5 HIGH SPEED COUNTER (HSC)

In this chapter we tell high speed counter's functions, including high speed count model, wiring method, read/write HSC value, reset etc.
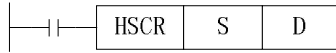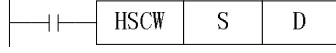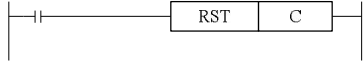
Instructions List for HSC

MNEMONIC	FUNCTION	CIRCUIT AND SOFT COMPONENTS		CHAPTER
READ/WRITE HIGH SPEED COUNTER				
HSCR	Read HSC	HSCR	S	D	5-6-1
HSCW	Write HSC	HSCW	S	D	5-6-2
OUT	HSC (High Speed Counter)	Cn Kn/D ( )		3-13
OUT	24 segments HSC Interruption	Cn Kn D ( )		5-10
RST	HSC Reset	RST C		3-13

XC series PLC has HSC (High Speed Counter) function which is independent with the scan cycle. Via choosing different counter, test the high speed input signals with detect sensors and rotary encoders. The highest testing frequency can reach 80KHz.
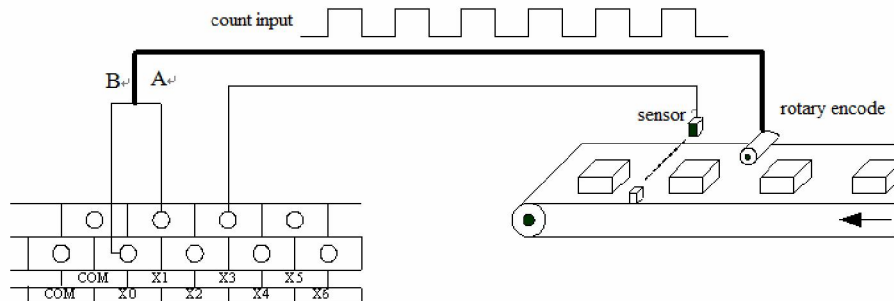
XC series high speed counter's function has three count modes: Increment Mode, Pulse+Direction Mode and AB phase Mode;

Increment Mode

Under this mode, count and input the pulse signal, the count value increase at each pulse's rising edge;
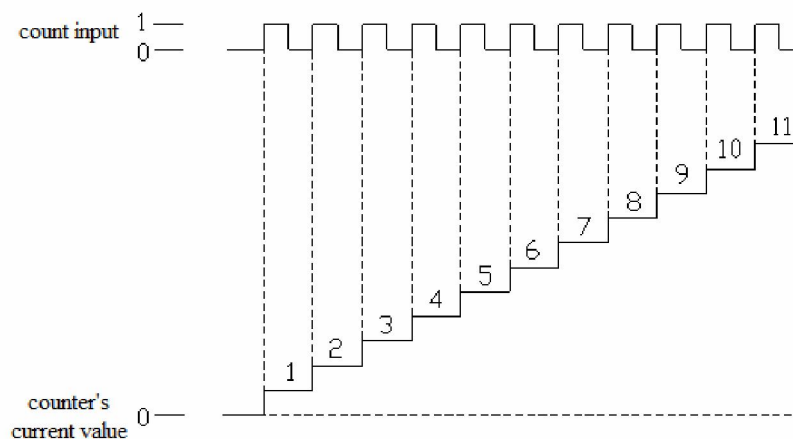
Pulse+Direction Mode

Under this mode, the pulse signal and direction signal are all inputted, the count value increase or decrease with the direction signal's status. When the count signal is OFF,

the count input's rising edge carry on plus count; When the count signal is ON, the count input's rising edge carry on minus count;
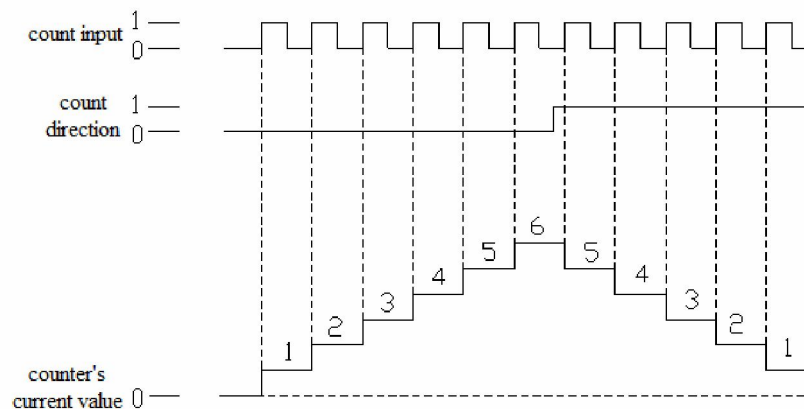
AB Phase Mode

Under this mode, the HSC value increase or decrease according to two differential signal (A phase and B phase). According to the multiplication, we have 1-time frequency and 4-time frequency two modes, but the default count mode is 4-time mode.

1-time frequency and 4-time frequency modes are shown below:
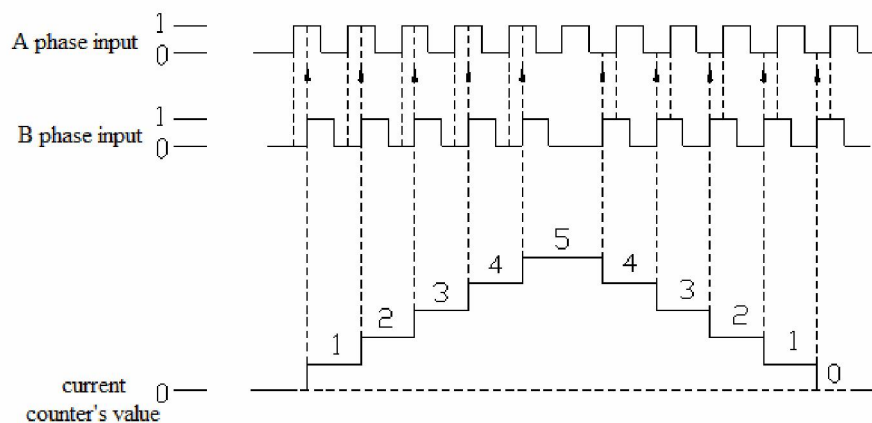
l **1-time Frequency**

l **4-time Frequency**
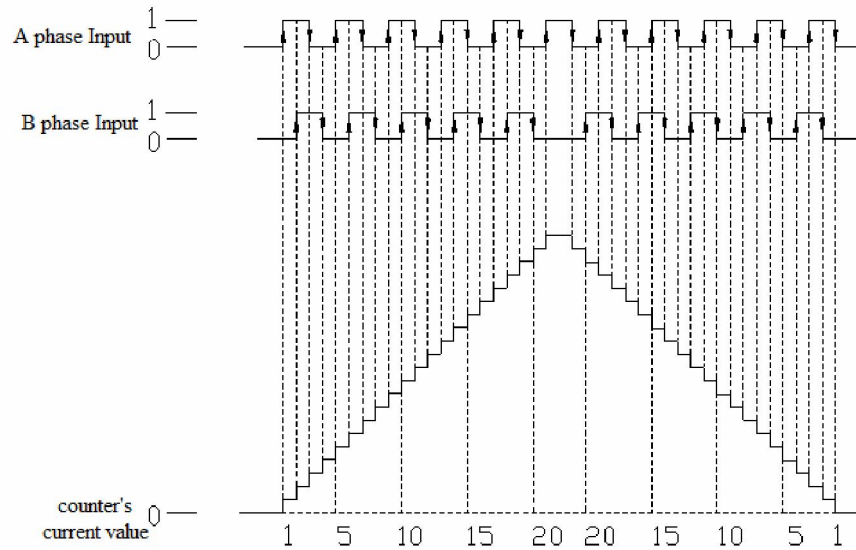
HSC's count range is: K-2,147,483,648 ~ K+2,147,483,647. If the count value overflows this range, then up flow or down flow appears;

For "up flow", it means the count value jumps from K+2,147,483,647 to be K-2,147,483,648, then continue to count; For "down flow", it means the count value jumps from K-2,147,483,648 to be K+2,147,483,647 then continue to count.

For the counter's pulse input wiring, things differ with different PLC model and counter model; several typical input wiring are shown below: (take XC3-48 as the example):

increment mode (Counter C600)
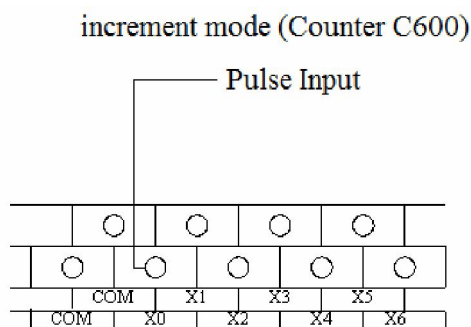
Pulse+Direction Mode (C620)
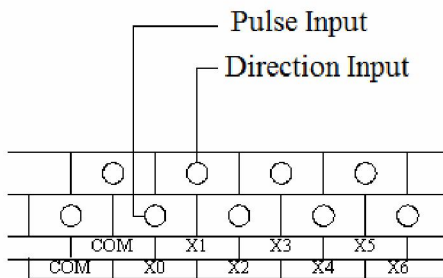
AB phase Mode (C630)
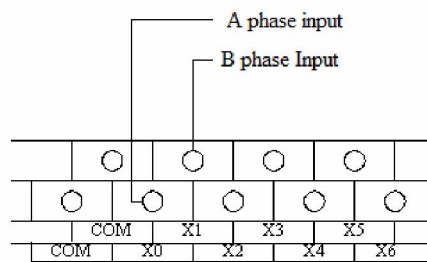
5-5   HSC ports assignment

Each letter's Meaning:

U	Dir	A	B
Pulse input	Count Direction Judgment (OFF=increment, ON=decrement)	A phase input	B phase input

Normally, X0 and X1 can accept 80KHz frequency under single phase mode and AB phase mode. Other terminals can accept only 10KHz under single phase mode, 5KHz under AB phase mode. X can use as normal input terminals when they are not used as high speed input. The detailed assignment is shown as below:

XC2 series PLC																	
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max.F	80K	80K	10K	10K	10K						80K	10K				80K	5K	
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001		U									Dir					B		
X002																		

	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
X003			U								U					A		
X004											Dir					B		
X005																		
X006				U														
X007					U													
X010																		
X011																		
X012																		

XC3-14 PLC																		
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
*Max.F	10K	10K	10K	10K							10K	10K				5K		
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001											Dir					B		
X002		U																
X003			U															
X004																		
X005				U														

* C600　C620　C630 can support 80KHz with special requirement

XC3-19AR-E																		
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max.F	10K	10K	10K	10K							10K	10K				5K	5K	
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001											Dir					B		
X002		U										U					A	
X003												Dir					B	
X004			U															
X005				U														

XC3-24　32 PLC and XC5-48　60 PLC																		
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634

Max.F	80K	80K	10K	10K	10K	10K					80K	10K	10K			80K	5K	5K
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001		U									Dir					B		
X002																		
X003			U									U					A	
X004												Dir					B	
X005																		
X006				U									U					A
X007													Dir					B
X010																		
X011					U													
X012						U												

XC3-48 60 PLC																		
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max.F	80K	80K	10K	10K							80K	80K				80K	80K	
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001											Dir					B		
X002		U										U					A	
X003												Dir					B	
X004			U															
X005				U														

XC5-24/32 PLC XCM-24/32 PLC																		
	Increment										Pulse+Dir Input					AB Phase Mode		
	C600	C602	C604	C606	C608	C610	C612	C614	C616	C618	C620	C622	C624	C626	C628	C630	C632	C634
Max.F	80K	10K									80K					80K		
4-times F																		
Count Interrupt																		
X000	U										U					A		
X001											Dir					B		
X002																		
X003		U																

X004																		
X005																		
X006																		

5-6   Read/Write HSC value

All high speed counters support read instruction [HSCR] and write instruction [HSCW], but users need to use hardware V3.1c and above.

5-6-1   Read HSC value [HSCR]

1   Instruction Summary

Read HSC value to the specified register;

Read from HSC [HSCR]/ write to HSC [HSCW]			
16 bits Instruction	-	32 bits Instruction	HSCR
Execution condition	Normally ON/OFF, rising/falling edge	Suitable models	XC2 XC3 XC5 XCM
Hardware requirement	V3.1c and above	Software requirement	-

2   Operands

Operands	Function	Type
S	Specify HSC code	32 bits, BIN
D	Specify the read/written register	32 bits, BIN

3   Suitable Soft Components

word	operands	system									constant	module	
		D	FD	ED	TD	CD	DX	DY	DM	DS	K/H	ID	QD
	S												
	D												

FUNCTIONS AND ACTIONS

- When the activate condition is true, read the HSC value in C630 (DWORD) into D10 (DWORD)
- Instruction HSCR read the HSC value into the specified register, improve HSC value's precision.

Sample Program:

```
    M8000
    ─┤├────┌──────────┬──────────┬──────────┐
                      │   HSCR   │   C630   │   D10    │
                      └──────────┴──────────┴──────────┘
    M8000
    ─┤├────┌──────────┬──────────┬──────────┐
                      │   HSCR   │   C632   │   D20    │
                      └──────────┴──────────┴──────────┘
    D10    K1000                           Y0
    ─┤D≥├──────────────────────────────────( S )
    D20    K5000                           Y0
    ─┤D≥├──────────────────────────────────( S )
```
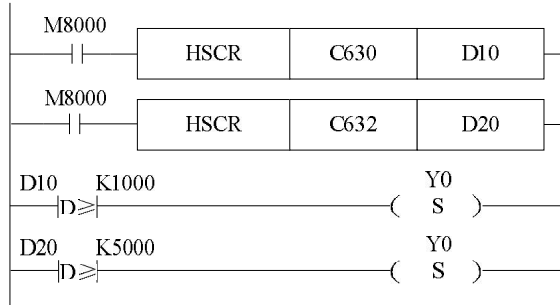
5-6-2   Write HSC value [HSCW]

1   Instruction Summary

Write the specified register value into HSC;

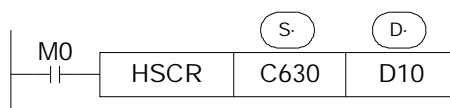| Write HSC value [HSCW]			
16 bits Instruction	-	32 bits Instruction	HSCW
Execution condition	Normally ON/OFF, rising/falling edge	Suitable models	XC2 XC3 XC5 XCM
Hardware requirement	V3.1c and above	Software requirement	-

2   operands

Operands	Function	Type
S	Specify HSC code	32 bits, BIN
D	Specify the read/written register	32 bits, BIN

3   suitable soft components

word	operands	system									constant	module	
		D	FD	ED	TD	CD	DX	DY	DM	DS	K/H	ID	QD
	S												
	D												

FUNCTIONS AND ACTIONS

```
        ┌─ S· ─┐   ┌─ D· ─┐
   M0   │      │   │      │
 ──┤↓├──┤ HSCW │ C630 │ D20 │
        └──────┴──────┴──────┘
```

| When the activate condition is true, write the value in D20 (DWORD) into C630 (DWORD), the original value is replaced;

| We suggest the users to apply high speed counter only with HSCR and HSCW, not with other instructions like DMOV, LD>, DMUL etc. and users must run after converting HSC to be other registers.

5-7   HSC Reset Mode

Reset HSC via software:

```
   M0                    C600      K2000
 ──┤ ├────────────────────────────────┤
   M1                    C600
 ──┤ ├────────────────────  R  ───────┤
```
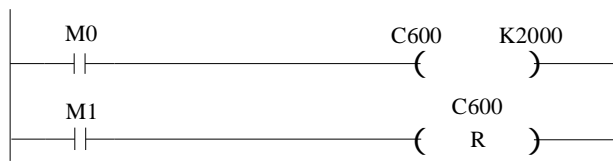
In the above graph, when M0 is ON, C600 starts to count the input pulse on X0; when M1 changes from OFF to be ON, reset C600, clear the count value

5-8   AB Phase counter multiplication setting

About AB phase counter, modify the frequency multiplication value via setting FLASH data register FD8241, FD8242, FD8243. If the value is 1, it is 1-time frequency, if it is 4, it is 4-time frequency.

Register	Function	Set Value	Meaning
FD8241	Frequency multiplication of C630	1	1-time frequency
		4	4-time frequency
FD8242	Frequency multiplication of C632	1	1-time frequency
		4	4-time frequency
FD8243	Frequency multiplication of C634	1	1-time frequency
		4	4-time frequency

Below, we take XC3-60 PLC as the example, to introduce HSC's program form;

Increment Mode

```
      M0                          C600    K2000
   ───┤├──────────────────────────(        )───
      M1                          C600
   ───┤↑├─────────────────────────(   R    )───
```

l   When M0 is ON, C600 starts the HSC with the OFF　ON of X000;

l   When comes the rising edge of M1, reset HSC C600

```
      M8000                        C600    K88888888
   ───┤├──────────────┬────────────(        )───
                      │
                      └──┤ HSCR │ C600 │ D0 │──
      M1                           C600
   ───┤↑├─────────────────────────(   R    )───
      D0    D2
   ──┤D<├───────────────────────────(   Y0   )───
      D0    D2   D0    D4
   ──┤D≥├───────┤D<├────────────────(   Y1   )───
      D0    D4
   ──┤D≥├───────────────────────────(   Y2   )───
```

l   When normally ON coil M8000 is ON, set the value of C600, the set value is K888888888, read the HSC value (DWORD) into data register D0 (DWORD).

l   If the value in C600 is smaller than value in D2, set the output coil Y0 ON; If the value in C600 equals or be larger than value in D2, and smaller than value in D4, set the output coil Y1 ON; If the value in C600 equals or be larger than value in D4, set the output coil Y2 ON;

l   When comes the rising edge of M1, reset HSC C600 and stop counting.

Pulse+Dir Mode

```
      M4                          C620    K999999
   ───┤├──────────────────────────(        )───
      M5                          C620
   ───┤↑├─────────────────────────(   R    )───
```

l   When M4 is ON, C620 starts the HSC with the OFF　ON of X000; judge the count direction according to the input X001 status (OFF or ON). If X001 is OFF, it's increment count; if X001 is ON, it's decrement count;

l   When comes the rising edge of M5, reset HSC C620 and stop counting.

```
      M8                        C630      K999999
    ──┤├──                      ──(        )──
      M8000
    ──┤├──               ┌──────┬──────┬──────┐
                         │ HSCR │ C630 │  D0  │
                         └──────┴──────┴──────┘
     D0   K3000                      Y2
    ──┤D≥├──────────────────────( )──
      M9                         C630
    ──┤↑├──                     ──( R )──
```
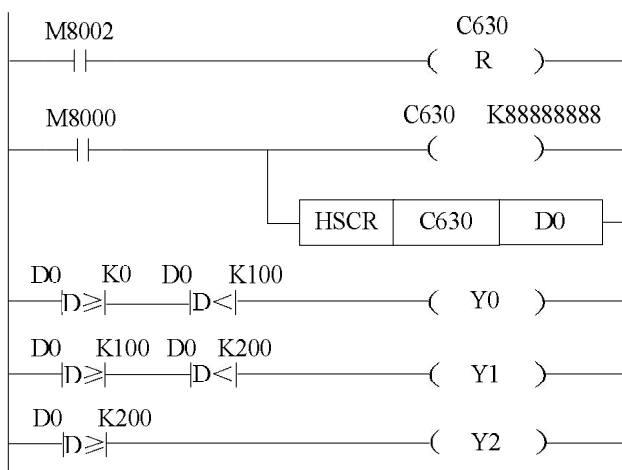
l   When M8 is ON, C630 starts to count immediately. Count input via X000 (B Phase)　X001 (A Phase)

l   When the count value exceeds K3000, output coil Y2 is ON;

l   When comes the rising edge of M9, reset HSC C630

```
      M8002                     C630
    ──┤├──                     ──( R )──
      M8000                     C630   K88888888
    ──┤├──────────┬────────────( )──
                  │      ┌──────┬──────┬──────┐
                  └──────│ HSCR │ C630 │  D0  │
                         └──────┴──────┴──────┘
     D0   K0   D0   K100
    ──┤D≥├────┤D<├──────────────( Y0 )──
     D0   K100 D0  K200
    ──┤D≥├────┤D<├──────────────( Y1 )──
     D0   K200
    ──┤D≥├──────────────────────( Y2 )──
```

l   When therising edge of initial positive pulse coil M8002 comes, i.e. Each scan cycle starts, HSC C630 reset and clear the count value.

l   When set coil M8000 ON, C630 starts to count, the count value is set to be K8888888

l   If the count value is greater than K0 but smaller than K100, the output coil Y0 set ON; If the count value is greater thanK100 but smaller than K200   the output coil Y1 set ON; If the count value is greater thanK200, the output coilY2 set ON;
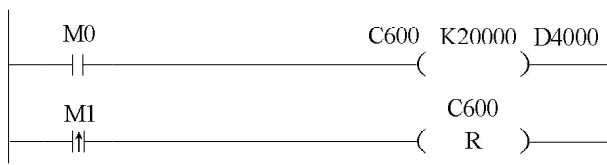
5-10. HSC Interruption

To XC series PLC, each HSC channels has 24 segments 32-bit pre-set value. When the HSC difference value equals the correspond 24-segment pre-set value, then interruption occures according to the interruption tag;

To use this function, please use hardware V3.1c or above;

5-10-1. Instruction Description

for the program about interruption, please refer chapter 5-10-4)

```
        M0                        C600  K20000 D4000
        ┤├──────────────────────( )
        M1                             C600
        ┤↑├─────────────────────( R )
```

LD	M0			//HSC activate condition M0 (interruption count condition)
OUT	C600	K20000	D4000	//HSC value and set the start ID of 24-segment
LDP	M1			//activate condition reset
RST	C600			//HSC and 24-segment reset (interruption reset)

As shown in the above graph, data register D4000 is the start ID of 24-segment pre-set value area. Behind it, save each pre-set value in DWORD form. Please pay attention when using HSC:

l   If certain pre-set value is 0, it means count interruption stops at this segment;

l   Set the interruption pre-set value but not write the correspond interruption program is not allowed;

l   24-segment interruption of HSC occurs in order. I.e. If the first segment interruption doesn't happen, then the second segment interruption will not happen;

l   24-segment pre-set value can be specified to be relative value or absolute value. Meantime, users can specify the et value to be loop or not. But the oop mode can't be used together with absolute value.

5-10-2. Interruption tags to HSC

In the below table, we list each counter's 24-segment pre-set value to its interruption tag. E.e.: 24-segment pre-set value of counter C600 correspond with the interruption pointer: I1001 I1002 I1003 …I1024.

Increment mode

Counter	Interruption tag
C600	I1001~I1024
C602	I1101~I1124
C604	I1201~I1224
C606	I1301~I1324
C608	I1401~I1424

pulse+direction mode

Counter	Interruption tag
C620	I2001~I2024
C622	I2101~I2124
C624	I2201~I2224
C626	I2301~I2324
C628	I2401~I2424

AB phase mode

Counter	Interruption tag
C630	I2501~I2524
C632	I2601~I2624
C634	I2701~I2724
C636	I2801~I2824
C638	I2901~I2924

C610	I1501~I1524
C612	I1601~I1624
C614	I1701~I1724
C616	I1801~I1824
C618	I1901~I1924

Define the presetvalue

HSC 24-segment pre-set value is the difference value, the count value equals the counter's current value plus the preset value, generate the interruption. N interruption tags correspond with N interruptionpreset values. The (N+1) preset value is 0;
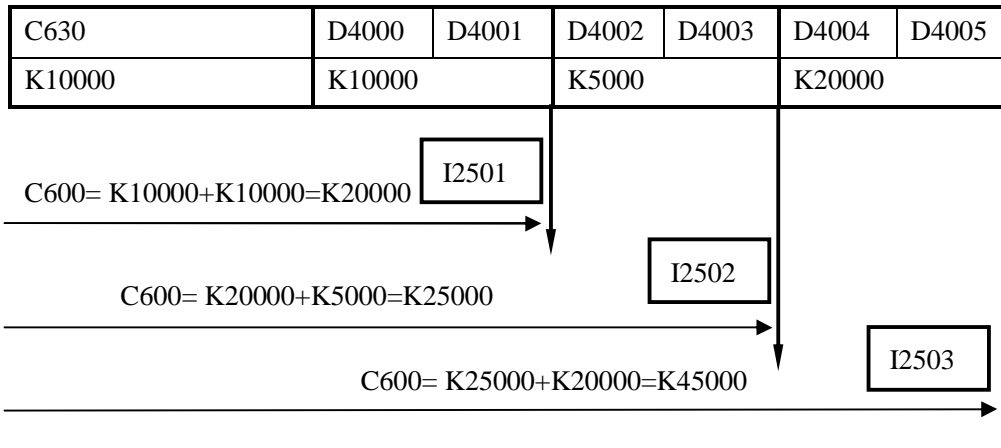
E.g. 1, the current value is C630 is 0, the first preset value is 10000, the preset value in segment 2 is 5000, the preset value in segment 3 is 20000. When start to count, the counter's current value is 10000, generate first interruption I2501; When start to count, the counter's current value is 5000, generate first interruption I2502 When start to count, the counter's current value is 25000, generate first interruption I2503.

See graph below:

C630	D4000	D4001	D4002	D4003	D4004	D4005
K0	K10000		K-5000		K20000	

C600= K0+K10000=K10000 [I2501]

C600= K10000+ K-5000 =K5000 [I2502]

C600= K5000+K20000=K25000 [I2503]
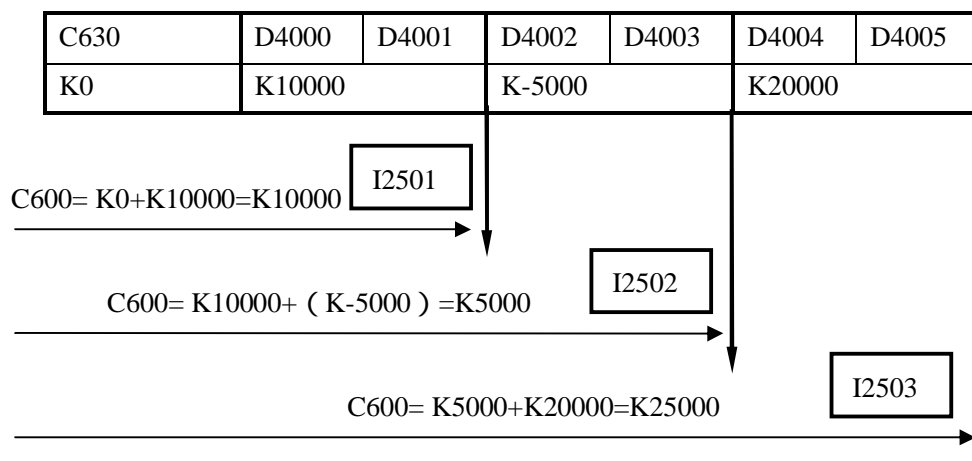
E.g. 2, the current value is C630 is 10000, the first preset value is 10000, the preset value in segment 2 is 5000, the preset value in segment 3 is 20000. When start to count, the counter's current value is 20000, generate first interruption I2501; When start to count, the counter's current value is 25000, generate first interruption I2502 When start to count, the counter's current value is 45000, generate first interruption I2503.

See graph below:

C630		D4000	D4001	D4002	D4003	D4004	D4005
K10000		K10000		K5000		K20000	

C600= K10000+K10000=K20000 [I2501]

C600= K20000+K5000=K25000 [I2502]

C600= K25000+K20000=K45000 [I2503]

5-10-3. Loop mode of HSC Interruption

Mode 1: Unicycle (normal mode)

Not happen after HSC interruption ends. The conditions below can re-start the interruption:

    (1) reset the HSC

    (2) Reboot the HSC activate condition

Mode 2: Continuous loop

Restart after HSC interruption ends. This mode is especially suitable for the following application:

    (1) continous back-forth movement

    (2) Generate cycle interruption according to the defined pulse

Via setting he special auxiliary relays, users can set the HSC interruption to be unicycle mode or continous loop mode. The loop mode is only suitable with the relative count. The detailed assignment is show below:

ID	HSC ID	Setting
M8270	24 segments HSC interruption loop (C600)	OFF: unicycle mode
M8271	24 segments HSC interruption loop (C602)	ON: continous loop mode
M8272	24 segments HSC interruption loop (C604)	
M8273	24 segments HSC interruption loop (C606)	
M8274	24 segments HSC interruption loop (C608)	
M8275	24 segments HSC interruption loop (C610)	
M8276	24 segments HSC interruption loop (C612)	
M8277	24 segments HSC interruption loop (C614)	
M8278	24 segments HSC interruption loop (C616)	
M8279	24 segments HSC interruption loop (C618)	
M8280	24 segments HSC interruption loop (C620)	

M8281	24 segments HSC interruption loop (C622)	
M8282	24 segments HSC interruption loop (C624)	
M8283	24 segments HSC interruption loop (C626)	
M8284	24 segments HSC interruption loop (C628)	
M8285	24 segments HSC interruption loop (C630)	
M8286	24 segments HSC interruption loop (C632)	
M8287	24 segments HSC interruption loop (C634)	

5-10-4. Example of HSC Interruption

E.g.2 Application on knit-weaving machine (continous loop mode)

The system theory is shown as below: Control the inverter via PLC, thereby control the motor. Meantime, via the feedback signal from encoder, control the knit-weaving machine and realize the precise position.
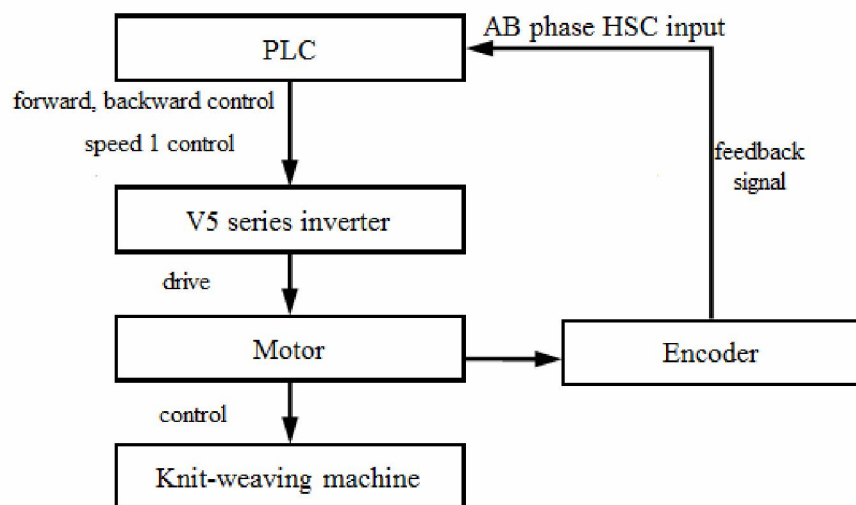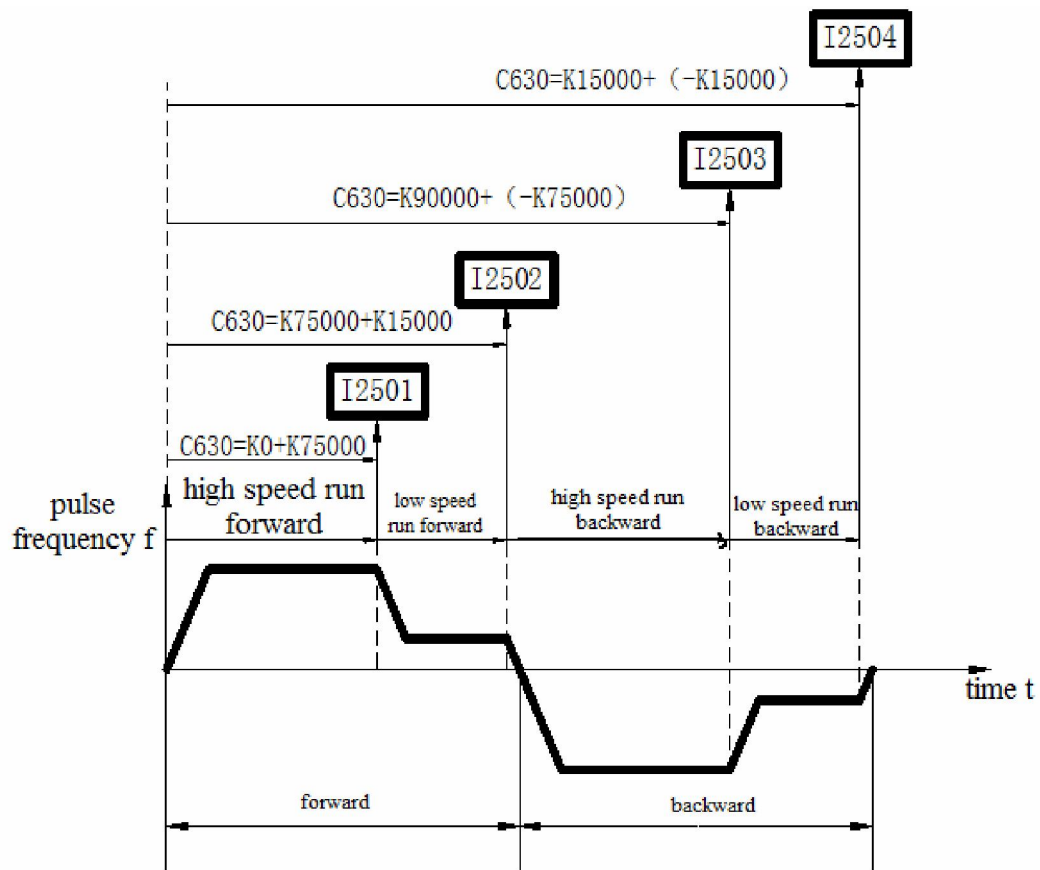
Below is PLC program: Y2 represents forward output signal; Y3 represents backward output signal; Y4 represents output signal of speed 1; C340: Back-forth times accumulation counter; C630: AB phase HSC;

```
 M8000                                    M8285
──┤├──────────────────────────────────┬──( S )──
                                       │    Y2
                                       └──( S )──

 Y2
──┤↓├─────────────────────────┌──────┬────────┬───────────┐
                              │ OUT  │  C340  │ K1000000  │
                              └──────┴────────┴───────────┘

 M8000
──┤├──────────────────────┬──┌───────┬─────────┬────────┐
                          │  │ DMOV  │ K75000  │ D4000  │
                          │  └───────┴─────────┴────────┘
                          │  ┌───────┬─────────┬────────┐
                          ├──│ DMOV  │ K15000  │ D4002  │
                          │  └───────┴─────────┴────────┘
                          │  ┌───────┬─────────┬────────┐
                          ├──│ DMOV  │ K-75000 │ D4004  │
                          │  └───────┴─────────┴────────┘
                          │  ┌───────┬─────────┬────────┐
                          └──│ DMOV  │ K-15000 │ D4006  │
                             └───────┴─────────┴────────┘

 M8000
──┤├──────┌──────┬────────┬────────────┬────────┐
          │ OUT  │  C630  │ K30000000  │ D4000  │
          └──────┴────────┴────────────┴────────┘

 M8000
──┤├──────────┌───────┬────────┬────────┐
              │ HSCR  │  C630  │  D200  │
              └───────┴────────┴────────┘

┌──────┐
│ FEND │
└──────┘

┌──────┐
│ I2501│
└──────┘

 M8000                                    Y4
──┤├──────────────────────────────────────( S )──

┌──────┐
│ IRET │
└──────┘

┌──────┐
│ I2502│
└──────┘

 M8000                                    Y4
──┤├──────────────────────────────────┬──( R )──
                                       │    Y2
                                       ├──( R )──
                                       │    Y3
                                       └──( S )──

┌──────┐
│ IRET │
└──────┘

┌──────┐
│ I2503│
└──────┘

 M8000                                    Y4
──┤├──────────────────────────────────────( S )──

┌──────┐
│ IRET │
└──────┘

┌──────┐
│ I2504│
└──────┘

 M8000                                    Y3
──┤├──────────────────────────────────┬──( R )──
                                       │    Y4
                                       ├──( R )──
                                       │    Y2
                                       └──( S )──

┌──────┐
│ IRET │
└──────┘
```
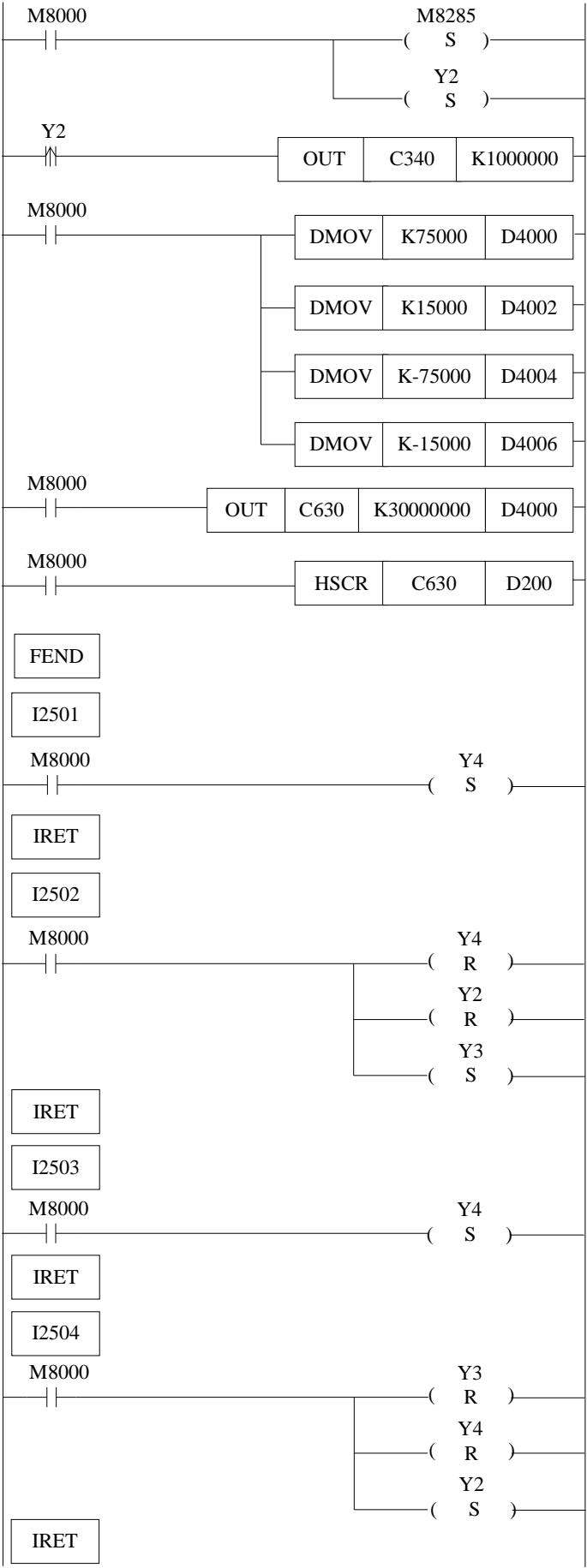
Instruction List Form:

```
LD  M8002                              //M8002 is initial positive pulse coil
SET M8285                              //special auxiliary relay set ON, to enable C630 continuous loop
SET Y2                                 //set output coil Y2 (i.e. Start run forth)
LDP Y2      //knit-weaving machine back-forth times counter's activate condition Y2 (forth rising edge activate)
OUT     C340     K1000000             //counter C340 starts to count
LD  M8000                              //M8000 is normally ON coil
DMOV   K75000  D4000                  //set segment-1 ID D4000 to be K75000
DMOV   K15000  D4002                  //set segment-2 D4002 to be K15000
DMOV   K-75000 D4004                  //set segment-3 D4004 to be K-75000
DMOV   K-15000 D4006                  //set segment-4 D4004 to be K-15000
LD  M8000                              //M8000 is normally ON coil
OUT   C630   K30000000   D4000        //HSC and start ID of 24-segment
LD  M8000                              //M8000 is normally ON coil
HSCR    C630      D200                 //read the HSC value of C630 to D200
FEND                                   //main program end
I2501                                  //interruption tag of segment 1
LD  M8000                              //M8000 is normally ON coil
SET     Y4                             //output coil Y4 set (low-speed run with speed 1)
IRET                                   //interruption return tag
I2502                                  ///interruption tag of segment 2
LD  M8000                              //M8000 is normally ON coil
RST Y4                                 //output coil Y4 reset (low-speed run stop)
RST Y2                                 //output coil Y2 reset (run forward stops)
SET Y3                                 //output coil Y3 set (back running)
IRET                                   //interruption return tag
I2503                                  ///interruption tag of segment 3
LD  M8000                              //M8000 is normally ON coil
SET Y4                                 //output coil Y4 set (low-speed run with speed 1)
IRET                                   //interruption return tag
I2504                                  ///interruption tag of segment 4
LD  M8000                              //M8000 is normally ON coil
RST Y3                                 //output coil Y3 reset (back running stop)
RST Y4                                 //output coil Y4 reset (low-speed run stop)
SET Y2                                 //output coil Y2 set (run forward)
IRET                                   //interruption return tag
```