Panasonic®

PROGRAMMABLE CONTROLLER

FP3

HIGH SPEED COUNTER UNIT

Technical Manual

FP3 HIGH SPEED COUNTER UNIT Technical Manual
ACG-M0020-2 '93.11

Matsushita Electric Works, Ltd.

Safety Precautions

Observe the following notices to ensure personal safety or to prevent accidents.
To ensure that you use this product correctly, read this User's Manual thoroughly before use.
Make sure that you fully understand the product and information on safe.
This manual uses two safety flags to indicate different levels of danger.

WARNING

If critical situations that could lead to user's death or serious injury is assumed by mishandling of the product.

-Always take precautions to ensure the overall safety of your system, so that the whole system remains safe in the event of failure of this product or other external factor.
-Do not use this product in areas with inflammable gas. It could lead to an explosion.
-Exposing this product to excessive heat or open flames could cause damage to the lithium battery or other electronic parts.

CAUTION

If critical situations that could lead to user's injury or only property damage is assumed by mishandling of the product.

-To prevent abnormal exothermic heat or smoke generation, use this product at the values less than the maximum of the characteristics and performance that are assure in these specifications.
-Do not dismantle or remodel the product. It could lead to abnormal exothermic heat or smoke generation.
-Do not touch the terminal while turning on electricity. It could lead to an electric shock..
-Use the external devices to function the emergency stop and interlock circuit.
-Connect the wires or connectors securely.
The loose connection might cause abnormal exothermic heat or smoke generation
-Do not allow foreign matters such as liquid, flammable materials, metals to go into the inside of the product. It might cause exothermic heat or smoke generation.
-Do not undertake construction (such as connection and disconnection) while the power supply is on.

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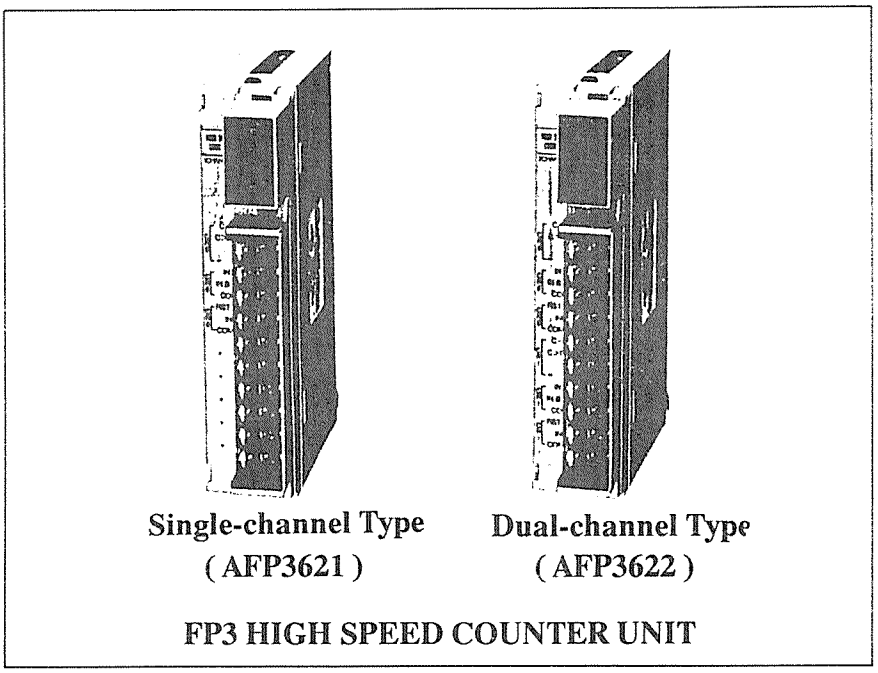
CHAPTER 1

SYSTEM CONFIGURATIONS AND SPECIFICATIONS

" PC " is the abbreviation for Programmable Controller.

1-1. Features



1. High speed response of 100 kcps

The phase input mode enables the two-phase pulses of rotary encoders to be counted for high accuracy and high speed positioning. Also accommodates individual inputs and directional inputs. (DIP switch selected.)

2. Interrupt Processing Function

The unit can be programmed without concern about scan delays to perform immediate processing when the set point is matched. (DIP switch selected)

3. Variable Input Filter Constant

If a high speed response of 100 kcps is not required and higher noise immunity is, the constant can be set to 50 kcps, 25 kcps or 8 kcps by the writing of data from the Programmable Controller.

4. Channel Control

Each channel of the Dual-channel High Speed Counter Unit can be controlled independently.

5.Wide range of values

The range comprises 24-bit codes (binary format) covering a wide range of -16,777,216 to 16,777,215.

6. Easy counter monitoring and data setting

With the built-in shared memory, data can be freely read or written through a Programmable Controller.

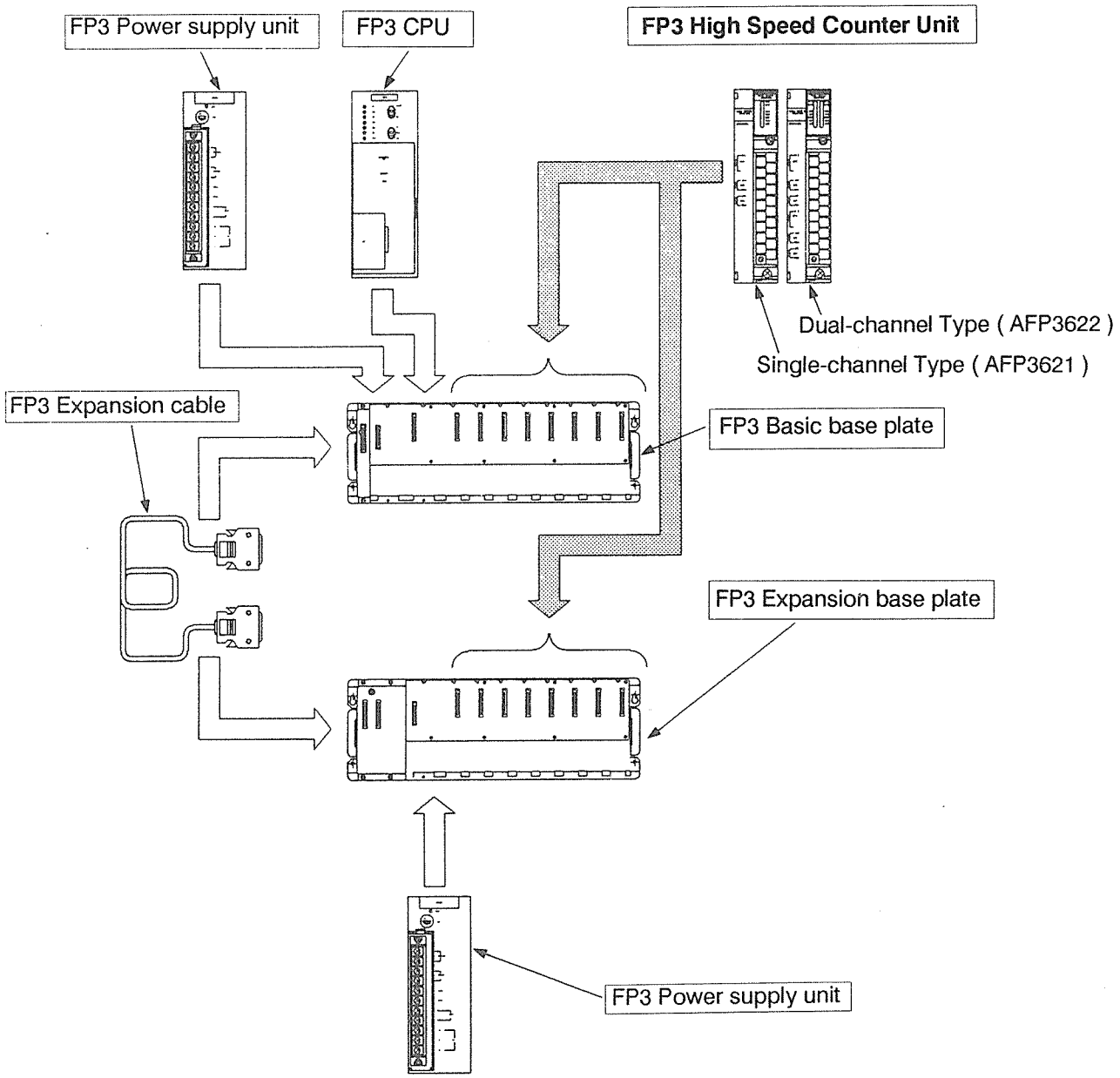
7. Comparison output, counter control input

A coincidence output for the preset value and count value, a 0 value output and a count overflow output are provided by the comparison output (C = P, C > P).
Counter reset(RESET), inputs for count inhibit(INH) are also included.
Operation from a Programmable Controller as well as from another external source are possible.

8. Invert Output

The Invert output is switchable for both coincidence and comparison output.
Refer to FP3 Hardware Technical Manual and FP Programming Technical Manual for further information on use of the high speed counter unit.

1-2. System Configuration



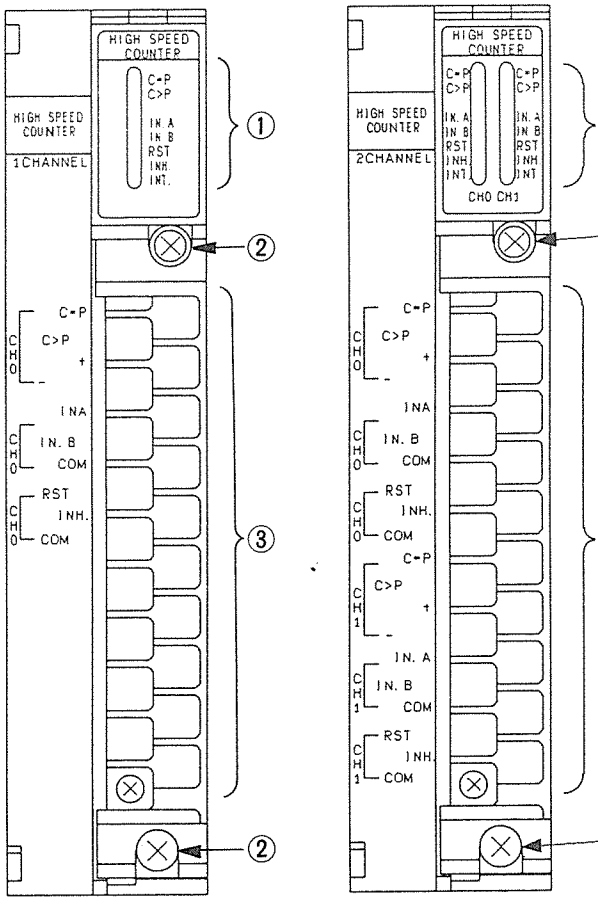
A sample system configuration is shown in the figure above.

- Any number of High Speed Counter Units can be installed to any slot on the basic base plate or expansion base plate.
- Up to eight units which can be interrupted based on the DIP switches on the rear side can be installed.
- For details on the CPU, Power supply unit, and Base plate, refer to the FP3 Hardware Technical Manual.

1-3. Part Names and Functions

Front panel

Single-channel Type **Dual-channel Type**



① **Input/Output operating indicator LEDs**
Indicate the ON/OFF state of the Input/Output.

② **Terminal board mounting screws**
Screws which secure the terminal board to the unit.

③ **Terminals connectors**
Terminals connectors for the Input/Output and power supply, they are removable from the unit.

② **Terminal board mounting screws**
Screws which secure the terminal board to the unit.

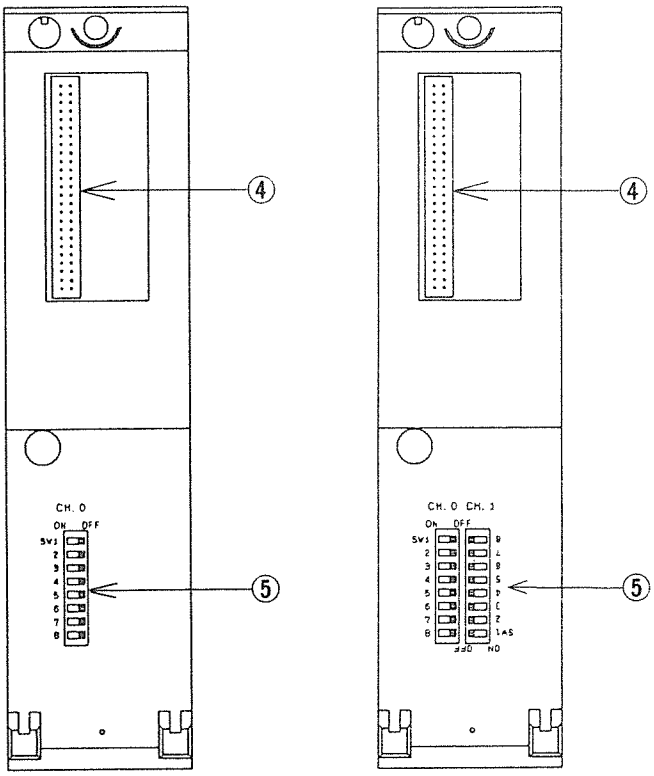
Input/Output operating indicator LED

LED	Function
Input	
IN.A	Turns ON when the encoder A phase is ON.
IN.B	Turns ON when the encoder B phase is ON.
RST	Turns ON when the counter reset signal is input.
INH.	Turns ON when the count stop signal is input.
Output	
C = P	Turns ON when C = P (match). The transistor also turns ON. C = P, C = 0, hold and one-shot are DIP switch selectable.
C > P	Turns ON when C > P. The transistor also turns ON.
INT.	Turns ON when the interrupt generating unit is set.

* **C : Count (Elapsed) value, P : Preset value**

Rear panel

Single-channel Type **Dual-channel Type**



④ **I/O unit connector (50-pin)**
Connector used to mount the unit to the base plate.

⑤ **Mode selector switches**
DIP switches used to select the counter function.
When shipped from the factory, the switches are set to OFF position.

Mode Select Switch

Settings table

	ON	OFF
SW1	Input mode settting *	
SW2		
SW3	Hold output	One-shot output
SW4	Interrupt enable	Interrupt disable
SW5	C = P mode	C = 0 mode
SW6	In C = P mode	
	C = P invert output	C = P output
	In C = 0 mode	
	C = P invert output	C = P output
SW7	C>P invert output	C>P output
SW8	Not used	

* : Input mode settting table

SW1	SW2	Mode
ON	ON	Phase input mode
ON	OFF	Unused
OFF	ON	Individual input mode
OFF	OFF	Directional discriminant mode

1-4. Specifications

1. General Specifications

Item	Specifications
Ambient operating temperature :	0°C to 55°C (32°F to 131°F)
Ambient storage temperature :	–20°C to +70°C (–4°F to +158°F)
Ambient operating humidity :	30 % to 85 % RH (non-condensing)
Ambient storage humidity :	30 % to 85 % RH (non-condensing)
Breakdown voltage :	Across DC terminal and frame ground : 500 V AC, 1 minute
Insulation resistance :	100 MΩ or more, Across DC terminal and frame ground (measured with 500 V DC)
Vibration resistance :	10 Hz to 55 Hz, 1 cycle per minute, double amplitude 0.75 mm (0.03 in.), 10 minutes for each of the X, Y and Z directions
Shock resistance :	98 m/s^2 or more, four times for each of X, Y and Z directions
Noise resistance :	1000 V, 50 ns, with pulse width 1μs (based on in-house measurements)
Operating condition :	Free of corrosive gases and excessive dust

2. Performance Specifications

Input and Counter Specifications

Item	Specification
INPUT	
Number of input points Single-channel Type : Dual-channel Type :	 4 points (IN.A, IN.B, RST, INH.) 8 points (IN.A, IN.B, RST, INH.) x 2 channels
Input voltage :	5 V DC to 24 V DC
Allowable voltage fluctuation range :	4.75 V DC to 26.4 V DC
ON voltage / ON current :	4.5 V or less / 3 mA or less
OFF voltage / OFF current :	1.5 V or more / 0.6 mA or more
COUNTER	
Number of counter points Single-channel Type : Dual-channel Type :	 1 point (up-down counter) 2 points (up-down counter)
Counting range :	24-bit including sign bit (binary format) (-16777216 to 16777215)
Set range :	24-bit including sign bit (binary format) (-16777216 to 16777215)
Maximum counting speed :	100 kcps
Minimum input pulse width :	5μs (when individual input used) : when 100 kcps mode is set

Output Specifications

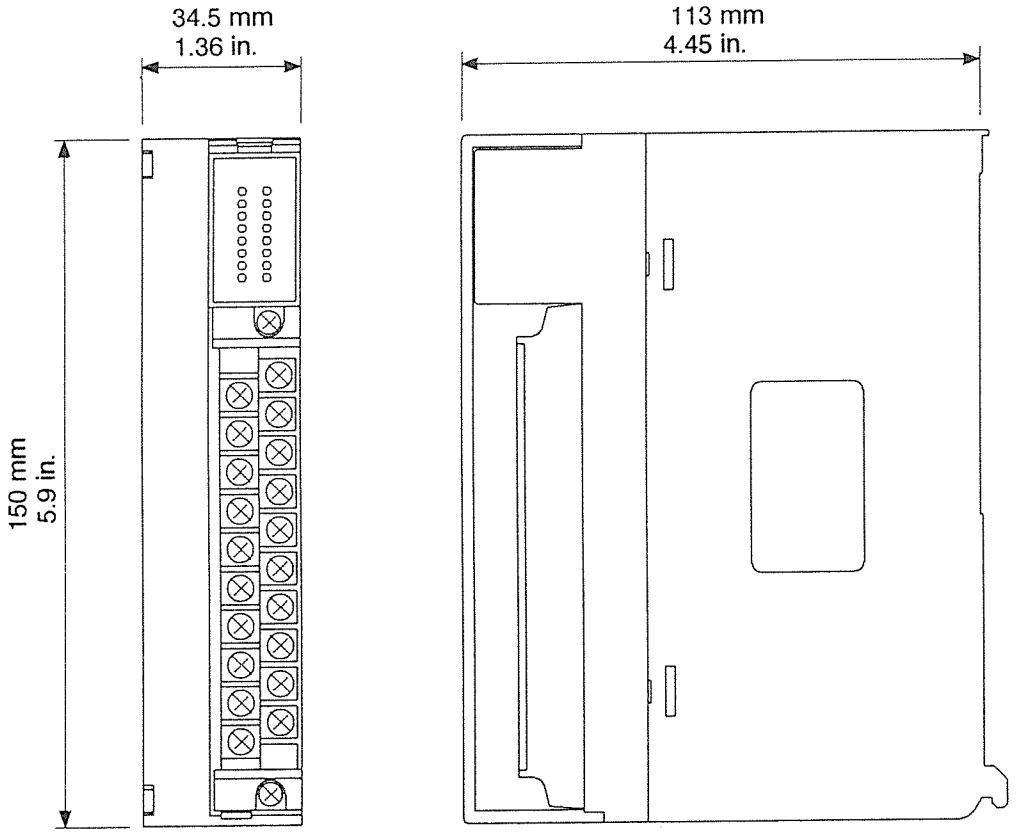
Item	Specification
Insulation method :	Photocoupler
Output configuration :	Transistor output (NPN, open collector)
Rated operating voltage :	5 V DC to 24 V DC
Allowable voltage fluctuation range :	4.75 V DC to 24 V DC
Maximum load current :	100 mA
Residual voltage :	0.5 V or less
Leakage current :	10μA
Number of output points Single-channel Type : Dual-channel Type :	 2 points (C = P, C > P) 4 points (C = P, C> P) x 2 channels
Common terminals :	2 points per common
Fuse :	None
Response time :	OFF → ON : 10 μs or less, ON → OFF : 400μs or less

* **C : Count (Elapsed) value, P : Preset value**

Miscellaneous Specifications

Item	Specification
Operating indication :	LED indicators
Internal consumption current (at 5 V) Single-channel Type : Dual-channel Type :	 150 mA 220 mA
External connection :	20-pin terminal board
Suitable wire size :	0.5 mm^2 to 1.25 mm^2
Terminal board mounting screw :	M3.5 screw
Weight Single-channel Type : Dual-channel Type :	 Approx. 300 g (10.6 ounces) Approx. 400 g (14.1 ounces)
Number of I/O points occupied :	32 points

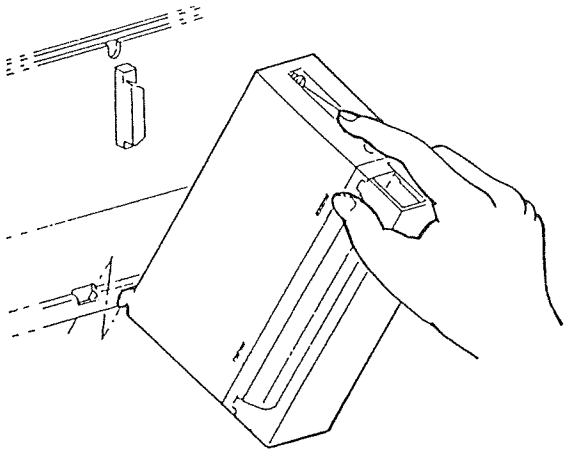
1-5. Dimensions



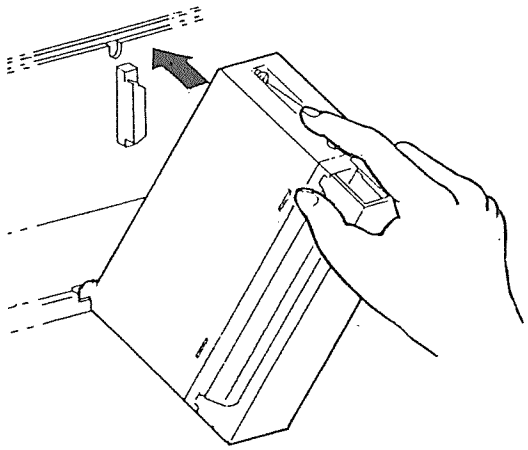
1-6. Mounting Method

Before mounting each unit, remove the connector cover on the base plate.

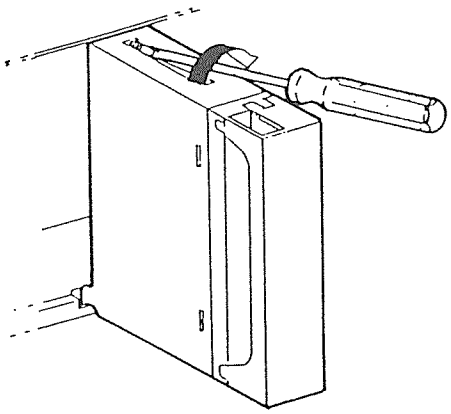
1. Fit the unit tabs into the unit holes on the base plate.



2. Push the unit in the direction of the arrow and mount onto the base plate.



3. After properly mounting the unit to the base plate, secure the mounting screw at the top.

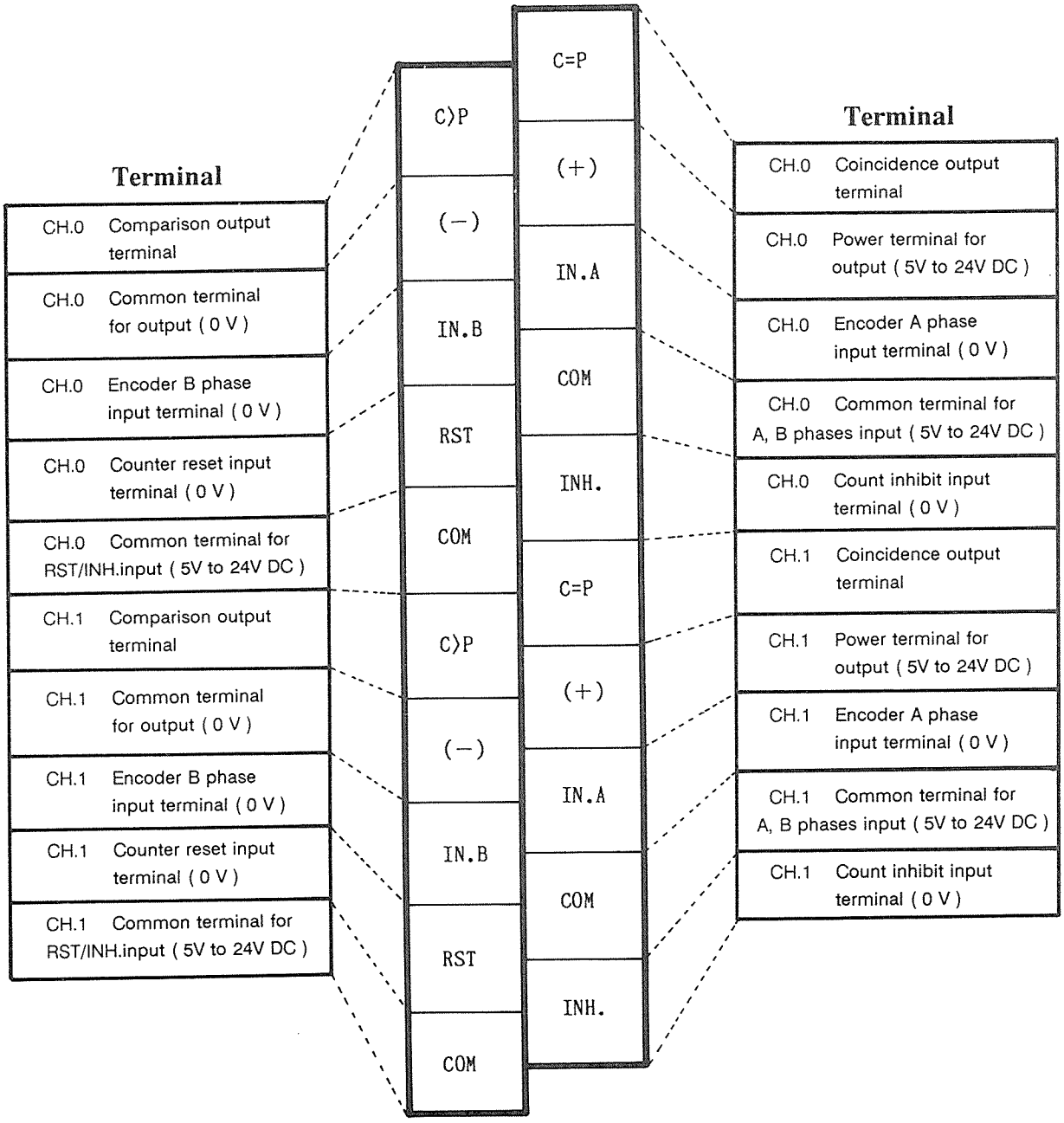


CHAPTER 2

WIRING

" PC " is the abbreviation for Programmable Controller.

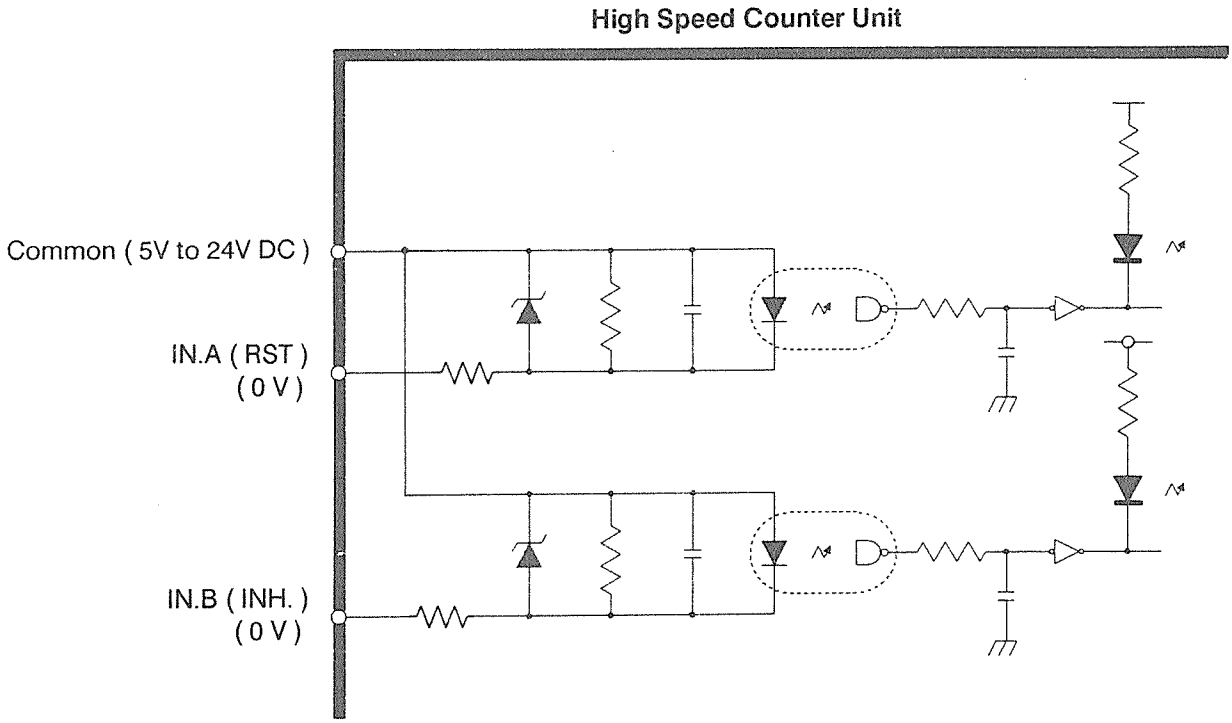
2-1. Terminal board Pin Layouts



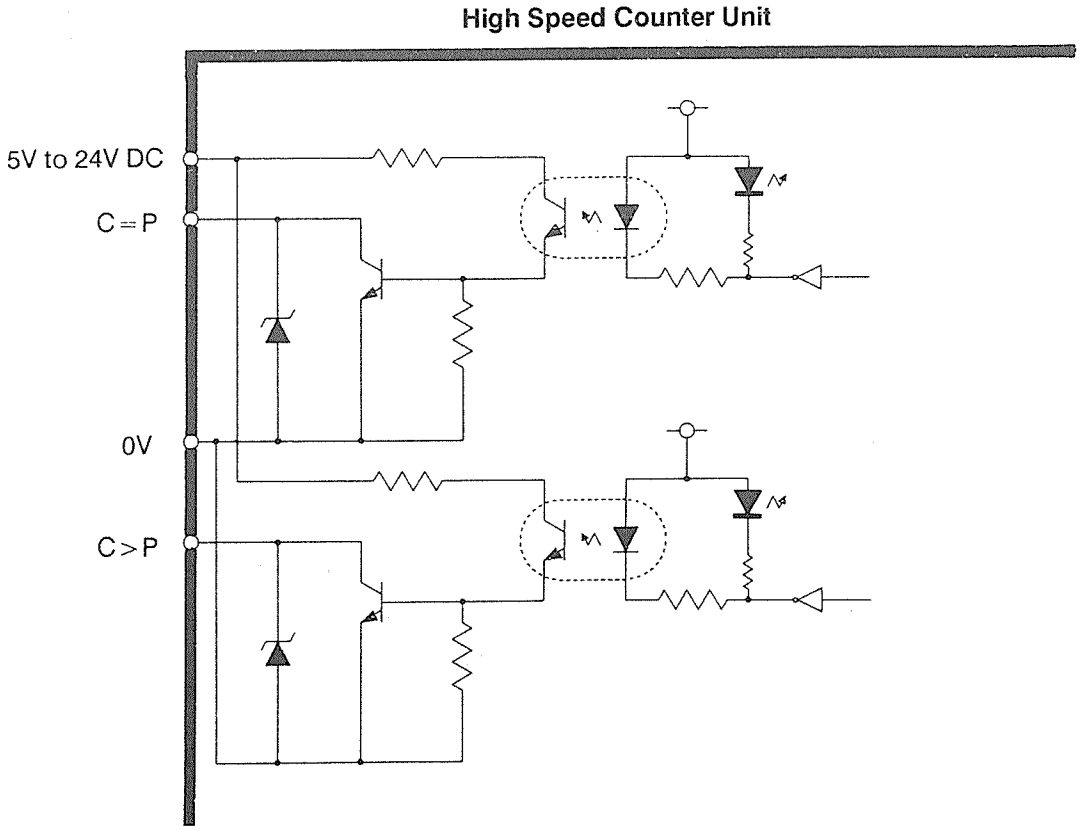
- For Single-channel High Speed Counter Unit (AFP3621), CH. 1 terminals are open terminal.

2-2. Internal Circuits

1. Input internal circuit



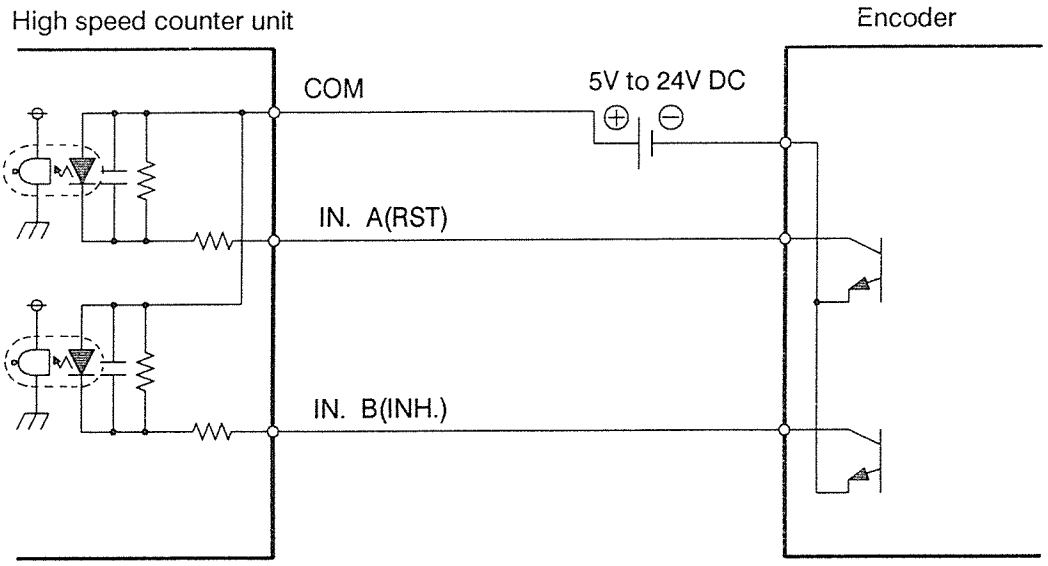
2. Output internal circuit



2-3. Wiring Examples

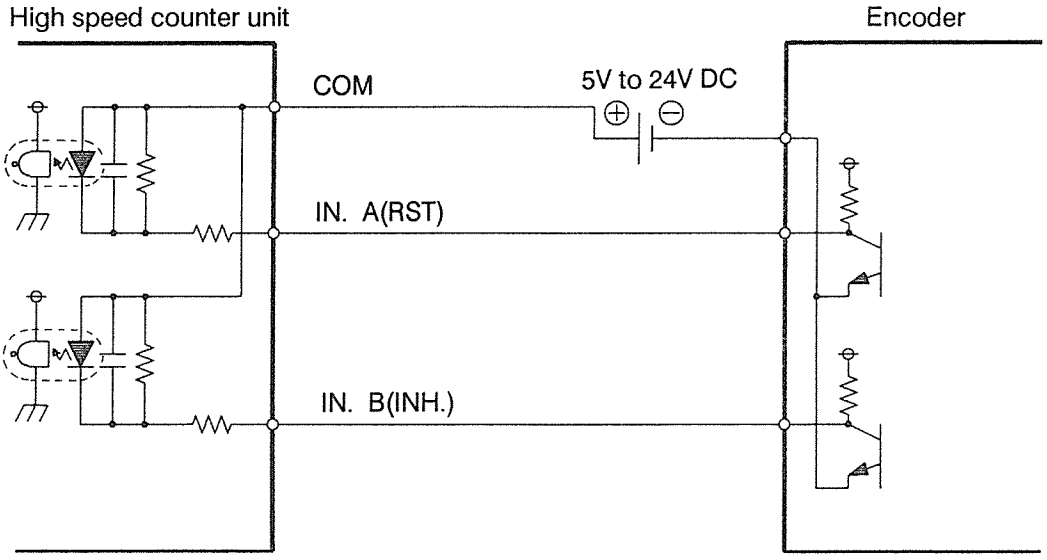
1. Input Wiring Examples

Example 1 : Encoder outputs are open collectors



Example 2 : Encoder outputs are voltage output open collectors

* The logic operation is opposite for Example 1.



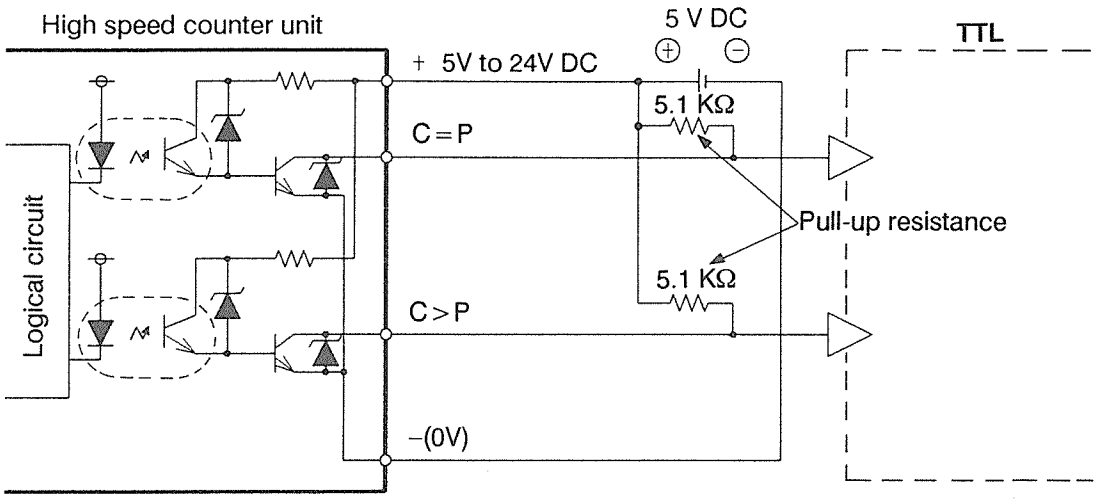
Input Wiring Notes :

Perform the following to prevent noise from entering the input wiring.

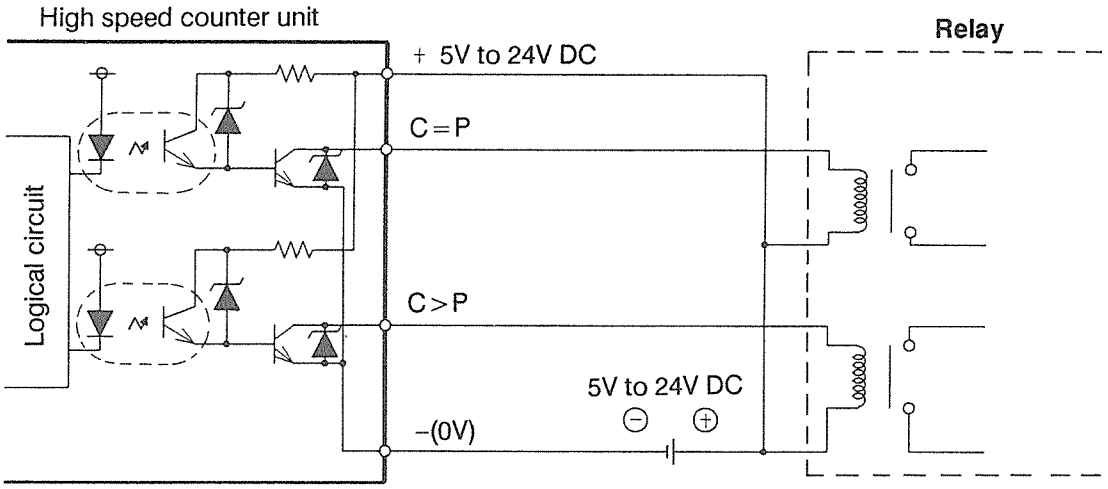
- Keep the input lines short and away from noisy lines such as power lines.
- Use shielded wires for the input wiring and ground the shield.
  Change the setting for the input filter to increase the chatter prevention effect when high speed response is not required.
  Refer to page 25, Section 3-2, 5. Input Filter Constant Setting, for further information.

2. Output Wiring Examples

Example 1 : TTL load

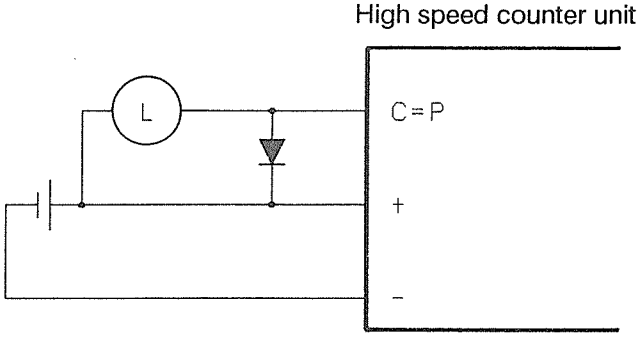


Example 2 : Relay load



Output Wiring Notes :

- Be sure to attach a pull-up resistance (approx. 5.1 kΩ) for the TTL connection.
- Use a protective circuit when switching inductive loads.
  For output device protection and contact protection when switching DC inductive loads, be sure to add a diode across the load to absorb any counter electromotive force.



CHAPTER 3

CONFIGURATIONS

3-1. Internal Configuration

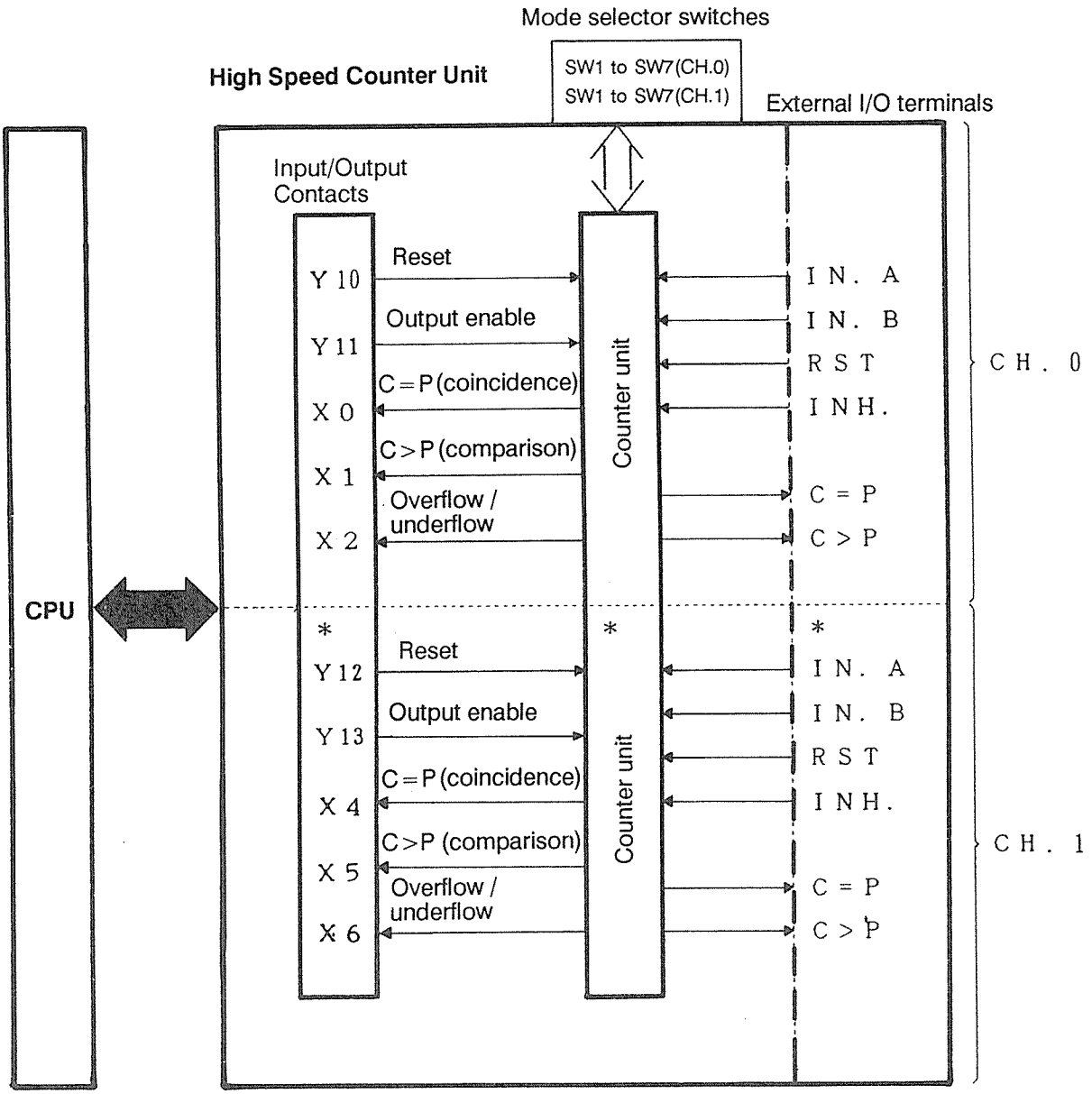
3-2. Data Format

1. Internal Input/Output Contacts
2. Data Memory Allocation
3. Initial Value Write
4. Preset Value Write
5. Input Filter Constant Setting
6. Count (Elapsed) Value Read

" PC " is the abbreviation for Programmable Controller.

3-1. Internal Configuration

- As shown in the figure below, the internal configuration of High Speed Counter Unit. The mode selector switches permit the various functions to be used.



*** C : Count (Elapsed) value, P : Preset value**

* CH. 1 applies only to the Dual-channel High Speed Counter Unit (AFP3622).

3-2. Data Format

1. Internal Input/Output Contacts

- The unit occupies a total of 32 points consisting of 16-input points and 16-output points.
- The allocation of the I/O contacts is shown below (when the high speed counter unit has been mounted to slot 0).

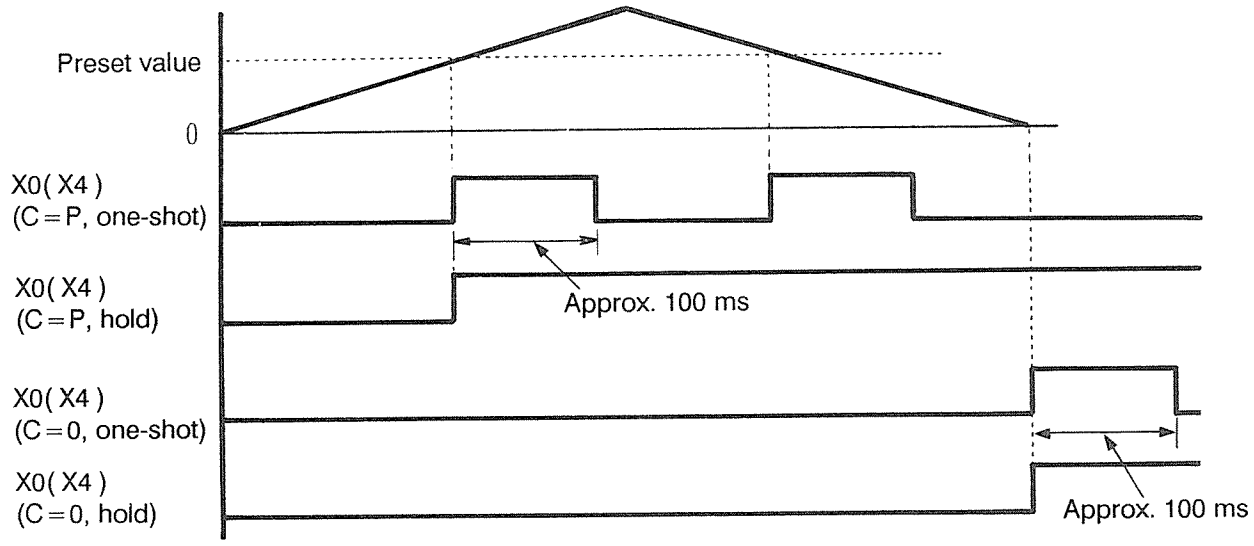
	Single-channel Type (AFP3621)	Dual-channel Type (AFP3622)
Input Contacts		
X0	C = P Coincidence Flag	C = P Coincidence Flag (Channel No.0)
X1	C > P Comparison Flag	C > P Comparison Flag (Channel No.0)
X2	Overflow Flag / Underflow Flag	Overflow Flag / Underflow Flag (Channel No.0)
X3	Disable	Disable
X4		C = P Coincidence Flag (Channel No.1)
X5		C > P Comparison Flag (Channel No.1)
X6		Overflow Flag / Underflow Flag (Channel No.1)
X7 ⋮ XF		Disable
Output Contacts		
Y10	Counter reset	Counter reset (Channel No.0)
Y11	Output enable	Output enable (Channel No.0)
Y12	Disable	Counter reset (Channel No.1)
Y13		Output enable (Channel No.1)
Y14 ⋮ Y1F		Disable

*** C : Count (Elapsed) value, P : Preset value**

C = P Coincidence Flag : X0 (X4)

Turns ON when count (elapsed) value coincided with preset value.
Hold, One-shot modes are Mode selector switches selectable.

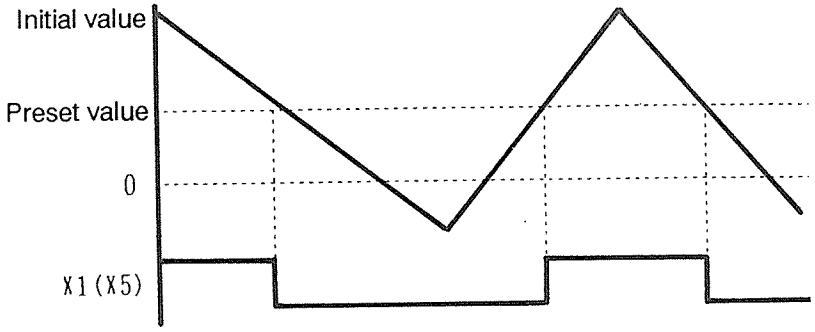
Changes in the same manner as the C=P output.
Hold, one-shot, C=P and C=0 modes are Mode selector switches selectable.



- The internal contact data assume the waveforms above also when the coincidence invert output mode is selected.

C > P Comparison Flag : X1 (X5)

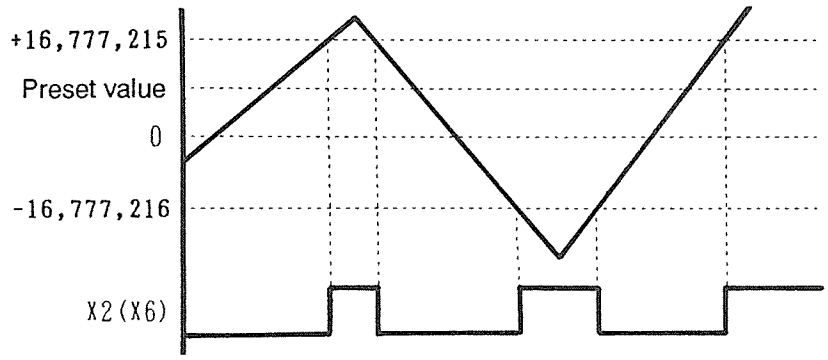
Turns ON when count (elapsed) value is greater than the preset value regardless of the mode.
It also turns ON when the initial value is greater than the preset value.



- The internal contact data assume the waveforms above also when the comparison invert output is selected.

Overflow Flag / Underflow Flag : X2 (X6)

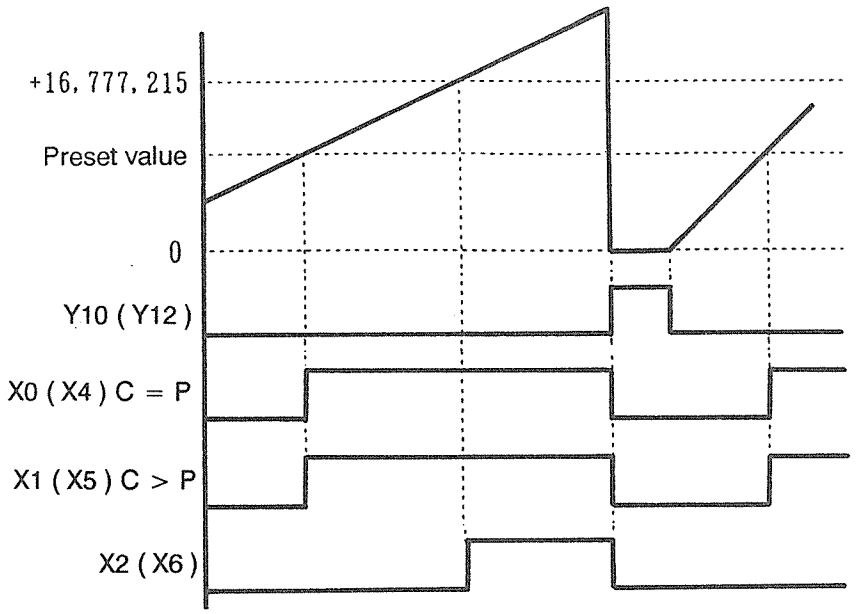
Turns ON when count (elapsed) value is beyond the range of -16,777,216 to +16,777,215 regardless of the mode.



- After an overflow / underflow occurs twice in succession, the flag becomes undefined.

Counter Reset : Y10 (Y12)

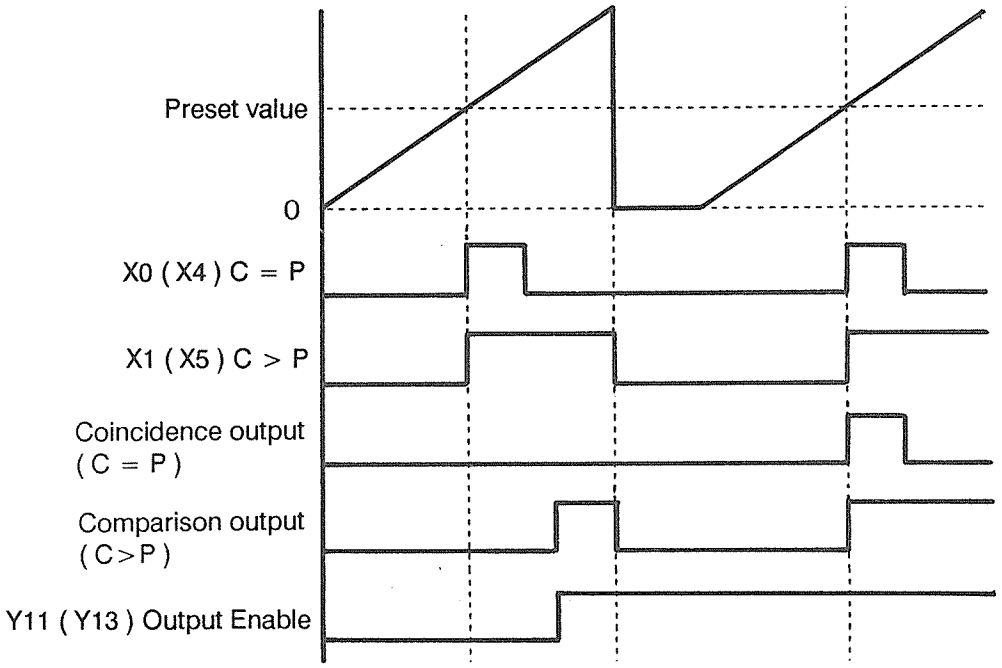
Same function as the external terminal.
Clears the count (elapsed) value, preset value and input filter constant value.
X0 to X6 that are ON are all turned OFF.



Output Enable : Y11 (Y13)

The output (transistor, LED) turns ON when the output enable flag matches the ON state and the comparison condition is satisfied.
The internal contacts turn ON and OFF regardless of the output enable flag.

The figure below is an example in the One-shot mode.



Notes on Using input contacts (X0 to X6)

Take the scan time at the CPU side into consideration when performing an operation using X0 to X6.
A scan time may delay execution.

2. Data Memory Allocation

The CPU sets the Initial value, Preset value, Input filter constant and reads Count (Elapsed) value at the High Speed Counter Unit.

The allocation for each data memory is shown below.
Data read and write are performed with the F150(READ)and F151(WRT)instructions.

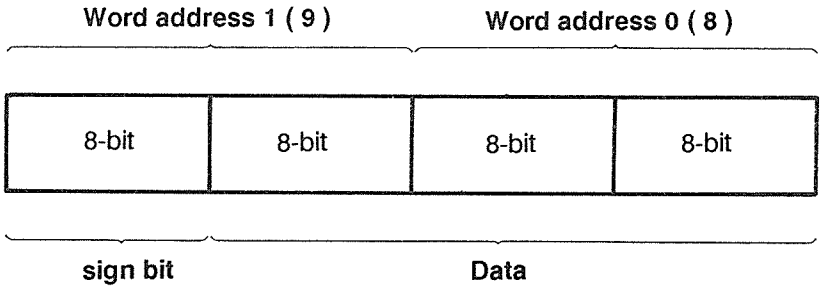
Words Address	READ data	WRITE data
K0 (K8)	Count (Elapsed) value (low order 16-bit)	Initial value (low order 16-bit)
K1 (K9)	Count (Elapsed) value (high order 8-bit and sign bit)	Initial value (high order 8-bit and sign bit)
K2 (K10)	Cannot be read	Preset value (low order 16-bit)
K3 (K11)	Cannot be read	Preset value (high order 8-bit and sign bit)
K4 (K12)	Cannot be read	Input filter constant 0 to 3
K5 (K13)	Cannot be read	Set Input filter constant to 0

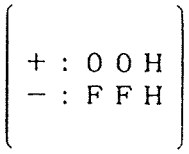
( ) contains the word address for chennel no.1(CH.1).
It cannot be used on Single-channel High Speed Counter Unit (AFP3621).

- Address for CH.1 = Address for CH.0 + 8

All become 0 when the power is turned ON or reset is input.

Initial Value :





(H000000 to HFFFFFF)

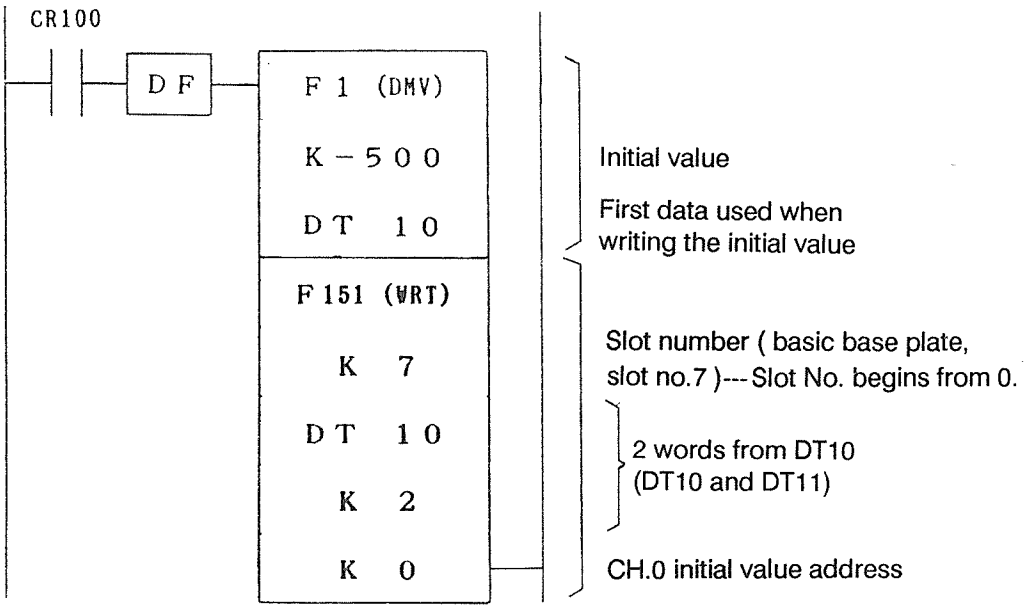
Negative numbers are represented as complements for hexadecimal data.
Reading and writing are also allowed for decimal data.

3. Initial Value Write

Since the initial value consists of a 32-bit format, set it in two word units.
It can be set with the Write instruction (F151) or 2-word Transfer instruction (F1).

Program Example

A program example is given below which writes -500 in decimal to the initial value of CH.0 of the High Speed Counter Unit mounted to slot no.7 on the basic base plate using DT10 and DT11.



Notes on Writing

- Decimal data "K-500" is "H FFFFFE0C" in hexadecimal.
- The slot numbers are given below when the expansion base plates are mounted.

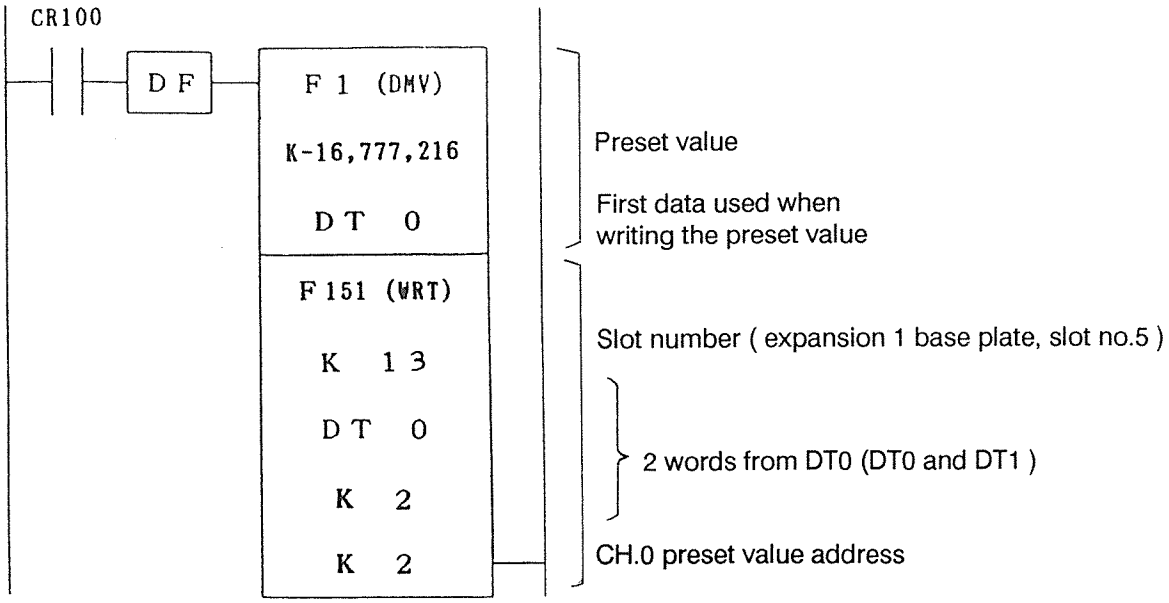
  (At 3, 5 and 8 slot types)
  Expansion 1 Slot number = Mounted slot of expansion 1 + 8 × 1
  Expansion 2 Slot number = Mounted slot of expansion 2 + 8 × 2
- For the high speed counter unit, set the number of original write data items to "K2".
- Set the initial value address to "K0". CH.1 becomes " K8 ".
- Write the initial value in one scan.
  If written at every scan, the count (elapsed) value returns to the initial value of each scan.
- The settable range is -16,777,216 to 16,777,215.
- The set value becomes "0" when the power is turned ON, an emergency stop input or Y10 (Y12) are ON.

4. Preset Value Write

Since the preset value consists of a 32-bit format, set it in 2-word units.
It can be set with the write instruction (F151) or 2-word transfer instruction (F1).

Program Example

A program example is given below which writes -16,777,216 in decimal to the preset value of CH.0 of the high speed counter unit mounted to slot no.5 on the expansion base plate using DT0 and DT1.



Notes on Writing :

- Decimal data K -16,777,216 is HFF000000 in hexadecimal.
- The slot numbers are given below when the expansion base plates are mounted.

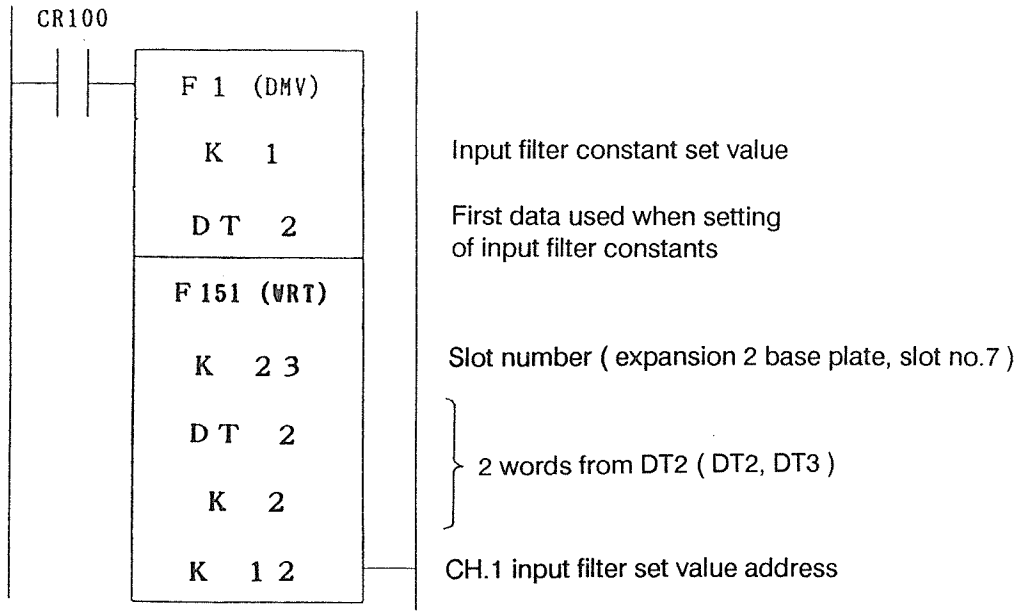
  (At 3, 5 and 8 slot types)
  Expansion 1 Slot number = Mounted slot of expansion 1 + 8 × 1
  Expansion 2 Slot number = Mounted slot of expansion 2 + 8 × 2
- For the high speed counter unit, set the number of original write data items to "K2".
- Set the preset value address to "K2". CH.1 becomes " K10 " or " HA ".
- The settable range is -16,777,216 to 16,777,215.
- The set value becomes "0" when the power is turned ON, an emergency stop input or Y10 (Y12) are ON.

5. Input Filter Constant Setting

Since the input filter constant set value data consists of a 32-bit format, set it in 2-word units.
It can be set with the 2-word write instruction (F151) or 2-word transfer instruction (F1).

Program Example

A program example is given below which sets 1 (50 kcps) to the input filter constant set value of CH.1 of the high speed counter unit mounted to slot no.7 on the expansion base plate using DT2 and DT3.



Notes on Setting :

- Do not set a number other than 0 to 3.

  "K0" : 100 kcps
  "K1" : 50 kcps
  "K2" : 25 kcps
  "K3" : 8 kcps

- The slot numbers are given below when the expansion base plates are mounted.

  (At 3, 5 and 8 slot types)
  Expansion 1 Slot number = Mounted slot of expansion 1 + 8 × 1
  Expansion 2 Slot number = Mounted slot of expansion 2 + 8 × 2

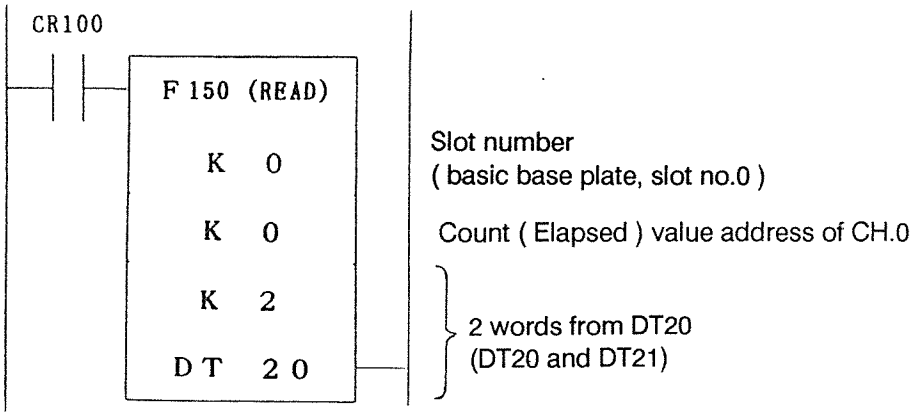
- For the high speed counter unit, set the number of original set data items to " K2 ".
- Set the input filter set value address to "K4".
- For CH.1 becomes " K12 " or " HC ".
- If normal counting is not obtained, increase the counting performance.
- Refer to page 28, Section 4-1. Input Modes for the input waveforms when the input filter is set.
- The input filter set value becomes "0" when the power is turned ON, an reset input or Y10 (Y12) are ON.

6. Count (Elapsed) Value Read

Since the count (elapsed) value data consists of a 32-bit format, read it in 2-word units.
It can be read with the read instruction (F150).

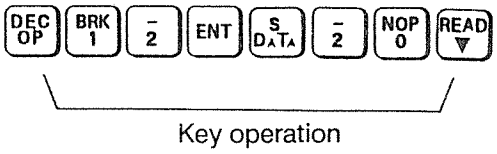
Program Example

A program example is given below which reads the count (elapsed) value of CH.0 of the high speed counter unit mounted to slot no.0 on the basic base plate and read it to DT20 and DT21.



Monitoring the count (elapsed) value

If the count (elapsed) value has been loaded to DT20 and DT21 as in the program example above, it can be monitored with the key operation of programming unit below.



Notes on Reading :

- The counter within the CPU cannot be read with OP2 since it is not a software counter.
- The slot numbers are given below when the expansion base plates are mounted.

  (At 3, 5 and 8 slot types)
  Expansion 1 Slot number = Mounted slot of expansion 1 + 8 × 1
  Expansion 2 Slot number = Mounted slot of expansion 2 + 8 × 2
- For the high speed counter unit, set the number of original read data items to " K2 ".
- Set the count (elapsed) value address to " K0 ". CH.1 becomes " K8 ".
- The count (elapsed) value becomes " 0 " when the power is turned ON, an reset input or Y10 (Y12) are ON.

CHAPTER 4

OPERATING MODES

" PC " is the abbreviation for Programmable Controller.

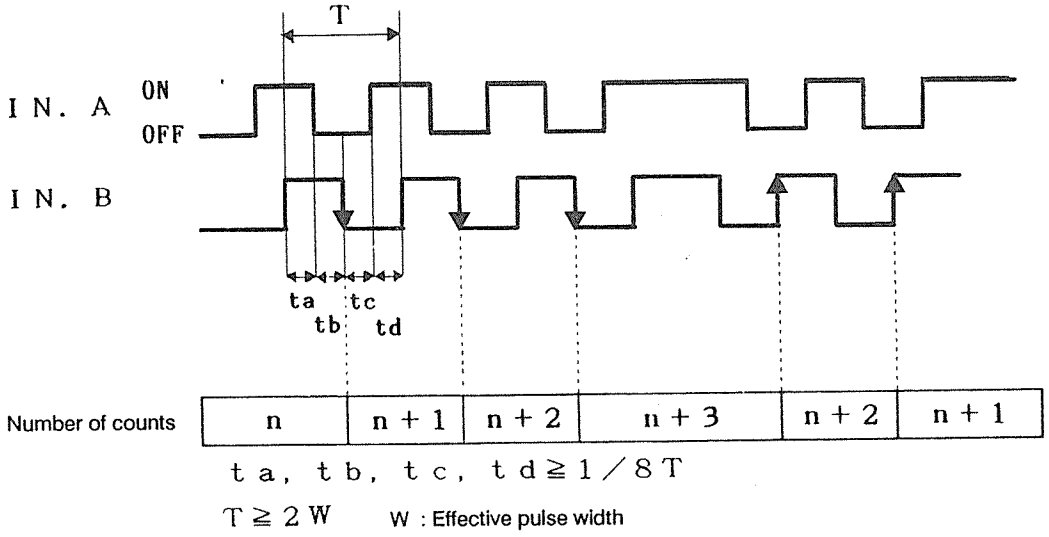
4-1. Input Modes

High speed count pulse input terminals which accommodate the three modes of Phase input, Individual input and Directional discriminant input set with the mode selector switches.

Further, the effective pulse width can be changed by setting the input filter constant.

1. Phase Input Mode

(mode select switches : SW1 ON and SW2 ON)



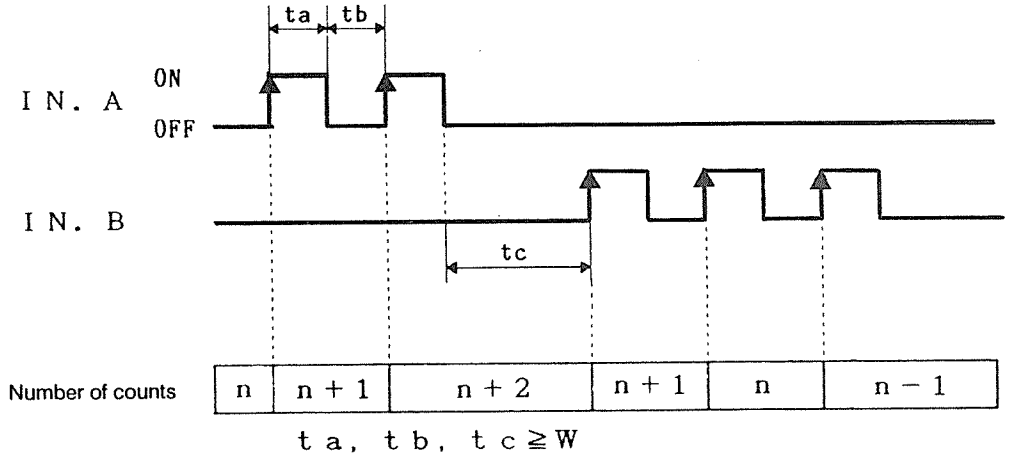
t a , t b , t c , t d ≧ 1 / 8 T

T ≧ 2 W W : Effective pulse width

Refer to page 29, 4. Input effective pulse Width, for further information.

2. Individual Input Mode

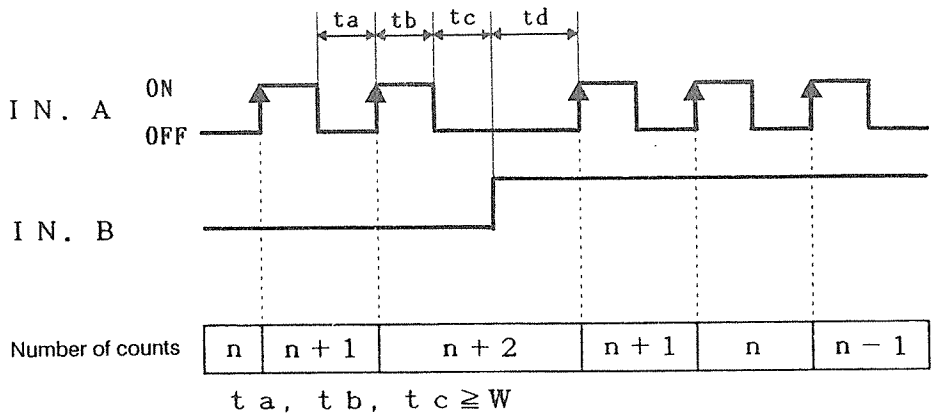
(mode select switches : SW1 OFF, SW2 ON)



t a , t b , t c ≧ W

3. Directional discriminant Input Mode

(mode select switches : SW1 OFF and SW2 OFF)



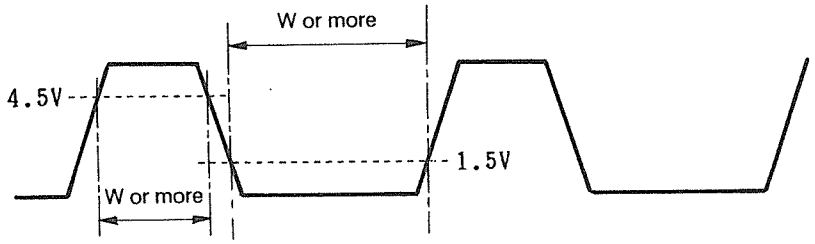
A	B	function
↓	H	down
↑	L	up

* H : ON
L : OFF (open)

4. Input effective pulse Width

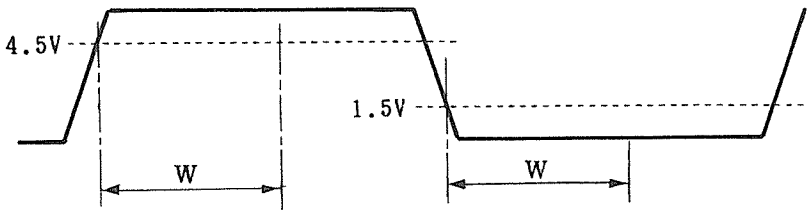
The input effective pulse width can be changed by setting the input filter constant.

When K0, calculating performance is 100 kcps, W : 5 μs
When K1, calculating performance is 50 kcps, W : 10 μs
When K2, calculating performance is 25 kcps, W : 20 μs
When K3, calculating performance is 8 kcps, W : 62.5μs



Notes :

- The input filter becomes " 0 " when the power is turned ON, reset input Y10(Y12) is ON.
- The count timing is shown below with a delay of Input effective pulse Width (W).
- Keep the rise and fall delays to 50μs or less.



4-2. Control Input Modes

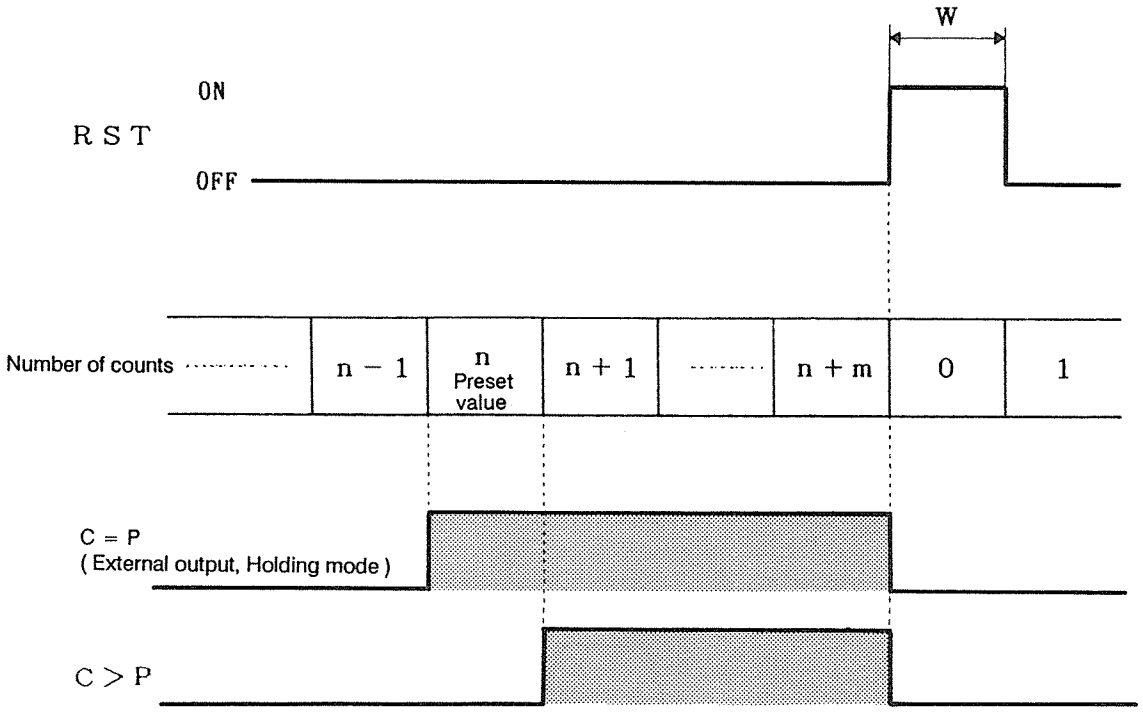
1. Reset Input (RST)

Resets the count (elapsed) value and preset value of counter and turns OFF the coincidence output (C = P) if it is being output.

The input effective width depends on the input filter constant.

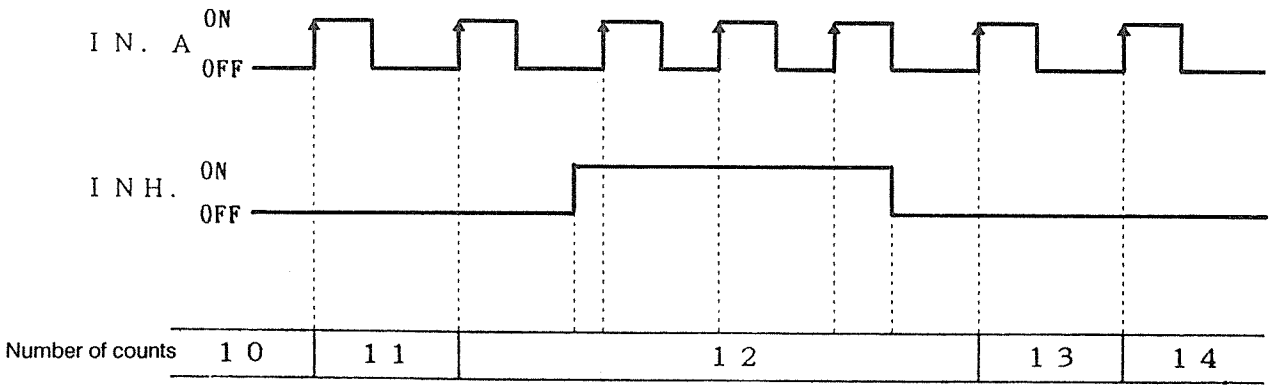
Refer to page 29, 4. Input effective pulse Width, for further information.

It performs level operations with the same functions as the counter internal relay Y10 (Y12).



2. Count Inhibit Input (INH.)

When this terminal is ON, any signals at number of count inputs (IN.A, IN.B) are not counted.

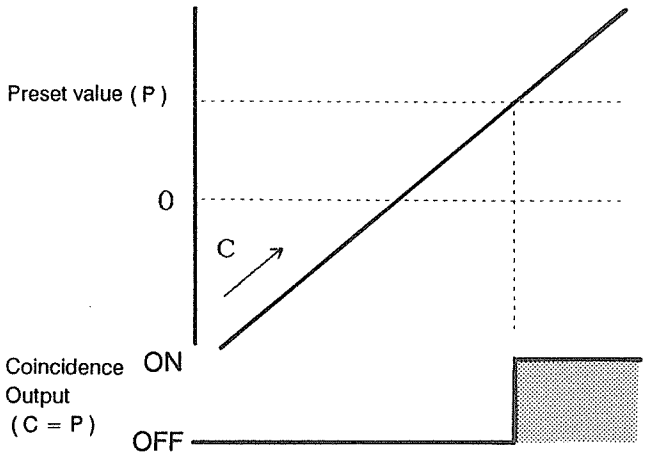


4-3. Output Modes

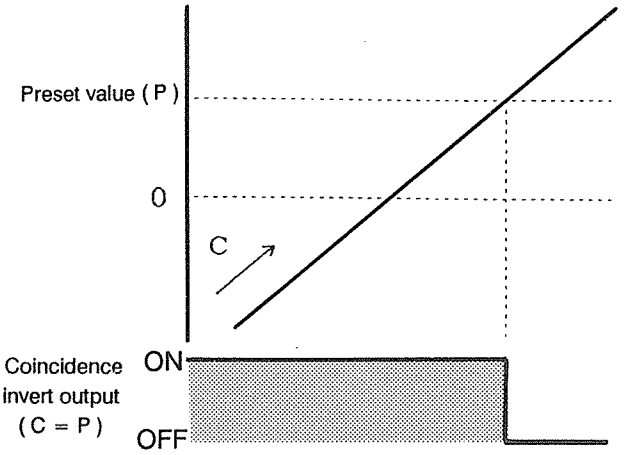
1. Coincidence Output (C = P) (C : Count (Elapsed) value, P : Preset value)

- SW5 selects whether to turn ON the coincidence output (C = P) when C = P or C = 0 are satisfied.

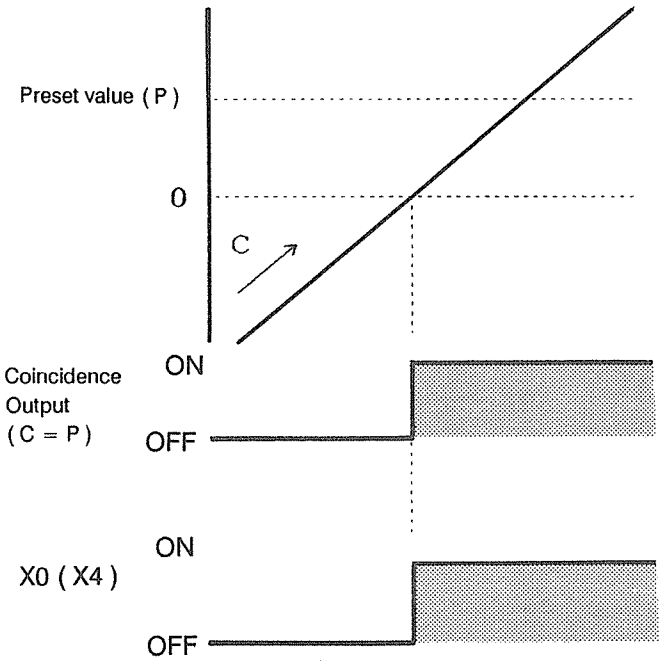
C = P Mode
(SW5 : ON and SW6 : OFF)



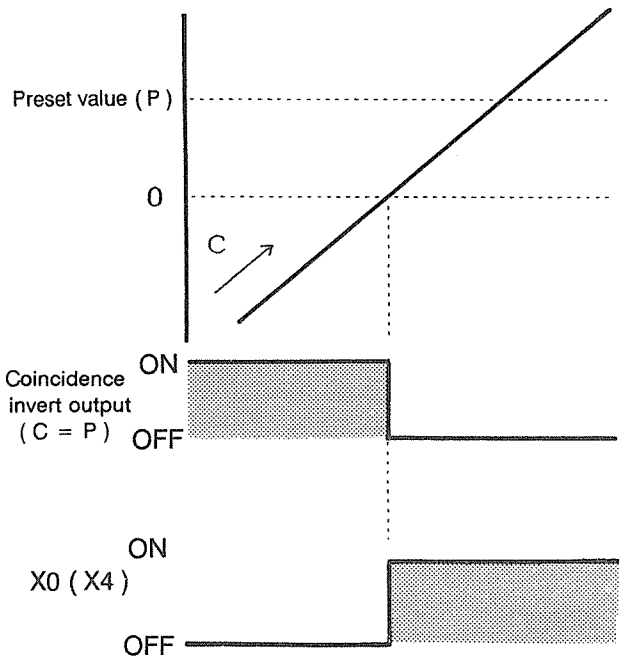
C = P Mode (invert output)
(SW5 : ON and SW6 : ON)



C = 0 Mode
(SW5 : OFF and SW6 : OFF)

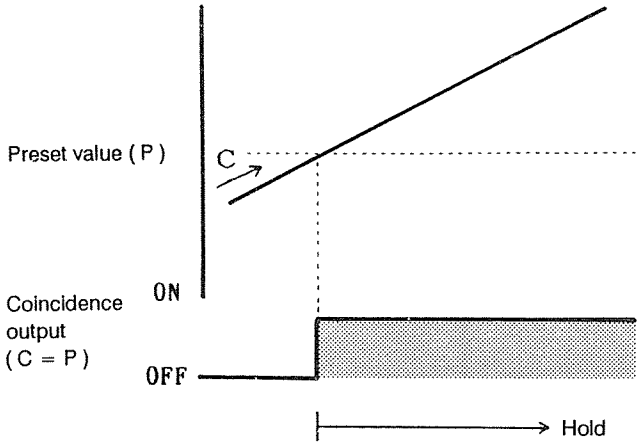


C = 0 Mode (invert output)
(SW5 : OFF and SW6 : ON)

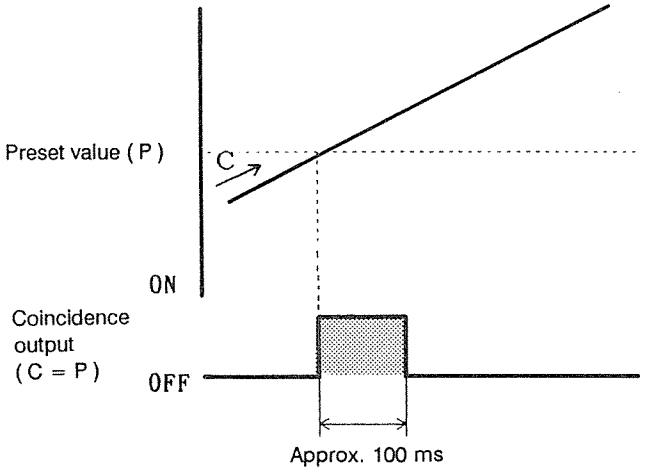


- SW3 selects whether to hold the coincidence output or output it as one-shot.

Hold Mode (SW3 : ON)



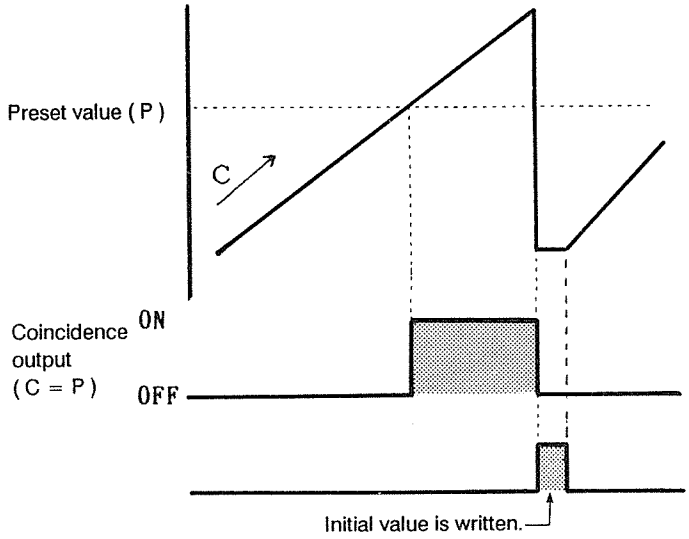
One-shot Mode (SW3 : OFF)



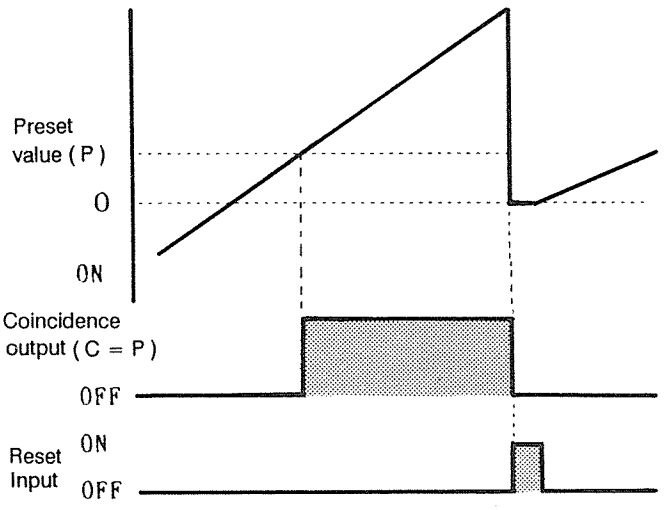
- During the one-shot output, the output can be turned OFF with a reset input.

- The hold output is cleared when the initial value is written or when a reset is performed.

When Initial Value is Written



When Reset is Input



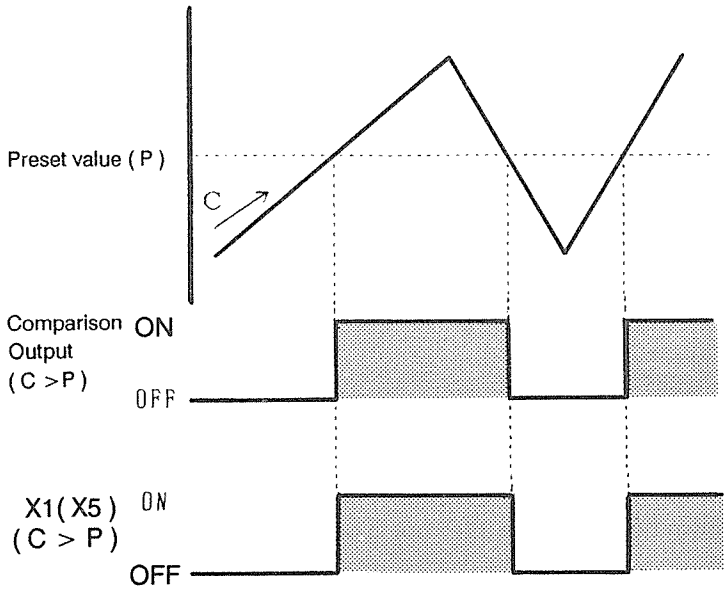
Notes :

1. Although both the initial value and preset value are set to " 0 " when the power is turned ON, a reset input Y10 (Y12) is ON, the coincidence output (C = P) does not turn ON.
2. If, when writing, the initial value match, the coincidence output (C = P) is issued.
3. For the invert output, 1 and 2 are inverted.
4. Be sure to turn ON Y11 (Y13) to issue an output.

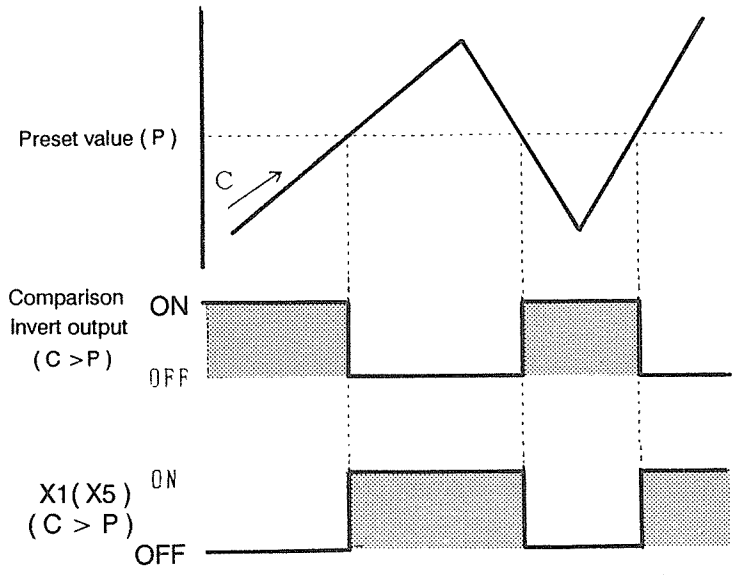
2. Comparison Output (C > P) (C : Count (Elapsed) value, P : Preset value)

The comparison output is issued in levels.
SW7 selects whether to turn ON or OFF when C > P is satisfied.

C > P Output (SW7 : OFF)



C > P Invert output (SW7 : ON)



Notes :

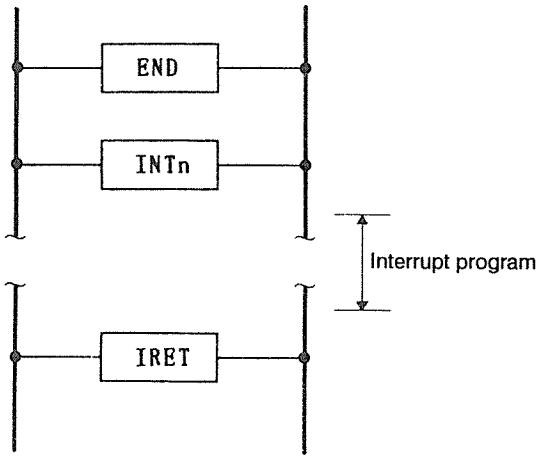
Output enable Y11 (Y13) must be in the ON state.
The internal relay performs positive logic even in the invert output mode.

4-4. Interrupt Mode

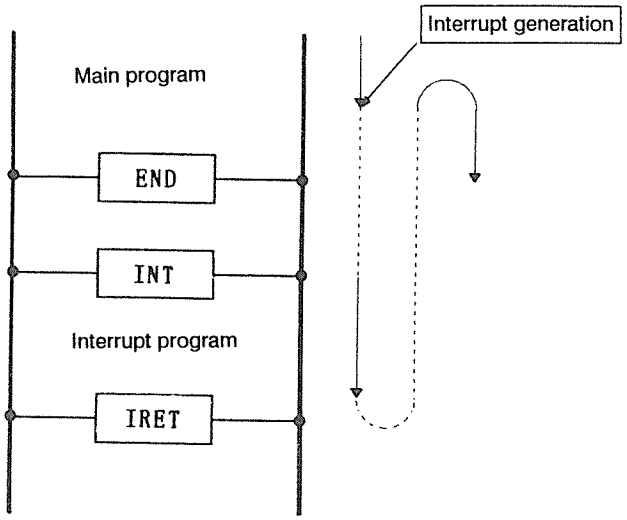
1. Overview

If SW4 is set to ON, the FP3 high speed counter unit pauses normal execution when the condition is satisfied (C = P) and executes an interrupt program.

The interrupt program is enclosed by the INT n (INT 16 to INT 23) and IRET instructions after the END instruction.



The state of the execution is shown below when a interrupt is generated.



Definition of Interrupt Inhibit (mask)

If the interrupt has been masked, the interrupt program is not executed even when the condition to execute the interrupt program is satisfied.
Since the satisfied condition is held internally, the interrupt program is executed immediately after the mask is cleared.
The interrupt is masked after the power is turned ON.

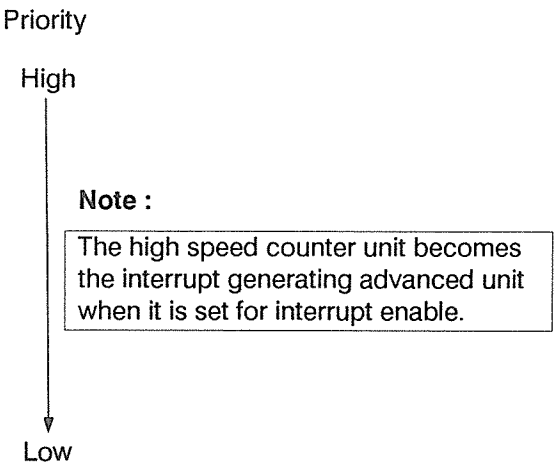
Interrupt Clear

If the interrupt has been cleared, the interrupt program is not executed even when the condition to execute the interrupt program is satisfied.
Since the satisfied condition is not held, the satisfied condition result during the clear does not remain even if the clear is disabled.

2. Relationship of Interrupt Input Number and Interrupt Program

The state of the execution is shown below when a interrupt is generated.
The relationship of the high speed counter unit and the interrupt program is a one-to-one correspondence of the unit and interrupt program.

Interrupt Generating Advanced Unit no.	Interrupt program no.
1	INT 16
2	INT 17
3	INT 18
4	INT 19
5	INT 20
6	INT 21
7	INT 22
8	INT 23



Note :

The high speed counter unit becomes the interrupt generating advanced unit when it is set for interrupt enable.

The unit numbers are numbered from the low slot numbers.
For example, when the condition for unit no.3 is satisfied, the interrupt program for INT18 is activated.
If several conditions are satisfied simultaneously, the execution priority is such that INT16 is the highest and INT23 is the lowest.
If an interrupt unit is mounted at the same time, the interrupt unit has the higher precedence.

3. Limitations on Mounting (location and quantity)

Only eight interrupt generating advanced units can be used for each CPU.
If nine or more are mounted, an error results and RUN (executing a program) is impossible.
If the mode selector switches (SW4 : OFF) are set so that the execution of interrupt programs is disabled, any number of units can be mounted.

The interrupt generating advanced unit can be installed at any position on either the basic base plate or expansion base plate.

The interrupt generating advanced unit cannot be installed on the base plate for the remote I/O slave.
If the mode selector switches (SW4 : OFF) are set so that the execution of interrupt program is disabled, units can be mounted.

4. Creating an Interrupt Program (instructions and syntax)

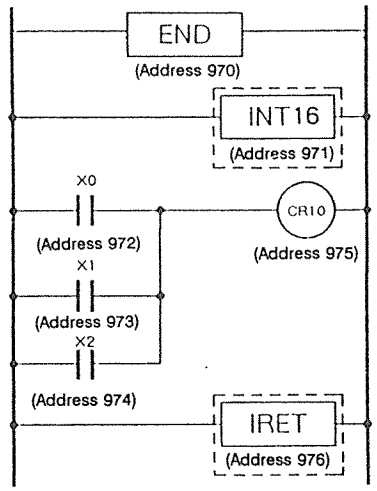
Overview of instructions to perform interrupt processing

INT n : Defines the start of an interrupt program.
IRET : Defines the end of an interrupt program.
ICTL : Performs controls such as interrupt inhibit (mask), enable and clear.

The instructions are detailed next page.

INT Interrupt

IRET Interrupt return

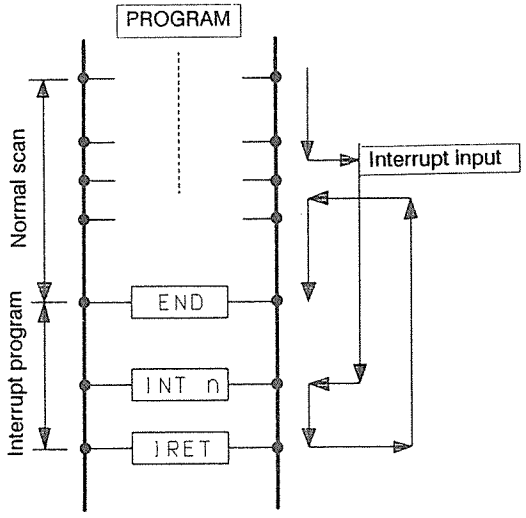


Address	Key operation	Mnemonic		
970	L E.D WRT	ED		
971	SFT INT 4 BRK 1 ICTL 6 WRT	INT		16
972	M ST↑ (0 15) X IN NOP 0 WRT	ST	X	0
973	0 OR (0 15) X IN BRK 1 WRT	OR	X	1
974	0 OR (0 15) X IN - 2 WRT	OR	X	2
975	R OUT (0 255) cR BRK 1 NOP 0 WRT	OT	R	10
976	SFT IRET 5 WRT	IRET		

To input an instruction printed on the upper half of the key top, press the SFT key before the instruction key.

Description

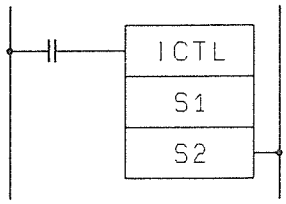
- The start address of the nth interrupt program is indicated by INT n.
  n is divided according to the type of interrupt:
  External interrupt (n = 0 to 15)
  Advanced interrupt unit (n = 16 to 23)
  Time interrupt (n = 24)
- The IRET instruction is used at the end of an interrupt program to return to the sequence program at the state before the interrupt was applied.
- Write the program of both the INT and IRET instructions after the END instruction (normal scan area end instruction).
- Interrupt program with the same number cannot be declared. (Duplicate use of INT n is not allowed).
- INT 0 to INT 15 are executed at the leading edge or trailing edge (specified at the unit) of the inputs for the interrupt unit.
- INT 16 to INT 23 are executed according to the execution request interrupt from the advanced unit.
- If interrupt are generated simultaneously from multiple points, the smaller intreeupt program number has priority.
  Furthermore, if during execution of an interrupt program, another interrupt is generated, it is processed after the executing program has completed.
- It is necessary to set interrupt enable or disable with ICTL (interrupt control instruction) to execute an interrupt program.
- Refer to page 37, ICTL Instruction, for further information.



ICTL

Interrupt control

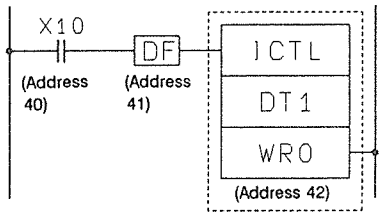
Basic instruction format



S1 : Area storing control specification data or simple control data.

S2 : Area storing control data or simple control data.

Program example



Address	Key operation	Mnemonic
40	M ST RT, (0, 15) X IN, BRK 1, NOP 0, WRT	ST X 10
41	P DF, WRT	DF
42	SFT, ICTL 6, ENT	ICTL
	S DATA, BRK 1, ENT	DT 1
	T WORD, (0, 0251) CR, NOP 0, WRT	WR 0

Operand specification area														Index modifier	Number of steps
Processing unit	Word unit														
Instruction	Set value	WX	WY	WR	WL	SV	EV	DT	LD	FL	IX	IY	K-constant-H		
ICTL	S1	O	O	O	O	O	O	O	O	O	O	O	O O	O	5
	S2	O	O	O	O	O	O	O	O	O	O	O	O O	O	

Description

- Masks,unmasks or clears an interrupt. (Program so that the mask, unmask or clear operation is executed only once when setting with the of instruction.)
- The object and method of interrupt control are specified with S1.

S1 :

15 - - 12	11 - - 8	7 - - 4	3 - - 0
A	B	C	D

2) Interrupt control function specification

1) Interrupt type specification

1) Interrupt type specification

CD = H00 : Interrupt unit specification
D = H01 : Advanced interrupt unit specification (INT 16 to INT 23)
CD = H02 : Time interrupt program specification (INT 24)

2) Interrupt control function specification

AB = H00 : Mask control specification (disable / enable specification)
AB = H01 : Clear control specification

Data for interrupt is specified with S2.

15 - - 12	11 - - 8	7 - - 4	3 - - 0
0 0 0 0	0 0 0 0	1 0 1 0	1 1 1 1

Control data for interrupt program 0

For the high speed counter, set bit 8 through bit 15 to " 0 ".

For mask specification
0 : Mask (disable)
1 : Unmask (enable)

For clear specification
0 : Clear
1 : Do not clear

For the time interrupt, the preset time is specified.
K0 to K3000 : Disabled with 0.

The time is set in 10 ms units.

It is 10 msec for K1 and 30 sec for K3000.

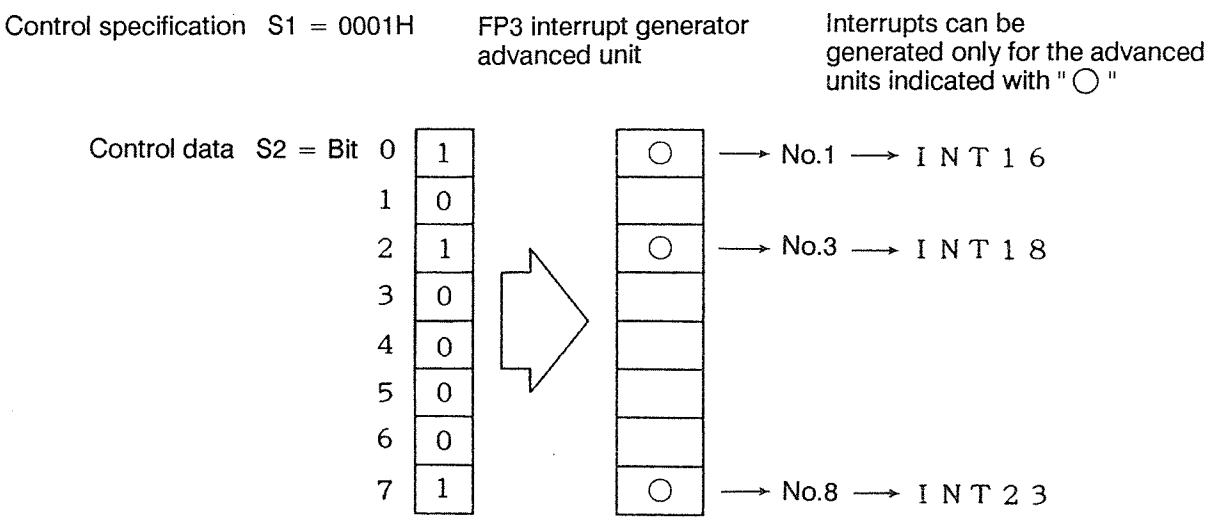
For the Dual-channel High Speed Counter Unit (AFP3622), mask and clear cannot be distinguished for CH.0 and CH.1.

1) Description of interrupt control

At the start of RUN, the FP3 interrupt unit, advanced interrupt unit and time interrupt program are all masked (execution is disabled).

Interrupts must be unmasked with ICTL instruction in order to make the necessary interrupt program executable.

Masking or unmasking of the interrupt unit



The mask (disable) state of advanced unit is in the special data register (DT9026).

Even if the control data specifies " 1 " (for unmask), the unit will not enter the unmasked state when an interrupt program is not present.

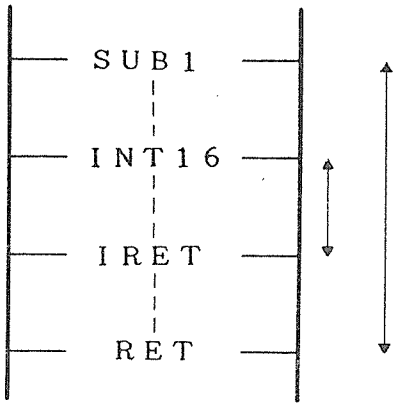
2) Subroutine and interrupt program syntax

The subroutine and interrupt program must be written after the END instruction.

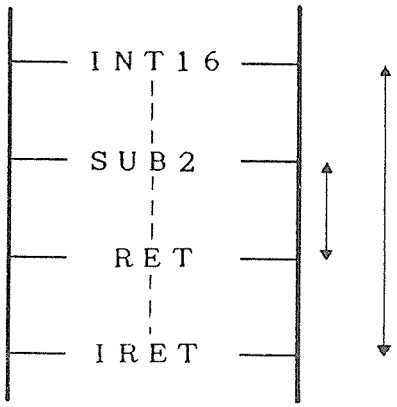
An interrupt program can not be written in the subroutine and a subroutine can not be written in the interrupt program.

Examples : The program shown below will result in syntax errors.

Interrupt definition in a subroutine

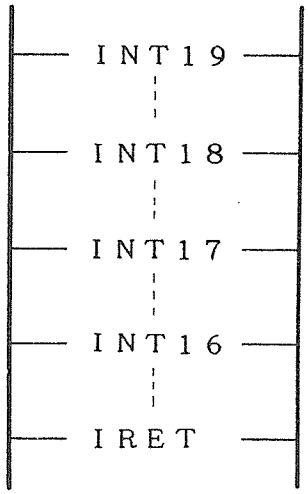


Subroutine difinition in an interrupt program

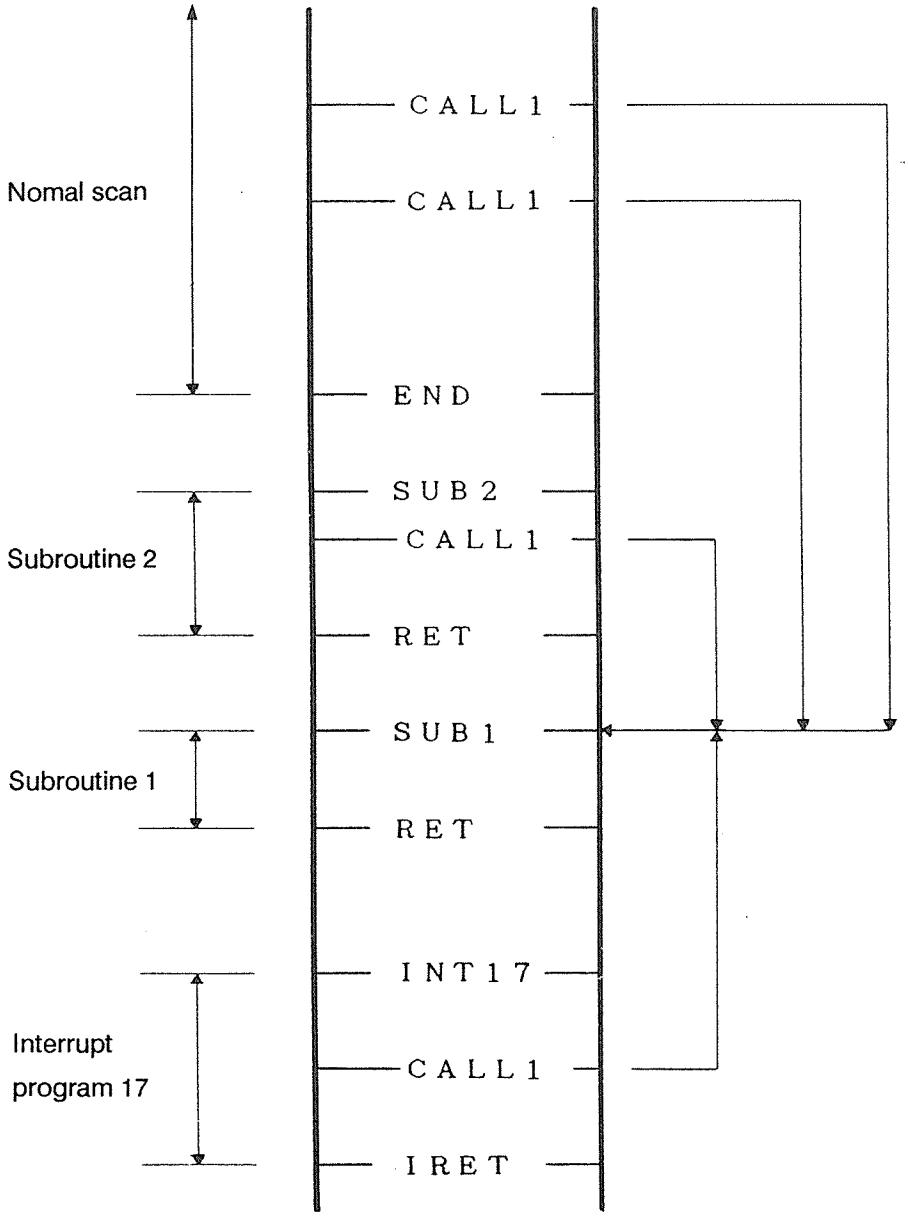


Subroutines and interrupt programs having multiple entry points and a single exit point can be written.

Example : The programs shown below are legal.

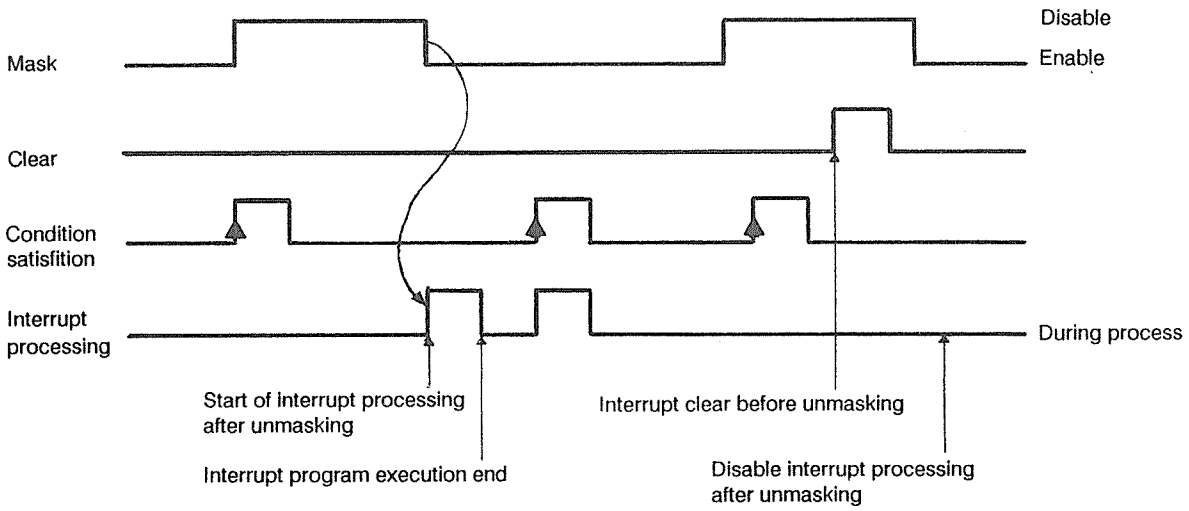


- The same subroutine can be called from any normal scan, subroutine or interrupt program.



5. Execution and control of interrupt program

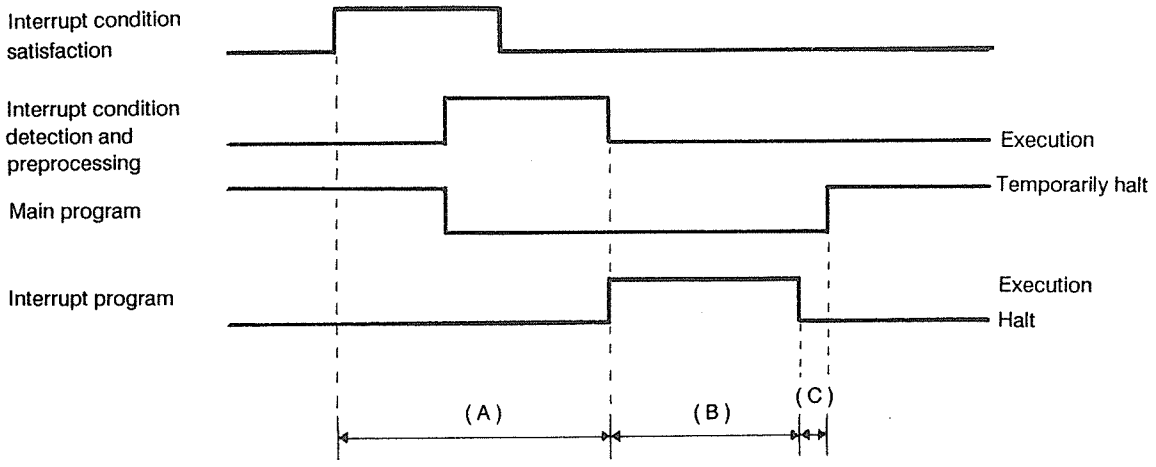
An interrupt program has three states : execution enabled, disabled and clear.
When the mode is changed from PROG. to RUN, execution is disabled.
To perform interrupt control, it is necessary to use the ICTL instruction during the first scan of execution to enable execution.
A specific interrupt can also be enabled or disabled during operation.
The relationships of the interrupt processing with the interrupt disable, enable and clear states are shown below.



6. Process timing for interrupt program

1) Interrupt Response Delay

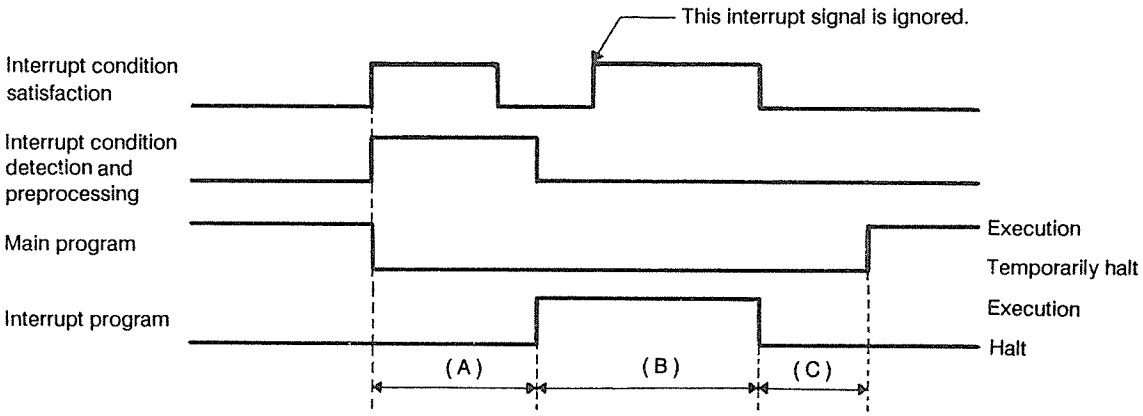
After the interrupt condition has been satisfied, the delay time until the interrupt program is actually executed is called the response delay.
The response delay is described next.



(A) : Interrupt condition detection and preprocessing time (within 0.35 ms)
(B) : Interrupt program processing time
(C) : Processing time after interrupt (within 0.13 ms)

2) Interrupt condition timing

When the interrupt condition is to be generated in succession, set the interrupt timing so that the spacing is at least the time (A) + (B) + (C) given on timing chart below.
Even if, during execution of the program for the previous interrupt signal, the same interrupt request is generated, the interrupt request signal is ignored.



(A) : Interrupt condition detection and preprocessing time (within 0.35 msec.)
(B) : Interrupt program processing time
(C) : Processing time after interrupt (within 0.13 msec.)

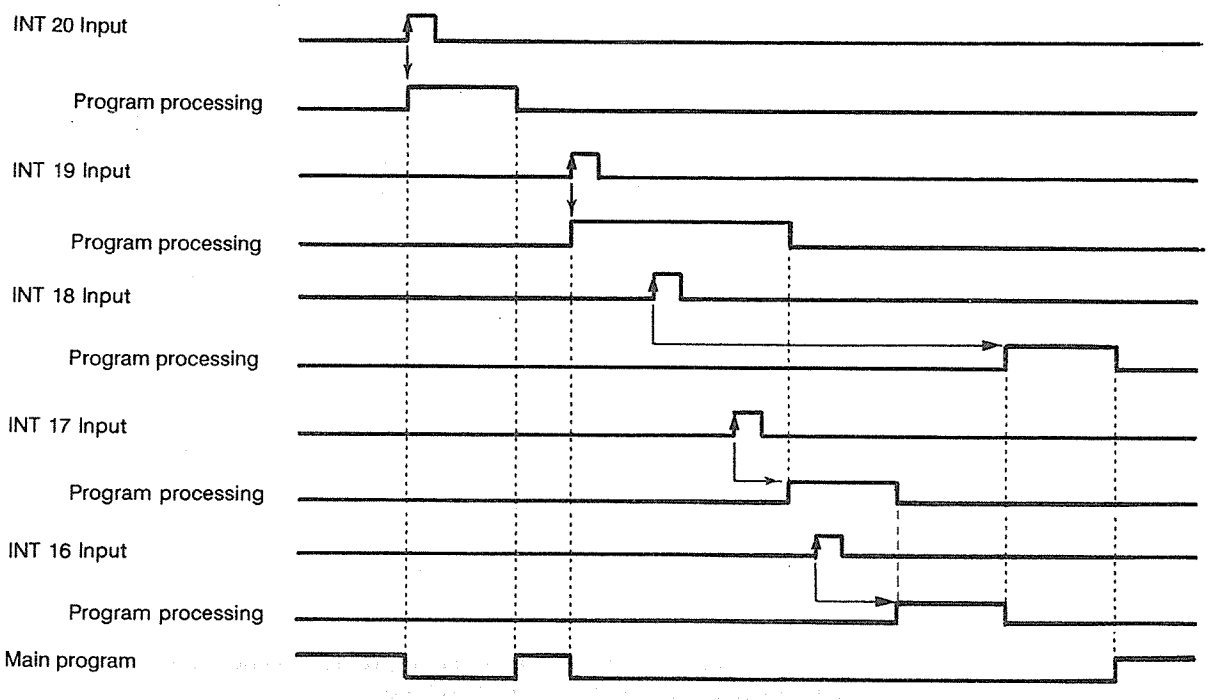
3) Interrupt processing priority

If during intrerrupt processing another interrupt is generated, it is processed after the executing program has completed.

The program being executed will not be terminated even if an interrupt having high priority is generated.

If during interrupt processing, many other interrupts are generated, the execution of the interrupt program at the time is completed then and execution begins from the interrupt program having the highest priority.

Example :



- **In the example above interrupt programs are executed in the order of :**

  INT 20 → INT 19 → INT 17 → INT 16 → INT 18.

Description of the Example

1. For the input of INT 20, the execution of the main program is halted and the program for INT 20 is executed.
   When this ends, the execution of the main program resumes.
2. Also for the input of INT 19, the execution of the main program is halted and the program for INT 19 is executed.
3. If, during processing of INT 19, interrupt requests are generated for INT 18 and INT 17, the processing transfers to the program for INT 17 which has the higher priority after the program for INT 19 is processed.
   Regardless of the generation sequence of the interrupt request inputs, the processing is performed in the sequence which follows the priority.
4. If, during processing of the program for INT 17, an interrupt request input for INT 16 is generated, the processing transfers to the program for INT 16 after the program for INT 17 is processed.
5. When the processing of the program for INT 16 completes, the processing transfers to the program for INT 18 which was in the waiting state.
   (The times for input delay, interrupt detection and preprocessing have been omitted in the figure.)

7. Notes on Dual-channel High Speed Counter Unit (AFP3622) Usage

Note the following when the mode selector switches are set to enable the interrupts for both CH.0 and CH.1 with the Dual-channel High Speed Counter Unit (AFP3622).

1. If interrupt requests are issued for CH.0 and CH.1 of the n th High Speed Counter Unit, the INT(n + 15) program is executed for both.
2. If, for 1, an interrupt request is issued from either CH.0 or CH.1, it can be distinguished by internal contacts X0 (CH.0) and X4 (CH.1).
3. The timing for both X0 and X4 is the same as for the external coincidence output (C = P)
4. As in Section 6.Process timing for interrupt programs 3), note the timing for the interrupt requests for CH.0 and CH.1.
5. The interrupt mask and clear control is set simultaneously for CH.0 and CH.1 and cannot be controlled separately.

CHAPTER 5

APPLICATION EXAMPLES

5-1. Speed Measurement

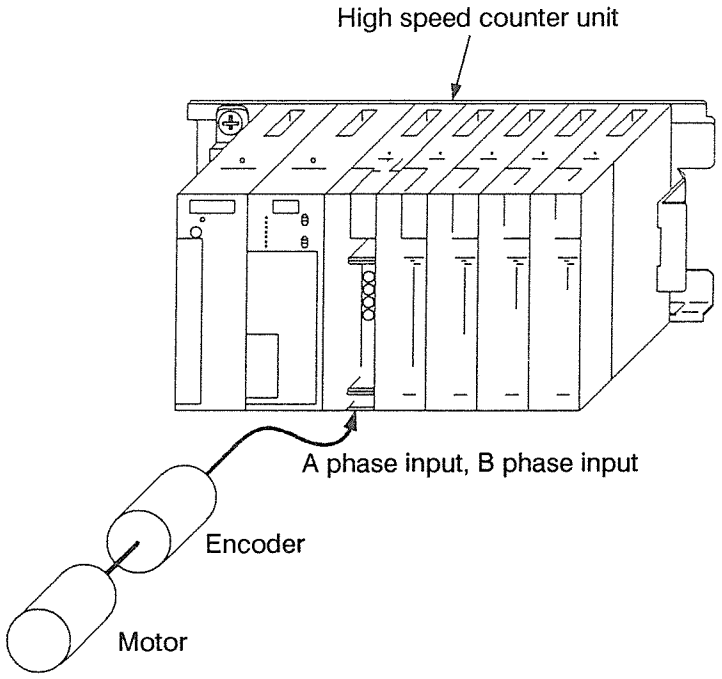
5-2. Fixed Length Cutting

5-3. Send Control Application

" PC " is the abbreviation for Programmable Controller.

5-1. Speed Measurement

Pulses from the encoder are measured for every fixed time and the rpm is determined.



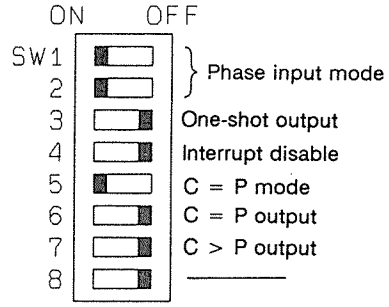
Example

An example program is shown which measures the number of pulses every second from an encoder with a resolution of 1,000 pulses per rotation and calculates the rpm.

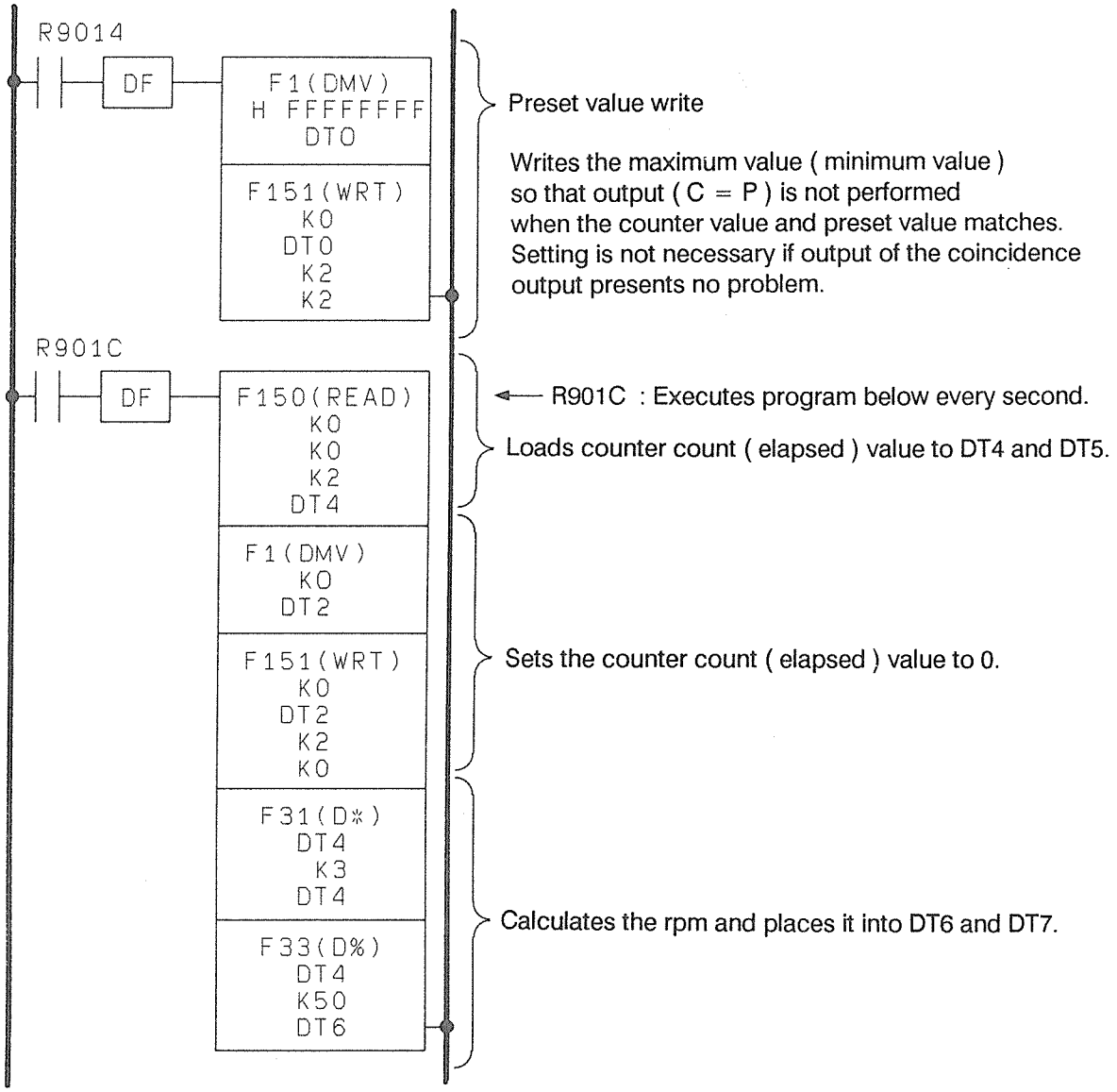
In this example, the High Speed Counter Unit is mounted to slot no.0 on the basic base plate.

$$\text{Revolutions per minute} = \frac{\text{Number of pulses per second}}{\text{Number of pulses per rotation}} \times 60 = \frac{\text{PLS} \times 60}{1000} = \text{PLS} \times \frac{3}{50}$$

- Mode select switch

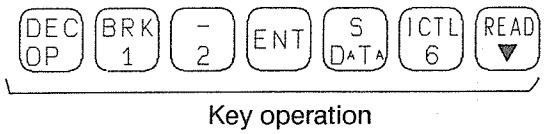


Program Example

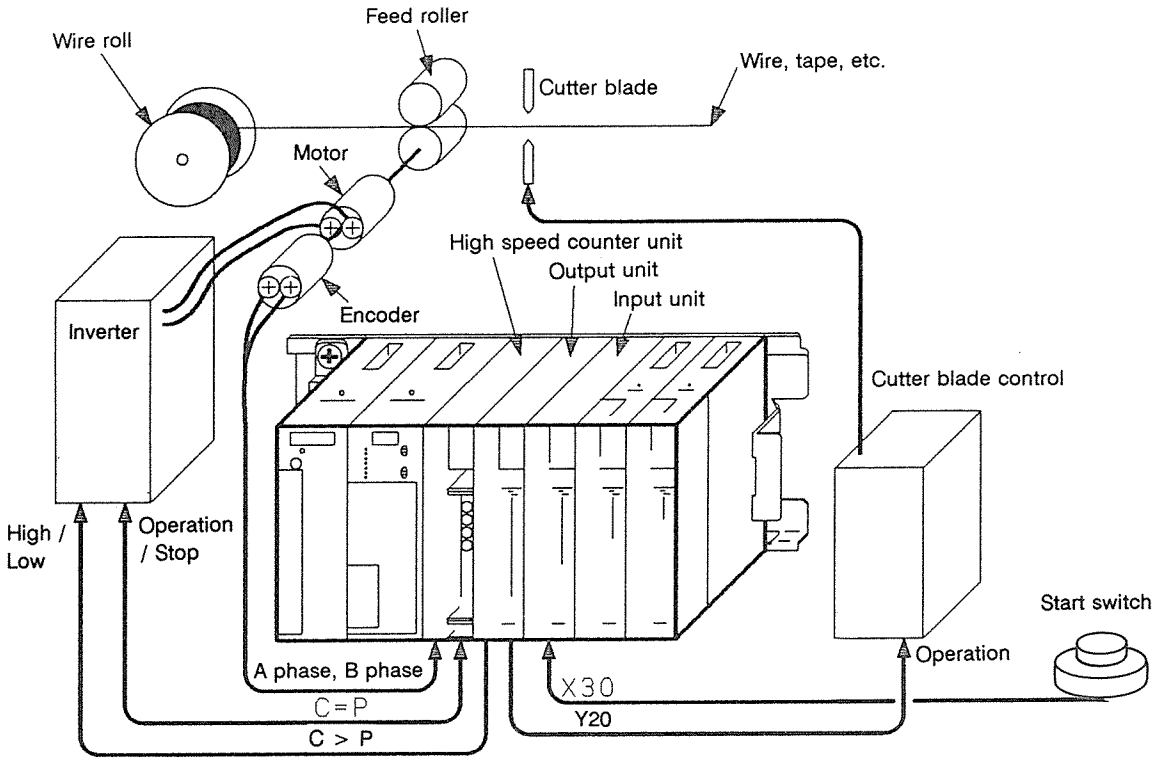


Monitor Method

Since the rpm is in DT6 and DT7, it can be monitored with the key operation of programming unit below.



5-2. Fixed Length Cutting



Example

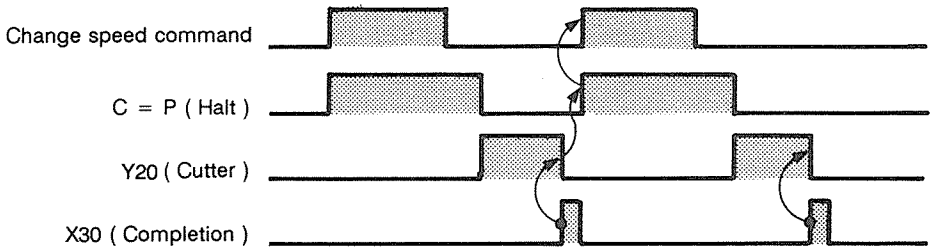
Assume the circumference of the feed roller is 10 cm (3.9 in.) and the resolution of the encoder is 500 pulses per rotation.

An example program is shown which cuts the wire every 100 cm (39.4 in.).

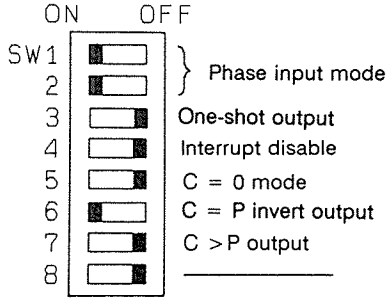
The roller's speed is decreased when 95 cm (37.4 in.) of wire has been fed.

In this example, High Speed Counter Unit is mounted to slot no.0 on the basic base plate.
The Output unit is mounted to slot no.1 on the basic base plate.
The Input unit is mounted to slot no.2 on the basic base plate.

- **Timming Chart**



- Mode select switch

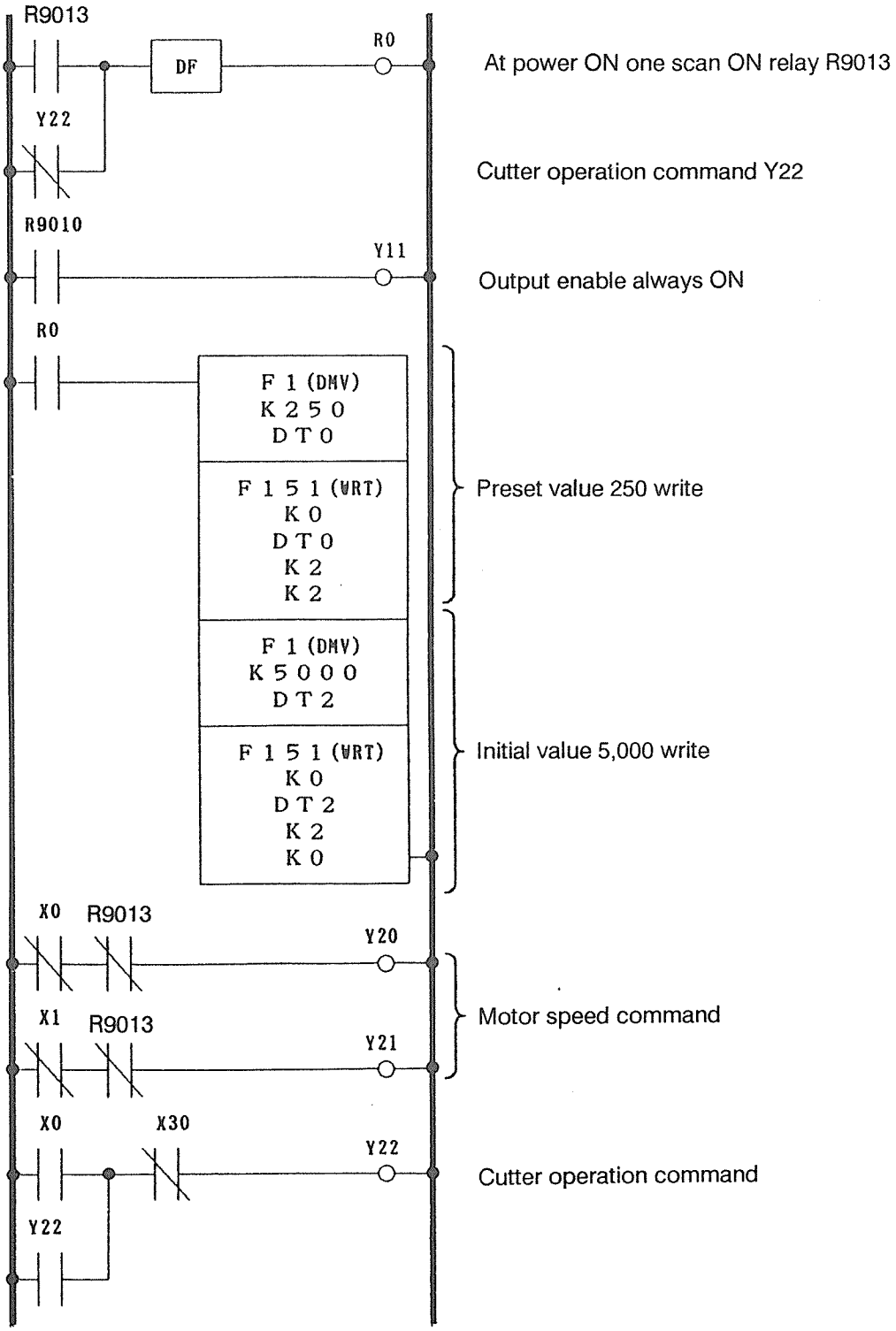


Executed in C = 0 mode with subtraction counting.

$$\text{Initial value} = \frac{\text{Send length}}{\text{Roller circumference}} \times \text{Encoder resolution} = \frac{100}{10} \times 500 = 5{,}000$$

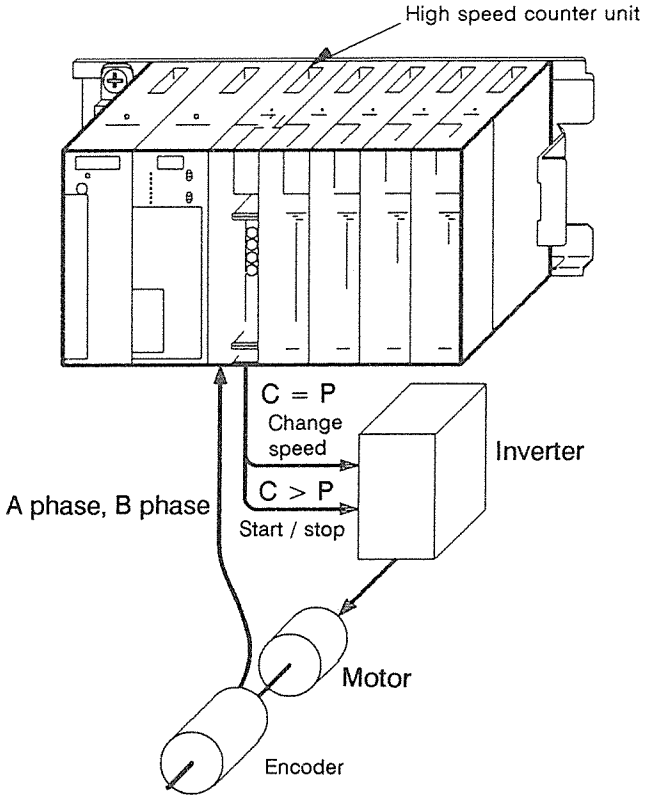
$$\text{Preset value} = \frac{5}{10} \times 500 = 250$$

Program Example



5-3. Send Control Application

An example is given which executes high speed control independently of the scan time of sequence program.

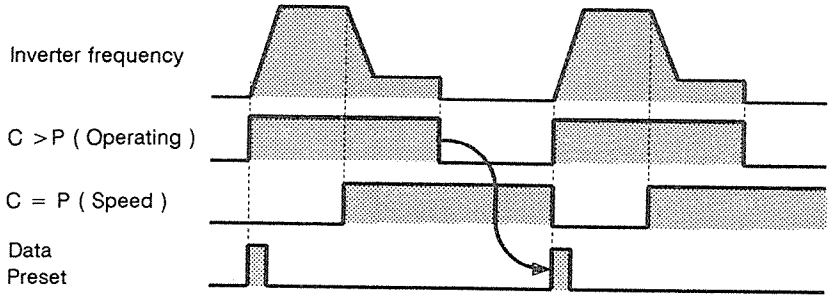


After performing the high speed operation of 10,000 pulses, the low-speed operation of 500 pulses is performed and the operation is stopped.

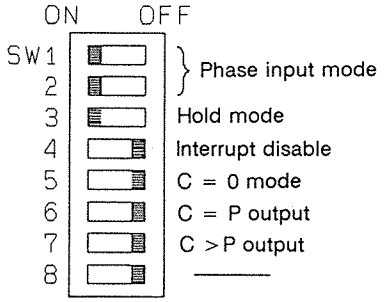
The mode is set to C = 0, and the encoder pulse which sets the initial value K10,000 and preset value K-500 is subtraction counted.

In this example, High Speed Counter Unit is mounted to slot no.0 on the basic base plate.

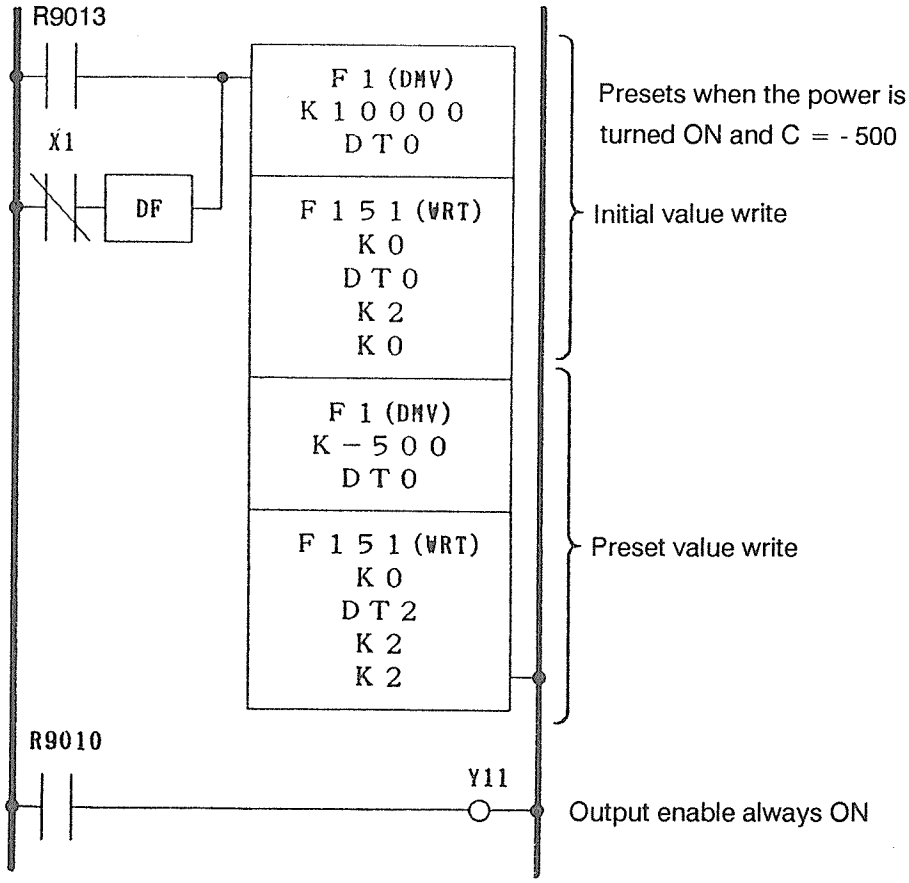
- **Timming Chart**



- Mode select switch



Program Example



CHAPTER 6

APPENDIX

" PC " is the abbreviation for Programmable Controller.

6-1. Mode Select Switch Setting

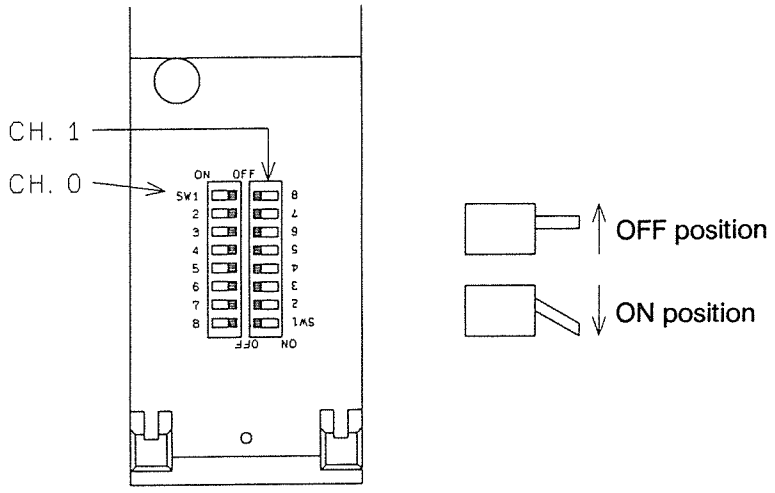
	ON	OFF
SW1	Input mode settting *	
SW2		
SW3	Hold output	One-shot output
SW4	Interrupt enable	Interrupt disable
SW5	C = P mode	C = 0 mode
SW6	In C = P mode	
	C = P invert output	C = P output
	In C = 0 mode	
	C = P invert output	C = P output
SW7	C>P invert output	C>P output
SW8	Not used	

* Input mode settting table

SW1	SW2	Mode
ON	ON	Phase input mode
ON	OFF	Unused
OFF	ON	Individual input mode
OFF	OFF	Directional discriminant mode

Single-channel Type (AFP3621) : One location (CH.0)
Dual-channel Type (AFP3622) : Two locations (CH.0, CH.1)

Mode selector switch (DIP switch)



(Rear panel)

6-2. Data Memory Allocation

Words Address	READ data	WRITE data
K0 (K8)	Count (Elapsed) value (low order 16-bit)	Initial value (low order 16-bit)
K1 (K9)	Count (Elapsed) value (high order 8-bit and sign bit)	Initial value (high order 8-bit and sign bit)
K2 (K10)	Cannot be read	Preset value (low order 16-bit)
K3 (K11)	Cannot be read	Preset value (high order 8-bit and sign bit)
K4 (K12)	Cannot be read	Input filter constant 0 to 3
K5 (K13)	Cannot be read	Set Input filter constant to 0

( ) contains the word address for chennel no.1(CH.1).
It cannot be used on Single-channel High Speed Counter Unit (AFP3621).

- Address for CH.1 = Address for CH.0 + 8

6-3. Internal Input/Output Contacts

<table>
<tr><th></th><th>Single-channel Type (AFP3621)</th><th>Dual-channel Type (AFP3622)</th></tr>
<tr><td colspan="3">Input Contacts</td></tr>
<tr><td>X0</td><td>C = P Coincidence Flag</td><td>C = P Coincidence Flag (CH.0)</td></tr>
<tr><td>X1</td><td>C > P Comparison Flag</td><td>C > P Comparison Flag (CH.0)</td></tr>
<tr><td>X2</td><td>Overflow Flag / Underflow Flag</td><td>Overflow Flag / Underflow Flag (CH.0)</td></tr>
<tr><td>X3</td><td rowspan="5">Disable</td><td>Disable</td></tr>
<tr><td>X4</td><td>C = P Coincidence Flag (CH.1)</td></tr>
<tr><td>X5</td><td>C > P Comparison Flag (CH.1)</td></tr>
<tr><td>X6</td><td>Overflow Flag / Underflow Flag (CH.1)</td></tr>
<tr><td>X7
⋮
XF</td><td>Disable</td></tr>
<tr><td colspan="3">Output Contacts</td></tr>
<tr><td>Y10</td><td>Counter reset</td><td>Counter reset (CH.0)</td></tr>
<tr><td>Y11</td><td>Output enable</td><td>Output enable (CH.0)</td></tr>
<tr><td>Y12</td><td rowspan="4">Disable</td><td>Counter reset (CH.1)</td></tr>
<tr><td>Y13</td><td>Output enable (CH.1)</td></tr>
<tr><td>Y14
⋮
Y1F</td><td>Disable</td></tr>
</table>

* **C : Count (Elapsed) value, P : Preset value**

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