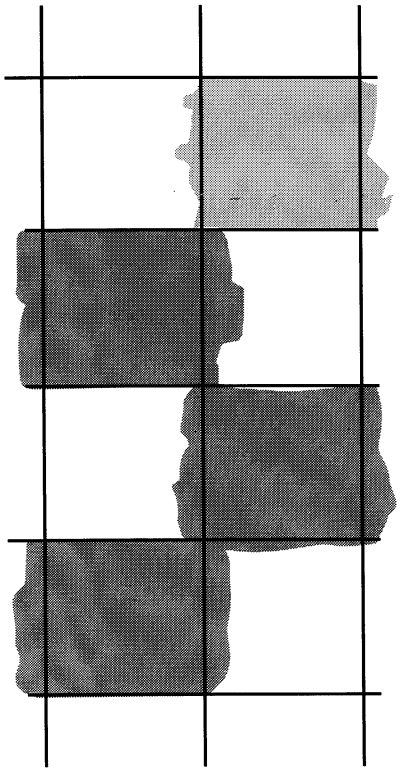
TOSHIBA

PROGRAMMABLE CONTROLLER



EX20PLUS/40PLUS

USER'S MANUAL

EX20PLUS/40PLUS
PROGRAMMABLE CONTROLLER
USER's MANUAL

Toshiba Corporation

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Introduction

Introducing The EX20PLUS/40PLUS

The Toshiba EX20PLUS/40PLUS Programmable Controllers provide an economical solution for efficient, dependable control of small-scale automated systems. Here are some of the special features that make the EX20PLUS/40PLUS models ideal for a wide scope of applications.

- Standard High-Speed Counter functions make it easy configure a system for positioning control.

- Optional Analog Input Units can be connected to input analog signals in three ranges: 0 to 10V, 0 to 5V, and 0 to 20mA for control applications requiring temperature, pressure, and similar analog inputs.

- The hand-held LCD Programmer features easy-to-use graphic input of control program ladder diagrams. This makes the EX20PLUS/40PLUS adaptable to operators of varying experience.

- Control programs can be written to and run from optional PROM modules using the built-in PROM writer functions of the EX20PLUS/40PLUS.

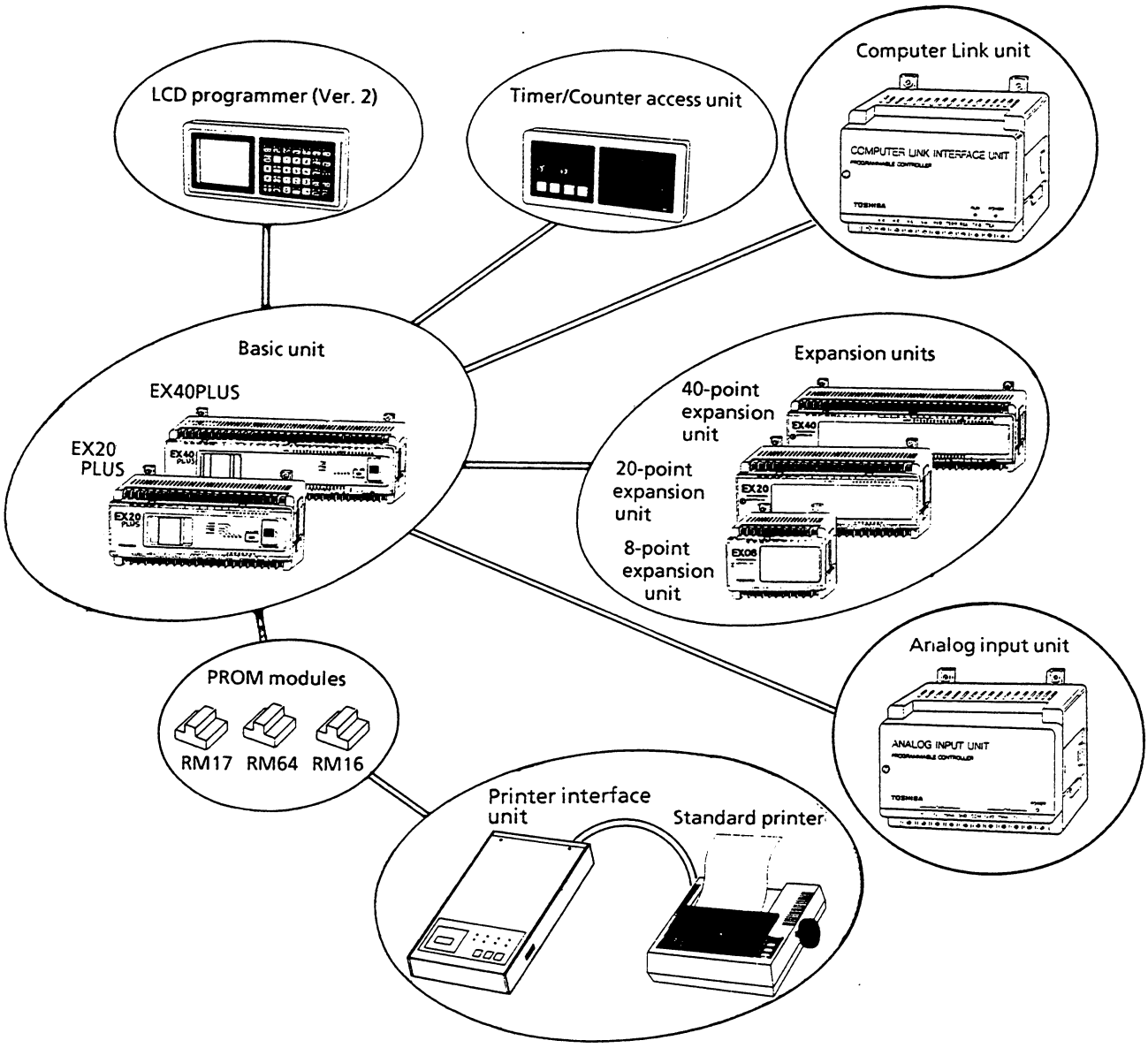
- The optional Computer Link Unit allows connection of a host computer via the standard RS-422 interface. This communications link allows a variety of functions to be performed from the host computer. These include monitoring and starting/stopping the operation of the EX20PLUS/40PLUS system, reading and writing data to and from devices and registers, and editing control programs. Up to 16 units may be connected on a single RS-422 channel to the computer.

About This Manual

This user's manual introduces the functions and operation of the Toshiba EX20PLUS/40PLUS Programmable Controllers. The manual is divided into the six following parts and reference appendices.

Part I: Hardware introduces the EX20PLUS/40PLUS system. The hardware specifications for major components of the system are presented in this part with details on installation and wiring procedures.

System configuration



Basic Unit

The basic unit is available in two models - the EX20PLUS and EX40PLUS. And each model is available in two input types-Dry contact input and 120 Vac input. The basic unit is the center of the PC system which stores user program, monitors input signals, and controls output signals according to the program.
Use of the High-Speed Counter function occupies two input points (dry contact input type only). When the function is not used all the basic unit input will be completely available. The EX20PLUS can use 12 input and 8 output points, and the EX40PLUS 24 input and 16 output points.

Expansion Units

Optional I/O expansion units are available in three types: 40-point (EX40exp), 20-point (EX20exp), and 8-point (EX08). Three kind of models of the EX08 are available: 8-input, 8-output, and 4-input/4-output.

Analog Input Unit

Optional Analog Input Units can be connected to input analog signals in three ranges: 0 to 10 V, 0 to 5V, or 0 to 20mA.
When an Analog Input Unit is connected, only one of expansion unit EX20exp , EX40exp, or EX08 can be connected.

LCD Programmer (VER. 2)

The LCD programmer (VER. 2) is a hand-held programming and debugging tool for the EX20PLUS/40PLUS.

Timer/Counter Access Unit

This unit is used for changing the preset value of the Timer and/or counter which is programmed in the EX20PLUS/40PLUS. The current value of the timer and/or counter can also be monitored.

Computer Link Unit

This unit allows RS-422 data communications between a host computer and the EX20PLUS/40PLUS.

PROM Modules

PROM module (RM17) is used as external memory to store and run the EX20PLUS/40PLUS program.

Printer Interface Unit

Program stored on PROM module (RM17) can be printed out using this unit, and a standard serial or parallel printer.

Part II: Programming and Operation introduces the basics of programmable control systems and use of the hand-held LCD Programmer to write, edit and monitor the running of control programs. Several sample programs are given with full descriptions of individual devices and instructions. The use of optional PROM modules is also covered in this part.

Part III: High-Speed Counter introduces the built-in High-Speed Counter functions of the EX20PLUS/40PLUS for positioning control applications.

Part IV: Analog Input Unit explains the wiring and programming of optional Analog Input Units for control applications requiring input from analog signal sources such as temperature and pressure sensors.

Part V: Computer Link Unit explains the functions and operation of the optional Computer Link Unit which allows data transfer between the EX20PLUS/40PLUS system and a host computer. This part describes the communication protocols and commands and gives sample programs.

Part VI: Guide to Applications presents several programming techniques for specific instructions. Practical examples of typical applications are also described for use of the High-Speed Counter function and optional Analog Input Units.

Appendices contain error message descriptions, ordering information, an explanation of octal numbers, and a glossary of programmable controller terminology.

Hints, Notes, and Cautions

Pay special attention to information preceded by the following markers in the left margin throughout the manual:

Helpful suggestion on how to use the equipment most effectively.

Information essential for complete understanding and best operation of the equipment.

Condition or operation which might result in equipment misoperation or human injury.

Terminology

A number of terms related to programmable controller operation are defined in the glossary in the Appendices. You should familiarize yourself with these terms before proceeding. The following is a list of abbreviations and acronyms used in this manual:

AWG	American wire gage
CMOS	Complementary metal oxide semiconductor
CPU	Central processing unit
EEPROM	Electrically erasable programmable read-only memory
EPROM	Erasable programmable read-only memory
G	Gravity. Unit of measurement for vibration and shock tests
I/O	Input /output
LCD	Liquid crystal display
LED	Light-emitting diode
ms	Millisecond
PC	Programmable controller
PROM	Programmable read-only memory
RAM	Random access memory
ROM	Read-only memory
µs	Microsecond
Vac	ac voltage
Vdc	dc voltage

Related Publications

The following related publications are available for the EX20PLUS/40PLUS. If you have any questions concerning these publications or need additional information, please contact your local Toshiba distributor.

User's Guide -Timer/Counter Access Unit	TDA-E002
User's Guide -8-Point Expansion Unit	TDA-E003
Printer Interface Instruction Manual	6F9E0068

PART I

HARDWARE

SECTION 1

Before You Begin

This section outlines this part and previews each section to provide a helpful headstart before you begin.

About This Part

This part provides easy-to-understand, quickly accessible information on all hardware aspects of the EX20PLUS/40PLUS. These include operating site considerations, mounting, wiring, troubleshooting, and maintenance. You should thoroughly familiarize yourself with this information before attempting to set up the PC system.

This is what you will find in the upcoming sections:

Section 2 System Configuration and Specifications
This introductory section illustrates and explains each system component and shows how they work together. It also names and explains each part of the programmable controller (PC).

Section 3 I/O Specifications and Connections
This section describes the Input/Output specifications of the EX20PLUS/40PLUS system. It also explains how to connect field devices, such as push buttons, limit switches, lamps, etc.

Section 4 Installation and Wiring
This section describes how to wire and install the PC. It first explains how to select the right installation site, then tells you, step-by-step, how to install and wire the PC system.

Section 5 and 6 Inspection, Maintenance and Troubleshooting
Your Toshiba PC will function efficiently with little or no downtime caused by malfunctions if you pay close attention to these sections. However, should any operating problem arise, these sections also tell you how to troubleshoot the cause.

Section 7 General Specifications and Dimensions

SECTION 2

System Configuration and Specifications

This section introduces the EX20PLUS/40PLUS PC system. In it you will find introductory information on the system configuration, peripheral devices, external features, and general specifications.

Introducing the EX20PLUS/40PLUS

The Toshiba EX20PLUS/40PLUS sends and receives control signals to and from its controlled devices. It does this based on a user-written ladder diagram program that tells the PC when to activate or deactivate each output.

These signals are received and sent through the PC's input/output (I/O) terminals to which each device is independently wired. The LED indicators light when an ON signal is being sent (OUTPUT) or received (INPUT).

A wide range of instructions can be programmed, including contacts, counters, timers, master control and jump circuits, step sequencers, shift registers, and flip-flops. How to program these instructions is explained in Part II, Programming and Operation.

System Configuration

A complete EX20PLUS/40PLUS system consists of the components shown in the figure on the next page.

I/O Expansion

The EX20PLUS basic unit has 12 input and 8 output points. The EX40PLUS has 24 input and 16 output points. I/O points can be expanded by connecting expansion units. The following combinations are available.

PC model	I/O points	Expansion units
EX20PLUS	20	EX20PLUS
	28	EX20PLUS — EX08
	36	EX20PLUS — EX08 — EX08
	40	EX20PLUS EX20exp
EX40PLUS	40	EX40PLUS
	48	EX40PLUS — EX08
	56	EX40PLUS — EX08 — EX08
	60	EX40PLUS EX20exp
	68	EX40PLUS EX20exp — EX08
	76	EX40PLUS EX20exp — EX08 — EX08
	80	EX40PLUS EX40exp

NOTE

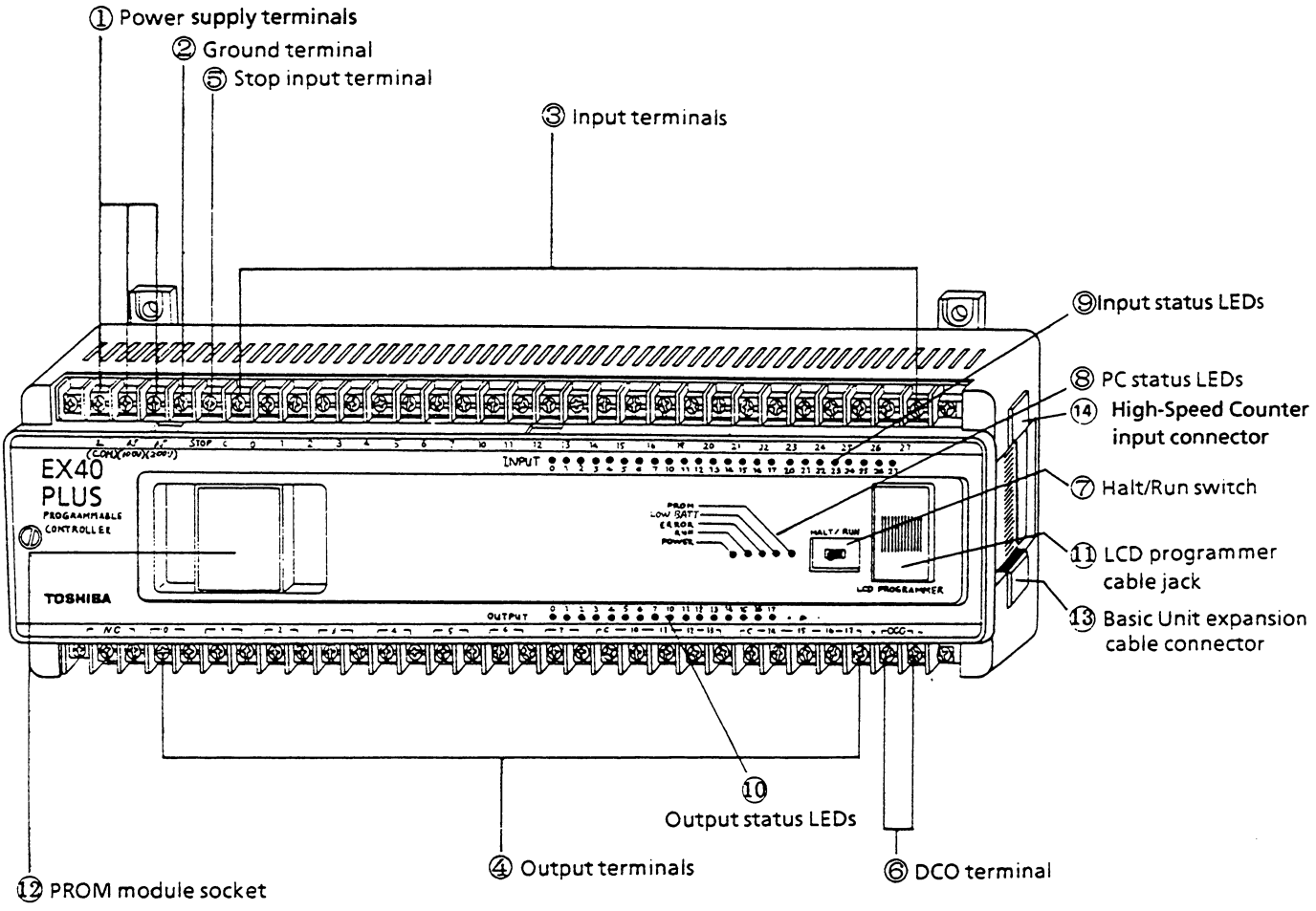
1) EX20exp, EX40exp, and EX08 respectively indicate a 20-point expansion unit, 40-point expansion unit, and an 8-point expansion unit.
2) Three types of the EX08, 8-input, 8-output, and 4-input/4-output, are available. Accordingly, the I/O ratio may be configured flexibly by using appropriate types of the EX08.
3) Use of the High-Speed-Counter function requires two input points. When the function is used, the EX20PLUS can use 10 input and 8 output points, and the EX40PLUS 22 input and 16 output (dry contact input type only).
4) When an Analog Input Unit is connected, only one of expansion units EX20exp,EX40exp, or EX08 expansion unit can be connected on.
The Analog Input Unit can be connected just next to the basic unit.

System Components

EX20PLUS/40PLUS basic unit

External features

BASIC UNIT (EX40PLUS)



	Name	Function
①	Power supply terminals	Supply AC power. 1) To use 100 to 120Vac ... Connect power cable leads to terminals N(100V) and L(COM). To use 200 to 240Vac ... Connect power cable leads to terminals N(200V) and L(COM).
②	Ground terminal	Use grounding 100Ω or less.
③	Input terminals	Receive input signals from field devices.
④	Output terminals	Send output signals to field devices.
⑤	Stop input terminal	When the input to this terminal is ON, program operation is halted, with output mode preserved intact.
⑥	DCO terminal	Supplies 24Vdc±15%, 0.1A power (dry contact input type only).
⑦	Halt/Run switch	Stops or starts program operation.
⑧	PC status LEDs	POWER ... ON when AC power is supplied to the PC. RUN ... ON while a program is running. ERROR ... ON when an error occurs. (switching all the outputs OFF). LOW BATT ... ON when the internal battery is low. PROM ... ON when a PROM module is mounted.
⑨	Input status LEDs	Indicate the ON status of each input signal.
⑩	Output status LEDs	Indicate the ON status of each output signal.
⑪	LCD programmer cable jack	Connects the LCD programmer or the timer/counter access unit.
⑫	PROM module socket	Optional PROM modules are mounted in this socket. (Shipped with a module blank in the socket.)
⑬	Basic Unit expansion cable connector	Expansion units come equipped with an expansion cable that plugs into this connector.
⑭	High-Speed Counter input connector (120 Vac input type only)	Connects the encoder or other pulse generating devices. (In the dry contact input type, input terminals No. 0 and 1 are used for this function.)

NOTE 1) 120 Vac input type can not accept 200 to 240 Vac for power supply.

CPU specifications

Model		EX20PLUS	EX40PLUS
Processing method		Stored program, cyclic scan system	
Programming method		Ladder diagram	
Program memory	Capacity	1022 steps	
	Type	CMOS RAM (battery backup)/EEPROM (option)	
Instructions [1]		NO (normally open) contact, NC (normally closed) contact, coil, transitional contact, timer, counter, master control, jump control, step sequencer, flip-flop, shift register, I/O update, and END (see Part II Programming and Operation)	
Execution time (contact)		60μs/step	
Internal memory	Internal relay (R)	128 (including 16 points special relay)	
	Latch relay (L)	128	
	Timer (T) [2]	56 (0.1~99.9s), 8(0.01~99.99s)	
	Counter (C) [3]	64 (1~9999)	
	Shift register (S)	256 bits	
Maximum input/output points		24 (I)/16 (O)	48 (I)/32 (O)
Self-diagnostics	LED indicators	POWER, RUN, ERROR, LOW BATT., PROM	
	Diagnostic items	Watchdog timer check, memory check, execution time check, battery voltage check	

NOTE

1) Detailed information regarding software is explained in Part II of this manual.
2) When an Analog Input Unit is used, 24 timer points are used for analog input. (See Part IV, Analog Input Unit)
3) When the High-Speed Counter function is used, 32 counter points are used. (See Part III, High-Speed Counter)

I/O specifications

Model		EX20PLUS	EX40PLUS
Digital I/O	Input points [1]	12 points	24 points
	Output points	8 points	16 points
	Input type [2]	Dry contact, 120 Vac	
	Output type [2]	Relay	
High-Speed Counter input [1]		1 point - counter input, 1 point - reset input	

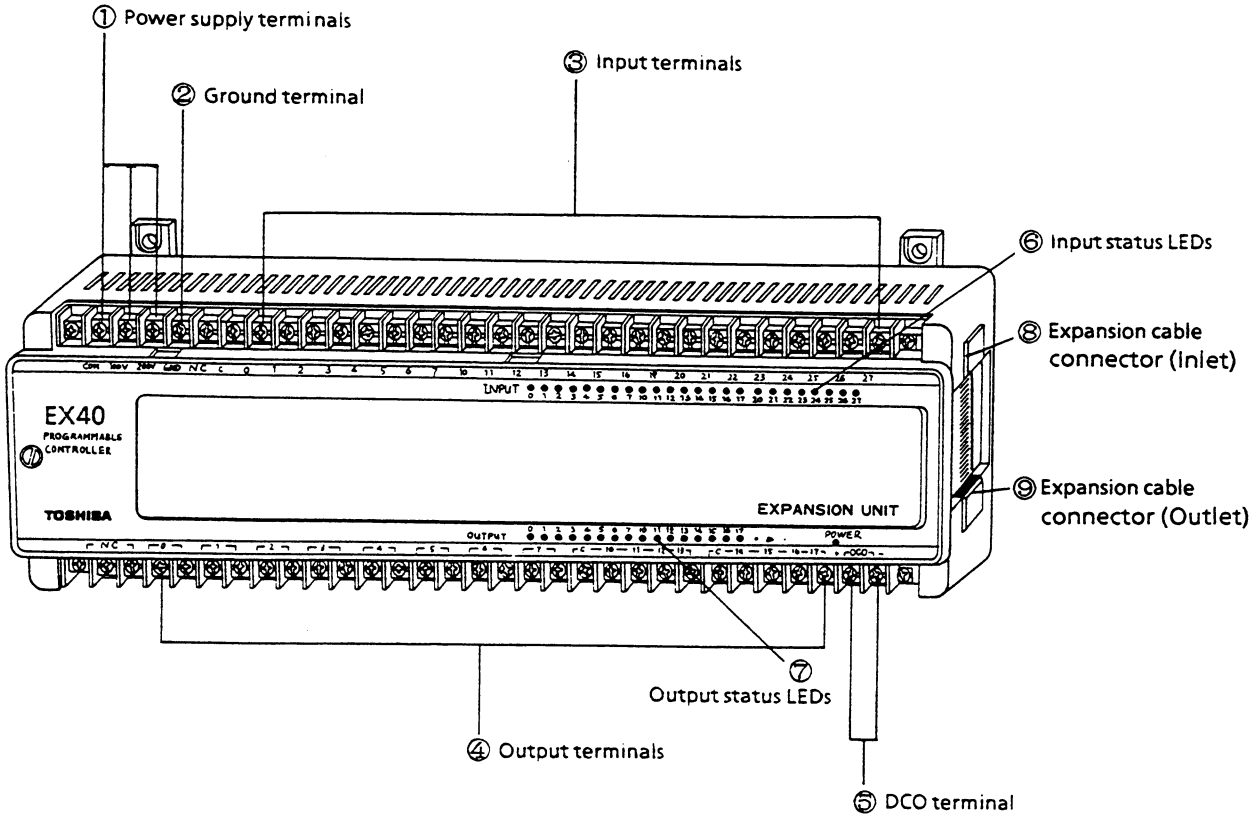
NOTE

1) When High-Speed Counter function is used, 2 input points are used (dry contact input type only).
2) Detailed I/O specifications and wiring are described in Section 3 of this part.

Expansion unit (EX20exp., EX40exp., EX08)

External features

EXPANSION UNIT (40-point Expansion)



	Name	Function
①	Power supply terminals	Supply AC power. To use 100 to 120Vac ... Connect power cable leads to terminals 100V and COM. To use 200 to 240Vac ... Connect power cable leads to terminals 200V and COM.
②	Ground terminal	Use grounding 100Ω or less.
③	Input terminals	Receive input signals from field devices.
④	Output terminals	Send output signals to field devices.
⑤	DCO terminal	Supplies 10 to 30Vdc, 0.1A power (dry contact input type only).
⑥	Input status LEDs	Indicate the ON status of each input signal.
⑦	Output status LEDs	Indicate the ON status of each output signal.
⑧	Expansion cable connector (Inlet)	Connects expansion cable from basic unit or another expansion unit. Connector cover keeps the cable from being pulled out.
⑨	Expansion cable connector (Outlet)	Connects expansion cable to next expansion unit. Connector cover keeps the cable from being pulled out.

I/O specifications (EX20exp/EX40exp.)

Item		EX20exp.	EX40exp.
Digital I/O	Input points	12 points	24 points
	Output points	8 points	16 points
	Input type	Dry contact, 120Vac, 24Vdc	
	Output type	Relay, Triac, Transistor	

NOTE Detailed specifications and wiring are described in Section 3 of this part.

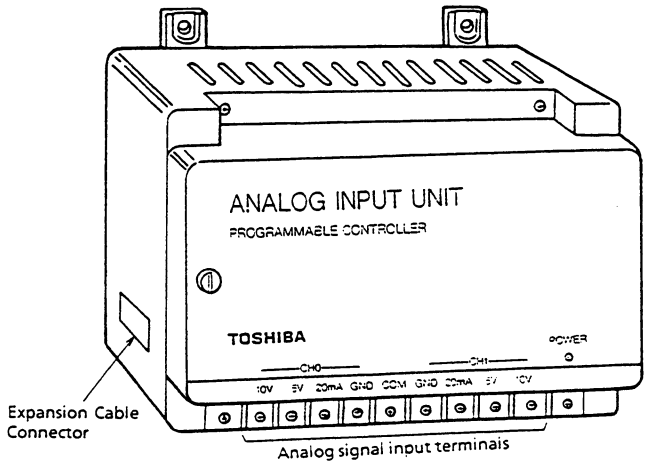
I/O specifications (EX08)

Item	EX08 (Input type)	EX08 (I/O type)	EX08 (Output type)
Input points	8 points	4 points	—
Output points	—	4 points	8 points
Input type	Dry contact, 120Vac, 24Vdc		—
Output type	—	Relay	Relay, Triac, Transistor

NOTE
1) EX08 comes in three models: 8 inputs, 4 inputs/4 outputs, and 8 outputs.
2) Detailed I/O specifications are described in Section 3 of this part.supplied with the unit.

Analog Input Unit

External features



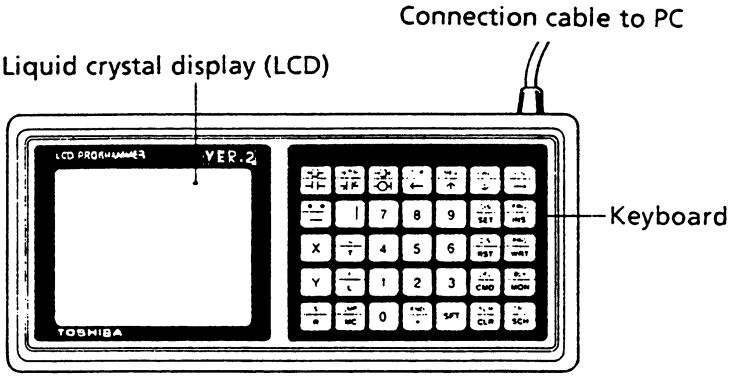
Analog Input Unit Specifications

Input channels		2 channels
Input range	Voltage	Unipolar 0 to +10Vdc, 0 to +5Vdc
	Current	Unipolar 0 to +20mA
Input impedance	Voltage	200kΩ (+10V), 100kΩ (+5V)
	Current	250Ω (+20mA)
Input filter parameters		2ms (Cut-off Frequency: 500Hz)
Digital conversion values		0 to 200 counts (in 8 bits)
Resolution		0.5% (over full scale)
Overall accuracy		±1% (over full scale)
Temperature drift		±300 PPM/°C
Conversion cycle time		1 scan time
Withstand voltage		500Vac, 1min.
Maximum input voltage		+20V (at the +10V input terminal) +10V (at the +5V input terminal)
Consumed current		50mA max. at 5Vdc (Supplied from PC)

NOTE The operation of the Analog Input Unit is explained in Part IV of this manual.

LCD Programmer (VER. 2)

External features



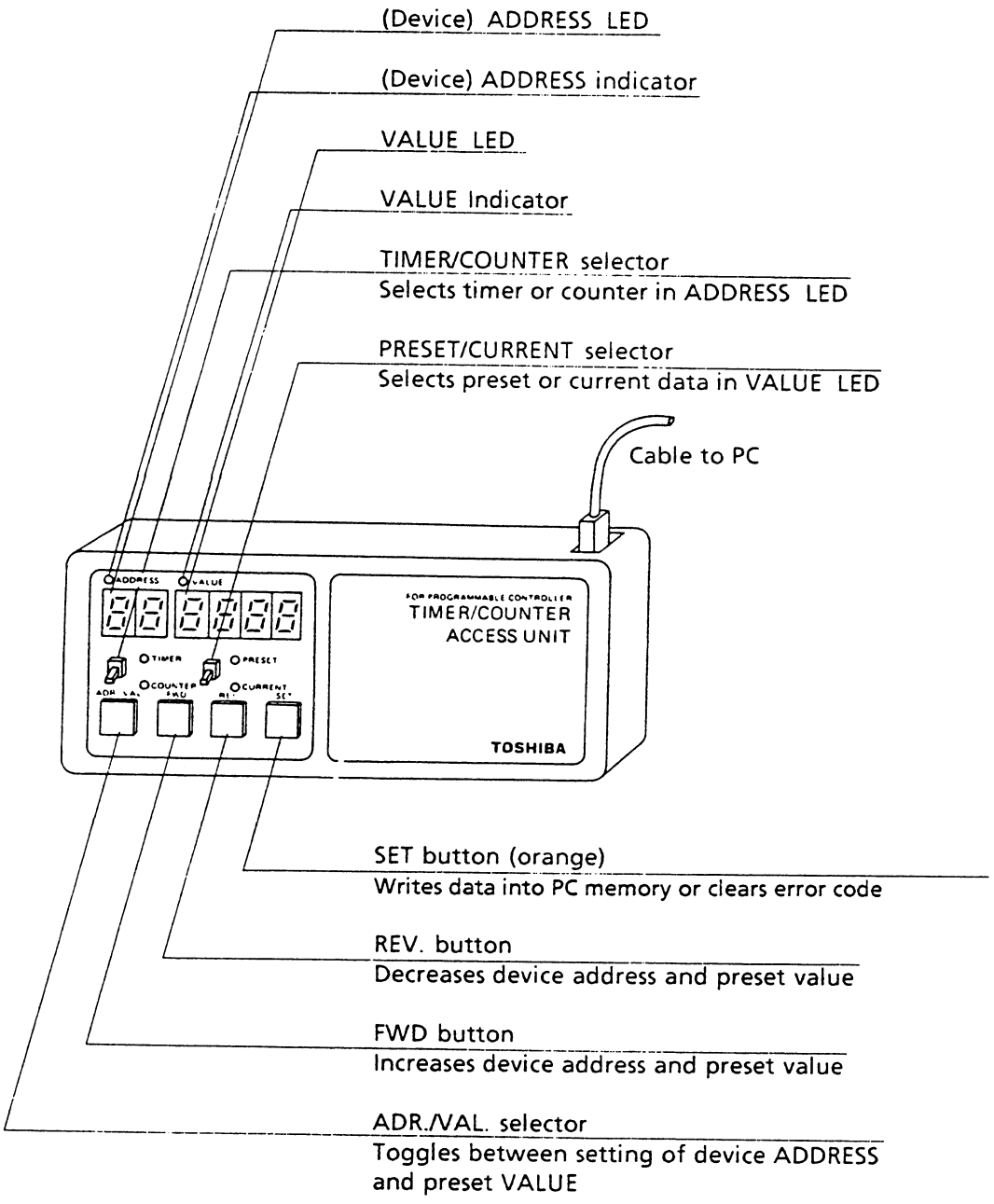
LCD Programmer Specifications

Power supply		Supplied from PC
Transmission mode		Serial (4800 bps)
Functions	Programming	Instruction write/delete/insert, Screen write/delete/insert
	Monitoring	Page monitor, Device monitor, Block monitor, Trace monitor
	Others	PC control (RUN, HALT, Error reset), Memory clear, PROM control (Load, Compare, Save), Error message display

NOTE The operation of the LCD programmer is explained in Part II of this manual.

Timer/Counter Access Unit

External features



Timer/Counter Access Unit Specifications

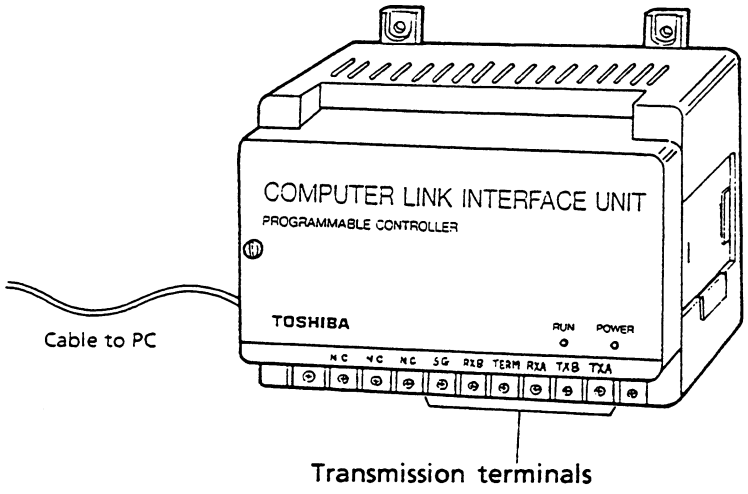
Power supply	Supplied from PC
Transmission mode	Serial (4800 bit/sec.)
Functions	Monitor timer/counter preset value, Monitor timer/counter current value, Change timer/counter preset value

NOTE

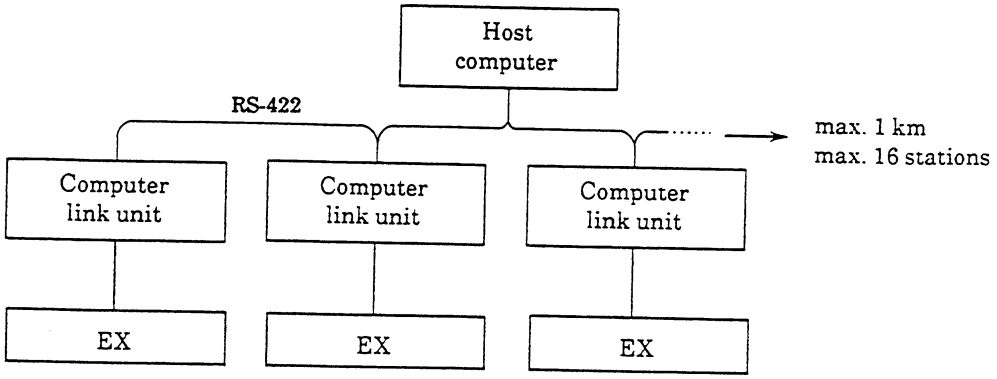
The operation of the Timer/Counter Access Unit is explained in a separate guide which is supplied with the unit.

Computer Link Unit

External features



Network configuration



Functions:

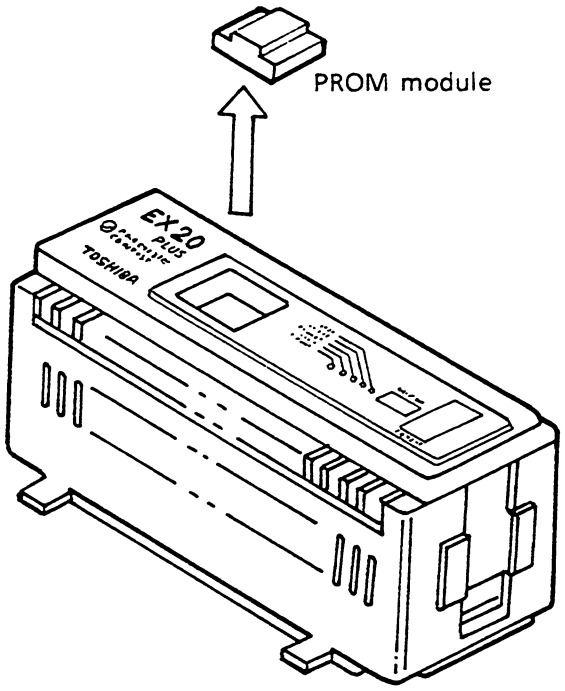
- Host computer monitors operating status of the EX20PLUS/40PLUS
- Reads/changes timer/counter values
- The execution control (RUN/HALT)
- Saves/loads the control program to/from host computer

NOTE Transmission specifications, terminal connection, and protocol are described in Part V of this manual.

PROM Modules

PROM module (RM17) is used as external memory for EX20PLUS/40PLUS programs. The following functions are available:

- Program save from PC RAM to PROM
- Program load from PROM to PC RAM
- Compare program on PROM and PC RAM
- Execute program from PROM
- Erase PROM (Electrically erasable PROM - EEPROM - is used.)



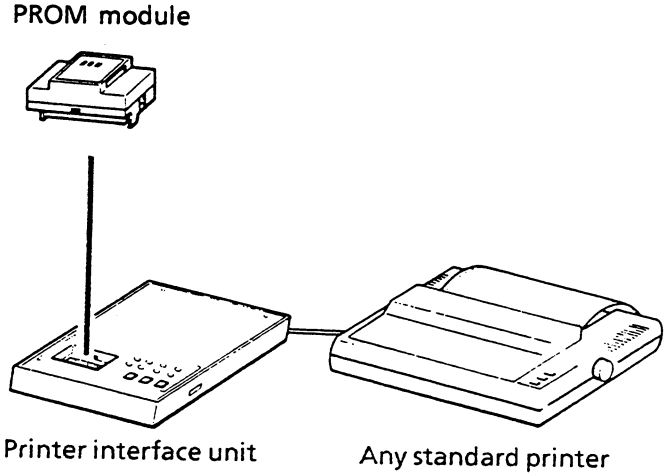
PROM Module Specifications

Model		RM17	RM64*	RM16*
Chip		EEPROM 2817A or equiv.	EPROM 2764 or equiv.	EEPROM 48016 or equiv.
Memory capacity		2K bytes	8K bytes	2K bytes
Eraser		EX20PLUS/ 40PLUS	Ultraviolet light	EX20/40/40H
Functions	Save to PROM	Yes	No	No
	Load from PROM	Yes	Yes	Yes
	Compare PROM and RAM	Yes	Yes	Yes
	PROM execution	Yes	Yes	Yes
	Erase PROM	Yes	No	No

NOTE * RM64 and RM16 are PROM modules for the EX20/40/40H models. See Part II of this manual for detailed PROM control operation.

Printer Interface Unit

The Printer Interface Unit is used for printing out programs from a PROM module.



Printouts	Print models	Printer interface
• Ladder diagram	• Bit image mode	• Centronics parallel
• Cross reference list	• Character mode	• RS-232C serial
• Device usage map		
• Instruction usage map		

NOTE

1) Any commercially available serial or parallel printer may be used. For best performance, Toshiba recommends LX-80™ or an equivalent dot matrix printer.
2) Use of the Printer Interface Unit is explained in a separate manual which is supplied with the unit.

SECTION 3

I/O Specifications and Connections

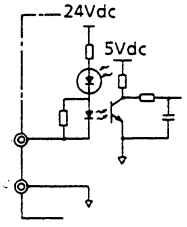
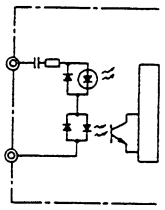
EX20PLUS Basic Unit

Two types of the EX20PLUS are available as listed below.

Model	Input type	Output type	Product code
EX20PLUS (12-I, 8-O)	Dry contact	Relay	EX20*4MCRD5
	120Vac		EX20*4MARD8

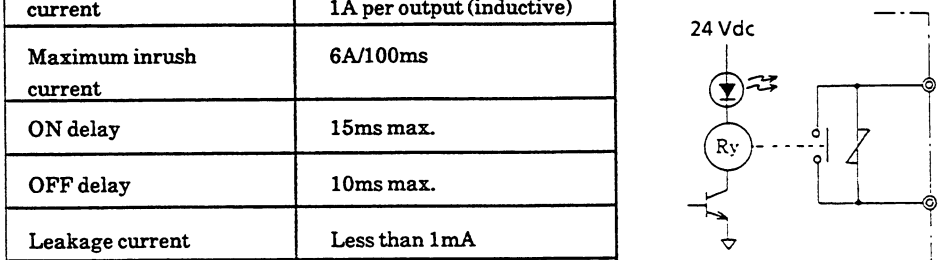
I/O specifications

- Input

	Dry contact input	120 Vac input
Input voltage	24 Vdc, ± 15% (supplied from PC)	100 to 120 Vac, + 10%, – 15%
Input current	10mA (24 Vdc)	10 mA (120Vac - 60Hz)
ON delay	7.5ms max.	15ms max. (100 Vac)
OFF delay	15ms max.	15ms max. (100 Vac)
ON voltage	Contact closed	70 Vac
OFF voltage	Contact open	30 Vac
Withstand voltage	1500 Vac - 1 min	1500 Vac-1min
Inner circuit		

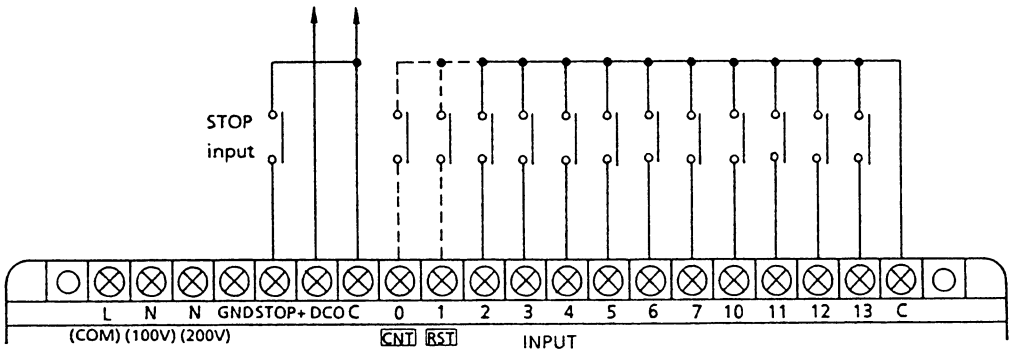
- Output

	Relay output	
Rated voltage	100 to 240 Vac, 24 Vdc	Inner circuit
Maximum load current	2A per output (resistive) 1A per output (inductive)	
Maximum inrush current	6A/100ms	
ON delay	15ms max.	
OFF delay	10ms max.	
Leakage current	Less than 1mA	
Minimum load current	20mA/12 Vdc	
Withstand voltage	1500 Vac - 1 min	



Connections

- Dry contact input

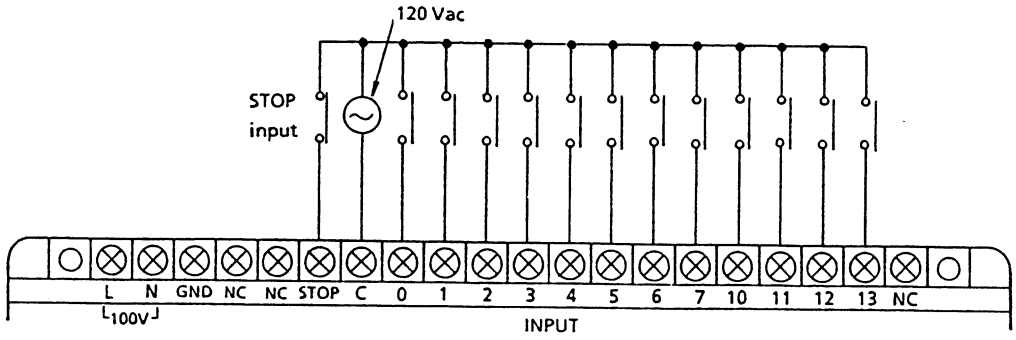


NOTE

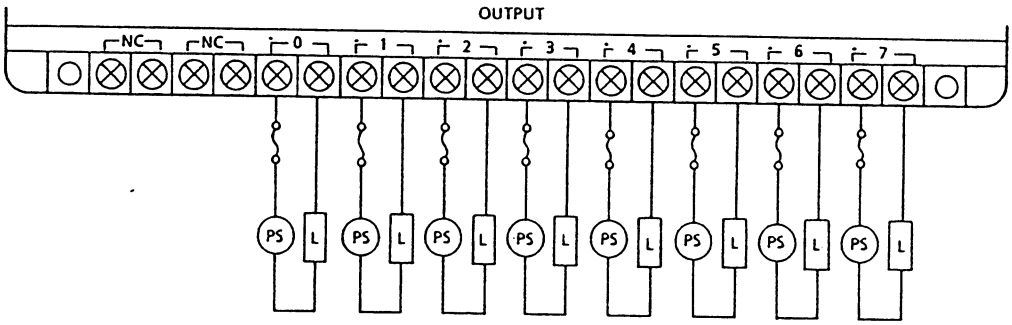
1) Inputs 0 and 1 are reserved for the High-Speed Counter when that function is in use; otherwise they can be used as normal input terminals.

2) + DCO terminal supplies 24 Vdc ± 15%, 0.1A max. to sensors or other devices.

- 120 Vac input



- Relay output



PS : Power supply
(100 to 240 Vac, 24 Vdc.)

L : Load

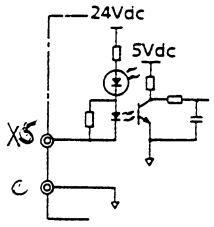
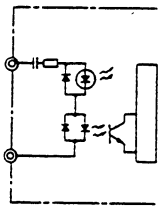
EX40PLUS Basic Unit

Two types of the EX40PLUS are available as listed below.

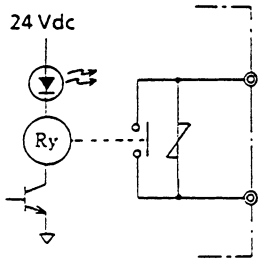
Model	Input type	Output type	Product code
EX40PLUS (24-I, 16-0)	Dry contact	Relay	EX40*4MCRD5
	120 Vac		EX40*4MARD8

I/O specifications

- Input

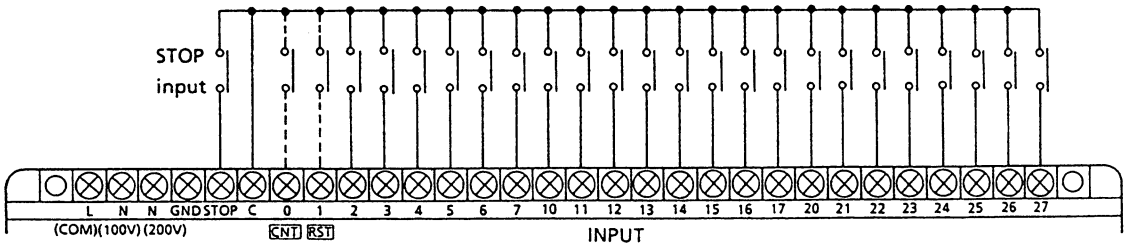
	Dry contact input	120 Vac input
Input voltage	24 Vdc, ± 15% (supplied from PC)	100 to 120 Vac, + 10%, – 15%
Input current	10mA (24 Vdc)	10 mA (120Vac - 60Hz)
ON delay	7.5ms max.	15ms max. (100 Vac)
OFF delay	15ms max.	15ms max. (100 Vac)
ON voltage	Contact closed	70 Vac
OFF voltage	Contact open	30 Vac
Withstand voltage	1500 Vac - 1 min	1500 Vac-1min
Inner circuit		

- Output

	Relay output	
Rated voltage	100 to 240 Vac, 24 Vdc	Inner circuit 
Maximum load current	2A per output (resistive) 1A per output (inductive)	
Maximum inrush current	6A/100ms	
ON delay	15ms max.	
OFF delay	10ms max.	
Leakage current	Less than 1mA	
Minimum load current	20mA/12 Vdc	
Withstand voltage	1500 Vac - 1 min	

Connections

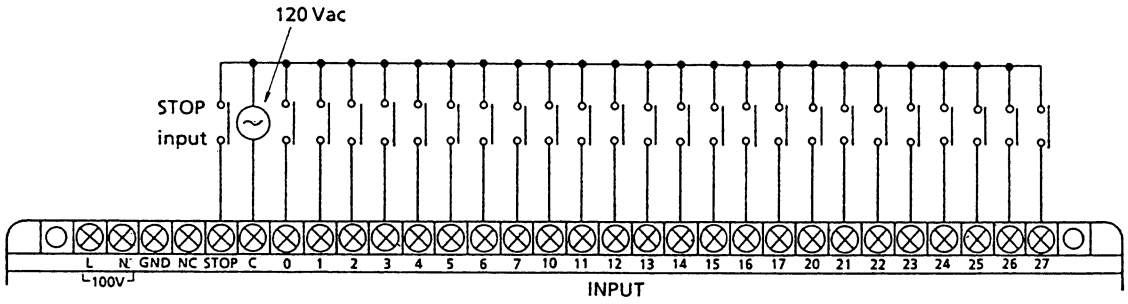
- Dry contact input



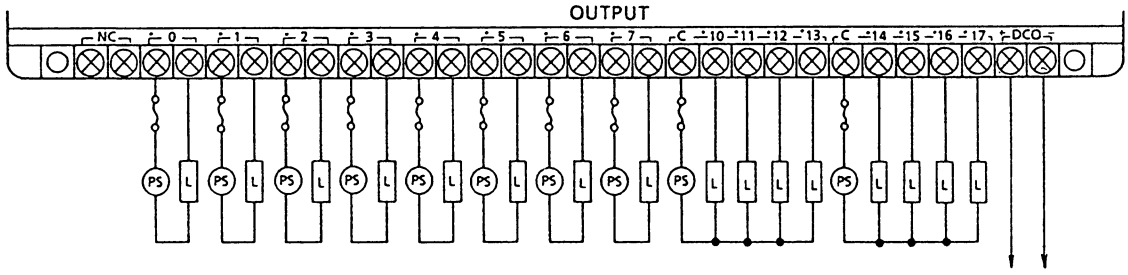
NOTE

Inputs 0 and 1 are reserved for the High-Speed Counter when that function is in use; otherwise they can be used as normal input terminals.

- 120 Vac input



- Relay output



(PS): Power Supply
(100 to 240 Vac, 24 Vdc)

[L]: Load

NOTE

DCO terminals supply 24 Vdc ± 15%, 0.1A max. to sensors or other devices. That terminals are provided only for the dry contact input type.

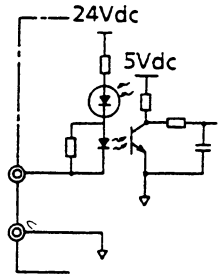
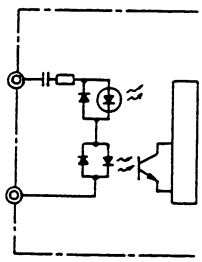
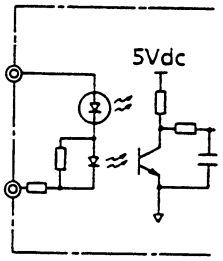
EX20 Expansion Unit

Seven types of the EX20 expansion unit are available as listed below.

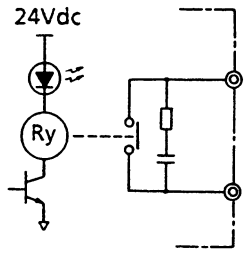
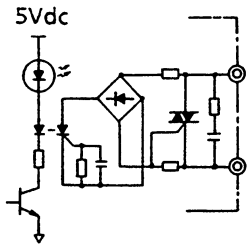
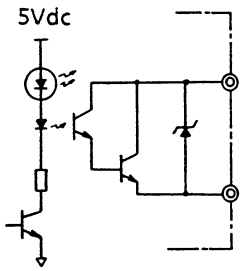
Model	Input type	Output type	Product code
EX20 expansion (12-I, 8-O)	Dry contact	Relay	EX20*2ECRA5
		Triac	EX20*2ECAA5
		Transistor	EX20*2ECDA5
	120Vac	Relay	EX20*2EARA5
		Triac	EX20*2EAAA5
	24Vdc	Relay	EX20*2EDRA5
		Transistor	EX20*2EDDA5

I/O Specifications

- Input

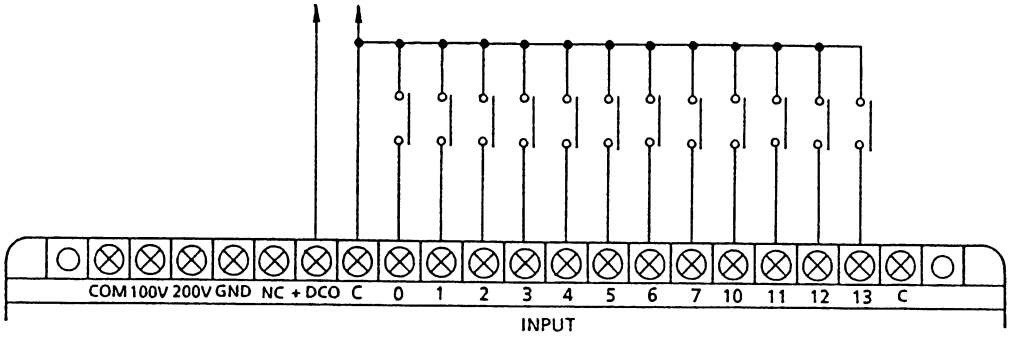
	Dry contact	120Vac input	24Vdc input
Input voltage	10 to 30Vdc (Supplied from PC)	100 to 120Vac, + 10%, – 15%	24Vdc, + 10%, – 15%
.Input current	10mA (24Vdc)	10mA (100Vac)	10 mA (24Vdc)
ON delay	7.5ms max.	15ms max. (100 Vac)	7.5ms max.
OFF delay	15 ms max.	15 ms max (100 Vac)	15ms max.
ON voltage	Contact closed	75Vac	16Vdc
OFF voltage	Contact open	25Vac	5Vdc
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1min
Inner circuit			

- Output

	Relay output	Triac output	Transistor output
Rated voltage	100 to 240Vac, 24Vdc	100 to 120Vac	24Vdc
Maximum load current	2A per output (resistive) 1A per output (inductive)	1A per output (resistive)	1A per output (resistive)
Maximum inrush current	6A/100ms	30A/30ms	10A/20ms
ON delay	15ms max.	0.1ms max.	0.3ms max.
OFF delay	10ms max.	10ms max.	2ms max.
Saturated voltage		2V max.	2V max.
Leakage current	Less than 2mA	Less than 1mA	Less than 0.2mA
Minimum load current	20mA/12Vdc	10mA	1mA
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1 min
Inner circuit			

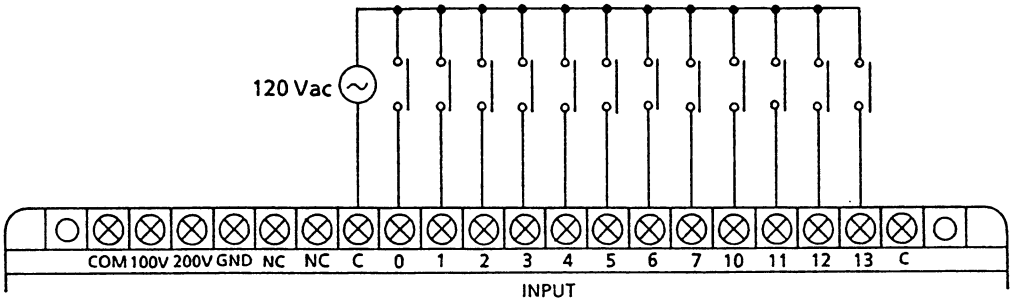
Connections

- Dry contact input

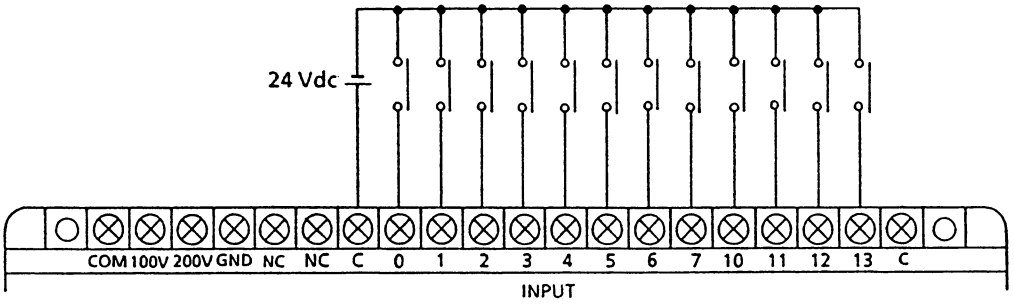


NOTE + DCO terminal supplies 10 to 30 Vdc, 0.1A max. to sensors or other devices.

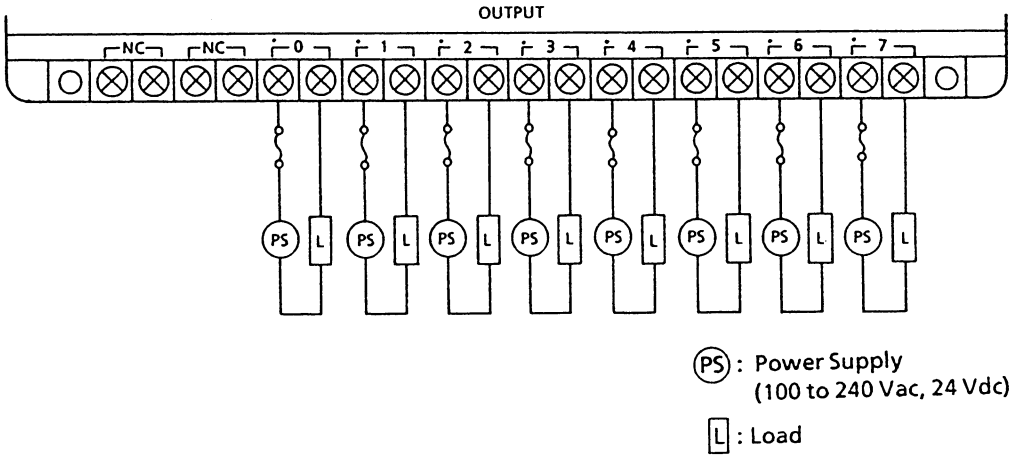
- 120Vac input



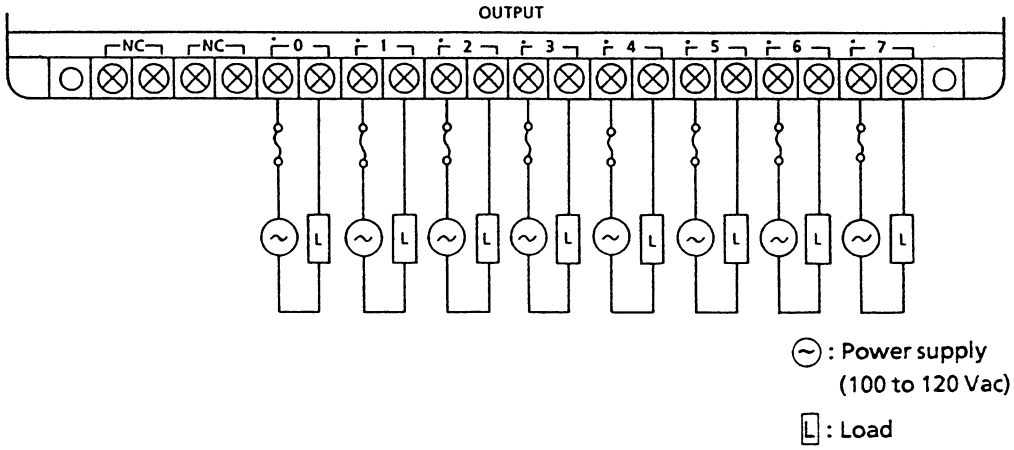
- 24Vdc input



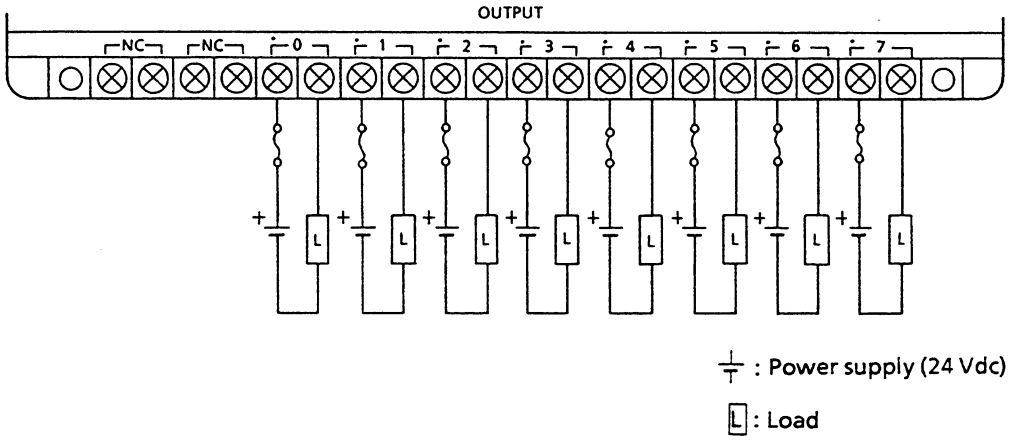
- Relay output



- Triac output



- Transistor output



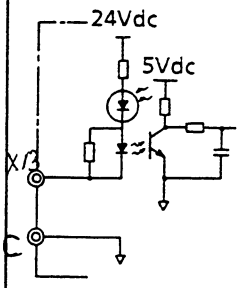
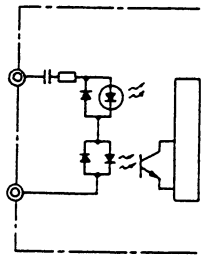
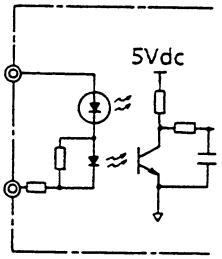
EX40 Expansion Unit

Seven types of the EX40 expansion unit are available as listed below.

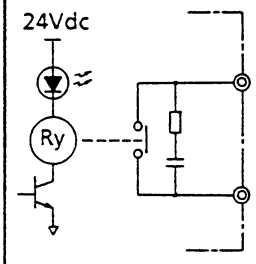
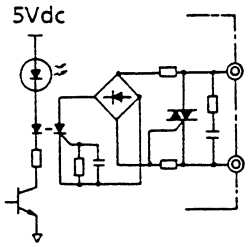
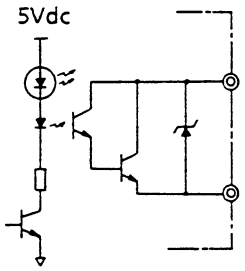
Model	Input type	Output type	Product code
EX40 expansion (24-I, 16-O)	Dry contact	Relay	EX40*2ECRA5
		Triac	EX40*2ECAA5
		Transistor	EX40*2ECDA5
	120Vac	Relay	EX40*2EARA5
		Triac	EX40*2EAAA5
	24Vdc	Relay	EX40*2EDRA5
		Transistor	EX40*2EDDA5

I/O Specifications

- Input

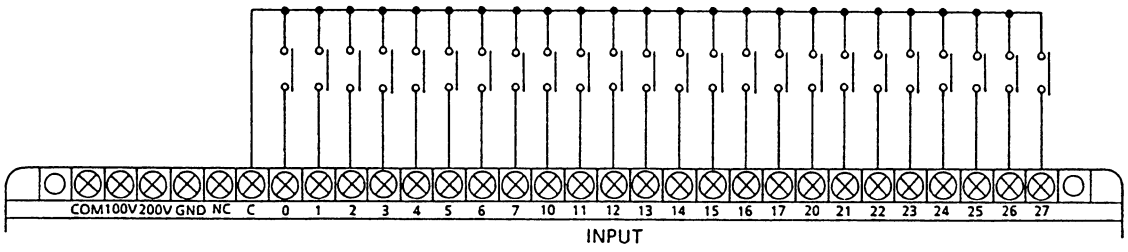
	Dry contact	120Vac input	24Vdc input
Input voltage	10 to 30Vdc (Supplied from PC)	100 to 120Vac, + 10%, – 15%	24Vdc, + 10%, – 15%
.Input current	10mA (24Vdc)	10mA (100Vac)	10mA (24Vdc)
ON delay	7.5ms max.	15ms max. (100Vac)	7.5ms max.
OFF delay	15 ms max.	15 ms max. (100 Vac)	15ms max.
ON voltage	Contact closed	75Vac	16Vdc
OFF voltage	Contact open	25Vac	5Vdc
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1min
Inner circuit			

- Output

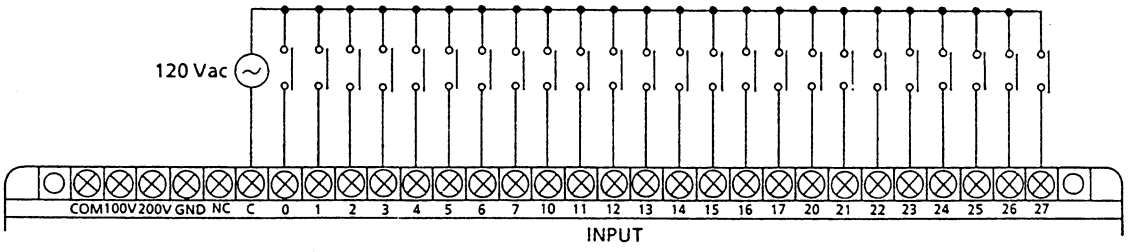
	Relay output	Triac output	Transistor output
Rated voltage	100 to 240Vac, 24Vdc	100 to 120Vac	24Vdc
Maximum load current	2A per output (resistive) 1A per output (inductive)	1A per output (resistive)	1A per output (resistive)
Maximum inrush current	6A/100ms	30A/30ms	10A/20ms
ON delay	15ms max.	0.1ms max.	0.3ms max.
OFF delay	10ms max.	10ms max.	2ms max.
Saturated voltage	-	2V max.	2V max.
Leakage current	Less than 2 mA	Less than 1 mA	Less than 0.2 mA
Minimum load current	20mA/12Vdc	10mA	1mA
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1 min
Inner circuit			

Connections

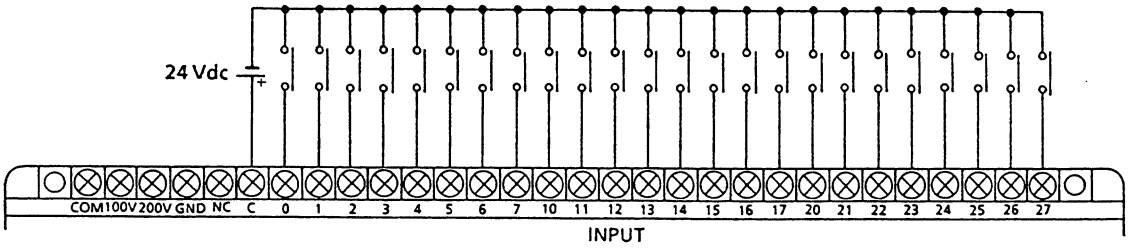
- Dry contact input



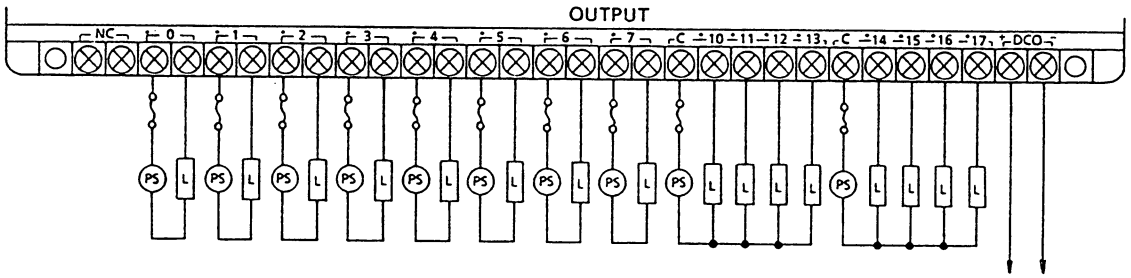
- 120 Vac input



- 24Vdc input



- Relay output



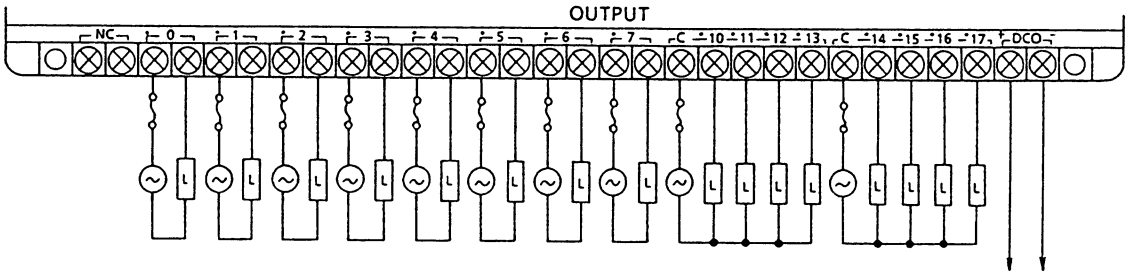
(PS) : Power Supply
(100 to 240 Vac, 24 Vdc)

[L] : Load

NOTE

DCO terminals supply 10 to 30 Vdc, 0.1A max. to sensors or other devices. That terminals are provided only for the dry contact input type.

- Triac output



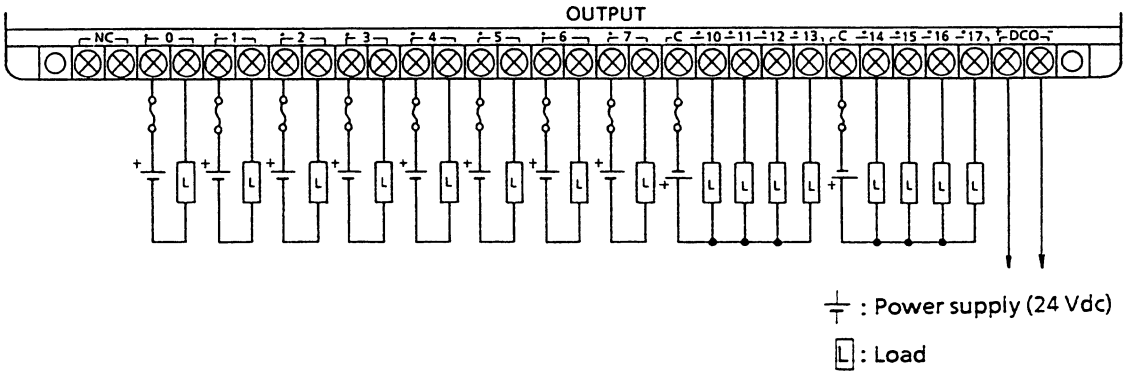
(~) : Power supply
(100 to 120 Vac)

[L] : Load

NOTE

DCO terminals supply 10 to 30 Vdc, 0.1A max. to sensors or other devices. That terminals are provided only for the dry contact input type.

- Transistor output



NOTE

DCO terminals supply 10 to 30 Vdc, 0.1A max. to sensors or other devices. That terminals are provided only for the dry contact input type.

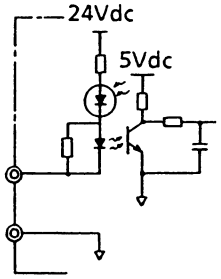
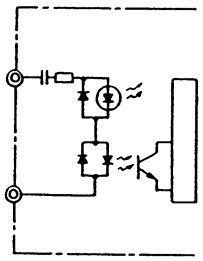
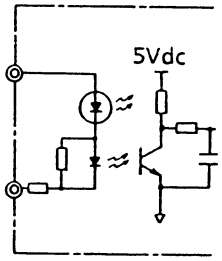
EX08 Expansion Unit

Nine types of the EX08 expansion unit are available as listed below.

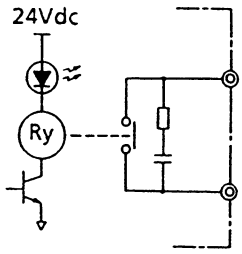
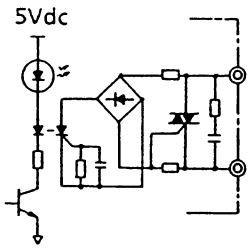
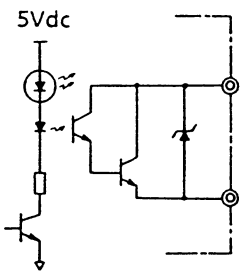
Model	I/O	Input type	Output type	Product code
EX08 expansion	8/0	Dry contact	-	EX08*2ECIA5
		120Vac	-	EX08*2EAIA*
		24Vdc	-	EX08*2EDIA*
	4/4	Dry contact	Relay	EX08*2ECRA5
		120Vac	Relay	EX08*2EARA5
		24Vdc	Relay	EX08*2EDRA5
	0/8	-	Relay	EX08*2EROA5
		-	Triac	EX08*2EAOA5
		-	Transistor	EX08*2EDOA5

I/O Specifications

- Input

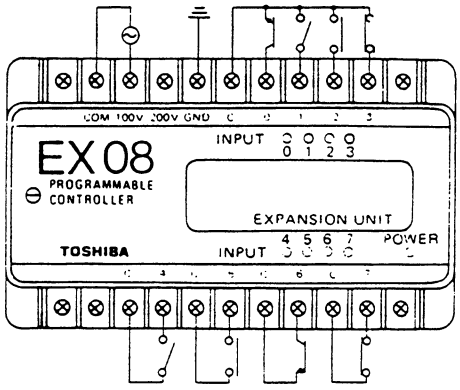
	Dry contact	120Vac input	24Vdc input
Input voltage	10 to 30Vdc (Supplied from PC)	100 to 120Vac, + 10%, – 15%	24Vdc, + 10%, – 15%
.Input current	10 mA (24Vdc)	10 mA (100Vac)	10 mA (24(Vdc)
ON delay	7.5ms max.	15ms max. (100 Vac)	7.5ms max.
OFF delay	15 ms max.	15 ms max. (100Vac)	15ms max.
ON voltage	Contact closed	75Vac	16Vdc
OFF voltage	Contact open	25Vac	5Vdc
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1min
Inner circuit			

- Output

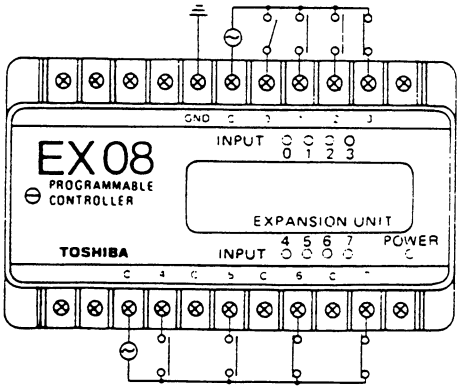
	Relay output	Triac output	Transistor output
Rated voltage	100 to 240Vac, 24Vdc	100 to 120Vac	24Vdc
Maximum load current	2A per output (resistive) 4A per 4 points common	1A per output (resistive)	1A per output (resistive) 2A per 4 points common
Maximum inrush current	6A/100ms	30A/30ms	10A/20ms
ON delay	15ms max.	0.1ms max.	0.3ms max.
OFF delay	10ms max.	10ms max.	2ms max.
Saturated voltage	-	2V max.	2V max.
Leakage current	Less than 2mA	Less than 1mA	Less than 0.2mA
Minimum load current	20mA/12Vdc	10mA	1mA
Withstand voltage	1500Vac - 1min	1500Vac - 1min	1500Vac - 1 min
Inner circuit			

Connections

- 8 inputs - Dry contact



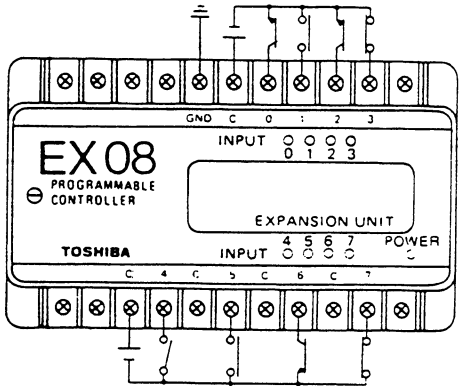
- 8 inputs - 120Vac



NOTE

1) AC power supply is not necessary.
2) The commons (c) of the lower terminal strip are connected to each other inside the unit.

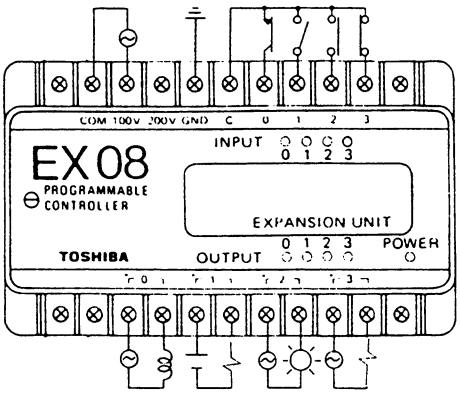
- 8 inputs - 24Vdc



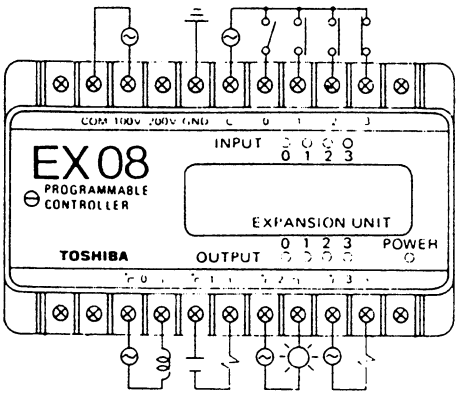
NOTE

1) AC power supply is not necessary.
2) The commons (c) of the lower terminal strip are connected to each other inside the unit.

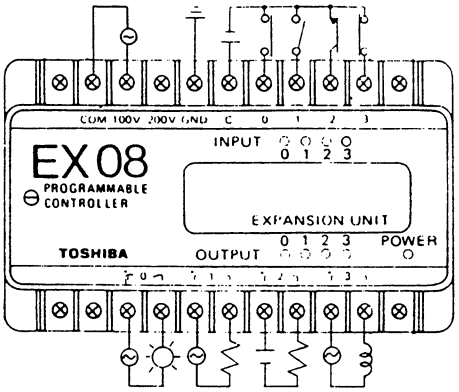
- 4 inputs/4 outputs - Dry contact/Relay



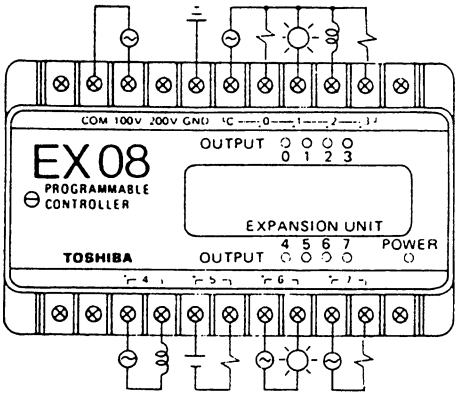
- 4 inputs/4 outputs - 120Vac/Relay



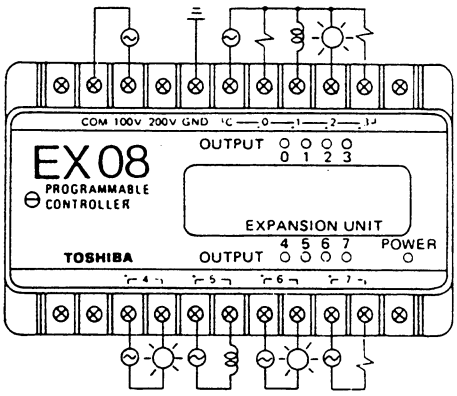
- 4 inputs/4 outputs - 24Vdc/Relay



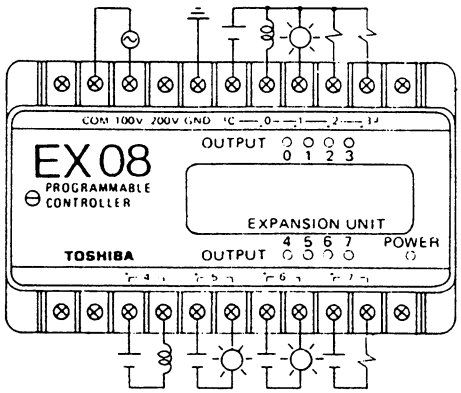
- 8 outputs - Relay



- 8 outputs - Triac (120Vac)



- 8 outputs - Transistor (24Vdc)



Precautions

Input

- Input Signal Read Enable Time

  The following conditions must be met for the input signal ON/OFF status to be read positively:

  Input ON Time ≧ ON Delay Time + One Scan Time

  Input OFF time ≦ OFF Delay Time + One Scan Time

- Solid-state Device Precaution

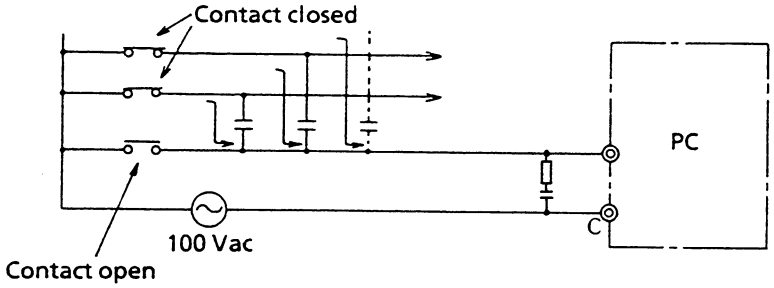
  When using a solid-state device for an input signal, the leakage current in the OFF mode of the device should be:

  120Vac input type – Less than 1.7mA

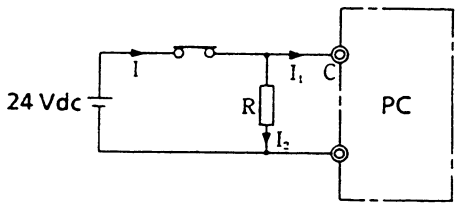
  24Vdc and dry contact type – Less than 1mA

- Where inter-equipment AC power supply cables are in long runs or a very large number of conducting cables are grouped together, inter-cable capacitances are likely to induce out of live lines a current flow in open control circuits. These voltages may reach to input ON levels, and disable any OFF detection even with an open contact.

  To prevent this problem either connect a resistor or resistor + capacitor across from each PC input to the common line, or use low capacitance, shielded cables.



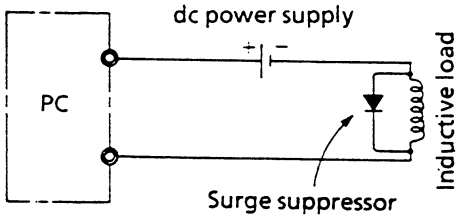
- If contact quality is questionable, its reliability cannot be assured by the standard input current at 10mA. In such a case, use the 120Vac input type or connect a bleed off resistor (R) and flow a dummy current through the contact.

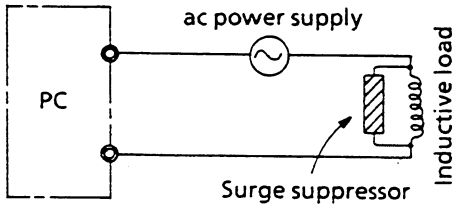


Output

- Operation life expectancy of the output relay is 100,000 electrical cycles and 20 million mechanical cycles.
- Protective fuses are not built in. Fuses rated for the output should be prepared by the user.

- Output Surge Protection
  Where an inductive load has been connected to the output, a relatively high energy transient voltage will be generated when the relay turns OFF. Other adverse influences on various signal circuits must also be guarded against when long cable runs are involved. To prevent problems be sure to connect a surge suppressor in parallel with the inductive load.

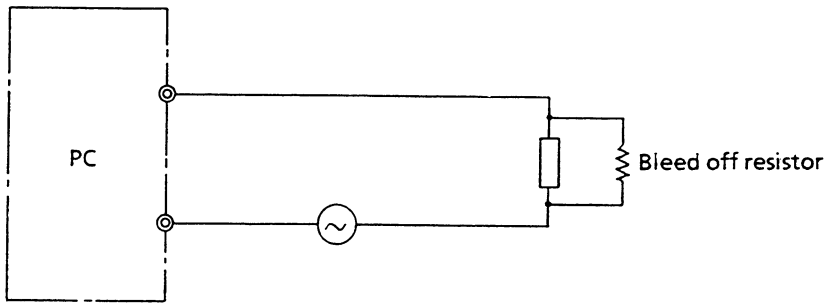




Surge Suppressor

- Flywheel Diode —▶|—
  (for dc applications only)
  Reverse withstand voltage:
  Double the circuit voltage or higher
  Forward current:
  The load current level or higher
- Varistor, TNR, or Transil —∿—
  Select one of these bidirectional overvoltage absorbing devices that matches the circuit voltage (generally at 400 to 600V).
- Snubber (CR) —|—□—
  R: 0.5 to 1Ω per V of the coil voltage
  C: 0.5 to 1μF per A of the coil current (a non-polarized capacitor rated at 400V min.)

- If leakage current of the output circuit causes a load to malfunction, connect a bleed off resistor parallel with the load.



SECTION 4

Installation and Wiring

This section describes how to select the best installation site for the PC, and then how to install the PC in five steps.

Site selection

Before getting out your tools to begin installation, you should answer these questions:

- Have you selected the best PC site?
  Consider such things as the amount of space you will need (including enough room for easy maintenance and possible system expansion), how to integrate the PC system with other plant machinery, and how to protect the system against environmental hazards.

- Is the environment suitable for the PC?
  You should avoid the following site conditions:

  - ☐ Temperature below 0°C (32°F) or above 60°C (140°F).
  - ☐ Humidity below 10% or over 95% (no condensation).
  - ☐ Dusty or subject to corrosive/flammable gases.
  - ☐ Abrupt temperature changes
  - ☐ Intense vibration or shocks
  - ☐ Metal or salt particles
  - ☐ Direct sunlight

- Have you chosen the proper enclosure for the PC?
  The user must supply a PC enclosure that conforms to the local electrical standards. This enclosure protects the unit from damage by contaminants in the air such as moisture, oil, dust, and corrosive substances.

  The enclosure should be large enough to allow easy access to the PC's wiring and components for maintenance and troubleshooting.

  When mounting the PC in the enclosure, insulate it from electrical interference generated by nearby control panels or electrical devices by the following measures:

  - ☐ Keep the PC at least 200 mm (8 in) away from other high-power control panels or enclosures.

- ☐ Ground the enclosure when the PC is installed with high frequency equipment.
- ☐ Protect the PC from leakage current generated by nearby equipment.
- ☐ To avoid electrical hazards to service personnel and to reduce the chance of electrical interference, do not install the PC in the same enclosure with high-voltage devices.

- Is heat going to be a problem?
  Even if the air temperature is within acceptable limits, heat-generating equipment or other heat sources may cause problems if they are too close to the PC. Therefore:

  - ☐ Do not install the PC above heat-generating equipment such as a heater, transformer, or high-capacity resistor.
  - ☐ Mount the PC vertically to achieve maximum air flow. Do not install it on the ceiling or other horizontal surfaces.
  - ☐ Allow enough space inside the PC enclosure for adequate ventilation and to permit maintenance and parts replacement.
  - ☐ Install a fan to prevent the temperatures inside the enclosure rise above 60°C (140°F).

Installation steps

Now that you have selected an appropriate site, you can begin installing the PC system. In the installation procedures given in the following pages, it is assumed you are installing the EX20PLUS/40PLUS system.

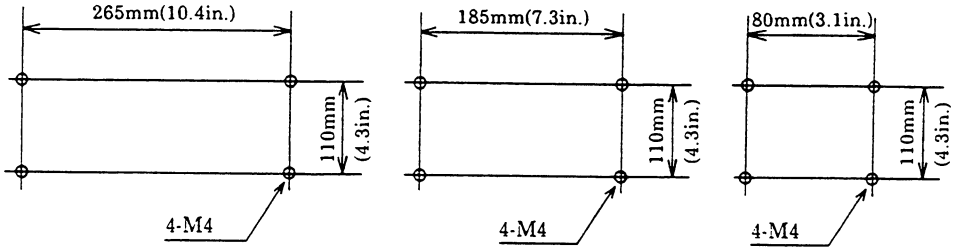
Installation can be done in five steps:

① Mount the PC in the protective enclosure
② Ground the PC system
③ Connect the power supply
④ Wire the I/O terminals
⑤ Test the system

Step 1 --- Mount the PC in the protective enclosure

Install the EX20PLUS/40PLUS (and one or two expansion units, if used) vertically in the enclosure using 4 mm screws in the four corner locations or using standard DIN rail (35 mm) shown below.

Position of screw mounting



EX40PLUS
EX40 expansion

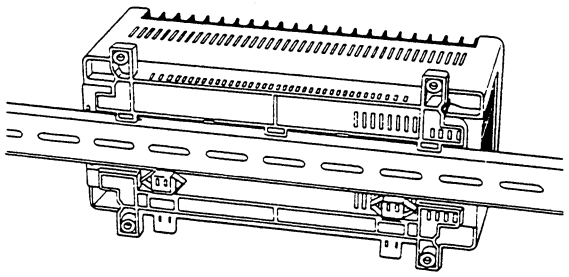
EX20PLUS
EX20 expansion

EX08

NOTE

The mounting layout should allow for expansion cable length if expansion units are used. A 30 cm (11.8 in) expansion cable is supplied with the EX20 and EX40 expansion units. And an 8 cm (3.11in) expansion cable is supplied with the EX08. If the supplied cable is too short, a 50 cm (19.7 in) expansion cable is available as an option.

DIN rail mounting

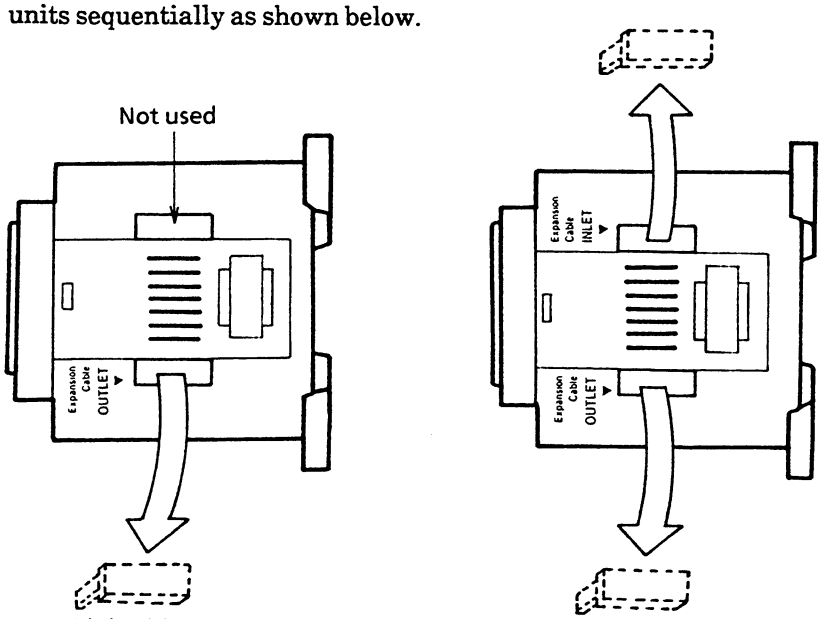


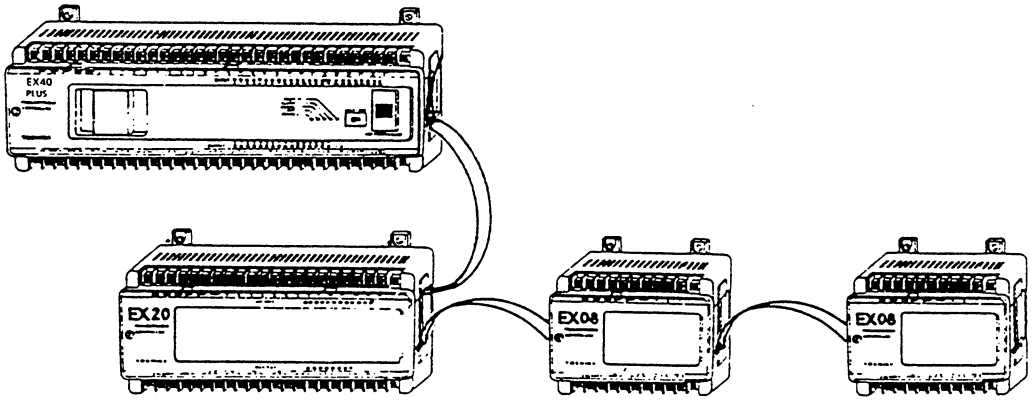
The EX20PLUS/40PLUS and its expansion units come equipped with a bracket at the rear for mounting the units on a 35 mm DIN rail.
To mount a unit on the rail, first hang the two tabs at the top rear of the unit on the DIN rail, and then push in on the bottom edge of the unit until it snaps in place on the rail.

Connecting expansion units

One or more expansion units can be connected to the basic unit to increase the number of I/O points.

Expansion cables supplied with the expansion units are used to connect the units sequentially as shown below.





NOTE

(1) After connecting an expansion cable, replace the connector cover to keep the cable from being pulled out.

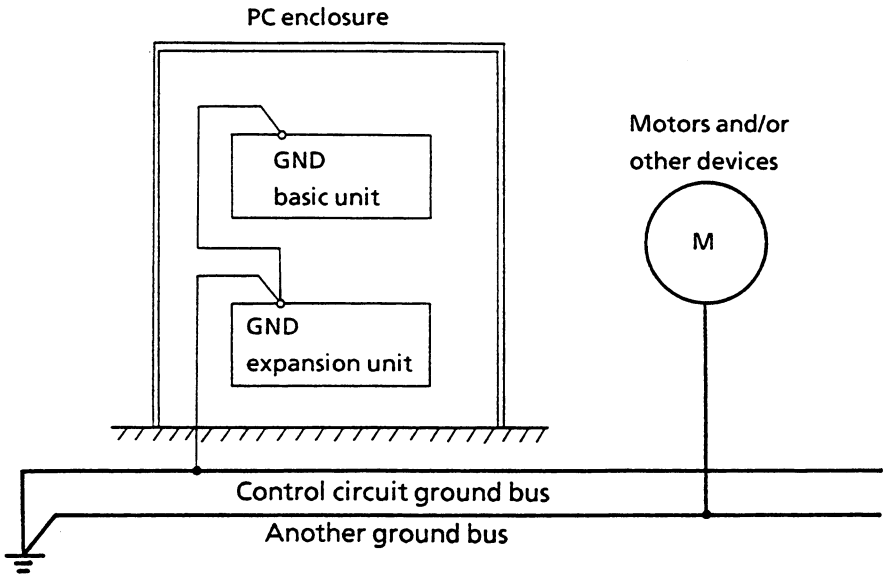
(2) Do not subject expansion cables to sharp twists or bends.

Step 2 --- Ground the PC system

Be sure to adequately ground the PC to ensure safety and reduce the possibility of electrical interference.

Observe all applicable codes and ordinances for these grounding connections. All ground connections must be permanent and continuous to allow a low-impedance path to earth.

If possible, ground the PC system separately from other devices to assure maximum immunity from electrical interference. However, common grounding is usually acceptable if it is done as shown below.



Grounding conditions

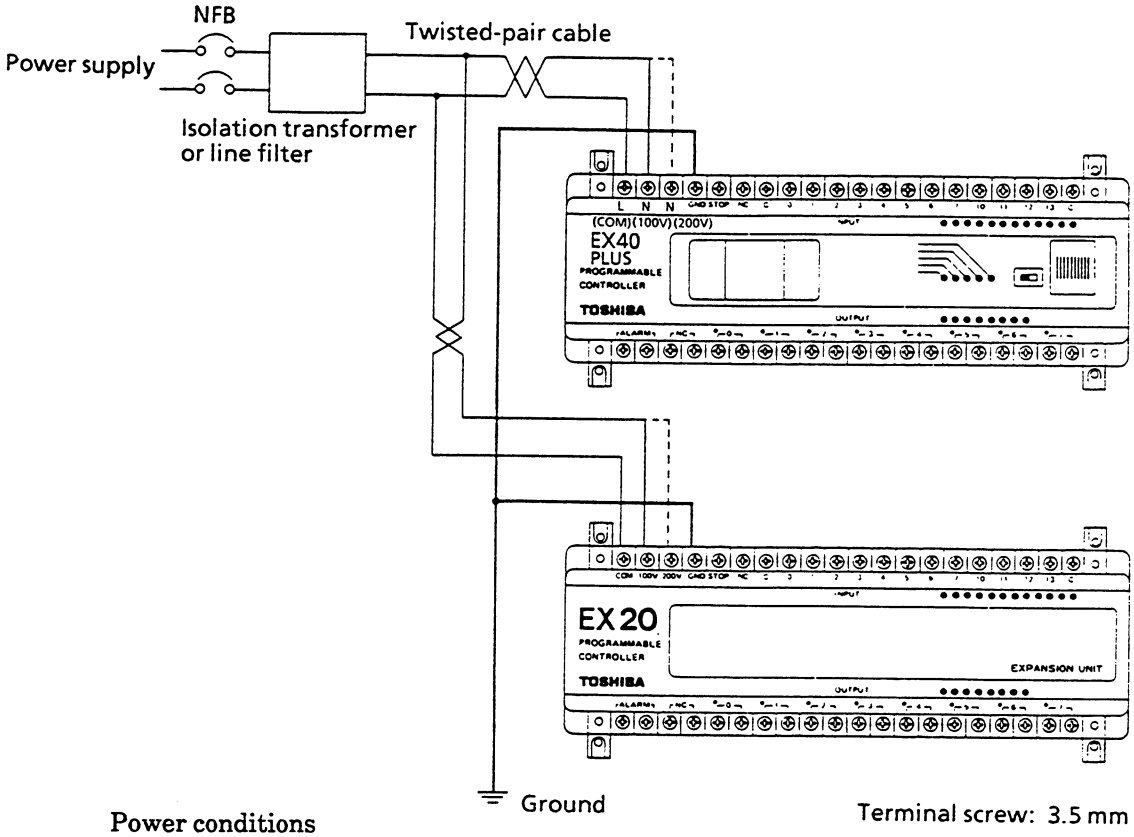
- 2 mm^2 (14AWG) or larger wire should be used as ground wire in the enclosure. (Terminal screw is 3.5 mm)
- 100Ω or less to earth is recommended.

NOTE For details on grounding procedures, always refer to applicable local codes and ordinances.

Step 3 --- Connect the power supply

The EX20PLUS/40PLUS and its expansion units operate on ac power. A wide range of power voltage is available (85 to 132 Vac or 170 to 250 Vac).

Wire the power terminals as shown below.



Power conditions

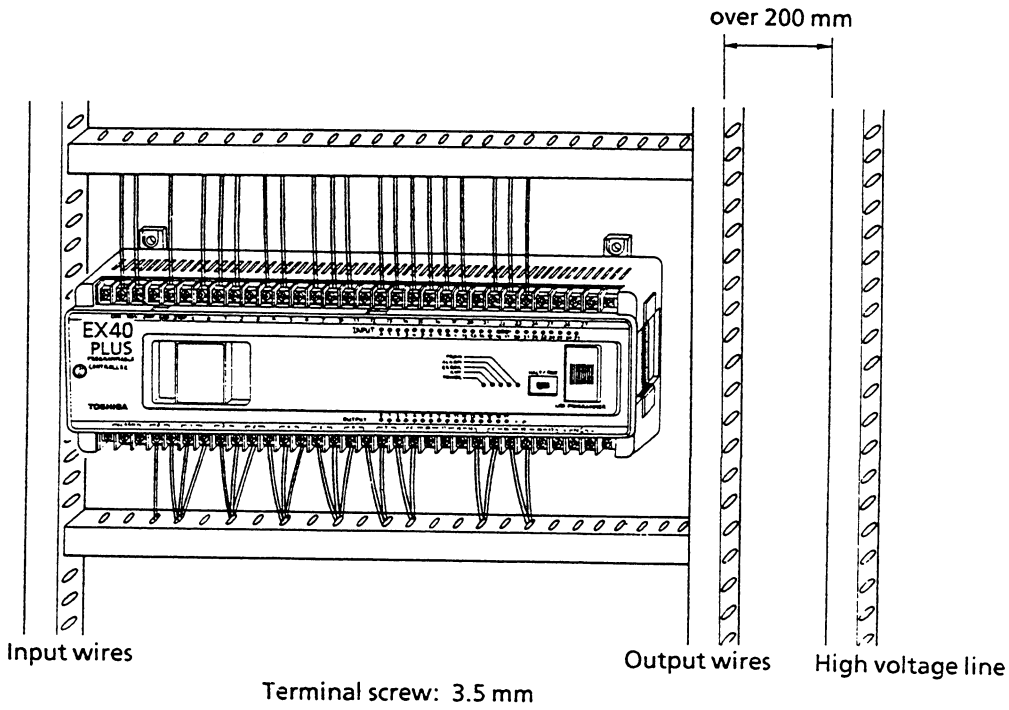
- Rated voltage: 100 to 120 Vac/200 to 240 Vac, + 10%, – 15% (terminal selectable)
- Frequency: 50/60H z, ± 5%
- Power consumption: 25 VA or less (EX40PLUS, EX40 exp unit)
  20 VA or less (EX20PLUS, EX20 exp unit)
  5 VA or less (EX08)
- Retentive power failure: Normal operation for less than 10ms

NOTE

1) 120 Vac input type of the basic unit can not accept 200 to 240 Vac for power supply.
2) ON/OFF control of ac power to the basic unit and expansion units should be simultaneous.
3) Twisted-pair cable should be used for the power supply, and separated from other cables.

Step 4 --- Wire the I/O terminals

Refer to section 3 for instructions on how to properly wire the I/O terminals.

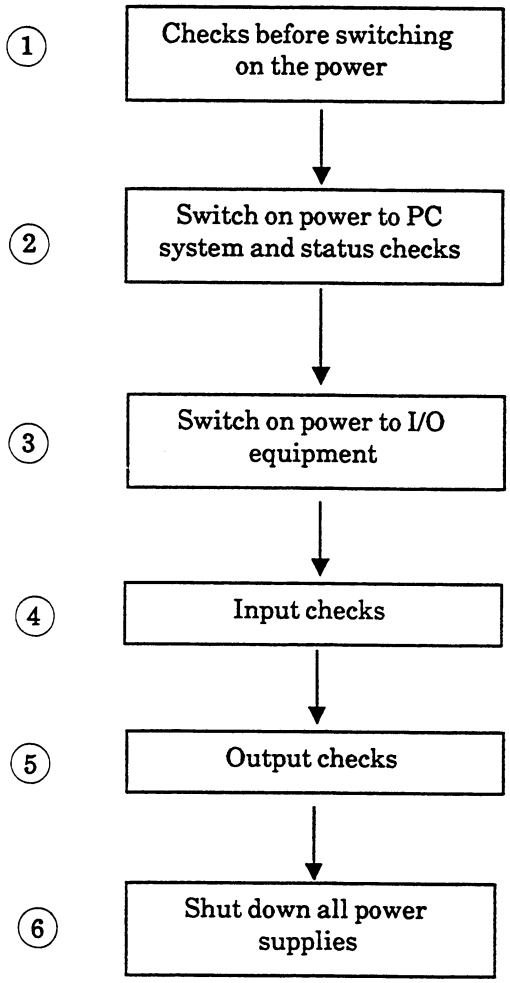


Wiring Notes

- Power, input, and output cables to the PC should be separated from each other.
- 1.25 mm^2 (16AWG) wire is recommended for I/O cables.
- If expansion units are used, separate the expansion cable from the power and I/O cables by at least 50 mm (2 in).

Step 5 --- Test the system

After installing and wiring the PC system, you should check that the system operates properly by following the procedure as shown below.



CAUTION

For safety when switching on power to I/O equipment, switch all drive circuits OFF in advance to assure that no equipment or machinery will start up, even in the event of inadvertent energization of magnetic switches or solenoid valves.
In addition, take any other safety precaution that may be required for your particular system and application.

Testing the system

① Checks before switching on the power

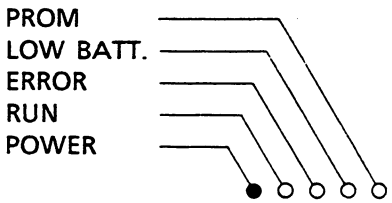
As minimal precautions before switching on the PC system power, check the following:

- Secure mounting of units
- Secure connection of expansion cables
- Secure connection of power and I/O lines with no loosening of any of the screws
- Supply voltage is within its specified range, and correct selection of power supply terminals.

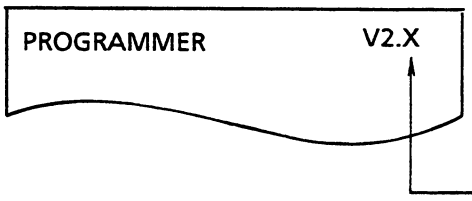
② Switch on power to PC system and status checks

HALT/RUN

1) Set the HALT/RUN switch on the basic unit front panel to HALT.
2) Switch on power to the EX20PLUS/40PLUS and its expansion units.
3) Check status LEDs on the basic unit front panel and verify that only the POWER LED has turned ON.



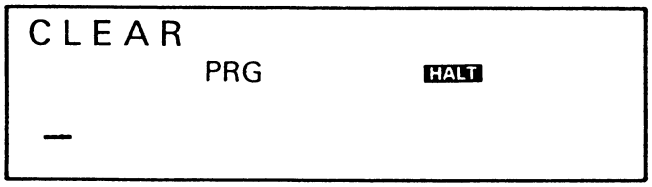
4) Connect the LCD programmer.
Check that the following message is on the LCD programmer display.



This is the software version number and may vary with the version you have.

5) Enter the key sequence shown at left to clear the EX20PLUS/40PLUS memory.

6) Check that the following message is on the LCD programmer display:



HALT/RUN

7) Set the HALT/RUN switch on the basic unit front panel to RUN to set the EX20PLUS/40PLUS in run mode.

③ Switch on power to I/O equipment

- Switch on power to I/O equipment.
  Then, check that there is no trouble in the system.

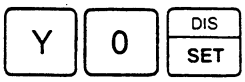
④ Input checks

- By manually operating input devices (such as pushbuttons or limit switches) ON and OFF, check that their corresponding PC input status LEDs turn ON and OFF.
  Use the block monitoring functions of the LCD programmer to check that the input signals in the above process have been read correctly. (For details on this operation, see part II of this manual.)
- Run the above checks on all input signals.

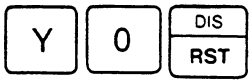
⑤ Output Checks

- It is safer and simpler to run output checks by forcing output functions of the EX20PLUS/40PLUS, than by shorting terminals or pins with wires.

- Entering the key sequence below forces the No. 0 output (Y0) ON.



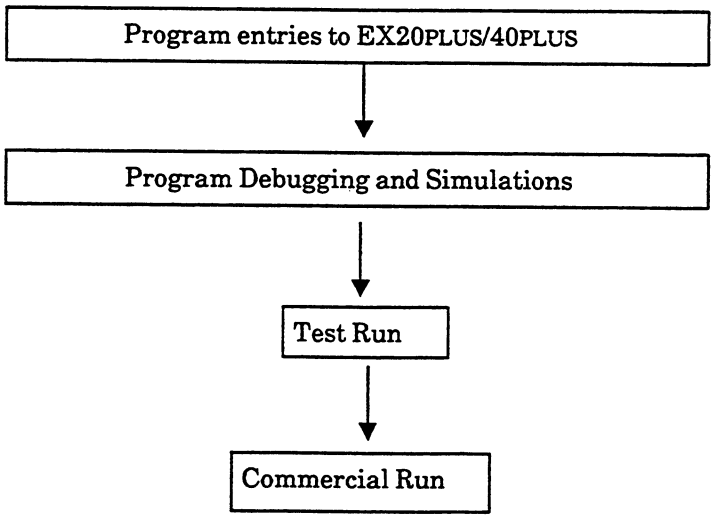
- Entering the key sequence below turns Y0 OFF.



- Use similar key sequence to switch the other outputs ON and OFF as well, and check that not only the EX20PLUS/40PLUS output status LEDs but also output equipment (such as magnetic switches or lamps) turn on and off.

⑥ Shut down all power supply

- This concludes basic functional checks on the PC system, and connection and functional checks on external equipment. Now, switch off all power supply.
- In practice, further system modifications are carried out thereafter in the following typical sequence



SECTION 5

Inspection and Maintenance

Your programmable controller works hard and continues working if given brief daily checks and periodic inspections. How to carry these out is explained in this section.

Daily inspection

Daily inspection of the PC is little more than a quick check of the PC's LEDs and a voltage check of the power and I/O signal lines.

Carry this out at a set time or operating point every day, depending on what is most practical for your system. For instance, it could be at power up, at shift start, or after a certain number of hours of operation. *When* is up to you and/or your supervisor. What's most important is that you follow a regular routine, preferably according to a checklist.

Here are the items you should check, and the meaning of indicator-lamp warnings.

No.	Inspection item	Procedure	Normal condition	Remarks
1	Check if basic unit LEDs are lit	Check POWER LED	POWER indicator is lit when power supply is normal.	POWER indicator is off when problem exists in AC power supply or fuse is burned out.
		Check RUN LED	RUN indicator is lit when PC is functioning normally.	RUN indicator is off when an abnormality exists with HALT/RUN switch, CPU or program.
		Check ERROR LED	ERROR indicator is lit when fault is detected in system.	ERROR indicator is lit when CPU failure occurs.
		Check LOW BATT. LED	LOW BATT. indicator is lit when battery voltage is low.	Replace battery.
2	Check if I/O LEDs are lit	Check input LED	Indicator is lit when input device is ON, and off when it is OFF.	Possible causes: input power supply failure, leakage current, input device malfunction, or damaged LED.
		Check output LED	LED indicator is lit when a load is driven and it is off when load is not driven.	Possible causes: load power source abnormality, leakage current, load malfunction, or damaged LED.
3	Voltage	Measure PC supply voltage	Supply voltage fluctuation should be within specified limits.	Use digital voltmeter to check.
		Measure I/O voltage	Specifications of connected device and PC I/O should be satisfied.	

Periodic inspection

Periodic inspections, conducted approximately every 3 months, involve both electrical and mechanical reviews which are more thorough than daily inspections. Here are the items you need to inspect:

No.	Inspection item	Procedure	Normal condition	Remarks
1	Mounting conditions	Check unit mounting screws	PC unit should be mounted securely.	Tighten with screwdriver.
2	Connection conditions	Check power source and I/O wiring	Terminal screws should be securely fastened.	Use solderless terminal, nipper, and screwdriver.
		Assure that expansion cable is connected securely	Connector should not be loose or damaged.	Fasten securely with connector hook and replace connector cover.
3	Environmental conditions	Ambient temperature check	Should conform to PC specifications.	Measure with thermometer, hygrometer. Adjust temperature and humidity with fan, cooling unit, humidifier, or dehumidifier.
		Humidity check	Should conform to PC specifications. No condensation.	
		Atmosphere check	Check for PC discoloration, deformation, or damage due to sunlight, dust, or corrosive gases.	Use double-walled housing to seal PC enclosure completely to prevent corrosion, or move PC elsewhere.
4	Safety conditions	Grounding check	Ground resistance and shared configuration must conform to specifications.	Protect PC from noise interference with surge suppressor if necessary.
		Check program of PC	Connect LCD Programmer, check for program errors.	
5	Program check	Ensure that backup program is stored.	No error with program in PROM module.	Check by reading printout. Do not expose EPROM to ultraviolet light.
6	Spare parts	Check spare parts and expendables.	No abnormalities with relay, battery, or fuse.	Replace unit or failed parts.

Replacing the battery

When no power is being supplied to the PC or a power outage occurs, the PC's built-in battery protects against loss of the program in RAM memory. The lithium cell has a service life of about 5 years. The date when the battery was installed is printed on the left side of the PC cover.

A replacement battery should be obtained from Toshiba (Model EX2040PBATT, rated at 3 Vdc, 1,200mAH).

Should the battery need replacing, the LOW BATT. and ERROR indicators both light up. To find out why they turned on, you must connect either the LCD Programmer or the Timer/Counter access unit to permit you to read the error message. When the battery voltage is too low, you will see the message:

ERR. 12 BATTERY

1) If the PC is operating when the battery goes dead, the LOW BATT. LED turns ON. The PC is not affected by the low battery condition until you turn off its power. Then, if you try to turn the power back ON, the PC will not work and the ERROR indicator lights up.

2) If a PROM module is installed, the PC will run with the program in PROM without a battery. But, the data of latched coils, counters, and shift registers will not be retained at power shut down.

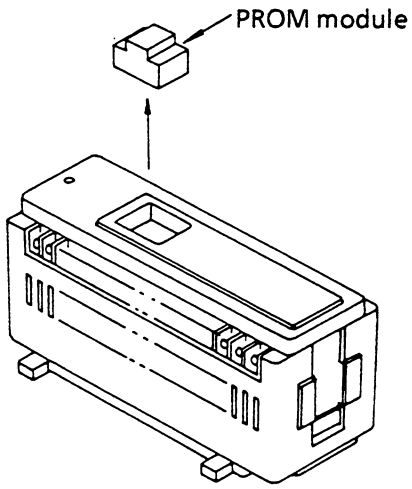
1) After removing the battery, you must install the new battery within five minutes or the program will be erased.

2) If a PROM module is installed, remove it only after first disconnecting the power. The PROM module may be damaged if removal is attempted when the PC is supplied with power.

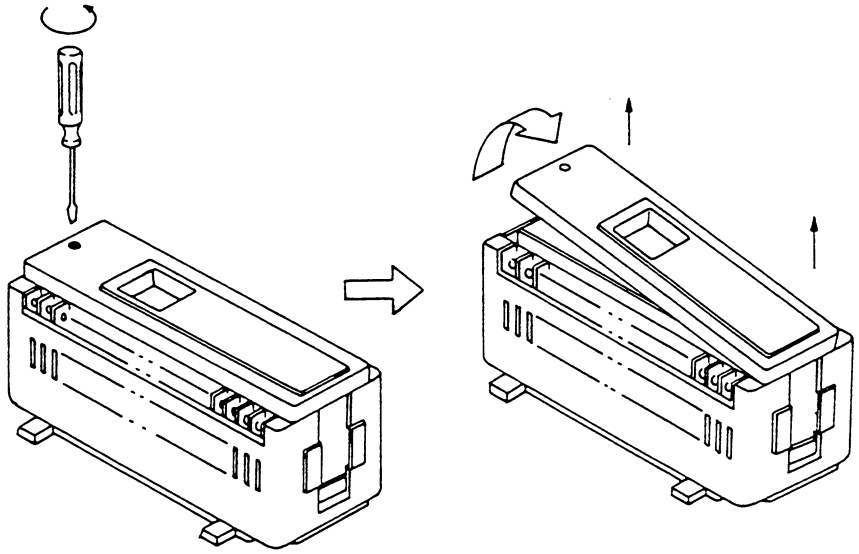
3) Discharge static electricity from your body by touching a grounded metallic object before attempting to open up the PC's housing. Failure to do so may cause damage to PC components.

Steps for replacing the battery

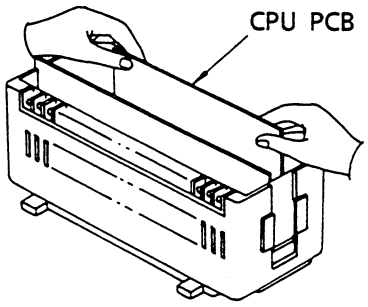
(1) Turn OFF ac power.
(2) If installed, remove the PROM module.



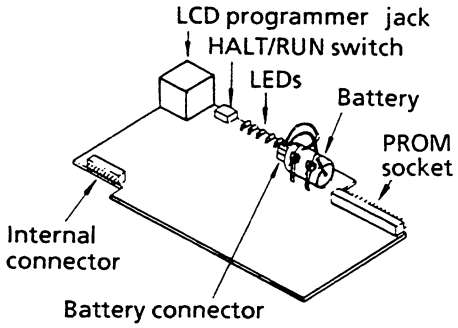
(3) Remove the front panel of the basic unit with a standard screwdriver.

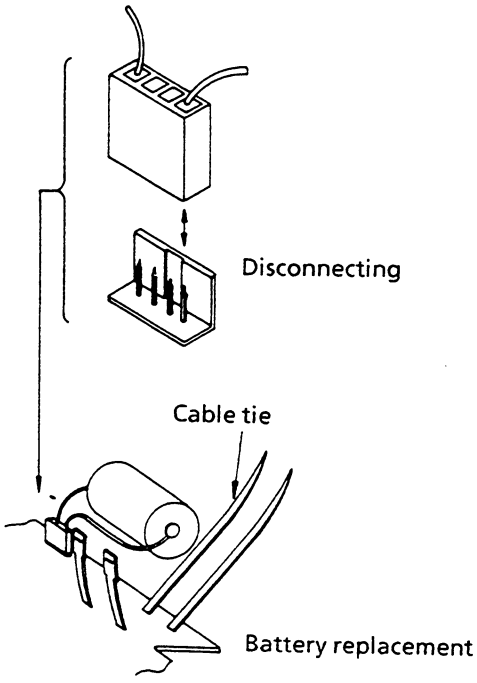


(4) Remove the CPU circuit board mounted in the center of the unit and place the CPU board on a flat insulator (wood, rubber, or the like).



The battery is located near the top edge of the board.





(5) Taking care not to touch any board parts, check the battery connection for looseness or other problems. Push the plug in firmly if it appears loose. If everything appears secure, go to the next step.

(6) Slightly loosen the two white plastic bands holding the battery. Then gently unplug the orange battery plug and remove the battery.

(7) Install the new battery. Its plug has a small protrusion, sort of a rectangular bump, that slips into a slot in the PC battery socket. Line up the bump with the slot and push down on the plug. You may need to wiggle the plug slightly while pressing firmly down to make sure it is seated securely.

(8) Slip the new battery into the two white plastic bands and tighten them.

(9) Replace the CPU board in the correct position in the basic unit.

(10) Replace the PC front panel and fasten its screw.

(11) If used, replace the PROM module.

(12) Resupply ac power to the PC.

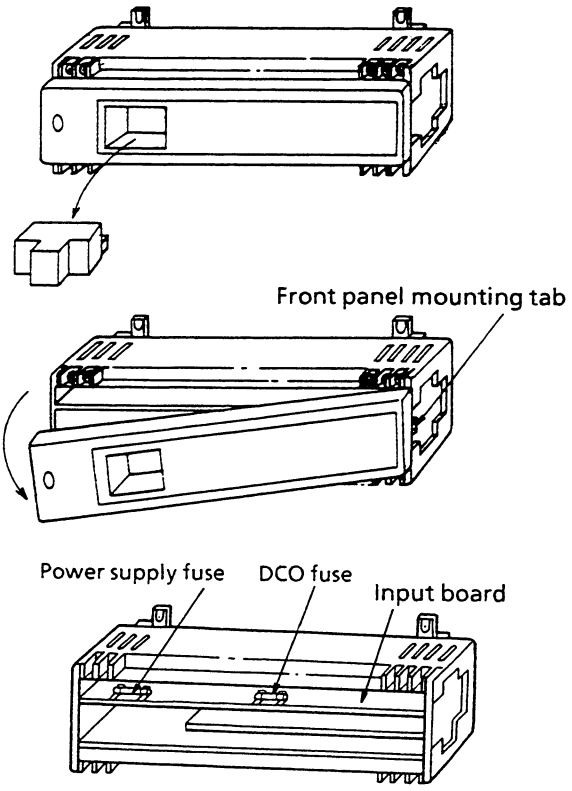
Now check the PC to see if you fixed the problem. If the LOW BATT. and ERROR indicators remain OFF, battery replacement is successfully completed. If the indicators are still ON, check the battery connector.

Replacing fuses

A power fuse is mounted on the input board of each unit. To replace the fuse, follow the procedure below, but first determine the cause of the blown fuse.

Replacement fuse:
- Power supply fuse ..... { EX2040PFU30, 250Vac, 3A
- DCO fuse ..... { EX2040PFU02, 250Vac, 0.2A

- Procedure



① Switch off ac power, and remove the PROM module.

② Remove the front panel with a standard screwdriver.

③ The fuse is visible on the input board.

④ Remove the blown fuse, and replace it with a new one.

⑤ Replace the front panel. Check that the mounting tab and case align properly and fasten its screw with 3 to 5 kg-cm torque. Don't overtighten.

⑥ If used, replace the PROM module.

⑦ Resupply ac power to the PC.

If the POWER indicator lights up, fuse replacement has been completed successfully.

NOTE In case of the EX40PLUS, the DCO fuse is mounted on the output board.

CAUTION Never attempt to substitute a fuse with a higher amp rating; it could damage the PC and create a possible fire hazard.

SECTION 6

Troubleshooting

When a system trouble has developed, it is important to fully grasp the nature of the trouble first, and then to isolate the cause to either the I/O equipment or the PC. Since a single cause may bring about secondary troubles, the entire system may require troubleshooting.

Described below are the EX20PLUS/40PLUS-related trouble symptoms, their possible causes and remedies. We recommend that spare units are kept on hand at all times for quicker restoration of your system when trouble occurs.

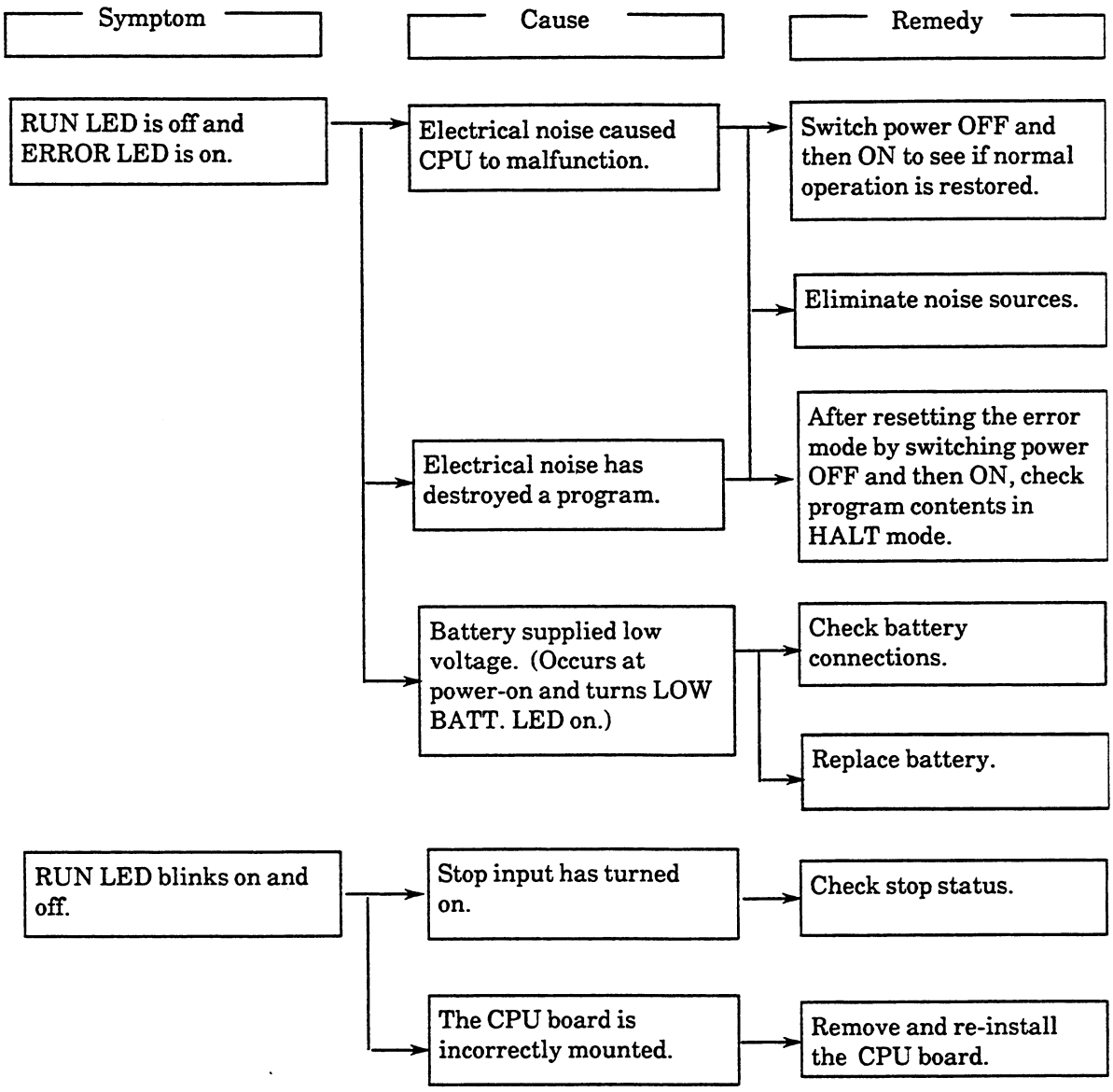
CAUTION At troubleshooting, take the following steps to prevent human injury and/or damage to the EX20PLUS/40PLUS controller:

1) Disconnect power from the controller before changing units or disconnecting cables.
2) Disconnect power to all I/O devices before changing units.

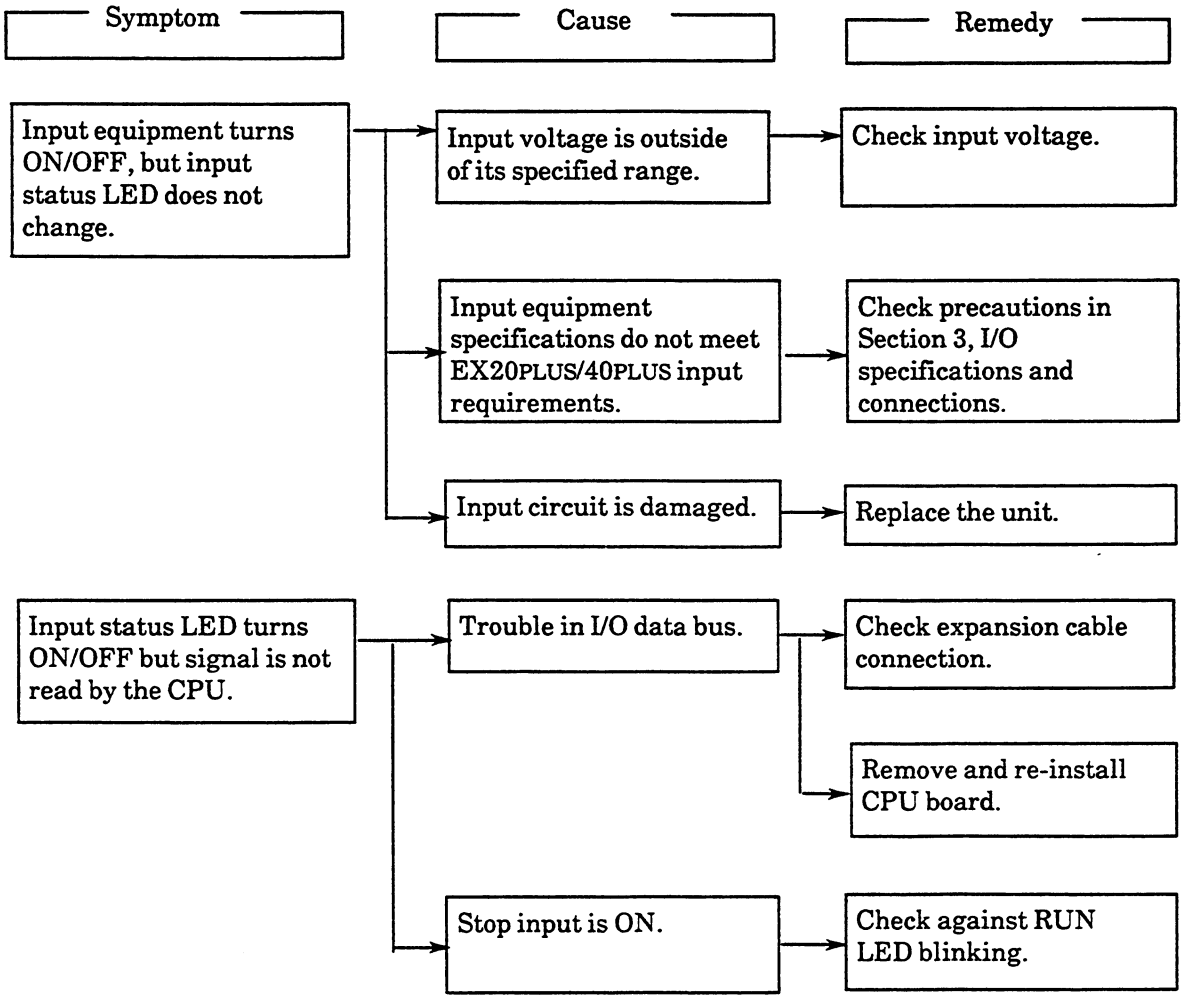
Power inspection

Symptom	Cause	Remedy
POWER LED is off	No power is supplied.	Measure voltage at power terminals, and supply system with AC power that meets specifications.
	AC power voltage is outside the specified range.	
	Power fuse has blown.	Find cause of blown fuse then replace fuse.
No voltage at DCO output terminals.	DCO output fuse has blown.	Replace fuse with new one rated at DCO output capacity of 0.1A max.

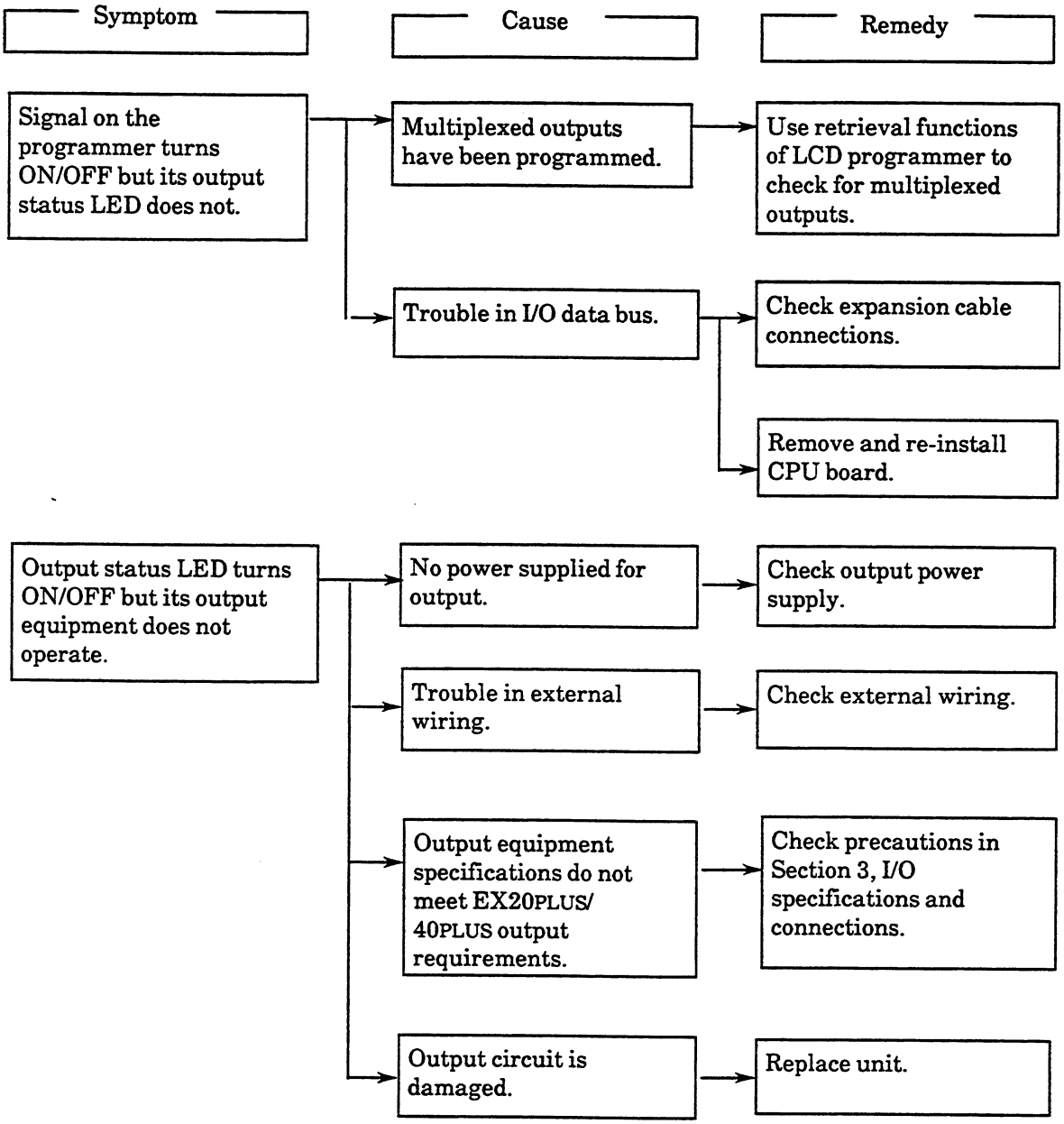
CPU inspection



Input Inspection



Output Inspection



SECTION 7

General Specifications and Dimensions

General specifications

Item	EX20PLUS/40PLUS		LCD programmer
Power supply	100 to 120 Vac/200 to 240Vac, +10%, - 15% 50/60 Hz, ± 5%		Supplied from the basic unit
Instantaneous power fault	Continuous operation for less than 10ms		—
Withstand voltage level	1500 Vac - 1 min.		—
Temperature	Operation: 0 to 60°C Storage: –15 to +75°C		Operation: 0 to 40°C Storage: –15 to +60°C
Humidity	10 to 95% RH, no condensation		
Vibration	16.7Hz, 3 mmp-p		
Shock	10G		
Atmosphere	No corrosive gases No flammable gases		
Noise withstand level	1000V - 1μs (noise simulator) NEMA ICS3 - 304		—
Grounding	Less than 100Ω, separated grounding		—
Weight, kg (lb)	EX20PLUS	1.5 (3.3)	0.3 (0.7)
	EX40PLUS	2.0 (4.4)	
	EX20 exp.	1.0 (2.2)	
	EX40 exp.	1.5 (3.3)	
	EX08	0.5 (1.1)	

NOTE

(1) 120 Vac input type of the EX20PLUS/40PLUS can not accept 200 to 240 Vac for power supply.

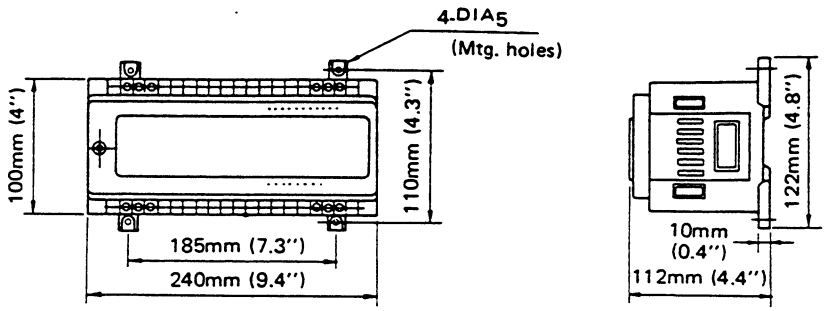
(2) Temperature specifications for the LCD programmer differ from the EX20PLUS/40PLUS

(3) Higher temperatures shorten the life of the lithium battery.
(Expected battery life):
2 years at 40°C (operation or storage)
5 years at 25°C (operation or storage)

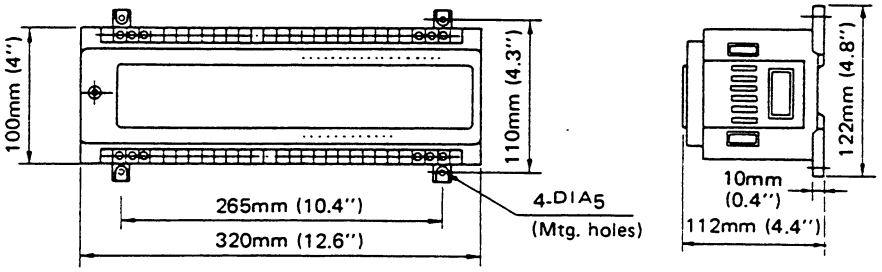
(4) For long-term storage, humidity should be less than 60% RH.

Dimensions

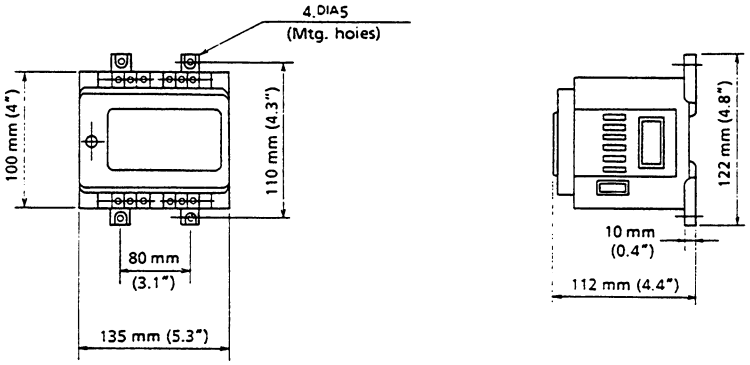
▪ EX20PLUS and EX20 expansion unit



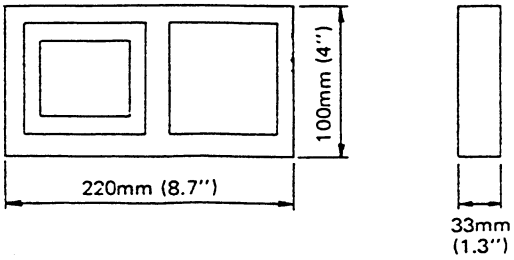
▪ EX40PLUS and EX40 expansion unit



▪ EX08, Analog input, and Computer link unit



▪ LCD programmer and Timer/counter access unit



PART II

PROGRAMMING and OPERATION

SECTION 1

Before You Begin

This section outlines this part and previews each section to give you a helpful headstart before you begin.

About this part

This part was written to meet the varying needs of operators whose experience with programmable controllers (PCs) ranges from none at all to extensive.

Those with little or no PC experience will find they have little difficulty understanding the procedures and concepts explained here. The only specific knowledge you require is a familiarity with relay ladder diagram logic. If you are an old hand at using PCs, you may wish to skim or completely skip certain sections, notably Section 2, which covers familiar PC concepts. Other sections with specific information on this PC should be read carefully.
This is what you will find in the upcoming sections:

Section 2 PC Basics.
This section covers necessary software-oriented preparations, such as how to analyze your control application requirements and assign internal and external device addresses.

Section 3 LCD Programmer.
This section looks at the functions of the LCD Programmer - how to use the keys, read the LCD display screen, and control the cursor.

Section 4 Sample Programs.
You are quickly introduced to the PC through hands-on use of the LCD Programmer to program simple demonstration circuits.

Section 5 and 6 Writing and Editing the Program.
The first of these two related sections explains how devices are programmed in ladder diagram logic. The second details how to edit the program.

Sections 7 and 8 Monitoring the Program and System Control.
Here you learn how to start, stop, and monitor the PC program, and how to change timer/counter values and set/reset devices.

Section 9 PROM Modules.
This section explains how to use PROM modules to save and run your programs.

SECTION 2

PC Basics

This section outlines the general concepts underlying PC control of automated systems.

PC background

The first PCs were developed in the early 1960s for U.S. automobile production engineers seeking a new kind of logic controller for industrial production processes. Before then, control systems for assembly lines and other automated processes depended on individual, actual devices to provide various control functions. These electromechanical timers, counters, on/off switches, relays, and other discrete devices were an improvement over manual process control. However, by today's solid-state standards they were inefficiently slow, bulky, and prone to misoperation or breakdown. Moreover, they were highly complex, usually requiring extensive wiring and maintenance. Once in place, changes in wiring or control design could take many days.

PC advantages

PCs offer several advantages over electromechanical relay control systems. In addition to their lower operating and maintenance costs PCs are:

- Simple - ease of programming and reprogramming PCs greatly facilitates modifying system logic to correct faults and comply with changing system requirements.
- Job specific - the modular configuration of PCs allows precise tailoring of a system to fit any particular application.
- Compact - the drastically reduced size of PC systems affords considerable savings in floor space previously required for the bulky cabinets and control wiring of electromechanical systems.
- Versatile - because PCs are general-purpose control devices with no mechanical parts to wear out, they can be reprogrammed for reuse in many other configurations even though the equipment they were originally tailored to control has become obsolete.
- Reliable - the solid state construction of PCs ensures precise, reliable performance due to the absence of electromechanical parts that can break or wear out. PCs can also be compactly stored for later use.

How PCs operate

The PC makes it possible to create a control program using the familiar concepts and symbols of relay ladder diagram-based logic, but without the actual wiring and control devices.

The intelligent microprocessor in the PC simulates the functions of the control relays and other elements within the controller itself. A wide range of devices can be programmed, including switches, counters, timers, master control and jump circuits, shift registers, and flip-flops.

Operation of the control devices is governed by the ladder diagram control program which is made up of a sequence of instructions. These instructions are stored in the PC's random access memory (RAM) as a series of screens, each of which is an individual program segment.

When the program is run, the instructions are sequentially executed until the program's final screen. When the end of the program is reached, the microprocessor returns to the first screen and starts the cycle over again. This continues until the PC is stopped by the operator.

Program capacity and storage

The EX20PLUS/40PLUS provides 1022 steps (1K) of user memory.

RAM is used to develop and test user programs, while optional programmable read-only memory (PROM) modules are recommended for everyday operation of controlled equipment. PROMs make it possible to store programs for later use and to duplicate them for identical control applications at more than one facility.

The PROM LED indicator on the PC lights when a PROM module is inserted in the PROM socket on the PC.

Error indication

The PC continuously monitors its operation and provides assistance to the operator during programming. When a fault is detected, a message appears on the LCD Programmer. LEDs indicating operating conditions and problems are also provided on the basic unit.

Monitoring

As the controlled system operates, it can be visually monitored on the display screen of the LCD Programmer. The PC features several different monitoring methods which are explained in detail in section 7.

Five programming steps

These are the steps generally followed when a control program is prepared and written.

Step 1

Analyze the control requirements of the target system

Determine what you want the controlled system to do, what internal and external devices are required, and how they relate. Then determine how the components should operate - that is, when, for how long, and in what order.

Step 2

Assign device addresses

Each device is addressed individually in the program using addresses assigned by you. You must do this before you begin programming with the LCD Programmer. These addresses are numbered in octal notation , which is a numbering scheme using 8 as the base. It is not necessary to be familiar with octal numbers. An explanation is given in Appendix C, along with a chart for converting from decimal numbers to octal.

Step 3

Write a ladder diagram program with the LCD Programmer

You may wish to sketch the ladder diagram on paper beforehand, especially for complicated control applications. Use the familiar relay symbols and concepts of conventional relay-based ladder diagram logic. Then, write the program directly in the keyboard of the LCD Programmer. You need not convert into special codes; the symbols themselves represent the simulated devices.

Step 4

Edit the program

Make all necessary adjustments. These include clearing error messages on the LCD screen and making modifications for best operation of the controlled system.

Step 5

Run, monitor, and modify the program

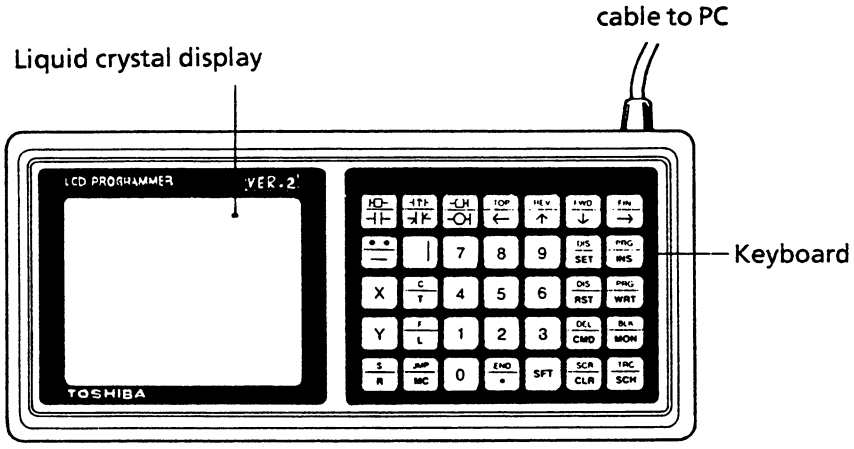
Finally, run the program. As the PC operates, you can monitor it to make sure everything is working smoothly. Final modifications can be done to the program on the LCD Programmer screen at this time, although the operation must be halted before changes can be registered.
Afterward, if you wish, you can save the program to an optional PROM module. You can also print out a hardcopy of the program using the optional printer interface and a standard printer.

SECTION 3

LCD Programmer

This section describes the LCD Programmer operations, modes, and key functions. It also explains how to read the display, control the cursor, and manage program screens.

Overview of LCD Programmer



The LCD Programmer is a hand-held control panel for communicating with the PC. It has a touch-sensitive, flexible keyboard used for programming the control logic, selecting devices for monitoring, and issuing software commands. Its LCD (liquid crystal display) screen displays the ladder diagram during programming. It also lets the PC communicate back to you – through error and PC status messages and information on devices you have selected for special monitoring as the controlled system runs.

Operating modes

The LCD Programmer is used in three modes: Program (PRG), Command (CMD), or Monitor (MONIT). Any mode can be entered from either of the other two. The current mode is displayed on the Mode line which is explained a little later. In most cases, mode selection occurs automatically depending on the function you want to perform.

Program mode

In this mode, you can write a program or edit one that has been stored in the PC memory. Program mode is entered automatically the first time you write a device to the Message line by pressing the write [PRG/WRT] key after

supplying the required device information. It is also entered when the Clear Memory command (Command 3) is initiated.

Command mode

This mode is automatically entered when you key-in a command. Commands serve several purposes, including halting and restarting the PC, resetting the error LED on the PC, clearing the existing memory, and various PROM management functions. Using commands is explained in Sections 8 and 9.

You control the PC by entering commands this way: press the command [DEL/CMD] key, then the desired one- or two-digit command code, followed by the write [PRG/WRT] key.

Monitor mode

In Monitor mode you can observe the operation of devices either individually or in groups while the program is running. You enter this mode when you use any of these key sequences:

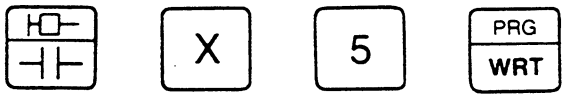
[Device] TRC/SCH	SFT BLK/MON	BLK/MON
SFT TRC/SCH	[Device] SFT PRG/WRT	[New screen] SFT PRG/INS

On the screen, you can see the program execution status in the ladder diagram format. Four different monitoring methods are explained in Section 7. Setting and resetting devices is also performed in monitor mode.

Keyboard layout

The keys are color-coded in three groups plus a shift key. Each keytop has a number, one or two symbols, or one or two codes. Some keys have two uses – a main function and a shift function. This section briefly introduces the keys to acquaint you with how they are used.

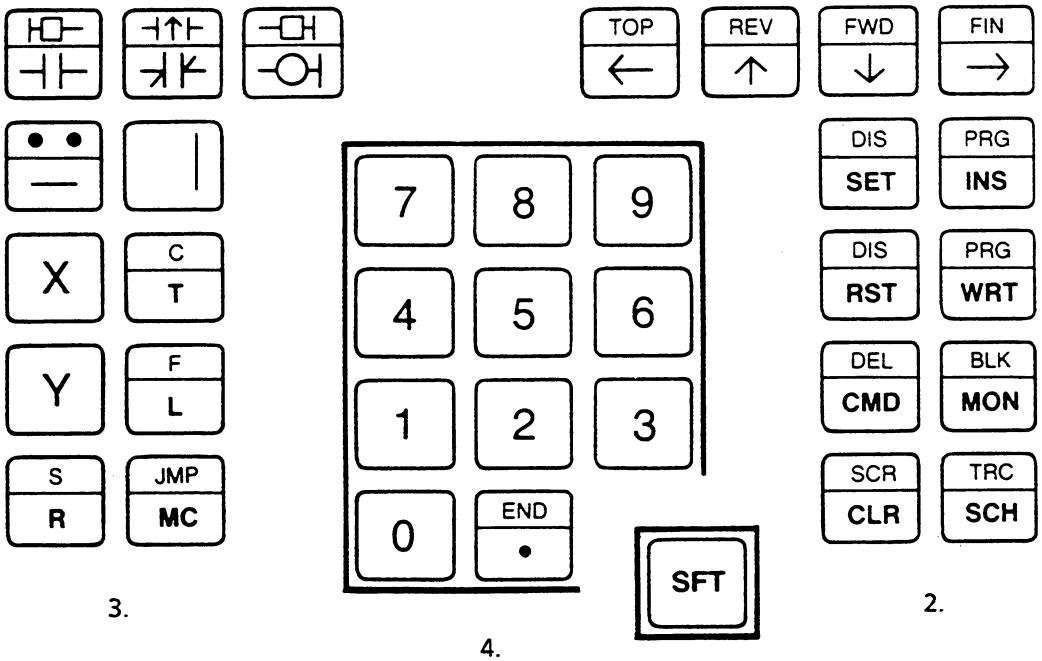
NOTE When pressed, each key except the Shift Key [SFT] beeps to confirm the entry. The typical key-in sequence followed in this manual is:



Symbol (blue) | Device (blue) | Address (white) | Writes device to ladder diagram

However, except for [PRG/WRT] and time/counter values (preceded by the separator [.] and entered after the address), these keys may be pressed in any sequence.

Key Groups

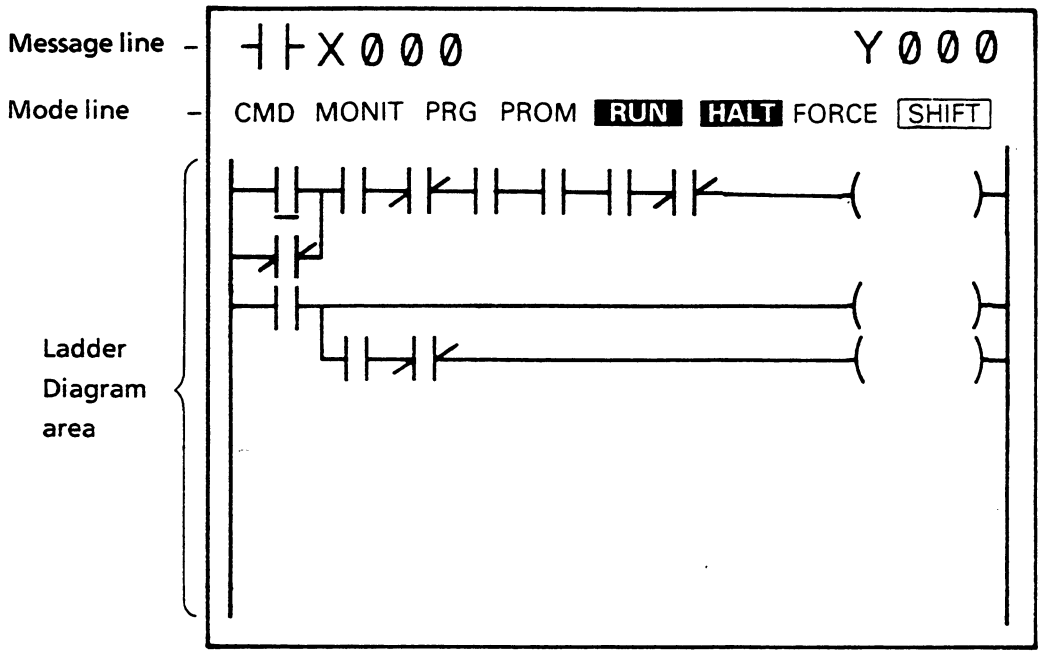


1. Shift key: For shifting between main and alternate (shift) key functions
2. Function keys: For programming instructions, entering commands, controlling the cursor and screens, monitoring, and editing
3. Device keys: For specifying devices
4. Numeric key pad: For assigning octal addresses, setting times in timers and counts in counters, and specifying commands

Display

The versatile LCD screen has three major divisions, each with its own function: Message line, Mode line, and Ladder Diagram area.

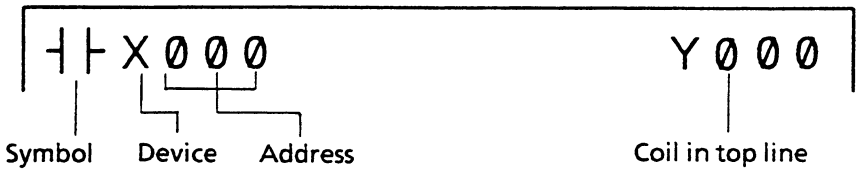
This is how the full screen appears with a program in memory.



Message line

The information displayed in the message line changes with each mode, with the position of the cursor, and with the type of operation.

In Program mode, when the cursor is under a device position in the ladder diagram, the left part of the message line shows the device symbol and its address. The right part of the message line shows the legend for the coil on the top line of the screen.



When the cursor is placed under one of the coils in the ladder diagram, the message line changes to the symbol and information of that coil. Such information as timer and counter values, and LCD Programmer functions are also shown on the message line.

The appearance of the message line changes according to the mode and what type of information is shown. Error messages are listed in Appendix A.

Mode line

The mode line indicates the current mode of the LCD Programmer, LCD Programmer functions, and the status of the PC.

Operating modes

PRG (Program mode)	-	For writing and editing programs
CMD (Command mode)	-	For entering commands
MONIT (Monitor mode)	-	For monitoring operation of devices
FORCE	-	When a device has been force set
SHIFT	-	When the shift (alternate) function has been specified for a two-function key

PC status

RUN/HALT	-	PC operation is halted or running
PROM	-	For saving to /loading from the PROM module

When the shift [SFT] key is pressed, SHIFT is shown enclosed in a box on the mode line.

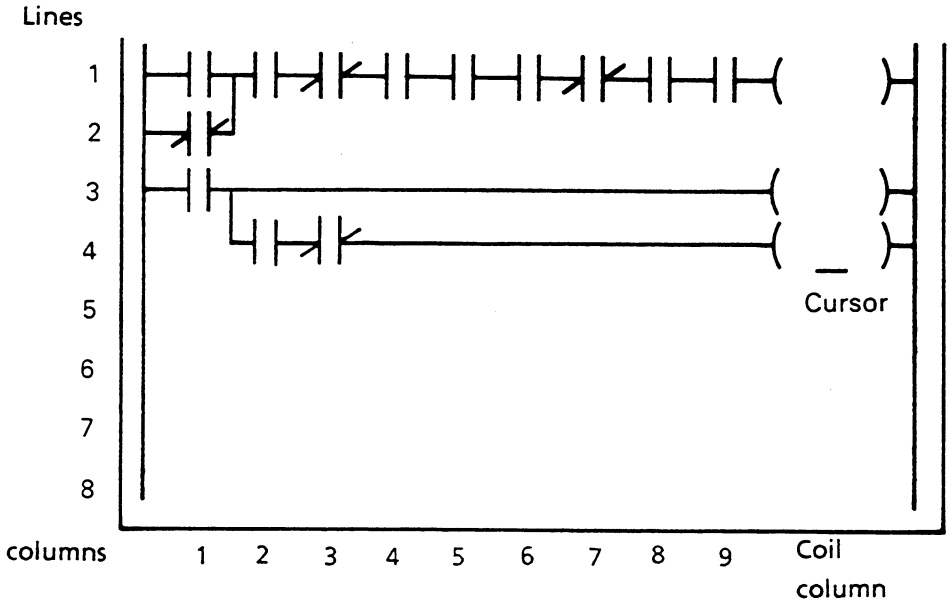
Depending on the position of the HALT/RUN switch on the PC, either HALT or RUN appears in reverse display on the mode line. When the PC is stopped or restarted with a software command, HALT or RUN appears both on the Message line and in reverse display on the mode line.

Ladder Diagram area

The lower part of the LCD screen is the largest – the area in which segments of the ladder diagram program are written and displayed.

When a device is written into the Ladder Diagram area, information on it is first shown in the message line as the operator programs the device. When all information has been supplied, the operator presses the write [PRG/WRT] key to write the device into the Ladder Diagram area. The device appears as part of the ladder diagram at the position of the cursor. When another device is keyed in, the cursor moves to the next column.

The figure below identifies the parts of the Ladder Diagram area.



Cursor control

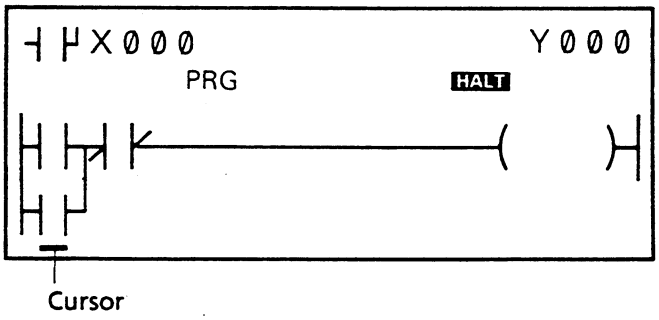
The cursor has two uses: it specifies locations as devices are written into the Ladder Diagram area and it displays information on devices on the message line.

During programming, the cursor automatically moves to the next column in the ladder diagram as you begin to write a new device. However, when you wish to edit or insert a device, you first move the cursor to the position with the cursor control keys and then make your change. There's another, quicker way to move through the program to a desired device. This is the search function which is covered in Section 6.

After a screen or part of a screen has been written, you can move the cursor to any desired device location to read information about the device, such as its address.

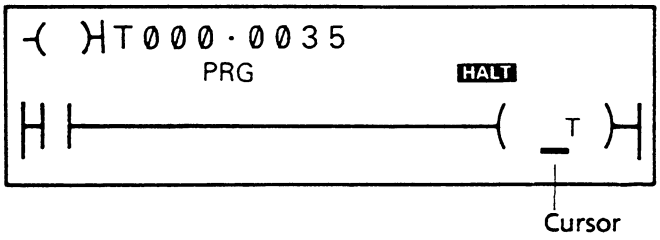
Placing the cursor under one of the devices displays its address and other information in the message line.

Instruction (NO contact) and device address (X000) appear in message line



When you place the cursor under one of the coils in the ladder diagram, the message changes to the coil symbol. If the coil is a timer or counter, its set value is shown in the message line.

Instruction (timer) and set value (3.5s) appear in message line



How screens are written

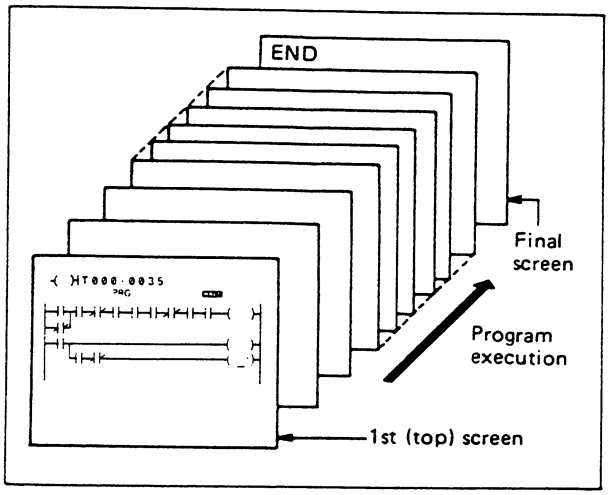
To fully grasp how the screens work, consider this:

- When a device is written into the ladder diagram on the display screen it does not actually become part of the program until the entire screen is stored in the PC memory using the program write [SFT] [PRG/WRT] key. In other words, although you see the diagram on the display, it is not recognized by the PC until you press [SFT] [PRG/WRT]. You don't have to store after writing each device. Instead, wait until you have completed and checked the entire screen, then store it in PC memory. (Or, if the program is particularly complicated, you may want to press the program write key after every two or three lines for added insurance. The next paragraph tells why.)

CAUTION If you clear a screen or replace it with another screen, or if you press the monitor [MON] key before the saving screen to the PC memory, you will lose the ladder diagram.

- The screens themselves are not numbered. However, they are entered sequentially into the PC memory and retain this order. Because each device has a program address, you can use device addresses to find and recognize screens. One method is to look at the address of the coil on the top line. This is the address you see on the right side of the Message line on each screen when the cursor is in the device area of the ladder diagram.

- While there is a limit to the number of steps in a program, as many screens as necessary can be written.



Locating screens

After a number of screens are saved to the PC memory, you can display a desired screen using the shift functions of the four cursor keys.

SFT + TOP ←	Go directly to first screen.
SFT + FIN →	Go directly to final screen.
SFT + FWD ↓	Go to next screen.
SFT + REV ↑	Go to preceding screen.

You will learn a faster method of moving from screen to screen in a later section.

SECTION 4

Sample Program

To quickly introduce you to the basics of PC programming, this section gets you started with a hands-on demonstration of how two simple circuits are programmed using the LCD Programmer.

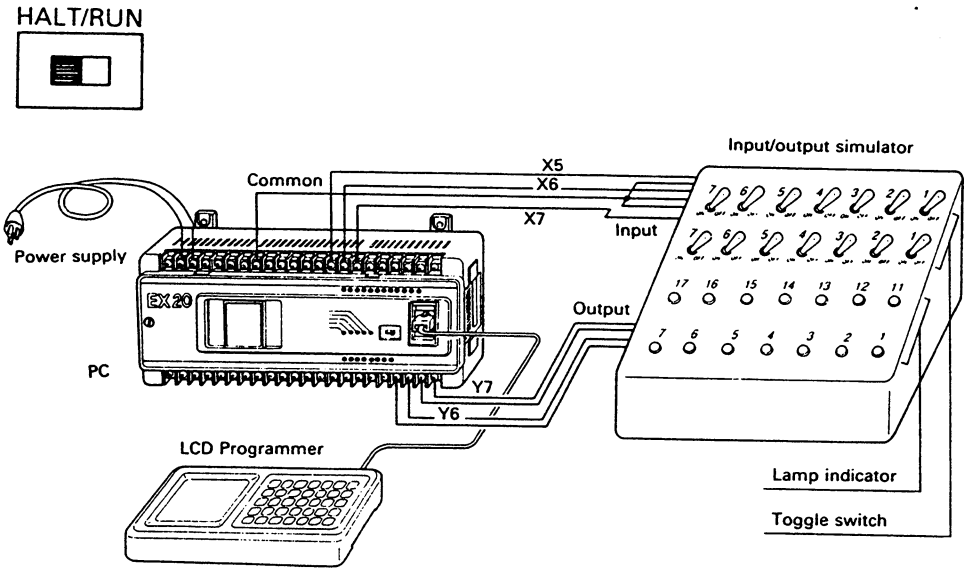
For this demonstration program we will first create a holding circuit and then a timing circuit. Each key sequence and corresponding display screen are shown. Be sure to enter the circuit elements exactly as given.

NOTE

For the sake of brevity, only essential information is provided for this demonstration program. Later sections explain each procedure in full.

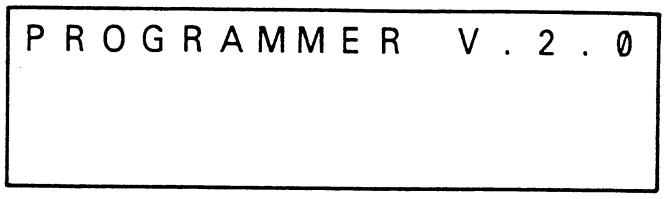
Getting started

- Connect the LCD Programmer to the basic unit.
- To see the program work, a simulator with input toggle switches and lamp indicators may be used. Connect three toggle switches on the simulator to input terminals 5, 6, and 7 on the PC. As well, connect two lamp indicators to the terminals of outputs 6 and 7 on the PC.
- When you supply the rated power to the AC power terminals of the PC, the POWER LED indicator on the PC lights.
- Set the HALT/RUN switch on the PC to the HALT position.



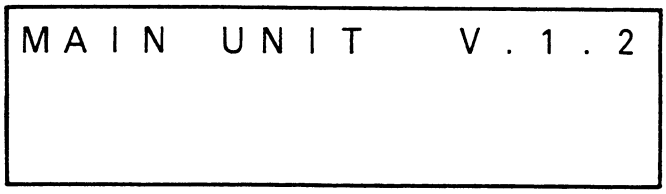
To begin programming

When the LCD Programmer is plugged into the PC and power is applied, a message showing the version number of the LCD Programmer appears.



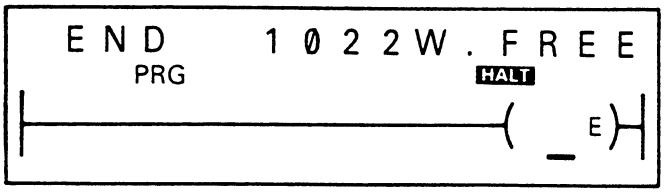
Press this key to clear the screen message.

Next, a message showing the version numbers of the PC is shown.



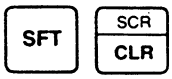
Illustrations and display messages may be somewhat different than shown here depending on the PC model you have. However, the circuits are programmed the same way for each model.

Again press the clear [SCR/CLR] key to clear this message.



If no program exists in memory, what you see is the final (FIN) screen containing the END instruction which automatically is appended to each program. The PC has 1022 steps (1K) of free memory.

Press these keys to obtain a blank screen to begin programming.



If a program already exists

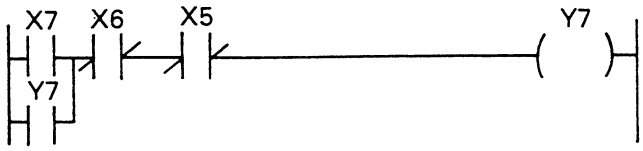
Press these keys to erase all screens in the PC memory.

You are now ready to start entering the demonstration program.

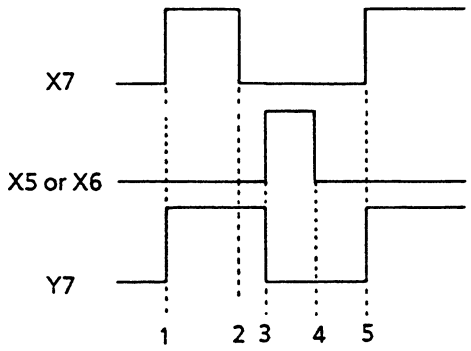
The cursor is controlled with the four arrow keys. Hold down a key and the cursor will continue to move in that direction.

Circuit example

This is the ladder diagram circuit we will now program.



Timing chart



This simple holding diagram shows how Coil Y7 can hold its on status caused by NO Contact X7, where X, Y are input/output devices and 5, 6, and 7 represent serial numbers (beginning with zero in octal) corresponding to the I/O numbers on the PC. These device addresses (X5, X6, X7, and Y7) are not displayed on the screen but are used for programming.
When NO Contact X7 turns on, Coil Y7 is turned on [1] and NO Contact Y7 is also turned on. This lets Coil Y7 hold its on status regardless of whether X7 is on or off [2] until X6 or X5 turns on [3] Coil Y7 does not turn on (irrespective of X6 and X5 turning off [4]) until X7 turns on again [5].

Let us now see how to write this circuit into the first screen of the program.

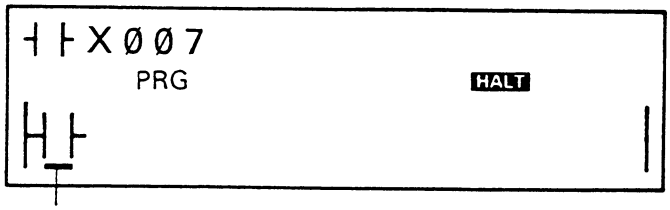
NOTE

Each program comprises individual ladder diagram segments called screens. A screen can hold up to eight lines, each of which accommodates up to nine contacts plus one coil. You use as much of the screen as you need before going on to write the next screen.

It might help to think of a screen as similar to a 35-mm slide picture being shown through a slide projector. Just as an entire slide is viewed a full frame at a time, so are the ladder diagram screens of the LCD Programmer. This is also how they are programmed and saved to the PC memory – one screen at a time.

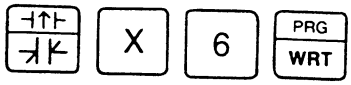
Now begin to write the first screen using the following key sequences.

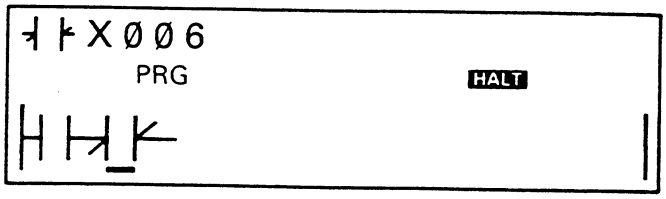
Write NO Contact X7 to first line.



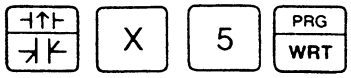
Cursor

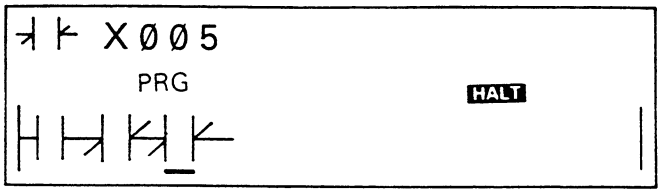
Add NC Contact X6



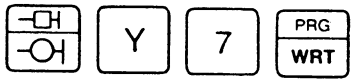


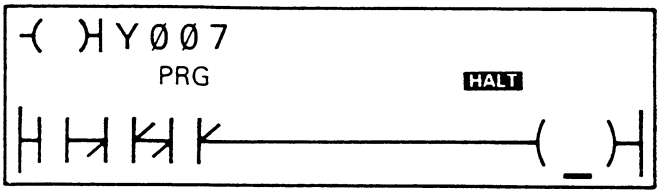
Add NC Contact X5





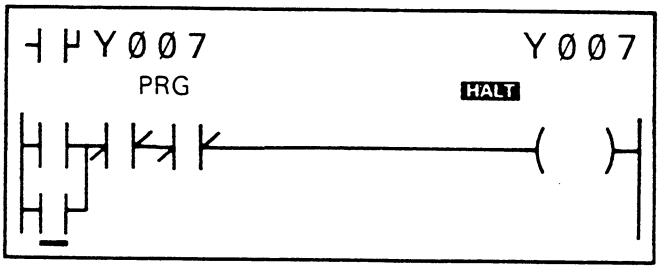
Add Coil Y7





At this point, when you press the next key the cursor automatically jumps down to the beginning of the next line.

Write NO Contact Y7 on second line, connecting to first line.



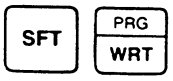
Correcting errors

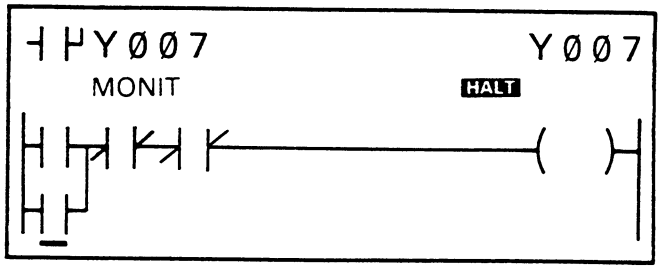
If you press an incorrect key before pressing the write [PRG/WRT] key, correct it immediately by simply pressing the correct key.

If you made an error but noticed it after pressing [PRG/WRT], move the cursor back to the error, then key in the correction. Press [PRG/WRT] to write your correction to the screen.

Saving the program

Now save the screen to the PC memory to complete the program. The display blinks when the screen is saved.





Congratulations! You have just programmed your first circuit. Now let us see how it works.

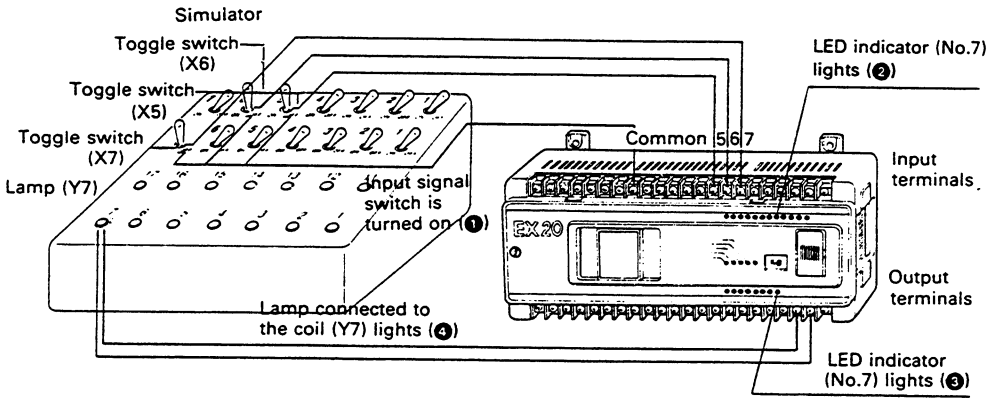
Running the program

To run the demonstration program, first set the HALT/RUN switch on the PC from the HALT position to the RUN position. The RUN LED lights on the PC to show it is in RUN status.

To watch the program work, turn on the input switch on the simulator corresponding to Contact X7.

When the input signal switch is turned on (①), Contact X7 closes. And lights the corresponding input status LED indicator (②). Then Coil Y7 is energized, the corresponding output status LED indicator lights (③), and the lamp connected to the output terminal (Y7) lights (④).

Then if you turn on the switch (X5 or X6), the LED for input Contact X5 or X6 goes on and the LED for output Coil Y7 goes out.

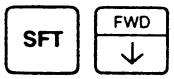


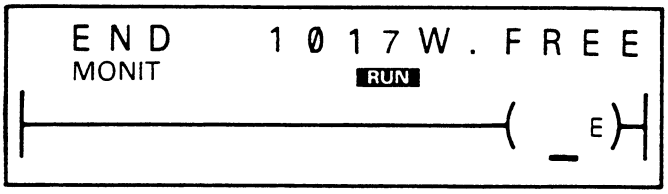
Repeat this operation several times and watch something interesting happening on the display. Each time power flows through an input contact, it becomes shaded when it passes power. The same thing happens to an output coil when it is energized. When power to the devices stops, the shading disappears. This lets you observe the operation of the program.

Adding second circuit

Adding a circuit for a delay timer is also easy. In normal programming you would probably want this circuit on the same screen with your first circuit, since enough space exists on its screen. For demonstration purposes, though, you will create a second screen.

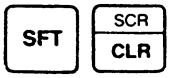
To show the next screen, press these keys.





As you can see, the screen containing the END instruction is still at the end of the program. This time, though, 1017 steps of free space remain. This is because our first circuit required five steps of memory.

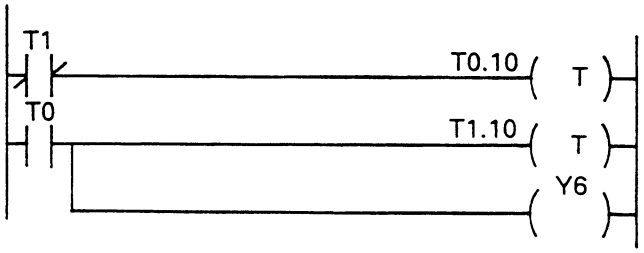
Clear the screen to start keying-in the timer circuit.



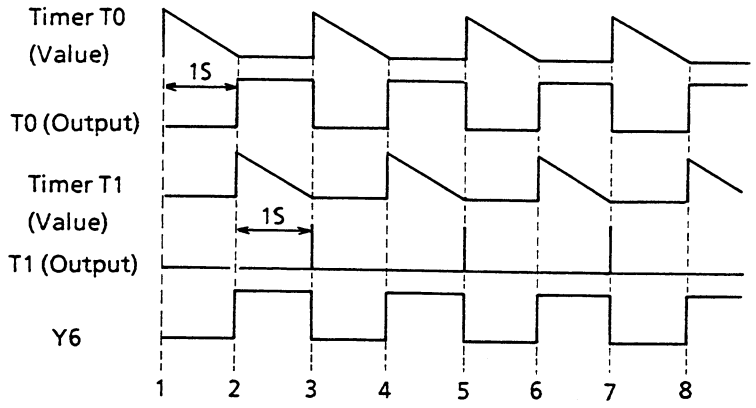
Set the HALT/RUN switch on the PC to the HALT position.

Timer circuit example

This is the timer display circuit to be programmed next.



Timing chart



This sample shows a self-blinking diagram in which output (coil) Y6 is energized and de-energized alternately and a corresponding lamp indicator on the simulator connected to Y6 on the PC blinks once every second.
Notations in the diagram are:

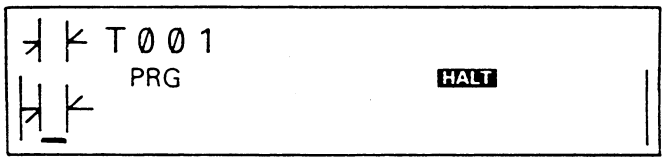
T0.10 : Timer (T0) with preset time of 1.0 second
T1.10 : Timer (T1) with preset time of 1.0 second
T0 : NO Contact (T0) of Timer (T0)
T1 : NC Contact (T1) of Timer (T1)

When the PC is set to RUN status, Timer T0 begins to count [1]. When Contact T0 is on after one second. Timer T1 begins to count and Coil Y6 is turned on [2]. When one second passes, Timer T1 is activated for one scan time to make Contact T0 turn off, Coil Y6 turn off, and Timer T0 to begin to count again [3]. After one second, Contact T0 turns on to make Timer T1 begin to count again [4]. After one second, Timer T1 is activated to reset Timer T0. After one scan of the PC, Timer T0 begins to count again [5] as in the case of [3]. The pattern of [2] [3] [4] is repeated again at [6] [7] [8].

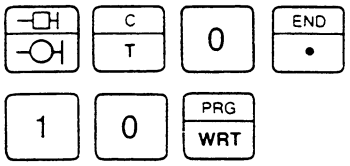
Write the second screen by keying-in this key sequences. Write NC Contact T1 to the first line.

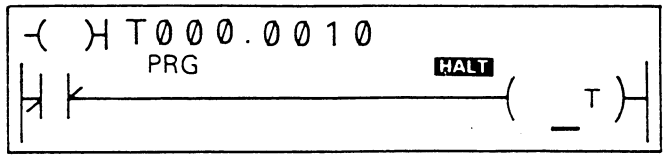
After one scan of the PC, Timer T0 begins to count again [5] as in the case of [3]. The pattern of [2] [3] [4] is repeated again at [6] [7] [8].

Write the second screen by keying-in this key sequences. Write NC Contact T1 to the first line.

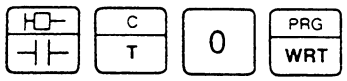


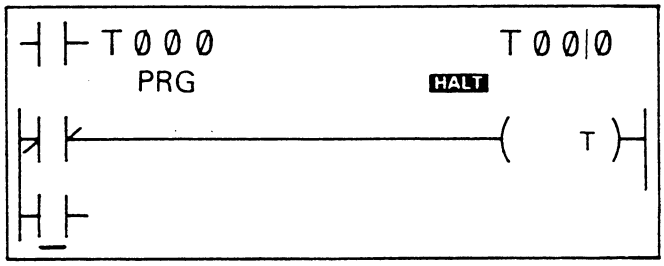
Add Timer T0 with a one second timing period.



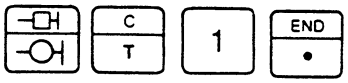


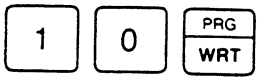
Write NO Contact T0 on next line.

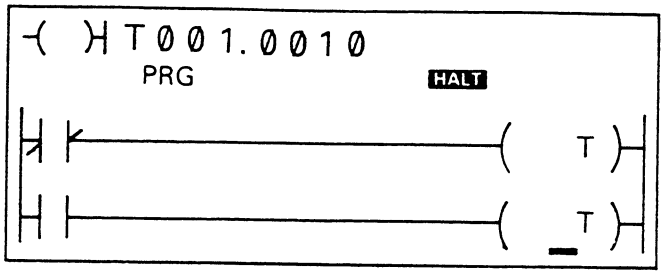




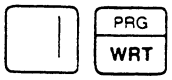
Add Timer T1 with a one second timing period.

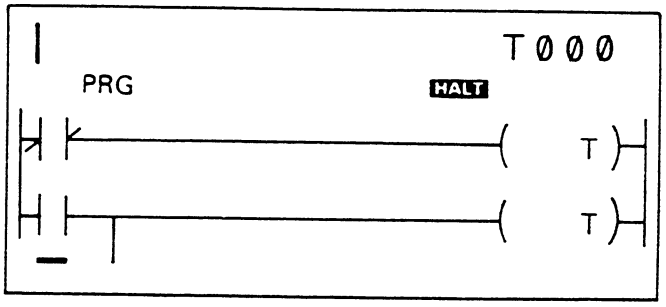




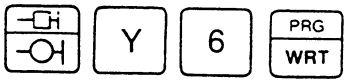


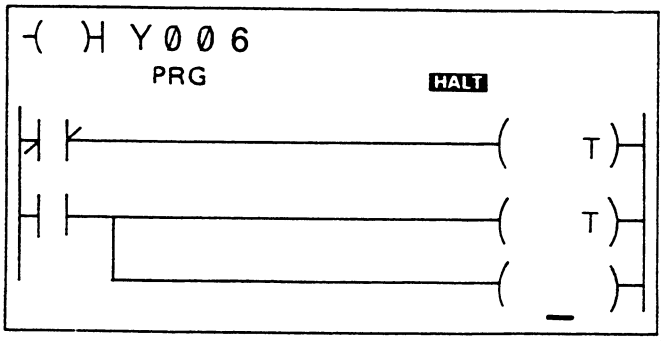
Add vertical connections



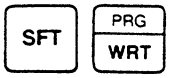


Add Coil Y6.





Now enter the new circuit into the PC memory to finish the new circuit.

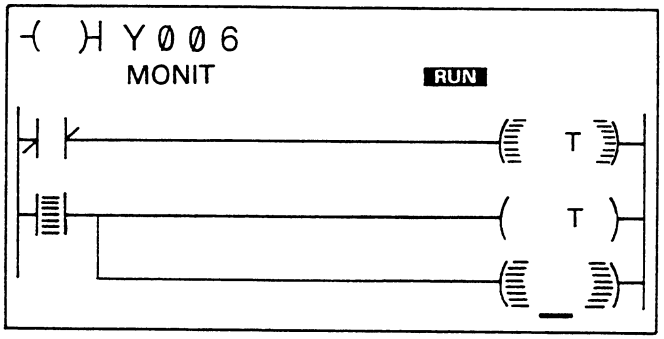


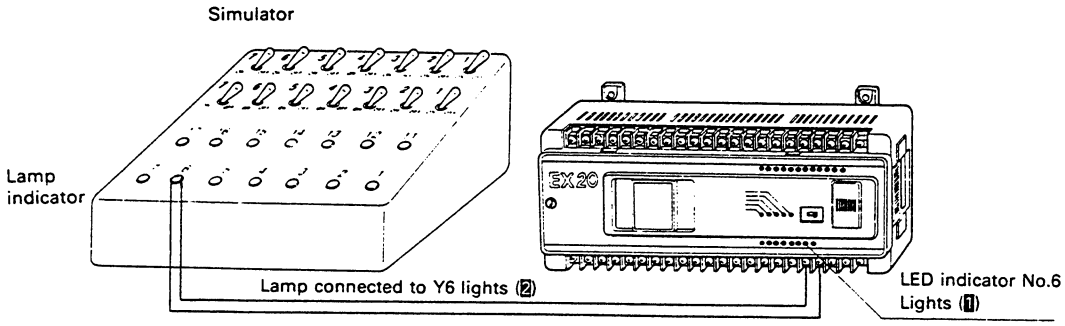
The display blinks when the screen is saved.

Running the expanded program

Set the HALT/RUN switch on the PC to the RUN position.

When the PC runs, Coil Y6 is energized and de-energized alternately. When Coil Y6 is on, output LED indicator No.6 on the PC is turned on [1] and at the same time a lamp indicator on the simulator is turned on [2]. As Coil Y6 is energized and de-energized alternately, the LED indicator on the PC and the lamp indicator on the simulator blink once every second.





You can see the shading of the ladder diagram devices as this happens. Shading indicates the power-on state.

SECTION 5

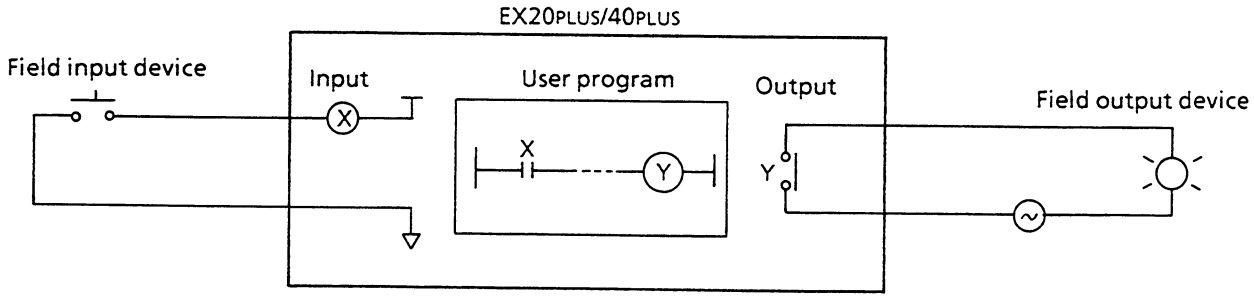
Writing the Program

A closer look at devices

The seven following types of devices are used for the EX20PLUS/40PLUS:

X : External Input
Y : External Output
R : Internal Relay
L : Latched Relay
S : Shift Register
T : Timer
C : Counter

The X (external input) device receives a signal arriving at one of the EX20PLUS/40PLUS input terminals. The Y (external output) device outputs a signal from the EX20PLUS/40PLUS. The conceptual diagram below illustrates these operations.



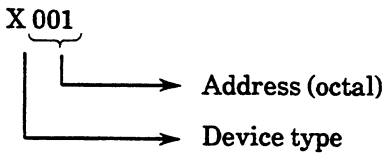
The R, L, S, T, and C devices have internal purposes. The R device is an auxiliary relay. The L device has the same purpose as R, but differs by retaining its status when power is switched off and back on again. The S, T, and C devices respectively provide the shift register, timer, and counter instructions. Similar to the L device, the S and C devices also retain their status when power is switched off and back on again.

Device / Operation	External input	External output	Internal relay	Latch relay	Shift register	Timer	Counter
	X	Y	R	L	S	T	C
Power switch [OFF] → [ON]	×	×	×	○	○	×	○
HALT/RUN Switch [HALT] → [RUN]	×	×	×	○	○	×	○
STOP (External Terminal) Input [STOP]→[RUN]	○	○	○	○	○	○	○

× : Initializes (Clears) ○ : Holds

Device addressing

Each individual device has its own octal address:



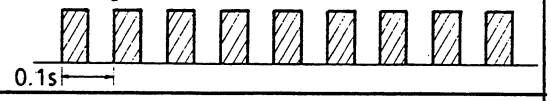
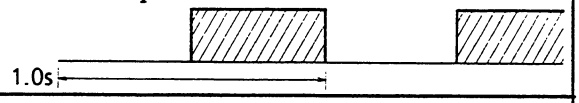
The table below gives the address ranges reserved for individual devices used in the EX20PLUS/40PLUS.

Device	EX20PLUS		EX40PLUS	
	Pts.	Address range	Pts.	Address range
External input (X)	24	X000 - X027	48	X000 - X057
External output (Y)	16	Y000 - Y017	32	Y000 - Y037
Internal relay (R)	128	R000 - R177	1)	
Latched relay (L)	128	L000 - L177		
Shift register (S)	256	S000 - S377		
Timer (T)	64	T000 - T077	2)	
Counter (C)	64	C000 - C077	3)	

NOTE

1) R160 through R177 are special relays.
2) T000 through T067 are 0.1 sec timers, and T070 through T077 are 0.01 sec timers. In analog input mode, however, T040 through T067 input analog signals. (See Part IV Analog Inputs.)
3) In high-speed counter mode, C040 through C077 are high-speed counters. (See Part III High -Speed Counters.)

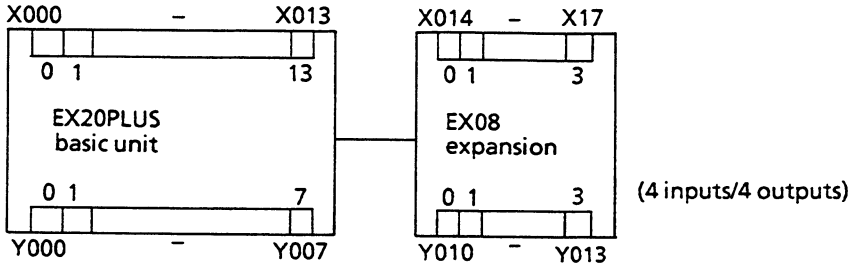
The EX20PLUS/40PLUS device numbers, R160 through R177 are allocated to the special relays listed below. Operating procedures are described later.

Device	Function
R160	Selects high-speed counter mode. ON: High-speed counter mode, OFF: Normal mode
R161	Selects 4-digit or 8-digit counter. ON: 8-digit mode, OFF: 4-digit mode
R162	Selects up- or down-counter mode. ON: Down-counter, OFF: Up-counter
R163	Sets the high-speed counter start flag. ON: Starts counting, OFF: Stops counting
R164	Selects shift direction of bidirectional shift registers. ON: Shifts backward, OFF: Shifts forward.
R165	Selects analog input mode. ON: Analog input mode, OFF: Normal mode.
R166	Always ON
R167	Always OFF
R170	Turns on when the memory backup battery voltage drops below a preset threshold.
R171	Turns one scan on at the beginning of a run.
R172	Provides 0.1-second clock pluses. 
R173	Provides 1.0-second clock pluses. 
R174	Device for the high-speed counter update.
R175	Device for all the individual inputs update.
R176	Device for all the individual outputs update.
R177	Device for all outputs turn off.

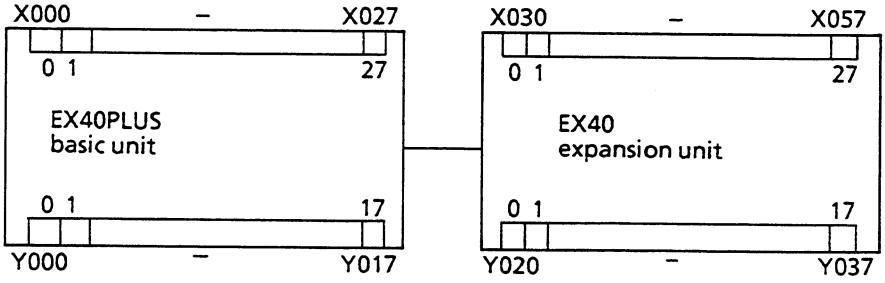
I/O Allocation

The external input (X) and external output (Y) devices are allocated in the order of their addresses, first to the basic unit and then to an expansion unit.

Example 1)



Example 2)



NOTE For possible combinations of the basic unit with one or more expansion units, refer to Part I Hardware, Section 2.

Program writing rules

Some basic rules should be followed while programming the ladder diagram circuit.

- Power flows from left to right.
- Each line starting from the left bus bar must end with a coil.
- Contacts cannot be placed to the right of an output coil.
- Normally, each coil is used only once in a program.
- Invalid key sequences are not accepted; if made, an error message is displayed on the LCD Programmer screen. When this occurs the device must be completely keyed-in again.
- Addresses use octal numbers; an address ending with number 8 or 9 causes an error message.
- The HALT/RUN switch on the PC must be in HALT position before a completed screen can be saved to the PC memory.
- When each screen program is completed, the screen program should be entered by this key sequence; [SFT][PRG/WRT].

Program writing hints

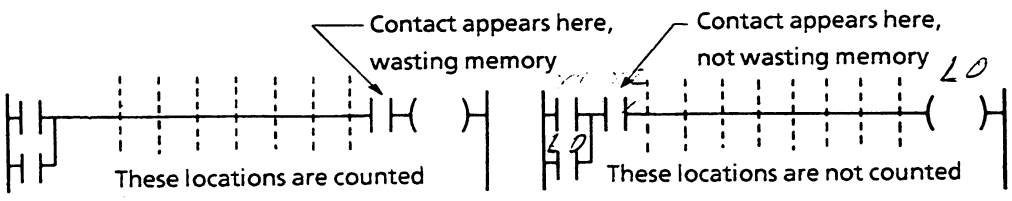
The following are some suggested ways to make program writing more convenient and efficient.

Multiple screens

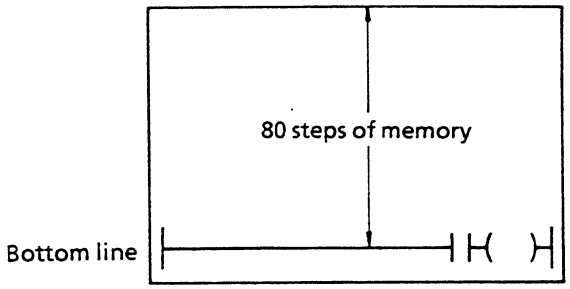
You can use as many screens as you want when writing your program, just as long as you stay within the memory requirements of the PC. Program execution time, as well, is not affected by the number of screens. In fact, splitting up the program into a number of screens can make it easier to read, monitor, and debug. However, devices which require more than one line must be completely written on the same screen.

Conserving PC memory

The amount of memory used by the program depends not just which and how many devices you use, but where you place the devices on their lines. As a general rule, do not leave horizontal blank spaces between devices. This is because all horizontal connection lines between devices use up memory. However, the horizontal connection between the right-most device on a line and that line's coil do not affect memory, as shown below.



Also, make sure your program line begins at the top of the screen. For instance, a line placed at the bottom of a screen wastes approximately 80 steps of memory space as shown below.



Instruction set

The EX20PLUS/40PLUS has the following instructions. The table on the next page covers symbols, steps in memory, devices, and execution time of each instruction. Detailed information and programming key sequences are explained later in this section.

Instruction		Symbol	Steps in memory	Applicable device	Execution time (μs)
Connection	Blank	• •	1	—	60
	Horizontal	–	1	—	60
	Vertical	|	1	—	60
	Horizontal & vertical	⌋	1	—	60
Contact	Normally open	⊣⊢	1	X,Y,R,L,S,T,C	60
	Normally closed	⊣/⊢	1	X,Y,R,L,S,T,C	60
	Transitional	⊣↑⊢	1	R	90
Coil		⊣ ⊢	1	Y,R,L	76
Timer	0.1 sec timer	⊣ T ⊢	2	T000 - T067	140
	0.01 sec timer	⊣ T ⊢	2	T070 - T077	140
Counter	Up count	⊣ C ⊢ ⊣ RC ⊢	2	C000 - C075	400
	Up/down count	⊣ C ⊢ ⊣ RC ⊢	2	C076, C077	400 (up) 360 (down)
Master control	Set	⊣S ⊢	1	—	72
	Reset	⊣ R ⊢	1	—	72
Jump	Set	⊣S ⊢	1	—	72
	Reset	⊣ R ⊢	1	—	72
Step sequencer	Input	|⊢	1	R,L	80
	Output	⊣S T⊢	1	R,L	270
Flip-flop		⊣S F⊢ ⊣R F⊢	3	Y,R,L	290
Shift register	One direction	⊣ SR ⊢ ⊣S ⊢ ⊣ R ⊢	5	S000 - S277	255 + 8n (n: number of S)
	Bidirectional	⊣SR ⊢ ⊣S ⊢ ⊣ R ⊢	5	C300 - S377	275 + 8n (n: number of S)
Critical high-speed counter update		⊣S F⊢ ⊣R F⊢	3	R174	750
Critical input update		⊣S F⊢ ⊣R F⊢	3	R175	640
Critical output update		⊣S F⊢ ⊣R F⊢	3	R176	430
Force all outputs off		⊣S F⊢ ⊣R F⊢	3	R177	430
End		⊣ E⊢	1	—	—

Normally open (NO) Contact

Devices X, Y, R, L, T, C, and S.

Symbol ⊣ ⊢

Function Power flows through the NO Contact if the state of the associated device is ON.

Normally closed (NC) Contact

Devices X, Y, R, L, T, C, and S.

Symbol ⊣/⊢

Function Power flows through the NC Contact if the state of the associated device is OFF.

Coil

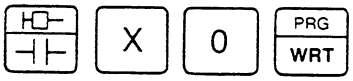
Devices Y, R, L

Symbol -( )-

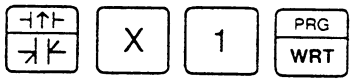
Function If the power reaches the left link of the coil, the associated device is set to ON. Otherwise, the device is set to OFF.

Key sequence for contacts and coil

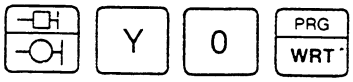
① NO Contact

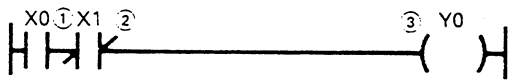


② NC Contact

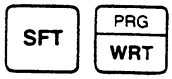


③ Coil Y0



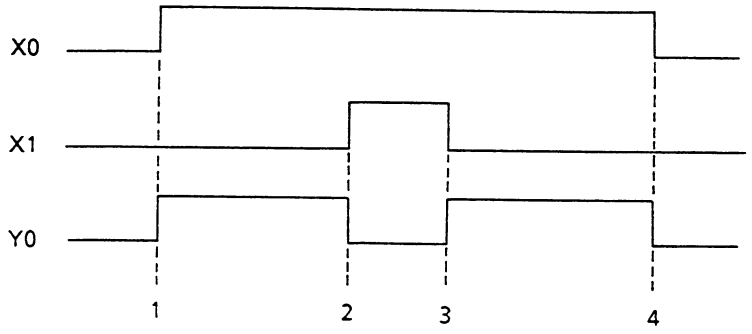


④ To enter screen into PC memory



Timing chart

When X0 turns on, Y0 is turned on [1]. When X1 turns on, Y0 is turned off [2]. When X1 returns to off, Y0 is turned on [3] and remains on until X0 turns off [4].



Connection

Symbol

- •• Blank
- – Horizontal connection
- | Vertical connection
- ⌋ Horizontal and vertical connection

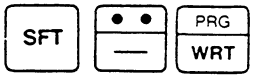
Function

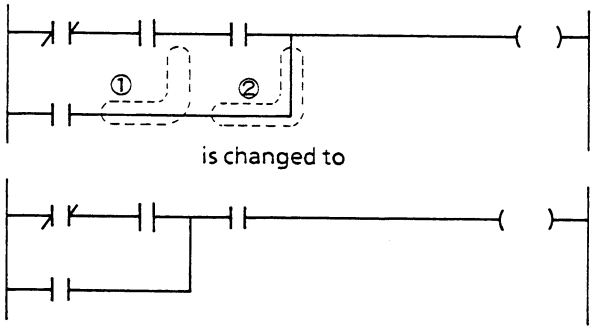
These connections are used to make or break connections between contacts. The vertical connection is used for parallel connections – that is, it is used in combination with another element to connect the element to the previous line. Blank and horizontal connection is typically used for editing.

Key sequence example

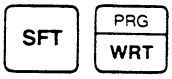
① Horizontal and vertical connection

② Blank





③ To enter screen into PC memory



NOTE Parallel connections cannot be performed from one screen to another screen.

Transitional contact (leading edge)

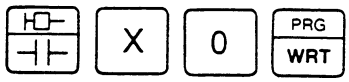
Device R

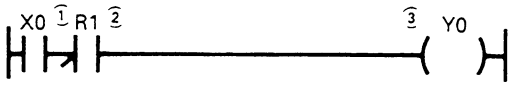
Symbol ⊣↑⊢ (key symbol: ⊣ ↑ ⊢)

Function Power flows through the transitional contact for one scan duration when the state of the left link is changed from OFF to ON.

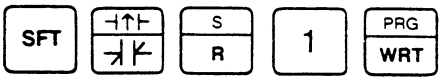
Key sequence example

① NO Contact X0



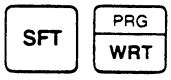


② Transitional Contact R1



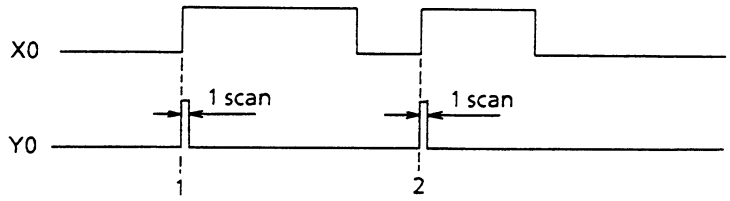
③ Coil Y0

④ To enter screen into PC memory



Timing chart

Transitional contact closes for one scan duration at the leading edge of X0 ([1] and [2]). Coil Y0 turns on when the transitional contact is closed.



NOTE The associated device of a transitional contact (in above example, R1) is used to store the state of the previous scan. Therefore, the device should not be used for other purposes in the program.

Timer

Device: T000 – T067 ... 0.1 sec timer
T070 – T077 ... 0.01 sec timer

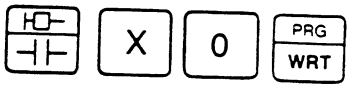
Symbol —(T)—|

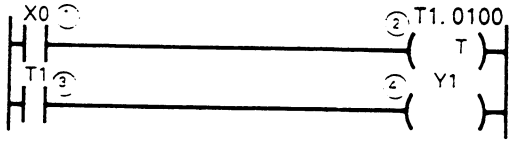
Function This timer works as an on-delay timer. When the state of the left link turns on, the timer begins counting down from its preset time. The timer device is turned on when the current value of the timer reaches zero.
Preset time is 0.1 to 999.9 seconds when a device from T000 to T067 is used and 0.01 to 99.99 seconds for T070 to T077.

Example of timer

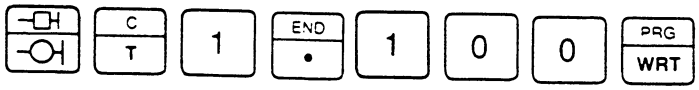
NOTE The preset time is entered digitally and is separated from the timer device by the separator [·].

① NO Contact X0

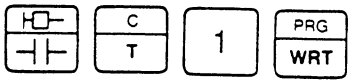




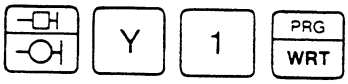
② Timer T1 with
preset value 100 (10.0 seconds preset time)



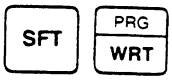
③ NO Contact T1



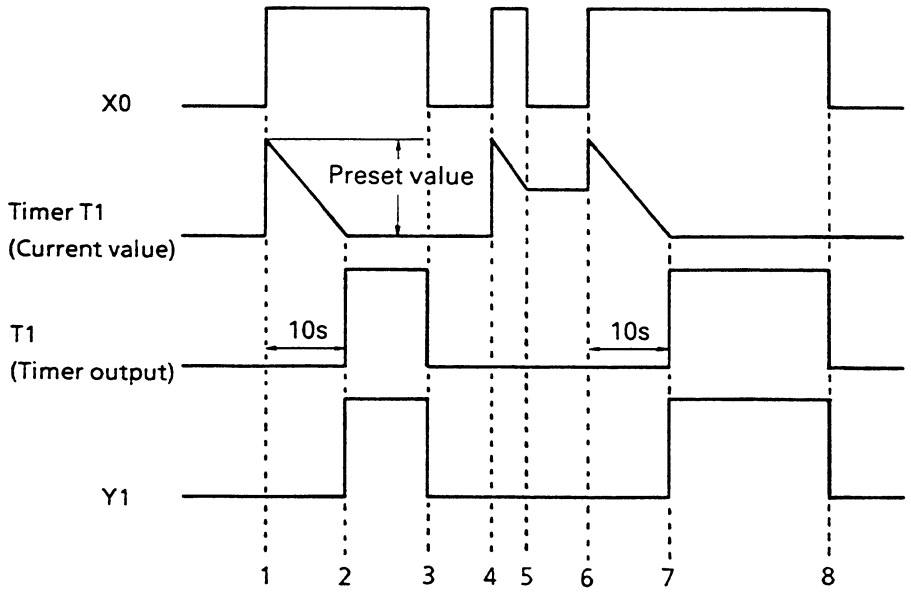
④ Coil Y1



⑤ To enter screen into PC memory



Timing chart



When Contact X0 turns on, Timer T1 passes power and the preset value begins to count down [1]. After 10 seconds, Contact T1 (timer output) is turned on to energize Coil Y1 [2]. When Contact X0 turns off, Contact T1 is turned off to de-energize Coil Y1 [3]. When Contact X0 turns on again, Timer T1 passes power [4], but counting down of T1 is soon stopped by the off signal from X0 [5]. This timer value is held until Contact X0 turns on again [6]. As Contact X0 turns on [6] and off [8], as before at [1] and [3], Contact T1 (timer output) is turned on to energize Coil Y1 [7] and turned off to de-energize Coil Y1 [8] as with [2] and [3].

NOTE When analog input is used, timer devices T040 to T067 are reserved for analog operation. (See Part Ⅳ)

Counter

Device

C000 – C075 ... Up-counter
C076, C077 ... Up/down-counter

Symbol

Counter input -(C)-
Reset input -(RC)-

Function

(1) Up-counter

When a device from C000 to C075 is used, the counter works as an up-counter. While reset input is on, the counter counts pulses at the counter input.
When the count is equal to the preset value, the counter stops counting, and sets the device on. When the reset input turns off, the count is reset to zero and the device is turned off. The preset value range is 1 to 9999.

(2) Up/down-counter

When C076 and/or C077 is used as a counter device, the counter works as an up/down-counter. Selection of either up or down counting is made by the special relay (R162) shown below.

The state of R162 must be fixed at one scan or more before the counter input turns on.

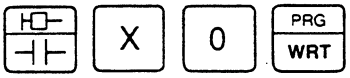
Counting digits can be selected, either 4(1-9999) or 8(1-99999999) by the special relay (R161).
When up-counter mode is selected, the count is reset to zero when the reset input turns off, and the counter device is turned on when the count becomes equal to the preset value.
When down-counter mode is selected, the count is reset to the preset value if the reset input turns off, and the counter device is turned on if the count becomes zero.

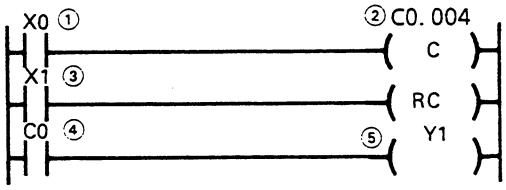
Special relay	Function	ON	OFF
R161	Counting digits selection	8	4
R162	Up/down selection	Down	Up

NOTE When high-speed counter mode is selected, counter devices C40 to C77 are reserved for the high speed counter. (See Part Ⅲ)

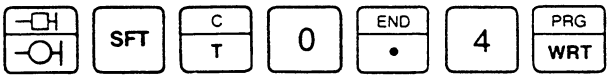
Example of up-counter

① NO Contact X0 for count input

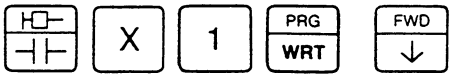




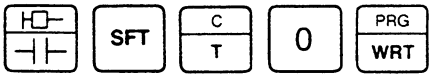
② Counter C0 with a preset value of 4



③ Contact X1 for reset input

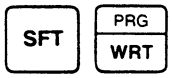


④ Contact C0

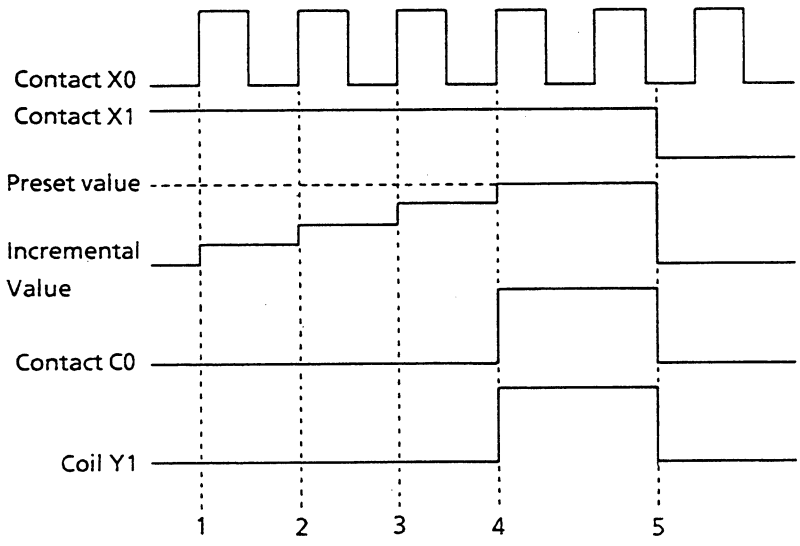


⑤ Coil Y1

⑥ To enter screen into PC memory



Timing chart

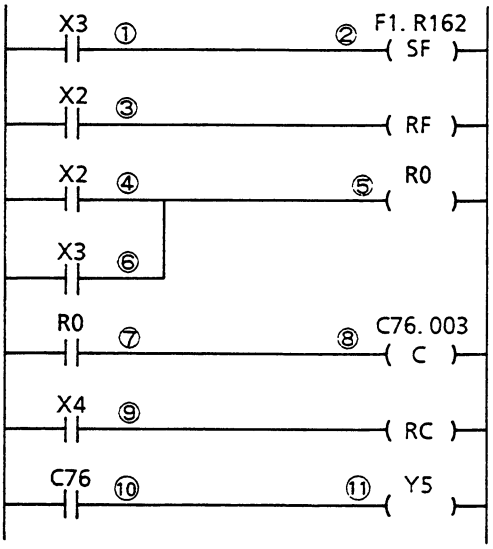


When Contact X0 turns on at Reset Contact X1's on-signal, Counter C0 is activated to count one time [1]. Counter C0 counts two [2] and three [3] by X0 [2] and [3] until Counter C0 reaches the preset value of four [4]. Then Counter C0 turns on and Contact C0 turns on to activate Coil Y1 [4]. Counter C0 and Coil Y1 are reset when Contact X1 turns off [5].

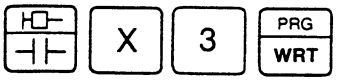
Example of up/down-counter

(1) 4-digit up/down-counter

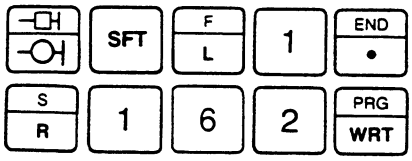
The 4-digit up/down-counter is programmed by either C76 or C77. In this example, up/down selection (R162) is controlled by a flip-flop explained later in this section.



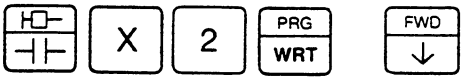
① NO Contact X3 for down-count selection



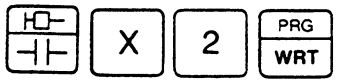
② Flip-flop R162



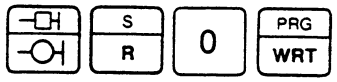
③ NO Contact X2 for up-count selection and move cursor down.



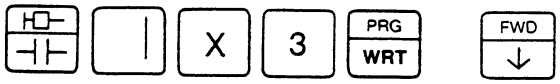
④ NO Contact X2



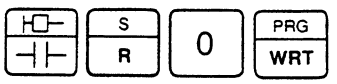
⑤ Coil R0



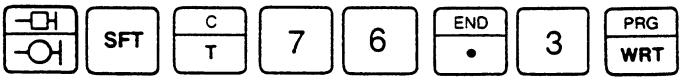
⑥ NO Contact X3 with vertical connection and move cursor down.



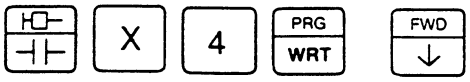
⑦ NO Contact R0 for counter input



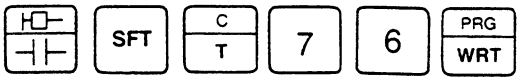
⑧ Up/down-counter C76 with a preset value three



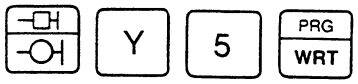
⑨ NO Contact X4 for reset input and move cursor down.



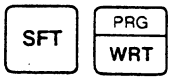
⑩ NO Contact C76



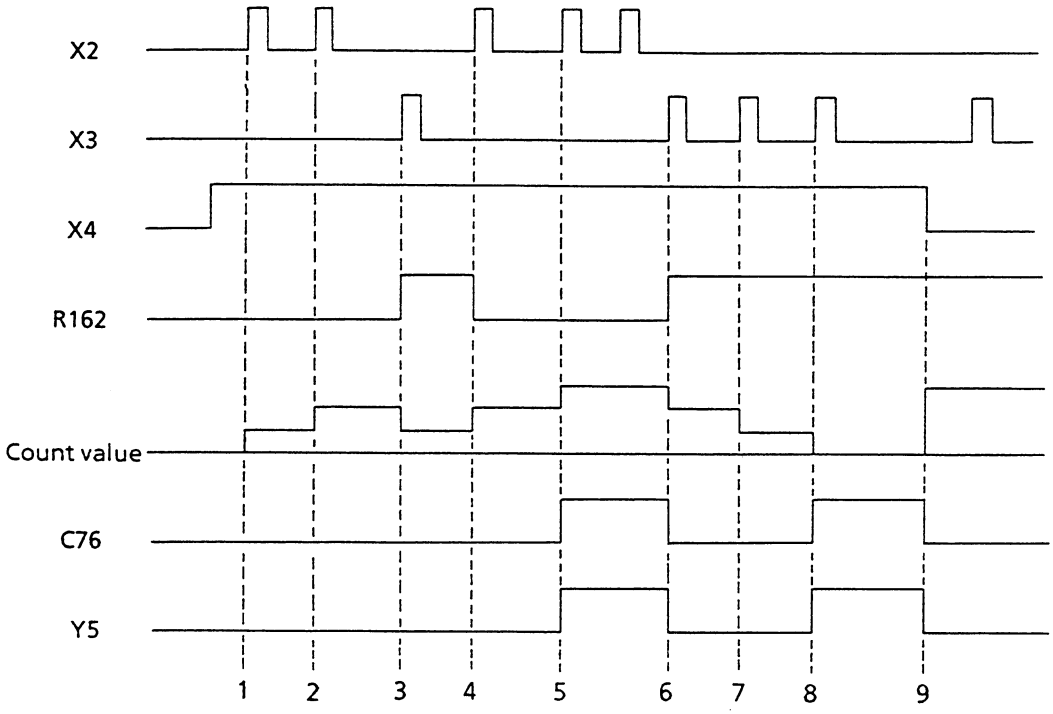
⑪ Coil Y5



⑫ To enter screen into PC memory



Timing chart



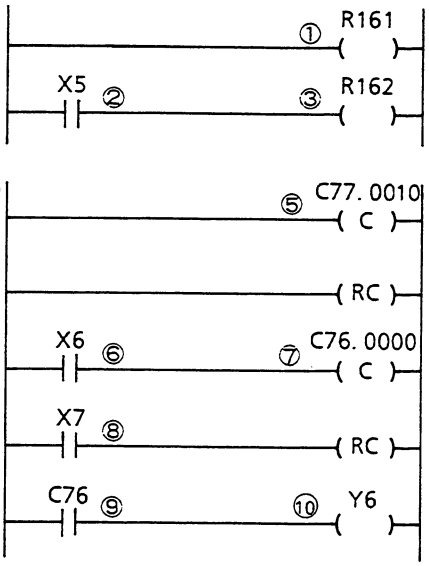
When up-count input X2 turns on while the reset input X4 is on, the up/down-counter C76 increments its value [1] and [2]. When down-count input X3 turns on, up/down special relay R162 is set to on, and the up/down counter C76 decrements its value [3]. When up-count input X2 turns on again, R162 is reset to off, and the up/down-counter increments its value [4]. When the count reaches the preset value three, the counter device C76 are turned on, and coil Y5 is activated [5] until the down-count input X3 is turned on [6]. The up/down-counter C76 decrements its value each time the down-count input X3 turns on [7] and [8]. When the count reaches zero, the counter device C76 is turned on

and coil Y5 is activated [8]. When the reset input X4 turns off, the counter device C76 is turned off, and count is reset to the preset value three because R162 is on [9].

(2) 8-digit up/down-counter

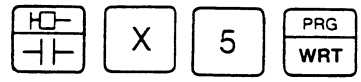
The 8-digit up/down-counter is programmed in combination with C76 and C77. C77 is used for the upper 4 digits of the preset value. C76 is used for the lower 4 digits of the preset value. When the count reaches the preset value, only C76 is turned on.

In this example, selection of up or down is made by X5. X6 is a count input. And X7 is a reset input.

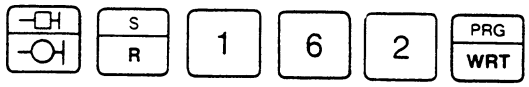


① Coil R161 (Always on)

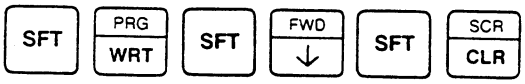
② NO Contact X5



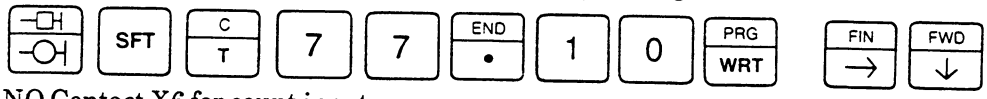
③ Coil R162



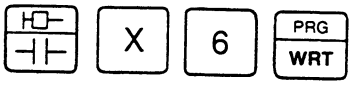
④ To enter screen, display next screen



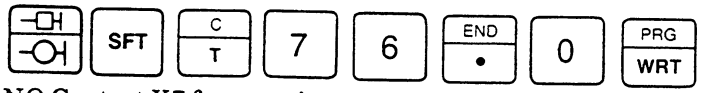
⑤ Up/down-counter C77 with a preset value 10 (upper 4-digits)



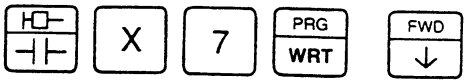
⑥ NO Contact X6 for count input



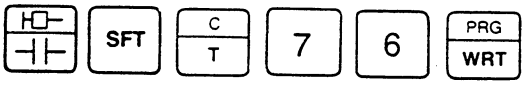
⑦ Up/down-counter C76 with a preset value 0 (lower 4 digits)



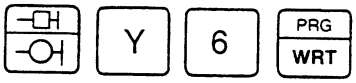
⑧ NO Contact X7 for reset input



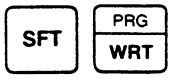
⑨ NO Contact C76



⑩ Coil Y6

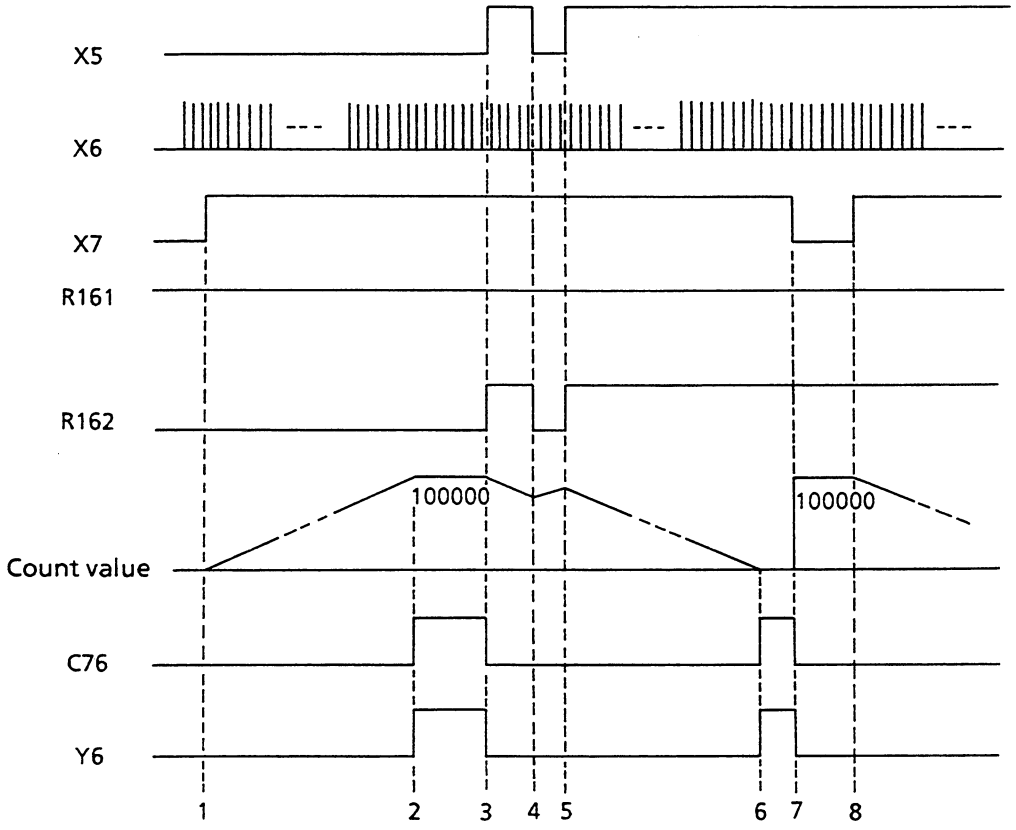


⑪ To enter second screen into PC memory



In this example, the preset value is set at 100000, because the upper 4 digits (C77) are 0010 and the lower 4 digits (C76) are 0000.

Timing chart



When reset input X7 turns on, the 8-digit up/down-counter C77, C76 begins counting up because up/down selector R162 is off [1]. C76 and Y6 is turned on when the count reaches the preset value (100000) [2]. When the up/down selector R162 is changed to on [3], the counter begins counting down from preset value. The counter changes direction, up or down, according to the state of R162, [4] and [5]. When the count value reaches zero in down-counter mode, C76 and Y6 are turned on [6]. When the reset input X7 turns off in down-counter mode, the count is reset to the preset value (100000) [7]. When the reset input X7 returns to on, the counter begins counting again [8].

Master control coil

Symbol —(S)— Master control set

—(R)— Master control reset

Function

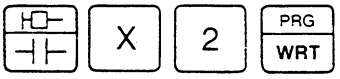
Master Control is similar to a hard-wired master control relay, making it possible to activate or deactivate all logical elements within a specified section of the ladder diagram program

CAUTION A hard-wired master control relay should also be provided as a back up to make it possible to shut down the controlled system for an emergency or other reasons. This hard-wired control relay halts operation of the controlled system by removing all power to I/O points, but has no direct effect on PC operation.

You specify the section to be affected by the Master Control function with Master Control Set Coil (MS) and Master Control Reset Coil (MR). Between these two devices is the portion of the ladder diagram program that is to be controlled. When the MS coil is powered, the subsequent screens to the MR coil are activated. When the MS coil is off, the subsequent screens are deactivated. MS and MR coils must be written on the last line of logic on the screen immediately preceding the Master-controlled portion of the program.

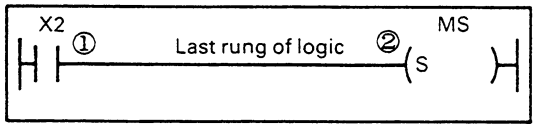
Example of Master Control function

①



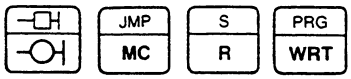
②

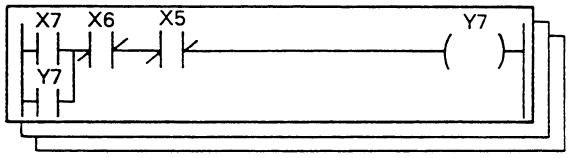
MS:
Master Control Set coil



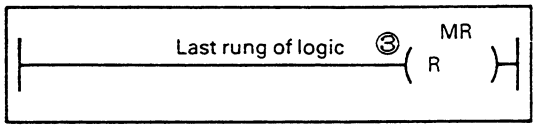
Screen(s) under
Master Control

③





MR:
Master Control Reset coil



MS and MR coils should be placed on the last rung of the screen. For the MR coil, no contact is required.

Jump coil

Symbol

-(S)-	Jump set
-(R)-	Jump reset

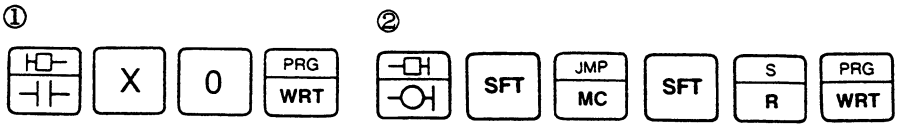
Function

Jump Coil is similar to Master Control, with several exceptions. When the Jump Coil is energized, all subsequent screens are skipped until the screen containing Jump Coil Reset is reached. All device elements on these screens are ignored and do not affect the operation of the controlled system. However, they retain their status while the Jump Coil is energized. For instance, if a timer was on, it continues to time, or if a counter was counting up, it retains its count and continues from that value when the Jump Coil is de-energized. When the coil is receiving no power, all program device elements operate as normal.

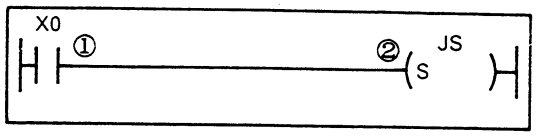
When programming the Jump Coil function, first key-in the contacts of its controlling devices. These should be on the last line of the screen. Then enter a coil, followed by the Jump Coil [SFT] [JMP/MC] key, and then [SFT] [S/R] to set. After checking for correctness, write the completed element to the ladder diagram by pressing [PRG/WRT]. Subsequent screens are the controlled screens.

The reset coil of the Jump Coil indicates the stopping point of the Jump Coil-controlled screens. The Jump Coil Reset (JR) coil is placed on the last line of the screen immediately following the controlled screens. This reset is programmed by first keying in a coil, followed by [SFT] [JMP/MC] keys, then [S/R] to reset. After checking for accuracy, write the completed element into the ladder diagram by pressing [PRG/WRT].

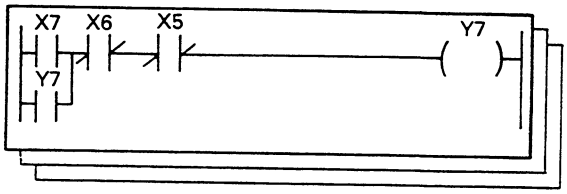
Example of Jump Coil function

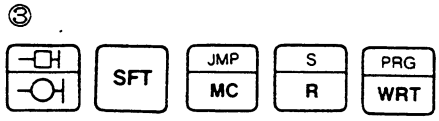


Jump Coil set screen

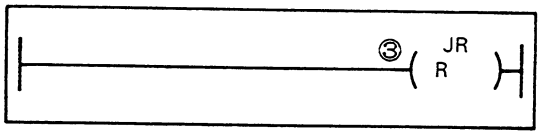


Screen(s) under
Jump Coil control





Jump Coil Reset screen



Flip-flop (F1)

Device Y, R, L

Symbol

Set input	-(SF)-
Reset input	-(RF)-

Function

A flip-flop is a bistable device with set and reset inputs. It remains set until its reset coil is powered; it then remains reset until its set coil is powered.

NOTE

If you attempt to program a flip-flop with insufficient space remaining on a screen, error message "ERR. 06 OV LINE" is displayed. If this happens, program the flip-flop on the next screen.

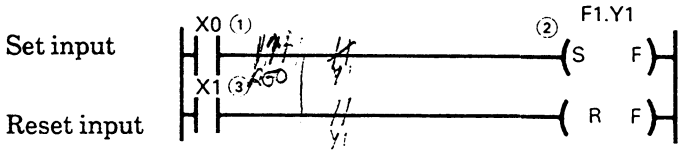
When a specified device is designated as the output of a flip-flop, it is either on or off depending on the status of the set and reset inputs. This is shown in the following table.

Set input	Reset input	Output status
OFF	OFF	Unchanged
OFF	ON	Reset
ON	OFF	Set
ON	ON	Reset

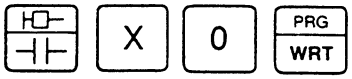
Set (output ON)
Reset (output OFF)

R and Y flip-flops are reset when power to the PC is interrupted or if the HALT/RUN switch on the PC is set to the HALT position. L flip-flops retain their status with power off.

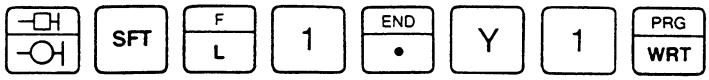
Example of flip-flop



① X0 is the set input for the flip-flop.

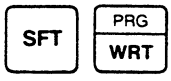


② The flip-flop of Y1.

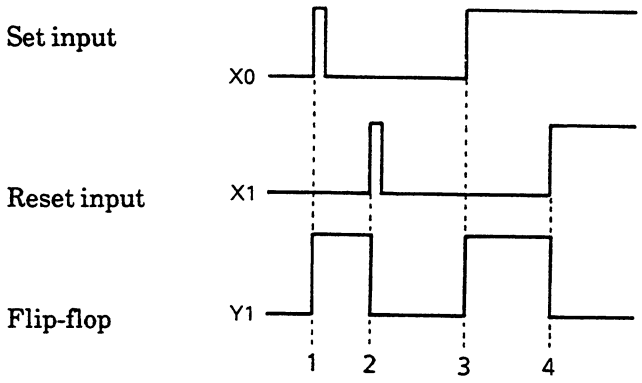


③ The second line of the program is Reset Input X1.

④ To enter screen into PC memory



Timing chart



When Contact X0 turns on, Flip-flop Y1 is turned on [1]. When Contact X1 turns on, Flip-flop Y1 is turned off [2]. When X0 turns on again, Y1 is turned on [3]. Y1 is turned off when X1 turns on [4].

NOTE

When the set coil (SF) of the flip-flop is written, its reset coil (RF) is automatically written.
A flip-flop coil normally functions when a Master Control Coil is energized. The flip-flop coil does not function when the Master Control Coil is de-energized and the status of the output remains unchanged.

Shift-register (F2)

Device

S000 – S277 ... One-direction shift register
S300 – S377 ... Bidirection shift register

Symbol

Data input —(SR)—
Shift input —(S)—
Reset input —(R)—

Function

(1) One direction shift register
When a device from S000 to S277 is specified as a shift register, it works as a one-direction shift register.
When reset input is on, all device states in a shift register are shifted to the next device each time shift input turns on. And the state of the data input is entered into the top device of the shift register. When reset input turns off, all devices in the shift register are reset to off.
A shift register is specified by the beginning device (B) and the end device (E).

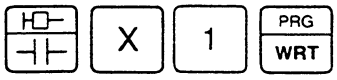
The range B – E of specified devices become a shift register. For instance, if B = S000 and E = S027, then S000 – S007,S010-S017and S020-S027 constitute a 24-bit shift register.
The device address B must be specified as S □ 0; device address E must be specified as S □ 7.

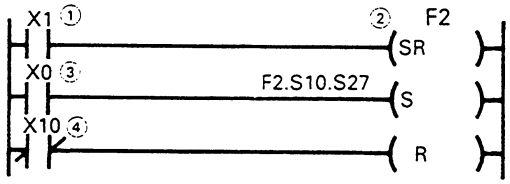
(2) Bidirection shift register
When a device from S300 to S377 is specified as a shift register, it works as a bidirection shift register.
The basic operation and specification are the same as the one-direction shift register. Shift direction is controlled by the special relay (R164) shown below.
When the reverse direction is selected, the state of the data input is entered into the last device of the shift register.

State of R164	Shift direction
OFF	Forward (0→7)
ON	Reverse (7→0)

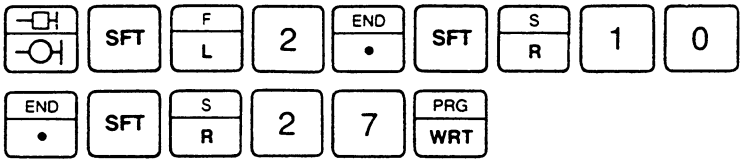
Example of one-direction shift register

① NO Contact X1 for data input

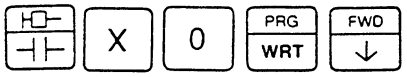




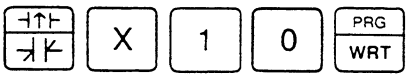
② Shift register S10 to S27
– SR, S, and R coils are automatically written.



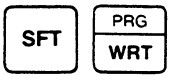
③ NO Contact X0 for shift input



④ NC Contact X10 for reset input

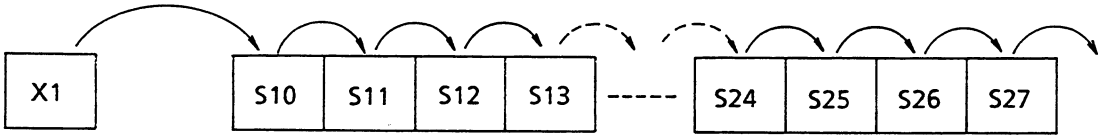


⑤ To enter screen program into PC memory



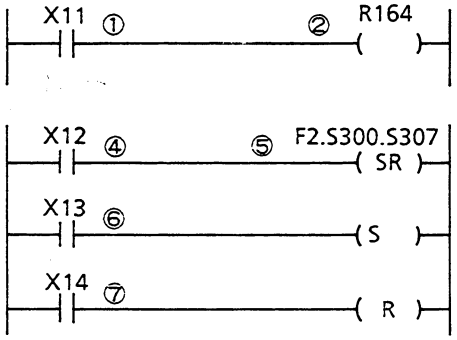
Operation

When X10 is off (NC Contact is closed), all shift register device states – S10 to S27 – are shifted to the next device each time shift input X0 turns on. At the same time, the state of data input X1 is entered into the S10 (top device of the shift register).

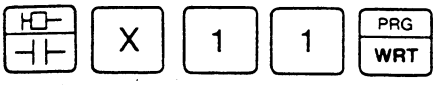


When X10 turns on, all shift register devices – S10 to S27 – are reset to off.

Example of bidirection shift register

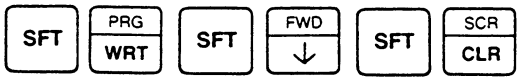


① NO Contact X11 for selection of forward or reverse

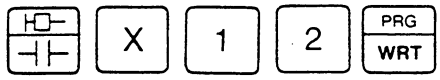


② Coil R164

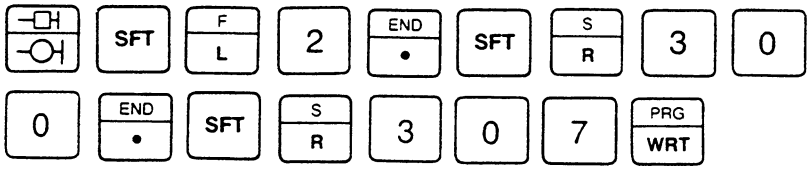
③ Enter screen into PC memory and display next screen



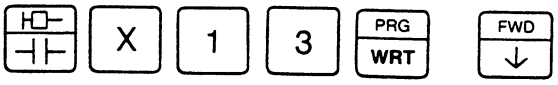
④ NO Contact X12 for data input



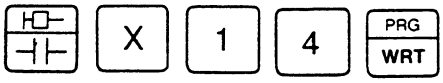
⑤ Shift register S300 to S307



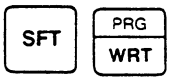
⑥ NO Contact X13 for shift input



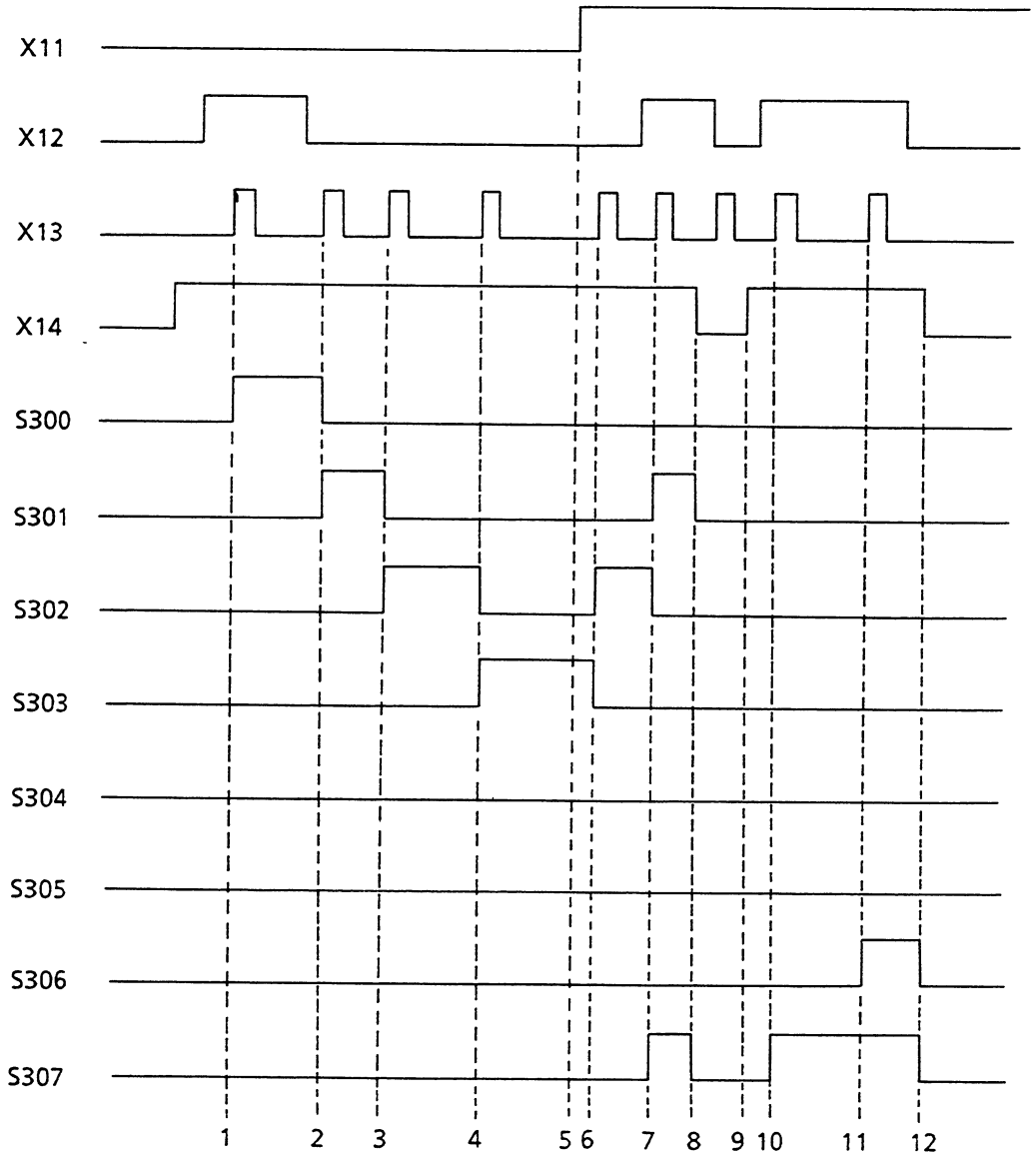
⑦ NO Contact X14 for reset input



⑧ To enter second screen into PC memory



Timing chart



When shift input X13 turns on, the state of data input X12 is copied to the top device of shift register S300 [1]. Every time the shift input X13 turns on, all shift register device states are shifted forward [2], [3], and [4]. When X11 turns on [5], the shift direction is reversed [6], and [7]. When the data input X12 is on at the rising edge of X13, the state of X12 is copied to the last device of the shift register S307 [7]. When the reset input X14 turns off, all devices of the shift register are reset to off [8]. When X14 returns on [9], it begins the shift operation again [10] and [11].

Step sequencer

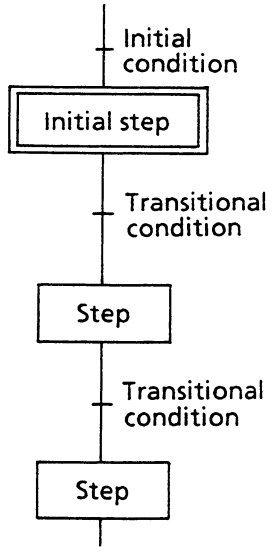
Device R, L

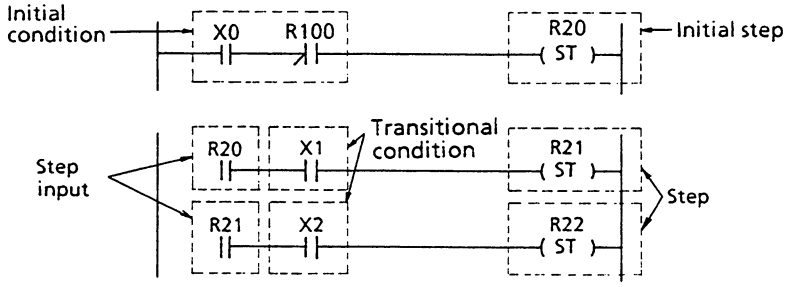
Symbol

⊢	Step input	(key symbol:	⊢□⊣)
⊣(ST)⊢	Step output	(key symbol:	⊣□⊢)

Function

The step sequencer performs sequential control. The state of each step is shifted to the next step as each transitional condition is fulfilled. The step sequencer program consists of four parts; initial step, step input, step output, and transitional condition. When the initial step is activated, the subsequent 15 devices are assigned for each step and reset to off. For instance, if the device of initial step is R0, subsequent 15 devices R1 to R17 are assigned for each step.



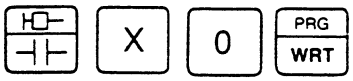


NOTE

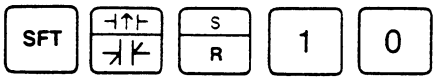
1) The initial step program must be on a separate screen at the beginning of the step sequencer program.
2) The initial step device must have the address, of which first digit is 0. Such as R□ 0, L□ 0.
3) The devices specified for step sequencer cannot be used for any other output function.

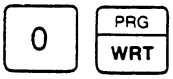
Example of step sequencer

① NO Contact X0

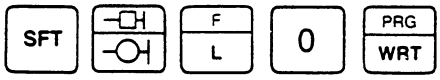


② Transitional Contact R100

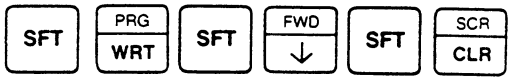




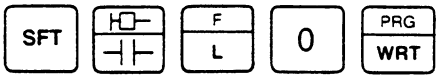
③ Initial step L0
(L0 to L17 are assigned for a step sequencer)



④ Enter 1st screen program and move to next screen.

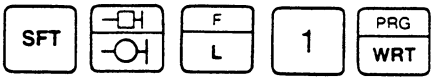


⑤ Step input L0

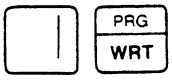


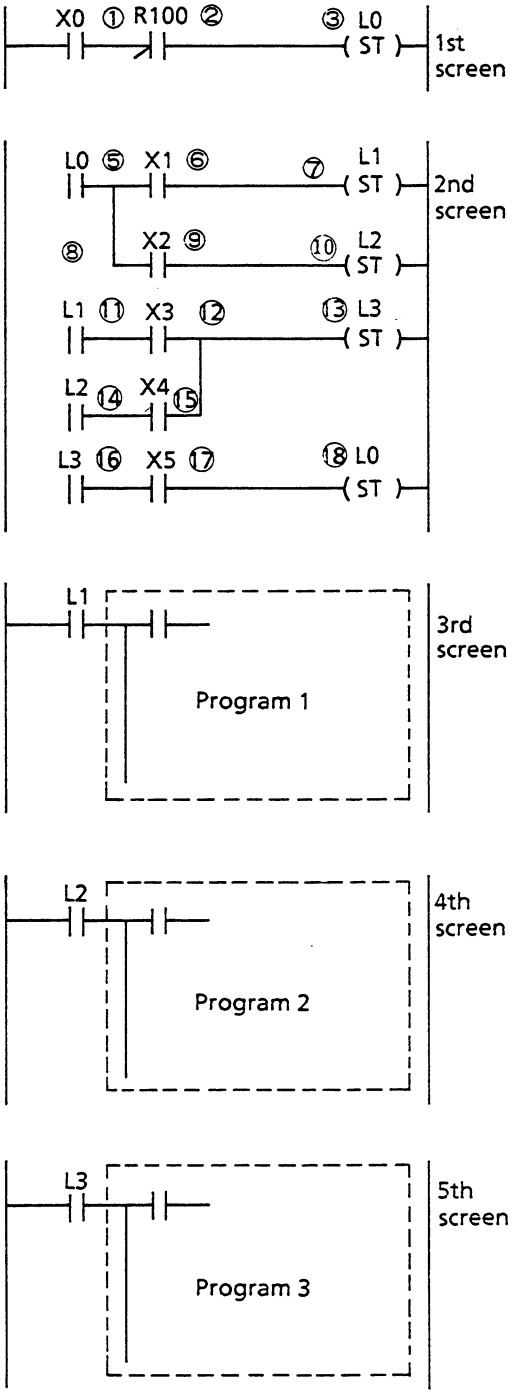
⑥ NO Contact X1 for transitional condition

⑦ Step output L1

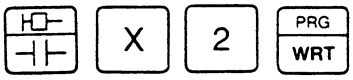


⑧ Vertical connection

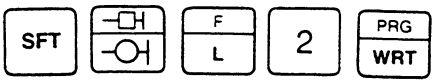




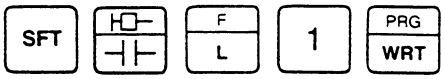
⑨ NO Contact X2 for transitional condition



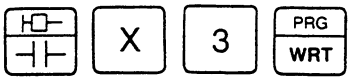
⑩ Step output L2



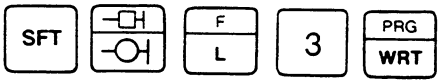
⑪ Step input L1



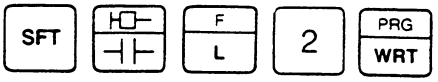
⑫ NO Contact X3 for transitional condition



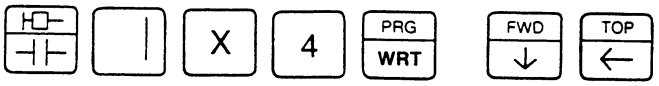
⑬ Step output L3



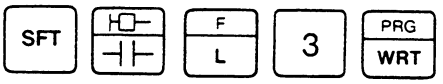
⑭ Step input L2



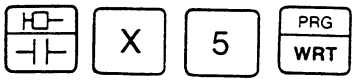
⑮ NO Contact X4 with OR connection



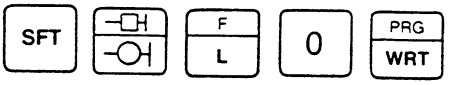
⑯ Step input L3



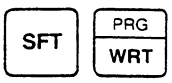
⑰ NO Contact X5 for transitional condition



⑱ Step output L0

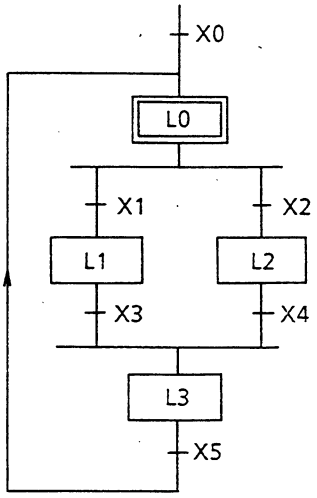


⑲ Enter 2nd screen program into PC memory



Operation

When X0 turns on, all devices of the step sequencer (L1 to L17) are reset to off and initial step L0 is turned on. Then, when either X1 or X2 turns on, Step L1 or L2 is turned on and the previous step L0 is turned off. If L1 is selected (X1 turned on), program 1 is activated. And if L2 is selected, (X2 turned on), program 2 is activated.
Then, when X3 or X4 turns on, the next step L3 is activated and the previous active step L1 or L2 is turned off and program 3 is activated.
When X5 turns on, the initial step L0 is turned on and one cycle is finished.



HINT

1) In this example, only four devices are used for the step sequencer. But when X0 turns on, the subsequent 15 devices of L0, L1 to L17, are reset to off. So if you use L4 to L17 in a program,please note.

2) A transitional contact should be used for the initial condition or the step sequencer will be initialized at every scan while the initial condition is on (In this case X0).

NOTE

1) Two or more steps should not be activated at the same time. (L1, L2 for example)
2) Step input with vertical connection is not possible.

Critical high-speed counter update

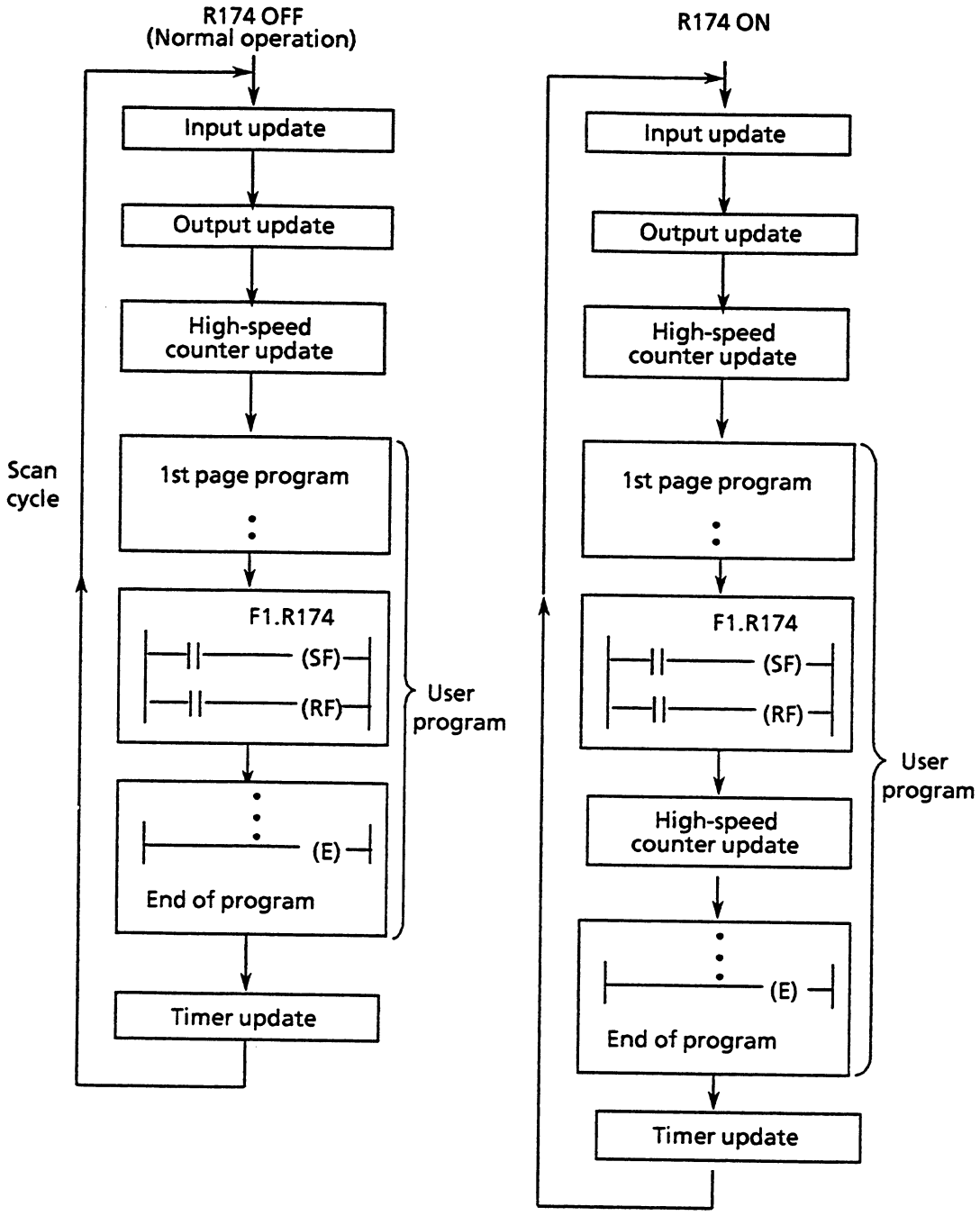
Device R174

Symbol

Set input -(SF)-
Reset input -(RF)-

Function

The high-speed counter update function is used to input the most recent high-speed counter value. When special relay R174 is set to on by this instruction, the high-speed counter value is saved to the associated register as shown next page.
Programming this function is the same as the flip-flop. And also, the state of R174 is controlled in the same way as flip-flop.



NOTE Using this function is explained with the high-speed counter function in Part III

Critical input update

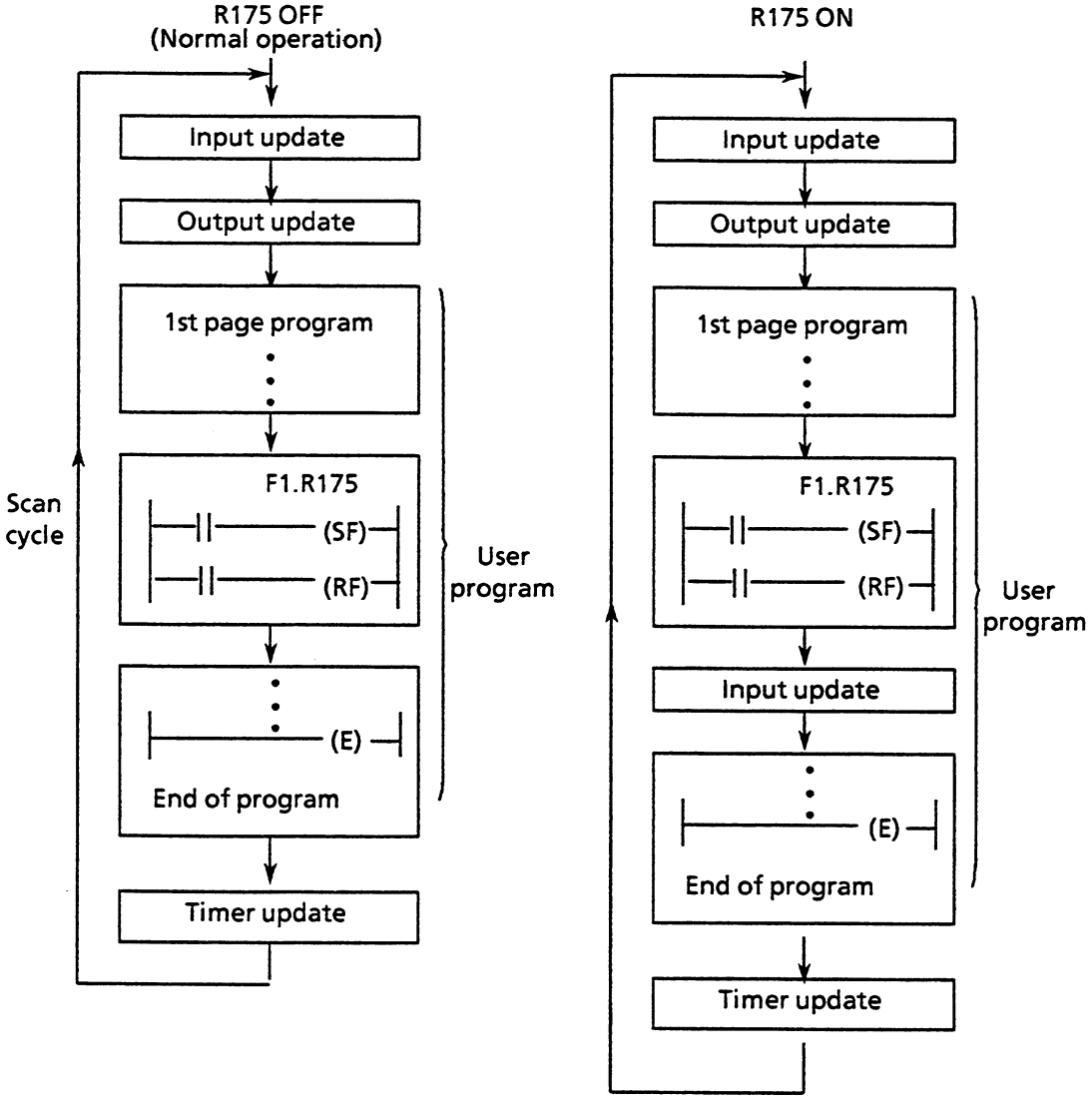
Device R175

Symbol

Set input —(SF)—
Reset input —(RF)—

Function

The input update function is used to input the most recent input signals. When special relay R175 is set to on by this instruction, all input signals are updated. That is, all X devices are updated at the same time as shown below.
Programming this function is the same as the flip-flop. The state of R175 is controlled in the same way as the flip-flop.
It is possible to use this function more than once within a program. But use of this function will increase over all scan time.



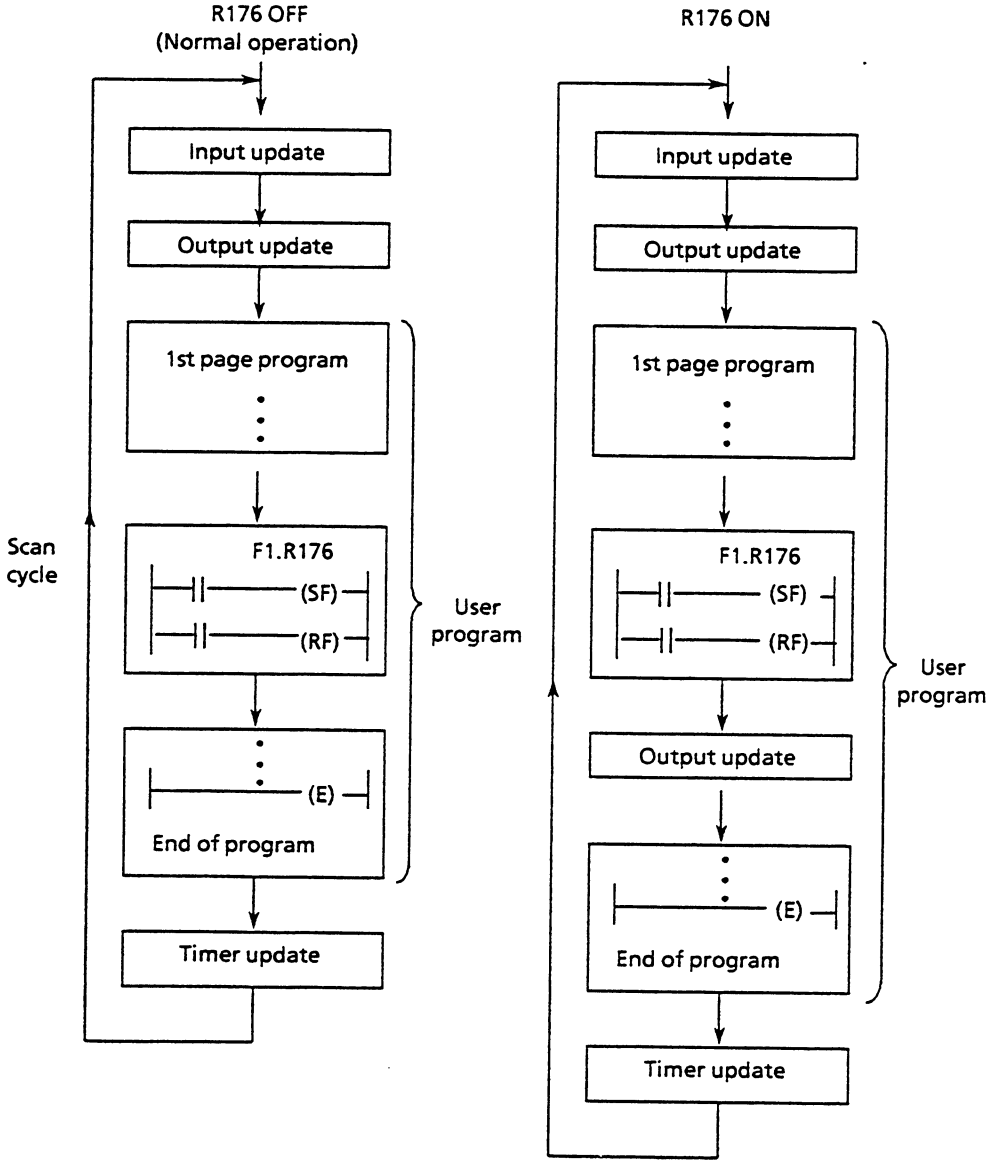
Critical output update

Device R176

Symbol
Set input —(SF)—
Reset input —(RF)—

Function

The output update function is used to drive the output devices immediately according to the most recent states of Y devices.
When special relay R176 is set to on by this instruction, all states of Y devices are output to output devices immediately as shown below.
Programming this function is the same as the flip-flop. And also, the state of R176 is controlled in the same way as the flip-flop.
It is possible to use this function more than once within a program. But use of this function will increase over all scan time.



Force all outputs off

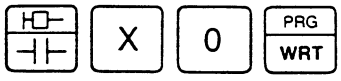
Device R177

Symbol Set input -(SF)-
Reset input -(RF)-

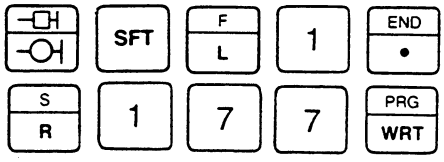
Function The output turn off function is used to stop the output update and sets to off all output devices without stopping program execution.
When special relay R177 is set to on by this instruction, all outputs are turned off. When R177 is reset to off, all outputs are returned to be controlled by user program. Programming this function is the same as the flip-flop. And also, the state of R177 is controlled in the same way as the flip-flop.

Example of output shut off

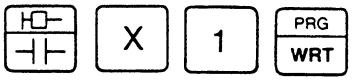
① NO Contact X0 for set input



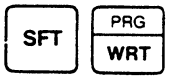
② Output turn off instruction

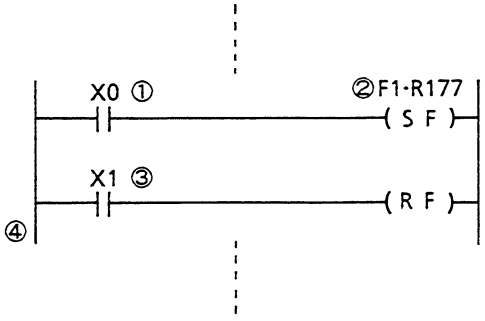


③ NO Contact for reset input

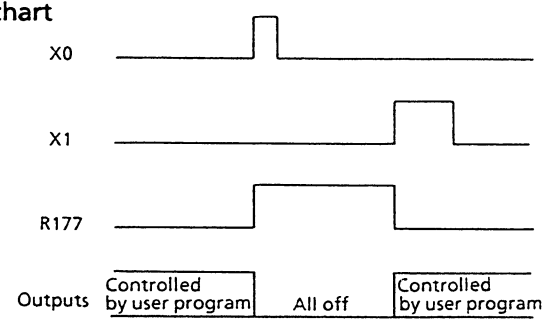


④ Enter screen program into PC memory





Timing chart

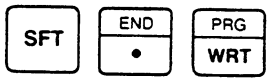


When X0 turns on, R177 is set to on and all outputs are turned off.
When X1 turns on, R177 is reset to off and all outputs are returned to normal operation.

END

Symbol -(E)-

Function END indicates the end of program. No program logic is permitted after the END instruction.

Key sequence 

When the PC memory is cleared by command 3, the END instruction is automatically written on all screens. So, normally, there is no need to write the END instruction.

SECTION 6

Editing the Program

You can freely edit your program while you write it as well as later when you want to make adjustments to how the controlled system operates. This section teaches you how to search, add, delete, and replace individual devices and screens. First you will learn how to quickly locate devices to edit. The rest of the section describes how editing is done.

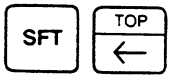
Locating devices

You have already learned how to use the cursor control keys to place the cursor on a desired device. There's another, usually quicker way to do this, especially if the device is not on the screen currently being displayed. The LCD Programmer's search function can be used to locate a device or repeated occurrences of the device anywhere it exists in a program.

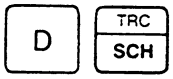
Normally you want to begin the search at the top of the first screen of the program. When you start the search, each subsequent screen is checked for the device you are hunting. When the device is located, its screen appears with the cursor marking the location of the device.

When you are searching for a device, you can leave the RUN/HALT switch on the PC in either RUN or HALT position.

Normally start the search procedure with this key sequence.



Then press these keys to search for the desired device.



"D" stands for a device, which may be an external input, external output, internal relay, latched relay, shift register, timer, or counter.

When you want to search for multiple occurrences of the same device throughout the program, repeatedly press the search [TRC/SCH] key.

Searching for a contact

Enter the address of the device that has the contact you want to locate (for example, X12). Then press the search [TRC/SCH] key. The address appears in the message line on the display. The screen simultaneously changes to the first screen containing the desired contact. The cursor will appear under the contact.

To search for the first contact of X12, press these keys.

Searching for a coil

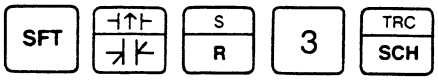
Enter the coil with its address and then press the search key.

To search for the coil of output Y2, press these keys.

Searching for a transitional contact

Enter the device with its address and then press the search key.

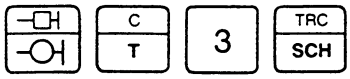
To search for transitional contact R3, press these keys.



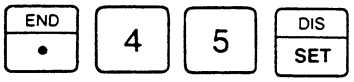
Searching for a timer/counter

Enter the device and its address, then press the search key. Two things happen: 1) The screen containing the timer or counter appears, with the cursor under the device; and 2) on the message line, the device symbol, address, and the preset time or count appear. At this time, you may change the preset value as shown below.

To search for timer T3, press these keys.



To change the present time to 4.5 seconds, do this key sequence.



Searching for a master control or jump coil

Both these instruction can be searched by either their set or reset coil. Key in first the coil symbol, then the function (either MC or JMP), and whether S (set) or R (reset) coil. Press the search key to make the screen appear that contains the desired instruction.

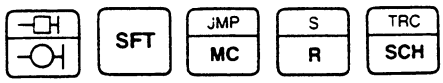
To search for the Master Control Set coil, press these keys.

One of the following messages appears on the message line:

-( )- MS ... When searching MC Set coil

-( )- MR ... When searching MC Reset coil

To search for the Jump Coil (reset), press these keys.



One of the following messages appears on the message line:

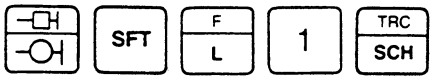
-( )- JS ... When searching JMP Set coil

-( )- JR ... When searching JMP Reset coil

Searching for a flip-flop (function F1)

Enter the coil symbol, then F1. Press the search [TRC/SCH] key to move the cursor to the first flip-flop. The message line displays its address (either R or L and an octal number). Repeatedly press [TRC/CH] to move to each successive flip-flop.

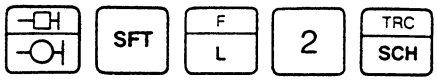
To search for a desired flip-flop, press these keys.



Searching for a shift register (function F2)

Enter the coil symbol, then F2. Press the search [TRC/SCH] key to move the cursor to the first shift register. The message line displays the shift register's beginning and ending addresses. The shift register contacts can also be directly located by entering these addresses (S and an octal number) after the symbol.

To search for a desired shift register, press these keys.



Locating screens

As you may have realized, it is also possible to use the search function to locate a desired screen. While the screens are not themselves numbered, and thus cannot be specifically addressed, the devices they contain can be directly searched. Thus you can save a lot of time by jumping from device to device when you want to move through your program. Coils are particularly good for that purpose. When you are near the screen you want, use the reverse screen [SFT] [REV] or forward screen [SFT] [FWD] keys to move back or forward to the screen you want.

Two ways to edit

Broadly speaking, there are two ways you can edit a program – either by individual device or by entire screen. For both types of editing, remember that you can make changes to the ladder diagram display but in order for the changes to be recorded in the program you must:

Make sure the HALT/RUN switch of the PC is in the HALT position. Save the entire screen at one time by pressing the program write [SFT] [PRG/WRT] keys as the final step in the editing process.

Editing on a screen

Editing can be started in either Program or Monitor mode. Because the former mode is automatically selected the first time you write an editing change to the ladder diagram, it is not necessary to first place the LCD Programmer in Program mode.

Changing element

Locate the screen and device you wish to change. Place the cursor on the device and key in the new information (symbol, address, set time/count or other.) As you do, the information appears in the message line. Verify that the new or corrected device has been correctly entered, then write it to the ladder diagram by pressing [PRG/WRT].

To change the device, move the cursor to the device position, enter the new or corrected device, and press this key.

Adding an element

This procedure is similar to the one above, except that you place the cursor on an empty location on the desired rung, then enter the required information.

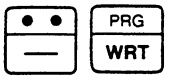
HINT

If the instruction requires more than one line, be sure the screen has enough room for the added line – that is, no instruction currently is written on the bottom line. If there is not enough room, write the new instruction onto a new screen and insert this screen behind the original screen.

Deleting horizontal connection element

Place the cursor on the device you want to delete. Then press the horizontal connector [⊣⊢] key. This procedure replaces the element to be deleted by the horizontal connection.

To delete an unwanted element, move the cursor to the element and press these keys.

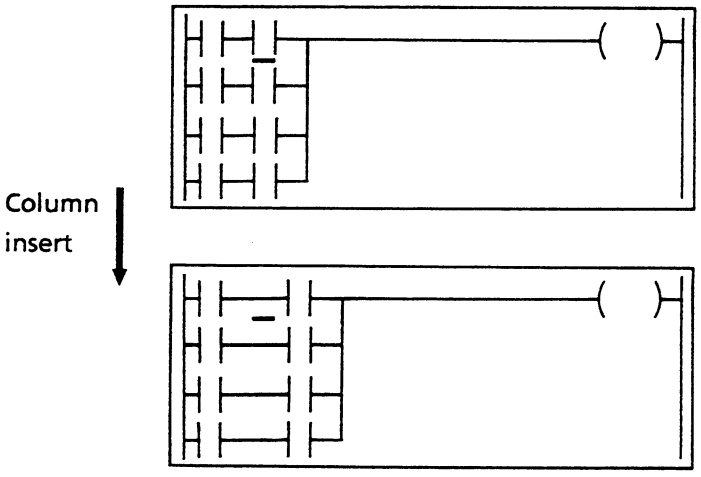


If the unwanted element should be replaced by the blank, move the cursor to the element and press these keys.

Inserting a column

When no space is vacant at the location where you want to place a device, you can make room by pushing all column devices over one column to the right. Horizontal lines are maintained and vertical connections remain unbroken. However, any devices that may exist in the ninth column (next to the coil area) are erased when the new column is inserted. Therefore, insert columns with care.

To insert a column, move the cursor to the location for the new column and press this key.

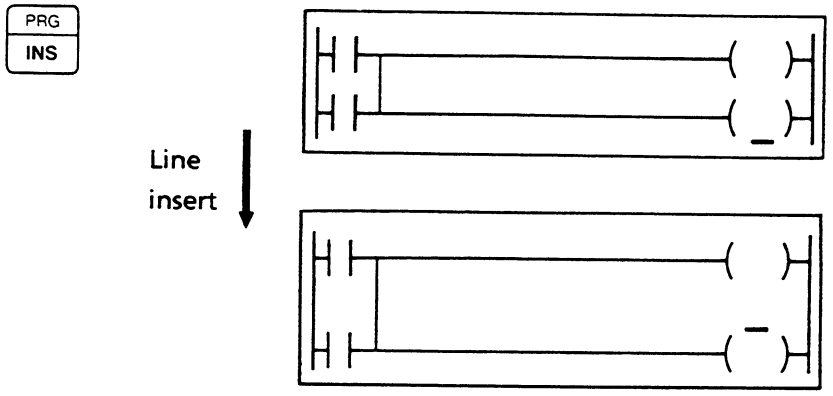


NOTE On inserting and deleting, the cursor position remains unchanged.

Inserting a line

You can also insert a vacant line between lines currently holding program devices. For this, the cursor must be placed on the coil position of the line. When you press the insert [PRG/INS] key, the existing lines move down by one. Vertical connections remain unbroken. However, if any devices exist on the bottom line of the screen, these devices are erased when the new line is inserted.

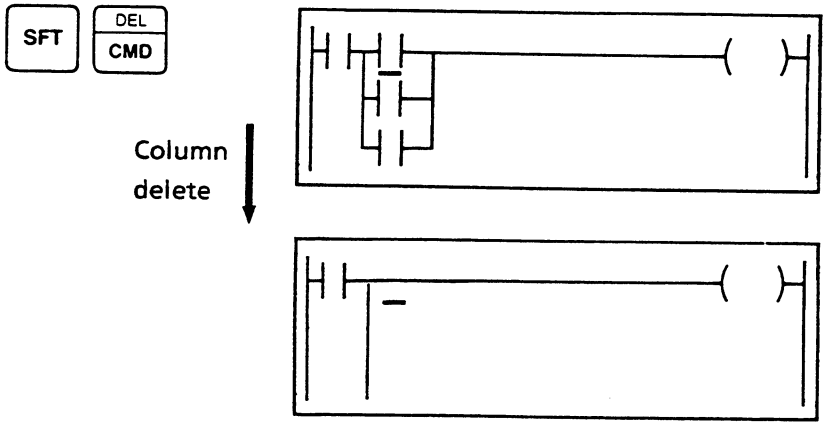
To insert a line, move the cursor to the coil of the desired line and press this key.



Deleting a column

Deleting a column has the opposite effect of inserting one. For this, the cursor may be placed on any line of the column you want to delete. When the delete [SFT] [DEL/CMD] key is pressed, the column is erased and all columns on the right move over one column to the left.

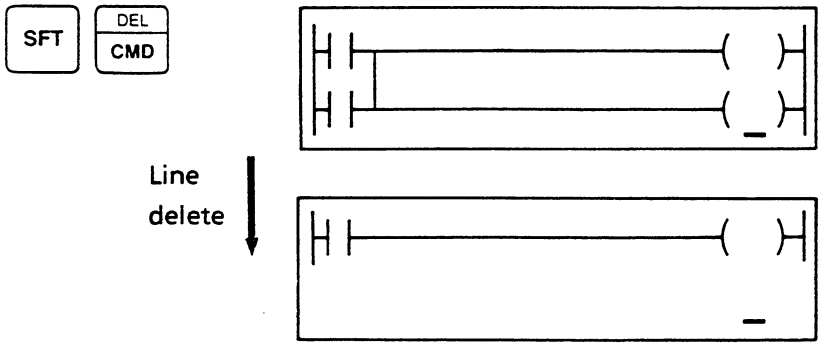
To delete a column, move the cursor to any line of the column and press these keys.



Deleting a line

Place the cursor on the coil symbol of the line you want to delete, then press the delete [SFT] [DEL/CMD] key. If you delete a line, you must also individually delete the vertical connections that remain.

To delete a line, move the cursor to the coil symbol on the line and press these keys.



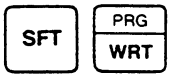
HINT

This deletion feature can be a big help during editing. You frequently may find it easier to remove an entire line at once (and add devices back, if needed) rather than delete several devices individually.

Saving the edited screen

When you have finished all editing on the currently displayed screen, the entire screen must be saved to the PC memory before beginning to write the next screen, pressing the monitor [MON] key, or performing any other operation.

To save the screen to memory, press these keys.



NOTE

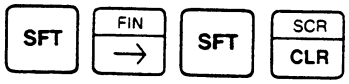
If you fail to save the edited screen before going to a different screen, all editing changes on that screen will be cancelled.

Editing by screen

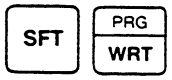
This is the second broad category of program editing mentioned earlier. It is done a screen at a time, rather than a device at a time. Following the procedures below, you can add, replace, insert, and delete entire screens.

Adding a screen

To add a screen, do this key sequence to display the final (FIN) screen of the program and clear it to provide a vacant display area for the next screen you want to write.



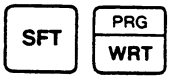
Then write the screen you wish to add and save it at the end of your program by pressing these keys.



Replacing a screen with a revised screen

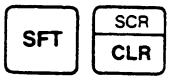
Display a screen in the program you wish to change and edit it according to the instructions on editing devices given earlier. Remember, the changes you make are not registered in the PC memory until you follow the next procedure.

Press these keys to replace the old screen with the new one.

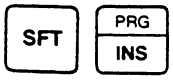


Inserting a new screen

Locate the existing screen that is to follow the inserted screen. Clear the existing screen display.



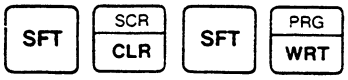
On the blank screen, write the new screen and then press these keys to insert the new screen before the existing screen.



Deleting an existing screen

Display the screen you want to delete. Then if you clear the screen and "save" the blank screen to memory, the original screen is erased. No blank screen, however, appears in its place when paging through the program.

To delete a screen, display the screen and press these keys.



SECTION 7

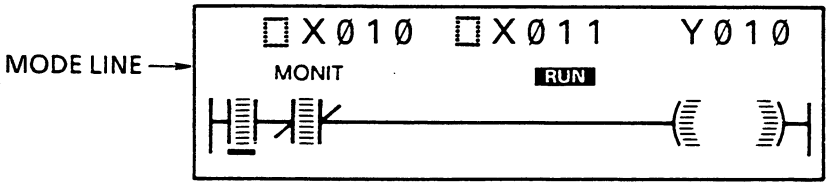
Monitoring

You can choose among four unique monitoring modes – screen, device, block, and trace. Each provides a "window" into the internal workings of the control program that gives you a quick and flexible way to view devices as they operate.

Screen monitoring

Program devices are called up and viewed for monitoring on the screen where they exist in the program. The opening and closing of contacts and the powering of coils are shown on the display as shaded individual devices. When a device is powered, it becomes shaded. When the device no longer is passing power, the shading disappears.

To monitor a device, display the screen on which the device is located. If the LCD Programmer is not already in Monitor mode, press this key.



The MONIT (monitor) indicator blinks on the mode line of the display.

Device monitoring

Device monitoring is independent of the screen currently being viewed. Up to four different devices can be selected from a list called the monitor menu. Two devices are shown at a time on the message line of the display. To rotate to the other two devices, press the monitor [BLK/MON] key.

Selecting the devices

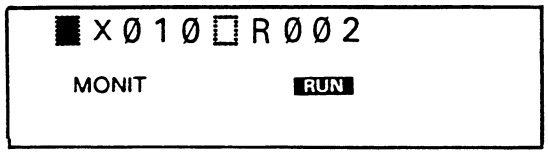
Assign the four devices by entering them one at a time using their symbol and address followed by [BLK/MON].

Press [BLK/MON] initially to enter device monitor mode.

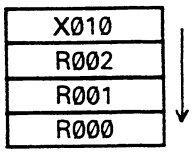
For instance, to select X10, X11, X12 and X13, you would enter the following key strokes. Devices previously in the menu might be displayed.

Device 1:

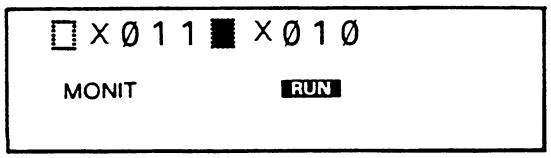
■: ON
□: OFF

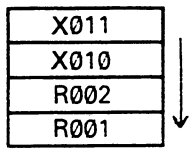


Monitor Menu

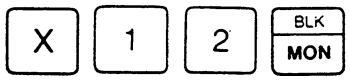


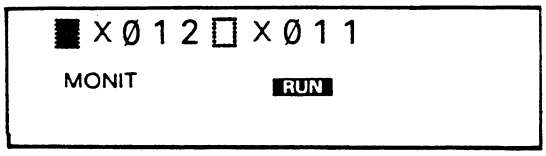
Device 2:

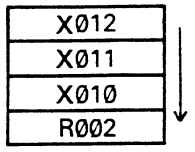




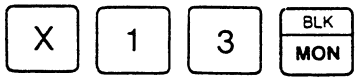
Device 3:

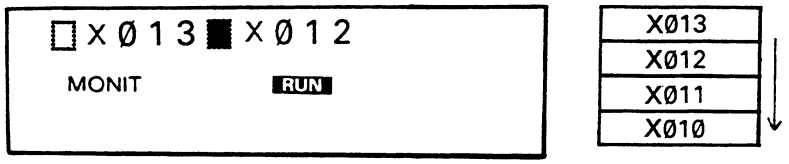




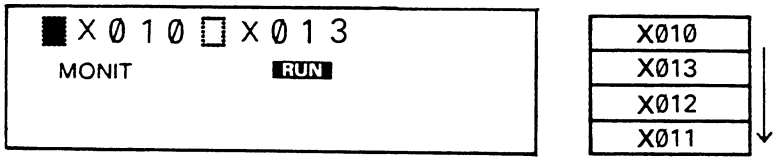


Device 4:





As each device is entered, it appears at the left in the message line. When the second device is entered, the first moves to the right. When devices 3 and 4 are entered, devices 1 and 2 are bumped off the Message line. However, they can be rotated back into view by pressing the monitor [BLK/MON] key.



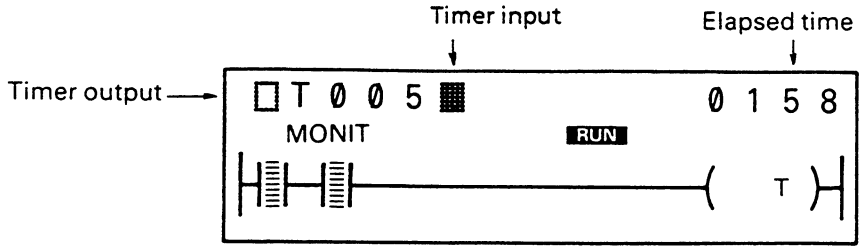
Other devices can be substituted in the menu; the addition of each new device replaces the original devices one at a time on a FIFO (first-in, first-out) basis.

The box to the left of each device in the message line shows the ON/OFF status of the device. When the device turns on, the box is shaded.

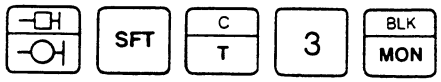
Timer/counter monitoring

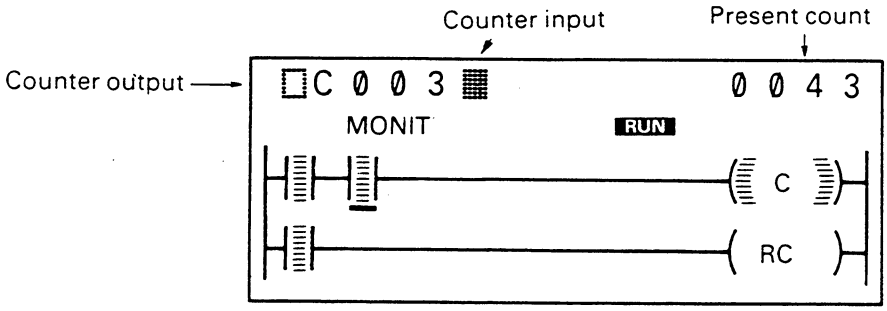
Timers and counters are monitored differently. You must first enter the device symbol and address of the timer or counter you want to see operate. Then the message line changes to the current value of the device. When the device's contact is powered, the value is shown as it decrements (for timers) or increments (for counters).

To display the status of timer T5, press these keys.



To display the status of counter C3, press these keys.





A box appears on each side of the device address in the message line. The box on the left shows the operation of the device's output – when it is shaded the preset value has been reached. The box on the right shows the status of the device passing power. When it is shaded the device starts operating. The number on the far right of the message line shows the elapsed time or current count, depending on whether a timer or counter is being monitored.

To stop monitoring, press the clear screen [SCR/CLR] key.

Block monitoring

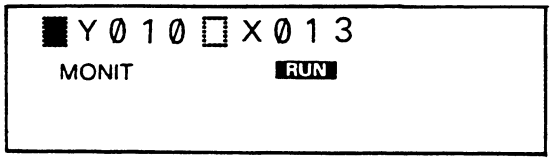
Block monitoring lets you view the simultaneous operation of a large number of similar devices spread throughout a program.

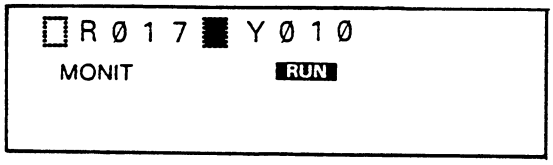
With this method, 64 devices can be viewed at the same time, in two groups of 32 similar devices. For instance, you could view 32 R devices and 32 Y devices, or 64 of either type. These homogenous groups are called device blocks. The device blocks are displayed as an 8 x 8 matrix, with each column a fixed octal number starting with 0 and ending with 7.

The two device blocks are defined by assigning to the monitor menu the first device of interest from each block. Assignment is done the same as in the device monitoring mode explained previously.

To understand how this works, suppose you wanted to monitor one block of internal relays including R017 and a second block of output devices including Y010.

First press these keys.

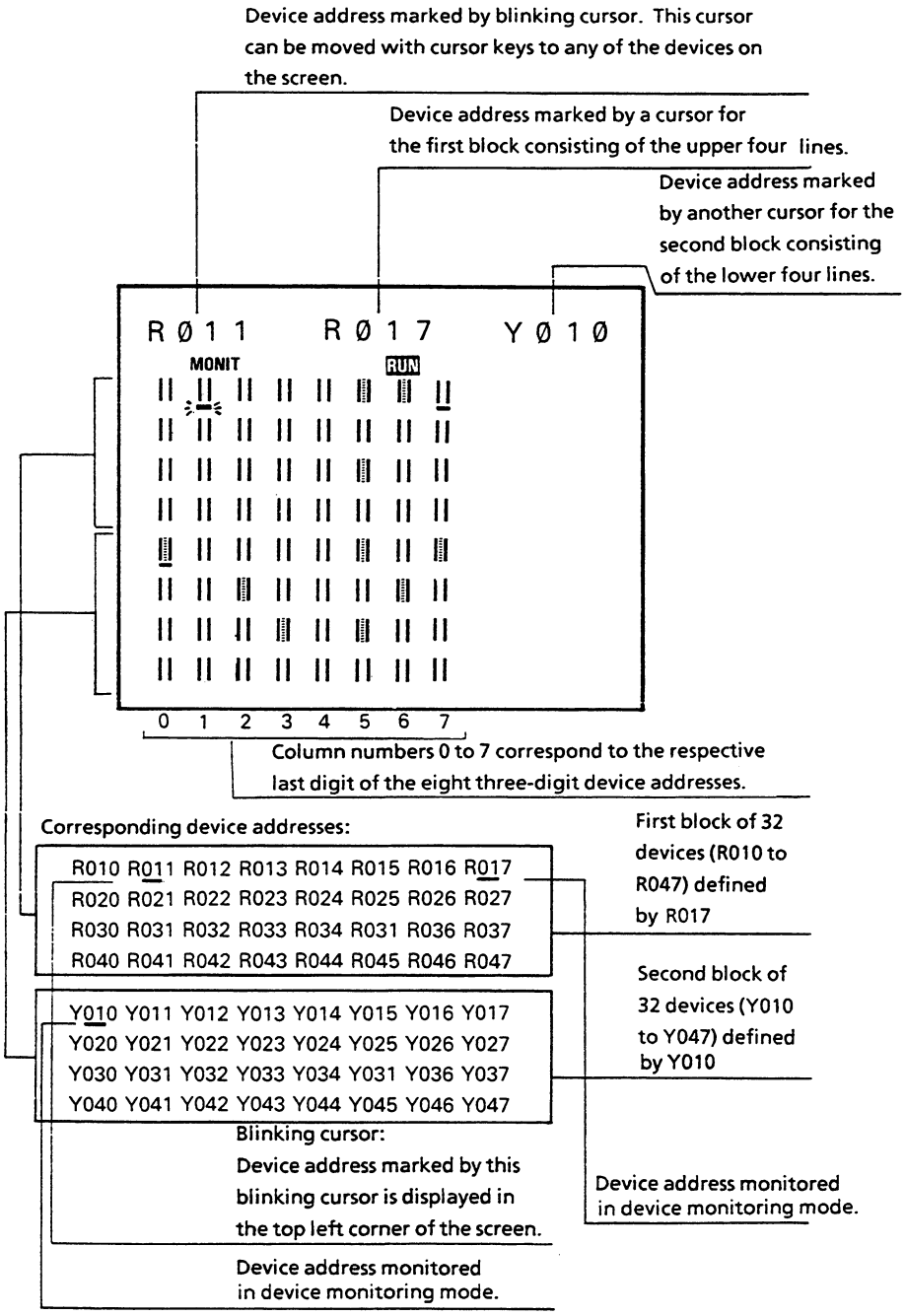




By assigning these two devices to the monitor menu and pressing the block monitor [SFT] [BLK/MON] key, the screen changes as illustrated on the next page.

Look at the message line in the illustration. Three different addresses are displayed there – the address of the device that defines the upper block, the address of the device that defines the lower block, and the address of the device indicated by the cursor.

In addition to the 64 devices, the display shows four things – a blinking cursor, the positions (marked by a solid cursor) of the devices that define the two blocks, and one or more shaded devices (if any is currently energized).



As you move the blinking cursor across a row or down a column, the address shown on the message line changes to that of the device at the cursor position.

As you can also see in the illustration, each of the two device blocks starts not with the designated device itself, but with the first device on the line (columns 0 - 7) that includes the designated device. Based on the octal numbering system, the upper block is R010 to R047 and the lower block is Y010 to Y047.

NOTE Up to four devices may be assigned to the monitor menu and rotated to show four different blocks, two at a time.

Press the monitor key [BLK/MON] to return to device Monitoring mode.

Trace monitoring

This mode gives you a graphic way to trace the operating status of the four devices in the monitor menu and is commonly used to time events in a program.

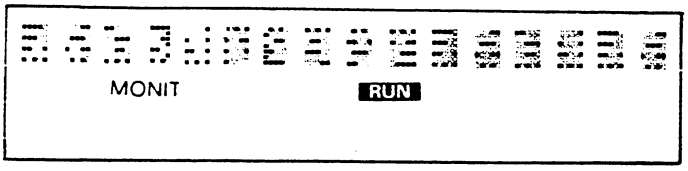
To start the trace, enter the addresses of four devices in the monitor menu as explained in the device monitoring mode. Then press the trace [SFT] [TRC/SCH] keys.

The message line takes on a completely new appearance. Instead of characters, it displays 16 small blocks each made up of a dot matrix five trace dots wide by seven high. Four horizontal rows of dots, separated by blank lines, represent the four devices in the monitor menu.

The lines are not identified by device, but it is easy to know which row of dots is associated with which device. If you number the lines from top to bottom, and the devices from left to right, the first, third, fifth, and seventh lines show the operations of the four devices entered in the monitor menu.

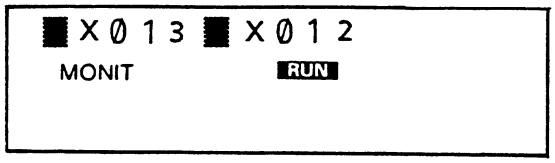
The blank lines (2, 4, and 6) are used to track the cursor position as it moves across the message line from left to right.

Message line of screen during trace monitoring:

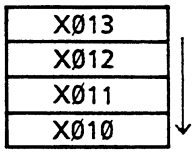


Example of trace monitoring:

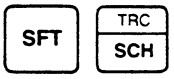
Device monitoring screen



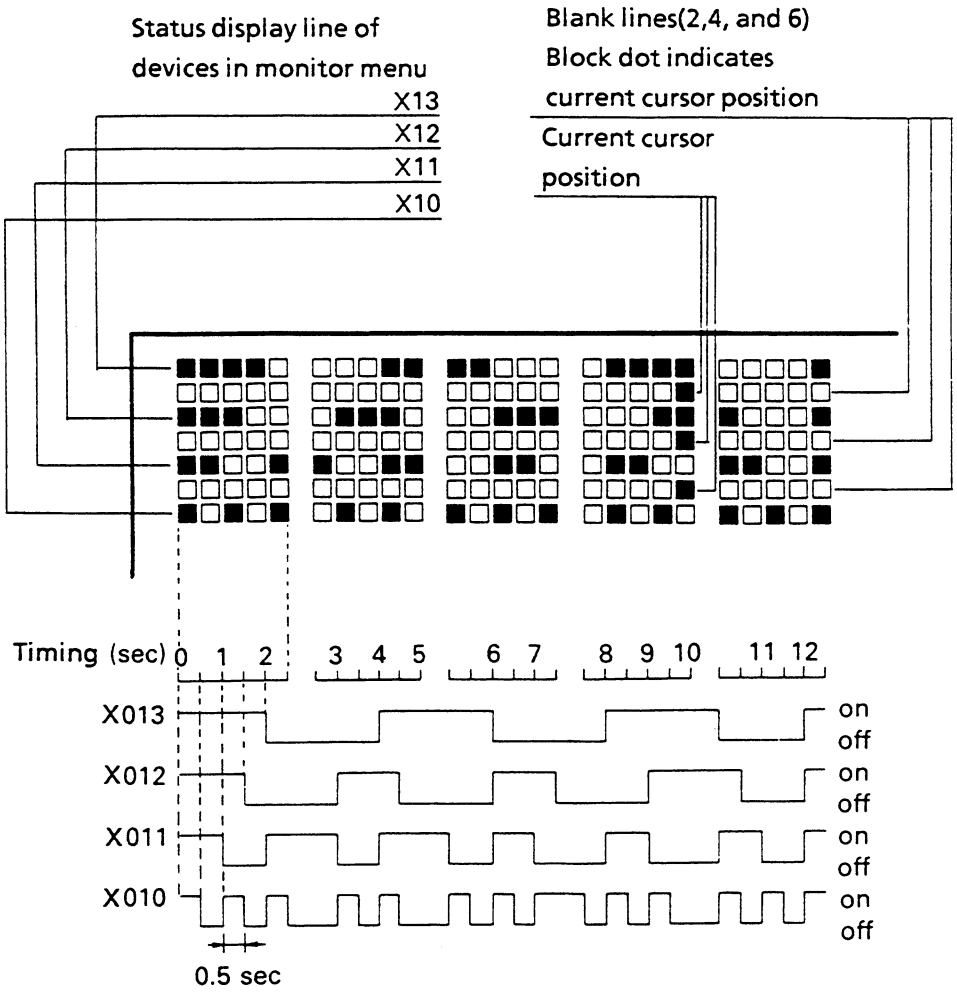
Monitor menu



To change to trace monitoring mode, press



Trace monitoring screen



What you see is a series of lines that trace the operation of four selected devices in 0.5-second units. Each "history" is shown for 40 seconds required for the 16 blocks on the message line where one block equals 0.5 second until the cursor makes another pass.

For timing purposes, each dot is equal to 0.5 second, which means that each block consisting of five dots is 2.5 seconds in width. As the cursor moves across the face of the blocks, it shows the operating status of the four devices by sampling them at 0.5-second intervals. Black dots indicate when a device is energized.

To stop or restart the trace, press [SFT]. To return to device monitoring mode, press [BLK/MON].

SECTION 8

System Control

This section covers the LCD programmer's command functions. Helpful functions for debugging are also explained here.

Memory clear

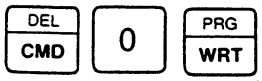
The memory clear command, command 3, clears the memory of the PC to prepare for a new program. This command should be used carefully because, once this command is issued, the whole program is lost permanently.

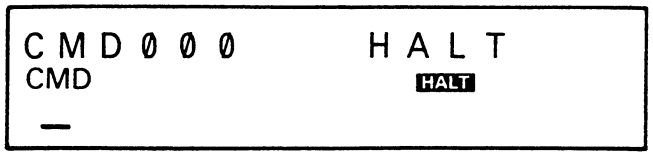
To clear the memory, press these keys.

Starting and stopping program execution

Program execution can be started or stopped by setting the HALT/RUN switch on the PC in the RUN or HALT position or Command 0 from the LCD programmer.

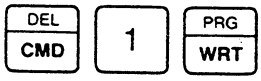
To stop the program execution, press these keys.

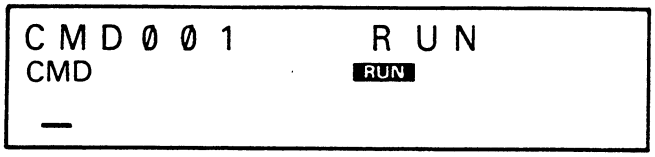




When the PC has been stopped by command 0, you can restart it by issuing the Restart PC command (Command 1).

To start the program again, press these keys.





NOTE These commands are available when the HALT/RUN switch is in RUN position. To return to the normal display, press either the monitor [BLK/MON] or search [TRC/SCH] key.

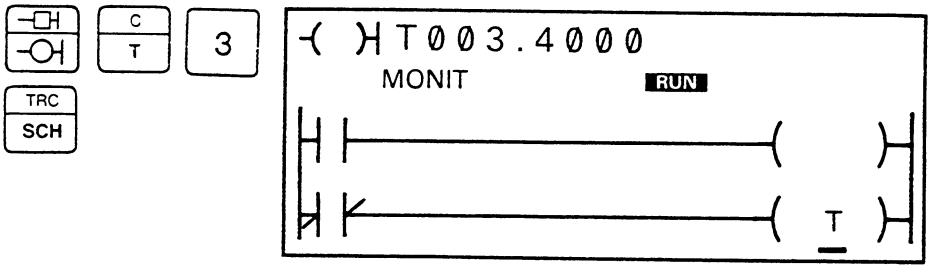
Changing timer/counter presets

The preset values of timers and counters can be changed during program execution.

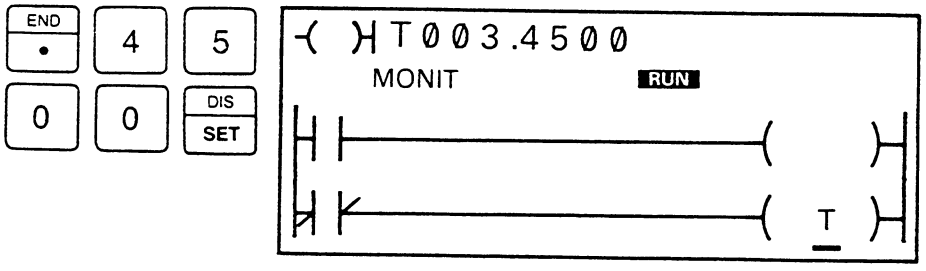
NOTE You cannot select the device to be reset using the cursor. You must first locate the timer or counter using the search function, then assign the new value.

To change the preset value of a timer or counter, follow these steps. In the example the time period for Timer 3 is changed from 4000 (400.0 seconds) to 4500 (450.0 seconds).

First search for the device.



Set the new value of the timer/counter



NOTE It is feasible to change timer/counter preset values even if the PROM module (RM17) is attached to the PC. (Programmer, Version 2.3 or up, is required.)

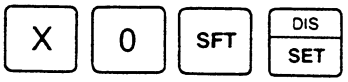
Disable function (Forcing)

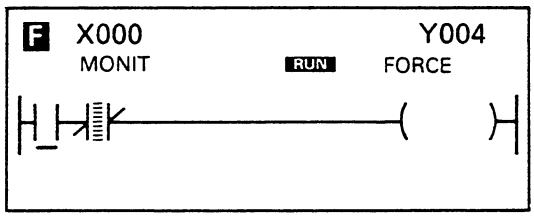
During program debugging and system testing, you might want to freeze a device in a certain state. Using the disable function and device set/reset function, you can set any device to ON or OFF.

Device disable (forcing)

To freeze a device, first select the device, then press [SFT] [DIS/SET]. Then you can set the device as desired, ON or OFF, by pressing [DIS/SET] or [DIS/RST].

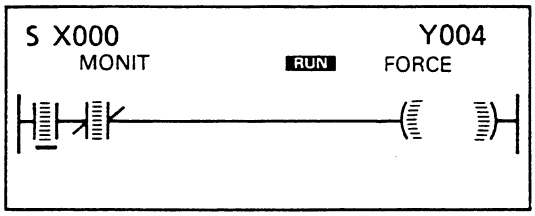
First press these keys.





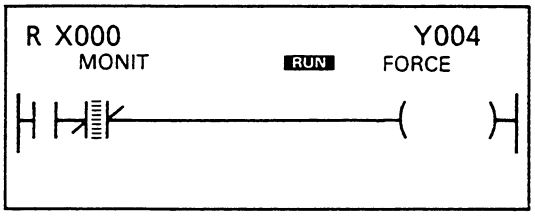
The letter **F** appearing in the message line indicates the device is disabled.

To set the device X0 to ON, press this key.



The letter S before the device indicates the device is set to on.

To reset the device X0 to OFF, press this key.



The letter R before the device indicates the device is reset to off.

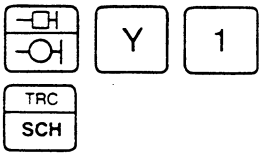
To release the disable condition, press these keys.

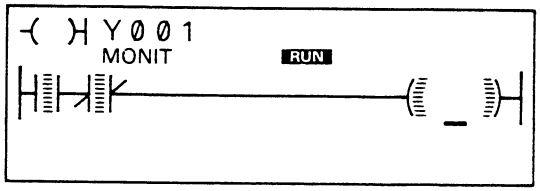
NOTE When power is turned off or a HALT status is established, all devices (except latched relays, counters, and shift registers) are cleared to off. Note a device forced to on may occasionally be forced to off.

Coil disable (forcing)

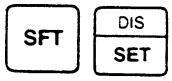
First search for the coil and then enter the following key sequence. When coil disable is executed, the state of the coil device is frozen.

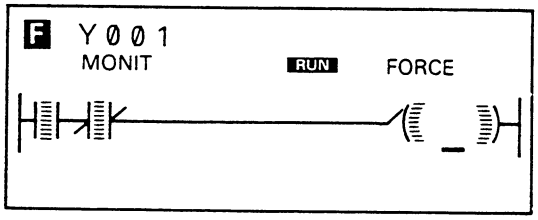
First search the coil you want to disable.





Then, to set the coil in its current state (energized), press these keys.

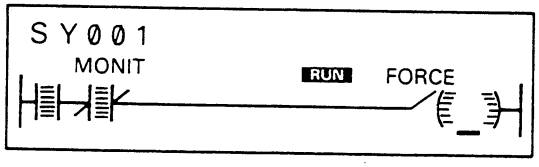




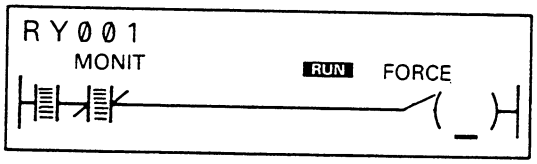
The letter **F** before the device in the message line indicates the disable set status. When the coil is disabled, the left link of the coil is broken.

After the coil is disabled, you can set the coil device as desired in the same way as disabling a device.

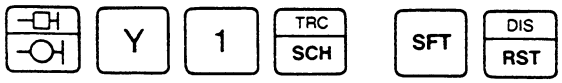
To set the device to ON, press this key.



To reset the device to OFF, press this key.



To remove the forced condition from the device (force indicator disappears from the screen), press these keys.



NOTE

1) Before setting/resetting coil disable, the search [SCH] function is necessary to locate the coil.

2) Coil disable is not possible for the master control coil, jump coil, step sequencer, shift register, or flip-flop.

3) When power is turned off or a HALT status is established, all devices (except latched relay, counter and shift register) are cleared to off. A device forced to on may occasionally be forced to off.

4) When coil disable exists in a program, it is not possible to write to a PROM (the error message "ERR. 29 FORCE" appears). Coil disable must be released before writing to the PROM. With device disable, all disabled devices are released automatically when a PROM is attached.

Device set/reset

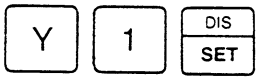
You can operate contacts or coils individually during monitor mode from the keyboard of the LCD Programmer. A device can be set/reset for one scan of the program, or, if needed, it can be frozen in a desired operating state using [DIS/SET] or [DIS/RST] after executing [SFT] [DIS/SET].

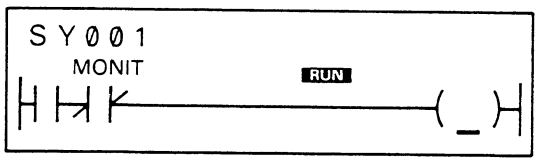
NOTE

A device may be forced only for one scan. From the next scan, the state of the device is controlled by input signal or program execution.

To set a device to on for one scan, first enter the device address and then press [DIS/SET] (as shown next for Coil Y1). The letter S appears before the device symbol in the message line to indicate the execution of the set function.

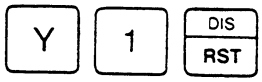
Press these keys.

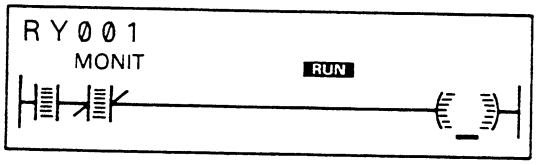




To reset a device to off for one scan, first enter the device address and then press [DIS/RST] (as shown below for output Coil Y1). The letter R appears before the device symbol in the message line to indicate the execution of the reset function.

Press these keys.

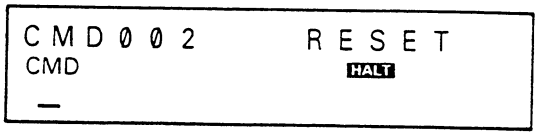




Error reset

If an error occurs in the PC, the error status is reset by turning off the power or Command 2 from the keyboard.

To reset the error status, press these keys.



The Reset ERROR command, Command 2 turns off the ERROR LED indicator.

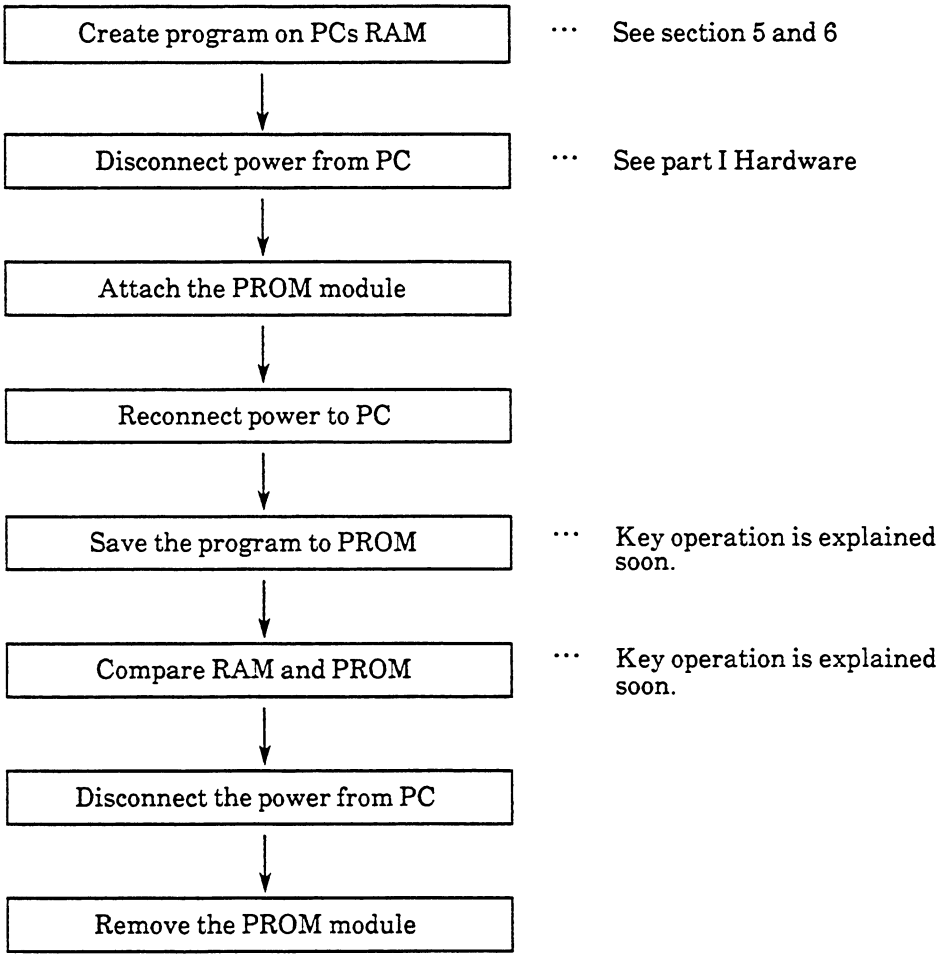
SECTION 9

Using PROM Modules

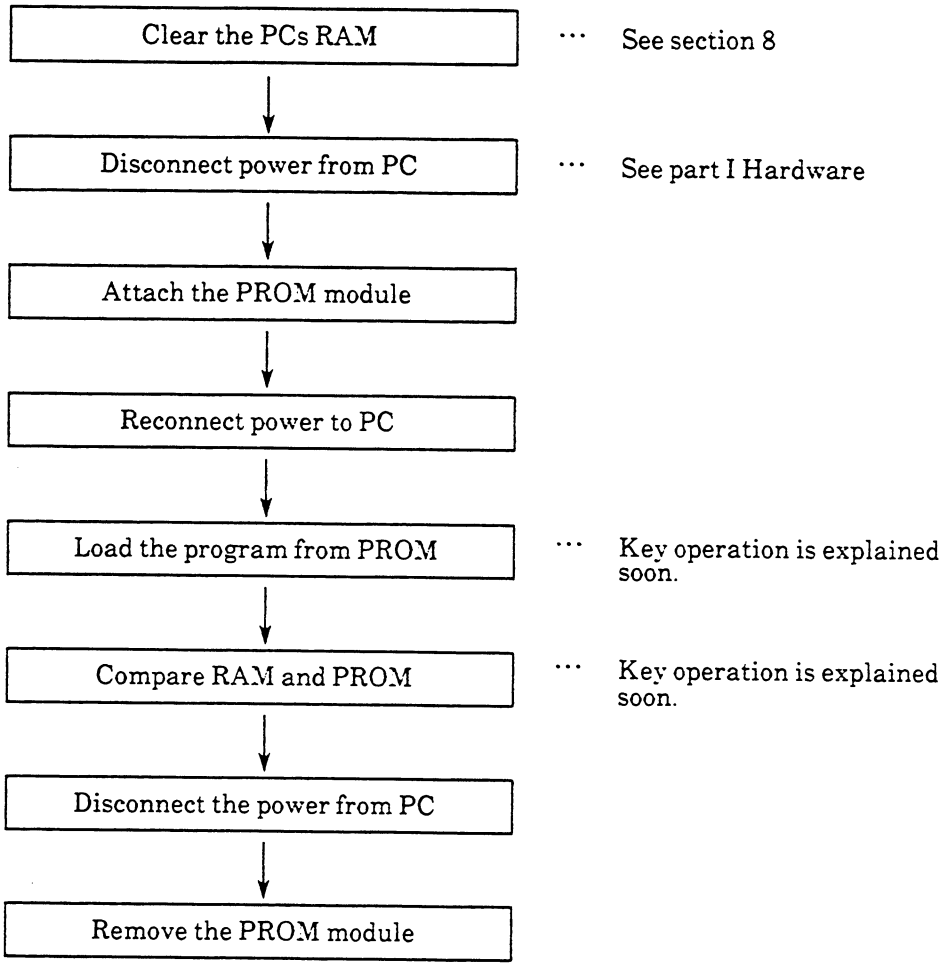
PROM module

PROM modules are used as external memory for the EX20PLUS/40PLUS. Following chart shows the general procedure for saving a program to PROM and loading a program from PROM.

① Saving a program (PCs RAM to PROM)



② Loading a program (PROM to PCs RAM)



When the HALT/RUN switch on the EX20PLUS/40PLUS is set to RUN with a PROM module attached, the program written on the PROM module is executed. Battery maintenance is not necessary.

NOTE The PROM LED on the PC is lit when a PROM module is attached.

CAUTION You should not attempt to insert or remove a PROM module while power is being supplied to the PC. Doing so may damage the PROM.

Saving a program (RAM to PROM)

Command 41, the Program Write command, saves a program currently in the PC memory to a PROM. After installing the PROM correctly, connect power to the PC. Check that the HALT/RUN operation switch on the PC is in the HALT position. Then execute Command 41 to save the program to the PROM Module. While saving, CMD flashes on the mode line. When saving is complete, WRITE appears on the message line.

To save the RAM program to PROM, press these keys.

DEL CMD | 4 | 1 | PRG WRT

```
CMD 041          WRITE
CMD                HALT
            (Cleared)
```

Comparing a program (RAM and PROM)

Command 42, the Compare command, compares a program in the PC memory with a program in a PROM Module. After installing the PROM correctly, connect power to the PC. Check that the HALT/RUN switch on the PC is in the HALT position. Execute Command 42 to compare the two memories. During the comparison, CMD flashes on the mode line. When program comparison is complete, COMPARE appears on the message line. If the programs are found to differ, "ERR.26 VERIFY" appears instead.

To compare the contents between RAM and PROM, press these keys.

DEL CMD | 4 | 2 | PRG WRT

```
CMD 042          COMPARE
CMD                HALT
            (Cleared)
```

Loading a program (PROM to RAM)

Command 43, the Load command, loads a program from a PROM Module to the PC memory. This command is used after initially installing the PROM. First install the PROM correctly, then connect power to the PC and check that the PC HALT/RUN operation switch is in the HALT position. Execute Command 43 to commence loading the program to the PC memory. While loading, CMD flashes on the mode line. When program loading is complete, LOAD appears on the message line.

To load a PROM program to PC RAM, press these keys.

DEL CMD | 4 | 3 | PRG WRT

```
CMD 043          LOAD
CMD                HALT
            (Cleared)
```

PROM erasing

PROM erasing is not necessary because you can overwrite any program stored on the PROM module (RM17).

PART III

HIGH-SPEED COUNTER

SECTION 1

Before You Begin

This section outlines this part and previews each section to provide a helpful headstart before you begin.

About this part:

This part was written to provide adequate basic information and practical operating examples on the high-speed counter function of the EX20PLUS/40PLUS. This is what you will find in the upcoming sections:

Section 2 Configurations and Specifications
This section introduces the high-speed counter function. It also contains specifications and how to connect an encoder.

Section 3 Programming
High-speed counter operation is explained in this section. Programming techniques and use of update functions are also covered.

SECTION 2

Configurations and Specifications

Introducing the high-speed counter

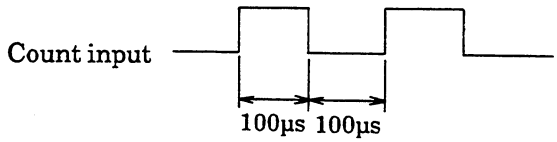
The EX20PLUS/40PLUS features an internal high-speed counter. This high-speed counter can receive pulses up to 4kHz. This allows positioning control using the EX20PLUS/40PLUS with the high-speed counter.

Two inputs are provided for the high-speed counter. One is a count input, and the other is a hard-reset input. Every time the count input turns on, the high-speed counter increases or decreases its value. You can set the counter to increment or decrement in the program as explained in section 3.
The hard-reset input is used to reset the counter value. When the hard-reset input turns on, the count is reset to zero. Soft-reset, that is resetting the counter from the program, is also possible.

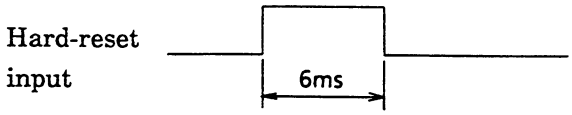
Selecting an encoder

When you select a rotary encoder for the high-speed counter, you should check the following points.

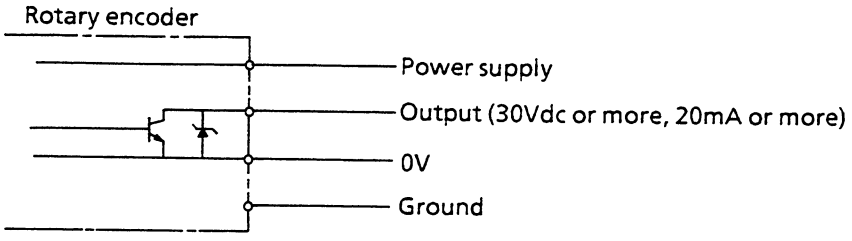
① The maximum response pulses are 4kHz. Pulse width must be longer than 100 µsec.



② The pulse width of the hard-reset must be longer than 6 msec.



③ The encoder's output circuit should be an open collector type. And it should allow 30Vdc or more output voltage and 20mA or more output current.

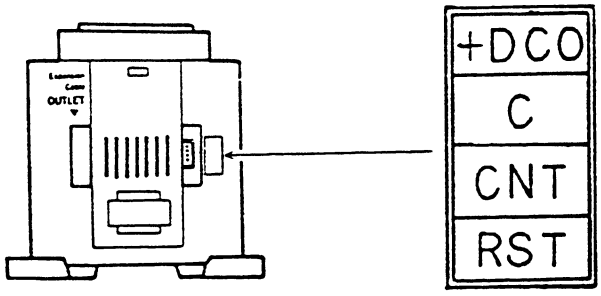


④ If the encoder's power supply voltage can accept 24Vdc ± 15%, the DCO of the EX20PLUS/40PLUS can be used. Current consumption of DCO should not be over 100mA. If the DCO cannot be used for the encoder power supply, a separate power supply must be connected.

Specifications

Item		Dry contact input model	120 Vac input model
Input points		1 point (count input), 1 point (hard-reset input)	
Input terminals	Count	Common with X0	Special connector (See figure below)
	Hard-reset	Common with X1	Special connector (see figure below)
Counting speed		4 kHz max.	
Pulse width		100 μs min. (count input), 6ms min. (hard-reset input)	
Input voltage		24 Vdc ± 15% (supplied from PC)	
Input current		10mA (24 Vdc)	
Counting range		4 digists decimal or 8 digits decimal (selectable by user program)	
Comparison points		30 points (4 digits mode), 15 points (8 digits mode)	
Software Limitations using High-speed counter		(1) Counter devices C40 - C77 are used for the High-speed counter function. (2) Input devices X0 and X1 can not be used in the program (Dry contact input model only).	

Connector pin arrangement of the 120 Vac input model:



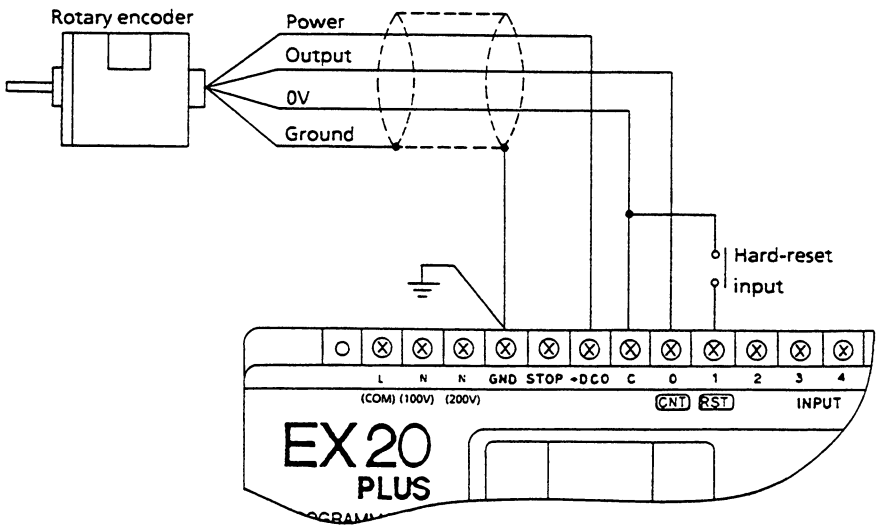
NOTE

1) Wiring to the connector can be easily made by user.
2) 2 pieces of the connectors (female) are supplied with the unit.

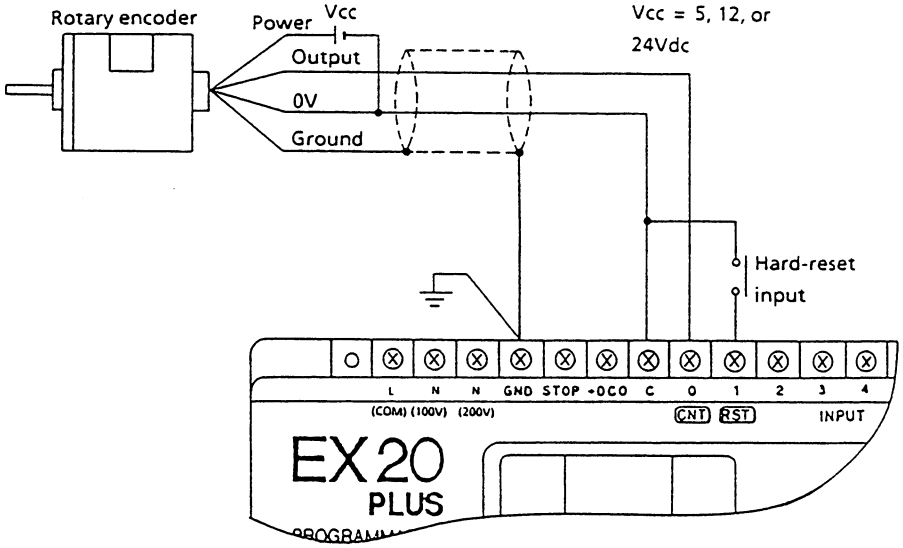
Typical connection diagram

For dry contact input model

① Encoder power supplied from DCO



② Encoder power supplied from separate power supply



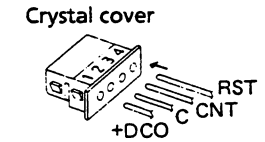
NOTE

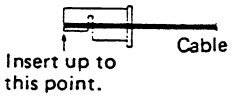
1) When the high-speed counter is used, inputs X0 and X1 cannot be used in a program.
2) DCO voltage is 24Vdc ± 15% and allowable current is 0.1A. If the DCO is used for the encoder power supply, you should check the encoder specifications.
3) Encoder cables should be separated from other I/O cables. And the cables should be as short as possible to avoid any inductive noise.

For 120 Vac input model

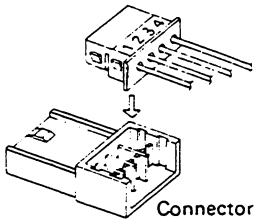
In case of the 120 Vac input model, the accessory connector is used to connect the high-speed counter.
Wiring procedure is shown below.

1) Insert cables deeply enough into the crystal cover of the connector. It is no need to peel off the cable's sheath.

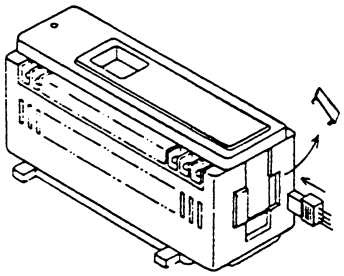




2) Put the crystal cover in the connector and press together.

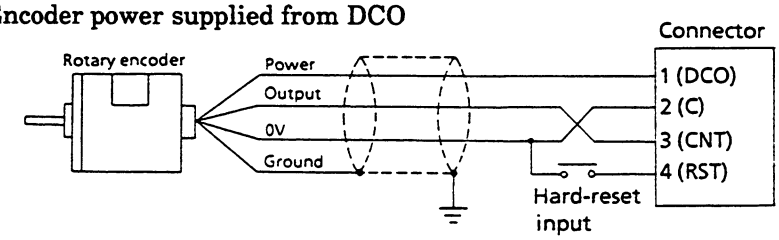


3) Remove the PC's connector cover and insert the connector on which wiring is completed.

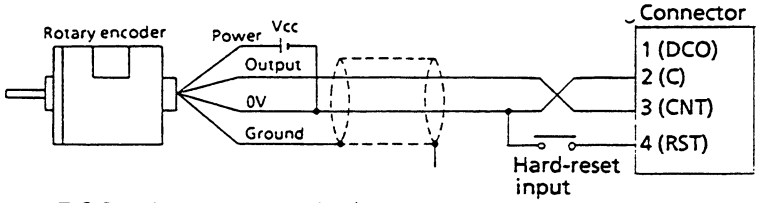


NOTE Use the shielded cables with the size of 26 AWG.

① Encoder power supplied from DCO



② Encoder power supplied from separate power supply



NOTE DCO voltage is 24 Vdc ± 15% and allowable current is 0.1 A. If DCO is used for the encoder power supply, you should check the encoder specifications.

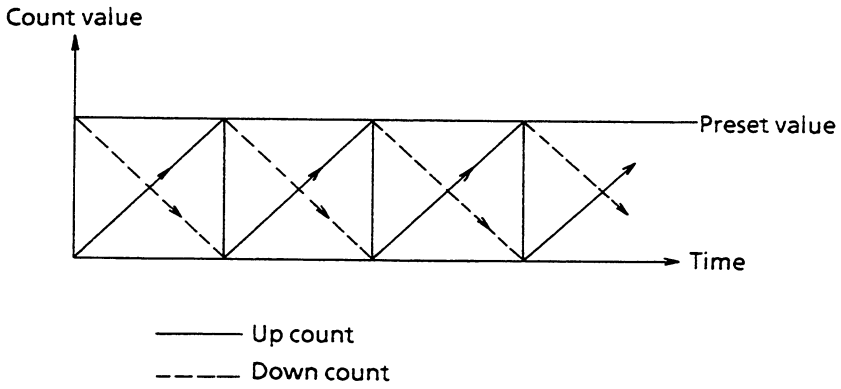
SECTION 3

Programming

Operating procedure

The high-speed counter in the EX20PLUS / 40PLUS is a ring counter which resets the current count when a preset count is reached. The count can be preset either in 4 decimal digits or 8 decimal digits. The selection of up- or down-count mode is also programmable.

The comparison output may be set at 30 points in 4-digit mode, or at 15 points in 8-digit mode.



Register allocation

For the high-speed counter register, counter C76 is used in 4-digit mode, and in 8-digit mode, counters C76 and C77 are used.

For the comparison output, counters C40 through C75 are used (for 30-point setting) in 4-digit mode, and C40 + C41 through C74 + C75 (for 15-point setting) in 8-digit mode.

NOTE

When the high-speed counter is not used, C0 through C75 can be used to execute normal counter instructions, and C76 and C77 to execute up/down-counter instructions. But when the high-speed counter is used, C40 through C77 are reserved for the high-speed counter processing operations. In case of the dry contact input model, external inputs X0 and X1 are used for the high-speed counter input, they cannot be used in a program.

Special relays

The following special relays are allocated for the high-speed counter.

Special relay	Function	ON	OFF
R160	High-speed counter mode selection	H*	N*
R161	Counting digits selection	8	4
R162	Up/down selection	Down	Up
R163	Count start flag	Start	Stop

* H: High-speed counter mode
* N: Normal mode

R160 --- By energizing R160, the high-speed counter mode can be phased in. This allocates counters C40 through C75 for the comparison output, and counters C76 and C77 as the high-speed counter registers.

R161 --- Either 4-digit or 8-digit counter mode is selected by R161. When R161 is on, 8-digit counter mode is phased in, and when off, 4-digit counter mode.

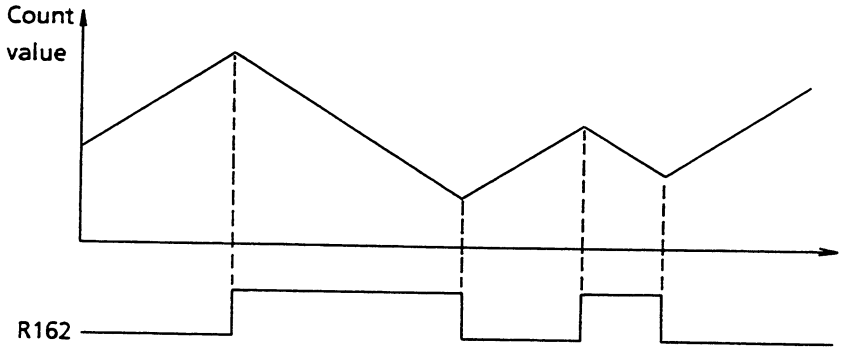
4-digit Counter Mode:

Counter Register --- C76 (max. setting at 9999)
Comparison Output--- C40 through C75 (for 30 points)

8-digit Counter Mode:

Counter Registers; C76 (for 4 lower digits) and
C77 (for 4 higher digits)
Comparison Output;
for 15 points { C40 (for 4 lower digits) , C41 (for 4 higher digits) to C74 (for 4 lower digits) , C75 (for 4 higher digits)

R162 — Up- or down-counter mode is selected by R162. When R162 is on, down-counter mode is phased in, and when off, up-counter mode.



R163 — When R163 is on, starts counting and when off, stops counting.

Programming techniques

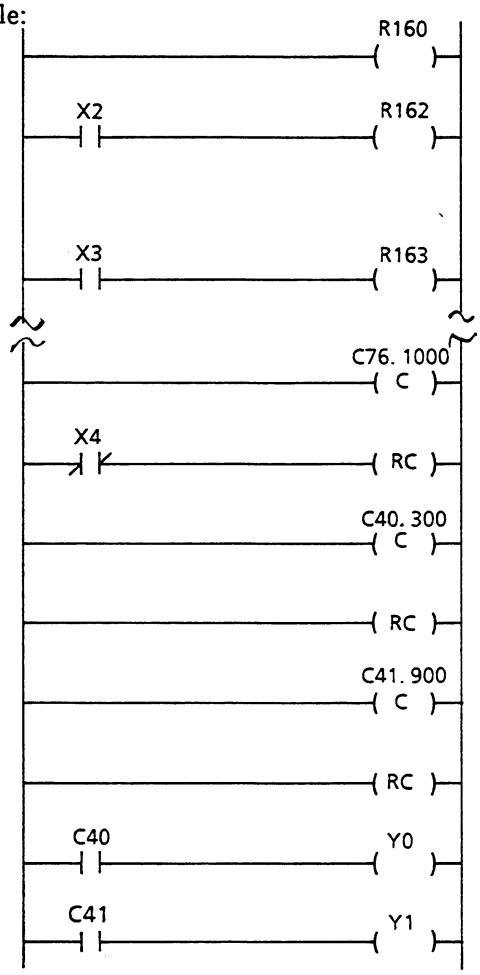
Programming both 4-digit and 8-digit counter modes are explained in this section. The high-speed counter instruction write operations are the same as those for normal counter instructions.

(1) 4-digit Counter Mode

Follow this procedure for writing the program.

[1] Select high-speed counter mode	R160: ON
[2] Select 4-digit mode	R161: OFF
[3] Set up- or down-count counting	R162: ON or OFF
[4] Set count start condition	R163 : ON or OFF
[5] Write high-speed counter instructions	C76 and a preset value
[6] Set comparison outputs	C40 through C75, and comparison values

Example:

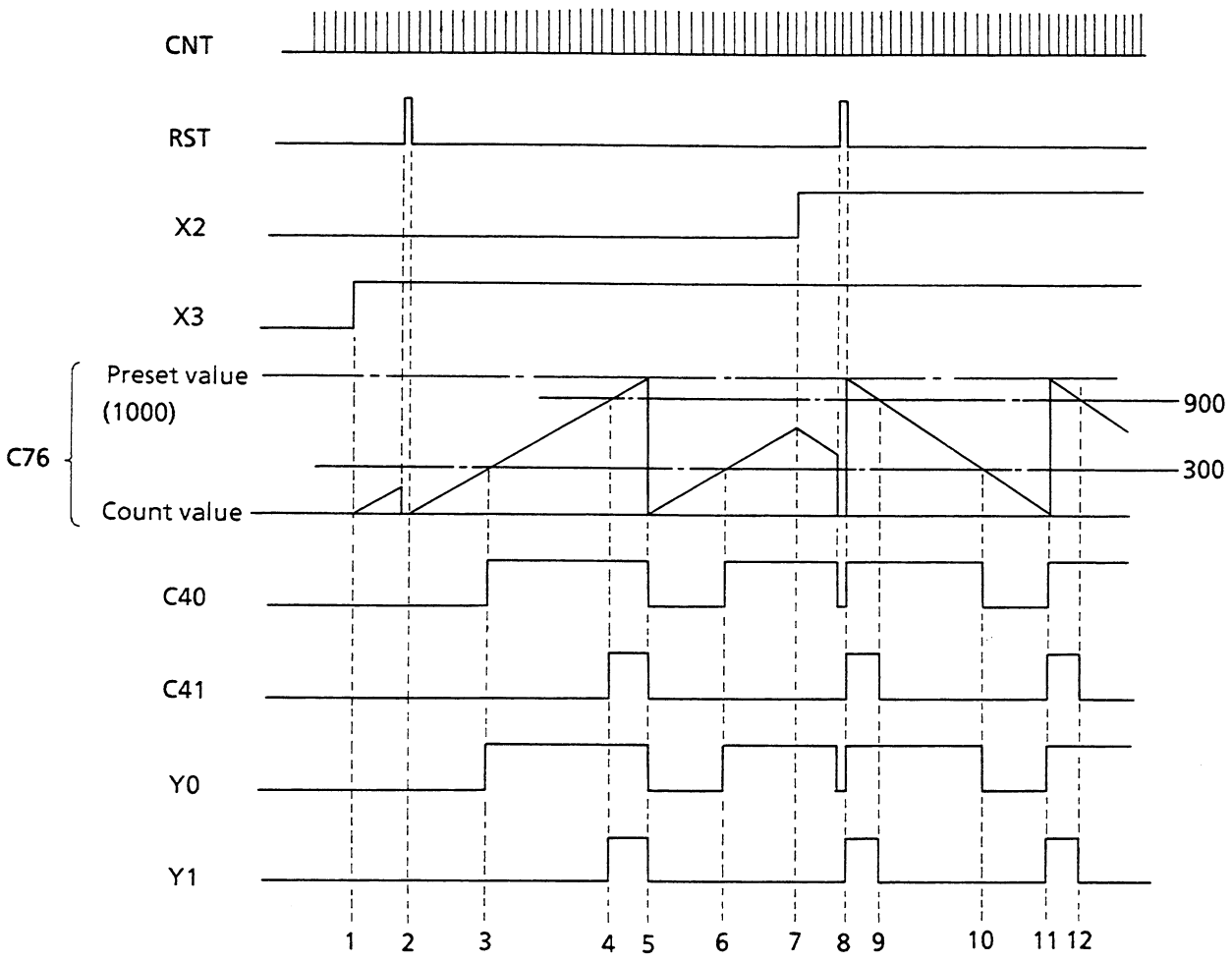


Connect an encoder output to the count input terminal (CNT) and the reset switch to the hard-reset terminal (RST).

As count start setter X3 turns on and the hard-reset terminal (RST) turns off, counting starts.

Up- or down-count is selected with X2. As the count reaches or exceeds 300, C40 and Y0 both turn on, and as it reaches or exceeds 900, C41 and Y1 turn on.

Timing Chart



As count start setter X3 turns on, the count input (CNT) signal starts to be counted: [1]. As the hard-reset input (RST) turns on, the count resets to zero, and as RST turns off, counting will be resumed: [2]. As the count reaches 300, comparison output C40 turns on, and external output Y0 also turns on: [3], [6]. As the count reaches 900, comparison output C41 turns on, and Y1 also turns on: [4]. As the count reaches a set value (1,000), the counter is reset to zero : [5]. As up/down-count selector X2 phases out of off mode to on, the up-count mode is phased out to down-count mode: [7]. As the hardware reset input (RST) turns on, the counter is reset. As RST turns off, counting starts over again: [8]. As the count drops down below 900, comparison output C41 turns off, and Y1 also turns off: [9], [12]. As the count drops down below 300, comparison output C40 turns off, and Y0 also turns off: [10].

(2) 8-digit counter mode

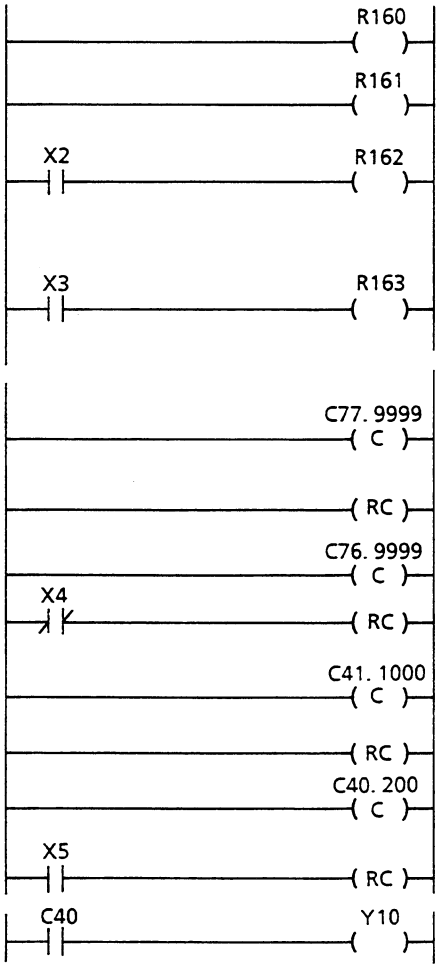
Except for the differences given below, the programming procedure is the same as for 4-digit counter mode.

[1] 8-digit mode is selected. ··· R161 : ON

[2] For the high-speed counter instructions, C76 and C77 should be operated to write the four lower digits of the value setting in C76, and the four higher digits in C77.

[3] As with high-speed counter instructions, two adjacent devices should be operated for a comparison output to set the four lower digits of the comparison value in the device at an even address and the four higher digits in the device at an adjacent odd address.
(Example: C40 (lower) + C41 (higher))

Example:



High-speed counter mode select: R160 = ON

8-digit mode select: R161 = ON

Up/down-count select:
- X2 = OFF for counting up
- X2 = ON for counting down

Count start condition set:
X3 = ON for counting

High-speed counter instruction set for:
4 higher digits = 9999

High-speed counter instruction set for:
4 lower digits = 9999

Soft-reset condition set: X4 = ON to reset

Comparison output level set at:
4 higher digits = 1000

Comparison output level set at:
4 lower digits = 0200

Comparison executing condition set:
X5 = ON to compare

At C40 = ON, external output Y10 = ON

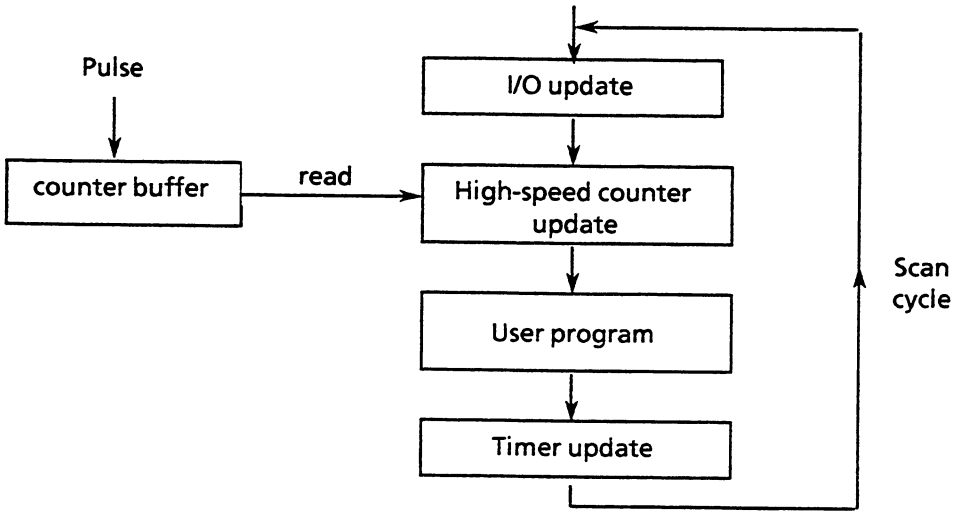
In the above example, the high-speed counter preset is "99999999" and the comparison value setting is "10000200". When the count is 10000200 or higher, comparison output C40 turns on. All other counter functions are the same as in 4-digit mode.

NOTE

1) Set both the soft-reset condition and comparison executing condition as 4 lower digit instructions.
2) The comparison output will emerge at the device handling the 4 lower digits of instructions (that is , C40 in the above example).

Using the update functions

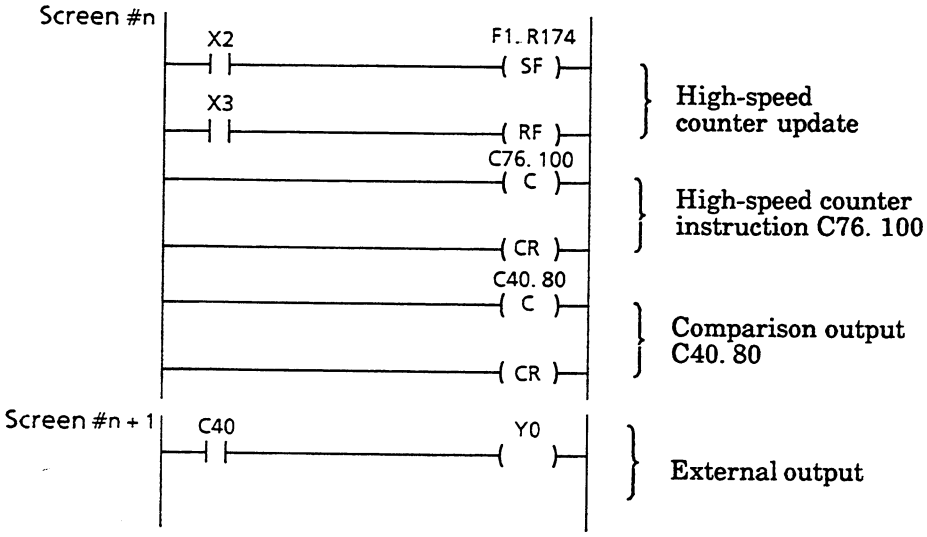
The current count of high-speed counter is read at every scan into high-speed counter registers (C76 and C77) as shown below.



A delay occurs in the high-speed counter comparison output due to the scan cycle time.
The high-speed counter update instructions minimize this delay.

As a high-speed counter update is executed, the latest count at that point in time is read into high-speed counter registers (C76 and C77)

Example:



In this example, as X2 turns on, R174 is set on. The high-speed counter update instruction is executed at every scan for the duration that R174 is on, and all latest counts are read.

HINT

When using a comparison output for the contact as in the above example, separate screens should be written for faster response (for C40 in the above example).

NOTE

High-speed counter update functions (the state of R174) and programming key sequences are the same as for a flip-flop. See Part II Programming.

PART IV

ANALOG INPUT

SECTION 1

Before You Begin

This section outlines this part and previews each section to provide a helpful head-start before you begin.

About this part

This part was written to provide adequate basic information and practical operating examples for the analog input unit.

This is what you will find in the upcoming sections:

Section 2 Configurations and Specifications
This section introduces the analog input unit.
The system configuration of the EX20PLUS/40PLUS using the analog input unit is described in this section.
Specifications of the analog input are also provided.

Section 3 Installation and Wiring
This section describes how to install and wire the analog input unit. Read this section carefully to input analog signals properly.

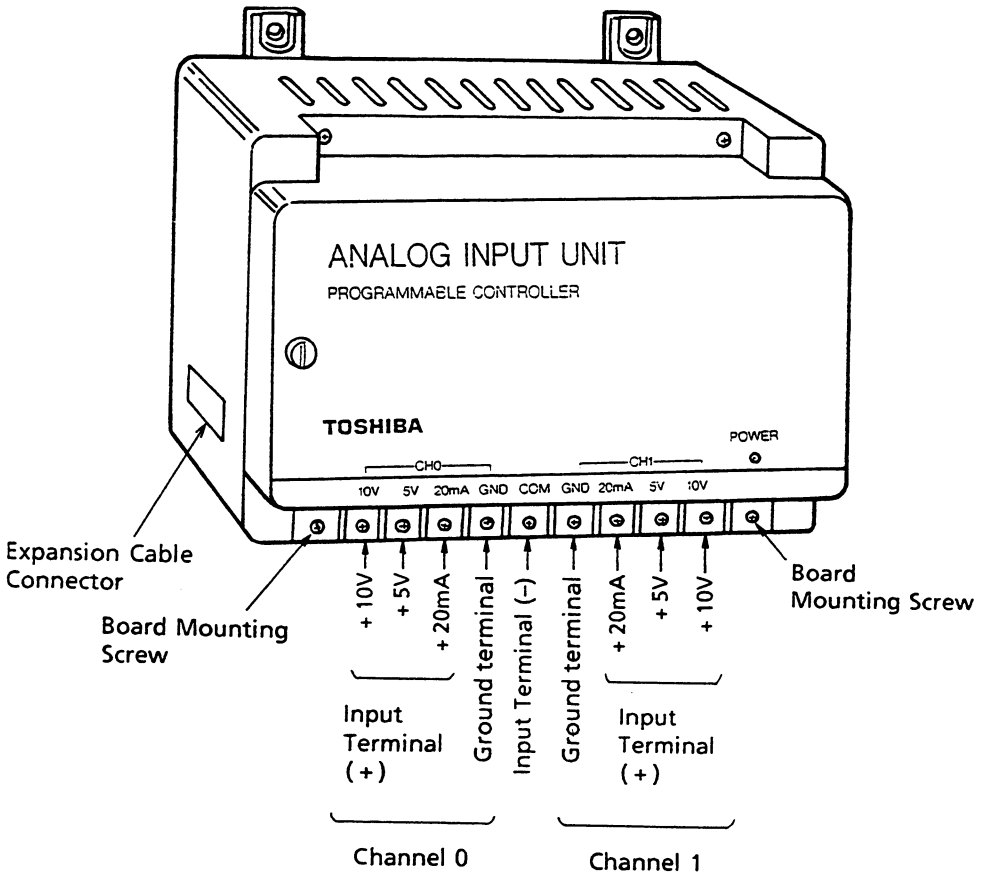
Section 4 Programming
This main section explains how to use the analog input.
Programming techniques are fully explained with practical examples.

SECTION 2

Configurations and Specifications

Introducing the analog input unit

By connecting an analog input unit, analog signals in ranges 0V to 5V or 10V, or 0mA to 20mA can be input to the EX20PLUS/40PLUS. This allows implementation of simplified temperature control and pressure monitoring systems.



The analog input unit can input two channels of analog signals. Any of the three input ranges can be selected for each channel, by wiring to appropriate terminals.

System configuration

Only one analog input unit can be connected to the EX20PLUS/40PLUS. In other words, the EX20PLUS/40PLUS can be configured for input of up to two channels of analog signals.

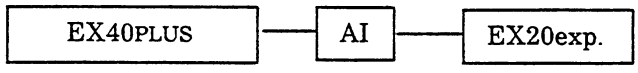
With the connection of one analog input unit, one expansion unit can be additionally connected. The possible combinations are shown below.

Model	Configuration
EX20PLUS	EX20PLUS — AI
	EX20PLUS — AI — EX08
	EX20PLUS — AI — EX20exp.
EX40PLUS	EX40PLUS — AI
	EX40PLUS — AI — EX08
	EX40PLUS — AI — EX20exp.
	EX40PLUS — AI — EX40exp.

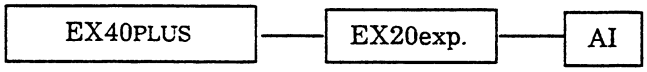
"AI" in the above table stands for an analog input unit.

NOTE The analog input unit must always be connected directly to the basic unit.

Correct



Incorrect



Specifications

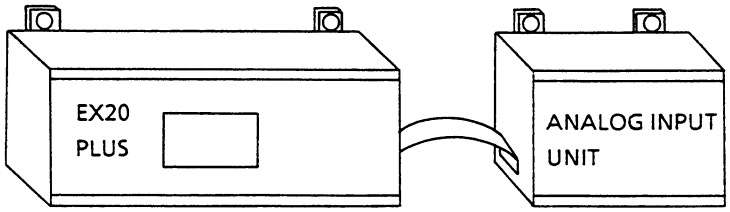
Item		Specification
No. of input channels		2 channels
Input range	Voltage	Unipolar 0 to +10V, 0 to +5V
	Current	Unipolar 0 to +20mA
Input impedance	Voltage	200 kΩ (+10V), 100 kΩ (+5V)
	Current	250Ω (+20mA)
Input filter parameters		2msec (Cut-off frequency: 500 Hz)
Digital conversion values		0 to 200 counts (in 8 bits)
Resolution		0.5% (over the full scale)
Overall accuracy		±1% (over the full scale)
Temperature drift		±300 PPM/°C
Conversion cycle time		One scan time
Withstand voltage		500Vac for one minute between the external and internal circuits
Maximum input voltage		+20V (Connection to +10V input terminal) +10V (Connection to +5V input terminal)
Consumed current		50mA max. at 5Vdc (Supplied from PC)

SECTION 3

Installation and Wiring

Installing the analog input unit

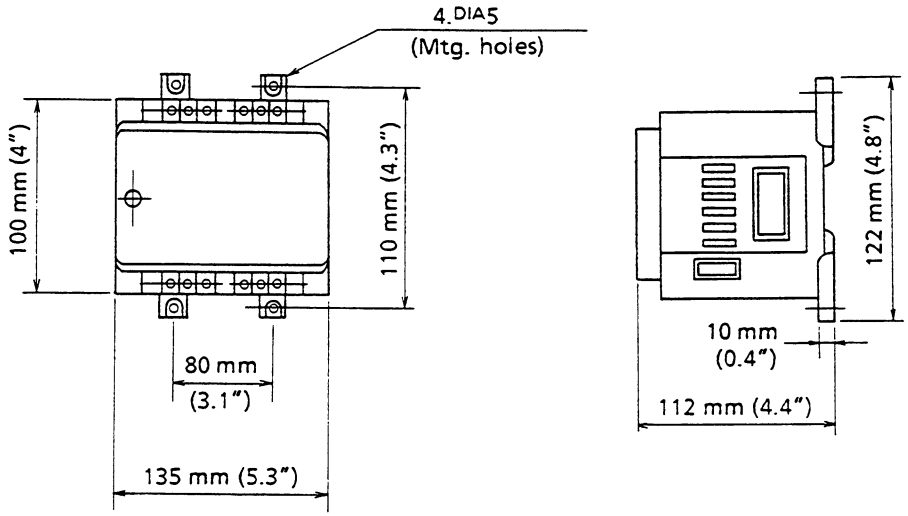
This section describes how to install and wire the analog input unit. Before installing the unit, see Part I, Section 4, for important information on installation.



NOTE

An 8 cm expansion cable is supplied with the analog input unit. Make sure to mount the unit at a position accessible with this cable length.

External dimensions

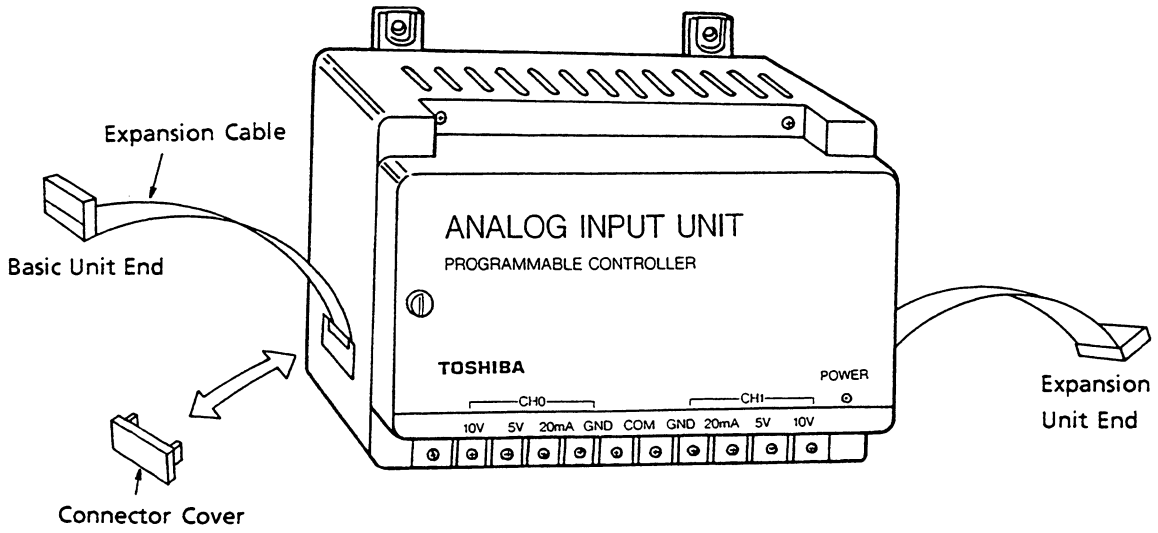


NOTE

Units may be mounted directly with screws or on a 35mm DIN rail. Use 4mm screws for direct mounting.

Making connections

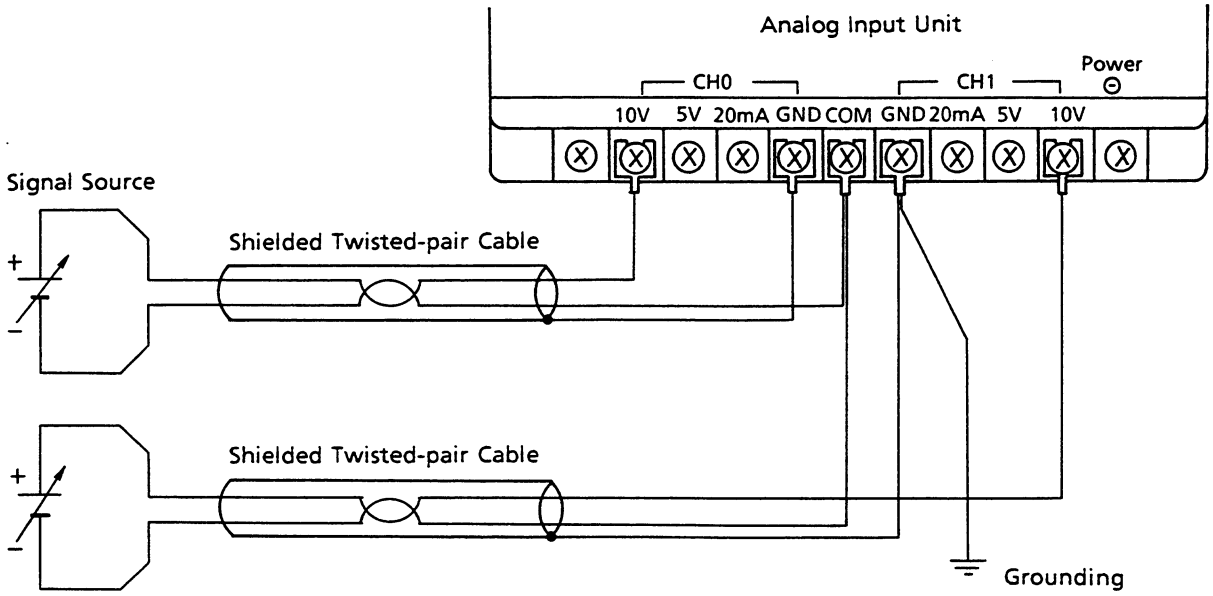
Each analog input unit comes equipped with an 8 cm expansion cable. Use the cable to connect the unit to the EX20PLUS/40PLUS basic unit.



NOTE After connecting the expansion cable, replace the connector cover to prevent the cable from being pulled out.

Wiring

To block electrical noise, use shielded twisted-pair cable for analog signal lines. Ground the cable shield by connecting it to the ground terminal (GND) on the analog input unit. Channel 0 and channel 1 share a common ground hard-wired inside the unit. Grounding to either will suffice.



Wiring precautions

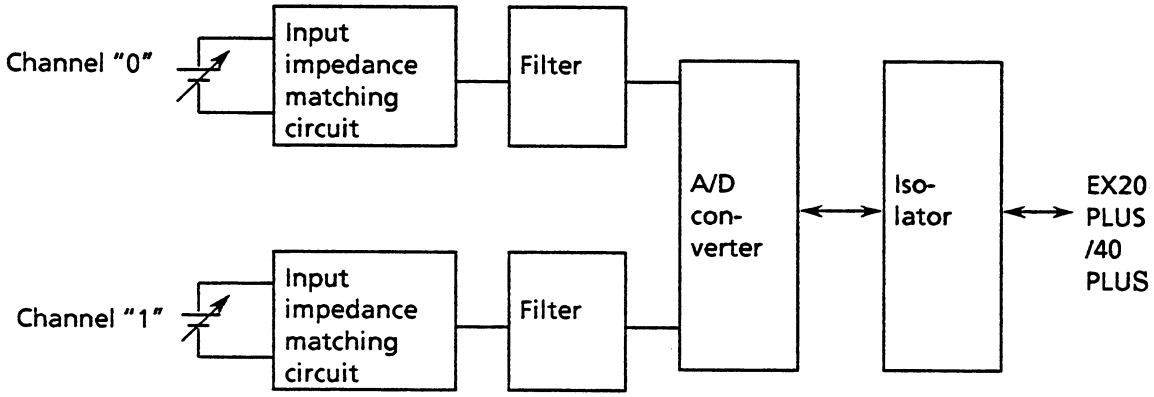
- Take care to connect correct polarity of the signals; otherwise it may cause damage to the Analog Input Unit.
- To block out electrical noise, use shielded twisted-pair cables for analog signal lines and lay it out spaced well away from digital I/O cables.
- For analog signal lines 1.25 mm^2 (16AWG) cable is recommended.
- For ground circuits, 2.0 mm^2 (14AWG) or heavier gauge cable is recommended. For other grounding requirements, see Part I.

SECTION 4

Programming

Operating procedures

An analog signal input to the analog input unit passes through an input impedance matching circuit and a filter, and enters an A/D converter. The AD converter converts the signal into digital values which are read at every scan into the EX20PLUS/40PLUS through an isolator.



Input ranges

Any of the three input ranges can be selected for analog signals for each channel: 0 to +10V, 0 to +5V, or 0 to +20mA.
The selection is made by wiring to the appropriate terminals.

A/D conversion table

The table below gives the analog signal levels for the three input ranges, and the corresponding digital values that will be read into the EX20PLUS/40PLUS.

Analog Signal Level			Digital Value
+10V range	+5V range	+20mA range	
+10.00	+5.000	+20.0	200
+9.95	+4.975	+19.9	199
+9.90	+4.950	+19.8	198
・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・
+5.05	+2.525	+10.1	101
+5.00	+2.500	+10.0	100
+4.95	+2.475	+9.9	99
・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・
+0.10	+0.050	+0.2	2
+0.05	+0.025	+0.1	1
0.00	0.000	0.0	0

Register allocation

To use an analog input, timer devices T40 through T67 and special relay R165 have to be programmed.

With R165 on, the analog input mode is phased in, and T40 through T67 are reserved for processing the analog input.

With R165 off, T40 through T67 can be used to execute normal timer instructions.

In the analog input mode, data input to channels 0 and 1 of the analog input unit are respectively stored in T40 and T54. T41 through T53 provide the comparison output against the channel 0 data, and T55 through T67 against the channel 1 data.

- Special relay

	OFF	ON
R165	Normal mode	Analog input mode

- Analog input registers

T40	Channel 0 input data
T41 T42 T43 T44 T45 T46 T47 T50 T51 T52 T53	Comparison output for channel 0.
T54	Channel 1 input data
T55 T56 T57 T60 T61 T62 T63 T64 T65 T66 T67	Comparison output for channel 1.

NOTE T40 and T54 can also be used to provide the comparison outputs.

Programming techniques

Follow this procedure for writing the program.

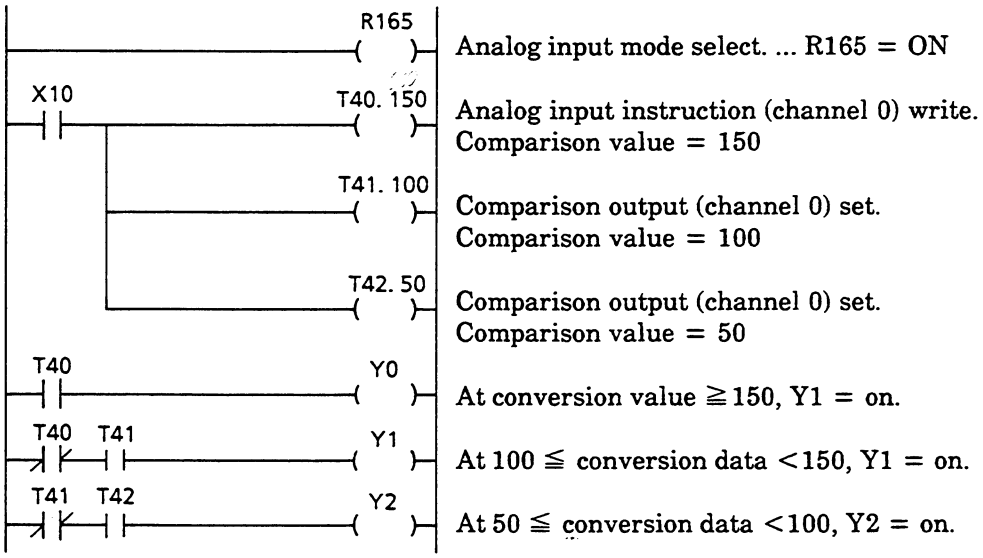
① Select an analog input mode. ..... R165 : ON

② Write analog input instructions. ..... T40 : channel 0
T54 : channel 1

③ Set comparison outputs ..... T41 through T53 : channel 0
T55 through T67 : channel 1

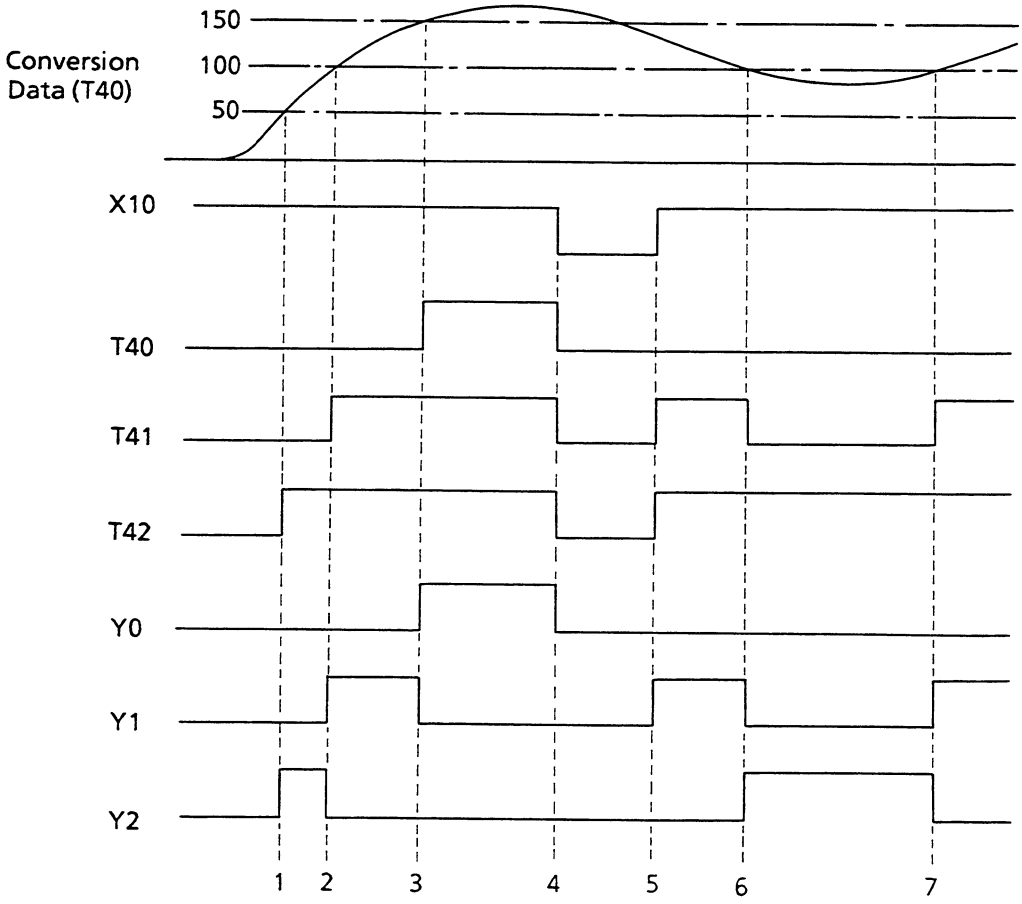
NOTE Both analog input instructions and comparison outputs can be programmed using the same procedure as for normal timer instructions.

Example



Input an analog signal in channel 0 of the analog input unit. As external input X10 turns on, comparisons will be made against the converted data.
In the above example, when the converted data is 150 or higher, T40 turns on. When it is 100 or higher, T41 turns on, while when it is 50 or higher, T42 turns on. Likewise, when the converted data is 50 or higher but below 100, Y2 turns on. When it is 100 or higher but below 150, Y1 turns on, while when it 150 or higher, Y0 turns on.

Timing chart



As the converted data exceeds 50, T42 turns on turning on Y2 at the same time: (1). As the converted data exceeds 100, T41 turns on turning Y1 on and Y2 off: (2). As the converted data exceeds 150, T40 turns on, turning Y0 on and Y1 off: (3). When X10 remains off, no comparisons are made, and the comparison output turns off: (4). When X10 turns on again, comparisons are resumed: (5).

NOTE

The programming procedure to input an analog signal in channel 1 is the same as that for channel 0, except that T54 through T67 are used instead of T40 through T53.

PART V

COMPUTER LINK UNIT

SECTION 1

Before You Begin

This section outlines this part and previews each section to provide a helpful headstart before you begin.

About this part

This part provides an introduction to the function and operation of the Computer Link Unit for the EX20PLUS/40PLUS. In this manual, PC is an abbreviation for Programmable Controller, not for Personal Computer.
This what you will find in the upcoming sections:

Section 2 System Configuration
This section introduces the computer interface function for the EX20PLUS/40PLUS. The system configuration and computer link network are described in this section.

Section 3 Installation and Wiring
This section explains how to install the Computer Link Unit, and how to connect between the interface unit and the computer.

Section 4 Specifications and Settings
This section contains the specifications of the communication interface. Switch settings on the Computer Link Unit are provided on this section.

Section 5 Command Format
This section explains the commands, which are sent from the computer to the EX20PLUS/40PLUS. A sample program for the personal computer is also provided here.

SECTION 2

System Configuration

Introducing the Computer Link Network

The Computer Link Unit makes the EX20PLUS/40PLUS capable of data communications with a host computer.

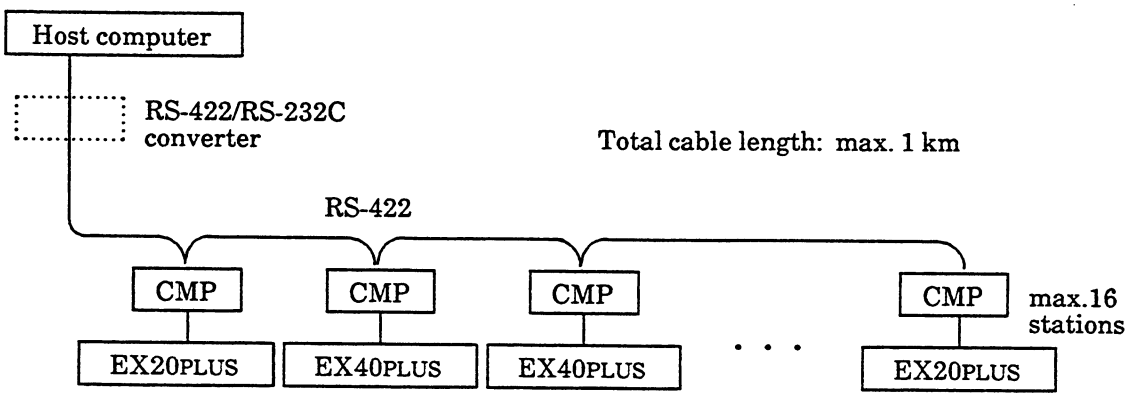
The data communications are carried out by the transmission of various request commands from the computer, and the return transmission of responses to the commands from the EX20PLUS/40PLUS.

The computer link functions allow the computer to implement the following functions with single or multiple units of the EX20PLUS/40PLUS:

1) Supervising the EXP20PLUS/40PLUS (monitoring the RUN/HALT/ERROR status)
2) Reading data from the EX20PLUS/40PLUS (including device and register data)
3) Controlling EX20PLUS/40PLUS operation (RUN/HALT)
4) Writing data to the EX20PLUS/40PLUS (including device and register data)
5) Program maintenance (uploading from /downloading to the EX20PLUS/40PLUS)

Computer Link Network

Up to 16 units of the EX20PLUS/40PLUS may be connected to a single computer. A station number (0, 1, ... 9, A, B, C , D, E, F) unique to each connected EX20PLUS/40PLUS units will be assigned. It is by the station number that the computer selects its communication partner.

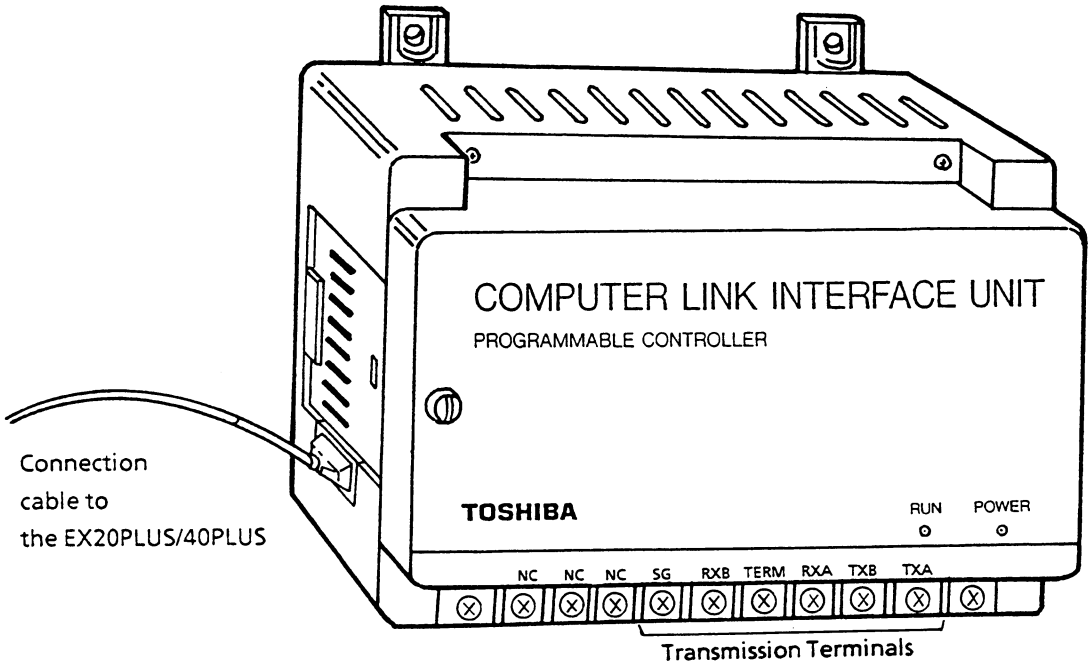


NOTE

1) CMP in the diagram stands for a Computer Link Unit.
2) The interface employed is RS-422. Where the computer operates under RS-232C, a converter (EX25PADP6237A) is required.
3) Where RS-422/RS-232C converter (EX25PADP6237A) is employed, up to 16 units may be connected. But where a computer's RS-422 port is connected directly, the number of PC units is sometimes limited by constraints at the computer side. Check the computer's RS-422 interface specifications before planning the network.

Computer Link Unit

The external features of the Computer Link Unit are shown below.



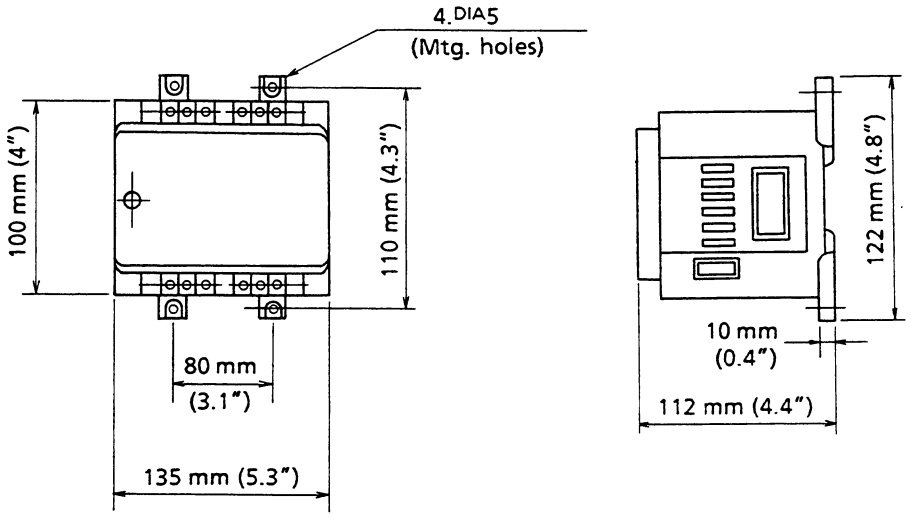
SECTION 3

Installation and Wiring

This section describes the Computer Link Unit installation procedure and transmission cable connections.

Installing the Computer Link Unit

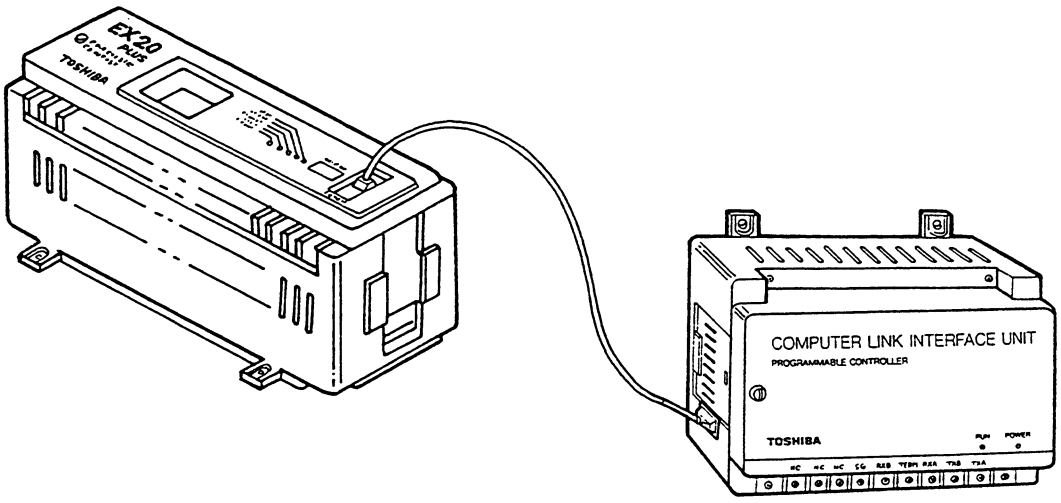
The unit is mounted either using 4mm screws or by clipping it to a 35mm DIN rail.



NOTE

The Computer Link Unit is connected to the EX20PLUS/40PLUS by a connection cable (30cm long) supplied together with each unit. When mounting the units, take the connecting cable length into consideration before assigning mounting locations.

Connecting units



Connect a Computer Link Unit to the EX20PLUS/40PLUS with the connection cable supplied with the unit. On the EX20PLUS/40PLUS, use the modular plug connector for the LCD programmer.

NOTE

1) The LCD programmer and Computer Link Unit cannot be used at the same time.
2) **When pulling a connector off the unit, always pull on the tab attached to the connector. Never pull the cable.**

Installation precautions

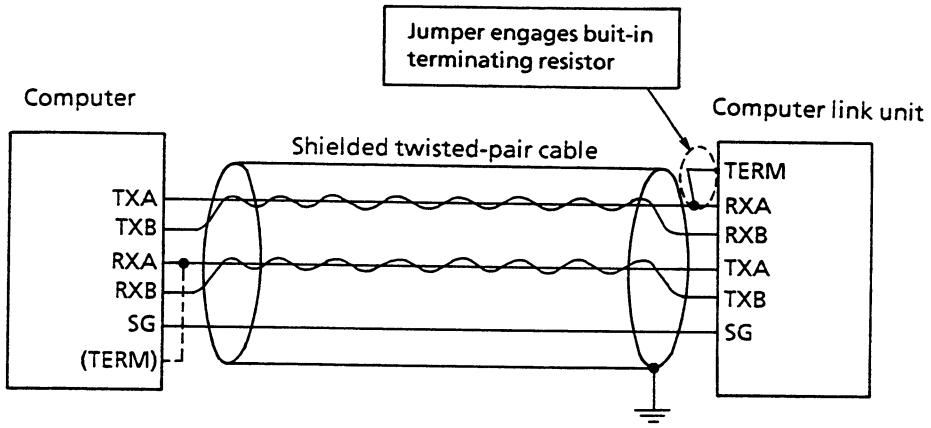
To avoid the adverse influence of electrical noise, isolate the cable that connects a Computer Link Unit with the EX20PLUS/40PLUS from all the other I/O signal lines, and lay it out as far as possible.

Transmission cable connection

The one-to-one mode and one-to-N mode of transmission cable connections are separately described.

A one-to-one mode means the configuration of a computer connected together with a single Computer Link Unit. A one-to-N mode is that of a computer connected together with multiple (2 to 16 units) Computer Link Units.

One-to-one Mode

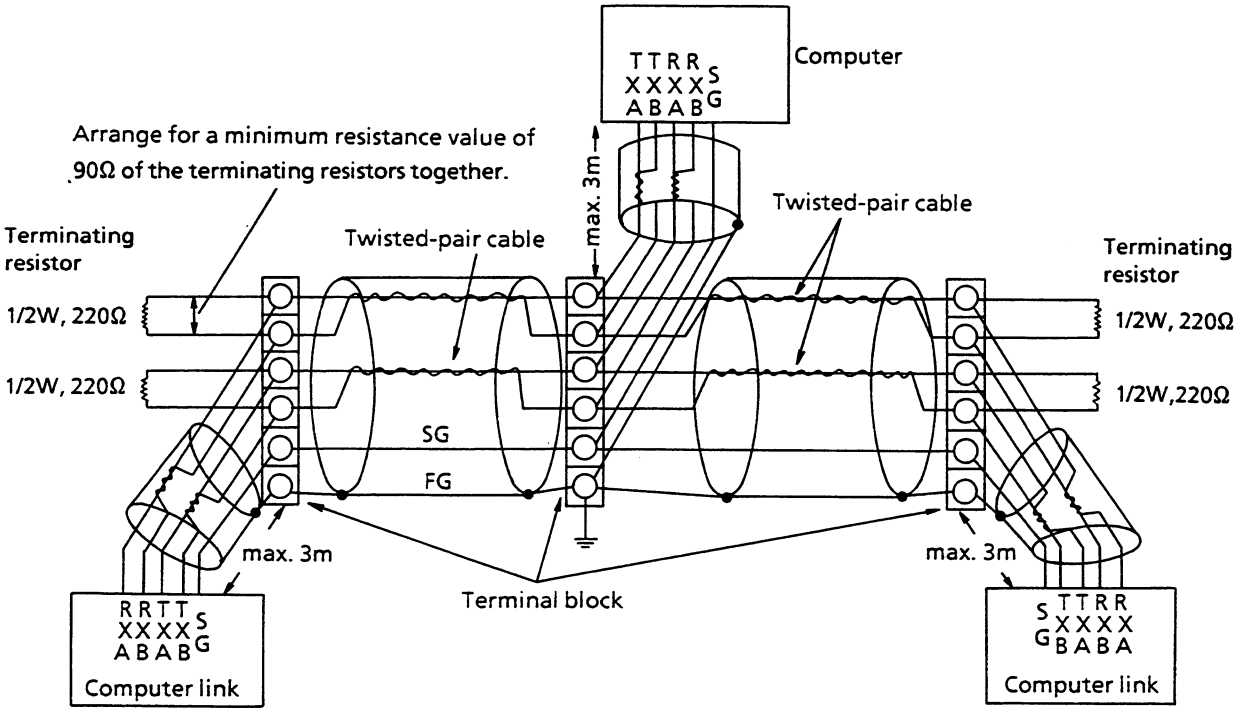


NOTE

1) For connecting cables, use shielded twisted-pair cables, and ground all their shields together at a single location.
2) To use the built-in terminating resistor of Computer Link Unit, connect its RXA and TERM terminals together externally.
3) If no terminating resistor is built in at the computer end, externally connect a 0.5-watt, 120-ohm resistor across terminals RXA and RXB of the computer.

One-to-N mode

(Examples of one to two)

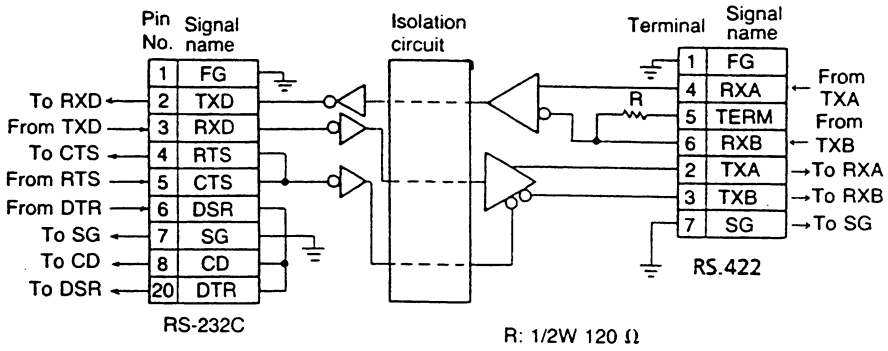


NOTE

1) Mount a 0.5-watt, 220-ohm terminating resistor on at each end of the transmission line, one across terminals RXA and RXB and the other across terminals TXA and TXB.
2) Use a shielded twisted-pair cable and ground its shield at a single location.
3) When branching a cable, use a terminal block as illustrated above, and keep the cable length from the terminal block to a Computer Link Unit or computer within 3 meters.

RS422/RS232C Converter (EX25PADP6237A)

The RS-422 interface has been employed for the Computer Link Unit. Where RS-232C interfaces are used for the computer instead of RS422, use an RS-422/RS-232C converter (EX25PADP6237A). An internal block diagram covering the converter is shown below.



NOTE Use DB-25P or equivalent connector on the RS-232C side.

Wiring precautions

- Total cable length should not exceed 1km.
- Use only shielded twisted-pair cable for RS-422 interface.
- The cable shield should be grounded at one point.

SECTION 4

Specifications and Settings

General specifications

General specifications of the Computer Link Unit are as follows.

Power consumption		Max. 200mA (supplied from PC)
Environ-ment	Operating temperature	0°C to 60°C (32° to 140°F)
	Storage temperature	-20° to 75°C (-4° to 167°F)
	Humidity	20 to 90% RH (no condensation)
Withstand voltage		500Vac for 1 min.

Transmission specifications

The following table shows the transmission specifications of the Computer Link Unit.

Interface	Conforms to RS-422 (RS-232C is used with RS-422/RS-232C converter)
Transmission mode	Half-duplex, 4-wire system
Synchronizing	System start-stop (asynchronous)
Transmission line configuration	Multidrop data highway (party line)
Transmission rates	1,200/2,400/4,800/9,600 bps (switchable)
Transmission distance	1 km (3,281 ft) max.
Transmission code	7-bit ASCII
Data length	8 bits (fixed)
Stop bit	1 bit (fixed)
Parity	Even/odd/no parity (switchable)
Number of connected stations	16 stations max.
Error check	Parity, BCC (Block check character)
Number of channels	1 channel

The number of connectable stations is sometimes limited by the RS-422 interface at the computer side. Check the computer specifications before planning.

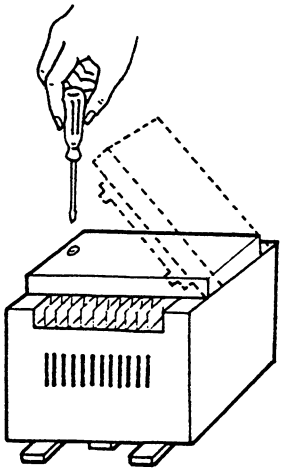
Switch settings

By setting the DIP (dual in-line packaged) switches on the Computer Link Unit, set the following:

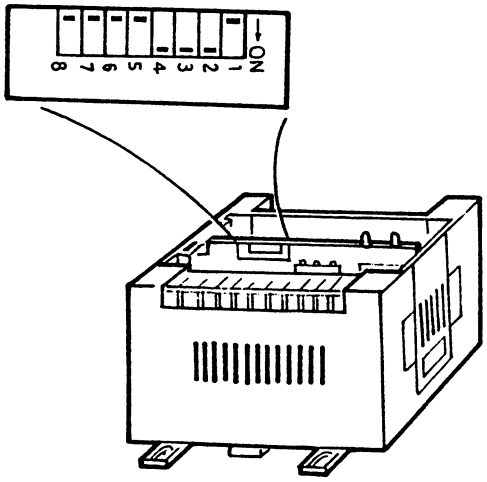
- Station No. – 0 to F
- Baud Rate – 1 ,200/2,400/4,800/9,600
- Parity – Yes/No
- Parity – Odd/Even (parity yes only)

Follow the steps described below.

① Remove the Computer Link Unit front panel.



② Find the DIP switches located as shown below on the computer link board.



③ By referring to the chart below, make the necessary settings.

Switch No.	ON	OFF
1 (PEN)	Parity	No parity
2 (EVN)	Even parity	Odd parity
3 (BR0)	Baud rate setting (see below)	
4 (BR1)		
5 (ADR0)	Station No. setting (see next page)	
6 (ADR1)		
7 (ADR2)		
8 (ADR3)		

Baud rate setting

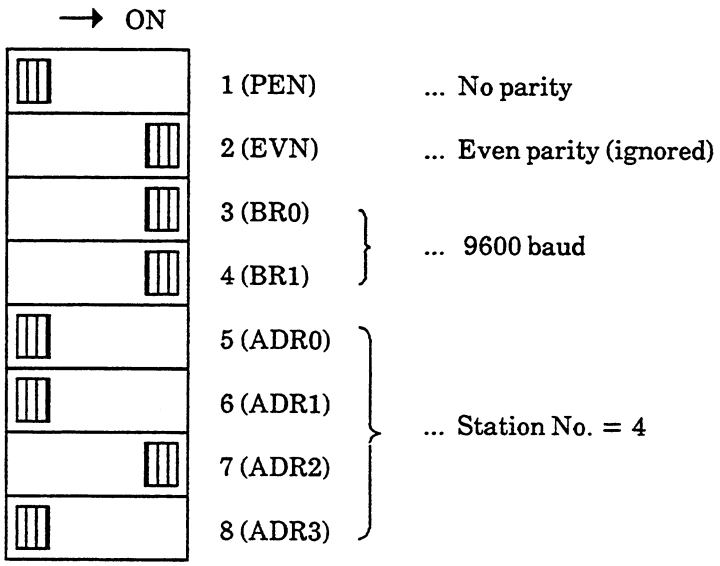
BR1	BR0	Baud rate
OFF	OFF	1200
OFF	ON	2400
ON	OFF	4800
ON	ON	9600

Station No. setting

ADR3	ADR2	ADR1	ADR0	Station No.
OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	ON	1
OFF	OFF	ON	OFF	2
OFF	OFF	ON	ON	3
OFF	ON	OFF	OFF	4
OFF	ON	OFF	ON	5
OFF	ON	ON	OFF	6
OFF	ON	ON	ON	7
ON	OFF	OFF	OFF	8
ON	OFF	OFF	ON	9
ON	OFF	ON	OFF	A
ON	OFF	ON	ON	B
ON	ON	OFF	OFF	C
ON	ON	OFF	ON	D
ON	ON	ON	OFF	E
ON	ON	ON	ON	F

HINT

Switch setting example



④ Replace the Computer Link Unit front panel back on. This concludes the switch setting operations.

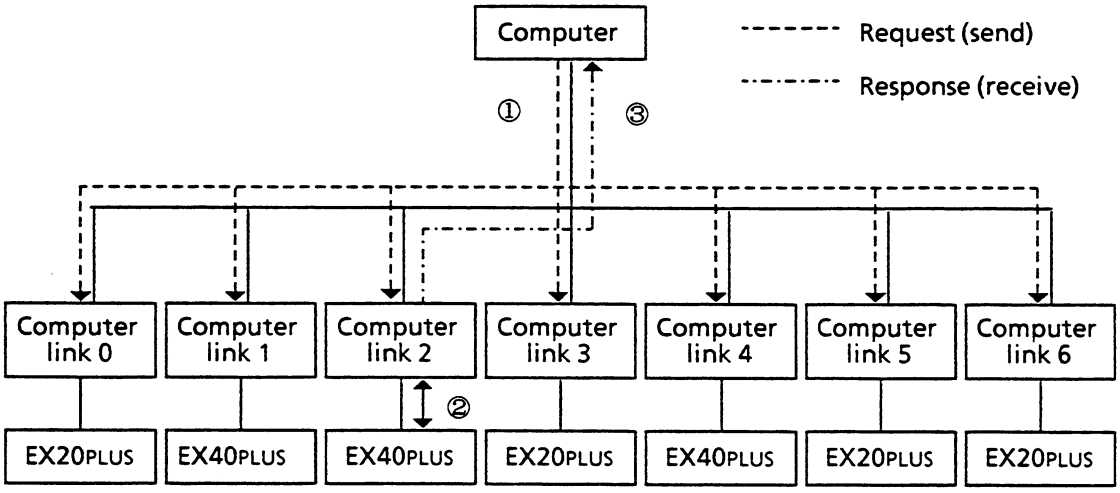
Switch settings are read at the initial power is supplied to the Computer Link Unit. Changes to settings while power is being supplied will have no effect.
Set switches either with power switched off the EX20PLUS/40PLUS or with the connecting cable between the EX20PLUS/40PLUS and Computer Link Unit disconnected.

SECTION 5

Command Format

Overview

In a computer link network, each Computer Link Unit constantly waits for requests issued by the computer. When a request is generated, each unit checks the station number of the request. The unit with the matching station number processes the request while the other Computer Link Units continue to stand by. This is why each Unit must have a unique station number; otherwise more than one unit may attempt to process the request, resulting in faulty data.
Processing flow executed when a request to station 2 is issued:

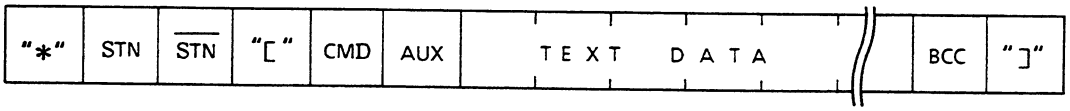


① Request is sent from computer to each station. (Request to station 2)
② Request is executed by station with same number as request. (only station 2 executes request.)
③ Processing result is returned as response to computer. (Response from station 2)

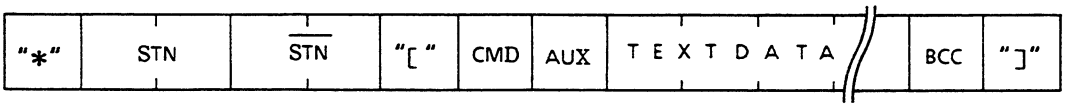
Data structure

Request frame format (from computer to Computer Link Unit)

a) Station No. is one character (0 to F)

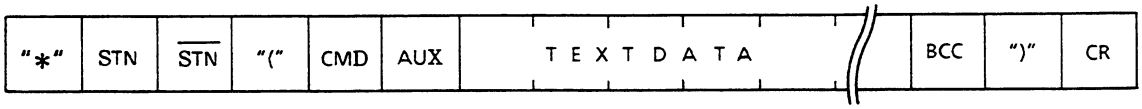


b) Station No. is two characters (00 to 0F)

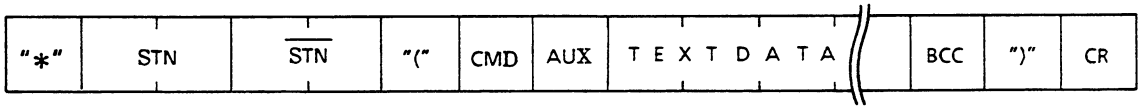


Response frame format (from Computer Link Unit to computer)

a) Station No. is one character (0 to F)

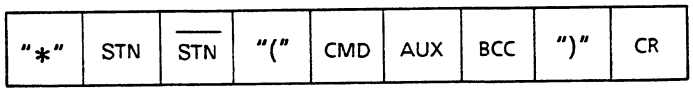


b) Station No. is two characters (00 to 0F)

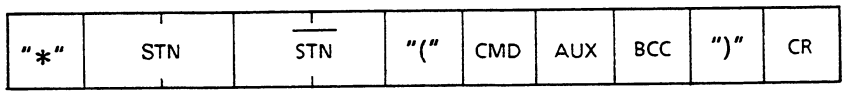


Abnormal response (from Computer Link Unit to computer)

a) Station No. is one character



b) Station No. is two characters



AUX for abnormal response means:

"1": NACK (No acknowledge) except for the following reasons:
"5": Error occurred in PC.
"8": Request frame is erroneous. } detected by Computer Link
"9": Response frame is erroneous. } Unit.

NOTE " " means an ASCII code for each charactor.

Field contents

- "*": Transmission begin (H2A)
- STN, $\overline{STN}$: Station No. and its invert (listed below)

	One character		Two characters	
	STN	$\overline{STN}$	STN	$\overline{STN}$
Station 0	"0" = H30	"F" = H46	"0", "0" = H30, H30	"F", "F" = H46, H46
Station 1	"1" = H31	"E" = H45	"0", "1" = H30, H31	"F", "E" = H46, H45
Station 2	"2" = H32	"D" = H44	"0", "2" = H30, H32	"F", "D" = H46, H44
Station 3	"3" = H33	"C" = H43	"0", "3" = H30, H33	"F", "C" = H46, H43
Station 4	"4" = H34	"B" = H42	"0", "4" = H30, H34	"F", "B" = H46, H42
Station 5	"5" = H35	"A" = H41	"0", "5" = H30, H35	"F", "A" = H46, H41
Station 6	"6" = H36	"9" = H39	"0", "6" = H30, H36	"F", "9" = H46, H39
Station 7	"7" = H37	"8" = H38	"0", "7" = H30, H37	"F", "8" = H46, H38
Station 8	"8" = H38	"7" = H37	"0", "8" = H30, H38	"F", "7" = H46, H37
Station 9	"9" = H39	"6" = H36	"0", "9" = H30, H39	"F", "6" = H46, H36
Station A	"A" = H41	"5" = H35	"0", "A" = H30, H41	"F", "5" = H46, H35
Station B	"B" = H42	"4" = H34	"0", "B" = H30, H42	"F", "4" = H46, H34
Station C	"C" = H43	"3" = H33	"0", "C" = H30, H43	"F", "3" = H46, H33
Station D	"D" = H44	"2" = H32	"0", "D" = H30, H44	"F", "2" = H46, H32
Station E	"E" = H45	"1" = H31	"0", "E" = H30, H45	"F", "1" = H46, H31
Station F	"F" = H46	"0" = H30	"0", "F" = H30, H46	"F", "0" = H46, H30

NOTE Two-character station number is reserved for future expansion. Later in this section, each command is explained using a one-character station number.

- "[": Data start code for request (H5B)
- "(": Data start code for response (H28)
- CMD: Command code (listed on the next page)

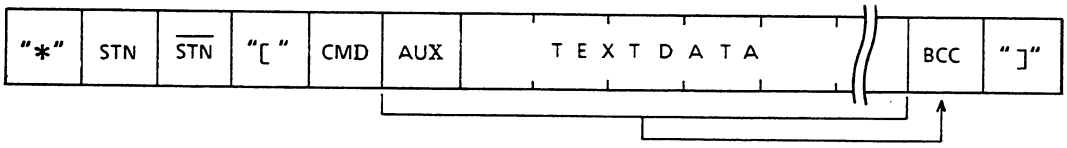
CMD	FUNCTION
"A" = H41	Sequential memory read
"B" = H42	Random memory read
"F" = H46	Status read
"H" = H48	Sequential memory write
"I" = H49	Random memory write
"J" = H4A	Random bit write
"L" = H4C	PC control
"T" = H54	Test

- AUX: Auxiliary command code ("0" to "9" = H30 to H39, specified by each command)

- TEXT DATA: Data field
- BCC: Block Check Character (error check code) (BCC error checking is explained later.)
- "]": Data end code for request (H5D)
- ")": Data end code for response (H29)
- CR: Carriage return code (H0D)

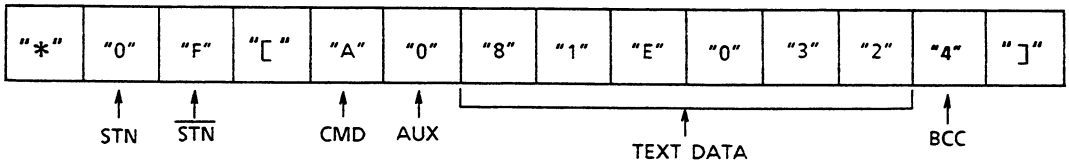
Programming BCC error checking

In a transmission frame shown below, the BCC is determined as follows:



All the individual digits of AUX and TEXT DATA as well as BCC which is regarded as a hexadecimal number are summed together, and BCC is determined by making the lowest single digit of the sum a zero (0)

Example:



In this example transmission frame, the BCC is calculated as follows:

0+8+1+E+0+3+2=1C (Hex)
1C+4=20(Hex)

Therefore:

BCC = "4"

EX20PLUS/40PLUS memory maps

Data Memory

Carry out the data read/write operations, referencing the following addresses.

De-vice	Address (HEX)	Bit							
		7	6	5	4	3	2	1	0
X	"0100"	X7	X6	X5	X4	X3	X2	X1	X0
	"0101"	X17	X16	X15	X14	X13	X12	X11	X10
	∫	∫							
	"0107"	X77	X76	X75	X74	X73	X72	X71	X70
	"0108"	X107	X106	X105	X104	X103	X102	X101	X100
Y	"0140"	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0
	"0141"	Y17	Y16	Y15	Y14	Y13	Y12	Y11	Y10
	∫	∫							
	"0144"	Y47	Y46	Y45	Y44	Y43	Y42	Y41	Y40
	"0145"	Y57	Y56	Y55	Y54	Y53	Y52	Y51	Y50
R	"0180"	R7	R6	R5	R4	R3	R2	R1	R0
	"0181"	R17	R16	R15	R14	R13	R12	R11	R10
	∫	∫							
	"018E"	R167	R166	R165	R164	R163	R162	R161	R160
	"018F"	R177	R176	R175	R174	R173	R172	R171	R170

De-vice	Address (HEX)	Bit							
		7	6	5	4	3	2	1	0
L	"01E0"	L7	L6	L5	L4	L3	L2	L1	L0
	"01E1"	L17	L16	L15	L14	L13	L12	L11	L10
	∫	∫							
	"01EE"	L167	L166	L165	L164	L163	L162	L161	R160
	"01EF"	L177	L176	L175	L174	L173	L172	L171	L170
S	"0200"	S7	S6	S5	S4	S3	S2	S1	S0
	"0201"	S17	S16	S15	S14	S13	S12	S11	S10
	∫	∫							
	"021E"	S367	S366	S365	S364	S363	S362	S361	S360
	"021F"	S377	S376	S375	S374	S373	S372	S371	S370
T	"0220"	T7	T6	T5	T4	T3	T2	T1	T0
	"0221"	T17	T16	T15	T14	T13	T12	T11	T10
	∫	∫							
	"0226"	T67	T66	T65	T64	T63	T62	T61	T60
	"0227"	T77	T76	T75	T74	T73	T72	T71	T70
C	"0260"	C7	C6	C5	C4	C3	C2	C1	C0
	"0261"	C17	C16	C15	C14	C13	C12	C11	C10
	∫	∫							
	"0266"	C67	C66	C65	C64	C63	C62	C61	C60
	"0267"	C77	C76	C75	C74	C73	C72	C71	C70

NOTE When an individual bit is 0, the corresponding device is off, and when it is 1, the device is on.

For example, when the data at address 0100 is 1F, it indicates the following:

X0: ON
X1: ON
X2: ON
X3: ON
X4: ON
X5: OFF
X6: OFF
X7: OFF

Timer/Counter current value

The current timer/counter value is stored at the following addresses.

Item	Address (HEX)	Contents	Item	Address (HEX)	Contents
Counter current value	"0300"	C0 lower byte	Timer current value	"0400"	T0 lower byte
	"0301"	C0 higher byte		"0401"	T0 higher byte
	"0302"	C1 higher byte		"0402"	T1 lower byte
	"0303"	C1 higher byte		"0403"	T1 higher byte
	∫	∫		∫	∫
	"037C"	C76 lower byte		"047C"	T76 lower byte
	"037D"	C76 higher byte		"047D"	T76 higher byte
	"037E"	C77 lower byte		"047E"	T77 lower byte
	"037F"	C77 higher byte		"047F"	T77 higher byte

NOTE The current timer/counter value consists of a lower byte and a higher byte. The value must be converted to read it with a computer link.

For example, when:

The data at address 0300 is C8, and the data at address 0301 is 16,

they indicate a current C0 value to be:

16C8 (HEX) = 5,832 (DECIMAL)

Program memory

The program memory area ranges from address 8000 to 87FF(RAM), and C000 to C7FF(if ROM is used).

NOTE To upload the PC program into a computer, data at addresses 8000 through 87FF are read successively by a sequential memory read command that will be discussed later. Then, by having the data uploaded to the computer written in addresses 8000 through 87FF of the PC by a sequential memory write command, PC programming (downloading) is controlled by the computer.

CAUTION Be very careful not to accidentally overwrite the program memory area data, as the PC system may crash.

Commands

Sequential memory read (command code = "A")

- Function
  Reads successive data up to 32 bytes , starting with a specified address.

- Request Frame

"*"	STN	$\overline{\text{STN}}$	"["	"A"	"0"	START ADDRESS	N	BCC	"]"

START ADDRESS: The starting address for data to be read (See Memory Map.)

N: The number of bytes to be read --- 00 to 20 (Hex)

- Response frame

"*"	STN	$\overline{\text{STN}}$	"("	"A"	AUX	START ADDRESS	D1	D2	...

...	DN	BCC	")"	CR

D1 through DN: Data contents ... "00" to "FF"

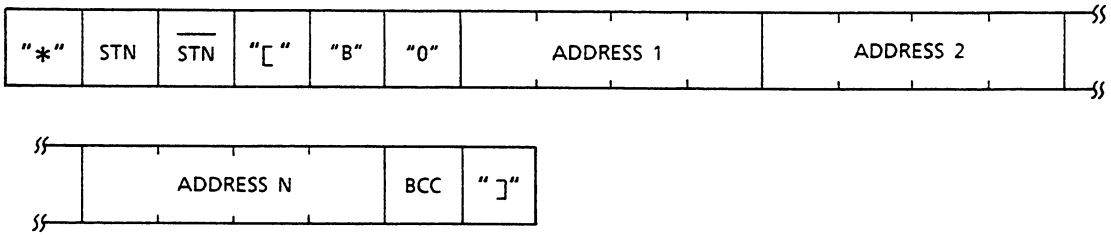
AUX: Auxiliary command ... "0" = Normal
"4" = Error occurred in PC

Random memory read (command code = "B")

- Function

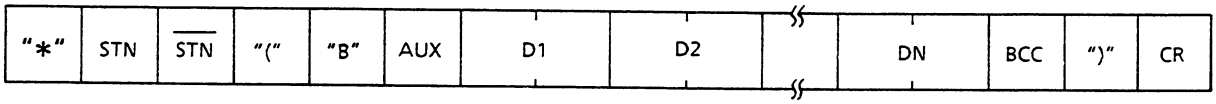
  Reads the data at a specified address to be read. Up to 17 addresses may be specified.

- Request frame



ADDRESS 1 through N: Specifiable address (See Memory Map.)
(N = 17 max.)

- Response frame



D1 through DN: Data at corresponding address ... "00" to "FF"

AUX: Auxiliary command ... "0" = Normal
"4" = Error occurred in PC

Status read (command code = "F")

- Function

  Read the PC status.

- Request frame

"*"	STN	$\overline{\text{STN}}$	"["	"F"	"0"	BCC	"]"

- Response frame

"*"	STN	$\overline{\text{STN}}$	"("	"F"	AUX	ST1	ST2	BCC	")"	CR

AUX: Auxiliary command ··
- "0" = Normal
- "4" = Error occurred in PC

ST1: PC Status ·····
- "00" = HALT
- "02" = RUN
- "03" = STOP

ST2: PC Error Code ··
- When AUX = "0", ST2 = "00"
- When AUX = "4", ST2 = Error Code (See below)

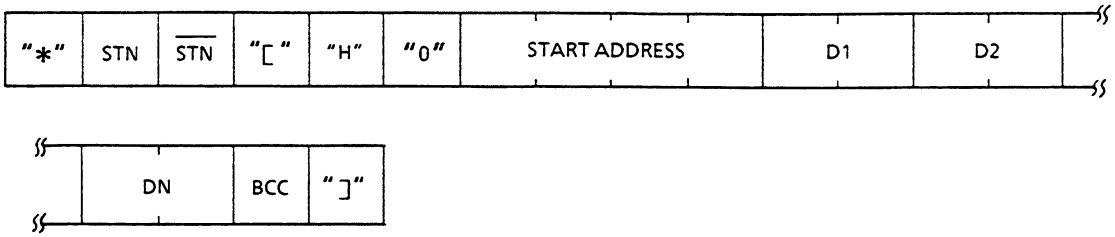
Error Code	Significance
"00"	Program error
"01"	PC's CPU error
"02"	Transmission data error
"03"	Transmission suspended

Sequential memory write (command code = "H")

- Function

  Writes any data at consecutive addresses starting with a specified address for 32 bytes maximum.

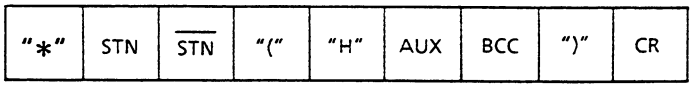
- Request frame



START ADDRESS: The starting address at which to write data (See Memory Map.)

D1 through DN: Writing data (N = 32 max.)

- Response frame



AUX: Auxiliary command ··
- "0" = Normal
- "3" = Write inhibit due to PC in a run mode
- "4" = Write inhibit due to PC error

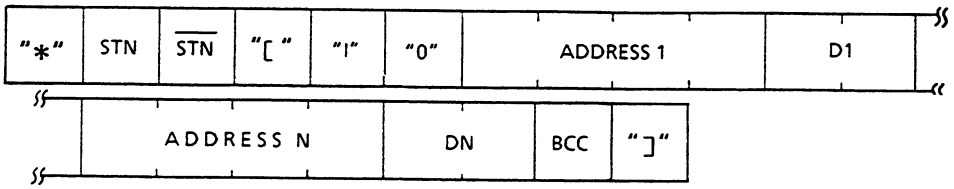
CAUTION

RAM memory in the PC may be overwritten by this command from a computer, but utmost caution should be exercised against malfunctions of the PC due to the overwriting.

Random memory write (command code = "I")

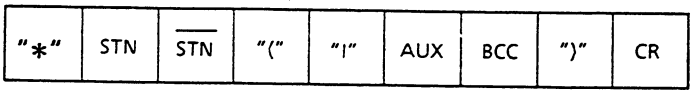
- Function
  Write data at up to 11 arbitrary addresses.

- Request frame



ADDRESS 1 through N: The address for data to be written at (See Memory Map.)
D1 through DN: Writing data (N = 11 max.)

- Response frame



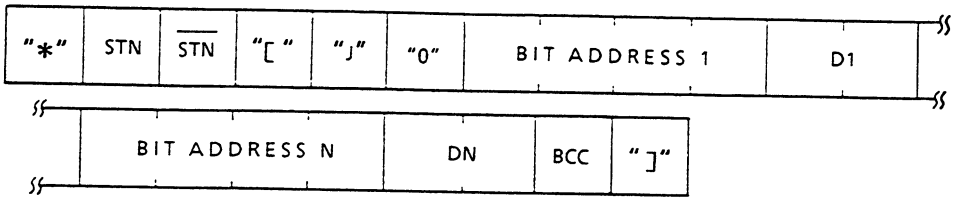
AUX: Auxiliary command ..... { "0" = Normal
"4" = Write inhibit due to a PC error

CAUTION RAM memory in the PC may be overwritten by this command from a computer, but utmost caution should be exercised against malfunctions of the PC due to the overwriting.

Random bit write (command code = "J")

- Function
  Write the ON/OFF status at a specified address on one of the devices, X, Y, R, L, T, C and S. Up to 11 addresses may be specified.

- Request frame



BIT ADDRESS 1 through N: Specified Bit Address (N = 11 max.)
(See table on next page.)

D1 through DN: Writing Data ..... { "00" = OFF
"01" = ON

- Response frame

"*"	STN	$\overline{\text{STN}}$	"("	"J"	AUX	BCC	")"	CR

AUX: Auxiliary command ..... { "0" = Normal / "4" = Write inhibit due to a PC error

CAUTION RAM memory in the PC may be over-written by this command from a computer, but utmost caution should be exercised against malfunctions of the PC due to the overwriting.

BIT ADDRESS	DEVICE
"0000"	X000
"0001"	X001
⋮	⋮
"0007"	X007
"0008"	X010
⋮	⋮
"000F"	X017
"0010"	X020
⋮	⋮
"0013"	X023
⋮	⋮
"0200"	Y000
"0201"	Y001
⋮	⋮
"0207"	Y007
"0208"	Y010
⋮	⋮
"020D"	Y015
⋮	⋮

BIT ADDRESS	DEVICE
"0400"	R000
"0401"	R001
⋮	⋮
"043F"	R077
"0440"	R100
⋮	⋮
"047F"	R177
⋮	⋮
"0700"	L000
"0701"	L001
⋮	⋮
"073F"	L077
"0740"	L100
⋮	⋮
"077F"	L177
⋮	⋮

BIT ADDRESS	DEVICE
"0800"	S000
"0801"	S001
⋮	⋮
"083F"	S007
"0840"	S100
⋮	⋮
"087F"	S177
"0880"	S200
⋮	⋮
"08BF"	S277
"08C0"	S300
⋮	⋮
"08FF"	S377

BIT ADDRESS	DEVICE
"0900"	T000
"0901"	T001
⋮	⋮
"0907"	T007
"0908"	T010
⋮	⋮
"093F"	T077
⋮	⋮
"0B00"	C000
"0B01"	C001
⋮	⋮
"0B07"	C007
"0B08"	C010
⋮	⋮
"0B3F"	C077

PC Control (command code = "L")

- Function

  Controls the PC run mode (Run/Halt), or clears the program memory area.

- Request frame

"*"	STN	$\overline{\text{STN}}$	"["	"L"	AUX	BCC	"]"

AUX: Auxiliary command ···
- "0" = RUN → HALT
- "1" = HALT → RUN
- "3" = Error reset
- "4" = Program memory clear

- Response frame

"*"	STN	$\overline{\text{STN}}$	"("	"L"	AUX	ST1	ST2	BCC	")"	CR

ST1: PC Status (See Status Read Command.)

ST2: PC Error Code (See Status Read Command.)

AUX: Auxiliary command ···
- "0" = Normal
- "4" = Error in PC

Test command (command code = "T")

- Function

  Tests transmission lines.

- Request frame

"*"	STN	$\overline{\text{STN}}$	"["	"T"	AUX	BCC	"]"

AUX: Auxiliary command ·····
- "0" = Tests all transmission lines.
- "1" = Tests the line between the computer and Computer Link Unit.

- Response frame

"*"	STN	$\overline{\text{STN}}$	"("	"T"	AUX	RES	BCC	")"	CR

RES: Response ··· { "00" = Normal response for request "T0"
"10" = Normal response for request "T1"

AUX: Auxiliary command ··· { "0" = Normal
"4" = Error in PC

Sample program

Shown below is a sample program written in IBM-PC™ BASIC. This example sets the baud rate at 9,600, no parity, 8 data bits, and one stop bit.

```
100  '************************************************
110  '*                  COMPUTER LINK TEST                  *
120  '*                  (SEND & RECEIVE TEST)               *
130  '*            6-15-1987    FILENAME = TESTEX             *
140  '************************************************
150  '******************** INITIALIZE **********************
160  KEY OFF : DEFSNG A - Z
170  '************ COMMUNICATION INITIALIZE ******************
180  OPEN "COM1 : 9600, N, 8, 1" AS #1
190  '***************** KEY INPUT ***************************
200  TEXT$ = "" : CLS
210  INPUT "INPUT DATA        = ", TEXT$
220  INPUT "STATION NO.       = ",STN$
230  L = LEN(TEXT$) :  BCC = 0
240  FOR M = 2  TO  L
250  BCC$ = MID$(TEXT$,M,1)
260  BCC = BCC + VAL ("&H" + BCC$)
270  NEXT M
280  IF BCC = 0 THEN BCC$ = "0" :GOTO 320
290  N = BCC/16
300  BCC = 16 - 16*(N - FIX(N))
310  BCC$ = HEX$(BCC)
320  STNINV$ = HEX$(15 - VAL("&H" + STN$))
330  TEXT1$ = "*" + STN$ + STNINV$ + "[" + TEXT$ + BCC$ + "]"
340  PRINT "SEND DATA         = ";TEXT1$
350  '************** DATA SEND ********************
360  PRINT #1,TEXT1$
370  '*************** RECEIVE  DATA ***************
380  A$ = "":B$ = "":RD$ = "":TIME$ = "00:00:00"
390  WHILE B$ <>CHR$(&HD)
400      IF TIME$ = "00:00:03" THEN CLS:PRINT "TIMEOUT ERROR":CLOSE:END
410      WHILE LOC (1) <>0
420          A$ = INPUT$(LOC(1),#1)
430          RD$ = RD$ + A$
440          B$ = RIGHT$(A$,1)
450      WEND
460  WEND
470  M = 6:IF MID$(RD$,4,1)<>"(" THEN M = 8
480  IF MID$(RD$,M,1) = "0" THEN PRINT "RECEIVE DATA = ";RD$:GOTO 500
490  PRINT "COMMUNICATION ERROR !!  ";RD$
500  LOCATE 23:INPUT "CONTINUE ?  [Y/N] " ,CONTINUE$
510  IF CONTINUE$ = "N" OR CONTINUE$ = "n" THEN CLS:CLOSE:END
520  IF CONTINUE$ = "Y" OR CONTINUE$ = "y" THEN 200
530  BEEP:GOTO 500
```

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Sample program execution example

An execution example is shown below using the test command (command code = "T").

1) Set DIP switches on the Computer Link Unit as follows:

- Station No. = 0
- Baud rate = 9600
- Parity = None

} See section 4 of this part.

2) Switch on the EX20PLUS/40PLUS power, and check that the POWER and RUN LEDs of the Computer Link Unit light up.
3) Run this sample program on the computer.
4) The following message will appear on the computer display:

```
INPUT DATA =
```

5) To execute test command AUX=0 (all the transmission lines to be tested), input T0 [↵]

```
INPUT DATA = T0
```

6) The following message will then appear on the display:

```
STATION NO. =
```

7) Since the station number has been set at 0 for this execution example, key-in 0 [↵]

```
STATION NO. = 0
```

8) The BCC calculations and data transmission/reception will be executed, and the following message will appear:

```
SEND DATA      = 0F [T00]
RECEIVE DATA   = 0F (T0000)
```

This display indicates normal operations.

NOTE

1) When COMMUNICATION ERROR is displayed, an error has occurred (unless AUX of the response is 0). Check the connection of transmission cables and the setting of DIP switches.
2) When TIMEOUT ERROR is displayed, no response has been sent from the Computer Link Unit. Check if the EX20PLUS/40PLUS power is on, or if correct station number settings have been made.

PART VI

GUIDE TO APPLICATIONS

SECTION 1

Before You Begin

This section outlines this part and previews each section to provide a helpful headstart before you begin.

About this part

This part provides hints for typical user applications.
The scope of applications for the EX20PLUS/40PLUS is wide and varied. This part presents selected examples of programming techniques and special functions.

This is what you will find in the upcoming sections.

Section 2 Programming Techniques

This section presents a number of programming techniques that extend the usefulness of the instructions.

Section 3 High-Speed Counter Application

This section shows an application example of the High-Speed Counter function. The hardware configuration is described and a sample program is provided.

Section 4 Analog Input Application

This section presents an application example of the analog input. Hardware configuration and a sample program are provided.

SECTION 2

Programming Techniques

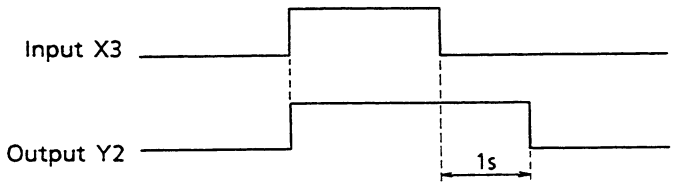
Timers

Programmable controllers basically function as timers. The following are two examples of the timer functions, the off-delay timer and extended timer.

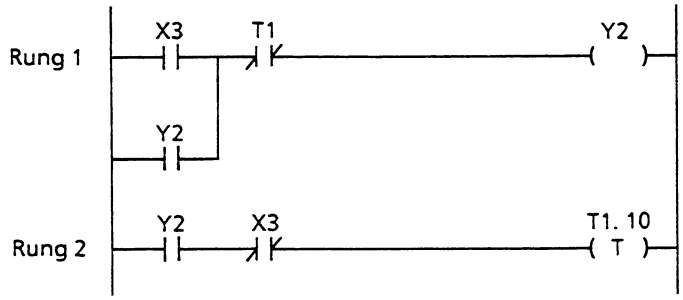
Off-delay timers

The off-delay timer function turns a timer on as the input signal turns on, then off at a preset interval after the input signal turns off.

Timing Chart



Ladder diagram

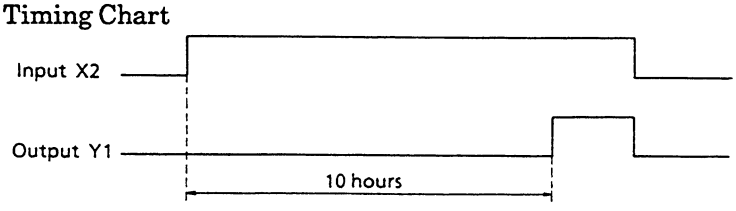


Rung 1: When X3 turns on, Y2 turns on and remains on until T1 turns on.
Rung 2: When X3 turns off while Y2 is on, timer T1 starts counting down, and one second later, T1 turns on.

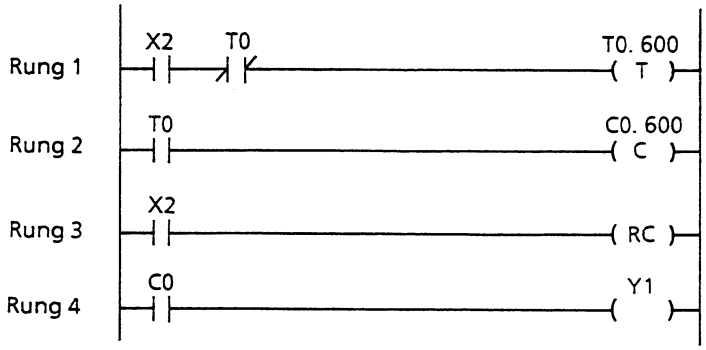
Extended timers

A long duration timer can be configured by programming two combined timers or a timer combined with a counter.
The following is an example of a 10 hour timer configured by combining a timer with a counter.

Timing Chart



Ladder Diagram



Rung 1: When X2 turns on, T0 pulses on every 60 seconds.

Rungs 2and 3: These constitute a counter circuit for counting the number of times T0 turns on, while X2 is on. As T0 finishes turning on 600 times, C0 turns on.

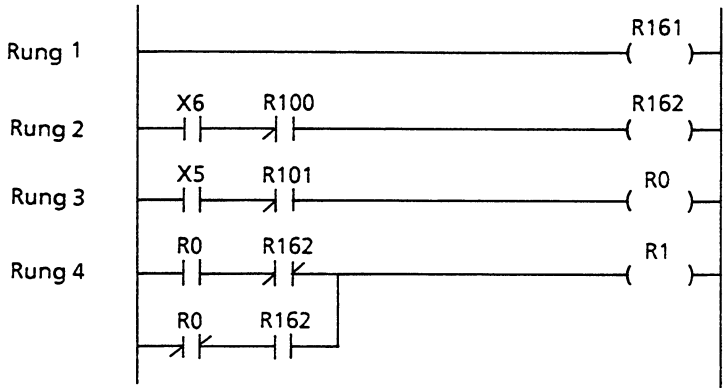
Rung 4: When C0 turns on, Y1 also turns on.

Counters

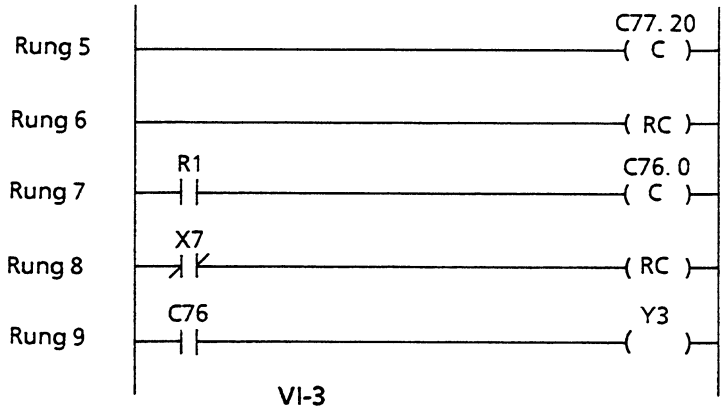
As an application example of the counter functions, the 8-digit up/down counter is presented here.

In the sample program below, "1" is added to the count (an up-count) as input X5 turns on, or is subtracted from the count (a down-count) as X6 turns on. Then, as the count reaches a preset value (200,000), output Y3 turns on. When X7 turns on, the count is cleared at "0".

Screen 1



Screen 2



Rung 1: Have R161 turn on (to select 8-digit mode).

Rung 2: Have R162 turn on for one scan at the rising edge where X6 turns on. (Down-counts at R162 = ON.)

Rung 3: Have R0 turn on for one scan at the rising edge where X5 turns on.

Rung 4: Have R1 turn on when either R0 or R162 is on. (If R0 and R162 are both on, R1 will remain off.)

Rungs 5 and 6: Provide a counter instruction for four upper digits, for a setting at 20.

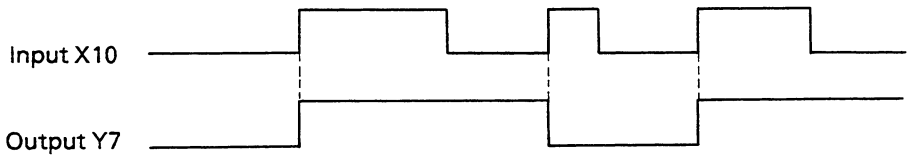
Rungs 7 and 8: Provide a counter instruction for four lower digits, for a setting at 0. (At 8-digit counter setting now made = 200,000) Count Input: R1, Reset Input: X7

Rung 9: When C76 turns on (when the count reaches 200,000), have Y3 turn on.

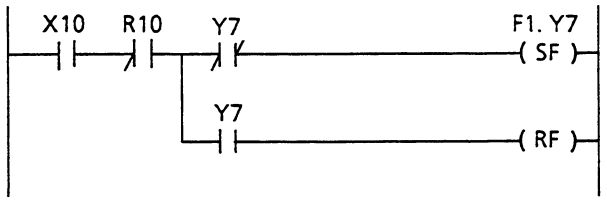
Transitional contacts

As an application example of the transitional contact, the status inverter combined together with a flip-flop is presented below.

Timing chart



Ladder diagram



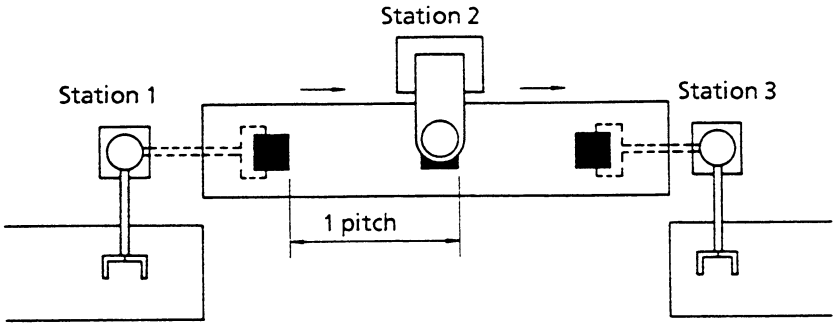
Step sequencers

Step sequencers enable sequential control.

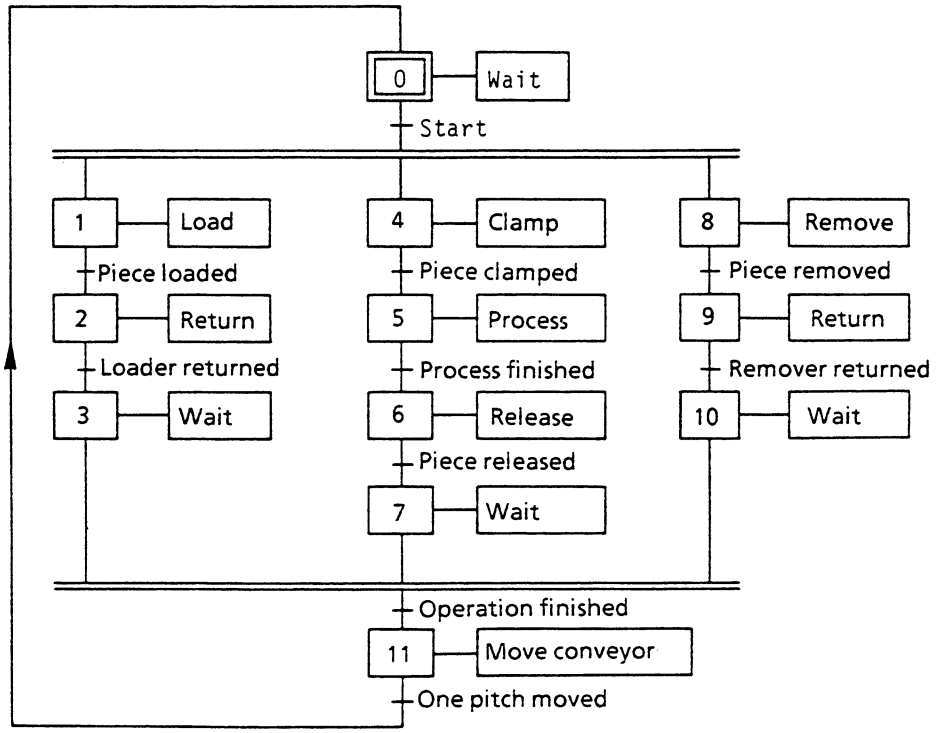
To see how this works, take a look at the figure below. In a manufacturing line, a conveyor belt is moved intermittently at one pitch in order to serve three work stations.

When the start signal comes on, operation begins at each station. At station 1, the loader loads the workpiece onto the conveyor. At station 2, the machine tool clamps the workpiece and performs processing. At station 3, the remover removes the workpiece from the conveyor.

When operations of every station are finished, the conveyor is moved one pitch.



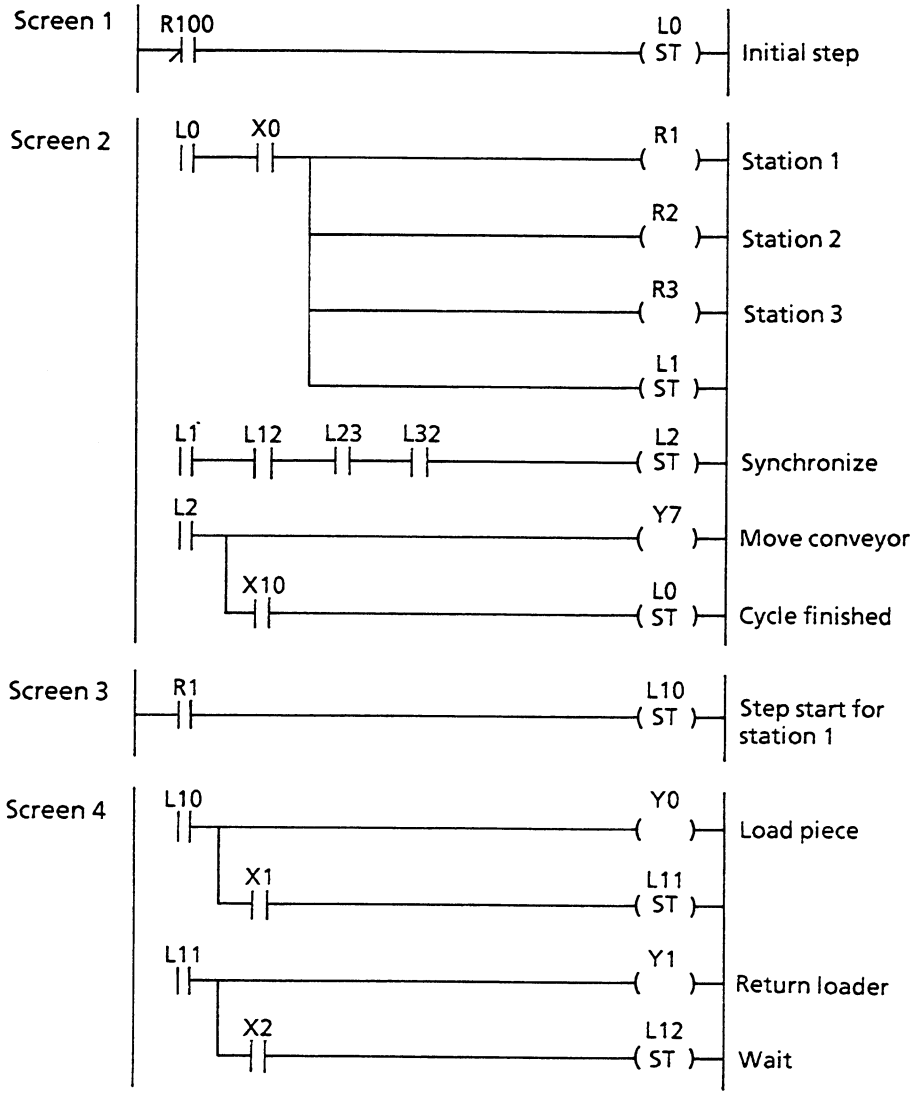
This sample operation is described in the following flow chart.

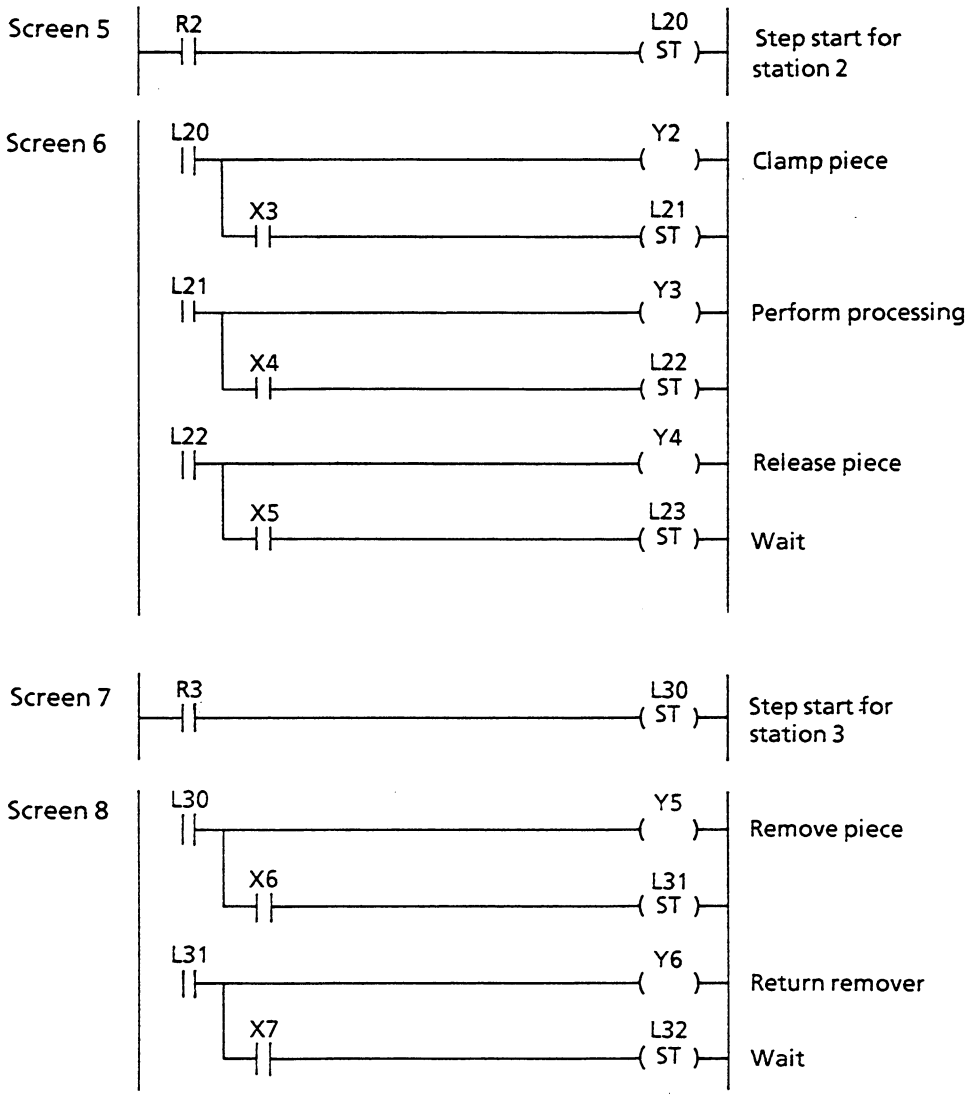


Device assignment

Input:		Output:	
Start signal	= X0	Load piece	= Y0
Piece loaded	= X1	Return loader	= Y1
Loader returned	= X2	Clamp piece	= Y2
Piece clamped	= X3	Perform process	= Y3
Process finished	= X4	Release piece	= Y4
Piece released	= X5	Remove piece	= Y5
Piece removed	= X6	Return remover	= Y6
Remover returned	= X7	Move conveyor	= Y7
One pitch moved	= X10		

Ladder diagram

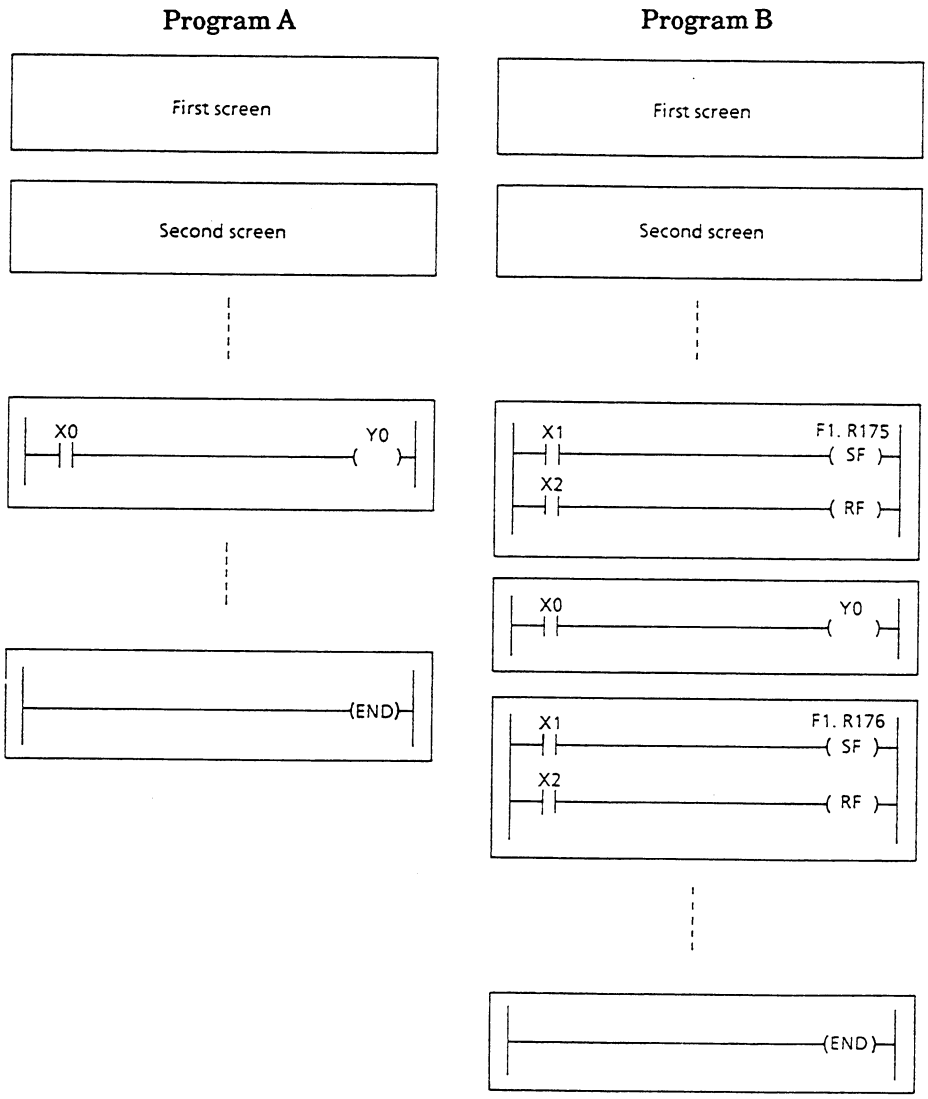



Screen 5
R2
L20
ST
Step start for station 2
Screen 6
L20
Y2
Clamp piece
X3
L21
ST
L21
Y3
Perform processing
X4
L22
ST
L22
Y4
Release piece
X5
L23
ST
Wait
Screen 7
R3
L30
ST
Step start for station 3
Screen 8
L30
Y5
Remove piece
X6
L31
ST
L31
Y6
Return remover
X7
L32
ST
Wait

Critical I/O update functions

Critical input update and output update functions effectively speed up the I/O responses.

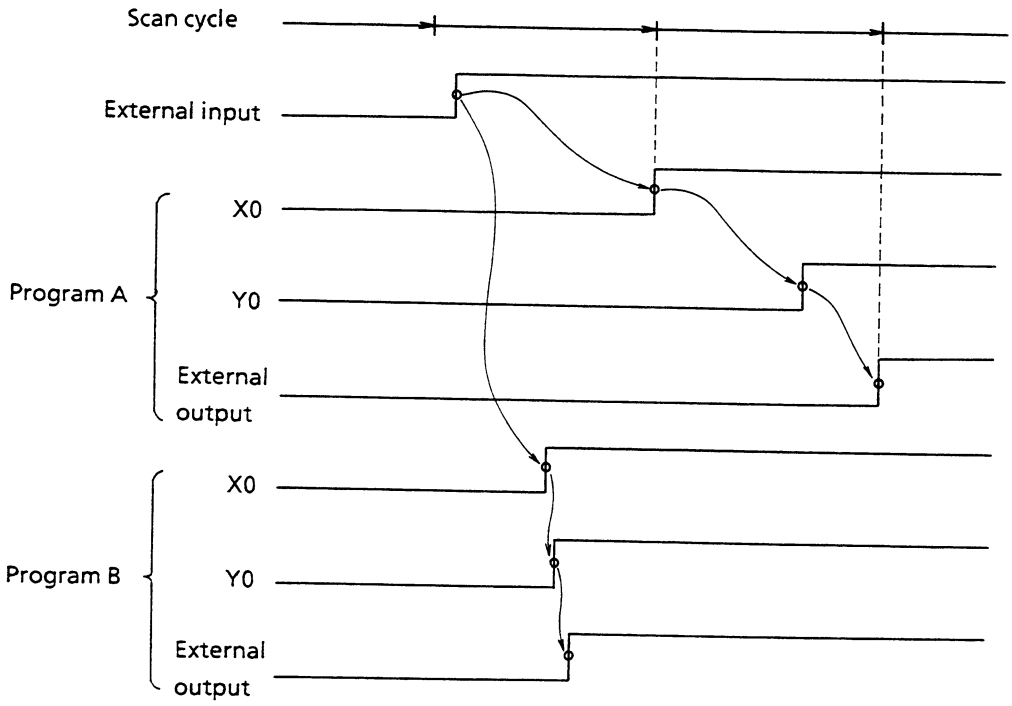
The I/O update function is described below by a simple example.



Program A above is a normal program, and program B one for which input update (F1-R175) and output update (F1-R176) functions are employed.

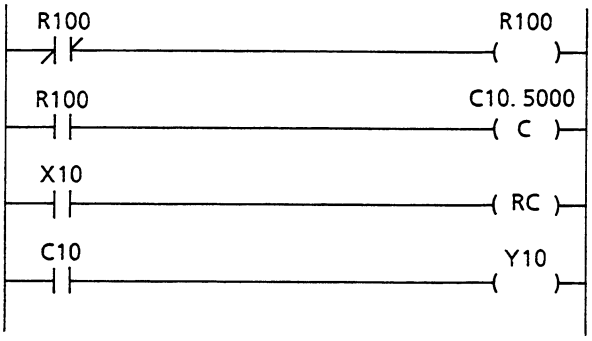
In program A, an external input signal is read at every scan into device X. Similarly, the device Y status is output at every scan as an external signal.
In program B, on the other hand, an external input signal is read into device X at the instant (midway through a scan) an input update is performed. The current device Y status is similarly output as an external signal at the instant (midway through a scan) an output update is performed.

An example of a timing chart for the activity is shown below. It reveals that the faster response is achieved by program B.



Scan time calculation

Although it is not a programming technique as such, the scan time measuring procedure is presented here for additional information. The scan time is lengthened or shortened according to the executed mode of individual instruction steps. But by adding the program shown below to a program being debugged, an approximate mean scan time is revealed.



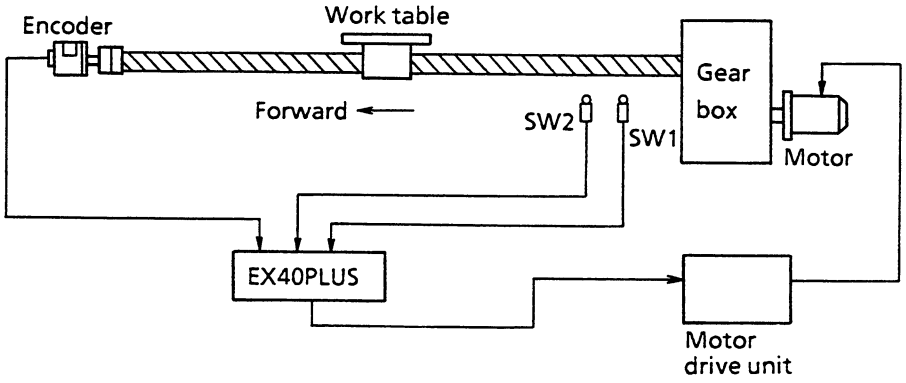
Scan time ≃ T/10000 (T: Time duration from the turning on of X10 to that of Y10)

SECTION 3

High-Speed Counter Application

Sample system

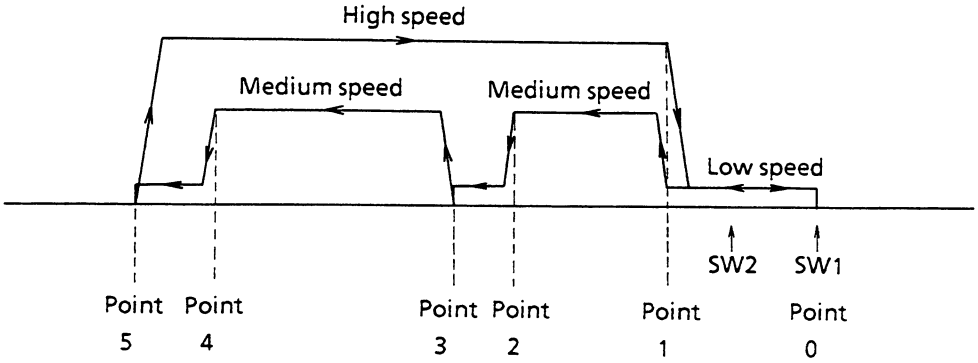
As a High-Speed Counter application example, the following illustrated simple positioning system is introduced.



In this sample system, EX40PLUS counts the signal pulses from an encoder, and by driving a motor, controls positioning of a work table.

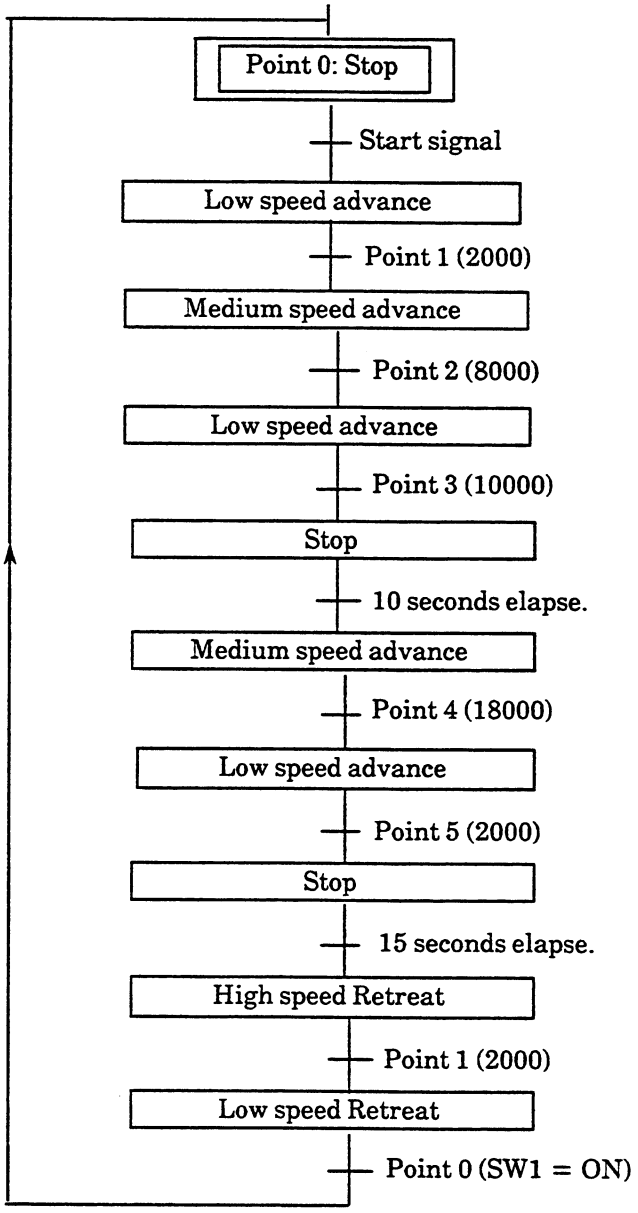
Functions

The sample system functions are discussed below.
The position at which photo-microswitch SW1 turns on represents the home position of the work table. As a start signal turns on, the work table starts advancing at a low speed and passes SW2. Since SW2 is connected to the High-Speed Counter hard-reset input of EX40PLUS, the count is cleared to zero the moment the work table passes SW2 (that is, when SW2 turns on). And a counting process commences at a point where SW2 turns off.



At a location (Point 1) where the count has reached 2,000, the work table advance velocity rises to a medium speed, and at another location (Point 2) where the count has reached 8,000, it is again slowed to a low speed. Next, at yet another location (Point 3) providing the count at 10,000, the work table stops and remains stationary for 10 seconds. After the 10 seconds are over, the work table again starts advancing at a medium speed until it arrives at a location (Point 4) providing the count at 18,000. It then advances at a low speed. Then at a location (Point 5) for the count at 20,000, the work table stops and remains stationary for 15 seconds. It then starts retreating at a high speed. As it retreats to the location for a 2,000 count (Point 1), its retreat velocity is reduced to a low speed, and the work table will come to a halt at the location where SW1 originally turned on, concluding one cycle of its movements.

The work table movement can be expressed by the flow chart shown below.



The allocation of individual signals and correspondence of individual points with counts are shown below.

Inputs:

Encoder pulse	count input	High-Speed Counter
SW2	hard-reset	
SW1	X2	
Start signal	X3	

Outputs:

Low Speed Advance	Y0
Medium Speed Advance	Y1
Low Speed Retreat	Y2
High Speed Retreat	Y3

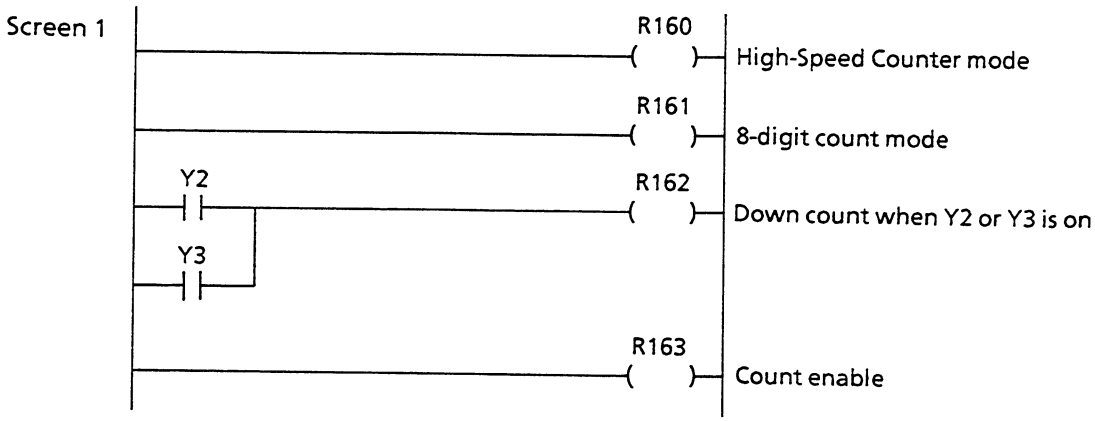
Point 0	SW1 = ON (X2 = ON)
Point 1	2,000 Count
Point 2.	8,000 Count
Point 3	10,000 Count
Point 4	18,000 Count
Point 5	20,000 Count

Sample Program

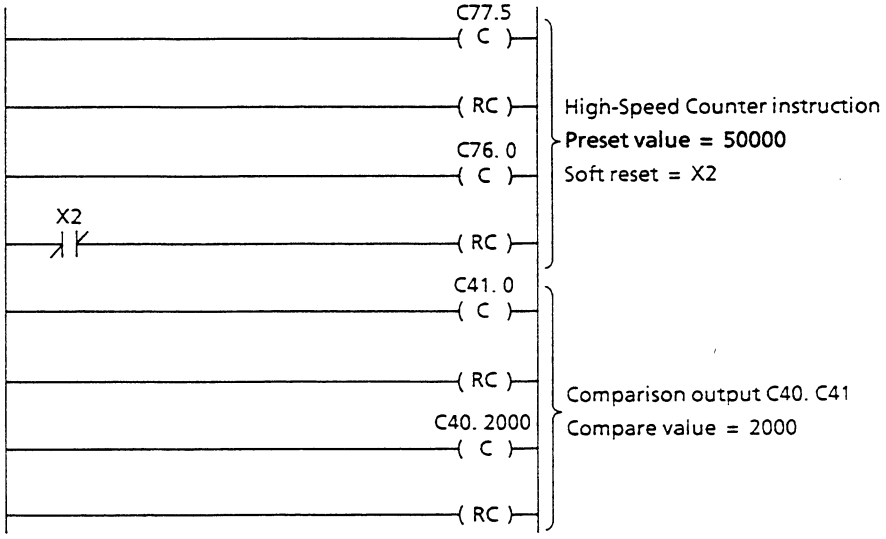
An example program is presented below in which a step sequencer is used. The High-Speed Counter is set to 8-digit mode and comparison outputs are programmed as follows:

C40•C41 = 2,000 Count
C42•C43 = 8,000 Count
C44•C45 = 10,000 Count
C46•C47 = 18,000 Count
C50•C51 = 20,000 Count

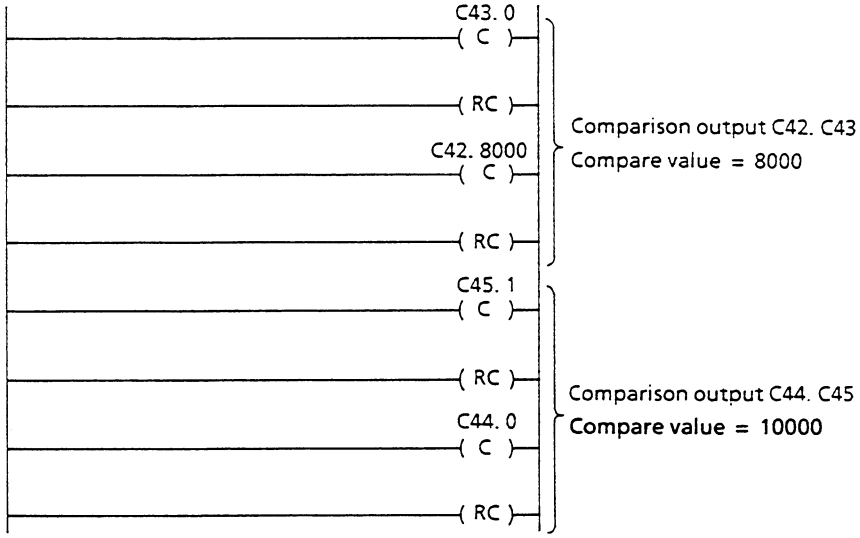
For the work table advance, an up-count mode is set, and for its retreat, a down-count mode is set.



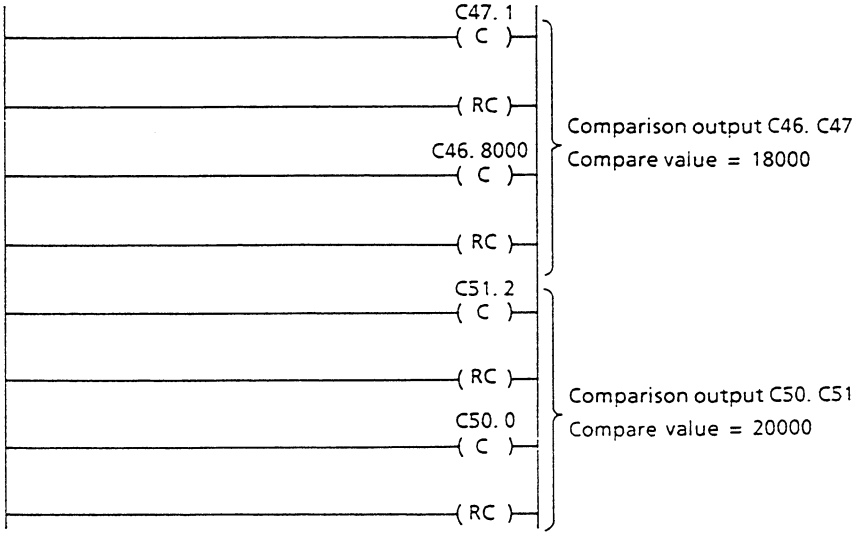
Screen 2



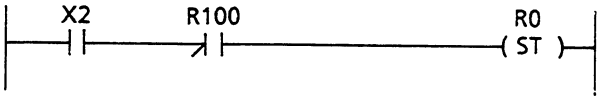
Screen 3



Screen 4

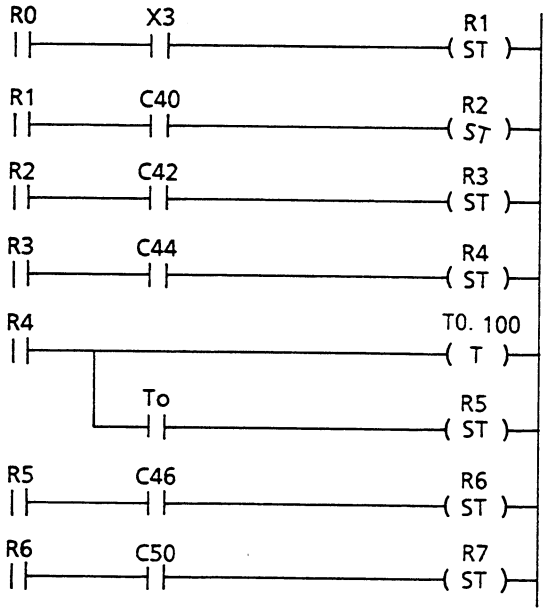


Screen 5



Initial step
X2 turns on when SW1 turns on.

Screen 6



X3 turns on when start signal comes on.

C40 is on when count value is 2000 or more

C42 is on when count value is 8000 or more.

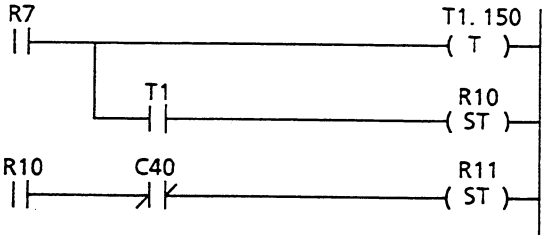
C44 is on when count value is 10000 or more.

Timer T0 with preset time 10 seconds.

C46 is on when count value is 18000 or more.

C50 is on when count value is 20000 or more.

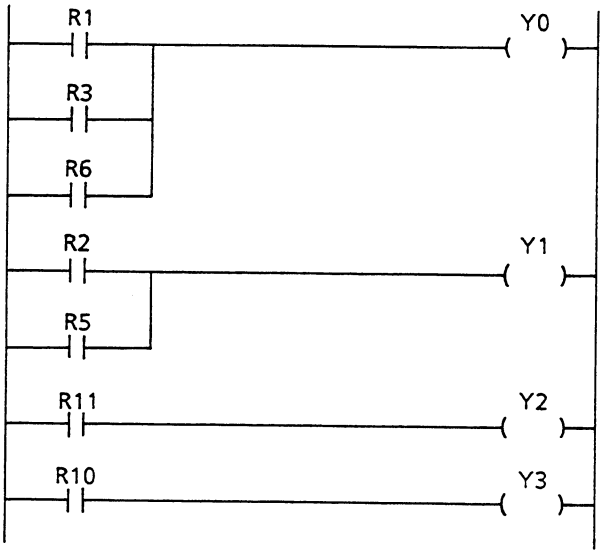
Screen 7



Timer T1 with preset time 15 seconds.

C40 is off when count value is less than 2000.

Screen 8



Low speed advance

Middle speed advance

Low speed reverse

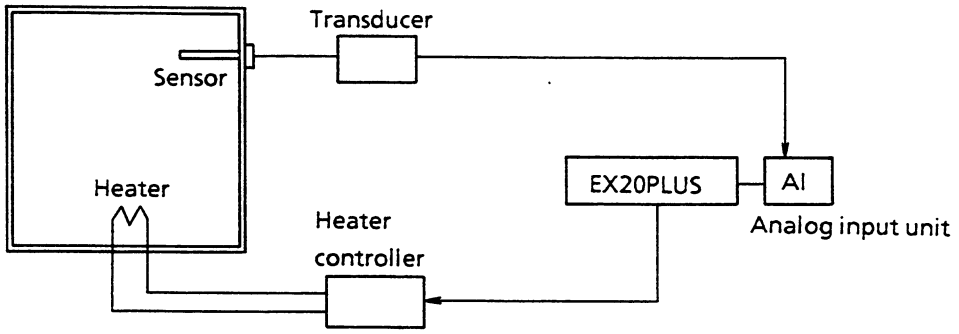
High speed reverse

SECTION 4

Analog Input Application

Sample system

As an application example for analog inputs, the temperature control system illustrated below is presented.



In this sample system, a temperature sensor and heater are employed to have the EX20PLUS control the intrachamber temperature within a 55°C to 70°C range.

Functions

The temperature measured by the temperature sensor is converted to a voltage by a transducer (at 0 to 10V for the full scale). The voltage signal is next converted to digital values by an Analog Input Unit, and read into the EX20PLUS. The temperature - voltage - digital value correspondence is shown below.

Temperature	Voltage	Digital Value
100°C	+10V	200
70°C	+7V	140
55°C	+5.5V	110
0°C	0V	0

When the converted digital value is 110 or lower, the EX20PLUS outputs a full-power signal to the heater controller, and when the value ranges from 110 to 140, it outputs a half-power signal. When the digital value exceeds 140, the EX20PLUS shuts off its output.

70 to 100°C ····· Output Off

55 to 70°C ····· Half-Power

0 to 55°C ····· Full-Power

The allocation of individual signals versus devices is shown below.

Inputs

Analog voltage	T40 (channel 0 of the analog input unit)
Start signal	X0

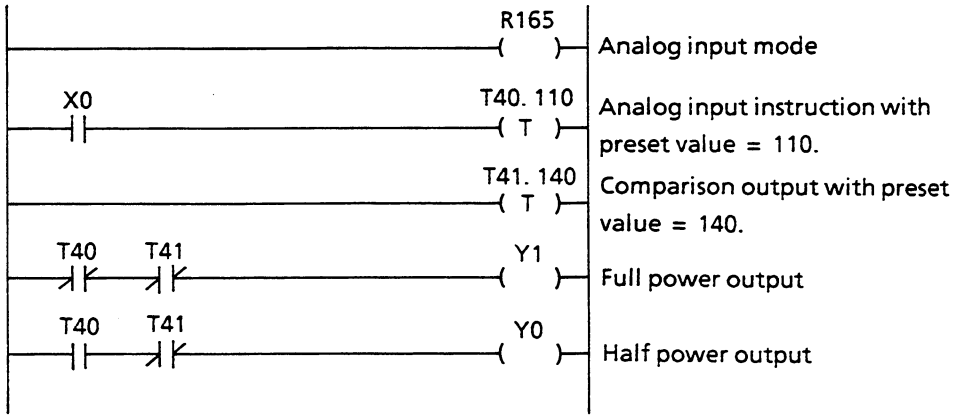
Outputs

Half power	Y0
Full power	Y1

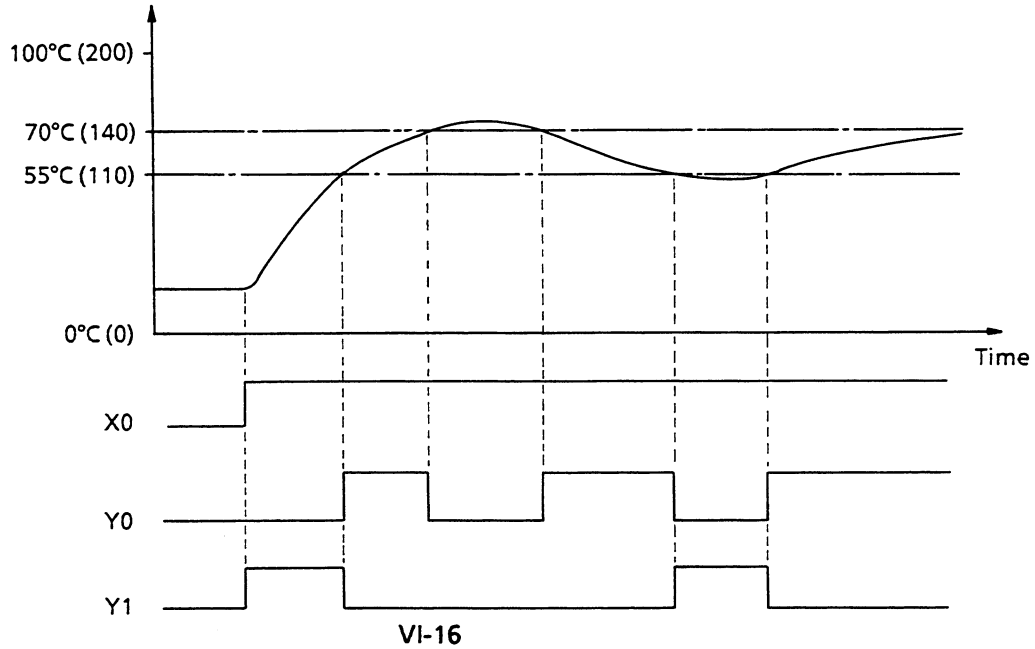
Sample program

T40 and T41 are used to provide comparison outputs that will respectively be set at 110 and 140.

In the program shown below, both T40 and T41 turn off when the converted digital value is below 110, to output Y1. When the digital value ranges from 110 to 140, T40 turns on but T41 turns off, to output Y0. When the digital value exceeds 140, both T40 and T41 turn on, to shut off both Y0 and Y1.



The timing chart of this activity is shown below.



APPENDICES

Appendix A: ERROR MESSAGES

Appendix B: GLOSSARY

Appendix C: OCTAL NUMBERS

Appendix D: ORDERING INFORMATION

Appendix A ERROR MESSAGES

When a programming or operation error occurs, a corresponding message appears in the message line of the LCD Programmer. These error messages, their causes, and their remedies are given in the table below.

Software		
Type	Message	Cause (C) and Remedy (R)
Operation or program error	ERR.01 MEM OVER	C: Insufficient memory capacity R: Delete unnecessary program segment
	ERR.02 NO END	C: No END instruction R: Write END instruction.
	ERR.03 ADDRESS	C: Incorrect device address R: Enter correct address.
	ERR.04 OPERATE	C: Incorrect operating procedure R: Redo operation correctly.
	ERR.05 SYNTAX	C: MC and JMP not on last rung R: Input Master Control Coil and Jump Coil on last rung.
	ERR.06 OV LINE	C: Counter/Flip-flop/Shift register not on one screen R: Program the function on one screen.
	ERR.07 SEARCH	C: Requested device cannot be found. R: Search contact/coil first.
	ERR.08 PC RUN	C: Invalid operation in RUN mode R: Place PC in HALT mode.
	ERR.09 CONNECT	C: Open circuit in ladder diagram R: Close/remove open circuit.
	ERR.10 USER PRG	C: No END instruction (RUN LED turns off.) R: Edit program.

NOTE Software error message is cleared when the next key is pressed.

Hardware		
Type	Message	Cause (C) and Remedy (R)
PC	ERR.11 CPU	C: Fault on CPU board (RUN LED turns off.) R: Replace CPU board.
	ERR.12 BATTERY	C: Low battery voltage (ALARM LED turns on.) R: Replace battery.
	ERR.13 DATA	C: Transmission data error to/from LCD Programmer R: 1. Check connector cable. 2. Have PC repaired.
	ERR.14 ANSWER	C: No answer received by LCD Programmer from PC. R: 1. Check connector cable. 2. Have PC repaired.
LCD Programmer	ERR.21 LCD CPU	C: Fault on LCD Programmer R: Have LCD Programmer repaired.
PROM Module	ERR.25 PROM	C: 1. Attempt made to write into unerased PROM. 2. Attempt made to write with PROM installed. R: 1. Erase PROM. 2. Remove PROM.
	ERR.26 VERIFY	C: Program in PROM does not match program in RAM. R: Rewrite program into PROM.
	ERR.27 NO PROM	C: PROM not inserted. R: Insert PROM.
	ERR.28 NO ERASE	C: PROM not erased. R: Erase PROM.
	ERR.29 FORCE	C: Disable Set (forced set) exists in RAM area. R: Remove Disable Set (forced set).

To reset ERROR LED after the hardware error that caused it to light has been remedied, press [CMD] [2] [WRT].

Appendix B GLOSSARY

address: A reference number assigned to a unique I/O memory location and used to access that location in program.

baud: Officially defined as the reciprocal of the shortest pulse width in a data communication stream, but usually used to refer to the number of binary bits transmitted per second during a serial data transmission.

bit: One binary digit. The smallest unit of binary information. A bit can have a value of 1 or 0. (Compare with "byte".)

byte: A group of adjacent bits usually operated upon as a unit, such as when moving data to and from memory. There are usually eight bits/byte. (Compare with "bit.")

branch: In a ladder diagram network, a section of logic between two adjacent branch points.

cascading: Following, one after the other. Used to refer to multiple time and/or counter configurations.

central processing unit (CPU): That part of the programmable controller that governs system activities, including the interpretation and execution of programmed instructions. In general the CPU consists of the arithmetic-logic unit, timing/control circuitry, accumulator, scratch-pad memory, program counter and address stack, and an instruction register. The central processing unit is sometimes referred to as the processor.

CMOS: Abbreviation for complementary metal oxide semiconductor. An integrated circuit family characterized by low power consumption and high noise immunity. A read/write random access memory most commonly employed for PCs. Will lose contents if power is lost.

coil: In a PC, a simulated device element energized by an input signal to a relay.

contact: In a PC, a simulated current-carrying part of a relay, switch, or connector that is engaged or disengaged to open or close associated electrical circuits.

counter: 1) An electromechanical relay-type device that counts the occurrence of some event. The event to be counted may be pulses developed from operations such as switch closures, interruptions of light beams, or other discrete events. 2) A programmable controller eliminates the need for hardware counters by using software counters. The software counter can be given a preset count value, and will count up or down, depending on program, whenever the counted event occurs.

CPU: See "central processing unit."

cursor: The blinking marker that acts as a pointer on the LCD Programmer screen.

device: A reference of I/O memory consisting of a function prefix, such as X, Y, R, etc., and an address.

energized: Activated.

EEPROM: Electrically Erasable Programmable Read-Only Memory (See "memory".)

EPROM: Erasable Programmable Read-Only Memory. A ROM that can be erased with ultraviolet light, and then reprogrammed. (See "memory".)

field devices: User-supplied devices typically providing information to the PC (Inputs: pushbutton, limit-switches, relay contacts, etc.) or performing PC tasks (Outputs: motor starters, solenoids, indicator lights, etc.)

hardware: Includes all the physical components of the programmable controller, including peripherals, as contrasted with the programmed software components that control its operation. (Compare with "software".)

input: Information sent to the processor from connected devices, via some input interface.

input device: Any connected equipment that will supply information to the central processing unit such as control devices (e.g., switches, buttons, sensors). Each type of input device has a unique interface to the processor.

I/O: Abbreviation for Input/Output.

I/O address: A unique number assigned to each input and output. The address number is used when programming, monitoring, or modifying a specific input or output.

K: Abbreviation for kilo or exactly 1,024. Used in conjunction with bit, or byte. For other engineering units, the k is always lowercased to denote exactly 1,000.

latched relay: A device that will remain in its last state, even though power has been removed.

ladder diagram: A graphic representation of control logic relay systems. The user-programmed logic is expressed using the symbols and concepts of relay-based control systems.

LED: Abbreviation for light-emitting diode. A semiconductor diode, the junction of which emits light when passing a current in the forward direction. LEDs are used as diagnostic indicators on various controller hardware components.

LCD: Abbreviation for liquid crystal display. A display device consisting basically of a liquid crystal, hermetically sealed between two glass plates. One type of LCD depends upon a backlighting source. The readout is usually dark characters on a dull white background.

logic: A fixed set of responses (outputs) to various external conditions (inputs). All possible situations for both synchronous and non-synchronous activity must be specified by the user. Also referred to as the program.

memory: That part of the programmable controller where data and instructions are stored either temporarily or semipermanently. The control program is stored in memory. Five types of memory chips frequently used by programmable controllers are:

RAM (random-access memory): A chip that can be addressed at any time.

ROM (read-only memory): A chip with a set of memory, fixed at the time of manufacture, that cannot be reprogrammed.

PROM (programmable read-only memory): A chip for which memory can be programmed after manufacture but which then cannot be reprogrammed.

EPROM (erasable programmable read-only memory): A chip for which memory can be programmed after manufacture and which can be erased with ultraviolet light and reprogrammed.

EEPROM (electrically erasable programmable read-only memory): A chip for which memory can be programmed after manufacture and which can be erased and reprogrammed electrically.

microprocessor: A digital electronics-logic package (usually on a single chip), capable of performing the program execution, control, and data processing functions of a central processing unit. The microprocessor usually contains an arithmetic logic unit, temporary storage registers, instruction decode circuitry, a program counter and bus interface circuitry.

microsecond (μs): One millionth of a second. $1x10^{-6}$ second or 0.000001 second.

millisecond (ms): One thousandth of a second. $1x10^{-3}$ second or 0.001 second.

noise: Random, unwanted electrical signals, normally caused by radio waves or electrical or magnetic fields generated by one conductor and picked up by another.

output: Information sent from the CPU to a connected device via some interface. Contents could be in the form of control data that will signal some device such as a motor to switch ON or OFF, or vary the speed of a drive.

output device: Any connected equipment receiving information or instructions from the central processing unit, such as control devices (e.g., motors, solenoids, alarms, etc.) or peripheral devices (e.g., line printers, disk drives, color displays, etc.). Each type of output device has a unique interface to the processor.

PC: See "programmable controller".

preset: A numerical value specified in a function to establish a limit for a counter or timer. A coil will energize when this value is reached.

program: A sequence of functions entered into a PC to be executed by the CPU for the purpose of controlling a machine or process.

programmable controller: A solid-state industrial control device which receives inputs from user-supplied control devices such as switches and sensors, implements them in a precise pattern determined by ladder-diagram based programs stored in the user memory, and provides outputs for control of user-supplied devices such as relays and motor starters. The PC consists of five basic components: processor, memory, power supply, input/output and programming device.

programmer: A device for entry, examination and alteration of the PC's memory, including logic and storage areas.

power flow: Used to indicate that the element shown on the display screen is in a state equivalent to an energized contact. During monitoring, the device is shaded each time it passes power. When all devices on a rung pass power, the coil is energized.

RAM: Random-Access Memory. Commonly referred to as read/write because it can be written to as well as read from. However, a stricter definition of RAM is a memory that stores data in such a way that each a bit of information can be stored or retrieved within the same amount of time as any other bit (as contrasted with serial memory, in which data is stored and retrieved in a sequential order). This type of memory is volatile; i.e., stored data is lost under no-power conditions, therefore a battery backup is required. (See "memory".)

relay: An electrically operated device that mechanically switches electrical circuits.

rung: A grouping network of a ladder diagram. A single rung may be only a portion of a complete program of several rungs.

scan time: The period of time necessary to execute all device instructions in the PC program one time, from the first screen to the last.

solid-state: Circurity designed using only integrated circuits, transistors, diodes, etc.; no electromechanical devices such as relays are utilized.

software: 1) Any written documents associated with the system hardware. 2) Stored instructions (the program).

step: The unit number of program instructions occupied in the program memory. In the EX20PLUS/40PLUS, a step is equal to 16 bits.

watchdog timer: A safety device used to ensure that certain events occur within a specified time span.

Appendix C OCTAL NUMBERS

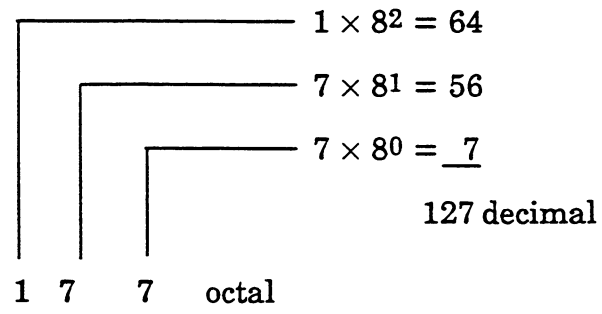
For addressing and internal operations, this PC uses the octal numbering system. This system is made up of eight digits - the numbers 0 to 7. The value of an octal number depends on the digits used and the place value of each digit.

Each place value in this system represents a power of 8 starting with 8 raised to the zero power ($8^0 = 1$). The value of each position is shown in the following table of equivalent octal and decimal values.

The decimal value of each octal number can be computed by multiplying each number by its corresponding place value and adding the numbers together.

For instance, the octal value 177 in decimal is 127, as shown below.

Octal numbering system



Equivalent octal and decimal values

The following table shows the equivalent octal and decimal values of the range of numbers used by the PC.

Decimal/octal	Decimal/octal	Decimal/octal	Decimal/octal
0 0	8 10	16 20	24 30
1 1	9 11	17 21	25 31
2 2	10 12	18 22	26 32
3 3	11 13	19 23	27 33
4 4	12 14	20 24	28 34
5 5	13 15	21 25	29 35
6 6	14 16	22 26	30 36
7 7	15 17	23 27	31 37

Decimal/octal	Decimal/octal	Decimal/octal	Decimal/octal
32 40	56 70	80 120	104 150
33 41	57 71	81 121	105 151
34 42	58 72	82 122	106 152
35 43	59 73	83 123	107 153
36 44	60 74	84 124	108 154
37 45	61 75	85 125	109 155
38 46	62 76	86 126	110 156
39 47	63 77	87 127	111 157
40 50	64 100	88 130	112 160
41 51	65 101	89 131	113 161
42 52	66 102	90 132	114 162
43 53	67 103	91 133	115 163
44 54	68 104	92 134	116 164
45 55	69 105	93 135	117 165
46 56	70 106	94 136	118 166
47 57	71 107	95 137	119 167
48 60	72 110	96 140	120 170
49 61	73 111	97 141	121 171
50 62	74 112	98 142	122 172
51 63	75 113	99 143	123 173
52 64	76 114	100 144	124 174
53 65	77 115	101 145	125 175
54 66	78 116	102 146	126 176
55 67	79 117	103 147	127 177

Powers of eight

The table below gives the decimal values for the powers of eight.

8^n	n	8^n	n
1	0	16777216	8
8	1	134217728	9
64	2	1073741824	10
512	3	8589934592	11
4096	4	68719476736	12
32768	5	549755813888	13
262144	6	4398046511104	14
2097152	7	35184372088832	15

Appendix D ORDERING INFORMATION

Basic unit

Model	Input	Output	Product code
EX20PLUS	Dry contact	Relay	EX20*4MCRD5
	120 Vac		EX20*4MARD8
EX40PLUS	Dry contact	Relay	EX40*4MCRD5
	120 Vac		EX40*4MARD8

Expansion unit

Model		Input	Output	Product code
EX20 Expansion		Dry contact	Relay	EX20*2ECRA5
			Triac	EX20*2ECAA5
			Transistor	EX20*2ECDA5
		120 Vac	Relay	EX20*2EARA5
			Triac	EX20*2EAAA5
		24 Vdc	Relay	EX20*2EDRA5
			Transistor	EX20*2EDDA5
EX40 Expansion		Dry contact	Relay	EX40*2ECRA5
			Triac	EX40*2ECAA5
			Transistor	EX40*2ECDA5
		120 Vac	Relay	EX40*2EARA5
			Triac	EX40*2EAAA5
		24 Vdc	Relay	EX40*2EARA5
			Transistor	EX40*2EDDA5
EX08	(8I)	Dry contact	-	EX08*2ECIA5
		120 Vac	-	EX08*2EAIA*
		24 Vdc	-	EX08*2EDIA*
	(8O)	-	Relay	EX08*2EROA5
		-	Triac	EX08*2EAOA5
		-	Transistor	EX08*2EDOA5
	(4I/4O)	Dry contact	Relay	EX08*2ECRA5
		120 Vac		EX08*2EARA5
		24 Vdc		EX08*2EDRA5

NOTE A 30 cm expansion cable (8 cm for EX08) is supplied with each expansion unit.

Programmer

Model	Product code
LCD Programmer (VER. 2)	EX2040 PRGD

NOTE A cable (2 m) is supplied with the LCD programmer.

Option

Description		Product code
Analog input unit		EX2040 AI2A
Computer link unit		EX2040 CMPA
Timer/Counter access unit		EX2040 TCUB
EEPROM module		EX28**RM17
Printer interface unit	120 Vac Parallel I/F	EX2040PIFA1
	120 Vac RS-232C I/F	EX2040PIFB1
	240 Vac Parallel I/F	EX2040PIFA2
	240 Vac RS-232C I/F	EX2040PIFB2

NOTE

Connecting cables are supplied with the analog input unit, computer link unit, and timer/counter access unit. A parallel (centronics) cable is attached with a printer interface unit.

Cable

Description		Product code
Programmer cable (2 m)		EX2040 PPRCA
Expansion cable	8 cm	EX2040 PEXPC1
	30 cm	EX2040 PEXPC
	50 cm	EX2040 PEXPC5
Computer link unit cable (30 cm)		EX2040PCMC03

Spare parts

Description		Product code
Battery (3V - 1200 mAH)		EX2040 PBATT
Fuse	Power supply (250Vac - 3A)	EX2040PFU30
	DCO (250Vac - 0.2A)	EX2040PFU02

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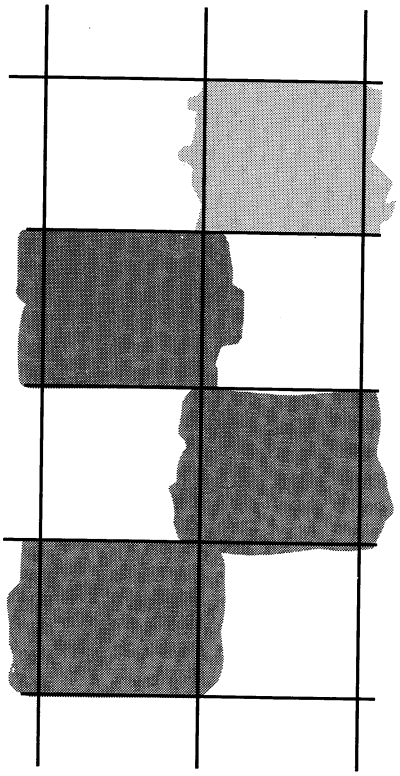

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