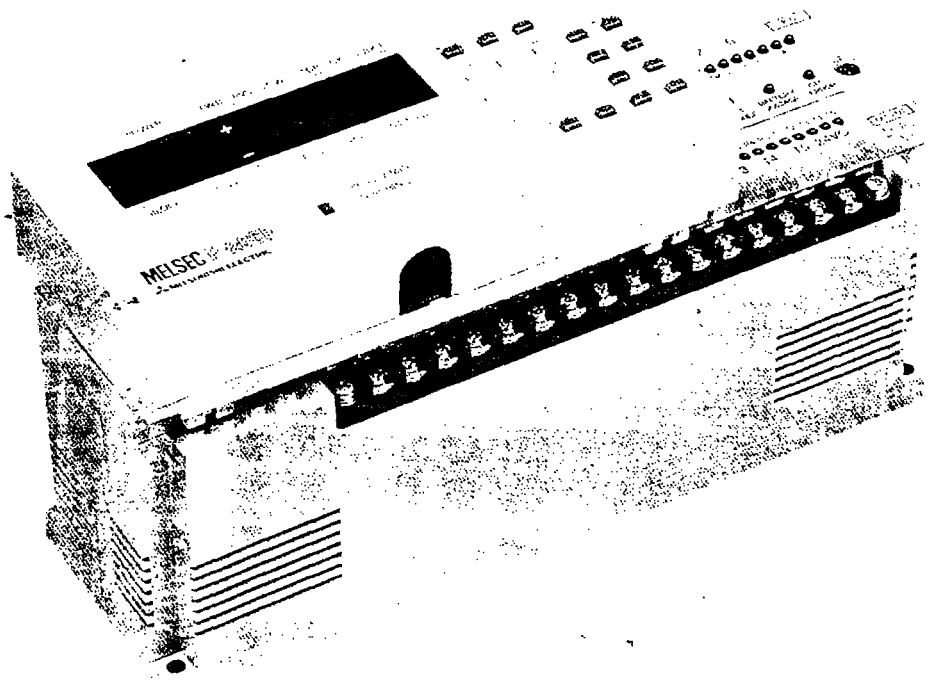
MITSUBISHI

MELSEC F Positioning Controller

INSTRUCTION MANUAL

Positioning Counter Module F-20CM-5
and Programming Unit F-20CP-E



- This manual provides technical information and guidance on the use of the Mitsubishi positioning counter module F-20CM-5 and programming unit F-20CP-E.
- Users should ensure that the detail of this manual is studied and understood before attempting to use the unit.
- Information concerning the programmable controller is covered in a separate manual.

MITSUBISHI ELECTRIC CORPORATION

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1. GENERAL DESCRIPTION

1. INTRODUCTION

FEATURES

1. MAX. 400 POSITIONING POINTS CAN BE PROGRAMMED

40 positioning points can be programmed in a block and MAX. 10 blocks are provided for different positioning patterns or conditions to control. All program blocks can be cascaded to operate in series.

2. TOOLING SEQUENCE CAN BE COMBINED WITH POSITIONING SEQUENCE

The PC instructs the counter unit to drive and the counter unit reports the implementation back to the PC, which controls the tooling sequence according to the positioning sequence.

3. EASY PROGRAMMING OF POSITIONS

Positioning points can be programmed by either counter value settings or teaching of actual positions.

4. ACCURACY JUDGEMENT FUNCTION AVAILABLE

Accuracy allowance can be programmed and actual stop position is verified according to the target position and allowance.

5. COUNTER MEMORY BACK-UP AND CMT STORAGE

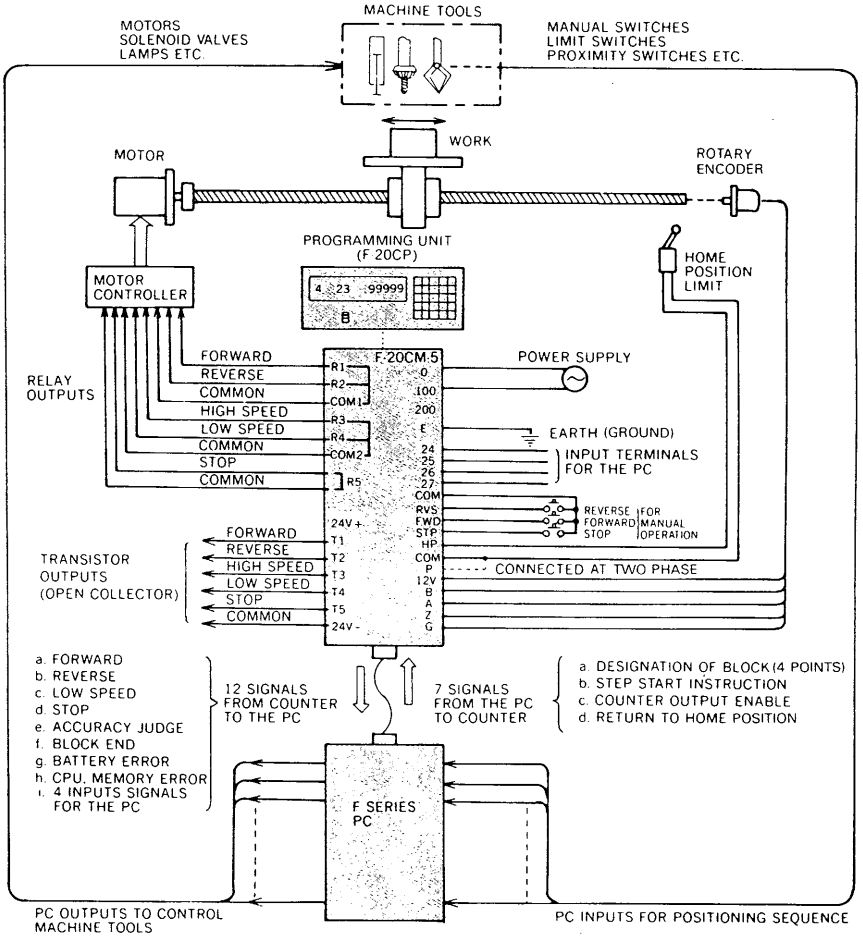
Counter program in RAM memory is backed by lithium battery and CMT interface function is provided in the programmer.

6. EITHER RELAY OR TRANSISTOR OUTPUTS ARE AVAILABLE

FEATURES EXTENDED TO THE PC

4 input terminals are provided for the PC to expand the number of inputs and these terminals accept intermittent short pulse signals of 5m·sec., which is converted to longer pulses for the transfer to the PC.

SYSTEM FORMATION



2. CONCEPT OF POSITIONING

① POSITIONING START

When the system is ready to start a certain step positioning, the counter starts one step drive according to the step start signal generated by the PC.

② FORWARD AND REVERSE

The counter recognizes present position by the counter value at any time, and compares it with the objective position. When the counter value difference is positive (or negative), the forward (or reverse) output is turned "ON" to approach the target position of the step. The high speed output is automatically turned "ON" at starting time of drive.

③ SPEED REDUCTION

When the high speed output is turned "ON", the machine drives toward the target position. The high speed output is turned "OFF" when the counter value reaches the speed reduction point which is programmed in the counter unit. At the same time, the low speed output is turned "ON" instead.

④ INERTIA COMPENSATION AND STOP

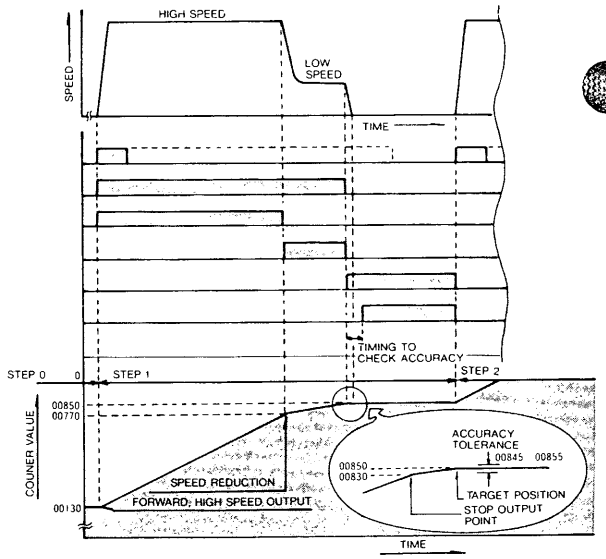
When the counter value reaches the target position, the low speed output and forward (or reverse) output are turned "OFF". At the same time, the stop output is turned "ON". For this procedure, a certain counter value can be programmed to compensate the over-run by the mechanical inertia. In this case, the stop output is turned "ON" before value equals target position. The stop output remains "ON" until the next step positioning starts.

⑤ ACCURACY ALLOWANCE AND JUDGEMENT

A certain accuracy tolerance can be programmed to the actual stop position.

After the machine stops, the counter recognizes the actual stop position and verifies it with the target position. When the stop position is within above tolerance programmed, "ON" signal is sent from counter to the PC. If not, the machine automatically stops.

SPEED CHART



CONTOL SIGNAL CHART

STEP START SIGNAL (FROM PC TO COUNTER)
FORWARD OUTPUT (COUNTER OUTPUT)
HIGH SPEED OUTPUT (COUNTER OUTPUT)
LOW SPEED OUTPUT (COUNTER OUTPUT)
STOP OUTPUT (COUNTER OUTPUT)
ACCURACY CONFIRMATION SIGNAL (FROM COUNTER TO PC)

COUNTER VALUE

DATA CODING EXAMPLE

	STEP NO.	BLOCK 0	BLOCK 1		BLOCK 9
TARGET POSITION SETTING ADDRESSES (0~39STEP, TOTAL 40 POINTS)	0	00130	·····		·····
	1	00850	·····		·····
	2	01191	·····		·····
	3	07760	·····		·····
	4	35280	·····		·····
		⌇	⌇		⌇
FORCE END (AUTOMATICALLY PROGRAMMED)	40	END	END	~	END
		⌇	⌇		⌇
LOW SPEED DISTANCE	70	00080	·····		·····
TIMING TO CHECK ACCURACY(m.s)	71	00500	·····		·····
ACCURACY TOLERANCE (+, −)	72	00005	·····		·····
ACCURACY CHECK OR NO-CHECK	73	00001	·····		·····
INERTIA COMPENSATION VALUE	74	00020	·····		·····

① 40 positioning addresses per block and 10 blocks are provided to compose a total of 400 positioning points.

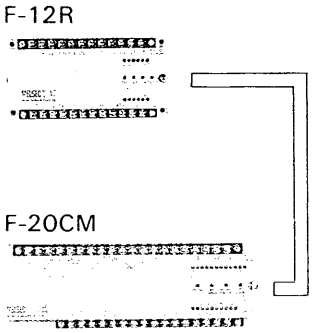
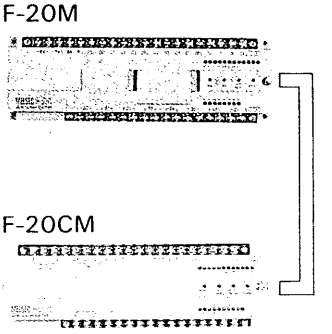
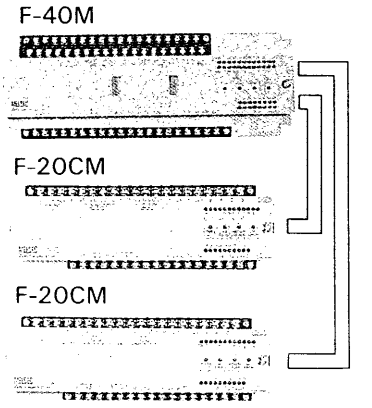
② Positioning conditions such as low speed distance, accuracy check conditions, inertia compensation value, are common in a block.

③ The block is selected by the PC.

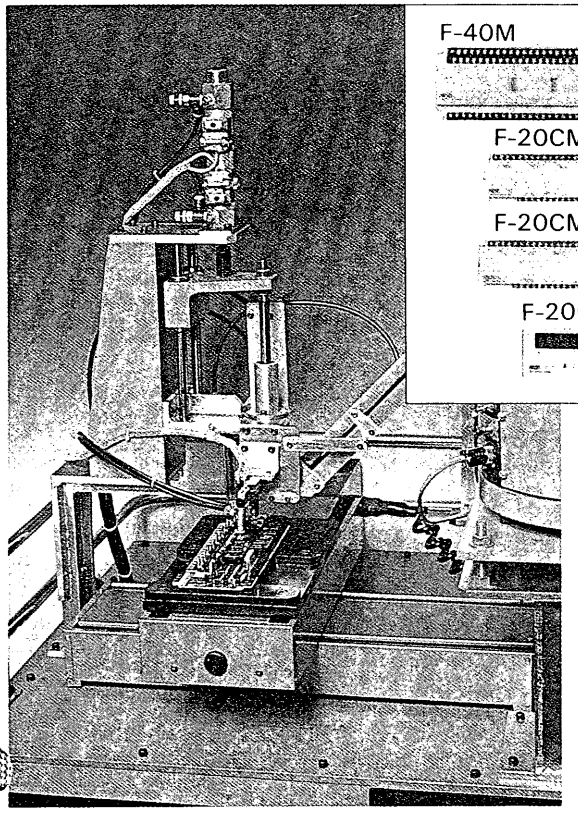
④ When the positioning procedure is completed in a block, a block end signal is sent from the counter to the PC. Accordingly all blocks can be cascaded in series by the PC program if required.

3. SELECTION OF THE PC

- The counter module is connected with the F series PC base unit in the same manner as the extension unit.
- F-12R or F-20M base unit can adapt a counter module for single axis control and F-40M base unit can be connected with two counter modules for dual axes controls.
- The PC selected can be from various F series models according to the requirements of axis and sequence scale to control.

F-12R	F-20M	F-40M
		

4. APPLICATION EXAMPLE

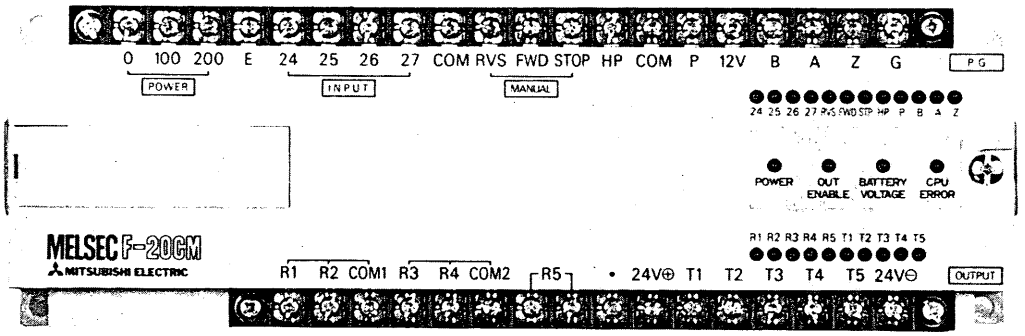


Automatic insertion machine for IC components or miniature relays is one example to apply the positioning counter module F-20CM, and its programmer F-20CP, in conjunction with F series PC.
MAX. 400 positioning points can be programmed per axis and the F-40M model PC can adapt two counter modules for dual axis control.

2. HANDLING OF F-20CM-5 HARDWARE

1. TERMINAL DESCRIPTION

SINK INPUT MODEL (F-20CM-5, F-20CM-5U TYPE)



※The terminal arrangement and silk print are based on sink input model. Terminal arrangement is different in case of source input model (ESS Type).

TERMINAL DESCRIPTIONS

	INPUTS		
	MARK	TERMINAL	DESCRIPTIONS
	0-100	POWER SUPPLY	AC 110/120V power
	0-200	//	AC 220/240V power
	E	EARTH (GROUND)	Earthing (Grounding)
	24	SHORT PULSE INPUT	Input for the PC
	25	//	//
	26	//	//
	27	//	//
※1	COM	COMMON	Common for inputs
	RVS	REVERSE INPUT	Low speed reverse input
	FWD	FORWARD INPUT	Low speed forward input
	STOP	STOP INPUT	Emergency stop input
	HP	HOME POSITION	Home position input
	P	PHASE	Sensor phase selection
	12V	SENSOR POWER	DC 12V power for sensor
※2	B	COUNTER INPUT B	Sensor B phase
※2	A	// A	Sensor A phase
※2	Z	// Z	Sensor zero phase
※3	G	SENSOR GROUND	Sensor power 0V terminal

OUTPUTS		
MARK	TERMINAL	DESCRIPTIONS
R1	RELAY OUTPUT No.1	Forward relay output
R2	// No.2	Reverse relay output
COM1	OUTPUT COMMON No.1	Common for forward, reverse
R3	RELAY OUTPUT No.3	High speed relay output
R4	// No.4	Low speed relay output
COM2	OUTPUT COMMON No.2	Common for high/low speed
R5	RELAY OUTPUT No.5	Stop relay output
DC24V⊕	TR POWER ⊕	TR power ⊕ connection
T1	TR OUTPUT No.1	Forward TR output
T2	// No.2	Reverse TR output
T3	// No.3	High speed TR output
T4	// No.4	Low speed TR output
T5	// No.5	Stop TR output
DC24V⊖	TR POWER ⊖	TR power ⊖ connection

※1. Two common terminals are provided for sink input model.
※2. When counter input signal is single phase, input B terminal is used for the input, while A and B shall be open.
※3. The G terminal is used as a ground to the 12VDC source for the pulse generator.

LED INDICATORS AND DIAGNOSIS

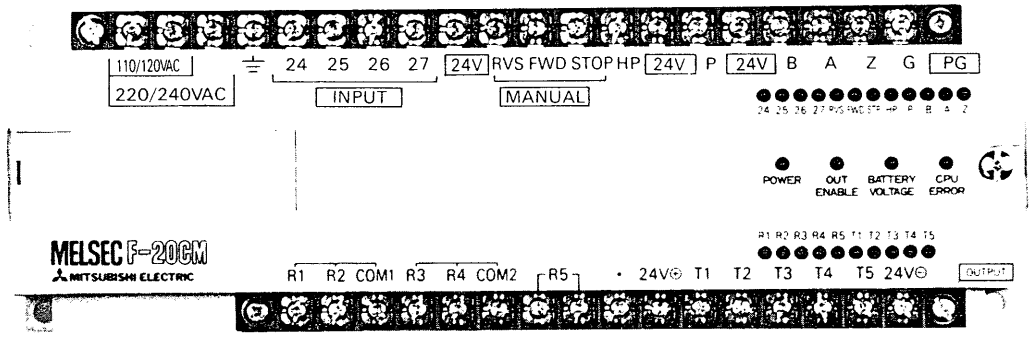
- All inputs and outputs have LED indicators, which are turned "ON" when inputs or outputs are "ON" status.
- 4 diagnostic indicators are provided as followings;

POWER	Power supply
OUT ENABLE	Permission for the counter unit to drive the output by the PC
BATTERY VOLTAGE	Battery voltage warning
CPU ERROR	Counter memory and CPU warning

SHORT PULSE INPUTS FOR THE PC

- 4 input terminals are provided for the PC to expand the number of inputs and these terminals accept intermittent short pulse signals of 2m.sec., which could not be accepted by the F series PC.
- When the input signals are transferred to the PC, the counter converts these short pulses to 50m. sec. width pulse for the PC.
- These input terminals are useful to accept the momentary "ON" signal generated by the limit switch or proximity switch for example.

SOURCE INPUT MODEL (F-20CM-5ESS TYPE)



TERMINAL DESCRIPTIONS

	INPUTS		
	MARK	TERMINAL	DESCRIPTIONS
	110/120VAC	POWER SUPPLY	AC110/120V power
	220/240VAC	〃	AC220/240V power
	⏚	EARTH (GROUND)	Earthing (Grounding)
	24	SHORT PULSE INPUT	Input for the PC
	25	〃	〃
	26	〃	〃
	27	〃	〃
※1	24V	24VDC POSITIVE	24VDC power source
	RVS	REVERSE INPUT	Low speed reverse input
	FWD	FORWARD INPUT	Low speed forward input
	STOP	STOP INPUT	Emergency stop input
	HP	HOME POSITION	Home position input
	P	PHASE	Sensor phase selection
	B	COUNTER INPUT B	Sensor B phase
	A	〃 A	Sensor A phase
	Z	〃 Z	Sensor zero phase
※2	G	24VDC NEGATIVE	24VDC ground

OUTPUTS		
MARK	TERMINAL	DESCRIPTIONS
R1	RELAY OUTPUT No.1	Forward relay output
R2	〃 No.2	Reverse relay output
COM1	OUTPUT COMMON No.1	Common for forward, reverse
R3	RELAY OUTPUT No.3	High speed relay output
R4	〃 No.4	Low speed relay output
COM2	OUTPUT COMMON No.2	Common for high/low speed
R5	RELAY OUTPUT No.5	Stop relay output
DC24V⊕	TR POWER +	TR power + connection
T1	TR OUTPUT No.1	Forward TR output
T2	〃 No.2	Reverse TR output
T3	〃 No.3	High speed TR output
T4	〃 No.4	Low speed TR output
T5	〃 No.5	Stop TR output
DC24V⊖	TR POWER −	TR power − connection

※1. Three 24V terminals are provided to be used as a positives of input circuits for non-voltage input devices such as limit switches. This terminals are also used as power sources for input sensors such as proximity switches, optical switches and pulse generator. (24V DC, 160m.Amp. total)

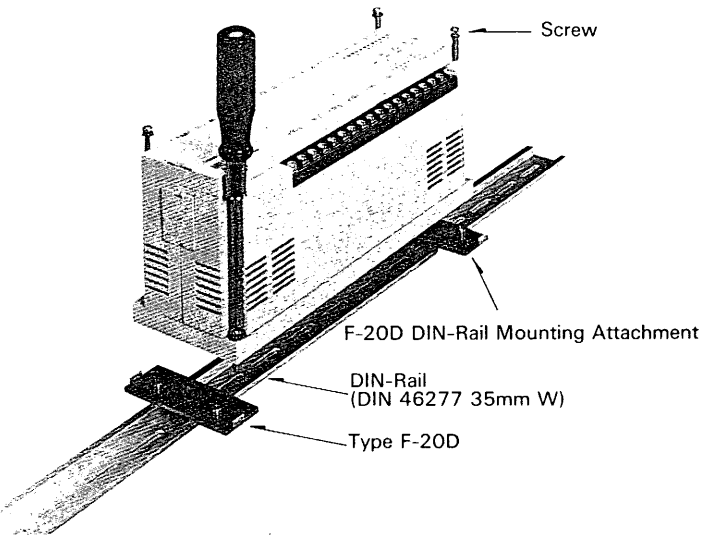
※2. The G terminal is used as a ground to the 24VDC source for input sensors such as proximity switches, optical switches and pulse generator in the same manner as the 0V terminals of the PC.

2. INSTALLATION AND ENVIRONMENT

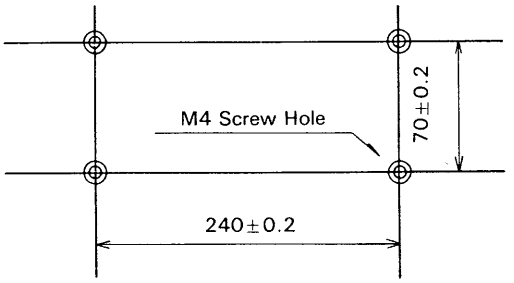
INSTALLATION

The F-20CM can be mounted with suitable screws direct to any flat surface by using the four corner holes provided. Althrnatively an optional DIN rail mounting kit is available.

Installation on DIN-Rail



Screw Hole Pitch
(Direct Installation) mm



In case of mounting the unit on a vertical face, beware of conductive trashes falling into the unit through the ventilation opening.

ENVIRONMENT

While the F-20CM is suitable for most industrial situations, it should not be used in excessively hostile environments associated with extremes of damp, dust, corrosive gases, vibration or mechanical impact.

The unit should not be installed in a situation where the temperature is likely to rise to above 50℃ and a space of some 30 mm should be allowed around the unit for heat dissipation.

ELECTRICAL NOISE INTERFERENCE

To avoid electrical noise interference from some external apparatus, the unit should not be installed near high voltage supply cables or other such electrical apparatus. The extension cable used to connect the F-20CM and PC base unit should be kept separate from any other cables or wires by a distance of 30 mm at least. The wiring is mentioned in next section.

WIRING

The input and output wires must be kept separate and away from any power supply cables or high voltage cables. In particular wires to 4 input terminals (24, 25, 26, 27) for the PC shall be bewared of external surge and inductives, because these inputs response to the high speed signal. The input wires should be bound or cabled together as well as output wires for the sake of convenience and appearance and to avoid damage of failure.

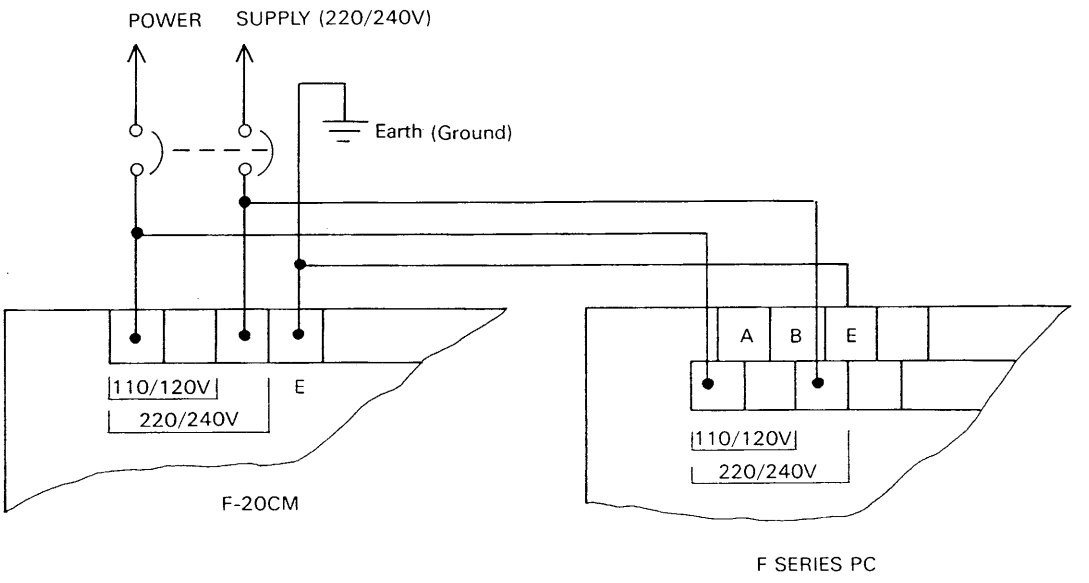
Since wires to the rotary encorder handle sensitive signals, the wires should be sealed and not longer than 10 meters. Other input and output wires can be longer but depends upon the conditions of the noise environment and voltage drop. It is recommended that the lenght is not longer than 20 meters for the general use.

3. POWER SUPPLY AND EARTHING

POWER SUPPLY

Connect a power supply cable of the correct rating to the unit together with the PC base unit as illustrated.

EXPL.



EARTHING

The unit must be earthed as illustrated. The resistance for earthing should be less than 100Ω.

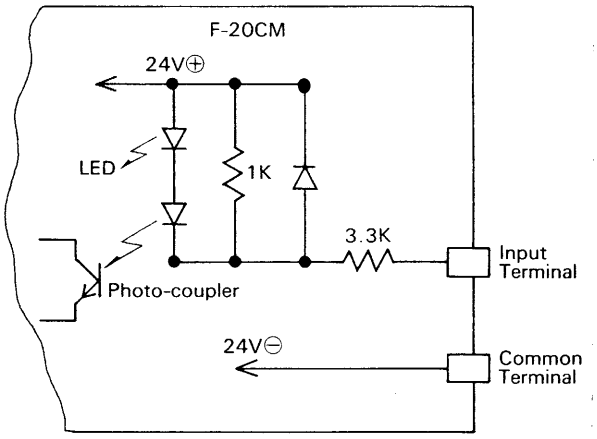
The earthing must not be shared with any high power equipment such as a motor system etc.

4. INPUT HANDLING

4-1 Input Connections (Except pulse Generator)

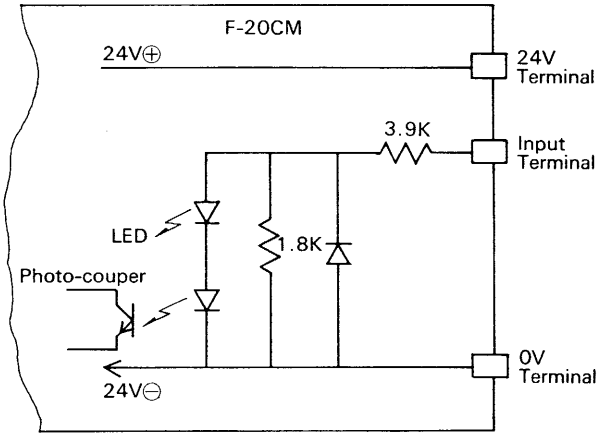
Connect input control devices such as limit switches, push buttons, proximity switches or photo switches to the input terminations. The input current rating at each input terminal is 24VDC, 7mA and control devices should be specified accordingly. Sink input model and source input model are available and the inner connections are as follows;

Sink Input Model (F-20CM-5, F-20CM-5U Type)



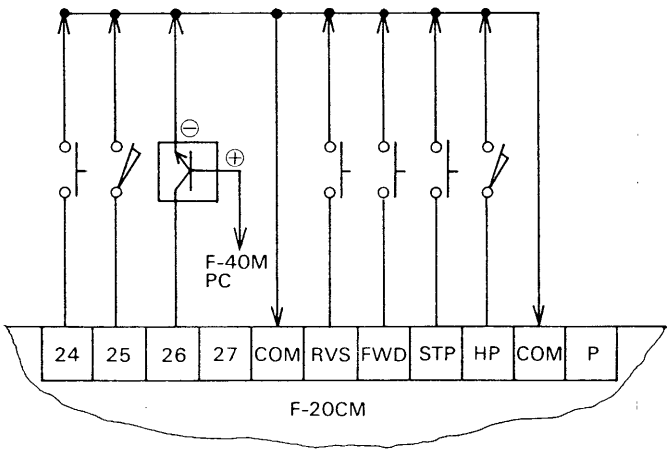
* Two common terminals are connected internally, however the common terminals of F-20CM and PC base unit are not linked unless connected together externally.
  When the F-20CM is connected to the F-40M PC, the PC has a 24V terminal point which can be used to power external transistors such as proximity switches or optical switches.

Source Input Model (F-20CM-5ESS Type)

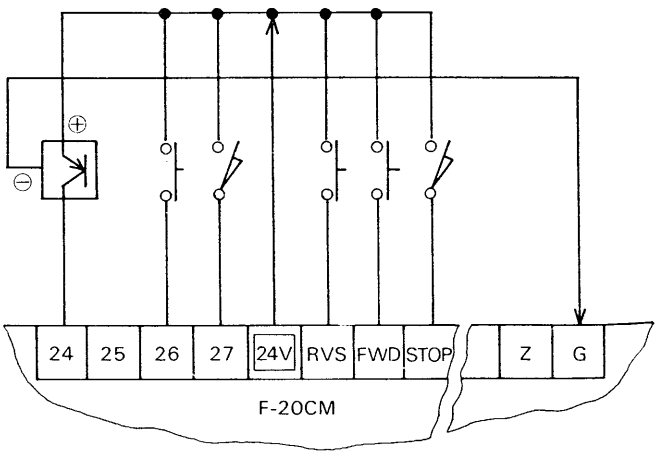


* The 24V terminal point provides a capacity of 160m.Amp. max, which can be used to power external transistors such as proximity switches or optical switches and encoder.
* The 0V terminal is used for negative of 24VDC source.

Example : Sink Input Model (F-20CM-5, F-20CM-5U Type)



Source Input Model (F-20CM-5ESS Type)



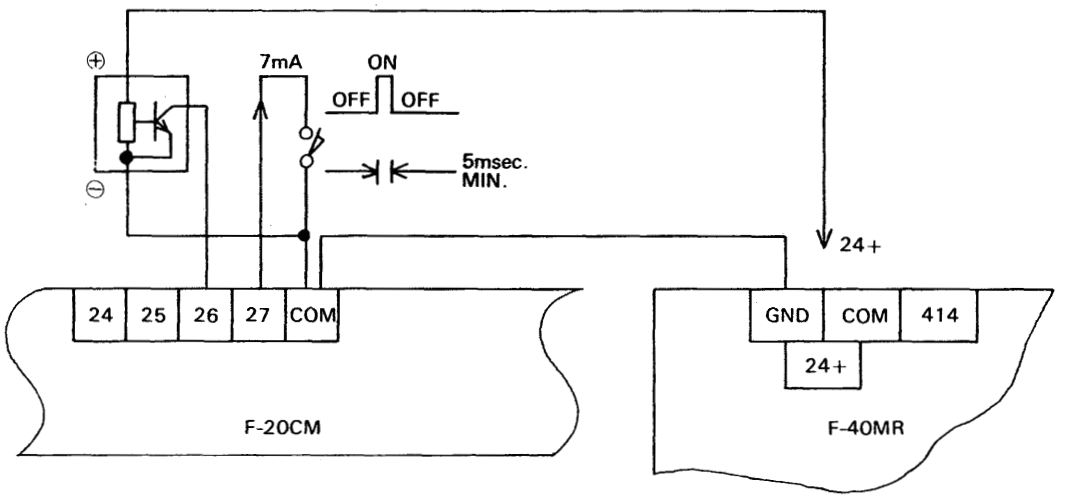
* If transistor circuits such as proximity switches are connected to input terminals, then their parallel resistance should be more than 100kΩ and their series resistance less than 1kΩ.

4-2 Input terminals extended to the PC

24 25 26 27

4 input terminals are provided for the PC to expand the number of inputs and these terminals accept intermittent short pulse signals of 5 m.sec., which could not be accepted by the PC. When the input signals are transferred to the PC, the pulse signals less than 50m.sec. are converted to 50m.sec. width pulse for the PC.
These input terminals are useful to accept the momentary "ON" signal generated by the limit switches or proximity switches for example.

Example of sink input model :



In case of "ON-OFF-ON" pulse, the pulse width should be 50m.sec. MIN. as same as the PC input.

Numeric assignments of these input terminals are same as the numbers of the PC extension input.

Input Terminals	PC applied		
	F-12R	F-20M	F-40M
24	24	24	424/524
25	25	25	425/525
26	26	26	426/526
27	27	27	427/527

4-3 Input Terminals for Opevation Control

RVS FWD STOP

These terminals are provided for the operation controls of forward/reverse movements and machine stop for the manual operations. The stop terminal is also used for the limit of the reverse movement at returnning to the home position.

(1) Forward/Reverse Terminals

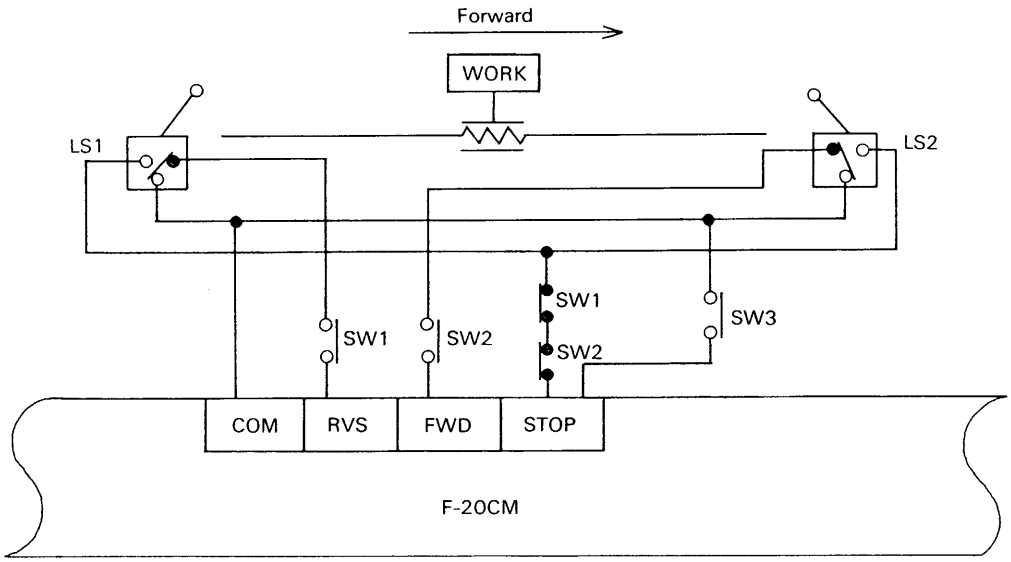
* When the forward or reverse terminal is turned "ON", the forward (R1, T1) or reverse outputs (R2, T2) are turned "ON", and the low speed output (R4, T4) are turned "ON" at same time. This means that the forward or reverse movements by these input terminals are executed at low speed.

* If the CPU of F-20CM should make error, these forward/reverse openations are disabled.

* Manual operations of forward/reverse movements can be also executed by the key operations of F-20CP, but the forward/reverse terminals of F-20CM are prior to the F-20CP operations.

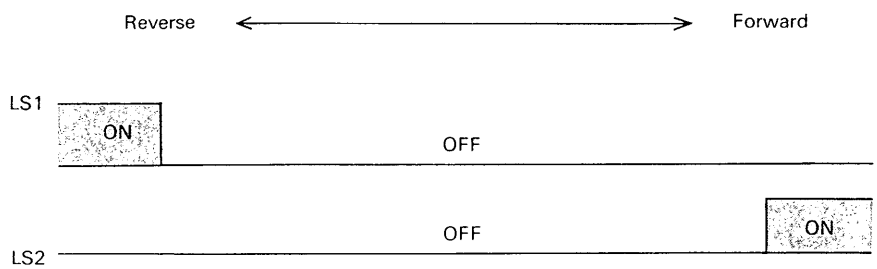
(2) Stop Terminal

When the stop terminal is turned "ON", the stop outputs (R5, T5) are turned "ON" and other outputs are turned "OFF". This terminal is used for the emergency stop or manual stop operation. In addition, this terminal is also needed to make a automatic sequence of the home position returning in following example ;



LS1 : Limit Switch (Reverse-End)
LS2 : Limit Switch (Forward-End)
SW1 : Manual reverse Switch (Low speed)
SW2 : Manual Forward Switch (Low speed)
SW3 : Emergency Stop Switch

* Polarity of limit switch action



Home-positioning

According to the instruction of home position returning given from the PC or key operation of the F-20CP, a work starts to move in reverse at high speed until the reverse-end limit switch LS1 is turned "ON". After the work stops at the reverse end position for a moment, the work automatically moves forward at low speed and stops after crossing over the home position (home positioning operation).

Since the stop terminal is also used for the guard of forward and reverse end and emergency stop, these switches shall be connected as illustrated above.

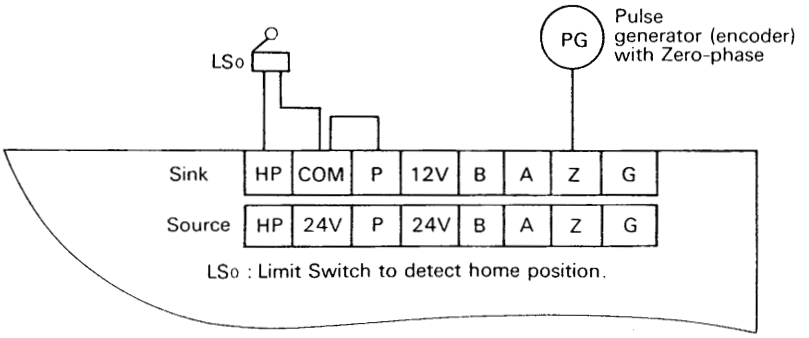
4-4 Input Terminal to detect home-position

H.P.

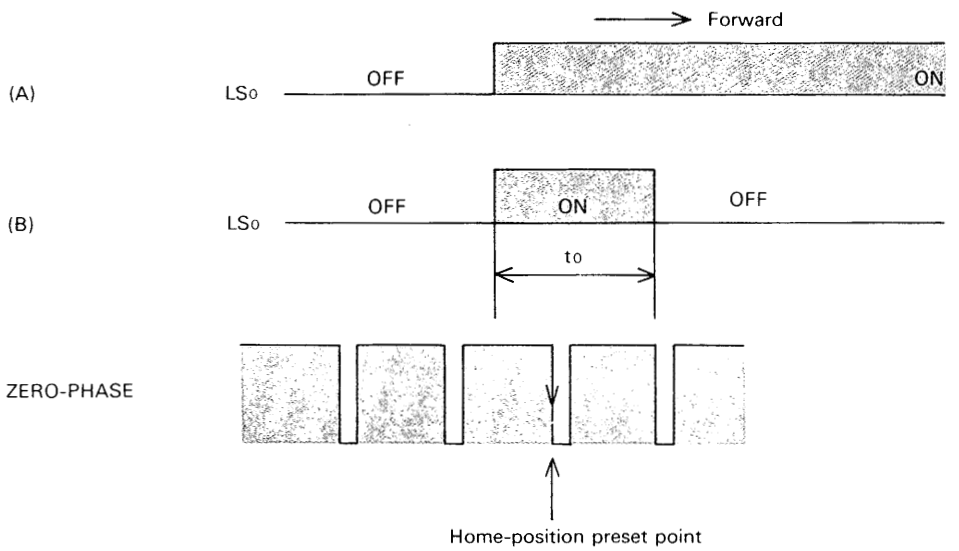
The input terminal H.P. is used to detect the home position in co-operation with the pulse generator.

(1) For encoder with zero phase signal

Example of connections ;



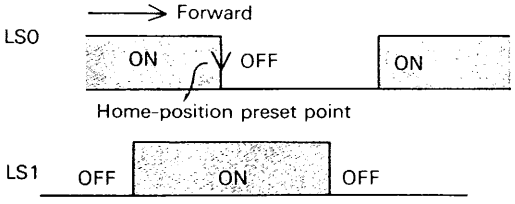
The input signal for home-position detection (LSo) can be either (A) or (B) in figure below. Since a zero-phase pulse is generated in a rotation of encoder axis, the LSo should be turned "ON" for one rotation time of the encoder at least .



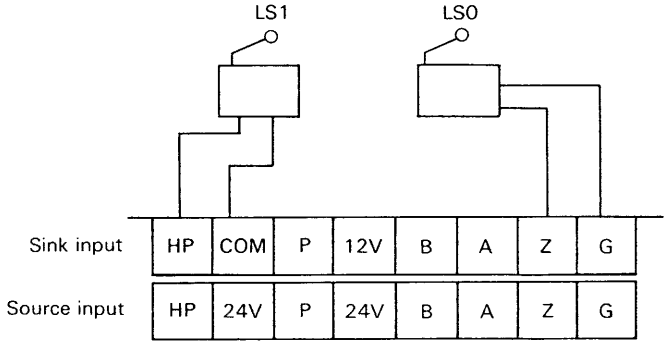
(2) For the pulse generator without zero-phase signal

When a proximity switch or optical switch is used for the pulse generator, the zero-phase signal can not be generated from these devices. In this case, provide two switches, LS0 and LS1, to detect and preset the home-position as illustrated below.

Input signals to detect the home-position :



Connection example to use limit switches :



The polarities and timings to handle the input signals should be in the manner as illustrated above. The switch LS0 is connected to the Z (zero-phase) terminal and G (sensor ground) terminal.

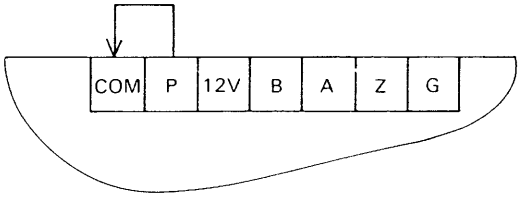
When the limit switches are used for the home-position detection, accurate position may not be detected because of the chattering etc. In this case, proximity switches, optical switches or touching switches are recommended instead.

4-5 Phase Changing Terminal [P]

The [P] terminal is provided to change the phase of counting signal depending upon the type of pulse generator. When encoder with two-phase signals, A and B, is used for the counting pulses, connect the [P] terminal as illustrated below.

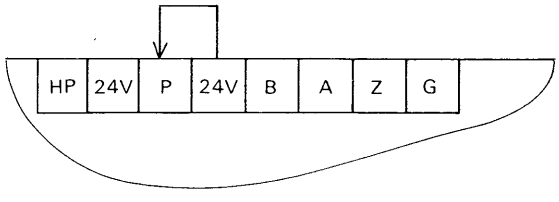
Sink Input Model

(F-20CM-5, F-20CM-5U)



Source Input Model

(F-20CM-5ESS)



When the proximity switches or optical switches etc. with single phase signal are used for the pulse generator, the phase terminal should be open.

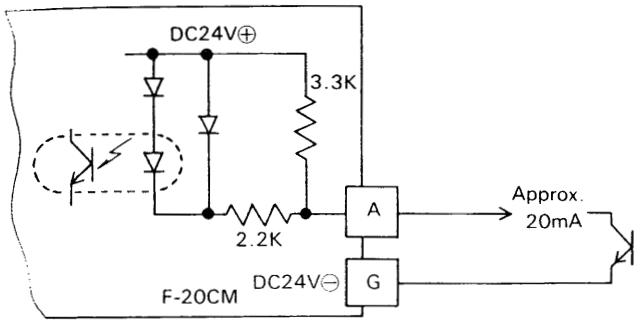
4-6 Pulse Generator Connections

There are many devices to be used for the pulse generator to detect the position, such as incremental rotary encoders, proximity switches, or optical switches etc. To detect more accurate positions, it is recommended to use rotary encoder which has two phases of 90 degrees with zero phase.

When the single phase signal such as proximity switch is used for the pulse generator, be aware that the mechanical backlash can not be read accurately.

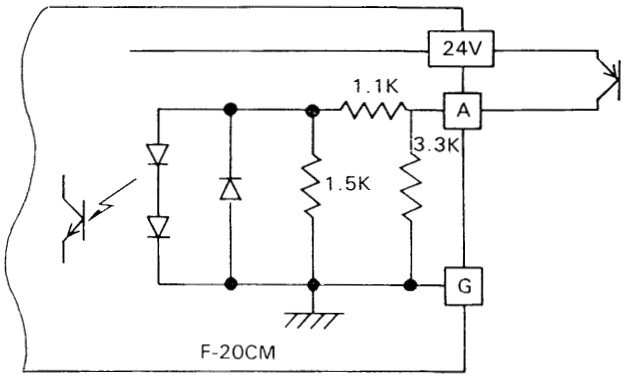
(1) Input Connections

Sink Input Models
(F-20CM-5, F-20CM-5U)



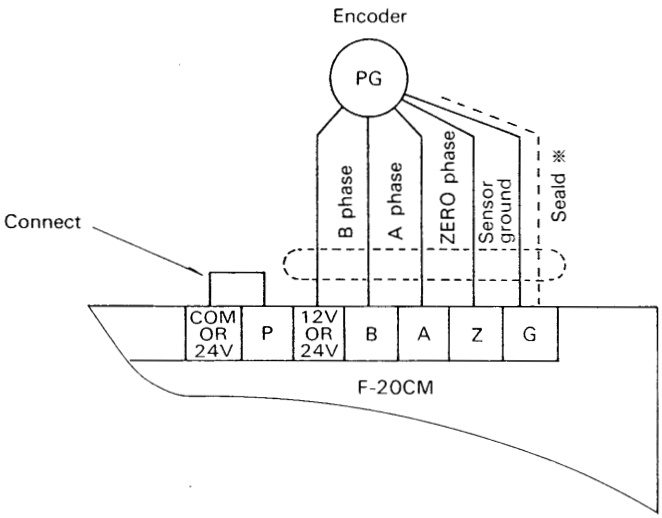
B and Z terminals are same connection as above connection of A terminal.

Source Input Models
(F-20CM-5ESS)



B and Z terminals are same connection as above connection of A terminal.

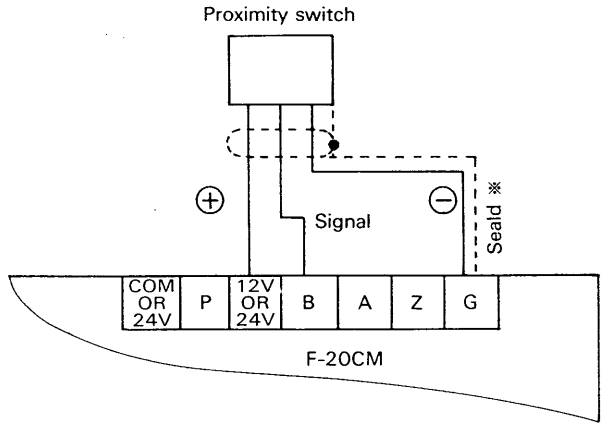
(2) Rotary Encoder



* When the sealding knitted wire is earthed at the encoder side, other side (F-20CM side) of the sealding wire shall be open.

* If the counter counts up at the reverse movement, and counts down at the forward, change the B phase and A phase.

(3) Proximity switch



When the sealding knitted wire is earthed at the encoder side, other side (F-20CM side) of the sealding wire shall be open.

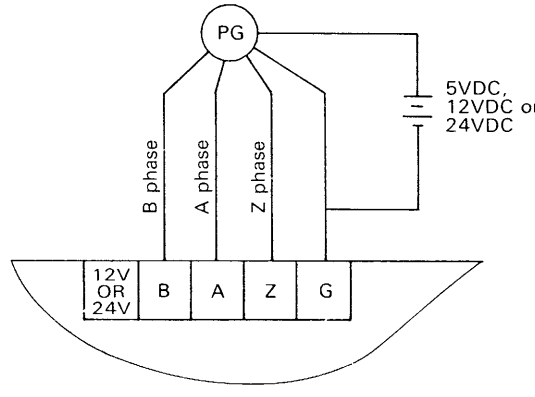
(4) Recommended rotary encoder

F-20CM Type	Sink Input Model	Source Input Model
Power supply	DC12V ± 10% 100m Amp MAX	DC24V ± 10% ※2 APPROX.80m Amp
Type of encoder	Incremental Type Square wave output	
Output signal	A phase B phase Zero phase	Open collector output DC24V, 25m Amp MIN
Response frequency	More than 5 kHz (Depending on system operation speed)	

When the proximity switch is used for the pulse generator instead, electrical specifications shall be simular as above encoder specifications but it is single phase.

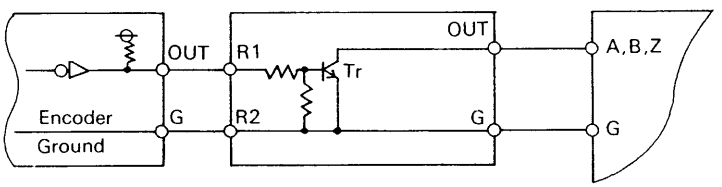
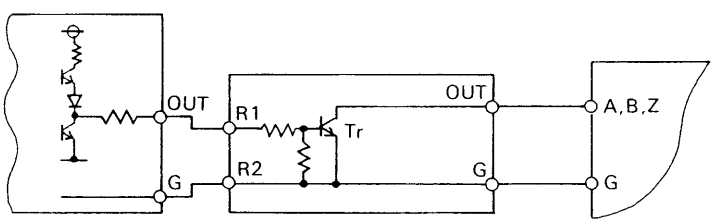
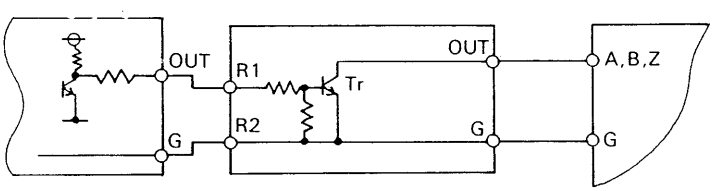
※1. The sink input model provides DC 12V supply terminal for the power source to the pulse generator and the source input model provides DC 24V supply terminal instead.
If the pulse generator needs power source other than stated above such as 5VDC, 12VDC or 24VDC, provide a external power source and connect as illustrated at right.

※2. The 24V terminal of source input model has a capacity of 160m.A, which is used not only for pulse generator power but also used for other inputs powers.



※3. If the rotary encoder or proximity switch is not a type of open collector output, provide a interface circuit between the pulse generator and the F-20CM in manner of following example ;

Typical example of sink input model ;

Encoder output circuit	Interface circuit	F-20CM
TTL Output type encoder		
Voltage output type encoder		
		

constant values

	Encoder power supply		
	5V	12V	24V
R1	1K	2.2K	4.7K
R2	10K	22K	47K

The transistor shall be equivalent to Mitsubishi model 2SC2320.

5. OUTPUT HANDLING

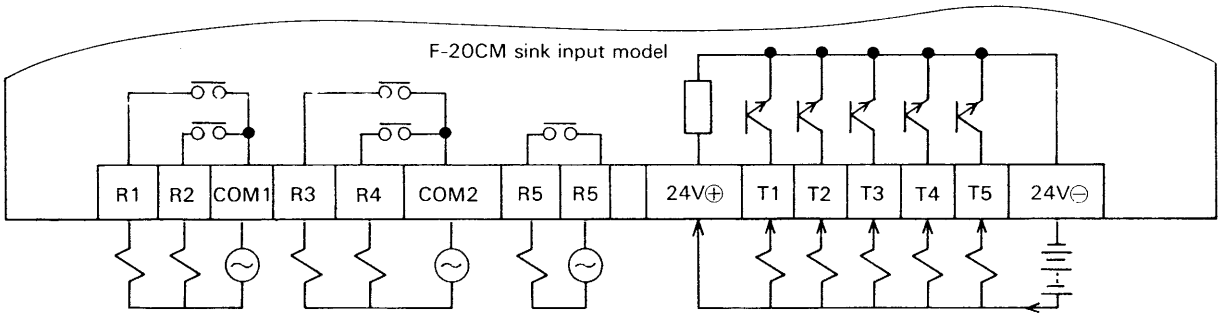
Since the F-20CM provides both relay outputs and transistor open-collector outputs in a unit, chose the type of outputs depending on the applications.
The relay outputs and transistor outputs are synchronized for the operation. The basic specifications of these outputs are same as the F series PC and refer to the instruction manuals of F series PC if detail specifications are required.

RATINGS OF OUTPUT LOADS

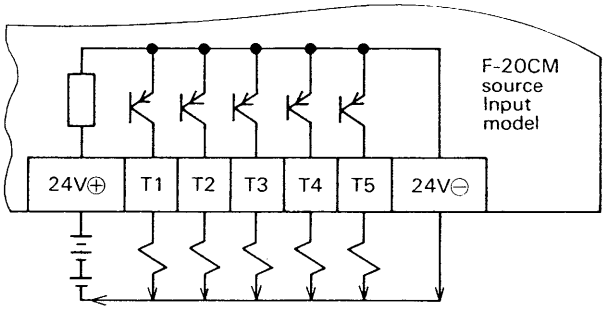
	Relay Output (AC100/200V, DC24V)	Transistor Output (DC24V)
Rated output current (Resistance load)	2 Amp per point	1 Amp per point
Inductive load	35VA ※	24W

※Manufacturer's guaranty level for 500,000 operations.
※The leakage current of relay output circuit is not expected. (C-R absorber circuit is not installed.)

OUTPUT TERMINAL ARRANGEMENT



R1, T1 Forward output relay contact and transistor
R2, T2 Reverse output //
R3, T3 High speed output //
R4, T4 Low speed output //
R5, T5 Stop output //



(1) Relay contact and transistor are turned "ON" or "OFF" at same time.
(2) If the F-20CM should make error, the STOP output is forcedly turned "ON" and other outputs is turned "OFF" automatically.
(3) Typical application examples of output devices are stated in other section of this manual.

※The transistor output circuit of source input model (F-20CM-5ESS) is the type of source output as illustrated above.
※When using coil load in a direct current circuit such as DC relay etc., it is recommended to connect a free-wheel diode in parallel to the output load.

3. CONTROLLING THE F-20CM-5

1. CONTROL SIGNALS BETWEEN THE PC AND F-20CM

Since the F-20CM is connected to the F series PC with a extension cable and many information signals are transferred between the PC and F-20CM counter module, the F-20CM can be controlled by the PC without external wiring and the PC can handle a high level of the sequence program to control the total machine system according to the information from the F-20CM.

These signals are assigned following numeric assignments as same as I/O numbers of the F series extension units ;

SIGNALS FROM THE PC TO THE COUNTER MODULE

NUMERIC ASSIGNMENT F-12R, F-20M (F-40M) PC	SIGNALS	REFERENCE
40 (440, 540)	Counter program block desigmation	Designated with the combination code
41 (441, 541)	//	
42 (442, 542)	//	
43 (443, 543)	//	
44 (444, 544)	Instruction of home position return	
45 (445, 545)	Instruction of step start	
46 (446, 546)	Output enable	

SIGNALS FROM THE COUNTER MODULE TO THE PC

NUMERIC ASSIGNMENT F-12R, F-20M (F-40M) PC	SIGNALS	REFERENCE
14 (414, 514)	Accuracy judgement result	"ON" : within tolerance
15 (415, 515)	block end	"ON" : all steps in a block are completed
16 (416, 516)	Battery voltage	"ON" : voltage drop
17 (417, 517)	Memory/CPU error	"ON" : error
20 (420, 520)	Forward output feed-back to the PC	
21 (421, 521)	Reverse output feed-back to the PC	
22 (422, 522)	Low speed output feed-back to the PC	
23 (423, 523)	Stop output feed-back to the PC	
24 (424, 524)	Input signal for the PC	5m.sec. pulse is accepted
25 (425, 525)	//	//
26 (426, 526)	//	//
27 (427, 527)	//	//

2. SIGNALS FROM THE PC TO THE F-20CM

2-1 Counter program block designations (—○40—, —○41—, —○42—, —○43—)

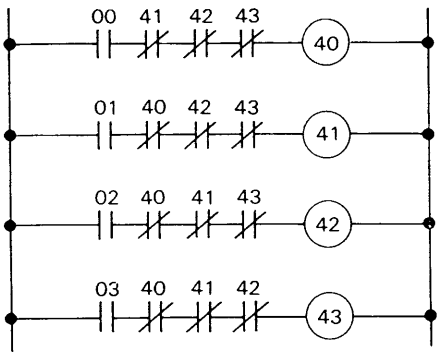
The positioning data is programmed in the F-20CM and ten programming blocks are provided for the different positioning patterns. A programming block to be operated can be designated by the BCD code of the PC output coils numbered from 40 to 43. Provide a program in the PC to designate the block with these numeric assignments of outputs.

Block to be operated	Numeric assignments of output coils			
	43	42	41	40
0	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	ON
2	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON
4	OFF	ON	OFF	OFF
5	OFF	ON	OFF	ON
6	OFF	ON	ON	OFF
7	OFF	ON	ON	ON
8	ON	OFF	OFF	OFF
9	ON	OFF	OFF	ON

(1) When no block designation program is provided in the PC, block "0" is automatically selected.

(2) When the positioning data is programmed within five blocks, the block designation program can be simple using the blocks numbered 0, 1, 2, 4 and 8 in following example ;

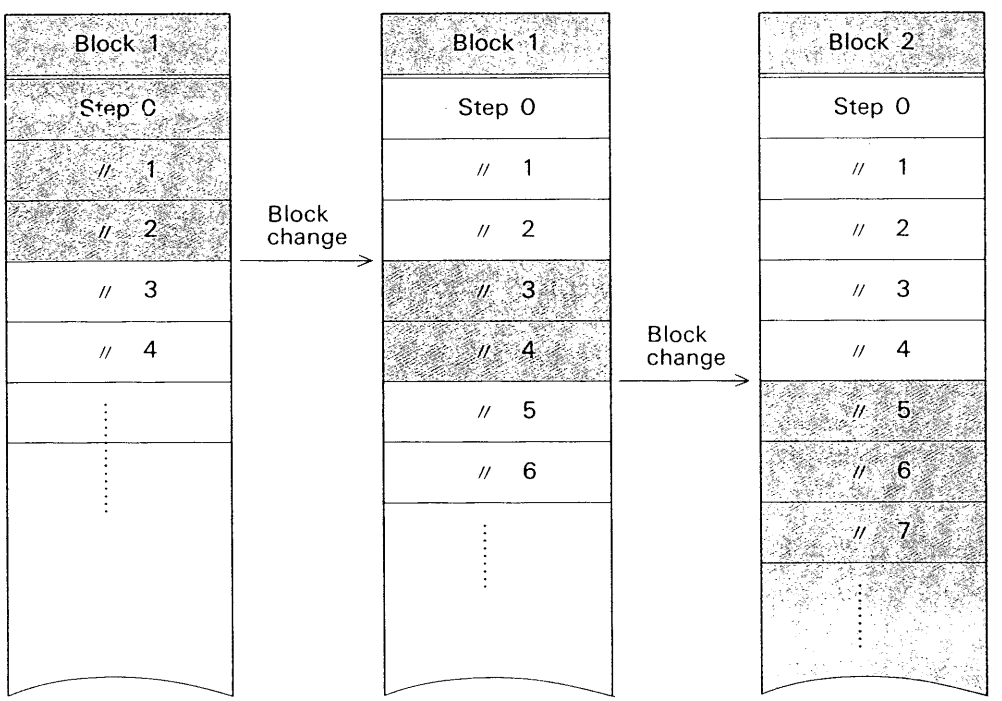
Programming example to designate 5 blocks or less.



Block 0 ← All inputs (00~03) are "OFF"
Block 1 ← Input 00 is "ON"
Block 2 ← Input 01 is "ON"
Block 4 ← Input 02 is "ON"
Block 8 ← Input 03 is "ON"

※1 The F-20CM reads and follows to the block designation when the step start signal is turned "ON".

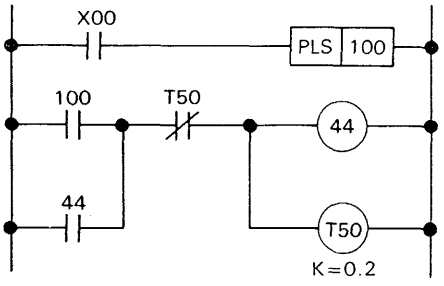
※2 If the block designation is changed during the running machine, the programming block is changed after completion of the present step positioning. In this case, the step number is stepped up as following example ;

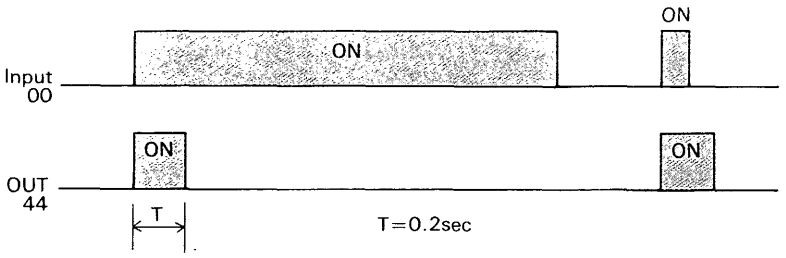


※3 The block can be changed easilly if the digital switch of BCD code is connected to the PC input terminals.

2-2 Home-positioning instruction (—○44⊣)

When the PC output numbered 44 is turned "ON", the F-20CM starts the operation of home positioning. The signal of the output coil 44 shall be a single pulse of 0.2m.sec. or longer.
Example of the sequence program to generate the single pulse :





After completion of home-positioning, the counter value is set at presetting data according to the home-position detection signal and the step number is set at step "0".

※1 The pulse signal generated by [PLS] instruction shall not be used for the out 44 directly, because the F-20CM may not accept such short pulse depending upon the PC program execution time.

※2 If the F-20CM should make the CPU or memory error, or block/step designations are not correct, this instruction is disabled.

※3 When the accuracy judgement signal or block end signal is turned ON, these signals are turned OFF at the time of this operation starts.

※4 After completion of the home-positioning operation, the accuracy judgement is executed for home position and the step of positioning program is set at step 0.

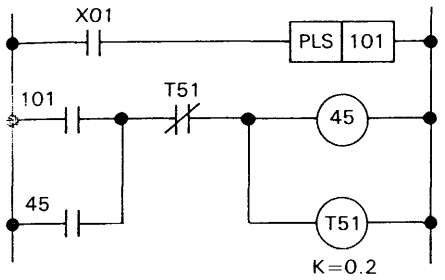
※5 During the home-positionihg operation, the machine can be stopped by the signal from STOP input terminal of F-20CM or programming/teaching slide switch of the F-20CP if necessary.

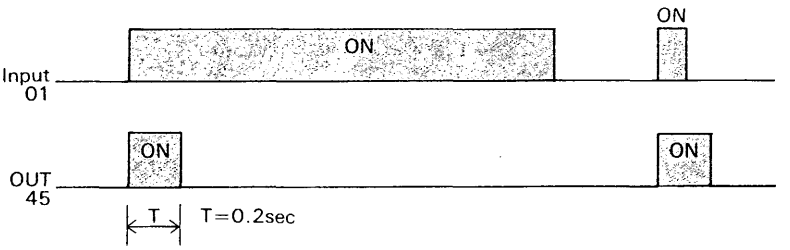
The home-positioning procedure is stated in the section of stop terminal in page 14, and the procedure of the home-position data presetting is stated in other section in page 48.

2-3 Step-start instruction (—○45—|)

When the PC output numbered 45 is turned "ON", the F-20CM starts automatic positioning operation for the single step. During the automatic operation, the F-20CM compares the present position and objective position and makes the output signals ON or OFF to approach the target position of the step.
The signal of the output coil 45 shall be a single pulse of 0.2m.sec. or longer as same as the pulse for the home-positioning in previous section 3-2-2.

Example of the sequence program to generate the single pulse ;





※1 When the step-start signal (output coil 45) is turned "ON", the step number is stepped up to execute the positioning of the next step. But the step-start signal is turned "ON" after the block-end signal is turned "ON" or [CLEAR] key of the F-20CP is depressed, the positioning operation starts in the step "0" without step change.

※2 If the F-20CM should make the CPU or memory error, or block/step designations are not correct, this instruction is disabled.

※3 When the accuracy judgement signal or block end signal is turned ON, these signals are turned OFF at the time of this operation starts.

2-4 Counter Output Enable Instruction (—○46—|)

Unless the PC output coil numbered 46 is turned "ON", any relay or transistor output contact of the F-20CM can not be closed except the stop outputs. Since this instruction (—○46—|) is to control only output terminals, the output signals (20~23) transferred from the F-20CM to PC can be turned "ON" regardless the coil 46 is turned "OFF".
The ON/OFF status of this instruction (coil 46) is indicated with LED on the F-20CM front cover.
This coil 46 shall be always turned "ON" in the PC program as following example ;

In the above example, M70 is always turned "ON" when the PC is running, but if the CPU error of the PC should be caused or emergency stop M77 is turned "ON", the output coil 46 is turned "OFF". When the PC is in stop mode, the F-20CM is also in stop mode.

2-5 Home-position Presetting by Software (—o42— , —o43—)

It is necessary to preset home-position before automatic machine operation starts, because the counter unit can not recognize the machine movement when the power is turned OFF, which may be happened.
The home-position returning operation to catch the zero phase signals at home-position is a normal method of presetting and home-position detecting is required.
However it is difficult to provide the home-position detecting facility for some applications such as coil material feeding rollers or simple positioning machine with single phase detection signals.
For these applications, the F-20CM has a function to preset the counter value with the home-position preset data by the software function instead of the home-position returning operation.
This presetting is executed by either the instruction signals from the PC or key operation of the F-20CP.

(1) Instruction by the PC

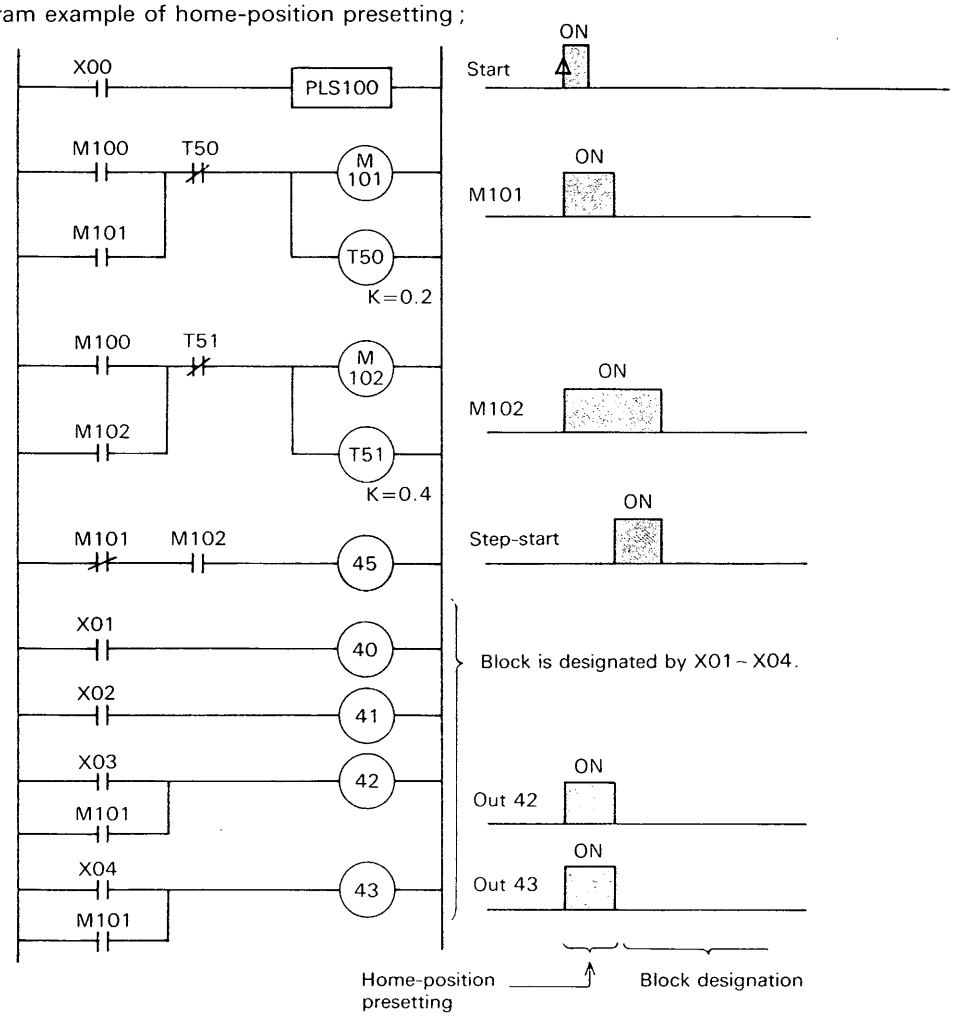
When the machine stops, the PC output coils numbered 42 and 43 (—o42— and —o43—) are turned ON at same time in the PC program. According to these signals from the PC, the counter is preset with a home-position preset data programmed in the F-20CM without machine movement. These instruction signals must be pulse signals.

(2) Instruction by the key operation of F-20CP

When the machine stops at teaching mode, the keys, [H·P] and [PRESET/SAVE], are depressed to instruct the presetting of the counter with a home-position preset data.

※After procedure of above presetting, the step number is set at step "0".

The PC program example of home-position presetting ;



※In above example, the block designation coils, 40 and 41 are not required to interlock with M101.

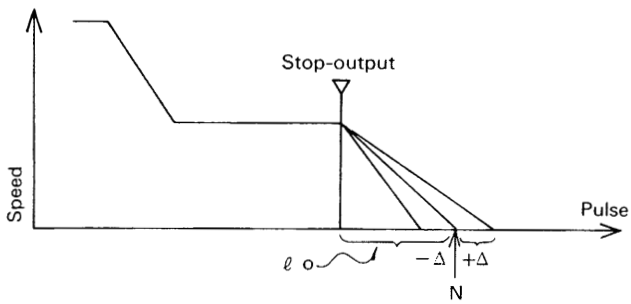
When the step start coil, 45 is turned ON, the presetting coils, 42 and 43 must be turned OFF.

3. SIGNALS FROM THE F-20CM TO PC

3-1 Accuracy Judgement Signal (⊣⊢^{14})

After the positioning movement is completed, the F-20CM checks if the stopped position is within or without a accuracy tolerance which is programmed in the F-20CM. When the stopped position is within a tolerance, the accuracy judgement signal is transferred from the F-20CM to the PC and a contact numbered 14 of the PC program is turned "ON". This signal can be used for the sequence program of next procedure to handle the toolings of the machine.

(1) Accuracy judgement of normal operation



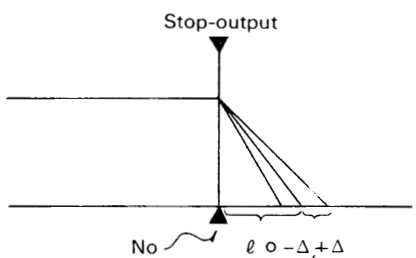
ℓ o : Inertia movement
N : Target Position
±Δ : Stop position error

Condition to make the accuracy judgement signal turned "ON";

Accuracy tolerance ≧ | ± Δ |

(2) Accuracy judgement at home-positioning

In case of home-positioning operation, the stop output is turned "ON" when the work crosses the home-position without inertia compensation. The accuracy judgement is executed in different manner.



No : Home-position
ℓ o : Inertia movement
± Δ : Stop position error

Condition to make the accuracy judgement signal turned "ON";

Inertia compensation data + Accuracy tolerance ≧ ℓ o + Δ

※1 The accuracy judgement signal is reset (OFF) at time of home-position data presetting by the F-20CP, home-position returning or the next step-starting. It is also reset when the [clear] key is depressed or programming/teaching mode slide switch on the F-20CP is turned to the programming mode.

※2 Accuracy tolerance and judging timing data for the accuracy judgement of home-positioning is according to the data in the block which is existed.

3-2 Block-end Signal (—| |[15])

When every step positioning operation is completed, the F-20CM checks if the next step is End instruction or not.

When the step reaches at End instruction, the F-20CM sends a block-end signal to the PC and a contact numbered 15 of the PC program is turned "ON". At the same time, the step number is reset to start from zero step.

This block-end signal (—| |[15]) is applied for the sequence program of the PC to change the block after positioning procedure is completed in a block for example.

Example :

Step No.	Positioning Data	
00	01500	Execution program
01	05000	
⟆	⟆	
19	12300	
20	END	→ Block-end signal output
21	00000	No execution program area
⟆	⟆	
39	00000	
40	END	← Force END

※1 The block-end signal is reset (OFF) at time of home-position presetting, home-position returning or the next step-starting. It is also reset when the clear key of the F-20CP is depressed but it is not reset by the programming/teaching mode switch.

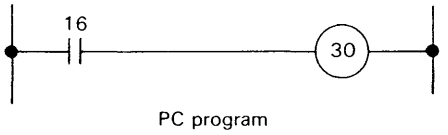
Setting (ON) and resetting (OFF) conditions of accuracy judgement and block end signals :

At the time of	To set signals (ON)		To reset signals (OFF)	
	Accuracy judgement (—| |—14)	Block-end (—| |—15)	Accuracy judgement (—| |—14)	Block-end (—| |—15)
Home-position data presetting by F-20CP			○	○
Home-position returning	○		○	○
Step-starting by PC program or F-20CP	○	○	○	○
Manual operation			○	
Force stopping		○		
Teaching mode ↓ Programming mode			○	
clear key at teaching mode			○	○

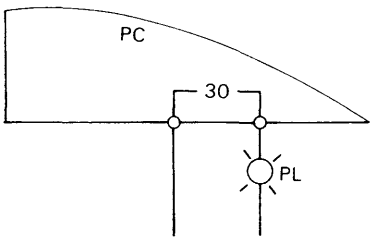
○ : The signal can be set or reset (But the setting needs all other conditions to be satisfied.)

3-3 Battery Voltage-drop Signal (⊣ ⊢[16])

When the lithum battery voltage in the F-20CM is dropped below the normal level to use, the F-20CM sends the battery voltage-drop signal to the PC and a contact numbered 16 of the PC program is turned "ON". The battery voltage-drop is displayed with a LED on the F-20CM front cover and it can be warnned by the external lamp providing the sequence program with this signal.



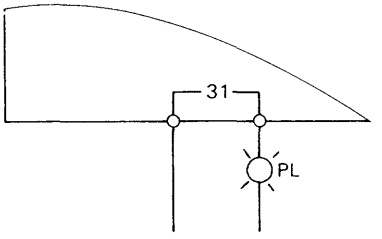
PC program



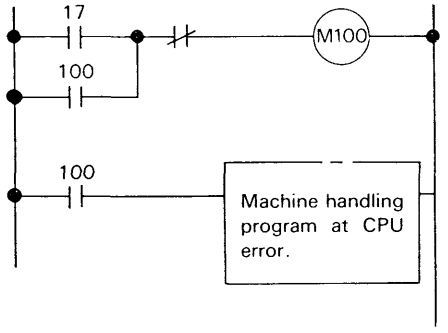
3-4 CPU/Memory Error Signal (⊣ ⊢[17])

If the CPU of F-20CM should make error by the noise interference etc., the F-20CM sends a signal to the PC and a contact numbered 17 is turned "ON". This error is displayed with a LED on the F-20CM front cover and this signal can be used in a sequence program for the warnning or protections by the PC. In case of the error that the program in the F-20CM is changed by the noise interference etc., this signal (⊣ ⊢[17]) flickers with 0.5sec. interval.

Example 1 :



Example 2 :



When this signal is used for the sequence program of the machine handling at the CPU error, provide latch circuit in a program.

3-5 Output Feedback Signals

(1) Forward output signal (⊣⊢[20])

When the forward output of F-20CM is turned "ON", the F-20CM also sends a signal to the PC and a contact numbered 20 of the PC program is turned "ON". This signal is used for the sequence program of tooling or machine control by the PC.

(2) Reverse output signal (⊣⊢[21])

When the reverse output of F-20CM is turned "ON", the F-20CM also sends a signal to the PC and a contact numbered 21 of the PC program is turned "ON". This signal is used in same manner as forward output signal.

(3) Low-speed output signal (⊣⊢[22])

When the low-speed output of F-20CM is turned "ON", the F-20CM also sends a signal to the PC and a contact numbered 22 of the PC program is turned "ON". This signal is used in same manner as forward output signal.

※When the forward or reverse output is turned "ON", the high-speed output is turned "ON" at same time for the start until the low-speed output is turned "ON". The F-20CM does not send the high-speed signal to the PC.

(4) Stop output signal (⊣⊢[23])

When the stop output of F-20CM is turned "ON", the F-20CM also send a signal to the PC and a contact numbered 23 of the PC program is turned "ON". This signal is used for the sequence program of tooling or machine controls by the PC.

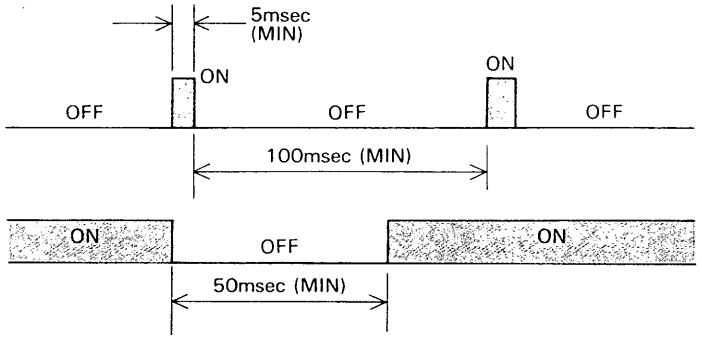
3-6 Input Signals Extended To The PC

(⊣⊢[24], ⊣⊢[25], ⊣⊢[26], ⊣⊢[27])

When the input terminals numbered from 24 to 27 of the F-20CM are turned "ON", these signals are transferred from the F-20CM to the PC and these signals are used for the sequence program of the PC as same as the inputs of extension unit.

These input terminals can accept short pulse signals of 5m.sec. MIN. (only in case of "OFF→ON→OFF") but these signals shorter than 50m.sec. are converted to 50m.sec width pulses when they are transferred to the PC.

In case of the pulse "ON→OFF→ON", the pulses shorter than 50m.sec. can not be accepted with these terminals.



4. MOTOR AND DRIVING CONTROLS

1. SELECTION OF MOTOR DRIVING SYSTEMS

The selection of motor controlling and driving system depends upon the machine size (moment of inertia, torque of load), frequency of operation, machine speed and accuracy of positioning. The features of each system are generally as follows ;

Drive system	Frequency of operations ※1	Machine speed	Accuracy ※2	Machine size	Brake power	Life
Servo motor and driver	◎	◎	◎	△	not required	Brush change is required
Clutch/Brake and ID motor	◎	◎	◎	○	———	Life is limited
Inverter and ID motor	○	◎	○	◎	not required	◎
Solid state soft stop and ID motor	△	◎	△	○	not required	◎
Pole change motor	△	◎	△	◎	Brake is required	◎
Vortex current coupling and ID motor	○	◎	○	○	Brake is required	◎

※1 It is suitable for the frequent operations of machine to use a driving system, which has small moment of inertia and which does not cause the motor starts and stops. It depends on the machine size but above information suggests following frequency of operations in general ;
◎……20～60 operations/minu.
○……10～20 operations/minu.
△……One operation/minu. or less

※2 According as the moment of inertia is small, the speed reduction ratio can be larger and the machine operation is stabilized at low speed, so the accuracy of system is higher.

2. DESIGNING CALCULATION EXAMPLE

When a positioning machine is designed, select the motor driving system according to preceding guidance and specify the details of pulse generator, motor and mechanical parts refering to the designing calculations for the moment of inertia and accuracy. Following is a typical example of the calculations for the inertia and accuracy ;

(Example)

(1) Mechanical specifications

Machine ..... Positioning of work table.
Weight of table ..... 50 kg
Weight of work ..... 10~30 kg
Speed ..... 7.5 m/minu.
Accuracy ..... ±0.2 mm
Frequency of operation..... 10 operations/minu.
Thrust shaft ..... Ball screw coupled with motor.
(The weight is supported on bed)

(2) Screw pitch and motor speed

$$P = \frac{V}{N} = \frac{7.5}{1,500} = 0.005 \text{ (m)}$$

[P : Screw pitch (m)
V : Horizontal movement speed (m/minu.)
N : Rotation speed (rpm)]

In case of screw with 5 mm pitch, motor speed is 1,500 rpm at high speed driving.

(3) Machine inertia on motor shaft $(GD^2)w$

$$(GD^2)w = W \cdot \left(\frac{P}{\pi}\right)^2 = (60\sim80) \cdot \left(\frac{0.005}{3.14}\right)^2 = 0.00015\sim0.0002 \text{ (kg·m}^2\text{)}$$

[$(GD^2)w$: Machine inertia
W : Weight (table + work) (kg)]

(4) Load torque of machine on motor shaft (T_L)

$$T_L = \frac{\mu \cdot W \cdot V}{6.3N \cdot \eta} = \frac{0.15\times(60\sim80)\times7.5}{6.3\times1,500\times0.95} = 0.0075\sim0.01 \text{ (kg·m)}$$

[T_L : Load torque (kg·m)
μ : Coefficient of friction
(ex. Bed surface : approx. 0.15
Ball bearing : approx. 0.005)
η : Efficiency
(ex. Gear, chain, belt and ball screw : approx. 0.95)]

(5) Rotary encoder

$$Pu = \frac{60 \cdot \omega}{N}$$

$$= \frac{60 \times 5{,}000}{1{,}500}$$

[Pu : Number of encoder pulse (pulse/rotation)
ω : Frequency of encoder pulse (Hz)
(Response frequency of F-20CM : 5KHz MAX.)]

= 200 MAX. (pulses/rotation)

According to the response frequency of the F-20CM, the rotary encoder to generate 200 pulses per rotation can be used.

In this example, Pu shall be 200 pulses.

In this case, one encoder pulse corresponds to 0.025 mm of horizontal movement.

$$\frac{P}{Pu} = \frac{5\,mm}{200\ pulses} = 0.025\ (mm/pulse)$$

Since the objective accuracy is within 0.2 mm, one pulse must corresponds to less than 0.1 mm.

(6) Motor and speed controller

The motor and speed controller shall be selected according to the guidance of the motor.

In this example, the motor shall be a induction motor of 0.4 KW three phases with N·B·brake, and the speed controller shall be a inverter specified as follows ;

[Mitsubishi Electric :
Motor ·····Model SF-ER, 0.4 KW, 4 Poles, NB-0.4 Brake
Inverter·····Model FR-K-400]

Motor inertia $(GD^2)_M$: 0.0107 $(kg \cdot m^2)$
Motor torque (T_M) : 0.4 (kg·m)
No response time (to) of motor : 0.025 sec.

(7) Stopping time ts (sec.)

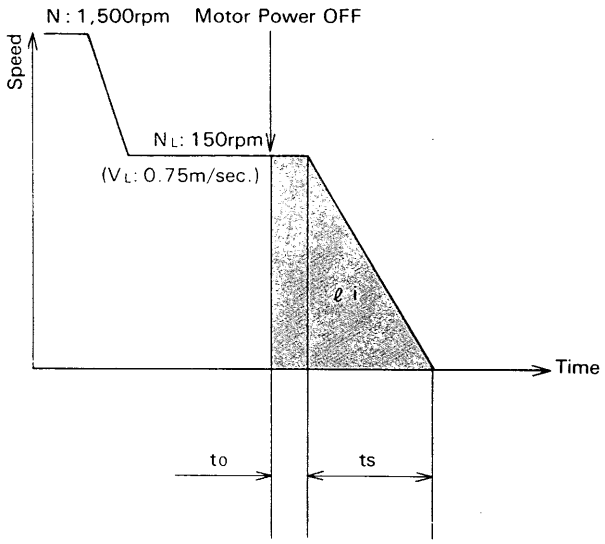
In this example, the motor speed is reduced from 1,500 rpm to 150 rpm approaching the positioning point.

$$ts = \frac{\{(GD^2)_W + (GD^2)_M\} \times N_L}{375\,(T_L + T_M)}$$

[N_L : Motor low speed (rpm)
V_L : Horizontal low speed (m/sec.)]

$$= \frac{(0.0002 + 0.0107) \times 150}{375 \times (0.01 + 0.4)}$$

$$= 0.0106\ (sec.)$$



(8) Distance of inertia movement ℓ i (m)

$$\ell i = \frac{V_L}{60} \cdot to + \frac{1}{2} \cdot \frac{V_L}{60} \cdot ts$$

$$= \frac{1}{60} \times (0.75 \times 0.025 + 0.5 \times 0.75 \times 0.0106)$$

$$= 0.00038 \text{ (m)}$$

$$= 0.38 \text{ (mm)}$$

The distance of 0.38 mm corresponds to approx. 15 pulses of the encoder signals which can be programmed for inertia compensation.

(9) Positioning error $\Delta \ell$ (mm)

The distance of positioning error ($\Delta \ell$) actually fluctuates depending on the motor speed, load torque, supply voltage, motor torque and no-response time of motor etc. The extent of this fluctuation is the accuracy of this positioning.
It is estimated, in general, that the accuracy is approximately half of the distance of inertia movement.

$$\Delta \ell = 0.5 \ \ell i$$

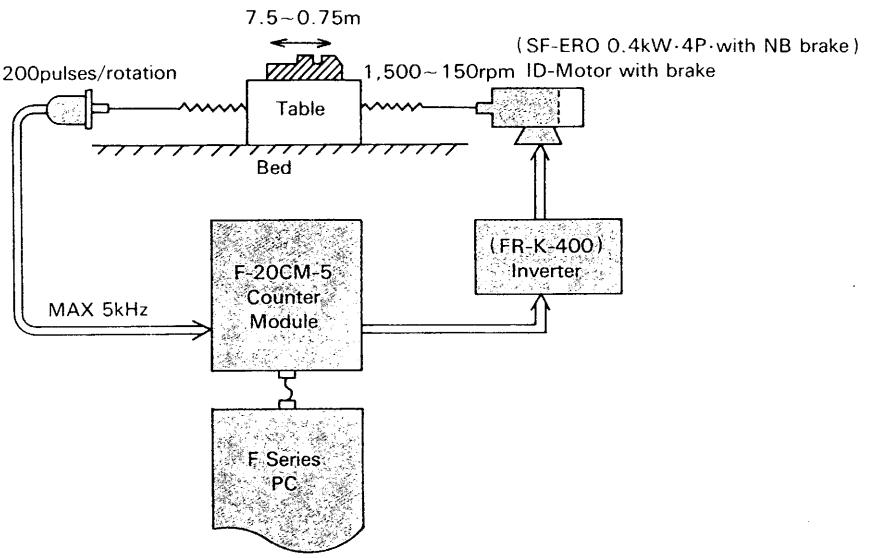
$$= 0.5 \times 0.38$$

$$= 0.19 \text{ (mm)}$$

$$\fallingdotseq 0.2 \text{ (mm)}$$

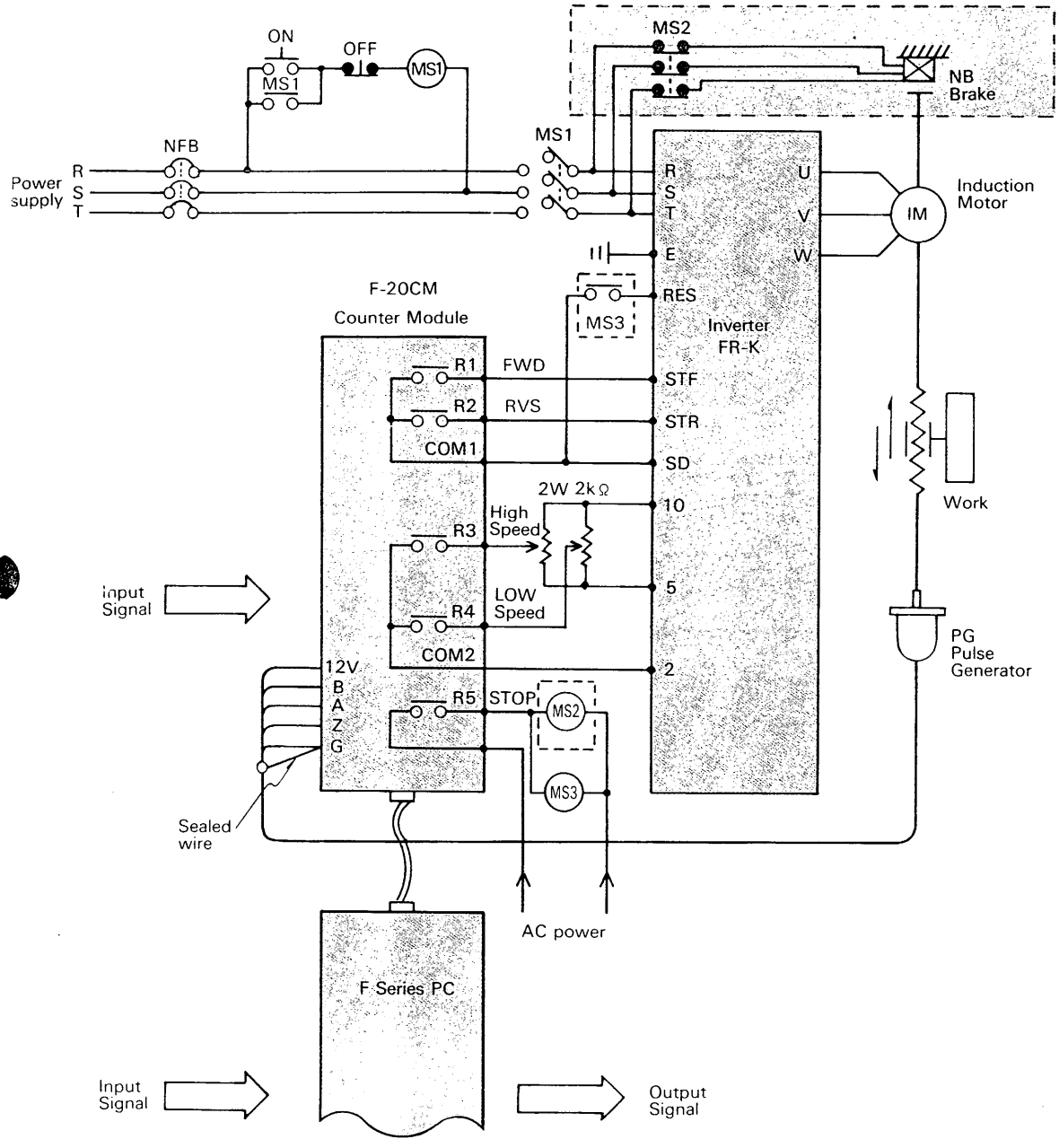
If more accurate positioning is required, use a motor with smaller moment of inertia such as a servo-motor.

(10) System formation



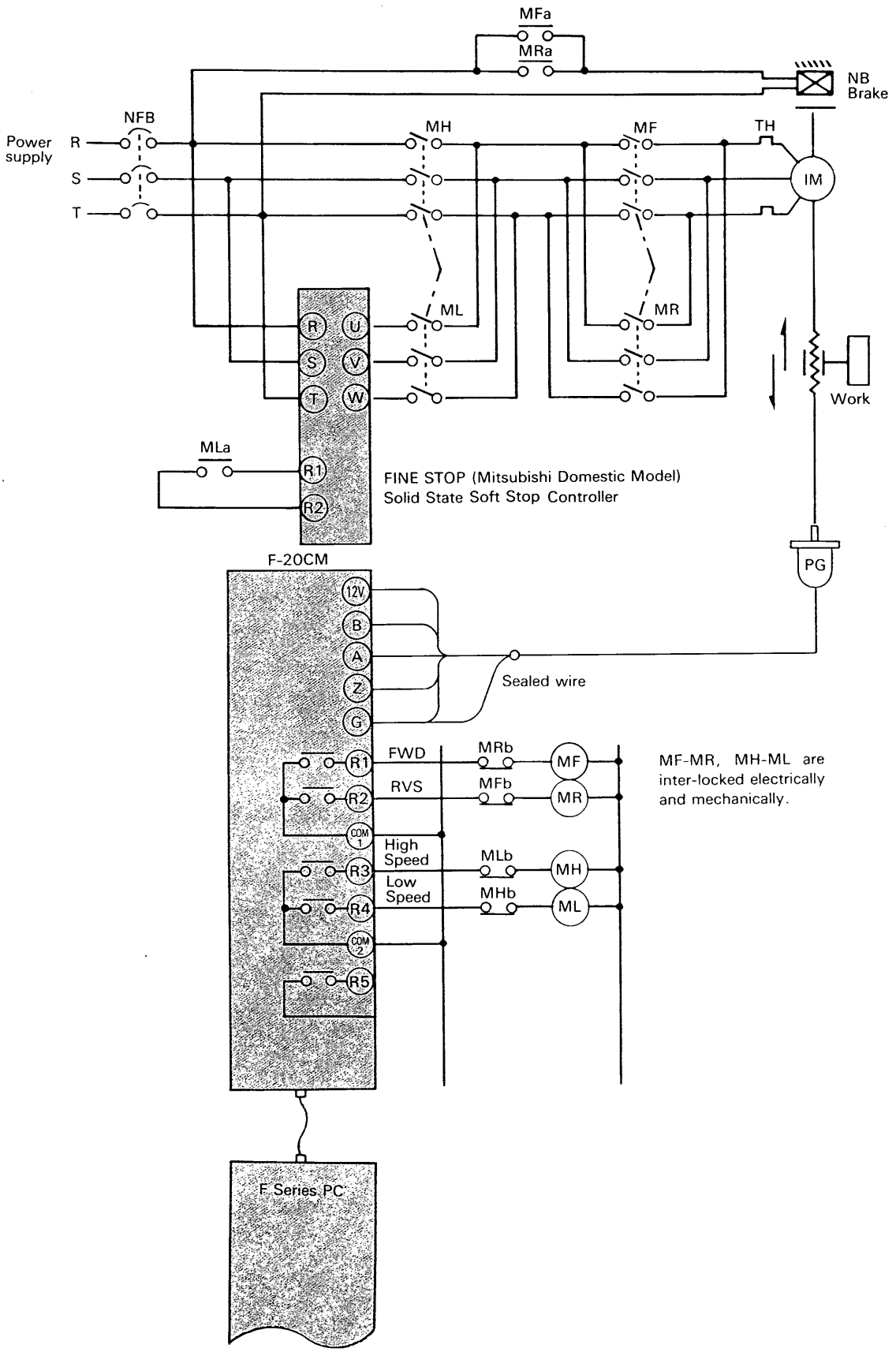
3. MOTOR CONTROL EXAMPLES

(1) Inverter (Mitsubishi FR-K) and induction motor

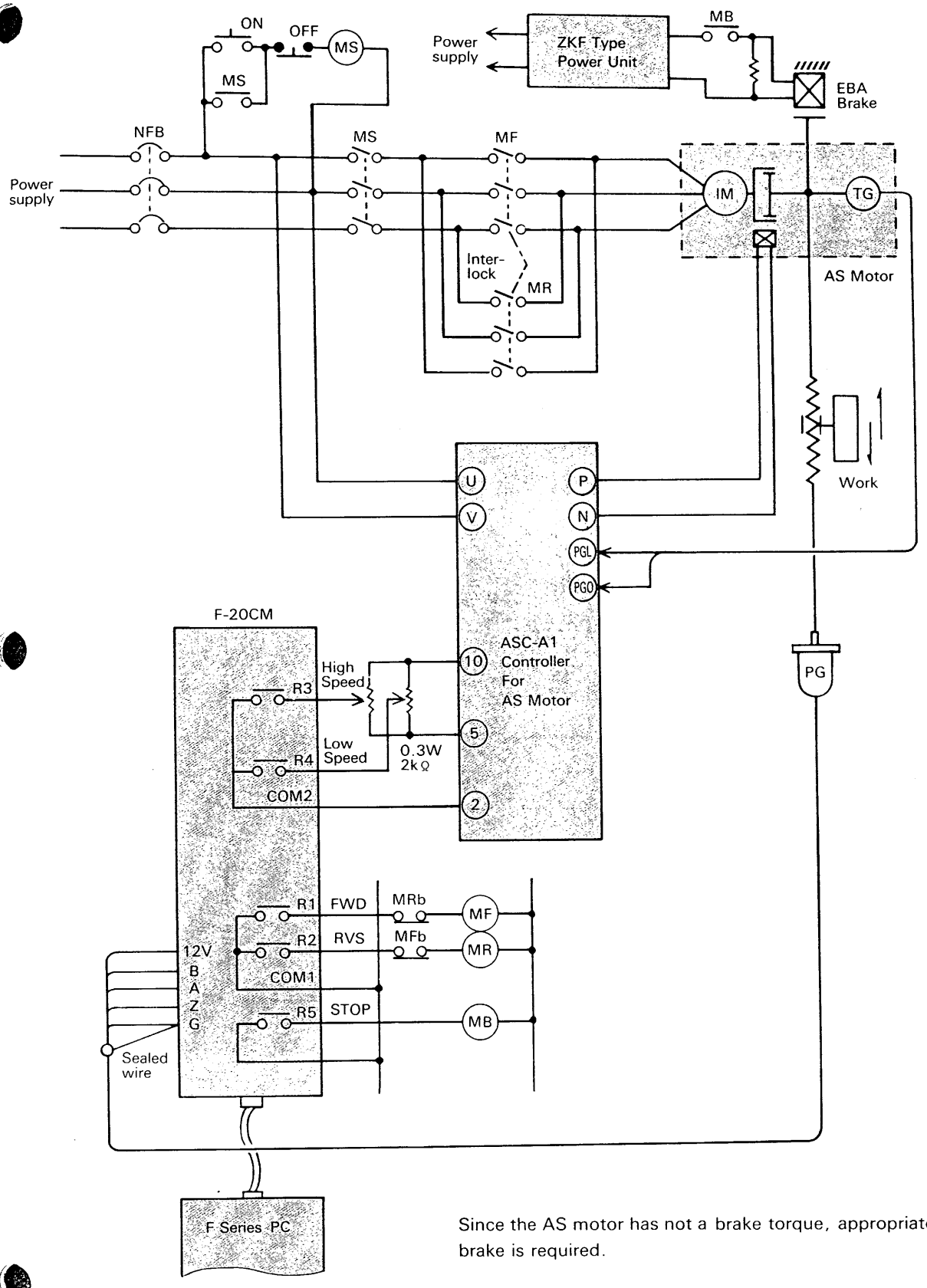


- Since small current flows at the MS3, the MS3 shall be a small current relay.
- Two external volumes are provided to set two speeds (High Speed and Low Speed).
- If stop holding torque is required, use of motor with magnetic brake is recommended.

(2) Solid state soft stop controller and induction motor

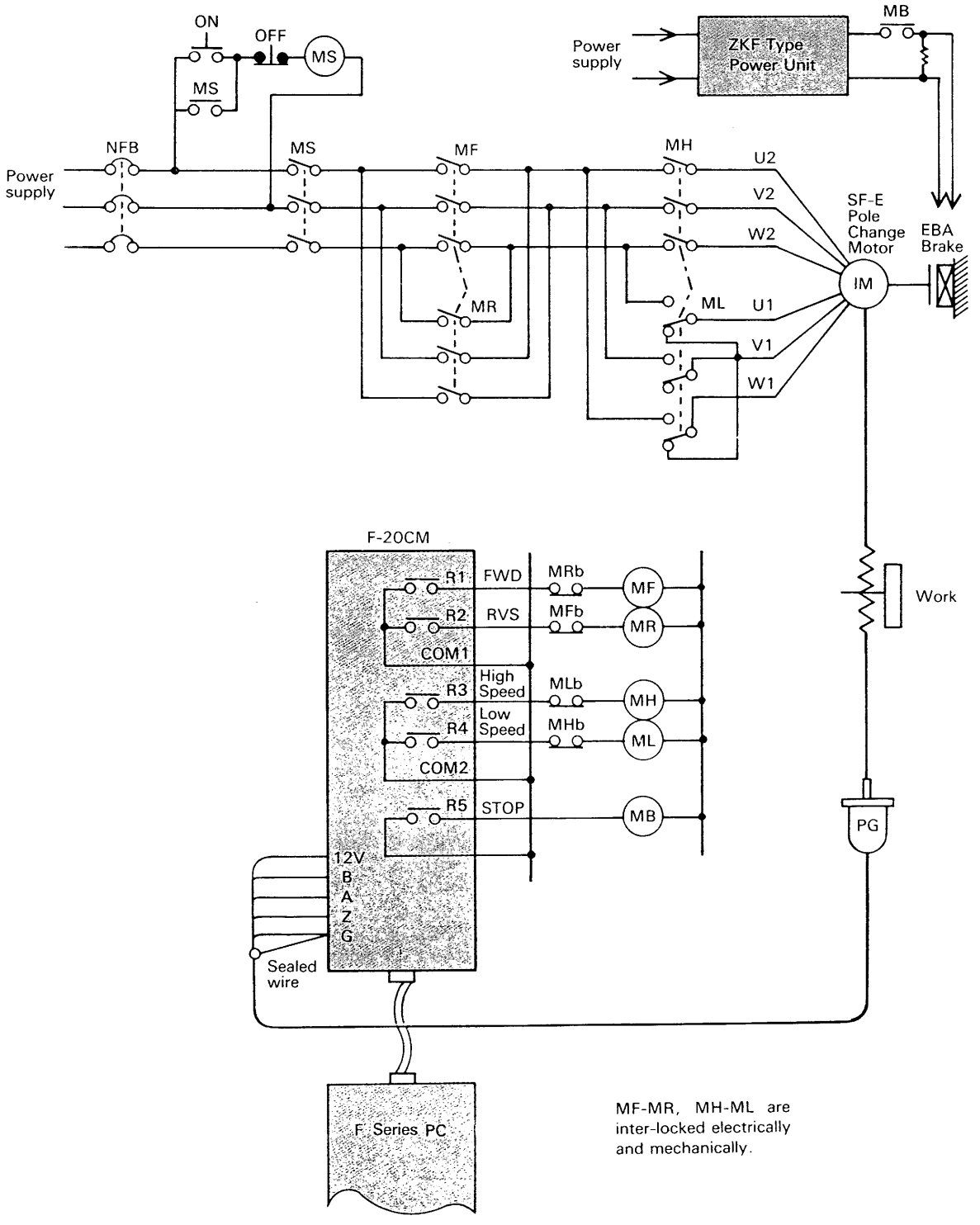


(3) Vortex current coupling and induction motor
(Mitsubishi Domestic Model : AS Motor)



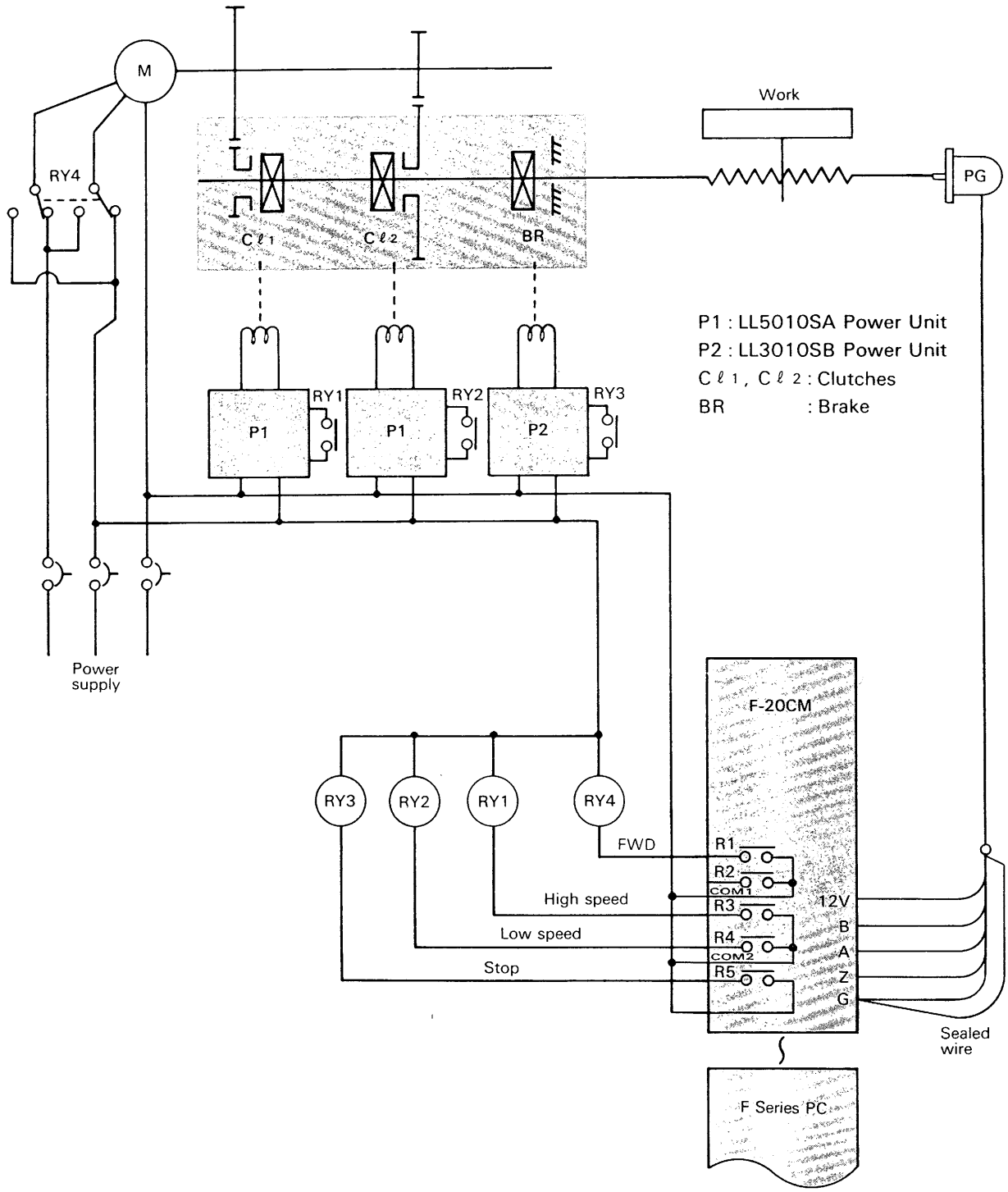
Since the AS motor has not a brake torque, appropriate brake is required.

(4) Pole change motor
(Mitsubishi Domestic Model SF-E Type)



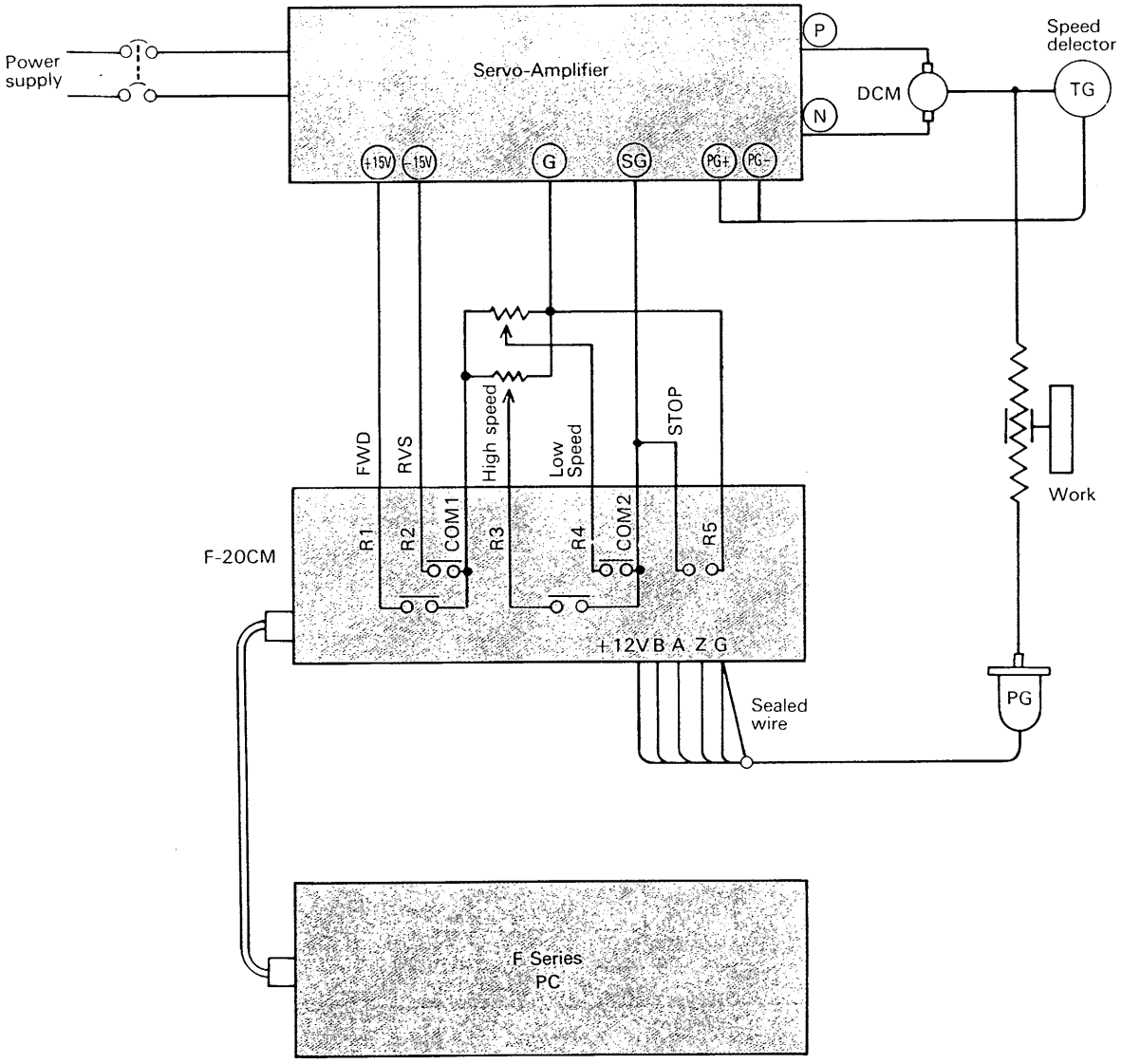
In above example, Mitsubishi domestic brake model ZKF type is used, but there are many alternatives.

(5) Clutches, Brakes and Motor



RY1 : Relay for High Speed clutch (Cl1)
RY2 : Relay for Low Speed clutch (Cl2)
RY3 : Relay for Brake (BR)
RY4 : Relay to change the motor rotation direction (FWD, RVS)

(6) Servo motor and Servo driver
(Analog type DC Serbo-motor)



- Two external volumes are required to set high speed and low speed.
- In case of servo-motor, the brake is not required normally. But if necessary, external brake can be connect to the PC output terminals.

5. HANDLING OF F-20CP-E UNIT

1. INTRODUCTION

1-1 Functions

The programming unit, F-20CP-E, clips directly onto the counter unit, F-20CM, to utilize following functions;

- Writing and reading of positioning data.
- Interface with CMT recorder for the data storage.
- Monitoring of actual positions.
- Manual operations of forward and reverse movements, and home-positioning.
- Writing of actual position by teaching operation.

1-2 Positioning Data Map

40 positioning addresses per block and 10 blocks are provided to compose a total of 400 positioning points.
Positioning conditions such as low speed distance, inertia compensation and accuracy check conditions are programmed in each block to cover all positionings in a block but a preset data of home-position is programmed in a special address to cover all blocks commonly.

Example of data formation :

step \ block	0	1	2	3	4	5	6	7	8	9
00	00130	01530	---	---	---	---	---	---	---	---
01	00850	00192	---	---	---	---	---	---	---	---
02	01981	03693	---	---	---	---	---	---	---	---
04	03195	18930	---	---	---	---	---	---	---	---
38	03593	END	---	---	---	---	---	---	---	---
39	04050	⋮	---	---	---	---	---	---	---	---
40	END	END	END	END	END	END	END	END	END	END
70	00080	00070	---	---	---	---	---	---	---	---
71	00500	00300	---	---	---	---	---	---	---	---
72	00005	00030	---	---	---	---	---	---	---	---
73	00001	00000	---	---	---	---	---	---	---	---
74	00020	00013	---	---	---	---	---	---	---	---
H·P	02000									

Positioning adresses (Step 0~39 total 40 points)

※ Force end →

Low speed distance →

Timing to check accuracy →

Accuracy tolerance →

Accuracy check or no-check →

Inertia compensation →

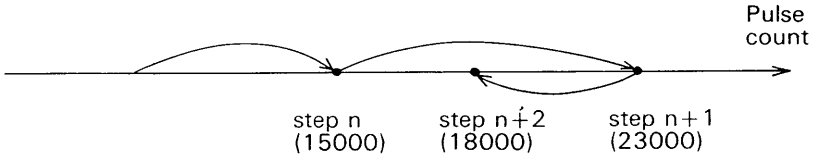
Home position preset →

※Since step 40 is occupied with the END instruction, positioning data can not be written in the step 40 and the END instruction can not be erased.

1-3 Absolute Data Setting/Relative Data Setting

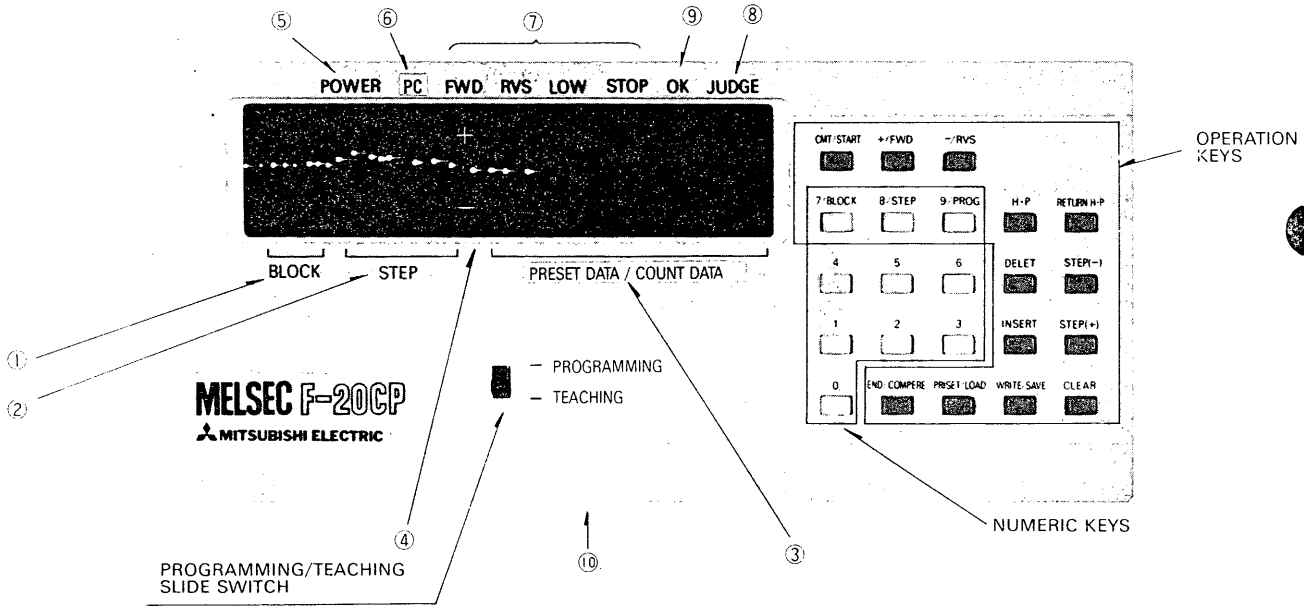
When the positioning data is programmed, either absolute data or relative data can be programmed and these data can be mixed.

Absolute data setting
(Data)
step n : 15000
step n+1 : 23000
step n+2 : 18000



Relative data setting
(Data)
step n : 15000
step n+1 : +8000
step n+2 : −5000

1-4 Operation Switches And Indicators



(1) Displays and indicators

①	BLOCK NUMBER DISPLAY	Block number is displayed during programming/running
②	STEP NUMBER DISPLAY	Step number is displayed during programming/running
③	COUNTER VALUE DISPLAY	Counter value is displayed during programming/running
④	PLUS/MINUS INDICATOR	Plus/minus polarity of setting value for relative setting
⑤	POWER SUPPLY INDICATOR	Power "ON" indication
⑥	BLOCK DESIGNATION BY PC	LED is turned "ON" when block destinated by PC is displayed
⑦	OUTPUT INDICATORS	Indications of output (forward, reverse, high/low speed, stop)
⑧	ACCURACY JUDGE OR NO JUDGE	LED is turned "ON" when accuracy judgement is programmed
⑨	ACCURACY JUDGE OK OR NOT	LED is turned "ON" when the stop position is within tolerance
⑩	CMT CONNECTOR	Interface connector with cassette magnetic tape recorder

(2) Operation keys

key	at programming mode	at teaching mode
CMT/START	CMT (recorder) mode	step start instruction
+/FWD	plus direction at relative data setting	manual forward operation (during depressing)
−/RVS	minus direction at relative data setting	manual reverse operation (during depressing)
7/BLOCK	block designation or numeric 7	same as programming mode
8/STEP	step designation or numeric 8	//
9/PROG	multi-functional setting key or numeric 9	//
H·P	designation of home-position data area	———
RETURN H·P	———	reverse-end returning or home positioning function
DELET	deteting of positioning data	———
INSERT	inserting of positioning data	———
STEP (+)	moving the step number forward	positioning of the step forward
STEP (−)	moving the step number back	positioning of the step backward
END/COMPARE	block end instruction or data comparison at CMT mode	———
WRITE/SAVE	data writing or recording at CMT mode	present position writing or home positioning start
PRESET/LOAD	home-position presetting or playing back at CMT mode	reverse-end returning function start
CLEAR	clearing of data display	same as programming mode

(3) Programming/teaching mode switch

Programming mode ;

Positioning addresses and condition data are written, read or changed in this mode when the machine stops. The programming unit, F-20CP, interfaces with CMT recorder for program storage in this mode. Whichever automatic or manual operation, the F-20CM can not operate the machine in this mode. If the mode switch is turned into programming mode during the machine running, the machine is forced to stop.

Teaching mode ;

The machine is operated in this mode whichever automatic or manual operation. The actual stopped position is written in the F-20CM for the positioning data during the machine running in this mode.

If the mode switch is turned into teaching mode during the CMT recorder is operated, the interface between the F-20CM and recorder is released.

※When the mode is changed from the teaching to programming, the F-20CP function is set in data reading function and the keys, [7/BLOCK], [8/STEP] and [9/PROG], are set as numeric keys automatically. If these keys are used for other than numeric keys, depress the [CLEAR] key twice.

2. PROGRAMMING PROCEDURES

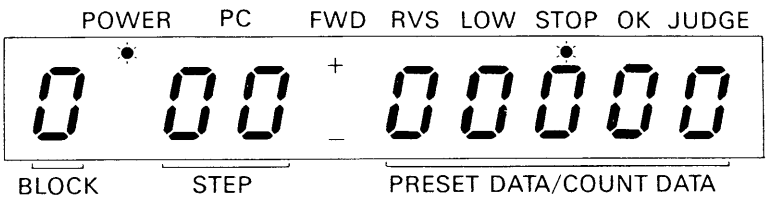
2-1 Erasure of Positioning Data

Before entering the positioning program, the previous contents in a certain block must be erased ready to receive a new program in the block by following procedure ;

Key Operation

[CLEAR] [CLEAR] ..... Display and function are cleared.
[7/BLOCK] ..... Block.
[0] ..... Designate "0" block.
[DELET] ..... All program data in block "0" is cleared.

Display :



※In this case, positioning conditions (step 70 to 74) are not cleared.

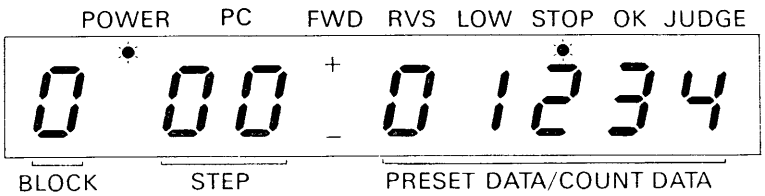
2-2 Writing of Positioning Data

After clearing the previous program in a certain block, a new positioning program is written in the block by following procedure ;

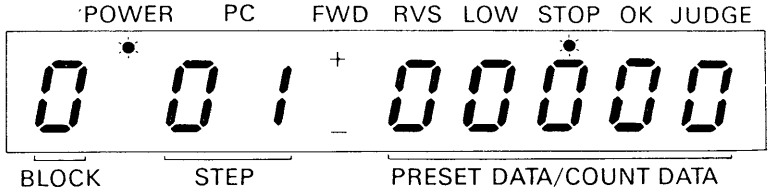
Key Operation

(Step 0 :) [7/BLOCK] ..... Block.
[0] ..... Block number "0".
[8/STEP] ..... Positioning step.
[0] [0] ..... Step number "0".
[9/PROG] ..... Program function.
[CLEAR] ..... Data clearing.
[1] [2] [3] [4] ..... Count value 1 2 3 4 is programmed in step number "0" of block "0".
[WRITE/SAVE] ..... Program is written in a memory.

Display : Before depressing [WRITE/SAVE] key.



After depressing [WRITE/SAVE] key, the next step data is automatically displayed.



Step 1 :

Key Operation

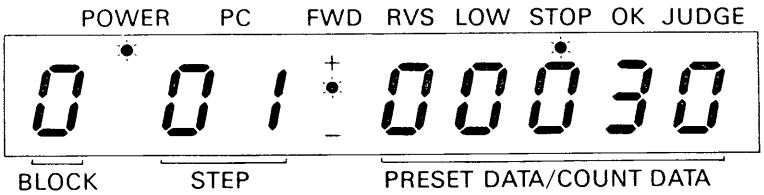
9/PROG ·····Program function.

CLEAR ·····Zero-clearing of display.

※ +/FWD ·····Relative value setting (positive).

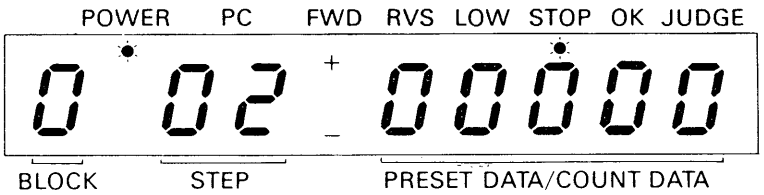
3 0 ·····30 counts forward from the step "0".

Display :



WRITE/SAVE

Display :



After depressing WRITE/SAVE key, the next step data is automatically displayed again.

→ When +/FWD or −/RVS key is not depressed, the setting value should be absolute value.

Step 2 ~ Step 39 By the same procedure above, positioning program can be written up to step "39".

END Instruction When positioning program is completed in a block, the End instruction can be written by following procedure ;

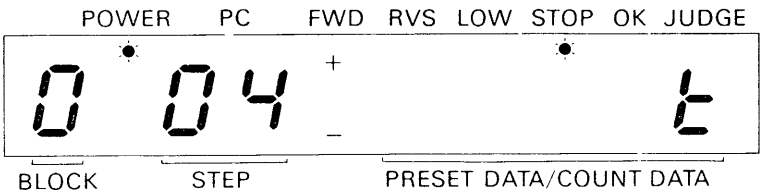
Key Operation

9/PROG ·····Program function.

CLEAR ·····Zero-clearing.

END/COMPARE ·····End instruction.

Display : Example to write "END" in step 4.



WRITE/SAVE ·····Write.

After depressing this key, the next step is displayed in the same block. Change program block and write a positioning program in the next block in the same manner if required.

Force END Even if the "END" is not written in the program, the END instruction has been programmed in the step "40".

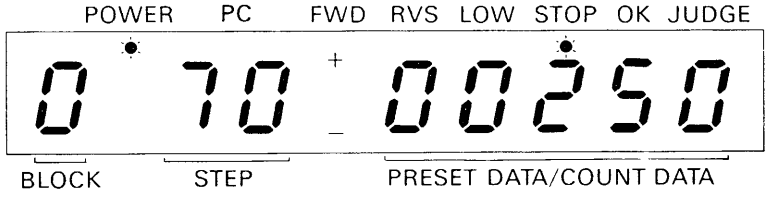
2-3 Writting of Positioning Conditions

5 Data of control conditions are programmed in the step 70 to step 74 by following procedure ;

(1) Low speed distance

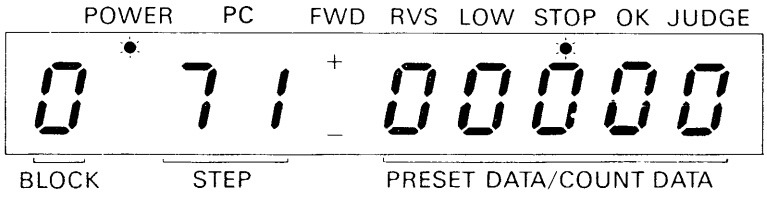
[CLEAR] . [CLEAR] ..... Clearing of function and display.
[7/BLOCK] [0] ..... Designation of block "0".
[8/STEP] [7] [0] ..... Designation of step "70".
[9/PROG] ..... Program function. Existing data is displayed if it exists.
[CLEAR] ..... Clearing the display.
[2] [5] [0] ..... 250 pulses are set for the low speed distance.

Display :



[WRITE/SAVE] ..... Write.
After depressing this key, the next step is automatically displayed.
In this time, existing data is displayed if it exists.

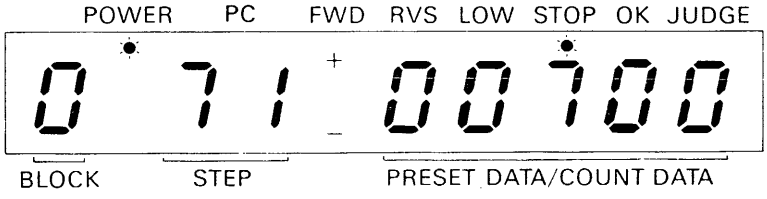
Display :



(2) Timing to check accuracy

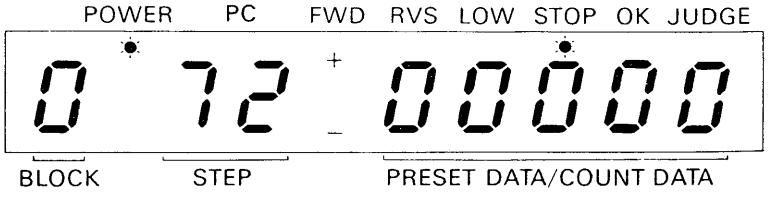
Key Operation
[9/PROG] ..... Program function.
[CLEAR] ..... Zero-clearing of display.
[7] [0] [0] ..... 700 mili-seconds is programmed for the time to start the accuracy check of stop position after "Stop" output is activated.

Display :



[WRITE/SAVE] ..... Write.
After depressing this key, the next step is displayed.

Display :



(3) Accuracy tolerance

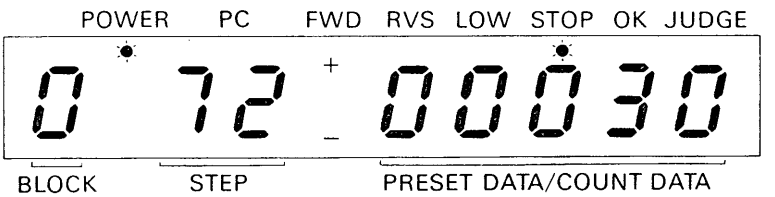
Key Operation

9/PROG ..... Program function.

CLEAR ..... Zero-clearing of display.

3 0 ..... Plus and minus 30 pulses are programmed for the tolerance to the stop position.

Display :



WRITE/SAVE ..... After depressing this key, the next step is displayed.

(4) Accuracy check or no-check

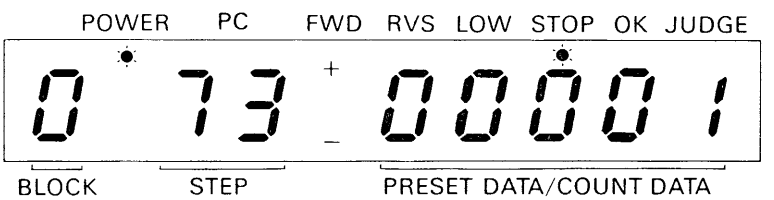
Key Operation

9/PROG ..... Program function.

CLEAR ..... Zero-clearing of display.

1 ..... When the accuracy check is needed, depress the 1 key. If not, depress the 0 key.

Display :



WRITE/SAVE ..... Write.

After depressing this key, the next step is displayed.

(5) Inertia compensation Value

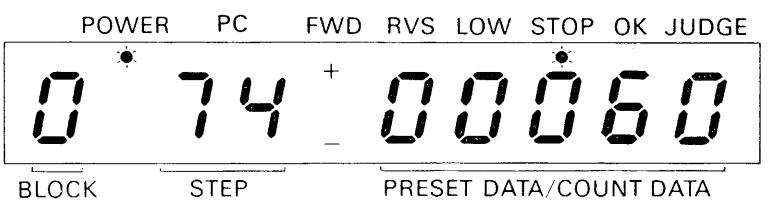
Key Operation

9/PROG ..... Program function.

CLEAR ..... Zero-clearing of display.

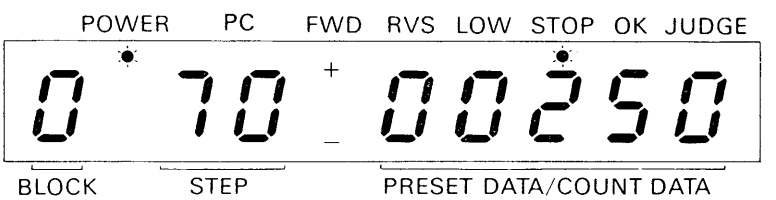
6 0 ..... 60 pulse is programmed for the inertia compensation value.

Display :



WRITE/SAVE ..... Write.

After depressing this key, the step 70 is displayed back.



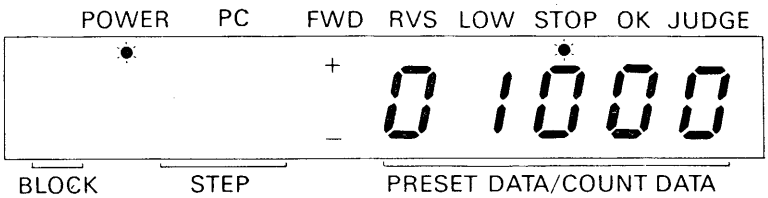
2-4 Writting of Home Position Presetting Data

The limit switch or proximity switch is provided to detect the home position in a system and the home position is registered in a program with a counter value. This section mentions the procedure to write the home position setting value.

Key Operation

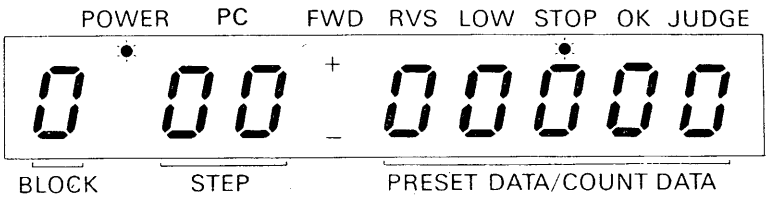
[CLEAR] [CLEAR] ·····Clearing of function and display.
[H·P] ·····Home position address.
[9/PROG] ·····Program function. Existing data is displayed if it exists.
[CLEAR] ·····Zero-clearing of display.
[1] [0] [0] [0] ·····Home position is registered in the counter as 1000 pulse.

Display :



[WRITE/SAVE] ·····Write.
[PRESET/LOAD] ·····Preset.

Display :



When the display indicates all zero, the writing is completed.

2-5 Reading A Program

Positioning program and conditions are displayed to read as following procedure ;

Key Operation

[CLEAR] [CLEAR] ·····Clearing of function and display.
[7/BLOCK] [0] ·····Designation of block "0".
[8/STEP] [3] [0] ·····Designation of step "30".
[9/PROG] ·····Counter data of step "30" in block "0" is displayed.
[STEP +] ·····Data of the next step is displayed.
[STEP -] ·····Data of the step one before is displayed.

2-6 Inserting of Positioning Data

To insert a positioning data in existing program, proceed as follows;

Key Operation

[CLEAR] [CLEAR] ·····Clearing of function and display.
[7/BLOCK] [0] ·····Designation of block "0".
[8/STEP] [0] [2] ·····Designation of step "2".
[9/PROG] ·····Reading data of step "2" in block "0".
[CLEAR] ·····Clearing of display.
[−/RVS] [4] [0] ·····Relative data "minus 40".
[INSERT] ·····"minus 40" is written in step 2 and all subsequent data is moved forward one step and the next step data is displayed.

※1 When previous program has a data in step 39, the data of step 39 is omitted by inserting procedure.

※2 The inserting function is not available for the condition data (step 70 to step 74).

※3 After above inserting procedure, the data can be confirmed by depressing the [STEP −] key.

2-7 Deleting of Positioning Data

To delete a positioning data in existing program, proceed as follows;

Key Operation

[CLEAR] [CLEAR] ·····Clearing of function and display.
[7/BLOCK] [0] ·····Designation of block "0".
[8/STEP] [0] [2] ·····Designation of step "2".
[9/PROG] ·····Reading data of step "2" in block "0".
[DELET] ·····Existing data in the step "2" is deleted and all subsequent data is moved up by one step. The next data is displayed in step "2".
[9/PROG] [DELET] ·····If continuous data is deleted, depress these keys as required.

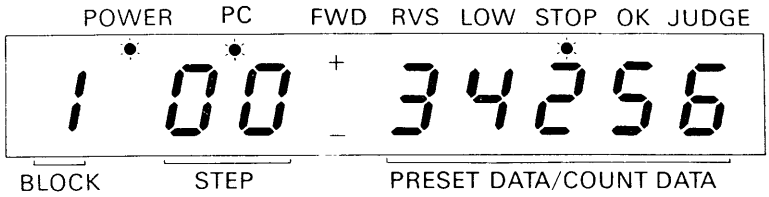
※1 After the deleting procedure, the END instruction is written in step "39" automatically.

※2 The deleting function is not available for the condition data (step 70 to step 74) or home-position data.
In this case, the data is changed by re-writing.

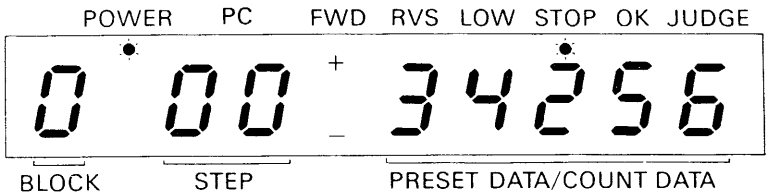
2-8 Teaching Operation

When the machine is positioned at certain point by manual operation, the actual position can be written in the F-20CM for the positioning data.
Proceed the teaching operation in teaching mode as follows;

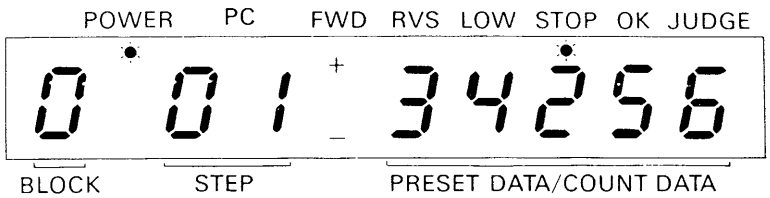
Move machine at certain position.
Display of actual position :



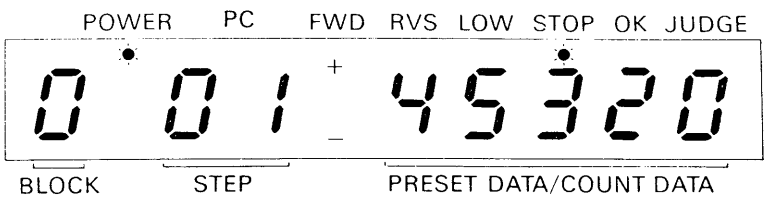
7/BLOCK 0 ·····Block0
8/STEP 0 0 ·····Step 0
} Address for the data to be programmed.



9/PROG WRITE/SAVE ···Actual position (34256 pulse counts) is written in the step "0" of block "0", and the next step number is displayed.



Move machine at next position to be programmed.
Display of the next position :



9/PROG WRITE/SAVE ···The position of 45320 pulse counts is written in the step "1" of block "0", and the next step number is displayed.

By the same procedure above, positioning data is programmed in the F-20CM up to step "39".
When positioning data is written in step "39", the data programming is completed in the block.

※1 All positioning data is written by the absolute data setting.

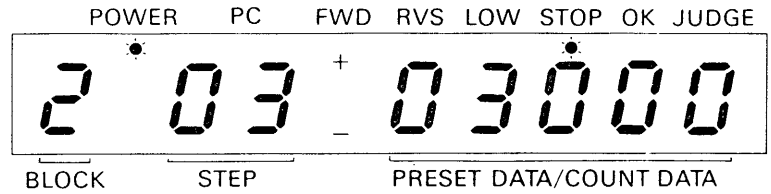
※2 To change the data by teaching operation, write new positioning data in the step.

※3 The END instruction can not be programmed in teaching mode. Write the END instruction in programming mode.

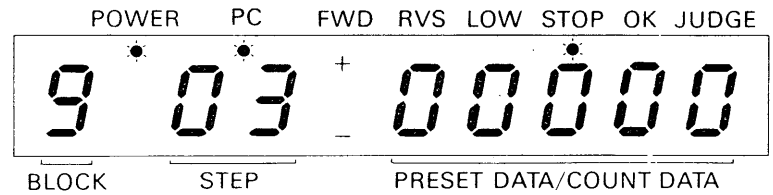
2-9 Display of Data Block

The F-20CP displays the block number which is designated by the key operations in programming mode. In case of teaching mode, the F-20CP displays the block number which is designated by the PC except when the [CLEAR] key is depressed as following example ;

The power is turned "ON" in programming mode and read the data of step "3" in block "2".

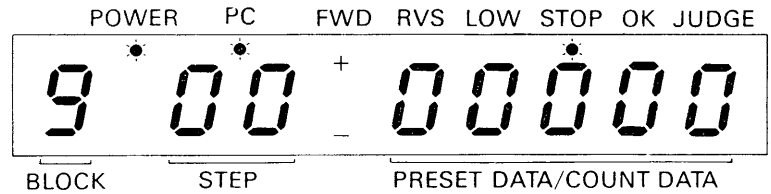


The mode switch is turned to teaching mode ;



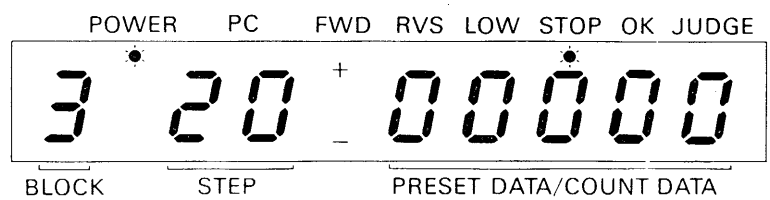
The block designated by the PC is displayed, but the step is not changed. In this case, positioning data is cleared (zero).

[CLEAR] key is depressed.

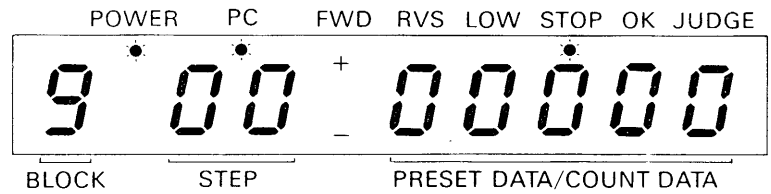


The step number is cleared (zero).

[7/BLOCK] [3] [8/STEP] [2] [0]



[CLEAR]

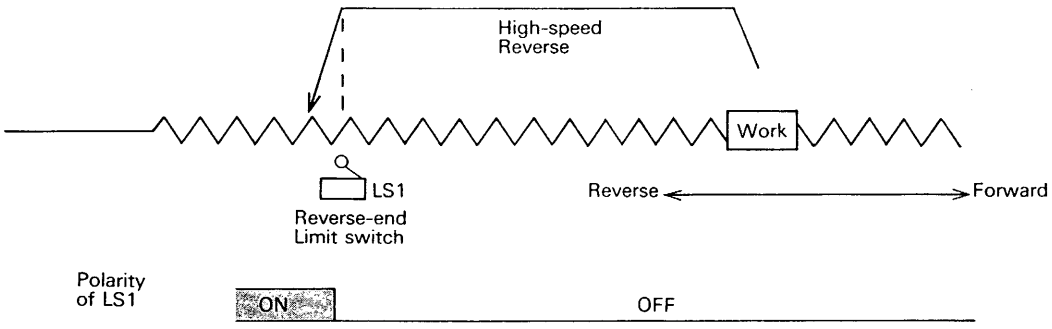


Display of the block designated by the PC. The step number is cleared (zero).

3. MACHINE OPERATIONS BY F-20CP IN TEACHING MODE

3-1 Reverse-end Returning

When the machine is moved to the reverse-end point, depress keys of [RETURN H.P.] and [PRESET/SAVE]. By this procedure, the reverse and high-speed outputs of F-20CM are turned "ON" until stop signal, such as reverse-end limit switch, is turned "ON" to make stop output "ON".



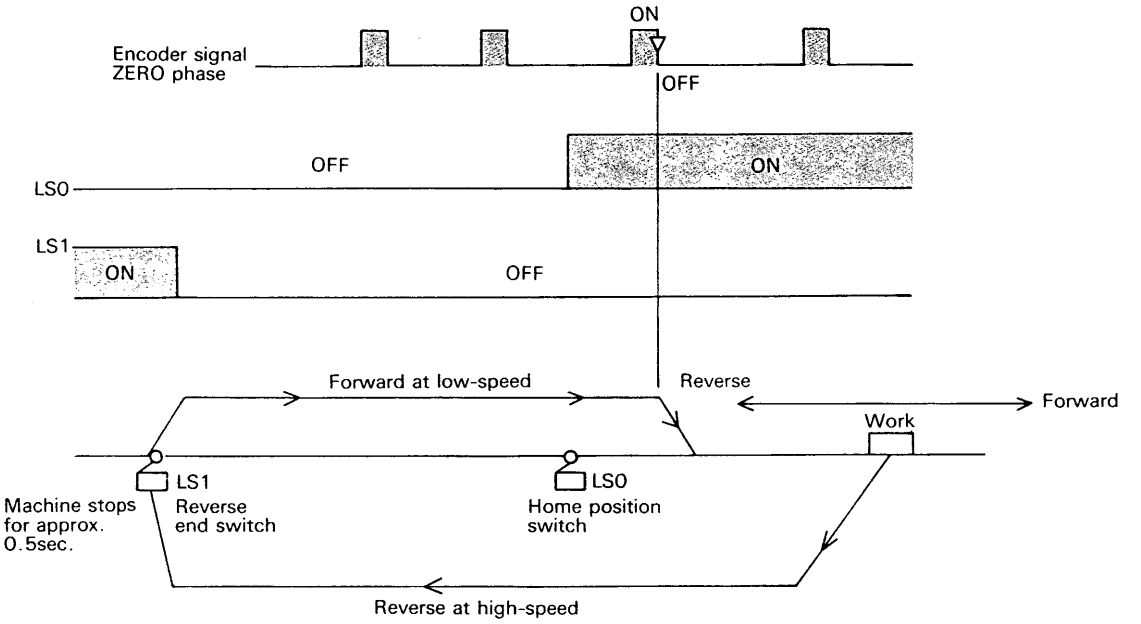
※1 Before the reverse-end returning operation is executed, make sure that the reverse-end switch is provided to stop the machine at certain point.

※2 When this operation is executed, accuracy judgement signal (—| |—[14]) and block end signal (—| |—[15]) are reset (OFF) automatically.

※3 During this operation, displays of the existing positioning block and step number are remained.

3-2 Home-positioning (home-position presetting)

The home-positioning operation starts when it is instructed by the PC (—o—[44]), or when the keys of [RETURN H.P.] and [WRITE/SAVE] are depressed. By the procedure above, the machine reverses at high speed until the reverse end switch is turned "ON", and the machine stops at reverse-end point, then after approx. 0.5 second, the machine automatically starts to move forward at low speed to approach the home position. When the first zero phase signal is generated after the machine crosses over the home-position, the pulse counting is automatically preset with the home-position data programmed in the F-20CM and the machine stops.



※1 When the F-20CM power is turned "ON", excute the home-positioning operation to drive the machine.
Automatic positioning operation can not be started unless this operation is executed.

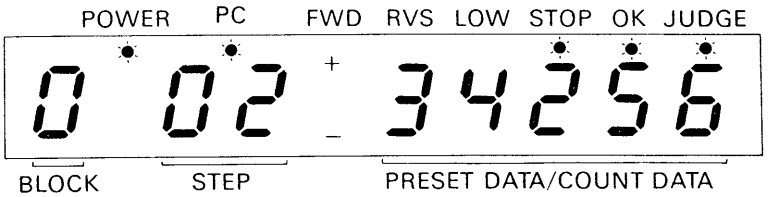
※2 After this operation is completed, step number is cleared (zero).
If home-positioning is executed during the positioning procedure, be aware that the next positioning start from step "0".

※3 When this operation is executed, accuracy judgement signal (—| |—[14]) and block end signal (—| |—[15]) are reset (OFF) automatically.

※4 After completion of this operation, the accuracy of stopped position is checked and accuracy judgement signal is turned "ON".

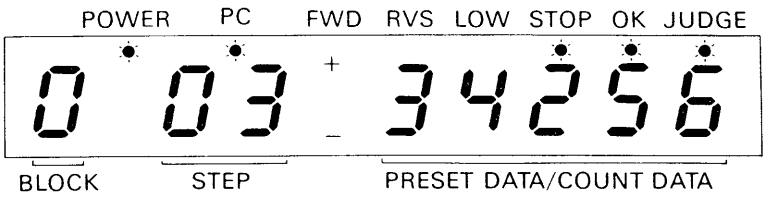
3-3 One Step Positioning Operation

When the machine stops at certain point of automatic operation in teaching mode, the machine can be operated to execute one step positioning by F-20CP key operation as following procedure ;

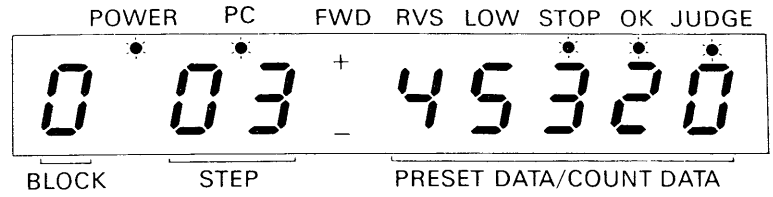


Display of present position.

STEP + ... Designation of next step.
(The next step number is displayed.)

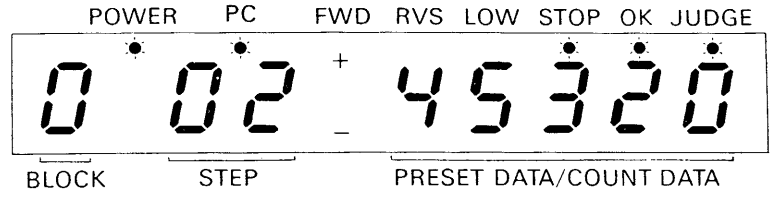


CMT /START ·····The positioning of step "3" starts and the machine stops at the point programmed in the step "3".

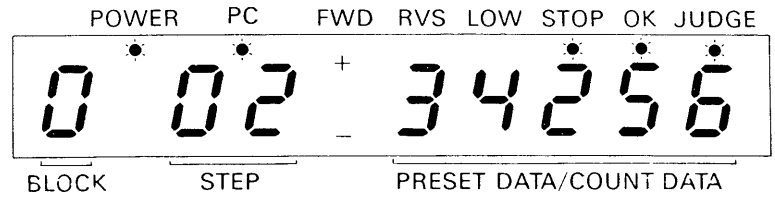


The step number for one step operation can be designated by the STEP + and STEP − keys.

STEP − ·····The step number moves one step back.



CMT /START ·····The positioning of step "2" is executed.



※1 When one step positioning is executed, accuracy judgement signal (—| |[14]) and block end signal (—| |[15]) are reset (OFF) automatically.

※2 If incorrect data has been programmed in the step designated, positioning operation can not be started. In this case, depress the CLEAR in teaching mode or execute home-positioning and start other positioning.

3-4 Manual Forward and Reverse Operations

The machine is moved forward or reversed at low speed manually by the forward or reverse input signals stated in the section of input terminals.

The + /FWD and − /RVS keys are also provided on the F-20CP for the manual operations of forward/reverse movements at low speed.

+ /FWD ·····Forward and low-speed outputs are turned "ON" during depressing this key.

− /RVS ·····Reverse and low-speed outputs are turned "ON" during depressing this key.

※1 The forward/reverse input signals of F-20CM prior to above key operation.

※2 Since above key operations prior to the stop input signal of F-20CM, the machine can cross the forward-end or reverse-end point by above key operation disregarding the forward-end switch or reverse-end switch.

※3 Unless the out-enable output of F-20CM (—○—[46]) is turned "ON", these manual operation can not be executed. Provide a sequence program in the PC to make a output (—○—[46]) "ON" at "RUN" mode.

4. PROGRAM STORAGE IN CMT (Cassette Magnetic Tape)

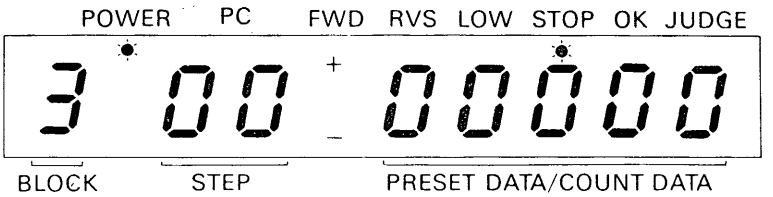
The F-20CP has interface function with CMT recorder for the program storage.

The operation is executed as following procedure in the programming mode ;

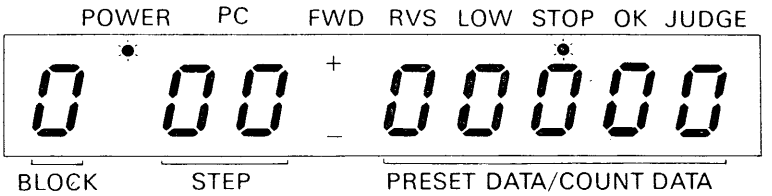
4-1 Recording

① Connect the F-20CP to a CMT recorder with a CMT cable.
② Supply the power to the recorder and start the recording.
③ Key stroke of the F-20CP.

[7/BLOCK] [3] ·····Recording the program three times. (MAX 5 times)
[CMT/START] [WRITE/SAVE] ···Data is transferred to the recorder after approx. 5 seconds.

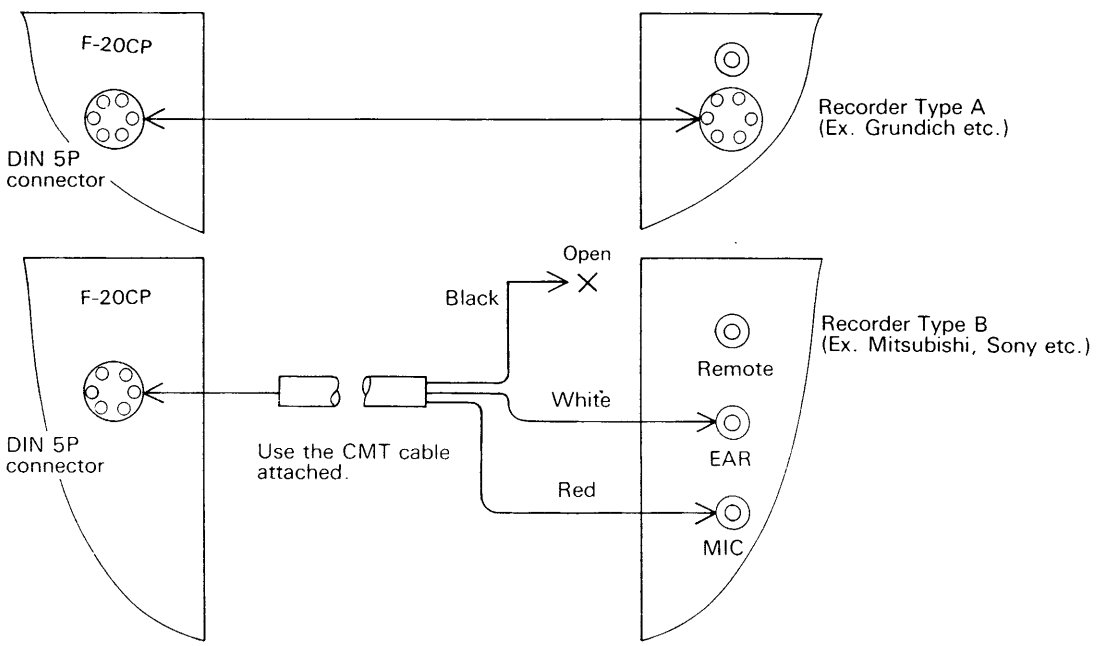


When three times of recording are completed, block number "0" is displayed.



※1 To make a stop of recording, turn the mode switch from programming mode to teaching mode.

※2 CMT cable connections are as follows ;



The remote function is not available.

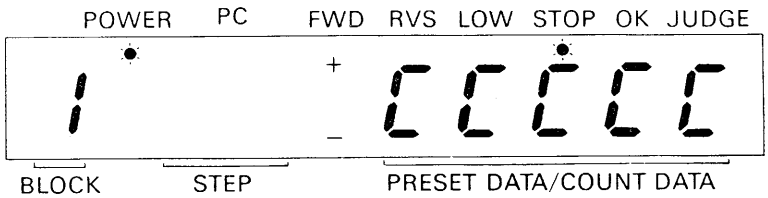
※3 When the recording time is not be keyed-in, one time of recording is executed.

4-2 Playback

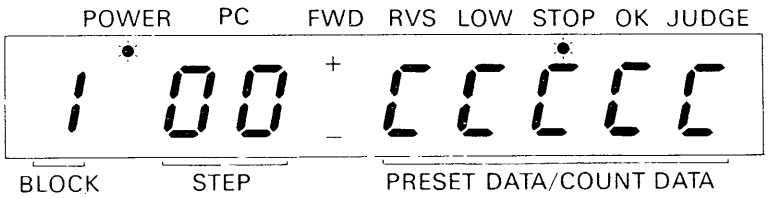
① Connect the F-20CP to a CMT recorder with a CMT cable as same as recording.
② Supply the power to the recorder.
③ Key-stroke of the F-20CP.

[CMT/START] [PRESET/LOAD] ···F-20CM is ready to receive the data from CMT.

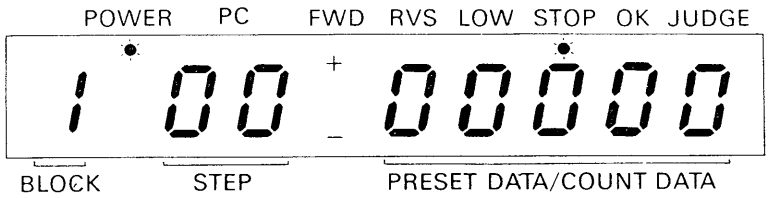
Recorded program number "1" is displayed.



④ Start to play the CMT.
When the signal level is correct, zero is displayed in the step area. If not, adjust the signal level.

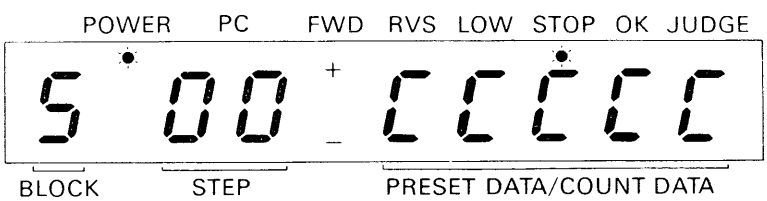


⑤ When program transfer from CMT to the F-20CM is completed, zero is displayed in the data area.



If any data code error exists in the program, the playback of second program is started when more than one program exists.

If the data code error exists in all programs, zero is not displayed in the data area.



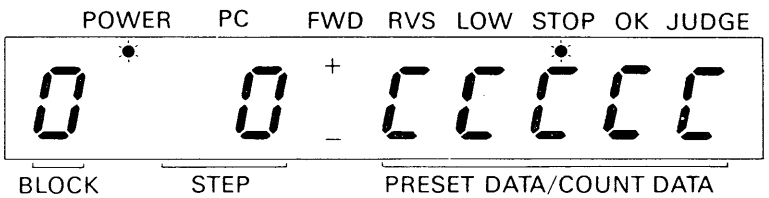
In this case, the last program is contained in the F-20CM even though data code error exists in the program and CPU ERROR LED on the F-20CM flickers, but the program can be corrected by the key operations in the programming mode.

※To make a stop of the playback, turn the mode switch from programming to teaching mode.

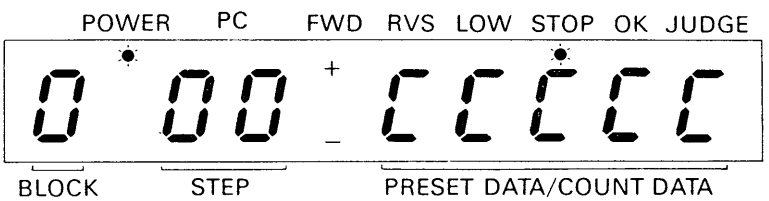
4-3 Verification

① Connect the F-20CP to a CMT recorder with a CMT cable as same as recording.
② Supply the power to the recorder.
③ Key-stroke of the F-20CP.

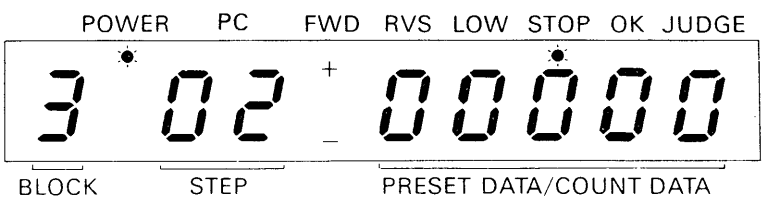
CMT/START END/COMPARE ···Ready to compare.



④ Start to play the CMT.
When the signal level is correct, double zero is displayed in the step area. If not, adjust the signal level.



The programmes in the CMT are verified with the program in the F-20CM and the verification result is displayed as following example ;



Number of incorrect program.

Number of correct program.
Total 5 programmes in the CMT are verified.

6. MAINTENANCE AND DIAGNOSTICS

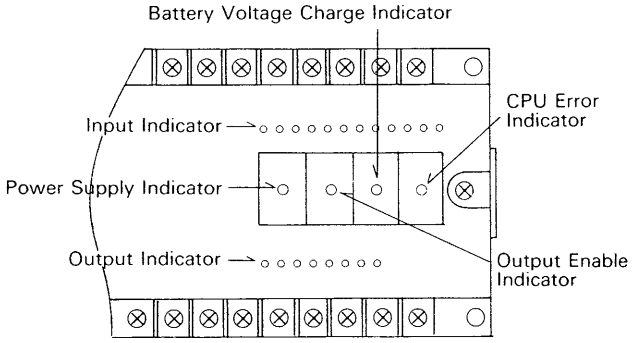
PERIODICAL CHECK

The unit does not contain wasting component except a battery and output relays which require periodical checks. If the battery voltage LED illuminates, then renew the battery. The battery life is approx 7 years but it is recommended to replace it every 5 years.

The output relay life is subjected to the output load and frequence of the use, and the durability data is same as relays of F series PC. The replacements of the battery and output relay board are also same as F series PC (see F series PC instruction manual).

DIAGNOSTICS

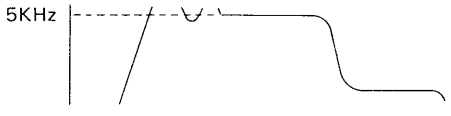
1. Power Supply
   LED illumination indicates that the power is "on". If the LED fails to illuminate when the unit is under apparent power, then the unit may be faulty.
2. Output Enable
   LED illumination indicates that the counter is allowed to make outputs by the PC.
3. Battery
   If the battery LED illuminates then renew the battery.
4. CPU and Memory Error
   If the CPU error LED is turned ON, this may be as a result of electrical noise interference from some external apparatus.
   Otherwise it indicates a fault in the unit or trouble cause by conductive trashes etc. In this case turn the power OFF and turn ON to check again. Replace the unit if the LED is still ON. If the LED flickers checking the parity error, check the program.



5. Input circuit operation
   Failure of the input LEDs to illuminate when properly connected and powered may be fault of the unit. If input circuit has resister for LED in parallel, check leakage current.
6. Outputs
   If outputs fail to function, whether the LEDs are illuminated, it may be a unit fault. In case of small current load, check leakage current of the absorber circuit in the unit.

MIS-POSITIONING CHECKS

1. Ensure that all termination connection, home-position detector and encoder are tight.
2. Rotate the encoder shaft by hand to check if the encoder signal is received correctly. The inputs, A, B, Z, are checked by input LEDs.
3. Ensure that the setting speeds, high speed and low speed, are not changed and that the low speed distance is set long enough to reduce the inertia. Check the stability of the low speed.
4. Ensure that the encoder signal speed is not over the response speed of the F-20CM. The F-20CM can not accept the signal faster than 6KHz. In particular, check the over-shoot at high speed.



5. Ensure that the mechanical load torque is not changed and not uneven specially on the screw shaft which may bent by the work weight.
6. Since the encoder wires are sensitive and easily receive external noise interference, use sealed wires and separate from other power cables.

GENERAL SPECIFICATIONS

POWER SUPPLY		AC110/120V and AC220/240V(85% to 110%), 50/60Hz
SIZE AND WEIGHT		255W×80H×100D(mm), approx.1.5KG(10.04W×3.15H×3.94INCH, 3.3LB)
ENVIRONMENT	AMBIENT TEMPERATURE	0 to 55 deg. C
	AMBIENT HUMMIDITY	90%RH (NO CONDENSATION)
INSULATION RESISTANCE		DC500V 5Mega-Ohm
INSULATION WITHSTAND VOLTAGE		AC1500V 1Min.
NOISE IMMUNITY		1000V 1micro sec. BY NOISE SIMULATOR

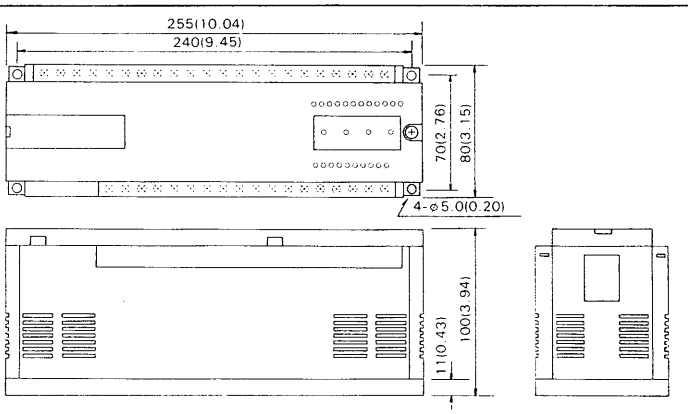
FUNCTIONS AND PERFORMANCE

COUNTER	TYPE	UP-DOWN, 1 AXIS software counter
	MAX. COUNT	MAX. 99999
	SPEED	5 KHz
SETTING	TYPE	KEY OPERATION (CONTOUR TEACHING AVAILABLE)
	POSITIONING POINTS	40 STEPS/BLOCK×10 BLOCKS
	LOW SPEED SECTION	COMMON IN A BLOCK
	ACCURACY ALLOWANCE	〃
	TIMING TO JUDGE	〃
	INERTIA COMPENSATION	〃
	HOME POSITION	ONE POINT/10 BLOCKS
MEMORY	DEVICE	C-MOS RAM MEMORY
	BACK-UP	BACKED BY LITHIUM BATTERY (5 YEARS)
COUNTING INPUTS	SIGNAL	SQUARE WAVE ONE PHASE OR TWO PHASES
	TYPE	CURRENT LOOP, PHOTO-COUPLLER ISOLATION
	SENSOR APPLIED	INCREMENTAL ENCODER W/ZERO OUTPUT OR PROXIMITY SWITCH
INPUTS FOR COUNTER	MANUAL OPERATION INPUTS	3 POINTS (STOP, LOW-FORWARD, LOW-REVERSE)
	HOME POSITION INPUT	1 POINT
	PHASE SELECTION	1 POINT (SINGLE PHASE OR TWO PHASE)
	INPUT DEVICE APPLIED	NO-VOLTAGE CONTACT OR TRANSISTOR (OPEN COLLECTOR)
CONTROL SIGNAL FROM PC TO COUNTER	DESIGNATION OF BLOCK	4 POINTS (CODE DESIGNATION)
	OPERATION CONTROL	3 POINTS (HOME POSITION RETURN, STEP START, OUTPUT ENABLE)
	TYPE OF SIGNAL	PC CONNECTION BUS
INPUTS FOR PC	NUMBER OF POINTS	4 POINTS (5m.sec. pulse LENGTH ACCEPTABLE)
	INPUT DEVICE APPLIED	NO-VOLTAGE CONTACT OR NPN TRANSISTOR (OPEN COLLECTOR)
OUTPUT	RELAY OUTPUT	2A 5 POINTS (FORWARD, REVERSE, LOW/HIGH SPEED, STOP)
	TRANSISTOR OUTPUT	0.5A 5 POINTS (FORWARD, REVERSE, LOW/HIGH SPEED, STOP)
FEED-BACK FROM COUNTER TO PC	CONTROL SIGNAL	6 POINTS (FORWARD, REVERSE, LOW SPEED, STOP, JUDGE, BLOCK END)
	DIAGNOSTICS	2 POINTS (MEMORY/CPU ERROR, BATTERY ERROR)
POWER SOURCE FOR SENSOR		DC12V, 100mA
DIAGNOSTICS		2 POINTS (MEMORY/CPU ERROR, BATTERY ERROR)

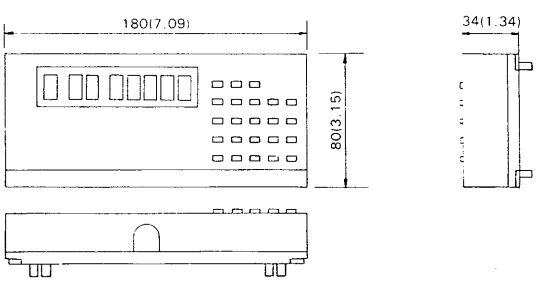
OUTLINES AND DIMENSIONS

COUNTER MODULE F-20CM

M.M (INCH)



PROGRAMMING UNIT F-20CP



MITSUBISHI ELECTRIC CORPORATION

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JY992D01801A (SEN) (A2)