Panasonic

PROGRAMMABLE CONTROLLER

MICRO CONTROLLER M TYPE Manual

MICRO CONTROLLER M TYPE Manual
ACG-M0005-3

Matsushita Electric Works, Ltd.

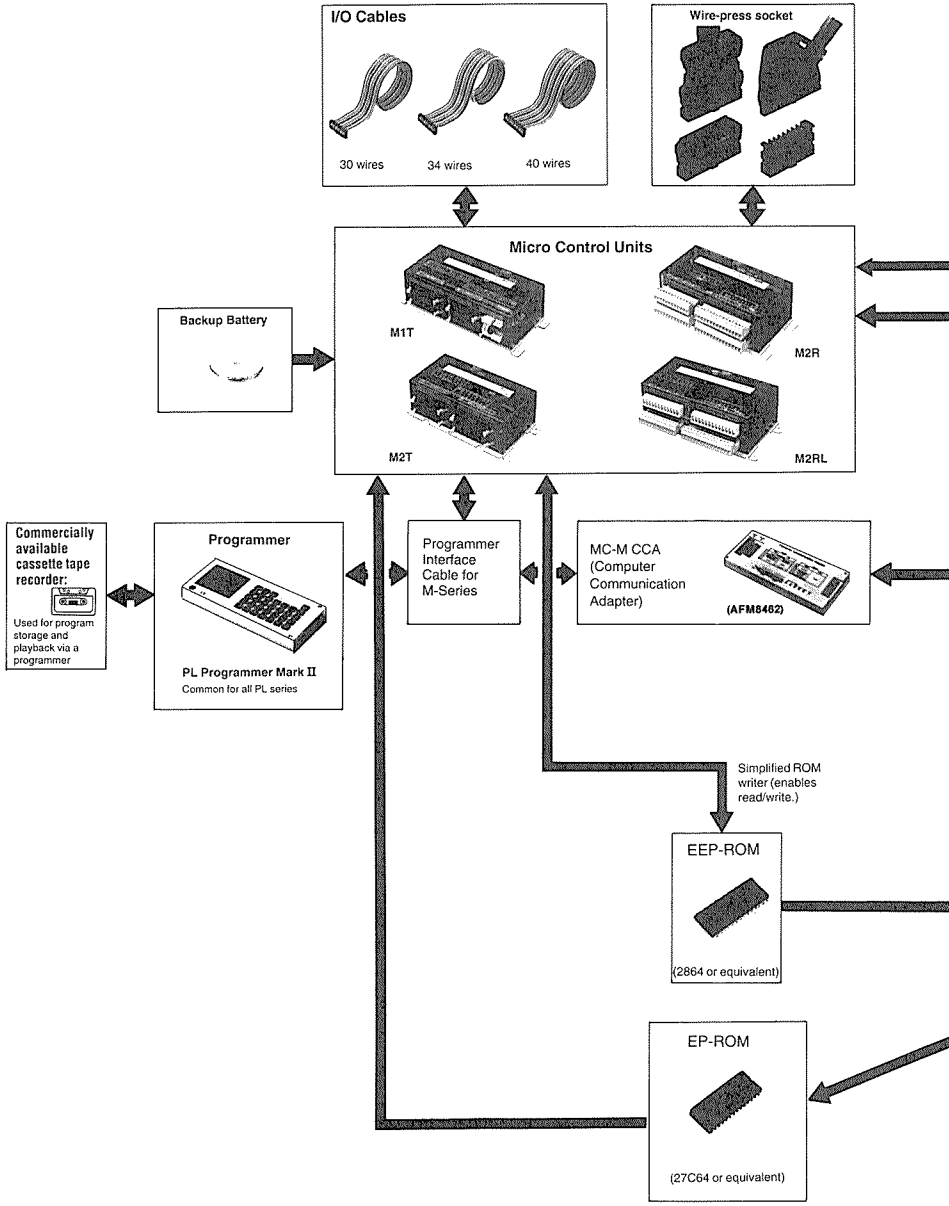
CONTENTS

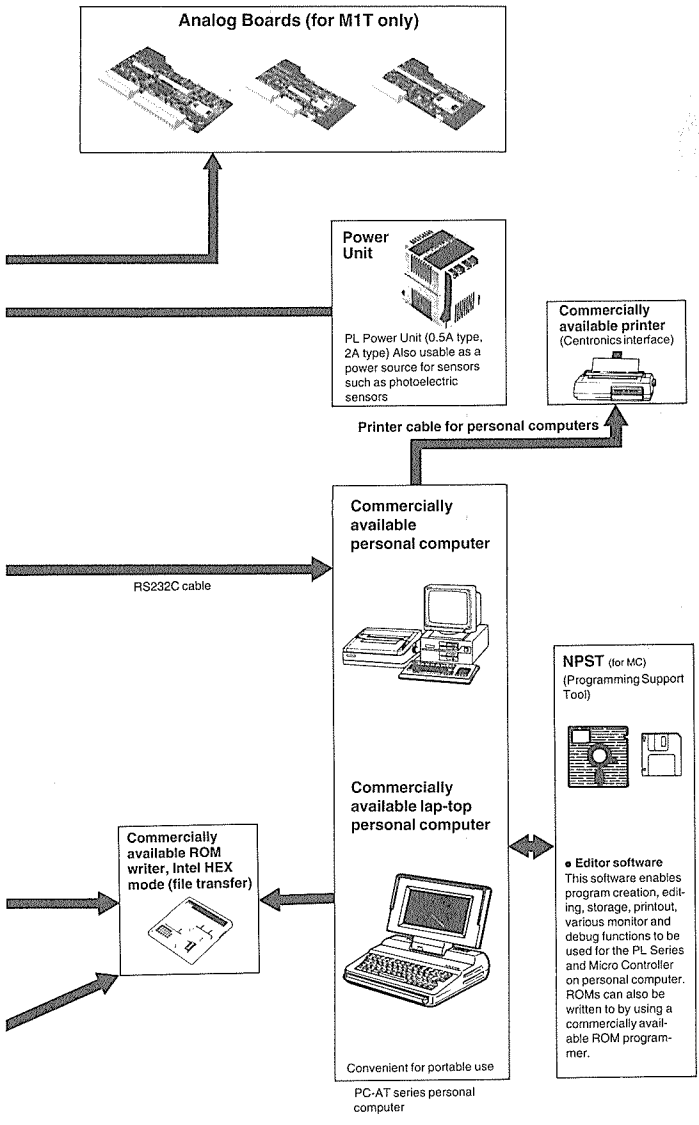
CHAPTER 1

SYSTEM CONFIGURATION AND FEATURES

"PC" is the abbreviation for Programmable Controller.

1-1. System Configuration





Peripheral Devices for Powerful Support of the Micro Controller

■ Features

1. Easy-to-use PL Programmer Mark II

The PL Programmer Mark II is a convenient programmer for simple program modifications. It can also be used with the PL series.

It includes the cassette-loader function and various monitor functions.

2. NPST (Programming Support Tool) converts a commercially available personal computer into an advanced programming device

NPST permits your personal computer to be used immediately as a Micro Controller programming device. If you use a laptop, if becomes a portable graphics programmer.

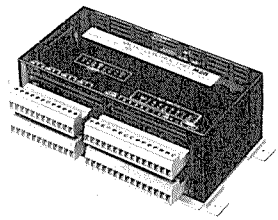
With the IBM PC-AT version, programs can be read or written over the telephone line using a commercially available Modem.

Your program maintenance service can be expanded worldwide.

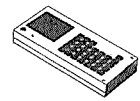
3. Stranded-wire compression sockets for wiring MIL connectors

The Micro Controller employs MIL connectors in the transistor output to achieve compact size. Compression sockets ideal for stranded wires are available when wiring the same stranded wires that were used for conventional screw terminals. Despite its small size, its ease of wiring is unsurpassed.

1-2. M2R Relay Output Micro Controller



Micro Control Unit M2R



PL Programmer Mark II APL2114

• Compact design ideal for embedded use:

Screw terminal type:
63.8 (H) × 193 (W) × 112 (D) · mm
2.5 (H) × 7.6 (W) × 4.4 (D) · in.
SIL terminal type:
63.8 (H) × 193 (W) × 94 (D) · mm
2.5 (H) × 7.6 (W) × 3.7 (D) · in.

• Cost comparable to relay controllers:

The M2R contains 64 timers, 48 counters and 252 relays. The M2R is more economical than relay controllers when the costs for specification changes and maintenance are considered.

• Customized controller designs available

• Machine language calls for advanced processing

The machine language call instruction enables the combined operation machine language routines and sequence programs. Useful for advanced processing such as for extra-fast processing speed.

• Password feature ensures user program security:

The password feature protects your valuable programs from unauthorized access. It is particularly useful for protecting copyrighted programs used in quantity products.

• Power saving design ideal for use in vehicles:

The DC-power version of the M2R can be battery powered. The controller's power supply contains a rectifier network; it may also be powered by an AC power source 20 V AC.

• High speed counter is built in:

Counting speed; 8 kcps
Counting range; 1 to 65,535
Counting mode; Addition (UP)
The counters can be used for position control or high-speed sensor inputs with a rotary encoder.

• High program capacity of 2,500 steps in a compact controller

• High processing speed of 4.25 μs per step for a basic instruction

• Simplified ROM writer function:

The simplified ROM writer can write EEP-ROM (AFB8602)

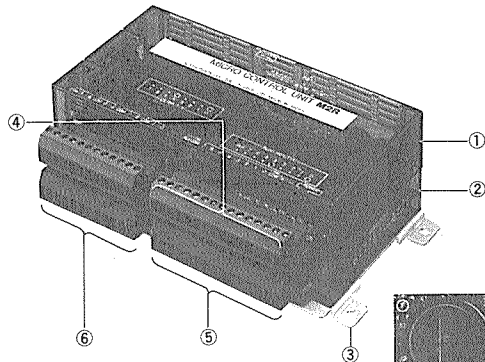
• Program compatible with PL series

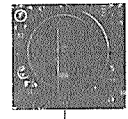
• Powerful programming support devices:

In addition to PL Programmer Mark II, NPST programming support tool turns your personal computer into a high-level programming device.

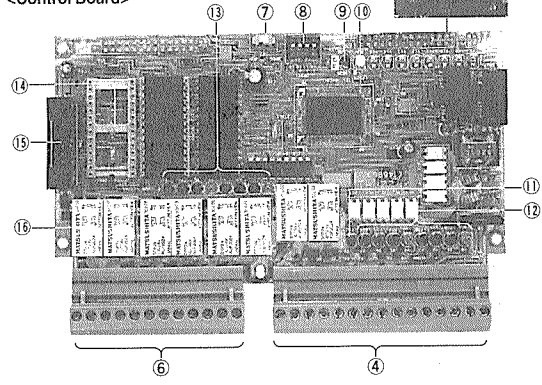
1. M2R Screw-terminal Micro Control Unit

<External view>

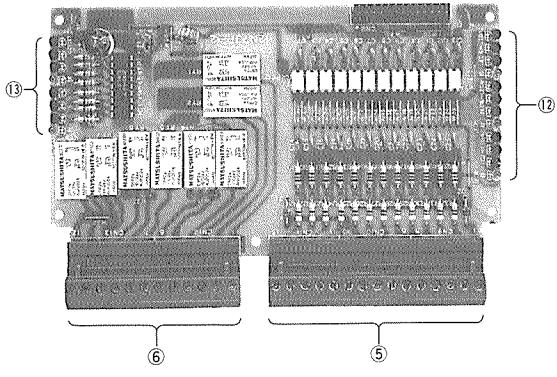




<Control Board>



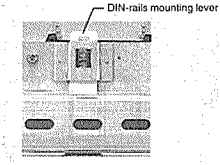
<I/O Expansion Board>



① **Control board case**
Protective case for the control boards.

② **Skirt case**
Case which protects the lowest part of the I/O expansion board.

③ **Main unit mounting plate**
Mounting plate used to mount the Micro Controller to a panel or device. In addition to direct screw mounting, it permits mounting to DIN-rails with its DIN-rail mounting lever. Easily removable.



④ **Power supply and input terminals**
On the control board, the controller's power supply, input power supply and input section are located on a single screw terminal block. Since the terminal block is removable, so it can be removed to connect the wiring and then re-attached.

⑤ **Input terminals of I/O Expansion board**
The input terminal block is removable. It can be removed to connect the wiring and then re-attached.

⑥ **Output terminals**
The output terminal block is removable. It can be removed to connect the wiring and then re-attached.

⑦ **PROG./RUN mode switch**
This switch is used to select between the PROG. and RUN modes.

⑧ **DIP switches (X16 to X19)**
These switches are used to set your password to protect the switch inputs and user program from unauthorized access.

⑨ **ALARM/BATT. indicator**
This indicator (red) light turns on if a CPU error (watchdog timer error, etc.) has occurred. it flashes when the internal back-up battery is low.

⑩ **RUN indicator**
This indicator (white) turns on when the PROG./RUN mode switch is set to RUN.

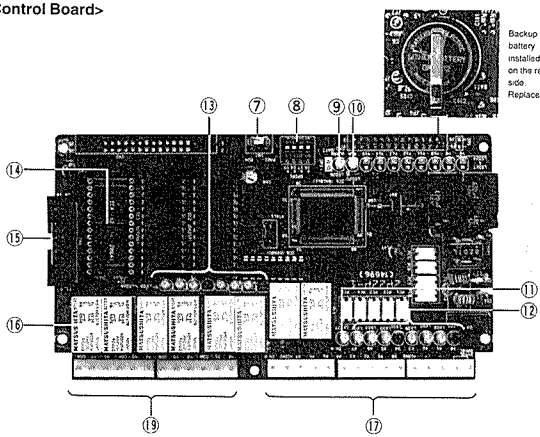
⑪ **High speed counter input indicator**
This indicator (red) turns on when a signal is applied to the IN.H input.

⑫ **Input status indicators**
A green LED indicator is provided for every four inputs so that the operation of each input can be easily confirmed.

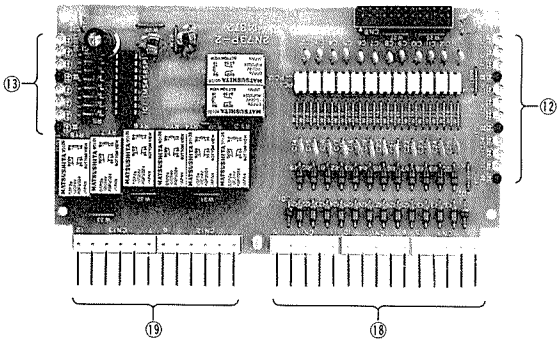
⑬ **Output status indicators**
A green LED indicator is provided for every four outputs so that the operation of each output can be easily confirmed.

2. SIL terminal Micro Control Unit

<Control Board>



<I/O Expansion Board>



I/O cable with five input conductor and power wires

I/O cable with six output conductor wires

⑭ User memory IC socket
With the controller power turned off, install the EP-ROM and EEP-ROM ICs into these sockets. When installing, straighten the IC pins so that they are aligned with the width of the sockets and make sure that the ICs are oriented correctly. When the mode is switched from PROG. to RUN with the ROM installed, the contents of the ROM are transferred to the internal RAM. If you wish to preserve the contents of the internal RAM, it is recommended that you store them in the EEP-ROM, cassette tape, floppy disk or other permanent medium.

⑮ Programmer connector
Connect the PL Programmer Mark II or MC-M CCA (Computer Communication Adapter) to this connector by using the M Programmer Interface Cable. To save power consumption, disconnect the PL Programmer Mark II when not in use.

⑯ Output relays
The output relays consist of high-efficiency, high-performance, DSP relays developed by Matsushita Electric Works' original technology.

⑰ Power and input connectors
The M2R SIL terminal control board uses SIL connectors for the controller power and input power connections. Connect using the optional I/O cable (containing five input conductors plus power) or female connector set.

⑱ Input terminals
A SIL connector is used. Connect using the optional I/O cable (containing five input conductors plus power) or female connector set.

⑲ Output terminals
A SIL connector is used. Connect using the optional I/O cable (containing six output conductors) or female connector set.

1-2-2. Specifications

1. General

Item	Description		
Rated operating and input voltage	Control power supply voltage : 24V DC / 12V DC Input voltage : 24V DC / 12V DC		
Rated power consumption	Type of board	Control power supply :	Input voltage :
		24V DC / 12V DC	24V DC / 12V DC
	Control board	Control board only: Approx. 3.6W With Programmer Mark II: Approx. 4.8W	Approx. 0.12W per input (at 24V DC) Approx. 0.06W per input (at 12V DC)
	I/O Expansion board	Approx. 3.2W per board	
Operating and input voltage range	95% to 110%V		
Ambient temperature	0°C to 50°C (32°F to 122°F)		
Ambient humidity	30% to 80%RH (non-condensing)		
Storage temperature	–20°C to 70°C (–4°F to 158°F)		
Battery life	3 years [ambient temperature +5°C to +35°C (41°F to 95°F)], lithium battery		
Noise resistance	Minimum 800V (based on in-house measurements)		
Vibration resistance	10 to 55Hz, 1 cycle per minute : double amplitude 0.75mm (0.03 in.), 10 minutes in each of the X, Y and Z axes		
Shock resistance	Minimum 10G, 4 times in each of the X, Y and Z axes		

2. Performance

Item	Description		
Program memory	ROM/RAM (during test run)		
Programming method	Relay symbol method		
Control method	Stored program, cyclic method		
Program capacity (Number of steps)	2,500 steps		
Calculation speed	Basic instruction 4.25 μs per step (average 7.5 μs per step)		
Types of instructions	Basic instruction: 19, High level instruction : 28 (including seven, high-speed counter instructions)		
Number of input/output points	Total: 36 points		
		Input	Output
	Control board	X0 to X7: 8 points DC input X16 to X19: 4 points DIP switch input IN. H: 1 point high speed counter input	Y0 to Y7: 8 points relay output
	I/O Expansion board	X8 to X19: 12 points DC input X16 to X19: 4 points can be also used for DIP switch input	Y8 to Y15: 8 points relay output
Number of internal relay points	252 points Non-holding type : 192 points (CR0 to CR191) Holding type (see Note 1) : 60 points (CR192 to CR251)		
Number of timer points (subtraction type)	64 points (T0 to T63) : Subtraction (DOWN) type, Non-holding type 0.01 s unit : 0.01 to 9.99 s 0.1 s unit : 0.1 to 99.9 s 1 s unit : 1 to 999 s		
Number of counter points	48 points DOWN type: 32 points (C0 to C31) UP/DOWN type: 16 points (C32 to C47) All holding type (see Note 1) 1 to 999 counts		
Number of shift register points	32 points/8 bits (SR0 to SR377) (Octal digit) All holding type (see Note 1)		
Number of JMP, MCR points	Each 32 points (0 to 31)		
Special internal relays	Initialize pulse relay: CR252 OFF during 1 scan immediately after operation is started. Scan pulse relay: CR253 ON and OFF is repeated every 1 scan 0.1 s clock relay: CR254 ON and OFF is repeated every 0.1 s Battery abnormality detection relay: CR255 ON at the time of voltage drop of backup battery.		
Alarm function	At CPU abnormality (watchdog timer): Alarm LED ON At battery abnormality: Alarm LED flashes		
Program protect function	Password method		

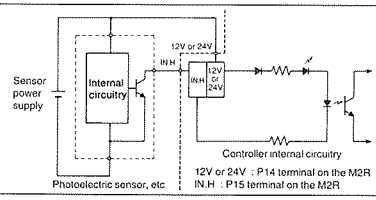
Notes: 1) The term "holding type" refers to the function of remaining at the condition existing at the time of a power interruption, permitting a return to that condition when power is restored.
2) When applying or interrupting power supply, alarm LED flashes for a moment. However, this does not signify abnormality.

3. High Speed Counter

Item	Description	
Counting input	One point	
Reset input	External one point (shared with X0 input) Internal one point (Y 199) (reset when ON)	
Count mode	UP only (non-holding type)	
Maximum count range	1 to 65535	
Counter contacts	32 points (C50 to C81)	
Settings	Maximum 128 (using each counter contact, settable at will)	
High-speed output	High speed scan + output update (limited to Y0 to Y3)	
Counting speed	Maximum 8 kcps (varies, however, depending upon number of high speed scan area steps, etc.)	
Minimum input time	Counting input: 62.5 µs, Reset input: 470 µs + t_{HS}	
Rated input voltage	12V DC to 24V DC	
ON voltage	19.2V DC or less	
OFF voltage	2.4V DC or more	
Maximum input voltage	26.4V DC	
Input current	Counting input (IN. H): Approx. 19mA (at 24V DC)	Reset input (X0): Approx. 5mA (at 24V DC)
Input impedance	Approx. 1.1kΩ	Approx. 4.7kΩ (at 24V DC) Approx. 2.0kΩ (at 12V DC)

Note: t_{HS}: Time needed for high-speed scan.

External Wiring Example



4. Input

Item	DC input	
Rated input voltage	24V DC (Allowable ripple rate: 10% or less)	12V DC (Allowable ripple rate: 10% or less)
Insulation method	Photocoupler	Photocoupler
Input impedance	Approx. 4.7kΩ	Approx. 2.0kΩ
ON voltage	19.2V DC or less9.6V DC or less	9.6V DC or less
OFF voltage	2.4V DC or more	2.4V DC or more
Input delay	OFF → ON: 2ms or less ON → OFF: 2ms or less	OFF →ON : 2ms or less ON → OFF : 2ms or less
Max. Input voltage	26.4V DC	13.2V DC
Common polarity	"+" polarity	"+" polarity

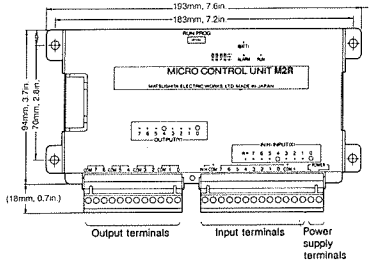
5. Output

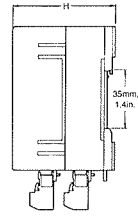
Item	Relay output
Output formula	1 Form A contact output (2 points/1 common)
Rated control capacity	2A 250V AC, 2A 30V DC, (cos ϕ = 1) ※
Mechanical life	5×10^7 or more
Electrical life	2×10^5 or more (at rated control capacity)
Breakdown voltage between contacts	1,000V AC (for 1 minute.)
Output delay	OFF → ON: 10ms or less ON → OFF: 5ms or less
Common polarity	Non-polarity

※ Per one point or per one common

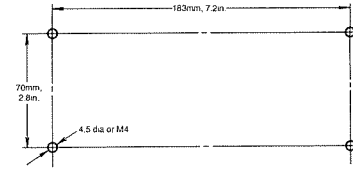
1-2-3. Dimensions

1. M2R Screw terminal Micro Control Unit



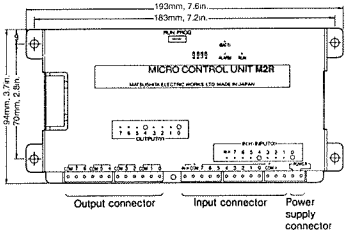


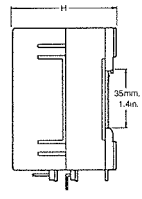
Mounting hole dimensions



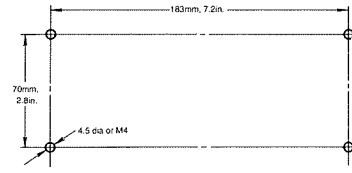
Type	H
1 control board	44.2mm, 1.7in.
1 control board 1 I/O Expansion board	63.8mm, 2.5in.

2. M2R SIL terminal Micro Control Unit





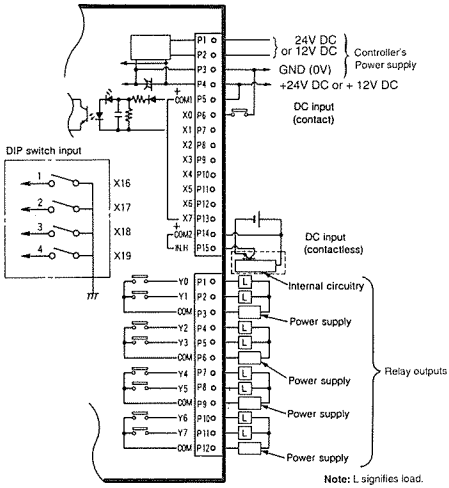
Mounting hole dimensions



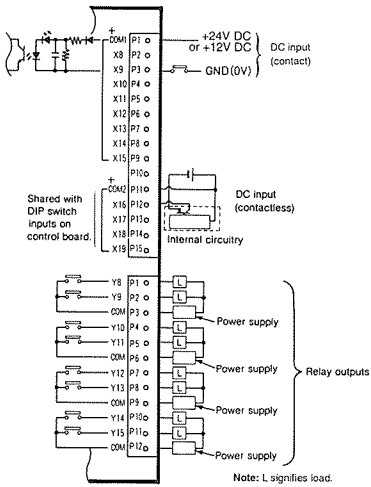
Type	H
1 control board	44.2mm, 1.7in.
1 control board 1 I/O Expansion board	63.8mm, 2.5in.

1-2-4. Wiring Diagrams

1. M2R Control Board



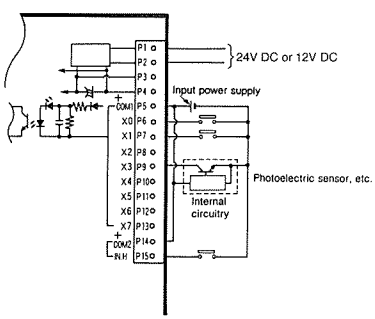
2. M2R I/O Expansion Board



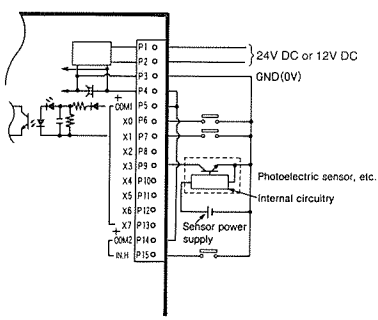
1) When inputting a limit switch with LED lamp, use one with a 15kΩ internal resistance. (SL, QL, VL, upright type)
2) The PL power supply unit is recommended for the controller power supply and internal circuitry of the sensor.

1-2-5. Input Examples

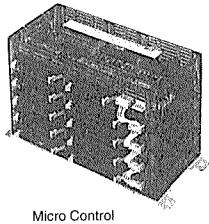
1. Supplying input power separately from the control power



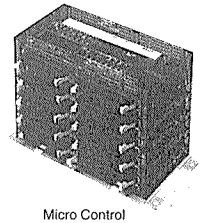
2. Using the control power supply for the input power supply



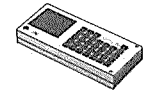
1-3. M1T, M2T Transistor Output Micro Controller



Micro Control
Unit M1T



Micro Control
Unit M2T



PL Programmer Mark II APL2114

• Compact design ideal for embedded use:

M1T type:
128.6 (H) × 215 (W) × 103.3 (D) · mm
5.1 (H) × 8.5 (W) × 4.1 (D) in.
M2T type:
128.6 (H) × 193 (W) × 103.3 (D) · mm
5.1 (H) × 7.6 (W) × 4.1 (D) in.
With MIL connectors used, the M1T/M2T incorporates 192 Input/Output channels in it's compact size.

• Cost comparable to relay controllers:

The M1T/M2T contains 64 timers, 48 counters and 252 relays.
The M1T/M2T are more economical than relay controllers when the cost for specification changes and maintenance are considered.

• Customized controller designs available:

• Machine language calls for advanced processing

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Useful for advanced processing such as for extra-fast processing speed.

• Password feature ensures user program security:

The password feature protects your valuable programs from unauthorized access. It is particularly useful for protecting copyright programs used in quantity products.

• Power saving design ideal for use in vehicles:

The DC-power version of the M1T/M2T can be battery powered.

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Counting speed ;8 kcps
Counting range ; 1 to 65, 535
Counting mode ; Addition (UP)
The counters can be used for position control or high-speed sensor inputs, with a rotary encoder.

• High program capacity of 2,500 steps in a compact controller

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• Simplified ROM writer function:

The simplified ROM writer can write EEP-ROM (AFB8602)

• Program compatible with PL series

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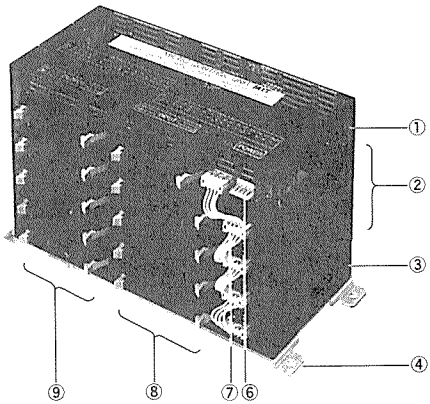
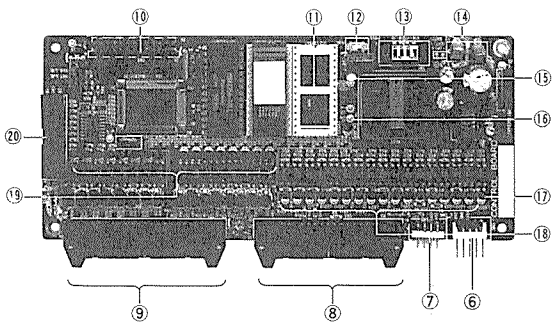
1. M1T Micro Control Unit

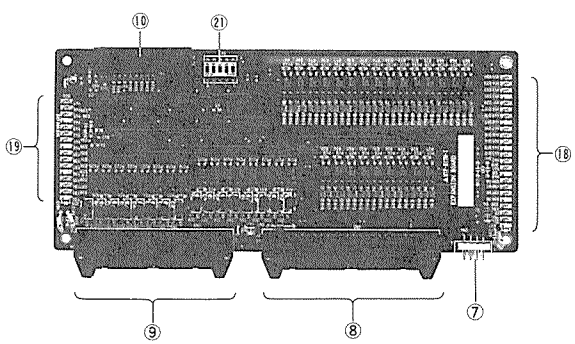
<External view>



<Control Board>



<I/O Expansion Board>

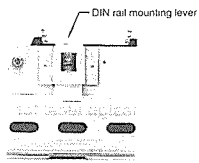


① **Control board case**
Protective case for the control boards.

② **I/O Expansion board case**
Case which protects the side of the I/O expansion board.

③ **Skirt case**
Case which protects the lowest part of the I/O expansion board.

④ **Main unit mounting plate**
Mounting plate used to mount the Micro Controller to a panel or device. In addition to direct screw mounting, it permits one-touch mounting to DIN rails with its DIN rail mounting lever and it is easy to remove.



⑤ **Power supply and input connector**
On the M2T control board, the controller power supply, the I/O power supply and the input section are located on a single 40-pin MIL connector. Use a MIL socket or wire-press socket for wiring.

⑥ **Power-supply connector**
The M1T has an independent, power-supply connector. Use the included power supply cable for wiring.

⑦ **Expansion power-supply connector**
The M1T uses an expansion, power-supply connector to supply the I/O power for each I/O expansion board.

⑧ **Input connector**
A 40-pin, MIL connector is used. (On the M1T control board, a 30-pin type is used.) Use a MIL socket or stranded-wire compression socket for wiring.

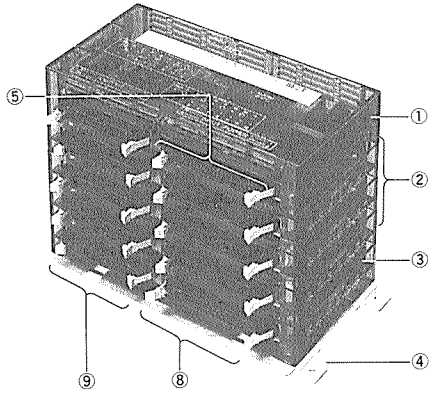
⑨ **Output connector**
A 34-pin, MIL connector is used. Use a MIL socket or wire-press socket.

⑩ **Expansion connector**
Bus connector used to connect an I/O expansion board.

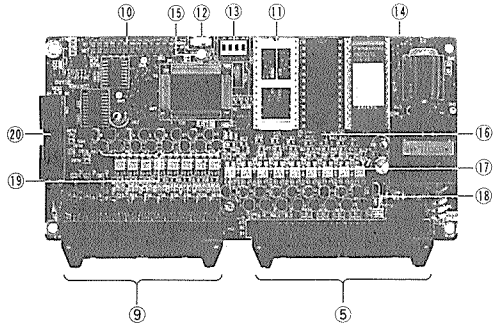
⑪ **User memory IC socket**
Accepts EP-ROM (AFB8601) or EEP-ROM (AFB8602). To mount, align the IC pins with the width of the IC socket, and with the power off, insert the IC chip with the proper orientation. With the ROM mounted, the contents of the memory (ROM) are transferred to the internal RAM when the mode is switched from PROG. to RUN or when the controller power supply is turned on in the RUN mode. Therefore, to retain the contents of the internal RAM, it is recommended they are stored to EEP-ROM, cassette tape, floppy disk or another medium.

2. M2T Micro Control Unit

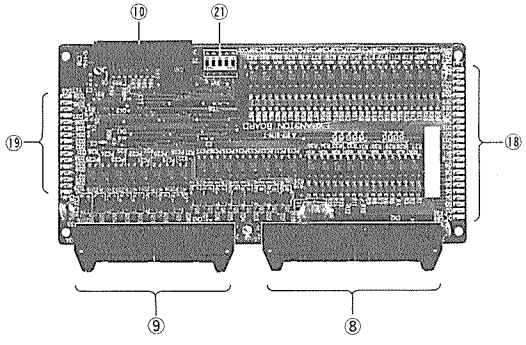
<External view>



<Control Board>



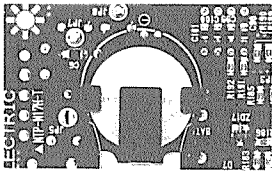
<I/O Expansion Board>



⑫ **PROG/RUN mode select switch**
This switch is used to select the PROG mode and the RUN mode.

⑬ **DIP switches (X16 to X19)**
Used to set the password for user program protection.

⑭ **Battery holder**
Permits easy replacement of the backup battery.



⑮ **RUN indicator**
Turns on (white) when the mode-select switch is set to the RUN mode.

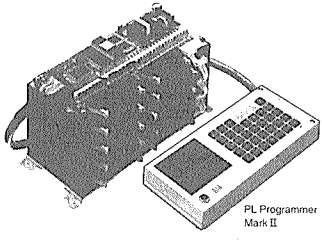
⑯ **ALARM/BATT. indicator**
Turns on (red) when a CPU error occurs (watchdog timer error, etc) and blinks to indicate a battery error when the battery is low.

⑰ **High speed counter input operation indicator**
Indicates the state input to IN.H. It turns on (red) when there is an input.

⑱ **Input status indicators**
A green LED at every four inputs permit easy operational checks of each input.

⑲ **Output status indicators**
A green LED at every four outputs permit easy operational checks of each output.

⑳ **Programmer connector**
Connects the MC-M CCA (Computer Communication Adapter) or PL Programmer Mark II using the M Programmer Cable. To conserve power, disconnect the PL Programmer Mark II when not in use.



㉑ **I/O number set switches**
These switches are used to set the I/O number for the I/O expansion board.

1-3-2. Specifications

1. General

Item	Description		
Rated operating and input voltage	Control power supply voltage : 24V DC / 12V DC Input voltage : 24V DC / 12V DC		
Rated power consumption	Type of board	Control power supply :	Input power supply :
		24V DC / 12V DC	24V DC / 12V DC
	Control board	Control board only: Approx. 1W With Programmer Mark II: Approx. 2.7W	Approx. 0.12W per input (at 24V DC) Approx. 0.06W per input (at 12V DC) Approx. 0.1W + load power, per transistor output (at 24V DC) Approx. 0.05W + load power per transistor output (at 12V DC)
	I/O Expansion board	Approx. 0.4W per board	
Allowable voltage fluctuation range	90% to 110%V		
Ambient temperature	0°C to 50°C (32°F to 122°F)		
Ambient humidity	30% to 80%RH (non-condensing)		
Storage temperature	–20°C to 70°C (–4°F to 158°F)		
Battery life	3 years [ambient temperature +5°C to +35°C (41°F to 95°F)], lithium battery		
Noise resistance	Minimum 800V (based on in-house measurements)		
Vibration resistance	10 to 55Hz, 1 cycle per minute: double amplitude 0.75mm (0.03in.), 10 minutes in each of the X, Y and Z axes		
Shock resistance	Minimum 10G, 4 times in each of the X, Y and Z axes		

2. Performance

Item	Description		
Program memory	ROM/RAM (test operation)		
Programming method	Relay symbol method		
Control method	Stored program, cyclic method		
Program capacity (Number of steps)	2,500 steps		
Calculation speed	Basic instruction 4.25 μs per step (average 7.5 μs per step)		
Types of instructions	Basic instruction: 19, High-level instruction: 28 (including seven high-speed instructions)		
Number of input/output points	Total: 192 points		
		Input	Output
	Control board	X 0 to X15: 16 points DC input X16 to X19: 4 points DIP switch input IN.H: 1 point high speed counter	Y0 to Y15: 16 points Transistor output
	I/O Expansion boards (2nd step) I/O Expansion boards (3rd step) I/O Expansion boards (4th step) I/O Expansion boards (5th step)	X 32 to X 55: 24 points DC input X 64 to X 87: 24 points DC input X 96 to X119: 24 points DC input X128 to X151: 24 points DC input	Y 32 to Y 47: 16 points Transistor output Y 64 to Y 79: 16 points Transistor output Y 96 to Y111: 16 points Transistor output Y128 to Y143: 16 points Transistor output
Number of internal relay points	252points Non-holding type: 192 points (CR0 to CR191) Holding type (see Note 1): 60 points (CR192 to CR251)		
Number of timer points (subtraction type)	64 points (T0 to T63) Subtraction (DOWN) type, Non-holding type 0.01 s unit: 0.01 to 9.99 s 0.1 s unit: 0.1 to 99.9 s 1 s unit: 1 to 999 s		
Number of counter points	48points DOWN type: 32 points (C0 to C31) UP/DOWN type: 16 points (C32 to C47) All holding type (see Note 1) 1 to 999 counts		
Number of shift register points	32 points/8 bits (SR0 to SR377) (Octal digit) All holding type (see Note 1)		
Number of JMP, MCR points	Each 32 points (0 to 31)		
Special internal relays	Initialize pulse relay: CR252 OFF during 1 scan immediately after operation is started. Scan pulse relay: CR253 ON and OFF is repeated every 1 scan 0.1 s clock relay: CR254 ON and OFF is repeated every 0.1 s Battery abnormality detection relay: CR255 ON at the time of voltage drop of backup battery.		
Alarm function	At CPU abnormality (watchdog timer): Alarm LED ON At battery abnormality: Alarm LED flashes		
Program protect function	Password method		

Notes: 1) The term "holding type" refers to the function of remaining at the condition existing at the time of a power interruption, permitting a return to that condition when power is restored.
2) When applying or interrupting power supply, alarm LED flashes for a moment. However, this does not signify abnormality.

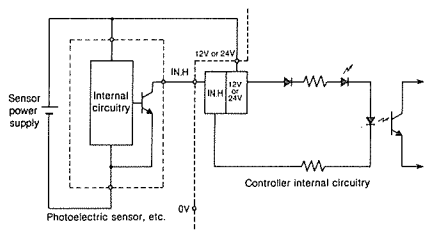
3. High Speed Counter

Item	Description	
Counting input	One point	
Reset input	External one point (shared with X0 input) Internal one point (Y199) (reset when ON)	
Count mode	UP only (non-holding type)	
Maximum count range	1 to 65535	
Counter contacts	32 points (C50 to C81)	
Settings	Maximum 128 (using each counter contact, settable at will)	
High-speed output	High speed scan + output update (limited to Y0 to Y3)	
Counting speed	Maximum 8 kcps (varies, however, depending upon number of high speed scan area steps, etc.)	
Minimum input time	Counting input: 62.5 μs, Reset input: 470 μs + t_{HS}	
Rated voltage	24V DC	
ON voltage	19.2V DC or less	
OFF voltage	2.4V DC or more	
Maximum input voltage	26.4V DC	
Input current	Counting input (IN.H): Approx. 19mA (at 24V DC)	Reset input (X0): Approx. 5mA (at 24V DC)
Input impedance	Approx. 1.1kΩ	Approx. 4.4kΩ (at 24V DC) Approx. 2.0kΩ (at 12V DC)

Note: t_{HS}: Time needed for high-speed scan.

External Wiring Example 1

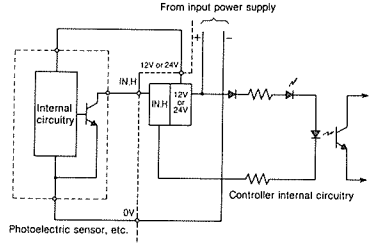
Using an external power supply



12V or 24V: Pin 1 on the M1T, Pin 11 on the M2T
IN.H: Pin 2 on the M1T, Pin 12 on the M2T
0V: Pins 11 ~ 14 on the M1T, Pins 21 ~ 24 on the M2T

External Wiring Example 2

Using an input power supply (M1T only)



12V or 24V: Pin 1
IN.H: Pin 2
0V: Pins 11 ~ 14

4. Input

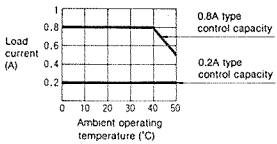
Item	DC input	
Rated input voltage	24V DC (Allowable ripple rate: 10% or less)	12V DC (Allowable ripple rate: 10% or less)
Insulation method	Photocoupler	Photocoupler
Input impedance	Approx. 4.4kΩ	Approx. 2.0kΩ
Input delay	OFF → ON: 2ms or less ON → OFF: 2ms or less	OFF → ON: 2ms or less ON → OFF: 2ms or less
Maximum input voltage	26.4V DC	13.2V DC
ON voltage	19.2V DC or less	9.6V DC or less
OFF voltage	2.4V DC or more	2.4V DC or more
Common polarity	"+" polarity	"+" polarity

5. Output

Item	Transistor output
Output formula	Transistor open collector output
Insulation method	Photocoupler
Rated operating voltage	24V DC / 12V DC
Allowable voltage function range	20.4V DC to 26.4V DC / 10.2V DC to 13.2V DC
Maximum control capacity	0.2A type: 200mA, 0.8A type: 800mA (see note)
Leakage current	100 μA Maximum
Residual voltage	1.5V Maximum
Output delay	OFF → ON: 1ms or less ON → OFF: 1ms or less
Common polarity	"–" polarity

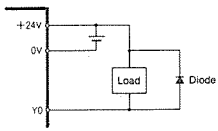
Note:

1. Follow the range below for the load current.



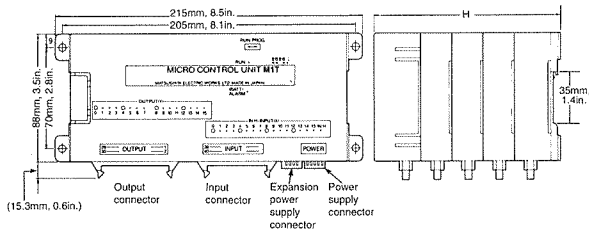
2. Limit the number of simultaneous ON, I/O points on each board to within 80%. Also, limit the simultaneous ON, load current from each board to a maximum of 5A at 16 points/common.

3. When using a solenoid, motor or solenoid value for load, it is recommended that a diode be connected across the load to prevent counter electromotive force.



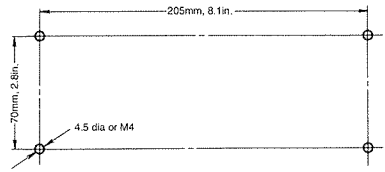
1-3-3. Dimensions

1. M1T Micro Control Unit

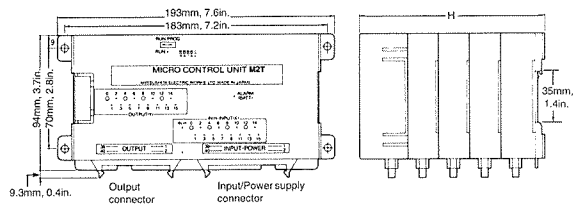


Type	H
One control board	44.2mm, 1.7in.
One control board One I/O Expansion board	63.8mm, 2.5in.
One control board Two I/O Expansion boards	85.4mm, 3.4in.
One control board Three I/O Expansion boards	107.0mm, 4.2in.
One control board Four I/O Expansion boards	128.6mm, 5.1in.

Mounting hole dimensions

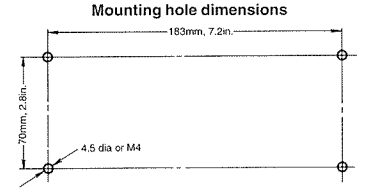


2. M2T Micro Control Unit



Type	H
One control board	44.2mm, 1.7in.
One control board One I/O Expansion board	63.8mm, 2.5in.
One control board Two I/O Expansion boards	85.4mm, 3.4in.
One control board Three I/O Expansion boards	107.0mm, 4.2in.
One control board Four I/O Expansion boards	128.6mm, 5.1in.

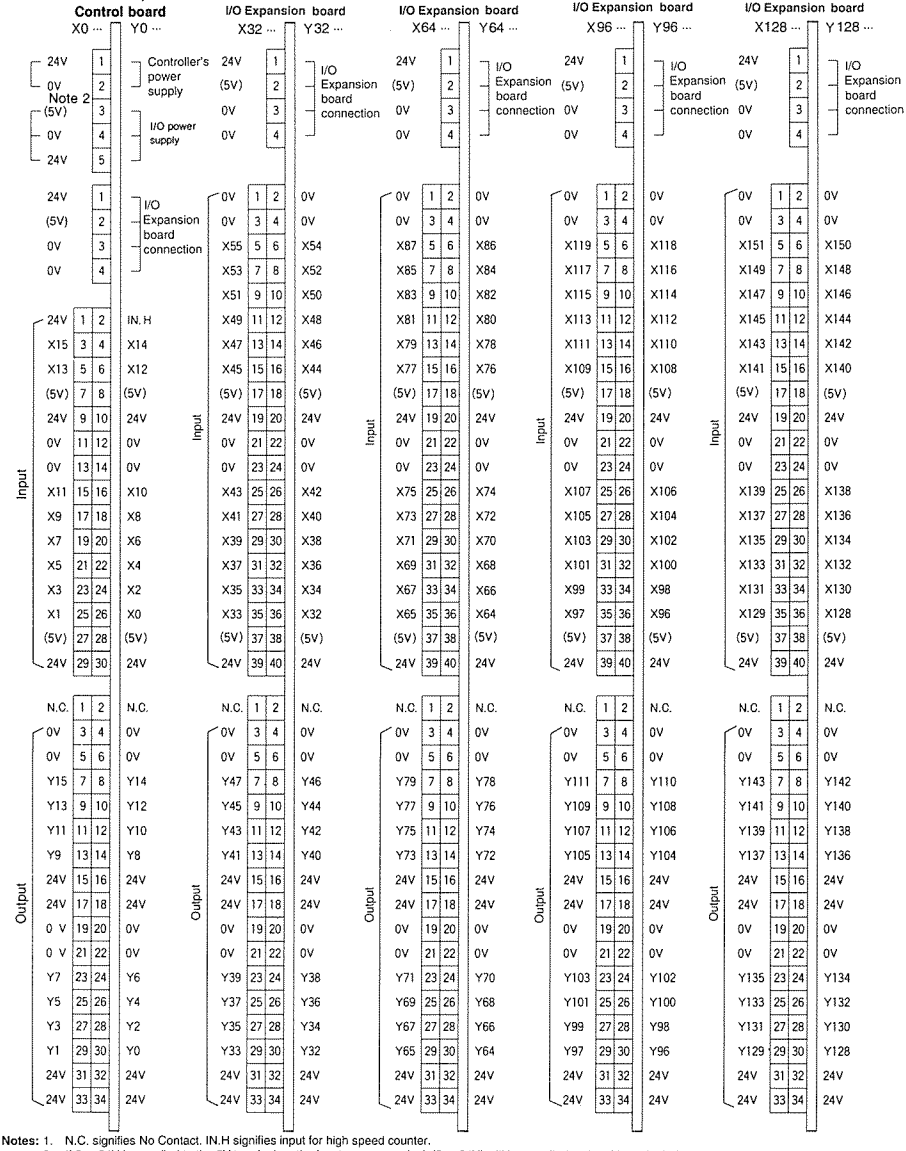
Mounting hole dimensions



1-3-4. Wiring Diagrams

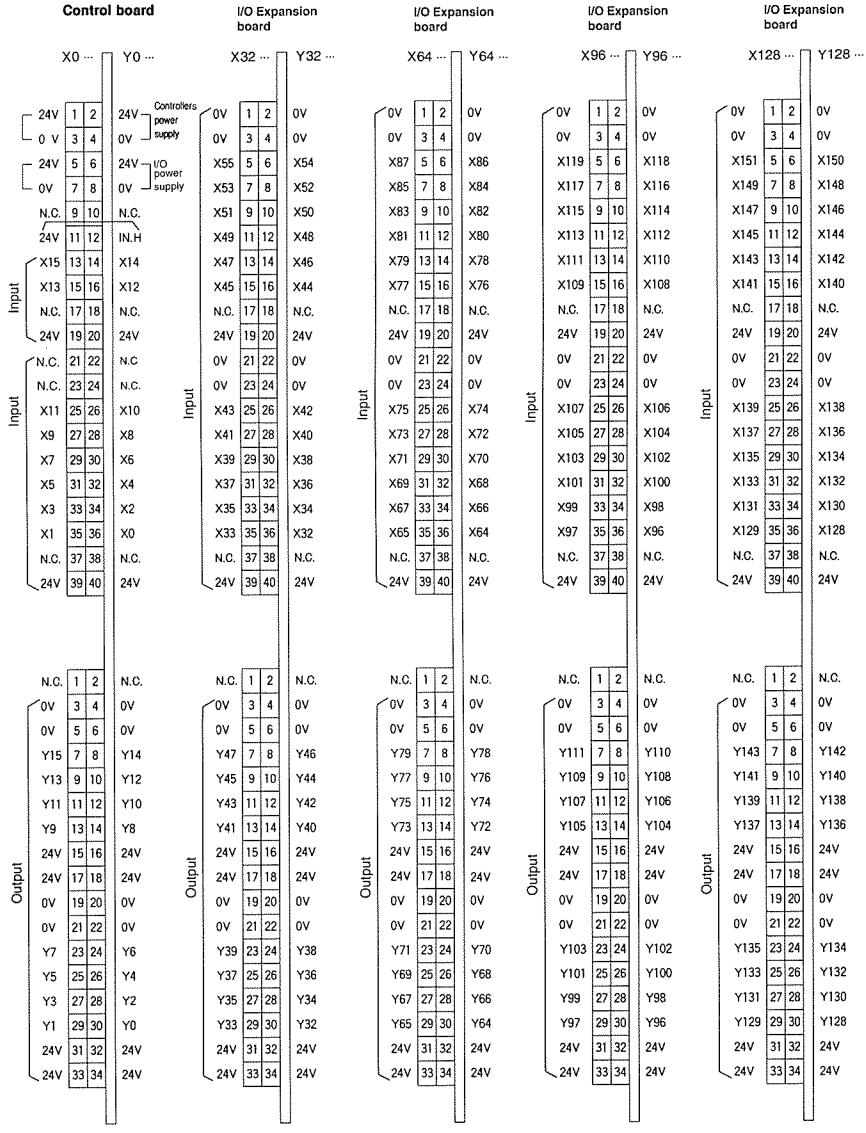
1. M1T connector pin layouts
(In case of 12V DC type, below "24V DC" will be 12V DC.)

Voltages are output to the 24V and 0V terminals on the input and output connectors when power is supplied to the controller power supply and I/O power supply. This simplifies the connections to external sensors and loads.



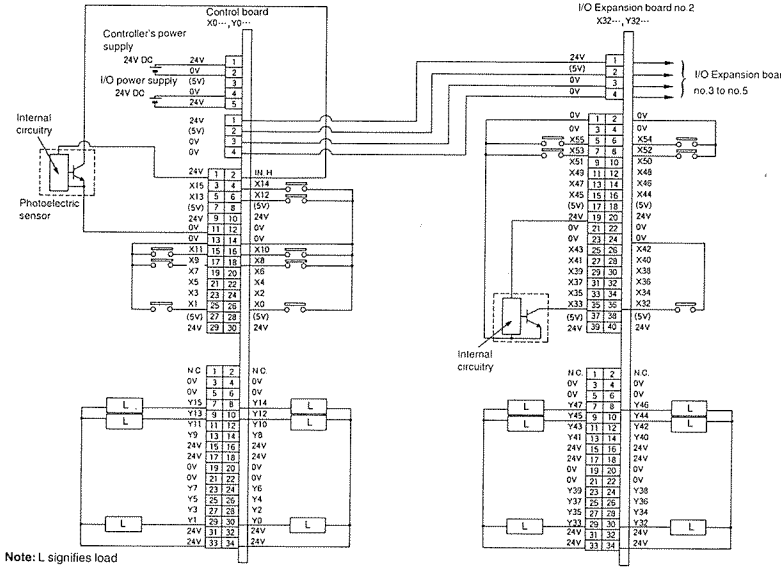
Notes: 1. N.C. signifies No Contact. IN.H signifies input for high speed counter.
2. If 5 to 24V is supplied to the 5V terminal on the input power supply, it (5 to 24V) will be supplied to the 5V terminal of the input connector.

2. M2T connector pin layouts
(In case of 12V DC type, below "24V DC" will be 12V DC.)



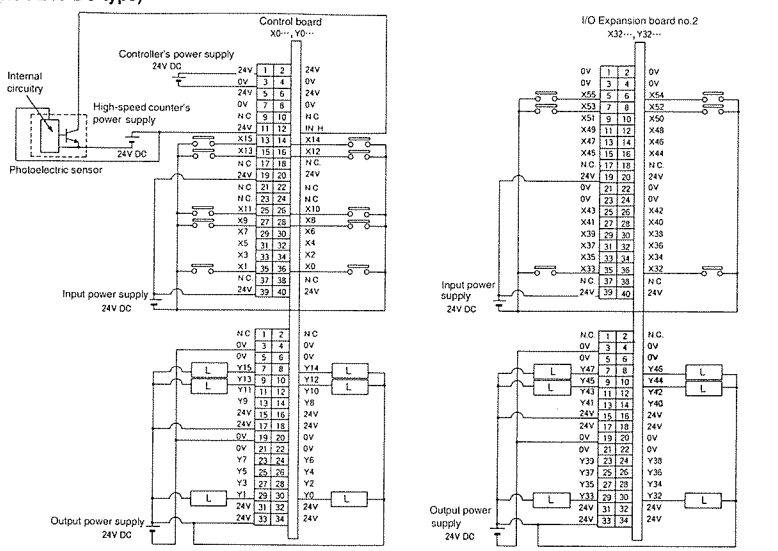
Notes: 1. N.C. signifies No Contact. IN.H signifies input for high speed counter.
2. Supply the I/O power supply to the 24V or 12V and 0V terminals on each I/O connector. (The 0V terminal on the input connector need not be connected.)

3. M1T Wiring diagram (Example: 24V DC type)



Note: L signifies load

4. M2T Wiring diagram (Example : 24V DC type)

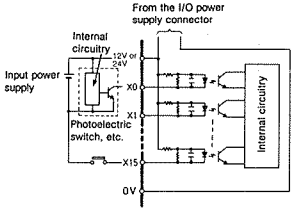


Note: L signifies load

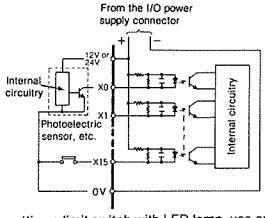
5. M1T Connection Diagram

• The input circuit, external connections and input numbers refer to those of the control board.

<Without using the I/O power supply>



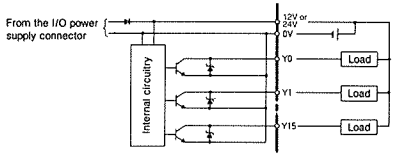
<Using the I/O power supply>



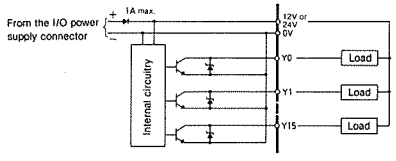
1) When inputting a limit switch with LED lamp, use one with a 15kΩ internal resistance. (SL, QL, VL, upright type).
2) The PL power supply unit is recommended for the controller's power supply and sensor internal circuitry.

• The output circuit, external connections and output numbers refer to those of the control board.

<Without using the I/O power supply>

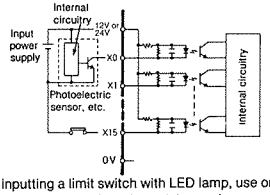


<Using the I/O power supply>



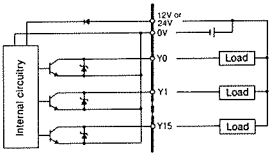
6. M2T Connection Diagram

• The input circuit, external connections and input numbers refer to those of the control board.

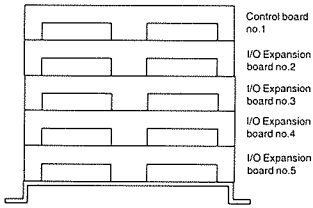


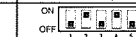
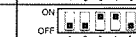
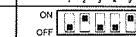
1) When inputting a limit switch with LED lamp, use one with a 15kΩ internal resistance. (SL, QL, VL, upright type).
2) The PL power supply unit is recommended for the controller's power supply and sensor internal circuitry.

• The output circuit, external connections and output numbers refer to those of the control board.



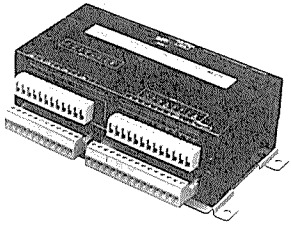
1-3-5. I/O Board Number



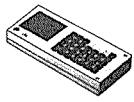
	I/O number set switch	I/O number
Control board no.1	I/O number setting unnecessary	X 0 ···, Y 0 ···
I/O Expansion board no.2		X 32 ···, Y 32 ···
I/O Expansion board no.3		X 64 ···, Y 64 ···
I/O Expansion board no.4		X 96 ···, Y 96 ···
I/O Expansion board no.5		X128 ···, Y128 ···

When using a number of I/O boards in combination, set their I/O numbers so that no two are identical.

1-4. M2RL Relay Output Micro Controller



Micro Control Unit M2RL



PL Programmer Mark II APL2114

- **Advanced functions at low cost for excellent economy.**
- **Interrupt processing and Pulse catch functions realize advanced sensor control:**

More consistent operation and quicker response for a wider range of applications.
Ideal for equipment control using sensors.

- **Miniature design ideal for incorporation into equipment:**

A 112mm × 193mm × 63.8mm (4.4in. × 7.6in. × 2.5in.), it is convenient for building into equipment using up very little space.

- **Customized controller designs available**
- **Powerful programming support devices:**

In addition to PL Programmer Mark II, NPST programming support tool turns your personal computer into a high-level programming device.

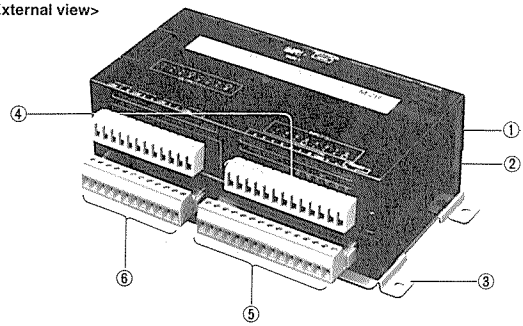
- **Simplified ROM writer function incorporated:**

The simplified ROM writer can write EEP-ROM (AFB8602).

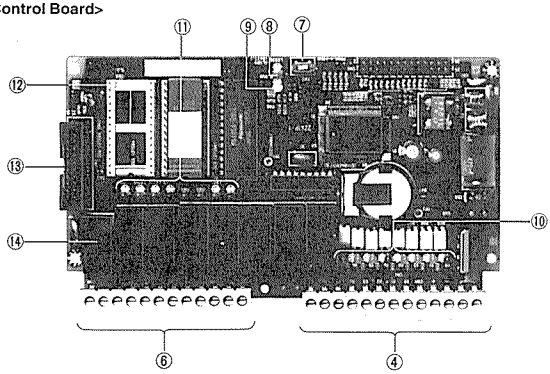
1-4-1. Part Names and Functions

1. M2RL Screw terminal Micro Control Unit

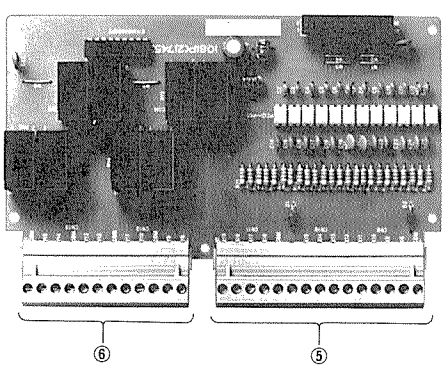
<External view>



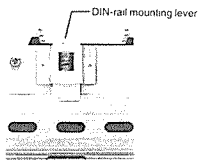
<Control Board>



<I/O Expansion Board>



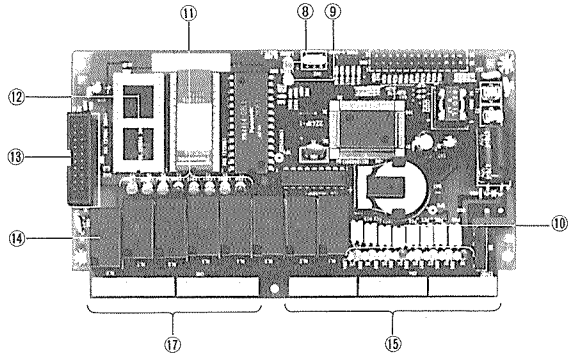
① **Control board case**
Protective case for the control boards.
② **Skirt case**
Case which protects the lowest part of the I/O expansion board.
③ **Main unit mounting plate**
Mounting plate used to mount the Micro Controller to a panel or device. In addition to direct screw mounting, it permits mounting to DIN-rails with its DIN-rail mounting lever. Easily removable.



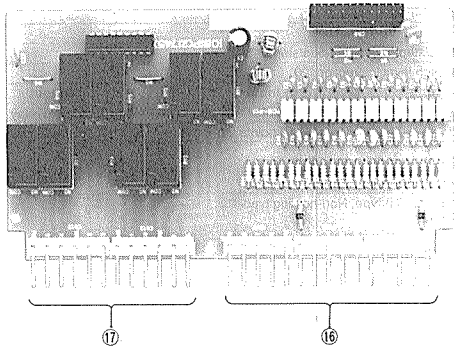
④ **Power supply and input terminals**
On the control board, controller's power supply, input power supply and input section are located on a single screw terminal block.
It is not removable.
⑤ **Input terminals of I/O expansion board**
The input terminal block of the I/O expansion board is removable. It can be removed to connect the wiring and then re-attached.
⑥ **Output terminals**
The output terminals on the control board are fixed and not removable.
The output terminals of the I/O Expansion board are removable.
The terminal board can be removed and then re-attached after tightening the screws.
⑦ **PROG./RUN mode switch**
This switch is used to select between the PROG. and RUN modes.
⑧ **ALARM/BATT. indicator**
This indicator (red) ligh turns on if a CPU error (watchdog timer error, etc.) has occurred. It flashes when the internal back-up battery is low.
⑨ **RUN indicator**
This indicator (white) turns on when the PROG./RUN mode switch is set to RUN.
⑩ **Input status indicator**
A green LED indicator is provided for every four inputs so that the operation of each input can be easily confirmed.
⑪ **Output status indicator**
A green LED indicator is provided for every four outputs so that the operation of each output can be easily confirmed.

2. SIL terminal Micro Control Unit

<Control Board>



<I/O Expansion Board>



I/O cable with five input conductor and power wires

I/O cable with six output conductor wires

⑫ **User memory IC socket**
With the controller power turned off. Install the EP-ROM (AFB8601) and EEP-ROM (AFB8602) ICs into these sockets. When installing, straighten the IC pins so that they are aligned with the width of the sockets and make sure that the ICs are oriented correctly. When the mode is switched from PROG. to RUN with the ROM installed, the contents of the ROM are transferred to the internal RAM. If you wish to preserve the contents of the internal RAM, it is recommended that you store them in the EEP-ROM, cassette tape, floppy disk or other permanent medium.

⑬ **Programmer connector**
Connect the PL Programmer Mark II or MC-M CCA (Computer Communication Adapter) to this connector by using the M Programmer Interface Cable. To save power consumption, disconnect the PL Programmer Mark II when not in use.

⑭ **Output relays**
Uses Matsushita Electric Works' relays.

⑮ **Power and input connectors**
The M2RL SIL terminal control board uses SIL connectors for the controller power and input power connections. Connect using the optional I/O cable (containing five input conductors plus power) or female connector set.

⑯ **Input terminals**
A SIL connector is used. Connect using the optional I/O cable (containing five input conductors plus power) or female connector set.

⑰ **Output terminals**
A SIL connector is used. Connect using the optional I/O cable (containing six output conductors) or female connector set.

1-4-2. Specifications

1. General

Item	Description		
Rated operating and input voltage	Control power supply voltage : 24V DC/12V DC Input voltage : 24V DC/12V DC		
Rated power consumption	Type of board	Control power supply :	Input voltage:
		24V DC/12V DC	24V DC/12V DC
	Control board	Control board only: Approx 2.8W With Programmer Mark II: Approx. 4.0W	Approx. 0.12W per input (at 24V DC) Approx. 0.06W per input (at 12V DC)
	Expansion I/O board	Approx. 2.4W per board	
Operating and input voltage range	95% to 110%V		
Ambient temperature	0°C to 40°C (32°F to 104°F)		
Ambient humidity	30% to 80%RH (non-condensing)		
Storage temperature	–20°C to 70°C (–4°F to 158°F)		
Battery life	3 years [ambient temperature +5°C to +35°C (41°F to 95°F)], lithium battery		
Noise resistance	Minimum 1,000V (based on in-house measurements)		
Vibration resistance	10 to 55Hz, 1 cycle per minute: double amplitude 0.75mm (0.03in.), 10 minutes in each of the X, Y and Z axes		
Shock resistance	Minimum 10G, 4 times in each of the X, Y and Z axes		

2. Performance

Item	Description		
Program memory	ROM/RAM (during test run)		
Programming method	Relay symbol method		
Control method	Stored program cyclic method		
Program capacity (Number of steps)	600 steps		
Calculation speed	Basic instruction 4.25μs/step (average 7.5μs/step)		
Types of instructions	Basic instruction: 19, High level instruction: 20		
Number of input/output points		Input	Output
	Control board	X0 to X7: 8 points DC input	Y0 to Y7: 8 points relay output
	I/O Expansion board	X8 to X19: 12 points DC input	Y8 to Y15: 8 points relay output
Number of internal relay points	252 points Non-holding type: 192 points (CR0 to CR191) Holding type (see Note 1): 60 points (CR192 to CR251)		
Number of timer points (subtraction type)	64 points: Subtraction (DOWN) type, Non-holding type 0.01 s unit: 0.01 to 9.99s 0.1 s unit: 0.1 to 99.9s 1 s unit: 1 to 999 s		
Number of counter points	48 points DOWN type: 32 points (C0 to C31) UP/DOWN type: 16 points (C32 to C47) All holding type (see Note 1) 1 to 999 counts		
Number of JMP, MCR points	Each 32 points (0 to 31)		
Number of shift register points	32 points/8 bits (SR0 to SR377) (Octal digit) All holding type (see Note 1)		
Special internal relays	Initialize pulse relay: CR252 OFF during 1 scan immediately after operation is started. Scan pulse relay: CR253 ON and OFF is repeated every 1 scan 0.1s clock relay: CR254 ON and OFF is repeated every 0.1s Batter abnormality detection relay: CR255 ON at the time of voltage drop of backup battery.		
Alarm function	At CPU abnormality (watchdog timer): Alarm LED ON At battery abnormality: Alarm LED flashes		
Data memory	96 points per 12 bits (D0 to D95) All holding type (see Note 1)		

Notes: 1) The term "holding type" refers to the function of remaining at the condition existing at the time of a power interruption, permitting a return to that condition when power is restored.
2) When applying or interrupting power supply, alarm LED flashes for a moment. However, this does not signify abnormality.

3. Input

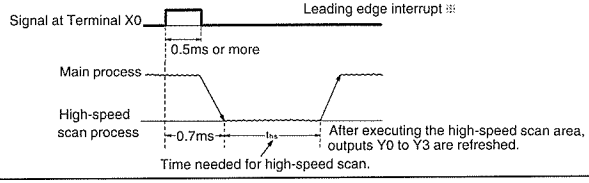
Item	DC input	
Rated input voltage	24V DC ± 10%	12V DC ± 10%
Input impedance	Approx. 4.7kΩ	Approx. 2.0kΩ
ON voltage	19.2V DC or less	9.6V DC or less
OFF voltage	2.4V DC or more	2.4 DC or more
Input delay	OFF → ON: 3ms or less ON → OFF: 3ms or less	
Maximum input voltage	30V DC	15V DC
Common polarity	"+" polarity	

4. Output

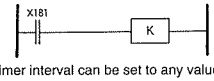
Item	Relay output
Output formula	1 Form A contact output (2 points/1 common)
Rated control capacity	2A 250V AC, 2A 30V DC, (cos ϕ = 1) ※
Mechanical life	5×10^7 or more (at 180 times/minute switching)
Electrical life	1×10^5 or more (at rated control capacity)
Breakdown voltage between contacts	750V AC (for 1 minute)
Output delay	OFF → ON: Approx. 8ms ON → OFF: Approx. 14ms
Common polarity	Non-polarity

※ Per one point or per one common

5. Interrupt

Item	Description
Number of input points	1 point (common with X0)
Edge detection	Leading/Trailing ※
Response delay time	Input delay: 0.5ms or less, Processing delay: 0.2ms or less
Processing	Executes high-speed scan area (range enclosed by STRT X 185, JP31 to JPE31) and immediately issues outputs Y0 to Y3.
Auxiliary relay	Interrupt relay (X25): Turns ON during interrupt processing
Operation	

※ Specified using the mode set instruction

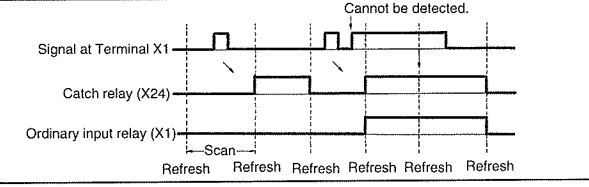


K : Mode number (only the following modes may be set)
10: Leading edge interrupt
11: Trailing edge interrupt
12: Timer interrupt (timer interval is specified by the contents of memory area no. 795)

Note: The timer interval can be set to any value between 640 μs to 16.3ms (10 to 256 in memory area no. 795).
Set the interval to a value somewhat longer than the time required to execute the high-speed scan area plus 640 μs.
The time interval increases approximately 64 μs for an increment in memory area no. 795.

Contents of memory area no. 795	Interval
10	Approx. 640 μs
⋮	⋮
256	Approx. 16.3ms

6. Pulse catch input

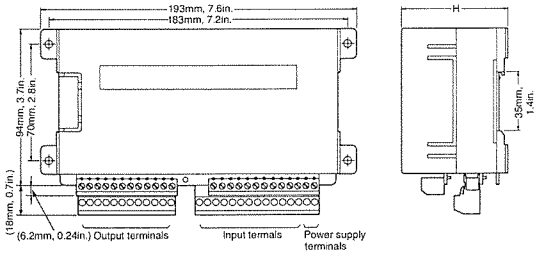
Item	Description
Number of input points	1 point (common with X1)
Response delay time	0.5ms
Auxiliary relay	Catch relay (X24): Turns ON if a pulse of 0.5ms or longer is detected during a scan.
Operation	

Notes: Use Catch relay (X24) to process a signal at Terminal X1 in a program. (X24 is a software auxiliary relay.)
X1 (input relay) is for ordinary input operation.
The catch relay turns ON for even one input pulse during a scan.
The input of multiple pulses cannot be detected.

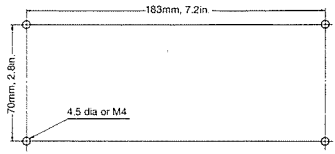
1-4-3. Dimensions

1. M2RL Screw terminal Micro Control Unit

<Set with case>



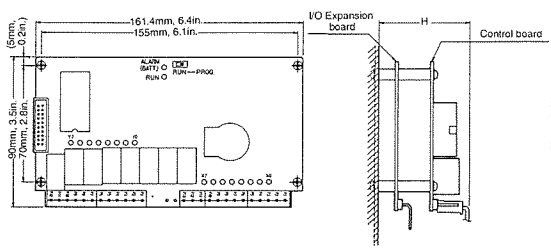
<Mounting hole dimensions>



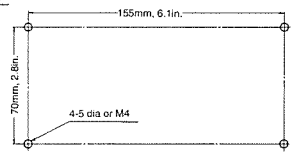
Type	H
One control board	44.2mm, 1.7in.
One control board One I/O Expansion board	63.8mm, 2.5in.

2. M2RL SIL terminal Micro Control Unit

<Board set>



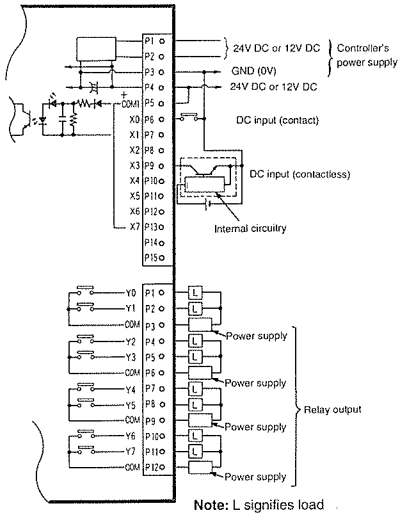
<Mounting hole dimensions>



Type	H
One control board	34.2mm, 1.4in.
One control board One I/O Expansion board	55.8mm, 2.2in.

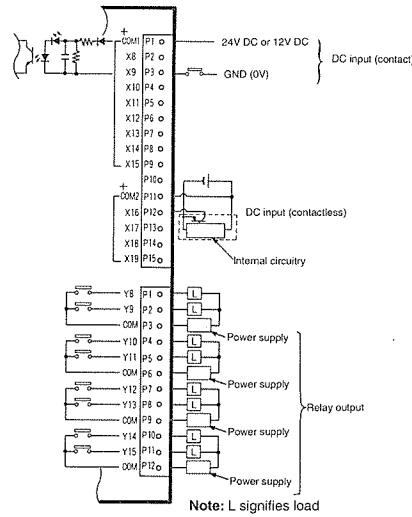
1-4-4. Wiring Diagrams

1. M2RL Control Board



Note: L signifies load

2. M2RL I/O Expansion Board

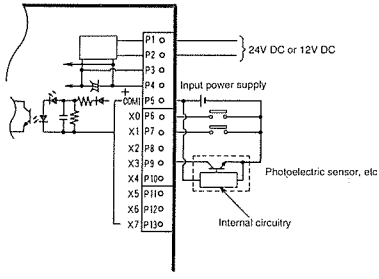


Note: L signifies load

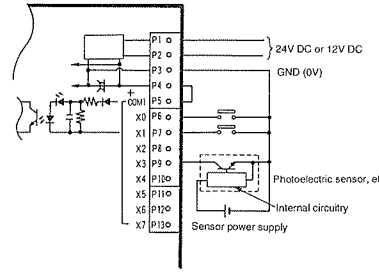
1) When inputting a limit switch with LED lamp, use one with a 15kΩ internal resistance. (SL, QL, VL, upright type)
2) The PL power supply unit is recommended for the controller power supply and internal circuitry of the sensor.

1-4-5. Input Examples

1. Supplying input power separately from the control power



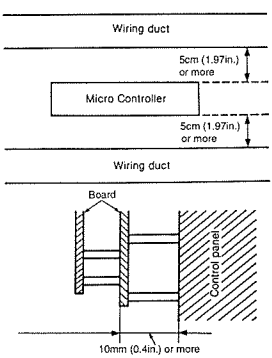
2. Using the control power supply for the input power supply



1-5. Cautions

1. Operating Environment

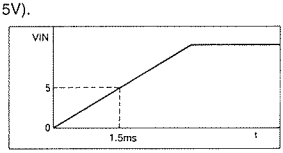
1) Operate the unit at an ambient temperature within 0 to 50°C (32°F to 122°F). (Ventilation to should be taken into consideration for panel-mounted equipment. Vertical mounting is recommended for mounting to a control panel. For horizontal mounting or installation directly over a heat source, ventilate with a cooling fan.)
2) Use a power supply voltage within 90 to 110% (M2R: 95% to 110%) of the rated voltage. Furthermore, use I/O voltage within 20.4 to 26.4 VDC.
3) Install away from high-voltage lines, high voltage equipment, motor lines, motorized equipment and equipment containing a transmitter (e.g. amateur radio equipment), or equipment which generates large switching surges. Also keep them as far as possible from the control panel.
4) Molded plastic is used in the unit. Do not operate the unit in an environment where the unit may come into contact with organic solvents (such as benzine, thinner or alcohol) or strong base substances (such as ammonia or caustic soda).
5)Avoid use in locations where flammable gases or corrosive gases are generated, locations with large amounts of dust, locations where the unit may come into contact with water droplets, or locations with severe vibrations and shock.
6) The Micro Controller should be installed 10mm (0.4in.) or more away from the control panel.
7) The wiring for input/output lines and power line should be separated as much as possible. Avoid allowing wiring to pass over the upper surface of the Micro Controller.



8) Because the printed-circuit board for this Micro Controller is exposed, care must be taken regarding wiring scraps, etc, adhering to conductive parts.
9) Connector removal/installation should be done only after first switching OFF the power.
10) A printed-circuit board should be handled only after the handler has been discharged by grounding.

2. Wiring and Circuit Configuration

1) Wiring should be performed according to the connector tables and wiring examples.
2) For screw terminal blocks, use wire size for M2R: "AWG28-AWG16", for M2RL: "AWG21-AWG14". The wire should be stripped 7 mm and the connection wire range should be 0.08mm^2 to 2.5mm^2 for M2R, 0.4mm^2 to 2.0mm^2 for M2RL. Use a tightening torque of 0.4 Nm for M2R, 0.35 Nm to 0.4Nm for M2RL.
3) For flat cable sockets, use wire size AWG24-AWG18 and compression tool for proper connection. Prepared I/O cables are also available. 5-conductor with one connector: 1m, 2m, 3m, 4m. (AFB8551, AFB8552, AFB8553, AFB8554) 6-conductor with one connector: 1m, 2m, 3m, 4m. (AFB8561, AFB8562, AFB8563, AFB8564)
4) Twisted pairs are recommended for motor and power line wiring to improve noise immunity.
5) The addition of a diode or surge absorber across the load is recommended if the load output device is inductive.
6) For grounding, the earth-plate resistance of 100Ω or less is recommended to improve noise resistance.
7) Avoid routing wires on the case surface. (If unavoidable, keep the wires at least 3cm away from the case surface.)
8) Cables should be disconnected or connected with the power off.
9) If the transistor output is used with a small load, the load may not completely turn off due to the leakage current. In this case, connect a resistor in parallel with the load.
10) Depending on the type of input device, the input may not turn off because of leakage currents even if the input signal is turned off.
11) The controller power supply and I/O power supply should be separated. Furthermore, all wiring to the power supply terminals should be from the same AC power supply and the power supply for the units should be switched simultaneously.
12) If a contact input (relay, switch, etc.) is connected to the counter contact (e.g. high speed counter input), chattering may cause erroneous counts.
13) Use shielded input wires and keep them short when connecting a sensor (e.g. rotary encoder) to prevent noise-induced errors.
14) If the rise time of the power supply voltage (battery supply, etc.) is short, the unit may not initialize.
Add a limiting resistor so that the rise time of the input voltage is 1.5ms (0 to 5V).



3. Handling

1) The cover of the control unit has been provided with ventilation slits. Be sure pieces of wire or metal do not fall into the unit during installation (such as to a panel).
2)If the control unit is to be operated with its cover removed, do not touch the electronic components as they are exposed. Furthermore, be sure that static electricity has been discharged before handling (e.g. use a grounded work table).
3) If the unit is to be used for the first time, set the mode select switch to PROG, turn on the power, and clear the program or initialize the password before writing a program.

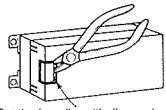
Clearing the Program

Programmer key sequence [CLR] [F] [0] [F] [SFT] [SHIFT]

Initializing the Password

Turn on DIP switch inputs (X16 to X19) and SW1 to 4 (X16 to X19), turn off SW3 (X18), turn off SW1 (X16), turn on SW3 (X18) and turn off SW4 (X19).
Note that initializing the password will clear not only the password, but also the user program and data memory.

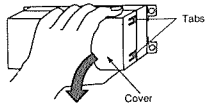
4) Use the M-type programmer cable (AFB8511) to connect the Programmer to the unit. If the Programmer is to be used continuously, operate it at an ambient temperature within 0 to 40°C (32°F to 104°F). It should be disconnected during RUN.
To connect the programmer cable to the set with case while the cover is in place, cut the four ribs holding the programmer connector opening with a pair of diagonal cutters.



Cut the four ribs with diagonal cutters

5) Keep away from transmitters (e.g. amateur radio equipment) when a cassette tape recorder is to be used with the Programmer. Using it near a transmitter will decrease its performance and may make proper operation impossible.
6) A monaural cassette tape recorder is recommended.
Use a connection cord that does not include a diode and resistor.
7) If errors occur when writing or reading a program with a commercially available cassette tape recorder adjust the volume control.
8) The outputs all turn off when the mode select switch is set from RUN to PROG. or when an alarm is issued in the RUN mode.
When the mode is switched back to RUN, execution is reset and operation starts from the beginning.
9) For the set with case, set the mode select switches and DIP switches and connect the programmer cable with the cover detached.

Detaching the cover

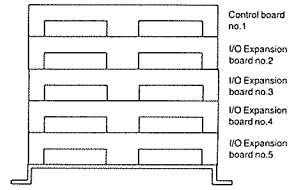


Grasp the edges of the cover and lift it off. If it is difficult to detach, lift the cover tabs and detach.

Attaching the cover

Align the cover with the printed-circuit board and temporarily attach the cover. First secure the tabs at the left end, then press the top right end of the cover to snap it in place. Be careful not to break the tabs.
10) The power junction cable supplied with the unit is a 5-junction cable for the full set of I/O Expansion boards.
Cut the leads with a pair of diagonal cutters leaving the length you plan to use.

11) When adding or replacing an I/O expansion board, set the I/O number set switches on it before installing the board. Be careful not to bend the pins on the I/O expansion connector, and be sure to securely fasten the spacers.
The frame ground trace on each board and the spacer mounting plate must be electrically connected through a low impedance to ensure noise immunity.

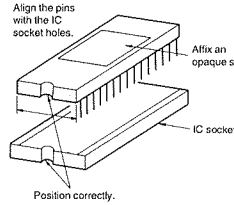


	I/O number set switch	I/O number
Control board no.1	I/O number setting unnecessary	X 0···, Y 0···
I/O Expansion board no.2		X 32···, Y 32···
I/O Expansion board no.3		X 64···, Y 64···
I/O Expansion board no.4		X 96···, Y 96···
I/O Expansion board no.5		X128···, Y128···

When using a number of I/O boards in combination, set their I/O numbers so that no two are identical.

4. Handling the Memory (ROM)

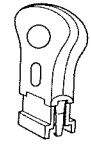
1) Mount the memory (EP-ROM, EEP-ROM) with the power off.
Correctly position the IC (with respect to the notch), align the pins of the IC chip with the IC socket holes and insert.
2) After the memory (ROM) has been inserted, its contents are transferred to the internal RAM whenever the power is turned on in the RUN mode or the mode is switched from PROG. to RUN. Therefore, to transfer a program from the internal RAM to an EEP-ROM for a test run, check that the mode is set to PROG. Then insert the (EEP-ROM) into the IC socket and turn on the power.
3) Affix an opaque sheet to the erase window on the EP-ROM chip before use. If the opaque sheet is not present, a flash of light may cause an error.



4) Writing a program to memory
① To write the contents of the internal RAM to the EEP-ROM, insert the EEP-ROM to the user memory IC socket with the power off and the mode set to PROG, and enter the programmer key sequence [AC/•] [F] [9] [9] [WR]. The program will be completely written after about one minute.

② Writing a sequence program to memory (EP-ROM)
First write the contents of the internal RAM to the EEP-ROM and then using commercially available ROM writer (27C64 mode), write the contents of the EEP-ROM to the EP-ROM.
5) When installing an EEP-ROM and turning on power to copy the internal RAM program onto it, may be displayed on the programmer.
If this appears even though a password has not been defined, the installed EEP-ROM contains undefined data taken to be a password.
In this case, initialize the password using the DIP switches while the EEP-ROM is installed (Refer to page 30, 3. Handling). This clears only the program in the EEP-ROM leaving that in the internal RAM intact.
6) In case of pulling out MEMORY (ROM) from IC socket, using of IC EXTRACTOR is recomended. Please note, the printed-circuit on the board might be damaged by using a screwdriver.

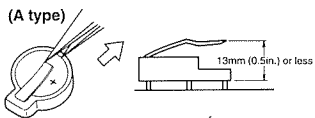
(Ex.)
IC
EXTRACTOR
MODEL GX-6
Sun hayato
MADE IN JAPAN



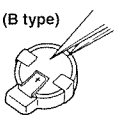
5. Handling the Battery

1) The ALARM LED flashes when it is time to replace the battery. Replace the battery within a week.
2) The battery is inserted in the battery holder located on the rear surface (soldered side) of the control board. With the power off, remove the control board and pull out the battery sideways using insulated tweezers. Before inserting the battery, check that nothing is attached to the + and – surfaces.
With the + side facing up, insert the battery by sliding it in sideways. The battery should be inserted within 5 minutes and the height of the + terminal of the battery holder A type should be 13mm (0.5 in.) or less.

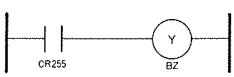
(A type)



(B type)

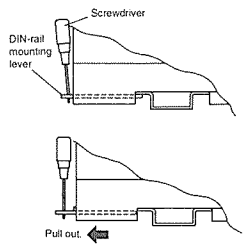


3) Inspection is simplified if a buzzer is made to sound in the program using the battery error detect relay (CR255).

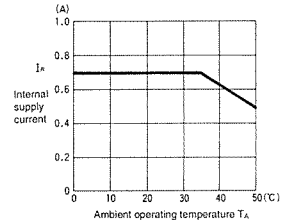


6. Mounting

1) Cut the mounting holes as shown in the dimensions diagram.
2) To mount to DIN-rails, use th DIN-rail mounting lever attached to the mounting plate. Align with the mounting rail groove and push to mount.
To detach from the rail, pull the lever with a slotted screwdriver.



Avoid rail mounting in locations with severe vibrations and shock, and mount directly to the panel with screws.
3) To mount a I/O Expansion board or special board for addition or replacement, secure the AFB8803 case set spacer (18mm long protrustion type) to the mounting plate.
In this case, be sure that the frame grounding trace on each board, spacer and mounting plate are electrically connected with low impedance.
4) When expanding by adding a special board, be sure that the total current I_R for the 5V supply and capacitance C_R are within the range given below.



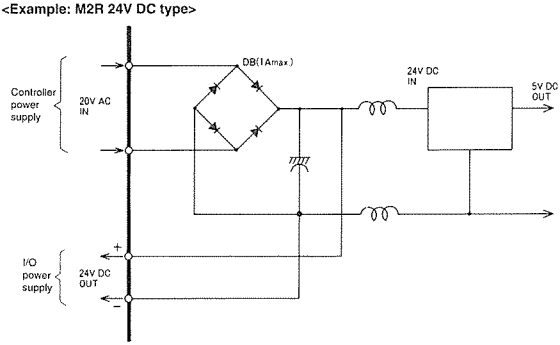
	I_R	C_R
Control board	With Programmer Approx. 280mA	200 μF
I/O Expansion board	Approx. 50mA/board	47 μF

I_R must follow the I_R-T_A characteristics shown above and C_R must be a total of 470 μF or less.

7. Note on the Controller Power Supply and I/O Power Supply

1) A transformer power supply (AC) can be used for the controller power supply. In this case, the 24V DC OUT can also be used for the I/O power supply.
How ever, it is necessary to check the actual operating conditions so that the DB control current does not exceed 1A, and the specifications such as voltage fluctuation, power supply ripple, power supply rise and fall characteristics, and temperature characteristics are satisfied.

<Example: M2R 24V DC type>



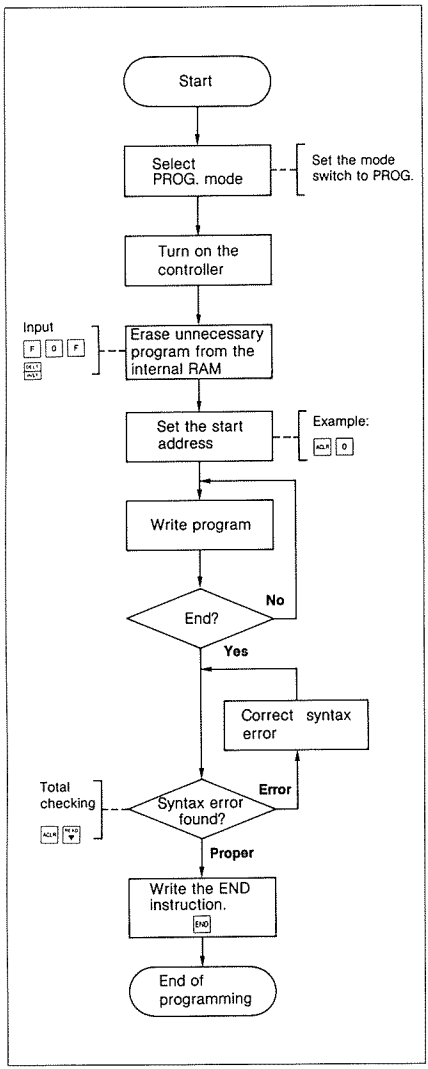
CHAPTER 2

BEFORE PROGRAMMING

"PC" is the abbreviation for Programmable Controller.

2-1. Programming Sequence and Operation Mode setting

■ PROGRAMMING SEQUENCE



■ SETTING OPERATION MODE

Before starting programming or operation, select the mode with the PROG./RUN mode switch on the control board:

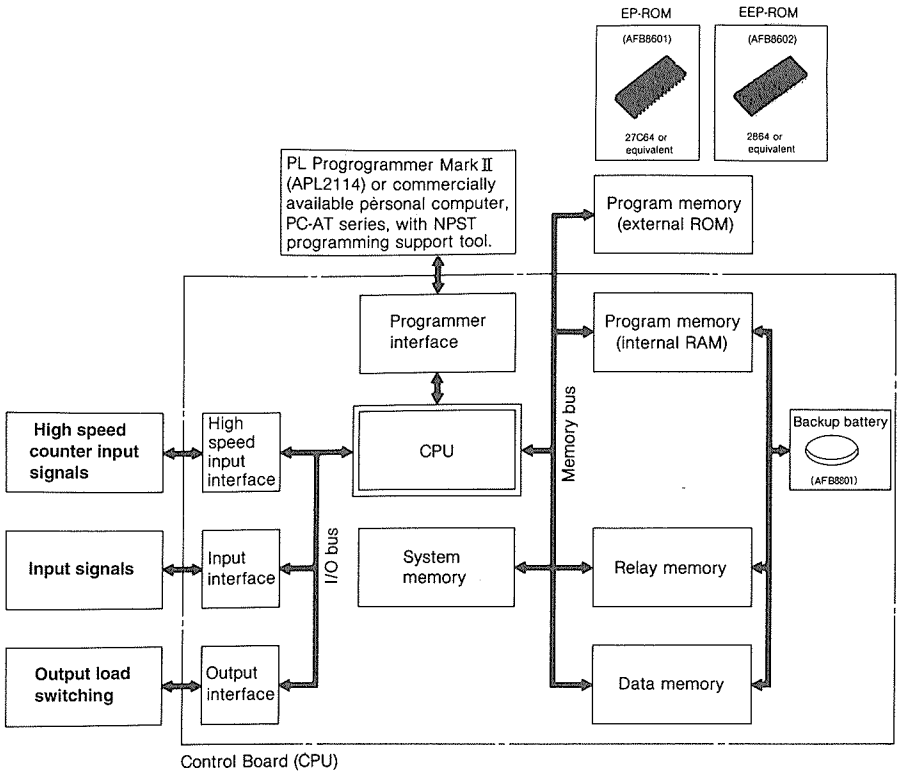
Mode switch setting	Mode	Description
PROG. RUN	PROG.	• This mode enables programming. • Select this mode before switching on the controller power.
PROG. RUN	RUN	• This mode runs operations which use I/O. • Once this mode is selected, the RUN indicator LED comes on.

• Note on Mode Setting

The contents of the internal hold relays (CR192 to CR251), counters (C0 to C47), and data memory areas (D0 to D299) are retained even after the PROG. mode has been selected. All other relays and counters will be reset.

2-2. User's Memory Configuration

■ M2R, M1T, M2T



Note:
The contents of the EP-ROM (AFB8601) are transferred to the internal RAM when the memory (ROM) is mounted and the power is switched on in the RUN mode or when the mode is switched from PROG. to RUN. Therefore, when transferring the contents of the internal RAM to EEP-ROM (AFB8602) during a test run, first check to make sure that the PROG. mode is selected, then insert EEP-ROM (AFB8602) into its socket, and finally switch on the power.

2-2-1. Relay Memory Contents

1) Relay number

Relay		M1T, M2T			M2R		
Name	Symbol	No.	No. of points		No.	No. of points	
Input relays (X16 to X19 are for DIP switch inputs; on the M2R they also serve as general inputs)	X	0 to 19	20	Total	0 to 19	20	Total
		32 to 55	24				
		64 to 87	24	116			20
		96 to 119	24				
		128 to 151	24				
Input relays (assigned to high level instructions)	X	160 to 180	21	21	160 to 180	21	21
Input relays (assigned to high speed counter instructions)	X	181 to 185	5	5	181 to 185	5	5
Flag relays	X	196 to 199	4	4	196 to 199	4	4
Input relays (unused)	X	20 to 31	12	Total	20 to 159	140	Total
		56 to 63	8		186 to 195	10	
		88 to 95	8		200 to 255	56	
		120 to 127	8	110			206
		152 to 159	8				
		186 to 195	10				
		200 to 255	56				
Output relays	Y	0 to 15	16	Total	0 to 15	16	Total
		32 to 47	16				
		64 to 79	16	80			16
		96 to 111	16				
		128 to 143	16				
Output relays (assigned to high speed counter instructions)	Y	198 to 199	2	2	198 to 199	2	2
Output relays (unused)	Y	16 to 31	16	Total	16 to 197	182	Total
		48 to 63	16		200 to 255	56	
		80 to 95	16				
		112 to 127	16	174			238
		144 to 197	54				
		200 to 255	56				
Internal relays (non-hold type)	CR	0 to 191	192	192	0 to 191	192	192
Internal relays (hold type)	CR	192 to 251	60	60	192 to 251	60	60
Special internal relays	CR	252 to 255	4	4	252 to 255	4	4
Timers (contacts)	T	0 to 63	64	64	0 to 63	64	64
Counters (contacts: DOWN counters)	C	0 to 31	32	Total	0 to 31	32	Total
Counters (contacts: UP/DOWN counters)	C	32 to 47	16	48	32 to 47	16	48
High speed counters (contacts)	C	50 to 81	32	32	50 to 81	32	32
High speed counters (for elapsed value reading)	C	48 to 49	2	2	48 to 49	2	2
Shift registers (contacts)	SR	0 to 377 (Octal)	256	256	0 to 377 (Octal)	256	256
Master control relays	MCR	0 to 31	32	32	0 to 31	32	32
Jump	JMP	0 to 31	32	32	0 to 31	32	32

Notes: 1. Input relays X16 to X19 are assigned to the DIP switch inputs for password setting. On the M2R, they also serve as general inputs.
2. The input and output relays assigned to the high level instructions and high speed counter instructions are not used for general inputs or outputs.
3. Unused input relays can be used as dummy contacts; unused output relays can be used as non-hold type, internal relays.

2) Timer and Counter Numbers

Timer/Counter		No.	No. of points	Set value range	Elapsed value	Operation mode
Name	Symbol					
ON-delay timer (0.01 s units)	T CR	(combined)	64	0 to 9.99 s (0 to 999)	0 to 9.99 s (0 to 999)	Decrement
ON-delay timer (0.1 s units)	TX	0 to 63		0 to 99.9 s (0 to 999)	0 to 99.9 s (0 to 999)	
ON-delay timer (1 s units)	TY			0 to 999 s (0 to 999)	0 to 999 s (0 to 999)	
Preset counter (DOWN hold type)	C	0 to 31	32	0 to 999	0 to 999	Decrement
Preset counter (UP/DOWN hold type)	C	32 to 47	16	0 to 999	0 to 999	Increment/ decrement

Note: The contents of the high speed counters depend on the operation mode. For more details, see the section on high speed counter set instruction in the description of instruction words.

3) Shift Register Numbers

Shift register (8-bit)	Shift register bits (contacts)							
Symbol & No. (used for shift register setting)	Symbol & No.							
S R 0	SR0	SR1	SR2	SR3	SR4	SR5	SR6	SR7
S R 1 0	SR10	SR11	SR12	SR13	SR14	SR15	SR16	SR17
S R 2 0	SR20	SR21	SR22	SR23	SR24	SR25	SR26	SR27
S R 3 0	SR30	SR31	SR32	SR33	SR34	SR35	SR36	SR37
S R 4 0	SR40	SR41	SR42	SR43	SR44	SR45	SR46	SR47
S R 5 0	SR50	SR51	SR52	SR53	SR54	SR55	SR56	SR57
S R 6 0	SR60	SR61	SR62	SR63	SR64	SR65	SR66	SR67
S R 7 0	SR70	SR71	SR72	SR73	SR74	SR75	SR76	SR77
S R 1 0 0	SR100	SR101	SR102	SR103	SR104	SR105	SR106	SR107
S R 1 1 0	SR110	SR111	SR112	SR113	SR114	SR115	SR116	SR117
S R 1 2 0	SR120	SR121	SR122	SR123	SR124	SR125	SR126	SR127
S R 1 3 0	SR130	SR131	SR132	SR133	SR134	SR135	SR136	SR137
S R 1 4 0	SR140	SR141	SR142	SR143	SR144	SR145	SR146	SR147
S R 1 5 0	SR150	SR151	SR152	SR153	SR154	SR155	SR156	SR157
S R 1 6 0	SR160	SR161	SR162	SR163	SR164	SR165	SR166	SR167
S R 1 7 0	SR170	SR171	SR172	SR173	SR174	SR175	SR176	SR177
S R 2 0 0	SR200	SR201	SR202	SR203	SR204	SR205	SR206	SR207
S R 2 1 0	SR210	SR211	SR212	SR213	SR214	SR215	SR216	SR217
S R 2 2 0	SR220	SR221	SR222	SR223	SR224	SR225	SR226	SR227
S R 2 3 0	SR230	SR231	SR232	SR233	SR234	SR235	SR236	SR237
S R 2 4 0	SR240	SR241	SR242	SR243	SR244	SR245	SR246	SR247
S R 2 5 0	SR250	SR251	SR252	SR253	SR254	SR255	SR256	SR257
S R 2 6 0	SR260	SR261	SR262	SR263	SR264	SR265	SR266	SR267
S R 2 7 0	SR270	SR271	SR272	SR273	SR274	SR275	SR276	SR277
S R 3 0 0	SR300	SR301	SR302	SR303	SR304	SR305	SR306	SR307
S R 3 1 0	SR310	SR311	SR312	SR313	SR314	SR315	SR316	SR317
S R 3 2 0	SR320	SR321	SR322	SR323	SR324	SR325	SR326	SR327
S R 3 3 0	SR330	SR331	SR332	SR333	SR334	SR335	SR336	SR337
S R 3 4 0	SR340	SR341	SR342	SR343	SR344	SR345	SR346	SR347
S R 3 5 0	SR350	SR351	SR352	SR353	SR354	SR355	SR356	SR357
S R 3 6 0	SR360	SR361	SR362	SR363	SR364	SR365	SR366	SR367
S R 3 7 0	SR370	SR371	SR372	SR373	SR374	SR375	SR376	SR377

2-2-2. Data Memory Contents

The data memory is 12-bit area which is used to store numerical data. High level instructions in a program can access data memory by specifying the desired memory area number. While data bits cannot be directly turned on or off, they can be transferred to a memory area and then manipulated bit-by-bit controlling the corresponding internal relays.

The special area in data memory is used to change the high speed counter's preset value while the program is running. If the high speed counter is not used, the special area can be used as an ordinary area in data memory. Note, however, that the special area is a non-hold memory and its contents are cleared when the power is turned off or when the mode is switched to PROG.

Data Memory Area Numbers

Data memory (12 bits) Symbol & No.	Memory area No.	No. of data items
Special area	621 to 699	79
D0 to D299	700 to 999	300

2-2-3. Program Memory Contents

1) Program Memory List

Name		Storage medium	Address	Memory capacity (number of steps)	Remarks
Program memory (internal RAM)		C-MOS RAM IC	0 to 2499	2500 steps	Backed up battery.
Program memory (external ROM)	User memory (AFB8601; EP-ROM)	EP-ROM IC	0 to 2499	2500 steps	Written to with the commercially available ROM writer.
	Master memory (AFB8602; EEP-ROM)	EEP-ROM IC	0 to 2499	2500 steps	Can be written to or erased with the Micro Controller M
Cassette tape		Magnetic	–	2500 steps or more (Note 1)	Used to save program in internal RAM.
Floppy disk (Note 1)		Magnetic	–	2500 steps or more (Note 1)	Save using PC-AT Series personal computer (with NPST).

Note: 1. The storage capacities of cassette tapes and floppy disks vary depending on the medium used.

2) Comparison of Program Storage Media

The programs of Micro Controllers may be saved on EP-ROMs (AFB8601), EEP-ROMs (AFB8602), cassette tapes, or floppy disks. The table compares the characteristics of these media to guide you in the choice of the most suitable program storage medium:

Name	Characteristics
EP-ROM (AFB8601)	High data storage reliability Low cost Preparation requires some effort and a ROM writer
EEP-ROM (AFB8602)	Directly written to by the microcontroller. Quick read/write access times High data storage reliability Higher cost than the EP-ROM.
Cassette tape	A program can be easily stored as long as a cassette deck or tape recorder is available. While a number of programs can be saved onto tape, retrieval takes time. Data storage reliability is not high (vulnerable to magnetism). Saving/loading operation takes much time.
Floppy disk	Many programs can be saved on a disk and retrieval is easy. Quick read/write access times Data reliability is not high (vulnerable to magnetism). Requires a commercially available personal computer, IBM PC-AT series, with NPST.

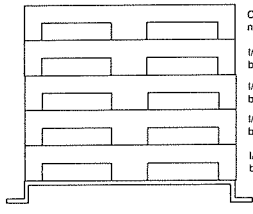
2-3. Relay Number Allocations

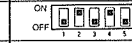
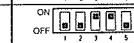
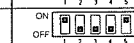
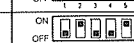
2-3-1. Relay Number List

Name	Description	Key	M1T, M2T No.	M1T, M2T No. of points		M2R No.	M2R No. of points	
Input relays (X16 to X19 are DIP switch inputs; on the M2R they also serve as general inputs)	Indicates external inputs and specifies input terminal numbers.	X (0-19)	0 to 19 32 to 55 64 to 87 96 to 119 128 to 151	20 24 24 24 24	Total 116 	0 to 19	20	Total 20
Output relays	Indicates external outputs and specifies output terminal numbers.	Y (1-5)	0 to 15 32 to 47 64 to 79 96 to 111 128 to 143	16 16 16 16 16	Total 80 	0 to 15	16	Total 16
Internal relays (non-hold)	Used only for internal operations without external output.	CR	0 to 191	192	192	0 to 191	192	192
Internal relays (hold)	These internal relays retain their contact state even after power failure.	CR	192 to 251	60	60	192 to 251	60	60
Timers (DOWN)	ON-delay type timers that can be set in units of 0.01, 0.1, and 1 sec	T	0 to 63	64	64	0 to 63	64	64
Counters (DOWN hold)	These preset counters retain their values even after the Controller is turned off.	C	0 to 31	32	Total	0 to 31	32	Total
Counters (UP/DOWN hold)		C	32 to 47	16	48	32 to 47	16	48
High speed counters (UP non-hold)	Preset counters with 8kHz response. They are reset when a power failure occurs.	C	50 to 81	32	32	50 to 81	32	32
Shift registers	Shift registers which are 8 bits wide. They retain their contents even after a power failure.	SR	0 to 377 (octal)	256	256	0 to 377 (octal)	256	256
Master control relays	When the MCR key is set to ON, the program placed between the MCR and END instructions is executed. When it is set to OFF, the output of the program placed between the two instructions is turned off.	MCR	0 to 31	32	32	0 to 31	32	32
Jump	When the JMP key is set to ON, the program placed between the JMP and END instructions is executed. When it is set to OFF, the output of the program placed between the two instructions retains the state before the JMP key was set to OFF.	JMP	0 to 31	32	32	0 to 31	32	32

Notes: 1. Shift register numbers are given in octal.
2. Relays X160 to X185 are assigned to the high level instructions. Their contacts are all normally off.
3. Relays X196 to X199 are assigned to the operation result flags. They change their states depending on the operation results.
4. Relay Y198 is used for modifying the high speed counter's set value; Y199 is used for resetting the high speed counter. (The high speed counter reset condition is the logical OR of internal reset relay Y199 and external reset input X0.)

2-3-2. I/O Number Allocations for I/O Expansion Boards (M1T, M2T)



	I/O number set switch	I/O number
Control board no.1	I/O number setting unnecessary	X 0 ···, Y 0 ···
I/O Expansion board no.2		X 32 ···, Y 32 ···
I/O Expansion board no.3		X 64 ···, Y 64 ···
I/O Expansion board no.4		X 96 ···, Y 96 ···
I/O Expansion board no.5		X128 ···, Y128 ···

When using a number of I/O boards in combination, set their I/O numbers so that no two are identical.

2-4. Memory Area List

• Memory Area Number Allocations (The symbols with ▒ are exclusive for those of NPST.)

1. External Inputs

Content	Memory area no.
X 0 to X 11	0
X 8 to X 19	1
X 32 to X 43	2
X 64 to X 75	3
X 96 to X107	4
X128 to X139	5

2. Readout fixed data

Content	Memory area no.
000	20
00F	21
0F0	22
0FF	23
F00	24
F0F	25
FF0	26
FFF	27
1	28
10	29
100	30
000	31
001	32
002	33
004	34
008	35
010	36
020	37
040	38
080	39
100	40
200	41
400	42
800	43
000	44
001	45
002	46
003	47
004	48
005	49
006	50
007	51
008	52
009	53
00A	54
00B	55
00C	56

Content	Memory area no.
00D	57
00E	58
00F	59
000	60
010	61
020	62
030	63
040	64
050	65
060	66
070	67
080	68
090	69
0A0	70
0B0	71
0C0	72
0D0	73
0E0	74
0F0	75
000	76
100	77
200	78
300	79
400	80
500	81
600	82
700	83
800	84
900	85
A00	86
B00	87
C00	88
D00	89
E00	90
F00	91

3. Internal relays

Content	Memory area no.
CR 0 to 11	600
CR 12 to 23	601
CR 24 to 35	602
CR 36 to 47	603
CR 48 to 59	604
CR 60 to 71	605
CR 72 to 83	606
CR 84 to 95	607
CR 96 to107	608

	Content	Memory area no.
Holding type	CR108 to 119	609
	CR120 to 131	610
	CR132 to 143	611
	CR144 to 155	612
	CR156 to 167	613
	CR168 to 179	614
	CR180 to 191	615
	CR192 to 203	616
	CR204 to 215	617
	CR216 to 227	618
	CR228 to 239	619
	CR240 to 251	620

4. External outputs

Content	Memory area no.
Y 0 to Y 11	500
Y 8 to Y 15	501
Y 32 to Y 43	502
Y 64 to Y 75	503
Y 96 to Y107	504
Y128 to Y139	505

5. Data memories

	Content (NPST)	Memory area no.
Special area	D921	621
	⋮	⋮
	D999	699
Holding type	D0	700
	⋮	⋮
	D299	999

6. Counters

	Content	Elapsed value		Set value	
		NPST	Memory area no.	NPST	Memory area no.
Holding type	C0	CE0	100	CS0	300
	⋮	⋮	⋮	⋮	⋮
	C47	CE47	147	CS47	347

7. Timers

Content	Elapsed value		Set value	
	NPST	Memory area no.	NPST	Memory area no.
T0	TE0	200	TS0	400
⋮	⋮	⋮	⋮	⋮
T63	TE63	263	TS63	463

Note: "Holding" is the function to maintain the condition existing at the time of power interruption when power returns.

2-5. M2RL and M2R2 Program Compatibility Comparison

Item	M2RL microcontrol unit	M2R2 microcontrol unit
Program capacity	600 steps	2,500 steps
Data memory	96 points	300 points
Special data memory	None	79 points
Program protect function	None	Password method
High speed counter	None	Yes
Interrupt input	1 point	None
Pulse catch	1 point	None
DIP switch input	None	4 points
Flag relay number	X20 to X23	X196 to X199

- Any program of 600 steps or less can be transferred by ROM, Cassette tape or NPST.
- A password-protected ROM cannot be used.
- The high-speed counter instructions below result in errors.

  STRT X182: Maximum counting value set instruction
  STRT X183: ON setting instruction
  STRT X184: OFF setting instruction
  OUT Y198: Set value change relay
  OUT Y199: Internal reset relay
- In the M2R2, unused Y from Y0 to Y255 can be used as internal relays. In the M2RL, however, Y32 to Y255 are unavailable.
- Any attempt to use them results in an error. The flag relays are X20 (Carry flag), X21 (Zero flag), X22 (> flag) and X23 (Error flag).
- The mode set instruction (STRT X181) can be used but modes 0 to 4 cannot be set. Only modes 10 to 12 are available for the M2RL.
- The high-speed scan area setting instruction (STRT X185 + JP31 to JPE31) is valid only when operating mode 10 to 12 has been set.
- The following special relays have been added to the M2RL.

Pulse Catch Relay (X24): The pulse input at terminal X1 is held in the ON state for one scan.

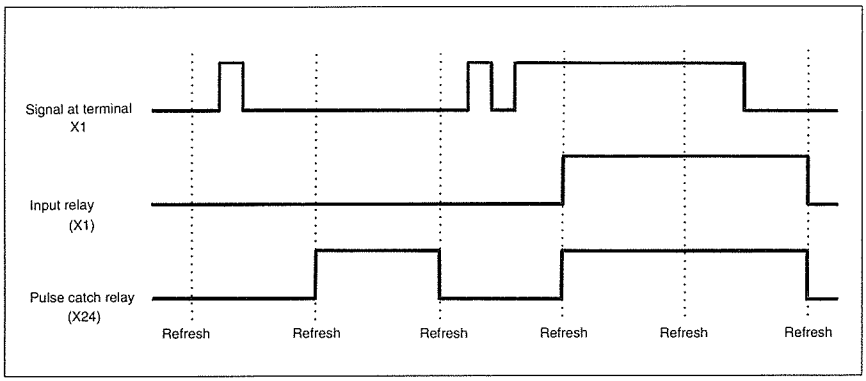
Interrupt Relay (X25): If an interrupt is generated, the relay turns ON only while it is being processed. Using the relay in the high-speed scan area permits the interrupt state and normal state to be distinguished.

2-6. M2RL Special relay

2-6-1. Pulse catch relay (X24)

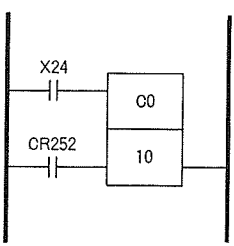
Using the pulse catch input

Accurately captures 0.5ms pulse.



- Signals arising during the refresh period as shown in the timing chart above are not captured by the ordinary input relay but are by the pulse catch relay.
- The catch relay turns ON if there are one or more pulses during a scan. It does not detect the number of pulses during the scan.

Program Example



This program counts the number of pulses at terminal X1. The input signal must be longer than 0.5ms wide and the OFF state at least one scan interval.

Use of the interrupt input

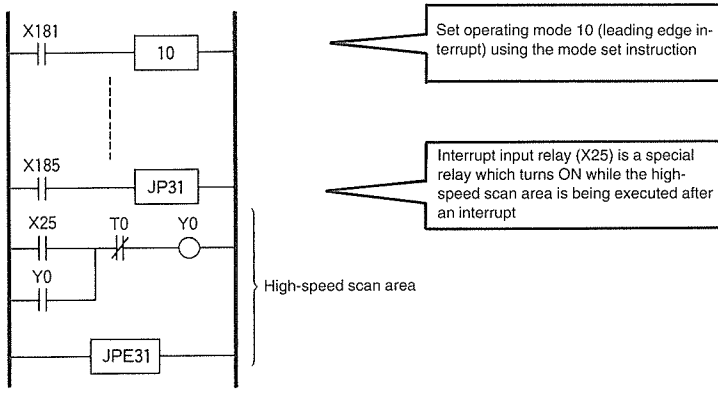
There are three types of interrupts which can be set using Mode set instruction (STRT X181).

Operating mode 10: Operation is interrupted to execute the high-speed scan area at the leading edge of the X0 input

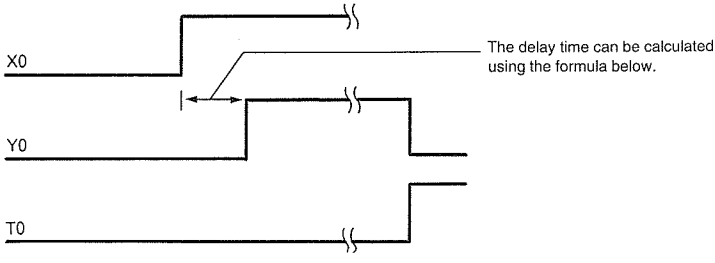
Operating mode 11: Operation is interrupted to execute the high-speed scan area at the trailing edge of the X0 input.

Operating mode 12: The high-speed scan area is executed at a timer interrupt.

Program Example 1



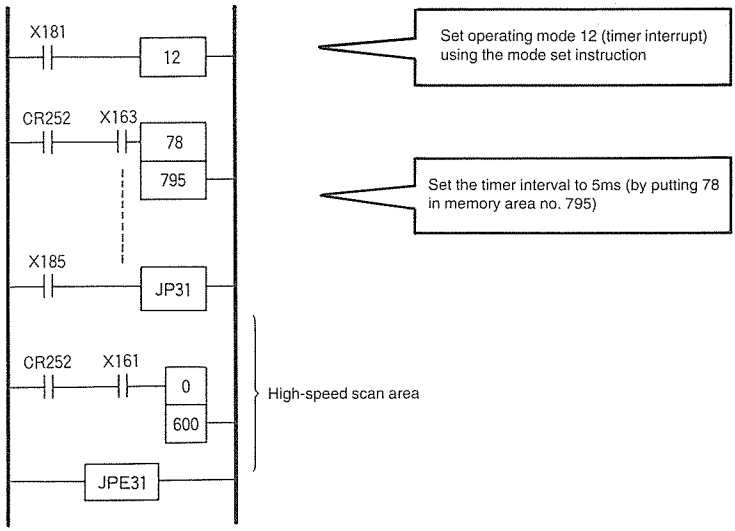
Timing chart



Calculation of the delay time

Response delay time = Input delay (within 0.5ms) + Processing delay (within 0.2ms) + High-speed scan area execution time (7.5 μs per step for basic instructions) + Output refresh time (Y0 to Y3 only) (Approx. 50 μs)

Program Example 2



- This program executes the high-speed scan area approximately every 5ms. The instant transfer instruction captures an external input and transfers it to an internal relay.
- The timer interval can be varied by changing the contents of memory area no. 795.

- The range is approximately from 640 μs to 16.3ms (corresponding to 10 to 256 in memory area no. 795)

Contents of memory area no. 795	Interval
10	Approx. 640 μs
⋮	⋮
256	16.3ms

Note: Set the interval to a value somewhat longer than the time required to execute the high-speed scan area plus 640 μs.
The timer interval increases approximately 64 μs for an increment of 1 in memory area no. 795.

2-7. M2RL Memory Area List

M2RL Memory Area

1. In general, the memory area numbers of the M2RL follow those of the earlier Micro Controller M series.
2. The external inputs are through to memory area no.1 of X8 to X19.
3. The data memory correspond to D0 to D95. The memory area numbers correspond to 700 to 795. (No special area)
4. The external outputs are through to memory area no.501 of Y8 to Y15.

M2RL Memory Area Number Allocations

1. External inputs

Content	Memory area no.
X0 to X11	0
X8 to X19	1

2. Data memories (Holding)

Content	Memory area no.
D0	700
⋮	⋮
D95	795

3. External outputs

Content	Memory area no.
Y0 to Y11	500
Y8 to Y15	501

4. Counters (Holding)

Content	Elapsed value		Set value	
	NPST	Memory area no.	NPST	Memory are no.
C0	CE0	100	CS0	300
⋮	⋮	⋮	⋮	⋮
C47	CE47	147	CS47	347

5. Timers

Content	Elapsed value		Set value	
	NPST	Memory area no.	NPST	Memory are no.
T0	TE0	200	TS0	400
⋮	⋮	⋮	⋮	⋮
T63	TE63	263	TS63	463

6. Internal relays

	Content	Memory area no.
Holding	CR 0 to 11	600
	CR 12 to 23	601
	CR 24 to 35	602
	CR 36 to 47	603
	CR 48 to 59	604
	CR 60 to 71	605
	CR 72 to 83	606
	CR 84 to 95	607
	CR 96 to 107	608
	CR108 to 119	609
	CR120 to 131	610
	CR132 to 143	611
	CR144 to 155	612
	CR156 to 167	613
	CR168 to 179	614
	CR180 to 191	615
	CR192 to 203	616
	CR204 to 215	617
	CR216 to 227	618
	CR228 to 239	619
	CR240 to 251	620

Note: "Holding" is the function to maintain the condition existing at the time of power instruction when power returns.

7. Readout fixed data

Content	Memory area no.
000	20
00F	21
0F0	22
0FF	23
F00	24
F0F	25
FF0	26
FFF	27
1	28
10	29
100	30
000	31
001	32
002	33
004	34
008	35
010	36
020	37
040	38
080	39
100	40
200	41
400	42
800	43

Content	Memory area no.
000	44
001	45
002	46
003	47
004	48
005	49
006	50
007	51
008	52
009	53
00A	54
00B	55
00C	56
00D	57
00E	58
00F	59
000	60
010	61
020	62
030	63
040	64
050	65
060	66
070	67

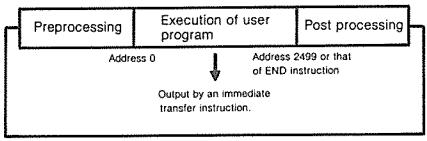
Content	Memory area no.
080	68
090	69
0A0	70
0B0	71
0C0	72
0D0	73
0E0	74
0F0	75
000	76
100	77
200	78
300	79
400	80
500	81
600	82
700	83
800	84
900	85
A00	86
B00	87
C00	88
D00	89
E00	90
F00	91

2-8. User Program and External ROM Types

2-8-1. Execution of User Program

1. Cyclic Operation

Program execution is repeated between address 0 and the address of the END instruction or address 2499.



User program execution is always preceded by preprocessing and succeeded by post processing. The contents of pre- and post-processings are as follows:

<Preprocessing>

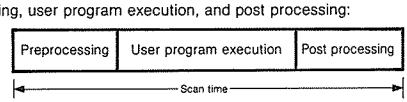
① Hardware check
② Stores contact status and data in relay memory.

<Post Processing>

① Outputs execution results to the output block.
Example: Outputs the contents of output relays to the external outputs.
② Programmer Service
NPST
The immediate transfer instruction (AND X161) enables outputs during execution of a user program. Since the output can be enabled any number of times during a single scan, the instruction is useful for high speed output processing such as high speed counter outputs.

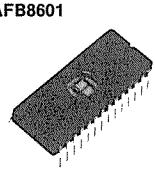
2. Scan Time

The scan time is the combined times required for preprocessing, user program execution, and post processing:



2-8-2. External ROM Types

1. EP-ROM; AFB8601



• Specifications

Item	Specifications
Memory specification	CMOS-EPROM 27C64-25 Access time: 250 ns or less Write voltage Vpp: $21^{+1.0}_{-0.5}$V
Applications	Used for ROM-based operation or program storage (stores 2500 program steps.)

• Method of Using the EP-ROM

1) ROM-based operation

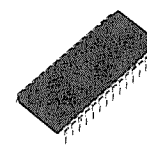
Once an EP-ROM is installed in the Micro Controller, the device enters the ROM operation mode. The contents of the ROM are transferred to the internal RAM and the device operates on RAM. Note, therefore, that the contents of the internal RAM become the same as that of the EP-ROM.

2) Writing EP-ROM

To write a program into the EP-ROM, first write it into EEP-ROM by means of a simplified ROM writer function of the Micro Controller and then copy the program with a commercially available ROM writer from the EEP-ROM to the EP-ROM. Use the following device specifications for the ROM writer:

Device specification for ROM writer (Vpp=21V)	
EEP-ROM X2864 Standard	AFB8602
EP-ROM 27C64 CMOS-EPROM (Fast write mode available)	AFB8601

2. EEP-ROM; AFB8602



• Specifications

Item	Specifications
Memory specification	EEP-ROM X2864 Access time: 250 ns or less
Applications	Program duplication and storage. This ROM can be written with the Micro Controller's simplified ROM writer function. It can hold up to 2500 program steps.

• How To Use EEP-ROM

1) Program duplication and storage (using simplified ROM writer function) :

When the master ROM is installed in the Micro Controller, the device enters the ROM operation mode, at which time you can copy the contents of the internal RAM to the EEP-ROM by using the Micro Controller's simplified ROM writer function.

How To Use the Simplified ROM Writer Function

(For more details, see the Operating Procedure.)
① Copy program from internal RAM to EEP-ROM:
Type [SHIFT] [F] [9] [9] [WRT] on the PL Programmer Mark II.
② Copy program from EEP-ROM to internal RAM:
Type [SHIFT] [F] [9] [0] [WRT] on the PL Programmer Mark II.

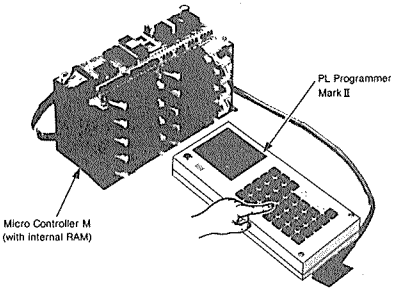
Caution:

Do not use the EEP-ROM to run the Micro Controller. The EEP-ROM itself has a low noise resistance and may cause a malfunction if it is used to run the Micro Controller.

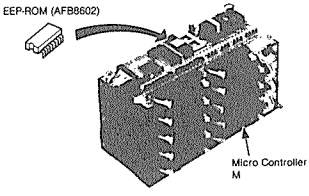
2-9. Preparing an EP-ROM

The Micro Controller contains a simplified ROM writer function for the EEP-ROM (AFB8602). The function allows easy program duplication and storage. With a commercially available ROM writer, the program stored in the EEP-ROM (AFB8602) can be copied to inexpensive EP-ROM (AFB8601) in quantity.

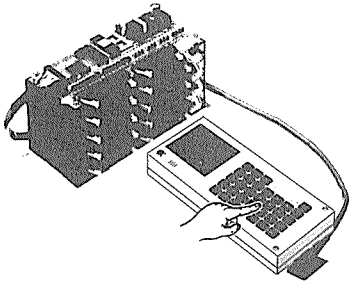
1. Write the program to the internal RAM.



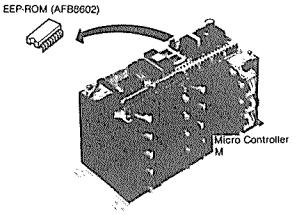
2. Install an EEP-ROM.



3. Transfer program from internal RAM to EEP-ROM. With the Micro Controller placed in PROG. mode, type [ACA] [F] [9] [9] [WRI] on the PL Programmer's keyboard.

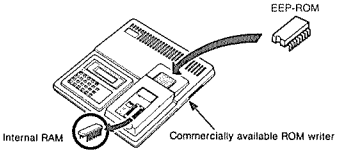


4. Remove the EEP-ROM.



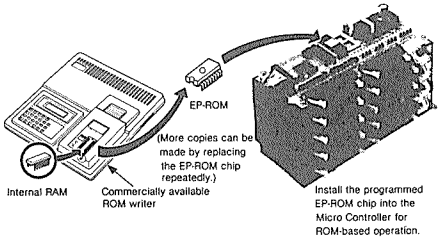
5. Transfer the contents of the EEP-ROM to your ROM writer's internal RAM. The following shows an example with the "Pecker-10" ROM Writer:

① Turn on the ROM writer, and press the [RST] key.
② Select the device, "2764FUJI", by typing:
[JOB] [SET]
[SET] or [−].
Set the selected device type with [JOB].
③ Install the EEP-ROM.
④ Press [LOD] [A] [SET] to clear the internal RAM.
⑤ Press [LOD] [SET] to transfer the program from the EEP-ROM to the ROM writer's internal RAM.

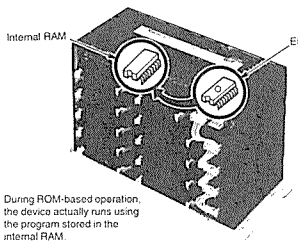


6. Replace the EEP-ROM with a EP-ROM chip and transfer the program from internal RAM to EP-ROM. The following shows an example with the "Pecker-10" ROM Writer:

① Remove the EEP-ROM.
② Install an EP-ROM chip in place of the EEP-ROM.
③ Press [ERS] [SET] to make sure that the EP-ROM is cleared.
④ Press [PRG] [SET] to transfer program from internal RAM to EP-ROM.



2-10. Memory Contents during ROM Operation

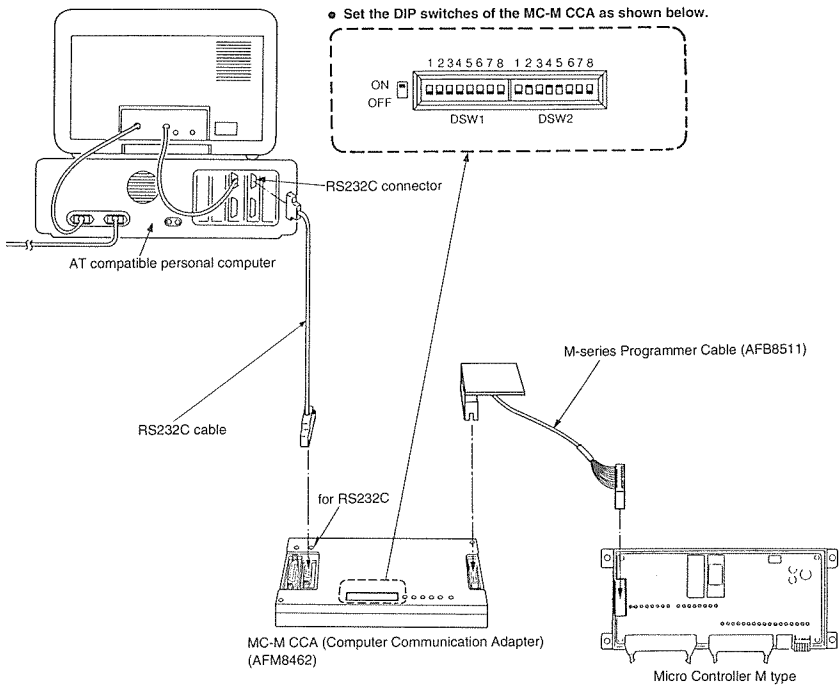


When the EP-ROM (AFB8601) is installed and the RUN mode is set, the Micro Controller writes the contents of the EP-ROM (AFB8601) to the internal RAM, and actually runs using the internal RAM.
Therefore, if you wish to transfer the contents of the internal RAM to the EEP-ROM (AFB8602) (F 9 9 WRT), be sure to set the PROG. mode and then turn on the power. If the EEP-ROM (AFB8602) is installed and power is turned on in the RUN mode, the contents of the EEP-ROM (AFB8602), will automatically be transferred to the internal RAM.

2-11. Connection of MC-M CCA (Computer Communication Adapter)

Installation of MC-M CCA

Communication with the Micro Controller M type is possible through the MC-M CCA (AFM8462).
Connect as shown below using the RS232C cable (for CCA and Personal Computer connection, see following pages) and M-series programmer cable (AFB8511).

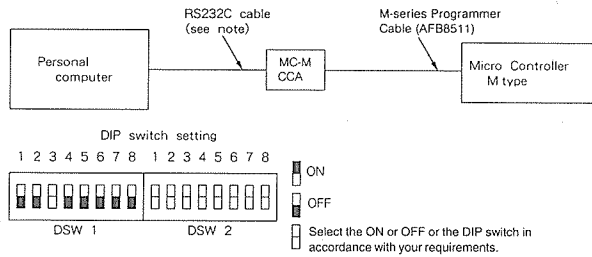


Notes:

- Turn OFF the power to both personal computer and Micro Controller M type before connecting them.
- For MC-M CCA and personal computer connection, refer to following page.

Connection of MC-M CCA

This connection is used to control the Micro Controller M type from the host computer.

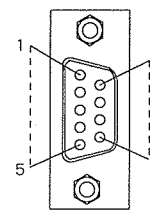


Notes:

1. Please select the ON or OFF of DIP switches (DSW 1 and DSW 2) in accordance with your requirements.
2. Please arrange RS232C cable with D-subminiature connector (9-pin) enclosed in the inner carton of MC-M CCA in accordance with their pin specifications.

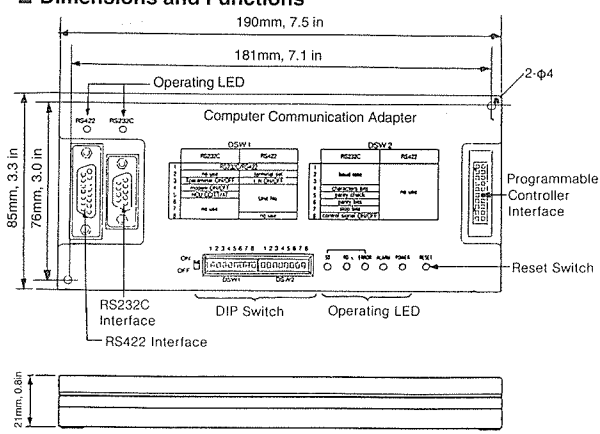
RS232C Interface Pin Specifications

Pin No.	Signal	Mnemonic	Direction	
			DTE	DCE
1	Frame Ground	FG	—	
2	Send Data	SD	→	
3	Receive Data	RD	←	
4	Request to Send	RS	→	
5	Clear to Send	CS	←	
6	Call Indication	CI	→	
7	Signal Ground	SG	—	
8	Carrier Detection	CD	←	
9	Equipment Ready	ER	→	



* The DTE in this table signifies MC-M CCA side pin.

Dimensions and Functions



Note:

- Communication Error LED (ERROR) turns on when parity error, framing or BCC error occurs. It goes off when normal signal is sent or received.

① • LED display

LED indication	Function of Lighting
POWER (Green)	Unit Operation
ALARM (Red)	Unit Erro (Press the reset switch of adapter and the ALARM LED goes off.)
SD: Monitoring of sending data (Green)	Sending
RD: Monitoring of receiving data (Green)	Receiving
ERROR: Communication Error (Red)	Communication Error
RS422: Operating (Green)	ON, during communication in RS422 mode
RS232C: Operating (Green)	ON, during communication in RS232C mode

② • Reset switch

Pressing the reset switch forcibly reset only the condition of the MC-M CCA.

2-12. Compatibility between the Micro Controller and PL Mark III

1. Shape and Dimensions

The Micro Controller and PL Mark III are not physically compatible with each other because they have different shapes and dimensions. They also have different wiring and power supply specifications.

2. Program Capacity

PL Mark III ..... 1,000 steps
Micro Controller ..... 2,500 steps

Since the PL Mark III is upward compatible with the Micro Controller, the program written for the PL Mark III can be loaded into the Micro Controller when the program written for the Micro Controller is loaded into the PL Mark III, the size of the program to be loaded does not exceed 1,000 steps.

3. Program Contents (Instruction Sets)

The instruction set for the Micro Controller is basically identical to that for the PL40M-III. However, since the two instruction sets have different I/O assignment numbers, they must be changed when programs are transferred. Furthermore, a machine language call instruction (AND X180), high speed counter mode set (STRT X181) and set value change relay (OUT Y198) have been added to the Micro Controller.

4. High Speed Counter

The Micro Controller's high speed counter allows mode switching or a change in the set value while it is running. The operation mode of the PL Mark III's high speed counter corresponds to operation Mode 0. The response speed is slightly faster in the PL Mark III.
PL Mark III: 10kHz
Micro Controller: 8kHz

5. Programming Tools

The following lists the programming tools available for the Micro Controller M and PL Mark III:

Programming Tool		Micro Controller M	PL Mark III
PL Programmer	APL211002	Incompatible	Compatible
	APL2114	Compatible	Compatible
PL ROM Writer Mark -5II		Incompatible	Compatible
NPST Note)		Compatible	Compatible

Note) There are some limitations of functions for PL Mark III.

6. Data Memory Read

Use the following operations to read the data memory contents:

PL Mark III ..... F 2
Micro Controller ..... F 8

On the Micro Controller, the contents of the data memory can be updated with the F 8 operation while running.

7. Peripheral Devices for PL Mark III

The PL analog timer unit (APL8609), PL ROM writer Mark II (APL222802, APL222602, APL222702) or PL high speed counter unit (APL2627) cannot be used with the Micro Controller.

CHAPTER 3

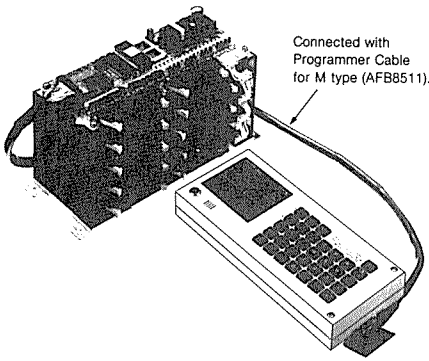
EXPLANATION OF INSTRUCTION

"PC" is the abbreviation for Programmable Controller.

3-1. Programming (Basic Operation)

Execute programming in the following sequence and check the contents of the instructions.

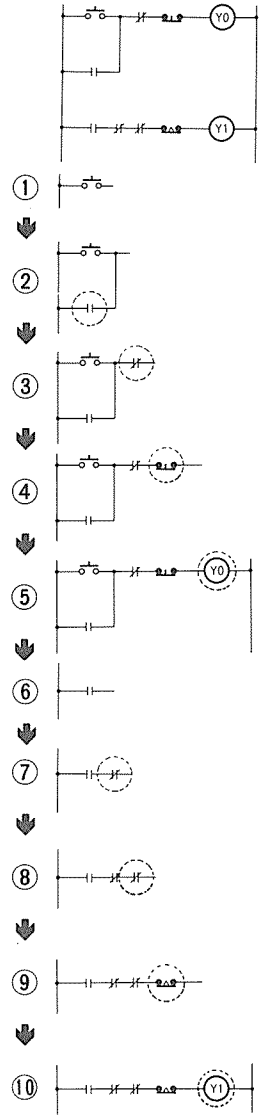
1. Attach the PL Programmer Mark II (APL2114) to the control unit.



2. Select the PROG mode and turn on the power supply.
   Operate the system in the prog. mode
   RUN → PROG.
3. Clear the program (erase the content in the memory).
   Press the keys [CLR] [F] [0] [F] and [DELT/INST].
4. Set the address.
   Press the keys [CLR] and [0].
5. Execute programming.
   (Example) [STEP/↑] [↓] [0] [WRT]
   ⋮
6. Totally check the contents of the instructions.
   [CLR] [READ/↓] ...If an abnormality does not exist, the display is cleared.
7. Operate the system in the run mode.
   PROG. → RUN
   Check the output state by inputting a signal.

• Program Procedure

When programming for the circuit diagram example using instructions it should be done following sequence from ① to ⑩.



3-2. Instructions

1. Basic instructions

Instructions	Key Indication	Function
START	STRT	Instruction to start logical operation with normally open contact
START NOT	STRT NOT	Instruction to start logical operation with normally closed contact
AND	AND	Instruction to carry out logical operation with prior condition and normally open contact
AND NOT	AND NOT	Instruction to carry out logical operation with prior condition and normally closed contact
OR	OR	Instruction to carry out logical addition (parallel connection) with prior condition and normally open contact
OR NOT	OR NOT	Instruction to carry out logical addition (parallel connection) with prior condition and normally closed contact
AND STACK	AND STK	Instruction to carry out logical operation between logic blocks (serial connection between blocks)
OR STACK	OR STK	Instruction to carry out logical addition between logic blocks (parallel connection between blocks)
OUT	OUT	Instruction to output operation result up to that point
TIMER (0.01 s)	T CR	0.01 second unit ON-delay timer instruction
TIMER (0.1 s)	T X (0.1S)	0.1 second unit ON-delay timer instruction
TIMER (1 s)	T Y (1S)	1 second unit ON-delay timer instruction
COUNTER	C	Counter instruction
MASTER CONTROL RELAY	MCR	Instruction to turn OFF operation circuit from this instruction to next MCR END
MASTER CONTROL RELAY END	MCR END	Instruction to finish MCR instruction
JUMP	JMP	The operation circuit condition from this instruction to the next JMP END is maintained
JUMP END	JMP END	This finishes the JMP instruction
SHIFT REGISTER	SR	Shift register instruction
END	END	At this instruction address the scanning is completed, and the scanning starts at "0" address with this instruction

2. Auxiliary instructions

Instructions	Key Indication	Function
Input	X (0.1S)	This identifies the external input and designates an input terminal number
Output	Y (1S)	This identifies an external output and designates an output terminal number
Internal relay	CR	This identifies an internal relay and designates the internal relay number
Timer	T	This identifies a timer contact and designates the timer number
Counter	C	This identifies a counter contact and designates the counter number
Shift register	SR	This identifies a shift register contact and designates the shift register number

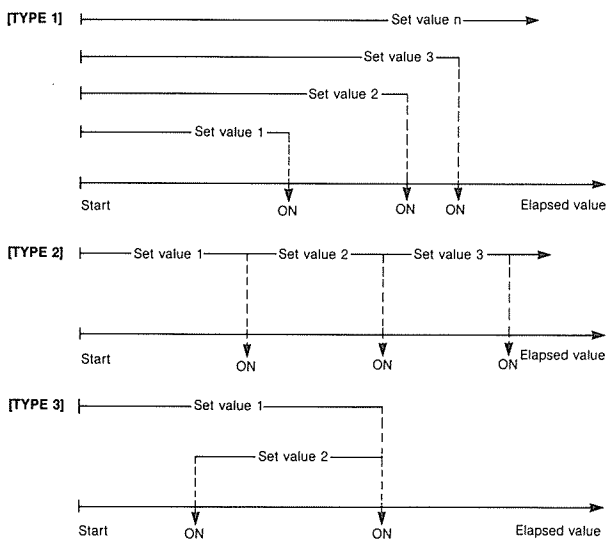
3. High speed counter set instruction

Instructions	Key operation	Function
Mode set	STAT X (0.1S) 1 8 1	Sets operation mode of high speed counter
Maximum counting value set	CNTR X (0.1S) 1 8 2	Setting of maximum counting value of high speed counter
ON setting	STAT X (0.1S) 1 8 3	Setting of ON conditions of high speed counter contacts
OFF setting	STAT X (0.1S) 1 8 4	Setting of OFF conditions of high speed counter contacts
High speed scan area setting	STAT X (0.1S) 1 8 5 + JMP 3 1 to JMP END 3 1	Sets scan area with interruption on count up status
Internal reset relay	OUT Y (1S) 1 9 9	Resets high speed counter counting value to zero and switch OFF each high speed counter contact
Set value change relay	OUT Y (1S) 1 9 8	Change set value of high speed counter contacts (C50 to C57) during RUN mode (It is possible during operation mode 2, 3 and 4)

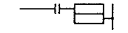
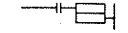
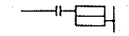
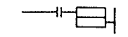
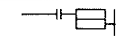
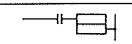
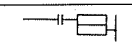
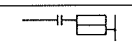
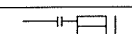
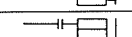
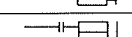
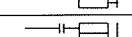
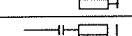
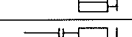
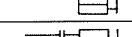
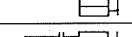
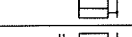
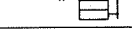
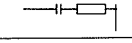
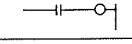
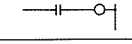
4. High speed counter specifications

Operation mode	Max. setting steps	Max. preset value	Used internal contact	ON/OFF setting	Operation type	Others
0	128	Total 65535	32 contacts C50 to C81	ON/OFF	TYPE 1	More than one contact can be set for 1 setting value
1	128	65535 for each step	32 contacts C50 to C81	ON/OFF	TYPE 2	Maximum counting value: 65535 × 128
2	8	Total 65535	8 contacts C50 to C57	ON setting only	TYPE 1	Preset value changeable during run operation Special areas 636 to 651 are used
3	8	Total 65535	8 contacts C50 to C57	ON setting only	TYPE 2	Preset value changeable during run operation Special areas 636 to 651 are used
4	2	Total 65535	2 contacts C50 to C51	ON setting only	TYPE 3	Preset value changeable during run operation Special areas 636 to 639 are used

Operation type



5. High level instructions

Instruction word	Key operation	Function	Numerical operation result relay change				Declared example
			<, CY X196	=, Z X197	> X198	ERR X199	
Transfer	AND X (0-15) 1 6 0	3-digit BCD (or 12-bit) data transfer	OFF	OFF	OFF	↕	
Real-time transfer	AND X (0-15) 1 6 1	3-digit BCD (or 12-bit) data transfer directly through I/O terminals	OFF	OFF	OFF	↕	
Inverted transfer	AND X (0-15) 1 6 2	Bit inverted transfer of 3-digit BCD (or 12-bit) data	OFF	OFF	OFF	↕	
Constant transfer	AND X (0-15) 1 6 3	Transfer of 3-digit BCD constant to memory area	OFF	OFF	OFF	OFF	
Indirect designation transfer	AND X (0-15) 1 6 4	Transfer of 3-digit (or 12-bit) data by indicact address designation	OFF	OFF	OFF	↕	
BCD-to-BIN conversion	AND X (0-15) 1 6 5	Conversion of 3-digit BCD to BIN data	OFF	OFF	OFF	↕	
BIN-to-BCD conversion	AND X (0-15) 1 6 6	Conversion of BIN data to 3-digit BCD	OFF	OFF	OFF	↕	
Comparison	AND X (0-15) 1 6 7	Comparison of BCD data	↕	↕	↕	↕	
Addition	AND X (0-15) 1 6 8	Addition of 3-digit BCD data	↕	↕	OFF	↕	
Subtraction	AND X (0-15) 1 6 9	Subtraction of 3-digit BCD data	↕	↕	OFF	↕	
Multiplication	AND X (0-15) 1 7 0	Multiplication of 3-digit BCD data	OFF	↕	OFF	↕	
Division	AND X (0-15) 1 7 1	Division of 3-digit BCD data	OFF	↕	OFF	↕	
Logical product (AND)	AND X (0-15) 1 7 2	Logical product of 12-bit data	OFF	↕	OFF	↕	
Logical sum (OR)	AND X (0-15) 1 7 3	Logical sum of 12-bit data	OFF	↕	OFF	↕	
Shift right	AND X (0-15) 1 7 4	Shift a data to the right by designated number of bits	↕	↕	OFF	↕	
Shift left	AND X (0-15) 1 7 5	Shift a data to the left by designated number of bits	↕	↕	OFF	↕	
Bit set/reset	AND X (0-15) 1 7 6	Switch ON or OFF of designated bit	OFF	OFF	OFF	↕	
HSC elapsed value transfer	AND X (0-15) 1 7 7	Transfer of the elapsed value of the high speed counter to a data memory	OFF	OFF	OFF	OFF	
Differential (positive)	AND X (0-15) 1 7 8	When input contact is switched from OFF to ON, designated internal relay is switched ON for 1-scan time.	—	—	—	—	
Differential (negative)	AND X (0-15) 1 7 9	When input contact is switched from ON to OFF, designated internal relay is switched ON for 1-scan time.	—	—	—	—	
Machine Language Call	AND X (0-15) 1 8 0	During input contact is on, call and execute desgnated machine language routine	—	—	—	—	

↕ : Changes in accordance with result.
OFF: Switches OFF
—: Does not change

Note:
- All flag relays are switched OFF when high level instructions are not executed. (The differential instruction does not cause a flag change.) If the error flag is switched ON, all other flags are switched OFF.
- HSC: built in high speed counter

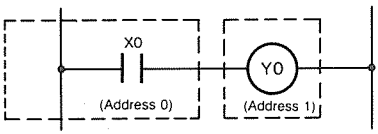
3-3. Description of Instructions

3-3-1. Basic Instructions

STRT START

OUT OUT

Program example



Address	Key operation
0	
1	

- For starting from bus, use instruction [STRT].
- For relay coil, use instruction [OUT].
- The address of the opening instruction of a sequence must be entered before entering in the instruction itself. In this example, press 0 before continuing with instruction entry.

■ Explanation

- [AND] and [NOT] are auxiliary instruction keys which indicate that they are external input and output elements.

[AND] key: Symbol for contact in normal operation, showing a contact symbol which is taken as an input signal through the input terminal

[NOT] key: Symbol for relay coil when the OUT instruction signal is outputed via an output terminal.

- The START X181 to X185, OUT Y198 to Y199 instructions have special meanings. (Refer to page 101, Section 3-3-3, High Speed Counter Instructions, for further information.)
- X160 to X180 instructions have special meanings.

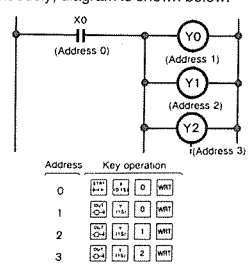
(Refer to page 70, Section 3-3-2, High Level Instructions, for further information.) There are no conbination of START X160 to X180.

• Terminology

STRT: Abbreviation for START and instruction for starting logical operation.
OUT: Output instruction
WRT: Abbreviation of WRITE and key for data write operation. In the above example, programs [STRT] [AND] [0] and [OUT] [NOT] [0] are written in memory (RAM) built-in control unit.

Before proceeding to the next page

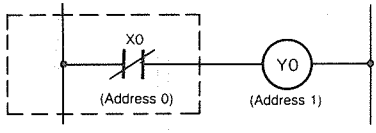
- The [CH] key is used only for internal numerical operation (like the auxiliary relay).
- OUT instruction can be used continuously, diagram is shown below.



STRT NOT

START·NOT

Program example

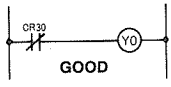


Address	Key operation				
0	STRT	NOT	X (0.1S)	0	WRT
1	OUT	Y (1S)	0	WRT	

• When starting point is N.C. (normally closed) contact, STRT NOT is used in place of STRT

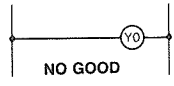
Explanation

• When it is desired to have the relay work at the same time that power is applied.

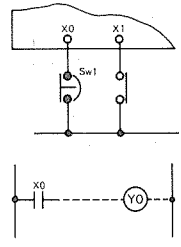


In the diagram, a dummy internal relay N.C. (normally closed) contact is inserted. If there is not CR30, the program can be written in, but:

The program initial address is ignored.



• When a N.C. (normally closed) contact is to be used as an input to the Micro Controller as an emergency stop switch or similar function, without using the STRT NOT instruction, the STRT instruction should be used. The reason for this is that in the condition shown in the diagram below, SW1 is already a closed circuit, and for that reason, X0 operates in an ON condition.



Terminology

STRT·NOT: Instruction for starting logical operation with N.C. (normally closed) contact.

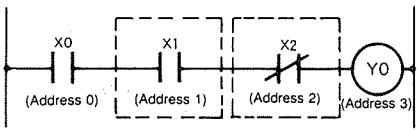
AND

AND

AND NOT

AND·NOT

Program example

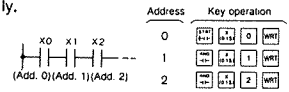


Address	Key operation				
0	STRT	X (0.1S)	0	WRT	
1	AND	X (0.1S)	1	WRT	
2	AND	NOT	X (0.1S)	2	WRT
3	OUT	Y (1S)	0	WRT	

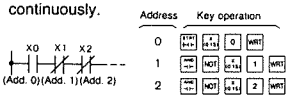
- Serial contact is connected by instruction [AND].
- When the serial contact is N.C. (normally closed) contact, instead of the [AND], an [AND] [NOT] is used.

Explanation

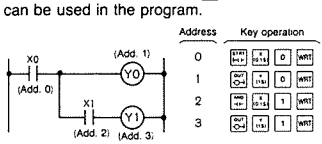
- Instruction [AND] can be used continuously.



- Instruction [AND] [NOT] can also be used continuously.



- In the following case, the [AND] instruction can be used in the program.



- For the output Y1, as a result of the operation of X0 and X1, there will be an output.

Note: The AND X160 to X180 instructions have special meanings. (Refer to page 70, Section 3-3-2, High Level Instructions.)

Terminology

AND: Logical product instruction.
AND·NOT: Instruction of AND with N.C. (normally closed) contact.

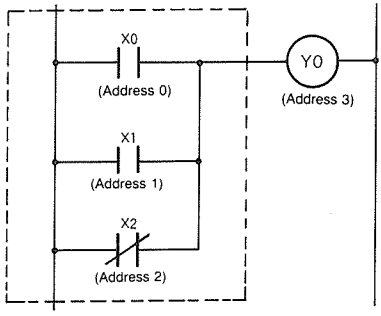
OR

OR

OR NOT

OR·NOT

Program example

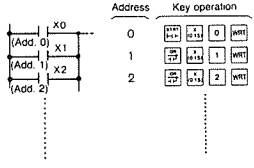


Address	Key operation
0	STRT X (0.1S) 0 WRT
1	OR X (0.1S) 1 WRT
2	OR NOT X (0.1S) 2 WRT
3	OUT Y (1S) 0 WRT

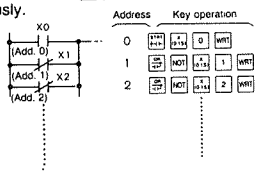
- Parallel contact is connected by instruction OR.
- Instruction STRT starts from bus like instruction STRT.
- When parallel contact is N.C. (normally closed) contact, instruction OR NOT is used in place of instruction OR.

Explanation

- Instruction OR can be used continuously.



- Instruction OR NOT can be used continuously.



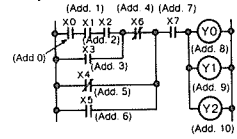
Terminology

OR: Logical sum instruction.
OR·NOT: Instruction of logical sum with N.C. (normally closed) contact.

Before proceeding to the next page

- Please look at the program of the circuit shown below.

Example



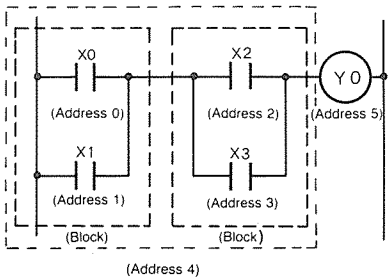
Solution for program

Address	Key operation
0	STRT X (0.1S) 0 WRT
1	OR X (0.1S) 1 WRT
2	AND X (0.1S) 2 WRT
3	OR X (0.1S) 3 WRT
4	AND NOT X (0.1S) 6 WRT
5	OR NOT X (0.1S) 4 WRT
6	AND X (0.1S) 5 WRT
7	AND X (0.1S) 7 WRT
8	OUT X (1S) 0 WRT
9	OUT Y (1S) 1 WRT
10	OUT Y (1S) 2 WRT

AND STK

AND·STACK

Program example



Address	Key operation			
0	STRT	X (0.1S)	0	WRT
1	OR	X (0.1S)	1	WRT
2	STRT	X (0.1S)	2	WRT
3	OR	X (0.1S)	3	WRT
4	AND	STK	WRT	
5	OUT	Y (1S)	0	WRT

- When integrating two blocks into series, use AND STK.
- Begin block with instruction STRT.

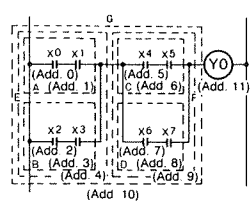
• Terminology

STK: Abbreviation of STACK.
For instruction STK, the instructions stored last is removed and combined with block stored just before to make a bigger block.
AND · STK: Logical product instruction between blocks.

Up to eight STACK instructions can be programmed continuously.

Example 1 of program

The following example should be executed after reading AND STK, OR STK.



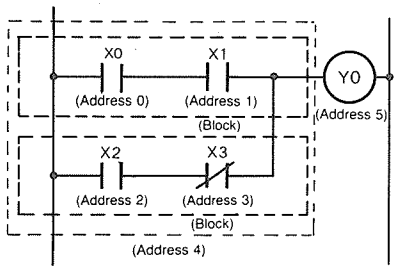
Address	Key operation			
0	STRT	X (0.1S)	0	WRT
1	OR	X (0.1S)	1	WRT
2	STRT	X (0.1S)	2	WRT
3	OR	X (0.1S)	3	WRT
4	AND	STK		
5	STRT	X (0.1S)	4	WRT
6	OR	X (0.1S)	5	WRT
7	STRT	X (0.1S)	6	WRT
8	OR	X (0.1S)	7	WRT
9	AND	STK		
10	AND	STK		
11	OUT	Y (1S)	0	WRT

Continued on to the next page.

OR STK

OR·STACK

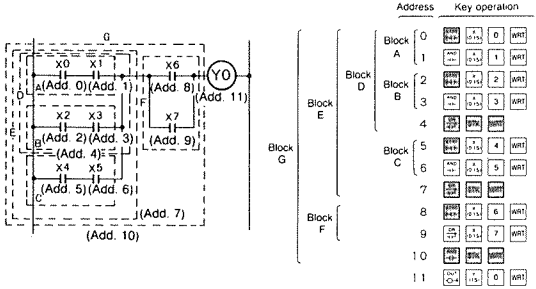
Program example



Address	Key operation				
0	STRT ⊣⊢	X (0.1S)	0	WRT	
1	AND ⊣⊢	X (0.1S)	1	WRT	
2	STRT ⊣⊢	X (0.1S)	2	WRT	
3	AND ⊣⊢	NOT	X (0.1S)	3	WRT
4	OR ⊣⊢	STK	WRT		
5	OUT ⊣○⊢	Y (1S)	0	WRT	

- When integrating two blocks in parallel, use [OR STK].
- Begin block with instruction [STRT].

Example 2 of program

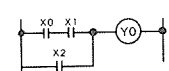


• Terminology

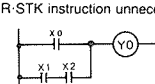
OR·STK: Logical sum instruction between blocks.

Before proceeding to the next page

Consider difference between the following two circuits.



(OR·STK instruction unnecessary.)



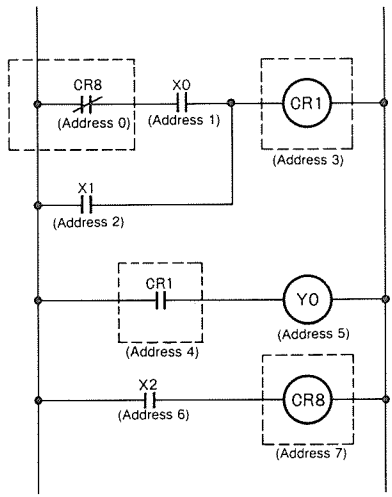
(OR·STK instruction necessary.)

Up to eight STACK instructions can be programmed continuously.

CR

INTERNAL RELAY

Program example



Address	Key operation				
0	STRT	NOT	CR	8	WRT
1	AND	X (0.1S)	0	WRT	
2	OR	X (0.1S)	1	WRT	
3	OUT	CR	1	WRT	
4	STRT	CR	1	WRT	
5	OUT	Y (1S)	0	WRT	
6	STRT	X (0.1S)	2	WRT	
7	OUT	CR	8	WRT	

• Internal relay is a relay constructed only on program not using it as external input and external output. It is represented as [CR].

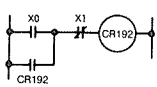
Explanation

• Internal relay [CR] is used in the same way as [0.1S], [1S].

• For internal relay [CR];
252 points from CR0 to CR251 are available.

• The 60 points from CR192 to CR251, are memory-hold internal relays for power-interruption memory. They are internal relays which memorize contact conditions before power is restored, the relays reproduce the status of the contacts before the power failure began.

• When making a circuit with power failure compensation function, use holding type internal relay as shown below.

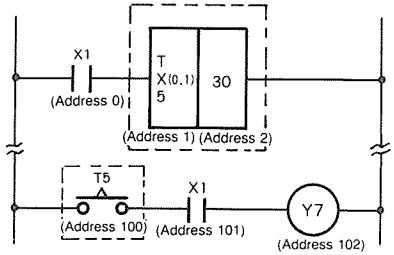


Terminology

Internal Relay: Relay used only on logical operation circuit inside Micro Controller.
CR: Abbreviation of control relay.

T TIMER

Program example



Address	Key operation			
0	STRT ⊣⊢	X (0.1S)	1	WRT
1	T	X (0.1S)	5	WRT
2	3	0	WRT	
⋮	⋮			
100	STRT ⊣⊢	T	5	WRT
101	AND ⊣⊢	X (0.1S)	1	WRT
102	OUT ⊣○⊢	Y (1S)	7	WRT

- Timer uses 2 steps at instruction [T].

Unit of timer (0.1 s) (5) No. of timer

[T] [X (0.1S)] [5]

[3] [0]

Set value of timer
3 s = 0.1 s × 30

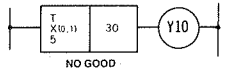
- When utilizing contact of timer used before, use instruction [T]

[T] [5]

No. of timer

Explanation

- Setting the timer's unit of time:
[T] [CR] . . . for a timer of 0.01 s unit (0 to 9.99 s).
[T] [X (0.1S)] . . . for a timer of 0.1 s unit (0 to 99.9 s).
[T] [Y (1S)] . . . for a timer of 1 s unit (0 to 999 s).
- Timer Numbers
64 points from T0 to T63 are available. (They include [T] [CR], [T] [X (0.1S)] and [T] [Y (1S)].)
- The timer resets when power is cut off.
- You can not begin by giving instruction [OUT] directly to timer.



- When programming timer, be sure to program contact input in the step just before
- Instruction [OUT], programmed immediately after programming timer, outputs after timer time expires.

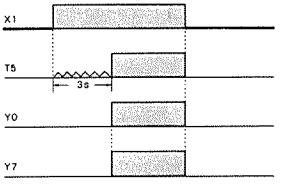
Terminology

T: Abbreviation of TIMER.

Before proceeding to the next page

Time set value of timer can be changed even while Micro controller is operating in RAM specification.

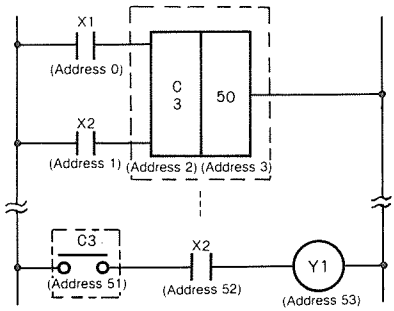
- For the example above, the timing chart is the following.



C

COUNTER (DOWN counting)

Program example



Address	Key operation			
0	STRT ⊣⊢	X (0.1S)	1	WRT
1	STRT ⊣⊢	X (0.1S)	2	WRT
2	C	3	WRT	
3	5	0	WRT	
51	STRT ⊣⊢	C	3	WRT
52	AND ⊣⊢	X (0.1S)	2	WRT
53	OUT -○-	Y (1S)	1	WRT

• Instruction [C] is programmed in sequence of count input and reset input.
Program of counter uses 2 steps.

Number of counter (3)

[C] [3]
[5] [0]

Count value (50 counts)

• When utilizing counter contact used before, use instruction [C]

[C] [3]
Number of counter

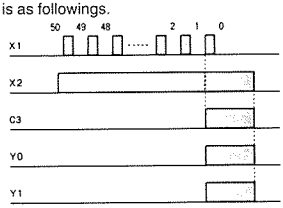
Notes) X1: Count input (1 count when X1 goes from OFF to ON.)
X2: Power input (Counter resets when X2 is OFF)

Explanation

• DOWN counting and UP/DOWN counting counters are as shown below.
DOWN counting: 32 points (C0 to C31)
UP/DOWN counting: 16 points (C32 to C47)
• The all reset when power is cut off.
• The counters can count from 1 to 999.
If power to the Micro Controller is cut off, the condition of the counters is retained. For more information, refer to the next page.

• Terminology

C: Abbreviation of COUNTER.
Count input contact: Contact of signal inputs for counting.
In the above example, X1 falls under this category.
Power input contact: When this contact is closed, counting is possible. In the above example, X2 falls under this category.
• For the example above, the timing chart is as followings.



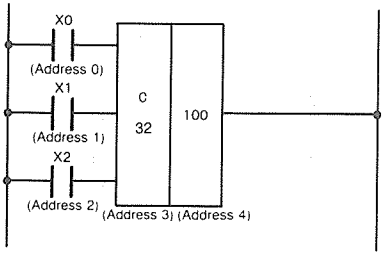
Before proceeding to the next page

• When programming counter, count input and reset input should also be programmed.
• When counter input is entered with reset input in continuity condition, counter operates for counting.
• Setting of count value of counter can be changed even while Micro Controller is operating in RAM specification.

C

COUNTER (UP/DOWN counting)

Program example



Address	Key operation			
0	STRT ⊣⊢	X (0.1S)	0	WRT
1	STRT ⊣⊢	X (0.1S)	1	WRT
2	STRT ⊣⊢	X (0.1S)	2	WRT
3	C	3	2	WRT
4	1	0	0	WRT

• For the [C] instruction, the sequence of the program is UP/DOWN input, count input, reset input. The counter program uses 2 steps.

X0: UP/DOWN input (When X0 is OFF, it is down counting, when X0 is ON, it is up counting)
X1: Count input (Counting when X1 comes from OFF to ON)
X2: Reset input (Counter resets when X2 is OFF)

Explanation

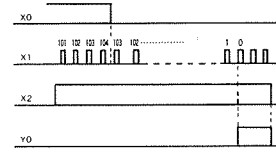
• Counter numbers are:
C32 to C47
These operate as UP/DOWN counters.
• All counters are of the holding type.
• When the UP/DOWN counter is in the UP condition, after the count value reaches 999, all subsequent counts are ignored.

• Terminology

UP/DOWN input contacts: The input should be selected for UP counting or DOWN counting. In the above example, the selection is made by X0.

Before proceeding to the next page

• The timing chart for the example shown above is displayed below.



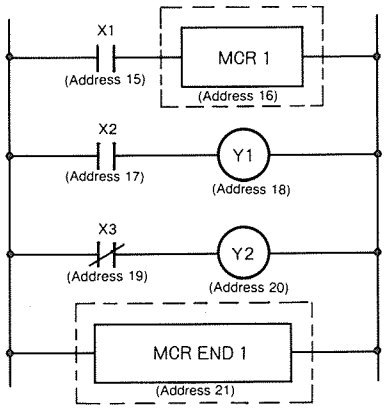
MCR

MASTER CONTROL RELAY

MCR END

MASTER CONTROL RELAY·END

Program example



Address	Key operation				
15	STRT ⊣⊢	X (0.1S)	1	WRT	
16	MCR	1	WRT		
17	STRT ⊣⊢	X (0.1S)	2	WRT	
18	OUT -○-	Y (1S)	1	WRT	
19	STRT ⊣⊢	NOT	X (0.1S)	3	WRT
20	OUT -○-	Y (1S)	2	WRT	
21	MCR	END	1	WRT	

• All steps from MCR to MCR END having the same numbers are controlled.

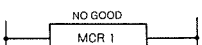
Explanation

• When the master control relay (X1 in the above diagram) is OFF, between MCR and MCR END instructions, the condition is as followings:

Output relay, Internal relay	OFF
Timer	Reset
Counter, shift register	Progress situation retained

• The MCR and MCR END instructions are usable up to 32 groups. (MCR0 to MCR31)

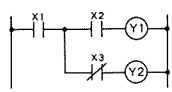
• It is impossible to give instruction STRT NOT directly to instruction MCR. Be sure to program contact input before instruction MCR.



• When instruction MCR is used, don't forget MCR END .

• If MCR END is programmed, without numbering the light of data area of the programmer goes on and off, indicating "000" , an error is displayed with a buzzer.

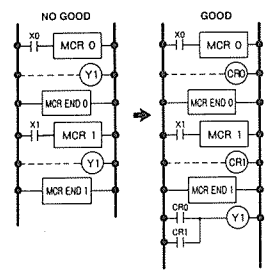
• The above circuit is same as the following relay circuit.



• **Terminology**

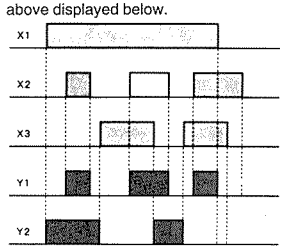
MCR: Abbreviation of MASTER CONTROL RELAY, and instuction for bus control.

Program between MCR and MCR END operates when MCR is ON. When MCR is OFF, program between MCR and MCR END does not operate.



Before proceeding to the next page

The timing chart for the example shown above displayed below.



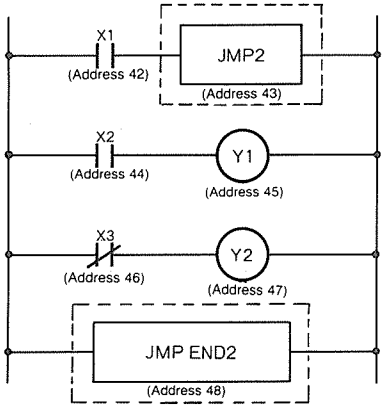
JMP

JUMP

JMP END

JUMP·END

Program example



Address	Key operation				
42	STRT	X (0.1S)	1	WRT	
43	JMP	2	WRT		
44	STRT	X (0.1S)	2	WRT	
45	OUT	Y (1S)	1	WRT	
46	STRT	NOT	X (0.1S)	3	WRT
47	OUT	Y (1S)	2	WRT	
48	JMP	END	2	WRT	

• All steps from JMP to JMP END having the same number are controlled.

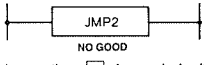
Explanation

• When X1 is OFF, commands between JMP and JMP END are shown as below.

Output relay, Internal relay	Condition retained
Timer	Progress situation retained
Counter, Shift register	Progress situation retained

• The JMP and JMP END commands can be used from JMP0 to JMP31.

• It is impossible to give instruction OUT NOT directly to instruction JMP. Be sure to program contact input before instruction JMP.



• When instruction JMP is used, don't forget JMP END.

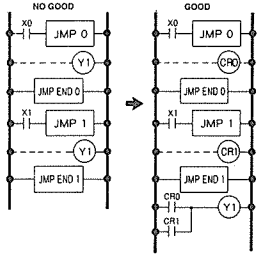
• When JMP END is programmed, without numbering the light of data area of the programmer goes on and off, displaying "000" an error is indicated with a buzzer.

Note: When the high-speed counter is used, the JMP31 to JMP END 31 series-of-instruction block becomes a high speed scan area-designation instruction block.

Terminology

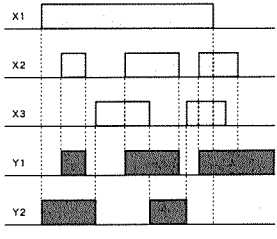
JMP: Abbreviation of JUMP.

• When JMP is ON, program between JMP and JMP END operates. When JMP is OFF, output program between JMP and JMP END stay in the previous condition.



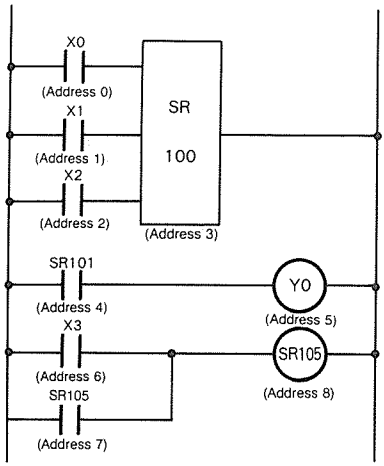
Before proceeding to the next page

• The timing chart for the example shown above is displayed below.



SR SHIFT REGISTER

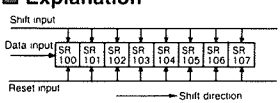
Program example



Address	Key operation
0	STRT X 0 WRT
1	STRT X 1 WRT
2	STRT X 2 WRT
3	SR 1 0 0 WRT
4	STRT SR 1 0 1 WRT
5	OUT Y 0 WRT
6	STRT X 3 WRT
7	OR SR 1 0 5 WRT
8	OUT SR 1 0 5 WRT

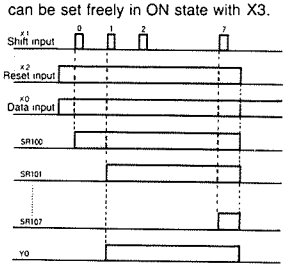
Notes) X0: Data input
X1: Shift input (Shift when changing from OFF to ON)
X2: Reset input (Reset at OFF time)

Explanation



- With the shift register instruction, the initial number of the 8-bit block is set.
- A desired bit of the shift register can be rewritten to be on with the OUT instruction.

In the above example, the content of SR105 can be set freely in ON state with X3.



- All of the shift registers do not reset if power is lost.

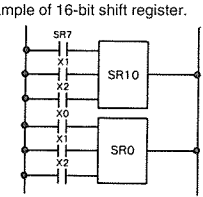
If the power source is cut off, the condition of the registers is retained.

- Shift register no. [(32 points × 8 bits) in octal notion].

Head no								
SR0	1	2	3	4	5	6	7
10	11	12	13	14	15	16	17
60	61	62	63	64	65	66	67
70	71	72	73	74	75	76	77
100	101	102	103	104	105	106	107
110	111	112	113	114	115	116	117
160	161	162	163	164	165	166	167
170	171	172	173	174	175	176	177
200	201	202	203	204	205	206	207
210	211	212	213	214	215	216	217
260	261	262	263	264	265	266	267
270	271	272	273	274	275	276	277
300	301	302	303	304	305	306	307
310	311	312	313	314	315	316	317
360	361	362	363	364	365	366	367
370	371	372	373	374	375	376	377

- For producing a shift register of more than 8 bits, the circuit shown below should be used.

Example of 16-bit shift register.

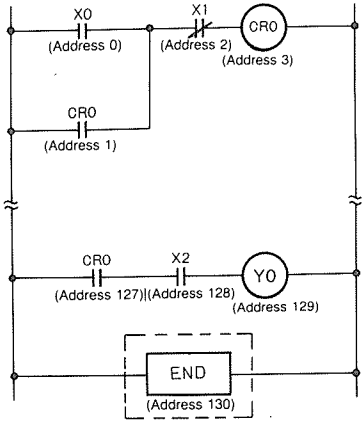


(If the sequence of SR10 and SR0 is reversed, a 15-bit shift register is produced.)

END

END

Program example



Address	Key operation				
0	STRT	X (0.1S)	0	WRT	
1	OR	CR	0	WRT	
2	AND	NOT	X (0.1S)	1	WRT
3	OUT	CR	0	WRT	
⋮					
127	STRT	CR	0	WRT	
128	AND	X (0.1S)	2	WRT	
129	OUT	Y (1S)	0	WRT	
130	END	WRT			

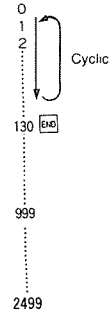
• At the end of program, enter END instruction. For instance, when program is finished at address 129, END instruction is programmed at address 130

Explanation

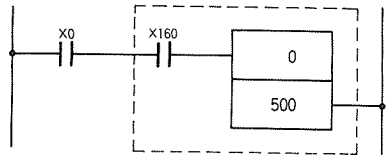
• The Micro Controller executes the logical operation without the END instruction.

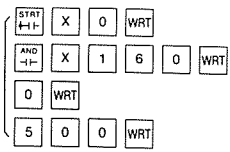
• **Terminology**

END: It means completion of program.



<Example>



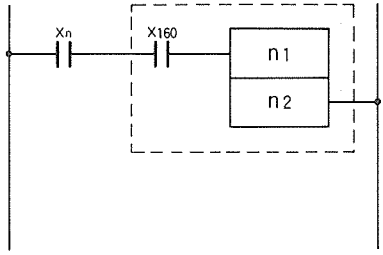


- The illustration above is an example of 3-digit BCD or 12-bit data transfer.
- In this example, the area within the ⬚ is the high level instructions; the instruction is executed if input status X0 is ON.
- The X160 within the ⬚ signifies a instruction; it does not signify a contact. (transfer instruction of 3-digit BCD)
- The 0 and the 500 within the ⬚ are the operands; in this example they indicate memory area no.0 (X0 to 11, 12-bit data) and memory area no.500 (Y0 to 11, 12-bit data). (For information concerning the memory area no., refer to the page 40, Section 2-4, Memory Area List.)
- Depending upon the numerical operation instruction, there are some instructions that have one operand, some that have two, and some that have three. (Refer to page 55, 5. High level instructions.)
- Basically, the 12-bit (3-digit BCD) data within the memory area designated by the operand is read out, and the numerical result is then written into the memory area.
- The memory area is segmented by numbers, indicating X, Y, CR, counter and timer elapsed values, set values, etc.
- The elapsed values and set values of the counter and timer must be treated as BCD data.
- Memory area No. 700 to 999 are data memory; all are the hold-type; a portion of X, Y and CR, however, is a non-hold-type area.
- Flag Relay:
  The flag relay for M2R, M1T, and M2T are X196 (Carry flag), X197 (Zero flag), X198 (>flag) and X199 (Error flag). The flag relay for M2RL are X20 (Carry flag), X21 (Zero flag), X22 (> flag) and X23 (Error flag).
  The flag relays will be varied according to the numerical operation.
  X196 (X20).....ON when subtraction result is smaller or carry flag is ON.
  X197 (X21).....ON when subtraction result is equal or result is 0 (Z).
  X198 (X22).....ON when subtraction result is larger.
  X199 (X23).....ON when a numeric operation error occurs.
- Write-in can not be made to the elapsed value area of the counter and timer. (Elapsed value can not be changed with high level instruction. However, it can be made with NPST programming support tool.)
- Write-in can be made to the set value area of the counter and timer. The program does not change at this time.
- The counter and timer preset the data of the set area at the time of activation or immediately after reset cancellation.
- The high level instructions are AND X160 to X180. AND NOT X⬚ or OR X⬚, etc. are not high level instructions.

Transfer (X160)

3-digit BCD (or 12-bit) data transfer.

• Basic system of instructions

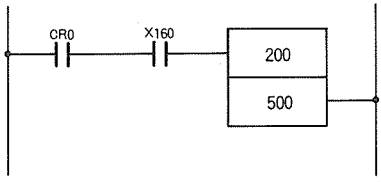


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if BIN data transferred to counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation

Address	Key operation
0	START ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.15) 1 6 0 WRT
2	2 0 0 WRT
3	5 0 0 WRT

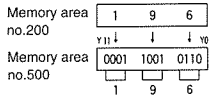
n1: Memory area no. to be trasferred from.
n2: Memory area no. to be trasferred to.

Explanation

When Xn is ON, the data in the memory area indicated by n1 are transferred to the memory area indicated by n2.
If BIN data are transferred to the set value area of the counter and timer, Error flag relay (X199/X23) is switched ON, and there is no transfer to the set value area.

Explanation of program example

When CR0 is switched ON, the data (elapsed value of T0) of memory area no. 200 is transferred to memory area no. 500 (Y0 to 11).



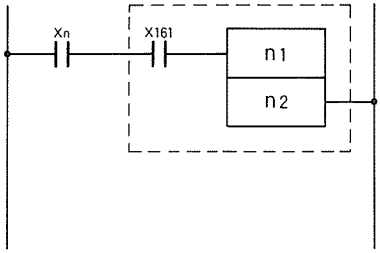
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

Real-time transfer (X161)

3-digit BCD (or 12-bit) data transfer.

• Basic system of instructions

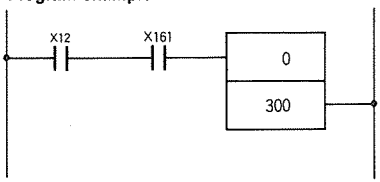


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	: ON if BIN data transferred to counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation

Address	Key operation
0	START, X (0.1S), 1, 2, WRT
1	AND, X (0.1S), 1, 6, 1, WRT
2	0, WRT
3	3, 0, 0, WRT

n1: Memory area no. to be transferred from.
n2: Memory area no. to be transferred to.

Explanation

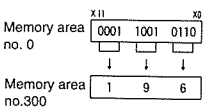
When Xn is ON, the data in the memory area indicated by n1 are transferred to the memory area indicated by n2. When n1 is 0 to 5, read-in is from the direct input terminal; when n2 is 500 to 505, transfer is to both the output terminal and to the memory area.

Explanation of program example

When X12 is ON, 3-digit BCD data is taken in from input terminals X0 to 11 and is transferred to memory area no. 300 (set value area of C0).

Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

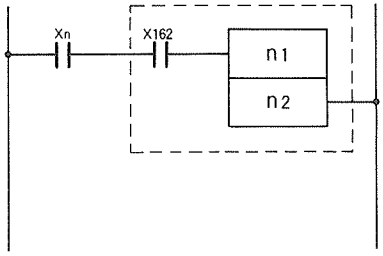


In this instance, read-in is from the direct input terminal. (Data when X1, X2, X4, X7 and X8 are ON)

Inverted transfer (X162)

Bit inverted transfer of 3-digit BCD (or 12-bit) data.

• Basic system of instructions

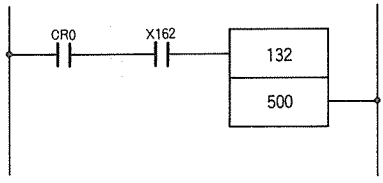


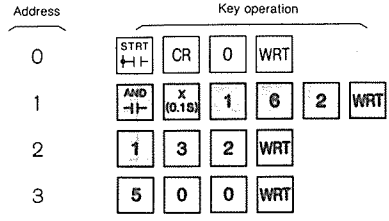
Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	ON if BIN data transferred to counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example





n1: Memory area no. to be transferred from.
n2: Memory area no. to be transferred to.

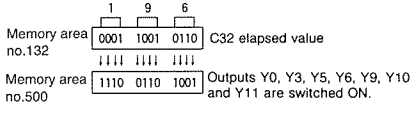
Explanation

When Xn is switched ON, the data of the memory area indicated by n1 is bit-inverted and is transferred to the memory area indicated by n2.
If BIN data is transferred to counter and timer set values, Error flag relay (X199/X23) is switched ON, and there is no transfer to set values.

Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

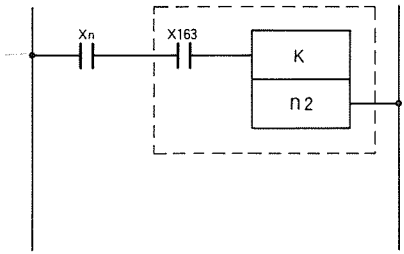
Explanation of program example
When CR0 is switched ON, the data (elapsed value of C32) of memory area no. 132 is bit-inverted and is transferred to memory area no. 500 (Y0 to 11).



Constant transfer (X163)

Transfer of 3-digit BCD constant (0 to 999) to a memory area.

• Basic system of instructions

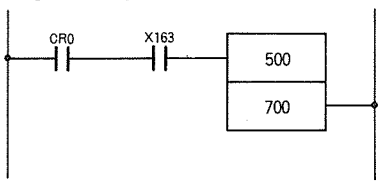


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	OFF

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation

Address	Key operation
0	STRT ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.1s) 1 6 3 WRT
2	5 0 0 WRT
3	7 0 0 WRT

K: Constants (0 to 999)
n2: Memory area no. to be transferred to.

Explanation

When Xn is ON, the K value (0 to 999) is transferred to the memory area indicated by n2.
A change of K is possible in the RUN mode.

Explanation of program example
When CR0 is switched ON, constant 500 is transferred to memory area no. 700 (data memory 0).

500 (K value)
↓
Memory area no. 700 [500] Data memory 0

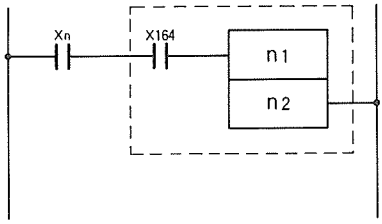
Designatable operand (marked with ○)

Memory area no.	Content	n2
0 to 5	X (external input)	—
20 to 91	Readout fixed data	—
100 to 147	Counter elapsed value	—
200 to 263	Timer elapsed value	—
300 to 347	Counter set value	○
400 to 463	Timer set value	○
500 to 505	Y (external output)	○
600 to 620	CR (internal relay)	○
621 to 699	Special area	○
700 to 999	Data memory	○

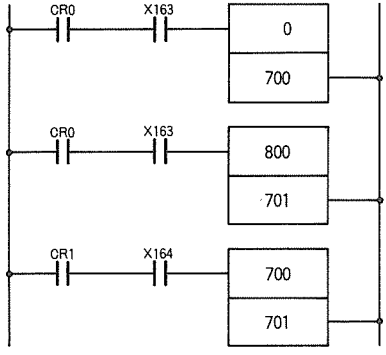
Indirect designation transfer (X164)

Transfer of 3-digit (or 12-bit) data by indirect address designation.

• Basic system of instructions



Program example



n1: Designated memory area no. to be transferred from.
n2: Designated memory area no. to be transferred to.

Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	↕

( ): Signifies flag relay for M2RL type.

Address	Key operation
0	STRT ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.1S) 1 6 3 WRT
2	0 WRT
3	7 0 0 WRT
4	STRT ⊣⊢ CR 0 WRT
5	AND ⊣⊢ X (0.1S) 1 6 3 WRT
6	8 0 0 WRT
7	7 0 1 WRT
8	STRT ⊣⊢ CR 1 WRT
9	AND ⊣⊢ X (0.1S) 1 6 4 WRT
10	7 0 0 WRT
11	7 0 1 WRT

Explanation

When Xn is ON, the data of the memory area indicated by n1 is presumed to be the transfer source memory area no., and the data of the memory area indicated by n2 is presumed to be the transfer destination memory area no., and is transferred.

If the data of the memory area indicated by n1 and n2 is not BCD data, if the memory area no. is non-designatable, or if BIN data is transferred to the counter and timer set values, Error flag relay (X199/X23) is switched ON and there is no transfer.

Explanation of program example

When CR0 is switched ON, 0 is transferred to memory area no.700 by constant transfer, and 800 is transferred to memory area no.701.

When CR1 is then switched ON, data are read in from 0 (X0 to 11), with 0 (which is the datum of memory area no.700) as the memory area no., and data are transferred to 800 (data memory 100), with 800 (which is the datum of memory area no.701) as the memory area no.

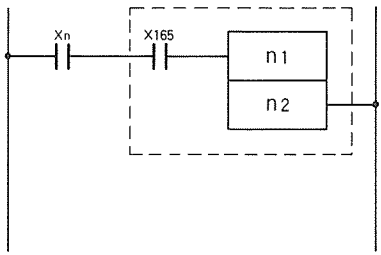
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	○
20 to 91	Readout fixed data	—	—
100 to 147	Counter elapsed value	○	○
200 to 263	Timer elapsed value	○	○
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
621 to 699	Special area	○	○
600 to 620	CR (internal relay)	○	○
700 to 999	Data memory	○	○

BCD-to-BIN conversion (X165)

Conversion of BCD data to BIN data

• Basic system of instructions

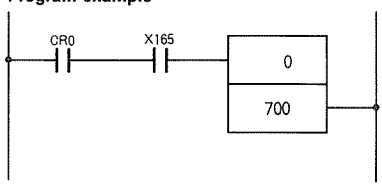


Flag relay operation

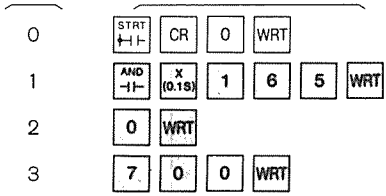
X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	; ON if read-in data are not BCD.

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation



n1: Memory area no. to be transferred from.
n2: Memory area no. to be transferred to.

Explanation

When Xn is ON, the data of the memory area indicated by n1 is converted to BIN data and is transferred to the memory area indicated by n2.
If the data of the memory area indicated by n1 is not BCD, Error flag relay (X199/X23) is switched ON, and there is no conversion transfer.

Explanation of program example

When CR0 is switched ON, BCD 3-digit data is read in from memory area no.0 (X0 to 11), is converted to BIN data, and is transferred to memory area no. 700 (data memory 0).

Memory area no.0 [0001 1001 0110] 196 (BCD DATA)
↓
Memory area no.700 [0000 1100 0100] (BIN DATA)

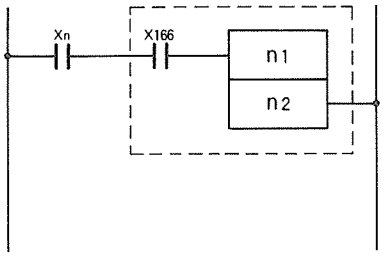
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	—
400 to 463	Timer set value	○	—
500 to 505	Y (external output)	○	○
621 to 699	Special area	○	○
600 to 620	CR (internal relay)	○	○
700 to 999	Data memory	○	○

BIN-to-BCD conversion (X166)

Conversion of BIN data to 3-digit BCD data

• Basic system of instructions

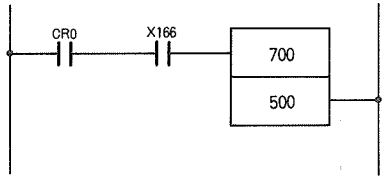


Flag relay operation

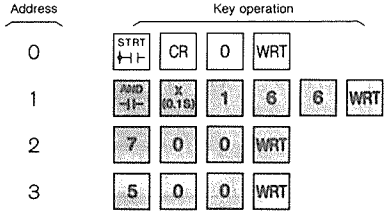
X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	: ON if BIN data is greater than 3E7 (BCD999).

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation



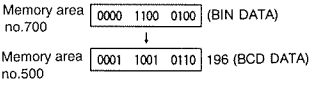
n1: Memory area no. to be transferred from.
n2: Memory area no. to be transferred to.

Explanation

When Xn is ON, the data of the memory area indicated by n1 is converted to BCD data and is transferred to the memory area indicated by n2.
If the data of the memory area indicated by n1 is greater than 3E7H (hexadecimal) (999 if converted to BCD), Error flag relay (X199/X23) is switched ON, and there is no conversion transfer.

Explanation of program example

When CR0 is ON, the data of memory area no.700 (data memory 0) is read in, converted to 3-digit BCD data, and transferred to memory area no.500 (Y0 to 11).



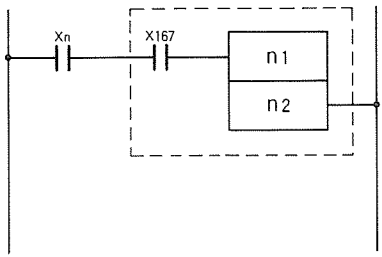
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	—	—
200 to 263	Timer elapsed value	—	—
300 to 347	Counter set value	—	○
400 to 463	Timer set value	—	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

Comparison (X167)

Comparison of two BCD data

• Basic system of instructions

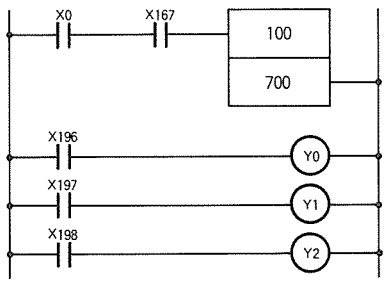


Flag relay operation

X196 (X20)	<, CY	: (n1) < (n2)
X197 (X21)	=, Z	: (n1) = (n2)
X198 (X22)	>	: (n1) > (n2)
X199 (X23)	ERR	: ON if not BCD data.

( ): Signifies flag relay for M2RL type.

Program example



Address	Key operation
0	START X (0.1S) 0 WRT
1	AND X (0.1S) 1 6 7 WRT
2	1 0 0 WRT
3	7 0 0 WRT
4	START X (0.1S) 1 9 6 WRT
5	OUT Y (1S) 0 WRT
6	START X (0.1S) 1 9 7 WRT
7	OUT Y (1S) 1 WRT
8	START X (0.1S) 1 9 8 WRT
9	OUT Y (1S) 2 WRT

n1: Comparison source memory area no.
n2: Comparison destination memory area no.

Explanation

When Xn is ON, the data of the memory area indicated by n1 and the data of the memory area indicated by n2 is compared, and the flag relay is changed according to which is greater. If not BCD data, Error flag relay (X199/X23) is switched ON, and the other flag relay is switched OFF.

Explanation of program example

When X0 is switched ON, the data (elapsed value of C0) of memory area no.100 and the data (data memory 0) of memory area no.700 are compared.
If the C0 elapsed value is smaller than the data of memory area no.700, Y0 is switched ON.
If the C0 elapsed value is the same as the data of memory area no.700, Y1 is switched ON.
If the C0 elapsed value is greater than the data of memory area no.700, Y2 is switched ON.

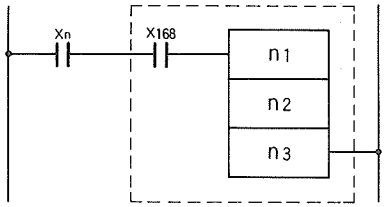
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2
0 to 5	X (external input)	○	○
20 to 91	Readout fixed data	○	○
100 to 147	Counter elapsed value	○	○
200 to 263	Timer elapsed value	○	○
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

Addition (X168)

Addition of 3-digit BCD data

• Basic system of instructions

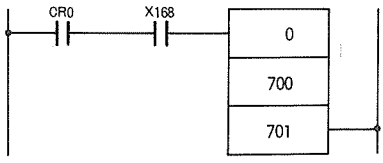


Flag relay operation

X196 (X20)	<, CY	↕ ON if the result exceeds 999.
X197 (X21)	=, Z	↕ ON if the result is 0.
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if not BCD data.

( ): Signifies flag relay for M2RL type.

Program example



Address	Key operation
0	STRT ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.1S) 1 6 8 WRT
2	0 WRT
3	7 0 0 WRT
4	7 0 1 WRT

n1: Summed memory area no.
n2: Added memory area no.
n3: Memory area no. to be transferred to.

Explanation

When Xn is switched ON, the data of the memory indicated by n1 and the data of the memory area indicated by n2 are BCD added, and the result is transferred to the memory area indicated by n3.
If the result exceeds 999, Carry flag relay (X196/X20) is switched ON and the lower three digits are transferred to the memory area indicated by n3.
If the result is 0 and 1000, Zero flag relay (X197/X21) (=) is switched ON.
If not BCD data, Error flag relay (X199/X23) is switched ON and there is no numerical operation transfer.

Explanation of program example

When CR0 is ON, the data of memory area no. 0 (X0 to 11) and the data of memory area no.700 (data memory 0) are added, and the result is transferred to memory area no.701 (data memory 1).

Memory area no.0 0000 1001 1001 99
+
Memory area no.700 0001 1001 0110 196
=
Memory area no.701 0010 1001 0101 295

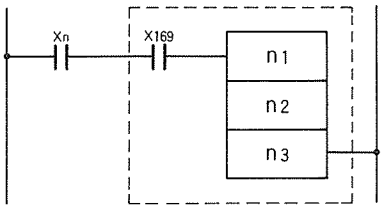
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	○
400 to 463	Timer set value	○	○	○
500 to 505	Y (external output)	○	○	○
600 to 620	CR (internal relay)	○	○	○
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○

Subtraction (X169)

Subtraction of 3-digit BCD data.

• Basic system of instructions

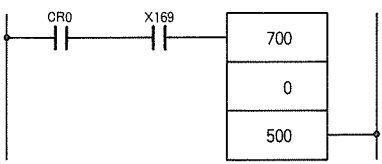


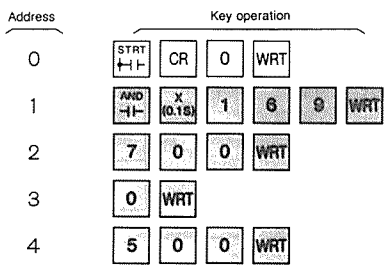
Flag relay operation

X196 (X20)	<, CY	: ON if the result is negative.
X197 (X21)	=, Z	: ON if the result is 0.
X198 (X22)	>	OFF
X199 (X23)	ERR	: ON if no BCD data.

( ): Signifies flag relay for M2RL type.

Program example





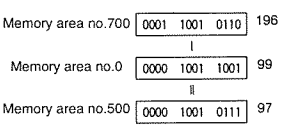
n1: Minuend memory area no.
n2: Subtrahend memory area no.
n3: Memory area no. to be transferred to.

Explanation

When Xn is switched ON, the data of the memory area indicated by n2 are subtracted from the data of the memory area indicated by n1, and the result is transferred to the memory area indicated by n3.
If the result is negative, Carry flag relay (X196/X20) switched ON and the absolute value is transferred to the memory area indicated by n3.
If not BCD data, Error flag relay (X199/X23) is switched ON and there is no numerical operation transfer.

Explanation of program example

When CR0 is switched ON, there is a numerical operation of the data of memory area no.0 (X0 to 11) from the data of memory area no.700 (data memory 0), and the result is transferred to memory area no.500 (Y0 to 11).



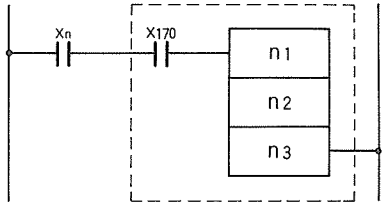
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	○
400 to 463	Timer set value	○	○	○
500 to 505	Y (external output)	○	○	○
600 to 620	CR (internal relay)	○	○	○
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○

Multiplication (X170)

Multiplication of 3-digit BCD data.

• Basic system of instructions

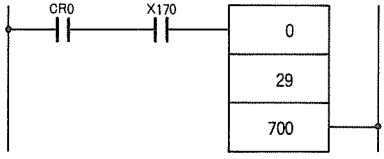


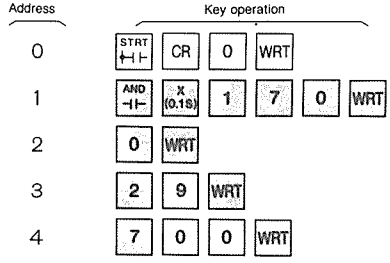
Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	↕ ON if the result is 0.
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if no BCD data.

( ): Signifies flag relay for M2RL type.

Program example





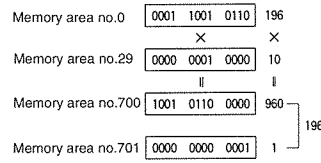
n1: Multiplicand memory area no.
n2: Multiplier memory area no.
n3: Memory area no. to be transferred to.

Explanation

When Xn is ON, the data of the memory area indicated by n1 and the data of the memory area indicated by n2 are multiplied, and the result is transferred to the memory areas indicated by n3 and n3+1.
"Hundreds" digits and below are transferred to n3, and "thousands" digits and above are transferred to n3+1.
If not BCD data, Error flag relay (X199/X23) is switched ON, and there is no numerical operation and transfer.

Explanation of program example

When CR0 is ON, the data of memory area no.0 (X0 to 11) and the data (constant 10) of memory area no.29 are multiplied (in other words are increased by ten times); the lower three digits of the result are transferred to memory area no.700 (data memory 0) and the upper three digits are transferred to memory area no.701 (data memory 1).



Designatable operand (marked with ○)

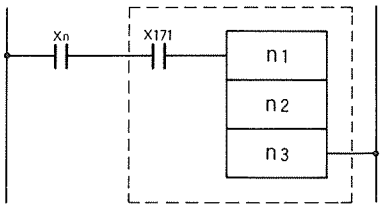
Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	—
400 to 463	Timer set value	○	○	—
500 to 505	Y (external output)	○	○	—
600 to 620	CR (internal relay)	○	○	—
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○*

*700 to 998

Division (X171)

Division of 3-digit BCD data.

• Basic system of instructions

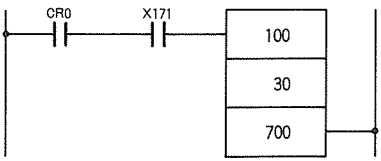


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	↕ ON if the result is 0.
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if not BCD data or if divided by 0.

( ): Signifies flag relay for M2RL type.

Program example



Address	Key operation
0	STRT CR 0 WRT
1	AND X (0.1S) 1 7 1 WRT
2	1 0 0 WRT
3	3 0 WRT
4	7 0 0 WRT

n1: Dividend memory area no.
n2: Divisor memory area no.
n3: Memory area no. to be transferred to.

■ Explanation

When Xn is ON, the data of the memory area indicated by n1 is divided by the data of the memory area indicated by n2, and the result is transferred to the memory areas indicated by n3 and n3 + 1.
The quotient is transferred to n3 and the remainder is transferred to n3 + 1.
If no BCD data or if the datum of n2 is 0, Error flag relay (X199/X23) is switched ON, and there is no transfer.

Explanation of program example

When CR0 is ON, the data (elapsed value of C0) of memory area no.100 are divided by the data (constant 100) of memory area no.30; the resulting quotient is transferred to memory area no.700 (data memory), and the remainder is transferred to memory area no.701 (data memory 1).

Memory area no.100 0001 1001 0110 196
÷ ÷
Memory area no.30 0001 0000 0000 100
‖
Memory area no.700 0000 0000 0001 1 Quotient
Memory area no.701 0000 1001 0110 96 Remainder

Designatable operand (marked with ○)

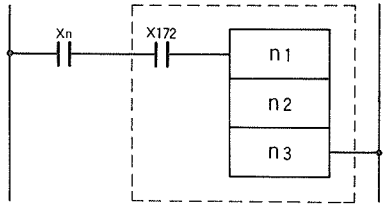
Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	—
400 to 463	Timer set value	○	○	—
500 to 505	Y (external output)	○	○	—
600 to 620	CR (internal relay)	○	○	—
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○*

*700 to 998

Logical product (AND) (X172)

Logical product of 12-bit data.

• Basic system of instructions

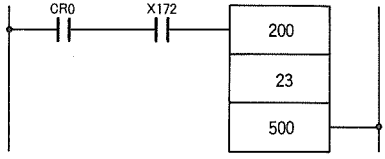


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	↕
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if BIN data are transferred to the counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example



Address	Key operation
0	START, CR, 0, WRT
1	AND, X (0.1S), 1, 7, 2, WRT
2	2, 0, 0, WRT
3	2, 3, WRT
4	5, 0, 0, WRT

n1: Subject memory area no.
n2: Subject memory area no.
n3: Memory area no. to be transferred to.

Explanation

When Xn is ON, the logical products (AND) of the data of the memory area indicated by n1 and of the data of the memory area indicated by n2 are obtained, and are transferred to the memory area indicated by n3.
If, when the logical product (AND) result is memory data, the memory area indicated by n3 is the counter and timer set value area, Error flag relay (X199/X23) is switched ON and there is no transfer.

Explanation of program example

When CR0 is switched ON, the logical products (AND) of the data (elapsed value of T0) of memory area no.200 and the data (read-out dedicated data OFF HEX) of memory area no.23 are obtained and are transferred to memory area no.500 (Y0 to 11).

Memory area no.200 0001 1001 0110 196 BCD
AND
Memory area no.23 0000 1111 1111 0FF HEX
↓
Memory area no.500 0000 1001 0110 096 BCD

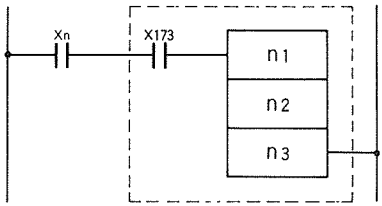
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	○
400 to 463	Timer set value	○	○	○
500 to 505	Y (external output)	○	○	○
600 to 620	CR (internal relay)	○	○	○
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○

Logical sum (OR) (X173)

Logical sum of 12-bit data.

• Basic system of instructions

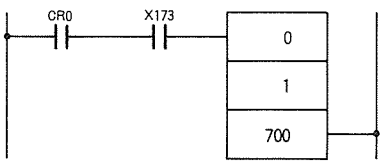


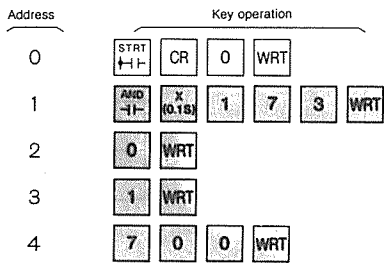
Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	;
X198 (X22)	>	OFF
X199 (X23)	ERR	; ON if BIN data are transferred to the counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example





n1: Subject memory area no.
n2: Subject memory area no.
n3: Memory area no. to be transferred to.

■ Explanation

When Xn is ON, the logical sums (OR) of the data of the memory area indicated by n1 and of the data of the memory area indicated by n2 are obtained and are transferred to the memory area indicated by n3.
If BIN data are transferred to the counter and timer set value area, Error flag relay (X199/X23) is switched ON and there is no transfer.

Explanation of program example

When CR0 is ON, the logical sums (OR) of memory area no.0 (X0 to 11) and memory area no.1 (X8 to 19) are obtained, and the result is transferred to memory area no.700 (data memory 0).

Memory area no.0 0001 1001 0110 196
OR
Memory area no.1 0011 1001 0001 391
↓
Memory area no.700 0011 1001 0111 397

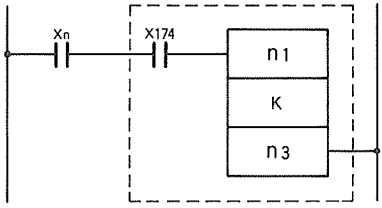
Designatable operand (marked with ○)

Memory area no.	Content	n1	n2	n3
0 to 5	X (external input)	○	○	—
20 to 91	Readout fixed data	○	○	—
100 to 147	Counter elapsed value	○	○	—
200 to 263	Timer elapsed value	○	○	—
300 to 347	Counter set value	○	○	○
400 to 463	Timer set value	○	○	○
500 to 505	Y (external output)	○	○	○
600 to 620	CR (internal relay)	○	○	○
621 to 699	Special area	○	○	○
700 to 999	Data memory	○	○	○

Shift right (X174)

Shift a data to the right by designated number of bits.

• Basic system of instructions

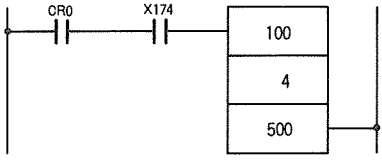


Flag relay operation

X196 (X20)	<, CY	↕
X197 (X21)	=, Z	↕
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if BIN data are transferred to the counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example



Address / Key operation

Address	Key operation
0	STRT ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.13) 1 7 4 WRT
2	1 0 0 WRT
3	4 WRT
4	5 0 0 WRT

n1: Subject memory area no.
K: Number of bits (1 to 12)
n3: Memory area no. to be transferred to.

■ Explanation

When Xn is ON, the data of the memory area indicated by n1 is shifted to the right by only the number of bits indicated by K, and is transferred to the memory area indicated by n3.
The range of K is from 1 to 12.
When there is a K = 1 shift, the value at bit 0 enters Carry flag relay (X196/X20).
If BIN data is transferred to the set value of the counter and timer, Error flag relay (X199/X23) is switched ON and there is no transfer.

Explanation of program example

When CR0 is switched ON, the data of memory area no.100 (C0 elapsed value) is shifted four bits to the right (one digit down), and is transferred to memory area no.500 (Y0 to 11).

Memory area no.100 0001 1001 0110 196
↓
Memory area no.500 0000 0001 1001 019 Carry flag relay (X196/X20) : OFF

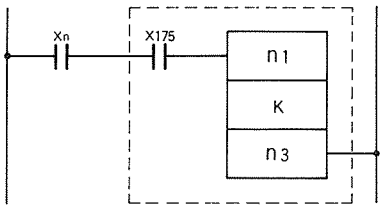
Designatable operand (marked with ○)

Memory area no.	Content	n1	n3
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

Shift left (X175)

Shift a data to the left by number of bits designated.

• Basic system of instructions

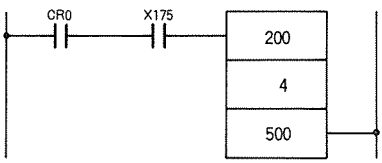


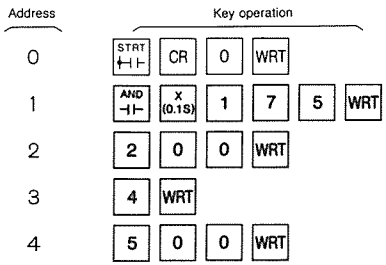
Flag relay operation

X196 (X20)	<, CY	⁝
X197 (X21)	=, Z	⁝
X198 (X22)	>	OFF
X199 (X23)	ERR	⁝ ON if BIN data are transferred to the counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example





n1: Subject memory area no.
K: Number of bits (1 to 12)
n3: Memory area no. to be transferred to.

■ Explanation

When Xn is ON, the data of the memory area indicated by n1 are shifted to the left by only the number of bits indicated by K, and are transferred to the memory area indicated by n3.
When there is a K = 1 shift, the value at the first bit enters Carry flag relay (X196/X20).
If BIN data are transferred to the set values of the counter and timer, Error flag relay (X199/X23) is switched ON and there is no transfer.

Explanation of program example

When CR0 is ON, the data (elapsed value of T0) of memory area no.200 are shifted to the left by four bits (BCD one digit up), and are transferred to memory area no.500 (Y0 to 11).

Memory area no.200 [0001 1001 0110] 196
↓
Memory area no.500 [1001 0110 0000] 960 Carry flag relay (X196/X20) : ON

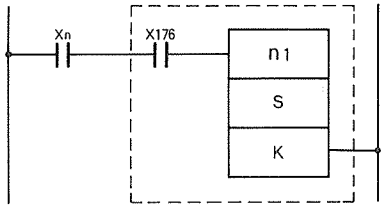
Designatable operand (marked with ○)

Memory area no.	Content	n1	n3
0 to 5	X (external input)	○	—
20 to 91	Readout fixed data	○	—
100 to 147	Counter elapsed value	○	—
200 to 263	Timer elapsed value	○	—
300 to 347	Counter set value	○	○
400 to 463	Timer set value	○	○
500 to 505	Y (external output)	○	○
600 to 620	CR (internal relay)	○	○
621 to 699	Special area	○	○
700 to 999	Data memory	○	○

Bit set/ reset (X176)

Switch ON or OFF of designated bit

• Basic system of instructions

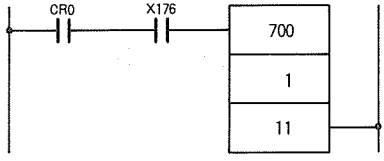


Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	↕ ON if BIN data are transferred to the counter and timer set values.

( ): Signifies flag relay for M2RL type.

Program example



Address	Key operation
0	STRT ⊣⊢ CR 0 WRT
1	AND ⊣⊢ X (0.13) 1 7 6 WRT
2	7 0 0 WRT
3	1 WRT
4	1 1 WRT

n1: Subject memory area no.
S: ON/OFF switch (1/0)
K: Designated bit (0 to 11)

■ Explanation

When Xn is ON, the bit (designated by K) of the data of the memory area indicated by n1 is switched ON or OFF. OFF when S is 0, ON when S is 1.
The range of K is from 0 to 11.
If BIN data is transferred to the set value of the counter and timer, Error flag relay (X199/X23) is switched ON and there is no execution.

Explanation of program example

When CR0 is ON, the eleventh bit of the data of memory area no.700 (data memory 0) is switched ON.

Memory area no.700 | 0001 1001 0110 | 196

Memory area no.700 | 1001 1001 0110 | 996
↑
11th bit

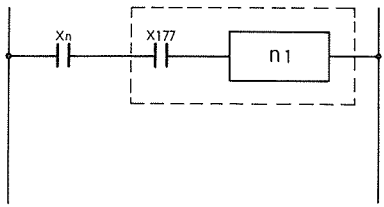
Designatable operand (marked with ○)

Memory area no.	Content	n1
0 to 5	X (external input)	—
20 to 91	Readout fixed data	—
100 to 147	Counter elapsed value	—
200 to 263	Timer elapsed value	—
300 to 347	Counter set value	○
400 to 463	Timer set value	○
500 to 505	Y (external output)	○
600 to 620	CR (internal relay)	○
621 to 699	Special area	○
700 to 999	Data memory	○

HSC elapsed-value transfer (X177)

Transfer of the elapsed value of the high speed counter (HSC) to a data memory

• Basic system of instructions

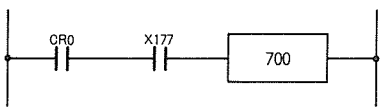


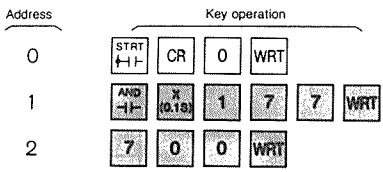
Flag relay operation

X196 (X20)	<, CY	OFF
X197 (X21)	=, Z	OFF
X198 (X22)	>	OFF
X199 (X23)	ERR	OFF

( ): Signifies flag relay for M2RL type.

Program example





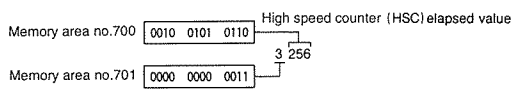
n1: Memory area no. to be transferred to.

■ Explanation

When Xn is ON, the elapsed value of the high speed counter is transferred to the memory areas indicated by n1 and n1 + 1.
"Hundreds" and lower digits enter the memory area indicated by n1, and "thousands" and higher digits enter the memory area indicated by n1 + 1. The range of the designatable memory areas is from 700 to 998.

Explanation of program example

When CR0 is ON, the high speed counter elapsed value is read in; "hundreds" and lower digits are transferred to memory area no.700 (data memory 0), and "thousands" and higher digits are transferred to memory area no.701 (data memory 1).



Designatable operand (marked with ○)

Memory area no.	Content	n1
0 to 5	X (external input)	—
20 to 91	Readout fixed data	—
100 to 147	Counter elapsed value	—
200 to 263	Timer elapsed value	—
300 to 347	Counter set value	—
400 to 463	Timer set value	—
500 to 505	Y (external output)	—
600 to 620	CR (internal relay)	—
621 to 699	Special area	—
700 to 999	Data memory	○*

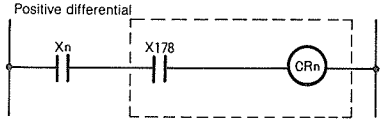
*700 to 998

Differential (X178) (X179)

When the input status is switched ON or OFF, the internal relay is ON only for 1 scan.

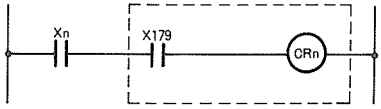
• Basic system of instructions

Positive differential

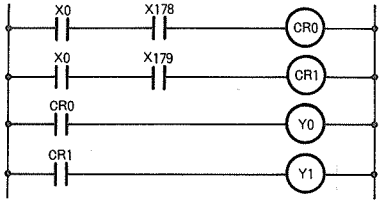


• Basic system of instructions

Negative differential



Program Example



Flag relay operation

X196 (X20)	<, CY	No change
X197 (X21)	=, Z	No change
X198 (X22)	>	No change
X199 (X23)	ERR	No change

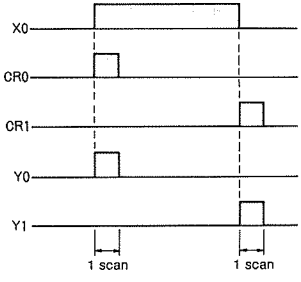
( ): Signifies flag relay for M2RL type.

Address	Key operation
0	STRT X (0.1S) 0 WRT
1	AND X (0.1S) 1 7 8 WRT
2	OUT CR 0 WRT
3	STRT X (0.1S) 0 WRT
4	AND X (0.1S) 1 7 9 WRT
5	OUT CR 1 WRT
6	STRT CR 0 WRT
7	OUT Y (1S) 0 WRT
8	STRT CR 1 WRT
9	OUT Y (1S) 1 WRT

Explanation

Positive differential: X178
When Xn is switched ON, CRn is ON only for 1 scan.
Negative differential: X179
When Xn is switched OFF, CRn is ON only for 1 scan.
For X178 and X179 instructions, do not use a contact after the instruction, but internal relay.

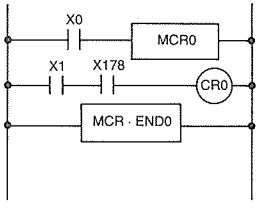
• Example timing charts



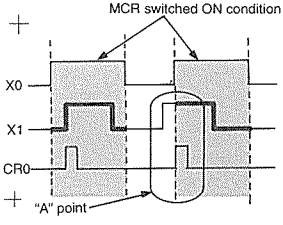
Note:
When "Differential instructions" are programmed between MCR and MCR-END instructions, the differential output (CR0) may switched ON even if the "Execution condition (X1)" is not changed.
(See "A" point of "Timing chart" on the right).

Program "Differential instructions" outside of MCR and MCR-END instructions, if you need to control differential output (CR0) only with the "Execution condition (X1)".

• Program Example



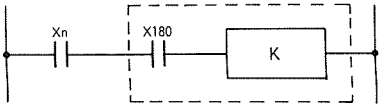
• Timing chart



Machine Language Call (X180)

Call and execute designated machine language routine.

• Basic system of instructions

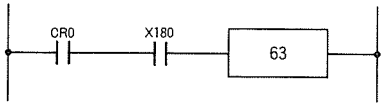


Flag relay operation

X196 (X20)	<, CY	No change
X197 (X21)	=, Z	No change
X198 (X22)	>	No change
X199 (X23)	ERR	No change

( ): Signifies flag relay for M2RL type.

• Program example



Address	Key operation
0	START, CR, 0, WRT
1	AND, X (0 1S), 1, 8, 0, WRT
2	6, 3, WRT

K: Designated machine language routine no.

Explanation

This instruction calls machine language routine to sequence program and executes.
When Xn is ON, call machine language routine which is designated by K.

• Operation method

When the scan time is longer than the monitor time in the program, many high level instructions area used. The ERROR LED is ON and operation is stopped in this case.

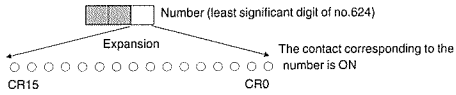
In order to avoid this, update the watchdog timer during program with the machine language call instruction so that it can execute the long scan time program without stopping.

Call no.	Instruction
40	Decode
41	Encode
42	Increment
43	Decrement
44	Set carry
45	Reset carry
50	Board no.0 A/D converter input
51	Board no.1 A/D converter input
52	Board no.2 A/D converter input
53	Board no.3 A/D converter input
54	Board no.0 D/A converter output
55	Board no.1 D/A converter output
56	Board no.2 D/A converter output
57	Board no.3 D/A converter output
58	Operate without carry
59	Operate with carry
60	Absolute value subtraction mode
61	Complement subtraction mode
62	Block transfer
63	Watchdog timer refresh

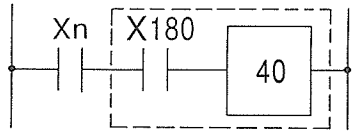
Call no. 40	Decode Instruction
Function	Expands the least significant digit of memory area no.624 into bit data.

Explanation

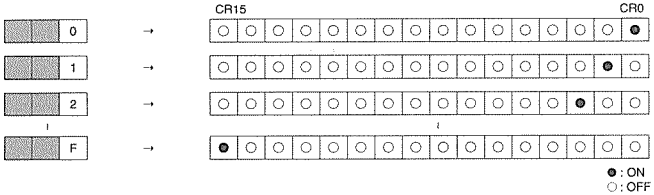
Expands data to internal relays CR0 to CR15.
Decode



Basic system of instructions



Memory area no.624 → Internal relays CR0 to CR15



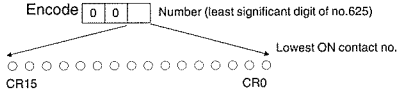
※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	OFF

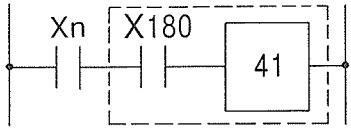
Call no. 41	Encode Instruction
Function	Encodes the lowest ON contact of internal relays CR0 to CR15 into the least significant digit of memory area no.625.

Explanation

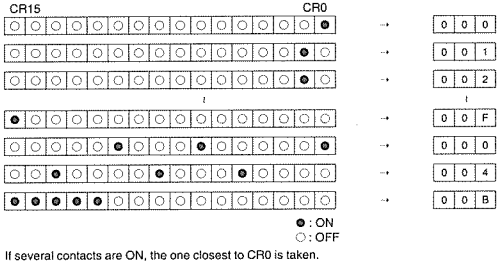
If several internal relays are ON, the lowest number contact is used.
If all contacts are OFF, the error flag is set and the value remains unchanged.



Basic system of instructions



Internal relays CR0 to CR15 → Memory area no.625



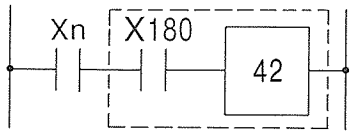
If several contacts are ON, the one closest to CR0 is taken.

※ All arithmetic operation flags are reset except the error flag which is set if all contacts are OFF.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	↕

Call no. 42	Increment Instruction
Function	Increments the BCD data in memory area no.626

Basic system of instructions



Explanation

If memory area no.626 is 999, it is reset to 0, and the carry flag set.
If the data is not a BCD value, the data is corrected into BCD and then incremented.
(The value is undefined.)

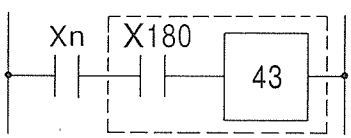
Increment
(No.626) ← (No.626) + 1 BCD addition,
0, 1, ...9, 10, ..., 99, 100,..... , 999, 0, 1.....

※ All arithmetic operation flags are reset except the carry flag which is set when the value changes from 999 to 0

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	↕	OFF	OFF	OFF

Call no. 43	Decrement Instruction
Function	Decrements the BCD data in memory area no.627.

Basic system of instructions



Explanation

If memory area no.627 is 0, it becomes 999 and the carry flag is set.
If the data is not a BCD value, the data is corrected into BCD and then decremented.
(The value is undefined.)

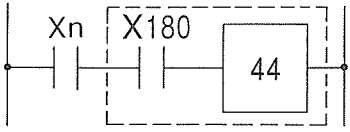
Decrement
(No.627) ← (No.627) −1 BCD subtraction
0, 1, ...10, 9, ..., 0, 999, 998 ....

※ All arithmetic operation flags are reset except the carry flag which is set when the value changes from 0 to 999.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	↕	OFF	OFF	OFF

Call no. 44	Set carry Instruction
Function	Sets the carry flag (X196/X20).

Basic system of instructions



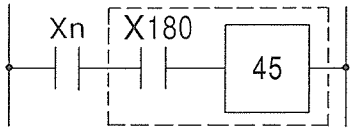
Explanation

Set the carry flag (X196/X20). Other flags are unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	ON	—	—	—

Call no. 45	Reset carry Instruction
Function	Resets the carry flag (X196/X20)

Basic system of instructions



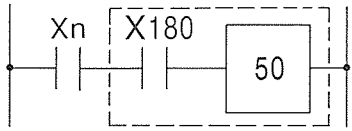
Explanation

Resets the carry flag (X196/X20). Other flags are unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: >flag	X199/X23: Error flag
	OFF	—	—	—

Call no. 50	Board 0 A/D converter input Instruction
Function	Stores the data for all 4 channels of the board 0 A/D converter in the corresponding data area.

Basic system of instructions



Explanation

Stores the data from each channel of the A/D converter to the following data areas as 3-digit BCD numbers.

Channel 0 : Memory area no.652
Channel 1 : Memory area no.653
Channel 2 : Memory area no.654
Channel 3 : Memory area no.655

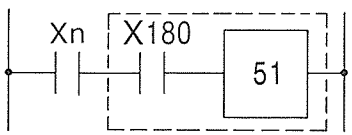
Automatically determines if the A/D converter is 8-bit or 10-bit.
For 10-bit data, any value exceeding 999 is read as 999.
This instruction does not check if the A/D converter has less than 4 channels, or if the board is in fact an A/D converter.
Any channels not corresponding to an A/D converter will result in undefined data.

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	OFF

Call no. 51	Board 1 A/D converter input Instruction
Function	Stores the data for all 4 channels of the board 1 A/D converter in the corresponding data area.

Basic system of instructions



Explanation

Stores the data from each channel of the A/D converter to the following data areas as 3-digit BCD numbers.

Channel 0 : Memory area no.656
Channel 1 : Memory area no.657
Channel 2 : Memory area no.658
Channel 3 : Memory area no.659

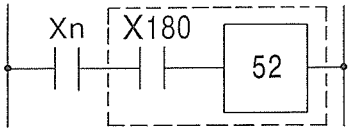
Automatically determines if the A/D converter is 8-bit or 10-bit.
For 10-bit data, any value exceeding 999 is read as 999.
This instruction does not check if the A/D converter has less than 4 channels, or if the board is in fact an A/D converter.
Any channels not corresponding to an A/D converter will result in undefined data.

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	OFF

Call no. 52	Board 2 A/D converter input Instruction
Function	Stores the data for all 4 channels of the board 2 A/D converter in the corresponding data area.

Basic system of instructions



Explanation

Stores the data from each channel of the A/D converter to the following data areas as 3-digit BCD numbers.

Channel 0 : Memory area no.660
Channel 1 : Memory area no.661
Channel 2 : Memory area no.662
Channel 3 : Memory area no.663

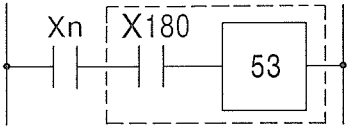
Automatically determines if the A/D converter is 8-bit or 10-bit.
For 10-bit data, any value exceeding 999 is read as 999.
This instruction does not check if the A/D converter has less than 4 channels, or if the board is in fact an A/D converter.
Any channels not corresponding to an A/D converter will result in undefined data.

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: >flag	X199/X23: Error flag
	OFF	OFF	OFF	OFF

Call no. 53	Board 3 A/D converter input Instruction
Function	Stores the data for all 4 channels of the board 3 A/D converter in the corresponding data area.

Basic system of instructions



Explanation

Stores the data from each channel of the A/D converter to the following data areas as 3-digit BCD numbers.

Channel 0 : Memory area no.664
Channel 1 : Memory area no.665
Channel 2 : Memory area no.666
Channel 3 : Memory area no.667

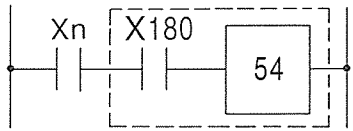
Automatically determines if the A/D converter is 8-bit or 10-bit.
For 10-bit data, any value exceeding 999 is read as 999.
This instruction does not check if the A/D converter has less than 4 channels, or if the board is in fact an A/D converter.
Any channels not corresponding to an A/D converter will result in undefined data.

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	OFF

Call no. 54	Board 0 D/A converter output Instruction
Function	Outputs data from the data area to 2 channels of the board 0 D/A converter.

Basic system of instructions



Explanation

The data in the following data area is output to each channel of the D/A converter.

Channel 0 : Memory area no.668
Channel 1 : Memory area no.669

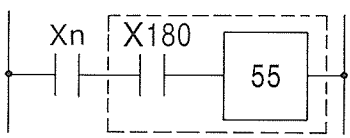
The data must be a 3-digit BCD value.
Otherwise the error flag is set and data is not output.
If the data of the other channel is BCD, it is output.
This instruction does not check if the corresponding board is in fact a D/A converter.
For 10-bit conversion, data from 000 to 999 is output.
For 8-bit, the data range is 000 to 255.
For any value larger than 256, only the 8 least significant bits of its binary representation are output. e.g.
511 → 255
512 → 000

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	↕

Call no. 55	Board 1 D/A converter output Instruction
Function	Outputs data from the data area to 2 channels of the board 1 D/A converter.

Basic system of instructions



Explanation

The data in the following data area is output to each channel of the D/A converter.

Channel 0 : Memory area no.670
Channel 1 : Memory area no.671

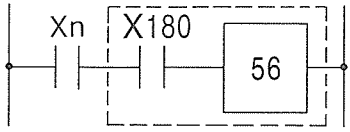
The data must be a 3-digit BCD value.
Otherwise the error flag is set and data is not output.
If the data of the other channel is BCD, it is output.
This instruction does not check if the corresponding board is in fact a D/A converter.
For 10-bit conversion, data from 000 to 999 is output.
For 8-bit, the data range is 000 to 255.
For any value larger than 256, only the 8 least significant bits of its binary representation are output. e.g.
511 → 255
512 → 000

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	⇅

Call no. 56	Board 2 D/A converter output Instruction
Function	Outputs data from the data area to 2 channels of the board 2 D/A converter.

Basic system of instructions



Explanation

The data in the following data area is output to each channel of the D/A converter

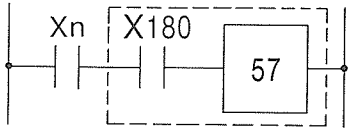
Channel 0 : Memory area no.672
Channel 1 : Memory area no.673
The data must be a 3-digit BCD value.
Otherwise the error flag is set and data is not output.
If the data of the other channel is BCD, it is output.
This instruction does not check if the corresponding board is in fact a D/A converter.
For 10-bit conversion, data from 000 to 999 is output.
For 8-bit, the data range is 000 to 255.
For any value larger than 256, only the 8 least significant bits of its binary representation are output. e.g.
511 → 255
512 → 000

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	⇅

Call no. 57	Board 3 D/A converter output Instruction
Function	Outputs data from the data area to 2 channels of the board 3 D/A converter.

Basic system of instructions



Explanation

The data in the following data area is output to each channel of the D/A converter.

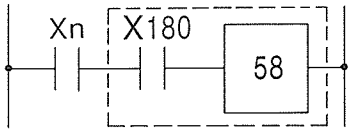
Channel 0 : Memory area no.674
Channel 1 : Memory area no.675
The data must be a 3-digit BCD value.
Otherwise the error flag is set and data is not output.
If the data of the other channel is BCD, it is output.
This instruction does not check if the corresponding board is in fact a D/A converter.
For 10-bit conversion, data from 000 to 999 is output.
For 8-bit, the data range is 000 to 255.
For any value larger than 256, only the 8 least significant bits of its binary representation are output. e.g.
511 → 255
512 → 000

※ All arithmetic operation flags are reset.

Effect on arithmetic flags	X196/X20: Curry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	⇅

Call no. 58	Operate without carry Instruction
Function	Specifies the exclusion of the carry flag in the arithmetic operations of addition and subtraction

Basic system of instructions



Explanation

Unless otherwise specified, carry is not included in or modified by the arithmetic operations.
For subtraction, the last designated mode is restored.

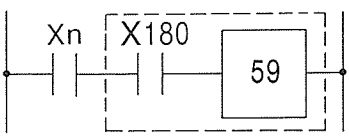
Addition : Result = Data 1 + Data 2
Subtraction : Result = Data 1 – Data 2

⁂ This instruction only specifies the method of operation.
The state of the carry flag before the execution of this instruction is unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	—	—	—	—

Call no. 59	Operate with carry Instruction
Function	Specifies the inclusion of the carry flag in the arithmetic operations of addition and subtraction

Basic system of instructions



Explanation

For subtraction, the complement method is used until operate without carry is specified regardless of the subtraction mode designated.

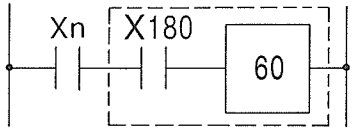
Addition : Result = Data 1 + Data 2 + Carry
Subtraction : Result = Data 1 – Data 2 – Carry (complement method)

⁂ This instruction only specifies the method of operation. The state of the carry flag before the execution of this instruction is unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	—	—	—	—

Call no. 60	Absolute value subtraction mode Instruction
Function	Specifies the expression of subtraction results of as an absolute value.

Basic system of instructions



Explanation

Unless otherwise specified, the result is expressed as an absolute value. e.g.

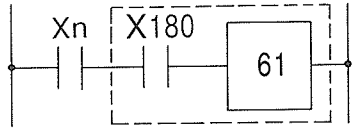
Absolute value
339-561 = 222, CY on
The result is expressed as an absolute value with carry.
(The carry indicates the sign.)

※ This instruction only specifies the method of operation.
The state of the carry flag before the execution of this instruction is unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	—	—	—	—

Call no. 61	Complement subtraction mode Instruction
Function	Specifies the expression of subtraction results in a complement format.

Basic system of instructions



Explanation

This mode is effective until the absolute value subtraction mode is designated. e.g.

Complement format
339-561 = 778, CY on

The result is expressed as the complement with carry.
(The carry indicates there was a borrow.)
Complement format
1339-561 = 778

※ This instruction only specifies the method of operation.
The state of the carry flag before the execution of this instruction is unchanged.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	—	—	—	—

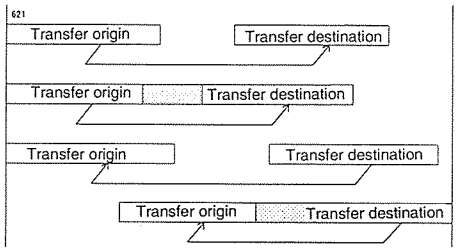
Call no. 62	Block transfer Instruction
Function	Performs block transfer in the data area.

Explanation

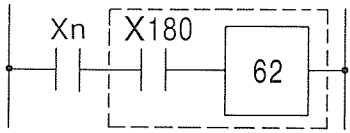
If a non-executable area is specified, the error flag is set and the transfer not performed.

Parameter designation
Specify the transfer parameters in the following memory areas:
Memory area no.621 : Transfer origin (no.621 to 999)
Memory area no.622 : Transfer destination (no.621 to 999)
Memory area no.623 : Block length (0 to 999)

The data ranges can overlap as shown below.



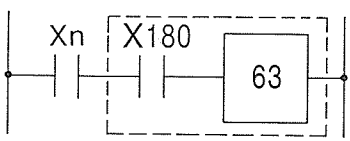
Basic system of instructions



Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	OFF	OFF	OFF	↕

Call no. 63	Watchdog timer refresh Instruction
Function	Performs refresh of the watchdog timer.

Basic system of instructions



Explanation

If the scan time exceeds 200ms and the watchdog timer turns ON, this subroutine must be called to refresh the watchdog timer.

Effect on arithmetic flags	X196/X20: Carry flag	X197/X21: Zero flag	X198/X22: > flag	X199/X23: Error flag
	—	—	—	—

3-3-3. High Speed Counter Instructions

1. Specifications

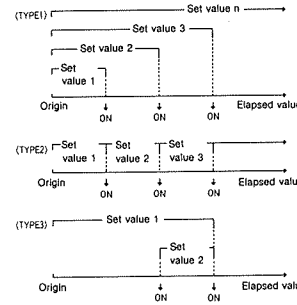
Item	Contents	
Counting input	1 point	
Reset input	External 1 point (also used for X0 input), internal 1 point (Y199) (reset while ON)	
Counting mode	Count up only (non-holding type)	
Count range	1 to 65535	
Number of counter contacts	32 contacts (C50 to C81)	
Number of setting steps	Maximum 128 steps (can be set as desired using each counter contact.)	
High speed output	High speed scan + output refresh (limited to Y0 to Y3)	
Count speed	Maximum 8k cps. (changed by the number of High speed scan are steps.)	
Minimum pulse width	Count input: 62.5 μs Reset input: 470 μs + ths	
Rated voltage	24V DC	
ON voltage	Maximum 19.2V DC	
OFF voltage	Minimum 2.4V DC	
Maximum input voltage	26.4V DC	
Input current	Count input (IN. H) : Approx. 19mA (at 24V DC)	Reset input (X0) : Approx. 5mA (at 24V DC)
Input impedance	Count input : Approx. 1.1kΩ	Reset input : Approx. 4.4kΩ

*ths: Time required to execute high-speed scan area

2. Operation Modes

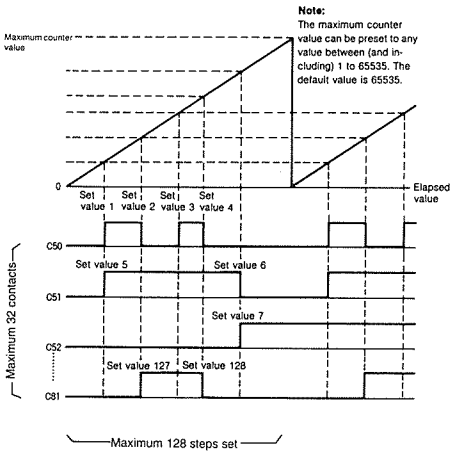
Operation mode	Max. No. of steps	Max. set value	Internal counter contacts	ON/OFF setting	Operation type	Other features
0	128 steps	Total 65535	32 contacts (C50 to C81)	ON/ OFF	Type 1	More than one contact can be controlled with each set value.
1	128 steps	65535 for each step	32 contacts (C50 to C81)	ON/ OFF	Type 2	Max. count value: 65535 × 128
2	8 steps	Total 65535	8 contacts (C50 to C57)	ON Setting only	Type 1	Set value can be changed while RUN mode (special areas 636 to 651 are used)
3	8 steps	65535 for each step	8 contacts (C50 to C57)	ON Setting only	Type 2	Set value can be changed while RUN mode (special areas 636 to 651 are used)
4	2 steps	Total 65535	2 contacts (C50 to C51)	ON Setting only	Type 3	Set value can be changed while RUN mode (special areas 636 to 639 are used)

• Operation type



1) Operation Mode 0

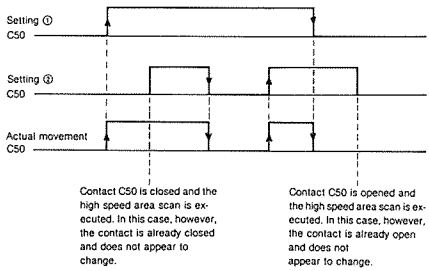
The high speed counter counts up until 65535. If the counting value is over the max. value (65535), then the counting value is reset, it starts counting again from zero. [In this case, the contact is not reset. It remains until the high speed counter is reset (see C52 in diagram).]
The maximum number of presettable steps that can be preset is 128. Any contact from C50 to C81 can be opened or closed when the counter value for a certain preset step is reached. It is possible to open or close a specific contact more than once.
When a counter value has reached the set value, the programmed contacts are opened or closed, then a fast scan is performed. The high speed scan area scans as usual. Contacts X, Y, and CR are also available in this area as well as C50 to C81.
After the high speed scan is completed, output update is performed for Y0 to Y3. Use them when you need high speed outputs.



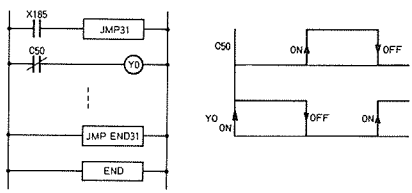
Note:
The maximum counter value can be preset to any value between (and including) 1 to 65535. The default value is 65535.

• When opening or closing the same contacts more than once, be sure that the set value areas do not overlap.

Example



When contact C50 is closed and opened three times as shown in timing charts ① and ② above, the contact actually behaves as shown in timing chart "Actual movement of C50".
If you wish to close a contact from elapsed value 0, set the scan area as follows:



2) Operation Mode 1

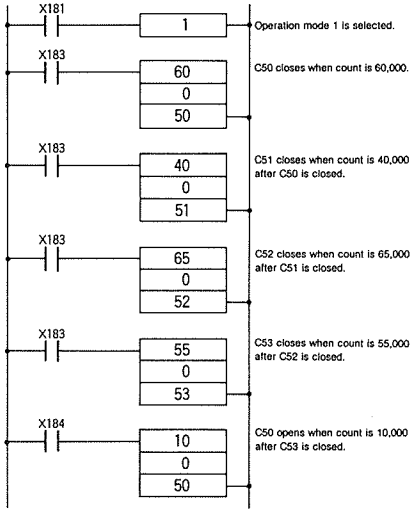
In operation mode 1, the high speed counter (HSC) allows you to set up to 128 steps, and any one of contacts C50 to C81 is closed or opened when the set value for each step is reached. While the set value cannot be changed during a RUN, the maximum counter value of 65535 can be preset for each step. This means that up to 65535 × 128 types of settings are possible.
The following example shows the operation of high speed counter contacts C50 to C53.

Key points on operation

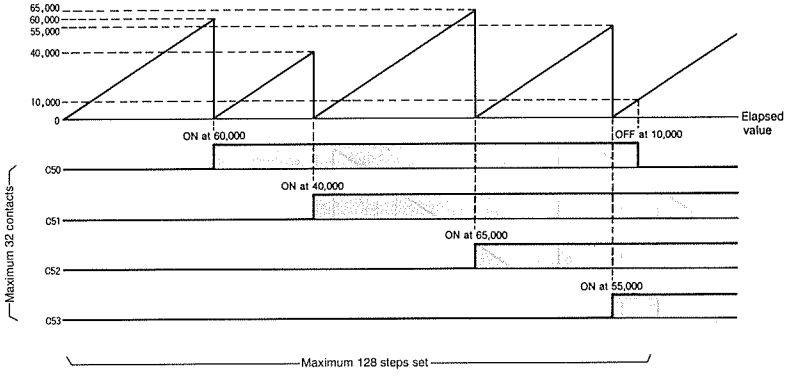
- High speed counter (HSC) ON and OFF instructions are executed in the programmed sequence.
- Each time a set value is reached, the high speed area scan is executed and the elapsed count value is reset to 0.
- A contact, once closed, is not opened until an off instruction is executed or a reset signal is input (X0 or Y199).
- If the maximum counter value is set after the last ON or OFF instruction is executed, the control returns to the first set value instruction in the program after the count reaches the set value. If a maximum counter value is not set, the control returns to the first set value instruction and continues operation after the counter reaches 65535.

The fast scan is not executed when the value set by the maximum counter value is reached.

• Programming Example



Set value



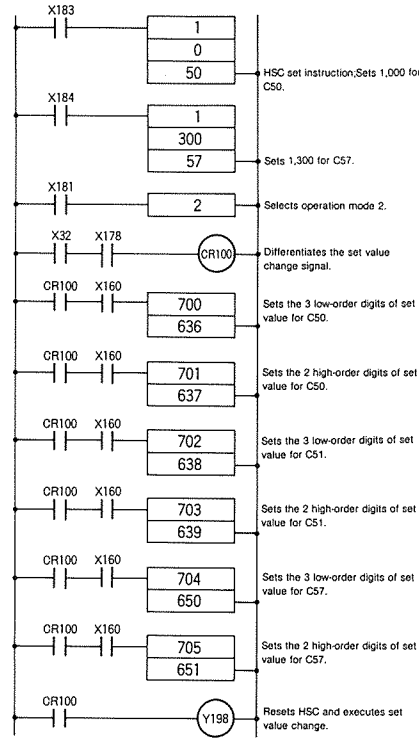
3) Operation Mode 2

In operation mode 2, the high speed counter (HSC) can count up to 65535. It allows you to preset up to 8 steps, and any of contacts C50 to C57 is closed each time the counter value for a preset step is reached. (Other HSC contacts, if programmed, will be ignored.)
Only open-to-close (ON-to-OFF) contact transitions can be programmed, but the set value can be changed during a RUN.
In the following example, the set values for high speed counter contacts C50, C51, and C57 are changed.

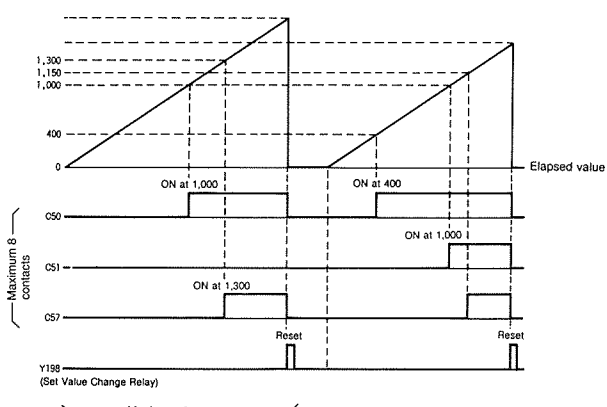
Key points on operation

- The HSC's contact-close (ON) instructions are executed in the ascending order of their set values.
- If the same counter contact is used in the contact-close instruction more than once, the last step is valid for that contact.
- If any contact from C50 to C57 is used in the contact open (OFF) instruction, the instruction acts as the contact close (ON) instruction.
- Set values for HSC contacts are automatically placed into the data memory's special area corresponding to each contact. The set value for a HSC contact can be modified by first updating the contents of the corresponding special area during a RUN and then closing the contacts of the set value change relay (Y198). The HSC is reset and then a new value is set while Y198 is closed.
- Even if a contact close (ON) instruction is not in the program, the HSC can be run by first writing set values into the special areas that correspond to counter contacts and then closing the contacts of Y198.

• Programming Example



Set value



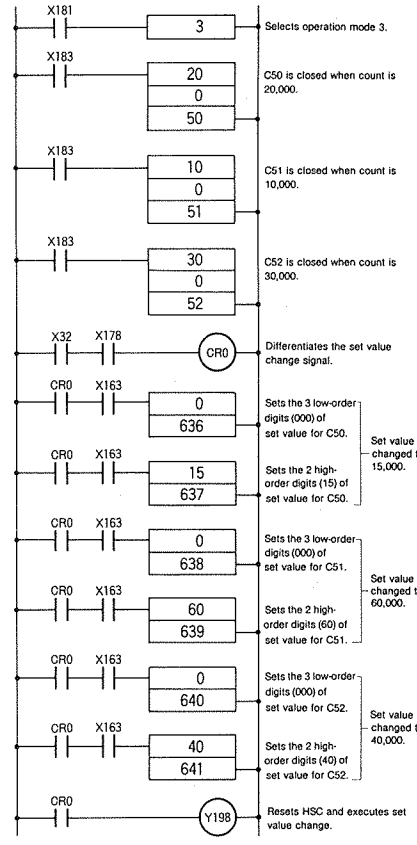
4) Operation Mode 3

• In operation mode 3, the HSC allows you to preset up to 8 steps, and any one of contacts C50 to C57 is closed each time the count value for a preset step is reached. (Other HSC contacts, even if programmed, will be ignored.)
Only open-to-close (ON-to-OFF) contact transitions can be programmed. Set value can be changed during a RUN.
The maximum count value of 65535 can be preset for each step. This means that up to 65535 × 8 types of setting is possible.
In the following example, the set values for HSC contacts C50, C51, and C52 are changed.

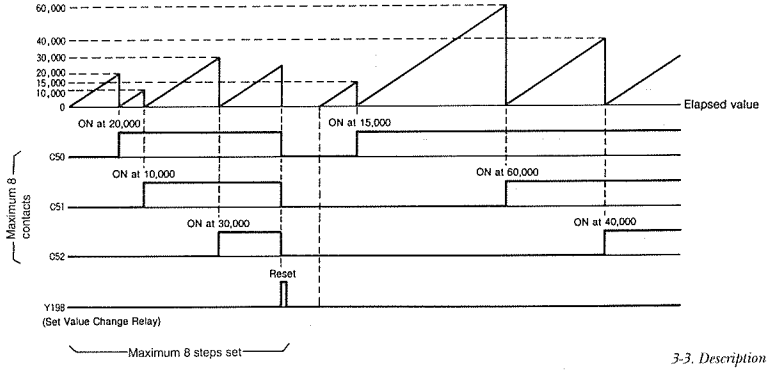
Key points on operation

• The HSC's contact-close (ON) instructions are executed in the ascending order of specified contact numbers (C50 to C57).
• If the same counter contact is used in the contact close instruction more than once, the last step is valid for that contact.
• If any contacts (C50 to C57) is used in the contact-open (OFF) instruction, the instruction acts as the contact-close (ON) instruction.
• Set values for HSC contacts are automatically placed into the data memory's special area corresponding to each contact. The set value for a HSC contact can be modified by first updating the contents of the corresponding special area during a RUN and then closing the contacts of the set value change relay (Y198). The HSC is reset and a new value is set while Y198 is closed.
• Even if a contact close instruction is not in the program, the HSC can be run by first writing set values into the special areas that correspond to counter contacts and then closing the contacts of Y198.

• Programming Example



Set value



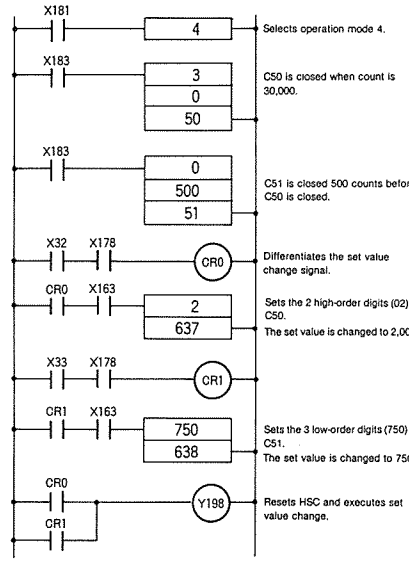
5) Operation Mode 4

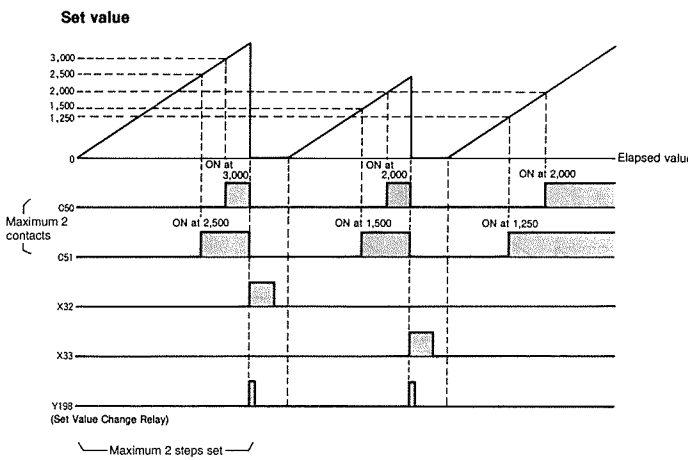
In operation mode 4, you can preset two steps (C50, C51) and count up to 65,535. The two steps are interlocked with each other, which means that C51 is always closed before C50 is closed, at the timing corresponding to the value set for C51. (Other HSC contacts, even if programmed, will be ignored.)
Only open-to-close (ON-to-OFF) contact transitions can be programmed. A set value can be changed during a RUN. In the following example, the set values for high speed counter contacts C50 and C51 are changed.

Key points on operation

- The set values for C50 and C51 should always satisfy the following condition:
  Set value for C50 > Set value for C51 > 0
- If the same counter contact is used in the contact-close instruction more than once, the last step is valid for that contact.
- If any of contacts C50 and C51 is used in the contact open (OFF) instruction, the instruction acts as the contact-close (ON) instruction.
- Set values for HSC contacts are automatically placed into the data memory's special area corresponding to each contact. The set value for a high speed counter contact can be modified by first updating the contents of the corresponding special area during a RUN and then closing the contacts of the set value change relay (Y198). The high speed counter is reset and then a new value is set while Y198 is closed.
- Even if a contact-close instruction is not present in the program, the high speed counter can be run by first writing set values into the special areas that correspond to counter contacts and then closing the contacts of Y198.

• Programming Example





3. Resetting

Resetting occurs when the external reset input (shared with X0) and the internal reset relay (Y199) are ON.
When a resetting is made, contacts C50 to C81 are all switched OFF, and high speed scan area execution + output update are conducted.

Contact C50 to C81 switch ON condition

- The contacts are ON from the time when the count value reaches the one set by the ON set instruction (STRT X183) to the time when the count value reaches the one set by the OFF set instruction (STRT X184) or when the high speed counter is reset.
- For the contacts which are not set by OFF instruction they are not switched from ON to OFF until reset is applied.
- If the maximum count value is exceeded, the count value is reset and counting begins again from 0, but there is not reset of the contacts.
- It is also possible to switch ON/OFF one contact several times, but care must be taken regarding a change of the contact it there is an overlap of the set value areas.

4. Operation notes

- This HSC is a non-hold type.
- If there is either an ON set instruction (STRT X183) or an OFF set instruction (STRT X184), the (IN. H) terminal becomes high speed pulse input, and X0 (RST) becomes high speed counter reset.
- STRT X183 and STRT X184 can be anywhere and in any order in the program, but the maximum count set instruction (STRT X182) must precede STRT X183 and STRT X184, and STRT X185 + JMP31 to JMP END31 must be at the end of the program.
- If high speed output is not necessary, the high speed scan area designation (STRT X185 + JMP31 to JMP END31) is not necessary.
- In operation mode 0, changing of the set value for the high speed counter while it is running is not allowed.

When the set value requires change either select operation mode 2 to 4, or make a high level instruction program that reads HSC's elapsed values and compares them.

5. Response speed

- **Minimum pulse width:**

$110\ \mu s + 15\ \mu s \times n1$

If there is an immediate transfer instruction in the high speed scan area, then the response speed will be as below.

$180\ \mu s + 15\ \mu s \times n1$

- **Minimum set value interval:**

$$\frac{230\ \mu s + 15\mu s \times n1 + t\,HS}{\text{Pulse cycle}}$$

If there is an immediate transfer instruction in the high speed scan area, then the response speed will be as below.

$$\frac{365\ \mu s + 15\ \mu s \times n1 + t\,HS}{\text{Pulse cycle}}$$

If there is no immediate transfer instruction in the high speed scan area, then the response speed will be as shown below.

$$\frac{185\ \mu s + 15\ \mu s \times n1}{\text{Pulse cycle}}$$

- **Minimum reset pulse width:**

$470\ \mu s + t\,HS$

If there is an immediate transfer instruction in the high speed scan area, then the response speed will be as below.

$600\ \mu s + t\,HS$

If there is no immediate transfer instruction in the high speed scan area, then the response speed will be as shown below.

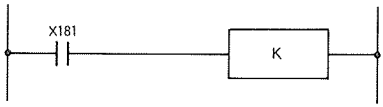
$450\ \mu s$

n1: number of contacts for ON or OFF switching when set value is reached
t HS: time required for high speed scan area execution ($7.5\mu s \times$ number of steps if basic instruction only)

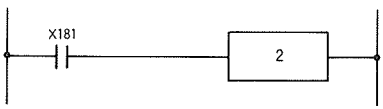
Mode Set (X181)

Sets operation mode of high speed counter

• Basic system of instructions



Program example



Address	Key operation
0	START, X (0.1S), 1, 8, 1, WRT
1	2, WRT

K: High speed counter operation mode number

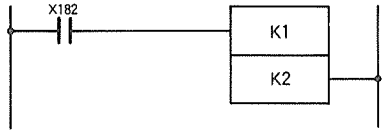
■ Explanation

This function sets the operation mode of the high speed counter (for description of operation modes, see pages 101 thru 107).
The example above shows how to set the operation mode 2.
If this instruction is not given, the high speed counter uses operation mode 0.

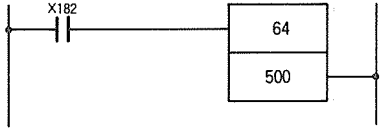
Max. counting value set (X182)

Setting of max. counting value of high speed counter.

• Basic system of instructions



Program example



Address	Key operation
0	START (–| |–) X (0.182) 1 8 2 WRT
1	6 4 WRT
2	5 0 0 WRT

■ Explanation

The max. count value of the high speed counter is set.

K: "thousands" and higher digits

K2: "hundreds" and lower digits

The max. set value is

K1 × 1,000 + K2, and note that

K1 × 1,000 + K2 ≤ 65,535.

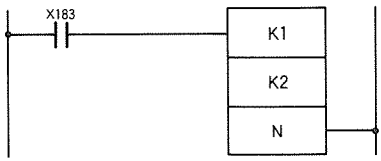
In the program example, the maximum count value is set to 64,500.

If there is no maximum count set instruction, it becomes 65,535.

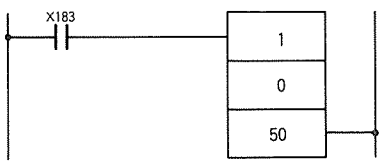
ON setting (X183)

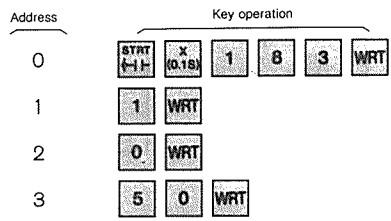
Setting ON conditions of high speed counter contacts.

• Basic system of instructions



Program example





■ Explanation

The count value and the contact that are switched ON when the high speed counter operates are set.

K1: "thousands" and higher digits
K2: "hundreds" and lower digits
N: contacts to be changed (50 to 81)

In the program example, the setting is made so that C50 is switched ON when the elapsed value is 1,000.

K1 × 1,000 + K2 must be a value smaller than the maximum counting value.

N is 50 when C50 is to be switched ON.

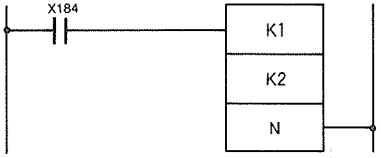
N is 81 when C81 is to be switched ON.

Designations can only be made within the 50 to 81 range.

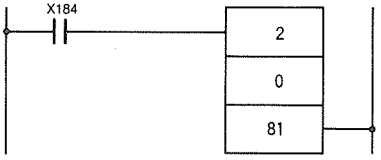
OFF setting (X184)

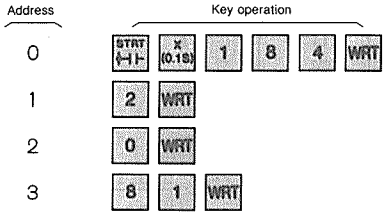
Setting OFF conditions of high speed counter contacts.

• Basic system of instructions



Program example





■ Explanation

The count value and the contact that are switched OFF when the high speed counter operates are set.

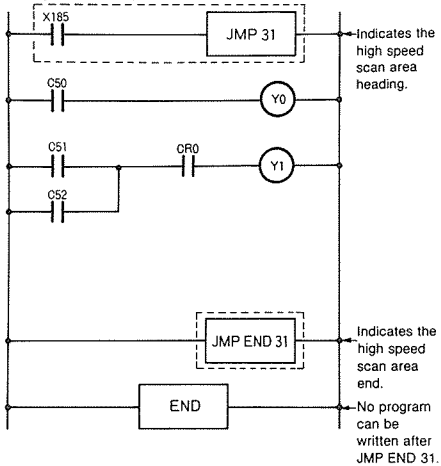
K1: "thousands" and higher digits
K2: "hundreds" and lower digits
N : contacts to be changed (50 to 81)

In the program example, the setting is made so that C81 is switched OFF when the elapsed value is 2,000.
K1 × 1,000 + K2 must be a value smaller than the maximum counting value.
This instruction is effective in the operation mode 0 and 1 of the high speed counter.

High speed scan area setting (X185)

Setting of scan area after counting-up of high speed counter.

• Program example



Address	Key operation
15	STRT X (0.15) 1 8 5 WRT
16	JMP 3 1 WRT
17	STRT C 5 0 WRT
18	OUT Y (1S) 0 WRT
19	STRT C 5 1 WRT
20	OR C 5 2 WRT
21	AND CR 0 WRT
22	OUT Y (1S) 1 WRT
23	JMP END 3 1 WRT
24	END WRT

Explanation

Within the high speed scan area, basic instructions (except timer), the immediate transfer and differential instructions can be used. The high speed scan area need not to be designated, when it is not necessary.
The high speed scan area shall be designated at the end of programming procedure.
X185 instruction is executed only with JMP31 and JMP END31.

- After execution of high speed scan, outputs (Y0 to Y3) are up-dated. Use Y0 to Y3, if high speed output is required.

Internal reset relay (Y199)

Resets the high speed counter counting value to zero and switch OFF each high speed counter contact.

• Basic system of instructions

• Program example

Address	Key operation
0	STRT, CR, 0, WRT
1	OUT, Y (1S), 1, 9, 9, WRT

Explanation

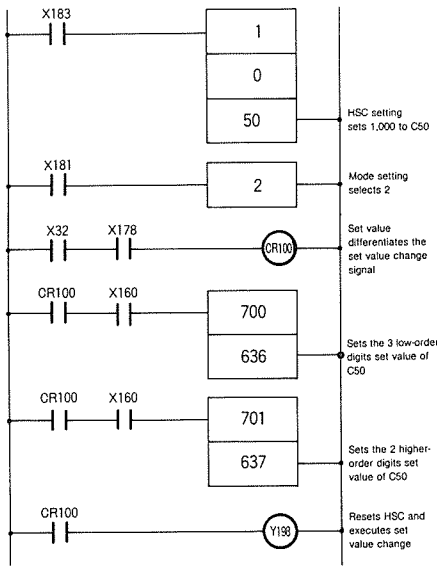
High speed counter resets high speed counter value to zero and switch each (C50 to C81) contact by switching ON Y199 of internal reset relay.
Simultaneously, high speed scan area execution + output update are conducted.
In the example above, when CR0 is ON, it resets high speed counter.

Set value change relay (Y198)

Change set value of high speed counter contacts (C50 to C57) during RUN mode.

• Basic system of instructions

• Program example



Address	Key operation
0	STRT X (0 1S) 1 8 3 WRT
1	1 WRT
2	0 WRT
3	5 0 WRT
4	STRT X (0 1S) 1 8 1 WRT
5	2 WRT
6	STRT X (0 1S) 3 2 WRT
7	AND X (0 1S) 1 7 8 WRT
8	OUT CR 1 0 0 WRT
9	STRT CR 1 0 0 WRT
10	AND X (0 1S) 1 6 0 WRT
11	7 0 0 WRT
12	6 3 6 WRT
13	STRT CR 1 0 0 WRT
14	AND X (0 1S) 1 6 0 WRT
15	7 0 1 WRT
16	6 3 7 WRT
17	STRT CR 1 0 0 WRT
18	OUT Y (1S) 1 9 8 WRT

■ Explanation

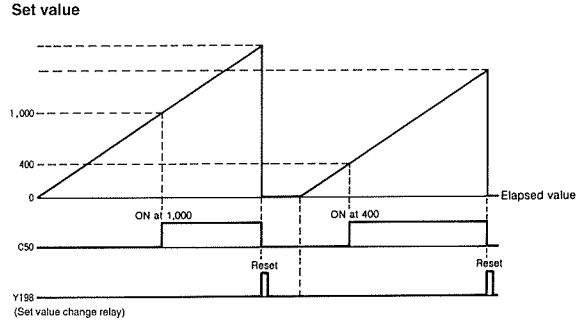
When Y198 is ON, high speed counter set value is changed by content of special data memory 636 to 651 (non-holding area).
When high speed counter is used, data memory 636 to 651 correspond to each contact and set value area as follows.

Data memory number	Set value area designation contact
636	Area of set value three low-order digits to switch C50 ON.
637	Area of set value two high-order digits to switch C50 ON.
638	Area of set value three low-order digits to switch C51 ON.
639	Area of set value two high-order digits to switch C51 ON.
• • • •	• • • •
651	Area of set value two high-order digits to switch C57 ON.

When the high speed counter instruction is not used (in case of no STRT X183, STRT X184), it is possible to use as non-holding data memory.

• Explanation of program example

Under the condition of setting 1,000 to C50, change to operation mode 2 and set 400 to data memory no.636, 637.
All the same time set value change relay switch ON, change C50 set value to 400 and reset high speed counter.
(Shows the status to be set "400" to data memory no.700, "0" to data memory no.701 before hand.)



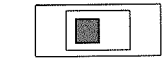
CHAPTER 4

HOW TO USE
PL PROGRAMMER Mark II (APL2114)

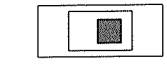
● The following diagramatic symbols used in "How to Use programmer" are used on the following understanding.

(RAM specification)
Shows only what can be operated when only the RAM built-in to the control unit is used.
(ROM specification)
Shows what can be operated only when the ROM is attached to the control unit.
(RAM specification/ROM specification)
They show what can be operated for both the built-in RAM and the ROM.
In operation, the memory (ROM) has priority.

• PROGRAM MODE



• RUN MODE



"PC" is the abbreviation for Programmable Controller.

4-1. Functions

[I key] denotes "instruction key" and [N key] denotes "numerical key".

• denotes the available function. ✳ denotes the cancel of retrieval.

RAM specification: When using only RAM built-in to control unit.

ROM specification: When using ROM, attaching it to control unit.

PROG. Mode, RUN Mode: Change mode change-over switch of control unit to PROG. or RUN.

Function	Key operation	RAM spec. PROG. mode	RAM spec. RUN mode	ROM spec. PROG. mode	ROM spec. RUN mode
1. Clearing of program	ACLR F 0 F DELI INST	•			
2. Writing program	ACLR N key I key N key WRT	•			
3. Readout of program	ACLR N key READ ▼ → ▼ (Increment) / ▲ (Decrement)	•	•	•	•
4. Address reference	ACLR I key N key READ ▼	•	•	•	•
5. Program insertion	ACLR N key I key N key DELI INST	•			
6. Program deletion	ACLR N key READ ▼ F DELI INST	•			
7. Elimination of one step of program	ACLR I key N key READ ▼ CLR WRT	•			
8. Deletion of NOP	ACLR F 1 F ▲	•			
9. Save program to tape	ACLR F 4 (Recording On) WRT	•		•	
10. Verification of tape	ACLR F 5 (Playback ON) READ ▼	•		•	
11. Load program from tape	ACLR F 6 (Playback ON) READ ▼	•			
12. Transfer to internal RAM from memory (ROM)	ACLR F 9 0 WRT			•	
13. Store program to EEP-ROM	ACLR F 9 9 WRT			•	
14. Total check of instruction contents	ACLR READ ▼	•		•	
15. Readout of elapsed value of timer/counter	ACLR F 2 → T / C → N key READ ▼		•		•
16. Changing of set value of timer/counter	ACLR → T / C → N key READ ▼ CLR READ ▼ CLR N key WRT ✳	•	•	⁂	⁂
17. Monitoring of circuit continuity	ACLR I key N key READ ▼ ▲ ✳		•		•
18. Forced output	ACLR F 1 0 N key OUT ON ····· NOT OFF	•		•	
19. Readout of high speed counter elapsed value	ACLR F 2 C → READ ▼		•		•
20. Readout and setting of data memory	ACLR F 8 N key READ ▼ CLR N key WRT	•	•	•	•
21. Constant value change of constant transfer instruction	ACLR AND SHIFT SET 1 6 3 READ ▼ CLR READ ▼ CLR N key WRT ✳	•	•	⁂	⁂

Note) For ⁂ ROM specifications, change should be carried out with the memory (ROM) detached after transferring the program contents to the built-in RAM (procedure No. 12 in the above list.)

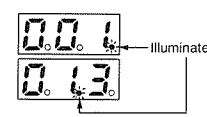
Function Key Operation List

Function No.		Function
F 0		Clearing of program
F 1		NOP deletion
F 2		Readout of elapsed value of timer/counter/high speed counter
F 4	Cassette loader	Save program to tape
F 5	Cassette loader	Verification of tape
F 6	Cassette loader	Load program to tape
r s		Readout and setting of data memory
F 1 0		Forced output
F 9 0	ROM writer	Transfer to internal RAM from memory (ROM)
F 9 9	ROM writer	Store program to EEP-ROM

• **Programmer address display**

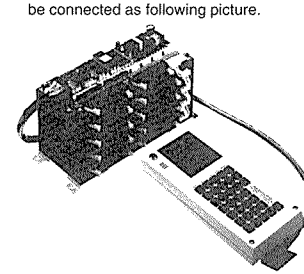
Address indication of Programmer is three digits.

Indication of address of 1000 and higher are displayed at the three digits numbered point.



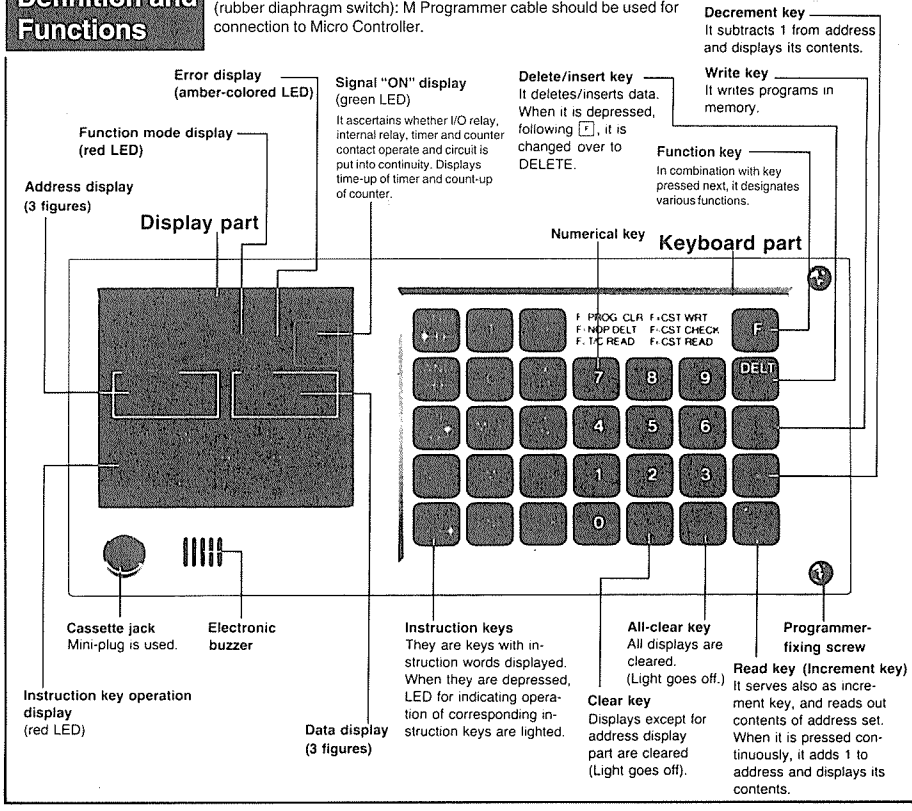
• **Connection of Programmer**

Programmer cable (AFB8511) should be connected as following picture.



Definition and Functions

PL Programmer Mark II is composed of display part and keyboard part (rubber diaphragm switch): M Programmer cable should be used for connection to Micro Controller.



Explanation

• Programmer keys are classified by color according to their operations.
Blue: Instruction key
Ivory: Numerical key
Green: Operation key (only DELT is yellow.)
Yellow: Function key

• F key can designate the following function modes in combination with N key pressed next.

F 0 : All-clear of programs (erasure)
F 1 : Deletion of NOP
F 2 : Read-out of elapsed value of timer/counter, high-speed counter and data memory
F 4 : Save program to tape
F 5 : Collation of cassette tape with memory
F 6 : Load program to tape
F 8 : Read-out and setting of data memory
F 1 0 : Forced output
F 9 9 : Store program to EEP-ROM
F 9 0 : Transfer of ROM contents to RAM contained in control unit.
F DELT : functions also as DELT key.

• Terminology

F: Abbreviation of FUNCTION
INST: Abbreviation of INSERT
DELT: Abbreviation of DELETE
WRT: Abbreviation of WRITE
ACLR: Abbreviation of ALL CLEAR
CLR: Abbreviation of CLEAR
PROG: Abbreviation of PROGRAM
CST: Abbreviation of CASSETTE
T/C: Abbreviation of TIMER/COUNTER
I/O: Abbreviation of INPUT/OUTPUT
NOP: Abbreviation of NO OPERATION, meaning instruction does not do anything.
INCREMENT: To add 1 to address.
DECREMENT: To subtract 1 from address.

(Note)
N key denotes "numercial key".

• Before proceeding to the next page

Rubber sheet switch in keyboard part is highly wear-resistant and environment-resistant by virtue of its flush printing, and letters don't become blurred semi-permanently. Further, it gives nice feel and is highly operative.

- Press DELT key for deleting all display part.
- Press CLR key for all display other than ADDRESS portion.
- PL programmer Mark II (APL2114) is improved version of PL Programmer (APL211002) and perform all previous function. It can be used with Micro Controller, PL Mark III, PL Mark II and PL ROM WRITER.

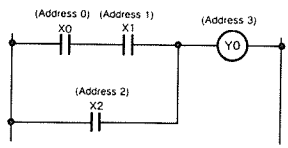
Clearing of program

When writing a new program, it is necessary to clear the memory built into the control unit. Do not write over old data. It will cause program errors.

(RAM Specification)

(PROGRAM Mode)

Example



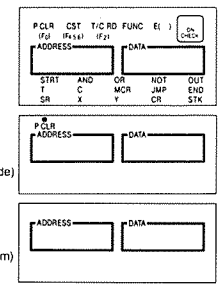
Operation Procedures

① Changing mode change-over switch to PROG mode.

② ACLR (Display all clear)

③ F 0 (Designating program clear mode)

④ F DELT/INST (Execution of clearing of program)



* From step 2 on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Changing mode		Changing mode-change switch of control unit to PROG (program mode)
② Clearing display	ACLR	Entire clearing of display part (Light is put out.)
③ Designation of program clear mode	F 0	Light of program clear mode goes on.
④ Executing program all clear	F DELT/INST	Executing ALL CLEAR

• Explanation

- By ALL CLEAR, contents of program memory (RAM) written in addresses from 0 to last address are all cleared.
- Conditions of holding-type internal relay and holding-type counter are all cleared.
- Data memory is not cleared.

• Terminology

ACLR : Abbreviation of ALL CLEAR. It is for clearing display entirely. (Light to what turns off)

DELT/INST : Abbreviation of DELETE/INSERT. When this key is pressed following F key, it functions for DELT.

Writing Program

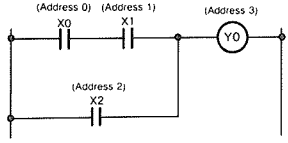
Writing programs in memory contained in control unit.

(RAM Specification)

(PROGRAM Mode)

PROG. RUN

Example

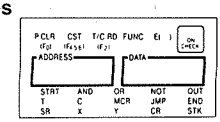


Memory after writing

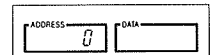
Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	OR	X (0.1S)	2
3	OUT	Y (1S)	0

Operation Procedures

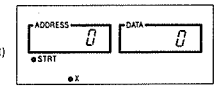
① ACLR (All clear of displays)



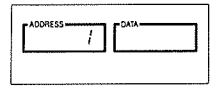
② 0 (Writing program from address 0)



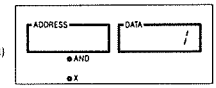
③ STRT X (0.1S) 0 (Program set)



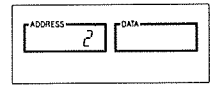
④ WRT (Write)



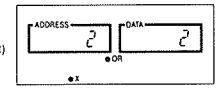
⑤ AND X (0.1S) 1 (Program set)



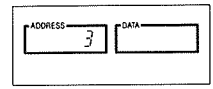
⑥ WRT (Write)



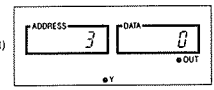
⑦ OR X (0.1S) 2 (Program set)



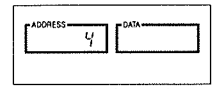
⑧ WRT (Write)



⑨ OUT Y (1S) 0 (Program set)



⑩ WRT (Write)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear. (Light is put out.)
② Address set	N key	Pushing numerical key, set address of memory desired to be written, to address display part.
③ Setting instruction statement	I key, N key	Set instruction statement desired to be written to display part. At this time, light of display corresponding to instruction key depressed goes on, and value of numerical key is displayed in data display part.
④ Writing in memory	WRT	Write instruction, which is set in display part, in memory. Then increasing address by 1, the contents are displayed.

• Explanation

• When program is written in memory by WRT, address is increased by 1 automatically. Grammatical errors are rejected, and display light of maloperated part goes on and off.
Cancel operation by CLR key (or ACLR key), and do it all over again.

(Note)
key denotes "instruction key".

• Terminology

WRT: Abbreviation of WRITE. It is a key for writing programs in memory. (RAM)

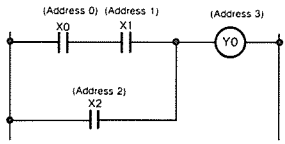
Readout of program

Reading out contents of program written in memory contained in control unit and confirms it. When memory unit (ROM) is attached, its contents are read out.

(RAM Specification/ROM Specification)

(PROGRAM mode) (RUN mode)

Example



Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	OR	X (0.1S)	2
3	OUT	Y (1S)	0

Operation Procedures

① ACLR (Display all clear)

② 0 (Setting at address 0)

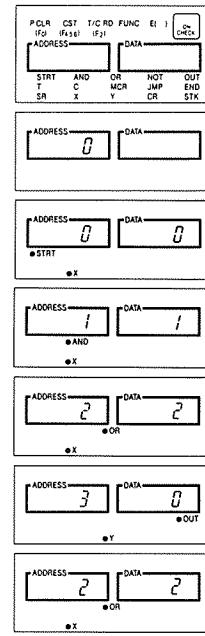
③ READ (Readout) (Contents [STRT] [X 0.1S] [0])

④ READ (Contents [AND] [X 0.1S] [1])

⑤ READ (Contents [OR] [X 0.1S] [2])

⑥ READ (Contents [OUT] [Y 1S] [0])

⑦ ▲ (Contents [OR] [X 0.1S] [2])



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear. (Light is extinguished.)
② Address set	N key	Pressing numerical key, set address of program desired to be read out to address display part.
③ Start of readout	READ ▼	When read key is pressed, contents of memory of address set are displayed.
④ Readout	READ ▼	Further, when this key is pressed, address is increased by 1, and contents of the memory are displayed.
	▲	When decrement key is pressed, address is decreased by 1, and contents of the memory are displayed.

• Explanation

- Data can be read out from any address number.
- For initial readout, press READ ▼ key.
- It is used for modifying programs and monitoring continuity condition of circuit during operation.

• Terminology

READ ▼: It reads out contents of address set. When it is pressed continuously, address is increased by 1, and the contents are displayed.

INCREMENT (increase): it means adding 1 to address or numerical value.
DECREMENT (decrease): it means decreasing address by 1.

Address reference-I

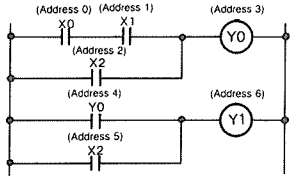
Retrieving addresses of designated programs from programs written in memory built-in control unit or programs written in memory unit.

(RAM Specification/ROM Specification)

(PROGRAM mode) (RUN mode)

PROG. RUN PROG. RUN

Example



Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	OR	X (0.1S)	2
3	OUT	Y (1S)	0
4	STRT	Y (1S)	0
5	OR	X (0.1S)	2
6	OUT	Y (1S)	1

Operation Procedures I

(when setting programs for 1 step)

Address search from instruction words.

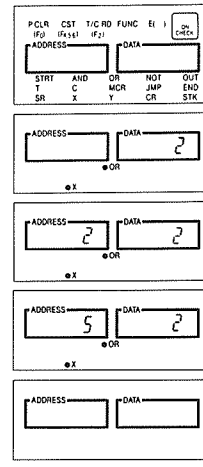
① ACLR (Display all clear)

② OR | X (0.1S) | 2 (Program set)

③ READ (Start of search)

④ READ (Re-search)

⑤ READ (Completion)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Setting programs	I key, N key	Setting programs desired to be searched
③ Retrieval	READ ▼	It retrieves from address 0 sequentially, and when programs to be searched are discovered, it displays the address and stops. When ▼ button is pressed again, it searches addresses onward. Upon completion, light of all displays is put out.

∘ Explanation

∘ Used for modifying programs and monitoring continuity condition of circuit being operated.

∘ Capable of search even only auxiliary instructions of [M 0-15], [T 0-15], [OR]. Refer to Operation Procedures II of Address reference -II.

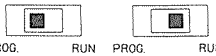
∘ Search only for numerical value is not possible.

Address reference-II

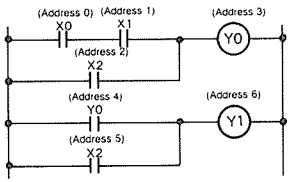
Retrieving addresses of designated programs from programs written in memory built-in control unit or programs written in memory unit.

(RAM Specification/ROM Specification)

(PROGRAM Mode) (RUN Mode)



Example



Address	Contents of memory		
0	STRT X	(0 1S)	0
1	AND X	(0 1S)	1
2	OR X	(0 1S)	2
3	OUT Y	(1S)	0
4	STRT Y	(1S)	0
5	OR X	(0 1S)	2
6	OUT Y	(1S)	1

Operation Procedures II

(When setting auxiliary instructions [↑ 0 1S], [↓ 1S], [CR] only.)

Address search from the No. of [↑ 0 1S], [↓ 1S], [CR].

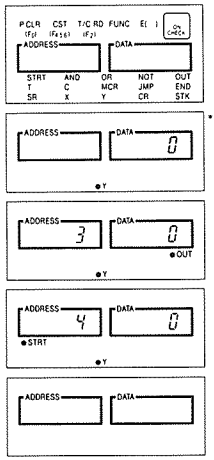
① ACLR (Display all clear)

② Y (1S) 0 (Setting auxiliary instructions)

③ READ (Start of search)

④ READ (Re-search)

⑤ READ (Completion)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Setting programs	↑ key, N key	Setting programs desired to be searched
③ Retrieval	READ ▽	It retrieves from address 0 sequentially, and when programs to be searched are discovered, it displays the address and stops. When ▽ button is pressed again, it searches addresses onward. Upon completion, light of all displays is put out.

• Explanation

• Used for modifying programs and monitoring continuity condition of circuit being operated.

Program insertion

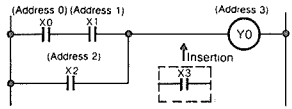
Programs are newly inserted in designated addresses of programs previously written.

(RAM Specification)

(PROGRAM Mode)

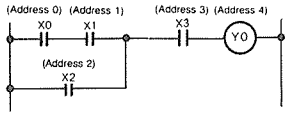
PROG. RUN

Example



Memory before insertion

Address	Contents of memory		
0	STRT	X (0 1S)	0
1	AND	X (0 1S)	1
2	OR	X (0 1S)	2
3	OUT	Y (1S)	0



Memory after insertion

Address	Contents of memory		
0	STRT	X (0 1S)	0
1	AND	X (0 1S)	1
2	OR	X (0 1S)	2
3	AND	X (0 1S)	3
4	OUT	Y (1S)	0

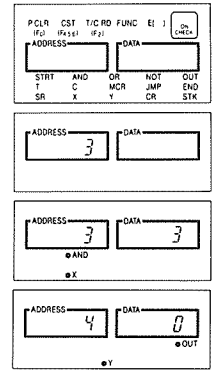
Operation Procedures

① ACLR (Display all clear)

② 3 READ ▽ CLR (Setting address 3)

③ AND X (0 1S) 3 (Setting programs)

④ DELT INST (Insertion)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear. (Light is put out.)
② Setting address	N key	Press numerical key and set address of program desired to be inserted, to address display part.
③ Setting instruction statement	I key N key	Set instruction statement to be newly inserted.
④ Insertion	DELT INST	Insert instruction statement in address set, then address being increased by 1, program is transferred and the contents are displayed.

• Explanation

• When a program is newly inserted into a designated address,, all addresses (up to those with next NOP instruction) are increased by 1 automatically, and the NOP instruction is eliminated. The address thereafter does not change.

• If the address with NOP instruction is the same as the program that is to be inserted, NOP instruction remains the same.

• An error will occur if a program is inserted in an address that exceeds the final address.

• An error will occur, and no insertion will be made, If the result of insertion would be to exceed the maximum capacity of the program.

• Terminology

INST: Abbreviation of INSERT. It is used when inserting program.

• Before proceeding to the next page

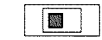
There are cases where programming is impossible unless STK instruction is used, so be sure to program them in.

Program deletion

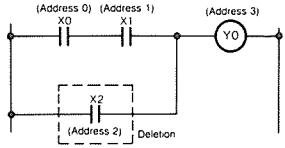
Programs of designated address are deleted out of programs previously written into the memory built-in control unit.

(RAM Specification)

(PROGRAM Mode)

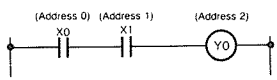


Example



Memory before deletion

Address	Contents of memory		
0	STRT X	(0 1S)	0
1	AND X	(0 1S)	1
2	OR X	(0 1S)	2
3	OUT Y	(1S)	0



Memory after deletion

Address	Contents of memory		
0	STRT X	(0 1S)	0
1	AND X	(0 1S)	1
2	OUT Y	(1S)	0

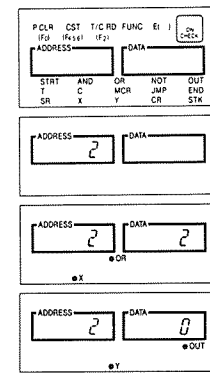
Operation Procedures

① ACLR (Display all clear)

② 2 (Setting address 2)

③ READ (Confirming readout of contents of address 2)

④ F DELT/INST (Deletion)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear. (Light is put out.)
② Address set	N key	Pressing numerical key, set address of program desired to be deleted to address display part.
③ Deletion	F DELT/INST	After deleting program of address set, address is decreased by 1, and program being transferred, contents are displayed.

• Explanation

• When a program of a designated address is deleted, programs after the designated address are decreased by 1 automatically, and the contents of memory from the next address are transferred forward.

• To make sure contents, above operation procedure ③ are carried out.

• Terminology

DELT: Abbreviation of DELETE. It is used when deleting program.

• Before proceeding to the next page

• When deleting program, there are programs relating to STK instruction, output programs or programs of contacts, so be sure to delete related programs also.

Elimination of one step of program

One step of a previously written program into the memory built-in control unit is erased.

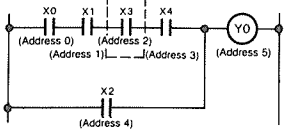
(RAM Specification)

(PROGRAM Mode)

PROG. RUN

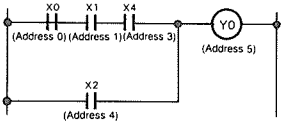
Example

One row elimination



Memory before erasure

Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	AND	X (0.1S)	3
3	AND	X (0.1S)	4
4	OR	X (0.1S)	2
5	OUT	Y (1S)	0



Memory after erasure

Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2			Condition of NOP
3	AND	X (0.1S)	4
4	OR	X (0.1S)	2
5	OUT	Y (1S)	0

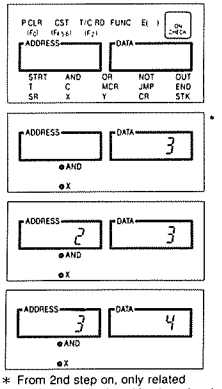
Operation Procedures

① ACLR (Display all clear)

② AND X (0.1S) 3 (Setting program)

③ READ (Search)

④ CLR WRT (Elimination of one step of program)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Setting programs	I key, N key	Setting program desired to be retrieved.
③ Retrieval	READ	Execution of retrieval
④ Erasing one step	CLR, WRT	Elimination of one step of program

• Explanation

• When you want to erase on step of a program, read out contents or program desired to be erased, and execute operation of CLR, WRT.

• Terminology

One row elimination: To change one row of a program of a certain address to NOP (NO operation).

• Before proceeding to the next page

• When deleting a program, be sure to erase all related program, since there are appended contact programs, etc.

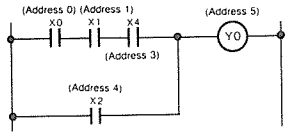
Deletion of NOP

Deleting all NOP instructions written into the memory built-in control unit and reducing programs.

(RAM Specification) Example

(PROGRAM Mode)

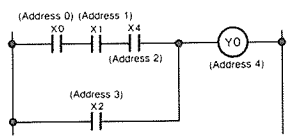
PROG. RUN



Memory before deletion of NOP

Address	Contents of memory		
0	STRT	X (0 1S)	0
1	AND	X (0 1S)	1
2			
3	AND	X (0 1S)	4
4	OR	X (0 1S)	2
5	OUT	Y (1S)	0

Condition of NOP



Memory after deletion of NOP

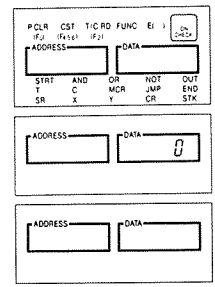
Address	Contents of memory		
0	STRT	X (0 1S)	0
1	AND	X (0 1S)	1
2	AND	X (0 1S)	4
3	OR	X (0 1S)	2
4	OUT	Y (1S)	0

Operation Procedures

① ACLR (Display all clear)

② F 1 (NOP delete mode set)

③ F ▲ (Deletion of NOP)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Attention!

"0" in data display part ② is display of function mode showing NOP delete F 1.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Designation of NOP delete mode	F 1	"0" is displayed in data part.
③ Execution of NOP delete	F ▲	Display "0" in data part disappears.

• Explanation

• Deletion of NOP removes all NOP's in memory of programmer and reduces programs, so that it is convenient to use it for arrangement of programs.

• Terminology

NOP: NO OPERATION

• Before proceeding to the next page

• When it is desired to delete only some parts of NOP, execute operation of "Program deletion" on page 126.

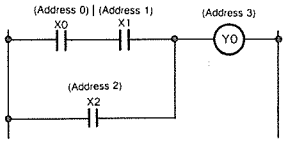
Save program to tape

Saving program written in memory built-in control unit or memory unit to tape.

(RAM Specification/ROM Specification)

(PROGRAM Mode)

Example



Address	Contents of memory		
0	STRT X0	X (0.1S)	0
1	AND X1	X (0.1S)	1
2	OR Y0	X (0.1S)	2
3	OUT Y0	Y (1S)	0

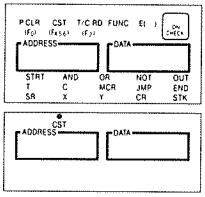
Operation Procedures

①

Connecting cassette tape recorder (Connected to microphone jack)

②

ACLR (Display all clear)



③

F 4 (Setting cassette write mode)

④

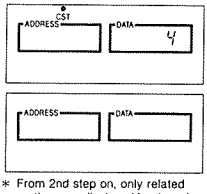
Sound-recording button of tape recorder furred on.

⑤

WRT (Write)

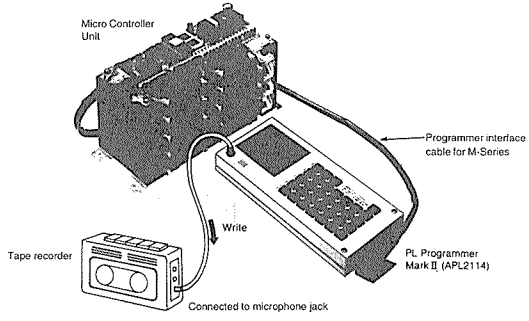
In course of saving

Saving completed.



* From 2nd step on, only related portions are displayed for the sake of explanation.

Connection Example



Basic Operating Procedures

① Connecting tape recorder		
② Clearing display	ACLR	Display part all clear. (Light is put out.)
③ Designating write-mode in cassette.	F 4	Light of cassette mode display goes on.
④ Tape recorder record button turned on.		
⑤ Write	WRT	• Start of transference from memory to cassette tape. • Upon completion, buzzer sounds and light of cassette display is put out.

• Explanation

• For cassette deck and tape, use commercial types available on the market.
• Position recording level of tape recorder to medium level.
• When saving to tape is finished, be sure to check whether or not there is anything wrong with contents of program. Refer to following page, "Verification of tape", for further information.

• Before proceeding to the next page

• Use a commercially available cord to connect PL Programmer Mark II to tape recorder.
Do not use a cord with a resistor in it.

Verification of tape

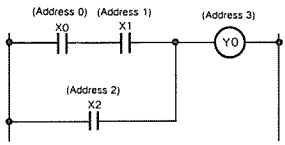
Verifying contents of tape with contents of memory built-in control unit.

(RAM Specification/ROM Specification)

(PROGRAM Mode)

PROG. RUN

Example



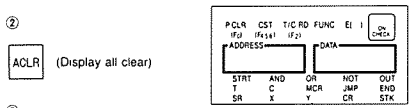
Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	OR	X (0.1S)	2
3	OUT	Y (1S)	0

Operation Procedures

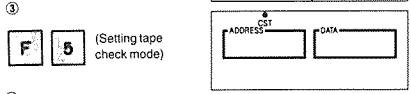
①

Connecting tape recorder (Connected to speaker or earphone jack)

②



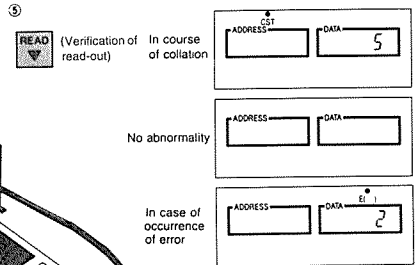
③



④

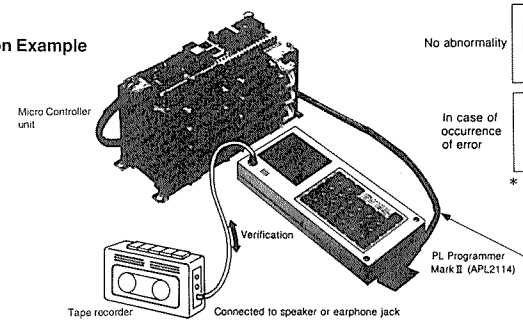
Tape recorder reproduction button turned on.

⑤



* From 2nd step on, only related portions are displayed for the sake of explanation.

Connection Example



Basic Operation Procedures

① Connecting tape recorder		
② Clearing display	ACLR	Display part all clear. (Light is put out.)
③ Designating cassette check mode	F 5	Light of cassette mode display turned on.
④ Tape recorder reproduction button turned on.		
⑤ Verification	READ	• Verifying contents of cassette tape with those of memory • Upon completion, buzzer sounds, and light of cassette display is put out. • When errors occur, E1 to 3 are displayed.

• Explanation

• When write and readout from tape are executed, be sure to check whether there is any error in transfer of program.

• Errors are displayed in the following cases:

1) When connecting cord is not properly connected to designated jack.
"E1" is displayed.

2) When volume of tape recorder is low.
"E1 is displayed.

3) When tape recorder is not operating.
"E1" is displayed.

4) When contents of tape do not conform with those of program memory.
"E2" is displayed.

5) When abnormalities, occur during verifying tape with memory.
"E3" is displayed.

After checking which error is the program, remove the error.

Note:
E shows E ( ) lamp of PL Programmer Mark II.

• Before proceeding to the next page

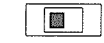
Even when verified, contents of memory do not change.

Load program from tape

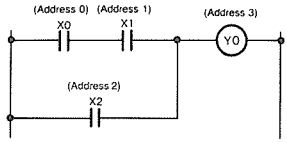
Readout program previously written into tape, and write in memory contained in control unit. By read-out, program contents can be confirmed.

(RAM specification)

(PROGRAM Mode)



Example



Contents of program after read-out

Address	Contents of memory		
0	STRT	X (0.1S)	0
1	AND	X (0.1S)	1
2	OR	X (0.1S)	2
3	OUT	Y (1S)	0

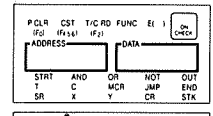
Operation Procedures

①

Connecting tape recorder
(Connected to speaker or earphone jack)

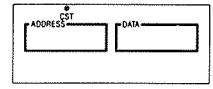
②

ACLR (Display all clear)



③

F 6 Setting tape read mode



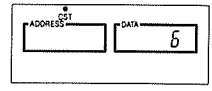
④

Tape recorder reproduction button turned on.

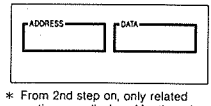
⑤

READ (Load)

In course of loading

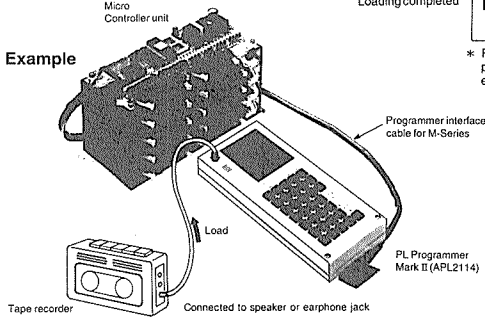


Loading completed



* From 2nd step on, only related portions are displayed for the sake of explanation.

Connection Example



Basic Operation Procedures

① Connecting tape recorder		
② Clearing displays	ACLR	Display part all clear. (Light is put out.)
③ Designating cassette read mode	F 6	Cassette mode display light goes on.
④ Tape recorder reproduction button turned on.		
⑤ Load	READ	• Start of transference of data from cassette tape to memory • Upon completion, buzzer sounds, and light of cassette mode display is put out.

• Explanation

• When abnormalities, such as tape ceasing to move during load, occur, "E3" is displayed.
Further, when connecting cord is not connected to specified jack, or in similar cases, "E1" is displayed.
• When having executed load program from tape, be sure to check whether there is anything wrong with contents of program.
Refer to preceding page, "Verification of tape" for further information.

Note: E shows E ( ) lamp of PL Programmer Mark II.

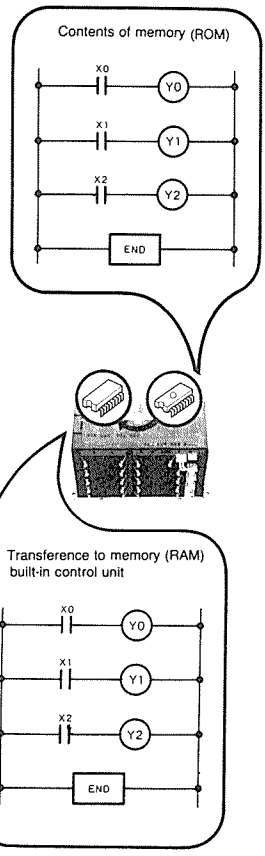
Transfer to internal RAM from memory (ROM)

Contents of memory (ROM) can easily be transferred to memory (RAM) built-in control unit.

(ROM Specification)

(PROGRAM Mode)

Example



Operation procedures

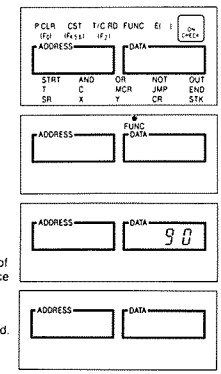
① ACLR (Display all clear)

② F 9 0 (Designating transfer made to RAM contained)

③ WRT (Transference)

In course of transference (approx. 1 s)

Transference completed.



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Transference to built-in RAM. Mode is designated.	F 9 0	Preparation for transfer to memory (RAM) built-in control unit.
③ Transference	WRT	During transfer, "90" is displayed in data display part. In about 1 s, light is put out, and transference is completed.

• Explanation

- When changing program, turn off power source after transfer and after removing unit, turn on power source again and change program by PL Programmer Mark II.
- Even if the previous programs remains in built-in RAM, the program contents shall be changed to those of memory (ROM) during transmission.

• Before proceeding to the next page

Memory (ROM) should be attached and detached after turning off power source.

Store program to EEP-ROM

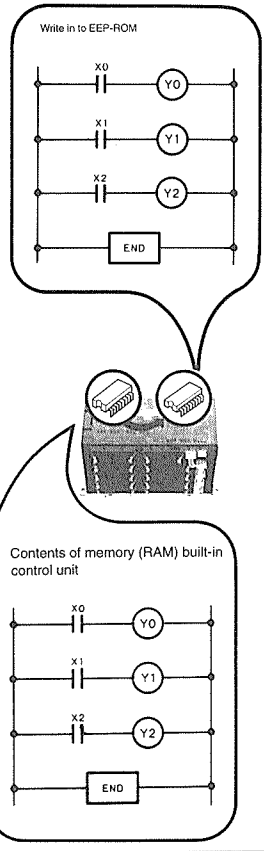
Contents of memory (RAM) built-in control unit shall be written in to EEP-ROM.

(ROM Specification)

(PROGRAM Mode)

PROG. RUN

Example



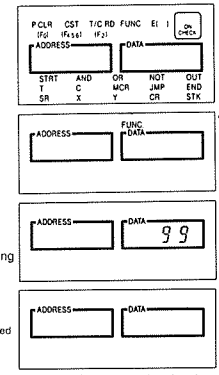
Operation Procedures

① ACLR (Display all clear)

② F 9 9 (Designating mode to write in master memory unit)

③ WRT (Write) In course of storing (about 30s)

Storing completed



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear (Light is put out.)
② Designation of write-in mode to EEP-ROM	F 9 9	Prepares for write-in from control unit internal memory (RAM) to EEP-ROM.
③ Write-in	WRT	During store, the data display section shows "99". In about 30 seconds it is cleared, indicating that the store is completed.

• Explanation

• In this function, the storage of the program is shifted to a tape, permitting a simple way of making copies at the production site.

• At the same time as the store occurs, the former program content of EEP-ROM is erased and the new program is substituted.

• Before proceeding to the next page

Memory (ROM) should be attached and detached after turning off power source.

Total check of instruction contents

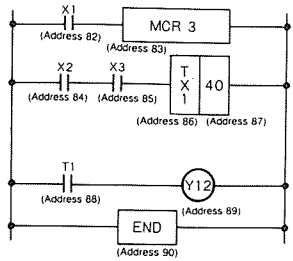
When writing procedure of all programs is completed, check whether of not there are any mistakes in contents.

(RAM Specification/ROM Specification)

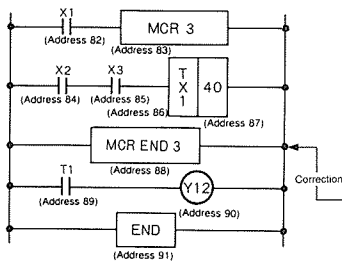
(PROGRAM Mode)

Example

Before correction



After correction



Memory before correction

Address	Contents of memory
82	STRT X (0 1S) 1
83	MCR 3 ← (MCR END 3 is missed.)
84	STRT X (0 1S) 2
85	AND X (0 1S) 3
86	T X (0 1S) 1
87	4 0
88	STRT T 1
89	OUT Y (1S) 1 2
90	END

Memory after correction

Address	Contents to memory
82	STRT X (0 1S) 1
83	MCR 3
84	STRT X (0 1S) 2
85	AND X (0 1S) 3
86	T X (0 1S) 1
87	4 0
88	MCR END 3
89	STRT T 1
90	OUT Y (1S) 1 2
91	END

Basic Operation Procedures

① Clearing display	CLR	Display part all clear (Light is put out.)
② Total check	READ	Addresses are checked from address 0 in sequence and if there is any mistake, checking is stopped at that address and contents are displayed.
③ Total check	READ	If ▽ is pushed again, addresses from that address on are checked.
		When checking is finished, lights of all displays are put out.

• Explanation

• Total check of instruction contents complies:

1) Check of syntax errors
2) When either one only of body coil or set value of timer, counter is programmed.
3) Whether both MCR and MCR END are programmed or not. Same with JMP and JMP END.

• Buzzer, when checked, rings and erroneous parts are displayed by light turning on and off.

Operation Procedures

• When there is abnormality.

① ACLR (Display all clear)

② READ ▽ (Total check starts. Erroneous parts are displayed.)

Show that there is no MCR END3

③ ACLR (Total check is discontinued. Before disconnecting, take note of erroneous parts.)

④ STRT T 1 (Programs after MCR END 3 are set on the basis of program setting circuit diagram.)

⑤ READ ▽ (Search)

⑥ CLR (Clear except address)

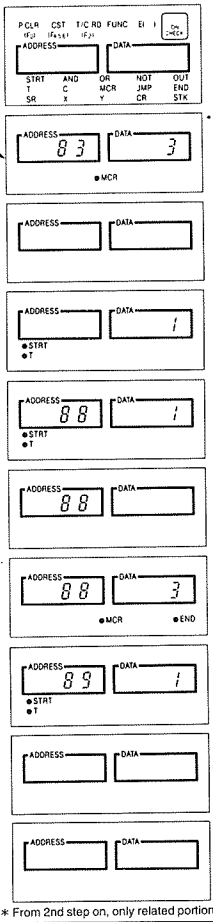
⑦ MCR END 3 (Setting of programs)

⑧ DELT INST (Insertion)

⑨ ACLR (Display clear)

⑩ READ ▽ (Total check again.)

A series of operations when programs MCR END 3 are inserted.

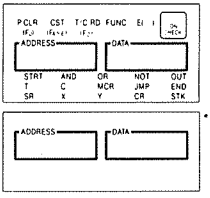


* From 2nd step on, only related portions are displayed for the sake of explanation.

• When there is no abnormality.

① ACLR (Display all clear)

② READ ▽ (Total check starts. Buzzer sounds and display part is entirely cleared.)



* From 2nd step on, only related portions are displayed for the sake of explanation.

• Before proceeding to the next page

When errors are found by ACLR READ ▽, operation is stopped at the address and contents are displayed.

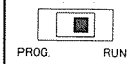
• When errors are found by pressing READ ▽, it is possible to continue checking.

Readout of elapsed value of timer/counter

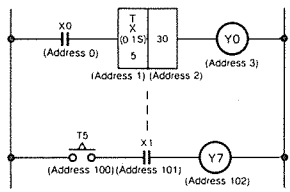
Elapsed condition of timer and counter programmed is read out during operation of Micro Controller.

(RAM Specification/ROM Specification)

(RUN Mode)



Example



Address	Contents of memory		
0	STRT	X (0.1S)	0
1	T	X (0.1S)	5
2	3	0	
3	OUT	Y (1S)	0
100	STRT	T	5
101	AND	X (0.1S)	1
102	OUT	Y (1S)	7

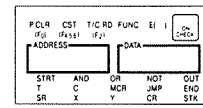
Operation Procedures

①

Positioning mode change switch to RUN.

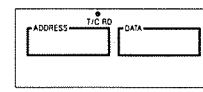
②

ACLR (Display all clear)



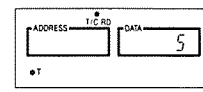
③

F 2 (Setting T/C read mode)



④

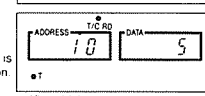
T 5 (Setting timer no. 5)



⑤

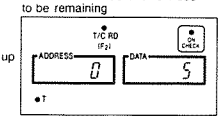
READ (Read-out)

2 s elapses after X0 is turned on.



"10" in ADDRESS shows 1 sec to be remaining

After time is up



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Mode change		Mode change switch of control unit is changed to RUN mode.
② Clearing display	ACLR	Display part all clear. (Light is put out.)
③ Designating T/C elapsed value readout mode	F 2	Light of timer/counter elapsed value read-out display turns on.
④ Setting T/C no.	T N key	Timer number is set.
	C N key	Counter number is set.
⑤ Readout of elapsed value	READ	Elapsed value is read out and displayed at address part.

• Explanation

• When micro controller is operated in RUN mode, elapsed value of timer/counter is read out, and operating condition can be confirmed. Timer and counter are displayed by down-counting.

• When it is desired to read out elapsed value of timer (or counter) as T6, T7... continuously, press READ key, then elapsed value of T6, T7 can be read out.

• Terminology

RUN: Condition of micro controller operating.

• Before proceeding to the next page

When mode change switch of control unit is put to "RUN", LED of RUN display of control unit is lit.

Changing of set value of timer/counter

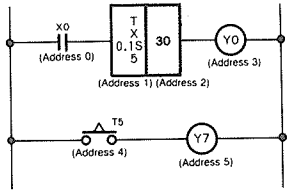
Set value of timer or counter programmed during operation of micro controller can be changed.

(RAM Specification)

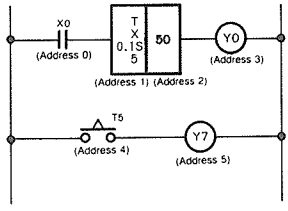
(PROGRAM Mode) (RUN Mode)

Example

- Before change of set value (T5 is set at 3.0 s)



- After change of set value (T5 is changed to 5.0 s)



Operation Procedures

① ACLR (Display all clear)

② T X (0.1S) 5 (Timer T5 is set.)

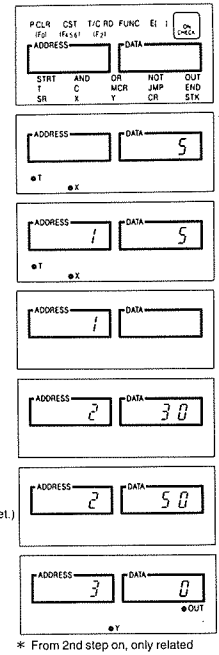
③ READ ▼ (Search)

④ CLR (Search is discontinued.)

⑤ READ ▼ (Display of set value)

⑥ CLR 5 0 (New set value is set.)

⑦ WRT (Set value is changed.)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Display clear	ACLR	Display part all clear. (Light is put out.)
② Timer or counter is set.	For timer: T, X (0.1S), 5, N key, OR; For counter: C, N key	No. of timer or counter, whose set value is desired to be changed, is set.
③ Retrieval	READ ▼	Timer or counter set is retrieved.
④ Retrieval is discontinued.	CLR	Cleared, leaving address display part.
⑤ Set value displayed.	READ ▼	Set value to be changed is displayed.
⑥ New set value is set.	CLR, N key	New set value desired to be changed is set.
⑦ Change of set value	WRT	Change of set value is executed

Explanation

- Set value of timer or counter programmed during operation of micro controller can be changed. It is convenient when set value requires frequent change like a molding machine.
- When changing set value during limited time or count, it operates with a new set value after time is up or count is up in the condition of former set value.

Before proceeding to the next page

- Changes can be made also in PROGRAM mode.
- While using memory (ROM) unit, remove it and then make change.

Monitoring of circuit continuity

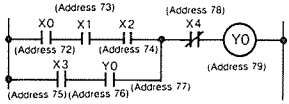
(RAM Specification /ROM Specification)

Monitors operating condition of coil part and contacts of each relay, timer and counter programmed with micro controller operating, and checks whether circuit is in continuity condition or not.

(RUN Mode)

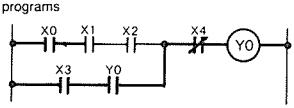
PROG. RUN

Example



Address	Contents of memory		
72	STRT	X (0 1S)	0
73	AND	X (0 1S)	1
74	AND	X (0 1S)	2
75	STRT	X (0 1S)	3
76	AND	Y (1S)	0
77	OR	STK	
78	AND	NOT X (0 1S)	4
79	OUT	Y (1S)	0

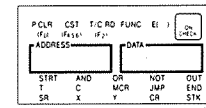
When operating condition from Y0 to X0 is checked in the order of programs



Continuity condition becomes clear as shown by thick line.

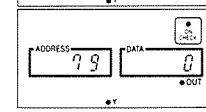
Operation Procedures

① ACLR (Display all clear)

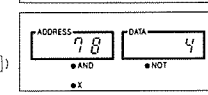


② OUT Y 0 (Setting program)

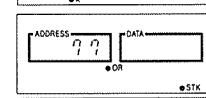
③ READ (Search) ON Condition



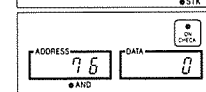
④ ▲ (Contents NOT 4) Continuity



⑤ ▲ (Contents STK) (Light of ON CHECK does not go on.)

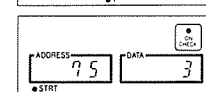


⑥ ▲ (Contents 0)



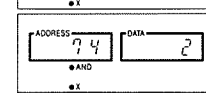
Continuity

⑦ ▲ (Contents 3)



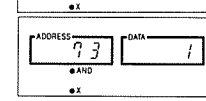
Continuity

⑧ ▲ (Contents 2)



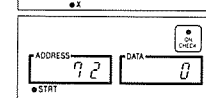
Interruption

⑨ ▲ (Contents 1)



Interruption

⑩ ▲ (Contents 0)



Continuity

∗ From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display part all clear. (Light is put out.)
② Setting programs	I Key N Key	Program of starting point desired to be traced is set.
③ Retrieval	READ	Address of program set is retrieved, and if circuit is in continuity, light of "ON CHECK" goes on.
④ Trace starts.	▲	When decrement key is pressed, address is decreased by 1, contents of that memory begin to be displayed and continuity begins to be monitored.
⑤ Trace	▲	Further, when this key is pressed, address is decreased by 1, contents of that memory are displayed and continuity is monitored.
	READ	When read key is pressed instead of decrement key, address is increased by 1, contents of that memory are displayed and continuity is monitored.

• Explanation

• It is programmed halfway while micro controller is being operated.

I/O relay (Examples: X 015 1, Y 015 0)

Internal relay (Example: CR 3)

Timer (Examples: T 2, T X 015 2)

Counter (Example: C 5)

Shift register (Example: SR 7)

Contacts of the above operate, and circuit is monitored and checked whether it is in continuity condition.

• If circuit is in continuity condition, LED for displaying "ON CHECK" is lit.

• If address where contact operation is desired to be confirmed, is known, address may be set and read out. In this case, it is possible to read out freely from any address you like.

• By set value of AND · STK, OR · STK, set value of timer, and that of counter, and address of MCR, JMP, END, light of "ON CHECK" does not go on.

Note: The X contact used for high level instructions AND X160 to AND X180 and STR X181 to STR X185 does not have the significance of a contact, and for that reason the continuity status both during execution and non-execution is OFF.

Forced output

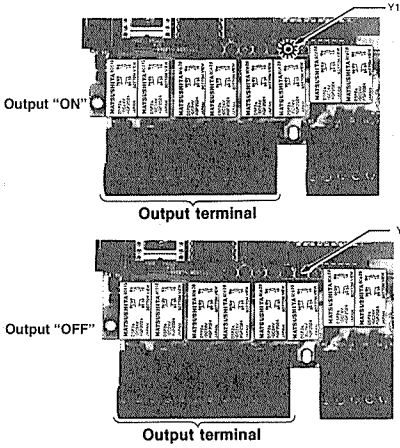
In case of test run of resistive apparatus, output relays of output units are forced operated regardless of program contents.

(RAM specification/ROM specification)

(PROGRAM mode)

Example

Forced output Y1



Operation procedures

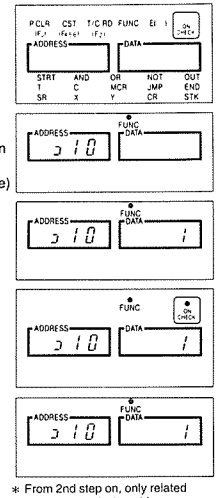
① ACLR (Display all clear)

② F 1 0 (Designation of forced output mode)

③ 1 (Setting of output relays numbers forced setting and resetting of output)

④ OUT Output "ON"

⑤ NOT Output "OFF"



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Clearing display	ACLR	Display all clear.
② Setting of forced output mode	F 1 0	Setting to forced output mode.
③ Setting of forced setting and resetting of output.	N key	Setting of No. of output relays for forced setting and resetting of output.
④ Output "ON"	OUT	Forced setting and resetting of output relays previously set.
⑤ Output "OFF"	NOT	Release forced setting and resetting of output.

• Explanation

• Forced output can be made regardless of program contents.

• In addition, when you want a forced output for Y2, following the operation ④ above, the [▼] key is pushed, and after the output relay number is increased by 1, by means of the [◇] key, the output "ON" is caused as a forced output. If [▼] and [◇] are pushed successively, Y3 and Y4 outputs mandatorily in succession. Also, conversely if the [▲] and [◇] are pushed, Y0 will mandatorily output.

By means of the above operation, many points can be output at the same time.

• Terminology

Forced output: Output relays are operated forcedly regardless of program contents.

• Before proceeding to the next page

When the [ACLR] key is pressed, all outputs go OFF and the forced output mode is cancelled.

Readout of high speed counter elapsed value

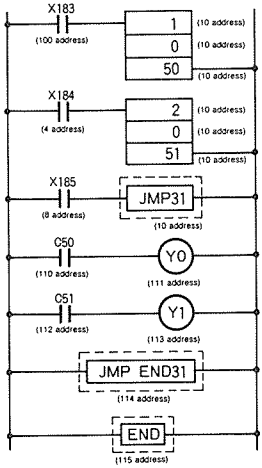
Read-out of the elapsed status of the high-speed counter programmed during programmable controller operation.

(RAM specifications/ROM specifications)

(RUN mode)

PROG. RUN

Example



Operation sequence

① Mode-select switch to RUN

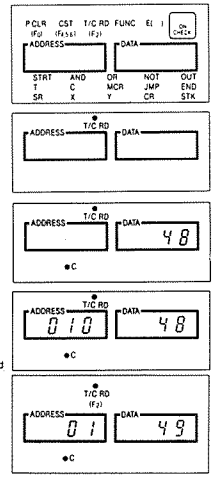
② ACLR (Display all clear)

③ F 2 (Setting of T/C read mode)

④ C 4 8 Designating the "hundreds" and lower digits of the high-speed counter

⑤ READ ▼ Readout of the "hundreds" and lower digits

⑥ READ ▼ Readout of the "thousands" and higher digits



* From 2nd step on, only related portions are displayed for the sake of explanation.

Address	Contents of memory	Address	Contents of memory
100	STRT X 1 8 3	108	STRT X 1 8 5
101	1	109	JMP 3 1
102	0	110	STRT C 5 0
103	5 0	111	OUT Y 1
104	STRT X 1 8 4	112	STRT C 5 1
105	2	113	OUT Y 1
106	0	114	JMP END 3 1
107	5 1	115	END

Basic Operation Procedures

① Mode change-over		Mode change-over switch of control unit is changed to RUN mode.
② Clearing display	ACLR	Display part all clear. (Light is put out.)
③ Designating T/C elapsed value read-out mode.	F 2	Light of timer/counter elapsed value read-out display goes on.
④ High-speed counter elapsed-value designation.	C 4 8	Designates high-speed counter elapsed-value "hundreds" position and lower.
	C 4 9	Designates high-speed counter elapsed-value "thousands" position and higher.
⑤ Readout of elapsed time	READ ▼	Elapsed value is read out and displayed at address part.

• Explanation

• Because the high-speed counter counts upward, the display is the addition method.

• Elapsed-value "hundreds" position and lower are displayed by C 4 8.

• Elapsed-value "thousands" position and higher are displayed by C 4 9.

Elapsed-value...61023

Read-out by C 4 8

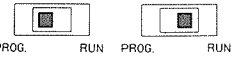
Read-out by C 4 9

Readout and setting of data memory

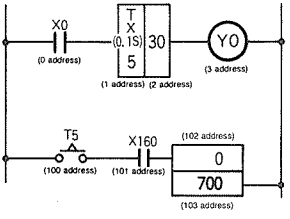
Readout of data memory values during micro controller operation.

(RAM specifications/ROM specifications)

(PROGRAM mode) (RUN mode)



Example



Address	Contents of memory		
0	STRT	X (0.1S)	0
1	T	X (0.1S)	5
2	3	0	
3	OUT	Y (1S)	0
100	STRT	T	5
101	AND	X (0.1S)	1 6 0
102	0		
103	7	0	0

Operation sequence

①

Mode-select switch to RUN

②

ACLR (Display all clear)

③

F 8 (Setting of T/C read mode)

④

7 0 0 (Making the data memory 700 address setting)

⑤

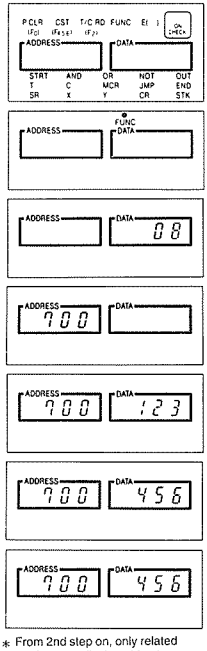
READ (Readout)

⑥

CLR 4 5 6 (New set value is set)

⑦

WRT (Set value is changed)



* From 2nd step on, only related portions are displayed for the sake of explanation.

Basic Operation Procedures

① Mode change-over		Mode change-over switch of control unit is changed to RUN mode.
② Clearing display	ACLR	Display part all clear. (Light is put out.)
③ Designating memory area value readout and setting.	F 8	Light to FUNC. display goes on.
④ Setting of data memory address	N N N	Sets the memory area no.
⑤ Readout	READ	Displays data memory values.
⑥ New set value set	CLR N N N	Sets new set value
⑦ Set value changed	WRT	Change the set value

• Explanation

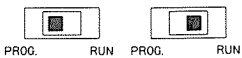
- Display is blank if data memory data are BIN data.
- The designatable memory areas no. range are 700 to 999 and special memory area 621 to 699.
- When reading out sequentially like 701, 702..., press READ key.
- The value in the data memory can be changed during operation.

Constant value change of constant transfer instruction

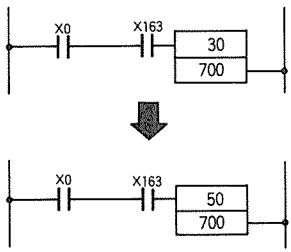
The constant value of the constant transfer instruction can be changed while micro controller operates.

(RAM specifications)

(PROG mode) (RUN mode)



Example



Operation sequence

①

ACLR (Display all clear)

②

AND ⊣⊢ X 1 6 3 (Sets the constant transfer command.)

③

READ ▼ (Search)

④

CLR (Clears, except address display.)

⑤

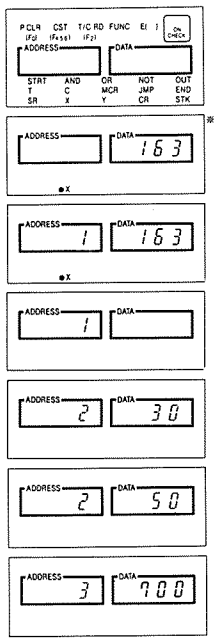
READ ▼ (Fixed constant display)

⑥

CLR 5 0 (New constant set)

⑦

WRT (Constant change)



* From 2nd step on, only related portions are displayed for the sake of explanation.

• Explanation

Changes the constant values among the programmed constant transfer instructions while the micro controller is being operated.

4-2. Password setting DIP switch

Note: Passwords function not available for M2RL type.

Passwords function

Function	Contents	RAM spec.		ROM spec.	
		PROG. mode	RUN mode	PROG. mode	RUN mode
1. Password setting	Protects program operation such as write, read etc.	●			
2. Password input	PL Programmer operation will be possible with password (8 digits) input when password is set	●	●	●	●
3. Password changing	Changes password	●			
4. Password initialization	Clears password (Clears user programs, data at the same time)	●		※	

※ Password initialization is possible only when EEP-ROM is installed.
Password operation is operated by DIP switch (X16 to X19).

Password setting

By setting the password, program write-in, read-out and other programmer services can be protected.

(RAM specifications)

(PROGRAM mode)

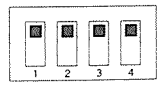
※ If any mistake is made in the operation of the DIP switches, start again from the beginning.

※ The password can be initialize if it is unknown.
(Refer to following page, Password initialization, for further information.)
And note danger, that the user program and data memory contents are all cleared in this instance.

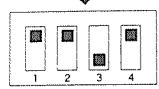
Operation Procedures

① Set the mode-select to the PROG mode.

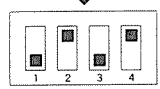
② Set the DIP switches in the following order.



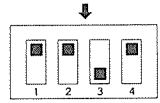
Set all DIP switches (1 to 4) to ON.



Set DIP switch 3 to OFF.

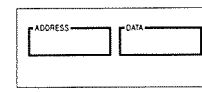


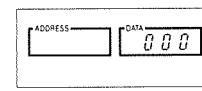
Set DIP switch 1 to OFF.



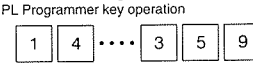
Set DIP switch 1 to ON.

When the buzzer sounds, the mode changes to the password-change mode.

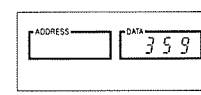




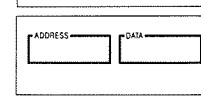
③ Password setting
PL Programmer key operation



Maximum: 8 digits (numerical keys)



④ WRT (setting)



⑤ Power OFF
The protect function is activated after the power is switched OFF.

Explanation

- Ordinary program operations can be conducted if the password setting is not made.
- The password setting can be made:
  1. When you begin a program.
  2. If the password is duplicated when you try and enter it.
- When there is password initialization (PROG mode).
- If the WRT key is pressed without pressing numerical keys, the setting will change to 00000000 (initialization).
- The eight digits immediately prior to pressing the WRT key will be newly set as the password.
- Keys (excluding WRT and CLR) other than numerical keys are not input.
- If there are fewer than eight numerical keys, zeros are used as the leading digits.
  Example: When 3 keys are used:
  1 2 3 WRT
  The password is 00000123.
- For the password "00000000", there is a change to the initialization mode, and the password function is not activated.
- For ROM use, the ROM's password takes precedence. If there is program transfer to the EEP-ROM, the present password is also set to the EEP-ROM.

Password input

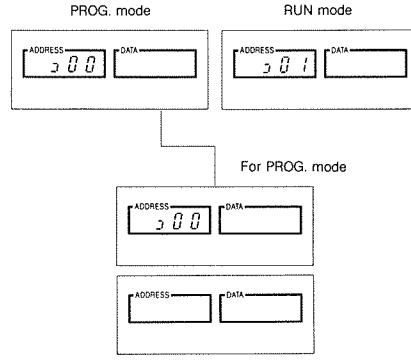
If the password is set programming is possible.
Password must be entered in order for program to start.

(RAM/ROM specifications)

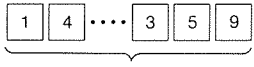
(PROGRAM mode) (RUN mode)

Operation Procedures

① Password input mode indicated.
Password input standby mode.



Password input
② Programmer key operation

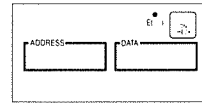


Maxmimum: 8 digits (numerical keys)

③ WRT (input)

- When the password is matched, the "Ɔ 00" or "Ɔ 01" display disappears and program operation is possible.

- If it does not match.



The error LED illuminates and the alarm sounds.
Reset by the [CA] key.

■ Explanation

The eight digits immediately prior to pressing the [WRT] key will be input as the password.

If there are fewer than eight digits, the leading digits will become the same as zero set input.

Example: Password "123"

Key operation

[0] [0] [0] [0] [0] [1] [2] [3] [WRT]

- If a ROM (EP-ROM/EEP-ROM) is connected to the IC socket, the ROM password must be input, because it takes precedence.

If the ROM is taken out without program transfer ([F] [9] [0] [WRT]) or run operation, there will be a return to the password when the RAM was used, as well as the user program and data memory.

- The password is not to be transferred to a tape. Because the tape program has no effect on the password.

Password change

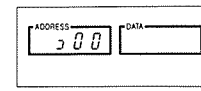
For a change of the password.

(RAM specifications)

(PROGRAM mode)

Operation Procedures

① Set the mode-select switch to the PROG. mode.



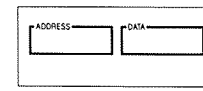
② Input the password now set.

[1] [4] •••• [3] [5] [9]

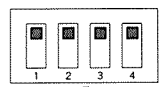
Password setting no. (8 digits)

[WRT]

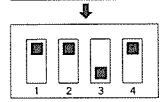
③ Set the DIP switches in the following order.



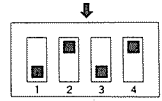
※ If any mistake is made in the operation of the DIP switches, start again from the beginning.



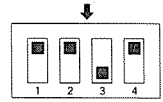
Set all DIP switches (1 to 4) to ON.



Set DIP switch 3 to OFF.



Set DIP switch 1 to OFF.

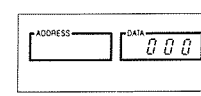


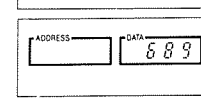
Set DIP switch 1 to ON:
When the buzzer sounds, the mode changes to the password-change mode.

④ New password setting Programmer key operation

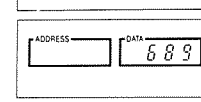
[2] [4] •••• [6] [8] [9]

Maximum: 8 digits (numerical keys)





⑤ [WRT] (change).



⑥ Power OFF
The protect function is activated after the power is switched OFF.

Explanation

- The eight digits you press before the [WRT] key will be the new password.
- If the [WRT] key is pressed without pressing numerical keys, the password will be initialize as 00000000, and the programmer service protection will be cancelled. (The user program and the data memory will be stored.)
- For an EP-ROM, the password cannot be changed. Re-use after erasing ultra-violet rays.

Password initialization

Initialize the password if it is forgotten, or if there is a password malfunction due to a problem, or some emergency.

(RAM specifications/ EEPROM specifications

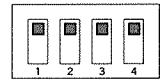
(PROGRAM mode)

※ If any mistake is made in the operation of the DIP switches, begin again from the beginning.

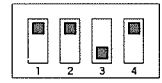
Operation Procedures

① Set the mode-select switch to the PROG. mode.

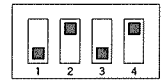
② Set the DIP switches in the following order.



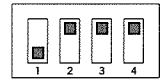
Set all DIP switches (1 to 4) to ON.



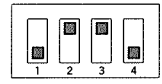
Set DIP switch 3 to OFF.



Set DIP switch 1 to OFF.



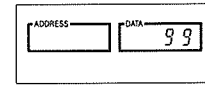
Set DIP switch 3 to ON.



Set DIP switch 4 to OFF.

Set all DIP switch to OFF

Programmer buzzer sounds.
For EEP-ROM



The "99" disappears to indicate the initialization is completed.

Explanation

- A RAM-specification password and EEP-ROM-specification password can be initialized.
  For EP-ROM, re-use after erasing ultra-violet rays.
- When a RAM password and EEP-ROM password are initialized, the user program and data memory contents are all cleared.
- To change the password (from the presently used password to 00000000), follow the procedures in "Password change".

CHAPTER 5

DIAGNOSTICS AND APPLICATIONS

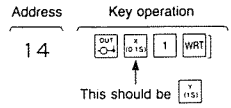
"PC" is the abbreviation for Programmable Controller.

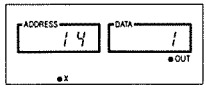
5-1. Syntax Error Checking

(I) Combination operation of unallowable instruction keys

Contact number error

Example

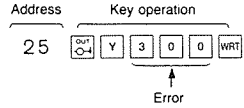




Light of LED for operation display "X" turns on and off and buzzer sounds.

(II) Use of unallowable numbers.

Example



Display flashes light and buzzer sounds.

Use the following Numbers.

Number	Description	Remarks
Input no.	X0 to X255	
Output no.	Y0 to Y255	
Internal relay no.	CR0 to CR251	
Timer no.	T0 to T63	including T CR, T X (0 1 5) and T Y (1 5)
Counter no.	C0 to C47, C50 to C81	
Master control relay no.	MCR0 to MCR31	
Jump no.	JMP0 to JMP31	

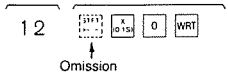
Besides the above,

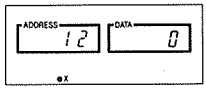
Initialize pulse relay number	: CR252
Scan pulse relay number	: CR253
0.1 s clock relay number	: CR254
Battery problem sensing relay number	: CR255

(III) Mis-operation in forming 1 (one) word necessary for programming

1) Program write without instruction key

Example Address Key operation

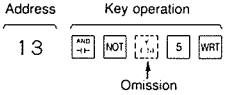


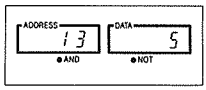


Light of LED for operation display "X" turns on and off, and buzzer sounds

2) Program write without auxiliary instruction key.

Example Address Key operation

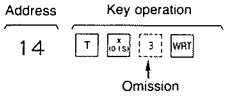


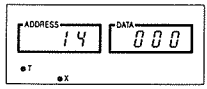


Buzzer sounds.

3) When writing program without data, not programming I/O no., internal relay no., timer no., counter no., master control relay (MCR, MCR END) no., and JUMP (JMP, JMP END) no.

Example Address Key operation

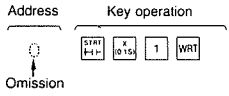


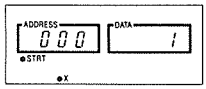


"000" appears in data display part, and light turning on and off, and buzzer sounds.

4) Write program without address

Example Address Key operation



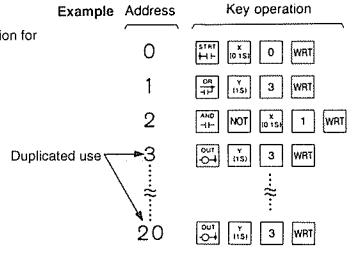


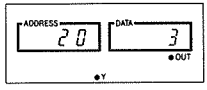
Light of "000" turns on and off in address display part, and buzzer sounds.

(IV) Duplicated use of instruction

1) It is impossible to use OUT instruction for same output relay.

Example Address Key operation

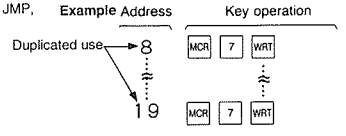


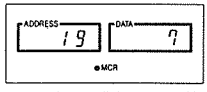


Display flashes light and buzzer sounds.

2) Duplicated use of instruction MCR, JMP, MCR END, JMP END

Example Address Key operation

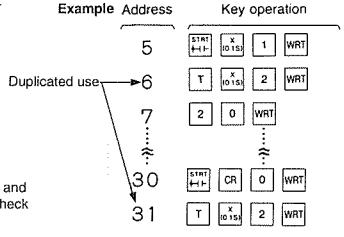


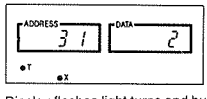


Display flashes light turns and buzzer sounds.

3) Duplicated use of timer and counter instrctions

Example Address Key operation





Display flashes light turns and buzzer sounds.

Concerning duplicated use of timer and counter instructions, make a total check of the instruction contact.

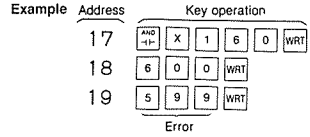
Notes 1) When data is written with duplicated items, first mis-operation is displayed and light turns on and off.
2) For either of the above, delete the error place by using CLR WRT . For 4) of (III), however, press the CLR key.

(V) Errors related to high level instructions (Errors other than when a memory area that cannot be designated by an operand is designated)

Note: Refer to the designatable operand for instruction.

1) Designation of an unallowable memory area no.

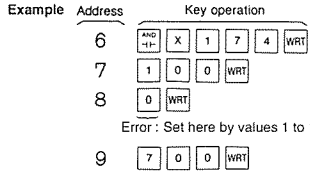
Example

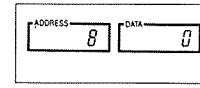


Display flashes light and buzzer sounds.

2) Designation of an unallowable numerical value

Example

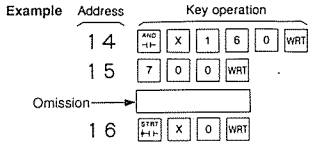


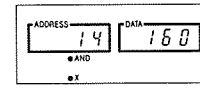


Display flashes light and buzzer sounds.

3) Operand insufficiency

Example



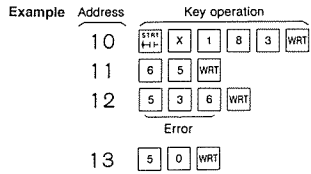


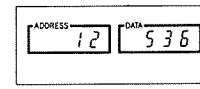
Operation display "AND" and "X" LEDs turns on and off continuously, and the buzzer sounds.

(VI) Error related to high speed counter instructions

1) If designated set value exceeds maximum counting value

Example

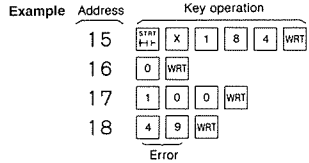


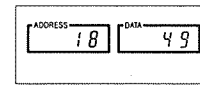


Display flashes light and buzzer sounds. (In this instance, if the maximum count value is 65535)

2) Use of unallowable contact numbers

Example

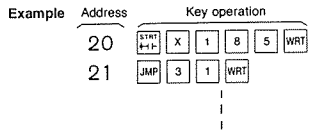




Display flashes light and buzzer sounds.

3) If there is a high speed scan area designation instruction without a setting instruction

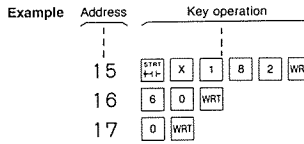
Example

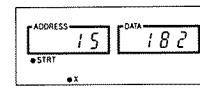


Operation display "STRT" and "X" LEDs turns on and off continuously, and the buzzer sounds.

4) If there is a maximum count value setting instruction after setting value instructions STRT X183, X184.

Example





Operation display "STRT" and "X" LEDs turns on and off continuously, and the buzzer sounds.

Notes: If the total check is made by instructions that have more than one operand (high level instructions, high speed counter, etc.), all operands, beginning from the operand at which there was an error, are displayed.
The error display disappears when the operand at which there was an error is corrected.

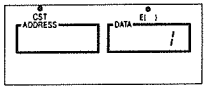
5-2. Error Messages

1. List of Cassette Loader Function Error Messages

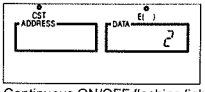
(1) Improper preparation for tape recorder
- Mis-connection of connecting cord
- Cassette is not moving
- Insufficient volume

(2) Wrong collation of tape with memory contents
- Contents of tape differ from those of memory
- Insufficient volume

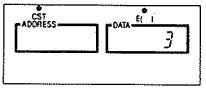
(3) Bad playback of tape
- When abnormality occurs to tape recorder during playback
- Insufficient volume



Continuous ON/OFF flashing light and buzzer sounds.



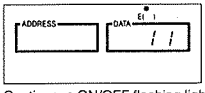
Continuous ON/OFF flashing light and buzzer sounds.



Continuous ON/OFF flashing light and buzzer sounds.

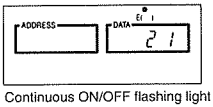
2. Simplified ROM Writer Function Error Messages

(1) Wrong
- Contents of EEP-ROM differ from those of internal RAM.



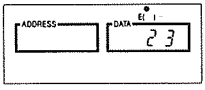
Continuous ON/OFF flashing light and buzzer sounds.

(2) Total check error
- When a program with syntax errors is written into EEP-ROM



Continuous ON/OFF flashing light and buzzer sounds.

(3) Readout error
- When transfer instruction to the internal RAM from ROM (F 9 0 WRT) is programmed without attaching the ROM.



Continuous ON/OFF flashing light and buzzer sounds.

5-3. Alarm Indicator LED

Alarm indicator LED which is attached at control board will be turned on at following occasions.

Error check	Alarm method	Output	Others
Abnormality of memory (including RUN mode, syntax error etc.)	Turns on alarm indicator LED	OFF	Turn off power supply to reset.
Abnormality of CPU			
Memory (ROM) disconnected during Power ON			
Abnormality of battery	Flashing alarm indicator LED	No change	CR255 relay will be turned ON when battery is abnormal.

5-4. Memory Check

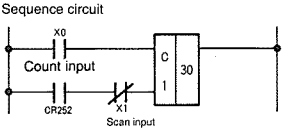
- When mode change switch is put to "RUN", memory is checked automatically.
- Contents of check are same as in total check.
- When abnormality is detected, light of ALARM LED display of control unit turns on. Output relays are entirely turned off.
- When abnormality is detected, cut off power source and let apparatus reset, put mode change switch to "PROG" and turn on power source again. Then after checking contents of instruction totally, check contents of programmer, and then make device RUN.

5-5. Use of the Special Internal Relay

1. **Initialize pulse relay (CR252)**
   This relay makes 1 scan immediately after the start of operation, then turns OFF.
   From the next scan, because it turns ON, it can be used to reset the counter and shift register to their initial condition.

Example

- Sequence circuit

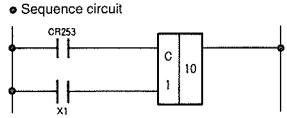


Immediately after the starting of operation, the counter can be used at any time in the reset condition.

2. **Scan pulse relay (CR253)**
   For each scan it repeats ON and OFF. It can be used to produce a timer having a shorter unit than 0.01 second timer.

Example

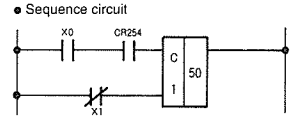
- Sequence circuit



3. **0.1 second clock relay (CR254)**
   This relay repeats ON and OFF every 0.1 second. It can be used in combination with a counter as a retention timer of 0.2 second unit (power interruption memory).

Example

- Sequence circuit

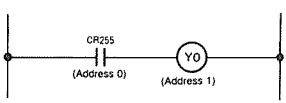


If the CR254 is used, it can become a 0.2 second stepping accumulating timer.

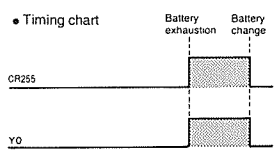
4. **Battery abnormal-condition detection relay (CR255)**
   For the control unit, a lithium battery is used as a back-up for the built-in memory (RAM).
   If the battery is exhausted, the control unit's ALARM LED flashes, and, in addition, this relay can used as a battery abnormality detection relay on programs by designating CR255.

Example

Circuits for programming



- Timing chart



- Program

Address	Key operation					
0	STRT	CR	2	5	5	WRT
1	OUT	Y (15)	0	WRT		

Output Y0 can be used as a battery cut off sensing output contact.

5-6. Battery Exchange for Back Up

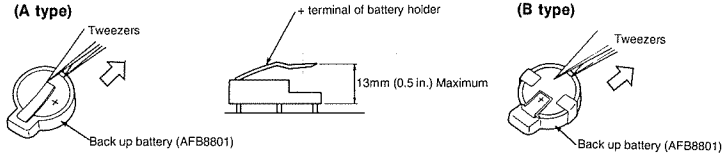
Exchange back up battery is as follows:

- **Exchange parts**

A lithium battery (AFB8801) is prepared as exchange part.

- **Method of exchange**

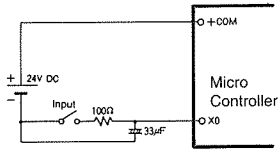
1. When ALARM LED in the Micro Controller is lit, it is time to exchange a back up battery. Exchange the battery within one week.
2. The battery is inserted in the battery holder located on the rear surface (soldered side) of the control board. With the power off, remove the control board and pull out the battery sideways using insulated tweezers. Before inserting the battery, check that nothing is attached to the + and – surfaces. With the + side facing up, insert the battery by sliding it in sideways. The battery should be inserted within 5 minutes and the height of the + terminal of the battery holder A type should be 13mm (0.5 in.) or less.



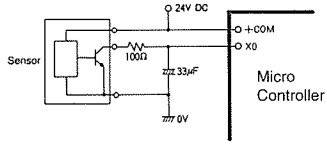
5-7. High Speed Pulse Input

Depending on the influence of the scan time and the noise preventive circuit of the input, the high speed pulse is not sometimes inputted, but if a C-R (capacitor-resistor)circuit is put between the input sensor and the Micro Controller a high speed pulse can be inputted.

Contact type input

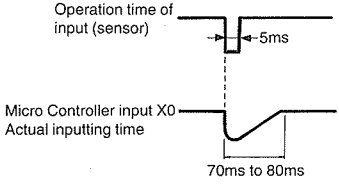


Non-contact type input



Timing chart

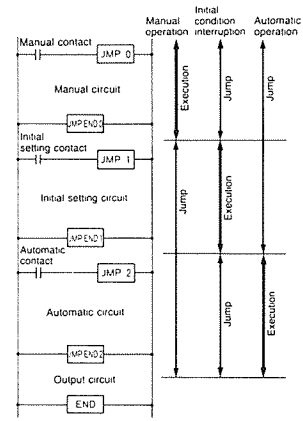
The example shows the input of a high speed pulse of 5ms.



5-8. Scan-speed Increasing System

The [JMP] instruction can shorten the processing time of the program actually executed and increase the scan speed. The example shows an instance in which the circuit is divided into three parts.
If, for example, it is activated for a maximum of 7.5 ms, scanning for one-third (approximately 2.5 ms) of that time is possible.

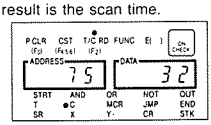
Example



5-9. Simple Measurement of Scan Time

Using the scan pulse relay (CR253), 0.1sec clock relay (CR254) and counter (UP/DOWN type), the scan time can be measured and displayed.

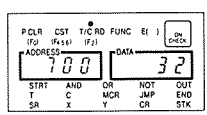
Measurement procedure I
Using a fact that one count is done every two scans, measure how many seconds are required to execute 999 counts.*
Set the display in the RUN mode and push the keys [MNT] [F] [2] [C] [3] [2] and [▼] to read out C32.
The number of counts in C32 are indicated on the address display. If the value measured is multiplied by 10^{-4} s, the result is the scan time.



This example shows a scan time of about 7.5 ms.

*: Although a count of 1000 would be ideal, the control unit can be set only to the 999 count. This is, however, within the tolerable error limit, and is therefore not an impediment.

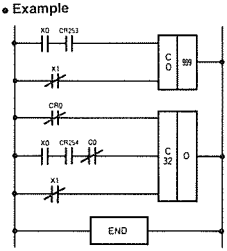
Measurement procedure II
Using a fact that one count is done every 0.2 second, measure how many time it is scanned for 10 seconds.
Though it is displayed in the same as the measurement procedure I, the calculation is necessory.
This is more accurate than the procedure I.



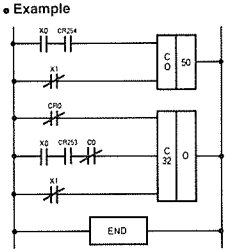
In this case, $5 \div 700 = 0.00714\ldots$ about 7.1 ms is obtained.

- **Measurement program circuit example**
  For use of X, C and CR, select those which have not been used in the main program yet.
  X1 is used for input of the count reset signal and X0 is for input of the measurement start signal.
  Be sure to use an addition/subtraction type counter as the counter to display the measurement (C32 is used here).

- **Example**



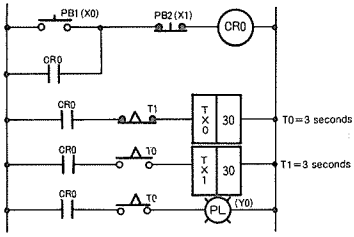
- **Example**



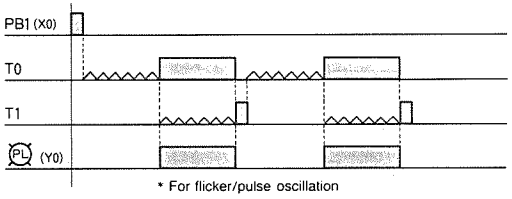
5-10. Program Examples

1. Timer instructions

1) Repeating circuit (flicker circuit)

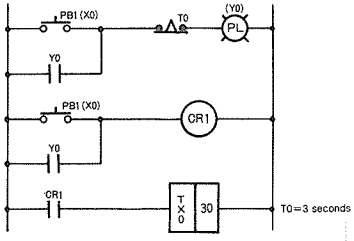


• Timing chart

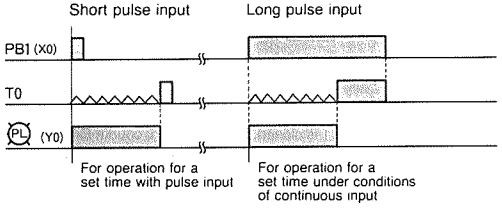


* For flicker/pulse oscillation

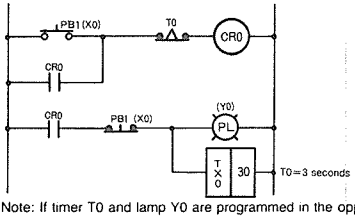
2) One-shot circuit (set period operation)



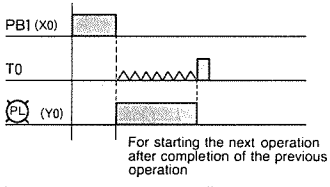
• Timing chart



3) OFF-delay circuit I

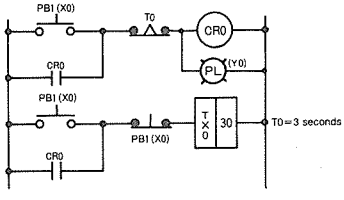


• Timing chart

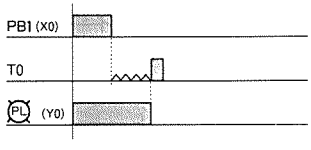


Note: If timer T0 and lamp Y0 are programmed in the opposite order, the operation will be different.

4) OFF-delay circuit II

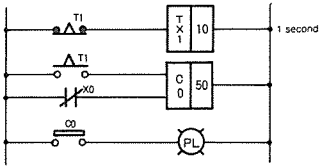


• Timing chart

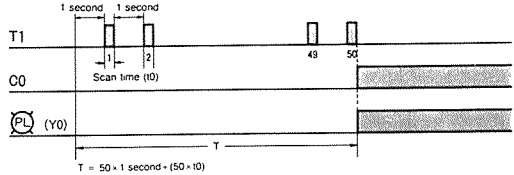


2. Counter instructions

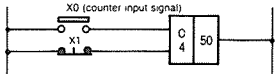
1) Long-time timer circuit



- Timing chart

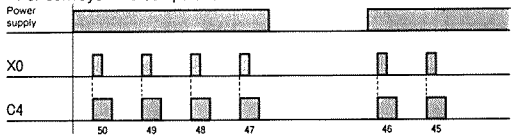


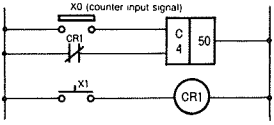
2) Holding counter circuit



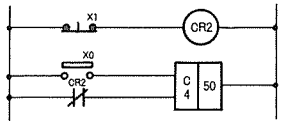
When the power supply is on, if the input X1 is closed, the value of counter C4 holds, but if the input is open, counter C4 is reset.

- For conveyor line computation

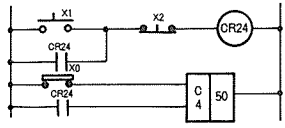




When the power supply is on, input X1 can be open or closed. But if X1 is closed, in the next scan, counter C4 will be reset.



When the power supply is on, if input X1 is closed, counte C4 will be reset. If it is open, counter C4 will hold the same.

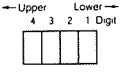


The counter status before the power supply is turned off is sent by input X1 into the internal relay (holding type) CR24 for self-holding. Therefore, when the power supply is turned on again, the counter C4 value will be the same.

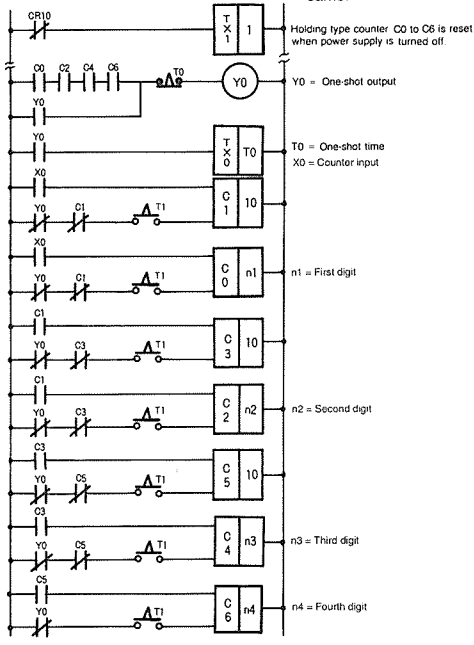
3. Four-digit counter circuit

The counter value can be up to four digits.

After the counting, the output is used as a one-shot output.

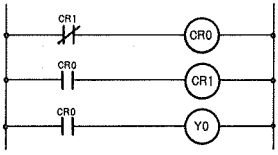


Note: Counter elapsed values can only be read one at a time

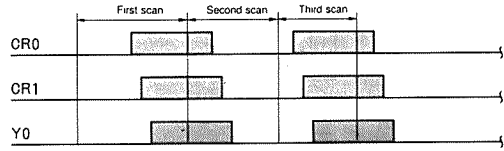


4. How to use the internal relay (CR)

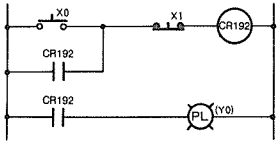
1) Clock signal circuit using the scan time



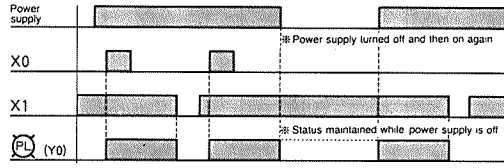
• Timing chart



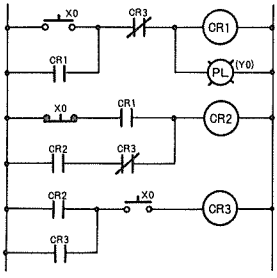
2) Using a holding type relay (CR192 to CR251)



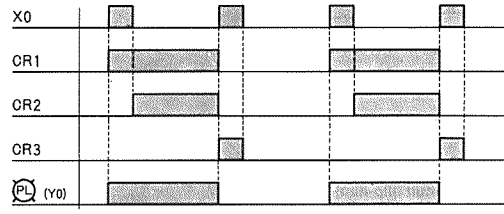
• Timing chart



3) One input latch (flip-flop) circuit



• Timing chart



4) Output branch circuit

Fig. Ⓐ

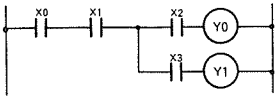
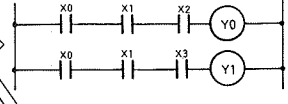
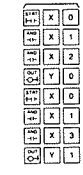


Fig. Ⓑ



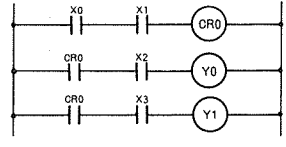
• Program

Memory content



• The circuit in Fig. Ⓐ cannot be programmed as is. It must be programmed as Fig. Ⓑ or Fig. Ⓒ.

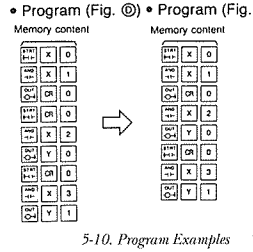
Fig. Ⓒ



• Operation of Fig. Ⓒ
The Fig. Ⓐ can be reorganized as Fig. Ⓒ.
The program for Fig. Ⓒ is shown in Fig. Ⓓ.
The CPU register content between LD CR 0 and LD CR 0 does not change.
Therefore, no problems arise even if LD CR 0 is omitted.
(Fig. Ⓔ is also acceptable.)

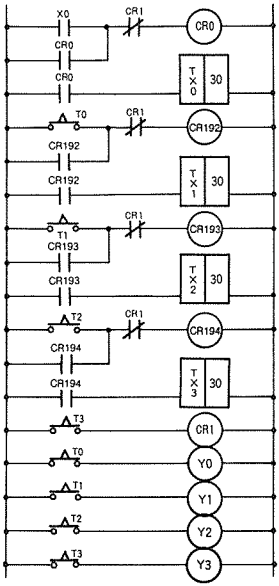
• Program (Fig. Ⓓ) • Program (Fig. Ⓔ)

Memory content

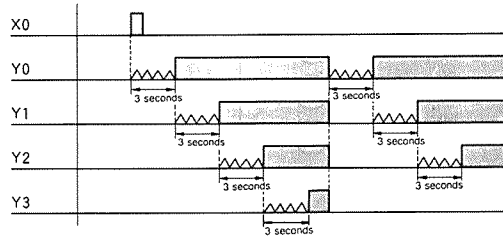


5) Example of connection operation in case of power failure

• Circuit for programming



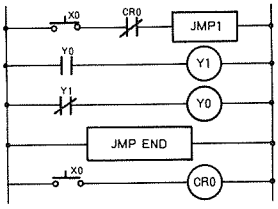
• Timing chart



• CR192 to CR194 are holding relays. For example, if the power supply is cut off at the Timing that CR192 is turned on, when the power supply is turned on again, T1 will start timing from 0.

5. How to use the JMP instruction

1) Bistable circuit (flip-flop)



• **Within the a_1 timing (X0: ON status)**

During the first scan, Y1 Y0 will be processed and CR0 will operate during the second scan so that the JMP circuit will be off and nothing can be processed.

• **Within the a_2 timing**

In the first scan (Y0=ON in the previous cycle)

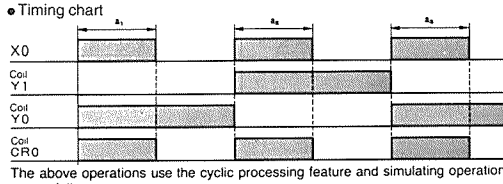
Y0 Y1 Y1 Y0 is processed, and CR0 will operate in the second scan so that the JMP circuit will be off and nothing can be processed.

• **Within the a_3 timing**

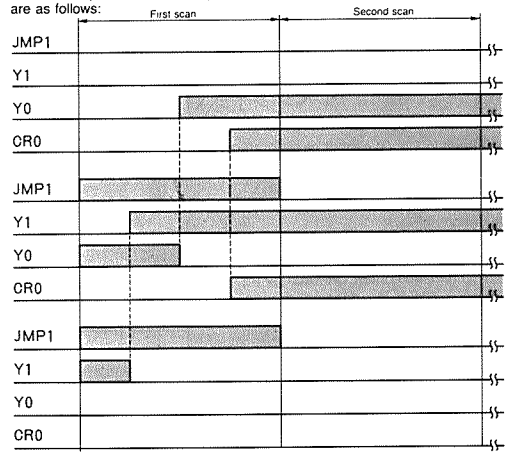
In the first scan (Y1=ON, Y0=OFF in the previous cycle)

Y0 Y1 Y1 Y0 is processed, and CR0 will operate in the second scan so that the JMP circuit will be off and nothing can be processed.

• Timing chart



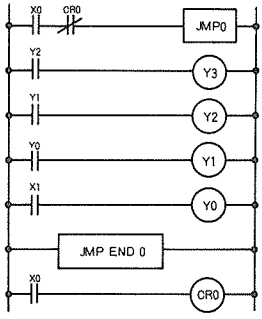
The above operations use the cyclic processing feature and simulating operations are as follows:



2) Shift register circuit

A shift register is a register (temporary memory) that moves (shifts) the data a stage at a time with a shift signal. When this operation is done with a micro controller, the basic circuit and program are as follows.

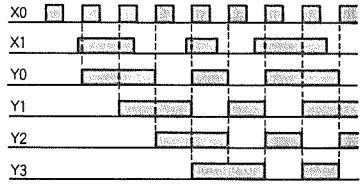
• Circuit for programming



• Program

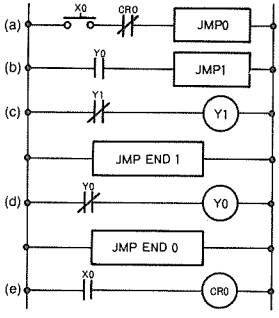
Address	Content of memory
0	START X 0
1	AND NOT CR 0
2	JMP 0
3	START Y 2
4	OUT Y 3
5	START Y 1
6	OUT Y 2
7	START Y 0
8	OUT Y 1
9	START X 1
10	OUT Y 0
11	JMP END 0
12	START X 0
13	OUT CR 0

• Timing chart

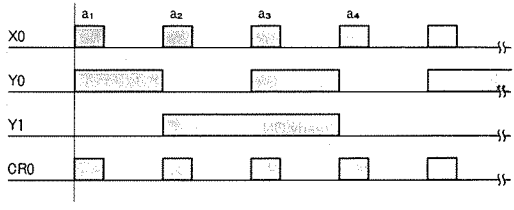


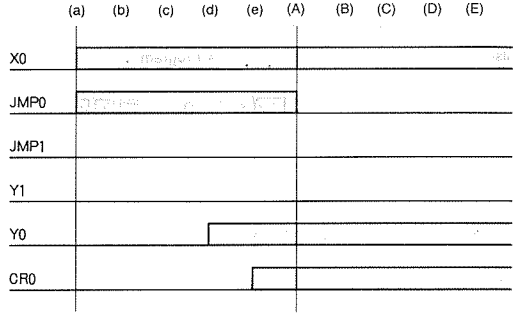
• Example of a 4-level shift register Y0, Y1, Y2 and Y3 respectively represent step 1, step 2, step 3 and step 4; X0 represents the shift input, and X1 represents the data input.

3) Binary counter



• Timing chart





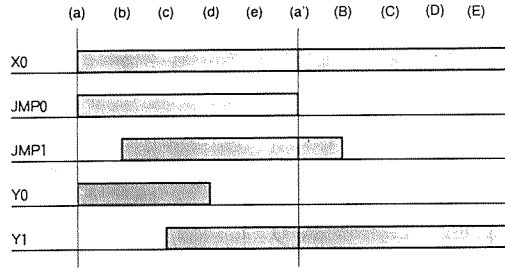
• **a_1 timing (X0; ON status)**

When X0 goes from OFF to ON with the (a) timing, JMP 0 goes ON, and processing can be done until JMP END 0. With the (b) timing, Y0 is OFF and thus the processing from JMP 1 to JMP END 1 cannot be done. Therefore, Y1 remains OFF. With the (d) timing, Y0 goes ON. With the (e) timing, CR0 goes ON.

• **a_2 timing**

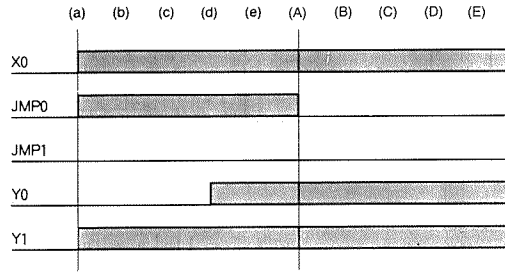
With the (a) timing, JMP 0 goes ON and the processing can be done until JMP END 0.
With the (b) timing, Y0 is ON and thus the processing can be done for JMP 1 to JMP END 1.
With the (c) timing, Y1 goes ON.
With the (d) timing, Y1 goes OFF.
With the (e) timing, CR0 goes ON.

• Timing chart



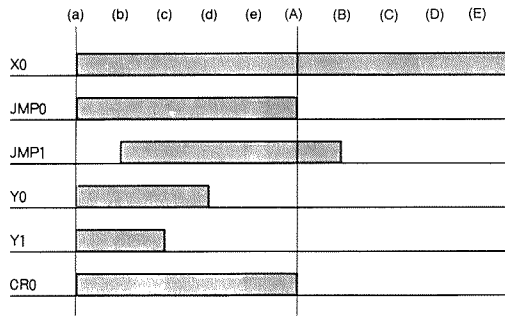
• **a_3 timing**

With the (a) timing, JMP 0 goes ON and the processing can be done until JMP END 0.
With the (b) timing, Y0 is OFF and thus the processing cannot be done for JMP 1 to JMP END 1. Therefore, Y1 remains ON.
With the (d) timing, Y0 goes ON.
With the (e) timing, CR0 goes ON.



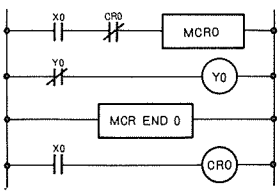
• **a_4 timing**

With the (a) timing, JMP 0 goes ON and the processing can be done until JMP END 0.
With the (b) timing, Y0 is ON and thus the processing can be done for JMP 1 to JMP END 1.
With the (c) timing, Y1 goes OFF.
With the (d) timing, Y0 goes OFF.
With the (e) timing, CR0 goes ON.
In the timing for a_1, a_2, a_3, and a_4 for the next scan (A) timing, CR0 is already ON and thus JMP 0 goes OFF and no processing can be done until JMP END 0. After this, until the a_2 timing, JMP 0 remains OFF, the processing of from JMP 0 to JMP END 0 is not doen, and no change occurs in Y0, Y1.



6. How to use the MCR instruction

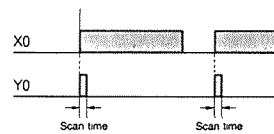
• Pulse circuit



• Program

Address	Content of memory
0	START X 0
1	AND NOT CR 0
2	MCR 0
3	START NOT Y 0
4	OUT Y 0
5	MCR END 0
6	START X 0
7	OUT CR 0

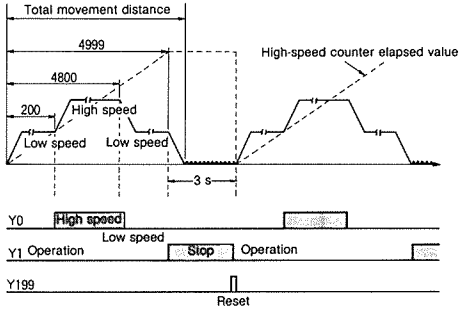
• Timing chart



7. How to use the high speed counter

Setting	Key Operation
High speed counter count maximum setting:	[START] [X] [015] 1 8 2
High speed counter ON setting:	[START] [F] [015] 1 8 3
High speed counter OFF setting:	[START] [X] [015] 1 8 4
High speed counter high speed scan area designation:	[START] [F] [015] 1 8 5 + [JMP] 3 1 to [JMP] [END] 3 1

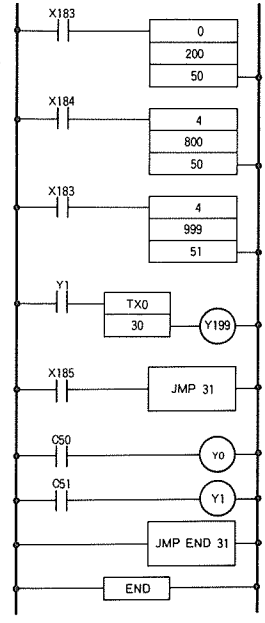
Start
(Elapsed value: 0)



(Y0: High-speed switching signal
Y1: Start/Stop signal)

When reset is applied (Y199 is switched ON), contacts C50 to C81 are all switched OFF, and the high speed scan area is executed. As a result, Y0 and Y1 are switched OFF and TX0 is reset by the next scan, so that Y199 is also switched OFF and reset is cancelled.

• Program Example



Contact C50 is switched ON when the high speed counter elapsed value is 200.

Contact C50 is switched OFF when the high speed counter elapsed value is 4800.

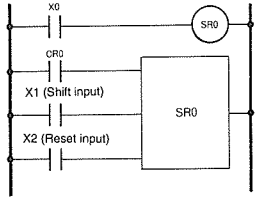
Contact C51 is switched ON when the high speed counter count is 4999.

High speed counter reset relay Y199 is switched ON three seconds after Y1 is switched ON.

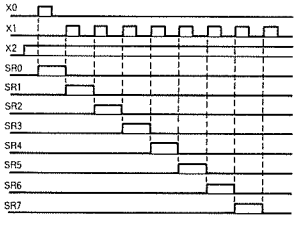
High speed scan area

8. Shift Register Application

• Circuit for programming



• Timing chart



CHAPTER 6

ANALOG BOARDS

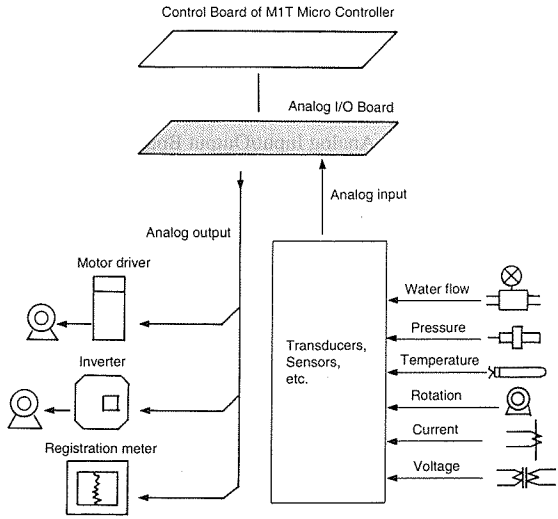
Analog boards applicable M1T Transistor Output Micro Controller;

- Analog Input/Output Board : AFB6480
- A/D Converter Board : AFB6400
- D/A Converter Board : AFB6410

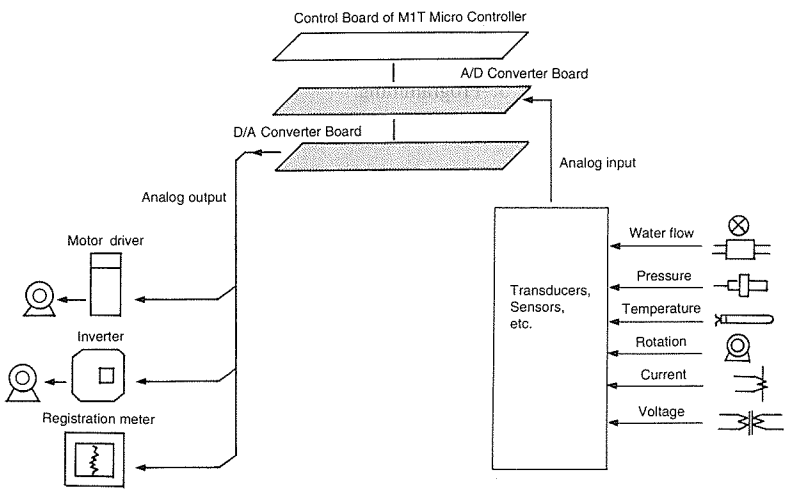
"PC" is the abbreviation for Programmable Controller.

6-1. System Configurations

1. Analog I/O Board

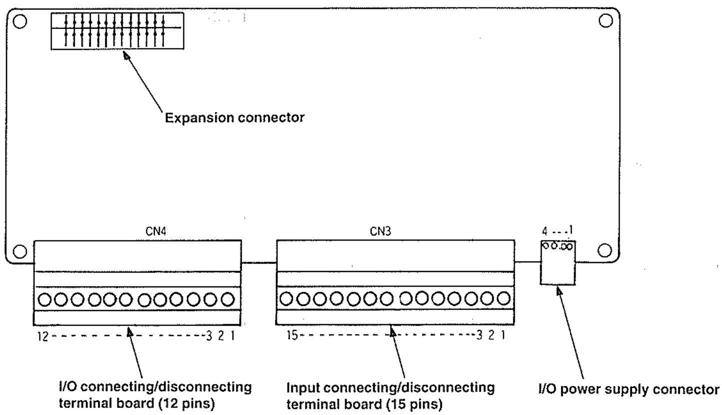


2. A/D and D/A Converter Boards

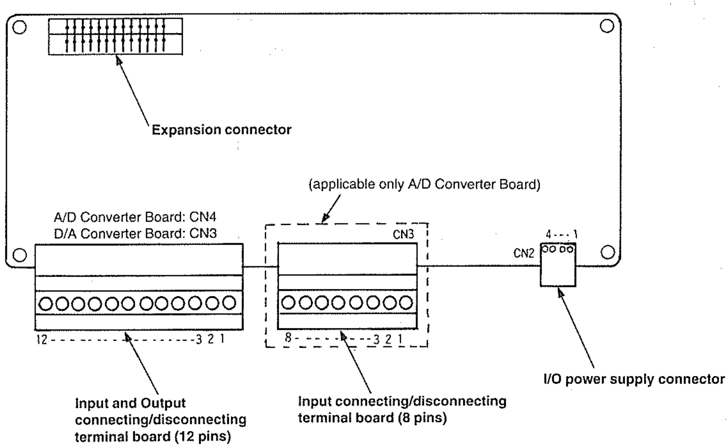


6-2. Board Descriptions

1. Analog I/O Board



2. A/D and D/A Converter Boards



6-3. Specifications

1. General Specifications

Items	Specifications
Ambient operating temperature:	0°C to 50°C (32°F to 122°F)
Ambient storage temperature:	–20°C to 70°C (–4°F to 158°F)
Ambient operating humidity:	30% to 80% RH (non-condensing)
Vibration resistance:	10Hz to 55Hz, 1 cycle per minute, double amplitude 0.75mm (0.03in.), 10 minutes for each of the X, Y and Z directions.
Shock resistance:	10G or more, four times in each of the X, Y and Z directions.
Noise resistance:	800V or more, with pulse width 1 μs (based on in-house measurements)

2. Performance Specifications

■ Analog I/O Board

1) Analog input

Items	Specifications
Input:	Four channels per board
Input signal range:	
Voltage :	0V to 5V or 0V to 10V (change over)
Current :	0mA to 20mA
Resolution:	1/256
Total accuracy:	±3LSB (at 25°C/77°F), ±5LSB (at 0 to 50°C/32°F to 122°F)
Conversion speed:	Maximum 2.5 ms per channel
Input impedance:	
Voltage :	Minimum 1MΩ
Current :	250Ω
Maximum absolute input:	
Voltage :	+15V
Current :	+30mA
Digital output:	BCD 0 to 255

2) Analog output

Items	Specifications
Output:	One channel per board
Output signal range:	
Voltage :	0V to 5V or 0V to 10V (change over)
Current :	0mA to 20mA
Resolution:	1/256
Total accuracy:	±1.0% F.S. (at 25°C/77°F), ±2.0% F.S. (at 0 to 50°C/32°F to 122°F)
Conversion speed:	Maximum 2.5 ms per channel
Output impedance:	Maximum 0.5Ω (at voltage output)
Maximum Ouptut current:	20mA (at voltage output)
Output load range:	0 to 500Ω (at current output)
Digital input:	BCD 0 to 255

3) Common

Items	Specifications
Insulation method:	Photocoupler insulation between I/O terminals and Micro Controller power supply (not insulated between channels)
I/O terminals:	27-point terminal
Internal current consumption:	Maximum 50mA per board (5V internal power supply) (supplied by Micro Controller control board)
External power supply: (See note)	20.4V DC to 26.4V DC (Current: Maximum 250mA per board)
Expansion:	Four boards per control board (address setting: switch selectable)

Note: Power to the board (24V DC) should be supplied either through the expansion power supply connector (CN2) or through the input terminal (CN3).

■ A/D and D/A Converter Boards

1) A/D Converter Board

Items	Specifications
Input:	Four channels per board
Input signal range:	
Voltage :	0V to 5V or 0V to 10V (change over)
Current :	0mA to 20mA
Resolution:	1/1,000
Total accuracy:	±1.0% F.S. (at 25 °C/77°F), ±2.0% F.S. (at 0 to 50°C/32°F to 122°F)
Conversion speed:	Maximum 2.5 ms per channel
Input impedance:	
Voltage :	Minimum 1MΩ
Current :	250Ω
Maximum absolute input:	
Voltage :	+15V
Current :	+30mA
Digital output:	BCD 0 to 999

2. D/A Converter Board

Items	Specifications
Output:	Two channels per board
Output signal range:	
Voltage :	0V to 5V or 0V to 10V (change over)
Current :	0mA to 20mA
Resolution:	1/1,000
Total accuracy:	±1.0% F.S. (at 25°C/77°F), ±2.0 F.S. (at 0 to 50°C/32°F to 122°F)
Conversion speed:	Maximum 2.5 ms per channel
Output impedance:	Maximum 0.5Ω (at voltage output)
Maximum Output current:	20mA (at voltage output)
Output load range:	0 to 500Ω (at current output)
Digital input:	BCD 0 to 999

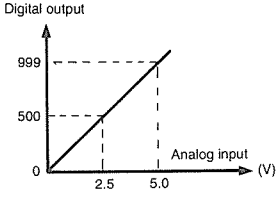
3) Common

Items	Specifications
Insulation method:	Photocoupler insulation between I/O terminals and Micro Controller power supply (not insulated between channels)
I/O terminals:	A/D Converter Board: 20-point terminal, D/A Converter Board: 12-point terminal
Internal current consumption:	Maximum 50mA per board (5V internal power supply) (supplied by Micro Controller control board)
External power supply: (See note)	20.4V DC to 26.4V DC (Current: Maximum 250mA per board)
Expansion:	Four boards per control board (address setting: switch selectable)

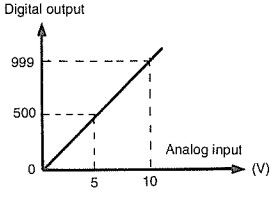
Note: Power to the board (24V DC) should be supplied either through the expansion power supply connector (CN2) or through the input terminal (CN3)

4) I/O Characteristics

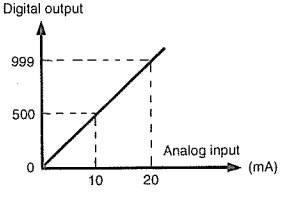
A/D Converter Board



(0 to 5V range)

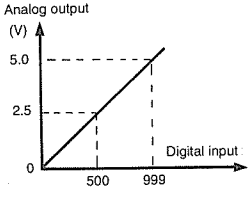


(0 to 10V range)

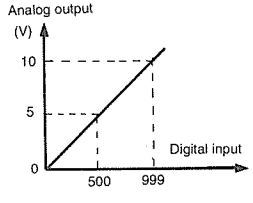


(0 to 20mA range)

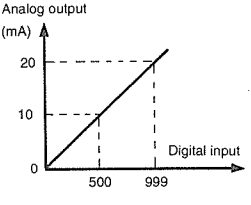
D/A Converter Board



(0 to 5V range)

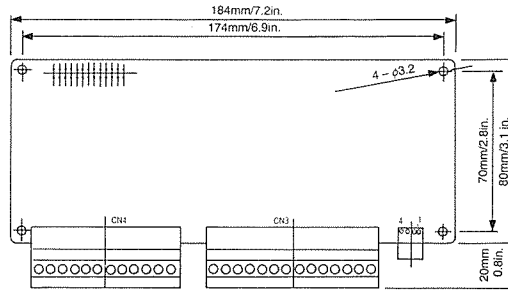


(0 to 10V range)

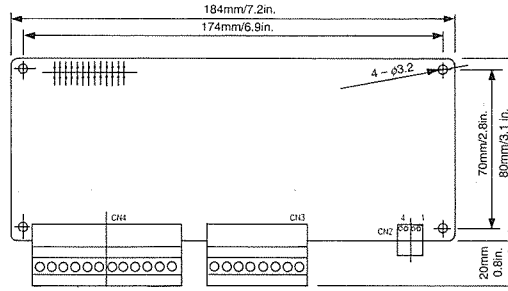


(0 to 20mA range)

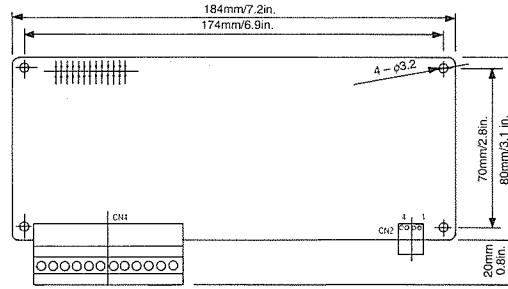
- Analog I/O Board



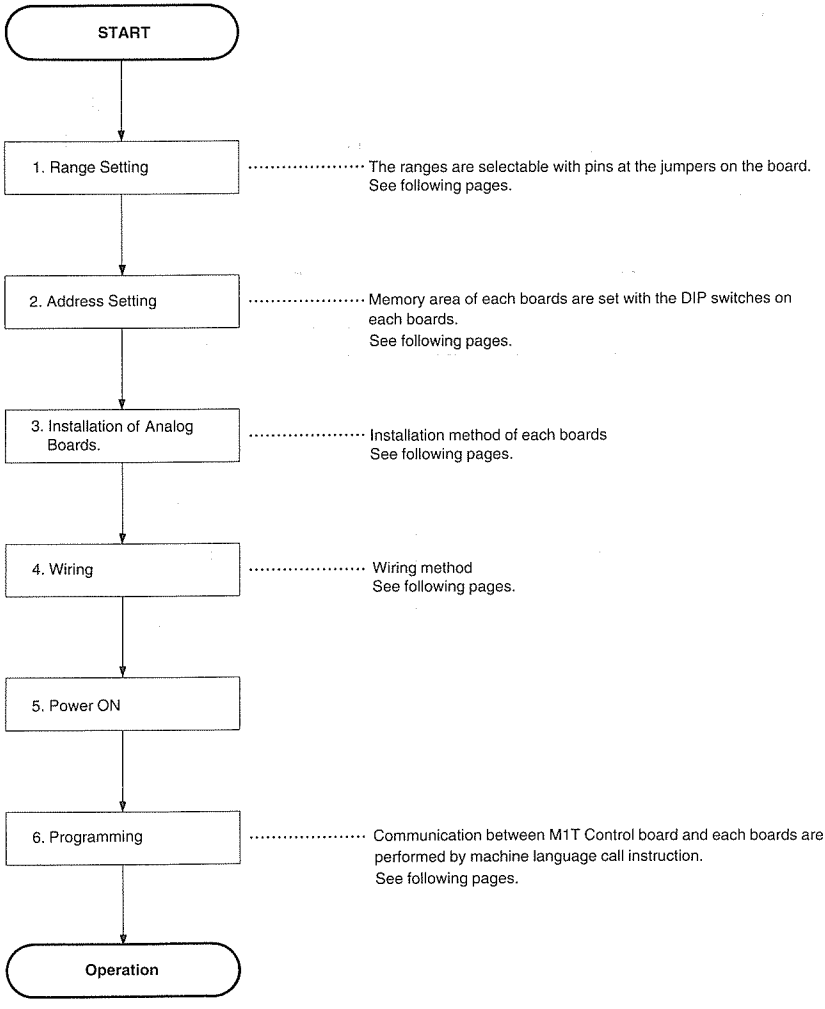
- A/D Converter Board



- D/A Converter Board



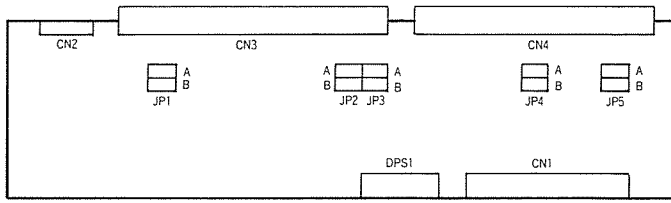
6-4. Configuring Analog Boards



1. Range Setting

The ranges are selectable with pins at the jumpers on the board.

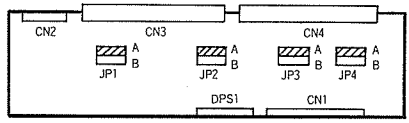
■ Analog I/O Board



Item		Jumper no.	Pin set position	Selectable range
Analog input	CH0	JP1	A	0 to 5V input
			B	0 to 10V input
	CH1	JP2	A	0 to 5V input
			B	0 to 10V input
	CH2	JP3	A	0 to 5V input
			B	0 to 10V input
	CH3	JP4	A	0 to 5V input
			B	0 to 10V input
Analog output	CH0	JP5	A	0 to 5V output
			B	0 to 10V output

Note: When shipped from the factory, the pins of the jumpers (JP1 to JP5) are set at "A" position.

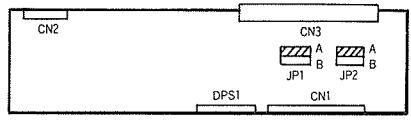
A/D Converter Board



Item		Jumper no.	Pin set position	Selectable range
Analog input	CH0	JP4	A	0 to 5V (or 0 to 20mA) input
			B	0 to 10V input
	CH1	JP3	A	0 to 5V (or 0 to 20mA) input
			B	0 to 10V input
	CH2	JP2	A	0 to 5V (or 0 to 20mA) input
			B	0 to 10V input
	CH3	JP1	A	0 to 5V (or 0 to 20mA) input
			B	0 to 10V input

Note: When shipped from the factory, the pins of the jumpers (JP1 to JP5) of the A/D Converter Board are set at "A" position. The JP5 of the A/D Converter Board should always be set at "A" position.

D/A Converter Board



Item		Jumper no.	Pin set position	Selectable range
Analogout-put	CH0	JP2	A	0 to 5V (or 0 to 20mA) output
			B	0 to 10V output
	CH1	JP1	A	0 to 5V (or 0 to 20mA) output
			B	0 to 10V output

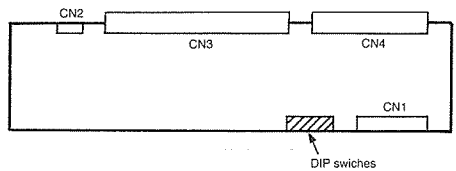
Note: When shipped from the factory, the pins of the jumpers (JP1 to JP4) of the D/A Converter Board are set at "A" position. The JP3 and JP4 of the D/A Converter Board should always be set at "A" position.

2. Address Setting

Memory are of the each Board are set with the DIP switches (DPS1) on each board as following:

■ Analog I/O Board

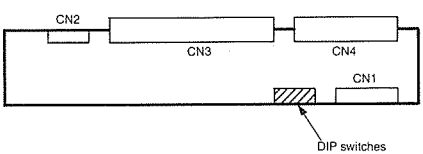
Board no.	DIP switches (DPS1)				Analog input memory area				Analog output memory area
	1	2	3	4	CH0	CH1	CH2	CH3	CH0
0	OFF	OFF	OFF	OFF	#652	#653	#654	#655	#668
1	ON	OFF	OFF	OFF	#656	#657	#658	#659	#670
2	OFF	ON	OFF	OFF	#660	#661	#662	#663	#672
3	ON	ON	OFF	OFF	#664	#665	#666	#667	#674



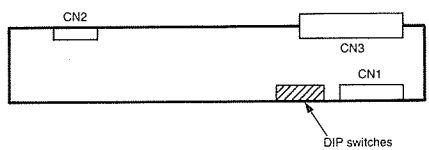
■ A/D and D/A Converter Boards

Board no.	DIP switches (DPS1)				Analog input memory area				Analog output memory area	
	1	2	3	4	CH0	CH1	CH2	CH3	CH0	CH1
0	OFF	OFF	OFF	OFF	#652	#653	#654	#655	#668	#669
1	ON	OFF	OFF	OFF	#656	#657	#658	#659	#670	#671
2	OFF	ON	OFF	OFF	#660	#661	#662	#663	#672	#673
3	ON	ON	OFF	OFF	#664	#665	#666	#667	#674	#675

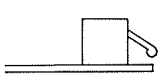
- **A/D Converter Board**

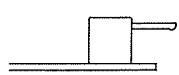


- **D/A Converter Board**



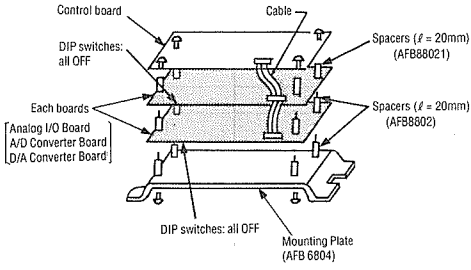
Note: When two or more boards with A/D functions (or with D/A functions) are connected to one Control Board, avoid specifying indentical memory area among themselves. (When one A/D Converter Board and one D/A converter Board are connected to one Control Board, the board numbers of two boards can be set to "0".)
The DIP switches (DPS1) are piano-key type (see pictures below).
When shipped from the factory, the piano-key tabs are set to board no.0.

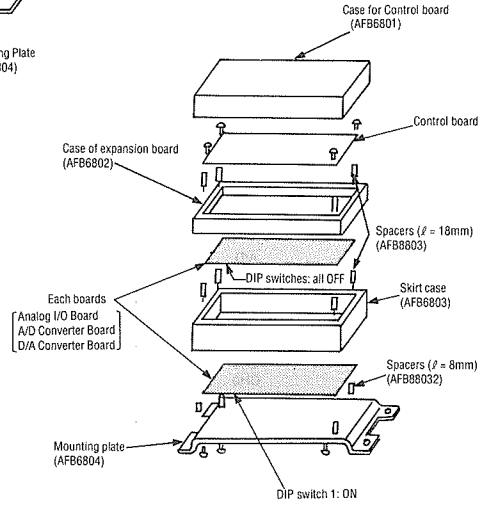




3. Installation of Analog Boards

When installing, adding or replacing boards, set the device address of each board with the DIP switches on the board referring to "2. Address Setting" not define identical address number.
Furthermore, take care not to bend the I/O pins of expansion connectors.
When installing, firmly secure the metal spacers with a hexagonal box wrench. (Opposite side 6mm)
To connect the board to the mounting plate (AFB6804), use the attached M3 screws and the metal spacers so that impedance becomes low value.
Finally, connect the cable for power junction to the 4-pin terminals on each board.
Cut excessive part of the cable for power junction with a wire cutter.
(When power is applied to A/D and D/A converter Boards through the CN3, do not connect power junction cable to them.)





Notes:

1. As the Micro Controllers are bare boards assembly, take special care not adhere conductive objects on the boards.
2. As precision electronic components are on the boards of Micro Controllers, first discharge static electricity and then handle the boards. Furthermore, do not touch the components nor terminals directly.
3. When installing or adding the boards to the Micro Control Unit (types with cases), please order specified spacers and cases because spacers for types with cases or cases are not attached to the additional expansion boards including A/D and D/A converter boards.
4. Do not install each boards (Analog I/O, A/D converter and D/A converter) between Expansion I/O boards.

■ Analog I/O Board

1. Terminal Specifications

- **Alignment of I/O terminals**

Terminal no.	Input and Output	Symbols	I/O specifications
CN3-1	External power supply IN	24V	24V DC
CN3-2		0V	
CN3-3	———	•	Not connected
CN3-4		•	
CN3-5		•	
CN3-6		•	
CN3-7		•	
CN3-8	A/D CH0	V0	Voltage input
CN3-9		I0	Current input
CN3-10		CO0	Input common
CN3-11		FG	Frame Ground
CN3-12	A/D CH1	V1	Voltage input
CN3-13		I1	Current input
CN3-14		CO1	Input common
CN3-15		FG	Frame Ground

CN4-1	A/D CH2	V2	Voltage input
CN4-2		I2	Current input
CN4-3		CO2	Input Common
CN4-4		FG	Frame Gound
GN4-5	A/D CH3	V3	Voltage input
CN4-6		I3	Current input
CN4-7		CO3	Input common
CN4-8		FG	Frame Ground
GN4-9	D/A CH0	V +	Voltage output
CN4-10		V –	Voltage output
CN4-11		I +	Current output
CN4-12		I –	Current output

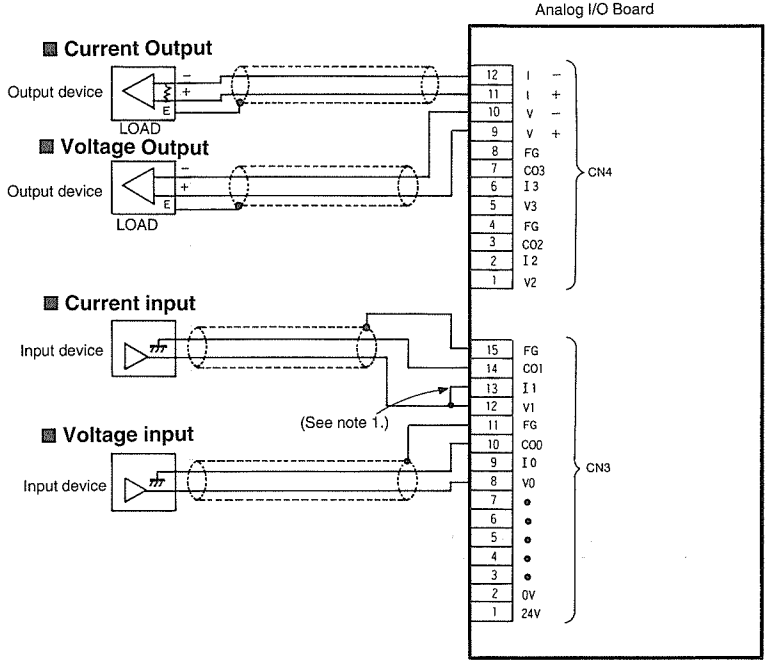
- **Alignment of expansion power supply terminals**

Terminal no.	Specifications	Symbols
CN2-1	24V DC	+
CN2-2	Not connected	
CN2-3	GND (0V)	–
CN2-4	GND (0V)	–

Note: Power supply of 24V DC to the Analog I/O Board should be applied either through CN3-1 and CN3-2 or through CN2-1 and CN2-3.

2. Wiring for Analog Input/Output

- To prevent electric or magnetic interference, use shielded twisted-cables (two-core) for input connections.
- Do not input cables close to the power supply or other high voltage lines nor bundle signal cables and high voltage lines together.
- The output cable should be grounded at the load equipment side.
  The input cable should be connected to the frame ground (FG) terminal of the Analog I/O Board.



Notes:

- When using current input, connect current input terminal "I1" to voltage input terminal "V1".
- Voltage and current range can not be used on the same channel at one time.
  Terminals for unused range should be left open.
- Use applicable wires AWG28 to AWG16 or sectional area of 0.08 to 2.5mm^2 (Stripped wire length: 7mm, tightening torque: 0.4Nm).
- When connecting more than two wires to a single terminal, select them as their total sectional area is within the applicable wire size.
  If stranded and soldered wires are connected to the same terminal, malconnection may occor.

A/D Converter Board

1. Terminal Specifications

- **Alignment of I/O terminals**

Terminal no.	Input	Symbols	I/O Specifications
CN3-1	External power supply IN	+	24V DC
CN3-2		–	GND
CN3-3	———	•	Not connected
CN3-4		•	
CN3-5	CH3	FG	Frame Ground
CN3-6		CO3	Input common
CN3-7		I3	Current input
CN3-8		V3	Voltage input

CN4-1	CH2	FG	Frame Ground
CN4-2		CO2	Input common
CN4-3		I2	Current input
CN4-4		V2	Voltage input
CN4-5	CH1	FG	Frame Ground
CN4-6		CO1	Input common
CN4-7		I1	Current input
CN4-8		V1	Voltage input
CN4-9	CH0	FG	Frame Ground
CN4-10		CO0	Input common
CN4-11		I0	Current input
CN4-12		V0	Voltage input

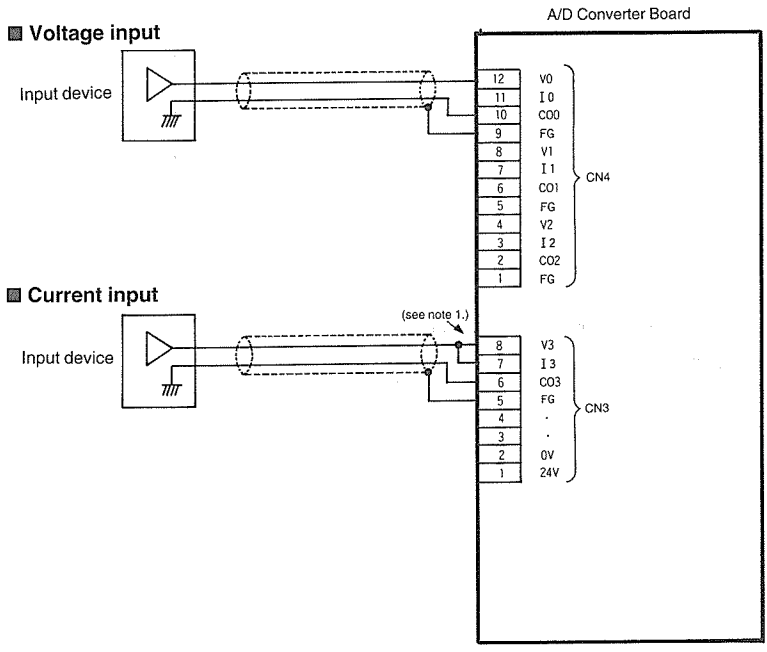
- **Alignment of expansion power supply terminals**

Terminal no.	Specifications	Symbols
CN2-1	24V DC	+
CN2-2	Not connected	
CN2-3	GND (0V)	–
CN2-4	GND (0V)	–

Note: Power supply of 24V DC to the A/D Converter Board should be applied either through CN3-1 and CN3-2 or through CN2-1 and CN2-3.

2. Wiring for Analog Input

- To prevent electric or magnetic interference, use shielded twisted-cables (two-core) for input connections.
- Do not input cables close to the power supply or other high voltage lines nor bundle signal cables and high voltage lines together.
- The input cable should be connected to the frame ground terminal of the A/D converter Board (Depending on the noise conditions, it might be better to ground the cable at the input equipment side.)



Notes:

- When using current input, connect current input terminal "I3" to voltage input terminal "V3".
- Use applicable wires AWG28 to AEG16 or sectional area of 0.08 to 2.5mm^2 (Stripped wire length: 7mm, tightening torque: 0.4Nm).
- When connecting more than two wires to a single terminal, select them as their total sectional area is within the applicabel wire size. If stranded and soldered wires are connected to the same terminal, malconnection may occor.

■ D/A Converter Board

1. Terminal Specifications

• Alignment of I/O terminals

Terminal no.	Input and Output	Symbols	I/O Specifications
CN3-1	External power supply IN	+	24V DC
CN3-2		–	GND
GN3-3	———	•	Not connected
CN3-4		•	
CN3-5	CH1	I1 –	Current output
CN3-6		I1 +	
CN3-7		V1 –	Voltage output
CN3-8		V1 +	
CN3-9	CH0	I0 –	Current output
CN3-10		I0 +	
CN3-11		V0 –	Voltage output
CN3-12		V0 +	

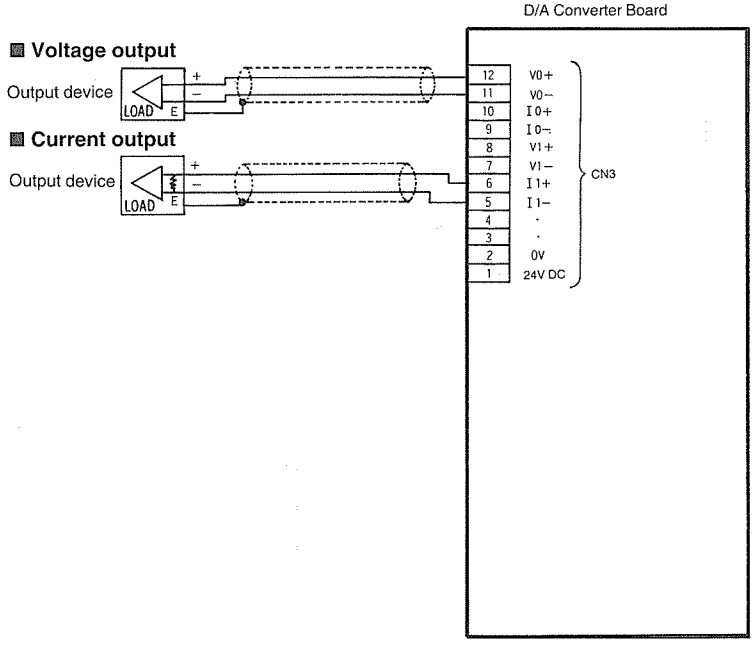
• Alignment of expansion power supply terminals

Terminal no.	Specifications	Symbols
CN2-1	24V DC	+
CN2-2	Not connected	
CN2-3	GND (0V)	–
CN2-4	GND (0V)	–

Note: Power supply of 24V DC to the D/A Converter Board should be applied either through CN3-1 and CN3-2 or through CN2-1 and CN2-3.

2. Wiring for Analog Output

- The prevent electric or magnetic interference, use shielded twisted-cables (two-core) for output connections.
- Do not output cables close to the power supply or other high voltage lines nor bundle signal cables and high voltage lines together.
- The output cable should be grounded at the load equipment side.
  (Depending on the noise conditions, it might be better not to ground the cable or to connect the cable to the output signal common side.)

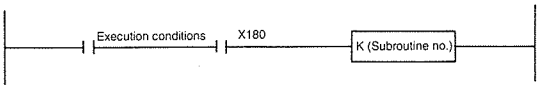


Notes:
- Voltage and current range can not be used on the same channel at one time.
  Terminals for unused range should be left open.
- Use applicable wires AWG28 to AWG16 or sectional area of 0.08 to 2.5mm^2 (Stripped wire length: 7mm, tightening torque: 0.4Nm).
- When connecting more than two wires to a single terminal, select them as their total sectional area is within the applicabel wire size.
  If stranded and soldered wires are connected to the same terminal, malconnection may occor.

■ Analog I/O Board

Communication between M1T Control board and Analog I/O Board is performed by machine language call instruction (X180).

1) Basic program

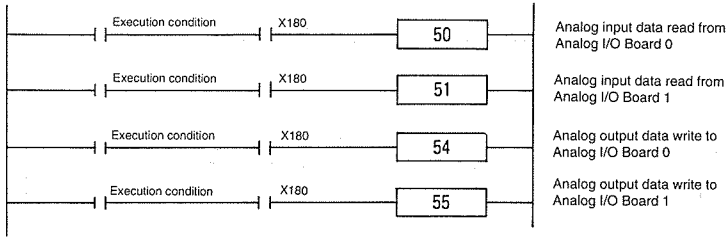


K	Operation
50	Store the 4-channel analog input data for "board 0" to memory area of #652 to #655.
51	Store the 4-channel analog input data for "board 1" to memory area of #656 to #659.
52	Store the 4-channel analog input data for "board 2" to memroy area of #660 to #663.
53	Store the 4-channel analog input data for "board 3" to memroy area of #664 to #667.
54	Read data from memory area #668 and transfer them to one analog output channel on "board 0".
55	Read data from memory area #670 and transfer them to one analog output channel on "board 1".
56	Read data from memory area #672 and transfer them to one analog output channel on "board 2".
57	Read data from memory area #674 and transfer them to one analog output channel on "board 3".

Notes:
- Data is stored in memory areas in 3-digit BCD (0 to 255).
- If analog input data of a non-exsistent board is read with the machine language call instruction, "255" is stored to the memroy area.
- When machine language subroutines of 50 to 53 are executed, operation flags of X196 to X199 are all reset.
- When machine language subroutines of 54 to 57 are executed, if the memory area to which data is to be output by these subroutines is not a BCD area, an error flag will be set.
- When machine language subroutines of 54 to 57 are executed in program mode, "000" will be output.

2) Program example

The following program assumes that two sets of Analog I/O Boards are connected to the M1T Control Board.
It reads eight channels of analog input data from Analog I/O Boards 0 and 1 into control board and writes output data to the two channels on Analog I/O Boards 0 and 1.

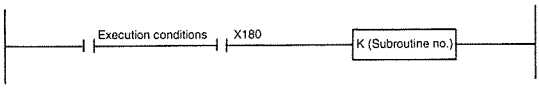


Note: This program can be used with the Micro Controller M1T with its version of ROM 1.2 or up.

■ A/D and D/A Converter Board

Communication between M1T Control board and A/D · D/A Converter Board is performed by machine language call instruction. (X180).

1) Basic program

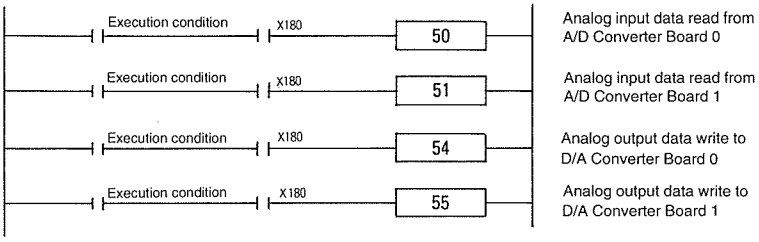


K	Operation
50	Store the 4-channel analog input data for "board 0" to memory area of #652 to #655.
51	Store the 4-channel analog input data for "board 1" to memory area of #656 to #659.
52	Store the 4-channel analog input data for "board 2" to memory area of #660 to #663.
53	Store the 4-channel analog input data for "board 3" to memroy area of #664 to #667.
54	Read data from memroy area #668 and #669 and transfer them to two analog output channels on "board 0".
55	Read data from memory area #670 and #671 and transfer them to two analog output channels on "board 1".
56	Read data from memory area #672 and #673 and transfer them to two analog output channels on "board 2".
57	Read data from memory area #674 and #675 and transfer them to two analog output channels on "board 3".

Notes:
- Data is stored in memory areas in 3-digit BCD (0 to 999).
- If analog input data of a non-exsistent board is read with the machine language call instruction, "255" is stored to the memory area.
- When machine language subroutines of 50 to 53 are executed, operation flags of X196 to X199 are all reset.
- When machine language subroutines of 54 to 57 are executed, if the memory area to which data is to be output by these subroutines is not a BCD area, an error flag will be set.
- When machine language subroutines of 54 to 57 are executed in program mode, "000" will be output.

2) Program example

The following program assumes that two sets of A/D and D/A Converter Boards are connecte to the M1T Control Board. It reads eight channels of analog input data from A/D Converter Boards 0 and 1 into control board and writes output data to the four channels on D/A Converter Boards 0 and 1.



Note: This program can be used with the Micro Controller M1T with its version of ROM 1.2 or up.

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Please contact .....

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