OMRON USER'S MANUAL

Programmable Controller

Model SYSMAC-M5R

ONICS CO.

INTRODUCTION

"OMRON SYSMAC" is the trade name of OMRON's programmable controllers unparalleled in reliability and versatility.
Programmable controllers, which were initially developed to meet the demands by equipment manufacturing industries and large-scale plants for their production facilities, now answer the needs of industries from every field and have become original equipment for installation at factories.
The above trend has induced original equipment manufacturers to design the incorporation of programmable controllers in their machinery and equipment, and thus the demand for availability of the programmable controllers that can be handled as easily as components has been increasing. Accordingly, OMRON has sought to develop programmable controllers which are: a. small and economical, b. easy to handle by merely connecting a load and power and c. easy to operate by anyone at site, in addition to possessing flexibility that permits adapting to changes to the controlled systems or control parameters with simple keyboard operation and high reliability which can be materialized only by electronic control.
OMRON now offers with confidence the OMRON SYSMAC-M5R Flat Board Type Programmable Controller, a first-class programmable controller with "CPU function" and "techniques responding adequately to the needs at every site." Programming with the SYSMAC-M5R can be performed easily and directly from ladder diagrams using the program console removable from the CPU base unit while the programmable controller is in operation or the optional graphic programming console (CRT).
SYSMAC-M5R is available in two basic types; 128 I/O type and 256 I/O type, enabling you to design a system for high cost-performance, according to the scale of the control required.
The programmable controller is software-compatible with the higher-grade version SYSMAC-M1R, so that it can be operated by a program written by the SYSMAC-M1R and loaded from a PROM or cassette tape.

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NOTE: For detailed information on the graphic programming console (CRT) Type SCY-CRT10-81E (-82E), please refer to the "USER'S MANUAL (Cat. No. W50-E1) for OMRON Graphic Programming Console Model SYSMAC-CRT10" published under separate cover.

1. Features

Flat board type programmable controller, best suited for incorporation in machines.

- **Conversational programming with optional graphic programming console (CRT).**
  - Programming and debugging can be greatly simplified through communications between the CPU and operator in a dialog mode via messages on the CRT screen.
  - The CRT console can also be used as a stand-alone machine since the console has its own CPU which can operate independently of the main CPU in the CPU base unit.
  - Programming time can be reduced greatly since the CRT console permits preprogramming of standardized circuits into memory, in addition to its capability to automatically display N.O. contacts which account for 60 to 70% of all ladder diagram symbols used in sequence circuits.
  - Monitor function allows at-a-glance identification of relay coil ON/OFF state of a circuit to facilitate program simulation and maintenance. The CRT console also has a labelling function to facilitate the identification of I/O devices during monitoring.
- **Software-compatible with SYSMAC-M1R**
  SYSAMC-M5R is software-compatible with the higher-grade version SYSMAC-M1R, so that it can be operated by a program written by the SYSMAC-M1R and loaded from a PROM or cassette tape.
- **Easy-to-use configuration**
  In addition to the program console that can be removed from the CPU base unit while SYSMAC-M5R is in operation, PROM writer function, cassette interface function and CRT interface function are provided as standard equipment.
- **Programs can be recorded on cassette tape**
  By connection of the exclusive interface cords, programs in the CPU memory may be dumped onto a commercially available cassette tape.
- **Instructions for sophisticated programming**
  Such instructions as ADD(+), SUB (−), MOV (I/O data transfer), CMP I/O data compare), FAL (Diagnosis),etc., are added to facilitate sophisticated programming.
- **Choice of 128 or 256 I/O points**
  SYSMAC-M5R is available in two basic types; 128 I/O type (CPU base unit with 128 I/O points) and 256 I/O type (CPU base unit and expansion base unit with 256 I/O points). Both types allow expansion of I/O units in increments of 32 points, i.e., 16 points for input and 16 points for output.
- **Abundance of monitor and diagnostic functions for improved maintenability and operability**
  - Multi-point monitoring feature (which allows simultaneous display of 4 I/O points) facilitates delicate timing check of sequence circuits.
  - Monitoring capability, such as trace (continuity) check, I/O status display, present value indication of each timer/counter, etc., assures easy program simulation and maintenance.
  - A variety of diagnostic functions provide positive system backup. All programming mistakes and operational errors are alerted immediately by electronic buzzer.

2. System Configuration and Specifications

2.1 Available Types

The SYSMAC-M5R consists of a CPU base unit, a program console, an expansion base unit and I/O units. A graphic programming console is available as an optional programming support tool.

- **128 I/O type**

Classification		Specification	Weight	Type
CPU base unit		Memory: 3K words* with battery, Program console blind patch (without EPROM or RAM chips and program console)	2.5kg max.	SCYM5R-CPU85E
I/O unit	Input/output unit (Input: 16 points, Output: 16 points)	Input: DC 12 to 24V Output: Transistor output DC 12 to 48V 500mA	350g	SCYM5R-IO021
	Input/output unit (Input: 24 points, Output: 8 points)	Input: DC 12 to 24V Output: Transistor DC 12 to 48V 500mA	350g	SCYM5R-IO022
	DC input unit (32 points)	DC 12 to 24V	340g	SCYM5R-ID021
	DC input unit (PNP type) (32 points)	DC 12 to 24V	340g	SCYM5R-ID026
	AC input unit (24 points)	AC 100/110V, 50/60Hz	425g	SCYM5R-IA101
	DC output unit (32 points)	Transistor output DC 12 to 48V 500mA	390g	SCYM5R-OD041
	DC power output unit (16 points)	Transistor output DC 12 to 48V 10A	430g	SCYM5R-OD042
	AC triac output unit (16 points)	Triac output AC 80 to 242V	450g	SCYM5R-OA202
	Contact output unit (for interface) (32 points)	Relay contact output AC 110V 0.5A, DC 24V 1A (resistive load) AC 110V 0.2A, DC 24V 0.3A (inductive load)	420g	SCYM5R-OC101
	Contact output unit (for power switching) (24 points)	Relay contact output AC 250V 2A, DC 24V 2A (resistive load)	420g	SCYM5R-OC202
	Contact output unit (for power switching) (24 points)	Relay contact output AC 250V 2A, DC 24V 2A (resistive load)	420g	SCYM5R-OC203
	Analog timer unit (16 points)	Time range: 0.1 to 10s/0.1 to 1s (selectable) Resetting time: 50ms max.	235g	SCYM5R-TM001
Peripheral equipment	Program console	———	650g max.	SCYM5R-PRO80E
	CRT I/F card	———	650g max.	SCYM5R-CIF81E
	Graphic programming console**	Supply voltage: AC 110/220V	13kg max.	SCY-CRT10-81E
		Supply voltage: AC 220/240V		SCY-CRT10-82E
	Program console connecting cable	Cable length: 1.5m	340g max.	SCYM5R-CN150
	CRT console interface cable	Cable length: 2m (for connection between SYSMAC-M5R and SYSMAC-CRT10)	220g max.	SCY-CN200
	Cassette interface cable	———	50g max.	SCYP0R-PLG01
	RS-232C interface cable	Cable length: 2m (for connection between SYSMAC-CRT10 and EPSON terminal printer)	220g max.	SCY-CN201
Battery		Lithium battery	20g max.	SCY-BAT01
EPROM chip		1K words/chip	10g max.	ROM-F
RAM chip				RAM-F
CPU base unit blind patch		———	925g max.	SCYM5R-PAT00
Dummy I/O unit		———	120g max.	SCYM5R-PAT03

NOTES: * The SYSMAC-M5R can use a maximum 3K words for programming. In this case, however, 3 EPROM or RAM chips are required. OMRON offers Type ROM-F (equivalent to 2716) or RAM-F developed under strict quality control as the EPROM or RAM (1K) chip for OMRON Programmable Controller series. Be sure to use the EPROM or RAM chips for the OMRON Programmable Controllers.

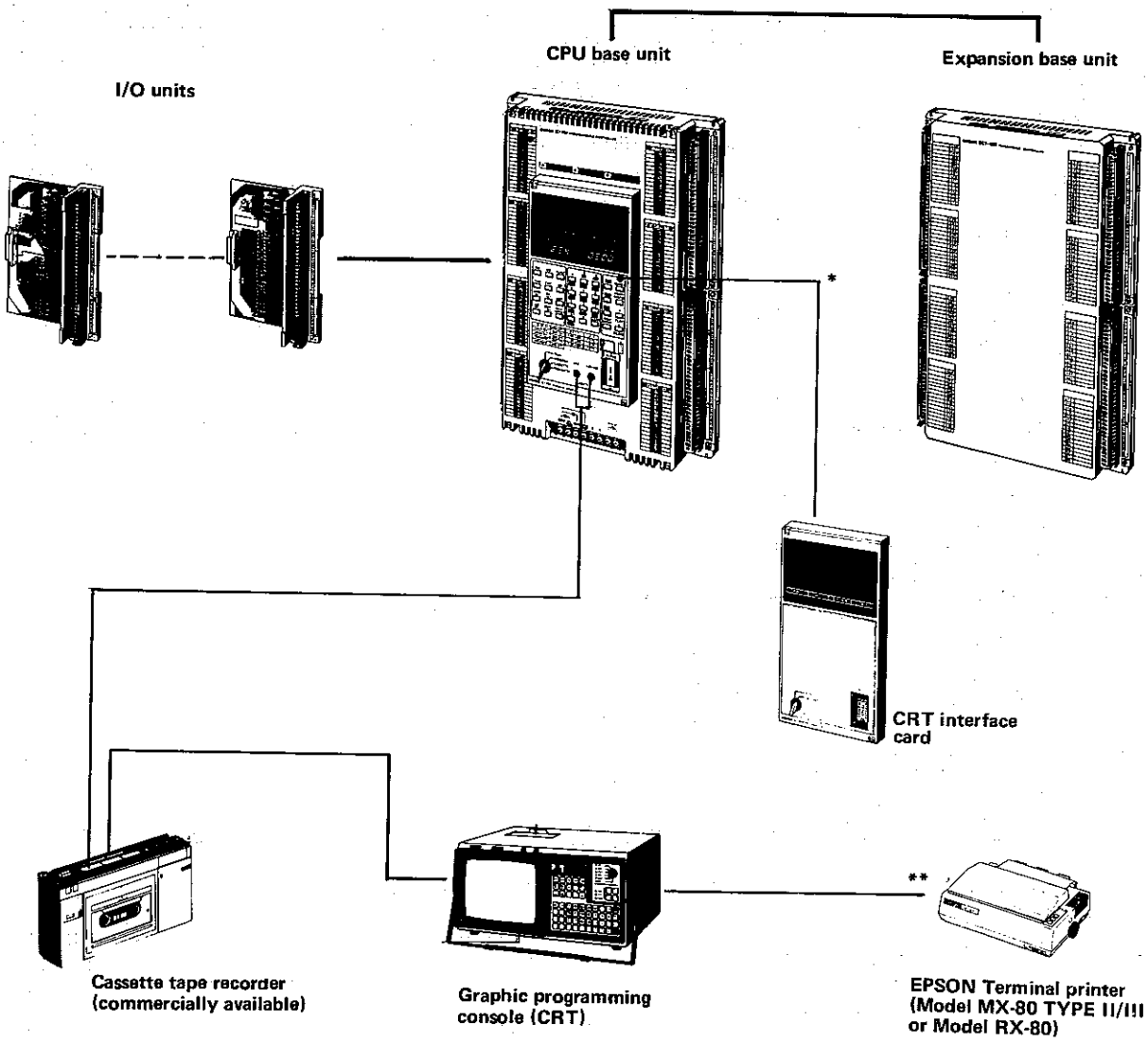
** For detailed information on the graphic programming console (CRT) Type SCY-CRT10-81E (-82E), please refer to the "USER'S MANUAL (Cat. No. W50-E1) for OMRON Graphic Programming Console Model SYSMAC-CRT10" published under separate cover.

● **256 I/O type**

Classification		Specification	Weight	Type
CPU base unit		Memory: 3K words* with battery, Program console blind patch (without EPROM or RAM chips and program console)	2.5kg max.	SCYM5R-CPU95E
Expansion base unit		———	1740g max.	SCYM5R-EXR01E
I/O connecting cable		Cable length: 15cm	45g max.	SCYM5R-CN010
		Cable length: 50cm	70g max.	SCYM5R-CN050
		Cable length: 100cm	100g max.	SCYM5R-CN100
I/O unit	Input/output unit (Input: 16 points Output: 16 points)	Input: DC 12 to 24V Output: Transistor output DC 12 to 48V 500mA	350g	SCYM5R-IO021
	Input/output unit (Input: 24 points Output: 8 points)	Input: DC 12 to 24V Output: Transistor DC 12 to 48V 500mA	350g	SCYM5R-IO022
	DC input unit (32 points)	DC 12 to 24V	340g	SCYM5R-ID021
	DC input unit (PNP type) (32 points)	DC 12 to 24V	340g	SCYM5R-ID026
	AC input unit (24 points)	AC 100/110V, 50/60Hz	425g	SCYM5R-IA101
	DC output unit (32 points)	Transistor output DC 12 to 48V 500mA	390g	SCYM5R-OD041
	DC power output unit (16 points)	Transistor output DC 12 to 48V 10A	430g	SCYM5R-OD042
	AC triac output unit (16 points)	Triac output AC 80 to 242V	450g	SCYM5R-OA202
	Contact output unit (for interface) (32 points)	Relay contact output AC 110V 0.5A, DC 24V 1A (resistive load) AC 110V 0.2A, DC 24V 0.3A (inductive load)	420g	SCYM5R-OC101
	Contact output unit (for power switching) (24 points)	Relay contact output AC 250V 2A, DC 24V 2A (resistive load)	420g	SCYM5R-OC202
	Contact output unit (for power switching) (24 points)	Relay contact output AC 250V 2A, DC 24V 2A (resistive load)	420g	SCYM5R-OC203
	Analog timer unit (16 points)	Time range: 0.1 to 10s/0.1 to 1s (selectable) Resetting time: 50ms max.	235g	SCYM5R-TM001
Peripheral equipment	Program console	———	650g max.	SCYM5R-PRO80E
	CRT I/F card	———	650g max.	SCYM5R-CIF81E
	Graphic programming console**	Supply voltage: AC 110/120V	13kg max.	SCY-CRT10-81E
		Supply voltage: AC 220/240V		SCY-CRT10-82E
	Program console connecting cable	Cable length: 1.5m	340g max.	SCYM5R-CN150
	CRT console interface cable	Cable length: 2m (for connection between SYSMAC-M5R and SYSMAC-CRT10)	220g max.	SCY-CN200
	Cassette interface cable	———	50g max.	SCYP0R-PLG01
	RS-232C interface cable	Cable length: 2m (for connection between SYSMAC-CRT10 and EPSON terminal printer)	220g max.	SCY-CN201
Battery		Lithium battery	20g max.	SCY-BAT01
EPROM chip		1K words/chip	10g max.	ROM-F
RAM chip				RAM-F
CPU base unit blind patch		———	100g max.	SCYM5R-PAT00
Expansion I/O base unit blind patch		———	1.3kg max.	SCYM5R-PAT01
Accessories for integrated mounting		Sliding brackets, mounting screws	90g max.	SCYM5R-PAT02
Dummy I/O unit		———	120g max.	SCYM5R-PAT03

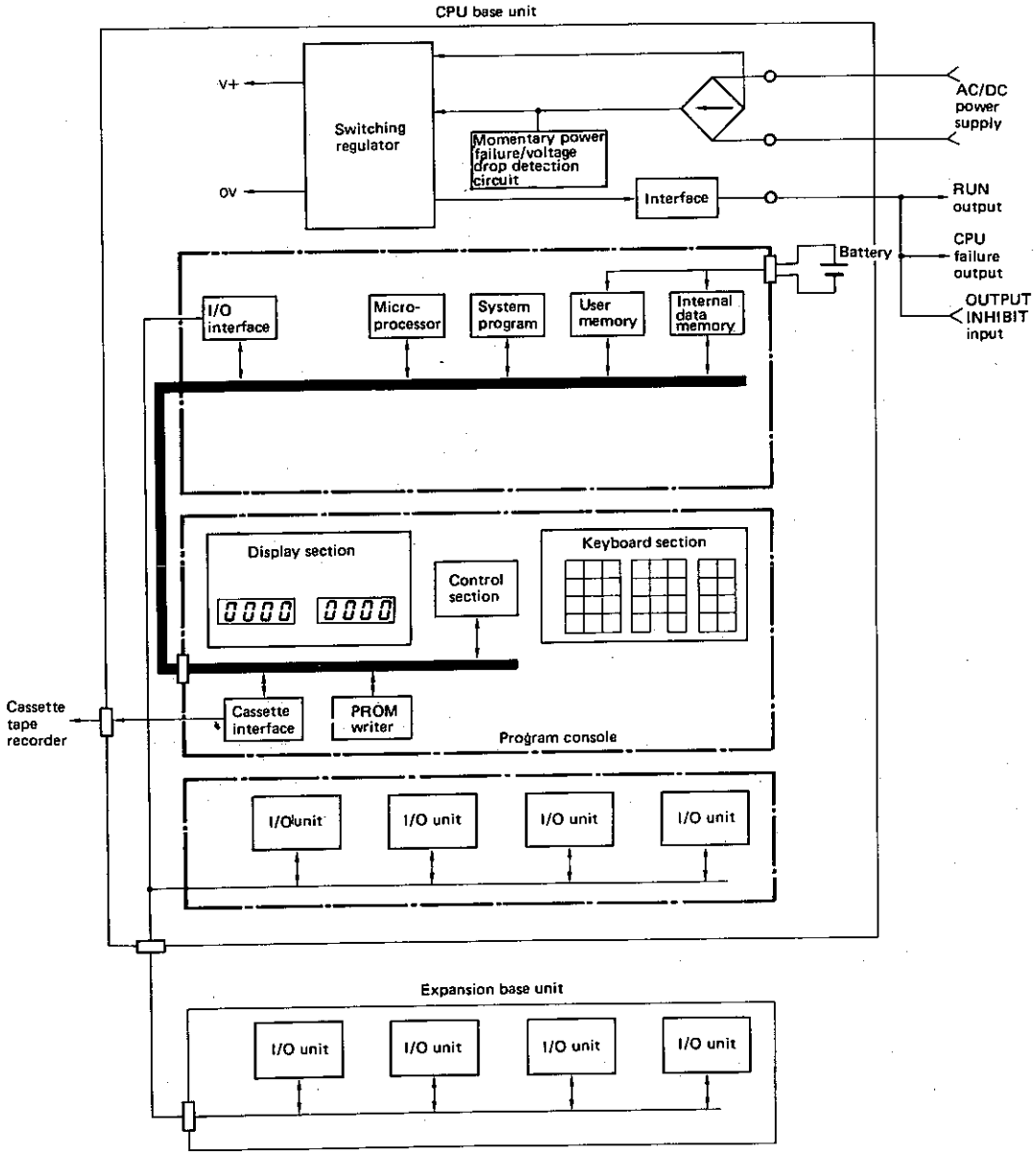
NOTES: * The SYSMAC-M5R can use a maximum 3K words for programming. In this case, however, 3 EPROM or RAM chips are required. OMRON offers Type ROM-F (equivalent to 2716) or RAM-F developed under strict quality control as the EPROM or RAM (1K) chip for OMRON Programmable Controller series. Be sure to use the EPROM or RAM chips for the OMRON Programmable Controllers.

** For detailed information on the graphic programming console (CRT) Type SCY-CRT10-81E (-82E), please refer to the "USER'S MANUAL (Cat. No. W50-E1) for OMRON Graphic Programming Console Model SYSMAC-CRT10" published under separate cover.



NOTES:
1. The CPU base unit is available in two types; one with 128 I/O points and the other with 256 I/O points. The expansion base unit cannot be connected to the 128 I/O type CPU base unit.
2. Both the CPU base unit and expansion base unit have a maximum of 128 I/O points.
3. A maximum of 4 I/O units each consisting of 32 I/O points can be mounted on both the CPU base unit and expansion base unit.
4. * The CRT console can be connected to the CPU base unit through the CRT interface card. To mount the CRT interface card on the CPU base unit, first dismount the program console. For detailed information on the graphic programming console (CRT) Type SCY-CRT10-81E (-82E), please refer to the "USER'S MANUAL (Cat. No. W50-E1) for OMRON Graphic Programming Console Model SYSMAC-CRT10" published under separate cover.
5. ** EPSON Model MX-80 Type II/III or Model RX-80 Terminal Printer can be connected to the graphic programming console (CRT).

2.2 System Configuration



NOTE: The above system configuration diagram applies to the 256 I/O type.

2.3 Specifications

■ RATINGS

Supply voltage	AC 24V 50/60Hz, DC 24V
Operating voltage range	85 to 110% of rated voltage*
Power consumption	50VA max.
Insulation resistance	20MΩ min. at DC 500V (between external terminal and mounting screw)
Dielectric strength	AC 1,500V, 50/60Hz for 1 minute (between external terminal and mounting screw)
Noise immunity	1,000Vp-p Rise time: 1nsec; Pulse width: 2μsec
Vibration	16.7Hz; 3mm double amplitude, (in X, Y, Z directions respectively 2hrs.)
Shock	10G's (in X, Y, Z directions, respectively 3 times)
Ambient temperature	Operating: 0 to +50°C Storage: −10°C to +70°C
Humidity	30 to 90% RH (without condensation)
Atmosphere	Must be free from corrosive gases
Structure	Flat board type
Coating	Ivory white
Weight	See Section 2.1, Available Types.

NOTES:
* AC input
A momentary power failure of less than 1/2 cycle at less than −15% of rated voltage is ignored by the programmable controller. If a momentary power failure of 1/2 to 1 cycle occurs, the power failure condition may or may not be detected by the programmable controller since it is in an unstable area. If a power failure of more than 1 cycle occurs, the programmable controller detects the power failure.
* DC input
A momentary power failure of less than 10msec at −15% of rated voltage is ignored by the programmable controller. If a power failure of 10 to 20msec occurs, the power failure condition may or may not be detected by the programmable controller since it is in an unstable area. If a power failure of more than 20msec occurs, the programmable controller detects the power failure. However, a power failure detection time when the battery is used will become longer than the above value.

■ CHARACTERISTICS

Control system	Stored program system
Main control element	LSI, TTL, C-MOS
Programming system	Ladder diagram
Instruction word length	1 word or 2 words (16 bits/word)
Number of instructions	26 kinds
Execution time/Word	Average: 15μsec/word
Programming capacity	RAM: 3k words EPROM: 3k words
Number of input/output points	128 I/O type: 128 points (Relay Nos. 0000 to 0177) 256 I/O type: 256 points (Relay Nos. 0000 to 0377)
Number of internal auxiliary relays	480 points (Relay Nos. 0400 to 1337)
Number of special auxiliary relays	28 points (Relay Nos. 1340 to 1367, 1374 to 1377) • Relay Nos. 1340 to 1347: Output area when FAL instruction is executed. • Relay Nos. 1350 to 1357, 1360: Result area when ADD/SUB instruction is executed. • Relay Nos. 1361 to 1363: Result area when CMP instruction is executed. • Relay Nos. 1364, 1366: Normally OFF • Relay Nos. 1365, 1367: Normally ON • Relay No. 1374: Turns ON when the battery is abnormal. • Relay No. 1375: 0.2 sec clock pulse • Relay No. 1376: 1 sec clock pulse • Relay No. 1377: 0.1 sec clock pulse
Number of latching relays	256 points (Relay Nos. 000 to 377)
Number of timers and counters	128 points (Relay Nos. 000 to 177) Timer: 0 to 99.9 sec Counter: 0 to 999 counts
Number of shift registers	256 points (Relay Nos. 000 to 377) 8 bits x 32
Number of temporary memory relays	8 points (Relay Nos. 0 to 7)
Memory protective function against power failure	Status data of respective latching relays, counters and shift registers before the power failure are retained in the memory.
Diagnostic functions	▪ RUN mode CPU failure (Watchdog timer) Battery failure (Rated voltage check)
	▪ PROGRAM mode (Program check) • Coil duplication check • END instruction check • Circuit error check (syntax check) • IL/JMP error check • Program over check

■ DIAGNOSTIC FUNCTIONS

As the diagnostic functions of the SYSMAC-M5R, checks on the items listed in the following tables are performed in the PROGRAM and RUN modes, respectively.

• PROGRAM mode

Diagnostic function		Function	Error indication
Item	Title		
Program check	Coil duplication check	Checks coil numbers for duplication.	ON
	END instruction check	Checks the presence of END instruction at the end of the program.	
	Circuit error check	Checks the circuit for proper configuration.	
	IL/JMP error check	Checks if IL-ILC, JMP-JME instructions are being used in pairs.	
	Program over check	Checks if the number of program steps exceeds the memory capacity in Program write or Contact (coil) addition operation.	

• RUN mode

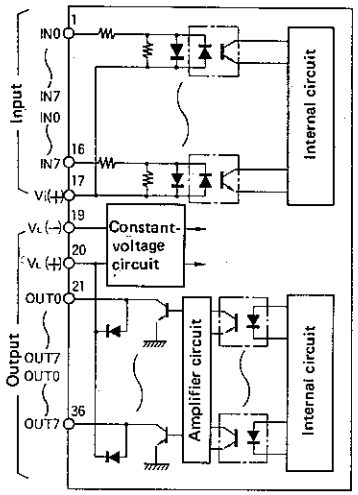
Diagnostic function		Display			Externally controlled I/O relay contact** (Transistor output: DC 24V 500mA max.)		Special internal auxiliary relay (Relay No. 1374)
Item	Title	ADDRESS	DATA	ERROR indicator	RUN output	CPU failure output	
Battery failure*	Rated voltage check	–	–	ON	–	–	ON
CPU failure	Watchdog timer				OFF	ON	Remains unchanged.

NOTES: * If the battery is left alone for a week or more without being replaced after the ERROR indicator illuminates, the contents of the program memory will be destroyed. When the battery is to be replaced, be sure to replace it within approx. 5 minutes after turning off the power switch.
** Refer to "8.7 Hints on Use of Externally Controlled I/O Relays."

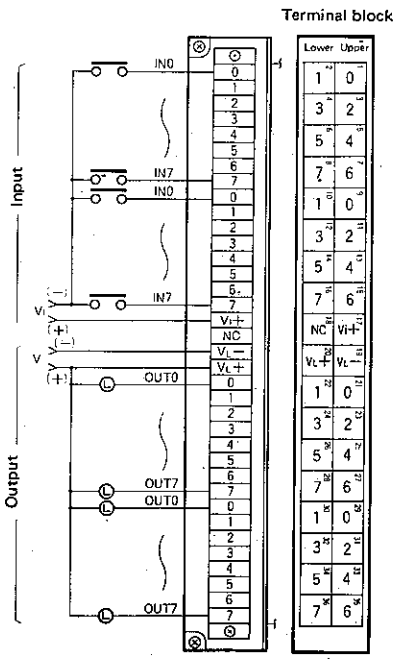
■ I/O units

Item	Type	DC input/output unit SCYM5R-L0021
Input section	Input voltage (VI)	DC 12V−15% to 24V+10%
	Input impedance	≒ 2kΩ
	Input current	6 to 12mA/point
	ON-delay time*	15ms max.
	OFF-delay time*	25ms max.
	Number of circuits	16 circuits
	ON voltage	7.2V max.
	OFF voltage	2.4V min.
Output section	Max. switching capacity	Transistor output: DC 52.8V, 500mA/circuit, 8A/unit
	Leakage current	100μA max.
	Saturation voltage	1.5V max.
	Voltage for internal constant-voltage circuit (VL)	DC 12V −15% to 48V +10%
	Current for internal constant-voltage circuit	30mA max.
	ON-delay time	0.2ms (resistive load)
	OFF-delay time	3ms (resistive load)
	Number of circuits	16 circuits
Common item	Current consumption for driving the unit (+5V)	80mA (5V) ±20%
	Weight	350g ±10%

Circuit configuration



Terminal connection

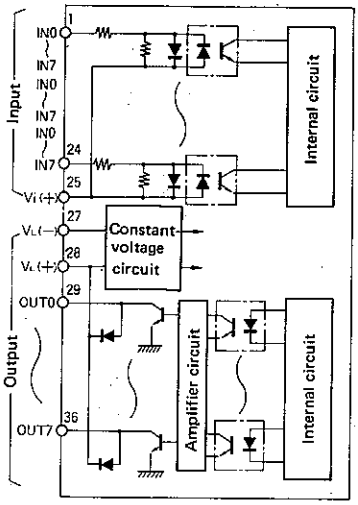


NOTE: If the input voltage is DC 12V, use only solid-state input devices, such as photoelectric and proximity switches.

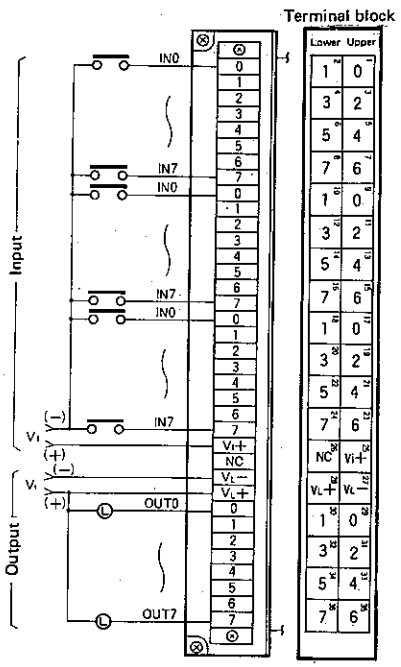
NOTES: The delay time from the application of an input signal until the activation of the output terminal of the unit.
The delay time from removal of the input signal until the inactivation of the output terminal of the unit.

Item	Type	DC input/output unit SCYM5R-IO022
Input section	Input voltage (VI)	DC 12V −15% to 24V +10%
	Input impedance	≒ 2kΩ
	Input current	6 to 12mA/point
	ON delay time*	15ms max.
	OFF delay time**	25ms max.
	Number of circuits	24 circuits
	ON voltage	7.2V max.
	OFF voltage	2.4V min.
Output section	Max. switching capacity	Transistor output: DC 52.8V, 500mA/circuit, 8A/unit
	Leakage current	100μA max.
	Saturation voltage	1.5V max.
	Voltage for internal constant voltage circuit (VL)	DC 12V −15% to 48V +10%
	Current for internal constant voltage circuit	15mA max.
	ON delay time	0.2ms (resistive load)
	OFF delay time	3ms (resistive load)
	Number of circuits	8 circuits
Common item	Current consumption for driving the unit (+5V)	40mA (5V) ±20%
	Weight	350g ±10%

Circuit configuration



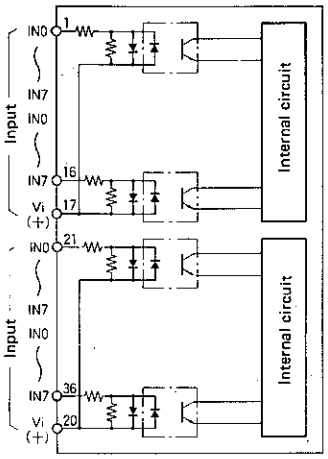
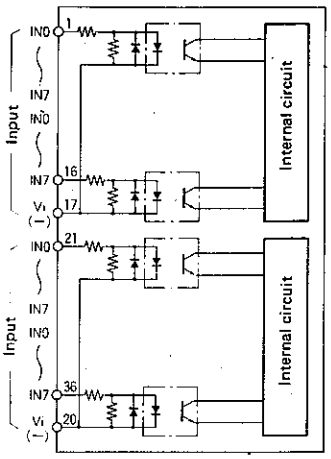
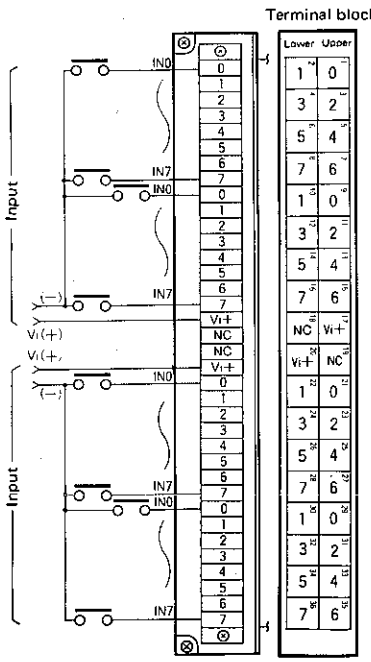
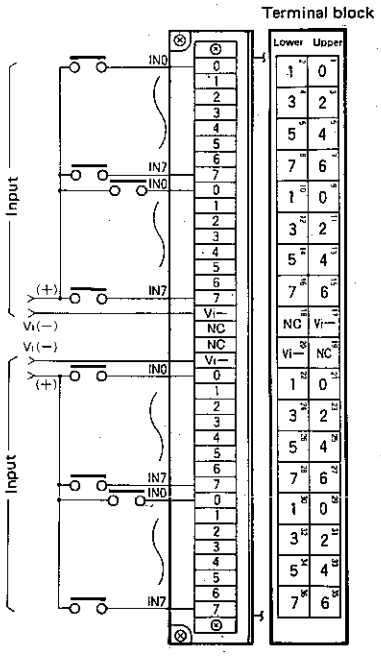
Terminal connection



NOTE: If the input voltage is DC 12V, use only solid-state input devices, such as photoelectric and proximity switches.

NOTES: * The delay time from the application of an input signal until the activation of the output terminal of the unit.
** The delay time from removal of the input signal until the inactivation of the output terminal of the unit.

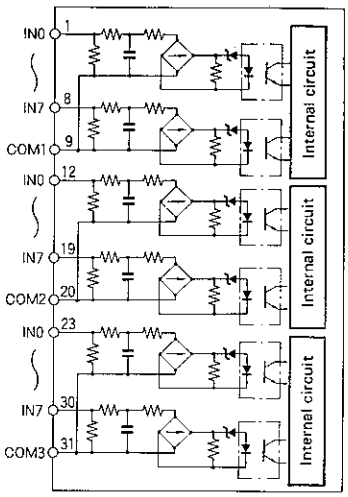
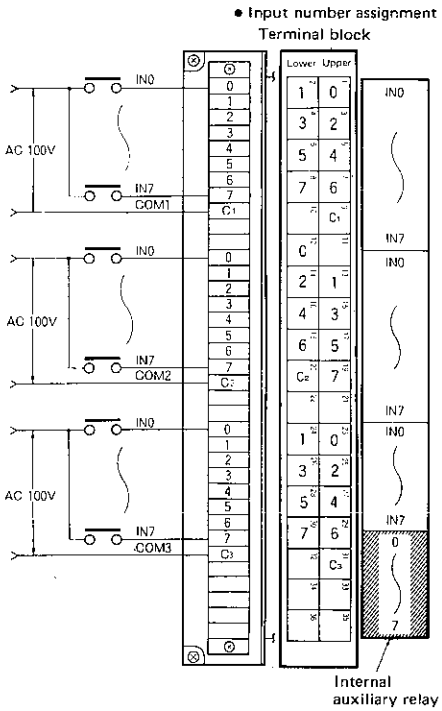
● Input units

Item \ Type	DC input unit	
	SCYM5R-ID021	SCYM5R-ID026 (PNP type)
Input voltage (VI)	DC 12V –15% to 24V +10%	DC 12V –15% to 24V +10%
Input impedance	≒ 2kΩ	≒ 2kΩ
Input current	6 to 12mA/point	12mA/point (DC 24V)
ON-delay time*	15ms max.	4 to 10ms (TYP 6ms)
OFF delay time**	25ms max.	7 to 15ms (TYP 10ms)
Number of circuits	32 circuits	32 circuits
ON voltage	7.2V max.	7.2V max.
OFF voltage	2.4V min.	2.4V min.
Current consumption for driving the unit (+5V)	8mA (5V) ±20%	8mA (5V) ±20%
Weight	340g ±10%	340g ±10%
Circuit configuration		
Terminal connection		

NOTES: 1. Terminal Nos. 17 and 20 are internally connected.
2. If the input voltage is DC 12V, use only solid-state input devices, such as photoelectric and proximity switches.

NOTES: 1. Terminal Nos. 17 and 20 are internally connected.
2. If the input voltage is DC 12V, use only solid-state input devices, such as photoelectric and proximity switches.

NOTES: * The delay time from the application of an input signal until the activation of the output terminal of the unit.
** The delay time from removal of the input signal until the inactivation of the output terminal of the unit.

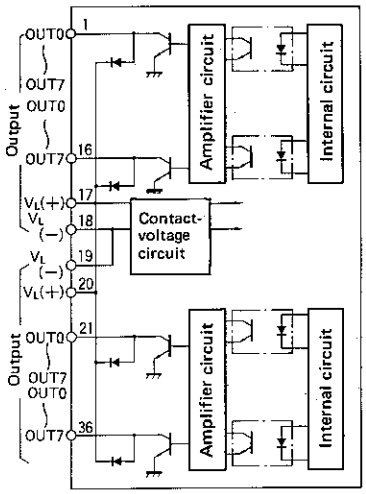
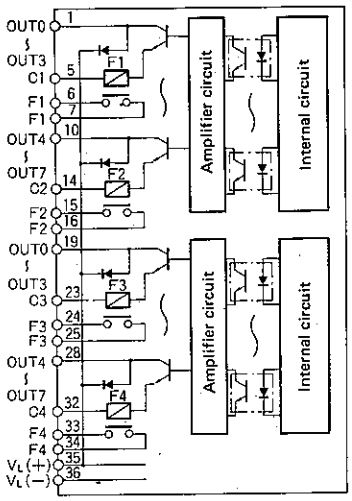
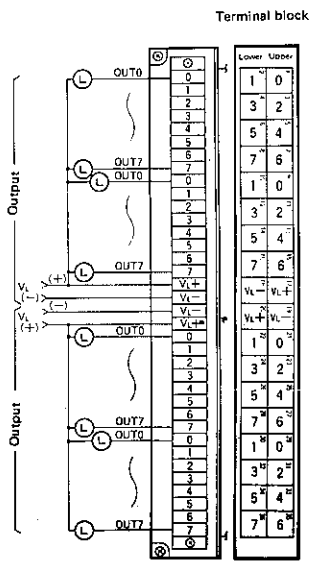
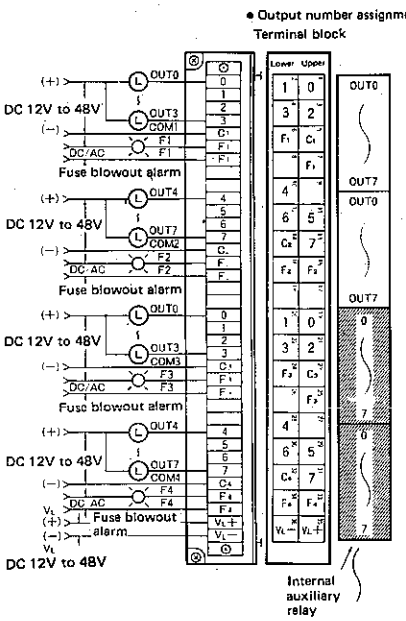
Item \ Type	AC input unit
	SCYM5R-IA101
Input voltage (VI)	AC 100/110V $^{+10\%}_{-15\%}$ 50/60Hz
Input impedance	≒ 10kΩ
Input current	10mA/point ±10%, 50Hz; 12mA/point ±10%, 60Hz (at 100 input voltage)
ON-delay time*	15ms max.
OFF-delay time**	35ms max.
Number of circuits	24 circuits
ON voltage	60V max. (initial)
OFF voltage	20V min.
Current consumption for driving the unit (+5V)	8mA (5V) ±20%
Weight	425g ±10%
Circuit configuration	
Terminal connection	

• Input number assignment
Terminal block

NOTE: Unused 8 input circuits (8 input points) can be used as internal auxiliary relays with monitor.

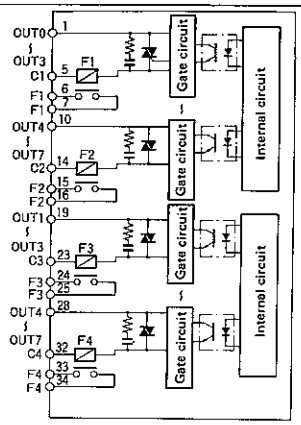
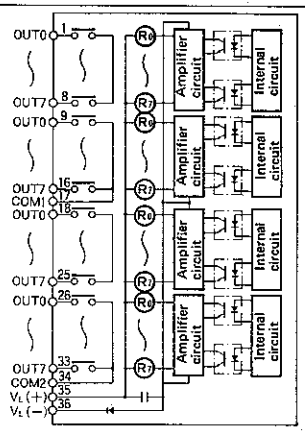
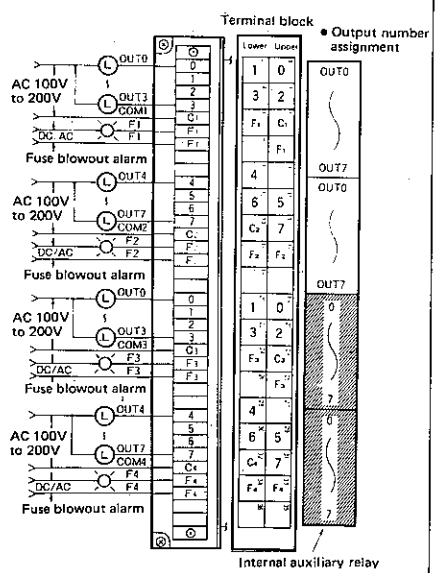
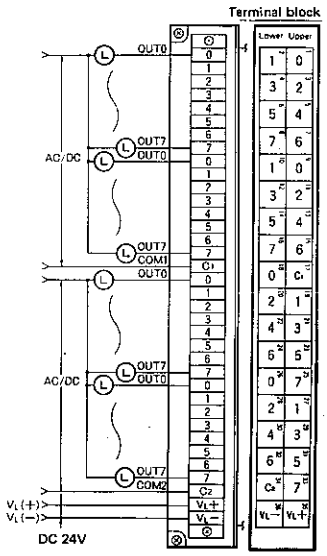
NOTES: * The delay time from the application of an input signal until the activation of the output terminal of the unit.
** The delay time from removal of the input signal until the inactivation of the output terminal of the unit.

● Output units

Item \ Type	DC output unit SCYM5R-OD041	DC power output unit SCYM5R-OD042
Max. switching capacity	Transistor output: DC 52.8V 500mA/circuit, 8A/unit	Transistor output: DC 52.8V 2A/ point, 4A/common, 10A/unit
Leakage current	100μA max.	100μA max.
Saturation voltage	1.5V max.	1.5V max.
Voltage for internal constant-voltage circuit (V_L)	DC 12V −15% to 48V +10%	DC12V −15% to 48V +10%
Current for internal constant-voltage circuit	Approx. 72mA max./unit	60mA/unit
ON-delay time	0.2ms max. (resistive load)	0.2ms max. (resistive load)
OFF-delay time	3ms max. (resistive load)	3ms max. (resistive load)
Fuse type	———	MP75
Fuse capacity	———	7.5A with fuse blowout alarm contact
Fuse contact rating	———	AC/DC 25VA, 0.5A
Number of circuits	32 circuits	16 circuits (4 circuits/common)
Current consumption for driving the unit (+5V)	120mA (5V) ±20%	72mA (5V) ±20%
Weight	390g ±10%	430g ±10%
Circuit configuration		
Terminal connection		

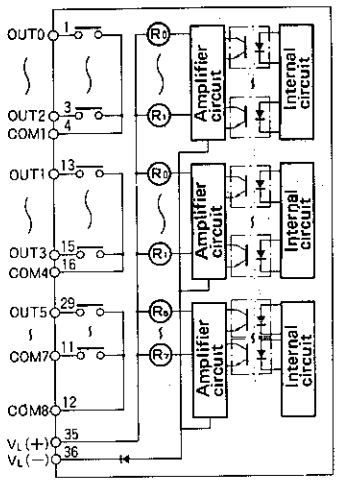
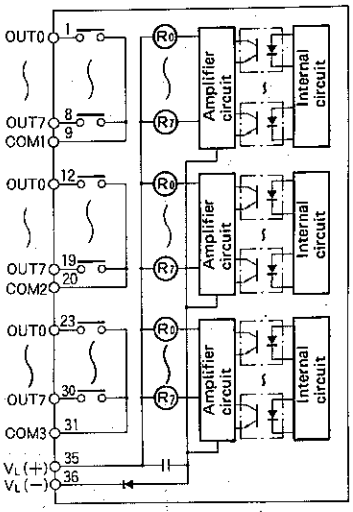
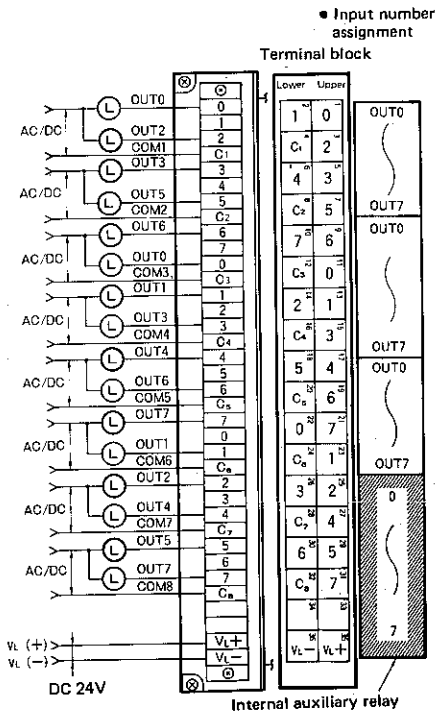
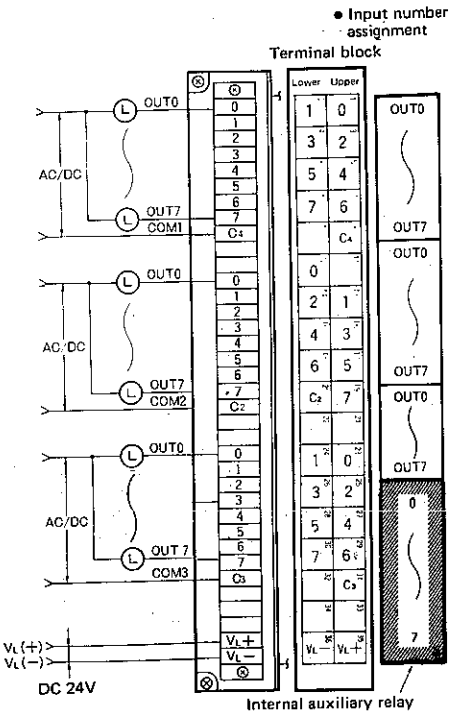
NOTE: Terminal Nos. 17 and 20 and 18 and 19 are internally connected.

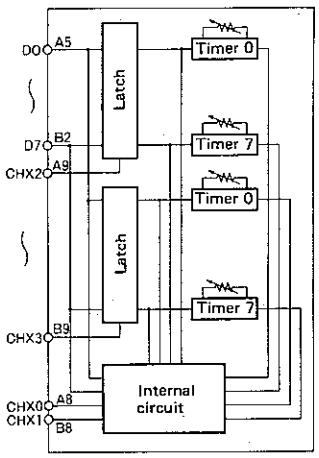
NOTES: 1. V_L must be equal to or larger than the load voltage.
2. Unused 16 output circuits (16 output points) can be used as internal auxiliary relays with monitor.

Item \ Type	AC triac output unit SCY M5R-OA202	Contact output unit (for interface) SCY M5R-OC101
Output switching capacity	———	Relay contact output (with OMRON G2E relay, DC 24V) AC 110V 0.5A, DC 24V 1A resistive load AC 110V 0.2A, DC 24V 0.3A inductive load
Maximum switching capacity	Triac output: AC 80 to 242V 2A/point, 4A/common, 10A/unit	———
Minimum switching capacity	10mA (AC 100V), 20mA (AC 200V)	———
Relay driving voltage	———	DC 24V $^{+10\%}_{-5\%}$, ripple factor 5% max.
Relay driving current	———	21mA/point, 336mA/unit
Leakage current	AC 100V 3mA max. AC 200V 6mA max. (60Hz)	———
Saturation voltage	1.5V max. (RMS value) at 2A load	———
ON-delay time	1ms max.	6ms max.
OFF-delay time	1/2 load frequency max.	10ms max.
Fuse type	MP75	———
Fuse capacity	7.5A with fuse blowout alarm contact	———
Fuse contact rating	AC/DC 25VA 0.5A	———
Number of circuits	16 circuits (4 circuits/common)	32 points
Max. inrush current	30A (1 cycle)/point	———
Service life	———	AC 110V 0.5A (resistive load) 200,000 operations min. DC 24V 1A (resistive load) 500,000 operations min.
Current consumption for driving the unit (+5V)	240mA (5V) ±20%	55mA (5V) ±20%
Weight	450g ±10%	420g ±10%
Circuit configuration		
Terminal connection		

NOTE: Unused 16 output circuits (16 output points) can be used as internal auxiliary relays with monitor.

NOTE: The maximum number of output points that can operate simultaneously is 16.

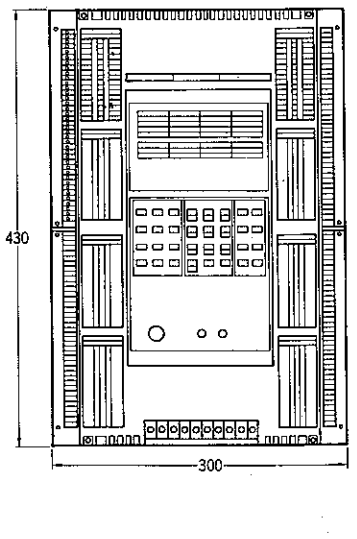
Item \ Type	Contact output unit (for power switching)	
	SCYM5R-OC202	SCYM5R-OC203
Output switching circuit	Relay contact output (with OMRON G6B-1114P relay DC 24) AC 250V 2A, DC 24V 2A (resistive load) 6A/common	Relay contact output (with OMRON G6B-1114P relay DC 24) AC 250V 2A, DC 24V 2A (resistive load) 8A/common
Relay driving voltage	DC 24V $^{+10\%}_{-5\%}$, ripple factor 5% max.	DC 24V $^{+10\%}_{-5\%}$, ripple factor 5% max.
Relay driving current	8.5mA/point, 204mA/unit	8.5mA/point, 204mA/unit
ON delay time	15ms max.	15ms max.
OFF delay time	15ms max.	15ms max.
Number of circuits	24 points	24 points
Service life	AC 250V 2A (resistive load): 200,000 operations DC 24V 2A (resistive load): 200,000 operations	AC 250V 2A (resistive load): 200,000 operations DC 24V 2A (resistive load): 200,000 operations
Current consumption for driving the unit (+5V)	55mA (5V) ±20%	55mA (5V) ±20%
Weight	420g ±10%	420g ±10%
Circuit configuration		
Terminal connection	 NOTE: Unused 8 output points can be used as internal auxiliary relays with monitor.	 NOTE: Unused 8 output points can be used as internal auxiliary relays with monitor.

Item \ Type	Analog timer unit 3G2V5E-TM001
Time range	0.1 to 10s/0.1 to 1s (selectable)
Reserving time	50ms max.
Setting method	Internal VR (can be set with screwdriver)
Operating principal	RC oscillation counting system
Number of circuits	16 circuits
Weight	235g ±10%
Current consumption for driving the unit (+5V)	90mA (5V) ±20%
ON-delay (application)	The timer unit can be used as an ON-delay timer for an output relay or a variable ON-delay timer for internal circuit.
Circuit configuration	
Terminal connection	———

NOTE: This unit is used as an internal analog timer. Timer numbers and timer contact numbers are determined according to where the unit is mounted. For example, when it is mounted instead of an I/O unit with I/O relays Nos. XX00 to XX37, I/O relays No. XX00 to XX17 are assigned as timer contact numbers, and I/O relay Nos. XX20 to XX37 as timer numbers. When the unit is mounted instead of an I/O unit with I/O relay Nos. XX40 to XX77, I/O relays Nos. XX40 to XX57 are assigned as timer contact numbers, and I/O relay Nos. XX60 to XX77 as timer numbers. Use the timer numbers and timer contact numbers thus determined to design circuits.

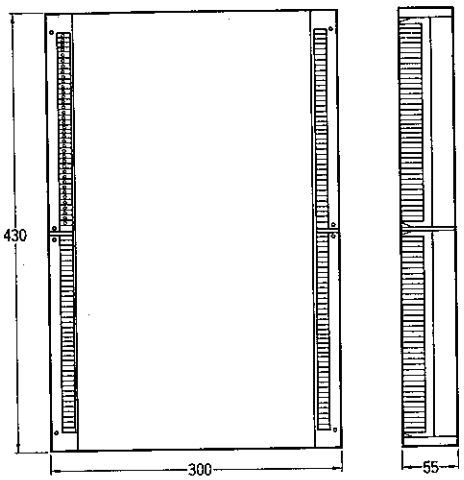
2.4 Dimensions

- **CPU base unit**

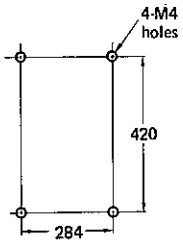


(When program console mounted.)

- **Expansion base unit**



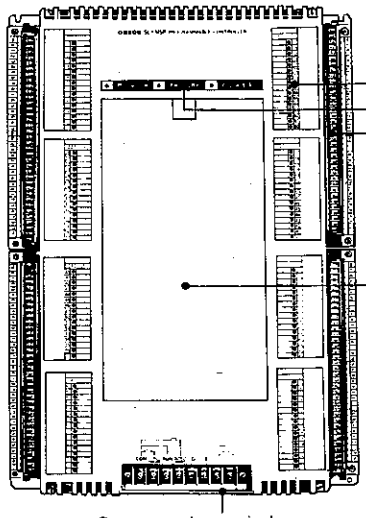
Mounting holes



2.5 Names of Respective Parts

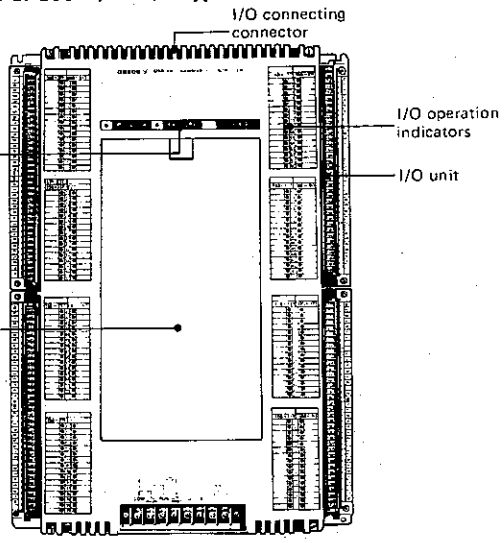
- **CPU base unit**

SCYM5R-CPU85E (128 I/O type)



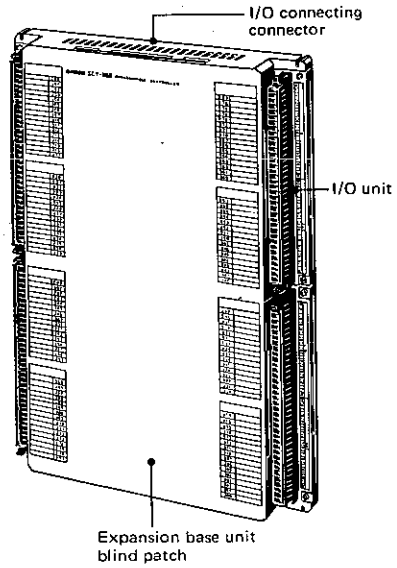
* Expansion base unit cannot be connected.

SCYM5R-CPU95E (256 I/O type)

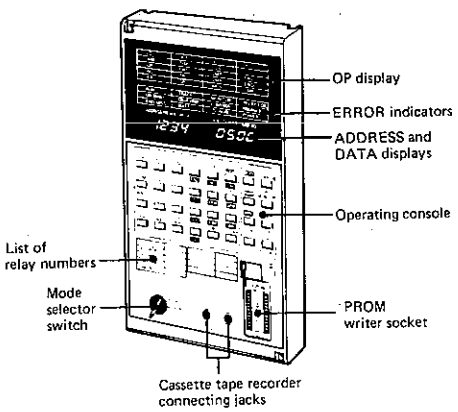


* Expansion base unit can be connected.

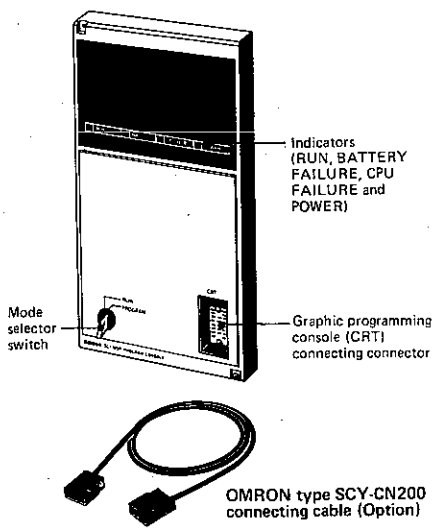
- **Expansion base unit**



- **Program console**



- **CRT I/F card**



OMRON type SCY-CN200 connecting cable (Option)

3. Assignment of Relay Numbers

Relay numbers correspond to the data memory areas and the operating state (ON/OFF) of each relay is stored in the corresponding memory area.
The method of assigning relay numbers used for the SYSMAC-M5R is as follows.

3.1 List of Relay Numbers

Name		No. of points	Symbol	Relay number															
Input/output relay	CPU base unit	128		0000	0010	0020	0030	0040	0050	0060	0070	0100	0110	0120	0130	0140	0150	0160	0170
				0001	0011	0021	0031	0041	0051	0061	0071	0101	0111	0121	0131	0141	0151	0161	0171
				0002	0012	0022	0032	0042	0052	0062	0072	0102	0112	0122	0132	0142	0152	0162	0172
				0003	0013	0023	0033	0043	0053	0063	0073	0103	0113	0123	0133	0143	0153	0163	0173
				0004	0014	0024	0034	0044	0054	0064	0074	0104	0114	0124	0134	0144	0154	0164	0174
				0005	0015	0025	0035	0045	0055	0065	0075	0105	0115	0125	0135	0145	0155	0165	0175
				0006	0016	0026	0036	0046	0056	0066	0076	0106	0116	0126	0136	0146	0156	0166	0176
				0007	0017	0027	0037	0047	0057	0067	0077	0107	0117	0127	0137	0147	0157	0167	0177
	Expansion base unit	128		0200	0210	0220	0230	0240	0250	0260	2070	0300	0310	0320	0330	0340	0350	0360	0370
				0201	0211	0221	0231	0241	0251	0261	0271	0301	0311	0321	0331	0341	0351	0361	0371
				0202	0212	0222	0232	0242	0252	0262	0272	0302	0312	0322	0332	0342	0352	0362	0372
				0203	0213	0223	0233	0243	0253	0263	0273	0303	0313	0323	0333	0343	0353	0363	0373
				0204	0214	0224	0234	0244	0254	0264	0274	0304	0314	0324	0334	0344	0354	0364	0374
				0205	0215	0225	0235	0245	0255	0265	0275	0305	0315	0325	0335	0345	0355	0365	0375
				0206	0216	0226	0236	0246	0256	0266	0276	0306	0316	0326	0336	0346	0356	0366	0376
				0207	0217	0227	0237	0247	0257	0267	0277	0307	0317	0327	0337	0347	0357	0367	0377
Internal auxiliary relay*		480		0400	0410	0420	0430	0440	0450	0460	0470	0500	0510	0520	0530	0540	0550	0560	0570
				0401	0411	0421	0431	0441	0451	0461	0471	0501	0511	0521	0531	0541	0551	0561	0571
				0402	0412	0422	0432	0442	0452	0462	0472	0502	0512	0522	0532	0542	0552	0562	0572
				0403	0413	0423	0433	0443	0453	0463	0473	0503	0513	0523	0533	0543	0553	0563	0573
				0404	0414	0424	0434	0444	0454	0464	0474	0504	0514	0524	0534	0544	0554	0564	0574
				0405	0415	0425	0435	0445	0455	0465	0475	0505	0515	0525	0535	0545	0555	0565	0575
				0406	0416	0426	0436	0446	0456	0466	0476	0506	0516	0526	0536	0546	0556	0566	0576
				0407	0417	0427	0437	0447	0457	0467	0477	0507	0517	0527	0537	0547	0557	0567	0577
				0600	0610	0620	0630	0640	0650	0660	0670	0700	0710	0720	0730	0740	0750	0760	0770
				0601	0611	0621	0631	0641	0651	0661	0671	0701	0711	0721	0731	0741	0751	0761	0771
				0602	0612	0622	0632	0642	0652	0662	0672	0702	0712	0722	0732	0742	0752	0762	0772
				0603	0613	0623	0633	0643	0653	0663	0673	0703	0713	0723	0733	0743	0753	0763	0773
				0604	0614	0624	0634	0644	0654	0664	0674	0704	0714	0724	0734	0744	0754	0764	0774
				0605	0615	0625	0635	0645	0655	0665	0675	0705	0715	0725	0735	0745	0755	0765	0775
				0606	0616	0626	0636	0646	0656	0666	0676	0706	0716	0726	0736	0746	0756	0766	0776
				0607	0617	0627	0637	0647	0657	0667	0677	0707	0717	0727	0737	0747	0757	0767	0777
				1000	1010	1020	1030	1040	1050	1060	1070	1100	1110	1120	1130	1140	1150	1160	1170
				1001	1011	1021	1031	1041	1051	1061	1071	1101	1111	1121	1131	1141	1151	1161	1171
				1002	1012	1022	1032	1042	1052	1062	1072	1102	1112	1122	1132	1142	1152	1162	1172
				1003	1013	1023	1033	1043	1053	1063	1073	1103	1113	1123	1133	1143	1153	1163	1173
				1004	1014	1024	1034	1044	1054	1064	1074	1104	1114	1124	1134	1144	1154	1164	1174
				1005	1015	1025	1035	1045	1055	1065	1075	1105	1115	1125	1135	1145	1155	1165	1175
				1006	1016	1026	1036	1046	1056	1066	1076	1106	1116	1126	1136	1146	1156	1166	1176
				1007	1017	1027	1037	1047	1057	1067	1077	1107	1117	1127	1137	1147	1157	1167	1177
				1200	1210	1220	1230	1240	1250	1260	1270	1300	1310	1320	1330	1340	1350	1360	1370
				1201	1211	1221	1231	1241	1251	1261	1271	1301	1311	1321	1331	1341	1351	1361	1371
				1202	1212	1222	1232	1242	1252	1262	1272	1302	1312	1322	1332	1342	1352	1362	1372
				1203	1213	1223	1233	1243	1253	1263	1273	1303	1313	1323	1333	1343	1353	1363	1373
				1204	1214	1224	1234	1244	1254	1264	1274	1304	1314	1324	1334	1344	1354	1364	1374
				1205	1215	1225	1235	1245	1255	1265	1275	1305	1315	1325	1335	1345	1355	1365	1375
				1206	1216	1226	1236	1246	1256	1266	1276	1306	1316	1326	1336	1346	1356	1366	1376
				1207	1217	1227	1237	1247	1257	1267	1277	1307	1317	1327	1337	1347	1357	1367	1377

Special auxiliary relay area

NOTE:
* With the SYSMAC-M5R, relay numbers 0400 to 0777 can be used as auxiliary relays. However, if compatibility with the SYSMAC-M1R is important, use relay numbers 1000 to 1337 as the auxiliary relays of SYSMAC-M5R.

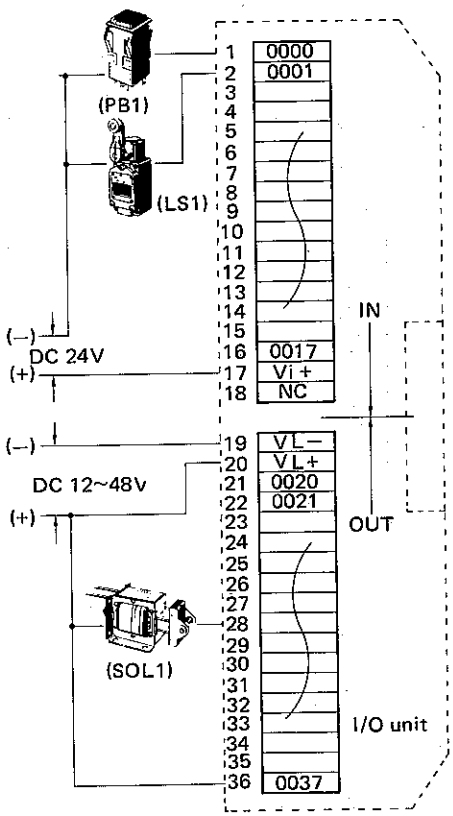
Name	No. of points	Symbol	Relay number															
Timer and counter	128	TIM CNT	000	010	020	030	040	050	060	070	100	110	120	130	140	150	160	170
			001	011	021	031	041	051	061	071	101	111	121	131	141	151	161	171
			002	012	022	032	042	052	062	072	102	112	122	132	142	152	162	172
			003	013	023	033	043	053	063	073	103	113	123	133	143	153	163	173
			004	014	024	034	044	054	064	074	104	114	124	134	144	154	164	174
			005	015	025	035	045	055	065	075	105	115	125	135	145	155	165	175
			006	016	026	036	046	056	066	076	106	116	126	136	146	156	166	176
			007	017	027	037	047	057	067	077	107	117	127	137	147	157	167	177
Latching relay	256	KR	000	010	020	030	040	050	060	070	100	110	120	130	140	150	160	170
			001	011	021	031	041	051	061	071	101	111	121	131	141	151	161	171
			002	012	022	032	042	052	062	072	102	112	122	132	142	152	162	172
			003	013	023	033	043	053	063	073	103	113	123	133	143	153	163	173
			004	014	024	034	044	054	064	074	104	114	124	134	144	154	164	174
			005	015	025	035	045	055	065	075	105	115	125	135	145	155	165	175
			006	016	026	036	046	056	066	076	106	116	126	136	146	156	166	176
			007	017	027	037	047	057	067	077	107	117	127	137	147	157	167	177
			200	210	220	230	240	250	260	270	300	310	320	330	340	350	360	370
			201	211	221	231	241	251	261	271	301	311	321	331	341	351	361	371
			202	212	222	232	242	252	262	272	302	312	322	332	342	352	362	372
			203	213	223	233	243	253	263	273	303	313	323	333	343	353	363	373
			204	214	224	234	244	254	264	274	304	314	324	334	344	354	364	374
			205	215	225	235	245	255	265	275	305	315	325	335	345	355	365	375
			206	216	226	236	246	256	266	276	306	316	326	336	346	356	366	376
			207	217	227	237	247	257	267	277	307	317	327	337	347	357	367	377
Shift register	8 bits ×32	SR	000	010	020	030	040	050	060	070	100	110	120	130	140	150	160	170
			001	011	021	031	041	051	061	071	101	111	121	131	141	151	161	171
			002	012	022	032	042	052	062	072	102	112	122	132	142	152	162	172
			003	013	023	033	043	053	063	073	103	113	123	133	143	153	163	173
			004	014	024	034	044	054	064	074	104	114	124	134	144	154	164	174
			005	015	025	035	045	055	065	075	105	115	125	135	145	155	165	175
			006	016	026	036	046	056	066	076	106	116	126	136	146	156	166	176
			007	017	027	037	047	057	067	077	107	117	127	137	147	157	167	177
			200	210	220	230	240	250	260	270	300	310	320	330	340	350	360	370
			201	211	221	231	241	251	261	271	301	311	321	331	341	351	361	371
			202	212	222	232	242	252	262	272	302	312	322	332	342	352	362	372
			203	213	223	233	243	253	263	273	303	313	323	333	343	353	363	373
			204	214	224	234	244	254	264	274	304	314	324	334	344	354	364	374
			205	215	225	235	245	255	265	275	305	315	325	335	345	355	365	375
			206	216	226	236	246	256	266	276	306	316	326	336	346	356	366	376
			207	217	227	237	247	257	267	277	307	317	327	337	347	357	367	377
Temporary memory relay	8	TR	0	1	2	3	4	5	6	7								

Name	No. of points	Symbol	Relay number		Description
Special auxiliary relay	28	—	1340	2^0	The FAL NO. (00~99) when the Diagnostic (FAL) instruction is executed, is output in BCD to each of relay Nos. 1340 to 1347.
			1341	2^1	$X10^0$ (Low-order digit)
			1342	2^2	
			1343	2^3	
			1344	2^0	
			1345	2^1	$X10^1$ (High-order digit)
			1346	2^2	
			1347	2^3	
			1350	2^0	The result of the Add (+) or Subtract (—) instruction executed is output in BCD to each of relay Nos. 1350 to 1357.
			1351	2^1	$X10^0$ (Low-order digit)
			1352	2^2	
			1353	2^3	
			1354	2^0	
			1355	2^1	$X10^1$ (High-order digit)
			1356	2^2	
			1357	2^3	
			1360		This relay turns ON if there is a carry in the result of the Add (+) instruction executed. This relay also turns ON if there is a borrow in the result of the Subtract (—) instruction executed.
			1361		This relay turns ON if the result of the Compare (CMP) instruction executed is less than (<).
			1362		This relay turns ON if the result of the Compare (CMP) instruction executed is equal (=).
			1363		This relay turns ON if the result of the Compare (CMP) instruction executed is more than (>).
			1364		This relay is normally OFF.
			1365		This relay is normally ON.
			1366		This relay is normally OFF.
			1367		This relay is normally ON.
			1370		These 4 relays are not used. Note that the "1" or "0" state of these relays is not clear. However, when the MOV instruction is executed, the 8-bit contents of the relay Nos. 1370 to 1377 will be transferred.
			1371		
			1372		
			1373		
			1374		This relay turns ON when the battery is abnormal.
			1375		This relay is used to generate 0.2sec clock pulse.
			1376		This relay is used to generate 1sec clock pulse.
			1377		This relay is used to generate 0.1sec clock pulse.

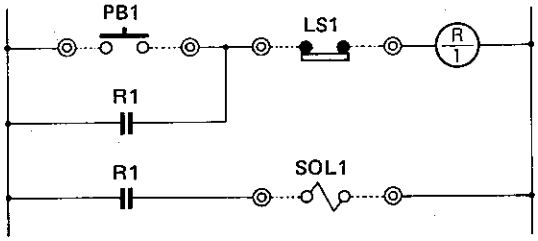
3.2 Determination of I/O Relay Numbers

1. In a sequence circuit diagram which is generally known, a sequence circuit is drawn with input/output devices included in the sequence circuit. With the SYSMAC, however, the sequence circuit is configured in such a form that input/output devices will be once accepted by I/O units. For this reason, it is necessary to determine the locations where I/O units are to be inserted into the CPU base unit or the expansion base unit for each I/O device and the I/O terminals to which I/O devices are to be connected.
2. The ladder diagrams of the SYSMAC-M5R require the relay numbers corresponding to the I/O devices. The relay numbers are determined by the mounting locations of the respective I/O units in the CPU base unit or expansion base unit to which I/O devices are to be connected and the connecting terminals of the I/O units. Each of these relay numbers must be used for ladder diagrams and programming.

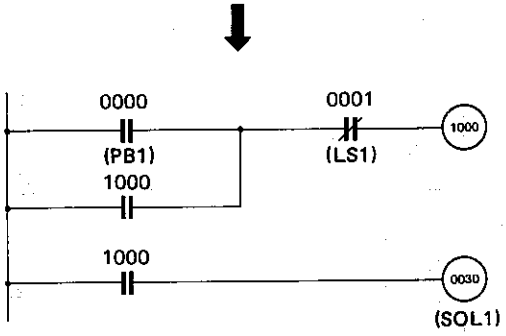
Example of wiring input/output devices (SCYM5R-IO021)



Circuit example



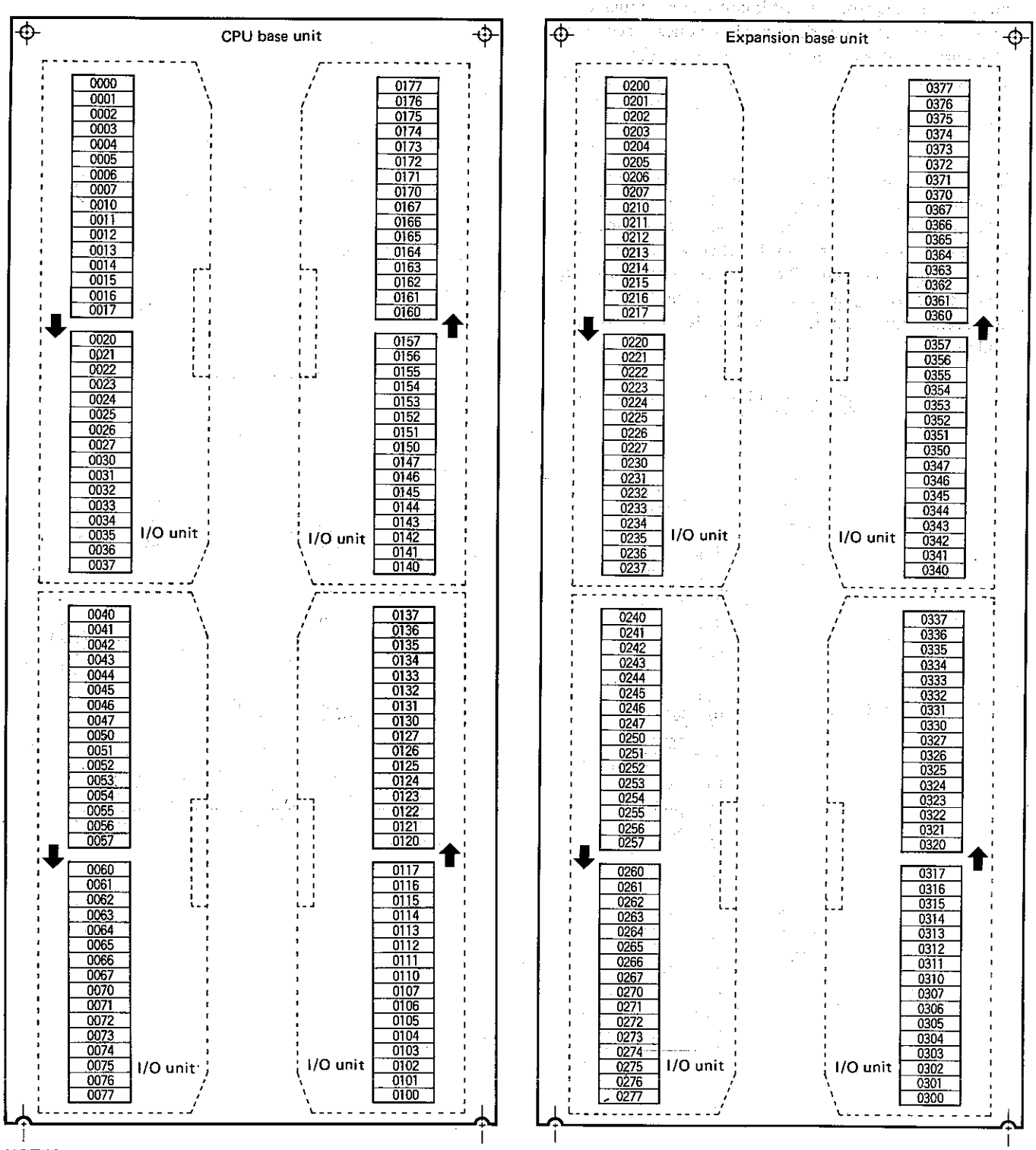
General sequence circuit



Ladder diagram of SYSMAC-M5R series

- PB1 and LS1 are connected to the input unit while SOL1 is connected to the output unit. R1 employs an internal auxiliary relay (1000). In this case SOL1 may be connected directly to the output unit without using the internal auxiliary relay.

3. The number of input/output relays are determined as follows, depending on the mounting locations of the I/O units incorporated in the CPU base unit or expansion base unit.



NOTES:
1. The mounting locations of I/O units in the CPU base unit or the expansion base unit are free. However, the CPU judges whether the unit located is an input unit or an output unit.
2. The relay number of the unit location to which no I/O unit is inserted can be used as an internal auxiliary relay number.
3. The input relay number of the unit location to which an I/O unit is inserted cannot be used as an internal auxiliary relay number.
4. The output relay number of the unit location to which an I/O unit is inserted but no output device is connected, can be used as an internal auxiliary relay. (However, the output relay will turn ON/OFF.)
5. In case the SYSMAC-M5R must be completely software-compatible with the SYSMAC-M1R, the I/O relay numbers of both programmable controllers should be identical.

3.3 Determination of Internal Auxiliary Relay Numbers

The SYSMAC-M5R has 480 internal auxiliary relays which are used for internal data transfer in sequence circuits. They are independent of I/O devices in sequence. Since the internal auxiliary relays are the data memories incorporated in the CPU, no I/O unit is required to be mounted.

- Relay numbers 0400 to 1337 may not necessarily be assigned consecutively.
- Relay coil numbers cannot be used in duplication within the same program. However, the number of relay contacts is not limited for use.
- If more than 480 internal auxiliary relays are required, I/O relay numbers to which no I/O unit is connected may be used. When an I/O unit to which no output device is connected is mounted, its output relay numbers may also be used as internal auxiliary relays.
- Relay numbers 0400 to 0777 can be used as auxiliary relays. However, if compatibility with the SYSMAC-M1R is important, use relay numbers 1000 to 1337 as auxiliary relays.

3.4 Determination of Special Auxiliary Relay Numbers

28 special auxiliary relays are provided. These relays are sort of internal auxiliary relays which operate and release according to the internal conditions controlled by hardware and are independent of the I/O devices in sequence.

Relay Nos. 1340 to 1347:

The FAL No. (00 to 99) when the Diagnostic (FAL) instruction is executed is output in BCD to each of relay numbers 1340 to 1347. If these relays are to be reset, execute the FAL00 instruction and the logical state of all the relays becomes "0."

1347	1346	1345	1344	1343	1342	1341	1340
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
$\times 10^1$ High-order digits				$\times 10^0$ Low-order digits			

Relay Nos. 1350 to 1357:

These relays output the result of the Add (+) or Subtract (−) instruction executed, in BCD to each of relay numbers 1350 to 1357. The output status of each relay is held until the next arithmetic operation instruction is executed.

1357	1356	1355	1354	1353	1352	1351	1350
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
$X10^1$ High-order digits				$X10^0$ Low-order digits			

Relay No. 1360:

This relay operates (ON) if a carry exists in the result of the Add (+) instruction executed. This relay also operates if a borrow exists in the result of the Subtract (−) instruction executed. When the next arithmetic operation instruction is executed, the logical state of the relay changes. The relay releases (OFF) when the END instruction is executed.

Relay Nos. 1361 to 1363:

These relays output the result of the Compare (CMP) instruction executed.

Relay No. 1361 operates if the result is less than (<).

Relay No. 1362 operates when the result is equal (=).

Relay No. 1363 operates when the result is more than (>).

The logical state of each relay changes when the next Compare instruction is executed. These relays release when the END instruction is executed.

Relay Nos. 1364 and 1366:

These relays are normally in the OFF state.

Relay Nos. 1365 and 1367:

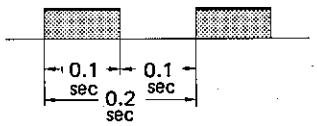
These relays are normally in the ON state.

Relay No. 1374:

This relay operates when a battery failure occurs and releases when the battery is returned to normal. When this relay operates, the ERROR indicator on the front panel of the CPU illuminates. If the BAT FAULT signal is desired to be transmitted externally, prepare and program a circuit using the contacts of this relay.

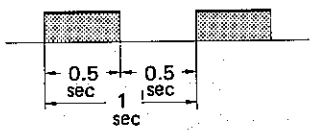
Relay No. 1375:

This relay is used to generate 0.2sec clock. When used in junction with a counter, it functions as a timer for memory retention during a power failure and as a long-time timer.



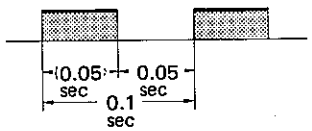
Relay No. 1376:

This relay is used to generate 1sec clock. When used in junction with a counter, it functions as a timer for memory retention during a power failure and as a long-time timer. The relay output can also be used as a flicker signal.



Relay No. 1377:

This relay is used to generate 0.1 sec clock. When used in junction with a counter, it functions as a timer for memory retention during a power failure.



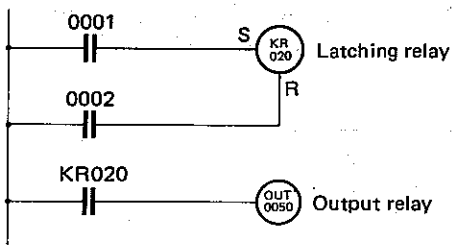
NOTES:

1. The ON time of 0.1sec clock is 50msec. Therefore, note that if the program execution time is prolonged, the CPU may fail to read the clock.
2. If the program capacity exceeds 2k words, be sure to use 0.2sec clock.

3.5 Determination of Latching Relay Numbers

The SYSMAC-M5R has 256 latching relays whose operating states before a power failure can be retained in the memory. Since the operating states of these relays are stored in the memory, all their outputs at the time of the power failure are turned off, but the relays will return to the state before the power failure when power is applied again.

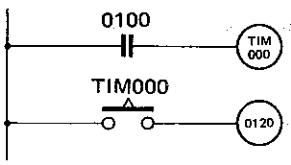
- Relay numbers 000 ~ 377 may not necessarily be assigned consecutively.
- When using a latching relay, the letters "KR" must be prefixed to the relay number. (ex. KR020)
- Relay coil numbers cannot be used in duplication. However, the number of relay contacts is not limited.
- When set and reset input signals are applied simultaneously, the reset input signal takes precedence over the set input signal.
- These relay outputs cannot be transmitted directly to an output terminal. If any of the relay outputs is desired to be transmitted externally, prepare and program a circuit so that the relay output is transmitted externally through an output relay.



3.6 Determination of Timer/Counter Numbers

The SYSMAC-M5R has 128 timers and counters which are used for timer/counter numbers in programming.

- Timer/counter numbers 000 ~ 177 are shared by both timers and counters. Therefore, a number already assigned to a timer cannot be used for any other counter.
- The same number will be used for both the coil and contact numbers of a timer or counter. To distinguish timer/counter contact numbers from input relay numbers, shift register and latching relay numbers, the letters "TIM" or "CNT" must be prefixed to each timer/counter contact number (e.g., TIM000, CNT001).



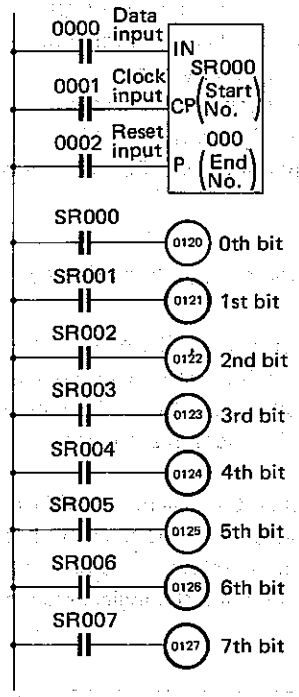
3.7 Determination of Temporary Memory Relay Numbers

The SYSMAC-M5R has 8 temporary memory relays which are used when plural outputs exist in a block.

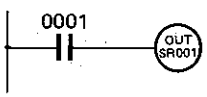
- Relay numbers 0 ~ 7 may not necessarily be assigned consecutively.
- Temporary memory relay coil numbers cannot be used in duplication within the same block. With two or more blocks, they can be used in duplication.
- When using a temporary memory relay, the letters "TR" must be prefixed to the relay number (e.g., TR0).

3.8 Determination of Shift Register Numbers

The SYSMAC-M5R has 32 shift registers (each consisting of 8 bits). With SR (Shift Register) instructions, the low-order digit always becomes "0" (000, 010, 020, 030, 040, 050, 060, 070, 100, 110, 120, 130, 140, 150, 160, 170, 200, 210, 220, 230, 240, 250, 260, 270, 300, 310, 320, 330, 340, 350, 360, 370). These instructions can be increased or decreased in units of 8 bits. The low-order digit of each bit becomes 0 ~ 7.



- Relay numbers 000 ~ 370 may not necessarily be assigned consecutively.
- Be sure to satisfy the condition; Start No. ≤ End No.
- Shift register coil numbers cannot be used in duplication. However, the number of contacts is not limited.
- When set and reset input signals are applied simultaneously, the reset input signal takes precedence over the set input signal.
- The shift register outputs cannot be transmitted directly to an output terminal. If any of the outputs is desired to be transmitted externally, prepare and program a circuit so that the output is transmitted externally through an output relay.
- Shift registers can also be used as auxiliary relays when used with an OUT instruction.



- When using a shift register, the letters "SR" must be prefixed to the relay number (e.g., SR001).

4. Instruction Words

4.1 List of Instructions

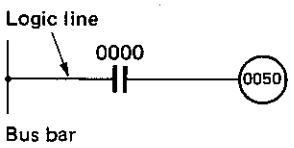
No.	Instruction	Symbol	Function	Word length	Data
1	LOAD	LD	Logical start operation.	1W	Input/output relays 0000~0377 Internal auxiliary relays 0400~1337 Special auxiliary relays 1340~1367, 1374~1377 Timers/counters 000~ 177 Latching relays 000~ 377 Shift registers 000~ 377 Temporary memory relays 0~ 7 (Only LOAD instruction can be used for temporary memory relays.)
2	LOAD NOT	LD NOT	Logical NOT start operation.	1W	
3	AND	AND	Logical AND operation.	1W	
4	AND NOT	AND NOT	Logical AND NOT operation.	1W	
5	OR	OR	Logical OR operation.	1W	
6	OR NOT	OR NOT	Logical OR NOT operation.	1W	
7	AND LOAD	AND LD	Logical AND operation with the previous condition.	1W	–
8	OR LOAD	OR LD	Logical OR operation with the previous condition.	1W	
9	OUT	OUT	Outputs the result of a logical operation to the specified output relay, internal auxiliary relay, latching relay or shift register.	1W	Input/output relays 0000~0377 Internal auxiliary relays 0400~1337 Latching relays 1360 Shift registers 000~ 377 Temporary memory relays 0~ 7 (Only OUT instruction can be used for temporary memory relays.)
10	OUT NOT	OUT NOT	Inverts the results of a logical operation and then outputs them to the specified output relay, internal auxiliary relay, latching relay or shift register.	1W	
11	TIMER	TIM	On-delay timer operation.	2W	Timers/counters 000~ 177
12	COUNTER	CNT	Down counter operation.	2W	
13	LATCHING RELAY	KR	Latching relay operation.	1W	Latching relays 000~ 377
14	SHIFT REGISTER	SR	Shift register operation.	2W	Shift registers 000~ 377
15	INTERLOCK	FUNC IL	Causes all the relay coils between this instruction and the ILC instruction to be reset or not reset according to the result immediately before this instruction.	1W	–
16	INTERLOCK CLEAR	FUNC ILC	Clears the IL instruction.	1W	
17	JUMP	FUNC JMP	Causes all the contents of a program between this instruction and the JME instruction to be ignored or executed according to the result immediately before this instruction.	1W	
18	JUMP END	FUNC JME	Clears the JMP instruction.	1W	
19	MOVE (MOV)	FUNC MOV	Transfers data between I/Os.	2W	1st word: 000~137, KR00~37, SR 00~99, ※00~※99 2nd word: 000~133, KR00~37, SR 00~37 TIM, CTN: 000~177 2nd word: 000~132, KR00~36, SR 00~36
20	MOVE NOT (MOV NOT)	FUNC MOV NOT	Inverts and transfers data between I/Os.	2W	
21	COMPARE (CMP)	FUNC CMP	Compares data between I/Os.	2W	1st word: 000~135, KR00~37, SR 00~37, ※00~※99 2nd word: 000~135, KR00~37, SR 00~37
22	ADD (ADD)	FUNC +	Adds data between I/Os.	2W	1st word: 000~134, KR00~37, SR 00~37, ※00~※99 2nd word: 000~134, KR00~37, SR 00~37
23	SUBTRACT (SUB)	FUNC −	Subtracts data between I/Os.	2W	
24	DIAGNOSTIC (FAL)	FUNC FAL	Indicates the type of failure or abnormal mode.	1W	00~99
25	END	FUNC END	The end of a program.	1W	–

NOTE: * The FUNC key must be first depressed before executing any of the instructions numbered 15 through 25 in the above list.

4.2 Explanation of Instruction Words

■ LOAD (LD) & OUTPUT (OUT) INSTRUCTIONS

If each logic line starts with an NO contact, use the LD instruction. Use the OUT instruction for a relay coil.



Coding

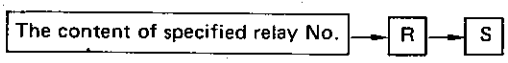
Address	OP	Data
0000	LD	0000
0001	OUT	0050

Contents of Registers

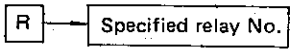
R	S
0000	—
0000	—

- **Operation of each register**

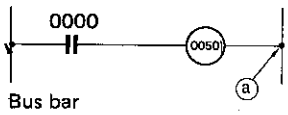
The LD instruction causes the content (ON or OFF state) of the specified relay number to be stored into the RESULT REGISTER (hereafter referred to as "R register"). It also causes the previous result in the R register to be transferred to the STACK REGISTER (hereafter referred to as "S register").



The OUT instruction causes the content of the R register to be output to the specified relay number. In this case, the content of the R register will remain unchanged.



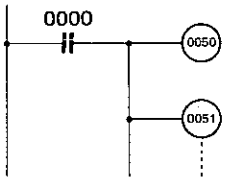
- Bus bar of a different phase is not required to be programmed.



Connection to the bus bar of a different phase (part ⓐ) is accomplished automatically by programming an OUT instruction.

- **Consecutive OUT instructions**

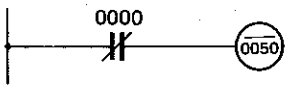
If the OUT instruction is followed by another OUT instruction, this condition is regarded as a circuit error during the program check. However, each output relay operates normally.



OP	Data
LD	0000
OUT	0050
OUT	0051
⋮	⋮

■ LOAD NOT (LD·NOT) & OUTPUT NOT (OUT·NOT) INSTRUCTIONS

If each logic line starts with an NC contact, use the LD·NOT instruction in place of the LD instruction. Use the OUT·NOT instruction to invert the output condition.



Coding

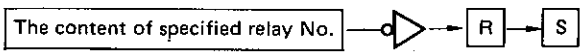
Address	OP	Data
0000	LD·NOT	0000
0001	OUT·NOT	0050

Contents of Registers

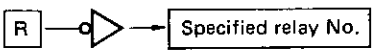
R	S
0000	—
0000	—

- **Operation of each register**

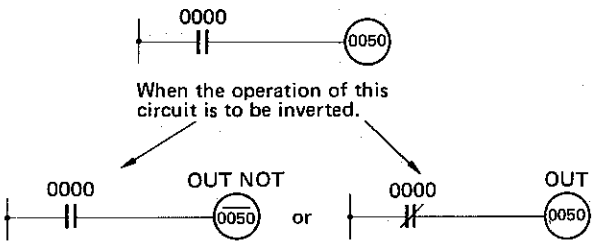
The LD·NOT instruction causes the content of the specified relay number to be inverted and then stored into the R register.



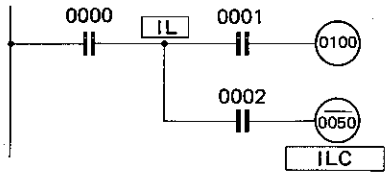
The OUT·NOT instruction causes the content of the R register to be inverted and then output to the specified relay number. In this case, the content of the R register will remain unchanged.



- **Application of OUT·NOT instruction**



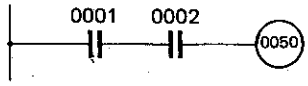
- **Use of OUT·NOT instruction between IL and ILC instructions**



Note that relay 0050 operates when the IL condition (0000 ⊣⊢) is OFF.

■ AND INSTRUCTION

NO contacts in series are processed by the AND instruction.



Coding

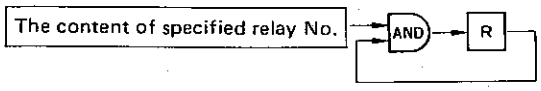
Address	OP	Data
0000	LD	0001
0001	AND	0002
0002	OUT	0050

Contents of Registers

R	S
0001	—
0001 0002	—
0001 0002	—

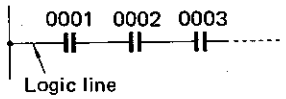
- **Operation of each register**

The AND instruction causes the logical AND operation to be performed between the content of the specified relay number and the content of the R register. The result of the logical AND operation will be newly stored in the R register.



- **Number of contacts**

The number of contacts is not limited for use on a logic line. As many NO contacts as required can be connected by means of the AND key.

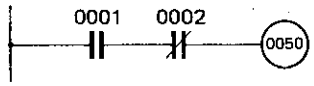


OP	Data
LD	0001
AND	0002
AND	0003
⋮	⋮

In this case, the contact of the first relay number 0001 is at the start of each logic line. Therefore, the relay contact must be programmed as "LD0001."

■ AND-NOT INSTRUCTION

If an NC contact is connected in series, use the AND-NOT instruction in place of the AND instruction.



Coding

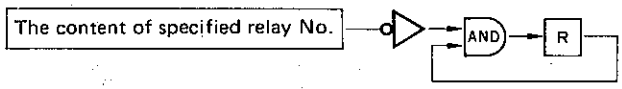
Address	OP	Data
0000	LD	0001
0001	AND-NOT	0002
0002	OUT	0050

Contents of Registers

R	S
0001	—
0001 0002	—
0001 0002	—

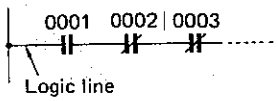
- **Operation of each register**

The AND-NOT instruction causes the content of the specified relay number to be inverted and then ANDed with the content of the R register. The result of the logical AND operation will be newly stored in the R register.



- **Number of contacts**

The number of contacts is not limited for use on a logic line. As many NC contacts as required can be connected in series by means of AND NOT keys.

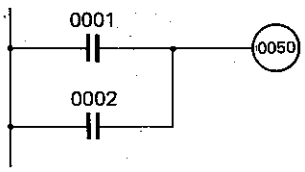


OP	Data
LD	0001
AND-NOT	0002
AND-NOT	0003
⋮	⋮

In this case, the contact of the first relay number 0001 is at the start of each logic line. Therefore, the relay contact must be programmed as "LD0001."

■ OR INSTRUCTION

NO contacts in parallel are processed by the OR instruction.



Coding

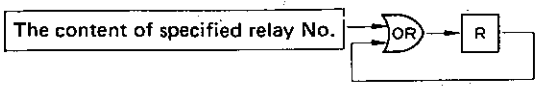
Address	OP	Data
0000	LD	0001
0001	OR	0002
0002	OUT	0050

Contents of Registers

R	S
0001	—
0001 / 0002	—
0001 / 0002	—

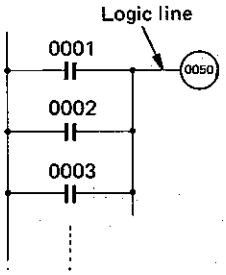
- **Operation of each register**

The OR instruction causes the logical OR operation to be performed between the content of the specified relay number and the content of the R register. The result of the logical OR operation will be newly stored in the R register.



- **Number of contacts**

The number of contacts is not limited for use on a logic line. As many NO contacts as required can be connected by means of the [OR] key.

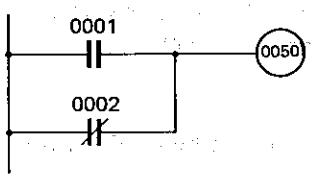


OP	Data
LD	0001
OR	0002
OR	0003
⋮	⋮
OUT	0050

In this case, the contact of the first relay number 0001 is at the start of each logic line. Therefore, the relay contact must be programmed as "LD0001."

■ OR·NOT INSTRUCTION

If an NC contact is to be connected in parallel, use the OR·NOT instruction in place of the OR instruction.



Coding

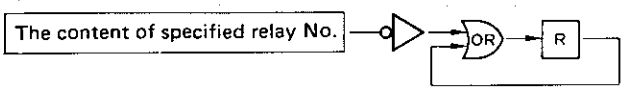
Address	OP	Data
0000	LD	0001
0001	OR·NOT	0002
0002	OUT	0050

Contents of Registers

R	S
0001	—
0001 0002	—
0001 0002	—

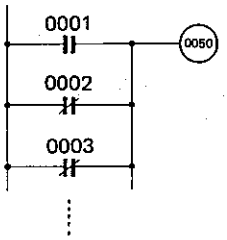
- **Operation of each register**

The OR·NOT instruction causes the content of the specified relay number to be inverted and then ORed with the content of the R register. The result of the logical OR operation will be newly stored in the R register.



- **Number of contacts**

The number of contacts is not limited for use on a logic line. As many NC contacts as required can be connected by means of [OR] [NOT] keys.

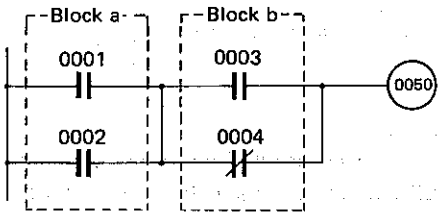


OP	Data
LD	0001
OR·NOT	0002
OR·NOT	0003
⋮	⋮
OUT	0050

In this case, the contact of the first relay number 0001 is at the start of each logic line. Therefore, the relay contact must be programmed as "LD0001."

■ AND·LOAD (AND·LD) INSTRUCTION

For inter-block AND operation between two or more blocks, use the AND·LD instruction.



Coding

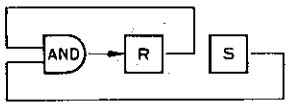
Address	OP	Data
0000	LD	0001
0001	OR	0002
0002	LD*	0003
0003	OR·NOT	0004
0004	AND·LD**	
0005	OUT	0050

Contents of Registers

R	S
0001	—
0001 0002	—
0003	0001 0002
0003 0004	0001 0002
0001 0003 0002 0004	—
0001 0003 0002 0004	—

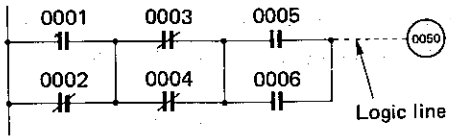
NOTES: * Use this instruction as the first instruction for the next block to be ANDed with the preceding block.
** Use the AND·LD instruction for series connection of two blocks (blocks a and b).

- **Operation of each register**
  1. By the LD0001 and OR0002 instructions, the result of the logical OR operation in block a is stored into the R register.
  2. By the LD0003 instruction in block b, the result of the operation in block a is transferred into the S register, while the result of the logical operation by instructions LD0003 and OR·NOT0004 in block b is stored into the R register.
  3. AND·LD instruction causes the logical AND operation to be performed between the R register and the S register. The result of the logical AND operation will be newly stored into the R register.



- **Number of blocks**

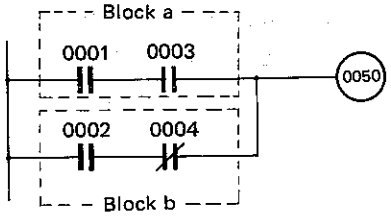
The number of blocks is not limited for AND·LD operation of a logic line. As many blocks as required can be continued for series connection by means of LD ~ AND LD keys.



OP	Data
LD	0001
OR·NOT	0002
LD·NOT	0003
OR·NOT	0004
AND·LD	
LD	0005
OR	0006
AND·LD	
⋮	⋮
OUT	0050

■ OR·LOAD (OR·LD) INSTRUCTION

For inter-block OR operation between two or more blocks, use the OR·LOAD instruction.



Coding

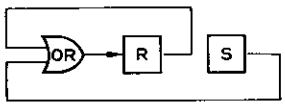
Address	OP	Data
0000	LD	0001
0001	AND	0003
0002	LD*	0002
0003	AND·NOT	0004
0004	OR·LD**	
0005	OUT	0050

Contents of Registers

R	S
0001	—
0001 0003	—
0002	0001 0003
0002 0004	0001 0003
0001 0003 / 0002 0004	—
0001 0003 / 0002 0004	—

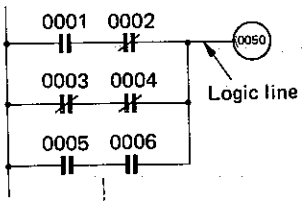
NOTES: * Use this LD instruction as the first instruction of the next block to be ORed with the preceding block.
** Use the OR·LD instruction for parallel connection of two blocks (blocks a and b).

- **Operation of each register**
  1. By the LD0001 and AND0003 instructions, the result of the logical AND operation in block a is stored into the R register.
  2. By the LD0002 instruction in block b, the result of the operation in block a is transferred into the S register, while the result of the logical operation by instructions LD0002 and AND·NOT0004 in block b is stored into the R register.
  3. The OR·LD instruction causes the logical OR operation to be performed between the R register and the S register. The result of the logical OR operation will be newly stored into the R register.



- **Number of blocks**

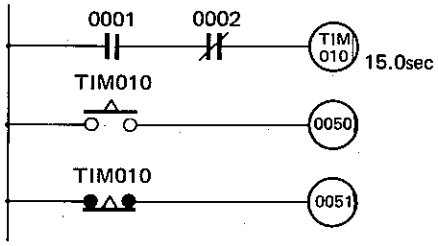
The number of blocks is not limited for OR·LD operation on a logic line. As many blocks as required can be continued for parallel connection by means of LD ~ OR LD keys.

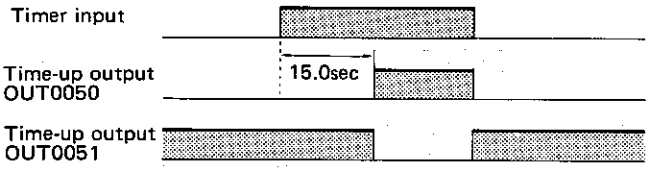


OP	Data
LD	0001
AND·NOT	0002
LD·NOT	0003
AND·NOT	0004
OR·LD	
LD	0005
AND	0006
OR·LD	
⋮	⋮
OUT	0050

■ TIMER (TIM) INSTRUCTION

The TIM instruction can be used as an ON-delay timer in the same manner as a relay circuit.

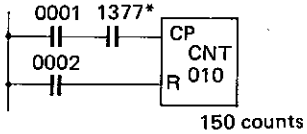




Address	OP	Data
0000	LD	0001
0001	AND-NOT	0002
0002	TIM	010*
0003		0150*
0004	LD-TIM	010
0005	OUT	0050
0006	LD-NOT-TIM	010
0007	OUT	0051

NOTES:
1. * Timer number 000 ~ 177.
2. ** Time setting value 000 ~ 999 x 0.1sec.
3. Timer numbers are shared by both timers and counters. Therefore, a number already assigned to a timer cannot be used for any other counter.

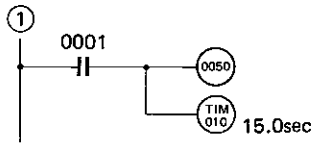
- **Operation of each register**
  The timer starts when the content of the R register is logical 1 and resets when the content of the R register is logical 0.
- **Number of contacts**
  A time-up contact designates the timer number itself. Both NO and NC contacts can be used in the required quantity.
- **Timer is of decrementing type**
  The timer is of a decrementing type which produces an output when the present value (time remaining) becomes "000." When the timer input is turned off, the present value of the timer returns to the preset value. The timer output is transmitted externally through an output relay as shown in the above circuit example.
- **Timer is reset at the time of a power failure**
  If a power failure occurs, the timer is reset and the present value returns to the preset value. Therefore, if it is required to retain the present value of the timer in the memory, a memory retentive type timer circuit as shown below must be used for programming.
- **Memory retentive type timer**
  A circuit to memorize the present value of the timer during a power failure is configured using a combination of clock instruction and counter (CNT) instruction.



OP	Data
LD	0001
AND	1377*
LD	0002
CNT	010
	150

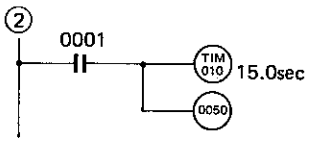
NOTE: * Special auxiliary relay 1377 is for 0.1sec clock.

- **Consecutive OUT instruction and TIM instruction**
  The operations of the circuits ① and ② below are the same, either of which may be used for programming.



OP	Data
LD	0001
OUT	0050
TIM	010
	150

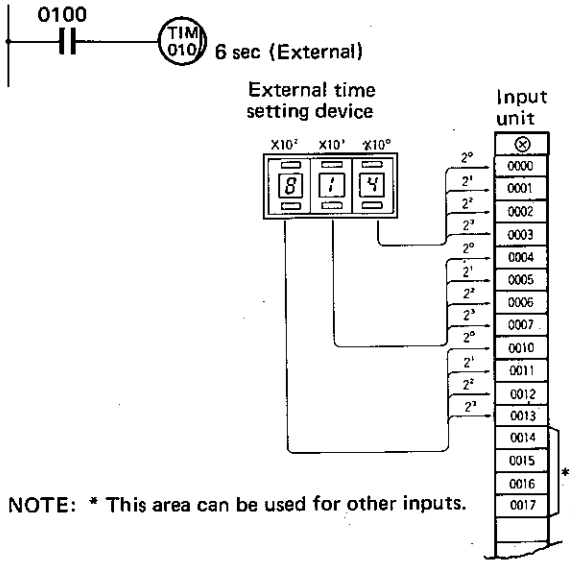
When the NO contact 0001 turns ON, output relay 0050 is energized and at the same time timer 010 starts operating.



OP	Data
LD	0001
TIM	010
	150
OUT	0050

When the NO contact 0001 turns ON, timer 010 starts operating and at the same time, output relay 0050 is energized.

- **External time setting is also possible.**

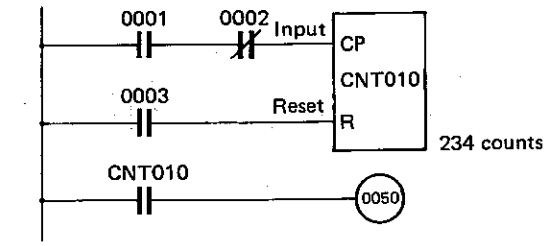


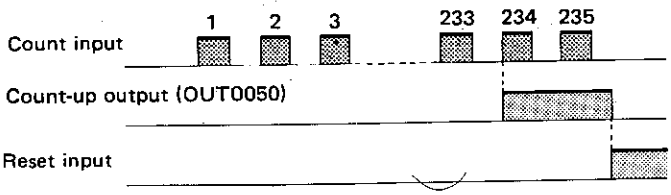
NOTE: * This area can be used for other inputs.

1. If ₭00 is specified as the second word of the data, the timer operation will be up after the lapse of 81.4sec set by the external time setting device which is connected to relay Nos. 0000 ~ 0013 as shown above.
2. For ₭□□ designation, ₭00 to ₭76 can be used.
   ₭00 → Relay Nos. 0000 ~ 0013
   ₭01 → Relay Nos. 0010 ~ 0023
   ⌇ ⌇
   ₭76 → Relay Nos. 0760 ~ 0773

■ COUNTER (CNT) INSTRUCTION

The CNT instruction can be used as a preset counter in the same manner as a relay circuit.



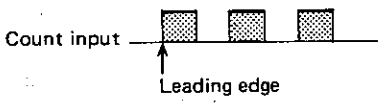


Coding

Address	OP	Data
0000	LD	0001
0001	AND-NOT	0002
0002	LD	0003
0003	CNT	010
0004		234
0005	LD-CNT	010
0006	OUT	0050

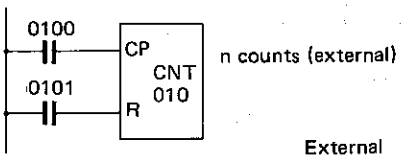
NOTES:
1. A counter program must be entered in the order of a count input circuit, a reset input circuit and a counter coil.
2. Counter number 000 ~ 177.
3. Counter setting value 000 ~ 999.
4. Counter numbers are shared by both counters and timers. Therefore, a number already assigned to a counter cannot be used for any timer.

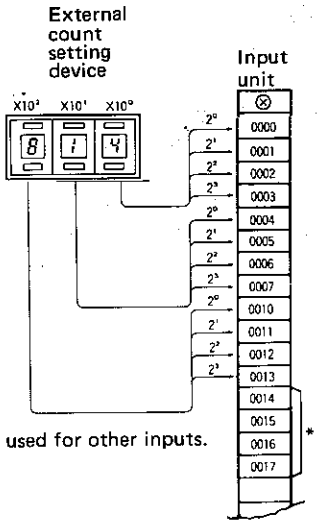
- **Operation of each register**
  The counter resets when the content of the R register is logical 1 and is enabled to count when the content of the R register is logical 0. A count input is provided from the S register.
- **Number of contacts**
  A count-up contact designates the counter number itself. Both NO and NC contacts can be used in the required quantity.
- **Counter is of decrementing type**
  The counter is of a decrementing type which produces an output when the count value becomes "000." The present value of the counter returns to the preset value when a reset input is applied. The counter output is transmitted externally through an output relay as shown in the circuit example.
- After the preset count is up, subsequent count inputs are ignored.
- At the leading edge (i.e., from OFF to ON) of a count input signal, the counter decrements the count value by 1.



- When both a count input and a reset input are applied simultaneously, the reset input takes precedence over the count input. Even if the reset input is removed after this, the counter performs no counting operation.
- **The present value of the counter is retained in memory during a power failure**
  If a power failure occurs, the counter is not reset and the present value (i.e., count remaining) of the counter is retained in the memory.

- **External count setting is also possible.**



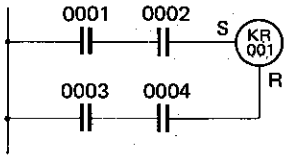


NOTE: * This area can be used for other inputs.

1. If ⁜00 is specified as the second word of the data, the counter operation will be up upon counting the value (814 counts) set by the external count setting device which is connected to the relay Nos. 0000 ~ 0013 as shown above.
2. For ⁜□□ designation, ⁜00 to ⁜76 can be used.
   ⁜00 → Relay Nos. 0000 ~ 0013.
   ⁜01 → Relay Nos. 0010 ~ 0023
   ≀ ≀
   ⁜76 → Relay Nos. 0760 ~ 0773

■ LATCHING RELAY (KR) INSTRUCTION

The KR instruction can be used as a latching relay in the same manner as a relay circuit.



Coding

Address	OP	Data
0000	LD	0001
0001	AND	0002
0002	LD	0003
0003	AND	0004
0004	KR*	001

Contents of Registers

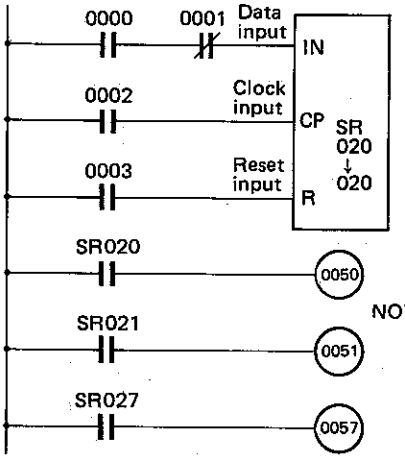
R	S
0001	—
0001 0002	—
0003	0001 0002
0003 | 0004	0001 0002
0003 | 0004	0001 0002

NOTES: * A latching relay program must be entered in the order of a set input circuit, a reset input circuit and a latching relay coil. Use the KR instruction to program a latching relay coil.

- **Operation of each register**
  The latching relay operates when the content of the R register is logical 0 and the content of the S register is logical 1. The relay releases when the content of the R register is logical 1.
- When both a set input and a reset input are applied simultaneously, the reset input takes precedence over the set input.
- The content of the latching relay is retained in the memory during a power failure. It continues to be retained until application of a reset input.

■ SHIFT REGISTER (SR) INSTRUCTION

The SR instruction can be used as a serial input shift register.

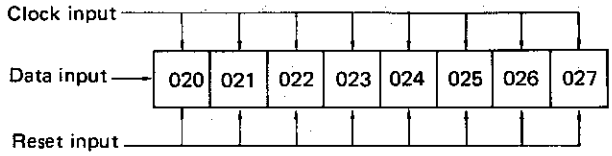


NOTE: A shift register must be programmed in the order of data input, clock input, reset input and SR.

Coding

Address	OP	Data
0200	LD	0000
0201	AND-NOT	0001
0202	LD	0002
0203	LD	0003
0204	SR	020
0205		020
0206	LD·SR	020
0207	OUT	0050
0208	LD·SR	021
0209	OUT	0051
0210	LD·SR	027
0211	OUT	0057

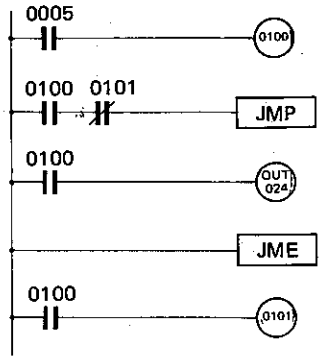
- Each SR instruction must be specified in units of 8 bits. In the above example, 8 bits from SR020 to SR027 are transferred.



- The 8-bit contents of the shift register (SR020 ~ SR027 in the above example) can be output bit by bit using a LD·SR instruction.

- When a reset input is applied to the shift register, 8 bits are reset all together.

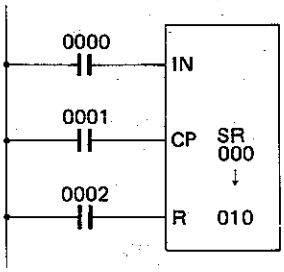
- Any of the 8 bits can be set or reset by force.



OP	Data
LD	0005
OUT	0100
LD	0100
AND-NOT	0101
JMP	
LD	0100
OUT-SR	024
JME	
LD	0100
OUT	0101

With a circuit arranged as shown above, a bit in SR024 can be set forcedly when NO contact 0005 is turned on. To reset the bit in SR024, use an OUT-NOT-SR instruction.

- Shift register exceeding 8 bits. In this case, a shift register circuit can be configured by combining two or more stages of 8-bit shift registers.

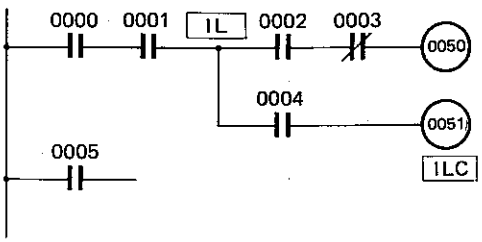


Address	OP	Data
0200	LD	0000
0201	LD	0001
0202	LD	0002
0203	SR	000
0204		010

The above circuit configuration shows a 16-bit shift register from SR000 to SR017. The data 000 for address 0203 indicates SR bits 000 ~ 007 and the data 010 for address 0204 indicates SR bits 010 ~ 017. Accordingly, any shift register configuration is possible by changing each data.

■ INTERLOCK (IL)/INTERLOCK CLEAR (ILC) INSTRUCTIONS

The IL and ILC instructions are used in pairs when branching a circuit to plural OUT instructions.



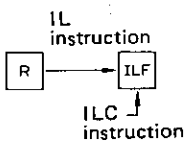
Coding

Address	OP	Data	
0200	LD	0000	
0201	AND	0001	
0202	IL		
0203	LD	0002	*
0204	AND-NOT	0003	
0205	OUT	0050	
0206	LD	0004	
0207	OUT	0051	
0208	ILC		
0209	LD	0005	*

NOTE: * When IL and ILC instructions are used in programming, be sure that an LD instruction will always follow the IL and ILC instructions respectively.

- **Operation of register**

The IL instruction causes the content of the R register to be transferred to the interlock flip-flop (ILF). Accordingly, the ILF is set to "0" if the content of the R register is "0" and to "1" if the content of the R register is "1."

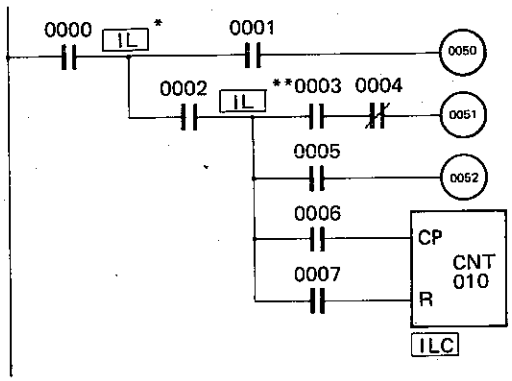


The ILC instruction causes the ILF to be set to "1" irrespective of the content of the R register. In other words, when the IL condition is OFF (i.e., when input 0000 or 0001 is OFF), the state of each relay between the IL and ILC instructions is as follows.

Output relay, internal auxiliary relay	OFF
Timer	Reset
Counter, shift register, latching relay	Holds present state

However, when the IL condition is ON, the state of each relay is the same as that in an ordinary relay circuit without IL/ILC instructions.

- **IL-ILC error**



If IL and ILC instructions are not used in pairs (as in the above example), it is judged as an IL-ILC error during the program check. The operation of the circuit, in this case, will be as programmed, which is shown below.

① If the condition of [IL] * is OFF, output relays 0050, 0051 and 0052 are all OFF and counter CNT10 retains it present count value.

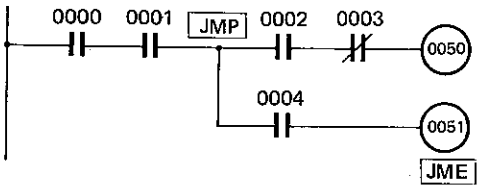
② If the conditions of both [IL] * and [IL] ** are OFF, the state of each relay is the same as ①.

③ If the condition of [IL] * is ON and that of [IL] ** is OFF, output relay 0050 turns ON or OFF if input 0001 is ON or OFF and relays 0051 and 0052 are OFF. Counter CNT010 retains its present count value.

④ If the condition of [IL] * is OFF and that of [IL] ** is ON, the state of each relay is the same as ① and ②.

■ JUMP (JMP)/JUMP END (JME) INSTRUCTIONS

The JMP instruction is used in conjunction with the JME instruction and causes the contents of a program between this instruction and the JME instruction to be ignored or executed according to the result immediately before this instruction.



Coding

Address	OP	Data
0200	LD	0000
0201	AND	0001
0202	JMP	
0203	LD	0002
0204	AND·NOT	0003
0205	OUT	0050
0206	LD	0004
0207	OUT	0051
0206	JME	

- **Operation of register**

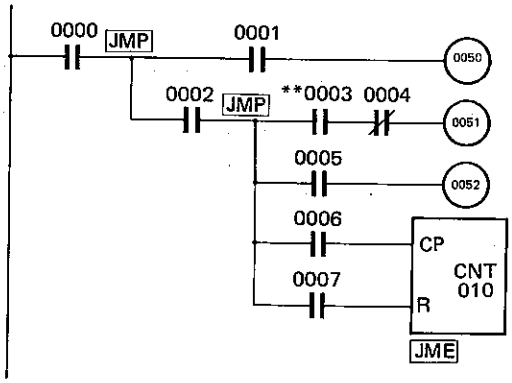
If the content of the R register is "0," the program steps between the JMP and JME instructions are not executed. If the content of the R register is "1," the program steps between the two instructions are executed.

In other words, when the JMP condition is OFF (i.e., when input 0000 or 0001 is OFF), the state of each relay between the JMP and JME instructions are as follows.

Output relay, internal auxiliary relay	Holds present state
Timer	ditto
Counter, shift register	ditto

However, if the JMP condition is ON, the state of each relay is the same as that in an ordinary relay circuit without JMP/JME instructions.

- **JMP-JME error**



If JMP and JME instructions are not used in pairs (as in the above example), it is judged as an JMP-JME error during the program check. The operation of the circuit, in this case, will be as programmed, which is shown below.

① If the condition of [JMP] * is OFF, output relays 0050, 0051 and 0052 remain in their present ON/OFF state, and counter CNT010 retains its present count value.

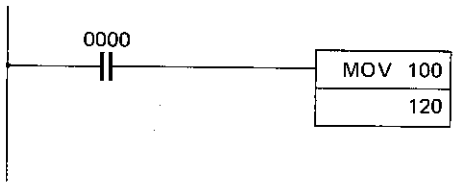
② If the conditions of both [JMP] * and [JMP] ** are OFF, the state of each output relay is the same as ①.

③ If the condition of [JMP] * is ON and that of [JMP] ** is OFF, output relay 0050 turns ON or OFF if input 0001 is ON or OFF, and output relays 0051 and 0052 remain in their present ON/OFF state. Counter CNT010 retains its present count value.

④ If the condition of [JMP] * is OFF and that of [JMP] ** is ON, the state of each output relay is the same as ① and ②.

■ MOVE (MOV)/MOVE NOT (MOV NOT) INSTRUCTIONS

The MOVE instruction is used to transfer the present value of a timer or counter in units of 12 bits and all other data in units of 8 bits. With this instruction, 2-digit constants (00 ~ 99) can also be transferred in units of 8 bits. The MOVE NOT instruction is used to transfer inverted data.



Coding

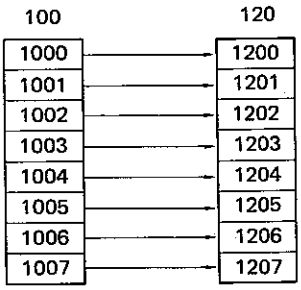
Address	OP	Data
0200	LD	0000
0201	MOV	100
0202		120
0203		

- **Operation of each register**

When the content of the R register is logical 0, nothing will be executed.

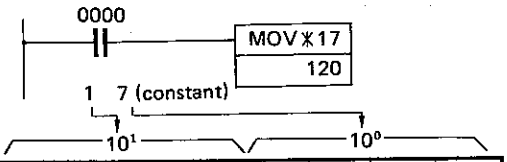
When the content of the R register is logical 1, data will be transferred as follows.

1. Data transfer in units of 8 bits,



According to the program shown above, the data of relay Nos. 1000 ~ 1007 are transferred to the relay Nos. 1200 ~ 1207, respectively.

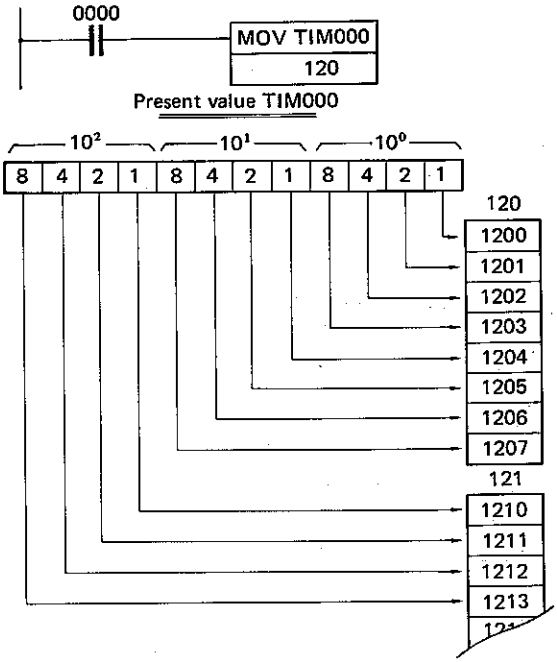
2. To transfer constant,



BCD code	8	4	2	1	8	4	2	1
Relay No.	1207	1206	1205	1204	1203	1202	1201	1200
Data	"0"	"0"	"0"	"1"	"0"	"1"	"1"	"1"

The constant "17" is output to relay Nos. 1200 ~ 1207.

3. To transfer the present value of a timer or counter in units of 12 bits,



The 12-bit data are transferred and relay Nos. 1210 ~ 1213 are automatically assigned to receive the data.

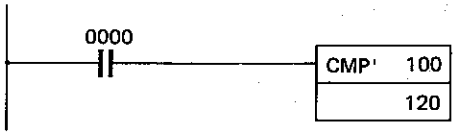
- **MOVE assignment area**

Instruction	1st word: Data (Specifies the data of the relay Nos. or the constant to be transferred)		2nd word: Data (Specifies the relay Nos. by which transferred data are to be received)	
MOV	000 ~ 137	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1377 in units of 8 bits.*	000 ~ 133	Specifies the data of I/O relay Nos. 0000 ~ 0777 or internal auxiliary relay Nos. 1000 ~ 1337 in units of 8 bits.*
	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**
	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**
	✱00 ~ ✱99	Specifies 2-digit constant 00 ~ 99.		
	Timer/ counter Nos. 000 ~ 177	Specifies timer or counter Nos. 000 ~ 177, the present value of which is to be transferred.	000 ~ 132	Specifies the data of I/O relay Nos. 0000 ~ 0777 or auxiliary relay Nos. 1000 ~ 1337 in units of 12 bits.***
			KR00 ~ 36	Specifies the data of latching relay Nos. 000 ~ 377 in units of 12 bits.
			SR00 ~ 36	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.

NOTES:
1. * When the 1st word is entered as "000", the 8 bits of I/O relay Nos. 0000 ~ 0007 are assigned.
2. ** When the 1st word is entered as "KR00", the 8 bits of latching relay Nos. 000 ~ 007 are assigned. In case of SR□□, the shift register assignment is the same as the latching relay Nos.
3. *** When the 1st word is entered as "0020", the 12 bits of I/O relay Nos. 0020 ~ 0033 are assigned.
4. Combination of the 1st and 2nd word data is free.

■ COMPARE (CMP) INSTRUCTIONS

The COMPARE instruction is used to compare any two 8-bit data to compare an 8-bit data with a 2-digit constant.



Coding

Address	OP	Data
0200	LD	0000
0201	CMP	100
0202		120
0203		

- **Operation of each register**

When the content of the R register is logical 0, the operation result area of special auxiliary relay Nos. 1361 ~ 1363 holds the previous state.

When the content of the R register is logical 1, the 8-bit contents of relay Nos. 1000 ~ 1007 are compared with those of relay Nos. 1200 ~ 1207 and the result of the comparison is output to special auxiliary relay No. 1361, 1362 or 1363.

Special auxiliary relay No. 1361:

The data specified by the 1st word is less than (<) the data specified by the 2nd word.

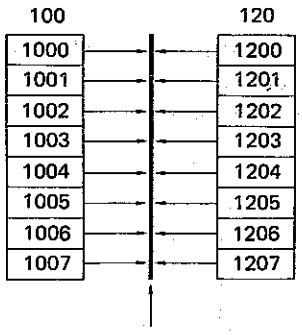
Special auxiliary relay No. 1362:

The data specified by the 1st word is equal to (=) the data specified by the 2nd word.

Special auxiliary relay No. 1363:

The data specified by the 1st word is greater than (>) the data specified by the 2nd word.

1. To compare any two 8-bit data,



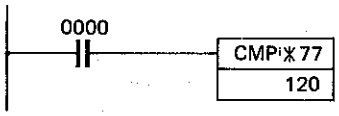
The results of the comparison are output as follows.

100 < 120 → Special auxiliary relay No. 1361.

100 = 120 → Special auxiliary relay No. 1362.

100 > 120 → Special auxiliary relay No. 1363.

2. To compare 8-bit data with 2-digit constant,



If ※77 is specified as the 1st word, the contents of relay Nos. 1200 ~ 1207 are compared with 2-digit BCD constant "77".

- **COMPARE operation assignment area**

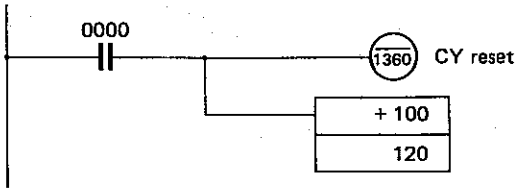
Instruction	1st word: Data (Specifies the data of the relay Nos. or the constant to be compared with the 2nd word data)		2nd word: Data (Specifies the data of the relay Nos. to be compared with the 1st word data)	
CMP	000 ~ 135	Specified the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337 or special auxiliary relay Nos. 1340 ~ 1357 in units of 8 bits.*	000 ~ 135	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1357 in units of 8 bits.*
	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**
	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**
	※00 ~ ※99	Specifies 2-digit constant 00 ~ 99.		

NOTES:

1. * When the 1st word is entered as "000", the 8 bits of I/O relay Nos. 0000 ~ 0007 are assigned.
2. ** When the 1st word is entered as "KR00", the 8 bits of latching relay Nos. 000 ~ 007 are assigned. In case of SR□□, the shift register assignment is the same as the latching relay Nos.
3. *** When the 1st word is entered as "0020", the 12 bits of I/O relay Nos. 0020 ~ 0033 are assigned.
4. Combination of the 1st and 2nd word data is free.

■ ADD (+) INSTRUCTION

The ADD instruction is used to execute the addition of 2-digit BCD data.



Coding

Address	OP	Data
0200	LD	0000
0201	OUT-NOT	1360
0202	+	100
0203		120

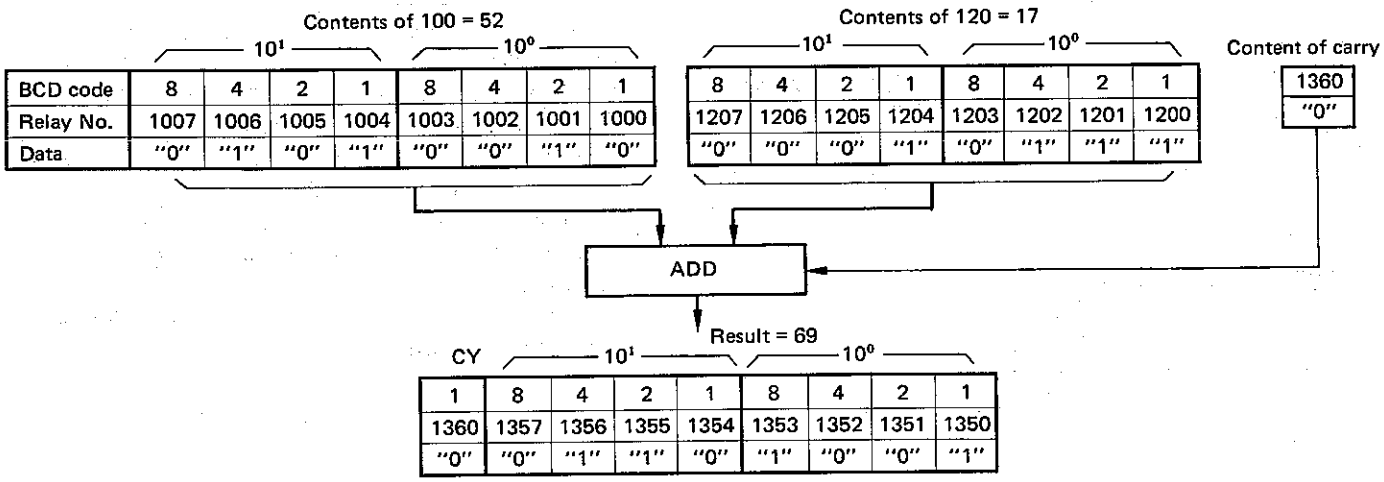
- **Operation of each register**

When the content of the R register is logical 0, only the content of the CY (carry) register (Relay No. 1360) becomes "1" and no addition is executed.

When the content of the R register is logical 1, the 8-bit data of relay Nos. 1000 ~ 1007 are added to the 8-bit data of relay Nos. 1200 ~ 1207, and the result of the addition is output to special auxiliary relay Nos. 1350 ~ 1357 and the content of the CY register to special auxiliary relay No. 1360.

The result of the operation is initialized whenever the mode selector switch of the SYSMAC-M5R is set to the RUN mode. The content of the CY register (1360) is cleared when the END instruction is executed.

1. To add 8-bit data,



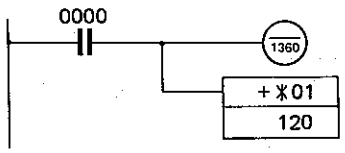
BCD code	10^1				10^0			
	8	4	2	1	8	4	2	1
Relay No.	1007	1006	1005	1004	1003	1002	1001	1000
Data	"0"	"1"	"0"	"1"	"0"	"0"	"1"	"0"

	10^1				10^0			
	8	4	2	1	8	4	2	1
	1207	1206	1205	1204	1203	1202	1201	1200
	"0"	"0"	"0"	"1"	"0"	"1"	"1"	"1"

1360
"0"

CY	10^1				10^0			
1	8	4	2	1	8	4	2	1
1360	1357	1356	1355	1354	1353	1352	1351	1350
"0"	"0"	"1"	"1"	"0"	"1"	"0"	"0"	"1"

2. To add constant,



If ✳01 is specified, 2-digit BCD constant "01" is added to the contents of internal auxiliary relay Nos. 1200 ~ 1207.

- Since the CPU doesn't judge whether the data subject to the operation is BCD or not, the result of the operation is indefinite if the BCD value is more than "A" (decimal 10).

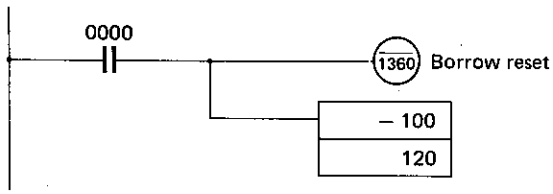
- **ADD operation assignment area**

Instruction	1st word		2nd word	
	Data (Specifies the data of relay Nos. or the constant to be added by the 2nd word data)		Data (Specifies the data of the relay Nos. to be added to the 1st word data)	
ADD (+)	000 ~ 134	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1347 in units of 8 bits.*	000 ~ 134	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1347 in units of 8 bits.*
	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**
	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**	SR00 ~ 37	Specifies the data of the shift register Nos. 000 ~ 377 in units of 8 bits.**
	※00 ~ ※99	Specifies 2-digit constant 00 ~ 99.		

NOTES:
1. * When the 1st word is entered as "000", the 8 bits of I/O relay Nos. 0000 ~ 0007 are assigned.
2. ** When the 1st word is entered as "KR00", the 8 bits of latching relay Nos. 000 ~ 007 are assigned. In case of SR□□, the shift register assignment is the same as the latching relay Nos.
3. *** When the 1st word is entered as "0020", the 12 bits of I/O relay Nos. 0020 ~ 0033 are assigned.
4. Combination of the 1st and 2nd word data is free.

■ SUB (–) INSTRUCTION

The subtract (SUB) instruction is used to execute the subtraction of 2-digit BCD data.



Coding

Address	OP	Data
0200	LD	0000
0201	OUT·NOT	1360
0202	–	100
0203		120

- **Operation of each register**

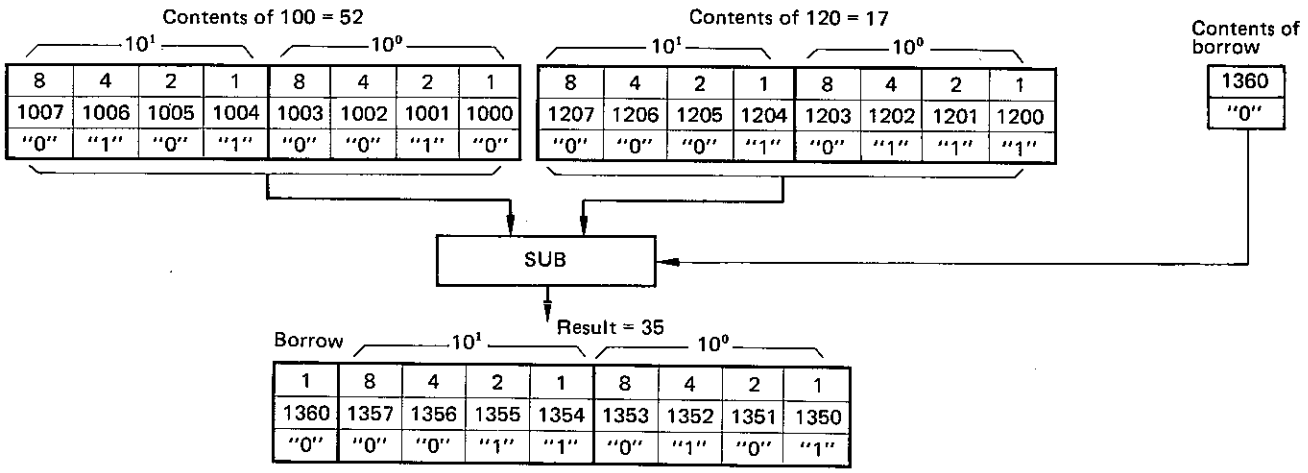
When the content of the R register is logical 0, only the content of the Borrow register (1360) becomes "1" and no subtraction is not executed.

When the content of the R register is logical 1, the 8-bit data of relay Nos. 1200 ~ 1207 are subtracted from the 8-bit data of relay Nos. 1000 ~ 1007 and the result of the subtraction is output to special auxiliary relay Nos. 1350 ~ 1357 and the content of the Borrow register to special auxiliary relay No. 1360.

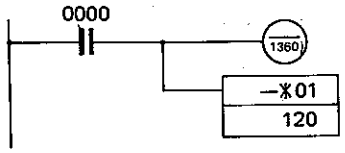
The result of the operation is initialized whenever the mode selector switch of the SYSMAC-M5R is set to the RUN mode.

The content of the Borrow register (1360) is cleared when the END instruction is executed.

1. To subtract 8-bit data,



2. To subtract constant,



If Ж01 is specified, 2-digit BCD constant "01" is subtracted from the contents of internal auxiliary relay Nos. 1200 ~ 1207.

- Since the CPU doesn't judge whether the data subject to the operation is BCD or not, the result of the operation is indefinite if the BCD value is more than "A (decimal 10)."

- **SUB operation assignment area**

Instruction	1st word: Data (Specifies the data of relay Nos. or the constant to be subtracted by the 2nd word data)		2nd word: Data (Specifies the data of the relay Nos. to be subtracted from the 1st word data)	
SUB (—)	000 ~ 134	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1347 in units of 8 bits.*	000 ~ 134	Specifies the data of I/O relay Nos. 0000 ~ 0777, internal auxiliary relay Nos. 1000 ~ 1337, or special auxiliary relay Nos. 1340 ~ 1347 in units of 8 bits.*
	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**	KR00 ~ 37	Specifies the data of latching relay Nos. 000 ~ 377 in units of 8 bits.**
	SR00 ~ 37	Specifies the data of shift register Nos. 000 ~ 377 in units of 8 bits.**	SR00 ~ 37	Specifies the data of the shift register Nos. 000 ~ 377 in units of 8 bits.**
	Ж00 ~ Ж99	Specifies 2-digit constant 00 ~ 99.		

NOTES:
1. * When the 1st word is entered as "000", the 8 bits of I/O relay Nos. 0000 ~ 0007 are assigned.
2. ** When the 1st word is entered as "KR00", the 8 bits of latching relay Nos. 000 ~ 007 are assigned. In case of SR□□, the shift register assignment is the same as the latching relay Nos.
3. ** When the 1st word is entered as "0020", the 12 bits of I/O relay Nos. 0020 ~ 0033 are assigned.
4. Combination of the 1st and 2nd word data is free.

■ DIAGNOSTIC (FAL) INSTRUCTION

The FAL instruction is used to output the failure or abnormal mode to the FAL area indicating the occurrence of a failure or abnormality in the internal circuit during the operation of the SYSMAC-M5R. To use this instruction, circuits which are presumed to fail or become abnormal must be programmed beforehand with a failure or abnormal mode (01 ~ 99) assigned to each of the faulty or abnormal circuits.

Coding

Address	OP	Data
0200	LD	0000
0201	FAL	17
0202		
0203		

- **Operation of each resister**
  When the content of the R register is logical 0, nothing is executed.

- When the content of the R register is logical 1, the failure or abnormal mode (01 ~ 99) is output in 2-digit BCD to special auxiliary relay Nos. 1340 ~ 1347. The value once stored in the FAL area is not cleared until execution of the FAL00 instruction. When the FAL00 instruction is executed, the next value is acceptable by the FAL area.

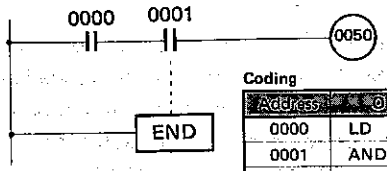
FAL area (17)

	10^1				10^0			
BCD code	8	4	2	1	8	4	2	1
Relay No.	1347	1346	1345	1344	1343	1342	1341	1340
Data	"0"	"0"	"0"	"1"	"0"	"1"	"1"	"1"

- **Values that can be assigned**
  FAL00 .... Clear
  FAL01 ~ FAL99 } Failure or abnormal mode 01 ~ 99

■ END INSTRUCTION

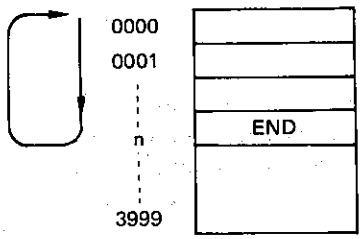
Insert this instruction at the end of a program.



Coding

Address	OP	Data
0000	LD	0001
0001	AND	0002
0002	OUT	0050
0003	⋮	⋮
0004	⋮	⋮
⋮	⋮	⋮
n	END	—

- The program memory of the SYSMAC-M5R is provided with addresses 0000 to 3999. The CPU scans program data from address 0000 to the address with an END instruction according to the sequence diagram.



- When performing a test run, insert an END instruction at each end of a sequence circuit and then delete the END instruction after confirming each circuit. In this manner, the test run can be executed smoothly.

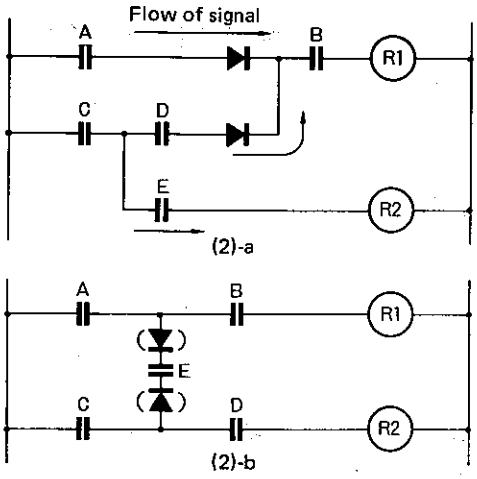
5. Programming

5.1 How to Program

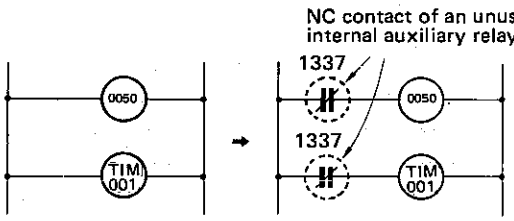
With the SYSMAC-M5R, a sequence circuit controlled according to the sequence of the instructions stored in the CPU memory. Therefore, it is necessary to observe the hints on correct programming and programming order.

■ HINTS ON CORRECT PROGRAMMING

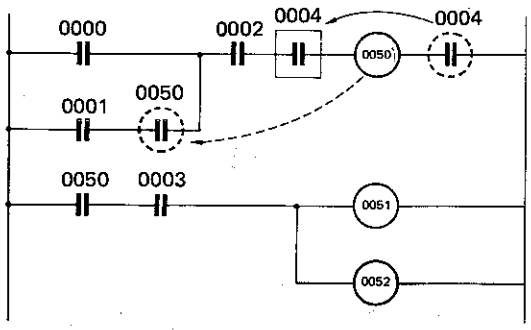
1. Since the number of contacts is not limited for input/output relays, internal auxiliary relays, timers, etc., it can be said that the best way to design a sequence circuit is to configure a simple, clear circuit, rather than a complicated circuit created by reducing the number of contacts.
2. In the SYSMAC-M5R, signals will flow from the left to the right. In other words, signals will flow as if diodes are inserted in the circuit as shown in (2)-a or (2)-b. To operate a circuit without diodes in the same manner as the circuit configured with general control relays, it is necessary to rewrite the circuit.



3. In a series-parallel circuit, the number of contacts that can be connected in series is not limited, as well as the number of contacts that can be connected in parallel.
4. No output relay can be connected directly from the bus bar. If necessary, connect it through the NC contact of an unused internal auxiliary relay or special auxiliary relay 1365.



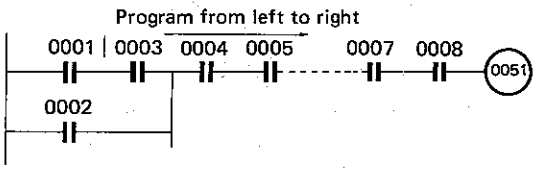
5. All output relays are provided with auxiliary contacts that can be used on a circuit, in addition to the output signal contacts to drive loads actually. The number of contacts that can be used per output relay is not limited.



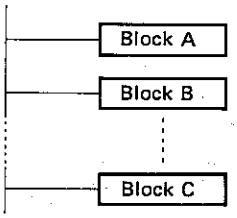
6. No relay contact can be inserted next to an output coil. If necessary, insert it before the output coil.
7. Two or more output coils can be connected in parallel.
8. For contact and coil numbers on the circuit, use the I/O relay numbers described in Section 3.1.
9. Output coil numbers (including those for timers, counters, shift registers and latching relays) cannot be used in duplication.

■ PROGRAMMING ORDER

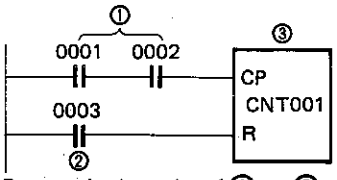
1. Program a circuit from its left to right.



2. Assume the circuit elements located from the bus bar to an output relay as one block. If a number of blocks are in line, programming can be started from any block. However, pay attention in case of circuits utilizing scan time or timing such as differentiator, shift register, etc.



3. When composite instructions such as timer, counter, shift register, latching relay, etc. are used, their order of programming is predetermined. Be sure to perform the programming according to the predetermined order.

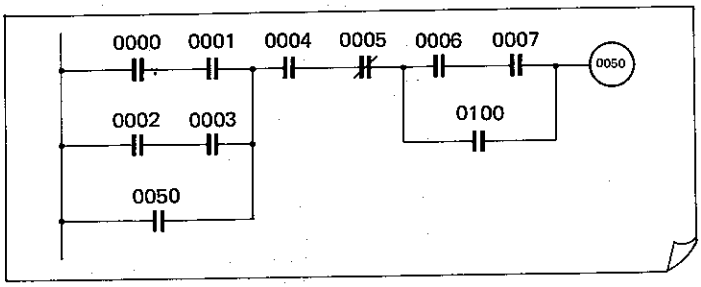


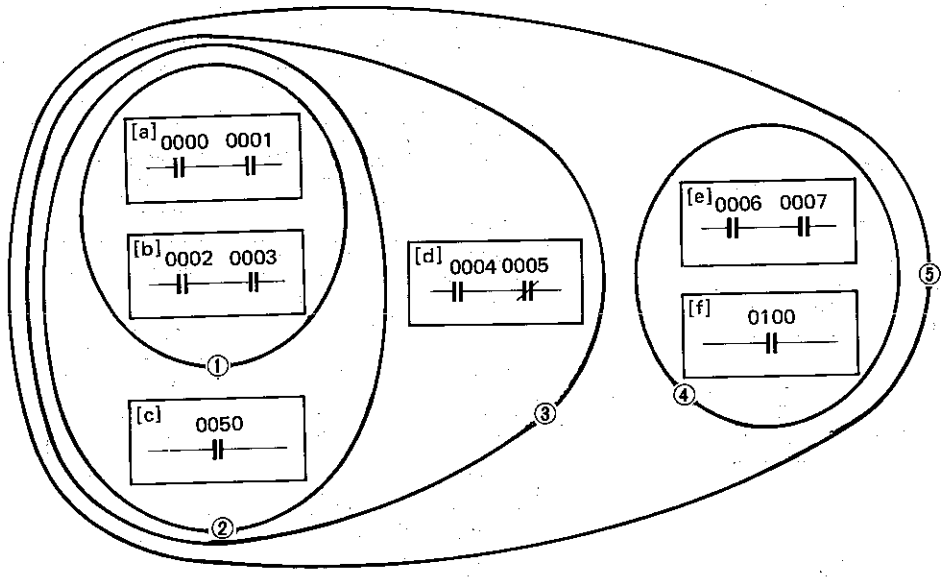
Program in the order of ① → ③

Address	OP	Data
⋮		⋮
n	LD	0001
n + 1	AND	0002
n + 2	LD	0003
n + 3	CNT	001
n + 4		056
⋮		⋮

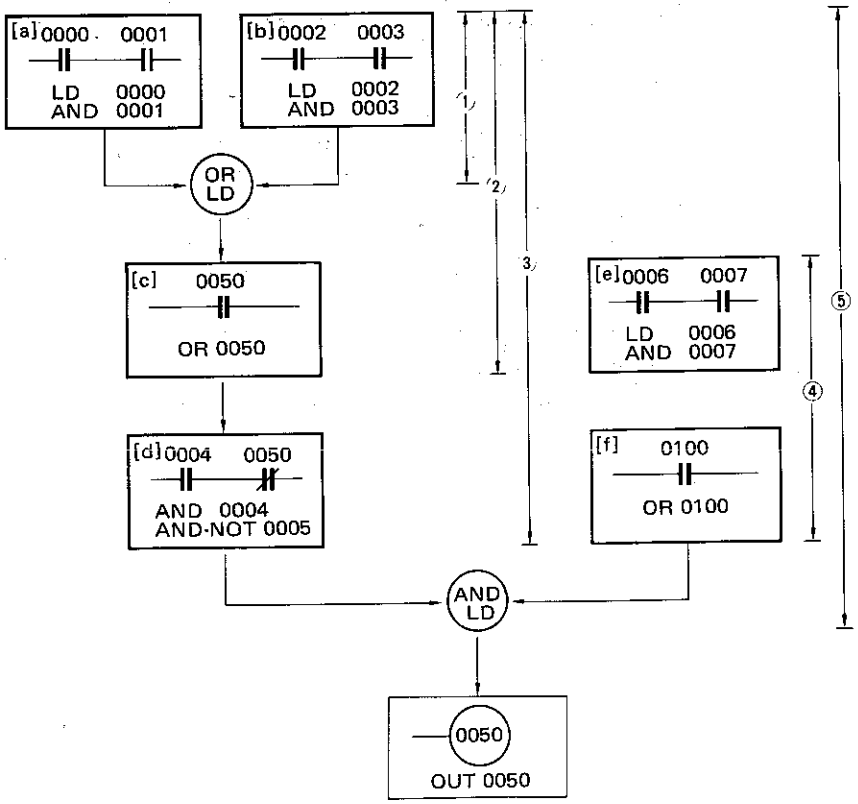
4. Be sure to insert an END instruction at the end of each program.
5. A ladder diagram such as the one shown below can be divided into small blocks as shown below, to program each block in the order of ① to ⑤. Eventually, the circuit will be programmed as one large block such as ⑤

- **Ladder diagram**





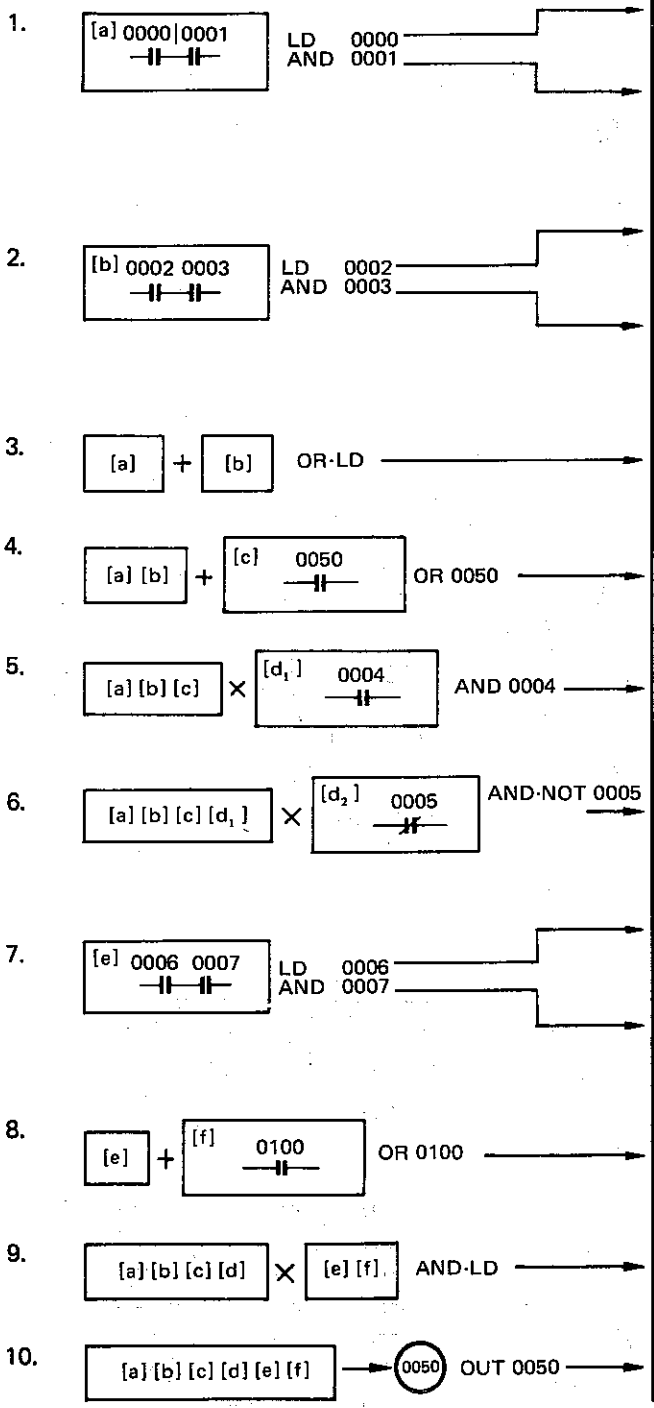
- **Programming procedure**



- **Coding**

Address	OP	Data
0000	LD	0000
0001	AND	0001
0002	LD	0002
0003	AND	0003
0004	OR·LD	
0005	OR	0050
0006	AND	0004
0007	AND-NOT	0005
0008	LD	0006
0009	AND	0007
0010	OR	0100
0011	AND·LD	
0012	OUT	0050
⋮		⋮
n	END	

- **Operations of R and S registers**

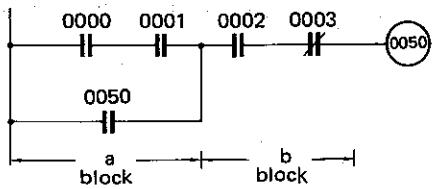


Content of register	R register	S register
The content ("1" or "0") of 0000 is stored in R register.	0000	Vacant
The content of R register is ANDed with the content of 0001 and the result of operation is stored in R register.	Result of 0000 0001 = [a]	Vacant
The previous content of R register is transferred to S register and the content of 0002 is newly stored in R register.	0002	[a]
The content of R register is ANDed with the content of 0003, and the result of operation is stored in R register.	Result of 0002 0003 = [b]	[a]
The content of R register (result [b]) is ORed with the content of S register (result [a]), and the result of operation is stored in R register.	Result of ORing [a] with [b] = [a] [b]	Vacant
The content of 0050 is ORed with the content of R register, and the result of operation is stored in R register.	Result of ORing [a] [b] with [c] = [a] [b] [c]	Vacant
The content of 0004 is ANDed with the content of R register, and the result of operation is stored in R register.	Result of ANDing [a] [b] [c] with [d_1] = [a] [b] [c] [d_1]	Vacant
The content of 0005 is ANDed with the content of R register and the result of operation is stored in R register.	Result of ANDing [a] [b] [c] [d_1] with [d_2] = [a] [b] [c] [d]	Vacant
The previous content of R register is transferred to S register, and the content of 0006 is stored in R register.	0006	[a] [b] [c] [d]
The content of R register is ANDed with the content of 0007, and the result of operation is stored in R register.	Result of 0006 0007 = [e]	[a] [b] [c] [d]
The content of R register is ORed with the content of 0100, and the result of operation is stored in R register.	Result of ORing [e] with [f] = [e] [f]	[a] [b] [c] [d]
The content of R register is ANDed with the content of S register, and the result of operation is stored in R register.	[a] [b] [c] [d] [e] [f]	Vacant
The result of R register is output to output relay OUT0050.	[a] [b] [c] [d] [e] [f]	Vacant

5.2 Applied Programs

■ WHEN LD/OR/AND/NOT INSTRUCTIONS ARE USED

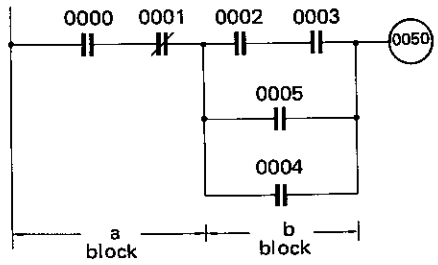
1. An example of parallel-series circuit



OP	Data	
LD	0000	a
AND	0001	
OR	0050	
AND	0002	b
AND·NOT	0003	
OUT	0050	
⋮	⋮	
END		

- Process block b after programming block a (parallel circuit).
- For coding, enter I/O relay numbers in the data field.

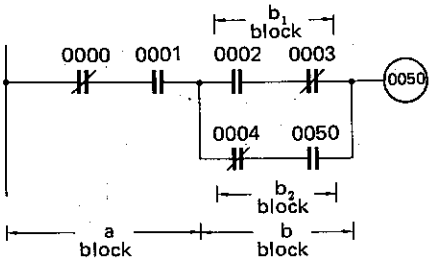
2. An example of series-parallel circuit



OP	Data	
LD	0000	a
AND·NOT	0001	
LD	0002	b
AND	0003	
OR	0050	
OR	0004	
AND·LD		
OUT	0050	
⋮	⋮	
END		

- Divide the circuit into blocks a and b and program each block.
- Then combine blocks a and b by AND·LD instruction.

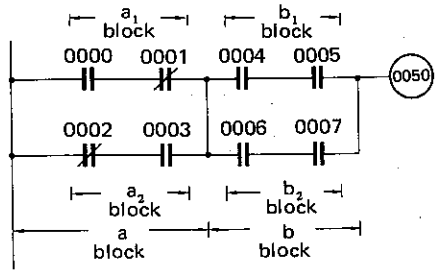
3. An example of series-parallel circuit



OP	Data	
LD·NOT	0000	a
AND	0001	
LD	0002	b_1
AND·NOT	0003	
LD·NOT	0004	b_2
AND	0050	
OR·LD		b_1+b_2
AND·LD		a·b
OUT	0050	
⋮	⋮	
END		

- Program block a.
- Program block b_1 and then block b_2.
- Combine blocks b_1 and b_2 using OR·LD instruction.
- Combine blocks a and b using AND·LD instruction.

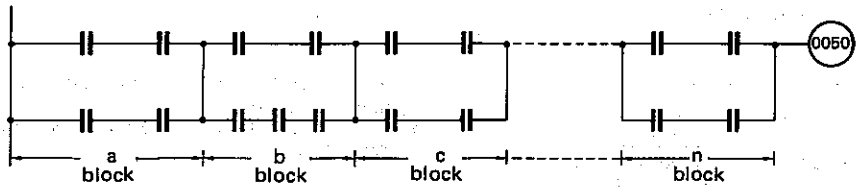
4. An example of connecting parallel circuits in series.



OP	Data	
LD	0000	a_1
AND·NOT	0001	
LD·NOT	0002	a_2
AND	0003	
OR·LD		a_1+a_2
LD	0004	b_1
AND	0005	
LD	0006	b_2
AND	0007	
OR·LD		b_1+b_2
AND·LD		a·b
OUT	0050	
⋮	⋮	
END		

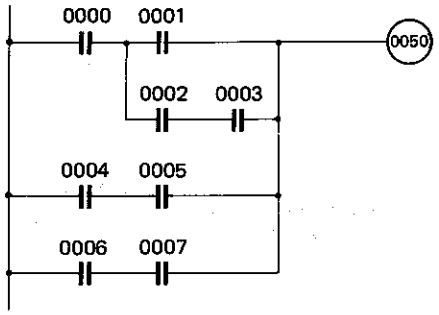
- Program block a_1 and then block a_2 and combine both blocks using OR·LD instruction.
- Program blocks b_1 and b_2 in the same manner as above.
- Combine blocks a and b using AND·LD instruction.

5. An example of connecting parallel circuits in series



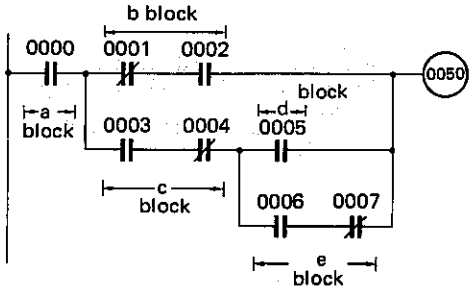
- When a number of blocks continue from block number a to n, the programming procedure is the same as paragraph 4 above. Namely, program the circuit in the following sequence.
  ① block a → ② block b → ③ blocks a·b → ④ block c → ⑤ blocks a·b·c → ⑥ .....

6. An example of complicated parallel circuit



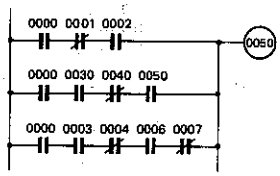
OP	Data
LD	0000
LD	0001
LD	0002
AND	0003
OR·LD	
AND·LD	
LD	0004
AND	0005
OR·LD	
LD	0006
AND	0007
OR·LD	
OUT	0050
⋮	⋮
END	

7. An example of complicated circuit



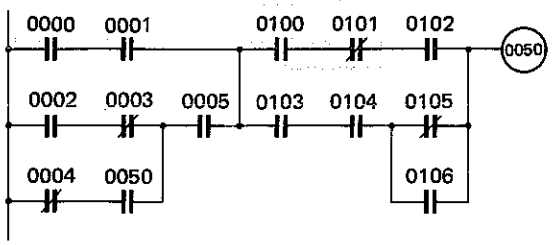
OP	Data	
LD	0000	a
LD·NOT	0001	b
AND	0002	
LD	0003	c
AND·NOT	0004	
LD	0005	d
LD	0006	e
AND·NOT	0007	
OR·LD		d+e
AND·LD		(d+e)·c
OR·LD		(d+e)·c+b
AND·LD		[(d+e)·c+b]·a
OUT	0050	
⋮	⋮	
END		

- The circuit shown on the left may be re-written as follows.



OP	Data
LD	0000
AND·NOT	0001
AND	0002
LD	0000
AND	0003
AND·NOT	0004
AND	0005
OR·LD	
LD	0000
AND	0003
AND·NOT	0004
AND	0006
AND·NOT	0007
OR·LD	
OUT	0050
⋮	⋮
END	

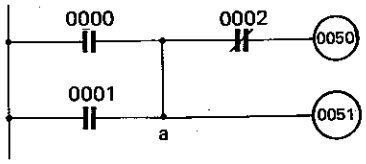
8. An example of complicated circuit



OP	Data
LD	0000
AND	0001
LD	0002
AND·NOT	0003
LD·NOT	0004
AND	0050
OR·LD	
AND	0005
OR·LD	
LD	0100
AND·NOT	0101

OP	Data
AND	0102
LD	0103
AND	0104
LD·NOT	0105
OR	0106
AND·LD	
OR·LD	
AND·LD	
OUT	0050
⋮	⋮
END	

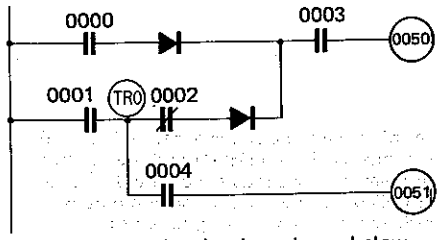
9. An example of circuit requiring caution



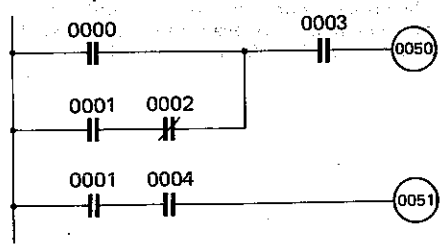
OP	Data
LD	0000
OR	0001
OUT	0051
AND·NOT	0002
OUT	0050
⋮	⋮
END	

- In such a case as shown on the left, program relay contact $\dashv\!\overset{0002}{/}\!\vdash$ after programming output relay 0051. This action is necessary for the following reason. Even if an output is sent to output relay 0050, the content of the R register at point a will remain unchanged. However, if $\dashv\!\overset{0002}{/}\!\vdash$ is programmed before output relay 0050, the content of the R register at point a will change and differ from the content sent to output relay 0051.

10. An example of circuit requiring caution



Separate the circuit as shown below.

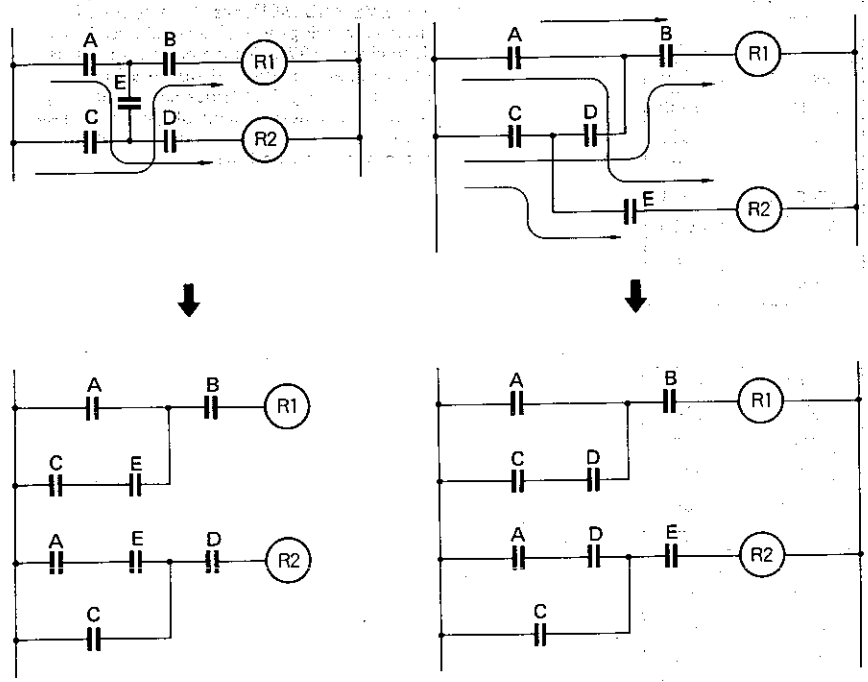


OP	Data
LD	0000
LD	0001
AND·NOT	0002
OR·LD	
AND	0003
OUT	0050
LD	0001
AND	0004
OUT	0051
⋮	⋮
END	

- If the circuit is to be programmed without separating it, program a temporary memory relay after relay contact $\dashv\!\overset{0001}{/}\!\vdash$. The following table shows an example of programming (TR0) after $\dashv\!\overset{0001}{/}\!\vdash$.

OP	Data
LD	0000
LD	0001
OUT·TR	0
AND·NOT	0002
OR·LD	
AND	0003
OUT	0050
LD·TR	0
AND	0004
OUT	0051
⋮	⋮
END	

11. Examples of circuit requiring rewrite

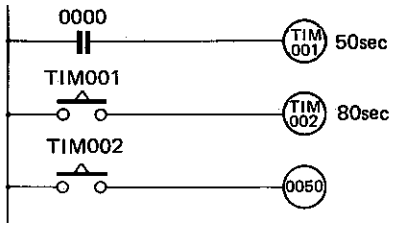


- Such circuits as shown on the upper left cannot be programmed and must therefore be rewritten as shown directly below.
- Since the two upper circuits are respectively configured with control relays, the circuits operate even by the flows of signals shown by the arrows. To permit the similar circuit operation with the SYSMAC-M5R, the two upper circuits must be rewritten into the corresponding circuits shown below.

■ WHEN TIM/CNT INSTRUCTIONS ARE USED

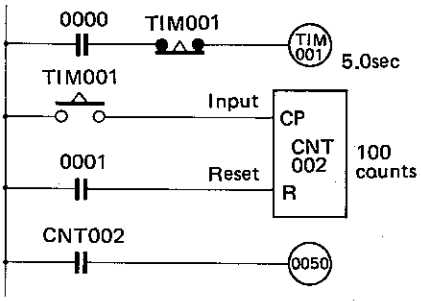
1. Long-time timer

a. Series connection of TIM instructions



OP	Data
LD	0000
TIM	001
	500
LD·TIM	001
TIM	002
	800
LD·TIM	002
OUT	0050
⋮	⋮
END	

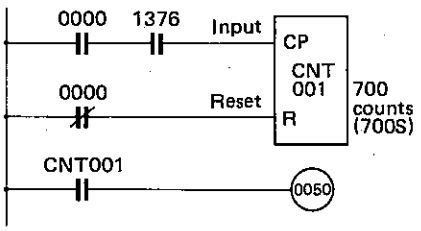
b. Use of CNT instruction (e.g., 500sec)



OP	Data
LD	0000
AND·NOT·TIM	001
TIM	001
	050
LD·TIM	001
LD	0001
CNT	002
	100
LD·CNT	002
OUT	0050
⋮	⋮
END	

- In this circuit, a pulse is generated every 5 seconds by timer TIM001 and then pulses at intervals of 5 seconds are counted by counter CNT002. The example shown here is a 500sec timer. The setting time of the timer is (timer + scan time) x number of counts.
- The present count value of the counter is retained in memory even if the power switch of the SYSMAC-M5R is turned off.

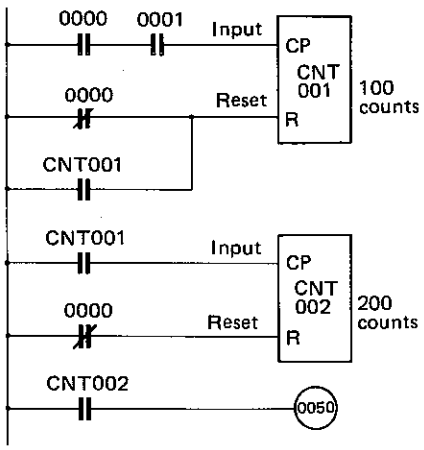
c. Use of internal clock pulse (e.g., 700sec)



OP	Data
LD	0000
AND	1376
LD·NOT	0000
CNT	001
	700
LD·CNT	001
OUT	0050
⋮	⋮
END	

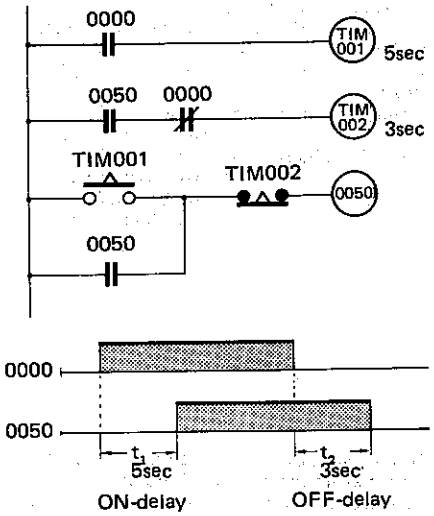
- The SYSMAC-M5R,has three types of internal clock pulses (0.2sec clock: 1375, 1sec clock: 1376, 0.1sec clock: 1377). By counting any of type of pulses with a counter, a long-time timer can be developed.
- As CNT instruction is employed, the present count value is retained in memory even after the power is turned off.

2. Multi-digit counter (e.g., 20,000 counts)



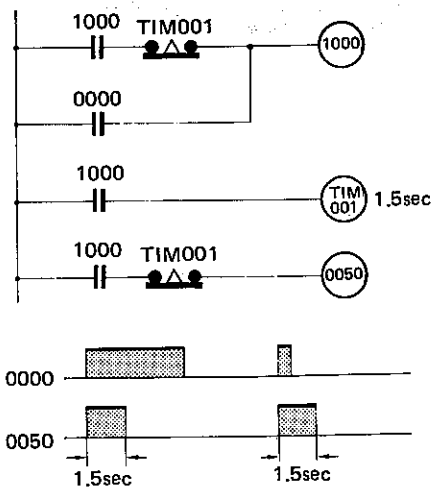
OP	Data
LD	0000
AND	0001
LD·NOT	0000
OR·CNT	001
CNT	001
	100
LD·CNT	001
LD·NOT	0000
CNT	002
	200
LD·CNT	002
OUT	0050
⋮	⋮
END	

3. An example of ON/OFF-delay timer circuit



OP	Data
LD	0000
TIM	001
	050
LD	0050
AND-NOT	0000
TIM	002
	030
LD-TIM	001
OR	0050
AND-NOT-TIM	002
OUT	0050
⋮	⋮
END	

4. An example of one-shot timer circuit

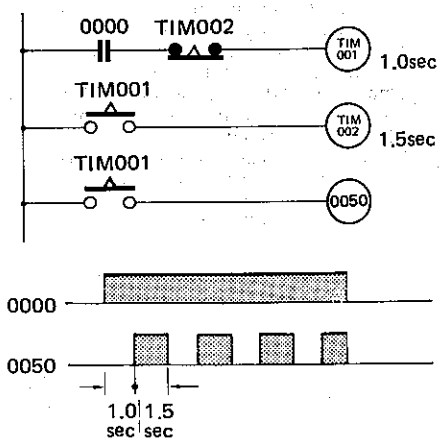


OP	Data
LD	1000
AND-NOT-TIM	001
OR	0000
OUT	1000
LD	1000
TIM	001
	015
LD	1000
AND-NOT-TIM	001
OUT	0050
⋮	⋮
END	

- One shot output is produced for only the set time of TIM001 after an input signal is applied. (Input 0000 > scan time)

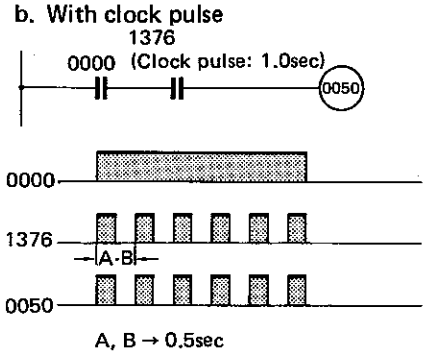
5. Examples of flicker circuit

a. With 2 timers used



OP	Data
LD	0000
AND-NOT-TIM	002
TIM	001
	010
LD-TIM	001
TIM	002
	015
LD-TIM	001
OUT	0050
⋮	⋮
END	

b. With clock pulse

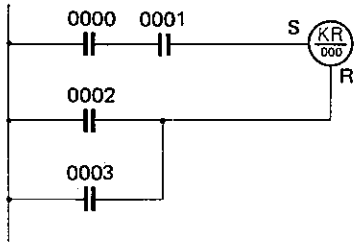


OP	Data
LD	0000
AND	1376
OUT	0050
⋮	⋮
END	

- Using an internal clock pulse (0.1sec, 1.0sec or 0.2sec), a flicker circuit can be processed easily. In this case, however, the flickering time is available only in the following 3 types.
  Special auxiliary relay number 1375: 0.2sec clock pulse
  Special auxiliary relay number 1376: 1.0sec clock pulse
  Special auxiliary relay number 1377: 0.1sec clock pulse

■ WHEN LATCHING RELAY IS USED

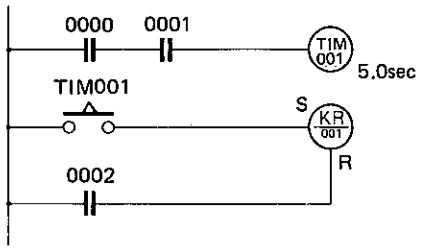
1. Basic circuit



OP	Data
LD	0000
AND	0001
LD	0002
OR	0003
KR	000
⋮	⋮
END	

- In the event of a power failure, the ON/OFF state before the power failure can be retained in memory, using a latching relay. SYSMAC-M5R has 256 latching relays with relay numbers KR000 ~ KR377.
- Memory retention time after a power failure is about 2 years just the same as that of the program memory.

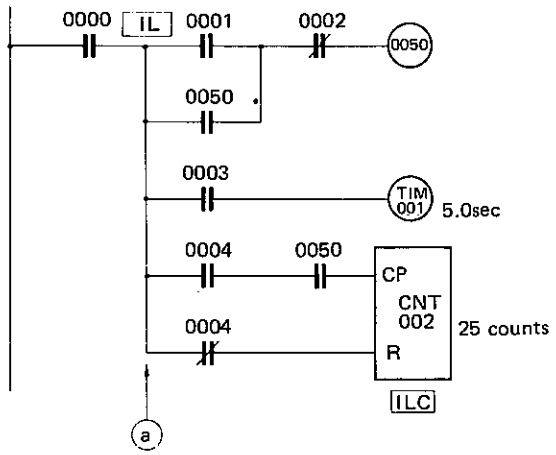
2. A circuit to keep the time-up state



OP	Data
LD	0000
AND	0001
TIM	001
	050
LD·TIM	001
LD	0002
KR	001
⋮	⋮
END	

■ WHEN IL/ILC INSTRUCTIONS ARE USED

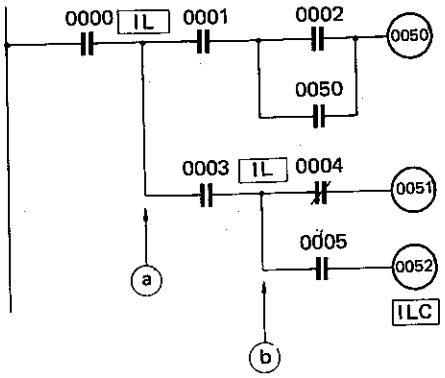
1. Basic circuit



OP	Data
LD	0000
IL	
LD	0001
OR	0050
AND·NOT	0002
OUT	0050
LD	0003
TIM	001
	050
LD	0004
AND	0050
LD·NOT	0004
CNT	002
	025
ILC	
⋮	⋮
END	

- Program the circuit by taking the common line ⓐ after the IL instruction, as a bus bar.
- An ILC instruction must always be added to the end of a circuit employing an IL instruction. The instructions between the IL and ILC instructions are executed.
- When input 0000 is OFF, timer TIM001 is reset but the present value of counter CNT002 is retained.
- When preparing an automatic/manual circuit, the circuit shown on the left can be operated only in the automatic mode by turning input 0000 on automatically.

2. Output branching circuit

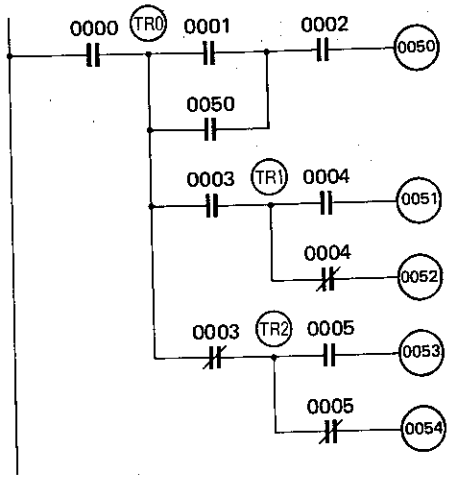


OP	Data
LD	0000
IL	
LD	0001
LD	0002
OR	0050
AND-LD	
OUT	0050
LD	0003
IL	
LD-NOT	0004
OUT	0051
LD	0005
OUT	0052
ILC	
⋮	⋮
END	

- IL instructions can be used for programming an output branching circuit (i.e., tree circuit).
- IL instructions can be used in as many stages as required, though this condition is regarded as an IL/JMP error during the program check.
  Each time an IL instruction is programmed, the bus bar changes from (a) to (b).

■ WHEN TR INSTRUCTIONS ARE USED

1. Output branching circuit

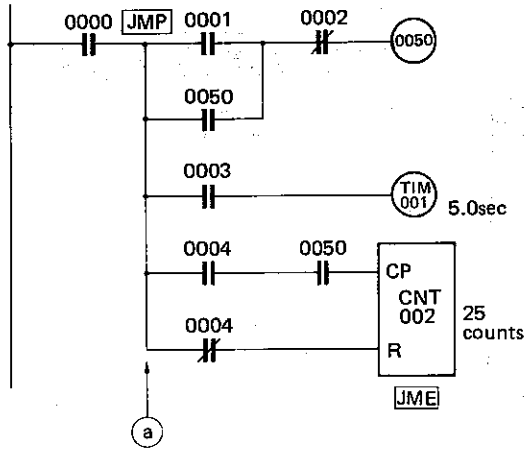


OP	Data
LD	0000
OUT-TR	0
LD-TR	0
LD	0001
OR	0050
AND-LD	
AND	0002
OUT	0050
LD-TR	0
AND	0003
OUT-TR	1
LD-TR	1
AND	0004
OUT	0051
LD-TR	1
AND-NOT	0004
OUT	0052
LD-TR	0
AND-NOT	0003
OUT-TR	2
LD-TR	2
AND	0005
OUT	0053
LD-TR	2
AND-NOT	0005
OUT	0054
⋮	⋮
END	

- In case of an output branching circuit, temporary memory relays (TR0 ~ TR7) are used at each branch point.
- Temporary memory relay coil numbers cannot be used in duplication within the same block. With two or more blocks, they can be used in duplication.

■ WHEN JMP/JME INSTRUCTIONS ARE USED

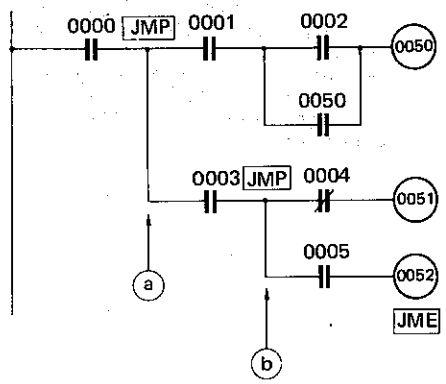
1. Basic circuit



OP	Data
LD	0000
JMP	
LD	0001
OR	0050
AND-NOT	0002
OUT	0050
LD	0003
TIM	001
	050
LD	0004
AND	0050
LD-NOT	0004
CNT	002
	025
JME	
⋮	⋮
END	

- Program the circuit by taking the common line ⓐ after the JMP instruction, as a bus bar.
- A JME instruction must always be added to the end of a circuit employing a JMP instruction.
- When input 0000 is ON, the instructions between the JMP and JME instructions are executed.
- When input 0000 is OFF, output relay 0050, timer TIM0001 and counter CNT002 retain their state immediately before the input is turned off.

2. Output branching circuit

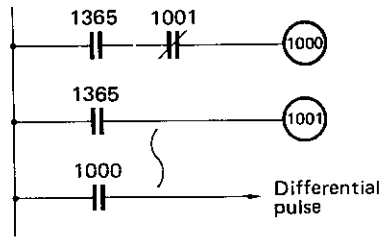


OP	Data
LD	0000
JMP	
LD	0001
LD	0002
OR	0050
AND-LD	
OUT	0050
LD	0003
JMP	
LD-NOT	0004
OUT	0051
LD	0005
OUT	0052
JME	
⋮	⋮
END	

- JMP instructions can be used in as many stages as required, although this condition is regarded as an IL/JMP error during the program check.
- Each time a JME instruction is programmed, the bus bar changes from ⓐ to ⓑ.
- When input 0000 is ON, the instructions between the JMP and JME instructions are executed.
- When input 0000 is OFF, output relays 0050, 0051 and 0052 retain their ON/OFF state immediately before the input is turned off.

■ 1-CYCLE DIFFERENTIATION

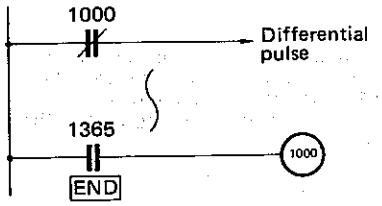
1.



OP	Data
LD	1365
AND-NOT	1001
OUT	1000
LD	1365
OUT	1001
≀	
LD	1000
⋮	⋮
END	

- Special auxiliary relay 1365 is normally ON. Shown here is a 1-cycle differentiation circuit when power is applied, using special auxiliary relay 1365.

2.

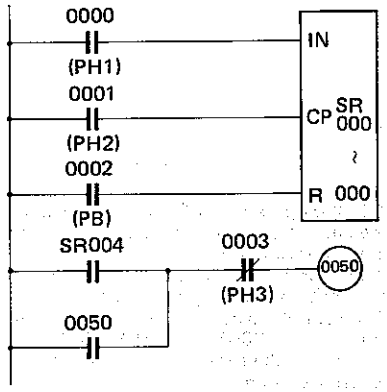


OP	Data
≀	
LD·NOT	1000
≀	
LD	1365
OUT	1000
END	

- Shown here is a 1-cycle differentiation circuit when power is applied, using special auxiliary relay 1365. In this case, be sure to program the instruction "OUT1000" at the end of the program.

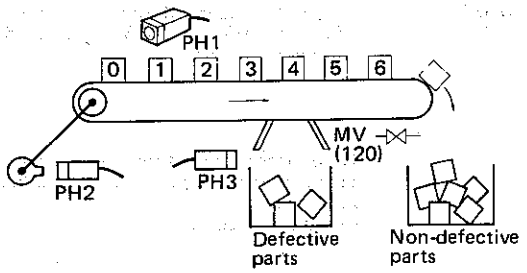
■ WHEN SR INSTRUCTIONS ARE USED

1. Defect detecting circuit (1-stage, 8-bit shift register)

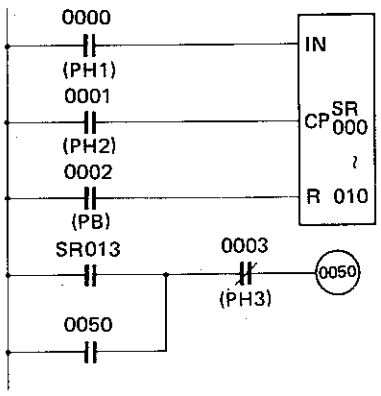


OP	Data
LD	0000
LD	0001
LD	0002
SR	000
	000
LD·SR	004
OR	0050
AND·NOT	0003
OUT	0050
⋮	⋮
END	

- This circuit can be used for such operations in a product inspection line as sorting defective products from non-defective products and distributing them with a cylinder.
- By specifying a shift register as SR000→ 000, shift register bits SR000 to SR007 can be operated to obtain the output of each bit arbitrarily.
- Data in excess of 8 bits are automatically cleared from the first-in data.



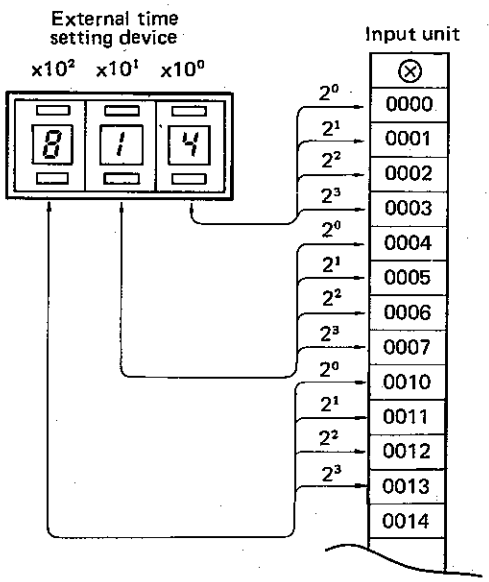
2. Multi-stage shift register (2-stage, 16-bit shift register)



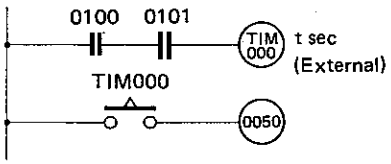
OP	Data
LD	0000
LD	0001
LD	0002
SR	000
	010
LD·SR	013
OR	0050
AND·NOT	0003
OUT	0050
⋮	⋮
END	

■ WHEN TIMER OR COUNTER IS USED THROUGH EXTERNAL SETTING

1. Timer



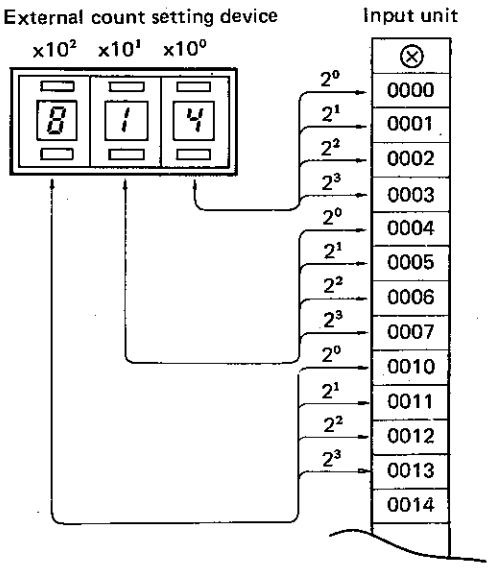
- By connecting an external 3-digit time setting device to input relay Nos. 0000 ~ 0013, the data of the external setting device is used as the setting time of the timer.



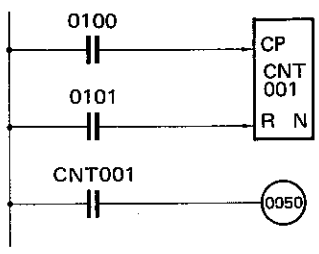
OP	Data
LD	0100
AND	0101
TIM	000
✳	00
LD TIM	000
OUT	0050

- TIM000 operates for 81.4sec according to the data of the external setting device shown in the above figure.
- When ✳ is entered into the TIM time setting area, external setting is specified.
- For example, when ✳00 is entered, relay Nos. 0000 ~ 0007 and 0010 ~ 0013 are assigned as the external terminals for external setting.
  Also, when ✳02 is entered, relay Nos. 0020 ~ 0027 and 0030 ~ 0033 are assigned as the external terminals.

2. Counter



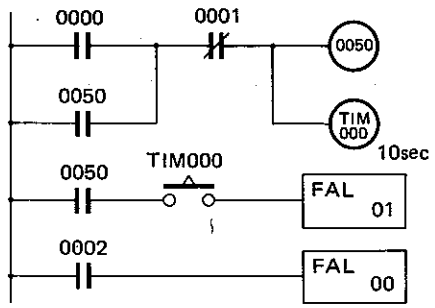
- By connecting an external 3-digit count setting device to input relay Nos. 0000 ~ 0017, the data of the external setting device is used as the count.



OP	Data
LD	0100
LD	0101
CNT	001
✳	00
LD·CNT	001
OUT	0050

- CNT001 operates for 814 counts according to the data of the external setting device shown in the above figure.
- When ✳ is entered into the count setting area, external count setting is specified.
- For example, when ✳00 is entered, relay Nos. 0000 ~ 0007 and 0010 ~ 0013 are assigned as the external terminals for external setting.
  Also, when ✳02 is entered, relay Nos. 0030 ~ 0033 are assigned as the external terminals.

■ WHEN FAL INSTRUCTION IS USED

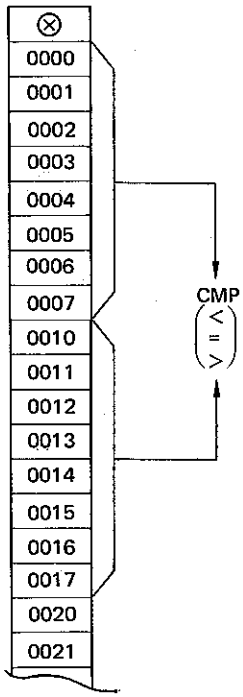


OP	Data	
LD	0000	
OR	0050	
AND·NOT	0001	
OUT	0050	
TIM	000	
	100	
LD	0050	
AND·TIM	000	
FAL	01	*
LD	0002	
FAL	00	**

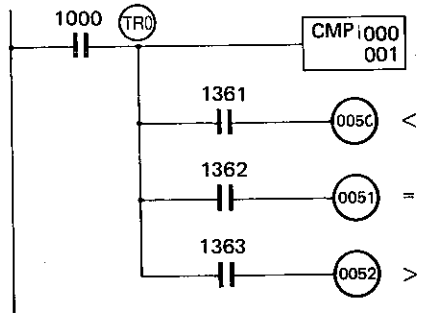
NOTES:
* In the left figure, the ON time of output relay 0050 is monitored. If the ON time of output relay 0050 is less than 10sec, the relay operation is normal. If the ON time exceeds 10sec for some reason or other, the failure or abnormal mode (01) is output to special auxiliary relay Nos. 1340 ~ 1347.
** To reset special auxiliary relay Nos. 1340 ~ 1347, execute the FAL00 instruction and the logical state of all the relays will become "0."

■ WHEN CMP INSTRUCTION IS USED

Input unit



Result → Less than (<) — Special auxiliary relay No. 1361 operates.
Equal (=) — Special auxiliary relay No. 1362 operates.
Greater than (>) — Special auxiliary relay No. 1363 operates.

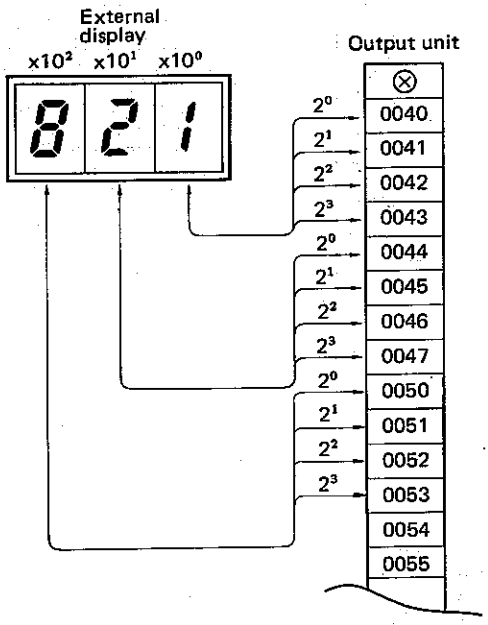


OP	Data
LD	1000
OUT·TR	0
CMP	000
	001
LD·TR	0
AND	1361
OUT	0050
LD·TR	0
AND	1362
OUT	0051
LT·TR	0
AND	1363
OUT	0052

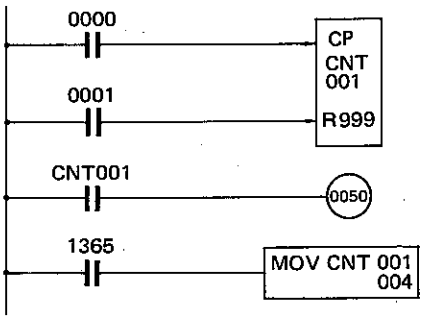
- The numeric data 000 and 001 of the CMP instruction are used by cutting the low-order digit (0 ~ 7) of relay Nos. 0000 ~ 0007 and 0010 ~ 0017, respectively.
- In the left figure, the 8 bits of relay Nos. 0000 ~ 0007 are compared with the 8 bits of relay Nos. 0010 ~ 0017 when relay No. 1000 is ON and the result of the comparison is output to special auxiliary relay No. 1361, 1362, or 1363.
- Since the result of the CMP instruction execution is retained in the memory until the execution of the next CMP instruction or END instruction, be sure to insert the condition of the CMP instruction execution in series with the result of the comparison (special auxiliary relay Nos. 1361 ~ 1363).

■ WHEN MOV INSTRUCTIONS ARE USED

1. To externally display the counter data



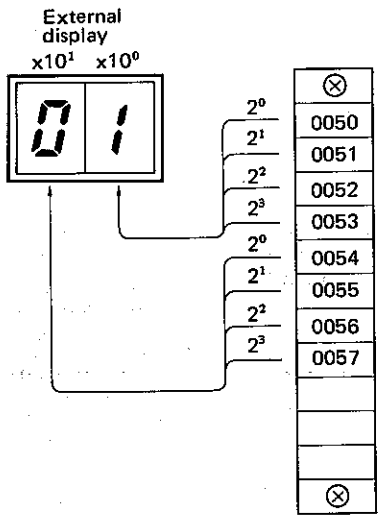
- By connecting an external 3-digit display to output relay Nos. 0040 ~ 0053, the changing data of the counter is indicated on the external display.
- Since the counter is of a decrementing type, the external dispaly indicates the remaining counts.



OP	Data
LD	0000
LD	0001
CNT	001
	999
LD·CNT	001
OUT	0050
LD	1365
MOV·CNT	001
	004 *

- Special auxiliary relay No. 1365 is normally ON.
- * mark indicates the location to which data is to be transferred by the MOV instruction. (Data 004 indicates external terminals 0040 ~ 0053 to which the data is to be transferred.)
- In the left figure, the changing data CNT001 is indicated on the external display through external terminals 0040 ~ 0053.

2. To externally display the diagnostic (FAL) result



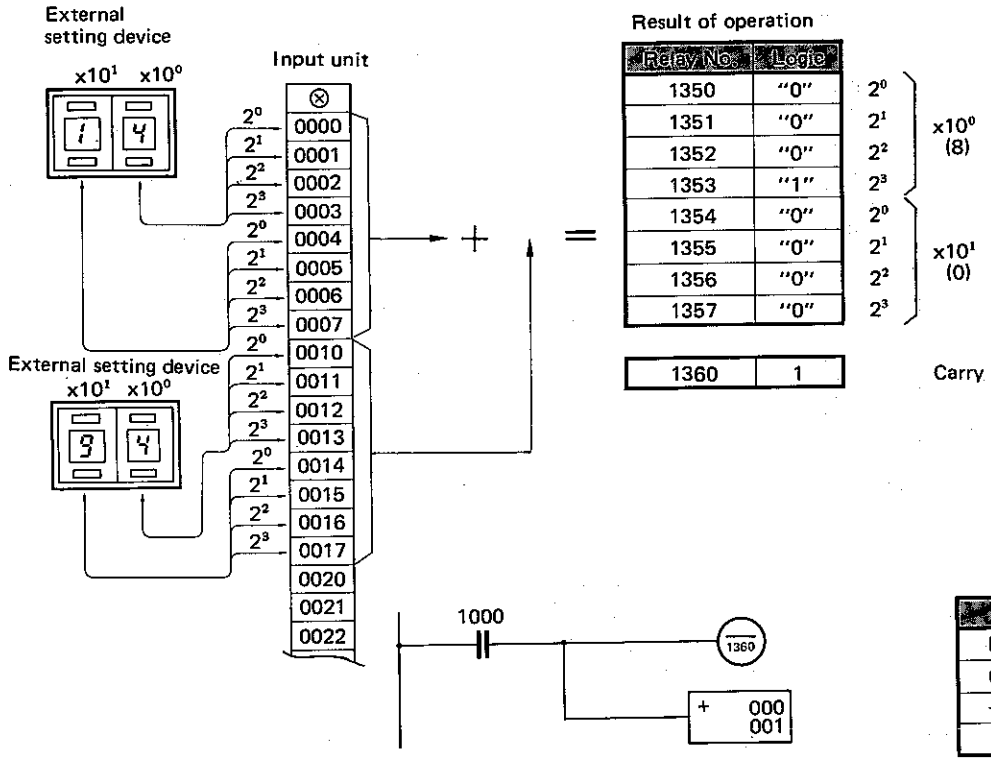
- By connecting an external 2-digit display to output relay Nos. 0050 ~ 0057, the failure or abnormal mode (01 ~ 99) is indicated on the external display.

OP	Data
LD	1365
MOV	134
	005

- Relay No. 1365 is normally in the ON state.
- The numeric data 134 and 005 of the MOV instruction are used by cutting the low-order digit (0 ~ 7) of relay Nos. 0050 ~ 0057 (FAL data).
- In the left figure, the 8-bit data of special auxiliary relay Nos. 1340 ~ 1347 are transferred to the 8 bits of the relay Nos. 0050 ~ 0057 and indicated on the external display.

■ WHEN ADD (+) INSTRUCTION IS USED

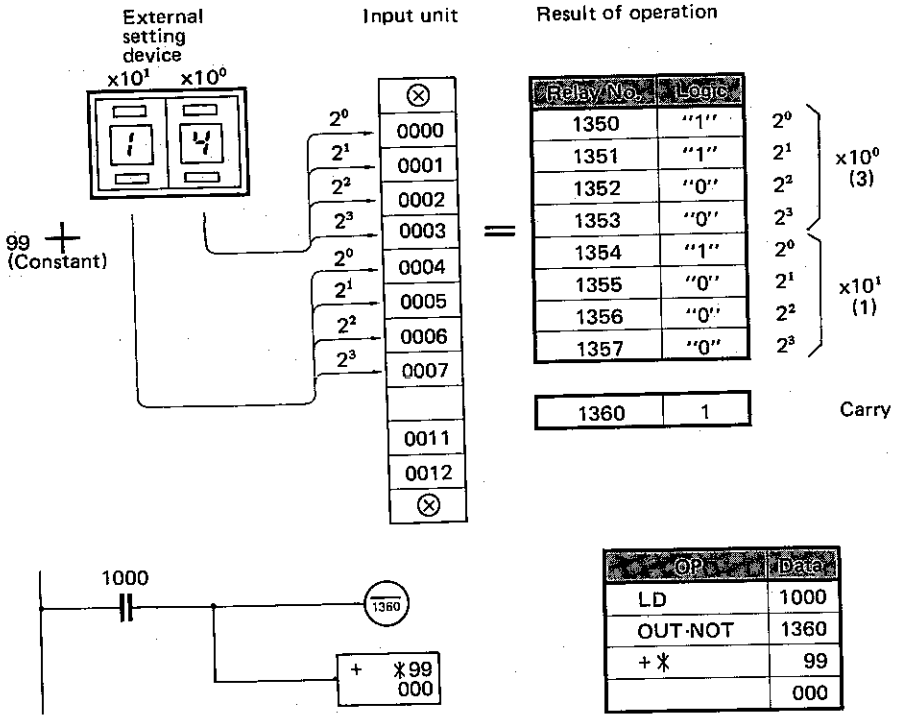
1. To add one externally set data to the other externally set data



OP	Data
LD	1000
OUT·NOT	1360
+	000
	001

- By connecting an external 2-digit setting device to input relay Nos. 0000 ~ 0007 and 0010 ~ 0017, respectively, the data set by both the external setting devices are added together and the result of the addition is output in BCD to special auxiliary relay Nos. 1350 ~ 1357 and 1360.
- The OUT NOT instruction (1360) is for initial resetting of special auxiliary relay No. 1360 and this instruction must always be used immediately before the ADD (+) instruction.
- The numeric data 000 and 001 of the ADD (+) instruction are used by cutting the low-order digit (0 ~ 7) of relay Nos. 0000 ~ 0007 and 0010 ~ 0017, respectively.
- In the left figure, the data "14" and "94" of both the external setting devices when relay No. 1000 is ON are added and the result of the addition "08" which represents the last 2 digits of "108" is output to special auxiliary relay Nos. 1350 ~ 1357.
  At the same time, special auxiliary relay No. 1360 (Carry) operates, indicating that a carry exists in the result.

2. To add fixed data to externally set data

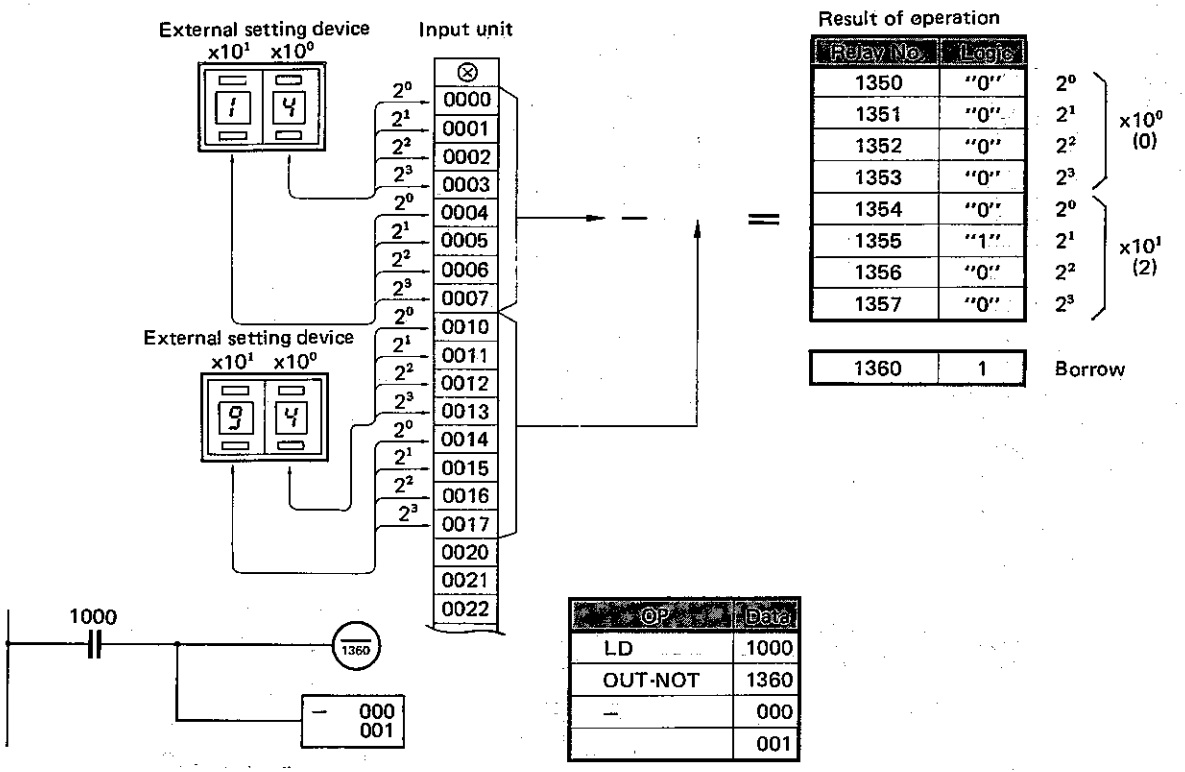


OP	Data
LD	1000
OUT·NOT	1360
+✳	99
	000

- By connecting an external 2-digit setting device to input relay Nos. 0000 ~ 0007, the constant (00 ~ 99) is added to the data set by the external setting device and the result of the addition is output in BCD to special auxiliary relay Nos. 1350 ~ 1357 and 1360.
- The OUT NOT instruction (1360) is for initial resetting of special auxiliary relay No. 1360 and this instruction must always be used immediately before the ADD (+) instruction.
- The data ✳99 of the ADD (+) instruction indicates the fixed data and the data 000 is used by cutting the low-order digit (0 ~ 7) of the relay Nos. 0000 ~ 0007.
- In the left figure, the constant "99" is added to the externally set data "14" when relay No. 1000 is ON and the result of the addition "13" which represents the last 2 digits of "113" is output to special auxiliary relay Nos. 1350 ~ 1357. At the same time, special auxiliary relay No. 1360 (Carry) operates, indicating that a carry exists in the result.

■ WHEN SUB (–) INSTRUCTIONS ARE USED

1. To subtract one externally set data from the other externally set data.



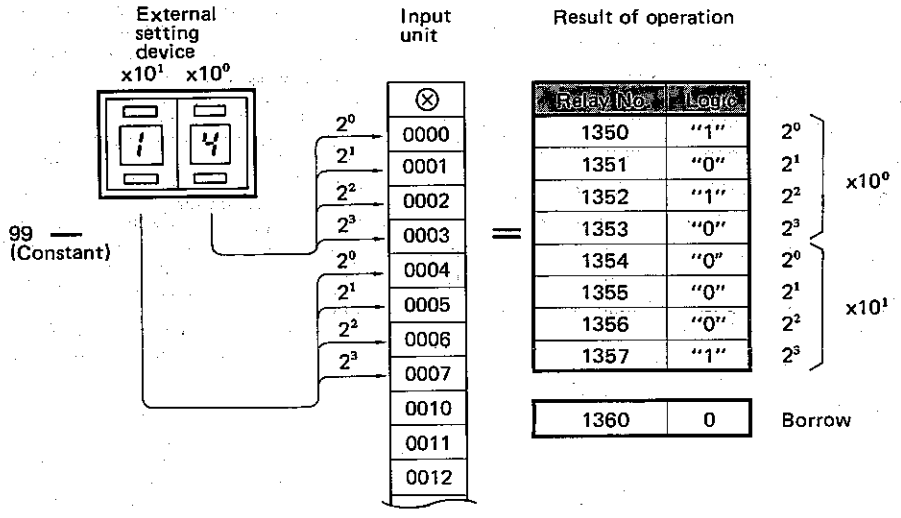
OP	Data
LD	1000
OUT·NOT	1360
–	000
	001

- By connecting an external 2-digit setting device to input relay Nos. 0000 ~ 0007 and 0010 ~ 0017, respectively, the data set by one externally setting device is subtracted from the data set by the other external setting device and the result of the subtraction is output in BCD to special auxiliary relay Nos. 1350 ~ 1357 and 1360.
- The OUT·NOT instruction (1360) is for initial resetting of special auxiliary relay No. 1360 and this instruction must always be used immediately before the SUB (–) instruction.
- The data 000 and 001 of the SUB (–) instruction are used by cutting the low-order digits (0 ~ 7) of relay Nos. 0000 ~ 0007 and 0010 ~ 0017, respectively.
- In the left figure, one externally set data "94" is subtracted from the other externally set data "14" when relay No. 1000 is ON and the result of the subtraction "20" is output to special auxiliary relay Nos. 1350 ~ 1357. At the same time, special auxiliary relay No. 1360 (Borrow) operates indicating that the result is a complement. To obtain a true complement, the complement must be subtracted from 00.

  00 – 20 = –80

  The data "80" is then output to special auxiliary relay Nos. 1350 ~ 1357 and special auxiliary relay No. 1360 operates.

2. To subtract externally set data from fixed data.

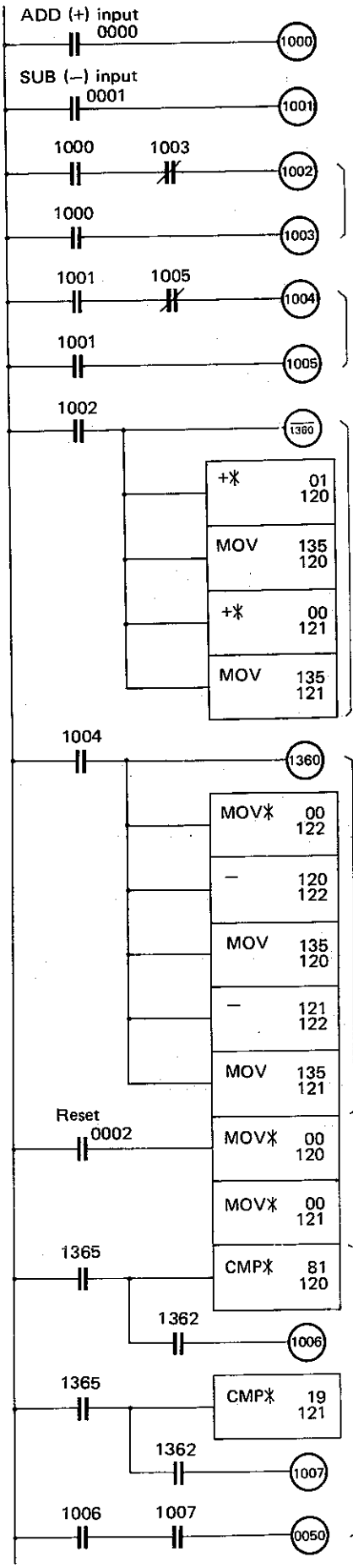


OP	Data
LD	1000
OUT·NOT	1360
– ✳	99
	000

- By connecting an external 2-digit setting device to input relay Nos. 0000 ~ 0007, the data set by the external setting device is subtracted from the constant (00 ~ 99) and the result of the subtraction is output in BCD to special auxiliary relay Nos. 1350 ~ 1357 and 1360.
- The OUT NOT instruction (1360) is for initial resetting of special auxiliary relay No. 1360 and this instruction must always be used immediately before the SUB (–) instruction.
- The data ✳99 of the SUB (–) instruction indicates the fixed data and the data 000 is used by cutting the low-order digit (0 ~ 7) of relay Nos. 0000 ~ 0007.
- In the left figure, the data "14" of the external setting device is subtracted from the constant 99 when the relay No. 1000 is ON and the result of the subtraction "85" is output to special auxiliary relay Nos. 1350 ~ 1357. Special auxiliary relay No. 1360 (Borrow) releases, indicating that the result is a true complement.

■ EXAMPLE OF ADD (+)/SUB (–) COUNTER CIRCUIT

1. Decimal 4-digit reversible counter



Calculation result area (Special auxiliary relays)

1360	1357	1356	1355	1354	1353	1352	1351	1350
Carry Borrow	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
					$\times10^1$ (High-order digit)			$\times10^0$ (Low-order digit)

Work area (Internal auxiliary relays)

1207	1206	1205	1204	1203	1202	1201	1200
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
			$\times10^1$				$\times10^0$ (Low-order digit)

1217	1216	1215	1214	1213	1212	1211	1210
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
$\times10^3$ (High-order digit)					$\times10^2$		

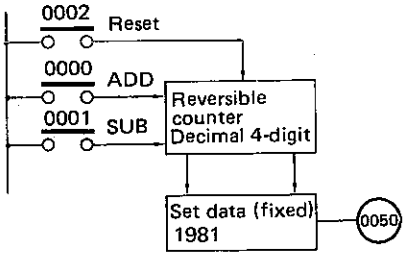
Data area (Internal auxiliary relays)

1227	1226	1225	1224	1223	1222	1221	1220
"0"	"0"	"0"	"0"	"0"	"0"	"0"	"0"
$\times10^1$ (High-order digit)				$\times10^0$ (Low-order digit)			

OP	Data
LD	0000
OUT	1000
LD	0001
OUT	1001
LD	1000
AND·NOT	1003
OUT	1002
LD	1000
OUT	1003
LD	1001
AND·NOT	1005
OUT	1004
LD	1001
OUT	1005
LD	1002
OUT·NOT	1360
+·⁒	01
	120
MOV	135
	120
+·⁒	00
	121
MOV	135
	121
LD	1004
OUT	1360
MOV·⁒	00
	122
–	120
	122
MOV	135
	120
–	121
	122
MOV	135
	121

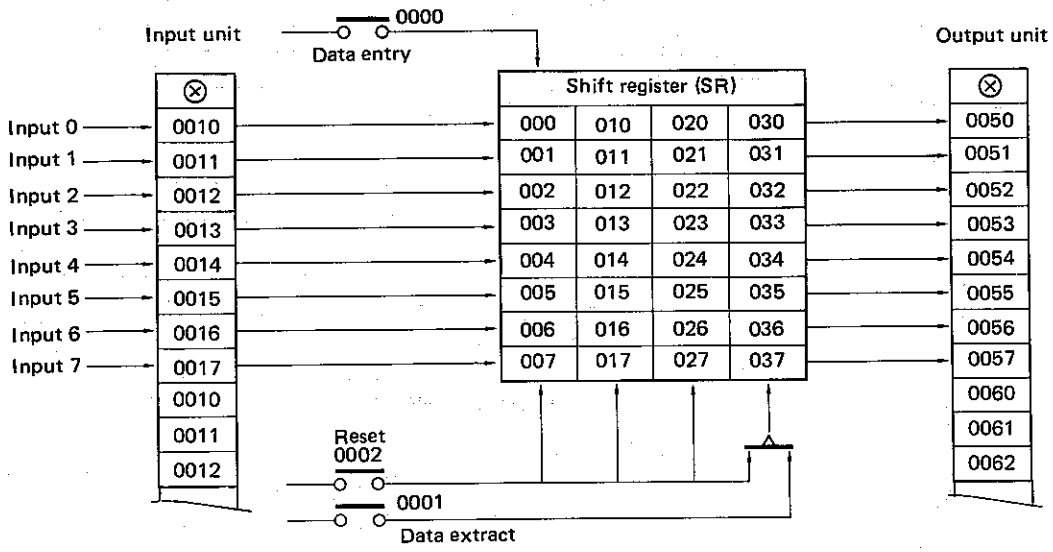
OP	Data
LD	0002
MOV·⁒	00
	120
MOV·⁒	00
	121
LD	1365
CMP·⁒	81
	120
AND	1362
OUT	1006
LD	1365
CMP·⁒	19
	121
AND	1362
OUT	1007
LD	1006
AND	1007
OUT	0050

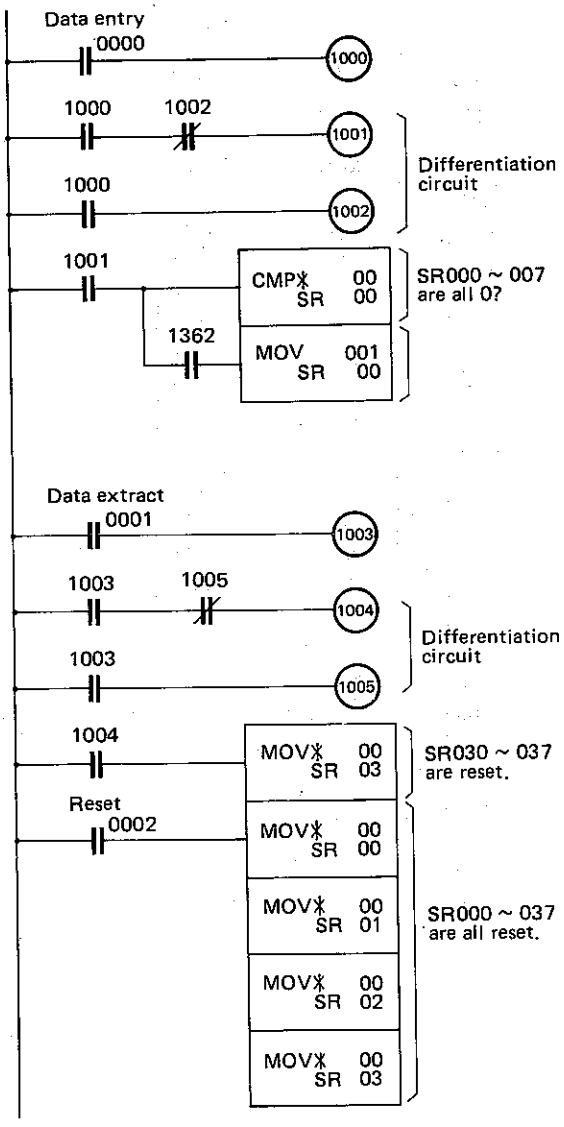
- Special auxiliary relay No. 1365 is normally ON.
- Special auxiliary relay No. 1362 operates when the result of the CMP instruction is equal (=).
- Equivalence circuit

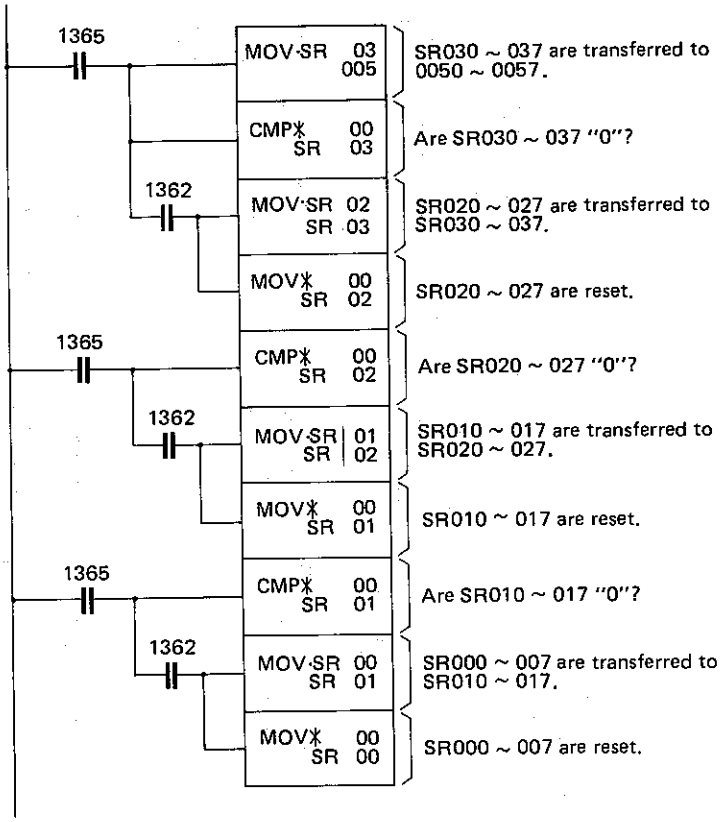


- If it is desired to retain the count data in the memory at the time of a power failure, use a latching relay and a shift register in the work area. In this manner, the data can be retained until a reset signal is input.

■ 8-BIT 4-STAGE FIFO SHIFT REGISTER







OP	Data
LD	0000
OUT	1000
LD	1000
AND-NOT	1002
OUT	1001
LD	1000
OUT	1002
LD	1001
CMP-✳	00
SR	00
AND	1362
MOV	001
SR	00
LD	0001
OUT	1003
LD	1003
AND-NOT	1005
OUT	1004
LD	1003
OUT	1005
LD	1004
MOV-✳	00
SR	03
LD	0002
MOV-✳	00
SR	00
MOV-✳	00
SR	01
MOV-✳	00
SR	02
MOV-✳	00
SR	03
LD	1365
MOV-SR	03
	005
CMP-✳	00
SR	03
AND	1362
MOV-SR	02
SR	03
MOV-✳	00
SR	02
LD	1365
CMP-✳	00
SR	02
AND	1362
MOV-SR	01
SR	02
MOV-✳	00
SR	01
LD	1365
CMP-✳	00
SR	01
AND	1362
MOV-SR	00
SR	01
MOV-✳	00
SR	00

- Special auxiliary relay No. 1365 is normally ON.
- Special auxiliary relay No. 1362 operates when the result of the CMP instruction execution is equal (=).
- Shift data is retained in the memory at the time of a power failure.

6. Operating Procedure

6.1 Cautions in Operating Program Console

When operating the SYSMAC-M5R, pay attention to the following points.

- The key to the Mode selector can be pulled out in RUN mode. The searching, monitoring or tracing operation is neverthless possible while the key is pulled out in RUN mode.
- The program console of the SYSMAC-M5R can be connected or disconnected in the on-line state. On-line, in this case, means that SYSMAC-M5R is in operation.

Disconnection in on-line state

- When the program console is disconnected from while it is in "RUN" mode, the SYSMAC-M5R continues to operate.
- When the program console is disconnected from while it is in a mode other than "RUN", the SYSMAC-M5R comes to a halt. To restart the operation, turn on the power switch again.

Connection in on-line state

- When the program console is connected while the SYSMAC-M5R is in operation, it continues to operate, regardless of the mode of the program console. In this case, "UUUU" appears at the ADDRESS display, if modes of the CPU and the program console differ.
- When the program console is connected while the SYSMAC-M5R is in a halt state, the SYSMAC-M5R remains in that state, regardless of the mode of the program console.

NOTES:

- When the modes of the CPU and the program console differ, "UUUU" appears at the ADDRESS display which means standby for password key operation.
- In this case, if the mode of the program console is specified and a password is entered by operating CLEAR DISPLAY and MONITOR keys, the display "UUUU" goes out to be replaced by the mode specified by the program console.
- By turning on the power switch again, the CPU enters the mode specified by the program console.
- In case the modes of CPU and the program console are identical, it retains its original mode.

6.2 Basic Functions

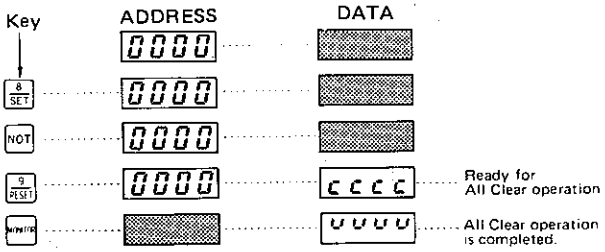
Items of Operation	Description
All program clear	Since the CPU retains previously stored data in memory (by battery back-up), all the memory contents must be cleared to write a new program into the memory.
Address setting	Address setting is required to designate an address in such operations as program read, program write, etc.
Program write	This operation is to store a program in the specified memory address.
Program read	This operation is to confirm whether or not data has been programmed properly in the specified memory address.
Program check	This operation is to confirm whether or not the program data written into the CPU memory through the program console are in agreement with the pre-determined rules (syntax).
RUN	This operation is to place the SYSMAC-M5R in the RUN (Program Execution) state.
Monitor	This operation is to monitor and display operating state of each relay, the operating state of each bit in the shift register or latching relay, or the present value of each timer or counter during execution of a program.
Multi monitor	This operation is to monitor and display the operating state of each relay, the operating state of each bit in the shift register or latching relay, or the present value of a timer or counter during the execution of a program.
Trace (continuity) check	When a circuit operation is to be checked in a program simulation or test run, this operation allows the operating state of each relay number to be displayed while tracing the programming sequence of the circuit.
Forced set/reset	This operation is to set or reset by force the operating state of a latching relay, the operating state of each bit in the shift register and the present value of a timer or counter during the execution of a program.
Instruction search	When a circuit change is to be made in a program simulation or test run, this operation allows an address where an instruction has been written in a program to be searched.
Contact (coil) number change	This operation is to change contact (or coil) number(s) in a program due to a circuit modification.
Contact (coil) addition	This operation is employed when contact (or coil) number(s) is to be added due to a circuit modification.
Contact (coil) deletion	This operation is to change contact (coil) number(s) from a program due to a circuit modification.

6.3 All Program Clear Operation

Since the CPU retains previously stored data (of SR, KR and CNT) in memory (by battery back-up), all the memory contents must be cleared to write a new program into the memory.

- **Operating procedure**

- **Display**



NOTES:

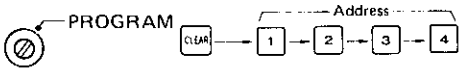
1. By the All Clear operation, all the programs (I/O relays, internal auxiliary relays, latching relays, timers and counters) stored in addresses 0000 ~ 2999 are cleared.
2. Before the key operation, change the mode selector switch position from "CASSETTE" to "PROGRAM."
3. In the All Clear operation, a beep sound is generated at the depression of each key.
4. Upon depression of the MONITOR key, the ADDRESS display is extinguished. Subsequent depression of the CLEAR key will cause the ADDRESS display to indicate "0000."

CAUTION:
After the PROGRAM mode selection, depression of the CLEAR key or any key other than the four keys shown above will not allow All Clear operation to be executed. In this case, repeat the operation starting from the mode selection.

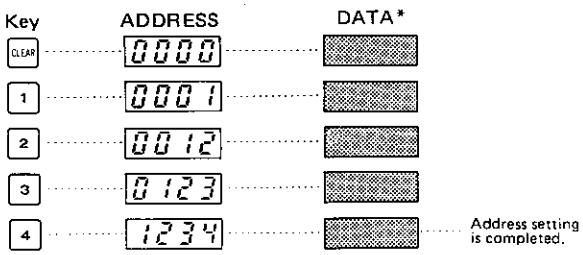
6.4 Address Setting Operation

Address setting is required to designate an address in such operations as program read, program write, etc.

- **Operating procedure**

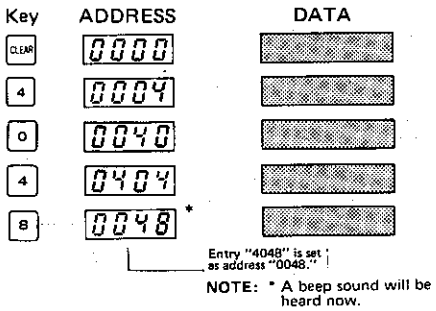


- **Display**



NOTES:

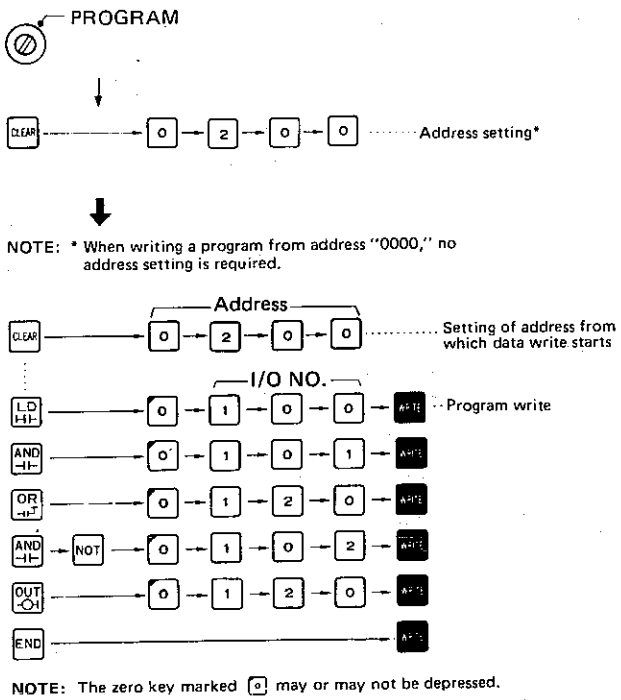
1. Each address is set in 4 digits using numeric 0000 ~ 2999. To set address "0000," no numeric entry is required. To set address "0003," depress only numeric key [3]. and to set address "0023," depress only numeric keys [2] and [3]. Preceding zero(s) may be omitted from key entry.
2. * The data entered will not be displayed by the address setting operation alone. To display the data entered, [*] [.] keys must be depressed.
3. In address setting, when numeric data entered as an address exceeds 2999, the first two digits of the 4-digit address are automatically processed as "0." Since the CPU does not recognize this as an error, the only way to identify this error is through confirmation by the operator.
   For example, if address 4048 is entered, it will be set as follows.



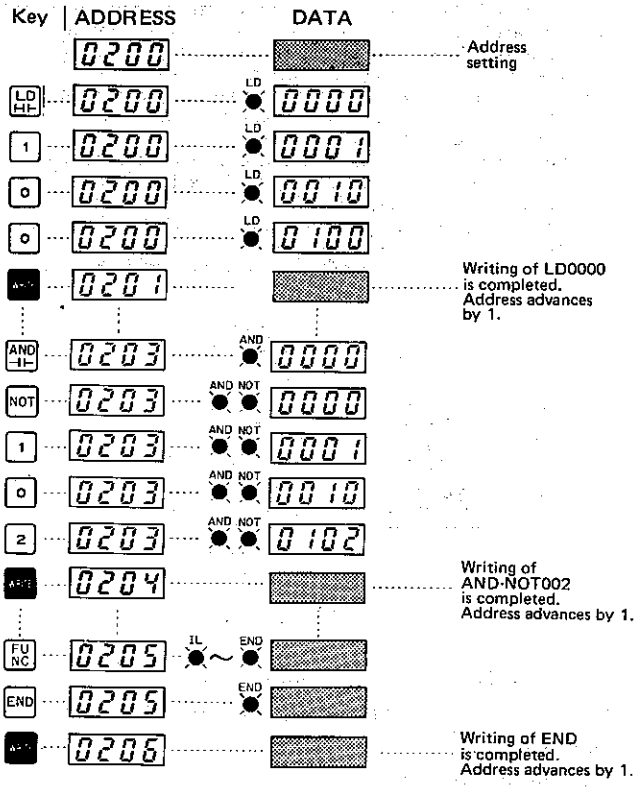
6.5 Program Write Operation

This operation is to store a program in the specified memory address.

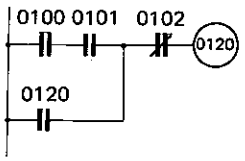
- **Operating procedure**



- **Display**



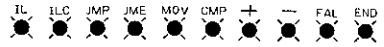
- **Circuit for exercise and programming example**



Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND-NOT	0102
0204	OUT	0120
0205	END	

NOTES:

1. At each depression of the WRITE key, the data appearing on the OP and DATA displays are written into memory.
2. When the WRITE key is depressed in the following cases, a beep sound is generated to signal an erroneous key operation.
   ① When the key is depressed in other than the PROGRAM mode.
   ② When a symbolic or numeric entry error exists (numeric entry error is applicable only when an SR instruction is used).
3. When the WRITE key is depressed in the following cases, a beep sound is generated to signal the requirement of a program change.
   ① When an overflow exists (no space for one word exists in the last address where changing a one-word instruction to a 2-word instruction).
   ② When attempt is made to write an instruction with more than 2-word length into the last address.
4. The END instruction is executed by depressing the [FUN/NOT] key and then the [END] key. Upon depression of the [FUN/NOT] key, the following indicators on the OP display will illuminate.



When the END [END] key is then depressed, only the END indicator illuminates, indicating that the instruction word END has been selected.

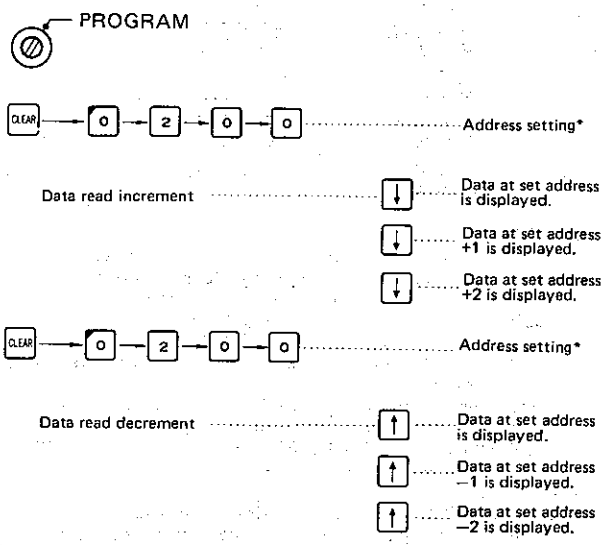
Correction Procedures when an error occurs in program write

1. If an error in programming is noticed before depressing the WRITE key, depress the CLEAR DISPLAY key and the re-entry operation becomes effective.
2. If an error in programming is discovered after depressing the WRITE key, repeat the operation from the address setting, or return to the address in which the error exists by depressing the [↑] key and then depress the CLEAR DISPLAY key and the re-entry operation becomes effective.

6.6 Program Read Operation

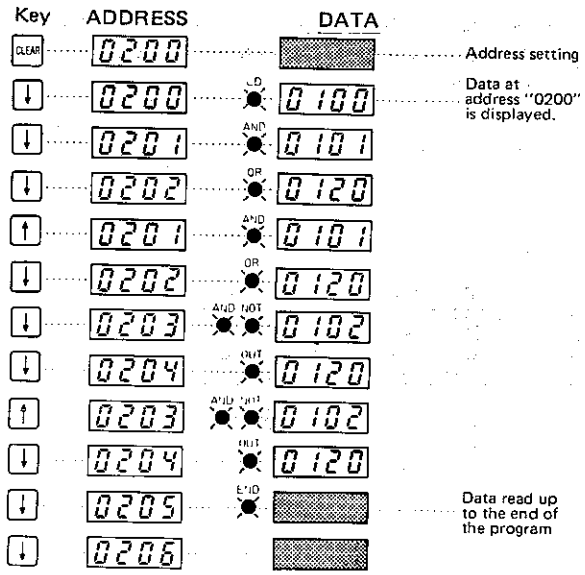
This operation is to confirm whether or not the data has been programmed properly in the specified memory address.

- **Operating procedure**

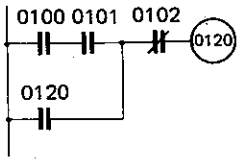


NOTES: 1. When reading a program from address "0000," no address setting is required.
2. The zero key marked [0] may or may not be depressed.

- **Display**



- **Circuit for exercise and programming example**



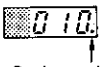
Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND·NOT	0102
0204	OUT	0120
0205	END	

NOTES:
1. At each depression of the [↓] key, the data at the set address +1 is displayed (i.e., data read increment). However, when the address reaches 2999, a beep sound is generated at each depression of the [↓] key.
2. At each depression the [↑] key, the data at the set address −1 is displayed (i.e., data read decrement). However, when the address reaches 0000, a beep sound is generated at each depression of the [↑] key.
3. In case of 2-word instructions, the 2nd word data is identified on the display as follows.
   - MOV
     COM
     ±

     Data

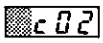
     

     2nd word
   - SR

     2nd word
4. When TIM, CNT, MOV, CMP, + and − instructions are used, the data (✱02) are identified on the display as follows.

   Data

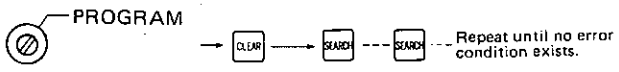
6.7 Program Check Operation

This operation is to confirm whether or not the program data written into the CPU memory through the program console are in agreement with the predetermined rules (syntax).

Items subject to program check are as follows.

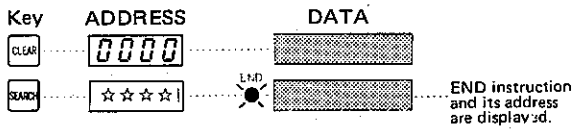
- Coil duplication error
- Circuit error
- IL/JMP error
- END instruction missing error

- **Operating procedure**

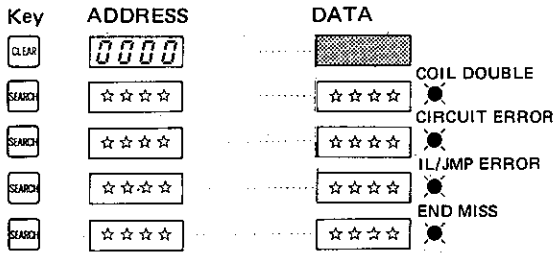


- **Display**

When a program error does not exist



When a program error exists



NOTE:
If a program error exists, the address where the error exists and its contents are displayed at each depression of the SEARCH key.

- **Error conditions**

1. Coil duplication error
   The "COIL DOUBLE" indicator illuminates when the OUT, OUT·NOT, OUT·SR, OUT·NOT·SR, SR, KR, TIM, CNT or MOV instructions of the same relay number except special auxiliary relays are contained in a program.
2. Circuit error
   The R register and S register are controlled by computing a difference between the number of logical start instructions (LD and LD·NOT) and the number of interblock logical instructions (AND·LD and OR·LD). If the difference is abnormal according to the nature of the instructions used when the result (OUT, OUT·NOT, OUT·SR, OUT·NOT·SR, CNT, TIM, SR, KR, FAL, CMP, MOV, MOV·NOT, +, −, IL, ILC, JMP, JME or END) is executed, it is regarded as a circuit error, and the "CIRCUIT ERROR" indicator illuminates.
3. IL/JMP error
   IL and ILC instructions and JMP and JME instructions must be used in pairs.
   When this rule is not observed in a program as shown below, "IL/JMP ERROR" indicator illuminates.
   ① ILC(JME) instruction is missing such as IL-IL (JMP-JMP).
   ② IL(JMP) instruction is missing and only ILC (JME) instruction is present.
   ③ The program ends with an IL (JMP) instruction before the END instruction or the last address.
4. END instruction missing error
   In the absence of an END instruction at the end of a program, the "END MISS" indicator illuminates.

NOTES:
1. If any programming error is discovered, correct the erroneous program in accordance with the program write procedure.
2. A circuit error is detected by taking that portion of the circuit from the LD-LD-NOT instruction after an OUT instruction to the next OUT instruction as a unit subject to detection.
3. Even if any of the following errors (except the END instruction missing error) occurs, the CPU can still perform the RUN operation. However, be sure to correct the error to execute the proper program.
   ① Coil duplication error
   ② Circuit error
   ③ IL/JMP error
4. Should an END instruction missing error occur, address 3998 is indicated as the last address on the ADDRESS display if the address contains a 2-word instruction. In all other cases, the last address is 3999.

6.8 RUN Operation

This operation is to place the SYSMAC-M5R in the RUN (Program Execution) condition.

- **Operating procedure**

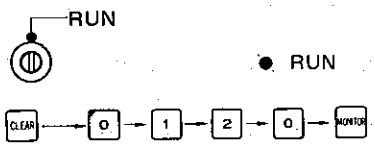
NOTES:
1. In the absence of an END instruction in a program, the RUN indicator will not illuminate even if the operation mode of the CPU is changed to "RUN." (All keys become inoperative.) At the same time, the "END MISS" indicator illuminates and the alarm buzzer sounds. In this case, change the operation mode to "PROGRAM" and enter an END instruction to correct the program.
2. After the CPU start operating, if an error occurs due to CPU failure or I/O bus failure, the RUN indicator goes out and the RUN outputs (control I/O relays) are turned off. All external outputs are also turned off.
   Refer to 9.4, LIST OF ERROR MESSAGES.
3. In other than the RUN mode, all external outputs are turned off. Also, when the "PROGRAM" mode is changed to the "RUN" mode, the CPU is initialized the same as when power is applied.

6.9 Monitor Operation

This operation is to monitor and display the operating state of each relay, the operating state of each bit in the shift register or latching relay, or the present value of each timer or counter during the execution of a program.

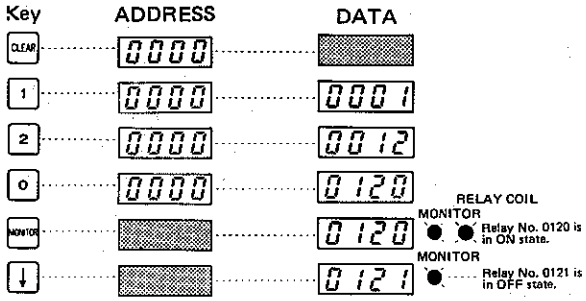
■ MONITORING OF THE OPERATING STATE OF AN INPUT/OUTPUT RELAY OR INTERNAL AUXILIARY RELAY

- **Operating procedure**



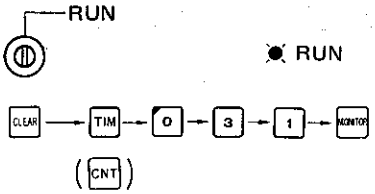
NOTE: The zero key marked [0] may or may not be depressed.

- **Display**

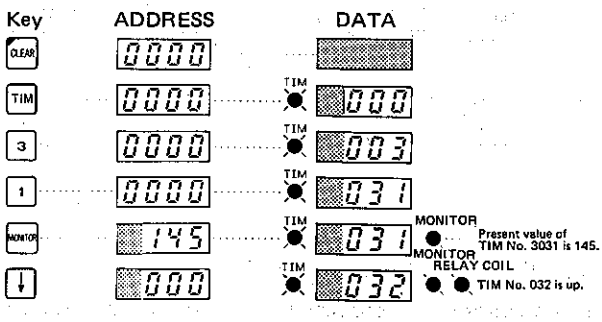


■ MONITORING OF THE PRESENT VALUE OF A TIMER OR COUNTER

- **Operating procedure**



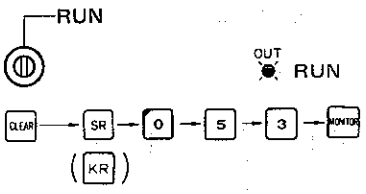
- **Display**



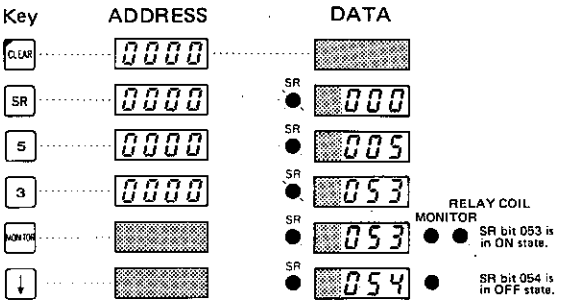
NOTE:
When the specified timer starts operating, the set time indicated on the ADDRESS display also starts to be decremented toward "0000," while indicating the present value (i.e., remaining time.).

■ MONITORING OF THE OPERATING STATE OF A SHIFT REGISTER OR LATCHING RELAY

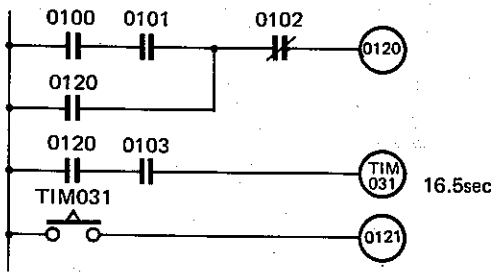
- **Operating procedure**



- **Display**



- **Circuit for exercise and programming example**



Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND-NOT	0102
0204	OUT	0120
0205	LD	0120
0206	AND	0103
0207	TIM	031
0208		165
0209	LD-TIM	031
0210	OUT	0121
0211	END	

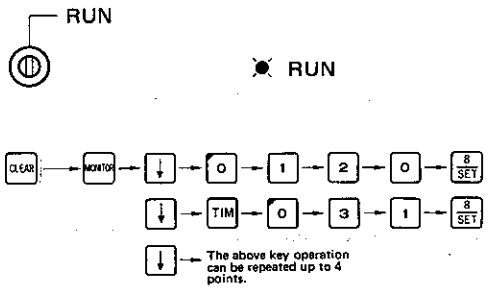
NOTES:

1. The operating state of each I/O relay, or internal auxiliary relay, is indicated by the "RELAY COIL" indicator (LED). This indicator illuminates when the state of the specified relay No. is ON and goes out when the state of the specified relay No. is OFF.
2. The present value of each timer or counter is indicated digitally on the ADDRESS display. When the set time of the specified timer has elapsed (or the set count of the specified counter is up), the "RELAY COIL" indicator illuminates.
3. The operating state of each bit in a shift register or latching relay is indicated by the "RELAY COIL" indicator. This indicator illuminates when the state of the specified bit number is ON and goes out when the state of the specified bit number is OFF.
4. Each depression of the ↓ or ↑ key subsequent to the depression of the MONITOR key causes a relay number, timer/counter number, or SR/KR bit number to be incremented or decremented by 1. Thus, the operating states of relays can be monitored consecutively.
5. When the MONITOR key is depressed in the following cases, a beep sound is generated to alert the operator. Check for the proper operating procedure.
   ① In other than RUN mode.
   ② When a symbolic or numeric error exists.
   ③ When an instruction other than OUT, OUT-NOT, OUT-NOT-SR, OUT-SR, TIM, CNT, SR and KR is used.
6. When the relay number reaches the upper limit during the monitor operation, each depression of the ↓ key causes a beep sound to be generated to alert the operator. Check for the proper operating procedure.
7. When the relay number becomes 0 during the monitor operation, each depression of the ↑ key causes a beep sound to be generated to alert the operator. Check for the proper operating procedure.

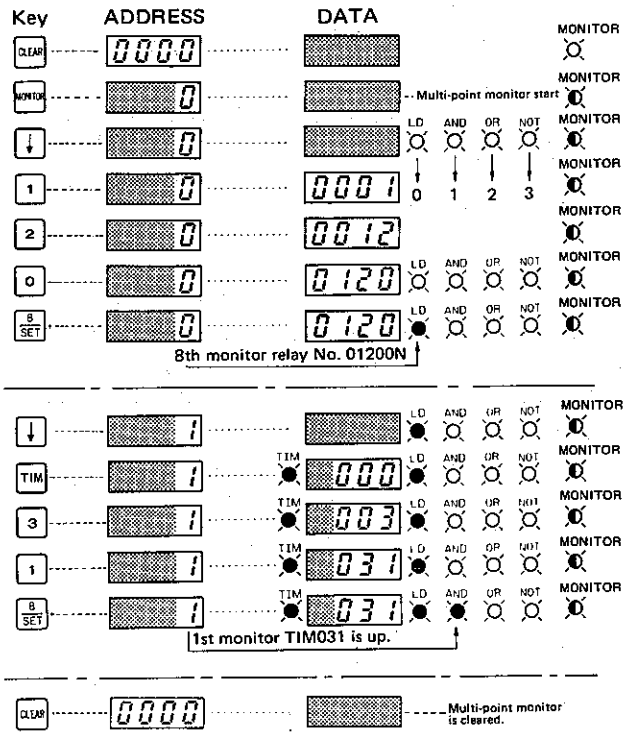
6.10 Multi Monitor Operation

This operation is to monitor and display the operating states of a maximum of 4 relays, shift registers, latching relays, timers and/or counters during the execution of a program. However, for a timer or counter, only the time-up or count-up condition is monitored.

- **Operating procedure**



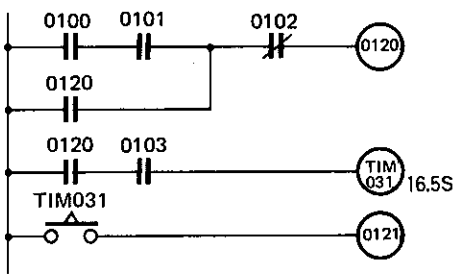
- **Display**



The indicator flashes ON and OFF.

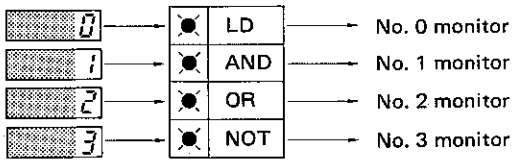
The indicator lights.

- **Circuit for exercise and programming example**



Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND NOT	0102
0204	OUT	0120
0205	LD	0120
0206	AND	0103
0207	TIM	031
0208		165
0209	LD TIM	031
0210	OUT	0121
0211	END	–

NOTES:
1. The numeric values 0 to 3 indicated on the ADDRESS display upon start of the multi-point monitor operation signify the following.



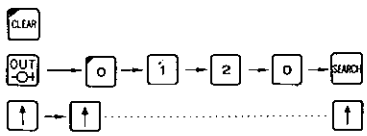
However, the above indicators do not mean that LD, AND, OR and NOT instructions are used during the multi-point monitor operation.
2. Special auxiliary relays such as those for operation result, FAL area, etc. can also be monitored.

6.11 Trace (Continuity) Check Operation

When a circuit operation is to be checked in a program simulation or test run, this operation allows the operating state of each relay number to be displayed while tracing the programming sequence of the circuit.

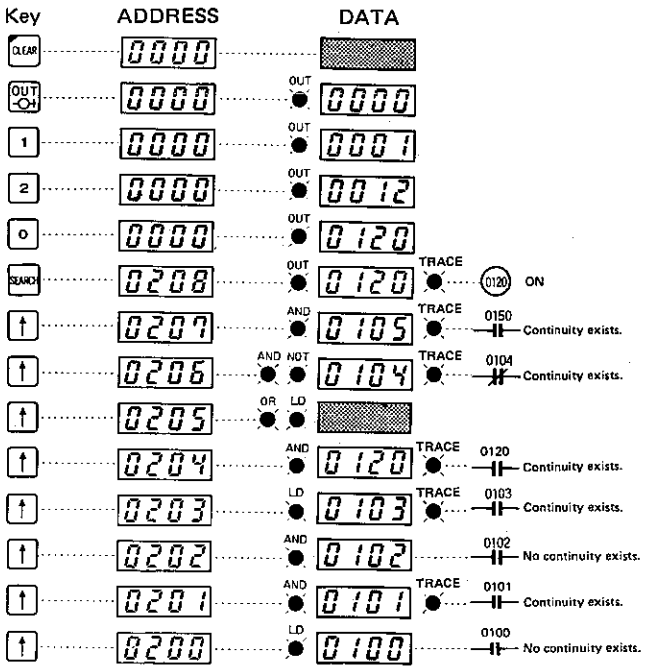
- **Operating procedure**

In the circuit for exercise shown on the right, the procedure to check the operating state of from (0120) to 0100 in the programming sequence is shown below.



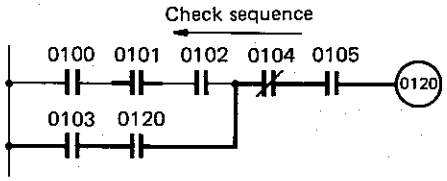
NOTE: The zero key marked [0] may or may not be depressed.

- **Display**



NOTES:
1. The above example shows the case where relays 0101, 0103, 0105 and 0150 are in the ON state and relays 0100, 0102 and 0104 are in the OFF state.
2. In the circuit shown on the upper right, is clear that 0120 is caused to turn on by the circuit shown by the bold line.

- **Circuit for exercise and programming examples**



Address	OP	Data
200	LD	0100
201	AND	0101
202	AND	0102
203	LD	0103
204	AND	0120

Address	OP	Data
205	OR LD	
206	AND NOT	0104
207	AND	0105
208	OUT	0120
209	END	

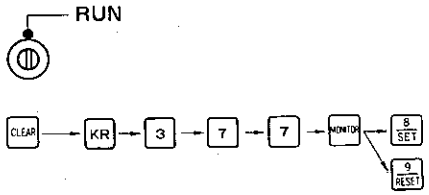
NOTES:
1. The following three methods of trace check are available.
   - Check starting from address 0000
     CLEAR → ↓ ..... ↑
   - Check starting from an OUT instruction.
     Refer to the foregoing operating procedure.
   - Check starting from an END instruction
     CLEAR → FUN → END → SEARCH → ↑ ..... ↓
     In general, an OUT instruction is first searched, and then the continuity of that block is checked according to the programming sequence.
2. The "TRACE" indicator illuminates when continuity exists and goes out when no continuity exists. At the address of AND LD, OR LD, 2nd word of a 2-word instruction, IL, ILC, JMP, JME, SR, MOV, MOV NOT, CMP, +, –, FAL, TR or END instruction, the "TRACE" indicator also goes out.
3. A beep sound is generated upon depression of the ↓ key after the address number has reached "2999." A beep sound is also generated upon depression of the ↑ key when the address number is "0000."

6.12 Forced Set/Reset Operation

This operation is to set or reset by force the operating state of each latching relay, the operating state of each SR bit, or the present value of each timer or counter during the execution of a program. In this forced set/reset operation, the operating state of a relay is caused to be set or reset only the instant the SET or RESET key is depressed, and subsequent circuit operation is the same as originally programmed.

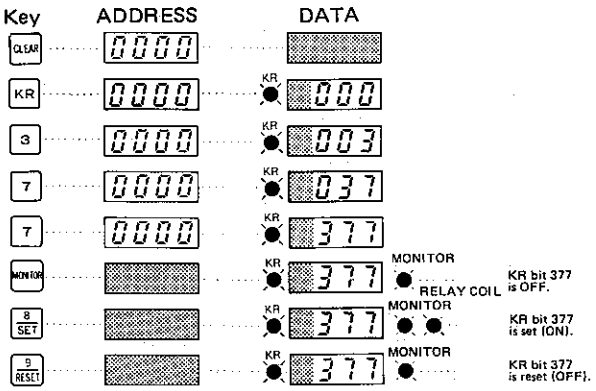
■ SET/RESET OPERATION OF THE LATCHING RELAY

- **Operating procedure**



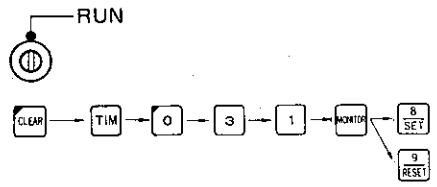
NOTE: The zero key marked [0] may or may not be depressed.

- **Display**

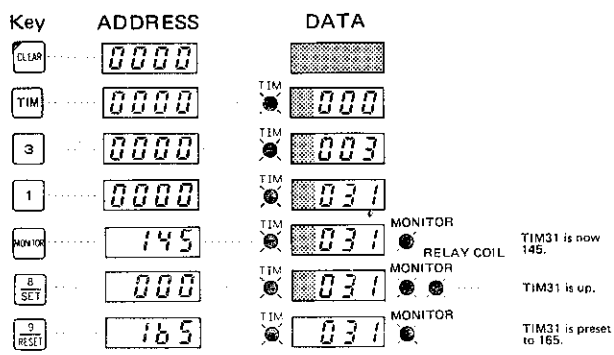


■ SET/RESET OPERATION OF THE PRESENT VALUE OF TIMER AND COUNTER

- **Operating procedure**

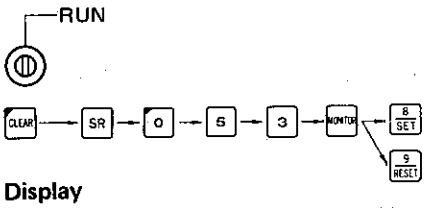


- **Display**

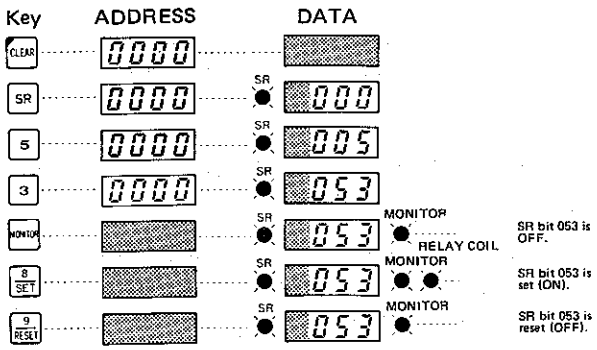


■ SET/RESET OPERATION OF THE SHIFT REGISTER

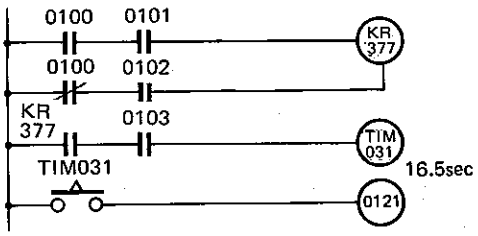
- **Operating procedure**



- **Display**



- **Circuit for exercise and programming example**



Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD·NOT	0100
0203	AND	0102
0204	KR	377
0205	LD·KR	377

Address	OP	Data
0206	AND	0103
0207	TIM	031
0208		165
0209	LD·TIM	031
0210	OUT	0121
0211	END	

NOTES:

1. Forced set/reset of the operating state of a latching relay.
   When the SET key is depressed, the operating state of the specified relay number is forcedly turned ON and the "RELAY COIL" indicator illuminates. When the RESET key is depressed, the operating state of the specified relay number is forcedly turned OFF and the "RELAY COIL" indicator goes out.
2. Forced set/reset of the present value of a timer or counter.
   When the SET key is depressed, the present value of the specified timer or counter number is forcedly cleared to zero and the "RELAY COIL" indicator illuminates.
   When the RESET key is depressed, the present value of the specified timer or counter number is forcedly returned to the preset value and the "RELAY COIL" indicator goes out.
3. Forced set/reset of the operating state of an SR bit.
   When the SET key is depressed, the operating state of the specified bit number is forcedly turned ON and the "RELAY COIL" indicator illuminates.
   When the RESET key is depressed, the operating state of the specified bit number is forcedly turned OFF and the "RELAY COIL" indicator goes out.

4. The forced set/reset function is applicable only to latching relays, timers/counters and shift registers.
5. When the SET or RESET key is depressed in any of the following cases, a beep sound is generated to alert the operator. Check for the proper operating procedure.
   1 In the CASSETTE or PROM WRITER mode
   2 During other than the monitoring operation in the RUN mode
   3 When setting other than the address setting and timer or counter data setting is performed in the PROGRAM mode.
   4 While a relay other than latching relay, timer or counter and shift register is being monitored.

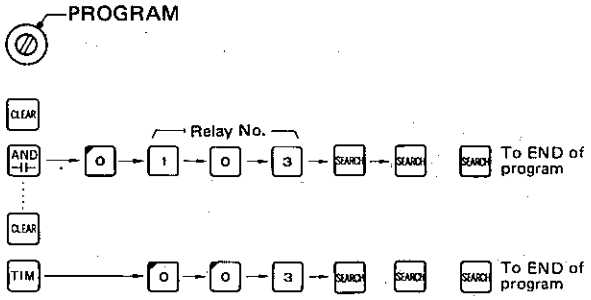
6.13 Instruction Search Operation

When a circuit change is to be made in a program simulation or test run, this operation allows an address where an instruction or relay number has been written in a program to be searched.

■ SEARCH OPERATION OF INSTRUCTION WORD

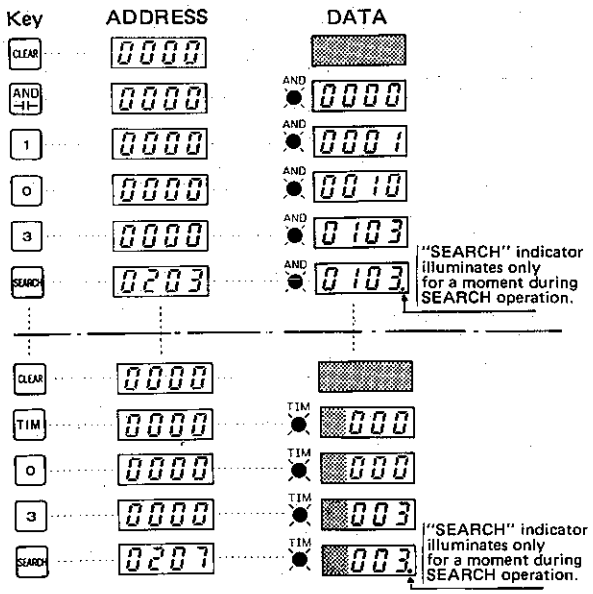
- **Operating procedure**

Referring to the circuit for exercise and programming example shown below, an example of searching 0103 —||— and (TIM 003) instructions is explained here.



NOTE: The zero key marked [0] may or may not be depressed.

- **Display**



NOTE: The zero key marked [0] may or may not be depressed.

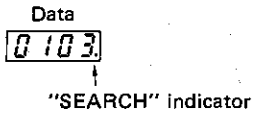
- **Circuit for exercise and programming example**

Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND	0103
0204	AND	0104

Address	OP	Data
0205	OUT	0120
0206	LD	0120
0207	TIM	003
0208		35
0209	END	

NOTES:

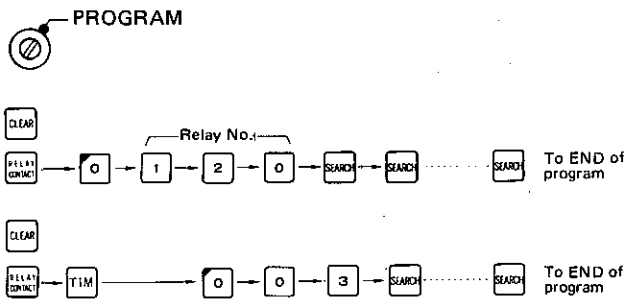
1. When the SEARCH key is depressed after entering an instruction, the first address where the instruction is stored is displayed. Continued depression of the SEARCH key causes all the addresses containing this instruction to be searched until the END instruction is encountered.
2. When the set value of a TIM, CNT instruction is to be searched, the TIM, CNT instruction must be searched before depressing the [↓] key. (The set value cannot be called directly.) The same holds for other 2-word instructions.
3. The "SEARCH" indicator illuminates momentarily while the address of the specified instruction is being searched and goes out upon completion of the search operation.



■ SEARCH OPERATION OF RELAY NUMBER

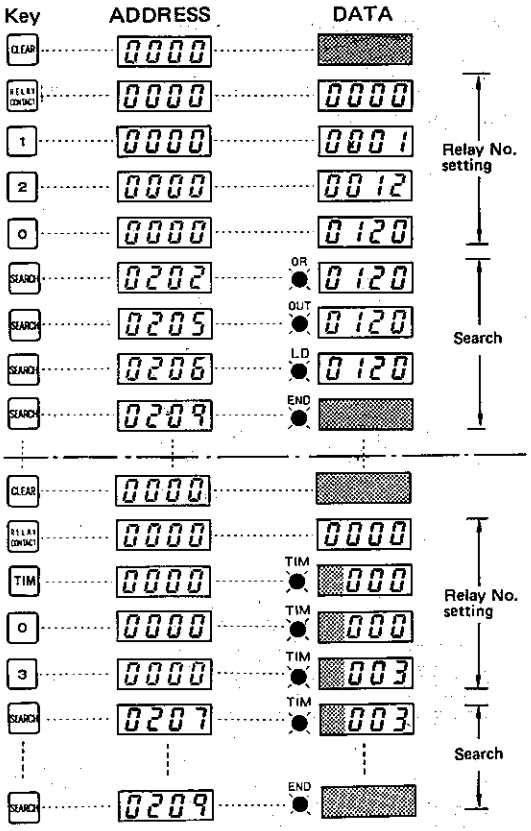
Referring to the circuit for exercise and programming example shown below, an example of searching relay No. 0120 throughout all addresses is explained here.

- **Operating procedure**

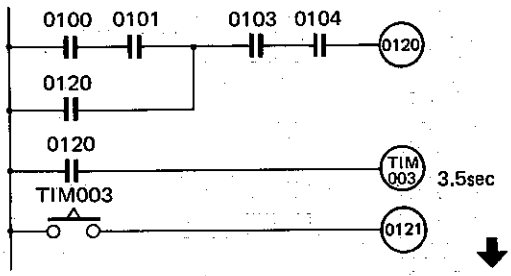


NOTE: The zero key marked [0] may or may not be depressed.

- **Display**



- **Circuit for exercise and programming example**

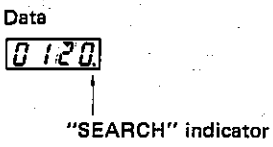


Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	OR	0120
0203	AND	0103
0204	AND	0104
0205	OUT	0120

Address	OP	Data
0206	LD	0120
0207	TIM	003
0208		035
0209	LD·TIM	003
0210	OUT	0121
0211	END	

NOTES:

1. Depress the RELAY CONTACT key, enter the relay number (also depress the OP key in case of a TIM, CNT, SR, KR or TR instruction), and depress the SEARCH key respectively until the last address of a program.
   The CPU stops at each pertinent address where the relay number being searched is located.
   In other words, the relay number search operation is executed from the address being presently displayed to the address when an END instruction is located or to the last address.
   Accordingly, if another relay number is to be searched continuously, depress the CLEAR key once.
2. The second word of a 2-word instruction (TIM, CNT, MOV, CMP, +, −) cannot be searched.
3. The "SEARCH" indicator illuminates momentarily while the address of the specified relay No. is being searched and goes out upon completion of the search operation.

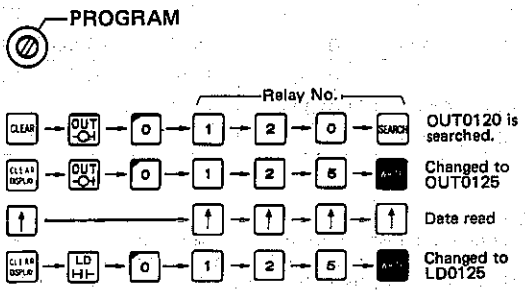


6.14 Contact (Coil) Number Change Operation

This operation is to change the contact (or coil) number in a program due to a circuit modification.

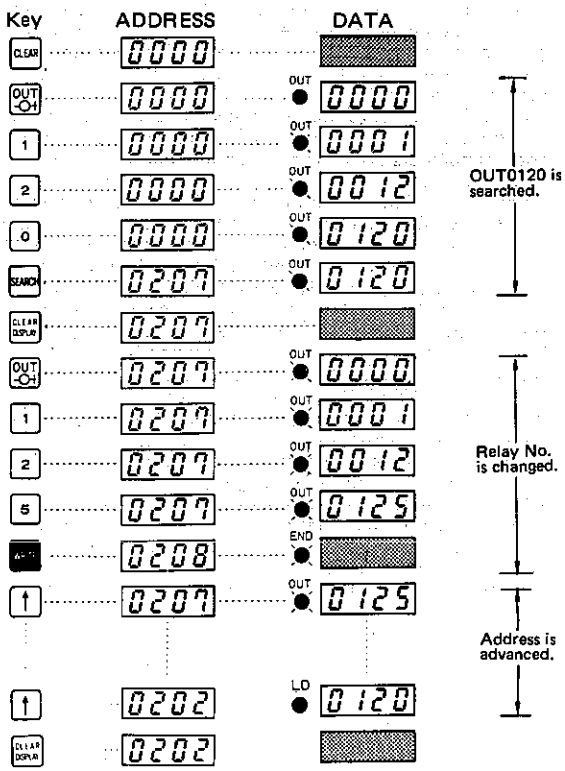
- **Operating procedure**

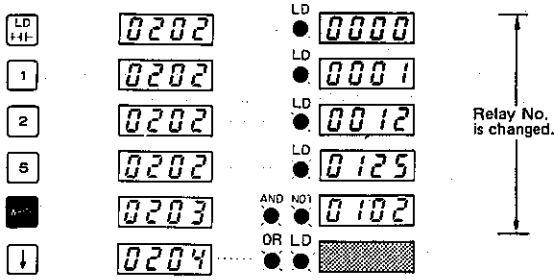
  Referring to the circuit for exercise and programming example shown on the right, an example of changing output relay No. 0120 to 0125 is explained here.



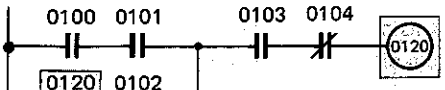
NOTE: The zero key marked [0] may or may not be depressed.

- **Display**





- **Circuit for exercise and programming example**



Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD	0120
0203	AND-NOT	0102
0204	OR-LD	

Address	OP	Data
0205	AND	0103
0206	AND-NOT	0104
0207	OUT	0120
0208	END	

NOTES:

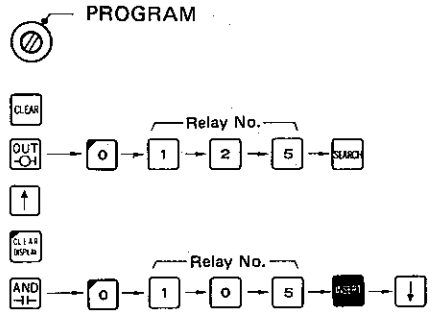
1. After an OUT instruction has been searched, depress the ↑ or ↓ key continuously to decrement the address number until the address where the contact (coil) number is to be changed. The instruction to be changed at an intended address may be searched directly. However, the same instruction may in some cases be stored in other memory addresses of the same program. Therefore, it is necessary to check instructions before and after the intended address. Since no two OUT instructions with an identical relay number exist in one program, the instruction to be changed can be found easily and quickly by first searching the OUT instruction and then searching before and after the OUT instruction.
2. When changing an instruction, the contact (coil) number setting is also required.
3. When a 2-word instruction is changed to a 1-word instruction, the 2nd word of the 2-word instruction is deleted and all the address numbers after the changed instruction will be decremented by 1.
4. When a 1-word instruction is changed to a 2-word instruction, an address where the 2nd word of the 2-word instruction is to be entered will be automatically secured and all the address numbers after the changed instruction will be incremented by 1. In this case, the "PROGRAM OVER" indicator will illuminate unless the last address has space for 1 word, prohibiting the instruction from being written into memory.
5. When the 1st word of a 2-word instruction is changed, note that the 2nd word of the instruction will be changed to 000.
6. When an OUT·TIM, CNT, SR, KR, MOV, + or − instruction is to be changed to another instruction, also check the circuit related to the instruction.
7. In the above operating procedure, the CLEAR DISPLAY key may be omitted from key entry.
8. After the contact (coil) number has been changed, be sure to perform the Program Check operation (CLEAR → SEARCH) to confirm that the program is free from any programming error.
9. A beep sound will be generated upon depression of the ↓ after the address number has reached "2999." A beep sound will also be generated upon depression of the ↑ key when the address number is "0000."

6.15 Contact (Coil) Addition Operation

This operation is employed when the contact (or coil) number is to be added due to a circuit modification.

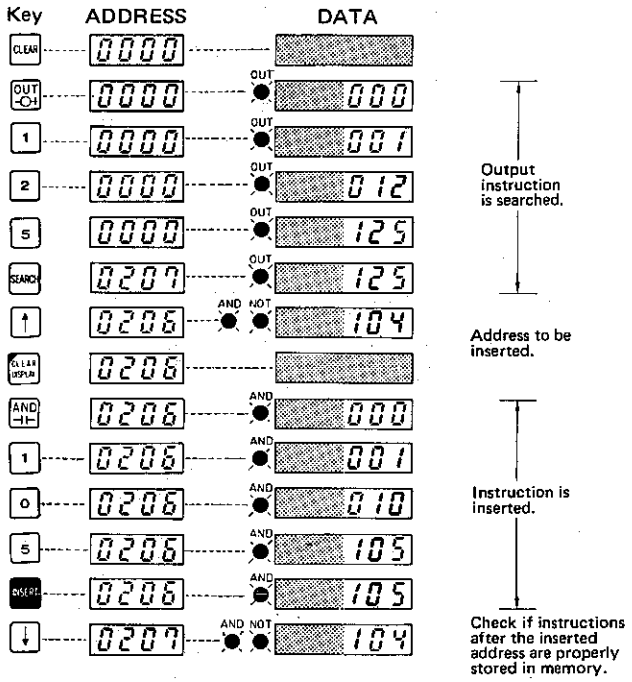
- **Operating procedure**

In the following the procedure of adding —|0105|— between —|0103|— and —|/0104|— is shown.



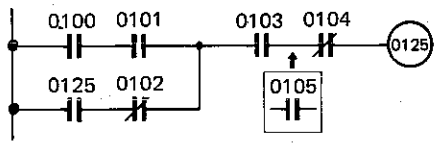
NOTE: The zero key marked 0 may or may not be depressed.

- **Display**



NOTE: The zero key marked 0 may or may not be depressed.

- **Circuit for exercise and programming example**



Before insertion

Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD	0125
0203	AND-NOT	0102
0204	OR-LD	
0205	AND	0103
0206	AND-NOT	0104
0207	OUT	0125
0208	END	

After insertion

Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD	0125
0203	AND-NOT	0102
0204	OR-LD	
0205	AND	0103
0206	AND	0105
0207	AND-NOT	0104
0208	OUT	0125
0209	END	

NOTES:

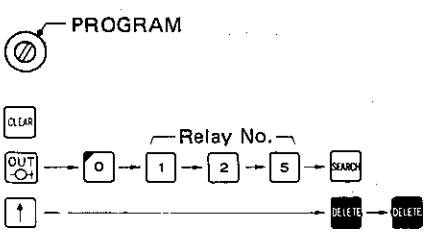
1. Search an OUT instruction, depress the [↑] key repetitively to advance the program up to the address where the instruction is to be inserted. Next, depress the CLEAR DISPLAY key, enter the instruction to be inserted and then depress the INSERT key. The address number after the inserted instruction will automatically be incremented by 1.
2. When a 2-word instruction is inserted, the address where the 2nd word of the 2-word instruction is to be entered will be automatically secured.
3. If a "Program Over" condition occurs as a result of the instruction insertion, the "PROGRAM OVER" indicator illuminates and a beep sound is generated to alert the operator.
4. If an attempt is made to insert an instruction into the address where the 2nd word of a 2-word instruction has been set, a beep sound is generated to signal the operator that the instruction cannot be inserted.
5. In other than the PROGRAM mode, no instruction can be inserted and a beep sound is generated to alert the operator.
6. After the instruction to be inserted has been entered, depression of the INSERT key two or more times in succession will be ignored and no instruction can be entered. In this case, a beep sound will also be generated to alert the operator.
7. After the insertion of the instruction, confirm instructions before and after the inserted address.
8. After the contact (coil) number has been inserted, be sure to perform the Program Check operation ([CLR] → [SRCH]) to confirm that the program is free from any programming error.
9. When the user memory is not equipped fully with 3K words. of RAMs, no "PROGRAM OVER" check can be performed.

6.16 Contact (Coil) Deletion Operation

This operation is to delete contact (or coil) number(s) from a program due to a circuit modification.

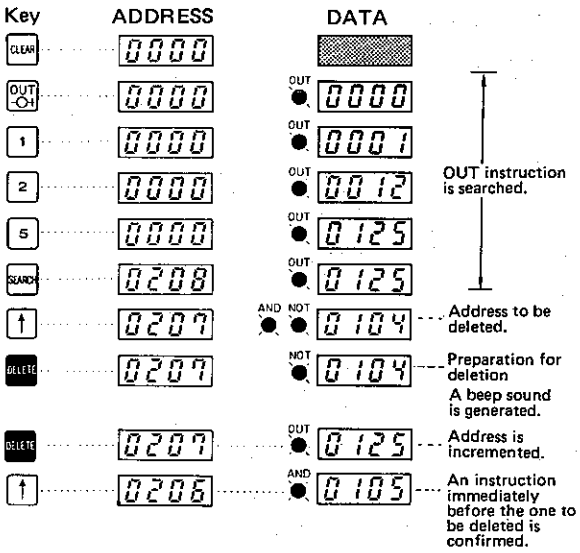
- **Operating procedure**

  Referring to the circuit for exercise shown below, an example of deleting $\dashv\vdash^{0104}$ is explained.

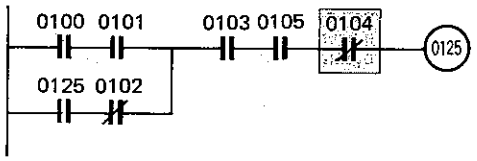


NOTE: The zero key marked [0] may or may not be depressed.

- **Display**



- **Circuit for exercise and programming example**



Before deletion

Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD	0125
0203	AND-NOT	0102
0204	OR-LD	
0205	AND	0103
0206	AND	0105
0207	AND-NOT	0104
0208	OUT	0125
0209	END	

After deletion

Address	OP	Data
0200	LD	0100
0201	AND	0101
0202	LD	0125
0203	AND-NOT	0102
0204	OR-LD	
0205	AND	0103
0206	AND	0105
0207	OUT	0125
0208	END	
0209		

NOTES:

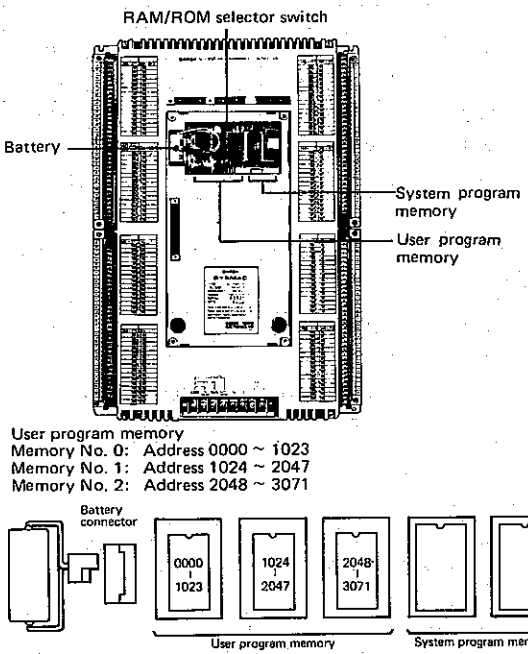
1. Search an OUT instruction, depress the [↑] key to advance the program up to the address where the instruction to be deleted is located, and depress the DELETE key twice in succession. All the address numbers after the deleted instruction will automatically be decremented by 1.
   The reason for depressing the DELETE key twice is to prevent an instruction from being deleted accidentally due to an erroneous key operation. The first depression of the key causes a beep sound to be generated to signal the preparation for an instruction deletion. The second and each subsequent depression of the key cause instructions to be deleted one by one.
2. When a 2-word instruction (TIM, CNT, MOV, +, or −) is deleted, the address where the address of the 2nd word is located will also be deleted automatically.
3. Only the 2nd word of a 2-word instruction (TIM, CNT, MOV, +, −) cannot be deleted. A beep sound generated if an attempt is made to do so.
4. After the instruction has been deleted, confirm instructions before and after the deleted address.
5. After the deletion of the instruction, be sure to execute the Program Check operation ([CLR] → [SRCH]). Particularly, the program check is mandatory when input, output or clock contact of such an instruction as TIM, CNT, SR or KR is deleted.
6. When the DELETE key is depressed in the CASSETTE, RUN or PROM WRITER mode, a beep sound is generated to alert the operator.

7. EPROM Chip and Cassette Tape Handling

7.1 Basic Functions

Items of operation	Description
EPROM write	This operation is to transfer the contents of any of the memory Nos. 0 ~ 2 in the user memory (RAM/ROM) program area to the EPROM chip mounted on the PROM socket.
EPROM read	This operation is to transfer the contents of the EPROM chip (mounted on the PROM socket) to any of the memories 0 ~ 2 in the user program (RAM) memory area.
EPROM verify	This operation is to verify the contents of the EPROM chip (mounted on the PROM socket) against the contents of any of the memory Nos. 0 ~ 2 in the user program (RAM) memory area.
Tape write	This operation is to record the contents of the user program (RAM/ROM) on a cassette tape.
Tape read	This operation is to transfer the program data recorded on the cassette tape into the user program (RAM).
Tape verify	This operation is to verify the contents of the user program (RAM/ROM) against the programmed data recorded on a cassette tape.

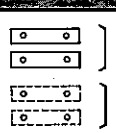
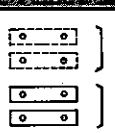
7.2 RAM and EPROM Chip Handling



■ HOW TO CONVERT BETWEEN RAM AND ROM

Set the two-pin RAM/ROM selector switch as shown below, according to the type of RAM or ROM to be used.

- **RAM/ROM selector switch**

RAM memory	ROM memory
	

NOTE: Two-pin RAM/ROM selector is factory set to the "RAM" position. When using ROM memory, set the RAM/ROM selector to the "ROM" position.

■ TO USE RAM MEMORY

1. Set the RAM/ROM selector switch to the "RAM" position.
2. Mount RAM chip(s) in the user program memory area (Memory No. 0 ~ 2).

NOTE: Applicable memory element: 5516 or its equivalent

CAUTION:
Do not turn the RAM/ROM selector switch to the "ROM" position while the RAM memory is in use, or the program may be destroyed.

■ TO USE ROM MEMORY

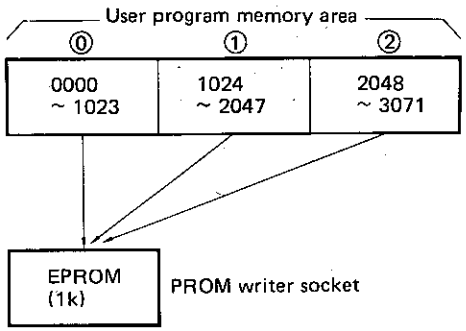
1. Set the RAM/ROM selector switch to the "ROM" position.
2. Mount ROM chips in the user program memory area (Memory No. 0 ~ 2).

NOTE: Applicable memory element: 2716 or its equivalent

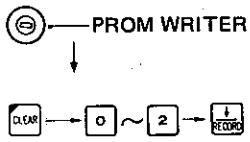
NOTES:
1. Do not remove or insert any user program memory chip (RAM/ROM) while power is being applied to the SYSMAC-M5R. Otherwise, the memory chip may be destroyed.
2. Completely erase the EPROM and then write data into the EPROM. The contents of the EPROM are erased by irradiating ultraviolet rays on the EPROM surface through the erase window. The EPROM cannot be erased completely if the irradiation by ultraviolet rays is insufficient. Therefore, be sure to observe the specified erase time. Whether or not the EPROM has been erased completely can be confirmed by the EPROM Verify operation. (Refer to paragraph 7.10, Errors in PROM WRITER or CASSETTE Mode.)
3. Erase time
   Completely erase the EPROM according to the specifications of the eraser to be used.
4. Frequency of re-programming
   Limit the frequency of re-programming the EPROM to 7 times. If the EPROM is re-programmed more than 7 times, the EPROM may malfunction.
5. Program protection
   To sustain the reliability of the EPROM, place the EPROM in a protective case or wrap it in aluminum foil if it is not to be used for an extended period.
6. Handling EPROM
   The EPROM is susceptible to static electricity being carried in the human body. When handling the EPROM, avoid touching its pins as much as possible.
7. Removal of EPROM
   The EPROM can be inserted or removed while power is being applied to the SYSMAC-M5R. However, never remove the EPROM chip during the EPROM write, read, or verify operation.
8. After the program debugging, be sure to attach a light-shielding seal to the erase window in order to maintain the reliability of the EPROM chip.

7.3 EPROM Write Operation

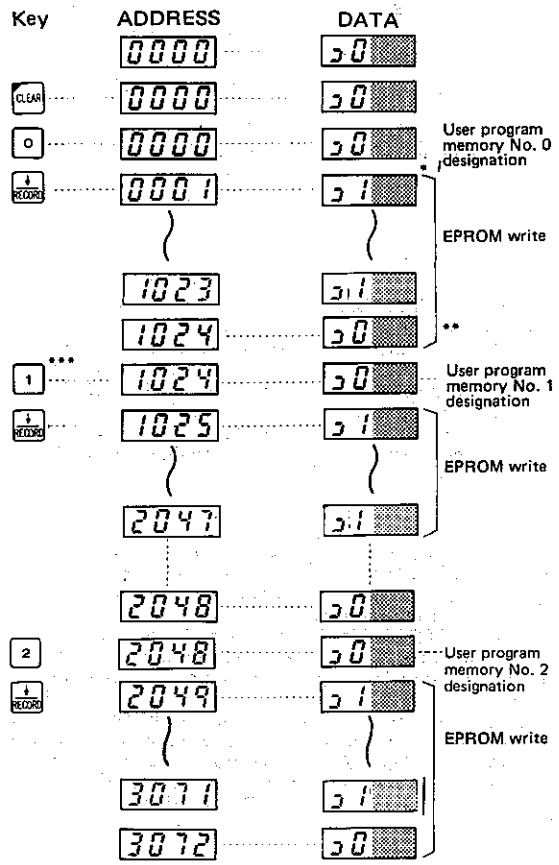
This operation is to transfer the contents of any of the memory Nos. 0 ~ 2 in the user program (RAM/ROM) memory area to the EPROM chip mounted on the PROM writer socket.



- **Operating procedure**



- **Display**



* [01] on the DATA display indicates that the EPROM Write operation is being executed.

** [00] on the DATA display indicates that the EPROM Write operation has been completed. The next address for EPROM write is indicated on the ADDRESS display.

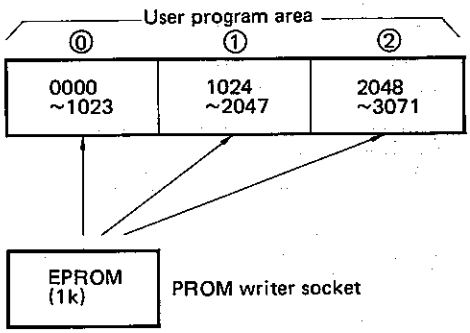
*** For example, to perform the EPROM Write operation from memory No. 1, depress the CLEAR key, specify memory No. 1 by depressing numeric key and then depress the RECORD key.

NOTES:

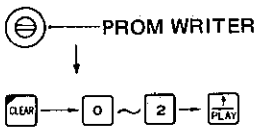
1. One of memory Nos. 0 ~ 2 must be specified. However, when the EPROM Write operation is to be performed successively from the memory No. 0, this memory number designation is not required.
2. Upon depression of the RECORD key, EPROM erase check is performed, and then the EPROM Write operation will start.
3. During the EPROM Write operation, if the power is turned off, or the EPROM chip is removed, the EPROM Write will be interrupted. In such a case, retry the EPROM write operation from the beginning after erasing the EPROM chip, or use other EPROM area.
4. During the EPROM Write operation, no PROGRAM key input will be accepted.
5. When any error occurs during the EPROM Write operation, the buzzer issues intermittent beep sounds to alert the operator.
6. After the EPROM Write operation, be sure to perform the EPROM Verify operation to check if the data have been written properly into the EPROM.
7. To stop the EPROM Write operation under execution, either depress the CLEAR key or operate the mode selector switch (to other than the PROM WRITER position).

7.4 EPROM Read Operation

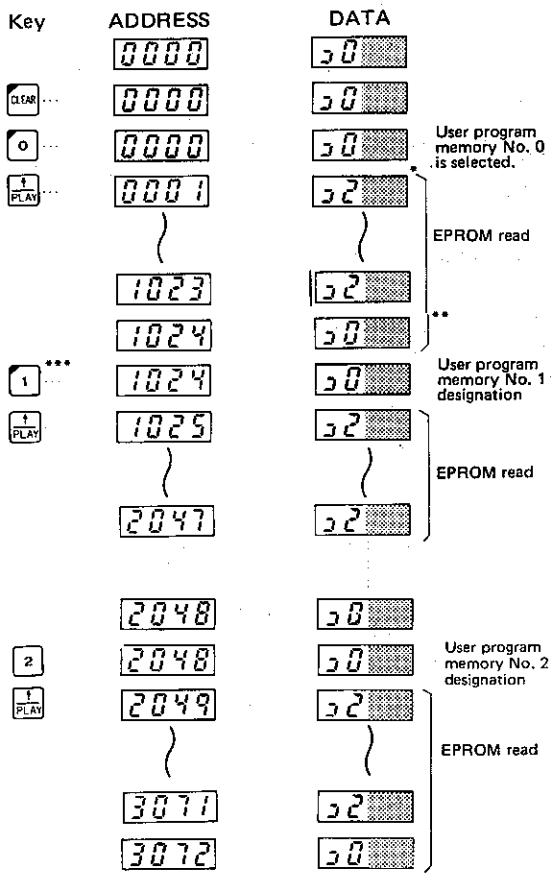
This operation is to transfer the contents of the EPROM chip (mounted on the PROM writer socket) to any of the memory Nos. 0 ~ 2 in the user program (RAM) memory area.



- **Operating procedure**



- **Display**

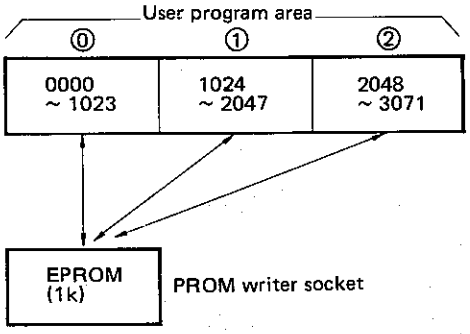


* [32] on the DATA display indicates that the EPROM Read operation is being executed.
** [30] on the DATA display indicates that the EPROM Read operation has been completed and the next address for EPROM read is indicated on the ADDRESS display.
*** For example, to transfer the EPROM chip data into memory No. 1, depress the CLEAR key, specify memory No. 1 by depressing numeric key 1 and then depress the PLAY key.

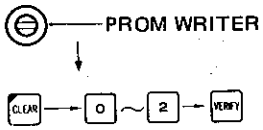
NOTES:
1. One of memory Nos. 0 ~ 2 must be specified. However, when the EPROM Read operation is to be performed successively from the memory No. 0, this memory number designation is not required.
2. During the EPROM Read operation, if the power is turned off or the EPROM chip is removed, the EPROM read will be interrupted. In such a case, retry the operation from the beginning.
3. When an error occurs during the EPROM Read operation, the buzzer issues intermittent beep sounds to alert the operator.
4. Be sure to perform the EPROM Verify operation to check if the data have been read properly by the RAM.
5. Upon completion of the EPROM Read operation, the specified memory No. will be indicated on the MEMORY No. display.
6. To stop the EPROM Read operation under execution, either depress the CLEAR key or operate the mode selector switch (to other than PROM WRITER).

7.5 EPROM Verify Operation

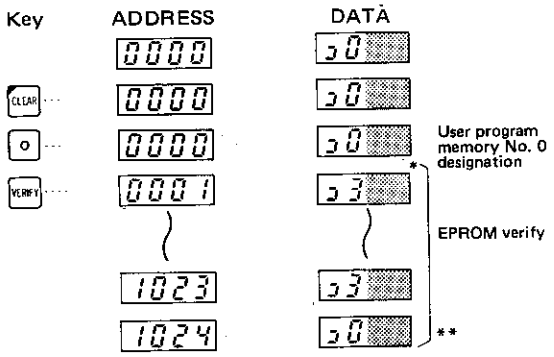
This operation is to verify the contents of the EPROM chip (mounted on the PROM writer socket) against the contents of any of the memory Nos. 0 ~ 2 in the user program (RAM) area.

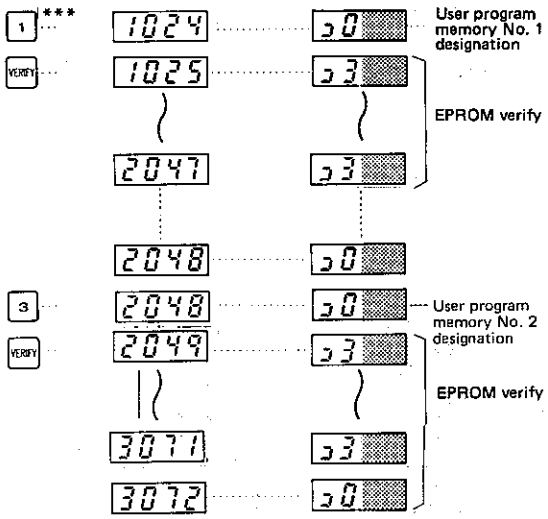


- **Operating procedure**



- **Display**



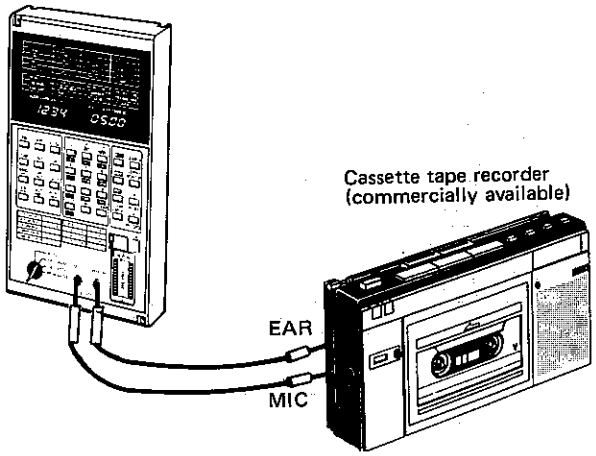


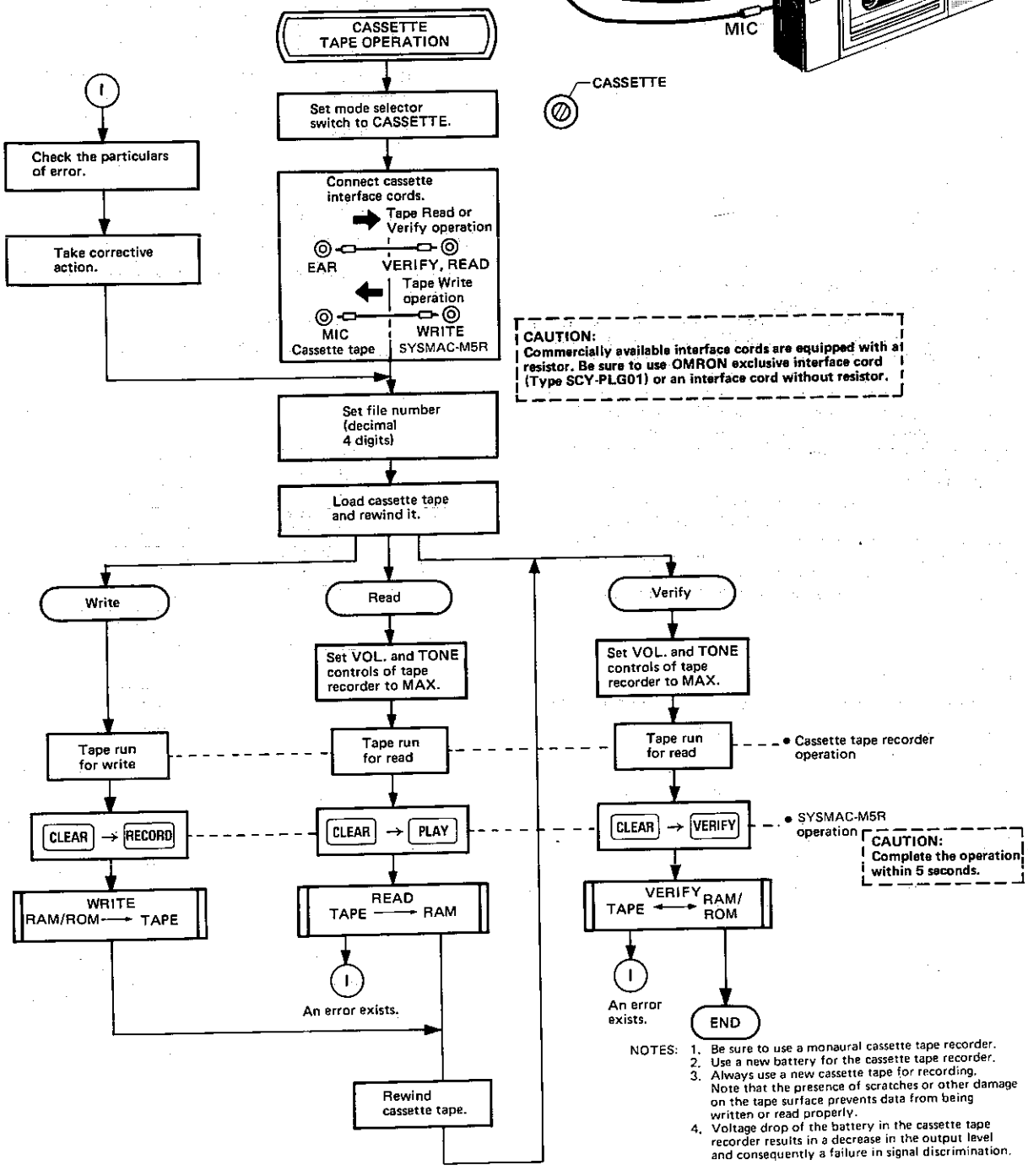
* [33] on the DATA display indicates that the EPROM Verify operation is being executed.
** [30] on the DATA display indicates that EPROM Verify operation has been completed and the next address for EPROM verify is indicated on the ADDRESS display.
*** For example, to perform EPROM Verify operation between the EPROM chip and memory No. 1, depress the CLEAR key, specify memory No. 1 by depressing numeric key 1, and then depress the VERIFY key.

NOTES:
1. One of memory Nos. 0 ~ 3 must be specified. However, when the EPROM Verify operation is to be performed successively from the memory No. 0, this memory number designation is not required.
2. During the EPROM Verify operation, if the power is turned off, or the EPROM chip is removed, the EPROM Verify operation will be interrupted. In such a case, retry the operation from the beginning.
3. When an error occurs during EPROM Verify operation, the buzzer issues intermittent beep sounds to alert the operator.
4. To stop the EPROM Verify operation under execution, either depress the CLEAR key or operate the mode selector switch (to other than the PROM WRITER position).

7.6 Cassette Tape Handling

As a method of keeping user programs in storage, data may be recorded on a cassette tape by using a commercially available cassette tape recorder.
In the following, a general operational flowchart is shown.





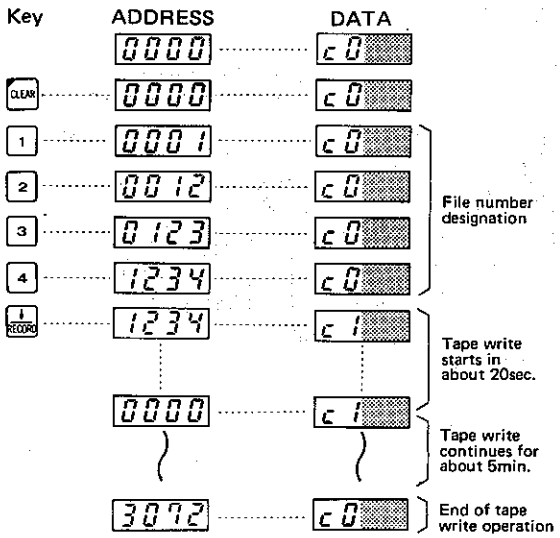
NOTES:
1. Be sure to use a monaural cassette tape recorder.
2. Use a new battery for the cassette tape recorder.
3. Always use a new cassette tape for recording. Note that the presence of scratches or other damage on the tape surface prevents data from being written or read properly.
4. Voltage drop of the battery in the cassette tape recorder results in a decrease in the output level and consequently a failure in signal discrimination.

7.7 Tape Write Operation

This operation is to record the contents of the user program (RAM/ROM) on a cassette tape.

- **Operating procedure**
  Refer to 7.6, Cassette Tape Handling.

- **Display**



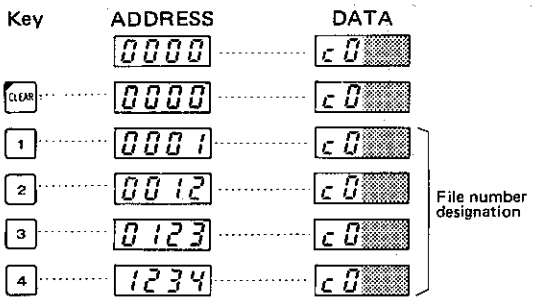
NOTES:
1. Upon completion of the Tape Write operation, be sure to perform the Tape Verify operation to confirm that the data have been recorded on the tape properly.
2. Error detection cannot be performed during the Tape Write operation. Even if the tape does not run, data will be transferred unilaterally from the RAM/ROM. So, be sure to confirm that the tape is running smoothly.
3. If the power is turned off or the cassette is ejected during the Tape Write operation, the tape write will be interrupted. Retry the tape write operation from the beginning.
4. During the Tape Write operation, no PROGRAM key input will be accepted.
5. For the Tape Write operation, use the WRITE → MIC jack to connect one of the cassette tape interface cords. For subsequent verify operation, use VERIFY READ ← EAR jack.
6. To stop the Tape Write operation under execution, either depress the CLEAR key or by operate the mode selector switch (to other than the CASSETTE position).
7. The program number is recorded as the file number on the tape.

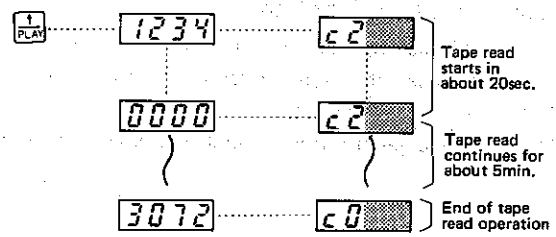
7.8 Tape Read Operation

This operation is to transfer the program data recorded on the cassette tape into user program (RAM).

- **Operating procedure**
  Refer to 7.6, Cassette Tape Handling.

- **Display**





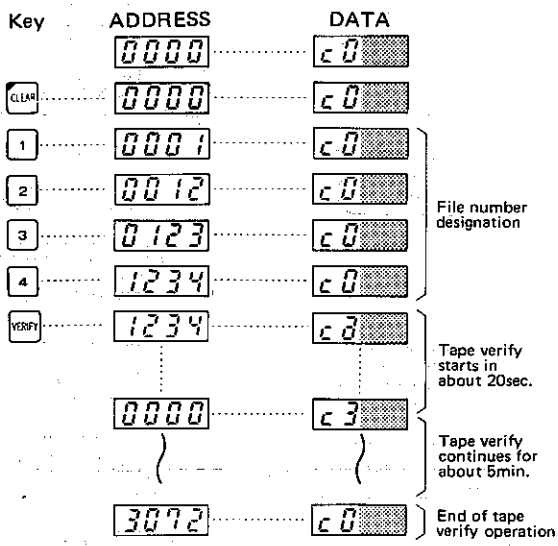
NOTES:
1. Upon completion of the Tape Read operation, be sure to perform the Tape Verify operation to confirm that the data have been transferred properly from the tape to the RAM.
2. If the power is turned off or the cassette is ejected during the Tape Read operation, the tape read will be interrupted. Retry the tape read operation from the beginning.
3. During the Tape Read operation, no PROGRAM key input will be accepted.
4. Be sure to set the volume control and tone control of the cassette tape recorder to maximum.
5. To stop the Tape Read operation under execution, either depress the CLEAR key or operate the mode selector switch (to other than the CASSETTE position).
6. If the file number does not coincide with the file number recorded in the Tape Write operation, this condition is regarded as an error and no Tape Read operation will be performed.
7. File number entry must be performed before running the tape for read.

7.9 Tape Verify Operation

This operation is to verify the contents of user program (RAM/ROM) against the programmed data recorded on a cassette tape.

- **Operating procedure**
  Refer to 7.6, Cassette Tape Handling.

- **Display**



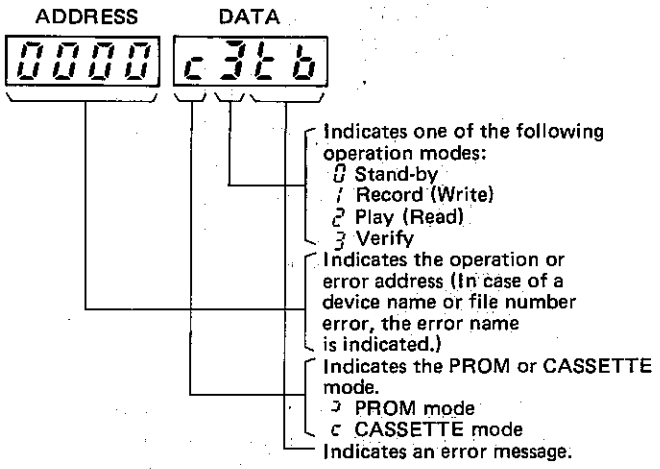
NOTES:
1. If the power is turned off or the cassette tape is ejected during the Tape Verify operation, the tape read will be interrupted. Retry the Tape Verify operation from the beginning.
2. During the Tape Verify operation, no PROGRAM key input will be accepted.
3. Be sure to set the volume control and tone control of the cassette tape recorder to maximum.
4. To stop the Tape Verify operation under execution, either depress the CLEAR key or operate the mode selector switch (to other than the CASSETTE position).

5. If the number does not coincide with the file number recorded in the Tape write operation, the condition is regarded as an error and no Tape Verify operation will be performed.
6. File number entry must be performed before running the tape for verify.

7.10 Errors in PROM WRITER or CASSETTE Mode

In the PROM WRITER or CASSETTE mode, the following indications may appear on the ADDRESS and DATA displays, respectively.

- **Display**



■ DESCRIPTION OF ERROR MESSAGE

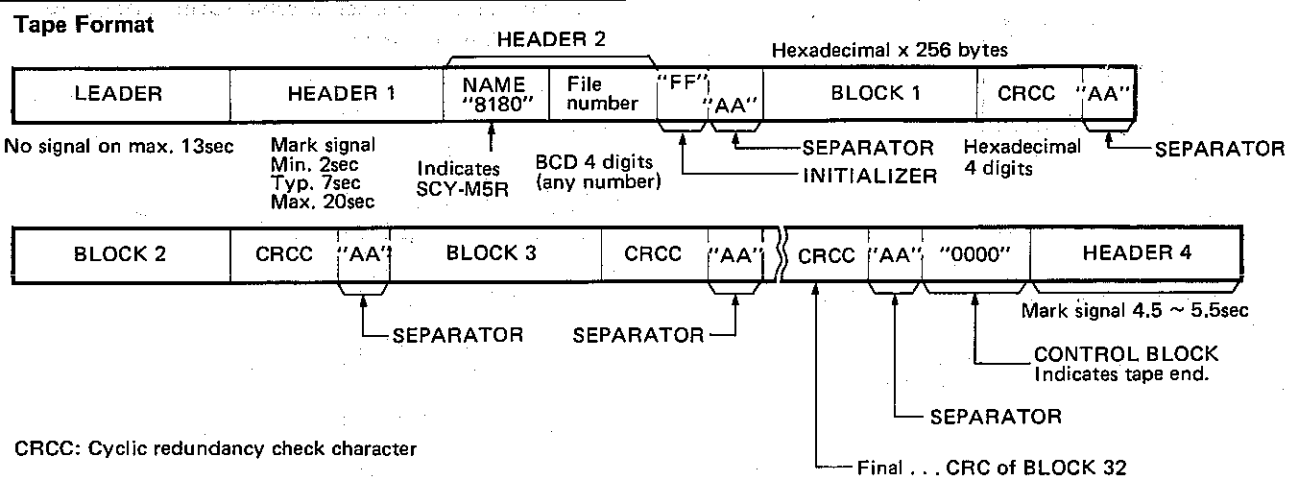
- **PROM Mode**

Operation	Error message	Description of message
EPROM write	1b	Verify error (as a result of verify check for each written word)
	17	Erase check error (as a result of the EPROM erasure check before EPROM write)
EPROM verify	3b	Verify error (as a result of EPROM Verify operation)

- **CASSETTE Mode**

Operation	Error message	Description of message
Tape read	21	Framing error (2 stop bits do not exist for one start bit)
	22	CRC check error (as a result of CRC check of one block (128 words or 256 bytes) of data)
	23	Time out error (HEADER 2 (device or file number) is not output within 35 sec after the start of the tape read operation.)
	24	Format error (Initializer or separator code is abnormal.)
	27	Device name error (The device name is other than the code "8180" of the SYSMAC-M5R in the tape read operation.)
	28	File number error (The recorded file number does not coincide with the file number entered by key operation.)
Tape verify	31	Framing error (2 stop bits do not exist for one start bit.)
	32	CRC check error (as a result of the CRC check of one block (128 words or 256 bytes) of data.)
	33	Time out error (HEADER 2 (device or file number) is not output within 35sec after the start of tape verify operation.)
	34	Format error (Initializer or separator code is abnormal.)
	3b	Verify error (Data recorded on the tape does not coincide with that stored in the user program memory.)
	37	Device name error (The device name is other than the code "8180" of the SYSMAC-M5R in the tape verify operation.)
	38	File number error (The recorded file number does not coincide with the file number entered by key operation.)

- **Tape Format**



NOTE:
For information on the Graphic programming console (CRT) Model SCY-CRT10-81E(-82E), please refer to the OMRON Graphic Programming Console Model SYSMAC-CRT10 User's Manual (Cat. No. W50-E1) published under separate cover.

8. Installation and Wiring

The SYSMAC-M5R is a highly reliable programmable controller which is resistant to adverse environmental conditions. However, in order to permit the programmable controller to fully exhibit its functions, as well as to enhance its reliability, care must be exercised on the following points when installing the programmable controller.

8.1 Mounting Locations and Environmental Conditions

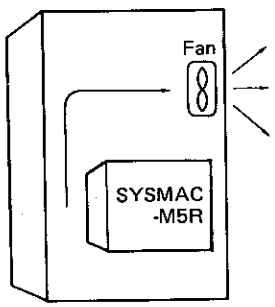
When installing the SYSMAC-M5R programmable controller, avoid the following locations.

- Location where the ambient temperature is beyond the range of 0 to 50°C.
- Location where temperature changes abruptly, thus resulting in condensation.
- Location where relative humidity exceeds the range of 30 to 90%.
- Location subject to corrosive gas or flammable gas.
- Location subject to excessive dust, salt, or iron particles.
- Location subject to vibration or shock.
- Location subject to direct sunlight.

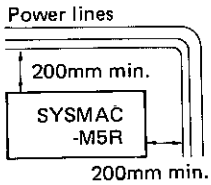
8.2 Mounting Positions within Control Panels

When mounting the SYSMAC-M5R in a control panel, take into consideration the operability, maintenability and environmental resistance of the programmable controller.

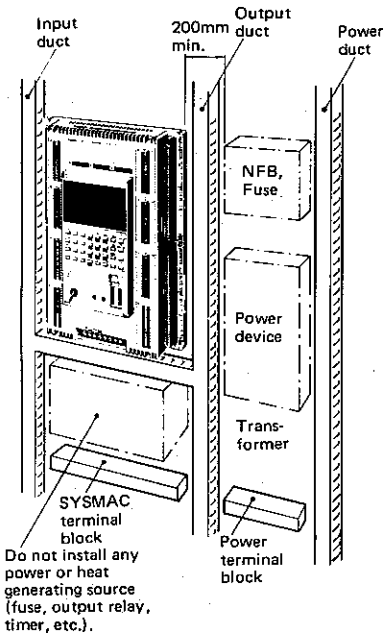
1. To permit the use of the SYSMAC-M5R within the ambient operating temperature range, pay attention to the following points.
   a. Provide the programmable controller with adequate space for ventilation.
   b. Avoid mounting the controller directly above any heat generating sources (heater, transformer, resistor of high capacity).
   c. Install a fan for forced ventilation if the ambient temperature exceeds 50°C.



2. Avoid mounting the SYSMAC-M5R in a panel in which high-tension equipment is installed.
3. Provide a distance of more than 200mm between the high-tension or power lines and the SYSMAC-M5R.



4. Mount the SYSMAC-M5R as far away as possible from high-tension equipment or power devices for the sake of safety in maintenance and operation.

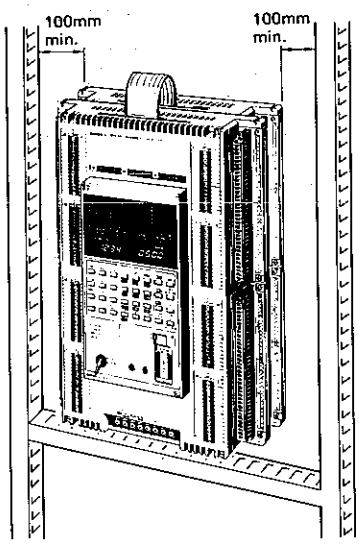


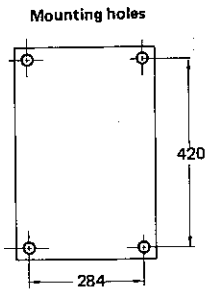
5. Mounting the SYSMAC-M5R at a height 1,000 to 1,600mm above the installed surface of the control panel will facilitate the operation of the programmable controller.

8.3 How to Install within Control Panels

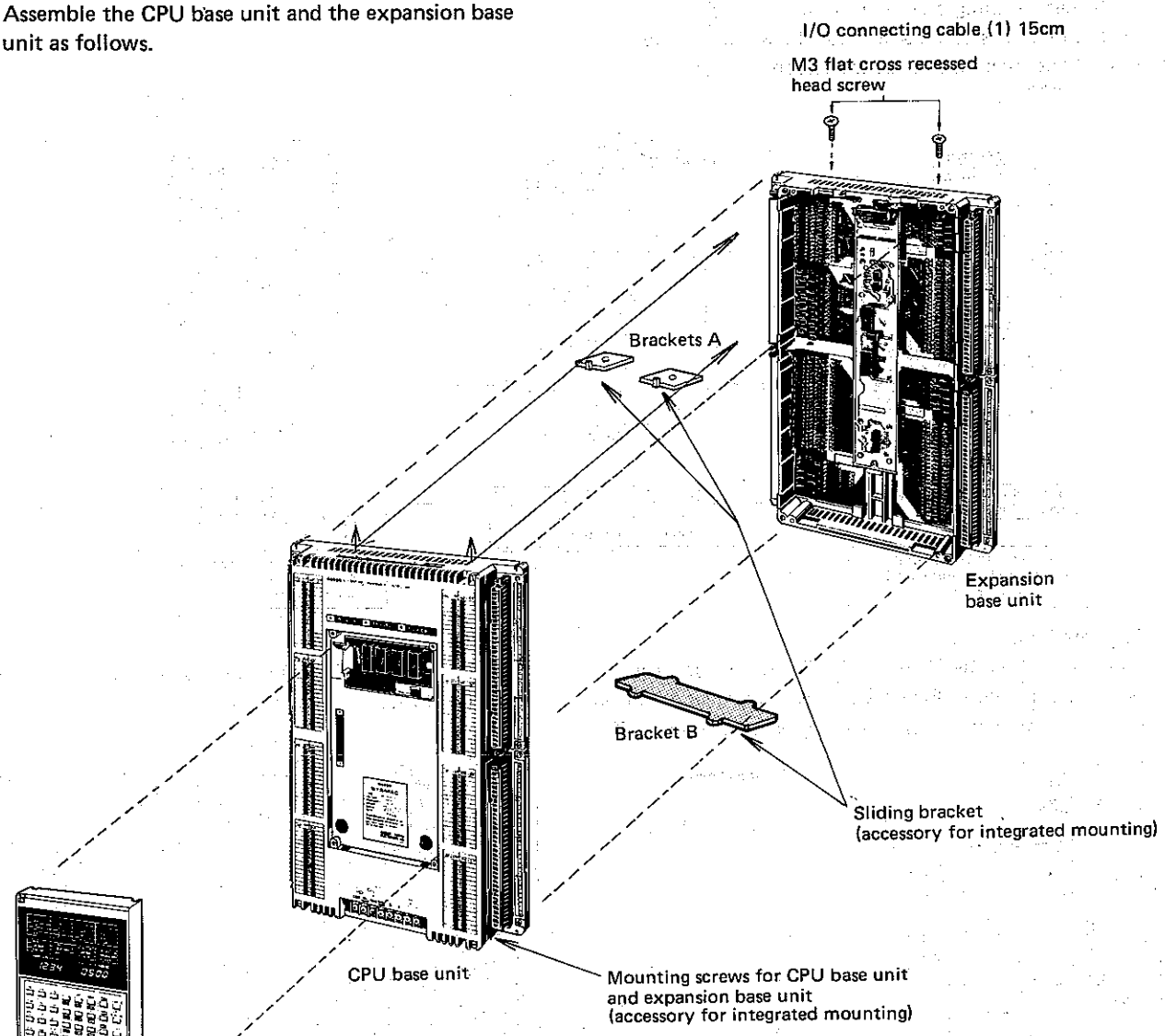
With the SYSMAC-M5R, its CPU base unit and expansion base unit can be mounted as either integrated units or separated units in a control panel.

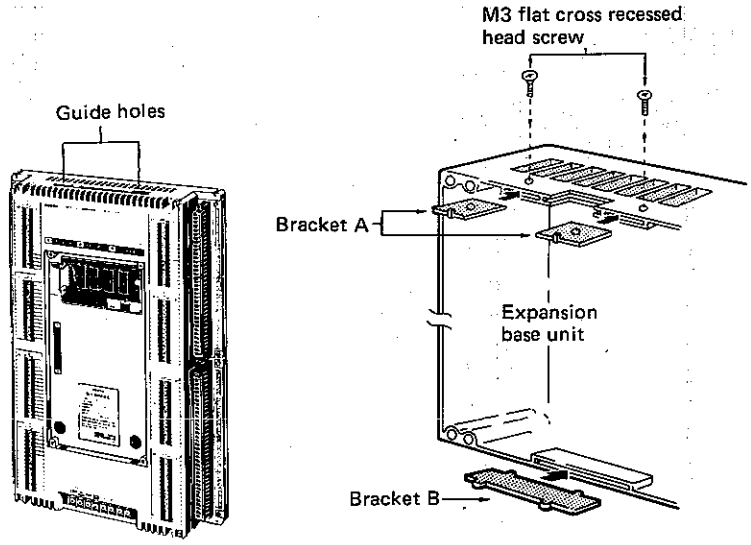
1. Integrated mounting
   a. When mounting the SYSMAC-M5R within a control panel, mount the expansion base unit on an intermediate mounting panel and then the CPU base unit on top of the expansion base unit as shown below, and use an I/O connecting cable 15cm in length for connection of both units.





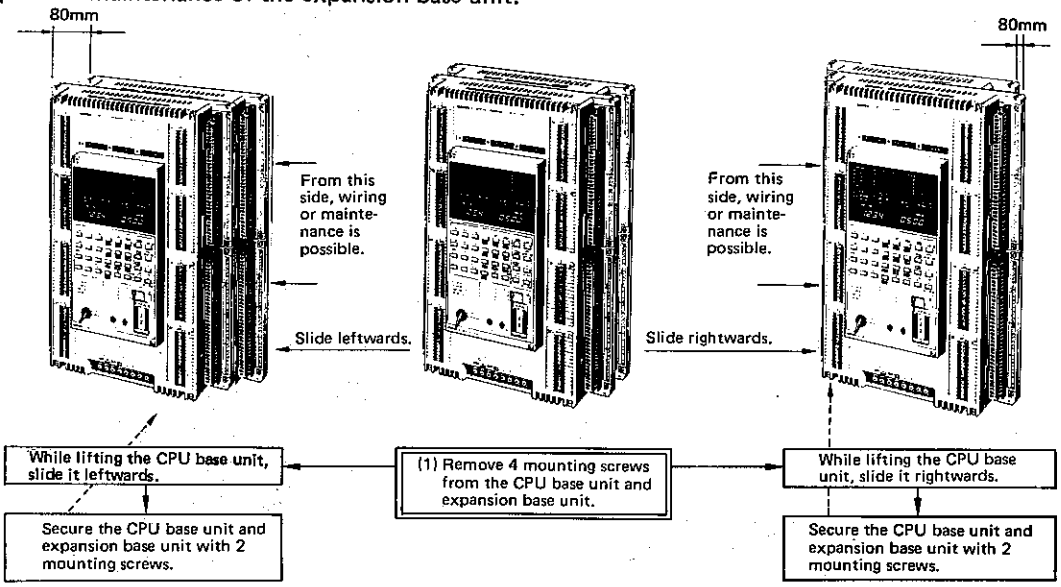
b. Assemble the CPU base unit and the expansion base unit as follows.





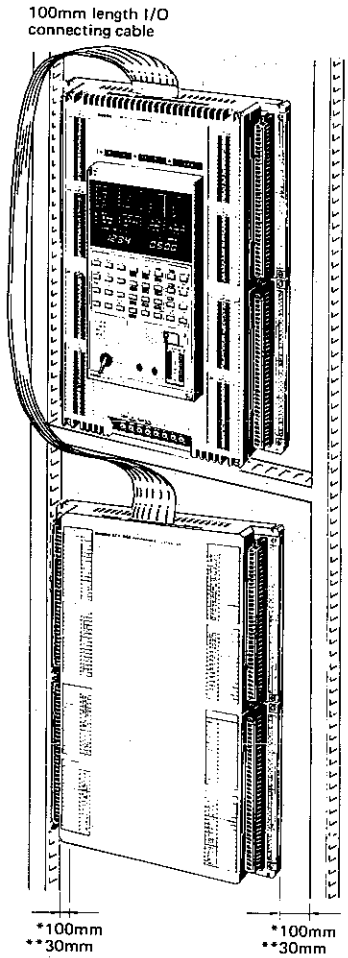
How to assemble both base units for integrated mounting
(1) Secure brackets A and B onto the expansion base unit.
(2) Fix two brackets A with two M3 flat cross recessed head screws.
(3) Insert the projection of each bracket A into the guide hole of the CPU base unit and then combine both units together.

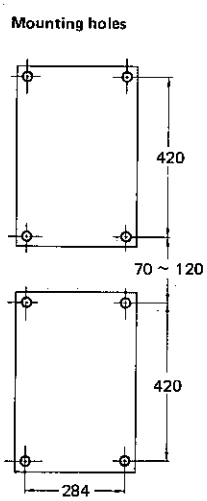
c. In the case of integrated mounting, follow the procedure as described below for the wiring of input/output and maintenance of the expansion base unit.

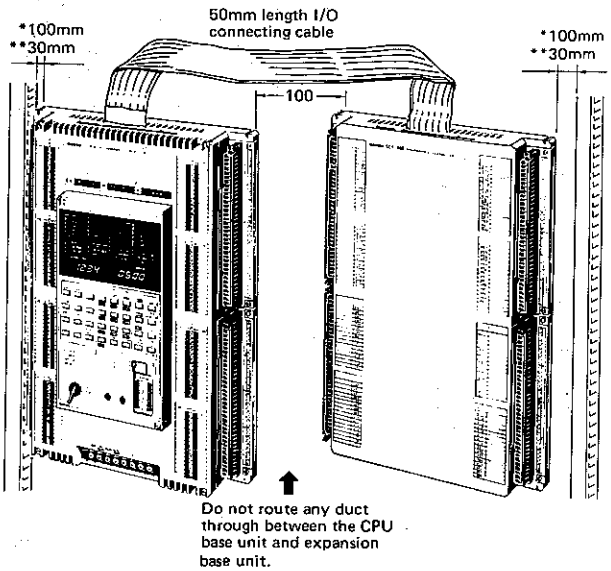


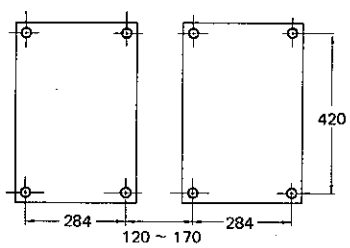
2. Separated mounting

When mounting the SYSMAC-M5R within a control panel, mount both CPU base unit and expansion unit on an intermediate panel as illustrated below and use a 50 or 100cm length I/O connecting cable according to the wiring method.



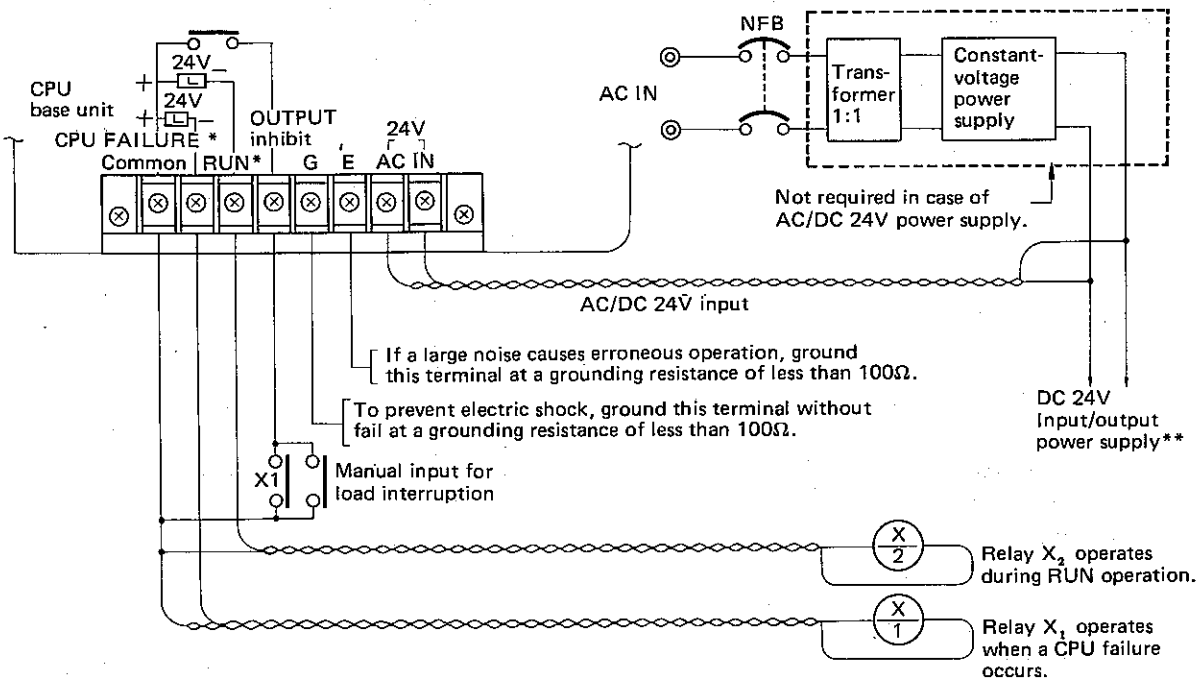






NOTES:
1. * To remove I/O units directly from the CPU base unit or expansion base unit, provide a space of 100mm for both right-hand and left-hand ducts.
2. ** To remove the I/O units right after the blind patch of the CPU base unit or expansion base unit is removed, provide a space of 30mm for both right-hand and left-hand ducts.
3. For the procedure for I/O unit replacement, refer to "How to Replace I/O units."

8.4 Processing of Wiring within Control Panels



NOTES:
1. For RUN output and CPU FAILURE output, a transistor output of 500mA max. is used. Connect the load across the common (+DC 24V) and RUN or FAILURE output terminal.
2. Formula for calculation of power supply output

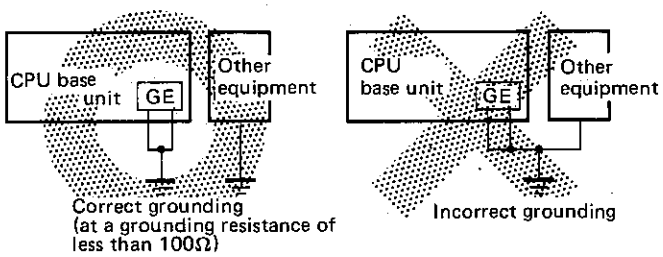
	CPU base unit current consumption (2,000mA)
	Output external supply current x No. of units
	Load current/unit x No. of units used
+	Input current/unit x No. of units used
	Total current output ☐ mA

3. Refer to Section 8.7 for the Hints on Use of the Externally Controlled I/O Relays.

- Power supply capacity
  The power consumption of the SYSMAC-M5R is less than 50VA. However, upon power application, inrush current of about 5 times the steady-state current will flow through the programmable controller. Take this point into account.
- As the power supply line of the SYSMAC-M5R, employ a wire of 2mm^2 min. so as to prevent voltage drop. (Use of twisted pair wires is recommended.)
- For general noise on the power supply line, the noise suppressing circuit in the SYSMAC-M5R is sufficient. However, supplying power through a transformer having a transformer voltage ratio of 1:1 will help reduce equipment-to-ground noise to a great extent and installation of such a transformer is recommended.
  Terminal G of the I/O unit is a ground terminal used for prevention of electric shock. Use an exclusive ground wire (having a conductor cross-sectional area of 2mm^2 min.) for grounding at a grounding resistance of less than 100Ω.

Terminal E is a noise filter neutral terminal and the grounding is not basically required. In case of a large noise which may cause an erroneous operation, E and G are short-circuited for exclusive grounding (at a grounding resistance of less than 100Ω).
Note that common use of the grounding line with other equipment or connecting to the beam of the building may adversely affect the system.
Keep the length of the ground wire within 20m. Care must be taken to the grounding resistance as it varies depending on the nature of ground, water content, season and the time elapsed after the underground laying of the ground wire.

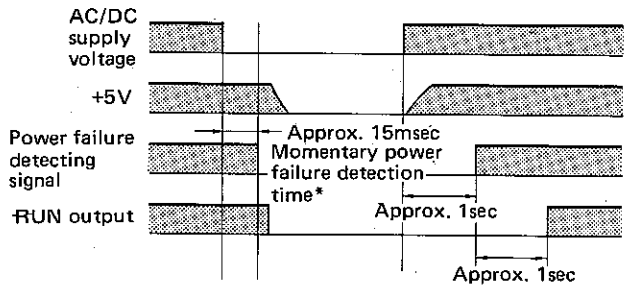
- Grounding with other equipment



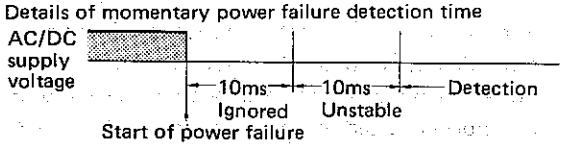
8.5 Operation at Power Failure

1. As the power supply of the SYSMAC-M5R, supply power within +10%, −15% of the supply voltage.
2. The power sequence circuit is incorporated in the power supply unit of the SYSMAC-M5R to prevent the programmable controller from malfunctioning due to a momentary power failure or a decrease in the supply voltage.
   a. Supply voltage drop
      If the supply voltage drops below its 85%, the operation of the SYSMAC-M5R stops, causing external output relays to turn off.
   b. Momentary power failure
      - CPU does not respond to a momentary power failure of less than 10msec, but continues its operation.
      - If a momentary power failure of 10msec to 20msec occurs, the power failure condition may or may not be detected by the programmable controller, since it is in an unstable area.
      - If the power failure is longer than 20msec, it is treated as a power failure, and the SYSMAC-M5R comes to a halt, resetting all output. In this case, the RUN output turns off.

CPU RUN/STOP Timing Chart



NOTE: Details of momentary power failure detection time

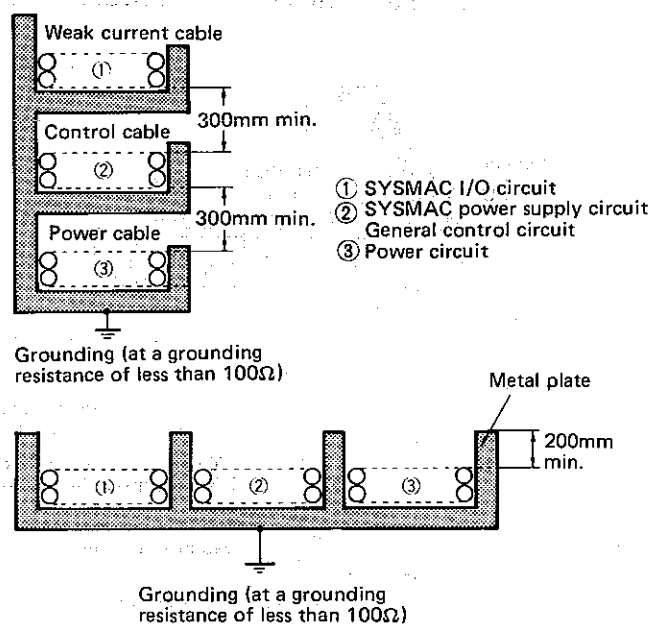


NOTE: * In case DC power is supplied by the battery, the momentary power failure detection time mentioned above will be longer.

   c. Automatic reset
      The SYSMAC-M5R will automatically resume its operation after the supply voltage (more than 85%) is restored.

8.6 External Wiring

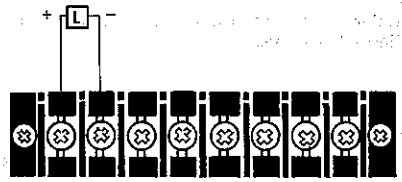
1. Be sure to process the input/output lines of the SYSMAC-M5R separately from other control lines. (Do not share the conductors of the I/O cable with others.)
2. To process the cables for the SYSMAC-M5R with power cables rated at 400V 10A max. or 220V 20A max.:
   a. Be sure to provide a minimum distance of 300mm between both cables when their racks are paralleled.
   b. Be sure to screen them with grounded metal plate when both cables are placed in the same duct at the termination process of the cable laying work.



8.7 Hints on Use of Externally Controlled I/O Relay

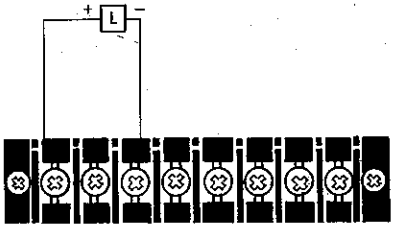
- **CPU failure output**
  This output is a transistor output which is activated (ON) when a CPU failure occurs while the CPU is in the RUN mode.

Switching capacity: DC 24V 50mA max.



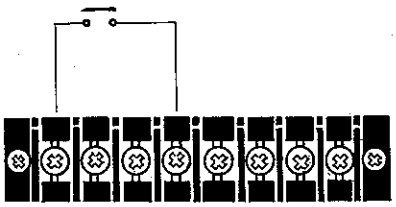
- **RUN output**
  This output is a transistor output which is activated (ON) while the CPU is in the RUN mode. The output, however, is inactivated (OFF) whenever one of the following conditions occur:
  (1) When a CPU failure occurs.
  (2) When a mode other than RUN is set.
  (3) When a momentary power failure occurs.
  (4) When the supply voltage drops below 85% of the rated voltage.
  (5) When the fuse in the CPU has blown out.

Switching capacity: DC 24V 50mA max.



- **OUTPUT INHIBIT input**

When the OUT INHIBIT input terminals are short-circuited (i.e., closed), the output relays release and when the input terminals are disconnected (i.e., open) the output relays operate.

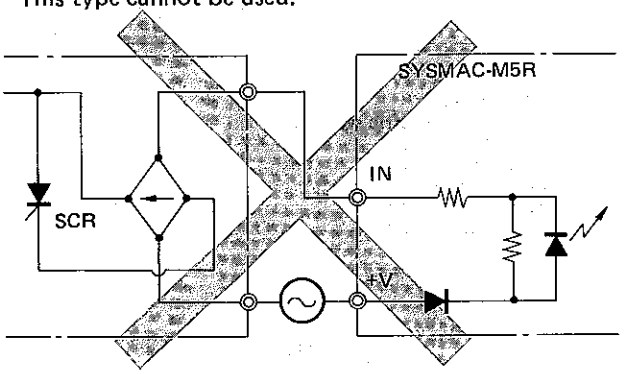


When contacts are open: All output relays are in the ON state.
When contacts are closed: All output relays are in the OFF state.

8.8 Interfacing Solid-state Input Devices

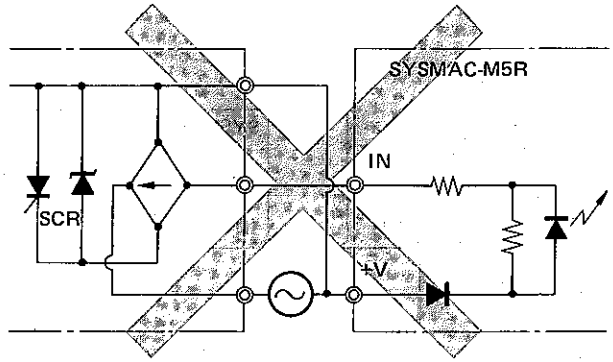
When using solid-state input devices, pay attention to the output forms of solid-state input sensors.
Examples of interfacing the I/O unit (SCYM5R-IO021 or -IO022) of the SYSMAC-M5R with OMRON proximity or photoelectric switches are shown below.

1. AC two-wire system type:
   This type cannot be used.



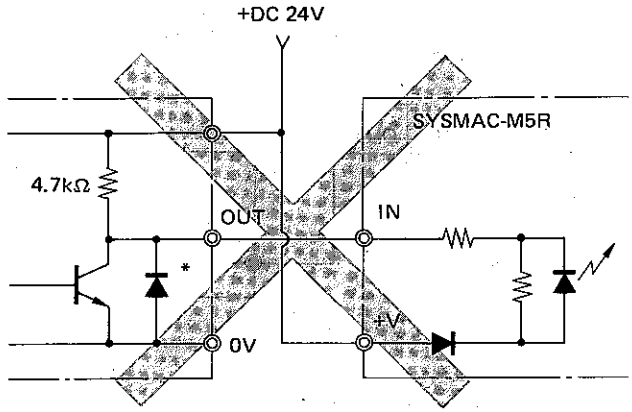
Models not applicable
- OMRON proximity switches
  - Type TL-XY(B)□(M) series
  - Type TL-YS(B)10R series
  - Type E2M-□Y□ series
  - Type E2K-C25MY□ series
  - Type TL-X□Y□-50 series
  - Model E2P series
  - Type TL-N(F)□MY□ series
  - Type TL-M□Y1 series
  - Type TL-X□Y□ series
  - Type TL-LY50

2. AC three-wire system type:
   This type cannot be used.



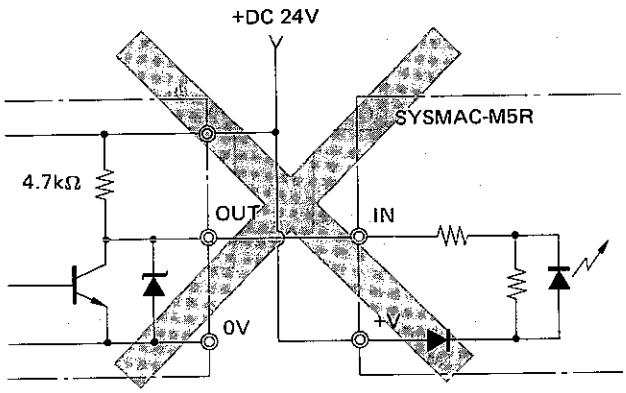
Models not applicable
- OMRON photoelectric switches
  - Type E3A-□Z□

3. NPN output type:
   This type cannot be used.



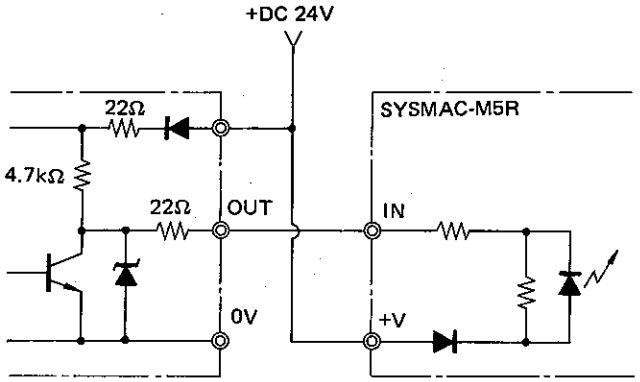
Models not applicable
- OMRON proximity switches
  - Type TL-X□(M) series
  - Type TL-G□/-Q□ series

NOTE: * Type TL-G□ is not equipped with a diode. Type TL-Q□ incorporates a capacitor (0.01μF) instead of a diode.

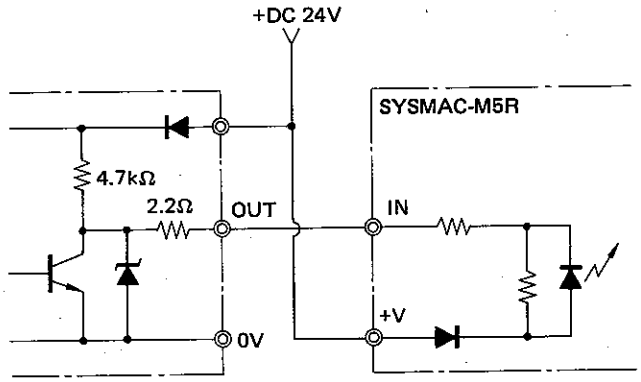


Models not applicable
- OMRON proximity switches
  - Type E2M-□□ series

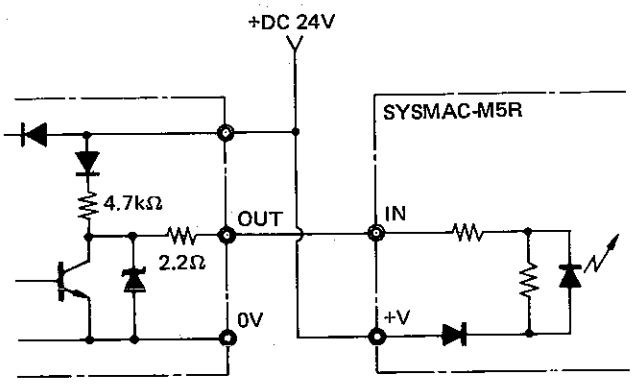
4. NPN output type:
This type can be used.



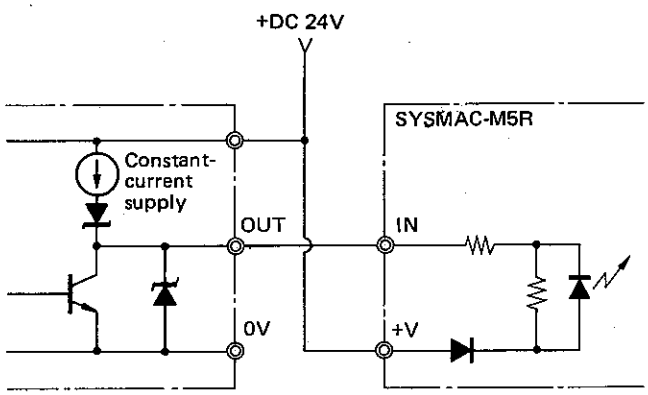
Applicable models
- OMRON proximity switches
  Type E2K-C25ME□ series



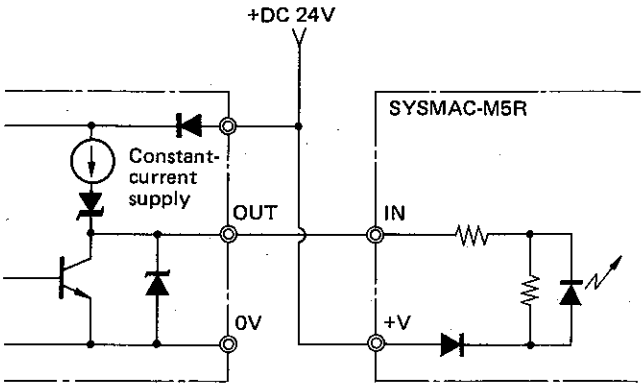
- OMRON proximity switches
  Type TL-N(F,H)□ME□ series
  (+V: DC 10 to 30V)



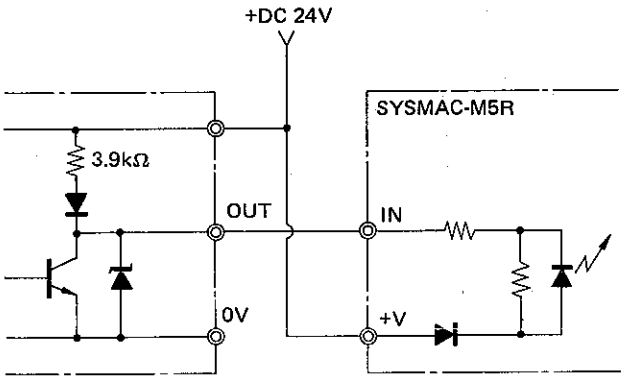
- OMRON proximity switches
  Type TL-M□E□ series



Applicable models
- OMRON proximity switches
  Type TL-X□E□ series

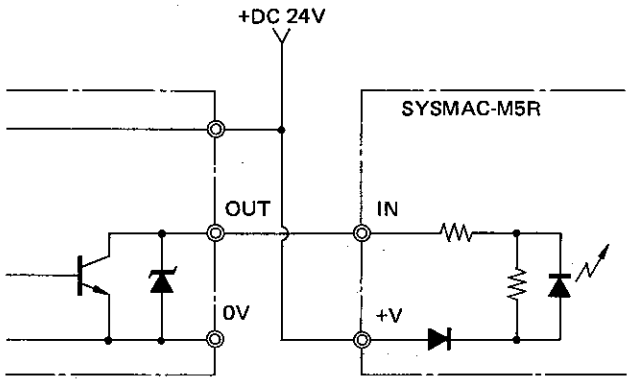


Applicable models
- OMRON photoelectric switches
  Model E3S series
  Model E3S-L series
  Model E3S-G series
  Model E3S-X series
  Model E3N series

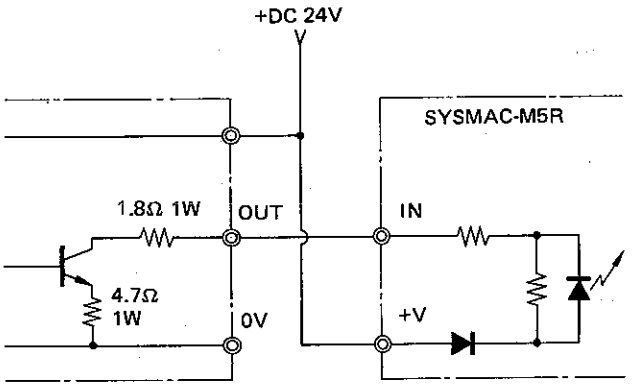


Applicable models
- OMRON photoelectric switches
  Type E3ML-□E4-G series

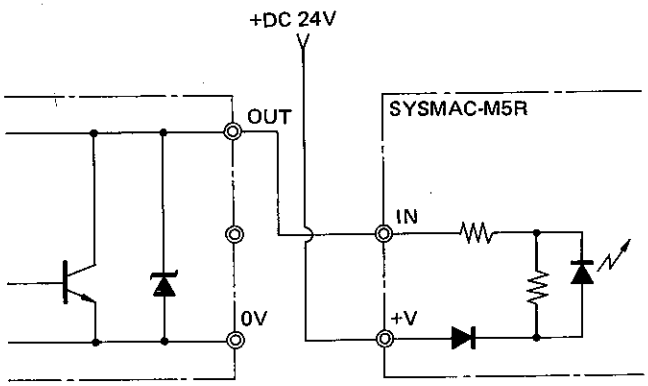
5. NPN open collector type:
   This type can be used.



Applicable models
- OMRON proximity switches
  Type TL-XP□ (M) series
  Type E2M-□P□ series

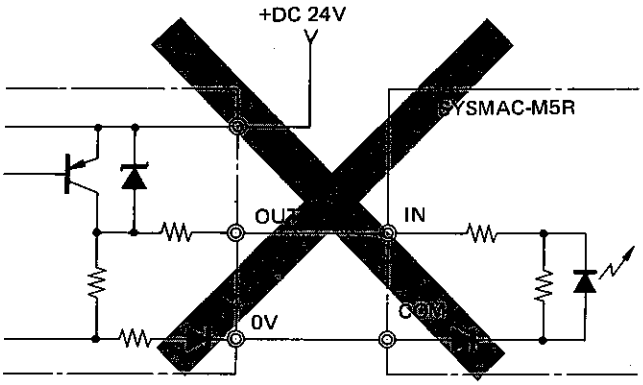


Applicable models
- OMRON proximity switches
  Type TL-LP50

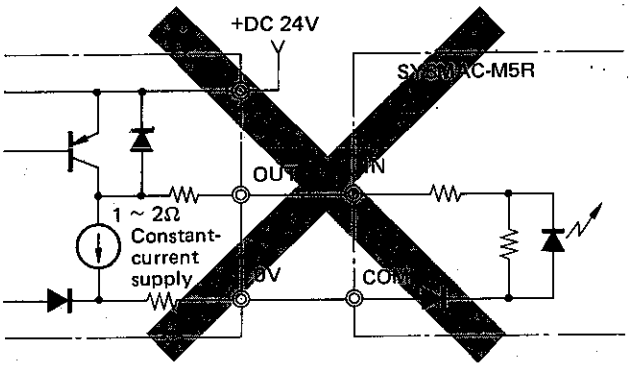


Applicable models
- OMRON photoelectric switches
  Type TL-XD series

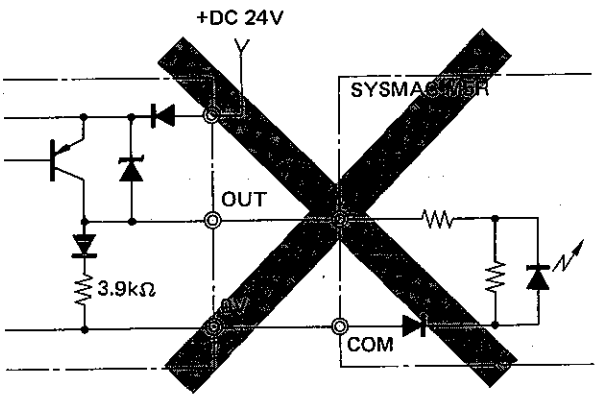
6. PNP output type:
   This type cannot be used.



Models not applicable
- OMRON proximity switches
  Type E2K-C25MF□ series

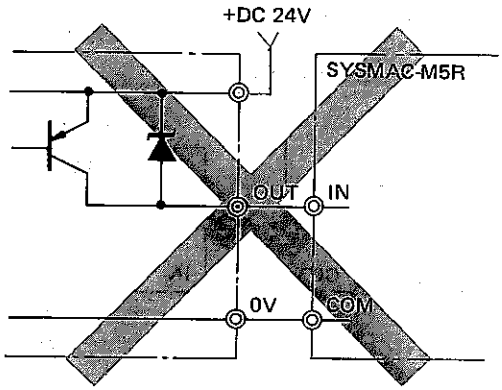


Models not applicable
- OMRON proximity switches
  Type TL-X□F□



Models not applicable
- OMRON photoelectric switches
  Type E3ML-□F4-G

7. PNP open collector type:
   This type cannot be used.

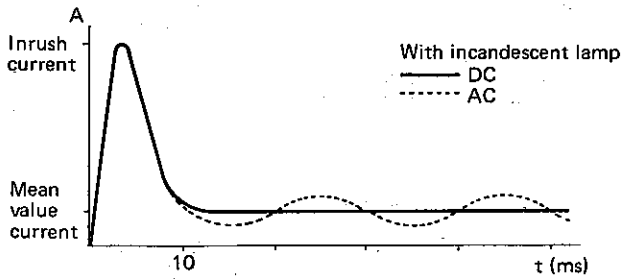


- OMRON proximity switches
  Type TL-XP□(M)P series

8.9 Hints on Use of Output Contact

■ Lamp load and inrush current

When a lamp is illuminated, a current 15 to 20 times the steady-state current flows into the lamp. In AC ratings, the steady-state current is indicated by a root mean square (rms) value. To figure out its peak value, I peak = $\sqrt{2}$ Irms should be taken into account.
With an AC lamp load, when an output unit with zero cross function is employed for switching the lamp load, the inrush current of the lamp load reduces to 1/2 to 1/3 of that when AC peak current is applied.

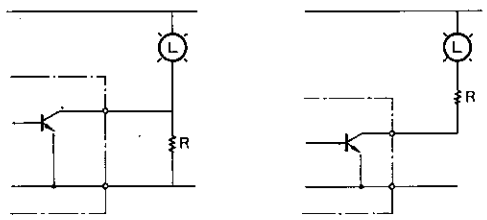


Maximum permissible lamp loads

Type		12V	24V	48V	100V	200V
IO021 IO022	DC	2.4W	4.8W	9.6W	–	–

■ How to reduce inrush current

When switching a lamp load greater than the specified ratings, the inrush current of the lamp load must be reduced by either of the following two methods.

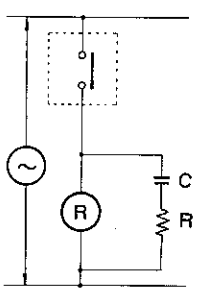


Bleeder method Limited resistance method

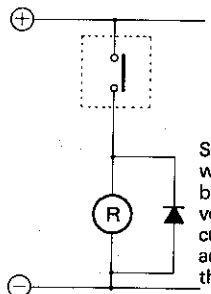
a. Bleeder method (i.e., to flow dark current by inserting a bleeder resistor)
   This method is not so effective for an output unit in which some leakage current is inevitable. For other output units, a bleeder resistor is inserted to cause a leakage current corresponding to 1/10 to 1/20 of the steady-state current to flow into the lamp load. As the result, these output units can be applied to the loads 50% larger than the maximum permissible lamp loads described above.
b. Limited resistance method (i.e., to insert a current-limiting resistor in series with lamp)
   In this method, the inrush current is limited by the current governed by resistor R. However, note that the greater the resistance value, the greater the current consumption by the resistor, which in turn reduces the voltage to be applied to the lamp.

■ Countermeasures against surges

The SYSMAC-M5R is provided with adequate measures to prevent the output unit from malfunctioning due to surging, for example, when switching a lamp load. However, take note that a surge voltage of several 1,000 volts may occur in electromagnetic switches, AC solenoids, etc.
For general-purpose relay such as OMRON Models MY and LY, no countermeasure against surges is required. For larger loads than these relays, the following countermeasures are recommended. It should be noted that when either of the countermeasures is provided, the release time of the relay will be delayed slightly.



AC power supply



DC power supply

Select a diode with the proper breakdown voltage and current ratings according to the load.

C: 0.5μF ±20% max. Non-polarity
   Breakdown voltage 1500V min.
R: 50Ω ±30% max. 0.5W

9. Maintenance and Inspection

To sustain the proper system operation at all times, it is necessary to inspect the SYSMAC-M5R daily. If any trouble occurs in the SYSMAC-M5R, how the system should be protected and how soon it can be recovered from the failure become important. In this chapter, the items to be inspected on the SYSMAC-M5R and the actions to be taken if the SYSMAC-M5R fails are described.

9.1 Inspection

To make the most of the functions of the SYSMAC-M5R under the best condition, it is necessary to inspect the SYSMAC-M5R daily or periodically.

■ INSPECTION ITEMS

The SYSMAC-M5R employs semi-conductors as its main component elements and has few or no supplies with a limited service life. However, the semi-conductors may deteriorate depending on the environmental conditions and must therefore be inspected periodically. The standard inspection cycle is 6 months to 1 year. According to the environmental conditions, it is recommended to advance the date of inspection. As a result of the daily or periodical inspection, if the SYSMAC-M5R is found to be outside the criteria in the following table, be sure to correct the SYSMAC-M5R so that it falls within the prescribed criteria.

No.	Inspection item	Particulars of inspection	Criteria
1	Power supply (a) Voltage (b) Fluctuation	(1) Is the rated voltage available when measured at power supply terminals of CPU base unit.	+10%, −15% of supply voltage
		(2) Does a momentary power failure occur frequently or is there any sharp rise or drop in the supply voltage?	The supply voltage must be within the permissible fluctuation range described above.
2	Environmental conditions (a) Ambient temperature (b) Humidity (c) Vibration (d) Dust, etc.	Are the temperature and humidity within the respective range? (When the SYSMAC-M5R is installed in a control panel, the temperature within the panel may be regarded as the ambient temperature of the programmable controller.)	(a) 0 to +50°C (b) 30 to 90% RH (c) Must be free from vibration. (d) Must be free from dust.
3	Power supply of I/O unit (a) Voltage (b) Fluctuation	Are the voltage and fluctuation within the operating range at power supply terminals?	Must conform with the specifications of I/O unit.
4	Mounting conditions	(1) Are the CPU base unit and expansion base unit secured firmly?	The mounting screws must not be loose.
		(2) Are each I/O units and interface unit fixed firmly?	Each expansion base unit and its interface unit must not be loose.
		(3) Is the I/O connecting cable inserted completely?	The connecting cables must not be loose.
		(4) Is there any loose screw in the external wiring?	The screw terminals must not be loose.
		(5) Is there any broken cable in the external wiring?	The external wiring must be free from any abnormalities in appearance.
5	Service life	Battery	2 years

CAUTION:
Be sure to turn off the power before replacing any unit of the SYSMAC-M5R.

■ NOTES ON INSPECTION

1. If a defective unit is discovered and replaced, confirm whether or not the replaced unit is abnormal.
2. In the event of a faulty contact of the cable, wipe the connector pins with a clean all-cotton cloth moistened with industrial alcohol. Be sure to plug in the flat cable connector after removing the cloth waste.

■ TOOLS AND TESTING EQUIPMENT REQUIRED FOR MAINTENANCE

In the maintenance of the SYSMAC-M5R, the following tools and testing equipment will facilitate the daily or periodic inspection of the programmable controller.

1. Tools and testing equipment recommended as mandatory equipment
   - Screwdrivers (Phillips and round-blade)
   - Tester or digital voltmeter
   - Industrial alcohol and all-cotton cloth
2. Measuring instruments recommended only if required.
   - Synchroscope
   - Pen-recording oscilloscope

■ MAINTENANCE PARTS

1. I/O unit
   If the SYSMAC-M5R fails, its repair is impossible without any spare parts no matter how early the trouble is discovered. So, it is recommended to have at least one I/O unit as a spare part.
2. Battery (Type SCY-BAT01)
   In general, the service life of a battery is regarded as the time when the capacity of the battery is reduced to 50% of its nominal capacity. The service life of a battery varies greatly depending on the ambient temperature of the battery, depth of discharging, discharge current, etc. With the SYSMAC-M5R, the life of the built-in battery is considered to be 2 years. Therefore, replace the battery with a new one every 2 years.
3. Fuse
   Main supply power fuse: Rated at 2A

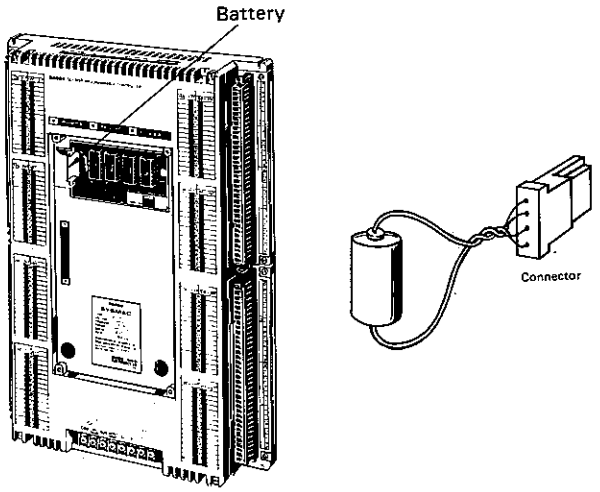
9.2 Replacement of Battery

Be sure to replace the battery within 5 minutes.

- **Procedure:**

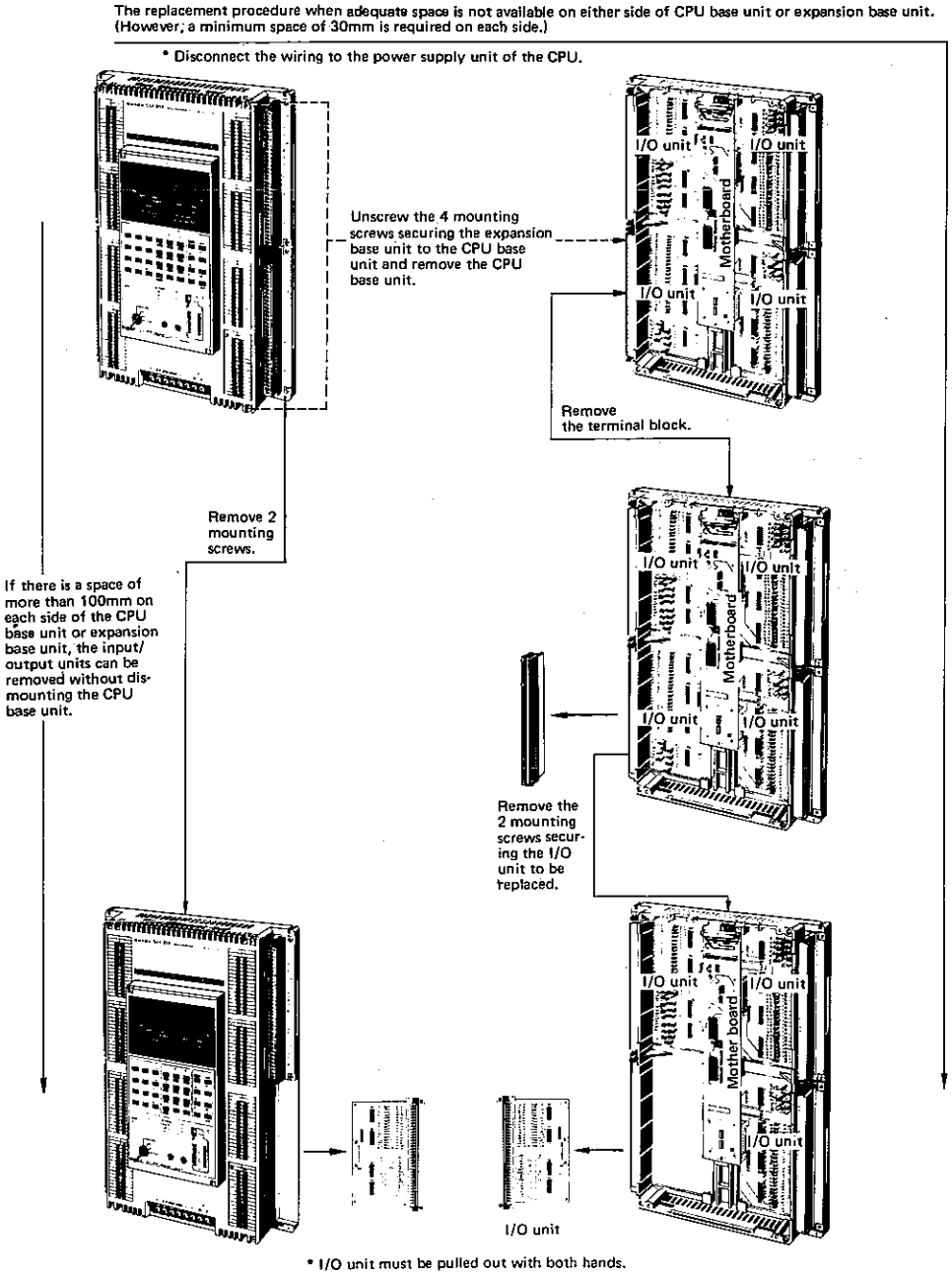
1. Prepare the replacement battery.
2. Turn off the main power supply.
3. Remove the program console from the CPU base unit.

NOTE: When the main power supply is not ON at the time of the battery replacement, first apply the main power supply for more than 10sec and then turn it off.



4. Remove the M3 screw securing the battery and unplug the battery connector.
5. Plug in the connector of the new battery, and then secure the new battery with the M3 screw.
6. Return the program console to its original position and secure it with the screws.
7. When the main power supply is applied, the battery starts operating.

9.3 How to Replace I/O Units



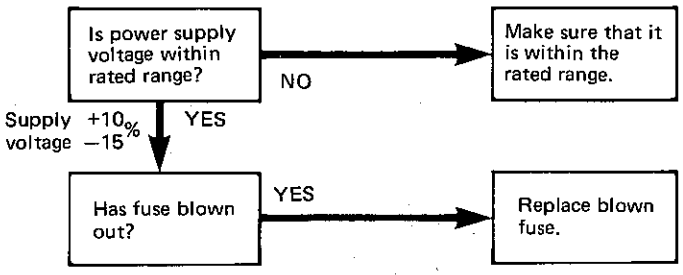
9.4 Troubleshooting

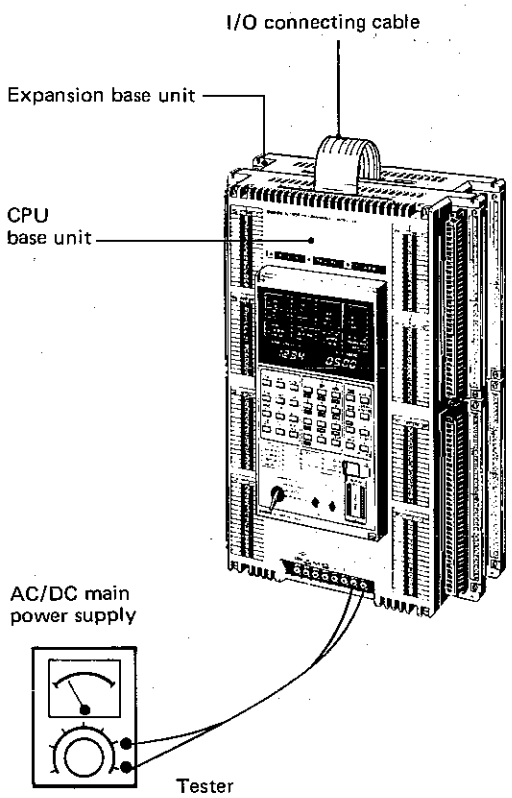
If any abnormality occurs in the SYSMAC-M5R, thoroughly grasp the condition of trouble, check whether the symptom is reproducible or is caused through relationship with other equipment, and then follow the troubleshooting flowcharts shown below.

■ POWER SUPPLY

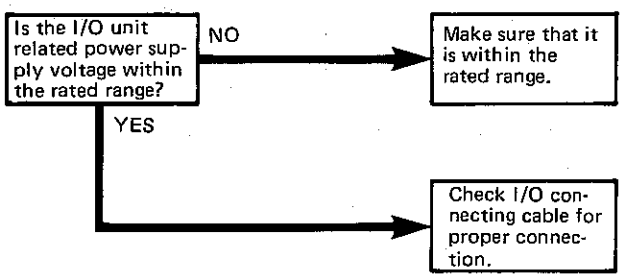
Power supply → Input/output → Terminal → CPU base unit → External environments

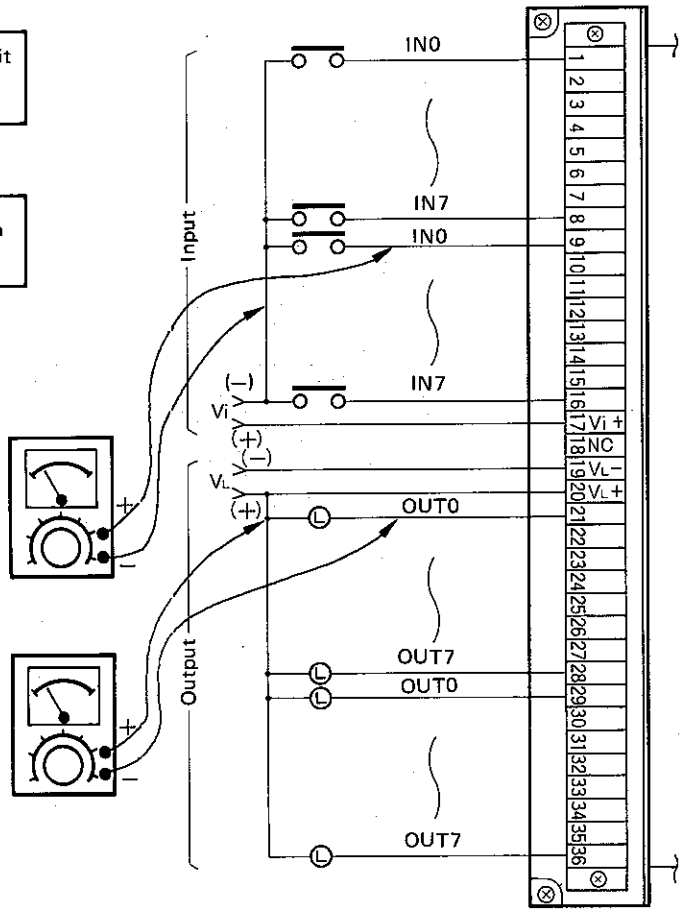
1. Main power supply check
   In this check, the power being supplied to the SYSMAC-M5R is confirmed if it is within the rated range (+10%, −15% of rated voltage).





2. I/O unit related power supply check
   The power supply for loads is connected to the terminals of each I/O unit. Should any abnormality occur in this power supply, I/O devices will not operate.



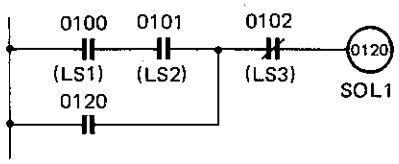


■ INPUT/OUTPUT UNIT

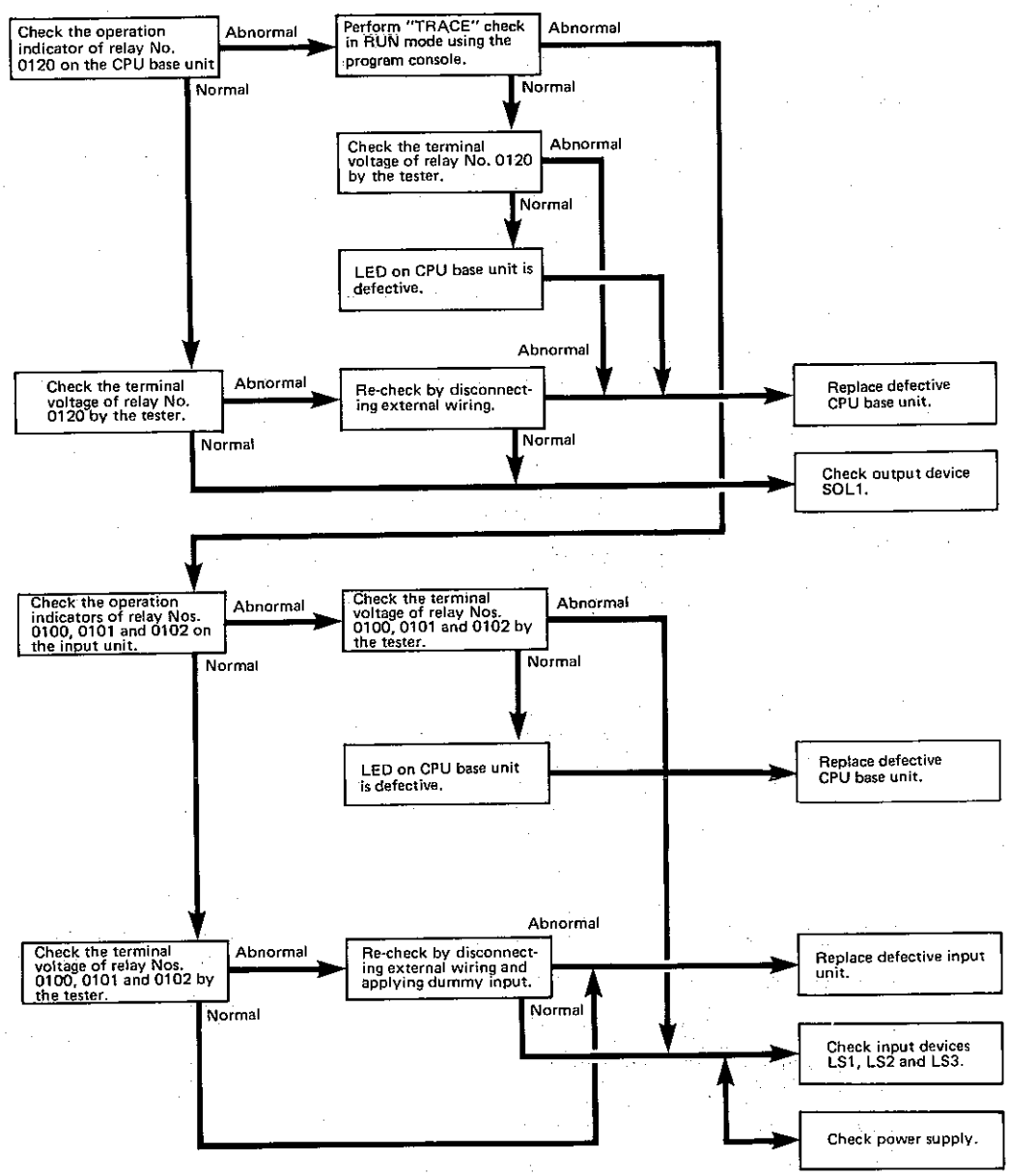
Power supply → Input/output → Terminal → CPU base unit → External environments

The following flowchart is indicated on the assumption that the maintenance spare parts are provided. If no spare part is provided, first check I/O devices thoroughly. The flowchart is illustrated based upon the circuit example shown below.

Circuit example



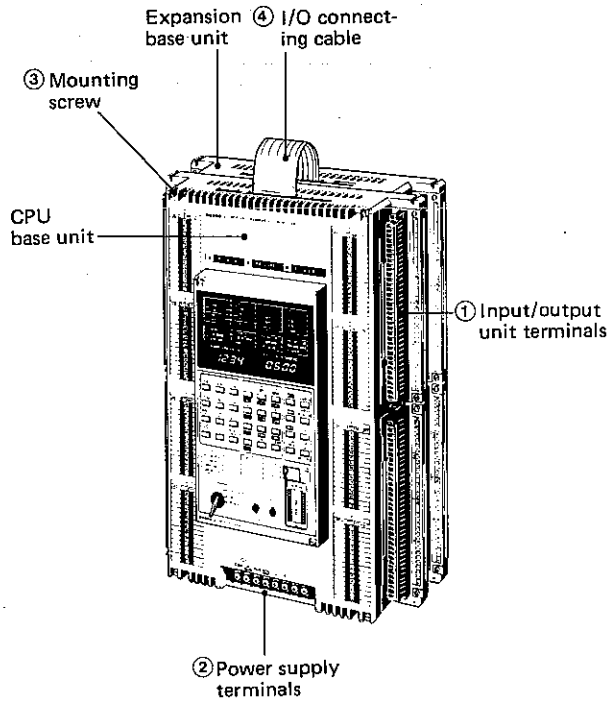
SOL1 malfunctions!!



■ TERMINALS

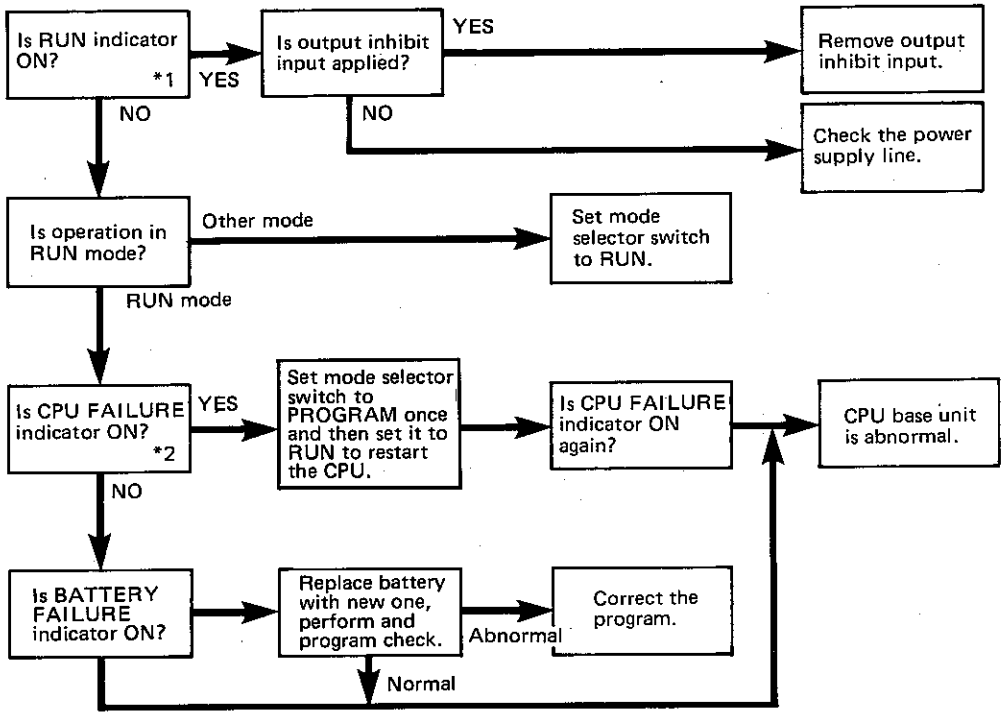
Power supply → Input/output → Terminal → CPU base unit → External environments

① Check each I/O unit for loose terminals.
② Check the power supply terminals for loose connection.
③ Check each unit for loose mounting screws.
④ Check the I/O connecting cable for proper mounting.



■ CPU BASE UNIT

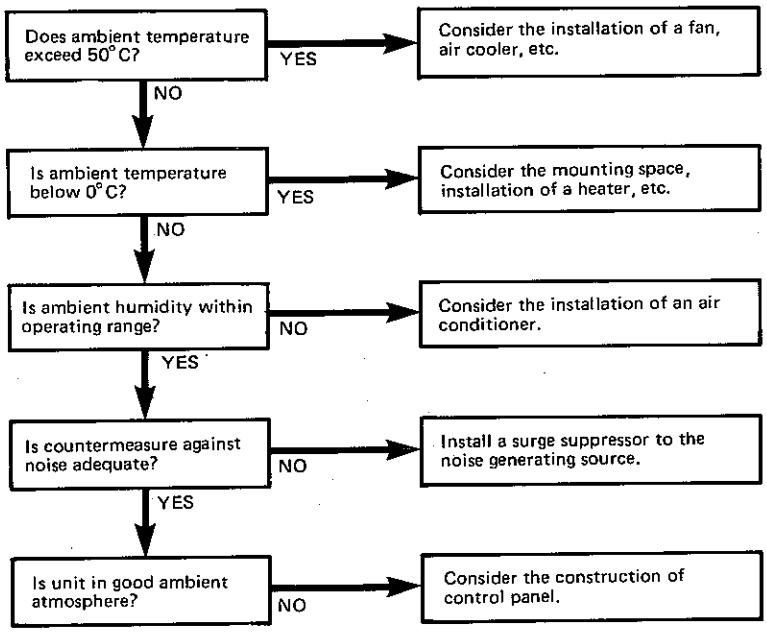
Power supply — Input/ output — Terminal — CPU base unit — External environments



NOTES: *1. When the supply voltage drops below 85% of the rated voltage, the SYSMAC-M5R detects the condition as a power failure. Even if a momentary power failure occurs but it is restored within 10msec, the SYSMAC-M5R ignores the power failure and continues operating.
If a momentary power failure continues for more than 20msec, SYSMAC-M5R detects the condition as a power failure and resets its operation.
If a momentary power failure of 10msec to 20msec occurs which is in an unstable area, the SYSMAC-M5R may continue or reset its operation.
Once the power failure is detected, even if the power supply is returned to normal; it takes about 1sec for the SYSMAC-M5R to reset. During this time, the RUN output of externally controlled relay is in the OFF state. Therefore, all outputs from the I/O units also turn OFF. The RUN output turns OFF when a CPU failure (watchdog timer) occurs. Should the RUN output be used in an emergency stop circuit, note the entire system operation may stop. So pay attention to the service life and contact ratings of this output relay.

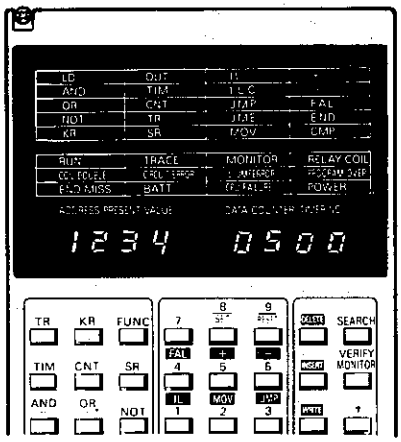
*2. How to recover from CPU FAILURE (watchdog timer)
Restart the SYSMAC-M5R by changing the mode selector switch position from "RUN" to "PROGRAM" and then to "RUN" again.
NOTES:
1. If any abnormality still exists in the CPU base unit, the CPU FAILURE indicator illuminates again.
2. The CPU FAILURE relay operates by depressing the CLEAR key or CLEAR DISPLAY key.

■ EXTERNAL ENVIRONMENT



9.5 List of Error Messages

An error message appears in the DATA display as shown on the right.



■ LIST OF ERROR MESSAGES

- The following error messages indicate the failure conditions occurred in the RUN mode.

NOTES:
1. The BATTERY FAILURE indicator will illuminate to alert the operator one week before the battery will be exhausted.
2. The buzzer will sound for about 1sec.
3. If the buzzer still sounds even after completion of the "Remedy" described in the above table, consult OMRON.

Item / Symptom		CPU base unit						
		RUN indicator	FAILURE indicator	Externally controlled I/O relay: RUN output	Externally controlled I/O relay: CPU FAILURE output	Special auxiliary relay No. 1374	Output indicator	Remedy
Power supply	Momentary power failure	OFF	–	OFF	–	–	OFF	–
	Voltage drop	OFF	–	OFF	–	–	OFF	–
	Fuse in CPU base unit has blown.	OFF	–	OFF	–	–	OFF	Replace the 2A fuse in the fuse holder on the rear of the CPU base unit. Then apply the power again.
RUN mode → Other mode (Mode selector switch)		OFF	–	OFF	–	–	–	–
CPU FAILURE (Watchdog timer)		OFF	ON*	OFF	ON	–	–	Check if the connector is not loose or is inserted incorrectly. Reconnect the connector and apply the power again.
BATTERY FAILURE		–	ON*	–	–	ON	–	Replace the battery within a week.

NOTE: * When the "FAILURE" indicator on the CPU base unit illuminates, confirm whether the failure is a CPU failure or Battery failure by the CPU FAILURE or BATT. indicator on the program console connected to the SYSMAC-M5R.

9.6 Abnormal Symptom, Possible Cause and Corrective Action

- **CPU base unit**

No.	Abnormal symptom	Possible cause	Corrective action	Remarks
1	Fuse blows repeatedly.	Pattern is short-circuited or damaged by burning.	Replace CPU base unit.	Check the DC 5V wiring for I/O unit.
2	DC voltage output failure	Constant voltage circuit is defective.	Replace CPU base unit.	—
3	"RUN output" contact of externally controlled I/O relay does not release. (RUN indicator ON)	(1) Control I/O relay or power circuit is defective.	Replace CPU base unit.	—
4	RUN indicator does not illuminate.	(1) DC voltage is not supplied. (2) Programming error (END instruction is missing.)	Replace CPU base unit. Correct program.	—
5	I/O indicators do not illuminate.	LEDs are defective.	Replace CPU base unit.	—

- **Expansion base unit**

No.	Abnormal symptom	Possible cause	Corrective action
1	Operation is not executed after specific relay No.	(1) Pattern is broken.	Check each bus line by buzzer.
		(2) Improper soldering	Resolder.
2	Abnormal relay Nos. of expansion base unit are in units of 8.	(1) Cable wiring is broken.	Check each bus line by buzzer.
		(2) Improper soldering	Resolder.
3	Output of a specific relay No. turns on.	(1) Improper soldering of connector	Check each bus line by buzzer.
4	All the relays of a specific I/O unit do not operate.	(1) Same as above	Check each bus line by buzzer.

- **Input units**

No.	Abnormal symptom	Possible cause	Corrective action
1	All input units do not turn on.	• Operation indicators (LEDs) are not illuminating. (1) External input voltage is not supplied or is low.	Supply the power. Raise the supply voltage.
		• Operation indicators (LEDs) are illuminating. (1) Signal level within unit is faulty.	Remove all the I/O units being used and insert them one by one to find the defective unit.
2	All of specific input units do not turn on. (Example) 0010 ~ 0017	(1) Same as above	Same as above Replace defective input unit.
		(2) Screws of terminal block are loose.	Retighten terminal screws.
3	All of specific input units do not turn off.	(1) Gate circuit is defective.	Replace defective input unit.
		(2) External voltage is not supplied.	Apply the external power supply.
4	Input of a specific relay No. does not turn on. (Example) 0010	(1) Gate circuit is defective.	Replace defective input unit.
		(2) Screws of terminal block are loose.	Retighten screw terminals.
		(3) ON time duration of external input is short.	Adjust external device.
		(4) Input circuit (photocoupler, etc.) is defective.	Replace defective input unit.
		(5) Input relay No. is incorrectly assigned to the OUT instruction of the program.	Correct the program.
5	Input of a specific relay No. does not turn off.	(1) Contact of jack is defective.	Clean the contact part with alcohol-moistened cloth.
		(2) Input circuit is defective.	Replace defective unit.
		(3) Input relay No. is incorrectly assigned to the OUT instruction of the program.	Correct the program.
6	Relay No. of abnormal operation is in units of 8. (Example) 0000, 0010, 0020	(1) Data bus signal is faulty.	Remove all I/O units being used and insert them one by one to find the defective unit.
		(2) IC-RAM of CPU is defective.	Replace CPU base unit.
7	Inputs turn ON and OFF irregularly.	(1) External input voltage is low.	Raise the external voltage.
		(2) Malfunction due to noise	Countermeasures against noise. • Install a surge suppressor. • Install an insulating transformer. • Wiring with a shielded cable
8	Input operation indicator does not illuminate. (Operation is normal.)	(1) LED indicator is defective.	Since this type of defect does not impede normal operation, repair it in spare time or at the next periodic inspection.

- **Output units**

No.	Abnormal symptom	Possible cause	Corrective action
1	All output units do not turn on.	(1) Load power supply is not applied.	Apply the load power supply. (Raise the voltage.)
		(2) Signal level within unit is defective.	Remove all the I/O units being used and insert them one by one to find the defect unit.
2	All of specific output units do not turn on. (Example) 0020 ~ 0027	(1) Same as 1 (1).	Same as above
		(2) Screws of terminal block are loose.	Retighten screw terminals.
		(3) Contact of jack is defective.	Clean the contact with alcohol-moistened cloth.
		(4) Fuse is blown.	Replace defective fuse.
		(5) Internal circuit is defective.	Replace defective unit.
3	All of specific output units do not turn off.	(1) Contact of jack and connector is defective.	Clean with alcohol-moistened cloth.
		(2) Gate circuit is defective.	Replace defective unit.
4	Output of a specific relay No. does not turn on.	• Operation indicator (LED) is not illuminating. (1) ON time duration of output is short. (2) Relay Nos. of the OUT instruction in the program are in duplication. (3) Power circuit is defective.	 Correct the program. Correct the program. Replace defective unit.
		• Operation indicator (LED) is illuminating. (1) Broken connection of external load (2) Screws of terminal block are loose. (3) Pattern is broken.	 Replace defective external load. Retighten screw terminals. Replace defective unit.
5	Output of specific relay No. does not turn off.	• Operation indicator (LED) is not illuminating. (1) Improper reset due to leakage current or saturation voltage.	Replace defective external load or add a dummy resistor.
		• Operation indicator (LED) is not illuminating. (1) Contact of jack is defective (bus line). (2) Relay Nos. of OUT instruction in the program are in duplication. (3) Power circuit is defective.	 Clean with alcohol-moistened cloth. Correct the program. Replace defective unit.
6	Relay No. of abnormal operation is in units of 8. (Example) 0020, 0030	(1) Data bus signal is faulty.	Remove all the I/O units being used and insert them one by one to find the defective unit.
		(2) IC-RAM of CPU is defective.	Replace CPU base unit.
7	Outputs turn on and off irregularly.	(1) Supply voltage of external load is low.	Raise the external supply voltage.
		(2) Relay Nos. of OUT instruction in the program are in duplication.	Correct the program.
		(3) Malfunction due to noise	Countermeasures against noise • Install a surge suppressor. • Install an insulating transformer. • Wiring with a shielded cable, etc.