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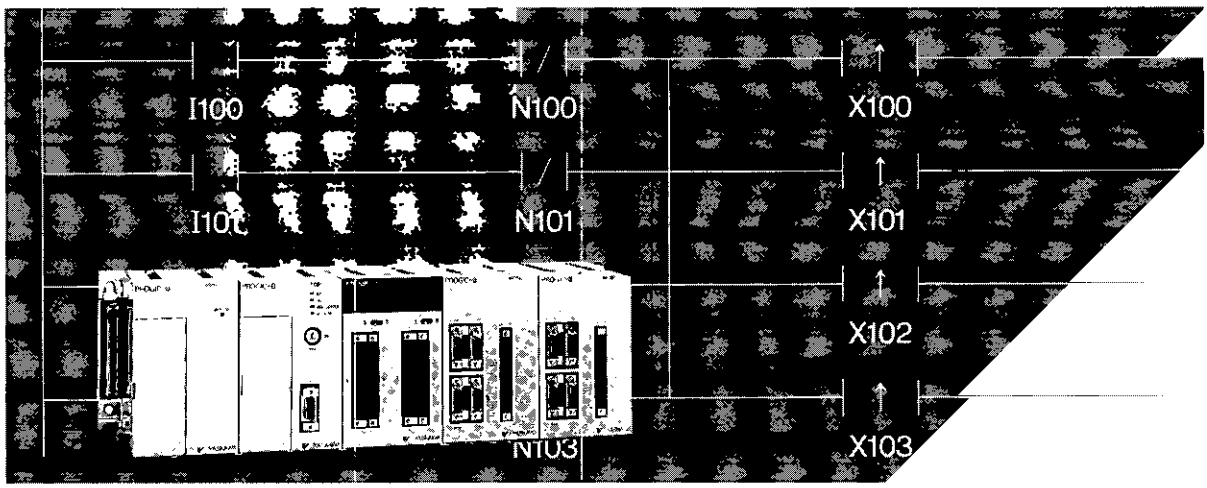
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PROGIC-8

MULTIAXES MOTION CONTROLLER

PROGRAMMING MANUAL FOR PLC UNIT



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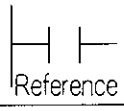
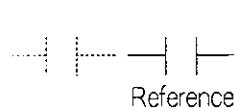
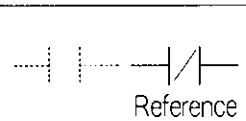
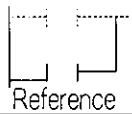
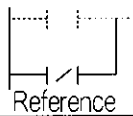
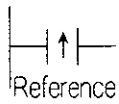
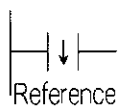
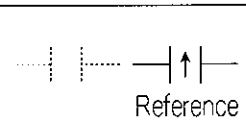
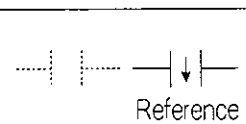
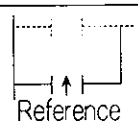
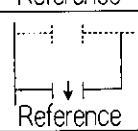
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1.1 LIST OF SEQUENCE PROGRAM COMMANDS

1.1.1 List of Basic Sequence Commands

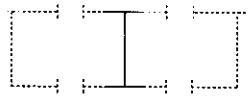
Table 1.1 Shows the list of the basic Sequence Commands

Table 1.1 List of Basic Sequence Program Commands

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
STORE		STR	Reference	Calculation starts at NO contact	Reference Output coil:O1 to O512 Internal coil: N1 to N1536 Input relay:I1 to I512 Timer coil:T1 to T256 Counter coil:C1 to C256 MC unit coil:Y1 to Y512 MC unit relay:X1 to X512 MC control coil:Q1 to Q256 MC control relay:P1 to P256 M-code relay: MUXX Link coil: D1 to D1024 Stepping relay:SYYXX
STORE NOT		STN	Reference	Calculation starts at NC contact	
AND		AND	Reference	Serial connection at NO contact	
AND NOT		ANN	Reference	Serial connection at NC contact	
OR		O R	Reference	Parallel connection at NO contact	
OR NOT		ORN	Reference	Parallel connection at NC contact	
STORE HIGH		STH	Reference	Start-up differential contact calculation starts	Reference Output coil:O1 to O512 Internal coil: N1 to N1536 Input relay:I1 to I512 Timer coil:T1 to T256 Counter coil:C1 to C256 Link coil: D1 to D1024
STORE LOW		STL	Reference	Start-down differential contact calculation starts	
AND HIGH		ANH	Reference	Start-up differential contact serial connection	
AND LOW		ANL	Reference	Start-down differential contact serial connection	
OR HIGH		ORH	Reference	Start-up differential contact parallel connection	
OR LOW		ORL	Reference	Start-down differential contact parallel connection	

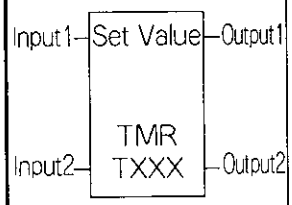
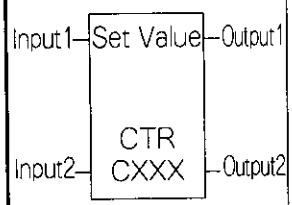
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Table 1.1 List of Basic Sequence Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
AND BLOCK		ANB		Serial connection between blocks	Without reference
OR BLOCK		ORB		Parallel connection between blocks	
OUT	—( )— Reference	OUT	Reference	Coil output	Reference Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 Link coil : D1 to D1024
LATCH	—(L)— Reference	LTC	Reference	Latch coil output	
SET	—(S)— Reference	SET	Reference	Operation holding output	
RESET	—(R)— Reference	RST	Reference	Operation holding release output	Reference Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 Link coil : D1 to D1024 Timer coil : T1 to T256 Counter coil : C1 to C256
TIMER SET	Set Value —(T)— TXXX	TIM	Set Value TXXX	Timer starts operation at input ON and TXXX is turned ON after time elapse of the set value.	Set value Constant : 1 to 9999 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 TXXX Timer set coil : T1 to T256 T1 to T128 : 100m/sec timer T129 to T256 : 10m/sec timer
COUNTER SET	Set Value —(C)— CXXX	CON	Set Value CXXX	From input OFF to ON, the counter is added with+1; when the counted value reaches the set value, CXXX is turned ON.	Set value Constant : 1 to 9999 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 CXXX Counter set coil : C1 to C256

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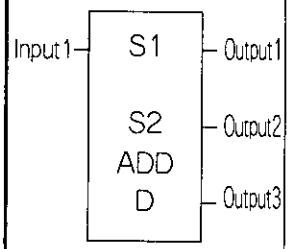
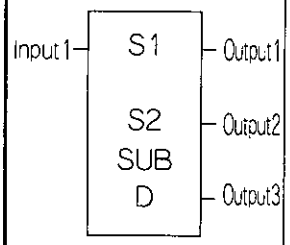
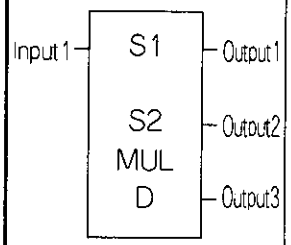
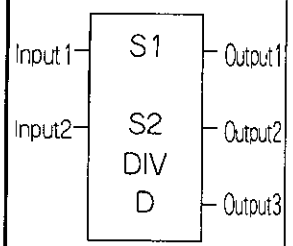
Table 1.1 List of Basic Sequence Program Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
TIMER		TMR	Set Value TXXX	On-delay timer (TXXX is turned ON when the timer counted value reaches the set value) T1 to T128: 100m/sec timer T129 to T256: 10m/sec timer	Set Value Constant:1 to 9999 Data register:W1 to W2048 Input register:Z1 to Z128 Link register:R1 to R1024 TXXX Timer coil: T1 to T256
COUNTER		CTR	Set Value CXXX	Addition counter CXXX: C1 to C128 Each time input 1 is turned OFF and then ON, +1 is added to the counter ; CXXX is turned ON when the counted value reaches the set value. Subtraction counter CXXX: C129 to C256 Each time input 1 is turned OFF and then ON, -1 is subtracted from the counter ; CXXX is turned ON when the counted value becomes 0.	Set Value Constant:1 to 9999 Data register:W1 to W2048 Input register:Z1 to Z128 Link register:R1 to R1024 CXXX Counter coil:C1 to C256

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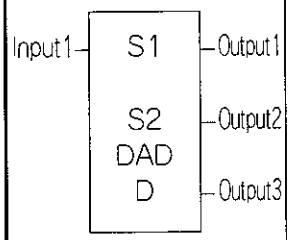
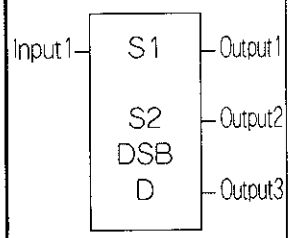
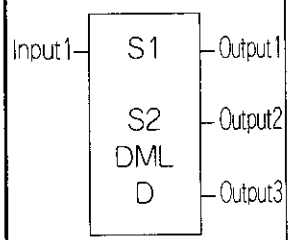
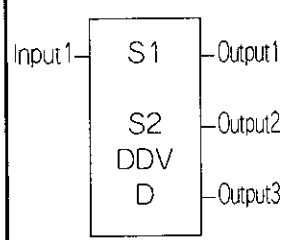
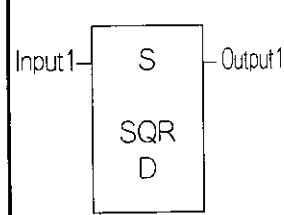
1.1.2 List of Applied Commands

Table 1.2 List of Applied Commands

Command	Symbol	Mnemonic	Operand	Function	Value of Operaud
Addition		ADD	S1 S2 D	Addition in 4 digits decimal S1 + S2=D	S1,S2 Constant : 1 to 9999 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 D Data register : W1 to W2048 Link register : R1 to R1024
Subtraction		SUB	S1 S2 D	Subtraction in 4 digits decimal S1 - S2=D	
Multiplication		MUL	S1 S2 D	Multiplication in 4 digits decimal S1 × S2 =D ;Upper 4 digits =D+1;Lower 4 digits	S1,S2 Constant : 1 to 9999 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Data register : W1 to W2047 Link register : R1 to R1023
Division		DIV	S1 S2 D	Division in 4 digits decimal S1,S1+1÷S2 =D ;Quotient D+1;Remainder or decimal point quotient	S1 Constant : 1 to 9999 Data register : W1 to W2047 Input register : Z1 to Z127 Link register : R1 to R1023 S2 Constant : 1 to 9999 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 D Data register : W1 to W2047 Link register : R1 to R1023

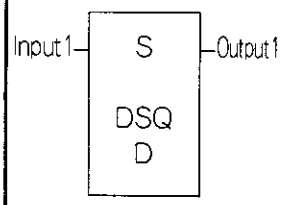
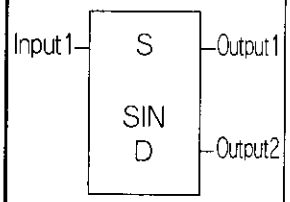
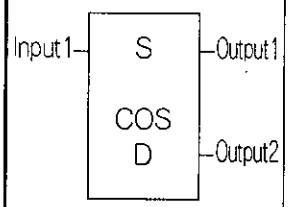
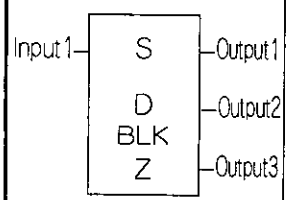
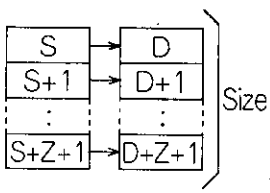
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Double-length Addition		DAD	S1 S2 D	Addition in 8-digit decimal (S1,S1+1) + (S2,S2+1) D ;Upper 4 digits D+1;Lower 4 digits	S1,S2 Data register : W1 to W2047 Input register : Z1 to Z127 Link register : R1 to R1023
Double-length Subtraction		DSB	S1 S2 D	Subtraction in 8-digit decimal (S1,S1+1) + (S2,S2+1) D ;Upper 4 digits D+1;Lower 4 digits	D Data register : W1 to W2047 Link register : R1 to R1023
Double-length Multiplication		DML	S1 S2 D	Multiplication in 8-digit decimal (S1,S1+1) × (S2,S2+1) D ;Uppermost 4 digits D+1;Upper 4 digits D+2;Lower 4 digits D+3;Lowermost 4 digits	S1,S2 Data register : W1 to W2047 Input register : Z1 to Z127 Link register : R1 to R1023 D Data register : W1 to W2045 Link register : R1 to R1021
Double-length Division		DDV	S1 S2 D	Division in 8-digit decimal S1,S1+1,S1+2,S1+3 ÷S2,S2+1 D, D+1 > Quotient D+2, D+3 > Remainder or decimal point quotient	S1 Data register : W1 to W2045 Input register : Z1 to Z125 Link register : R1 to R1021 S2 Data register : W1 to W2047 Input register : Z1 to Z127 Link register : R1 to R1023 D Data register : W1 to W2045 Link register : R1 to R1021
Square Root		SQR	S D	Square root in 4-digit decimal $\sqrt{S}$=D ;Integral section D+1;Decimal section	S Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 D Data register : W1 to W2047 Link register : R1 to R1023

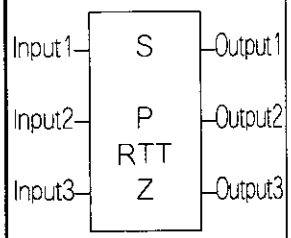
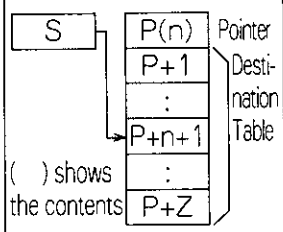
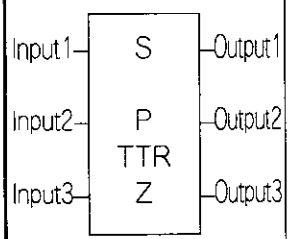
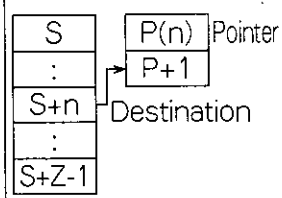
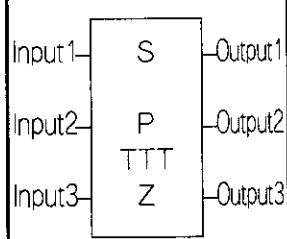
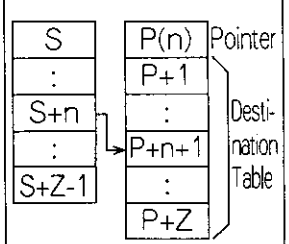
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Double-length Square Root		DSQ	S D	Square root in 8-digit decimal $\sqrt{S,S+1}$ =D ;Integral section D+1;Decimal section	S Data register : W1 to W2047 Input register : Z1 to Z127 Link register : R1 to R1023
Sine		SIN	S D	Sine between 0° and 360° SIN{ [S] . [S+1] } (integral) (decimal) = [D] . [D+1] (integral) (decimal)	D Data register : W1 to W2047 Link register : R1 to R1023
Cosine		COS	S D	Cosine between 0° and 360° COS{ [S] . [S+1] } (integral) (decimal) = [D] . [D+1] (integral) (decimal)	
Block Transfer		BLK	S D Z	Data of the source table are sent simultaneously to the destination table. 	S;Source table start Output coil : O1 to O497 Internal coil : N1 to N1521 Input relay : I1 to I497 Timer register : T1 to T256 Counter register : C1 to C256 MC unit coil : Y1 to Y497 MC unit relay : X1 to X241 MC control coil : Q1 to Q241 MC control relay : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 D;Destination table start Output coil : O1 to O497 Internal coil : N1 to N1521 Link coil : D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024 Z;Table size Constant : 1 to MAX100

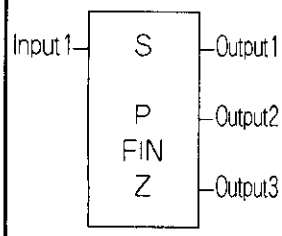
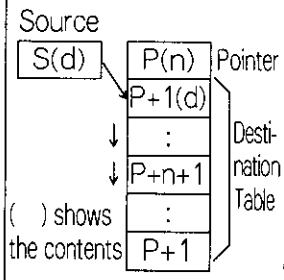
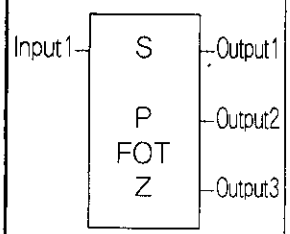
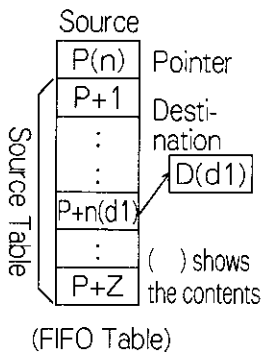
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Register to Table Transfer		RTT	S P Z	Data of the source reference, which are in accordance with the constants of the pointer, are transferred to the destination table at every register per scan. 	S;Source reference Output coil : O1 to O497 Internal coil : N1 to N1521 Input relay : I1 to I497 Timer register : T1 to T256 Counter register : C1 to C256 MC unit coil : Y1 to Y497 MC unit relay : X1 to X241 MC control relay : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024
Table to Register Transfer		TTR	S P Z	Data of the source table, which are in accordance with the constants of the pointer, are transferred from every register per scan to the next register to the pointer. 	P; Pointer Data register : W1 to W2047 Link register : R1 to R1023 Z; Table size Constant : 1 to 999
Table to Table Transfer		TTT	S P Z	Data of the source reference, which is at the nth+1 indicated by the pointer constants n, are sent to the nth+1 of the destination table at every register per scan. 	

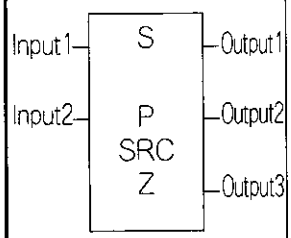
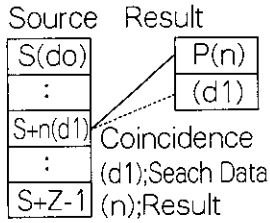
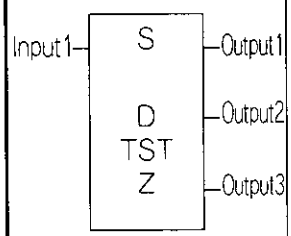
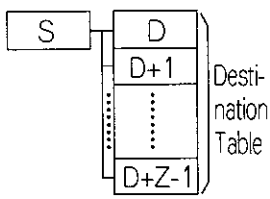
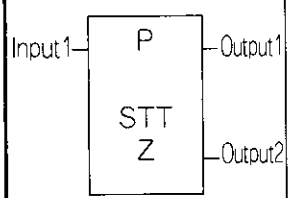
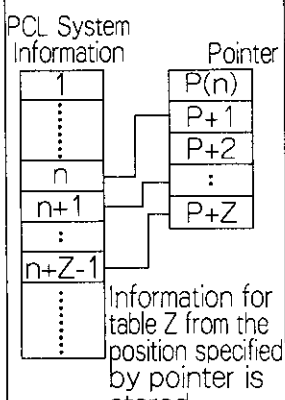
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
First-in		FIN	S P Z	Data of the destination table are moved up and data of the source reference are transferred to the first empty destination table. 	S;Source reference Output coil : O1 to O497 Internal coil : N1 to N1521 Input relay : I1 to I497 Timer register : T1 to T256 Counter register : C1 to C256 MC unit coil : Y1 to Y497 MC unit relay : X1 to X241 MC control relay : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 P; Pointer Data register : W1 to W2047 Link register : R1 to R1023 Z; Table size Constant : 1 to 100
First-out		FOT	P D Z	A transfer in which the desination table used for FIN (FIFO table) is to be the source table; the nth data indicated by the pointer contents n are transferred to the destination. 	P; Pointer Data register : W1 to W2047 Link register : R1 to R1023 D;Destination reference Output coil : O1 to O497 Internal coil : N1 to N1521 Input relay : I1 to I497 Timer register : T1 to T256 Counter register : C1 to C256 MC unit coil : Y1 to Y497 MC unit relay : X1 to X241 MC control relay : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Z; Table size Constant : 1 to 100

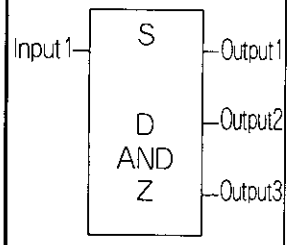
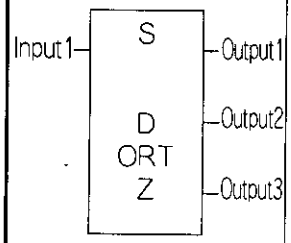
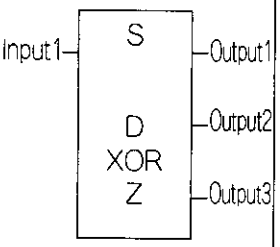
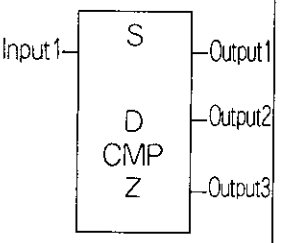
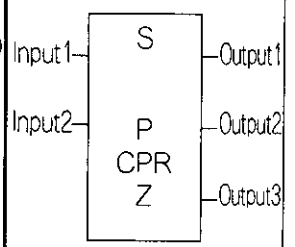
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Search		SRC	S P Z	Date which coincide with the specified data are searched for in the source table and the result (the nth source table from the top) is stored in the pointer. 	S: Source table starting reference Data register: W1 to W2048 Input register: Z1 to Z128 Link register: R1 to R1024 P: Pointer Data register: W1 to W2047 Link register: R1 to R1023 Z: Table size Constant:1 to 100
Table Set		TST	S D Z	The contents of the source are transferred to all tables of the destination. 	S: Source table reference Data register: W1 to W2048 Input register: Z1 to Z128 Link register: R1 to R1024 D: Destination table starting reference Date register: W1 to W2048 Link register: R1 to R1024 Z: Table size Constant:1 to 100
Status Read		STT	P Z	PCL unit system information is read out from the specified register. 	P: Pointer Data register: W1 to W2047 Link register: R1 to R1023 Z: Table size Constant:1 to 100

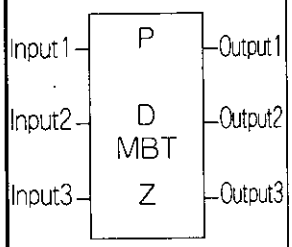
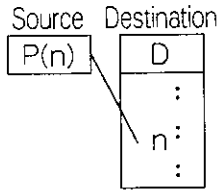
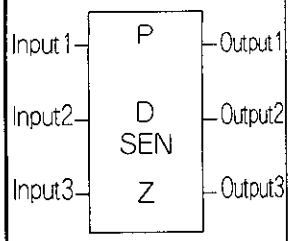
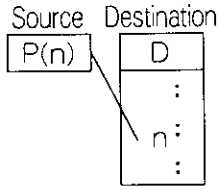
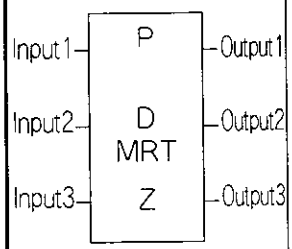
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
AND Table		AND	S D Z	Logical operation AND is executed between the source table and destination table to store the result in the destination table.	S: Source table starting reference Output coil: O1 to O497 Internal coil: N1 to N1521 Input relay: I1 to I497 Timer register: T1 to T256 Counter register: C1 to C256 MC unit coil: Y1 to Y497 MC unit relay: X1 to X241 MC control coil: Q1 to Q241 MC control relay: P1 to P241 Link coil: D1 to D1009 Data register: W1 to W2048 Input register: Z1 to Z128 Link register: R1 to R1024
OR Table		ORT	S D Z	Logical operation OR is executed between the source table and destination table to store the result in the destination table.	
Exclusive OR Table		XOR	S D Z	Logical operation XOR is executed between the source table and destination table to store the result in the destination table.	D: Destination table starting reference Output coil: O1 to O497 Internal coil: N1 to N1521 Link coil: D1 to D1009 Data register: W1 to W2048 Link register: R1 to R1024
Complement (Bit Reverse)		CMP	S D Z	All bit information of the source table is reversed and stored in the destination table .	Z: Table size Constant: 1 to MAX.100
Compare (Bit Comparison)		CPR	S P Z	The same bit numbers of the source table and destination table are compared to each other by one bit.	S: Source table starting reference Same as complement (CMP) P: Pointer Data register: W1 to W2047 Link register: R1 to R1023 Z: Table size Constant: 1 to MAX.100

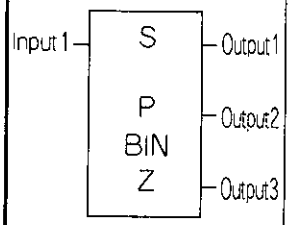
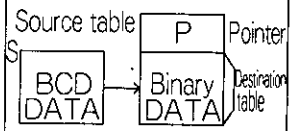
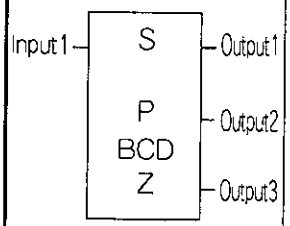
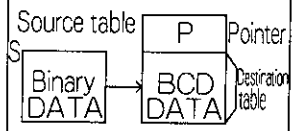
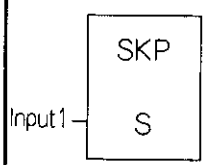
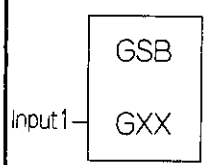
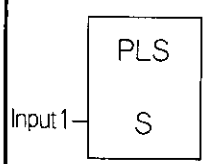
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Modify Bit		MBT	P D Z	Among destination tables, the status of the bit at the specified order designated by the pointer is forcedly set or cleared. 	P: Pointer Constant: 1 to 9600 Data register: W1 to W2048 Input register: Z1 to Z128 Link register: R1 to R1024 D: Destination table starting reference Output coil: O1 to O497 Internal coil: N1 to N1521 Link coil: D1 to D1009 Data register: W1 to W2048 Link register: R1 to R1024
Sense (Bit Sensing)		SEN	P D Z	Among destination tables, whether the status of the bit at the specified order designated by the pointer is "1" or "0". 	Z: Table size Constant: 1 to MAX100
Multi rotate		MRT	S D Z	The destination table bit arrangement status is shifted to the left or right for the shifting number (1 to 15) specified in the source register.	S: Source register Data register: W1 to W2048 Link register: R1 to R1024 D: Destination table starting reference Data register: W1 to W2048 Link register: R1 to R1024 Z: Table size Constant: 1 to 100

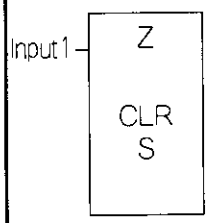
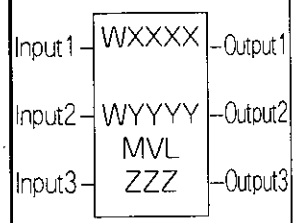
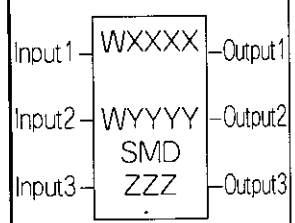
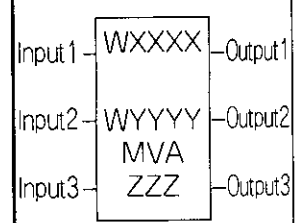
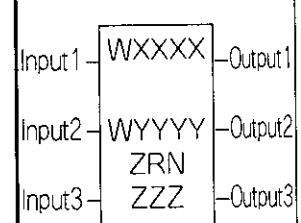
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operaud
BCD to BIN Conversion		BIN	S P Z	Source table BCD data are converted to binary in one scan and transferred to the destination table. 	S; Source table starting reference Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 P ; Pointer Data register : W1 to W2047 Link register : R1 to R1023 Z ; Table size Constant : 1 to 16
BIN to BCD Conversion		BCD	S P Z	Source table binary data are converted to BCD in one scan and transferred to the destination table. 	
Skip		SKP	S	Circuit block processing for the number specified by the source reference is frozen and the frozen circuit block is skipped to decode the program.	S ; Source reference Data register : W1 to W2048 Input register : Z1 to Z128 Constant : 1 to 9999
Subroutine		GSB	GXX	The specified subroutine circuit is called to decode.	GXX ; Subroutine No. : G01 to G99
Pulse Output		PLS	S	The coil specified by the source reference is turned ON only for one scan.	S ; Source reference Output coil : O1 to O512 Internal coil : N1 to N1536

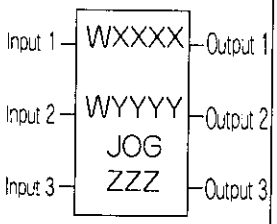
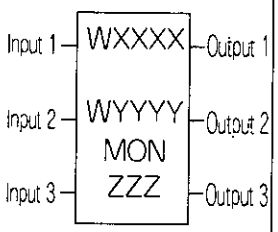
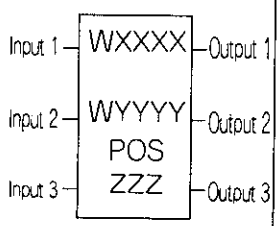
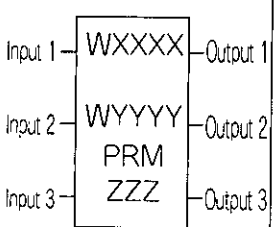
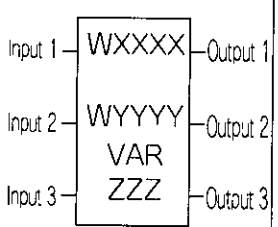
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Coil Clear		CLR	S Z	As many coils as specified of the coils specified with the coil numbers are turned OFF.	Z: Number of coils S: Coil No. Output coil: O1 to O512 Internal coil: N1 to N1536 Link coil: D1 to D1024 MC unit coil: Y1 to Y512 MC control coil: Q1 to Q256
Program Operation		MVL	WXXXX WYYYY ZZZ	Motion program operation is executed.	WXXXX; Setting data Data register: W1 to W2048 WYYYY; Monitor data Data register: W1 to W2048 ZZZ; constant: 1 to 999 (not used)
Single-block Operation Mode		SMD	WXXXX WYYYY ZZZ	Motion program during program operation is executed block by block.	
Independent Axis Operation MVA/MVB		MVA	WXXXX WYYYY ZZZ	Axis A or B independent operation is performed.	
Zero-point Return Operation		ZRN	WXXXX WYYYY ZZZ	Zero-point return is performed for the specified axis of the specified MC unit.	

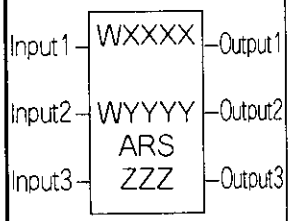
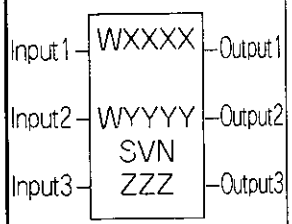
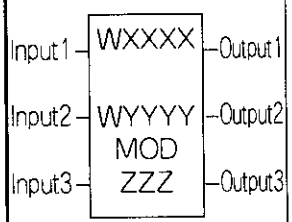
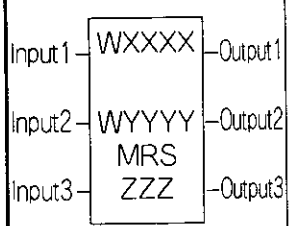
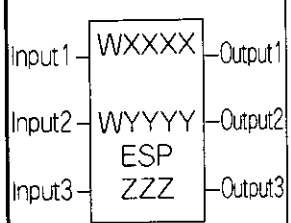
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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operaud
Jog Operation		JOG	WXXXX WYYYY ZZZ	JOG operation is performed for the specified axis of the specified MC unit.	WXXXX ; Setting data Data register : W1 to W2048 WYYYY ; Monitor data Data register : W1 to W2048 ZZZ ; Constant : 1 to 999 (not used)
Monitor		MON	WXXXX WYYYY ZZZ	The contents specified with the monitor No. is monitored.	
Current Value Setting		POS	WXXXX WYYYY ZZZ	The specified current value data are set to the MC unit.	
Parameter Setting		PRM	WXXXX WYYYY ZZZ	The specified parameter is set to the MC unit.	
Constant Value Setting		VAR	WXXXX WYYYY ZZZ	The specified compensated value is set to the MC unit.	

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Table 1.2 List of Applied Commands (Cont'd)

Command	Symbol	Mnemonic	Operand	Function	Value of Operand
Alarm Reset		ARS	WXXXX WYYYY ZZZ	The specified axis alarm is cleared.	WXXXX; Setting data Data register: W1 to W2048
Servo ON		SVN	WXXXX WYYYY ZZZ	Current conduction status to the motor of the specified axis No. is switched.	WYYYY; Monitor data Data register: W1 to W2048 ZZZ; constant: 1 to 999 (not used)
Mode Set		MOD	WXXXX WYYYY ZZZ	MC unit mode is switched.	
Reset		MRS	WXXXX WYYYY ZZZ	MC unit is initialized and the program No. is switched.	
Emergency Stop Signal Information		ESP	WXXXX WYYYY ZZZ	Emergency stop signal is sent to the MC unit.	

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1.2 OUTLINE OF SEQUENCE PROGRAM

Sequence program is described in ladder language or mnemonic language. There are mainly two types of commands used for each language; basic sequence commands and applied commands. The basic sequence commands are such as NO contact, NC contact, coil, timer, or counter command. Applied commands are such as four types of calculation, data transfer, logic operation, etc.

1.3 RELATION BETWEEN MNEMONIC AND LADDER

Sequence program is created based on the sequence control specifications. It may be created in mnemonic language or ladder language. These languages can be converted to each other by converting process (compile).

Sequence program created in ladder language is to be executed by the PLC unit.

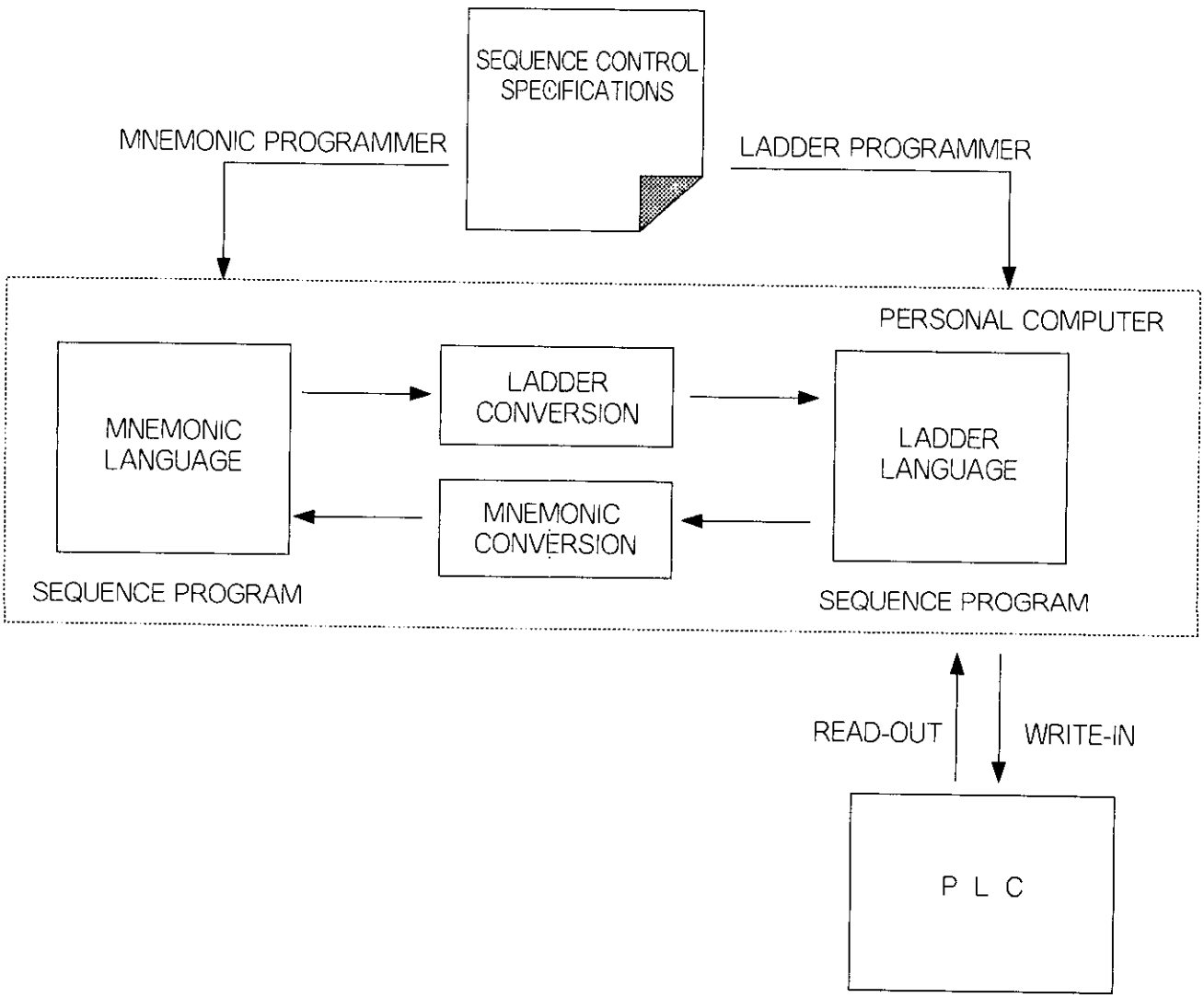


Fig.1.1 Relation between Mnemonic and Ladder

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1.4 CONFIGURATION OF SEQUENCE PROGRAM

Sequence program is stored in the PLC memory. The PLC reads out and executes the program to perform the aimed sequence control. Up to 16k-step of sequence program can be stored in ladder language conversion. One step size is 3 bytes.

Sequence programs are stored in the order of the numbers with the circuit block (described in Section 3) as the reference unit).

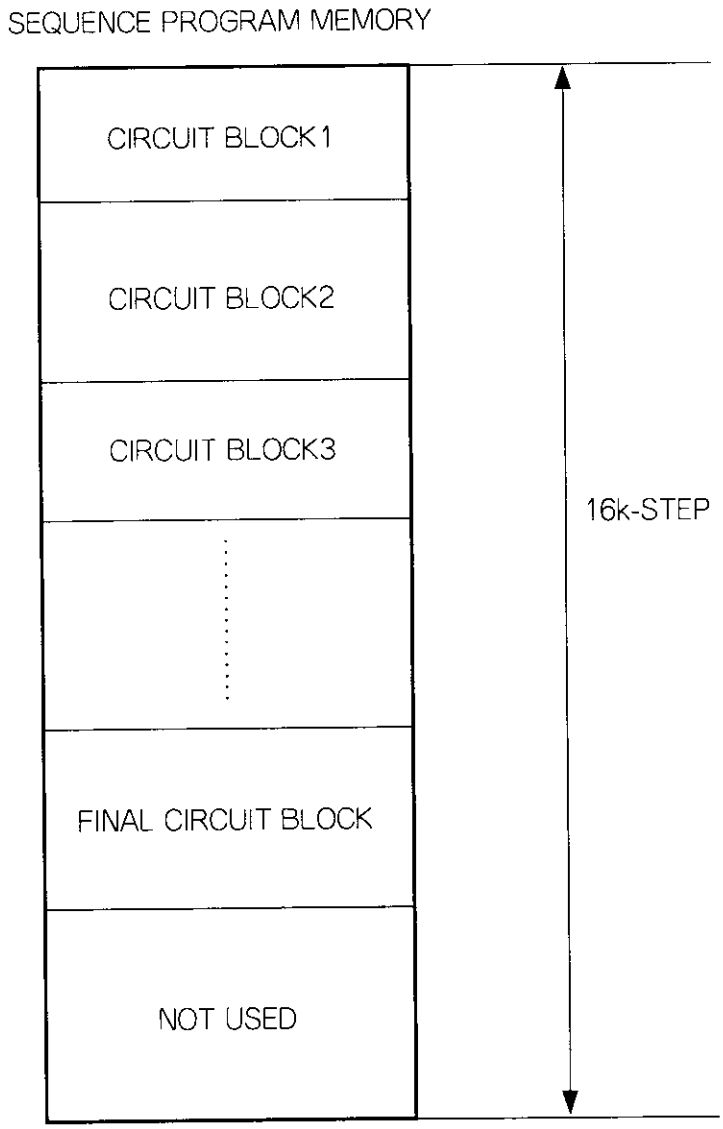


Fig.1.2 Configuration of Sequence Program

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References indicate addresses assingned to the I/0 device in which the PLC sends and receives the signals to/from external devices. They are used as command operand (contact No./ register No.) in the sequence program.

2.1 LIST OF REFERENCES

Table 2.1 shows the list of references used for the PLC unit.

Table 2.1 List of References

	Name	Points	Reference No.	Remarks
Discrete References	Output coil	512 points	O1 to O512	O1 to O96 (Basic I/O unit)
	Input relay	512 points	I1 to I512	I1 to I160 (Basic I/O unit)
	Internal coil	1536 points	N1 to N1536	N1536: Battery coil (ON at battery voltage normal)
	Timer coil	256 points	T1 to T256	T1 to T128: 100ms timer, T129 to T256: 10ms timer
	Counter coil	256 points	C1 to C256	C1 to C128: addition counter, C129 to C256: subtraction counter
	MC unit coil	512 points	Y1 to Y512	Signal output from PLC unit to MC unit
	MC unit relay	512 points	X1 to X512	Signal output from MC unit to PLC unit
	MC control coil	256 points	Q1 to Q256	Not used
	MC control relay	256 points	P1 to P256	Control input relay from MC unit to PLC unit
	M-code relay	180 points	MUXX	U; MC unit Nos. : 1,2 XX; code Nos. : 00 to 89
	Stepping relay	3618 points	SYYXX	YY; stage Nos. : 01 to 32 XX; step Nos. : 1 to 99
	Link coil	1024 points	D1 to D1024	A kind of internal coil
Register References	Dta register	2048 words	W1 to W2048	Data registers W1 to W128 are output registers
	Input register	128 words	Z1 to Z128	Not used
	Link register	1024 words	R1 to R1024	A kind of data register
	Timer register	256 words	T1 to T256	Register to store timer measured values
	Counter register	256 words	C1 to C256	Register to store timer counted values

Note: When Txxxx (timer reference) and Cxxxx (counter reference) is used for the basic sequence commands, they indicate timer coil and counter coil, respectively. When they are used in the applied commands, they indicate registers to store the time measured value and counted value, respectively.

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2.2 DESCRIPTION OF EACH REFERENCE

The details of each reference and data contents which can be used in the commands will be explained in the description of the commands. In this paragraph, a general explanation will be given.

(1) Type of references

When the references are classified according to the data word length, there are two types: discrete type of 1-bit data length and register type of 16-bit length.

(a) Discrete reference

References having bit data of ON and OFF are generally called "discrete references". (See Table 2.1)

(b) Register reference

References havihg 16-bit word data are generally called "register references". (See Table 2.1)

(2) I/0 reference

Various references of discrete and register types which can be sent or received to/from the external devices (relays, valves, etc.,) through the PLC I/O section are I/O references. Fig. 2.1 shows the relation between the PLC I/O and references.
There are four types of I/O references; discrete input, discrete output, register input and register output.

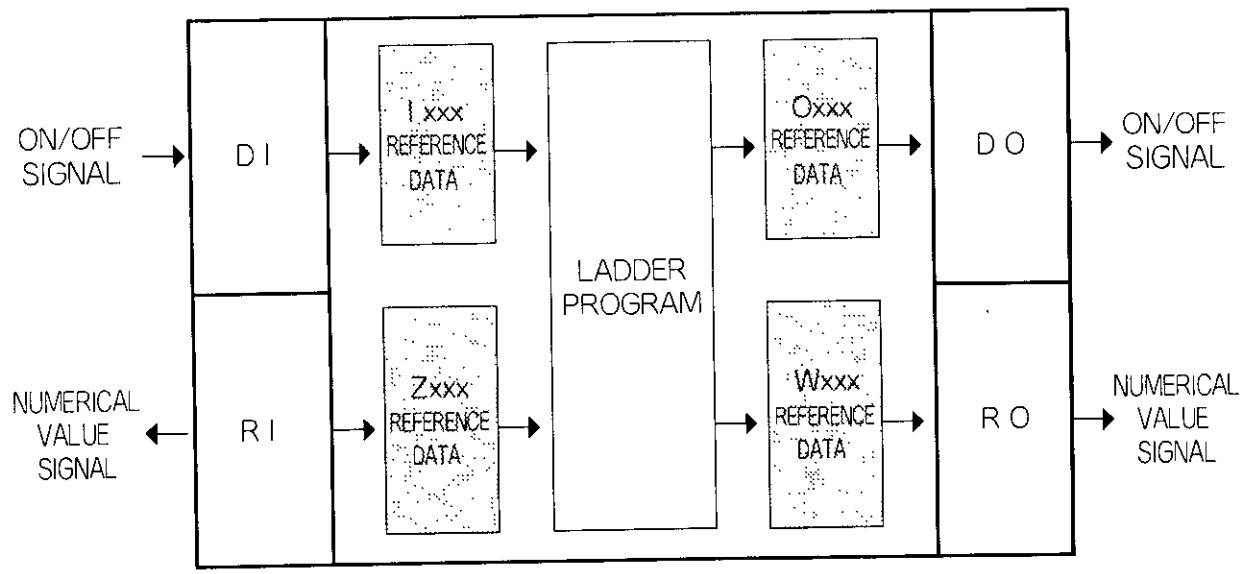


Fig. 2.1 Relation between PLC I/O and Reference

(a) Output coil reference (Oxxx)

References which can output ON/OFF signal to the PLC output section among discrete references. They are indicated as Oxxx (XXX: 1 to 512) and called output coil references. The output sections where ON/OFF signal can be output are generally called discrete output (DO).

(b) Input relay reference (Ixxx)

Input relays are references which can input ON/OFF signal from the PLC input section among the discrete references. They are indicated as Ixxx (XXX: 1 to 512) and called input relay references.
The input sections where ON/OFF signal can be input are generally called discrete input (DI).

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(c) Output registerreference (Wxxx)

Output registers are references which can output register data to the PLC output section among the data registers. They are indicated as Wxxxx (xxxx: 1 to 128) and called output register references. The output sections where register data can be output are generally called register output (RO).

(d) Input register reference (Zxxx)

Input registers are references which can input register data from the PLC input section. They are indicated as Zxxxx (xxxx: 1 to 128) and called input register references. The input sections where register data can be input are generally called register input (RI).

(3) References for MC unit

References assigned to the I/O number sent/received between the PLC andMC units. References assigned to the signals which the PLC outputs and the MC unit inputs are called MC unit coils. These MC unit coils are indicated with references of Yxxx (xxx: 1 to 512). References assigned to the signals which the MC unit outputs and the PLC input are called MC unit relays. These MC unitrelays are indicated by Xxxx (xxx: 1 to512). Additionally, there are some special relayscalledMC control relays (Pxxx) or M-code relays. Fig 2.2 shows the MC unit reference data to be sent/received between the PLC and MC units.

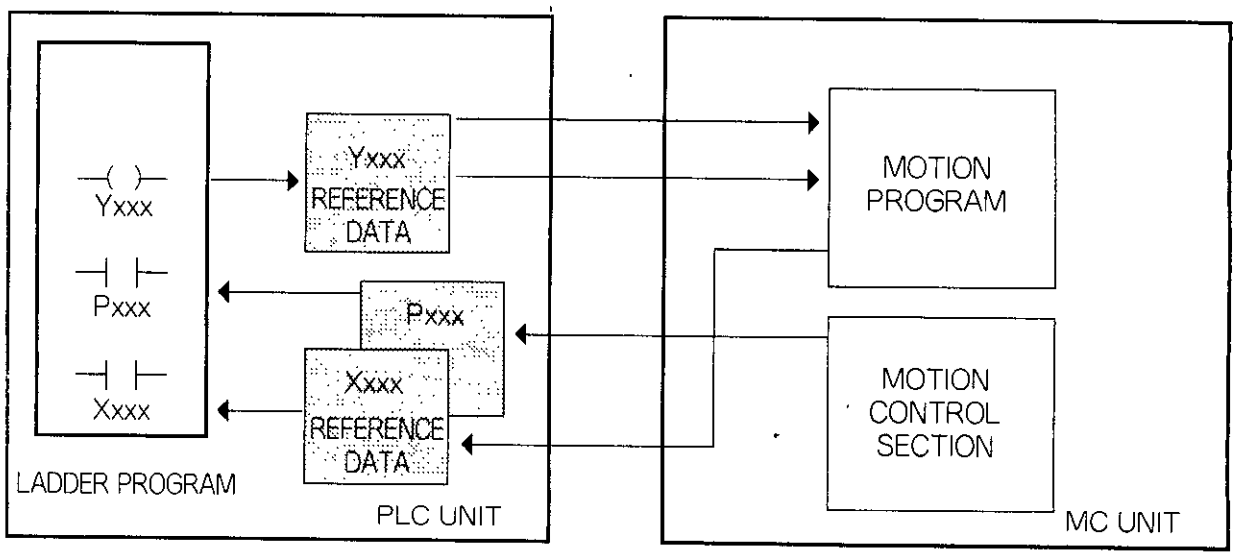


Fig.2.2 Reference for MC unit

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① MC unit relay

MC unit relays are references to read output variable #0 on the MC side.
Table 2.2 shows the corresponding relation between the MC unit relays and output variables.

Table 2.2 Relation between MC Unit Relays and Output Variables

Reference	Corresponding Output Variables	Reference	Corresponding Output Variables
X1	MC unit 1 output variable #01	X257	MC unit 2 output variable #01
X2	MC unit 1 output variable #02	X258	MC unit 2 output variable #02
X3	MC unit 1 output variable #03	X259	MC unit 2 output variable #03
⋮	⋮	⋮	⋮
X255	MC unit 1 output variable #255	X511	MC unit 2 output variable #0255
X256	MC unit 1 output variable #256	X512	MC unit 2 output variable #0256

② MC unit coil

MC unit coils are references to write sequence data on the PLC side into MC unit input variables #i.
Table 2.3 shows the corresponding relation between the MC unit coils and intput variables.

Table 2.3 Relation between MC Unit Coils and Input Variables

Reference	Corresponding Input Variables	Reference	Corresponding Input Variables
Y1	MC unit 1 input variable #i1	Y257	MC unit 2 input variable #i1
Y2	MC unit 1 input variable #i2	Y258	MC unit 2 input variable #i2
Y3	MC unit 1 input variable #i3	Y259	MC unit 2 input variable #i3
⋮	⋮	⋮	⋮
Y255	MC unit 1 input variable #i255	Y511	MC unit 2 input variable #i255
Y256	MC unit 1 input variable #i256	Y512	MC unit 2 input variable #i256

Note: MC unit relays and MC unit coils are effective at interlocking between the PLC unit (sequence control) and MC unit (motion control).

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③ MC control relay

MC control relays indicate each status signal on the MC unit side.
For the details of the signal functions, refer to the PROGIC-8 PROGRAMMING MANUAL FOR MC (SIE-C888-1.2).
Table 2.4 shows the list of the MC control relays. The commands in quotation marks indicate motion commands in the table. References in parentheses indicate the MC control relays of MC unit 2. (Those without parentheses indicate MC control relays of MC unit 1.)

Table 2.4 List of MC Control Relays

Reference	Signal Name	Meaning in ON Status
P1 (P129)	MCRD	Indicates MC unit ready status (completion of MC unit preparation).
P2 (P130)	ALRM	Indicates that an alarm is occurring in the MC unit.
P3 (P131)	STRL	Indicates that the program is being operated (during execution of MVL) or that a command from the programming panel is being executed for a block.
P4 (P132)	HLDL	Indicates the temporary stop status during program operation.
P5 (P133)	SBKL	Indicates that one block is being executed by single-block during program operation.
P6 (P134)	STPL	Indicates that "STP" command is being executed during program operation. (OFF at restart)
P7 (P135)	ENDL	Indicates that "END" command is being executed during program operation. (OFF at restart)
P8 (P136)	ZRNL	Indicates that zero-point return operation is being performed.
P9 (P137)	MOV1	Indicates that axis-1 is moving.
P10(P138)	MOV2	Indicates that axis-2 is moving.
P11(P139)	MOV3	Indicates that axis-3 is moving.
P12(P140)	MOV4	Indicates that axis-4 is moving.
P13(P141)	SVN1	Indicates that axis-1 is in the servo ON status.
P14(P142)	SVN2	Indicates that axis-2 is in the servo ON status.
P15(P143)	SVN3	Indicates that axis-3 is in the servo ON status.
P16(P144)	SVN4	Indicates that axis-4 is in the servo ON status.
P17(P145)	ZPT1	Indicates that axis-1 is at the zero-point position.
P18(P146)	ZPT2	Indicates that axis-2 is at the zero-point position.
P19(P147)	ZPT3	Indicates that axis-3 is at the zero-point position.

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Table 2.4 List of MC Control Relays (Cont'd)

Reference	Signal Name	Meaning in ON Status
P20(P148)	ZPT4	Indicates that axis 4 is at the zero-point position.
P21(P149)	ALM1	Indicates that an alarm is occurring in axis 1.
P22(P150)	ALM2	Indicates that an alarm is occurring in axis 2.
P23(P151)	ALM3	Indicates that an alarm is occurring in axis 3.
P24(P152)	ALM4	Indicates that an alarm is occurring in axis 4.
P25(P153)	MANL	Indicates the manual operation mode.
P26(P154)	AUTL	Indicates the automatic operation mode.
P27(P155)	ONEL	Indicates the online edit mode.
P28(P156)	No signal assigned	For future use. Do not use.
P29(P157)	MFIL	Indicates that it is requested to read M-code output.
P30(P158)	MDEN	Indicates an instruction to complete moving.
P31(P159)	No signal assigned	For future use. Do not use.
P32(P160)	ERST	Reset request signal
P33~P40 (P161~P168)	No signal assigned	For future use. Do not use.
P41(P169)	M0	0 bit of M-code output
P42(P170)	M1	1st bit of M-code output
P43(P171)	M2	2nd bit of M-code output
P44(P172)	M3	3rd bit of M-code output
P45(P173)	M4	4th bit of M-code output
P46(P174)	M5	5th bit of M-code output
P47(P175)	M6	6th bit of M-code output
P48(P176)	M7	7th bit of M-code output

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Table 2.4 List of MC Control Relays (Cont'd)

Reference	Signal Name	Meaning in ON Status
P49(P177)	AM0	Indicates the 0 bit of alarm code.
P50(P178)	AM1	Indicates the 1st bit of alarm code.
P51(P179)	AM2	Indicates the 2nd bit of alarm code.
P52(P180)	AM3	Indicates the 3rd bit of alarm code.
P53(P181)	AM4	Indicates the 4th bit of alarm code.
P54(P182)	AM5	Indicates the 5th bit of alarm code.
P55(P183)	AM6	Indicates the 6th bit of alarm code.
P56(P184)	AM7	Indicates the 7th bit of alarm code.
P57(P185)	AM8	Indicates the 8th bit of alarm code.
P58(P186)	AM9	Indicates the 9th bit of alarm code.
P59(P187)	AM10	Indicates the 10th bit of alarm code.
P60(P188)	AM11	Indicates the 11th bit of alarm code.
P61(P189)	AM12	Indicates the 12th bit of alarm code.
P62(P190)	AM13	Indicates the 13th bit of alarm code.
P63(P191)	AM14	Indicates the 14th bit of alarm code.
P64(P192)	AM15	Indicates the 15th bit of alarm code.
P65(P193)	POT1	Indicates that overtravel occurs on the plus side of axis-1. (MC unit direct input status)
P66(P194)	NOT1	Indicates that overtravel occurs on the minus side of axis-1. (MC unit direct input status)
P67(P195)	DEC1	Indicates the deceleration dog signal of axis-1. (MC unit direct input status)
P68(P196)	ZER1	Indicates the zero-point pulse signal of axis-1. (MC unit direct input status)
P69(P197)	POT2	Indicates that overtravel occurs on the plus side of axis-2. (MC unit direct input status)
P70(P198)	NOT2	Indicates that overtravel occurs on the minus side of axis-2. (MC unit direct input status)
P71(P199)	DEC2	Indicates the deceleration dog signal of axis-2. (MC unit direct input status)
P72(P200)	ZER2	Indicates the zero-point pulse signal of axis-2. (MC unit direct input status)

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Table 2.4 List of MC Control Relays (Cont'd)

Reference	Signal Name	Meaning in ON Status
P73(P201)	POT3	Indicates that overtravel occurs on the plus side of axis-3. (MC unit direct input status)
P74(P202)	NOT3	Indicates that overtravel occurs on the minus side of axis-3. (MC unit direct input status)
P75(P203)	DEC3	Indicates the deceleration dog signal of axis-3. (MC unit direct input status)
P76(P204)	ZER3	Indicates the zero-point pulse signal of axis-3. (MC unit direct input status)
P77(P205)	POT4	Indicates that overtravel occurs on the plus side of axis-4. (MC unit direct input status)
P78(P206)	NOT4	Indicates that overtravel occurs on the minus side of axis-4. (MC unit direct input status)
P79(P207)	DEC4	Indicates the deceleration dog signal of axis-4. (MC unit direct input status)
P80(P208)	ZER4	Indicates the zero-point pulse signal of axis-4. (MC unit direct input status)
P81(P209)	BRK1	Indicates the brake signal of axis-1.
P82(P210)	BRK2	Indicates the brake signal of axis-2.
P83(P211)	BRK3	Indicates the brake signal of axis-3.
P84(P212)	BRK4	Indicates the brake signal of axis-4.
P89 to P128 (P213 to P252)	No signal assigned	For future use. Do not use.

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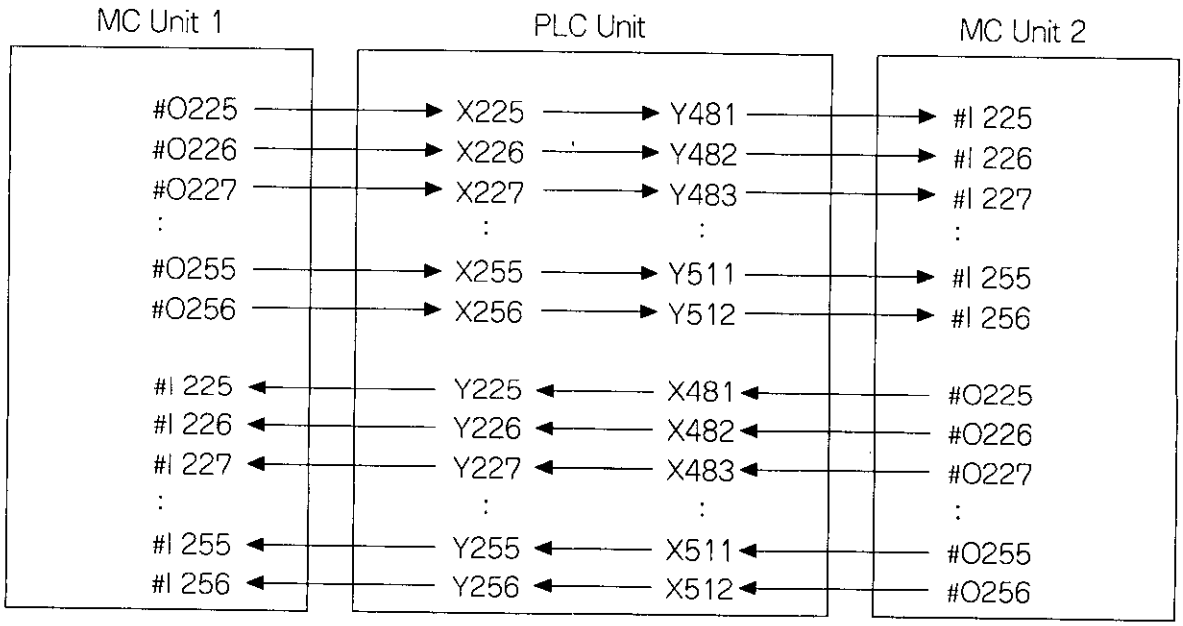
Note; MC unit relays and coils exclusive for returning operation

When the MC unit is mounted on a 2-unit mounting base, the last 32 points of each MC unit relay and coil are used exclusively for returning operation of MC1 and MC2. The PLC unit transfers the ON/OFF status of the following unit relays to the corresponding unit coils at every 10ms forcedly disregarding the ladder.

MC1 Unit	MC2 Unit
X 225 to X 256 →	→ Y 481 to Y 512
Y 225 to Y 256 ←	← X 481 to X 512

This is equivalent to decoding the following ladders at every 10ms.





Since the above unit coils and relays are sent/received between MC units every 10ms without passing the ladder, they are effective when the interlocking conditions between the units are to be processed at a high speed.

When only one MC unit is used, returning operation is not performed.

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(4) Internal reference

Among references, those which are assigned to the data used in the PLC without sending/receiving to/from any external devices other than the PLC are called internal references.

There are four types of internal references: internal coils [Nxxxx(XXXX: 1 to 1536)], timer relays [Txxx (XXX: 1 to 256)], counter relays [Cxxx (xxx:1 to 256)], stepping relays [SYYXX (YY:01 to 32, XX:0 to 99)] and data registers [Wxxxx (XXXX: 129 to 2048)].

(a) Internal coil reference (Nxxxx)

Except that the ON/OFF status cannot be output directly to the output module, they are functionally the same as output coils.

On the contrary, when an output coil is not output to the output module, they are the same as internal coils. Only N1536 is reserved by the PLC as a coil for battery monitoring. Therefore, it can be used as a relay from the ladder block but it cannot be used as a coil.

(b) Timer relay reference (Txxx)

This relay is turned ON when the measuring time coincides with the set value by the timer command (when the time is up).

For details, refer to the timer command paragraph. T1 to T128T are relay references assigned for time measurement every 100msec. T129 to T256 are assigned for the timer measurement every 100msec.

(c) Counter relay reference (Cxxx)

This relay is turned ON when the counted value coincides with the set value by the counter command (when the count is up).

For details, refer to the counter command paragraph. C1 to C128 are relay references assigned for addition counter. C129 to C256 are assigned for subtraction counter.

(d) Stepping relay (Syyxx)

Stepping relays are special relays; the relay with step No. xx which coincides with data register corresponding to stage No. yy is turned ON (at NO contect.)

For details, refer to the stepping command paragraph.



(e) Data register reference (Wxxxx)

They are 16-bit registers and used for various calculation commands.

W1 to W128 can output the data to the output section as output registers.

Fig. 2.3 shows the relation between the ladder program and internal reference.

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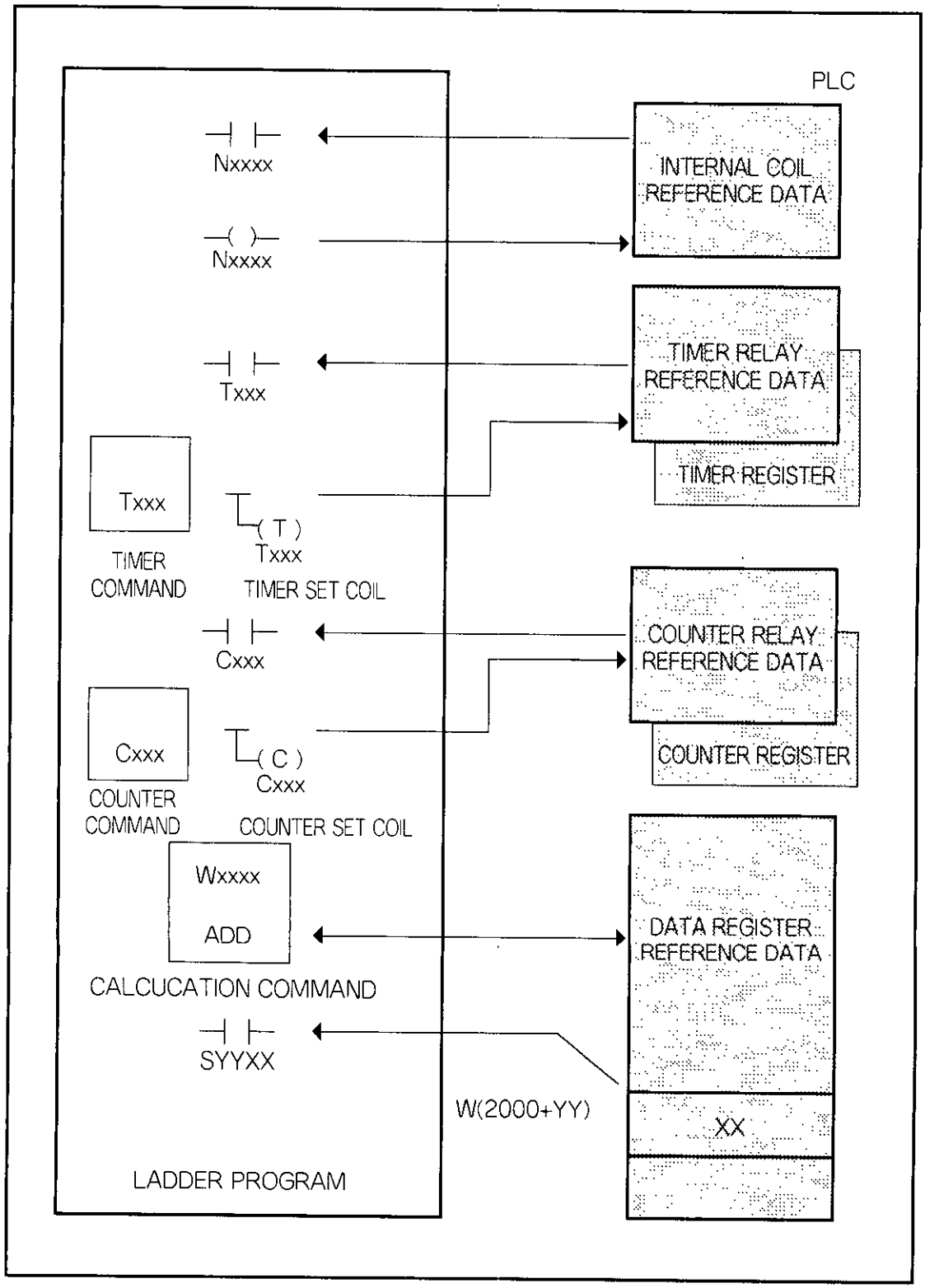


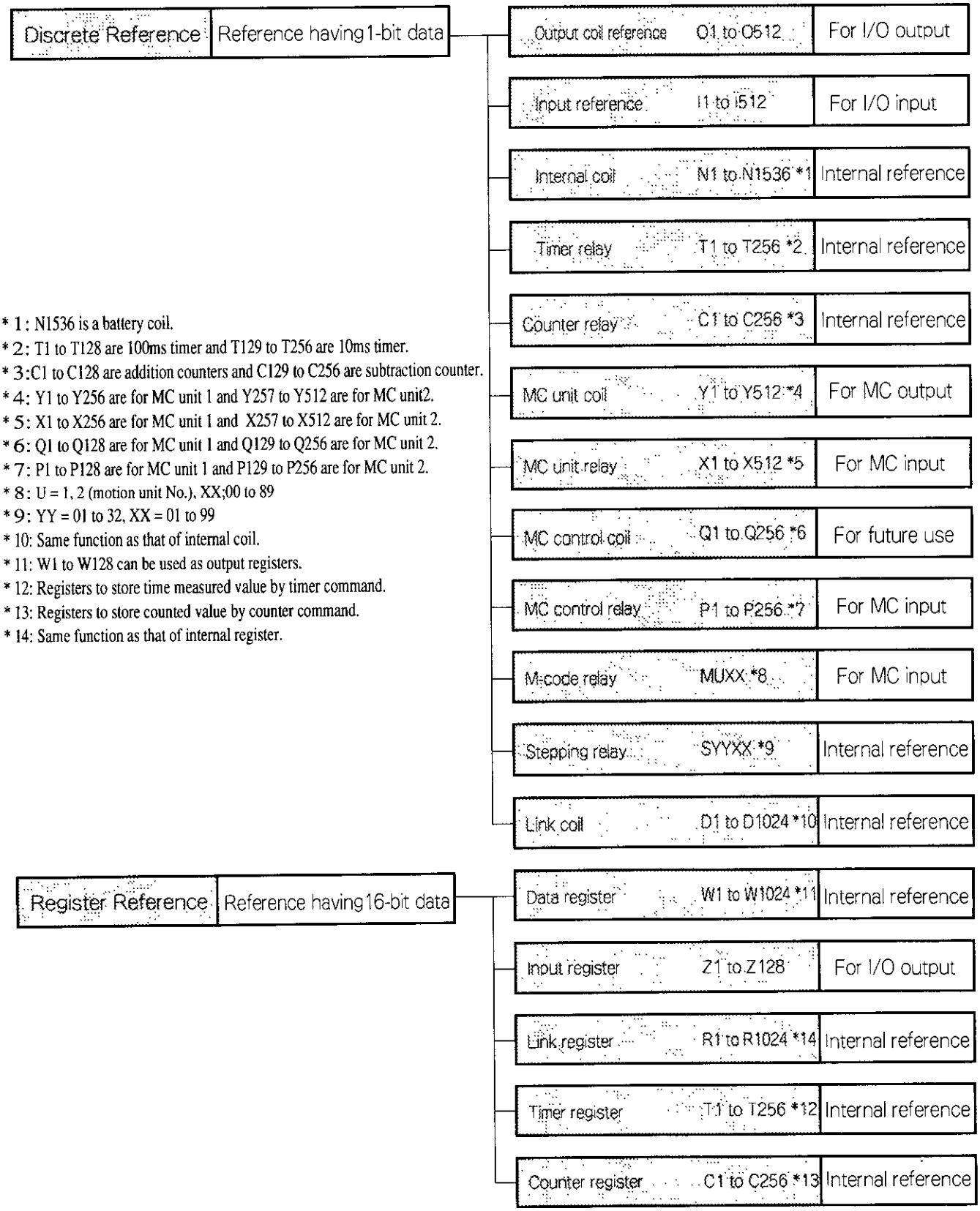
Fig.2.3 Relation between Ladder Program and Internal Reference

(5) Link relay,link register reference

Link relay and link register can be used for the same function as internal coil and data register, respectively.

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2.3 SYSTEM OF REFERENCES



* 1: N1536 is a battery coil.
* 2: T1 to T128 are 100ms timer and T129 to T256 are 10ms timer.
* 3:C1 to C128 are addition counters and C129 to C256 are subtraction counter.
* 4: Y1 to Y256 are for MC unit 1 and Y257 to Y512 are for MC unit2.
* 5: X1 to X256 are for MC unit 1 and X257 to X512 are for MC unit 2.
* 6: Q1 to Q128 are for MC unit 1 and Q129 to Q256 are for MC unit 2.
* 7: P1 to P128 are for MC unit 1 and P129 to P256 are for MC unit 2.
* 8: U = 1, 2 (motion unit No.), XX;00 to 89
* 9: YY = 01 to 32, XX = 01 to 99
* 10: Same function as that of internal coil.
* 11: W1 to W128 can be used as output registers.
* 12: Registers to store time measured value by timer command.
* 13: Registers to store counted value by counter command.
* 14: Same function as that of internal register.

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A sequence program is composed with circuit blocks as reference units as described in Par. 1.4, "CONFIGURATION OF SEQUENCE PROGRAM".

A sequence program is decoded from the circuit blocks with the smaller No.

There are two types of circuit blocks: basic sequence circuit blocks composed of basic sequence commands (NO contacts, NC contacts, differential contacts, coils) and applied circuit block commands (four types of calculation, data transfer commands, logic operation, motion commands).

3.1 BASIC SEQUENCE CIRCUIT BLOCK

For the basic sequence circuit, a closed circuit with one coil as a reference is to be a circuit block.

The sequence conditions of up to 7 lines and 10 columns can be described.

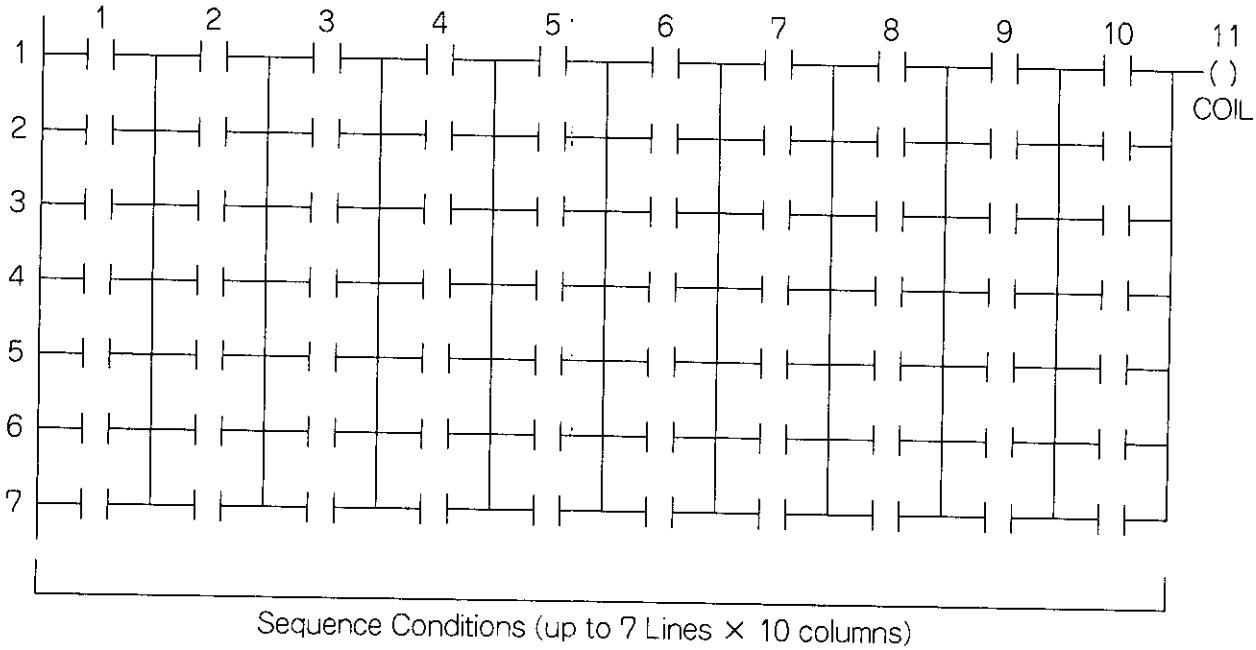


Fig. 3.1 Basic Sequence Circuit Block

3.2 APPLIED COMMAND CIRCUIT BLOCK

For the applied command circuit block, a closed circuit with one applied command (function) as a reference is to be a circuit block.

There are three types of applied commands; 1I/O, 2I/O and 3I/O. For details, refer to Par. 7.1.

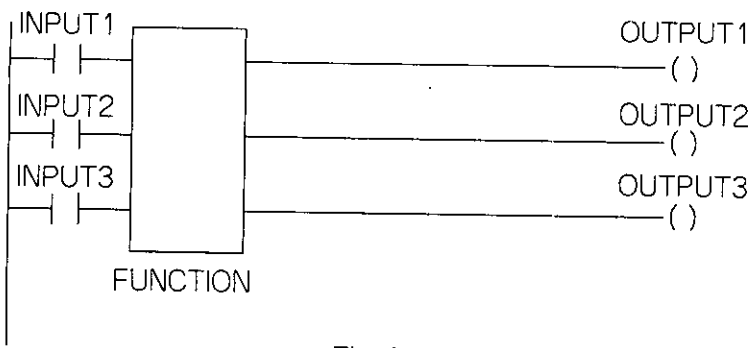


Fig. 3.2 Applied Command Circuit Block

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4.1 PLC INTERNAL PRODESSING FLOWCHART

Fig. 4.1 shows the PLC internal processing flowchart.

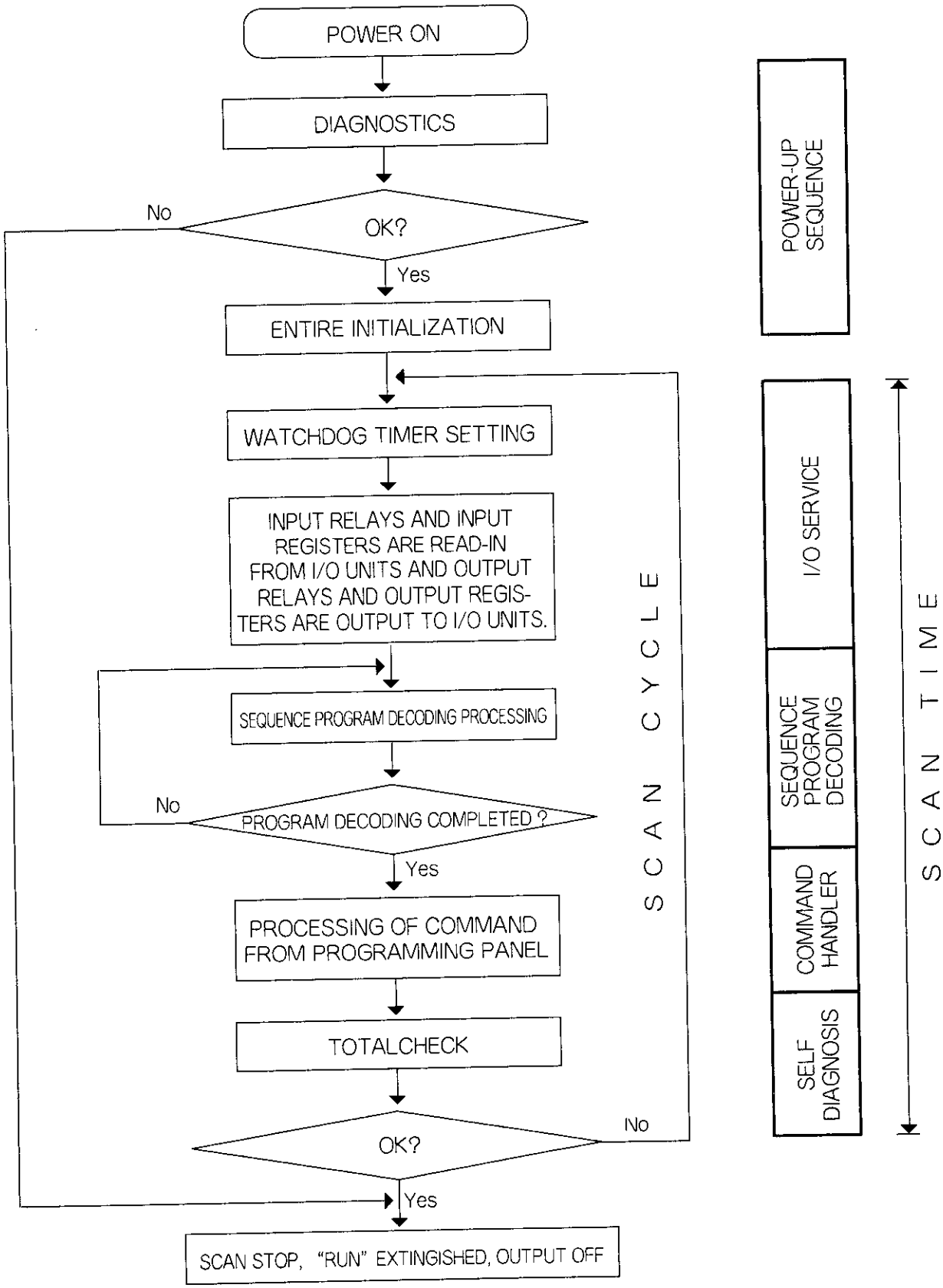


Fig. 4.1 PLC Internal Processing

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4.2 SCAN CYCLE AND SCAN TIME

As shown in Fig. 4.1, after the power supply is turned ON and the power-up sequence is completed in the PLC, a serial operation of I/O service, sequence program decoding processing, command handler and self-diagnosis is repeated.
This serial operation is called a scan cycle and the time required for one cycle is called scan time.

Table 4.1 shows the processing time of each processing in the scan time.
Approximate scan time T can be calculated by the following equation:

$$T = ① + ② + ③ + ④ \ (ms)$$

As shown in Table 4.1, sequence program decoding time differs according to the number of commands. Since each command has a different time when it is executed or not, the scan time varies.

Table 4.1 Scan Time

Scan Time

	Processing Name	Contents of Processing	Processing Time
①	I/O service	• Input relays and input registers are read-in from the I/O unit. • Output relays and output registers are output to the I/O unit.	0.03ms per basic I/O unit
②	Sequence Processing Name	Sequence program command execution is processed.	Σ (CIRCUIT BLOCK PROCESSING TIME)
③	Command handler	Command from the programming panel is processed.	0.2ms
④	Self-diagnosis	• Watchdog timer setting • Total sum check • Scan time check	2.9ms

Relation between Circuit Block Decoding Processing and Scan

A sequence program in the scan cycle is decoded in the order of the circuit block Nos. In one scan, it is decoded in the order from circuit block 1 to the final circuit block.

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Watchdog Timer

Watchdog timer is one of the self-diagnostic functions and monitors the scan cycle to prevent sequence programs from getting out of sequence. It is set firmly set at the beginning of the scan cycle; unless the timer is set again within 500ms for any reason, a scan fault is issued to stop scanning. At the same time, the "RUN" indicator lamp is extinguished and all outputs are turned OFF.

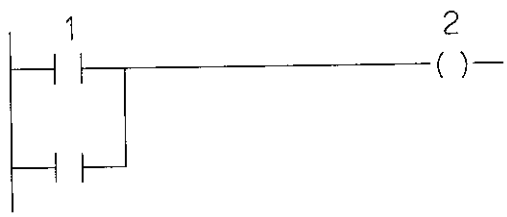
Processing Time of Circuit Block

The processing time of circuit block is calculated as shown below.

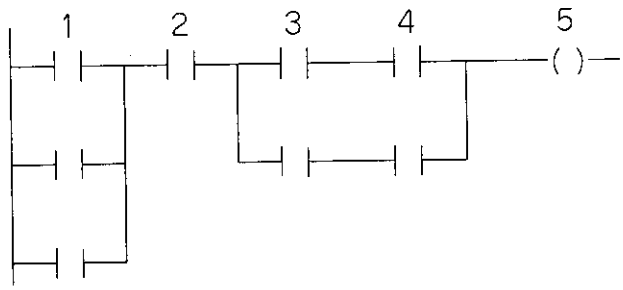
3.75 μs + (number of columns with command of the circuit block) × 0.5 μs + Σ (each command processing time in the circuit block)

Refer to Table 4.2.

[Number of columns with command]



The number of columns with command is 2 in the above circuit example.



The number of columns with command is 5 in the above circuit example.

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4.3 COMMAND EXECUTION TIME

Table 4.2 Command Execution Time

Command			Processing Time (μs)		Remarks
Name		Symbol	No-execution	Execution	
Relay	NO contact	—| |—	0.125	0.125	Processed by hardware without passing microprocessor
	NC contact	—|/|—	0.125	0.125	Processed by hardware without passing microprocessor
	Start-up differential contact	—|↑|—	0.5	0.5	Processed by hardware without passing microprocessor
	Start-down differential contact	—|↓|—	0.5	0.5	Processed by hardware without passing microprocessor
	Stepping relay		8	8	Processed by hardware without passing microprocessor
Coil	Coil	—( )—	1.5	1.5	Processed by hardware without passing microprocessor
	Latch	—(L)—	1.5	1.5	Processed by hardware without passing microprocessor
	Set	—(S)—	7.25	21.25	
	Reset	—(R)—	7.25	21	
Timer	0.1 sec	TMR	21	24	
	1 sec	TMR	21	24	
Counter	Addition	CTR	21	37	
	Subtraction	CTR	21	37	
4 Types of Calculations	Addition	ADD	25	34	
	Double-length addition	DAD	25	46	
	Subtraction	SUB	25	34	
	Double-length subtraction	DSB	25	50	
	Multiplication	MUL	25	34 to 45	34 μs at 0×0, 45 μs at 9999×9999
	Double-length multiplication	DML	25	41 to 115	43 μs at 0×0, 45 μs at 9999×9999
	Division	DIV	25	43/49	MAX. 43 μs of integral quotient, MAX. 49 μ decimal quotient,
	Double-length division	DDV	25	337/619	MAX. 337 μs of integral quotient, MAX. 619 μ decimal quotient,
Arithmetic Operation	Square root	SQR	21	24 to 203	24 μs at $\sqrt{0}$, 203 μs at $\sqrt{9999}$
	Double-length square root	DSQ	21	25 to 321	25 μs at $\sqrt{0}$, 321 μs at $\sqrt{99999999}$
	Sine	SIN	21	279	
	Cosine	COS	21	284	

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Table 4.2 Command Execution Time (Cont'd)

Command			Processing Time (μs)		Remarks
Name		Symbol	No-execution	Execution	
Data Transfer	Register-to-table transfer	RTT	25	37	
	Table-to-register transfer	TTR	25	40	
	Table-to-table transfer	TTT	25	38	
	Table setting	TST	25	27+1.25×n	n : Table size (1≦n≦100)
	Block transfer	BLK	25	33+1.25×n	n : Table size (1≦n≦100)
	First-in	FIN	25	37+1.73×n	n : Table size (1≦n≦100)
	First-out	FOT	25	38	
	Status read	STT	21	26+0.5×n	n : Table size (1≦n≦100)
Matrix	AND table	ANT	25	29+2.25×n	n : Table size (1≦n≦100)
	OR table	ORT	25	29+2.25×n	n : Table size (1≦n≦100)
	XOR table	XOR	25	29+2.25×n	n : Table size (1≦n≦100)
	Bit comparison	CPR	25	*1	
	Bit reverse	CMP	25	29+2×n	n : Table size (1≦n≦100)
	Search	SRC	25	34+2×n	n : Table size (1≦n≦100)
	Bit sensing	SNS	25	44	
	Modify bit	MBT	25	43	
	Multi-rotate	MRT	25	31+2.25×n	n : Table size (1≦n≦100)
Data Conversion	BCD to BIN conversion	BIN	25	31+22.75×n	n : Table size (1≦n≦100)
	BIN to BCD conversion	BCD	25	31+16×n	n : Table size (1≦n≦100)
Special	Skip	SKP	4.75	*2	
	Subroutine	CSB	3	32.75	
	Pulse output	PLS	4.75	14.25	

*1: Bit comparison processing time: 2.75×n+5.25×m+40 when unmatched.
[n: Table size, m: unmatched bit No. (1≦n≦100)]
2.75×n+40 when matched

*2: Skip processing time: 3×m+4.5×n
(n: Number of circuits to skip, m: number of commands to skip)

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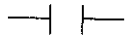
Basic commands for creation of sequence control program using the PLC.

1 RELAY

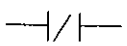
NO, NC and differential contacts are provided.

(1) NO/NC centacts

(a) Symbol



REFERENCE NO.
[NO Contact]



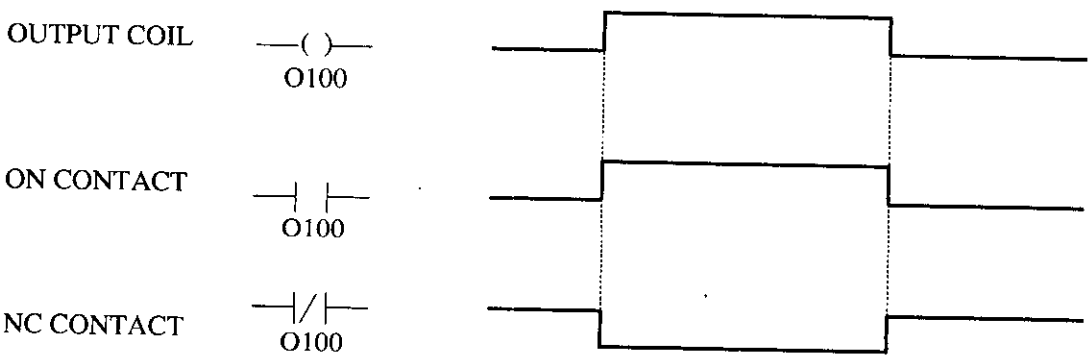
REFERENCE NO.
[NC Contact]

(b) Function

NO contact: While the coil specified by reference is turned ON, current is conducted and the signal is passed from the left to the right.
NC contact: While the coil specified by reference is turned OFF, current is conducted and the signal is passed from the left to the right.

> Note: For details of the timer and counter, refer to Pars, 5.3, "TIMER" and 5.4, "COUNTER".
> For details of the stepping switch, refer to Par, 7.13, "STEPPING SWITCH".

<Typical operation>



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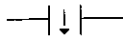
(2) Differential contact

(a) Symbol



REFERENCE NO.

[Start-up Differential Contact]



REFERENCE NO.

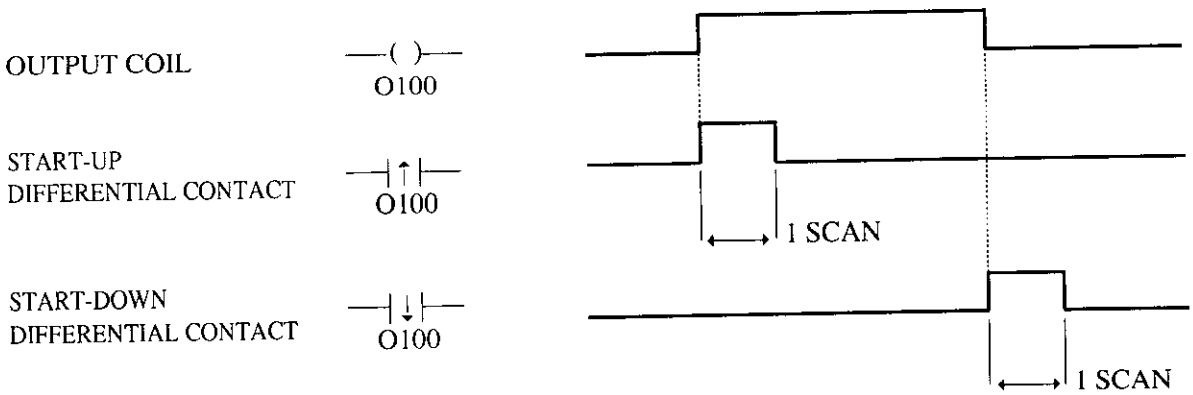
[Start-down Differential Contact]

(b) Function

Start-up differential contact : When the coil specified by reference is turned OFF and then ON, current is conducted only for one scan and the signal is passed from the left to the right.

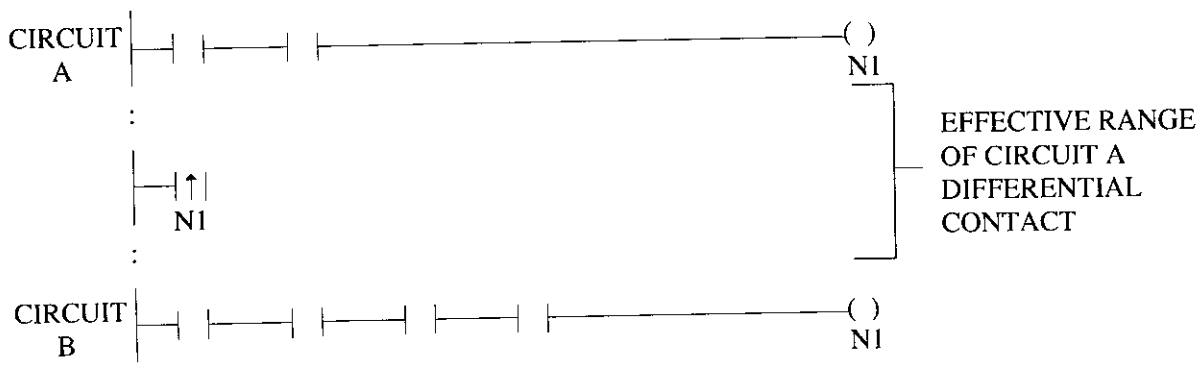
Start-down differential contact : When the coil specified by reference is turned ON and then OFF, current is conducted only for one scan and the signal is passed from the left to the right.

(c) Typical Operation



Precautions on Use of Differential Contact

1. Differential contact cannot be used for stepping switches (No. SYYXX).
2. When coils with the same number are used, the differential effective range is between these coils. However, the coil clear command (CLR) is not applied in this case. Additionally, one pair of a set coil and reset coil with the same number are regarded as one coil.



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Table 5.1 List of Relay Commands

Name	Symbol	Meaning	Reference Nos. to be Used
NO Contact	—⊣ ⊢— Reference No.	• Output coil, internal coil, MC unit coil, MC control coil, link coil → Current conduction when the corresponding coil -( )- is ON • Timer, counter → Current conduction when the corresponding timer command or counter command is up. • Input relay, MC unit relay, MC control relay, M-code relay → Current conduction when the signal from the corresponding external device is turned ON.	Output coil : O1 to O512 Input relay : I1 to I512 Internal coil : N1 to N1536 Timer relay : T1 to T256 Counter relay : C1 to C256 MC unit coil : Y1 to Y512 MC unit relay : X1 to X512 MC control coil : Q1 to Q256 MC control relay : P1 to P256 M-code relay : MUXX Stepping relay : SYYXX Link coil: D1 to D1024
NC Contact	—⊣/⊢— Reference No.	• Output coil, internal coil, MC unit coil, MC control coil, link coil → Current conduction when the corresponding coil -( )- is OFF • Timer, counter → Current conduction when the corresponding timer command or counter command is not up. • Input relay, MC unit relay, MC control relay, M-code relay → Current conduction when the signal from the corresponding external device is turned OFF.	Same as NO contact
Start-up Differentact Contact	—⊣↑⊢— Reference No.	• Output coil, internal coil, link coil → Current conduction only for one scan when the corresponding coil -( )- is OFF in the previous scan and ON in the current scan. • Timer, counter → Current conduction only for one scan when the corresponding timer command or counter command is up. • Input relay → Current conduction only for one scan when the signal from the corresponding external device is turned OFF.	Output coil : O1 to O512 Input relay : I1 to I512 Internal coil : N1 to N1536 Timer relay : T1 to T256 Counter relay : C1 to C256 Link coil: D1 to D1024
Start-down Differential Contact	—⊣↓⊢— Reference No.	• Output coil, internal coil, link coil → Current conduction only for one scan when the corresponding coil -( )- is ON in the previous scan and OFF in the current scan • Timer, counter → Current conduction only for one scan when the corresponding timer command or counter command is up and reset. • Input relay → Current conduction only for one scan when the signal from the corresponding device is turned ON in the previous scan and OFF in the current scan.	Same as start-up differential contact

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5.2 COILS

There are several commands in coil : coil, latch coil, set coil and reset coil.

(1) Set coil and reset coil

(a) Symbol

—( )—
Reference No.
[Coil]

—(L)—
Reference No.
[Latch Coil]

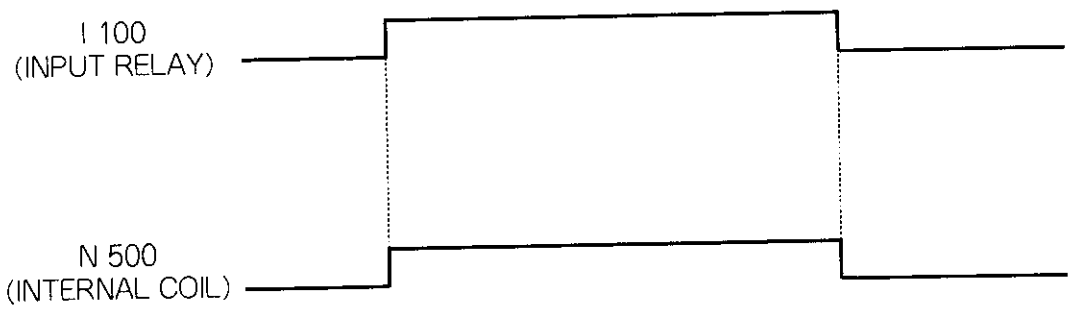
(b) Function

C o i l : ON when signal is input from the left of a coil. When the reference No. indicates output coil reference, the ON/OFF signal can be output externally via output module.
When the reference No. indicates an MC unit coil, the ON/OFf signal can be output to the MC (motion control).
When the reference No. indicates an internal coil or link coil, it is used for assembly of logic and the ON/OFF status cannot be output to any external device directly.

Latch coil : The functions are the same as those of the above-mentioned coil.
When latch coil is used, the ON/OFF status before a power loss can appear again at recovery from a power loss.
With normal coils, ladder decoding starts in the Off status when the power supply is turned ON.

(b) Typical Operation

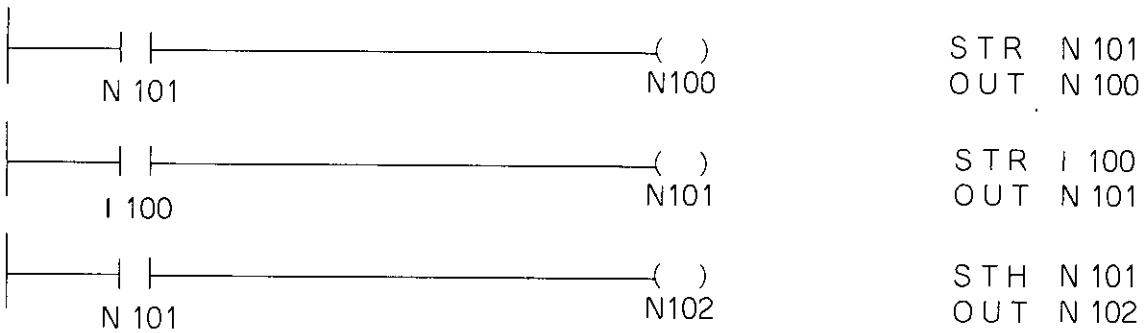


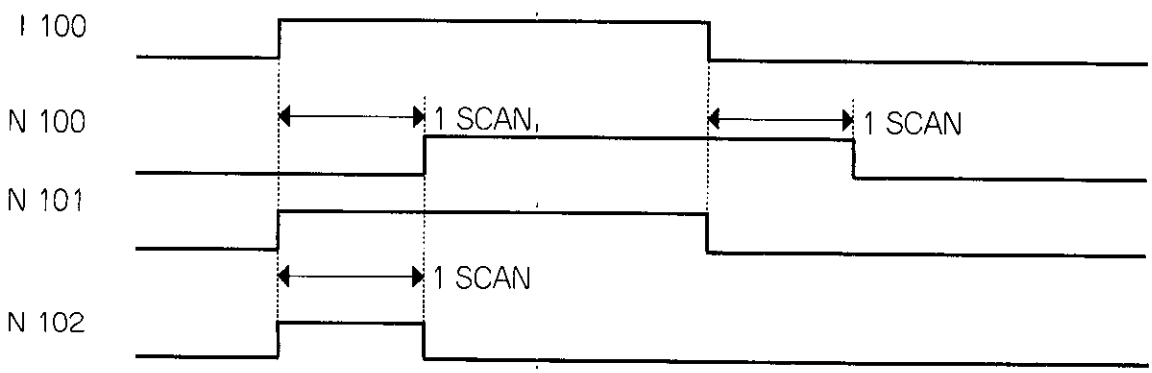


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Relation between Coil, Contact and Differential Contact

The coil status is determined when the coil is decoded. Additionally, at this time, the coil history is renewed. Therefore, when the status is changed from OFF to ON according to the resultant coil decoding, NO contact of the same reference No. as the coil No. is not in current conduction in the previous circuit to the coil even in the same scan, and NO contact enters current conduction in the latter circuit. NC contact has the reverse relation. Differential contact with the same reference No. as the coil No. is in current conduction for one scan from when the status is changed from OFF to ON (start-up differential) or ON to OFF (start-down differential) until the coil is decoded in the next scan.





When more than one circuit has the same coil No.

When more than one circuit has the same output coil No., the circuit outputs coil ON/OFF status to the output module. Also, with MC coils, the last MC unit coil status is output to the MC side.

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(2) Set coil, reset coil

(a) Symbol

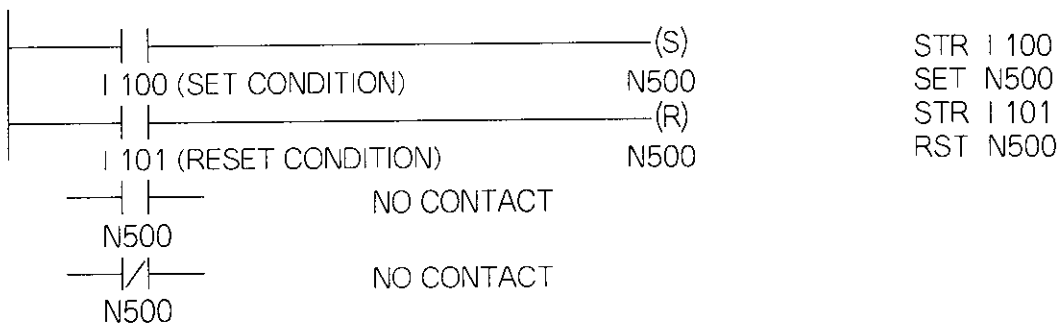


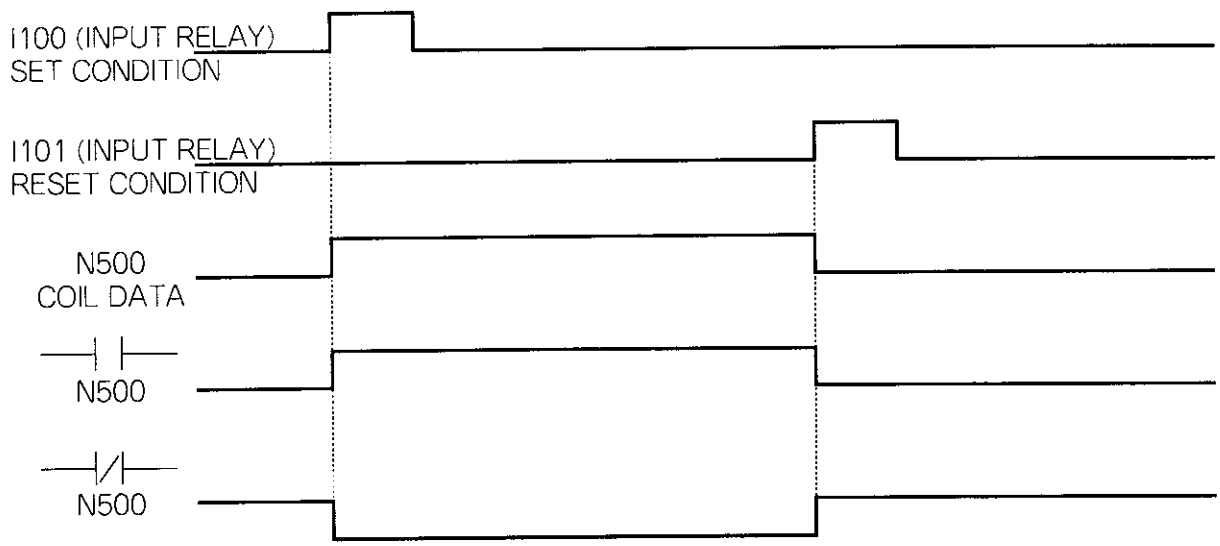
(b) Function

Set coil : When the input at the left side is turned OFF and then ON, the coil data specified by the reference No. are turned ON.

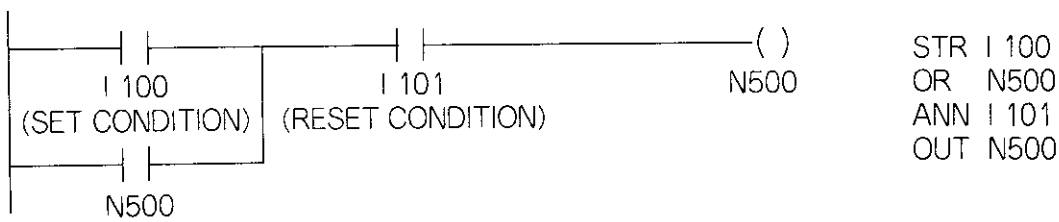
Reset coil : When the input at the left side is turned ON, the coil data specified by the reference No. are turned ON.

(c) Typical operation





The functions of set coil or reset coil are logically equivalent to those of the following ladder logic.

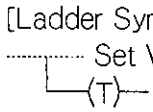


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(3) Timer set coil

(a) Symbol

[Ladder Symbol]



[Mnemonic]
TIM Set Value Reference No.

Table 5.2 100msec Timer and 10msec Timer

Item		100msec Timer	10msec Timer
Set Value	Direct designation	Constant 1 to 9999	
	Indirect designation	Data register : W1 to W2048, input register : Z1 to Z128, link register : R1 to R1024	
Reference		T1 to T128	T129 to T256
Time Measuring Range		0.1 to 999.9 sec	0.01 to 99.99 sec

(b) Function : When the time indicated by the set value elapses, the timer coil specified by the timer reference No. is turned ON.

Table 5.3 Timer Coil ON/OFF and Operation

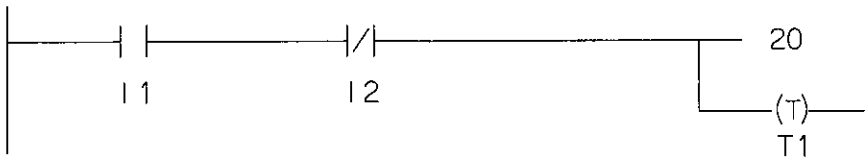
Input	Operation
ON	Timer measures the time. · At measured value < set value, time measurement is continued. The timer coil specified by the reference No. is turned OFF. · At measured value ≧ set value, the timer coil specified by the reference No. is turned ON by making measured value = set value. (Time elapsed status)
OFF	The time measured value is set to 0 and the timer coil specified by the reference No. is turned OFF.

Note: When the timer set coil commands of the same reference No. are used in more than one circuit, proper time may not be measured.

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(c) Typical operation

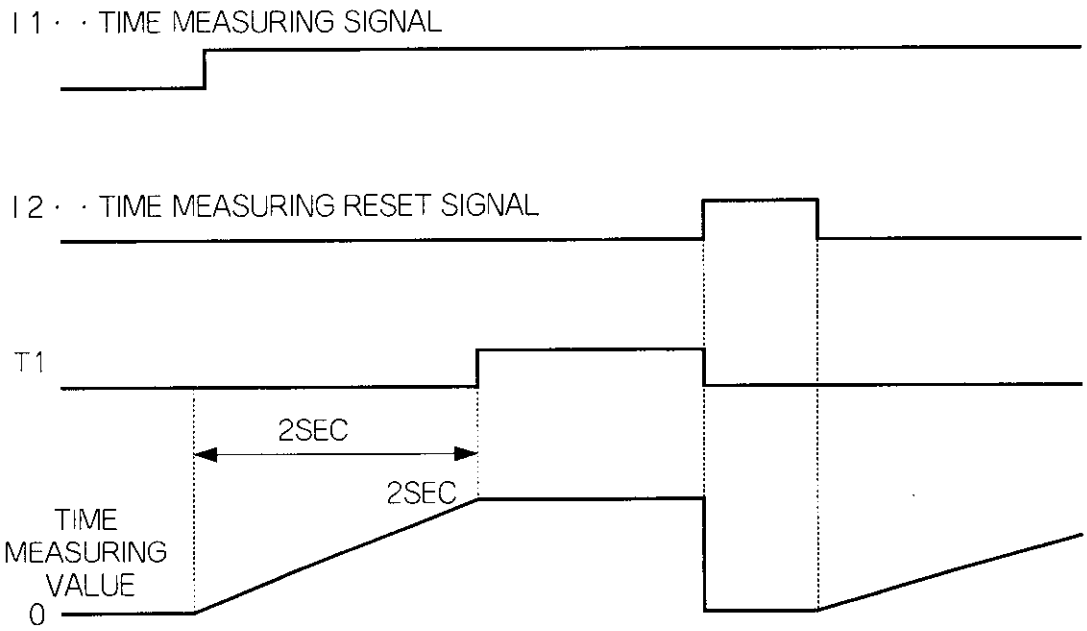
[Ladder Program]



[Mnemonic]

```
STR  I 1
ANN  I 2
TIM  20 T 1
```

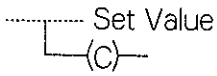
Time measuring time : 100ms×20=2000ms=2sec



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(4) Counter set coil

(a) Symbol



[Ladder Symbol]

CON Set Value Reference No.

[Mnemonic]

Table 5.4 Counter

Item	Counter	
Set Value	Direct designation	Constant 1 to 9999
	Indirect designation	Data register : W1 to W2048, input register : Z1 to Z128, link register : R1 to R1024
Reference	C1 to C256	
Counting Range	1 to 9999	

(b) Function : Counts the number of input ON/OFF times. Every time ON to OFF from counted value 0, 1 is added to the set value. The counter is reset by reset coil —(R)—.
Cxxx

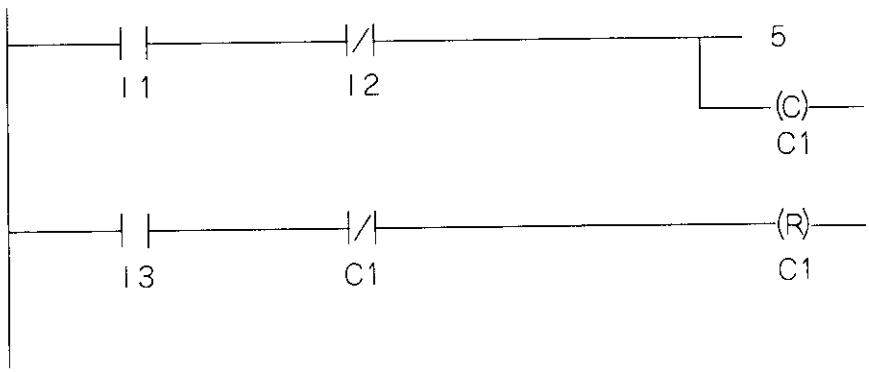
Table 5.5 Counter Coil ON/OFF and Operation

Input	Operation
OFF to ON	· 1 is added to counted value. (Addition counter) · At counted value ≧ set value, the counter coil specified by the reference No. is turned ON by making counted value = set value. · When the counter has not elapsed, the reference coil remains OFF.
ON to OFF Remains ON. Remains OFF.	· Counting is not performed and the current counted value is held. · When the counter has elapsed, the counter coil specified by the reference No. is turned ON. · When the counter has not elapsed, the counter coil specified by the reference No. is turned OFF.

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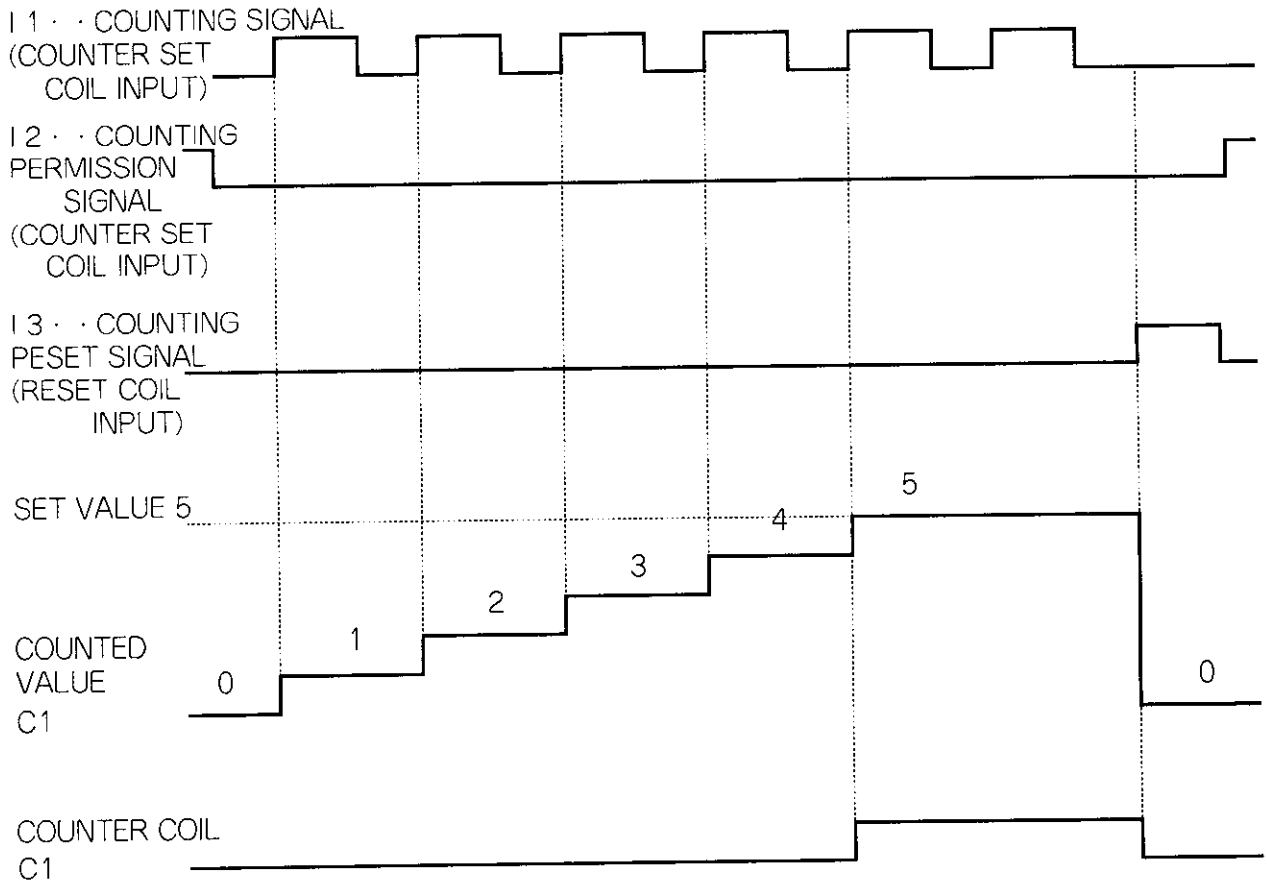
(c) Typical operation

[Ladder Program]



[Mnemonic]

```
STR  I 1
ANN  I 2
CON  5 C1
STR  I 3
AND  C1
RST  C1
```



Note : If counter set coil commands with the same reference No. are used in more than one circuit, counting many not be performed correctly.

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Table 5.6 List of Coil Commands

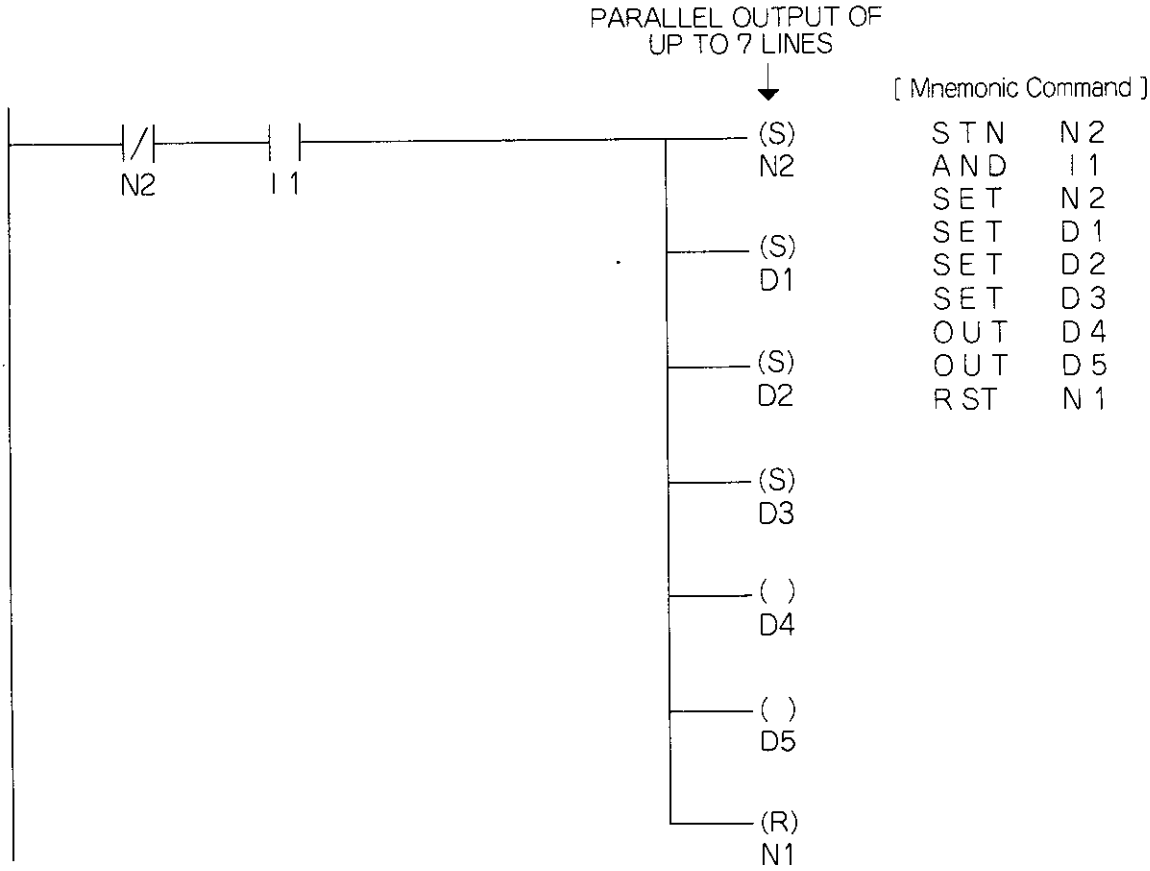
Name	Symbol	Meaning	Reference No. to be Used
Coil	—( )— Reference No.	When a signal is input from the left side, the coil data specified by the reference No. are turned ON. After the power supply is turned ON, the coil data decoding starts in the OFF status.	Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 PC link coil : D1 to D1024
Latch Coil	—(L)— Reference No.	When a signal is input from the left side, the coil data specified by the reference No. are turned ON. After the power supply is turned ON, decoding status is the same as before the power loss.	Same as coil
Set Coil	—(S)— Reference No.	When a signal is changed from OFF to ON from the left side, the coil data specified by the reference No. is turned OFF.	Same as coil
Reset Coil	—(R)— Reference No.	When a signal is changed from OFF to ON from the left side, the coil data specified by the reference No. is turned OFF.	Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 PC link coil : D1 to D1024 Timer coil : T1 to T256 Counter coil : C1 to C256
Timer Set Coil	Set Value —(T)— Reference No.	When a signal is changed from OFF to ON from the left side, the timer specified by the reference No. operates. When the operating time reaches the set value, the timer coil specified by the reference No. is turned ON. When a signal is turned OFF from the left side, the timer operation stops and the counted value is cleared to 0.	T001 to T128 : 100msec timer T129 to T256 : 10msec timer
Counter Set Coil	Set Value —(C)— Reference No.	When a signal is changed from OFF to ON from the left side, +1 is added to the counter specified by the reference No. When the counted value reaches the set value, the counter coil specified by the reference No. is turned ON. To reset the counter coil, the reset coil (—(R)—) is used.	C1 to C256 Note: When a counter set coil is used, addition counting operation is performed.

Note: A timer circuit can be created by using timer set coil and counter set coil. Additionally, the same circuit can be created by using the timer command and counter command described in Pars. 5.3 and 5.4, respectively. However, if timers or counters with the same number are used simultaneously, proper operation may not be possible.

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Coil Parallel Output

Coil commands can be output in parallel up to 7 lines. However, the timer set coil and counter set coil are each equivalent to output of 1 command in 2 lines.



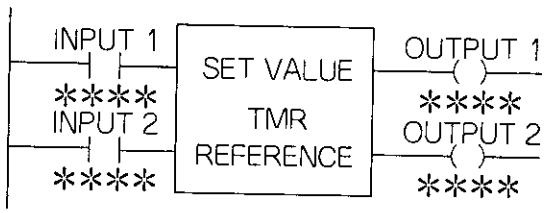
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5.3 TIMER

There are two types of timer commands; 100msec timer to measure the time every 100msec and 10msec timer every 10msec.

(1) Symbol

[Ladder Command]



[Mnemonic Command]

```
STR   ****
STR   ****
TMR   SET VALUE REFERENCE
OUT   ****
OUT   ****
```

Table 5.7 100msec Timer and 10msec Timer

Item		100msec Timer	10msec Timer
Set Value	Direct designation	Constant 1 to 9999	
	Indirect designation	Data register : W1 to W2048, input register : Z1 to Z128, link register : R1 to R1024.	
Reference		T1 to T128	T129 to T256
Time measuring Range		0.1 to 999.9 sec.	0.01 to 99.99 sec.

(2) Function : When the time indicated by the set value elapses, the timer coils specified by the timer reference No. is turned ON.

Table 5.8 Timer coil ON/OFF and Operation

Input 1	Input 2	Operation
ON	ON	• At measured value < set value, time measurement is continued. The timer coil specified by the reference No. is turned OFF. Output 2 is to be ON and output 1 is to be OFF. • At measured value ≧ set value, the timer coil specified by the reference No. is turned ON by making measured value = set value. (Time elapsed status) Output 1 is to be ON and output 2 is to be OFF.
OFF	ON	• Time is not measured and the current measured value is held. • When time measurement has elapsed, the timer coil specified by the reference No. is turned ON. Output 1 is to be ON and output 2 is to be OFF. • When time measurement has not elapsed, the timer coil specified by the reference No. is turned OFF. Output 1 is to be OFF and output 2 is to be ON.
*	OFF	• The time measured value is set to 0 and the timer coil specified by the reference No. is turned OFF.

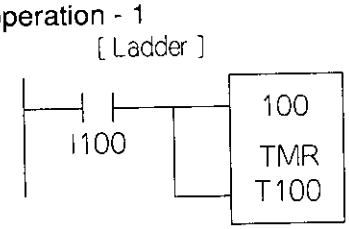
* : Indicates ON or OFF status (this is applied hereafter.)

Note: When input 2 command is omitted in mnemonic, input 1 and input 2 are to be directly connected. (See Typical Operation 1.)

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(3) Typical operation

(a) Typical operation - 1

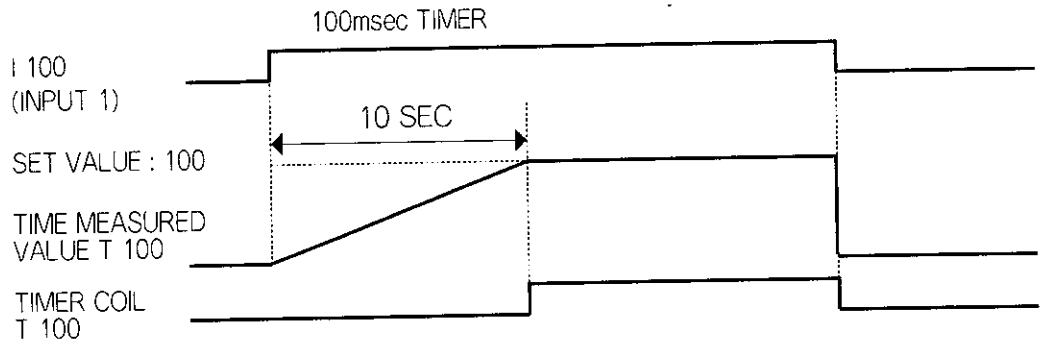


[Mnemonic]

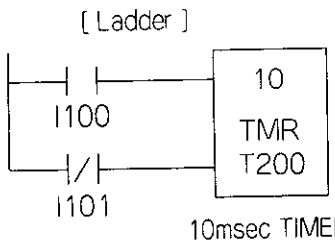
```
STR  I 100
TMR  100 T100
```

(INPUT 1)
(Set value 100, reference No. T 200)

Time measuring time : 100msec × 100 = 10000msec = 10sec



(b) Typical operation - 2

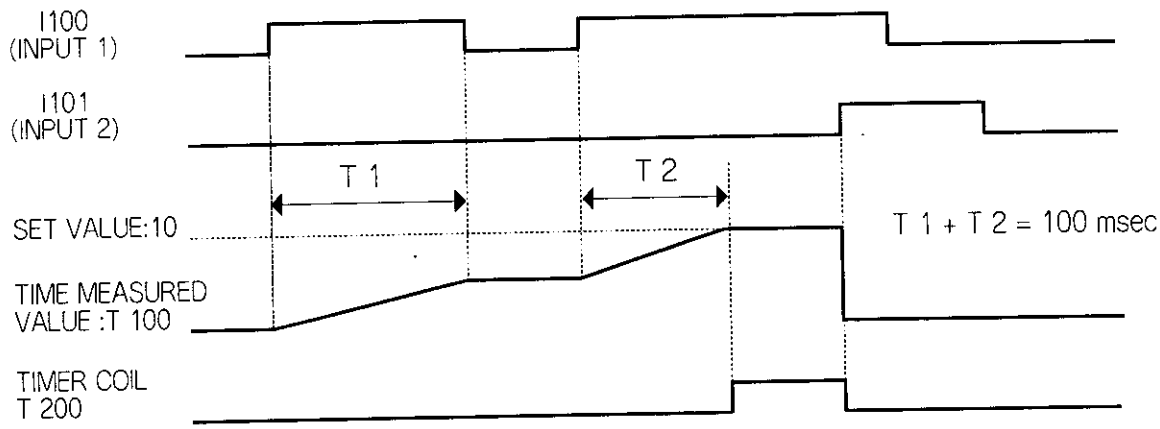


[Mnemonic]

```
STR  I 100
STN  I 101
TMR  10 T200
```

(INPUT 1)
(INPUT 2)
(Set value 10, reference No. T200)

Time measuring time : 10msec × 10 = 100msec



Timer Error

Since an error becomes larger when the timer set value is set to 1, do not use set value 1.
The timer operating time error is calculated by the following equation.

Maximum error value = minimum unit of setting time + 1 - scan time

For example, when the set value is to be 1 and 100msec timer is used, an error of 100msec (time has elapsed 100msec earlier) may occur. Therefore, in such a case, it is recommended to use 10msec timer.

Timer Measured Value

The timer measured value is stored in timer register Txxx. By specifying TRxxx by the programming panel online ladder (data display) function, Txxx measured value can be seen.

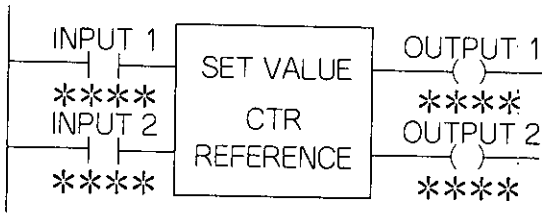
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5.4 COUNTER

There are two types of counter commands : addition counter and subtraction counter.

(1) Symbol

[Ladder Command]



[Mnemonic Command]

```
STR   ****
STR   ****
CTR   SET VALUE REFERENCE
OUT   ****
OUT   ****
```

Table 5.9 Addition Counter and Subtraction Counter

Item		Up Counter	Down Counter
Set Value	Direct designsation	Constant 1 to 9999	
	Indirect designation	Data register : W1 to W2048, input register : Z1 to Z128, link register : R1 to R1024.	
Reference		C 1 to C 128	C 129 to C256
Counting Range		1 to 9999	

(2) Function : The number of times input 1 ON to OFF is counted. +1 is added to the addition counter every time ON to OFF from counted value 0, up to the set value and -1 is subtracted from the subtraction counter down to 0.

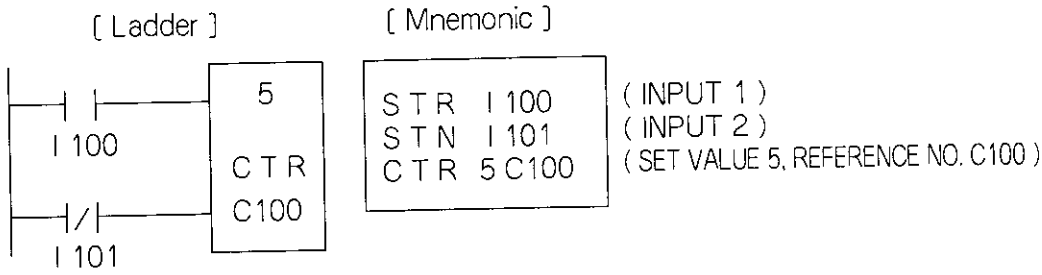
Table 5.10 Counter ON/OFF and Operation

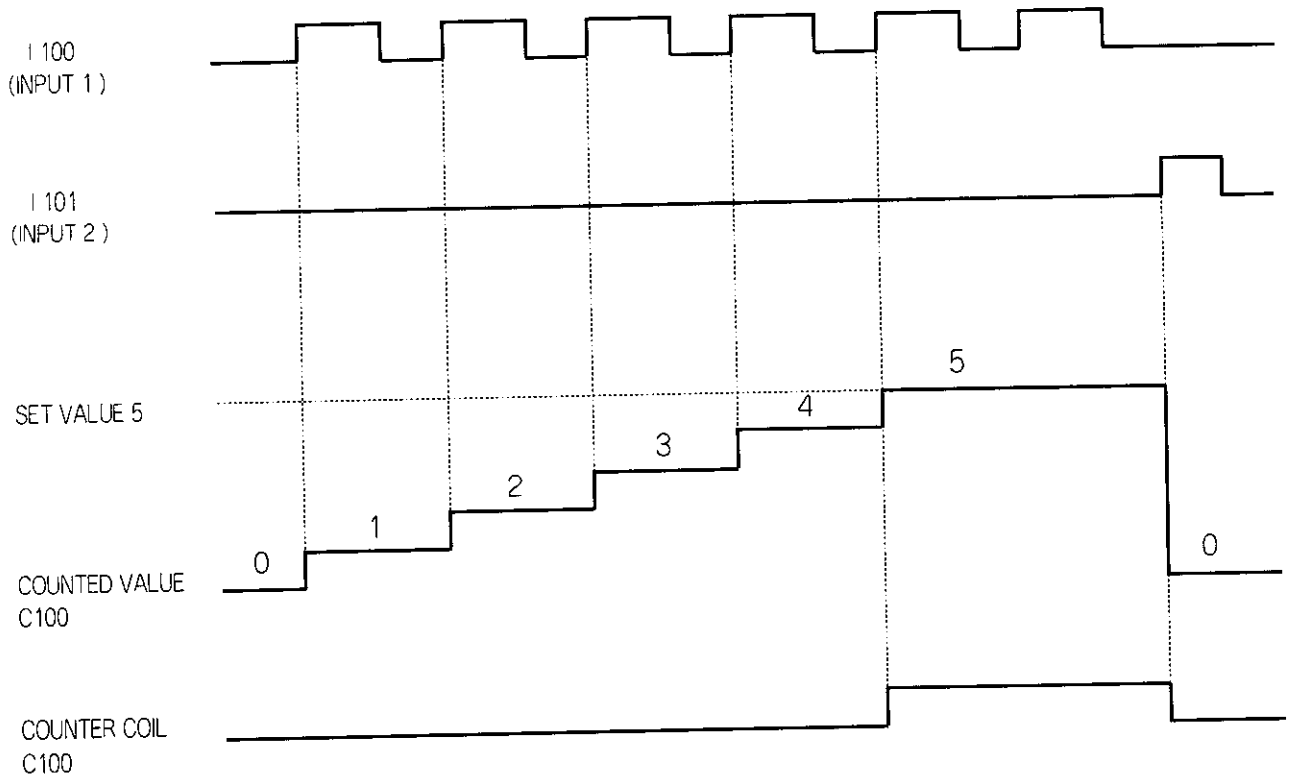
Input 1	Input 2	Operation
OFF to ON	ON	• +1 is added to the counted value (addition counter). -1 is subtracted from the counted value (subtraction counter). • At counted value ≧set value, the counter coil specified by the reference No. is turned ON by making counted value = set value (addition counter) and output 1 is turned ON and output 2 is OFF. • At counted value = 0, the counter coil specified by the reference No. is turned ON (subtraction counter) and output 1 is turned OFF and output 2 is turned ON. • When the counter has not elapsed, the reference coil remains OFF. Output 1 is turned OFF and output 2 is turned ON.
ON to OFF Either remains ON or OFF	ON	• Counting is not performed and the current counted value is held. • Whenthe counter has elapsed, the counter coil specified by the reference No. is turned ON. Output 1 is turned ON and output 2 is OFF. • When the counter has not elapsed, the counter coil specified by the reference No. is turned OFF. Output 1 is turned OFF and output 2 is ON.
*	OFF	• Set the counted value to 0 (addition counter). • Set the counted value to the set value (subtraction counter). • The counter coils pecified by the reference No. is turned OFF. • Output 1 is turned OFF and output 2 is ON.

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(3) Typical operation (addition counter)

I 100 : Counting signal
I 101 : Reset input (off reset)





Note :If the timer or counter commands with the same reference No. are used in more than one circuit, proper time measurement or counting may not be possible.

Counter Counted Value

The counter counted value is stored in counter register Cxxx. Additionally, by specifying CRxxx by the programming panel online ladder (data display) function, Cxxx counted value can be seen.

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(4) Typical timer or counter circuit program

The following shows a typical circuit to measure the PLC scan time.

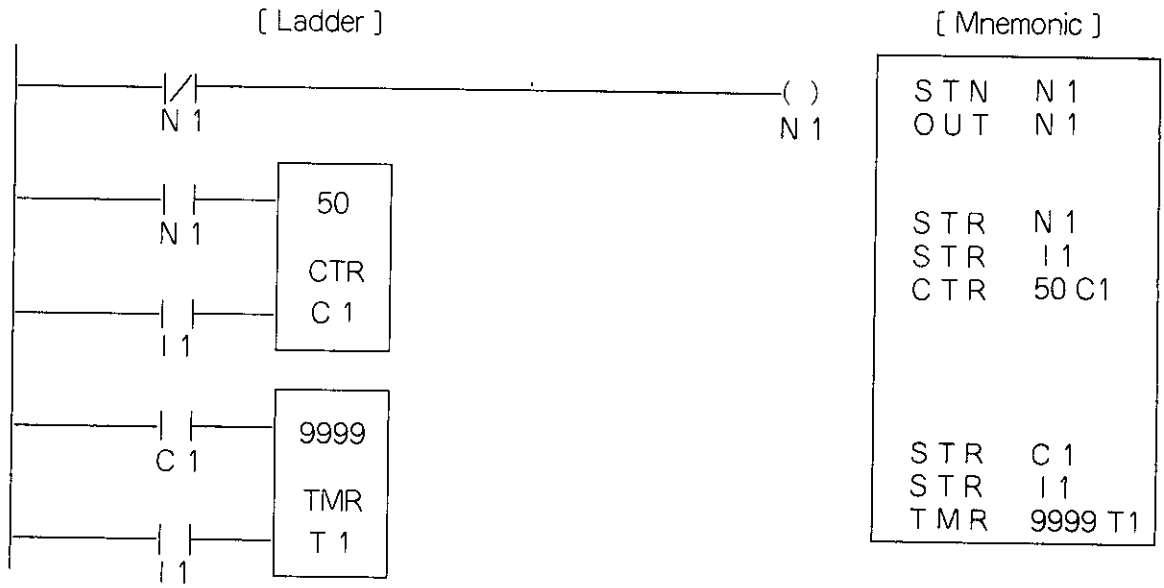


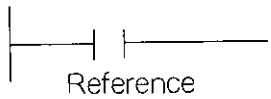
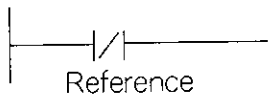
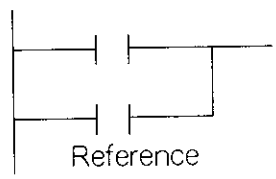
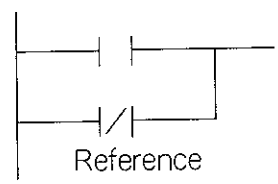
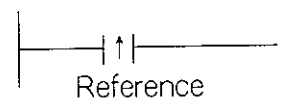
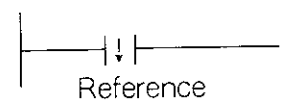
Fig. 5. 1 Typical Timer/Counter Circuit Program

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The following table describes the basic sequence commands in mnemonic language.
For details of the timer and counter, refer to Pars.5.3 and 5.4, respectively.

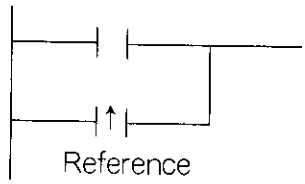
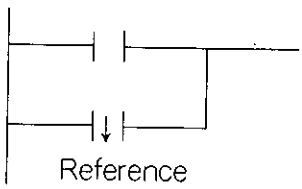
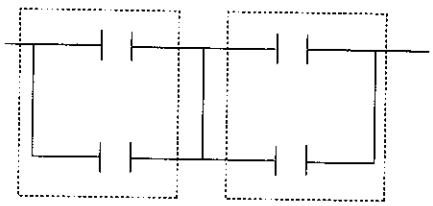
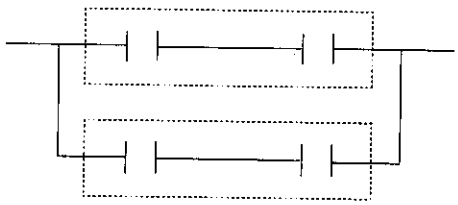
6.1 RELAY

Table 6.1 Basic Sequence Command (Relay)

Command	Equivalent Ladder Circuit	Reference to be Used
STR Reference (STORE)		Output coil : O1 to O512 Internal coil : N1 to N1536 Input relay : I1 to I512 Timer relay : T1 to T256 Counter relay : C1 to C256 MC unit coil : Y1 to Y512 MC unit relay : X1 to X512 MC control coil : Q1 to Q256 MC control relay : P1 to P256 M-code relay : MUXX Stepping relay : Syyxx Link relay: D1 to D1024
STN Reference (STORE NOT)		
AND Reference (AND)		
ANN Reference (AND NOT)		
OR Reference (OR)		
ORN Reference (OR NOT)		
STH Reference (STORE HIGH)		Output coil : O1 to O512 Internal coil : N1 to N1536 Input relay : I1 to I512 Timer relay : T1 to T256 Counter relay : C1 to C256 Link relay: D1 to D1024
STL Reference (STORE LOW)		
AND Reference (AND HIGH)		

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Table 6.1 Basic Sequence Command (Relay) (Cont'd)

Command	Equivalent Ladder Circuit	Reference to be Used
ANL Reference (AND LOW)		Output coil : O 1 to O 512 Internal coil : N 1 to N 1536 Input relay : I 1 to I 512 Timer relay : T 1 to T 256 Counter relay : C 1 to C 256 Link relay : D 1 to D 1024
ORH Reference (OR HIGH)		
ORL Reference (OR LOW)		
ANB (AND BLOCK)		No reference
ONB (OR BLOCK)		No reference

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6.2 COILS

Table 6.2 Basic Sequence Command (Coil)

Command	Equivalent Ladder Circuit	Reference to be Used
OUT Reference (OUT)	——————( )—— Reference	Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 Link coil : D1 to D1024
LTC Reference (LATCH)	——————(L)—— Reference	
SET Reference (SET)	——————(S)—— Reference	
RST Reference (RESET)	RST Reference (RESET)	Output coil : O1 to O512 Internal coil : N1 to N1536 MC unit coil : Y1 to Y512 MC control coil : Q1 to Q256 Link coil : D1 to D1024 Timer coil : T1 to T256 Counter coil : C1 to C256
TIM Set Value Txxx	TIM Set Value Txxx	Timer set coil : T1 to T256 T1 to T128 : 100msec timer T129 to T256 : 1sec timer
CON Set Value Cxxx	CON Set Value Cxxx	Counter set coil : C1 to C256

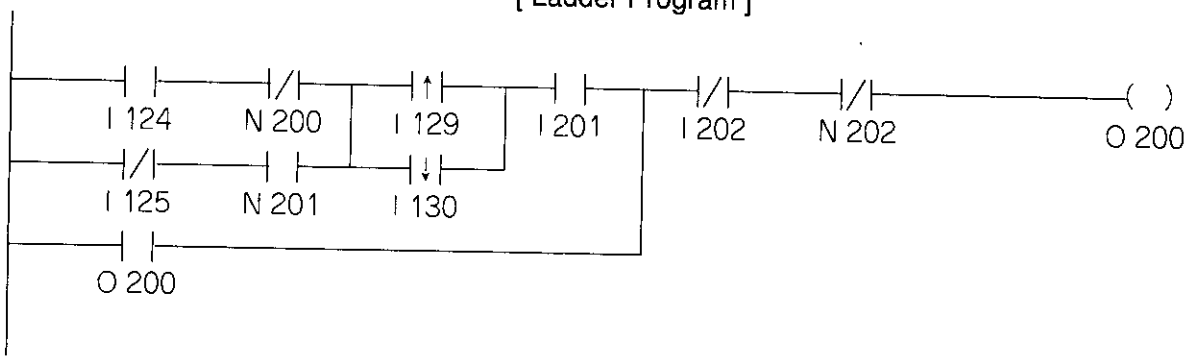
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6.3 TYPICAL BASIC SEQUENCE PROGRAM

The following shows an example of basic sequence program ladder and the equivalent mnemonic.

(Example 1)

[Ladder Program]



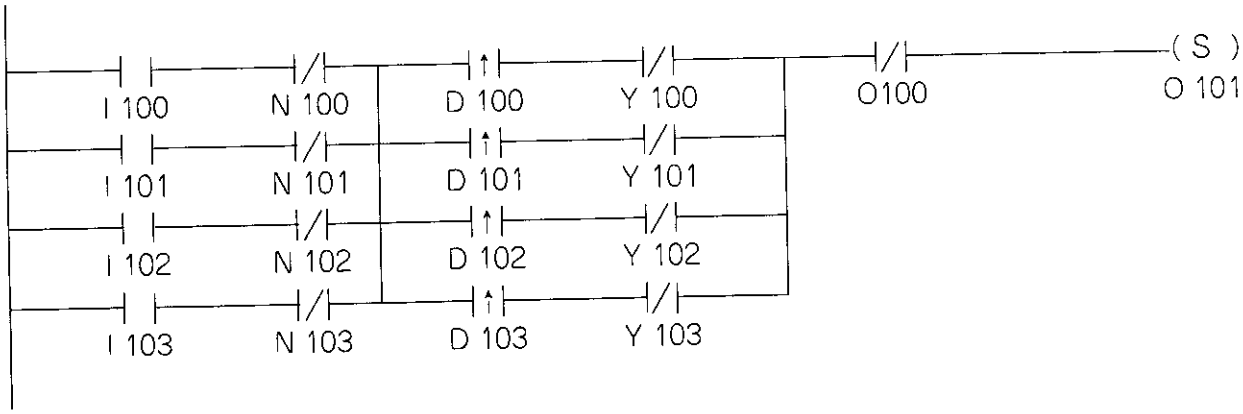
[Mnemonic Program]

```
STR   I 124
ANN   N200
STN   I 125
AND   N201
ORB
STH   I 129
ORL   I 130
ANB
ANN   I 201
OR    O200
ANN   I 202
ANN   N202
OUT   O200
```


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(Example 2)

[Ladder Program]



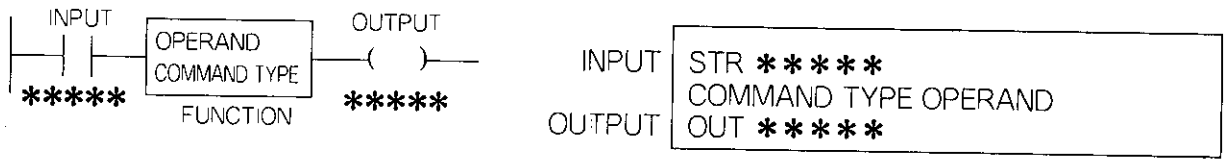
[Mnemonic Program]

```
STR     I 100
ANN     N100
STR     I 101
ANN     N101
ORB
STR     I 102
ANN     N102
ORB
STR     I 103
ANN     N103
ORB
STH     D100
ANN     Y100
STH     D101
ANN     Y101
ORB
STH     D102
ANN     Y102
ORB
STH     D103
ANN     Y103
ORB
ANB
ANN     O100
SET     O101
```

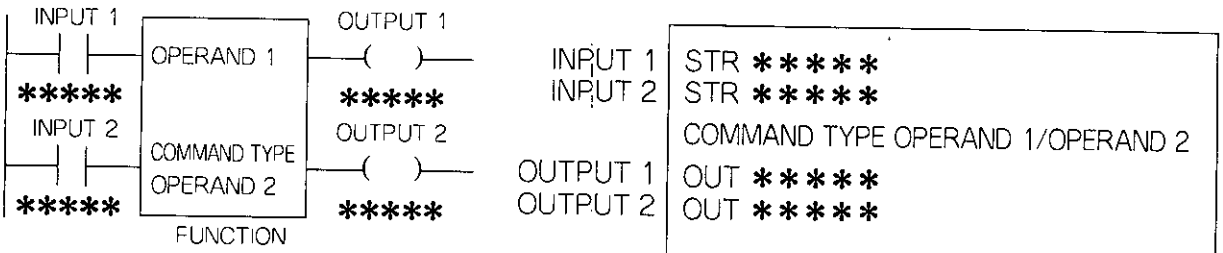
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There are three types of applied commands (functions), considering the notation: 1 - input / 1 - output type (to be called 1-element command hereafter), 2 - input / 2 - output type (2 - element command) and 3 - input / 3 - output type (3 - element command).

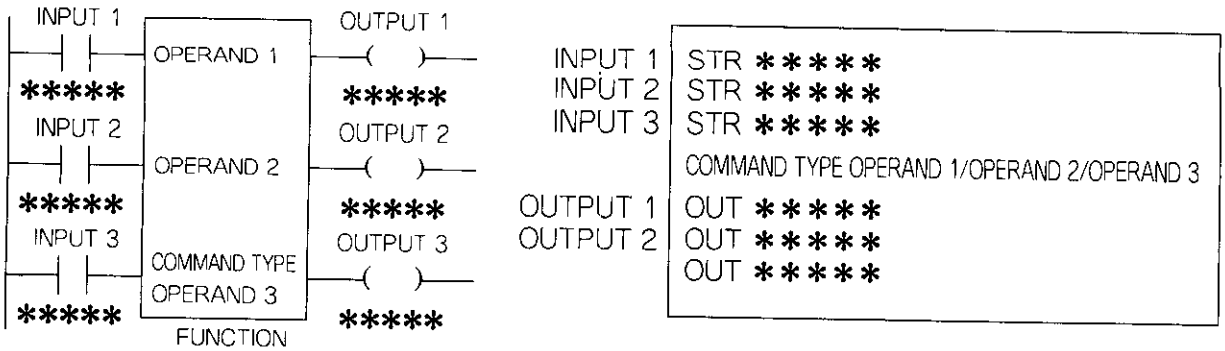
Inputs are used as calculation control inputs to determine whether the applied command is executed.
Outputs are used to reflect the resultant calculation execution (such as completion of calculation, calculation error, etc.) on coils.
Figs. 7.1 and 7.2 shows each element command notation.



(a) 1-element command



(b) 2-element command

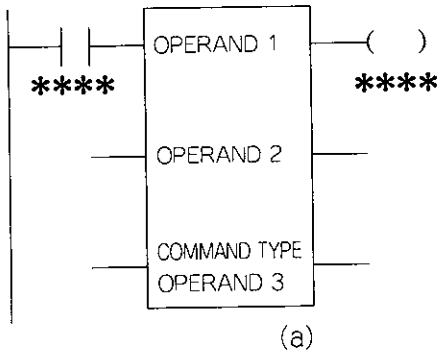


(c) 3-element command

Notes:
1. ***** shows reference Nos. to reflect each input condition or resultant output.
2. [ ] indicates the corresponding mnemonic expression.

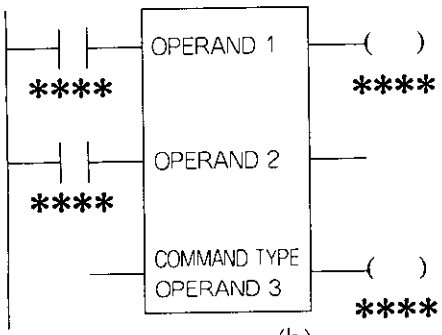
Fig. 7.1 Element Command Notations

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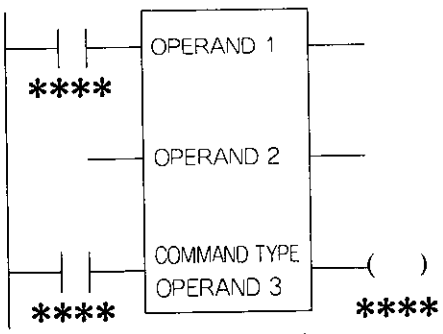
(a)

```
STR  ****
COMMAND TYPE OPERAND 1/OPERAND 2/OPERAND 3
OUT  ****
```



(b)

```
STR  ****
STR  ****
COMMAND TYPE OPERAND 1/OPERAND 2/OPERAND 3
OUT  ****
NOP
OUT  ****
```



(c)

```
STR  ****
NOP
STR  ****
COMMAND TYPE OPERAND 1/OPERAND 2/OPERAND 3
NOP
NOP
OUT  ****
```

Notes:
1. * * * * * shows reference Nos. to reflect each input condition or resultant output.
2. [ ] indicates the corresponding mnemonic expression.
3. When a space is provided between inputs or outputs, NOP is used in mnemonic.

Fig. 7.2 Element Command Notations
(When unused inputs or outputs are omitted)

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7.1 CONFIGURATION OF APPLIED COMMAND CIRCUIT BLOCK

The following describes each element to compose an applied command circuit block.

7.1.1 Input Command and Output Command

(1) Input command

For the input command, the basic sequence commands (NO contact, NC contact and differential commands, excluding coils) are used. The input command is used for the function calculation control (calculation,reference, calculation mode, etc.). The following shows an example of input command.

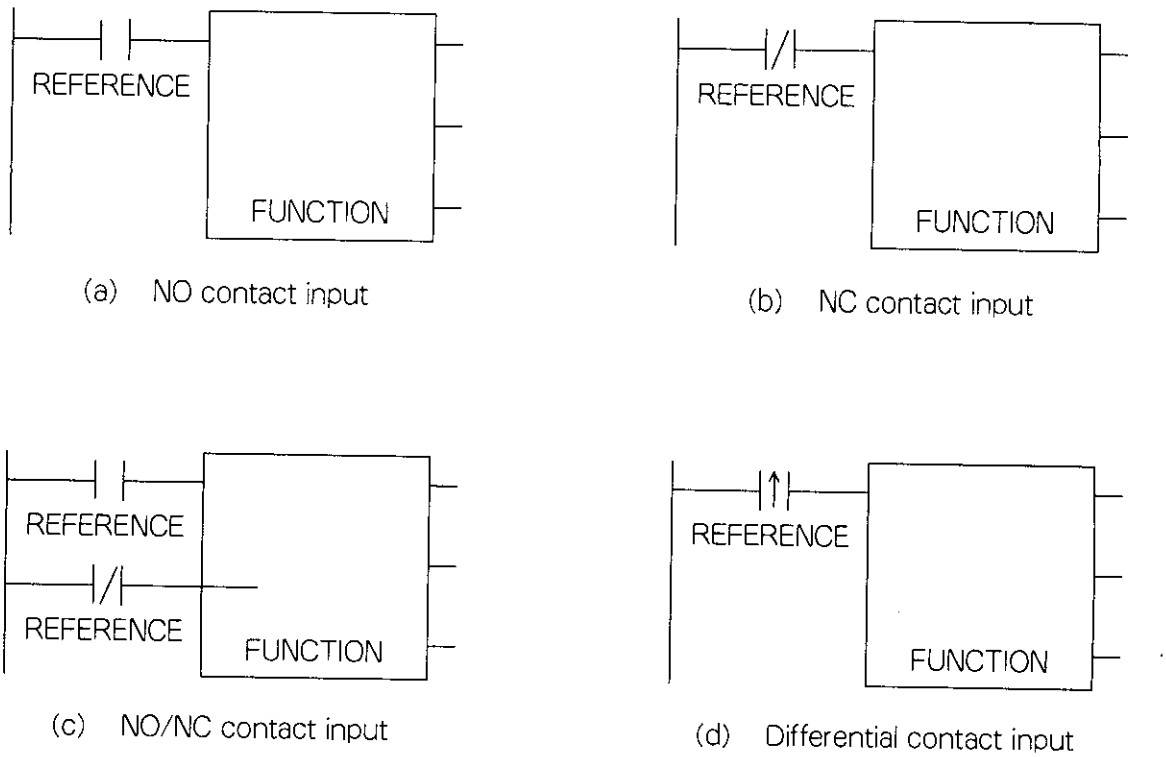


Fig. 7.3 Input Command

(1) Output command

For the output command, the coil commands one of the basic sequence commands. These coils can be used as calculation flags according to each function calculation content. The following shows an example of output command.

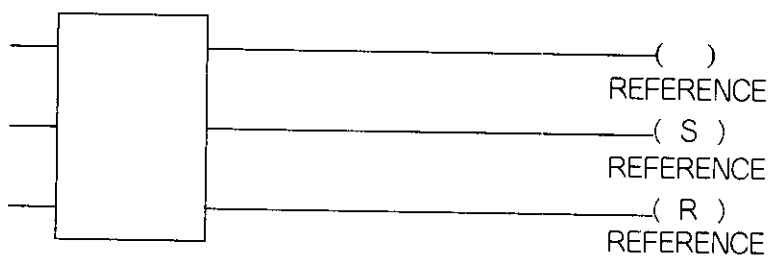


Fig. 7.4 Output Command

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7.1.2 Function

(1) Command type

Command types indicate the function calculation functions.
Table 7.1 shows the list of commands.

Table 7.1 List of Commands

Name of Command	Number of Command Elements	Command Symbol	Function
Addition	3	ADD	Addition in 4 - digit decimal
Subtraction	3	SUB	Subtraction in 4 - digit decimal
Multiplication	3	MUL	Multiplication in 4 - digit decimal
Division	3	DIV	Division in 4 - digit decimal
Double - length addition	3	DAD	Addition in 8 - digit decimal
Double - length subtraction	3	DSB	Subtraction in 8 - digit decimal
Double - length multiplication	3	DML	Multiplication in 8 - digit decimal
Double - length division	3	DDV	Division in 8 - digit decimal
Square root	2	SQR	Square root in 4 - digit decimal
Double - length square root	2	DSQ	Square root in 8 - digit decimal
Register-to-table transfer	3	RTT	Transfers register data to register table.
Table-to-register transfer	3	TTR	Transfers register table data to register.
Table-to-table transfer	3	TTT	Transfers register table data to register table.
Block transfer	3	BLK	Transfers all data simultaneously.
First - in	3	FIN	Stores data items to the register table in order of arrival.
First - out	3	FOT	Outputs data items to the register table in order of arrival.
Table set	3	TST	
AND table	3	ANT	Data and data AND
OR table	3	ORT	Data and data OR
Exclusive OR	3	XOR	Data and data XOR
Comparison	3	CPR	Comparison of data in units of bits
Reverse	3	CMP	Data bit reversed (1 to 0; 0 to 1)
Search	3	SRC	Searches specified data from register table.
Bit sensing	3	SEN	Checks special bit 1 or 0.
Modify bit	3	MBT	Sets special bit 1 or 0.
Multi - rotate	3	MRT	Rotates register table data.
BCD to BIN	3	BIN	Converts BCD data to BIN data.
BIN to BCD	3	BCD	Converts BIN data to BCD data.
Sine (SIN)	2	SIN	Triangle functional operation command (sine)
Cosine (COS)	2	COS	Triangle functional operation command (cosine)
Status read	2	STT	Reads out each piece of PLC section error status data
Skip	1	SKP	Program skip command
Subroutine	1	GSB	Subroutine read - out command
Pulse	1	PLS	Pulse output command
Coil clear	2	CLR	Coil OFF command

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Table 7.1 List of Commands (Cont' d)

Name of Command	Number of Command Elements	Command Symbol	Function
Program operation	3	MVL	For details, refer to Par. 8 , " MOTION COMMAND ".
Single - block mode	3	SMD	
Independent A - axis operation	3	MVA	
Independent B - axis operation	3	MVB	
Zero - point return operation	3	ZRN	
Jog operation	3	JOG	
Monitor	3	MON	
Current position setting	3	POS	
Parameter setting	3	PRM	
Variable setting	3	VAR	
Alarm reset	3	ARS	
Servo ON	3	SVN	
Mode set	3	MOD	
Reset	3	MRS	

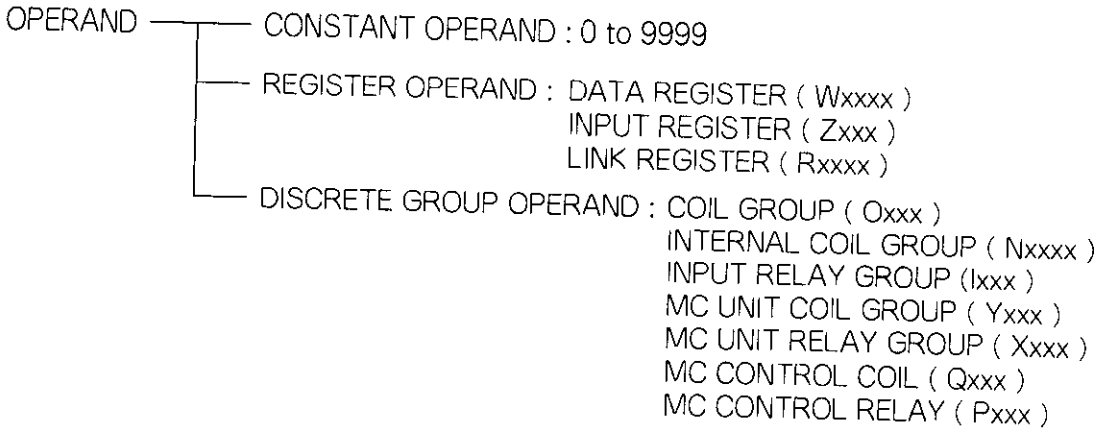
7.1.2 Operand

Operand specifies the data required for caluculation.

For example, those indicators of caluculated values, caluculating values and resultant caluculation in four types of caluculation become an operand. In data transfer commands, an operand indicates the source, destination and number of transfer data items. There are three types of operands: constant operand indicating constants, register operand indicating register references such as input registers or data registers and discrete group operands specifying coils or input relays in group units.

Constant operands are called "direct designation" since they directly specify the values required for calculation.

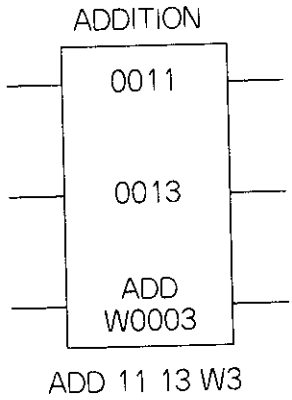
On the other hand, register operands and discrete operands are called "indirect designation" since they specify the data indirectly.



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(1) Constant operand

Constants (4 - digit decimals) among commands are used directly as operands.
In the following example of addition command, constants 11 and 13 will be constant operands.

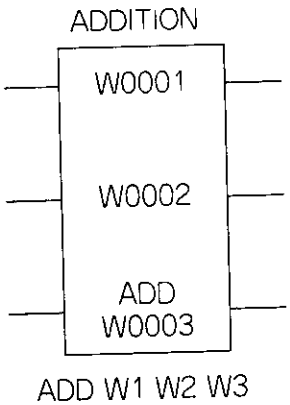


11
+
13
↓
W0003 : 24 RESULTANT ADDITION IS INPUT TO DATA REGISTER W0003

(2) Register operand

A register having 16 - bit word length. With a register operand, when register No. is used in the function, the data to be stored in the register specified by the register No. are to be specified.

For example, the following example of a function shows addition command; the calculation function indicates that register W0001 contents and register W0002 are added and the result is stored in W0003.



REGISTER CONTENTS

W001 : 203
+
W002 : 117
↓
W003 : 320

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(3) Discrete group operand

ON / OFF data discrete group references (Qxxxx, Ixxxx, Nxxxx, Yxxx, Xxxx, Qxxx, Pxxx, Mxxx, Dxxx) are stored in the memory in units of 16 points (bits). The data items are stored in the order from the smallest reference No. from the uppermost bit. The following example shows output coil Oxxx ON / OFF data arrangement.

Discrete group operand is a method to specify data for 16 points by using the reference No. at the uppermost bit position. The block transfer command in Fig. 7.5 indicates that ON / OFF data for 32 points of output coils 017 to 048 to data registers W0001 and W0002.

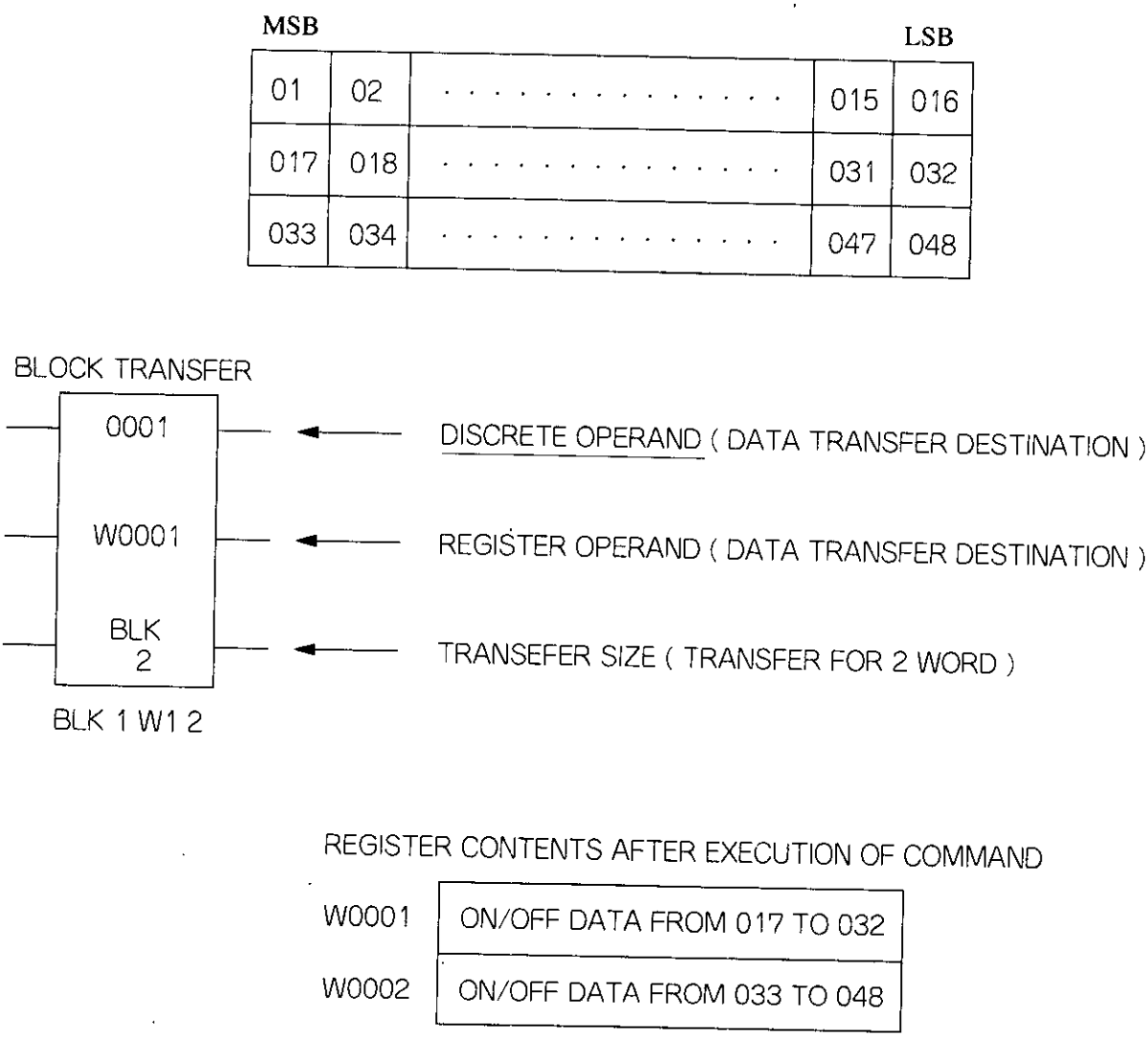


Fig 7.5 Block Transfer Command

Discrete operand is effective for simultaneous processing of ON / OFF data.

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7.2 FOUR TYPES OF CALCULATION COMMANDS

There are four types of calculation commands: addition(+), subtraction(−), multiplication(×), and division(÷).

7.2.1 Addition (ADD)

(1) Command symbol

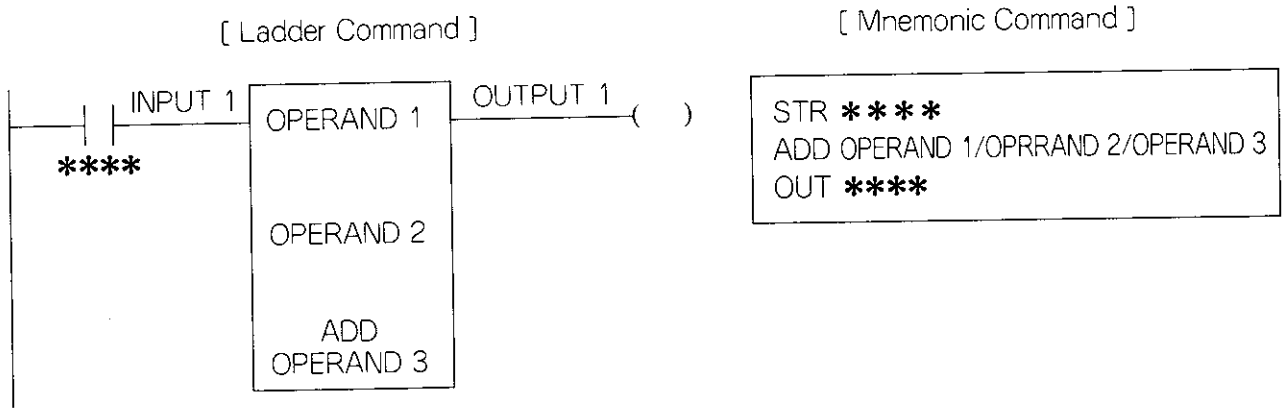


Fig 7.6 Command Symbols

(2) Calculating function

When input 1 is turned ON by the addition command, the following addition (range 0 to 9999) is executed.
Inputs 2 and 3 are not used.
Output 1 is turned ON when the addition resultant exceeds 9999.
Outputs 2 and 3 are not used.

(Operand 1) + (Operand 2) = (Operand 3)

(3) Operand

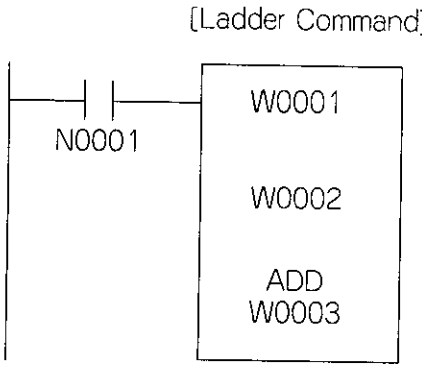
Table 7.2 Operands

Operand 1, Operand 2	Constant : 0 to 9999 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Data register : W1 to W2048 Link register : R1 to R1024

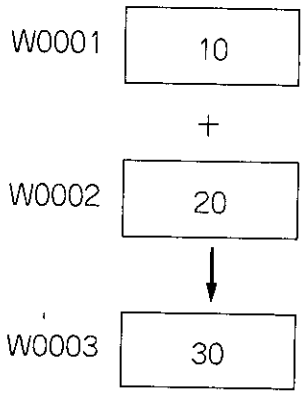
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(3) Typical calculation

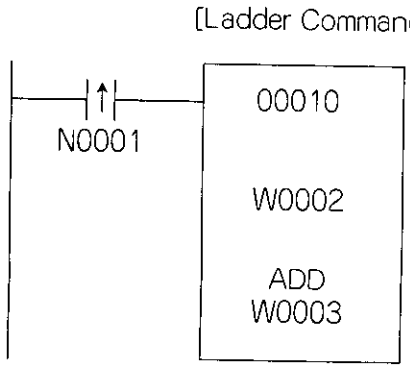
[Example 1] Addition of registers



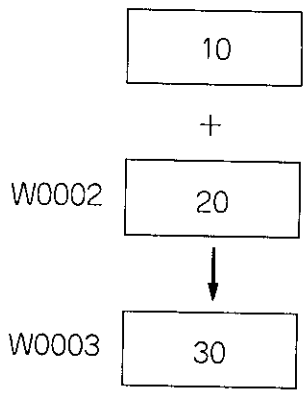
When N0001 is turned ON, the contents of register W001 and register W0002 are added and the result is stored in W0003



[Example 2] Addition of register and constant



When N0001 is turned OFF and then ON, the contents of constant 10 and register W0002 are added and the result is stored in W0003



Note : When the added value exceeds 9999, the value obtained by subtracting 10000 from the resultant addition is stored as the resultant addition. In example 1, assuming that W0001 is 9000 and W0002 is 1001, the resultant calculation is 1 and output 1 is turend ON.

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7.2.2 Subtraction (SUB)

(1) Command symbol

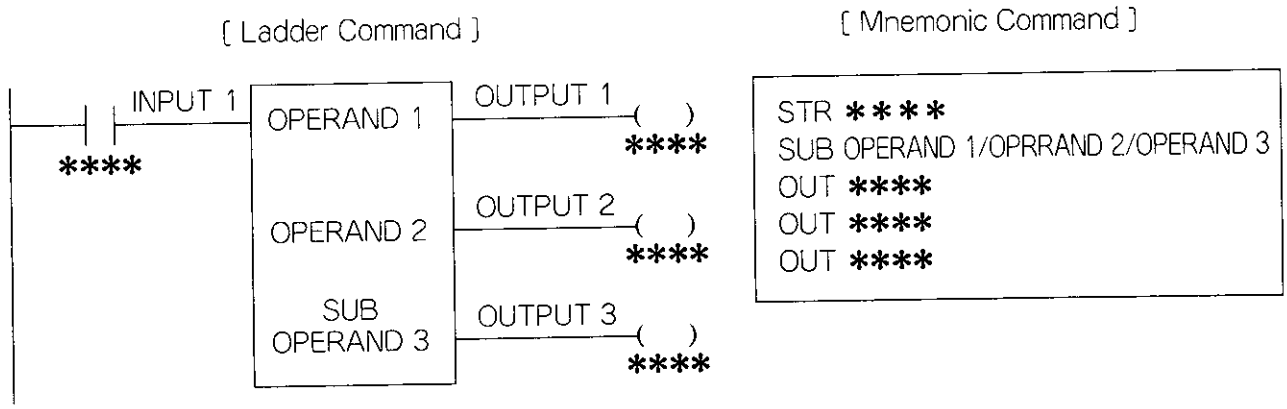


Fig 7.7 Command Symbols

(2) Calculating function

When input 1 is turned ON by the subtraction command, the following subtraction is executed.
Inputs 2 and 3 are not used.
Output 1 is turned ON when the resultant subtraction is plus (> 0).
Output 2 is turned ON when the resultant subtraction is zero (= 0).
Output 3 is turned ON when the resultant subtraction is minus (< 0).
When input 1 is turned ON ;

(Operand 1) + (Operand 2) = (Operand 3)

※ When the resultant subtraction is minus, the absolute value becomes the result.

(3) Operand

Table 7.3 Operand

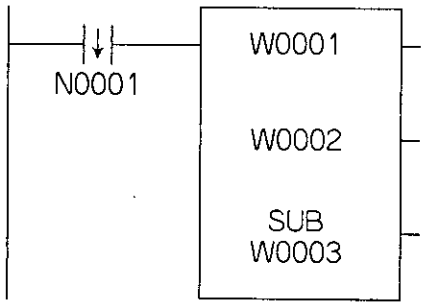
Operand 1, Operand 2	Constant : 0 to 9999 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Data register : W1 to W2048 Link register : R1 to R1024

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(4) Typical calculation

[Example 1] Subtraction of registers

[Ladder Command] [Mnemonic Command]



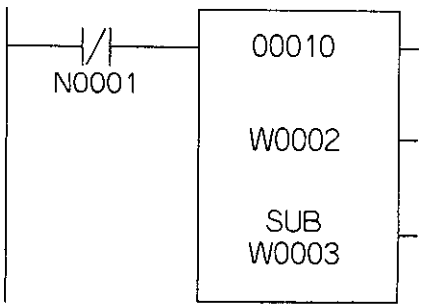

```
STL N1
SUB W1 W2 W3
```

When N0001 is turned ON and then OFF, the contents of register W0002 are subtracted from the contents of register W0001 and the result is stored in W0003.

Input 1	W0001	W0002	Output1	Output2	Output3	W0003
ON	30	10	ON	OFF	OFF	20
ON	30	30	OFF	ON	OFF	0
ON	10	30	OFF	OFF	ON	20

[Example 2] Subtraction of registers and constants

[Ladder Command] [Mnemonic Command]




```
STL N1
SUB 10 W2 W3
```

When N0001 is turned ON and then OFF, the contents of register W0002 are subtracted from the contents of constant 10 and the result is stored in W0003.

Input 1	W0002	Output1	Output2	Output3	W0003
OFF	5	ON	OFF	OFF	5
OFF	10	OFF	ON	OFF	0
ON	30	OFF	OFF	ON	20

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7.2.3 Multiplication (MUL)

(1) Command symbol

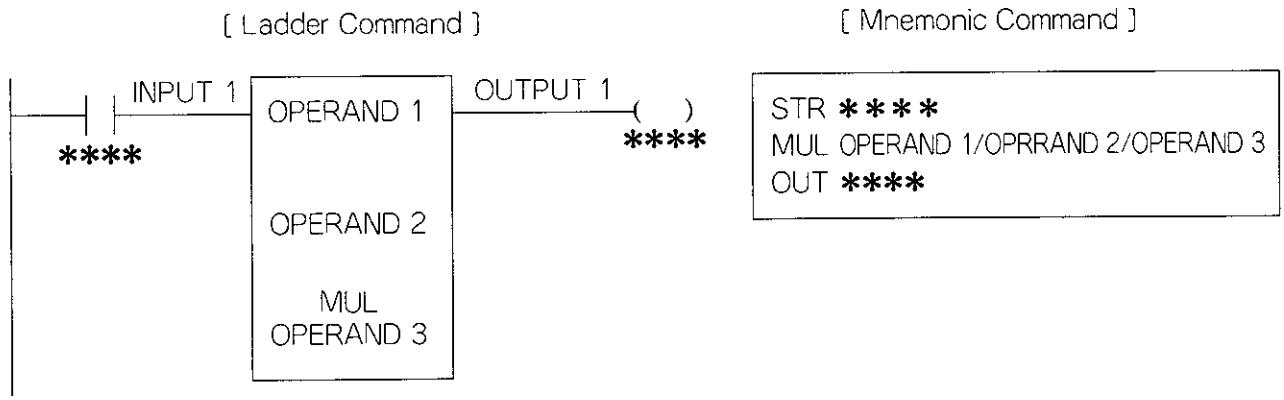


Fig 7.8 Command Symbol

(2) Calculating function

When input 1 is turned ON by the multiplication command, the following multiplication is executed.
Inputs 1 and 2 are not used.
Output 1 is turned ON when input is turned ON.
Outputs 2 and 3 are not turned ON.

(Operand 1) × (operand 2) = (operand 3), (operand 3 + 1)

The lower 4 digits of the resultant multiplication are stored in (operand 3 + 1).
The upper 4 digits of the resultant multiplication are stored in (operand 3).

(3) Operand

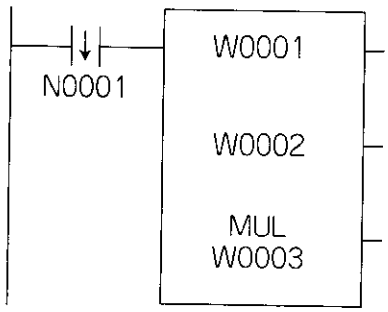
Table 7.4 Operand

Operand 1, Operand 2	Constant : 0 to 9999 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Data register : W1 to W2047 Link register : R1 to R1023

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(4) Typical calculation

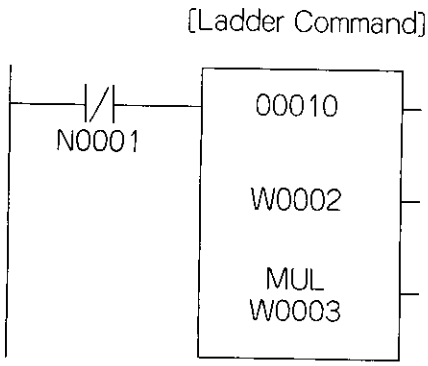
[Example 1] Multiplication of registers



When N0001 is turned ON, the contents of register W0010 are multiplied by the contents of register W0020 and the result is stored in W0101.

Input 1	W0010	W0020	Output 1	Output 2	Output 3	W0100	W0101
ON	10	25	ON	OFF	OFF	0	250
ON	100	25	ON	OFF	OFF	0	2500
ON	1000	25	ON	OFF	OFF	2	5000

[Example 2] Multiplication of registers and constants



When N0001 is turned OFF, the contents of constant 10 are multiplied by the contents of register W0020 and the result is stored in W0100.

Input 1	W0020	Output 1	Output 2	Output 3	W0100	W0101
ON	25	ON	OFF	OFF	0	250
ON	250	ON	OFF	OFF	0	2500
ON	2500	ON	OFF	OFF	2	5000

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7.2.4 Division (DIV)

(1) Command symbol

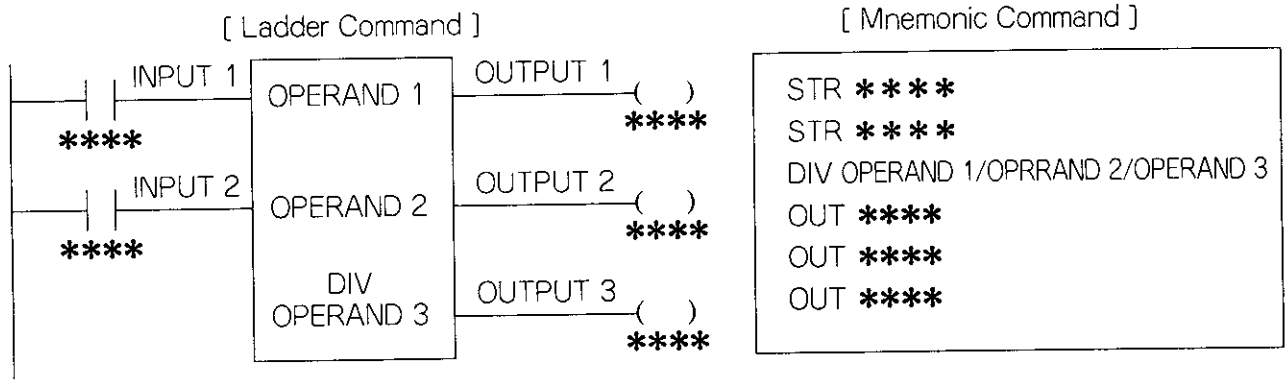


Fig 7.9 Command Symbols

(2) Calculating function

When input 1 is turned ON by the division command, the following division is executed.

Input 2 specifies whether the resultant division is obtained in the form of " quotiend and remainder " or "quotient and decimal quotient ". The former is specified when it is turned OFF and the latter when it is ON.

Input 3 is not used.

Output 1 is turned ON when quotient is less than 10000.

Output 2 is turned ON when overflow (quotient exceeds 10000) occurs (division error).

Output 3 is turned ON when Operand 2 is 0 (division error).

(Operand 1, Operand 1 + 1) ÷ (Operand 2) = (Operand 3) ; quotient
(Operand 3 + 1) ; remainder (input 2 OFF)
decimal quotient (input 2 ON)

Upper 4 digits of dividend are stored in (Operand 1)

Lower 4 digits of dividend are stored in (Operand 1 + 1)

(3) Operand

Table 7.5 Operands

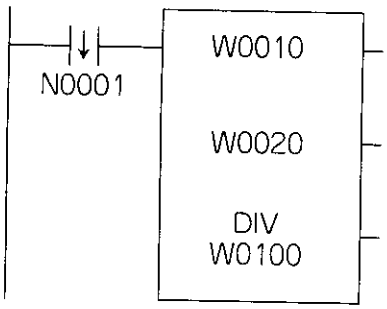
Operand 1	Constant : 0 to 9999 Input register : Z1 to Z127 Data register : W1 to W2047 Link register : R1 to R1023
Operand 2	Constant : 1 to 9999 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Data register : W1 to W2047 Link register : R1 to R1023

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(4) Typical calculation

[Example 1] Division of registers

[Ladder Command] [Mnemonic Command]




```
STL N1
DIV W10 W20 W100
```

When N0001 is turned ON and then OFF, the contents of registers W0010 and W0011 are divided by register W0020; the quotient is stored in W0101 and the remainder (input 2 OFF) or decimal quotient (input 2 ON) is stored in W0101.

Input 1	Input 2	W0010	W0011	W0020	OUTPUT 1	OUTPUT 2	OUTPUT 3	W0100	W0101	Calculation contents
ON	OFF	0001	2500	80	ON	OFF	OFF	156	20	12500÷80
ON	ON	0001	2500	80	ON	OFF	OFF	156	2500	12500÷80
ON	ON/OFF	0001	2500	1	OFF	ON	OFF	0	0	12500÷ 1
ON	ON/OFF	0001	2500	0	OFF	OFF	ON	0	0	12500÷ 0

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7.3 FOUR DOUBLE - LENGTH CALCULATION

7.2.1 Double - length Addition (DAD)

(1) Command symbol

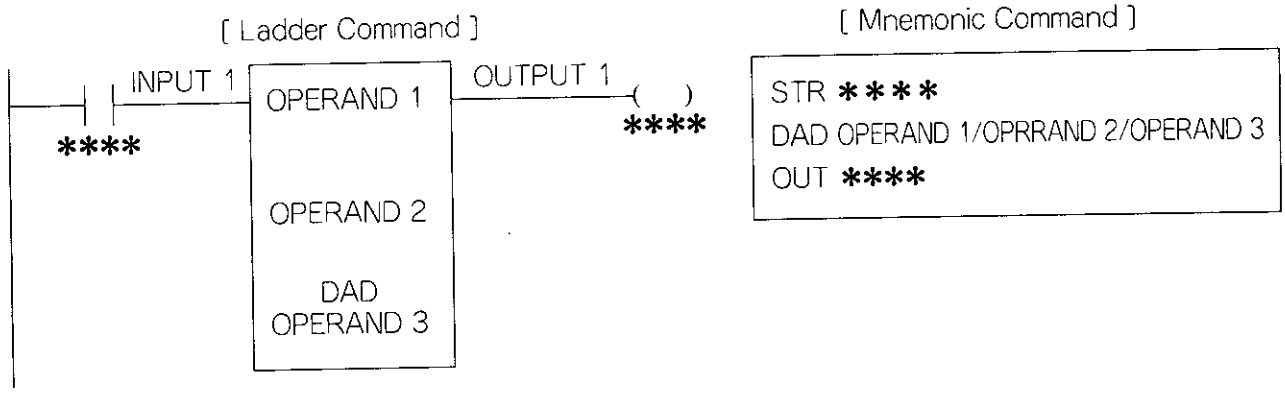


Fig 7.10 Command Symbols

(2) Operand

Table 7.6 Operand

Operand 1, Operand 2	Input register : Z1 to Z127 Data register : W1 to W2047 Link register : R1 to R1023
Operand 3	Data register : W1 to W2047 Link register : R1 to R1023

(3) Calculating function

When input 1 is turned ON by the addition command, the following addition in 8 - digit decimal is executed.

Inputs 2 and 3 are not used.

Upper 4 digits of the addend are set in the register specified by Operand 1 and the lower 4 digits in the next register.

Upper 4 digits of the addend are set in the register specified by Operand 2 and the lower 4 digits in the next register.

Upper 4 digits of the resultant addition are set in the register specified by Operand 3 and the lower 4 digits in the next register.

Output 1 is turned ON when the resultant addition exceeds 99,999,999. At this time, the value obtaind by subtracting 100,000,000 from the resultant addition becomes the result.

Outputs 2 and 3 are not used. (They are always OFF .)

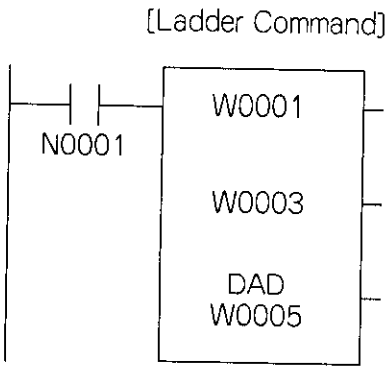
—— Equation ——

[Operand 1, Operand 1 + 1] + [Operand 2, Operand 2 + 1] = [Operand 3, Operand 3 + 1]

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(4) Typical calculation

[Example 1]



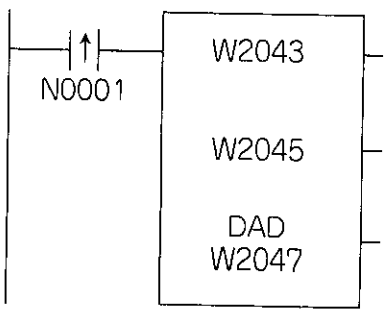
[Mnemonic Command]

```
STR N1
DAD W1 W3 W5
```

When N0001 is turned ON, the following double - length addition is executed.
The following shows typical double-length addition where 12 is stored in W0001, 3456 in W0002, 98 in W0003 and 7654 in W0004.

W0001	W0002		W0003	W0004		W0005	W0006
0012	3456	+	0078	9012	=	0091	2468

[Example 2]



[Mnemonic Command]

```
STH N1
DAD W2043 W2045 W2047
```

When N0001 is turned OFF and then ON, the double-length addition is executed where 9001 is stored in W2043, 3 in W2044, 1002 in W2044 and 4 in W2045.

W2043	W2044		W2045	W2046		W2047	W2048
9001	0003	+	1002	0004	=	0003	0007

Since the resultant calculation exceeds 99,999,999, output 1 is turned ON.

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7.3.2 Double-length Subtraction (DSB)

(1) Command symbol

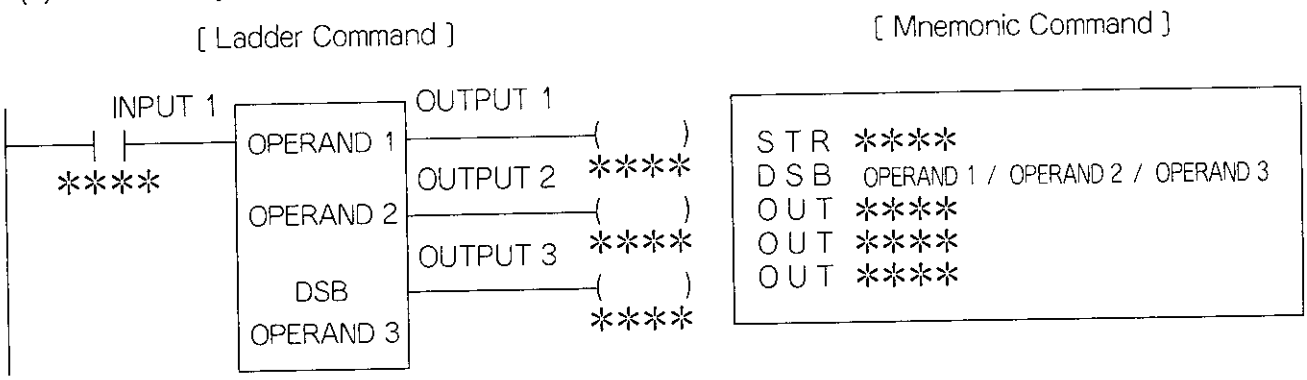


Fig. 7. 11 Command Symbols

(2) Operand

Table 7.7 Operand

OPERAND 1, OPERAND 2	Input register : Z 1 to Z 127 Data register : W 1 to W 2047 Link register : R 1 to R 1023
OPERAND 3	Data register : W 1 to W 2047 Link register : R 1 to R 1023

(3) Calculating function

When input 1 is turned ON by the subtraction command and the following subtraction in 8-digit decimal is executed.
Inputs 2 and 3 are not used.
Upper 4 digits of the minuend are set in the register specified by Operand1 and the lower 4 digits in the next register.
Upper 4 difits of the subtrahend are set in the register specified by Operand 2 and the lower 4 digits in the next register.
Upper 4 digits of the resultant subtraction are set in the register specified by Operand 3 and the lower 4 digits in the next register.
Output 1 is turned ON when the resultant subtraction is plus (0 >).
Output 2 is turned ON when the resultant subtraction is zero (= 0).
Output 3 is turned ON when the resultant subtraction is minus (0 <). The absolute value becomes the resultant calculation.

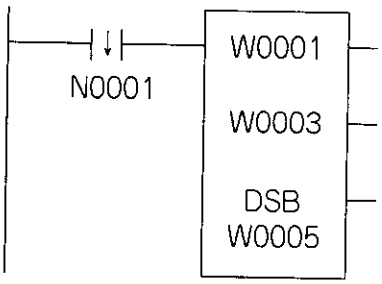
—— Equation ——

[Operand 1, Operand 1 + 1] - [Operand 2, Operand 2 + 1] = [Operand 3, Operand 3 + 1]

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(4) Typical calculation

[Ladder Command]



[Mnemonic Command]

```
STL   N1
DSB   W1  W3  W5
```

When N0001 is turned ON and then OFF, double-length subtraction is executed.
The following shows the resultant calculation when W0001 to W0004 are the values in the table.

Minuend		Subtrahend		Resultant Calculation		Calculation Flag		
W0001	W0002	W0003	W0004	W0005	W0006	Output 1	Output 2	Output 3
0009	1000	0001	1001	0007	9999	ON	OFF	OFF
0009	1000	0009	1000	0000	0000	OFF	ON	OFF
0009	1000	0009	1001	0000	0001	OFF	OFF	ON
9876	5432	1234	5678	8641	9754	ON	OFF	OFF

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7.3.3 Double-length Multiplication (DML)

(1) Command symbol

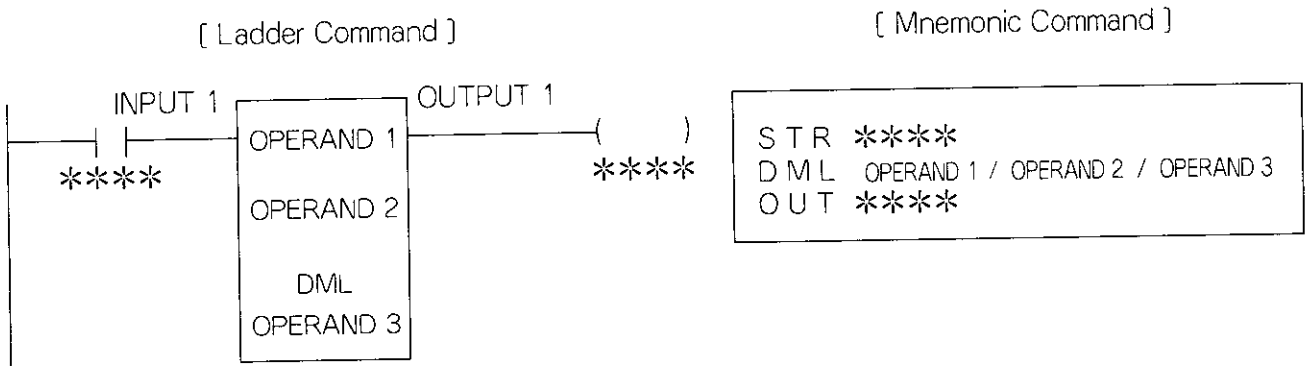


Fig. 7. 12 Command Symbols

(2) Operand

Table 7.7 Operand

OPERAND 1, OPERAND 2	Input register : Z 1 to Z 127 Data register : W 1 to W 2047 Link register : R 1 to R 1023
OPERAND 3	Data register : W 1 to W 2045 Link register : R 1 to R 1021

(3) Calculating function

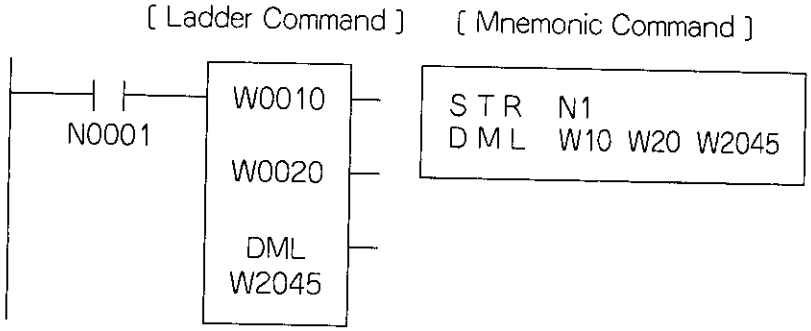
When input 1 is turned ON by the multiplication command and the following multiplication in 8-digit decimal is executed.
Inputs 2 and 3 are not used.
Output 1 is turned ON when input 1 is turned ON.
Outputs 2 and 3 are not used.
Upper 4 digits of the multiplicand are set in the register specified by Operand 1 and the lower 4 digits in the next register.
Upper 4 digits of the multiplier are set in the register specified by Operand 2 and the lower 4 digits in the next register.
The resultant multiplication in 16-digit decimal is stored in 4 contiguous registers with register specified by Operand 3 as the uppermost 4 digits.

—— Equation ——

[Operand 1, Operand 1 + 1] × [Operand 2, Operand 2 + 1] = [Operand 3, Operand 3+1, Operand 3 + 2, Operand 3+3]

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(4) Typical calculation



When N0001 is turned ON, double-length multiplication is executed.
The following shows the resultant calculation for each value of the following table.

Multiplicand		Multiplier		Resultant Calculation				Calculation Flag	
W0010	W0011	W0020	W0021	W2045	W2046	W2047	W2048	Output 1	Output 2,3
0001	2345	0000	0009	0000	0000	0011	1105	ON	OFF
0001	2345	0001	0009	0000	0001	2356	1105	ON	OFF
1001	1009	1000	0009	0100	1101	8009	9081	ON	OFF

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7.3.4 Double-length Division (DDV)

(1) Command symbol

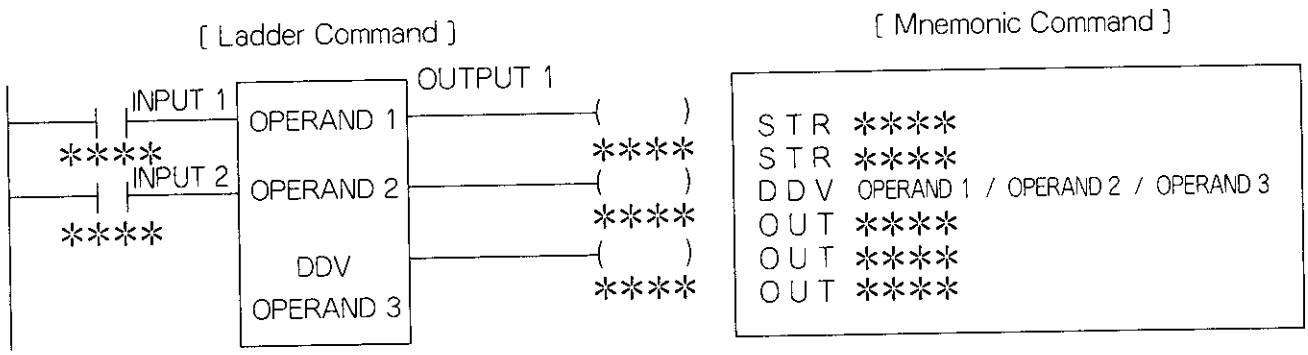


Fig. 7. 13 Command Symbols

(2) Operand

Table 7.9 Operand

OPERAND 1	Input register : Z 1 to Z 127 Data register : W 1 to W 2045 Link register : R 1 to R 1021
OPERAND 2	Input register : Z 1 to Z 127 Data register : W 1 to W 2047 Link register : R 1 to R 1023
OPERAND 3	Data register : W 1 to W 2045 Link register : R 1 to R 1021

(3) Calculating function

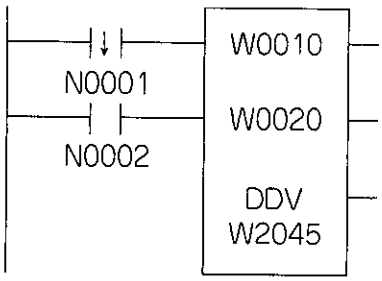
When input 1 is turned ON by the division command, the following double-length division is executed.
Input 2 specifies whether the resultant division is obtained in the form of "quotient and remainder" or "quotient and decimal quotient". The former is specified when it is OFF and the latter when it is ON.
Input 3 is not used.
Output 1 is turned ON when the quotient is less than 100,000,000.
Output 2 is turned ON when overflow (quotient exceeds 100,000,000) occurs (division error).
Output 3 is turned ON when Operand 2 is 0 (division error).
When a division error occurs, the resultant calculation becomes 0.
The dividend in 16-digit decimal is set in 4 contiguous registers with the register specified by Operand 1 as the uppermost 4 digits.
Upper 4 digits of the divisor are set in the register specified by Operand 2 and the lower 4 digits in the next register.
The resultant calculation in 16-digit decimal is stored in 4 contiguous registers with register specified by Operand 3 as the uppermost 4 digits.
Integral quotient in 8 digits is stored in the first 2 registers and the remainder in 8 digits or decimal quotient is stored in the lower 2 registers.

[Operand 1, Operand 1 + 1, Operand 1 + 2, Operand 1 + 3] ÷ [Operand 2, Operand 2 + 1]
= [Operand 3, Operand 3 + 1] (integral quotient);
at input 2 OFF [Operand 3 +, Operand 3 + 3] (remainder)
at input 2 ON [Operand 3 + 2, Operand 3 + 3] (decimal quotient)

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(4) Typical calculation

[Ladder Command] [Mnemonic Command]




```
STL   N1
STR   N2
DDV   W10 W20 W2045
```

When N0001 is turned ON and then OFF, double-length division is executed. The following shows a typical resultant calculation for each value of the following table.

- When N0002 (INPUT 2) is OFF

Dividend				Divisor		Resultant Division: Quotient		Resultant Division: Remainder		OUTPUT 1	OUTPUT 2	OUTPUT 3
W0010	W0011	W0012	W0013	W0020	W0021	W2045	W2046	W2047	W2048			
0000	0001	0000	0000	0003	0000	0000	3333	0001	0000	ON	OFF	OFF
0000	0001	0000	0000	0000	0003	0000	0000	0000	0000	OFF	ON	OFF
0000	0001	0000	0000	0000	0000	0000	0000	0000	0000	OFF	OFF	ON

- When N0002 (INPUT 2) is ON

Dividend				Divisor		Resultant Division: Quotient		Resultant Division: Remainder		OUTPUT 1	OUTPUT 2	OUTPUT 3
W0010	W0011	W0012	W0013	W0020	W0021	W2045	W2046	W2047	W2048			
0000	0001	0000	0000	0003	0000	0000	3333	3333	3333	ON	OFF	OFF
0000	0001	0000	0000	0000	0003	0000	0000	0000	0000	OFF	ON	OFF
0000	0001	0000	0000	0000	0000	0000	0000	0000	0000	OFF	OFF	ON

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7.4 SQUARE ROOT

7.4.1 Square Root (SQR)

(1) Command symbol

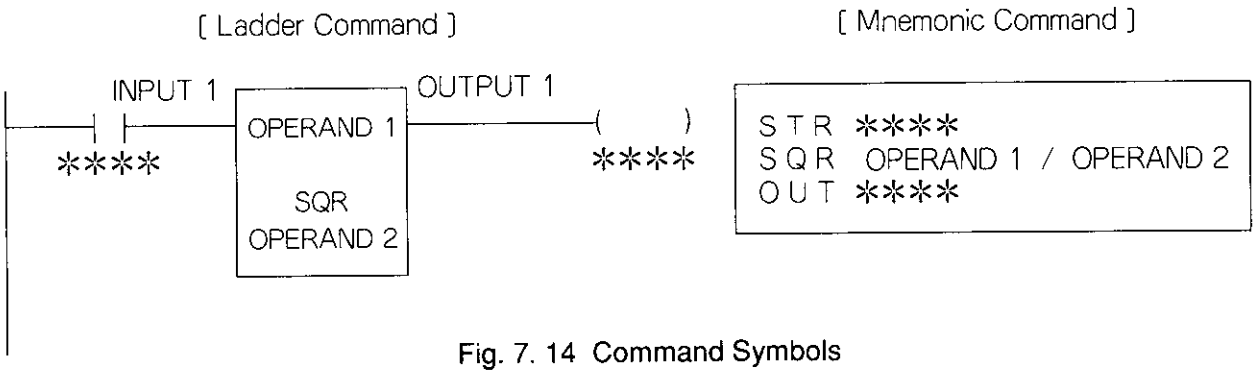


Fig. 7. 14 Command Symbols

(2) Operand

Table 7.10 Operand

OPERAND 1	Input register : Z 1 to Z 128 Data register : W 1 to W 2048 Link register : R 1 to R 1024
OPERAND 2	Data register : W 1 to W 2047 Link register : R 1 to R 1023

(3) Calculating function

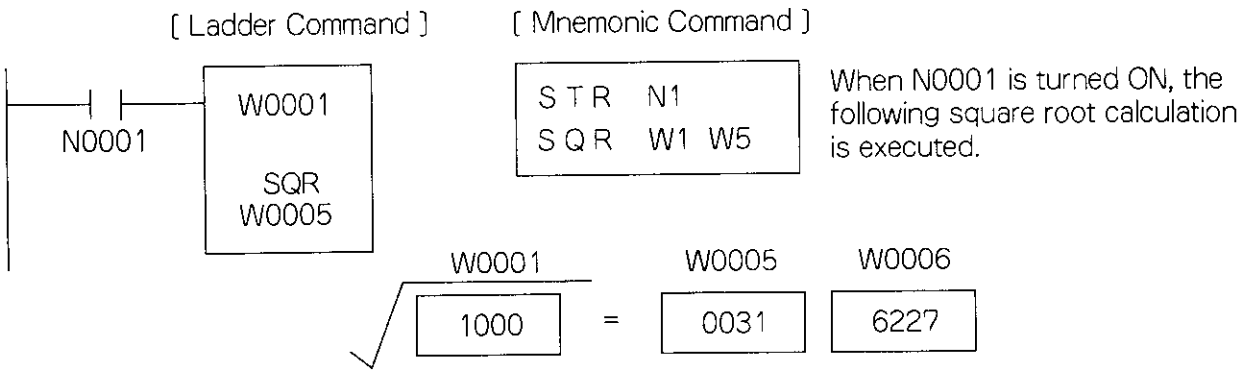
When input 1 is turned ON by the square root command, the following square root is extracted. Inputs 2 and 3 are not used.
Operand 1 is a register to store the calculated value to extract 4-digit decimals.
Operand 2 is a register to store the resultant calculation; the integral section of the resultant extraction of square root is stored in Operand 2 and the decimal section is stored in the next register.
Output 1 is turned ON when input 1 is turned ON. Output 2 and 3 are not used. (They are always OFF.)

—— Equation ——

$$\sqrt{[\text{Operand 1}]} = [\text{Operand 2}, \text{Operand 2} + 1]$$

Integral section — Decimal section

(4) Typical calculation



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7.4.2 Double-length Square Root (DSQ)

(1) Command symbol

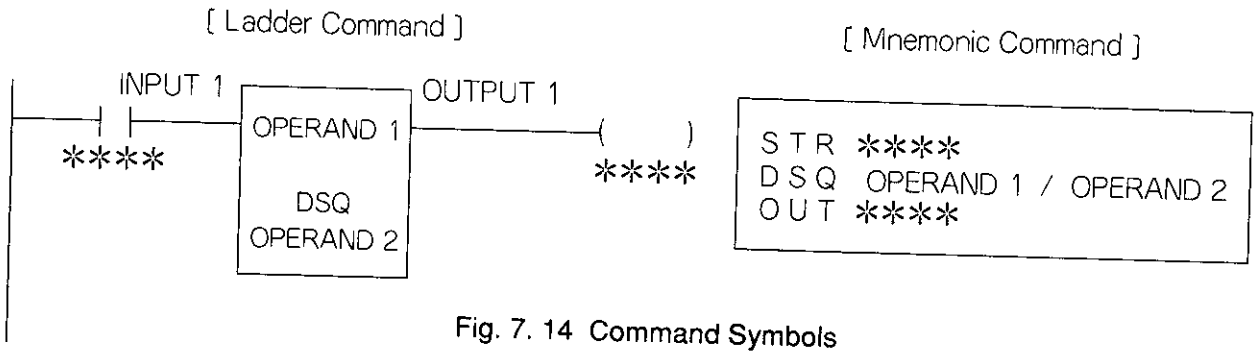


Fig. 7. 14 Command Symbols

(2) Operand

Table 7.11 Operand

OPERAND 1	Input register : Z 1 to Z 127 Data register : W 1 to W 2047 Link register : R 1 to R 1023
OPERAND 2	Data register : W 1 to W 2047 Link register : R 1 to R 1023

(3) Calculating function

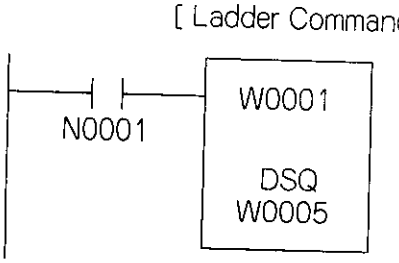
When input 1 is turned ON by the square root command, the following square root is extracted. Inputs 2 and 3 are not used.
The register specified by Operand 1 and the next register store the calculated value and execute extraction of aquare root in 8-digit decimals.
The register specified by Operand 2 and the next register store the resultant calculation; the integral section of the resultant square root is stored in Operand 2 and the decimal section is stored in the next register.
Output 1 is turned ON when input 1 is turned ON.
Outputs 2 and 3 are not used. (They are always OFF.)

—— Equation ——

$$\sqrt{[\text{Operand 1, Operand1 + 1}]} = [\text{Operand 2, Operand 2 + 1}]$$

Integral section — Decimal section

(4) Typical calculation



[Mnemonic Command]

```
STR  N1
DSQ  W1  W5
```

When N0001 is turned ON, the following square root calculation is executed.

W0001	W0002		W0005	W0006
0002	0000	=	0141	4213

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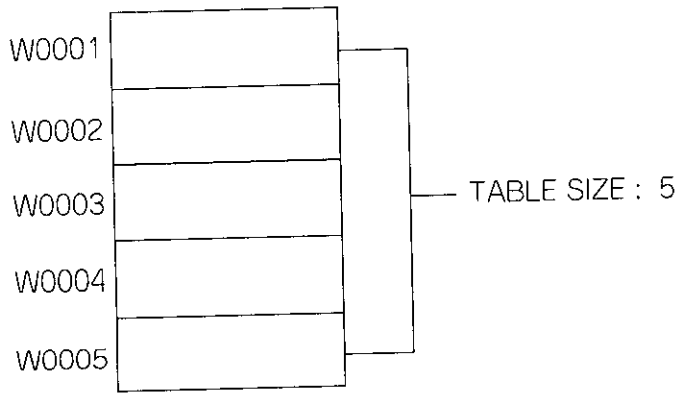
7.5 DATA TRANSFER

7.5.1 Basic Terms

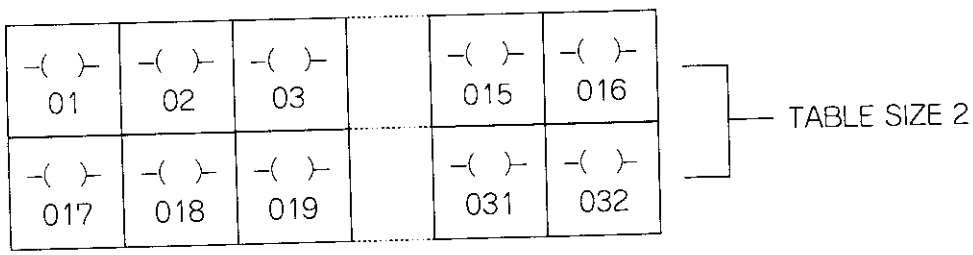
(1) Data table and table size

Data transfer is performed between data groups (data tables).
The data tables are groups of registers with continuons reference numbers (register table) or discrete groups such as coils or relays (discrete group table).
The table size indicates the size of the table in units of registers (register table) or in units of 16 points (discrete group table).

(Example 1) Data table composed of five continuous data registers

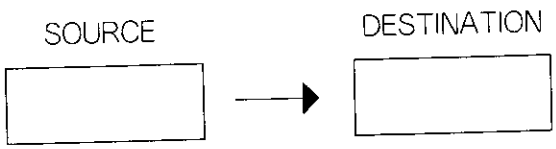


(Example 2) Output coil table composed of 32 continuous output coils (table to store the coil ON/OFF status)



(2) Source, destination

The places that the data are transferred from/to are called source and destination, respectively.
The contents of the source are stored in the destination.
The contents of the source are not changed even after data transfer.



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(3) Pointer

Pointer is a register used to indicate the specified position of the data table. Since the value of the pointer is 3 in the following example, the pointer indicates register W1002 located at the third stage from the data table head.

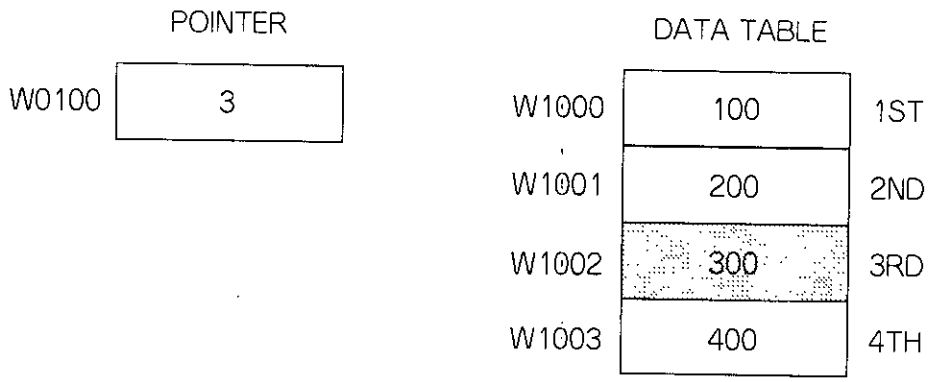
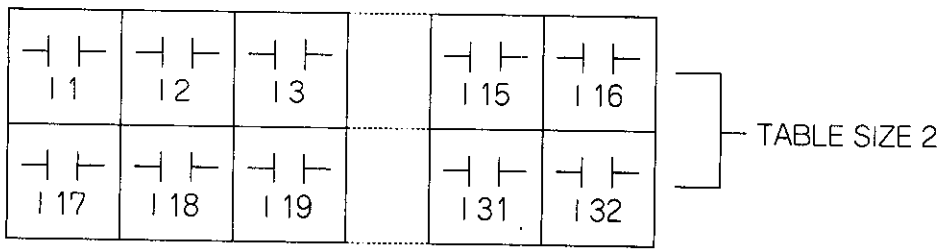


Fig. 7.16 Pointer

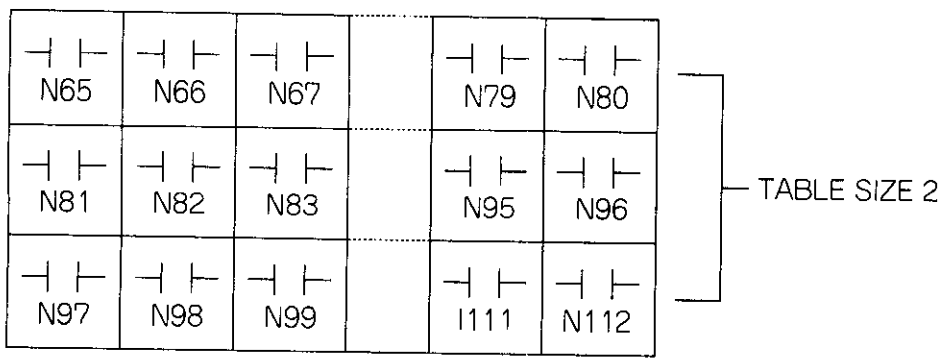
(4) Reference Nos. of Source and Destination

When a discrete group No. is specified as a reference No. of the source or destination, it is necessary to have n = 16m + 1 (m = 0, 1, 2...) assuming that the reference No. is n.

(Example 1) When I32 is specified from input relay group I1, I1 becomes the starting reference No.



(Example 2) When N112 is specified from internal coil group N65, N65 becomes the starting reference No.



(5) Types of data transfer commands

There are 9 types of data transfer commands : BLK (block transfer), RTT (register-to-table transfer), TTR (table-to-register transfer), TTT (table-to-table transfer), FIN (first-in), FOT (first-out), SRC (table search), TST (table set) and STT (status read).

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7.5.2 Block Transfer (BLK)

(1) Command symbol

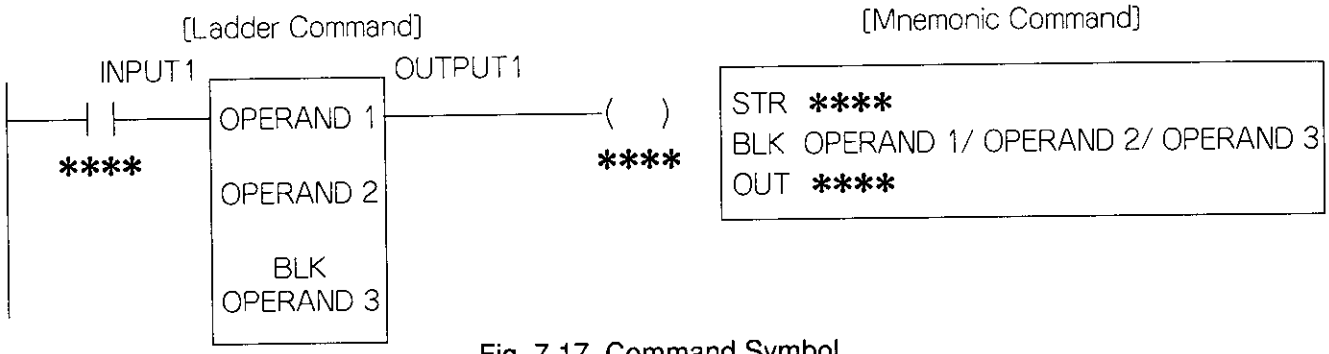


Fig. 7.17 Command Symbol

(2) Operand

Table 7.12 Operand

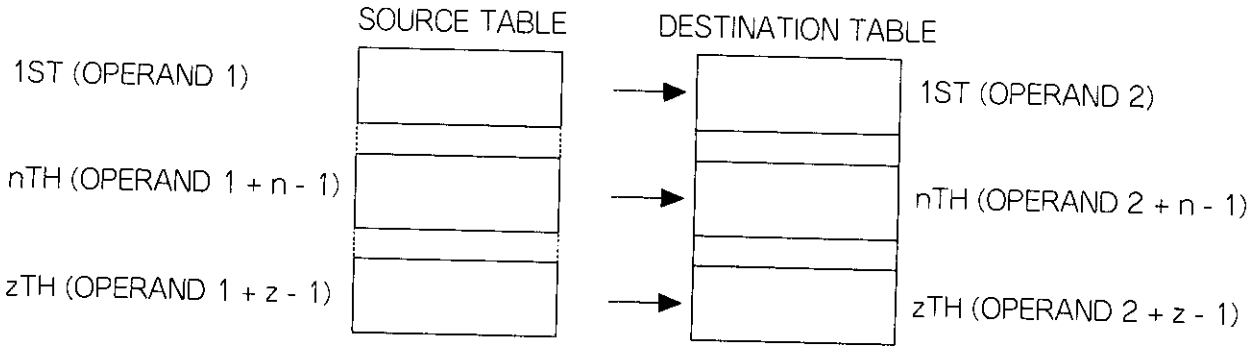
OPERAND 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 MC control coil group : Q1 to Q241 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
OPERAND 2	Output coil group : O1 to O497 Internal coil group : N1 to N1521 Link coil : D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxx : 1 to 64, Nxxx : 1 to 96 Zxxx, Rxxx, Wxxx : 1 to 100 The smaller constant range is specified between Operands 1 to 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 100 of Zxxx.

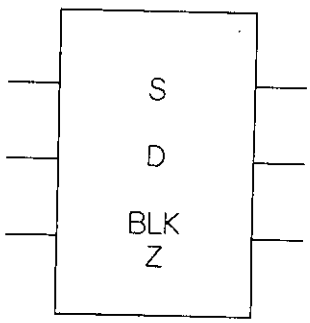
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(3) Calculating function

A transfer where both the source and destination are tables; all data are sent for one scan.
When input 1 is turned ON, the first data of the source table are sent to the first destination for one scan. In this way, all source data are sent to the same number of destination for one scan.

Inputs 2 and 3 are not used.
When output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Outputs 2 and 3 are not used. (They are always OFF.)



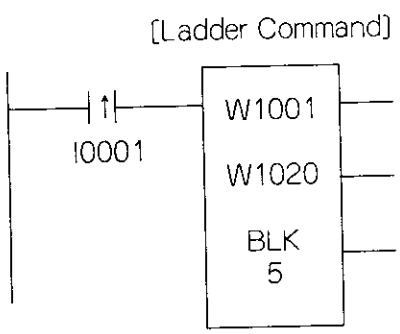


S : OPERAND 1 D : OPERAND 2 Z : OPERAND 3

Fig. 7.18 BLOCK (BLK) Transfer Calculation

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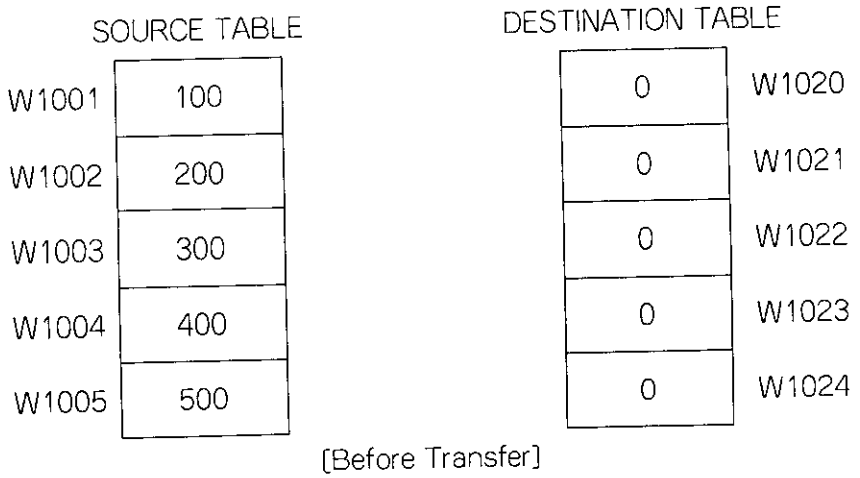
(4) Typical use



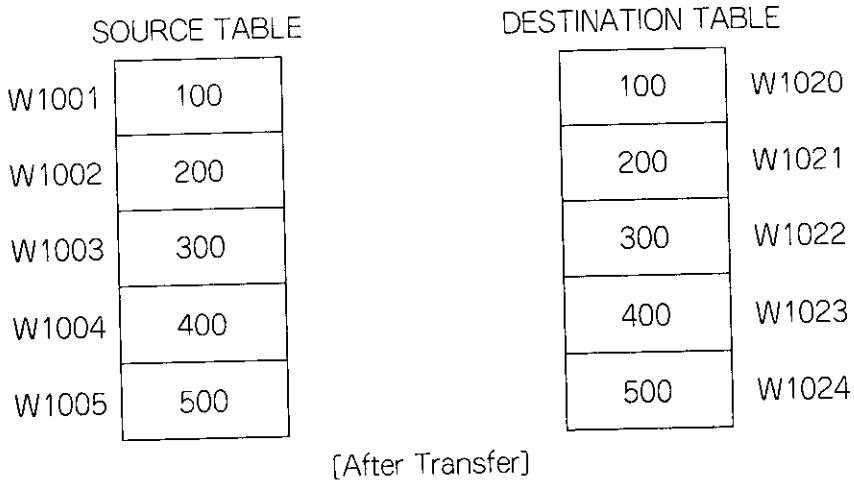
[Mnemonic Command]

```
STH  I 1·
BLK  W1001  W1020  5
```

When I001 is turned OFF and then ON, block transfer is executed.



[Before Transfer]



[After Transfer]

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7.5.3 Register-to-Table Transfer (RTT)

(1) Command symbol

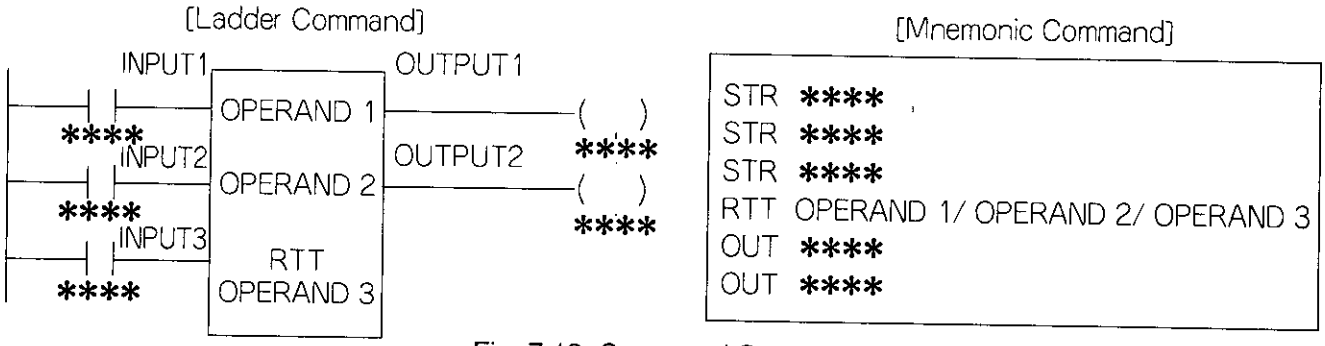


Fig. 7.19 Command Symbols

(2) Operand

Table 7.13 Operand

OPERAND 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
OPERAND 2	Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxx : 1 to 64 Nxxx : 1 to 96 Zxxx : 1 to 128 Rxxx, Wxxx : 1 to 999 The smaller constant range is specified between Operands 1 to 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 128 of Zxxx.

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(3) Calculating function

Transfer is executed in the ratio of one register per scan (or discrete of one set of 16 points).

When input 1 is turned ON, the source data are transferred to the (n+1)th of the destination table according to the pointer value n; after that, +1 is added to the pointer automatically. When n ≧ table size Z, transfer is not executed if input 1 is turned ON. Therefore, when both inputs 1 and 2 are turned ON, data are transferred to the same destination register unless n is renewed in another circuit.

When input 3 is turned ON, n becomes 0 disregarding the ON/OFF status of input 1. If inputs 1 and 3 are turned ON, n becomes 0 and then the source data are input to the first of the destination tables; and after that becomes 1. When all inputs 1, 2 and 3 are turned ON, the data are transferred to the first register and n remain 0.

Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Output 2 is turned ON at n = table size disregarding the ON/OFF status of input 1.
Output 3 is not used. (It is always OFF)

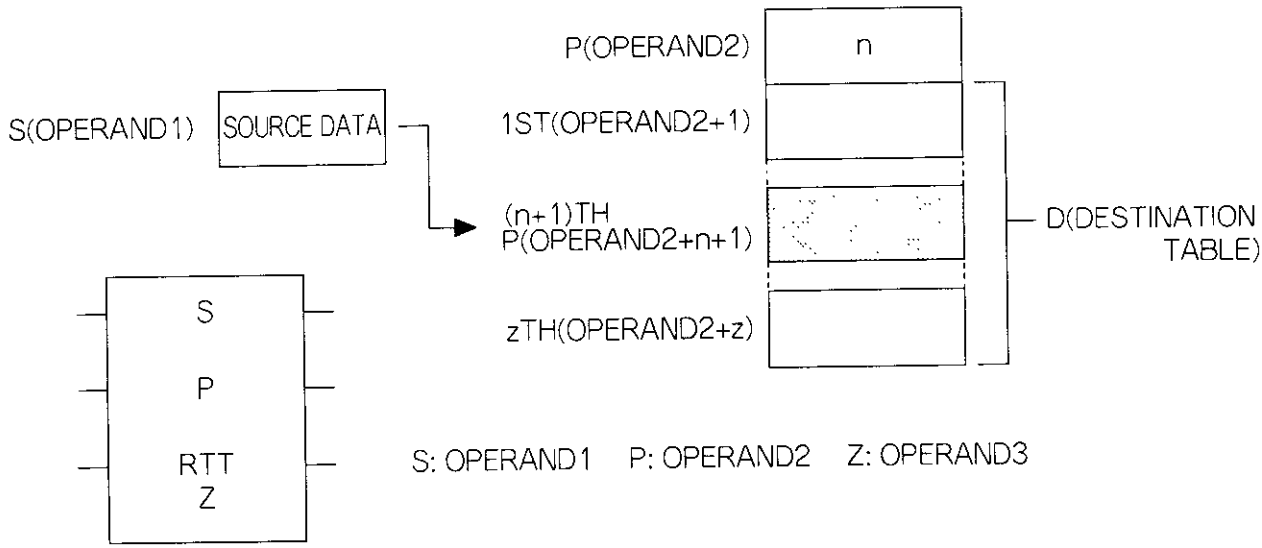


Fig. 7.20 Register-to-table Transfer (RTT) Calculation

Table 7.14 Input Meaning

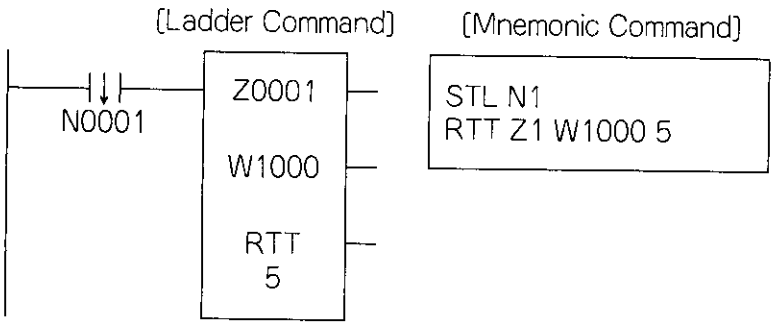
Input X	Meaning
Input 1	Transfer is executed and +1 is added to pointer value.
Input 2	Pointer renewal is prohibited.
Input 3	Pointer value is cleared to 0 (disregarding input 1 ON/OFF)

Table 7.15 Output Meaning

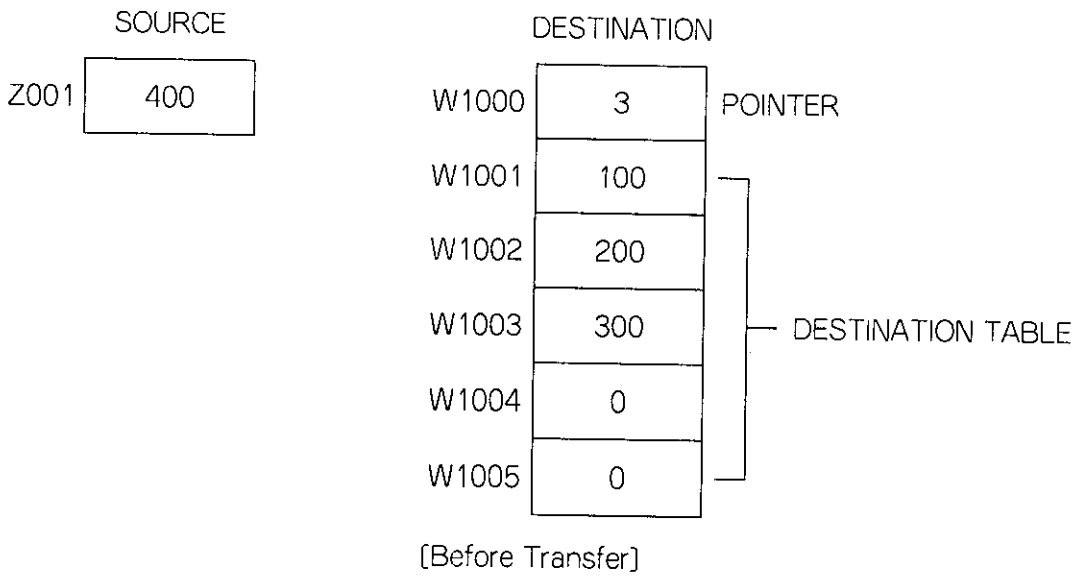
Output X	Meaning
Output 1	Same as input 1 ON/OFF status
Output 2	On at pointer = table size (disregarding input 1 ON/OFF)
Output 3	Always OFF

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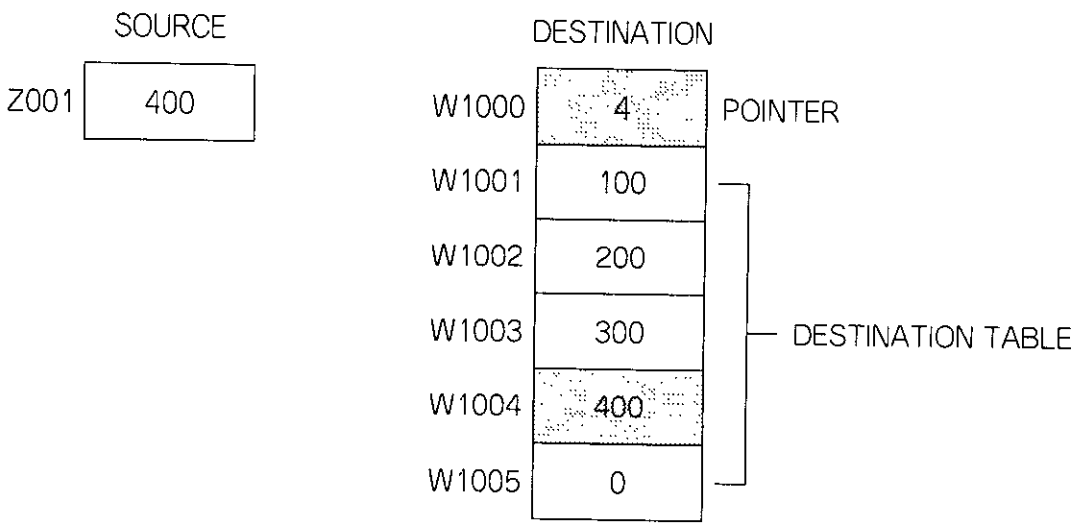
(3) Typical use



When N0001 is turned ON and then OFF, register-to-table transfer is executed.



[Before Transfer]



[After Transfer]

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7.5.4 Table-to-Register Transfer (TTR)

(1) Command symbol

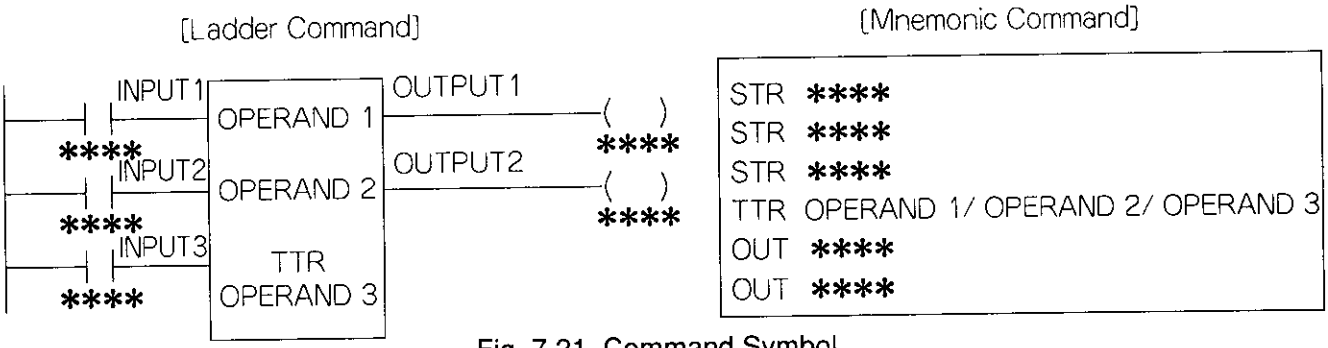


Fig. 7.21 Command Symbol

(2) Operand

Table 7.16 Operand

OPERAND 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
OPERAND 2	Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxx : 1 to 64 Nxxx : 1 to 96 Zxxx : 1 to 128 Rxxx, Wxxx : 1 to 999 The smaller constant range is specified between Operands 1 to 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 128 of Zxxx.

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(3) Calculating function

Transfer is executed in the ratio of one register per scan (or discrete of one set of 16 points).
When input 1 is turned ON, the (n+1)th data indicated by the pointer value n are transferred to the register next to the destination point; after that, +1 is added to the pointer value automatically. When n ≧ table size Z, transfer is not executed even if input 1 is turned ON.
When input 2 is turned ON, automatic renewal of the pointer is prohibited after transfer, as well as RTT.
When input 3 is turned ON, n becomes 0 disregarding the ON/OFF status of input 1, as well as RTT.

Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Output 2 is turned ON at n= table size disregarding the ON/OFF status of input 1.
Output 3 is not used. (It is always OFF.)

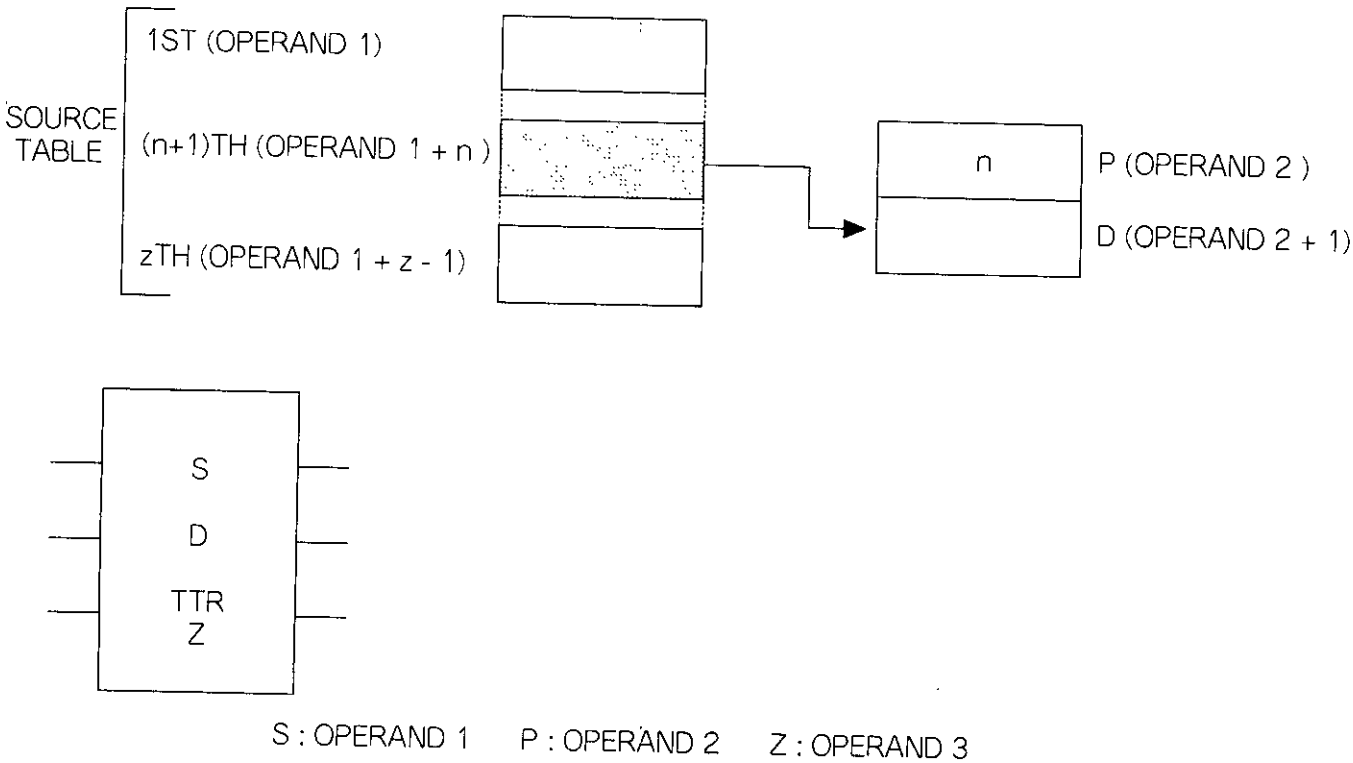


Fig. 7.22 Table-to-Register Transfer (TTR) Calculation

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Table 7.17 Input Meaning

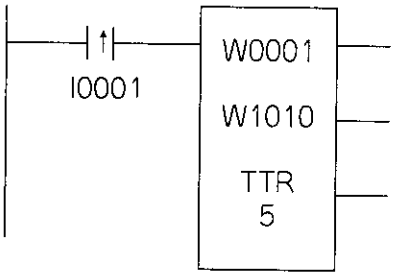
Input X	Meaning
Input 1	Transfer is executed and +1 is added to pointer value.
Input 2	Pointer renewal is prohibited.
Input 3	Pointer value is cleared to 0 (disregarding input 1 ON/OFF.)

Table 7.18 Output Meaning

Output X	Meaning
Output 1	Same as input 1 ON/OFF status
Output 2	ON at pointer = table size (disregarding input 1 ON/OFF.)
Output 3	Always OFF

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(4) Typical use



[Mnemonic Command]

```
STH I 1
TTR W1001 W1010 5
```

When I0001 is turned OFF and then ON, table to register transfer is executed.

SOURCE TABLE

W1001	100
W1002	200
W1003	300
W1004	400
W1005	500

[Before Transfer]

DESTINATION TABLE

3	W1010 (POINTER)
300	W1011 (DESTINATION)

SOURCE TABLE

W1001	100
W1002	200
W1003	300
W1004	400
W1005	500

[After Transfer]

4	W1010 (POINTER)
400	W1011 (DESTINATION)

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7.5.5 Table-to-Table Transfer (TTT)

(1) Command symbol

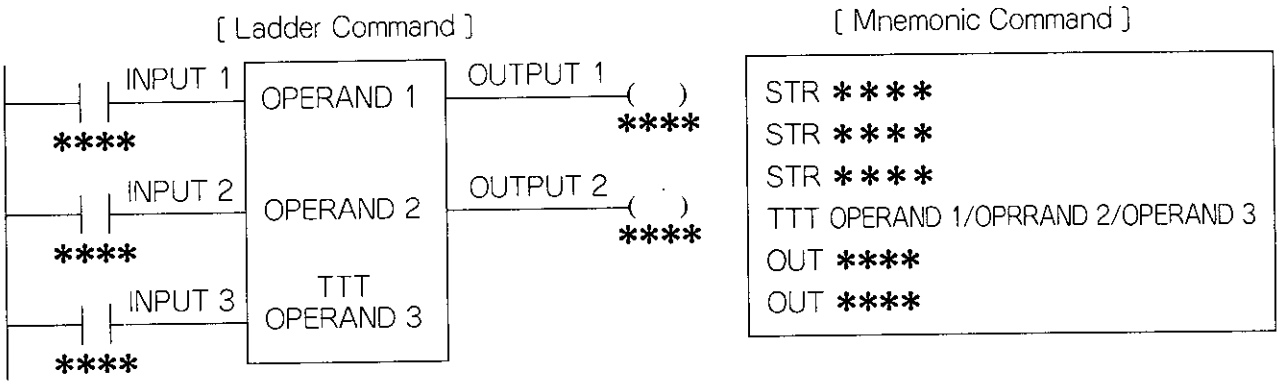


Fig 7.23 Command Symbol

(2) Operand

Table 7.19 Operand

Operand 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
Operand 2	Data register : W1 to W2047 Link register : R1 to R1023
Operand 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64 Nxxxx : 1 to 96 Zxxx : 1 to 128 Rxxxx, Wxxxx : 1 to 999 The smaller constant range is specified between Operands 1 and 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 128 of Zxxx.

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(4) Typical calculation

Transfer is executed in the ratio of one register per scan (or discrete of one set of 16 points).

When input 1 is turned ON, the (n + 1) th data indicated by the pointer value n in source table are transferred to the (n + 1) th of the destination table ; after that,+1 is added to the pointer value automatically. When n ≧ table size Z, transfer is not executed even if input 1 is turned ON.

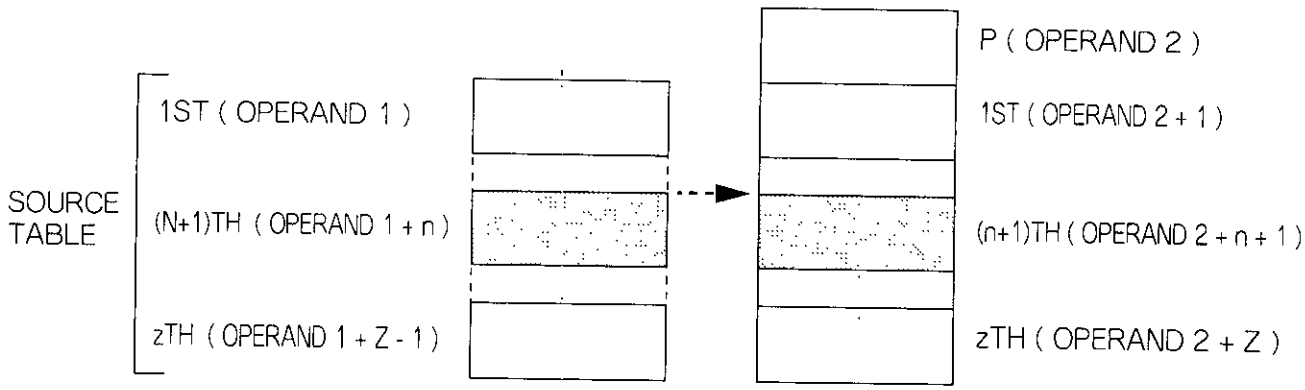
When input 2 is turned ON, automatic renewal of the pointer is prohibited after transfer, as well as RTT.

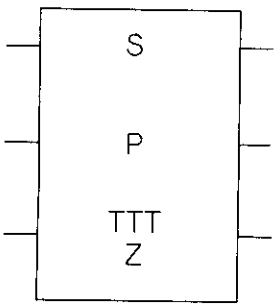
When input 3 is turned ON, n becomes 0 disregarding the ON/OFF status of input 1, as well as RTT.

Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.

Output 2 is turned ON at n = table size disregarding the ON/OFF status of input 1.

Output 3 is not used. (It is aiways OFF.)





S : OPERAND 1 P : OPERAND 2 Z : OPERAND 3

Fig 7.24 Table-to-Table Transfer (TTT) Calculation

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Table 7.20 Input Meaning

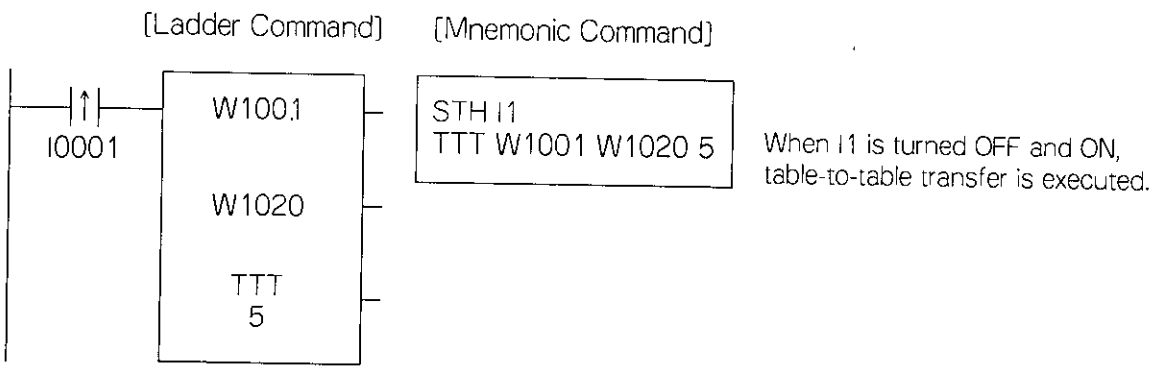
Input X	Meaning
Input 1	Transfer is executed and +1 is added to the pointer value.
Input 2	Pointer renewal is prohibited.
Input 3	Pointer value is cleared to 0 (disregarding input 1 ON / OFF).

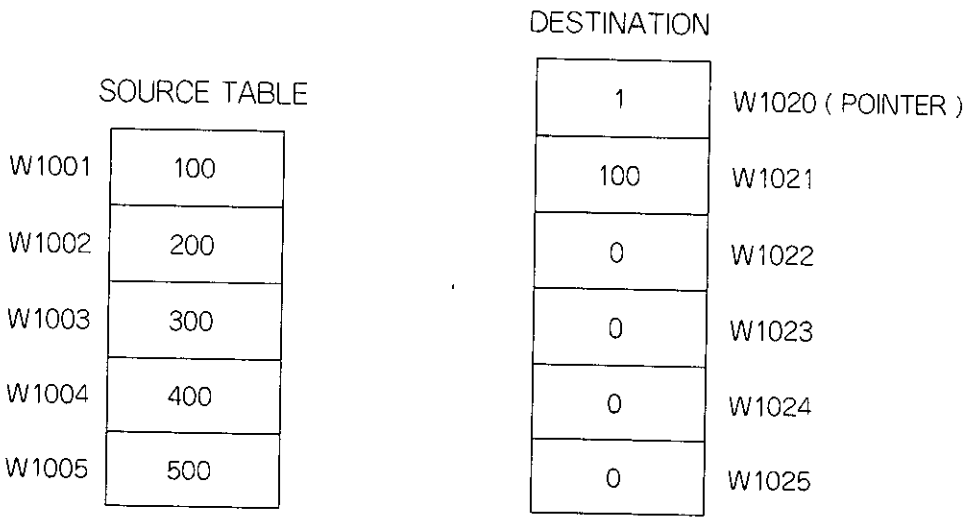
Table 7.21 Output Meaning

Output X	Meaning
Output 1	Same as input 1 ON / OFF status.
Output 2	ON at pointer = table size (disregarding input 1 ON / OFF).
Output 3	Allways OFF.

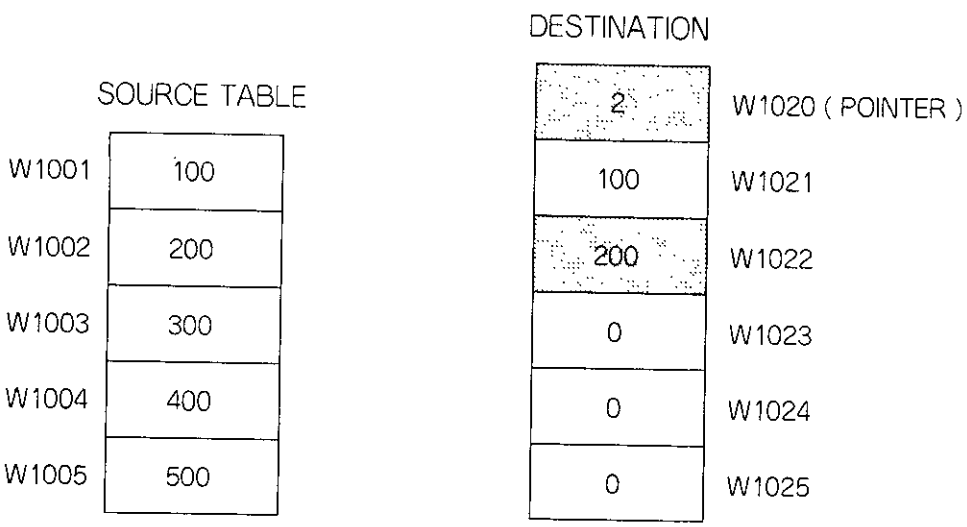
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(4) Typical use





[Before Transfer]



[After Transfer]

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7.5.6 First-in (FIN)

(1) Command symbol

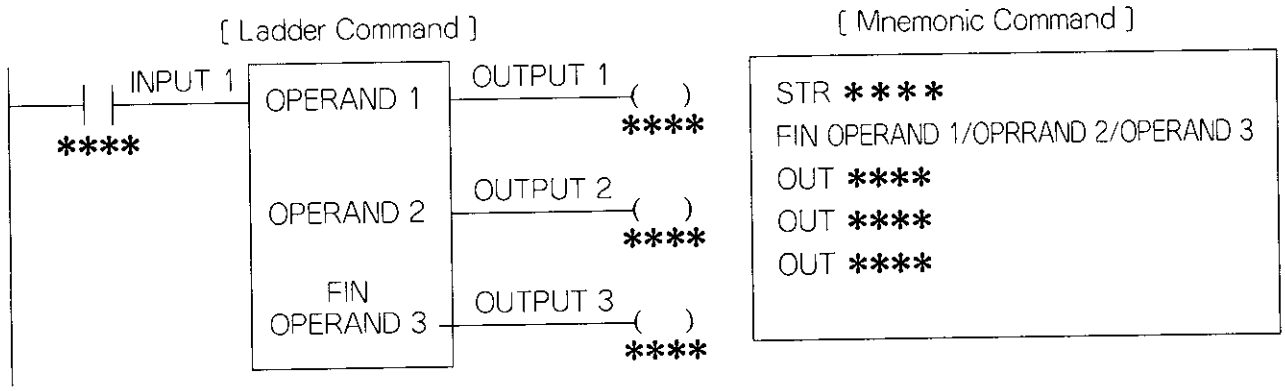


Fig 7.25 Command Symbol

(2) Operand

Table 7.22 Operand

Operand 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
Operand 2	Data register : W1 to W2047 Link register : R1 to R1023
Operand 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64 Nxxxx : 1 to 96 Zxxx, Rxxx, Wxxx, : 1 to 100 The smaller constant range is specified between Operands 1 and 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 100 of Zxxx.

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(3) Calculating function

FIN is normary used together with first - out (FOT). Transfer is executed in the same way as register-to-table trasnsfer (RTT), except that the data stored in the destination by FIN are taken out in the order stored by FOT.
The destination table in FIN is called FIFO table*.

*: FIFO table is a table used for first - in / first - out, an abbreviation of FIRST IN / FIRST OUT TABLE.

When input 1 is turned ON, the nth (the oldest) data stored in the destination table are shifted down to the (n + 1) th, (n- 1) th to the nth and the like ; that is, older data are shifted down by one register sequentially and the source data are transferred to the first empty stage. As a result, in the register table, data are stored in the order from the newest data, from the top down (from register with the smallest to the largest number). After completion of serial data shift, +1 is added to the pointer value. Data shift → the latest data storing → pointer renewal are performed for one scan disregarding the table size. Inputs 2 and 3 are not used.
Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Output 2 is turned ON at n = table size (table full) disregarding the ON/OFF status of input 1.
Output 3 is turned ON at n = 0 (table vacant) disregarding the ON/OFF status of input 1.

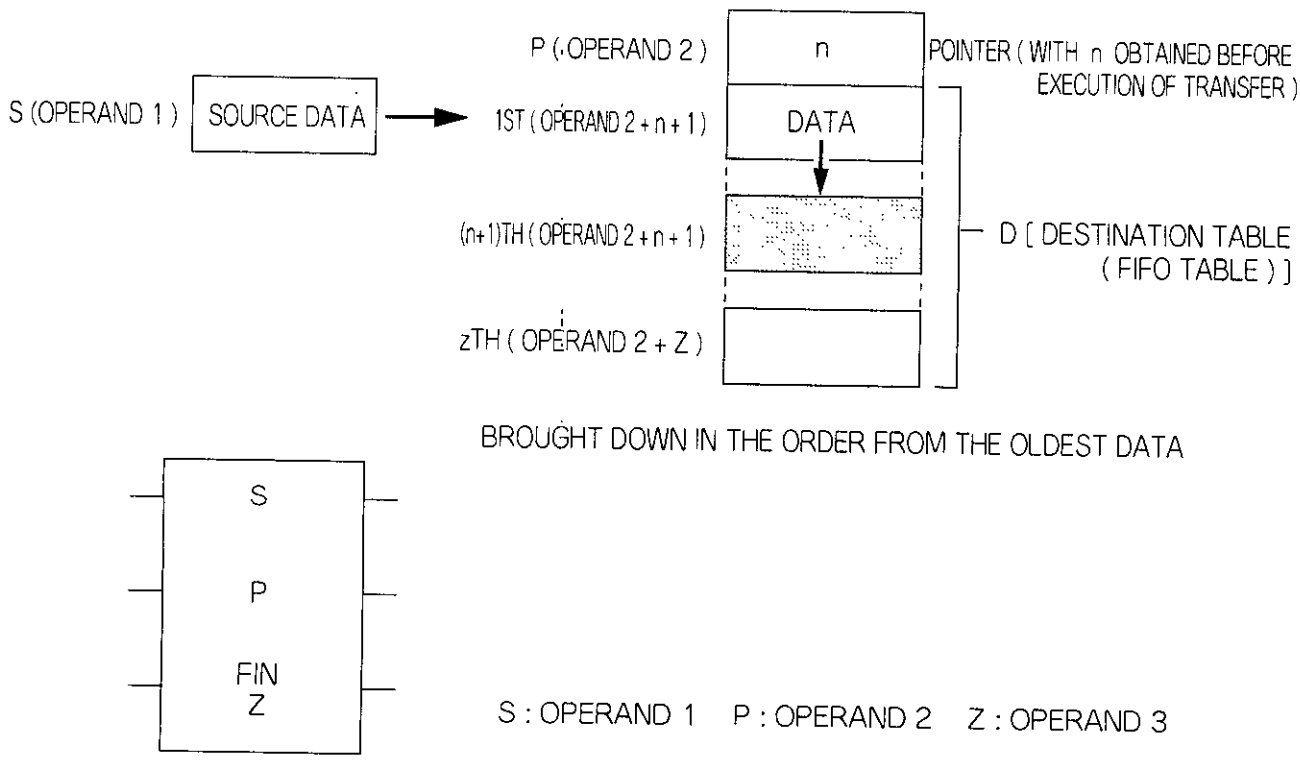


Fig 7.26 First-in (FIN) Calculation

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Table 7.23 outlines the FIN operation.

Table 7.23 FIN Operation

Input 1	Operation	Conditions	Output 1	Output 2	Output 3
ON	Execution*	Pointer value = table size	ON	ON	OFF
		Pointer value = 0		OFF	ON
		In any case other than above values		OFF	OFF
OFF	–	Pointer value = table size	OFF	ON	OFF
		Pointer value = 0		OFF	ON
		In any case other than above values		OFF	OFF

* : Not executed when pointer value ≧ table size.

(4) Typical use

Refer to Par. 7.5.7(4).

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7.5.7 First - out (FOT)

(1) Command symbol

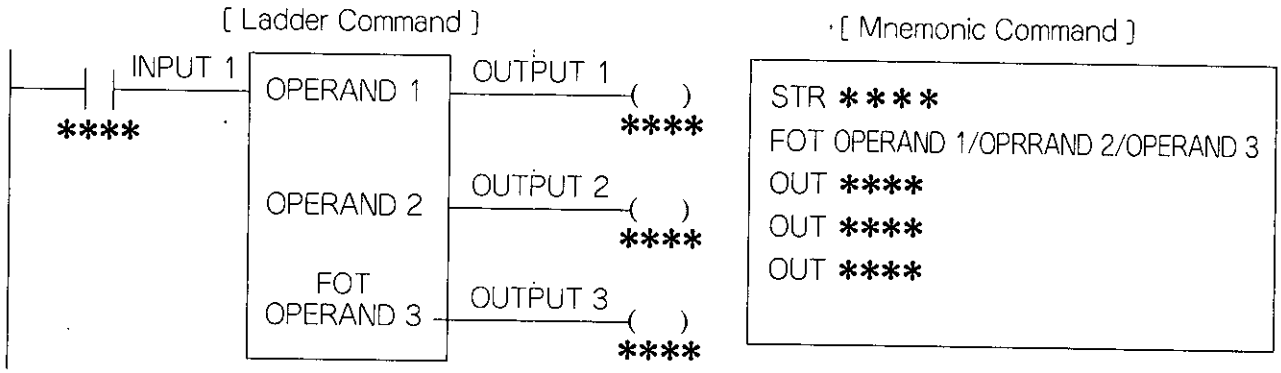


Fig 7.27 Command Symbols

(2) Operand

Table 7.22 Operand

Operand 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
Operand 2	Data register : W1 to W2047 Link register : R1 to R1023
Operand 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64 Nxxxx : 1 to 96 Zxxx, Rxxxx, Wxxxx, : 1 to 100 The smaller constant range is specified between Operands 1 and 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 100 of Zxxx.

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(3) Calculating function

The destination table used in FIN (FIFO table) becomes the source table for FOT. FOT performs transfer of N : 1 type to destination. Transfer is executed in the ratio of one register per scan. The data stored in the FITO table are taken out in the order from the oldest to realize first - in and first - out.

When input 1 is turned ON, the nth data of the source table is indicated by the pointer value n (since n indicates the number of data which have been already stored. FOT does not take out the (N + 1) th but nth) are transferred to the destination.

After that, -1 is subtracted from the pointer value.
When n = 0, transfer is not executed even if input 1 is turned ON.
Inputs 2 and 3 are not used.
The contents of the source register (nth register) taken out by FOT are cleared to 0 unless the next data enter there by FIN.

Output 1 is turned ON and OFF then input 1 is turned ON and OFF, respectively.
Out put 2 is turned ON at n = table size (table full) disregarding the ON/OFF status of input 1.
Output 3 is turned ON at n = 0 (table vacant) disregarding the ON/OFF status of input 1.

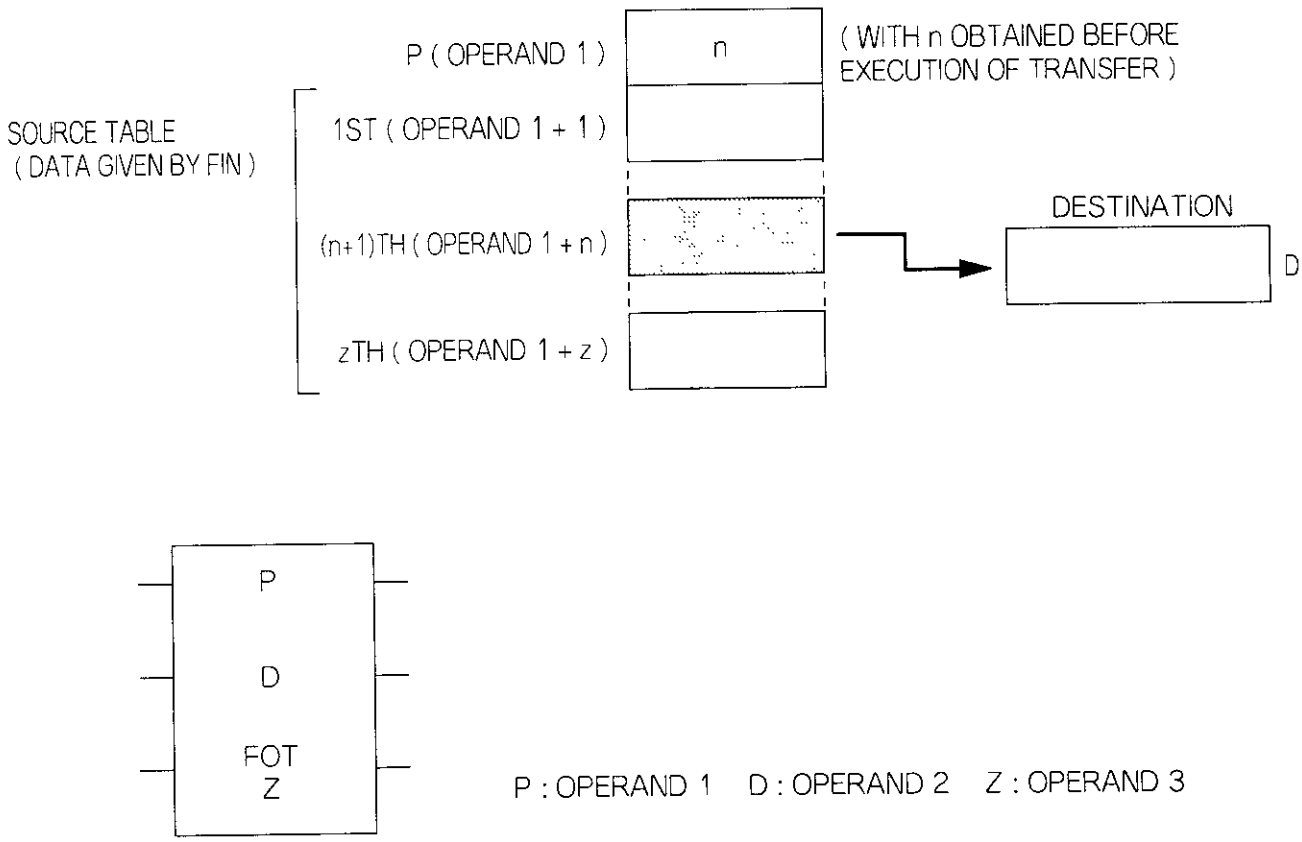


Fig 7.28 First-out (FOT) Calculation

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Table 7.25 FOT Operation

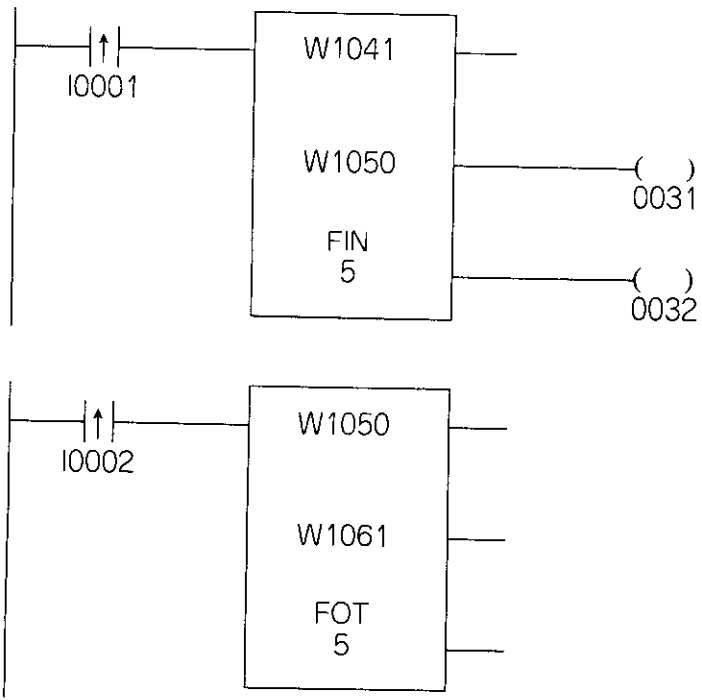
Input 1	Operation	Conditions	Output 1	Output1	Output1
ON	Execution*	Pointer value = table size	ON	ON	OFF
		Pointer value = 0		OFF	ON
		In any case other than above values		OFF	OFF
OFF	—	Pointer value = table size	OFF	ON	OFF
		Pointer value = 0		OFF	ON
		In any case other than above values		OFF	OFF

* : Not executed when pointer value > table size

(4) Typical use

FIN (first - in) is executed when I001 is turned OFF and then ON.
FOT (first - out) is executed when I002 is turned OFF and then ON.

[Ladder Command]



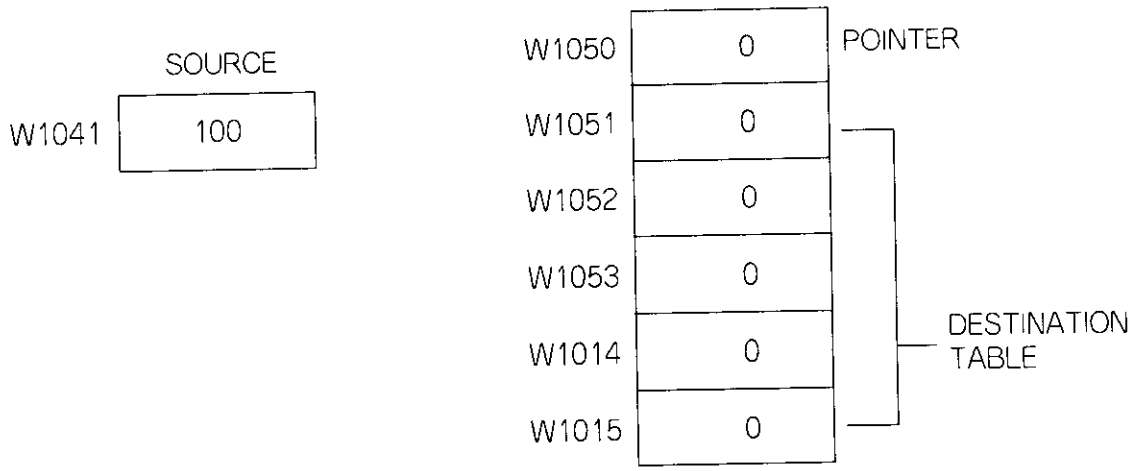
[Mnemonic Command]

```
STH  I1
FIN  W1041  W1050  5
NOP
OUT  31
OUT  32
STH  I2
FOT  W1050  W1061  5
```

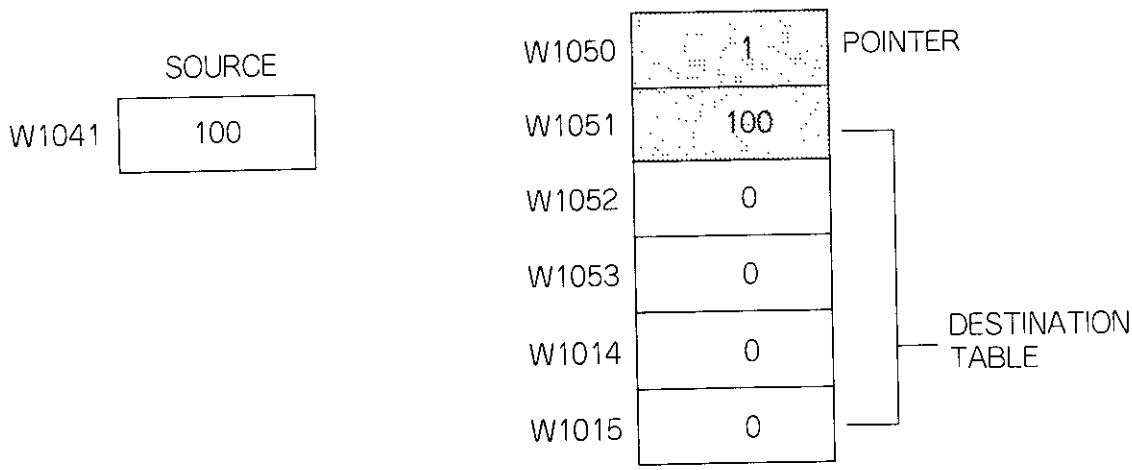

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[Contents of Transfer] (FIN)

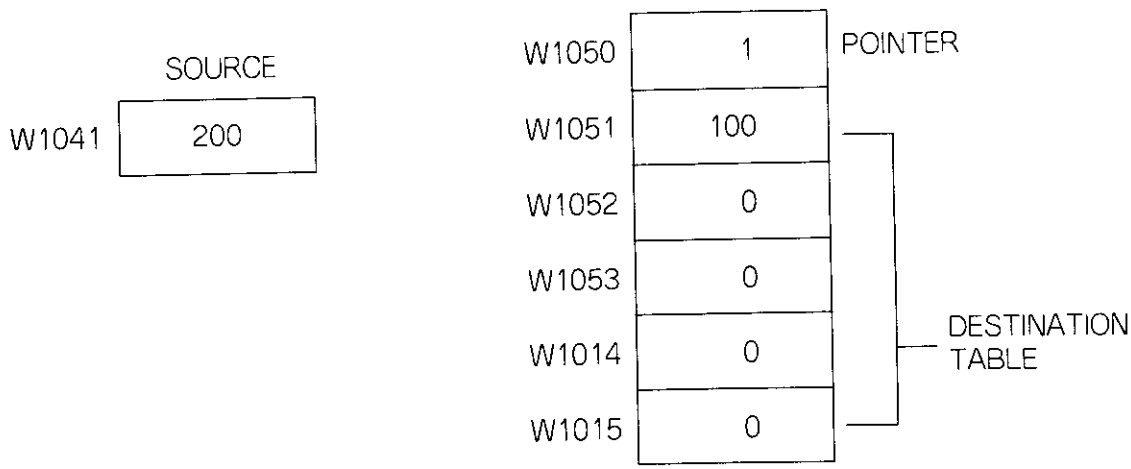
① When the contents of the FIFO table before execution of transfer (first time) are as shown below;



② When I0001 is turned OFF and then ON and the first transfer is executed;

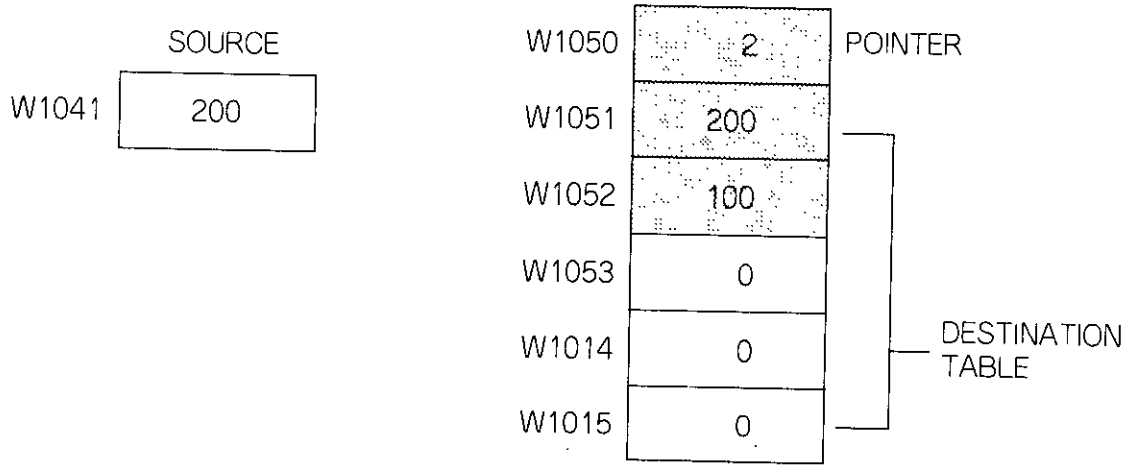


③ The following shows the contents of the register before the second transfer;



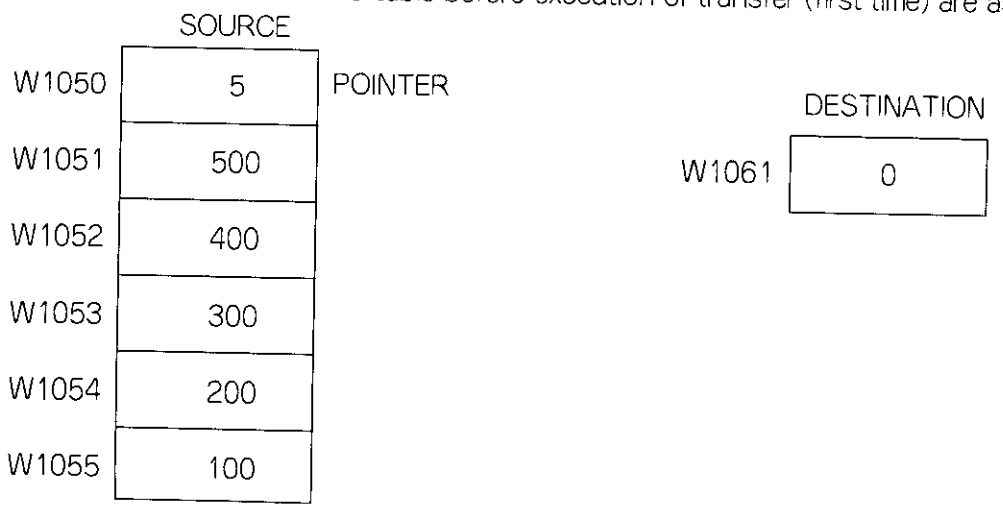
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④ When I0001 is turned OFF and then ON and the second transfer is executed, the first transferred data are shifted down and the current source data are stored in the top of the destination table.

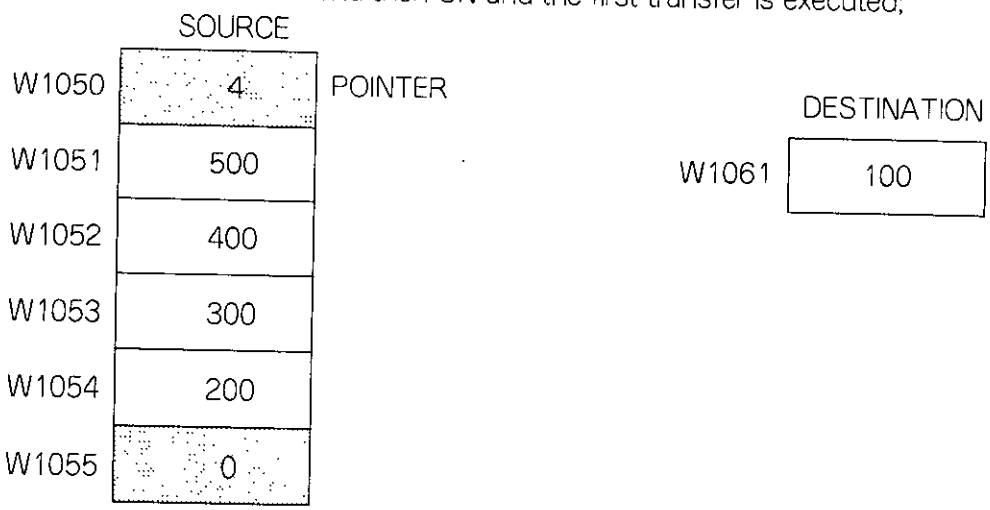


[Contents of Transfer] (FOT)

① When the contents of the FIFO table before execution of transfer (first time) are as shown below ;



② When I0002 is turned OFF and then ON and the first transfer is executed;



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③ When I0002 is turned OFF and then ON and the second transfer is executed;

	SOURCE	
W1050	3	POINTER
W1051	500	
W1052	400	
W1053	300	
W1054	0	
W1055	0	

	DESTINATION
W1061	200

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7.5.8 Search (SRC)

(1) Command symbol

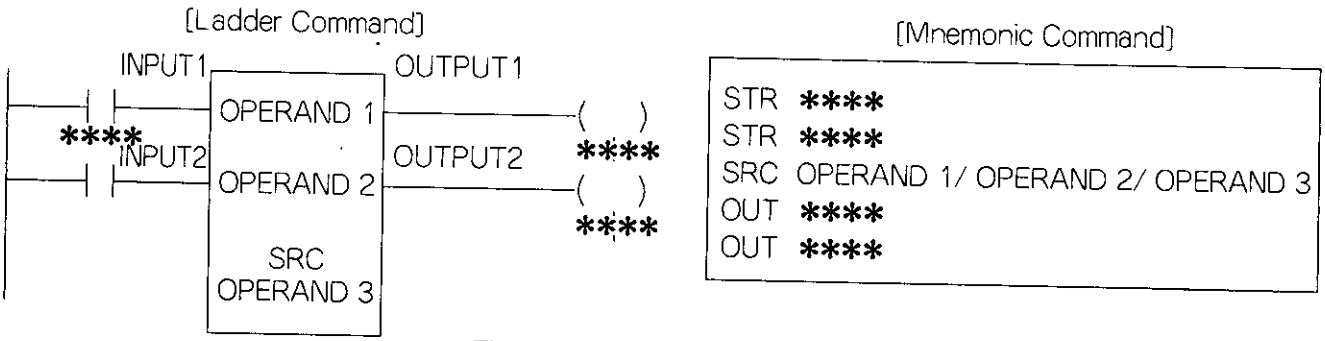


Fig. 7.29 Command Symbols

(2) Operand

Table 7.26 Operand

OPERAND 1	Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 2	Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 3	Constants 1 to 100

(3) Calculating function

A function to search for the data which coincide with the specified value (0 to 9999) or binary 16-bit pattern in the register table and indicates where it is found by the number (pointer).

(a) Search function

Before searching, the specified data are stored in the register next to the destination pointer. Assuming that the pointer value is n when the search command is given, search is started from the (n+1) th source data, and when there are data that coincide with the specified data at the mth, m is left in the contents of the pointer and search is completed. If no data are found, the contents of the pointer are cleared to 0 and search is completed.

Search operation finds one coincidence in one scan. Therefore, when all source table contents are the same as those specified, if there is no coincidence, search is completed in a scan.

Where the next search operation starts after one search operation is completed it will differ depending on the status of inputs 1 and 2.

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(b) Search operation

When only input 1 is turned ON, search is performed after clearing n automatically before execution of search. That is, search is always executed from the top of the source table. Therefore, even if there are several items of data which coincide with the specified data in the source table, those to be searched for are the first ones.

When inputs 1 and 2 are turned ON, assuming the value of the pointer immediately before the data is n, the search starts from the (n+1)th of the source table. Therefore, to start searching from the ith, turn ON inputs 1 and 2 after setting the pointer value to i-1.

When the data that coincide with the specified data K are located at m1th, m2th and m3th in the source table, set the pointer value to (i-1) th and turn ON inputs 1 and 2, and search starts from the ith and completes at the (n+m2)th; the next search starts from the (m2+1)th and completes at (n=m3)th.

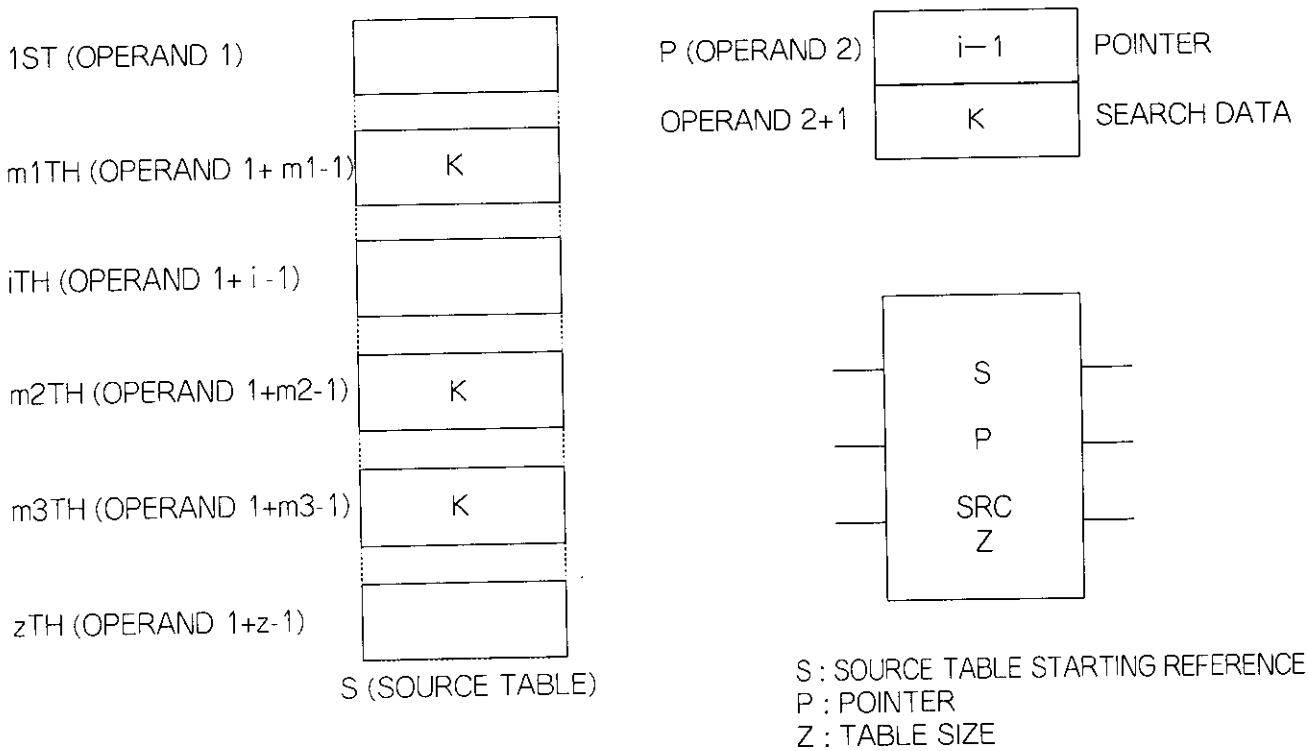


FIG. 7.30 Search Operation

Either when only input 1 is turned ON or when both inputs 1 and 2 are turned ON, if no data coincide with the specified data, search is completed in that scan at n=N (N: table size) and n=0 is set. (Search is never returned to the beginning of the same scan to be executed.)

When input is turned OFF and then ON at n≧N, n is cleared to 0 automatically and search starts from the top of the source data.

Input 3 is not used.

When input 1 is turned OFF, the pointer value is always 0.

Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.

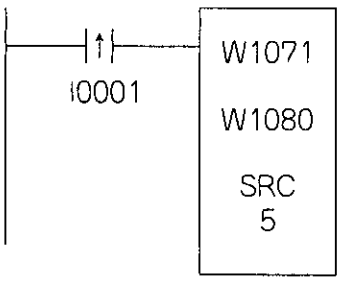
Output 2 is turned ON when coincident data are found by search.

Output 3 is not used. It is always OFF.

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(4) Typical use

[Ladder Command]



[Mnemonic Command]

```
STH I 1
SRC W1071 W1080 5
```

① Contents of execution (search data provided)

When I001 is turned OFF and then ON, data which coincide with the search data are found at the third register from the top of the following source table and 3 is set in the pointer.

W1071	100
W1072	200
W1073	300
W1074	400
W1075	500

SOURCE TABLE

W1080	0	POINTER
W1081	300	DATA TO BE SEARCHED FOR

[Before Search]

W1071	100
W1072	200
W1073	300
W1074	400
W1075	500

SOURCE TABLE

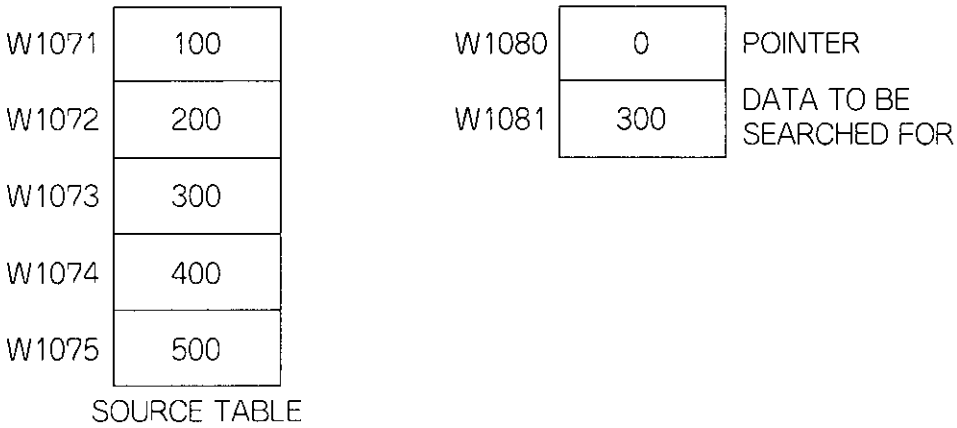
W1080	3	POINTER
W1081	300	DATA TO BE SEARCHED FOR

[After Search]

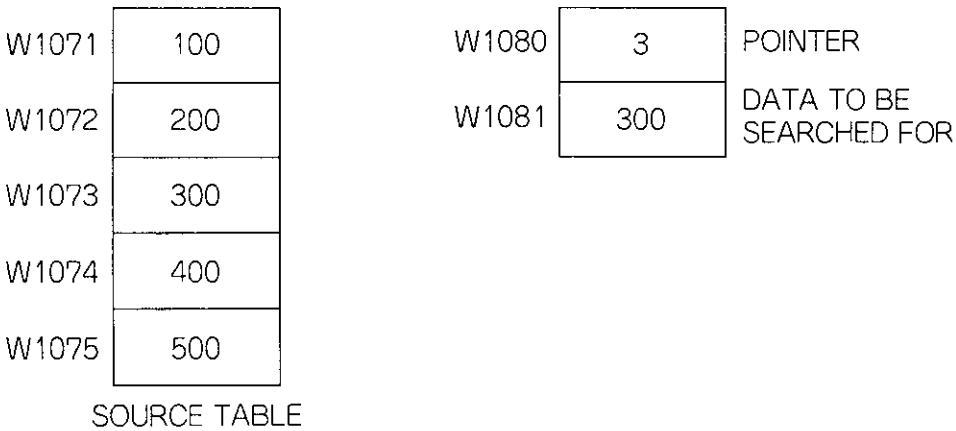
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② Contents of execution (search data are not provided)

When I001 is turned OFF and then ON, search status from the 4th register from the top of the source table according to the pointer indication. If after the 4th register, there are no data that coincide with the search data, the pointer value is not renewed and the setting is still 3.



[Before Search]



[After Search]

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7.5.9 Table Set (TST)

(1) Command symbol

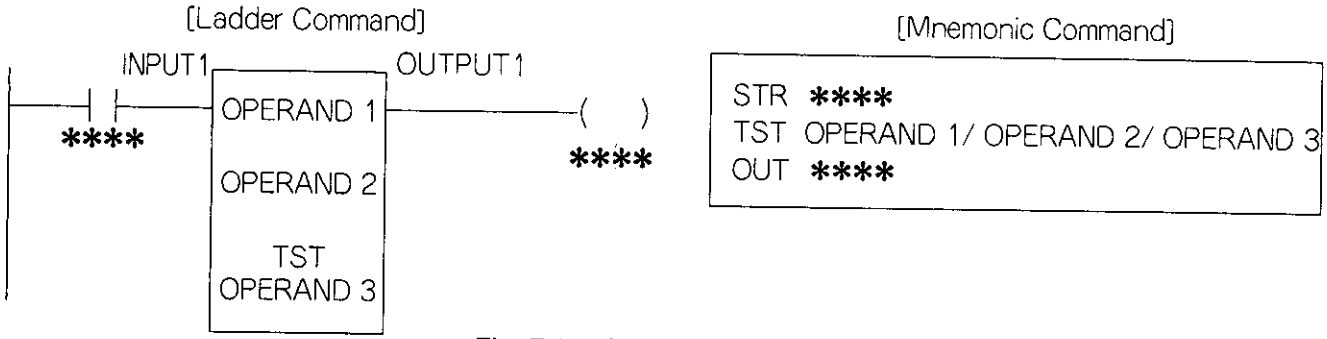


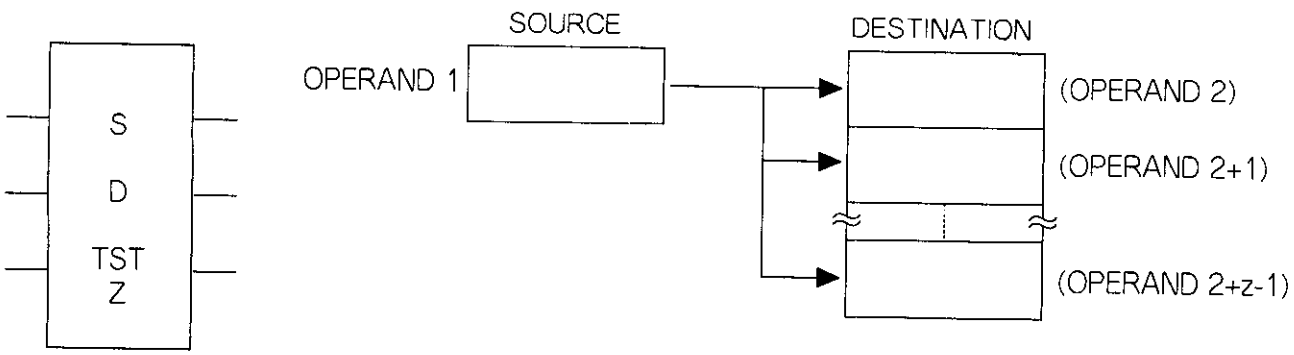
Fig. 7.31 Command Symbols

(2) Operand

Table 7.27 Operand

OPERAND 1	Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 2	Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 3	Constants 1 to 100

(3) Calculating function



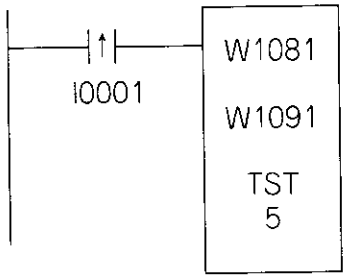
S : Source register
D : Destination cable starting reference
Z : Table size

Fig. 7.32 Table Set Transfer (TST) Calculation

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(4) Typical use

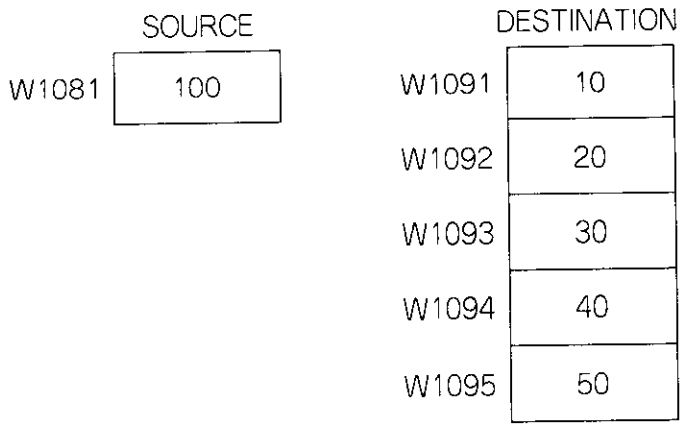
[Ladder Command]



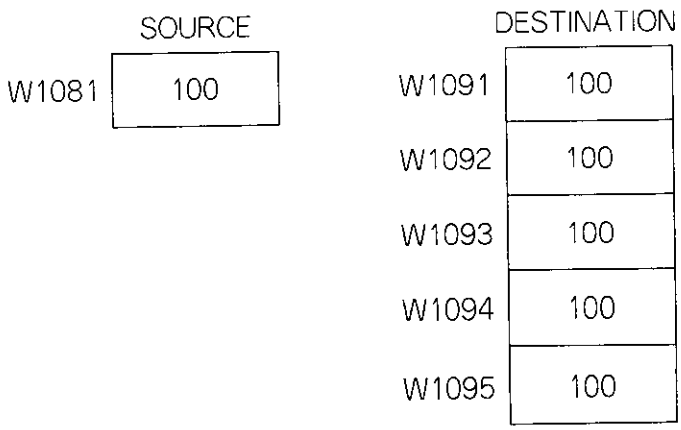
[Mnemonic Command]

```
STH I 1
TST W1081 W1091 5
```

When input I001 is turned OFF and then ON, data 100 of register W1081 are transferred to destination tables W1091 to W1095.



[Before Execution]



[After Execution]

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7.5.10 Status Read (STT)

(1) Command symbol

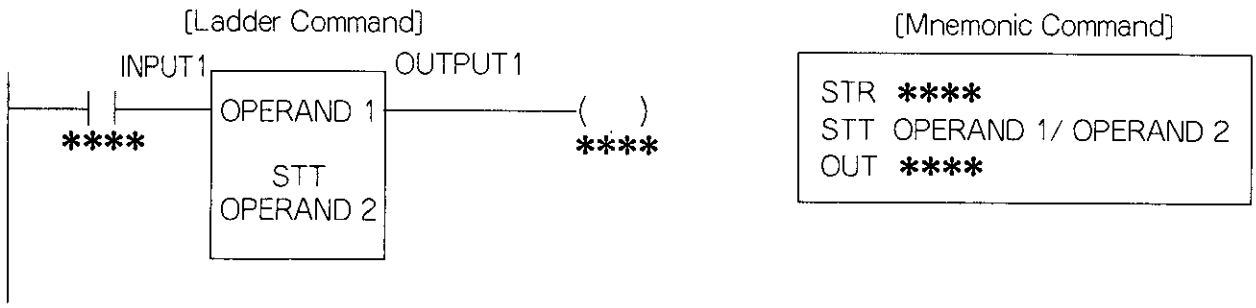


Fig. 7.33 Command Symbols

(2) Operand

Table 7.28 Operand

OPERAND 1	Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 3	Constants 1 to 100

(3) Calculating function

The system status read command reads out the system information (various status, error information) of the PLC unit for each register. The system information of the PLC unit is stored in the memory specified in advance and renewed every scan. It is also possible to read out the status information for the size from the position specified by the STT command and store it in the specified register.

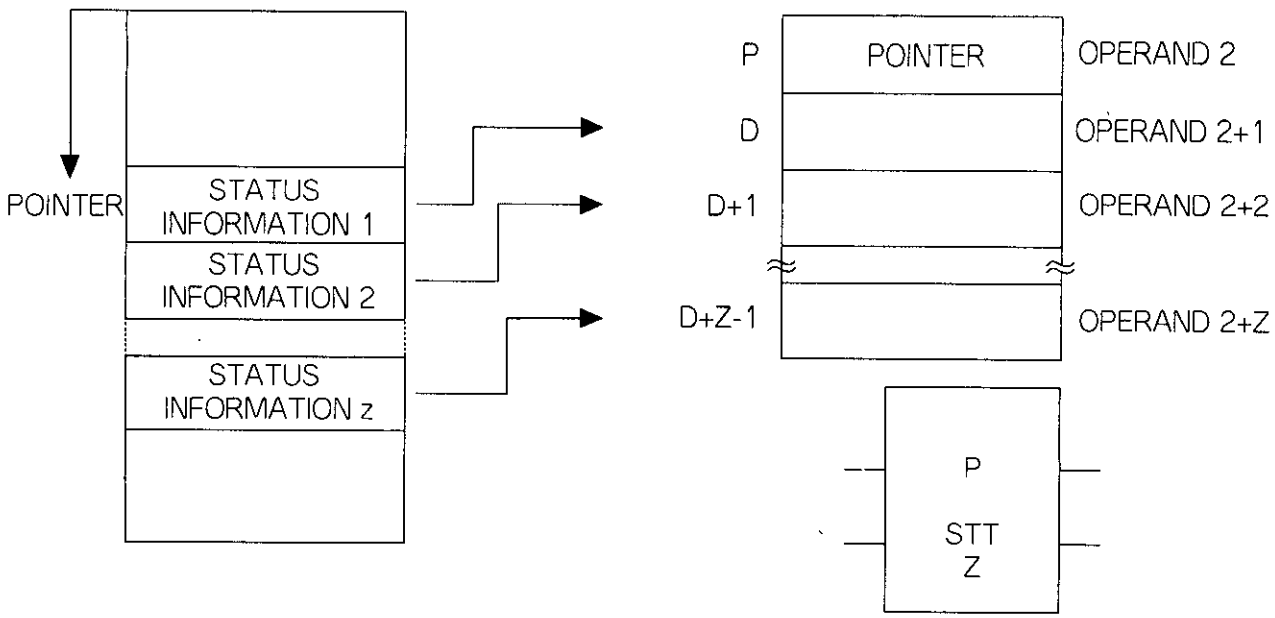


Fig. 7.34 Status Read (STT) Calculation

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Fig. 7.35 shows the PLC system information.

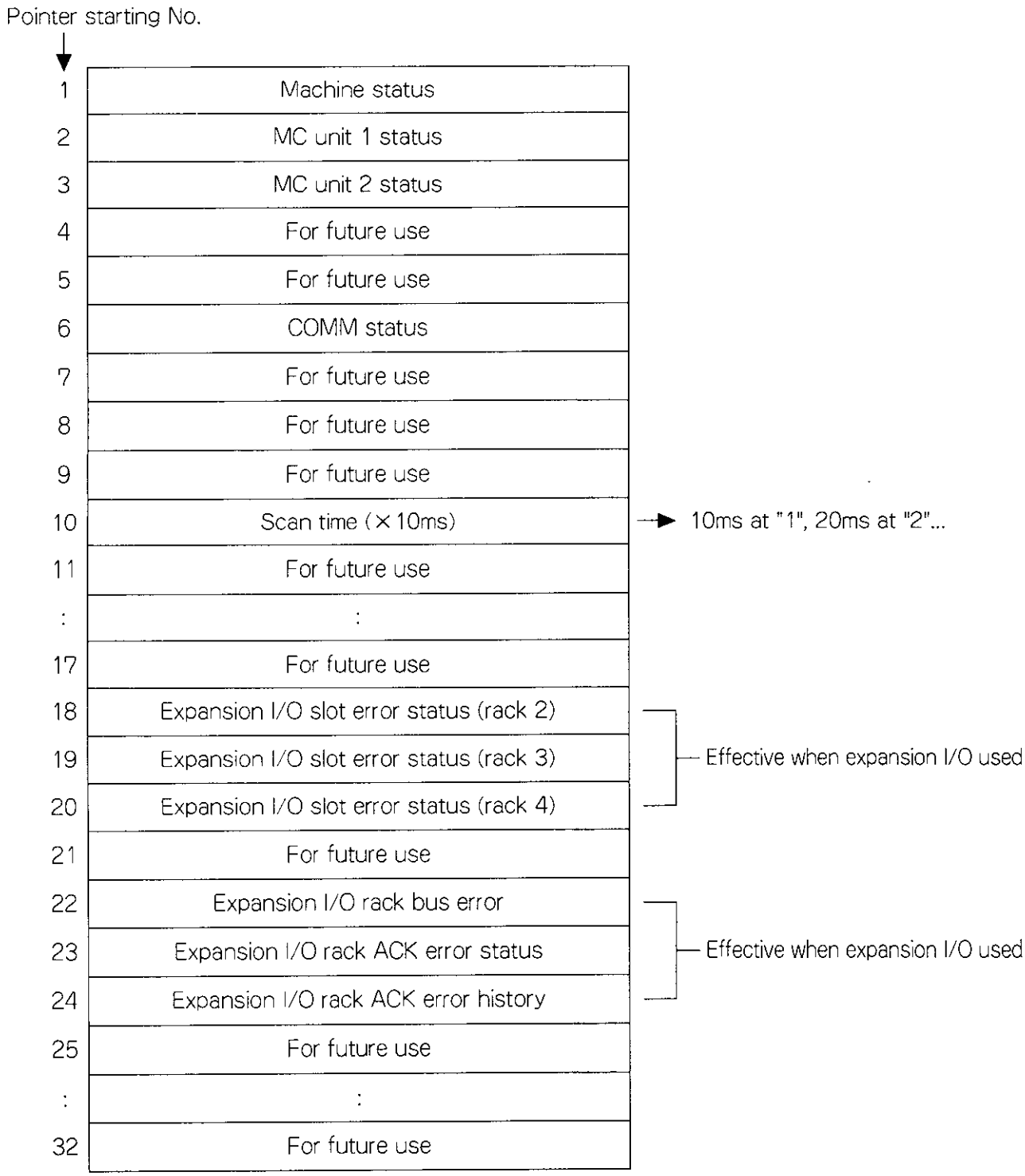


Fig. 7.35 PLC System Information

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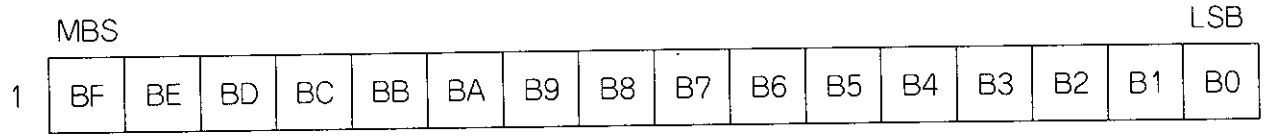
Pointer starting No.

33	MC unit 1	axis-1 current value	H I
34	MC unit 1	axis-1 current value	LO
35	MC unit 1	axis-2 current value	H I
36	MC unit 1	axis-2 current value	LO
37	MC unit 1	axis-3 current value	H I
38	MC unit 1	axis-3 current value	LO
39	MC unit 1	axis-4 current value	H I
40	MC unit 1	axis-4 current value	LO
41	MC unit 2	axis-1 current value	HI
42	MC unit 2	axis-1 current value	LO
43	MC unit 2	axis-2 current value	HI
44	MC unit 2	axis-2 current value	LO
45	MC unit 2	axis-3 current value	HI
46	MC unit 2	axis-3 current value	LO
47	MC unit 2	axis-4 current value	H I
48	MC unit 2	axis-4 current value	LO
49	MC unit 1	axis-1 deviation	H I
50	MC unit 1	axis-1 deviation	LO
51	MC unit 1	axis-2 deviation	H I
52	MC unit 1	axis-2 deviation	LO
53	MC unit 1	axis-3 deviation	H I
54	MC unit 1	axis-3 deviation	LO
55	MC unit 1	axis-4 deviation	H I
56	MC unit 1	axis-4 deviation	LO
57	MC unit 2	axis-1 deviation	H I
58	MC unit 2	axis-1 deviation	LO
59	MC unit 2	axis-2 deviation	H I
60	MC unit 2	axis-2 deviation	LO
61	MC unit 2	axis-3 deviation	H I
62	MC unit 2	axis-3 deviation	LO
63	MC unit 2	axis-4 deviation	H I
64	MC unit 2	axis-4 deviation	LO

Fig. 7.35 PLC System Information (Cont'd)

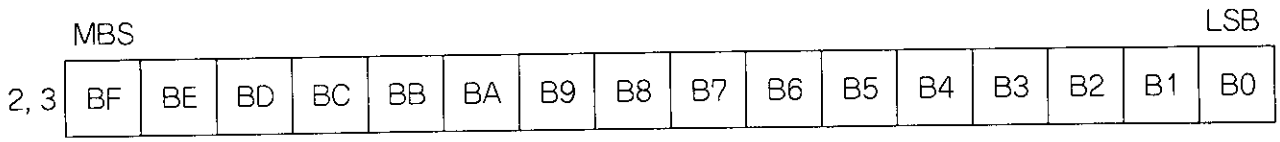
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【Machine Status】



BF : Momentary power loss flag
BE : I/O error
BD : COMM error
BC : For future use
BB : For future use
BA : For future use
B9 : For future use
B8 : For future use
B7 : MC unit 1 error
B6 : MC unit 2 error
B5 : For future use
B4 : For future use
B3 : For future use
B2 : For future use
B1 : For future use
B0 : For future use

【MC Units 1 and 2 Status】

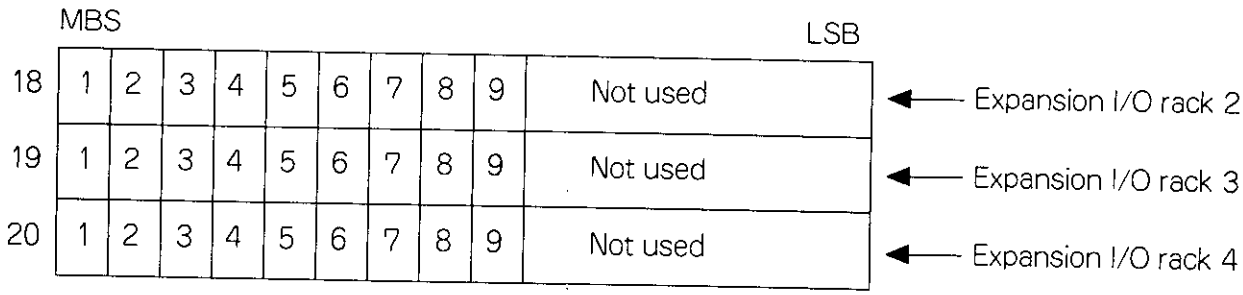


BF : [MC main] For future use
BE : [MC main] ROM total check error
BD : [MC main] 2-port check error
BC : [MC main] CMOS check error
BB : [MC main] For future use
BA : [MC main] Power supply error
B9 : [MC main] System error
B8 : [MC main] 0-division, overflow
B7 : [MC servo] For future use
B6 : [MC servo] ROM total check error
B5 : [MC servo] 2-port check error
B4 : [MC servo] RAM check error
B3 : [MC servo] Watchdog error
B2 : [MC servo] Power supply error
B1 : [MC servo] System error
B0 : [MC servo] 0-division, overflow

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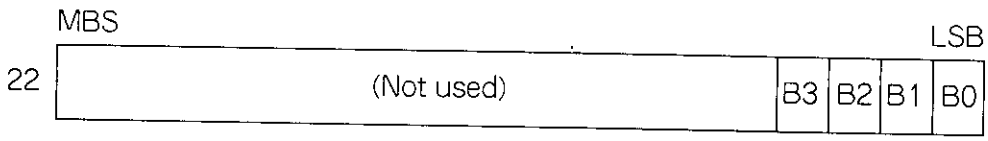
【Expansion I/O Slot Error Status】

The data indicating an error of the series 2000 I/O module mounted on each rack of the expansion I/O are stored. When the I/O module is not mounted in I/O assignment of the expansion I/O, "1" is set to the relevant bit.



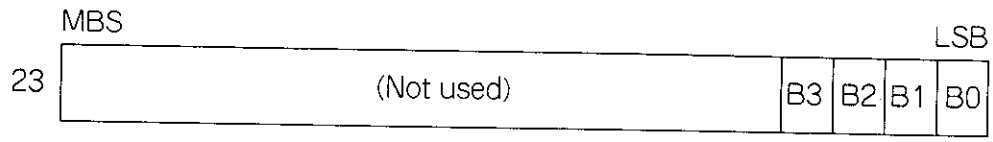
Note : 1 to 9 indicate each expansion I/O slot No.

【Expansion I/O Rack Bus Error】



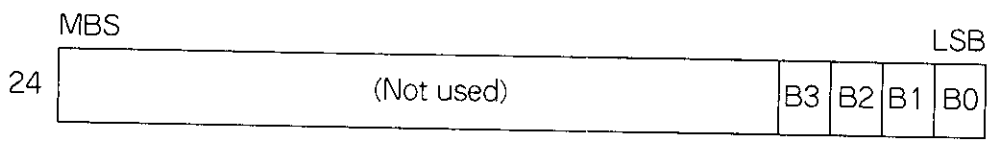
B3 : Rack 4 bus check error
B2 : Rack 3 bus check error
B1 : Rack 2 bus check error
B0 : For future use

【Expansion I/O Rack ACK Error Status】



B3 : Rack 4 no-response
B2 : Rack 3 no-response
B1 : Rack 2 no-response
B0 : For future use

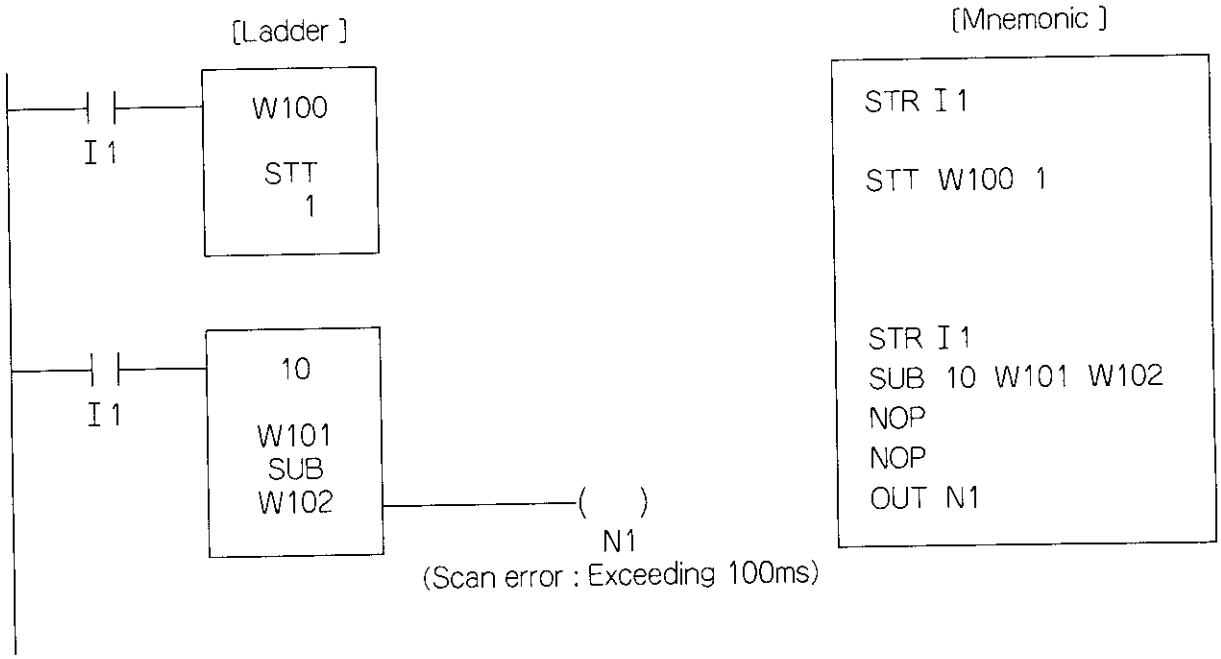
【Expansion I/O Rack ACK Error History】



B3 : Rack 4 no-response (previous scan)
B2 : Rack 3 no-response (previous scan)
B1 : Rack 2 no-response (previous scan)
B0 : For future use

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(4) Typical use



When I 1 is turned ON, the scan time is input to W101.

W100	10 (Pointer)
W101	Scan time

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7.6 MATRIX

The matrix commands execute calculation among several data tables as well as data transfer.

In data transfer, data are processed in units of one register or a set of 16 points of discrete group data (ON/OFF data) comprising the table.

However, in the matrix, register or discrete group data comprising the table is divided into bit units and treated as a bit pattern.

Since one register or one set of discrete group data are comprised of 16 bits, the size of the matrix table is a multiplier of 16 by counting in bit numbers.

One bit has either status of "1" (ON) or "0" (OFF). For example, with 100-register matrix table size, 1600-bit "1" or "0" status is to be processed. In this way, bits are provided with serial numbers, which are called bit numbers.

The bit numbers are provided in the order from the register of the smallest number (or discrete) MSB (position 2). Fig. 7.36 shows how to provide the bit numbers of the matrix table comprised of four registers. It is necessary to compose the table using continuous registers (or discrete group data) as well as data transfer.

	MBS					LSB
W1001	1 ,	2 ,	3 ,	4 ,	··· ···	, 16
W1002	17 ,	18 ,	19 ,	20 ,	··· ···	, 32
W1003	33 ,	34 ,	35 ,	36 ,	··· ···	, 48
W1004	41 ,	42 ,	43 ,	44 ,	··· ···	, 64

Fig. 7.36. Matrix Table

There are 8 types of matrix commands as shown in Table 7.29.

Table 7.29. Matrix Commands

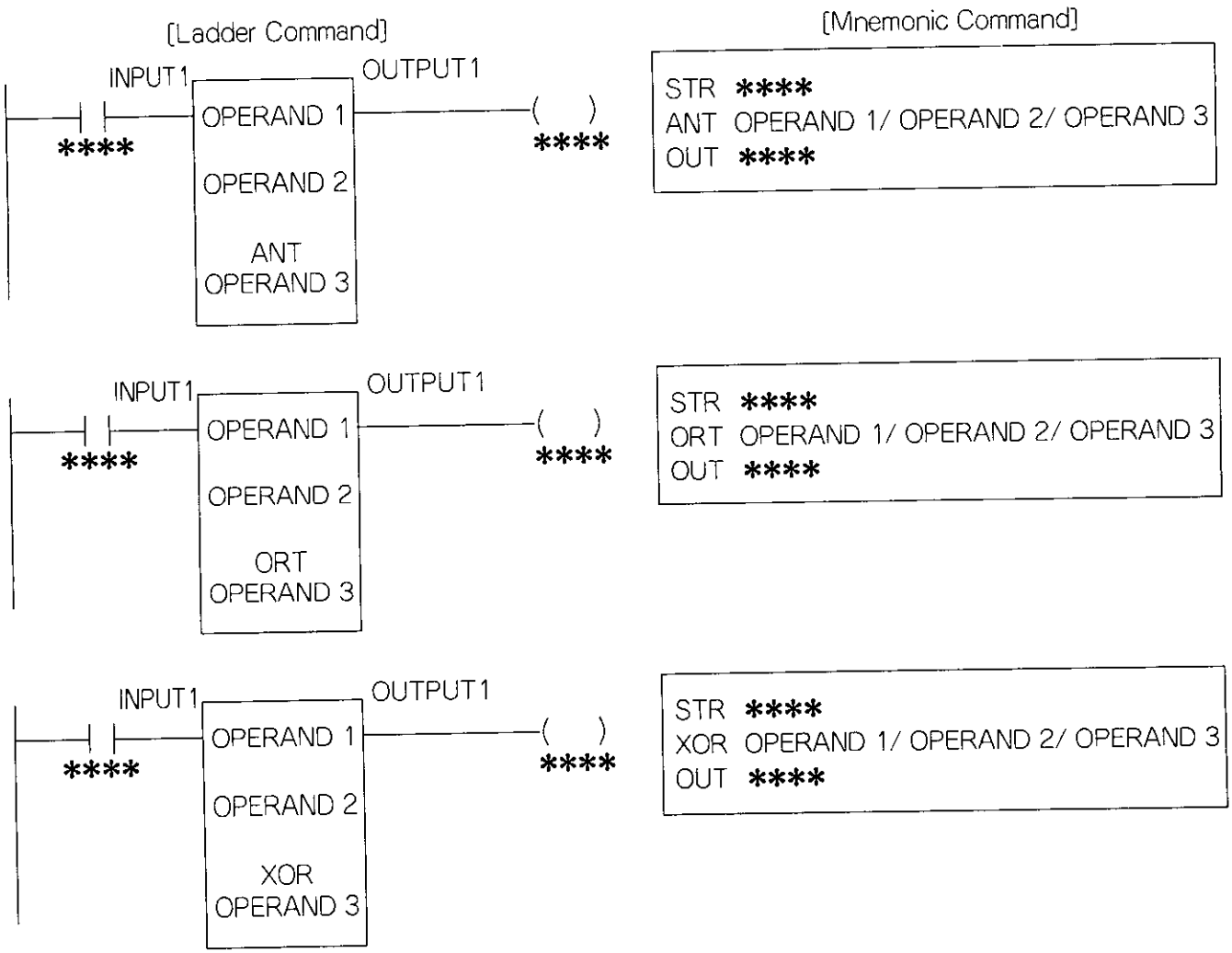
Name	Symbol	Function
AND table	ANT	Logical product
OR table	ORT	Logical sum
Exclusive OR table	XOR	Logical exclusive sum
Complement	CMP	Bit reverse
Compare	CPR	Bit comparison
Modify bit	MBT	Bit modification
Sense	SNS	Bit sensing
Multi-rotate	MRT	Multi-bit shift, rotation

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7.6.1 AND Table (ANT), OR Table (ORT), Exclusive OR Table (XOR)

Since those three logical operation functions have simliar composition, they are explained together.

(1) Command symbol



OPERAND 1 : Source table starting reference
OPERAND 2 : Destination table starting reference
OPERAND 3 : Table size

Fig. 7.38 Command Symbols

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(2) Operand

Table 7.30 Operand

OPERAND 1	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 MC control coil group : Q1 to Q241 Input relay group : I1 to I497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
OPERAND 2	Output coil group : O1 to O497 Internal coil group : N1 to N1521 Link coil : D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 3	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64, Nxxxx : 1 to 96 Zxxx, Rxxxx, Wxxxx : 1 to 100 The smaller constant range is specifed between Operands 1 to 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxxx (data register), the constant range is 1 to 100 of Zxxx.

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(3) Calculating function

When input 1 is turned ON, calculation is executed.
Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Outputs 2 and 3 are not used. They are always OFF.
Fig. 7.37 shows the truth value table of 1-bit ANT, ORT and XOR.

ANT (A · B=C)

A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

ORT (A+B)

A	B	C
0	0	0
1	0	1
0	1	1
1	1	1

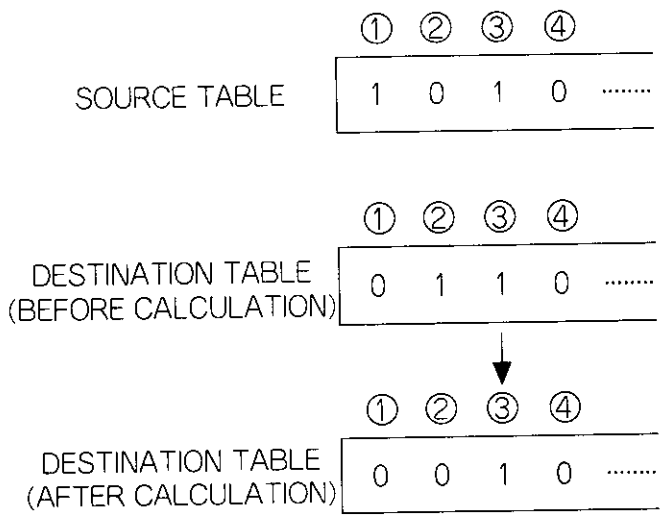
XOR (A · $\bar{B}$+$\bar{A}$ · B)

A	B	C
0	0	0
1	0	1
0	1	1
1	1	0

Fig. 7.37 Truth Value Table

ANT, ORT and XOR in the matrix, logical operation is executed for the source table and destination table in the same size with the same bit number according to the truth value table. The results are stored at the same bit number as the destination table.

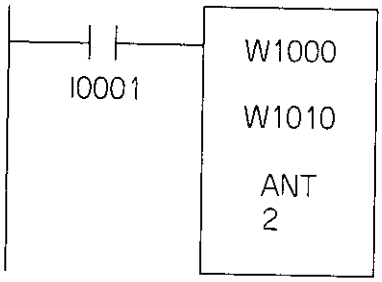
(Example) AND table calculation



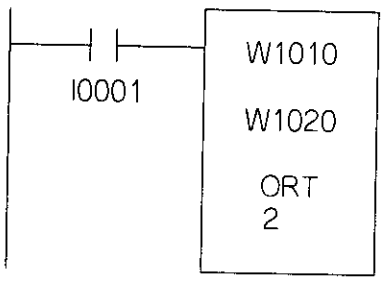
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(4) Typical use

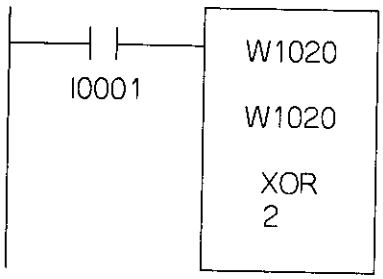
When input I001 is turned ON, ANT, ORT and XOR are operated in that order.




```
STR I 1
ANT W1000 W1010 2
```




```
STR I 1
ORT W1010 W1020 2
```




```
STR I 1
XOR W1020 W1020 2
```

① Before calculation

W1000	1100111011101110
W1001	1111111000001111
W1010	1010101010101010
W1011	0101010101010101
W1020	0000000011111111
W1021	1111111100000000

② After calculation of ANT

W1000	1100111011101110
W1001	1111111000001111
W1010	1000101010101010
W1011	0101010000000101
W1020	0000000011111111
W1021	1111111100000000

③ After calculation of ORT

W1000	1100111011101110
W1001	1111111000001111
W1010	1000101010101010
W1011	0101010000000101
W1020	1000101011111111
W1021	1111111100000101

④ When XOR is operated, since the source and destination tables are the same, the contents of W1020 and W1021 are all 0. However, the contents of W1000, W1001, W1010 and W1011 are not changed.

In this way, the tables can be cleared by using XOR.

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7.6.2 Complement (CMP)

(1) Command symbol

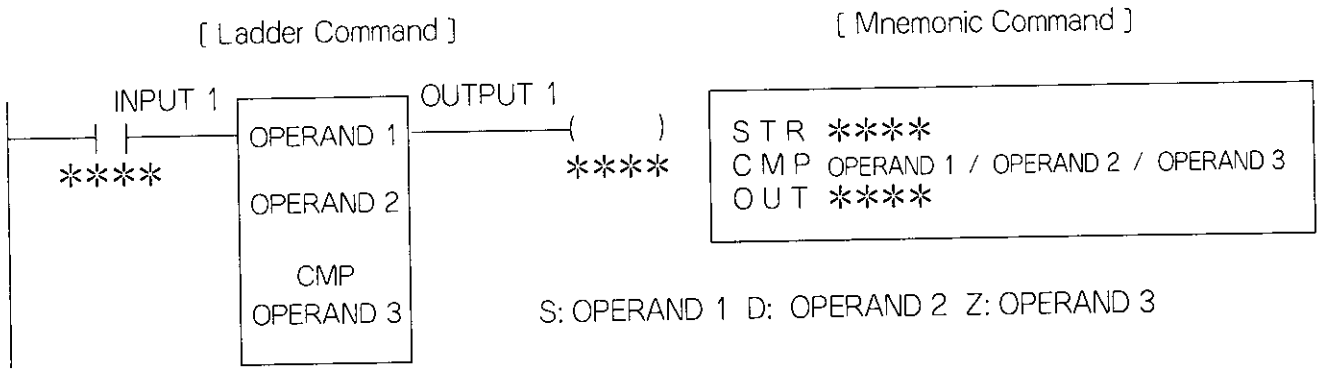


Fig. 7 39 Command Symbol

(2) Operand

Table 7.31 Operand

Operand 1	Source reference	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I 1 to I 497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil : D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
Operand 2	Destination reference	Output coil group : O1 to O497 Internal coil group : N1 to N1521 Link coil : D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Table size	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64, Nxxxx : 1 to 96 Zxxx, Rxxxx, Wxxxx : 1 to 100 The smaller constant range is specified between Operands 1 and 2. For example, when Operand 1 is Zxxx (input register) and Operand 2 is Wxxx (data register), the constant range is 1 to 100 of Zxxx.

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(3) Calculating function

All-bit status of the source table is reversed ("1" to "0" , "0" to "1") and stored at the same bit No. of the destination table.
calculation is executed for one scan disregarding the table size.
When input 1 is turned ON, calculation is executed. Inputs 2 and 3 are not used.

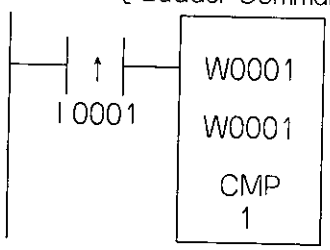
Output 1 is turned ON and OFF when input 1 is turned ON and OFF, respectively.
Outputs 2 and 3 are not used. They are always OFF.

(4) Typical use

When I001 is turned OFF and then ON, CMP (reverse) is executed.

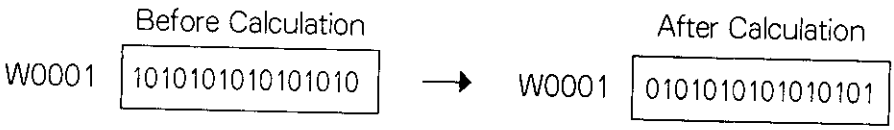
[Exzmple 1]

[Ladder Command]



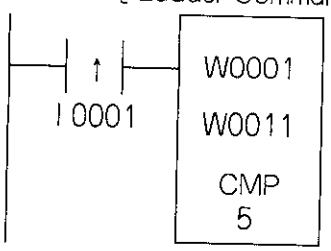
[Mnemonic Command]

```
STH   I 1
CMP   W1  W1  1
```



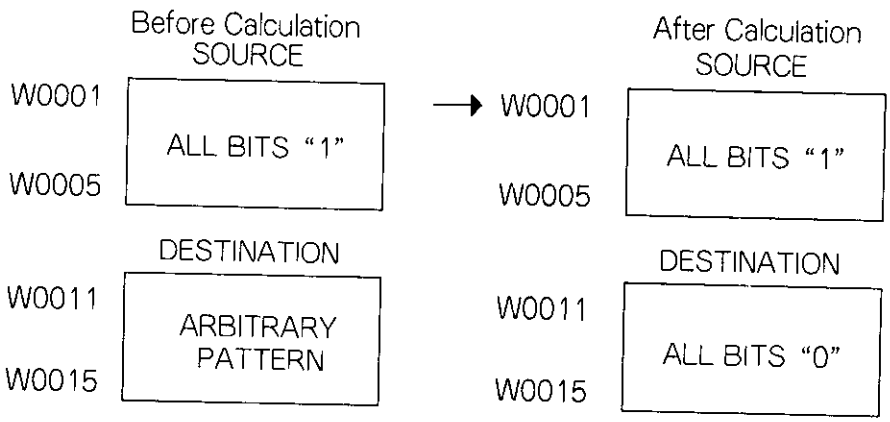
[Exzmple 2]

[Ladder Command]



[Mnemonic Command]

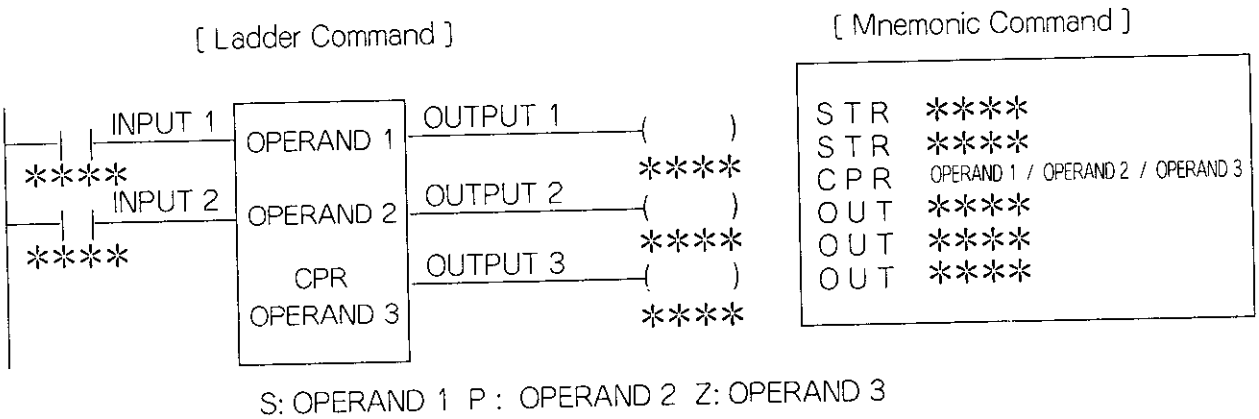
```
STH   I 1
CMP   W1  W11  5
```



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7.6.3 Compare (CPR)

(1) Command symbol



S: OPERAND 1 P : OPERAND 2 Z: OPERAND 3

Fig. 7. 40 Command Symbols

(2) Operand

Table 7.32 Operand

Operand 1	Source reference	Output coil group : O1 to O497 Internal coil group : N1 to N1521 MC unit coil group : Y1 to Y497 Input relay group : I 1 to I 497 MC unit relay group : X1 to X241 MC control relay group : P1 to P241 Link coil: D1 to D1009 Data register : W1 to W2048 Input register : Z1 to Z128 Link register : R1 to R1024 Timer register : T1 to T256 Counter register : C1 to C256
Operand 2	Destination reference	Data register : W1 to W2047 Link register : R1 to R1023
Operand 3	Table size	Constant (table size) Constant range is determined by Operand 1 and 2 registers. Pxxx, Qxxx, Txxx, Cxxx : 1 to 16 Oxxx, Ixxx, Yxxx, Xxxx : 1 to 32 Dxxxx : 1 to 64, Nxxxx : 1 to 96 Zxxx, Rxxxx, Wxxxx : 1 to 100 The smaller constant range is specified between Operands 1 and 2. For example when Operand 1 is Zxxx (input register) and Operand 2 is Wxxxx (data register), the constant range is 1 to 100 of Zxxx.

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(3) Calculating function

Source table and destination table with the same bit No. are compared in their bits (whether they coincide with each other or not) by one bit. The bit No. to start comparison with is determined by the pointer value located at the top of the destination.

When calculation starts with the pointer value n-1, the nth bits are compared for the first time; when they coincide with each other (both the source and destination are "1" or "0"), the (n+1) th bits are compared. Then when they coincide, the (n+2) th bits are compared. In this way, as far as the bits coincide, comparison continues in the order of bit numbers.

When some bits do not coincide, then bit No. m is left in the pointer and comparison is halted in the scan.

When all bits coicide, comparison is completed at the last bit specified by the table size. At this time, the pointer value becomes 0.

In this way, CPR finds one mismatch in one scan disregarding table size.
Therefore, when all bits coincide, all bit comparison is completed in one scan.
However, when the first bits do not coincide, only one bit comparison can be performed in one scan. The destination table data excluding the source table size and pointer value are not changed because of calculation. Additionally, the pointer value can be changed by other logic operation.

Comparison starts from the (pointer value + 1) th bit. When this value is the last bit No. or exceeds it at starting, the pointer value is automatically cleared to 0 and comparison starts from the first bit.

Comparison is executed when input 1 is turned ON. By turning ON input 2, the pointer value is cleared to 0 disregarding the ON/OFF status of input 1. Input 3 is not used.

Output 1 is a copy of input 1. Input 2 is turned ON when mismatched bits are found by comparison. Output 3 is turned ON when mismatched bits are found and the bit source is "1" and destination is "0". However, it is not turned ON when the source is "0" and destination is "1" in the previous bits.

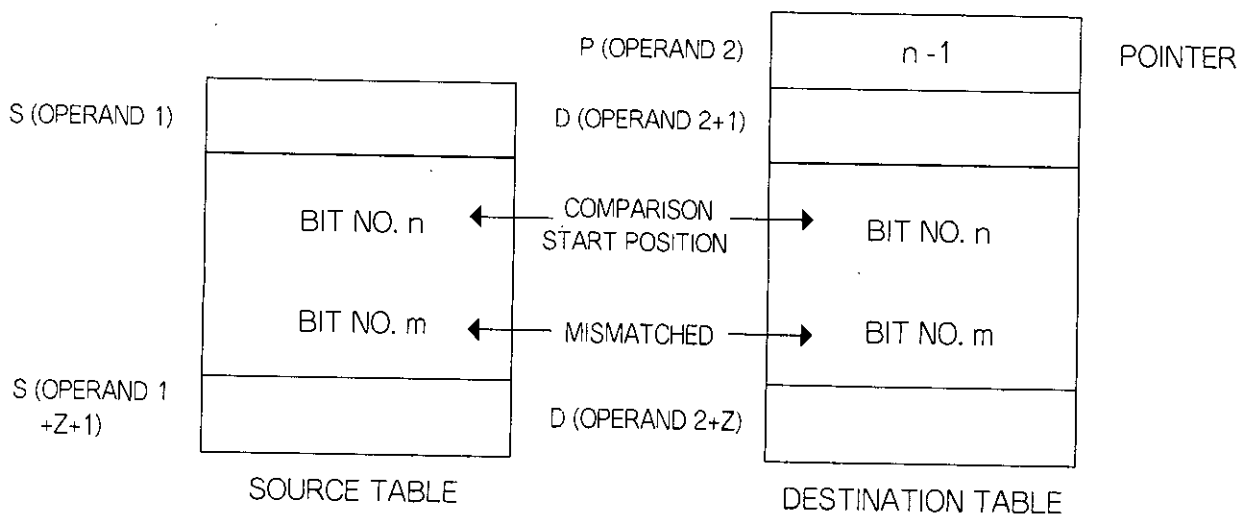
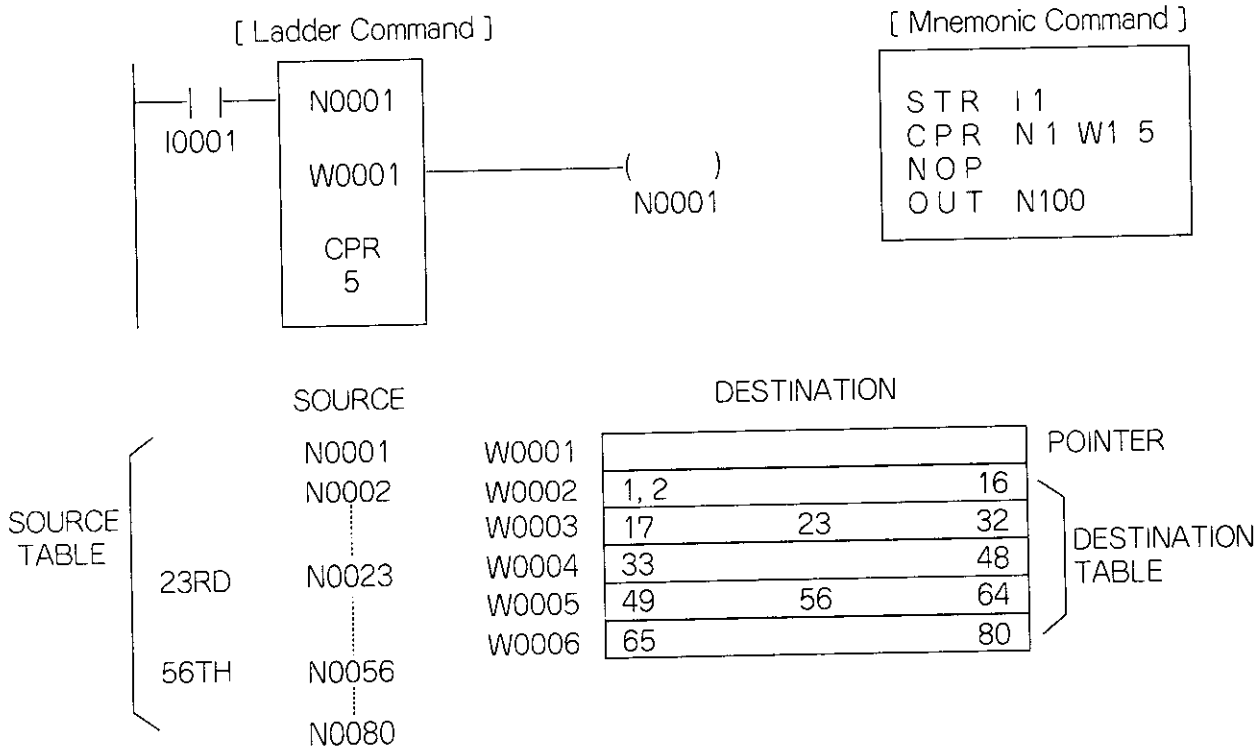


Fig. 7. 41 Calculation

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(4) Typical use



Suppose that the bits at the 23rd and 56th are found to be mismatched in the above example.

Also when coil I0001 is turned OFF and then ON, the pointer value is 0. After that, I0001 remains ON.

In the first scan where I0001 is turned ON, comparison starts from the first bit and stops at the 23rd, leaving 23 in the pointer. Then coil N0100 is turned ON.

In the next scan, comparison starts from the 24th bit and stops after entering 56 to the pointer. At this time, coil N0100 is still ON.

In the next scan, comparison starts from the 56th bit and stops. The pointer value becomes 81 and coil N0100 is turned OFF.

In the next scan, since the pointer value exceeds the last bit, it is cleared to 0 automatically.

After that, comparison starts again from the first bit. In this way, comparison continues unless the status of the source or destination is changed.

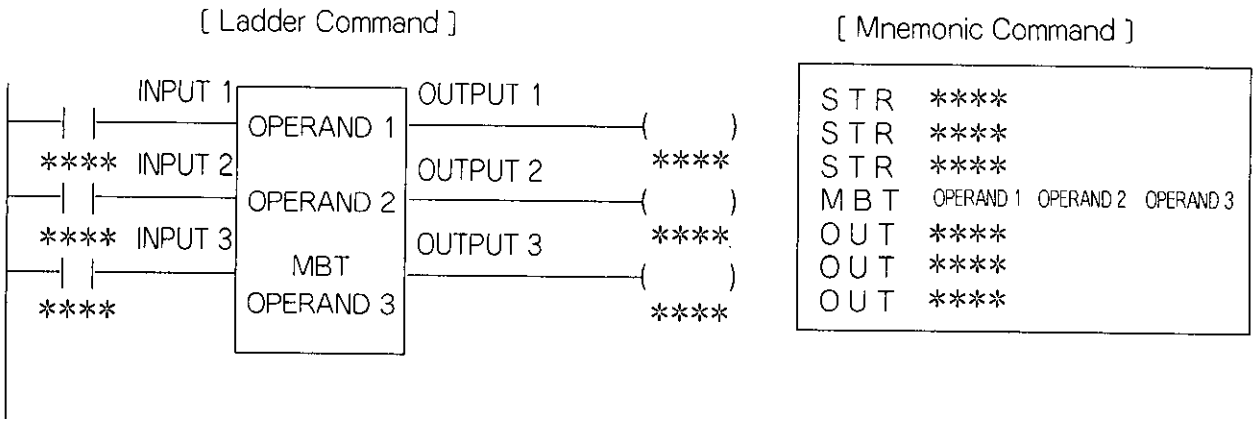
In this example, the status where output 2 is turned ON for 2 scans and OFF for 1 scan repeats.

Normally, then there are n mismatched bits, the status where output 1 is turned ON for n scans and OFF for one scan as far as input 1 is turned ON. However, when both inputs 1 and 2 are turned ON, output 2 remains ON if there is even one mismatched bit.

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7.6.4 Modify Bit (MBT)

(1) Command symbol



S: OPERAND 1, D : OPERAND 2, Z: OPERAND 3

Fig. 7. 42 Command Symbols

(2) Operand

Table 7.33 Operand

Operand 1	Pointer	Constant : 1 to 9600 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 2	Destination table	Output coil group : O1 to O497 Internal coil group : N1 to N1521 Link coil : D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Table size	According to the Operand element 2, the following ranges of constants are determined. Oxxx : 1 to 32 Nxxxx : 1 to 96 Dxxxx : 1 to 64 Wxxxx, Rxxx : 1 to 600

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(3) Calculating function

Among the destination table bits, the status of the bit specified by the pointer is set to "1" or cleared to "0" forcedly.

When input 1 is tuned ON, the bit is set or cleared. When inputs 1 and 2 are turned ON, the relevant bit is set; when input 2 is turned OFF, the bit is cleared.

When input 3 is tuned ON, after execution of bit is setting or clearing, +1 is added to the pointer value if Operand 1 (source) is a register.

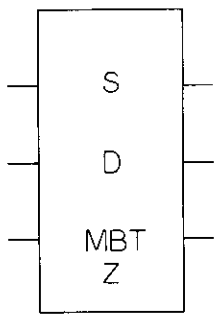
If the pointer value exceeds the largest bit number determined by the table size after +1 is added, the pointer value is automatically returned to 1.

Both inputs 2 and 3 are effective when input 1 is turned ON.

Output 1 is a copy of input 1. Output 2 is turned ON when the bit is set to "1" after execution of setting/clearing (verification of input 2).

Output 3 is turned ON when the pointer value exceeds the largest bit No. specified by the table size, disregarding the ON/OFF status of input 1. (Excess size alarm)

Only the specified bit is set or cleared for one scan; Other bit status is not changed.



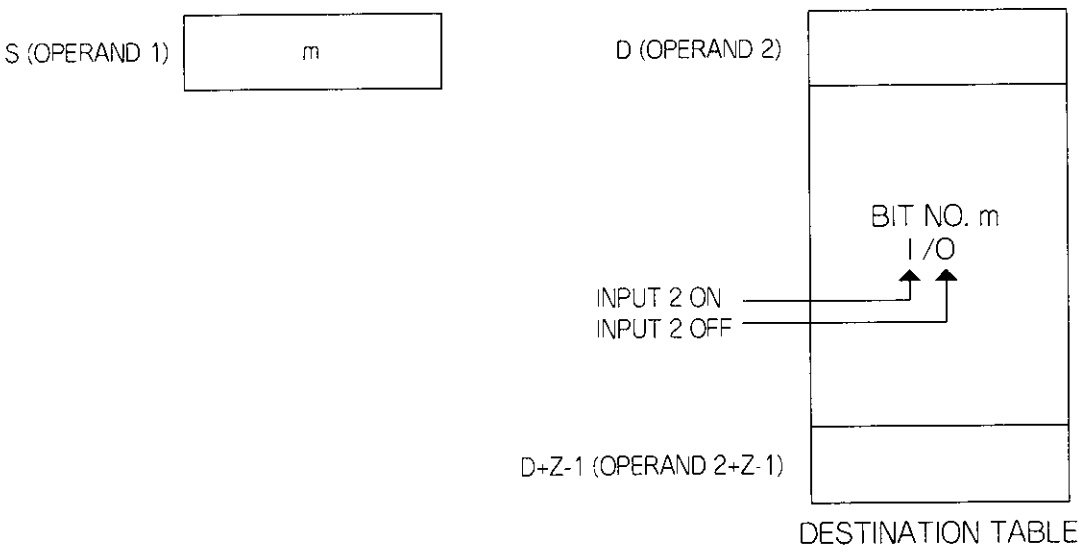
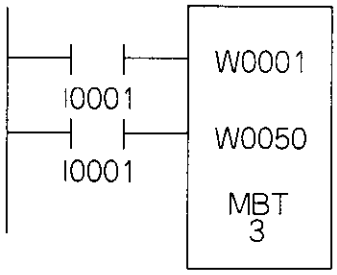


Fig. 7. 45 Modify Bit (MBT) Calculation

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(4) Typical use

[Ladder Command]



[Mnemonic Command]

```
STH  I1
STR  I1
MBT  W1  W1  1
```

[Before Execution of Calculation]

	SOURCE		DESTINATION	
W0001	3	W0050	10001 ····· 010
		W0051	
		W0052	

[After Execution of Calculation]

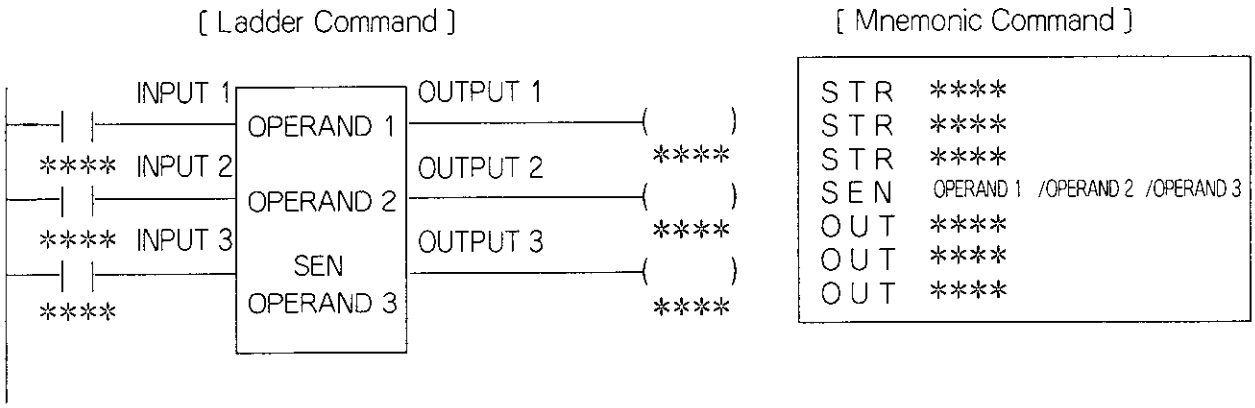
	SOURCE		DESTINATION	
W0001	3	W0050	10101 ····· 010
		W0051	
		W0052	

When relay I0001 is turned ON and the pointer value is 3, the destination table No. 3 becomes "1". The pointer value remains 3.

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7.6.5 Sense (SEN)

(1) Command symbol



P: OPERAND 1, D : OPERAND 2, Z: OPERAND 3

Fig. 7. 44 Command Symbols

(2) Operand

Table 7.34 Operand

Operand 1	Pointer	Constant : 1 to 9600 Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 2	Destination table top No.	Output coil group : O1 to O497 Internal coil group : N1 to N1521 Link coil: D1 to D1009 Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Table size	According to the Operand element 2, the following ranges of constants are determined. Oxxx , Yxxx, Ixxx, Xxxx : 1 to 32 Dxxxx : 1 to 64 Nxxxx : 1 to 96 Pxxx, Qxxx : 1 to 16 Zxxx, Wxxxx, Rxxxx : 1 to 600

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(3) Calculating function

Among the destination bits, the status of the bit specified by the pointer is checked to be "1" or "0". When input 1 is turned ON, sense is executed.
Input 2 is related to renewal of the pointer countents; only when inputs 1 and 2 are turned ON and when the register is used as the pointer, +1 is added to the pointer value after execution of sense.
When the pointer value exceeds the bit No. specified by the table size after +1 is added, the pointer value is automatically returned to 1.
When input 3 is turned ON and Operand 1 is a register, the pointer value is set to 1 disregarding the ON/OFF status of input 1.
Output 1 is a copy of input 2. Output 2 is turned ON when the specified bit No. is "1" after execution of sense.
Output 3 is turned ON when the pointer value exceeds the largest bit No. determined by the table size, disregarding the ON/OFF status of input 1. (Excess size alarm)

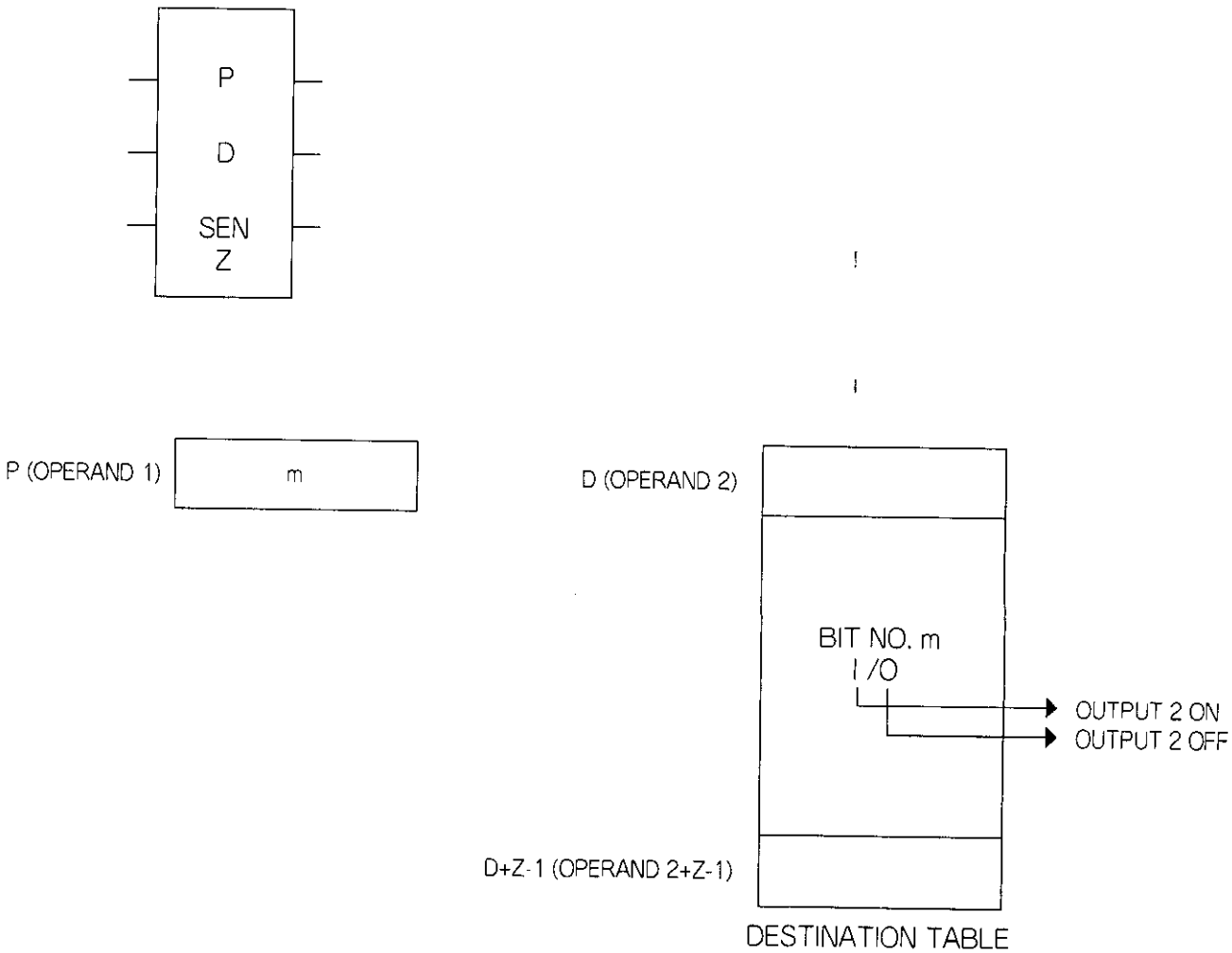
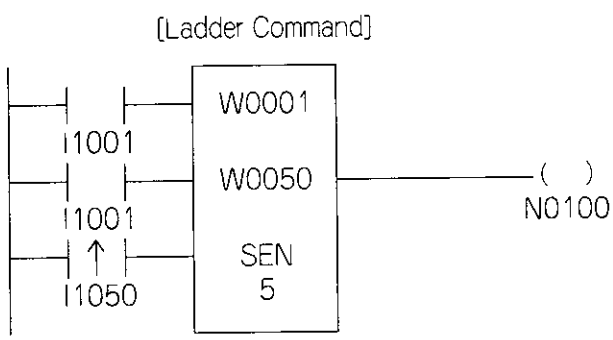


Fig. 7. 45 Sense (SEN) Calculation

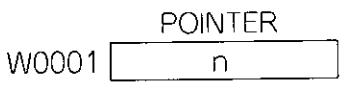
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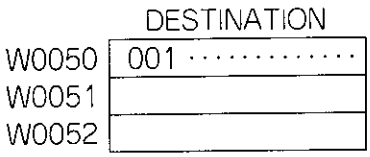
(4) Typical use



[Mnemonic Command]

```
STR    I 1
STR    I 1
STH    I 50
SEN    W1 W50 5
NOP
OUT    N100
```





When relay I0001 is turned OFF and then ON, assume that the value of W0001 is 0 and I0001 remains ON afterwards.

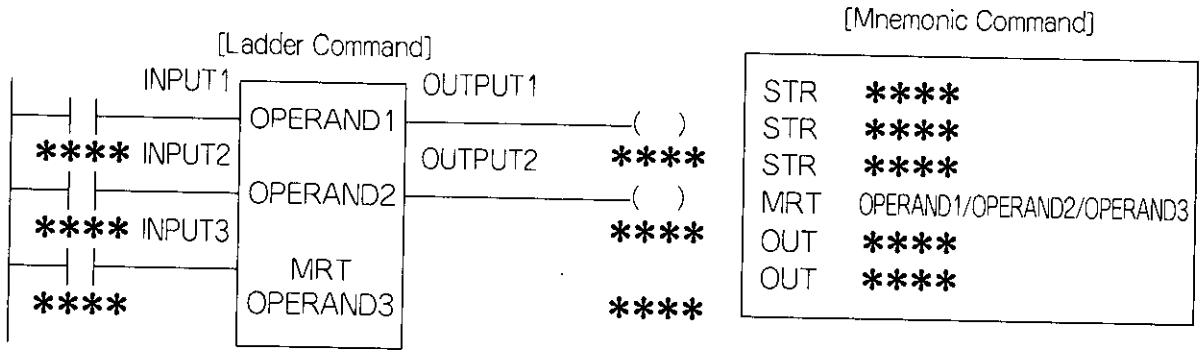
Since n = 0 in the first scan, sense is not executed. But n becomes 1 since input 2 is turned ON. In the next scan, the first bit sense is executed. However, since the value is "0", coil N0100 remains OFF and n becomes 2. In the next scan, n becomes 3; in the next scan, the coil is turned ON and n becomes 4. In this way, as far as relay I0001 remains ON, sense is executed in the ratio of one bit per scan. When sense is completed at the last bit (bit No. 80), the pointer value is returned to 1 in the next scan and sense starts again from the first bit.

In the scan when rely I0050 is turned OFF and then ON, sense starts from the first bit.

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7.6.6 Multi-Rotate (MRT)

(1) Command symbol



S : OPERAND 1, D : OPERAND 2, Z : OPERAND 3

Fig. 7.46 Command Symbols

(2) Operand

Table 7.35 Operand

Operand 1	Source reference	Data register : W1 to W2048 Link register : R1 to R1024
Operand 2	Destination Table	Data register : W1 to W2048 Link register : R1 to R1024
Operand 3	Table size	Constant 1 to 100

(3) Calculating function

The bit arrangement status of the destination table is shifted to the left or right by the shifting number (1 to 15) specified to the source register.

When input 1 is turned ON, shifting is executed. Input 2 determines the shifting direction as follows :

- Shifts to the left when inputs 1 and 2 are turned ON (shifts to smaller bit No.)
- Shifts to the right when input 1 is turned ON and 2 OFF (shifts to larger bit No.)

Input 3 determines what to input to the vacancy.

- When inputs 1 and 3 are turned OFF, carry (bits overflowing by shifting) is entered in the vacancy.
- When inputs 1 and 3 are turned OFF, bit "0" is entered in the vacancy.

Output 1 is turned ON when input 1 is turned ON and shifting can be executed. Output 2 is turned ON when input 1 is turned ON and shifting cannot be executed (the number of shifting times, specified by the source register, is 16 or more, or the source register is included in the destination table.) Fig. 7. 47 shows typical bit shift.

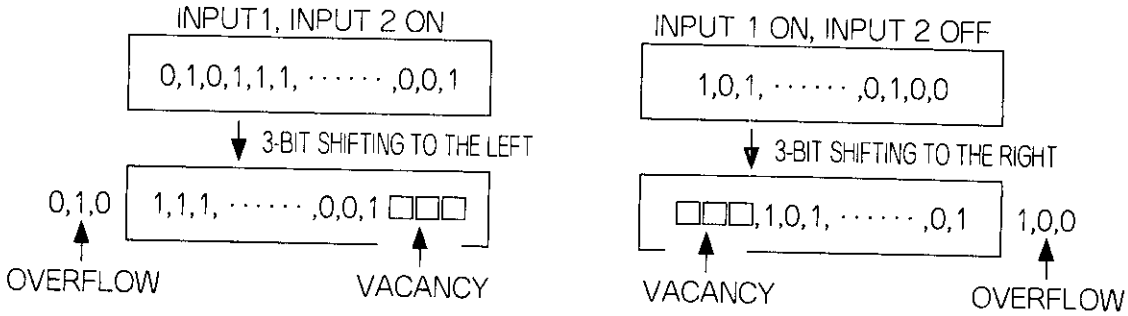


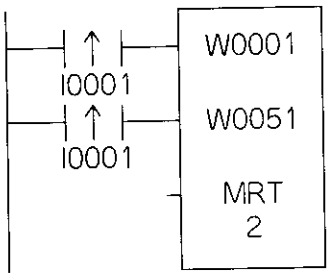
Fig. 7.47 Typical 3-bit Shift

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(4) Typical use

(Example 1)
The following shows an example of 5-bit left shifting. Since input 3 is turned OFF, "0" is entered in the "vacancy"

[Ladder Command]



[Mnemonic Command]

```
STH     I 1
STH     I 1
MRT     W1 W51  2
```

[Before Execution of Calculation]

	SOURCE
W0001	5

	DESTINATION
W0051	0111 0010 1100 0101
W0052	0001 0110 1110 1011

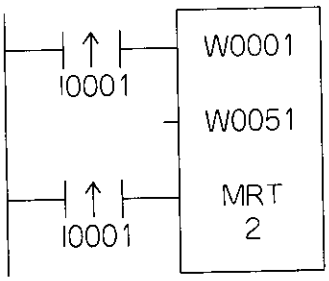
[After Execution of Calculation]

	SOURCE
W0001	5

	DESTINATION
W0051	0101 1000 1010 0010
W0052	1101 1101 0110 0000

(Example 2)
The following shows an example of 8-bit right shifting. Since input 3 is turned ON, carry is entered in the "vacancy"

[Ladder Command]



[Mnemonic Command]

```
STH     I 1
NOP
STH     I1
MRT     W1 W51  2
```

[Before Execution of Calculation]

	SOURCE
W0001	8

	DESTINATION
W0051	0111 0010 1100 0101
W0052	0001 0110 1110 1011

[After Execution of Calculation]

	SOURCE
W0001	8

	DESTINATION
W0051	1110 1011 0111 0010
W0052	1100 0101 0001 0110

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7.7 DATA CONVERSION

There are two types of data conversions; BCD to BIN and BIN to BCD.

7.7.1 BCD to BIN Conversion (BIN)

(1) Command symbol

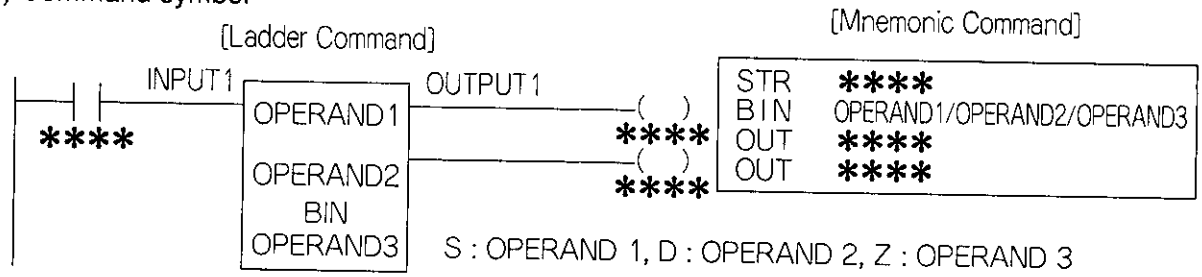


Fig. 7.48 Command Symbols

(2) Operand

Table 7.36 Operand

Operand 1	Source table top No.	Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
Operand 2	Pointer	Data register : W1 to W2047 Link register : Z1 to Z127
Operand 3	Table size	Constant 1 to 16

(3) Calculating function

When input 1 is turned ON, the source table contents expressed in BCD are converted to binary for one scan and transferred to the destination table. When the source table data are not BCD data, at which stage data located from the top are counted and indicated by counting them down from the pointer (or from LSB).

Conversion is executed until the end; Additionally, data which are not BCD (values exceeding 9999) are converted to binary and stored in the destination table as BCD data in any event. However, they are not correct data.

Inputs 2 and 3 are not used.

Output 1 is a copy of input 1.

Output 2 is turned ON when data that are not BCD exist in the source table. The pointer value indicates in which register No. the data exist.

Ouptut 3 is not used. It is always OFF.

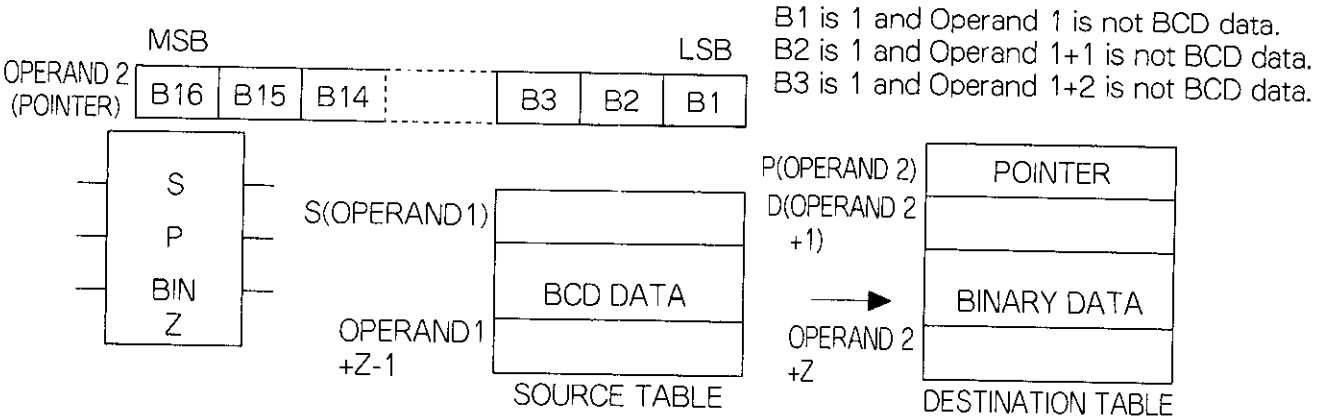
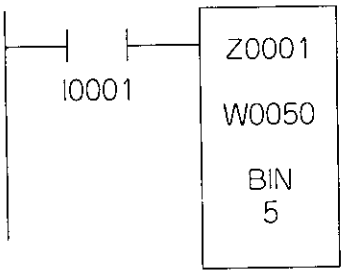


Fig. 7.49

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(4) Typical use

[Ladder Command]



[Mnemonic Command]

```
STH  I 1
BIN  Z1  W50  5
```

[Resultant Calculation]

SOURCE TABLE

Z0001	0001 0000 0000 0000
Z0002	0010 0000 0000 0000
Z0003	0011 0000 0000 0000
Z0004	0100 0000 0000 0000
Z0005	0101 0000 0000 0000

DESTINATION

W0050	0000 0000 0000 0000	POINTER
W0051	0000 0011 1110 1000	
W0052	0000 0111 1101 0000	DESTINATION TABLE
W0053	0000 1011 1011 1000	
W0054	0000 1111 1010 0000	
W0055	0001 0011 1000 1000	

While input relay I0001 is ON, the above conversion is executed.

BIN is mainly used to convert input register BCD data, which are input, to binary of internal notation when the input device is of BCD notation.

Assume that Z0004 data are "0110 1111 0101 0001" that is not BCD; "1" is set at the 4th bit down from W0050 which is a pointer register, and conversion is continued until the last bit of the source table. W0054 data are converted to binary but they are not BCD data that can be indicated. Additionally, output 2 is turned ON when data that are not BCD are contained in the source table.

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7.7.2 BIN to BCD Conversion (BCD)

(1) Command symbol

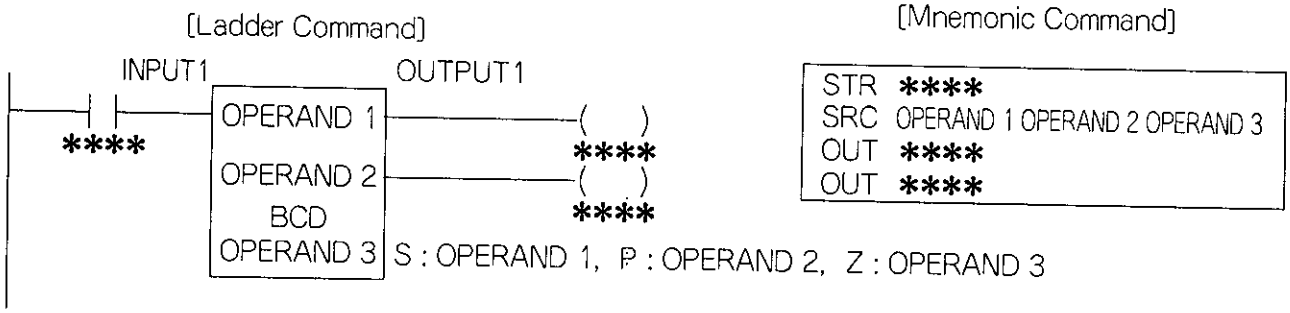


Fig. 7.50 Command Symbols

(2) Operand

Table 7.37 Operand

OPERAND 1	Source table top No.	Input register : Z1 to Z128 Data register : W1 to W2048 Link register : R1 to R1024
OPERAND 2	Pointer	Data register : W1 to W2047 Link register : Z1 to Z127
OPERAND 3	Table size	Constants 1 to 16

(3) Calculating function

When input 1 is turned ON, the source table contents expressed in binary are converted to BCD for one scan and transferred to the destination table. When the source table data cannot be converted to BCD, at which stage data located from the top are counted and indicated by counting them down from the pointer (or from LSB). Conversion is executed until the end. Additionally, data which cannot be converted to BCD (values exceeding 9999) are converted to BCD and stored in the destination table as BCD data in any event. However, they are not correct data.
Inputs 2 and 3 are not used.

Output 1 is a copy of input 1.
Output 2 is turned ON when data that cannot be converted to BCD exist in the source table. The pointer value indicates in which register No. the data exist.
Output 3 is not used. It is always OFF.

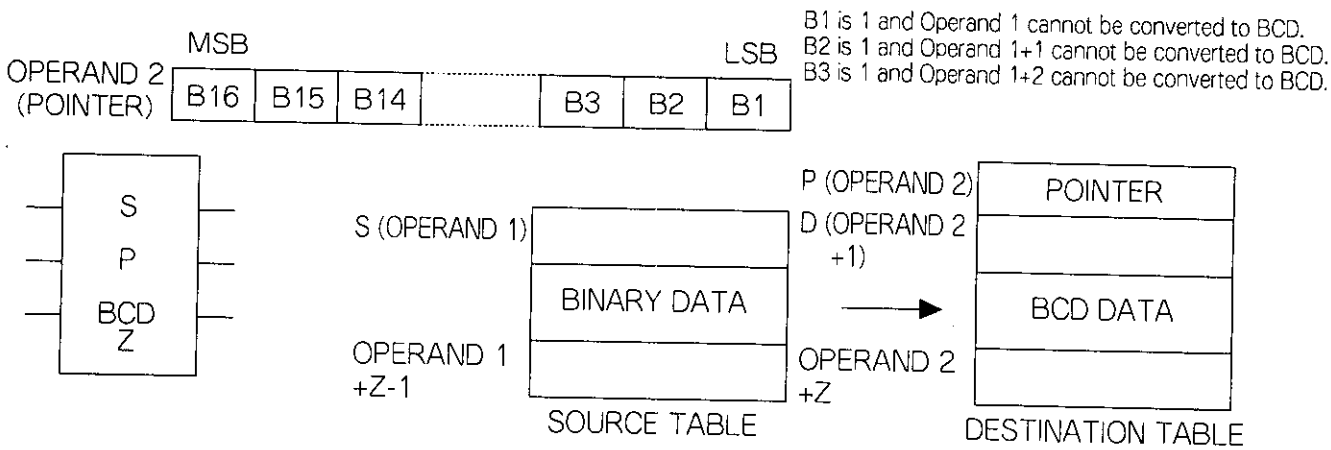
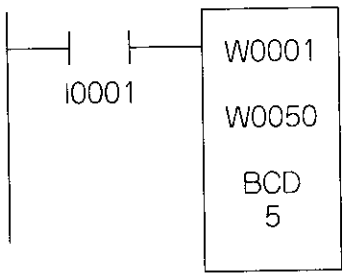


Fig. 7.51 Calculation

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(4) Typical use

[Ladder Command]



[Nnemonic Command]

```
STR  I 1
BCD  W1  W50  5
```

[Before Execution of Calculation]

SOURCE TABLE

W0001	1000 0000 1010 0000
W0002	0000 1000 0000 0000
W0003	0000 0000 0000 1111
W0004	0000 0000 0001 0000
W0005	0000 0001 0000 0000

DESTINATION

W0050	0000 1000 0000 0000	POINTER
W0051	ARBITRARY PATTERN	
W0052		
W0053		
W0054		
W0055		

[After Execution of Calculation]

SOURCE TABLE

W0001	1000 0000 1010 0000	(-160)
W0002	0000 1000 0000 0000	(2048)
W0003	0000 0000 0000 1111	(15)
W0004	0000 0000 0001 0000	(16)
W0005	0000 0001 0000 0000	(256)

DESTINATION

W0050	0000 0000 0000 0001	POINTER
W0051	WRONG DATA	
W0052	0010 0000 0100 1000	
W0053	0000 0000 0000 1111	
W0054	0000 0000 0001 0000	
W0055	0000 0010 0101 0110	

While input relay I0001 is ON, the above conversion is executed.

BCD is mainly used to convert input register binary data, which are the result of internal calculation, to BCD and output them when the output device is of BCD notation.

In the above example, the contents of W0001 (the data are assumed to be a minus value) of the source table will be 32988 (5 digits) by converting them to BCD. Since the value cannot be entered in the register, wrong data are stored. In this case, "1" is set at the lowest digit bit of pointer W0050 and conversion is continued until the end of the source table. In this way, according to the pointer value, in which register wrong data are contained can be indicated. Additionally, output 2 is turned ON when data that cannot be converted to 4-digit BCD are contained in the source table.

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7.8 TRIGONOMETRIC FUNCTION

Trigonometric function command calculates a value of sine (SIN) or cosine (COS) of calculated value up to 4 digits following the decimal point in the range of 0° to 360°. There are two types ; sine (SIN) and cosine (COS).

7.8.1 Sine (SIN)

(1) Command symbol

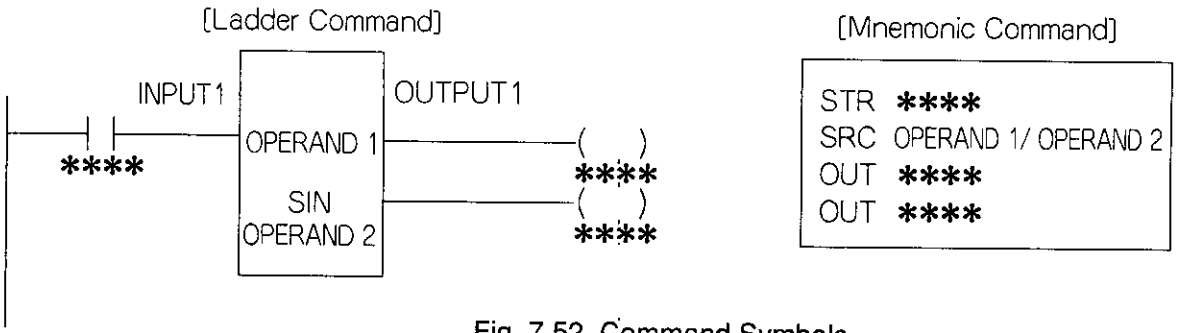


Fig. 7.52 Command Symbols

(2) Operand

Table 7.38 Operand

OPERAND 1	Input register : Z1 to Z127 Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 2	Data register : W1 to W2047 Link register : R1 to R1023

(3) Calculating function

When input 1 is turned ON, sine (SIN) calculation is executed up to 4 digits after the decimal point in the range of 0° to 360°.

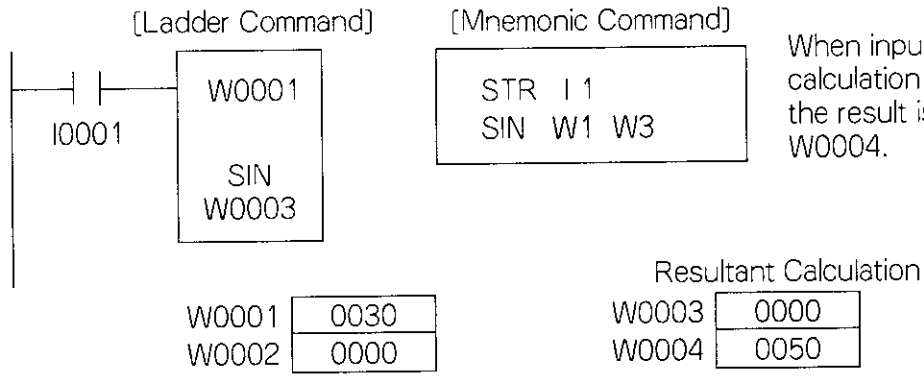
The result is divided into the integral section and decimal section (5th digit or more after the decimal point is discarded) and stored in two registers.

Output 1 is turned ON when input 1 is turned ON and the resultant calculation is minus. It remains OFF when the value is plus. Output 2 is turned ON when input 1 is turned ON and the resultant calculation (contents of Operand 1) exceeds 360.

SIN {[Operand 1] . [Operand 1+1]}=[Operand 2] . [Operand 2+1]
Integral section | Decimal section Integral section | Decimal section
Decimal point Decimal point

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(4) Command symbol



7.8.2 Cosine (COS)

(1) Command symbol

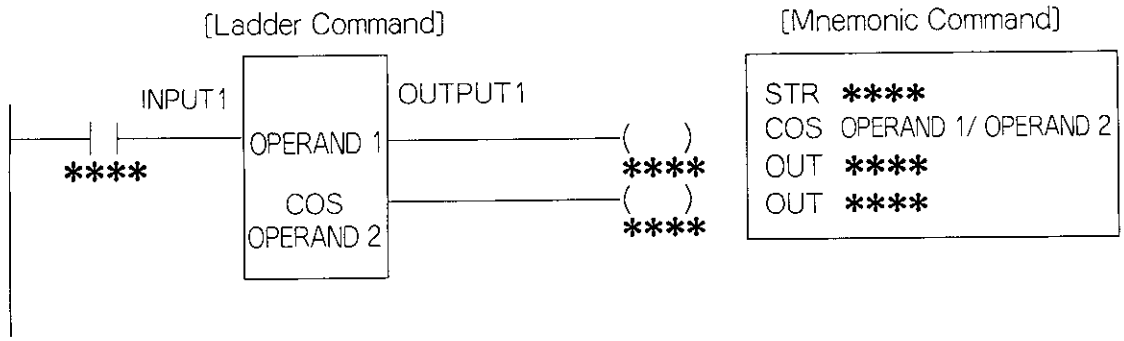


Fig. 7.53 Command Symbols

(2) Operand

Table 7.38 Operand

OPERAND 1	Input register : Z1 to Z127 Data register : W1 to W2047 Link register : R1 to R1023
OPERAND 2	Data register : W1 to W2047 Link register : R1 to R1023

(3) Calculating function

When input 1 is turned ON, cosine (COS) operation, up to 4 digits after the decimal point in the range of 0° to 360°, is executed.

The result is divided into the integral section and decimal section (5th digit or more after the decimal point is discarded) and stored in two registers.

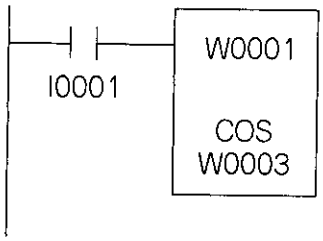
Output 1 is turned ON when input 1 is turned ON and the resultant calculation is minus. It remains OFF when the value is plus. Output 2 is turned ON when input 1 is turned ON and the resultant calculation (contents of Operand 1) exceeds 360.

COS {[Operand 1] . [Operand 1+1]}=[Operand 2] . [Operand 2+1]
Integral section / Decimal section Integral section / Decimal section
Decimal point Decimal point

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(4) Typical use

[Ladder Command]



[Mnemonic Command]

```
STR  I 1
COS  W1  W3
```

When input relay I0001 is turned ON, calculation of COS60° is executed and the result is stored in W0003 and W0004.

W0001	0060
W0002	0000

Resultant Calculation

W0003	0000
W0004	0050

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7.9 SKIP (SKP)

(1) Command symbol

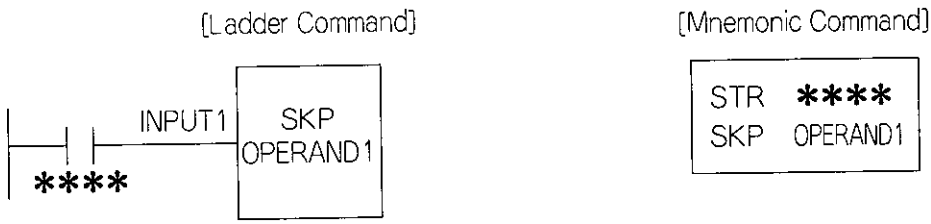


Fig. 7.54 Command Symbols

(2) Operand

Table 7.40 Operand

Operand1	Constant : 0 to 9999 Input register : Z1 to Z128 Data register : W1 to W2048

(3) Calculation function

Skip has a function to freeze processing of as many circuit blocks as specified. That is, skipped circuit blocks are not decoded, and the coil ON/OFF status and register contents contained in these blocks are kept in the status immediately before skip. They are not changed during skip.

When input 1 is turned ON, processing of circuit blocks of N, N+1,...N+j-1 is canceled.

Assuming J=0, or when J> exists in the blocks, skip is executed until the last circuit block.

Using skip when many applied command circuit blocks are provided is effective for reduction of scans. However, when most circuit blocks to be skipped belong to the basic sequence commands, operation can be faster if they are decoded without skipping.

Output 1 is not used.

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7.10 SUBROUTINE (GSB)

(1) Command symbol

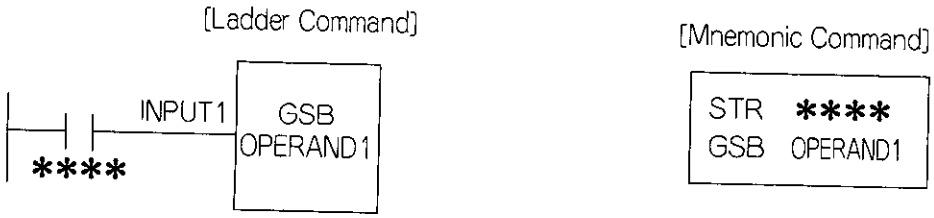


Fig. 7.55 Command Symbols

(2) Operand

Table 7.41 Operand

Operand1	Subroutine No. : G01 to G99

(3) Calculating function

99 types of subroutine circuits can be described. When the same circuit is created many times in the ladder circuit, by storing it as a subroutine circuit, it is possible to call it freely from the ladder circuit so that the efficiency of ladder program creation will be better. However, other subroutines cannot be called from the subroutine circuit. When input 1 is turned ON, the circuit block specified by a subroutine No. is decoded. Output 1 is not used.

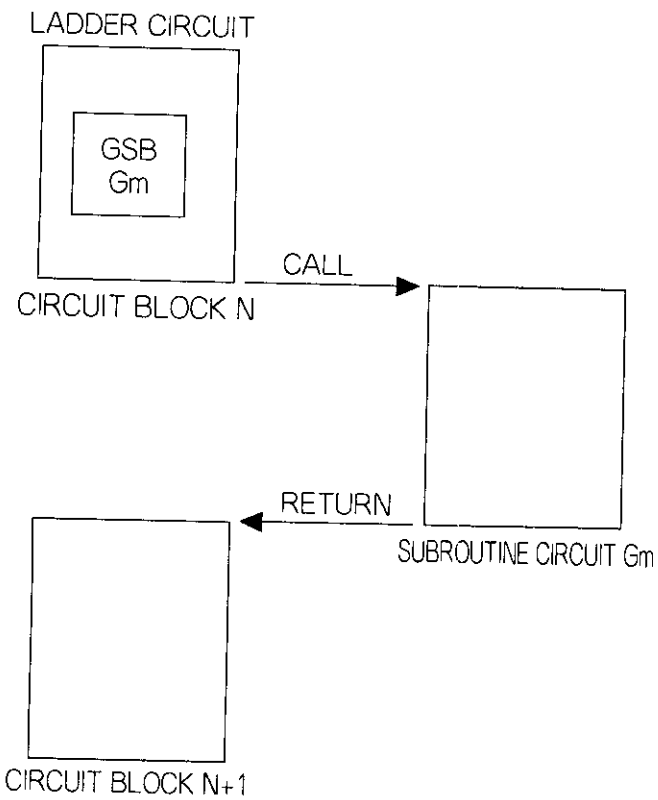


Fig 7.56 Subroutine (GSB) Calculation

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7.11 PULSE OUTPUT (PLS)

(1) Command symbol

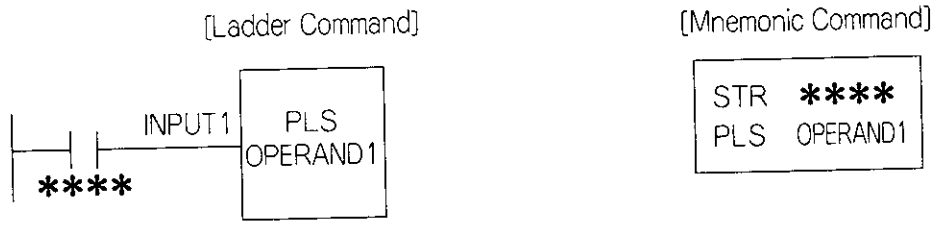


Fig. 7.57 Command Symbols

(2) Operand

Table 7.42 Operand

Operand 1	Output coil No. : O1 to O512 Internal coil No. : N1 to N1536

(3) Operation function

The coil specified by Operand 1 is turned ON only for one scan. (The coil No. is not from the discrete group reference but from a normal coil No.)

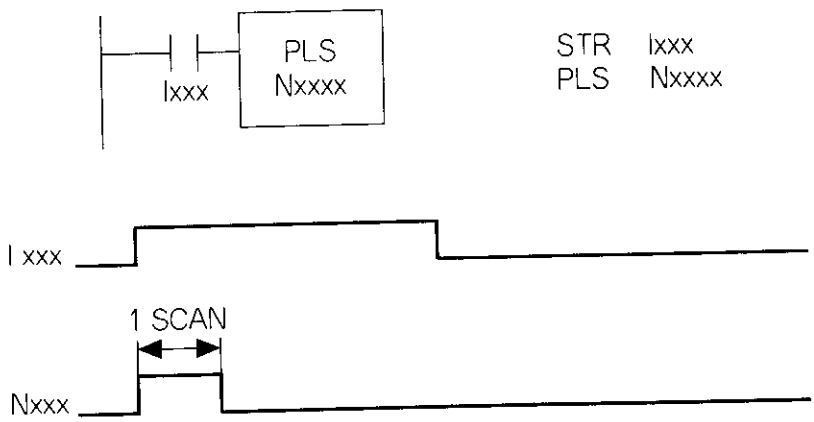


Fig. 7.58 Pulse Output (PLS) Calculation

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7.12 COIL CLEAR (CLR)

(1) Command symbol

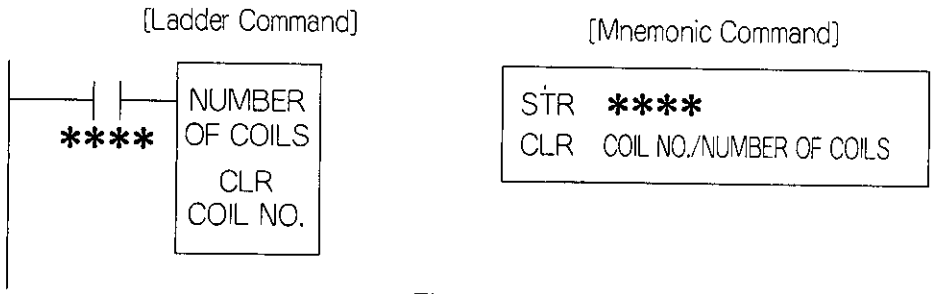


Fig. 7.59 Command Symbols

(2) Operand

Table 7.43 Operand

Coil No.	Number of Coils
Output coil : O1 to O512	1 to 512
Internal coil : N1 to N1536	1 to 1536
Link coil : D1 to D1024	1 to 1024
MC unit coil : Y1 to Y512	1 to 512
MC control coil : Q1 to Q256	1 to 256

(3) Calculating function

As many coils as specified by coil Nos. are turned OFF. In the following example of a circuit, when input signal I1 is turned ON, internal coils N1 to N256 are turned OFF.

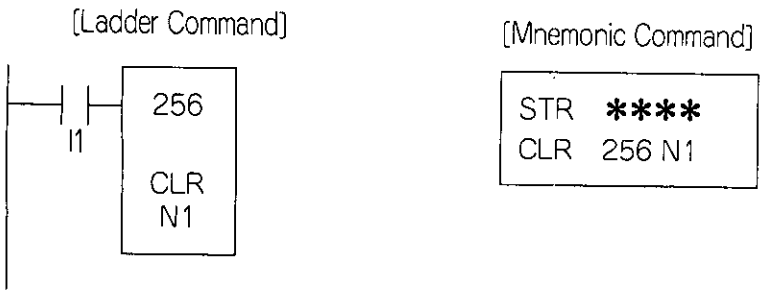
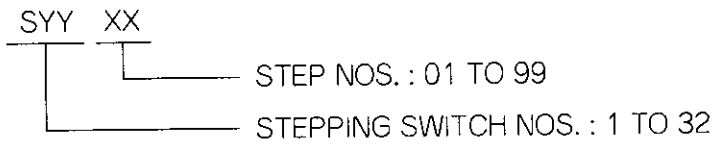


Fig 7.60 Coil Clear (CLR) Calculation

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7.13 STEPPING SWITCHES

(1) Command symbol



(1) Function

PROGIC-8 is provided with 32 stepping switches. 99 steps are available for each switch.
Each stepping switch from 1 to 32 is controlled by each contents (numerical value) of data registers W2001 to W2032. These register (called stepping switch control registers) contents can be controlled by such functions as timer, counter, addition, subtraction, etc. in order to serve as stepping switches in that order, or to perform return or jump operation.
Fig. 7.61 shows the equivalent circuit of stepping switch 1. As shown in the figure, stepping switch 1 operates according to contents n of holding register W2001.

(a) When n is within the range of 1 to 99

Any one of the arbitrary coils S0101 to S0199 is turned ON corresponding to value n; the NO contact is in current conduction and NC is not. For example, when n = 1, only imaginary coil S0101 is turned ON and its NO contact is in current conduction and NC is not.

(a) When n is out of the range of 1 to 99

All arbitrary coils S0101 to S0199 are turned OFF.

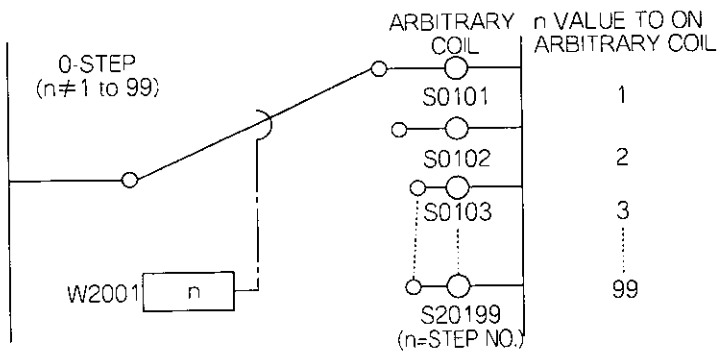


Fig. 7.61 Equivalent Circuit of Stepping Switch

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Table 7.44 shows operation of stepping switches 1 to 32.

Table 7.44 Operation of Stepping Switches

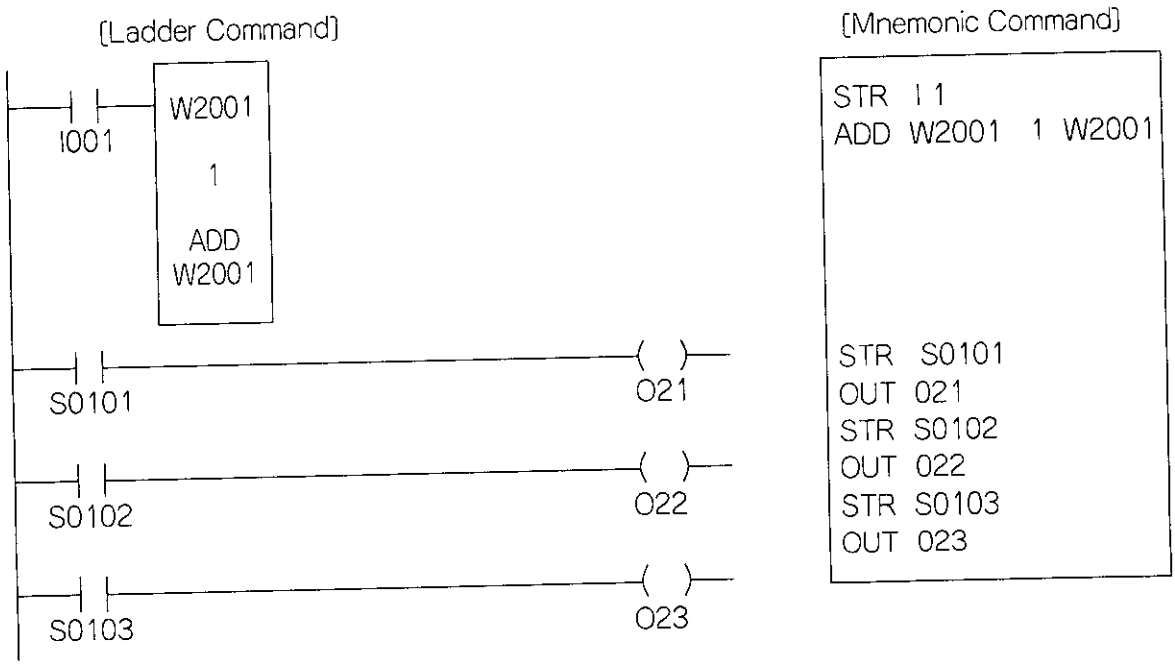
Stepping Switch No.	Stepping Switch Control Register No.	Contents of Stepping Switch Control Register (Numerical Value)				
		001	002	003	•••••••	009
1	W2001	only S0101 "ON"	only S0102 "ON"	only S0103 "ON"	•••••••	only S0199 "ON"
2	W2002	only S0201 "ON"	only S0202 "ON"	only S0203 "ON"	•••••••	only S0299 "ON"
3	W2003	only S0301 "ON"	only S0302 "ON"	only S0303 "ON"	•••••••	only S0399 "ON"
4	W2004	only S0401 "ON"	only S0402 "ON"	only S0403 "ON"	•••••••	only S0499 "ON"
5	W2005	only S0501 "ON"	only S0502 "ON"	only S0503 "ON"	•••••••	only S0599 "ON"
⋮	⋮	⋮	⋮	⋮	⋮	⋮
31	W2031	only S3101 "ON"	only S3102 "ON"	only S3103 "ON"	•••••••	only S3199 "ON"
32	W2032	only S3201 "ON"	only S3202 "ON"	only S3203 "ON"	•••••••	only S3299 "ON"

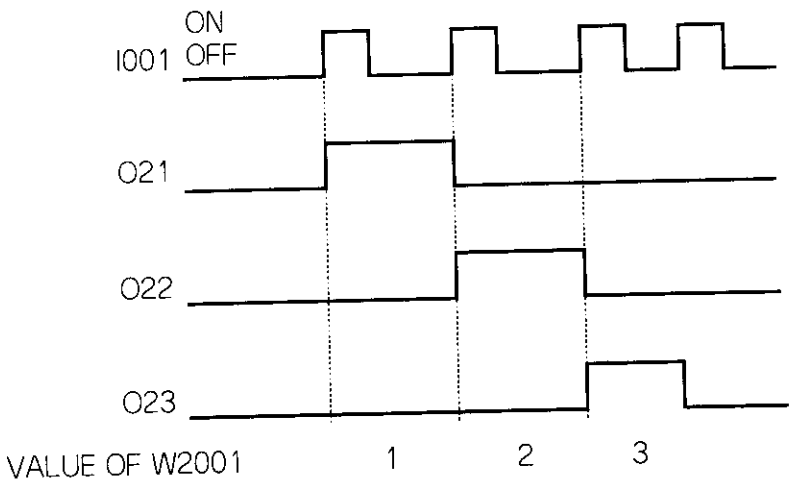
Notes : 1. If any stepping switch is not used, W2001 to W2032 can be used as normal holding registers.
2. When a stepping switch is used in the network, its NO/ NC contacts are used. Differential contacts cannot be used.

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(3) Typical use

(Example 1) Example of stepping switch 1 activated by ADD command

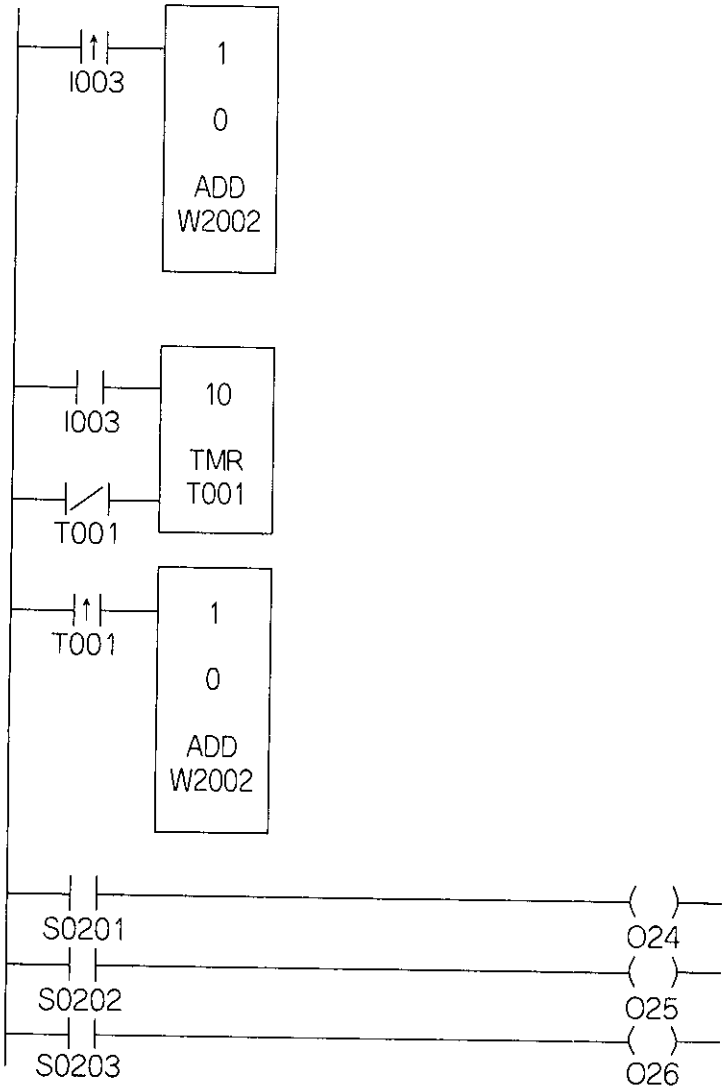




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(Example 2) Example of stepping switch 2 activated by timer

[Ladder Command]



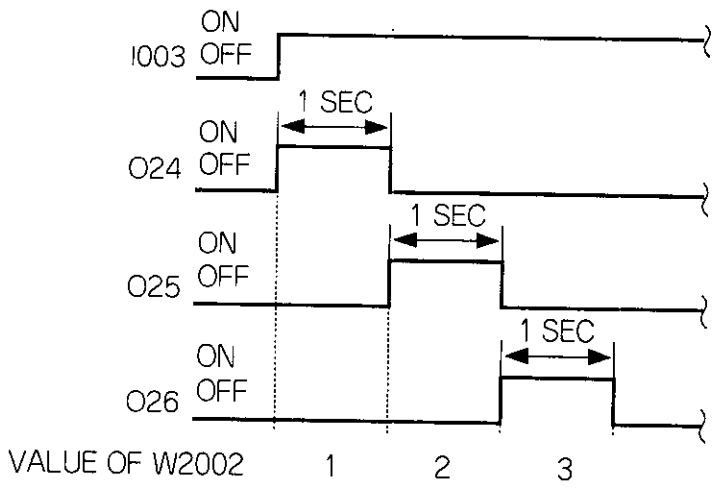
[Mnemonic Command]

```
STH  I3
ADD  1  0  W2002

STR  I3
STN  T1
TMR  I0  T1

STR  T1
ADD   1  0  W2002

STR  S0201
OUT  O24
STR  S0202
OUT  O25
STR  S0203
OUT  O26
```



Note : Consider "timer error".

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Table 8.1 shows the list of motion command functions.
Motion commands are used to execute motion control in the ladder circuit. With these commands, more than one command cannot be activated simultaneously for one MC unit (program operation and parameter setting, etc.). However, some commands (monitor command, etc.) can be activated at the same time as other commands.

Table 8.1 List of Motion Command Function

No.	Name	Symbol	Function
1	Program operation	MVL	Performs program operation.
2	Single-block operation mode	SMD	Switches to the single-block operation mode.
3	Independent axis operation (A-axis)	MVA	Operates A-axis independently from PLC unit.
4	Independent axis operation (B-axis)	MVB	Operates B-axis independently from PLC unit.
5	Zero-point return operation	ZRN	Performs zero-point return operation.
6	Jog operation	JOG	Performs jog operation.
7	Monitor	MON	Monitors alarms, parameters
8	Current value setting	POS	Changes the current value data.
9	Parameter setting	PRM	Performs parameter setting.
10	Compensated value setting	VAR	Sets values to compensation variables.
11	Alarm reset	ARS	Resets an MC unit alarm.
12	Servo ON	SVN	Performs current conduction to the motor. Stops current conduction to the motor.
13	Mode setting	MOD	Switches the MC unit mode.
14	Reset	MRS	Initializes the MC unit and changes the program No.
15	Emergency stop information	ESP	Informs the MC unit that the emergency stop button switch has been depressed.

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Table 8. 2 shows the commands that can be activated simultaneously for one MC unit.

Table 8.2 Commands that can be Activated for One MC Unit

Command to be Activated	Command under Execution														
	MVL	SMD	MVA	MVB	ZRN	JOG	MON	POS	PRM	VAR	ARS	SVN	MOD	MRS	ESP
MVL	—	○	○	○	—	—	○	—	—	—	—	○	○	—	—
SMD	○	—	○	○	—	—	○	—	—	—	—	○	○	—	—
MVA	○	○	—	○	—	—	○	—	—	—	—	○	○	—	—
MVB	○	○	○	—	—	—	○	—	—	—	—	○	○	—	—
ZRN	—	—	—	—	○	—	○	—	—	—	—	○	○	—	—
JOG	—	—	—	—	—	○	○	—	—	—	—	○	○	—	—
MON	○	○	○	○	○	○	—	○	○	○	○	○	○	○	○
POS	—	—	—	—	—	—	○	—	—	—	—	○	○	—	—
PRM	—	—	—	—	—	—	○	—	—	—	—	○	○	—	—
VAR	—	—	○	○	—	—	○	—	—	—	—	○	○	—	—
ARS	—	—	○	○	—	—	○	—	—	—	—	○	○	—	—
SVN	○	○	○	○	○	○	○	○	○	○	○	○	○	○	—
MOD	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
MRS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	—
ESP	○	○	○	○	○	○	○	○	○	○	○	○	○	○	—

○ : Possible to activate — : Impossible to activate

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8.1 MOTION COMMAND FUNCTIONS

Each PLC unit motion command has the following operation function.
Accel/decel curve of each operation is determined by parameter setting.

(1) Memory operation function
- Program operation (MVL)
- Single-block operation (SMD)

Used at automatic operation by motion program stored in the memoty in the MC unit.

(2) Independent axis operation function
- A-axis independent operation (MVA)
- B-axis independent operation (MVB)

Sets aimed position and speed from the PLC unit to perform postioning.
Program operation is not enabled for axes where A-axis and B-axis setting is performed.

(3) Jog operation function
- Jog operation (JOG)

Used to move a machine by manual feeding. Feeding speed is determined by parameter and override values.

(4) Zero-point return operation function
- Zero-point return operation (ZRN)

Returns to the peculiar machine zero-point. PG with zero-point pulse and external limit switch indicating zero-point area are used.

(5) Setting and monitoring
- Monitor (MON)
- Current value setting (POS)
- Parameter setting (PRM)
- Compensated value setting (VAR)

Used for machine current position value change (POS), parameter change in MC unit (PRM), compensated value setting in motion program (VAR) or MC unit status monitoring (MON).

(6) Servo control function
- Servo ON (SVN)
- Alarm reset (ARS)

Servo ON is used to control servo amplifier unit baseblock and set the motor to current conduction/no-conduction status. Alarm reset is used to reset the alarm after MC unit detects an alarm.

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(7) Setting and monitoring
- Mode switching (MOD)
- Reset (MRS)
- Emergency stop information (ESP)

Mode switching is used to switch the MC unit mode (manual, automatic, online edit, edit).
Reset is used to return the MC unit status to initialized status and switch the program No. to the set value.
Table 8.3 shows the commands to be activated in each mode.

Table 8.3 Commands to be Activated in Each Mode

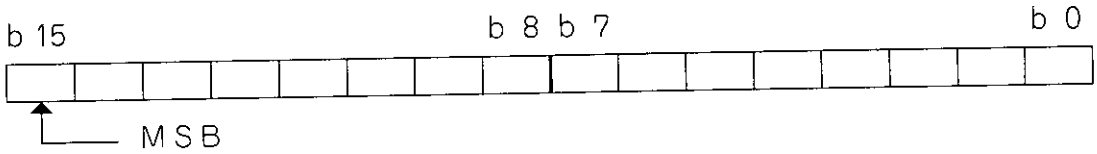
Command \ Mode	Manual	Automatic	Online Edit	Edit
M V L		○		
S M D		○		
M V A		○	○	
M V B		○	○	
Z R N	○			
J O G	○		○	
M O N	○	○	○	○
P O S	○		○	
P R M	○		○	○
V A R	○	○	○	
A R S	○	○	○	○
S V N	○	○	○	○
M R S	○	○	○	○
E S P	○	○	○	○

○ : Possible to activate

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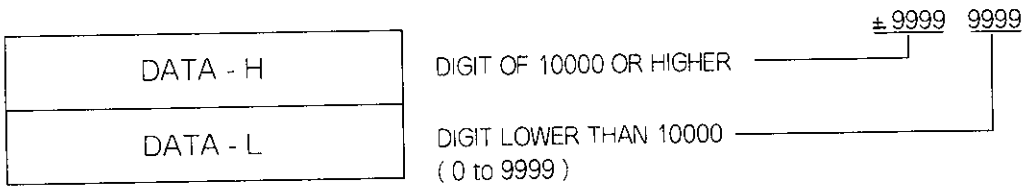
8.2 DESCRIPTION OF MOTION COMMANDS

WXXXX/WYYYY used in this manual indicates the internal data register No. of the PLC unit.
Plus/minus numerical value data setting or monitor data input is enabled for data registers.
One data register is composed of 16 bits; when 1 is input to the MSB, the value becomes minus.



M S B (b 15) = 0 : Indicates a plus value.
M S B (b 15) = 1 : Indicates a minus value.

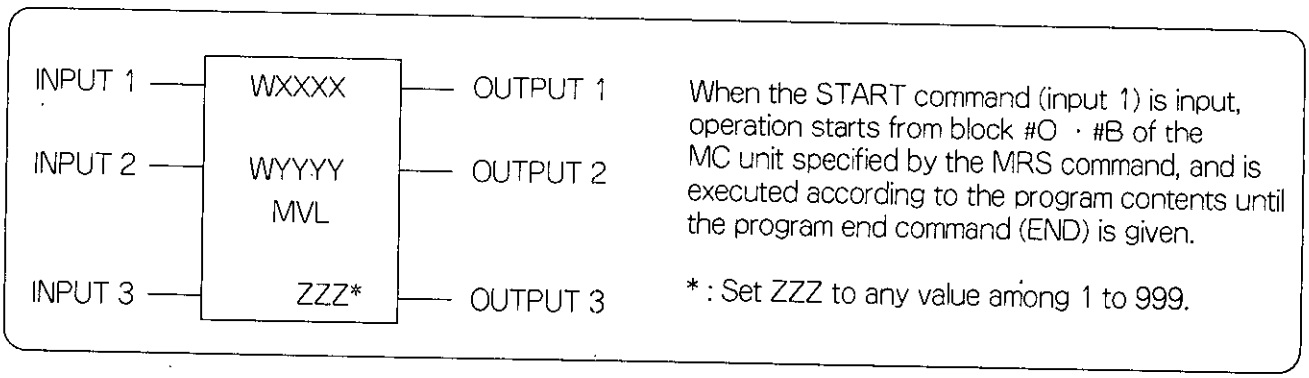
To set numerical value data by two data registers, the data are divided into upper and lower digits. The upper digit is expressed by adding "-H" and the lower digit "-L" to the data name. When 1 is input to the upper digit MSB, the value becomes minus.



Even if a ladder circuit exists to set data to a data register for "system use" to activate a motion command, the command does not operate. In this case, an error is not displayed.
Additionally, if "system use" register which has been used for a certain motion command once, is used for other motion commands, the motion command malfunctions and MC unit may break down.
Therefore, do not use "system use" register twice.

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8.2.1 Program Operation (MVL)



● Data to be set

WXXXX	UNIT NO.	MC unit No. : 1 to 2
WXXXX + 1	INTERPOLATION OVERRIDE	Speed compensation selection No. for interpolation operation: 0 to 15
WXXXX + 2	RAPID TRAVERSE OVERRIDE	Speed compensation selection No. for rapid traverse operation: 0 to 15
WXXXX + 3	SYSTEM USE	Used as execution flag in system

• Override No. and compensated value for interpolation operation (override value)

Table 8.4 Override No. and Compensated Value for Interpolation Operation (Override Value)

No.	Override value	No.	Override value	No.	Override value	No.	Override value
0	50%	4	90%	8	130%	12	170%
1	60%	5	100%	9	140%	13	180%
2	70%	6	110%	10	150%	14	190%
3	80%	7	120%	11	160%	15	200%

• Override No. and compensated value for rapid traverse operation (override value)

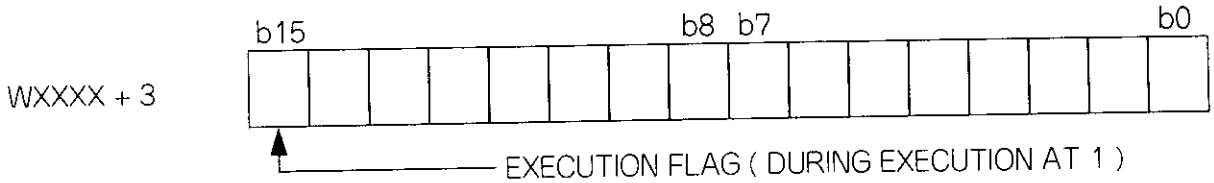
Speed is obtained by multiplying the first feed speed by the override value in Table 8.5
However, No. 0 is the second feed speed.

Table 8.4 Override No. and Compensated Value for Rapid Traverse Operation (Override Value)

No.	Override value	No.	Override value	No.	Override value	No.	Override value
0	2nd feed speed	4	6%	8	30%	12	70%
1	1%	5	8%	9	40%	13	80%
2	2%	6	10%	10	50%	14	90%
3	4%	7	20%	11	60%	15	100%

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• System execution flag



● Data to be monitored

The current value and error status are displayed.

WYYYY	CURRENT VALUE 1- H
WYYYY + 1	CURRENT VALUE 1- L
WYYYY + 2	CURRENT VALUE 2- H
WYYYY + 3	CURRENT VALUE 2- L
WYYYY + 4	CURRENT VALUE 3- H
WYYYY + 5	CURRENT VALUE 3- L
WYYYY + 6	CURRENT VALUE 4- H
WYYYY + 7	CURRENT VALUE 4- L
WYYYY + 8	STATUS

0 to ± 9999 (WYYYY)

9999 (WYYYY + 1)

For the status after starting, refer to Par. 8..2.15.

● Description of operation

Table 8.6 Description of Program Operation (MVL)

Input 1	• START: Execution command Commanded by start-up differential contact (—┤↑├—). Even if the command is ON/OFF during execution, it is not accepted. If input 3 is turned ON first, it is not accepted.
Input 2	• MFIN: MFIN response MFIN signal is turned ON by NO contact (—┤ ├—). Hold it until M-code relay is turned OFF.
Input 3	• FEEDHOLD: Stop command Operation is halted temporarily while this command is ON. Operation restarts when it is OFF. Unless output 1 is turned ON, it is not accepted.
Output 1	• RUN: During running ON during command execution. OFF at completion of operation.
Output 2	• ERROR: Error ON only for one scan at termination of error.
Output 3	• END: Completion ON only for one scan at normal completion.

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●Typical operation

(i) Operation and motion program

Interpolation is performed between axes X, Y and Z of the SERVOMOTOR connected to the MC unit.

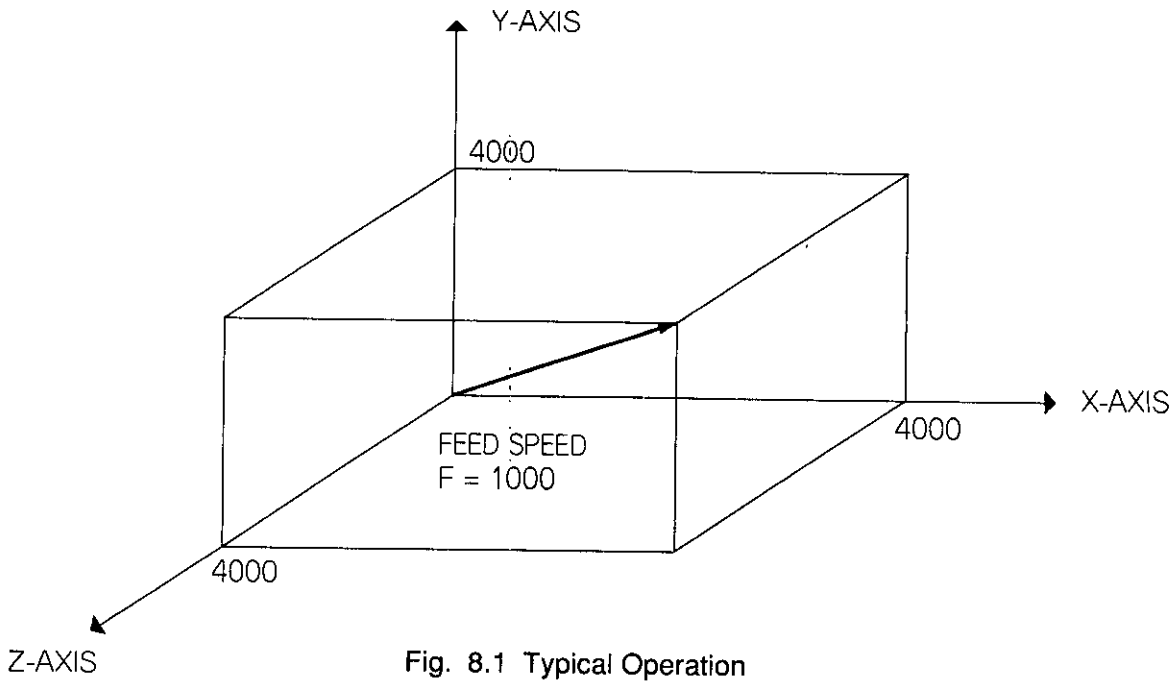


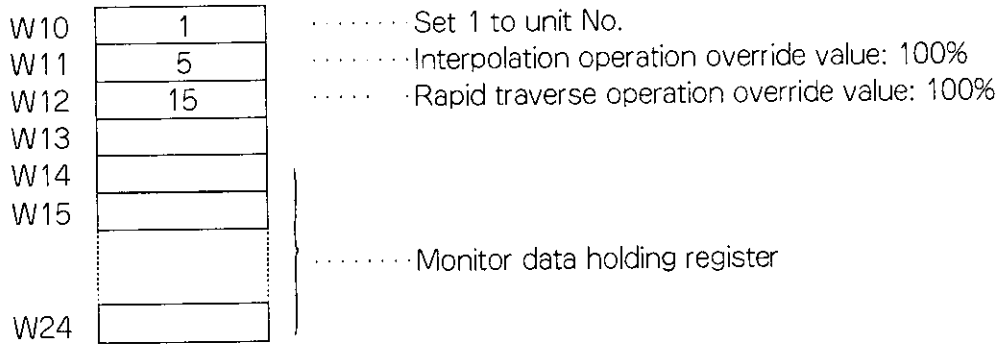
Fig. 8.1 Typical Operation

After creating the following program, loading on MC unit and setting program # and block #, start the MVL command.
To set the program # and block #, execute the MRS command.

```
O01
   N001   MVS   X4000   Y4000   Z4000   F1000 ;
   N002   SET   M50;
   N003   MVS   X0      Y0      Z0      F1000 ;
   N004   END ;
```


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(ii) Sequence ladder circuit



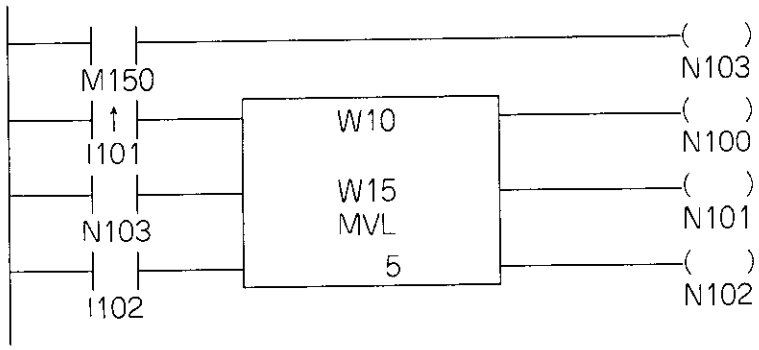


Fig. 8.2 Sequence Ladder Circuit

(iii) I/O timing

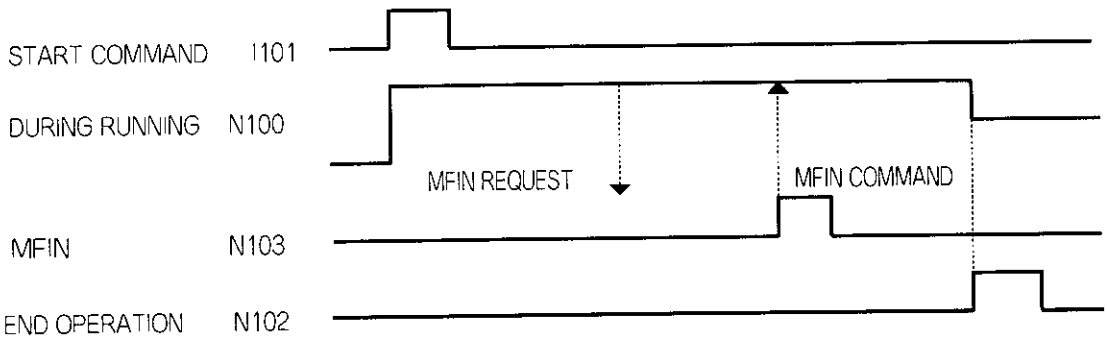
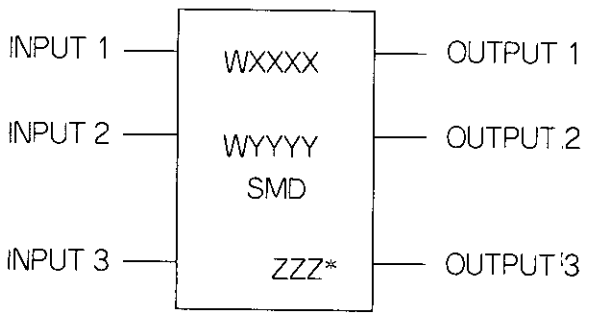


Fig. 8.3 I/0 Timing

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8.2.2 Single-block Operation Mode (SMD)

Motion program is executed block by block.



When single-block command (input 1) is input, program operation under execution by the MVL command stops when the blocks under execution are completed. After that, each time the MVL command operation reference (input 1) is input, operation continues by only one block.

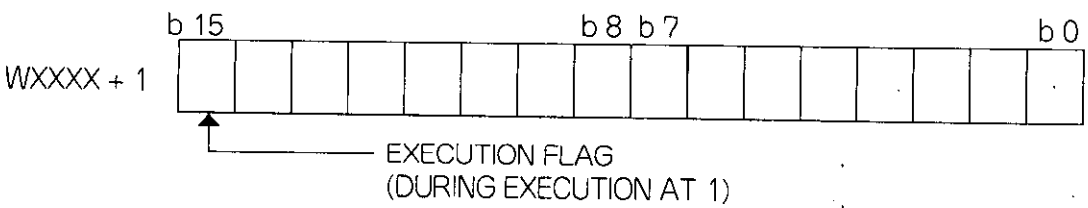
When the MVL command operation reference is input after the single-block command is turned OFF, continuous operation is continued.

*: Set ZZZ to any value from 1 to 999.

● Data to be set

WXXXX	UNIT NO.	MC unit No. : 1 to 2
WXXXX + 1	SYSTEM USE	Used as execution flag in system

• System execution flag



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● Data to be monitored

The current value and error status are displayed.

WYYYY	CURRENT VALUE 1-H
WYYYY + 1	CURRENT VALUE 1-L
WYYYY + 2	CURRENT VALUE 2-H
WYYYY + 3	CURRENT VALUE 2-L
WYYYY + 4	CURRENT VALUE 3-H
WYYYY + 5	CURRENT VALUE 3-L
WYYYY + 6	CURRENT VALUE 4-H
WYYYY + 7	CURRENT VALUE 4-L
WYYYY + 8	STATUS

0 to ±9999 (WYYYY)

9999 (WYYYY + 1)

For the status after starting, refer to Par. 8..2.15.

● Description of operation

Table 8.7 Description of Single-block Operation Mode (SMD)

Input 1	• SINGLE: Single-block Operation mode command Commanded by NO contact (⊣ ⊢). Single-block operation mode entered at ON.
Input 2	• NOTE: Not used.
Input 3	• NOTE: Not used.
Output 1	• RUN: During runnig ON during execution of command. OFF at completion of operation and completion of STOP.
Output 2	• ERROR: Error ON for only one scan at termination of error.
Output 3	• EXEC: During execution ON during execution of one block (during moving).

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(i) Motion program

The following program is created and loaded on the MC unit.

```
0001
   N001   MVS   X4000   Y4000   Z4000   F1000 ;
   N002   MVS   M3000   Y1000   Z3000   F500 ;
   N003   MVS   X0      Y0      Z0      F100 ;
   N004   END ;
```

(iii) Sequence ladder circuit

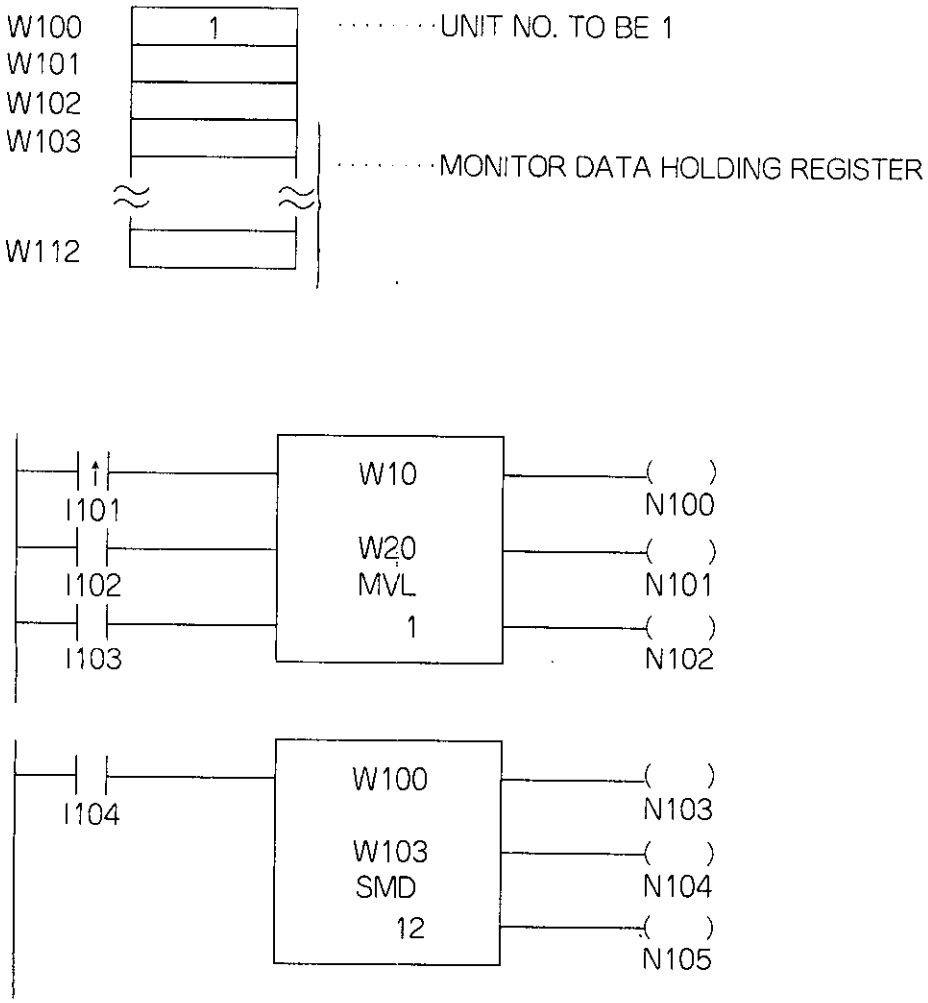


Fig. 8.4 Sequence Ladder Circuit

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(iii) I/O timing

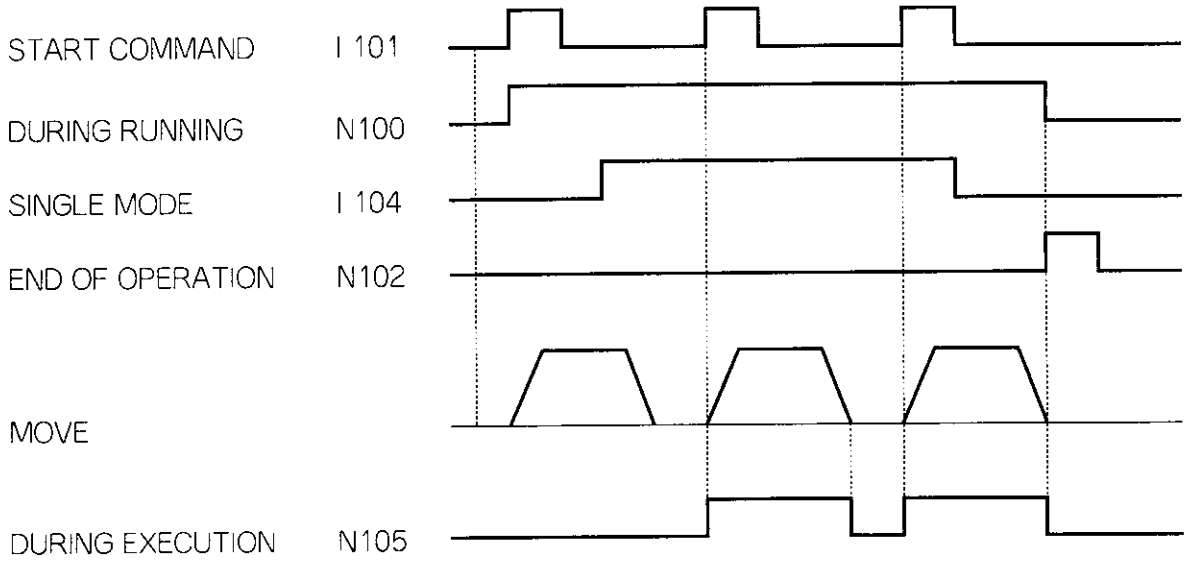


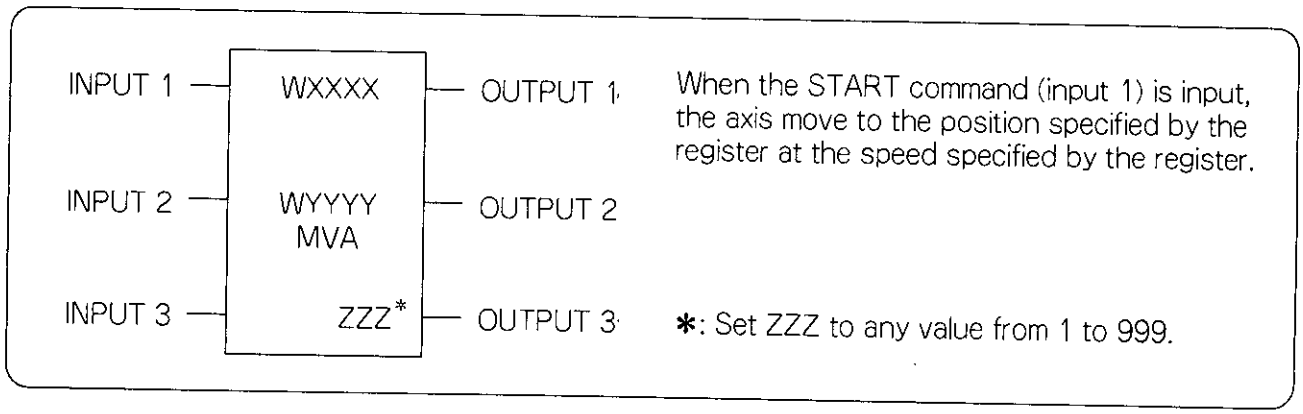
Fig. 8.5 I/O Timing

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8.2.3 Independent Axis Operation (MVA/MVB)

When the SERVOMOTOR axis is specified to A/B axes, move command is executed by MVA/MVB commands, respectively.

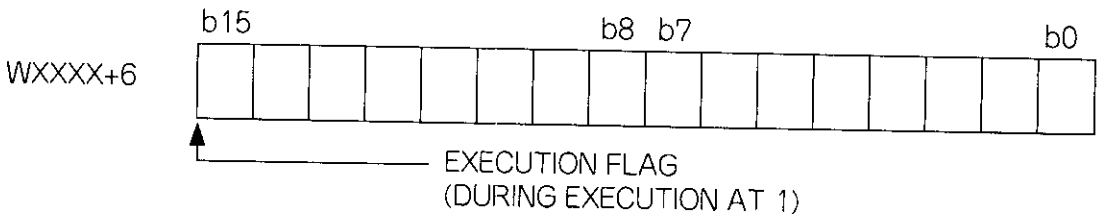
When the SERVOMOTOR axis is specified to A/B axes, operation by motion program in the MC unit is not enabled.



● Data to be set

WXXXX	UNIT NO.	MC unit No. : 1 to 2
WXXXX+1	COMMAND MODE	Aimed position data classification: 0 = absolute; 1 = relative value
WXXXX+2	AIMED POSITION-H	Aimed position (reference unit)
WXXXX+3	AIMED POSITION-L	
WXXXX+4	SPEED-H	Feeding speed (×1000 reference unit)
WXXXX+5	SPEED-L	
WXXXX+6	SYSTEM USE	Used as execution flag in system

● System execution flag



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● Data to be monitored

The current value and error status (absolute value coordinate disregarding the reference mode) are displayed.

WYYYY	CURRENT VALUE-H	0 to ±9999 (WYYYY)
WYYYY+1	CURRENT VALUE-L	9999 (WYYYY+1)
WYYYY+2	STATUS	

For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.8 Description of Operation

Input 1	• START : Execution command Commanded by start-up differential contact (⊣↑⊢). Even if the command is ON/OFF during execution, it is not accepted. If input 3 is turned ON first, it is not accepted.
Input 2	• NONE : Not used.
Input 3	• FEEDHOLD : Stop command Operation is halted temporarily while this command is ON. Operation restarts when it is OFF. Unless output 1 is turned ON, it is not accepted.
Output 1	• RUN : During running ON during command execution. OFF at completion of operation.
Output 2	• ERROR : Error ON only for one scan at termination of error.
Output 3	• DONE : Completion ON only for one scan at normal completion.

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● Typical operation

(i) Operation

SERVOMOTOR A-axis is operated.

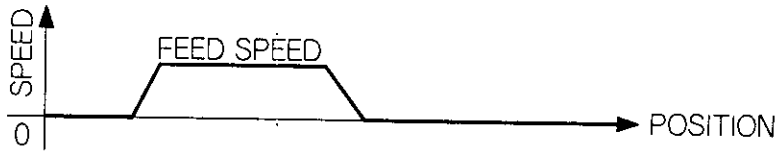
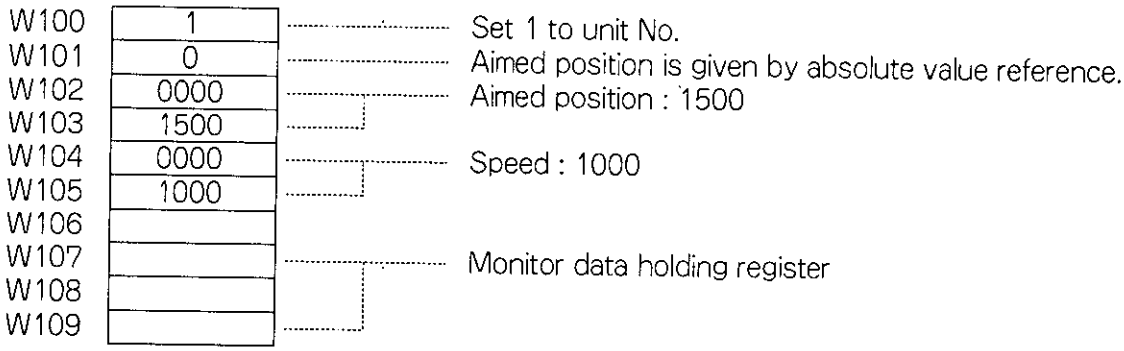


Fig. 8.6 Typical Operation

(ii) Sequence ladder circuit



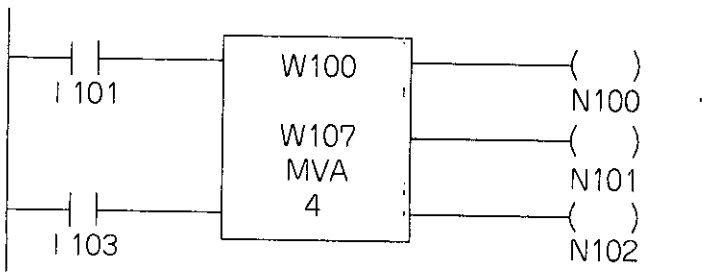


Fig. 8.7 Sequence Ladder Circuit

(iii) I/O timing

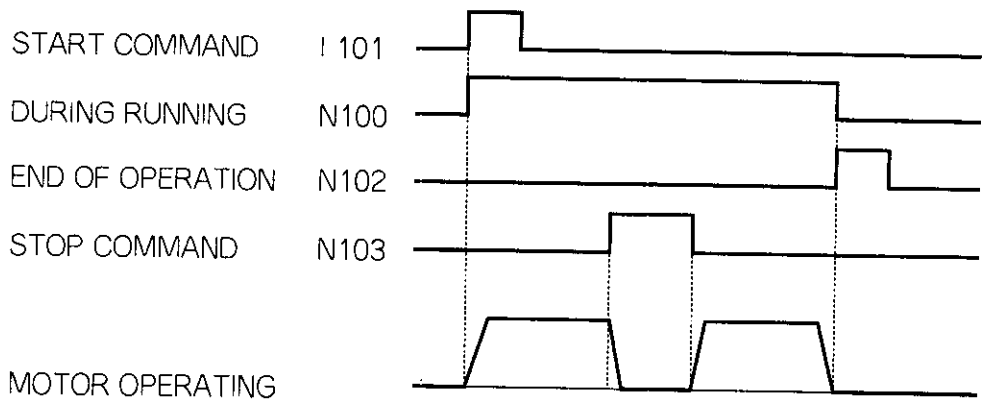


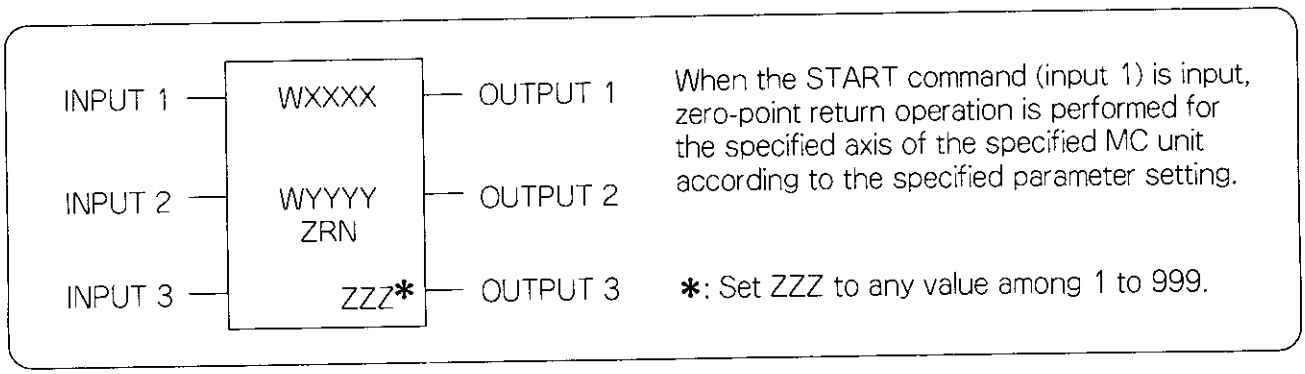
Fig. 8.8 I/O Timing

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8.2.4 Zero-point Return Operation (ZRN)

There are four operation patterns of zero-point return.

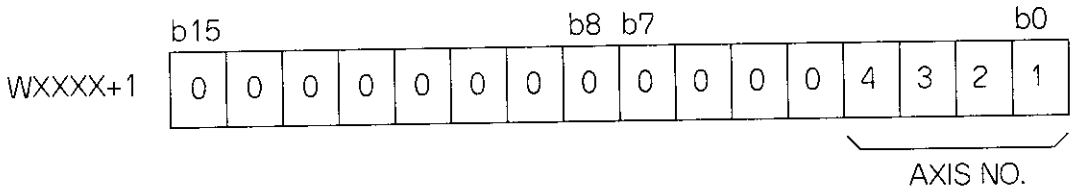
For operation patterns of zero-point return, select a mode [mode I (=0), mode II (=1), mode III (=2) and mode IV (=3)] by setting parameter P49 in advance.



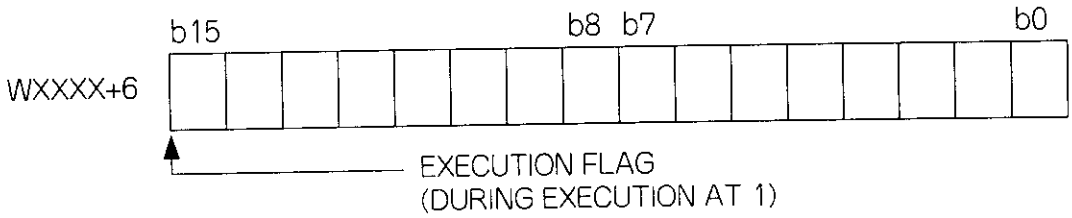
● Data to be set

WXXXX	UNIT NO.	MC unit No. :1 to 2
WXXXX+1	AXIS NO.	MC unit axis No. : 1 to lower digit byte bit
WXXXX+2	SYSTEM USE	Used as execution flag in system.

● MC unit axis No. : Set 1 to an axis to be specified from 0- to 3-bit.



● System execution flag



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● Data to be monitored

The current value and error status are displayed.

WYYYY	CURRENT VALUE1-H
WYYYY+1	CURRENT VALUE1-L
WYYYY+2	CURRENT VALUE2-H
WYYYY+3	CURRENT VALUE2-L
WYYYY+4	CURRENT VALUE3-H
WYYYY+5	CURRENT VALUE3-L
WYYYY+6	CURRENT VALUE4-H
WYYYY+7	CURRENT VALUE4-L
WYYYY+8	STATUS

0 to ±9999 WYYYY

9999 WYYYY+1

For the status after starting, refer to Par. 8.2.15.

● Description of operation

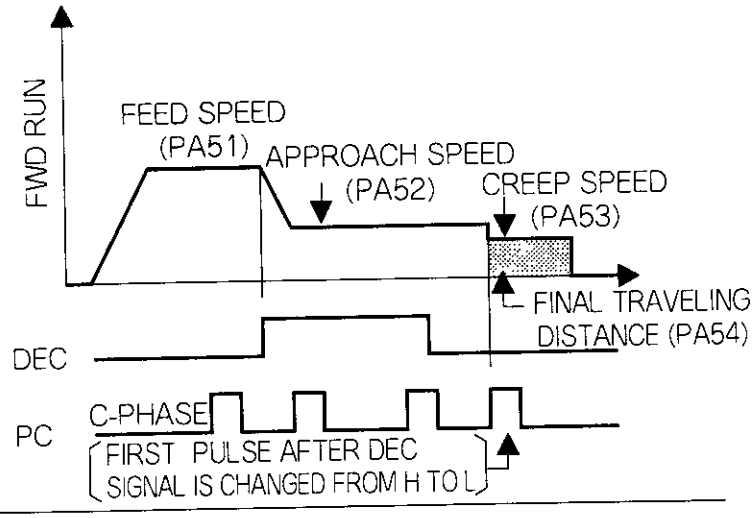
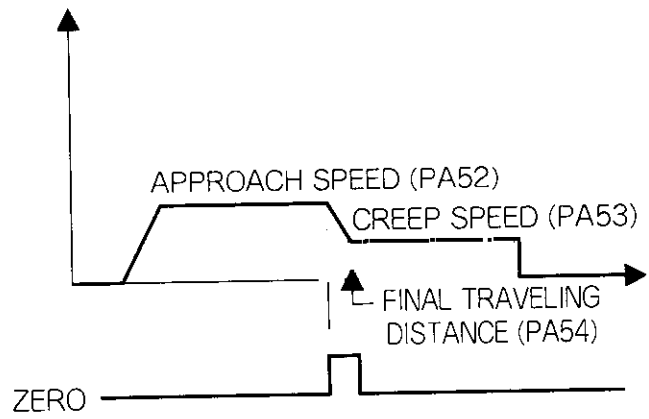
Table 8.9 Description of Operation

Input 1	• START : Execution command Commanded by start-up differential contact. Even if the command is ON/OFF during execution, it is not accepted. If input 3 is turned ON first, it is not accepted.
Input 2	• REVERSE : Reverse run command Specifies the rotating direction. Forward run by OFF and reverse run by ON. Effective only when execution command is input.
Input 3	• STOP : Stop command Operation is halted while this command is ON.
Output 1	• RUN : During running ON during command execution. OFF at completion of operation or completion of stop.
Output 2	• ERROR : Error ON for only one scan at termination of error.
Output 3	• DONE : Compration of zero-point return ON for only one scan at normal completion.

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● Zero-point return modes

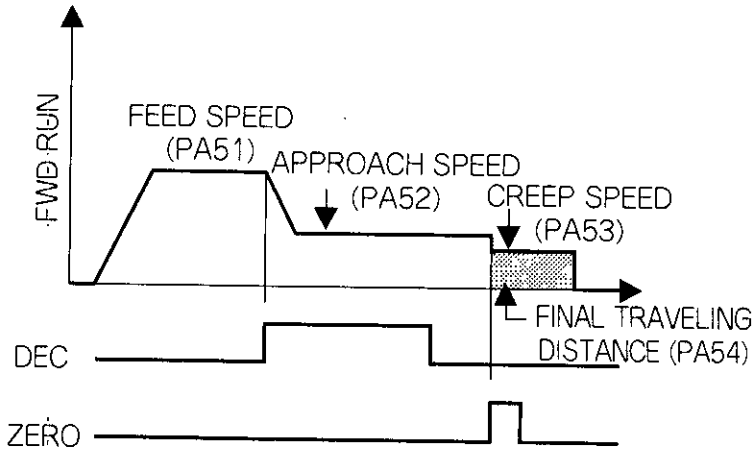
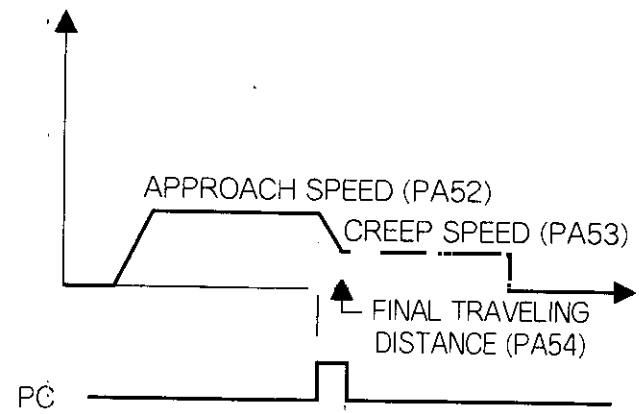
Table 8.10 Parameters and Zero-point Return

Parameter	Zero-point Return Method	Operation
PA49=0, Mode I	3-step deceleration method using phase-C pulse signal of DEC signal (deceleration limit switch) PG	
PA49=1, Mode II	2-step deceleration method using ZERO signal (stop limit switch)	

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● Zero-point return modes (Cont'd)

Table 8.10 Parameters and Zero-point Return (Cont'd)

Parameter		Zero-point Return Method	Operation
PA18−b4=1	PA49=2, Mode III	3-step deceleration method using 1 DEC signal (deceleration limit switch) and ZERO signal (stop limit switch)	
	PA49=3, Mode IV	2-step deceleration method using PG phase-C pulse signal	

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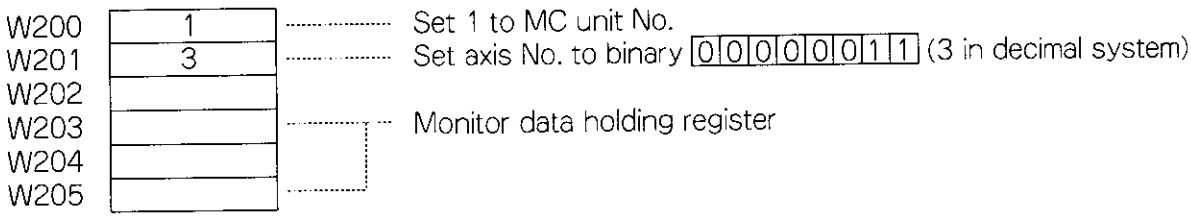
● Typical operation

(i) Operation

Zero-point return operation is performed for the SERVOMOTOR of axis Nos. 1 (X) and 2 (Y). In zero-point return mode I (P149=0, P249=0), the motor is returned in the forward run direction.

Assume that feed speed (P151, P251), approach speed (p152, P252), creep speed (P153, P253) and accel/decel are set by parameters.

(ii) Sequence ladder circuit



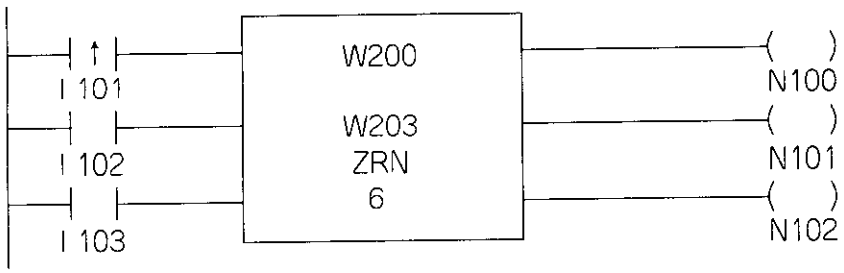


Fig. 8.9 Sequence Ladder Circuit

(iii) I/O timing

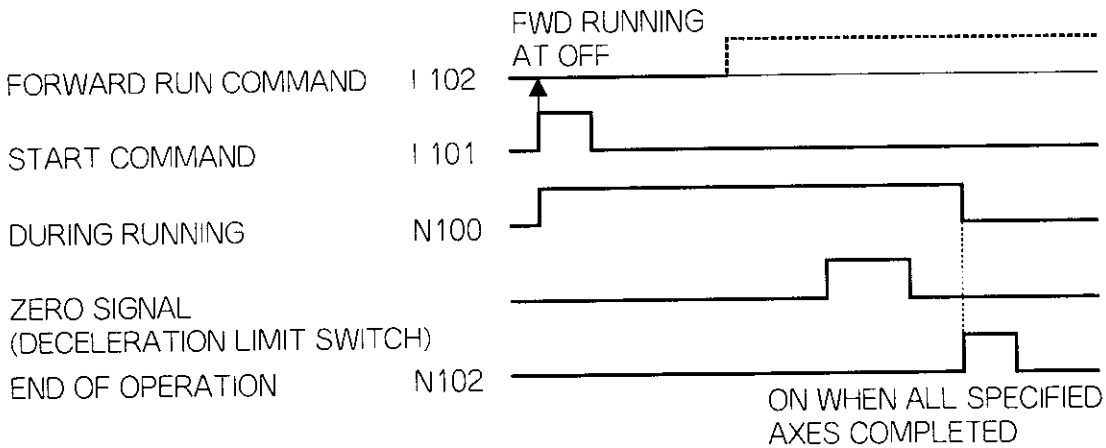
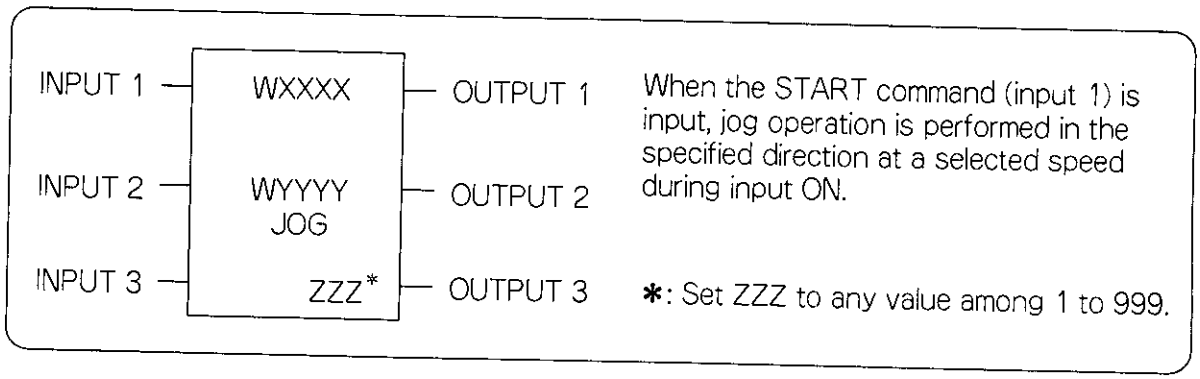


Fig. 8.10 I/O Timing

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8.2.5 JOG Operation (JOG)

JOG command is used to move the machine by manual feed.
Feed speed is obtained by multiplying speed (1) by override value selected by speed No.
However, for speed No. 0, the speed set to speed (2) is used.
When the speed Nos. are different at simultaneous activation of several commands, the speed No. of the last command activated becomes effective.



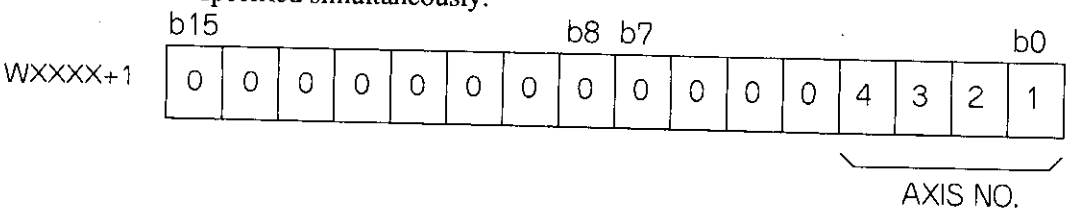
● Data to be set

WXXXX	UNIT NO.
WXXXX+1	AXIS NO.
WXXXX+2	SPEED NO.
WXXXX+3	SYSTEM USE

Note : Only PC 050

MC unit No. : 1 to 2
MC unit axis No. : 1 to lower byte 1 bit.
Feed speed No. : 0 to 15 (override value)
Used as execution flag in system

● MC unit axis No. : Set 1 to one axis to be specified from 0- to 3-bit. More than one axis cannot be specified simultaneously.



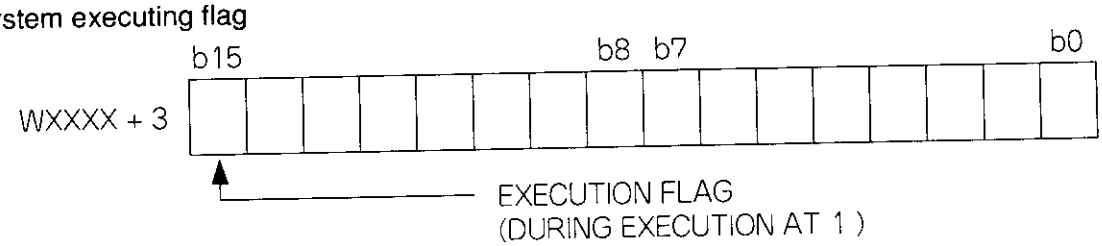
● Speed No. and Override Value

Table 8.11 Speed No. and Override Value

No.	Override Value	No.	Override Value	No.	Override Value	No.	Override Value
0	2nd feed speed	4	6%	8	30%	12	70%
1	1%	5	8%	9	40%	13	80%
2	2%	6	10%	10	50%	14	90%
3	4%	7	20%	11	60%	15	100%

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· System executing flag



● Data to be monitored

The current value and error status are displayd.

WYYYY	CURRENT VALUE - H	0 to ±9999 (WYYYY)
WYYYY + 1	CURRENT VALUE - L	9999 (WYYYY + 1)
WYYYY + 2	STATUS	

For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.12 Description of Operation

Input 1	· START : Execution command Commanded by NO contact (⊣ ⊢). During JOG operation execution while the command is ON. Stops at OFF.
Input 2	· NONE : Not used.
Input 3	· REVERSE : Reverse run command Specifies the rotating direction. Forward run at OFF and reverse run at ON. Effective only when execution command is input.
Output 1	· RUN : During running ON during command execution. OFF at completion of operation and completion of STOP.
Output 2	· ERROR : Error ON for only one scan at termination of error.
Output 3	· DONE : Completion ON for only one scan at normal completion.

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● Typical operation

(i) Operation

JOG operation is performed in the forward direction for SERVOMOTOR axis No.4.
Feed speed : speed(1)×2%

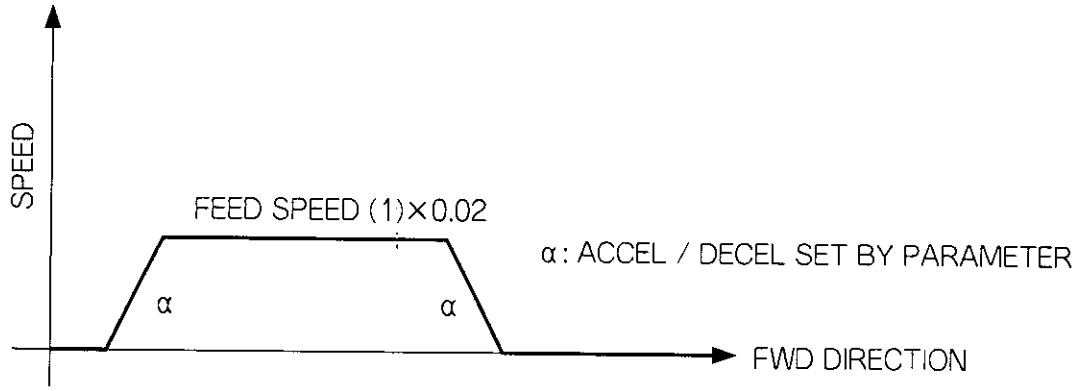


Fig 8.11 Typical Operation

(ii) Sequence ladder circuit

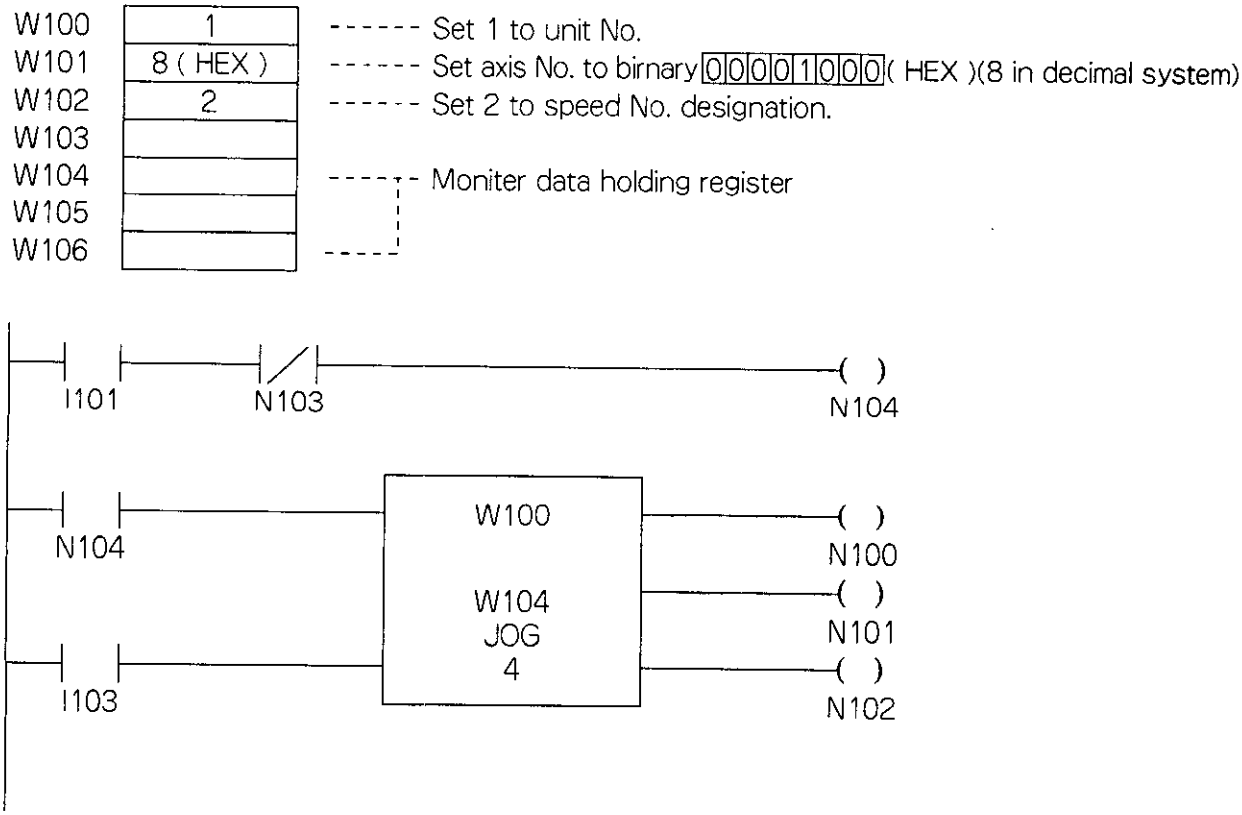


Fig 8.12 Sequence Ladder Circuit

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(iii) I/O timing

FWD RUN COMMAND	I 103
START COMMAND	I 101
DURING RUNNING	N 100
END OF OPERATION	N 102

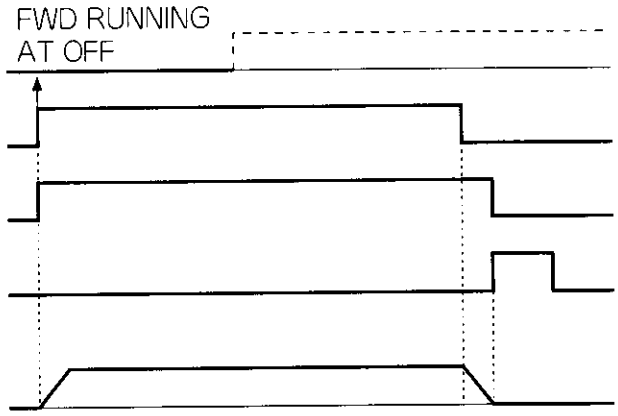
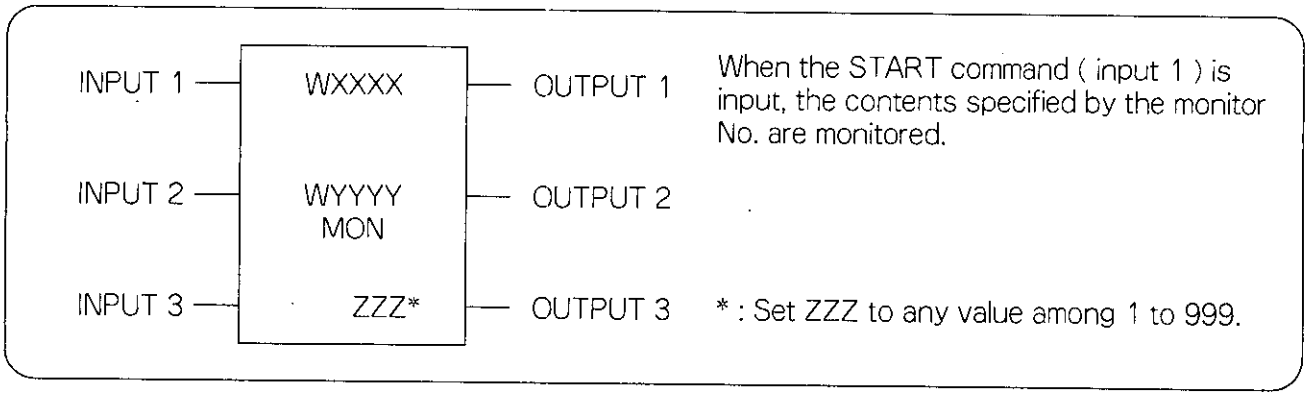


Fig. 8.13 Sequence Ladder Circuit

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8.2.6 Moniter (MON)

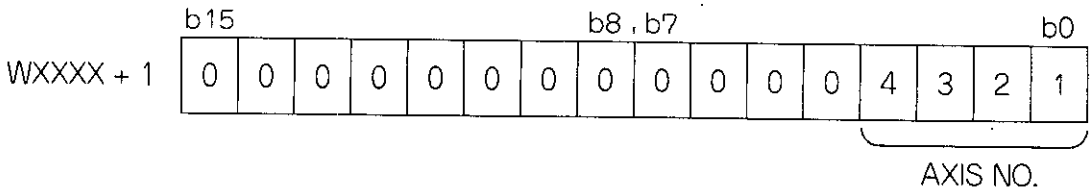
By executing the command for monitor, the status of the specified axis can be monitored.



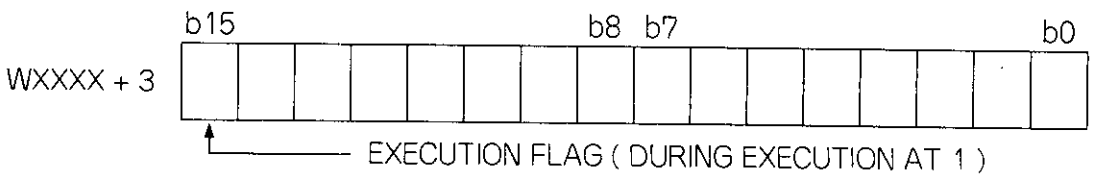
● Data to be set

WXXXX	UNIT NO.	MC unit No. : 1 to 2
WXXXX + 1	AXIS NO.	MC unit axis No. : 1 to lower byte 1 bit.
WXXXX + 2	MONITOR NO.	Monitor No. : Specifies contents to be monitored.
WXXXX + 3	SYSTEM USE	Used as execution flag in system

· MC unit axis No. : Set 1 to one axis to be specified from 0 - to 3 - bit. More than one axis cannot be specified simultaneously.



· System execution flag



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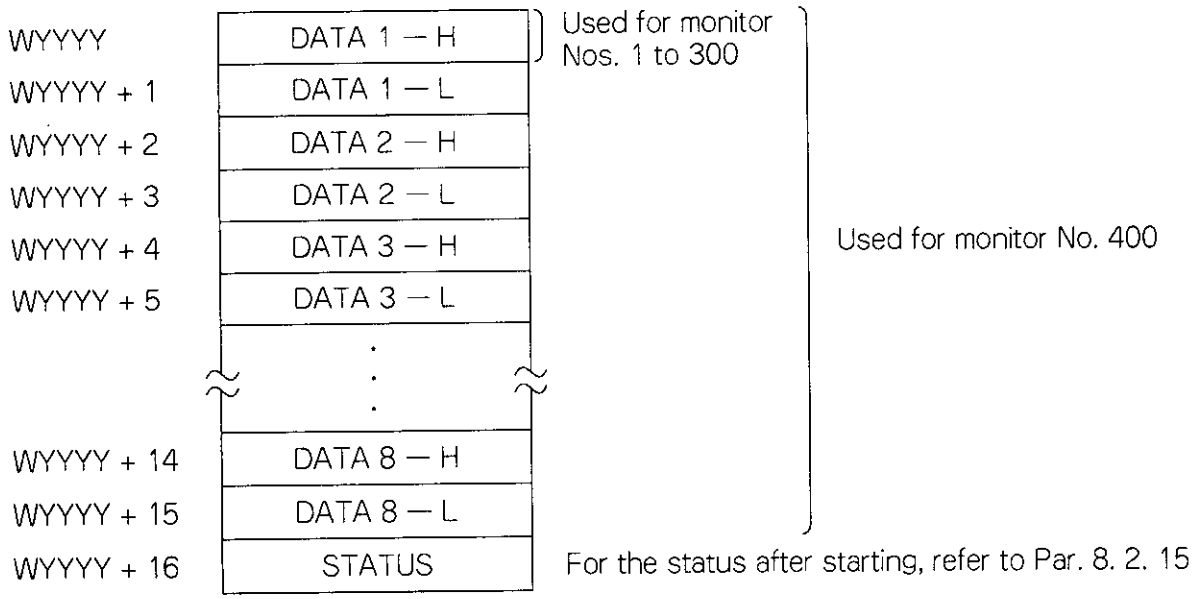
· Monitor No.
The contents to be monitored are specified.

Table 8.13 Moniter No. and Contents

Monitor No.	N	Contents	Axis No. Effective
000N	1	Current position	○
	2	Position deviation	
	3	Current speed	○
	4	Reference speed	○
001N	0 to 9	0 : Alarm that is currently occurring 1 to 9 : Alarms that occured 1 to 9 times before	
002N	1 to 7	MC unit external input status (8 points)	
003N	1 to 4	MC unit external input status (4 points)	
01NN	0 to 99	Refer to common servo parameters.	
02NN	1 to 99	Refer to relevant axis servo parameters.	○
0300		Program No. under execution.	
0400		Data of compensated values H1 to H8	

○ : Effective

● Data to be monitored
The data and error status are displayed.



For monitor Nos. 1 to 300, data 1 — H/ — L are used. When the data are minus, 1 is set to data 1— H MSB.

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● Description of operation

Table 8.14 Description of Operation

Input 1	· START : Execution command Commanded by start - up differential contact (⊣↑⊢). Even if the command is turned ON/OFF during execution, it is not accepted.
Input 2	· NONE : Not used.
Input 3	· NONE : Not used.
Output 1	· BUSY : During Execution ON during command execution. OFF at completion.
Output 2	· ERROR : Error ON for only one scan at termination of error.
Output 3	· DONE : Completion ON for only one scan at normal completion.

● Detailed monitor contents

(i) Monitor No.

Table 8.15 Monitor No. and Contents

Monitor No.	Contents	Data Display	Unit
01	Current position	0 to ±99999999	Reference unit
02	Position deviation	0 to ±99999999	Pulse, ×4 conversion value of PG pulse
03	Current speed (motor rotating speed)	0 to ±99999	r / min
04	Reference speed	0 to ±999999	×1000 reference unit / min

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(ii) Alarm monitor

In the MC unit, up to 9 alarms that occur at the same time can be stored.

Table 8.16 Monitor No. and Contents

Monitor No.	Contents	
10	Alarm status	Alarm that occurred last
11 to 19		Alarm stored in the occurring order (For example, "11" is second from the last.)

Table 8.17 List of Alarm Codes

	Code	Contents
Alarm	001	Program capacity exceeded
	002	Number of program characters exceeded
	003	Program No. not provided
	004	Command argument error
	005	Numerical value error, decimal point error
	006	Character error
	007	Error of number of data digits
	008	Command error (SYNTAX)
	009	Command error (more than one command)
	010	F command error
	011	Circular arc interpolation radius not provided
	012	Specification exceeding circular arc interpolation area
	013	Out of program No. range
	014	Notch command error
	015	
	016	Interpolation command error, plane command error, end point command error
	017	Wrong compensation No.
	018	Subprogram No. not specified
	019	Subprogram not provided
	020	Subprogram completion error (without RET)
	021	Subprogram multi - call error
	022	Program completion error (without END)
	023	Time not specified for time-waiting command
	024	Axis error (undefined)
	025	Zero - division
	026	Overflow
	027	Branching command error
	028	Repeat command error
	029	
	030	

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Table 8.17 List of Alarm Codes (Cont' d)

	Code	Contents
Alarm 2	071	MC unit fault (1) RAM
	072	MC unit fault (2) RAM
	073	MC unit fault (3) RAM
	074	MC unit fault (4) RAM
	075	MC unit fault (1) ROM
	076	MC unit fault (2) ROM
	077	MC unit fault (3) ROM
	078	MC unit fault (4) ROM
	079	Parameter destroyed
	080	Axis name overtravel
	081	Emergency stop
	082	
Alarm 3	A01	Servo amplifier fault
	A02	+ direction overtravel
	A03	- direction overtravel
	A04	Excessive deviation
	A05	+ direction numerical overtravel
	A06	- direction numerical overtravel
	A07	Improper positioning
	A08	(For future use)
	A09	(For future use)
	A10	PG disconnection
	A11	Overrun detection
	A12	
	A13	
	A14	
	A15	
	A16	

Note : Axis No. 1 to 4 is set to A.

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(iii) MC unit input signal status monitor

Table 8.18 Monitor No. and Contents (MC unit I/O Signal Status)

Monitor No.	Contents							
	b7	b6	b5	b4	b3	b2	b1	b0
21	ZERO2	DEC2	N - OT2	P - OT2	ZERO1	DEC1	N - OT1	P - OT1
22	ZERO4	DEC4	N - OT4	P - OT4	ZERO3	DEC3	N - OT3	P - OT3
23						PG pulse 1		
						ORG	PB	PA
24						PG pulse 2		
						ORG	PB	PA
25						PG pulse 3		
						ORG	PB	PA
26						PG pulse 4		
						PA	PB	PC
27								

" 1 " or " 0 " is set to b0 to b7.
Constant : [closed : 0; open : 1]
Pulse : [H level : 1; L level : 0]

(iv) MC unit output signal status monitor

Table 8.19 Monitor No. and Contents (MC unit Output Signal Status)

Monitor No.	Contents							
	b7	b6	b5	b4	b3	b2	b1	b0
31					BRAKE4	BRAKE3	BRAKE2	BRAKE1
32								
33								
34								

" 1 " or " 0 " is set to b0 to b7.
Output : [ON : 0; OFF : 1]

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(v) Parameter value monitor

Table 8.20 Monitor No. and Contents (Parameter Value)

Monitor No.	Contents
100 to 199	Stores common parameter data set to the MC unit. 100 corresponds to parameter No. 0 (P000) and 199 to No.99 (P 099) to store each item of data. Refer to the list of parameters.
201 to 299	Stores parameter data of each axis set to the MC unit. 201 corresponds to parameter 1 (PA01) and 299 to No.99 (PA99) to store each item of data. Refer to the list of parameters.

(vi) Motion program No. monitor

Table 8.21 Monitor No. and Contents (Motion Program No.)

Monitor No.	Contents
300	DATA 1 - H ..... No. O (Motion program No.) DATA 1 - L ..... No. B (Sequence block No.)

(vii) Compensated value monitor

Table 8.22 Monitor No. and Contents (Compensated Value)

Monitor No.	Contents	Data Display
400	Compensation	Data 1 : H 1 0 to ±99999999 Data 2 : H 2 0 to ±99999999 Data 3 : H 3 0 to ±99999999 Data 4 : H 4 0 to ±99999999 Data 5 : H 5 0 to ±99999999 Data 6 : H 6 0 to ±99999999 Data 7 : H 7 0 to ±99999999 Data 8 : H 8 0 to ±99999999

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● Typical operation

(i) Operation

Parameter 4 (PO4) feeding speed of axis No. 4 is monitored (read out).

(ii) Sequence ladder circuit

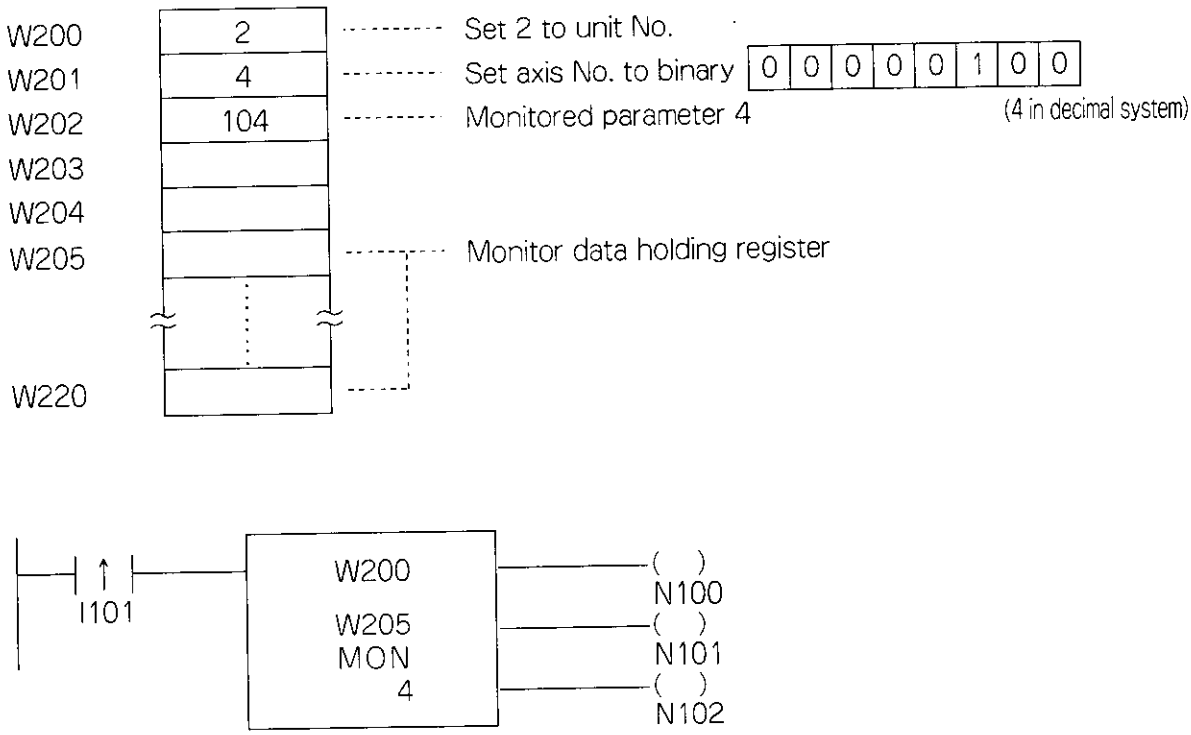
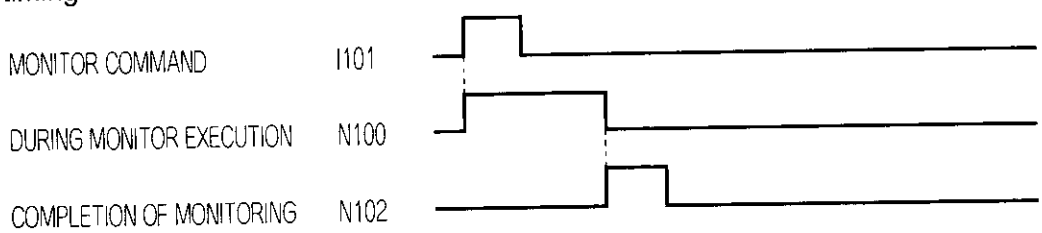
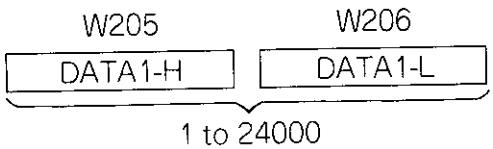


Fig. 8.14 Sequence Ladder Circuit

(iii) I/O timing





Stores the set value of parameter 4 to DATA1-H and DATA1-L

*Register contents of W207 to W220 are not specified.

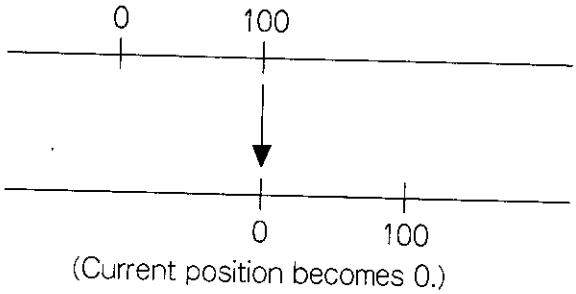
Fig. 8.15 I/O Timing

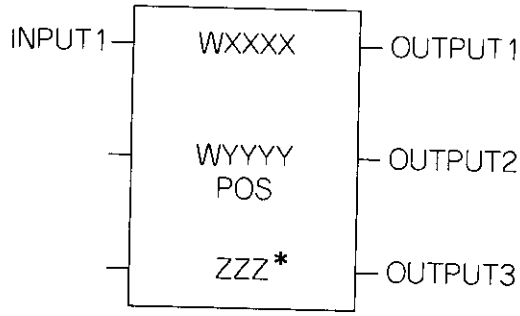
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8.2.7 Current Value Setting (POS)

POS is a command to change the current position; after execution of the command, the coordinate is changed.

(Example) Coordinate with specified machine zero point





When the START command (input1) is input, the specified value (current value data) is set to the MC unit.

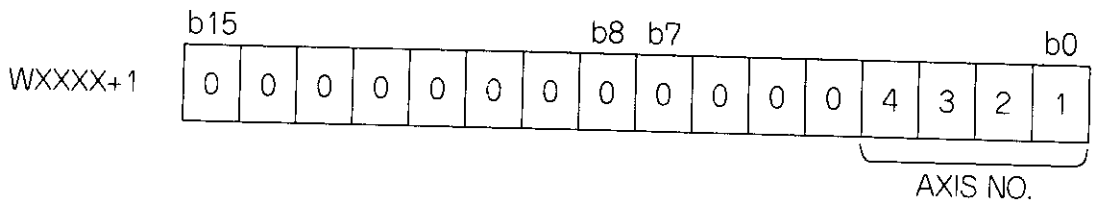
*: Set ZZZ to any value from 1 to 999.

Note : When the control power supply is turned OFF, the current value coordinate system set by the POS command becomes ineffective.

● Data to be set

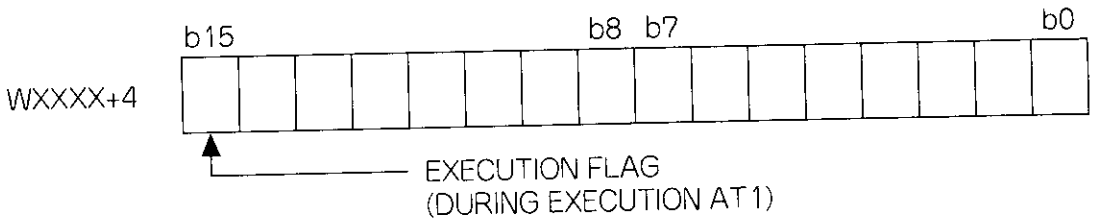
WXXX	UNIT NO.	MC unit No. : 1 to 2
WXXX+1	AXIS NO.	MC unit axis No. : 1 to lower byte 1 bit.
WXXX+2	SET VALUE-H	Set value : 0 to ±9 9 9 9 9 9 9 9 (WXXXX+2 : WXXXX+3)
WXXX+3	SET VALUE-L	
WXXX+4	SYSTEM USE	Used as execution flag in system

· **MC unit axis No.** : Set 1 to one axis to be specified from 0-bit to 3-bit. More than one axis cannot be specified simultaneously.



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· System execution flag



● Data to be monitored

The error status is displayed.

WYYYY | STATUS | For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.23 Description of Operation

Input1	· START : Execution command Commanded by start-up defferential contact (—|↑|—). Even if the command is turned ON/OFF during execution, it is not accepted.
Input2	· NONE : Not used.
Input3	· NONE : Not used.
Output1	· BUSY : During execution ON during command execution. OFF at completion.
Output2	· ERROR : Error ON for only one scan at termination of error.
Output3	· DONE : Completion ON for only one scan at normal completion.

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● Typical operation

(i) Operation

The current position of axis No. 1 is changed to +10000.

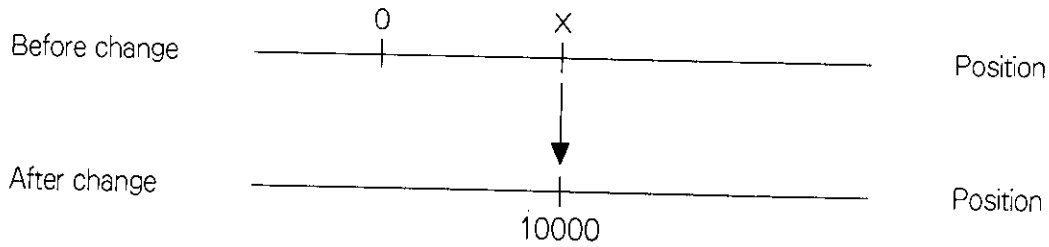


Fig. 8.16 Operation

(ii) Sequence ladder circuit

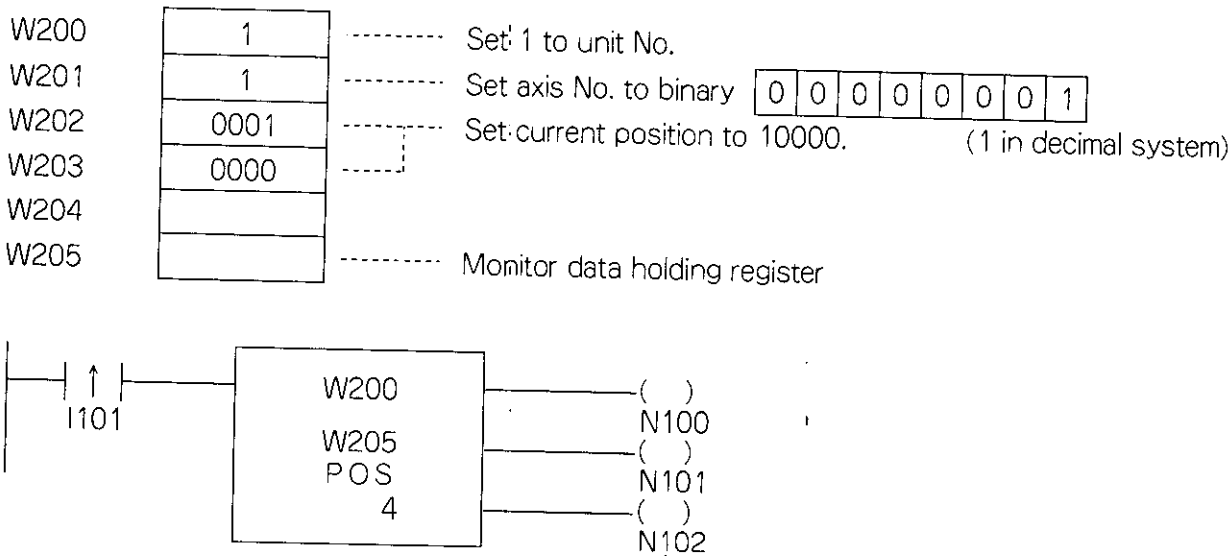


Fig. 8.17 Sequence Ladder Circuit

(iii) I/O timing

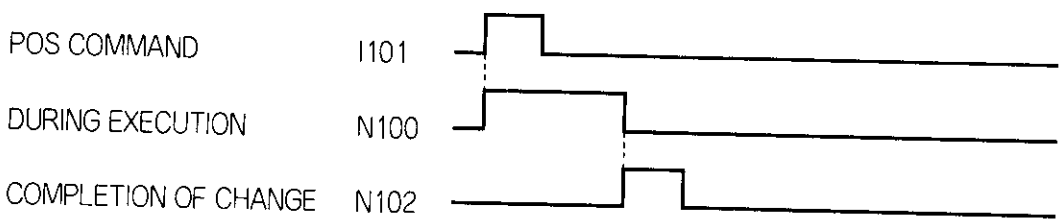


Fig. 8.18 I/O Timing

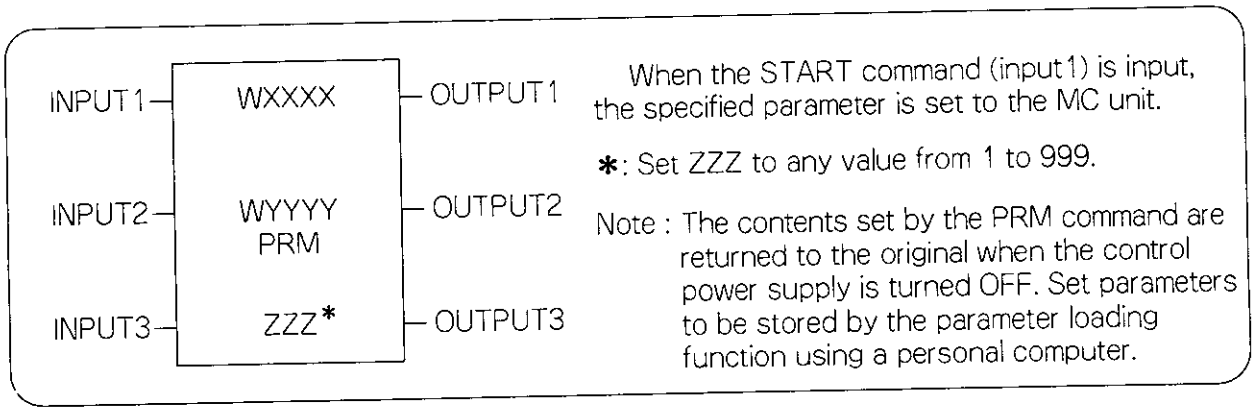
(iv) Precautions

The coordinate changed by the POS command is returned to the original when the control power supply is turned OFF.

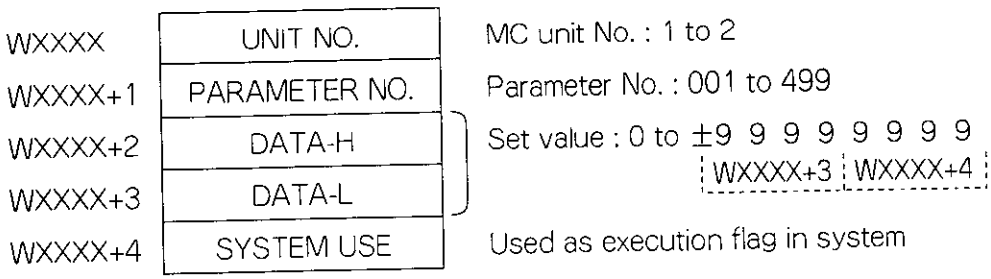
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8.2.8 Parameter Setting (PRM)

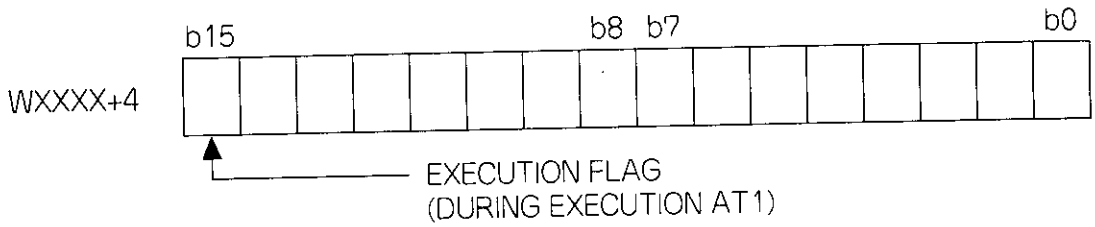
PRM is a command to change parameter No. Pxx of the MC unit.
Parameters can be changed during running. However, the parameter Nos. that can be changed by PRM command are limited. For details, refer to Table 8.25.



● Data to be set

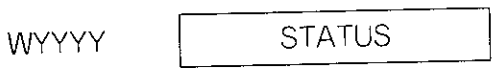


· System execution flag



● Data to be monitored

The current value and error status is displayed.



For the status after starting, refer to Par. 8.2.15.

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● Description of operation

Table 8.24 Description of Operation

Input1	· START : Execution command Commanded by start-up differential contact (—┤↑├—). Even if the command is turned ON/OFF during execution, it is not accepted.
Input2	· NONE : Not used.
Input3	· NONE : Not used.
Output1	· BUSY : During execution ON during command execution. OFF at completion.
Output2	· ERROR : Error ON for only one scan at termination of error.
Output3	· DONE : Completion ON for only one scan at normal completion.

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● Parameter to be set

Any Parameters other than those described in Table 8.25 are ineffective.

Table 8.25 Parameters to be Set by PRM

Parameter No.	Name	Range	Unit
010	Maximum Interpolation feeding speed	0 to 240000	(×1000) reference unit/min
A01	Position loop gain : Kp	0 to 200	S^{-1}
A04	1st feed speed (positioning)	1 to 240000	(×1000) reference unit/min
A05	Linear accel/decel constant (1)	1 to 32767	15625 reference unit/min
A06	Positioning completion range	1 to 250	Reference unit
A07	Positioning completion checking time	0 to 32767	ms
A09	Servo tracking error value	1 to 99999999	Pulse
A31	2nd feed speed (positioning)	1 to 240000	(×1000) reference unit/min
A38	Linear accel/decel constant (2)	1 to 32767	15.625mm/s^2
A39	Linear accel/decel changing speed	1 to 240000	(×1000) reference unit/min
A40	+direction limit switch	±99999999	Reference unit
A41	−direction limit switch	±99999999	Reference unit
A42	Backlash compensation value	0 to 32767	Pulse
A43	Brake time	8 to 1000	ms
A44	Brake ON/motor rotating speed	1 to 10000	r/min
A46	Speed limiting value	1 to 240000	(×1000) reference unit/min
A47	Exponential accel/decel time constant	8 to 1000	ms
A48	Exponential accel/decel bias speed	0 to 24000	(×1000) reference unit/min
A51	Zero-point return feed speed	0 to 240000	(×1000) reference unit/min
A52	Zero-point return approach speed	0 to 240000	(×1000) reference unit/min
A53	Zero-point return creep speed	0 to 240000	(×1000) reference unit/min
A54	Zero-point return final traveling distance	0 to ±99999999	Reference unit
A55	Zero-point position output width	0 to 32767	Pulse

Note : A: Axis Nos. : 1 to 4 (Example: Parameters for 1st axis are 101 to 199.)
A = 0 (Example: 010,011) is a common parameter.

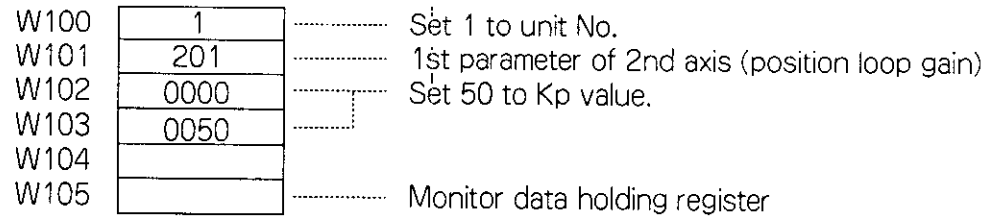
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● Typical operation

(i) Operation

The SERVOMOTOR axis No. 2 Kp value is set to 50 (1/S).

(ii) Sequence ladder circuit



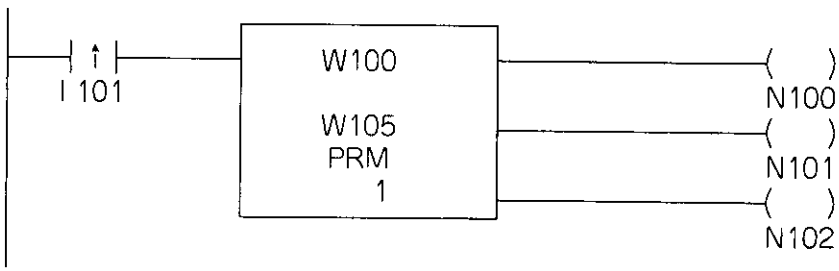


Fig. 8.19 Sequence Ladder Circuit

(iii) I/O timing

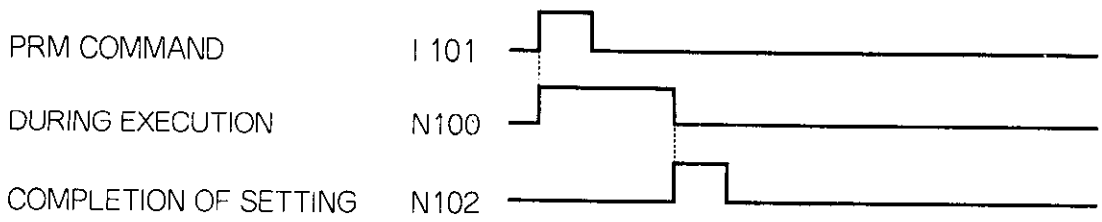


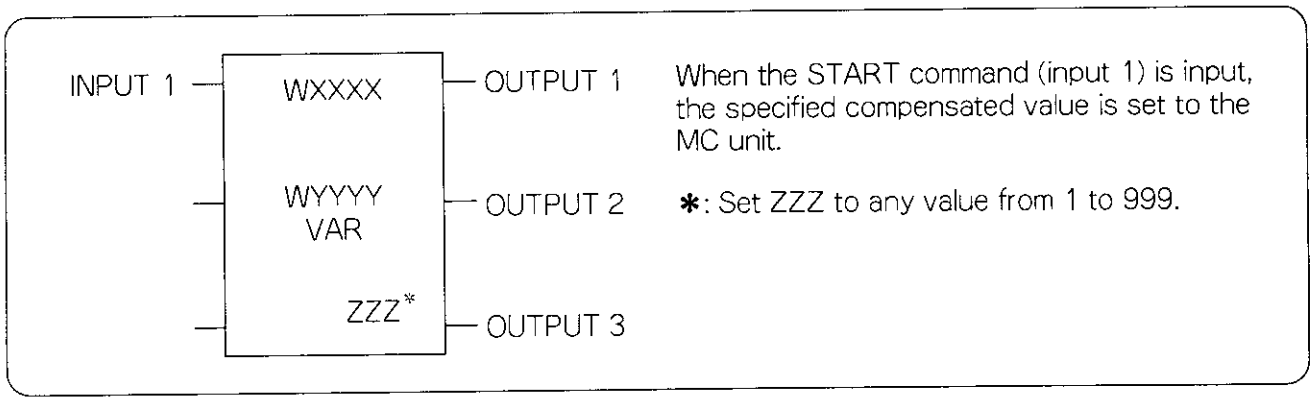
Fig. 8.20 I/O Timing

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8.2.9 Compensated Value Setting (VAR)

Using H1, H2, H3, H4, H5, H6, H7 and H8 compensation, motion program can be created. VAR is a command to set the compensation value.

(Example) MVS XH1 YH2 FH3 ;

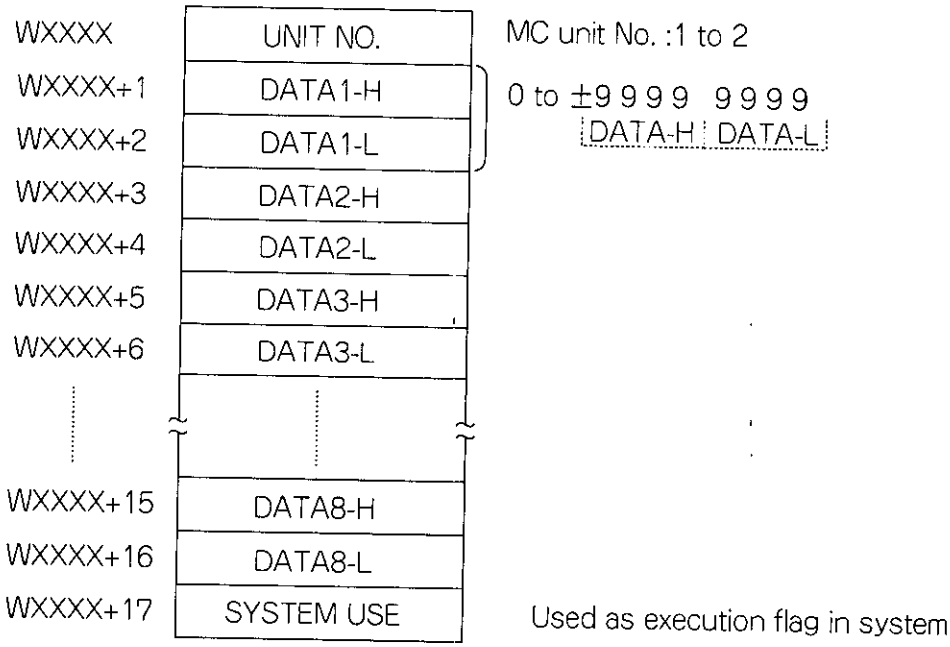


Once a compensated value is set, the value is held in the MC unit.
However, compensated values cannot be calculated together.

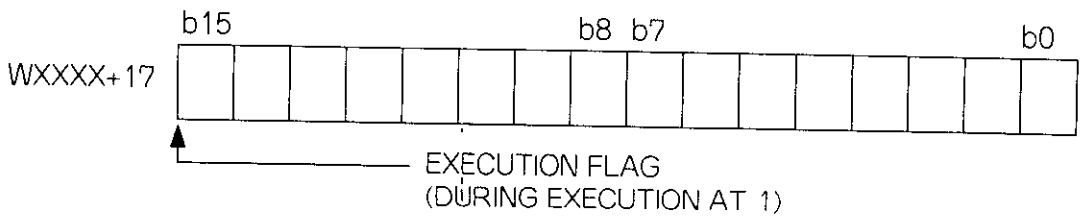
(Example) MVS XH1 +H2 ; (This is not possible.)

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● Data to be set



● System flag



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● Data to be monitored

The current value and error status are displayed.

WYYYY | STATUS | For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.26 Description of Operation

Input 1	• START : Execution command Commanded by start-up differential contact (┤↑├). Even if the command is turned ON/OFF during execution, it is not accepted.
Input 2	• NONE : Not used.
Input 3	• NONE : Not used.
Output 1	• BUSY : During execution ON during command execution. OFF at completion.
Output 2	• ERROR : Error ON for only one scan at termination of error.
Output 3	• DONE : Completion ON for only one scan at normal completion.

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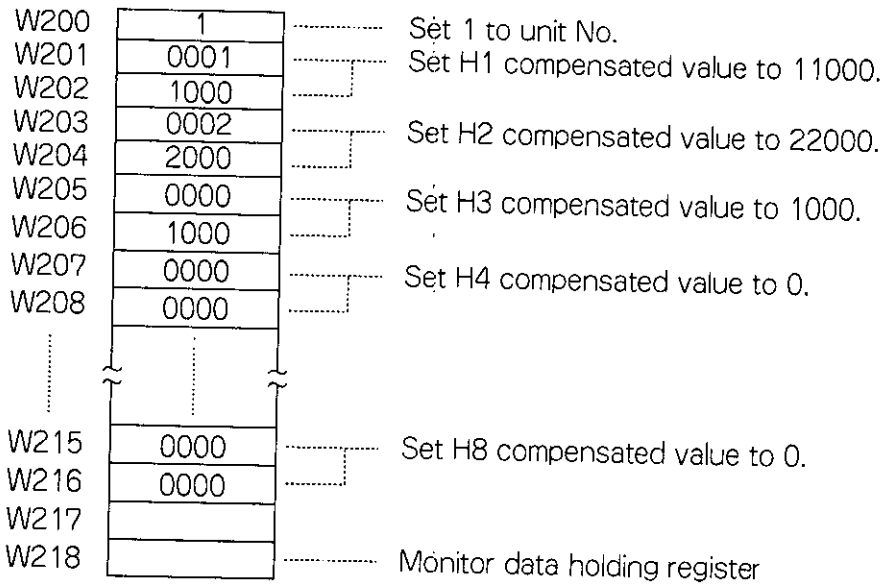
● Typical operation

(i) Operation

Sets H1=11000, H2=22000 and H3=1000 of a motion program to perform compensation for SERVOMOTOR axes Nos. 1 (X) and 2 (Y).

```
MVS   XH1   YH2   FH3 ;
```

(ii) Sequence ladder circuit



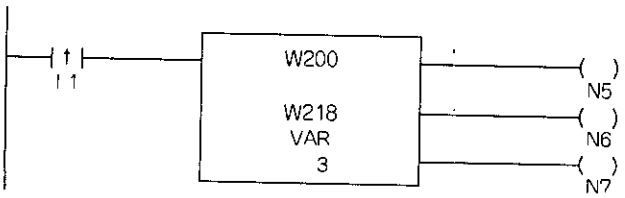


Fig. 8.21 Sequence Ladder Circuit

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(iii) I/O timing

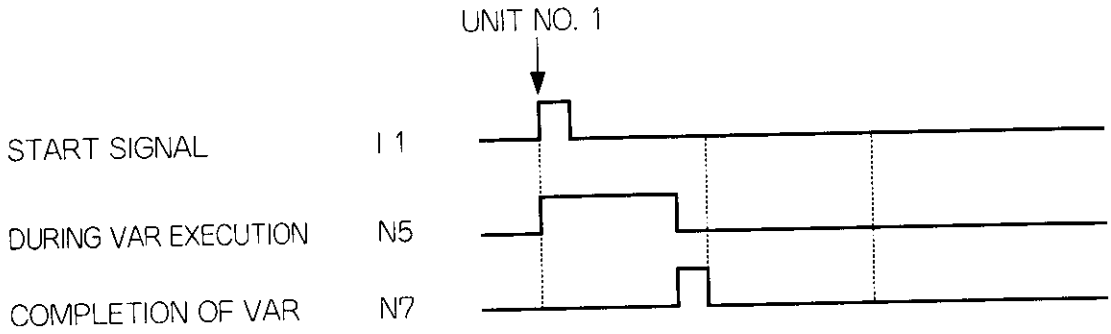
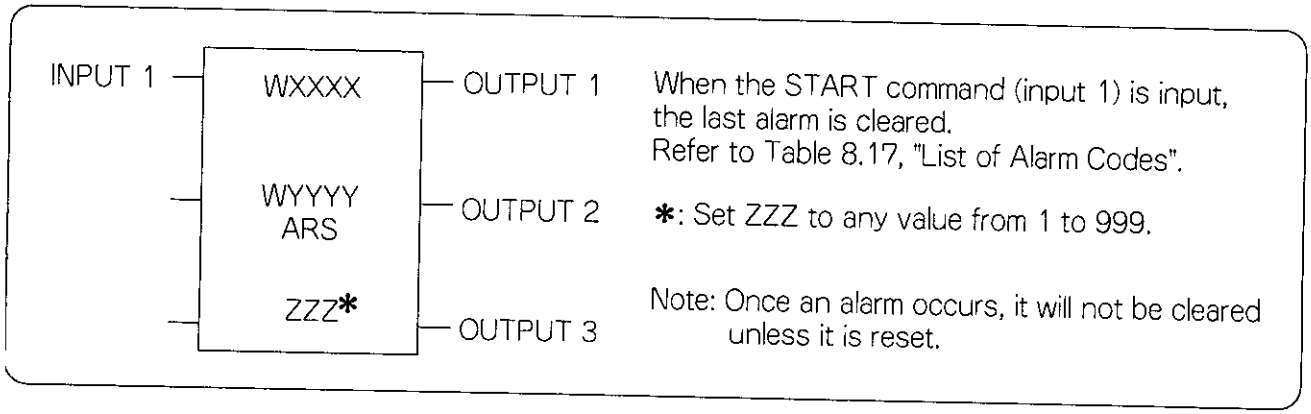


Fig. 8.22 I/O Timing

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8.2.10 Alarm Reset (ARS)

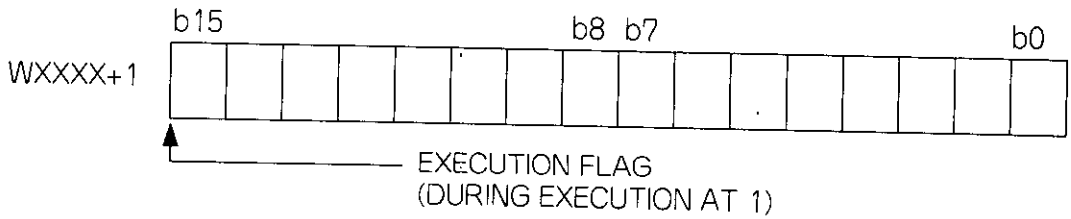
A command to reset the alarm when an alarm occurs in the MC unit.



● Data to be set

WXXXX	UNIT NO.	MC unit No. :1 to 2
WXXXX+1	SYSTEM USE	Used as execution flag in system

● System flag



● Data to be monitored

WYYYY	STATUS	For the status after starting, refer to Par. 8.2.15.

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● Description of operation

Table 8.27 Description of Operation

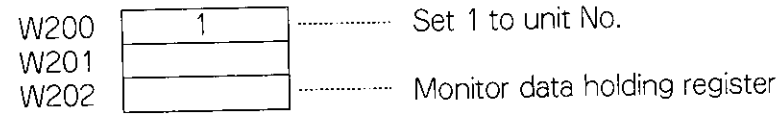
Input 1	• START : Execution command Commanded by start-up differential contact (⊣↑⊢). Even if the command is turned ON/OFF during execution, it is not accepted.
Input 2	• NONE : Not used.
Input 3	• NONE : Not used.
Output 1	• BUSY : During execution ON during command execution. OFF at completion.
Output 2	• ERROR : Error ON for only one scan at termination of error.
Output 3	• DONE : Completion ON for only one scan at normal completion.

● Typical operation

(i) Operation

An alarm is reset.

(ii) Sequence ladder circuit



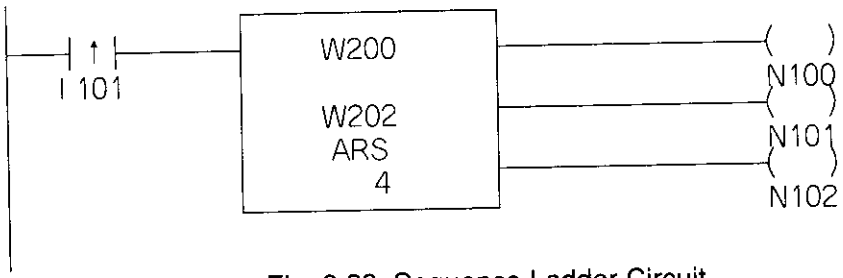


Fig. 8.23 Sequence Ladder Circuit

(iii) I/O timing

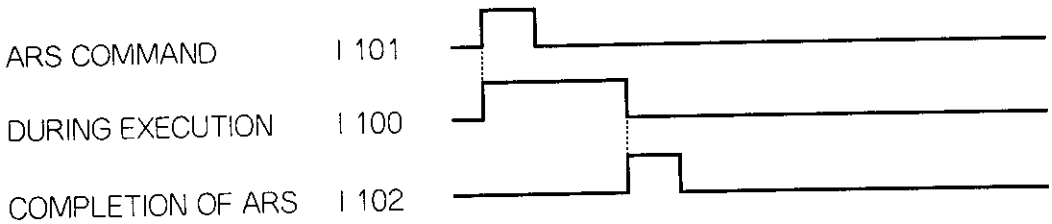
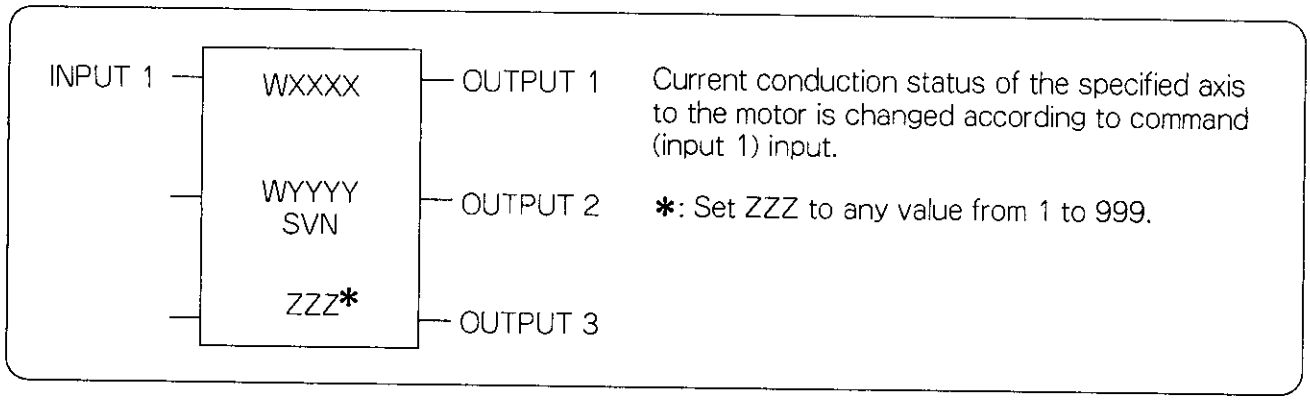


Fig. 8.24 I/O Timing

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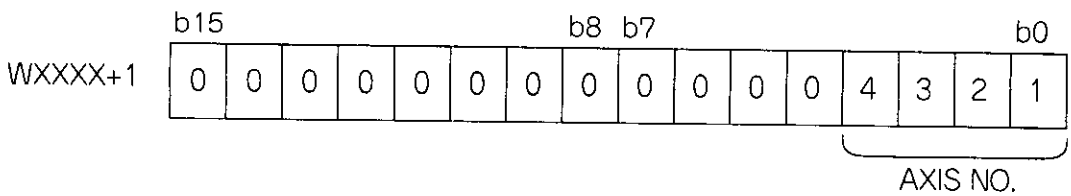
8.2.11 Servo ON (SVN)



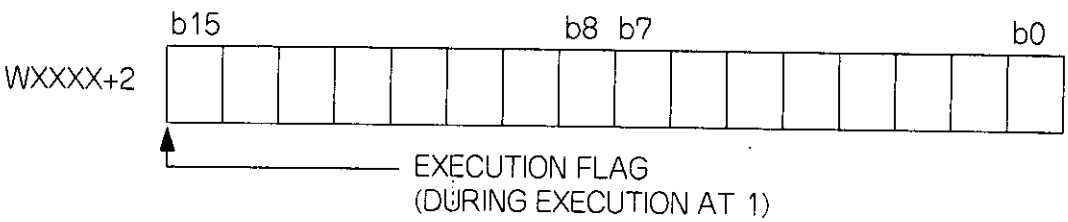
● Data to be set

WXXXX	UNIT NO.	MC unit No. :1 to 2
WXXXX+1	AXIS NO.	MC unit axis No. : 1 to lower digit byte.
WXXXX+2	SYSTEM USE	Used as execution flag in system

● MC unit axis No. : Set 1 to the axis to be specified from 0- to 3-bit.



● System execution flag



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● Data to be monitored

The current value and error status are displayed.

WYYYY | STATUS | For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.28 Description of Operation

Input 1	• START : Execution command Commanded by NO contact (┤├). Servo ON when the command is ON and servo OFF when the command is OFF.
Input 2	• NONE : Not used.
Input 3	• NONE : Not used.
Output 1	• BUSY : During execution ON during command execution. OFF at completion.
Output 2	• ERROR : Error ON for only one scan at termination of error.
Output 3	• DONE : Completion ON for only one scan at normal completion.

Note : One command can be provided either for one axis or four axes.

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● Typical operation

(i) Operation

SERVOMOTOR axes Nos. 1, 2 and 3 are set to current conduction status.

(ii) Sequence ladder circuit

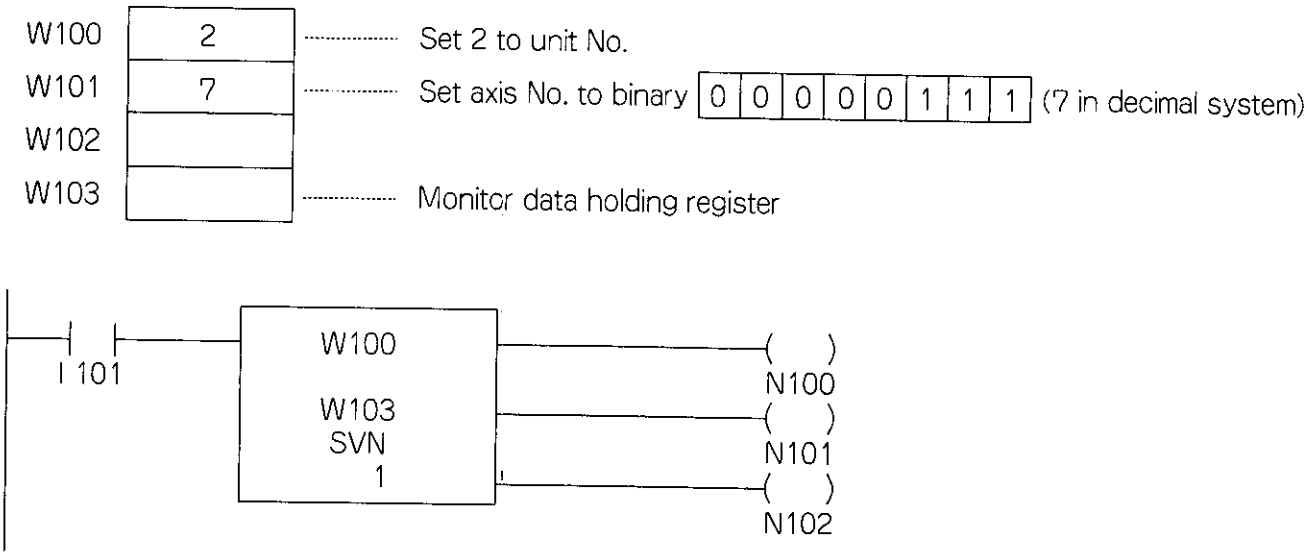
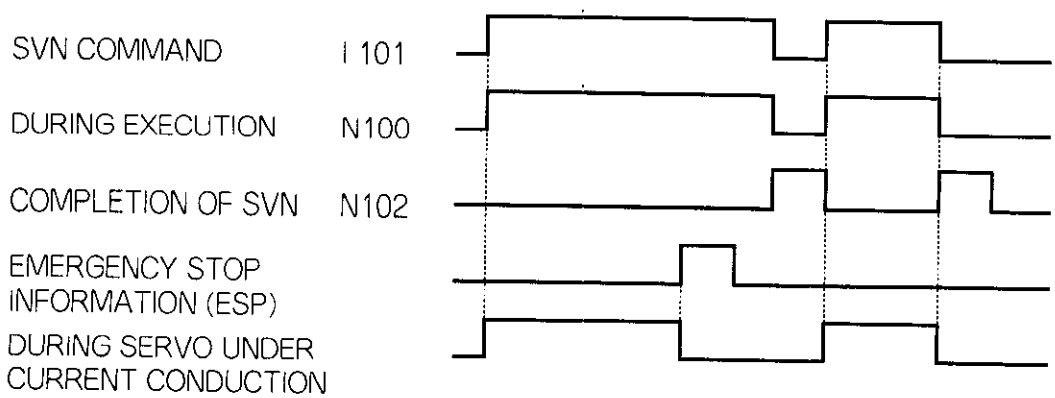


Fig. 8.25 Sequence Ladder Circuit

(iii) I/O timing



Note : Servo is in the OFF status when emergency stop information is provided.
To turn it ON again; turn OFF the SVN command input once and then turn it ON after error resetting.

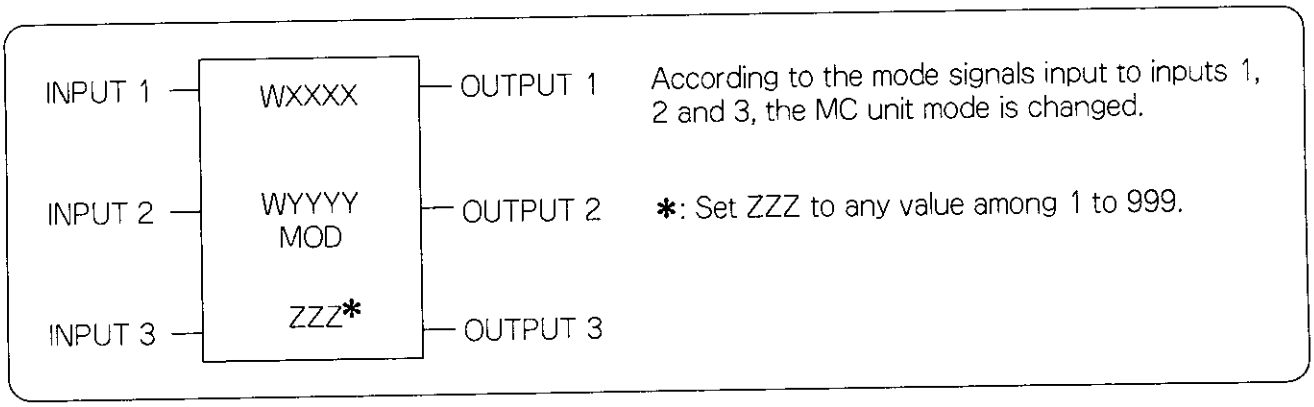
Fig. 8.26 I/O Timing

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8.2.12 Mode Set (MOD)

MC unit mode is changed.

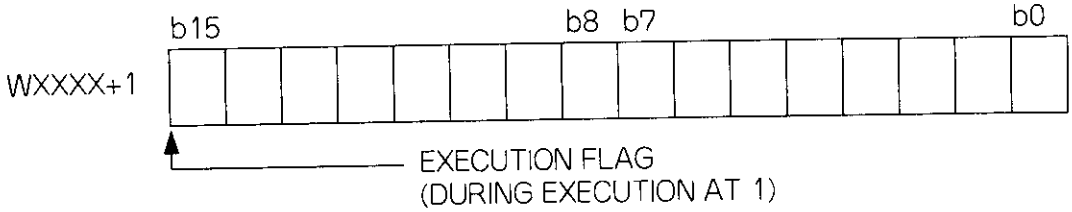
There are four modes available:edit mode, manual operation mode, program operation (automatic) mode and online edit mode.



● Data to be set

WXXXX	UNIT NO.	MC unit No. :1 to 2
WXXXX+1	SYSTEM USE	Used as execution flag in system

● System execution flag



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● Data to be monitored

The error status is displayed.

WYYYY | STATUS | For the status after starting, refer to Par. 8.2.15.

● Description of operation

Table 8.29 Description of Operation

Input 1	• MANUAL: Manual operation mode command Commanded by NO contact (┤├). Manual operation mode entered at ON.
Input 2	• AUTO : Program operation mode command Commanded by NO contact (┤├). Program operation mode entered at ON.
Input 3	• ONLINE-EDIT : Online edit command Commanded by NO contact (┤├). Online edit mode entered at ON.
Output 1	• MANUAL: Manual operation mode ON when MC unit is in the manual operation mode.
Output 2	• AUTO : Program operation mode ON when MC unit is in the program operation mode.
Output 3	• ONLINE-EDIT : Online edit mode command ON when MC unit is in the online edit mode.

Notes : 1. All outputs 1, 2 and 3 are turned OFF in the edit mode in the MC units.
2. If the mode is change during SERVOMOTOR operation (program operation, JOG operation, MVA/MVB, etc.), the SERVOMOTOR under operation coasts to a stop.

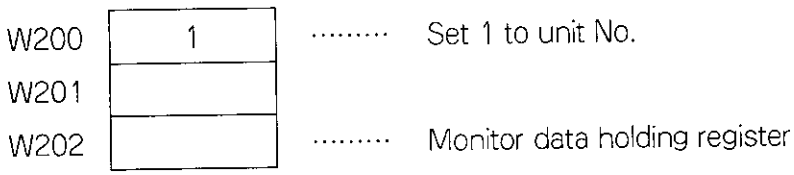
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● Typical operation

(i) Operation

MC unit 1 is set to the program operation mode.

(ii) Sequence ladder circuit



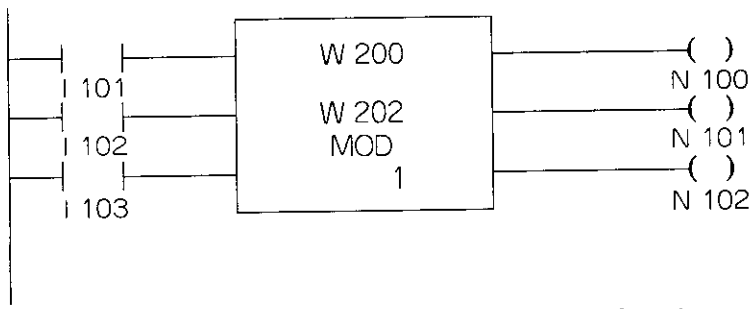


Fig 8.27 Sequence Ladder Circuit

(iii) I/O timing

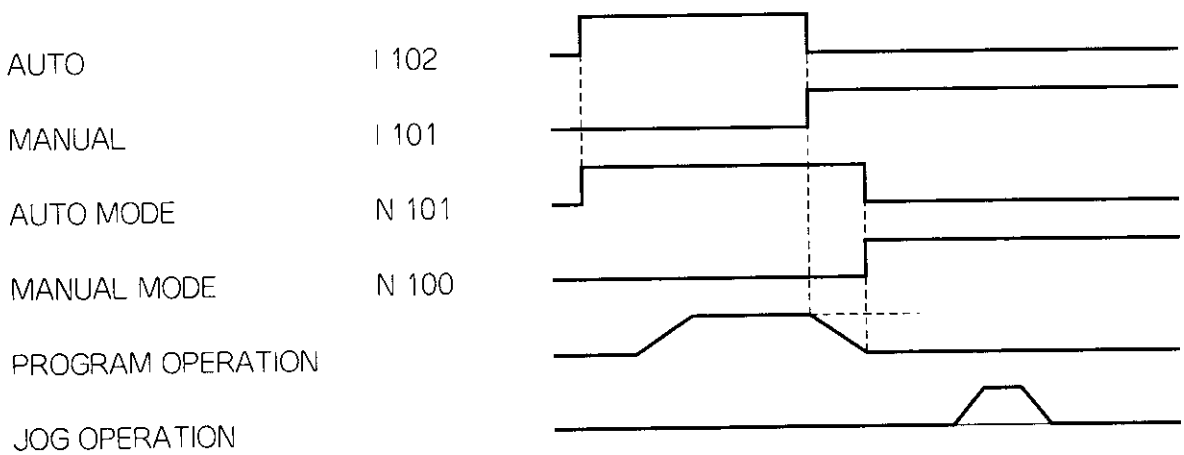
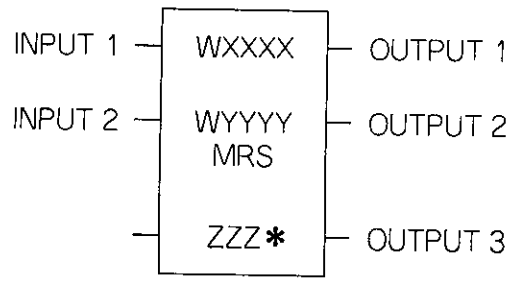


Fig 8.28 I/O Timing

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8.2.13 Reset (MRS)



When the reset command (Input 1) is input, the motion program under execution is changed to the program No. (#O) and block (#B) set by register after each SERVOMOTOR coasts to a stop (program reset).

Parameter set by the PRM command is not cleared but remains as it is.

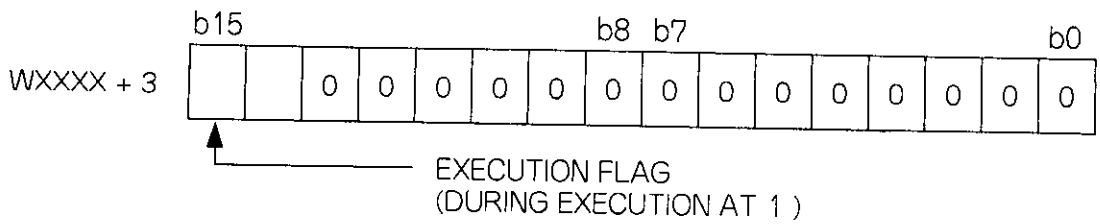
When input 1 is turned ON with input 2 ON, all MC unit relays are placed in OFF status at the same time as program reset.

*: Set ZZZ to any value from 1 to 999.

● Data to be set

WXXXX	UNIT NO.	MC unit No. : 1 to 2
WXXXX + 1	NUMBER O	Motion program #O : 1 to 99
WXXXX + 2	NUMBER B	Motion program #B : 1 to 9999
WXXXX + 3	SYSTEM USE	Used as execution flag in system

· System execution flag



● Data to be monitored

The current value and error status are displayed.

WYYYY	STATUS

For the status after starting, refer to Par. 8.2.15.

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● Discription of operation

Table 8.30 Description of Operation

Input 1	· START : Execution command Commanded by start - up differential contact (⊣↑⊢). Even if the command is turned ON/OFF, it is not accepted.
Input 2	· SELECT : MC unit relay reset selection, reset at ON.
Input 3	· NONE : Not used.
Output 1	· BUSY : During execution ON during command execution. OFF at completion.
Output 2	· ERROR :Error ON for only one scan at termination of error.
Output 3	· DONE : Completion ON for only one scan at normal completion.

● Typical operation

(i) Operation

MC unit 2 is set to program No. 1 and sequence No. 1.

(ii) Sequence ladder circuit

W100	2	..... Set 2 to unit No.
W101	1	..... Set 1 to program No. (#O)
W102	1	..... Set sequence block operation starting No. to 1 (top).
W103		
W104		..... Monitor data holding register.

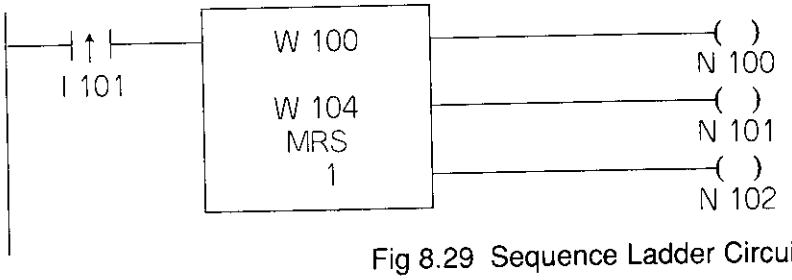


Fig 8.29 Sequence Ladder Circuit

(ⅲ) I/O timing

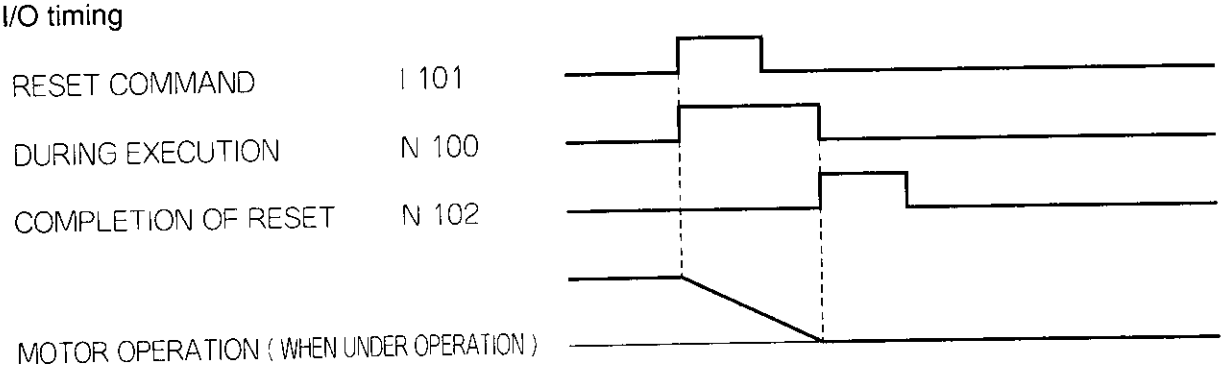
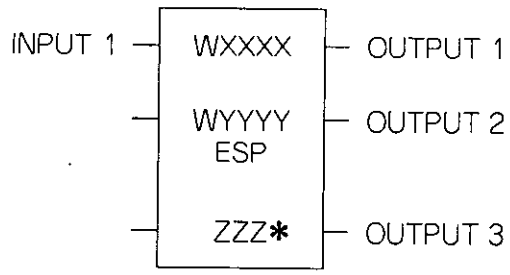


Fig 8.30 I/O Timing

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8.2.14 Emergency Stop Information (ESP)



When the information command (input 1) is input, the motion program under execution enters the servo OFF status after each SERVOMOTOR stops immediately (zero - speed command).

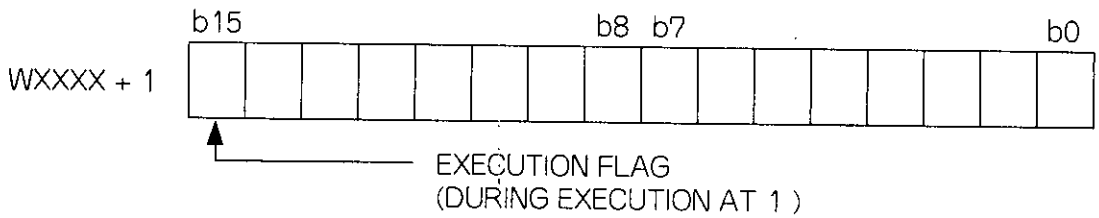
To turn it ON again, input the servo ON command after resetting the alarm. When the servo power supply is turned OFF, the motion program cannot be continued. Restart with zero - point return operation.

*: Set ZZZ to any value from 1 to 999.

● Data to be set

WXXXX	UNIT NO.	MC unit No. : Not used
WXXXX + 1	SYSTEM USE	Used as execution flag in system

· System execution flag



● Data to be monitored

The current value and error status are displayed.

WYYYY	STATUS	For the status after starting, refer to Par. 8.2.15

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● Description of operation

Table 8.31 Description of Operation

Input 1	· ESP : Information command Commanded by NO contact (⊣ ⊢). Emergency stop status information at ON.
Input 2	· NONE : Not used.
Input 3	· NONE : Not used.
Output 1	· BUSY : During execution ON during command execution. OFF at completion.
Output 2	· ERROR :Error ON for only one scan at termination of error.
Output 3	· DONE : Completion ON for only one scan at normal completion.

● Typical operation

(i) Operation

Informs the MC units that the external emergency stop circuit operates. It is not necessary to specify the unit No. It is output to all MC units connected simultaneously.

(ii) Sequence ladder circuit

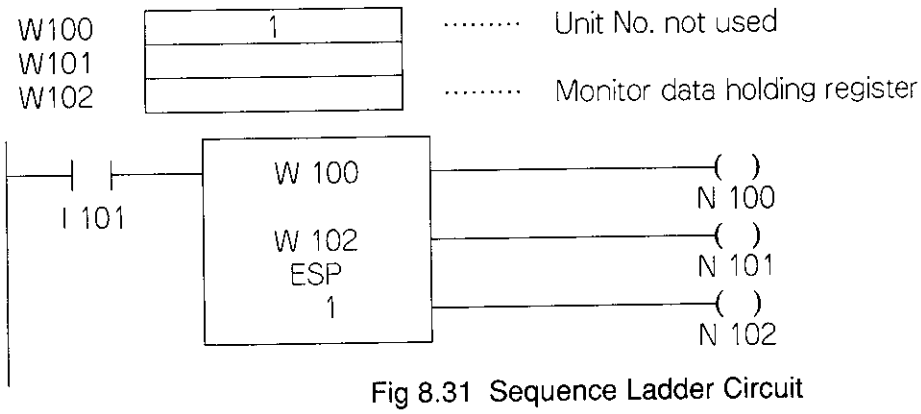
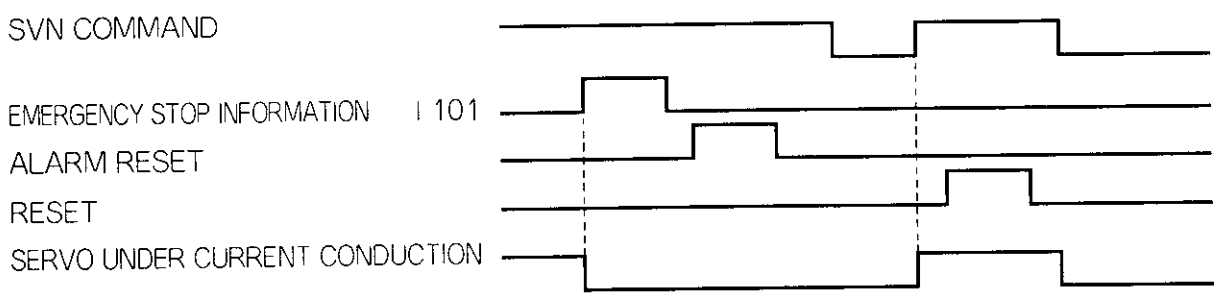


Fig 8.31 Sequence Ladder Circuit

(iii) I/O timing



Note : Servo OFF status is enterd by emergency stop instruction. To turn it ON again, turn OFF the SVN command input once and then turn it ON again.

Fig 8.32 I/O Timing

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8.2.15 Status

The status after each command start is stored in the status in the data to be monitored.

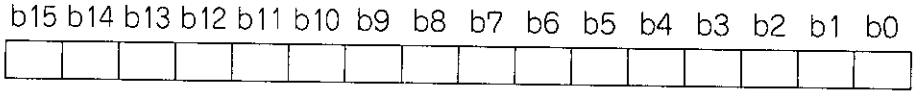


Table 8.32 Status

Bit	Item	Bit Data	Contents
b0	1st axis servo ON	1	During current conduction to 1st axis motor
b1	2nd axis servo ON	1	During current conduction to 2nd axis motpr
b2	3rd axis servo ON	1	During current conduction to 3rd axis motpr
b3	4th axis servo ON	1	During current conduction to 4th axis motpr
b4	1st axis alarm	1	During 1st axis alarm occurrence Alarm contents are monitored by MON command.
b5	2nd axis alarm	1	During 2nd axis alarm occurrence Alarm contents are monitored by MON command.
b6	3rd axis alarm	1	During 3rd axis alarm occurrence Alarm contents are monitored by MON command.
b7	4th axis alarm	1	During 4th axis alarm occurrence Alarm contents are monitored by MON command.
b8	Common alarm	1	During common alarm occurrence Alarm contents are monitored by MON command.
b9	Axis designation error	1	• Axis No. is out of the designation range. • The specified axis is not defined.
b10	Data error	1	Error occurs in setting data. Setting data is out of range, etc.
b11	during command prohibition	1	The command by motion command cannot be accepted by the MC unit.
b12	Without unit	1	The specified MC unit is not provided.
b13	Busy error	1	A command which is impossible to activate simultaneously with this command is under execution.
b14	Time-out error	1	Although a command is issued in the MC unit, no response is given.
b15	——		

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8.2.16 M-code Relay

In order to synchronize a sequence program with a motion program, M-code relay, MC unit coil and MC unit relay are used.

Table 8.33 Matching of Sequence Program and Motion Program

	Sequence Program		Motion Program	
	Name	Program	Name	Program
M-code Relay	M-code relay	⊣ ⊢ MUXX U : Unit No. XX : Code Nos. : 00 to 89	MFIN input waiting M-code output	SET MXX ; XX : Code No. 00 to 89
	MC unit coil	—( )— Y1 to Y512	Signal input	IF #I 5 = 1 GOTO nn ; #10 = #I 10 ;
	MC unit relay	⊣ ⊢ X1 to X512	Signal output	#O56 = 1 ; (ON) #O57 = 0 ; (OFF)

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(i) M-code relay

By executing motion program " SET MXX "; by the MC unit, the corresponding M-code relay (reference No. : MUXX) is turned ON and the motion program is waiting for MFIN. By turning ON the sequence program MFIN input in this status, the waiting status is released and the next block is executed.

● Typical operation

(a) Motion program

Attempt to create the following program to load on the MC unit of the first axis.

```
O01 ;
   N001   MVS   X100    F 100 ;
   N002   SET   M21 ;
   N003   MVS   X200    F 100 ;
   N004   SET   M11 ;
   N005   SET   M21 ;
   N006   MVS   X 0     F 100 ;
   N007   END ;
```

(b) Sequence ladder circuit

Assume that program No. and starting sequence No. are set by reset command MRS.

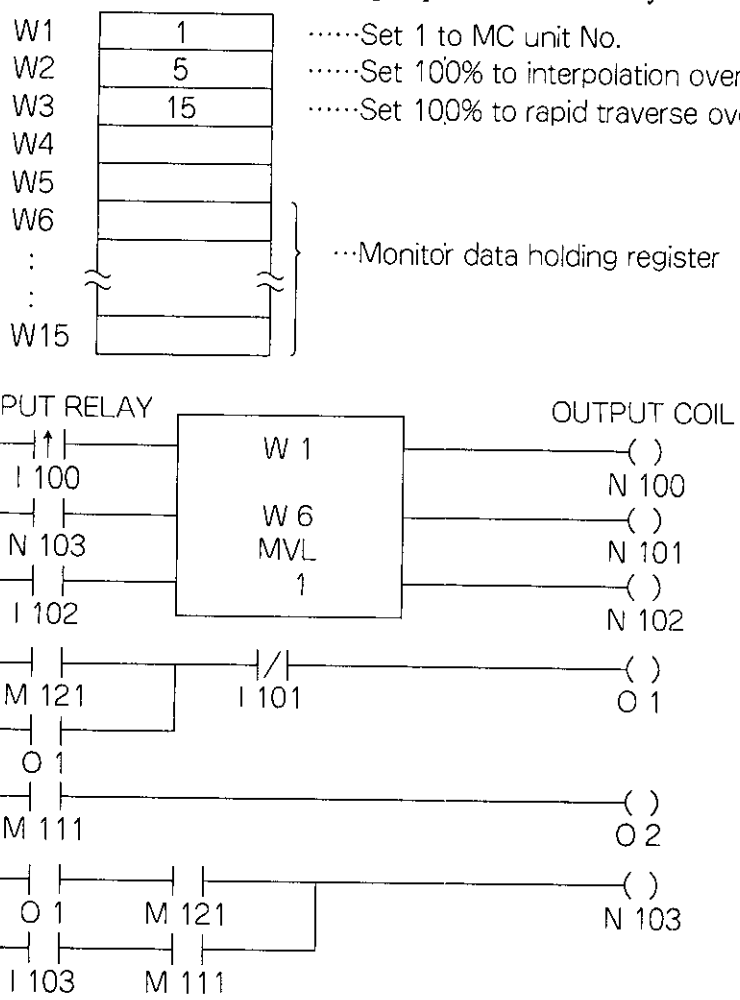


Fig. 8.33

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(c) I/O timing

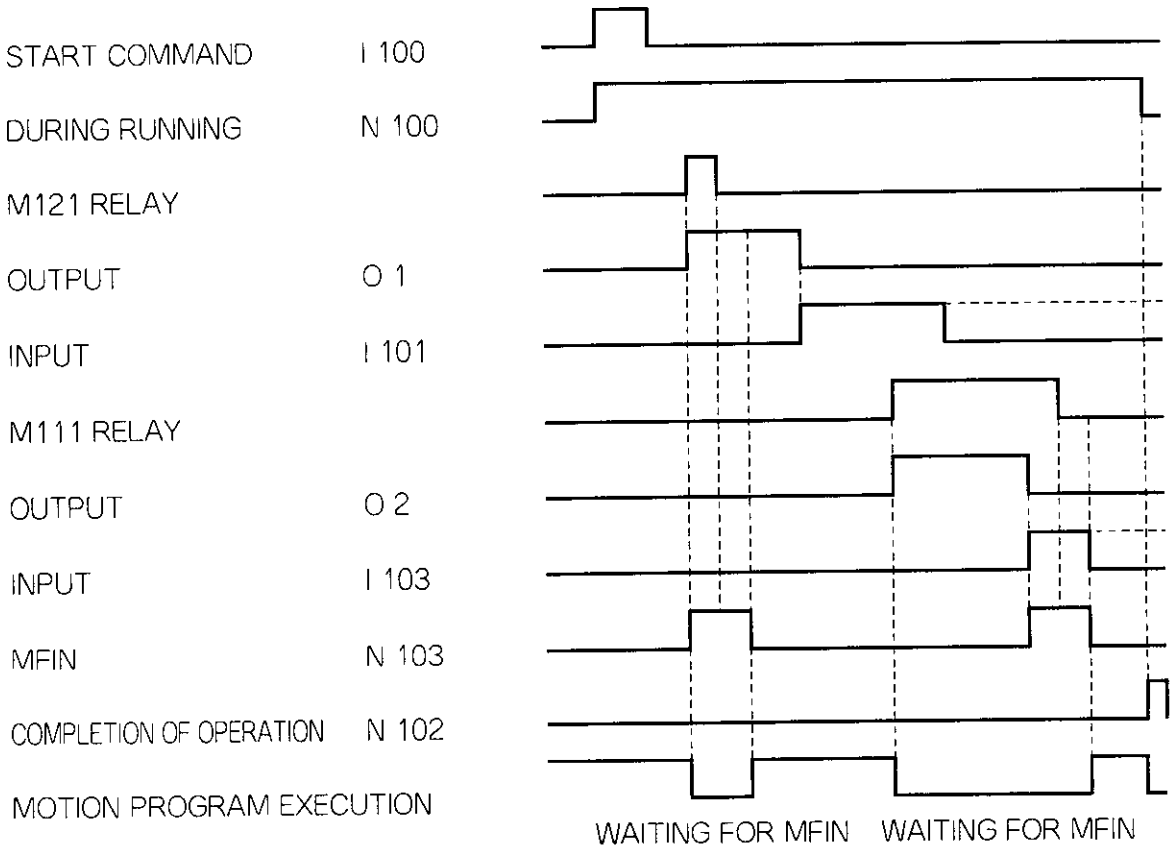


Fig 8.34 I/O Timing

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8.2.17 Typical Use of Motion Commands

The motion commands required for activation of SERVOMOTORS are MVL, SMD, MVA, MVB, ZRN, JOG and SVN.

In order to activate each motion command, the following combinations are needed as a minimum.

(1) MVL

In order to activate motion command MVL, the following conditions ①, ② and ③ are needed in the sequence program. Conditions ①, ② and ③ must be satisfied to activate the MVL and operate the SERVOMOTORS according to the motion program set in the MC unit.

① Select the program operation mode (turn ON input 2) by MOD
② Activate SVN
③ Set motion program #O and #B by MRS.

[Example]

This example shows the simplest sequence program required to activate a motion program set in MC unit 1.

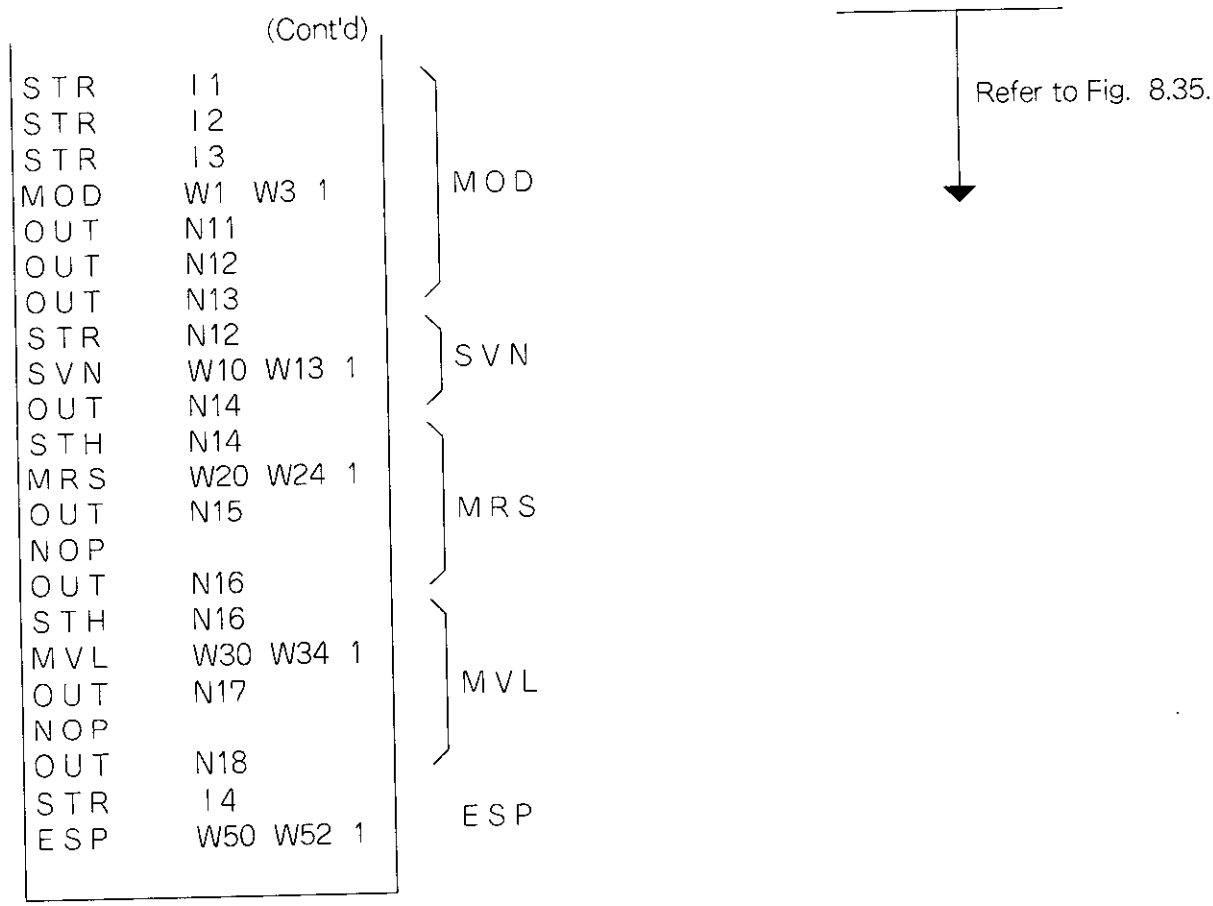
[Mnemonic Program]

```
STN   N 1
OUT   N 2
STH   N 2
SUB   1     0   W1     Set MOD unit No.
STH   N 2
SUB   1     0   W10    Set SVN unit No.
STH   N 2
SUB   1 5   0   W11    Set SVN axis No.
STH   N 2
SUB   1     0   W20    Set MRS unit No.
STH   N 2
SUB   1     0   W21    Set MRS program No.
STH   N 2
SUB   1     0   W22    Set MRS block No.
STH   N 2
SUB   1     0   W30    Set MVL unit No.
STH   N 2
SUB   5     0   W31    Set MVL interpolation override.
STH   N 2
SUB   1 5   0   W32    Set MVL rapid traverse operation override.
STH   N 2
SUB   1     0   W50    Set ESP unit No.
```

Set the setting data to be used for motion commands.

(Cont'd on next page)

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When the power supply of the PROGIC-8 is started up and the PLC unit RUN indicator lights, each item of setting data is stored in each motion command holding register WXXXX by the SUB command.

Then after checking that the MC units and SERVOPACK have been started up, turn ON external input relay I0002.

When each motion command is automatically activated and MVL input 1 is turned ON, the program operation is executed. Additionally, by turning ON external input relay I0004, ESP is activated for emergency stop.

For details, see the ladder circuit of this sequence program shown on the next page.

(SUB command is omitted.)

When I0002 (MOD input 2) is turned ON, the automatic program operation mode is selected and coil N0012 is turned ON.

When coil N0012 is turned ON, all servo axes 1 to 4 are turned ON.

Then coil N0012 (output 1) is turned ON.

When coil N0014 is turned ON, the MRS command is activated and the motion program of MC unit 1 is changed to program No.1. Then coil N0016 (output 3) is turned ON for one scan.

When coil N0016 is turned ON, the MVL command is activated and the SERVOMOTOR connected to MC unit 1 performs program operation according to the motion program of program No. 1 and block No. 1 (set in advance).

At completion of program operation, coil N0018 (MVL output 3) is turned ON for one scan.

In this way, by turning ON external input relay I0002 at NO contact, the MVL is activated and program operation is executed.

Note: If the same register is used in some motion commands, they may malfunction.
Register WXXXX which has been used once in a certain motion command must not be used in other motion commands.

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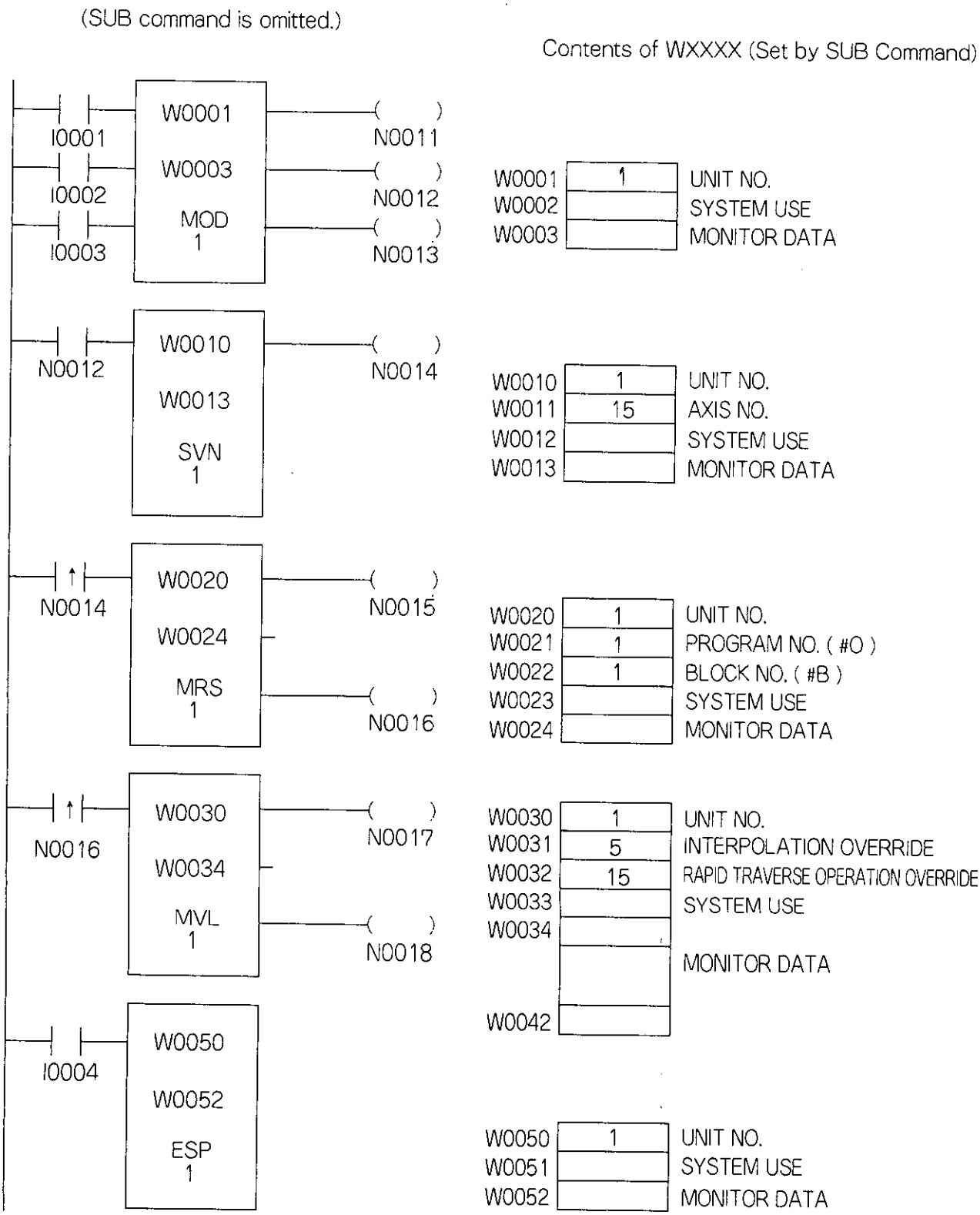


Fig. 8.35 Ladder Circuit

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[Motion Program]

```
O01" MC  TEST"
N001    M V S   X 1000.   Y 1000.   Z 1000. ;
N002    M V S   X 0   Y 0   Z0  ;
N003    M V S   X 1000.   Y 1000.  ;
N004    M V S   X 0   Y 0  ;
N005    M V S   Y 1000.   Z 1000.  ;
N006    M V S   Y 0   Z 0  ;
N007    M V S   X 1000.   Z 1000;
N008    M V S   X 0   Z 0  ;
N009    E N D  ;
```

By executing the above program by this sequence program, interpolation operation shown in Fig. 8.36 is performed between axes X, Y and Z of the SERVOMOTOR connected to MC unit 1.

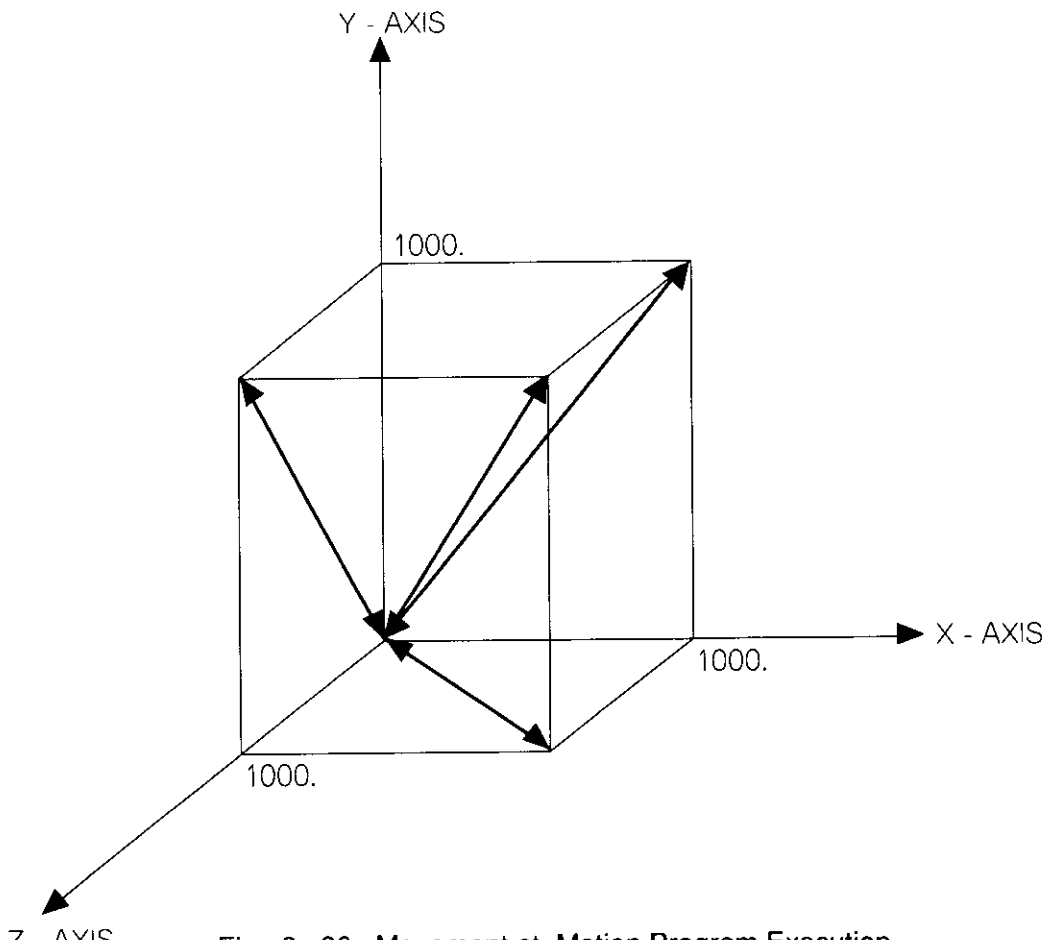


Fig. 8. 36 Movement at Motion Program Execution

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(2) MVA/MVB

In order to activate motion commands MVA/MVB, conditions ①and ②are needed in the sequence program. Conditions ①and ②must satisfied in order to activate the MVA/MVB and operate the SERVOMOTORS according to the parameters set to the MC unit.

① Select the program operation mode (turn ON input 2) by MOD.
② Activate the SVN.

(3) JOG · ZRN

In order to activate motion commands JOG/ZRN, conditions ① ans ② are needed in the sequence program. Conditions ① and ② must be satisfied in order to activate the JOG/ZRN and operate the SERVOMOTORS.

① Select the manual mode (turn ON input 1) by MOD.
② Activate the SVN.

[Example]

In this example, JOG operation at the second and third axes of MC unit 1 is shown. In this case, it is assumed that the parameters at the second and third axes have been set.*

[Mnemonic Program]

```
STN  N 1
OUT  N 2
STH  N 2
SUB  1   0  W 1      Set MOD unit No.
STH  N 2
SUB  1   0  W 10     Set SVN unit No.
STH  N 2
SUB  6   0  W 11     Set SVN axis No.
STH  N 2
SUB  1   0  W 20     Set JOG unit No.
STH  N 2
SUB  2   0  W 21     Set JOG axis No.
STH  N 2
SUB  15  0  W 22     Set JOG speed No.
STH  N 2
SUB  1   0  W 30     Set JOG unit No.
STH  N 2
SUB  4   0  W 31     Set JOG axis No.
STH  N 2
SUB  15  0  W 32     Set JOG speed No.
STR  I 1
STR  I 2
STR  I 3
MOD  W 1  W 3  1     MOD
OUT  N 11
OUT  N 12
OUT  N 13
```

(Cont'd on next page)

*: For the parameter setting, refer to SIE-C888-1.2 "PROGIC-8 PROGRAMMING MANUAL for MC unit" ..

Set the setting data to be used for motion commands.

Refer to Fig. 8. 37.

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(Cont'd)

```
STR   N 11
SVN   W 10  W 13   1   SVN
STR   I 4
JOG   W 20  W 24   1   JOG
STR   I 5
JOG   W 30  W 34   1   JOG
```

[Ladder Circuit]

(SUB command is omitted.)

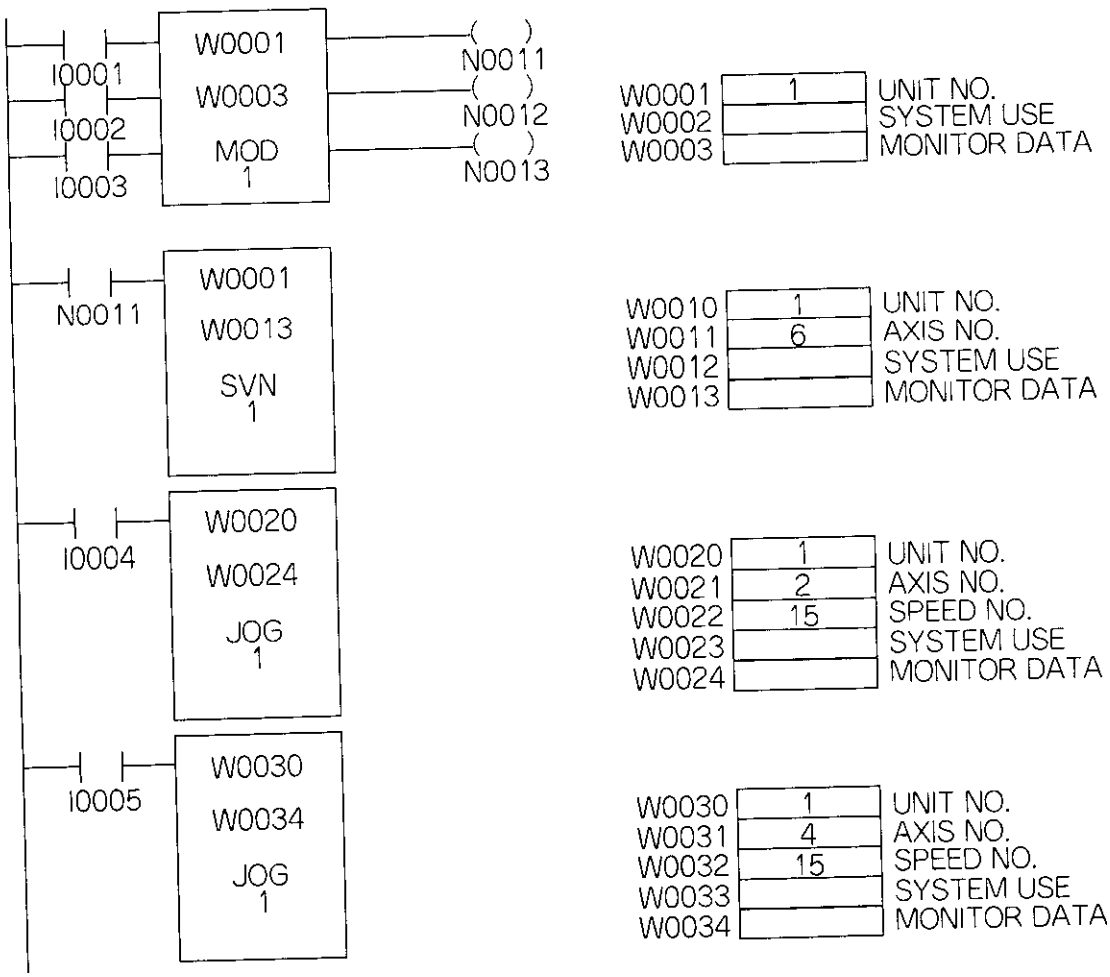


Fig. 8. 36 Ladder Circuit

When the power supply of the PROGIC-8 is started up and the PLC unit RUN indicator lights, each item of setting data is stored in each motion command holding register WXXXX by the SUB command.

Then when external input relay I0001 or MOD input 1 is turned ON after checking that MC unit 1 and the SERVOPACK have been started up, the manual mode is selected and coil N0011 is turned ON.

By turning ON coil N0011 (SVN input 1), SVN is activated and the servo of the second and third axes set with the axis Nos. is turned ON.

After that, turn ON or OFF external input relay I10004, which is an execution command for the second axis JOG operation, and external input relay I0005,which is an execution command for the third axis JOG operation, to perform JOG operation at the second or third axis freely.

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NOTE

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PROGIC-8

MULTIAXES MOTION CONTROLLER

PROGRAMMING MANUAL FOR PLC UNIT

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SIE-C888-1.1

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