Chapter 16 PLC Function Applications

16-1 PLC Summary

16-1-1 Introduction

The commands provided by the MS3's built-in PLC functions, including the ladder diagram editing tool WPLSoft, as well as the use of basic commands and application commands, follow the operating methods of Delta's PLC DVP series.

16-1-2 WPLSoft ladder diagram editing tool

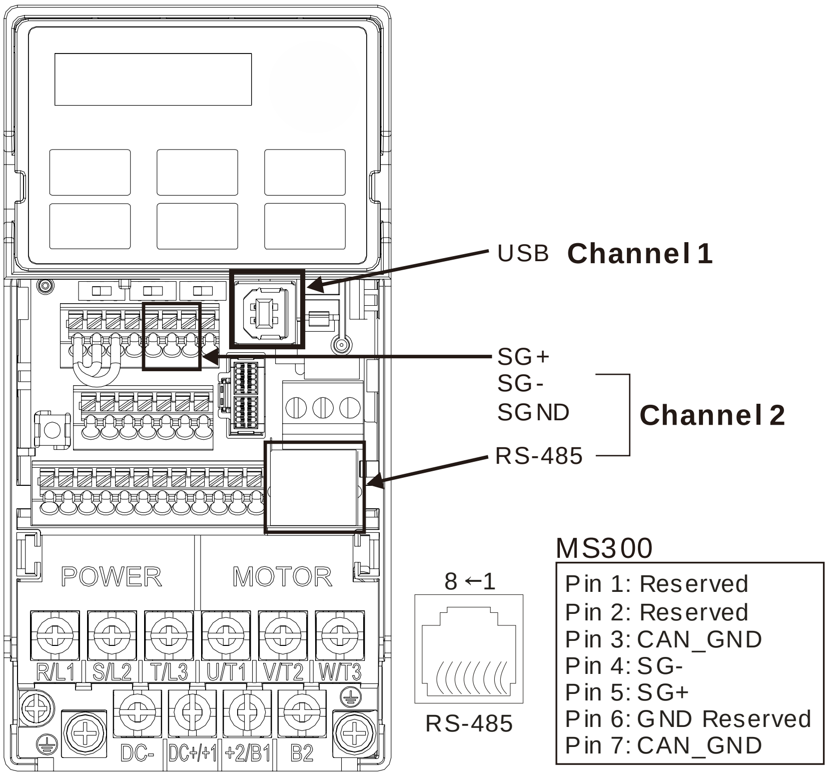
WPLSoft is Delta's software program for the DVP and MS3 programmable controllers in Windows operating system environment. In addition to general PLC program design and general Windows editing functions (such as cut, paste, copy, and multiple windows), WPLSoft also provides many features such as Chinese/English annotation editing, registry editing, settings, file reading, saving, and contact graphic monitoring and settings.

The following table lists the basic requirements for installing the WPLSoft editing software:

Item	System requirements
Operating system	Windows○,R XP / Vista / 7 (32-bit / 64-bit) / 8 / 10 (64-bit)
CPU	At least Pentium 90
Memory	At least 16 MB (we recommend at least 32 MB)
Hard drive	Hard drive capacity: at least 100 MB of free space One optical drive (to install this software)
Display	Resolution: 640×480, at least 16 colors; it is recommended that the screen area be set at 800×600 pixels.
Mouse	Ordinary mouse or Windows-compatible pointing device
Printer	Printer with Windows driver software
RS-485 port	Must have at least an RS-485 port to link to the PLC

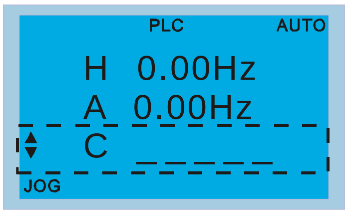
16-2 Notes Before Using a PLC

1. The MS3 provides two communication serial ports that you can use to download programs to the PLC (see figure below).
2. Channel 1 communication format is the same as channel 2.
3. Channel 2 has a preset communication format of 7, N, 2, 9600; you can change to ASCII in Pr.09-01 (transmission speed) and Pr.09-04 (communication protocol).
4. The PLC preset is node 2; you can change the PLC node in Pr.09-35 (PLC address), but this address may not be the same as the drive's address setting in Pr.09-00 (communication address).



5. The host controller can simultaneously access data from the drive and the internal PLC, using the identifier for the node. For instance, if the drive node is 1 and the internal PLC node is 2, then the host controller command depends on the node address
   - 01 (node) 03 (read) 0400 (address) 0001 (1 data item), indicating that it must read the data in drive Pr.04-00.
   - 02 (node) 03 (read) 0400 (address) 0001 (1 data item), indicating that it must read the data in internal PLC X0.
6. The PLC program is disabled when uploading/downloading programs.
7. Note that when using WPR commands to write parameters, you may modify values up to a maximum of 10^6 times; otherwise, after which a memory write error occurs. The number of modifications depends on whether the parameter value has changed. If you do not change the value, it does not change the number of modifications; however, if the entered value is different from before, the number of modifications increases by one.
8. When you set Pr.00-04 to 28, the displayed value is the value of PLC register D1043, as shown

below).

Digital Keypad VERSI-KP-LCD (optional) Can display 0–65535 

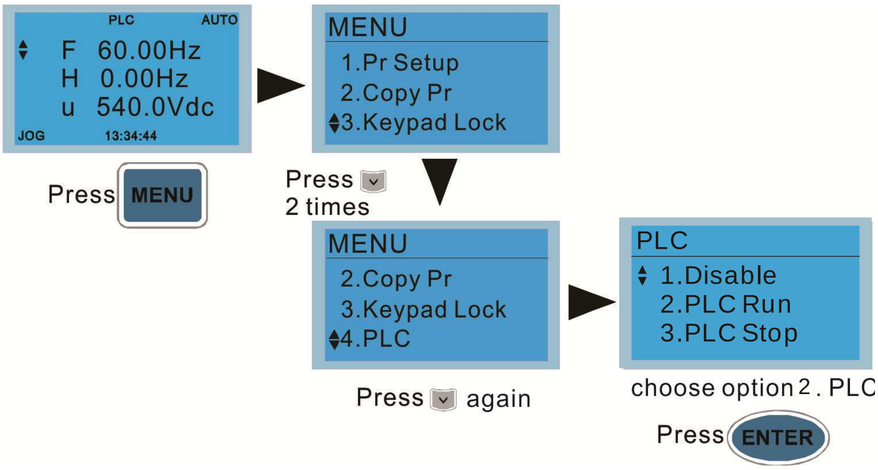
9. In the PLC Run and PLC Stop mode, you cannot set Pr.00-02 to the values 9 or 10, and cannot be reset to the default value.
10. You can reset the PLC to the default value when you set Pr.00-02 to 6.
11. The corresponding MI function is disabled when the PLC writes to input contact X.
12. When the PLC controls the drive operation, the control commands are entirely controlled by the PLC and are not affected by the setting for Pr.00-21.
13. When the PLC controls the drive's Frequency commands (FREQ commands), the Frequency commands are entirely controlled by the PLC, and are not affected by the setting for Pr.00-20 or the HAND ON/OFF configuration.
14. When the PLC controls the drive operation, if the keypad STOP setting is valid, this triggers an FStP error and causes the drive to stop.

16-3 Turn on

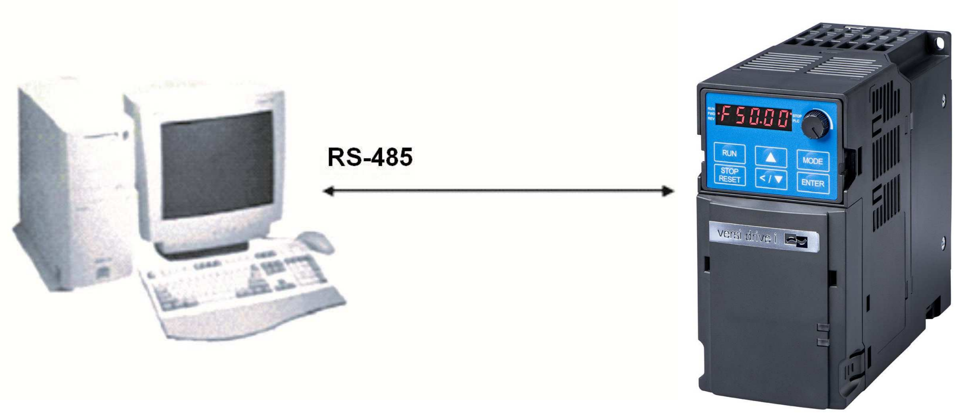
16-3-1 Connect the Drive to the PC

You start operating the PLC functions with the following four steps:

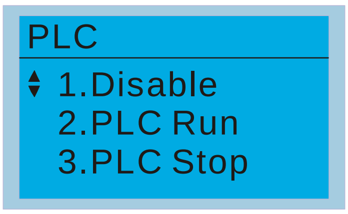
After pressing the MENU key and choosing 4: PLC on the VERSI-KP-LCD digital keypad (optional), press the ENTER key (see figure below).



1. Wiring: Connect the drive's RJ45 communications interface to a PC through the RS-485 cable.



2. PLC function usage

Digital keypad VERSI-KP-LCD (optional) 	PLC functions are as shown in the figure on the left; select item 2. PLC Run to enable the PLC functions. 1: No function (Disable) 2: Enable PLC (PLC Run) 3: Stop PLC functions (PLC Stop)

Digital keypad (VERSI-KP-LED)

Select PLC1 to enter PLC mode setting.
PLC 0: Do not implement PLC functions
PLC 1: Initiate PLC Run
PLC 2: Initiate PLC Stop

- The MS3 automatically switches to PLC mode when the external multifunctional input terminals (MI1–MI7) are in PLC Mode selection bit 0 (51) or PLC Mode selection bit1 (52), and the terminal contact is closed or open. In this case, keypad switching is ineffective. The corresponding actions are listed in the following table.

PLC mode		PLC Mode selection bit1 (52)	PLC Mode selection bit0 (51)
Using VERSI-KP-LCD (optional)	Using VERSI-KP-LED		
Disable	PLC 0	OFF	OFF
PLC Run	PLC 1	OFF	ON
PLC Stop	PLC 2	ON	OFF
Maintain previous state	Maintain previous state	ON	ON

Using the MS3 digital keypad to implement the PLC functions

☑ When the PLC screen switches to the PLC1 screen, this triggers one PLC action, and you control the PLC program start/stop by communications with WPLSoft.

☑ When the PLC screen switches to the PLC2 screen, this triggers one PLC stop, and you control the PLC program start/stop by communications with WPLSoft.

☑ The external terminal control method is the same as shown in the table above.

NOTE

- When the input/output terminals (MI1–MI7) are included in the PLC program, these input/output terminals are used only by the PLC. For example, when the PLC program controls Y0 during PLC operation (PLC1 or PLC2), the corresponding output terminal relay (RA/RB/RC) operates according to the program. At this time, the multifunctional input/output terminal setting has no effect. Because these terminal functions are already being used by the PLC, you can determine the DI / DO / AO in use by the PLC by looking at Pr.02-52, 02-53, and 03-30.
- When the PLC's procedures use special register D1040, the corresponding AO contact AFM1 is occupied.
- Pr.03-30 monitors the state of action of the PLC function analog output terminals; bit 1 corresponds to the AFM1 action state.

16-3-2 I/O device explanation

Input devices:

Serial No.	X0	X1	X2	X3	X4	X5	X6	X7	X10	X11	X12	X13	X14	X15	X16	X17
1	MI1	MI2	MI3	MI4	MI5	MI6	MI7									

Output devices:

Serial No.	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17
1	RY			MO1	MO2											

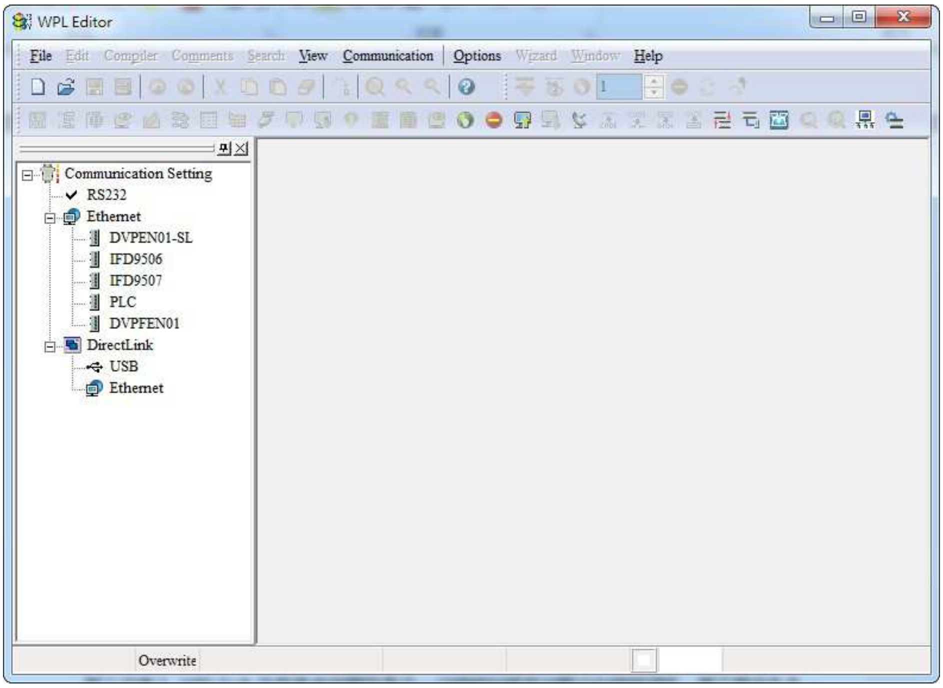
16-3-3 Installing WPLSoft

See Delta's website where you can download the WPLSoft editing software:
http://www.delta.com.tw/product/em/download/download_main.asp?act=3&pid=3&cid=1&tpid=3

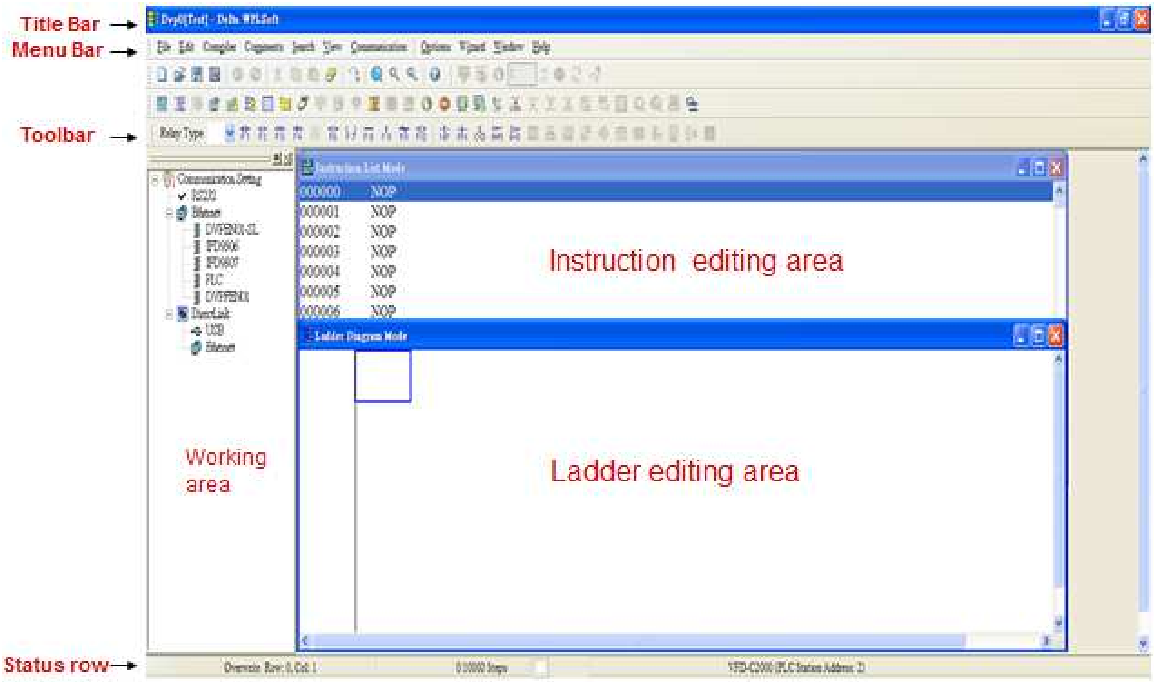
16-3-4 Writing programs in WPLSoft

After you install WPLSoft, the WPLSoft program is located in the folder "C:\Program Files\Delta Industrial Automation\WPLSoft x.xx." You can run the editing software by double-clicking the WPL icon.

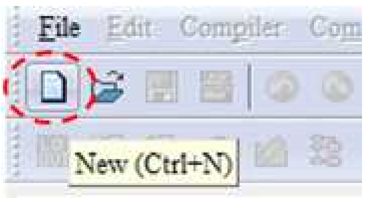
The WPL editing window appears after three seconds (see figure below). When running WPLSoft for the first time, before you create a new project file, the menu bar shows only **File**, **View**, **Communications**, **Options**, and **Help** menus.



The next time you run WPLSoft, the program opens the last project file you edited. The following picture describes the main parts of the WPLSoft editing window.



To open a new project file, on the Toolbar, click the New button (or press Ctrl+N)



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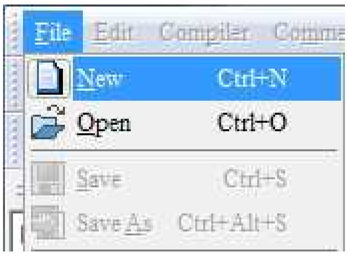
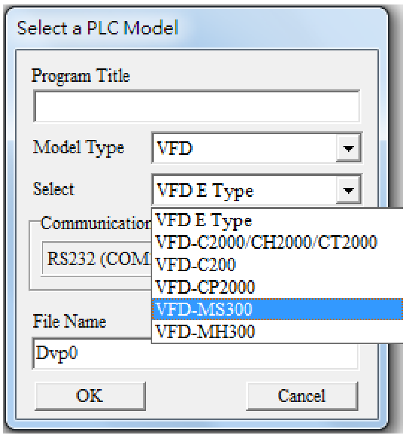
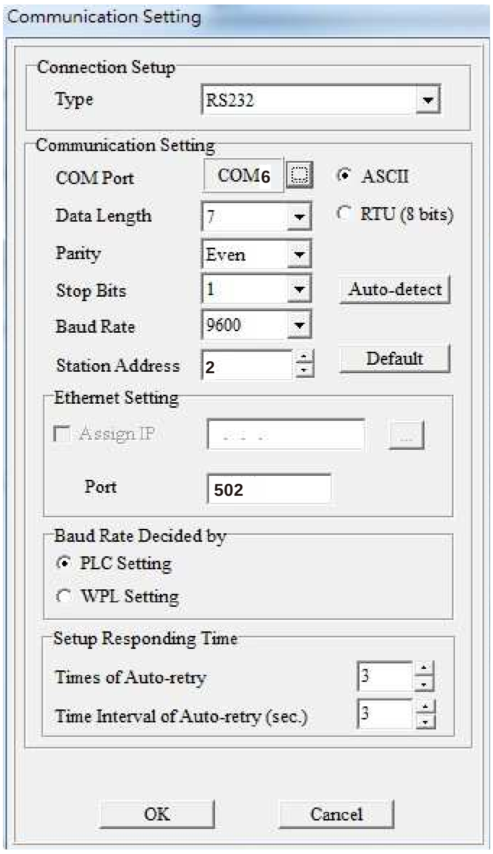
Alternatively, on the **File** menu, click **New** (Ctrl+N).



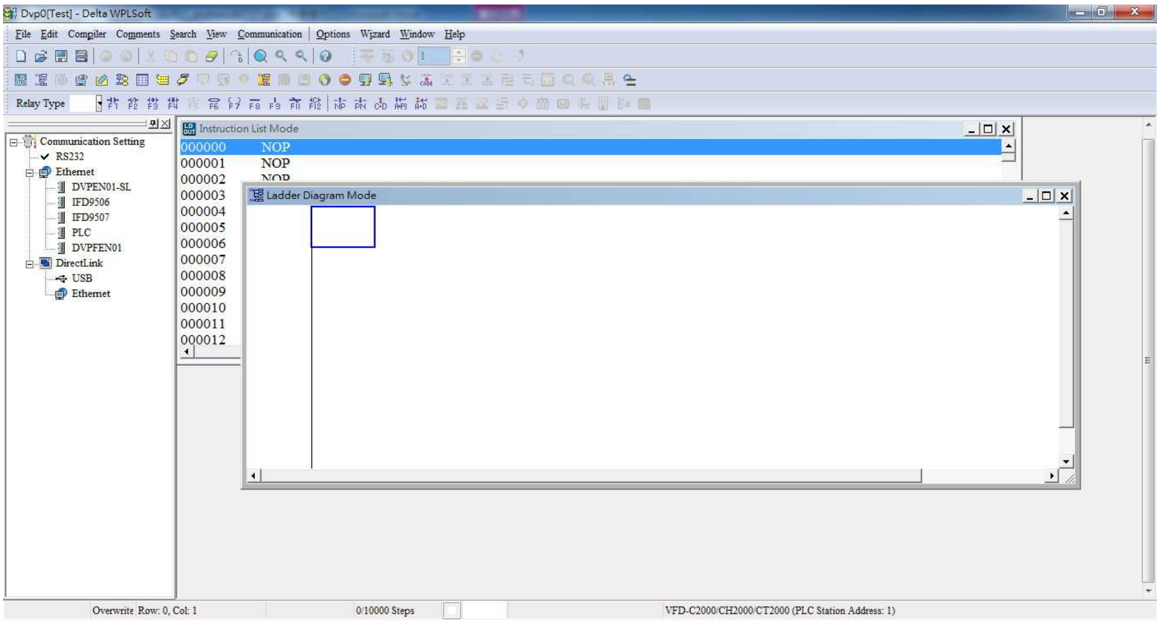
This displays the **Select a PLC Model** dialog box where you can enter the **Program Title**, **File Name**, and select the device and communication settings.



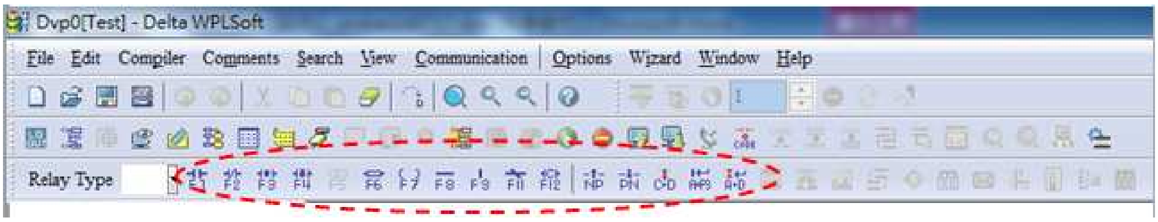
In the **Communication Setting** dialog box, define the communication settings and then click **OK**.

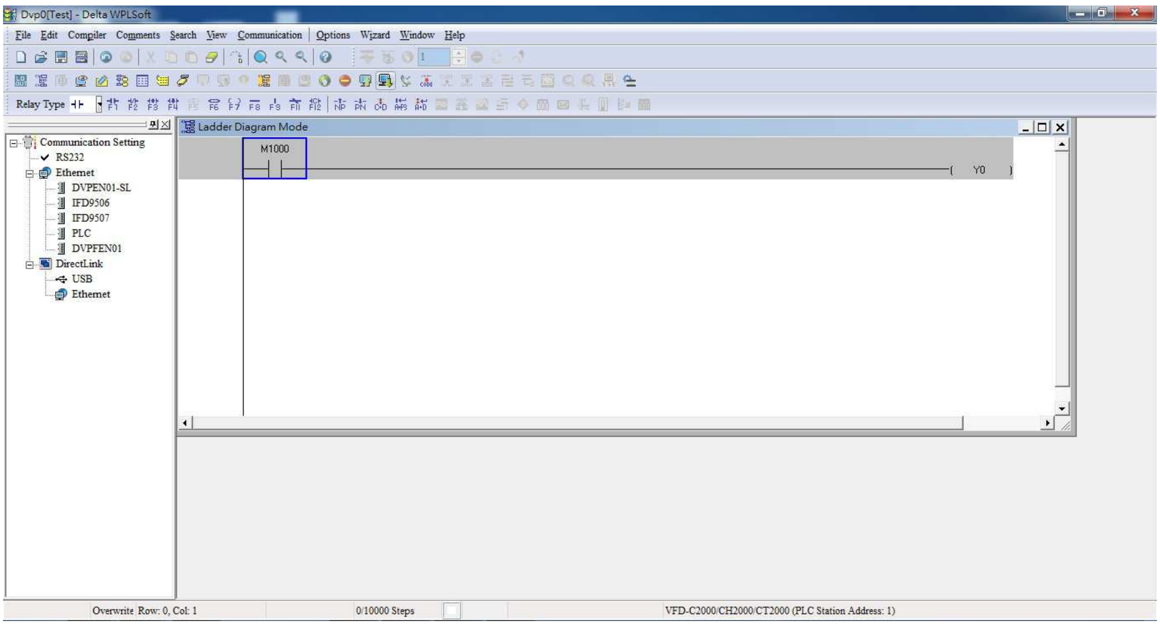


You can then begin editing the program. There are two program editing methods: you can edit in the command mode, or edit in the ladder diagram mode.



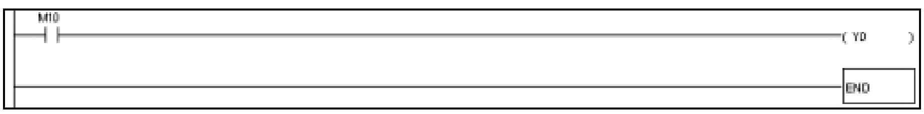
In the ladder diagram mode, you can use the buttons on the function icon row on the toolbar.





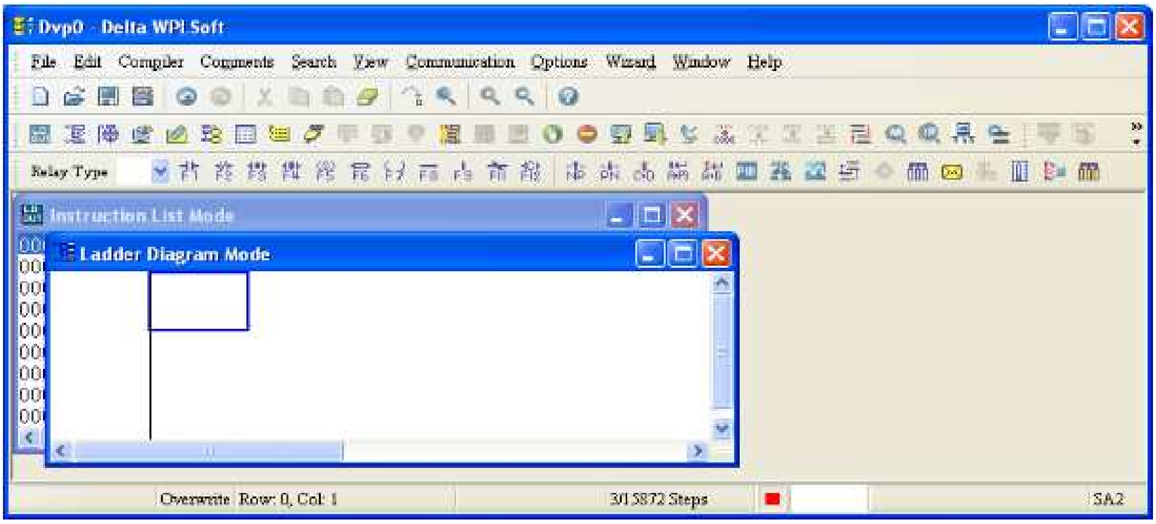
Basic Operation

Example: Create the ladder diagram in the following picture.

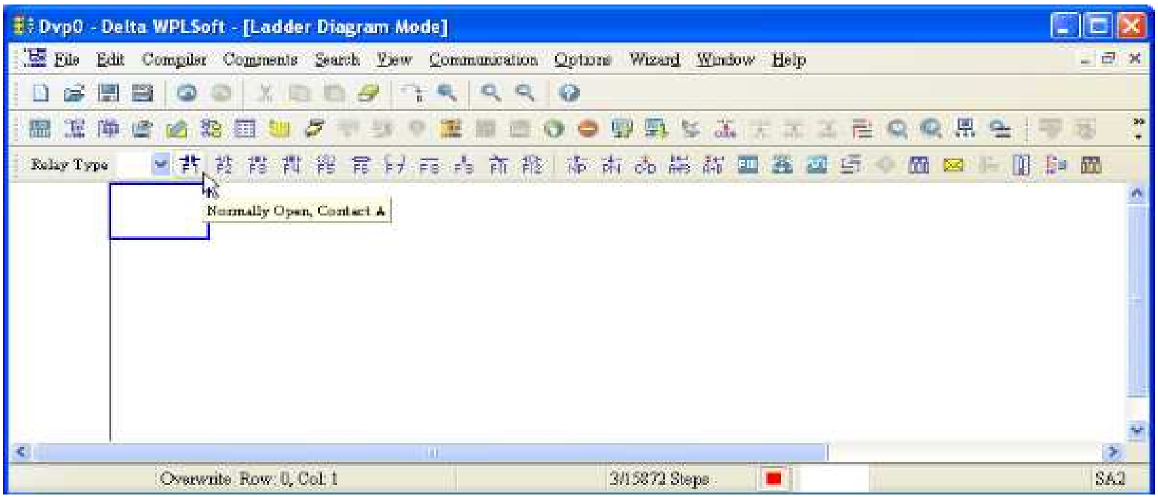


Use the following steps to create the ladder diagram. These steps show you how to use both the mouse and the keyboard (F1–F12) to add functions.

1. The following picture shows the WPLSoft program after you create a new project file.



2. Add an always-open switch. On the toolbar click the always-open switch button or press F1.



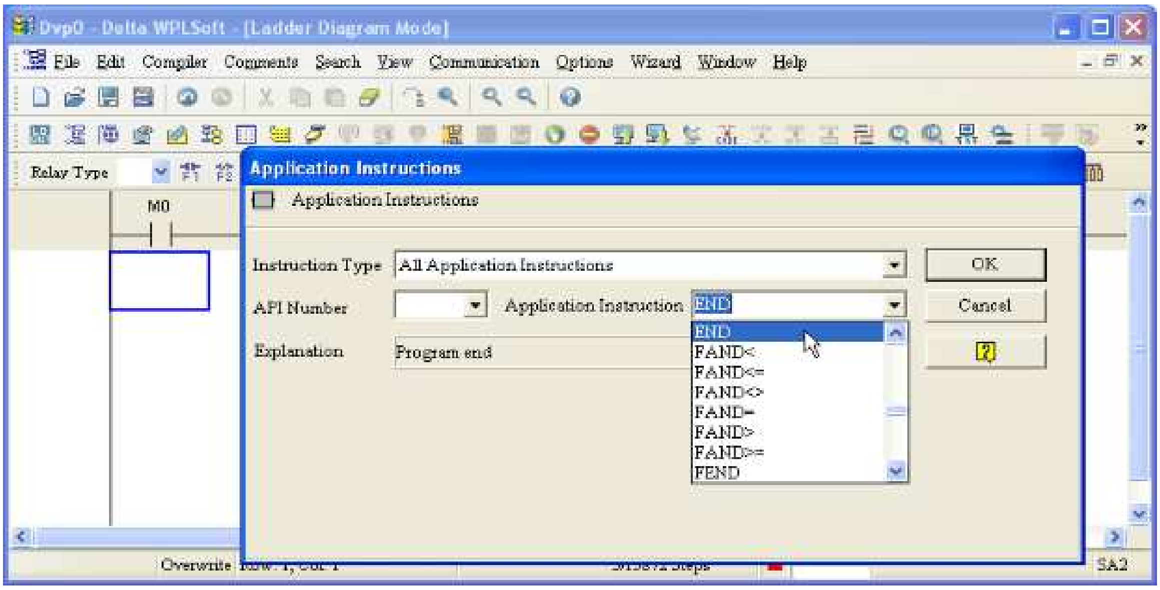
3. In the **Input Device Instruction** dialog box, select the device name (such as **M**), device number (such as **10**) and enter comments (such as **auxiliary coil**). Click **OK** when finished.

4. Add an output coil. Click the output coil button or press F7.

   In the **Input Device Instruction** dialog box, select the device name (such as **Y**), the device number (such as **0**) and enter comments (such as **output coil**).Click **OK** when finished.

5. On the toolbar, click the Application Command button or press F6.

   In the **Application Instructions** dialog box, in **Instruction Type** drop-down list, select **All Application Instructions**. In the **Application Instruction** drop-down list, select **END**, or use the keyboard to type "END", and then click **OK**.



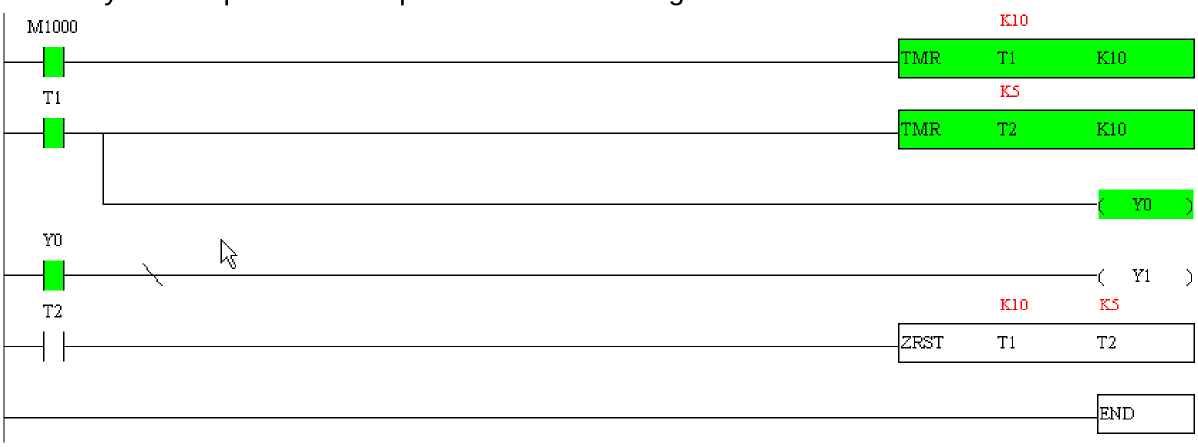
6. Compile the program. On the toolbar, click the Compile button to compile the edited ladder diagram into a command program. After compiling, the number of rungs appear on the left side of the busbar.

16-3-5 Program download

After you compile your program, download it to the device. Click the Download button . WPLSoft downloads the program to the online PLC in the communication format that you specified for the communication settings.

16-3-6 Program monitoring

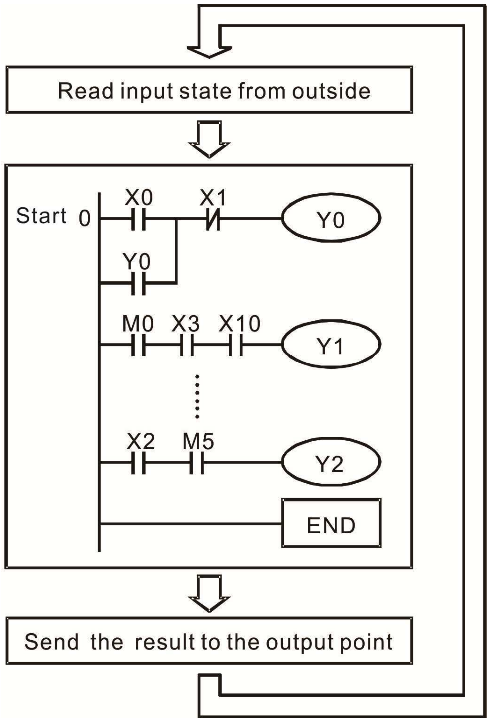
After you download the program, confirm that the PLC is in Run mode. On the Communication menu, click Online Mode , and then click **Start Ladder Diagram Control** (see the following picture). This allows you to supervise and operate the ladder diagram while online.



16-4 Basic Principles of PLC Ladder Diagrams

16-4-1 Schematic diagram for PLC ladder diagram program scanning

Output results are calculated on the basis of the ladder diagram configuration (internal devices have real-time output before results are sent to an external output point)



Repeated program scans

16-4-2 Introduction to ladder diagrams

Ladder diagrams use a graphic language widely applied in automatic controls. They employ common electrical control circuit symbols. After you use a ladder diagram editor to create a ladder diagram program, the PLC program design is complete. Using a graphic format to control processes is very intuitive and is readily accepted by personnel who are familiar with electrical control circuit technology. Many of the basic symbols and actions in a ladder diagram mimic common electrical devices in conventional automatic control power distribution panels, such as buttons, switches, relays, timers, and counters.

Internal PLC devices: The types and quantities of internal PLC devices vary in different brands of products. Although these internal devices use the same names as the conventional electrical control circuit elements (such as relays, coils, and contacts), a PLC does not actually contain these physical devices, and they instead correspond to basic elements in the PLC's internal memory (bits). For instance, if a bit is 1, this may indicate that a coil is electrified; and if that bit is 0, it indicates that the coil is not electrified. You can use a N.O. contact (Normally Open, or contact A) to directly read the value of the corresponding bit, and use a NC contact (Normally Closed, or contact B) to get the inverse of the bit's value. Multiple relays occupy multiple bits, and eight bits comprise one byte. Two bytes comprise one word, and two words comprise a double word. When multiple relays are processing at the same time (as in addition/subtraction or displacement), it can use a byte, a word, or a double word. Furthermore, a PLC contains two types of internal devices: a timer and a counter. It not only has a coil, but can count time and numerical values. Because of this, when it is necessary to process numerical values, these values are usually in the form of bytes, words, or double words (internally in the PLC).

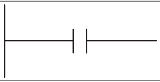
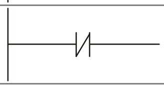
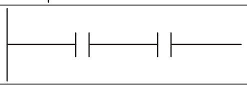
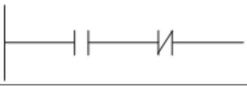
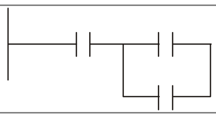
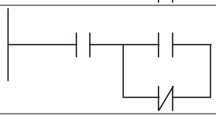
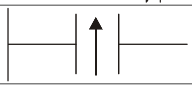
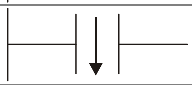
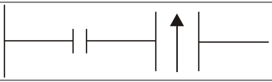
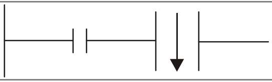
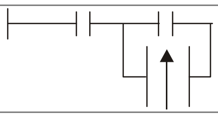
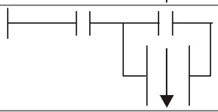
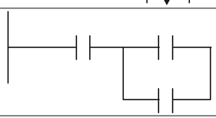
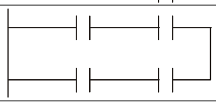
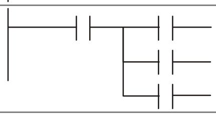
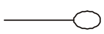
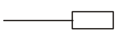
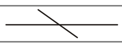
The various internal devices in a PLC use a certain amount of memory in the PLC's storage area. When you use these devices, the content of the corresponding storage area is read in the form of bits, bytes, or words.

The following table describes the internal devices in a PLC

Device Type	Description of Function
Input Relay	An input relay constitutes the basic unit of storage in a PLC's internal memory, and corresponds to an external input point. It serves as a terminal connecting with an external input switch and receiving external input signals. It is driven by external input signals, to which it assigns values of 0 or 1. A program design method cannot change the input relay status, and therefore cannot rewrite the corresponding basic units of an input relay. You cannot use WPLSoft to manually perform ON/OFF actions. You can use a relay's contacts (contacts A and B) an unlimited number of times in a program. An input relay with no input signal must be left idle and cannot be used for some other purpose. ☑ Input devices are indicated by X0, X1, X7, X10, X11, and so on. These devices are indicated with the symbol X, and a device's order is indicated with an octal number. Input point numbers are indicated in the main PLC and in expansion devices.
Output Relay	An output relay constitutes the basic unit of storage in a PLC's internal memory, and corresponds to an external output point. It connects with an external load. It can be driven by an input relay contact, a contact on another internal device, or its own contacts. It uses one N.O. contact to connect with external loads or other contacts, and like the input contacts, you can use the output relay's contacts an unlimited number of times in a program. An output relay with no input signal is idle, but can be used by an internal relay if needed. ☑ Output devices are indicated by Y0, Y1, Y7, Y10, Y11, and so on. These devices are indicated with the symbol Y, and a device's order is indicated with an octal number. Output point numbers are indicated in the main PLC and in expansion devices.
Internal Relay	Internal relays have no direct connection with the outside. These relays are auxiliary relays inside a PLC. Their function is the same as that of an auxiliary (central) relay in an electrical control circuit: Each auxiliary relay corresponds to a basic unit of internal storage; they can be driven by input relay contacts, output relay contacts, and the contacts of other internal devices. You can use an internal auxiliary relay's contacts an unlimited number of times in a program. Internal relays have no outputs to the outside, and their status must output through an output point. ☑ Internal relay devices are indicated by: M0, M1–M799, and so on. These devices are indicated with the symbol M, and the device's order is indicated with a decimal number.
Counter	Counters perform counting operations. The setting value for a counter (such as the number of pulses to be counted) must be assigned when a counter is used. A counter contains a coil, contact, and a counting storage device. When the coil goes from OFF → ON, this indicates that the counter receives an input pulse, and adds one to its count. There are 16 bits available in the counter. ☑ Counter device are indicated by: C0, C1–C79, and so on. These devices are indicated by the symbol C, and the device's order is indicated with a decimal number.
Timer	Timers perform timing for operations. The timer contains a coil, contact, and a time value register. When the coil is electrified, and the setting value for the timer is reached, the contact is actuated (contact A closes, contact B opens), and the timer's fixed value is given by the setting value. A timer has a regulated clock cycle (timing units: 100 ms). As soon as power to the coil is cut off, the contact is no longer be actuated (contact A opens, contact B closes), and the original timing value returns to zero. ☑ Timer devices are indicated by: T0, T1–T159, and so on. These devices are indicated by the symbol T, and the device's order is indicated with a decimal number.
Data register	Data registers are used exclusively to store data and various parameters. When you use a PLC is to perform various types of sequence control, set time values, and count value controls, the PLC performs data processing and numerical operations and stores the operands, parameters, and results in data registers. Each data register contains 16 bits of binary data (one word). Two data registers with adjacent numbers can process double words.

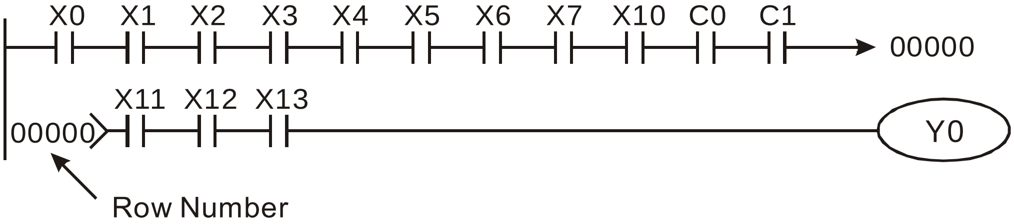
Device Type	Description of Function
	☑ Data register devices are indicated by: D0, D1– D399, and so on. These devices are indicated by the symbol D, and the device's order is indicated with a decimal number.

Ladder diagram images and explanations

Ladder diagram structures	Explanation of commands	Command	Using Device
	N.O. switch, contact A	LD	X, Y, M, T, C
	N.C. switch, contact B	LDI	X, Y, M, T, C
	Series N.O.	AND	X, Y, M, T, C
	Series N.C.	ANI	X, Y, M, T, C
	Parallel N.O.	OR	X, Y, M, T, C
	Parallel N.C.	ORI	X, Y, M, T, C
	Rising edge-triggered switch	LDP	X, Y, M, T, C
	Falling edge-triggered switch	LDF	X, Y, M, T, C
	Rising edge-triggered series	ANDP	X, Y, M, T, C
	Falling edge-triggered series	ANDF	X, Y, M, T, C
	Rising edge-triggered parallel	ORP	X, Y, M, T, C
	Falling edge-triggered parallel	ORF	X, Y, M, T, C
	Block series	ANB	N/A
	Block parallel	ORB	N/A
	Multiple outputs	MPS MRD MPP	N/A
	Coil driven output commands	OUT	Y, M
	Some basic commands, application commands.	Some basic commands, application commands.	
	Inverted logic	INV	N/A

16-4-3 Overview of PLC ladder diagram editing

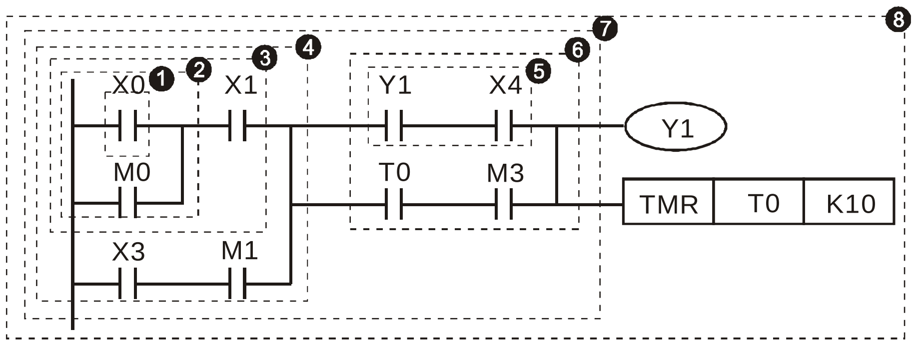
The program editing method in WPLSoft begins from the left busbar and proceeds to the right busbar (the right busbar is not visible in WPLSoft). Continue to the next row after completing each row; there are a maximum of 11 contacts on each row. If this is not sufficient, WPLSoft generates a continuous line to indicate the continued connection, so that you can add more devices. A continuous series of numbers is generated automatically and you can use identical input points repeatedly (as shown in the following diagram).



The PLC scans a ladder diagram programs from the upper left corner to the lower right corner. The coils and application command computing box are handled in the output, and in the ladder diagram are placed on the farthest right of a rung. Taking the diagram below as an example, we can analyze the procedural sequence of the ladder diagram. The number in the upper right corner gives the sequential order.

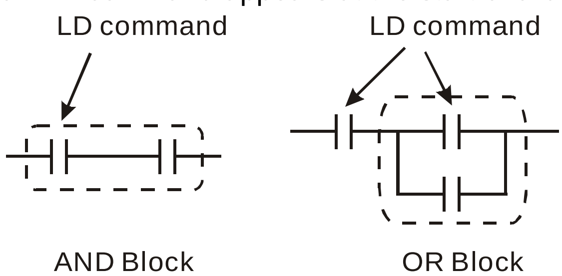
Explanation of command sequence

1	LD	X0	
2	OR	M0	
3	AND	X1	
4	LD	X3	
	AND	M1	
	ORB		
5	LD	Y1	
	AND	X4	
6	LD	T0	
	AND	M3	
	ORB		
7	ANB		
8	OUT	Y1	
	TMR	T0	K10

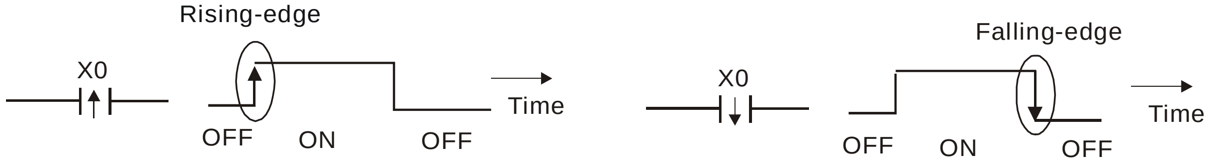


Explanation of basic structure of ladder diagrams

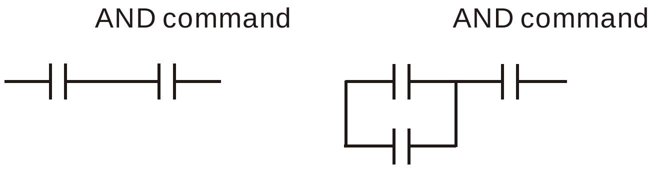
LD (LDI) command: An LD or LDI command appears at the start of a block.



LDP and LDF use this command structure, but there are differences in their action state. LDP, LDF only act at the rising or falling edge of a conducting contact (see diagram below).

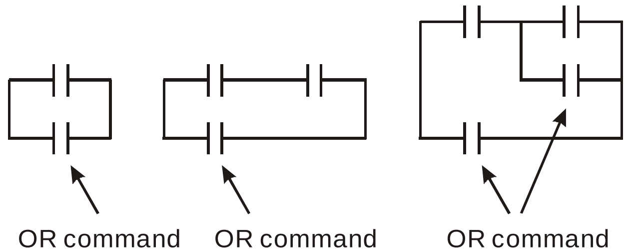


AND (ANI) command: a series configuration in which a single device is connected with one device or a block.



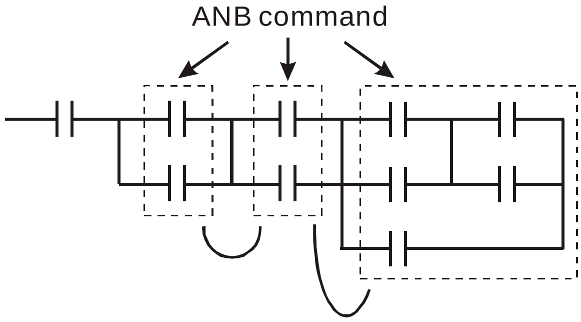
ANDP, ANDF use this structure, but their action occurs at the rising and falling edge of a conducting contact.

OR (ORI) command: a single device is connected with one device or a block.

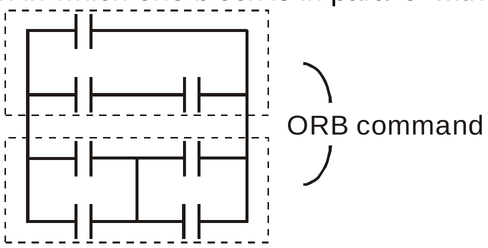


ORP, ORF use this structure, but their action occurs at the rising and falling edge a conduction contact.

ANB command: a configuration in which one block is in series with one device or block.



ORB command: a configuration in which one block is in parallel with one device or block.



In the case of ANB and ORB operations that connect a number of blocks, they should be combined to form a block or network from the top down or from left to right.

MPS, MRD, MPP commands: branching point memory for multiple outputs that enable multiple different outputs. The MPS command begins at a branching point, which refers to the intersection of horizontal and vertical lines. Control relies on the contact status along a single vertical line to determine whether the next contact can give a memory command. While each contact is basically able to give memory commands, in view of convenience and the PLC's capacity restrictions, this can be omitted from some places when editing a ladder diagram. You can use the structure of the ladder diagram to judge what kinds of contact memory commands are used.

MPS is indicated by use of the ┬ symbol. You can use this command consecutively up to eight times. The MRD command is read from branching point memory; because logic states along any one vertical line must be the same, in order to continue analysis of other parts of the ladder diagram, the

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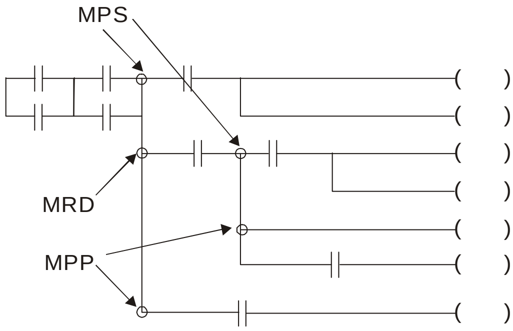
original contact status must be read. MRD is indicated by the ├ symbol.

The MPP command is read from the starting state of the uppermost branching point, and it is read from the stack (pop operation); because it is the final command along a vertical line, it indicates that the state of the vertical line can be concluded. MPP is indicated by the └ symbol.

Although there should basically be no errors when using the foregoing analytical approach, the compiling program may sometimes omit identical state output, as shown in the following diagram.



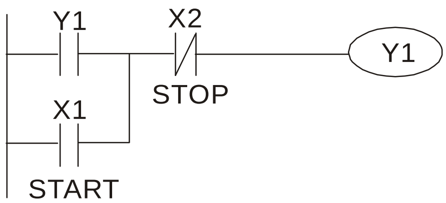
16-4-4 Common basic program design examples

Start, stop, and protection circuits

Some applications may require a brief close or brief break using a button to start and stop equipment. A protective circuit must therefore be designed to maintain continued operation in these situations. This protective circuit may employ one of the following methods.

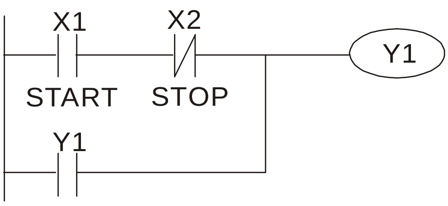
Example 1: Priority stop protective circuit

When the start N.O. contact X1=ON, and the stop N.C. contact X2=OFF, Y1=ON. If X2 switches to ON, coil Y1 is no longer electrified, and this is therefore referred to as priority stop.



Example 2: Priority start protective circuit

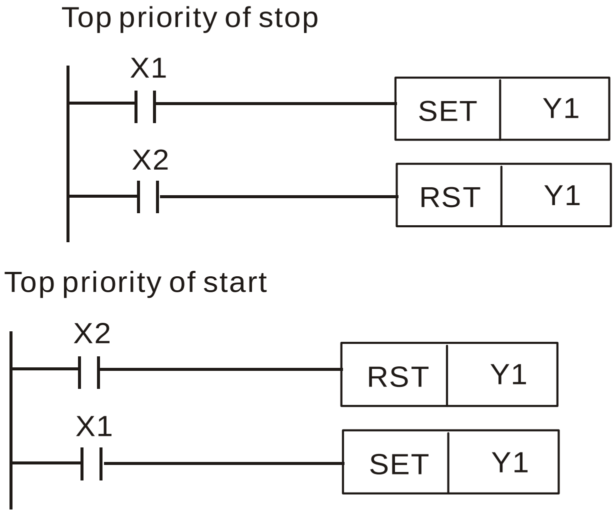
When the start N.O. contact X1=ON, and the stop N.C. contact X2＝OFF, Y1=ON, and coil Y1 is electrified and protected. If X2 switches to ON, coil Y1 still protects the contact and continues to be electrified, and this is therefore referred to as priority start.



Example 3: Setting (SET) and reset (RST) command protective circuit

The following diagram shows a protective circuit composed of RST and SET commands. A priority stop occurs when you place the RST command after the SET command. Because the PLC executes programs from the top down, at the end of the program, the state of Y1 indicates whether coil Y1 is electrified. When X1 and X2 both actuate, Y1 loses power, and this is therefore referred to as priority stop.

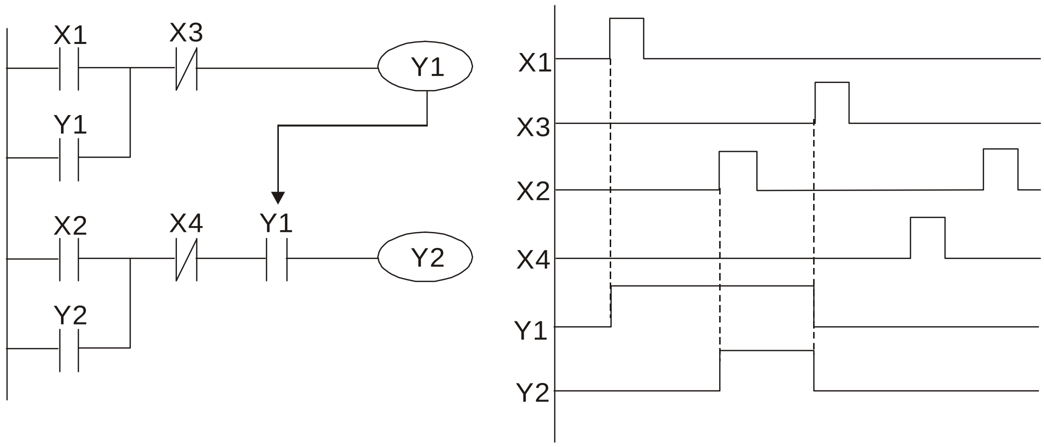
A priority start occurs when you place the SET command after the RST command. When X1 and X2 both actuate, Y1 electrifies, and this is therefore referred to as priority start.



Commonly used control circuits

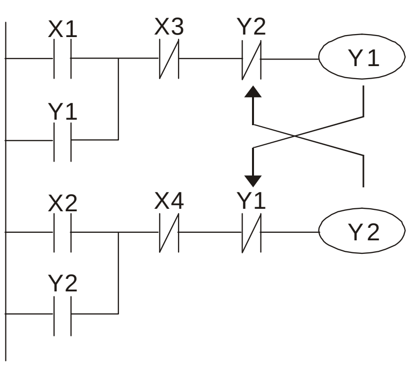
Example 4: Conditional control

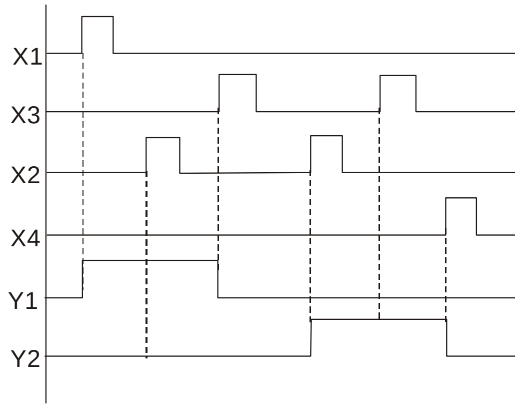
X1 and X3 respectively start and stop Y1; and X2 and X4 respectively start and stop Y2. All have protective circuits. Because Y1's N.O. contact is in series with Y2's circuit, it becomes an AND condition for the actuation of Y2. The action of Y1 is therefore a condition for the action of Y2, and Y1 must actuate before Y2 can actuate.



Example 5: Interlocking control

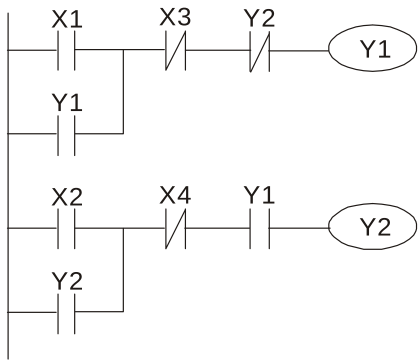
The diagram below shows an interlocking control circuit. Depending on which of the start contacts X1 or X2 becomes valid first, the corresponding output Y1 or Y2 actuates, and when one actuates, the other does not actuate. Y1 and Y2 cannot actuate at the same time (interlocking effect). Even if both X1 and X2 are valid at the same time, because the ladder diagram program is scanned from the top down, it is impossible for Y1 and Y2 to actuate at same time. This ladder diagram assigns priority only to Y1.





Example 6: Sequence control

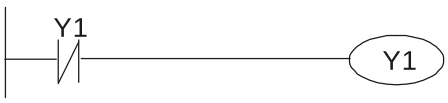
If the N.C. contact of Y2 in the interlocking control configuration from example 5 is put in series with the Y1 circuit, to create an AND condition for actuation of Y1 (see diagram below), not only is Y1 a condition for the actuation of Y2 in this circuit, but the actuation of Y2 also stops the actuation of Y1. This configuration confirms the actuation order of Y1 and Y2.

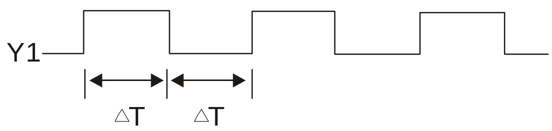


Example 7: Oscillating circuit

Oscillating circuit with a period of ΔT+ΔT

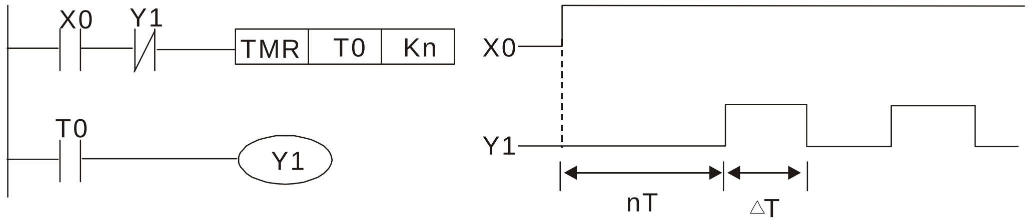
The diagram below shows a very simple ladder diagram. When starting to scan the Y1 N.C. contact, because the Y1 coil has lost power, the Y1 N.C. contact is closed. When the Y1 coil is then scanned, it is electrified, and the output is 1. When the Y1 N.C. contact is scanned in the next scanning cycle, because the Y1 coil is electrified, the Y1 N.C. contact is open, the Y1 coil then loses power, and the output is 0. Following repeated scanning, the output of Y1 coil has an oscillating waveform with a period of ΔT(ON)+ΔT(OFF).





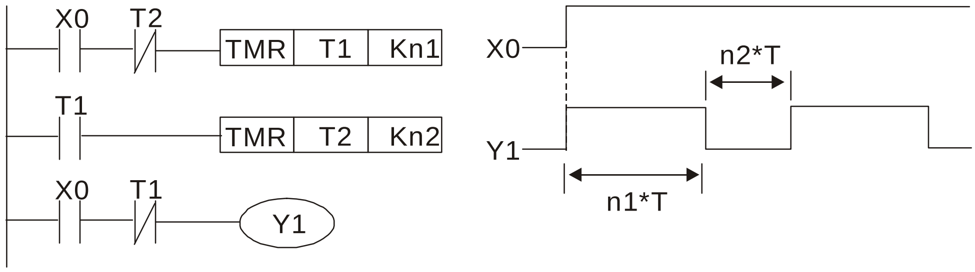
Oscillating circuit with a period of nT+ΔT

The ladder diagram shown below uses timer T0 to control coil Y1's electrified time. After Y1 is electrified, it causes timer T0 to close during the next scanning cycle, which causes the output from Y1 to oscillate as shown in the diagram below. The constant n is the timer's decimal setting value, and T is the clock cycle of the timer.



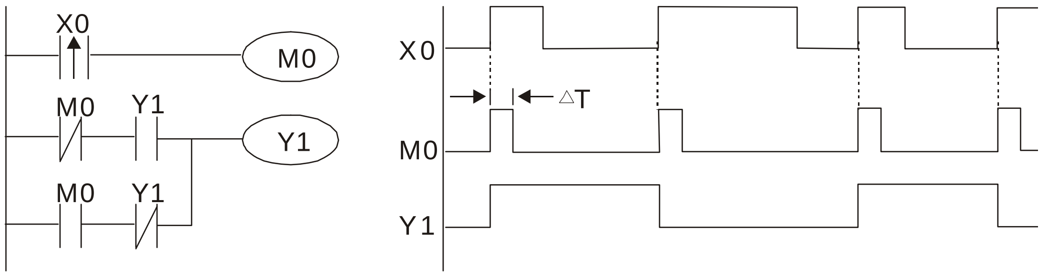
Example 8: Flashing circuit

The following diagram shows an oscillating circuit of a type commonly used to cause an indicator to flash or a buzzer to buzz. It uses two timers to control the ON and OFF time of Y1 coil. Here constants n1 and n2 are the setting values of timers T1 and T2, and T is the clock cycle of the timer.



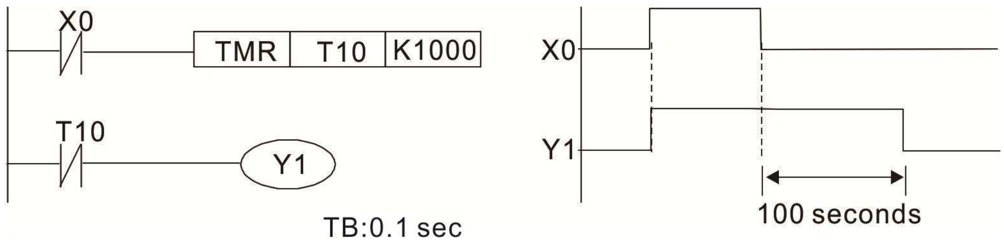
Example 9: Triggering circuit

In the diagram below, a rising edge in input X0 causes coil M0 to generate a single pulse for ΔT (length of one scanning cycle), and coil Y1 is electrified during this scanning cycle. Coil M0 loses power during the next scanning cycle, and N.C. contact M0 and N.C. contact Y1 are both closed. This causes coil Y1 to stay in an electrified state until there is another rising edge in input X0. This again causes the electrification of coil M0 and the start of another scanning cycle, while also causing coil Y1 to lose power, and so on. You can see the sequence of these actions in the diagram below. This type of circuit is commonly used to enable one input to perform two alternating actions. You can see from the time sequence in the diagram below that when input X0 is a square wave signal with a period of T, the output of coil Y1 is a square wave signal with a period of 2T.

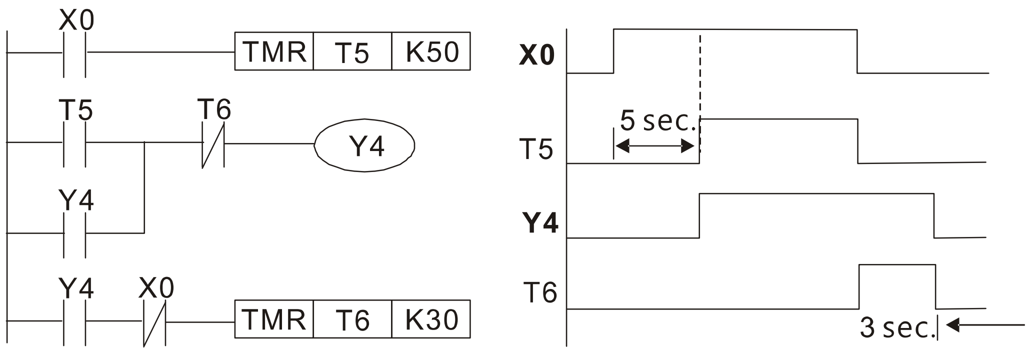


Example 10: Delay circuit

When input X0 is ON, because the corresponding NC contact is OFF, the timer T10 is in a no power state, and output coil Y1 is electrified. T10 receives power and begins to counter the time only after input X0 is OFF, and output coil Y1 is delayed for 100 seconds (K1000*0.1 sec. =100 sec.) before losing power. You can see the sequence of actions in the diagram below.

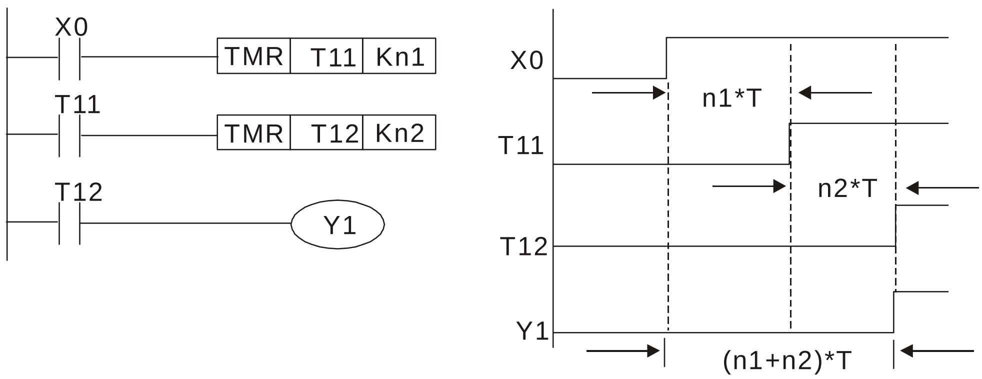


Example 11: The open/close delay circuit is composed of two timers; output Y4 has a delay no matter input X0 is ON or OFF.



Example 12: Extended timing circuit

In the circuit in the ladder diagram on the left, the total delay time from the moment input X0 closes to the time output Y1 is electrified is (n1+n2)*T, where T is the clock cycle. The timers are T11 and T12, and the clock cycle is T.



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16-5 Various PLC Device Functions

Item	Specifications	Notes
Algorithmic control method	The program is stored internally, alternating back-and-forth scanning method.	
Input/output control method	When the scan starts again after ending (after execution to the END command), the input/output is immediately refreshed.	
Algorithmic processing speed	Basic commands (several μs);	Application command (1 to several tens of μs)
Programming language	Command + ladder diagram	
Program capacity	2000 steps	
Input/output terminal	Input (X): 10, output (Y): 4	This is the number for MS3 input/output contacts; other devices have different correspondences.

Type	Device	Item		Range		Function
Relay bit form	X	External input relay		X0–X17, 16 points, octal number	Total 32 points	Corresponds to external input point
	Y	External output relay		Y0–Y17, 16 points, octal number		Corresponds to external output point
	M	Auxiliary Relay	General Use	M0–M799, 800 points	Total 1080 points	Contact can switch ON/OFF within the program
			Special purpose	M1000–M1279, 280 points		
	T	Timer	100 ms timer	T0–T79, 80 points	Total 80 points	Timers referred to by the TMR command; T contact with the same number switches ON when the time is reached.
	C	Counter	16-bit counter, general use	C0–C39, 40 points	Total 40 points	Counter referred to by the CNT command; C contact with the same number switches ON when the count is reached.
Register word data	T	Current timer value		T0–T79, 80 points		The contact switches ON when the time is reached.
	C	Current counter value		C0–C39, 16-bit counter 40 points		The counter contact switches ON when the count is reached.
	D	Data Register	Used to maintain power OFF	D0–D9, 10 points	Total 420 points	Used as data storage memory area
			Special purpose	D10–D199, 190 points D1000–D1219, 220 points		
Constant	K	Decimal	Single-byte	Setting Range: K-32,768–K32,767		
			Double-byte	Setting Range: K-2,147,483,648–K2,147,483,647		
	H	Hexadecimal	Single-byte	Setting Range: H0000–HFFFF		
			Double-byte	Setting Range: H00000000–HFFFFFFFF		
Serial communication port (program write/read)				RS-485/keypad port		
Input/output				Built-in three analog inputs and two analog outputs		
High-speed counting				Built-in a (MI7) 32-bit high-speed counter		
Function expansion module			Optional Accessories	--		
Communication Expansion Module			Optional Accessories	EMC-COP01, (CANopen)		

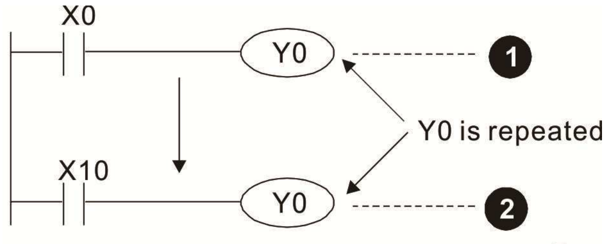
16-5-1 Introduction to device functions

Input/output contact functions

Input contact X has this function: input contact X is connected with an input device, and reads input signals entering the PLC. There are no restrictions on the number of times that the input contact A or B appear in the program. The ON/OFF state of input contact X changes as the input device switches between ON and OFF; you cannot use a peripheral device (WPLSoft) to force contact X ON or OFF.

Output contact Y functions

The output contact Y sends an ON/OFF signal to drive the load connected to output contact Y. There are two types of output contacts: relays and transistors. There are no restrictions on the number of times that contact A or B of an output contact Y appear in a program, but it is recommended that you use the number of output coil Y only once in a program; otherwise the output state when the PLC performs program scanning is determined by the program's final output Y circuit.



The output of Y0 will be decided by circuit ❷ , i.e. decided by On/Off of X10.

Numerical value, constant [K] / [H]

Constant	Single-byte	K	Decimal	K-32,768–K32,767
	Double-byte			K-2,147,483,648–K2,147,483,647
	Single-byte	H	Hexadecimal	H0000–HFFFF
	Double-byte			H00000000–HFFFFFFFF

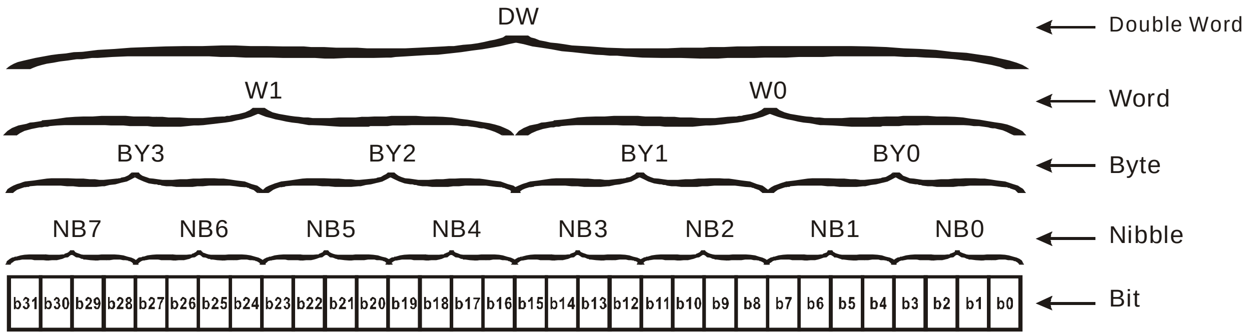
The PLC uses five types of numerical values to implement calculations based on its control tasks; the following topics explain the use and function of the different numerical values.

Binary Number, BIN

The PLC's numerical operations and memory employ binary numbers. The following table explains terms related to binary numbers.

bit	Bits are the fundamental units of binary values, and have a state of either 1 or 0.
Nibble	Comprised of a series of 4 bits (such as b3–b0); can be used to express a one-nibble decimal number 0–9 or hexadecimal number: 0–F.
Byte	Comprised of a series of two nibbles (i.e. 8 bits, b7–b0); can express a hexadecimal number: 00-FF.
Word	Comprised of a series of two bytes (i.e. 16 bits, b15–b0); can express a hexadecimal number with four nibbles: 0000–FFFF.
Double Word	Comprised of a series of two words (i.e. 32 bits, b31–b0); can express a hexadecimal number with eight nibbles: 00000000–FFFFFFFF

The following diagram shows the relationship between bits, digits, nibbles, words, and double words in a binary system (see figure below).



Octal Number, OCT

The external input and output terminals of a DVP-PLC are numbered using octal numbers.

Example: External input: X0–X7, X10–X17…(Device number table);
External output: Y0–Y7, Y10–Y17…(Device number table)

Decimal Number, DEC

A PLC uses decimal numbers for the following purposes:

- ☑ The setting values of timer T or counter C, such as TMR C0 K50 (K constant).
- ☑ The numbers of devices including M, T, C, or D, such as M10 or T30 (device number).
- ☑ An operand in an application command, such as MOV K123 D0 (K constant).

Binary Coded Decimal, BCD

Uses one nibble or four bits to express the data in a decimal number; a series of 16 bits can therefore express a decimal number with four nibbles. These are used to read the input value of a rotating numerical switch to input or output a numerical value to a seven-segment display drive.

Hexadecimal Number, HEX

A PLC uses hexadecimal numbers as operands in application commands, such as MOV H1A2B D0 (H constant).

Constant K

PLC's usually prefixed decimal numbers with K, such as K100. This indicates that it is a decimal number with a numeric value of 100.

Exceptions: You can combine K with a bit device X, Y, M, or S to produce data in the form of a nibble, byte, word, or double word, such as in the case of K2Y10 or K4M100. Here K1 represents a 4-bit combination, and K2–K4 represent 8-, 12-, and 16-bit combinations.

Constant H

PLC's usually prefixed hexadecimal numbers with H, such as in the case of H100. This indicates a hexadecimal number with a numeric value of 100.

Functions of auxiliary relays

Like an output relay Y, an auxiliary relay M has an output coil and contacts A and B, and you can use the output relay contacts any number of times in a program. You can use an auxiliary relay M to configure the control circuit, but cannot use the auxiliary relay to directly drive an external load. There are two types of auxiliary relays:

Ordinary auxiliary relays: ordinary auxiliary relays all revert to the OFF state when a power outage occurs while the PLC is running, and remains in the OFF state when power is restored.

Special purpose auxiliary relays: each special purpose auxiliary relay has its own specific use. Do not use any undefined special purpose auxiliary relays.

Timer functions

Timers use 100 ms as their timing unit. When the timing method is an upper time limit, and the current timer value = setting value, the timer output coil is energized. Timer setting values use decimal K values; you can also use the data register D as a setting value.

Actual timer setting time = timing units * set value

Counter features

Item	16-bit counter
Type	General Type
CT Direction:	Up
Setting	0–32,767
Designation of set value	Constant K or data register D
Change in current value	When the count reaches the setting value, it stops counting.
Output contact	When the count reaches the setting value, the contact switches ON and stays ON.
Reset	The current value reverts to 0 when an RST command is executed, and the contact reverts to OFF.
Contact actuation	All are actuated after the end of scanning.

Counter functions

When a counter's counting pulse input signal switches from OFF to ON, if the counter's current value is equal to the setting value, the output coil switches ON. The setting value can be either a decimal K or a data register D.

16-bit counter:

☑ 16-bit counter setting range: K0–K32,767. When K0 and K1 are identical, the output contact is immediately ON during the first count.

☑ The current counter value is cleared from an ordinary counter when power to the PLC turns OFF.

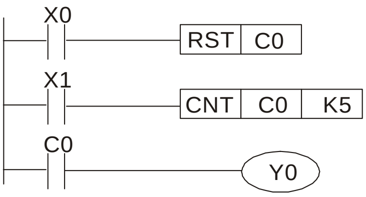
☑ If you use the MOV command or WPLSoft to transmit a value greater than the setting value to the C0 current value register, when the next X1 switches from OFF to ON, the C0 counter contact changes to ON, and the current value changes to the setting value.

☑ You can set a counter's setting value directly using a constant K, or indirectly using the value in register D (not including special data registers D1000–D1199 or D2000–D2799).

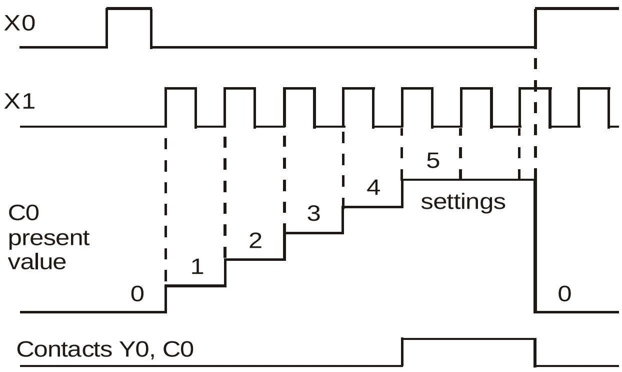
☑ If the setting value is a constant K, the value must be a positive number. If the setting value is from data register D, the value can be either a positive or negative number. If using a data register, and the current value is 32,767, incrementing the count causes the count value to roll over to -32,768 as the count continues to accumulate.

Example

LD	X0
RST	C0
LD	X1
CNT	C0 K5
LD	C0
OUT	Y0



1. When X0 = ON and the RST command is executed, the current value of C0 reverts to 0, and the output contact reverts to OFF.
2. When X1 switches from OFF to ON, the current value of the counter is incremented by one (add one).
3. When the count in C0 reaches the set value K5, the contact C0 switches to ON, and the current value of C0 = setting value = K5. Afterwards, additional changes in X1 do not affect the count value, and C0 remains at K5.



16-5-2 Introduction to special relay functions (special M)

R/W column: RO means read only; RW means read and write.

Special M	Function Descriptions	R/W *
M1000	Monitors N.O. contact (contact A). N.O. while RUN, contact A. This contact is ON while in the RUN state.	RO
M1001	Monitors N.C. contact (contact B). NC while RUN, contact B. This contact is OFF while in the RUN state.	RO
M1002	Initiates a forward pulse (the instant RUN is ON). Initial pulse, contact A. Produces a forward pulse when RUN begins; pulse width = scan cycle.	RO
M1003	Initiates a reverse pulse (the instant RUN is OFF). Initial pulse, contact A. Produces a reverse pulse when RUN ends; pulse width = scan cycle.	RO
M1004	Reserved	RO
M1005	Drive malfunction instructions	RO
M1006	Drive has no output	RO
M1007	Drive direction FWD(0) / REV(1)	RO
M1008 – M1010	--	--
M1011	10 ms clock pulse, 5 ms ON / 5 ms OFF.	RO
M1012	100 ms clock pulse, 50 ms ON / 50 ms OFF.	RO
M1013	1 sec. clock pulse, 0.5 s ON / 0.5 s OFF	RO
M1014	1 min. clock pulse, 30 s ON / 30 s OFF	RO
M1015	Frequency reached (when used with M1025)	RO
M1016	Parameter read/write error	RO
M1017	Parameter write successful	RO
M1018	--	--
M1019	--	--
M1020	Zero flag	RO
M1021	Borrow flag	RO
M1022	Carry flag	RO
M1023	Divisor is 0	RO
M1024	--	--
M1025	Drive frequency = set frequency (ON) Drive frequency = 0 (OFF)	RW
M1026	Drive operating direction FWD (OFF) / REV (ON)	RW
M1027	Drive Reset	RW
M1028	--	--
M1029	--	--
M1030	--	--
M1031	--	--
M1032	--	--
M1033	--	--
M1034	--	--
M1035	--	--
M1036	--	--
M1037	--	--
M1038	MI7 count begins	RW
M1039	Reset MI7 count value	RW
M1040	Hardware power (Servo On)	RW
M1041	--	--
M1042	Quick Stop	RW
M1043	--	--
M1044	Pause (Halt)	RW
M1045	--	--

Special M	Function Descriptions	R/W *
– M1047		
M1048	--	--
M1049	--	--
M1050	--	--
M1051	--	--
M1052	Lock frequency (lock, frequency locked at the current operating frequency)	RW
M1053	--	--
M1054	--	--
M1055	--	--
M1056	Hardware already has power (Servo On Ready)	RO
M1057	--	--
M1058	On Quick Stopping	RO

16-5-3 Introduction to special register functions (special D)

Special D	Function Descriptions	R/W *
D1000	--	--
D1001	Device system program version	RO
D1002	Program capacity	RO
D1003	Total program memory content	RO
D1004 – D1009	--	--
D1010	Current scan time (units: 0.1 ms)	RO
D1011	Minimum scan time (units: 0.1 ms)	RO
D1012	Maximum scan time (units: 0.1 ms)	RO
D1013 – D1017	--	--
D1018	Current integral value	RO
D1019	Force setting for PID I integral	RW
D1020	Output frequency (0.00–599.00 Hz)	RO
D1021	Output current (####.#A)	RO
D1022	--	--
D1023	Communication expansion card number 0: No expansion card 1: DeviceNet Slave 2: PROFIBUS-DP Slave 3: CANopen Slave 4: Modbus-TCP Slave 5: EtherNet/IP Slave	RO
D1024 – D1026	--	--
D1027	PID calculation frequency command (frequency command after PID calculation)	RO
D1028	AVI value (0.00–100.00%)	RO
D1029	ACI value (0.00–100.00%)	RO
D1030	--	--
D1031 – D1034	--	--
D1035	VR value (0.0–100.00%)	RO
D1036	Servo error bit	RO

PETER electronic

Special D	Function Descriptions	R/W *
D1037	Drive output frequency	RO
D1038	DC BUS voltage	RO
D1039	Output voltage	RO
D1040	Analog output value AFM1 (-100.00–100.00%)	RW
D1041 – D1042	--	--
D1043	Can be user-defined (is displayed on panel when Pr.00-04 is set to 28; display method is Cxxx)	RW
D1044	--	-
D1045	--	--
D1046 – D1049	--	--
D1050	Actual operation mode 0: Speed 1: Position 2: Torque 3: Homing Origin	RO
D1051	--	--
D1052	--	--
D1053	--	--
D1054	MI7 current calculated count value (low word)	RO
D1055	MI7 current calculated count value (high word)	RO
D1056	Rotating speed corresponding to MI7	RO
D1057	MI7's rotating speed ratio	RW
D1058	MI7 refresh rate (ms) corresponding to rotating speed	RW
D1059	Number of nibbles of rotating speed corresponding to MI7 (0–3)	RW
D1060	Operation mode setting 0: Speed	RW
D1061	485 COM1 communications time-out time (ms)	RW
D1062	Torque command (torque limit in speed mode)	RW
D1063	--	--
D1064	--	--
D1065	--	--
D1066	--	--
D1067	--	--
D1068	--	--
D1069	--	--
D1100	Target frequency	RO
D1101	Target frequency (must be operating)	RO
D1102	Reference frequency	RO
D1103	--	--
D1104	--	--
D1105	--	--
D1106	--	--
D1107	π (Pi) low word	RO
D1108	π (Pi) high word	RO
D1109	Random number	RO

16-5-4 PLC Communication address

Device	Range	Type	Address (Hex)
X	00–17 (Octal)	bit	0400–040FF
Y	00–17 (Octal)	bit	0500–050F
T	00–79	bit/word	0600–064F
M	000–799	bit	0800–0B1F
M	1000–1279	bit	0BE8–0CFF
C	0–39	bit/word	0E00–0E27
D	00–199	word	1000–10C7
D	1000–1219	word	13E8–14C3

Command codes that can be used

Function Code	Function Descriptions	Function target
H1	Coil status read	Y, M, T, C
H2	Input status read	X, Y, M, T, C
H3	Read single unit of data	T, C, D
H5	Force single coil status change	Y, M, T, C
H6	Write single unit of data	T, C, D
HF	Force multiple coil status change	Y, M, T, C
H10	Write multiple units of data	T, C, D

NOTE

When PLC functions have been activated, the MS3 can match the PLC and drive parameters; this method uses different addresses for drives (default station number is 1, PLC sets station number as 2).

16-6 Introduction to the Command Window

16-6-1 Overview of basic commands

- Ordinary commands

Command code	Function	OPERAND	Execution speed (μs)
LD	Load contact A	X, Y, M, T, C	0.8
LDI	Load contact B	X, Y, M, T, C	0.8
AND	Connect contact A in series	X, Y, M, T, C	0.8
ANI	Connect contact B in series	X, Y, M, T, C	0.8
OR	Connect contact A in parallel	X, Y, M, T, C	0.8
ORI	Connect contact B in parallel	X, Y, M, T, C	0.8
ANB	Series circuit block	N/A	0.3
ORB	Parallel circuit block	N/A	0.3
MPS	Save to stack	N/A	0.3
MRD	Stack read (pointer does not change)	N/A	0.3
MPP	Read stack	N/A	0.3

- Output command

Command code	Function	OPERAND	Execution speed (μs)
OUT	Drive coil	Y, M	1
SET	Action continues (ON)	Y, M	1
RST	Clear contact or register	Y, M, T, C, D	1.2

- Timer, counter

Command code	Function	OPERAND	Execution speed (μs)
TMR	16-bit timer	T-K or T-D commands	1.1
CNT	16-bit counter	C-K or C-D (16-bit)	0.5

- Main control command

Command code	Function	OPERAND	Execution speed (μs)
MC	Common series contact connection	N0–N7	0.4
MCR	Common series contact release	N0–N7	0.4

- Contact rising edge/falling edge detection command

Command code	Function	OPERAND	Execution speed (μs)
LDP	Start of rising edge detection action	X, Y, M, T, C	1.1
LDF	Start of falling edge detection action	X, Y, M, T, C	1.1
ANDP	Rising edge detection series connection	X, Y, M, T, C	1.1
ANDF	Falling edge detection series connection	X, Y, M, T, C	1.1
ORP	Rising edge detection parallel connection	X, Y, M, T, C	1.1
ORF	Falling edge detection parallel connection	X, Y, M, T, C	1.1

- Upper/lower differential output commands

Command code	Function	OPERAND	Execution speed (μs)
PLS	Upper differential output	Y, M	1.2
PLF	Lower differential output	Y, M	1.2

- Stop command

Command code	Function	OPERAND	Execution speed (μs)
END	Program conclusion	N/A	0.2

- Other commands

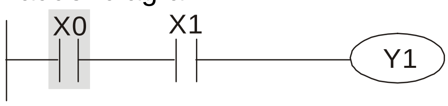
Command code	Function	OPERAND	Execution speed (μs)
NOP	No action	N/A	0.2
INV	Inverse of operation results	N/A	0.2
P	Index	P	0.3

16-6-2 Detailed explanation of basic commands

Command	Function					
LD	Load contact A					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the LD command for contact A starting at the left busbar or contact A starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

Example: Ladder diagram:

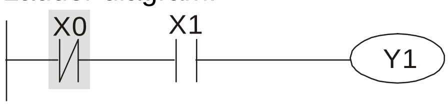


Command code:		Description:
LD	**X0**	Load Contact A of X0
AND	X1	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil

Command	Function					
LDI	Load contact B					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the LDI command for contact B starting at the left busbar or contact B starting at a contact circuit block; its function is to save current content and save the acquired contact status in the cumulative register.

Example: Ladder diagram:

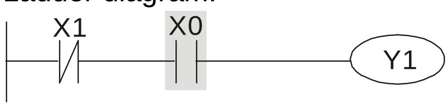


Command code:		Description:
LDI	**X0**	Load Contact B of X0
AND	X1	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil

Command	Function					
AND	Connect contact A in series					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the AND command to create a series connection to contact A; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform "AND" operation; saves the results in the cumulative register.

Example: Ladder diagram:



Command code:		Description:
LDI	X1	Load Contact B of X1
AND	**X0**	Create a series connection to contact A of X0
OUT	Y1	Drive Y1 coil

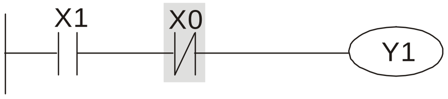
Command	Function					
ANI	Connect contact B in series					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation

Use the ANI command to create a series connection to contact B; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform "AND" operation; saves the results in the cumulative register.

Example

Ladder diagram:



Command code:		Description:
LD	X1	Load Contact A of X1
ANI	**X0**	Create a series connection to contact B of X0
OUT	Y1	Drive Y1 coil

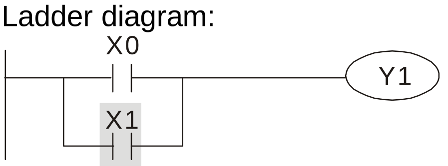
Command	Function					
OR	Connect contact A in parallel					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation

Use the OR command to establish a parallel connection to contact A; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform "OR" operation; saves the results in cumulative register.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
OR	**X1**	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil

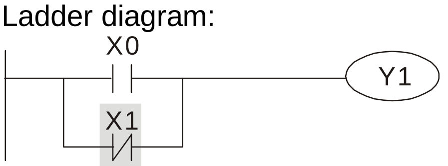
Command	Function					
ORI	Connect contact B in parallel					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation

Use the ORI command to establish a parallel connection to contact B; its function is to first read the current status of the designated series contact and the logical operation results before contact in order to perform "OR" operation; saves the results in cumulative register.

Example

Ladder diagram:

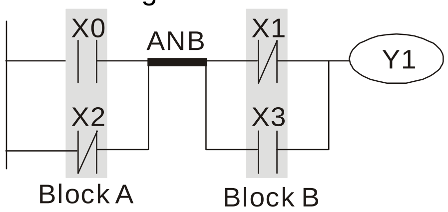


Command code:		Description:
LD	X0	Load Contact A of X0
ORI	**X1**	Create a series connection to contact B of X1
OUT	Y1	Drive Y1 coil

Command	Function
ANB	Series circuit block
Operand	N/A

Explanation: ANB performs an "AND" operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:

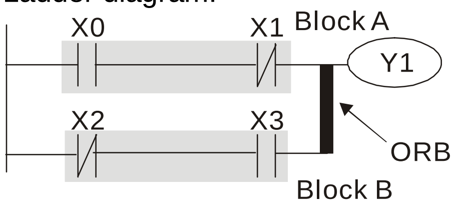


Command code:		Description:
LD	X0	Load Contact A of X0
ORI	X2	Establish a parallel connection to contact B of X2
LDI	X1	Load Contact B of X1
OR	X3	Establish a parallel connection to contact A of X3
ANB		Series circuit block
OUT	Y1	Drive Y1 coil

Command	Function
ORB	Parallel circuit block
Operand	N/A

Explanation: ORB performs an "OR" operation on the previously saved logic results and the current cumulative register content.

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
ANI	X1	Establish a parallel connection to contact B of X1
LDI	X2	Load Contact B of X2
AND	X3	Establish a parallel connection to contact A of X3
ORB		Parallel circuit block
OUT	Y1	Drive Y1 coil

Command	Function
MPS	Save to stack
Operand	N/A

Explanation: Saves the current content of the cumulative register to the stack (add one to the stack pointer).

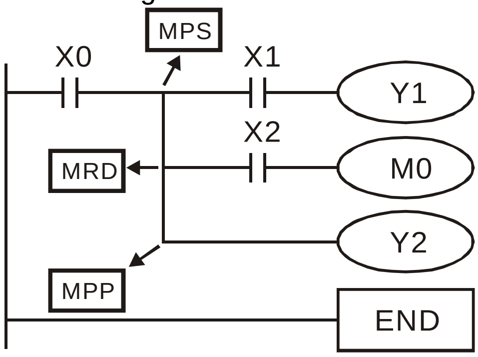
Command	Function
MRD	Read stack (pointer does not change)
Operand	N/A

Explanation: Reads the stack content and saves to the cumulative register (the stack pointer does not change).

Command	Function
MPP	Read stack
Operand	N/A

Explanation: Retrieves the result of the previously saved logical operation from the stack, and saves to the cumulative register. (subtract one from stack pointer)

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
MPS		Save to the stack
AND	X1	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil
MRD		Read the stack (pointer does not change)
AND	X2	Create a series connection to contact A of X2
OUT	M0	Drive M0 coil
MPP		Read stack
OUT	Y2	Drive Y2 coil
END		Program conclusion

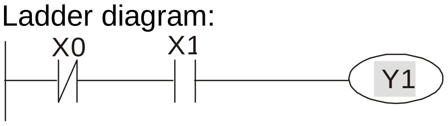
Command	Function					
OUT	Drive coil					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	-	✓	✓	-	-	-

Explanation: Outputs the result of the logical operation before the OUT command to the designated element.

Coil contact action:

Result:	Out command		
	Coil	Access Point:	
		Contact A (N.O.)	Contact B (N.C.)
FALSE	OFF	Not conducting	Conducting
TRUE	ON	Conducting	Not conducting

Example: Ladder diagram:

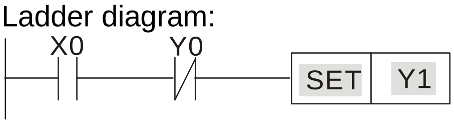


Command code:		Description:
LD	X0	Load Contact B of X0
AND	X1	Establish a parallel connection to contact A of X1
OUT	**Y1**	Drive Y1 coil

Command	Function					
SET	Action continues (ON)					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	-	✓	✓	-	-	-

Explanation: Sets the designated element to ON, and maintains it in an ON state, regardless of whether the SET command is still driven. Use the RST command to set the element as OFF.

Example: Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
AN	Y0	Establish a parallel connection to contact B of Y0

SET	**Y1**	Action continues (ON)

Command	Function					
RST	Clear contact or register					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	-	✓	✓	✓	✓	✓

Explanation

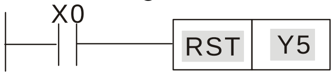
Resets the designated element as described.

Element	Mode
Y, M	Both coil and contact are set as OFF.
T, C	Sets the current timing or count value to 0, and both the coil and contact are set to OFF.
D	Sets the content value to 0.

If the RST command is not executed, the status of the designated element remains unchanged.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
RST	**Y5**	Clear the contact or register

Command	Function	
TMR	16-bit timer	
Operand	T-K	T0–T159, K0–K32,767
	T-D	T0–T159, D0–D399

Explanation

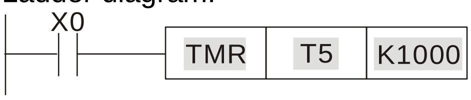
Electrifies the designated timer coil, and the timer begins timing. The contact's action is as follows when the timing value reaches the designated setting value (timing value ≥ setting value):

N.O. (Normally Open) contact	Closed
N.C. (Normally Closed) contact	Open

If the RST command is not executed, the status of the designated element remains unchanged.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
TMR	**T5**	T5 timer
	K1000	Set value as K1000

Command	Function	
CNT	16-bit counter	
Operand	C-K	C0–C79, K0–K32,767
	C-D	C0–C79, D0–D399

Explanation

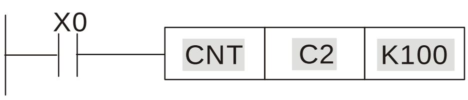
When you execute the CNT command from OFF to ON, switch the designated counter coil from no power to electrified and add one to the counter's count value. When the count reaches the designated value (count value = setting value), the contact has the following action:

N.O. (Normally Open) contact	Closed
N.C. (Normally Closed) contact	Open

After reaching the count value, the contact and count value both remain unchanged even with continued count pulse input. Use the RST command to restart or clear the count.

Example

Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
CNT	**C2 K100**	C2 counter Set value as K100

Command	Function
MC/MCR	Connect/release a common series contact
Operand	N0–N7

Explanation

MC is the main control initiation command, and any command between MC and MCR is executed normally. When the MC command is OFF, any command between MC and MCR acts as follows:

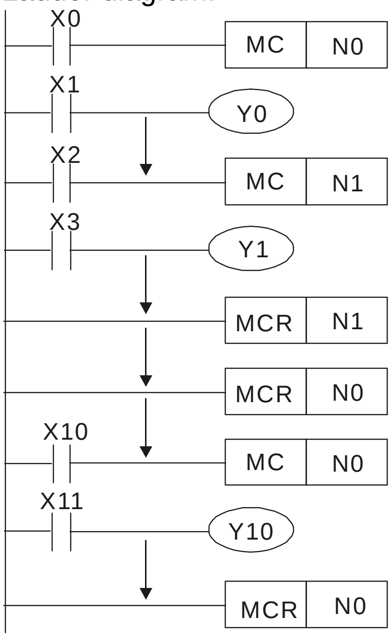
Determination of commands	Description
Ordinary timer	The timing value reverts to 0, the coil loses power, and the contact does not operate.
Counter	The coil loses power, and the count value and contact stay in their current state.
Coil driven by OUT command	None receives power.
Elements driven by SET, RST commands	They remain in their current state.
Application commands	None are actuated.

MCR is the main control stop command, and is placed at the end of the main control program. There may not be any contact command prior to the MCR command.

The MC-MCR main control program commands support a nested program structure with a maximum of only eight levels; use in the order N0–N7. Refer to the following program example:

Example

Ladder diagram:



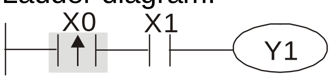
Command code:		Description:
LD	X0	Load Contact A of X0
MC	**N0**	Connection of N0 common series contact
LD	X1	Load Contact A of X1
OUT	Y0	Drive Y0 coil
:		
LD	X2	Load Contact A of X2
MC	**N1**	Connection of N1 common series contact
LD	X3	Load Contact A of X3
OUT	Y1	Drive Y1 coil
:		
MCR	**N1**	Release N1 common series contact
:		
MCR	**N0**	Release N0 common series contact
:		
LD	X10	Load Contact A of X10
MC	**N0**	Connection of N0 common series contact
LD	X11	Load Contact A of X11
OUT	Y10	Drive Y10 coil
:		
MCR	**N0**	Release N0 common series contact

Command	Function					
LDP	Start of rising edge detection action					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: The LDP command has the same use as LD, but its action is different. Its function is to save the current content while also saving the detected state of the rising edge of the contact to the cumulative register.

Example

Ladder diagram:



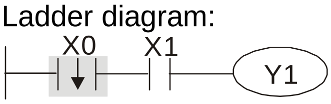
Command code:		Description:
LDP	**X0**	Start of X0 rising edge detection action
AND	X1	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil

Command	Function					
LDF	Start of falling edge detection action					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: The LDF command has the same use as LD, but its action is different. Its function is to save the current content while also saving the detected state of the falling edge of the contact to the cumulative register.

Example

Ladder diagram:



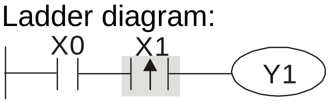
Command code:		Description:
LDF	**X0**	Start of X0 falling edge detection action
AND	X1	Create a series connection to contact A of X1
OUT	Y1	Drive Y1 coil

Command	Function					
ANDP	Rising edge detection series connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the ANDP command for a contact rising edge detection series connection.

Example

Ladder diagram:

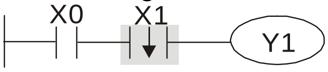


Command code:		Description:
LD	X0	Load Contact A of X0
ANDP	**X1**	X1 Rising edge detection series connection
OUT	Y1	Drive Y1 coil

Command	Function					
ANDF	Falling edge detection series connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the ANDF command for a contact falling edge detection series connection.

Example: Ladder diagram:

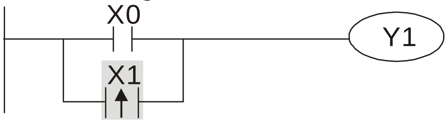


Command code:		Description:
LD	X0	Load Contact A of X0
ANDF	**X1**	X1 Falling edge detection series connection
OUT	Y1	Drive Y1 coil

Command	Function					
ORP	Rising edge detection parallel connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the ORP command for a contact rising edge detection parallel connection.

Example: Ladder diagram:

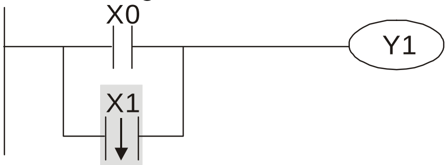


Command code:		Description:
LD	X0	Load Contact A of X0
ORP	**X1**	X1 Rising edge detection parallel connection
OUT	Y1	Drive Y1 coil

Command	Function					
ORF	Falling edge detection parallel connection					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	✓	✓	✓	✓	✓	-

Explanation: Use the ORF command for a contact falling edge detection parallel connection.

Example: Ladder diagram:



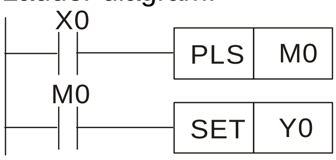
Command code:		Description:
LD	X0	Load Contact A of X0
ORF	**X1**	X1 Falling edge detection parallel connection
OUT	Y1	Drive Y1 coil

Command	Function					
PLS	Upper differential output					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	-	✓	✓	-	-	-

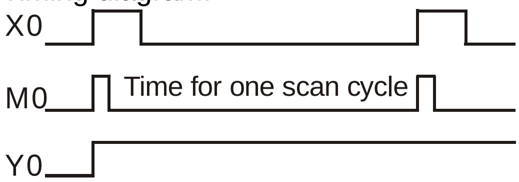
Explanation: Upper differential output command: when X0 switches from OFF to ON (rising edge-triggered), the PLS command is executed, and M0 sends one pulse with the pulse length consisting of one scanning period.

Example

Ladder diagram:



Timing diagram:



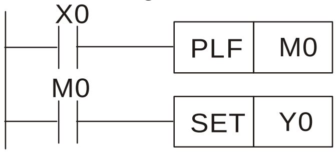
Command code:		Description:
LD	X0	Load Contact A of X0
PLS	**M0**	M0 Upper differential output
LD	M0	Load Contact A of M0
SET	Y0	Y0 Action continues (ON)

Command	Function					
PLF	Lower differential output					
Operand	X0–X17	Y0–Y17	M0–M799	T0–159	C0–C79	D0–D399
	-	✓	✓	-	-	-

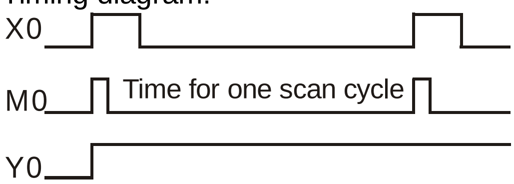
Explanation: Lower differential output command: when X0 switches from ON to OFF (falling edge-triggered), the PLF command is executed, and M0 sends one pulse with the pulse length consisting of one scanning period.

Example

Ladder diagram:



Timing diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
PLF	**M0**	M0 Lower differential output
LD	M0	Load Contact A of M0
SET	Y0	Y0 Action continues (ON)

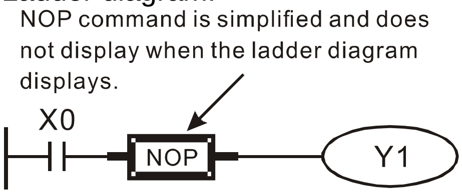
Command	Function
END	End of Program
Operand	N/A

Explanation: An END command must be added to the end of a ladder diagram program or command program. The PLC scans the program from address 0 to the END command, and then returns to address 0 and begins scanning again.

Command	Function
NOP	No action
Operand	N/A

Explanation The NOP command does not perform any operation in the program. Because execution of this command retains the original logical operation results, you can use it in the following situation: use the NOP command instead of a command that is deleted without changing the program length.

Example Ladder diagram:

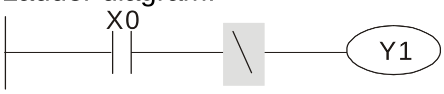


Command code:		Description:
LD	X0	Load Contact B of X0
NOP		No action
OUT	Y1	Drive Y1 coil

Command	Function
INV	Inverse of operation results
Operand	N/A

Explanation Saves the result of the logic inversion operation prior to the INV command in the cumulative register.

Example Ladder diagram:

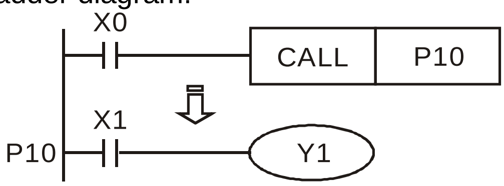


Command code:		Description:
LD	X0	Load Contact A of X0
INV		Inverse of operation results
OUT	Y1	Drive Y1 coil

Command	Function
P	Pointer
Operand	P0–P255

Explanation Use pointer P as the target in a subprogram call (command API 01 CALL). Using P does not require starting from zero, but the number cannot be used repeatedly; otherwise, an unpredictable error occurs.

Example Ladder diagram:



Command code:		Description:
LD	X0	Load Contact A of X0
CALL	P10	Call command CALL to P10
:		
P10		Pointer P10
LD	X1	Load Contact A of X1
OUT	Y1	Drive Y1 coil

16-6-3 Overview of application commands

Classification	API	Command code 16 bit	Command code 32 bit	P command	Function	STEPS 16 bit	STEPS 32 bit
Circuit control	01	CALL	-	✓	Call subprogram	3	-
	2	SRET	-	-	End a subprogram	1	-
	06	FEND	-	-	End a main program	1	-
Send comparison	10	CMP	DCMP	✓	Compare set output	7	13
	11	ZCP	DZCP	✓	Range comparison	9	17
	12	MOV	DMOV	✓	Move data	5	9
	15	BMOV	–	✓	Send all	7	–
Four logical operations	20	ADD	DADD	✓	BIN addition	7	13
	21	SUB	DSUB	✓	BIN subtraction	7	13
	22	MUL	DMUL	✓	BIN multiplication	7	13
	23	DIV	DDIV	✓	BIN division	7	13
	24	INC	DINC	✓	BIN add one	3	5
	25	DEC	DDEC	✓	BIN subtract one	3	5
Rotational displacement	30	ROR	DROR	✓	Right rotation	5	–
	31	ROL	DROL	✓	Left rotation	5	–
Data Process	40	ZRST	–	✓	Clear range	5	-
	49	–	DFLT	✓	Convert BIN whole number to binary floating point number	-	9
Communication	150	MODRW	–	✓	Modbus read/write	7	–
Floating point operation	110	–	DECMP	✓	Compare binary floating point numbers	–	13
	111	–	DEZCP	✓	Compare binary floating point number range	–	17
	116	–	DRAD	✓	Convert angle to diameter	–	9
	117	–	DDEG	✓	Convert diameter to angle	–	9
	120	–	DEADD	✓	Add binary floating point numbers	–	13
	121	–	DESUB	✓	Subtract binary floating point numbers	–	13
	122	–	DEMUL	✓	Multiply binary floating point numbers	–	13
	123	–	DEDIV	✓	Divide binary floating point numbers	–	13
	124	–	DEXP	✓	Find exponent of a binary floating point number	–	9
	125	–	DLN	✓	Find natural logarithm of a binary floating point number	–	9
	127	–	DESQR	✓	Find the square root of binary floating point number	–	9
	129	–	DINT	✓	Convert binary floating point number to BIN whole number	–	9
	130	–	DSIN	✓	Find the sine of a binary floating point number	–	9
	131	–	DCOS	✓	Find the cosine of a binary floating point number	–	9
	132	–	DTAN	✓	Find the tangent of a binary floating point number	–	9
	133	–	DASIN	✓	Find the arcsine of a binary floating point number	–	9
	134	–	DACOS	✓	Find the arccosine of a binary floating point number	–	9
	135	–	DATAN	✓	Find the arctangent of a binary floating point number	–	9
Floating point operation	136	–	DSINH	✓	Find the hyperbolic sine of a binary floating point number	–	9

Classification	API	Command code 16 bit	Command code 32 bit	P command	Function	STEPS 16 bit	STEPS 32 bit
	137	–	DCOSH	✓	Find the hyperbolic cosine of a binary floating point number	–	9
	138	–	DTANH	✓	Find the hyperbolic tangent of a binary floating point number	–	9
Calendar	160	TCMP	–	✓	Compare calendar data	11	–
	161	TZCP	–	✓	Compare calendar data range	9	–
	162	TADD	–	✓	Calendar data addition	7	–
	163	TSUB	–	✓	Calendar data subtraction	7	–
	166	TRD	–	✓	Calendar data read	3	–
GRAY code	170	GRY	DGRY	✓	Convert BIN to GRAY code	5	9
	171	GBIN	DGBIN	✓	Convert GRAY code to BIN	5	9
Contact form logical operation	215	LD&	DLD&	-	Contact form logical operation LD#	5	9
	216	LD|	DLD|	-	Contact form logical operation LD#	5	9
	217	LD^	DLD^	-	Contact form logical operation LD#	5	9
	218	AND&	DAND&	-	Contact form logical operation AND#	5	9
	219	AND|	DAND|	-	Contact form logical operation AND#	5	9
	220	AND^	DAND^	-	Contact form logical operation AND#	5	9
	221	OR&	DOR&	-	Contact form logical operation OR#	5	9
	222	OR|	DOR|	-	Contact form logical operation OR#	5	9
	223	OR^	DOR^	-	Contact form logical operation OR#	5	9
Contact form comparison command	224	LD =	DLD =	-	Contact form compare LD*	5	9
	225	LD >	DLD >	-	Contact form compare LD*	5	9
	226	LD <	DLD <	-	Contact form compare LD*	5	9
	228	LD < >	DLD < >	-	Contact form compare LD*	5	9
	229	LD < =	DLD < =	-	Contact form compare LD*	5	9
	230	LD > =	DLD > =	-	Contact form compare LD*	5	9
	232	AND =	DAND =	-	Contact form compare AND*	5	9
	233	AND >	DAND >	-	Contact form compare AND*	5	9
	234	AND <	DAND <	-	Contact form compare AND*	5	9
	236	AND < >	DAND < >	-	Contact form compare AND*	5	9
	237	AND < =	DAND < =	-	Contact form compare AND*	5	9
	238	AND > =	DAND > =	-	Contact form compare AND*	5	9
	240	OR =	DOR =	-	Contact form compare OR*	5	9
	241	OR >	DOR >	-	Contact form compare OR*	5	9
	242	OR <	DOR <	-	Contact form compare OR*	5	9
	244	OR < >	DOR < >	-	Contact form compare OR*	5	9
	245	OR < =	DOR < =	-	Contact form compare OR*	5	9
	246	OR > =	DOR > =	-	Contact form compare OR*	5	9

Classification	API	Command code		P command	Function	STEPS	
		16 bit	32 bit			16 bit	32 bit
Floating point contact form	275	-	FLD =	-	Floating point number contact form compare LD*	-	9
	276	-	FLD >	-	Floating point number contact form compare LD*	-	9
	277	-	FLD <	-	Floating point number contact form compare LD*	-	9
Comparison command	278	-	FLD < >	-	Floating point number contact form compare LD*	-	9
	279	-	FLD < =	-	Floating point number contact form compare LD*	-	9
	280	-	FLD > =	-	Floating point number contact form compare LD*	-	9
	281	-	FAND =	-	Floating point number contact form compare AND*	-	9
	282	-	FAND >	-	Floating point number contact form compare AND*	-	9
	283	-	FAND <	-	Floating point number contact form compare AND*	-	9
	284	-	FAND < >	-	Floating point number contact form compare AND*	-	9
	285	-	FAND < =	-	Floating point number contact form compare AND*	-	9
	286	-	FAND > =	-	Floating point number contact form compare AND*	-	9
	287	-	FOR =	-	Floating point number contact form compare OR*	-	9
	288	-	FOR >	-	Floating point number contact form compare OR*	-	9
	289	-	FOR <	-	Floating point number contact form compare OR*	-	9
	290	-	FOR < >	-	Floating point number contact form compare OR*	-	9
	291	-	FOR < =	-	Floating point number contact form compare OR*	-	9
	292	-	FOR > =	-	Floating point number contact form compare OR*	-	9
Drive special command	139	RPR	–	✓	Read servo parameter	5	–
	140	WPR	–	✓	Write servo parameter	5	–
	141	FPID	–	✓	Drive PID control mode	9	–
	142	FREQ	–	✓	Drive torque control mode	7	–
	262	–	DPOS	✓	Set target	-	5
	263	TORQ	–	✓	Set target torque	5	-
	261	CANRX	–	✓	Read CANopen slave station data	9	-
	264	CANTX	–	✓	Write CANopen slave station data	9	-
	265	CANFLS	–	✓	Refresh special D corresponding to CANopen	3	-
	320	ICOMR	DICOMR	✓	Internal communications read	9	17
	321	ICOMW	DICOMW	✓	Internal communications write	9	17

16-6-4 Detailed explanation of application commands

API				
01	CALL	P	S	Call a subprogram

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D

Notes on operand usage:

The S operand can designate P.

MS3 series device: The S operand can designate P0-P63.

16-bit command (3 STEP)

CALL	Continuous execution type	CALLP	Pulse execution type

32-bit command

-	-	-	-

Flag signal: none

Explanation

- **S**: Call subprogram pointer.
- Write the subprogram after the FEND command.
- The subprogram must end after the SRET command.
- Refer to the FEND command explanation and sample content for detailed command functions.

API				
02	SRET	P	-	End a subprogram

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D

Notes on operand usage:

No operand

A contact-driven command is not needed.

16-bit command (1 STEP)

FEND	Continuous execution type	-	-

32-bit command

-	-	-	-

Flag signal: none

Explanation

- A contact-driven command is not needed. Automatically returns next command after CALL command.
- Indicates end of subprogram. After end of subprogram, SRET returns to main program, and executes next command after the original call subprogram CALL command.
- Refer to the FEND command explanation and sample content for detailed command functions.

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API					
06		**FEND**		-	End of a main program

	bit device			Word device								16-bit command (1 STEP)			
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	FEND	Continuous execution type	-	-
												32-bit command			
												-	-	-	-

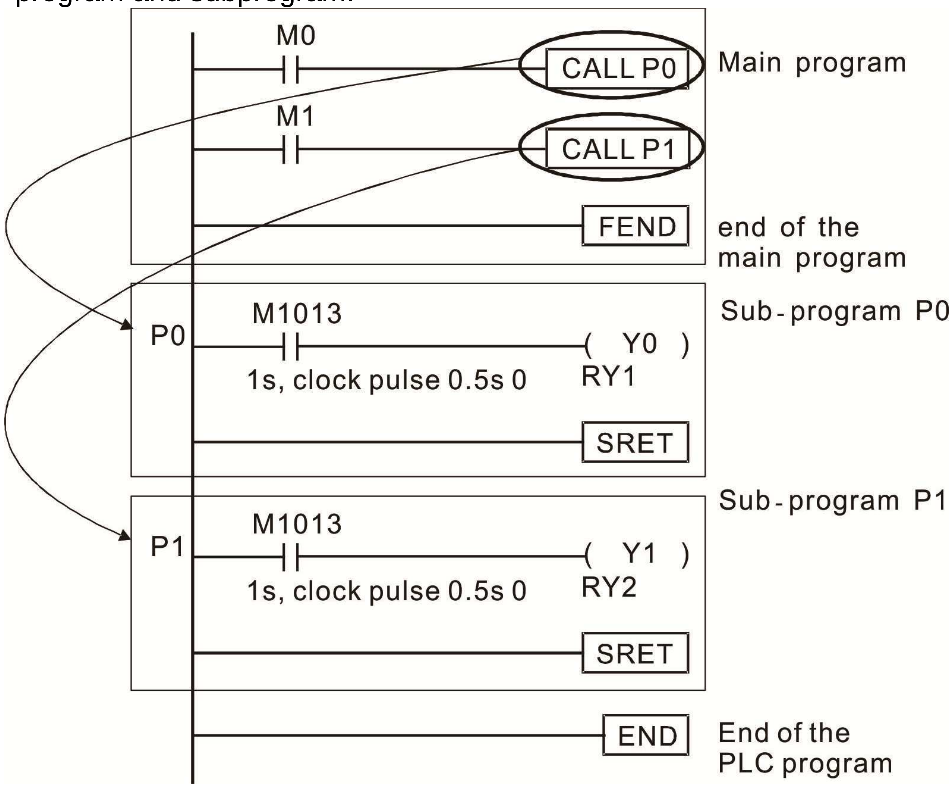
Notes on operand usage:
No operand
A contact-driven command is not needed.

Flag signal: none

Explanation

- This command indicates the end of the main program. It is the same as the END command when the PLC executes this command.
- The CALL command program must be written after the FEND command, and the SRET command is added to the end of the subprogram.
- When using the FEND command, an END command is also needed. However, the END command must be placed at the end, after the main program and subprogram.

CALL command process



API					
10	D	CMP	P	S1 S2 D	Compare set output

	bit device			Word device								16-bit command (7 STEP)
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	CMP Continuous execution type; CMPP Pulse execution type
S1				*	*	*	*	*	*	*	*	32-bit command (13 STEP)
S2				*	*	*	*	*	*	*	*	DCMP Continuous execution type; DCMPP Pulse execution type
D		*	*									

Notes on operand usage:
The operand D occupies three consecutive points

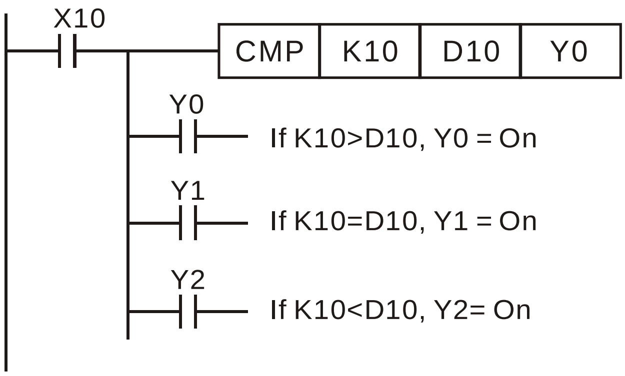
Flag signal: none

Explanation

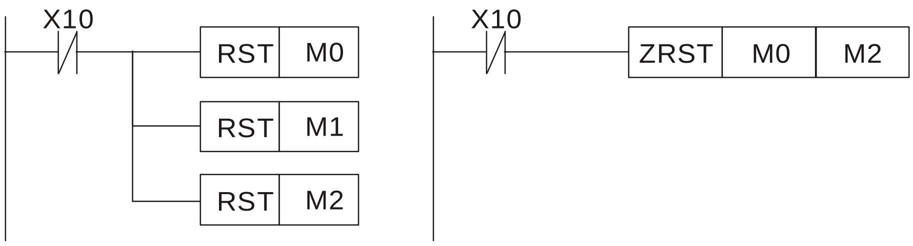
- S1: Compare value 1. S2: Compare value 2. D: Results of comparison.
- Compares the size of the content of operand S1 and S2; stores the results of the comparison in D.
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is Y0, it automatically occupies Y0, Y1 and Y2.
- When X10=ON, the CMP command executes, and Y0, Y1 or Y2 is ON. When X10=OFF, the CMP command does not execute, and the state of Y0, Y1 and Y2 remain in the state prior to X10=OFF.
- For ≥, ≤, or ≠ comparison results, use series and parallel connections among Y0–Y2.



- To clear results of comparison, use the RST or ZRST command.



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API					
11	D	**ZCP**	P	(S1) (S2) (S) (D)	Range comparison

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
S				*	*	*	*	*	*	*	*
D		*	*								

Notes on operand usage:
The content value of operand S1 is less than the content value of S2 operand.
The operand D occupies three consecutive points.

16-bit command (9 STEP)

ZCP	Continuous execution type	ZCPP	Pulse execution type

32-bit command (17 STEP)

DZCP	Continuous execution type	DZCPP	Pulse execution type

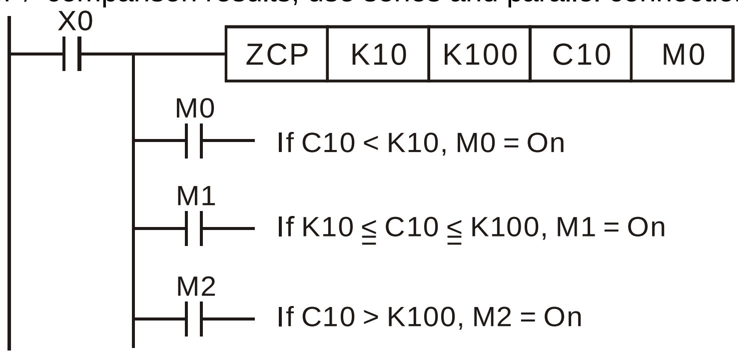
Flag signal: none

Explanation

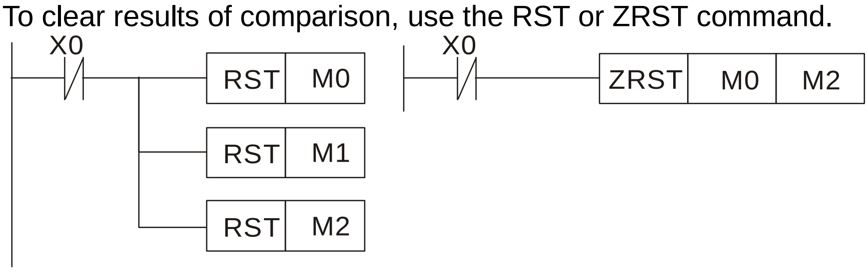
- (S1): Lower limit of range comparison. (S2): Upper limit of range comparison. (S) : Comparative value. (D): Results of comparison.
- Compares value (S) with the lower limit (S1) and upper limit (S2), and stores the results of comparison in (D).
- When lower limit (S1) > upper limit (S2), the command uses the lower limit (S1) as the upper and lower limit.
- Size comparison is performed algebraically. All data is compared in the form of numerical binary values. Because this is a 16-bit command, when b15 is 1, this indicates a negative number.

Example

- When the designated device is M0, it automatically occupies M0, M1 and M2.
- When X0=ON, the ZCP command executes, and M0, M1 or M2 is ON. When X0=OFF, the ZCP command does not execute, and the state of M0, M1 or M2 remains in the state prior to X0=OFF.
- For ≥, ≤, or ≠ comparison results, use series and parallel connections for M0–M2.



- To clear results of comparison, use the RST or ZRST command.



API 12	D	MOV	P	(S) (D)	Move data

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (5 STEP)

MOV	Continuous execution type	MOVP	Pulse execution type

32-bit command (9 STEP)

DMOV	Continuous execution type	DMOVP	Pulse execution type

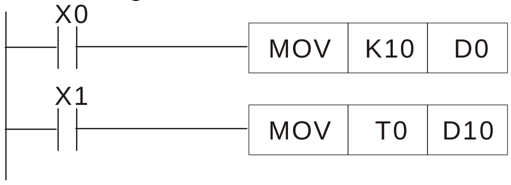
Flag signal: none

Explanation

- (S): Data source. (D): Destination of data movement.
- Moves the content in (S) to (D). When the command does not execute, the content of (D) does not change.

Example

- When X0 = OFF, the content of D10 does not change; if X0 = ON, the value K10 is moved to data register D10.
- When X1 = OFF, the content of D10 does not change; if X1 = ON, the current value of T0 is moved to data register D10.



API	BMOV	P	(S) (D) (n)	Send all
15				

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S						*	*	*	*	*	*
D							*	*	*	*	*
n				*	*				*	*	

Notes on operand usage:

n operand scope n = 1 to 512

16-bit command (7 STEP)			
BMOV	Continuous execution type	BMOVP	Pulse execution type
32-bit command			
-	-	-	-

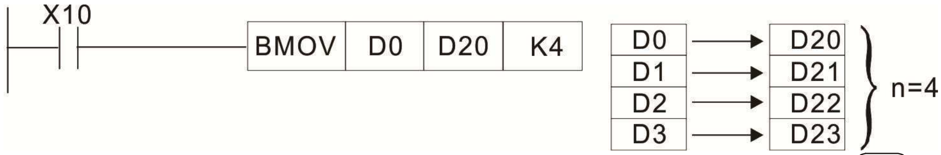
Flag signal: none

Explanation

- (S): Initiate source device. (D): Initiate destination device. (n): Send block length.
- Sends the content of n registers starting from the initial number of the device designated by (S) to the n registers starting from the initial number of the device designated by (n); if the number of points referred to by n exceeds the range used by that device, sends only points within the valid range.

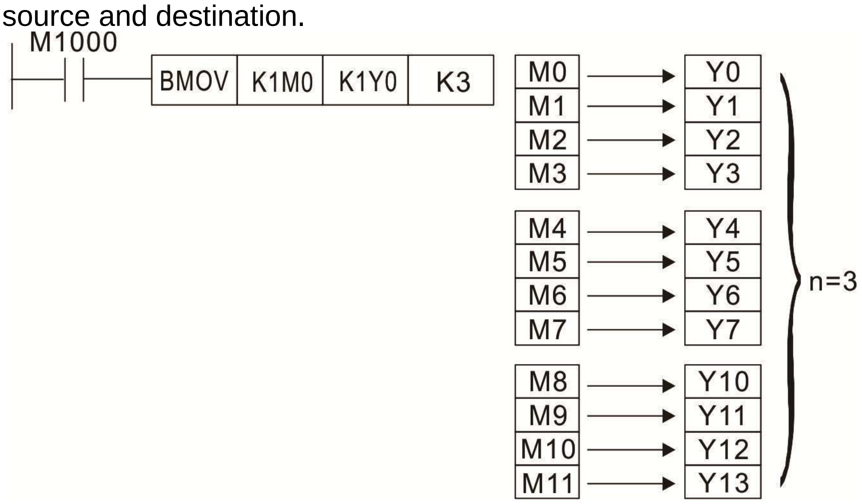
Example 1

- When X10=ON, sends the content of registers D0–D3 to the four registers D20–D23.



Example 2

- When sending from designated bit devices KnX, KnY, and KnM, (S) and (D) must have the same number of nibbles, which means n must be identical for source and destination.



API					
20	D	**ADD**	P	(S1) (S2) (D)	BIN addition

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (7 STEP)

ADD	Continuous execution type	ADDP	Pulse execution type

32-bit command (13 STEP)

DADD	Continuous execution type	DADDP	Pulse execution type

Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Refer to the following supplementary explanation

Explanation

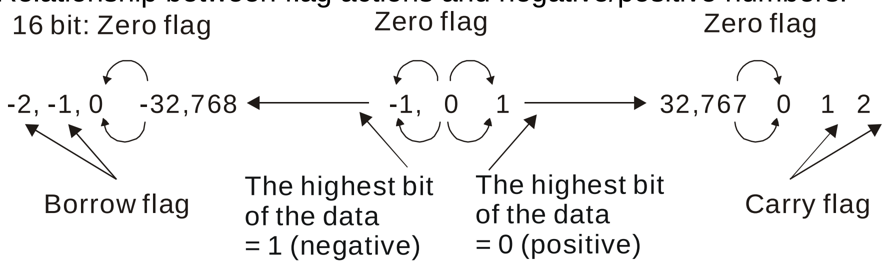
- (S1): Augend. (S2): Addend. (D): Sum.
- Adds (S1) and (S2) using the BIN method and stores result in (D).
- The highest bit of any data defines the sign: bit=0 indicates (positive) bit=1 indicates (negative); enables the use of algebraic addition operations (for instance: 3+(-9)=-6).
- Flag changes connected with the addition.
  1. When calculation results are 0, the zero flag M1020 is ON.
  2. When calculation results are less than -32,768, the borrow flag M1021 is ON.
  3. When calculation results are greater than 32,767, the carry flag M1022 is ON.

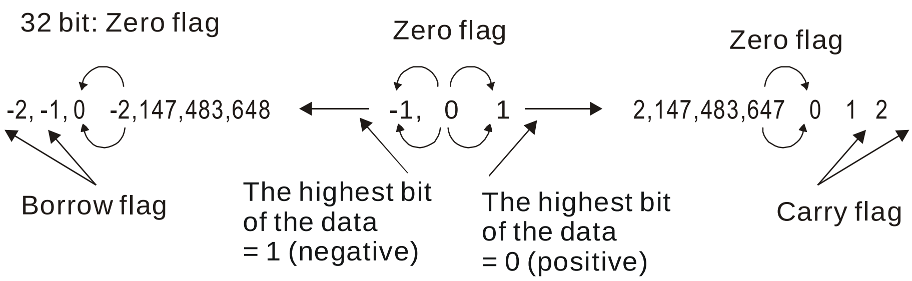
Example

- 16-bit BIN addition: When X0 = ON, saves the result of the content of addend D0 plus the content of augend D10 in the content of D20.

Remark

- Relationship between flag actions and negative/positive numbers:





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API 21	D	SUB	P	(S1) (S2) (D)	BIN subtraction

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (7 STEP)

SUB	Continuous execution type	SUBP	Pulse execution type

32-bit command (13 STEP)

DSUB	Continuous execution type	DSUBP	Pulse execution type

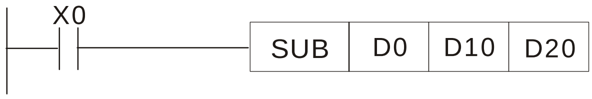
Flag signal: M1020 Zero flag
M1021 Borrow flag
M1022 Carry flag
Refer to the following supplementary explanation

Explanation

- (S1): Minuend. (S2): Subtrahend. (D): Difference.
- Subtracts (S2) from (S1) using the BIN method and stores result in (D).
- The highest bit of any data defines the sign bit=0 indicates (positive) bit=1 indicates (negative); enables the use of algebraic subtraction operations.
- Flag changes connected with subtraction.
  1. When calculation results are 0, the zero flag M1020 is ON.
  2. When calculation results are less than -32,768, the borrow flag M1021 is ON.
  3. When calculation results are greater than 32,767, the carry flag M1022 is ON.

Example

- 16-bit BIN subtraction: When X0 = ON, subtracts the content of D10 from the content of D0, and stores the difference in D20.



API 22	D	MUL	P	S1 S2 D	BIN multiplication

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
The 16-bit command operand D occupies two consecutive points.

16-bit command (7 STEP)

MUL	Continuous execution type	MULP	Pulse execution type

32-bit command (13 STEP)

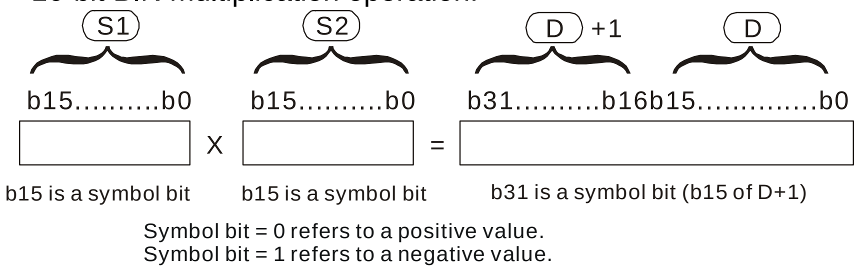
DMUL	Continuous execution type	DMULP	Pulse execution type

Flag signal: none

Explanation

- S1: Multiplicand. S2: Multiplier. D: Product.
- Multiplies S1 and S2 using the BIN method, and stores the product in D.

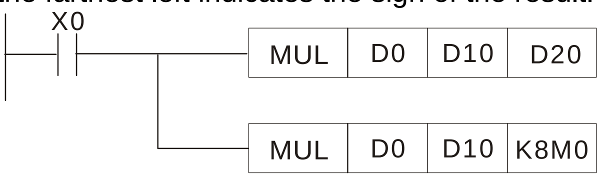
16-bit BIN multiplication operation:



When D is a bit device, K1–K4 can be designated as a hexadecimal number, which occupies two consecutive units.

Example

- When 16-bit DO is multiplied by 16-bit D10, the result is a 32-bit product; the upper 16 bits are stored in D21, and the lower 16 bits are stored in D20. The bit at the farthest left indicates the sign of the result.



API				
23	D	**DIV** P	(S1) (S2) (D)	BIN division

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
The 16-bit command operand D occupies two consecutive points.

16-bit command (7 STEP)			
DIV	Continuous execution type	DIVP	Pulse execution type

32-bit command (13 STEP)			
DDIV	Continuous execution type	DDIVP	Pulse execution type

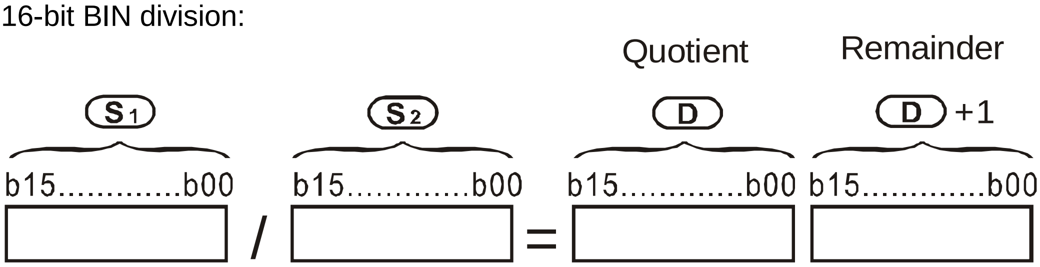
Flag signal: none

Explanation

- (S1): Dividend. (S2): Divisor. (D): Quotient and remainder.

Divides (S1) by (S2) and stores the quotient and remainder in (D) using the BIN method. The sign bit for (S1), (S2) and (D) must be kept in mind when performing a 16-bit operation.

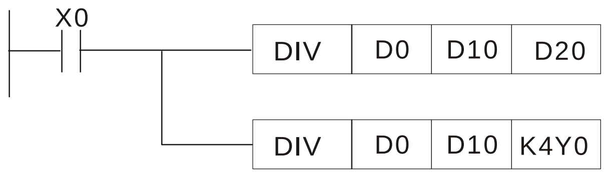
16-bit BIN division:



If (D) is a bit device, K1–K4 can be designated as 16 bits, which occupy two consecutive units and yield the quotient and remainder.

Example

- When X0=ON, stores the quotient resulting from division of dividend D0 by divisor D10 in D20, and the remainder in D21. The highest bit indicates the sign of the result.
-



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API					
24	D	**INC**	P	(D)	BIN add one

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*

Notes on operand usage: none

16-bit command (3 STEP)

INC	Continuous execution type	INCP	Pulse execution type

32-bit command (5 STEP)

DINC	Continuous execution type	DINCP	Pulse execution type

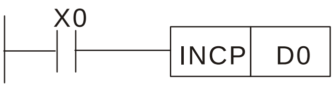
Flag signal: none

Explanation

- (D): Destination device.
- If a command is not the pulse execution type, adds 1 to the content of device (D) during each scanning cycle.
- Generally use this command as a pulse execution type command (INCP).
- During 16-bit operation, 32,767 +1 rolls over to -32,768. During 32-bit operation, 2,147,483,647 +1 rolls over to -2,147,483,648.

Example

- When X0 switches from OFF to ON, it automatically adds 1 to the content of D0.



API					
25	D	**DEC**	P	(D)	BIN subtract one

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D				*	*	*	*	*			

Notes on operand usage: none

16-bit command (3 STEP)

DEC	Continuous execution type	DECP	Pulse execution type

32-bit command (5 STEP)

DDEC	Continuous execution type	DDECP	Pulse execution type

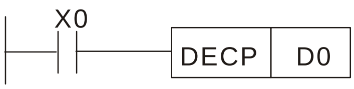
Flag signal: none

Explanation

- (D): Destination device.
- If a command is not the pulse execution type, adds 1 to the content of device (D) during each scanning cycle.
- Generally use this command as a pulse execution type command (DECP).
- During 16-bit operation, -32,768 -1 rolls over to 32,767. During 32-bit operation, -2,147,483,648 -1 rolls over to 2,147,483,647.

Example

- When X0 switches OFF to ON, it automatically subtracts 1 from the content of D0.



API					
30	D	ROR	P	(D) (n)	Right rotation

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*
n				*	*						

Notes on operand usage:
K4 (16-bit) is only valid if the operand D is designated as KnY or KnM.
n operand n=K1-K16 (16-bit)

16-bit command (5 STEP)

ROR	Continuous execution type	RORP	Pulse execution type

32-bit command (9 STEP)

DROR	Continuous execution type	DRORP	Pulse execution type

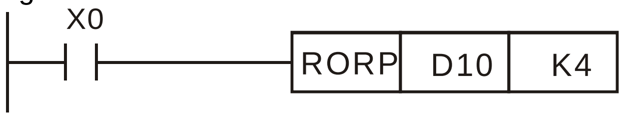
Flag signal: M1022 Carry flag

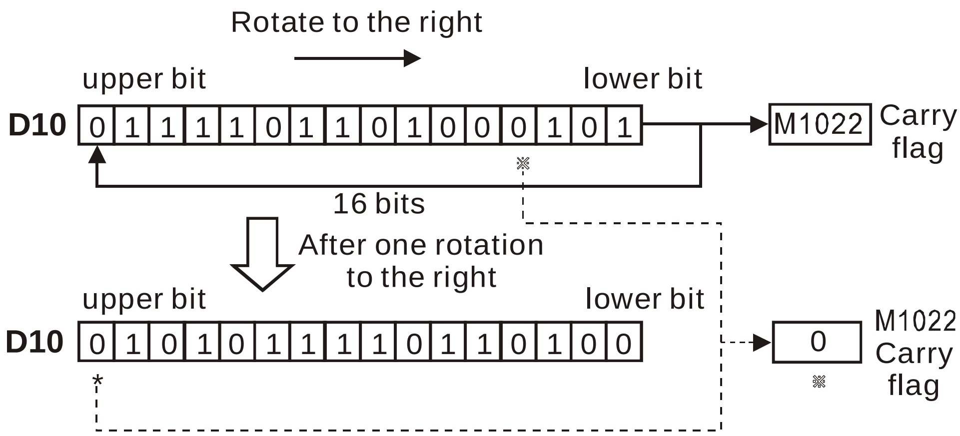
Explanation

- (D): Device to be rotated. (n): Number of bits for one rotation.
- Rotates the device designated by (D) to the right (n) bits.
- Generally use this command as a pulse execution type command (RORP).

Example

- When X0 switches OFF to ON, 4 of the 16 bits in D10 specify a right rotation; the content of the bit indicated with * (see diagram below) is sent to the carry flag signal M1022.





API				
31	D	**ROL**	P	(D) (n)	Left rotation

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D							*	*	*	*	*
n				*	*						

Notes on operand usage:
K4 (16-bit) is only valid if the operand D is designated as KnY or KnM.
n operand n=1 to 16 (16-bit)

16-bit command (5 STEP)

ROL	Continuous execution type	ROLP	Pulse execution type

32-bit command (9 STEP)

DROL	Continuous execution type	DROLP	Pulse execution type

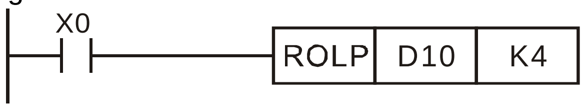
Flag signal: M1022 Carry flag

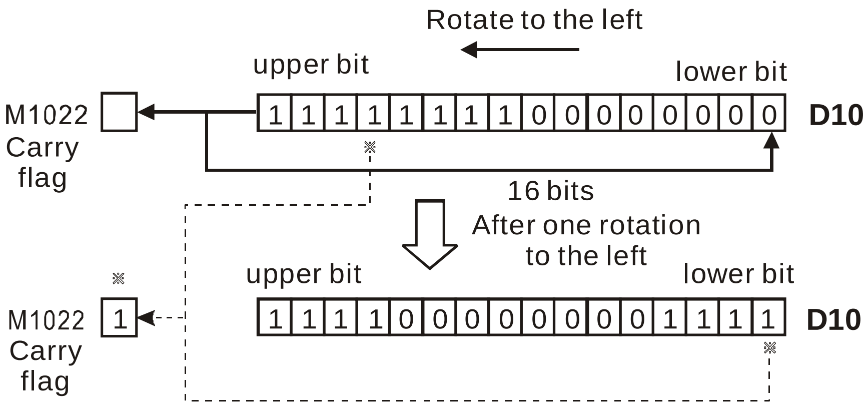
Explanation

- (D): Device to be rotated. (n): Number of bits for one rotation.
- Rotates the device designated by (D) to the left (n) bits.
- Generally use this command as a pulse execution type command (ROLP).

Example

- When X0 switches OFF to ON, 4 of the 16 bits in D10 specify a left rotation; the content of the bit indicated with * (see diagram below) is sent to the carry flag signal M1022.





API 40	ZRST	P	(D1) (D2)	Clear range

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
D1		*	*						*	*	*
D2		*	*						*	*	*

Notes on operand usage:
Number of operand D_1 operand ≤ number of operand D_2.
Operands D_1, D_2 must designate the same type of device. Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)			
ZRST	Continuous execution type	ZRSTP	Pulse execution type

32-bit command			
-	-	-	-

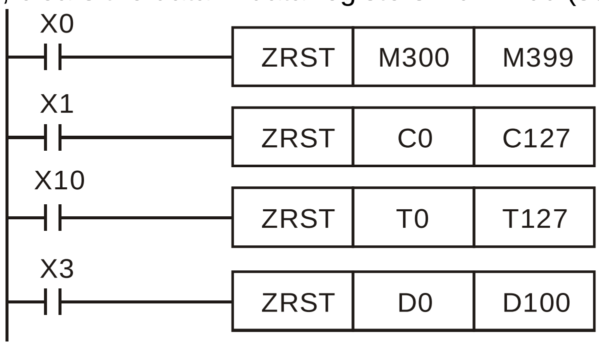
Flag signal: none

Explanation

- $\mathbf{D_1}$: Clear range's initial device. $\mathbf{D_2}$: Clear range's final device.
- When the number of operand D_1 > number of operand D_2, only the operand designated by D_2 is cleared.

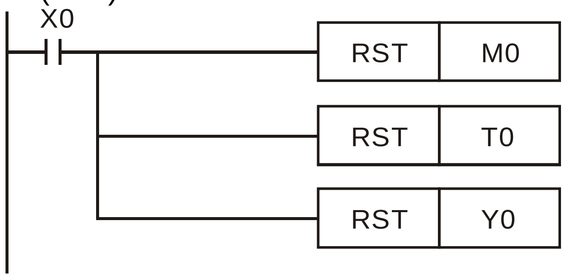
Example

- When X0 is ON, clears auxiliary relays M300–M399, changes them to OFF.
- When X1 is ON, 16-bit clears counters C0–C127 (writes 0, and clears and changes contact and coil to OFF).
- When X10 is ON, clears timer T0–T127 (writes 0, and clears and changes contact and coil to OFF).
- When X3 is ON, clears the data in data registers D0–D100 (sets to 0).



Remark

- Devices such as bit device Y, M and word device T, C, D can independently use the clear command (RST).



API					
49	D	**FLT**	P	(S) (D)	Convert BIN whole number to binary decimal

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S		*	*						*	*	*
D		*	*						*	*	*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage
The operand D occupies two consecutive points.

16-bit command

-	-	-	-

32-bit command (9 steps)

DFLT	Continuous execution type	DFLTP	Pulse execution type

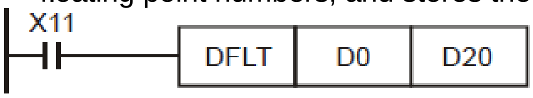
Flag signal: none

Explanation

- **S**: Source device. **D**: Result device.
- Converts a BIN whole number into a binary decimal value.

Example

- When X11 is ON, converts the whole number corresponding to D0 and D1 into floating point numbers, and stores the result in D20 and D21.



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API	D	ECMP	P	S1 S2 D	Compare binary floating point numbers
110					

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D				*	*						*

Notes on operand usage:
The operand D occupies three consecutive points. Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (13 STEP)

DECMP	Continuous execution type	DECMPP	Pulse execution type

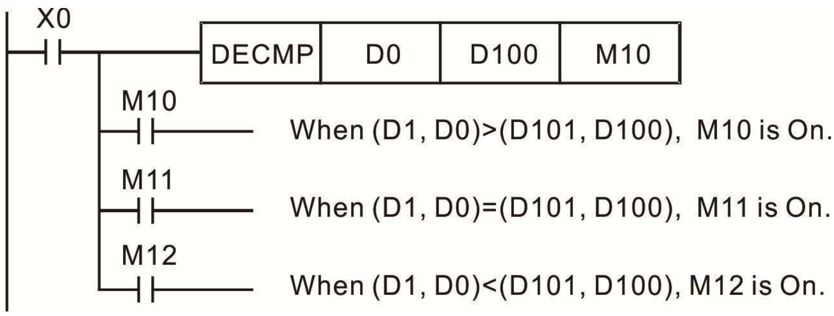
Flag signal: none

Explanation

- **S_1**: Binary floating point number 1. **S_2**: Binary floating point number 2. **D**: Results of comparison, occupies three consecutive points.
- Compares binary floating point number 1 with binary floating point number 2, and stores the result of comparison (>, =, <) in **D**.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command converts the constant to a binary floating point number for the purpose of comparison.

Example

- When the designated device is M10, it automatically occupies M10-M12.
- When X0=ON, the DECMP command executes, and one of M10–M12 is ON. When X0=OFF, the DECMP command does not execute, and M10–M12 remains in the X0=OFF state.
- For ≥, ≤, or ≠ comparison results, use series and parallel connections for M10–M12.
- Use the RST or ZRST command to clear the result.



API					
111	D	**EZCP**	P	S1 S2 S D	Compare binary floating point number range

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
S				*	*						*
D		*	*								

Notes on operand usage:
The operand D occupies three consecutive points.
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (17 STEP)

DEZCP	Continuous execution type	DEZCPP	Pulse execution type

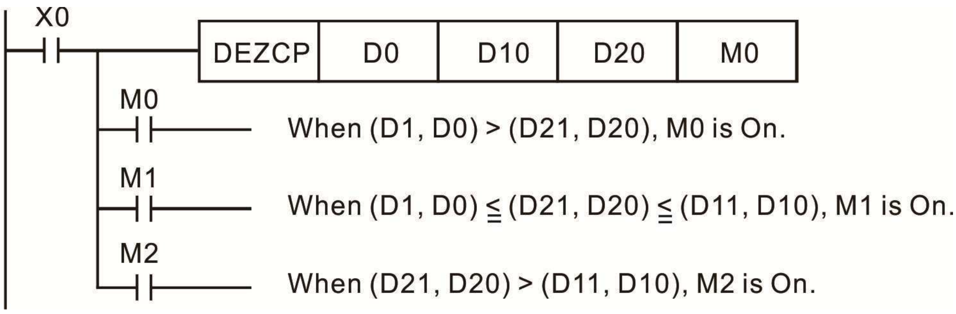
Flag signal: none

Explanation

- **S_1**: Lower limit of binary floating point number in range comparison. **S_2**: Upper limit for binary floating point number in range comparison. **S**: Comparison of binary floating point numerical values. **D**: Results of comparison, occupies three consecutive points.
- Compares binary floating point number **S** with the lower limit value **S_1** and the upper limit value **S_2**; stores the results of comparison in **D**.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command converts the constant to a binary floating point number for the purpose of comparison.
- When the lower limit **S_1** is greater than the upper limit **S_2**, the command uses **S_1** as the lower and upper limit.

Example

- When the designated device is M0, it automatically occupies M0–M2.
- When X0=ON, the DEZCP command executes, and one of M0–M2 is ON. When X0=OFF, the EZCP command does not execute, and M0–M2 remains in the X0=OFF state.
- Use the RST or ZRST command to clear the result.



API					
116	D	RAD	P	S D	Convert angle to diameter

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DRAD	Continuous execution type	DRADP	Pulse execution type

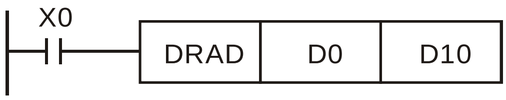
Flag signal: none

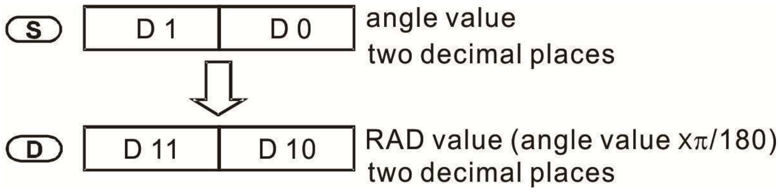
Explanation

- **S**: data source (angle). **D**: result of conversion (diameter).
- Uses the following formula to convert angles to radians.
  Diameter = Angle × (π/180)

Example

- When X0=ON, converts the angle of the designated binary floating point number (D1, D0) to radians and stores the result in (D11, D10); the result is a binary floating point number.





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API					
117	D	DEG	P	S D	Convert diameter to angle

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DDEG	Continuous execution type	DDEGP	Pulse execution type

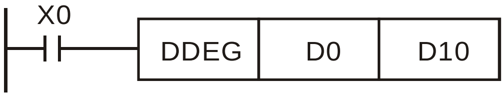
Flag signal: none

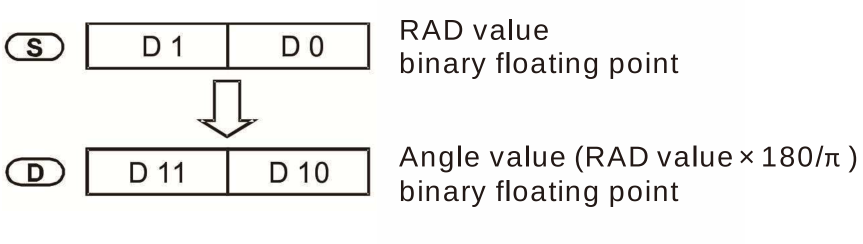
Explanation

- **S**: data source (diameter). **D**: results of conversion (angle).
- Uses the following formula to convert radians to an angle.
- Angle = Diameter × (180/π)

Example

- When X0=ON, angle of the designated binary floating point number (D1, D0) in radians is converted to an angle and stored in (D11, D10), with the content consisting of a binary floating point number.





API					
120	D	**EADD**	P	S1 S2 D	Add binary floating point numbers

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DEADD	Continuous execution type	DEADDP	Pulse execution type

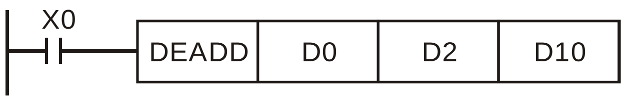
Flag signal: none

Explanation

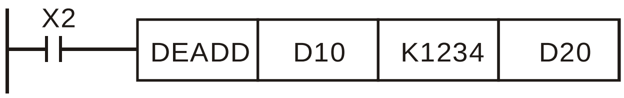
- S_1: addend. S_2: augend. **D**: sum.
- Adds the content of the register designated by S_2 to the content of the register designated by S_1, and stores the result in the register designated by **D**. Addition is performed entirely using binary floating point numbers.
- **If the source operand** S_1 or S_2 designates a constant K or H, the command converts that constant into a binary floating point number for use in addition.
- **In the situation when** S_1 and S_2 designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is ON, the register performs addition once during each scan. You generally use Pulse execution type commands (DEADDP) under ordinary circumstances.

Example

- When X0=ON, adds a binary floating point number (D1, D0) to a binary floating point number (D3, D2), and stores the results in (D11, D10).



- When X2 =ON, adds a binary floating point number (D11, D10) to K1234 (which is automatically converted to a binary floating point number), and stores the results in (D21, D20).



API					
121	D	ESUB	P	S1 S2 D	Subtract binary floating point numbers

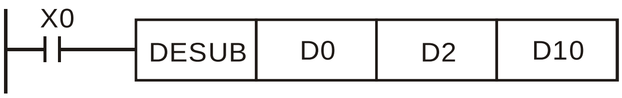
	bit device			Word device								16-bit command			
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	-	-	-	-
S1				*	*						*				
S2				*	*						*	32-bit command (13 STEP)			
D											*	DESUB	Continuous execution type	DESUBP	Pulse execution type
Notes on operand usage: Refer to the function specifications table for each device in series for the scope of device usage.												Flag signal: none			

Explanation

- **S_1**: minuend. **S_2**: subtrahend. **D**: difference.
- Subtracts the content of the register designated by **S_2** from the content of the register designated by **S_1**, and stores the difference in the register designated by **D**; subtraction is performed entirely using binary floating point numbers.
- **If the source operand S_1** or **S_2** designates a constant K or H, the command converts that constant into a binary floating point number for use in subtraction.
- **In the situation when S_1** and **S_2** designate identical register numbers, if a "continuous execution" command is employed, when conditional contact is ON, the register performs subtraction once during each scan. You generally use pulse execution type commands (DESUBP) under ordinary circumstances.

Example

- When X0=ON, subtracts a binary floating point number (D1, D0) from a binary floating point number (D3, D2), and stores the results in (D11, D10).



- When X2 =ON, subtracts the binary floating point number (D1, D0) from K1234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).

API 122	D	EMUL	P	(S1) (S2) (D)	Multiply binary floating point numbers

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command			
-	-	-	-
32-bit command (13 STEP)			
DEMUL	Continuous execution type	DEMULP	Pulse execution type

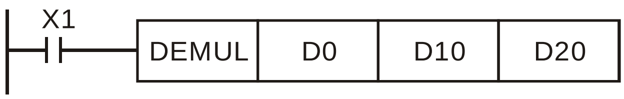
Flag signal: none

Explanation

- S_1: multiplicand. S_2: multiplier. **D**: product.
- Multiplies the content of the register designated by S_1 by the content of the register designated by S_2, and stores the product in the register designated by **D**; multiplication is performed entirely using binary floating point numbers.
- **If the source operand S_1** or S_2 designates a constant K or H, the command converts that constant into a binary floating point number for use in multiplication.
- **In the situation when S_1** and S_2 designate identical register numbers, if you employ a "continuous execution" command, when conditional contact is ON, the register performs multiplication once during each scan. You generally use pulse execution type commands (DEMULP) under ordinary circumstances.

Example

- When X1=ON, multiplies the binary floating point number (D1, D0) by the binary floating point number (D11, D10), and stores the product in the register designated by (D21, D20).



- When X2 =ON, multiplies the binary floating point number (D1, D0) by K1234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).

API					
123	D	**EDIV**	P	S1 S2 D	Divide binary floating point numbers

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (13 STEP)

DEDIV	Continuous execution type	DEDIVP	Pulse execution type

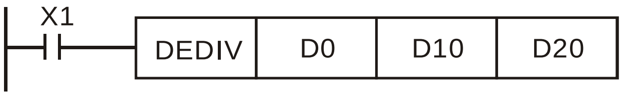
Flag signal: none

Explanation

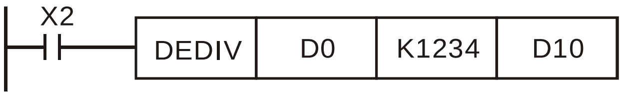
- S_1: dividend. S_2: divisor. **D**: quotient.
- Divides the content of the register designated by S_1 by the content of the register designated by S_2 and stores the quotient in the register designated by **D**; division is performed entirely using binary floating point numbers.
- **If the source operand** S_1 or S_2 designates a constant K or H, the command converts that constant into a binary floating point number for use in division.

Example

- When X1=ON, divides the binary floating point number (D1, D0) by the binary floating point number (D11, D10), and stores the quotient in the register designated by (D21, D20).



- When X2 =ON, divides the binary floating point number (D1, D0) by K1,234 (which is automatically converted to a binary floating point number), and stores the results in (D11, D10).



API 124	D	EXP	P	S D	Find the exponent of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DEXP	Continuous execution type	DEXPP	Pulse execution type

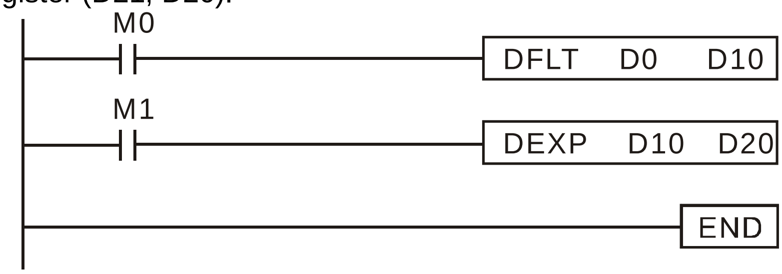
Flag signal: none

Explanation

- **S**: operation source device. **D**: operation results device.
- Taking e =2.71828 as a base, **S** is the exponent in the EXP operation.
- [**D** +1, **D**]=EXP[**S +1, S**]
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. Performs the operation using floating point numbers, and converts **S** to a floating point number.
- Content of operand **D** =e^{S} ; e=2.71828, **S** is the designated source data.

Example

- When M0 is ON, converts the value of (D1, D0) to a binary floating point number, and stores the result in register (D11, D10).
- When M1 is ON, performs the EXP operation on the exponent of (D11, D10), converts the result to a binary floating point number and stores it in register (D21, D20).



API					
125	D	LN	P	S D	Find the natural logarithm of a binary floating point

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DLN	Continuous execution type	DLNP	Pulse execution type

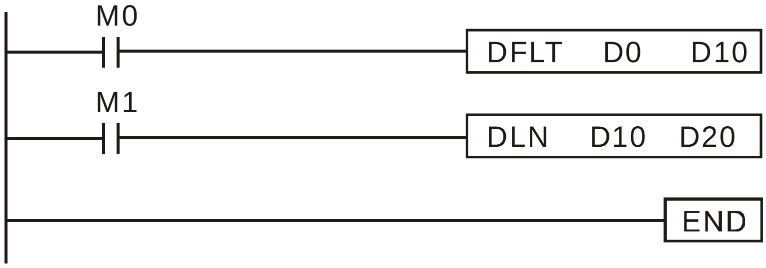
Flag signal: none

Explanation

- **S**: operation source device. **D**: operation results device.
- Taking e =2.71828 as a base, **S** is the exponent in the EXP operation.
- [**D** +1, **D**]=EXP[**S +1, S**]
- Valid regardless of whether the content of **S** has a positive or negative value. The designated register D must have a 32-bit data format. Performs the operation using floating point numbers and converts **S** to a floating point number.
- Content of operand **D** $=e^{S}$; e=2.71828， **S** is the designated source data

Example

- When M0 is ON, converts the value of (D1, D0) to a binary floating point number, and stores the result in register (D11, D10).
- When M1 is ON, performs the EXP operation on the exponent of (D11, D10); converts the result to a binary floating point number stores it in register (D21, D20).



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API					
127	D	ESQR	P	(S) (D)	Find the square root of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DESQR	Continuous execution type	DESQRP	Pulse execution type

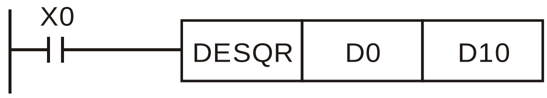
Flag signal: none

Explanation

- **S**: source device for which square root is desired **D**: result of finding square root.
- Finds the square root of the content of the register designated by **S**, stores the result in the register designated by **D**. Square roots are performed entirely using binary floating point numbers.
- If the source operand **S** refers to a constant K or H, the command converts that constant into a binary floating point number for use in the operation.

Example

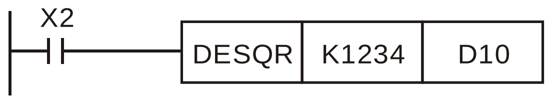
- When X0=ON, finds the square root of the binary floating point number (D1, D0), and stores the result in the register designated by (D11, D10).



$$\sqrt{(D1, D0)} \rightarrow (D11, D10)$$

Binary floating point → Binary floating point

- When X2 =ON, finds the square root of K1,234 (which has been automatically converted to a binary floating point number), and stores the results in (D11, D10).



API				S D	Convert binary floating point number to BIN whole number
129	D	INT	P		

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S											*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command			
-	-	-	-
32-bit command (9 STEP)			
DINT	Continuous execution type	DINTP	Pulse execution type

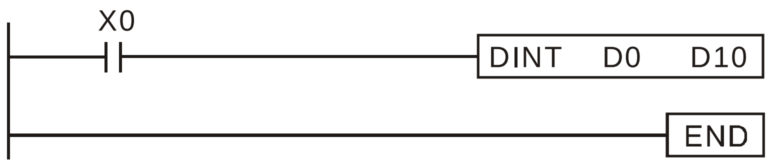
Flag signal: none

Explanation

- **S**: the source device to be converted. **D**: results of conversion.
- Converts the content of the register designated by **S** from a binary floating point number format to a BIN whole number, and stores the results in **D**. The BIN whole number floating point number is discarded.
- The action of this command is the opposite of that of command API 49 (FLT).

Example

- When X0=ON, converts the binary floating point number (D1, D0) into a BIN whole number, and stores the result in (D10); the BIN whole number floating point number is discarded.



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API					
130	D	SIN	P	S D	Find the sine of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command			
-	-	-	-

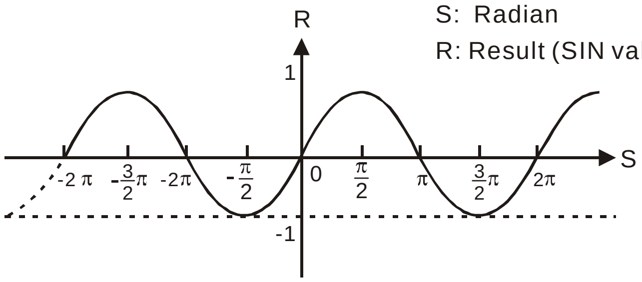
32-bit command (9 STEP)			
DSIN	Continuous execution type	DSINP	Pulse execution type

Flag signal: none

Explanation

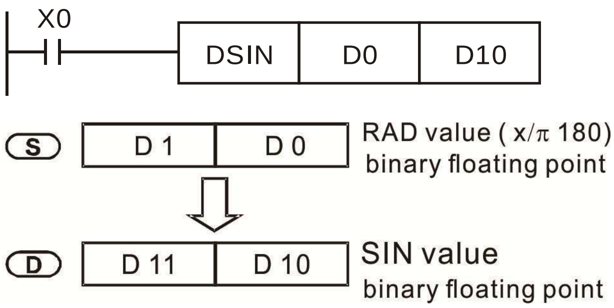
- **S**: the designated source value. **D**: the SIN value result.
- **S** is the designated source in radians.
- The value in radians (RAD) is equal to (angle × π/180).
- Finds the SIN from the source value designated by **S** and stores the result in **D**.

The following figure displays the relationship between the arc and SIN results:



Example

- When X0=ON, finds the SIN value of the designated binary floating point number (D1, D0) in radians (RAD) and stores the result in (D11, D10) as a binary floating point number.



API					
131	D	COS	P	S D	Find the cosine of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

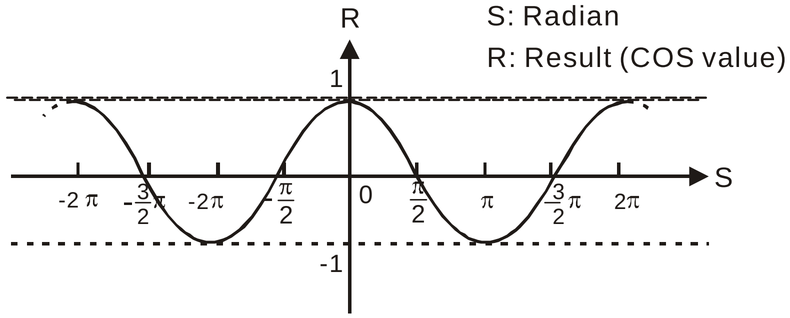
DCOS	Continuous execution type	DCOSP	Pulse execution type

Flag signal: none

Explanation

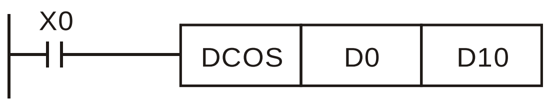
- **S**: the designated source value. **D**: the COS value result.
- Finds the COS of the source value designated by **S** and stores it in **D**.

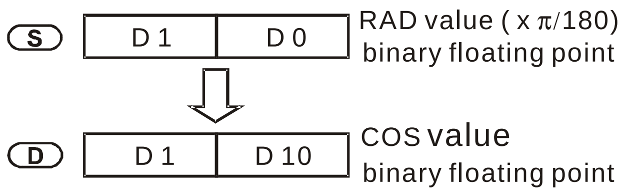
The following figure displays the relationship between the arc and COS results:



Example

- When X0=ON, finds the COS value of the designated binary floating point number (D1, D0) in radians and stores the result in (D11, D10), as a binary floating point number.





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API					
132	D	**TAN**	P	(S) (D)	Find the tangent of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

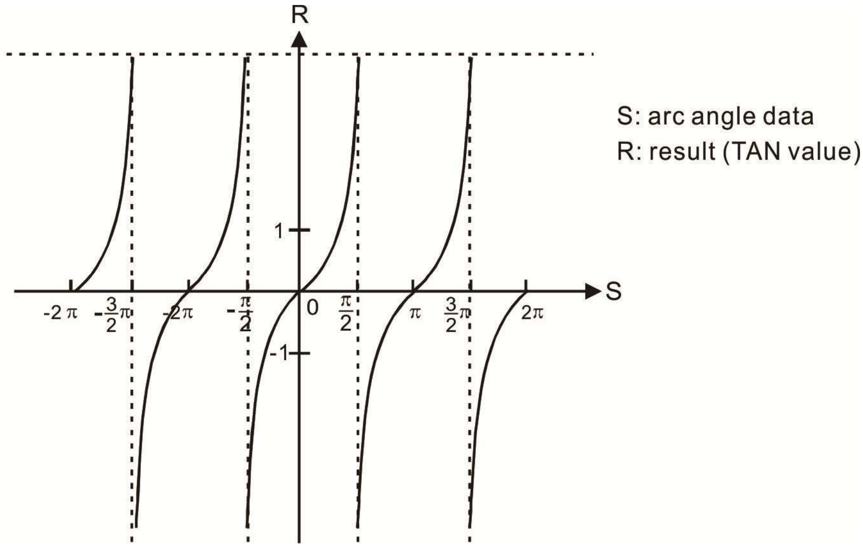
DTAN	Continuous execution type	DTANP	Pulse execution type

Flag signal: none

Explanation

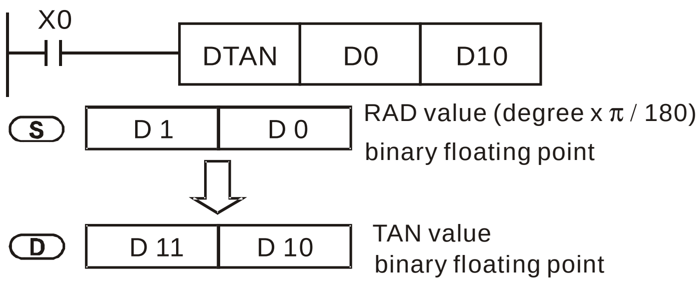
- **S**: the designated source value. **D**: the TAN value result.
- Finds the TAN of the source value designated by **S** and stores it in **D**.

The following figure displays the relationship between the arc and TAN results:



Example

- When X0=ON, finds the TAN value of the designated binary floating point number (D1, D0) in radians (RAD) and stores it in (D11, D10), as a binary floating point number.



API 133	D	ASIN	P	S D	Find the arcsine of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

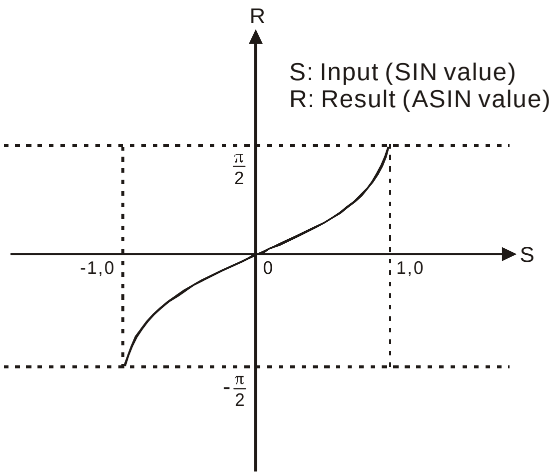
DASIN	Continuous execution type	DASINP	Pulse execution type

Flag signal: none

Explanation

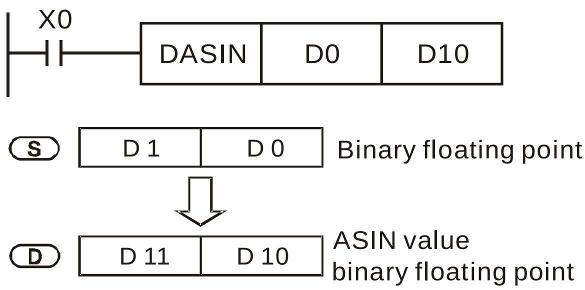
- **S**: the designated source (binary floating point number). **D**: the ASIN value result.
- ASIN value $=\sin^{-1}$

The figure below shows the relationship between input data and result:



Example

- When X0=ON, finds the ASIN value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



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API				
134	**D** **ACOS** **P**	(S) (D)	Find the arccosine of a binary floating point number	

	bit device X	Y	M	Word device K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

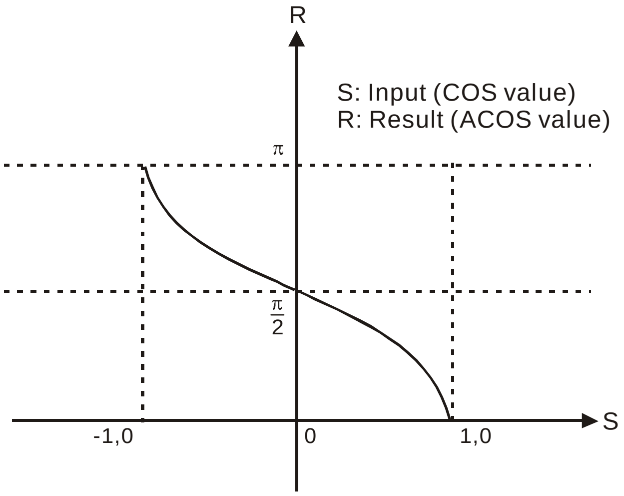
DACOS	Continuous execution type	DACOS P	Pulse execution type

Flag signal: none

Explanation

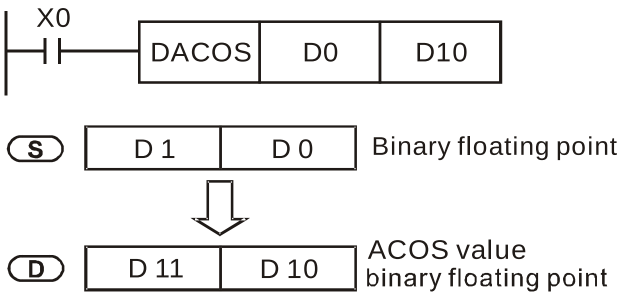
- **S**: the designated source (binary floating point number). **D**: the ACOS value result.
- ACOS value $=\cos^{-1}$

The figure below shows the relationship between input data and result:



Example

- When X0=ON, finds the ACOS value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



API					
135	D	ATAN	P	S D	Find the arctangent of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

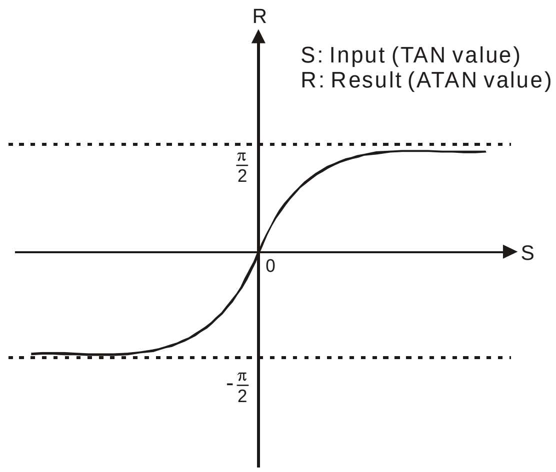
DATAN	Continuous execution type	DATANP	Pulse execution type

Flag signal: none

Explanation

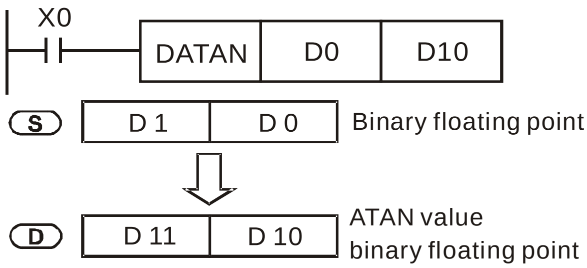
- **S**: the designated source (binary floating point number). **D**: the ATAN value result.
- ATAN value $=\tan^{-1}$

The figure below shows the relationship between input data and result:



Example

- When X0=ON, finds the ATAN value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



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API 136	D	SINH	P	(S) (D)	Find the hyperbolic sine of at binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DSINH	Continuous execution type	DSINHP	Pulse execution type

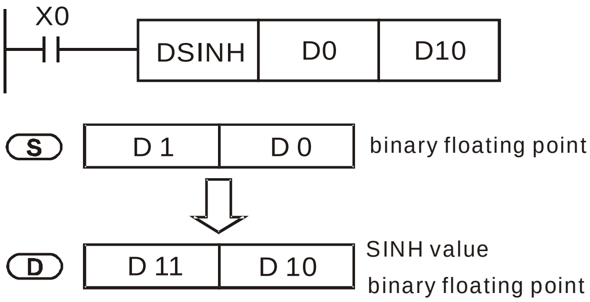
Flag signal: none

Explanation

- **S**: the designated source (binary floating point number). **D**: the SINH value result.
- SINH value =$(e^{s}-e^{-s})/2$

Example

- When X0=ON, finds the SINH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.



API					
137	D	COSH	P	(S) (D)	Find the hyperbolic cosine of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DCOSH	Continuous execution type	DCOSHP	Pulse execution type

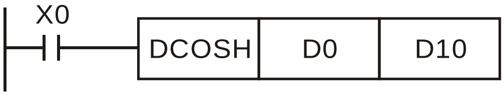
Flag signal: none

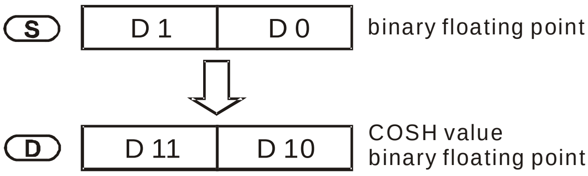
Explanation

- **S**: the designated source (binary floating point number). **D**: the COSH value result.
- COSH value $=(e^{s}+e^{-s})/2$

Example

- When X0=ON, finds the COSH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.





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API					
138	D	**TANH**	P	(S) (D)	Finds the hyperbolic tangent of a binary floating point number

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*						*
D											*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

DTANH	Continuous execution type	DTANHP	Pulse execution type

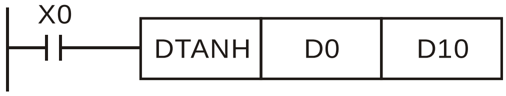
Flag signal: none

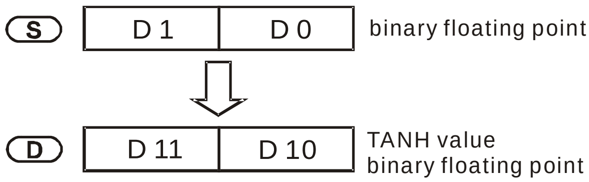
Explanation

- **S**: the designated source (binary floating point number). **D**: the TANH value result.
- TANH value $=(e^{S}-e^{-S})/(e^{S}+e^{-S})$

Example

- When X0=ON, finds the TANH value of the designated binary floating point number (D1, D0) and stores the result in (D11, D10), as a binary floating point number.





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API		Mnemonic		Operands	Function
170	**D**	**GRY**	**P**	(S) (D)	Convert BIN to GRAY code

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

GRY	Continuous execution type	GRYP	Pulse execution type

32-bit command (9 STEP)

DGRY	Continuous execution type	DGRYP	Pulse execution type

Flag signal: none

Explanation

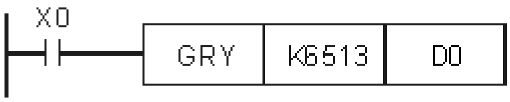
- **S**: source device. **D**: device storing GRAY code.
- Converts the BIN value of the device designated by **S** to a GRAY code, and stores the result in the device designated by **D**.
- The valid range for **S** is as shown below; if you exceed this range, it is an error, and the command does not execute.

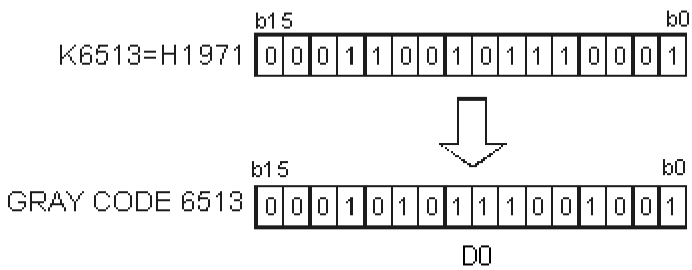
16-bit command: 0–32,767

32-bit command: 0–2,147,483,647

Example

- When X0=ON, converts the constant K6513 to a GRAY code and stores it in D0.





API					
171	D	**GBIN**	P	S D	Convert GRAY code to BIN

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S				*	*	*	*	*	*	*	*
D							*	*	*	*	*

Notes on operand usage:
Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

GBIN	Continuous execution type	GBINP	Pulse execution type

32-bit command (9 STEP)

DGBIN	Continuous execution type	DGBINP	Pulse execution type

Flag signal: none

Explanation

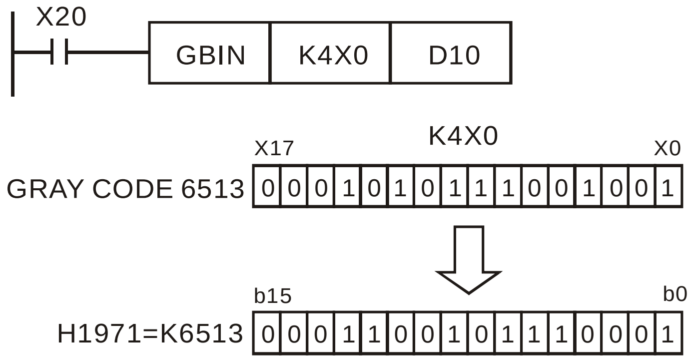
- **S**: source device storing GRAY code. **D**: device storing BIN value after conversion.
- Converts the GRAY code corresponding to the value of the device designated by **S** that is converted into a BIN value, and stores it in the device designated by **D**.
- This command converts the value of the absolute position encoder connected with the PLC's input (this encoder usually has an output value in the form of GRAY code) into a BIN value, and stores it in the designated register.
- The valid range of **S** is as shown below; if you exceed this range, it is an error, and the command does not execute.

16-bit command: 0–32,767

32-bit command: 0–2,147,483,647

Example

- When X20=ON, converts the GRAY code of the absolute position encoder connected with input points X0–X17 to a BIN value and stores it in D10.



API 215–217	D	LD#	S1 S2	Contact form logical operation LD#

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: **#** , : , &, |, ^

Refer to the function specifications table for each device in series for the range of device usage.

16-bit command (5 STEP)

LD#	Continuous execution type	-	-

32-bit command (9 STEP)

DLD#	Continuous execution type	-	-

Flag signal: none

Explanation

- $\mathbf{S_1}$: data source device 1. $\mathbf{S_2}$: data source device 2.
- This command compares the contents of $\mathbf{S_1}$ and $\mathbf{S_2}$. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- You can use the LD# command directly to connect with the busbar

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
215	LD&	**D**LD&	$\mathbf{S_1}$	&	$\mathbf{S_2}$	≠ 0	$\mathbf{S_1}$	&	$\mathbf{S_2}$	＝0
216	LD|	**D**LD|	$\mathbf{S_1}$	|	$\mathbf{S_2}$	≠ 0	$\mathbf{S_1}$	|	$\mathbf{S_2}$	＝0
217	LD^	**D**LD^	$\mathbf{S_1}$	^	$\mathbf{S_2}$	≠ 0	$\mathbf{S_1}$	^	$\mathbf{S_2}$	＝0

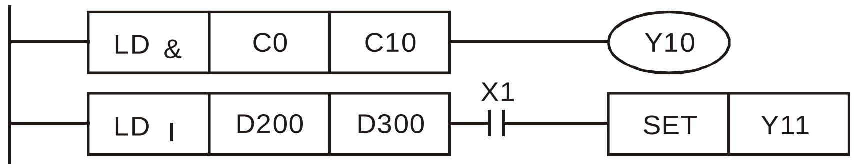
&: logical AND operation.

|: logical OR operation.

^: logical XOR operation.

Example

- When you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y10=ON.
- When you compare the content of D200 and D300 with the logical OR operation, and the result is not equal to 0, and X1=ON, then Y11=ON and remains in that state.



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API				
218–220	D	**AND#**	(S1) (S2)	Contact form logical operation AND#

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage:: #, : , &, |, ^

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)			
AND#	Continuous execution type	-	-

32-bit command (9 STEP)			
DAND#	Continuous execution type	-	-

Flag signal: none

Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the contents of **S_1** and **S_2**. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- The AND# command is an operation command in series with the contact.

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
218	AND&	DAND&	**S_1**	&	**S_2**	≠0	**S_1**	&	**S_2**	=0
219	AND|	DAND|	**S_1**	|	**S_2**	≠0	**S_1**	|	**S_2**	=0
220	AND^	DAND^	**S_1**	^	**S_2**	≠0	**S_1**	^	**S_2**	=0

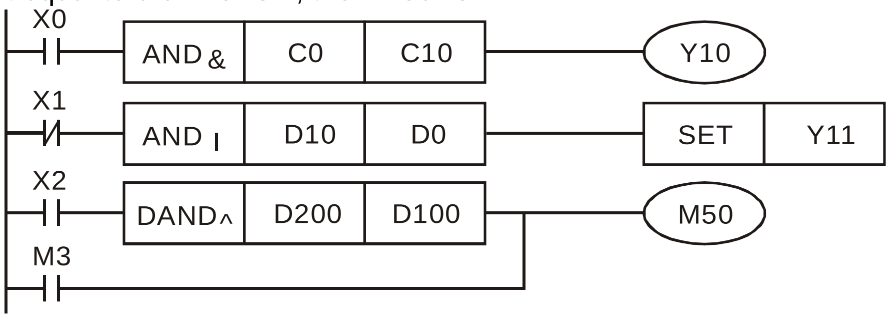
&: logical AND operation.

|: logical OR operation.

^: logical XOR operation.

Example

- When X0=ON and you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y10=ON.
- When X1=OFF and you compare the contents D10 and D0 with the logical OR operation, and the result is not equal to 0, then Y11=ON and remains in that state.
- When X2 =ON and you compare the contents of the 32-bit register D200 (D201) and the 32-bit register D100 (D101) with the logical XOR operation, and the result is not equal to 0 or M3=ON, then M50=ON.



API 221–223	D	OR#		S1 S2	Contact form logical operation OR#

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: #, : , &, |, ^

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

OR#	Continuous execution type	-	-

32-bit command (9 STEP)

DOR#	Continuous execution type	-	-

Flag signal: none

Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the contents of **S_1** and **S_2**. When the result of comparison is not 0, this command activates; when the result of comparison is 0, this command does not activate.
- The OR# command is an operation command in series with the contact.

API No.	16-bit commands	32-bit commands	Conditions for activation				Conditions for inactivation			
221	OR&	**D**OR&	**S_1**	&	**S_2**	≠ 0	**S_1**	&	**S_2**	= 0
222	OR|	**D**OR|	**S_1**	|	**S_2**	≠ 0	**S_1**	|	**S_2**	= 0
223	OR^	**D**OR^	**S_1**	^	**S_2**	≠ 0	**S_1**	^	**S_2**	= 0

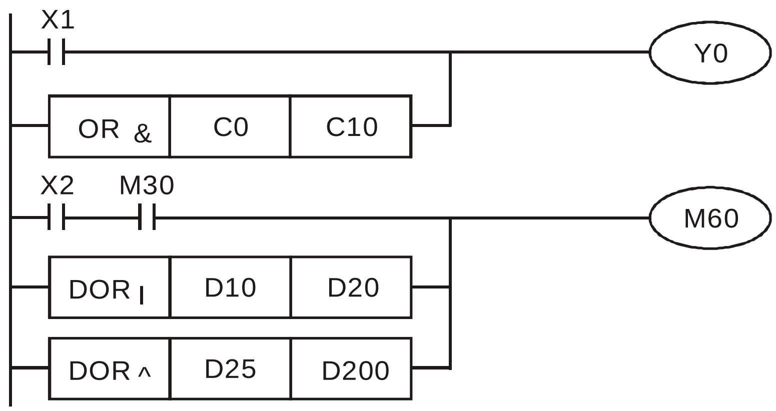
&: logical AND operation.

|: logical OR operation.

^: logical XOR operation.

Example

- When X1=ON or you compare the contents of C0 and C10 with the logical AND operation, and the result is not equal to 0, then Y0=ON.
- When X2 and M30 are both equal to ON, or you compare the contents of the 32-bit register D10 (D11) and the 32-bit register D20 (D21) with the logical OR operation, and the result is not equal to 0, or you compare the contents of the 32-bit counter C235 and the 32-bit register D200 (D201) with the logical XOR operation, and the result is not equal to 0, then M60=ON.



API 224–230	D	LD※	S1 S2	Contact form compare LD*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※,: , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

LD※	Continuous execution type	-	-

32-bit command (9 STEP)

DLD※	Continuous execution type	-	-

Flag signal: none

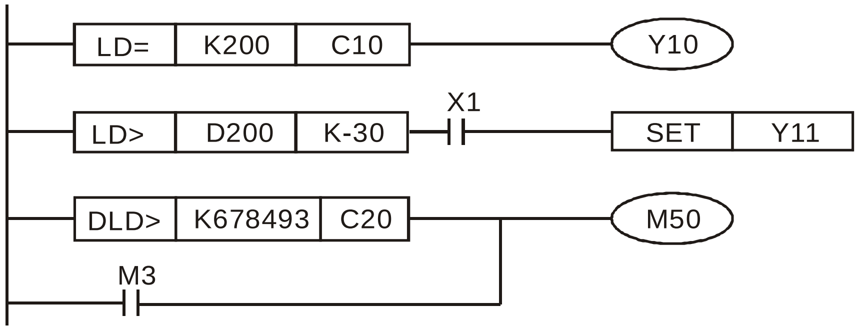
Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the contents of **S_1** and **S_2**. Taking API 224 (LD=) as an example, this command activates when the result of comparison is "equal," and does not activate when the result is "unequal."
- You can use the LD* directly to connect with the busbar

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
224	LD =	**D**LD =	$S_1 = S_2$	$S_1 \neq S_2$
225	LD >	**D**LD >	$S_1 > S_2$	$S_1 \leq S_2$
226	LD <	**D**LD <	$S_1 < S_2$	$S_1 \geq S_2$
228	LD < >	**D**LD < >	$S_1 \neq S_2$	$S_1 = S_2$
229	LD < =	**D**LD < =	$S_1 \leq S_2$	$S_1 > S_2$
230	LD > =	**D**LD > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When the content of C10 is equal to K200, then Y10=ON.
- When the content of D200 is greater than K-30, and X1=ON, then Y11=ON and remains in that state.



API				
232–238	D	AND※	(S1) (S2)	Contact form compare AND*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※,: , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

AND※	Continuous execution type	-	-

32-bit command (9 STEP)

DAND※	Continuous execution type	-	-

Flag signal: none

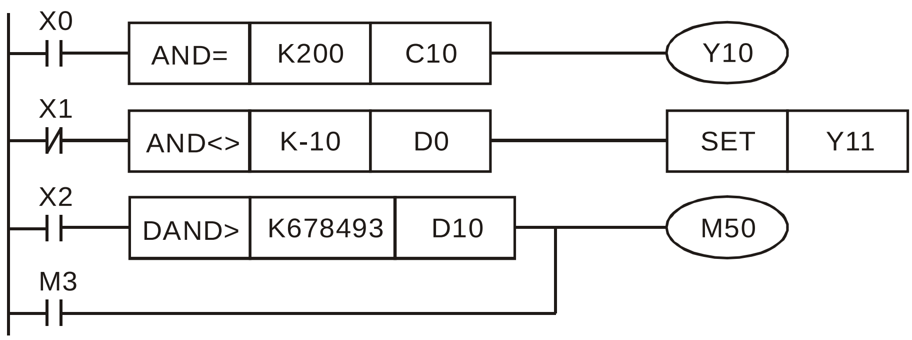
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the contents of S_1 and S_2. Taking API 232 (AND=) as an example, when the result of comparison is “equal”, this command activates; when the result of comparison is “unequal”, this command does not activate.
- The AND* command is a comparison command in series with a contact.

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
232	AND =	DAND =	$S_1 = S_2$	$S_1 \neq S_2$
233	AND >	DAND >	$S_1 > S_2$	$S_1 \leq S_2$
234	AND <	DAND <	$S_1 < S_2$	$S_1 \geq S_2$
236	AND < >	DAND < >	$S_1 \neq S_2$	$S_1 = S_2$
237	AND < =	DAND < =	$S_1 \leq S_2$	$S_1 > S_2$
238	AND > =	DAND > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When X0=ON and the current value of C10 is also equal to K200, then Y10=ON.
- When X1=OFF and the content of register D0 is not equal to K-10, then Y11=ON and remains in that state.
- When X2 =ON and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=ON, then M50=ON.



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API 240–246	D	OR※		(S1) (S2)	Contact form compare OR*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*	*	*	*	*	*	*
S2				*	*	*	*	*	*	*	*

Notes on operand usage: ※,: , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command (5 STEP)

OR※	Continuous execution type	-	-

32-bit command (9 STEP)

DOR※	Continuous execution type	-	-

Flag signal: none

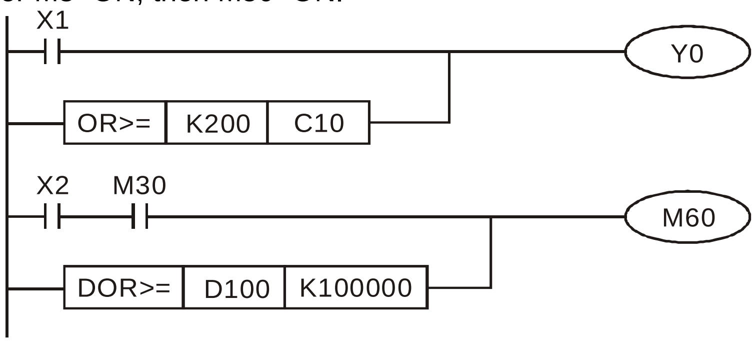
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the contents of S_1 and S_2. Taking API 240 (OR=) as an example, when the result of comparison is "equal", this command activates; when the result of comparison is "unequal", this command does not activate.
- The OR* command is a comparison command in parallel with a contact.

API No.	16-bit commands	32-bit commands	Conditions for activation	Conditions for inactivation
240	OR =	**D**OR =	$S_1 = S_2$	$S_1 \neq S_2$
241	OR >	**D**OR >	$S_1 > S_2$	$S_1 \leq S_2$
242	OR <	**D**OR <	$S_1 < S_2$	$S_1 \geq S_2$
244	OR < >	**D**OR < >	$S_1 \neq S_2$	$S_1 = S_2$
245	OR < =	**D**OR < =	$S_1 \leq S_2$	$S_1 > S_2$
246	OR > =	**D**OR > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When X0=ON and the current value of C10 is also equal to K200, then Y10=ON.
- When X1=OFF and the content of register D0 is not equal to K-10, then Y11=ON and remains in that state.
- When X2 =ON and the content of the 32-bit register D0 (D11) is less than 678,493, or M3=ON, then M50=ON.



API		
API 275–280	**FLD※** (S1) (S2)	Floating point number contact form compare LD*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*

Notes on operand usage: ※,: , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

FLD※	Continuous execution type	-	-

Flag signal: none

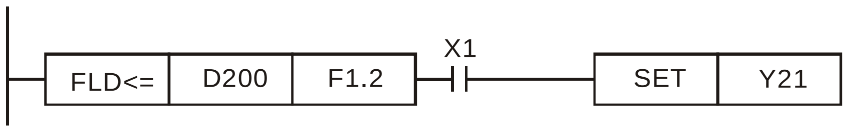
Explanation

- **S_1**: data source device 1. **S_2**: data source device 2.
- This command compares the contents of **S_1** and **S_2**. Taking "FLD=" as an example, if the result of comparison is “equal”, this command activates; but it does not activate when the result is “unequal”.
- The FLD* command can directly input floating point numbers (for instance: F1.2) to the **S_1**, **S_2** operands, or store floating point numbers in register D for use in operations.
- You can use this command while directly to connect with the busbar

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
275	FLD =	$S_1 = S_2$	$S_1 \neq S_2$
276	FLD >	$S_1 > S_2$	$S_1 \leq S_2$
277	FLD <	$S_1 < S_2$	$S_1 \geq S_2$
278	FLD < >	$S_1 \neq S_2$	$S_1 = S_2$
279	FLD < =	$S_1 \leq S_2$	$S_1 > S_2$
280	FLD > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When the floating point number in register D200 (D201) is less than or equal to F1.2, and X1 is activated, then contact Y21 activates and remains in that state.



API			
281–286	FAND※	S1 S2	Floating point number contact form compare AND*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

FAND※	Continuous execution type	-	-

Flag signal: none

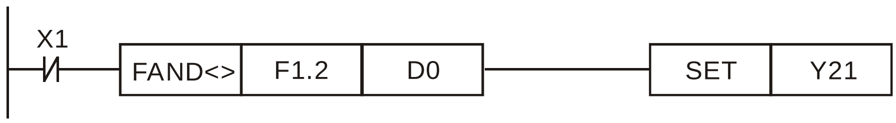
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the contents of S_1 and S_2. Taking "FAND=" as an example, if the result of comparison is “equal”, this command activates; but it does not activate when the result is “unequal”.
- The FAND* command can directly input floating point numbers (for instance: F1.2) to the S_1 and S_2 operands, or store the floating point numbers in register D for use in operations.
- You can use this command directly to connect with the busbar.

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
281	FAND =	$S_1 = S_2$	$S_1 \neq S_2$
282	FAND >	$S_1 > S_2$	$S_1 \leq S_2$
283	FAND <	$S_1 < S_2$	$S_1 \geq S_2$
284	FAND < >	$S_1 \neq S_2$	$S_1 = S_2$
285	FAND < =	$S_1 \leq S_2$	$S_1 > S_2$
286	FAND > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When X1=OFF, and the floating point number in register D100 (D101) is not equal to F1.2, then Y21=ON and remains in that state.



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API			
287–292	**FOR※**	S1 S2	Floating point number contact form compare OR*

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1									*	*	*
S2									*	*	*

Notes on operand usage: ※, : , =, >, <, <>, ≤, ≥

Refer to the function specifications table for each device in series for the scope of device usage.

16-bit command

-	-	-	-

32-bit command (9 STEP)

FOR※	Continuous execution type	-	-

Flag signal: none

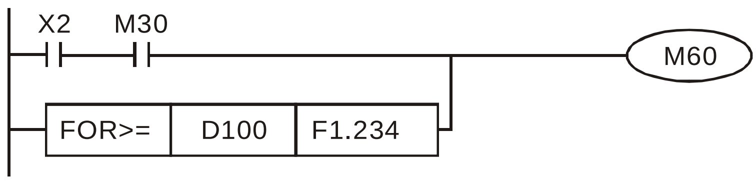
Explanation

- S_1: data source device 1. S_2: data source device 2.
- This command compares the contents of S_1 and S_2. Taking "FOR=" as an example, if the result of comparison is “equal”, this command activates; but it does not activate when the result is “unequal”.
- The FOR* command can directly input floating point numbers (for instance: F1.2) to the S_1, S_2 operands, or store floating point numbers in register D for use in operations.
- You can use this command directly to connect with the busbar.

API No.	32-bit commands	Conditions for activation	Conditions for inactivation
287	FOR =	$S_1 = S_2$	$S_1 \neq S_2$
288	FOR >	$S_1 > S_2$	$S_1 \leq S_2$
289	FOR <	$S_1 < S_2$	$S_1 \geq S_2$
290	FOR < >	$S_1 \neq S_2$	$S_1 = S_2$
291	FOR < =	$S_1 \leq S_2$	$S_1 > S_2$
292	FOR > =	$S_1 \geq S_2$	$S_1 < S_2$

Example

- When X2 and M30 are both equal to ON, or the floating point number in register D100 (D101) is greater than or equal to F1.234, then M60=ON.



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16-6-5 Detailed explanation of drive special application commands

API		Mnemonic		Operands	Function
139		**RPR**	**P**	(S1) (S2)	Read servo parameter

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2											*

Notes on operand usage: none

16-bit command (5 STEP)			
RPR	Continuous execution type	RPRP	Pulse execution type

32-bit command			
-	-	-	-

Flag signal: none

Explanation
- (S1): Parameter address of data to be read. (S2): Register where data that is read is stored.

API		Mnemonic		Operands	Function
140		**WPR**	**P**	(S1) (S2)	Write servo parameter

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*

Notes on operand usage: none

16-bit command (5 STEP)			
WPR	Continuous execution type	WPRP	Pulse execution type

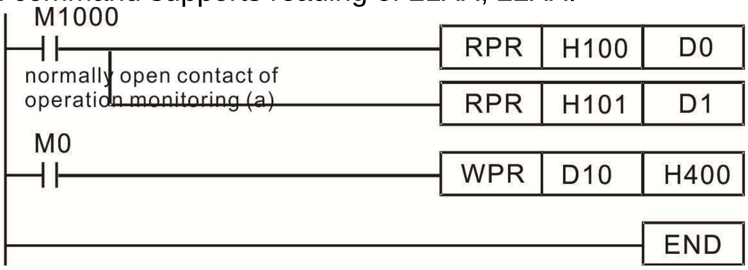
32-bit command			
-	-	-	-

Flag signal: M1016 parameter read/write error, M1017 parameter written successfully.

Explanation

Example

- (S1): Data to write to specified page. (S2): Parameter address of data to be written.
- When the data in the MS3 drive's parameter H01.00 is read and written to D0, data from H01.01 is read and written to D1.
- When M0=ON, the content of D10 is written to the MS3 drive Pr.04.00 (first speed of multiple speed levels).
- When M1017=ON, the parameter has been written successfully.
- The MS3's WPR command does not support writing to the 20XX address, but the RPR command supports reading of 21XX, 22XX.



Recommendation Be cautious when using the WPR command. When writing parameters, most parameters are recorded when they are written, and these parameters may only be revised 10^6 times: a memory write error may occur if parameters are written more than (MS)10^6 or (MH)10^9 times.

The number of times a parameter is written is based on whether the written value is modified. For instance, writing the same value 100 times at the same time counts as writing only once.

API				
141	**FPID**	**P**	(S1) (S2) (S3) (S4)	Drive PID control mode

	bit device			Word device								16-bit command (9 STEP)			
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D	FPID	Continuous execution type	FPIDP	Pulse execution type
S1				*	*						*	32-bit command			
S2				*	*						*	-	-	-	-
S3				*	*						*	Flag signal: none			
S4				*	*						*				

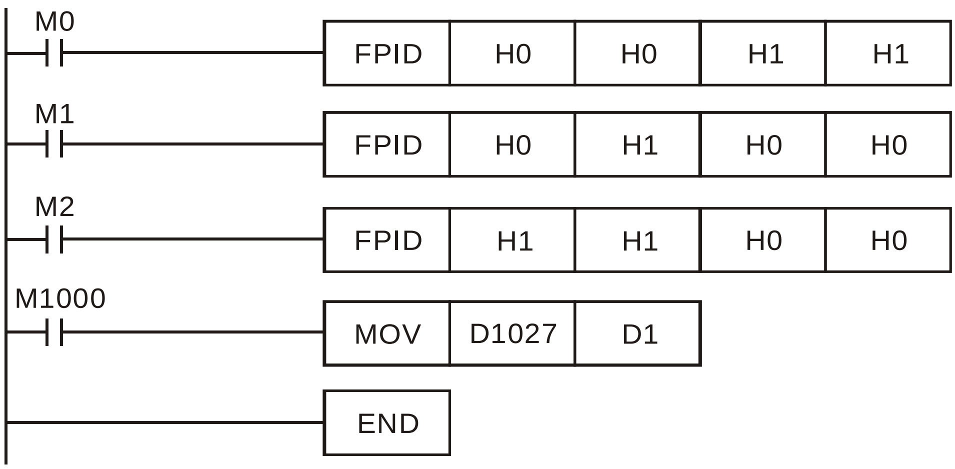
Notes on operand usage: none

Explanation

- (S1): PID reference target value input terminal selection. (S2): PID function proportional gain P. (S3): PID function integral time I. (S4): PID function differential time D.
- The FPID command can directly control the drive's PID feedback control Pr.08-00 Terminal Selection of PID Feedback, Pr.08-01 Proportional Gain (P), Pr.08-02 Integral Time (I), and Pr.08-03 Differential Time (D).

Example

- When M0=ON, the set PID reference target value input terminal selection is 0 (no PID function), the PID function proportional gain P is 0, the PID function integral time I is 1 (units: 0.01 sec.), and the PID function differential time D is 1 (units: 0.01 sec.).
- When M1=ON, the set PID reference target value input terminal selection is 0 (no PID function), the PID function proportional gain P is 1 (units: 0.01), the PID function integral time I is 0, and the PID function differential time D is 0.
- When M2=ON, the set PID reference target value input terminal selection is 1 (target frequency input is controlled through the digital keypad), the PID function proportional gain P is 1 (units: 0.01), the PID function integral time I is 0, and the PID function differential time D is 0.
- D1027: Frequency command after PID operation.



API 142	FREQ	P	(S1) (S2) (S3)	Drive speed control mode

	bit device			Word device							
	X	Y	M	K	H	KnX	KnY	KnM	T	C	D
S1				*	*						*
S2				*	*						*
S3				*	*						*

Notes on operand usage: none

16-bit command (7 STEP)			
FREQ	Continuous execution type	FREQP	Pulse execution type

32-bit command			
-	-	-	-

Flag signal: M1015

Explanation

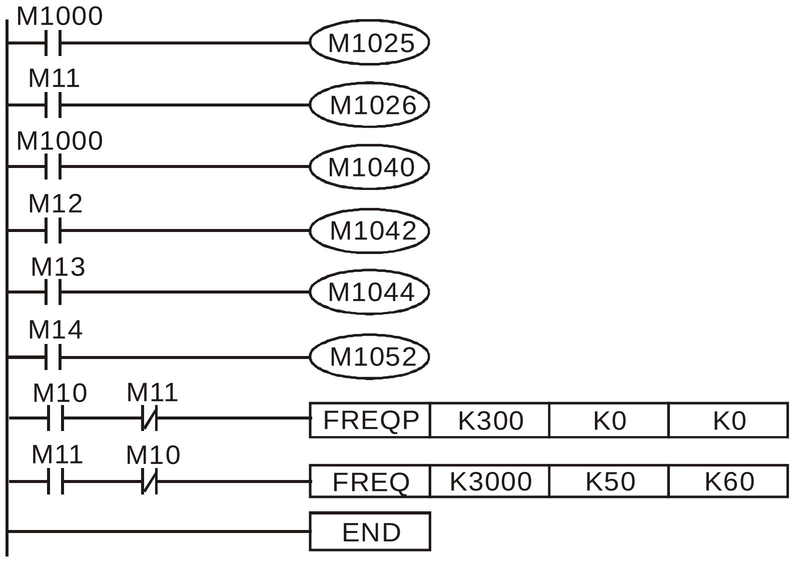
- (S1): Frequency command. (S2): Acceleration time. (S3): Deceleration time
- S2,S3: In the acceleration and deceleration time settings, the number of decimal places is determined by the definition in Pr.01-45.

Example
When Pr.01-45=0: units of 0.01 sec.
A setting of S2=50 (acceleration time) in the ladder diagram below implies 0.5 sec., and the S3 (deceleration time) setting of 60 implies 0.6 sec..

- The FREQ command can control drive Frequency commands, and acceleration and deceleration time. It also uses special register control actions, such as:
  M1025: Control drive RUN(ON)/STOP(OFF) (RUN requires Servo On (M1040 ON) to be effective)
  M1026: Control drive operating direction FWD(OFF)/REV(ON)
  M1040: Control Servo On/Servo Off.
  M1042: Trigger Quick Stop (ON)/does not trigger Quick Stop (OFF).
  M1044: Pause (ON)/release pause (OFF)
  M1052: Lock frequency (ON)/release lock frequency (OFF)

Example

- M1025: Drive RUN (ON)/STOP (OFF), M1026: drive operating direction FWD(OFF)/REV(ON). M1015: frequency reached.
- When M10=ON, sets the drive frequency command K300 (3.00 Hz) with an acceleration and deceleration time of 0.
  When M11=ON, sets the drive frequency command K3000 (30.00 Hz), with an acceleration time of 50 (0.5 sec.) and deceleration time of 60 (0.6 sec.) (when Pr.01-45=0).
- When M11=OFF, the drive frequency command changes to 0.



- Pr.09-33 are defined on the basis of whether reference commands have been cleared before the PLC operation

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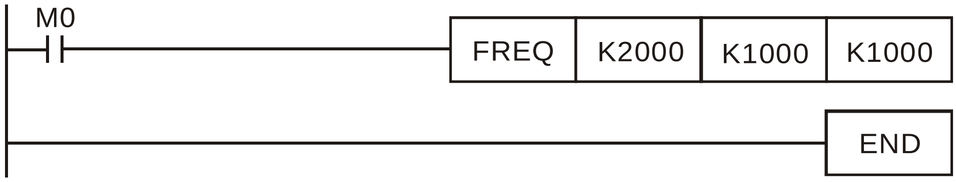
bit 0 : Prior to PLC scanning procedures, acts on whether the target frequency has been cleared to 0. This is written to the FREQ command when the PLC is ON.

bit 1 : Prior to PLC scanning procedures, acts on whether the target torque has been cleared to 0. This is written to the TORQ command when the PLC is ON.

bit 2 : Prior to PLC scanning procedures, acts on whether speed limits in the torque mode have been cleared to 0. This is written to the TORQ command when the PLC is ON.

Example: When using r to write a program,



If we force M0 to 1, the frequency command is 20.00 Hz; but when M0 is set to 0, there is a different situation.

Case 1: When the Pr.09-33 bit 0 is 0, and M0 is set as 0, then the frequency command remains at 20.00 Hz.

Case 2: When the Pr.09-33 bit 0 is 1, and M0 is set as 0, then the frequency command changes to 0.00 Hz

This is because when the Pr.09-33 bit 0 is 1 prior to PLC scanning procedures, the frequency first reverts to 0.

When the Pr.09-33 bit 0 is 0, the frequency does not revert to 0.

16-7 Error Display and Handling

Code	ID	Description	Recommended error resolution
PLod	50	Data writing memory error	Check whether the program has an error and download the program again.
PLSv	51	Data write memory error during program execution	Cycle the power and download the program again.
PLdA	52	Program transmission error	Try uploading again; if the error persists, send it to the manufacturer for service.
PLFn	53	Command error while downloading program	Check whether the program has an error and download the program again.
PLor	54	Program exceeds memory capacity or no program.	Cycle the power and download the program again.
PLFF	55	Command error during program execution	Check whether the program has an error and download the program again.
PLSn	56	Check code error	Check whether the program has an error and download the program again.
PLEd	57	Program has no END stop command.	Check whether the program has an error and download the program again.
PLCr	58	MC command has been used continuously more than nine times.	Check whether the program has an error and download the program again.
PLdF	59	Download program error	Check whether the program has an error and download again.
PLSF	60	PLC scan time excessively long	Check whether the program code has a writing error and download again.

*ID: Warning code

16-8 Explanation of PLC Speed Mode Control

The following tables describe the control mode and setting. These are the register tables for speed mode.

Control special M

Special M	Function Description	Attributes
M1025	Drive frequency = set frequency (ON) / drive frequency = 0 (OFF)	RW
M1026	Drive operating direction FWD (OFF) / REV (ON)	RW
M1040	Hardware power (Servo On)	RW
M1042	Quick Stop	RW
M1044	Pause (Halt)	RW
M1052	Lock frequency (lock, frequency locked at the current operating frequency)	RW

Status special M

Special M	Function Description	Attributes
M1015	Frequency reached (when used with M1025)	RO
M1056	Hardware already has power (Servo On Ready)	RO
M1058	On Quick Stopping	RO

Control special D

Special D	Function Description	Attributes
D1060	Mode setting (speed mode is 0)	RW

Status special D

Special D	Function Description	Attributes
D1037	Drive output frequency (0.00–599.00 Hz)	RO
D1050	Actual operation mode (speed mode is 0)	RO

Speed mode control commands:

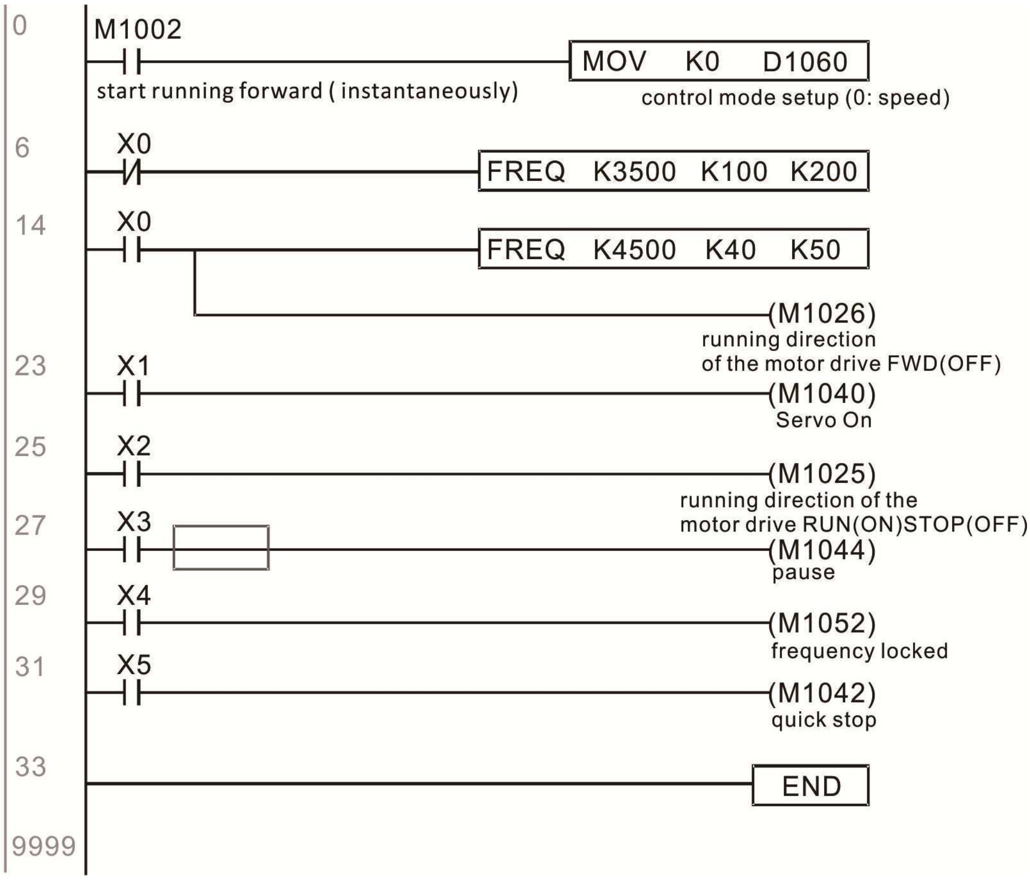
FREQ(P)	S1	S2	S3
	Target speed	The first acceleration time setting	The first deceleration time setting

Example of speed mode control:

Before using speed control, if you use the FOC (magnetic field orientation) control method, you must first complete the setting of the electro-mechanical parameters.

1. Setting D1060 = 0 shifts the drive to speed mode (default).
2. Use the FREQ command to control frequency, acceleration time, and deceleration time.
3. Setting M1040 = 1, the drive is now excited, but the frequency is 0.
4. Setting M1025 = 1, the drive Frequency command now jumps to the frequency designated by FREQ, and acceleration and deceleration is controlled on the basis of the acceleration time and deceleration time specified by FREQ.
5. Use M1052 to lock the current operation frequency.

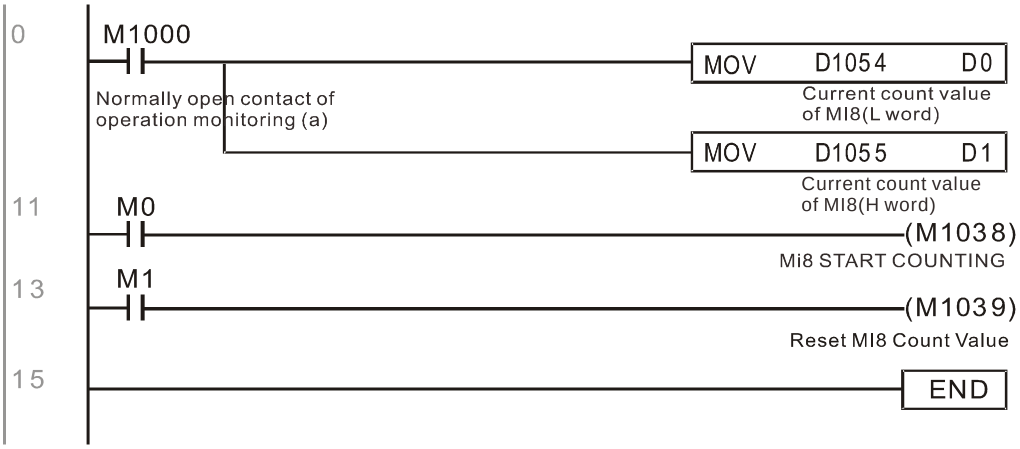
6. Use M1044 to temporarily pause the operation, and the deceleration method uses the deceleration settings.
7. Use M1042 to perform Quick Stop, and deceleration is as fast as possible without causing an error. There may still be a jump error if the load is too large.
8. Control user rights: M1040 (Servo ON) > M1042 (Quick Stop) > M1044 (Halt) > M1052 (LOCK)



16-9 Count Function Using Pulse Input

16-9-1 High-speed count function

The MS3's MI7 supports one-way pulse counting with a maximum speed of 33 k. The starting method is very simple, and only requires setting M1038 to begin counting. The 32-bit count value is stored in D1054 and D1055 in non-numerical form. M1039 resets the count value to 0.

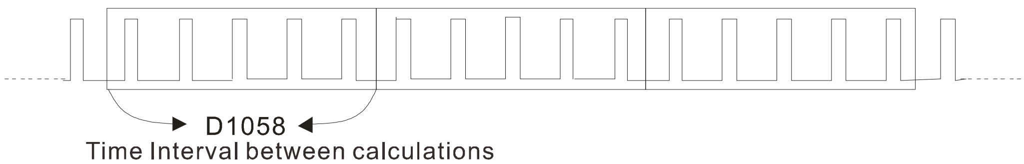


※ When the PLC program defines MI7 for use as a high-speed counter, that is, when M1038 or M1039 is written in PLC procedures, other functions of MI7 are disabled.

16-9-2 Frequency calculation function

Apart from high-speed counting, the MS3's MI7 can also convert a received pulse to a frequency. The following figure shows that there is no conflict between frequency conversion and count calculations, which the MS3 can perform simultaneously.

PLC speed calculation formula
D1057 Speed
D1058 Interval between calculations
D1059 Decimal places
Assume that there are five input pulses each second, (see figure below) we set D1058 = 1000 ms = 1.0 second as the calculation interval. This enables five pulses to be sent to the drive each second.



Assume that each five pulses correspond to 1 Hz, we set D1057 = 5.
Setting D1059 = 2 displays numbers to two decimal places, which is also 1.00 Hz. The numerical value displayed at D1056 is 100. For simplicity, the D1059 conversion formula can be expressed in the following formula:

$$D1058 = \frac{\text{Pulses per second}}{D1057} \times \frac{1000}{D1057} \times 10^{D1059}$$

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