ADVANCED AND EVER ADVANCING **MITSUBISHI ELECTRIC**

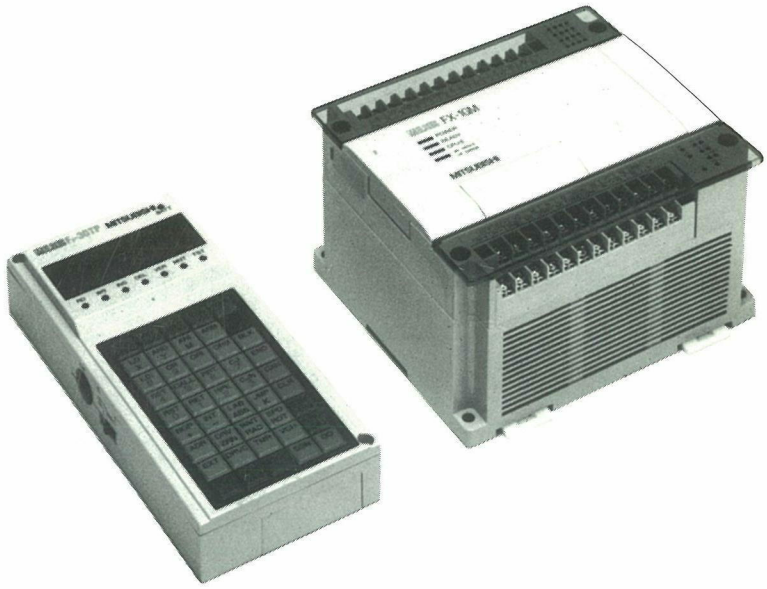
MITSUBISHI

PROGRAMMABLE CONTROLLERS

MELSEC-F

HANDY MANUAL

FX-1GM POSITION CONTROL UNIT



CONTENTS

1 GENERAL INFORMATION ON POSITIONING CONTROL

1.1 Why is Positioning Control Necessary?

Positioning control units using a pulse motor (stepping motor) or servo motor are utilized in a wide variety of applications.

Positioning control is not intended to improve positioning accuracy alone; speed is also an important factor.

Problems involving accurate stopping may occur as speeds are increased to enhance the efficiency of the machine.

This has led to the ever-increasing demand for high-quality positioning controllers to solve these problems.

If you are not taking positioning accuracy into account, your machine may be operating at reduced efficiency.

Used properly, this positioning control unit may greatly increase your production rate.

This manual has been compiled.....

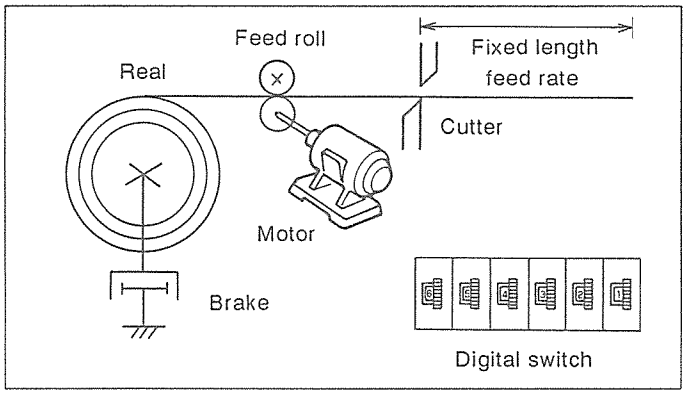
For beginners, not only as a manual, but as an easy-to-understand series of explanations.

"Positioning control" is situated at the interface between electronic control and mechanical control. Although certain portions of this manual may be hard to grasp at first, positioning control is an indispensable aspect of machine automation in this era of high technology.

Read this manual thoroughly and carefully and make sure you understand it completely so that you can get the best results from this product.

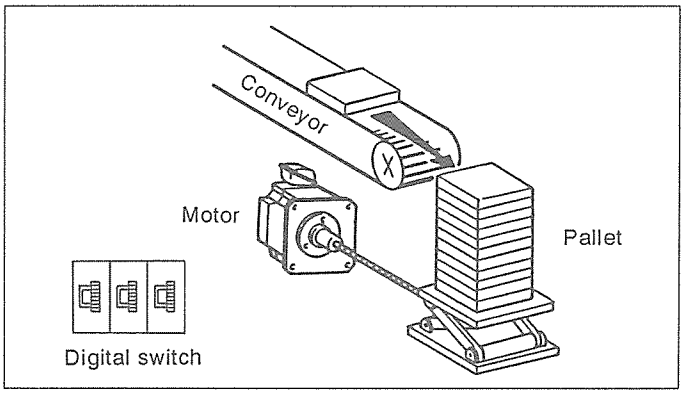
1.2 What This Positioning Unit Can Do

Application examples



Fixed size feed control

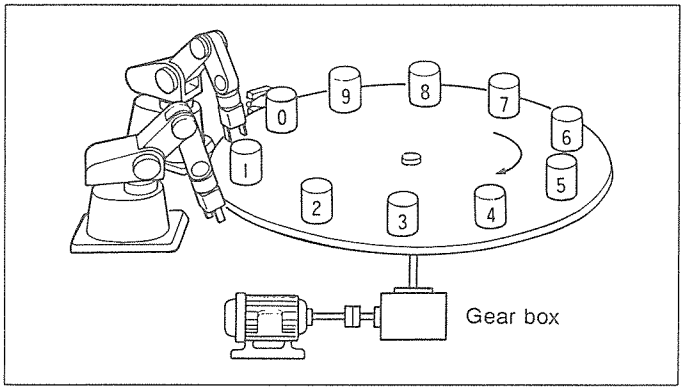
High-accuracy, high-speed feeding and cutting of sheets in terms of sizes set by the digital switch. The digital switch can be set to up to 6 digits.



Fixed amount multi-stage feed control

Uses home positioning to put the pallet at the same height as the conveyor.

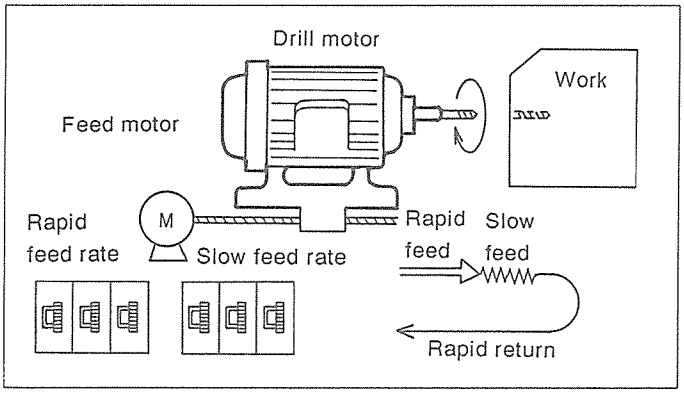
Then, it lowers the pallet by a fixed amount each time an object is unloaded from the conveyor onto the pallet. The amounts can be changed by using the digital switch.



Rotary table control

Divide the index table or rotary disc into "n" equal portions by using designated angles.

Execute the shortest-distance positioning mode in accordance with commands sent from the programmable controller in any order.

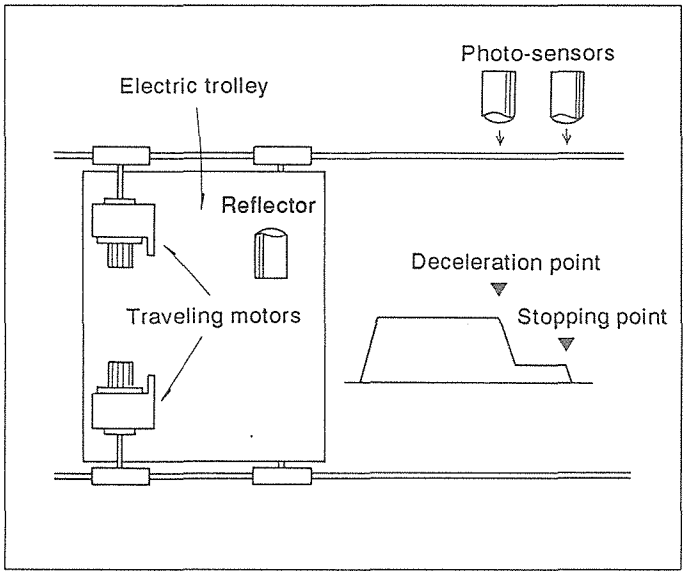


Positioning feed rate and depth control

Execute rapid return after completing rapid feed and slow feed (cutting feed) from the home position.

Set rapid feed and slow feed rates can be changed by using the digital switch.

1 GENERAL INFORMATION ON POSITIONING CONTROL

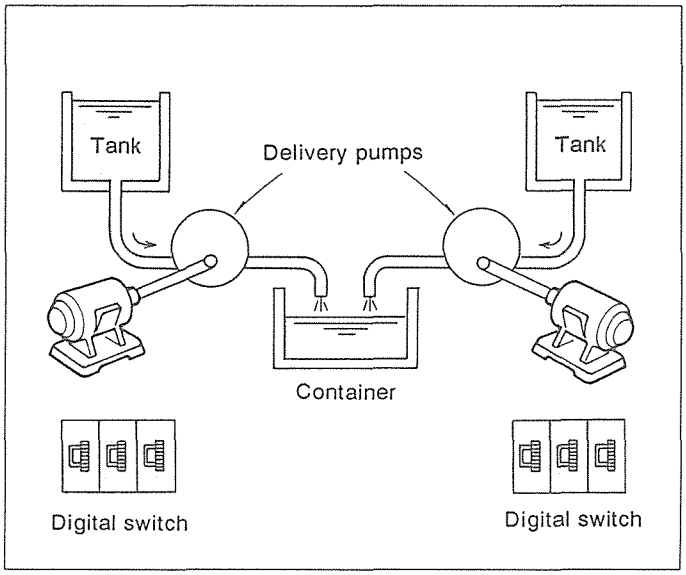


Speed matching operation

Executes the speed matching operation for both wheels of a wide trolley driven by separate travel motors to ensure smooth movement.

Decelerates at a point before the target position to stop the trolley just in front of the target position.

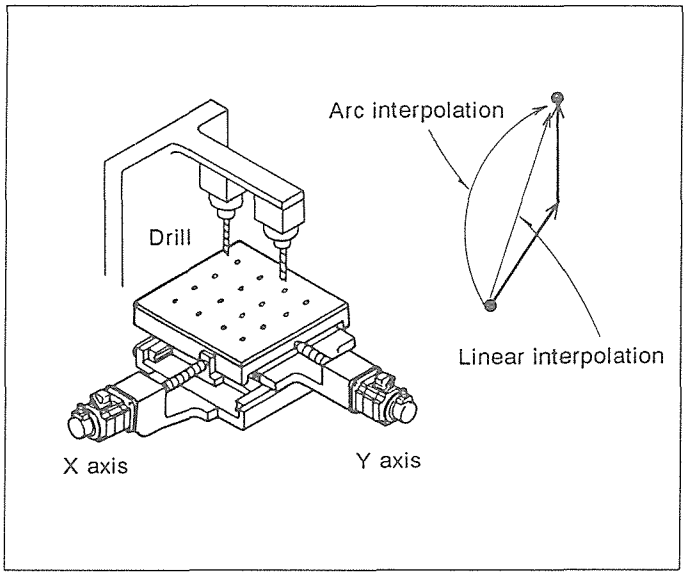
Deceleration-start points, stopping positions, return positions, etc. are determined by sensor inputs sent from the photo-electric switch, limit switch, etc.



Fixed volumes liquid-mixing unit

This is a liquid-mixing unit which uses delivery pumps whose feed rates per rotation are fixed.

The volumes of liquid fed from each tank are set by using the digital switch.



Independent 2-axis plane control

Moves the table transversely and longitudinally to permit drilling of a workpiece.

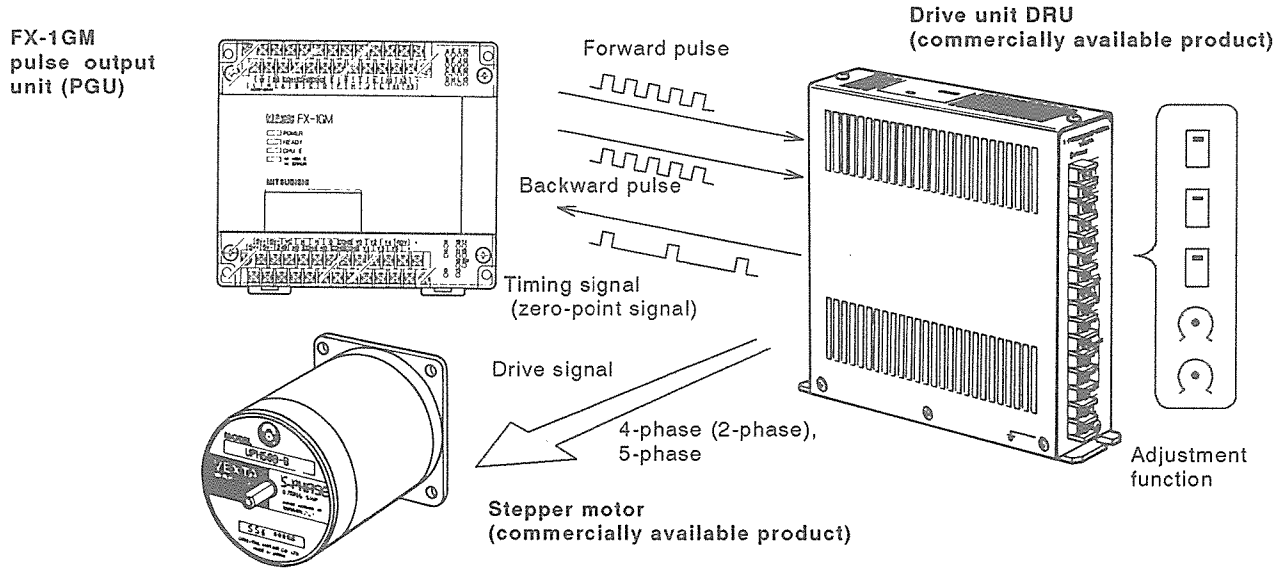
2 drills (small, large) are used, each of which is selected and controlled by the programmable controller.

Up to 8 axes can be controlled by 1 programmable controller, but linear interpolation and arc interpolation are not supported.

However, interlocked operations can be controlled by using multi-axis synchronizing signals.

1.3 General Information on Drive Units

1.3.1 When using a stepper motor



Any commercially available stepper motor can be used to drive a small capacity load.

Rotating speed

The stepper motor is a motor which rotates in short, uniform angular movements initiated by a input pulse.

Accordingly, the rotation angle of the motor is directly in proportion to the input pulses, and thus it is possible to obtain a rotating speed which is proportional to the pulse frequency.

$$N = 60 \times \frac{f}{n} \text{ (RPM)}$$

$$n = \frac{360}{\theta s} \text{ (P/R)}$$

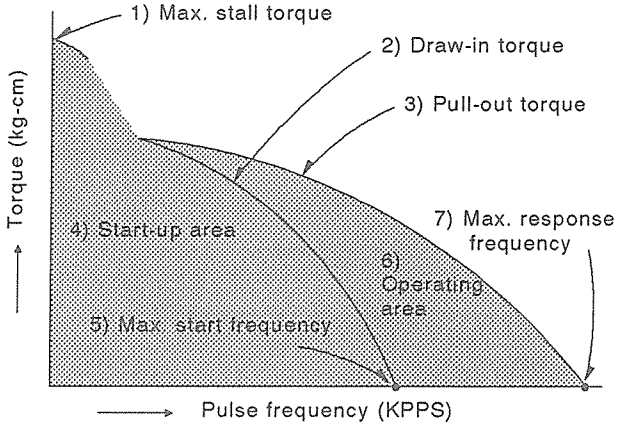
N : Rotating speed (RPM)
f: Pulse frequency (PPS)
θs: Step angle (deg.)
n : Number of pulses required to turn 1 revolution of the motor (P/R)

Torque

Unlike the servo motor system (see Section 1.3.2), the stepping motor adopts an "open loop" system, which means smaller size and cost for the entire system.

If, because of load inertia, the motor response delay is too great, it may become out of step with the input pulse, leading to an error in the final step angle.

Because of this, it is necessary to be particularly careful when selecting the motor and executing such controls such as slow start, slow stop, etc.

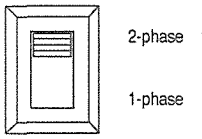


1 GENERAL INFORMATION ON POSITIONING CONTROL

Adjusting the drive unit

The adjustments given below are necessary.

Switching pulse systems



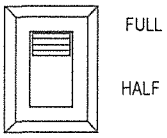
Type A

System in which the forward pulse is applied to one pulse input terminal, and the backward pulse to another pulse input terminal.

Type B

System in which both the forward pulse and backward pulse are applied to one pulse input terminal, and forward/backward switching signals are applied to another pulse input terminal.

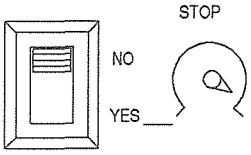
Switching step angles



As shown below, the step angle can be changed, by making the step mode full step or half step.

Number of phases (motor)	Basic step angles	FULL STEP		HALF STEP	
		Step angles	Pulses/ rotation	Step angles	Pulses/ rotation
5-phase	0.36°	0.36°	1,000	0.18°	2,000
	0.72°	0.72°	500	0.36°	1,000
4-phase (2-phase)	0.9°	0.9°	400	0.45°	800
	1.8°	1.8°	200	0.9°	400

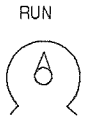
Adjusting the hold current



When the holding torque function is required when stopping the motor, some units permit adjustment of the hold current by using the STOP potentiometer.

When a large holding torque is not required, keep the current low to help prevent the motor from overheating.

Adjusting the operating current

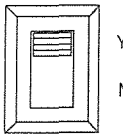


Where there is surplus capacity in the motor torque, some units permit decreasing the operating current by using the RUN potentiometer to help keep the motor from overheating or vibrating.

However, reducing the current too much may increase the mechanical response delay.

Overheating shut OFF function

Some units are provided with a selector switch to automatically turn the current OFF when the motor overheats.

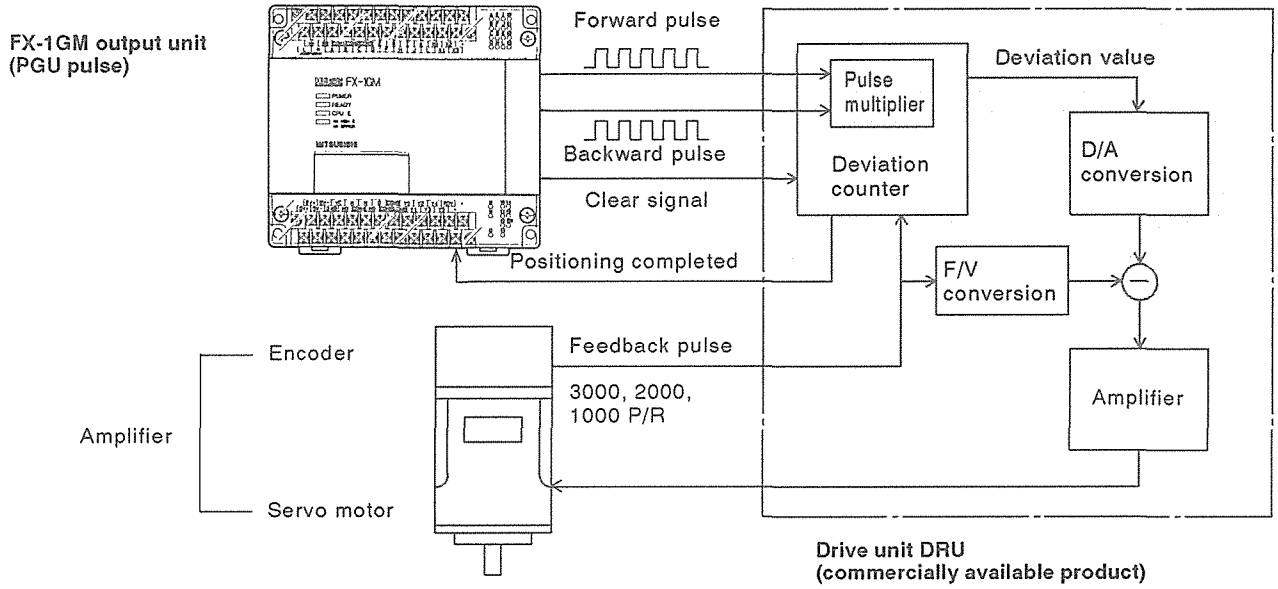


YES ——— Shuts the current OFF automatically when the motor overheats.

NO ——— Current is not shut OFF.

- See the manufacturer's Instruction Manual for details.

1.3.2 When using a servo motor



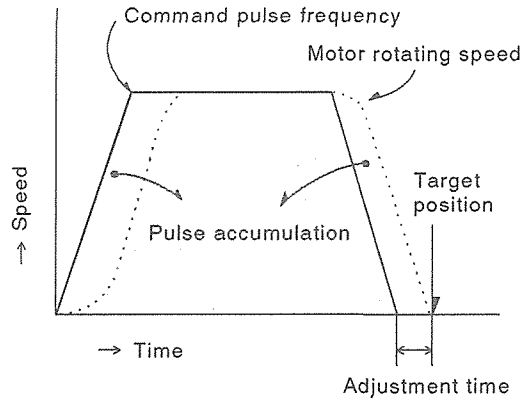
A commercially available AC or DC servo motor can be used.

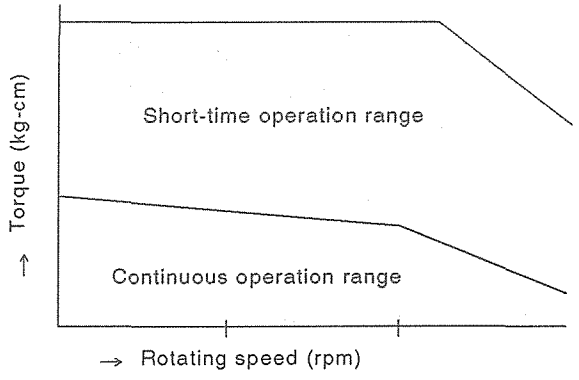
- The servo motor driver detects the amount of load movement by using the encoder and operates the motor so that the deviation between the generated command pulse and the feedback pulse is "0".

  Thus, improved accuracy can be ensured since this is a closed loop system.
- The rotating speed of the motor is almost in proportion to the command pulse frequency.

  When the pulse signal is received, the positive or negative pulse is counted by the deviation counter.

  If this counter value becomes smaller than the in-position parameter value, the "positioning completed" signal is sent out, but the motor continues operating until the deviation counter reaches within ± 1 pulse.





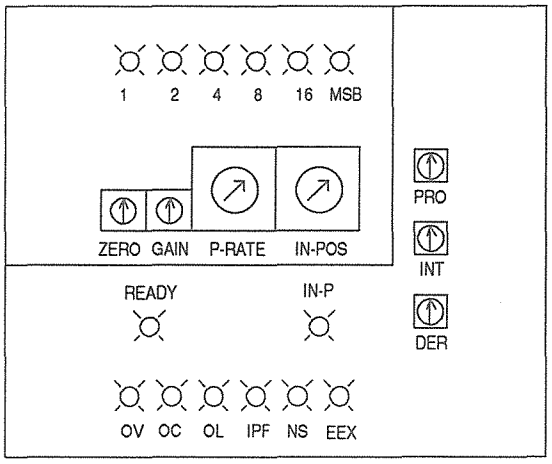
1 GENERAL INFORMATION ON POSITIONING CONTROL

Adjusting the drive unit

Since the following points in the drive unit have to be adjusted, the correct setting must be executed in advance.

- The operating characteristics of the drive unit can be adjusted in various ways by DIP switches, potentiometers, keys, etc.

  Adjust the position or speed loop gain, speed integrating compensation value, and maximum rotating speed setting according to the load specifications.



- Some drive units have a P-RATE (pulse rate) parameter. This is used to match the pulse rate of the driver output with the FX-1GM output.

  If the servo driver has a max. rate of 200 kPPS (kilo-pulses per sec.), this pulse rate multiplier must be set at x 2 since the max. output from the FX-1GM is only 100 kPPS.

  The required output pulse rate from the servo driver is directly related to the speed and the number of pitches per revolution of the motor and encoder.

- A relatively large IN-POS (in-position) parameter setting allows the positioning completed signal to be sent earlier.

- For details, see the Servo Driver Instruction Manual.

Positioning accuracy

The theoretical accuracy in the positioning unit using a stepping motor or servo motor is restricted by the feed rate per pulse.

This can be calculated as follows in respect to the relationship between the pulse frequency and feed speed.

$$\delta l = \pm \frac{V}{60f} \times 10^{6} \ (\mu m/PLS)$$

f: Pulse frequency (PPS)

V: Feed rate (m/min.)

δl: Feed rate per pulse(μm/PLS)

For instance, when V is 6m/min. and f is 100000 PPS, the theoretical accuracy will be ± 1μm.

1.4 Positioning Language

1.4.1 Absolute and relative positions

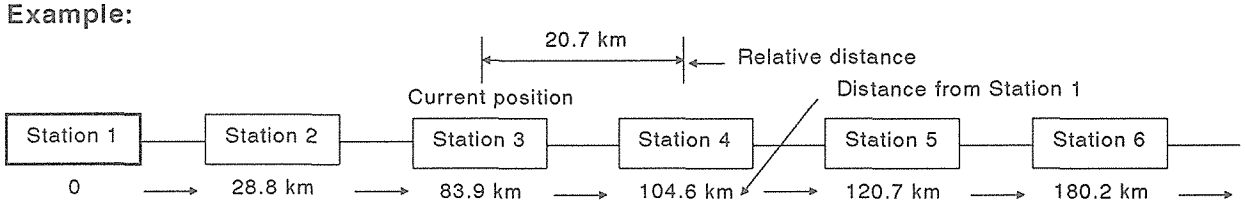
An ADR (ADDRESS) instruction is prepared to designate the movement distance (or rotation angle) of the machine.

This operates the machine in combination with the DRV (DRIVE) instruction.

The address instruction is shown either by the distance from the reference point or the distance from the current position.

The former is called "absolute position designation" and the latter is "relative distance designation".

Example:



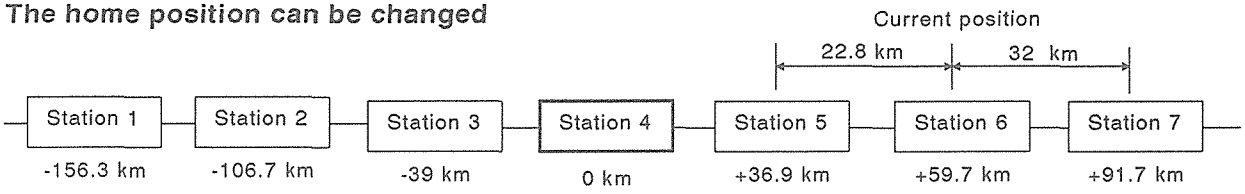
Suppose that the train is now at Station 3, and the next target is Station 4.

In this case, it is correct to designate 104.6 km in the case of absolute position designation. However, it is necessary to clearly define that the reference home position is Station 1.

In the case of relative distance designation, it is necessary to designate 20.7 km.

It is also necessary to designate whether the train is going forward or backward.

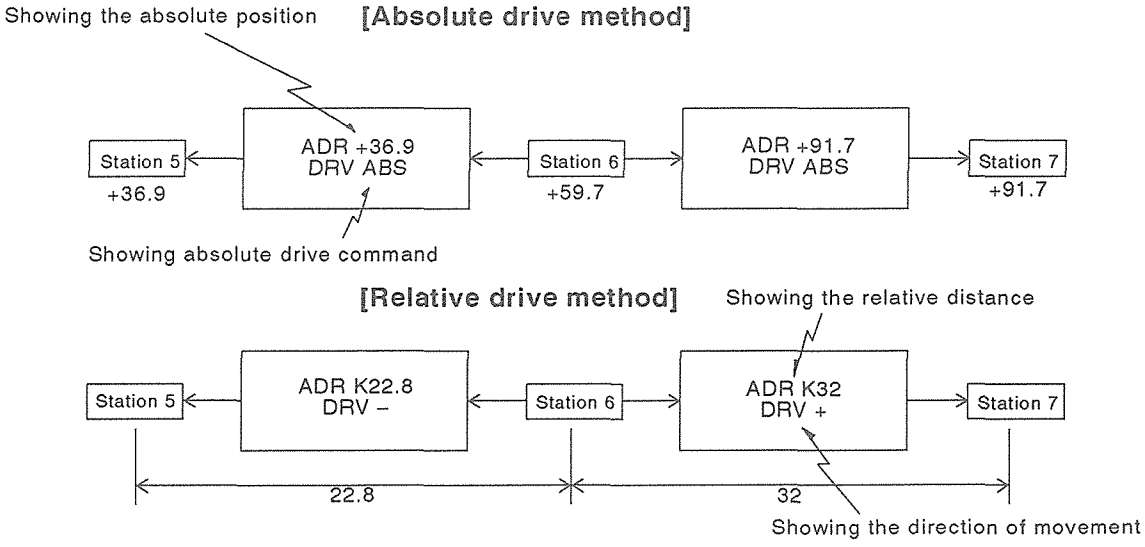
The home position can be changed



In the above figure, the absolute position is designated at each station with Station 4 as the home position.

In this case, the absolute positions exist in both positive and negative values.

If it is necessary to go to Station 7 or Station 5 when the train is at Station 6, this is expressed as follows:



1.4.2 Machine home position return

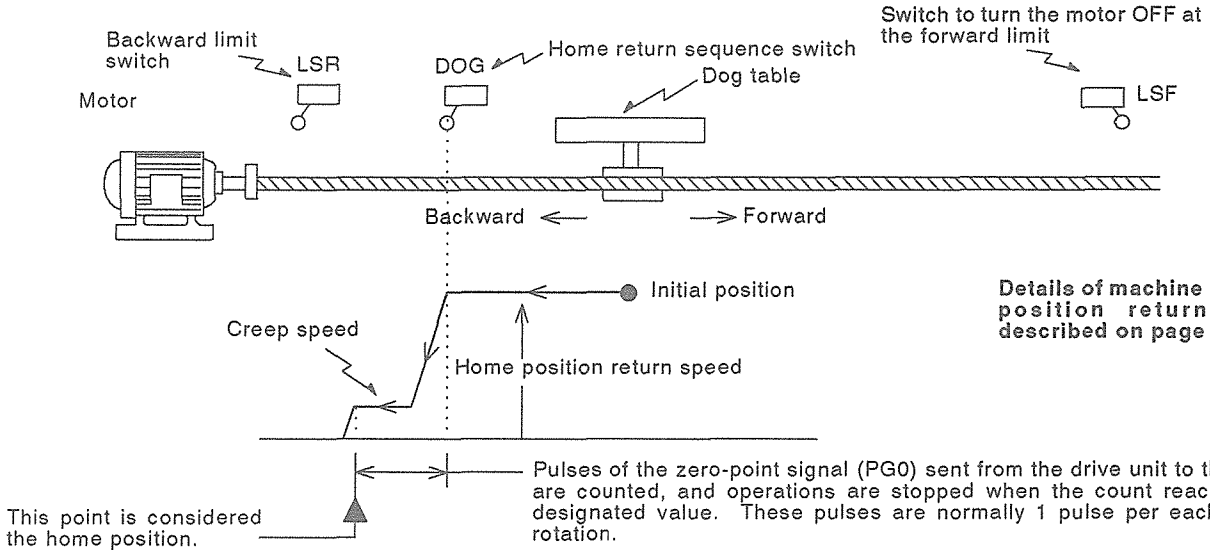
The FX-1GM PGU has a built-in current value register (storing the absolute address) which is incremented/decremented by the forward pulse or backward pulse it generates.

This allows the machine position to be calculated at all times.

When the operation is started for the first time, it is necessary to teach the current machine position to the register.

A machine home position return DRV ZRN (DRIVE ZERO RETURN) instruction is prepared to execute this operation automatically.

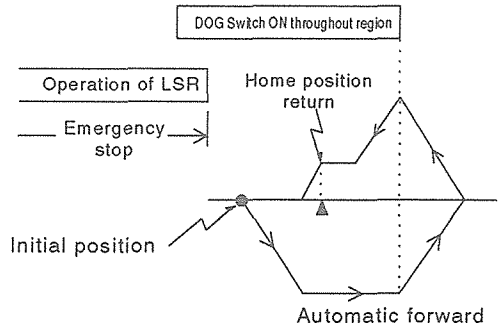
DRV ZRN is an independent instruction which is not accompanied by address instructions, unlike DRV ABS or DRV ± instructions. It is operated in the following sequence:



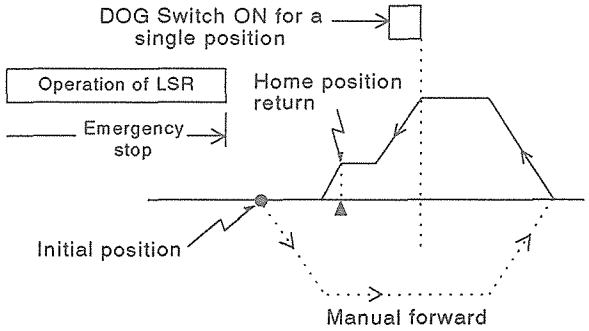
Details of machine home position return are described on page 25.

DOG Switch Configurations

Generally, DOG switches are configured as either a single point or a regional signal. In single point operations, the DOG switch is only switched ON when the DOG table is at the start of home return deceleration. Thereafter, it is switched OFF.



If the initial position is situated within the ON region of the dog switch, the machine home return operation can be executed after advancing to out of range automatically.



In the above case, if the DOG table is initially situated within the home deceleration area, it will not be detected by the DOG switch. Hence manual forward must be driven before the automatic mode can be switched ON.

1.5 What is the Program Like?

1.5.1 Distribution of functions

The FX-1GM PGU can be operated together with the FX series programmable controller in executing positioning control.

PC sequence control and positioning control are very different. Thus, each requires a dedicated language best suited for that application, making understanding and software design much easier.

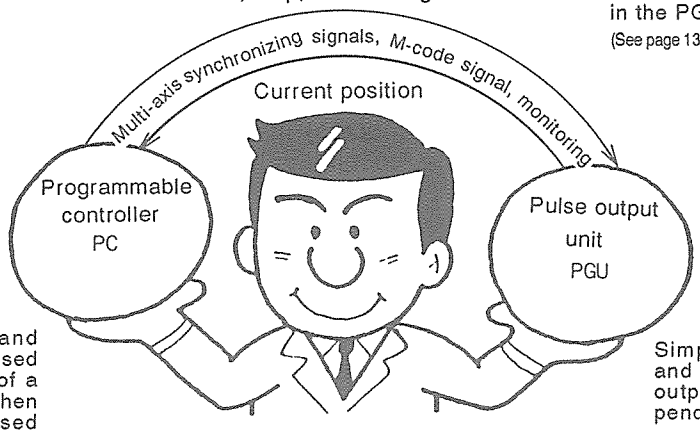
(See page 134 for PC versions.)

Though the multi-axis interpolation function is not supported, interlocked operations can be controlled by using multi-axis synchronizing signals.

Simple signal communication by structured sequence.

Travel distance, speed,
the number of repetition designation
Start, stop, block designation

Program is written from the F_2-30TP teaching panel (TP) to the FX-EEPROM-4 ROM cassette installed in the PGU.
(See page 134 for F2-30TP versions.)



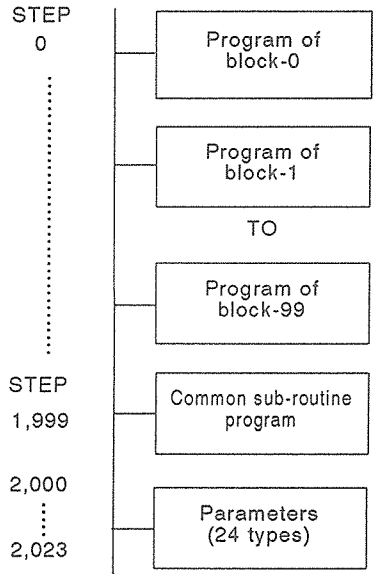
Executes control of the entire system and auxiliary machines by dedicated sequence language.

Executes complicated positioning control by dedicated positioning language.

General-purpose inputs and outputs of the PGU can be used as the inputs and outputs of a programmable controller when the PGU and a PC are used together.

Simple sequence instructions and general-purpose inputs and outputs are supported for independent operations.

Configuration of the PGU program



- The program capacity of the ROM cassette built in the PGU has a max. of 2000 steps.

  It can be divided into a max. of 100 blocks of variable length.

- Which block program to execute is designated by the programmable controller (or digital switches connected to the PGU).

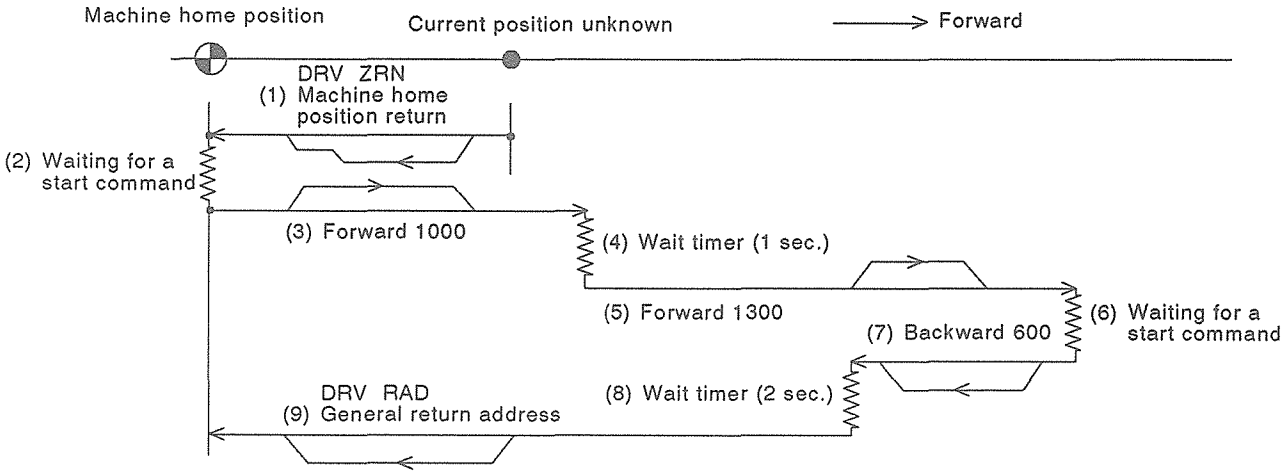
- Program machine movement and speed routine block by block.

  Areas commonly used in each block can be handled as a sub-routine program.

- 24 parameters exist in the PGU so that its performance matches that of the external equipment (e.g.motor drive).

1.5.2 Putting theory aside

Now, let's put theory aside and see what a program inside the PGU is actually like.



When the SET RAD (setting of the return address) instruction is executed, the current position is stored as the general return position. The machine is moved to this position by executing the DRV RAD instruction.

The DRV RAD instruction only executes the movement to the return address: it has no connections with the DOG switch or the DRV ZRN instructions

Operation	Program Step	Instructions			Remarks
	0	BLK	K	0	Designates block number 0.
(1)	1	DRV	ZRN		Executes machine home position. ZERO RETURN
	2	SET	RAD		Sets the machine home position to the general return position
(2)	3	WAIT			Instruction to wait for a start input signal. Proceeds when received.
	4	ADR	K	1,000	Relative movement distance. (Depends on the parameter.)
(3)	5	DRV	+		Forward drive at the speed set by the parameter unless otherwise designated.
(4)	6	TMR	K	100	1 second delay (unit = 10 msec.)
	7	ADR	K	1,300	Relative movement distance
(5)	8	DRV	+		Forward drive
(6)	9	WAIT			Wait for start input.
	10	ADR	K	600	Relative movement distance
(7)	11	DRV	-		Backward drive
(8)	12	TMR	K	200	2 sec delay
(9)	13	DRV	RAD		Go to the general return position.
	14	END			End of block. Wait for the start signal for the next block operation.

1.6 General Description of the System Structure

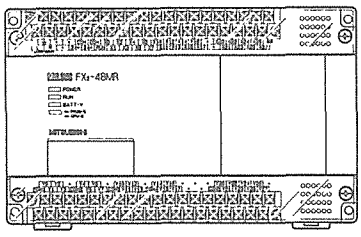
1.6.1 Main unit and peripheral units

An FX-1GM pulse output unit can be used by itself or as a special extension unit of an FX series PC. The system structure shown below is an example of an FX-1GM used as a main unit connected to several peripheral units. (See page 134 for applicable versions of PCs and teaching panels.)

For complicated controls:

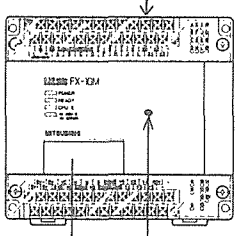
FX series PCs

Up to 8 FX-1GM units can be connected to 1 programmable controller.

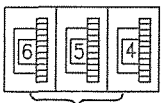


Data read FROM

Data write TO



For directly setting data:

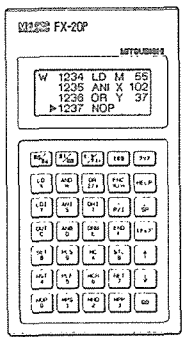


Digital switch

(commercially available product)

Max. 6 digits

Stepping motor or servo motor drive unit (commercially available product)

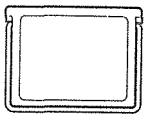


FX-20P programming panel (HPP)

Since complicated positioning control is executed by the PGU, programming is done with an emphasis on general sequence control (control of aux. machine).

PGU

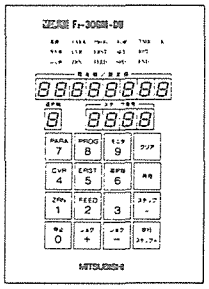
For changing a program:



FX-EEPROM-4 ROM cassette

1 cassette is incorporated in each main unit.

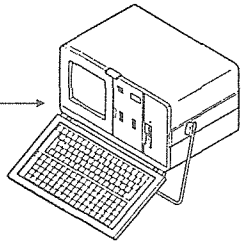
For setting and displaying data:



F_2-30GM-DU setting and display unit

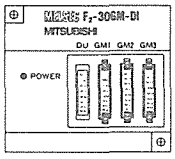
When a teaching panel is not connected, this panel-mounted unit can be used for displaying current values and error codes, as well as for setting and modifying data.

For programming and storing programs:



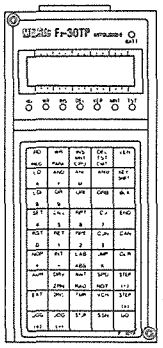
F-A6GPP-KIT/GM kit

By using an A6GPP/PHP, program listing, storing programs to floppy disks, and printing of instruction lists can be performed.



F_2-30GM-DI interface unit

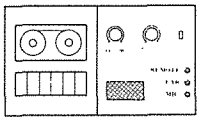
Up to 3 FX-1GMs can be connected to 1 F2-30GM-DU by using this unit.



F_2-30TP teaching panel (TP)

Even a very complicated positioning operation can be easily programmed using the convenient instructions expressed by relevant symbols. Programs thus created can also be transferred to the PGU for use there. While operation monitoring and test operations are also possible, this panel is not necessary during actual operations.

For storing a program to an audio tape:



Audio cassette recorder (commercially available product)

2 SIGNAL HANDLING AND PARAMETER SETTING

Signal

The FX-1GM PGU exchanges signals with the programmable controller, motor driver unit, and receives signals from BCD switches, limit switches, etc.

To understand the basic specifications of the product, it is necessary to understand what these signals mean.

What is a parameter?

Various pieces of external equipment have various specifications such as signal logic, position direction, etc. Because of this, parameters are required to be set so that optimal matching can be ensured.

Guidepost

Since this chapter contains a great deal of difficult material, we recommend trying to understand just the main parameters first and learning the entire contents at a later stage.

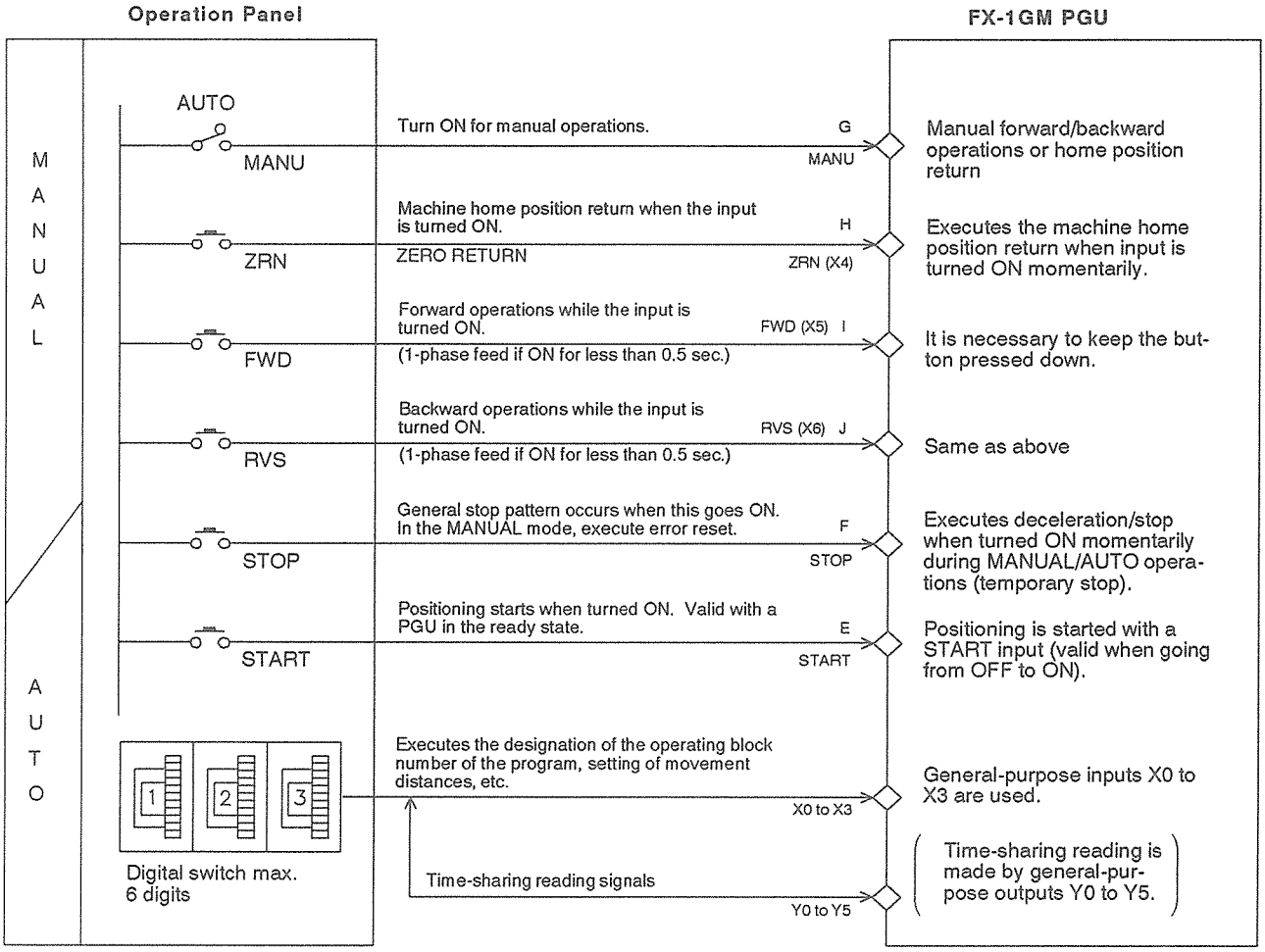
2 SIGNAL HANDLING AND PARAMETER SETTING

2.1 Signals Handled

2.1.1 Signals concerned with I/O terminals

Operation inputs

The input signals sent from the switches on the operation panel are as follows:



Others

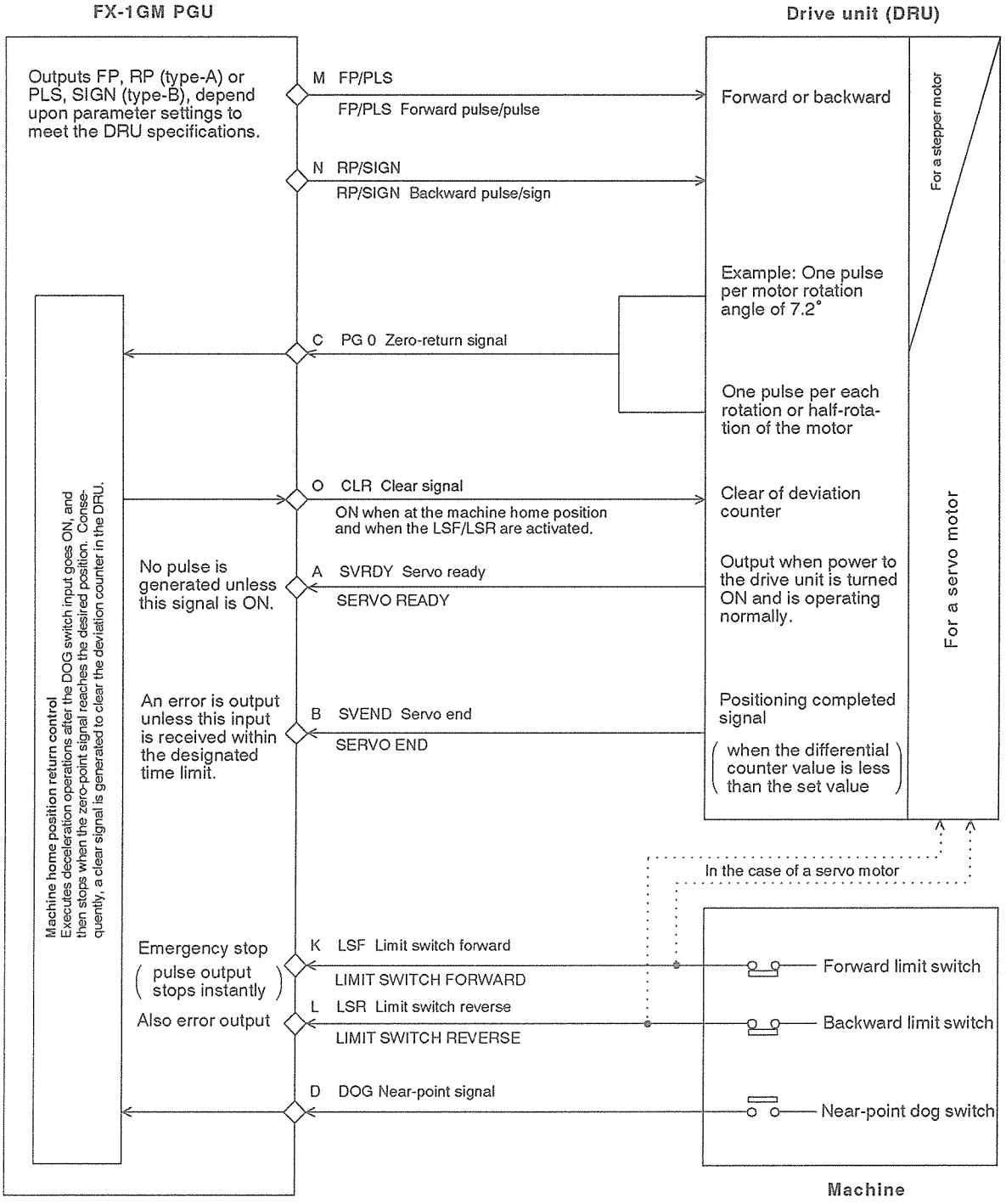
Operation Panel	From the Teaching Panel	From the Programmable Controller
ZRN Machine Home Position Return	Instructions can be entered in the CPU/TST mode when the MANUAL input is ON.	(Good PGU programming allows indirect control.)
FWD Manual Forward	Instruction values can be changed in the CPU/TST mode when MANUAL input is ON by pressing the JOG+ and JOG- keys.	———
RVS Manual Reverse		
STOP Deceleration/Stop	Instructions can be entered by using the STOP key in the CPU/TST and CPU/MNT modes.	Instructed by a BFM#1b4 signal from a PC (during MANUAL/AUTO operations).
START Positioning Start	———	Instructed by a BFM#1b3 signal from a PC (during AUTO operations).

Note: ZRN, FWD, and RVS inputs can be used as general-purpose inputs X4, X5, and X6 in the AUTO mode.

2 SIGNAL HANDLING AND PARAMETER SETTING

Drive unit connections

The I/O signals exchanged between the PGU and the drive unit include the following:

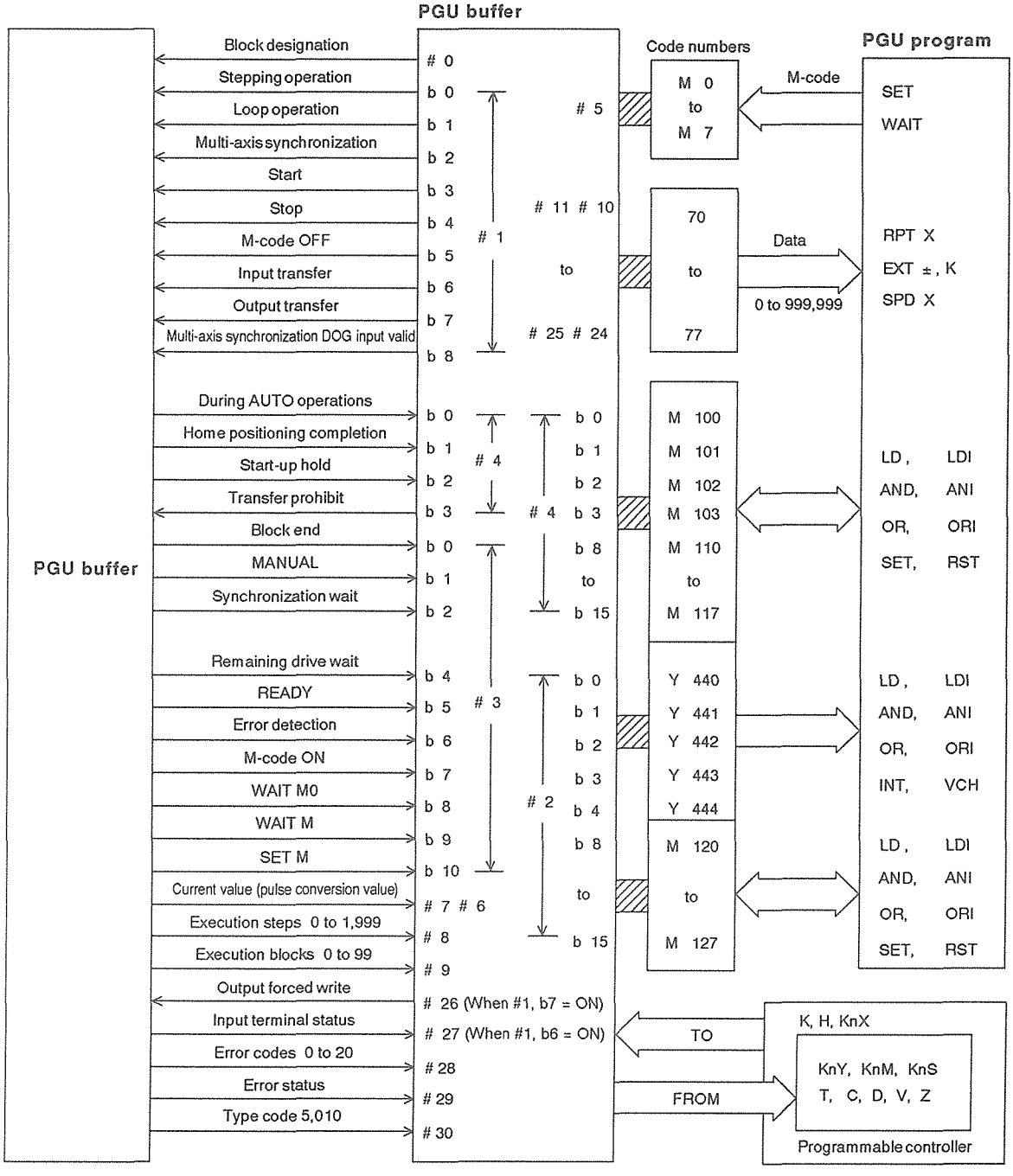


2.2 When Using the Programmable Controller with a PGU

2.2.1 Signals related to the programmable controller

Signal communications between a PGU and a programmable controller are performed via the buffer memory (BFM) in the PGU by using FROM/TO instructions. General BFM address allocations are as shown below. (See pages 102 and 125 for details.)

Buffer (BFM) contents



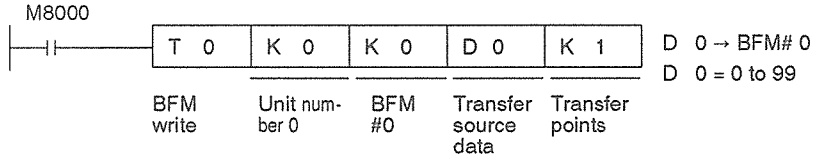
See page 134 for applicable versions.

- M0 to M127, Y440 to Y444, and data registers 70 to 77 are code numbers used for programs in the PGU.

  For example, BFM#2 b0 is coded as Y440, and these two numbers indicate the same memory area. Therefore, when BFM#2 b0 is turned ON by the programmable controller, the instruction of the LD Y440 instruction in the PGU also goes ON.

Block designation signals

Block numbers 0 to 99 can be selected by using the instruction given below.

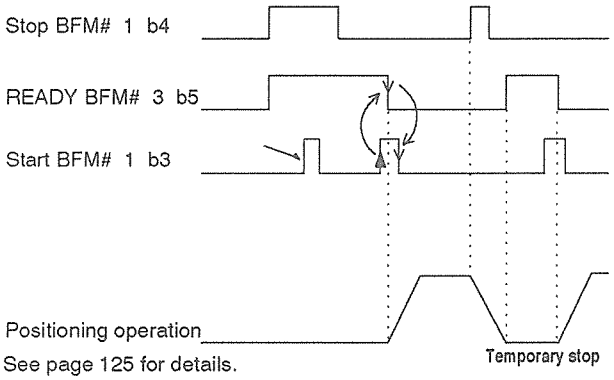


Elements K, H, KnX, KnY, KnM, KnS, T, C, D, V, Z, etc. are used as transfer source data. Index qualification is also possible. (See page 132.)

Start, and stop mode signals

The following start, and stop mode signals are supported by the PGU:

(Start/stop)



See page 125 for details.

(Multi-axis synchronizing signals)

- BFM#1 b2 = ON

  This signal automatically sets in the wait state before execution of drive instructions, such as DRV and DRVC. And then, BFM#3 b2 goes ON. When a start command is given or a DOG signal of the PGU is input, driving starts and BFM#3 b2 is turned OFF.

- BFM#1 b2 = OFF

  This signal does not set in the wait state before execution of drive instructions, such as DRV and DRVC.

(Conditions required for starting)

(1) Start command: BFM#1 b3 = OFF to ON
(2) M code OFF command: BFM#1 b5 = ON

Modes	BFM# 1			Wait	Wait	Executing	Timer Wait Instantaneous Instruction	END Instruction Wait
	b 2	b 1	b 0					
PGU mode	——	OFF	OFF	(1) *1	(1) and (2)	Automatically starts after drive is completed.	Proceeds automatically to the next step.	(1)
						(1) when transfer prohibition M103 is ON.		
Stepping mode	——	OFF	ON	(1) *1	(1) and (2)	Program steps are processed in order when a start command is given		
				Start commands are ignored during instruction execution. M103 turns ON.				
Loop mode	——	ON	OFF	(1) *1	(2) *2	Automatically starts after drive is completed.	Proceeds automatically to the next step	(1)
Continue mode	——	ON	ON	(1) *1	(2) *2	Automatically starts after drive is completed	Proceeds automatically to the next step.	Proceeds automatically to the next designated block.

*1 When a start command is sent to the PGU, the M codes are automatically turned OFF in the PGU.

*2 Start is automatically performed by an M code OFF command. (See page 130.)

(Note) Starting by a DOG input is enabled only when BFM#1 b8 is ON.

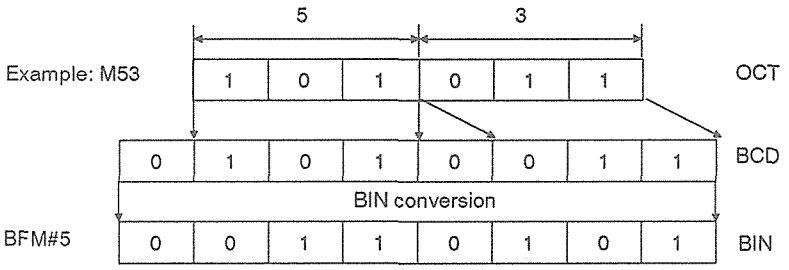
M-code signal .....BFM#5

Generally, other machine operations (e.g. tool change, drill) are operated together with the positioning operation.

Thus, an M-code is set within the PGU to inform the PC which auxiliary machine to operate. 64 max. kinds can be transmitted.

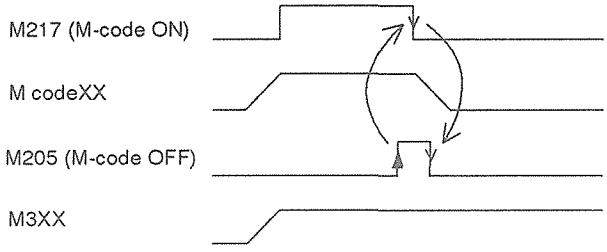
If the instruction WAIT MXX or SET MXX (XX = 0 to 77, octal) is driven inside the PGU.

BFM#5 b7 to b0 are operated as shown below:



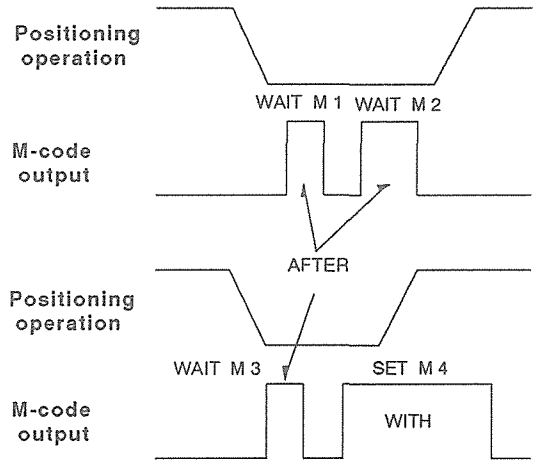
- Since M codes use octal notation of 0 to 77, data 0 to 77 which exclude numbers 8 and 9 out of 0 to 255, when expressed in decimals, in BFM#5 is valid.

The sequence program shown on the following page enables the operations shown below.



- The M code ON signal given by the WAIT (WAIT M0) instruction of the PGU is automatically reset by a start command.
- M300 to M377 are operated when any one of them is switched. (Those with numbers 8 or 9 do not operate.)

AFTER MODE and WITH MODE



AFTER MODE

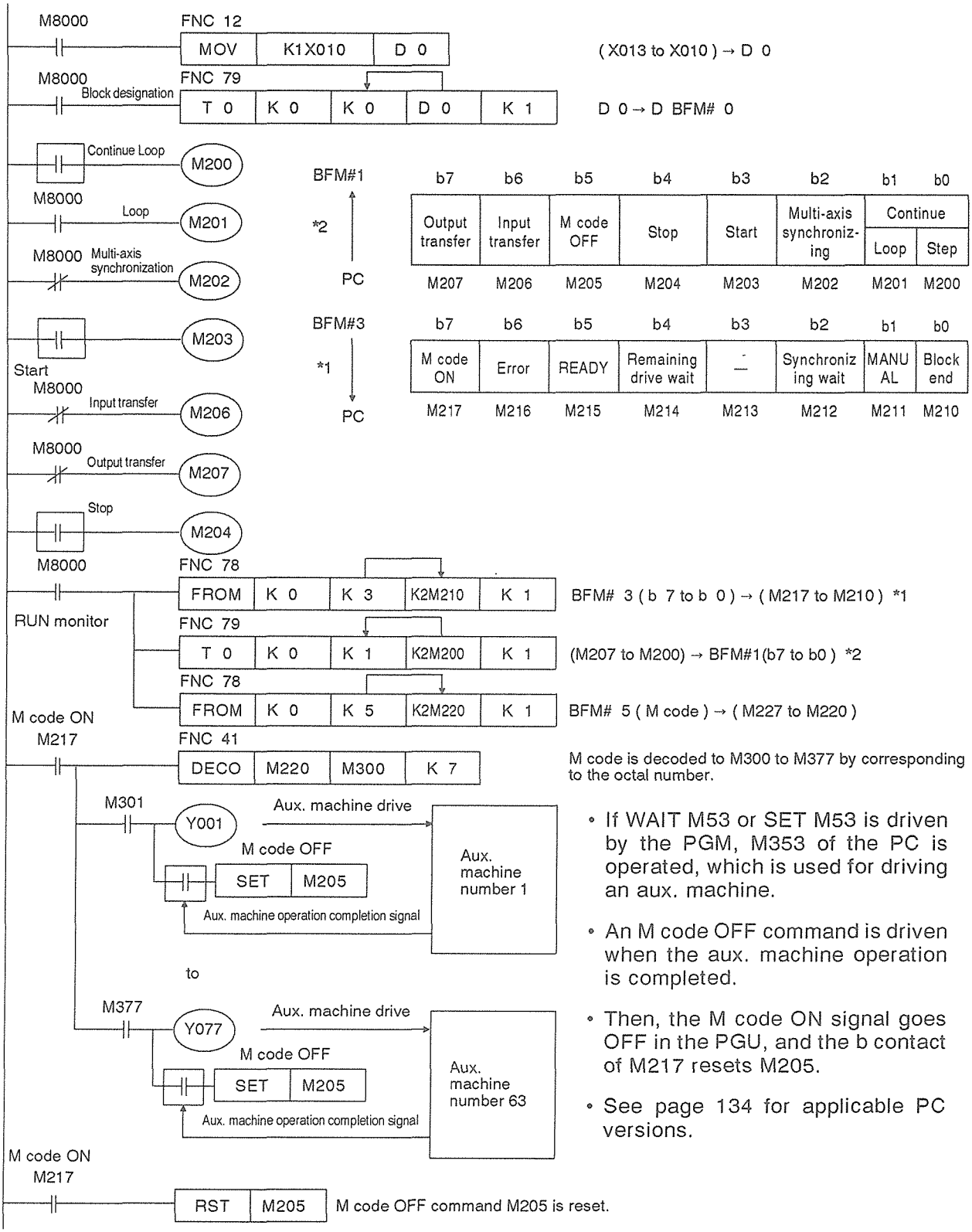
Use WAIT M instructions between successive positioning instructions.

WITH MODE

Use a SET M instruction when the succeeding positioning instruction is executed during an M-code output.

A WAIT M instruction is an instruction to wait for a start command (in the loop or continue mode, it is also started by an M code OFF command), and a SET M instruction is an instantaneous instruction. Both can be used alone or in combination.

Recommended sequence examples



- If WAIT M53 or SET M53 is driven by the PGM, M353 of the PC is operated, which is used for driving an aux. machine.
- An M code OFF command is driven when the aux. machine operation is completed.
- Then, the M code ON signal goes OFF in the PGU, and the b contact of M217 resets M205.
- See page 134 for applicable PC versions.

2.3 Initial Parameter Settings

2.3.1 Setting units

It is necessary to set the following parameters in the FX-1GM PGU:

The F_2-30TP teaching panel has been factory-set with standard values.

When transferring them to the PGU, it may be necessary to change some of them, depending on which type of machine is used.

PARA number 0

System unit setting.

UNIT

Recommended modes →

Setting-1 (factory setting)
Programming is made on the basis of the number of pulses (PLS). This is called the "motor system unit".

Setting-0
This setting is used when entering the position command on the basis of mm, deg., inch, etc. This is called the "machine system unit".

Setting-2
This setting is used when entering the position command on the basis of the machine system unit and the speed command on the basis of the motor system unit. This is called the "composite system unit".

PARA Number 0 System Unit	"0" Machine System Unit	"1" Motor System Unit	"2" Composite System Unit
PARA Number 1, 2	Setting required	Invalid	Setting required
PARA Number 3, 7, Number15 , 19	mm, deg, inch	PLS	mm,deg, inch
PARA Number 4, 5, 6 Number 20, 21	cm/min, deg/min inch/min	PLS/sec	PLS/sec

PARA number 3

UNIT SCALE

ORDER

When using the machine system unit or composite system unit, it is also necessary to set PARA1 and PARA2.

Select the appropriate parameter value from the following table:

PARAMETER Number 0 / PARA Number 3	Setting Value "0" Machine System Unit Setting Value "2" Composite System Unit			Setting Value "1" Motor System Unit
	mm	deg	Inch	
Setting value "0"	10^{0}	10^{0}	10^{-1}	10^{3}
Setting value "1"	10^{-1}	10^{-1}	10^{-2}	10^{2}
Setting value "2"	10^{-2}	10^{-2}	10^{-3}	10^{1}
Setting value "3"	10^{-3}	10^{-3}	10^{-4}	10^{0}

1/10inch=2.54mm

ADR K1000 means 10 mm.

ADR K1000 means 10,000 pulses.

PARA number 1

Pulse rate

PULSE/REV

Set the pulse rate to be the number of pulses required to be sent to the motor driver DRU to drive the motor 1 revolution. The following range is permitted:

A = 1 to 65,535 PLS/REV

2000 (factory setting)

PARA number 2

Feed rate

MOVEMENT/REV

The actual machine movement is often driven by gears and screw shafts. The final movement distance for 1 motor revolution should be the value of this parameter. If the value entered is in mm, then the system unit will be in mm (see page 131).

B = 1 to 999,999 μm/REV

1 to 999,999 mdeg./REV

1 to 999,999 x 10^{-4} inch/REV

2000 (factory setting)

PARA number 1 and number 2 are valid only for the machine system unit and composite system unit. They are ignored when the motor system unit is used.

2.3.2 Speed and acceleration times

Set the following speeds and acceleration/deceleration times within the specified ranges:

The max. speed parameter is the ultimate max. operating speed regardless of any other instruction or settings. However, operations may be changed to a lower speed by an SPD instruction or if the movement distance is too short for full acceleration to this max. speed.

PARA number 4

Max. speed

MAX SPEED

Set the max. speed within the following ranges:

* Machine system ..... 1 to 153,000 (cm/min., 10 deg./min., inch/min.)
* Motor system and composite system .....10 to 100,000 (PLS/sec.)

(When using the machine system unit, 10 to 100,000 PLS/sec must be used.)

100,000 PLS/sec. (factory setting)

Read the Note at the bottom of page 131 and avoid setting values too high.

PARA number 5

Manual JOG speed

JOG SPEED

Set the operating speed for JOG (+), JOG (–) of the manual forward/reverse operations (or FWD/RVS input of the PGU) on the teaching panel. The permitted range is the same as that of the MAX SPEED parameter.

10,000 PLS/sec. (factory setting)

PARA number 6

Bias speed

BIAS SPEED

Stepper motors suffer from high resonance peaks at low pulse rates. To avoid chattering caused by this, set the bias speed so that the low pulse rate region can be skipped.

* Machine system ..... 0 to 15,300 (cm/min., 10 deg./min., inch/min.)
* Motor system and composite system ..... 0 to 10,000 (PLS/sec.)

0 PLS/sec. (factory setting)

PARA number 20

Home position return speed

ZERO RETURN SPEED

This is the operating speed when DRV ZRN is executed in either AUTO or MANUAL. The permitted range is same as that of the MAX SPEED parameter.

50,000 PLS/sec. (factory setting)

PARA number 21

Creep speed

CREEP SPEED

The home position return has 2 speed levels. Operation is at ZERO RETURN SPEED first. When the DOG switch is detected, it decelerates to CREEP SPEED. Set in the following ranges

* Machine system ..... 0 to 15,300 (cm/min. x 10 deg./min. inch/min.)
* Motor system and composite system ..... 10 to 10,000 (PLS/sec.)

1,000 PLS/sec. (factory setting)

PARA number 8

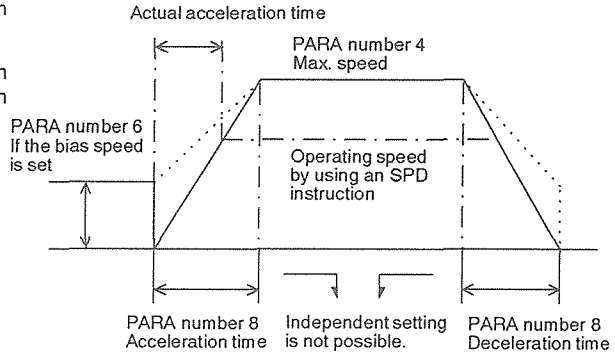
Acceleration/decelerati on times

ACCELERATE/DECEL ERATE TIMES

Set the acceleration/decelera- tion time within the range from 50 msec to 5,000 msec.

The acceleration/deceleration times will vary, depending on the actual operating speed.

1,000 PLS/sec. (factory setting)



2.3.3 Compensation for mechanical failings

The following parameters apply to all instructions in the program:

PARA number 19

Home position address

ZERO ADDRESS

All absolute DRV instructions in the program will use this point as the reference position. Normally, this is zero, but sometimes it may be more convenient to set this to some other value: range: 0 to ± 999,999. Unit based on PARA number 3 (Unit Scale).

0 (factory setting)

PARA number 7

Backlash compensation

BACKLASH

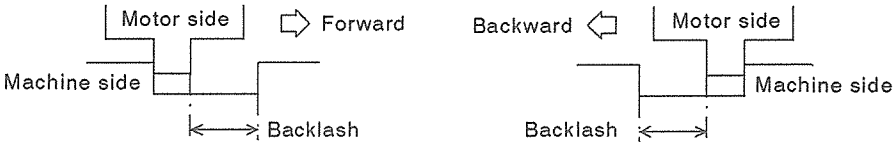
The backlash compensation amount can be set in the following ranges:

* Machine system and composite system ..... 0 to 65,535 (μm, mdeg., x 10^{-1} m inch)
* Motor system ..... 0 to 65,535 (PLS)

0 (factory setting)

When changing the direction during automatic operations, mechanical backlash in the gears can cause positioning errors.

Compensate by adding an extra movement distance whenever the direction is changed. This distance is to be specified in this parameter.



PARA number 15

Travel distance compensation

POSITION BIAS

The bias value can be set within the following range:

* Machine system and composite system ..... 0 to ± 65,535 (μm, mdeg., x 10^{-1} m inch)
* Motor system ..... 0 to ± 65,535 (PLS)

0 (factory setting)

This bias adds an extra position amount to all ADR instructions. Normally, this is zero but it can be changed depending on mechanical requirements.

2.3.4 Positioning time limit

PARA number 13

Error judgment time

ERROR TIME

Set the positioning completion determination time within the range from 0 to 5,000 msec.

5,000 msec (factory setting)

An error is output when the time between the pulse transmission completion and the SERVO END signal going ON is greater than allowed by this parameter.

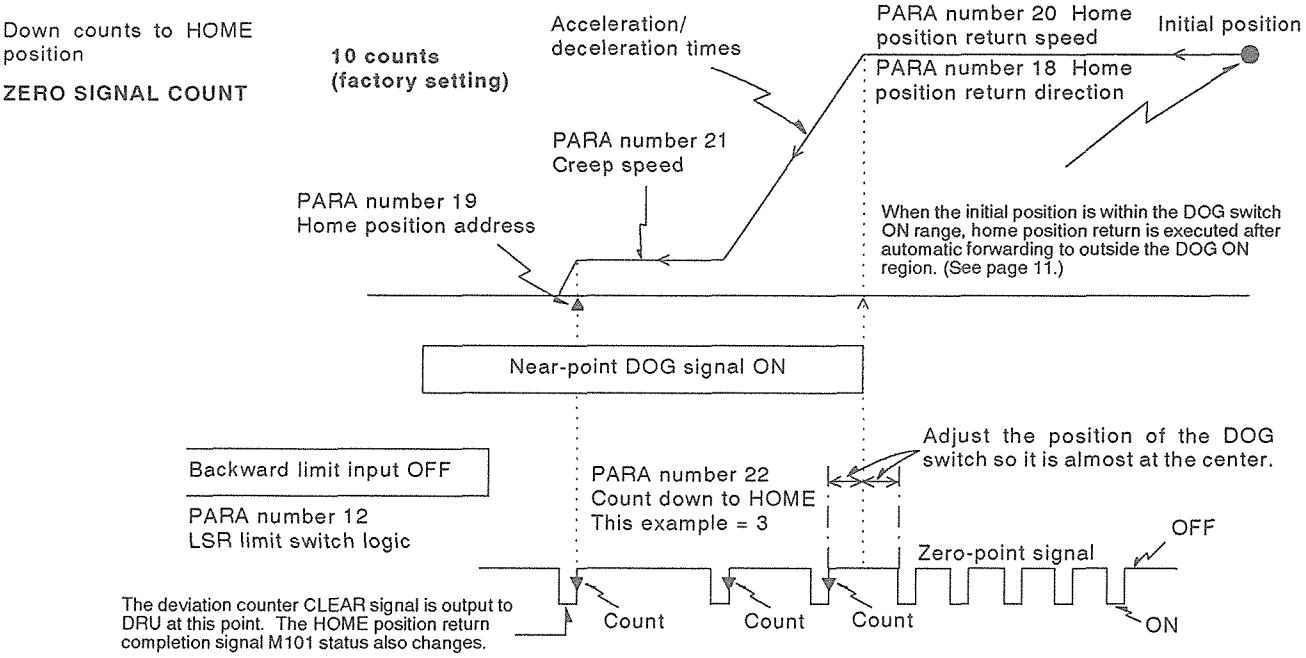
In the case of the stepping motor, keep the SERVO END input turned ON at all times.

2.3.5 Machine home position return

Since the machine home position return is concerned with various parameters as shown below, always be sure to execute the setting correctly.

PARA number 22

The number of zero-point signal (PGO) counts during machine home position return can be set within the range from 0 to 255. If PGO is not available, set this parameter to zero.



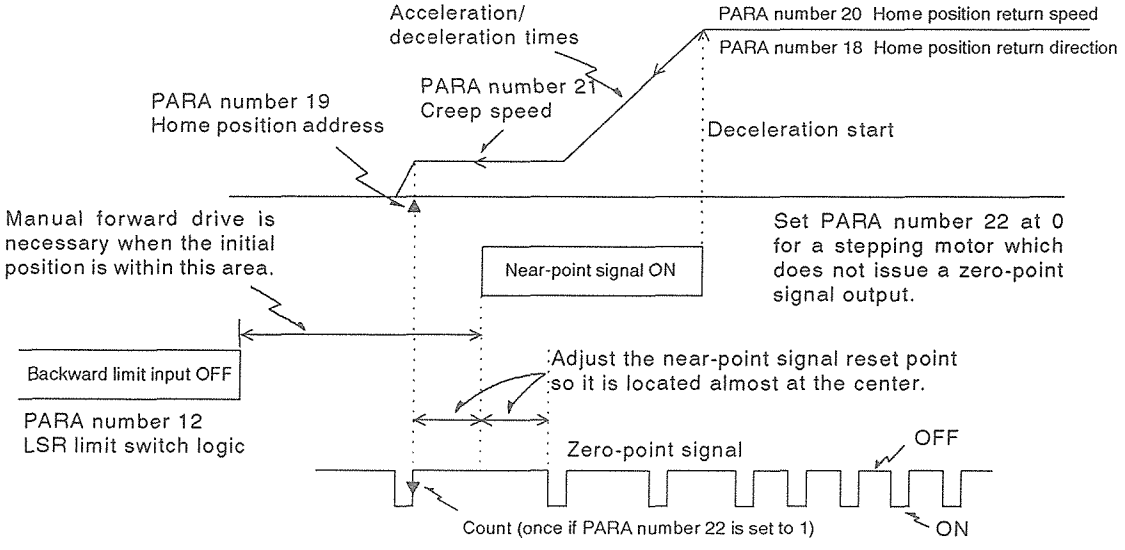
PARA number 23

The count start logic of the DOG switch can be changed.

Count start logic

COUNT START

PARA Number 23	Near-Point DOG Status Change at Counter Start	Status Changes of the HOME Position Return Completion Signal M101
Setting "0"	OFF to ON	Turns ON at the HOME position return completion in the AUTO mode. Turns OFF when the mode is switched from AUTO to MANUAL.
Setting "1" (factory setting)	ON to OFF	
Setting "2"	OFF to ON	Turns ON at HOME position return completion regardless of the mode. Remains in the ON state until the power is turned OFF. See the above figure for settings "0" and "2" and the following figure for settings "1" and "3".
Setting "3"	OFF to ON	



2.3.6 Setting of the operating mode

The following parameters are used to set the logic of each signal:

PARA number 9

Pulse output type

TYPE

Setting "1" (type-A) (factory setting)
PGU output FP is for forward pulse and RP is for reverse pulse.

Setting "0" (type-B)
FP signals how far to move and RP determines the direction. (see following table).

PARA number 10

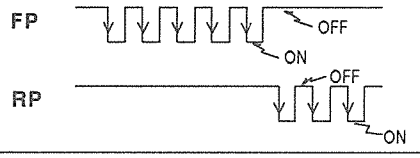
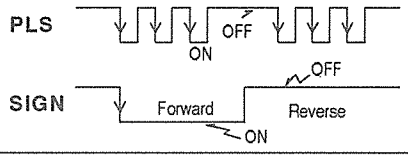
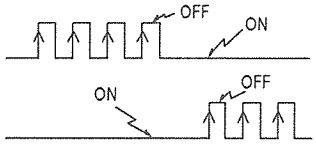
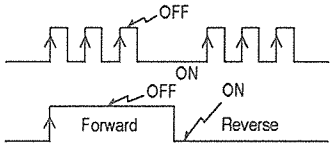
Pulse logic

LOGIC

Setting "1" (negative logic) (factory setting)
The pulse waveforms designated with PARA number 9 mentioned above are as shown below.

Setting "0" (positive logic)
The effects are shown in the following table.

The LED on the PGU is lit when the pulse waveform is at level L (transistor ON).

PARA Number 9 / PARA Number 10	Setting "1" (Type-A) FP = Forward Pulse RP = Reverse Pulse	Setting "0" (Type-B) FP = Pulse RP = Sign
Setting "1" Negative logic		
Setting "0" Positive logic		

PARA number 11

Rotating direction setting

DIRECTION

Setting "0" (factory setting)
Increases the current address register within the PGU when a forward pulse is output, and decreases it when a reverse pulse is output.

Setting "1"
Increases the current address register within the PGU when a reverse pulse is output, and decreases when a forward pulse is output.

PARA number 18

Home position return direction

ZERO DIRECTION

Setting "0", "2"
Moves in a direction so that the current address register is increased.

Setting "1", "3" (factory setting)
Moves in a direction so that the current address register is decreased.

Setting "0" "1"
Data input time from the digital switch is 8 msec/digit.

Setting "2" "3"
64 msec/digit. See page 136 for details.

PARA number 12

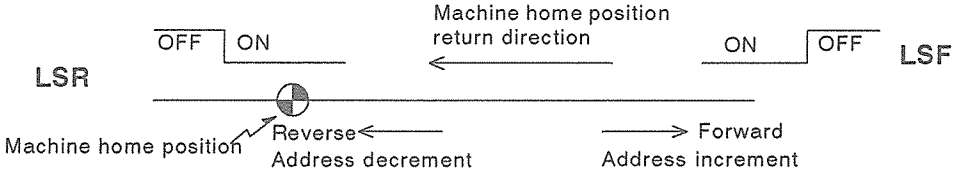
LSF and LSR logic

LIMIT SWITCH

Setting "1" (factory setting)
Emergency stop unless both LSF and LSR are ON.

Setting "0"
Emergency stop unless both LSF and LSR are OFF.

The initial preset values of PARA numbers 11, 12, and 18 are as shown on the right.



PARA number 14

Block designation

BLOCK

See page 31 for the block number setting using the digital switches (DSW).

(factory setting) →

PARA Number 14	Block Number Designations	PGU Outputs						PGU Inputs
		Y2	Y3	Y4	Y5	Y6	Y0,Y1	X0 to X3
Setting "0"	0 only	General purpose	General purpose	General purpose	General purpose	READY	General purpose	General purpose
Setting "1"	0 to 9 (DSW)	↑	↑	↑	(1)	↑	↑	DSW input
Setting "2"	0 to 99 (DSW)	↑	↑	(1)	(1)	↑	↑	↑
Setting "3"	0 to 99 (BFM)	↑	↑	General purpose	General purpose	↑	↑	General purpose
Setting "4"	0 only	(2)	(3)	↑	↑	↑	↑	↑
Setting "5"	0 to 9 (DSW)	(2)	(3)	↑	(1)	↑	↑	DSW input
Setting "6"	0 to 99 (DSW)	(2)	(3)	(1)	(1)	↑	↑	↑
Setting "7"	0 to 99 (BFM)	(2)	(3)	General purpose	General purpose	↑	↑	General purpose
Setting "8"	0 only	General purpose	(3)	↑	↑	↑	↑	↑
Setting "9"	0 to 9 (DSW)	↑	(3)	↑	(1)	↑	↑	DSW input
Setting "10"	0 to 99 (DSW)	↑	(3)	(1)	(1)	↑	↑	↑
Setting "11"	0 to 99 (BFM)	↑	(3)	General purpose	General purpose	↑	↑	General purpose
Setting "12"	0 only	(2)	General purpose	↑	↑	↑	↑	↑
Setting "13"	0 to 9 (DSW)	(2)	↑	↑	(1)	↑	↑	DSW input
Setting "14"	0 to 99 (DSW)	(2)	↑	(1)	(1)	↑	↑	↑
Setting "15"	0 to 99 (BFM)	(2)	↑	General purpose	General purpose	↑	↑	General purpose

(1) Dedicated for digit designation by the digital switches (DSW).

(2) Block end (BFM#3, b0) is output to Y2.

(3) Error detection (BFM#3, b6) is output to Y3.

See PARA number 16.

PARA number 16

Setting of PGU output Y6

READY

Setting "0" (factory setting) READY (BFM#3, b5) is output to Y6 output of PGU.

Setting "1" Y6 can be used for general purposes.

Setting "2" Y6 is reserved automatically for the reading of the digital switch connected to the PGU for such purposes as block and external address assignments (see page 123).

PARA number 17

STOP mode

STOP

PARA Number 17	Operations Caused by a STOP Command in the AUTO Mode and the Following Operation:	M102 (Start Hold) in the AUTO Mode
Setting '0'	A deceleration stop is not performed.	M102 is reset by a STOP command.
Setting '1' (factory setting)	When restarted after a deceleration stop, an operation drive is executed for the remaining distance. (A START command is needed.) ..... Remaining drive	↑
Setting '2'	After a deceleration stop, the remaining distance is ignored and the operation proceeds to the next step. So, a START command is not needed. ..... Remaining discontinue	———
Setting '3'	After a deceleration stop, the remaining distance is ignored and the operation proceeds to the END step. ..... END return	Reset by a STOP command except in the CONT mode.

2.3.7 Aux. relays

M110 to M117 and M120 to M127 aux. relays (16 points in all) are prepared in the PGU, which can be freely utilized by the user.

The following special aux. relays (except for M103) can only be read, as they are reserved and driven automatically by the PGU.

M100
Under AUTO operation

BFM#4 b0

This is active at all times in the AUTO mode if an error has not been generated. This is used to forcibly drive various coil instructions which are driven by contacts. (see page 126).

M101
Home positioning completion

BFM#4 b1

In the AUTO mode, M101 is set and held when DRV ZRN is completed. It is only reset when the mode is switched to MANUAL or the power is turned OFF.

Therefore, this can be used so that home reset only occurs 1 time (see page 45).

However, when the PARA number 23 setting is "2" or "3", M101 is turned ON by the machine home position return regardless of the operating mode, and the operation status is held even after AUTO mode is canceled.

M102
Start-up holding

BFM#4 b2

M102 is ON when a start pulse is received in the AUTO mode, and is reset by the STOP input (BFM#1 b4 signal sent from input terminal of the PGU or the programmable controller).

M102 may serve as the signal to acknowledge that a start command has already been entered.

M103
Transfer prohibit

BFM#4 b3

When M103 is driven, execution of the succeeding steps (excluding BLK inst.) are prohibited anywhere in the program.

1-step transfer is executed each time the START command is applied (see page 50).

This is valid when both BFM#1 b0 and b1 are OFF. If BFM#1 b0 is ON and b1 is OFF, M103 is operated and a similar stepping operation is performed.

M110 to M117

BFM#4

These are used as general outputs to programmable controllers.

When M110 to M117 are turned ON and OFF, BFM#4 b8 to b15 go ON and OFF.

Y440 to Y444
M120 to M127

BFM#2

These are used as general inputs from programmable controllers.

When BFM#2 b0 to b4 and b8 to b15 are turned ON and OFF, Y440 to Y444 and M120 to M127 go ON and OFF.

3 CONTROL INSTRUCTIONS

In the previous sections, the I/O signals and the parameters of the pulse output unit (PGU) were explained.

This section explains how the PGU is controlled.

Program instructions and parameters are both entered by using the teaching panel.

The instructions come in the format "Instruction + Element symbol + Data (element number, etc.)", "Instruction + Element symbol", or the instruction alone.

This section gives details about each instruction (see Section 7 for summarized definitions).

IMPORTANT

Program Operations

Instructions in the program are executed sequentially step by step. The succeeding step is not executed until the preceding step is fully completed. Be sure that you understand the difference between this and the cyclic operations of the programmable controller.

The program is divided into blocks. Each block can be an individual routine, and execution is selected by either a numeric switch input or by the programmable controller.

If neither is used, block zero will be executed.

Note that some of the instructions involve waiting.

Program execution does not continue until the appropriate conditions have been met. For example, a WAIT instruction requires a start input signal.

Others are instantaneous when the execution time is indicated.

3 CONTROL INSTRUCTIONS

3.1 Basic Instructions

3.1.1 Block designation instructions

BLK

BLOCK

Start of sub-program

Relevant elements:

(1) K0 to K99 (from the programmable controller)

(2) K0 to K99 (from a numeric switch)

Execution time:

Instantaneous progressing type

1) 1 msec or less 2) DSW read time See page 136.

END

END

End of sub-program

Relevant elements:

None

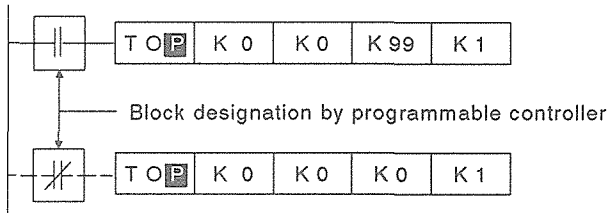
Execution time:

Waiting type (waits for a start input signal).

Designation from the programmable controller

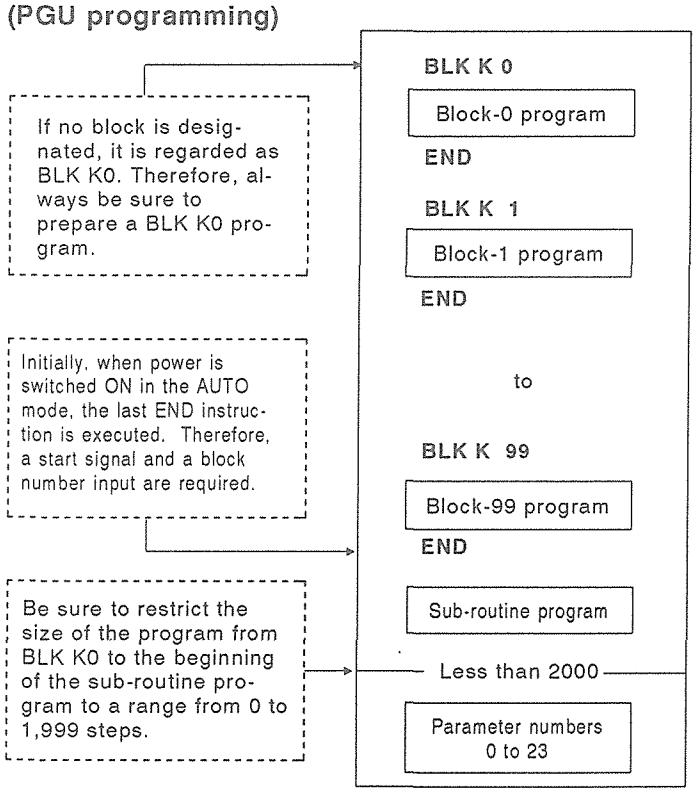
(Program on the PC)

When the parameter number 14 setting is "3", "7", "11", or "15", block numbers of 100 divisions or less are designated as K0 to K99.



When the block designation input turns ON, K99 is written to BFM#0. To transfer K0 when the designation input turns OFF, program the ladder indicated by the broken line.

(PGU programming)



Typical instructions in each block are as follows:

1) Speed instructions

   Not needed when the operation is performed at parameter speed.

2) Address instructions

   Designate travel distances by relative and absolute addresses.

3) Drive instructions

   Operation execution instructions.

4) Wait instructions

   Designate the waiting time to start the next operation, or an instruction to wait for a START command.

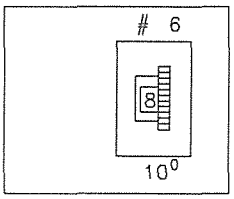
The above completes 1 operation. A group of operations completes 1 program block.

Designation by numeric switch

When the PARA number 14 setting is "1", "2", "5", "6", "9", "10", "13", or "14", block numbers of 100 divisions or less are designated as K0 to K99.

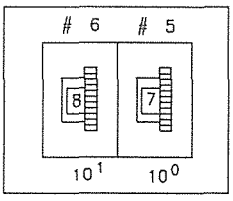
It is possible to connect DSW#1 to #6 by using the general-purpose inputs (X0 to X3) and the general-purpose outputs (Y0 to Y5) of the PGU (see below).

When the setting value of parameter number 14 is "1","5","9", or "13", 1 digit (DSW#6) is used. If the setting value is "2","6","10", or "14", 2 digits (DSW#6 and #5) are used.



1-digit input

When the BLK instruction is executed, the general purpose output Y5 is turned ON automatically, and the setting value (for instance, "8") of DSW#6 is read, thus executing BLK K8.

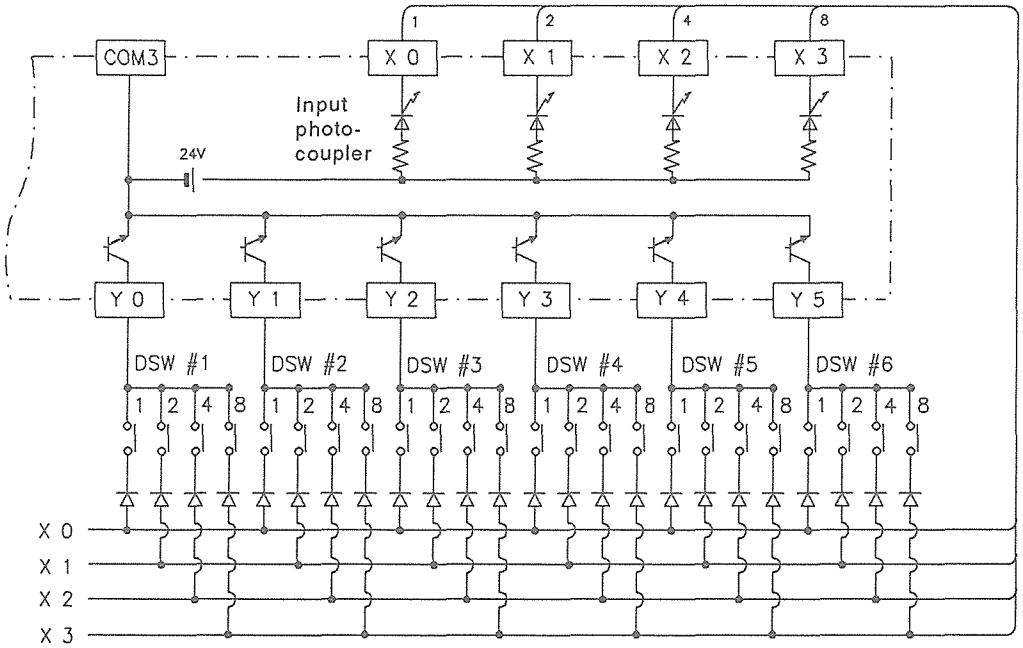


2-digit input

When the BLK instruction is executed, the general purpose outputs Y5 and Y4 are turned ON sequentially, and the setting values (for instance, "87") of DSW#6 and #5 are read, thus executing BLK K87.

Digital switch connection example

Type FX-1GM PGU



The following types of digital switches to which diodes can be externally mounted are commercially available:

SDG4101DX (FUJISOKU) , 31J52M (JAE) , A7AS-207 (TATEISHI)

3.1.2 Speed instruction

SPD

SPEED

Speed designation

Relevant elements:

(1) K10 to K100,000 or K0 (motor system or composite system)
(2) K1 to K153,000 or K0 (machine system)
(3) X70 to X77 The setting of (1) applies to the motor system and the composi tesystem. Setting of (2) applies to the machine system.
(4) X1 to X654,321

Execution time:

Instantaneous progressing type
(1),(2) 1 msec or less
(3) 1 programmable controller operation cycle or less
(4) DSW read time See page 136.

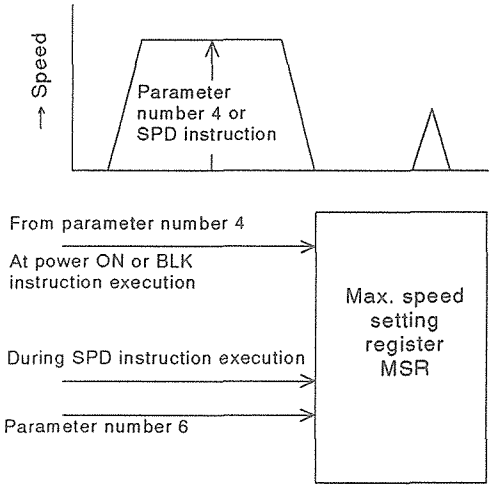
(When the relevant element is K)

This instruction is programmed within each block when the motor must be operated at a speed less than the max. motor speed set by parameter number 4.

When SPD K1,000 is designated with the unit parameter number 0 to 1 (motor system), for instance, the speed will be 1,000 PLS/sec.

If the SPD instruction is not programmed, the motor will be operated at the max. speed as set by parameter number 4.

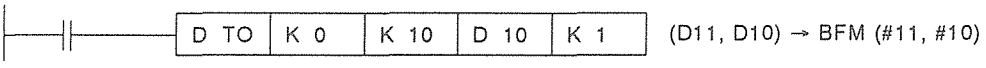
The SPD instruction is only effective when it is less than the max. speed parameter.



- The acceleration/deceleration times are determined by parameter number 8.
- If the movement distance is too short, the motor may decelerate without reaching max. speed.
- The contents of max. speed setting register MSR will be changed each time the SPD instruction or BLK instruction is executed, and all operations are performed in accordance with these values.
- The motor speed will not become lower than the bias speed of parameter number 6.
- The motor speed will not become higher than the max. speed of parameter number 4.
- Page 134 gives details about the applicable versions of the F_2-30TP.

(When the relevant element is X)

X70 to X77: Setting of BFM#25 to #10 written from a programmable controller designates the speed. For example, X70 is designated by the setting of BFM#11 and #10.



Designation	X77	X76	X75	X74	X73	X72	X71	X70
BFM	#25,#24	#23,#22	#21,#20	#19,#18	#17,#16	#15,#14	#13,#12	#11,#10

X1 to X654,321: Speed is designated by digital switches. The connecting method is as shown on the previous page. By designating digit numbers, setting values of such designated digital switches can be used. (Digit designations and scaling are done like the EXT instruction given on the next page.)

3.1.3 Address designation instructions

ADR

ADDRESS
Designation of position

Relevant elements:
± 0 to 999,999 (absolute addresses)
K0 to K999,999 (relative addresses)

Execution time:
Instantaneous progressing type (1 msec or less)

- The element symbol may be +(plus)/–(minus), or K, depending on whether the position address is absolute or relative.

  This value indicates the target position or the movement distance for the execution with the DRV instruction. Its unit will be determined by unit parameter number 3.

EXT

EXTERNAL
Designation of an external address

Relevant elements:
Absolute addressing
1) ± 1 to 654,321 2) ± 70 to 77
Relative addressing
3) K1 to K654,321 4) K70 to K77

Execution time:
1) and 3) DSW read time See page 136.
2) and 4) 1 programmable controller operation cycle

(Designation with digital switches)

- In the above ADR instruction, the position is designated immediately by the constant within the instruction.

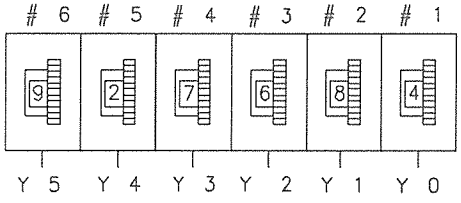
  However, if the EXT instruction is used, it is possible to designate the position by using the digital switch (DSW#6 to #1) (see page 31) connected to the general-purpose input of the PGU.

  (The setting unit depends upon the value of parameter number 3.)

  However, digits #6 and #5 cannot be used with the EXT instruction when DSW#6 or #5 is being used for the designation of the block.

- The relevant element number dictates which digital switch is used. The digits of this number should be in consecutive descending order.

Digital switch (DSW)



When the setting values of the digital switch are as shown above, the actual address designations will be as shown on the right.

Example 1
EXT K321 = ADR K684

Example 2
EXT K32100 = ADR K68400

Example 3
EXT K654321 = ADR K927684

If "0" is added to the lower digit, scaling is shifted up 1 digit.

- Page 134 gives details about the applicable versions of the F_2-30TP.
- Other valid examples include plural address instructions such as EXT K654 and EXT K321.

(Designations from the buffer)

BFM#25 to #10 are used to designate 70 to 77 as the SPD instruction given on the previous page. The contents of designation determine the addresses, and the setting units are determined according to parameter number 3 setting "0" to "3".

3.1.4 Register control instruction

SET

SET
Setting of registers

Relevant elements:
± 0 to 999,999 (setting of current value registers)
RAD (setting of return address HOME position register)

Execution time:
Instantaneous progressing type (1 msec or less)

SET instructions may be also used for relevant elements such as Y, M, etc. (see pages 42 and 43) This section describes ±, RAD only.

(SET RAD instruction)

When this instruction is executed, the current position of the machine during execution is set to the RAD register (return address register).

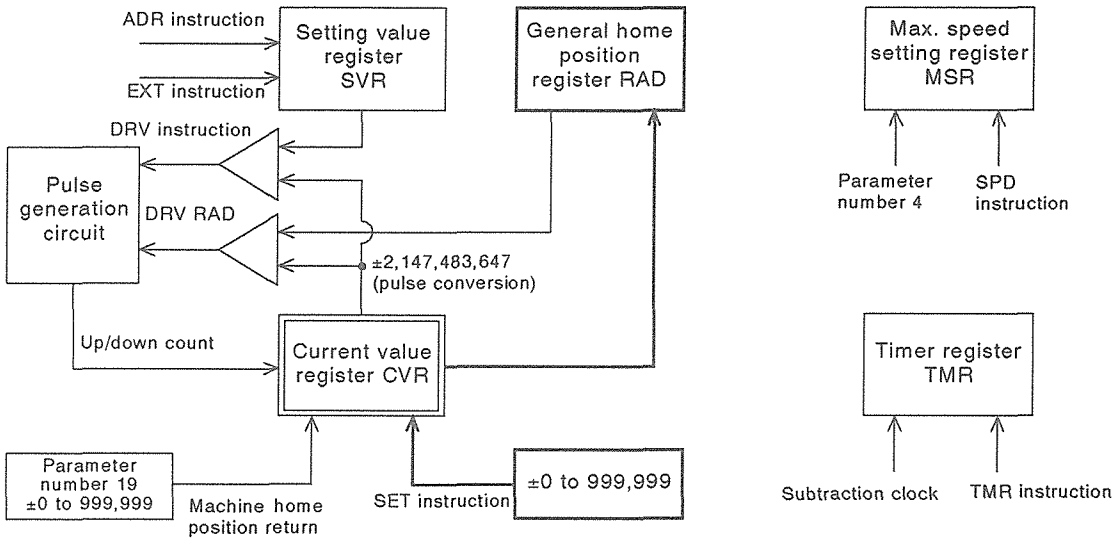
With this step, it is possible to drive to the general return position by using the DRV RAD instruction.

(SET ± 0 to 999,999 instruction)

When this instruction is executed, the contents of the current value register within the PGU are changed to the data designated by the SET instruction.

For instance, when a fixed length feed-out control is executed, it is possible to return the current value to "0" by a SET +0 (or SET –0) instruction each time the desired dimension feed-out is completed.

General description of internal registers



Other registers used in instructions such as DRVC and VCH are stored in the programmable controller because the data received is from the programmable controller.

3.1.5 Dedicated instruction for waiting

WAIT

WAIT
Waiting for a start command

Relevant elements:
M0 to M77 (octal) (M0 need not be designated.)

Execution time:
Waiting type (Waits for a start signal.)

WAIT M0 to WAIT M77 instructions are the same as SET M0 to SET M77 instructions (see page 43), in that they are used for the generation of M-codes (see page 20).

A SET M instruction is an instantaneous progressing type instruction, whereas a WAIT M instruction is a waiting type (waiting for a start signal).

WAIT M0 may be also described simply as "WAIT".

WAIT M and SET M instructions, except for WAIT M0, will not be executed unless the M-code ON signal (BFM#3 b7) is turned OFF.

These instructions are valid while the equipment is used in combination with the programmable controller. However, a WAIT (M0) instruction is valid as a dedicated instruction for waiting even when the PGU is used independently.

	WAIT M0 to M77	SET M0 to M77
M-code Data	When this instruction is executed, M-code data BFM#5 is operated. M-code ON signal BFM#3 b7 is turned ON.	
Execution of Instructions	After WAIT M1 to M77, SET M0 to M77 instructions will not be executed unless the M-code ON signal BFM#3 b7 has been turned OFF by the M-code OFF command BFM#1 b5 (waiting state).	
Shortened Instructions	A WAIT M0 instruction may simply be given as WAIT (omitting M0).	———

(Notes)

(1) For instructions of a waiting nature, such as WAIT, END, etc., operations are moved to the next program step by a start signal.

Start signals are valid when switching from OFF to ON. The next start cannot be executed if it stays ON.

(2) In the LOOP or CONT mode, an M code OFF command causes the operation to move to the next step. The M code ON signal by WAIT M0 is turned OFF by a START command.

TMR

TIMER
Pause instruction

Relevant elements:
K0 to K9,999 (unit: 10 msec)

Execution time:
Waiting type (Timer wait)

If TMR K100 is used, for instance, the operation proceeds to the succeeding program step after waiting 1 sec.

The waiting time is defined as 1/100 of the designated data 0 to 9,999.

3.1.6 Drive execution instruction

DRV

DRIVE
Fixed speed drive instruction

Relevant elements:

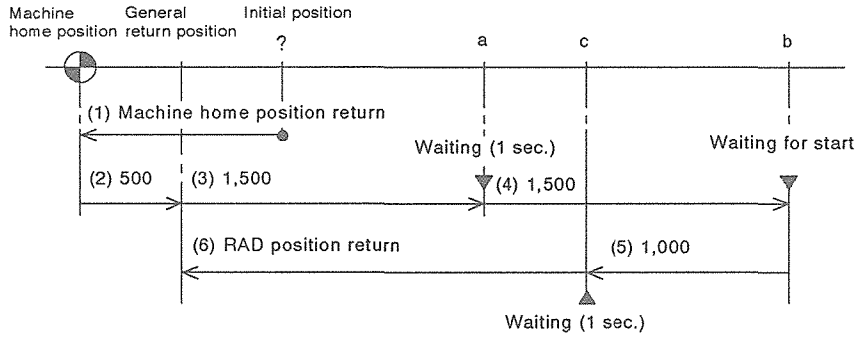
1) ZRN	Machine home position return
2) RAD	General home position return
3) ±	Relative drive
4) ABS 1 to 9,999	Absolute drive
5) ROT	Rotary table drive

Execution time:
Waiting type (Indefinite until motor positioning is completed.)

Example of relative drive

The relative addresses such as ADR, K, EXT K, etc. are valid for the drive command DRV ±.

ADR ± instruction, EXT ± instruction, etc. are also regarded as ADR K, EXT K, etc. respectively when DRV ± is used.



Try operation steps (1) to (6).

	Steps	Instructions	Elements	Data	Remarks
	0	BLK	K	0	Block-0 start
(1)	1	DRV	ZRN		Machine home return (ZERO RETURN)
	(2	SPD	K	8,000)	Omitted if parameter speed is used.
	3	ADR	K	500	Steps 2 and 3 are interchangeable.
(2)	4	DRV	+		
	5	SET	RAD		Sets the general return position to 500. (Note)
	6	ADR	K	1,500	
(3)	7	DRV	+		Movement to point a
	8	TMR	K	100	Waiting for 1 sec.
		●			(Step 6 data is used for the next ADR K1500 instruction.).
(4)	9	DRV	+		Movement from point a to point b
	10	WAIT			
	11	ADR	K	1,000	Waiting for 1 sec.
(5)	12	DRV	−		Movement form point b to point c
	13	TMR	K	100	
(6)	14	DRV	RAD		General return
	15	END			Completion of block 0

Note: The absolute address of the machine home position is determined by the home position address parameter number 19. If it is 0, the general return is written as +500 in the general return position register.

If there is no program in step 3 and step 4, the general return position becomes equal to the machine home position, which mean the contents in the return address register will become 0 (when PARA number 19 is "0").

DRV ZRN

When this instruction is executed, home return is executed to the machine home position in accordance with the procedure described on page 25.

This position is normally the position with an absolute address of 0 (set by parameter number 19).

DRV RAD

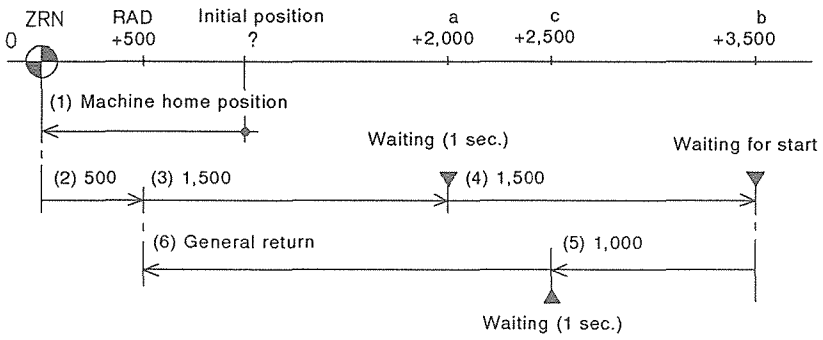
This drives to the general return position as indicated by the return address RAD register. This differs from DRV ZRN in that positioning is based on a register and not on the external hardware position of the DOG switch. Thus, the accuracy of the DRV ZRN is greater. DRV RAD is a convenient secondary temporary home position in the work area.

Example of absolute drive

The relative addresses such as ADR ±, EXT ±, etc. are valid as position addresses.

The ADR K instruction, EXT K instruction, etc. are also regarded as the ADR +, EXT +, etc. respectively.

Try operation steps (1) to (6).



(DRV ABS instruction)

	Steps	Instructions	Elements	Data
	16	BLK	K	1
(1)	17	DRV	ZRN	
	18	SPD	K	8,000
	19	ADR	+	500
(2)	20	DRV	ABS	
	21	SET	RAD	
	22	ADR	+	2,000
(3)	23	DRV	ABS	
	24	TMR	K	100
	25	ADR	+	3,500
(4)	26	DRV	ABS	
	27	WAIT		
	28	ADR	+	2,500
(5)	29	DRV	ABS	
	30	TMR	K	100
(6)	31	DRV	RAD	
	32	END		

(DRV ABS n instruction)

	Steps	Instructions	Elements	Data	Remarks
	33	BLK	K	2	
(1)	34	DRV	ZRN		
	35	SPD	K	8,000	
	36	ADR	+	500	
(2)	37	DRV	ABS	(1)	
	38	SET	RAD		
(3)	39	DRV	ABS	4	4x500
	40	TMR	K	100	
(4)	41	DRV	ABS	7	7x500
	42	WAIT			
(5)	43	DRV	ABS	5	5x500
	44	TMR	K	100	
(6)	45	DRV	RAD		
	46	END			

DRV ABS n

n = 1 to 9,999

n = 1 need not be designated.

When n is not specified or n = 1, the movement is made to the absolute address position.

Address data is specified by the previous ADR or EXT instruction. In general, when n is specified the target position address will be n-times the given address.

3.2 Examples of Operation Controls

DRV ROT

Rotary drive

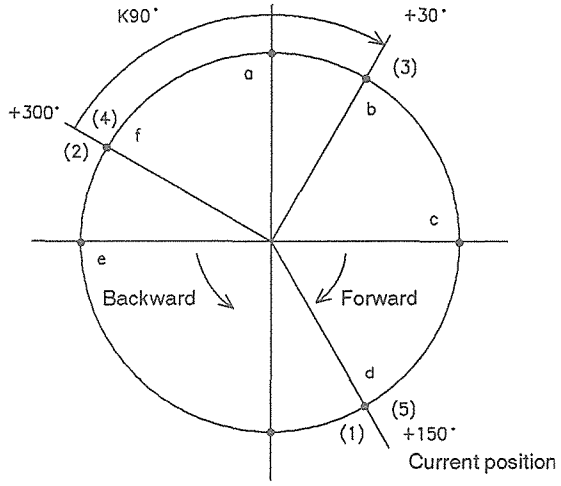
When executing indexing control of a rotary table, relative drive or absolute drive can be performed by designating the rotation angle with an ADR or EXT instruction in the same manner as linear movements.

The use of a DRV ROT instruction will allow a rotational drive automatically with a max. angle of 360° (see page 123).

Example of rotary control

ADR + is devoted to the designation of the position for a DRV ROT instruction. ADR K, ADR –are also regarded as ADR +.

The unit for an ADR instruction as a rotational angle is determined in accordance with the setting value ("0" to "3") of the parameter number 3. When the setting value is "1", for instance, the setting unit is 0.1°. With a DRV ROT instruction, ADR + 0 to 3,600 may be valid. (In this case, the value of parameter number 0 must be set to "0" or "2".)



If it is necessary to drive in the order of d, f, b, f, and d when the current position is at point d (as shown on the left), particular care must be taken with its rotation direction in the case of a DRV ABS instruction.

When a DRV ROT instruction is used, the rotation direction is always made so that the shortest route will be taken.

The following example compares them. (The system unit is 1 in this example.)

(Combined use of the DRV ABS, DRV ± instructions)

	ADR	+	300		
(2)	DRV	ABS		d → e → f	
	TMR	K	100		
	ADR	K	90		Note 1
(3)	DRV	+		f → a → b	
	TMR	K	100		
	SET	+	30	(Change from 390° to 30°)	
(4)	DRV	–		b → a → f	
	SET	+	300	(Change from –60° to 300°)	
	ADR	+	150		
(1)	DRV	ABS		f → e → d	
	WAIT				

Note 1: If ADR +30, DRV ABS are used, then the operation is executed in the order of f, e, c, and b.

(Use of the DRV ROT instruction)

	ADR	+	300		
(2)	DRV	ROT		d → e → f	
	TMR	K	100		
	ADR	+	30		Note 2
(3)	DRV	ROT		f → a → b	
	TMR	K	100		
	ADR	+	300		
(4)	DRV	ROT		b → a → f	
	TMR	K	100		
	ADR	+	150		
(1)	DRV	ROT		f → e → d	
	WAIT				

Note 2: The shortest distance drive is executed from address +300 to address +30.

DRVC

DRVC CHANGE
Multi-stage speed drive

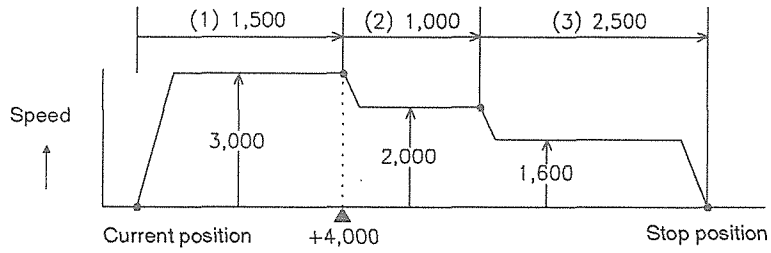
Relevant elements:
1) ABS Absolute drive
2) ± Relative drive

Execution time:
Waiting type (Indefinite until positioning has been completed.)

The multi-stage speed drive can be executed by using an SPD instruction and position designation instruction in combination.

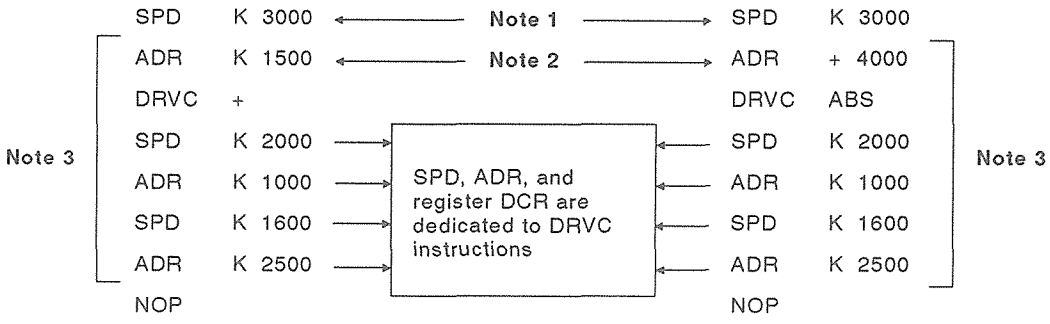
Example of a multi-stage speed drive

ADR, EXT instructions are applicable to the designation of the position.



In this example, execute positioning while changing the operation speed in areas (1) to (3).

(Initial relative drive) **(Initial absolute drive)**



Note 1: This instruction is not necessary when driving at a speed designated by parameter number 4.

Note 2: The previous relative address or absolute address is valid to the position data of the DRVC instruction.

Use DRVC +- instruction or DRVC ABS instruction as appropriate.

Note 3: Speed changes can be done in up to 8 stages by a series of instructions. In such cases, however, other instructions cannot be programmed in between.

Only the relative address is valid for the designation of a series of positions after a DRVC instruction.

Always be sure to program an NOP instruction to indicate the DRVC end (i.e., stop).

A series of these instructions are read in advance by the dedicated register DCR when the DRVC instruction is executed, and then the actual operation is executed.

After completing the operation of the DRVC instruction, the values of the max. speed setting register (MSR) and setting value register (SVR) are returned to the original values before the DRVC instruction.

3.2.1 Multi-stage speed operation

VCH

VELOCITY CHANGE

Fixed speed change command

Relevant elements:

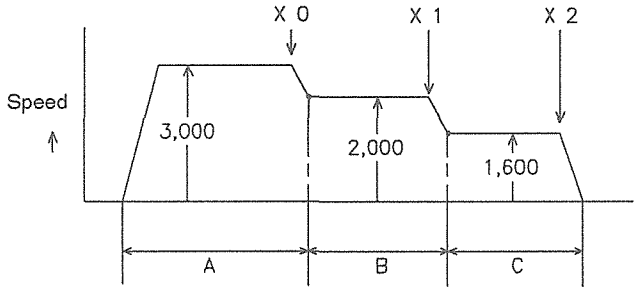
1) X0 to X6 (general-purpose input)

2) Y440 to Y444 (BFM#2 b0 to b4)

Execution time:

Instantaneous progressing type (1 msec or less)

The instruction is used when execution must be done at a desired speed regardless of the movement distance.



Let's operate A, B,and C by turning ON the general-purpose inputs X0, X1, and X2 sequentially.

	Steps	Instructions	Elements	Data	Remarks
	47	BLK	K	3	
	48	SPD	K	3,000	Omitted if parameter speed is used.
	49	VCH	X	0	Instantaneous progress regardless of the ON/OFF status of X0.
A	50	SPD	K	2,000	Set the next speed in a special register.
	51	DRV	+		Drive at speed 3000. Change to 2000 when X0 is ON, and then continue.
	52	VCH	X	1	Instantaneous progress regardless of the ON/OFF status of X1.
B	53	SPD	K	1,600	Set the next speed in a special register.
	54	DRV	+		Drive at speed 2000. Change to 1600 when X1 is ON, and then continue.
	55	VCH	X	2	Instantaneous progress regardless of the ON/OFF status of X2.
C	56	SPD	K	0	The last speed command is always "0".
	57	DRV	+		Drive at speed 1600. Change to speed 0 when X2 is ON and then continue.
	58	END			

Note 1: VCH instruction proceeds to the succeeding step regardless of the input state, and executes DRV ± instruction immediately after reading the SPD instruction data. Then, the operation waits for an input operation such as X0.

When the input of VCH instruction having been read is turned ON while executing the DRV ± instruction, the operation proceeds to the succeeding step after changing to the desired speed.

Note 2: A, B, C, ... must be a consecutive set of instructions. Other instructions cannot be programmed in between.

Only DRV ± is valid as the drive instruction, and 0 must be set to the final speed command.

Note 3: After completing the VCH operation, the data of SPD at step 48 is returned to the MSR register. (If there is no SPD instruction, the speed designated by the parameter becomes valid.)

3.2.2 Drive interrupt

INT

INTERRUPT
Drive interrupt by inputs

Relevant elements:

General-purpose inputs
1) X0 to X6 2) K0 to K6
BFM#2 3) Y440 to Y444 4) K440 to K444

Execution time:

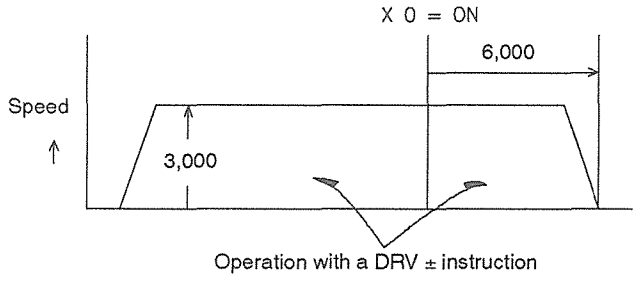
Instantaneous progressing type (1 msec)or less.

Response times:

1), 2) Approx. 4 msec
3), 4) Approx. 10 msec + operation cycle of programmable controller

(Relevant elements X and Y)

After an input signal is turned ON, the operation is executed for a designated distance.



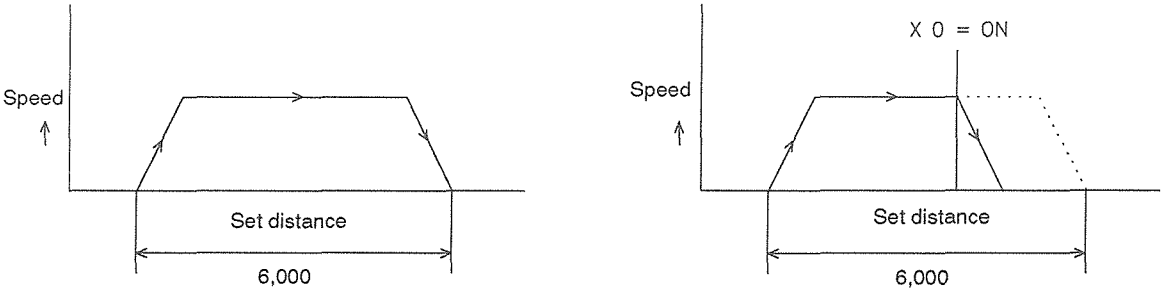
Start the operation at a speed of 3,000, and stop it after a movement of 6,000 after X0 has been turned ON.

```
SPD   K   3000 <-- A program is not necessary if the speed has been set by a parameter.
ADR   K   6000 <-- An EXT instruction can also be used. (Absolute address is invalid.)
INT   X      0 <-- X0 to X6 and Y440 to Y444 can be designated
                   (from the programmable controller BFM #2, see page 102).
DRV   +       <-- Only a relative drive instruction (DRV ±) is valid.
Execute the programming in the sequence shown above. Other instructions cannot be programmed in between.
```

An INT instruction proceeds to the succeeding DRV instruction immediately whether X0 is ON or OFF. The relative drive of ADR K6000 is executed after X0 has been turned ON.

(Relevant element K)

When an input signal is turned ON, THE deceleration stop is executed and completed ignoring the remaining distance.




```
ADR   K   6,000 <-- Absolute address can also be used. An EXT instruction can also be used.
INT   K       0 <-- K440 to K444 can also be designated.
DRV   +         <-- Absolute drive instruction can also be used.
Execute the programming in the sequence shown above. Other instructions cannot be programmed in between.
```

Though the relevant element is K, the actual operation is carried out responding to general inputs X0 to X6 or BFM#2 Y440 to Y444.

• Page 134 gives details about the applicable versions of the F_2-30TP.

3.3 Well-known Instructions

3.3.1 Sequence instructions

As with the programmable controller, there are the following sequence instructions, all of which are of the instantaneous progressing type (1 msec or less).

Contact instructions such as LD/LDI, AND/ANI, and OR/ORI are used to drive coil instructions such as SET/RST and CJ/CJN (see page 126).

LD	**LOAD** Logical operation start (NO-contact)	LDI	**LOAD INVERSE** Logical operation start (NC-contact)
AND	**AND** Series contact connection (NO-contact)	ANI	**AND INVERSE** Series contact connection (NC-contact)
OR	**OR** Parallel contact connection (NO-contact)	ORI	**OR INVERSE** Parallel contact connection (NC-contact)
ANB	**AND BLOCK** Series connection of circuit block	ORB	**OR BLOCK** Parallel connection of circuit block
NOP	**NO OPERATION** Non-processing		
SET	**SET** Output holding instruction	RST	**RESET** Output holding reset

Relevant elements

(1) X0 to X6
(general-purpose input)

(2) Y0 to Y6
(general-purpose output)

(3) Y440 to Y444
(programmable controller)

(4) Special aux. relays
M100 to M103

(5) General aux. relays
M110 to M127

Instruction not accompanied by a relevant element

Relevant elements:
Y0 to Y6
M100 to M127
For others, see pages 34, 43.

OR

An OR instruction is used as an addition and subtraction operation instruction as well as a parallel contact connection instruction.

Example 1

```
ADR  +1,000
ADR  +2,000
OR
```

Set value register SVR stores +1,000 +2,000 = +3,000.

Example 2

```
EXT  K654
ADR  -400
OR
```

When the digital switch DSW#654 = 100, set value register SVR stores 100 −400 = −300.
(EXT K designated by a DSW is regarded as a positive number.)

Example 3

```
EXT  K70
EXT  K654
OR
EXT  -71
OR
```

When BFM#11 and #10 = +500, DSW#654 = 100, and BFM#13 and #12 = 1000, +500 +100 = +600 and +600 −1000 = −400. Set value register stores −400.

The above examples show an addition of set values designated by 2 ADR or EXT instructions.
The following additions use OR instructions.

• Page 134 gives details about the applicable versions of the F_2-30TP.

3.3.2 M-code setting instruction

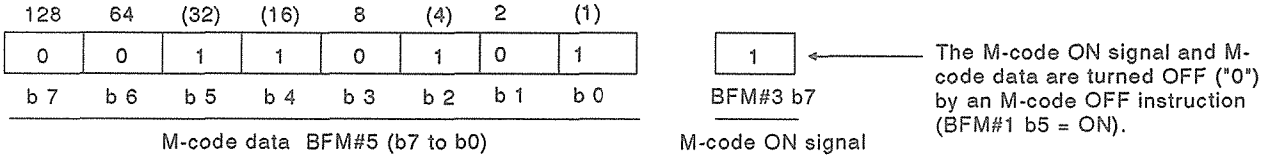
SET

SET
Output holding instruction

Relevant elements:
M0 to M77 (octal)
(For others, see pages 34 and 42.)

Execution time:
Instantaneous progressing type (1 msec or less)

When the SET MXX is driven within the PGU, programmable controller's input points BFM#5 operate automatically as soon as the WAIT MXX is executed.



If SET M53 or WAIT M53 is driven, for instance, BFM#3 b7 is turned ON after b0, b2, b4, and b5 are turned ON.

At the programmable controller side, each aux. machine is driven in accordance with the M-code data.

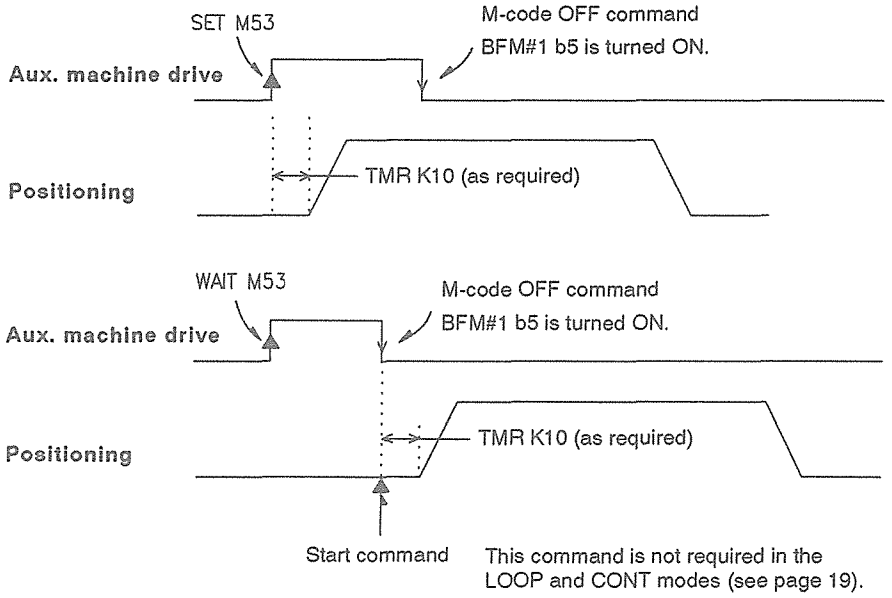
Since, unlike a WAIT M instruction, a SET M instruction does not require any start command, it serves as a convenient instruction to start the succeeding positioning operation (WITH MODE), while the programmable controller drives the aux. machine.

(WITH MODE)

```
SET   M   53
TMR   K   10
ADR   K   100
DRV   +
```

(AFTER MODE)

```
WAIT  M   53
TMR   K   10
ADR   K   100
DRV   +
```



Note: Other SET M0 to M77 and WAIT M0 to M77 instructions will not be executed unless the M-code ON signal BFM#3 b7 has been turned OFF by the M-code OFF command BFM#1 b5 (from the programmable controller).

See pages 20 and 130 for the differences between SET M and WAIT M instructions.

3.4 Controlling Program Flow

3.4.1 Jump instructions

LAB — **LABEL**
Step transfer destination

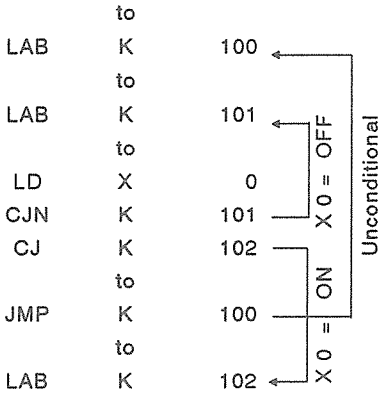
JMP — **UNCONDITIONAL JUMP**
Jump to a designated label

Relevant elements:
K0 to K255

Execution times:
Instantaneous progressing time (1 msec or less)

CJ — **CONDITIONAL JUMP**
Jump when the input is turned ON.

CJN — **CONDITIONAL JUMP NOT**
Jump when the input is turned OFF.



(Description of operations)

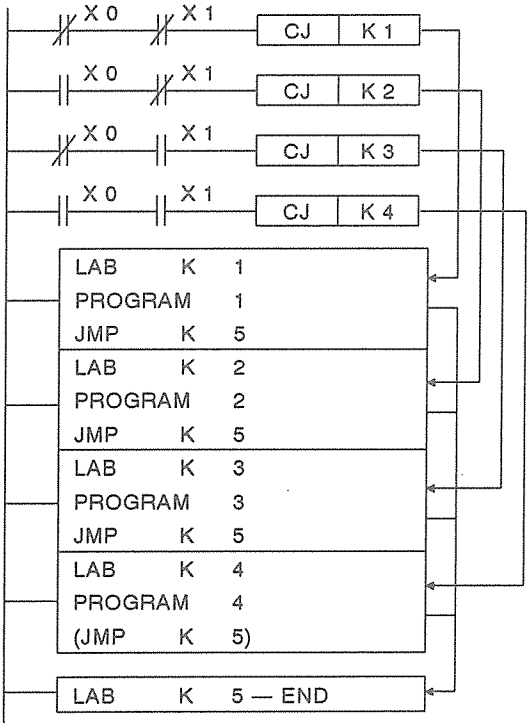
- A jump occurs to a LAB instruction having the same number as that designated by the data of CJ, CJN, and JMP instructions.

  LAB number must not be used more than once throughout the program.

- A LAB instruction may be used before or after CJ, CJN, and JMP instructions.

  It may also be used inside or outside the block.

  It is not necessary to finish at the END of the same block. Other END instructions in other blocks are acceptable.



(Selection of the execution program by general-purpose input)

- When the digital switch is not connected to the general-purpose input, X0 to X3 may be used as jump instructions.
- The example shown on the left shows a case in which X0 and X1 are used to select 1 of 4 different programs.
- For instance, program 1 is executed when both X0 and X1 are turned OFF.

3.4.2 Sub-routine instructions

CALL
Subroutine call

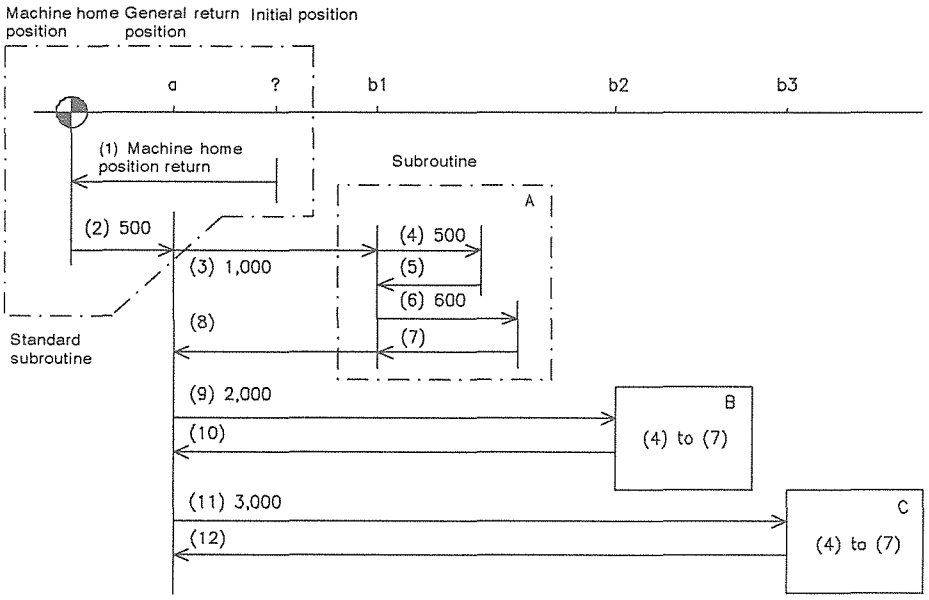
Relevant elements:
K0 to K255
CALL instructions under a CALL instruction can be used up to 15 times.

Execution time:
Instantaneous progressing type (1 msec or less)

RET
RETURN
Subroutine return

Relevant elements:
Not necessary

Execution time:
Instantaneous progressing type (1 msec or less)



Repeat steps (4) to (7) at points b1, b2, and b3.

Main program

Operations	Steps	Instructions	Elements	Data	
	59	BLK	K	4	
	60	CALL	K	255	
	61	ADR	K	1,000	A
A	62	CALL	K	6	
→	63	ADR	K	2,000	B
B	64	CALL	K	6	
→	65	ADR	K	3,000	C
C	66	CALL	K	6	
→	67	END			

Subroutine program

Operations	Steps	Instructions	Elements	Data	
→	1,500	LAB	K	6	
(3)(9)(11)	1,501	DRV	+		
	1,502	ADR	K	500	
(4)	1,503	DRV	+		
(5)	1,504	DRV	−		
	1,505	ADR	K	600	
(6)	1,506	DRV	+		
(7)	1,507	DRV	−		
(8)(10)(12)	1,508	DRV	RAD		
	1,509	WAIT			
	1,510	RET			
→	1,991	LAB	K	255	
	1,992	LD	M	101	
	1,993	CJ	K	254	
(1)	1,994	DRV	ZRN		
	1,995	LAB	K	254	
(2)	1,996	ADR	+	500	
	1,997	DRV	ABS		
	1,998	SET	RAD		
	1,999	RET			

Jump if home positioning has already been completed.

Standard program for home position return

CALL K255 may be in any block.

Home return is performed only once and M101 is then turned ON.

Thereafter, this process is jumped.

General return is performed at the end of the LAB K6 subroutine.

IMPORTANT

3.4.3 Repeat instructions

RPT — **REPEAT**
Start of the repeat instruction

RPT instructions under a RPT instruction can be used up to 15 times.

Relevant elements:
1) K1 to K9999
2) X70 to X77 (BFM)
3) X1 to X6543 (digital switch)

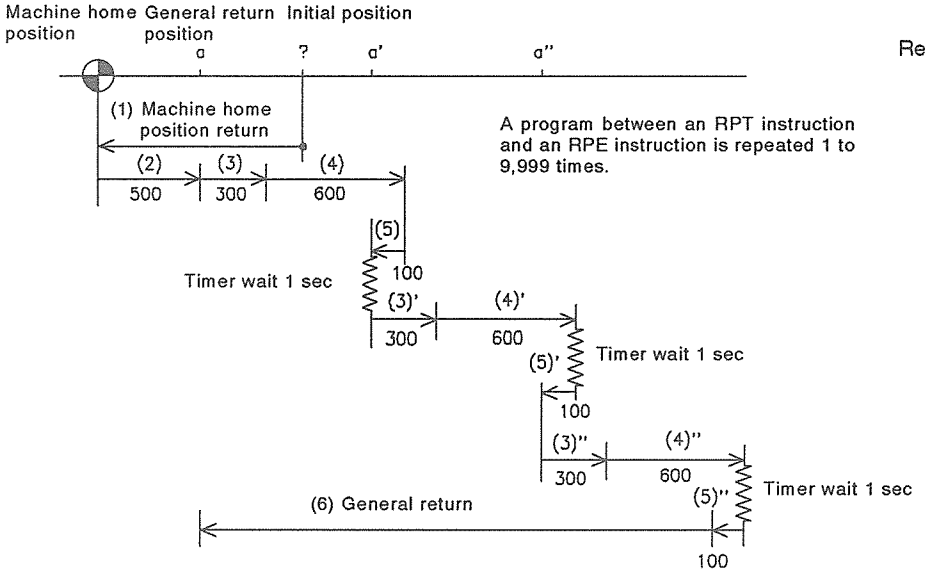
} A value of 0 to 9,999 is valid.
A value of 0 will execute once.

Execution time:
Instantaneous progressing type
1) 1 msec or less
2) 1 programmable controller cycle
3) See page 136.

RPE — **REPEAT END**
End of repeat section

Relevant elements:
Not necessary

Execution time:
Instantaneous progressing time (1 msec or less)



A program between an RPT instruction and an RPE instruction is repeated 1 to 9,999 times.

Repeat steps (3) to (5) 3 times.

Operations	Steps	Instructions	Elements	Data	
	68	BLK	K	5	
(1)(2)	69	CALL	K	255	← The subroutine given on page 45 can be used directly.
	70	RPT	K	3	← It is a command standard program for home position return.
	71	WAIT			
	72	ADR	K	300	
(3)(3)'(3)''	73	DRV	+		
	74	ADR	K	600	
(4)(4)'(4)''	75	DRV	+		
	76	ADR	K	100	
(5)(5)'(5)''	77	DRV	−		
	78	TMR	K	100	
	79	RPE			
(6)	80	DRV	RAD		← Set the general return so that it is used by every block. In this way, the block may be repeated from the general return position instead of the last position.
	81	END			

Repeated operation (3 times)

- Page 134 gives details about the applicable versions of the F_2-30TP.

4 HOW TO OPERATE THE TEACHING PANEL

Functions of the teaching panel

The F_2-30TP teaching panel (TP) is provided with the following 4 modes:

Program mode

In the program mode, the TP executes program writing, reading, inserting, deleting, and verifying (program check with the PGU) in the memory built in the TP.

Parameter mode

In the parameter mode, the TP executes parameter writing, reading, inserting, deleting, and verifying (parameter check) in the memory built in the TP.

CPU mode

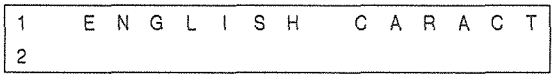
In the CPU mode, it is possible to execute the transfer of programs or parameters between the TP and the PGU (reading, writing), verifying (comparing), monitoring, testing, etc. with the PGU.

CMT mode

In the CMT mode, it is possible to execute the transfer (reading, writing) and verifying (comparing) between the TP and the CMT (Audio cassette tape).

This section explains the TP key operation procedures for all 4 modes described above. These are summarized in Section 7.

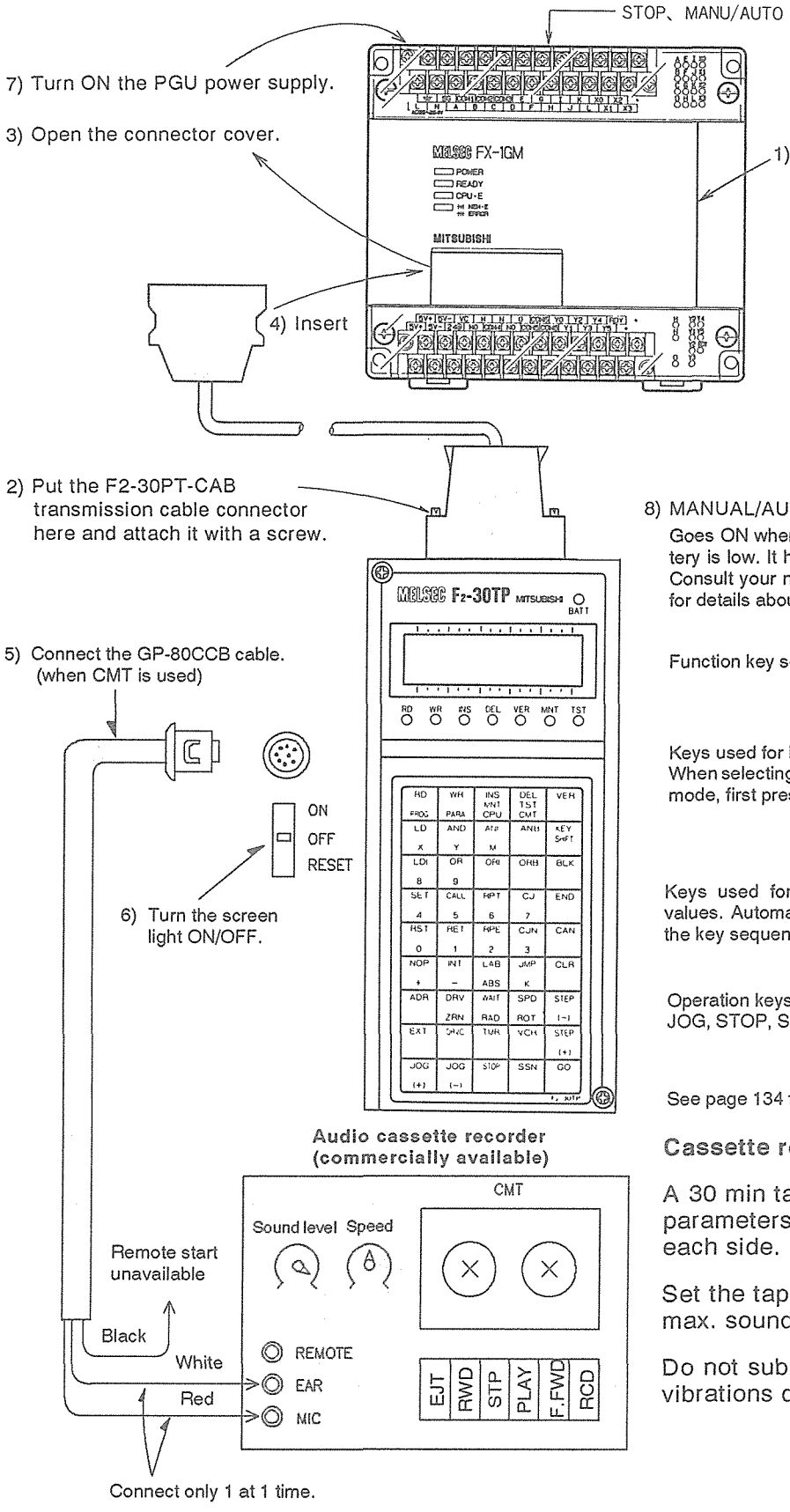
When power is applied to the F_2-30TP through the FX-1GM, the following message is displayed. Press key 1 to work in English characters.



Initial screen

4 HOW TO OPERATE THE TEACHING PANEL

4.1 Preparatory Operations



8) MANUAL/AUTO STOP
Goes ON when voltage in the TP's built-in battery is low. It has a lifetime of approx. 5 years. Consult your nearest Mitsubishi representative for details about battery replacement.

Function key selection indicators.

Keys used for both modes and functions. When selecting the PROG, PARA, CPU, or CMT mode, first press the KEY SHIFT key.

Keys used for instructions/elements/numeric values. Automatically selected, depending upon the key sequence.

Operation keys such as CAN, CLR, STEP, GO, JOG, STOP, SSN, etc.

See page 134 for applicable versions.

Cassette recorder handling

A 30 min tape allows programs and parameters to be stored 3 times on each side.

Set the tape speed to standard and max. sound level.

Do not submit the unit to shocks or vibrations during operations.

4.2 About Functions

Functions and overall procedures

Generation of new programs

Use the TP keys to write programs and parameters to the RAM memory built in the TP to execute reading, correcting, (inserting, deleting, rewriting), verifying, etc.

Changing existing programs

After reading programs from the FX-EEPROM-4 cassette mounted onto the PGU or from the CMT (audio cassette recorder) to the TP, execute corrections and verification checks as necessary.

Transferring to the PGU for execution

After writing programs from the RAM built in the TP to the FX-EEPROM-4 ROM cassette of the PGU, perform test operations as necessary.

Storing programs

Programs and parameters in the FX-EEPROM-4 ROM cassette can be stored in the PGU instead of the CMT tape cassette or the TP's RAM memory.

Mode and function directory

All functions (unless otherwise specified) are valid in the MANUAL and AUTO modes.

Functions / Modes	INS INSERT	DEL DELETE	RD READ	WR WRITE	VER VERIFY	MNT MONITOR	TST TEST
KEY SHIFT + PROG PROGRAM	Program insertion 53	Program deletion 50, 53	Program reading/ display 52, 53	Program writing/ rewriting 51, 53	Program checking 54	— Error codes (See page 108.)	
KEY SHIFT + PARA PARAMETER	Reference parameter reading 121	—	Parameter reading/ display 55	Parameter rewriting 55	Parameter checking 56	— Error codes (See page 109, 110.)	
KEY SHIFT + CMT CASSETTE MAGNETIC TAPE	—		TP ↑ Read CMT 63	TP ↓ Write CMT 63	TP ↑↓ Verify CMT 64	—	
KEY SHIFT + CPU CENTRAL PROCESSING UNIT	—		TP ↑ Read PGU 58	TP → PGU Write MANUAL (PROTECT-OFF) 57	TP Verify PGU 58	PGU operation monitor STOP key valid 59	PGU test MANUAL (PROTECT-OFF) 60 to 62

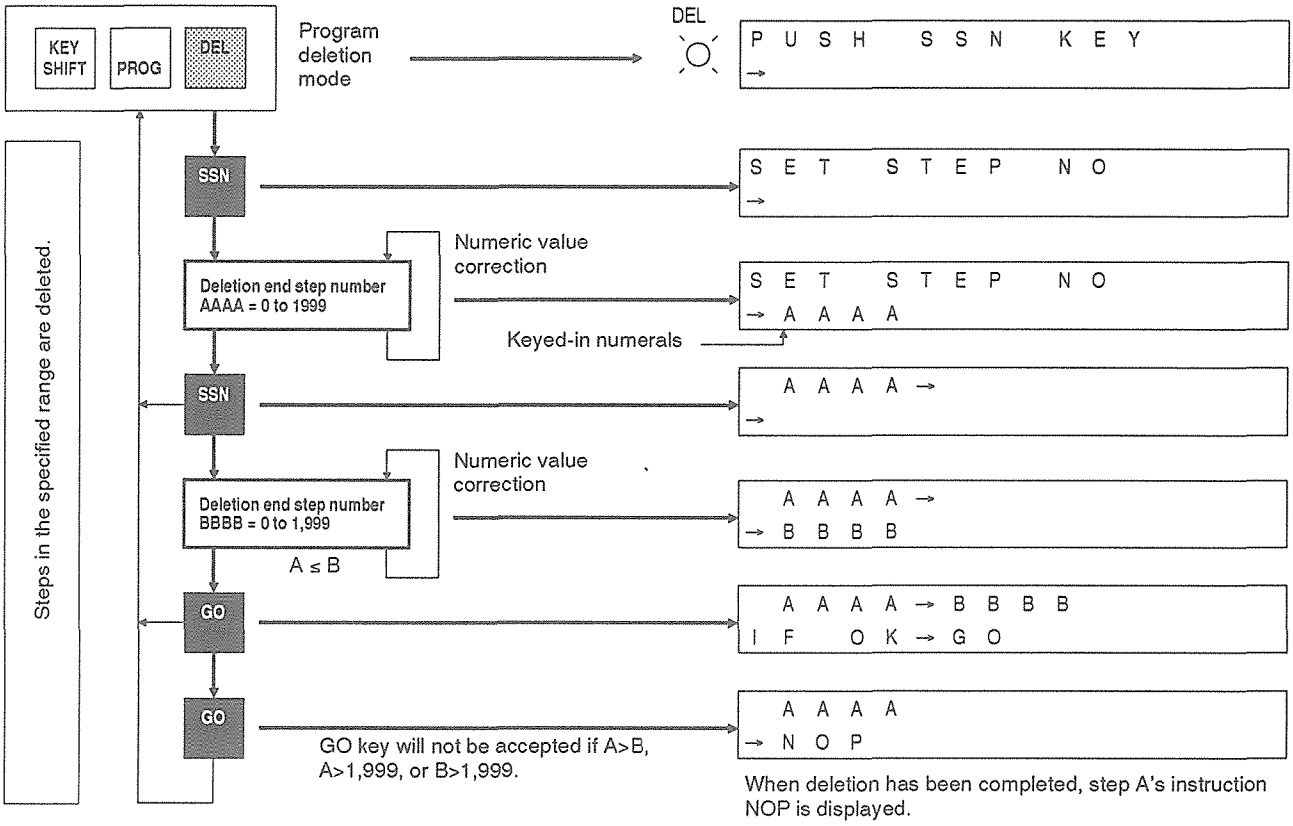
CPU TST Functions

(1) Home position return function
(2) PGU, TP program simultaneous rewrite function
(3) PGU, TP parameter simultaneous rewrite function
(4) Register rewrite function
(5) Error reset function (See error code pages 108 to 110.)
(6) Fixed length feed function
JOG +, JOG –, STOP keys also valid.

4.3 Batch Deleting of Programs

Program deletion

This section explains the block delete function. The display shows an instance when the whole program area is to be deleted.



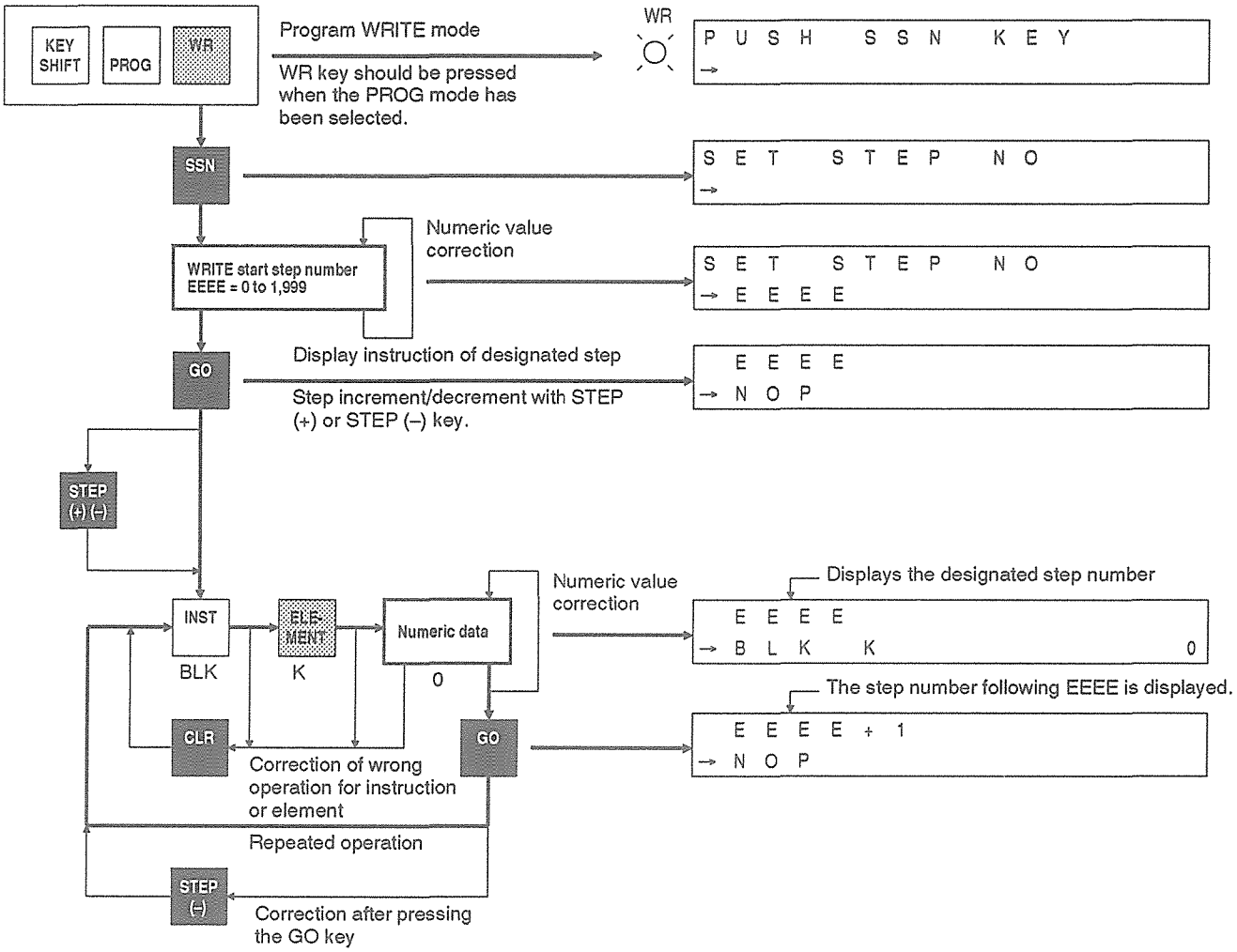
Step Control

BLK K ΔΔ CALL K100	Insert a CALL instruction immediately after the BLK instruction in each program. Write SET and RST instructions for special aux. relay M103 as the contents of the CALL instruction.
to	
LAB K100 LD X 0 SET M103 LDI X 0 RST M103 RET	This example shows that M103 is SET when the PGU's general input X0 is ON and then transition is prohibited. Every time a START command is given, the program progresses 1 step. However, START commands are ignored during a timer wait state or until the drive operation is completed.

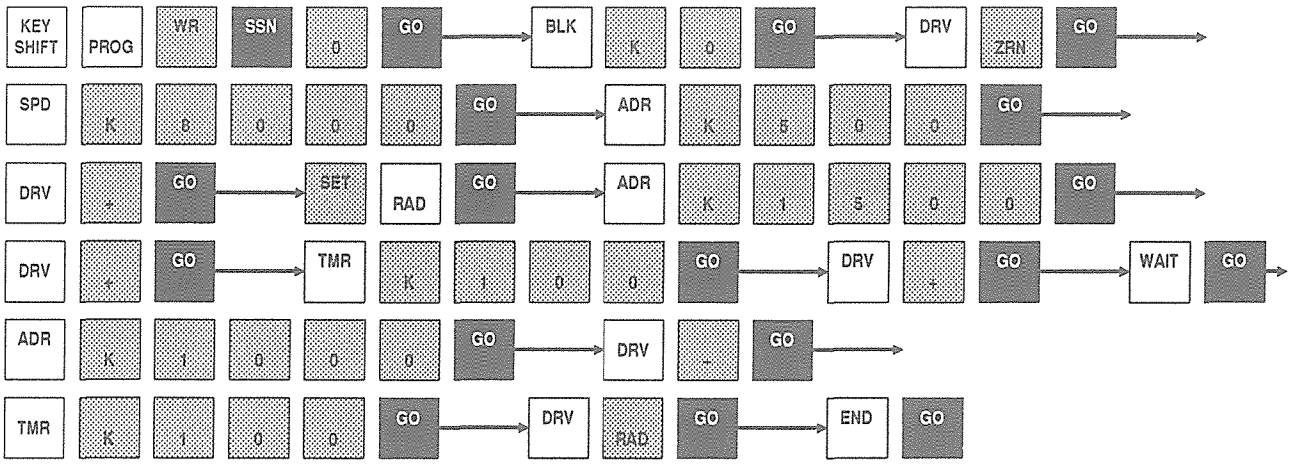
4.4 Writing a Program

Creating a new program

After deletion of a program, the steps given in this section will allow you to write a new program. When the first line of the following sample program is entered, the following display appears:



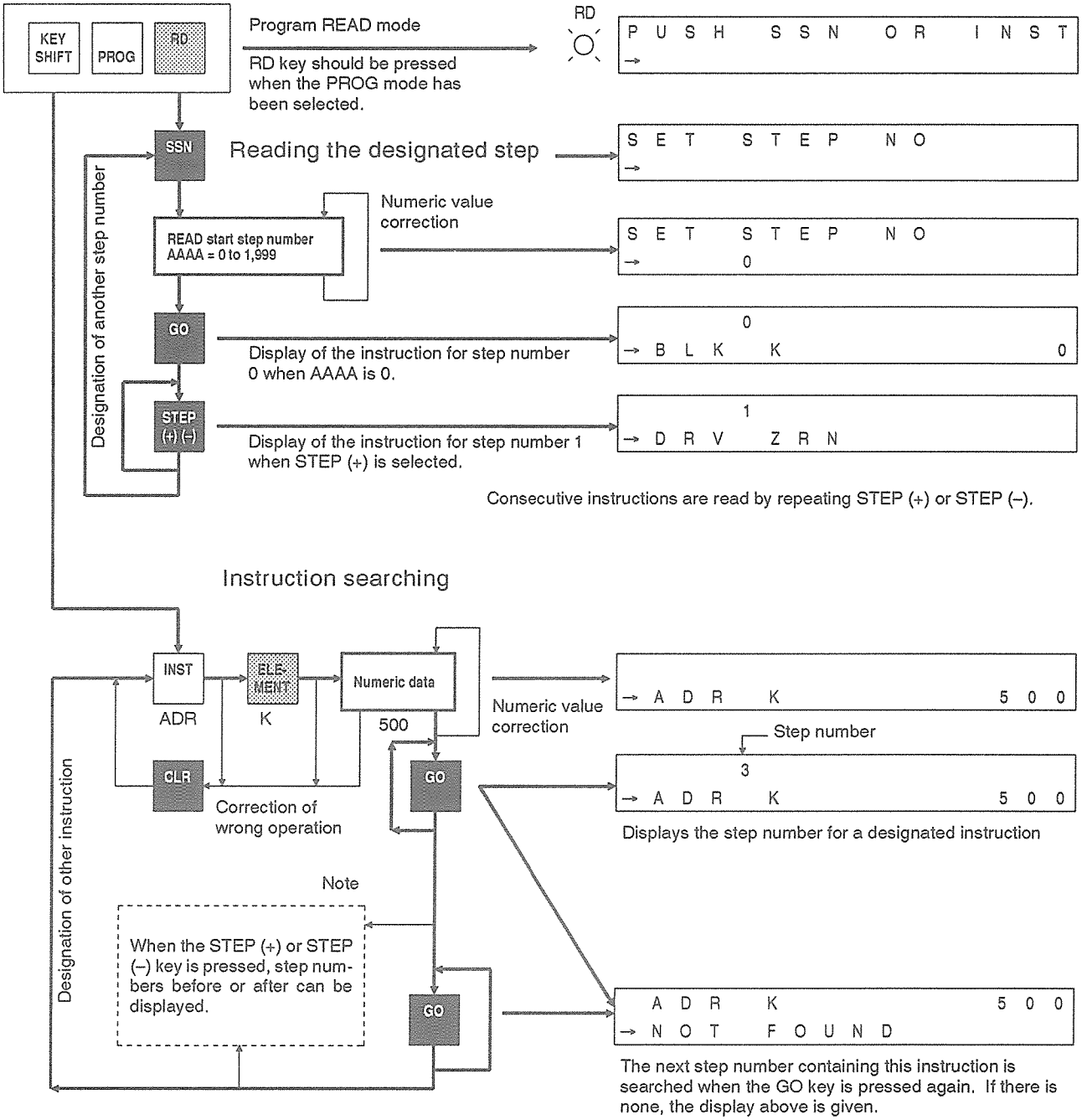
- The following writes the program shown on page 36.



4.5 Reading, Checking, and Searching for a Program

Reading/searching for an instruction

This section describes the procedures for program reading and instruction searching so that corrections may be executed.

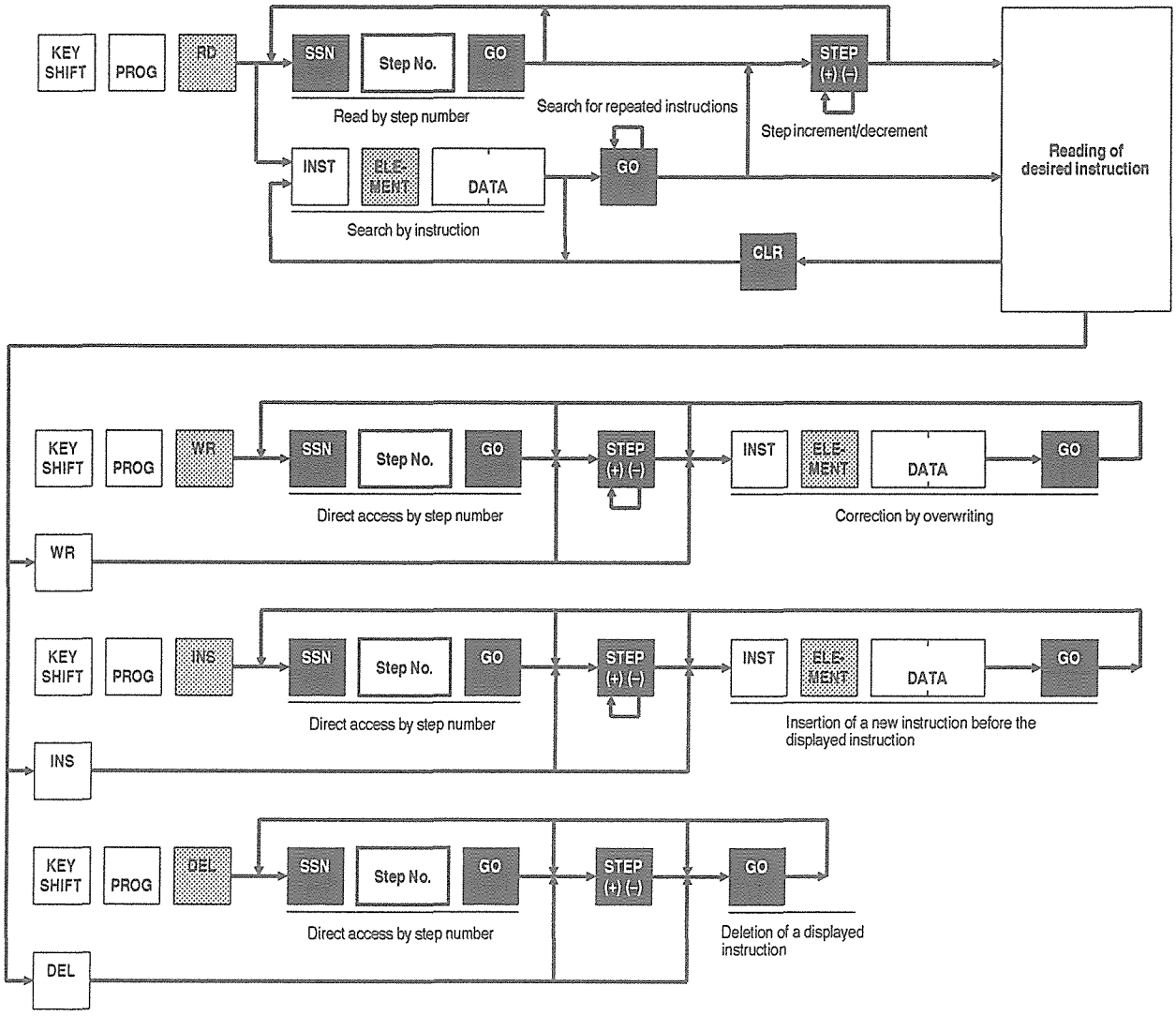


Note: Pressing the GO key when a step number is displayed reads and displays the corresponding designated instruction following that step number.
When a step number is not displayed, the search is made from step zero. Otherwise, it is made from the current position.

4.6 Modifying a Program

Program correction

Correction is made based on the idea that the correction point is searched before the appropriate WR, INS, or DEL operation is selected.



Insertion, deletion, and step numbers

There will not be any change in the step number when an instruction is rewritten.

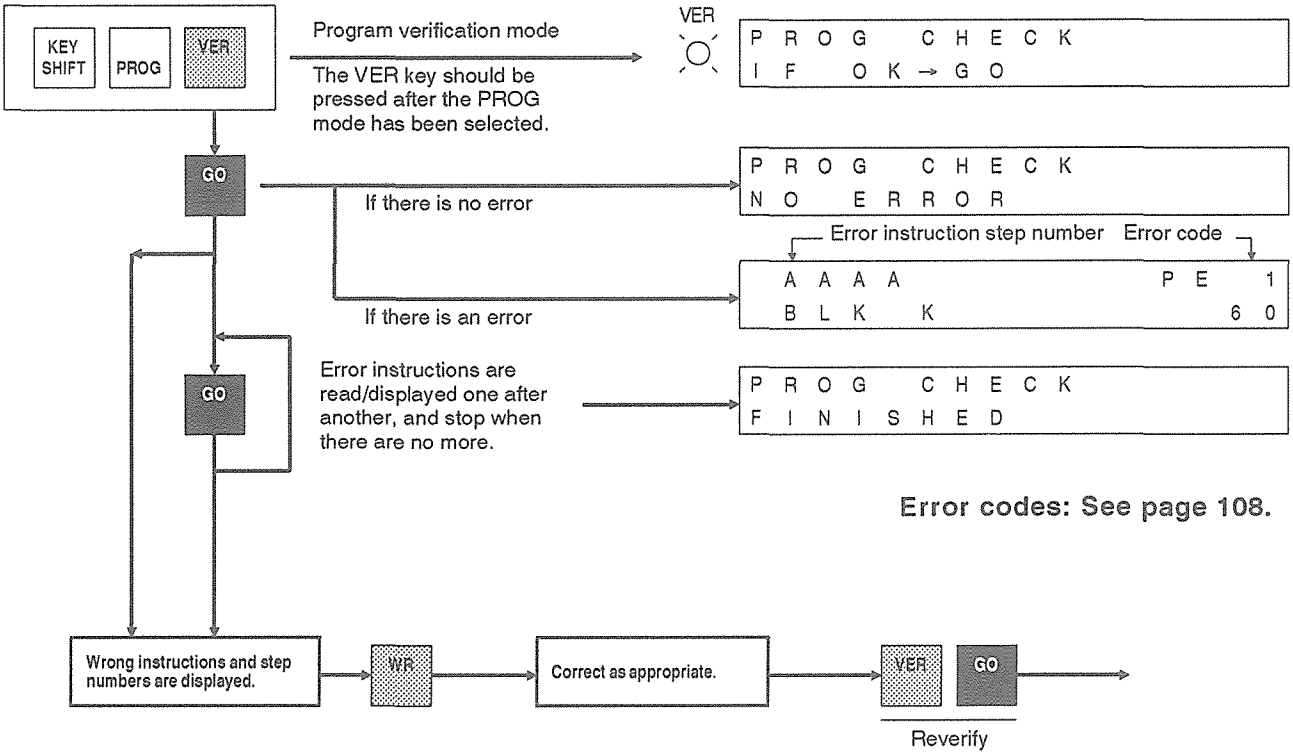
When a deletion is executed, however, the program steps of the program after the deletion instruction are automatically decremented.

When an insertion is executed, the step numbers of the instructions after the inserted instruction are all incremented.

4.7 Checking a Program

Program checking and error codes

The syntax of programs can be checked automatically in accordance with the following procedure:



Error codes: See page 108.

Other checks

PROG/VER Operation page 54 → Check by TP → TP display error code page 108

- In the PROG-VER mode, programs in the TP are checked by the TP.
  As a result, the error codes (PE0 to PE8) shown on page 108 may be displayed by the TP.

PARA/VER Operation page 56 → Check by TP → TP diaplay error code pages 109 and 110

- In the PARA-VER mode, parameters in the TP are checked by the TP. As a result, the error codes (PE10 to PE18) shown on pages 109 and 110 may be displayed by the TP.
  Since programs and parameters are interrelated, always be sure to check both the parameter and the program when one of them requires correcting.

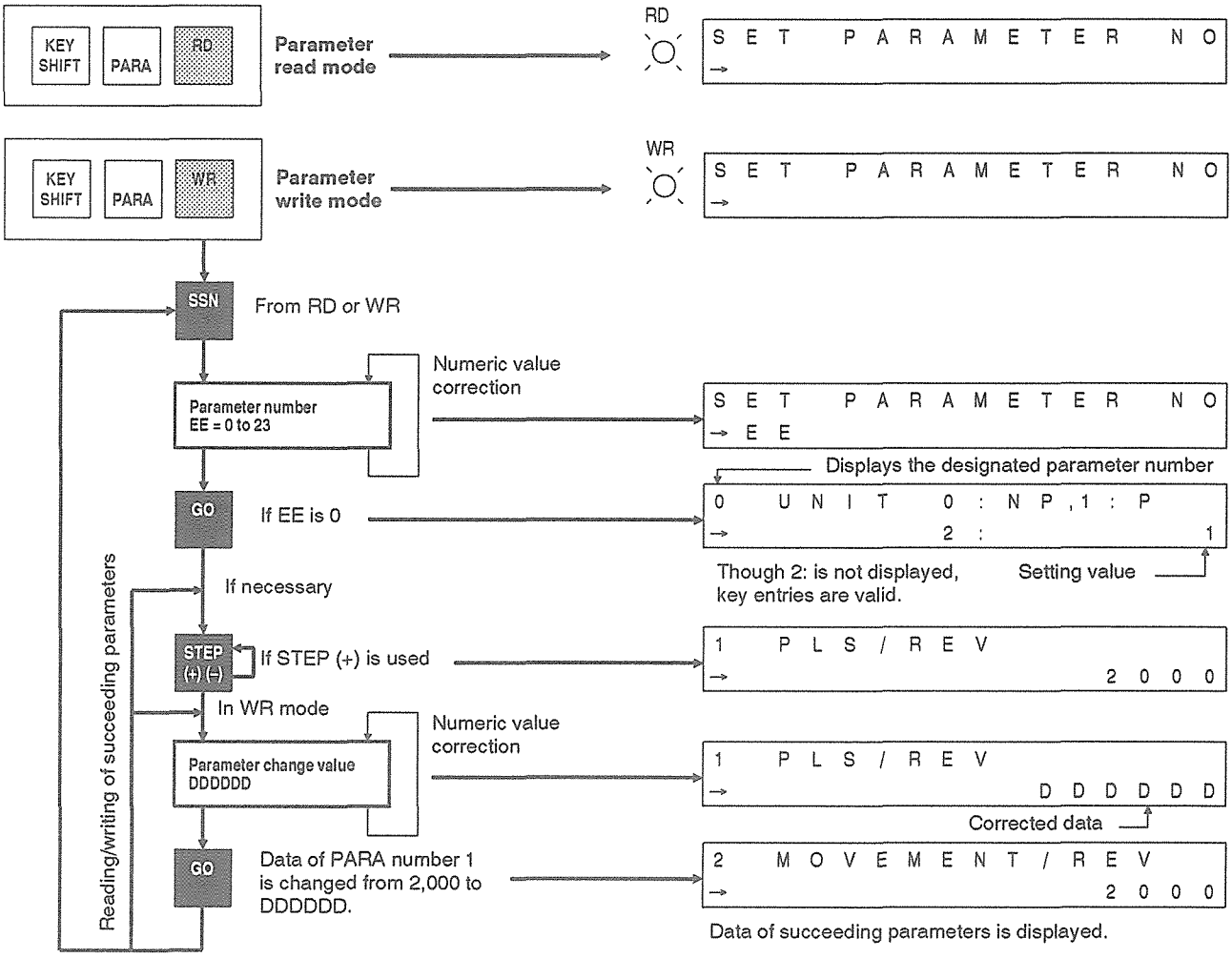
CPU/TST Operation page 62 → Check by PGU → TP display error code pages 108 to 110

- When a program or parameter containing an error is sent to the PGU, the error check is also performed by the PGU. Its error codes (CE1 to CE20) shown on pages 108 to 110 will be displayed by the TP.
  In this case, the error detect output BFM#3 b6 to the programmable controller and the error display LED on the PGU panel are also activated.

4.8 Rewriting Parameters

Reading/writing parameters

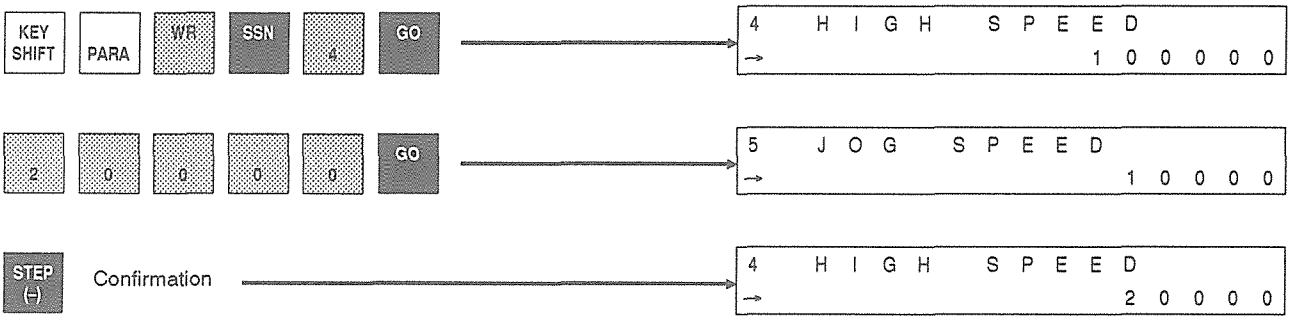
The procedure to read, write and rewrite parameters is as follows:



• See page 124 for parameter reading from the TP system ROM to the RAM.

(Parameter correction example)

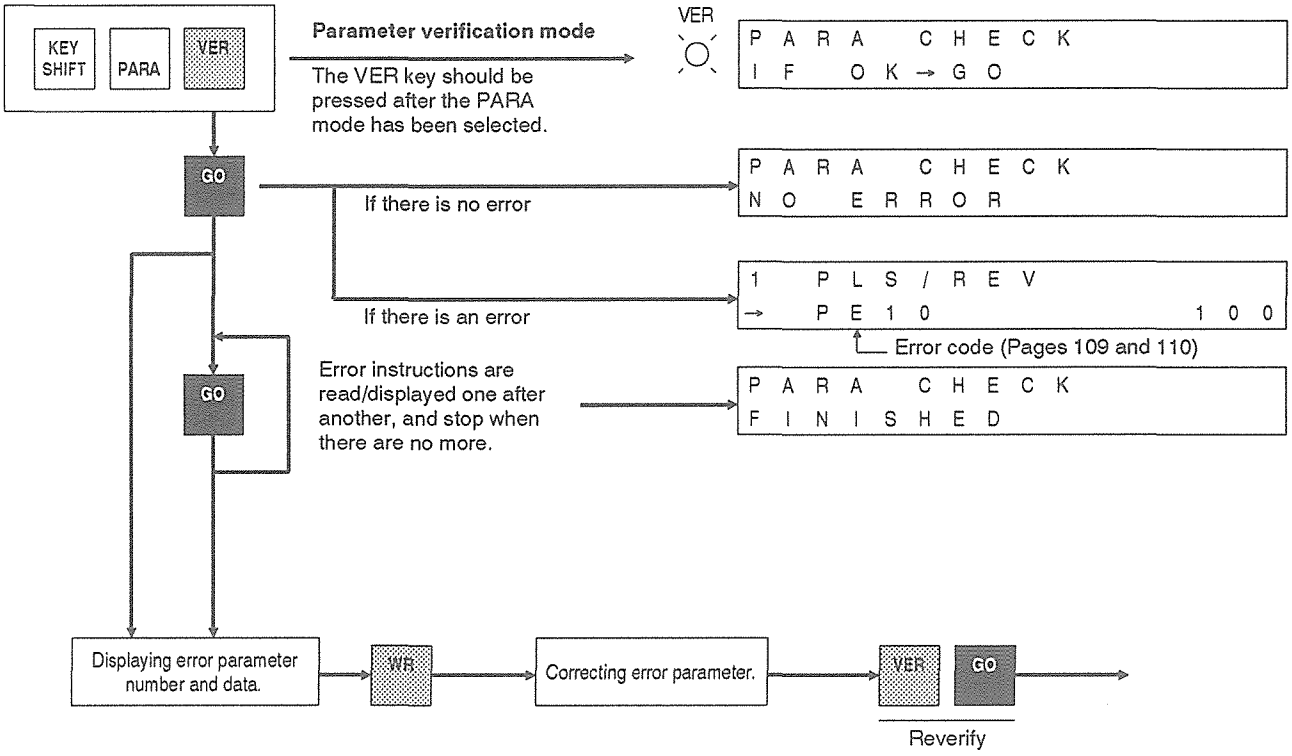
Changing the value of parameter number 4 from 100,000 to 20,000 when parameter number 0 is set to "1".



4.9 Parameters Can Also be Checked

Parameter checking and error codes

The parameter errors can be checked automatically in accordance with the following procedure:



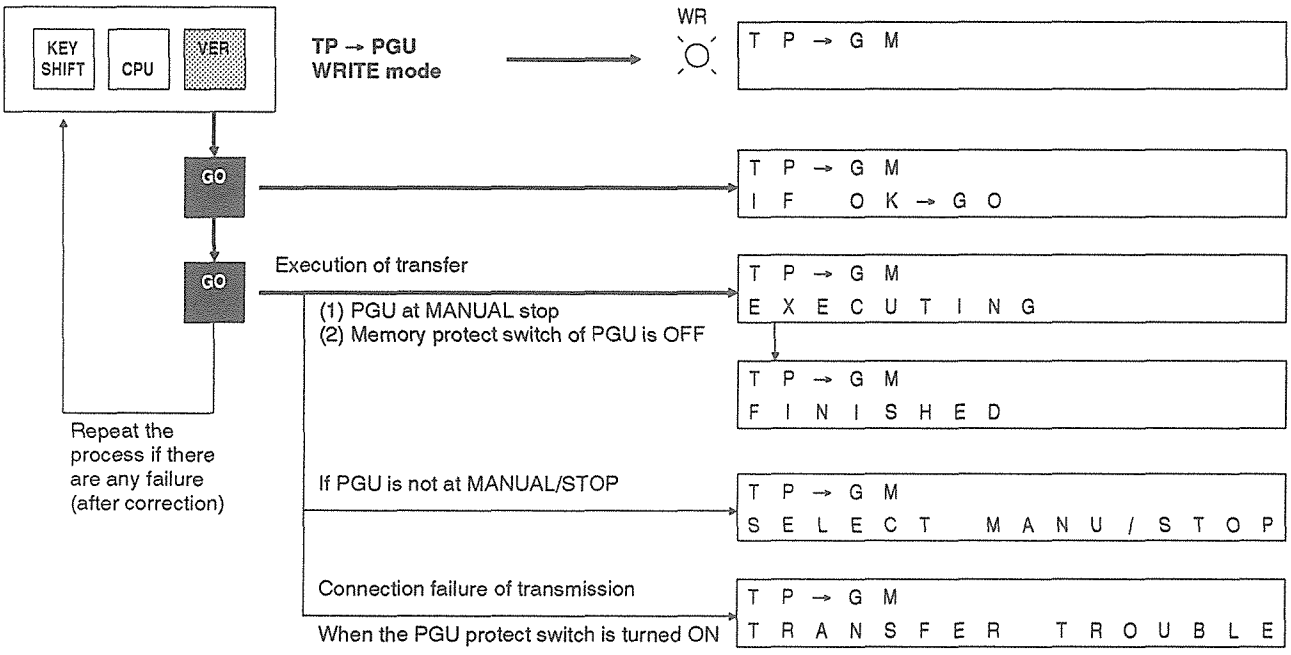
Drive errors due to the system unit

- The proportion between pulse rate A (1 to 65,535) of PARA number 1 and feed rate B (1 to 999,999 μm/REV, mdeg/REV, x10 $^{-4}$ inch/REV) of PARA number 2 need not be an integral value.
- *If the movement distance "C" (μm, mdeg, x10 $^{-4}$inch) is generated, A/B x C indicates the* amount of pulses generated by the PGU.
- There is no immediate significant error if A/B x C is not an integral value.
  However, the size of the error will accumulate if it is operated repeatedly using the relative drive instruction. In the case of absolute drive, an error of 1 pulse may occur due to rounding.

4.10 Transferring Programs and Parameters

Transferring/writing to the PGU

Execute the writing of both programs and parameters together from the TP after turning the PGU to MANUAL & STOP, and also turning the EEPROM memory protect switch OFF.

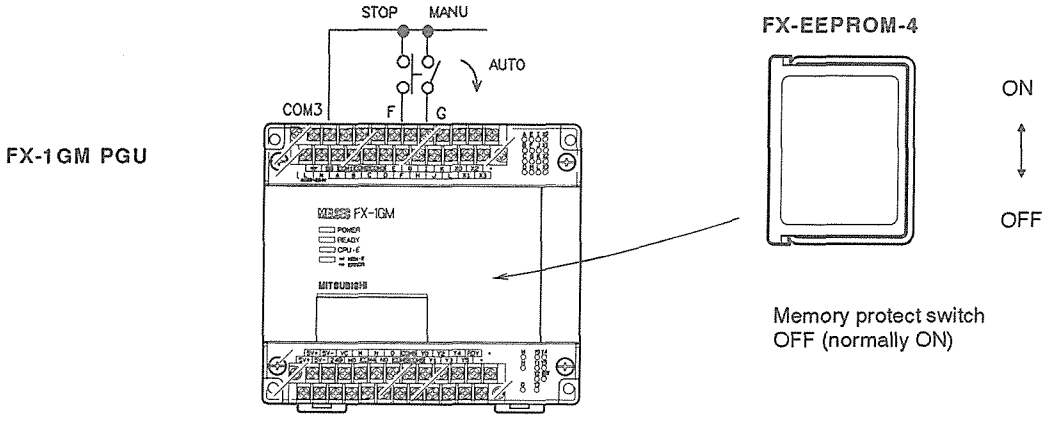


Precautions when writing to the PGU

When transferring/writing programs or parameters from the TP to the PGU, the following preparations must be done. (The same applies when the TEST mode is used.)

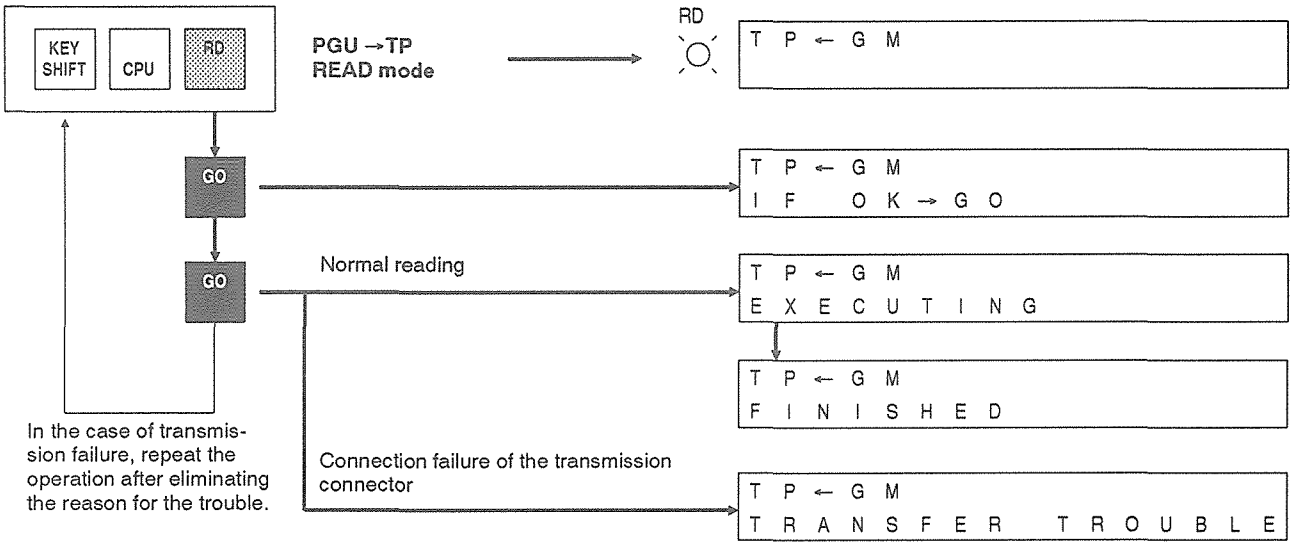
(1) Do not attempt to execute manual operation of XRN, FWD, RVS, etc.
If the home position return is in operation, wait for the completion of this operation, or use the STOP input to stop the operation.

(2) Turn OFF the memory protect switch of the FX-EEPROM-4 ROM cassette.



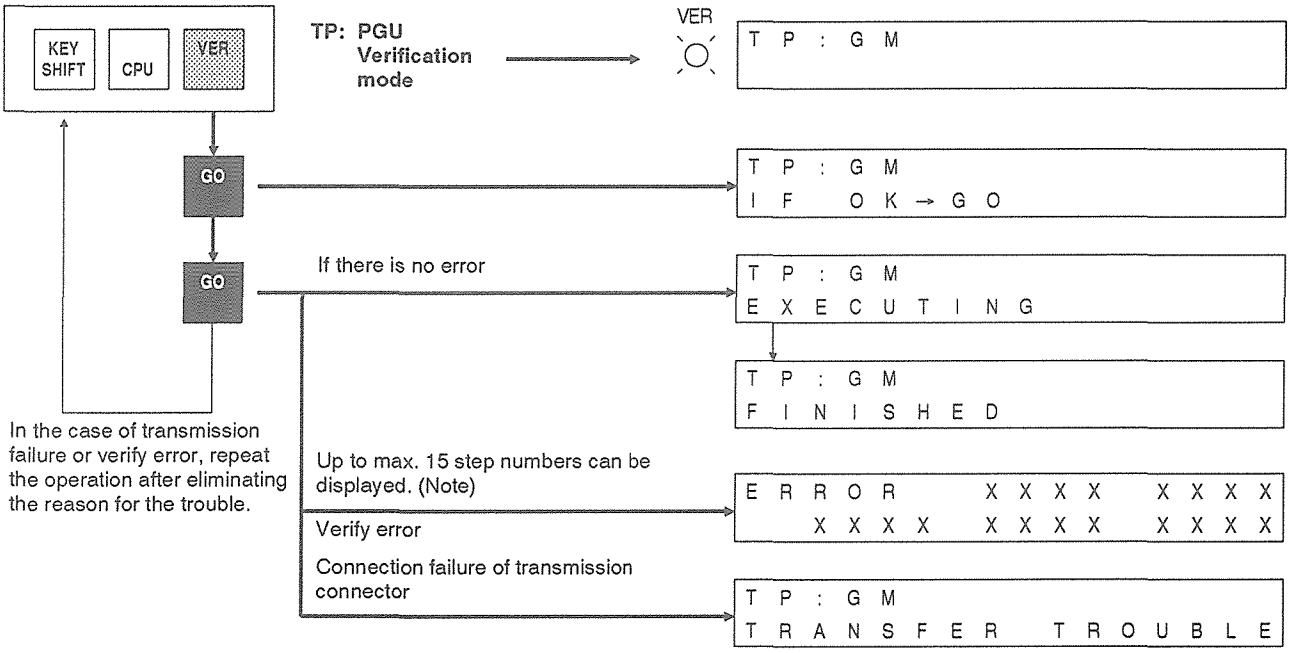
Reading from the PGU

Execute the reading of programs and parameters from the FX-EEPROM-4 ROM cassette built in the PGU to the TP. (In this case, data in the TP is destroyed.)



PGU/TP verifying

Execute verifying/comparing of programs and parameters in the PGU and the TP.
If there is any inconsistency, the relevant step number is displayed.



Note: Inconsistent step numbers of parameters and programs are given as follows:

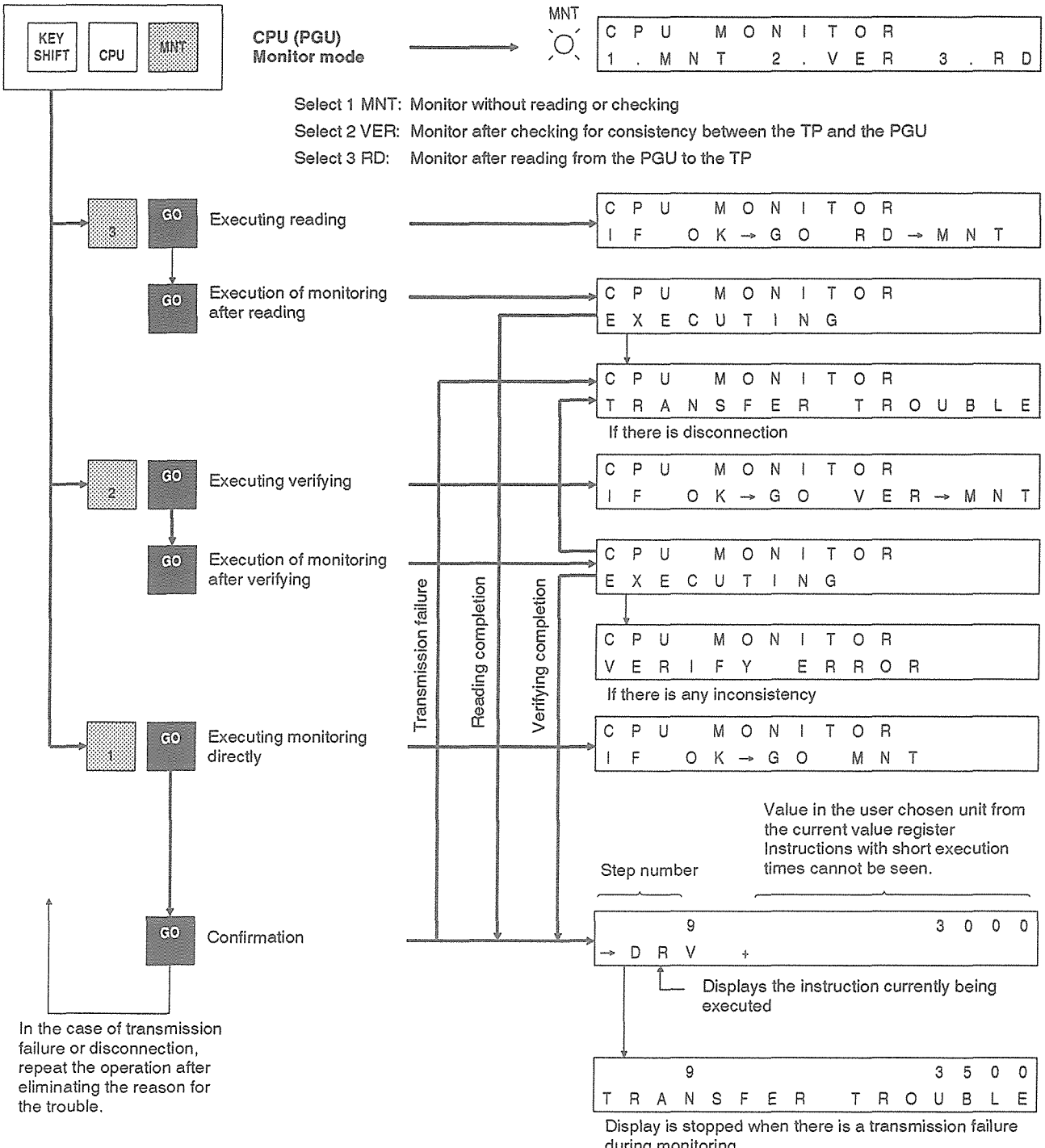
20□□ (In the case of parameter number 14, for instance, 2014 is displayed.)

└── Inconsistent parameter number

4.11 Starting Operation

Monitoring operation

The operating condition of the PGU in the AUTO or MANUAL mode can be monitored by using the TP.



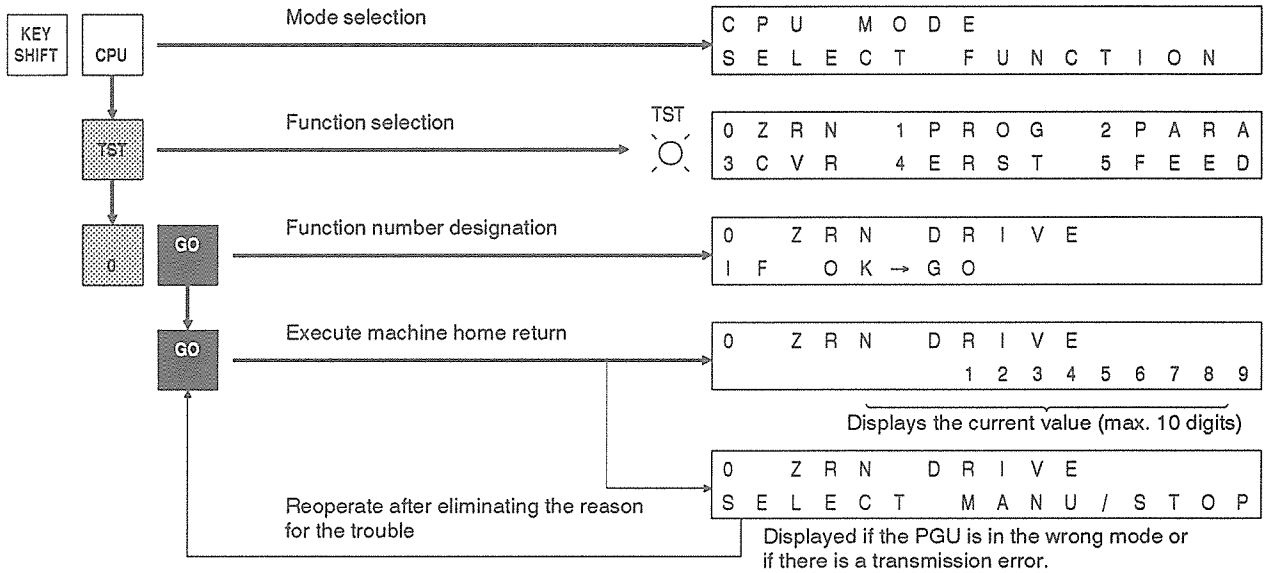
STOP

When the STOP key is pressed during an operation, the machine decelerates and stops.
When a START command is given to the PGU, operations such as END return, remaining operation discontinuation, or operation continuation from the current status are executed according to the PARA number 17 setting.

4.12 Other Useful Functions

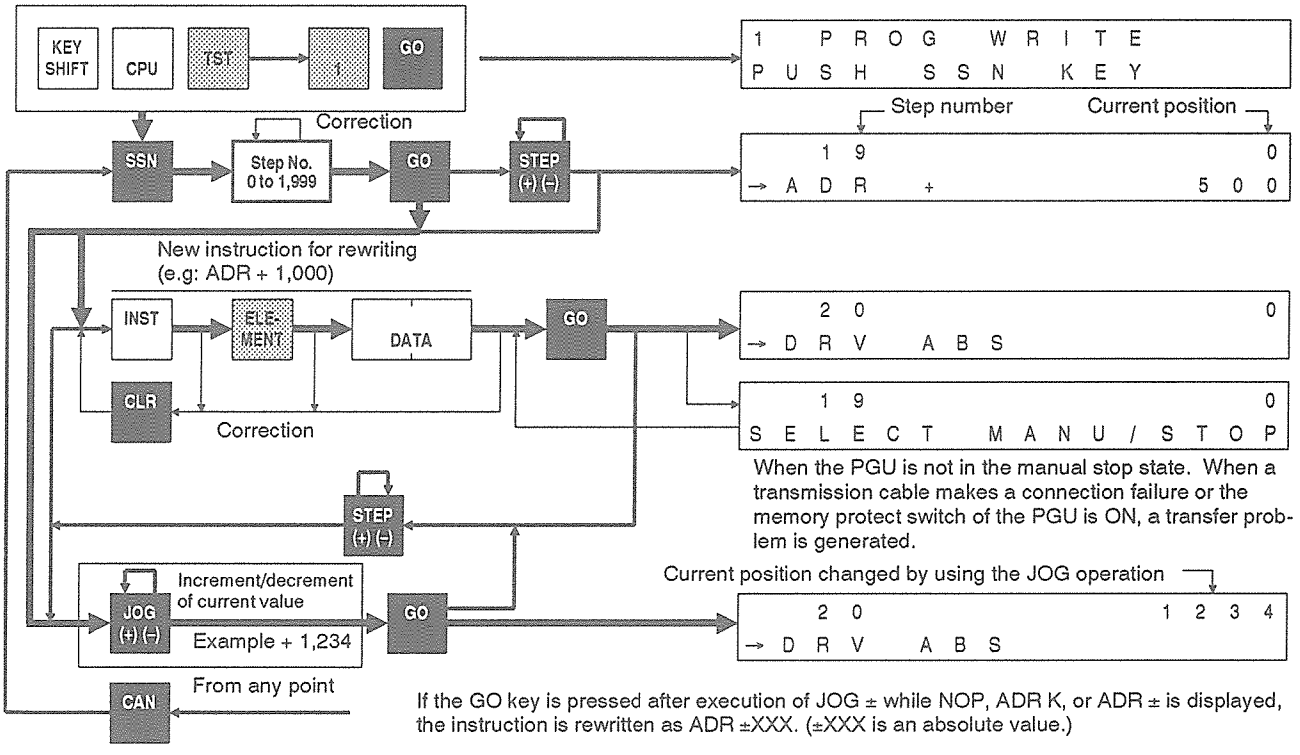
Manual home position return

It is possible to execute the manual home position return operation from the TP when the PGU has stopped in the MANUAL mode.



Program rewrite

In the CPU TEST mode, changes are made to the PGU EEPROM and the TP memory simultaneously.
The PGU must be in stopped and in the MANUAL mode, with the memory protect switch OFF.
The position address can be rewritten directly or by using the JOG function.
The user can program the target address more easily by actual machine movement utilizing the JOG ± keys. See page 129 during automatic operation.



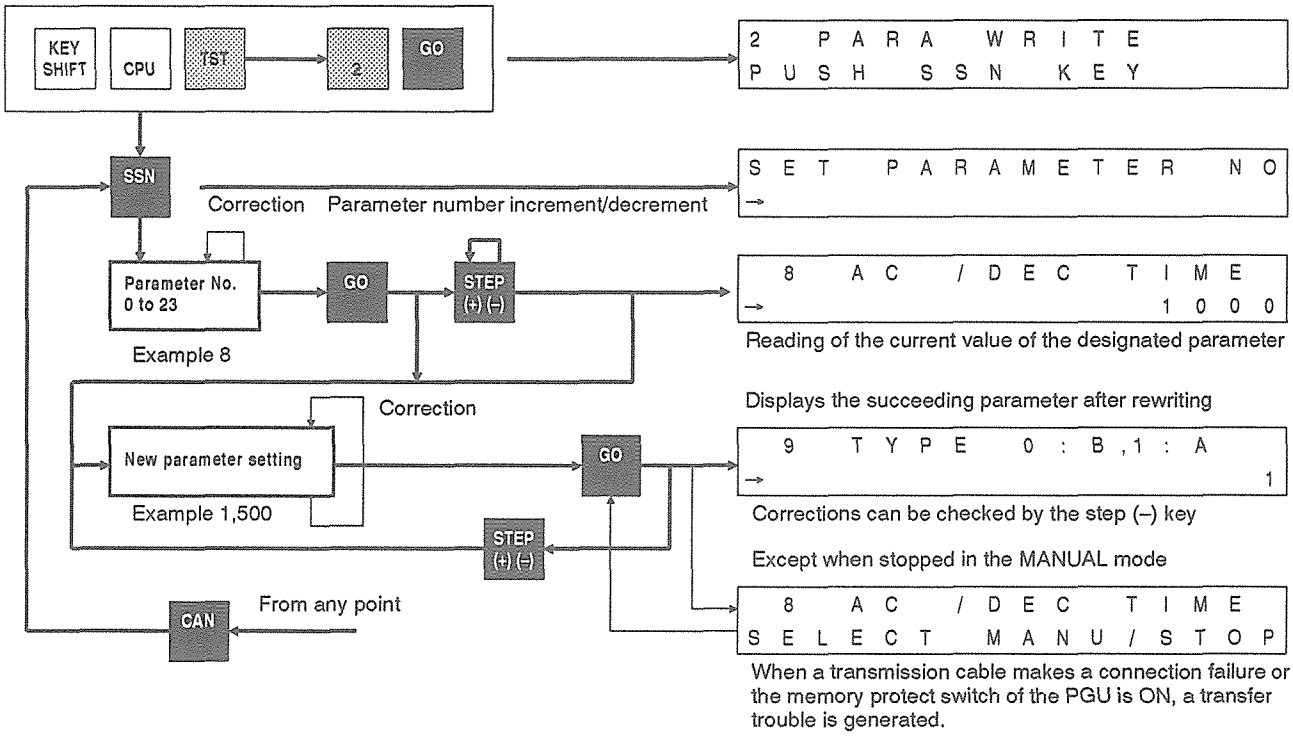
4 HOW TO OPERATE THE TEACHING PANEL

In the CPU TEST mode, the following function numbers may be selected:

0: Manual home position return
1: Rewriting of program (PGU, TP)
2: Rewriting of parameter (PGU, TP)
3: Correction of current value
4: Error reset
5: Fixed length feed

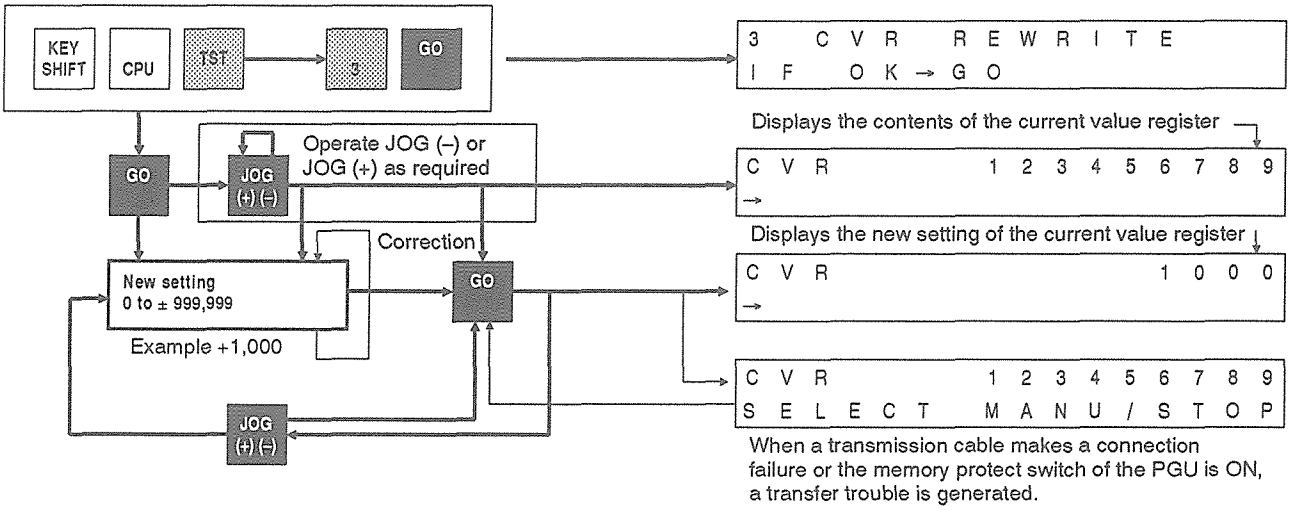
Parameter rewriting

It is possible to rewrite TP parameters while the PGU continues, when the memory protect switch of the PGU is OFF in the MANUAL mode. However, the PGU must be stopped first.



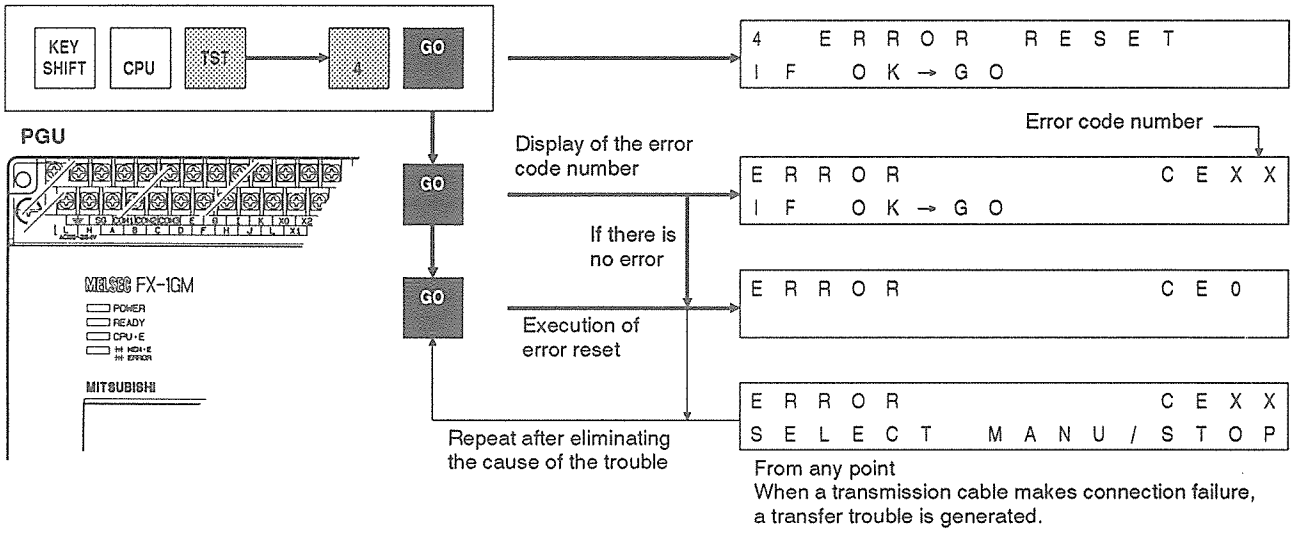
Overwriting the current value register

Rewrite the contents of current register with the currently keyed-in data with the PGU stopped in the MANUAL mode.
This register stores the current position address of the machine.



Error display/reset

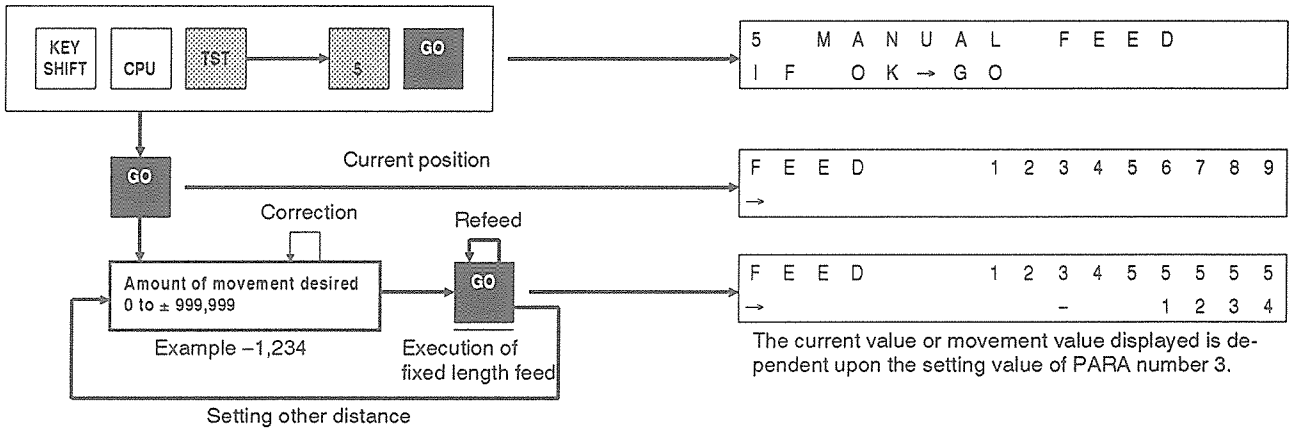
When an error occurs in AUTO mode of the PGU, the error code can be read if the mode is changed to the MANUAL mode using the following operation.



When the error is reset, the LED of the PGU is turned OFF and the error detection signal BFM#3 b6 to the programmable controller is also turned OFF.
It can also be reset by turning on the STOP input manually. However, care must be taken in this case, as the error code is reset and lost. (Error code: see pages 108 to 110.)

Fixed length feed

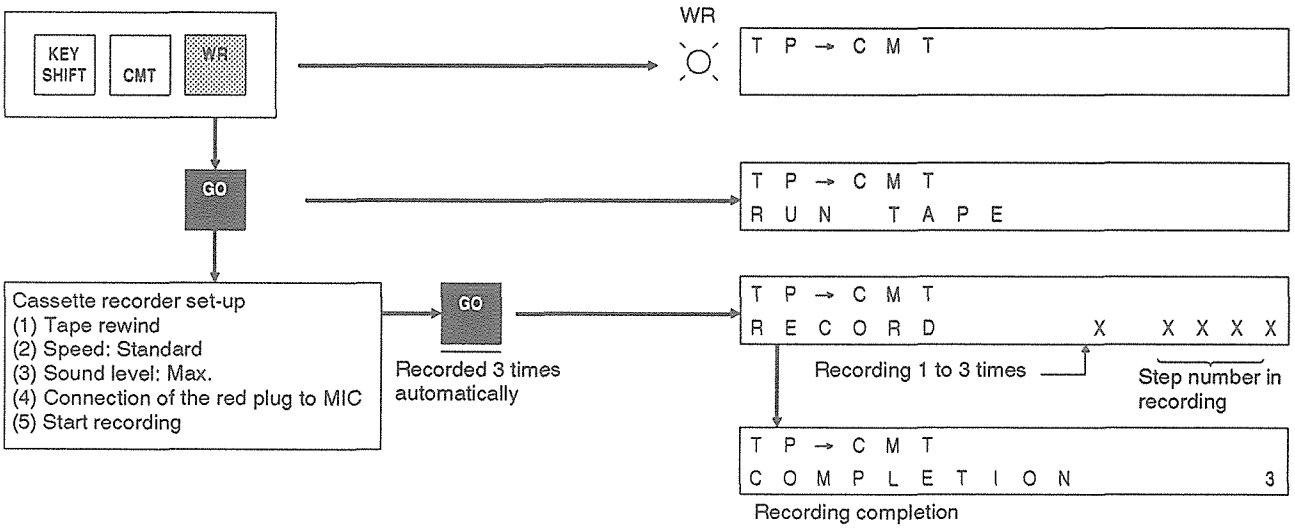
The fixed length feed operation can be executed from the teaching panel. The system unit in this case is dependent upon the setting value of PARA number 3.



4.13 Using a Cassette Recorder

Transfer/writing to a cassette recorder (CMT)

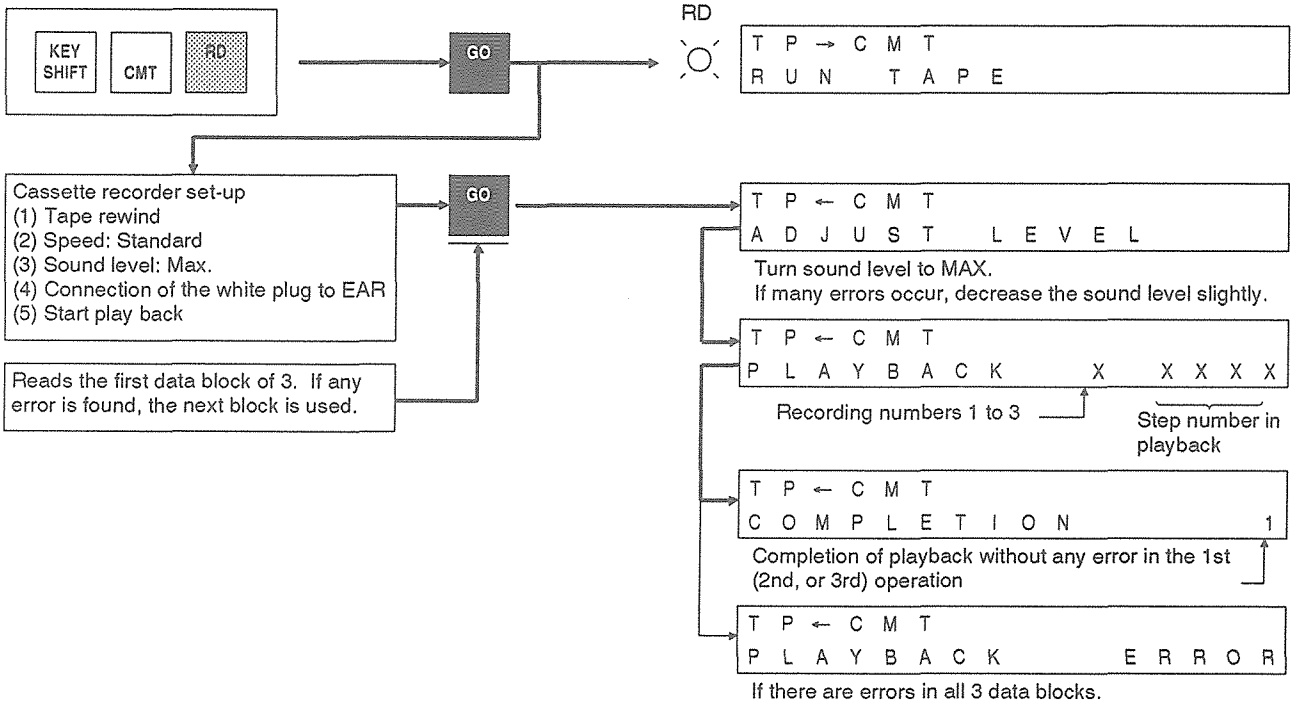
Execute the transfer/writing of programs and parameters together from the TP to the CMT.



Execution is interrupted with the [CAN] or [KEY SHIFT] + [MODE].
Continuation is not possible.

Transfer/reading from the CMT

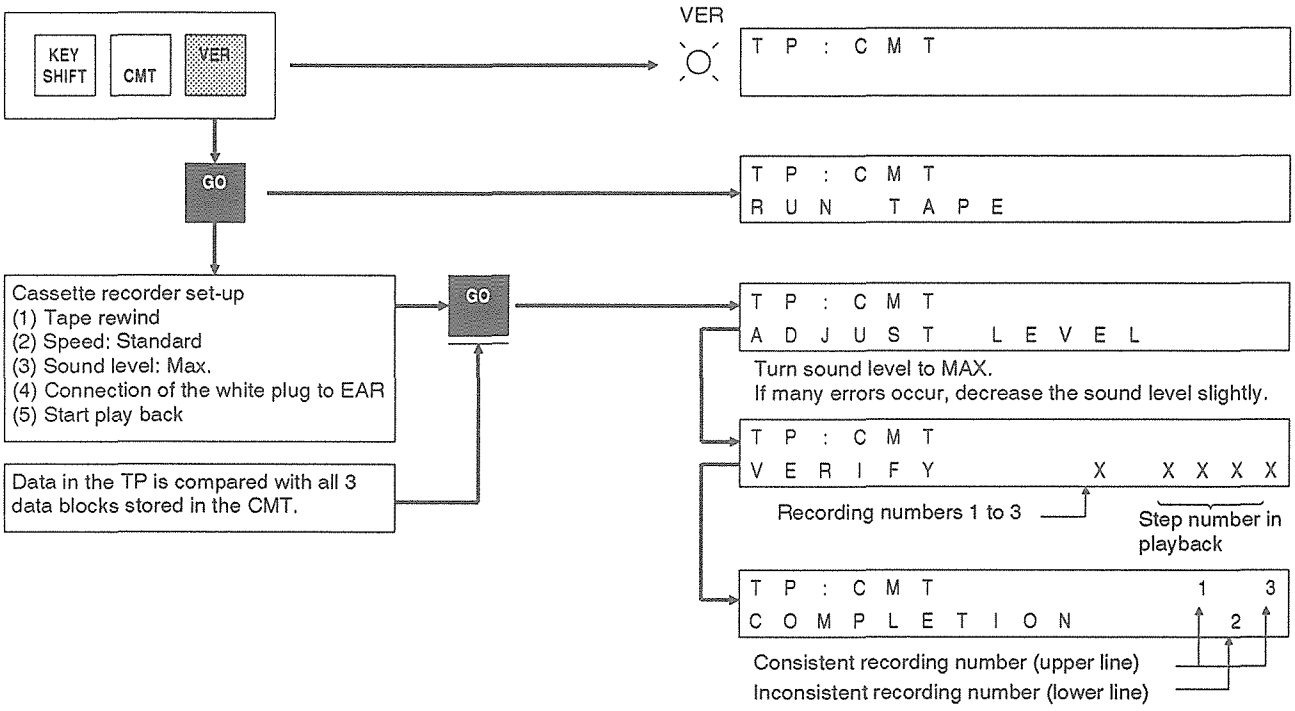
The transfer/reading of programs and parameters can be executed together from the CMT to the TP.



Execution is interrupted with [CAN] or [KEY SHIFT] + [MODE].
Continuation is not possible.

Verification between the TP and CMT

Batch verification of programs and parameters can be executed between the TP and the CMT.



Execution is interrupted with the [CAN] or [KEY SHIFT] + [MODE].
Continuation is not possible.

Handling of the cassette recorder

Be careful not to apply any shock to the cassette recorder or change the tape speed during recording or playback. Set the sound level to MAX.
If many errors occur, try decreasing the sound level slightly.

Connect the red plug to the MIC terminal when recording, and the white plug to the EAR terminal when playing back respectively.
Connect only 1 of the plugs at any 1 time.
Do not attempt to connect the black plug, as REMOTE start is not used in this case.

Use an audio cassette tape which lasts longer than 30 min.

5 PROGRAM CREATION APPLICATION EXAMPLES

Putting theory aside

The fastest way to understand program creation is to learn by programming and monitoring simple examples.

This section not only shows just how to create a program, but also shows how to check for troubles by using the equipment listed below.

Since the drive unit and motor are not used, always be sure to check the current position by using the monitor display of the TP when a simulation is in progress.

Items to prepare

Items related to the programmable controller

(1) FX-20P programming panel 1

(2) FX-32MR programmable controller 1

(3) FX-32SW simulation input switch 1

Items related to the PGU

(1) FX-1GM PGU 1

(2) F_2-30TP TP 1

(3) F_2-30GM-SIM simulation kit 1

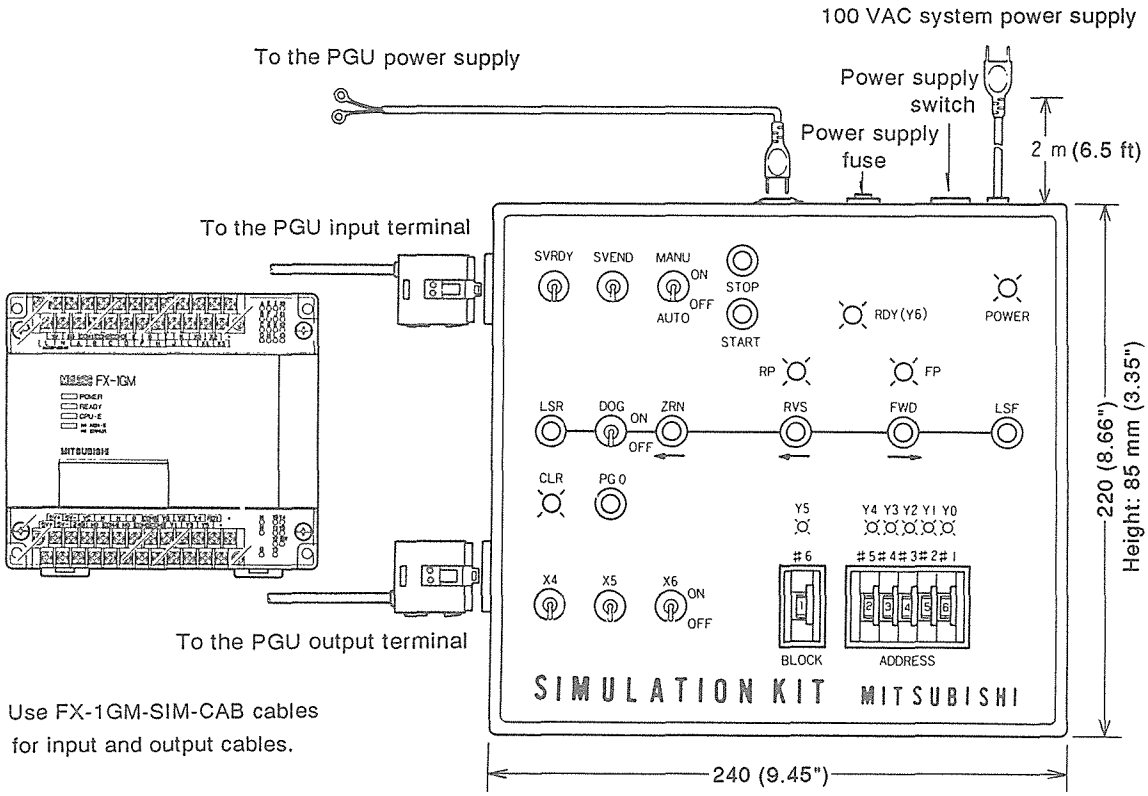
(4) FX-1GM-SIM-CAB cable ..... 1 set

For application examples 1 and 2, it is not necessary to prepare the programmable controller or its related parts.

5 PROGRAM CREATION APPLICATION EXAMPLES

5.1 Kit Familiarization

5.1.1 General description of the F_2-30GM-SIM kit



Operation procedure

MANUAL mode

- When the ZRN button is pressed, the machine home position return is started. If the PG0 button is pressed 10 times with the DOG input turned ON, the CLR lamp is turned ON at the same time, indicating that home position return has been completed. In this case, the home position address becomes 0.
  After completion of the above, always be sure to turn the DOG switch to OFF.
- When the FWD button or RVS button is pressed, the machine is moved forward or backward. In this case, the FP or RP lamp flickers.

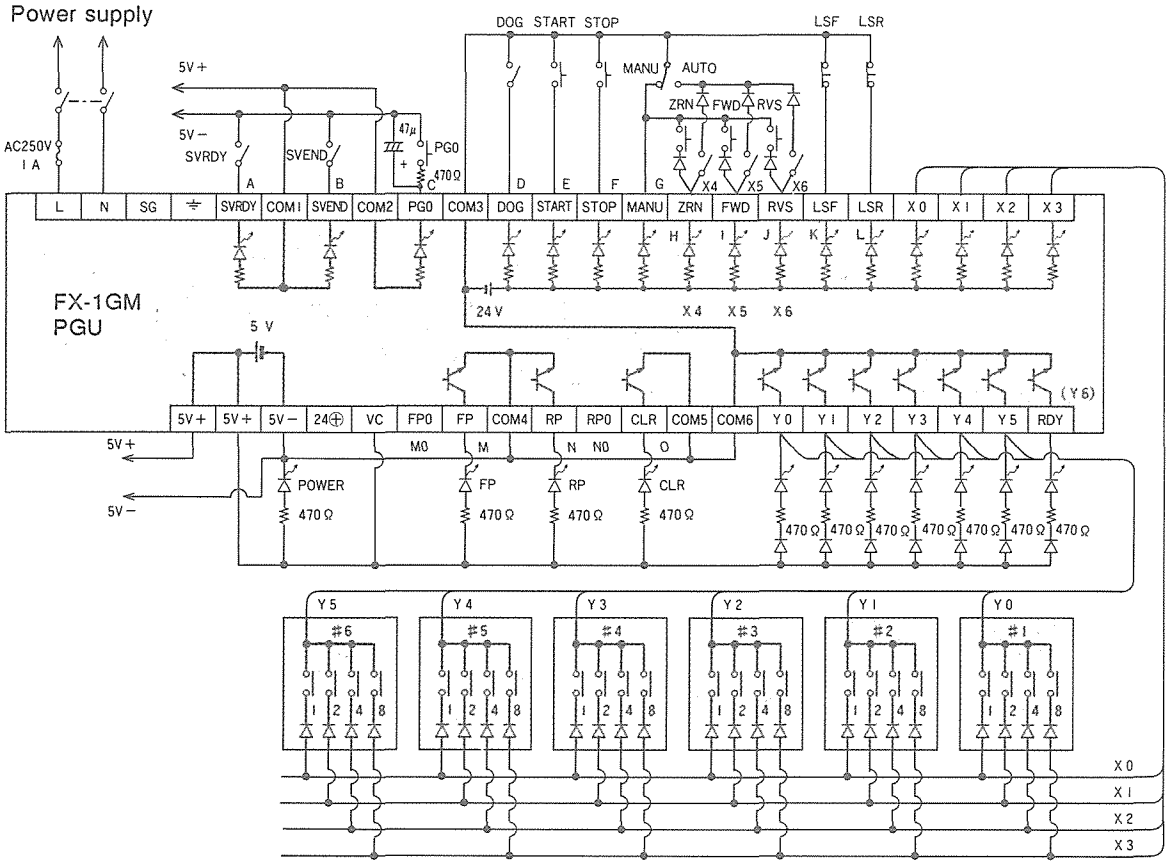
AUTO mode

- Keep the SVRDY and SVEND switches turned ON. This operation is not possible if SVRDY is turned OFF. In addition, an error will occur when a drive instruction has been completed when the SVEND is turned OFF.
- To simulate the action of a positioning mechanism, the DOG switch must be turned ON manually. Then, press the PG0 button the required number of times when executing a machine home position return instruction in the AUTO operation mode.

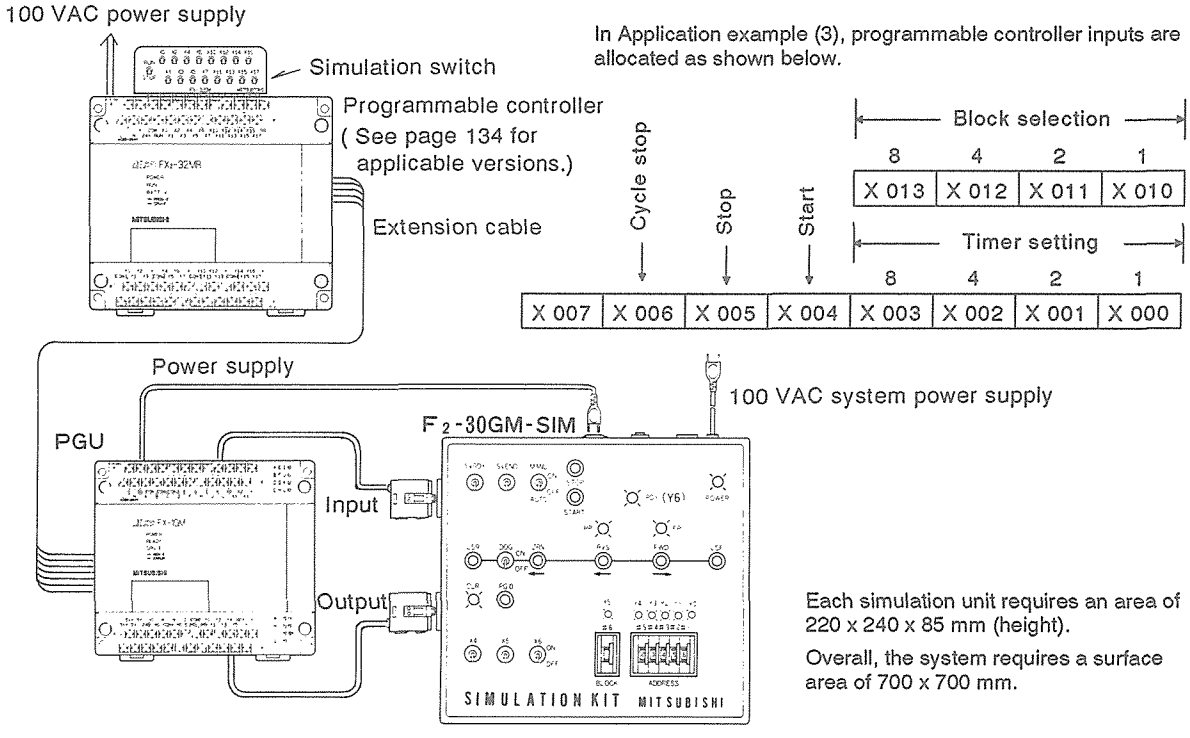
Parameter

- Always be sure to set all the parameter settings to the values shown in the following examples.

5.1.2 Internal wiring of the kit



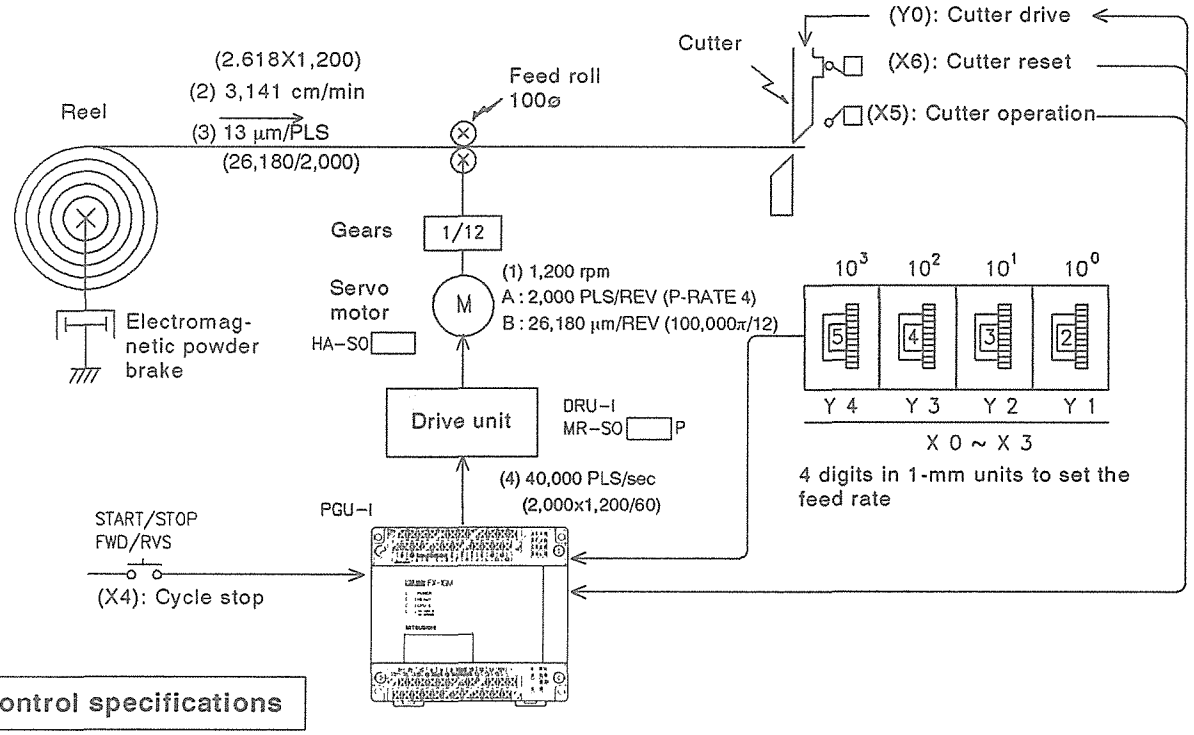
Overall connection



5.2 Learning Application Programming (1)

Application example (1)

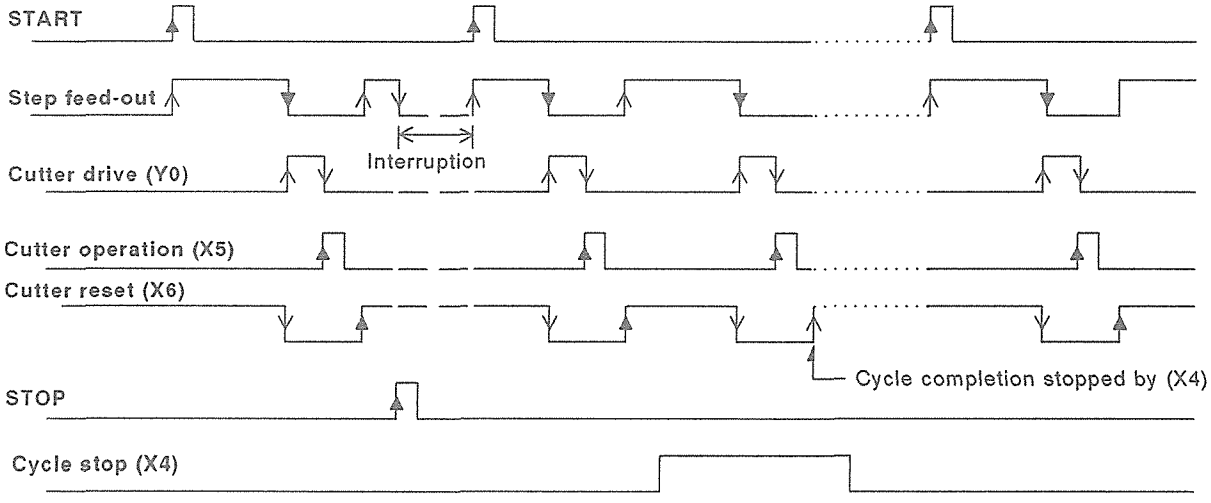
Fixed size cutting unit set by the operator



Control specifications

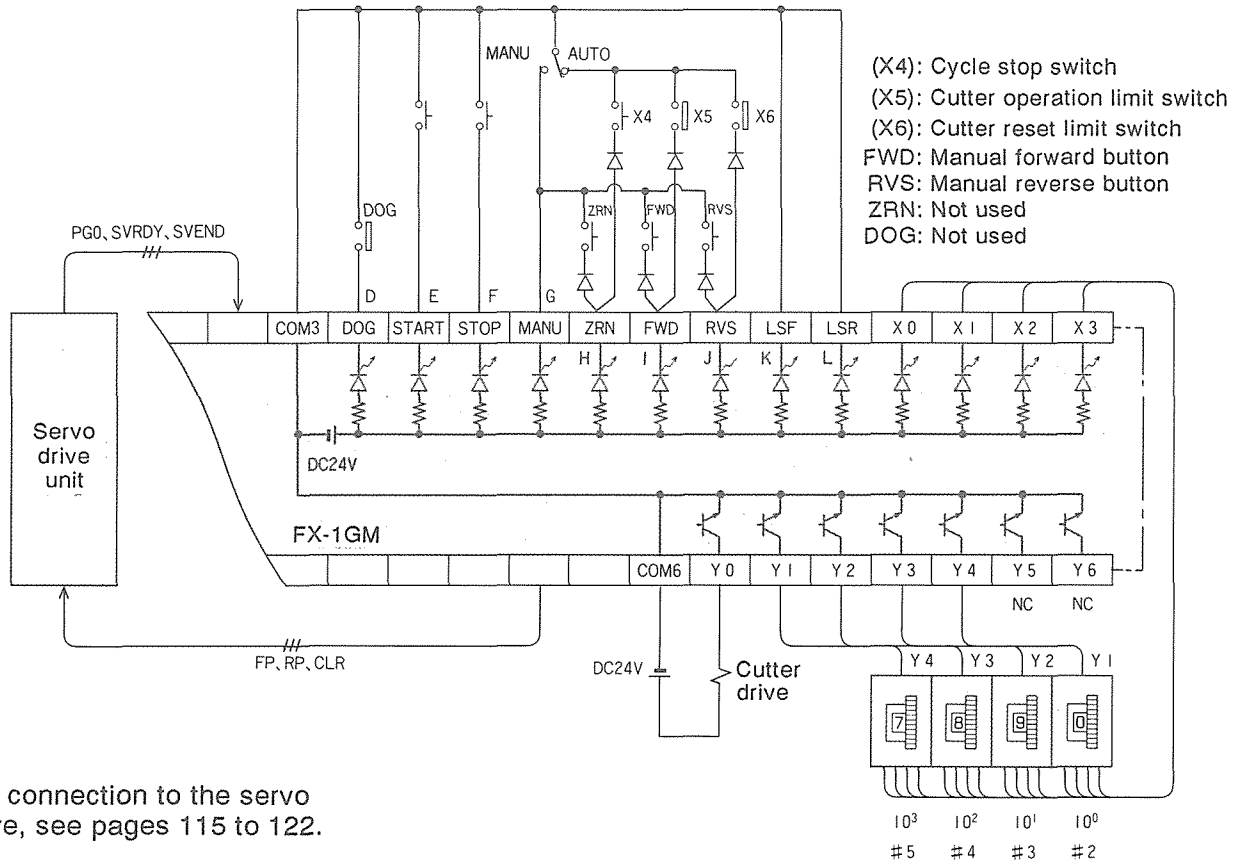
The programmable controller is not used in this example.

- The lengthy material wound on the reel is unwound by the servo motor and cut by the cutter. The fixed feed-out dimension is a variable set by the 4-digit switch. The cutter is driven by output Y0 of the PGU-1. The X5 and X6 limit switches must be prepared for checking the operation.
- Before switching to AUTO, the material must be between the feed rollers. A cycle stop can be done by the X4 input in addition to the available immediate STOP input.



5 PROGRAM CREATION APPLICATION EXAMPLES

(1) External connections diagram



For connection to the servo drive, see pages 115 to 122.

(2) Required parameter settings

Parameter Numbers	Required Settings (at Delivery)	Units
PARA-0 System unit	0	Machine system unit
PARA-1 Pulse rate	(2,000)	PLS/REV
PARA-2 Feed rate	26,180	μm/REV
PARA-3 Unit scale	0	mm
PARA-4 Max. speed	3,141	cm/min
PARA-5 Manual JOG speed	300	cm/min
PARA-6 Bias speed	(0)	cm/min
PARA-7 Backlash compensation	(0)	μm
PARA-8 Acceleration/deceleration time	(1,000)	msec
PARA-9 Pulse output mode	(1)	Forward pulse Backward pulse
PARA-10 Pulse logic	(1)	High to low trigger
PARA-11 Rotation direction	(0)	Increase the current value using the forward pulse

Parameter Numbers	Required Settings (at Delivery)	Units
PARA-12 Ultimate LS logic	(1)	Normally close
PARA-13 Error judgment time	(5,000)	msec
PARA-14 Block designation	0	Block 0 only
PARA-15 Position bias	(0)	μm
PARA-16 Setting of RDY output Y6	(0)	RDY valid
PARA-17 STOP mode	(1)	STOP valid
PARA-18 Home position return direction	(1)	Address decrement
PARA-19 Home position address	(0)	mm
PARA-20 Home position return speed	3,141	cm/min
PARA-21 Creep speed	30	cm/min
PARA-22 Down counts to home position	0	Times
PARA-23Count start logic	(0)	OFF → ON

(3) Coding

The following instructions form the program for this fixed size cutting example.

Step Numbers	Instructions			Descriptions
0	BLK	K	0	Only BLK K0 is valid, as PARA-14 is set to "0".
1	LAB	K	0	Designates the start step for a continuous repeat operation.
2	SET	+	0	Sets the current value register to "0".
3	EXT	K	5432	Designates the relative movement distance by using digital switches #5, #4, #3, and #2. (absolute address EXT+5432 is also applicable.)
4	DRV	+		Drives the distance set by digital switch. (DRV ABS is used for EXT+5432.)
5	SET	Y	0	SVEND signals the end of DRV and step 5 sets Y0 (cutter) ON.
6	LAB	K	1	Cycles between steps 6 and 8 until the cutter operation checking limit switch X5 is turned ON. X5 must be kept ON for more than approx. 10 msec. (Note)
7	LD	X	5	
8	CJN	K	1	
9	RST	Y	0	Resets the cutter drive output Y0 when the cutter is operated.
10	LAB	K	2	Cycles between steps 10 and 12 until the cutter reset checking limit switch X6 is turned ON. (Note)
11	LD	X	6	
12	CJN	K	2	
13	LD	X	4	Operates from step 1 again unless the cycle stop input X4 is turned ON. END when X4 is turned ON.
14	CJN	K	0	
15	END			Waits for the start command (condition before starting a block execution).

Note: Since the FX-1GM employs a sequential instruction-by-instruction operation, the ON/OFF condition will not be read unless the instruction concerned is being executed.

In this regard, the FX-1GM uses such a cycle method to wait for the input.

Momentary operations such as pushbuttons, etc. will not be accepted if the pulse is less than 10 msec (except for INT and VCH instructions).

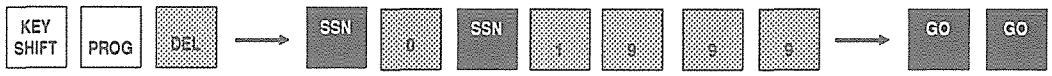
(4) Program preparations

(a) Turn OFF the memory protect switch of the FX-EEPROM-4 ROM cassette mounted onto the PGU (always be sure to turn it ON after programming has been completed.).

(b) Connect the PGU to the F_2-30TP TP with the transmission cable, and then turn ON the power to the PGU.

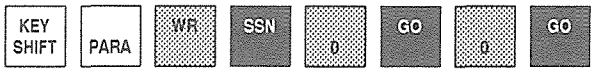
(c) Turn ON the MANUAL input of the PGU.

(d) Execute an all-program deletion in the TP by using the following procedure:

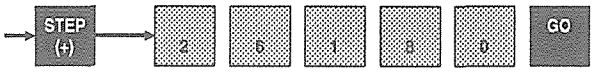


(5) Parameter rewriting

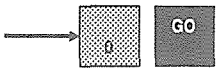
Rewriting parameters prior to program creation.



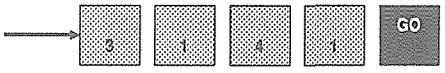
PARA No.0 → [0]



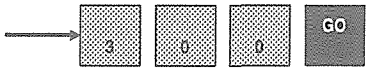
PARA No.2 → 26,180



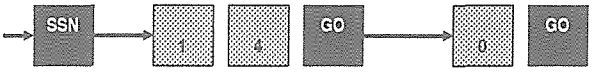
PARA No.3 → 0



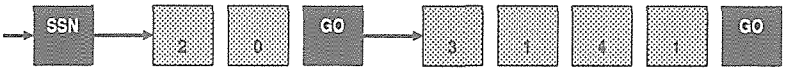
PARA No.4 → 3,141



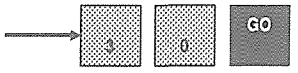
PARA No.5 → 300



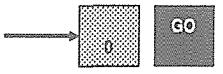
PARA No.14 → 0



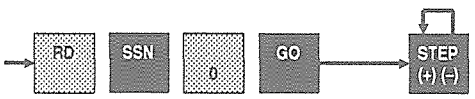
PARA No.20 → 3,141



PARA No.21 → 30



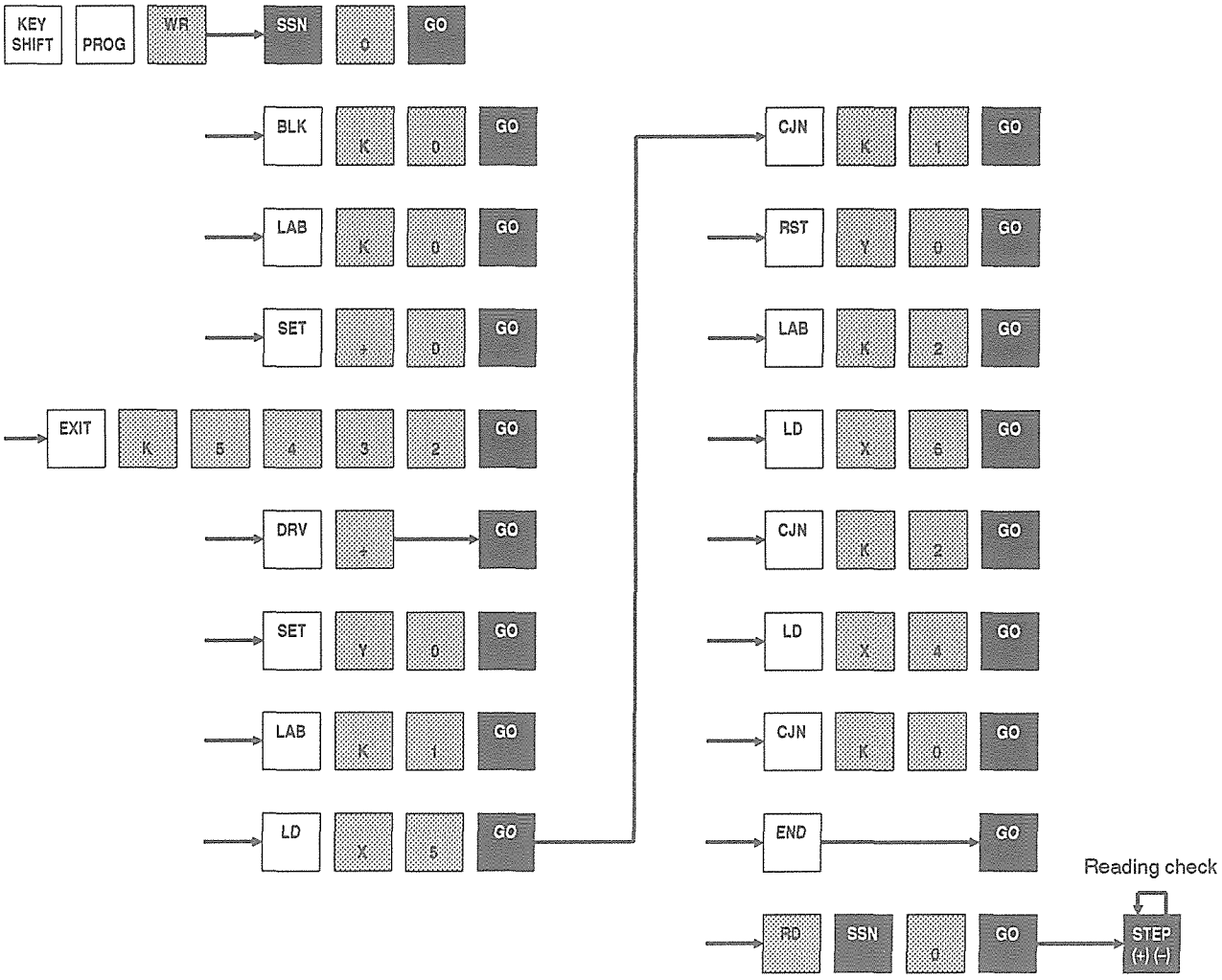
PARA No.22 → 0



Reading check

(6) Program writing

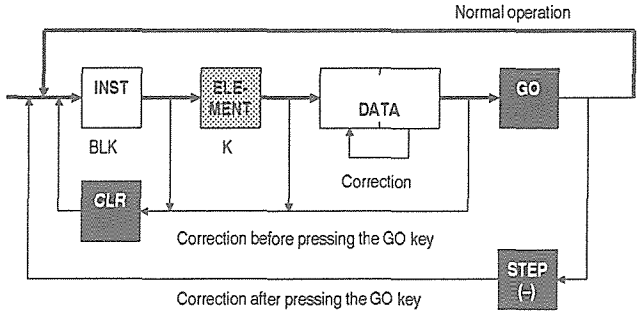
Execute the program writing as shown below in accordance with the program in the coding sheet.



Correcting

When A key operation is executed incorrectly while writing an instruction, it can be corrected by the following procedure:

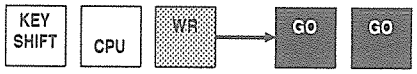
(For the full procedure, see page 53.)



(7) Operation procedure

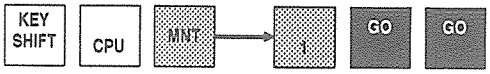
Writing to the PGU

During the MANUAL stop



Transfer

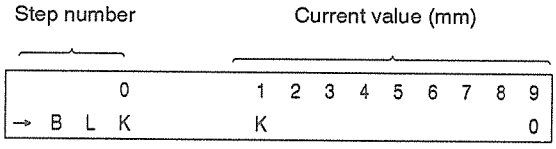
Monitoring operation



Monitor execution (MANUAL/AUTO)

MANUAL operation

- Keep the MANUAL/AUTO input switch turned to MANUAL during manual operation. (When it is necessary to clear the contents of the current value register in the PGU, this can be done in the CPU TST mode.)
- When the FWD button is pressed, the forward operation is executed. When the RVS button is pressed, the backward operation is executed. Both of these can be monitored by looking at the current value displayed by the TP.

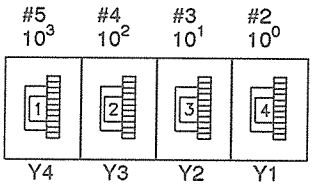


AUTO operation

SVRDY = ON

SVEND = ON

- Turn the MANUAL/AUTO switch to AUTO.
- Set the digital switches as shown below (for example).

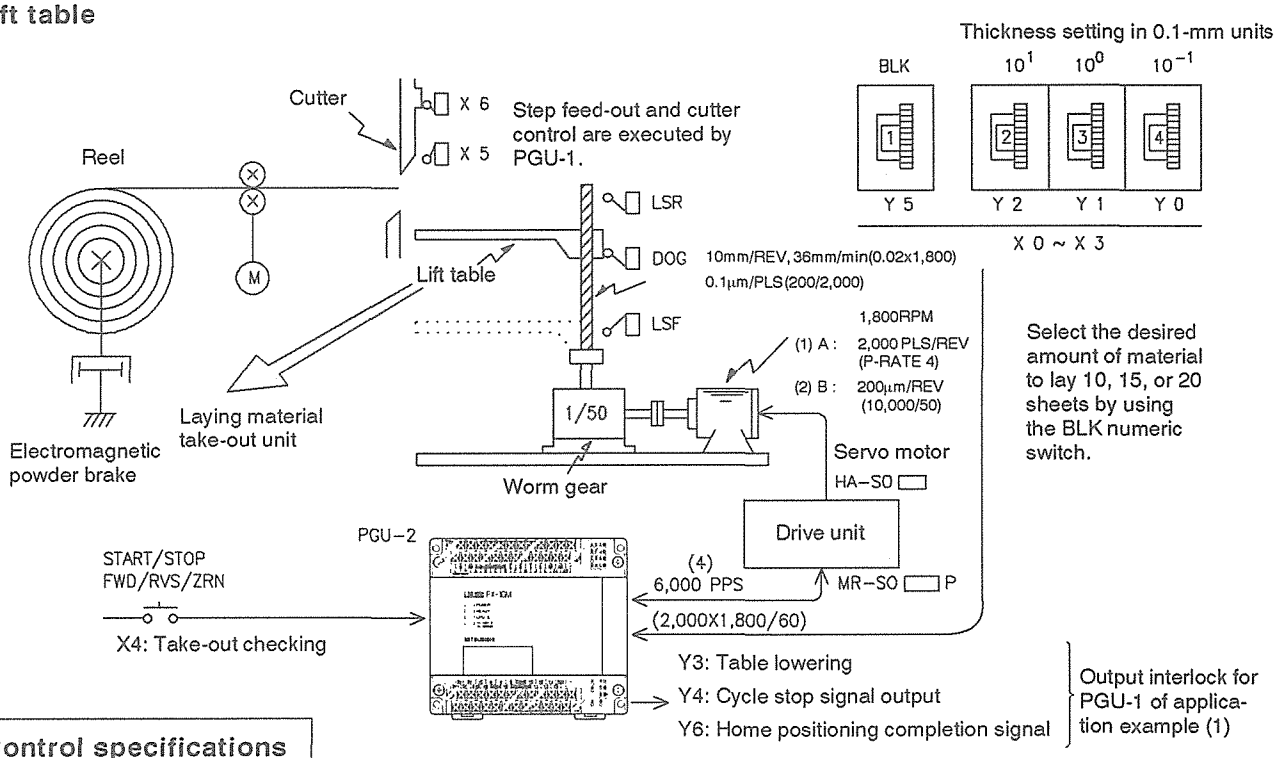


- When the START button is turned ON, the forward operation is started, which increases the current value displayed by the TP from 0.
  If the STOP button is pressed in the course of the operation, the movement decelerates and stops.
  If the START button is pressed again, the operation resumes from the current position.
- When the cutter drive output Y0 is turned ON after positioning is completed, the cutter operation should turn limit switch X4 from OFF to ON and then back OFF.
  If the cutter return limit switch X6 is turned from ON to OFF and then ON, the cutting operation is completed and the next step is executed.
- The above operation is performed repeatedly if the cycle stop input X4 is OFF.
  If X4 is turned ON, the operation stops at the end of the cycle at the END instruction.
  Turn ON the START button to restart the operation.
- Note the current value displayed by the TP during this simulation.

5.3 Learning Application Programming (2)

Application example (2)

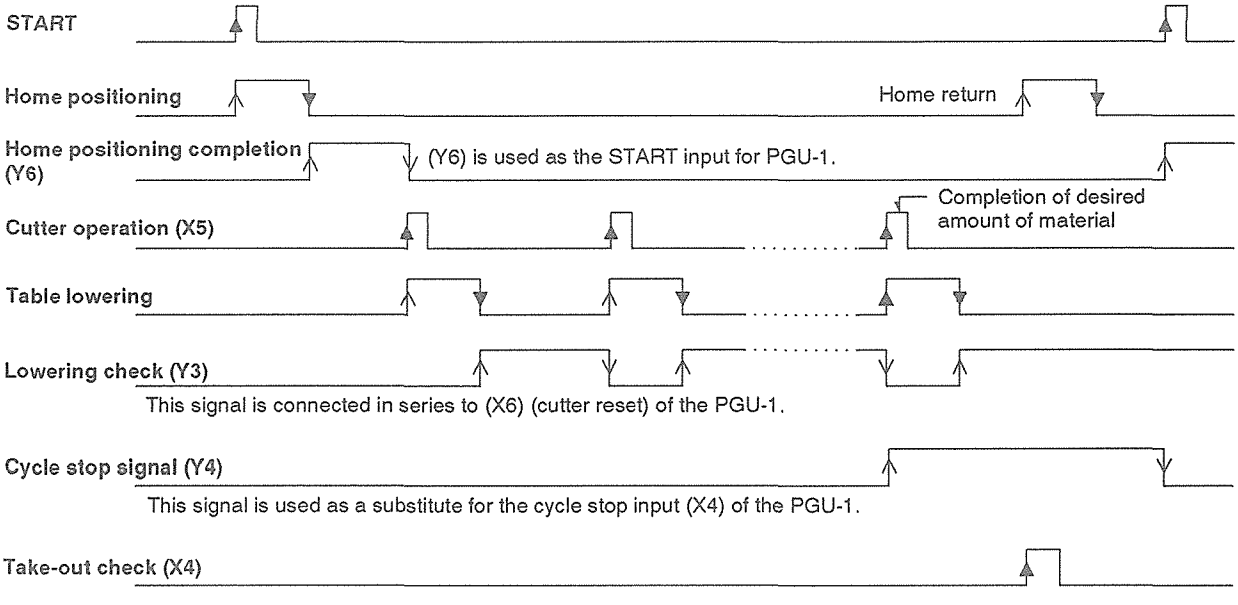
Lift table



Control specifications

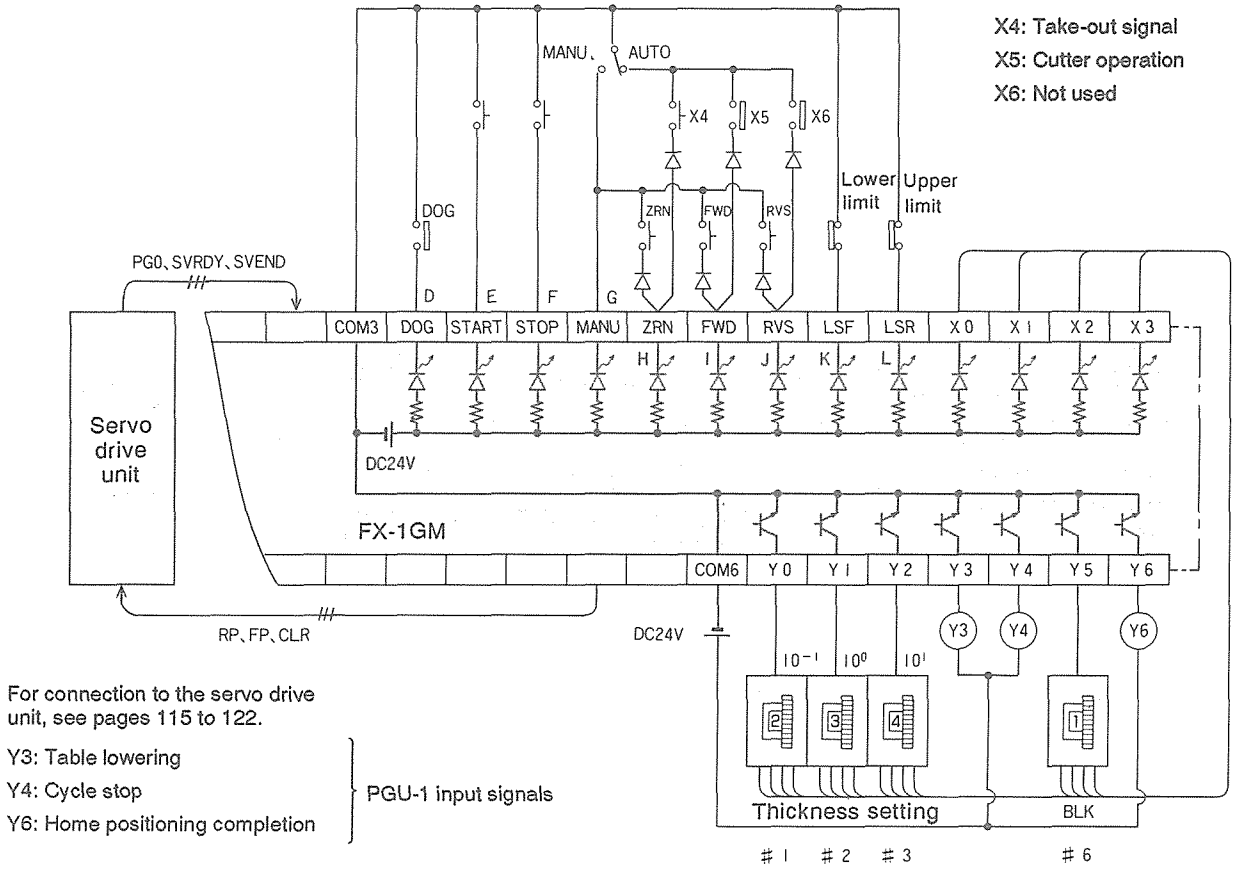
The programmable controller is not used in this example.

- Each time the sheet material is cut by the cutter, the table is lowered by the same amount as the thickness of the cut material.
  When the sheet material cut reaches the desired number of sheets, the operation is completed, and the material on the table is removed by other means.
  In this case, the take-out confirmation switch X4 is actuated.
- It is possible to interlock the operation with the PGU-1 shown in application example (1) by using the general-purpose outputs Y3, Y4, and Y6 (see the next page.).



5 PROGRAM CREATION APPLICATION EXAMPLES

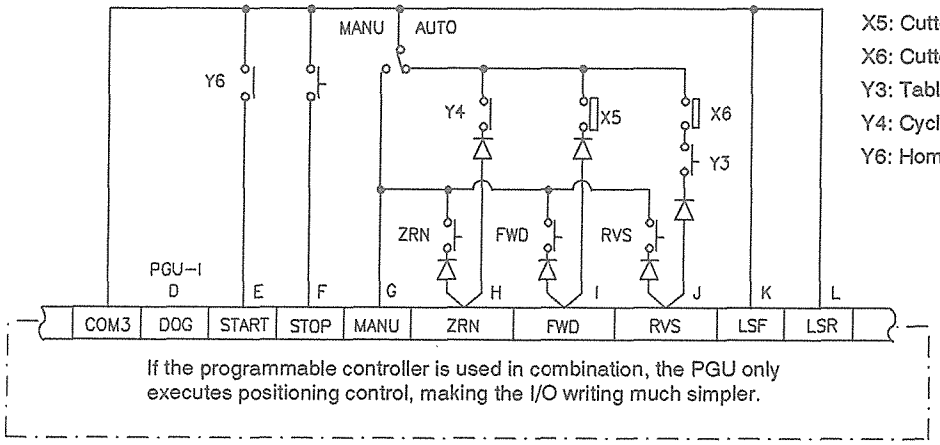
(1) External connections diagram



Synchronizing PGU-1 and PGU-2

Application examples (1) and (2) show cases where the PGU is operated independently without the programmable controller.

Even so, it is possible to perform operations in combination by connecting the output of the PGU-2 to the input of the PGU-1.



(2) Required parameter settings

Parameter Numbers	Required Settings (at Delivery)	Units
PARA-0 System unit	0	Machine system unit
PARA-1 Pulse rate	(2,000)	PLS/REV
PARA-2 Feed rate	* 200	μm/REV
PARA-3 Unit scale	* 1	0.1mm
PARA-4 Max. speed	* 36	cm/min
PARA-5 Manual JOG speed	* 36	cm/min
PARA-6 Bias speed	(0)	cm/min
PARA-7 Backlash compensation	(0)	μm
PARA-8 Acceleration/deceleration time	(1,000)	msec
PARA-9 Pulse output mode	(1)	Forward pulse Backward pulse
PARA-10 Pulse logic	(1)	High to low trigger
PARA-11 Rotation direction	(0)	Increase the current value using the forward pulse

Parameter Numbers	Required Settings (at Delivery)	Units
PARA-12 Ultimate LS logic	(1)	Normally close
PARA-13 Error judgment time	(5,000)	msec
PARA-14 Block designation	* 1	Block 0 only
PARA-15 Position bias	(0)	μm
PARA-16 Setting of RDY output Y6	* 1	RDY valid
PARA-17 STOP mode	(1)	STOP valid
PARA-18 Home position return direction	(1)	Address decrement
PARA-19 Home position address	(0)	mm
PARA-20 Home position return speed	* 36	cm/min
PARA-21 Creep speed	* 3	cm/min
PARA-22 Down counts to home position	* (10)	Times
PARA-23Count start logic	(0)	OFF → ON

Data settings marked with * need to be changed when the data setting used in Application example (1) is used.

(3) Coding

Step Numbers	Instructions			Descriptions
0	BLK	K	0	Program for 10 sheets
1	CALL	K	1	Home positioning
2	RPT	K	9	Repeated 9 times for the first 9 sheets
3	CALL	K	2	
4	PRE			
5	CALL	K	3	Waiting for the final sheet to be taken out
6	END			Waiting for start
7	BLK	K	1	Program for 15 sheets
8	CALL	K	1	Home positioning
9	RPT	K	14	Repeated 14 times for the first 14 sheets
10	CALL	K	2	
11	RPE			
12	CALL	K	3	Waiting for the final sheet to be taken out
13	END			Waiting for start
14	BLK	K	2	Program for 20 sheets
15	CALL	K	1	Home positioning
16	RPT	K	19	Repeated 19 times for the first 19 sheets
17	CALL	K	2	
18	RPE			
19	CALL	K	3	Waiting for the final sheet to be taken out
20	END			Waiting for start
50	LAB	K	1	For CALL K1 (Home positioning)
51	LD	M	100	Normally turned ON if there is no error.
52	RST	Y	3	Table lowering output reset
53	RST	Y	4	Cycle stop output reset
54	LD	M	101	ON after home positioning
55	CJ	K	4	Operate machine home position return and set the general return position if home positioning has not yet been completed.
56	DRV	ZRN		
57	SET	RAD		
58	LAB	K	4	
59	LD	M	101	(Y6) operates and the PGU-1 starts when home positioning has been completed.
60	SET	Y	6	
61	RET			

Continued on next page.

Step Numbers	Instructions			Descriptions
62	LAB	K	2	For CALL K2 (Table lowering after cut)
63	LAB	K	5	Waiting for the cutter operation
64	LD	X	5	
65	CJN	K	5	
66	LD	M	100	Table lowering signal (Y3) and home positioning signal (Y6) are reset after the cutter operation.
67	RST	Y	3	
68	RST	Y	6	
69	EXT	K	321	Table lowered to the setting value of digital switches #3, #2, and #1.
70	DRV	+		
71	LD	M	100	Sets the table ready signal (Y3).
72	SET	Y	3	
73	RET			
74	LAB	K	3	For CALL K3 (Return stacker after sheet removal)
75	LD	M	100	Sets the cycle stop signal (Y4).
76	SET	Y	4	
77	LAB	K	6	Waiting for the cutter operation
78	LD	X	5	
79	CJN	K	6	
80	LAB	K	7	Waiting for the taking out of stacked material
81	LD	X	4	
82	CJN	K	7	
83	DRV	RAD		Home position return
84	RET			

(4) Transfer/writing operation

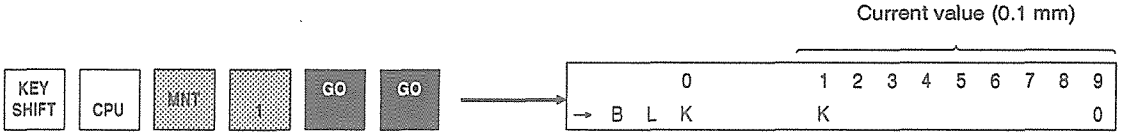
Prepare parameters and programs by using the TP, and transfer them to the PGU-2.
For the operating procedure, see Application example (1) and the description given in Section 4.

(5) Execution simulation

Check the program operation by using the F_2-30GM-SIM simulation kit.

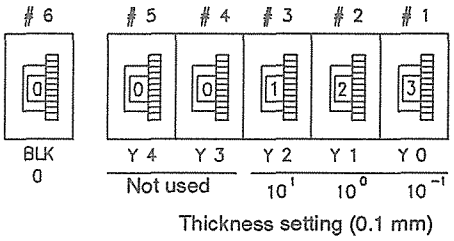
MANUAL mode

- Home positioning is completed by pressing the PG0 button 10 times after pushing the ZRN button and turning ON the DOG switch (in that order).
- When the FWD, RVS buttons are pressed, the forward operation (table lowering) and backward operation (table lifting) are executed.
  Check the operating condition by reading the current value displayed by the TP.



AUTO mode

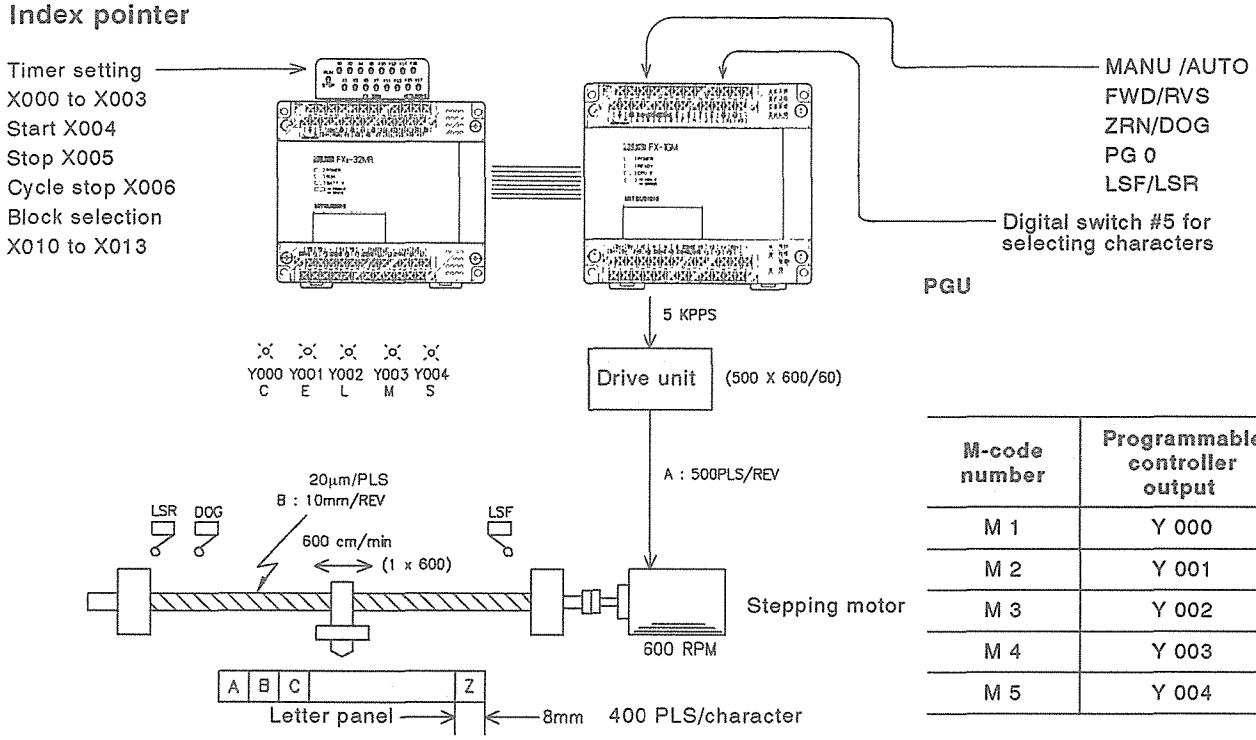
- Set the block number (0 to 2) and the thickness of the sheets by using the digital switch shown below:



- When the START button is pressed, the machine home positioning is executed only 1 time for the initial start operation.
  When the RP lamp goes ON, turn ON the DOG switch, and then press the PG0 button 10 times in succession to simulate the signals from the drive unit when returning to home.
  The output display Y6 is turned ON when home positioning has been completed.
- When the cutter operation checking switch X5 is turned from OFF to ON and then back OFF, the table starts the lowering operation, and the lowering checking signal Y3 is quickly operated.
- After this operation has been performed 9 times, the cycle stop signal Y4 is operated.
  When the take-out checking switch X4 is turned from OFF to ON and then back OFF, the table returns to the home position and waits for a start signal.
- If the STOP button is pressed during any operation, the equipment decelerates and stops.
  If the START button is now pressed, the operation resumes from the current position.
  If the STOP button is pressed while any instruction other than DRV is being executed, the operation stops at the current program step.
  In this case, if the START button is pressed, the operation is restarted from the current step.

5.4 Learning Application Programming (3)

Application example (3)



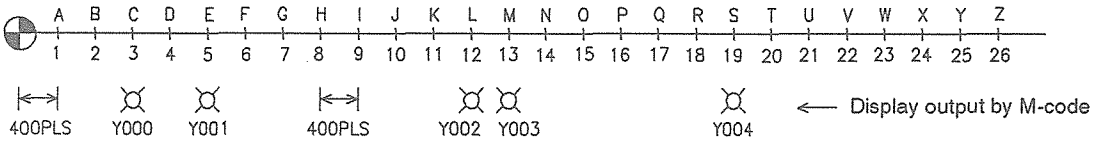
M-code number	Programmable controller output
M 1	Y 000
M 2	Y 001
M 3	Y 002
M 4	Y 003
M 5	Y 004

Control specifications

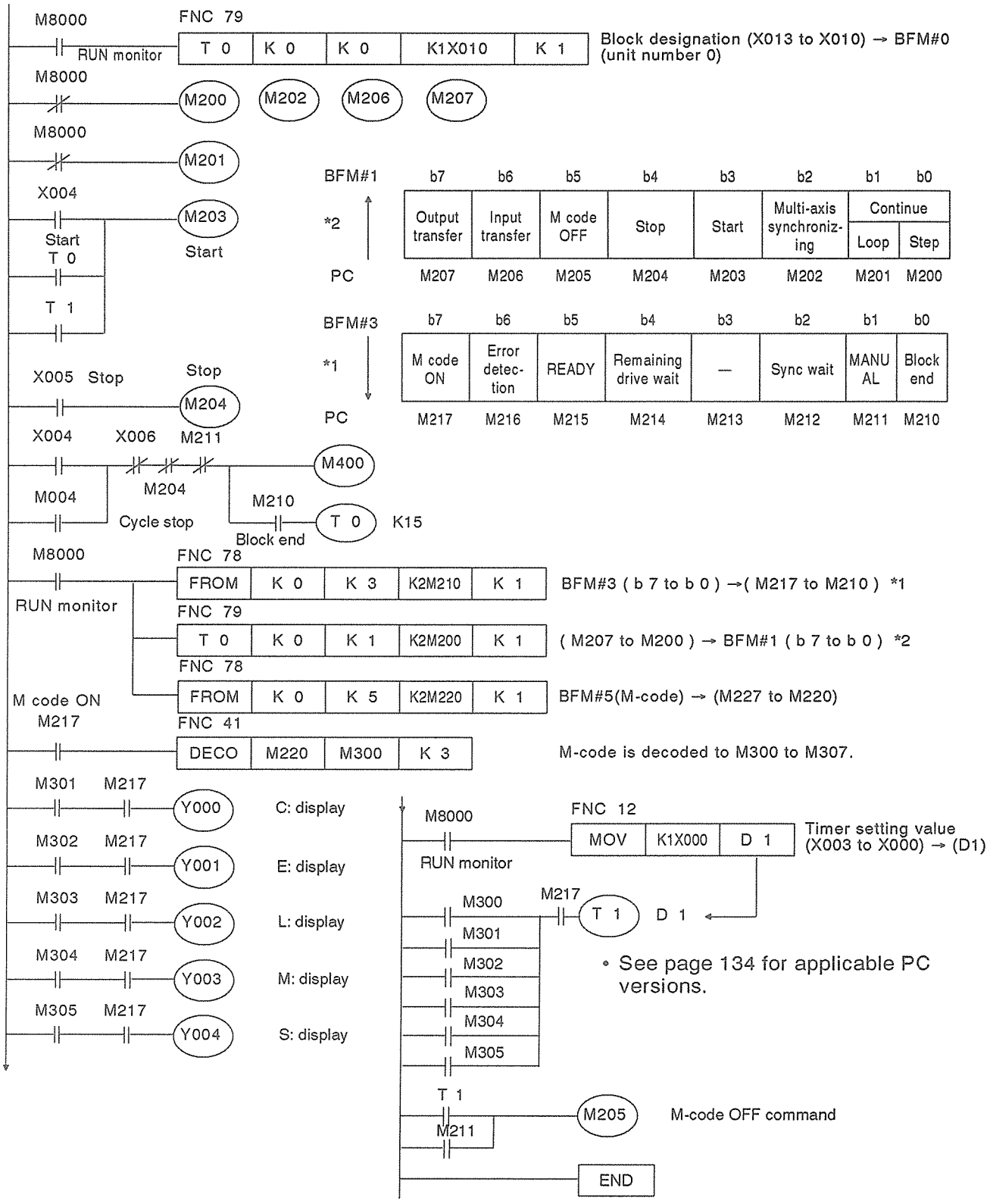
This example shows how to designate a block or handle M-code when using the programmable controller. Spell out the appropriate words in the following table based on the setting of block numbers by inputs X010 to X013 of the FX-32SW and #5 digital switch on the F_2-30GM-SIM. Set the pause time range to 0 to 0.9 sec. by using inputs X000 to X003 of the FX-32SW.
(See page 134 for applicable versions of programmable controllers.)

Programmable Controller Inputs	Digital Switch #5 Setting Values		
	1	2	0, 3 to 9
0	MELCO JAPAN	MITSUBISHI JAPAN	JAPAN
1	MELCO GERMANY	MITSUBISHI GERMANY	GERMANY
2	MELCO AMERICA	MITSUBISHI AMERICA	AMERICA
3	MELCO ENGLAND	MITSUBISHI ENGLAND	ENGLAND

The character layout on the panel is as shown below. The corresponding lamp goes ON when the positions of any of the letters M, E, L, S, E, C has been reached.



(1) Circuit design on the programmable controller side



• See page 134 for applicable PC versions.

• When WAIT M0, and WAIT M1 to WAIT M5 are driven on the PGU, M300 to M305 are turned ON. M301 to M305 are used to drive outputs Y000 to Y004 of the programmable controller.

• The operation progresses after the time duration set with the timer T1 designated by each WAIT instruction.

(2) Parameter setting changes and instruction coding

The parameter settings are as given in column (2) of the table on page 124. (The minimum address unit is 10 PLS.)
Set PARA-22 appropriately.

Step Numbers	Instructions			Remarks
0	BLK	K	0	
1	CALL	K	1	
2	DRV	ABS	10	J
3	WAIT			
4	DRV	ABS	1	A
5	WAIT			
6	DRV	ABS	16	P
7	WAIT			
8	DRV	ABS	1	A
9	WAIT			
10	DRV	ABS	14	N
11	END			
12	BLK	K	1	
13	CALL	K	1	
14	DRV	ABS	7	G
15	WAIT			
16	DRV	ABS	5	(E)
17	WAIT	M	2	
18	DRV	ABS	18	R
19	WAIT			
20	DRV	ABS	13	(M)
21	WAIT	M	4	
22	DRV	ABS	1	A
23	WAIT			
24	DRV	ABS	14	N
25	WAIT			
26	DRV	ABS	25	Y
27	END			
28	BLK	K	2	
29	CALL	K	1	
30	DRV	ABS	1	A
31	WAIT			
32	DRV	ABS	13	(M)
33	WAIT	M	4	
34	DRV	ABS	5	(E)
35	WAIT	M	2	
36	DRV	ABS	18	R
37	WAIT			

Step Numbers	Instructions			Remarks	
38	DRV	ABS	9	I	
39	WAIT				
40	DRV	ABS	3	(C)	
41	WAIT	M	1		
42	DRV	ABS	1	A	
43	END				
44	BLK	K	3		
45	CALL	K	1		
46	DRV	ABS	5	(E)	
47	WAIT	M	2		
48	DRV	ABS	14	N	
49	WAIT				
50	DRV	ABS	7	G	
51	WAIT				
52	DRV	ABS	12	(L)	
53	WAIT	M	3		
54	DRV	ABS	1	A	
55	WAIT				
56	DRV	ABS	14	N	
57	WAIT				
58	DRV	ABS	4	D	
59	END				
60	LAB	K	1		
61	LD	M	101		
62	CJ	K	2		Home positioning completed
63	DRV	ZRN			
64	SET	RAD			
65	LAB	K	2		
66	ADR	+	40	400PLS	
67	LD	M	100		
68	SET	Y	4		
69	TMR	K	2		
70	LD	X	0		Setting 1
71	ANI	X	1		
72	ANI	X	2		
73	ANI	X	3		
74	CJN	K	3		
75	DRV	ABS	13	(M)	

Step Numbers	Instructions			Remarks	
76	WAIT	M	4		
77	DRV	ABS	5	(E)	
78	WAIT	M	2		
79	DRV	ABS	12	(L)	
80	WAIT	M	3		
81	DRV	ABS	3	(C)	
82	WAIT	M	1		
83	DRV	ABS	15	O	
84	WAIT				
85	LAB	K	3		
86	LDI	X	0		Setting 2
87	AND	X	1		
88	ANI	X	2		
89	ANI	X	3		
90	CJN	K	4		
91	DRV	ABS	13	(M)	
92	WAIT	M	4		
93	DRV	ABS	9	I	
94	WAIT				
95	DRV	ABS	20	T	
96	WAIT				
97	DRV	ABS	19	(S)	
98	WAIT	M	5		
99	DRV	ABS	21	U	
100	WAIT				
101	DRV	ABS	2	B	
102	WAIT				
103	DRV	ABS	9	I	
104	WAIT				
105	DRV	ABS	19	S	
106	WAIT	M	5		
107	DRV	ABS	8	H	
108	WAIT				
109	DRV	ABS	9	I	
110	WAIT				
111	LAB	K	4		
112	RET				
113					

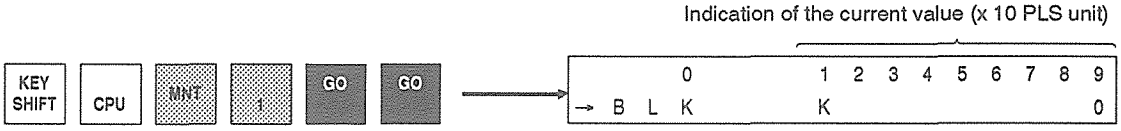
(3) Operation confirmation

PREPARATION

- Write programs to the programmable controller by using the programming panel.
- Prepare the parameters and positioning program by using the TP, and transfer/write them to the PGU.

MANUAL mode

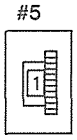
- Turn on the MANUAL input of the F_2-30GM-SIM, which activates ZRN/FWD/RVS, etc. in manual operations.
  When executing the machine home position return, press the ZRN button, turn the DOG switch ON, and then press the PG0 button 10 times in succession.
- During this period, monitor the current value by the TP, since this indicates the simulated present position.



AUTO mode

- Turn OFF the MANUAL input of the F_2-30GM-SIM, and set digital switch #5 to 1 or 2.

  Instruction SET Y4 of step 68 selects digital switch #5.



8	4	2	1
X 003	X 002	X 001	X 000

Timer setting

By making settings of 1 to 9 using programmable controller inputs X003 to X000, timer T1 makes delay operations of 0.1 to 0.9 sec.

8	4	2	1
X 013	X 012	X 011	X 010

Block setting

Make settings of 0 to 3 by using programmable controller inputs X013 to X010. If other inputs are used for block setting, a block omission error is generated.

This enables reading of DSW#5.

- Turn the programmable controller to RUN and turn ON the start input X004, which starts the home position return operation.
  On the F_2-30GM-SIM, turn the DOG switch ON, and then press the PG0 button 10 times.
- The PGU is operated automatically thereafter, depending of the block designation and timer setting values.
  If cycle stop input X006 is turned ON, the operation is stopped at the block end.
  If stop input X005 is turned ON, the equipment decelerates and stops.
  In either case, the operation can be restarted by using start input X004.

6 INSTALLATION

The sections so far have described the functions of the FX-1GM and its programming procedures.

Now, let's step forward from desk theory to the practical use of the machine.

This section explains the installation, wiring, maintenance/inspection, and troubleshooting of the main unit.

Mitsubishi recommends that this information be delivered to the end user.

6.1 Installing in the Panel

6.1.1 General installation and wiring items

Installation dimensions

[Mounting to DIN rails]

The PGU can be mounted to a DIN46277 DIN rail (35 mm wide) with no additional work.

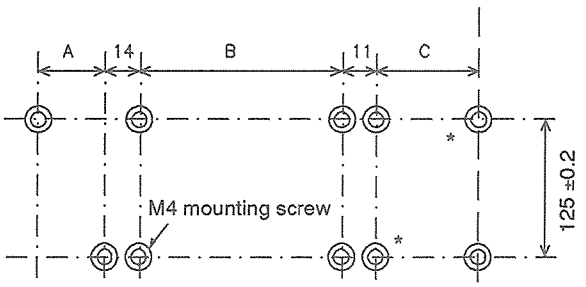
To remove the unit, pull down the hook on the DIN rail and remove the unit.

- Do not attempt to mount the unit on the surface of the floor or ceiling since doing so blocks the ventilation system. Be sure to mount the unit on the wall.
- Thread pitches of the screw holes (M4) for direct mounting are as given in the table below.

Unit Type	A ± 0.2	B ± 0.2	C ± 0.2
FX-16M, 24M FX-32M FX-48M FX-64M FX-80M FX-128M		140 150 220 260 320 390	
FX-32E, FX-1GM FX-48E			150 220
* FX-8E, 8EX, 8EY * FX-16E[ ]-V * FX-16E[ ]-C * FX-16EX, 16EY * FX_2-24EI			35 35 35 63 35
FX_2-40AP, 40AW FX-8AV FX-232AW	35 35 35		

[Direct mounting method]

Mounting holes marked with * are not provided to the types of units marked with a * shown in the table above. Main units and extension units can be mounted in 2 rows.



6 INSTALLATION

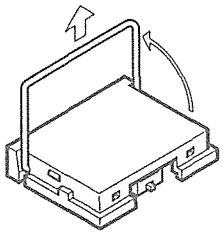
Notes for handling each part of the unit

[Connecting extension cables]

Always be sure that the extension cable connectors are securely engaged.

[Memory cassette handling]

When detaching a memory cassette, raise the wire handle and slowly pull the handle attached to the cassette. Always be sure the power to the unit is OFF before attaching and detaching memory cassettes.



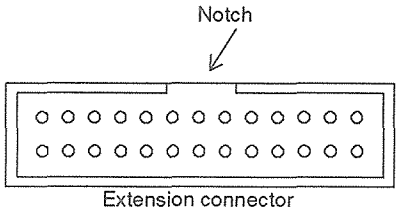
[Special function unit labels]

Special function units and blocks such as FX-1GM PGU, analog I/O units, and high-speed counter units which are accessed by using FROM/TO instructions are numbered from 0 to 7 beginning with the one closest to the main unit of a programmable controller.

Use the unit number labels supplied with the unit by sticking them to the front panel of each special function unit.

See page 134 for applicable versions of programmable controllers.

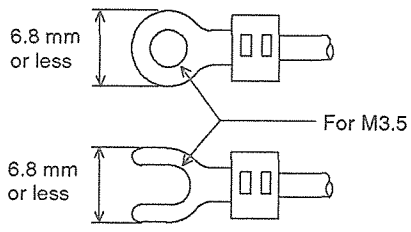
Installing extension cables



Since extension cables are very vulnerable to noise, always be sure to keep them 30 to 50 mm away from other electric wiring.

- Remove the connector covers on the right hand side of both the programmable controller and FX-1GM, so that the cable may be inserted.
- The extension cable has notched connectors to prevent wrong installation. Always be sure to align these notches properly when inserting them.
- To connect an extension cable, remove (by breaking the attachments) the fixed protective cover of the cable outlet. The left side faces toward the main unit.

Wiring terminal dimensions



- Mitsubishi recommends using solderless terminals with the dimensions shown in the figure on the left.
- The recommended tightening torque of terminals is 5 to 8 kg.cm. Always make sure terminal screws are securely tightened to prevent malfunctions of the unit.
- Do not connect wires to unused (reserved) terminals.

6 INSTALLATION

Precautions during installation

Installation environment

- Do not to install the unit in environments with excessive dust, oil, smoke, conductive debris, or corrosive gas.
- Do not install the unit where direct vibration or shock may be applied.
- Do not install the unit where it may be exposed to high-temperature, dewing, wind, or rain.

Installation work

- When doing threading or wiring, always be sure no chips, pieces of wiring or other foreign matter falls inside the unit.
- After installation, remove the dust-proof sheet (outside the unit) to prevent overheating during actual operations.
- Always be sure to keep the unit at least 50 mm from any other equipment or structure.

  Mitsubishi recommends keeping the unit as far away as possible from any high-voltage equipment or power equipment.

Wiring work

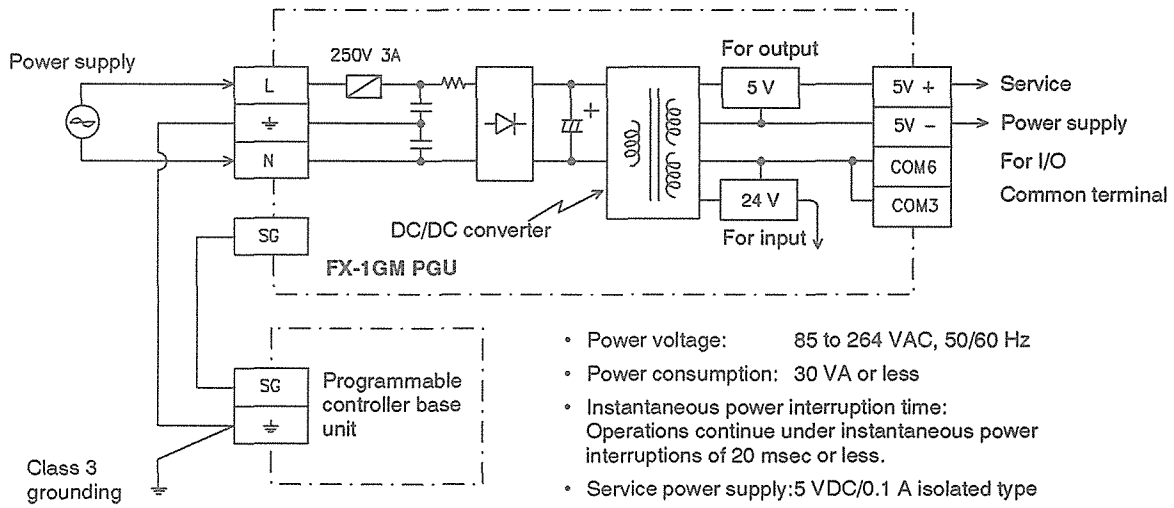
- Do not run the I/O signal line of the PGU through the same cable sheath as power drive lines or high output lines.
- Pages 113 to 122 give details about wiring between the PGU, the drive unit, and the motor.

  The signal lines should be of length less than 2 to 3 m. Mitsubishi recommends that shielded twisted pair wires be used.

6.2 Connecting Terminals

6.2.1 Power circuit configuration and specifications

The configuration and specifications of the power circuit built in the FX-1GM PGU are as follows:



- When using an FX-1GM as a stand-alone unit, connect the SG terminal to the ⏚ terminal for grounding purposes.
- Connect the SG terminals to each other on the main unit of the programmable controller, extension units, and extension blocks.

Precautions during connection

AC power supply

- 100 to 240 VAC (+10%, –15%) may be used as the power supply. Remember that incorrect connection of power lines to the input terminal of the PGU can damage the PGU.
- Always switch the power to the programmable controller together with the PGU.
- If the power is interrupted for more than 20 msec, or if the voltage drops excessively, the PGU will stop and the outputs will be turned OFF at the same time.
- Use a wire greater than 2 mm^2 for the power line to prevent excessive voltage drops.

Grounding

- Connect the ground terminal of the PGU to that of the programmable controller, and execute class-3 grounding (less than 100Ω) on the programmable controller side.

  In this case, do not attempt to execute grounding commonly with any high-tension system.

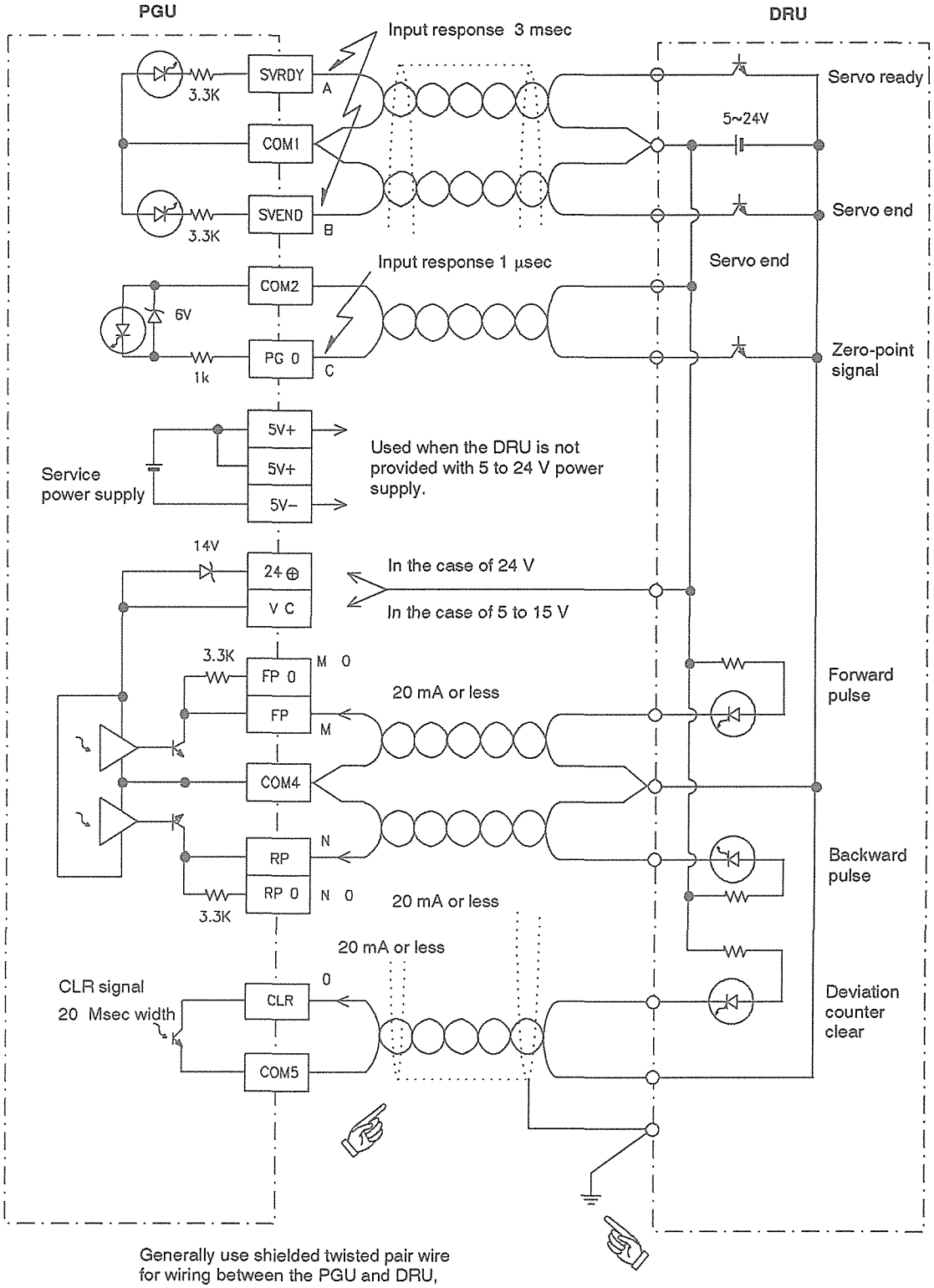
  (Where executing grounding is difficult, the unit may be used without any grounding.)
- Mitsubishi recommends not executing grounding commonly with the drive unit or any high-tension system.

Service power supply

- The power supply is intended for driving positioning control signals to/from the PGU if the drive unit does not incorporate a 5V power supply.
- When an overload exceeding 0.1 A occurs, the voltage is automatically dropped, to prevent damage to the unit.

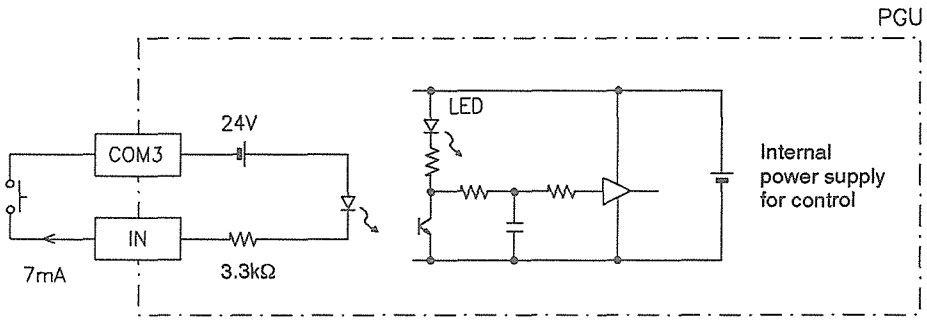
6.2.2 Drive unit connections

For the following 2 connection diagrams between the PGU and the DRU drive units, both the FX-1GM and pages 113 to 122 will apply as they are the same except for the label names of 2 terminals. (see diagrams.)



6.2.3 Connection of general-purpose input terminals

Input specifications



Input terminal:

By connecting the input terminal to COM3 terminal with a no-voltage contact or an NPN open collector transistor, the input ON state is established and the input indicator LED is lit.

Input circuit:

The primary circuit of the input is insulated from its secondary circuit by the photo-coupler, and the secondary circuit is provided with a C-R filter which is intended to avoid mis-triggering caused by chattering of the input contact or noise from the input line.

Because of this, there is a response lag of approx. 3 msec for both ON to OFF and OFF to ON transitions. (response lag of 0.5 msec for DOG input)

Input sensitivity:

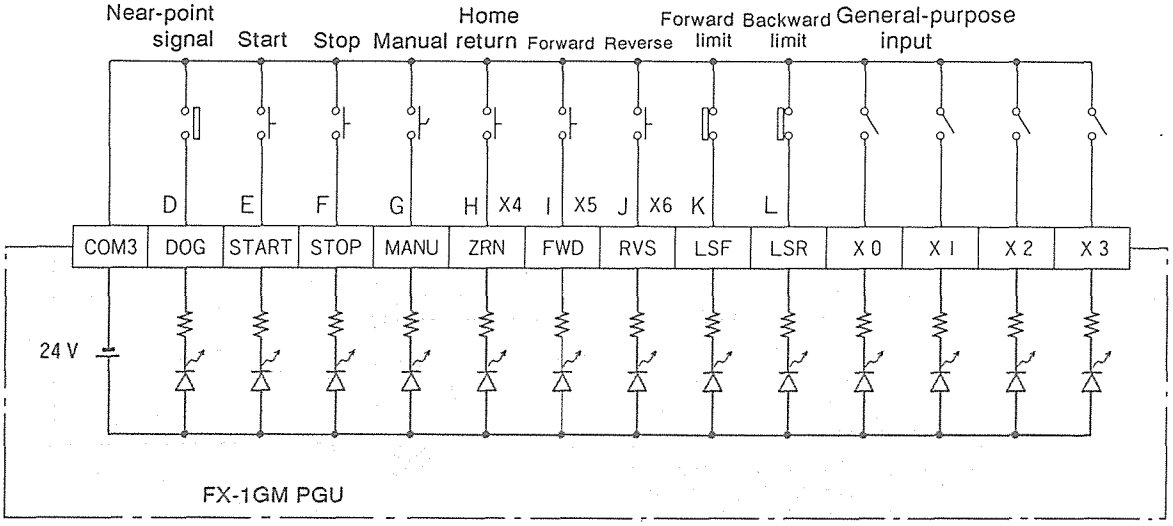
The input sensitivity current of the PGU is 1.5 to 3.4 mA.

Always be sure to allow an input current of more than 4mA for the input to turn ON safely, and less than 1mA to allow it to go OFF with proper noise immunity.

Input connection example

When the forward (reverse) limit switch is turned OFF, the forward (reverse) pulse generation stops.

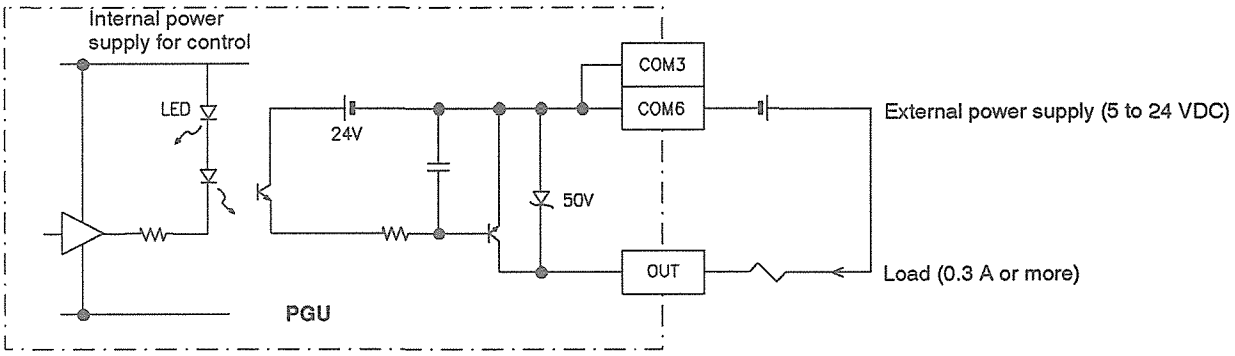
If the connection of the pulse generation is incorrectly made, operations often cannot be started nor stopped.



- For the connection of digital switch to the general-purpose inputs (X0 to X3), see pages 31 and 123.

6.2.4 Connection of general-purpose output terminals

Output specifications



Output terminal:

A terminal common to all outputs is used.

Use a smooth power supply of 5 to 24V DC for the external power supply for load driving.

Circuit insulation:

The circuit built in the PGU is isolated from the output transistor with a photo-coupler, however, the transistor base current is supplied by the built-in 24V DC power supply used for the general-purpose inputs.

Operation lights:

The output LED indicator is arranged in the photo-coupler drive circuit.

The output transistor is turned ON when the LED is turned ON.

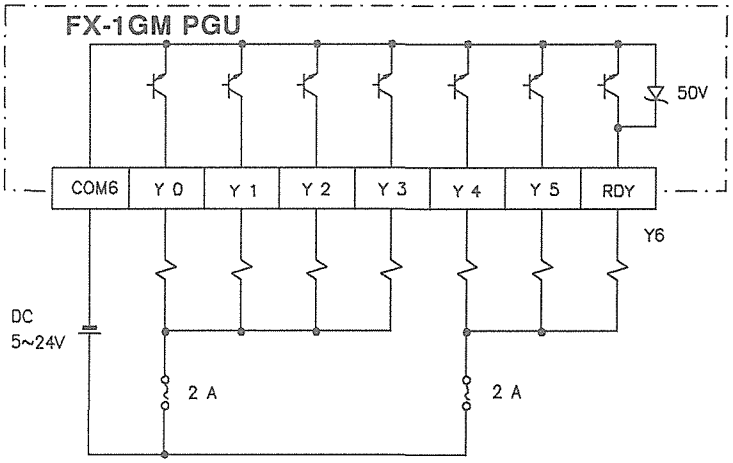
Response time:

The switching time from ON to OFF and OFF to ON is less than 1 msec.

Output current:

It is possible to flow a max. of 0.3A current per 1 output point.

Output connection example



It is possible to connect loads such as relays, solenoid valves, etc. to the general-purpose outputs (Y0 to Y6).

Mitsubishi recommends inserting a 2 A fuse every 4 points to protect the transistor from short-circuit loads.

- For the connection of digital switch to the general-purpose inputs (X0 to X3), see pages 31 and 123.

6.3 Before Starting an Operation

6.3.1 Preliminary checks

Mechanical specifications

Always be sure that the mechanical specifications such as load torque, load inertia, acceleration/deceleration times, operation speed, stopping accuracy, etc. are correct.

All these points must be fully checked even if they seem to be complicated, in addition to providing data for selecting the optimum motor.

Initial settings

Always be sure that each of the parameters in the drive unit and the PGU are compatible.

For instance, doublecheck the mode of the position control pulse, logic polarity of each signal, rotating speed/direction of the motor, etc., or allowable pulse error (in-position), error judgment times, etc.

Performing correct wiring

Since excessive voltage, power terminal short-circuits in output wiring, etc. can result in serious accidents, always be sure to check these points carefully before turning ON the power supply.

6.3.2 Checks in the MANUAL mode

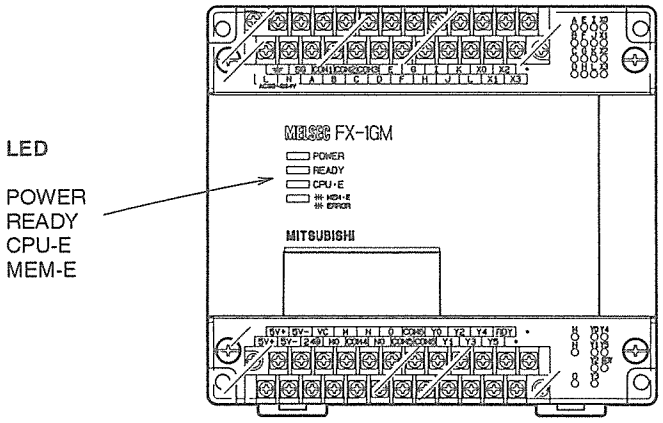
Power-ON check

When power is supplied to the PGU, the power indication LED on the upper right hand side of the PGU goes ON.

This LED is so designed as to be turned ON by the built-in power regulator in the PGU.

If the LED fails to go ON when the power supply is connected, a hardware fault such as a broken fuse caused by the contamination by foreign matter may have occurred.

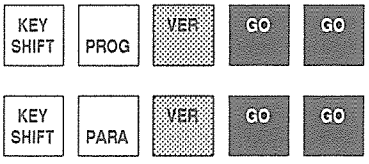
Please consult your nearest Mitsubishi representative.



Program check

Mitsubishi recommends checking the programs and parameters stored in the PGU by using the teaching panel (TP).

When either a parameter or program is changed, it is absolutely necessary to check both the parameter and program, as they are interrelated.



Program check

If there is any error, it is necessary to change the program (see the error codes (PE0 to PE8) given on page 108).

Parameter check

If there is any error, it is necessary to change the parameter, (see the error codes (PE10 to PE18) given on pages 109 and 110).

Always be sure to perform these checks before executing the program.

Error Detection

When an error code CE1 to CE20 mentioned on pages 108 to 110 is detected, the error detecting BFM#3 b6 is operated as given below. (See pages 93 and 94.)

	During positioning operation or stopping	Only during stopping in positioning
MANUAL or AUTO	CE10: Watchdog timer error CE15: Emergency LS is ON Either code results an emergency stop during operation.	CE11 to 14, 17: Parameter error CE16: Servo end error (Stop completion delay) CE20: Servo ready error (DRU failure)
AUTO only		CE1, 2, 5 to 9: Instruction error CE3, 4: Register overflow

6.4 Starting an Operation

6.4.1 Indicators in manual operations

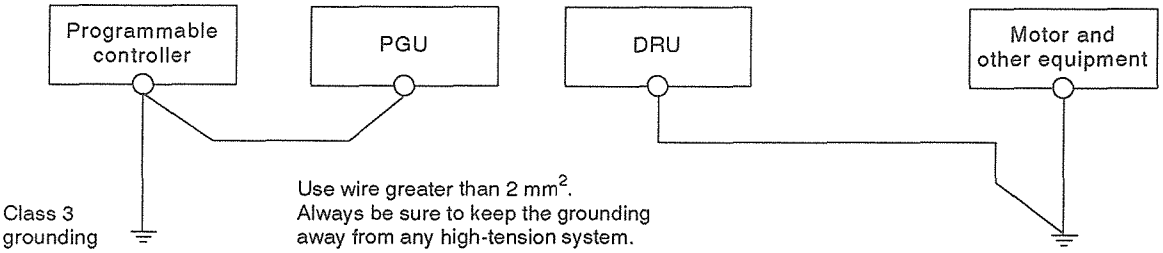
CPU-E LED

If the CPU-E LED is turned ON by turning ON the power supply to the PGU in MANUAL mode, then a watchdog timer error has occurred.

In this case, check for an unusual noise generating source, conductive foreign matter, etc.

Also, execute class 3 grounding (grounding resistance of less than 100Ω) by using a wire greater than 2 mm^2.

Should the equipment be affected by noise, try grounding as shown below:



READY indicator

When the READY indicator is turned ON, the manual home position return (ZRN), manual forward (FRD) and manual reverse (RVS) buttons become valid when the MANUAL input is active.

The LED is normally turned OFF during positioning.

If the MEM-ERROR LED goes ON or flickers when a manual operation is executed, read the error code in the TEST mode of the TP to investigate the cause of the trouble.

Error codes CE10 to CE20 apply here. They are explained on pages 109 and 110. (See also page 92.)

The probable causes of such trouble include improper parameter settings, operation of the emergency limit switches, servo end error (delayed positioning completion), servo delay error (DRU power OFF to failure), etc.

When an error occurs, press the STOP button to reset the error flag. (Restarting cannot be done unless the error flag is reset.)

Execute the necessary parameter setting change, and then the parameter/program check described on the previous page.

Even if such errors do not occur, Mitsubishi recommends always checking to be sure that the operation direction and speed are correct.

6.4.2 Checks in the AUTO mode

MEM-E and ERROR indicators

When the manual input to the PGU is turned OFF (AUTO mode), the READY indicator normally goes ON.

When the START button is pressed in the above state, program execution is started.

If any error occurs during the operation, the MEM-E is turned ON, or the ERROR display flickers which stops the motor.

In such a case, turn on the manual input to the PGU, which will allow the cause of the error to be investigated by using the TP.

Error codes CE1 to CE20 apply here and are explained on pages 108 to 110. (See also page 92.)

The cause of this trouble is mainly due to misuse of program instructions.

For instance, if blocks 8 or 9 are designated when only programs 0 to 7 exist, the designated BLK does not exist and this can also cause this error.

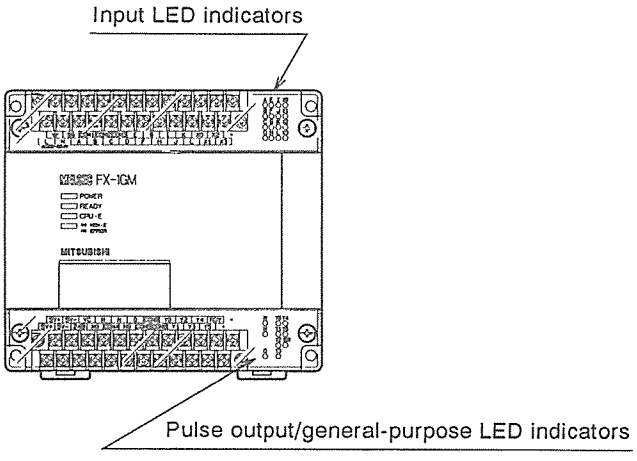
The TP is also used for resetting an error. The STOP button of the PGU, after switching from AUTO to MANUAL, or BFM#1 b4 of a command from the programmable controller can also be used for resetting an error.

I/O indicators

Check the input wiring of the PGU by making sure that the input indicators go ON corresponding to the ON/OFF states of the appropriate input switches.

Also, make sure there are no contact faults in the input switches.

If the load does not turn ON/OFF according to the output indicator, check the output wiring.



Pulse output display

The pulse output is displayed by LED, M, N.

Since it flickers rapidly, it will appear to be turned ON dimly during normal operations.

During acceleration/deceleration, however, the flickering may be briefly visible.

6.4.3 Motor rotating direction

The motor rotating direction is determined by the contents of parameters number 11 and number 18, and the wiring orientation between the PGU and the DRU.

Rotating direction

PARA-11	Rotating direction setting "0"	Rotating direction setting "1"
Current value	Increase with forward pulse FP Decrease with backward pulse RP	Decrease with forward pulse FP Increase with backward pulse RP
Instruction operation	Generates forward pulse FP with DRV +instruction Generates backward pulse RP with DRV –instruction	Generates backward pulse RP with DRV +instruction Generates forward pulse FP with DRV –instruction
FWD input JOG+input	Generates forward pulse	Generates backward pulse
RVS input JOG–input	Generates backward pulse	Generates forward pulse
Home position return direction	Generates forward pulse FP when PARA number 18 is set to "0". Generates backward pulse RP when PARA number 18 is set to "1".	Generates backward pulse RP when PARA number 18 is set to "0". Generates forward pulse FP when PARA number 18 is set to "1".

- The direction the motor turns when the machine is moved by a forward pulse may also be changed by the wiring and the machine specifications.

Correct connection of emergency limit switches

Classifications	For Stepping Motors	For Servo Motors
Emergency LS connection	Connect to the PGU Normally ON on the DRU	Connect to the DRU Normally ON on the PGU (See Memo below.)
LSF	When the LSF is turned OFF (Note), the forward pulse FP stops. After manual stop, backward pulse RP can be output.	When the LSF is turned OFF, the forward pulses in the DRU stop. Backward pulses are accepted.
LSR	When the LSR is turned OFF (Note), the backward pulse RP stops. After manual stop, forward pulses FP can be output.	When the LSR is turned OFF, the backward pulses in the DRU stop. Forward pulses are accepted.

Notes: When PARA number 12 is "0", pulse generation stops when an emergency LS is turned ON.
When PARA number 12 is "1", pulse generation stops when an emergency LS is turned OFF.

- Install the LSF and LSR to positions a little away from the normal operating range.
- When an emergency LS is actuated, the motor stops running. Manually give a STOP input to the PGU to reset errors before restarting operations.

(Memo)

To enable servo motor operation, LSF and LSR must be connected to the DRU, and the setting on the PGU must be normally ON (PARA number 12 "1") or OFF (PARA number 12 "0").

In this case, when the DRU is automatically stopped by an actuation of LSF or LSR, the PGU cannot recognize the stop state. Therefore, use the auxiliary LSF and LSR which operate before LSF or LSR operates and are connected to the PGU for improved operations control.

6.4.4 Internal operations of the PGU

The I/O signals are only read/written at certain times and are specified in the following table:

Signal fetching timing

Input Signals	MANUAL Mode		AUTO Mode	
	Motor is Stopped	Motor is Turning	Motor is Stopped	Motor is Turning
SVRDY	Before DRV	—	Before DRV	—
SVEND	After DRV	—	After DRV	—
PG0	—	When DOG is ON while turning for home positioning	—	When DOG is ON while turning for home positioning
DOG	Before home positioning drive	Monitoring at all times while turning for home positioning	Before home positioning drive	Monitoring at all times while turning for home positioning
START, BFM#1b3	—		Monitoring at all times during READY	—
STOP, BFM#1b4	Monitoring at all times			
MANU	Monitoring at all times	—	At the completion of each step	—
ZRN	Monitoring at all times	—		
FWD, RVS JOG+, JOG-	Monitoring at all times		—	
LSF, LSR	Before DRV	Monitoring at all times	Before DRV	Monitoring at all times
X0 to X6 Y440 to Y444	—		Only when executing instructions concerning these inputs.	Monitoring at all times after execution of INT, VCH instructions
M0 to M127	—		Only when executing instructions concerning these inputs.	
BFM#1 b5 (M-code OFF)	—		Monitoring at all times	

Motor Speed

Command pulses generated by the PGU have a time duration expressed by integers in 1-μsec units. Therefore, the pulse generation frequency is obtained as follows:

$$f = \frac{1}{2n} \times 10^6 \text{ (PPS)}$$ where n is an integer in the 5 to 50,000 range.

When n = 5, f = 100,000 PPS. When n = 6, f = 83,333 PPS. Any frequency between these is not available.

If parameter setting or a speed command designates 90,000 PPS, actual operation is executed with 83,333 PPS which is the closest available frequency.

When a stepping motor is driven in a high frequency range, there may be abrupt fluctuations in frequency and the motor may malfunction. The recommended frequency range is 20 kPPS or less.

6.5 Maintenance

Maintenance and inspection

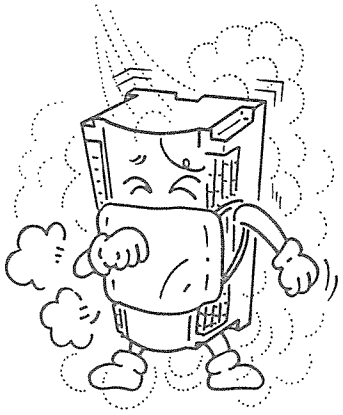
The PGU does not have any items such as a battery which can run down or wear out, or result in a relatively short life time.

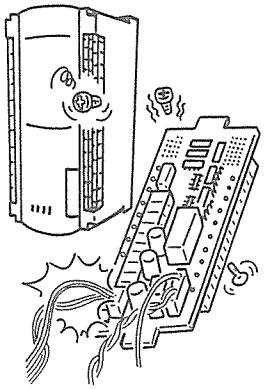
In performing the maintenance/inspection, be extremely careful about the following points along with the inspection of other equipment.

(1) Always be sure that the inside temperature is not exceptionally high due to an external heating source or direct sunlight.

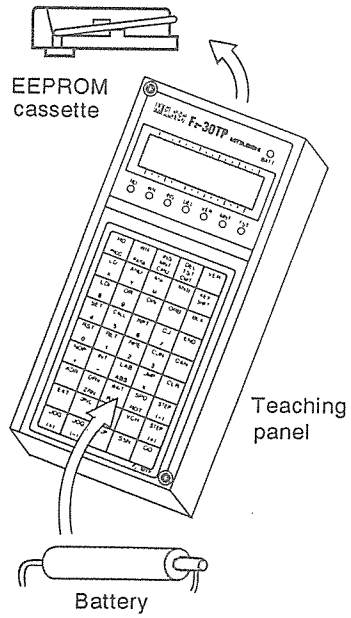
(2) Always be sure that excessive dust or conductive debris has not entered into the unit.

(3) Always be sure that the terminals are not loose and are free from rust.





Teaching panel



The teaching panel comes equipped with a lithium battery which can hold program and parameter data in the event of a power failure.

If the data is transferred to the EEPROM cassette of the PGU in advance, then this battery is not required.

Since the battery will be serviceable for approx. 5 years (free guarantee period: 1 year), consult your nearest Mitsubishi representative before this time expires.

See page 134 for applicable versions.

7 SUMMARY

The chapters so far have described in detail all areas on the use of the FX-1GM PGU.

This chapter summarizes the main points to allow the design work to be made by quick referencing of these pages.

The chapter also gives a connection diagram of the stepping motor/servo motor drive unit (of some makers) to the PGU.

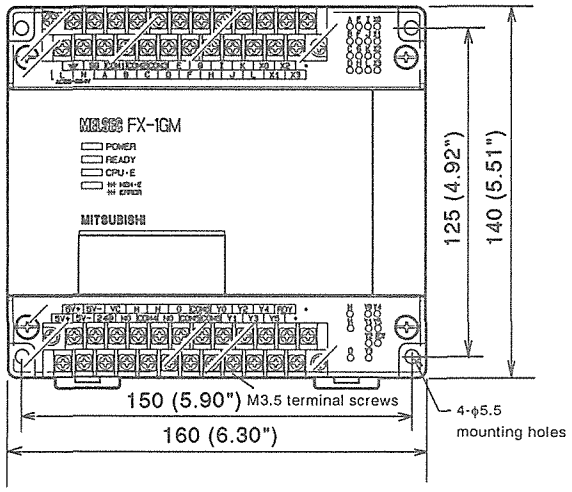
Manuals prepared by the relevant manufacturers give details about connecting the drive unit and motor.

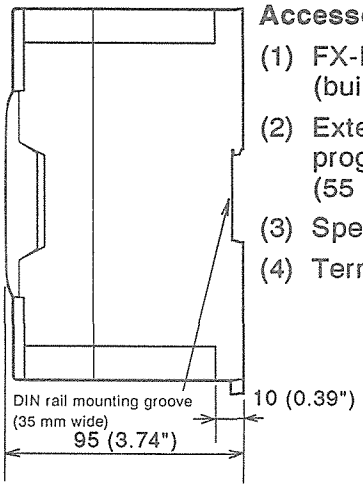
7 SUMMARY

7.1 Outside Dimensions and Specifications

7.1.1 Outside dimensions (mm)

FX-1GM pulse output unit





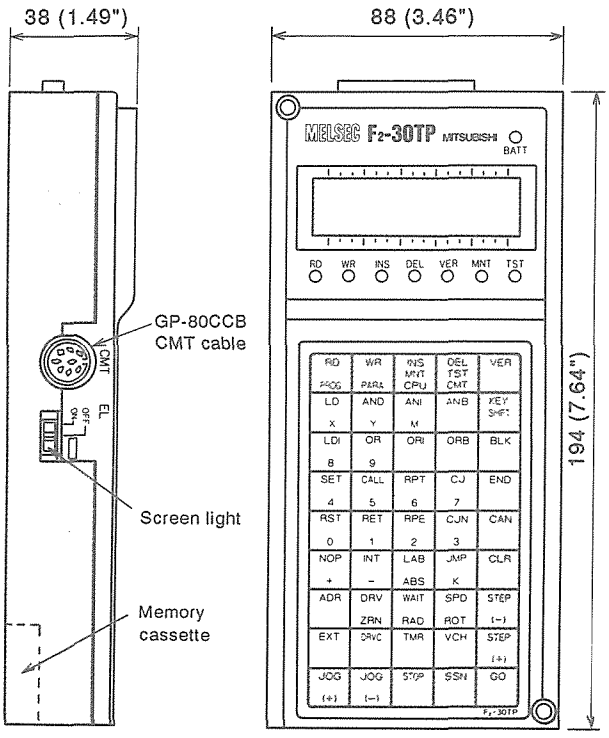
Accessories

(1) FX-EEPROM-4 ROM cassette (built-in)
(2) Extension cable to the programmable controller (55 mm, 650 mm, 1 each)
(3) Special unit numbering label
(4) Terminal symbol label

Body color: Munsell 7.5Y 7.5/1 5/1

Weight: Approx. 1.5 kg

F_2-30TP teaching panel



Accessories

(1) F_2-30TP-CAB transmission cable (3 m, one piece)
(2) GP-80CCB CMT cable (0.8 m, one piece)

Power source:

Supplied from FX-1GM (+5V)

Display:

16-character, 2-line liquid crystal (with back lamp)

Battery:

Lithium battery
5-year service life (guarantee period: 1 year)

Functions:

Program	WRITE, READ, INSERT, DELETE, VERIFY
Parameter	WRITE, READ, VERIFY, INSERT
CPU	WRITE, READ, VERIFY, MONITOR, TEST
CMT	WRITE, READ, VERIFY

Weight:

Approx. 0.5 kg

Applicable versions:

See page 134.

7 SUMMARY

7.1.2 Specifications of the main unit

General specifications

Items		Specifications
Power source		85 to 264 V AC, 50/60 Hz Power consumption 30 VA Operation is continued if instantaneous power failure is less than 20 ms.
Environment	Temperature, Humidity	0 to 55°C, 35 to 85%RH or less respectively (no condensation)
	Vibration	Resists vibrations of 10 to 55 Hz (max. 2G) for 2 hr in all 3 axes directions.*
Noise resistance		Noise voltage: 1,000 Vpp Noise width: 1μs (by noise simulator)
Withstand voltage, insulation		Withstand voltage: 1,500 V AC for 1 min Insulation resistance: 500 V DC, 5MΩ and over (from all terminals to the ground terminal)
Working atmosphere		Must be free from corrosive gas and dust.

* 0.5 G or less when mounted to a DIN rail. Conforms to JIS C0911.

Performance specifications

Items		Specifications	
Number of control axes		1 axis Number of occupying points for extensions of programmable controllers: 8 points (for either input or output points)	
Program	Capacity	2000 steps (dividable to up to 100 blocks) EEPROM cassette type	
	Setting	By using the F2-30TP teaching panel	
	Instruction	30 instructions Common parameter setting (24 types)	
Position control	Address	Relative or absolute position designation method. Designation by 6 digits max.	
	Speed	10 to 100,000 PLS/sec	Accumulation address register range ± 2,147,483,647
	Acceleration/deceleration	Automatic trapezoidal acceleration/deceleration time: 50 to 5,000 msec	
	Compensation	Backlash compensation / Movement bias compensation	
	Unit system	Machine system: mm, deg., inch, etc.; Motor system: PLS; Composite system	
Pulse output type		Separate forward/reverse pulse lines or direction and magnitude type.	Open collector transistor output 5 to 24 V DC/20 mA
Clear signal		Clear of DRU deviation counter when returning to the machine home position. (20 msec response time)	
Position return function		Machine home position and general return function	
JOG operation function		Manual forward, manual reverse	
M-code function		M-code output function 2 x 3 bit octal digits (64 codes)	
General-purpose input		4 points + 3 points (shared with ZRN, FWD, and RVS) 24 V DC/7 mA May be driven by internal DC source	Usable for programmable controller extension input/output
General-purpose output		6 points + 1 point (READY signal) Open collector transistor output 5 to 25 V DC, 0.3 A (power supply from the external unit)	
Input/output insulation		Photocoupler isolation is executed for all input/output terminals of the PGU.	
Service power source		Isolated type: +5 V/0.1 A (external power supply is available.)	
Number of units connectable to a programmable controller		Up to 8 FX-1GM units can be connected to 1 FX series programmable controller.	

7.2 Signals

7.2.1 Input/output terminal-related signals

Terminal Signals Signal Names		Signal Directions		
SVRDY Servo ready	A	DRU ↓ PGU	Servo DRU output ON if no error. Set it to ON if a stepping motor is used.	
SVEND Servo end	B		Servo DRU output ON after positioning is completed. Set it to ON for stepping motor.	
PGO Zero-point signal	C		One-turn (or half-turn) signal of servo motor e.g.7.2°/pulse for stepping motor	
FP/PLS Forward pulse	M	PGU ↓ DRU	Set by PARA No.9. Type A: Forward pulse Type B: Reverse pulse	
RP/PLS Reverse pulse	N		Set by PARA No.9. Type A: Reverse pulse Type B: Forward pulse	
CLR Clear signal	O		Clears deviation counter when servo motor returns to home position. Not required for stepping motor.	
LSF Forward limit	K	Machine ↓ PGU (DRU)	Turns OFF when the forward limit is passed. When PARA No. 12 is "1".	Keep PGU input ON when the switches are connected to the DRU side.
LSR Reverse limit	L		Turns OFF when the reverse limit is passed. When PARA No. 12 is "1".	
DOG Near-point signal	D		Turns ON when a point near the machine home position is passed. Provided in front of the reverse limit.	
MANUAL Manual operation	G	Operation panel ↓ PGU	ON: Manual operation (MANUAL mode) OFF: AUTO operation (AUTO mode)	
START Positioning start	E		Starts automatic operation when turned ON momentarily. To restart operation after STOP, START needs to be turned ON again. Same as START signal BFM#1b3 of programmable controller.	
STOP Stop signal	F		Manual or automatic operation stops when this is momentarily turned ON. START is not accepted when this is ON. Same as STOP of programmable controller or teaching panel.	
ZRN(X4) Machine home position return	H		Machine home return starts when it is turned ON momentarily.	Valid in manual only. Command is also possible from teaching panel under the TEST mode.
FWD(X5) Manual forward	I		Forward operation is enabled when this is ON. One-pulse feed is executed for every ON of 0.5 sec or less.	
RVS(X6) Manual reverse	J		Reverse operation is enabled when this is ON. One-pulse feed is executed for every ON of 0.5 sec or less.	
X0 to X3 General-purpose input			Block or position data designation, general-purpose control input, etc.	
Y0 to Y5 General-purpose output		PGU ↓ Machine operation panel	Turned ON/OFF by program stored in PGU.	
READY(Y6) General-purpose output			General-purpose output or READY (waiting for START), depending on PARA No.16.	

PGU panel indicators

POWER	Turned ON when power to the PGU is ON.
READY	Turned ON when a process is completed. Affected by WAIT and END instructions. (when waiting for a START command)
CPU-E	Turned ON when a CPU error occurs. (watchdog timer error: 0.3 to 400 msec)
MEM-E ERROR	Turned ON when there is a program/parameter abnormality or parity error. Flashes when there is an emergency stop (LSF, LSR operation), servo ready error, servo end error, etc.

7.2.2 Programmable controller-related signals

When the power to the PGU is turned OFF, all data is cleared.

BFM		Description															
		b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
→	#0	Block designation (0 to 99)															
→	#1	—	—	—	—	—	—	—	Multi-axis synch dog valid	Output transfer	Input transfer	M-code OFF	Stop	Start	Multi-axis sync	Continuous Loop	Continuous Step
→	#2	M127	M126	M125	M124	M123	M122	M121	M120	—	—	—	Y444	Y443	Y442	Y441	Y440
→	#3	—	—	—	—	—	SET M	WAIT M	WAIT M0	M-code ON	Error detection	READY	Remaining drive wait	—	Sync wait	MANUAL	Block end
←	#4	M117	M116	M115	M114	M113	M112	M111	M110	—	—	—	—	M103	M102	M101	M100
←	#5	M codes 0 to 77 (see page 20.)															
←	#6	Lower bit	Current PGU value (converted to pulses)														
	#7	Higher bit															
←	#8	Execution step number (0 to 1,999)															
←	#9	Execution block number (0 to 99)															
→	#10	Lower bit	Setting value register 70														
	#11	Higher bit															
→	#12	Lower bit	Setting value register 71														
	#13	Higher bit															
→	#14	Lower bit	Setting value register 72														
	#15	Higher bit															
→	#16	Lower bit	Setting value register 73														
	#17	Higher bit															
→	#18	Lower bit	Setting value register 74														
	#19	Higher bit															
→	#20	Lower bit	Setting value register 75														
	#21	Higher bit															
→	#22	Lower bit	Setting value register 76														
	#23	Higher bit															
→	#24	Lower bit	Setting value register 77														
	#25	Higher bit															
→	#26	—	—	—	—	—	—	—	—	—	Y6	Y5	Y4	Y3	Y2	Y1	Y0
←	#27	X3	X2	X1	X0	L	K	J (X6)	I (X5)	H (X4)	G	F	E	D	C	B	A
←	#28	Error code: 0 to 20 is stored corresponding to error codes CE0 to CE20. (See pages 108 to 110.)															
←	#29	Error state: When a FROM/TO error occurred, b0 = 1 (ON).															
←	#30	Type code: 5,010 (FX-1GM's used number) This is written automatically when the power is turned ON.															
	#31	Unusable															

Current values, execution step numbers, and execution block numbers of the PGU are automatically written to these areas. State of these areas can be monitored by the programmable controller.

Numeric values written to the setting value registers ** (** = 70 to 77) from a programmable controller can be used by the programs in the PGU.

SPD X**..... Speed designation
EXT ±**..... Absolute address
EXT K**..... Relative address
RPT X**..... Repeat command

Applicable numeric value ranges vary according to each instruction. However, the range of positive values of 0 to 999,999 is applicable.

Notes: See page 19 for BFM#1, and pages 21 and 125 for BFM#3.

(1) BFM#1, b6 = ON (Input transfer)

The ON/OFF states of the input terminals (A to L, X0 to X3) of the PGU are written to BFM#27. By reading the state using the programmable controller, they can be used for input monitoring or as extension inputs for the programmable controller.

(2) BFM#1, b7 = ON (Output transfer)

The ON/OFF states of BFM#26 are output to Y0 to Y6 of the PGU. Since they are already used in the programs in the PGU, SET Y0 to Y6 instructions cannot be used in the PGU. Also, the PGU's digital switch setting cannot be read.

(3) BFM#2, #4: See page 28.

(4) See page 134 for the applicable versions of programmable controllers.

7 SUMMARY

7.3 Instructions

Instructions and their elements and data

Categories	Instructions	Pages	Object Elements	Data (Set by Number Keys)	Remarks	
Block designation instruction	BLK	30	K	0 to 99 BCD	Designated from the programmable controller	
				0 to 9 or 0 to 99 BCD	Designated from the PGU digital switch	
	END		None	Not necessary	Use at the end of each program block. Waiting for start input. The final END instruction is executed at power ON. The READY output state is ON.	
Contact instruction	LD	42	X Y Y M	0 to 6 (PGU general-purpose input) 0 to 6 (PGU general-purpose output) 440 to 444 (from the programmable controller) 100 to 127	Start of the logical operation	Normally-open contact
	LDI					Normally-closed contact
	AND				Connection of series contact	Normally-open contact
	ANI					Normally-closed contact
	OR				Parallel connection of a normally-open contact Algebraic addition of ADR and EXT	
	ORI				Parallel connection of normally-closed contact	
Connection instruction	ANB	42	None	Not necessary	Series connection of logical blocks	
	ORB				Parallel connection of logical blocks	
Output instruction		42	Y	0 to 6	PGU general-purpose output holding operation	
		42	M	100 to 127	General aux. relay	
		43		0 to 77	Generation of M-code output	
	SET	34	RAD	Not necessary	Setting of the current position address to the setting value of this instruction	
			+ / −	0 to 999,999	Change of the current position address to the setting value of this instruction	
	RST	42	M Y	M: 110 to 127 Y: 0 to 6	Reset of aux. relay or general-purpose output	

7 SUMMARY

Categories	Instructions	Pages	Object Elements	Data (Set by Number Keys)	Remarks	
Step control instruction	LAB	44	K	0 to 255 (label No. must not be used repeatedly)	CJ, CJN, JMP, CALL jump destination.	
	CJ				Jump to the designated label if condition logic is ON.	
	CJN				Jump to the designated label if condition logic is OFF.	
	JMP				Jump to the designated label unconditionally	
	CALL	45			Subroutine call. Jumps unconditionally to the designated label. Return to original call instruction when RET is executed to continue from the succeeding step.	
	RET		None	Not necessary		
Step control instruction	RPT	46	K	1 to 9,999	Direct designation	Programs between RPT and RPE instructions are repeated 1 to 9,999 times.
			X	1 to 6,543	Digital switch	
				70 to 77	BFM#10 to #25	
	RPE		None	Not necessary		
Interrupt instruction	INT	41	X	0 to 6	PGU general-purpose input	By programming before DRV ± instruction, a designated distance is driven after an input is turned ON.
			Y	440 to 444	Command from the programmable controller	
			K	0 to 6	PGU general-purpose input	After an input is turned ON, driving is discontinued and execution is completed.
				440 to 444	Command from the programmable controller	
	VCH	40	X	0 to 6	PGU general-purpose input	After an input is turned ON, operation is executed at the speed designated after a VCH instruction.
			Y	440 to 444	Command from the programmable controller	
Address instruction	ADR	33	K	0 to 999,999	Relative address instruction	
			+ −	0 to 999,999	Absolute address instruction	
	EXT		K	1 to 654,321	Digital switch	Relative address: 0 to 999,999
				70 to 77	BFM #10 to #25	
			+ −	1 to 654,321	Digital switch	Absolute address: 0 to 999,999
				70 to 77	BFM #10 to #25	

7 SUMMARY

Categories	Instructions	Pages	Object Elements	Data (Set by Number Keys)	Remarks
Drive instruction	DRV	36 to 38, 123	ZRN	Not necessary	Machine home position return instruction
			RAD	Not necessary	General return instruction
			ROT	Not necessary	Rotary drive instruction (1 turn: 360°) with ADR + XXX (angle) instruction
			ABS	1 to 9,999 (1 need not be designated.)	Absolute address instruction at n-times (n) a magnified drive instruction
			+ −	Not necessary	Drive direction corresponding to the relative address designated by + or −
	DRVC	39, 123	+ −	Not necessary	
			ABS	Not necessary	Drive instruction corresponding to the absolute address Speed can be changed.
Waiting instruction	WAIT	35	M	0 to 77 (octal)	Waiting for a START command generates M-code and RDY outputs
	TMR		K	0 to 9,999	Transfer to succeeding step after a pause. Data unit 0.01 sec.
Speed instruction, etc.	SPD	32	K	10 to 100,000, 0	PLS/sec
				1 to 153,000, 0	cm/min, 10 deg/min, inch/min
			X	1 to 654,321	Digital switch Valid value is according to PARA No. 4 setting.
				70 to 77	BFM #10 to #25
	NOP	42	None	Not necessary	No processing Transfer to the next step.

7.4 Parameters

Initial parameter settings

PARA No. (Explanatory Pages)	Items	Machine System Units		Motor System Units		Composite System Units	
		Setting Values	Units	Setting Values	Units	Setting Values	Units
0 (22)	System unit setting	0	—	1	—	2	—
1 (22)	Number of command pulses per motor rotation	1 to 65,535	PLS/REV	Invalid	—	1 to 65,535	PLS/REV
2 (22)	Movement amount for 1 or 10 motor rotations	1 to 999,999	μm/REV mdeg/REV 10^{-4}inch/REV	Invalid	—	1 to 999,999	μm/REV mdeg/REV 10^{-4}inch/REV
3 (22)	Minimum command unit (max. number of digits: 6) (max. current value register range ±2,147,483,647 pulses)	0	1 mm 1 deg 0.1 inch	0	10^{3} PLS	0	1 mm 1 deg 0.1 inch
		1	0.1 mm 0.1 deg 0.01 inch	1	10^{2} PLS	1	0.1 mm 0.1 deg 0.01 inch
		2	0.01 mm 0.01 deg 0.001 inch	2	10^{1} PLS	2	0.01 mm 0.01 deg 0.001 inch
		3	0.001 mm 0.001 deg 0.0001 inch	3	10^{0} PLS	3	0.001 mm 0.001 deg 0.0001 inch
4 (23)	Max. speed	1 to 153,000	cm/min 10deg/min inch/min	10 to 100,000	PLS/sec	10 to 100,000	PLS/sec
5 (23)	Manual JOG speed	1 to 153,000		10 to 100,000		10 to 100,000	
6 (23)	Bias speed	0 to 15,300		0 to 10,000		0 to 10,000	
7 (24)	Backlash compensation	0 to 65,535	μm mdeg 10^{-4}inch	0 to 65,535	PLS	0 to 65,535	μm mdeg 10^{-4}inch
8 (23)	Acceleration/ deceleration time	50 to 5,000 msec • Time between the bias speed (No.6) and max. speed (No.4), gradient is common to all operations.					

Note: Initial parameter setting can be changed to that for servo motors or stepping motors by following the procedures on page 124.

7 SUMMARY

PARA No. (Explanatory Pages)	Items	Machine System Units		Motor System Units		Composite System Units	
		Setting Values	Units	Setting Values	Units	Setting Values	Units
9 (26)	Pulse output type	Setting "0" (B-type): PLS + SIGN (rotating direction) Setting "1" (A-type): Forward + reverse pulses					
10 (26)	Pulse logic	Setting "0" (positive logic): Low to High trigger Setting "1" (negative logic): High to Low trigger					
11 (26)	Setting of rotation direction	Setting "0" (increase): Current value increases with a forward pulse Setting "1" (decrease): Current value decreases with a forward pulse					
12 (26)	Ultimate LS logic	Setting "0" (NO): Switch ON for error Setting "1" (NC): Switch OFF for error					
13 (24)	Error judgment time	0 to 5,000 msec					
14 (27)	Block designation	Block: 0 / 0 to 9 / 0 to 99 / 0 to 99 Occupied output: — / Y5 / Y5, Y4 / BFM#0 Setting: 0 / 1 / 2 / 3 Occupied output: — Setting: 4 / 5 / 6 / 7 Occupied output: Y2, Y3 added Setting: 8 / 9 / 10 / 11 Occupied output: Y3 added Setting: 12 / 13 / 14 / 15 Occupied output: Y2 added					
15 (24)	Position bias compensation	0 to ±65,535	μm mdeg 10^{-1}minch	0 to ±65,535	PLS	0 to ±65,535	μm mdeg 10^{-1}minch
16 (27)	RDY output (Y6) setting	Setting "0": PGU RDY output valid (Y6 terminal) Setting "1": PGU general-purpose output Y6 valid Setting "2": During digital switch reading Y6 active (BLK, EXT)					
17 (27)	STOP mode	Setting "0": STOP command invalid (during AUTO) Setting "1": Temporary stop. Continue with START. Setting "2": To the next step after STOP. (Remaining distance ignored) Setting "3": To the END step after STOP. (Remaining distance ignored)					
18 (26)	Home return direction	Setting "0": Address increase Setting "1": Address decrease					
19 (24)	Home position address	−999,999 to +999,999	Depends on the setting of PARA No.3.	−999,999 to +999,999	Depends on the setting of PARA No.3.	−999,999 to +999,999	Depends on the setting of PARA No.3.
20 (23)	Home position return speed	1 to 153,000	cm/min 10deg/min inch/min	10 to 100,000	PLS/sec	10 to 100,000	PLS/sec
21 (23)	Creep speed	1 to 153,000		10 to 10,000		10 to 10,000	
22 (25)	Down counts to home	0 to 255 times					
23 (25)	Count start logic	Setting "0" or "2": DOG input from OFF to ON Setting "1" or "3": DOG input from ON to OFF → Count starts. Setting "0" or "1": Turns OFF when switched from AUTO to MANUAL. Setting "2" or "3": No change when switched from AUTO to MANUAL. → Home position completion M101					

7.5 Error Codes Checking

7.5.1 Program checks

Instructions	Valid Elements	TP (KEY SHIFT, PROG, VER)	PGU (KEY SHIFT, CPU, TST)	LED
All instructions	—	PE 0 **Parity error**	CE 1 **Parity error, without ROM cassette** Write protect ON	MEM-E ON
BLK	K0 to K99	PE 1 **BLK No. error** Other than 0, 0 to 9, 0 to 99 depending on "0" to "15".	CE 2 **BLK missing, non-BCD** Designated program block does not exist. (at START) When BLK0 does not exist, the operation starts from step 0.	ERROR FLASH
SPD	X70 to X77 X1 to X654,321 K0 to K153,000	PE 2 **Outside the valid range (& SPD K0):** (1) PARA 0 "0": 1 to 153,000 (2) PARA 0 "1": 10 to 100,000 (3) PARA 6 ≤ SPD K ≤ PARA 4	PGU automatically defaults to a speed between PARA 6 & and PARA 4.	—
ADR	±0 to ±999,999 K0 to K999,999	—	CE 3 **Setting value register (SVR) overflow** ± 2,147,483,647 or more	MEM-E ON
DRV	ABS 1 to 999,999			
EXT	± 1 to ±654,321 ± 70 to ±77 K1 to K654,321 K70 to K77	PE 3 **Wrong EXT No.** Element other than +, −, or K is used. When 8 or 9 is used.	CE 2 **External setting error** When no BCD data	ERROR FLASH
SET	± 0 to ±999,999 M0 to M127 Y0 to Y6, RAD	—	When PARA 16 is "0" or "2", SET Y6, RST Y6 instructions are ignored.	—
WAIT	M0 to M77			
TMR	K0 to K9,999		—	—
DRV	ZRN, RAD ± ABS ABS 1 to 9,999 ROT	PE 4 **Wrong angular setting** Set PARA 0 to "0" and PARA 18 to "0" for DRV ROT. Preceding ADR may be 0 to 360, 3,600, 36,000, or 360,000 depending on "0" to "3" or PARA 3.	CE 4 **Current value (CVR) overflow** Inoperative if DRV RAD drive overflows ± 2,147,483,647.	MEM-E ON
DRVC	± ABS	PE 5 **Instruction format error** Not DRVC, SPD K, ADR K (EXTK)	CE 5 **Inst. format error (as left)** More than 8 ADR (EXT) or other than DRVC	MEM-E ON
VCH	X0 to X6 Y440 to Y444	PE 6 **Instruction format error** Must use VCH SPD K DRV +- together & end with SPD K0.	—	—
INT	X0 to X6, K0 to K6, Y440 to Y444, K440 to K444	PE 7 **Instruction format error** See page 126.	CE 5 **Inst. format error** (as left)	MEM-E ON
LD/LDI AND/ANI OR/ORI	Same as above, Y0 to Y6, M100 to M127	—	—	—
RST	Y0 to Y6, M100 to M127	—	—	—
LAB	K0 to K255	PE 8 **Duplicated use** LAB No. cannot be repeated.	LAB of a later step valid if duplicated.	—
JMP CJ/CJN	K0 to K255	—	CE 6 **No LAB instruction**	MEM-E ON
CALL	K0 to K255	—	CE 7 **CALL failure** (1) LAB missing (2) More than 16 nested CALLs	MEM-E ON
RPT	K1 to K9,999 X70 to X77 X1 to X6,543	—	CE 8 **RPT failure** More than 16 RPT LOOPs	MEM-E ON
END, WAIT, NOP, ANB/ORB, RET, RPE	—	—	CE 9 **END instruction missing** Program end failure	MEM-E ON

7.5.2 Parameter checks

Parameter	Keyed-In Numerical Values	TP [KEY SHIFT] [PROG] [VER]	PGU [KEY SHIFT] [CPU] [TST]	LED
All parameters	—	PE 10 Parity error	CE 10 Watchdog timer error Emergency stop (pulse output stopped immediately)	CPU-E ON
PARA-0 System unit setting	0: Machine system 1: Motor system 2: Composite system	—	—	—
PARA-1 Pulse rate	1 to 65,535	—	—	—
PARA-2 Feed rate	1 to 999,999			
PARA-3 Unit scale	0 to 3	—	—	—
PARA-4 Max. speed	1 to 153,000/ machine system 10 to 100,000/ motor system 10 to 100,000/ composite system	PE 12 Max. speed setting error Other than shown at left	CE 11 Excessive speed More than 100 KP/S when converted into pulse	MEM-E ON
PARA-5 Manual JOG speed		PE 13 JOG speed error Other than shown at left	Auto. default to less than PARA-4.	—
PARA-6 Bias speed	0 to 15,300/ machine system 0 to 10,000/ motor system 0 to 10,000/ composite system	PE 14 Bias speed error (1) Other than shown at left (2) PARA-6 > PARA-4, PARA-5	CE 12 Bias speed error If PARA-6 is greater than PARA-4	MEM-E ON
PARA-7 Backlash compensation	0 to 65,535	PE 15 Compensation range Other than shown at left	CE 17 Compensation range Over 65535 (pulse conversion)	MEM-E ON
PARA-8 Acceleration/deceleration time	50 to 5,000	—	CE 13 Below 50 msec CE 14 Over 5,000 msec	MEM-E ON
PARA-9 to PARA-12	0.1	—	CE 15 Limit SW LSF/LSR activated Emergency stop (pulse output stopped immediately.)	ERROR FLASH
PARA-13 Error judgment time	0 to 5,000	—	CE 16 Servo end error Positioning not completed in usual time	ERROR FLASH
PARA-14 Block designation	0 to 15	—	—	—
PARA-15 Position bias	0 to ±65,535	PE 16 Outside the range Other than shown at left	CE 17 Excessive compensation range Max. 65,535 (pulse conversion)	MEM-E ON
PARA-16	0, 1, 2	—	If PARA-16 is set to "0" or "2", RST Y6 and SET Y6 are ignored.	—
PARA-17	0, 1, 2, 3			
PARA-18 Home return direction	0.1	—	—	—
PARA-19 Home position address	0 to ±999,999		CE 3 Setting value register overflow Beyond ±2,147,483,647	MEM-E ON
PARA-20 Home return speed	1 to 153,000/ machine system 10 to 100,000/ motor system 10 to 100,000/ composite system	PE 17 Out of range (1) Other than shown at left (2) PARA-20 > PARA-4	Auto default to less than max. value. (PARA No.4)	

7 SUMMARY

Parameter	Keyed-In Numerical Values	TP [KEY SHIFT] [PROG] [VER]	PGU [KEY SHIFT] [CPU] [TST]	LED
PARA-21 Creep speed	1 to 153,000/ machine system 10 to 100,000/ motor system 10 to 100,000/ composite system	PE 15 Out of range (1) Other than shown at left (2) PARA-20 < PARA-21 < PARA-6	—	—
PARA-22 Down counts to home	0 to 255	—	—	—
PARA-23 Count start logic	0, 1, 2, 3	—	CE 20 SVRDY error Servo DRU error SVRDY signal is not ON.	ERROR FLASH

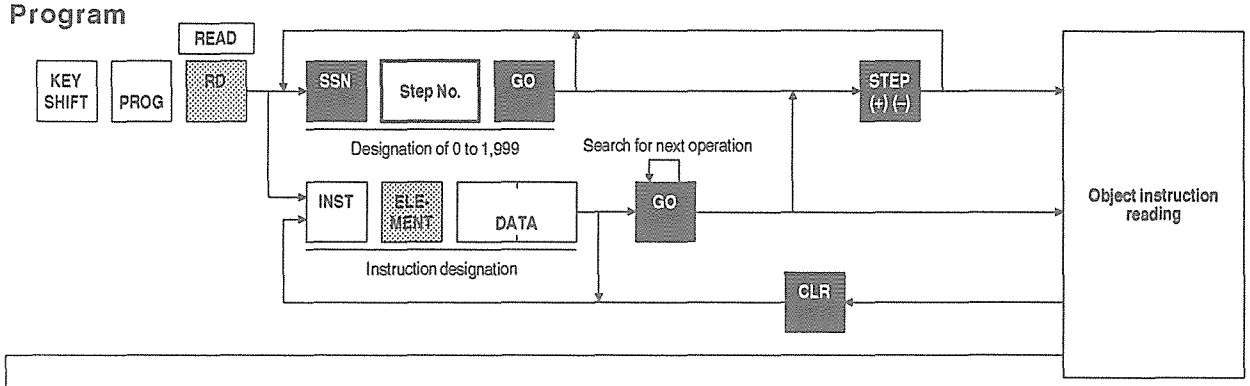
Error detection signal BFM #3b6 is operated when errors (CE1 to CE20) occur. (See page 91.)

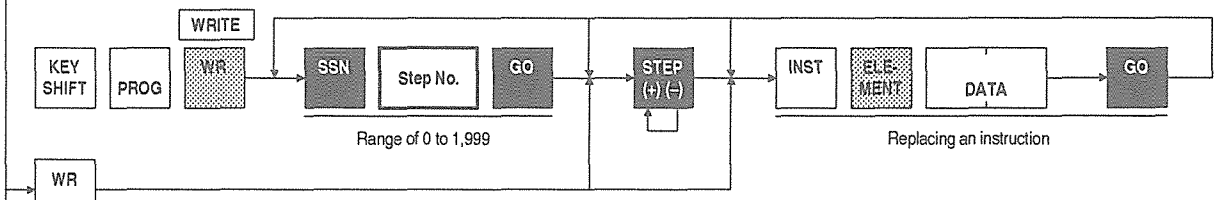
In this case, give a STOP command in the MANUAL mode or TEST mode of the TP to reset the error flags.

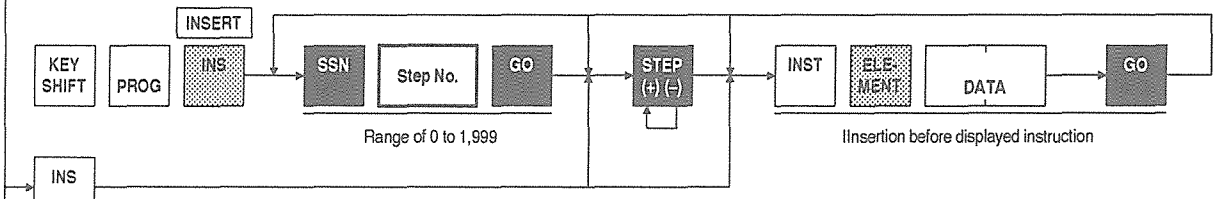
7.6 Teaching Panel Operations

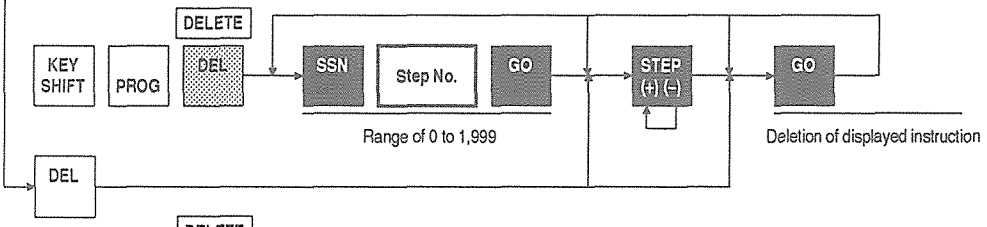
7.6.1 PROG and PARA modes

Program

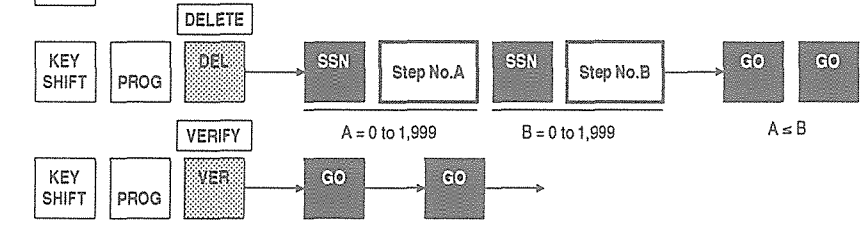








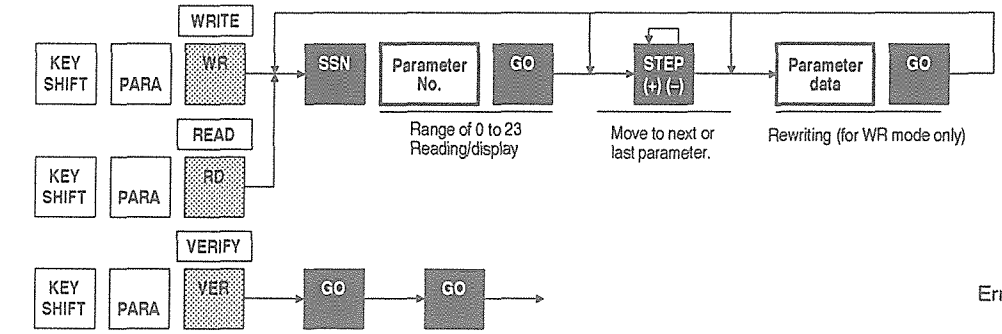
Deletion of 1 instruction



Section delete from A to B

Error code (see page 108)

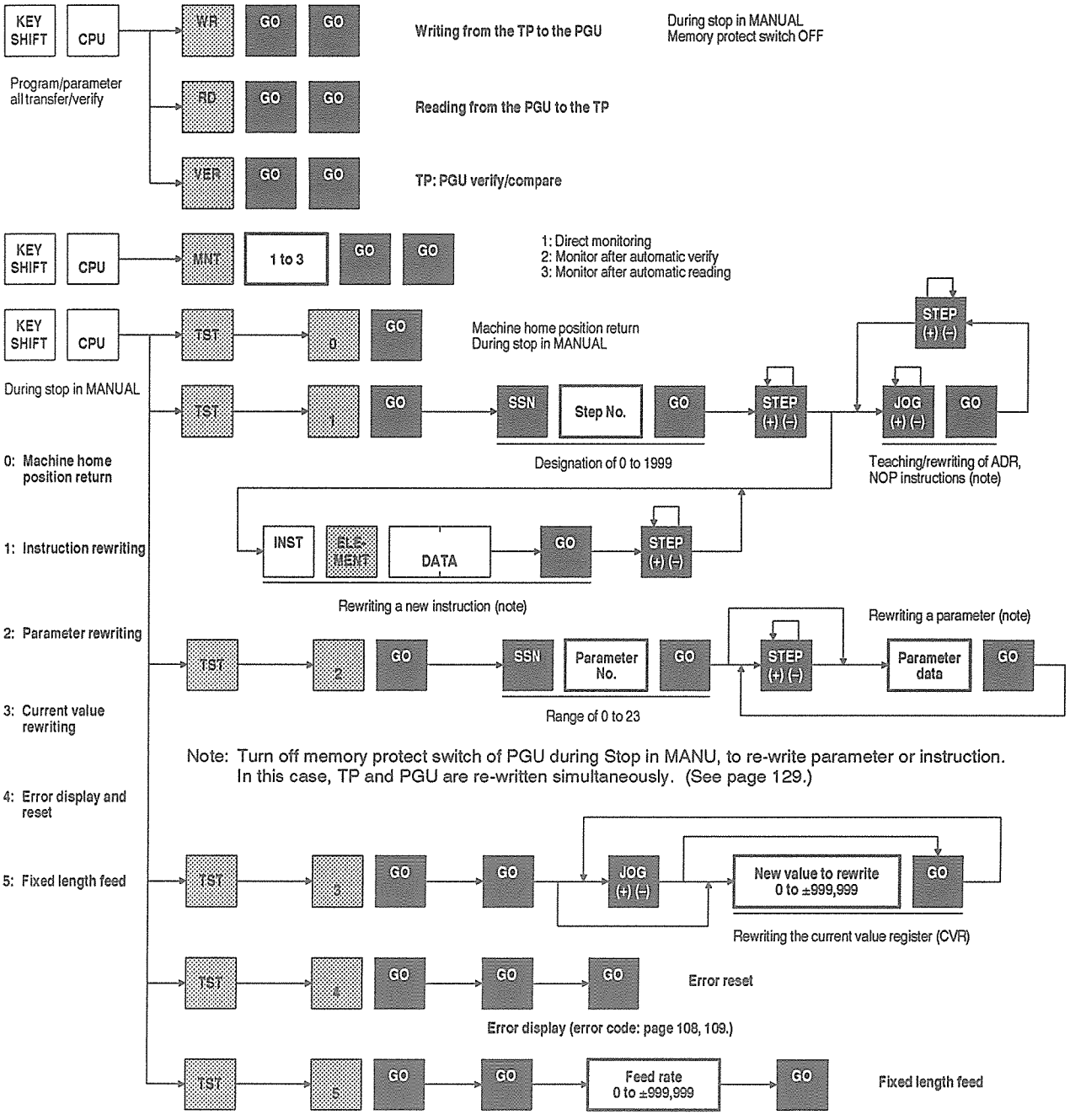
Parameter



Error code (see page 109, 110)

7.6.2 CPU and CMT modes

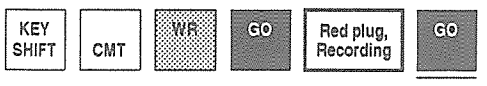
CPU mode



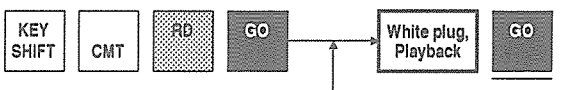
Note: Turn off memory protect switch of PGU during Stop in MANU, to re-write parameter or instruction. In this case, TP and PGU are re-written simultaneously. (See page 129.)

CMT mode

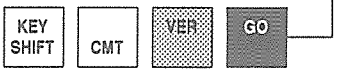
Recording from the TP to the CMT



Playback from the CMT to the TP



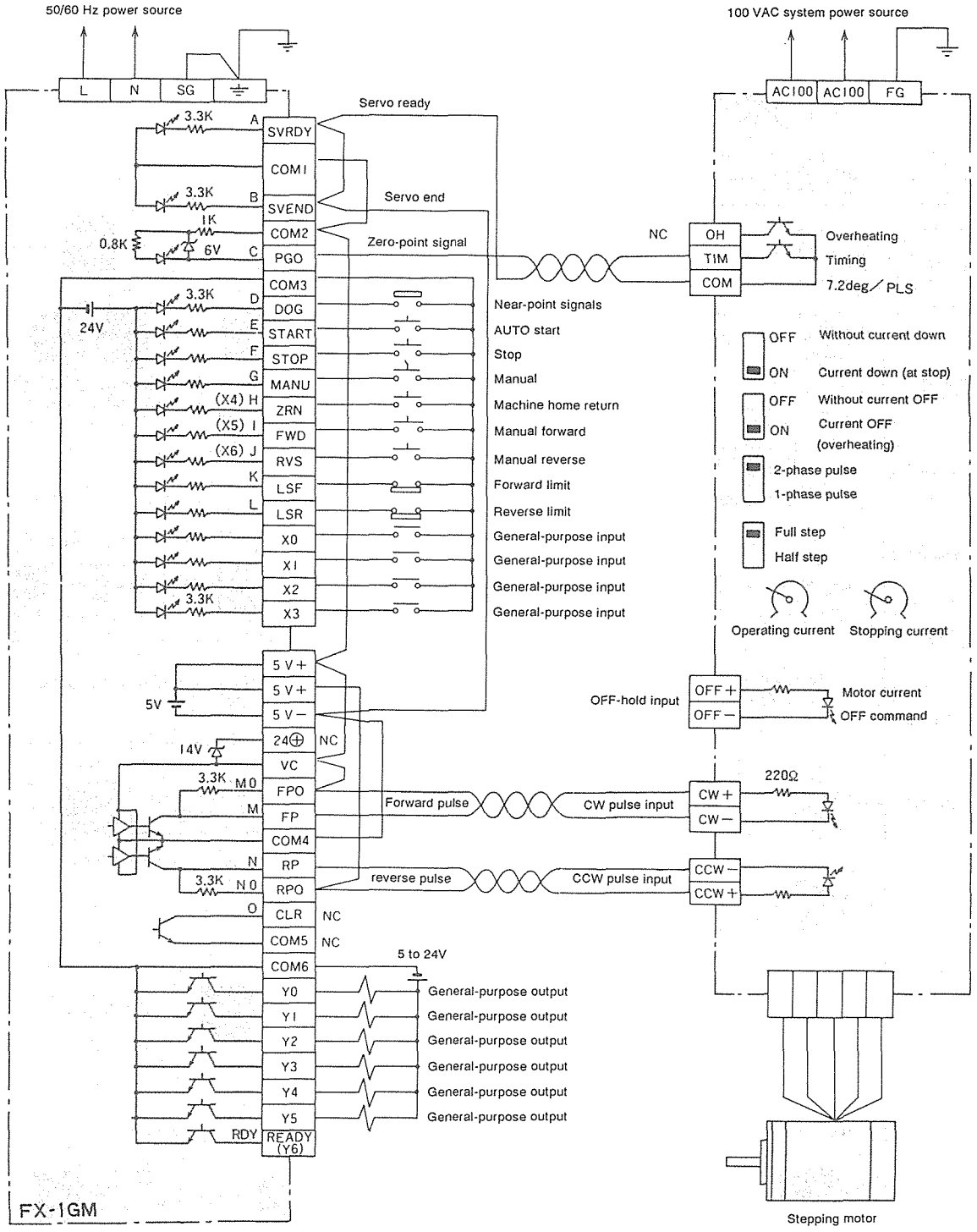
Verification between the CMT and the TP



7.7 Connection to Drive Units

7.7.1 For a stepping motor

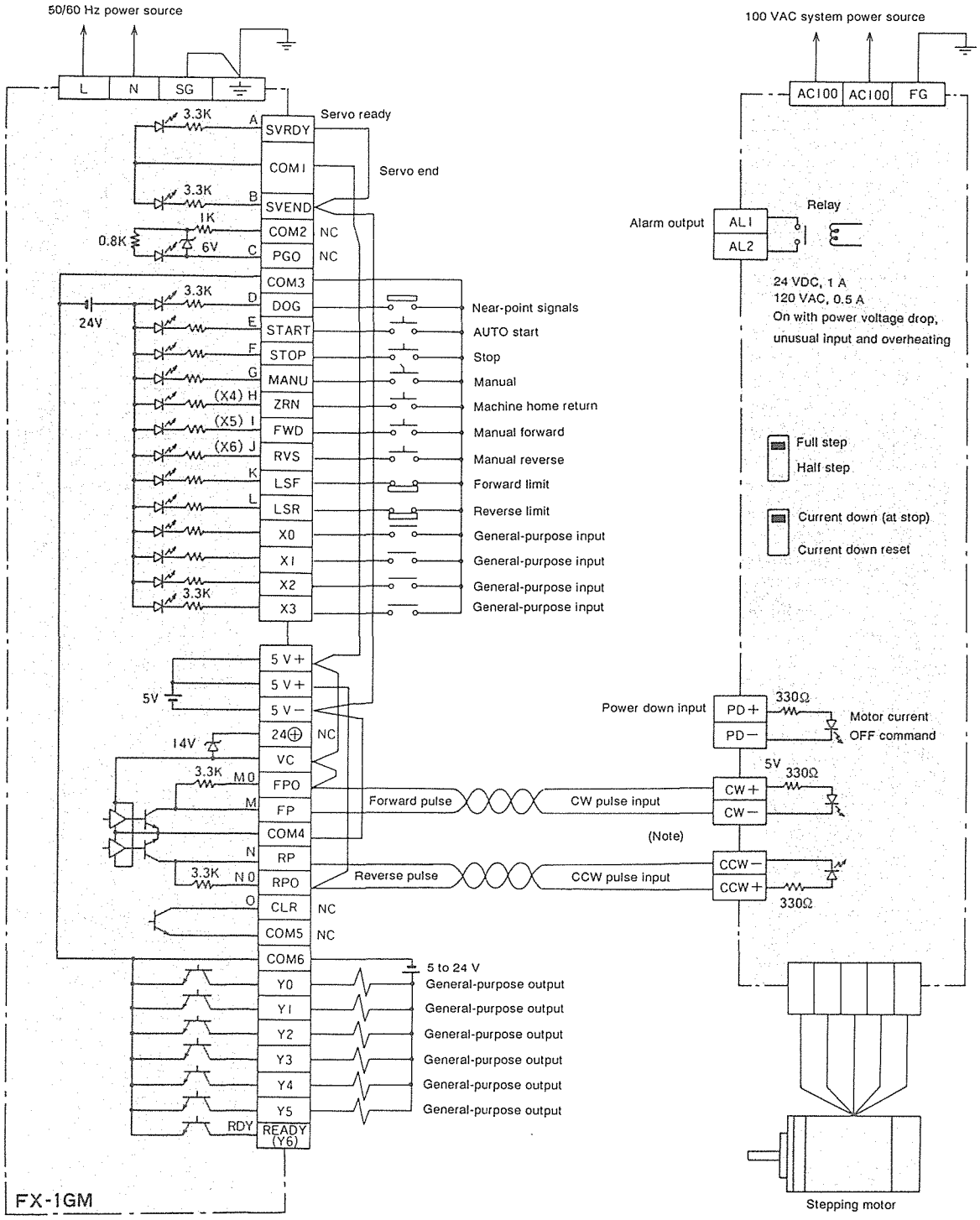
Oriental UPD, UMD series



UPD series (5-phase)	Full step 0.72°/pulse (500P/R)
	Half step 0.36°/pulse (1,000P/R)
UMD series (2-phase)	Full step 1.8°/pulse (200P/R)
	Half step 0.9°/pulse (400P/R)

7 SUMMARY

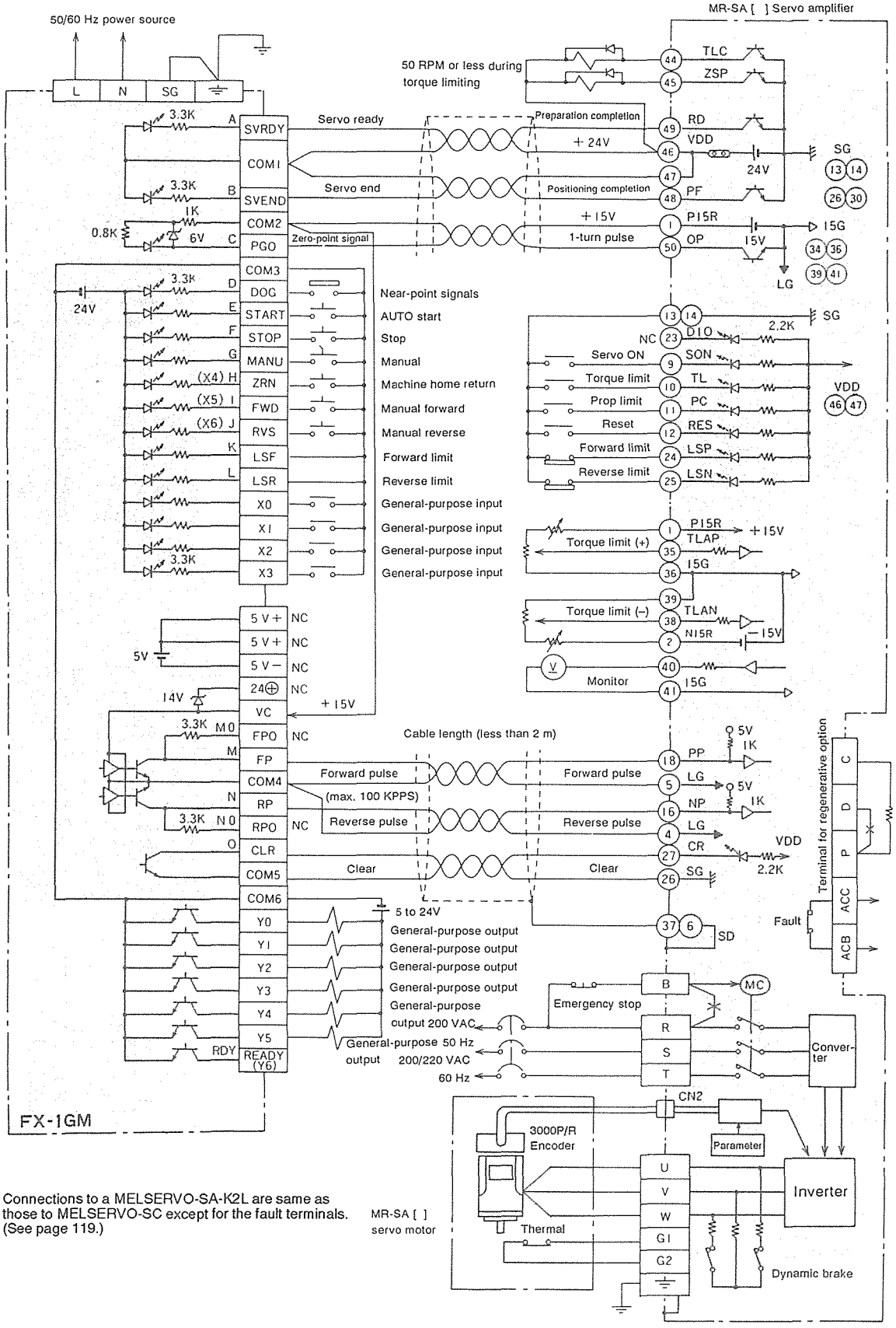
SANYO DENKI PMM series



Note: PENTASYN PMM series (5-phase)
Full step 0.72°/pulse (500P/R)
Half step 0.36°pulse (1,000P/R)

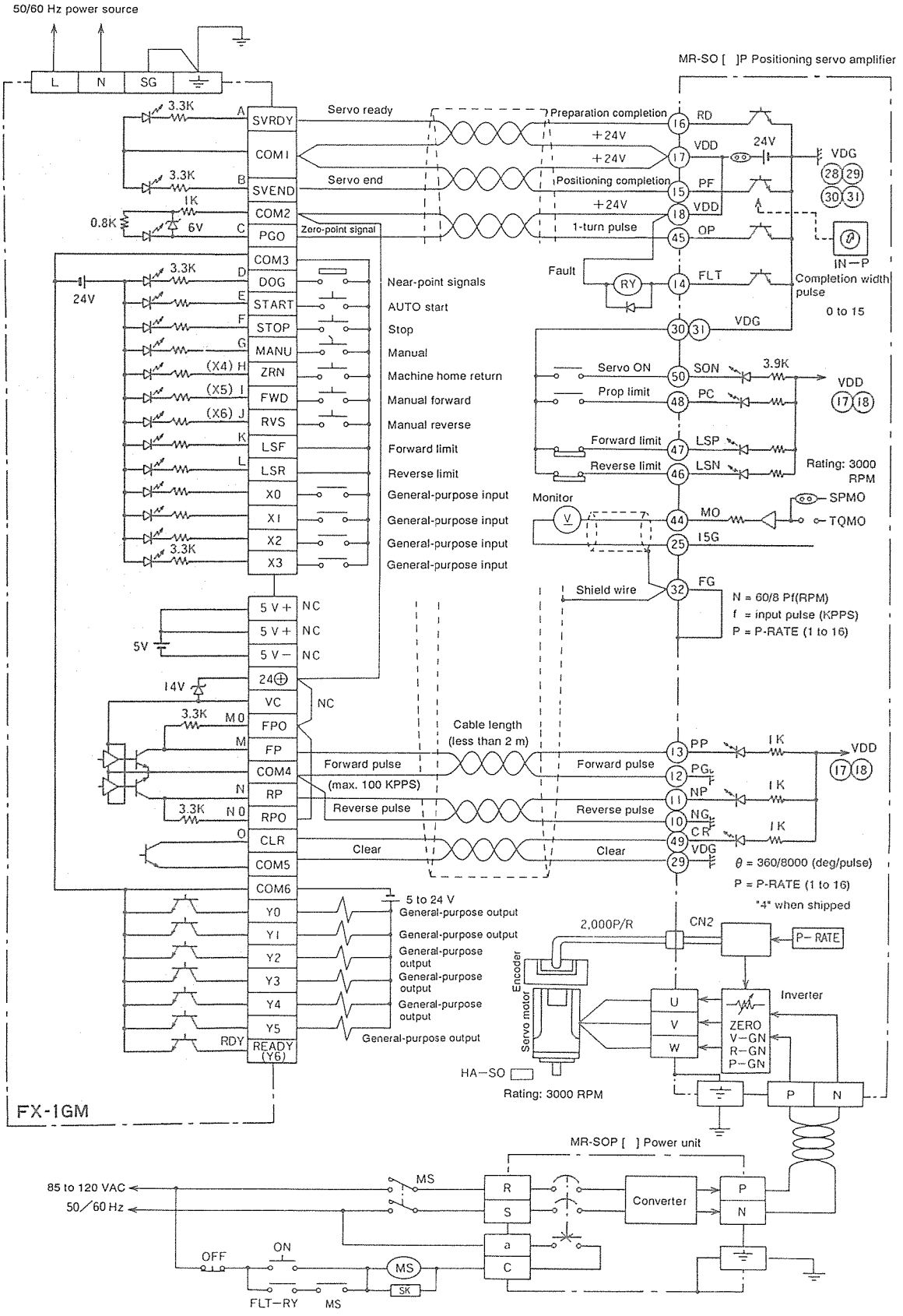
7.7.2 For a servo motor

Mitsubishi Electric MELSERVO-SA

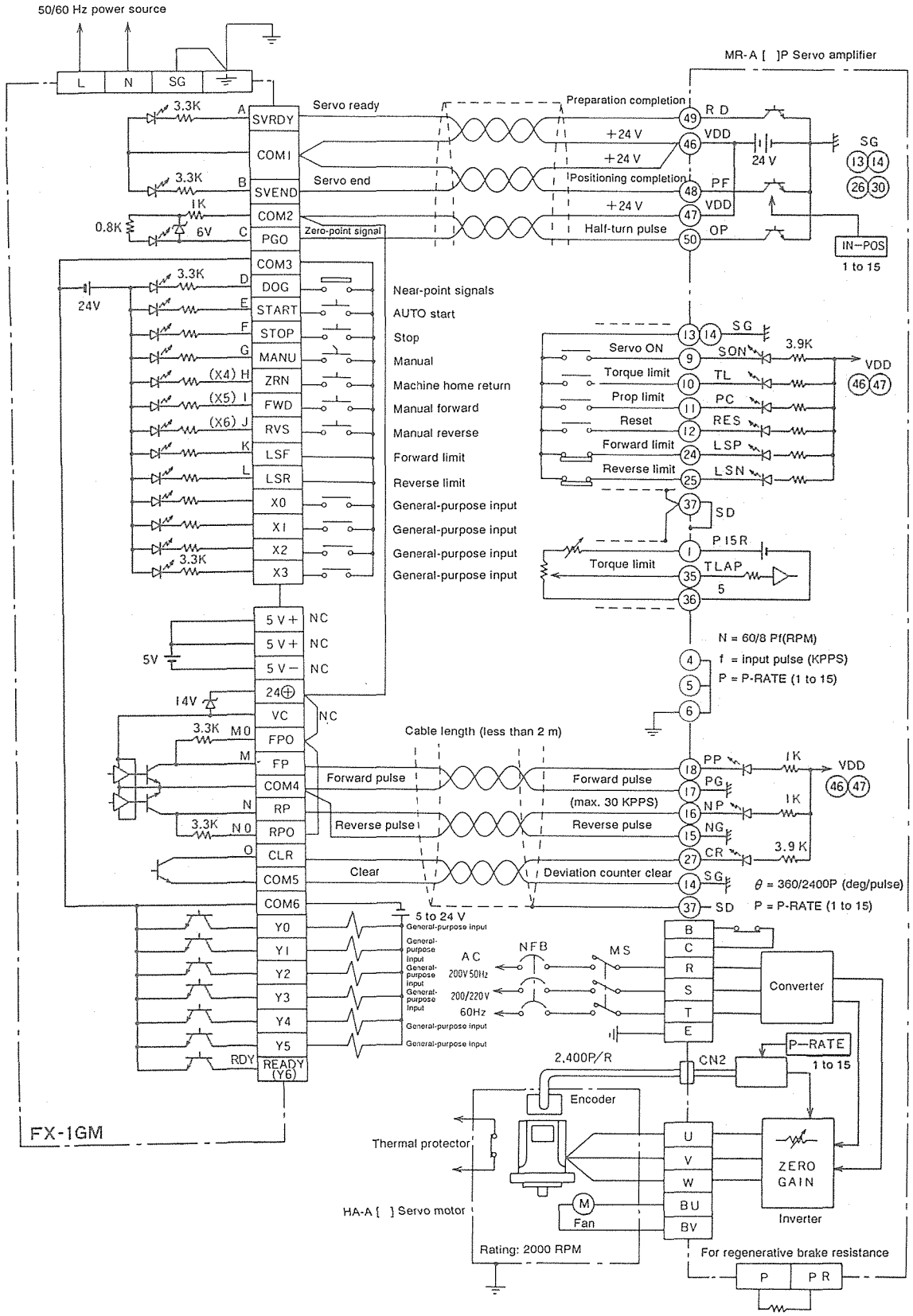


Note: Connections to a MELSERVO-SA-K2L are same as those to MELSERVO-SC except for the fault terminals. (See page 119.)

Mitsubishi Electric MELSERVO-SO

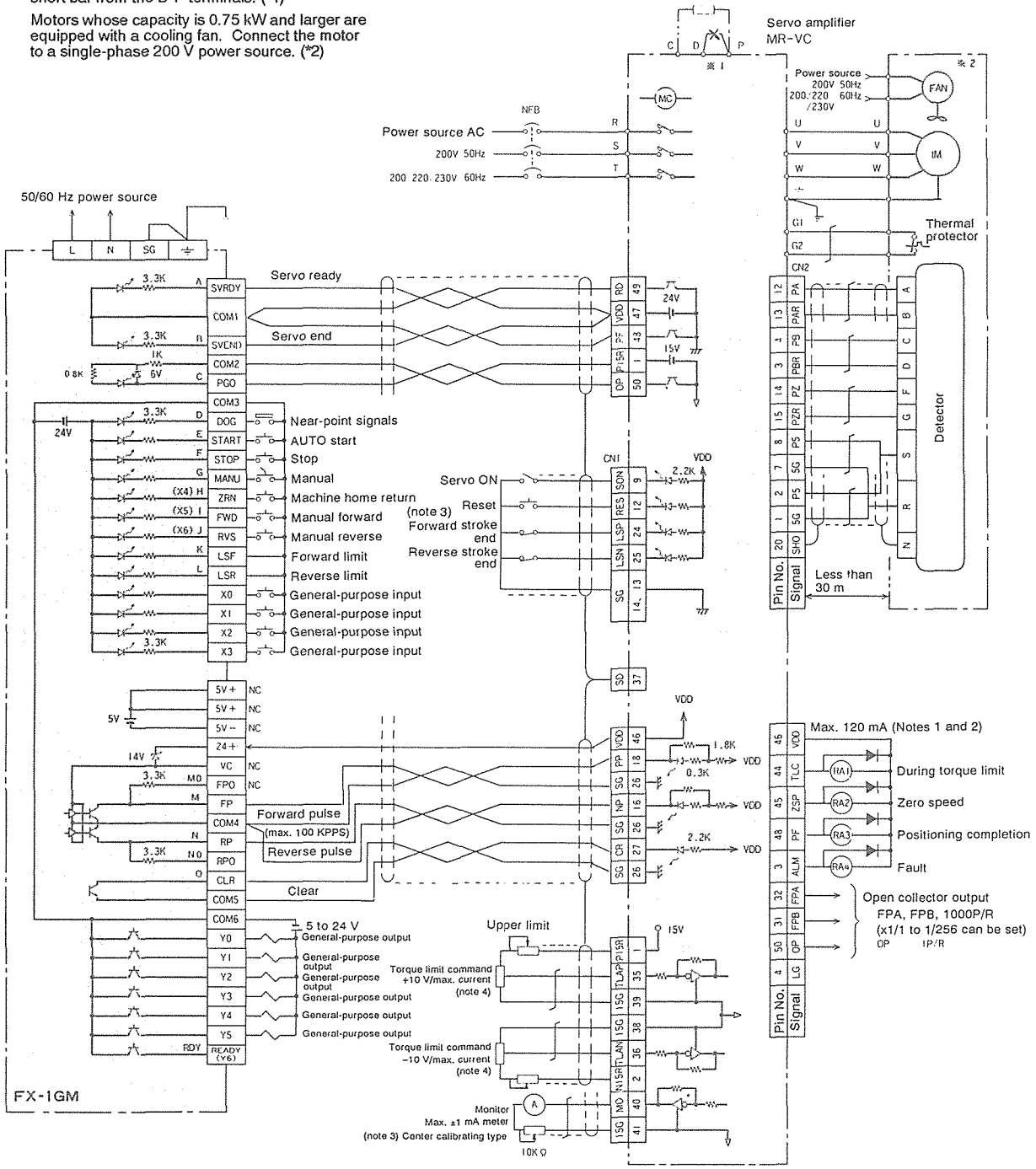


Mitsubishi Electric MELSERVO-A



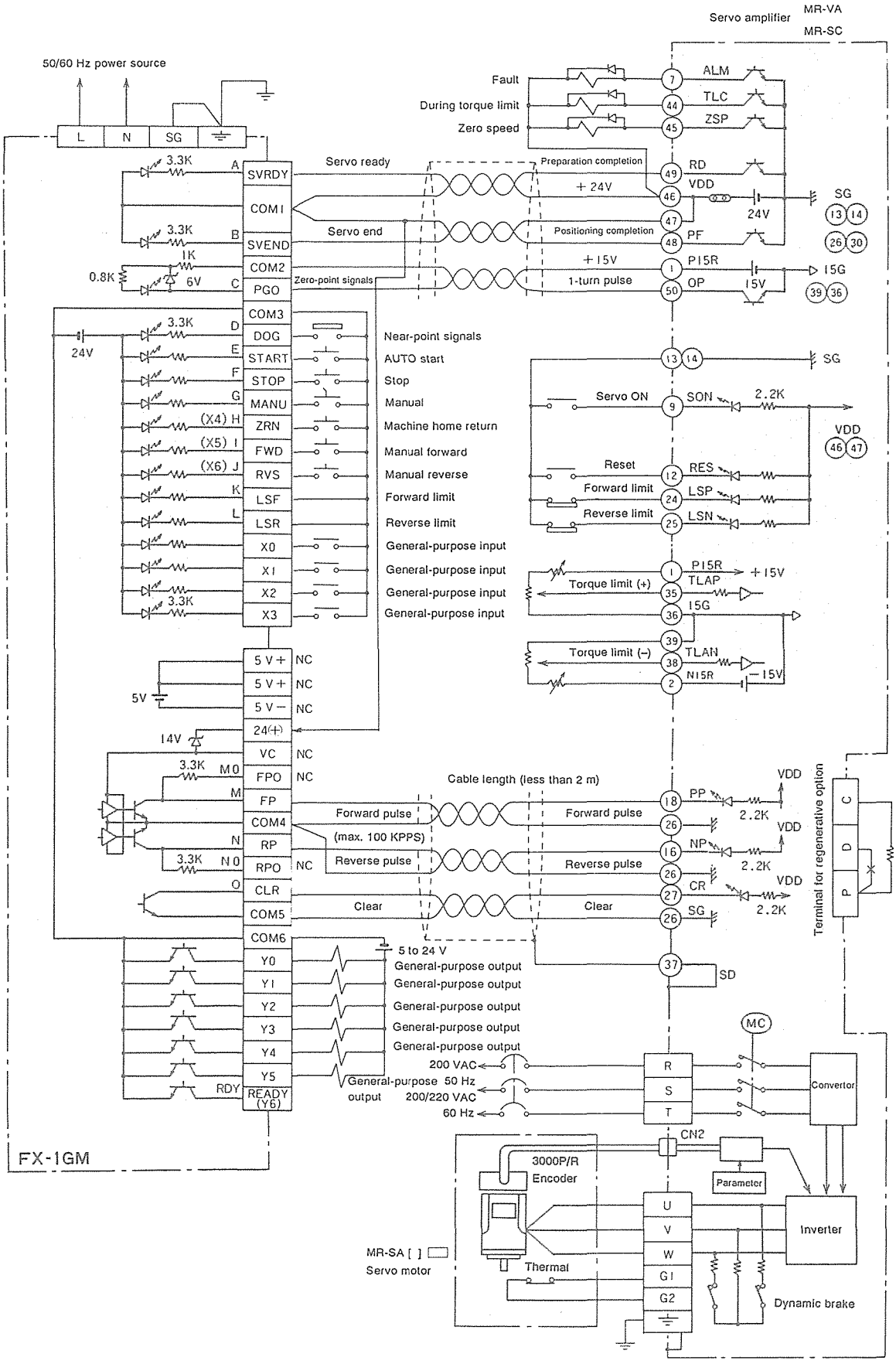
Mitsubishi Electric MELSERVO-VC

Note: When using the regenerative option, remove the short bar from the D-P terminals. (*1)
Motors whose capacity is 0.75 kW and larger are equipped with a cooling fan. Connect the motor to a single-phase 200 V power source. (*2)



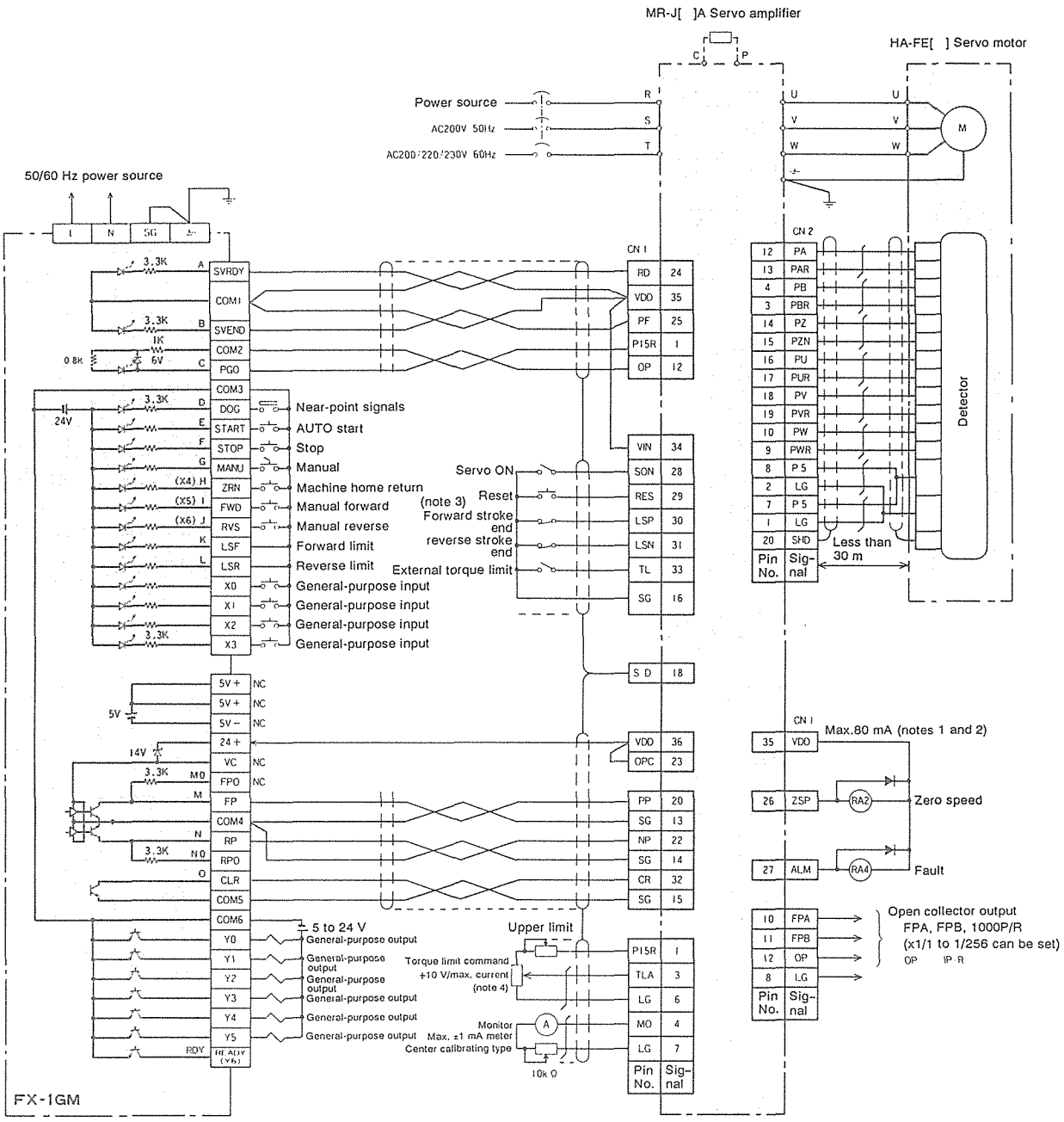
Notes: 1. Total currents of the external relays must be 120 mA or less.
2. Make sure all diodes are connected with correct polarity. If the polarity is wrong, the amplifier will be damaged.
3. Stroke end LSP and LSN must be connected during operations. (b contact)
4. To make the external torque limit valid, change the setting of parameter Nos. 17 and 18 of the drive unit.

Mitsubishi Electric MELSERVO-SC (MELSERVO-VA)



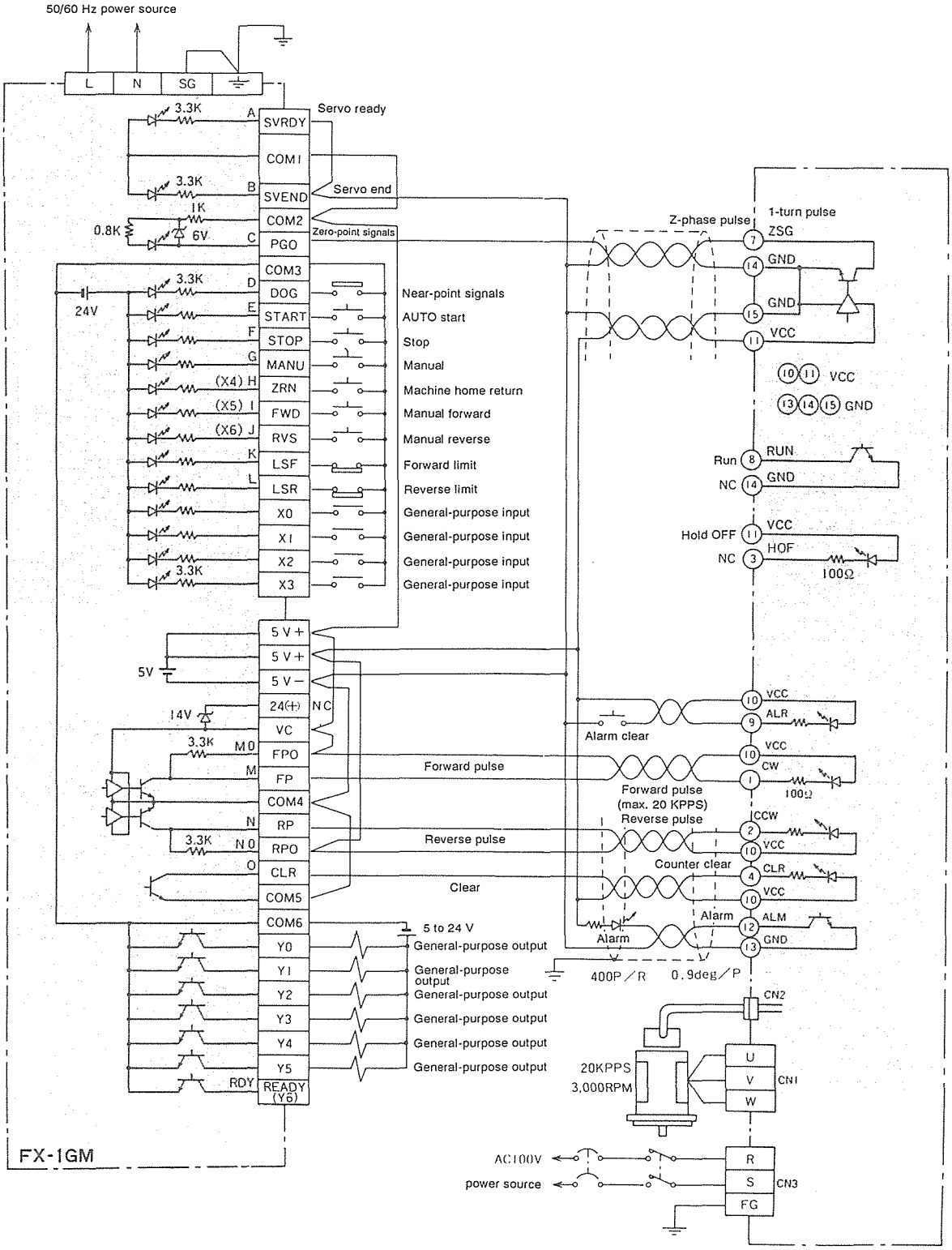
7 SUMMARY

Mitsubishi Electric MELSERVO-J

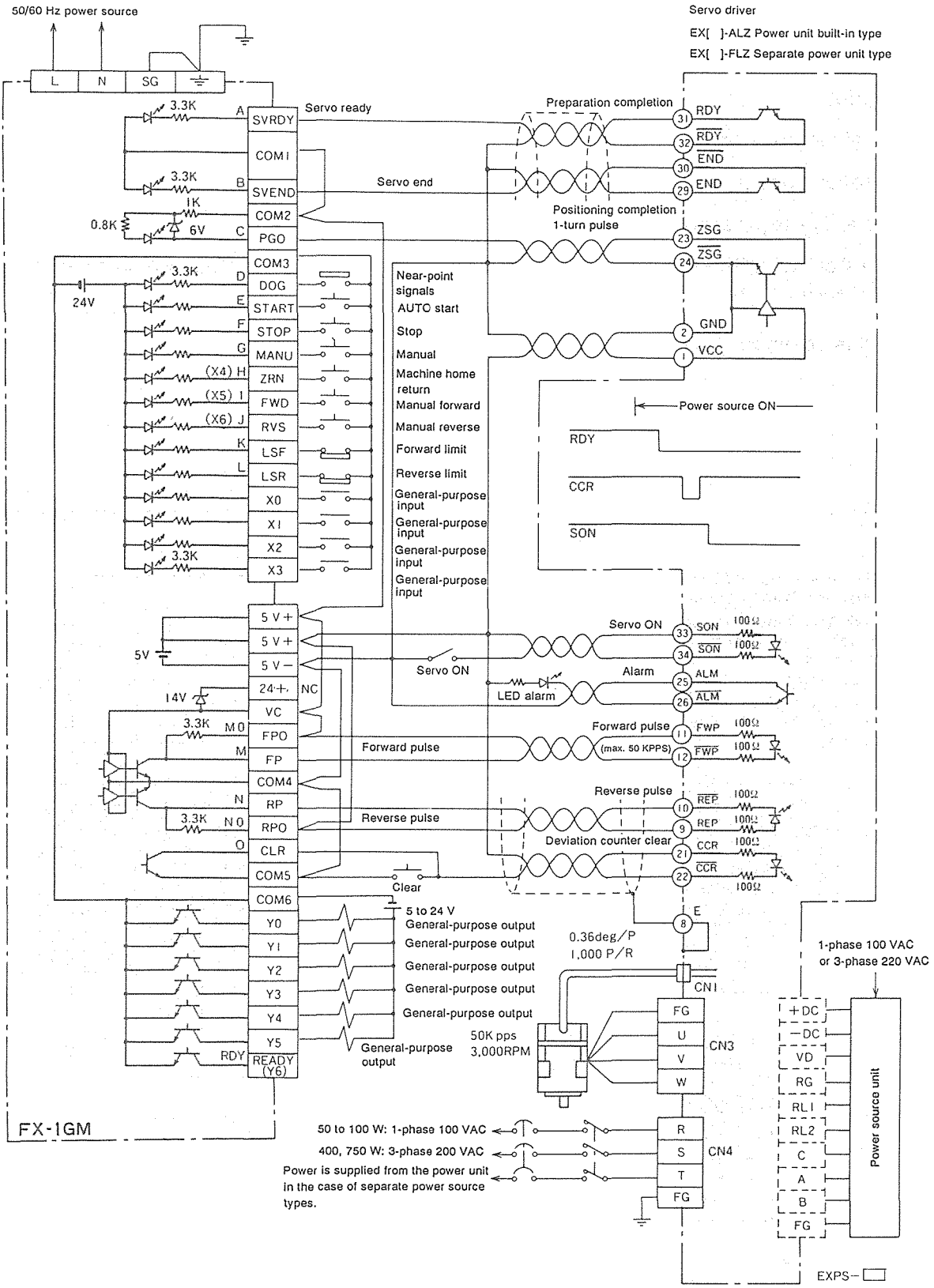


Notes:
1. The external relays' total current must be 80 mA or less.
2. Make sure all diodes are connected with correct polarity. If the polarity is wrong, the amplifier will be damaged.
3. Stroke end LSP and LSN must be connected during operations. (b contact)
4. To make the external torque limit valid, turn ON the servo amp external torque limit LS.

Oriental Motor KX series



Oriental Motor EX series



Shortest Distance Movement Control

If the shortest distance movement control is required in a bidirectional conveyor belt, a DRV ROT instruction (see page 38) may be used.

However some slight calculations are required to obtain the true mechanical movement assuming that 1 turn of the conveyor makes 360 degrees.

(Example)

Belt total length: 18 m

Motor revolutions to turn the conveyer 1 time: 1800 revs

Feedrate B is expressed as (360°/1800) x 10^3 = 200 mdeg/REV.

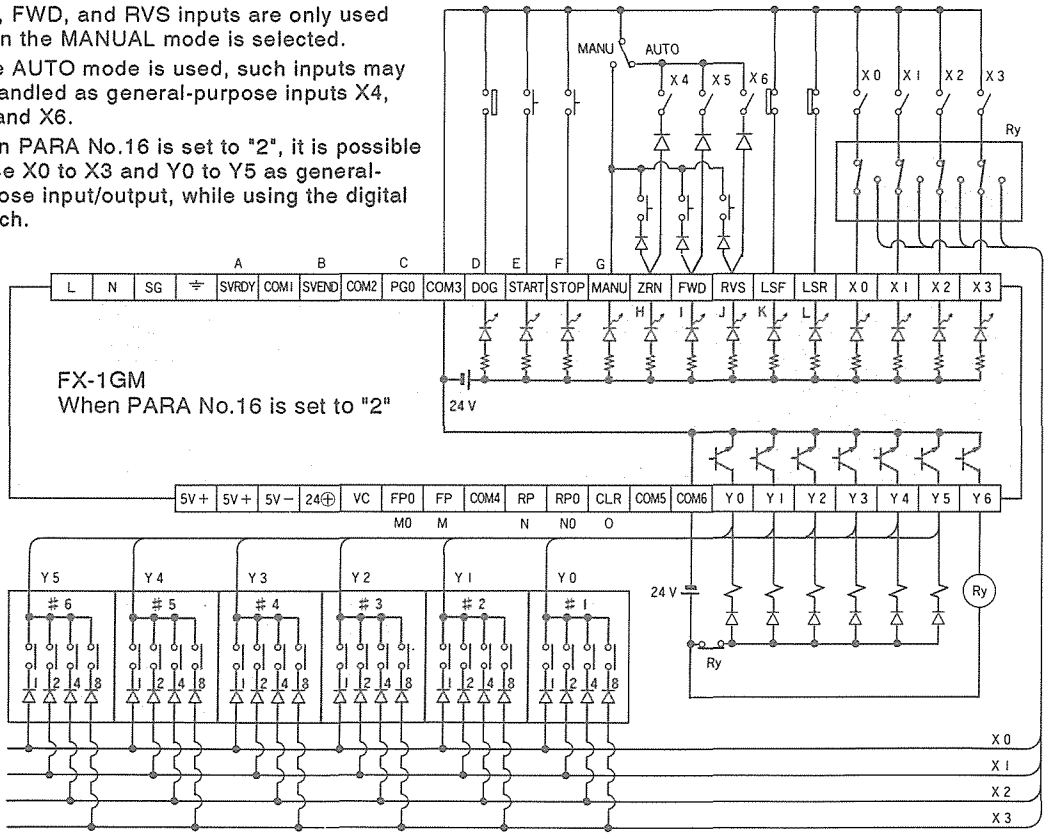
If the system unit (PARA No. 3) is set to "2" i.e., 10^{-2} deg. e.g. ADR + 1,000 would mean a movement of 1,000 x 10^{-2} = 10°.

Using this command, the conveyor moves $\frac{10}{360}$ x 18 = 0.5 m.

Input/output terminal sharing

(1) ZRN, FWD, and RVS inputs are only used when the MANUAL mode is selected.
If the AUTO mode is used, such inputs may be handled as general-purpose inputs X4, X5, and X6.

(2) When PARA No.16 is set to "2", it is possible to use X0 to X3 and Y0 to Y5 as general-purpose input/output, while using the digital switch.



- When parameter No.16 is set to "2", the general-purpose output Y6 is operated when the BLK instruction and EXT instruction are executed.
  If the other general-purpose outputs Y0 to Y5 are operating for load drive, using the Ry relay to read the digital switches breaks the load circuit.

7 SUMMARY

Reading Reference Parameters

The following two kinds of reference parameters are written to the system ROM of the F_2-30TP:

Use the following key operation to read any of the parameters to the RAM of the F_2-30TP, and modify them to transfer them to the FX-1GM.

KEY SHIFT → PARA → INS → 1 or 2 → GO

1 : Servo motor setting reference parameter
2 : Stepping motor setting reference parameter

PARA NOs.	Items	For Servo Motors [1]	For Stepping Motors [2]	Remarks	
0	Unit system setting	1	1	Motor system pulse unit	
1	Pulse rate	2,000	500	PLS/REV	In-valid
2	Feed rate	2,000	2,000	μm/REV, mdeg/REV, 10^{-1} minch/REV	
3	Min. setting unit	2	2	10 PLS (ADR K100 or 1,000 PLS)	
4	Max. speed	100,000	5,000	PLS/sec	
5	Manual JOG speed	10,000	1,000	PLA/sec	
6	Bias speed	0	250	PLS/sec	
7	Backlash compensation	0	0	PLS	
8	Acceleration/deceleration time	1,000	100	msec	
9	Pulse output mode	1	1	A-type	
10	Pulse logic	1	1	Negative logic	
11	Rotation direction setting	0	0	Current value is increased with forward pulse.	
12	Ultimate LS logic	1	1	Normally closed	
13	Error judgment time	5,000	5,000	msec	
14	Block designation	3	3	Block designation by the programmable controller	
15	Position bias	0	0	PLS	
16	Setting of RDY output	0	0	PGU RDY output valid	
17	STOP mode	1	1	STOP command valid	
18	Home return direction	1	1	Address decrease	
19	Home position address	0	0	PLS	
20	Home position return speed	50,000	2,500	PLS/sec	
21	Creep speed	1,000	500	PLS/sec	
22	Down counts to home	10	100	Times	
23	Count start logic	0	0	DOG input OFF - ON	

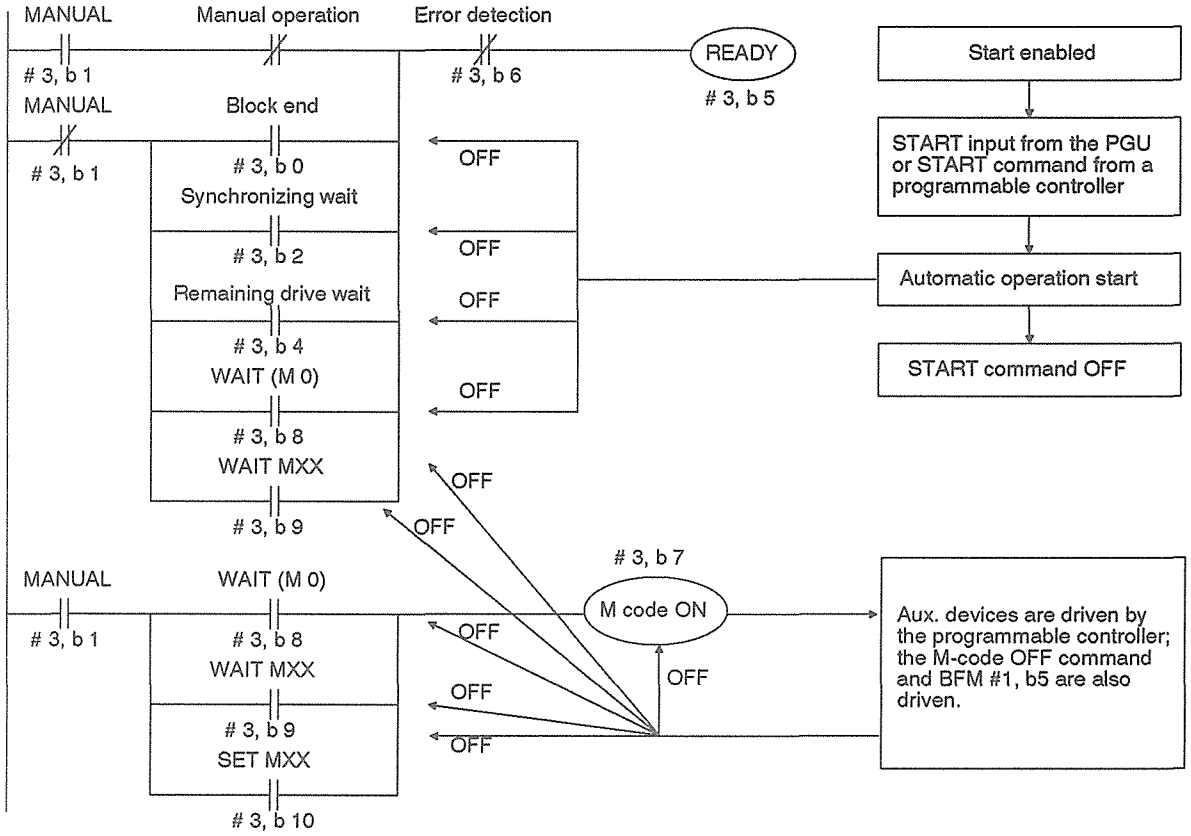
Note: Reference parameters of [1] are transferred into the RAM of the F_2-30TP before shipping.

7 SUMMARY

READY Signals and START Commands

READY signals (the wait state for START commands) generated in the PGU operate in the following equivalent circuit.

[START commands are not accepted if a READY signal is not ON.]

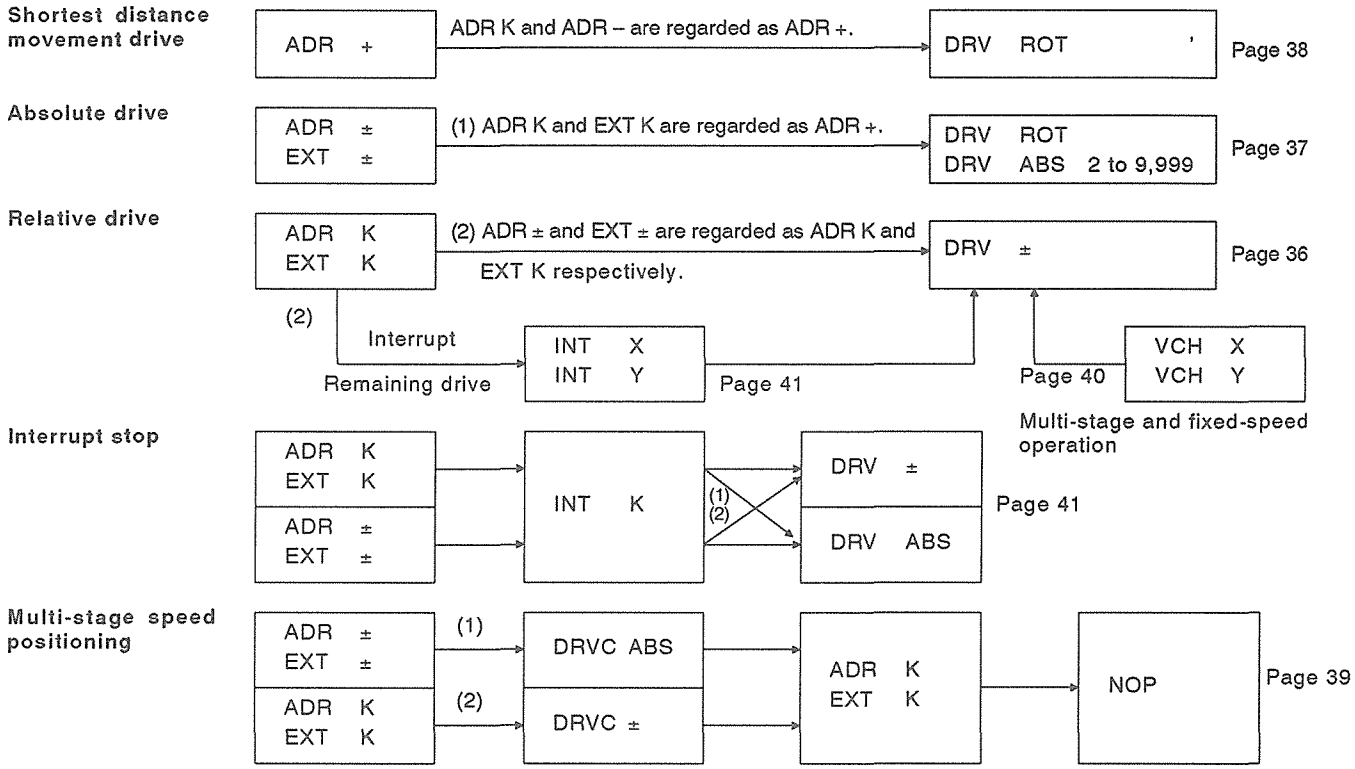


BFM # 3		ON Condition	OFF Condition
b0	Block end	PGU executed an END instruction and is in the wait state.	Any other
b1	MANUAL	MANUAL input of the PGU is ON.	MANUAL input of the PGU is OFF. (AUTO mode)
b2	Synchroniz-ing wait	The wait state before execution of DRV or DRVC instruction in multi-axis synchronizing mode (BFM #1, b2 = ON).	OFF by a START command or DOG input ON (BFM #1.b8 = ON).
b3	—		
b4	Remaining drive wait	Temporary stop (PARA No. 17 is "1".) in the remaining drive mode	OFF by a START command.
b5	READY	As shown by the equivalent circuit above.	
b6	Error detection	Error code CE1 to CE20 is operated.	OFF by a STOP command in the MANUAL mode.
b7	M code ON	As shown by the equivalent circuit above.	When an M code OFF command (BFM #1, b5) is turned ON.
b8	WAIT M0	When a WAIT instruction or WAIT M0 instruction is executed	When an M code OFF command or a START command is turned ON
b9	WAIT M	When a WAIT M1 to M77 instruction is executed	When an M code OFF command is turned ON
b10	SET M	When a SET M0 to M77 instruction is executed	When an M code OFF command is turned ON

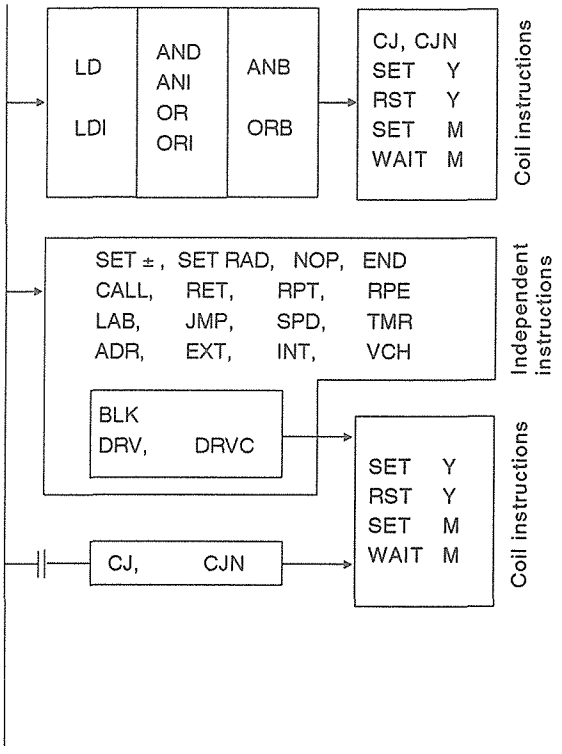
7 SUMMARY

Supplement Related to Instructions

(1) Combinations of drive instructions and address instructions



(2) Handling of sequence instructions



- Instructions driven by contact instructions such as LD and LDI are called "coil instructions".

  When it is necessary to drive a coil instruction unconditionally, use LD M100 (ON all the time during automatic operations).

- Instructions which operate independently of the contact instruction are called "independent instructions".

- After executing instructions such as BLK, DRV, DRVC, CJ, and CJN, it is also possible to drive coil instructions such as SET Y, RST Y, SET M, and WAIT M directly without using an LD M100 instruction.

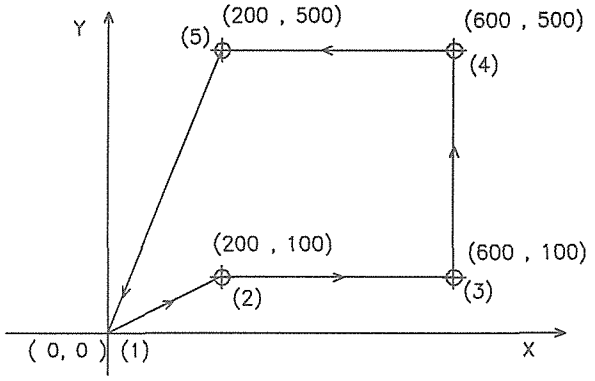
7 SUMMARY

2-Axis Operations

This section following gives an example of a 2-axis operation when two FX-1GM units are connected to 1 FX series programmable controller.

To make holes at the 4 positions shown on the right:

- Operation proceeds in the directions indicated by the arrows, and holes are made at points (2), (3), (4), and (5). (Interpolation is not provided.)
- M codes are designated for X-axis movements only. WAIT instructions are used for Y-axis movements. Y-axis READY signals are used by the programmable controller as the conditions for aux. device actuation.
- By making programs on the FX-1GM common to the X and Y axes (using the same step numbers), it is easy to watch the programs on the screen. This also makes the sequence programs of the programmable controller simple.



(Programming on the PGU side)

Unit No. 0 (X axis)

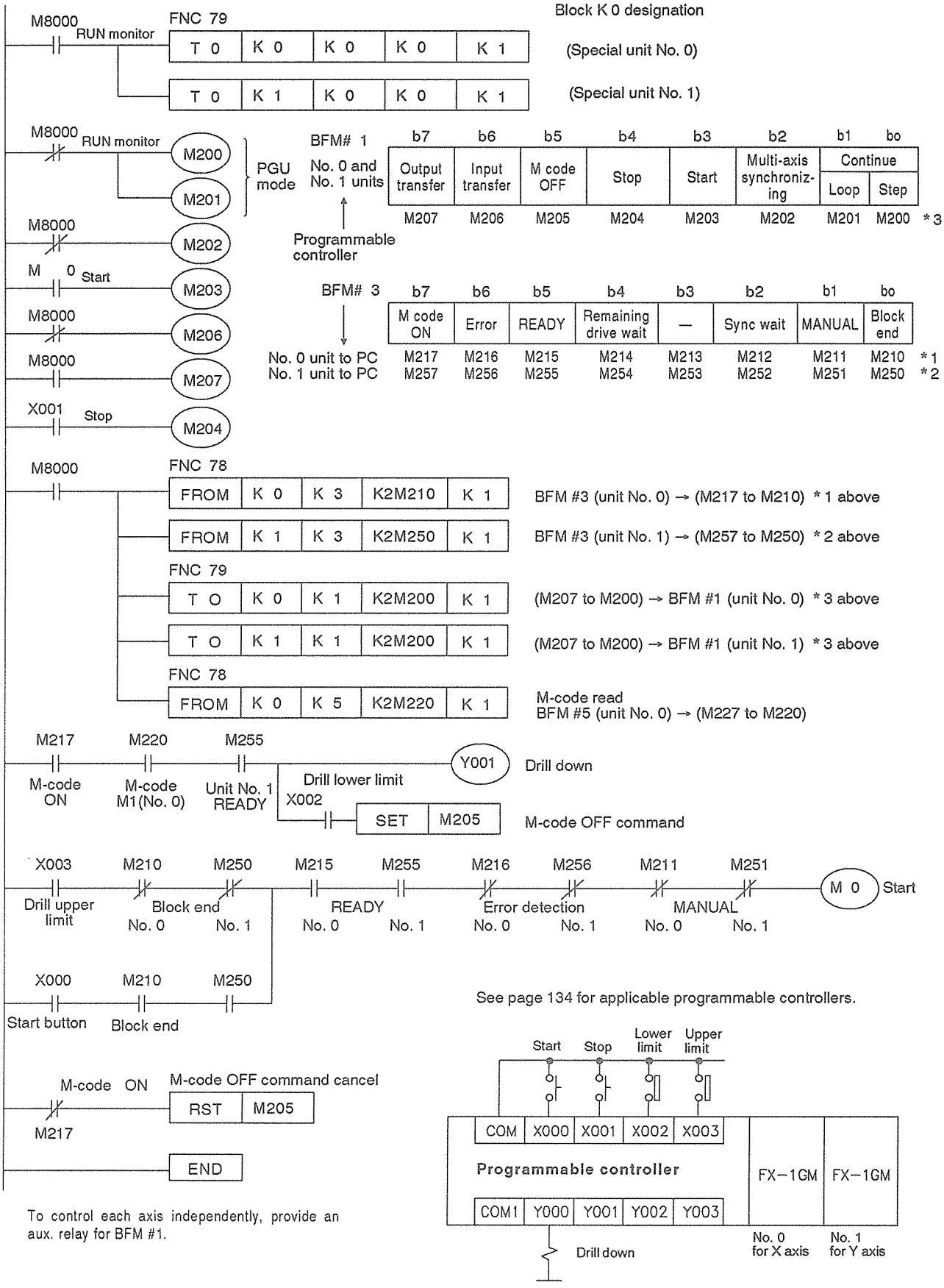
	Steps	Instructions			Remarks
	0	BLK	K	0	
	1	LD	M	101	Home position return completion
	2	CJ	K	254	
	3	DRV	ZRN		
	4	SET	RAD		
	5	LAB	K	254	
	6	ADR	+	0	
(1)	7	DRV	ABS		
	8	ADR	+	200	
(2)	9	DRV	ABS		
	10	WAIT	M	1	M220 ON
	11	ADR	+	600	
(3)	12	DRV	ABS		
	13	WAIT	M	1	M220 ON
	14	ADR	+	600	NOP is also usable.
(4)	15	DRV	ABS		NOP is also usable.
	16	WAIT	M	1	M220 ON
	17	ADR	+	200	
(5)	18	DRV	ABS		
	19	WAIT	M	1	M220 ON
(1)	20	DRV	RAD		
	21	END			

Unit No. 1 (Y axis)

	Steps	Instructions			Remarks
	0	BLK	K	0	
	1	LD	M	101	
	2	CJ	K	254	
	3	DRV	ZRN		
	4	SET	RAD		
	5	LAB	K	254	
	6	ADR	+	0	
(1)	7	DRV	ABS		
	8	ADR	+	100	
(2)	9	DRV	ABS		
	10	WAIT			
	11	ADR	+	100	NOP is also usable.
(3)	12	DRV	ABS		NOP is also usable.
	13	WAIT			
	14	ADR	+	500	
(4)	15	DRV	ABS		
	16	WAIT			
	17	ADR	+	500	NOP is also usable.
(5)	18	DRV	ABS		NOP is also usable.
	19	WAIT			
(1)	20	DRV	RAD		
	21	END			

7 SUMMARY

(Programming on the programmable controller side)



7 SUMMARY

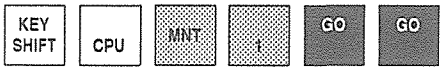
Teaching in the Automatic Step Operation Mode

Using the signal step flag M103 (see page 28), position constants can be changed more easily when READY is ON while trial-running the program even during automatic operations. This feature had been available in the TEST mode when MANUAL input was ON (manual operation). Use the following procedure:

[Applicable versions: F_2-30TP ROM version V1.2 (October, 1988 and after)]

(Operating examples)

First, switch the PGU to RUN and set the TP to monitor:

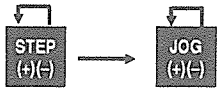



```
   1 0                          3 0 0 0   ← Current position
→ A D R    +                1 0 0 0 0
```

Change to the TEST mode:

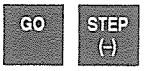

```
   1 0                          3 0 0 0   ← Current position
→ A D R    +                1 0 0 0 0
```

JOG operation:




```
     8                          3 0 3 0   ← Current position
→ A D R    +                3 0 0 0
```

Change the program constant to that of the current position:




```
     8                          3 0 3 0   ← Current position
→ A D R    +                3 0 3 0
```

Pressing the GO key increases the step number by 1. The ADR K instruction, which is used to confirm overwriting, switches to an ADR ± instruction.

Return to the MNT mode:


```
   1 0                          3 0 3 0   ← Current position
→ A D R    +                1 0 0 0 0
```

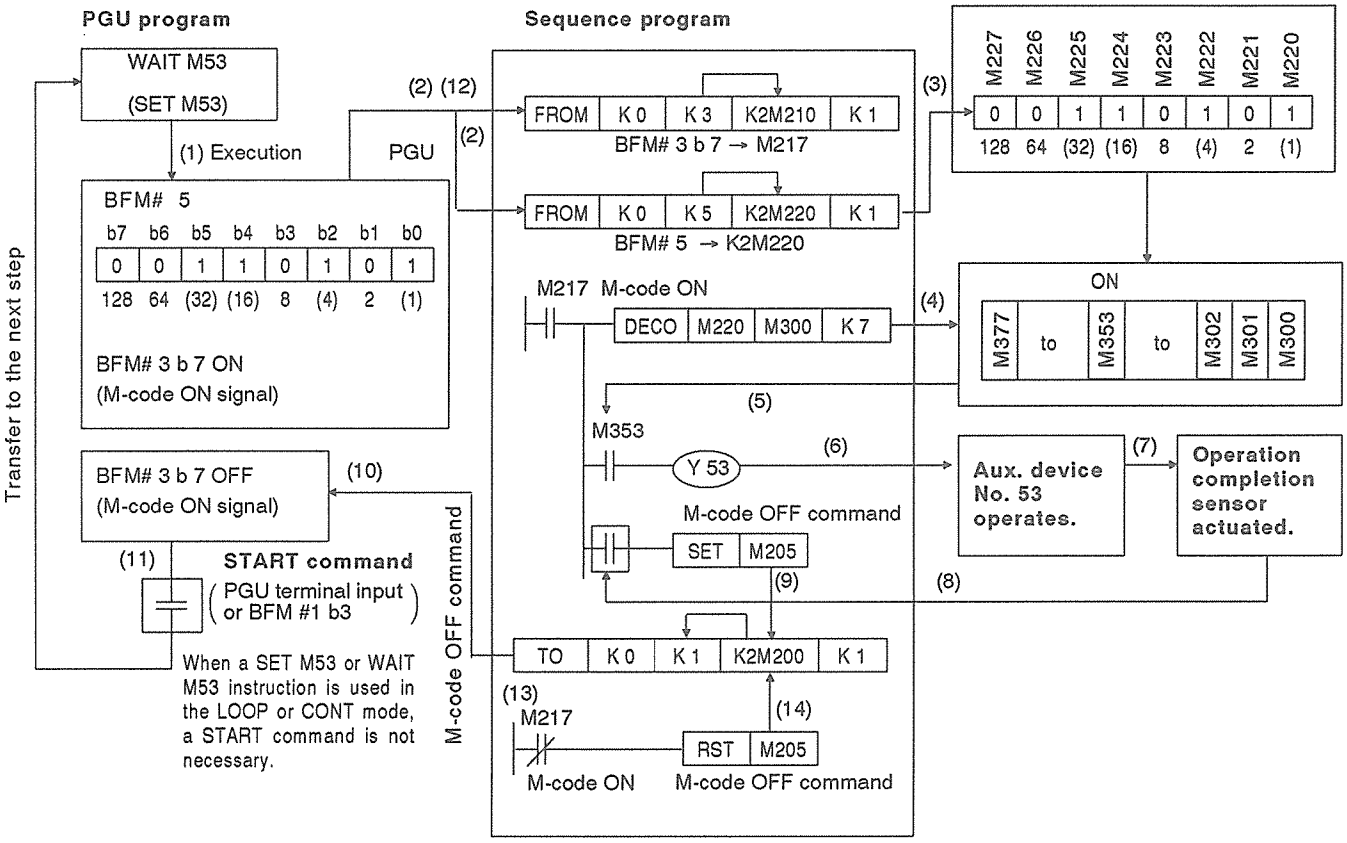
Hereafter, pulsing the start input will advance the program execution to the next step.

Note: Remember that this the TEST mode is while the PGU is in AUTO mode.

Hence, the outputs Y0 to Y6 may become ON; in addition manual DRV ZRN and fixed length feed on the TP are invalid.

7 SUMMARY

M-Code Data Handling

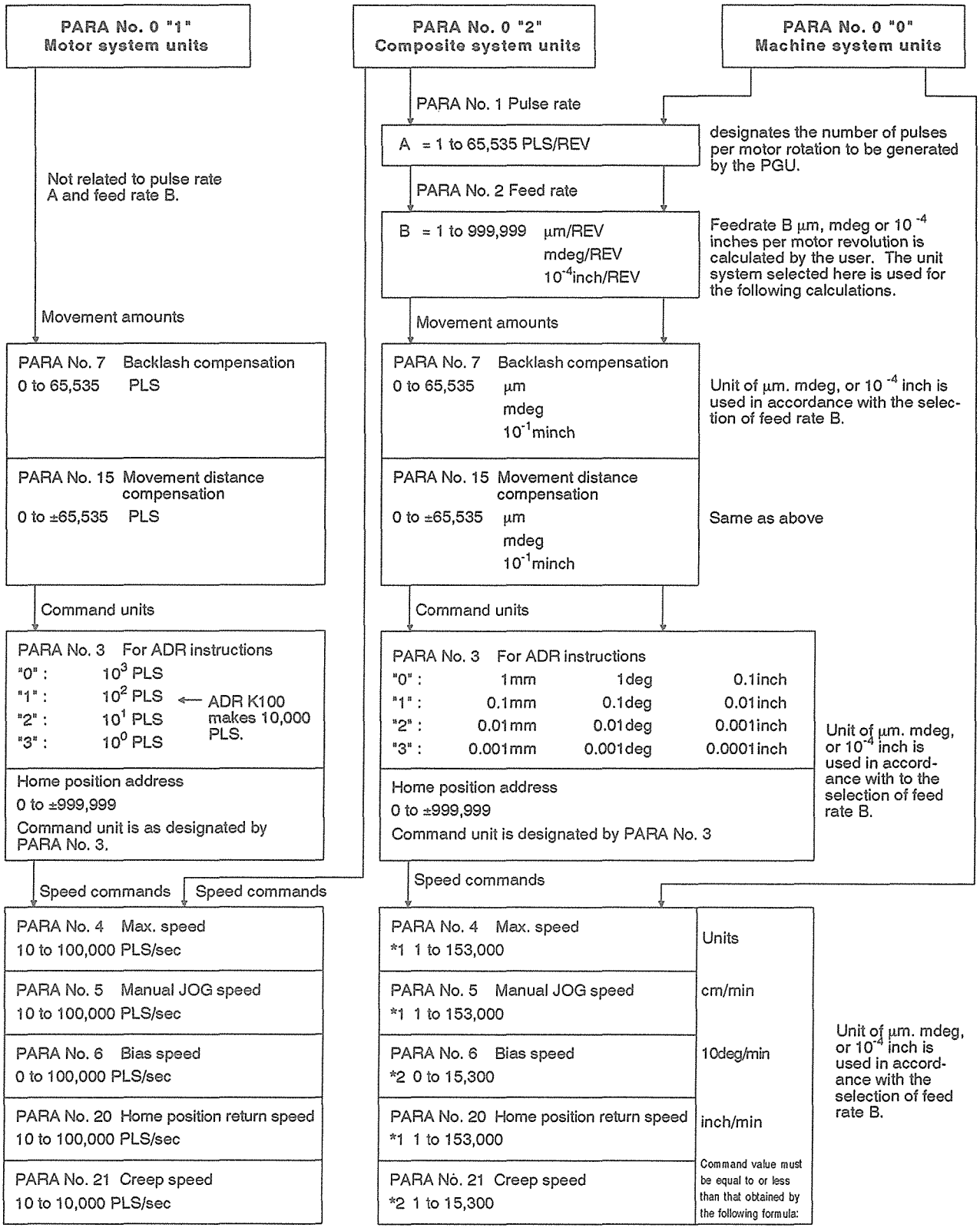


(Differences between WAIT M and SET M instructions (See pages 19,20,35,43))

Instructions	M-Code ON Signals BFM #3 b7	READY Signals BFM #3 b5		Operating Mode Signals BFM #1 b1, b0
WAIT (M 0)	M-code ON signal is OFF. Then, M-code data (BFM #5) is generated and the M-code ON signal turns ON. After the aux. device operation is completed, unless the M-code ON signal is turned OFF by an M-code OFF command (BFM #1 b5) etc., the next WAIT M0, WAIT M, or SET M instruction is not executed, and the wait state remains ON. (M-code ON signal OFF wait state)	When a WAIT M0 or WAIT M instruction is executed, the READY signal turns ON and the START command wait state is set. (AFTER mode)	When a START command is given, the M-code ON signal is turned OFF automatically in the PGU.	PGU mode STEP mode LOOP mode CONT mode
WAIT MXX XX = 01 to 77 Octal number			After the M-code ON signal is turned OFF, give a START command.	
			When an M-code OFF command is turned ON, the operation starts automatically.	
SET MXX XX = 00 to 77 Octal number		The READY signal does not turn ON, and the operation goes to the next step without a START command. (WITH mode) However, if a WAIT M0, WAIT M, or SET M instruction exists in the next step, the wait state is set until the M-code ON signal is turned OFF.		

7 SUMMARY

Unit Systems for Parameters



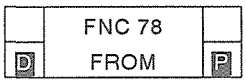
Note: *(Speed command value)* $\times \frac{A \times 10^4}{B \times 60} \leq$ 100,000 or 10,000 PLS/sec.

*1 *2

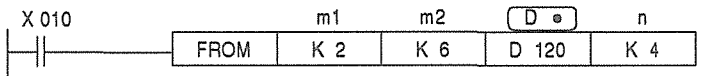
7 SUMMARY

Outline of FROM/TO Instructions

Communications between an FX series programmable controller and an FX-1GM PGU are controlled by the FROM/TO instructions of the programmable controller. (See page 134 for applicable programmable controllers.)



BFM read



Read command Reading from special unit No. 2 BFM #6 to #9

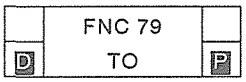
→ 4 word data is transferred to programmable controllers D120 to D123.

m1 : Special unit number or block number
(Units such as an FX-1GM, FX-4AD, FX-2AD-PT, FX-2DA, and FX-1HC are numbered No. 0 to No. 7, beginning with the one nearest the main unit.)

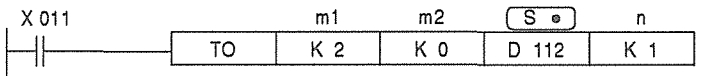
m2 : Head designating number (m2 = K0 to K31) of BFM

(D •) : Head element number of the destination of transfer. T, C, D, KnY, KnM, KnS, V, and Z can be designated.
(Index registers V and Z can be used for qualification of element numbers.)

n : Number of transfer points (in units of 1 word with 16-bit instructions. n = K1 to K32 / In units of 2 words with 32-bit instructions. n = K1 to K16)



BFM write



Write command Writing from the programmable controller's D112 to special unit No. 2 BFM #0.

m1, m2, n : Same as above.

(S •) : Head element number of the source of transfer. T, C, D, KnX, KnY, KnM, KnS, V, Z, K, and H can be designated. (Index registers V and Z can be used for qualification of element numbers.)

Notes:

(1) Putting D makes a 32-bit instruction, and putting P makes a pulse execution instruction. Each instruction can be used in 4 combinations.

(2) When X010 or X011 is OFF, transfer is not executed, and the data in the destination does not change. When a pulse execution instruction is used, transfer is executed only when the instruction drive input state is switched from OFF to ON.

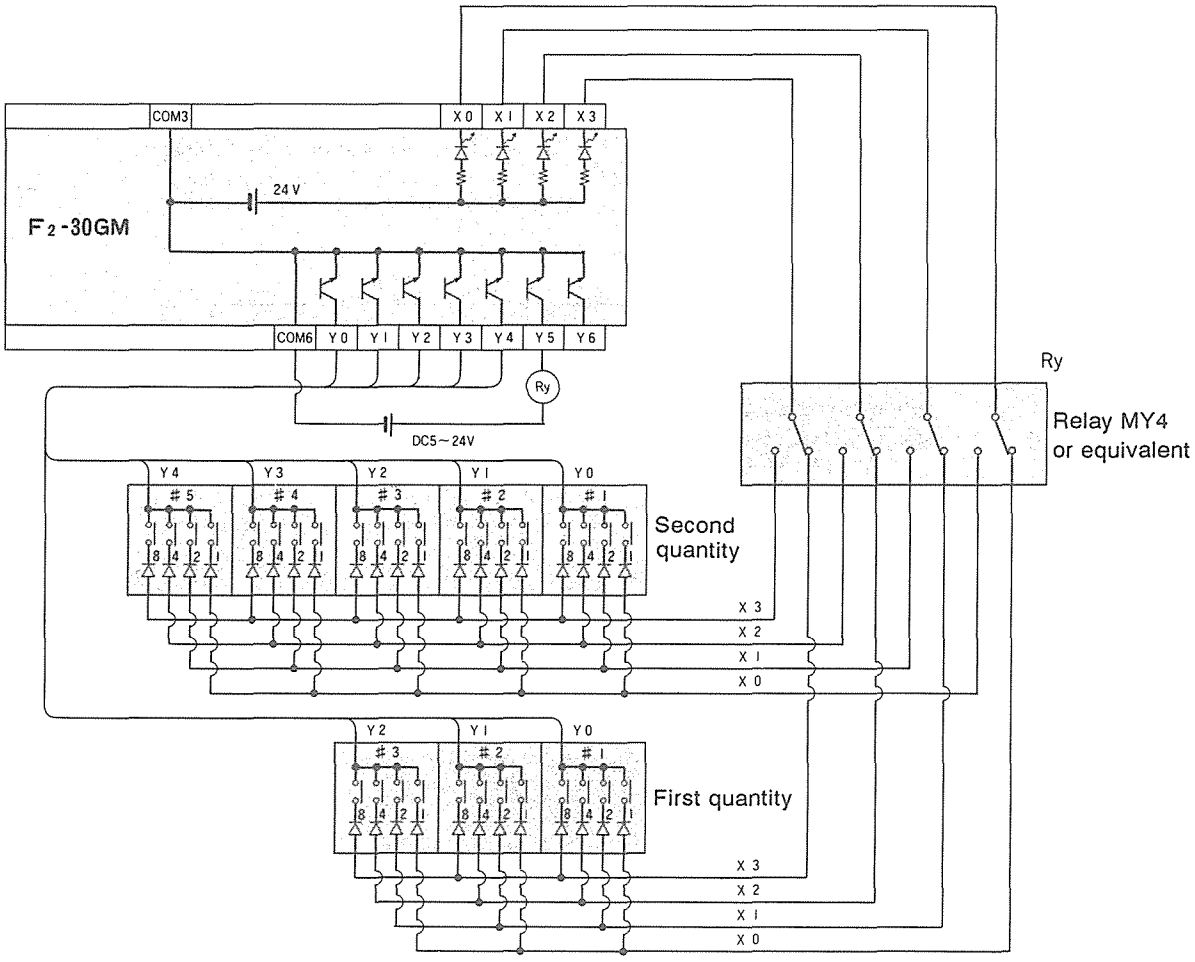
Reading Two Data Quantities from Digital Switches (When the Data Quantity Exceeds 6 Digits)

When addresses are externally designated using digital switches (DSW), or when the speed and the number of repetitions as well as addresses are designated using the new feature provided by this version, there often occur some cases that the whole amount of data cannot be designated by using a DSW which has only 6 digits.

In such cases, an external relay Ry can be connected to read two data quantities through a DSW.

(Example)

When the movement amount uses 5 digits and a speed command uses 3 digits:



Program example:

```
BLK K  0
SPD X  32,100      First quantity is read. (Speed setting)
SET Y  5           Ry ON. Switching for reading the second quantity.
TMR K  2           Wait 20 msec for the relay operating time.
EXT K  54,321      Second quantity is read. (Address setting)
RST Y  5           Ry OFF
DRV +
END
```

- By using Y6 for switching, up to two DSWs, each having 6 digits, can be utilized.
  (When Y6 is used, set PARA-16 RDY output to "1" to make Y6 a general-purpose output.)

7 SUMMARY

Applicable Versions

Make sure the versions of the FX series programmable controllers, FX-20P programming panels, and F_2-30TP teaching panels are applicable before using these units.

[FX series programmable controllers]

Versions V2.10 and after are applicable. (Contents of special data register D8001 in the programmable controller must be K20210 or higher.)

[FX-20P programming panels (HPP)]

Versions V2.10 and after support FROM/TO instructions and are applicable.
(V2.00 supports FROM/TO instructions. However, only word devices can be used for writing to sources and destinations.)

[F_2-30TP teaching panels (TP)]

Versions V1.3 (March, 1989) and after are applicable, and all functions are usable. Versions released before V1.2 have function limitations as shown below.

O : Usable functions X : Unusable functions

F_2-30TP Versions			Functions
V1.0 (May, 1988 and before)	V1.1 (June, 1988 and after)	V1.2 (October, 1988 and after)	
X	O	O	SPD instruction (see page 32) (3)X70 to 77 (4) X1 to 654,321
X	O	O	EXT instruction (see page 33) (2) ±70 to 77 (4) K70 to 77
X	O	O	OR instruction (see page 42) Used for adding and subtracting numerical value instructions.
X	O	O	RPT instruction (see page 46) (2) X70 to 77 (3) X1 to X6,543
X	X	O	PARA No. 23 (see page 25) Count start period Setting: "2", "3"
X	X	O	PARA No. 17 (see page 27) Stop mode Setting: "2", "3"
X	X	O	INT instruction (see page 41) (2) K0 to K6 (4) K440 to K444
X	X	O	Teaching in the automatic step operation mode (see page 129)
X	X	X	PARA No. 0 (see page 22) Unit system setting Setting: "2"
X	X	X	PARA No. 14 (see page 27) Block designation Setting: "4" to "15"
X	X	X	PARA No. 18 (see page26) Home position return direction Setting: "2", "3"

7 SUMMARY

Responses of Each Signal

The responses of each signal of an FX-1GM are described using the programming example given below.

(Programming example:)

Steps	Instructions			Remarks
0	BLK	K	0	
1	ADR	K	10	10 pulses are output.
2	DRV	+		
3	WAIT	M	1	Waits for an M-code OFF signal from the programmable controller.
4	DRV	+		
5	END			

Parameters

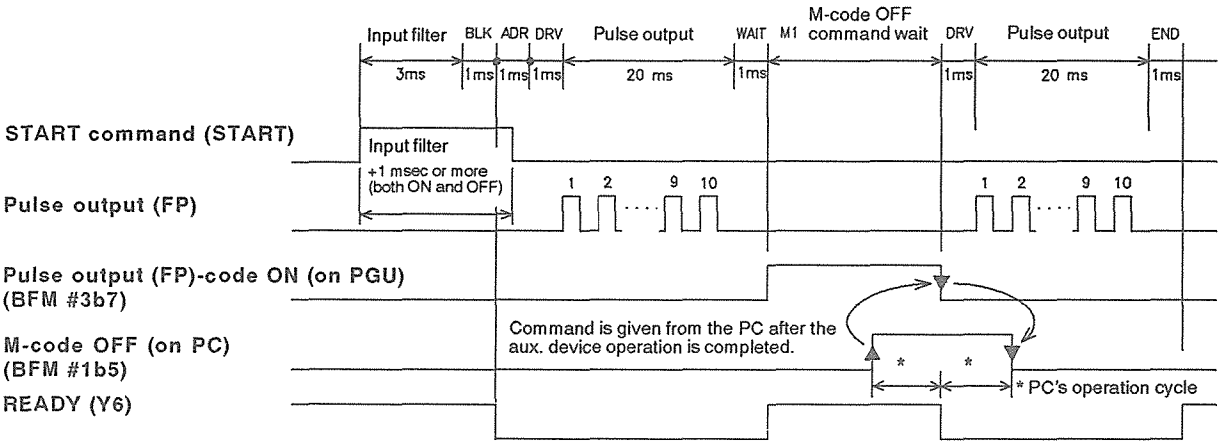
No. 4 Max. speed: 500 PPS

No. 5 Bias speed: 500 PPS

Others

Used in combination with a programmable controller.

The SV END signal is always kept ON.



Input Filter Times

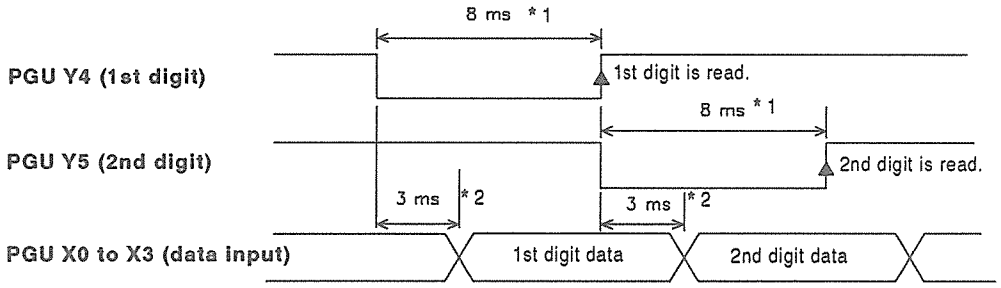
Signals	Input Filter Times
PGO	1 μs
DOG	0.5 msec
Other than the above	3 msec

Timing for Fetching from an External Digital Switch

PARA No. 18 is used to designate the home position return direction. This is also used for selecting the timing for fetching the signals from an external digital switch. Either timing of 8 msec/digit or 64 msec/digit can be selected by using an F_2-30TP (version V1.3 or after).

PARA No. 18	Current PGU Addresses at Machine Home Position Return	External Digital Switch Fetching Timing
Setting "0"	Current address increases.	8 msec/digit
Setting "1"	Current address decreases.	
Setting "2"	Current address increases.	64 msec/digit
Setting "3"	Current address decreases.	

- The following shows the external digital switch input timing when the PARA No. 14 (block designation) setting is "2";

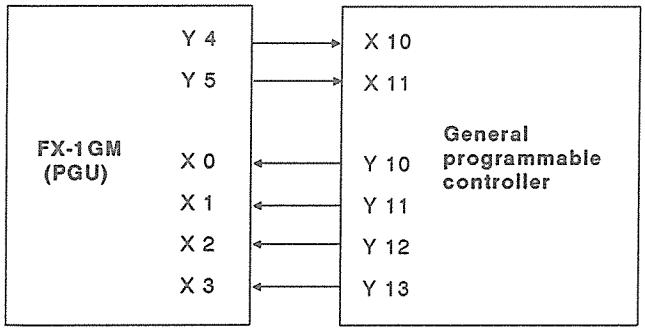


*1: 8 msec when PARA No. 18 is "0" or "1", and 64 msec when it is "2" or "3".

*2: Input filter timing

- The same timing is used for data fetching from an external digital switch when an SPD, EXT, or RPT instruction is used.
- Usually a timing of 8 msec/digit is selected for fetching data from an external digital switch.

When output data of a programmable controller other than the FX series is fetched through the input channels of the PGU, as shown below, and if the response of the programmable controller is slow, select 64 msec/digit to improve the timing of the I/O operations between the two.



When X10 is ON, the 1st digit of data is output to Y10 to Y13.

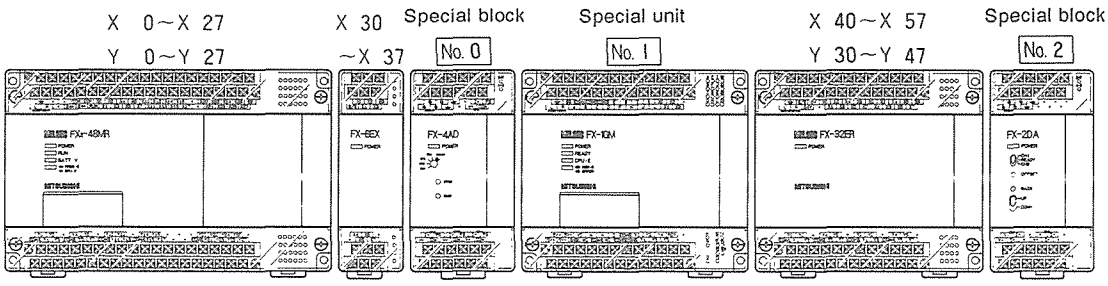
When X11 is ON, the 2nd digit of data is output to Y10 to Y13.

After X10 or X11 is turned ON, data has to be output within 61 msec (64 msec - input filter 3 msec).

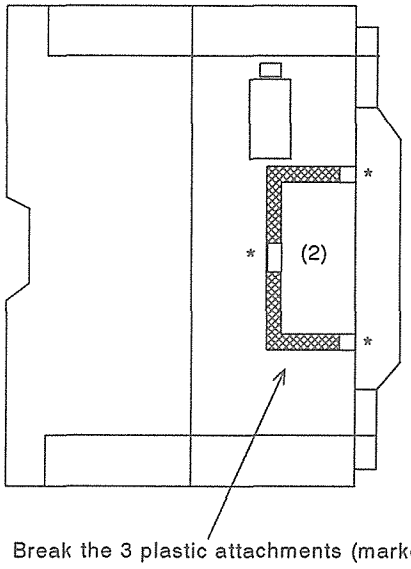
(a)

When Making Connections Using Extension Cables

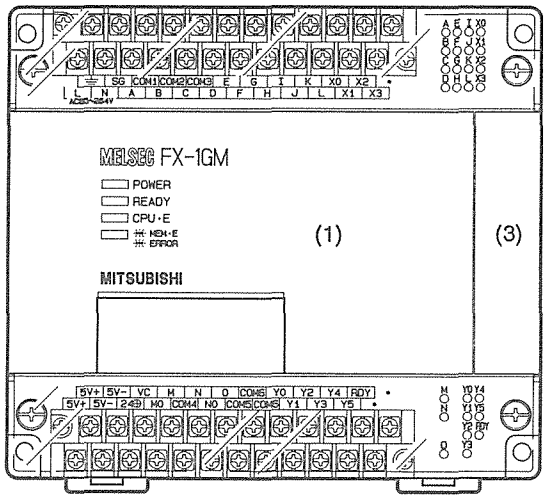
Special units and blocks such as pulse output units, analog input blocks, analog output blocks, and high-speed counter blocks which are operated by FROM/TO instructions can be connected directly to the main unit of an FX series programmable controller or to the right side of other extension blocks or units. Up to 8 special units and blocks can be connected to 1 main unit, and they are numbered as Numbers 0 to 7 beginning with the one nearest the main unit.



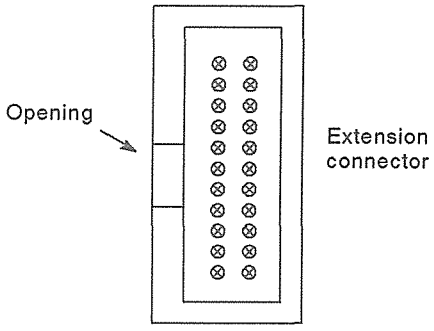
To connect an extension cable to an FX-1GM pulse output unit, open the panel cover (1) and remove (by breaking the attachments) the fixed protective cover (2) of the cable outlet on the left side of the FX-1GM pulse output unit. Open the connector cover (3) on the extension unit or block, and then connect the extension cable.



Break the 3 plastic attachments (marked *).



There is a projection on the extension cable connector to ensure it is correctly inserted. Fit this projection in the opening on the left side of the extension connector when connecting the cable.



MEMO

REVISIONS

EDITION DATE	MANUAL NUMBER	REVISION
Mar., 1993	JY992D36201A	First edition
Jan., 1994	JY992D36201B	Add Diagrams : P137

Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.

All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

Owing to the very great variety in possible applications of this equipment, you must satisfy yourself as to its suitability for your specific application.

HANDY MANUAL

FX-1GM POSITION CONTROL UNIT

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
HIMEJI WORKS: 840, CHIYODA CHO, HIMEJI, JAPAN

JY992D36201B
(ILC 9705)

Effective JAN. 1994
Specifications are subject to change without notice.