types of RTD sensor: PT-100 and PT-1000.

This combination measurement module occupied 4 numerical input registers and 8 points digital output. The maximum measureable temperature point of a PLC main unit is 32 points. The update rate for temperature reading value can be set as normal (the resolution is 0.1°) or fast (the resolution is 1°).

The WinProladder provides the very user friendly table editing operation interface to configure the temperature measurement, for example, selecting the temperature module, type of sensor, and assign the registers to store the reading values. As to the temperature control, it has the convenient instruction FUN86 (TPCTL) to perform the PID operation to control the heating or cooling of the temperature process. Please refer to Chapter 18 for analog input operations and analog input modules setup.

21.1 Specifications of Temperature and Analog Input Measuring Modules

21.1.1 Specifications of Temperature Measurement

Items / Specifications	Module FBs-2A4TC
Number of input points	4 points
Thermocouple type and temperature measurement range	J(−200～900°C) E(−190～1000°C) K(−190～1300°C) T(−190～380°C) R(0～1800°C) B(350～1800°C) S(0～1700°C) N(−200～1000°C)
I/O Points Occupied	2 IR(Input Register)、8 DO(Discrete Output)
Software Filter	Moving Average
Average Sample	NO 1、2、4、8Configurable
Compensation	Built-in cold junction compensation
Resolution	0.1°C
Conversion Time	2 or 4 seconds
Overall Precision	±(1%+1°C)
Isolation	Transformer (Power) and photocouple (Signal) isolation (per-channel isolation)

Specifications \ Item	Module
	FBs-2A4RTD
RTD input points	4 points
RTD type and temperature measurement range	3-wire RTD sensor JIS(α=0.00392) or DIN(α=0.00385) Pt-100(−200～850°C) Pt-1000(−200～600°C)
I/O Points Occupied	2 IR(Input Register)、8 DO(Discrete Output)
Software Filter	Moving Average
Average Samples	No 1、2、4、8 Configurable
Resolution	0.1°C
Conversion Time	1 or 2 seconds
Overall Precision	±1%
Isolation	Transformer(Power) and photocouple (Signal) isolation (pre-channel isolation)

21.1.2 Specifications of Analog Input Measurement

Specifications \ Item	Module
	FBs-2A4TC/FBs-2A4RTD
Input Channel	2 Channel
Digital input reading	−8192～+8191 or 0～16383(14-bit) −2048～+2047 or 0～4095(12-bit)
Input signal types	Voltage: -10~+10V, -5~+5V,0~5V,0~10V Current: -20~+20mA,-10~+10mA,0~10mA,0~20mA
Resolution	14 or 12 bits
Finest resolution	Voltage：0.3mV Current：0.61μA
I/O Points Occupied	2 IR(Input Register)
Accuracy	Within ±1% of full scale
Conversion Time	Updated each scan
Maximum absolute input signal	Voltage：±15V（max） Current：±30mA（max）
Input resistance	63.2KΩ（Voltage Input）、250Ω（Current Input）
Isolation	Transformer (Power) and photocouple (Signal)

21.1.3 Common Specifications

Specifications \ Item	Module	
	FBs-2A4TC	FBs-2A4RTD
Internal Current Consumption	5V, 50mA	5V, 50mA
External Current Consumption	24V, 39mA	24V, 39mA
Indicator(s)	5V PWR LED	
Operating Temperature	0 ~ 60 ℃	
Storage Temperature	-20 ~ 80 ℃	
Dimensions	40(W)x90(H)x80(D) mm	

21.2 The Procedures of Using Temperature Measurement

Please refer this part to section 20.2

21.3 The Procedures to Configure the Temperature Measurement

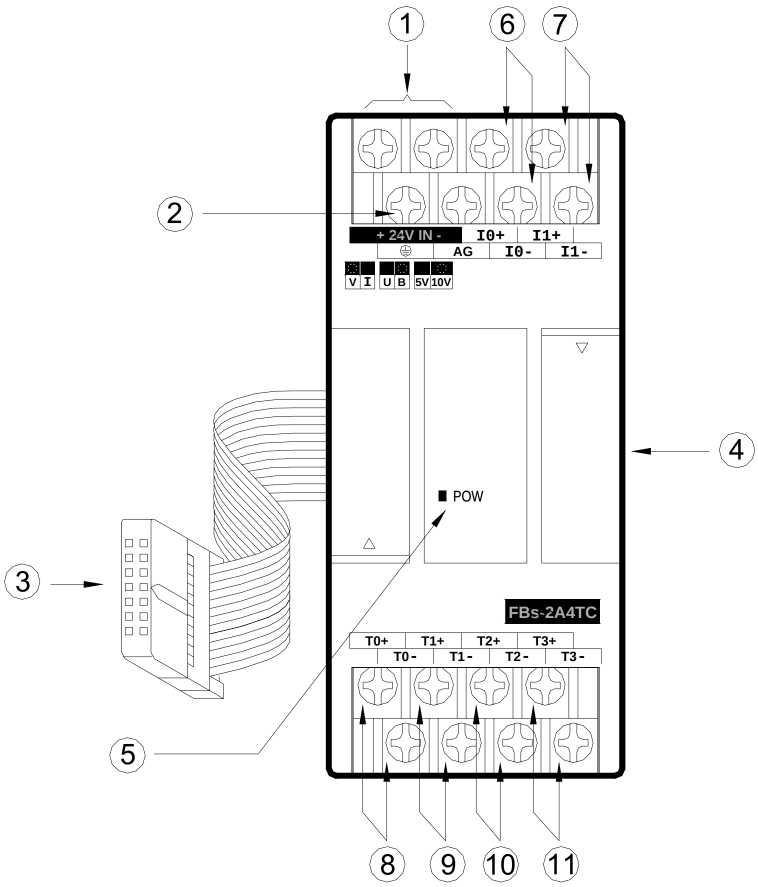
Please refer this part to section 20.3

21.4 Hardware Descriptions of Modules

FBs-2A4TC and FBs-2A4RTD is composed by three circuit boards. The lowest layer is the power board (provides isolated power supply module), the medium is the I/O board (terminal blocks in this layer), the top layer is the control board (control and expand input and output connections). The description is as follows:

21.4.1 FBs-2A4TC/FBs-2A4RTD Outlook of Top View

2A4TC outlook of top view



① External power input terminal：Power supply of analog circuit for this module, the voltage can be 24VDC±20%.

② Protecting ground terminal：Connect to the shielding of signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector：Provides the connection for next expansion unit.

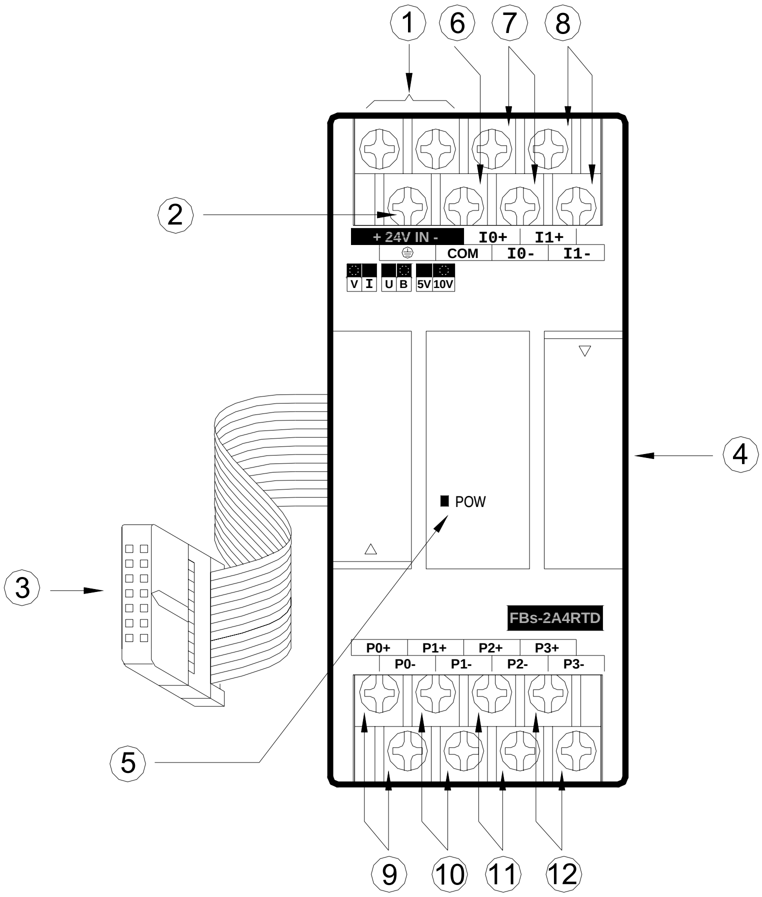
⑤ Power Indicator：It indicates whether the power supply of the analog circuit and external input power source of this module are normal.

⑥ Analog input terminal of CH0：The analog signal input of channel 0(I0+、I0-).

⑦ Analog input terminal of CH1：The analog signal input of channel 1(I1+、I1-).

⑧～⑪ Thermocouple input terminal of CH0～CH3：The thermocouple input of channel 0～channel 3(T0+,T0-~T3+,T3-).

2A4RTD outlook of top view



① External power input terminal：Power supply of analog circuit for this module, the voltage can be 24VDC±20%.

② Protecting ground terminal：Connect to the shielding of signal cable.

③ Expansion input cable：It should be connected to the front expansion unit, or the expansion output of main unit.

④ Expansion output connector：Provides the connection for next expansion unit.

⑤ Power indicator：It indicates whether the power supply of the analog circuit and external input power source of this module are normal.

⑥ Common terminals of RTD：To connect to the common wire of each 3-wires RTD input.

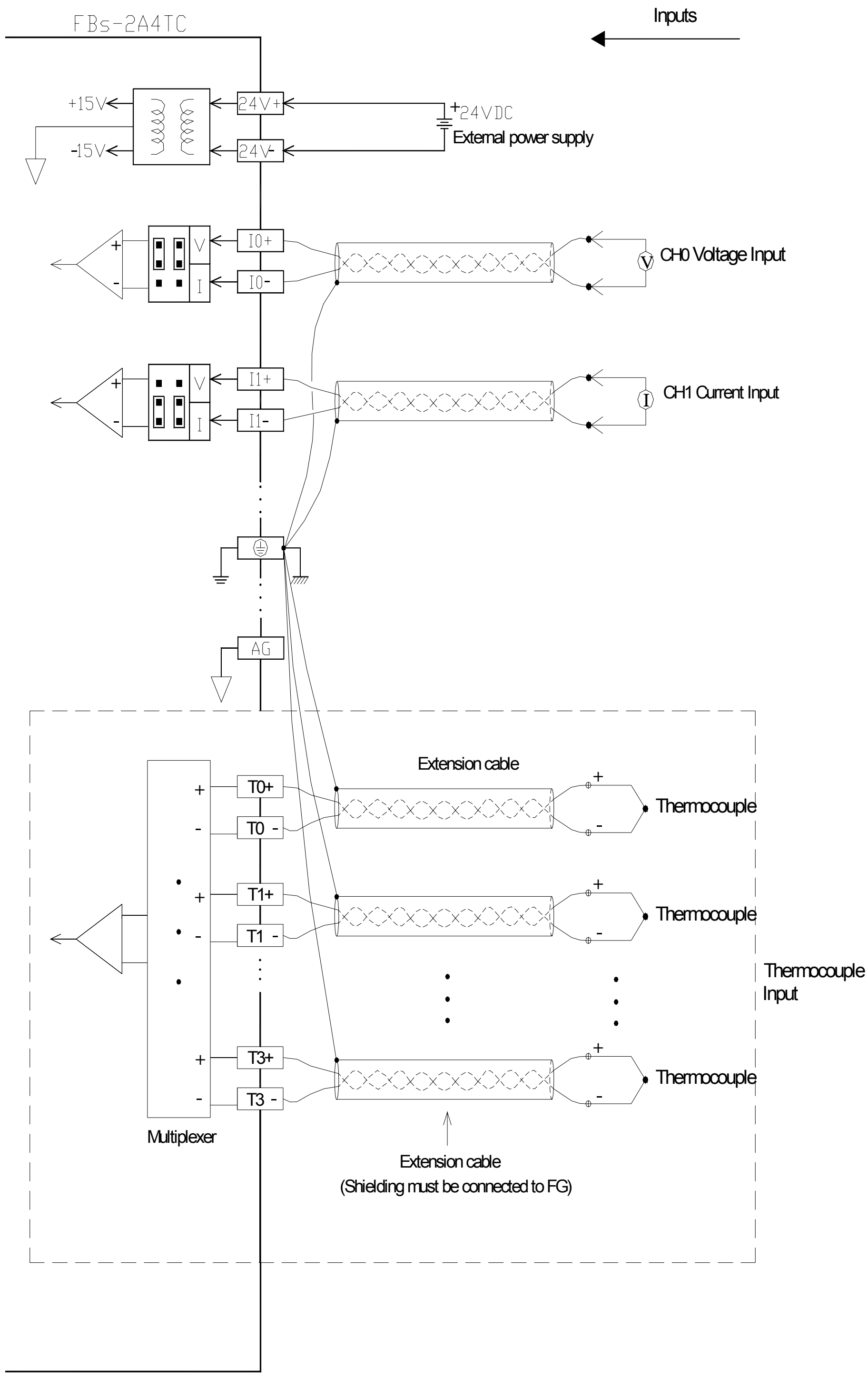
⑦ Analog input terminal of CH0：The analog signal input of channel 0(I0+、I0-).

⑧ Analog input terminal of CH1：The analog signal input of channel 1(I1+、I1-).

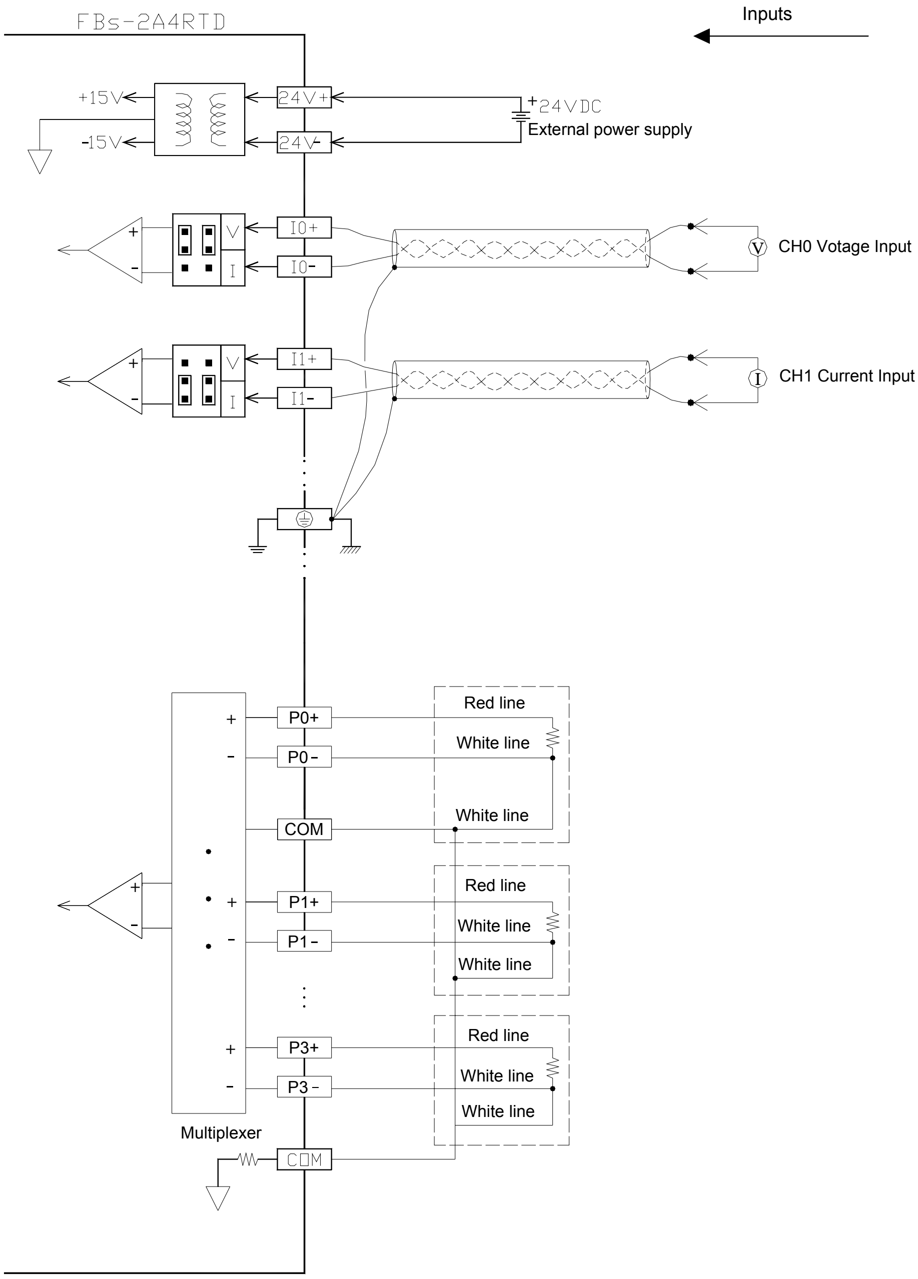
⑨～⑫ Input terminal for CH0～CH3 RTD：The RTD input of channel0～channel3 (P0+,P0-~P3+,P3-).

21.5 Wiring of Modules

21.5.1 Wiring of 2A4TC Module



21.5.2 Wiring of 2A4RTD Module

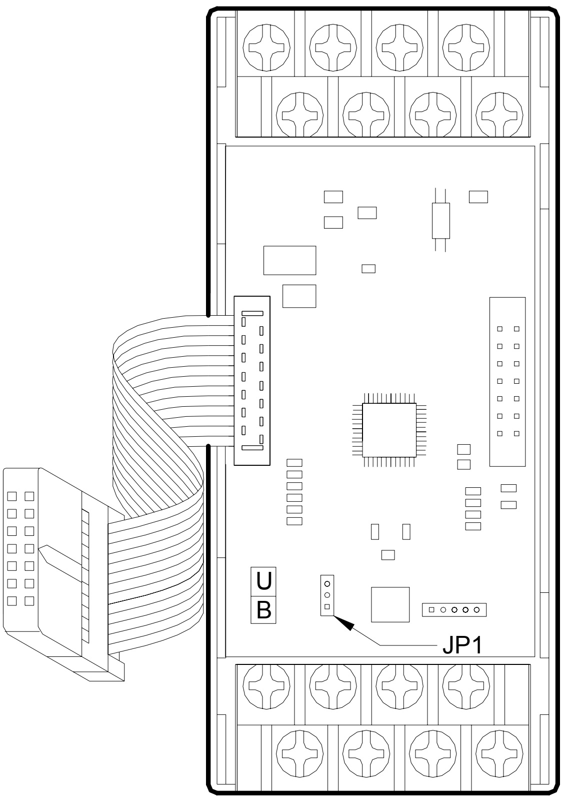


21.6 The Jumper Setup of 2A4RTD/2A4TC

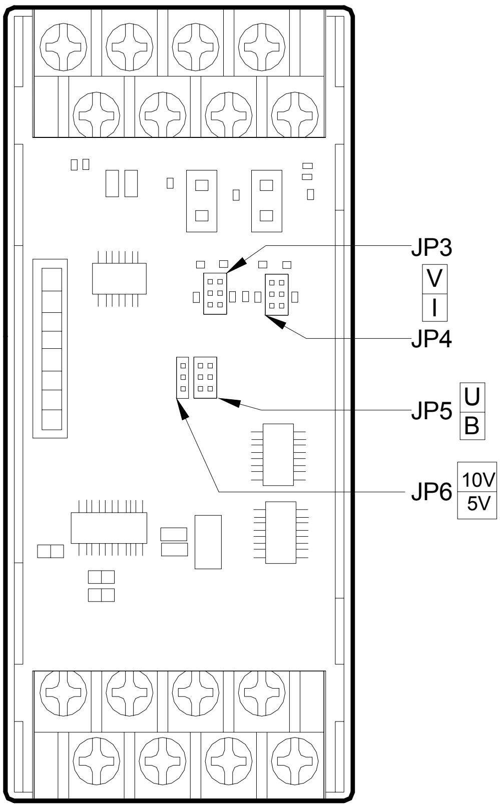
The analog input measurements of measurement signal and measurement range of these two modules are selected and set by the jumper's connection

21.6.1 Position Jumper

21.6.1.1 The Position Jumper of 2A4TC

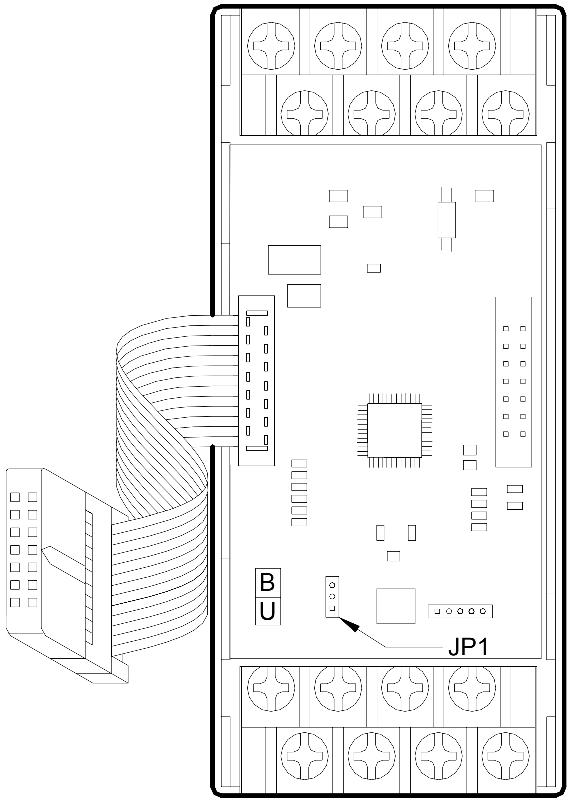


Pin layout in control board(open top cover)

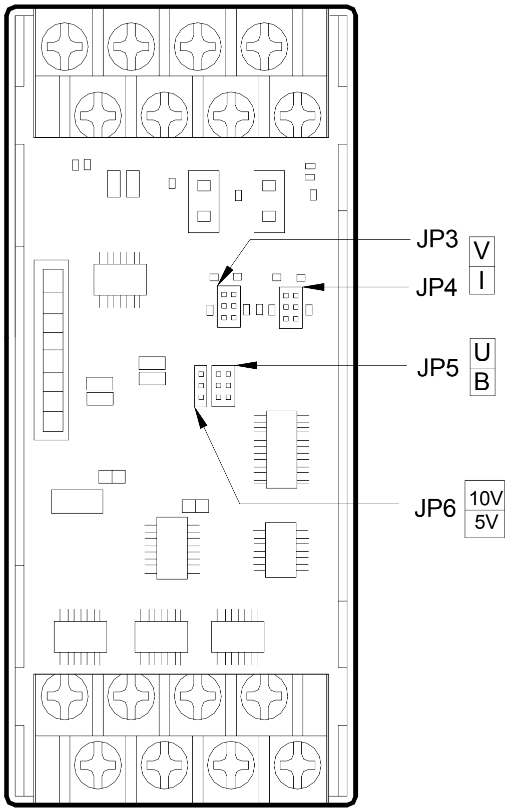


Pin layout on I/O board (remove control board)

21.6.1.2 The Position Jumper of 2A4RTD



Pin layout in control board(open top cover)



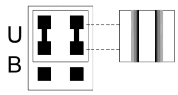
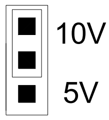
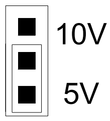
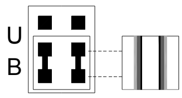
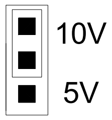
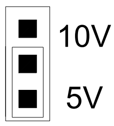
Pin layout on I/O board (remove control board)

21.6.2 Input Code Format Selection of Jumper Setting

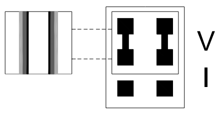
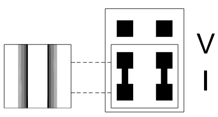
Input Code Format	JP1 Setting	Input Value Range	Corresponding Input Signals
Bipolar	JP1 U B	-8192～8191	-10V～10V(-20mA～20mA) -5V～5V(-20mA～20mA) 0V～10V(0mA～20mA) 0V～5V(0mA～10mA)
Unipolar	JP1 U B	0～16383	

Regarding the explanations of choosing input code format, please refer to section 18.1.4.1.

21.6.3 Input Signal Form of Jumper Setup

<table>
<tr><th>Signal Form</th><th>JP5 Setting</th><th>JP6 Setting</th></tr>
<tr><td>0～10V
or
0～20mA</td><td rowspan="2"></td><td></td></tr>
<tr><td>0～5V
or
0～10mA</td><td></td></tr>
<tr><td>-10～+10V
or
-20～+20mA</td><td rowspan="2"></td><td></td></tr>
<tr><td>-5～+5V
or
-10mA～+10mA</td><td></td></tr>
</table>

21.6.4 Input Signal Type of Jumper Setup

<table>
<tr><th>Signal Form</th><th>JP3(CH0) , JP4(CH1) Setting</th></tr>
<tr><td>Voltage</td><td></td></tr>
<tr><td>Current</td><td></td></tr>
</table>

The default factory settings of FBs-2A4TC/FBs-2A4RTD are:

Input code format → Bipolar

Input signal type → -10V～+10V

For those applications that require the setting differ than the above default setting should make some modifications of jumper position according to above tables. While application, besides the setting of jumper should be conducted, the AI module configurations of Winproladder also need to be performed. (Refer to section 18.1.7 for explanation)

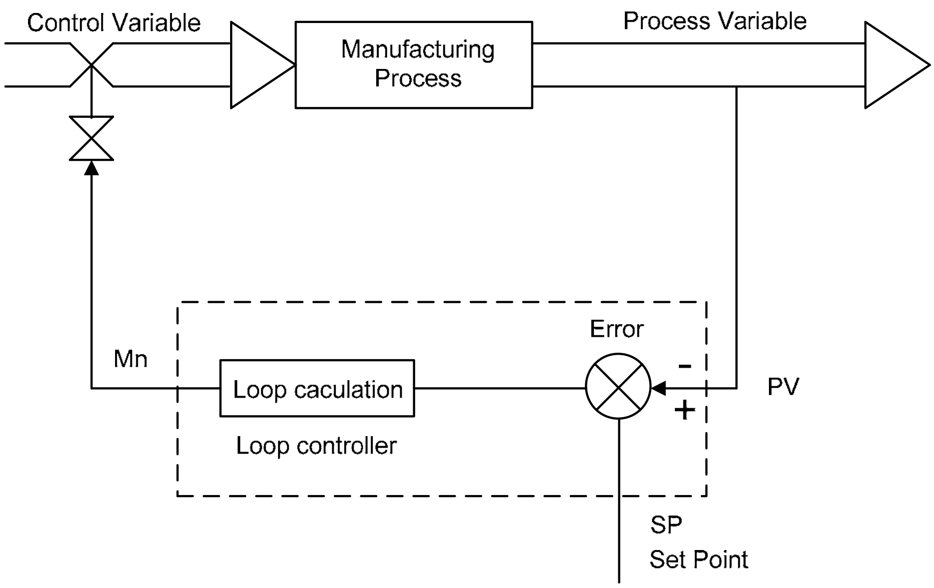
Chapter 22 General Purpose PID Control

22.1 Introduction of PID Control

As the general application of process control, the open loop methodology may be good enough for most situations, because the key control elements or components are more sophisticated, and the performances of which are getting better, there is no doubt, the stability and reliability may meet the desired requirement. It is the way to get not bad C/P value with great economic consideration. But the characteristics of the elements or components may change following the time eclipse and the controlling process may be affected by the change of loading or external disturbances, the performance of open loop becomes looser; it is the weakness of such solution. Thus, closed loop (with the sensors to feedback the real conditions of controlling process for loop calculation) PID control is one of the best choices for manufacturing process to make perfect quantity and best products.

FBs-PLC provides digitized PID mathematical algorithm for general purpose application, it is enough for most of applications, but the response time of loop calculation will have the limitation by the scan time of PLC, thus it must be taken into consideration while in very fast closed loop control.

For an introduction to key parts of a control loop, refer to the block diagram shown below. The closed path around the diagram is the "loop" referred to in "closed loop control".



Typical Analog Loop Control System

22.2 How to Select the Controller

Depends on the requirement, the users may apply the suitable controller for different applications; it is much better of the thinking that the control algorithm is so simple and easy to operate and the final result will be good enough, that's all. Therefore comes the answers, there are three types of controller could be activated from the PID mathematical expression, these are so called "Proportional Controller”, "Proportional + Integral Controller" and "Proportional + Integral + Derivative Controller". The digitized mathematical expression of each controller shown bellows.

22.2.1 Proportional Controller

The digitized mathematical expression as follows:

$$Mn = (D4005/Pb) \times (En) + Bias$$

Where,

Mn ：Output at time “n”.

D4005：The gain constant, the default is 1000, it's range is 1～5000.

Pb ：Proportional band

- the expression stating the percent change in error required to change the output full scale.

〔Range：1～5000, unit in 0.1%；Kc(gain)=D4005/Pb〕

En ：The difference between the set point (SP) and the process variable (PV) at time "n";

En = SP - PVn

Ts ：Solution interval between calculations（Range：1～3000, unit in 0.01S）

Bias ：Offset to the output（Range：0～16383）

The algorithm of "Proportional Controller" is very simple and easy to implement, and it takes less time for loop calculation. Most of the general applications, this kind of controller is good enough, but it needs to adjust the offset（Bias）to the output to eliminate the steady state error due to the change of set point.

22.2.2 Proportional + Integral Controller

The digitized mathematical expression as follows:

$$Mn = (D4005/Pb) \times (En) + \sum_{0}^{n} [(D4005/Pb) \times Ki \times Ts \times En] + Bias$$

Where,

Mn ： Output at time “n”.

D4005：The gain constant, the default is 1000, it's range is 1～5000.

Pb ： Proportional band 〔Range：1～5000，unit in 0.1%；Kc(gain)=D4005/Pb〕

En ： The difference between the set point (SP) and the process variable (PV) at time "n";

En = SP - PVn

Ki ： Integral tuning constant（Range：0～9999，it means 0.00～99.99 Repeats/Minute）

Ts ： Solution interval between calculations（Range：1～3000, unit in 0.01S）

Bias ： Offset to the output（Range：0～16383）

The most benefit of the controller with integral item is to overcome the shortage of the "Proportional Controller" mentioned above; via the integral contribution, the steady state error may disappear, thus it is not necessary to adjust the offset manually while changing the set point. Almost, the offset（Bias）to the output will be 0.

22.2.3 Proportional + Integral + Derivative Controller

The digitized mathematical expression as follows:

$$Mn = (D4005/Pb) \times (En) + \sum_{0}^{n} [(D4005/Pb)\times Ki\times Ts\times En] - [(D4005/Pb)\times Td\times (PVn - PV_{n-1})/Ts] + Bias$$

Where,

Mn ：Output at time “n”.

D4005：The gain constant, the default is 1000, it's range is 1～5000.

Pb ：Proportional band 〔Range：1～5000，unit in 0.1%；Kc(gain)=D4005/Pb〕

En ： The difference between the set point (SP) and the process variable (PV) at time "n";
En = SP - PVn

Ki ： Integral tuning constant（Range：0～9999，it means 0.00～99.99 Repeats/Minute）

Td ：Derivative tuning constant （Range：0～9999，it means 0.00～99.99 Minute）

PVn ： Process variable at time “n”

PV_{n-1} ： Process variable when loop was last solved

Ts ：Solution interval between calculations（Range：1～3000, unit in 0.01S）

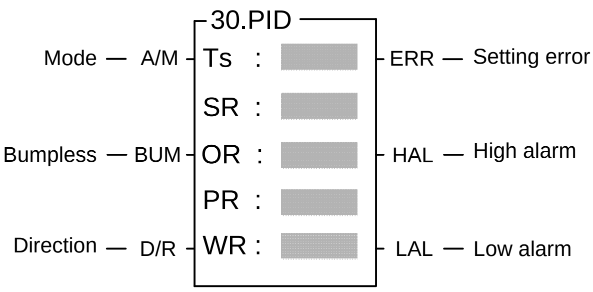
Bias ：Offset to the output（Range：0～16383）

Derivative item of the controller may have the contribution to make the response of controlling process smoother and not too over shoot. But because it is very sensitive of the derivative contribution to the process reaction, most of applications, it is not necessary of this item and let the tuning constant (Td) be equal to 0.

22.3 Explanation of the PID Instruction and Example Program Follows

The followings are the instruction explanation and program example for PID (FUN30) loop control of FBs-PLC.

Ladder symbol



Range / Operand	HR	ROR	DR	K
	R0 | R3839	R5000 | R8071	D0 | D3999	
Ts	○	○	○	1～3000
SR	○	○*	○	
OR	○	○*	○	
PR	○	○*	○	
WR	○	○*	○	

Ts : Solution interval between calculations (1～3000 ; unit in 0.01S)

SR : Starting register of loop settings ; it takes 8 registers in total.

OR : Output register of PID loop operation.

PR : Starting register of loop parameters; it takes 7registers.

WR : Staring register of working registers for this instruction ; it takes 5 registers and can't be repeated in using.

- The FBs-PLC software algorithm uses mathematical functions to simulate a three-mode (PID) analog controlling technique to provide direct digital control. The control technique responds to an error with an output signal. The output is proportional to the error, the error's integral and the rate of change of the process variable. Control algorithms include, P, PI, PD and PID which all include the features of auto/manual operation, bumpless/balanceless transfers, reset wind-up protection, and adaptive tuning of gain, integral, and derivative terms.
- The digitized mathematical expression of FBs-PLC PID instruction as bellows:

$$Mn = (D4005/Pb) \times (En) + \sum_{0}^{n} [(D4005/Pb)\times Ki\times Ts\times En] - [(D4005/Pb)\times Td\times(PVn - PVn\text{-}1)/Ts] + Bias$$

Where,

Mn : Output at time “n”

D4005 : The gain constant, the default is 1000, which can be set between 1～5000.

Pb : Proportional band
- the expression stating the percent change in error required to change the output full scale.
〔Range：1～5000，unit in 0.1%；Kc(gain)=D4005/Pb〕

Ki : Integral tuning constant （Range：0～9999，it means 0.00～99.99 Repeats/Minute）

Td : Derivative tuning constant （Range：0～9999，it means 0.00～99.99 Minute）

PVn : Process variable at time “n”

PV_{n-1} : Process variable when loop was last solved

En : The difference between the set point (SP) and the process variable (PV) at time "n";
En = SP - PVn

Ts : Solution interval between calculations（Range：1～3000, unit in 0.01S）

Bias : Offset to the output（Range：0～16383）

Principle of PID parameter adjustment

- As the proportional band (Pb) adjustment getting smaller, the larger the proportional contribution to the output. This can obtain a sensitive and rapid control reaction. However, when the proportional band is too small, it may cause oscillation. Do the best to adjust "Pb" smaller (but not to the extent of making oscillation), which could increase the process reaction and reduce the steady state error.
- Integral item may be used to eliminate the steady state error. The larger the number (Ki, integral tuning constant), the larger the integral contribution to the output. When there is steady state error, adjust the "Ki" larger to decrease the error.
  When the "Ki" = 0, the integral item makes no contribution to the output.
  For ex, if the reset time is 6 minutes, Ki=100/6=17；if the integral time is 5 minutes, Ki=100/5=20.
- Derivative item may be used to make the process smoother and not too over shoot. The larger the number (Td, derivative tuning constant), the larger the derivative contribution to the output. When there is too over shoot, adjust the "Td" larger to decrease the amount of over shoot.
  When the "Td" = 0, the derivative item makes no contribution to the output.
  For ex, if the rate time is 1 minute, then the Td = 100; if the rate time is 2 minutes, then the Td = 200.
- Properly adjust the PID parameters can obtain an excellent result for loop control.

Instruction description

- When control input "A/M"=0, it performs manual control and will not execute the PID calculation. Directly fill the output value into the output register (OR) to control the loop operation.
- When control input "A/M"=1, it defines the auto mode of loop control; the output of the loop operation is loaded by the PID instruction every time it is solved. It is equal to Mn (control loop output) in the digital approximation equation.
- When control input "BUM"=1, it defines bumpless transfer while the loop operation changing from manual into auto mode.
- When control input "A/M"=1, and direction input "D/R"=1, it defines the direct control for loop operation; it means the output increases as error increases
- When control input "A/M"=1, and direction input "D/R"=0, it defines the reverse control for loop operation; it means the output decreases as error increases
- When comes the error setting of loop setting points or loop parameters, the PID operation will not be performed and the output indication "ERR" will be ON
- While the engineering value of the controlling process is greater than or equal to the user set High Limit, the output indication "HAL" will be ON regardless of "A/M" state.
- While the engineering value of the controlling process is less than or equal to the user set Low Limit, the output indication "LAL" will be ON regardless of "A/M" state.

- **Description of operand Ts：**
  - Ts：It defines the solution interval between PID calculations, the unit is in 0.01 sec; this term may be constant or variable data.
- **Description of operand SR (Loop setting registers)：**
  - SR+0 = Scaled Process Variable：This register is loaded by the PID instruction every time it gets solved. A linear scaling is done on SR+6 using the high and low engineering range found in SR+4 and SR+5.
  - SR+1 = Setpoint (SP) ：The user must load this register with the desired setpoint the loop should control at. The setpoint is entered in engineering units, it must be the range：LER ≦ SP ≦ HER
  - SR+2 = High Alarm Limit (HAL)： The user must load this register with the value at which the process variable should be alarmed as a high alarm (above the setpoint). This value is entered as the actual alarm point in engineering units and it must be the range：LER ≦ LAL < HAL ≦ HER
  - SR+3 = Low Alarm Limit (LAL)： The user must load this register with the value at which the process variable should be alarmed as a low alarm (below the setpoint). This value is entered as the actual alarm point in engineering units and it must be the range：LER ≦ LAL < HAL ≦ HER
  - SR+4 = High Engineering Range (HER)： The user must load this register with the highest value for which the measurement device is spanned. (For example a thermocouple might be spanned for 0 to 500 degrees centigrade, resulting in a 0 to 10V analog input to the FBs-PLC (0V=0℃, 10V=500℃); the high engineering range is 500, this is the value entered into SR+4.)
    The high engineering range must be：–9999 < HER ≦ 19999
  - SR+5 = Low Engineering Range (LER)：The user must load this register with the lowest value for which the measurement device is spanned.
    The low engineering range must be：–9999 ≦ LER ≦ LAL < HAL ≦ HER
  - SR+6 = Raw Analog Measurement (RAM)：The user's program must load this register with the process variable (measurement). It is the value that the content of analog input register（R3840～R3903）is added by the offset if necessary. It must be the range：0 ≦ RAM ≦ 16380 if the analog input is 14-bit format but valid 12-bit resolution, and 0 ≦ RAM ≦ 16383 if the analog input is 14-bit format and valid 14-bit resolution.
    The resolution of analog input can be defined by register D4004,
    D4004=0, it means 14-bit format but valid 12-bit resolution ; D4004=1, it means 14-bit format and valid 14-bit resolution.
  - SR+7 = Offset of Process Variable (OPV)：The user must load this register with the value as described follows: OPV must be 0 if the raw analog signal and the measurement span of the analog input module are all 0～20mA, there is no loss of the measurement resolution; OPV must be 3276 if the raw analog signal is 4～20mA but the measurement span of the analog input module is 0～20mA, there will have few loss of the measurement resolution（16383x4 / 20 = 3276）.
    It must be the range： 0 ≦ OPV < 16383
  - When the setting mentioned above comes error, it will not perform PID operation and the output indication "ERR" will be ON.
- **Description of operand OR：**
  - OR：Output register, this register is loaded directly by the user while the loop in manual operation mode. While the loop in auto operation mode, this register is loaded by the PID instruction every time it is solved. It is equal to Mn (control loop output) in the digital approximation equation. It must be the range：0 ≦ OR ≦ 16383

- **Description of operand PR (Loop parameters)：**

  - PR+0 = Proportional Band (Pb)：The user must load this register with the desired proportional constant. The proportion constant is entered as a value between 1 and 5000 where the smaller the number, the larger the proportional contribution.
    (This is because the equation uses D4005 divided by Pb.)
    It must be the range：$1 \leqq Pb \leqq 5000$, unit is in 0.1%
    Kc(gain)=D4005/ Pb; the default of D4005 is 1000, and it's range is $1 \leqq D4005 \leqq 5000$.

  - PR+1 = Integral tuning Constant (Ki)：The user may load this register to add integral action to the calculation. The value entered is "Repeats/Minute" and is entered as a number between 0 and 9999. (The actual range is 00.00 to 99.99 Repeats/Minute.) The larger the number, the larger the integral contribution to the output.
    It must be the range：$0 \leqq Ki \leqq 9999$ (0.00～99.99 Repeats/Minute)

  - PR+2 = Rate Time Constant (Td)：The user may load this register to add derivative action to the calculation. The value is entered as minutes and entered as a number between 0 and 9999. (The actual range is 0.00 to 99.99 minutes.) The larger the number, the larger the derivative contribution to the output.
    It must be the range：$0 \leqq Td \leqq 9999$ (0.00～99.99 Minutes)

  - PR+3 = Bias：The user may load this register if a bias is desired to be added to the output when using PI or PID control. A bias must be used when running proportional only control. The bias is entered as a value between 0 and 16383 and is added directly to the calculated output. Bias is not required for most applications and may be left at 0.
    It must be the range：$0 \leqq Bias \leqq 16383$

  - PR+4 = High Integral Wind_up Limit (HIWL)：The user must load this register with the output value, (1 to 16383), at which the loop shoud go into "anti-reset wind-up" mode. Anti-reset wind-up consists of solving the digital approximation for the integral value. For most applications this should be set to 16383.
    It must be the range：$1 \leqq HIWL \leqq 16383$

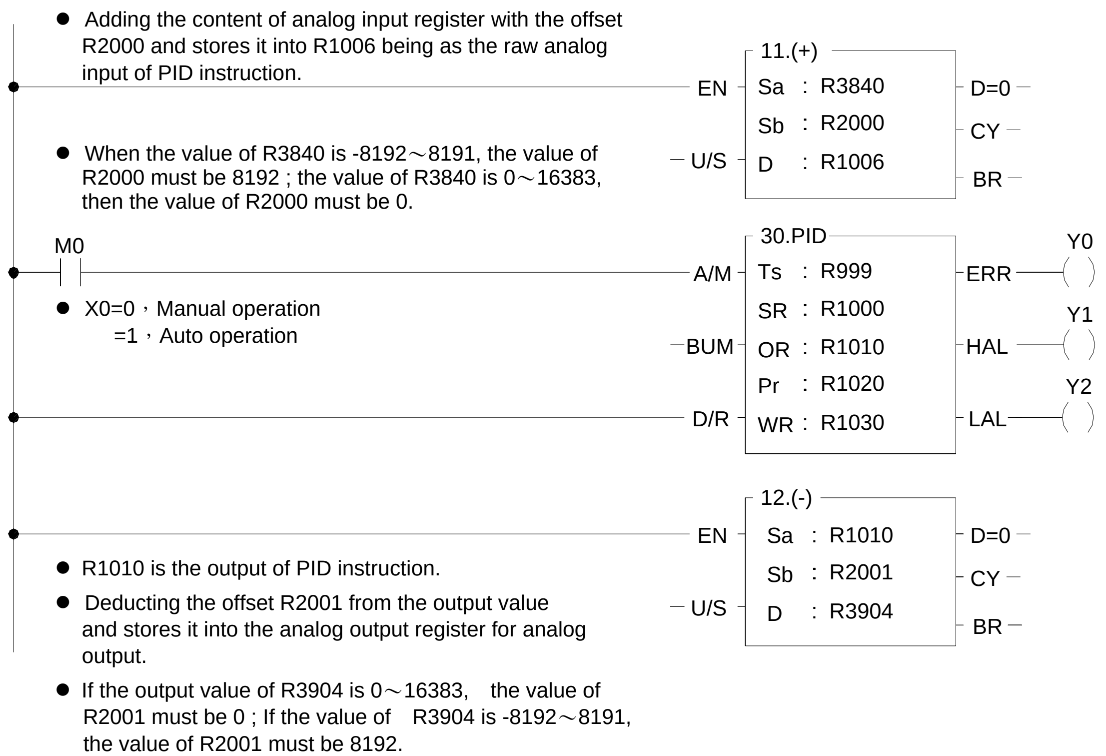
  - PR+5 = Low Integral Wind_up Limit (LIWL)：The user must load this register with the output value, (0 to 16383), at which the loop shoud go into "anti-reset wind-up" mode. It functions in the same manner as PR+4. For most applications this should be set to 0.
    It must be the range：$0 \leqq LIWL \leqq 16383$

  - PR+6 = PID Method：
    =0 , Standard PID method;
    =1 , Minimum Overshoot Method;
    Method 0 is prefer because most applications using PI control (Td=0).
    The user may try method 1 when using PID control and the result is not stable.

  - When the setting mentioned above comes error, it will not perform PID operation and the output indication "ERR" will be ON.

- **Description of operand WR (Working registers)：**
  - WR+0 = Loop status register：
    Bit0 =0 , Manual operation mode
    =1 , Auto mode
    Bit1 : This bit will be a 1 during the scan the solution is being solved, and it is ON for a scan time.
    Bit2=1 , Bumpless transfer
    Bit4 : The status of "ERR" indication
    Bit5 : The status of "HAL" indication
    Bit6 : The status of "LAL" indication
  - WR+1 = Loop timer register：This register stores the cyclic timer reading from the system's 1ms cyclic timer each time the loop is solved. The elapsed time is calculated by calculating the difference between the current reading of the system's 1ms cyclic timer and the value stored in this register. This difference is compared to 10× the solution interval. If the difference is greater than or equal to the solution interval, the loop should be solved this scan.
  - WR+2 = Low order integral summation：This register stores the low order 16 bits of the 32-bit sum created by the integral term.
  - WR+3 = High order integral summation：This register stores the high order 16 bits of the 32-bit sum created by the integral term.
  - WR+4 = Process variable - previous solution：The raw analog input (Register SR+6) at the time the loop was last sovled. This is used for the derivative control mode.

Program example



R999 : The setting of solution interval between calculations; for example the content of R999 is 200, it means it will perform this PID operation every 2 seconds.

R1000 : Scaled process variable, which is the engineering unit loaded by the PID instruction every time it gets solved. A linear scaling is done on R1006 using the high and low engineering range found in R1004 and R1005.

R1001 : Setpoint, it is the desired value the loop should control at; which is entered in engineering unit. For example the span of controlling process is 0°C～500°C, the setting of R1001 is equal to 100, it means the desired result is at 100°C.

R1002 : The setting of high alarm limit; which is entered in engineering unit.
The example mentioned above, if the setting of R1002 is equal to 105, it means there will have the high alarm while the loop is greater than or equal to 105°C.

R1003 : The setting of low alarm limit; which is entered in engineering unit. The example mentioned, if the setting of R1003 is equal to 95, it means there will have the low alarm while the loop is less than or equal to 95°C.

R1004 : The setting of high engineering range. The example mentioned, if the setting of R1004 is equal to 500, it means the highest value of this loop is 500°C.

R1005 : The setting of low engineering range. The example mentioned, if the setting of R1005 is equal to 0, it means the lowest value of this loop is 0°C.

R1006 : Raw analog measurement; it is the value that the content of analog input register (R3840～R3903) is added by the offset of 2048.

R1007 : Offset of process variable; let it be 0 if the raw analog signal and the span of the analog input module are all 0～10V.

R1020 : The setting of proportional band; for example the content of R1020 is 20, it means the proportional band is 2.0% and the gain is 50.

R1021 : The setting of integral tuning constant; for example the content of R1021 is 17, it means the reset time is 6 minutes (100/6≒17).

R1022 : The setting of derivative tuning constant; for example the content of R1022 is 0, it means PI control.

R1023 : The setting of the bias to the output; most applications let it be 0.

R1024 : The setting of high integral wind-up; most applications let it be 16383.

R1025 : The setting of low integral wind-up; most applications let it be 0.

R1026 : The setting of PID method; most applications let it be 0.

R1030 = Loop status register

Bit0 =0, Manual operation mode
=1, Auto operation mode

Bit1 : This bit will be a 1 during the scan the solution is being solved, and it is ON for a scan time.

Bit2=1 , Bumpless transfer

Bit4 : The status of "ERR" indication

Bit5 : The status of "HAL" indication

Bit6 : The status of "LAL" indication

R1031～R1034: They are the working registers, please refer to the description of operand WR.