XCM motion controller

User manual

Xinje Electronic Co., Ltd.

Data No. PC02 20080412 3.0

XCM

Motion control type PLC

User manual

Catalog

The first edition

This manual includes some basic precautions which you should follow to keep you safe and protect the products. These precautions are underlined with warning triangles in the manual. About other manuals that we do not mention please follow basic electric operating rules.

Precautions

Please follow the precautions. If not, it may lead the control system incorrect or abnormal, even cause fortune lose.

Correct Application

The models could only be used according to the manual, and an only be used along with the peripheral equipments recognized or recommended by Xinje Electronic. They could only work normally in the condition of be transported, kept and installed correctly, also please operate and maintain them according to the recommendation.

Duty Declare

We have checked the manual, its content fits the hardware and software of the products.As mistakes are unavoidable, we couldn't promise all correct. However, we would check the data in the manual frequently, and in the next edition, we will correct the necessary information. Your recommendation would be highly appreciated

20008.06

CATALOG

Foreword

—— Features of XCM motion controller

XCM motion controller features:

- **The PLC integrate motion control function and ordinary PLC function in one**

  XCM motion controller not only supports proprietary function, but also majority functions of ordinary PLC, including high speed pulse, high speed count, interruption, PID control, etc.

- **Support at most 10-axis pulse output function**

  XCM series contains 3/4/10-axis pulse output, meet users control demands.

- **Predominant motion control capability**

  It can make 2-axis linkage motion, support basic motion control instructions such as circular, linear interpolation, etc.

- **Plane transformation**

  Support PLAN instruction, can transform among plane X-Y, Y-Z, X-Z etc.

- **Can expand XC series digital, analog module and BD board**

  Similar to XC series, XCM series also support module and BD board expansion, including digital I/O, temperature control and analog module, etc.

- **Tracking control function**

  XCM-32T-E-3PLS has tracking control function, which is suitable for continuous processing. It can realize fixed-length and fixed-scale working.

XCM serials including models:

- XCM-32T-E：4-axis pulse output, transistor output.
- XCM-32T-E-3PLS: 3-axis pulse output, transistor output.
- XCM-60T-E：10-axis pulse output.

Supplement explanation:

The instruction noted in this manual is motion control function instructions, other instructions such as sequence control, application or special function instructions, please refer to **XC series PLC user manual.**

Notes:

(1) XCM-60T-E can expand BD board, but cannot expand modules.

(2) XCM-60T-E cannot support motion control instructions.

Remark

1. XCM motion controller summarize

The chapter focus on XCM series product general specifications, appearance and dimension, terminal arrangement and the definition of each communication pin.

1-1. Internal specification

General specification

Items	Specifications
Insulate voltage	Above DC 500V 2MΩ
Anti-noise	1000V 1uS pulse 1 minute
Ambient temperature	0~60℃
Ambient humidity	5%~95%
COM 1	RS-232, connect with host machine, HMI program or debug
COM 2	RS-232/RS-485, connect with network or aptitude instrument、inverters etc.
COM 3	BD board COM port RS-232C/RS-485
Installation	Can use M3 screw to fix or install directly on DIN46277 (Width 35mm) rail
Ground	The third type of ground (can't ground with strong power system.)

Performance & Specification

XCM performance & specification table:

Item		Specification	
		32 points	60 points
Program executing format		Loop scan format, timing scan format	
Program format		Instruction, C language, ladder chart	
Dispose speed		0.3μs	
Power cut retentive		Use FlashROM and Li battery	
User program's capacity		128KB	
I/O points		Input 18 points Output 14 points	Input 36 points Output 24 points
Interior coil's points (M)		8768 points	
Timer (T)	Points	640 points	
	Spec.	100mS timer：Set time 0.1~3276.7 seconds 10mS timer：Set time 0.01~327.67 seconds 1mS timer：Set time 0.001~32.767 seconds	
Counter (C)	Points	640 points	
	Spec.	16 bits counter：set value K0~32767 32 bits counter：set value K0~2147483647	

Data Register（D）	5024 words
FlashROM Register（FD）	524 words
High speed dispose	High speed count, pulse output, external interrupt
Setting of time scan space	0~99mS
Password protection	6 bits ASCII
Self diagnose function	Power on self-diagnose, Monitor timer, grammar checking

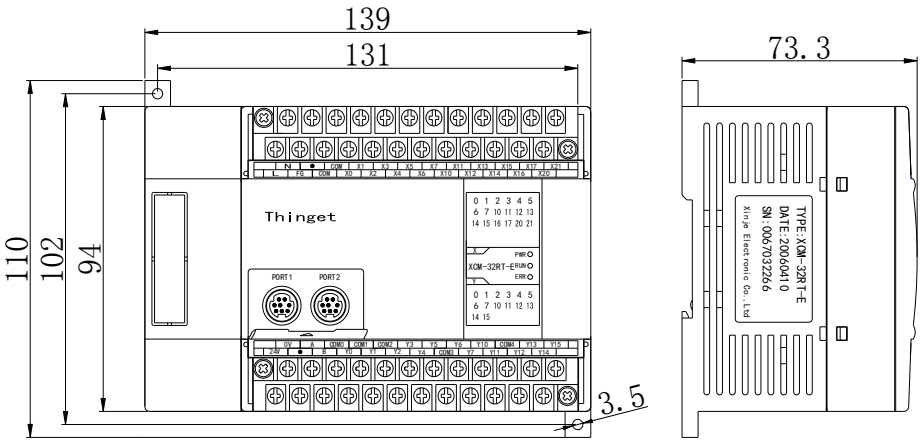
Note: the “user program capacity 128KB” should choose password download mode.

1-2. Appearance & dimension

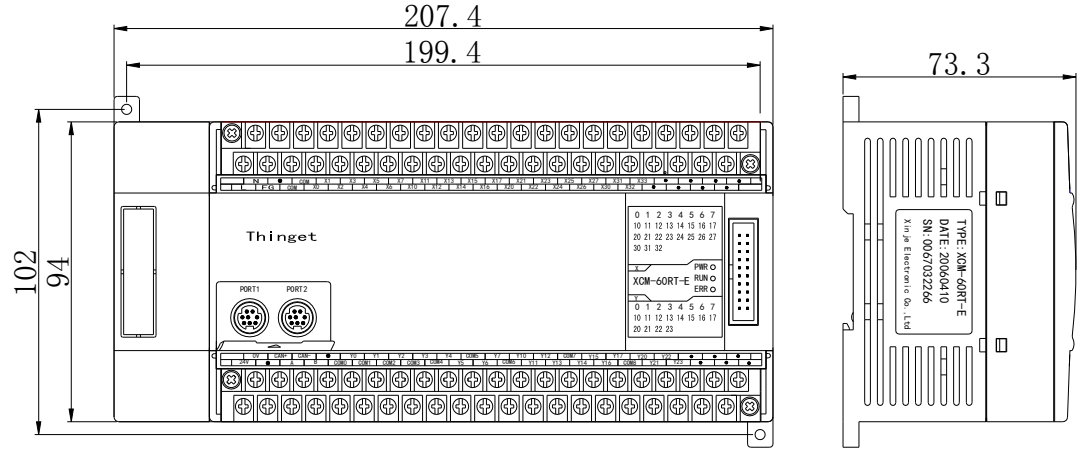
Appearance & Dimension

（Unit: mm）

XCM series 32-point main units

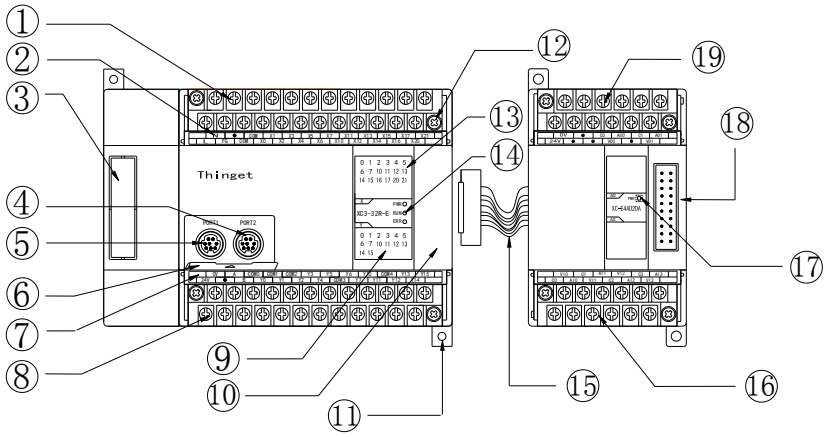


XCM series 60-point main units



1-3. Terminal arrangement

Main units



① : input terminal, power supply
② : input label
③ : expansion BD port
④ : COM2
⑤ : COM1
⑥ : cover
⑦ : output label
⑧ : output terminal, 24V output
⑨ : output LED
⑩ : expansion module port
11: mounting hole
12: screw
13: input LED
14: LED
PWR: power supply
RUN: program run
ERR: error
15: expansion cable
16: output terminals
17: PWR: power LED
18: expansion module port
19: input terminal, power input

XCM series 60-point main units：36 Input /24 Output

	N	●	COM	X1	X3	X5	X7	X11	X13	X15	X17	X21	X23	X25	X27	X31	X33	X35	X37	X41	X43						
	L	FG	COM	X0	X2	X4	X6	X10	X12	X14	X16	X20	X22	X24	X26	X30	X32	X34	X36	X40	X42						

	0V	●	●	●	Y0	Y1	Y2	COM3	Y5	Y6	COM5	Y11	Y12	COM7	Y15	Y17	Y20	Y22	COM9	Y25	Y27						
24V	●	A	B	COM0	COM1	COM2	Y3	Y4	COM4	Y7	Y10	COM6	Y13	Y14	Y16	COM8	Y21	Y23	Y24	Y26	●						

XCM series 32-point main units：18 Input /14 Output

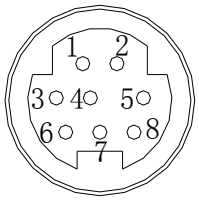
	N	●	COM	X1	X3	X5	X7	X11	X13	X15	X17	X21		
	L	FG	COM	X0	X2	X4	X6	X10	X12	X14	X16	X20		

	0V	A	COM0	COM1	COM2	Y3	Y5	Y6	Y10	COM4	Y13	Y15		
	24V	●	B	Y0	Y1	Y2	Y4	COM3	Y7	Y11	Y12	Y14		

1-4. COM Port definition

COM 1

Pin of COM 1:

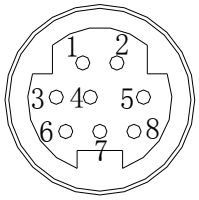


2: PRG
4: RXD
5: TXD
6: VCC
8: GND

Mini Din 8 core socket (hole)

COM 2

Pin of COM 2:



4: RXD
5: TXD
8: GND

Mini Din 8 core socket (hole)

Program cable

Connection of programmable cable as the following：

Mini Din 8core socket (pin)　　DB 9 pin (hole)

2. Power specification, I/O specification, external layout

This chapter focus on the power composing, internal signal circuit composing, output circuit composing and external layout method.

2-1. Power specification

For the power specification of XCM motion controller basic units, please see the following table：

AC power type

Rated voltage	AC100V~240V
Voltage allowable range	AC90V~265V
Rated frequency	50/60Hz
Allowable momentary power-cut time	Interrupt time≤0.5 AC cycle， alternation≥1 s
Impact current	Max 40A 5mS below/AC100V max 60A 5mS below /AC200V
Max power consumption	12W
Power for sensor	24VDC±10%　max 400mA

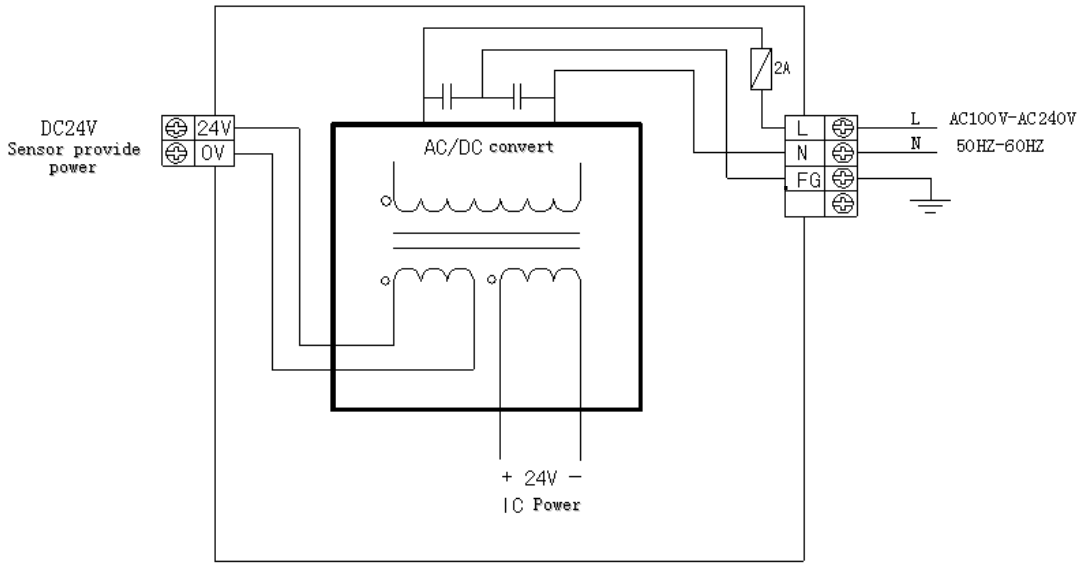
- To avoid voltage decrease, please use the power cable above 2mm^2
- Even power off within 10ms, PLC still can work. But if power off for long time or abnormal power voltage decreasing, PLC will stop working, output will be in OFF status, when the power on again, the PLC will auto-run.
- Connect the ground terminals of basic units and expansion modules together, and then ground.

DC power type

Rated voltage	DC24V
Voltage allowable　range	DC21.6V~26.4V
Input current (Only for basic unit)	120mA　DC24V
Allowable momentary power-cut time	10mS　　DC24V
Impact current	10A　　DC26.4V
Max power consumption	12W
Power for sensor	24VDC±10%　Max 400mA

2-2. AC power supply, DC input

Wiring

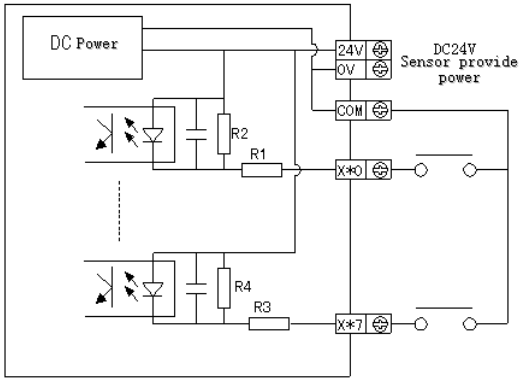


- The power is connected between L and N terminals.
- 24+, COM terminals can be used as 400mA/DC24V power for sensor. Besides, this terminal can't be given power from outside.
- [ ] Terminal is vacant terminal, please do not connect it or use it as relay terminal.
- Please connect the [COM] terminals of basic unit and expansion unit.

2-3. Input specification

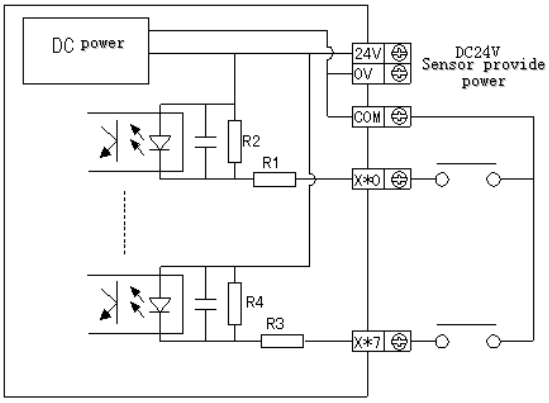
Basic Units

Model	XCM-32T/XCM-60T
Input signal voltage	DC24V±10%
Input signal current	7mA/DC24V
Input ON current	Above 4.5mA
Input OFF current	Below 1.5mA
Input response time	About 10ms
Input signal format	Contactor input or NPN open collector transistor
Circuit insulation	Optical-coupled insulation
Input action display	LED lights when input ON



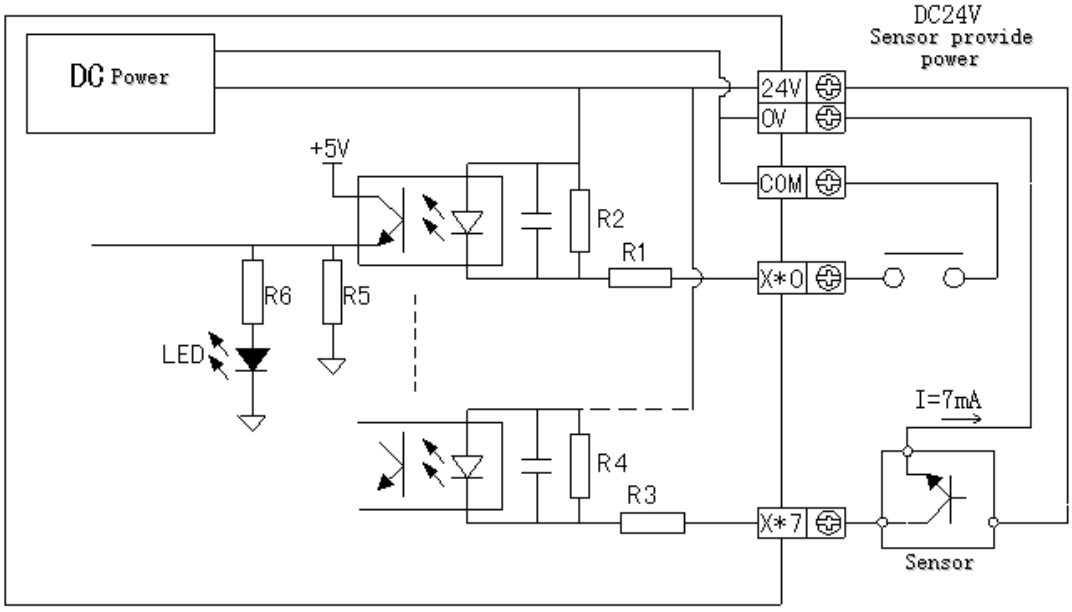
Expansions

Model	XCM-32T/XCM-48T
Input signal voltage	DC24V±10%
Input signal current	7mA/DC24V
Input ON current	Above 4.5mA
Input OFF current	Below 1.5mA
Input response time	About 10ms
Input signal's format	Contactor input or NPN open collector transistor
Circuit insulation	Optical-coupled insulation
Input action display	LED lights when input ON.



2-4. DC Input Signal Operation (AC Power)

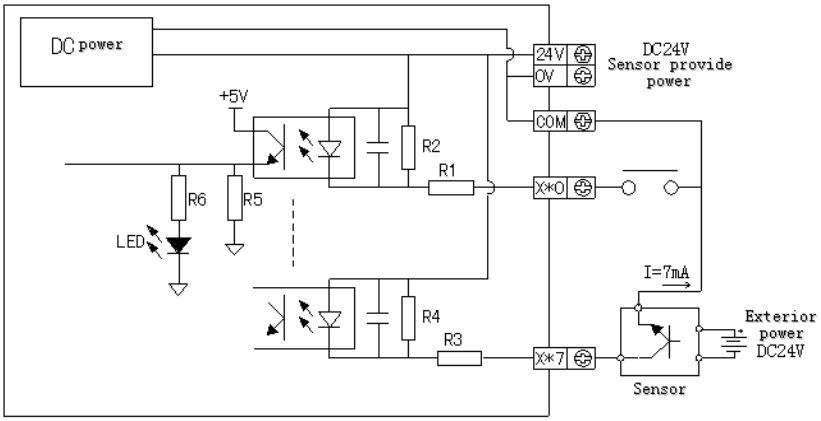
DC input signal



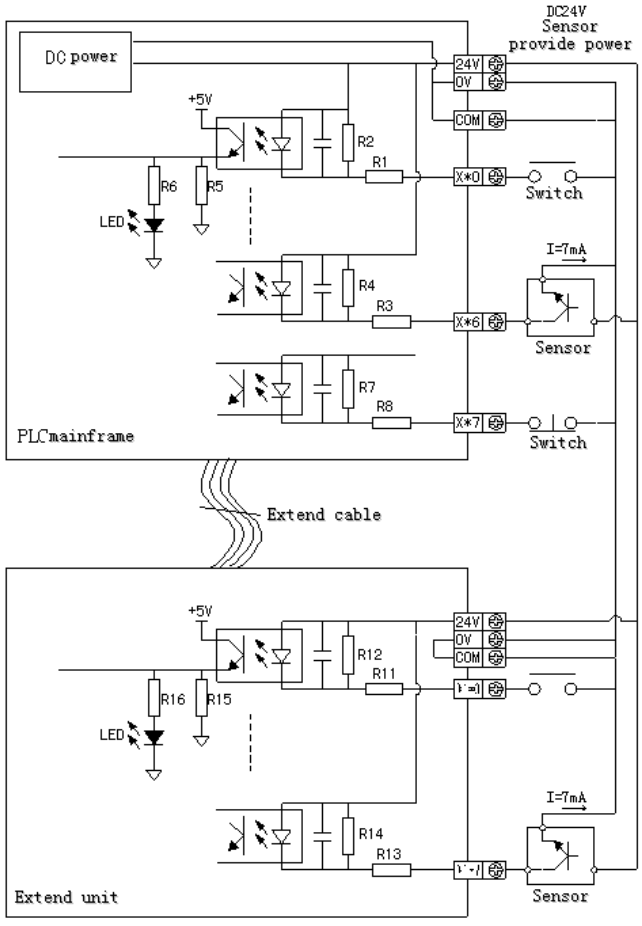
- Input terminal
  When connect input terminal and COM terminal with no-voltage contactor or NPN open collector transistor, if input is ON, LED lamp lights. There are many COM terminals in the PLC.
- Input circuit
  Use optical coupler to insulate the input primary circuit and secondary circuit, There's a C-R filter in the secondary circuit. It is set to avoid wrong operation caused by vibration of input contactor or noise along with input signal. As the preceding reason, for the changing of input ON→OFF, OFF→ON, in the PLC, the response time delays about 10ms. There is built-in digital filter for input terminals.
- Input sensitivity
  XCM input current is 7mA, in order to get reliable action, the ON current is above 3.5mA, the OFF current is below 1.5mA.

Exterior circuit for the sensors

The input current of XCM is supplied by inside 24V power. If use external power to drive sensor or optical-electricity switch, the voltage should be DC 24V±4V, please use NPN open collector transistor for sensor output.



Input Connection



2-5. Transistor output circuit and specifications

The output terminals of XCM are all transistor type which can be divided into high-speed pulse output and normal transistor output.

High-speed pulse output

Model	XCM-32T-E	XCM-32T-E-3PLS	XCM-60T-E
High-speed pulse output terminal	Y0~Y3	Y0~Y2	Y0~Y11
External power supply	Below DC5~30V		
Action display	LED		
Max current	50mA		
Max output frequency of the pulse	200KHz		

Notes:

(1) For XCM-32T-E-3PLS, Y0 and X7 (high speed counter input) cannot use at the same time.

(2) Y1 cannot work with expansion BD board at the same time.

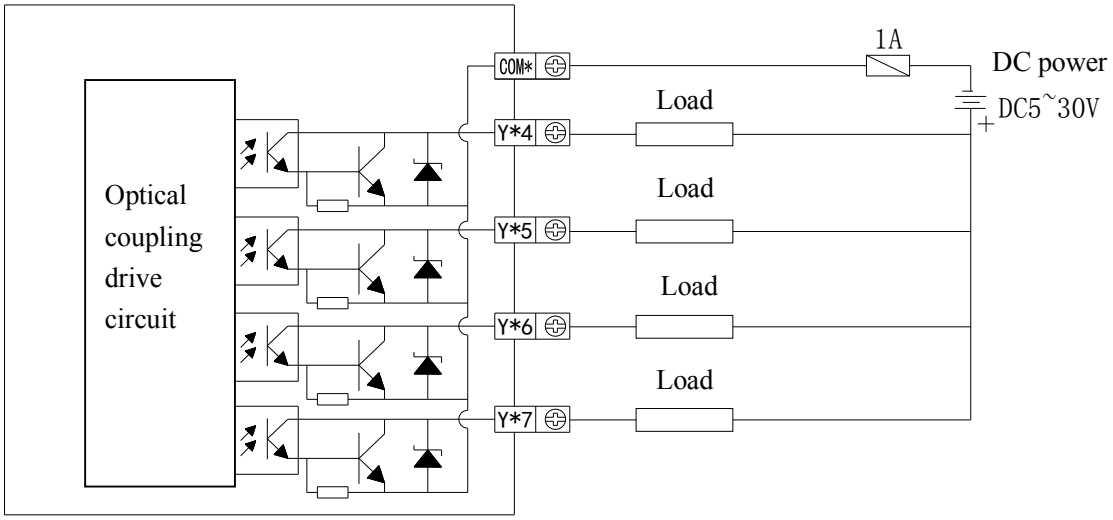
Normal transistor output

Model		XCM-32T-E	XCM-32T-E-3PLS	XCM-60T-E
Transistor output terminal		Y4~Y15	Y3~Y15	Y12~Y23
External power supply		Below DC5~30V		
Circuit insulation		Optical-coupling insulation		
Action display		LED		
Maximum load	Resistance load	0.8A		
	Induce load	12W/DC24V		
	Lamp load	1.5W/DC24V		
Minimum load		DC5V 2mA		
Response time	OFF→ON	Below 0.2ms		
	ON→OFF	Below 0.2ms		

Normal transistor output circuit

- Output terminal
  The transistor output of basic unit has 1~4 common output.
- External power supply
  Please use DC5~30V power supply to drive the load.
- Circuit insulation
  Use the photo-electricity-coupling to insulate the PLC internal circuit and output transistor. Beside, each public block is separated.
- Action display
  When driving the optical-coupling, LED lights, output transistor is ON.
- Response time
  From photo-electricity coupling device driving (or cut) to transistor ON (or OFF), the time is below 0.2ms.
- Output current
  The current is 0.5A per point. But as restrict of temperature rising, the current is 0.8A every four points.
- Open circuit current
  Below 0.1mA.

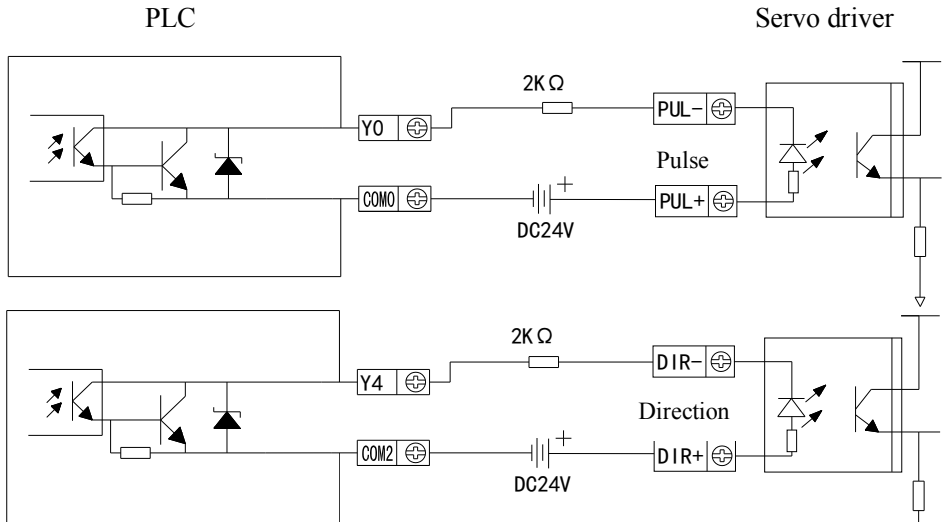
To avoid burning output unit and the PLC PCB board, please choose suitable fuse.



(**Note:** For XCM-60T-E, when connect the optical coupling output to the load, please use output terminal Y12~Y23).

Connect with servo driver

The following is the wiring diagram of RT type PLC and servo driver.



(If external power supply is DC5V, there is no need to connect 2KΩ resistance.)

3. Motion control instruction, parameter, special data register and auxiliary relay

The chapter introduces XCM motion control instruction function, motion control parameter, special data register and auxiliary relay. In the end of the chapter, we select two examples for reference.

3-1. Soft element ID list

XCM series soft element ID is as follows.
Besides, when connect input, output expansion device and special expansion device with basic units, for the input/output relay NO., please see user manual.

Mark	Name	Range		Points	
		32 points	60 points	32 points	60 points
X	Input point	X000~X021（Octal ）	X000~X043（Octal）	18 points	36 points
Y	Output point	Y000~Y015（Octal）	Y000~Y027（Octal）	14 points	24 points
M	Internal relay	M0~M2999【M3000~M7999】		8000	
		Special use M8000~M8767		768	
S	Flow	S0~S511 【S512~S1023】		1024	
T	Timer	T0~T99：100ms not accumulation		640	
		T100~T199：100ms accumulation			
		T200~T299：10ms not accumulation			
		T300~T399：10ms accumulation			
		T400~T499：1ms not accumulation			
		T500~T599：1ms accumulation			
		T600~T639：1ms with interruption, precise timing			
C	Counter	C0~C299：16 bits positive/negative counter		640	
		C300~C599：32 bits positive/negative counter			
		C600~C639：high speed counter			
D	Data register	D0~D2999 【D4000~D4999】		4000	

		Special use D8000~D9023	1024
FD	FlashROM register	FD0~FD63	64
		Special use FD8000~FD8349, FD8890~FD8999	460
ED	Expansion internal register	ED0~ED36863	36864

◆ **NOTE:**

※1. The area in 【 】 is the defaulted power failure retentive area. The retentive area of D, M, S, T, C can be changed. For the details, please see the following table.

※2. Flash ROM register does not have to set power failure retentive area; its data won't lose when power is off (No battery).

※3. The address of input coil, output relay are octal data, other No. are all decimal data.

※4. The I/O which does not connect to external device can be used as internal relay.

Soft element power-off retentive area settings:

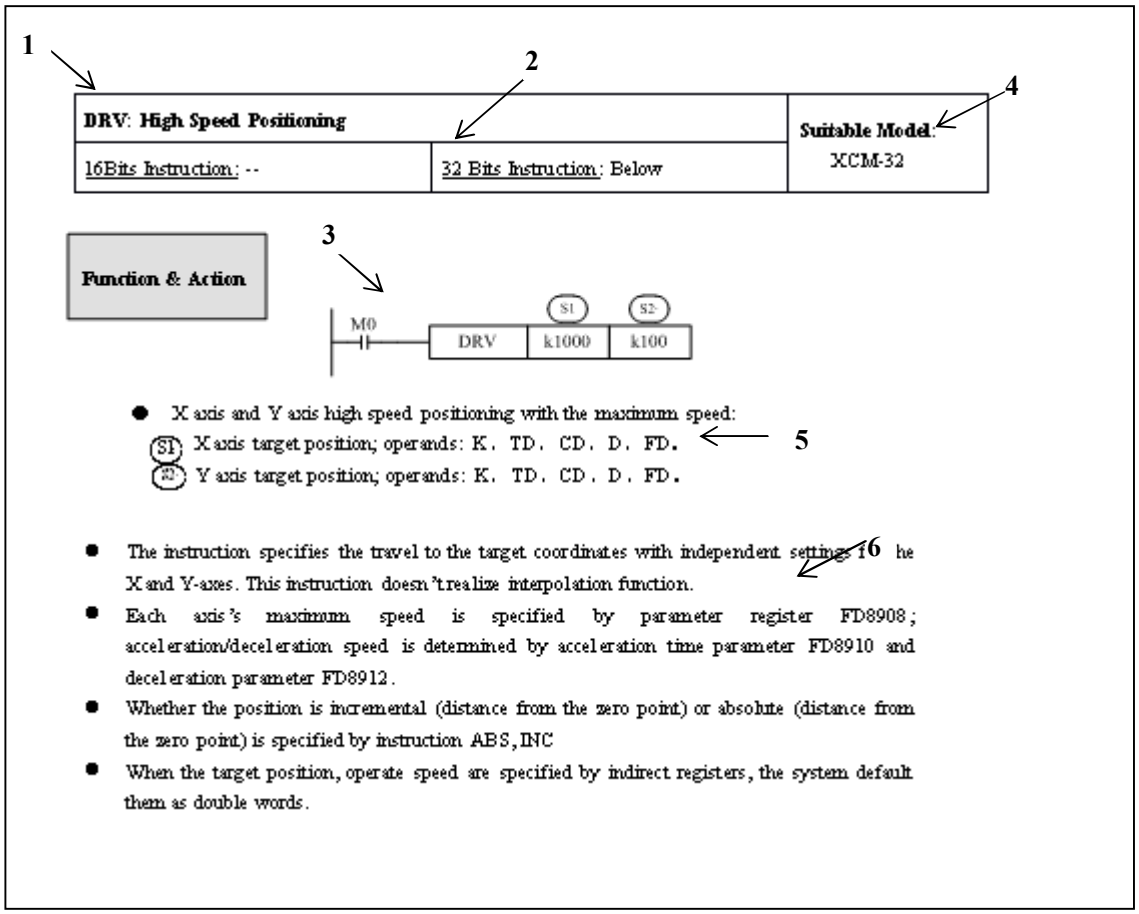
Name	Area	Function	System default value	Power-off retentive range
D	FD8202	Start denotation of D power-off retentive area	4000	D4000~D4999
M	FD8203	Start denotation of M power-off retentive area	3000	M3000~M7999
T	FD8204	Start denotation of T power-off retentive area	620	Not set
C	FD8205	Start denotation of C power-off retentive area	320	C320~C635
S	FD8206	Start denotation of S power-off retentive area	512	S512~S1023
ED	FD8207	Start denotation of ED power-off retentive area	0	ED0~ED36863

3-2. Motion control instruction list (Special for XCM series)

DRV	High speed positioning
LIN	Linear Interpolation Positioning
CW	Circular clockwise interpolation
CCW	Circular anticlockwise interpolation
DRVZ	Back to machine zero
CHK	Servo checking end
DRVR	Back to electrical zero
SETR	Electrical zero setting
TIM	Delay instruction
ABS	Absolute address
INC	Incremental address
SETP	Set coordinate system
PLAN	Plane selection
FOLLOW	Following instruction

Notes: XCM-60T-E cannot support motion control instructions.

3-3. How to read the instructions



Notes:

1. Instruction name
2. 16 bits instruction and 32 bits instruction
3. Ladder chart illustration
4. Applicable models
5. (S·) It denotes that the operand doesn't change with the instruction, called source operand.
   (D·) It denotes that the operand changes with the instruction, called target operand.
6. Successively explain the instruction's basic movement, use method, application example, expansion function, notice point, etc.

3-4. Output terminal arrangement table

There are rules for XCM output terminal function and related operation axis:

XCM-32T-E

Output	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Function	Pulse output				Direction output			
Operation axis	K0	K1	K2	K3	K0	K1	K2	K3
Axis	X	Y	Z	U	X	Y	Z	U

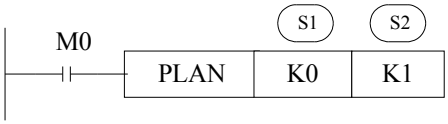
XCM-32T-E-3PLS

Output	Y0	Y1	Y2	Y3	Y4	Y5
Function	Pulse output			Direction output		
Operation axis	K0	K1	K2	K0	K1	K2
Axis	X	Y	Z	X	Y	Z

3-5. Motion Control Instructions

PLAN: select plane or space	
16-bit instruction：--	32-bit instruction：see the description below

Function & Action



Function: select axis X and Y for operation which is XY plane. It defines the operation axis of all the following motion instructions.

(S1·): define the first operation axis; the following instructions will recognize this axis as the first operation axis.

(S2·): define the second operation axis; the following instructions will recognize this axis as the second operation axis.

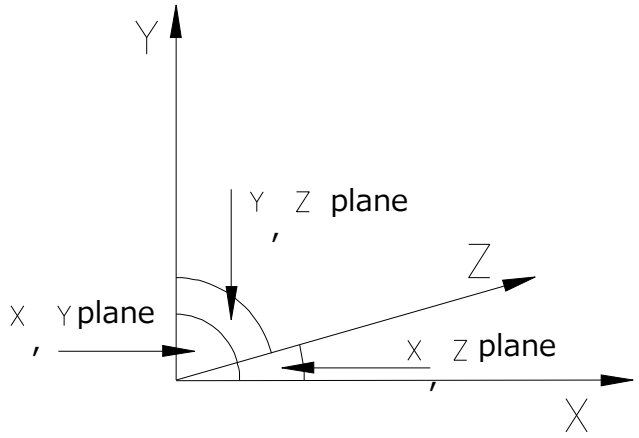
Notes: If do not use PLAN to define the plane, X and Y axis are default operation axis. Operation plane is X, Y.

Example

Instructions:
LD M0
PLAN K1 K2
SETP K10000 K20000

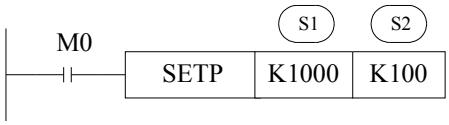
When M0 ON, select K1 and K2 as operation axis, which is Y, Z plane.

SETP can set coordinate system instruction. Change the current position register value to 10000 and 20000 for K1 and K2 axis.



SETP: set coordinate system	
16-bit instruction：--	32-bit instruction： see the description below

Function & action



Function: set the coordinate, define the plane by PLAN instruction (such as the up diagram, the new coordinate is K1000, K100).

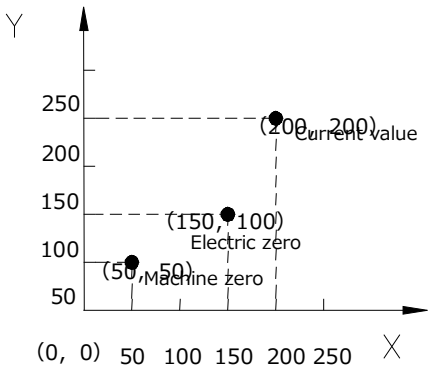
(S1·) Set the new coordinate of the first operation axis

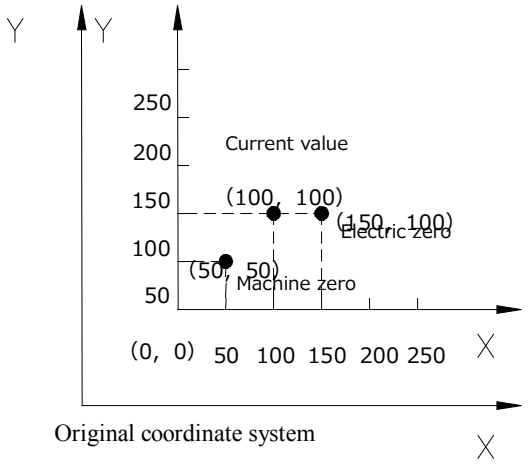
(S2·) Set the new coordinate of the second operation axis

Notes: The new coordinate will instead of the old one when this instruction is executed. Besides, the value in machine zero and electric zero registers have not changed, so in fact the position of the machine zero and electric zero have changed.

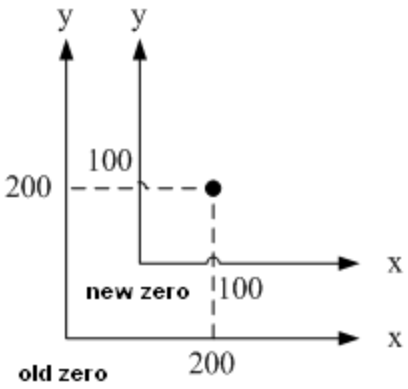
Example

Such as the following diagram, in the original coordinate system, the current register value is (200, 200), machine zero register value is (50, 50), electric zero register value is (150, 100); after implementation of the instruction SETP K100 K100, the reference frame has changed, but the register value has not changed, at last the position has changed.



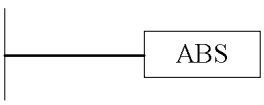


Such as: current value is (200, 200) (absolute coordinates), after implementation of the instruction SETP K100 K100, the zero has changed as the following:



ABS: absolute address		**Suitable type:** XCM-32
16-bit instruction：--	32-bit instruction：--	

Function & action

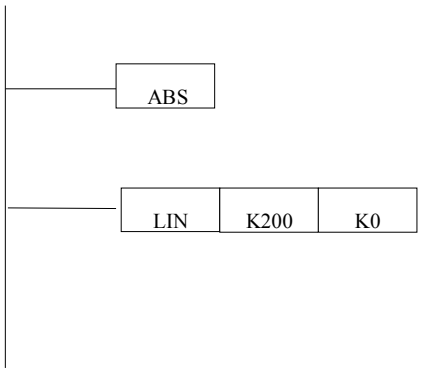


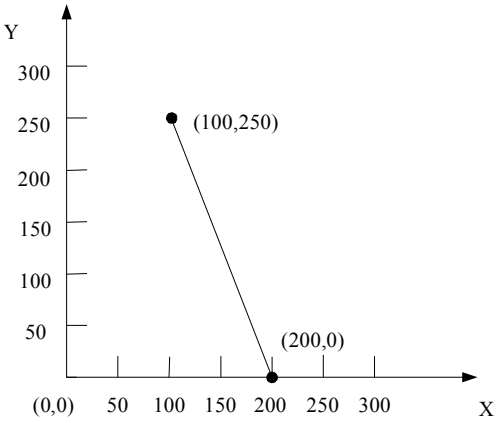
- After executing ABS instruction, coordinates (X, Y) will be recognized as the absolute value of zero (0, 0).

- The displacement value of arc center (I, J) and radius (r) will be recognized as incremental value.
- If the address isn't defined, it will be recognized as absolute value.

Notes: ABS is corresponding to INC, once the ABS instruction is executed; it will be effective until the INC instruction is executed.

Example

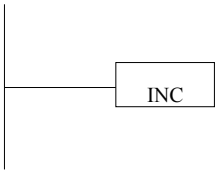




After ABS instruction, the LIN instruction will do linear interpolation according to the absolute coordinates.

INC: incremental address		**Suitable type**
16-bit instruction: --	32-bit instruction: --	XCM-32

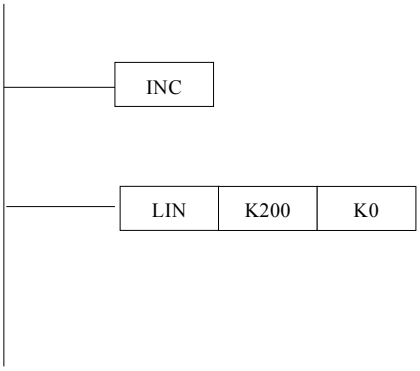
Function & action

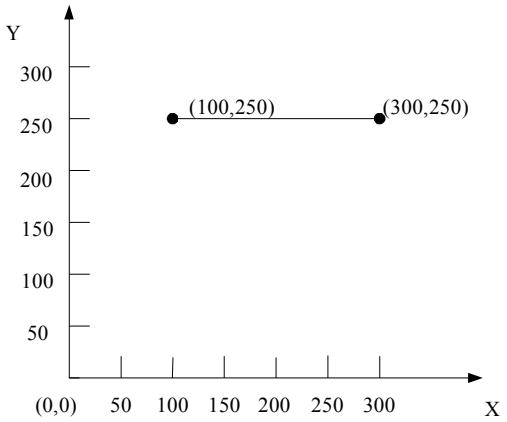


- After the implementation of INC instruction, address (X, Y) will be recognized as incremental value of the current position.
- INC instruction is similar to ABS, once INC is executed, it will be effective until ABS is

executed.

Example

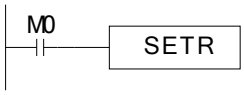




After executing INC instruction, LIN instruction will do linear interpolation according to the incremental address relatives to the current position.
In the up diagram, same coordinates produce different results by using ABS and INC instructions.

SETR: set electric zero		**Suitable type:** XCM-32
16-bit instruction：--	32-bit instruction：--	

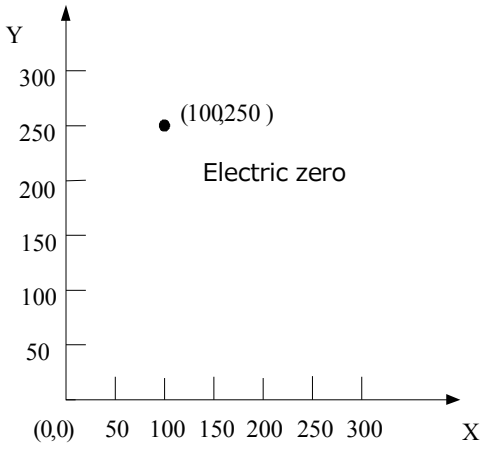
Function & action



- The current position will be stored into the electric zero register, the original zero will be replaced.

Example

After executing SETR instruction, the current coordinates (100, 250) will be stored into electric zero register. For actual applications, this instruction can simplify the coordinate system.



DRVR: electric return to zero		**Suitable type:** XCM-32
16-bit instruction：--	32-bit instruction：--	

Function & action

- The machine will return to the electric zero at high-speed and do servo end checking.
- The acceleration time is up to FD8910, deceleration time is up to FD8912, operation speed is up to FD8908.

In actual applications, DRVR makes the coordinate system clear and simplifies the operation, decreases the error.

DRVZ: return to machine zero		Suitable type: XCM-32
16-bit instruction：--	32-bit instruction：--	

Function & action

First, we will introduce the machine zero.

(1) There are two modes 1 and 2. Parameter 26 can set the mode (which is return to machine zero parameter). The bit 4 to 7 defines whether to use close-point switch. Besides, the bit 8 to 11, 12 to 15 is also related to close-point switch.

(2) The other parameters related to machine zero include: (the details please refer to the appendix)

Parameter 16, 17, 18, 19: set the machine zero of axis X, Y, Z, U.

Parameter 20: the speed (frequency) of return to machine zero.

Parameter 21: crawling speed of return to machine zero.

Parameter 22, 23: corresponding to axis X, Y, zero (phase Z) pulse value whose crawling speed needs count.

About mode 1 and 2:

Mode1: The bit 4 to 7 of parameter 26 is 0, means do not use close-point switch.

Mode2: The bit 4 to 7 of parameter 26 is 1, means use close-point switch.

The bit 4 to 7 of parameter 26 is corresponding to the close-point switch of axis X, Y, Z and U.

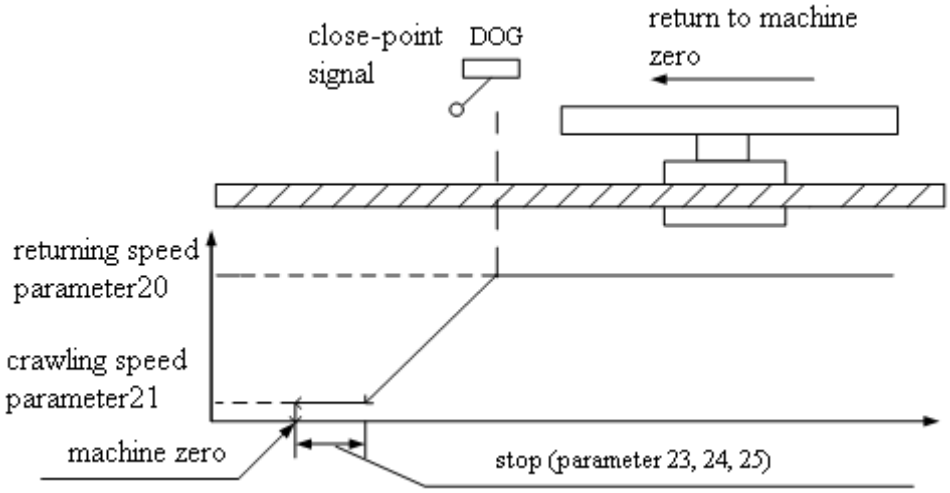
The X-axis and Y-axis support mode 1 and 2. The Z-axis and U-axis support mode1 only. The input terminals of the switch setting:

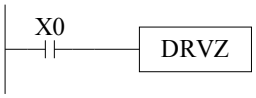
Operation axis	X-axis	Y-axis	Z-axis	U-axis
Close-point switch setting input	X2	X10	—	—
Z-phase zero input	X5	X11	—	—

Mode 1: there is no close-point switch setting. The machine decides the target position coordinates according to the parameter 16 to 19 when returning to the machine zero, and decides the direction of return to machine zero according to bit 0 to 3 of parameter 26, return speed depends on parameter 20.

Mode 2: there is close-point switch setting. During the machine is returning to the machine zero, when the machine arrives the close-point switch, the speed will decrease from the value of parameter 20 (setting speed) to parameter 21 (crawling speed). The machine will stop according to the counting zero (Z-phase) pulse signal of parameter 22 and 23. Please see the following

diagram:





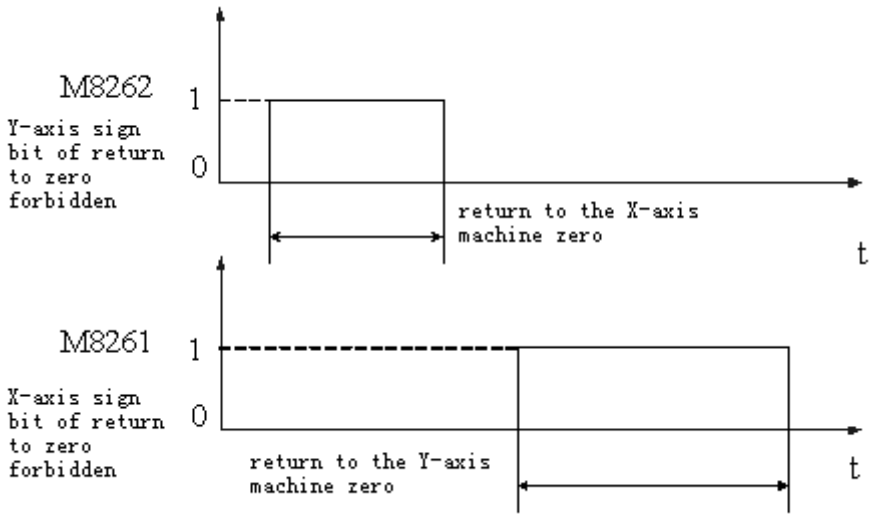
Function: the machine will return to machine zero at the highest speed.

- PLC will select which axis to return according to the current plane, it will also decide whether to return to the machine zero according to the value of M8261~M8264 (sign bit of return to machine zero forbidden).
- M8265~M8268 (returning to zero sign bit of axis X, Y, Z) will be ON after returning to the zero.
- Two axes will return to machine zero at the same time. If need one return after another, set ON sign bit of return to machine zero forbidden.
- Please refer to chapter 3-5 and 3-7 for sign bits and parameters.

Program example

Return to the zero of axis-X, and then return to the zero of Y-axis.

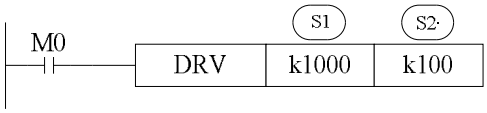
SET M8262	forbid the Y-axis to return to zero
DRVZ	the X-axis returns to machine zero
RST M8262	permit the Y-axis to return to zero
SET M8261	forbid the X-axis to return to zero
DRVZ	the Y-axis returns to machine zero
RST M8261	permit the X-axis to return to zero



Notes: If M8261 and M8262 are all ON, DRVZ will not be executed.

DRV: High Speed Positioning		**Suitable Model:** XCM-32
16Bits Instruction: --	32 Bits Instruction: Below	

Function & Action



- X-axis and Y-axis high speed positioning with the maximum speed:

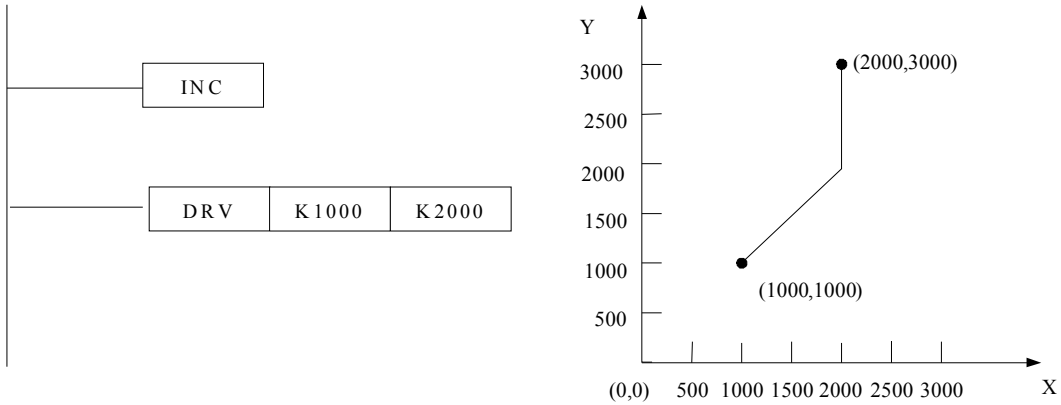
(S1·) X-axis target position; operands: K、TD、CD、D、FD.

(S2·) Y-axis target position; operands: K、TD、CD、D、FD.

- The instruction specifies the travel to the target coordinates with independent settings for the X and Y-axes. This instruction doesn't realize interpolation function.
- Each axis maximum speed is specified by parameter register FD8908; acceleration/deceleration speed is determined by acceleration time parameter FD8910 and deceleration parameter FD8912.

- Whether the position is incremental (distance from the zero point) or absolute (distance from the zero point) is specified by instruction ABS, INC.
- When the target position, operate speed are specified by indirect registers, the system default them as double words.

Program Example

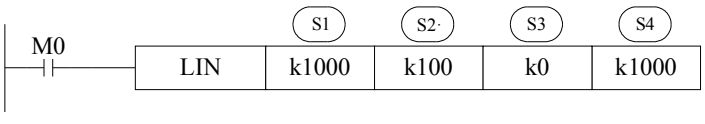


INC Incremental Drive Method;

DRV K1000 K2000 High speed positioning with the maximum speed, the target address is: (1000,2000)

LIN: Linear Interpolation Positioning		**Suitable Model:** XCM-32
16bits instruction:--	32bits instruction: Below	

Function & Action



Function: The first and second axes do linear interpolated positioning at appointed speed; the plane will be defined by PLAN.

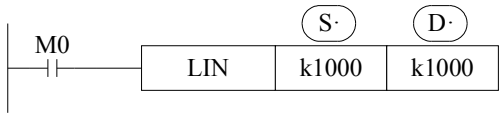
(S1) First axis target position coordinates. Operand: K, TD, CD, D, FD

(S2·) Second axis target position coordinates. Operand: K, TD, CD, D, FD

(S3·) Third axis target position coordinates. Operand: K, TD, CD, D, FD
(Notes: three axes motion control is not open, it is not useful to set the parameter here, but these bits must be reserved.)

(S4) The speed of linear interpolated positioning. Operand: K, TD, CD, D, FD.
(The highest speeds can up to 80 kHz for LIN and CW/CCW instructions)

If there is no appointed speed for the first and second axes, the PLC will do linear interpolated positioning at the highest speed.

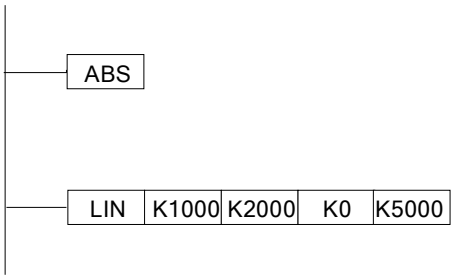


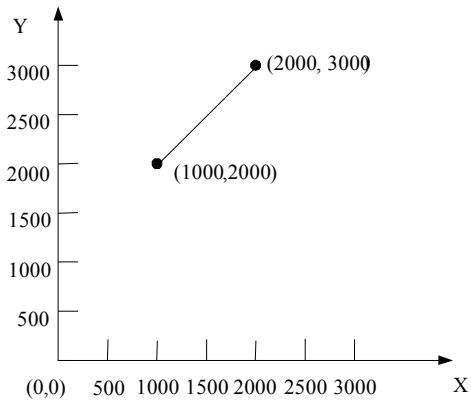
(S) The first axis target position coordinates. Operand: K, TD, CD, D, FD

(D) The second axis target position coordinates. Operand: K, TD, CD, D, FD

- This instruction uses two axes to move the machine to target position through beeline
- INC and ABS will define whether the target position is incremental or absolute value
- The default operation is double words when the target position and speed are appointed by registers.

Program example





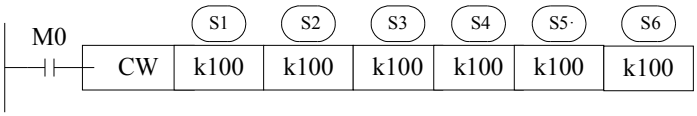
ABS

Absolute drive method ;

LIN K1000 K2000 K0 K5000 this instruction moves the machine to the target position (1000, 2000) with linear interpolated positioning at the speed of 5 KHz.

CW/CCW：Circular interpolation		Applicable model XCM-32
16 digit instructions--	32 digit instructions：The following	

Function & Action



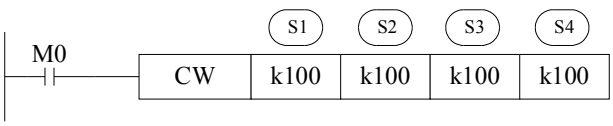
Function: run circular interpolation at certain speed according to the center position and target position of first and second axes.

- The coordinate plane will be defined by PLAN.
- CW is clockwise interpolation, CCW is counterclockwise interpolation.

(S1·) The first axis target position coordinates, operands: K, TD, CD, D, FD.
(S2·) The second axis target position coordinates, operands: K, TD, CD, D, FD.
(S3) Arc center position coordinates of the first axis, operands: K, TD, CD, D, FD.
(S4·) Arc center position coordinates of the second axis, operands：K, TD, CD, D, FD.

(S5) The third axis position, operands: K, TD, CD, D, FD.
(Notes: three axes motion control is not open, so these parameters are not useful but they are reserved.)
(S6) Circular peripheral speed, operands: K, TD, CD, D, FD.
(The highest speed can up to 80 kHz for LIN and CW/CCW instructions)

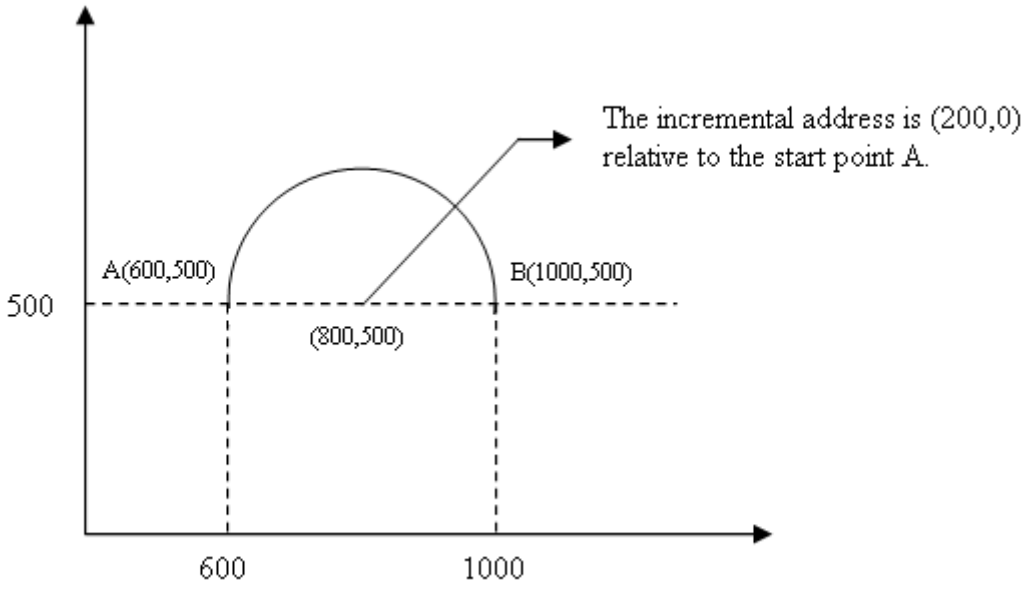
If the peripheral speed is not defined, the system will default to the highest speed:



- The center coordinates of first and second axes will be seemed as incremental address based on starting point.

- Acceleration/deceleration time of the peripheral speed is set individually in FD8910 and FD8912.
- INC and ABS will define whether the target position is incremental or absolute value.
- It is default to double words operation when the target position or speed is defined by registers.
- If the start position and the target position is the same, the trajectory is a full circle.

Program example



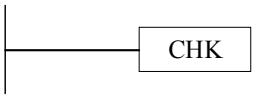
ABS

CW K1000 K500 K200 K0 K5000

Define the drive method is absolute address, move along the arc whose center incremental address is (200, 0) at the speed of 5 kHz, start from A(600,500) to B(1000,500).

CHK：Servo end check		Applicable models XCM-32
16-bit instructions：--	32-bit instructions：--	

Function & Action



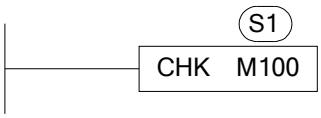
Function: the machine runs servo end checking after finishing the interpolation, then runs another operation. If there is no servo end checking, the machine will run without pause when interpolating, the turning point will become smooth curve.

Please note the following points when using motion control instructions:

(1) If insert CHK between 2 motion control instructions, the trajectory will pause for a while when gets to appointed point, then continue running the next instruction. Otherwise, the trajectory is a smooth curve.

(2) When continuous use PLAN, please add CHK before the second PLAN, otherwise the trajectory will deviate.

The coil can be contained in CHK. The coil can stand for the positioning completion signal of the servo driver. The machine will pause when running CHK. The machine will run the next instruction when the coil is ON. If the coil is always ON, the function is the same as CHK without coil. If the coil is always OFF, the machine will stop and never go to the next instruction.

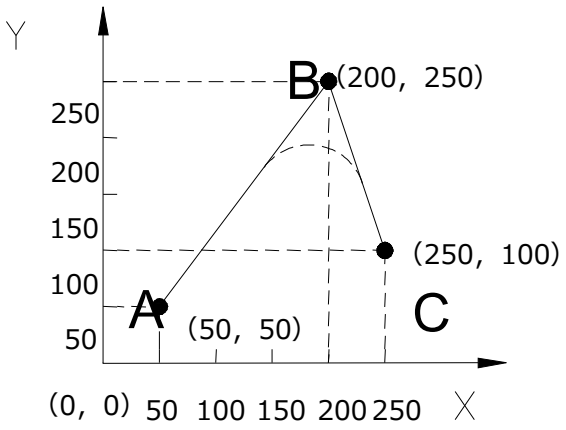


(S1·) : the coil of CHK, operand: X, Y, M, S, T, C

Example 1

The machine moves from A to B to C. If inserts CHK between LIN, the trajectory is like solid line. If no CHK, the trajectory is like dotted line.

```
INC
LIN   K150   K200 K0   K5000
CHK
LIN   K50   K-150   K0   K5000
```

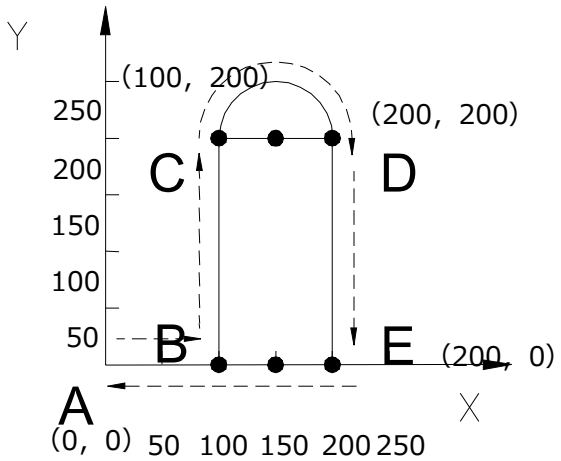


Example 2

The machine moves from A to B to C to D to E to A. Please see the solid line in the following diagram.

In the program, select the XY plane at first. Select absolute drive mode, set the coordinate system to (K0, K0). At this time, select incremental drive mode in order to measure the coordinate system. After completion of the first linear interpolation instruction, run CHK M0 to cause pause which avoid smooth curve. It runs the next LIN instruction when M0 is ON.

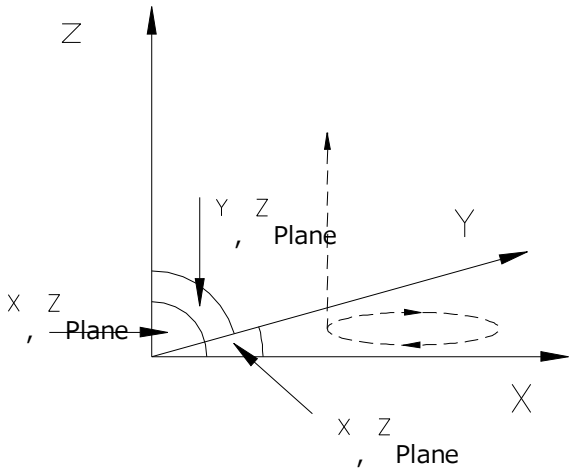
```
PLAN   K0   K1
ABS
SETP   K0   K0
INC
LIN   K100   K0   K0   K100
CHK   M0
LIN   K0   K200   K0   K100
CHK   M1
CW   K100   K0   K50   K0   K0   K100
CHK
LIN   K0   K-200   K0   K100
CHK
LIN   K-200   K0   K0   K100
```



Example（3）

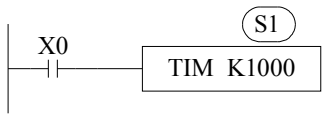
When there are many plane conversions in the program, select XY plane and do circular interpolations in incremental mode, then insert CHK, and select YZ plane.

```
PLAN    K0   K1
INC
CW K0   K0   K15000   K0   K0   D2
CHK
PLAN    K1   K2
INC
LIN K0   K10000   K0   D2
```



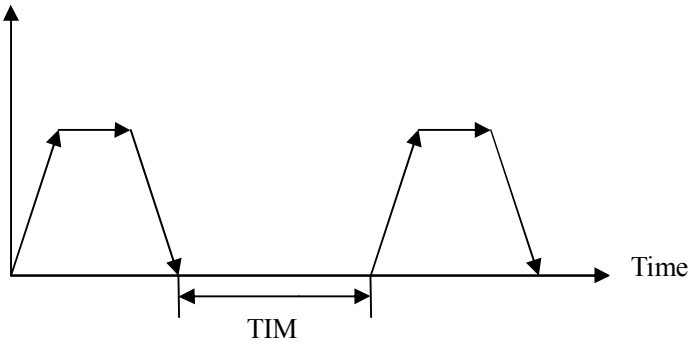
TIM: Delay		**Applicable models** XCM-32
16-bit instruction：--	32-bit instruction: remarks	

Function & Action



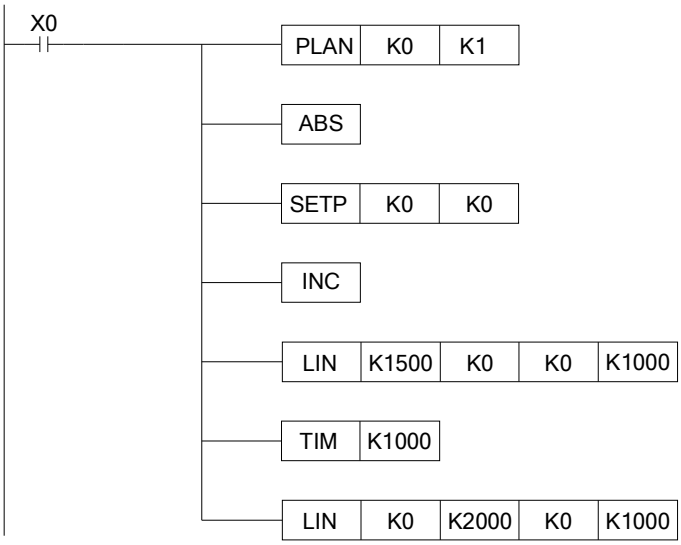
(S1) Delay time(Dwell),operands：K、TD、CD、D、FD.

- Use this instruction to set the waiting time between completion of one instruction and execution of another.



- Unit is 1ms, K1000 means delay 1s.
- The value of delay time is indirect set by data register. Default is double words operation.

Example

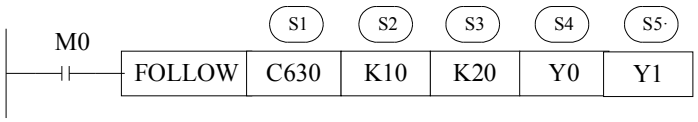


As the ladder chart, delay 1s after the completion of linear interpolation, then run the second linear interpolation instruction. Please see the following instructions:

```
LD   X0
PLAN   K0   K1
ABS
SETP   K0   K0
INC
LIN   K1500   K0   K0   K1000
TIM
LIN   K0   K2000   K0   K1000
```

FOLLOW：Following instruction		Applicable models XCM-32
16-bit instruction：--	32-bit instruction：As follows	

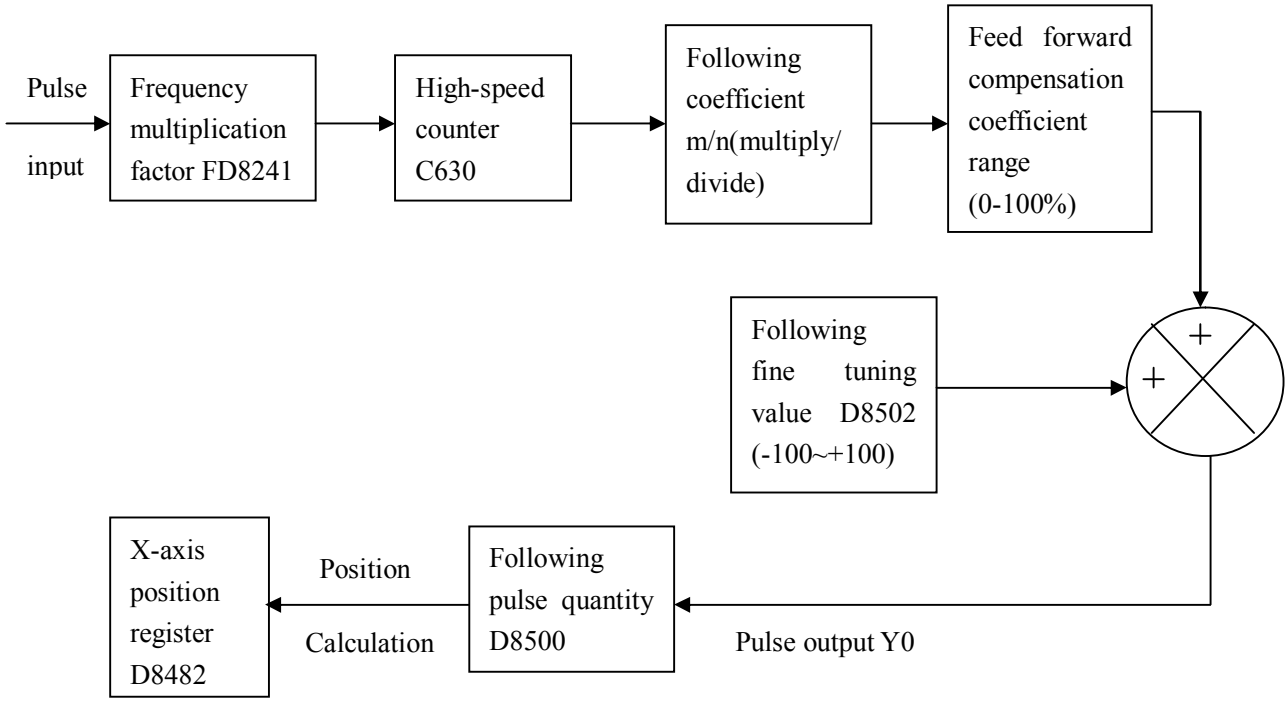
Function & Action



(S1·) : High-speed counter, it can be AB phase, single phase or direction +pulse
(S2·) : Operand K10 is multiplicative coefficient, operands: K, TD, CD, D, FD
(S3) : Operand K20 is divided coefficient, operands: K, TD, CD, D, FD
(S4·) : Operand Y0 is port No. of pulse output
(S5) : Operand Y1 is port NO. of pulse direction output

- Following instruction can output 4 or 1 time of the high-speed counter signal. The output frequency will change as the input frequency, the pulse quantity is calculated by multiply/divide coefficient.
- The meaning of following is: geometric magnify or minify the high-speed counter signal, then add pulse forward or backward via phase checking, finally output the pulse in the mode of pulse+direction.
- The output pulse quantity depends on C630. The pulse quantity is 4 times of 1-time pulse input mode when selecting 4-time pulse input mode.
- This instruction is used to adjust the digital control system. Control the back/forward of the operation table by manual pulse generator. It also can be applied in some cases need precise synchronization.

FOLLOW instruction diagram: (take Y0 as an example)



The relationship between FOLLOW and motion control instructions:

FOLLOW can be used independently without motion instructions. However, it needs to build the relationship between FOLLOW and motion control instructions when need manual pulse generator to adjust coordinates position.

The pulse quantity is stored in register D8500~D8501 when running FOLLOW. At the same time, the pulse variation will be transformed into position variation of corresponding output axis, and reflect in current axis register. So FOLLOW and motion control instructions will constitute a whole unit. FOLLOW can point at X-axis, Y-axis, Z-axis, U-axis.

Make sure the direction of position and encoder is consistent, the direction of FOLLOW and motion control must be consistent. Such as the above example, Y0 outputs the pulse, the direction must output from Y4.

Feed forward compensation coefficient:

XCM has delay from receiving to sending pulse. Modify the feed forward compensation coefficient (FD8950) to decrease the delay. The range is 0~100%. 0 means no feed forward compensation.

Following fine tuning pulse quantity

If the following runs for long time, it may produce the pulse accumulated error which causes the motor pulse to lead or lag. Modify D8502 can adjust the error of next pulse period.

If the motor leads, set D8502 to negative, if the motor lags, set it to positive.

The value in D8502 is effective in one pulse period; D8502 will be reset after the fine tuning.

3-6. Motion control parameter

The motion control parameter can be set in special FLASH register. Each parameter and corresponding XCM register address is as following:

PARA NO.	Special register	Name	Description	Default value
1	FD8892 FD8893	Pulse rate (X-axis)	Pulse number per revolution	0
2	FD8894 FD8895	Pulse rate (Y-axis)	Pulse number per revolution	0
3	FD8896 FD8897	Pulse rate (Z-axis)	Pulse number per revolution	0
4	FD8898 FD8899	Pulse rate (U-axis)	Pulse number per revolution	0
5	FD8900 FD8901	Motor resolution(X-axis)	Move distance per revolution	0
6	FD8902 FD8903	Motor resolution(Y-axis)	Move distance per revolution	0
7	FD8904, FD8905	Motor resolution(Z-axis)	Move distance per revolution	0
8	FD8906 FD8907	Motor resolution(U-axis)	Move distance per revolution	0
9	FD8908 FD8909	The highest speed	Unit: Hz	0
10	FD8910 FD8911	Accelerate time	Unit: ms	0
11	FD8912 FD8913	Decelerate time	Unit: ms	0
12	FD8914 FD8915	Electrical zero (X-axis)		0
13	FD8916 FD8917	Electrical zero (Y-axis)		0
14	FD8918 FD8919	Electrical zero (Z-axis)		0
15	FD8920 FD8921	Electrical zero (U-axis)		0
16	FD8922 FD8923	Machine zero (X-axis)		0

17	FD8924 FD8925	Machine zero (Y-axis)		0
18	FD8926 FD8927	Machine zero (Z-axis)		0
19	FD8928 FD8929	Machine zero (U-axis)		0
20	FD8930 FD8931	The speed of return to machine zero		0
21	FD8932 FD8933	Interruption trigger: return to machine zero at crawling speed	External input X2 (X-axis) External input X10 (Y-axis)	0
22	FD8934	Zero-point (Z phase) pulse number of X-axis crawling speed which need to be count	External input X5 (X-axis)	0
23	FD8935	Zero-point (Z phase) pulse number of Y-axis crawling speed which need to be count	External input X11 (Y-axis)	0
24	FD8936	-	-	0
25	FD8937	-	-	0
26	FD8938	Return to machine zero settings	See table (3-5-1)	0
27	FD8940	Magnification coefficient	(power series of 2)	
28	FD8950	Feed forward coefficient		0

The following is the detailed explanation of motion control parameters:

PARA.1: Pulse rate

Set the X-axis pulse number per revolution which add to the driver unit

Setting range: 1~65535 PLS/REV (pulse/revolution)

When the servo motor is equipped with an electronic gear, its magnification should be taken into account. The relationship between the pulse rate and the electronic gear is as follows:

Pulse rate (PARA.1) = Resolution of encoder (positioning feedback pulse)/electronic gear

PARA.2, PARA.3, PARA.4: set the Y-axis, Z-axis, U-axis pulse number per revolution add to the driver unit. The basic settings are the same as PARA.1.

PARA.5: Feed rate
Set the trip of the machine per rotation of the motor

Setting range :1~999999（um/REV, mdeg/REV, 10^{-1}minch/REV）

PARA.6, PAARA.7, PARA.8 set motor per rotation trip of Y-axis, Z-axis, U-axis. The basic settings are the same as PARA.1.

PARA.9: Maximum speed (default speed)
The machine runs as this speed if there is no appointed speed in positioning program. Other speed must be set equal to or less than this speed.
Setting range: 0~200000 Hz
Notes: the highest speed is 80KHz for LIN and CW/CCW instructions.

PARA.10: Acceleration time
Set the time of achieving the maximum speed
Setting range: 0~5000ms
When PARA.10 is 0, the machine actually accelerates in 1 ms.

PARA.11: Deceleration time
Set the time to stop the machine.
Setting range: 0~5000ms
When PARA.11 is 0, the machine actually decelerates in 1 ms.

PARA.12: X-axis electric zero address
The absolute address of DRVR instruction

Setting range：-999999 to +999999

The address is an absolute value.

PARA.13, PARA.14, PARA.15 set the electric zero absolute address of Y-axis, Z-axis, U-axis. The basic setting is the same as PARA.12.

PARA.16: Machine zero address
After the operation of DRVZ(return to zero), set the current address as the machine configuration.
Setting range:-999999 to +999999

PARA.17, PARA.18, PARA.19 set the machine zero address of Y-axis, Z-axis, U-axis. The basic setting is the same as PARA. 16.

PARA20: return to machine zero speed
Set the speed when the machine is returning to the zero point, the set value must be equal to or less than the maximum speed of PARA.9
Setting range:10 to 50000 Hz.

PARA.21: crawling speed returning to the machine zero

The low speed after the near-point DOG signal (external input X2 of X-axis, external input X10 of Y-axis) is turn on.

Setting range: 10 to 50000 Hz

PARA.22: zero point (Z phase) pulse number of crawling speed which needs to be count

After near-point DOG signal is triggered, the external input X5 of X-axis and external input X11 of Y-axis receive the encoder zero-point signal. If this signal is equal to the appointed zero point pulse number, the machine will stop.

Setting range: 0 to 2147483647

PARA.23: zero point (Z phase) pulse number of Y-axis crawling speed which needs to be count. The basic setting is the same as PARA.22.

PARA.24, PARA.25: invalid parameters

PARA.26: returning to machine zero (FD8938)

(0~3 bit) the direction returning to the machine zero

(4~7 bit) Whether to use proximity switch

If not use proximity switch, then machine zero returning is the same as electrical zero returning, direct decelerate and stop.

(8~11 bit) Proximity switch state

0: normal open 1: normal closed

(12~15 bit) Proximity switch logic

0: rising edge is effective 1: falling edge is effective

0 bit	1 bit	2 bit	3 bit
X-axis machine zero returning direction (0:positive 1:negative)	Y-axis machine zero returning direction (0:positive 1:negative)	Z-axis machine zero returning direction (0:positive 1:negative)	U-axis machine zero returning direction (0:positive 1:negative)

4 bit	5 bit	6 bit	7 bit
X-axis whether to use proximity switch (0: not use 1: use)	Y-axis whether to use proximity switch (0: not use 1: use)	Z-axis whether to use proximity switch (0: not use 1: use)	U-axis whether to use proximity switch (0: not use 1: use)

8 bit	9 bit	10 bit	11 bit
X-axis proximity switch state (0: normal open 1: normal close)	Y-axis proximity switch state (0: normal open 1: normal close)	Z-axis proximity switch state (0: normal open 1: normal close)	U-axis proximity switch state (0: normal open 1: normal close)

12 bit	13 bit	14 bit	15 bit
X-axis proximity switch logic(0: rising 1: falling)	Y-axis proximity switch logic(0: rising 1: falling)	Z-axis proximity switch logic(0: rising 1: falling)	U-axis proximity switch logic(0: rising 1: falling)

PARA.27: Amplification factor

When the system operates the data, all the decimals will be ignored, the data will be stored in integer. Before the system operation, expand 2^n (n: amplification factor) times for the data which can improve the calculation precision. After the calculation, divide the data by 2^n.

The bigger the amplification factor, the higher the calculation precision. However, if the factor is too big, the register will overflow. Generally, set the factor to 6. (Notes: normally, don't set this parameter, to avoid calculation error).

PARA.28: Feed forward compensation coefficient

Range: 0%~100%. 0% means no feed forward compensation.

The following instruction outputs the pulse after receiving the pulse and internal processing, so there will be delay effect. Modify the delay effect by feed forward compensation to achieve the best synchronization.

3-7. Special data register list

No.	Special data register	Function	Explanation	Default value
1	D8482 D8483	Current position (0-axis)	0-axis current coordinates position	0
2	D8484 D8485	Current position (1-axis)	1-axis current coordinates position	0
3	D8486 D8487	Current position (2-axis)	2-axis current coordinates position	0
4	D8488 D8489	Current position (3-axis)	3-axis current coordinates position	0
5	D8490 D8491	Current segment	The No. of current running motion control instruction. (Current segment only points to motion control instructions. General PLC instructions are not included in it.)	0

6	D8500 D8501	Current pulse number of following	The pulse number output by FOLLOW instruction	
7	D8502	Fine tuning pulse number of following	Increased or decreased pulse number in one scanning period. It resets after the scanning period.	

3-8. Special auxiliary relay list

NO.	Special auxiliary relay	Function	Explanation	Default value
1	M8260	Flow control bit	See note[1]	0
2	M8261	Forbid X-axis return to machine zero bit	When this bit is ON, the return to zero instruction of this axis will not work.	0
3	M8262	Forbid Y-axis return to machine zero bit	When this bit is ON, the return to zero instruction of this axis will not work.	0
4	M8263	Forbid Z-axis return to machine zero bit	When this bit is ON, the return to zero instruction of this axis will not work.	0
5	M8264	Forbid U-axis return to machine zero bit	When this bit is ON, the return to zero instruction of this axis will not work.	0
6	M8265	X-axis return to machine zero end bit	When running DRVZ, this bit will from ON to OFF, when machine reach the zero point, this bit become ON, see Note [2].	0
7	M8266	Y-axis return to machine zero end bit	When running DRVZ, this bit will from ON to OFF, when machine reach the zero point, this bit become ON.	0
8	M8267	Z-axis return to machine zero end bit	When running DRVZ, this bit will from ON to OFF, when machine reach the zero point, this bit become ON.	0
9	M8268	U-axis return to machine zero end bit	When running DRVZ, this bit will from ON to OFF, when machine reach the zero point, this bit become ON.	0

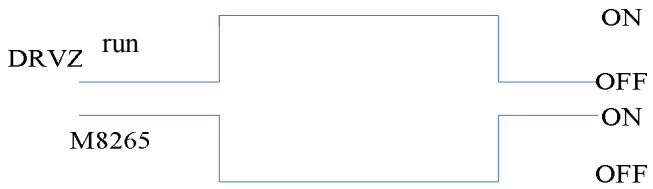
Note[1]：

When scanning the ladder chart in PLC, implement one after another. But motion control is based on process control, only when one instruction is completed, the next one will be executed.

So, uses a special M register (M8260) to show the state of the last positioning instruction. When running, set ONM8260; when completed, set it OFF. The next instruction starts to run when receiving the M8260 falling edge signal. When running, set ON M8260 again; when completed, set it OFF. Repeat as this way, the program will run in order.

Note[2]：

When running DRVZ instruction, M8265 turns from ON to OFF. When machine reaches machine zero point, M8265 turns to ON again.



3-9. Pulse output sign bit

Bit register:

Address	Function	Explanation	Pulse number
M8170	Pulse output	ON when pulse output	PULSE_1
M8171	32-bit pulse output overflow	ON when overflow	
M8172	Direction	1 is positive direction, related direction output ON	
M8173	Pulse output	ON when pulse output	PULSE_2
M8174	32-bit pulse output overflow	ON when overflow	
M8175	Direction	1 is positive direction, related direction output ON	
M8176	Pulse output	ON when pulse output	PULSE_3
M8177	32-bit pulse output overflow	ON when overflow	
M8178	Direction	1 is positive direction, related direction output ON	
M8179	Pulse output	ON when pulse output	PULSE_4
M8180	32-bit pulse output overflow	ON when overflow	

M8181	Direction	1 is positive direction, related direction output ON	
M8730	Pulse output	ON when pulse output	PULSE_5
M8731	32-bit pulse output overflow	ON when overflow	
M8732	Direction	1 is positive direction, related direction output ON	
M8733	Pulse output	ON when pulse output	PULSE_6
M8734	32-bit pulse output overflow	ON when overflow	
M8735	Direction	1 is positive direction, related direction output ON	
M8736	Pulse output	ON when pulse output	PULSE_7
M8737	32-bit pulse output overflow	ON when overflow	
M8738	Direction	1 is positive direction, related direction output ON	
M8739	Pulse output	ON when pulse output	PULSE_8
M8740	32-bit pulse output overflow	ON when overflow	
M8741	Direction	1 is positive direction, related direction output ON	
M8742	Pulse output	ON when pulse output	PULSE_9
M8743	32-bit pulse output overflow	ON when overflow	
M8744	Direction	1 is positive direction, related direction output ON	
M8745	Pulse output	ON when pulse output	PULSE_10
M8746	32-bit pulse output overflow	ON when overflow	
M8747	Direction	1 is positive direction, related direction output ON	
M8210	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_1
M8211	Whether to ignore the alarm	1 is stop output when alarm	
M8212	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_2
M8213	Whether to ignore the alarm	1 is stop output when alarm	
M8214	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_3
M8215	Whether to ignore the alarm	1 is stop output when alarm	
M8216	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_4

M8217	Whether to ignore the alarm	1 is stop output when alarm	
M8750	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_5
M8751	Whether to ignore the alarm	1 is stop output when alarm	
M8752	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_6
M8753	Whether to ignore the alarm	1 is stop output when alarm	
M8754	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_7
M8755	Whether to ignore the alarm	1 is stop output when alarm	
M8756	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_8
M8757	Whether to ignore the alarm	1 is stop output when alarm	
M8758	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_9
M8759	Whether to ignore the alarm	1 is stop output when alarm	
M8760	pulse alarm (frequency change suddenly)	1 is alarm, 0 is correct	PULSE_10
M8761	Whether to ignore the alarm	1 is stop output when alarm	

Words register:

Address	Function	Explanation	Pulse number
D8170	Low 16-bit accumulative pulse quantity	Latched	PULSE_1
D8171	High 16-bit accumulative pulse quantity		
D8172	Current segment (No. n segment)		
D8173	Low 16-bit accumulative pulse quantity	Latched	PULSE_2
D8174	High 16-bit accumulative pulse quantity		
D8175	Current segment (No. n segment)		
D8176	Low 16-bit accumulative pulse quantity	Latched	PULSE_3
D8177	High 16-bit accumulative pulse quantity		
D8178	Current segment (No. n segment)		
D8179	Low 16-bit accumulative pulse quantity	Latched	PULSE_4
D8180	High 16-bit accumulative pulse quantity		
D8181	Current segment (No. n segment)		

D8730	Low 16-bit accumulative pulse quantity	Latched	PULSE_5
D8731	High 16-bit accumulative pulse quantity		
D8732	Current segment (No. n segment)		
D8733	Low 16-bit accumulative pulse quantity	Latched	PULSE_6
D8734	High 16-bit accumulative pulse quantity		
D8735	Current segment (No. n segment)		
D8736	Low 16-bit accumulative pulse quantity	Latched	PULSE_7
D8737	High 16-bit accumulative pulse quantity		
D8738	Current segment (No. n segment)		
D8739	Low 16-bit accumulative pulse quantity	Latched	PULSE_8
D8740	High 16-bit accumulative pulse quantity		
D8741	Current segment (No. n segment)		
D8742	Low 16-bit accumulative pulse quantity	Latched	PULSE_9
D8743	High 16-bit accumulative pulse quantity		
D8744	Current segment (No. n segment)		
D8745	Low 16-bit accumulative pulse quantity	Latched	PULSE_10
D8746	High 16-bit accumulative pulse quantity		
D8747	Current segment (No. n segment)		
D8210	Error segment no.		PULSE_1
D8212	Error segment no.		PULSE_2
D8214	Error segment no.		PULSE_3
D8220	Accuracy of frequency measurement	The bit behind decimal point 1 means ×10, 2 means ×100	
D8216	Error segment no.		PULSE_4
D8750	Error segment no.		PULSE_5
D8752	Error segment no.		PULSE_6
D8754	Error segment no.		PULSE_7
D8756	Error segment no.		PULSE_8

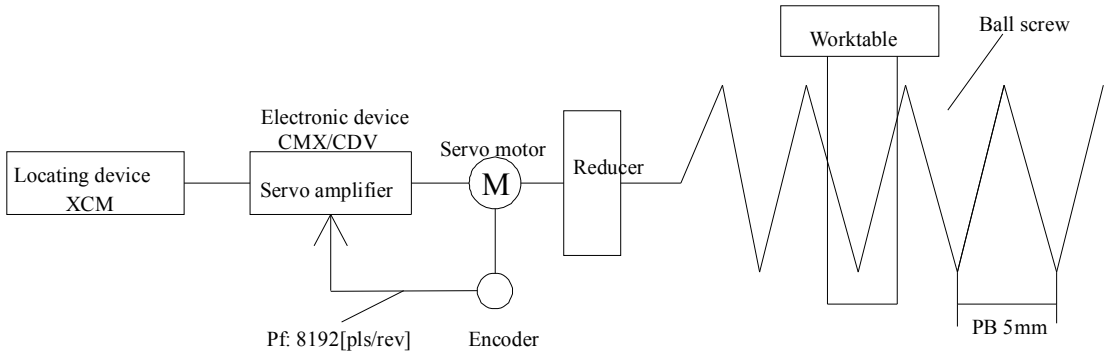
D8758	Error segment no.		PULSE_9
D8760	Error segment no.		PULSE_10
D8190	Low 16-bit of current pulse quantity		PULSE_1
D8191	High 16-bit of current pulse quantity		
D8192	Low 16-bit of current pulse quantity		PULSE_2
D8193	High 16-bit of current pulse quantity		
D8194	Low 16-bit of current pulse quantity		PULSE_3
D8195	High 16-bit of current pulse quantity		
D8196	Low 16-bit of current pulse quantity		PULSE_4
D8197	High 16-bit of current pulse quantity		
D8770	Low 16-bit of current pulse quantity		PULSE_5
D8771	High 16-bit of current pulse quantity		
D8772	Low 16-bit of current pulse quantity		PULSE_6
D8773	High 16-bit of current pulse quantity		
D8774	Low 16-bit of current pulse quantity		PULSE_7
D8775	High 16-bit of current pulse quantity		
D8776	Low 16-bit of current pulse quantity		PULSE_8
D8777	High 16-bit of current pulse quantity		
D8778	Low 16-bit of current pulse quantity		PULSE_9
D8779	High 16-bit of current pulse quantity		
D8780	Low 16-bit of current pulse quantity		PULSE_10
D8781	High 16-bit of current pulse quantity		
D8230	Rising time of absolute/relative positioning instruction (Y0)		PULSE_1
D8231	Falling time of origin returning instruction (Y0)		
D8232	Rising time of absolute/relative positioning instruction (Y1)		PULSE_2
D8233	Falling time of origin returning instruction (Y1)		
D8234	Rising time of absolute/relative positioning instruction (Y2)		PULSE_3
D8235	Falling time of origin returning instruction (Y2)		
D8236	Rising time of absolute/relative positioning instruction (Y3)		PULSE_4
D8237	Falling time of origin returning instruction (Y3)		
D8790	Rising time of absolute/relative positioning instruction (Y4)		PULSE_5
D8791	Falling time of origin returning instruction (Y4)		
D8792	Rising time of absolute/relative positioning instruction (Y5)		PULSE_6
D8793	Falling time of origin returning instruction (Y5)		
D8794	Rising time of absolute/relative positioning instruction (Y6)		PULSE_7
D8795	Falling time of origin returning instruction (Y6)		

D8796	Rising time of absolute/relative positioning instruction (Y7)		PULSE_8
D8797	Falling time of origin returning instruction (Y7)		
D8798	Rising time of absolute/relative positioning instruction (Y10)		PULSE_9
D8799	Falling time of origin returning instruction (Y10)		
D8800	Rising time of absolute/relative positioning instruction (Y11)		PULSE_10
D8801	Falling time of origin returning instruction (Y11)		

3-9. Application

1. Model system

XCM controls the worktable position via controlling the servo motor.



2. Parameter settings

(1) Servo driver parameter settings:

The rated speed of servo motor is 3000[r/min], the feedback pulse of encoder is 8192 [pls/rev]. As the characteristic of servo motor, at certain rotation speed, command pulse frequency f_0 is equal to the feedback pulse frequency P_B, and then you will obtain the following equation:

$f_{0:}$ Command pulse frequency (Hz) (Output from the XCM)

$P_{f:}$ Feedback pulse (locating feedback pulse) quantity [pls/rev]

$P_{B:}$ The screw pitch of ball screw

N_0: The rotation speed of servo motor[r/min]

CMX: The numerator of servo driver command pulse amplification (electronic gear)

CDV: The denominator of servo driver command pulse amplification (electronic gear)

When the servo motor reaches the rated rotation speed, XCM needs to output the maximum command pulse frequency, here we select 200 KHz. The result is as below:

$$\frac{CMX}{CDV} = P_f \times \frac{N0}{60} \times \frac{1}{f_0} = \frac{256}{125}$$

So, set "CMX=256，CDV=125" in servo amplifier.

(2) Pulse rate and feed rate

Deduce pulse rate and feed rate according to the following steps.

1. Pulse rate means the pulse quantity of servo motor rotating a circle, it can calculate pulse rate as the following formula:

$$A = P_f \times \frac{1}{\frac{CMX}{CDV}}$$

Substitute the previous value (CMX:256 CDV:125) into the formula, then you will get the pulse rate.

Pulse rate: $A = 8192[pls/rev] \times \frac{1}{\frac{256}{125}} = 4000[pls/rev]$

2. Feed rate means the motion quantity of the work piece when servo motor rotates one circle.

When ball screw finishes one screw pitch P_B, motor rotates N2 circles, and the transmission ratio between motor and ball screw is N1.

Feed rate $B = \mathrm{N1} \times \mathrm{P_B} \times \frac{1}{\mathrm{N2}}$

N1: machine transmission ratio

N2: rotate circle quantity

P_B: screw pitch of the ball screw

Below is calculating process:

Feed rate $B = \frac{1}{1} \times 5[mm] \times \frac{1}{1[rev]} = 5[mm/rev]$

(3) Convert motion quantity to pulse quantity

$$\text{Pulse quantity} = \frac{\text{Machine quantity}}{\text{Motor feed rate per rotation}} \times \text{pulse quantity of every motor rotation}$$

We need the work piece to move 200mm, then convert it to pulse quantity:

$$\text{Pulse quantity (pls)} = \frac{200[\text{mm}]}{5[\text{mm/rev}]} \times 4000[\text{pls/rev}] = 160000[\text{pls}]$$

So if the work piece moves 200mm, XCM need to output 160000 pulses.

If the work piece moves at the speed of 30cm/min, then convert it to pulse frequency:

Pulse quantity:

$$(\mathrm{Hz}) = \frac{30[\mathrm{cm}/\mathrm{min}] \times 10 \times 1/60}{5[mm/rev]} \times 4000[pls/rev] = \frac{300 \times 1/60}{5} \times 4000 = 4000Hz$$

So if the work piece moves at 30cm/min, XCM should output pulse frequency of 4000Hz.

3. Program explanation

▲ Axis position control operation

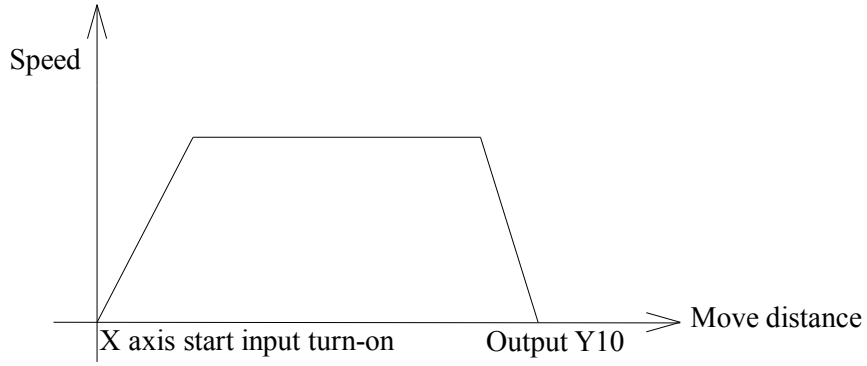
Positioning summarize: positioning device only moves as the current motion quantity.

● Operating steps

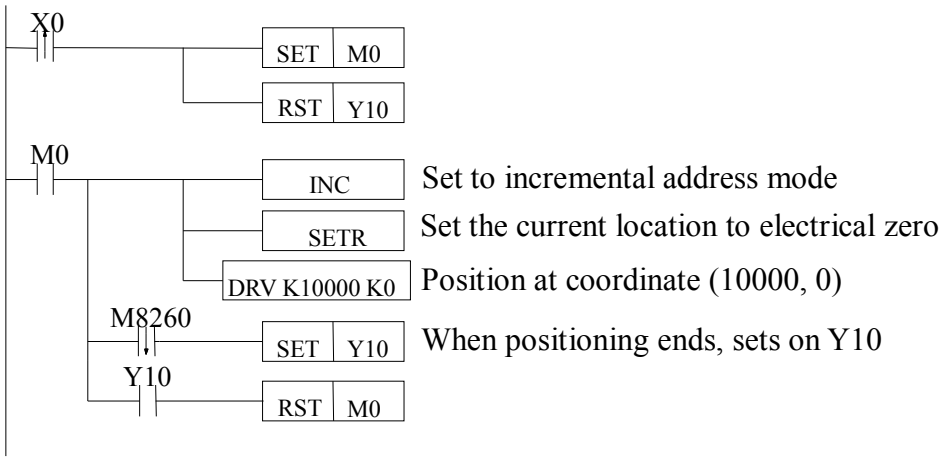
ⅰ：When positioning device receives starting command, it will move as current quantity.

ⅱ：When the moving ends, sets ON Y10.

● Motion diagram



● Procedure



▲ Position with reciprocating motion constant

● Positioning summarize

XCM controls work piece moving from left to right, and controls work piece up-down moving via electromagnet.

● Operate steps

(1) Only the first time work piece returns to zero via starting command.

(2) The electromagnet Y0 turns on which moves down the work piece. When lower limit switch X0 turns on, clamping electromagnet Y1 turns on to clamp work piece.

(3) After 1.5s, move-down electromagnet Y0 turns off, work piece moves up.

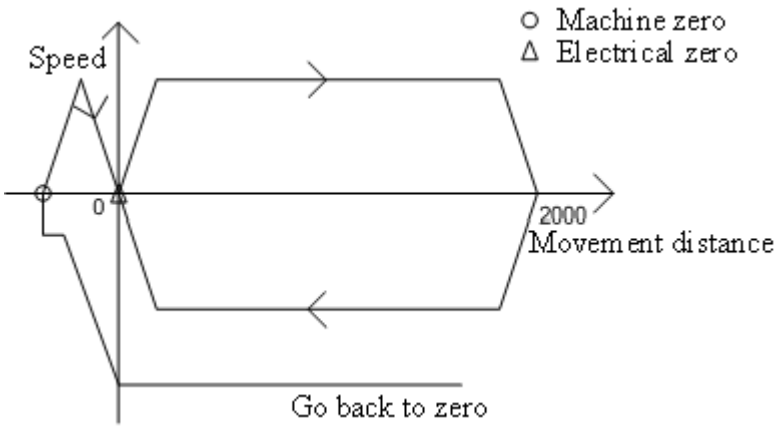
(4) When upper limit switch X1 turns on, work piece moves right.

(5) When positioning device arrives at right side of the worktable (2000, 0), move-down electromagnet Y0 turns on, work piece starts to move down. When lower limit switch X0 turns on, clamping electromagnet Y1 turns off, the clamp loose to put down the work piece.

(6) After 1.5s, move-down electromagnet Y0 turns off, positioning device moves up.

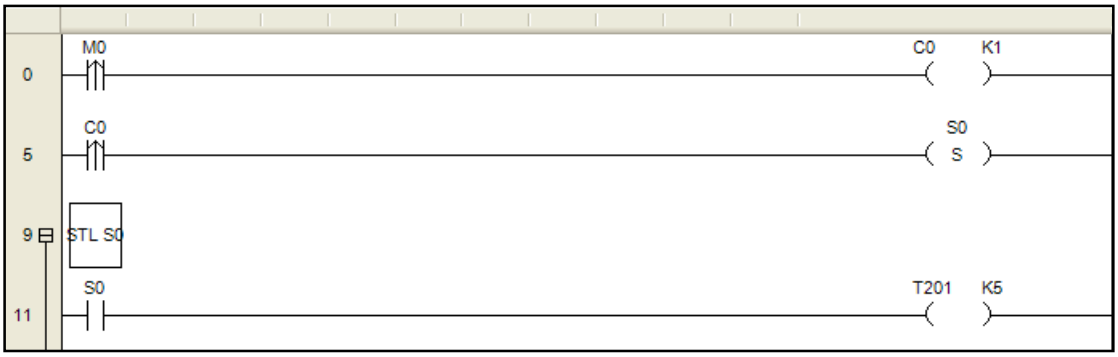
(7) When upper limit switch X1 turns on, work piece goes back to the left side of worktable.

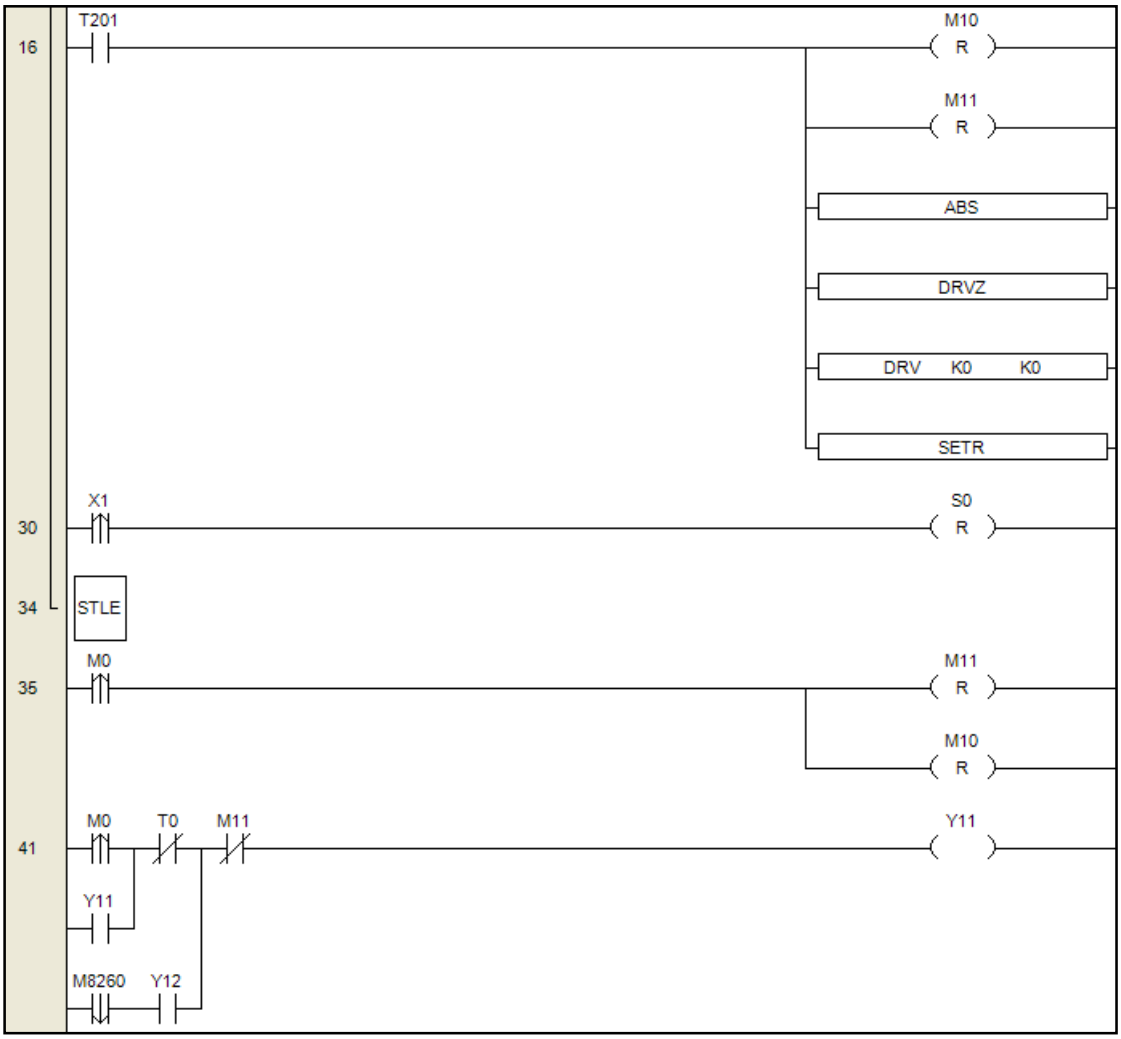
● Running diagram

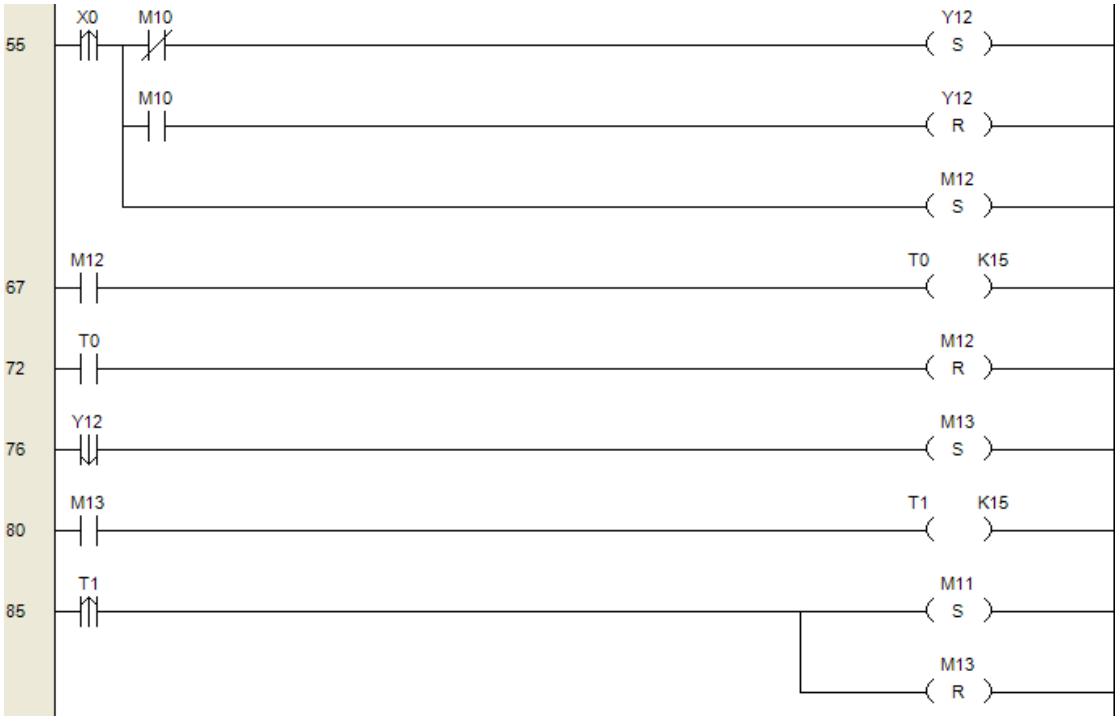


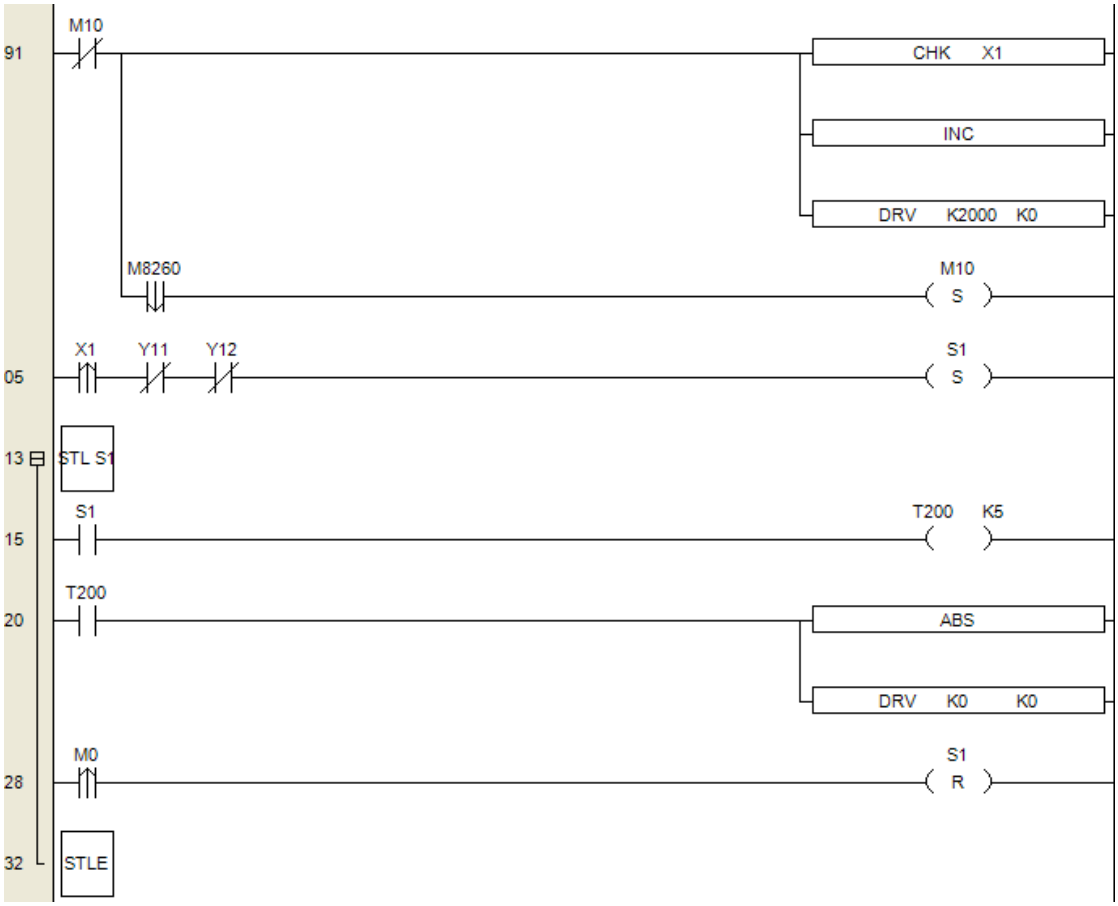
● Program

Ladder chart:




16
T201
M10
R
M11
R
ABS
DRVZ
DRV K0 K0
SETR
30
X1
S0
R
34
STLE
35
M0
M11
R
M10
R
41
M0
T0
M11
Y11
Y11
M8260
Y12


55
X0
M10
Y12
S
M10
Y12
R
M12
S
67
M12
T0
K15
72
T0
M12
R
76
Y12
M13
S
80
M13
T1
K15
85
T1
M11
S
M13
R



Instruction:

```
LDP     M0
OUT     C0      K1      count the starting times
LDP     C0              when starting at the first time, set on process S0
SET     S0
STL     S0
LD      S0
OUT     T201    K5
LD      T201
RST     M10
RST     M11
ABS
DRVZ                    go back to electrical zero
DRV     K0      K0      fast position to (0, 0)
SETR                    set the current position to electrical zero
LDP     X1
RST     S0
STLE
LDP     M0              not start M0 at the first time
```

```
RST     M11          reset M11 and M10
RST     M10
LDP     M0
OR      Y11          when M0 turns on, move-down electromagnet Y11 turns on
ANI     T0
LDF     M8260
AND     Y12          when move right is finished, move-down electromagnet Y11 turns on
ORB
ANI     M11
OUT     Y11
LDP     X0           when lower limit switch X0 turns on, clamping electromagnet Y12 turns on
MCS
LDI     M10
SET     Y12
LD      M10
RST     Y12
LD      M8000
SET     M12          M12 is seemed as X0 lower limit switch sign
MCR
LD      M12
OUT     T0   K15     delay for 1.5 seconds and clamping electromagnet turns on
LD      T0
RST     M12          after 1.5 seconds, loose the move-down electromagnet
LDF     Y12
SET     M13
LD      M13
OUT  T1  K15         delay for 1.5 seconds, after 1.5 seconds, turn off the move-down
                     electromagnet, it moves up
LDP     T1
SET     M11
RST     M13
LDI     M10
MCS
CHK     X1
INC
DRV     K2000  K0    when X1 turns on, fast position to (2000, 0)
LDF     M8260
SET     M10
MCR
LDP     X1
ANI     Y11          when X1 turns on again, start process S1 and fast return
ANI     Y12
SET     S1
STL     S1
```

```
LD      S1
OUT     T200    K5
LD      T200
ABS
DRV     K0  K0
LDP     M0
RST     S1
STLE
```

4. Appendix

The chapter introduces the basic and applied instructions of PLC, motion control instructions and parameters of motion controller.

4-1. Basic order control instruction list

Instruction	Function	Usable soft element
LD	Initial logical operation NO (normally open) contactor	X、Y、M、S、T、C、Dn.m、FDn.m
LDD	Directly read state from contactor	X
LDI	Initial logical operation NC (normally closed) contactor	X、Y、M、S、T、C、Dn.m、FDn.m
LDDI	Directly read NC(normally closed) contactor	X
LDP	Initial logical operation-Rising edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
LDF	Initial logical operation-Falling /trailing edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
AND	Serial connection of NO (normally open) contactors	X、Y、M、S、T、C、Dn.m、FDn.m
ANDD	Directly read state from contactor	X
ANI	Serial connection of NC (normally closed) contactors	X、Y、M、S、T、C、Dn.m、FDn.m
ANDDI	Directly read NC(normally closed) contactor	X
ANDP	Serial connection of rising edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
ANDF	Serial connection of falling/trailing edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
OR	Parallel connection of NC (normally closed) contactors	X、Y、M、S、T、C、Dn.m、FDn.m
ORD	Directly read state from contact	X
ORI	Parallel connection of NC (normally closed) contactors	X、Y、M、S、T、C、Dn.m、FDn.m
ORDI	Directly read NC(normally closed) contactor	X
ORP	Parallel connection of rising edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
ORF	Parallel connection of falling/trailing edge pulse	X、Y、M、S、T、C、Dn.m、FDn.m
ANB	Serial connection of multiply parallel circuits	None
ORB	Parallel connection of multiply parallel circuits	None

OUT	Final logic operation coil drive	Y、M、S、T、C、Dn.m
OUTD	Directly output to loop	Y
SET	Set a bit device permanently ON	Y、M、S、T、C、Dn.m
RST	Reset a bit device permanently OFF	Y、M、S、T、C、Dn.m
PLS	Rising edge pulse	X、Y、M、S、T、C、Dn.m
PLF	Falling/trailing edge pulse	X、Y、M、S、T、C、Dn.m
MCS	Connect the public serial contactors	None
MCR	Clear the public serial contactors	None
ALT	The status of the assigned device is inverted on every operation of the instruction	X、Y、M、S、T、C、Dn.m
NOP	No operation or null step	None
END	Force the current program scan to end	None
GROUP	Start the fold of instruction group	None
GROUPE	End the fold of instruction group	None

（Note: refer to《XC series instruction manual》）

4-2. Application instruction list

Application instruction kinds and corresponding kinds of each series showed as below:

Sort	Mnemonic	Function
Program Flow	CJ	Condition jump
	CALL	Call subroutine
	SRET	Subroutine return
	STL	Flow start
	STLE	Flow end
	SET	Open the assigned flow, close the current flow
	ST	Open the assigned flow, not close the current flow
	FOR	Start of a FOR-NEXT loop
	NEXT	End of a FOR-NEXT loop
	FEND	First end
Data Compare	LD＝	LD activates if (S1) = (S2)
	LD＞	LD activates if (S1) > (S2)
	LD＜	LD activates if (S1) =< (S2)
	LD＜＞	LD activates if（S1）≠（S2）
	LD＜＝	LD activates if（S1）≤（S2）
	LD＞＝	LD activates if（S1）≥（S2）
	AND＝	AND activates if（S1）＝（S2）
	AND＞	AND activates if（S1）＞（S2）
	AND＜	AND activates if（S1）＜（S2）
	AND＜＞	AND activates if（S1）≠（S2）
	AND＜＝	AND activates if（S1）≤（S2）
	AND＞＝	AND activates if（S1）≥（S2）
	OR＝	OR activates if（S1）＝（S2）

	OR＞	OR activates if（S1）＞（S2）
	OR＜	OR activates if（S1）＜（S2）
	OR＜＞	OR activates if（S1）≠（S2）
	OR＜＝	OR activates if（S1）≤（S2）
	OR＞＝	OR activates if（S1）≥（S2）
Data Move	CMP	Data compare
	ZCP	Data zone compare
	MOV	Move
	BMOV	Block move
	FMOV	Fill move
	FWRT	Flash ROM write
	MSET	Zone set
	ZRST	Zone reset
	SWAP	Exchange the high byte and low byte
	XCH	Exchange
Data Operation	ADD	Addition
	SUB	Subtraction
	MUL	Multiplication
	DIV	Division
	INC	Increment
	DEC	Decrement
	MEAN	Mean
	WAND	Word And
	WOR	Word OR
	WXOR	Word exclusive OR
	CML	Compliment
	NEG	Negative

Data Shift	SHL	Arithmetic Shift Left
	SHR	Arithmetic Shift Right
	LSL	Logic shift left
	LSR	Logic shift right
	ROL	Rotation shift left
	ROR	Rotation shift right
	SFTL	Bit shift left
	SFTR	Bit shift right
	WSFL	Word shift left
	WSFR	Word shift right

Data Convert Float Point Operation	WTD	Single word integer converts to double word integer
	FLT	32 bits integer converts to float point
	FLTD	64 bits integer converts to float point
	INT	Float point converts to binary
	BIN	BCD converts to binary
	BCD	Binary converts to BCD
	ASC	Hex. converts to ASCII
	HEX	ASCII converts to Hex
	DECO	Coding
	ENCO	High bit coding
	ENCOL	Low bit coding
	ECMP	Float compare
	EZCP	Float Zone compare
	EADD	Float Add
	ESUB	Float Subtract
	EMUL	Float Multiplication
	EDIV	Float division
	ESQR	Float Square Root
	SIN	Sine
	COS	Cosine
	TAN	Tangent
	ASIN	Anti-sine
	ACOS	Anti-cosine
	ATAN	Anti-tangent
Clock Operation	TRD	Read RTC data
	TWR	Set RTC data

（Note: refer to《XC series instruction manual》）

4-3. Special function instruction list

Generic special instruction list

Instruction sign	Instruction name
PLSY	Single segment pulse output without accelerate/decelerate
PLSR	Single/multiple segment, with accelerate/decelerate, single/double direction pulse output
PLSF	Variable frequency pulse output
PLSNEXT/PLSNT	Pulse segment switch
PLSMV	Save pulse number into register
STOP	Pulse stop
COLR	Modbus loop read
INPR	Modbus input loop read
COLW	Modbus single loop write
MCLW	Modbus multiple loops write
REGR	Modbus register read
INRR	Modbus input register write
REGW	Modbus single register write
MRGW	Modbus multiple registers write
SEND	Free format data send
RCV	Free format data incept
CCOLR	CAN-bus loop read
CCOLW	CAN-bus loop write
CREGR	CAN-bus register read
CREGW	CAN-bus register write
PWM	Pulse width modulate
FRQM	Frequency measurement
STR	Precise timing
EI	Allow interruption
DI	Forbid interruption
IRET	Interruption return
PID	PID operation control
ZRN	Zero point returning
DRVA	Absolute positioning
DRVI	Relative positioning

（**Note:** refer to《XC series instruction manual 》）

4-4. High speed counter assignment

XCM high speed count input distribution as follows:

XCM-32T-E

	Incremental mode										Pulse + direction mode					AB phase mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max frequency	80K	10K									80K					80K		
4-time frequency																√		
Interruption	√	√									√					√		
X000	U										U					A		
X001											Dir					B		
X002																		
X003		U																

XCM-32T-E-3PLS

	Incremental mode										Pulse + direction mode					AB phase mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max frequency	80K	10K	10K	10K							80K	10K				80K	10K	
4-time frequency																√		
Interruption	√	√									√					√		
X000	U										U					A		
X001											Dir					B		
X002																		
X003		U										U					A	
X004												Dir					B	
X005																		
X006			U															
X007				U														

Notes: X7 cannot work with Y0 at the same time.

XCM-60T-E

	Incremental mode										Pulse + direction mode					AB phase mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max frequency	80K	10K	10K	10K												80K	10K	10K
4-time frequency																√	√	√
Interruption	√	√														√		
X000	U															A		
X001		U														B		
X002																		
X003																		
X004																		
X005																		
X006			U														A	
X007																	B	
X010				U														A
X011																		B

4-5. External input interruption assignment

XCM external interruption definition:

XCM-32T-E:

Input	Pointer		Disable interruption
	Rising interruption	Falling interruption	
X2	I0000	I0001	M8050
X5	I0100	I0101	M8051
X10	I0200	I0201	M8052
X11	I0300	I0301	M8053
X12	I0400	I0401	M8054
X13	I0500	I0501	M8055

XCM-32T-E-3PLS:

Input	Pointer		Disable interruption
	Rising interruption	Falling interruption	
X2	I0000	I0001	M8050
X5	I0100	I0101	M8051
X10	I0200	I0201	M8052

XCM-60T-E:

Input	Pointer		Disable interruption
	Rising interruption	Falling interruption	
X2	I0000	I0001	M8050
X3	I0100	I0101	M8051
X4	I0200	I0201	M8052
X5	I0300	I0301	M8053

4-6. Frequency measurement

XCM frequency measurement input:

Type	Input
XCM-32T-E	X3
XCM-32T-E-3PLS	X6, X7
XCM-60T-E	X1

Notes: X7 and Y0 of XCM-32T-E-3PLS cannot work at the same time.

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