SYSMAC

C**K
Host Link Units

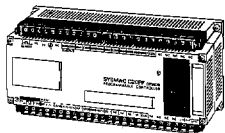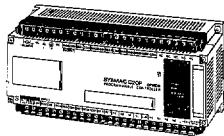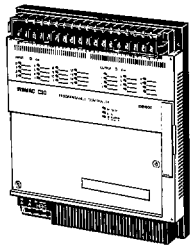# SYSTEM MANUAL

OMRON

Host Link Units

System Manual

Revised May 1995

iv
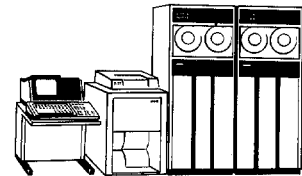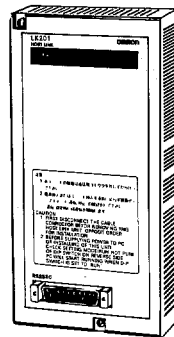
Notice:

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

The following conventions are used to indicate and classify warnings in this manual. Always heed the information provided with them.

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

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

OMRON Product References

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

The abbreviation "Ch," which appears in some displays and on some OMRON products, means "word" and is abbreviated "Wd" in documentation.

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

Visual Aids

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

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

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

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About this Manual:

This manual describes the functions, characteristics, and operating procedures of the Host Link Units for use with the C20/K-type PCs.

Section 1 describes the basic physical features of the Host Link Units and gives examples of systems using them.

Section 2 describes how to incorporate Host Link Units into a larger system. It provides information on how to set the switches so that the Unit will provide the desired functions during operation, how to mount the device, and how to establish communications between the Host Link Unit and the host computer. The final section includes details about the procedures for preparing RS–422 and RS–232C cables for connection.

Section 3 describes the different operating modes and the steps in data flow of the PC as determined by the Host Link Unit settings. The procedures for communications testing are also explained.*Section 3–4* describes how to calculate the maximum and minimum response times between a Unit receiving an input signal and producing an output.

Section 4 describes the commands and responses covered by this manual. It gives the basic format for each command and response and covers the factors which might affect the operating speed of the PC when dealing with such commands and responses.

Section 5 describes the range of errors that can be expected when operating a computerized system incorporating a Host Link Unit. It discusses the development of an error-processing program and also provides a tabulated troubleshooting guide.

Appendix A describes the standard range of Host Link Units available.

Appendix B lists the specification details for the various Host Link Unit and Link Adapter models.

Appendix C provides an ASCII code table.

Appendix D describes the standard range of accessories for Host Link Units and their features.

The *Glossary* gives a comprehensive list of expressions commonly used when dealing with Host Link Units and Programmable Controllers.

SECTION 1
Introduction

This document is designed to introduce the reader to the principles of operation of **Host Link Units** for the SYSMAC C20 PC (Programmable Controller) and the SYSMAC K-type PCs

A Host Link Unit allows a host computer to monitor the operating status and data areas of the PCs and to control the communications with the PCs in the control system.

One Host Link Unit is required for each PC, and up to 32 PCs can be connected to a single host computer. The Host Link Units described in this manual are referred to as "CPU mounting." As the name suggests, CPU-mounting Host Link Units are mounted directly to the PC's CPU.

Section 1–1 explains the names for the different parts of the Units and *Section 1–2* gives some typical system configurations. Most of these systems also employ Link Adapters, which are normally used to branch between Host Link Units and host computers, etc., or to interface wire cables with optical fiber cables, or to perform both of these functions.

1–1   Nomenclature

The following figures give details of switches, selectors, and connector types for your Host Link Unit. It will be necessary to refer to these diagrams from time to time as you read further in the manual, particularly when reading *Section 2–1 Host Link Unit Settings*.

Front panels

3G2C7–LK201–EV1   **3G2C7–LK202–EV1**

READY indicator
RCV (receive) indicator
XMT (transmit) indicator
ERRor indicator
        (Parity, framing, overrun, and FCS errors)
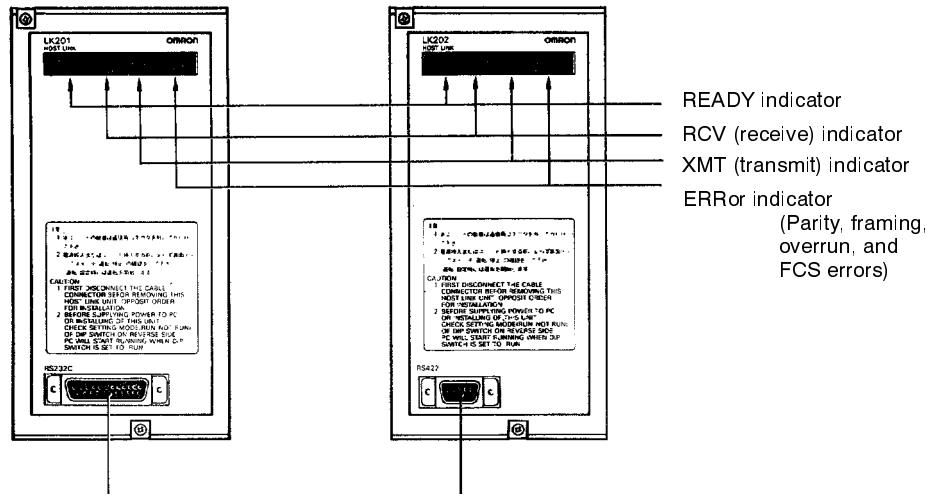
RS–232C cable connector
        See *Example 3* in *Section 1–2 System Configuration* for restrictions with RS–232C cable.

RS–422 cable connector

Rear panels

3G2A7–LK201–EV1   **3G2A7–LK–202–EV1**

SW1   SW1
SW2   SW2

SW3   SW3
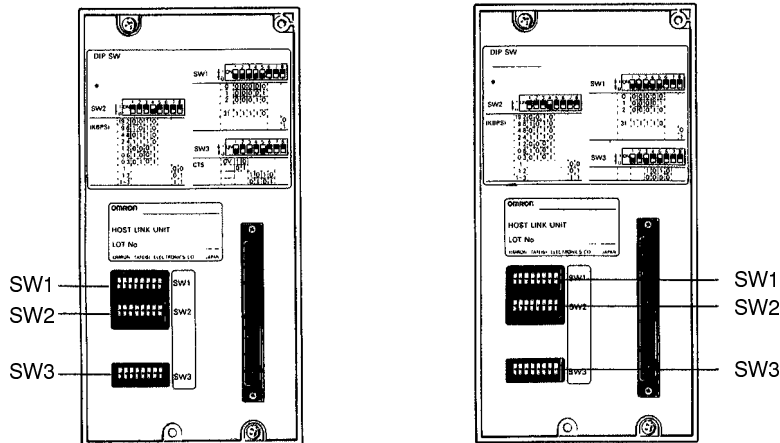
1–2   System Configuration

The following examples illustrate possible applications of Host Link Units in wired or optical systems, or both.

Some systems will contain just one Host Link Unit connected to a single host computer. This is known as a "single-link" system. Others systems might contain several Host Link Units connected to a host computer. This configuration is known as a "multiple-link" system. Although most systems will require only one host computer, if both Rack-mounting and CPU-mounting Host Link Units are used together, two host computers can be connected to the same PC, independent of each other. The PC can then execute commands sent from either host computer.

In all but the first configuration example, Link Adapters are used to branch between system devices, or to convert between different types of cables, or to perform both of these functions. The first part of the Link Adapter model numbers (i.e., 3G2A9–) in the examples has been omitted.

1–2–1   Connections

System components can be connected using RS–232C or RS–422 cables, or both, any of three types of optical fiber cable, or a combination of wired and optical sections. In any system, the maximum length of RS–232C cable is 15 m. The total length of all RS–422 cable must be no longer than 10 m. RS–232C and RS–422 cables which are used to connect the Host Link Unit to the host computer are not available from OMRON and must be purchased from an alternative source.

Maximum lengths for optical fiber cables are determined by the type of cable and the particular models employed. Models which finish with "–P" in the code number can be set at a length of 20 m for APF cable and 200 m for PCF cable. Models without the "–P" coding can be set at a maximum length of 800m with PCF cable.

1–2–2   System Examples

Example 1   Serial Multiple-link System

3
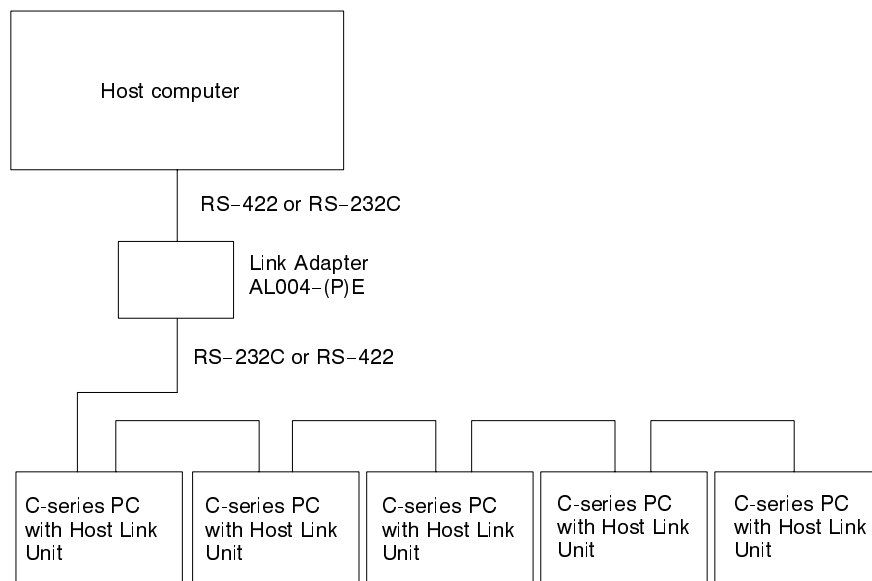
As shown above, more than one Host Link Unit can be connected in series. If, however, any failure (due to power failure, disconnection, etc.) occurs in one of the Units, the series connection will cause all subsequent Host Link Units to cease to operate. This situation can be avoided by using Link Adapters such as the AL002–(P)E Link Adapter shown in the following example.

Example 2   Parallel Multiple-link System with Optical Fiber Cable
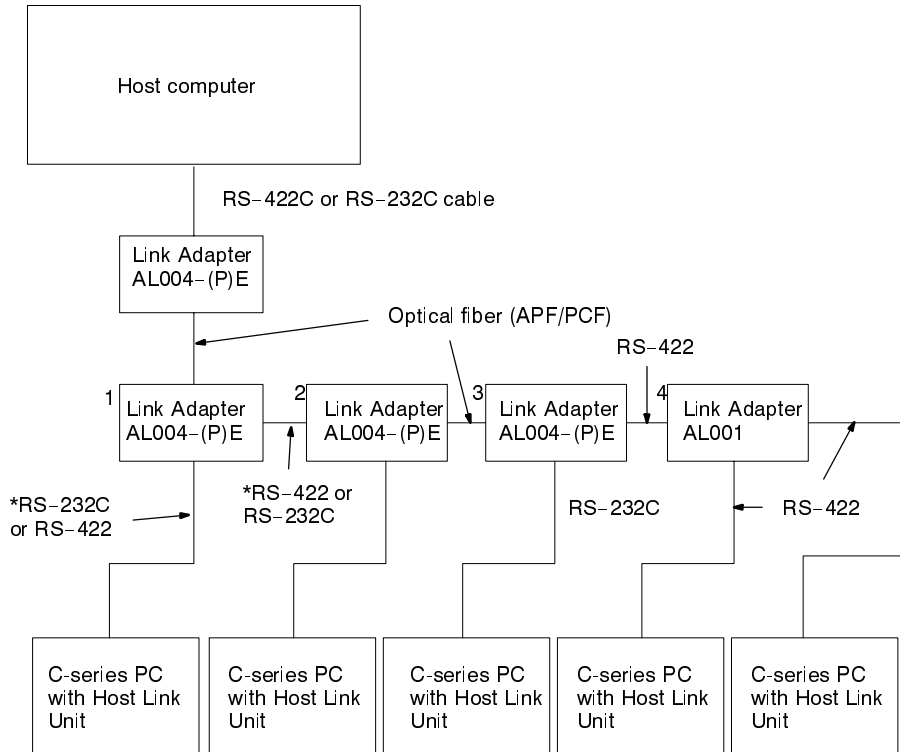
Note *When using AL004–(P)E Link Adapters, the connections can only include the following: one optical fiber, one RS–232C, and one RS–422. As the Host Link Units can only be connected to either RS–232C or RS–422 cables (depending on the model), the rest of the System must be configured according to these restrictons. To meet these limitations, and having AL004–(P)E models as the first three Link Adapters, the rightmost Link Adapter in the above System would need to be an AL001 with three RS–422 cable connections, and the corresponding Host Link Unit would need to be an LK202–EV1 model. (Other configurations are possible, e.g., if the top Link Adapter was omitted, the cable between Link Adapters 1 and 2 would need to be optical fiber, and this would affect the available connections for the remaining Units.) See *Appendix B* or a *Link Adapters Manual* for further information.

The above example uses AL004–(P)E Adapters to connect the Units in parallel. These Link Adapters bypass any Host Link Unit not properly connected so that the rest of the system can operate normally. Even if a power failure occurs in a Host Link Unit connected to a branch line of a Link Adapter, signals are still transmitted to the other Host Link Units.

Example 3   Single-link System with RS–232C Cable

In a system where a RS–232C cable connects a Host Link Unit directly to a host computer, only one Host Link Unit can be connected to that host computer, i.e., it has a single-link. It should be noted that the PC onto which the

Host Link Unit is mounted could have another Host Link Unit connected directly or indirectly connected to another host computer.

```
┌─────────────────────────┐              ┌──────────────┐
│                         │              │              │
│     Host computer       │──────────────│ Host Link Unit│
│                         │              │              │
└─────────────────────────┘              └──────────────┘
```
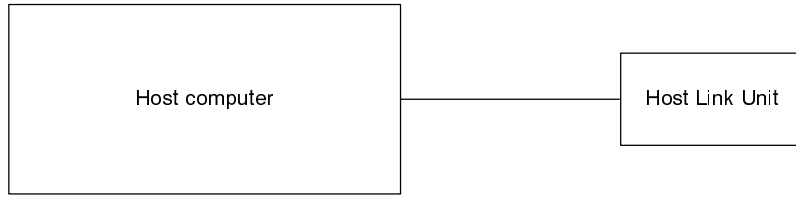
Example 4

Multiple-link System with RS–232C and RS–422 Cable

By using RS–422 cable and AL001 Link Adapters, more than one Host Link Unit can be connected to the same host computer to make a Multiple-link System.

```
          ┌──────────────────────┐
          │                      │
          │    Host computer     │
          │                      │
          └──────────┬───────────┘
                     │ RS–232C cable
              ┌──────┴──────┐
              │             │  Link Adapter
              │             │  AL004–(P)E
              └──────┬──────┘
 RS–422 cable        │
 Link Adapter ┌──────┴──────┐   Link Adapter  Link Adapter  Link Adapter
 AL001        │             │   AL001         AL001         AL001
              │             ├───┤        ├───┤        ├───┤        ├──┐
              └──────┬──────┘   └───┬────┘   └───┬────┘   └───┬────┘  │
                     │              │            │            │       │
 RS–422 cable        │              │            │            │       │
   ┌─────────┐ ┌─────────┐ ┌─────────┐ ┌─────────┐ ┌─────────┐
   │C-series PC│ │C-series PC│ │C-series PC│ │C-series PC│ │C-series PC│
   │with Host  │ │with Host  │ │with Host  │ │with Host  │ │with Host  │
   │Link Unit  │ │Link Unit  │ │Link Unit  │ │Link Unit  │ │Link Unit  │
   └─────────┘ └─────────┘ └─────────┘ └─────────┘ └─────────┘
```
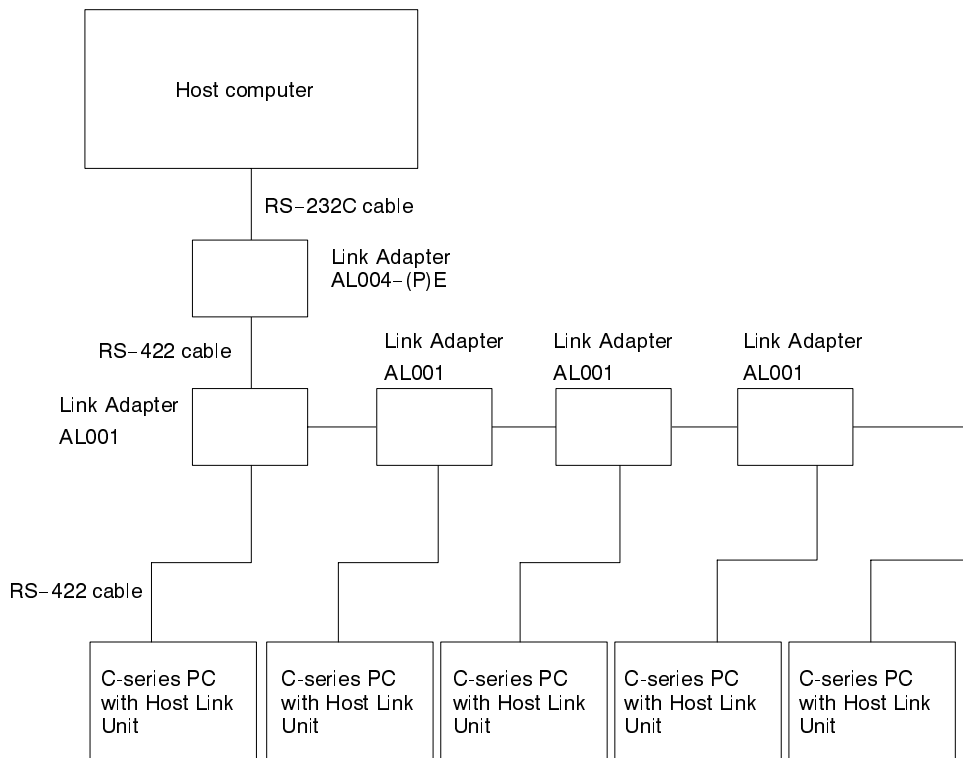
SECTION 2
Setting Up

This section provides the basic information necessary to incorporate a Host Link Unit into a larger system. *Section 2−1* explains how to set the Host Link Unit switches and selectors for the required tasks, *Section 2−2* provides information on how to establish data communications between the Host Link Unit and the host computer, *Section 2−3* explains the correct way to interface the Host Link Units to the host computers using the various types of cables, and *Section 2−4* details the correct procedures for connecting RS−232C and RS−422 cables.

2–1   Host Link Unit Settings

The selectors and DIP switches on a Host Link Unit, on both the front and back panels, must be set properly before the Unit is mounted.

2–1–1   SW1

SW1 will perform one of two different functions depending on the Unit. In both instances, the first five DIP switches are used to set the Unit number as shown below.

Unit No.

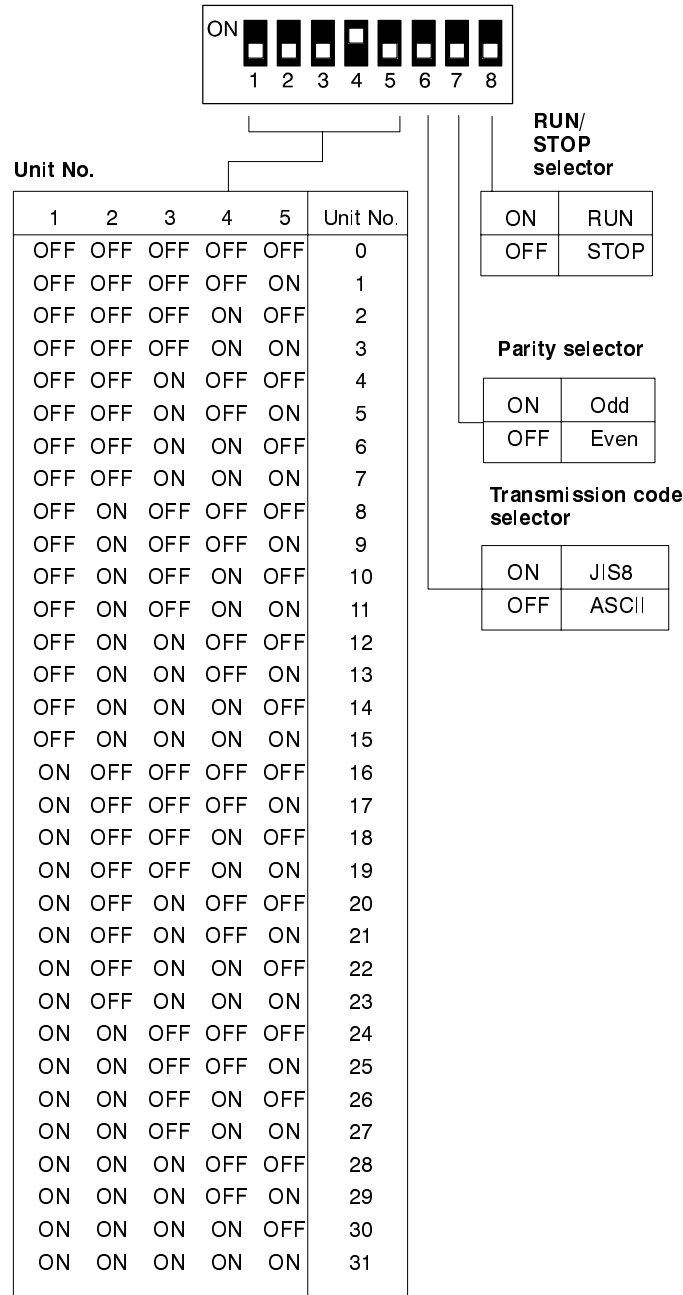| 1	2	3	4	5	Unit No.
OFF	OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	OFF	ON	1
OFF	OFF	OFF	ON	OFF	2
OFF	OFF	OFF	ON	ON	3
OFF	OFF	ON	OFF	OFF	4
OFF	OFF	ON	OFF	ON	5
OFF	OFF	ON	ON	OFF	6
OFF	OFF	ON	ON	ON	7
OFF	ON	OFF	OFF	OFF	8
OFF	ON	OFF	OFF	ON	9
OFF	ON	OFF	ON	OFF	10
OFF	ON	OFF	ON	ON	11
OFF	ON	ON	OFF	OFF	12
OFF	ON	ON	OFF	ON	13
OFF	ON	ON	ON	OFF	14
OFF	ON	ON	ON	ON	15
ON	OFF	OFF	OFF	OFF	16
ON	OFF	OFF	OFF	ON	17
ON	OFF	OFF	ON	OFF	18
ON	OFF	OFF	ON	ON	19
ON	OFF	ON	OFF	OFF	20
ON	OFF	ON	OFF	ON	21
ON	OFF	ON	ON	OFF	22
ON	OFF	ON	ON	ON	23
ON	ON	OFF	OFF	OFF	24
ON	ON	OFF	OFF	ON	25
ON	ON	OFF	ON	OFF	26
ON	ON	OFF	ON	ON	27
ON	ON	ON	OFF	OFF	28
ON	ON	ON	OFF	ON	29
ON	ON	ON	ON	OFF	30
ON	ON	ON	ON	ON	31

RUN/STOP selector

ON	RUN
OFF	STOP

Parity selector

ON	Odd
OFF	Even

Transmission code selector

ON	JIS8
OFF	ASCII

Note   Each unit must be given a different unit number.

Unit Number

Each Host Link Unit must have a unique unit number. Do not allocate the same number to different Host Link Units.

Parity
Pin 6 is used to set the parity. If the Host Link Unit is used with other models (such as the 3G2A5–LK201–E), even parity can be obtained by setting this pin to OFF. The parity of the Host Computer and the Host Link Unit must match.

Transmit Code
Set pin 7 to OFF to use ASCII codes. In ON the transmission is in Japanese codes.

RUN/STOP Selector
Pin 8 is used to set the PC in RUN or PROGRAM mode upon the application of power. If the pin is set to ON the PC will be in RUN mode and will start operating when power is applied or when the Host Link Unit is mounted to a PC which already has the power applied. If the pin is set to OFF, the PC is set to PROGRAM mode upon the application of power. When mounting the Host Link Unit to a PC with power applied, the PC will retain the previously set mode. Refer to *Section 3–1 PC Operating Mode* for details.

2–1–2   SW2

SW2
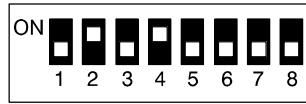
1	2	3	4	Baud rate
OFF	ON	OFF	ON	300bps
ON	OFF	OFF	ON	600bps
OFF	OFF	OFF	ON	1,200bps
ON	ON	ON	OFF	2,400bps
OFF	ON	ON	OFF	4,800bps
ON	OFF	ON	OFF	9,600bps
OFF	OFF	ON	OFF	19,200bps
ON	ON	OFF	OFF	38,400bps

Transmission Speed
The transmission speed of the Host Link Unit must match that of the host computer.

2–1–3   SW3

ON
1 2 3 4 5 6 7 8

ON ───── CTS always ON
OFF ───── External CTS signal

ON
1 2 3 4 5 6 7 8

ON   ON ───── Termination resistance ON
OFF   OFF ───── Termination resistance OFF
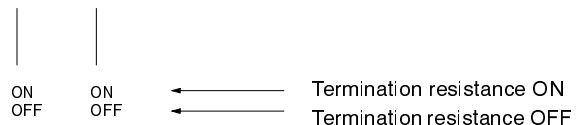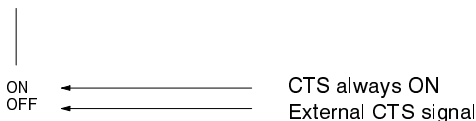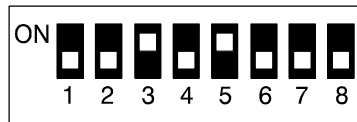
Termination Resistance
When this switch is set to ON, a built-in termination resistance of 220 Ω is connected. When set to OFF, the termination resistance is disconnected. When using a RS–422 cable throughout a system, the Host Link Unit at each end of the cable system must have the termination resistances turned ON as

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detailed in the following diagram. Note that different cabling and Link Adapters can be used. (For further information see *Appendix B*.)

Turn the termination resistance ON for these two Host Link Units.
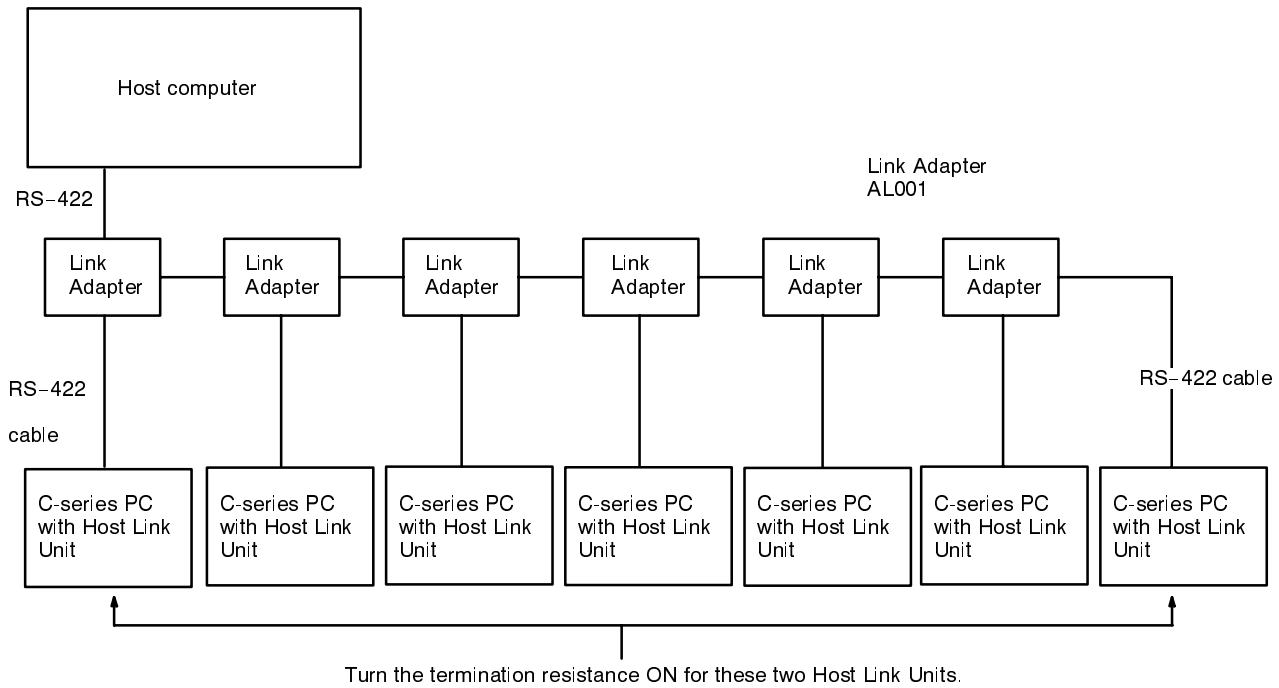
CTS Selector

When the selector is set to 0 V, the clear-to-send (CTS) signal is continuously ON. When the selector is set to external, the Unit will respond to externally generated CTS signals.

2–2 Host Computer Settings

To establish correct data communications with the Host Link Unit, the communications conditions listed below must match on both the host computer and the Host Link Unit. For the actual setting of these conditions, refer to the host computer manual.

Transmission Speed

The transmission speed of the Host Link Unit must match that of the host computer. See *Section 2–1 Host Link Unit Settings* for the setting procedure.

Single-character Data Format

Set the host computer to the following 11-bit data format (7-bit ASCII):

Number of start bits:	1
Data Length:	7 bits
Even (vertical) parity:	1 bit
Number of stop bits:	2

The following 11-bit format can also be set (8-bit JIS). Make sure that the host computer and Host Link Unit format settings are the same.

|	
Number of start bits:	1
Data length:	8 bits
Parity (odd or even):	1 bit
Number of stop bits:	1

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2–3 Types of Interfaces

The system must be properly interfaced to enable error-free communications. Use the following information to correctly interface your system.

2–3–1 RS–232C Interface

When using an optical fiber cable or RS–422 cable, several Host Link Units can be connected to one host computer. When RS–232C cables are used, however, the connection must be made on a one-to-one basis, or a Link Adapter must be used to convert to RS–422 cable or optical fiber cable. (See *Appendix B Specifications* or the *Link Adapter* manuals for details). The table below gives the proper connections for an RS–232C interface.

Signal*	Symbol	Pin No.
Frame Ground	FG	1
Signal Ground	SG	7
Send Data	SD	2
Receive Data	RD	3
Request to send	RS	4
Clear to send	CS	5
Equipment Ready	ER	20

* Viewed from the Host Link Unit.
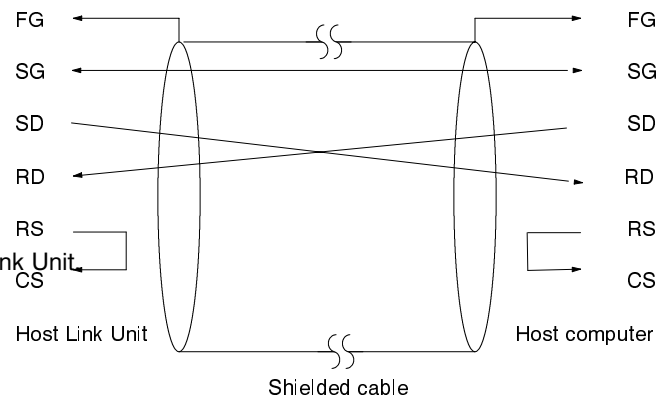
The maximum cable length is 15 m. Ground the FG terminals of both the PC and the host computer at a point that has a resistance of less than 100 Ω.

2–3–2 RS–422 Interface

The following table details the pin connections for a RS–422 interface.

Signal*	Symbol	Pin No.
Send Data B	SDB	5
Receive Data A	RDA	6
Receive Data B	RDB	1
Signal Ground	SG	3
Frame Ground	FG	7

* Viewed from the Host Link Unit.

Termination Resistance *   Termination Resistance *

* The total termination resistance must be 100 W min.
  The built-in resistance is 220 W.

The maximum cable length is 500 m. Ground the FG terminals on both the PC and the host computer to a point where the resistance is less than 100 Ω. For more information, refer to the PC or host computer manuals.
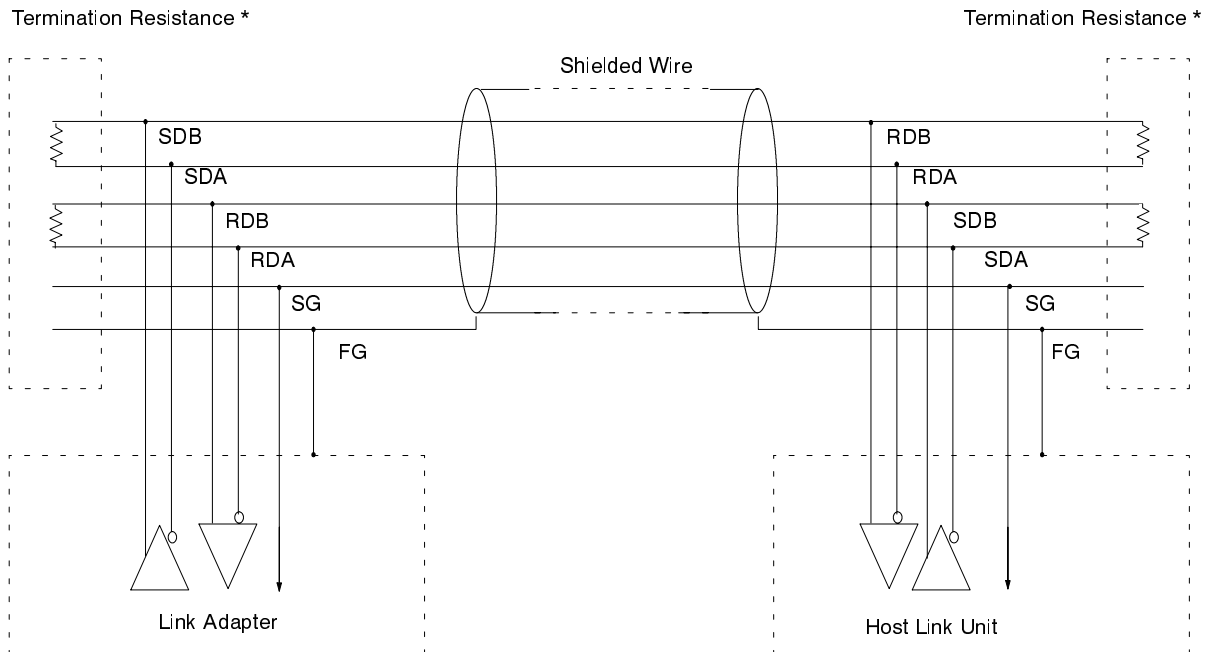
The maximum cable length is 500 m. Ground the FG terminals of both the PC and the host computer to a point with a resistance of less than 100 Ω. For details, refer to the PC or host computer manuals.

Multiple-link Connections   When connecting a multiple-link system with RS–422 cable, use shielded twisted pair cables for connections to the Host Link Unit. The cable length for the entire system must not exceed 500 m. The length of each branch line should be kept to less than 10 m.

2–4   Wiring RS–232C and RS–422 Cable Connectors

The following procedures should be followed when wiring RS–232C and RS–422 connectors.

2–4–1   Preparation of Shielded Cable

The following list outlines the procedures for preparing a shielded cable which is to be connected to FG. The instructions listed below correspond to the diagrams which follow.

1, 2, 3...   1.   Cut the cable to the required length.
   2.   Use a sharp knife or razor to cut away the sheath (taking care not to damage the braiding underneath): 25 mm for RS–422 cable; 40 mm for RS–232C cable.
   3.   Use scissors to cut away all but 10 mm of the exposed braiding.
   4.   Use wire strippers to remove the insulation from the last 5 mm of each wire.

5. Move the boot to cut the edge of the sheath and fold the braiding back over the end of it.

6. Wrap aluminum foil tape over the top of the braiding on top of the boot for one-and-a-half turns.

Aluminum foil tape
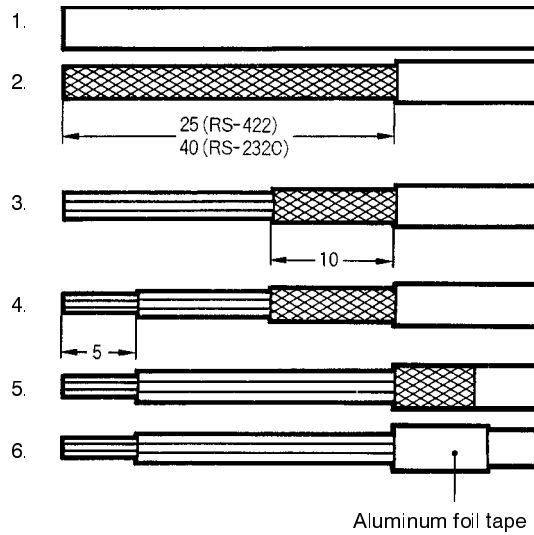
2–4–2   Preparation of Unshielded Cable

The following list outlines the procedures for preparing an unshielded cable which is to be connected to FG. The instructions listed below correspond to the diagrams following.

1, 2, 3...   1. Cut the cable to the required length.

2. Use a razor blade to cut away the sheath: 25 mm for RS–422 cable; 40 mm for RS–232C cable.

3. Use scissors to cut away the exposed braiding.

4. Use wire strippers to remove the insulation from the last 5 mm of all wires.

5. Wrap insulating tape over the top and end of the the cut sheath.

Electrician's tape
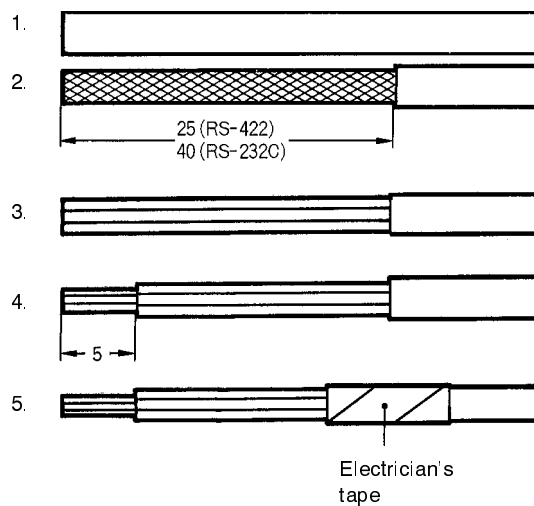
Soldering   Observe the following when soldering the prepared wires onto the connectors.

1, 2, 3...   1.   Place heat-shrinking tubes onto all wires, far enough away from the end so as not to interfere with the soldering.

2.   Presolder all wires and connector terminals.

3.   Solder wires, inserting 4 mm of the exposed 5 mm of wire into the connector terminal.

4.   Move the heat-shrinking tubes onto the soldered area and shrink them into place.

Hood Assembly   Assemble the hood as shown in the following diagram.

Boot

Aluminum foil tape

Hood (FG) connected
to shield wire

Hood (FG) not connected
to shield wire
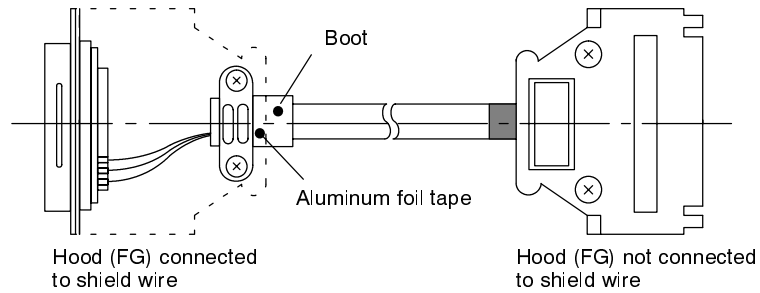
SECTION 3
Operation

In *Section 3−1* the effects of Host Link Unit settings on the PC operating mode and data flow in different modes are explained. *Section 3−2* details the different formats that make up the communications protocol under which the system operates. Communications testing is covered in *Section 3−3*. In *Section 3−4* the minimum and maximum response times are explained.

3–1 PC Operating Mode

The operating mode of the PC depends an the setting of the mode selector on the Host Link Unit, the RUN/STOP selector on the Host Link Unit, and the status of any peripheral device connected to the PC.

Power-up

If the PC is in RUN mode, it will begin operation immediately the power is applied.

Caution Label

The CPU-mounting 3GC27 Host Link Units are supplied with a self-adhesive caution label. If the RUN/STOP selector is set to RUN, the label should be attached as shown below. It warns users that the Unit is set to RUN mode, indicating that the PC will commence operation as soon as the power is applied.

Attach label here
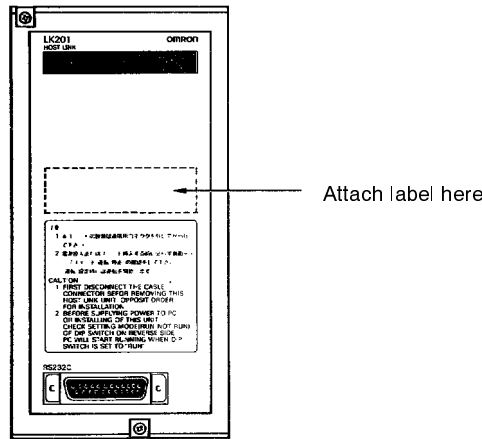
Sending a RUN Start Command to the PC

The following flowchart shows the computer decision making processes for ensuring that the PC is in RUN mode after startup.
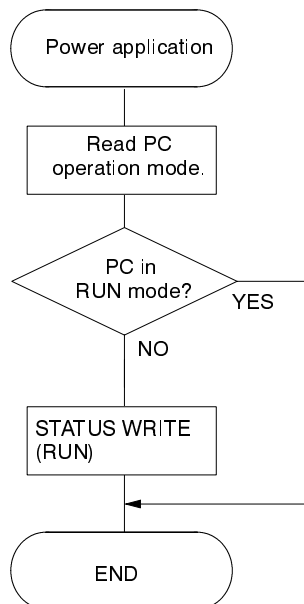
3–2   Communications Protocol

The host computer has initial transmission priority. Data transfer between the host computer and the Host Link Unit is, therefore, initiated when the computer sends a command to the Host Link Unit.

A set of data in a transmission is called a "block". The data block sent from the host computer to the Host Link Unit is called a "command block." The block sent from the Host Link Unit to the computer is called a "response block." In a multiple-link communications system, each block starts with a unit number and a header, and ends with a Frame Check Sequence (FCS) code and a terminator (* and CR). In a single-link system, however, each block starts with only a header, and ends with only a terminator. The terminator in the command block enables the Host Link Unit to send a response. The terminator in the response block enables the host computer to send another command.

3–2–1   Block Format

Multiple-link System
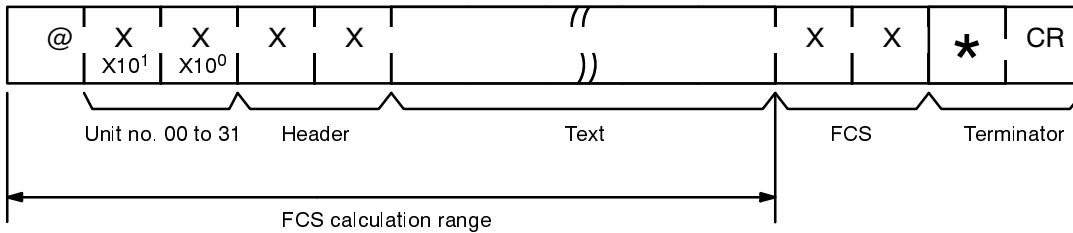
Single-link System
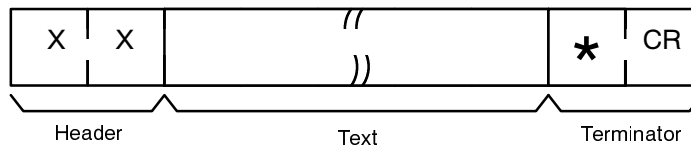
A block is usually made up of one unit called a "frame," but long blocks of data are divided into more than one frame. In a multiple-link system, the first frame can have up to 127 characters, and subsequent frames can have up to 124 characters. In a single-link system, however, every frame (the first included) has up to 124 characters. The data must then be divided into more than one frame when there is a block consisting of more than 127 characters in a multiple-link system, or more than 124 characters in a single-link system. In this case, the beginning and intermediate blocks end with a delimiter (CR), instead of a terminator (*CR).

3–2–2   Block Format With More Than One Frame

Multiple-link System

First Frame (127 Characters or Less)
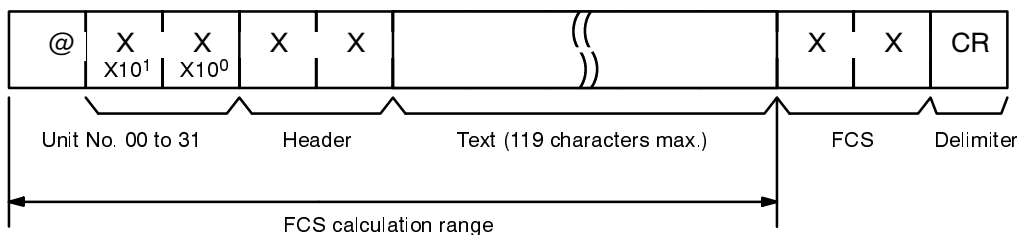
Intermediate Frames (124 Characters or Less)

	X	X	CR

Text (121 characters max.) FCS Delimiter

FCS calculation range

Last Frame (124 Characters or Less)

	X	X	*	CR

Text no. M (120 characters max.) FCS Terminator

FCS calculation range
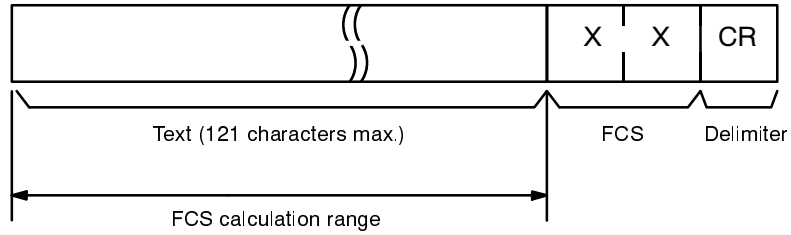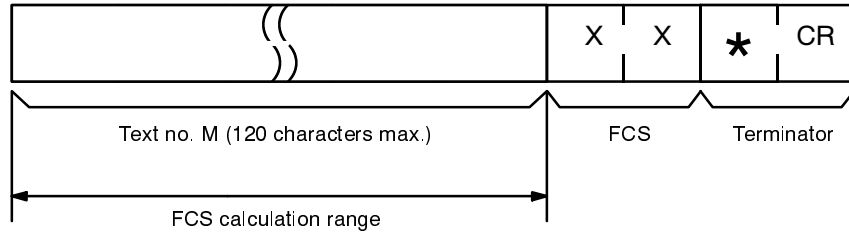
Single-link System

First Frame (124 Characters or Less)
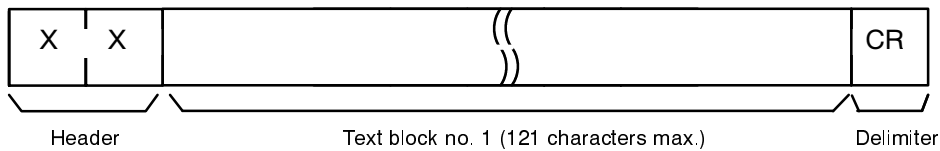
X	X		CR

Header Text block no. 1 (121 characters max.) Delimiter

Intermediate Frame(s) (124 Characters or Less)

	CR

Text block no. 2 (123 characters max.) Delimiter

Last Frame (124 Characters or Less)

	*	CR

Text block no. M (122 characters max.) Terminator
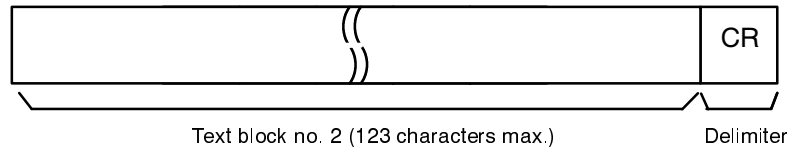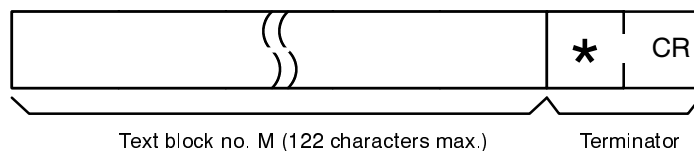
Sending Commands

To send a command block (with more than one frame) from the computer, initially send only the first frame in the block. Do not send the next frame until the host computer has received the delimiter which should have been sent back in the response block from the Host Link Unit. Do not split data from a single word into different frames for any write command.
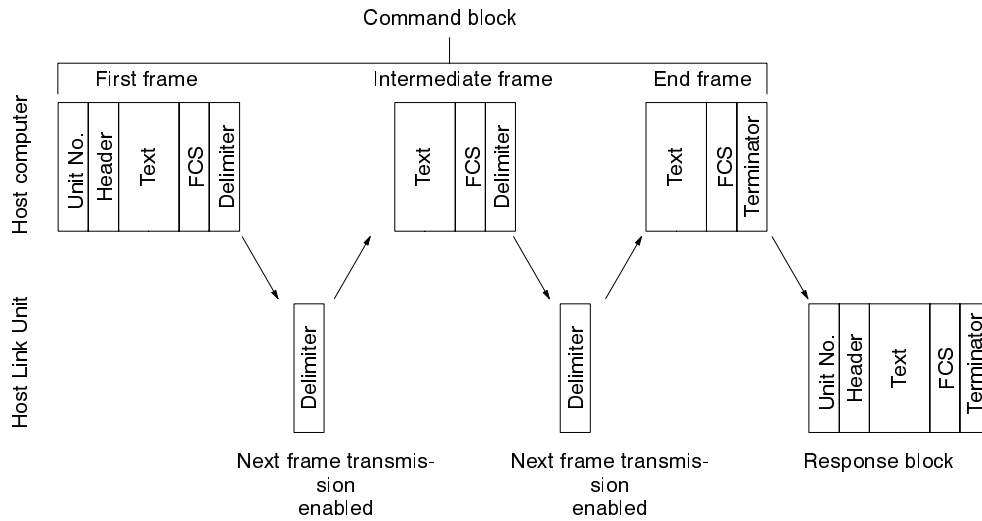
Receiving Commands   To receive a response block consisting of more than one frame from the Host Link Unit, the host computer must send the carriage return code (delimiter) to the Host Link Unit after it receives the delimiter from the Host Link Unit. This enables the Host Link Unit to send the next frame.
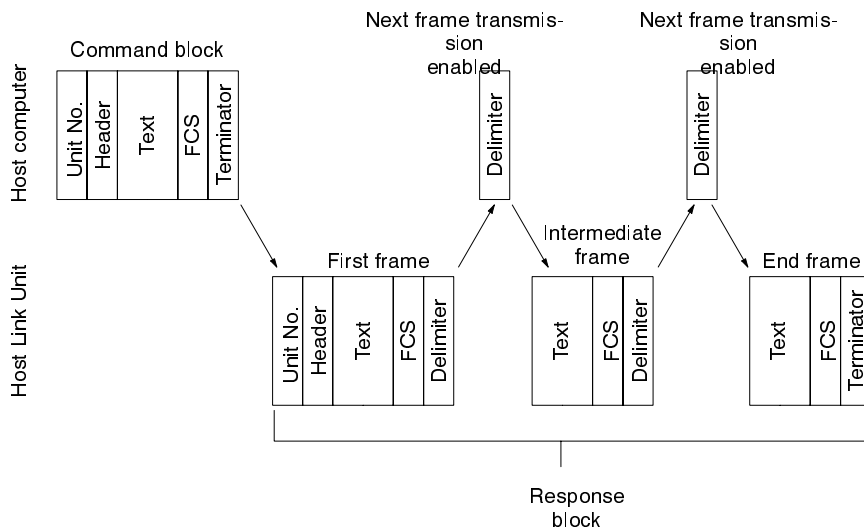
3–2–3   Data Representation

Numerical data within a transmission is expressed in hexadecimal or decimal. Refer to the format example of each command in *Section 4 Commands and Responses* for details.

3–3   Communications Tests

Prior to an actual data transaction between the Host Link Unit and host computer, check the system by following the nine steps listed below.

1, 2, 3... 1. Check the settings of the Host Link Unit's DIP switches and selectors. make sure the transmission speeds, specified interfaces, and data formats of both the Host Link Unit and host computer match.

2. Mount the Host Link Unit to the PC.

3. Connect the Host Link Unit to the host computer with the proper cable. For details, refer to *Section 2*.

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4.   Apply power to the PC and the host computer.
5.   If the ERROR or ALARM indicators on the PC illuminate, rectify the error and then clear the alarm.
6.   If the Host Link Unit is ready, the RUN indicator will illuminate. Confirm that this is so before proceeding.
7.   Prepare and execute a test program on the host computer.
8.   If the data test is completed successfully, the system is operational.
9.   If an error occurs, perform the required error processing by referring to *Section 5*.

3–3–1   Data Transaction Test Program

The following program example is designed to send test data to the Host Link Unit and return it, unaltered, to the host computer. By executing this program, the transmit and receive data are both displayed on the screen of the host computer. If the transmit data and the receive data match, the system is operational. The example is for a multiple-link system, and the program is executed by Host Link Unit number 0.

Transaction Test Program   The following program example is used to send commands to a Host Link Unit and receive back the response at the host computer. When this program is executed, the transmit and received data are both displayed on the screen of the host computer for visual confirmation. The program also automatically adds the FCS to the transmission before sending it.

Line 10010 opens the RS-232C port. Line 10020 displays "COMMAND..." The desired commands should be entered in response. For example, @00RR00000006* and then a carriage return can be input to read out data from IR 00 through IR 05 of Unit #0. The principal parts of the remaining lines of the program function as follows:

```
10000  CONSOLE 0,25,1,1
10010  OPEN"COM:E73"AS#1 :COLOR 6 - - - - - - - - - - - - - - - - - - - - - - - - - - - - -  Opens RS–232C
10020  COLOR 6 :LINE INPUT"COMMAND...",A$:IF A$="@**" OR A$="" OR A$="*"
                                          THEN A$=A$+CHR$(13):GOTO 10070
10030  GOSUB *FCSSET - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -  Calculation of FCS
10040  A$=A$+FCS$+B$+CHR$(13) - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -  Transmission data
10050  '                                                                                    entered
10060  '
10070  PRINT#1,A$;:COLOR 2 :PRINT A$ - - - - - - - - - - - - - - - - - - - - - -  Displays the
10080  COLOR 4 :IF A$<>"@**"+CHR$(13) AND A$<>"@00XZ42*"+CHR$(13)  transmission data
                           THEN LINE INPUT#1,Q$ ELSE 10020 - - - -  Receives the response
10090  COLOR 4:PRINT"RESPONSE...",Q$ - - - - - - - - - - - - - - - - - - - - - -  Displays the response
10100  GOTO 10020
10110  '
10120  '
10130  *FCSSET
10140  B$=RIGHT$(A$,1):IF B$="*" THEN A$=LEFT$(A$,LEN(A$)-1) ELSE B$=""
10150  Q=0 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -  Setting of initial value
10160  FOR I=1 TO LEN(A$)                                                                   for EOR calculation
10170  Q=Q XOR ASC(MID$(A$,I,1))
10180  NEXT I
10190  FCS$="0"+HEX$(Q):FCS$=RIGHT$(FCS$,2)
10200  RETURN
```

3–3–2   FCS Calculation

The FCS is 8-bit data converted into two ASCII characters. The 8-bit data is the result of an Exclusive OR sequentially performed on each character, from the first character in the frame to the last character of the text in that frame.

Example

@ 1 0	R H	0 0 3 1 0 0 0 1	5 8	* CR
Unit no.	Header	Text	FCS	Terminator

```
@       0100      0000
                EOR
1       0011      0001
                EOR
0       0011      0010
                EOR
R       0101      0010


0       0011      0000
                EOR
1       0011      0001

        0101      1000
```

       Conversion
       to ASCII

```
0011    0101      0011      1000
```

```
FCS
```
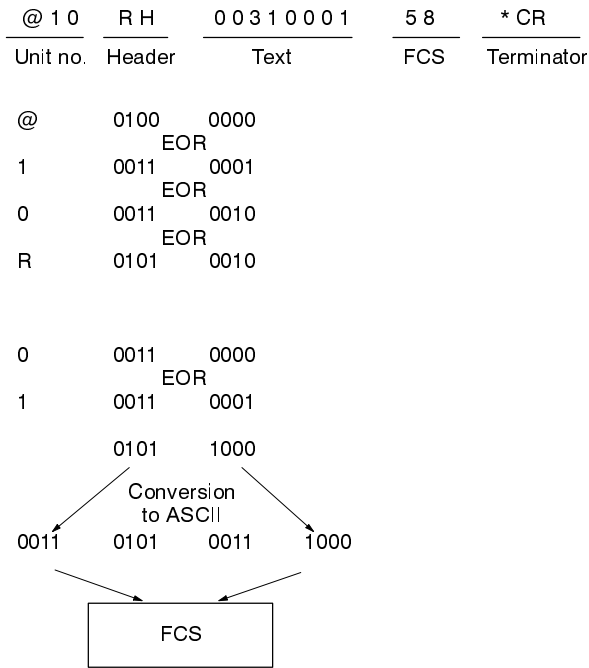
3–3–3 FCS Calculation Program Example

The following program is an example of how FCS calculation can be performed on received data.

```
400 *FCSCHECK
405 L=LEN(RESPONSE$) - - - - - - - - - - - - - - - - - - - - - - -  Transmit/receive data
410 Q=0:FCSCK$=" "
415 A$=RIGHT$(RESPONSE$,1)
417 PRINT RESPONSE$,A$,L
420 IF A$="*" THEN LENGS=LEN(RESPONSE$)-3 ELSE LENGS=LEN(RESPONSE$)-2
430 FCSP$=MID$(RESPONSE$,LENGS+1,2)
440 FOR I=1 TO LENGS - - - - - - - - - - - - - - - - - - - - - - -  Number of characters in FCS calculation range.
450 Q=ASC(MID$(RESPONSE$,I,1)) XOR Q - - - - - - - - - - -  Receive data contains an FCS, delimiter,
460 NEXT I                                                    terminator, etc. The ABORT command,
470 FCSD$=HEX$(Q)                                             however, does not contain an FCS.
480 IF LEN(FCSD$)=1 THEN FCSD$="0"+FCSD$ - - - - - - - -  FCS calculation result
490 IF FCSD$<>FCSP$ THEN FCSCK$="ERR" - - - - - - - - - -  Receive FCS data
495 PRINT "FCSD=";FCSD$,"FCSP=";FCSP$,"FCSCK=";- -  A space follows the semicolon if the
500 RETURN                                             FCS reception is performed normally. If
                                                       it is not performed, ERR is displayed.
```

Note: in this example, CR (CHR$(13))
is not included in RESPONSE$.

3–4 I/O Response Times

The processing that determines, and the methods for calculating, the minimum and maximum times required from an input on one PC with a Host Link Unit to an output on another PC with a Host Link Unit are described below. The transfer between the PCs is handled through a host computer connected to both these PCs.

The calculations used in this section assume that all host computer commands and PC responses require no more than one host link servicing peri-

od to complete transmission. To compute response times for situations involving a longer command and/or response, the number of host link servicing periods (i.e., the number of scans) required to complete the command or response would have to be incorporated into the equations.

In considering response times, it is important to remember the sequence of processing that occurs during the PC scan. The main factor that affects the response time is the timing of inputs and outputs, and of the host computer processing in relation to this sequence.

The following diagram illustrates the setup used in response time calculations
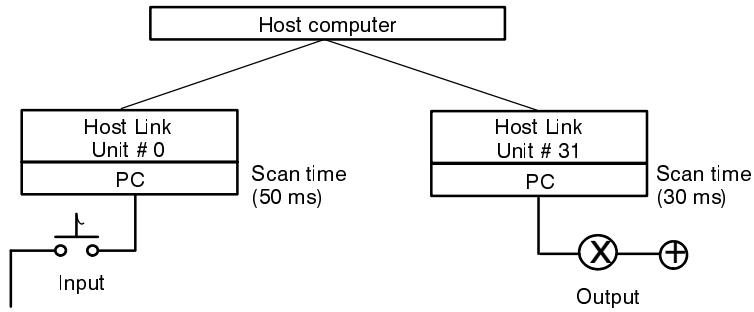
Minimum Response Time   The data flow that will produce the minimum response time is shown below. This flow assumes that all signals and data transmissions are processed as soon as they occur. The equation for the minimum response time is given below the diagram.
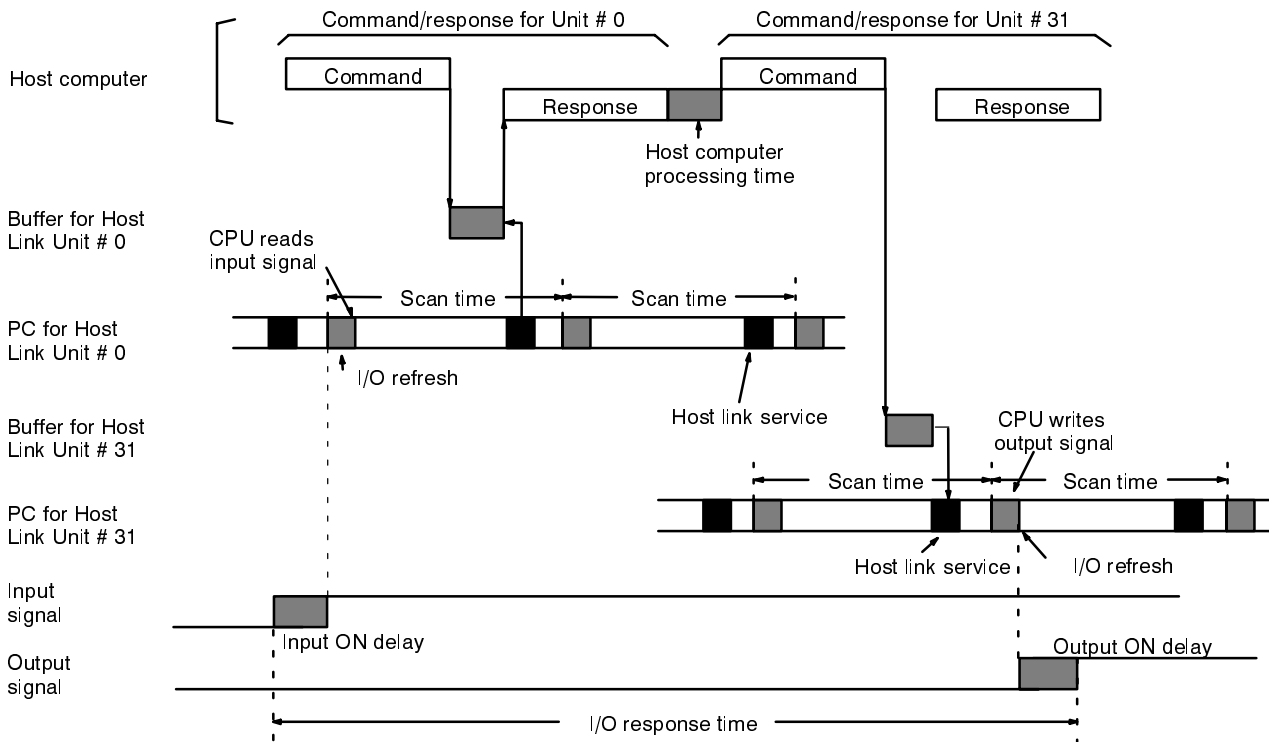
Minimum response time =   Input ON delay + Command transmission time + Scan time of PC for Unit #0 + Response transmission time + Host computer processing time + Command transmission time + Output ON delay

Maximum Response Time   The data flow that will produce the maximum response time is shown below. Delays over the minimum response time occur because the input to be transferred through the host computer is received immediately following the I/O refresh period (requiring a wait to the next scan) and because the command from the host computer to write the bit to be output from PC for Unit #31 is received immediately following host link servicing (again requiring a wait to the next scan). The equation for the maximum response time is given below the diagram.
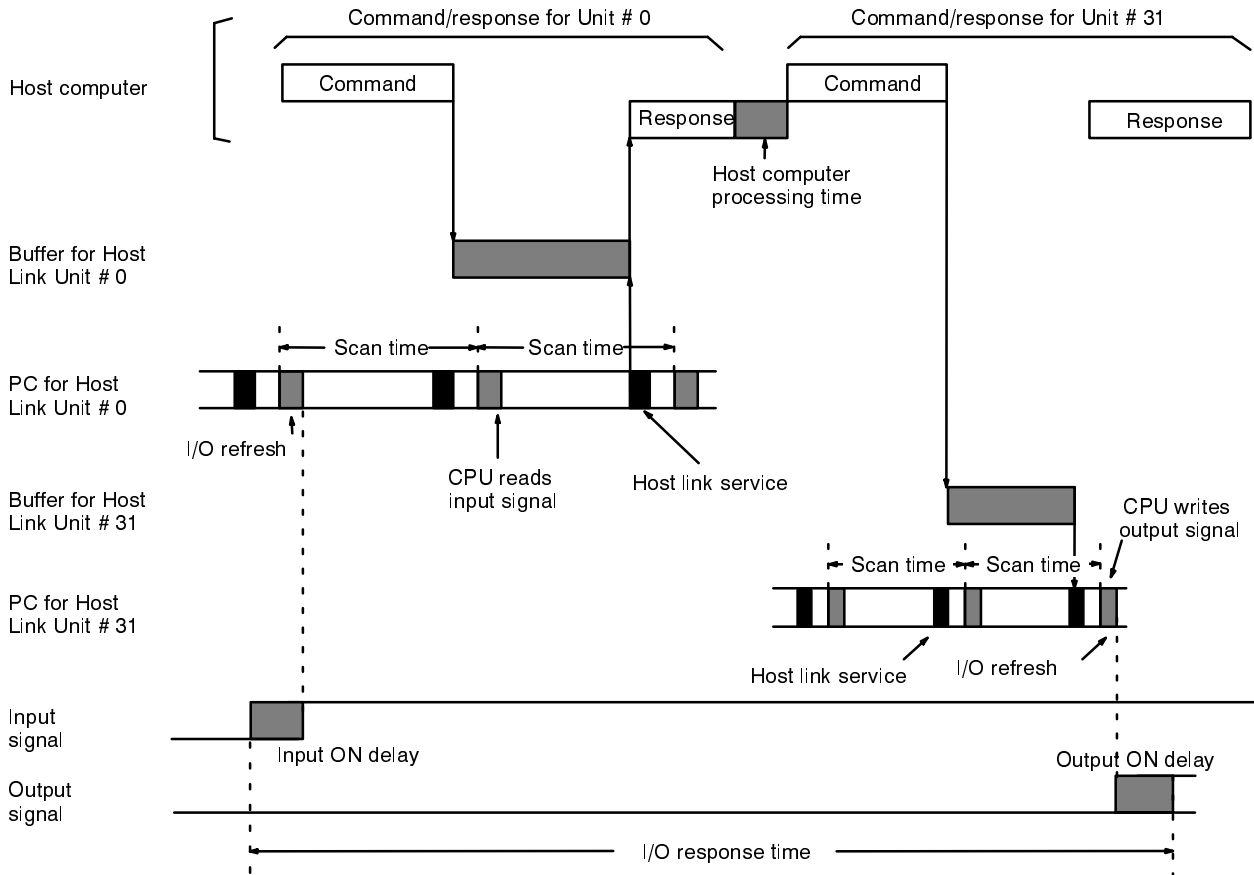
Maximum response time =   Input ON delay + Command transmission time + (Scan time of PC for Unit #0 x 2) + Response transmission time + Host computer processing time + Command transmission time + Scan time of PC for Unit #31 + Output ON delay

SECTION 4
Commands and Responses

This section lists the commands and responses for Host Link Units. *Section 4−1 Command Response Set* lists all of the commands and responses which apply to the K-type Host Link Units. Also refer to *Section 3−2 Communications Protocol* for basic format information (see also *Section 4−2*).

The format examples shown in this section are for multiple-link systems. The differences between the formats of multiple-link and single-link systems are explained in *Section 3−2 Communications Protocol*. All response formats shown are for normal responses, for which the response code is "00." Refer to *Section 4−34 Response Code List* for other response codes.

The explanation for each command also includes possible data (e.g., programming instructions) which may need to be read. The actual data that will be valid for your system depends on the PC(s) used. Therefore, when reading the explanations, remember to confirm the programming instructions, the data areas, and the data area sizes available in your PC(s).

The response speed of the Host Link Unit varies depending on the communication speed and data capacity selected. Furthermore, it is also affected by the operating mode of the PC, whether the PC employs ladder diagram or flowchart programming, and the PC's scan time (for ladder diagram programming). Therefore, in applications where high-speed data processing is vital, these factors need to be taken into consideration when calculating the response speed.

4–1   Command and Response Set

The following table gives the list of commands and responses available for the K-type Host Link Unit and the modes in which they are applicable.

Header Code	Name	PC Mode		
		RUN	**MONITOR**	**PROGRAM**
TS	TEST	Valid	Valid	Valid
MS	STATUS READ	Valid	Valid	Valid
MF	ERROR READ	Valid	Valid	Valid
RR	IR AREA READ	Valid	Valid	Valid
RH	HR AREA READ	Valid	Valid	Valid
RG	TC STATUS READ	Valid	Valid	Valid
RD	DM AREA READ	Valid	Valid	Valid
RC	PV READ	Valid	Valid	Valid
R#	SV READ 1	Valid	Valid	Valid
R$	SV READ 2	Valid	Valid	Valid
R%	SV READ 3	Valid	Valid	Valid
SC	STATUS WRITE	Valid	Valid	Valid
WR	IR AREA WRITE	Not Valid	Valid	Valid
WH	HR AREA WRITE	Not Valid	Valid	Valid
WG	TC STATUS WRITE	Not Valid	Valid	Valid
WD	DM AREA WRITE	Not Valid	Valid	Valid
WC	PV WRITE	Not Valid	Valid	Valid
W#	SV CHANGE 1	Not Valid	Valid	Valid
W$	SV CHANGE 2	Not Valid	Valid	Valid
W%	SV CHANGE 3	Not Valid	Valid	Valid
KS	FORCED SET	Not Valid	Valid	Not Valid
KR	FORCED RESET	Not Valid	Valid	Not Valid
KC	FORCED SET/RESET CANCEL	Not Valid	Valid	Not Valid
MM	PC MODEL READ	Valid	Valid	Valid
XZ	ABORT (command only)	Valid	Valid	Valid
IC	Undefined command (response only)	Valid	Valid	Valid
RP	PROGRAM READ	Valid	Valid	Valid
WP	PROGRAM WRITE	Not valid	Not valid	Valid
QQ	I/O REGISTER, I/O READ	Valid	Valid	Valid

4–2   Command and Response Formats

The format examples in this manual apply to multiple-link systems. The explanation for each command/response includes the ranges of the possible data (e.g., program instructions to be read, operand values, etc.). The actual data that is valid for the system depends on the PCs being used. Therefore,

it is important that you check that the program instructions and the data areas (and sizes) are available for the PCs in your system.

Numerical data within a transmission is expressed in hexadecimal or decimal format. Refer to the format example of each command for details. The appropriate range is indicated in the following manner.

Hexadecimal Data

	$X16^3$	$X16^2$	$X16^1$	$X16^0$	
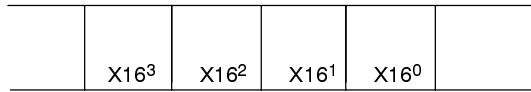
In the above diagram, the elements $X16^3$ to $X16^0$ indicate that the data is expressed in hexadecimal. Each digit can, therefore, be in the range from 0 (0000) to F (1111).

Decimal Data

	$X10^3$	$X10^2$	$X10^1$	$X10^0$	
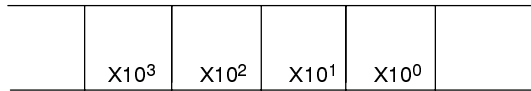
In this figure, $X10^3$ to $X10^0$ indicate that the data is expressed in decimal. Each digit can, therefore, be in the range from 0 (0000) to 9 (1001).

4–3   TEST

Transmits one block of data to the PC and then returns it, unaltered, to the host computer. Each frame is treated as a block regardless of whether it uses a terminator or delimiter.

Command Format

@	Unit no. $X10^1$	$X10^0$	T	S	Any characters (118 max.) other than a carriage return	FCS	✱	CR

Response Format

@	Unit no. $X10^1$	$X10^0$	T	S	Any characters (118 max.) other than a carriage return	FCS	✱	CR
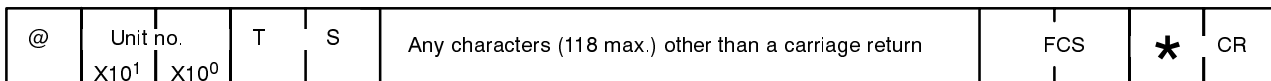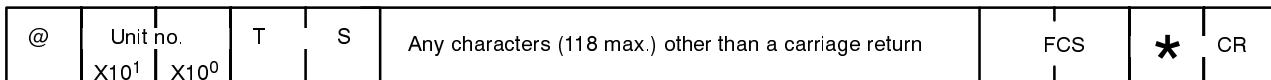
4–4   STATUS READ

Reads the operating status of the PC.

Command Format

@	Unit no. $X10^1$	$X10^0$	M	S	FCS	✱	CR

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Response Format Sticker

@	Unit no.		M	S	Response code		Status data					FCS	✱	CR
	$X10^1$	$X10^0$			$X16^1$	$X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$				

C20, K-type PCs
28: Program ROM 48: Program ROM
20: Program RAM 40: Program RAM

00: PROGRAM mode
02: RUN mode
03: MONITOR mode
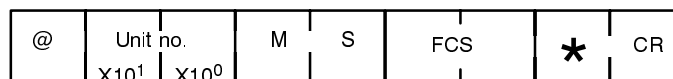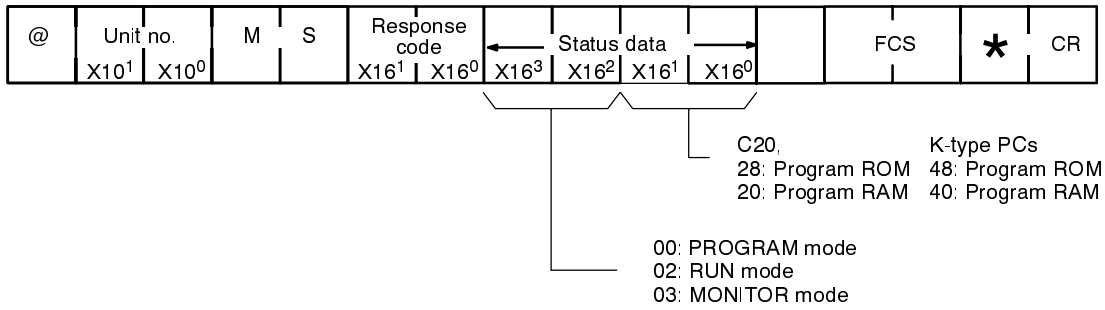
4–5 ERROR READ

Reads and clears errors in the PC. Also checks whether previous errors have already been cleared. When both Rack- and CPU-mounting Host Link Units are used in combination, errors in either type of Unit are indicated in the same manner.

Command Format

@	Unit no.		M	S	Error clear	FCS	✱	CR
	$X10^1$	$X10^0$						

00: Error is not cleared
01: Error is cleared

Response Format

@	Unit no.		M	F	Response code		Error (first word)				Error (second word)				FCS	✱	CR
	$X10^1$	$X10^0$			$X16^1$	$X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$			

15	14	13	12	11	10	9	8

7	6	5	4	3	2	1	0

Not used

15	14	13	12	11	10	9	8

1: END instruction missing (F0)
1: I/O bus error (C0 to 4)
1: Memory error (F1)

1: Battery failure (F7)

7	6	5	4	3	2	1	0
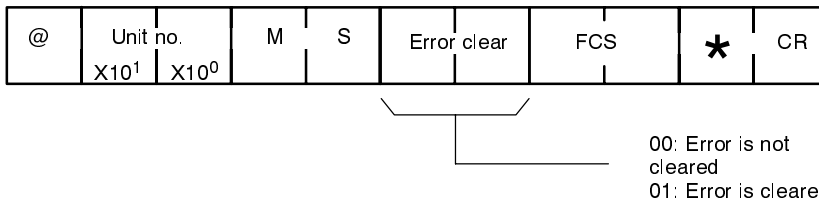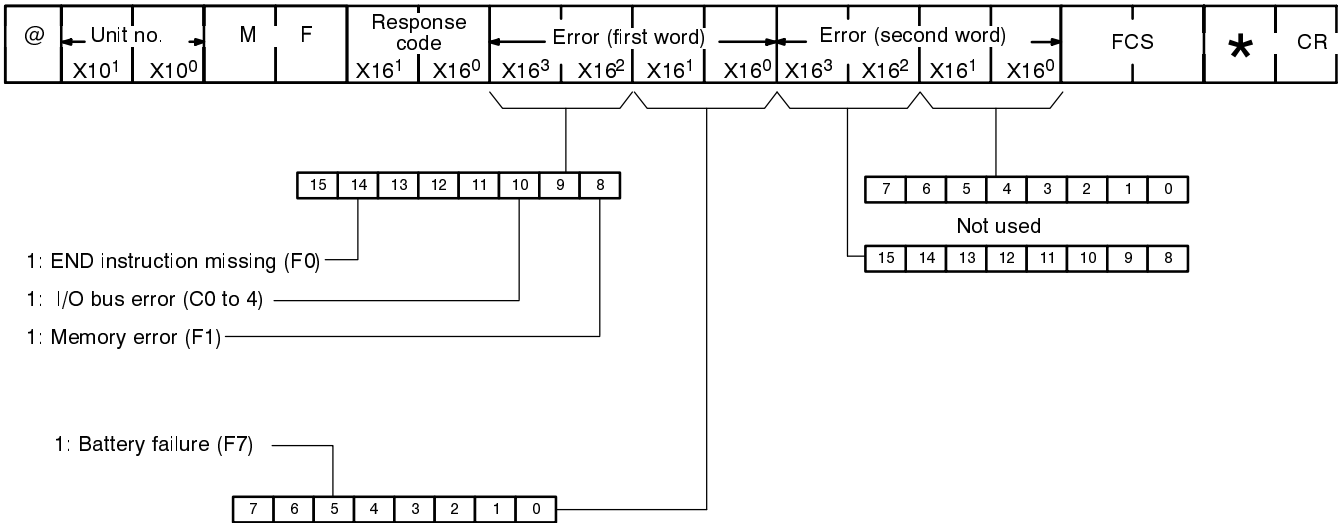
4–6 IR AREA READ

Reads the contents of the specified number of IR area words, starting from the specified word.

Command Format

@	Unit no.		R	R	Beginning word				No. of words				FCS	✱	CR
	$X10^1$	$X10^0$			$X10^3$	$X10^2$	$X10^1$	$X10^0$	$X10^3$	$X10^2$	$X10^1$	$X10^0$			

Response Format

@	Unit no.		R	R	Response code	Data from beginning word				Data from second word				
	$X10^1$	$X10^0$			$X16^1$ $X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$	

FCS	★	CR
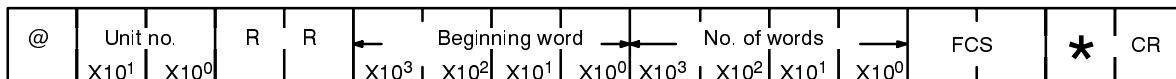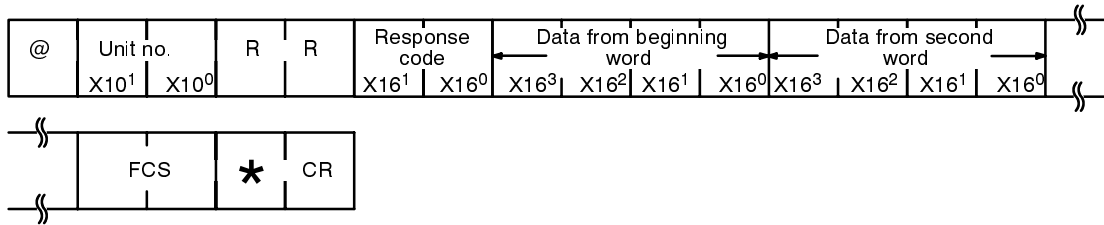
4–7 HR AREA READ

Reads the contents of the specified number of HR area words, starting from the specified word.

Command Format

@	Unit no.		R	H	Beginning word				No. of words					FCS	★	CR
	$X10^1$	$X10^0$			$X10^3$	$X10^2$	$X10^1$	$X10^0$	$X10^3$	$X10^2$	$X10^1$	$X10^0$				

Response Format

@	Unit no.		R	C	Response code	Data from beginning word				Data from second word				
	$X10^1$	$X10^0$			$X16^1$ $X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$	$X16^3$	$X16^2$	$X16^1$	$X16^0$	

FCS	★	CR
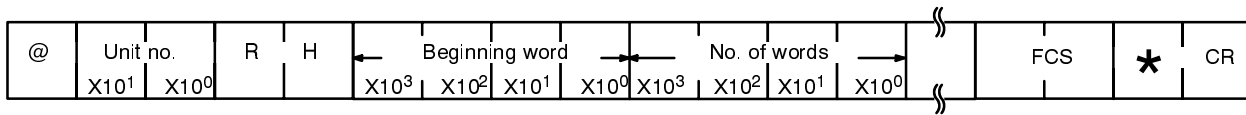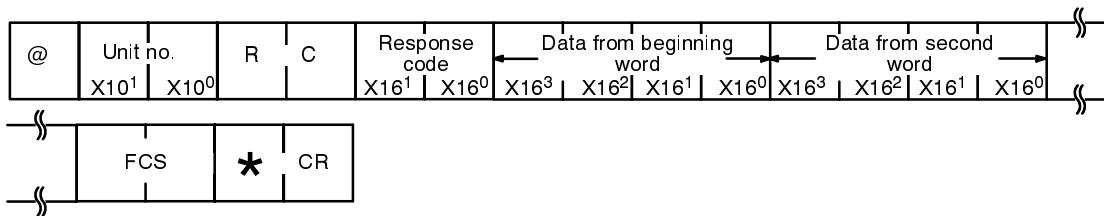
4–8 TC STATUS READ

Reads the status of the Completion Flags of the specified number of timers/counters, starting from the specified timer/counter.

Command Format

@	Unit no.		R	G	Beginning timer/counter				No. of timers/counters				FCS	★	CR
	$X10^1$	$X10^0$			$X10^3$	$X10^2$	$X10^1$	$X10^0$	$X10^3$	$X10^2$ $X10^1$	$X10^0$				

Response Format

@	Unit no.		R	G	Response code	ON/ OFF	ON/ OFF		FCS	★	CR
	$X10^1$	$X10^0$			$X16^1$ $X16^0$						

Data from second timer/counter

Data from beginning timer/counter

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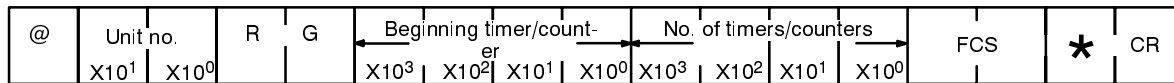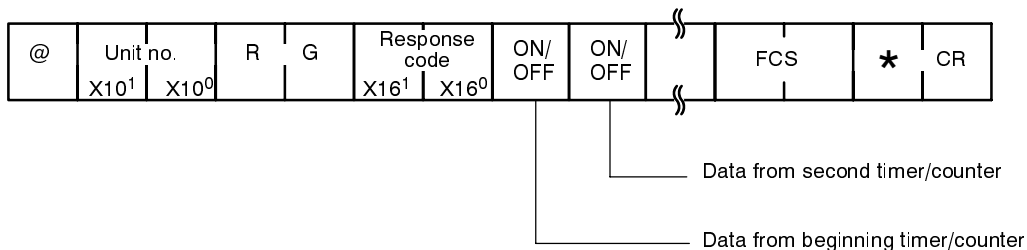
4–9 DM AREA READ

Reads the contents of the specified number of DM (Data Memory) area words, starting from the specified word.
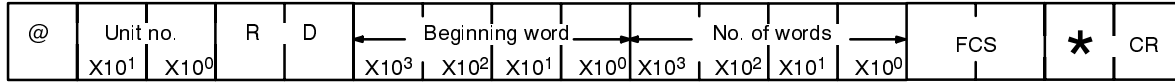
Command Format

@	Unit no.		R	D	← Beginning word →	← No. of words →	FCS	∗	CR
	$X10^1$	$X10^0$			$X10^3$ $X10^2$ $X10^1$ $X10^0$	$X10^3$ $X10^2$ $X10^1$ $X10^0$			

Response Format

@	Unit no.		R	D	Response code	Data from beginning word	Data from second word	
	$X10^1$ $X10^0$				$X16^1$ $X16^0$	$X16^3$ $X16^2$ $X16^1$ $X16^0$	$X16^3$ $X16^2$ $X16^1$ $X16^0$	

FCS	∗	CR
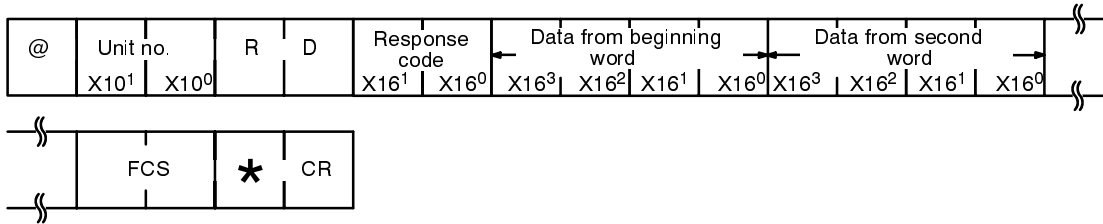
4–10 PV READ

Reads the specified number of timer/counter PVs (present values), starting from the specified word.

Command Format

@	Unit no.		R	C	← Beginning word →	← No. of words →	FCS	∗	CR
	$X10^1$	$X10^0$			$X10^3$ $X10^2$ $X10^1$ $X10^0$	$X10^3$ $X10^2$ $X10^1$ $X10^0$			

Response Format

@	Unit no.		R	C	Response code	Data from beginning word	Data from second word	
	$X10^1$ $X10^0$				$X16^1$ $X16^0$	$X16^3$ $X16^2$ $X16^1$ $X16^0$	$X16^3$ $X16^2$ $X16^1$ $X16^0$	

FCS	∗	CR
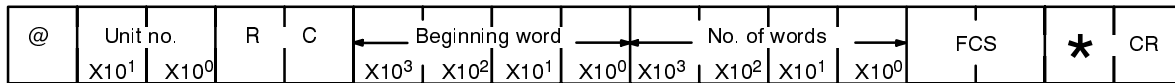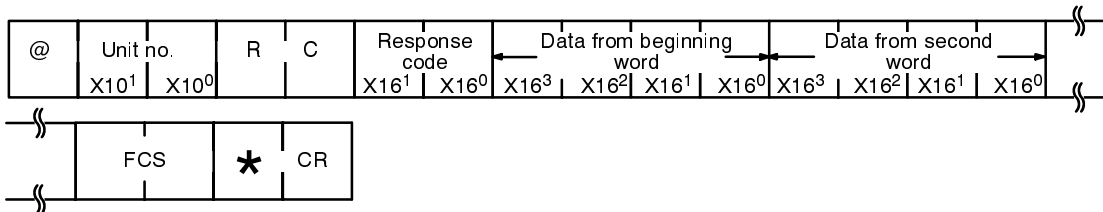
4–11 SV READ 1

Reads the set value (a constant) of the specified timer/counter instruction. Reads from the beginning of the program and can therefore take up to 20 seconds to produce a response. Refer also to SV READ 2 and SV READ 3.

Command Format

@	Unit no.		R	#	← TIM/CNT →	← Number →	FCS	∗	CR
	$X10^1$	$X10^0$			$X10^3$ $X10^2$ $X10^1$ $X10^0$	$X10^3$ $X10^2$ $X10^1$ $X10^0$			

T	I	M	–	0	0	0	0
T	I	M	H	:	:	:	:
C	N	T	–	:	:	:	:
C	N	T	R	0	0	4	7

Response Format

| @ | Unit no. X10¹ X10⁰ | R | # | Response code X16¹ X16⁰ | ← Set value → X10³ X10² X10¹ X10⁰ | FCS | * | CR |
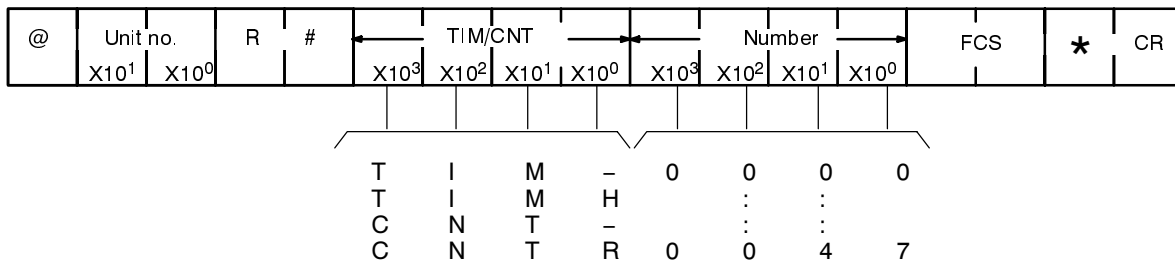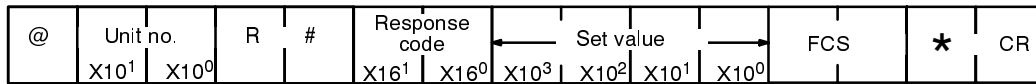
If the command is used more than once, the set value of only the first instruction will be read.

4-12 SV READ 2

Reads the set value (a constant, or data area and word) of the specified timer/counter instruction. The timer/counter instruction is designated by its program address. If the program has more than 9,999 addresses, use SV READ 3, described in the next section.

Command Format

| @ | Unit no. X10¹ X10⁰ | R | $ | ← Address → X10³ X10² X10¹ X10⁰ | X10³ X10² X10¹ X10⁰ TIM/CNT | Number X10³ X10² X10¹ X10⁰ |

```
T  I  M  –   0  0  0  0
T  I  M  H   :  :     :
C  N  T  –   :  :     :
C  N  T  R   0  0  4  7
```

| FCS | * | CR |

Response Format

| @ | Unit no. X10¹ X10⁰ | R | $ | Response code X16¹ X16⁰ | ← Data area → | ← Word → X10³ X10² X10¹ X10¹ | FCS | * | CR |

```
C  I  O  –...IR area
H  R  –  –...HR area
D  M  –  –...DM area
C  O  N  –...Constant
```
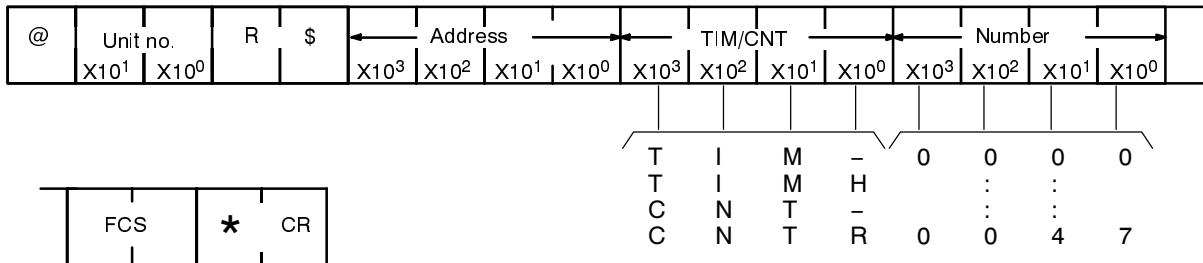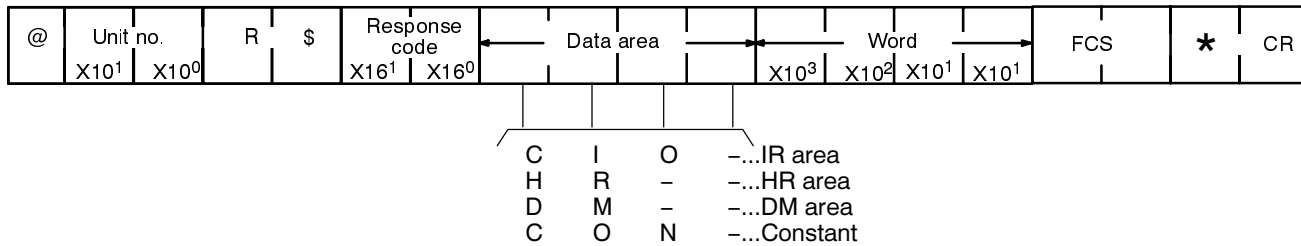
4-13 SV READ 3

Reads the set value (a constant, or data area and word) of the specified timer/counter instruction. The operation is similar to SV READ 2, but the SV READ 3 is capable of reading from higher program addresses.

Command Format

| @ | Unit no. X10¹ X10⁰ | R | % | ← Address → X10⁵ X10⁴ X10³ X10² X10¹ X10⁰ | X10³ X10² X10¹ X10⁰ TIM/CNT |

Always 0

```
T  I  M  –
T  I  M  H
C  N  T  –
C  N  T  R
```

| ← Number → X10³ X10² X10¹ X10⁰ | FCS | * | CR |

```
0  0  0  0
:  :     :
:  :     :
0  0  4  7
```

Response Format

| @ | Unit no. $X10^1$ $X10^0$ | R | % | Response code $X16^1$ $X16^0$ | ← Data area → | Word $X10^3$ $X10^2$ $X10^1$ $X10^1$ | FCS | ∗ | CR |
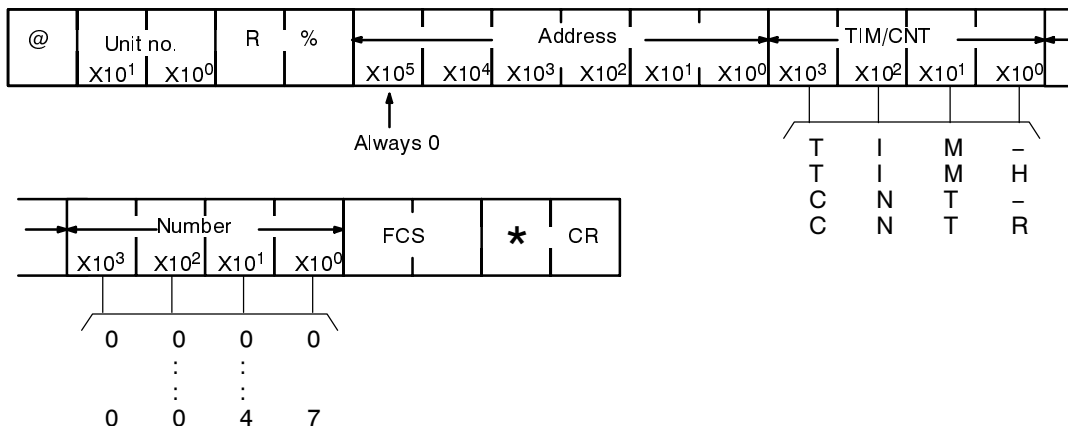
```
C   I   O   –...IR area
H   R   –   –...HR area
D   M   –   –...DM area
C   O   N   –...Constant
```
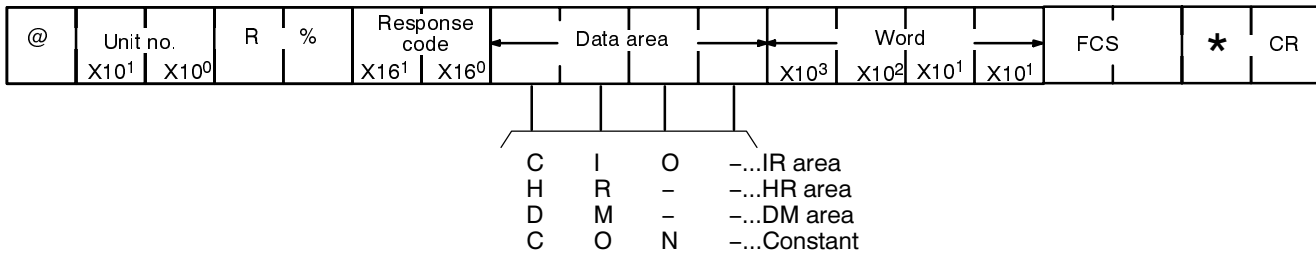
4–14 STATUS WRITE

Changes the operating mode of the PC according to the information entered into word $X16^0$.

Command Format

| @ | Unit no. $X10^1$ $X10^0$ | S | C | ← Mode data → $X16^1$ $X16^0$ | FCS | ∗ | CR |

$X16^1$ $X16^2$

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

0   0   0   0   0   0

```
0   0: PROGRAM mode
1   0: MONITOR mode
1   1: RUN mode
```

Response Format

| @ | Unit no. $X10^1$ $X10^0$ | S | C | Response code $X16^1$ $X16^0$ | FCS | ∗ | CR |
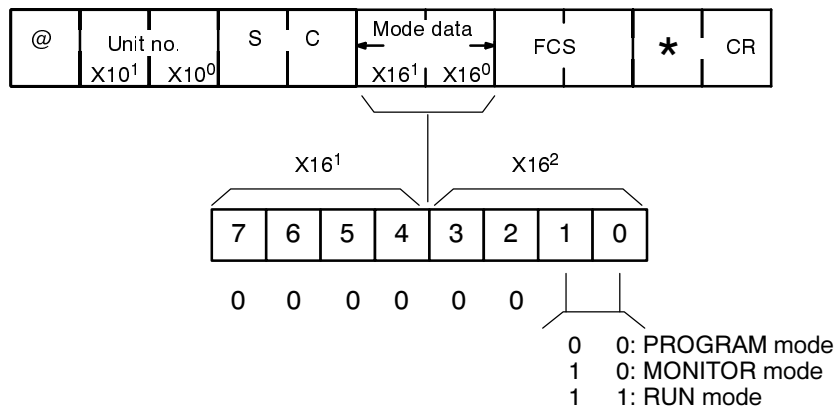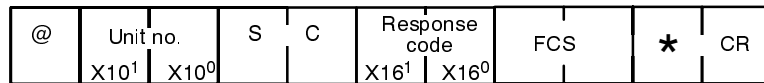
4–15 IR AREA WRITE

Writes data to the IR area, starting from the specified word. Writing is done word by word.

Command Format

| @ | Unit no. $X10^1$ $X10^0$ | W | R | ← Beginning word → $X10^3$ $X10^2$ $X10^1$ $X10^0$ | Data for beginning word $X16^3$ $X16^2$ $X16^1$ $X16^0$ | Data for second word $X16^3$ $X16^2$ $X16^1$ $X16^0$ |

| | | FCS | ∗ | CR |

Response Format

| @ | Unit no. $X10^1$ $X10^0$ | W | R | Response code $X16^1$ $X16^0$ | FCS | ∗ | CR |

4–16 HR AREA WRITE

Writes data to the HR area, starting from the specified word. Writing is done word by word.

Command Format

@	Unit no. $X10^1$	$X10^0$	W	H	←	Beginning word $X10^3$	$X10^2$	$X10^1$	$X10^0$	Data for beginning word $X10^3$	$X10^2$	$X10^1$	$X10^0$	Data for second word $X10^3$	$X10^2$	$X10^1$	$X10^0$

	FCS	★	CR

Response Format

@	Unit no. $X10^1$	$X10^0$	W	H	Response code $X16^1$	$X16^0$	FCS	★	CR

4–17 TC STATUS WRITE

Writes the status of the Completion Flags to the TC area, starting form the specified timer/counter.

Command Format

@	Unit no. $X10^1$	$X10^0$	W	G	←	Timer/Counter $X10^3$	$X10^2$	$X10^1$	$X10^0$	ON/OFF	ON/OFF	FCS	★	CR

Status of second timer/counter
Status of beginning timer/counter
Beginning timer/counter

0: OFF
1: ON

Response Format

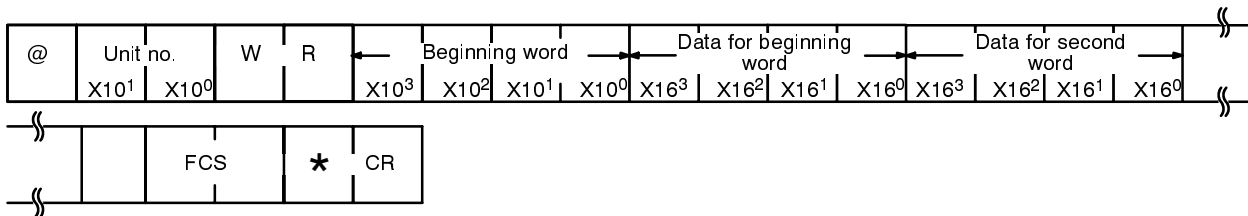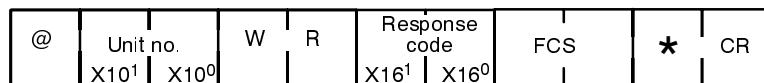| @	Unit no. $X10^1$	$X10^0$	W	G	Response code $X16^1$	$X16^0$	FCS	★	CR
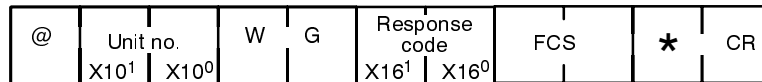
4–18 DM AREA WRITE

Writes data to the DM area, starting from the specified word. Writing is done word by word.
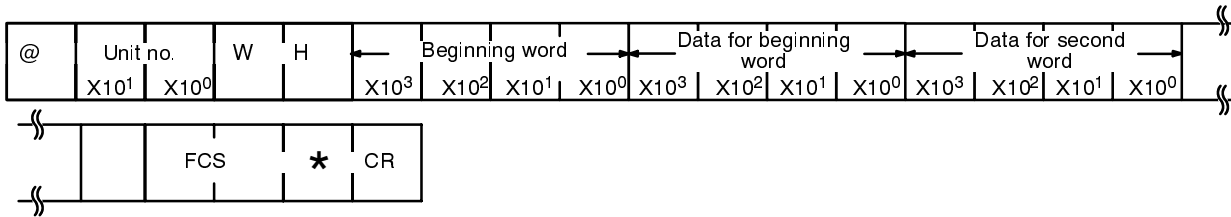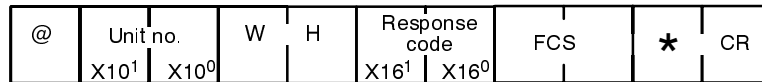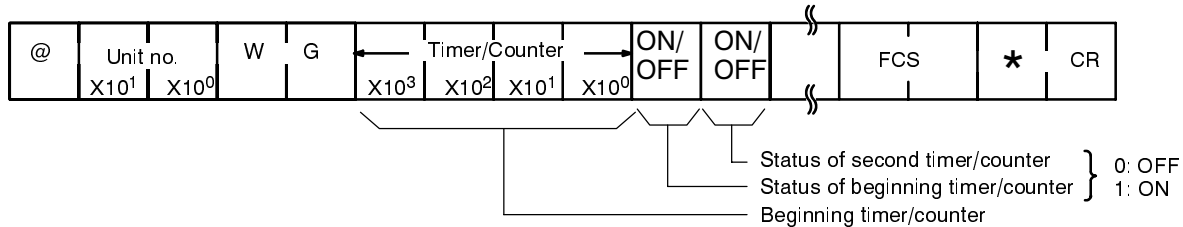
Command Format

@	Unit no. $X10^1$	$X10^0$	W	D	←	Beginning word $X10^3$	$X10^2$	$X10^1$	$X10^0$	Data for beginning word $X16^3$	$X16^2$	$X16^1$	$X16^0$	Data for second word $X16^3$	$X16^2$	$X16^1$	$X16^0$

	FCS	★	CR

Response Format

@	Unit no. $X10^1$ $X10^0$	W	D	Response code $X16^1$ $X16^0$	FCS	∗	CR
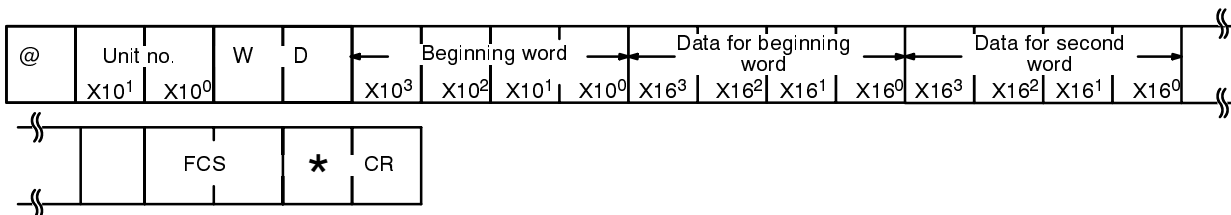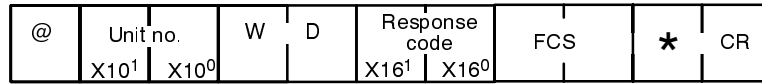
4–19 PV WRITE

Writes data to the present value area, starting from the specified word. Writing is done word by word.
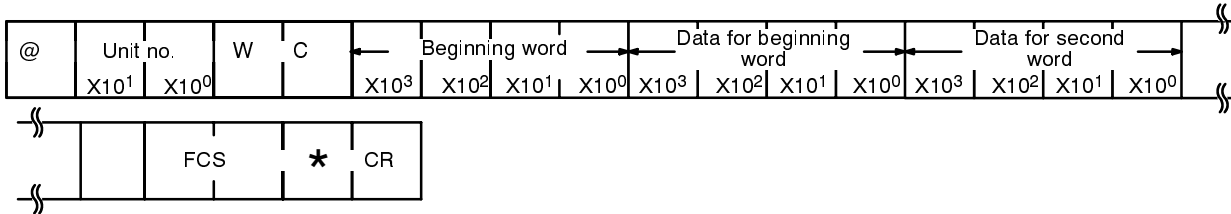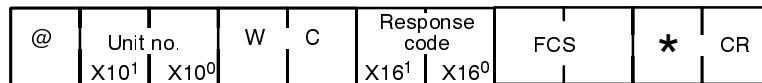
Command Format

@	Unit no. $X10^1$ $X10^0$	W	C	← Beginning word → $X10^3$ $X10^2$ $X10^1$ $X10^0$	Data for beginning word $X10^3$ $X10^2$ $X10^1$ $X10^0$	Data for second word $X10^3$ $X10^2$ $X10^1$ $X10^0$

	FCS	∗	CR

Response Format

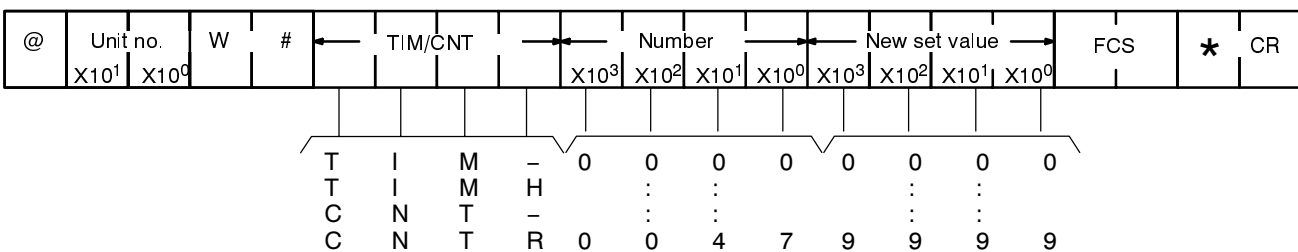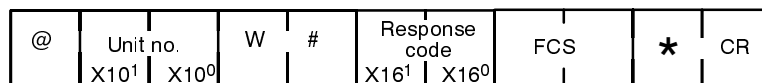| @	Unit no. $X10^1$ $X10^0$	W	C	Response code $X16^1$ $X16^0$	FCS	∗	CR

4–20 SV CHANGE 1

Changes the set value (constant only) of the specified timer/counter instruction. Reads from the beginning of the program and therefore take up to 20 seconds to produce a response. Refer also to SV CHANGE 2 and SV CHANGE 3.

Command Format

@	Unit no. $X10^1$ $X10^0$	W	#	← TIM/CNT →	← Number → $X10^3$ $X10^2$ $X10^1$ $X10^0$	← New set value → $X10^3$ $X10^2$ $X10^1$ $X10^0$	FCS	∗	CR

```
T   I   M   –   0   0   0   0   0   0   0   0
T   I   M   H   :   :           :   :
C   N   T   –   :   :           :   :
C   N   T   R   0   0   4   7   9   9   9   9
```

Response Format

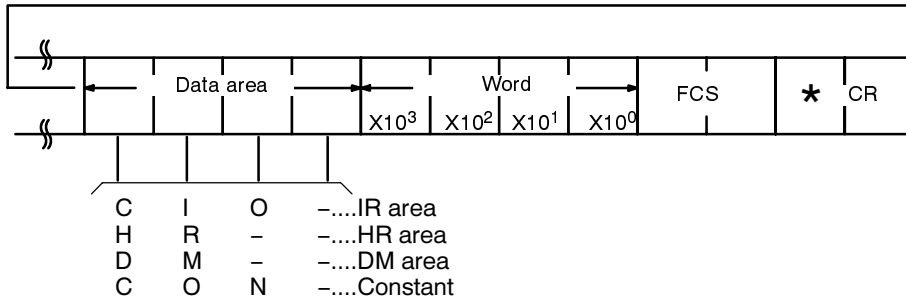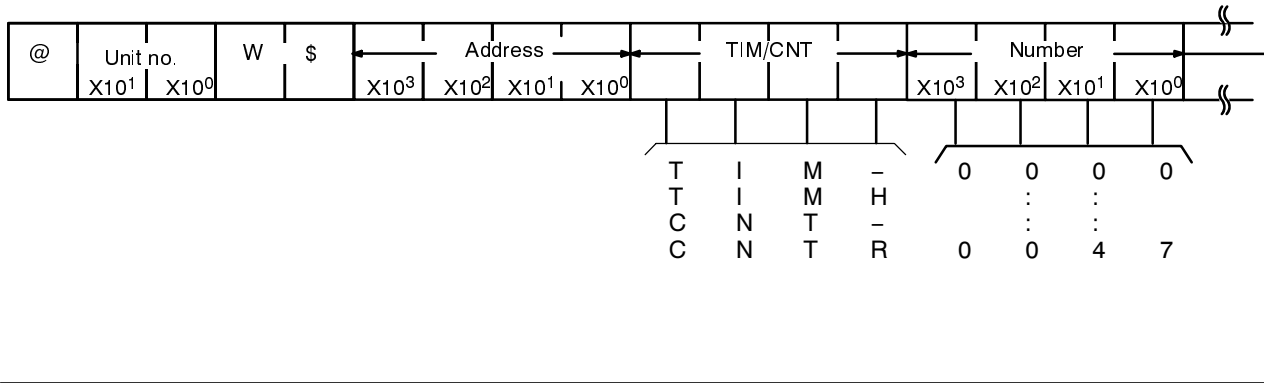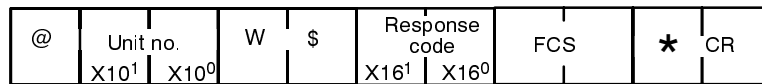| @	Unit no. $X10^1$ $X10^0$	W	#	Response code $X16^1$ $X16^0$	FCS	∗	CR

4–21 SV CHANGE 2

Changes the set value (a constant, or data area and word) of the specified timer/counter instruction. The instruction is specified by its program address.

If the program has more than 9,999 addresses, use SV CHANGE 3, described in the next subsection.

Command Format

@	Unit no. X10¹ X10⁰	W	$	Address X10³ X10² X10¹ X10⁰	TIM/CNT	Number X10³ X10² X10¹ X10⁰

```
        T  I  M  –        0  0  0  0
        T  I  M  H        :  :  :  :
        C  N  T  –
        C  N  T  R        0  0  4  7
```

Data area	Word X10³ X10² X10¹ X10⁰	FCS	∗ CR

```
   C  I  O  –....IR area
   H  R  –  –....HR area
   D  M  –  –....DM area
   C  O  N  –....Constant
```

Response Format

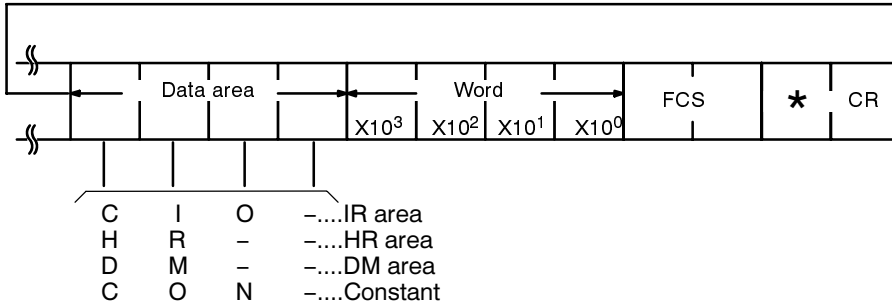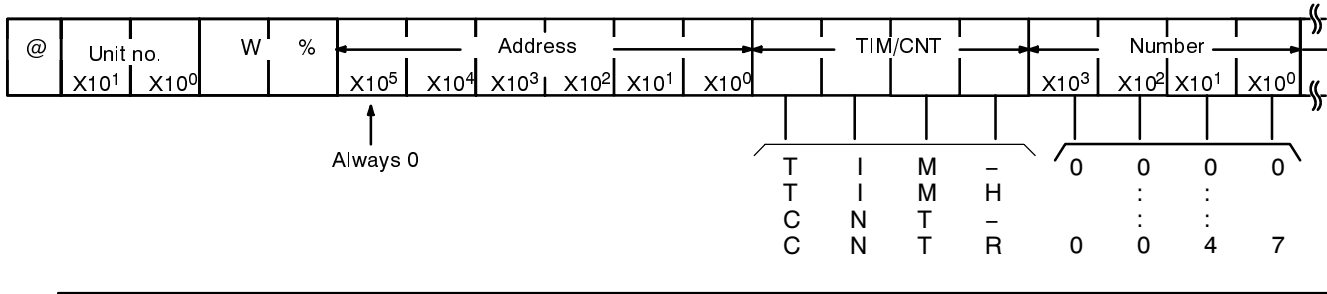| @	Unit no. X10¹ X10⁰	W	$	Response code X16¹ X16⁰	FCS	∗ CR

4–22 SV CHANGE 3

Changes the set value (a constant, or data area and word) of the specified instruction. The operation is similar to SV CHANGE 2, but SV CHANGE 3 can change SVs at higher program addresses.

Command Format

Always 0

T	I	M	–
T	I	M	H
C	N	T	–
C	N	T	R

0	0	0	0
:	:	:	:
0	0	4	7

C I O –....IR area
H R – –....HR area
D M – –....DM area
C O N –....Constant
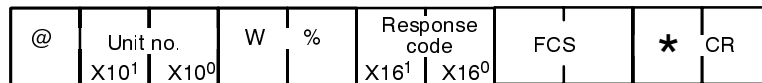
Response Format

4–23 FORCED SET

Forced sets a bit in an IR, LR, HR, AR, or TC area. Bits need to be force set one at a time.

Command Format

C I O – . . . . . . IR area

H R – – . . . . . HR area

T I M –
T I M H
C N T –   } TC area
C N T R
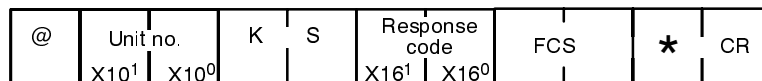
Response Format

4–24 FORCED RESET

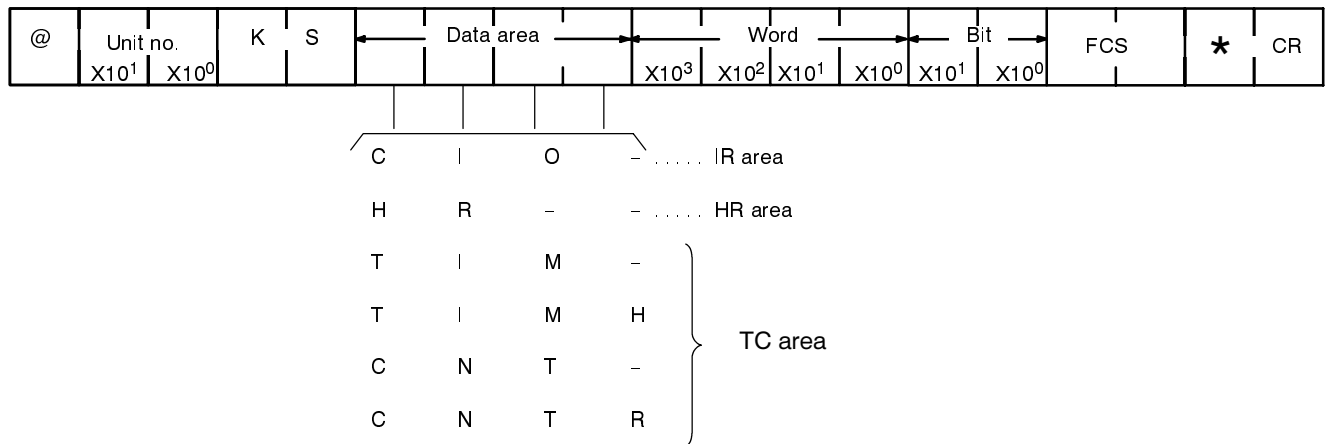Force resets a bit in an IR, LR, HR, AR, or TC area. Bits can only be force reset one at a time. If an attempt is made to simultaneously force reset more than one bit, none of the bits will reset.

Command Format
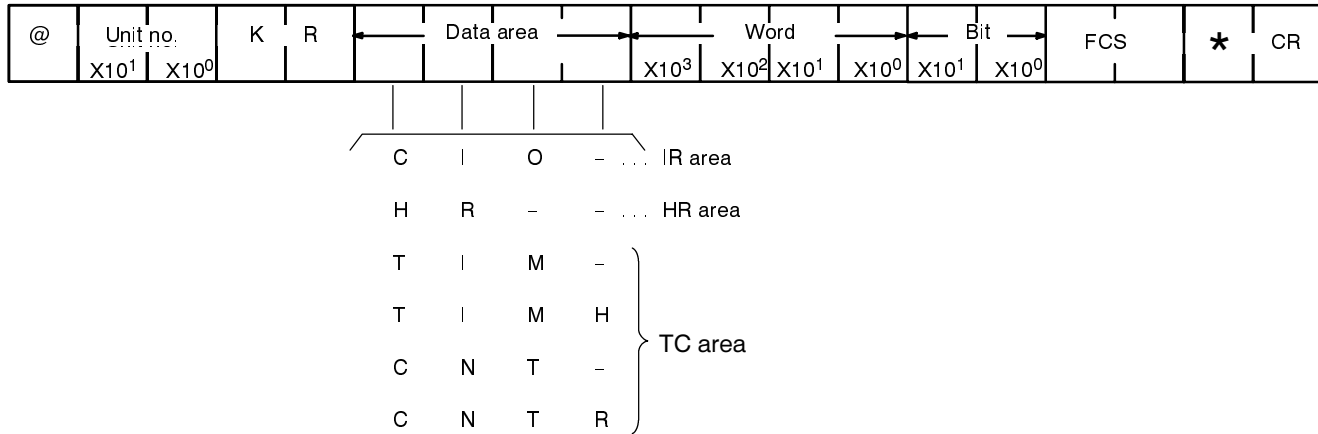
Response Format
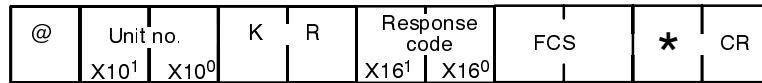
4–25 FORCED SET/RESET CANCEL

Cancels all forced set and forced reset bits (including those achieved via MULTIPLE FORCED SET/RESET for the C200H).

Command Format

Response Format

4–26 PC MODEL READ

Reads the model type of the PC.

Command Format

Response Format

@	Unit no. $X10^1$ | $X10^0$	M	M	Response code $X16^1$ | $X16^0$	PC model code $X16^1$ | $X16^0$	FCS	∗	CR

```
                              0    3   C20
                              1    1   K-type
```

4-27 ABORT and INITIALIZE

The ABORT command is used to abort the process being performed by the Host Link Unit and to then enable reception of the next command. The INITIALIZE command initializes the transmission control procedure of all the PCs connected to the host computer. Neither command receives a response.

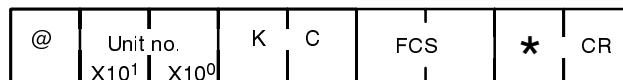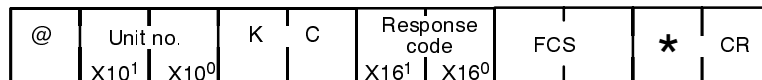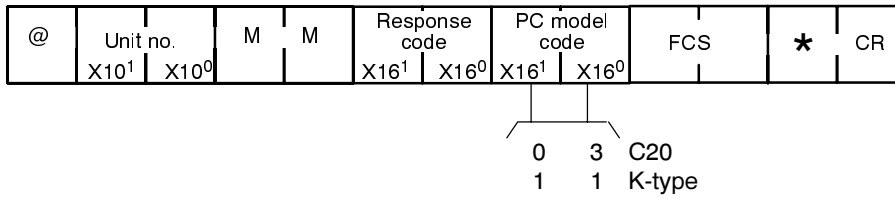A processing time of 100 ms is required between reception of the ABORT or INITIALIZE commands, and reception of the next command. If INITIALIZE is used in a single-link system, it will be regarded as undefined.

ABORT Command Format

@	Unit no. $X10^1$ | $X10^0$	X	Z	FCS	∗	CR
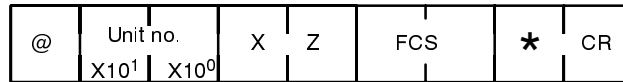
INITIALIZE Command Format

@	∗	∗	CR
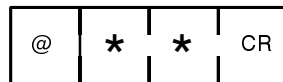
4-28 Response to an Undefined Command

This response is sent if the Host Link Unit cannot read the command's header code, or if the specified command is not valid for the command level or model of PC. If this response is received check the header code, command level, and PC model, then execute the correct command.

Response Format

@	Unit no. $X10^1$ | $X10^0$	I	C	FCS	∗	CR
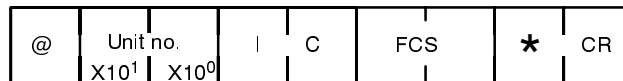
4-29 Response Indicating an Unprocessed Command

This response is sent when the Host Link Unit cannot process a command. The type of error encountered by the Host Link Unit can be identified via the response code.

Response Format

@	Unit no. $X10^1$ | $X10^0$	Header code	Response code $X16^1$ | $X16^0$	FCS	∗	CR

The header code varies according to the command which was sent. The headers of some commands include subheader codes (e.g., I/O REGISTER, I/O READ, and DM SIZE CHANGE).

4–30 PROGRAM READ

Reads the contents of the PC program memory and converts the program into machine language.
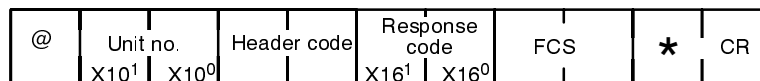
Command Format

@	Unit no.		R	P	FCS		*	CR
	$X10^1$	$X10^0$						

Response Format

@	Unit no.		R	P	Response code		Program				FCS		*	CR
	$X10^1$	$X10^0$			$X16^1$	$X16^0$	$X16^1$	$X16^0$	$X16^1$	$X16^0$				

Memory size
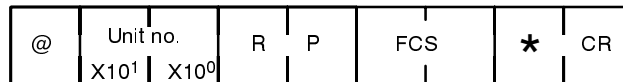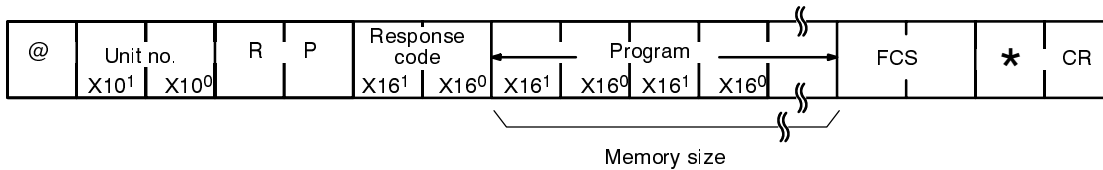
4–31 PROGRAM WRITE

Takes a machine language program stored in the host computer, converts it to a ladder diagram, and writes it to the PC program memory.

Command Format

@	Unit no.		W	P	Program				FCS		*	CR
	$X10^1$	$X10^0$			$X16^1$	$X16^0$	$X16^1$	$X16^0$				

Up to maximum memory capacity

Response Format

@	Unit no.		W	P	Response code		FCS		*	CR
	$X10^1$	$X10^0$			$X16^1$	$X16^0$				
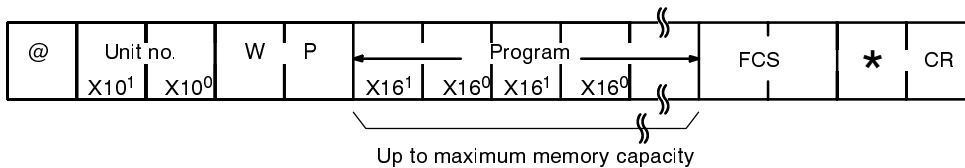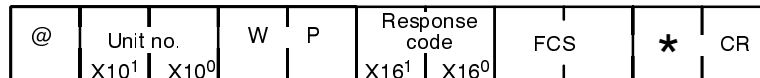
4–32 I/O REGISTER

Registers the IR, LR, HR, AR, or TC area bit, or the DM word that is to be read via I/O READ (described in the next subsection). Registered data is retained until new data is registered, or the power is turned OFF.

Command Format

@	Unit no. $X10^1$ $X10^0$	Q	Q	M	R	← Data area →	Word $X10^3$ $X10^2$ $X10^1$ $X10^0$	Bit no. or Word →	,

Subheader code

C	I	O	–....IR area
H	R	–	–...HR area
T	I	M	–
T	I	M	H
C	N	T	–
C	N	T	R
D	M	–	–....DM area

TC area

Delineator

,	OP1	OP2	OP3	OP4	← Data area → Word $X10^3$ $X10^2$ $X10^1$ $X10^0$	Bit no. or Word OR1 OR2	FCS	*	CR

Response Format

@	Unit no. $X10^1$ $X10^0$	Q	Q	M	R	Response code $X16^1$ $X16^0$	FCS	*	CR
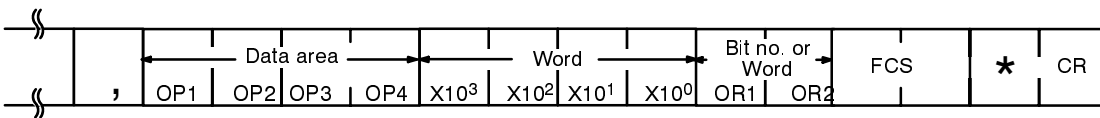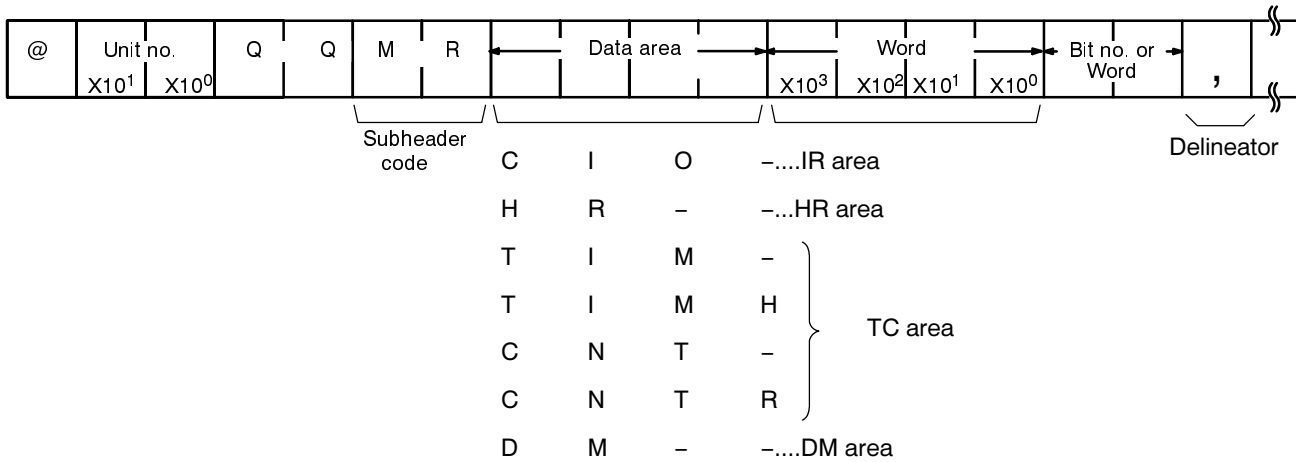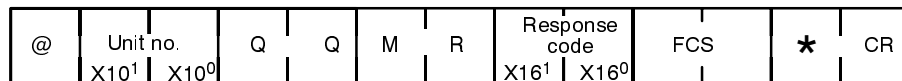
4–33   I/O READ

Reads the data specified by I/O REGISTER.

Command Format

@	Unit no. $X10^1$ $X10^0$	Q	Q	I	R	FCS	*	CR

Subheader code

Response Format

@	Unit no. $X10^1$ $X10^0$	Q	Q	I	R	Response code $X16^1$ $X16^0$	ON/ OFF	Present value $X10^3$ $X10^2$ $X10^1$ $X10^0$	,

Subheader code   Delineator

,	ON/ OFF	,	,	Read word data $X16^3$ $X16^2$ $X16^1$ $X16^0$	FCS	*	CR
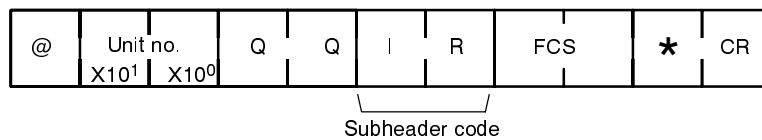
Read bit status   End of one data set
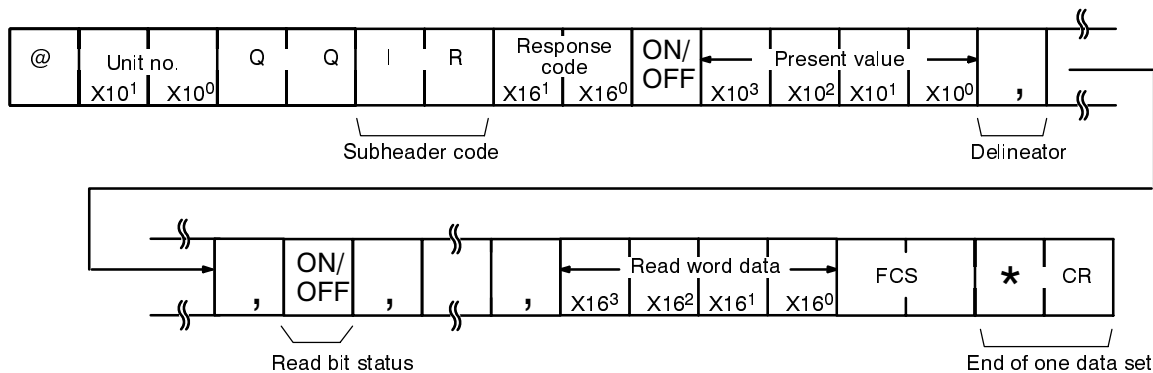
4–34 Response Code List

X16^1	X16^0	Description
0	0	Normal Completion
0	1	Not executable in RUN mode
0	2	Not executable in MONITOR mode
0	3	Not executable with PROM mounted
0	4	Address over (data overflow)
0	9	I/O REGISTER capacity exceeded (no registration made), I/O READ unexecutable.
0	B	Not executable in PROGRAM mode
1	0	Parity error
1	1	Framing error
1	2	Overrun
1	3	FCS error
1	4	Format error (parameter length error)
1	5	Entry number data error (parameter error, data code error, data length error)
1	6	Instruction not found
1	8	Frame length error
1	9	Not executable (due to unexecutable error clear, non-registration of I/O table, etc.)
A	0	Aborted due to parity error in transmit data
A	1	Aborted due to framing error in transmit data
A	2	Aborted due to overrun in transmit data
A	4	Aborted due to format error in transmit data
A	5	Aborted due to entry number data error in transmit data
A	8	Aborted due to frame length error in transmit data

4–35   Communications Examples

The following are examples of commands from the host computer (first line) and the responses that would be given by the Host Link Unit (second line). The arrows indicate the transfer of the right to transmit.

Reading Data from Multiple PC Words (IR Wd 4 to 6) (Normal Completion)

| @ | 1 0 | R R | 0 0 0 4 | 0 0 0 3 | 4 6 | ✳ | CR |

FCS

| @ | 1 0 | R R | 0 0 | F E D C | B A 9 8 | 7 6 5 4 | 4 7 | ✳ | CR |

Data in Wd 04

Data in Wd 05

Data in Wd 06

FCS
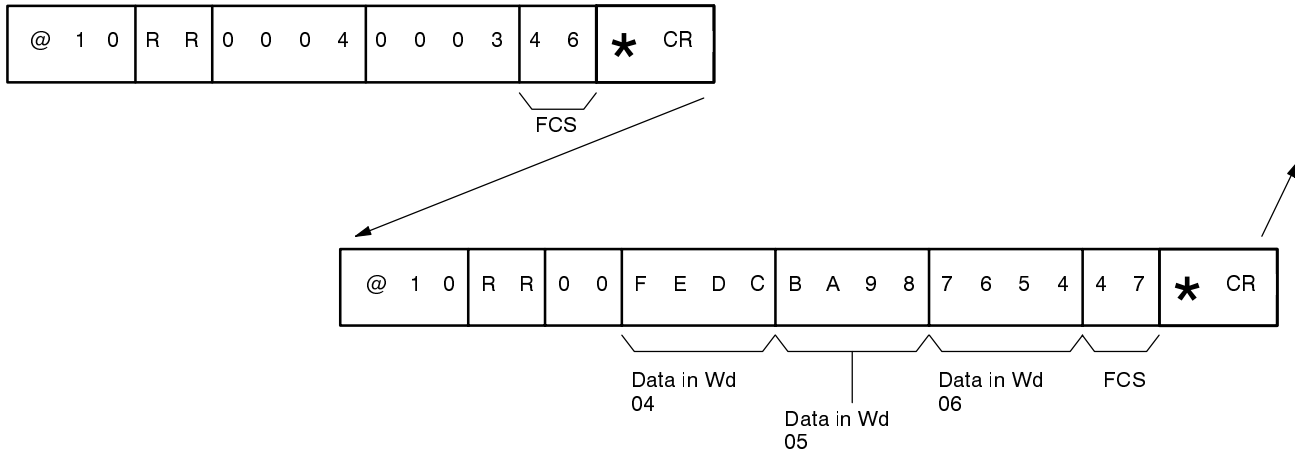
Wd 9000 Specified by Mistake in a DM AREA WRITE Command

| @ | 1 0 | W D | 9 0 0 0 | A B C D | 5 F | ✳ | CR |

FCS

| @ | 1 0 | W D | 1 5 | 5 6 | ✳ | CR |

FCS
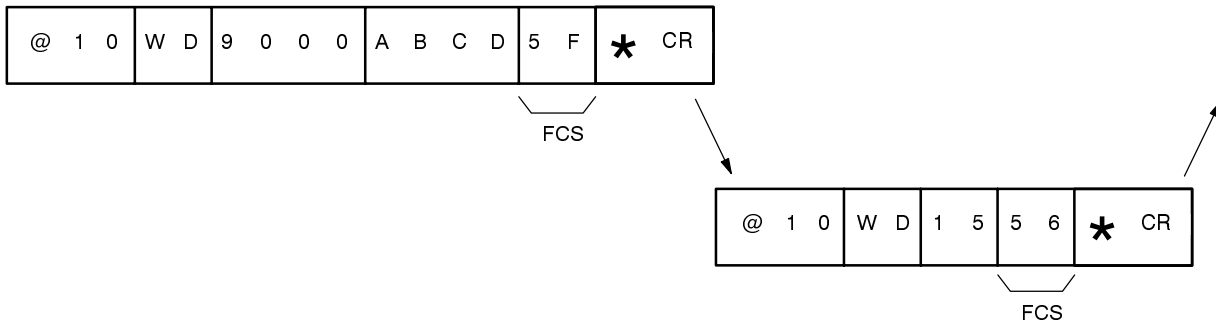
Header Code Destroyed During ERROR READ Operation

| @ | 1 0 | (M)(F) | ✳ | CR |

| @ | 1 0 | I C | 4 B | ✳ | CR |

FCS
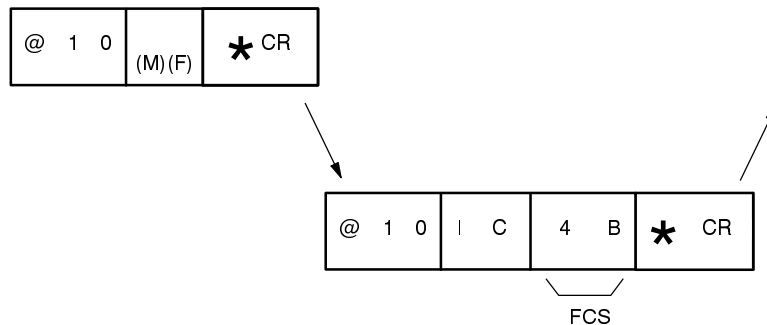
Writing Data into PC Words ("0123" to DM Wd 400 and "FEDC" to DM Wd 401) and Confirming with DM AREA READ.

@	1 0	W D	0 4 0 0	0 1 2 3	F E D C	5 2	✳ CR

FCS

@	1 0	W D	0 0	5 2	✳ CR

FCS

@	1 0	R D	0 4 0 0	0 0 0 2	5 1	✳ CR

FCS

@	1 0	R D	0 0	0 1 2 3	F E D C	5 3	✳ CR

FCS
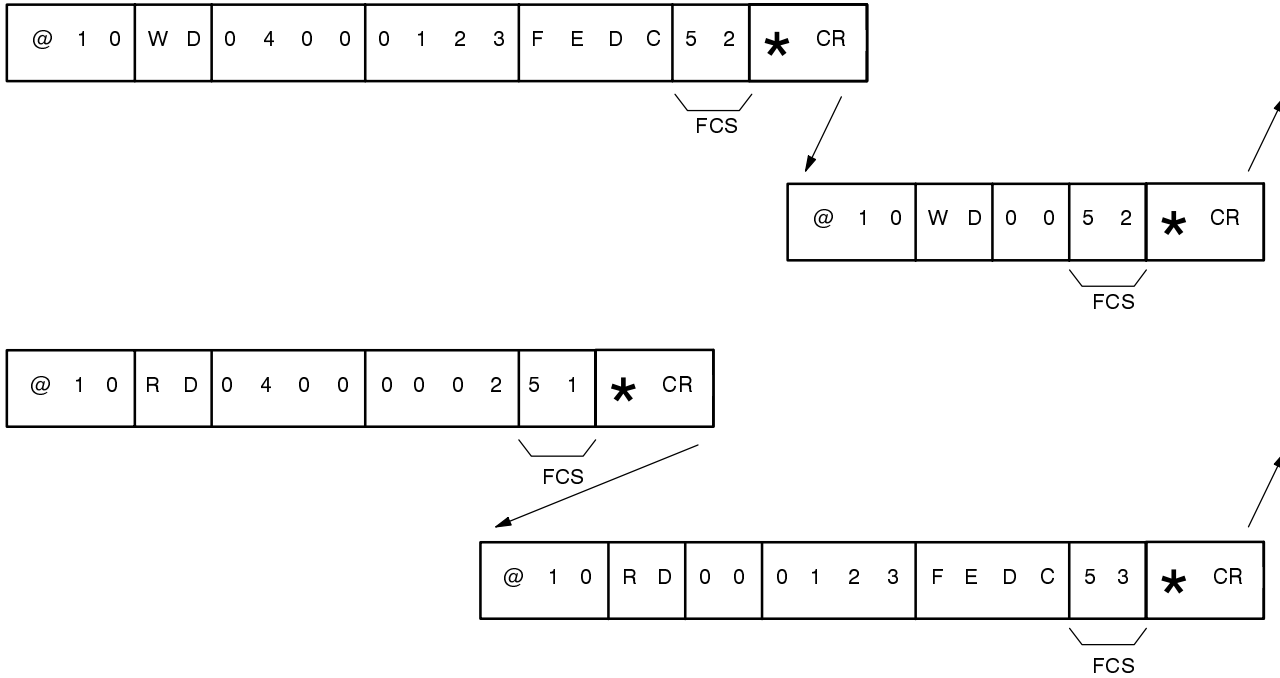
SECTION 5
Error Processing

This section describes errors that can occur in a computer-linked system employing one or more Host Link Units. These errors are classified into the following three categories:

1, 2, 3...
1. Errors Indicated by the Host Link Unit (see *Section 5–3 Troubleshooting*).
2. Errors Processed by the PC.
3. Errors processed by the host computer (see *Sections 5–2 Error Control, 3–2 Communications Protocol,* and all of *Section 4*, especially *Sections 4–27 ABORT and INITIALIZE*, and *4–34 Response Code List).*

5–1   Development of an Error-processing Program

Programs to monitor communication time and error handling need to be developed on the host computer. Be sure that these include processes that can respond appropriately to errors and other abnormalities from the PC by taking into consideration the kinds of errors described in the sections listed above.

5–2   Error Control

The host computer is responsible for ensuring system recovery after errors occur in the Host Link Unit.

The Host Link Unit runs the following checks to detect errors:

1, 2, 3...   1.   Parity check
2.   Framing check
3.   Overrun check
4.   Format check
5.   Entry data check (The start word, read word, etc., in the command format.)
6.   FCS (An Exclusive OR check is performed on all command or response data, from the unit number to the end of the text.)

Of the above commands, 1 to 3 are performed on a character by character basis. Checks 4 to 6, however, are performed on each block (frame).

Transmit data in a multiple-link system is checked by means of a parity check and a Frame Check Sequence (FCS). The FCS check is not performed in single-link systems.

Invalid Processing

If the Host Link Unit detects an error in a single-frame command or the first frame of a command block, it will regard the command as invalid. The command will not be processed and, after the terminator is received, an error response will be sent to the host computer. (For details of the error response, refer to *Section 4–28 Response to an Unprocessed Command*.

Process Interruption

If the Host Link Unit detects an error in an intermediate frame, the commands up to that point will be processed normally. Those following the erroneous frame, however, will not be processed. After the Host Link Unit has received the terminator of the erroneous block, it responds with a response code that informs the host computer of the process interruption. (For details, refer to *Section 4–34 Response Code List.)*

Time Monitoring

If the Host Link Unit does not receive a delimiter or terminator, it cannot send a response to the host computer. Similarly, if the computer does not receive a delimiter or terminator, it cannot transmit further commands to the Host Link Unit. To allow transmission to alternate smoothly between the computer and the Host Link Unit, the process times need to be monitored. It is therefore necessary to have a time-monitoring program on the host computer side. Its purpose is to initiate remedial action if the right to transmit is not transferred quickly enough.

5–3   Troubleshooting

The following troubleshooting guide outlines the basic steps for remedying the errors most likely to occur when using Host Link Units.

Problem	Possible Cause	Remedy	Reference
READY indicator does not light. (When power is applied to the Host Link Unit, and the reset is released, the indicator should illuminate.)	Power is not applied to the PC. Faulty contact in the connector between the PC and the Host Link Unit. PC is resetting the Host Link Unit. Host Link Unit is defective.	Apply power to the PC. Check and repair connections. Turn the PC OFF, then ON. If necessary, check the PC for an error or abnormal reset. Replace the Host Link Unit.	
RCV indicator does not blink. (When a signal is input at the receive connector, the indicator should blink regardless of the nature of the signal.)	No signal is being output form the host computer. The signal from the host computer is not reaching the Host Link Unit. The indicator circuit is defective.	Check the program and output of the host computer. Check the wiring: • Cable not connected? • Cable damaged? • Cable incorrectly connected? • Faulty contact in connector? If the signal is being transmitted and received normally, the Host Link Unit is faulty and needs to be replaced.	Section 2
XMT indicator does not illuminate after the RCV indicator. (If the Unit number on the computer side matches that of the Host Link Unit, the Host Link Unit receives the terminator, the CTS signal then goes ON, and the Host Link Unit sends data irrespective of its nature.)	The unit numbers of the computer and the Host Link Unit do not match. The Host Link Unit is not receiving a terminator. The signal is ignored because the Host Link Unit cannot correctly read it. • Transmission speeds of the host computer and the Host Link Unit do not match. • Incorrect wiring. • Incorrect setting for the termination resistance. Parities or transmission codes don't match. Error in operating level setting.	Check the unit number settings. Check whether the host computer is outputting a terminator. Check the settings of the Host Link Unit and the Link Adapter. Check the wiring for the CTS signal. Check the parity or transmission code settings. Check the operating level settings.	Section 2
ERR indicator illuminates.	Parity error (even parity). Framing error. Overrun error. Occurrence of momentary power failure.	Send correct data. If a momentary power failure occurs, both the PC and the Host Link Unit are reset and initialized. The ERRor indicator will turn off.	
Although the XMT indicator illuminates, the Host Link Unit cannot send a response to the host computer.	Operation error on the host computer side. • I/O channel processing error. • Program error. The correct signal is not reaching the host computer. • Cable damage. • Incorrect cable wiring. • Faulty contact in connector.	–––	Section 2

Appendix A
Standard Models

Product	Description	Model Number
Host Link Unit	RS–232C	3G2C7–LK201–EV1
	RS–422	3G2C7–LK202–EV1
Link Adapter	RS–422 (3 connectors)	3G2A9–AL001
	Optical (APF/PCF) (3 connectors)	3G2A9–AL002–PE
	Optical (PCF) (3 connectors)	3G2A9–AL002–E
	Optical (APF/PCF), RS–232C, RS–422 (1 connector each)	3G2A9–AL004–PE
	Optical (PCF), RS–232C, RS–422 (1 connector each)	3G2A9–AL004–E
	Optical (APF/PCF), optical (AGF) (1 connector each)	3G2A9–AL005–PE
	Optical (PCF), optical (AGF) (1 connector each)	3G2A9–AL005–E
	Optical (APF/PCF) (1 connector), optical (AGF) (2 connectors)	3G2A9–AL006–PE
	Optical (PCF) (1 connector), optical (AGF) (2 connectors)	3G2A9–AL006–E

Appendix B
Specifications

Host Link Unit

Model Number	Interface	Transmission Distance	Weight	Power Consumption
3G2C7−LK201−EV1	RS−232C	15 m	600 g max.	1 A max. at 5 VDC
3G2C7−LK202−EV1	RS−422	10 m/branch (500 m total*)		

*Total in the system.

Communications

Communications protocol	4-wire, half duplex
Synchronization	Start/stop (2 stop bits)
Transmission speed	300, 600, 1,200, 2,400, 4,800, 9,600, 19,200 or 34,000 bps (switch-selectable)
Character code	ASCII (7 bits) or JIS (8 bits)
Error check	Vertical (even) parity and FCS
Interface	RS−232C (3G2C7−LK201−EV1), RS−422 (3G2C7−LK202−EV1)

Dimensions

The dimensions of the 3G2C7−LK201−EV1 and 3G2C7−LK202−EV1 Host Link Units are as detailed in the following diagrams.
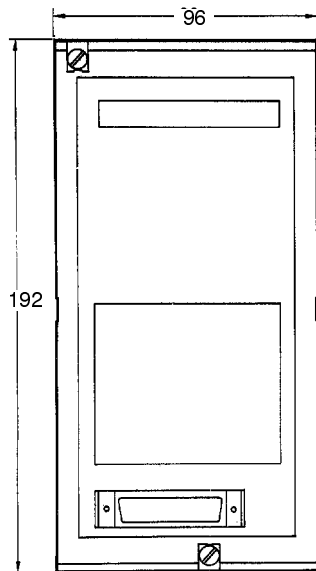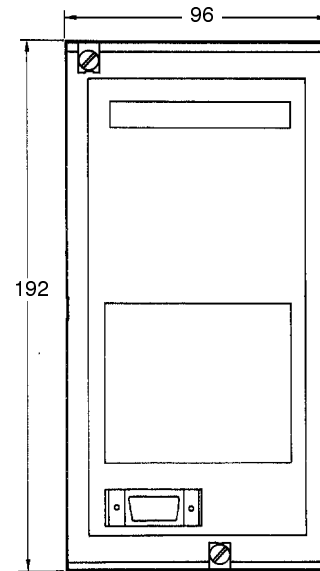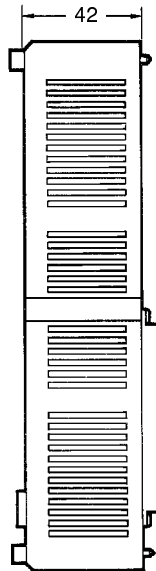
3G2C7−LK201−EV1   **3G2C7−LK202−EV1**

Link Adapter

The following are the specifications for Link Adapters suitable for use with the C20/K-type PCs. Care should be taken to to choose a Link Adapter with the appropriate connections for the Units in the System. Other Link Adapters may be included in the System in association with other types of Host Link Units (refer to the applicable *Host Link Manual* or *Link Adapter Manual*).

Link Adapter	Connection	Supply voltage	Operating voltage range	Weight	Power Consumption
3G2A9–AL001	RS–422 / RS–422 / RS–422	Not required	–––	250 g max.	–––
3G2A9–AL004–P–E	Optical Fiber (APF) / RS–422 / RS–232C	100/200 VAC	85 to 110 VAC 170 to 220 VAC	1 kg max.	10 VA max.
3G2A9–AL004–E	Optical Fiber (PCF) / RS–422 / RS–232C				

Appendix C
Accesories

Optical Interface

(Used to interface C500–LK203, 3G2A5–LK201–EV1, and 3G2A6–LK201–EV1 Host Link Units.)

Product	Description	Model Number
Optical Interface	RS–232C = optical converter	Z3RN–A–5
Optical Fiber Cable	"n" replaced with cable length: 1, 5, 10, 20, 30, 50, 100, 200, 400, or 500 m.	Z3F2–4DnM
AC Adapter	For Optical Interface power supply. One required for C500–LK203; two for 3G2A5–LK201–EV1 or 3G2A6–LK201–EV1 Host Link Units.	Z3GP–01

Wire Cable

RS–422 and RS–232C connecting cables must be supplied by the user.

Plastic Optical Fiber Cable (APF)

Product	Description	Model Number
Plastic optical fiber cable*	Cable only (without optical connector). Order in multiples of 5 m (from 5 to 100 m), or in lengths of 200 m or 500 m.	3G5A2–PF002*
Optical connector A	2 Optical connectors (brown). For plastic optical fiber cable 8 to 20 m long.	3G5A2–C0001
Optical connector B	2 Optical connectors (black). For plastic optical fiber cable 8 to 20 m long.	3G5A2–C0002
Plastic optical fiber set	1 m cable with connector A attached.	3G5A2–PF101

*The optical connector for the 3G5A2–PF002 cable must ordered separately.

Crystal Fiber Cable (AGF)

Crystal fiber cable is not available from OMRON. It must be supplied by the user.

Plastic-clad Optical Fiber Cable (PCF)

Cable Type	Description	Operating Environment	Model Number
Indoor	0.1 m, with connector	Operating temperature: −10º to 70ºC	3G5A2−OF011
	1 m, with connector		3G5A2−OF101
	2 m, with connector		3G5A2−OF201
	3 m, with connector		3G5A2−OF301
	5 m, with connector		3G5A2−OF501
	10 m, with connector		3G5A2−OF111
	20 m, with connector		3G5A2−OF211
	30 m, with connector		3G5A2−OF311
	40 m, with connector		3G5A2−OF411
	50 m, with connector		3G5A2−OF511
Indoor/outdoor	10 to 500 m, with connector (order in multiples of 10 m)	Operating temperature: −10º to 70ºC	3G5A2−OF002
	510 to 800 m, with connector (order in multiples of 10 m)	Operating temperature: 0º to 55ºC (Do not expose to direct sunlight)	

Note   As splicing of optical fiber cables is more difficult than for wire cables, be sure to order sufficient excess cable to allow for initial splicing and subsequent repairs and alterations. The cable length does not include connectors.

Appendix D
Ascii Codes

Bits	5 to 8	0000	00001	0010	0011	0100	0101	0110	0111
1 to 4	Digits (HEX)	0	1	2	3	4	5	6	7
0000	0	NUL	DLE	SPACE	0	@	P	'	p
0001	1	SOH	DC_1	!	1	A	Q	a	q
0010	2	STX	DC_2	"	2	B	R	b	r
0011	3	ETX	DC_3	#	3	C	S	c	s
0100	4	EOT	DC_4	$	4	D	T	d	t
0101	5	ENQ	NAK	%	5	E	U	e	u
0110	6	ACK	SYN	&	6	F	V	f	v
0111	7	BEL	ETB	'	7	G	W	g	w
1000	8	BS	CAN	(	8	H	X	h	x
1001	9	HT	EM	)	9	I	Y	i	y
1010	A	LF	SUB	*	:	J	Z	j	z
1011	B	VT	ESC	+	;	K	[	k	{
1100	C	FF	FS	,	<	L		l	'
1101	D	CR	GS	–	=	M	]	m	}
1110	E	S0	RS	.	>	N	^	n	–
1111	F	S1	US	/	?	O	–	o	DEL

Glossary

address The location in memory where data is stored. For data areas, an address consists of a two-letter data area designation and a number that designate the word and/or bit location. For the UM area, an address designates the instruction location (UM area); for the FM area, the block location (FM area), etc.

AGF Code for crystal optical fiber cable.

allocation The process by which the PC assigns certain bits or words in memory for various functions. This includes pairing I/O bits to I/O points on Units.

AND A logic operation whereby the result is true if and only if both premises are true. In ladder-diagram programming the premises are usually ON/OFF states of bits or the logical combination of such states called execution conditions.

APF Acronym for all plastic optical fiber cable.

AR area A PC data area allocated to flags, control bits, and word bits.

arithmetic shift A shift operation wherein the carry flag is included in the shift.

ASCII Short for American Standard Code for Information Interchange. ASCII is used to code characters for output to printers and other external devices.

ASCII Unit An Intelligent I/O Unit used to program in BASIC. When connected to an NSU on a Net Link System, commands can be sent to other nodes.

Backplane A base onto which Units are mounted to form a Rack. Backplanes provide a series of connectors for these Units along with wiring to connect them to the CPU. Backplanes also provide connectors used to connect them to other Backplanes. In some Systems, different Backplanes are used for different Racks; in other Systems, Racks differ only according to the Units mounted to them.

BCD Short for binary-coded decimal.

BCD calculation An arithmetic calculation that uses numbers expressed in binary-coded decimal.

binary A number system where all numbers are expressed to the base 2, i.e., any number can be written using only 1's or 2's. Each group of four binary bits is equivalent to one hexadecimal digit.

binary calculation An arithmetic calculation that uses numbers expressed in binary.

binary-coded decimal A system used to represent numbers so that each four binary bits is numerically equivalent to one decimal digit.

bit A binary digit; hence a unit of data in binary notation. The smallest unit of information that can be electronically stored in a PC. The status of a bit is

either ON or OFF. Different bits at particular addresses are allocated to special purposes, such as holding the status input from external devices, while other bits are available for general use in programming.

bit address	The location in memory where a bit of data is stored. A bit address must specify (sometimes by default) the data area and word that is being addressed as well as the number of the bit.
bit designator	An operand that is used to designate the bit or bits of a word to be used by an instruction.
bit number	A number that indicates the location of a bit within a word. Bit 00 is the rightmost (least-significant) bit; bit 15 is the leftmost (most-significant) bit.
block	Block can refer to one of three aspects of PC operation: a block in the FM area, a block instruction (program), or a logic block. A block in the FM is the unit used to transfer data to and from the File Memory Unit and equals 128 words. Refer to *block instruction, block program,* and *logic block* for definitions of these.
block instruction	A special class of instruction used within ladder-diagram programming to allow flowchart-like coding, which is often difficult to write with ladder diagrams. Function codes for block instructions are indicated between pointed parentheses <like this>.
block program	A section of program written within a ladder diagram but based on block instructions. Block programs can also contain some, but not all, of the ladder-diagram instructions.
buffer	A temporary storage space for data in a computerized device.
building-block PC	A PC that is constructed from individual components, or "building blocks." With building-block PCs, there is no one Unit that is independently identifiable as a PC. The PC is rather a functional assembly of components.
bus bar	The line leading down the left and sometimes right side of a ladder diagram. Instruction execution proceeds down the bus bar, which is the starting point for all instruction lines.
call	A process by which instruction execution shifts from the main program to a subroutine. The subroutine may be called by an instruction or by an interrupt.
carry flag	A flag that is used with arithmetic operations to hold a carry from an addition or multiplication operation, or to indicate that the result is negative in a subtraction operation. The carry flag is also used with certain types of shift operations.
clock pulse	A pulse available at a certain bit in memory for use in timing operations. Various clock pulses are available with different pulse widths.
clock pulse bit	A bit in memory that supplies a pulse that can be used to time operations. Various clock pulse bits are available with different pulse widths, and therefore different frequencies.
condition	An message placed in an instruction line to direct the way in which the terminal instructions, on the right side, are to be executed. Each condition is as-

signed to a bit in memory that determines its status. The status of the bit assigned to each condition determines, in turn, the execution condition for each instruction up to a terminal instruction on the right side of the ladder diagram.

constant
An operand for which the actual numeric value is specified by the user, and which is then stored in a particular address in the data memory.

control bit
A bit in a memory area that is set either through the program or via a Programming Device to achieve a specific purpose, e.g., a Restart bit is turned ON and OFF to restart a Unit.

Control System
All of the hardware and software components used to control other devices. A Control System includes the PC System, the PC programs, and all I/O devices that are used to control or obtain feedback from the controlled system.

controlled system
The devices that are being controlled by a PC System.

control signal
A signal sent from the PC to effect the operation of the controlled system.

counter
Either a dedicated number of digits or words in memory used to count the number of times a specific process has occurred or a location in memory accessed through a TC bit and used to count the number of times the status of a bit or an execution condition has changed from OFF to ON.

CPU
An acronym for central processing unit. In a PC System, the CPU executes the program, processes I/O signals, communicates with external devices, etc.

CPU Backplane
A Backplane used to create a CPU Rack.

CPU Rack
Part of a building-block PC, the CPU Rack contains the CPU, a power supply, and other Units. With most PCs, the CPU Rack is the only Rack that provides linkable slots.

CTS
An acronym for clear-to-send, a signal used in communications between electronic devices to indicate that the receiver is ready to accept incoming data.

data area
An area in the PC's memory that is designed to hold a specific type of data, e.g., the LR area is designed to hold common data in a PC Link System. Memory areas that hold programs are not considered data areas.

data area boundary
The highest address available in a data area. When designating an operand that requires multiple words, it is necessary that the highest address in the data area is not exceeded.

data sharing
An aspect of PC Link Systems and of Data Links in Net Link Systems in which common data areas or common data words are created between two or more PCs.

debug
A process by which a draft program is corrected until it operates as intended. Debugging includes both removal of syntax errors, as well as fine-tuning of timing and coordination of control operations.

decimal
A number system where all numbers are expressed to the base 10. Although in a PC all data is ultimately stored in binary form, four binary bits are often

	used to represent one decimal digit, via a system called binary-coded decimal.
decrement	Decreasing a numeric value.
default	A value assumed and automatically set by the PC when a specific value is not input by the user. Many devices will assume such default conditions upon the application of power.
definer	A number used as an operand for an instruction but that serves to define the instruction itself rather that the data on which the instruction is to operate. Definers include jump numbers, subroutine numbers, etc.
delimiter	A carriage return (CR) indicating the end of the current frame within a multi-frame block of information. A terminator indicates the end of the block.
destination	The location where data in an instruction is to be placed, as opposed to the location from which data is to be taken, for use in the instruction. The location from which data is to be taken is called the source.
differentiated instruction	An instruction that is executed only once each time its execution condition goes from OFF to ON. Nondifferentiated instructions are executed each scan as long as the execution condition stays ON.
differentiation instruction	An instruction used to ensure that the operand bit is never turned ON for more than one scan after the execution condition goes either from OFF to ON for a Differentiate Up instruction or from ON to OFF for a Differentiate Down instruction.
digit	A unit of storage in memory that consists of four bits.
digit designator	An operand that is used to designate the digit or digits of a word to be used by an instruction.
distributed control	An automation concept in which control of each portion of an automated system is located near the devices actually being controlled, i.e., control is decentralized and 'distributed' over the system. Distributed control is a concept basic to PC Systems.
DM area	A data area used to hold word data. A word in the DM area cannot be accessed bit by bit.
download	The process of transferring a program or data from a higher-level computer to a lower-level computer or PC.
electrical noise	Spurious signals superimposed on a transmitted signal which can cause errors in communications signals, False triggering of inputs or outputs, and even component breakdown if the noise signal is very large.
error code	A numeric code output to indicate the existence, and something about the nature, of an error. Some error codes are generated by the system; others are defined in the program by the operator.
exclusive OR	A logic operation whereby the result is true if one and only one of the premises is true. In ladder-diagram programming the premises are usually ON/

OFF states of bits, or the logical combination of such states, called execution conditions.

exclusive NOR A logic operation whereby the result is true if and only if both of the premises are true or both of the premises are false. In ladder-diagram programming the premises are usually ON/OFF states of bits, or the logical combination of such states, called execution conditions.

exection condition The ON or OFF status under which an instruction is executed. The execution condition is determined by the logical combination of conditions on the same instruction line and up to the instruction being executed.

execution time The time required for the CPU to execute either an individual instruction or an entire program.

Expansion I/O Backplane A Backplane used to create an Expansion I/O Rack.

Expansion I/O Rack Part of a building-block PC, an Expansion I/O Rack is connected to either a CPU Rack or another Expansion I/O Rack to increase the number of slots available for mounting Units.

extended counter A counter created in a program that counts higher than any of the standard counters provided by the individual instructions.

extented timer A timer created in a program that times longer than any of the standard timers provided by the individual instructions.

Factory Intelligent Terminal A programming device provided with advanced programming and debugging capabilities to facilitate PC operation. The Factory Intelligent Terminal also provides various interfaces for external devices, such as floppy disk drives.

fatal error An error that will stop PC operation and require correction before operation can be continued.

FCS Acronym for frame check sequence.

FIT Abbreviation for Factory Intelligent Terminal.

flag A dedicated bit in memory that is set by the system to indicate some type of operating status. Some flags, such as the carry flag, can also be set by the operator or program.

flicker bit A bit that is programmed to turn ON and OFF at a specific frequency.

floating point decimal A decimal number expressed as a number between 0 and 1 (the mantissa) multiplied by a power of 10, e.g., 0.538×10^{-5}.

Floppy Disk Interface Unit A Unit used to interface a floppy disk drive to a PC so that programs and/or data can be stored on floppy disks.

FM area A memory area located in a File Memory Unit used to store/backup programs and/or data.

force reset The process of forcibly turning OFF a bit via a programming device. Bits are usually turned OFF as a result of program execution.

force set	The process of forcibly turning ON a bit via a programming device. Bits are usually turned ON as a result of program execution.
function code	A two-digit number used to input an instruction into the PC.
GPC	Acronym for Graphic Programming Console.
Graphic Programming Console	A programming device provided with advanced programming and debugging capabilities to facilitate PC operation. A Graphic Programming Console is provided with a large display onto which ladder-diagram programs can be written directly in ladder-diagram symbols for input into the PC without conversion to mnemonic form.
hardware error	An error originating in the hardware structure (electronic components) of the PC, as opposed to a software error, which originates in software (i.e., programs).
hexadecimal	A number system where all numbers are expressed to the base 16. Although in a PC all data is ultimately stored in binary form, displays on and inputs through Programming Devices are often expressed in hexadecimal to facilitate operation. Each group of four binary bits is numerically equivalent to one hexadecimal digit.
Host Link System	One or more host computers connected to one or more PCs through Host Link Units so that the host computer can be used to transfer data to, and to receive data from, the PC(s). Host Link Systems enable centralized management and control of PC Systems.
Host Link Unit	An interface used to connect a PC to a host computer in a Host Link System.
host computer	A computer that is used to transfer data or programs to or receive data or programs from a PC in a Host Link System. The host computer is used for data management and overall system control. Host computers are generally personal or business computers.
HR area	A data area used to store and manipulate data, and to preserve data when power to the PC is turned OFF.
increment	Increasing a numeric value.
indirect address	An address whose contents indicates another address. The contents of the second address will be used as the operand. Indirect addressing is possible in the DM area only .
initialization error	An error that occurs either in hardware or software during the PC System startup, i.e., during initialization.
initialize	Part of the startup process whereby some memory areas are cleared, system setup is checked, and default values are set.
input	The signal coming from an external device into the PC. The term input is often used abstractly or collectively to refer to incoming signals.
input bit	A bit in the IR area that is allocated to hold the status of an input.

input device	An external device that sends signals into the PC System.
input point	The point at which an input enters the PC System. Input points correspond physically to terminals or connector pins.
input signal	A change in the status of a connection entering the PC. Generally an input signal is said to exist when, for example, a connection point goes from low to high voltage or from a nonconductive to a conductive state.
instruction	A direction given in the program that tells the PC of an action to be carried out, and which data is to be used in carrying out the action. Instructions can be used to simply turn a bit ON or OFF, or they can perform much more complex actions, such as converting and/or transferring large blocks of data.
instruction block	A group of instructions that is logically related in a ladder-diagram program. Although any logically related group of instructions could be called an instruction block, the term is generally used to refer to blocks of instructions called logic blocks that require logic block instructions to relate them to other instructions or logic blocks.
instruction execution time	The time required to execute an instruction. The execution time for any one instruction can vary with the execution conditions for the instruction and the operands used within it.
instruction line	A group of conditions that lie together on the same horizontal line of a ladder diagram. Instruction lines can branch apart or join together to form instruction blocks.
Intelligent I/O Unit	A Unit, such as an ASCII Unit or Ladder Diagram I/O Unit, that is equipped with its own CPU and can be programmed.
interface	An interface is the conceptual boundary between systems or devices and usually involves changes in the way the communicated data is represented. Interface devices such as NSBs perform operations like changing the coding, format, or speed of the data.
interlock	A programming method used to treat a number of instructions as a group so that the entire group can be reset together when individual execution is not required. An interlocked program section is executed normally for an ON execution condition and partially reset for an OFF execution condition.
interrupt (signal)	A signal that stops normal program execution and causes a subroutine to be run.
Interrupt Input Unit	A Rack-mounting Unit used to input external interrupts into a PC System.
inverse condition	A condition that produces an ON execution condition when the bit assigned to it is OFF, and an OFF execution condition when the bit assigned to it is ON.
I/O capacity	The number of inputs and outputs that a PC is able to handle. This number ranges from around one hundred for smaller PCs, to two thousand for the largest ones.
I/O Control Unit	A Unit mounted to the CPU Rack in certain PCs to monitor and control I/O points on Expansion I/O Units.

I/O devices	The devices to which terminals on I/O Units, Special I/O Units, or Intelligent I/O Units are connected. I/O devices may be either part of the Control System, if they function to help control other devices, or they may be part of the controlled system.
I/O Interface Unit	A Unit mounted to an Expansion I/O Rack in certain PCs to interface the Expansion I/O Rack to the CPU Rack.
I/O Link	Created in an Optical Remote I/O System to enable input/output of one or two IR words directly between PCs. The words are input/output between the PC controlling the Master and a PC connected to the Remote I/O System through an I/O Link Unit or an I/O Link Rack.
I/O Link Unit	A Unit used with certain PCs to create an I/O Link in an Optical Remote I/O System.
I/O point	The place at which an input signal enters the PC System, or at which an output signal leaves the PC System. In physical terms, I/O points correspond to terminals or connector pins on a Unit; in terms of programming, an I/O points correspond to I/O bits in the IR area.
I/O response time	The time required for an output signal to be sent from the PC in response to an input signal received from an external device.
I/O table	A table created within the memory of the PC that lists the IR area words allocated to each Unit in the PC System. The I/O table can be created by, or modified from, a Programming Device.
I/O Unit	The most basic type of Unit mounted to a backplane to create a Rack. I/O Units include Input Units and Output Units, each of which is available in a range of specifications. I/O Units do not include Special I/O Units, Link Units, etc.
I/O word	A word in the IR area that is allocated to a Unit in the PC System.
IR area	A data area whose principal function is to hold the status of inputs coming into the system and that of outputs that are to be set out of the system. Bits and words in the IR that are used this way are called I/O bits and I/O words. The remaining bits in the IR area are work bits.
JIS	Acronym for Japanese Industrial Standards.
jump	A type of programming where execution moves directly from one point in a program to another, without sequentially executing any instructions inbetween. Jumps are usually conditional on an execution condition.
jump number	A definer used with a jump that defines the points from and to which a jump is to be made.
ladder diagram (program)	A form of program arising out of relay-based control systems that uses circuit-type diagrams to represent the logic flow of programming instructions. The appearance of the program is similar to a ladder, and thus the name.
ladder diagram symbol	A symbol used in a ladder-diagram program.

ladder instruction	An instruction that represents the 'rung' portion of a ladder-diagram program. The other instructions in a ladder diagram fall along the right side of the diagram and are called terminal instructions.
Ladder Support Software	A software package that provides most of the functions of the Factory Intelligent Terminal on an IBM AT, IBM XT, or compatible computer.
LAN	An acronym for local area network.
leftmost (bit/word)	The highest numbered bits of a group of bits, generally of an entire word, or the highest numbered words of a group of words. These bits/words are often called most-significant bits/words.
Link Adapter	A Unit used to connect communications lines, either to branch the lines or to convert between different types of cable. There are two types of Link Adapter: Branching Link Adapters and Converting Link Adapters.
link	A hardware or software connection formed between two Units. "Link" can refer either to a part of the physical connection between two Units (e.g., optical links in Wired Remote I/O Systems) or a software connection created to data existing at another location (Network Data Links).
linkable slot	A slot on either a CPU or Expansion I/O Backplane to which a Link Unit can be mounted. Backplanes differ in the slots to which Link Units can be mounted.
Link System	A system that includes one or more of the following systems: Remote I/O System, PC Link System, Host Link System, or Net Link System.
Link Unit	Any of the Units used to connect a PC to a Link System. These are Remote I/O Units, I/O Link Units, PC Link Units, Host Link Units, and Net Link Units.
load	The processes of copying data either from an external device or from a storage area to an active portion of the system such as a display buffer. Also, an output device connected to the PC is called a load.
local area network	A network consisting of nodes or positions in a loop arrangement. Each node can be any one of a number of devices, which can transfer data to and from each other.
logic block	A group of instructions that is logically related in a ladder-diagram program and that requires logic block instructions to relate it to other instructions or logic blocks.
logic block instruction	An instruction used to locally combine the execution condition resulting from a logic block with a current execution condition. The current execution condition could be the result of a single condition, or of another logic block. AND Load and OR Load are the two logic block instructions.
logic instruction	Instructions used to logically combine the content of two words and output the logical results to a specified result word. The logic instructions combine all the same-numbered bits in the two words and output the result to the bit of the same number in the specified result word.
loop	A group of instructions that can be executed more than once in succession (i.e., repeated) depending on an execution condition or bit status.

LR area	A data area that is used in a PC Link System so that data can be transferred between two or more PCs. If a PC Link System is not used, the LR area is available for use as work bits.
LSS	Abbreviation for Ladder Support Software.
main program	All of a program except for the subroutines.
masking	'Covering' an interrupt signal so that the interrupt is not effective until the mask is removed.
Master	Short for Remote I/O Master Unit.
memory area	Any of the areas in the PC used to hold data or programs.
mnemonic code	A form of a ladder-diagram program that consists of a sequential list of the instructions without using a ladder diagram. Mnemonic code is required to input a program into a PC when using a Programming Console.
MONITOR mode	A mode of PC operation in which normal program execution is possible, and which allows modification of data held in memory. Used for monitoring or de-bugging the PC.
most-significant (bit/word)	See *leftmost (bit/word).*
NC input	An input that is normally closed, i.e., the input signal is considered to be present when the circuit connected to the input opens.
nest	Programming one loop within another loop, programming a call to a subrou-tine within another subroutine, or programming an IF–ELSE programming section within another IF–ELSE section.
Net Link System	An optical LAN formed from PCs connected through Net Link Units. A Net Link System also normally contains nodes interfacing computers and other peripheral devices. PCs in the Net Link System can pass data back and forth, receive commands from any interfaced computer, and share any interfaced peripheral device.
Net Link Unit	The Unit used to connect PCs to a Net Link System. The full name is "SYS-MAC Net Link Unit."
Network Service Board	A device with an interface to connect devices other than PCs to a Net Link System.
Network Service Unit	A Unit that provides two interfaces to connect peripheral devices to a Net Link System.
node	One of the positions in a LAN. Each node incorporates a device that can communicate with the devices at all of the other nodes. The device at a node is identified by the node number. One loop of a Net Link System (OMRON's LAN) can consist of up to 126 nodes. Each node is occupied by a Net Link Unit mounted to a PC or a device providing an interface to a computer or other peripheral device.
NO input	An input that is normally open, i.e., the input signal is considered to be pres-ent when the circuit connected to the input closes.

noise interference	Disturbances in signals caused by electrical noise.
nonfatal error	A hardware or software error that produces a warning but does not stop the PC from operating.
normal condition	A condition that produces an ON execution condition when the bit assigned to it is ON, and an OFF execution condition when the bit assigned to it is OFF.
NOT	A logic operation which inverts the status of the operand. For example, AND NOT indicates an AND operation with the opposite of the actual status of the operand bit.
NSB	An acronym for Network Service Board.
NSU	An acronym for Network Service Unit.
OFF	The status of an input or output when a signal is said not to be present. The OFF state is generally represented by a low voltage or by non-conductivity, but can be defined as the opposite of either.
OFF delay	The delay between the time when a signal is switched OFF (e.g., by an input device or PC) and the time when the signal reaches a state readable as an OFF signal (i.e., as no signal) by a receiving party (e.g., output device or PC).
ON	The status of an input or output when a signal is said to be present. The ON state is generally represented by a high voltage or by conductivity, but can be defined as the opposite of either.
ON delay	The delay between the time when an ON signal is initiated (e.g., by an input device or PC) and the time when the signal reaches a state readable as an ON signal by a receiving party (e.g., output device or PC).
one-shot bit	A bit that is turned ON or OFF for a specified interval of time which is longer than one scan.
on-line removal	Removing a Rack-mounted Unit for replacement or maintenance during PC operation.
operand	Bit(s) or word(s) designated as the data to be used for an instruction. An operand can be input as a constant expressing the actual numeric value to be used or as an address to express the location in memory of the data to be used.
operand bit	A bit designated as an operand for an instruction.
operand word	A word designated as an operand for an instruction.
operating error	An error that occurs during actual PC operation as opposed to an initialization error, which occurs before actual operations can begin.
Optical I/O Unit	A Unit that is connected in an Optical Remote I/O System to provide 8 I/O points. Optical I/O Units are not mounted to a Rack.

Optical Slave Rack	A Slave Rack connected through an Optical Remote I/O Slave Unit.
OR	A logic operation whereby the result is true if either of two premises is true, or if both are true. In ladder-diagram programming the premises are usually ON/OFF states of bits or the logical combination of such states called execution conditions.
output	The signal sent from the PC to an external device. the term output is often used abstractly or collectively to refer to outgoing signals.
output bit	A bit in the IR area that is allocated to hold the status to be sent to an output device.
output device	An external device that receives signals from the PC System.
output point	The point at which an output leaves the PC System. Output points correspond physically to terminals or connector pins.
output signal	A signal being sent to an external device. Generally an output signal is said to exist when, for example, a connection point goes from low to high voltage or from a nonconductive to a conductive state.
overseeing	Part of the processing performed by the CPU that includes general tasks required to operate the PC.
overwrite	Changing the content of a memory location so that the previous content is lost.
parity	Adjustment of the number of ON bits in a word or other unit of data so that the total is always an even number or always an odd number. Parity is generally used to check the accuracy of data after being transmitted by confirming that the number of ON bits is still even or still odd.
PC	An acronym for Programmable Controller.
PCB	An acronym for printed circuit board.
PC configuration	The arrangement and interconnections of the Units that are put together to form a functional PC.
PCF	Acronym for plastic-clad optical fiber cable.
PC Link System	A system in which PCs are connected through PC Link Units to enable them to share common data areas, i.e., each of the PCs writes to certain words in the LR area and receives the data of the words written by all other PC Link Units connected in series with it.
PC Link Unit	The Unit used to connect PCs in a PC Link System.
PC System	With building-block PCs, all of the Racks and independent Units connected directly to them up to, but not including the I/O devices. The boundaries of a PC System are the PC and the program in its CPU at the upper end; and the I/O Units, Special I/O Units, Optical I/O Units, Remote Terminals, etc., at the lower end.

peripheral device	Devices connected to a PC System to aid in system operation. Peripheral devices include printers, programming devices, external storage media, etc.
PLC	Acronym for Programmable Logic Controller, also known as Programmable Controller or PC.
port	A connector on a PC or computer that serves as a connection to an external device.
present value	The current value registered in a device at any instant during its operation. Present value is abbreviated as PV.
printed circuit board	A board onto which electrical circuits are printed for mounting into a computer or electrical device.
Printer Interface Unit	A Unit used to interface a printer so that ladder diagrams and other data can be printed out.
program	The list of instructions that tells the PC the sequence of control actions to be carried out.
Programmable Controller	A computerized device that can accept inputs from external devices and generate outputs to external devices according to a program held in memory. Programmable Controllers are used to automate control of external devices. Although single-component Programmable Controllers are available, building-block Programmable Controllers are constructed from separate components. Such building-block Programmable Controllers are formed only when enough of these separate components are assembled to form a functional assembly, i.e., no one individual Unit is called a PC.
programmed alarm	An alarm given as a result of execution of an instruction designed to generate the alarm in the program, as opposed to one generated by the system.
programmed error	An error arising as a result of the execution of an instruction designed to generate the error in the program, as opposed to one generated by the system.
programmed message	A message generated as a result of execution of an instruction designed to generate the message in the program, as opposed to one generated by the system.
Programming Console	The simplest form or programming device available for a PC. Programming Consoles are available both as hand-held models and as CPU-mounting models.
Programming Device	A peripheral device used to input a program into a PC or to alter or monitor a program already held in the PC. There are dedicated programming devices, such as Programming Consoles, and there are non-dedicated devices, such as a host computer.
PROGRAM mode	A mode of operation that allows inputting and debugging of programs to be carried out, but that does not permit normal execution of the program.
PROM Writer	A peripheral device used to write programs and other data into a ROM for permanent storage and application.

prompt	A message or symbol that appears on a display to request input from the operator.
PV	Acronym for present value.
Rack	An assembly of various Units on a Backplane that forms a functional unit in a building-block PC System. Racks include CPU Racks, Expansion I/O Racks, I/O Racks, and Slave Racks.
refresh	The process of updating output status sent to external devices so that it agrees with the status of output bits held in memory and of updating input bits in memory so that they agree with the status of inputs from external devices.
relay-based control	The forerunner of PCs. In relay-based control, groups of relays are interconnected to form control circuits. In a PC, these are replaced by programmable circuits.
Remote I/O Master Unit	The Unit in a Remote I/O System through which signals are sent to all other Remote I/O Units. The Remote I/O Master Unit is mounted either to a CPU Rack or an Expansion I/O Rack connected to the CPU Rack. Remote I/O Master Unit is generally abbreviated to Master.
Remote I/O Slave Unit	A Unit mounted to a Backplane to form a Slave Rack. Remote I/O Slave Unit is generally abbreviated to Slave. The opertion of a Slave is controlled by a Master.
Remote I/O System	A system in which remote I/O points are controlled through a Master mounted to a CPU Rack or an Expansion I/O Rack connected to the CPU Rack.
Remote I/O Unit	Any of the Units in a Remote I/O System. Remote I/O Units include Masters, Slaves, Optical I/O Units, I/O Link Units, and Remote Terminals.
remote I/O word	An I/O word allocated to a Unit in a Remote I/O System.
reset	The process of turning a bit or signal OFF or of changing the present value of a timer or counter to its set value or to zero.
retry	The process whereby a device will retransmit data which has resulted in an error message from the receiving device.
return	The process by which instruction execution shifts from a subroutine back to the main program (usually the point from which the subroutine was called).
reversible counter	A counter that can be both incremented and decremented depending on the specified conditions.
reversible shift register	A shift register that can shift data in either direction depending on the specified conditions.
right-hand instruction	Another term for terminal instruction.
rightmost (bit/word)	The lowest numbered bits of a group of bits, generally of an entire word, or the lowest numbered words of a group of words. These bits/words are often called least-significant bits/words.

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rotate register	A shift register in which the data moved out from one end is placed back into the shift register at the other end.
RUN mode	The operating mode used by the PC for normal control operations.
scan	The process used to execute a ladder-diagram program. The program is examined sequentially from start to finish and each instruction is executed in turn based on execution conditions.
scan time	The time required for a single scan of the ladder-diagram program.
scheduled interrupt	An interrupt that is automatically generated by the system at a specific time or program location specified by the operator. Scheduled interrupts result in the execution of specific subroutines that can be used for instructions that must be executed repeatedly for a specified period of time.
self diagnosis	A process whereby the system checks its own operation and generates a warning or error if an abnormality is discovered.
self-maintaining bit	A bit that is programmed to maintain either an OFF or ON status until set or reset by specified conditions.
servicing	The process whereby the PC provides data to or receives data from external devices or remote I/O Units, or otherwise handles data transactions for Link Systems.
set	The process of turning a bit or signal ON.
set value	The value from which a decrementing counter starts counting down or to which an incrementing counter counts up (i.e., the maximum count), or the time from which or for which a timer starts timing. Set value is abbreviated SV.
shift register	One or more words in which data is shifted a specified number of units to the right or left in bit, digit, or word units. In a rotate register, data shifted out one end is shifted back into the other end. In other shift registers, new data (either specified data, zero(s) or one(s)) is shifted into one end and the data shifted out at the other end is lost.
Slave	Short for Remote I/O Slave Unit.
Slave Rack	A Rack containing a Remote I/O Slave Unit and controlled through a Remote I/O Master Unit. Slave Racks are generally located away from the CPU Rack.
slot	A position on a Rack (Backplane) to which a Unit can be mounted.
software error	An error that originates in a software program.
software protect	A means of protecting data from being changed that uses software as opposed to a physical switch or other hardware setting.
source	The location from which data is taken for use in an instruction, as opposed to the location to which the result of an instruction is to be written. The latter is called the destination.

Special I/O Unit	A dedicated Unit that is designed for a specific purpose. Special I/O Units include Position Control Units, High-speed Counter Units, Analog I/O Units, etc.
SR area	A data area in a PC used mainly for flags, control bits, and other information provided about PC operation. The status of only certain SR bits may be controlled by the operator, i.e., most SR bits can only be read.
subroutine	A group of instructions placed after the main program and executed only if called from the main program or activated by an interrupt.
subroutine number	A definer used to identify the subroutine that a subroutine call or interrupt activates.
SV	Abbreviation for set value.
switching capacity	The maximum voltage/current that a relay can safely switch on and off.
syntax error	An error in the way in which a program is written. Syntax errors can include 'spelling' mistakes (i.e., a function code that does not exist), mistakes in specifying operands within acceptable parameters (e.g., specifying unwritable SR bits as a destination), and mistakes in actual application of instructions (e.g., a call to a subroutine that does not exist).
system configuration	The arrangement in which Units in a system are connected.
system error	An error generated by the system, as opposed to one resulting from execution of an instruction designed to generate an error.
system error message	An error message generated by the system, as opposed to one resulting from execution of an instruction designed to generate a message.
TC area	A data area that can be used only for timers and counters. Each bit in the TC area serves as the access point for the SV, PV, and Completion flag for the timer or counter defined with that bit.
TC number	A definer that corresponds to a bit in the TC area and used to define the bit as either a timer or a counter.
terminal instruction	An instruction placed on the right side of a ladder diagram that uses the final execution conditions of an instruction line.
terminator	The code comprising an asterix and a carriage return (* CR) which indicates the end of a block of data, whether it is a single-frame or multi-frame block. Frames within a multi-frame block are separated by delimiters.
timer	A location in memory accessed through a TC bit and used to time down from the timer's set value. Timers are turned ON and reset according to their execution conditions.
TM area	A memory area used to store the results of a trace.
transmission distance	The distance that a signal can be transmitted.
TR area	A data area used to store execution conditions so that they can be reloaded later for use with other instructions.

trace	An operation whereby the program is executed and the resulting data is stored in TM memory to enable step-by-step analysis and debugging.
transfer	The process of moving data from one location to another within the PC, or between the PC and external devices. When data is transferred, generally a copy of the data is sent to the destination, i.e., the content of the source of the transfer is not changed.
trigger address	An address in the program that defines the beginning point for tracing. The actual beginning point can be altered from the trigger by defining either a positive or negative delay.
UM area	The memory area used to hold the active program, i.e., the program that is being currently executed.
Unit	In OMRON PC terminology, the word Unit is capitalized to indicate any product sold for a PC System. Though most of the names of these products end with the word Unit, not all do, e.g., a Remote Terminal is referred to in a collective sense as a Unit. Context generally makes any limitations of this word clear.
unit number	A number assigned to some Link Units and Special I/O Units to facilitate identification when assigning words or other operating parameters to it.
watchdog timer	A timer within the system that ensures that the scan time stays within specified limits. When limits are reached, either warnings are given or PC operation is stopped depending on the particular limit that is reached.
Wired Slave Rack	A Slave Rack connected through a Wired Remote I/O Slave Unit.
word	A unit of data storage in memory that consists of 16 bits. All data areas consists of words. Some data areas can be accessed only by words; others, by either words or bits.
word address	The location in memory where a word of data is stored. A word address must specify (sometimes by default) the data area and the number of the word that is being addressed.
word multiplier	A value between 0 and 3 that is assigned to a Master in a Remote I/O System so that words can be allocated to non-Rack-mounting Units within the System. The word setting made on the Unit is added to 32 times the word multiplier to arrive at the actual word to be allocated.
work bit	A bit in a work word.
work word	A word that can be used for data calculation or other manipulation in programming, i.e., a 'work space' in memory. A large portion of the IR area is always reserved for work words. Parts of other areas not required for special purposes may also be used as work words, e.g., LR words not used in a PC Link or Net Link System.

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Revision History

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

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⎿⎯ Revision code

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

Revision code	Date	Revised content
1	July1990	Converted to standard manual and page formats. The text was rewritten to give extra clarity. Terminology standardized.
		System configuration examples in *Sections 1* and *2* have been corrected.
		Link Adapters section omitted. Some details added to *Appendix B.*
		Section 3–4 I/O Response Times has been added for greater clarity.
		The *Appendices* have been rearranged and expanded.
	February 1991	Format changed but content left unchanged.
1A	May 1995	Address change