E5M Temperature Controller

Operation Manual

Produced June 1997

Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to head precautions can result in injury to people or damage to the product.

DANGER! Indicates information that, if not heeded, is likely to result in loss of life or serious injury.

WARNING Indicates information that, if not heeded, could possibly result in loss of life or serious injury.

Caution Indicates information that, if not heeded, could result in relative serious or minor injury, damage to the product, or faulty operation.

OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “PC” means Programmable Controller and is not used as an abbreviation for anything else.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1, 2, 3... 1. Indicates lists of one sort or another, such as procedures, checklists, etc.

TABLE OF CONTENTS

About this Manual:

Section 1 explains the features of the E5M Temperature Controller, how it can be configured into various systems, and handling precautions that should be followed.

Section 2 gives details on the E5M components that can be used in a temperature control system. Each component is described individually, including the Temperature Control Master/Slave units, Programming Console, Display, and Memory Units. The terminals and their functions are described in the last section.

Section 3 describes the modes of operation for the different components available for an E5M Temperature Control System. The specifications are given for each Unit depending on the type communications methods they employ. Operation examples are given in *Section 3-3*. The process for autotuning from the Programming Console is detailed, and an explanation of the Error Display is given.

Section 4 explains the Host Link communications for RS-232C and RS-422, and SYSMAC BUS systems. It also gives details for the entire range of commands and responses which are available for programming and error checking. An error checklist is provided for trouble shooting communications problems.

Section 5 details the procedures for installation of the E5M Temperature Controller, and how to connect it. The information includes directions on how to connect several Units into the same system. The dimensions of the different components are also given.

Appendix A provides details on the standard controller models and the optional system components.

Appendix B lists the common specifications for the system components, as well as specifications and performance characteristics for the Temperature Control Unit.

SECTION 1
Introduction

1-1 Features

Flexible Assembly

The E5M Temperature Control System permits flexible assembly of its four main component parts – Temperature Controllers (Master/Slave), Programming Consoles, Displays, and Memory Units – to suit the particular conditions of each application.

Host Computer Interface

When connected to a host computer or Programmable Controller by means of a communications link (RS-232C, RS-422 or SYSMAC BUS), coordination of a multiple E5M system is possible. Temperature control (1 group = 80) can thus be greatly increased, and simultaneous setting of data values and centralized data management easily performed.

Memory Function

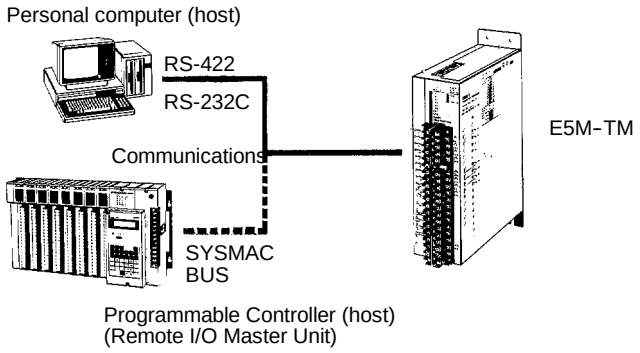
The Memory Unit component of the E5M Temperature Control System permits the storing in memory of all data values. It is possible to change data values to meet the requirements of different stages of a manufacturing process without any loss of data input, and to recall previous data input at a later point.

1-2 Configuration

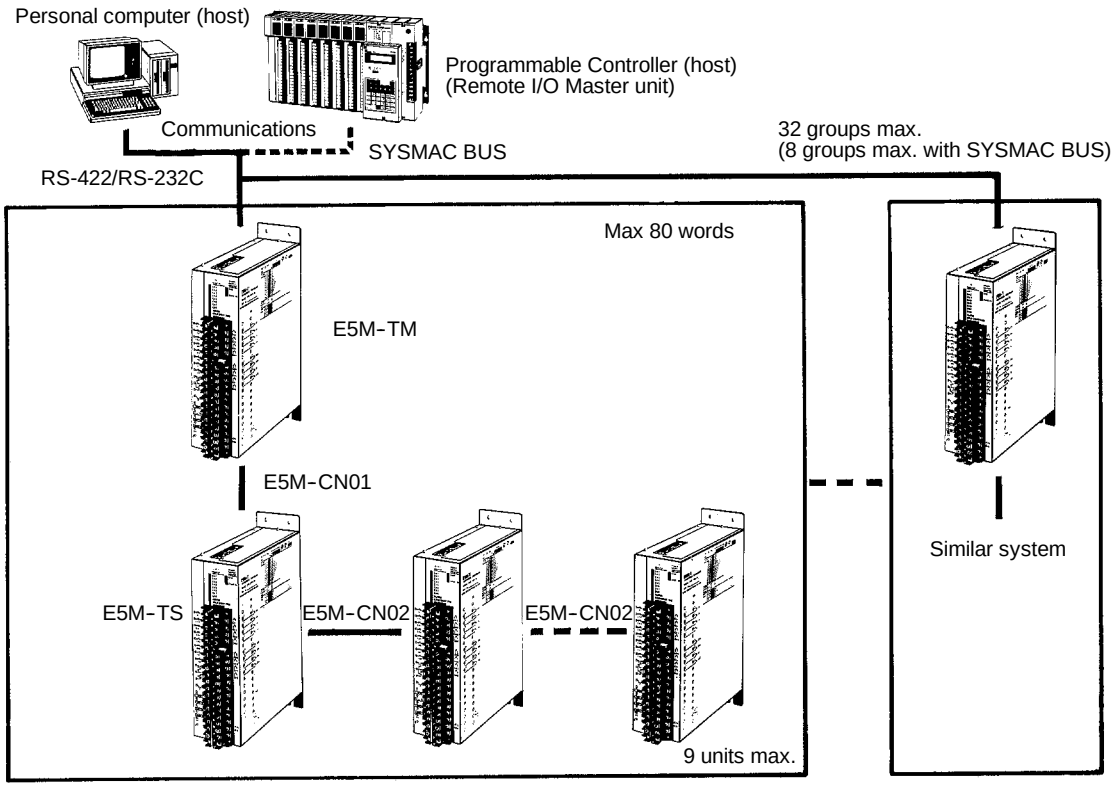
There are two types of E5M system configuration, depending on whether the Temperature Controller Master Unit (E5M-TM) or the Programming Console (E5M-SD) is employed as the system centerpiece. A personal computer (host) can be connected via an RS-232C or RS-422 interface, or a Programmable Controller (host) an be connected via SYSMAC BUS. Only one of these may be connected at one time.

1-2-1 Temperature Controller Master Unit System

Basic System



Expanded System

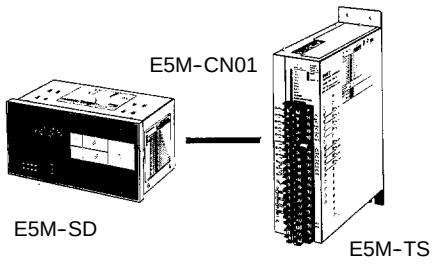


Note The E5M-CN01 connector is used solely for linking the Temperature Controller Master Unit (E5M-TM) to a Temperature Controller Slave Unit (E5M-TS). The E5M-CN02 connector is used solely for linking Slave Units.

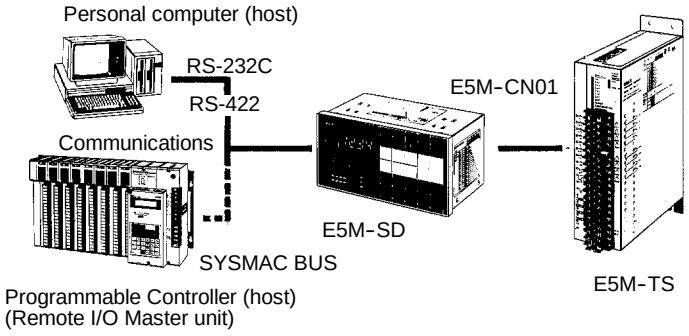
1-2-2 Programming Console Systems

Basic System

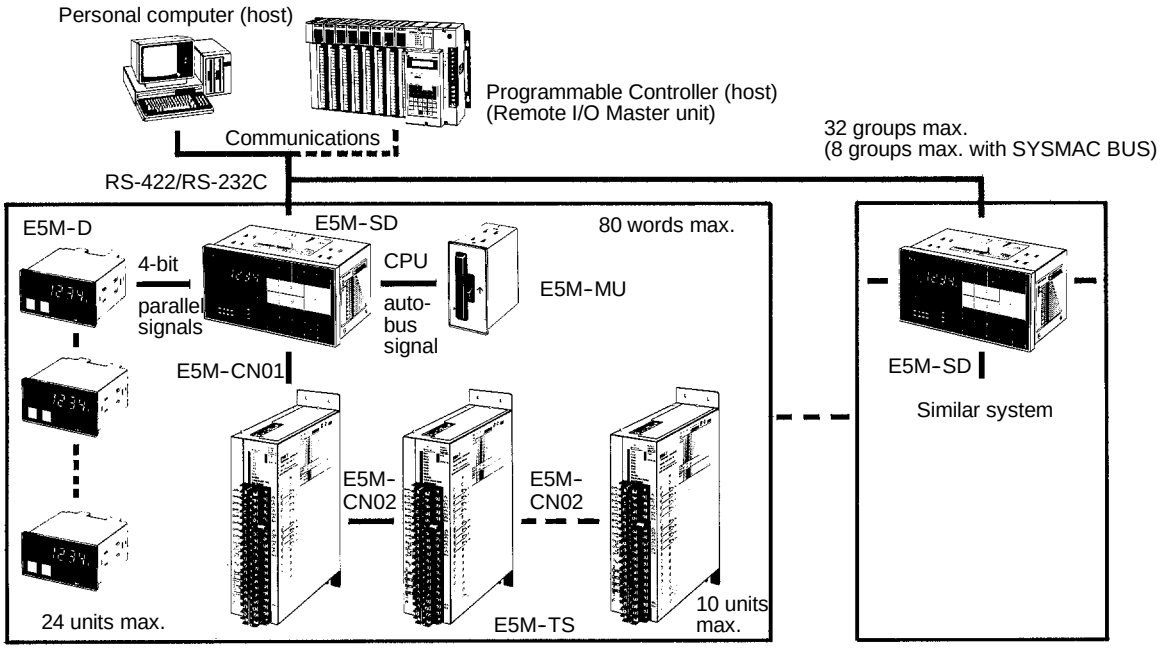
No Communications with Host



Communications with Host



Expanded System



1-2-3 Communications with Host Systems

For more information, see the section *Host Link Communications* of this manual.

Communications Methods

Three methods – RS-232C, RS-422, and Optical SYSMAC BUS – are possible. Select any one of the corresponding communications units. Using SYSMAC BUS, connection to the Remote I/O Master Unit of an OMRON SYSMAC C-series Programmable Controller is possible via optical fiber cable.

System Expansion

The maximum number of channels possible is limited by the number of Masters, 32, when using an RS-232C or RS-422 interface, or the number of groups, 8, when using the SYSMAC BUS. Additional Temperature Controller Master Units (E5M-TM) or Programming Consoles (E5M-SD) are required when expanding.

a) RS-232C, RS-422
A maximum of 80 Ch X 32 Masters = 2,560 channels

b) SYSMAC BUS
A maximum of 80 Ch X 8 groups = 640 channels

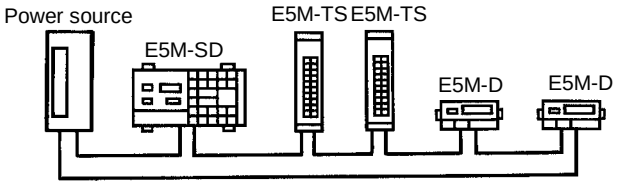
1-3 Handling Precautions

Operational Points

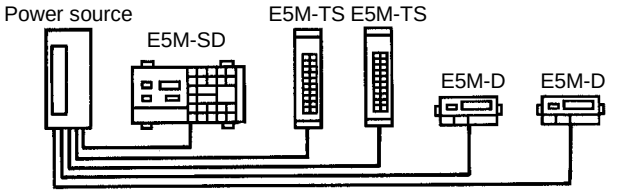
- Except for the E5M-MU, E5M system components require both a 24 V and a 5 V power supply. When large numbers of units are to be started simultaneously, be sure to provide a power supply having a capacity of 1.5 to 2 times the stable current.
- Since a 5 V power source has low voltage, the influence of wiring resistance is large. Be sure to measure the terminal area of each E5M unit and adjust the actual voltage to within 5 V + 5%.

For wiring of the E5M system, use one of the following methods.

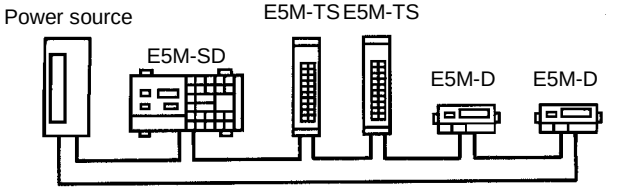
1. Hook up to the power source from the end of the power source wire.



2. Octopus-leg wiring



3. Use of a remote terminal attachment power source (not shown)



- To keep the communications cables and sensor wires used among the E5M units free from interference due to noise or induction, place them as far as possible from power lines and cable lines.
- Always set the DIP switches before operation. E5M models are designed to operate in a system, and therefore will not operate properly until the initial settings are made.
- The reset input for the E5M is used for initializing communications. Output remains OFF for several seconds when resetting, but there is no effect on temperature control while the reset input is ON. When the E5M-TS is turned on after the E5M-SD/TM, a communication error will occur. Clear the error before proceeding.
- Power is to be turned on in the order of E5M-TS followed by E5M-SD or E5M-TM; this should be done either simultaneously or sequentially. There is no sequence for turning on the power for E5M-D. The 24 V and 5 V power supplies may be turned on either simultaneously or in the order of 24 V followed by 5 V.
- Heat in the terminal area of E5M Units can cause errors between channels. To prevent heat build-up in the terminal area, install a fan and place the connectors above the terminal area.

Installation Environment

- Do not use in areas where corrosive gases (especially sulphuric or ammonia gases) are emitted.

- Do not use in places subject to severe vibration or shock, or in places with excessive humidity or dust.
- Set up as far removed as possible from strong high-frequency electromagnetic sources, such as high-frequency welders and sewing machines.
- Avoid installation in areas subject to major swings in ambient temperature or in places receiving heat projected from furnaces. Install in areas within a temperature range of -10% to +55%C.

Recommended Power Supply

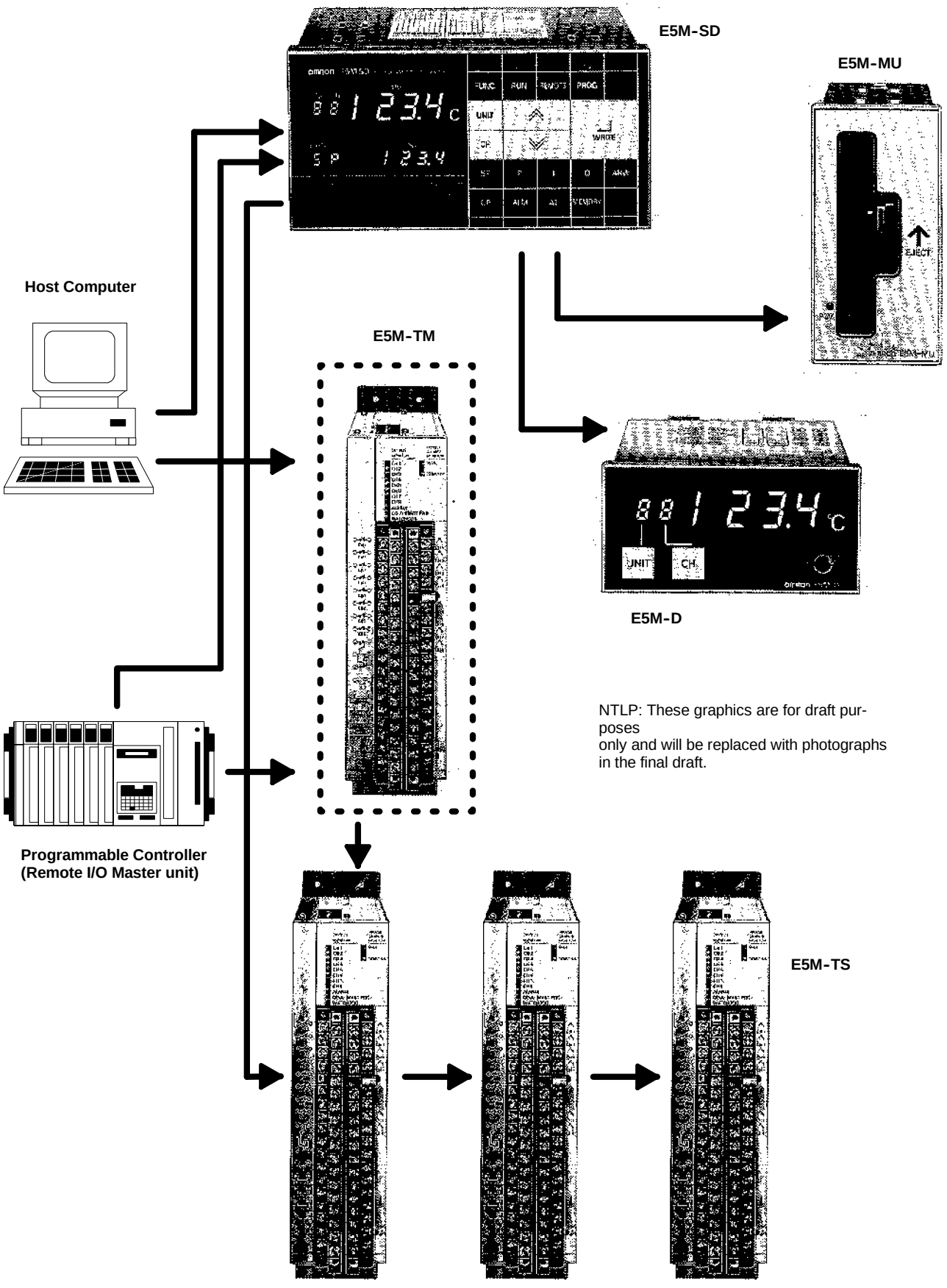
Since a surge current flows into the E5M, use a power supply with a capacity twice the stable current.

OMRON S82J Series

Input voltage	Capacity	Output voltage/current				Open	With cover
		5 V	12 V	15 V	24 V	Model	Model
100 V	10 W	2 A	---	---	---	S82J-0105	S82J-5105
		---	1 A	---	---	S82J-0112	S82J-5112
		---	---	0.7 A		S82J-0115	S82J-5115
		---	---	---	0.5 A	S82J-0124	S82J-5124
	25 W	5 A	---	---	---	S82J-0205	S82J-5205
		---	2.1 A	---	---	S82J-0212	S82J-5212
		---	---	1.7 A	---	S82J-0215	S82J-5215
		---	---	---	1.1 A	S82J-0224	S82J-5224
	50 W	10 A	---	---	---	S82J-0505	S82J-5505
		---	4.2 A	---	---	S82J-0512	S82J-5512
		---	---	---	2.1 A	S82J-0524	S82J-5524
200 V	10 W	2 A	---	---	---	S82J-2105	S82J-6105
		---	1 A	---	---	S82J-2112	S82J-6112
		---	---	0.7 A	---	S82J-2115	S82J-6115
		---	---	---	0.5 A	S82J-2124	S82J-6124
	25 W	5 A	---	---	---	S82J-2205	S82J-6205
		---	2.1 A	---	---	S82J-2212	S82J-6212
		---	---	1.7 A	---	S82J-2215	S82J-6215
		---	---	---	1.1 A	S82J-2224	S82J-6224
	50 W	10 A	---	---	---	S82J-2505	S82J-6505
		---	4.2 A	---	---	S82J-2512	S82J-6512
		---	---	---	2.1 A	S82J-2524	S82J-6524

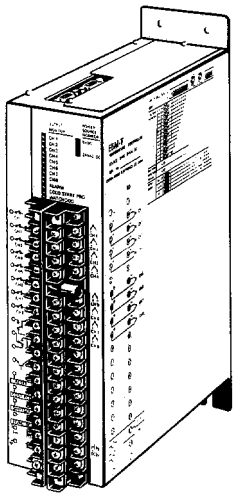
SECTION 2
Components and Settings

2-1 Components



2-2 Component Functions

2-2-1 Temperature Controller Master/Slave (E5M-TM/TS)



There are two types of Temperature Controller: Master (E5M-TM) and Slave (E5M-TS). Each can conduct temperature control for 8 channels.

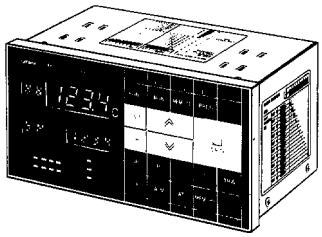
Up to nine Slaves can be connected to the Master so that an 80-channel system can be constructed. Slaves can also be connected to the Programming Console. Should a larger number of channels be required, the system can be expanded to a maximum of 2560 channels with the use of a personal computer.

The Master can be connected to a host computer by means of a communications link (RS-232, RS-422; SYSMAC BUS). Either type of host computer communications may be used.

A solid−state sensor input employing an analog multiplexer has been adopted to achieve a high degree of reliability. Either thermocouple or platinum thermometer sensors may be selected.

A unique algorithm has been incorporated to auto-tune the heat interference system.

2-2-2 Programming Console (E5M-SD)



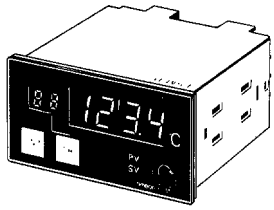
The Programming Console can be used for either the setting of Temperature Controller parameters or for the monitoring of data.

By connecting an E5M-TS to the Programming Console, a local 8-channel temperature control system is formed. Up to 10 such Slaves may be connected, allowing expansion to an 80-channel system.

In addition to digital setting using **UP/DOWN** keys, setting is possible by means of communications from a host computer via remote mode. In the latter case, a personal computer can be connected by RS232C or RS422, or an OMRON Programmable Controller (Sysmac C Series) can be connected by SYSMAC BUS (fiber optic cable). Temperature setting, PID, and other parameters can be set on the front panel.

The Display Unit (E5M-D) and Memory Unit (E5M-MU) can be connected as accessories.

2-2-3 Display (E5M-D)

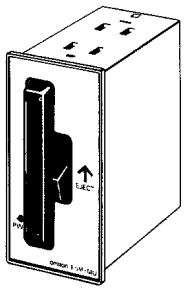


When connected to the E5M-SD, this device operates as a temperature monitor for discrete channels. It can also display error messages by means of data transmission from the Programming Console.

If the Setting Display Unit signals are amplified, it is possible to have a continuous link of up to 24 Displays. In this way, the simultaneous monitoring of large numbers of channels becomes possible.

The desired channel is monitored by use of the **UNIT** key and **CH** key. Changeover between the process temperature and the setting temperature is possible by pressing the display changeover key.

2-2-4 Memory Unit (E5M-MU)



When connected to the E5M-SD, this Unit functions as an external memory allowing the recording in memory of all kinds of data.

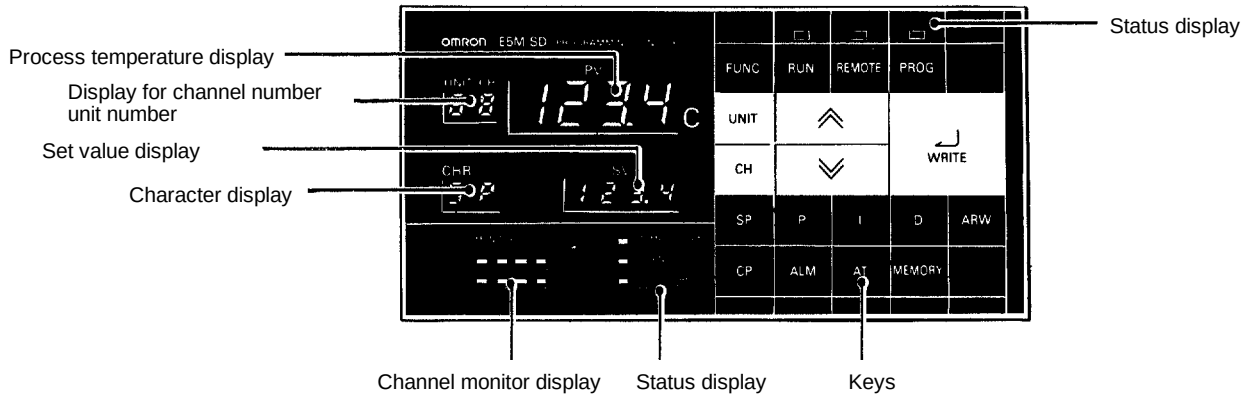
With one memory cartridge, the total data contents of three 80-channel groups -- a total of 240 channels -- can be recorded in memory (recording capacity is identical to that for 8-Kbyte SRAM).

Memory cartridges can be freely inserted and removed from the Memory Unit. Cartridges can thus be substituted for one another to match up with different systems.

Read/Write commands for the cartridge can be performed by either key manipulation or communications involving the E5M-SD.

Memory contents are preserved for 10 years.

2-3 Programming Console



Explanation of Display Area

Display	Function
-PV- 123.4 ℃	Displays process temperature (PV=Process Value). When an error occurs in the system, error code is displayed.
-SV- 1234	Displays set value (SV=Set Value).
UNIT/CH 8.8.	Displays unit numbers (0 to 9) and channel numbers (1 to 8). In program mode, "a" is displayed when the **UNIT** and **CH** keys are pressed simultaneously.
CHR SP	The meaning of the present set value is displayed in characters.
MONITOR 1 2 3 4 5 6 7 8	When a unit number appears on the display, pertinent channel where an alarm or heater burn-out has been detected, or auto-tuning is effective, are displayed. When auto-tuning is effective, the channel number will flash.
▭ TEMP ALARM	Lights when the upper or lower limit alarm is triggered. Display flashes when the channel number subject to the alarm is on the unit number/channel number display.
▭ BURNOUT	Lights when heater burn-out has been detected. Display flashes when the channel number where heater burn-out has been detected appears on the unit number/channel number display.
▭ COLD START PROTECTION	Lights when one or more channels are in a cold start protection period.
▭ RUN	Lights during control operation. Not lit when control ceases (output OFF).
▭ REMOTE	Lights in remote mode. Not lit in local mode.
▭ PROG	Lights in program mode. Not lit in program protect mode.

Note Channels where heater burn-out has been detected are displayed first, then channels where an alarm has been detected, and then channels where auto-tuning is effective.

Explanation of Key Area

Key	Name	Function	Character Display
	Up key	Increments the set value. Automatically increments if held down. If pressed simultaneously with the **DOWN** key, automatic automatic increment accelerates. Stops at the upper limit value.	
	Down key	Decrements the set value. Automatically decrements if held down. If pressed simultaneously with the **UP** key, automatic decrement accelerates. Stops at the lower limit value or the invalid setting character (–).	
	Write key	Conducts write of set data (write cannot be conducted during auto-tuning).	
SP	Set point key	Shifts to control temperature setting mode.	CHR SP
P	Proportional band setting key	Shifts to proportional band setting mode.	CHR P
I	Integral time setting key	Shifts to integral time setting mode.	CHR I
D	Derivative time setting key	Shifts to derivative time setting mode.	CHR d
ARW	Anti-reset wind up value setting key	Shifts to ARW setting mode.	CHR AY
CP	Control period setting key	Shifts to control period setting mode.	CHR CP
ALM	Alarm temperature setting key	Shifts to upper limit alarm setting mode. By pressing continuously, shifts to lower limit alarm setting mode.	CHR AH Upper limit CHR AL Lower limit
AT	Auto-tuning key	Shifts to auto-tuning grouping setting mode. Displays the group number (1 to 8) of the pertinent channel on the SV display. If pressed down for more than 3 seconds, auto-tuning for the pertinent UNIT group is performed. If the UNIT display registers “a,” performance for all groups occurs.	CHR tU
MEMORY	Memory cartridge key	Shifts to memory cartridge operation mode. Displays the memory cartridge division number on the SV display. By pressing continuously, shifts to WRITE operation mode. Execute by pressing the **WRITE** key.	CHR -rr Read CHR -wY Write
RUN	Run/stop key (effective only in program mode)	Selects control execution/cancelling. Press this key to show the RUN mode and STOP mode alternately. The RUN LED lights up in RUN mode. RUN: control execution. STOP: control cancelled for all channels.	
REMOTE	Local/Remote key (effective only in program mode)	Selects local/remote mode. Press this key to show the local mode and remote mode alternately. REMOTE LED lights up in remote mode. Local: setting from the host is not possible; changing of set values can be performed by Programming Console key manipulation. Remote: setting from the host is possible; setting cannot be done by Programming Console; monitoring of set values is possible. Local/remote changeover cannot be performed from the host computer.	

Note The character display remains empty until changed with key operation.

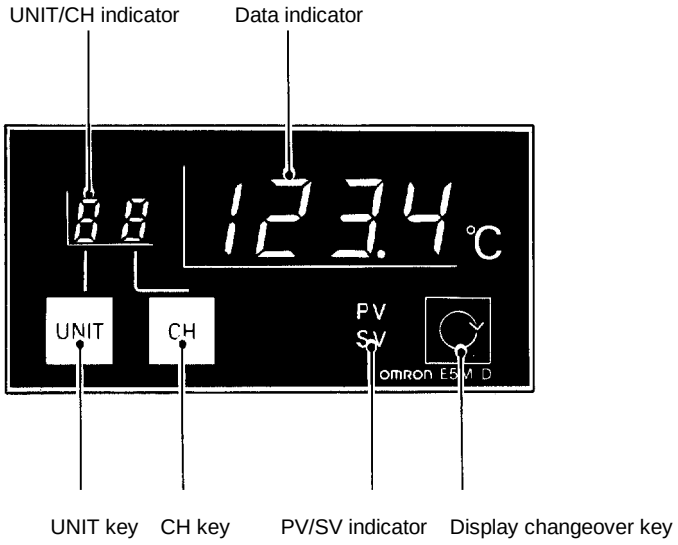
Key	Name	Function
PROG	Program/ program protect key	Selects program program protect mode. When in remote mode, press this key to show the program mode and program protect mode alternately. PROG LED lights up in the program mode. It is possible to change set values by key operation in program mode. In program protect mode, it is not possible to change set values by key operation; monitoring, however, is possible.
UNIT	UNIT key	Increments the unit number by 1 in a range of 0 to 9. In the program mode, the character "a" will appear in the unit display if the **CH** key is pressed while the **UNIT** key is held down. Press the **UNIT** key to clear. If the **UNIT** key is held down for more than 3 seconds, a program protect mode will be entered and the channel numbers of operative units will be displayed at 2-second intervals. Press the **PROG** or **UNIT** key to restore the normal display. The normal display is restored automatically if a write command is sent from a host computer.
CH	Channel key	Increments the channel number by 1 in a range of 1 to 8. In the program, the character "A" will appear in the **CH** display if the **UNIT** key is pressed while the **CH** key is held down. If the **CH** key is held down for more than 3 seconds, a program protect mode automatically ensues and only the operative channels within the present unit are subject to scanning display at 2-second intervals. Press the **PROG** or **UNIT** key to restore the normal display. The normal display is restored automatically if a write command is sent from a host computer.
FUNC	Function key	Displays the output amount (%).

Control Parameters and Initial Values

The setting range for each control parameter and the initial value (memory initialize mode) are as follows:

Parameter	Setting range	Initial values
Setting temperature	0 to FS (full scale)	"----" (inoperative)
Proportional band	0.0% to 999.9%	0 (ON/OFF control)
Integral time	0 to 3999 s	Integral time setting disabled
Derivative time	0 to 3999 s	0
ARW	0 to 99	50
Control period	1 to 99 s (Output change period in the case of current output)	20 s
Alarm temperature with upper limit standby sequence	0 to FS	"----" (inoperative)
Alarm temperature with lower limit standby sequence	0 to FS	"----" (inoperative)
Groups (auto-tuning)	1 to 8	"----" (inoperative)

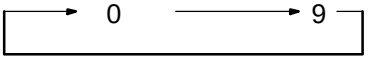
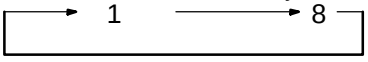
2-4 Display



The Display

Display	Description
	Displays the data for the channel on the UNIT/CH display. Display data can be changed from process temperature to setting temperature using the display changeover key..
	Displays the UNIT/CH number. UNIT numbers are from 0 to 9 and CH numbers from 1 to 8.
PV SV	Indicates the type of displayed data. PV (Process Value): process temperature. SV (Set Value): setting temperature.

Keys

Key	Name	Function
	Display changeover key	Changes displayed data. By pressing this key, the process temperature and set temperature are shown alternately. The PV/SV indicators also change with each pressing.
	UNIT key	Increments the unit number by 1. 
	Channel key	Increments the CH number by 1. 

Note If power fails, UNIT and CH values are backed up. PV/SV indicator returns to the PV setting.

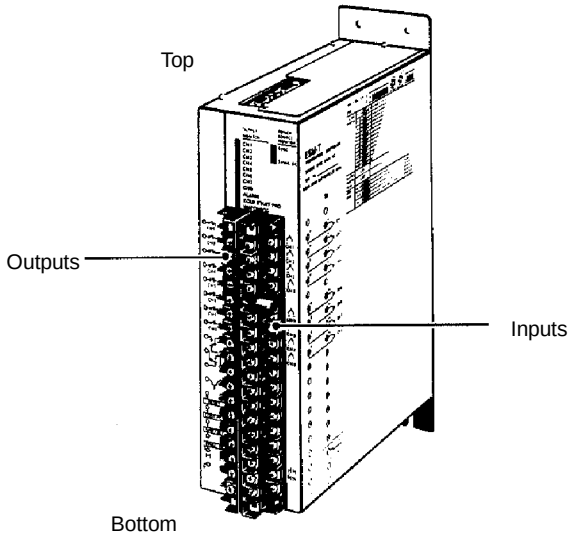
2-5 Terminal Arrangement and Functions

There are terminals for external connection located at the back and side of the Temperature Controller, the Programming Console, and the Display. As the terminals differ in function, wire carefully.

2-5-1 Temperature Controller Master/Slave

Terminal Arrangement

The following figure and tables provide information on the arrangement and function of terminals for the E5M-TM/TS.



Thermocouple Inputs

Output terminal block				Input terminal block			
A 1	Ch 1 – OUT DT	B 1	Ch 1 + OUT NO	C 1	Ch 1 Input +	D 1	Ch 1 Input –
A 2	Ch 2 – OUT DT	B 2	Ch 2 + OUT NO	C 2	Ch 2 Input +	D 3	Ch 2 Input –
A 3	Ch 3 – OUT DT	B 3	Ch 3 + OUT NO	C 3	Ch 3 Input +	D 3	Ch 3 Input –
A 4	Ch 4 – OUT DT	B 4	Ch 4 + OUT NO	C 4	Ch 4 Input +	D 4	Ch 4 Input –
A 5	Ch 5 – OUT DT	B 5	Ch 5 + OUT NO	C 5	Cold junction compensation resistance	D 5	Cold junction compensation resistance
A 6	Ch 6 – OUT DT	B 6	Ch 6 + OUT NO	C 6	Ch 5 Input +	D 6	Ch 5 Input –
A 7	Ch 7 – OUT DT	B 7	Ch 7 + OUT NO	C 7	Ch 6 Input +	D 7	Ch 6 Input –
A 8	Ch 8 – OUT DT	B 8	Ch 8 + OUT NO	C 8	Ch 7 Input +	D 8	Ch 7 Input –
A 9	Alarm output NO	B 9	Alarm output DT	C 9	Ch 8 Input +	D 9	Ch 8 Input –
A 10	Cold start protection output DT	B 10	Alarm output NC	C 10	---	D 10	---
A 11	Cold start protection output NC	B 11	Cold start protection output NO	C 11	---	D 11	---
A 12	Watchdog output common	B 12	Watchdog output	C 12	---	D 12	---
A 13	Reset input common	B 13	Reset input	C 13	---	D 13	---
A 14	Cold start protection input common	B 14	Cold start protection input	C 14	---	D 14	---
A 15	---	B 15	---	C 15	---	D 15	---
A 16	---	B 16	---	C 16	---	D 16	---
A 17	GND 24 VAC/VDC	B 17	24 VAC/VDC	C 17	5 VDC	D 17	GND 5 VDC
A 18	FG	B 18	COM 2	C 18	COM 1	D 18	---

PT Inputs

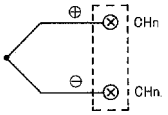
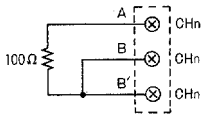
Output terminal block				Input terminal block			
A 1	Ch 1 – OUT DT	B 1	Ch 1 + OUT NO	C 1	Ch 1 Input A	D 1	Ch 2 Input A
A 2	Ch 2 – OUT DT	B 2	Ch 2 + OUT NO	C 2	Ch 1 Input B	D 3	Ch 2 Input B
A 3	Ch 3 – OUT DT	B 3	Ch 3 + OUT NO	C 3	Ch 1 Input B’	D 3	Ch 2 Input B’
A 4	Ch 4 – OUT DT	B 4	Ch 4 + OUT NO	C 4	Ch 3 Input A	D 4	Ch 4 Input A
A 5	Ch 5 – OUT DT	B 5	Ch 5 + OUT NO	C 5	Ch 3 Input B	D 5	Ch 4 Input B
A 6	Ch 6 – OUT DT	B 6	Ch 6 + OUT NO	C 6	Ch 3 Input B’	D 6	Ch 4 Input B
A 7	Ch 7 – OUT DT	B 7	Ch 7 + OUT NO	C 7	Ch 5 Input A	D 7	Ch 6 Input A
A 8	Ch 8 – OUT DT	B 8	Ch 8 + OUT NO	C 8	Ch 5 Input B	D 8	Ch 6 Input B
A 9	Alarm output NO	B 9	Alarm output DT	C 9	Ch 5 Input B’	D 9	Ch 6 Input B’
A 10	Cold start protection output DT	B 10	Alarm output NC	C 10	Ch 7 Input A	D 10	Ch 8 Input A
A 11	Cold start protection output NC	B 11	Cold start protection output NO	C 11	Ch 7 Input B	D 11	Ch 8 Input B
A 12	Watchdog output common	B 12	Watchdog output	C 12	Ch 7 Input B’	D 12	Ch 8 Input B’
A 13	Reset input common	B 13	Reset input	C 13	---	D 13	---
A 14	Cold start protection input common	B 14	Cold start protection input	C 14	---	D 14	---
A 15	---	B 15	---	C 15	---	D 15	---
A 16	---	B 16	---	C 16	---	D 16	---
A 17	GND 24 VAC/VDC	B 17	24 VAC/VDC	C 17	5 VDC	D 17	GND 5 VDC
A 18	FG	B 18	COM 2	C 18	COM 1	D 18	---

Voltage, Current Inputs

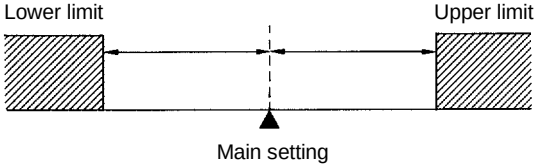
Output terminal block				Input terminal block			
A 1	Ch 1 – OUT DT	B 1	Ch 1 + OUT NO	C 1	Ch 1 Input +	D 1	Ch 2 Input +
A 2	Ch 2 – OUT DT	B 2	Ch 2 + OUT NO	C 2	Ch 1 Input –	D 3	Ch 2 Input –
A 3	Ch 3 – OUT DT	B 3	Ch 3 + OUT NO	C 3		D 3	
A 4	Ch 4 – OUT DT	B 4	Ch 4 + OUT NO	C 4	Ch 3 Input +	D 4	Ch 4 Input +
A 5	Ch 5 – OUT DT	B 5	Ch 5 + OUT NO	C 5	Ch 3 Input –	D 5	Ch 4 Input –
A 6	Ch 6 – OUT DT	B 6	Ch 6 + OUT NO	C 6	---	D 6	---
A 7	Ch 7 – OUT DT	B 7	Ch 7 + OUT NO	C 7	Ch 5 Input +	D 7	Ch 6 Input +
A 8	Ch 8 – OUT DT	B 8	Ch 8 + OUT NO	C 8	Ch 5 Input –	D 8	Ch 6 Input –
A 9	Alarm output NO	B 9	Alarm output DT	C 9	---	D 9	---
A 10	Cold start protection output DT	B 10	Alarm output NC	C 10	Ch 7 Input +	D 10	Ch 8 Input +
A 11	Cold start protection output NC	B 11	Cold start protection output NO	C 11	Ch 7 Input –	D 11	Ch 8 Input –
A 12	Watchdog output common	B 12	Watchdog output	C 12	---	D 12	---
A 13	Reset input common	B 13	Reset input	C 13	---	D 13	---
A 14	Cold start protection input common	B 14	Cold start protection input	C 14	---	D 14	---
A 15	---	B 15	---	C 15	---	D 15	---
A 16	---	B 16	---	C 16	---	D 16	---
A 17	GND 24 VAC/VDC	B 17	24 VAC/VDC	C 17	5 VDC	D 17	GND 5 VDC
A 18	FG	B 18	COM 2	C 18	COM 1	D 18	---

Note
1. Do not use unused terminals (indicated with "---").
2. Do not touch the cold junction compensation resistance. If this connection is not secure, input temperatures for all channels will not be read normally.
3. Be sure to adjust the power supply to meet the rated values of 24 V, 5 V at the E5M terminal block.

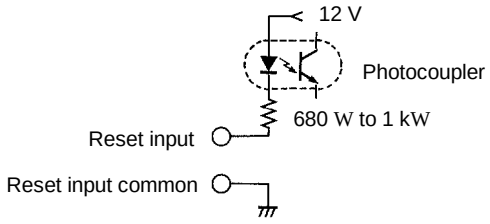
Terminal Functions This table presents a detailed breakdown of terminal functions.

Terminal	Input/output	Function
Ch n input + Ch n input – Ch n input A Ch n input B Ch n input B'	Thermocouple (voltage, current input), or platinum resistance thermometer	Wire the sensor input/output terminal as in the illustrations. Thermocouple  Platinum Resistance Thermometer 
Cold junction compensation resistance	Thermo-sensitive resistor	Thermo-sensitive resistor for the detection of terminal temperature. Only necessary for thermocouple input. (A dedicated compensation resistor is connected to the terminal.)
COM1, COM2	---	Connection is normally unnecessary; however, connect to the Programming Console FG(A18) in places with high noise levels.
FG	---	Always ground in order to prevent surge. Also prevents noise interference in high noise environments.
Ch n out NO, + Ch n out DT, –	Relay or current/ voltage	Terminals for control output. For relay output, NO is the normally open contact, and DT is the double-throw contact. (250 VAC 3 A). For voltage output, 12VDC 15mA output is provided with NO terminal (+) and DT terminal (–). A short-circuit prevention circuit is built-in for voltage output. For current output, NO should be (+) and DT (–).
Alarm output: NO Alarm output: NC Alarm output: DT *(see Note 1)*	Relay	Terminals for general alarm outputs; the NO, NC, and DT contacts for each relay are connected (250 VAC 3A). The general alarm output is produced in the following conditions (only in RUN mode). Upper/lower limit alarm; sensor burnout (sensor error); and A/D error.
Cold start protection output (NO, NC, DT)	Relay	Terminal for cold start protection function output; the NO, NC, DT contact of each relay are connected (250 VAC 3A). The relay is turned ON at the end of the cold start protection period. For details on the cold start protection function, refer to the last part of section 3-1-1.
Watchdog output	(Transistor) open-collector output	Output is produced when a CPU error, or an abnormal supply voltage is detected. Remains ON for approximately 1 second after power is turned ON. (30 VDC, 20 mA)
Reset input *(see Note 2)*	Reset input	Resets CPU. The settings are preserved when the reset signal is input.

Note 1. The alarms use an upper limit/lower limit independent deviation setting system, and each is provided with standby sequence function. A standby sequence function means that the alarm function for either limit will not be affected until input has momentarily exceeded the lower limit or fallen below the upper limit. A standby condition results when power is cut or the temperature setting is changed.



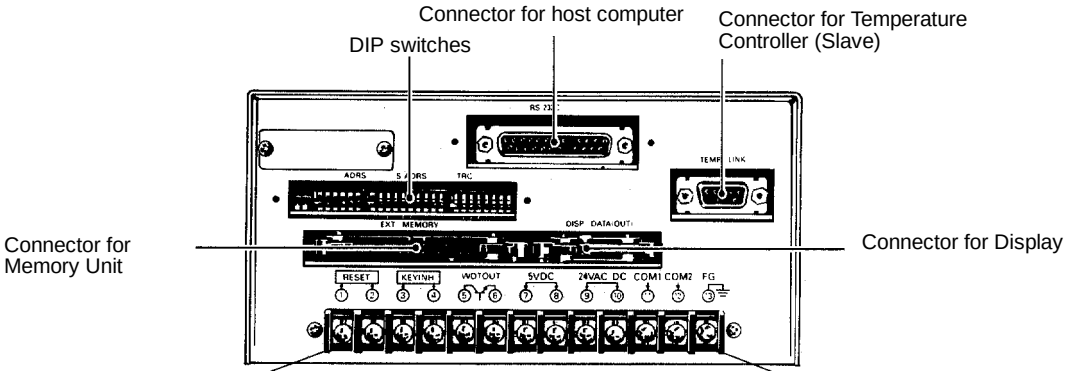
2. A rough circuit diagram for the external signal input (reset input or cold start protection) is shown below. Wire carefully when connecting an external circuit.



2-5-2 Programming Console

Terminal Arrangement

The power supply and input/output terminals, various connectors, and the DIP switches for function selection, are located on the back of the Programming Console. Refer to *3-2 Function Selection for Programming Console* for details on DIP switch settings and host computer connection.



Terminal block:

1.	Reset input	7.	5 VDC
2.	Reset input common	8.	5 VDC GND
3.	Key protect input	9.	24 VAC/VDC
4.	Key protect input common	10.	24 VAC/VDC GND
5.	Watchdog output	11.	COM 1
6.	Watchdog output	12.	COM 2
		13.	FG

Terminal Functions

The following table gives a detailed breakdown of terminal functions for E5M-SD.

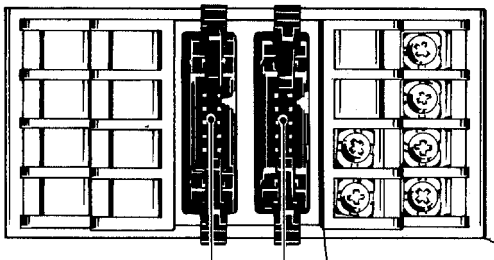
Terminals	Function
Reset input	CPU is reset by short-circuiting with reset input common, i.e., the system is reset and initialized. The settings are preserved.
Key protect input	Shifts to key protect mode when short-circuited with key protect input common. In this mode, it is possible to monitor operations, but not to change settings. Unless this external input is cleared, it is not possible to shift to program mode even by pressing the **PROG** key. In the remote mode, however, setting from the host computer is possible via communications link.
Watchdog output	Output is produced when a CPU error, or an abnormal supply voltage is detected. Remains ON for approximately 1 second after power is turned ON. (30 VDC 20mA, open-collector)
COM1 COM2	Connection is normally unnecessary; however, connect to the Programming Console FG(A18) in places with high noise levels.
FG	Always ground in order to prevent surge. Also prevents noise interference in high noise environments.

Note
1. The external signal input circuit (reset input, key protect input) is the same as that of the Temperature Controller (see *Section 2-3-1*, Note 2 under *Terminal Functions*).
2. Be sure to adjust the power supply voltage to meet the rated values of 5 V, 24 V for the E5M terminal block.

2-5-3 Display

Terminal Arrangement

The power supply terminals and the display signal input/output connectors are located on the back of the Display. Be sure to connect the signal from the Programming Console to the connector for input signals (on the right in the figure below). There will be no temperature display if the connections are reversed.



Terminal allocations:

9		13.	5 VDC
10		14.	5 VDC GND
11.	COM 1	15.	24 VAC/VDC
12.	COM 2	16.	24 VAC/VDC

Note: Terminal numbers 1 to 10 are not used.

Terminal Functions The following table gives a breakdown of terminal functions for E5M-D.

Terminal	Function
Connector for input signals	This connector receives signals from a Programming Console or output signals from other Displays. Use the proper connector.
Connector for output signals	This connector sends display signals to other Displays. Use the proper connector.
COM1 COM2	Connection is normally unnecessary; however, connect to the Programming Console FG (A18) in places with high noise levels.

Note Be sure to adjust the power supply voltage to meet the rated values of 24 V, 5 V at the E5M terminal block.

SECTION 3
E5M System Operation

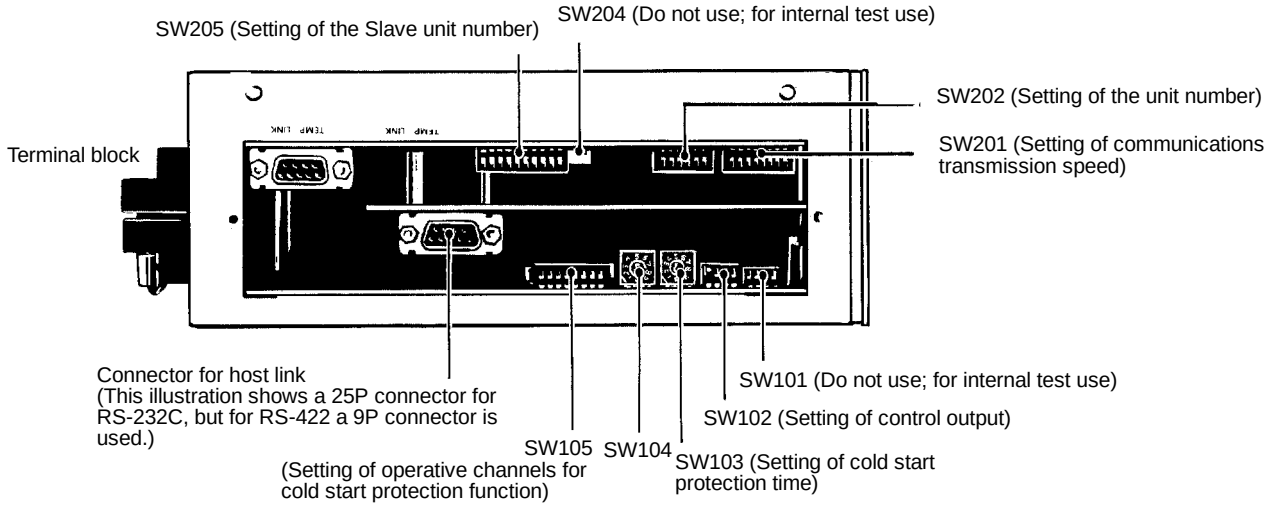
3-1 Function Selection for Masters/Slaves

Function selection for Temperature Controller Masters/Slaves is accomplished with DIP switches. Set the functions to suit the system before operation. DIP switch settings are different with each model. The DIP switch settings are read only when power is turned on, so be sure to turn the power off and then on again after changing settings.

3-1-1 Masters with RS-232C, RS-422 Specifications

DIP Switch Position

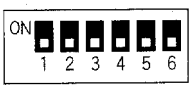
The figure below shows the positions of the various DIP switches of Masters with RS-232C, RS-422 specifications (E5M−TM01, E5M−TM02).



Unit Number (SW202)

When using more than one Master and when connecting to the host computer by communications link, the DIP switch is used to set a unit number enabling the differentiation of each Master by the host computer. If there is only one Master, use the factory settings (unit number = 0).

(All pins are factory set to OFF.)

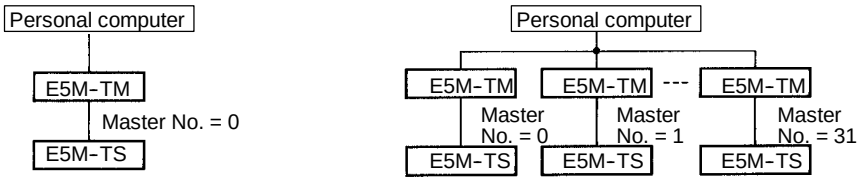


Pin No.	1	2	3	4	5	6
Value when ON	2^0	2^1	2^2	2^3	2^4	Always OFF

Note

1. Be sure that pin 6 is in the OFF position.
2. The setting range is from 0 to 31.
3. When a pin is ON, its corresponding value is as shown above. For example, when the unit number is 5, pins 1 and 3 are turned ON, while the other pins are turned OFF ($5 = 2^0 + 2^2$).
4. Transmission is not possible when two or more Masters have the same unit number.

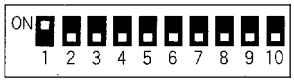
The following diagrams provide examples of unit number selection.



Slave Unit Number (SW205)

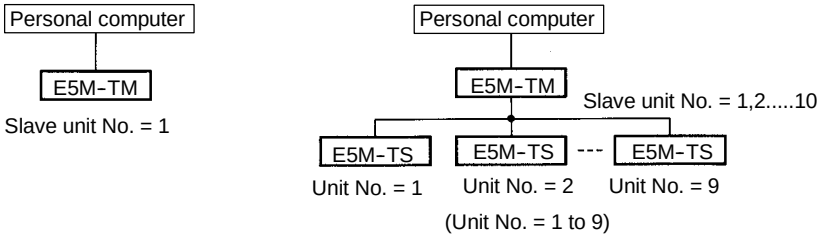
When no Slaves are connected, turn ON pin 1 only (the factory setting). When two or more Slaves are connected, the DIP switch settings register Slave unit numbers.When a Slave with unit number N is connected, turn ON pins 1 and N + 1. For example, when Slaves with unit numbers 1, 2, and 3 are connected, turn ON pins 1, 2, 3, and 4 -- a total of 4 pins. Up to 9 Slaves can be connected.

(Only pin 1 is factory set to ON.)



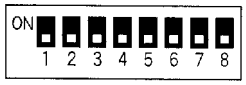
Note
1. If a Slave is connected, and its corresponding DIP switch pin is not turned ON, that slave will be ignored by the Master.
2. If the pin has been turned ON, and the corresponding unit has not been properly connected, a communications error will occur.

The following diagrams provide examples of Slave unit number selection.



Host Transmission Speed (SW201)

When communicating with a host computer, the transmission speed must be set. The transmission speed is selected by turning ON only the pin corresponding to one of the following seven settings.



(All pins are factory set to OFF.)

Pin No.	1	2	3	4	5	6	7	8
BPS	Always OFF	9600	4800	2400	1200	600	300	150

Note
1. Pin 1 should always be OFF.
2. Be sure to turn ON only one pin. If 2 or more are pins are turned ON, communications cannot be conducted.

Control Output (SW102)

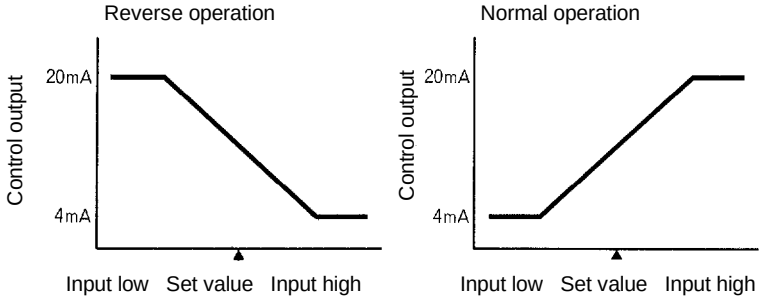
The control output mode must be set.

Function selection				1	2	3	4
Control output	Normal/ reverse output	Ch 1 to 8	Normal	Do not change	ON	---	---
		Ch 1 to 6	Reverse		OFF		
		Ch 8	Normal		OFF	ON	---
			Reverse			OFF	
		Ch 7	Normal		OFF	---	ON
			Reverse				OFF

Pins 2, 3, and 4 are factory set to OFF. The factory setting of pin 1 depends on the specifications, with relay voltage output specifications it is ON, and with current output specifications, it is OFF.

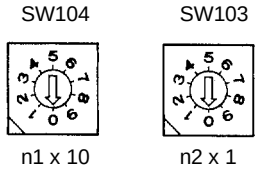
Note

1. Do not change pin 1.
2. It makes no difference whether the unspecified pins are ON or OFF.
3. If pin 2 is in the ON position, all channels follow regular operation.
4. If pin 2 is in the OFF position, channels 1 to 6 follow reverse operation while channels 7 and 8 are set by pins 3 and 4.
5. Reverse operation indicates an operation whereby output volume is increased when input falls below the set value. Normal operation indicates an operation opposite to this (see graphs below). For ON/OFF control for relay or voltage output, the proportion of ON and OFF reverses with the changeover from normal to reverse operations. Control by use of heater requires reverse operation, while control by use of cooler requires normal operation.
6. Auto-tuning can be performed even with normal operation.
7. Even during normal operation, output is turned off when STOP mode is entered (a condition identical to power flow interruption).



Cold Start Protection Time (SW103, 104)

DIP switches SW103 and SW104 set the Cold Start Protection Time in the range of 0 to 99 minutes.



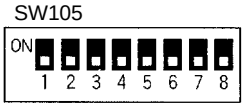
(All switches are factory set to OFF.)

SW No.	Time
SW 104	n_1 x 10 min
SW 103	n_2 x 1 min

Note 1. Set time is in minutes.
2. See the following pages for further details about the cold start protection function.

Operative Channels for Cold Start Protection (SW105)

Setting of operative channels for the cold start protection function is done by the SW105 DIP switch.



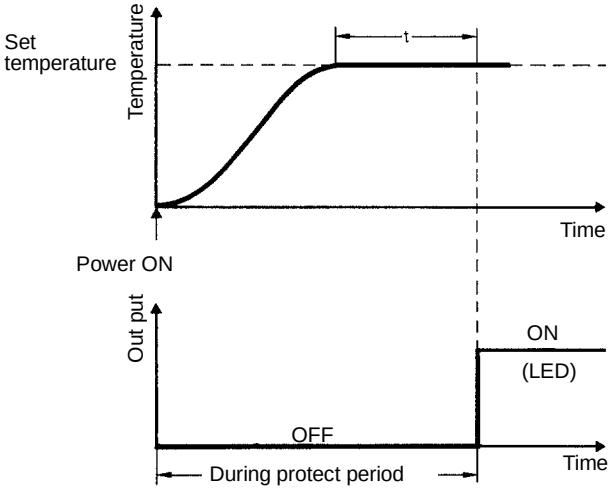
(All pins are factory set to OFF.)

Channel	Corresponding pin	Cold start protection status
Ch 1	Pin 1 ON/OFF	Enabled/disabled
Ch 2	Pin 2 ON/OFF	Enabled/disabled
Ch 3	Pin 3 ON/OFF	Enabled/disabled
Ch 4	Pin 4 ON/OFF	Enabled/disabled
Ch 5	Pin 5 ON/OFF	Enabled/disabled
Ch 6	Pin 6 ON/OFF	Enabled/disabled
Ch 7	Pin 7 ON/OFF	Enabled/disabled
Ch 8	Pin 8 ON/OFF	Enabled/disabled

Operation of Cold Start Protection

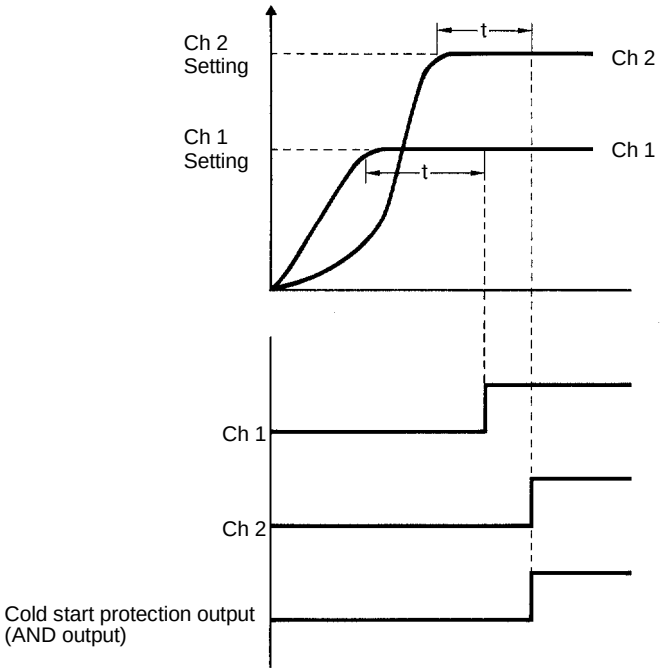
- This function delays start-up until all points have reached the set temperature, not just the point where the sensor is located. The operator must determine the time delay from when the sensor reaches the set temperature until all points reach the set temperature; this time delay is called the cold start protection time. Start-up will occur after power is turned on, the set

temperature is reached at the sensor, and the cold start protection time set by the operator on the DIP switch has passed.



t: cold start protection time

- With the E5M-TM, the channels for which the cold start protection function are operative are set by DIP switch SW105. For example, if the DIP switches corresponding to channels 1 and 2 are set in the ON position, after these 2 channels have both reached the set temperature and following the time period set by SW103/104, output is activated. In other channels, the AND signal of the valid channels set by SW105 becomes the starting signal for the protection time.
  The cold start protection function does not operate at all if all pins in SW105 are OFF (the output relay remains OFF and the LED extinguished).



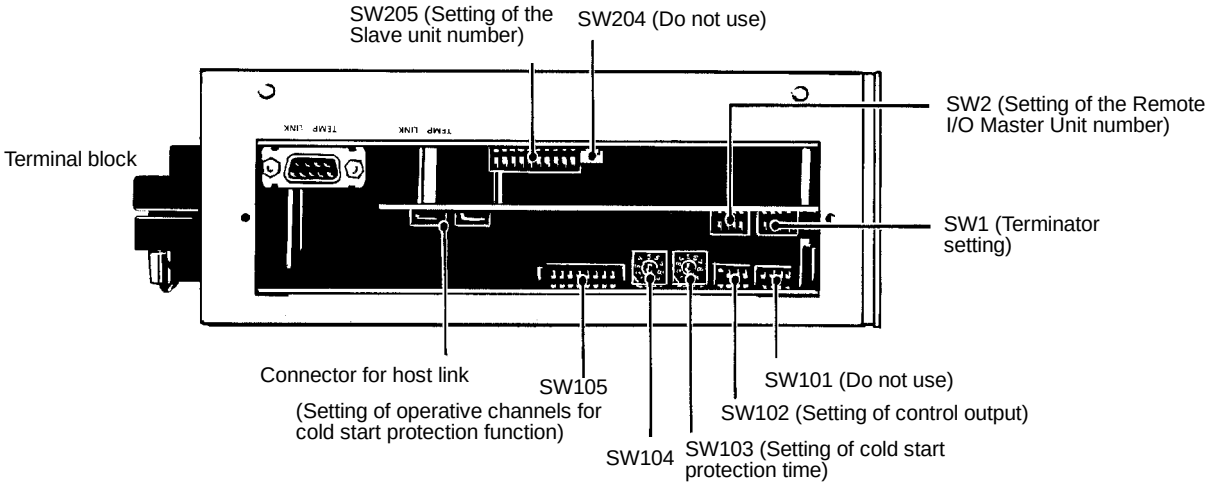
- If any of the cold start protection terminals of connected Temperature Controllers are short circuited, the cold start protection function will be inactivated and the cold start protection output will be turned ON.

- If power is interrupted or Stop mode is entered during operation, the Temperature Controller will be reset. Changing settings, for example, the number of channels. during operation will cause errors.
  Changing the set temperature will not cause reset.

3-1-2 Master with SYSMAC BUS Specifications

DIP Switch Position

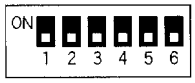
The figure below shows the positions of the various DIP switches of Masters with SYSMAC BUS specifications (E5M-TM10).



Unit Number

When connecting the Master to a Programmable Controller via a communications link, it is necessary to set the number of the Remote I/O Master Unit in SYSMAC BUS by DIP switch to allow for the allocation of words in PC memory. The Temperature Controller makes exclusive use of 4 I/O words. Do not use one unit number for more than one Master.

(All pins are factory set to OFF.)



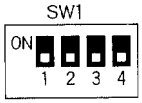
Pin No.	1	2	3	4	5	6
Value when ON	2^0	2^1	2^2	2^3	2^4	Always OFF

Note
1. Be sure that pin 6 is in the OFF position.
2. When a pin is ON, its corresponding value is as shown above. For example, when the unit number is 5, pins 1 and 3 are turned ON, while the other pins are turned OFF ($5 = 2^0 + 2^2$). In this case, the E5M system group would be allocated IR 005, 006, 007, and 008.

Terminator (SW1)

This DIP switch designates the terminator when SYSMAC BUS is used as the host. The Unit at the end of the optical cable, not the highest unit number, must be set as the terminator.

(All pins are factory set to OFF.)



Function selection	1	2	3	4
Terminator	ON	Always OFF		
Not terminator	OFF			

Note Be sure to keep pins 2, 3 and 4 OFF. If ON, transmission will not maintain normal speed (187,500 bps).

Switches other than SW1, SW2

The use of SW204 and 205, SW101 to 105 are the same as for RS-232C, RS-242 Temperature Controllers.

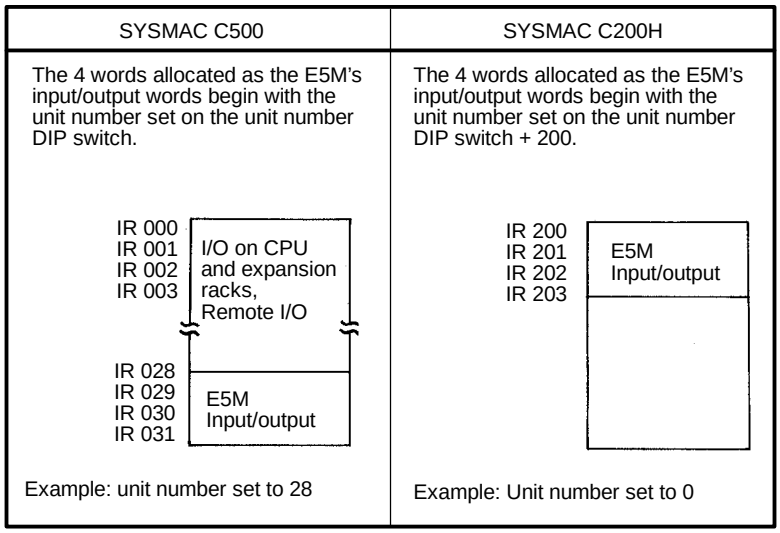
Slave Unit Number

The same as for RS-232C, RS-422 Temperature Controllers.

Programmable Controller I/O Word Allocation

In the C500, IR bits are allocated to I/O points automatically and consecutively beginning with IR 000. Be sure that the words allocated to the E5M by the unit number are not already allocated to I/O points in the PC.

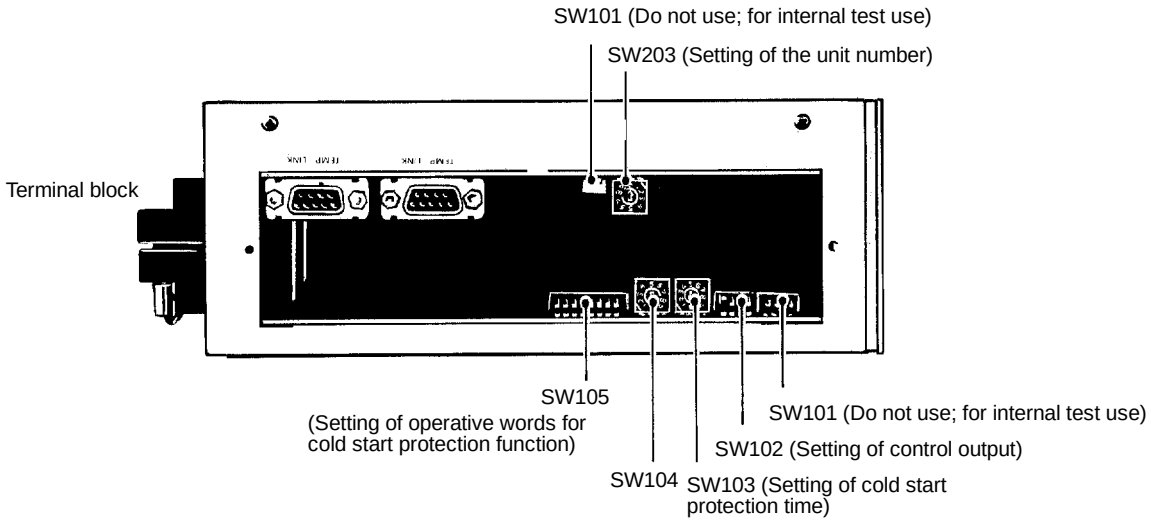
In the C200H, a different method of allocation is used, and bits cannot be allocated to both I/O points and Masters.



3-1-3 Slave

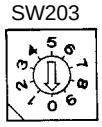
DIP Switch Position

The figure below shows the positions of the various DIP switches of Slaves (E5M-TS).



Unit Number (SW203)

When more than one Slave is connected, a unit number is set by DIP switch to allow differentiation of the Slaves by the Master or the Programming Console.



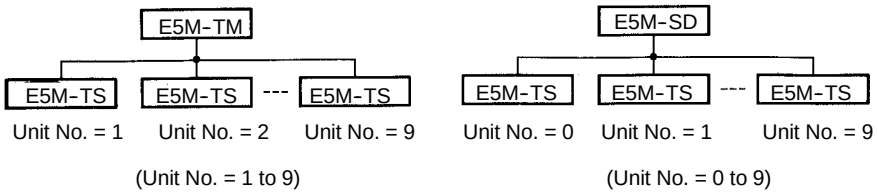
(Factory set to OFF.)

Switch No.	Unit No.
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Note
1. If a Slave number is set to 0 in systems connected to a Master, that unit will be ignored by the Master.
2. Be sure that in each system group unit numbers are used only once. If one number is used more than once, a communications error occurs and the system stops operating.

3. The setting range is as follows: for systems connected to a Master, 1 to 9; for systems connected to a Programming Console, 0 to 9.

The following diagrams provide examples of unit number selection.



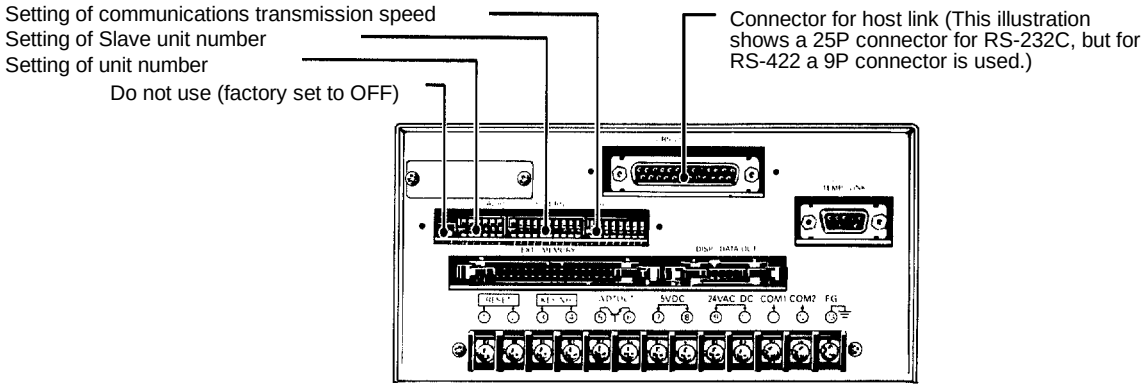
Switches Other Than SW203 The uses of SW204 and SW101 to 105 are the same as for RS-232C, RS-422.

3-2 Function Selection for Programming Console

Function selection for the Programming Console is accomplished with DIP switches. Set the functions to suit the system before operation. DIP switch settings are different with each model. The DIP switch settings are read only when power is turned on, so be sure to turn the power off and then on again after changing settings.

3-2-1 Programming Console With RS-232C, RS-422 Specifications

DIP Switch Position The figure below shows the position of the various DIP switches of Programming Consoles with RS-232C, RS-422 specifications (E5M-SD01/SD02).



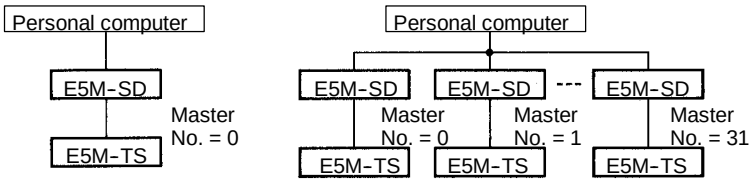
Unit Number When using the Programming Console and communicating with the host computer via RS-232C or RS-422, the unit number enabling the host computer to differentiate each Programming Console is set with this DIP switch. When connecting only one Programming Console to the host computer, use the factory setting (Master unit number = 0).

(All pins are factory set to OFF.)

Pin No.	1	2	3	4	5	6
Value when ON	2^0	2^1	2^2	2^3	2^4	Always OFF

Note
1. Be sure that pin 6 is in the OFF position.
2. The setting range is from 0 to 31.
3. When a pin is ON, its corresponding value is as shown on the previous page. For example, when the unit number is 5, pins 1 and 3 are turned ON, while the other pins are turned OFF ($5 = 2^0 + 2^2$).
4. Transmission is not possible when two or more Masters have the same unit number.

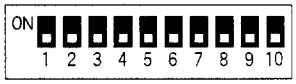
The following diagrams provide examples of unit number selection.



Slave Unit Number

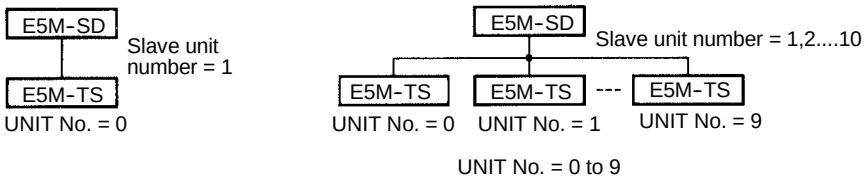
The Programming Console always has Temperature Controller Slaves connected to it and the Slave unit numbers set on the DIP switches enable the Programming Console to differentiate these Slaves. For a Slave number "N," turn ON the N + 1 number pin. For example, if 4 Units whose unit numbers are 0, 1, 2, and 3 are connected, turn ON pins 1, 2, 3, and 4, with all of the others remaining OFF.

(All pins are factory set to OFF.)



Note
1. The setting range for the Slave numbers is N = 0 to 9.
2. If all pins are OFF, operation will stop in the reset condition (the entire display registering 000...).
3. If a Slave is properly connected, but the pin corresponding to its unit number is not ON, the unit will be ignored.
4. If the proper pin is ON, but the corresponding unit is not connected, a communications error (E555) will occur.

The following diagrams provide examples of Slave number selection.



Host Communications Transmission Speed

The transmission speed for communications with a host computer must be set. The speed is selected by setting ON one of the following seven modes.

(All pins are factory set to OFF.)

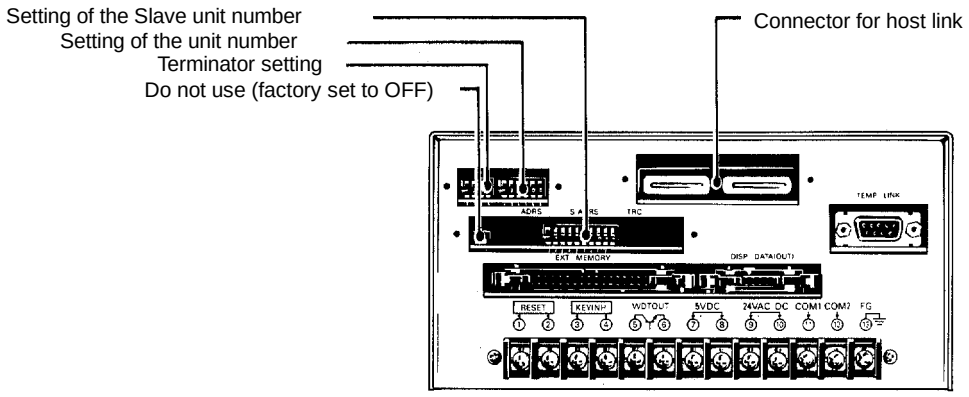
Pin No.	1	2	3	4	5	6	7	8
bps	Always OFF	9,600	4,800	2,400	1,200	600	300	150

Note 1. Be sure to keep pin 1 OFF.
2. Be sure to set only one pin ON. If 2 or more are set ON, communications with the host will not be possible.

3-2-2 Programming Console with SYSMAC BUS Specifications

DIP Switch Position

The figure below shows the positioning of the various DIP switches for Programming Consoles with SYSMAC BUS specifications (E5M-S10).



Unit Number

When using the Programming Console connected to the Programmable Controller via SYSMAC BUS, it is necessary to set the unit number to allocate words in PC memory. A Temperature Controller uses 4 words; be sure that these words are allocated to the Temperature Controller only.

(All pins are factory set to OFF.)

Pin No.	1	2	3	4	5	6
Value when ON	2^0	2^1	2^2	2^3	2^4	Always OFF

Note 1. Be sure that pin 6 is in the OFF position.
2. When a pin is ON, its corresponding value is as shown on the previous page. For example, when the unit number is 5, pins 1 and 3 are turned ON, while the other pins are turned OFF ($5 = 2^0 + 2^2$). In this case, the E5M system group makes exclusive use of I/O words 5, 6,7, 8 (with the C500 PC).

Terminator

When using the Programming Console and when communicating with the host computer via SYSMAC BUS, the terminator is selected by the terminator DIP switch. The unit at the end of the optical cable, not the highest unit number, must be set as the terminator.

(All pins are factory set to OFF.)

Pin No.	1	2	3	4
Terminator	ON	Always OFF		
Not terminator	OFF			

Note Be sure to keep pins 2, 3, 4 OFF. If ON, transmission will not maintain normal speed (187,500 bps).

Selection of Slave Unit Number

The same as for RS-232C, RS-422 Temperature Controllers.

Programmable Controller I/O Table Allocation

As the I/Os incorporated into the Programmable Controller are automatically allotted in order from IR 000, be sure to set the E5M unit number so that the words do not overlap with other I/Os. SYSMAC BUS communications for the E5M system carry out word allocation identical with that of Optical I/O Units. Since word allocation is determined by means of a word multiplier in the SYSMAC C1000H and C2000H series, exercise caution.

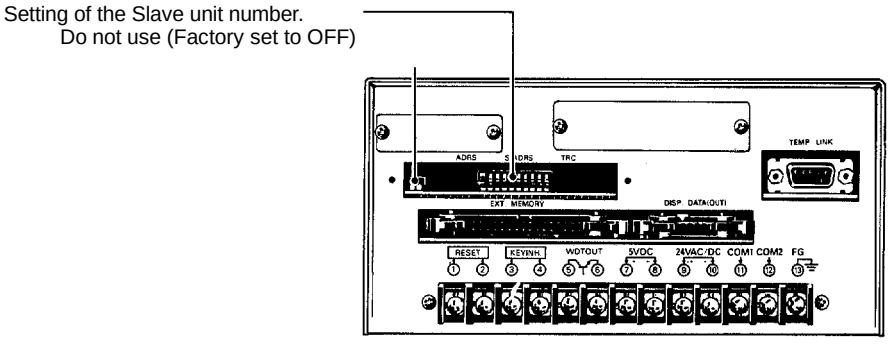
When using the C200H series, consult the following chart. Since the program and I/O allocation examples given in *4-2* are for C500 PCs, when using C200H, change the E5M input/output words in accordance with the chart information.

SYSMAC C500	SYSMAC C200H
The 4 words allocated as the E5M's input/output words begin with the unit number set on the unit number DIP switch.	The 4 words allocated as the E5M's input/output words begin with the unit number set on the unit number DIP switch + 200.
IR 000 IR 001 IR 002 IR 003 — I/O on CPU and expansion racks, Remote I/O IR 028 IR 029 IR 030 IR 031 — E5M Input/output	IR 200 IR 201 IR 202 IR 203 — E5M Input/output
Example: unit number set to 28	Example: unit number set to 0

3-2-3 Programming Console with No Host Communications Function

DIP Switch Position

The figure below shows the position of DIP switches for Programming Consoles with no host communications function (E5M-SD00).



Selection of Slave unit Number The same as for RS-232C, RS-422 Temperature Controllers.

3-3 Programming Console Operation Examples

3-3-1 Initializing Memory

All set values stored in memory can be initialized with the procedure given below. The following procedure can also be used to initialize memory after a memory error (E111) has occurred.

1, 2, 3...

1. Press the PROG key. The PROG indicator will light indicating that the Controller is in PROGRAM mode.
2. Enter the memory initialization mode by holding down the FUNCTION key and then simultaneously pressing the SET POINT key for at least 3 seconds. The memory initialization mode will not be entered if the Set Point key is pressed before the Function key. If the memory initialization mode has been entered, *CLERr* will appear on the PV display.
3. Press the WRITE key. The PV display will go blank and - - - - will appear on the SV display. If any other key is pressed, the initialization operation will be canceled and the Controller will return to the condition it was in before the operation was started.
4. Turn the power to the Controller off and then back on. This completes memory initialization; all set values in memory will have been initialized.

Note Memory can be initialized in PROGRAM mode only.

3-3-2 Setting Operations

Setting Specific Channels The following example shows how to write various set values for channel 1 of Unit 0.

1, 2, 3...

1. Press the PROG key. The PROG indicator will light indicating that the Controller is in PROGRAM mode.
2. Press the REMOTE key to shift to LOCAL mode. The REMOTE indicator will go off.
3. Press the UNIT key to set the unit number to 0.
4. Press the CH key to set the channel number to 1.
5. Press the desired set key (SP, P, I, D, etc.). The current set value will flash on the display.
6. While the display is flashing, use the UP and DOWN keys to change the set value as desired.
7. When the desired set value appears on the display, press the WRITE key to write this value into memory. The display will stop flashing.
8. Continue setting any other set values required by repeating steps 5 through 7.

Setting All Channels The follow example shows how to write identical set values for all channels of a given Unit.

1, 2, 3...

1. Press the PROG key. The PROG indicator will light indicating that the Controller is in PROGRAM mode.
2. Press the REMOTE key to shift to LOCAL mode. The REMOTE indicator will go off.
3. Set the unit number to one less than the number of the desired Unit. (Step 4, below, will cause the unit number to be incremented by 1.) It is not necessary to set the unit number if only one Controller is being used.
4. Hold down the CH key and then simultaneously press the UNIT key. "*A*" will appear on the display.

5. Press the desired set key (SP, P, I, D, etc.). The current set value will flash on the display.
6. While the display is flashing, use the UP and DOWN keys to change the set value as desired.
7. When the desired set value appears on the display, press the WRITE key to write this value into memory. The display will stop flashing.
8. Read out the set values for any channel to confirm that the set values have been input properly.

Setting All Units

The follow example shows how to write identical set values for all channels of all Units.

1, 2, 3...

1. Press the PROG key. The PROG indicator will light indicating that the Controller is in PROGRAM mode.
2. Press the REMOTE key to shift to LOCAL mode. The REMOTE indicator will go off.
3. Hold down the UNIT key and then simultaneously press the CH key. This will set the unit number to *R*.
4. Press the desired set key (SP, P, I, D, etc.). The current set value will flash on the display.
5. While the display is flashing, use the UP and DOWN keys to change the set value as desired.
6. When the desired set value appears on the display, press the WRITE key to write this value into memory. The display will stop flashing.
7. Read out the set values for any channel in any Unit to confirm that the set values have been input properly.

3-3-3 Memory Unit Operations

Read/Write

The memory cartridge divides memory into 3 zones, with each zone containing all set values for a maximum of 80 channels. When conducting memory operations, be sure to first designate the zone number, 1 to 3. When the **MEMORY** key is entered, nr is displayed at CHR, and the Read mode is entered. When the **MEMORY** key is pressed again, nu is displayed at CHR and the Write mode is entered.

Operation	Key	Display	SV	Description
Memory Cartridge Read mode	MEMORY	CHR nr	-SV- 1	Pressing the **MEMORY** key causes a Memory Cartridge Read mode to be entered.
Zone number setting	▲ or ▼	CHR nr	-SV- 2	Set the SV display zone number using the UP/DOWN keys. CHR registers a flashing display.
Memory Cartridge Read operation	↵	CHR nr	-SV- 2	When the **WRITE** key is held down for more than 3 seconds, a Memory Cartridge Read operation is executed. In the example on the left, the contents of zone number "2" are read on the Programming Console.
Memory Cartridge Write mode	MEMORY	CHR ny	-SV- 2	Pressing the **MEMORY** key again causes a Memory Cartridge Write mode to be entered.
Zone number setting	▲ or ▼	CHR ny	-SV- 3	Set the SV display zone number using the UP/DOWN keys. CHR registers a flashing display.
Memory Cartridge Write mode	↵	CHR ny	-SV- 3	When the **WRITE** key is held down for more than 3 seconds, the Memory Cartridge Write operations are executed. In the example on the left, all set values on the Programming Console are written in addressed to zone "3."

Note Pressing keys other than those indicated will cause the current mode to be left.

Execution Confirmation and Error Display

Since no final display is shown following execution of Write or Read, be sure to keep the **WRITE** key firmly pressed down for more than 3 seconds.

The following errors during Memory Cartridge operation will result in an error message (E999).

1, 2, 3...

1. When a Memory Cartridge is not inserted.
2. When data is not read out properly from the Memory Cartridge.
3. When data is not written in properly onto the Memory Cartridge.

In any of these three cases, operations continue under the previous conditions. The error message can be cleared by pressing any key.

Handling Precautions for Memory Cartridge

Be sure to insert and remove the Memory Cartridge only after turning off the power to the Programming Console (insertion or removal during operation can destroy memory contents).

3-3-4 Operation Commencement

Once all settings have been completed, operations can commence. Channels with set values and alarm set values which are outside of the allowable ranges will result in no control output. Refer to section *3-4* when performing auto-tuning prior to operation commencement.

To commence operations, press the RUN key. The RUN LED lights and all operative channels (channels which have no invalid settings) begin operation.

If the RUN key is pressed while Unit is operating, the RUN LED goes off and operation ceases. The RUN key is valid only in PROGRAM mode. Be sure to confirm whether the Temperature Controllers are operating by checking the output indicator on each Unit.

3-4 Auto-tuning via Programming Console

The E5M is a temperature control system with PID control. When using for the first time, the optimum PID and ARW values for the control conditions need to be set prior to operation. Since the E5M is provided with an auto-tuning function, follow the procedures listed below to tune PID constants and ARW values.

3-4-1 Procedure

Grouping

Grouping refers to bringing together channels which are likely to be subject to mutual heat interference, and allotting a number to the group (see section *3-5-2*).

Note

1. For the E5M, auto-tuning cannot be performed for channels not subject to grouping. Since no grouping exists at the time of shipment or as a result of memory initialization (see section *3-3-1*), all channels for which auto-tuning is desired must be grouped by the user.
2. Grouping is valid only within the Unit in question. Auto-tuning for groupings extending to two or more units is not possible.
3. Grouping numbers range from 1 to 80. One Unit can thus have eight groupings.
4. If channels within a Unit all belong to the same group, a block grouping for the Unit is possible by making the channel number equal to R.
5. If all channels in all Units belong to one group, an all-unit block grouping is possible by making the unit number equal to R.

Execution of Auto-tuning

To perform auto-tuning (only possible in RUN and PROGRAM modes), the control system and sensors must be properly connected and the temperature setting completed.

After completion of grouping and designation in RUN mode (the RUN LED is lit) of the group for which execution is desired, auto-tuning is begun by holding the AT key pressed down for more than 3 seconds (the temperature set values for each channel must previously be set).

When R is entered as the unit number, auto-tuning starts simultaneously for all groups of all units.

To interrupt the auto-tuning operation, press the RUN key to enter STOP mode (RUN LED extinguishes).

Completion of Auto-tuning

The channels on which auto-tuning is being performed are indicated by the flashing of the corresponding LEDs.

When auto-tuning is completed, the flashing ceases, the optimum PID values are calculated and stored in memory, and control is performed with these values.

The PID constants and ARW values calculated in auto-tuning are saved in back-up memory which is maintained in the case of power failures.

3-4-2 Auto-tuning Example

The following example shows auto-tuning for groups “1, 2, 3” under these conditions:
Unit number = 0.
Grouping: Ch 1 to 3 = Group 1;
Ch 4 to 6 = Group 2;
Ch 7 to 8 = Group 3.

Operation	Key	Unit/Ch	Character or channel	Set Value	Description
Auto-tuning grouping setting mode	PROG or AT	UNIT/CH 08	CHR tG	-SV- -	The Unit enters PROGRAM mode upon pressing the **PROG** key. Press the AT key to enter grouping mode. If grouping has not been performed for any group, the SV display shows “-” display.
Unit/channel number setting	UNIT or CH	UNIT/CH 01	CHR tG	-SV- 3	Press UNIT or CH key to register UNIT = 0, Ch = 1. In the example on the left, this channel is allocated to group 3.
Group number setting	↑ or ↓	UNIT/CH 01	CHR tG (flashing)	-SV- 1	The CHR display flashes. Set the group number at SV display to 1 by using **UP/DOWN** key.
Group number Write	↵	UNIT/CH 01	CHR tG	-SV- 1	Write in the set data by pressing the **WRITE** key. The CHR display ceases flashing.
All channels completed? No / Yes	⋮	⋮	⋮	⋮	Grouping is conducted in the same way for all channels.
Grouping termination	↵	UNIT/CH 08	CHR tG	-SV- 3	Register UNIT = 0, Ch = 8 in group “3” and terminate grouping.
RUN mode	RUN	UNIT/CH 08	CHR tG	-SV- 3	RUN LED lights.
Setting of auto-tuning execution group numbers	↑ or ↓	UNIT/CH 01	CHR tG	-SV- 1	Set the channel number allocated to a group for which auto-tuning is to be performed is set via the CH key on the CH display.
Auto-tuning execution	AT	UNIT/CH 01	MINITOR 1 2 3 4 5 6 7 8	-SV- 1	Press the AT key for more than 3 seconds, and auto-tuning is executed for group 1 (Ch 1, 2, 3). The channel monitor lamps (1, 2, 3) flash.
Auto-tuning termination		UNIT/CH 01	MINITOR 1 2 3 4 5 6 7 8	-SV- 1	Auto-tuning is completed for group 1 and the channel monitor lamp goes off. Group 1 starts operation under PID control.
Auto-tuning terminated? No / Yes → END		UNIT/CH 07	CHR tG	-SV- 3	Similarly, after auto-tuning for groups 2 and 3 has been completed, operation starts under PID control.

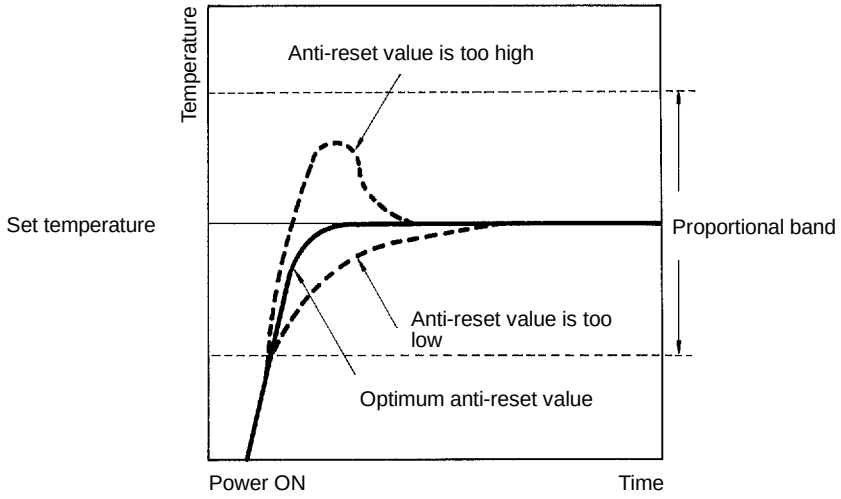
3-5 Functions

3-5-1 ARW

In control operation with integral operation, over-integration during the initial stages of control operations can result in temperature overshoot. To prevent overshooting, the ARW value provides the convergent value of the integral as the initial value. The procedure is as follows:

1, 2, 3...

1. When the convergent value is not known for a control object, a value of 50 (ARW = 50) is set and control is performed.
2. When control attains a stable condition, the output value becomes the convergent value of the integral, and setting is renewed using this as ARW value.
3. When power is next applied to the Unit, control performance with an extremely small amount of overshoot can be expected.



3-5-2 Auto-tuning Procedure and Precautions

E5M grouping function enables auto-tuning for heat interference. Auto-tuning for normal output (cooling control) is also possible.

Operation Procedure

The operation differs according to the type of host communications link. For details, refer to the specifications for each host link. An outline of the procedure is as follows:

1, 2, 3...

1. **Grouping**
   Grouping is valid only within one Unit; grouping extending to two or more Units is not possible.
   Group numbers range from 1 to 8; i.e., each unit can contain up to eight groups.
   Auto-tuning cannot be conducted if grouping has not been performed. Even if there is no heat interference, be sure to perform grouping for each individual channel.
2. **Temperature setting**
   The PID constant differs according to the control temperature. Input the desired temperature set value.
3. **Control period setting**
   The control period after memory initialization is set at 20 seconds. Set a control period suited to actual output. The shorter the control period is,

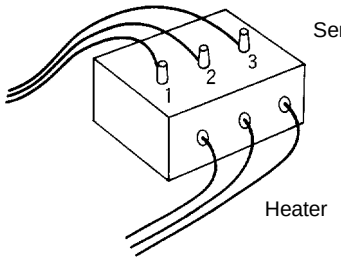
the better the control characteristics becomes. but as the frequency of contact opening and closing becomes higher, contact life is shortened. With solid-state outputs, there is no relationship between control period and life span since there is no contact. Set to 1 second.
With current outputs control period has no affect on the output. The output current is controlled by the sampling period.

4. **Power application to the control object.**
In order for auto-tuning to measure the heat characteristics of the control object, it is necessary to actually raise the temperature. Be sure to maintain conditions such that temperature control is possible.
5. **Operation**
With the Programming Console, press the RUN switch while PROG is lit. When communicating from a host computer, an operation command is sent.
6. **Auto-tuning**
Auto-tuning is started.

Auto-tuning Precautions

Where there is strong heat interference, as with metal molds, control by set temperature may not be possible. Exercise caution.

Example



1...Set temperature = 200%C
2...Set temperature = 50%C
3...Set temperature = 200%C
If the output value of sensor no. 2 is 0% and the temperature exceeds 50%C, temperature control with these settings cannot be performed.

The PID and ARW values obtained by auto-tuning have an amplitude decrease rate of 25%, and they may not suit some heating systems or application. In such cases, perform setting manually referring to the auto–tuning value.

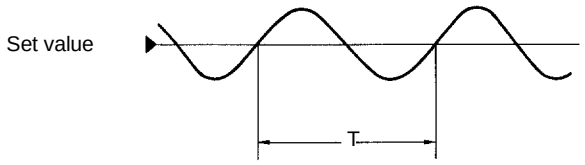
To eliminate hunting (when slow response is acceptable). For slow hunting...increase P or I value. For hunting in short cycles...decrease D value. To eliminate overshoot (when long rise time is acceptable)...decrease ARW value.

Heat characteristic measurement is not possible with operations with automatic changeover of heater capacity by temperature, or cooling at a temperature slightly higher than a set temperature. Conduct auto-tuning in the fixed heat system of the desired temperature.

When controlling heat/cool application, optimum PID parameter cannot be obtained. Set parameters manually.

The E5M may not perform stable control in heating systems with dead time of less than 40 seconds. In such a case, set parameters manually to conduct PID control. To measure dead time: conduct ON/OFF control (P = 0); after

the set value has been exceeded, measure the time required to return to the set value.



3-5-3 E5M Auto-tuning Algorithm

Step Response Method Auto-tuning (Pin no. 3 of SW101 is OFF)

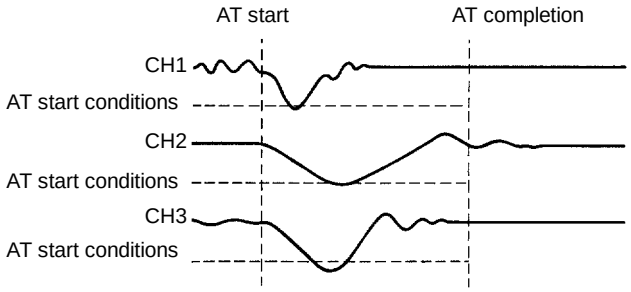
1, 2, 3... 1. E5M requires the following conditions to perform the step response auto-tuning. It will turn the output OFF and wait in stand-by condition until conditions are satisfied.

Reverse operation (heating system):
Present Temperature ≤ (Set Temperature − FS Lower Limit Temperature) x 2/3

Normal operation (cooling system):
Present Temperature ≥ FS Upper Limit Temperature − (FS Upper Limit Temperature − Set Temperature) x 2/3

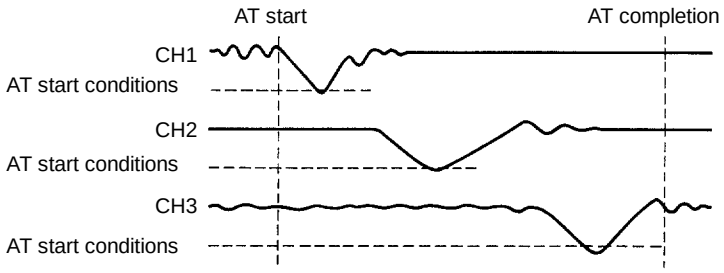
2. If the conditions are not satisfied, then auto-tuning commences after approx. 1 hour, based on the temperature at that time.
3. The first auto-tuning after power application starts on all the channels which have been grouped together.

Example: Ch 1, Ch 2, Ch 3 have been set in the same group.



4. Auto-tuning is conducted in order by channel number by group.

Example: Ch 1, Ch 2, Ch 3 have been set in the same group.

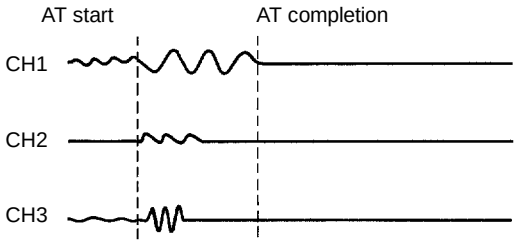


5. If eight channels are grouped together and there is heat interference, a stand-by of approximately 1 hour may occur for each due to the heat capacity of each channel. Thus, a total of 8 hours or more of auto-tuning time is required.

Limit Cycle Method Auto-tuning

1, 2, 3... 1. The limit cycle method of auto-tuning conducts ON/OFF control at set temperature, measures 3-cycle hunting, and calculates the PID constant. Since the temperature variation of the hunting is the same as with ordinary ON/OFF control, the temperature fluctuation differs according to the heat system. The same can be said of auto-tuning time.

2. The first auto-tuning after power application starts on all the channels which have been grouped together.
A desired channel can be selected regardless of the group in which it is included. (*See note below)*
Example: Ch 1, Ch 2, Ch 3 have been set in the same group.



3. The limit cycle method of tuning is conducted in order by channel number for each group.
Example: Ch 1, Ch 2, Ch 3 are set in the same group.

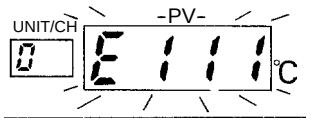
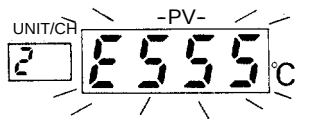
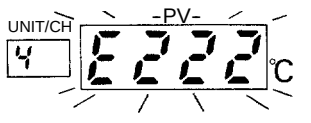
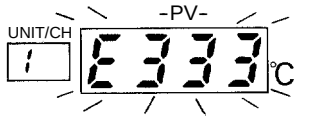
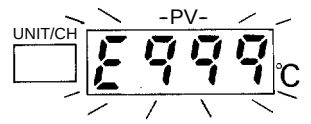
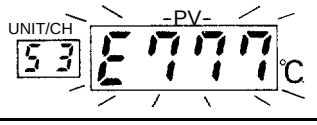
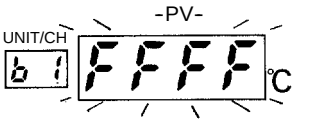
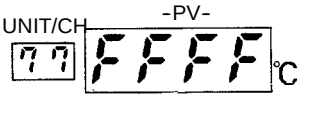
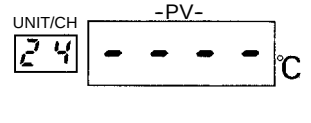
Note When auto-tuning is executed for the first time, either the step response method or the limit cycle method will be selected depending on the conditions stated below. For all auto-tuning operations after the first one, the limit cycle method will be employed regardless of the conditions.

Reverse operation (heating):
Process temperature ≤ (Set temperature − FS lower-limit temperature) x 2/3
Normal operation (cooling):
Process temperature ≤ FS upper-limit temperature − (FS lower-limit temperature − Set temperature) x 2/3

When the process temperature satisfies the above condition, the step response method will be employed. Otherwise, the limit cycle method will be employed.

3-6 Error Display Summary

The E5M possesses the full range of self-diagnostic functions. During communications, all types of error information are transmitted in the form of status data (for details, refer to the *Host Link Communications* section). For the Programming Console and Display, error messages are shown on the PV display as shown below:

Priority	Diagnosis	Display	Problem	Remedy
1	Memory error		Error is detected in the internal memory. The relevant unit number is displayed.	After initializing memory (see *3-3-1*), turn off the power or conduct external reset.
2	Communications error		Communications error is detected with the Temperature Controller Slave. The relevant unit number is displayed.	If after power application, either turn off the power or reset. If during operations, press any key.
3	Internal voltage error		Error is detected with the internal DC power supply. The relevant unit number is displayed. The unit in question is then in a condition identical to power OFF and all outputs are OFF.	See note 2.
4	A/D converter error		Error is detected with the A/D converter. The relevant unit number is displayed. The unit in question is then in a condition identical to power OFF and all outputs are OFF.	See note 2.
5	Memory Cartridge operation error		Memory cartridge Read/Write operation cannot be conducted normally.	Press any key.
6	Setting error		A set value error occurs. The relevant unit and channel are indicated by a flashing display.	As for memory error.
7	Sensor error		Input sensor error is detected. Control output turns OFF when the relevant channel is displayed. The BURNOUT LED of the status display flashes.	Reconnect or replace sensor.
8	Overflow		When input exceeds the measurable range (exceeding + 110% FS). Control output turns OFF when the relevant channel is displayed.	Maintain input level within measurable range.
9	Underflow		When input falls below the measurable range (below −10% FS). Control output turns ON when the relevant channel is displayed	Maintain input level within measurable range.

Note 1. Multiple errors are registered on the display in order of priority. In the case of simultaneous occurrence in multiple channels, priority is given to the lowest numbered channel.

2. When a memory error, communications error, A/D convertor error, or internal voltage error is displayed and the display does not extinguish after memory initialization and turning off and on the power, a hardware error exists and repair is necessary.

3. The PV displays flash on the E5M−SD, but do not flash on the E5M−D.

SECTION 4
Host Link Communications

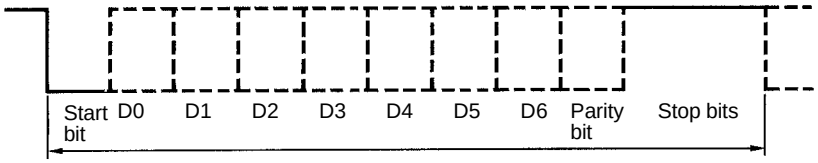
4-1 Communications Procedures for RS-232C, RS-422

4-1-1 General Specifications

1. Transmission path connection: multipoint
2. Communications method: 4-line system half double
3. Synchronization: Start-stop (2 stop bits)
4. Transmission speed: 150/300/600/1,200/2,400/4,800/9,600 bps (changeover by internal switch)
5. Transmission code: ASCII (7 bit)
6. Error detection: vertical parity (even numbers) and FCS (Frame Check Sequence)
7. Interface: RS-232C/RS-422

Definition Terminal Definition (DTC)

Note: Stop-start synchronization data structure



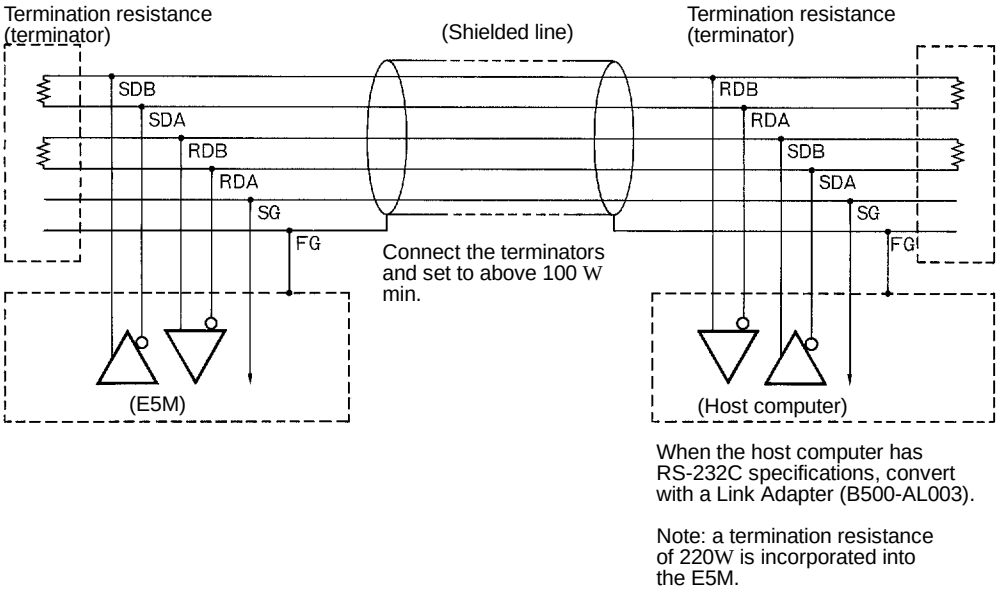
4-1-2 Interface and Setting Method

Direct Flow Interface

- Electric characteristics: EIA conformity to RS-422
- Connection signals

Signal name	Code	Signal direction	Pin no.
Send data A	SDA	Output	9
Send data B	SDB	Output	5
Receive data A	RDA	Input	6
Receive data B	RDB	Input	1
Signal ground	SG	---	3
Frame ground	FG	---	7

- Compatible connector: XM2 D-subconnector (9 pin, OMRON)
- Connection method (in the case of connection by RS-422): a connection of up to 1:32 is possible.



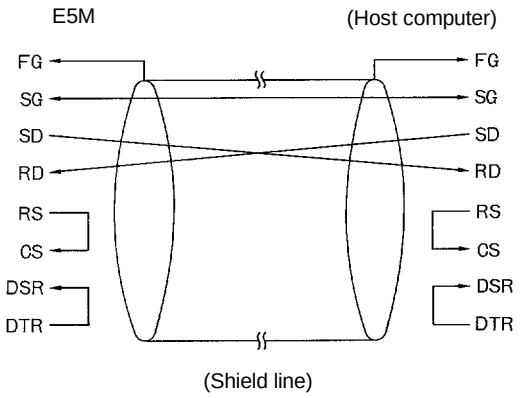
- Synchronous clock: internal clock
- Path length: 500 m maximum
- Recommended cable: CO-HC-ESV-3P X 7/0.2 (ribbon cable)

Modem Interface

- Electric characteristics: EIA conformity to RS-232C
- Connection signals

Circuit name	Code	Signal direction	Pin No.
Frame ground	FG	---	1
Signal ground	SG	---	7
Send data	SD	Output	2
Receive data	RD	Input	3
Send request	RS	Output	4
Send possible	CS	Input	5
Data set ready	DSR	Input	6
Data end ready	DTR	Output	20

- Compatible connector: XM2 D-subconnector (25P, OMRON)
- Connection method (in the case of direct connection by RS-232C): only a 1:1 connection is possible.

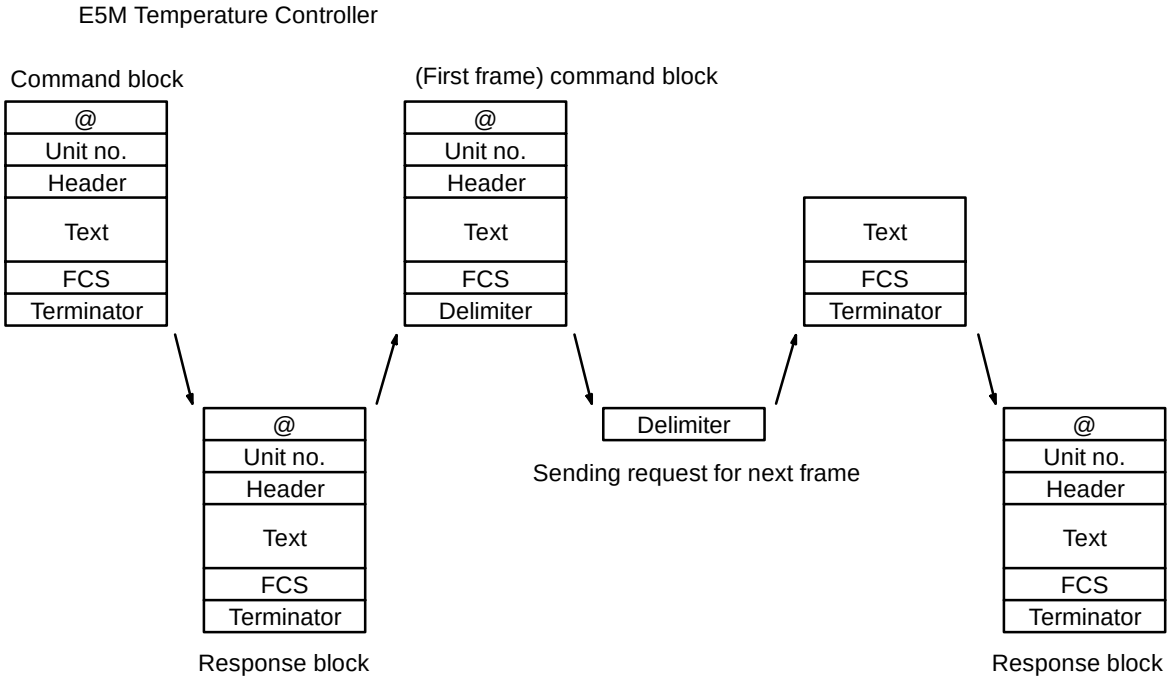


- Synchronous clock: Internal clock
- Path length: 15 m maximum

4-1-3 Communications Protocol and Error Detection

Communications Control Procedure

The transmission procedure for this Unit is a conversational form with exclusive and checksum procedure. The initial transmission right is held by the host computer side, and this right is transferred with each 1-block transmission. When a command is sent, a response is always returned.

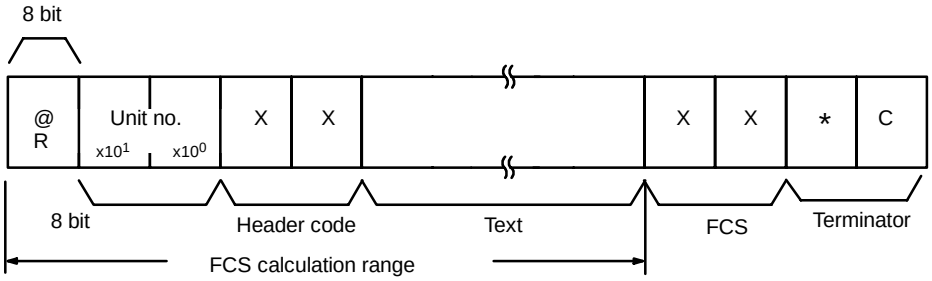


Note If more than one E5M Unit is connected, carefully set the DIP switch so that no overlap of unit numbers occurs.

Block Definition

The block sent from the host computer is called the command block; the block sent from the temperature controller is called the response block.

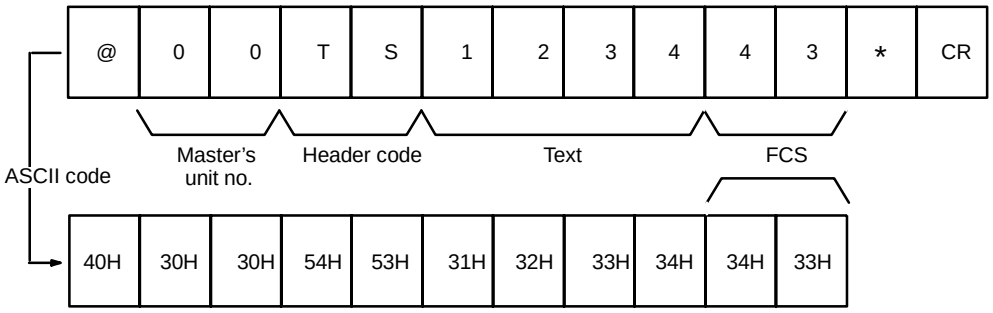
An individual block begins with the unit number of the Master and a header code, and ends with FCS and terminator.



Data characters are in ASCII.

FCS is the 2-character ASCII equivalent of the 8-bit data generated by taking the exclusive OR of the data from @ to the final character of the text.

Sample calculation of FCS:



Note: FCS=40H 30H 30H 54H 53H 31H 32H 33H 34H=43H (4=34H, 3=33H in ASCII code)
(indicates exclusive OR, data is given here as the hexadecimal equivalent of binary)

If the number of characters of 1 block (CR from @) is greater than 128, divide the command block into a multiple number of frames to transmit. When doing so, the initial and intermediate frames must end with a delimiter (CR).

In the above case, the host computer cannot transmit the following frame until it has received a transmit request delimiter (CR).

When transmission is made from the E5M, command block must be divided in the same way. Support delimiter control on the host side also.

Error Control

Errors involving the E5M can be reset only from the host computer. Error detection functions involving transmission to or from this Unit are as stated below.

Check by Character (Data Is Checked Bit-by-bit)

1, 2, 3... 1. Vertical parity check (even-numbered parity): parity check per individual character.
2. Framing check: in the case where "0" is detected in the stop bit position, it is assumed that an error has occurred during transmission.
3. Overrun check: If, while in the middle of processing one character, the following character is received.

Block Check (Data Is Checked by Block)

1, 2, 3... 1. Format check: checking of the command format structure of each block.

2. Value range check: checking the value range of the start channel, read channel, etc.
3. FCS: exclusive OR of all data from @ to the final character of text. The FCS is the ASCII equivalent of the result.

Note Send a TS command if there is no response after transmission of a command, and confirm if it is sent back in response.

Operational Precautions

It is necessary to conduct Write/Read of numeric data according to the data type and taking decimal points into consideration. All data is entered as 4 digits.

Example

An integral time/derivative time value of 10 s 0010
An ARW value of 5% 0005
Proportional band 5.0% 0050

With Temperature Controller model P01 (0.0 to 100.0)
A set temperature of 20.0%C 0200
A process temperature of −1.5%C 8015

When a command is sent, there should always be a response. Check the response contents and take measures for errors the host side.

If an overflow, underflow, setting error, burn-out, A/D error, communications error, etc., is detected, normal operations cannot be performed. Be sure to include data status check in the program.

If there are more than 128 characters, it is necessary to divide them into a multiple number of frames for both transmitting or receiving, otherwise the communications buffer will overflow. Develop a program which allows delimiter processing for both transmitting and receiving. In the case where (*) is the character immediately preceding (CR), a terminator results. In the case where FCS data is the character immediately preceding (CR), a delimiter (data still remaining due to frame division) results.

After the power has been turned on, test communication to confirm that E5M is activated.

When using normal BASIC for communications, the computer will wait for inputs and not operate until they are received. Timed interrupts must thus be used to prevent communications from locking up when malfunctions occur, such as could happen when E5M power is not on.

Since the RS-232C of E5M uses DTE (data terminal definition), it cannot provide support for the CD signal (pin 8) from the host. If the host requires a CD signal, perform processing on the host side (the FC984 does not require CD).

Since the character for " " (space) is format checked as a character, do not use it in the command.

The E5M analyzes the characters from (CR) to (CR) and then makes use of them. Before a command block beginning with @, be sure to place (CR). If there is a character other than (CR) before @, E5M will interpret this as a command to a different device and will not read it.

4-2 Commands and Responses

Command list

Header code	Name	Master	Programming Console	LOCAL mode	Remarks
WS	Set Temperature Write	Valid	Valid	Not-valid	0 to FS
W%	Upper-limit Alarm Temperature Write	Valid	Valid	Not-valid	0 to FS
W&	Lower-limit Alarm Temperature Write	Valid	Valid	Not-valid	0 to FS
WB	Proportional Band Write	Valid	Valid	Not-valid	0.0 to 999.9%
WN	Integral Time Write	Valid	Valid	Not-valid	0 to 3,999 s
WV	Derivative Time Write	Valid	Valid	Not-valid	0 to 3,999 s
WA	ARW Value Write	Valid	Valid	Not-valid	0 to 99%
WT	Control Period Write	Valid	Valid	Not-valid	1 to 99 s
WJ	All Values Write	Valid	Valid	Not-valid	---
WM	Memory Cartridge Write	Not-valid	Valid	Valid	---
RS	Set Temperature Read	Valid	Valid	Valid	---
R%	Upper-limit Alarm Temperature Read	Valid	Valid	Valid	---
R&	Lower-limit Alarm Temperature Read	Valid	Valid	Valid	---
RB	Proportional Band Read	Valid	Valid	Valid	After auto-tuning completion
RN	Integral Time Read	Valid	Valid	Valid	After auto-tuning completion
RV	Derivative Time Read	Valid	Valid	Valid	After auto-tuning completion
RA	ARW Value Read	Valid	Valid	Valid	After auto-tuning completion
RT	Control Period Read	Valid	Valid	Valid	---
RJ	All Values Read	Valid	Valid	Valid	After auto-tuning completion
RM	Memory Cartridge Read	Not-valid	Valid	Not-valid	---
RU	Initial Status Read	Valid	Valid	Valid	---
RX	Measured Data Read 1	Valid	Valid	Valid	For ordinary operation
RY	Measured Data Read 2	Valid	Valid	Valid	Immediately after auto-tuning completion
OS	Operation Start	Valid	Valid	Not-valid	---
OP	System Stop	Valid	Valid	Not-valid	---
AS	Auto-tuning Start	Valid	Valid	Not-valid	---
AP	Auto-tuning Stop	Valid	Valid	Not-valid	---
AG	Auto-tuning Grouping	Valid	Valid	Not-valid	---
TS	Test Communication	Valid	Valid	Valid	---
UE	Undefined Error	Valid	Valid	Valid	Response only
AA	Data Global Write	Valid	Valid	Not-valid	Used with other commands
MC	Set Value Initialize	Valid	Valid	Not-valid	---

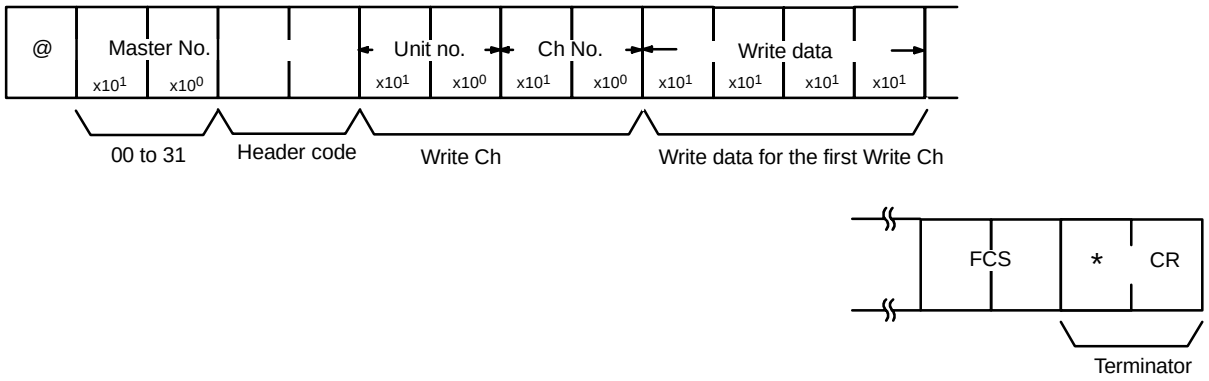
Note 1. When in LOCAL mode using a Programming Console, only Read commands are valid, and if a Write command is transmitted, end code “OD” (unable to perform in LOCAL mode) is given in response. Memory Cartridge Read commands are also invalid in LOCAL mode. Operations identical to those in LOCAL mode are performed during auto-tuning.

2. If there is a mistake made concerning the valid range of the setting data during transmission, register data error “15” is output for the end code.

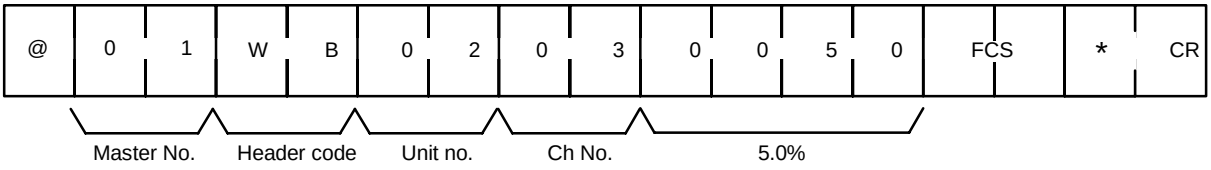
4-2-1 Set Temperature Write

This section covers the writing of the set temperature, upper/lower limit alarm, proportional band, integral and derivative time, ARW values, and control period.

Command Format

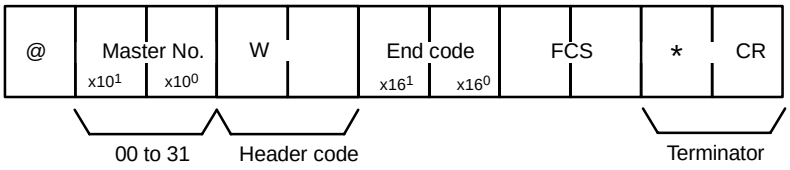


(Example) When setting a proportional band of 5% for channel number 3 of slave unit number 2 under master unit number 1, the command format is as follows.



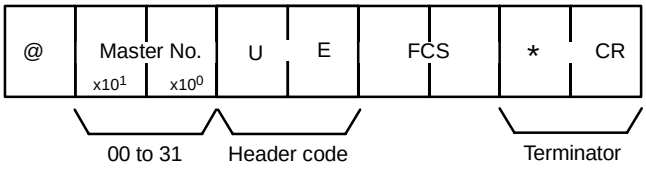
Note Write data must be written according to data type and taking decimal points into consideration (see *Section 4-1-3*, under *Operational Precautions*, for a typical example).

Response Format 1



Conditions are normal when the end code is “00.” Command processing is impossible with any end code other than “00.”

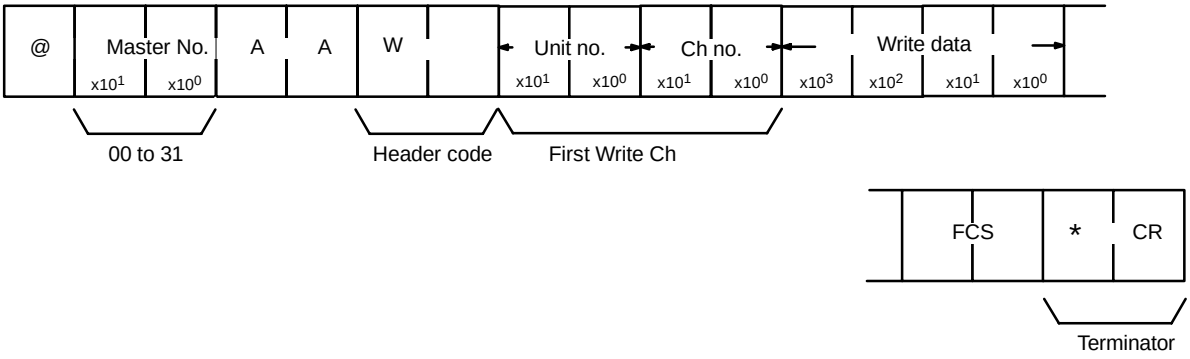
Response Format 2 (Command Header Code Cannot Be Read)



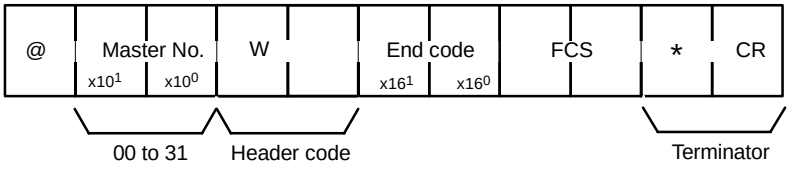
Note
1. The range of unit numbers is 0 to 99, and that of Ch (channel) numbers 01 to 08.
2. For negative data, the leftmost digit (10^3) is 8 (example: –35%C=8035).
3. The block Write command is WJ. With the WJ command, it is possible to transfer block data channel-by-channel in the order of set temperature, upper limit alarm temperature, lower limit alarm temperature, proportional band, integral time, derivative time, ARW value, and control period.
4. The upper/lower limit alarm temperature is the deviation setting for the set temperature.
5. To make the upper/lower limit alarm an invalid setting, write in the Write data as “CCCC.”
6. To make a channel an invalid setting, write in the set temperature data as “CCCC.”
7. The setting range of the control period is 1 to 99. When 0000 is written in, a register data error is detected.
8. When Write is conducted for a Unit during auto-tuning, since it is in LO-CAL mode, execution is not possible.

4-2-2 Data Global Write

Command Format

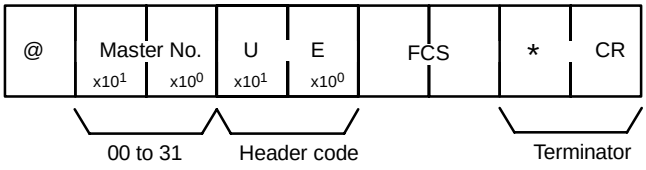


Response Format 1



Conditions are normal when the end code is “00.” Command processing is impossible with any end code other than “00.”

Response Format 2 (Command Header Code Cannot Be Read)

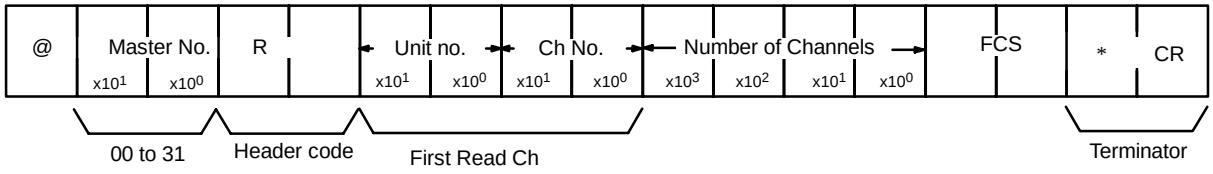


Note
1. By appending the desired Write command (with the exceptions of AG, WJ, WM) after the composite command AA, it is possible to write in an identical setting for all grouped channels following the first Write channel. For the AG, WJ, WM commands, a response indicating that the command header code is impossible to read (UE response) is registered.
2. To make the upper/lower limit alarm an invalid setting, write in the Write data as "CCCC."
3. To make a channel an invalid setting, write in the set temperature data as "CCCC."

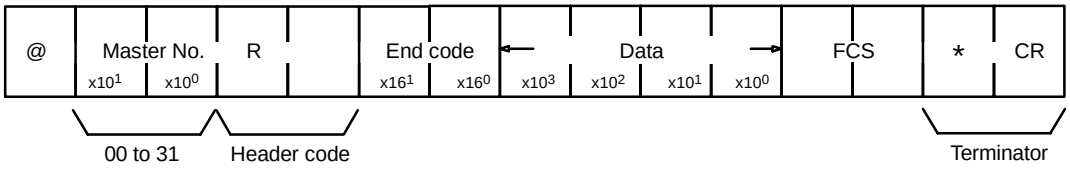
4-2-3 Set Temperature Read

This section covers the reading of set temperature values, upper/lower limit alarm, proportional band, integral and derivative time, ARW value, and control period.

Command Format

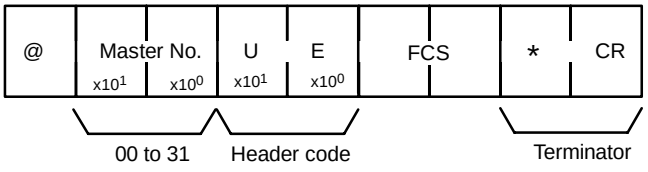


Response Format 1



Conditions are normal when the end code is "00." Command processing is impossible with any end code other than "00."

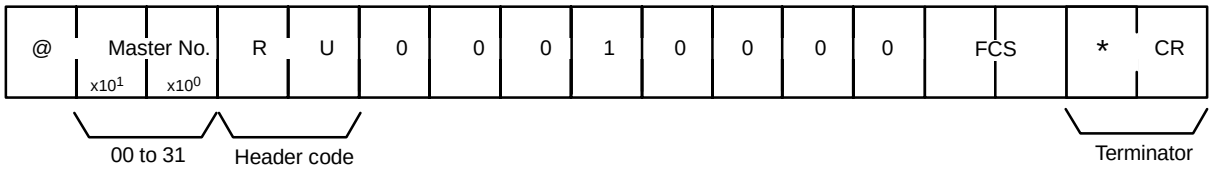
Response Format 2



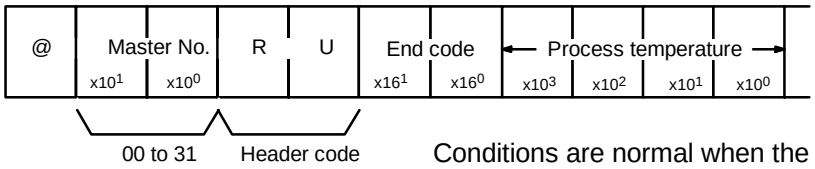
Note
1. The block Read command is RJ. In response to the RJ command, it is possible to read data channel-by-channel in the order of: set temperature, upper limit alarm temperature, lower limit alarm temperature, proportional band, integral time, derivative time, ARW value, and control period.
2. For each Read command, entering 0000 as the Read channel data causes continuous reading of data from the first Read channel to the final valid channel within each Unit.

4-2-4 Initial Status Read

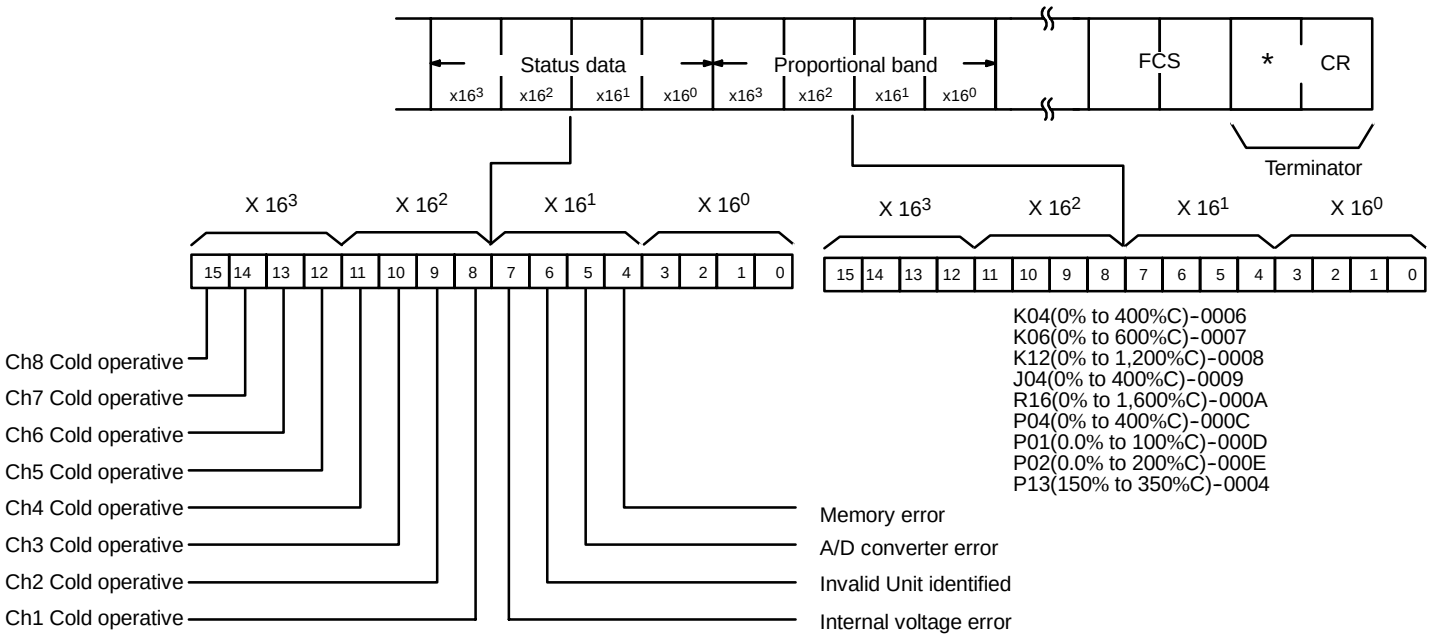
Command Format



Response Format 1



Conditions are normal when the end code is "00." Command processing is impossible with any end code other than "00."



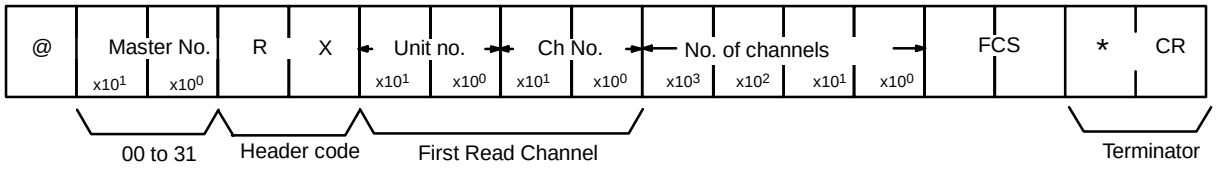
(Example) When Ch1 to 8 are cold operative and free of any error, the initial status is "FF00" (ASCII=46H, 46H, 30H, 30H). When a memory malfunction occurs, after executing a set value initialize command, turn off power and turn it on again.

(Example) With P01, the Temperature Controller type is "000D" (ASCII=30H, 30H, 30H, 44H).

Note
1. Other responses are omitted.
2. With this command, it is possible to confirm the initial conditions of the system.
3. In response to an unconnected unit number, an invalid Unit differentiation bit appears. Use this for confirmation.
4. As the response exceeds 128 characters, it is divided into multiple frames.

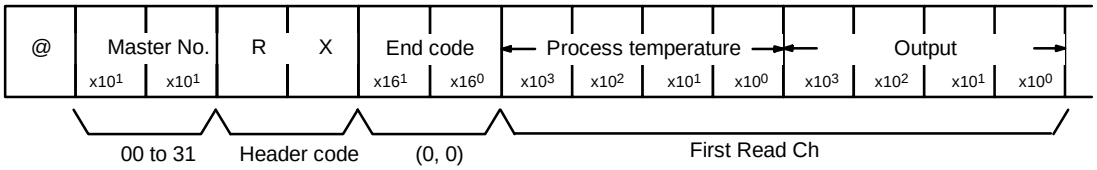
4-2-5 Measured Data Read (1)

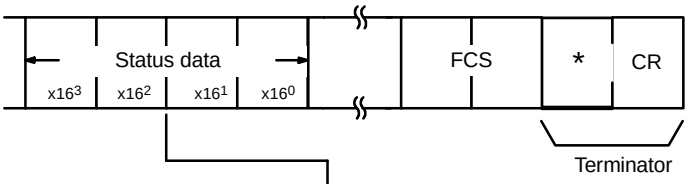
Command Format

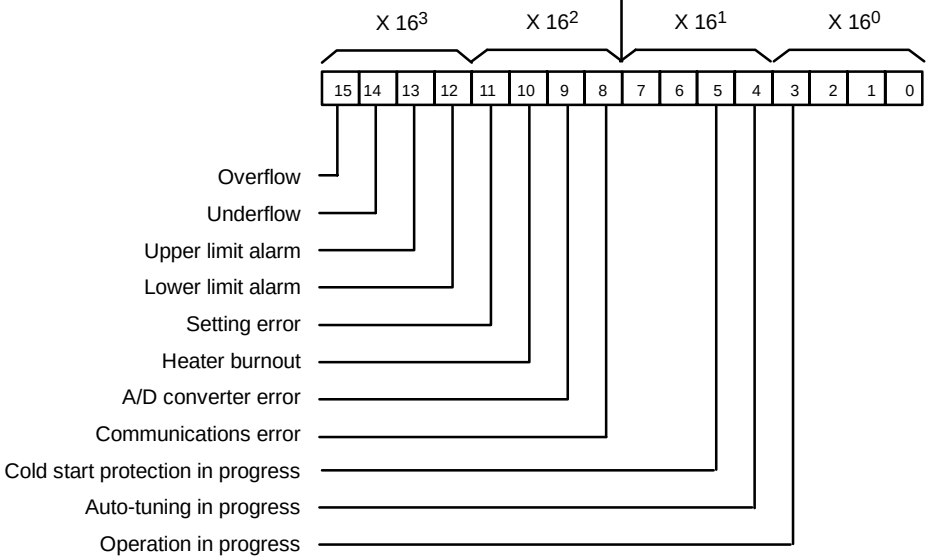


Note A correct measured temperature cannot be output if Set Temperature Write *(see section 4-1-5)* has not been performed.

Response Format 1 (Normal Processing Time)

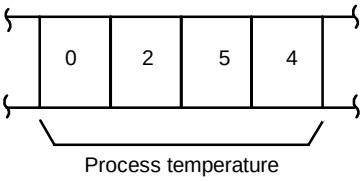






(Example) When the upper limit alarm is detected, the status data becomes "2008" (ASCII=32H, 30H, 30H, 38H).

Note 1. With a platinum resistance thermometer P02 (Pt0.0% to 200.0%C), the measurement temperature data is as shown below (when the temperature is 25.4%C).

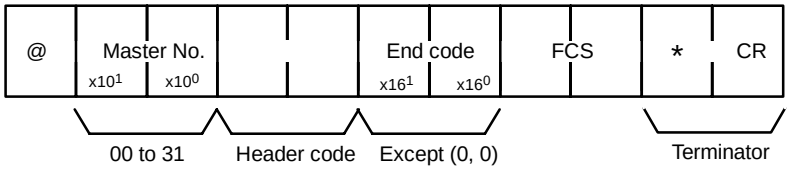


Exercise caution regarding decimal point position.

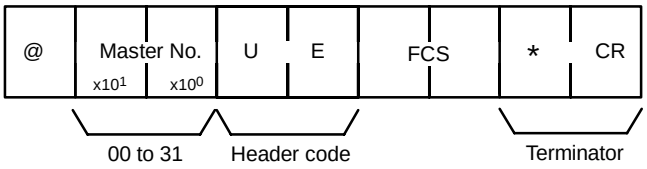
The cases of P01 (0.0% to 100.0%C) and P13 (150.0% to 350.0%C) are identical.

2. The range for the output amount is 0 to 100%. For example, when an output amount is 50%, the result would appear as 0 0 5 0.
3. If the set temperature data is input as “CCCC,” a correct measurement temperature cannot be output.
4. Since status data is output after Temperature Controller operations, the response to operational command auto-tuning will be delayed..

Response Format 2 (When Command Processing Is Not Possible)



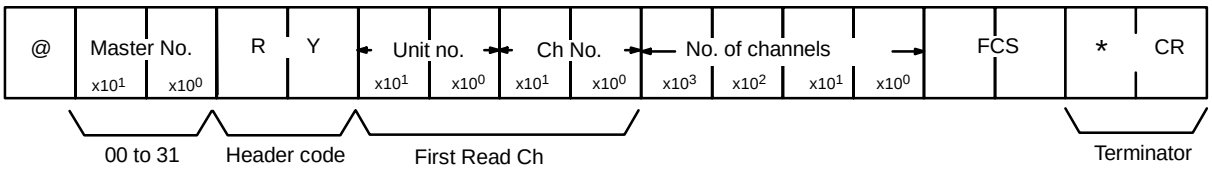
Response Format 3 (Command Header Code Cannot Be Read)



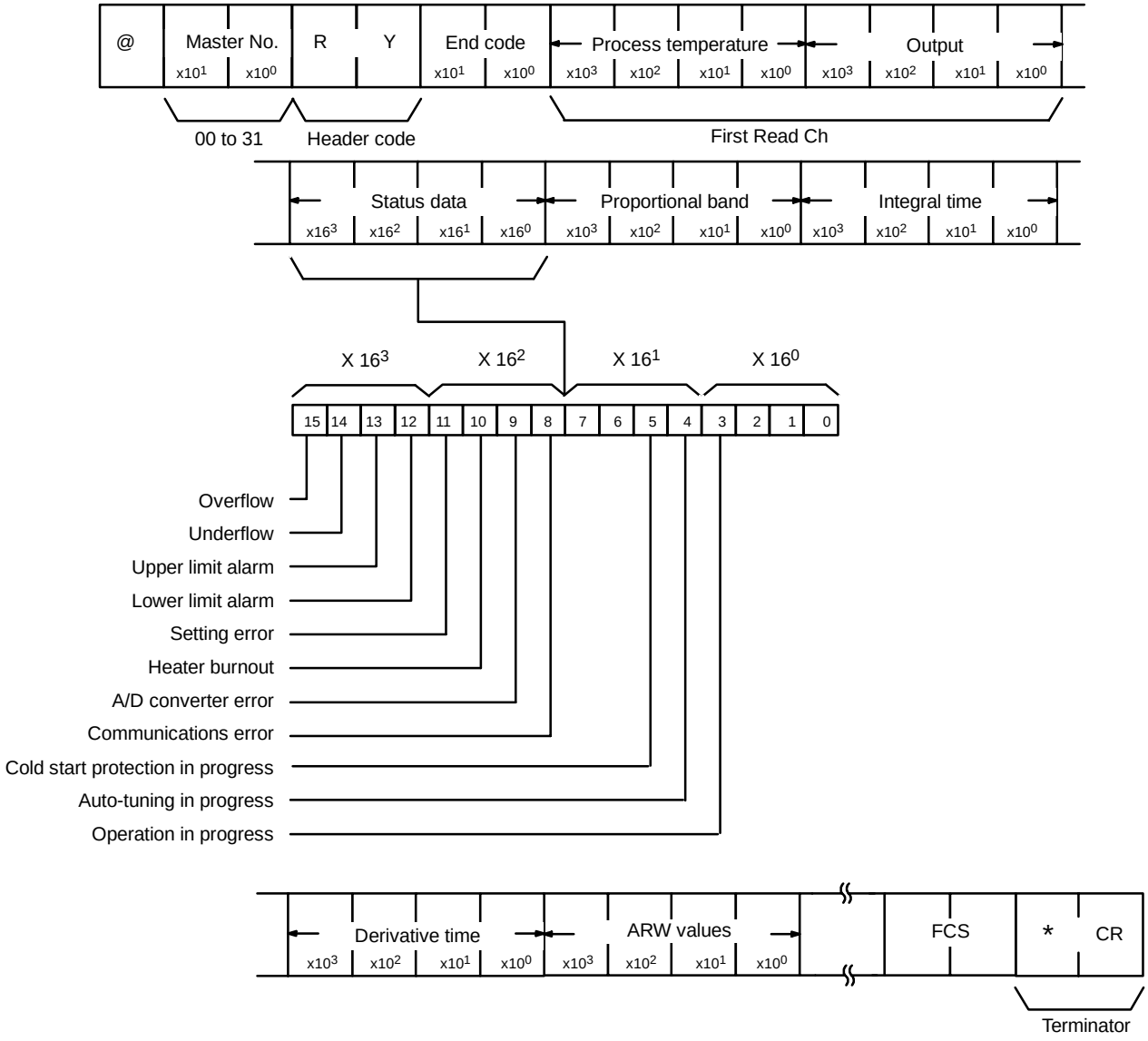
4-2-6 Measured Data Read (2)

The following shows the procedure for reading control parameters.

Command Format



Response Format



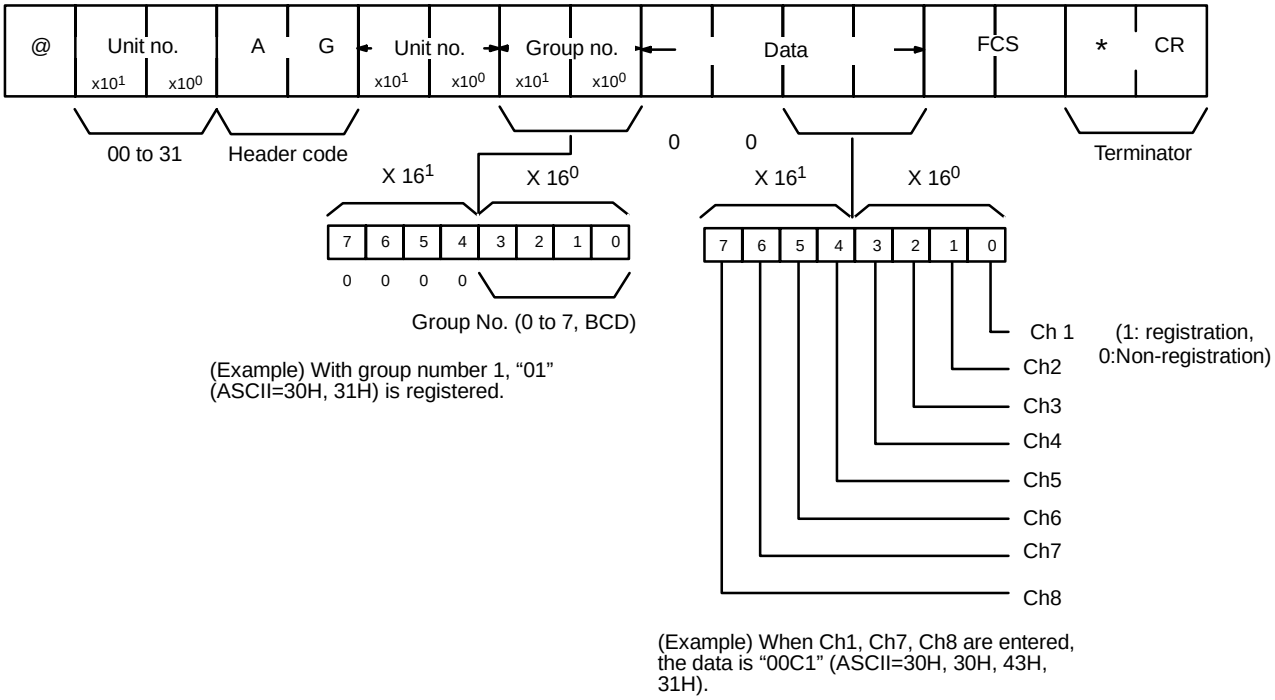
Note 1. Other response formats are omitted.

2. Since the proportional band, integral time, etc. are transferred together with the measured temperature by means of this command, it is valid for the Read of the parameter values calculated after completion of auto-tuning operations.

3. Since status data is output after Temperature Controller operations, the response to operational command auto-tuning will be delayed.

4-2-7 Auto-tuning Grouping

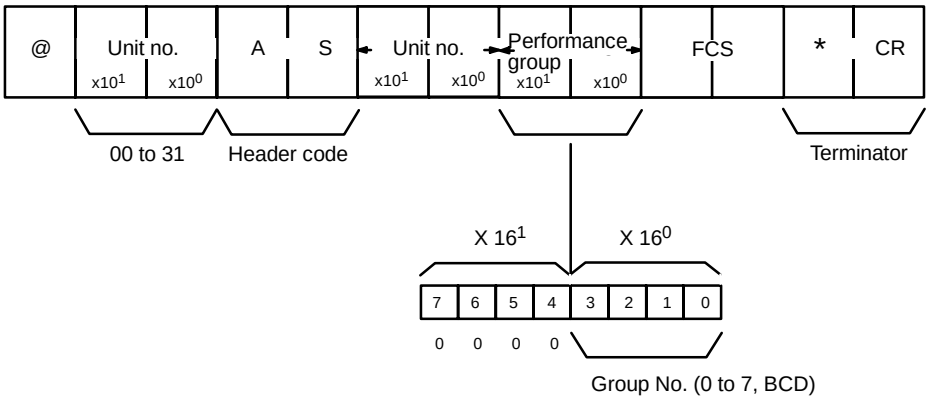
Command Format



Note
1. Response formats are omitted.
2. Auto-tuning grouping is limited to within each Unit i.e. it is not possible to extend grouping over two or more Units.
3. Grouping numbers range from 0 to 7 (BCD), with number 8 being reserved for invalid group setting. When inputting from the Programming Console, however, group numbers range from 0 to 8.
4. Exercise caution so that no channel is registered to 2 or more groups.

4-2-8 Auto-tuning Start (According to Group)

Command Format

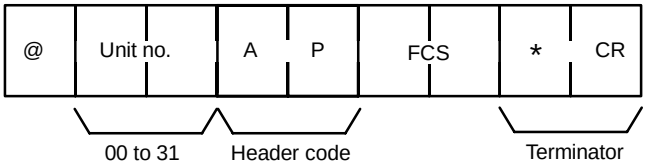


Note
1. Auto-tuning can be started only in RUN mode after the completion of grouping and temperature setting.
2. Response formats are omitted.

3. To simultaneously start all groups grouped together, input “F” as the group number.
4. Confirm auto-tuning performance and termination via the status data of the response to a Read (1) command. During execution of the “auto-tuning in progress” bit in the status data, “1” is registered; after termination, “0” is registered.
5. Confirm the PID, ARW values following auto-tuning termination by Readout via Measurement Data (2) command.

4-2-9 Auto-tuning Stop (Interrupt)

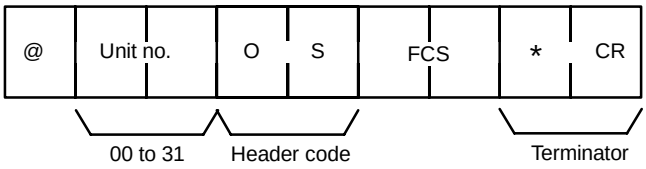
Command Format



Note 1. Response formats are omitted.
2. This command is common to all Units.

4-2-10 Operation Start

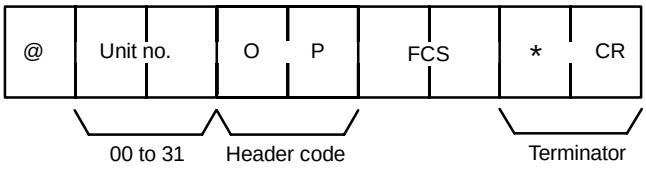
Command Format



Note 1. Response formats are omitted.
2. This command is common to all Units.

4-2-11 System Stop

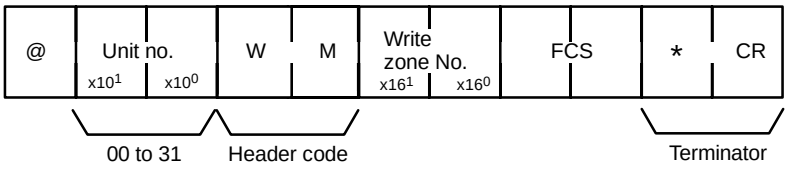
Command Format



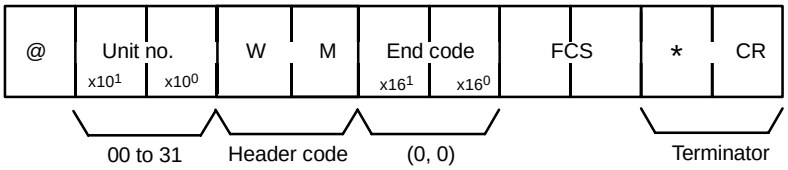
Note 1. Response formats are omitted.
2. This command is common to all Units.

4-2-12 Memory Cartridge Write

Command Format

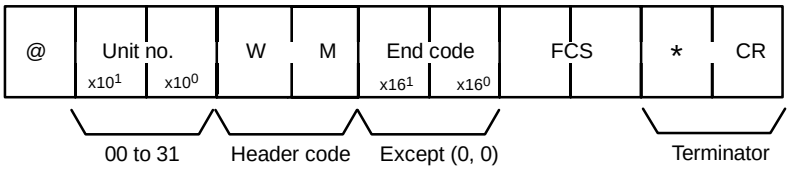


Response Format 1 (Normal Operation)

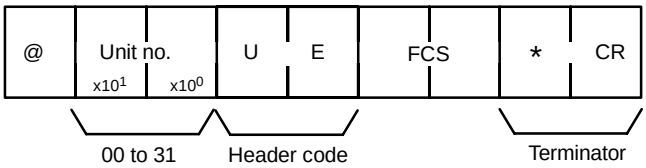


Response Format 2 (Command Processing Is Not Possible)

This format is used when there is a Memory Cartridge error or when the Memory Cartridge has not been properly inserted.



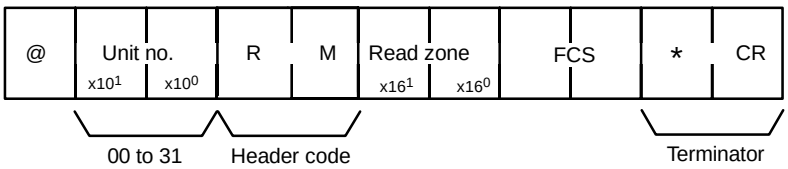
Response Format 3 (Command Header Code Cannot Be Read)



Note
1. The Write zone numbers range from 1 to 3. If other numbers are sent a register data error will result.
2. The memory Write data, which is the set value presently set to the programming console, is written into the specified zone.

4-2-13 Memory Cartridge Read

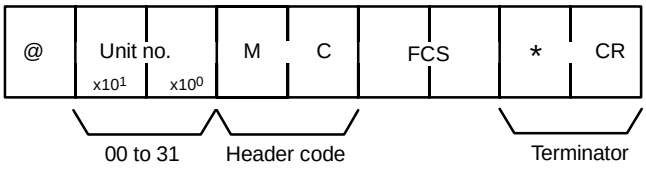
Command Format



Note
1. Response formats are omitted.
2. Read zone range is from 1 to 3. If other numbers are sent, a register data error will result.
3. Read memory is transferred from a specified zone to the programming console unconditionally. Before executing this command, it is necessary to check the data within the Programming Console otherwise it will overwrite what is presently being set.

4-2-14 Set Value Initialize

Command Format



To initialize after executing this command, turn off power to the Programming Console (SD) or the Master (TM) and then turn power on again, or input a reset signal.

Note 1. Response formats are omitted.

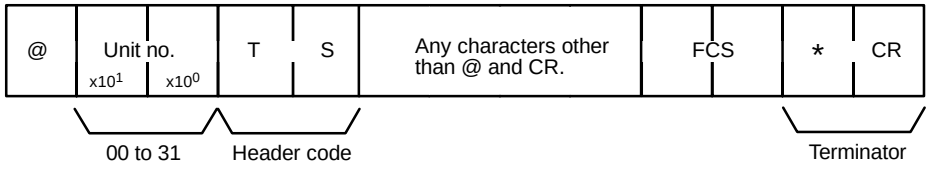
2. As a result of initializing, each set value becomes as shown below.

Set temperature:	“CCCC” (invalid setting)
Upper limit alarm set temperature:	“CCCC” (invalid setting)
Lower limit alarm set temperature:	“CCCC” (invalid setting)
Proportional band:	0
Integral time:	0
Derivative time:	0
ARW values:	50
Control period:	20
Auto-tuning group number:	8 (invalid group)

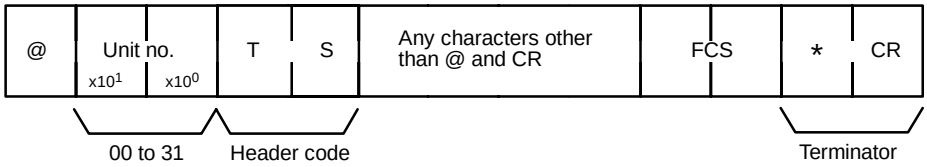
4-2-15 Test Communication

A single block of data sent from the host is returned as is. Test communications can also be accepted in a LOCAL mode.

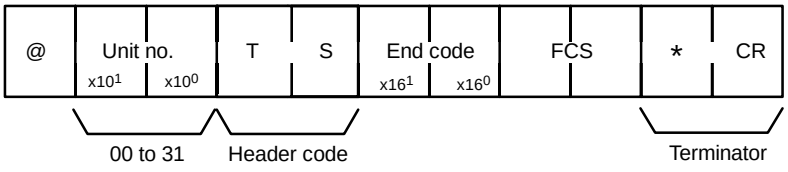
Command Format



Response Format 1 (Normal Processing)

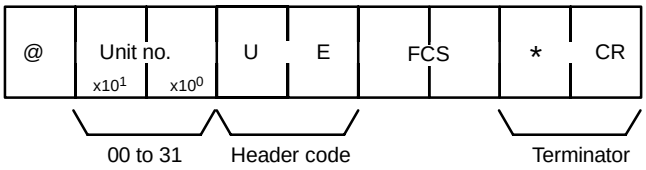


Response Format 2 (Command Processing Is Not Possible)



Note Error contents are indicated by the end code.

Response Format 3 (Command Header Code Cannot Be Read)



4-2-16 End Codes

$X16^1$	$X16^0$	Description
0	0	Normal ending
0	1	---
0	2	---
0	3	---
0	4	Address over (more than 81 characters designated)
0	B	---
0	C	---
0	D	Execution not possible due to LOCAL mode (includes during AT)
1	0	Parity error (even numbered parity)
1	1	Framing error
1	2	Overrun error
1	3	FCS error
1	4	Format error (parameter length error)
1	5	Register data error (parameter, data code, data length)
1	8	Frame length error
1	9	---
2	0	---
A	0	Interruption due to occurrence of a parity error in data transmission during processing.
A	1	Interruption due to occurrence of a framing error in data transmission during processing.
A	2	Interruption due to occurrence of an overrun error in data transmission during processing.
A	3	Interruption due to occurrence of a FCS error in data transmission during processing.
A	4	Interruption due to occurrence of a format error in data transmission during processing.
A	5	Interruption due to occurrence of out-of-range data error in transmission during processing.
A	8	Interruption due to occurrence of a frame length error in data transmission during processing.
B	0	Memory Cartridge not properly inserted
B	1	Memory Cartridge data malfunction (Read, Write)

Note
1. When the Unit in question detects an error in the first frame, processing is not conducted and the relevant error response is returned.,
2. When an error is detected in an intermediate frame, further processing is refused and the relevant error response is returned.
3. When in LOCAL mode, the Write of set values during auto-tuning is not possible.(OD).

4-2-17 Communications Time

Due to transmission speed and E5M internal processing, communications involving RS-232C and RS-422 experience time delays in the manner shown below. Exercise due care.

Example 1: Set Temperature Write

Setting of 50.0%C to channel number 1 of slave unit number 0 under master unit number 0.

- Command Format
  @ 0 0 W S 0 0 0 1 0 5 0 0 (FCS 2 columns) * ....17 bytes
  From the structure of Stop-start synchronization data, 11 bits are required for each byte. 11 bits X 17 bytes=187 bits
  If communications are conducted at 1200 bps, 187/1200 bps = Approx. 0.2 s.
- The data communications time from the SD to TS interval or the TM to TS interval.
  0.5 s/Ch (since for this example only 1channel changes, 0.5 s is required).
- TS internal processing time
  Max. 2 s
- Temperature control calculation cycle
  Max. 2 s
  Thus, the time from the start of communications to actual operations is 4.7 s max. (0.2+0.5+2+2).

Example 2: Measurement Data Read

Reading temperature of channel number 8 of slave unit number 2 under master unit number 1. There are two Units.

- Command Format
  @0 1 R X 0 2 0 8 0 0 0 1 (FCS 2 columns) * .....17 bytes
  11 bits/byte X 17 bytes=187bits
  Response Format
  @ 0 1 R X 0 0 0 5 0 0 0 0 0 5 0 (status data 4 columns) (FCS 2 columns) * ...23 bytes (process temperature of 50.0 C, with output of 50%)
  11 bits/byte X 23 bytes=253 bits
  If communications are conducted at 1,200bps, 187 + 253 bits/1,200bps=0.37 s
  After command transfer until response has been output, a Max. of 0.1 s is required.
- Temperature Measurement Cycle
  Max. 2 s
- TS Internal Processing Time
  Max. 2 s
- The data communications time for the TS to SD interval or the TS to TM interval.
  0.5 s/Unit (since there are 2 Units, 0.5 X 2=1 second)
  Thus, from communications start to the measurement temperature read takes approximately 0.5 s (0.3 + 0.1), but this displayed temperature is the temperature measured at a maximum of 5 s (2+2+1) before.

4-2-18 ASCII Code Chart

Bits	5 to 8	0000	0001	0010	0011	0100	0101	0110	0111
1 to 4	Digits (HEX)	0	1	2	3	4	5	6	7
0000	0	NUL	DLE	SPACE	0	@	P		p
0001	1	SOH	DC_1	!	1	A	Q	a	q
0010	2	STX	DC_2	”	2	B	R	b	r
0011	3	ETX	DC_3	#	3	C	S	c	s
0100	4	EOT	DC_4	$	4	D	T	d	t
0101	5	ENQ	NAK	%	5	E	U	e	u
0110	6	ACK	SYN	&	6	F	V	f	v
0111	7	BEL	ETB	,	7	G	W	g	w
1000	8	BS	CAN	(	8	H	X	h	x
1001	9	HT	EM	)	9	I	Y	i	y
1010	A	LF	SUB	*	:	J	Z	j	z
1011	B	VT	ESC	+	;	K	[	k	{
1100	C	FF	FS	,	<	L	\	l	|
1101	D	CR	GS	-	=	M	]	m	}
1110	E	SO	RS	.	>	N	^	n	~
1111	F	SI	US	/	?	O	-	o	DEL

4-3 SYSMAC BUS Communications Procedures

The E5M can be connected to OMRON's Programmable Controller via a Remote I/O Master Unit. In this manual, only aspects directly related to E5M are presented. In actual use, consult OMRON's Remote I/O Systems Manual.

4-3-1 Allocation of Data Transmitted and Received

PC I/O	OUT				IN			
Bit\Wd	n+2		n+3		n		n+1	
0	Write data 0	10^0	(1)	Unit No.	Busy flag		Read data 0	10^0
1	Write data 1		(2)		(1)	Temperature	Read data 1	
2	Write data 2		(4)		(2)	control type	Read data 2	
3	Write data 3		(8)		(4)		Read data 3	
4	Write data 4	10^1	(1)	Channel	(8)		Read data 4	10^1
5	Write data 5		(2)	No.	Don't care		Read data 5	
6	Write data 6		(4)		Auto-tuning in progress		Read data 6	
7	Write data 7		Auto-tuning start		Cold start protection in progress		Read data 7	
8	Write data 8	10^2	(1)	Data	(1)	Error code	Read data 8	10^2
9	Write data 9		(2)	designation	(2)		Read data 9	
10	Write data 10		(4)		(4)		Read data 10	
11	Write data 11		(8)		(8)		Read data 11	
12	Write data 12	10^3	Read command		---		Read data 12	10^3
13	Write data 13		Write command		---		Read data 13	
14	Write data 14		Operational command		Operation in progress		Read data 14	
15	Write data 15		Memory Cartridge operation		---		Read data 15	

4-3-2 Data Allocation Details

Bits	15 14 13 12 | 11 10 9 8 | 7 6 5 4 | 3 2 1 0	Remarks
Setting data of all kinds	10^3 | 10^2 | 10^1 | 10^0	Ignore decimal points
Cold start operative channels	0 0 0 0 | 0 0 0 0 | 8 7 6 5 4 3 2 1 Operative channels	Bit correspondence
Auto-tuning grouping	0 0 0 0 | 10^0 | 8 7 6 5 4 3 2 1 Group numbers (0 to 7) Channels being grouped (for the Programming Console, however, 1 to 8)	Bit correspondence
Auto-tuning performance groups	0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 10^0 Performance group numbers (0 to 7) (for the Programming Console, however, 1 to 8)	Only auto-tuning start command operative
Memory Cartridge zone division numbers	0 0 0 0 | 0 0 0 0 | 0 0 0 0 | 10^0 Zone division numbers (0 to 2) (for the Programming Console, however, 1 to 3)	Only Memory Cartridge operation command operative

4-3-3 Signal Functions

Signal	Function	Remarks
Writing data	Data transmission from Programmable Controller to temperature control board: BCD	---
Unit No.	Board number: 0 to 9	---
Channel No.	Channel numbers within board: 0 to 7 (1 to 8 Ch)	---
Data designation	0: Do not use 1: Do not use 2: set temperature 3: Lower limit alarm 4: Upper limit alarm 5: P constant 6: I constant 7: D constant 8: Control period 9: ARW value A: process temperature B: Auto-tuning grouping C: Operation amount D: Cold start protection time E: Cold start operative Ch F: Auto-tuning performance groups	Only monitor operation is operative for A, C, D, E. Only Write operation is operative for B, F.
Read command	When performing Read data: ON	---
Write command	When performing Write data: ON	---
Busy flag	Identification of inoperative Units Inoperative: 0 Operative: 1	---
Temperature control type	3: PT64 (-60.0 to 40.0) 4: P13 (150.0 to 350.0) 6: K04 (0 to 400) 7: K06 (0 to 600) 8: K12 (0 to 1200) 9: J04 (0 to 400) A: R16 (0 to 1600) C: P04 (0 to 400) D: P01 (0.0 to 100.0) E: P02 (0.0 to 200.0) F: C (4 to 20 mA)	---
Auto-tuning start	Performance of PID automatic calculations starts at rising edge, stops at falling edge.	---
Error code	1: Command error 2: Register data error 3: Setting not possible due to LOCAL mode 4: Memory error 5: A/D converter error 6: Communications error (not connected) 7: Memory Cartridge error 8: Internal voltage error A: Heater burnout B: set temperature malfunction C: Lower limit alarm D: Upper limit alarm E: Underflow F: Overflow	Priority order 1>3>2 4>6>5>8 7>B A>E or F>C or D
Memory Cartridge operation	When performing Write or Read for Memory Cartridge: ON	When not used, "0"
Operational command	Starts at rising edge, stops at falling edge	---
Reading data	Data transmission from temperature control board to Programmable Controller: BCD	---

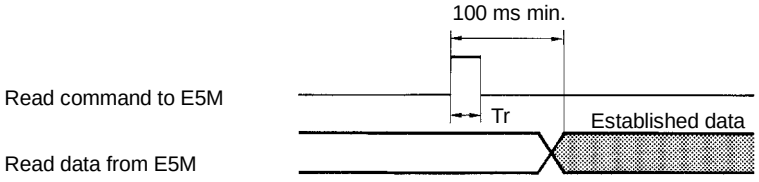
Note

1. Channel numbers 0 to 7 correspond to channels 1 to 8 on the Programming Console.
2. When multiple commands are given, the priority order is as follows:
   1) operational command; 2) auto-tuning start; 3) Memory Cartridge Write; 4) Memory Cartridge Read; 5) set value Write; 6) set value, data Read.
3. For Memory Cartridge operations, by using the Read command and Write command simultaneously, read/write operations can be conducted.
4. To initialize set value, set the unit number to "F," put the Write command ON, and then either turn off and then on the power to the Programming Console (SD) or the Master (TM), or reset.
5. An invalid auto-tuning grouping can be set by selecting "8" for group number.
6. Special codes are as follows.
   CCCC set temperature invalid (process temperature cannot be correctly read). Bit15=1 indicates a negative value. (Example) process temperature of 8015 for specifications of 0.0 to 200.0%C : -1.5%C.
7. Under abnormal input condition such as with heater burnout, process temperature cannot be correctly read. Be sure to check the error code.

8. While a Write command is being processed, it is impossible to read information such as operations in progress or auto-tuning in progress. Set the Write command to 0 to read.
9. Decimal points are ignored and four digits are used for Write and Read data, as with RS-232C.
10. The setting range of the control period is 0001 to 0099. If 0000 is entered, a data error will result.
11. While auto-tuning is in progress, Write operations for the same Unit are not possible.

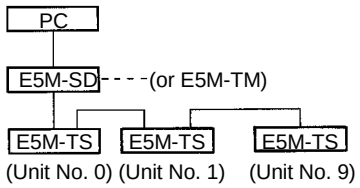
4-3-4 Communications Time

Read operations for E5M data involving SYSMAC BUS communications require at least 100 ms min. as processing time for E5M to output data. Conduct data Read after 100 ms. The ON time for the Read and Write command is 20 ms min.



Tr: Read command ON time: 20 ms min.

Other possible delays are listed below, though they will not directly affect the programming of the programmable controller.

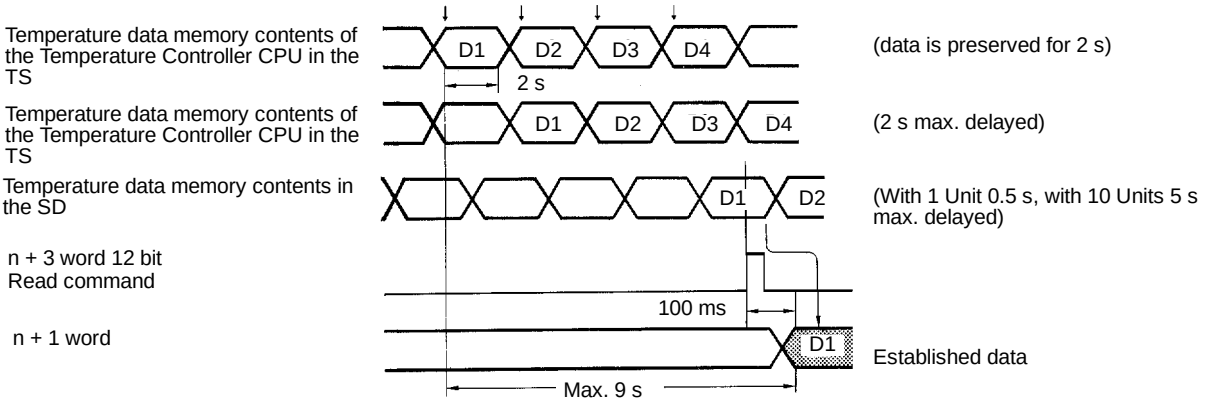


Example 1: A set temperature is written in one of the channels of unit number 9.

- Data communications time for SD to TS ....approx. 0.5 s/Ch
- TS internal processing time....Max 2 s
- TS control quantity calculation period....Max 2 s

Note When executing a Write command, the output value corresponding to the set value reflected in operation (e.g., relay, voltage output, current output) 4.5 s maximum.

Example 2: Temperature data of one of the channels of Slave unit number 9 is read out.



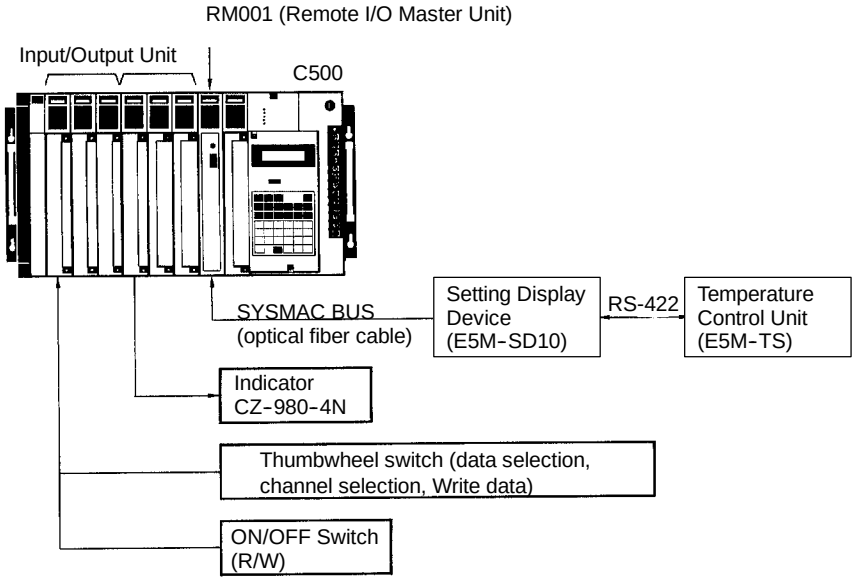
Note After execution of the Read command, the data read out is the data of 9 s max. before.

E5M is treated as an Optical I/O Unit. Determine communications time taking the timing of SYSMAC C series PC system into consideration.

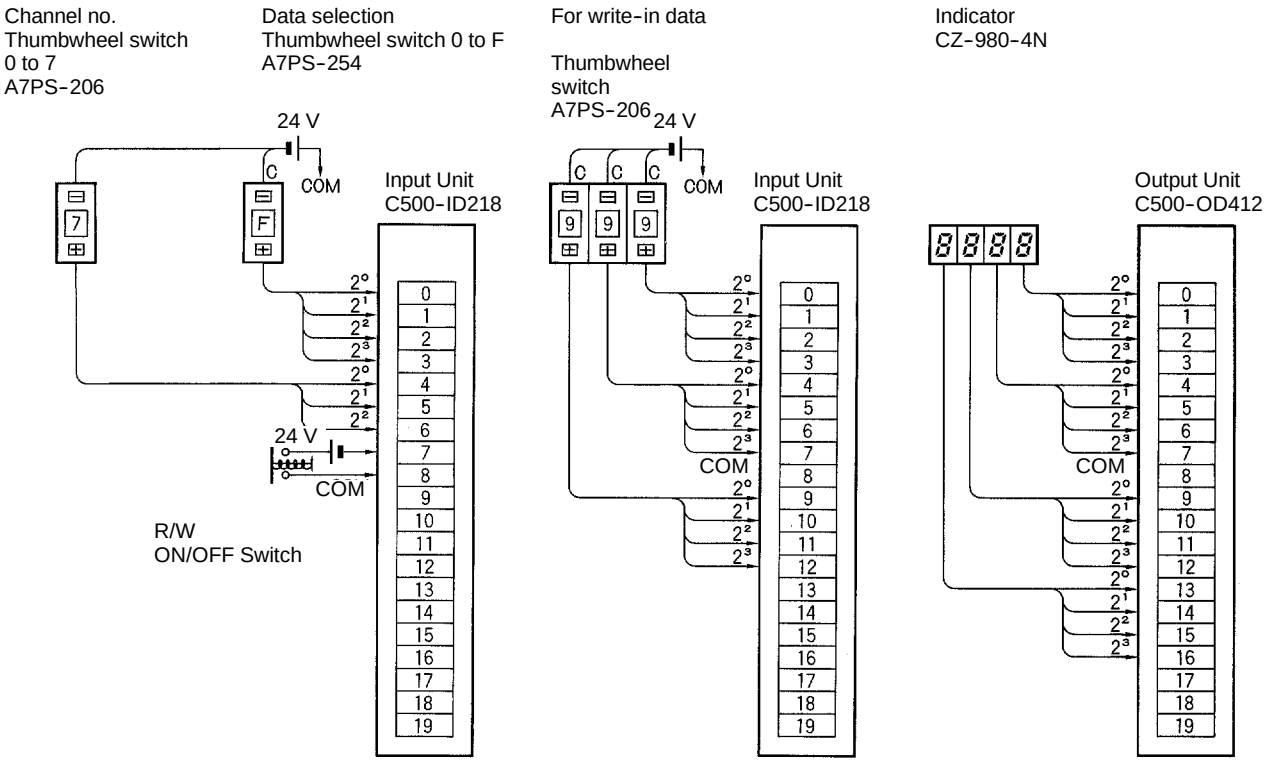
4-3-5 SYSMAC BUS Link Program Examples

The program for communications between E5M and the Programmable Controller via SYSMAC BUS is explained by the system examples given below (to simplify the examples, only data Read and Write are conducted).

Outline of Hardware Arrangement



Connection of Display Device, Thumb Rotary Switch, ON/OFF Switch



Outline Explanation of Operation

If the R/W switch is turned on when channel number is set to “0,” and the data selection is set to “2 (set temperature),” the values set in the Write data at that time are written in as “set temperature” onto the E5M-SD and the E5M-TS.

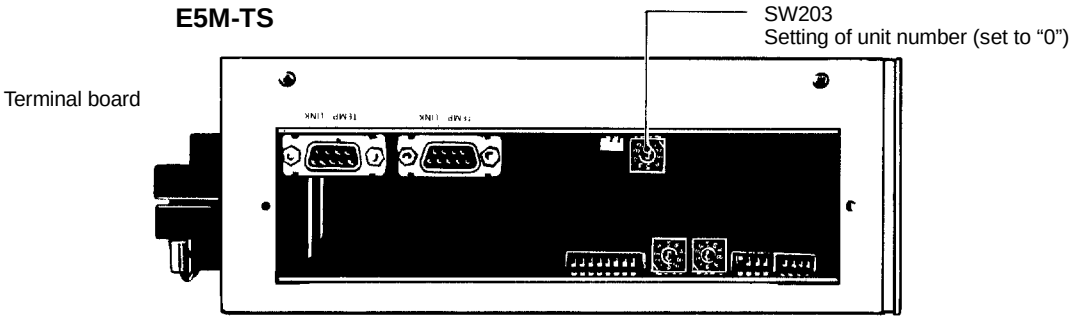
Next, if the data selection is set to “A” (process temperature) when R/W switch is turned off, the temperature at that time is displayed on the Display Device. By changing data selection, it is possible to conduct Read and Write for other constants (P, I, D, ARW - - -), as well.

Note The example uses 1 Slave (E5M-TS) Unit for this system, and no unit number is designated.

Setting of DIP Switch for Function Selection for E5M-TS, E5M-TM

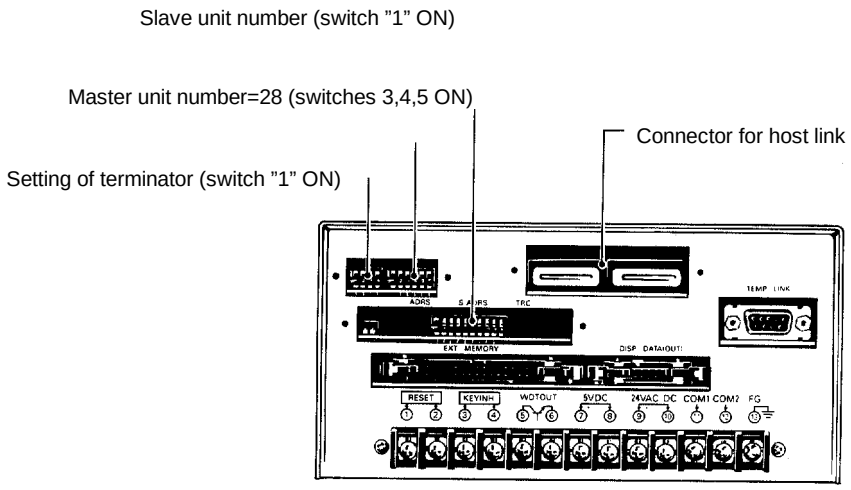
Explanation for DIP switch settings directly related to this system example is given below.

E5M-TS



Note Since other switch settings are not required for the example, no particular settings are given.

E5M-SD



Program Example 1

All data is directly communicated via input/output words to E5M.

• Allocation of Input/Output Words

In this system example, the Programmable Controller input/output words are allocated as shown below.

Bit	Words				
	Input			Output	
	0	1	2, 3	4	5, 6, 7
0	Data select 0 to F	Write data 10^0	Unused	Read data 10^0	Unused
1					
2					
3					
4	Channel No. 0 to 7	Write data 10^1		Read data 10^1	
5					
6					
7	R/W Switch				
8	Unused	Write data 10^2		Read data 10^2	
9					
10					
11					
12		Unused		Read data 10^3	
13					
14					
15					

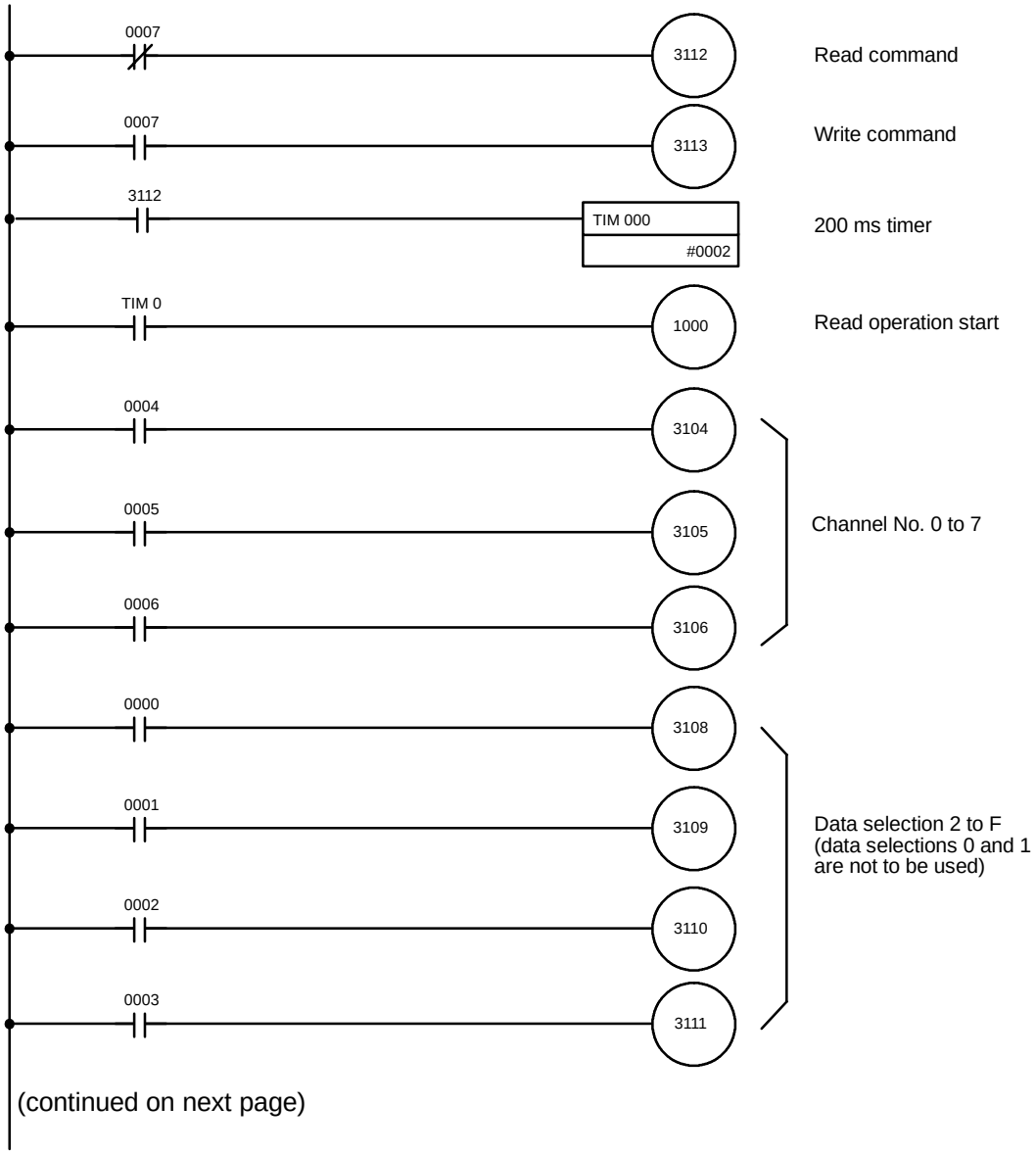
• Allocation of Send and Receive Data (Remote I/O Systems)

One E5M-SD10 Unit (terminator setting) is connected to the Remote I/O; its Master unit number is 28. In this case, the E5M-SD10 Unit makes exclusive use of the IR 28, 29, 30, 31 in the Programmable Controller. Set at n=28 on the send/receive data allocation chart (refer to the following chart).

PC I/O	OUT				IN			
Bit\Wd	30 (n+2)		31 (n+3)		28 (n)		29 (n + 1)	
0	Write data 0	10^0	(1)	Unit No.	Busy flag		Read data 0	10^0
1	Write data 1		(2)		(1)	Temperature	Read data 1	
2	Write data 2		(4)		(2)	control type	Read data 2	
3	Write data 3		(8)		(4)		Read data 3	
4	Write data 4	10^1	(1)	Channel No.	(8)		Read data 4	10^1
5	Write data 5		(2)		Don't care		Read data 5	
6	Write data 6		(4)		Auto-tuning in progress		Read data 6	
7	Write data 7		Auto-tuning start		Cold start protection in progress		Read data 7	
8	Write data 8	10^2	(1)	Data	(1)	Error code	Read data 8	10^2
9	Write data 9		(2)	designation	(2)		Read data 9	
10	Write data 10		(4)		(4)		Read data 10	
11	Write data 11		(8)		(8)		Read data 11	
12	Write data 12	10^3	Read command		---		Read data 12	10^3
13	Write data 13		Write command		---		Read data 13	
14	Write data 14		Operational command		Operation in progress		Read data 14	
15	Write data 15		Memory Cartridge operation		---		Read data 15	

• Program

According to the structural outline given from sections 4-2-1 to 4-2-4, the following program example is presented.



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Address	Instruction	Operands
00000	LD NOT	0007
00001	OUT	3112
00002	LD	0007
00003	OUT	3113
00004	LD	3112
00005	TIM	0
		# 0002
00006	LD	TIM 0
00007	OUT	1000
00008	LD	0004
00009	OUT	3104
00010	LD	0005

Address	Instruction	Operands
00011	OUT	3105
00012	LD	0006
00013	OUT	3106
00014	LD	0000
00015	OUT	3108
00016	LD	0001
00017	OUT	3109
00018	LD	0002
00019	OUT	3110
00020	LD	0003
00021	OUT	3111

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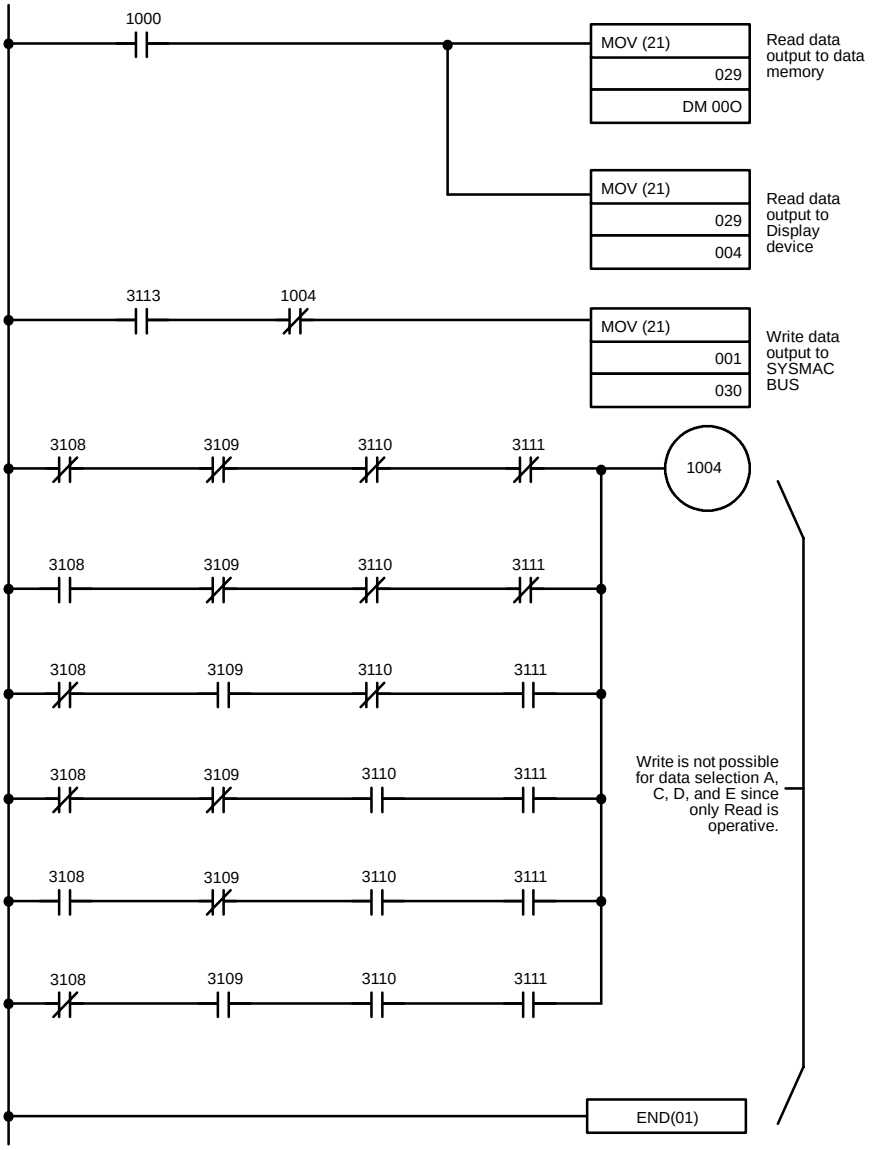
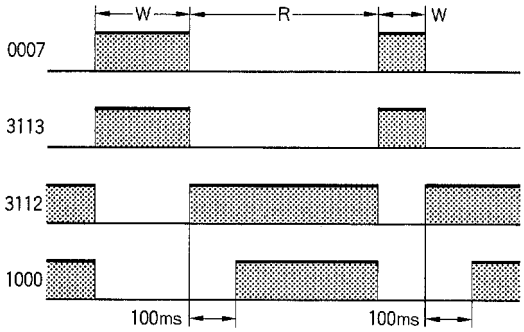


Address	Instruction	Operands
00022	LD	1000
00023	MOV(21)	---
		29
		DM 0
00024	MOV(21)	---
		IR 29
		IR 4
00025	LD	3113
00026	AND NOT	1004
00027	MOV(21)	---
		1
		30
00028	LD NOT	3108
00029	AND NOT	3109
00030	AND NOT	3110
00031	AND NOT	3111
00032	LD	3108
00033	AND NOT	3109
00034	AND NOT	3110
00035	AND NOT	3111
00036	LD NOT	3108
00037	AND	3109
00038	AND NOT	3110
00039	AND	3111
00040	LD NOT	3108
00041	AND NOT	3109
00042	AND	3110
00043	AND	3111
00044	LD	3108
00045	AND NOT	3109
00046	AND	3110
00047	AND	3111
00048	LD NOT	3108
00049	AND	3109
00050	AND	3110
00051	AND	3111
00052	OR LD	---
00053	OR LD	---
00054	OR LD	---
00055	OR LD	---
00056	OR LD	---
00057	OUT	1004
00058	END	---



Note Write is executed when the R/W switch is turned ON.

• Auto-tuning performance

1. Setting of auto-tuning groups.
   When data selection is set at B and Write is executed, the Write data contents are set as the auto-tuning group. For example, if channels 2 and 3 are set as group 3, the results are as shown below. In this case, the E5M channel number selection of IR 31 is ignored.

PC I/O	OUT			
Bit/Wd	30 (n+2)		31 (n+3)	
0	Write data 0	10^0	(0)	Channel No.2, No.3
1	Write data 1		(1)	
2	Write data 2		(1)	
3	Write data 3		(0)	
4	Write data 4	10^0	(0)	
5	Write data 5		(0)	
6	Write data 6		(0)	
7	Write data 7		(0)	
8	Write data 8	10^0	(1)	Group No.3
9	Write data 9		(1)	
10	Write data 10		(0)	
11	Write data 11		(0)	
12	Write data 12	10^0	(0)	
13	Write data 13		(0)	
14	Write data 14		(0)	
15	Write data 15		(0)	

2. Performance of auto-tuning.
   When data is set at F and the auto-tuning start is turned ON, auto-tuning is executed for the Write data groups.

Note
1. Perform auto-tuning after grouping has been executed.
2. Be sure to conduct temperature setting for the channels for which auto-tuning is being performed.
3. Performance of auto-tuning for a number of groups.
   When simultaneously performing auto-grouping for a number of groups, change the unit number and group number, and set the Write command to “1” while maintaining the auto-tuning start signal “1” and performing

auto tuning for the desired groups. (Consult the E5M SYSMAC BUS timing chart 3.)

Program Example 2

Simultaneous storing and preservation of the data onto the Programmable Controller's data memory and onto E5M setting data are conducted.

Note
1. Since programs are divided up by function Units, correct as necessary and use.
2. For 1 E5M Unit, 99 memories are used. Keep this in mind when using data memory. DM 500 is used for managing the unit numbers.

• IR Word Allocation

Bit	Word			
	Input			
	0	1	2	3
0	Unit No.	Data selection	Channel No.	Write data 10^0
1				
2				
3				
4	Unused	Unused	Unused	**W**rite data 10^1
5				
6				
7				
8				Write data 10^2
9				
10				
11				
12				Write data 10^3
13				
14				
15				

• DM Word Allocation

	00	10	20	30	40	50
0	Total number of Units	Set value number 1	Lower limit setting number 3	Upper limit alarm number 5	P constant number 7	D constant number 1
1	Unit number	Set value number 2	Lower limit setting number 4	Upper limit alarm number 6	P constant number 8	D constant number 2
2	Data selection	Set value number 3	Lower limit setting number 5	Upper limit alarm number 7	I constant number 1	D constant number 3
3	Channel No.	Set value number 4	Lower limit setting number 6	Upper limit alarm number 8	I constant number 2	D constant number 4
4	For calculations	Set value number 5	Lower limit setting number 7	P constant number 1	I constant number 3	D constant number 5
5		Set value number 6	Lower limit setting number 8	P constant number 2	I constant number 4	D constant number 6
6		Set value number 7	Upper limit alarm number 1	P constant number 3	I constant number 5	D constant number 7
7		Set value number 8	Upper limit alarm number 2	P constant number 4	I constant number 6	D constant number 8
8		Lower limit setting number 1	Upper limit alarm number 3	P constant number 5	I constant number 7	Control period number 1
9		Lower limit setting number 2	Upper limit alarm number 4	P constant number 6	I constant number 8	Control period number 2

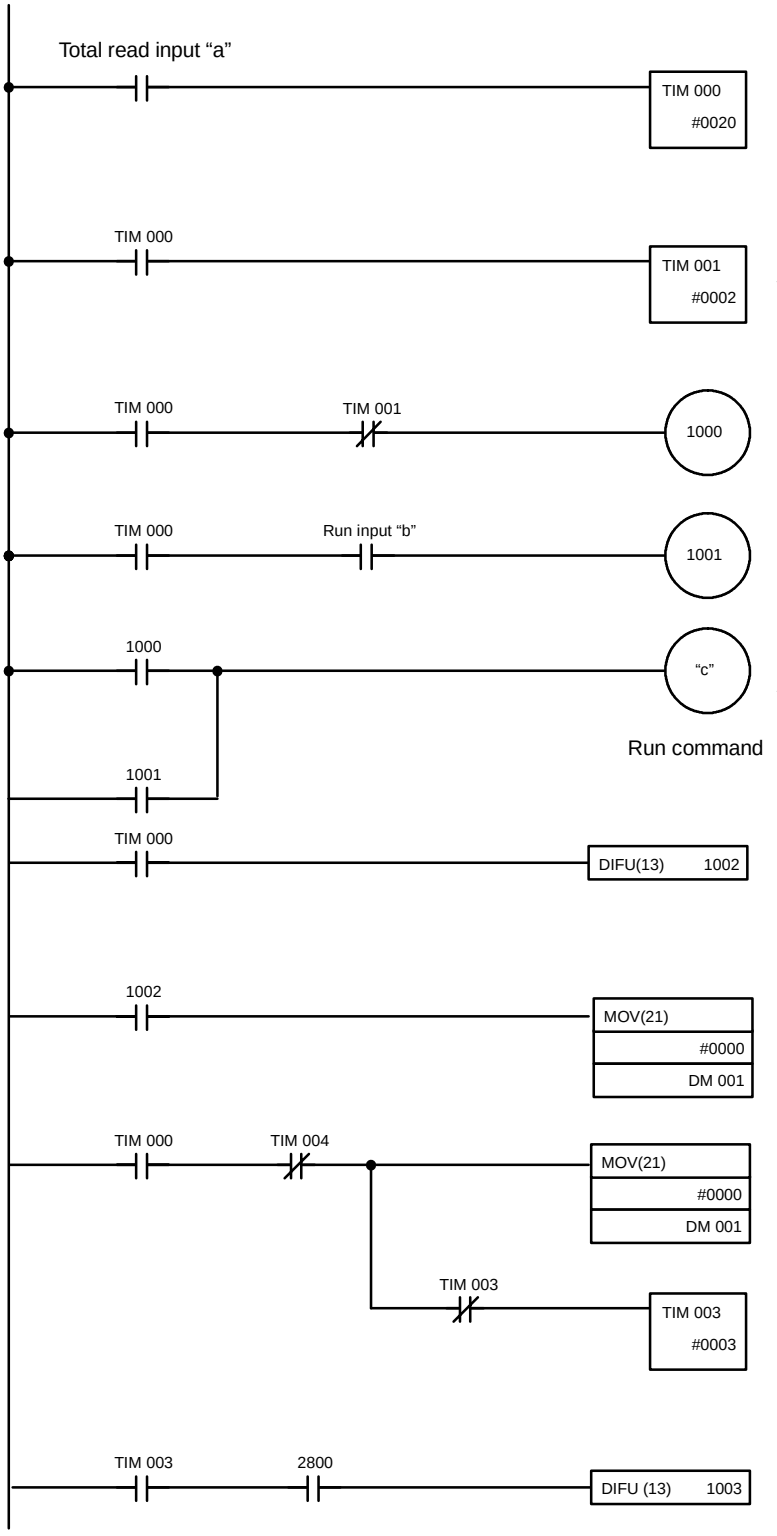
	60	70	80	90	100	101
0	Control period number 3	ARW value number 5	Process temperature number 7	Operation amount number 1	Auto-execution G	
1	Control period number 4	ARW value number 6	Process temperature number 8	Operation amount number 2	Error code number 1	
2	Control period number 5	ARW value number 7	Auto-tuning group number 1	Operation amount number 3	Error code number 2	
3	Control period number 6	ARW value number 8	Auto-tuning group number 2	Operation amount number 4	Error code number 3	
4	Control period number 7	Process temperature number 1	Auto-tuning group number 3	Operation amount number 5	Error code number 4	
5	Control period number 8	Process temperature number 2	Auto-tuning group number 4	Operation amount number 6	Error code number 5	
6	ARW value number 1	Process temperature number 3	Auto-tuning group number 5	Operation amount number 7	Error code number 6	
7	ARW value number 2	Process temperature number 4	Auto-tuning group number 6	Operation amount number 8	Error code number 7	
8	ARW value number 3	Process temperature number 5	Auto-tuning group number 7	Cold time	Error code number 8	
9	ARW value number 4	Process temperature number 6	Auto-tuning group number 8	Cold operative		

Note 1. From DM 109, data of unit number 1 is read in from set value number 1 in order.

2. Regarding addresses DM 000 and DM 500, write in the total number of Units.

Program (1)

Write of all data by turning on the power source (this includes operational command initializing and system malfunction). If the system malfunctions, IR1007 comes ON.



Address	Instruction	Operands	
00000	LD		a
00001	TIM		000
		#	0020
00002	LD	TIM	000
00003	TIM		001
		#	0002
00004	LD	TIM	000
00005	AND NOT	TIM	001
00006	OUT		1000
00007	LD	TIM	001
00008	AND		b
00009	OUT		1001
00010	LD		1000
00011	OR		1001
00012	OUT		c
00013	LD	TIM	000
00014	DIFU(13)		1002
00015	LD		1002
00016	MOV(21)		---
		#	0000
		DM	001
00017	LD	TIM	000
00018	AND NOT	TIM	004
00019	MOV(21)		---
		DM	001
			31
00020	AND NOT	TIM	003
00021	TIM		003
		#	0003
00022	LD	TIM	003
00023	AND		2800
00024	DIFU(13)		1003

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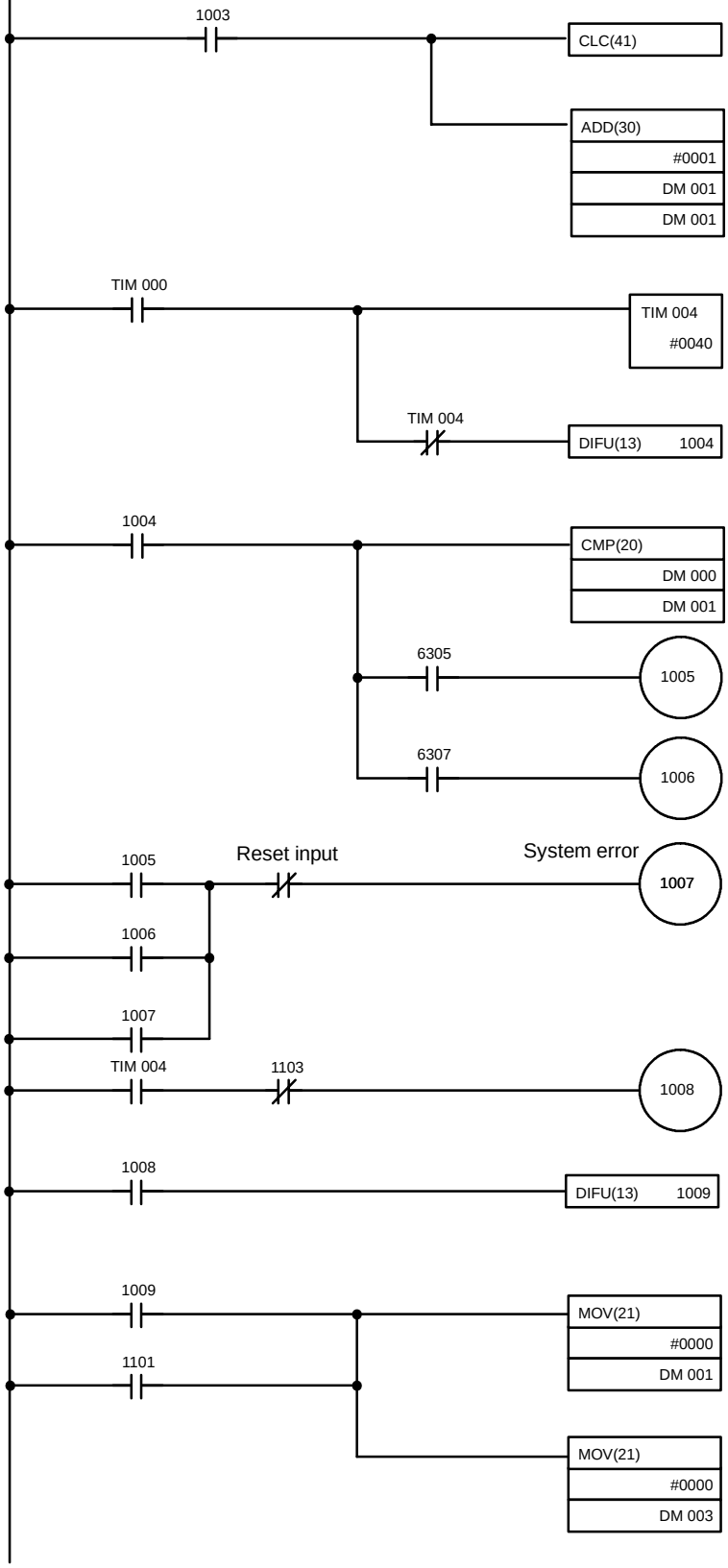

Address	Instruction	Operands
00025	LD	1003
00026	CLD(41)	---
00027	ADD(30)	---
		# 0001
		DM 001
		DM 001
00028	LD	TIM 000
00029	TIM	004
		# 0040
00030	AND NOT	TIM 004
00031	DIFU(13)	1004
00032	LD	1004
00033	CMP(20)	---
		DM 000
		DM 001
00034	AND	6305
00035	OUT	1005
00036	LD	1004
00037	AND	6307
00038	OUT	1006

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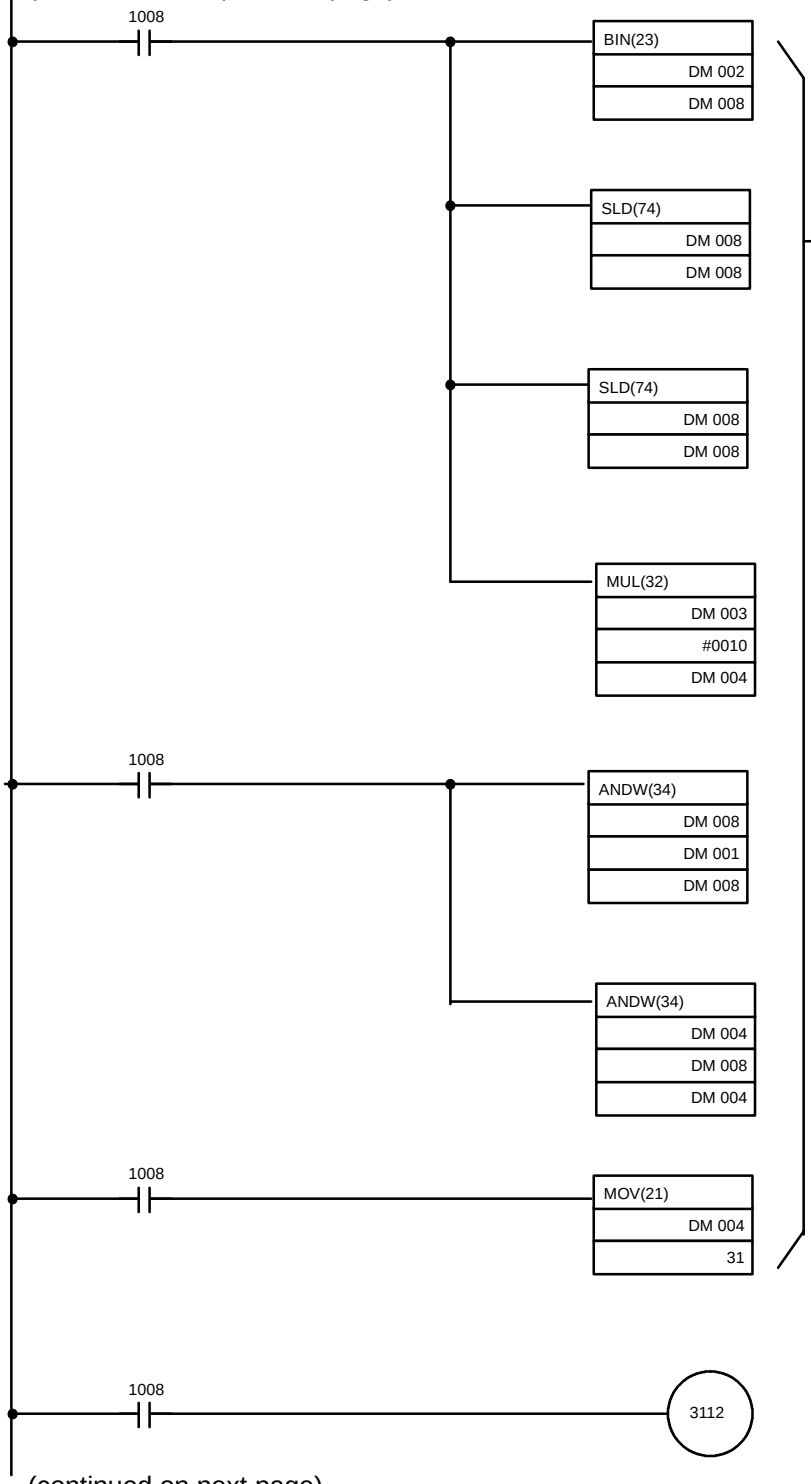

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Address	Instruction	Operands	
00052	LD		1008
00053	BIN(23)		---
		DM	002
		DM	008
00054	SLD(74)	DM	008
		DM	008
			00
00055	SLD(74)	DM	008
		DM	008
			00
00056	MUL(32)		---
		DM	003
		#	0010
		DM	004
00057	LD		1008
00058	ANDW(34)		---
		DM	008
		DM	001
		DM	008
00059	ANDW(34)		---
		DM	004
		DM	008
		DM	004
00060	LD		1008
00061	MOV(21)		---
		DM	004
			31
00062	LD		1008
00063	OUT		3112

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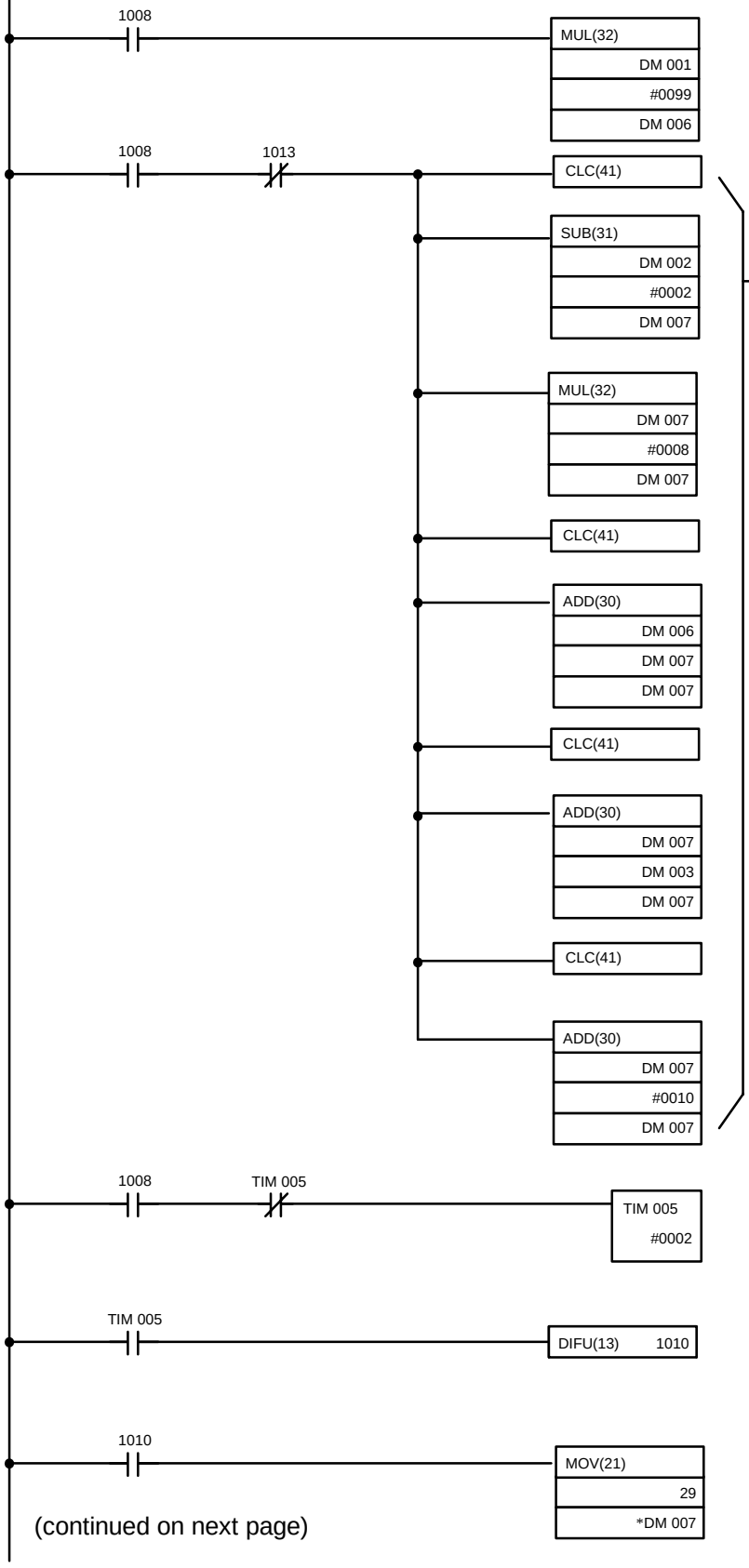

Setting of storing address for Read data

Address	Instruction	Operands	
00064	LD		1008
00065	MUL(32)		---
		DM	001
		#	0099
		DM	006
00066	LD		1008
	AND NOT		1013
00067	CLC(41)		---
00068	SUB(31)		---
		DM	002
		#	0002
		DM	007
00069	MUL(32)		---
		DM	007
		#	0008
		DM	007
00070	CLC(41)		---
00071	ADD(30)		---
		DM	006
		DM	007
		DM	007
00072	CLC(41)		---
00073	ADD(30)		---
		DM	007
		DM	003
		DM	007
00074	CLC(41)		---
00075	ADD(30)		---
		DM	007
		#	0010
		DM	007
00076	LD		1008
	AND NOT		1010
00077	TIM		005
		#	0002
00078	LD	TIM	005
00079	DIFU(13)		1010
00080	LD		1010
00081	MOV(21)		---
			29
		DM	007

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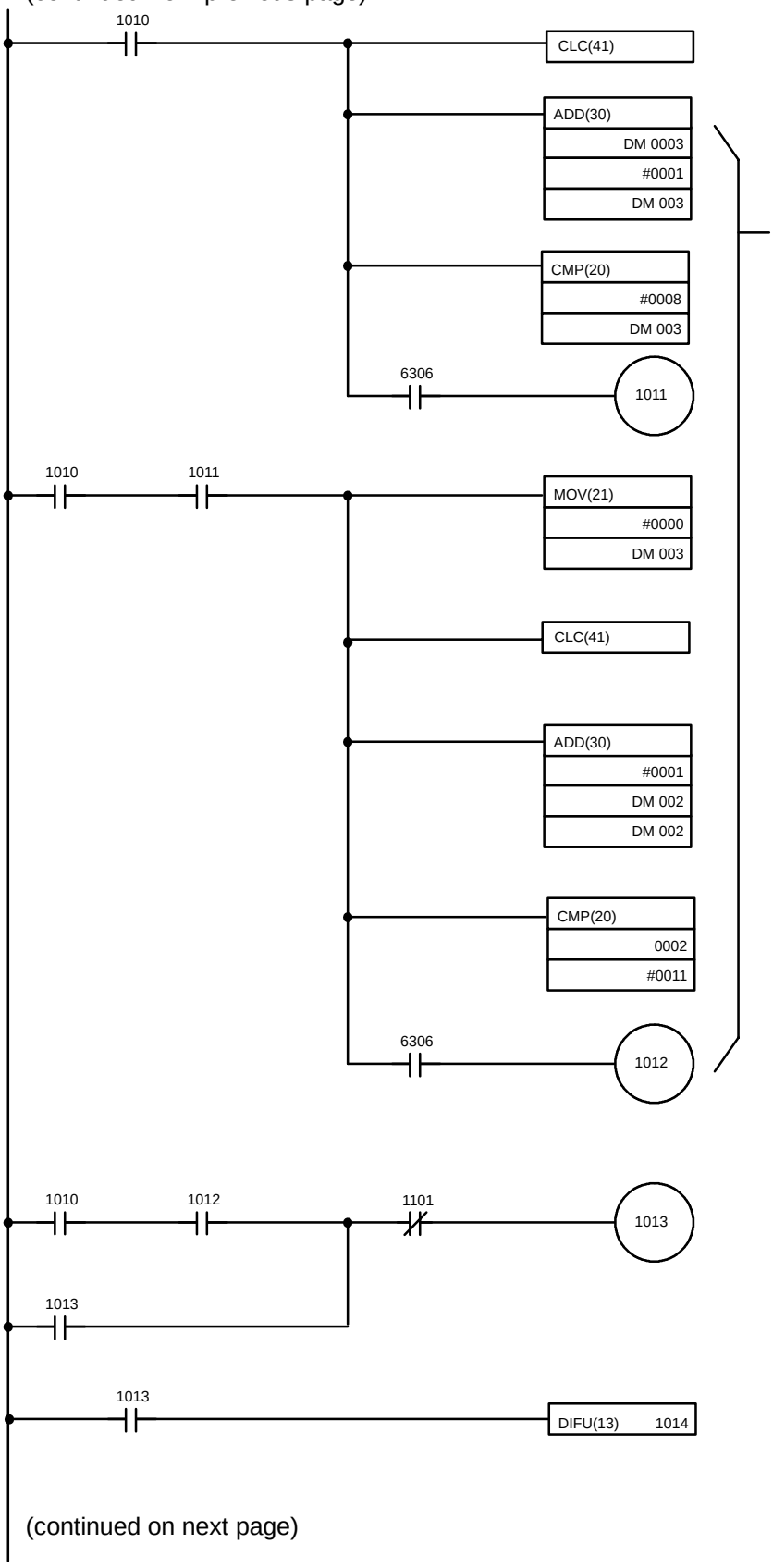

Address	Instruction	Operands
00082	LD	1010
00083	CLC(41)	---
00084	ADD(30)	---
		DM 003
		# 0001
		*DM 003
00085	CMP(20)	---
		# 0008
		DM 003
00086	AND	6306
00087	OUT	1011
00088	LD	1010
00089	AND	1011
00090	MOV(21)	---
		# 0000
		DM 003
00091	CLC(41)	---
00092	ADD(30)	---
		# 0001
		DM 002
		DM 002
00093	CMP(20)	---
		DM 002
		# 0011
00094	AND	6306
00095	OUT	1012
00096	LD	1010
00097	AND	1012
00098	LD	1013
00099	OR LD	---
00100	AND NOT	1101
00101	OUT	1013
00102	LD	1013
00103	DIFU(13)	1014

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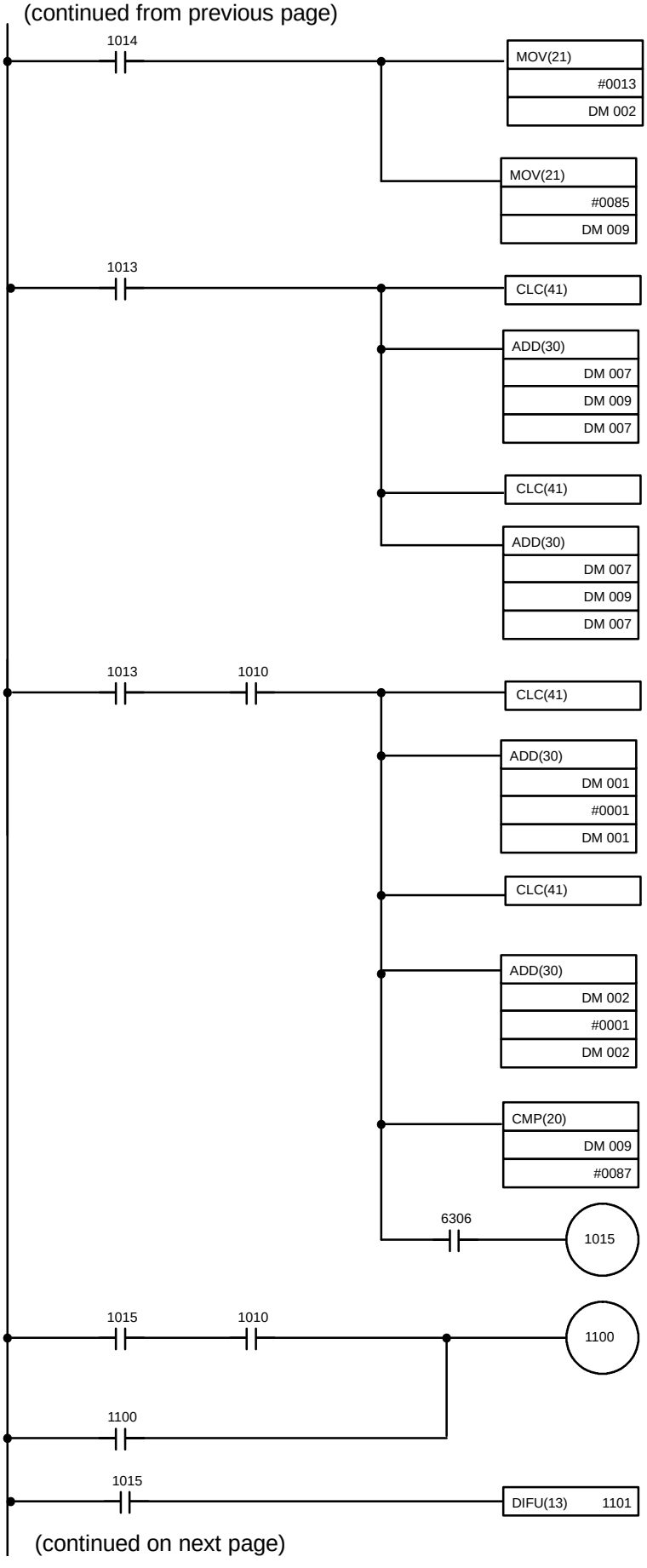

Address	Instruction	Operands
00104	LD	1014
00105	MOV(21)	---
		# 0013
		DM 002
00106	MOV(21)	---
		# 0085
		DM 009
00107	LD	1013
00108	CLC(41)	---
00109	ADD(30)	---
		DM 006
		DM 002
		DM 007
00110	CLC(41)	---
00111	ADD(30)	---
		DM 007
		DM 009
		DM 007

Determination of Read completion for normal-operation channels

Address	Instruction	Operands
00112	LD	1013
00113	AND	1010
00114	CLC(41)	---
00115	ADD(30)	---
		DM 009
		# 0001
		DM 009
00116	CLC(41)	---
00117	ADD(30)	---
		DM 002
		# 0001
		DM 002
00118	CMP(20)	---
		DM 009
		# 0087
00119	AND	6306
00120	OUT	1015
00121	LD	1015
00122	AND	1010
00123	LD	1100
00124	OR LD	---
00125	OUT	1100
00126	LD	1015
00127	DIFU(13)	1101

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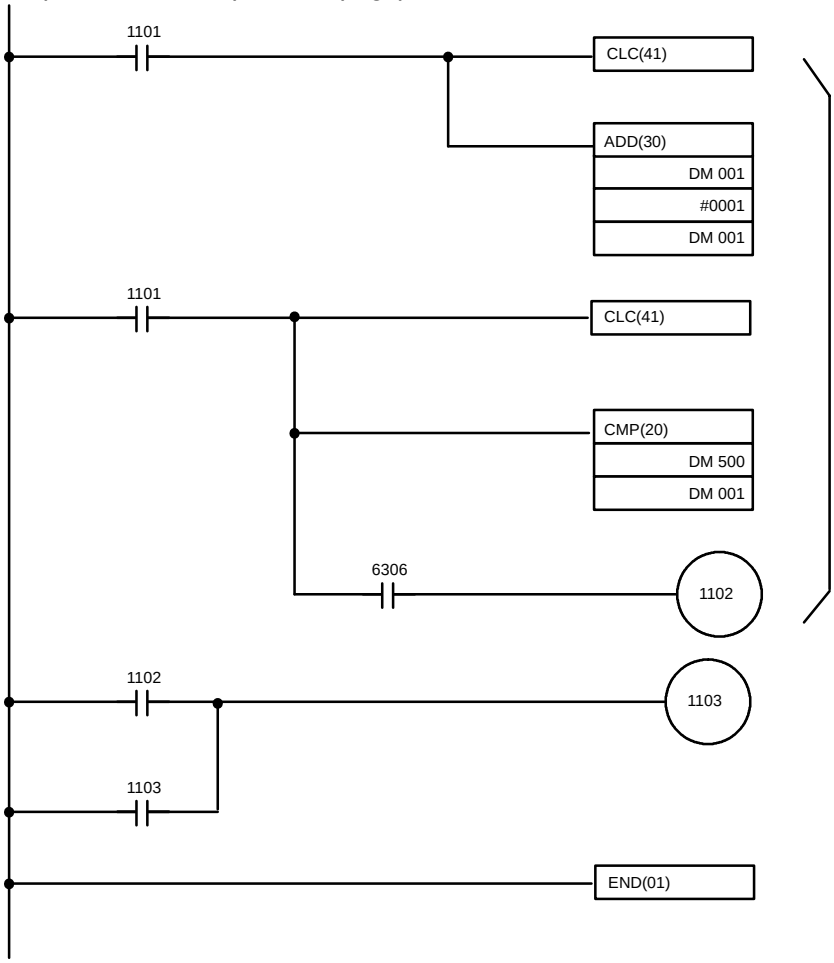


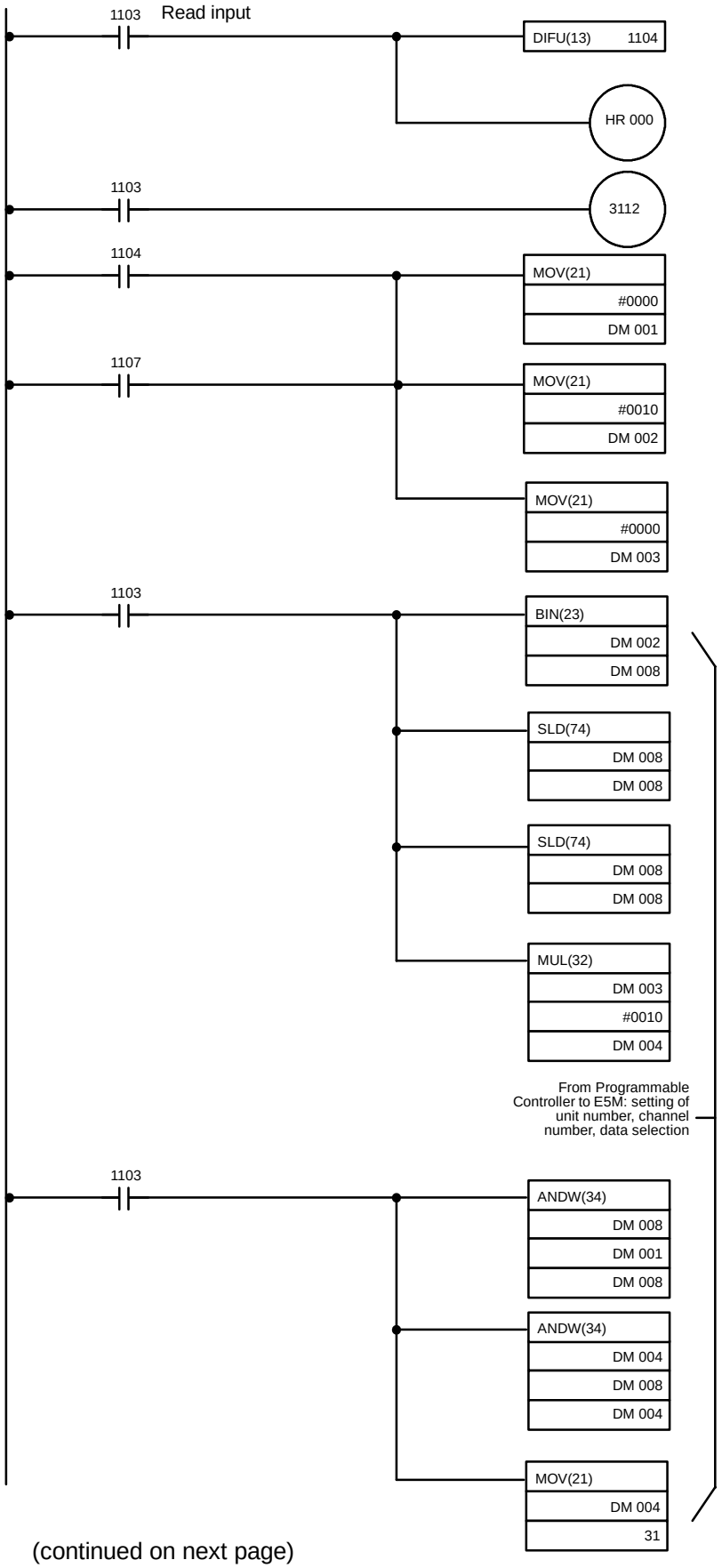
Determination of completion of all Units

Read termination plug

Address	Instruction	Operands	
00128	LD		1101
00129	CLC(41)		---
00130	ADD(30)		---
		DM	001
		#	0001
		DM	001
00131	LD		1101
00132	CLC(41)		---
00133	CMP(20)		---
		DM	500
		DM	001
00134	AND		6306
00135	OUT		1102
00136	LD		1102
00137	OR		1103
00138	OUT		1103
00139	END		---

Program (2)

Continuous reading of present temperature and output value.
With Read conditions “ON,” the condition of the present values and operation value of all channels of the Unit designated on IR 0 are read in to the data memory.



Normal time Read

Address	Instruction	Operands	
00000	LD		1103
00001	DIFU(13)		1104
00002	OUT	HR	0000
00003	LD		1103
00004	OUT		3112
00005	LD		1104
00006	OR		1107
00007	MOV(21)		---
		#	0000
		DM	001
00008	MOV(21)		---
		#	0010
		DM	002
00009	MOV(21)		---
		#	0000
		DM	003
00010	LD		1103
00011	BIN(23)		---
		DM	002
		DM	008
00012	SLD(74)		---
		DM	008
		DM	008
			00
00013	SLD(74)		---
		DM	008
		DM	008
			00
00014	MUL(32)		---
		DM	003
		#	0010
		DM	004
00015	LD		1103
00016	ANDW(34)		---
		DM	008
		DM	001
		DM	008
00017	ANDW(34)		---
		DM	004
		DM	008
		DM	004
00018	MOV(21)		---
		DM	004
			31

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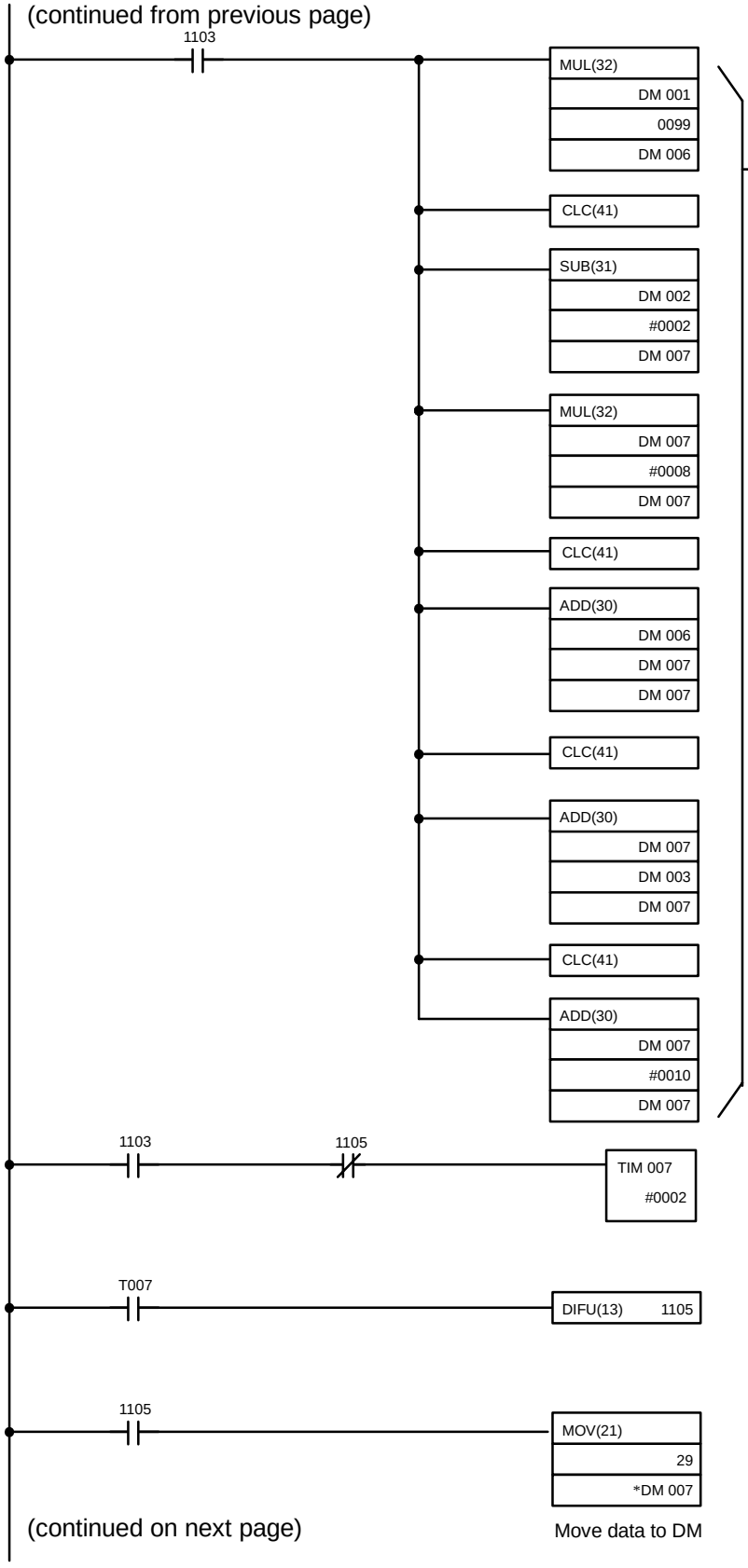

Address	Instruction	Operands	
00019	LD		1103
00020	MUL(32)		---
		DM	001
			0099
		DM	006
00021	CLC(41)		---
00022	SUB(31)		---
		DM	002
		#	0002
		DM	007
00023	MUL(32)		---
		DM	007
		#	0008
		DM	007
00024	CLC(41)		---
00025	ADD(30)		---
		DM	006
		DM	007
		DM	007
00026	CLC(41)		---
00027	ADD(30)		---
		DM	007
		DM	003
		DM	007
00028	CLC(41)		---
00029	ADD(32)		---
		DM	007
		#	0010
		DM	007
00030	LD		1103
00031	AND NOT		1105
00032	TIM		007
		#	0002
00033	LD	TIM	007
00034	DIFU(13)		1105
00035	LD		1105
00036	MOV(21)		---
			29
		*DM	007

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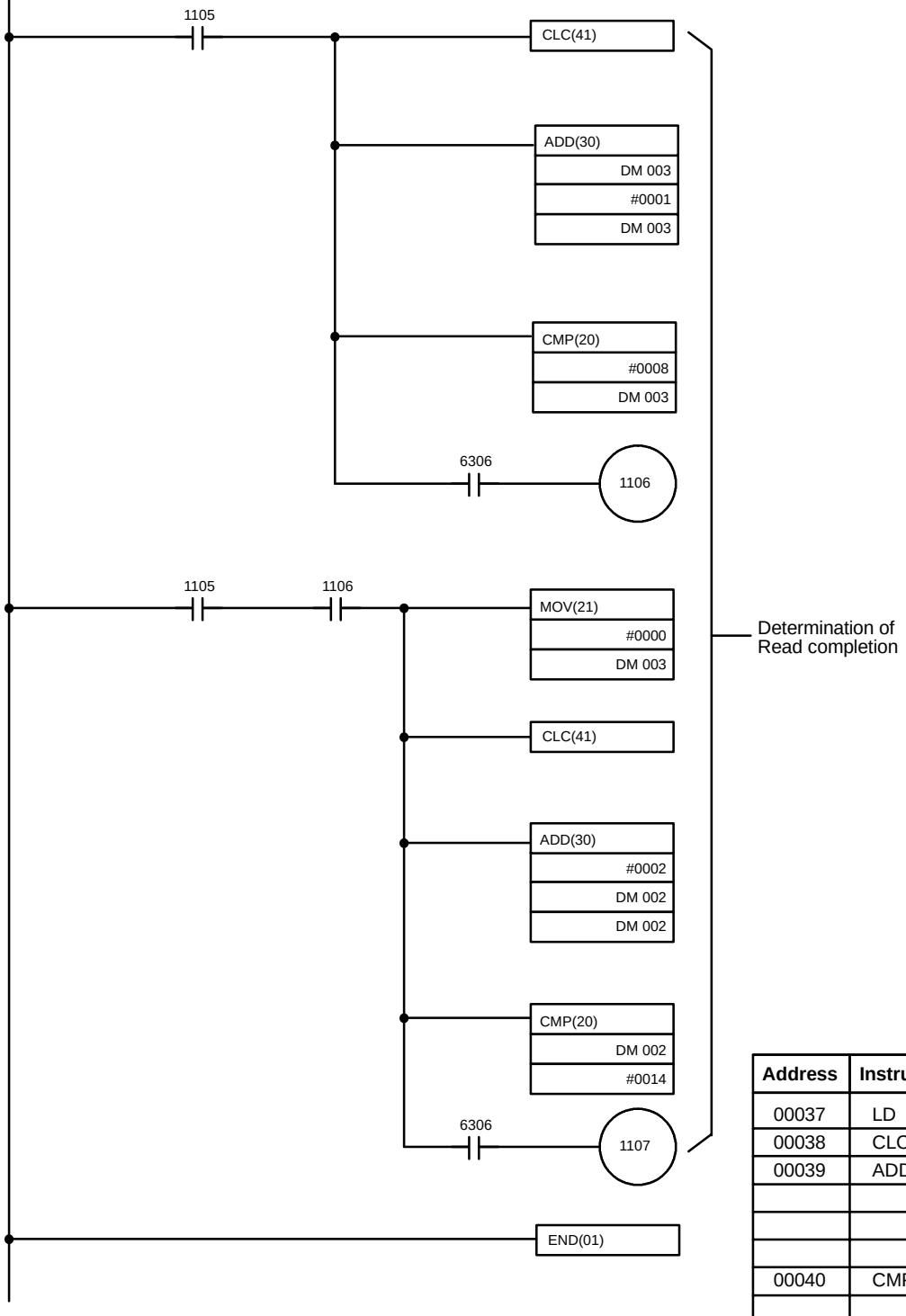
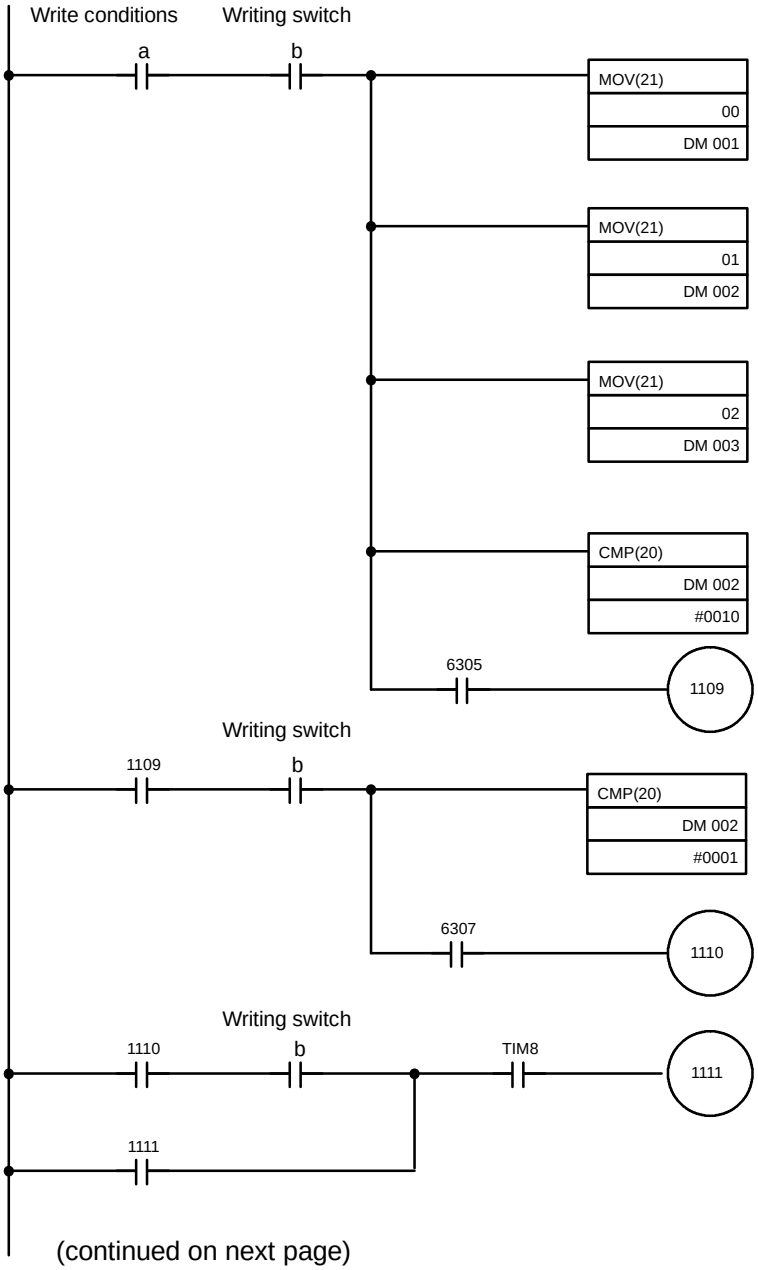


Address	Instruction	Operands
00037	LD	1105
00038	CLC(41)	---
00039	ADD(30)	---
		DM 003
		# 0001
		DM 003
00040	CMP(20)	---
		DM 002
		# 0014
00041	AND	6306
00042	OUT	1107
00043	END	---

Program (3)

Data Write.

Data Write such as set value change are performed. Error detection is performed at data write and when confirmed, output 1114 turns ON.



Address	Instruction	Operands
00000	LD	a
00001	AND	b
00002	MOV(21)	---
		00
		DM 001
00003	MOV(21)	---
		01
		DM 002
00004	MOV(21)	---
		02
		DM 003
00005	CMP(20)	---
		DM 002
		# 0010
00006	LD	6305
00007	OUT	1109
00008	LD	1109
00009	AND	b
00010	CMP(20)	---
		DM 002
		# 0001
00011	AND	6307
00012	OUT	1110
00013	LD	1110
00014	AND	b
00015	LD	1111
00016	OR LD	---
00017	AND	TIM 8
00018	OUT	1111

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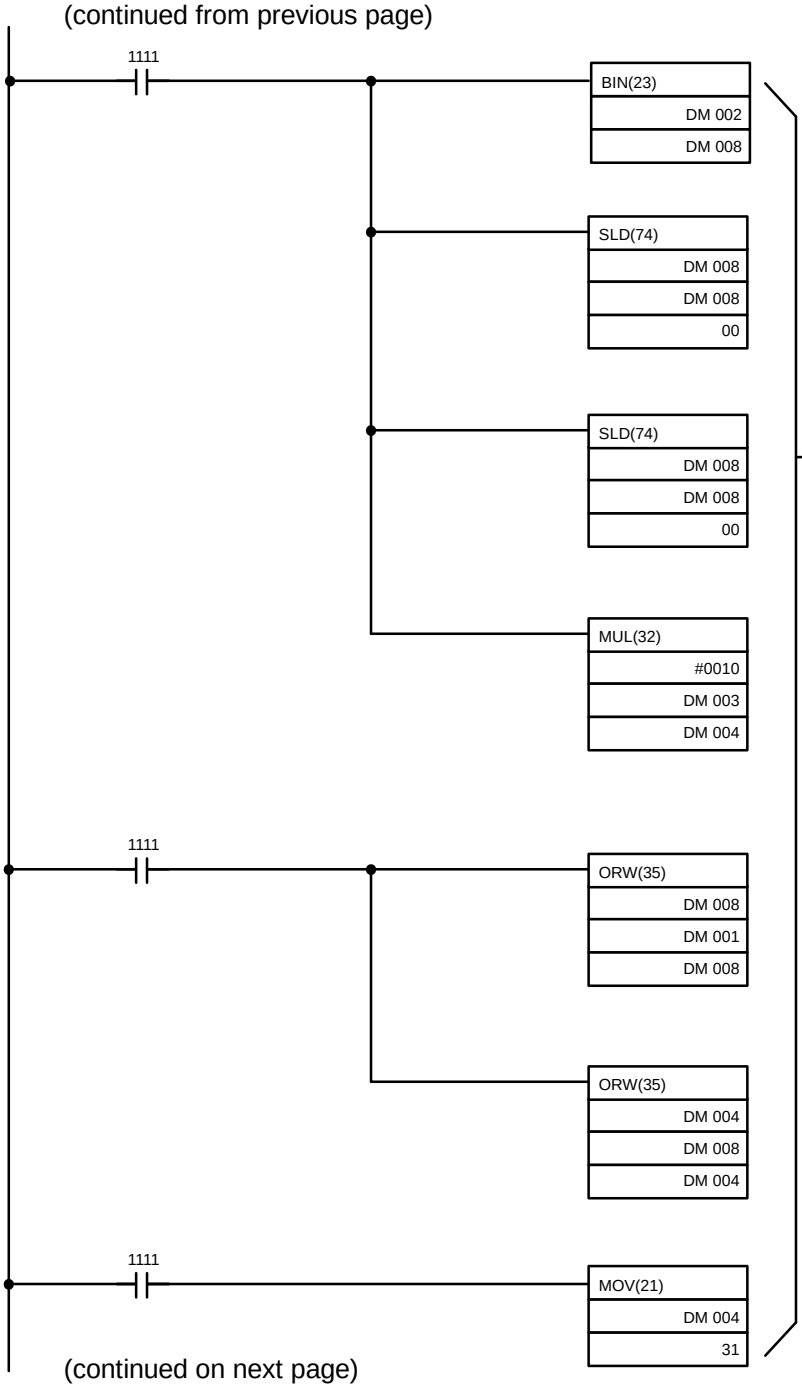

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Address	Instruction	Operands	
00019	LD		1111
00020	BIN(23)		---
		DM	002
		DM	008
00021	SLD(74)		---
		DM	008
		DM	008
			00
00022	SLD(74)	DM	008
		DM	008
			00
00023	MOL(32)		---
		#	0010
		DM	003
		DM	004
00024	LD		1111
00025	ORW(35)		---
		DM	008
		DM	001
		DM	008
00026	ORW(35)		---
		DM	004
		DM	008
		DM	004
00027	LD		1111
00028	MOV(21)		---
		DM	(004)
			31

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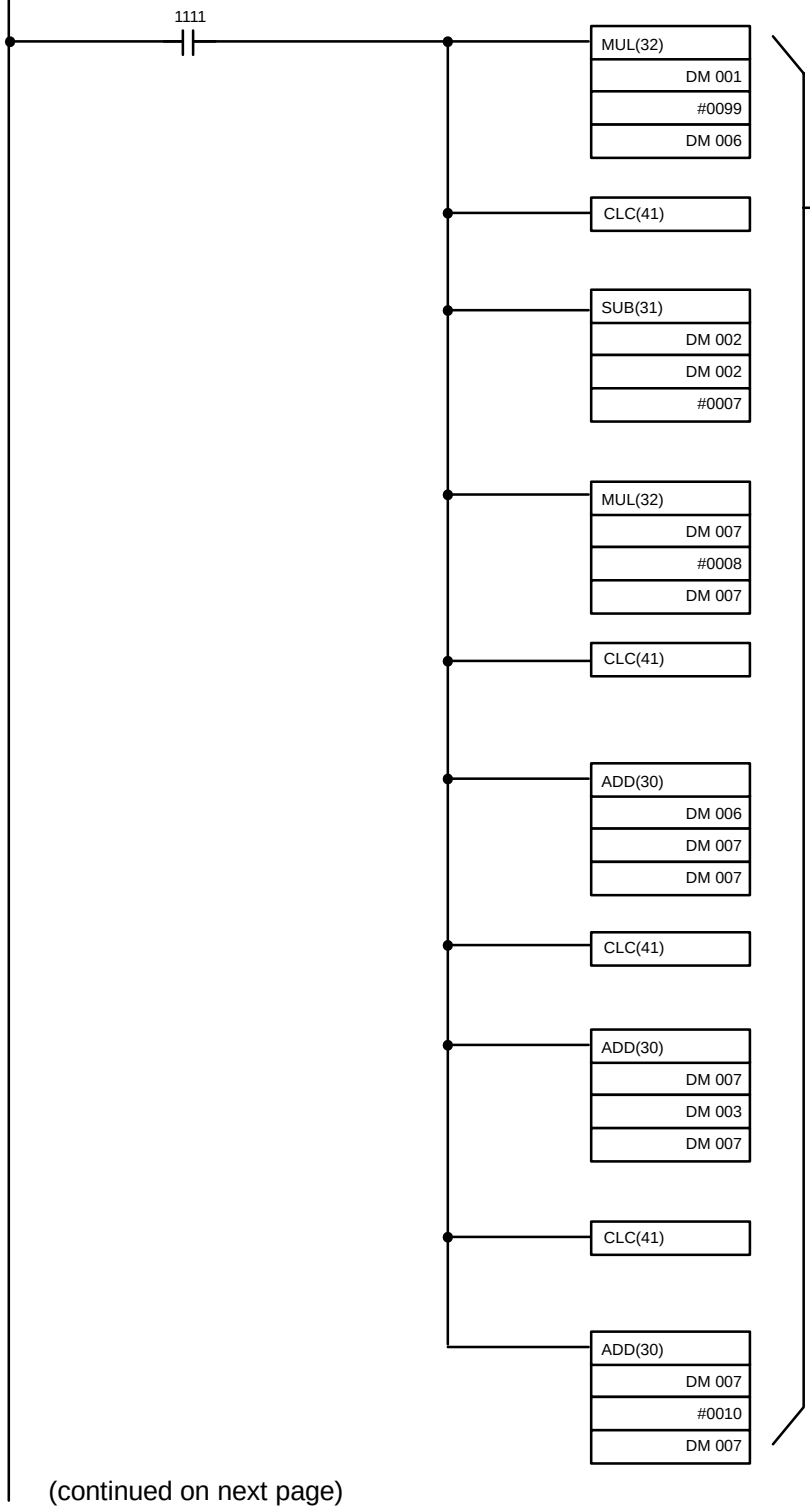

Address	Instruction	Operands	
00029	LD		1111
00030	MUL(32)		---
		DM	001
		#	0099
		DM	006
00031	CLC(41)		---
00032	SUB(31)		---
		DM	002
		DM	002
		#	0007
00033	MUL(32)		---
		DM	007
		#	0008
		DM	007
00034	CLC(41)		---
00035	ADD(30)		---
		DM	006
		DM	007
		DM	007
00036	CLC(41)		---
00037	ADD(30)		---
		DM	007
		DM	003
		DM	007
00038	CLC(41)		---
00039	ADD(30)		---
		DM	007
		#	0010
		DM	007

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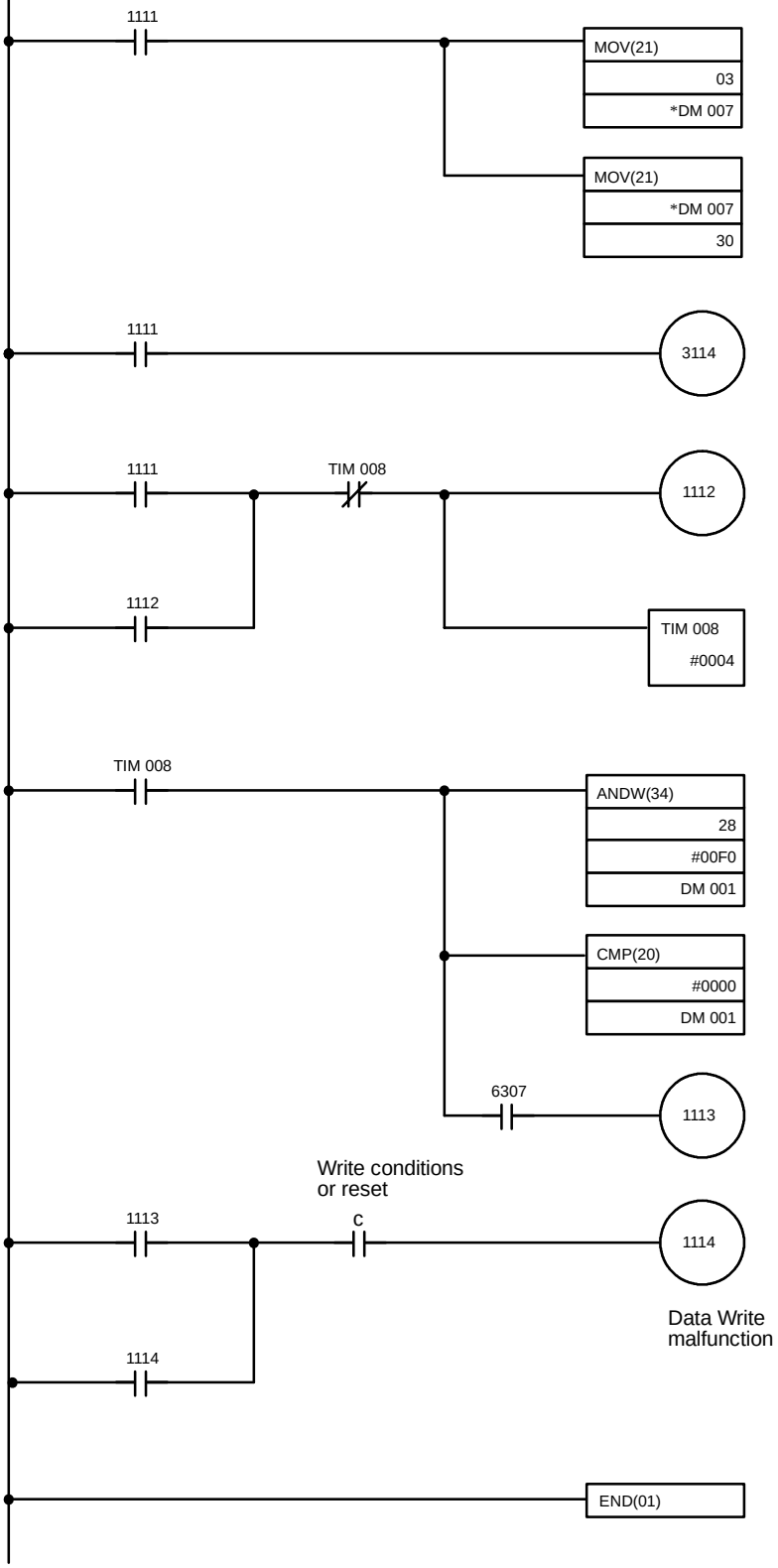


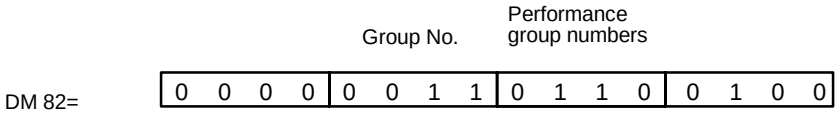
Address	Instruction	Operands
00040	LD	1111
00041	MOV(21)	---
		03
		*DM 007
00042	MOV(21)	---
		*DM 007
		30
00043	LD	1111
00044	OUT	3114
00045	LD	1111
00046	OR	1112
00047	AND NOT	TIM 008
00048	OUT	1112
00049	TIM	008
		# 0004
00050	LD	TIM 008
00051	ANDW(34)	---
		28
		# 00F0
		DM 001
00052	CMP(20)	---
		# 0000
		DM 001
00053	AND	6307
00054	OUT	1113
00055	LD	1113
00056	OR	1114
00057	LD	a
00058	OR	r
00059	AND LD	---
00060	OUT	1114
00061	END	---

Program (4)

Auto-tuning group Write.
The auto-tuning groups for all Units are written in the E5M. When executing the program, set the auto-tuning groups and the executed channels in advance onto each data memory according to the following formula.

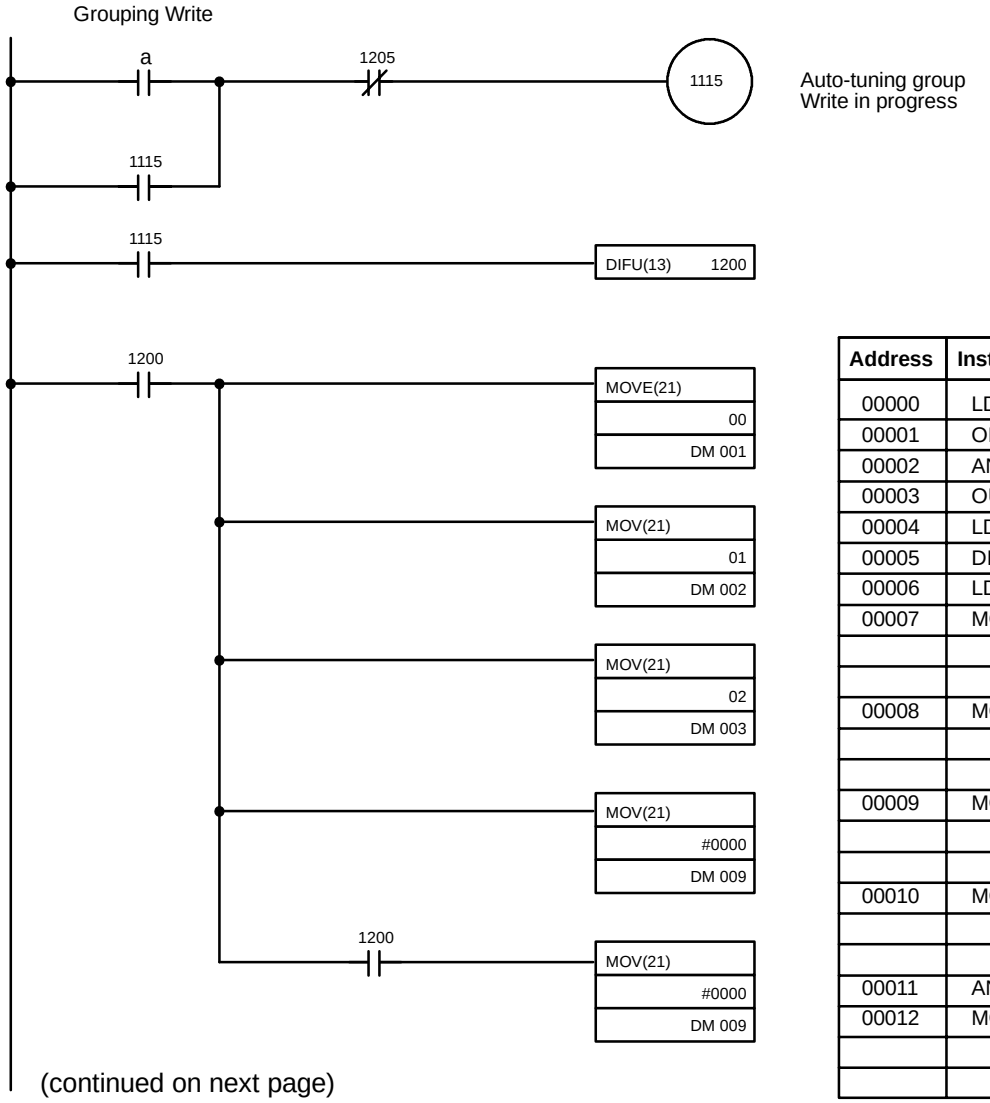
Address = Unit number x 99 + (82 to 89)
Note: auto-tuning can be set for up to a maximum of 8 groups for 1 Unit.

Contents



Group number = 3 Executed channel numbers 3, 6, 7

In this example, when auto-tuning is performed in group 3, channels 3, 6, 7 conduct auto-tuning.



Address	Instruction	Operands
00000	LD	a
00001	OR	1115
00002	AND NOT	1205
00003	OUT	1115
00004	LD	1115
00005	DIFU(13)	1200
00006	LD	1200
00007	MOV(21)	---
		00
		DM 001
00008	MOV(21)	---
		01
		DM 002
00009	MOV(21)	---
		02
		DM 003
00010	MOV(21)	---
		# 0000
		DM 009
00011	AND	1200
00012	MOV(21)	---
		# 0000
		DM 009

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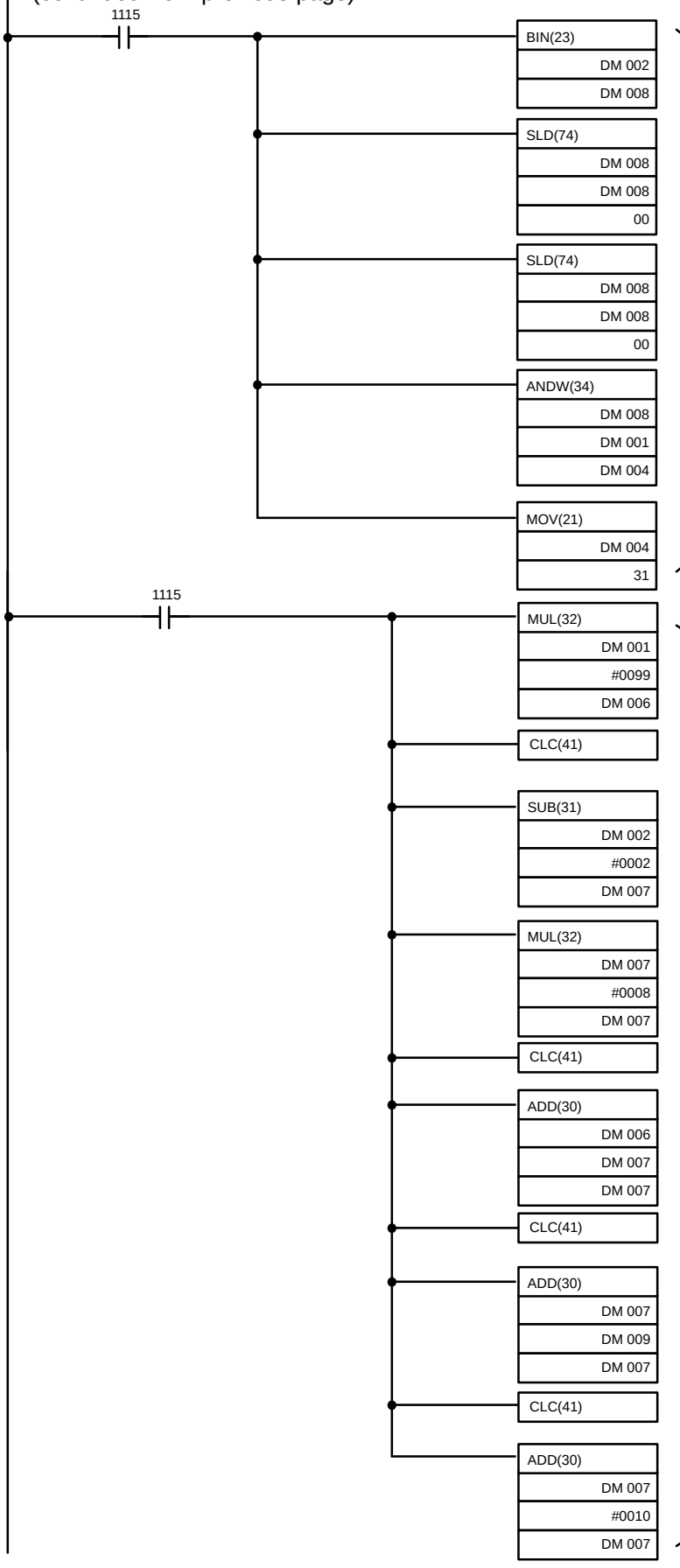
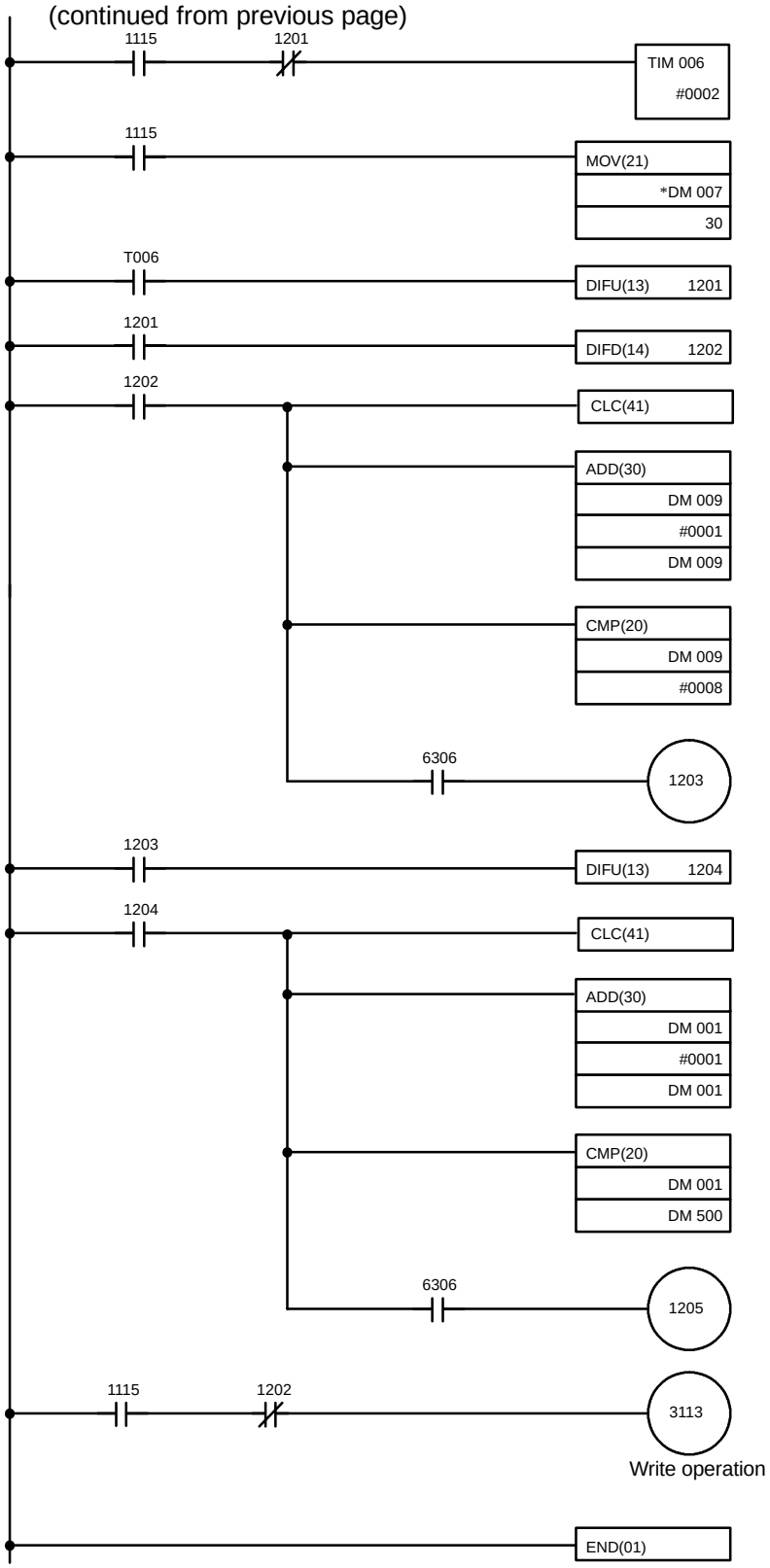


From Programmable Controller to E5M: setting of unit number, channel number, data selection

Address	Instruction	Operands
00013	LD	1115
00014	BIN(23)	---
		DM 002
		DM 008
00015	SLD(74)	---
		DM 008
		DM 008
		00
00016	SLD(74)	---
		DM 008
		DM 008
		00
00017	ANDW(34)	---
		DM 008
		DM 001
		DM 004
00018	MOV(21)	---
		DM 004
		31

DM address calculation for Write data

Address	Instruction	Operands
00019	LD	1115
00020	MUL(32)	---
		DM 001
		# 0099
		DM 006
00021	CLC(41)	---
00022	SUB(31)	---
		DM 002
		# 0002
		DM 007
00023	MUL(32)	---
		DM 007
		# 0008
		DM 007
00024	CLC(41)	---
00025	ADD(30)	---
		DM 006
		DM 007
		DM 007
00026	CLC(41)	---
00027	ADD(30)	---
		DM 007
		DM 009
		DM 007
00028	CLC(41)	---
00029	ADD(30)	---
		DM 007
		# 0010
		DM 007



Address	Instruction	Operands
00030	LD	1115
00031	AND NOT	1201
00032	TIM	006
		# 0002
00033	LD	1115
00034	MOV(21)	---
		*DM 007
		30
00035	LD	TIM 006
00036	DIFU(13)	1201
00037	LD	1201

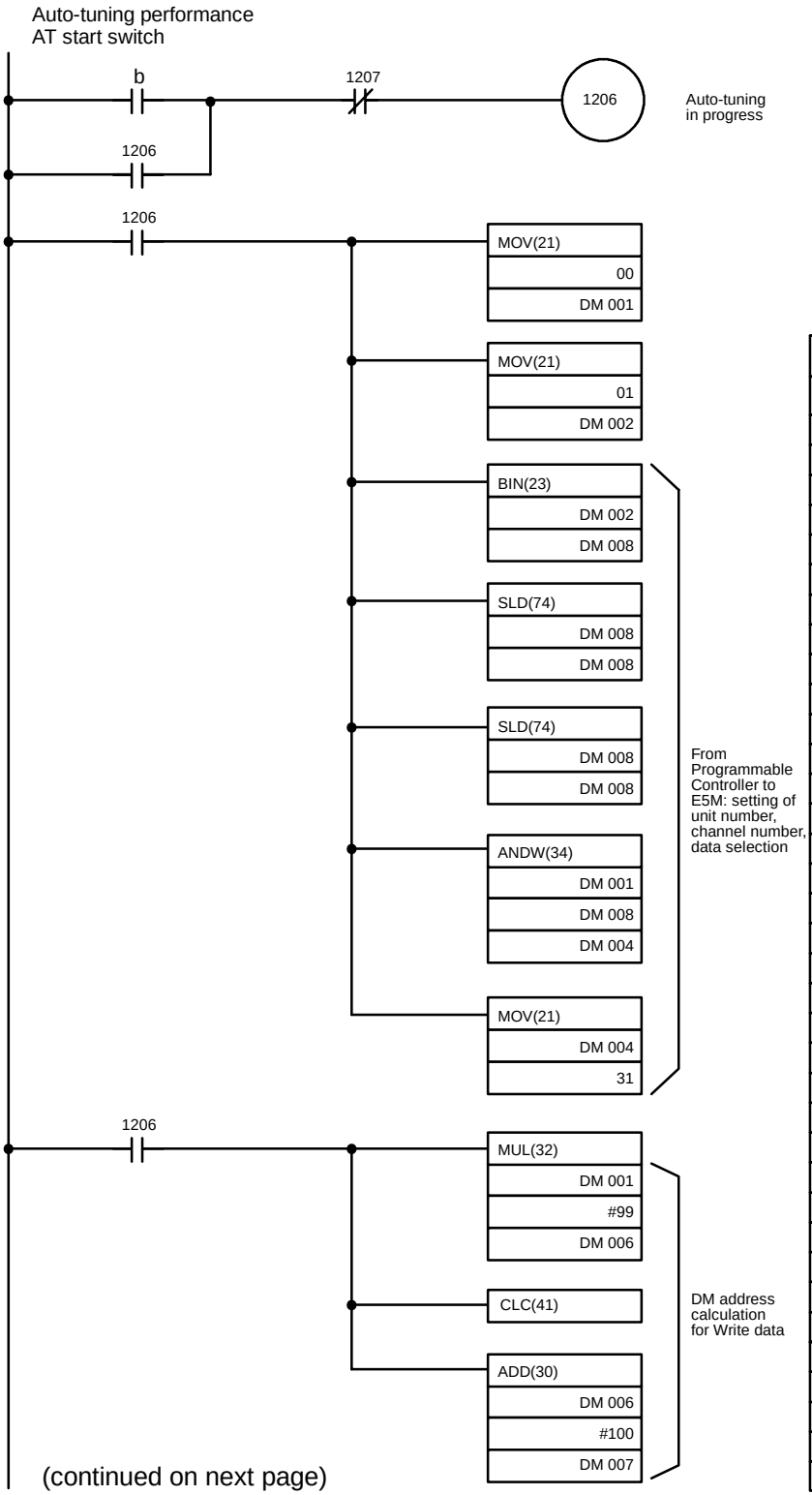
Address	Instruction	Operands
00030	LD	1115
00031	AND NOT	1201
00032	TIM	006
		# 0002
00033	LD	1115
00034	MOV(21)	---
		*DM 007
		30
00035	LD	TIM 006
00036	DIFU(13)	1201
00037	LD	1201
00038	DIFD(14)	1202
00039	LD	1202
00040	CLC(41)	---
00041	ADD(30)	---
		DM 009
		# 0001
		DM 009
00042	CMP(20)	---
		DM 009
		# 0008
00043	AND	6306
00044	OUT	1203
00045	LD	1203
00046	DIFU(13)	1204

Address	Instruction	Operands
00047	LD	1204
00048	CLC(41)	---
00049	ADD(30)	---
		DM 001
		# 0001
		DM 001
00050	COM(29)	---
		DM 001
		DM 500
00051	AND	6306
00052	OUT	1205
00053	LD	1115
00054	AND NOT	1202
00055	OUT	3113
00056	END	---

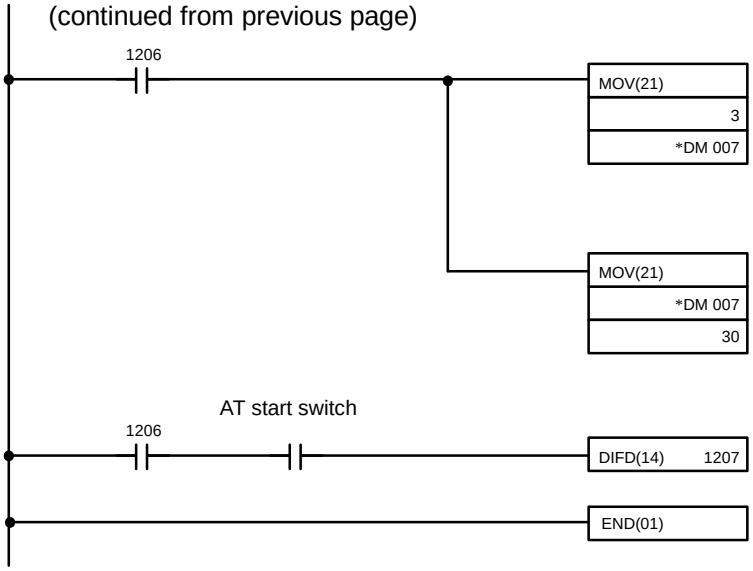
Program (5)

Auto-tuning performance.
Auto-tuning is performed by individual group for the groups set in program (4). In SYSMAC BUS auto-tuning, auto-tuning is conducted for only 1 group at a time. The groups selected in are auto–tuned.

Note When selecting groups, be sure to enter Write data in one column.



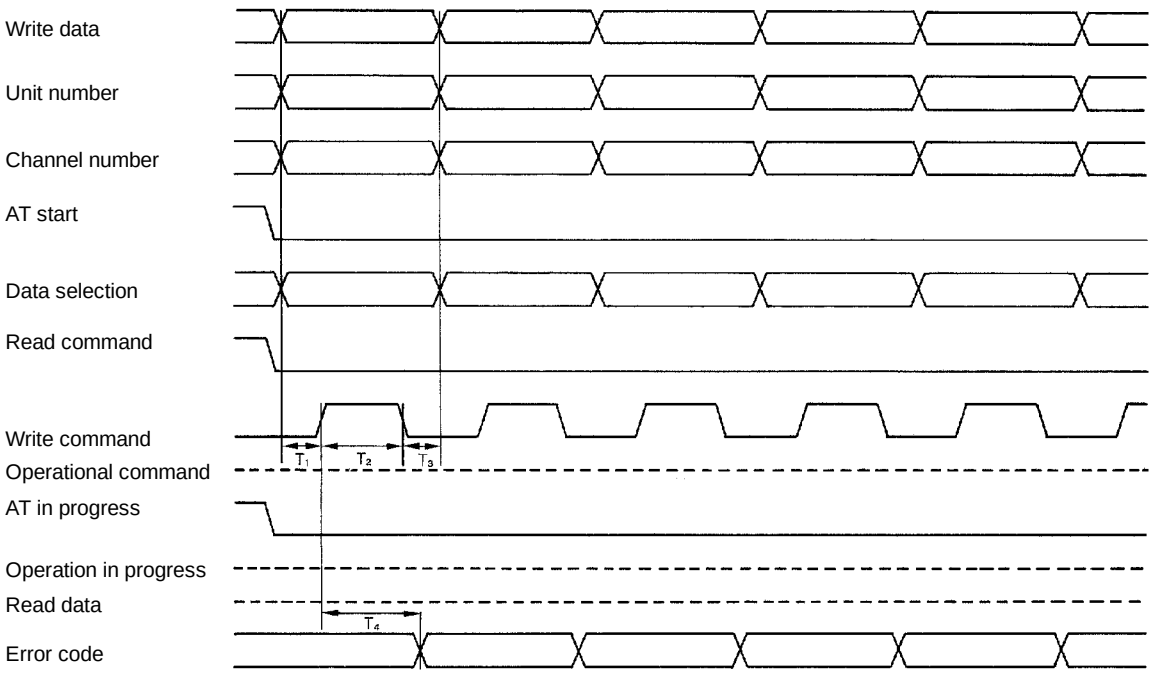
Address	Instruction	Operands
00000	LD	a
00001	OR	1206
00002	AND NOT	1207
00003	OUT	1206
00004	LD	1206
00005	MOV(21)	---
		00
		DM 001
00006	MOV(21)	---
		01
		DM 002
00007	BIN(23)	---
		DM 002
		DM 008
00008	SLD(74)	---
		DM 008
		DM 008
00009	SLD(74)	---
		DM 008
		DM 008
00010	ANDW(34)	---
		DM 001
		DM 008
		DM 004
00011	MOV(21)	---
		DM 004
		31
00012	LD	1206
00013	MUL(32)	---
		DM 001
		# 99
		DM 006
00014	CLC(41)	---
00015	ADD(30)	---
		DM 006
		# 100
		DM 007



Address	Instruction	Operands
00016	LD	1206
00017	MOV(21)	---
		3
		*DM 007
00018	MOV(21)	---
		*DM 007
		30
00019	LD	1206
00020	AND	2806
00021	DIFD(14)	1207
00022	END	---

4-3-6 E5M SYSMAC BUS Timing Chart

Write

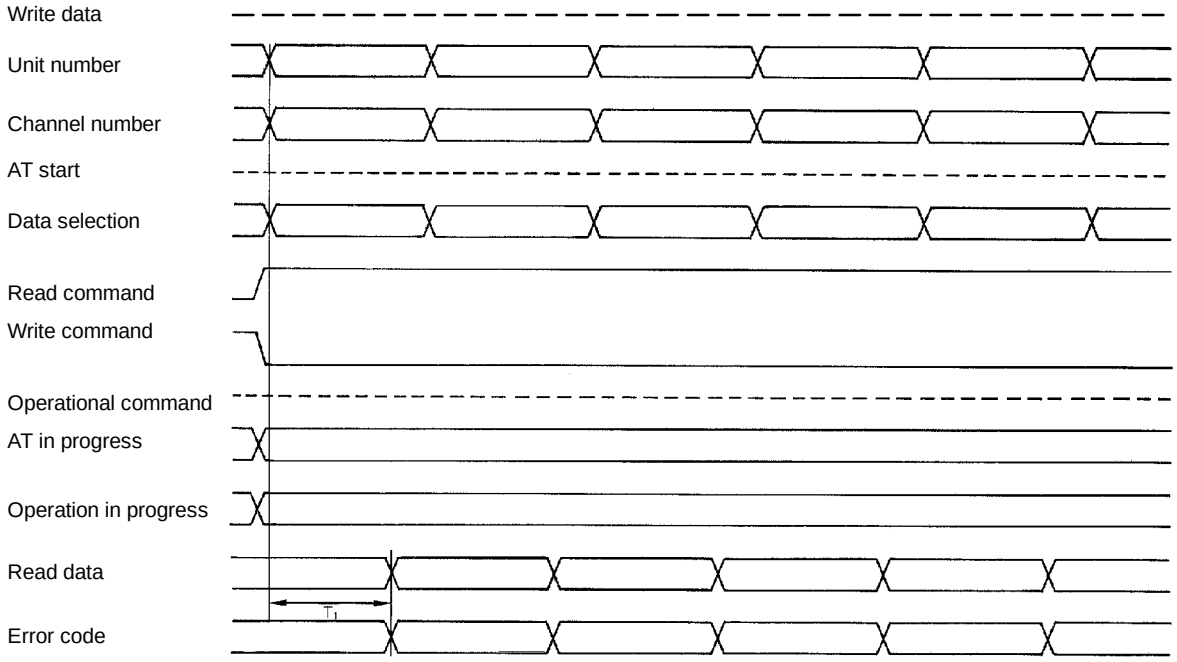


Note 1. T1 ≥ 100 ms. There is an error of −1 count in the timer of the Programmable Controller. Set to TIM = 0002 or TIMH = 0011.
T2 ≥ 100 ms. There is an error of −1 count in the timer of the Programmable Controller. Set to TIM=0002 or TIMH=0011,
T3 ≥ 100 ms. There is an error of −1 count in the timer of the Programmable Controller. Set to TIM=0002 or TIMH=0011.
T4 ≥ 100 ms. The error code requires 150 ms for a distinction to be made.

2. To prevent Write errors, constantly observe the error code during Write. After Write, it is also advisable to read out and check the data.

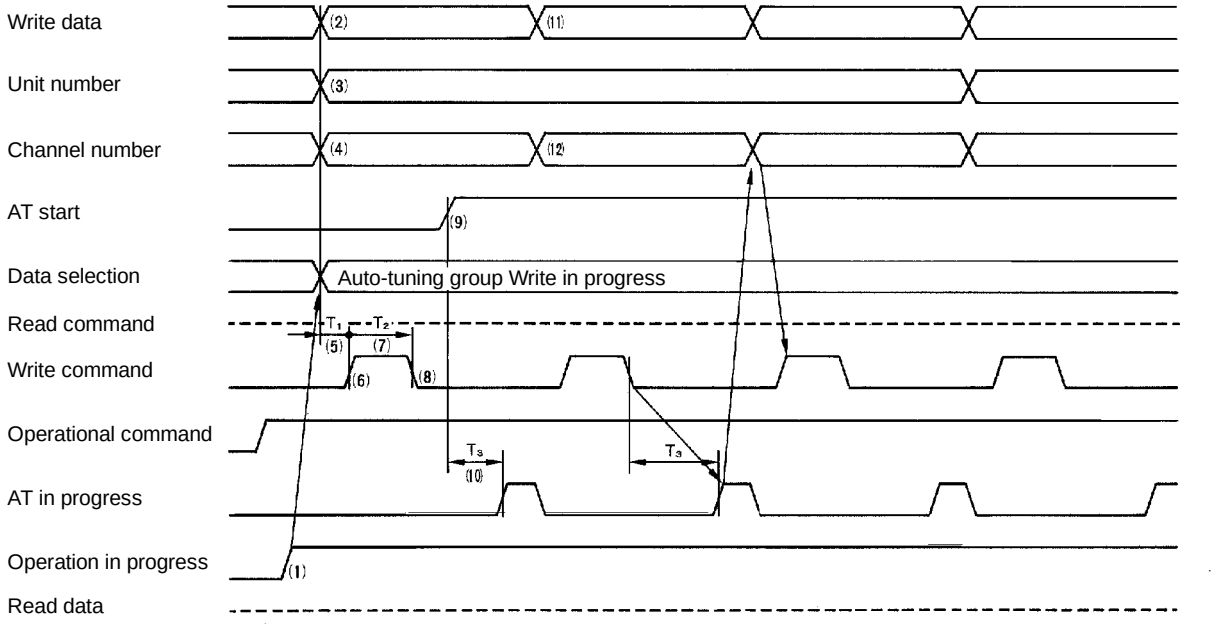
3. The dotted line indicates no relation to Write. It may be ignored.

Read



Note
1. T1 ≤ 100 ms. A maximum of 100 ms are required for the E5M to respond and for Read data to be output. Including the Programmable Controller scan time, Remote I/O scan time, assume a Read waiting time of 100 ms minimum.
2. Process temperature Read is operative only for channels which have been subject to temperature setting. Be sure to conduct temperature setting in advance.
3. Heater burnout and underflow are not expressed in process temperature data. Observe the error code. A process temperature reading under error conditions is not reliable.
4. Change unit number, channel number, and data selection in one scan of the ladder program. When bit changes are done in more than 2 scans, data is read in while change is in progress and abnormal data may be read.

Auto-tuning Start



Note

1. T1 ≥ 100ms, T2 ≥ 100ms. There is an error of −1 count in the timer of the Programmable Controller. Set to TIM=0002 or TIMH=0011.
2. T3 ≥ 16 s. After activation of auto-tuning (AT) start or AT continuous activation group Write, 16 s maximum are required until auto-tuning in progress registers.
3. When the AT stop bit falls, AT stop can be conducted. AT stop covers all Units in a block.
4. Prevent Write errors by constantly observing the error code during Write.
5. For AT performance, temperature setting and group setting are always necessary. Make sure that there are no channels without set temperature (setting=cccc) in the same group.
6. AT performance procedure:
   (1) Confirm that operation is in progress.
   (2) Write the AT performance group numbers into the Write data.
   (3) Write the AT performance Unit into the unit number.
   (4) Write any channel from the AT performance group into the channel number.
   (5) Wait more than 0.1 s.
   (6) Write command turns ON.
   (7) Wait more than 0.1 s.
   (8) Write command turns OFF.
   (9) AT start turns ON.
   (10) Wait until AT in progress turns ON.
   (11) Write the next AT performance group number into the Write data.
   (12) Write any channel from the next AT performance group into the channel number.
   (13) Return to (5); Activate at for the required group.

4-4 Error Checklist for Communications Links

4-4-1 Checklist for RS-232C, RS-422 Communications Errors

No.	Observation	Probable Cause	Measures
1	Though commands are sent, no responses are returned.	(1) Both 5V and 24V are not being supplied.	Supply both 5V and 24V.
		(2) The power supply is not providing the rated voltage.	Measure the voltage at the E5M power supply terminal and provide heavier duty power cable to obtain the rated voltage. Perform any necessary voltage adjustment.
		(3) The communications speed settings do not match.	Set the switches so that the baud rate on the host computer match the Controller.
		(4) Communications methods do not match.	Set the host computer parameters so that stop bit, parity check, and transmission bit all match that of the E5M.
		(5) The wrong software is loaded into the host computer.	Run one of the test programs included in the operation manual.
		(6) The communications connector is incorrectly wired.	Carry out wiring according to the instructions in the operation manual.
		(7) The E5M is being reset.	Cancel reset input.
		(8) The E5M Master unit number and the command unit number do not match.	Set Master unit numbers correctly.
2	Communications can be conducted with the SD or TM, but the TS data cannot be read out normally.	(1)The power supply is not providing the rated voltage.	Measure the voltage at the E5M power supply terminal and provide heavier duty power cable to obtain the rated voltage. Perform any necessary voltage adjustment.
		(2) The Slave address is not set for SD or TM.	The appropriate TS number must be turned ON. Set the slave address number switch corresponding to the TS.
		(3) The TS unit number is not set.	Set unit numbers that do not overlap.
		(4) The wrong cable is connected.	Use E5M-CN01 to connect SD to TS, and TM to TS. Use E5M-CN02 to connect TS to TS.
		(5) The TS is being reset.	Cancel reset input.
3	The response is incomplete.	The response is divided because its length exceeds 128 characters.	In the case where * is not the final character, send the next frame request signal, program the host software to receive the remaining frames.
4	The response format is abnormal. When read out several times, a normal response is returned.	The responses are not read out every time.	When a command is sent, there is always a response in return. If Read is not performed, the responses are stored in the host buffer and will be transferred, in order, later.

No.	Observation	Probable Cause	Measures
5	When a set value is written to the TM, an end code (OD) appears indicating performance impossible due to LOCAL mode (but the TM is not provided with a LOCAL mode).	Auto-tuning is in progress.	For operation modes which do not permit Write, an end code (OD) is always given. Do not attempt to conduct Write.
6	When the SYSMAC use FC984 communications software is used, normal functioning does not occur.	The method of sending the command differs.	Commands differ for the SYSMAC host link. Make use of special-use communications software.
7	When the AAAG, AAWJ, AAWM commands are executed, function failure occurs.	Use of AAAG, AAWJ, AAWM is prohibited.	Do not use AAAG, AAWJ or AAWM.
8	Settings cannot be cleared when the WJ command is sent as well as zeros. An end code (15) appears, indicating a register data error.	The control period is set to 0.	A setting of control period 0 is not possible. Set in a range of 1 to 99.
9	When reading out temperature, abnormal data readings such as 8050 are returned.	(1) Temperature has not been set.	If temperature setting has not been performed (Setting:CCCC), normal temperature Read, etc. cannot be conducted. Perform temperature setting.
		(2) Sensor failure.	Connect sensors correctly.
10	Auto-tuning cannot be activated.	(1) The unit is not operating.	Unless operation is in progress, auto-tuning cannot be activated. Connect the input/output and conduct operation.
		(2) Temperature has not been set.	Perform temperature setting to enable auto-tuning.
		(3) Grouping has not been conducted.	Perform grouping for at least 1 channel to enable auto-tuning.

4-4-2 Checklist for SYSMAC BUS Communications Errors

No.	Observation	Probable Cause	Measures
1	Terminator check of the Remote I/O Master Unit does not extinguish.	(1) Both 5V and 24V are not being supplied.	Supply both 5V and 24V.
		(2) The power supply is not providing the rated voltage.	Measure the voltage at the E5M power supply terminal and provide heavier duty power cable to obtain the rated voltage. Perform any necessary voltage adjustment.M
		(3) Remote I/O Master Unit does not conform to the SYSMAC CPU.	Remote I/O Master Units differ according to CPU Use the correct model.
		(4) SYSMAC BUS cable is not properly assembled.	Assemble the SYSMAC BUS cable correctly.
		(5) Terminator has not been set correctly.	Set the terminator only for the Unit to be connected to the physical extremity of SYSMAC BUS.
		(6) The E5M is being reset.	Cancel reset input.
2	I/O table cannot be registered.	(1) I/O Unit and E5M addresses are overlapping.	E5M cannot conduct automatic address setting. Set the address switch so that other Units and addresses do not overlap.
		(2) Remote I/O Master Unit does not conform to the SYSMAC CPU.	Use the correct models.
3	An I/O comparison error is indicated.	The I/O table and the actual condition differ.	Re-register the I/O table.
4	An I/O setting error is indicated.	The I/O Unit and the E5M address are overlapping.	E5M cannot conduct automatic address setting. Set the address switch so that other Units and addresses do not overlap.
5	System does not operate even if E5M is exchanged.	The end of the cable is projecting from the connector and interrupting the E5M's optical connection.	Reduce fiber projection to less than 0.3 mm.
6	Even though an operational command is being sent, the Unit does not operate.	(1) Operational command is not sent at the rising edge.	Operation starts with operational commands at the rising edge. Start operation by first turning the signal OFF and then ON.
		(2) Error is detected.	After checking the error code, remove the cause of the error.
		(3) A Write command is applied.	While a Write command is applied, the IN data cannot be changed. When the Write command is no longer necessary, set to 0.

No.	Observation	Probable Cause	Measures
7	Operation does not cease even though an operation command is not being sent.	(1) Operation commands is not sent at the falling edge.	Operation stops with operation command at the falling edge. Stop operation by first turning the signal ON and then OFF.
		(2) Error is detected.	After checking the error code, remove the cause of the error.
		(3) A Write command is applied.	While a Write command is applied, the IN data cannot be changed. When the Write command is not necessary, set to 0.
		(4) SYSMAC has stopped.	Even when SYSMAC has stopped operating due to power failure, a disconnected optical fiber cable, etc., the E5M continues to operate. After SYSMAC has begun operating again, execute the operation command at the falling edge.
8	Auto-tuning cannot be activated.	(1) The unit is not operating.	Unless operation is in progress, auto-tuning cannot be activated. Connect the input/output and conduct operation.
		(2) Temperature has not been set.	Perform temperature setting to enable auto-tuning.
		(3) Grouping has not been conducted.	Perform grouping for at least 1 channel to enable auto-tuning.
9	Communications can be conducted with the SD or TM, but the TS data cannot be read out normally.	(1) The power supply is not providing the rated voltage.	Measure the voltage at the E5M power supply terminal and provide heavier duty power cable to obtain the rated voltage. Perform any necessary voltage adjustment.
		(2) The Slave address is not set for SD or TM is not set.	The appropriate TS number must be turned ON. Set the slave address number switch corresponding to the TS.
		(3) The TS unit number is not set.	Set unit numbers that do not overlap.
		(4) The wrong cable is connected.	Use E5M-CN01 to connect SD to TS, and TM to TS. Use E5M-CN02 to connect TS to TS.
		(5) The TS is being reset.	Cancel reset input.

SECTION 5
Installation

5-1 Installation

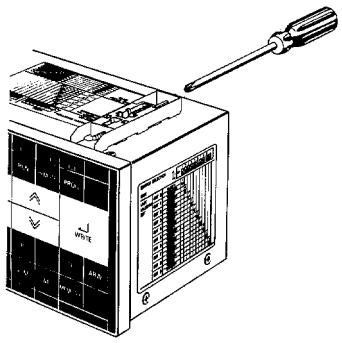
5-1-1 Installation Methods

Temperature Control Unit

Using a screwdriver, secure the top and bottom of the Unit with M5 screws.

Programming Console and Display

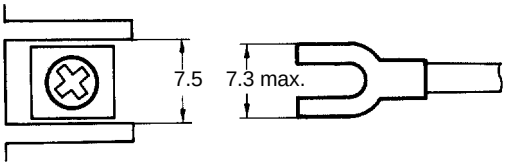
Using a screwdriver, secure the brackets to be attached on top and bottom or right and left. Tighten by turning to the right until the ratchet of the bracket clicks.



5-1-2 Connections

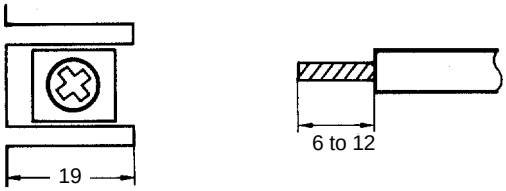
Crimp Terminals

Use a solderless terminal which fits M3.5 screw terminals. For the terminal screw, use an M3.5X8 screw with a self-rising washer.



Wires

The screw has a self-rising washer, allowing easy connection. The exposed part of the wire must be between 6 and 12 mm. Be sure that the tip of the wire is soldered to prevent fraying. Don't over tighten the screw.



Input Signal Line

To avoid interference from noise or induction, keep system cabling as far away as possible from power lines or high voltage machines. In particular, since the sensor input of the Temperature Control Unit operates using low voltage signals, be sure to keep it away from output lines and power lines.

Unused Sensor Input Terminals

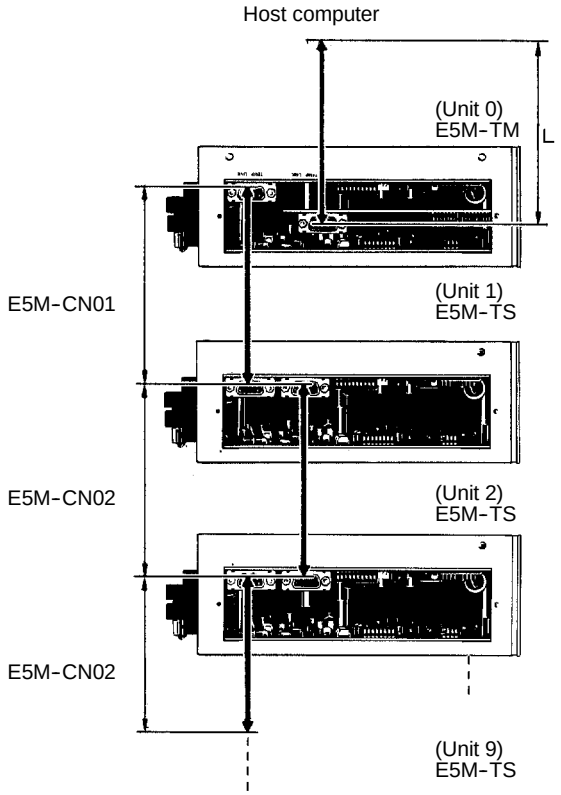
Unused sensor input terminals should be treated as described below. Otherwise, malfunction may be caused.

Thermocouple types: short-circuit the + and – terminals.
Platinum resistance types: connect resistors showing temperature in full scale between the A and B terminals, and short-circuit between B and B'.
Resistors examples:
0.0% to 100.0%C . . . . . 100 to 139.16 W
0.0% to 200.0%C . . . . . 100 to 177.13 W
0% to 400%C . . . . . 100 to 249.56 W
150.0% to 350.0%C . . . . 158.29 to 231.89 W

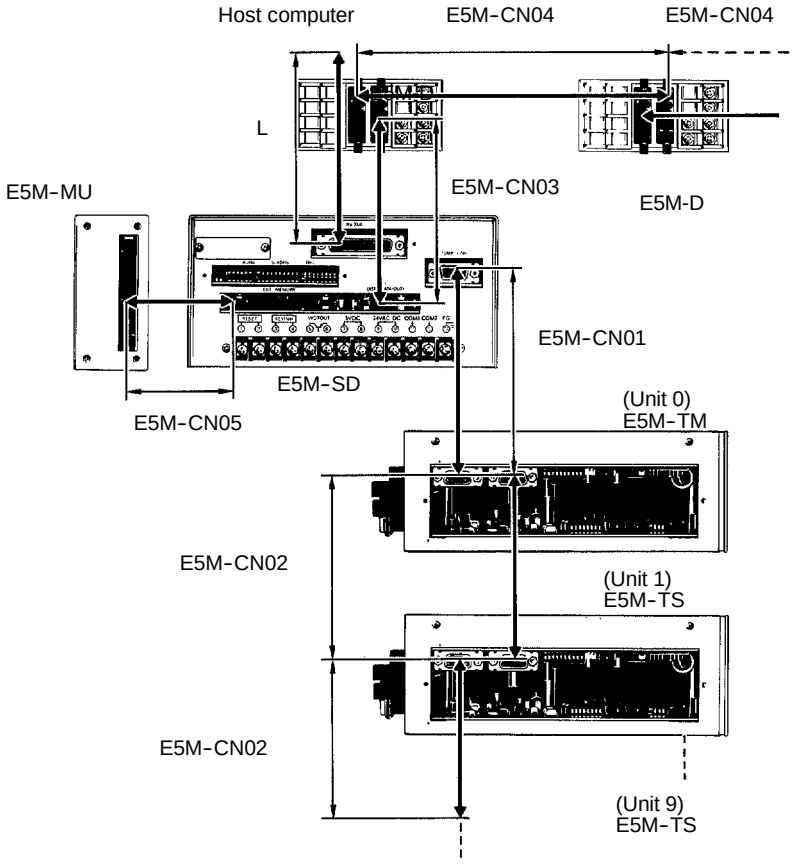
5-2 Connections Between Units

For connection between E5M Units, use dedicated cables and follow the connection diagrams below.

Temperature Control Unit (Master) System



Programming Console System



Connections other than L-part

Cable model	Length	Extension	Connectors used (OMRON)	Parts connected
E5M-CN01	2 m	30 max.	Hood: XM2S-0911 Plug: XM2A-0901	Temperature Control Unit (Master) Programming Console to Slave
E5M-CN02	0.3 m	30 m max.	Hood: XM2S-0911 Plug: XM2A-0901	Slave to Slave
E5M-CN03	1 m	2 m max.	Socket: XG3M-1000 Strain relief: XG3T-1004	Programming Console to Display
E5M-CN04	0.2 m	2 m max.	Socket: XG3M-1000 Strain relief: XG3T-1004	Display to Display
E5M-CN05	0.5 m	0.5 m max.	Socket: XG3M-3400 Strain relief: XG3T-3404	Programming Console to Memory Unit

L-part Connections

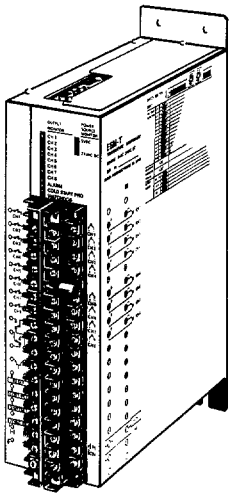
L-part refers to the host computer connection cable. Make necessary preparations with reference to the information below:

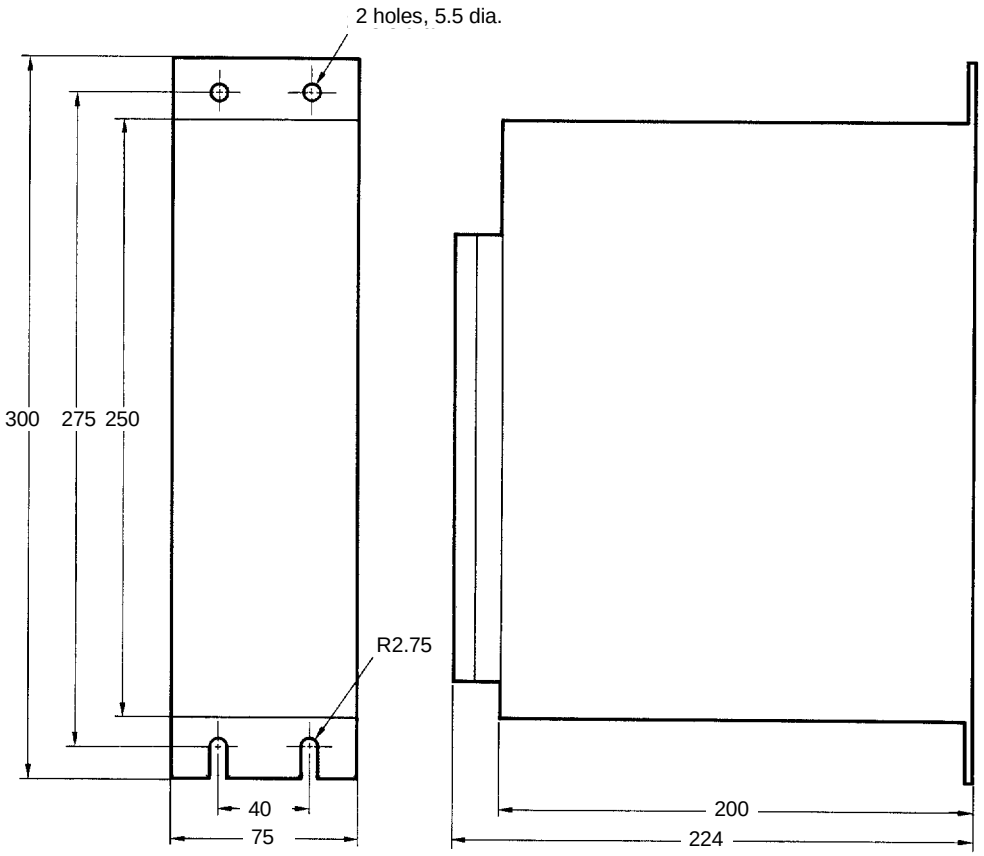
- Maximum extension of cable.
  RS-422: 500 mm
  RS-232C: 15 m
  SYSMAC BUS: All-plastic optical fiber cable (APF): 20 m
  Plastic-clad optical fiber cable (PCF): 200 m
- Recommended connector
  RS-422 : XM2 D-subconnector (9 pins, OMRON)
  RS-232C: XM2 D-subconnector (25 pins, OMRON)
- SYSMAC BUS recommended cable
  Plastic optical fiber cable : B500-PF002 (OMRON)
  Quartz-polymer optical fiber cable: B500-OF002 (OMRON)
  B500-OF*** (OMRON)

5-3 Dimensions

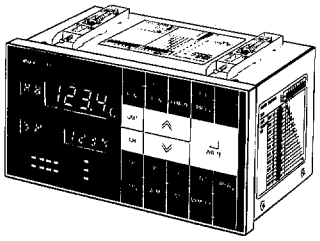
External Dimensions

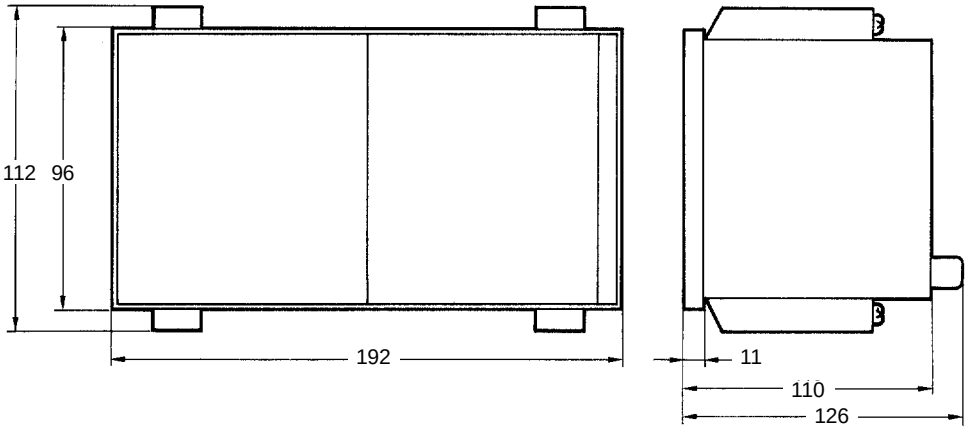
Temperature Control Unit (Master, Slave)



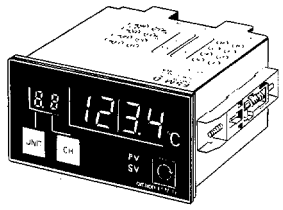


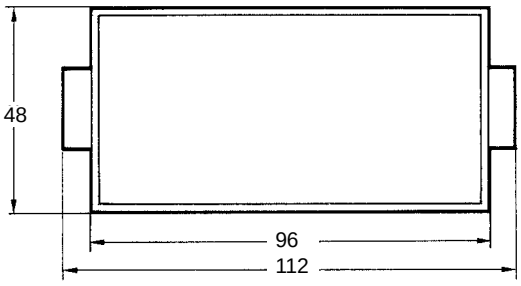
Programming Console

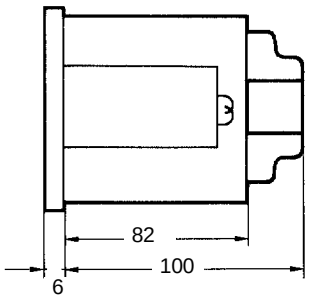




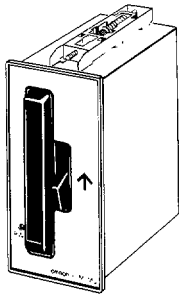
Display

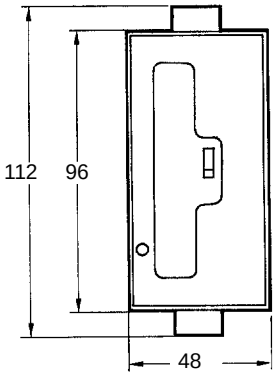


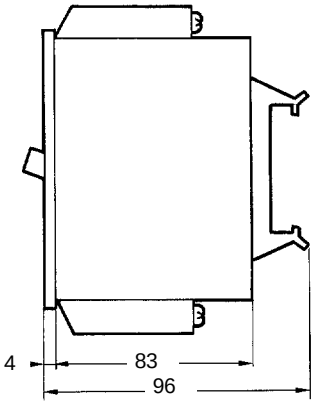




Memory Unit

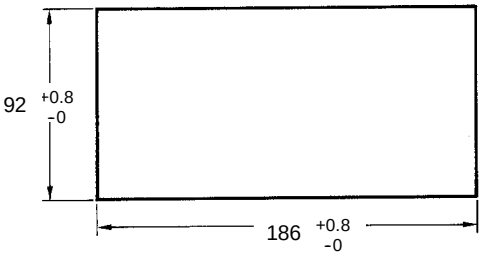




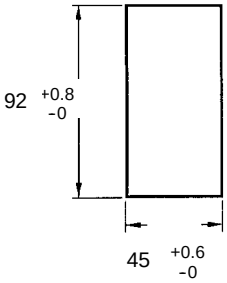


Panel Cutouts

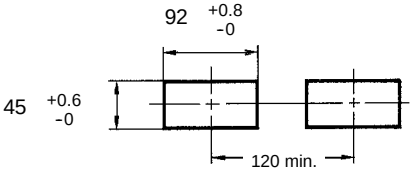
Programming Console

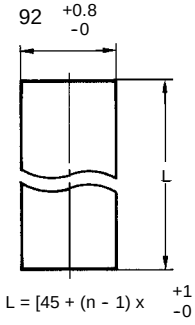


Memory Unit



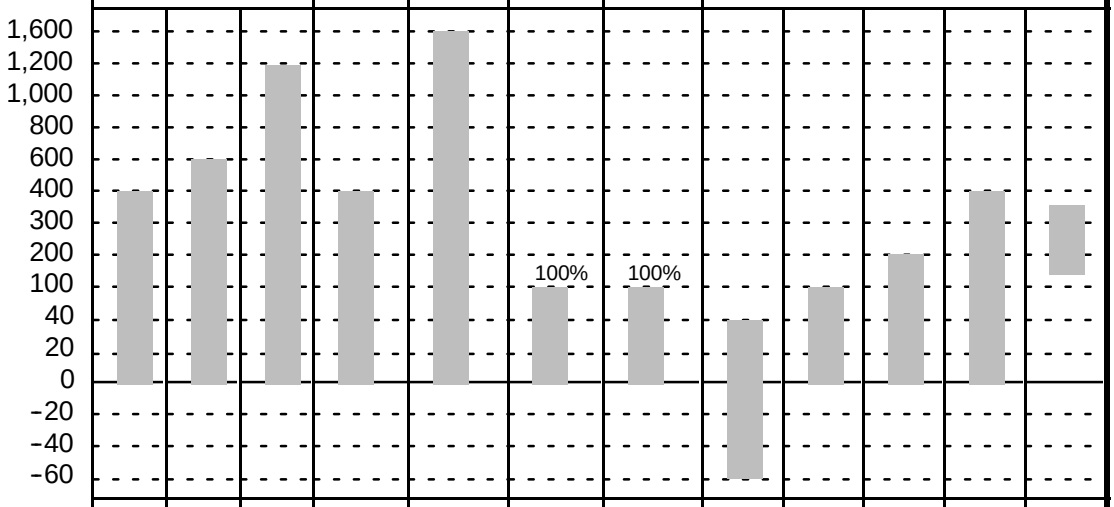
Display





Appendix A
Standard Models

Temperature Control Unit (Master)

Input			Thermocouple					Current	Voltage	Temperature resistance thermometer				
Standard scale			K(CA)			J(IC)	R(PR)	4 to 20 mA	1 to 5 V	PT 100 W				
														
Host link (transmission specifications)			1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	1	0.1
RS-232C	Relay	Model	E5M-TM01RK			E5M-TM01RJ	E5M-TM01RR	E5M-TM01RC	E5M-TM01RV	E5M-TM01RP				
	Voltage	Model	E5M-TM01QK			E5M-TM01QJ	E5M-TM01QR	E5M-TM01QC	E5M-TM01QV	E5M-TM01QP				
	Current	Model	E5M-TM01CK			E5M-TM01CJ	E5M-TM01CR	E5M-TM01CC	E5M-TM01CV	E5M-TM01CP				
RS-422	Relay	Model	E5M-TM02RK			E5M-TM02RJ	E5M-TM02RR	E5M-TM02RC	E5M-TM02RV	E5M-TM02RP				
	Voltage	Model	E5M-TM02QK			E5M-TM02QJ	E5M-TM02QR	E5M-TM02QC	E5M-TM02QV	E5M-TM02QP				
	Current	Model	E5M-TM02CK			E5M-TM02CJ	E5M-TM02CR	E5M-TM02CC	E5M-TM02CV	E5M-TM02CP				
SYSMAC BUS	Relay	Model	E5M-TM10RK			E5M-TM10RJ	E5M-TM10RR	E5M-TM10RC	E5M-TM10RV	E5M-TM10RP				
	Voltage	Model	E5M-TM10QK			E5M-TM10QJ	E5M-TM10QR	E5M-TM10QC	E5M-TM10QV	E5M-TM10QP				
	Current	Model	E5M-TM10CK			E5M-TM10CJ	E5M-TM10CR	E5M-TM10CC	E5M-TM10CV	E5M-TM10CP				
---	Relay	Model	E5M-TSRK			E5M-TSRJ	E5M-TSRR	E5M-TSRC	E5M-TSRV	E5M-TSRP				

Host link (transmission specifications)			1	1	1	1	1	0.1	0.1	0.1	0.1	0.1	1	0.1
	Voltage	Model	E5M-TSQK			E5M-TSQJ	E5M-TSQR	E5M-TSQC	E5M-TSQV	E5M-TSQP				
	Current	Model	E5M-TSCK			E5M-TSCJ	E5M-TSCR	E5M-TSCC	E5M-TSCV	E5M-TSCP				

Options (Order Separately)

Unit	Host link	Model no.
Programming Console	---	E5M-SD00
	RS-232C	E5M-SD01
	RS-422	E5M-SD02
	SYSMAC BUS	E5M-SD10
Display	---	E5M-D
Memory Unit	---	E5M-MU
Memory Cartridge	---	E5M-MC8

Note 1. The Memory Cartridge is used with the Memory Unit. It is an 8-Kbyte SRAM (Static RAM).

2. The Memory Unit is supplied with one Memory Cartridge.

Special Use Cables (Order Separately)

Parts connected	Standard cable length	Maximum extension	Model no.
SD.TM and TS	2 m	30 m	E5M-CN01
TS and TS	0.3 m	30 m	E5M-CN02
SD and D	1 m	2 m	E5M-CN03
D and D	0.2 m	2 m	E5M-CN04
SD and MU	0.5 m	0.5 m	E5M-CN05

Note Special use cables do not come with the E5M. Choose the required cables according to the information given in *5-3.* The cables must be ordered separately.

Appendix B
Specifications

Common Characteristics and Performance

The following are common characteristics and performance ratings for the Temperature Control Unit, Programming Console, Display, and Memory Unit.

Common Ratings

Power supply voltage	24 VAC/VDC, 5 VDC (2 power sources)
Power supply range	24 VAC, ±10% 24 VDC, ±10% 5 VDC, ±5%
Ambient temperature	–10% to +55%C
Ambient humidity	35% to 85%
Storage temperature	–25% to +65%C

Common Characteristics

Insulation resistance		20 MW max. (at 500 VDC)
Dielectric strength		500 VAC, 50/60 Hz for 1 min (between the current-carrying parts and exposed non-current-carrying parts)
Vibration	Malfunction durability	15 to 55 Hz, 0.3 mm double amplitude (2G)
	Mechanical durability	10 to 35 Hz, 0.75 mm double amplitude
Shock	Malfunction durability	100 m/s^2, in 6 directions, 3 times each
	Mechanical durability	300 m/s^2, in 6 directions, 3 times each
Noise resistance		Power supply: Normal 10 E/common 500 V I/O terminals: Normal 10 E/common 500 V

Note 5 VDC is supplied to the Memory Unit because of its signalling requirements.

Communications Characteristics

The following information outlines the communications performance of the Programming Console and Temperature Control Unit (Master).

	RS-422, RS-232C	SYSMAC BUS
Communications method	4-conductor half duplex	Half duplex
Synchronizing method	Start-stop synchronization (2 stop bits)	---
Baud rate (DIP switch selection)	150, 300, 600, 1,200, 2,400, 4,800, 9,600 bps	187,500 bps
Transmission code	ASCII (7-bit)	---
Transmission path	---	Optical fiber

Temperature Control Unit Specifications

Specifications

Consumption current		24 VAC/VDC: 0.5 A, 5 VDC: 1 A
Input		Thermocouple/Platinum resistance thermometer Pt100Ω
Control output	Relay output	250 VAC, 3 A STSP NO (resistive load)
	Voltage output	12 VDC, 15 mA (with short-circuit protection)
	Current output	4 to 20 mA DC. Load resistance below 600 Ω (approx. 200 resolution) Output cycle 2 s
Adjustment mode		PID control (with auto-tuning function)
General alarm output		250 VAC, 3 A SPST NC (resistive load)
Cold start protection output		250 VAC, 3 A SPST NC (resistive load)
Watchdog output		Open-collector output 30 VDC, 20 mA max. Residual voltage: 1.4 V max. Leakage current: 0.1 mA
External signal input		Contact signal input (operates when ON)
Setting method		Digital setting by key switches (Programming Console) or external setting by data communications
Other functions		Detection of breaks in wiring, output monitor

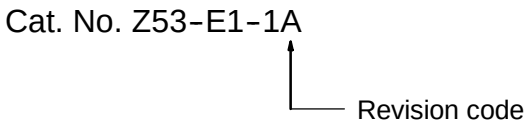
Performance Characteristics

Setting accuracy		No relative errors with indicated value; set value and indicated value are the same.
Designated accuracy		+0.5% FS + 1 digit
Hysteresis		0.2% FS (fixed)
Proportional band		0.0 to 999.9% FS (in units of 0.1%)
Integral time		0 to 3,999 s (in units of 1 s)
Derivative time		0 to 3,999 s (in units of 1 s)
ARW value		0 to 99% (in units of 0.1%)
Alarm setting range		0 to FS (deviation for set temperature)
Control period		1 to 99 seconds (in units of 1%)
Cold start protection Timer start temperature		Setting value
External control signal		Reset, cold start protection protect
Life expectancy	Mechanical	10,000,000 operations min. (with relay outputs)
	Electrical	100,000 operations min. (with relay outputs)
Memory protection		Lithium battery back-up (10 years at constant, rated temperature)
Momentary power failure security time		20 ms
Communications		Master: consult description of communications capacity given elsewhere Slave: none
Sampling period		2 s/8 words

Note The minimum output time for relay and voltage output is 10 ms or 1% of the control period, whichever is smaller.

Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

Revision code	Date	Revised content
1	October 1990	Original production
1A	June 1997	**Page 108:** Hood model numbers corrected.