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RENESAS

USER'S MANUAL

IE-78310A-R

HARDWARE

Document No. EEU-1247A
(O. D. No. EEU-645A)
Date Published March 1994 P
Printed in Japan

USER'S MANUAL

NEC

IE-78310A-R

HARDWARE

The IE-78310A-R conforms to the standards of VCCI which restricts radio disturbance in commercial and industrial areas.

Since the IE-78310A-R used in residential districts or their neighboring districts may cause radio and TV disturbance, follow the IE-78310A-R Manual.

MAJOR CHANGES

Page	Description
Before the CONTENTS	CAUTIONS has been added.
P. 1-2	The description stating that the MD series or PG-2000 is not manufactured has been added.
PP. B-1 to B-29	APPENDIX B has been added.

CAUTIONS

This part describes the cautions for the IE-78310A-R.

Read this part before developing an application system. The number enclosed in parentheses represents the page on which the caution is described.

(1) Cautions in Chapter 4

- To disconnect the target system temporarily when connecting the MD-116FD-20/HD-21 to the IE-78310A-R, follow the procedure below: (pp. 4-31, 4-32)

  ① Execute an RES_H command.

  ② The following message appears. (Do not enter anything.)
  Power on target system (Y/N)

  ③ Turn off the power switch of the target system, then disconnect the target system.

  ④ Connect the target system, then turn on the power switch.

  ⑤ Enter Y <cr>.

(2) Cautions in Chapter 5

- Always connect a device in the terminal mode to a device in the modem mode through the RS-232-C interface. Never connect two devices both in the terminal mode or both in the modem mode. (p. 5-8)

- Always set the RTS DIP switch to the RTSN setting except when a pro-typer is connected. (pp. 5-17, 5-30)

- The IE-78310A-R can be connected to the PG-2000 both in the modem mode because the cable attached to the PG-2000 is internally modified to accommodate such connection. Be sure to use the cable attached to the PG-2000 to connect them. Never use other cables. (This caution also applies to the PG-1500.) (p. 5-28)

- Always connect handshake signals before selecting hardware handshaking. (p. 5-39)

(3) Cautions in Chapter 6

- At shipment, the basic clock is set so as to use an external clock (input at pin 30 of the target probe). When an external clock is not used, set the clock by software (commands) so as to use the internal clock. (p. 6-3)

- A ▽ mark, which indicates the position of pin 1, is marked on the SHRINK DIP type target probe. Fit the target probe into the self-diagnostic socket so that the mark is aligned with pin 1 of the self-diagnostic socket.

  The ground clip of the target probe need not be connected to pin GND.

  Great care should be taken that the target probe is not fitted in reverse and the pins are not broken or bent. Otherwise, the target interface circuit of the IE-78310A-R will be destroyed. (p. 6-8)

- At shipment, the part base which contains the wiring for the external clock signal (input at pin 30 of the target probe) is already fitted on the emulation board. Using this base, the clock signal used in the target system can also be used as the basic clock signal in the IE-78310A-R.

  When the crystal oscillator is directly connected to pins X1 and X2 (pins 30 and 31) of the uPD78312A or uPD78310A in the target system, this oscillation signal cannot be supplied to the IE-78310A-R. In this case, install a crystal oscillator on the emulation board using the part base. (p. 6-11)

- If the external sense clips are connected to signal lines other than TTL-level signal lines, the IE-78310A-R cannot sense signal lines correctly and the sensor of the IE-78310A-R may be destroyed, depending on the voltage level. (p.6-20)

- When the target probe is fitted into the CPU socket of the target system (p. 6-22)

  ① Fit the target probe into the CPU socket of the target system so that the IC mark of the target probe is aligned with the first-pin mark.
  Care should be taken that the target probe is not fitted in reverse. Otherwise, the target interface circuit of the IE-78310A-R will be destroyed.

  ② Care must be taken that the pins of the target probe are not broken or bent.

  ③ The ground clip of the target probe shall be connected to pin GND.

- When the external sense clips are connected to the target system (p. 6-22)

  ① Be sure to connect an external sense clip to a signal line. If it is connected to a power line, a failure occurs.

  ② Use an IC clip to connect the external sense clips.

CONTENTS

CHAPTER 1 INTRODUCTION

The IE-78310A-R is an in-circuit emulator which has been developed to efficiently debug hardware and software using a uPD78312A or uPD78310A.

The IE-78310A-R Manual explains the unpacking of an IE-78310A-R, debugging, and applications. The IE-78310A-R Manual consists of the following two parts: Hardware and Software.

Hardware:

Chapter 1 Introduction(Note)
Chapter 2 Function Overview
Chapter 3 Installation
Chapter 4 Configuring the System
Chapter 5 RS-232-C Interface Functions
Chapter 6 Connecting the Target System
Appendix A(Note)
Appendix B

Software:

Chapter 1 Introduction(Note)
Chapter 2 Function Overview
Chapter 3 Basic Operating Instructions
Chapter 4 Description of Commands
Chapter 5 Applications
Appendix(Note)

Note: Chapter 1 and the Appendix of the IE-78310A-R Manual (Hardware) are the same as those of the IE-78310A-R Manual (Software).

This manual is intended for users who are using the MD series (Concurrent CP/M™). Users not using the MD series (i.e. users using the PC-9800 series or IBM PC/AT™) should also refer to Appendix B.

Remark: The MD series or PG-2000 is not manufactured.

1.1 Use of the IE-78310A-R Manual

This section explains the relationship between the procedure from installation of the IE-78310A-R to debugging and gives the chapters to be referred to.

Work	Chapters to be referred to
Start:	Chapter 1 (Hardware/Software)
↓	
Unpacking:	Chapter 3 (Hardware)
↓	
Installation:	Chapter 3 (Hardware)
↓	
Connecting peripheral equipment:	Chapter 4 (Hardware)
↓	
Connecting the target system:	Chapter 6 (Hardware)
↓	
Debugging:	Chapters 2 and 3 (Software)

- For the basic specifications and appearance of the IE-78310A-R as a debugger, refer to Chapter 2 (Hardware).
- To know more about the RS-232-C interface of the IE-78310A-R, refer to Chapter 5 (Hardware).
- To know more about the IE-78310A-R commands, refer to Chapter 4 (Software).
- To learn the efficient debugging method, refer to Chapter 5 (Software).

1.2 Configuration of the IE-78310A-R Manual

Hardware

Chapter 2: Function Overview

Explains the basic specifications and appearance of the IE-78310A-R as a debugger.

Skim through this chapter before using the IE-78310A-R.

Chapter 3: Installation

Describes unpacking the IE-78310A-R, connecting the accessories, and setting the main unit in detail. Read this chapter before using the IE-78310A-R.

Chapter 4: Configuring the System

Describes how to connect peripheral equipment such as a host machine, terminal, or PROM programmer to the IE-78310A-R in detail. Refer to the sections corresponding to your peripheral equipment.

After an IE-78310A-R is installed according to Chapter 3 (Hardware), read this chapter to connect peripheral equipment to the IE-78310A-R.

Chapter 5: RS-232-C Interface Functions

Describes the serial interface functions (channels 1 and 2) of the IE-78310A-R as an RS-232-C interface in detail. This chapter may be skipped when you use peripheral equipment manufactured by NEC. Read this chapter when you connect an IE-78310A-R serial interface to a device manufactured by a company other than NEC.

Chapter 6: Connecting the Target System

Describes in detail how to connect the target system in which the uPD78312A or uPD78310A is used to the IE-78310A-R.

After peripheral equipment is connected to the IE-78310A-R according to Chapter 4, read this chapter to connect the target system to the IE-78310A-R.

Software

Chapter 2: Function Overview

Gives details of the IE-78310A-R functions for the stand-alone system and system software.

Skim through this chapter before debugging.

Each IE-78310A-R function described in this chapter corresponds to a command.

Chapter 3: Basic Operating Instructions

Explains the debugging procedure of the IE-78310A-R and how to use commands.

Read this chapter before debugging.

This chapter explains the debugging procedure and commands used for each operation. An example of execution using a sample program is also explained in detail.

This chapter will aid the user in debugging.

Chapter 4: Description of Commands

Details all the IE-78310A-R commands. This chapter may be skipped.

Read this chapter to learn more about the commands.

Chapter 5: Applications

Explains the advanced functions of the IE-78310A-R.

Read this chapter to learn the efficient debugging method.

CHAPTER 2 FUNCTION OVERVIEW

2.1 Overview

This chapter explains the basic specifications and appearance of the IE-78310A-R as a debugger. Refer to Chapter 2 in the IE-78310A-R Manual (Software) for the debugger functions.

Chapter 2 consists of the following five sections.

Section 2.1 outlines the IE-78310A-R functions.

Section 2.2 explains the basic specifications of the IE-78310A-R as a debugger.

Section 2.3 explains the system configuration of the IE-78310A-R.

Section 2.4 explains the appearance and electrical specifications of the IE-78310A-R.

Section 2.5 explains the configuration of the IE-78310A-R using a block diagram.

2.2 Basic Specifications

Item		Contents
Target CPU		uPD78312A, uPD78310A
CPU clock		Up to 6 MHz, (external oscillation for 12 MHz)
Built-in memory	Alternate memory capacity	64K bytes (expansion memory) plus 16K bytes (internal ROM alternate memory)
	Mapping unit	Internal ROM: 0, 4K, 8K, or 16K bytes Expansion memory: 256 bytes
Break function	Break address	5 points or 5 partitions
	Break register	BRA, BRD, BRE, BRT
	Break factor	1. Address 2. Data 3. Status 4. Loop count 5. External data 6. Number of steps 7. Timer 8. Forced break (manual break, non-map break, write-protect break)
Realtime trace	Trace capacity	44 bits x 2K words
	Trace mode	Entire trace, qualify trace
	Trace contents	Addresses (16 bits), data (8 bits), one of ports 0 to 5, external signal, I-buffer status, read/write macro service status
Command function		Online assembling, disassembling
		Symbolic debugging
		Console redirection, line edition, help commands
External interface (RS-232-C)		Number of channels: 2 Baud rate: 300, 600, 1200, 2400, 4800, 9600, 19200 (bps)

(to be continued)

(Cont'd)

Item	Contents
External interface (RS-232-C)	Character specifications: For channel 1 Character length: 8 bits Parity bit: None Stop bit length: 2 bits For channel 2 Character length: 7 or 8 bits Parity bit: Even, odd, none Stop bit length: 1 or 2 bits Data transfer: For channel 1 Single-character handshaking and flow control handshaking For channel 2 Single-character handshaking or flow control handshaking Equipment to be connected: For channel 1 Console and host machine For channel 2 PROM programmer (PG-1500, PG-2000)
Others	. Stand-by function is supported. . Latch-up protection circuit is built in.

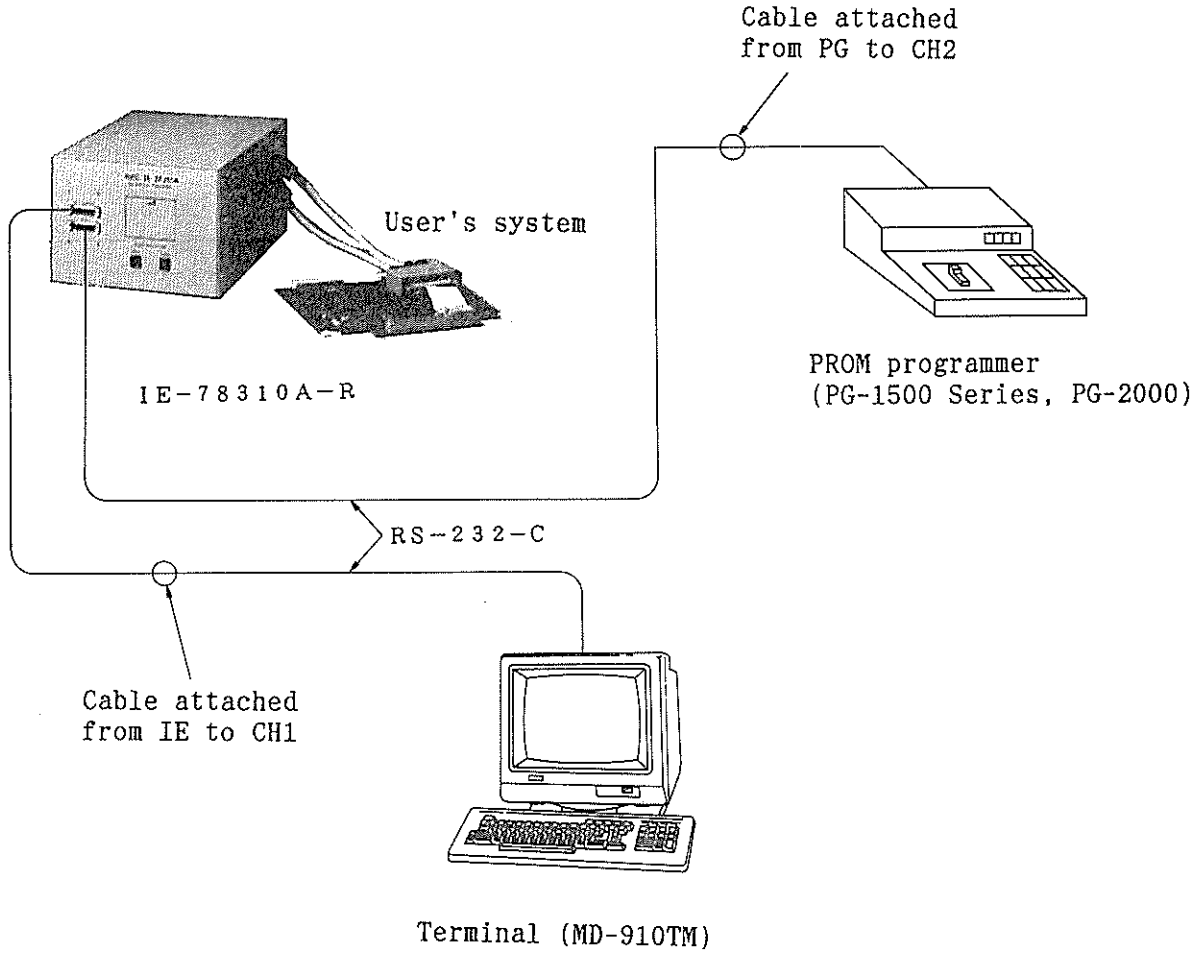
2.3 System Configuration

The IE-78310A-R can be used by itself or in conjunction with a host machine.

When the IE-78310A-R is to be used by itself, connect it as shown in Figure 2-1.

This is called the stand-alone mode.

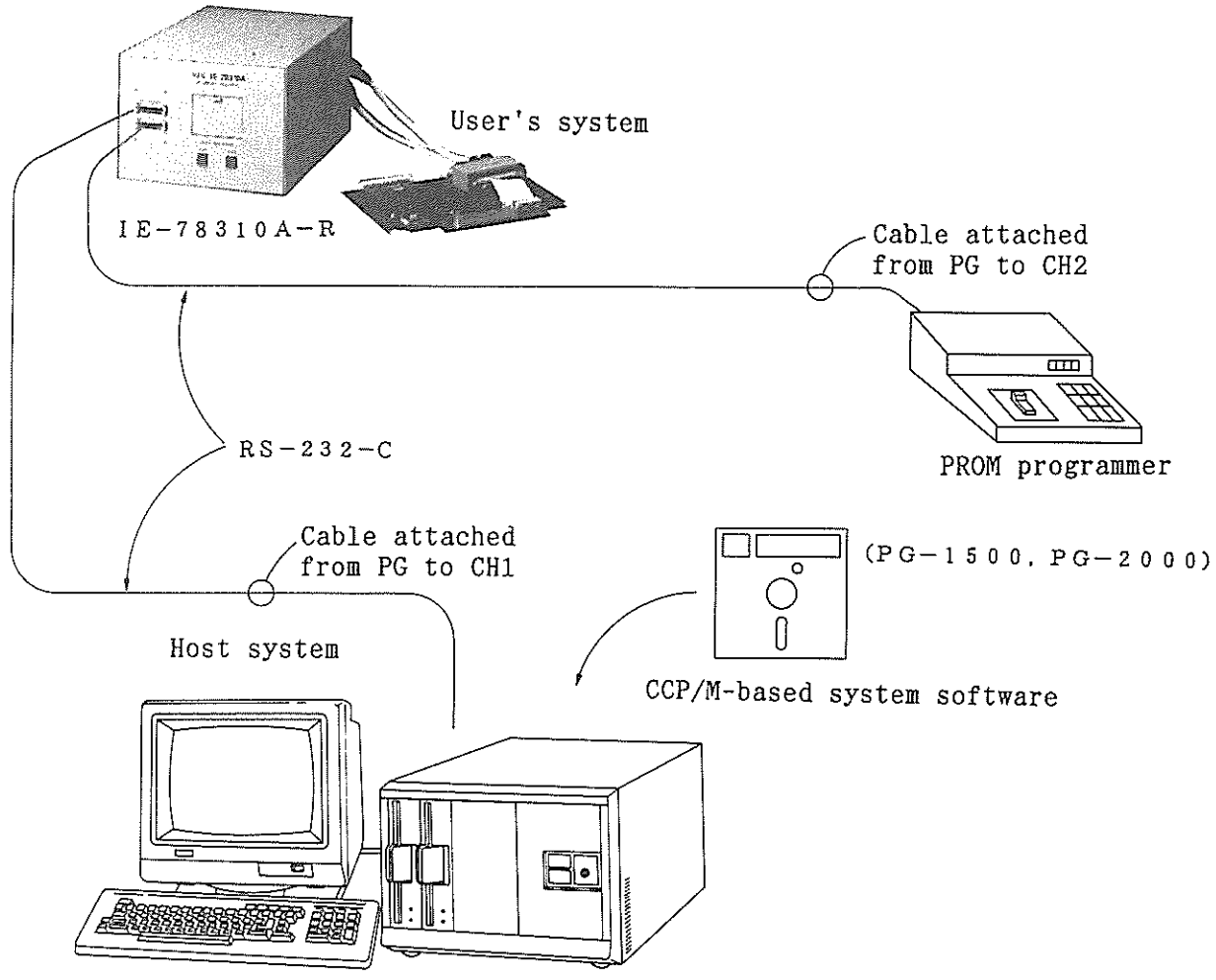
Fig. 2-1 Example of Connecting the IE-78310A-R in the Stand-alone Mode



When the IE-78310A-R is used with a host machine, connect them as shown in Figure 2-2.

This is called the system mode.

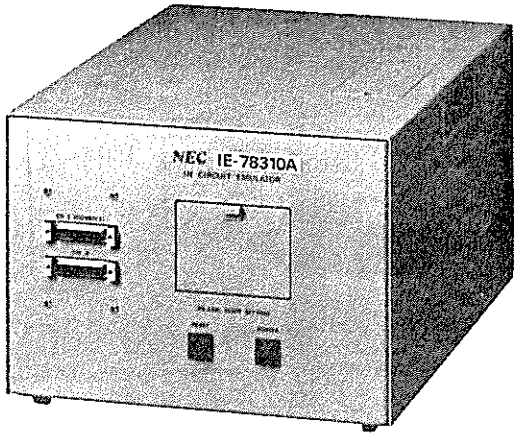
Fig. 2-2 Example of Connecting the IE-78310A-R in the System Mode



2.4 Appearance

Appearance

Fig. 2-3 IE-78310A-R



Dimensions

Depth: 395 mm
Width: 291 mm
Height: 217 mm

Weight

10.5 kg

Rating

100 VAC, 50 or 60 Hz, 5 A

Operating temperature

10° C to 40° C

Storage temperature

-20° C to +45° C

Ambient humidity

10% to 90% (RH)

2.5 Configuration

Figure 2-4 shows the basic hardware configuration of the IE-78310A-R.

Fig. 2-4 IE-78310A-R Hardware Configuration

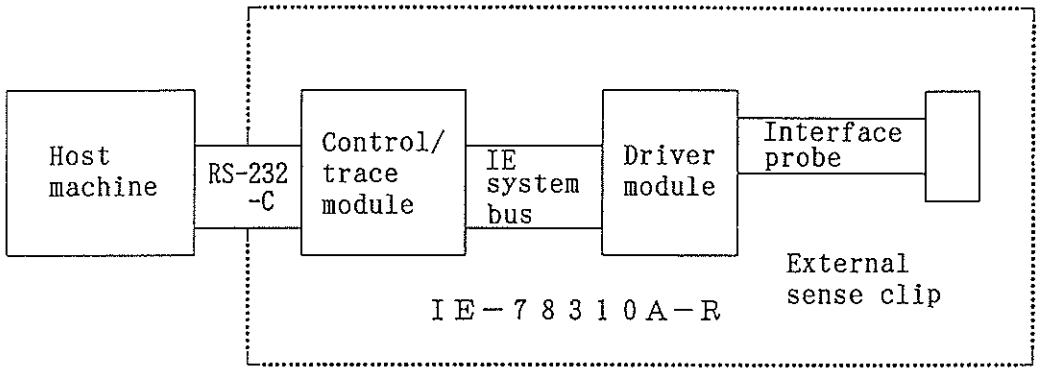


Figure 2-5 is the block diagram of a driver module.
Figure 2-6 is the block diagram of a control/trace module.

Target system

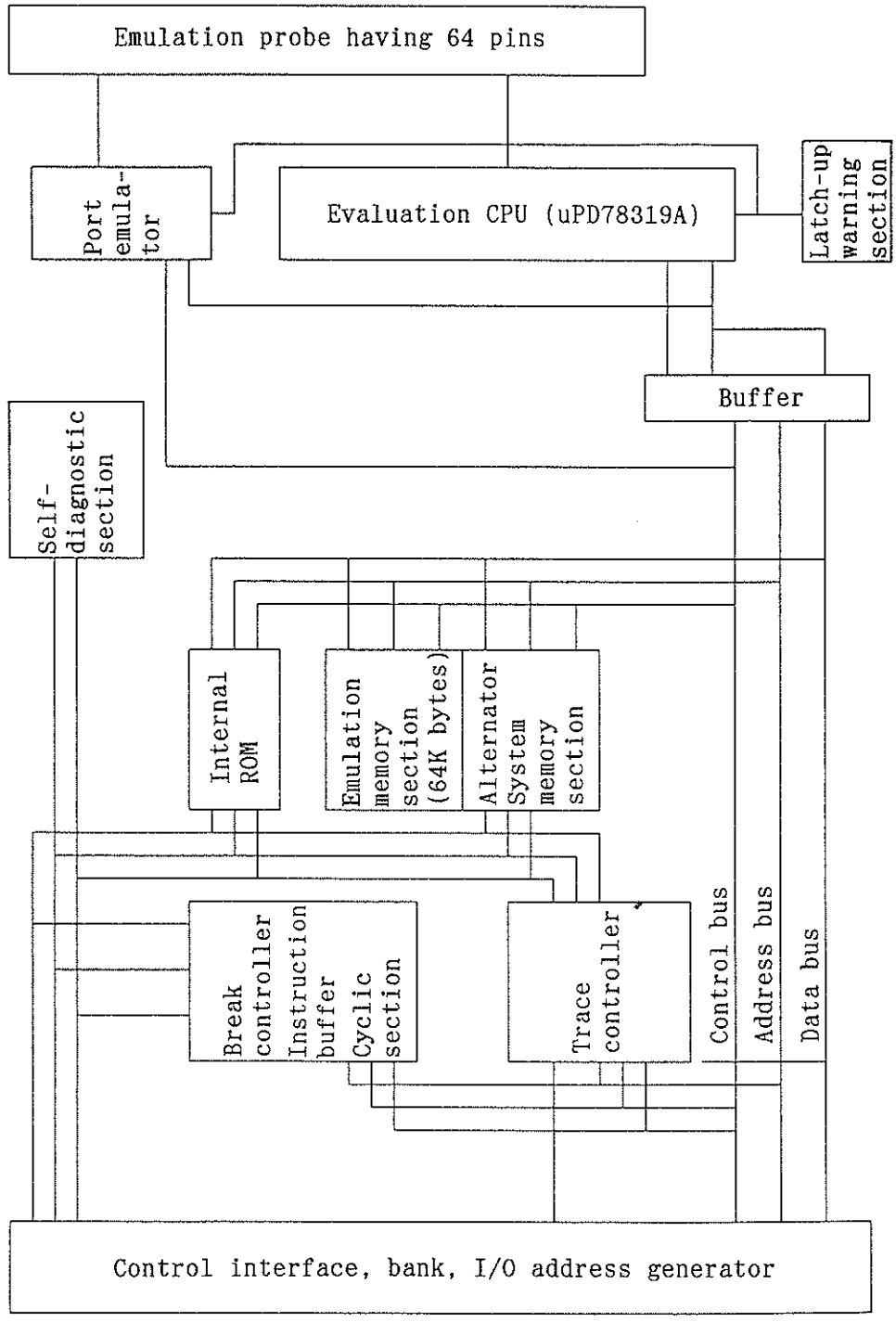


Fig. 2-5 Block Diagram of Driver Module

Control/trace module

Port emulator

The port emulator emulates the ports (P1, P4, and P5) on a uPD78312A or uPD78310A, but not on the uPD78319A (evaluation chip) in the external circuit.

Break controller

The IE-78310A-R is provided with various break functions.

A combination of break conditions enables different break condition to be set.

The break controller controls the break conditions.

Trace controller

The IE-78310A-R is provided with various trace functions.

A combination of trace conditions enables different trace condition to be set.

The trace controller controls such trace conditions.

Self-diagnostic section

The self-diagnostic section diagnoses the IE-78310A-R functions when the target probe is inserted into the self-diagnostic socket.

The self-diagnostic section has circuits for diagnosing the IE-78310A-R internal circuits, checking port inputs and outputs, checking the data and address buses in the extended mode, and checking analog inputs.

Latch-up warning section

When a latch-up occurs on the evaluation chip, the latch-up warning section turns off the power of the evaluation chip, the CMOS around the evaluation chip, and the TTL device before the CMOS.

Alternator, system memory section

The alternator and system memory section control basic operations when the evaluation chip is inoperative.

Emulation memory section

The IE-78310A-R has a 64K-byte memory which can be accessed by the uPD78310A or uPD78312A.

When the target system has not been developed, the software can be debugged logically by using this memory.

Internal ROM

The uPD78312A has an internal ROM, which enables faster operation than an external memory. The IE-78310A-R also has a memory equivalent to an internal ROM which enables high-speed operation, in addition to an emulation memory.

An internal ROM of 0, 4K, 8K, or 16K bytes can be used.

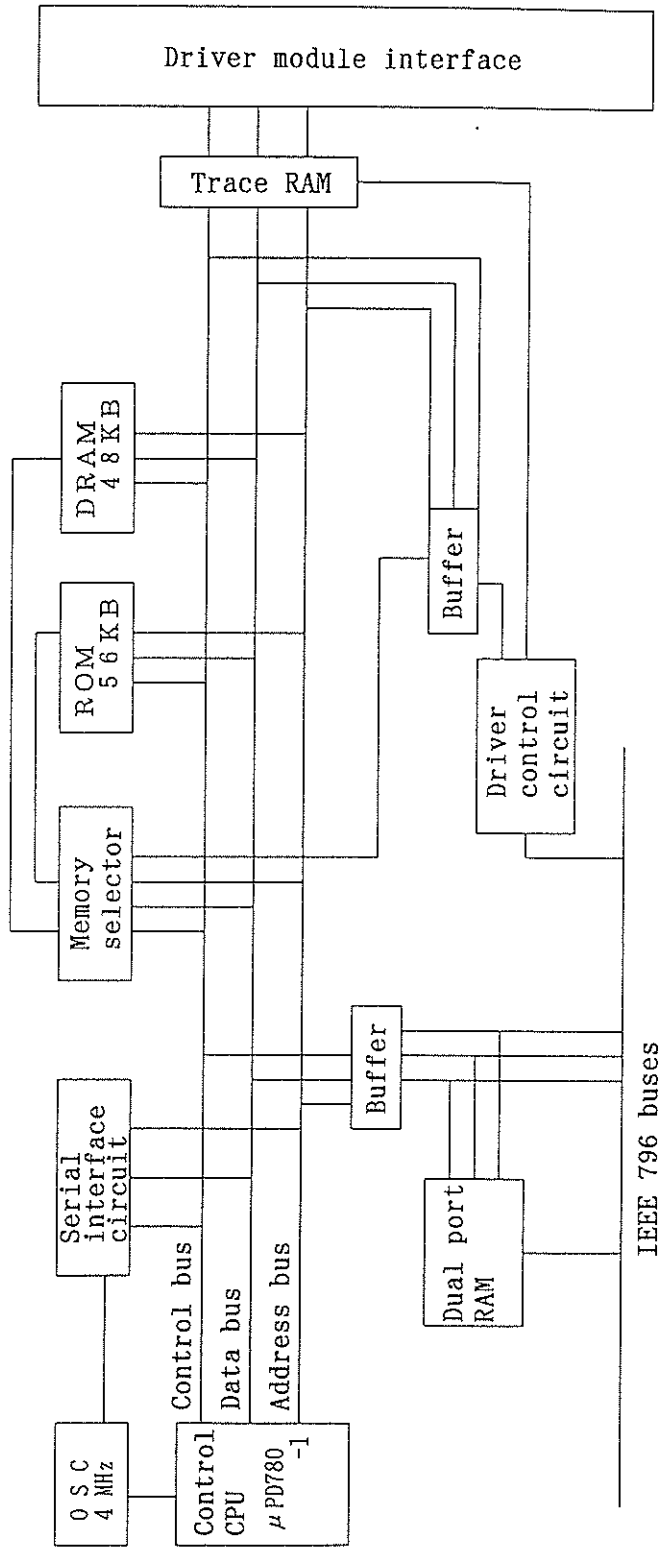


Fig. 2-6 Block Diagram of Control/Trace Module

Dual port RAM

The dual port RAM is the work area for the control CPU and the communication area for the multiple buses and the control CPU.

Driver control circuit

The driver control circuit interfaces with a driver module.

Serial interface circuit

The serial interface circuit has an RS-232-C interface (two channels).

Trace RAM

The trace RAM retains trace data of up to 2047 steps for each event.

Memory selector

The memory selector selects a ROM, DRAM, dual port RAM, trace RAM, or driver memory by switching the memory bank.

CHAPTER 3 INSTALLATION

3.1 Overview

This chapter describes unpacking the IE-78310A-R, connecting the accessories, and setting the main unit in detail.

Read this chapter before using the IE-78310A-R.

Refer to Chapter 4 for details of how to connect peripheral equipment to the IE-78310A-R.

Section 3.2 explains unpacking the IE-78310A-R.

Section 3.3 explains the IE-78310A-R main unit and its accessories.

Section 3.4 explains how to connect accessories to the IE-78310A-R main unit, and gives notes about the installation location.

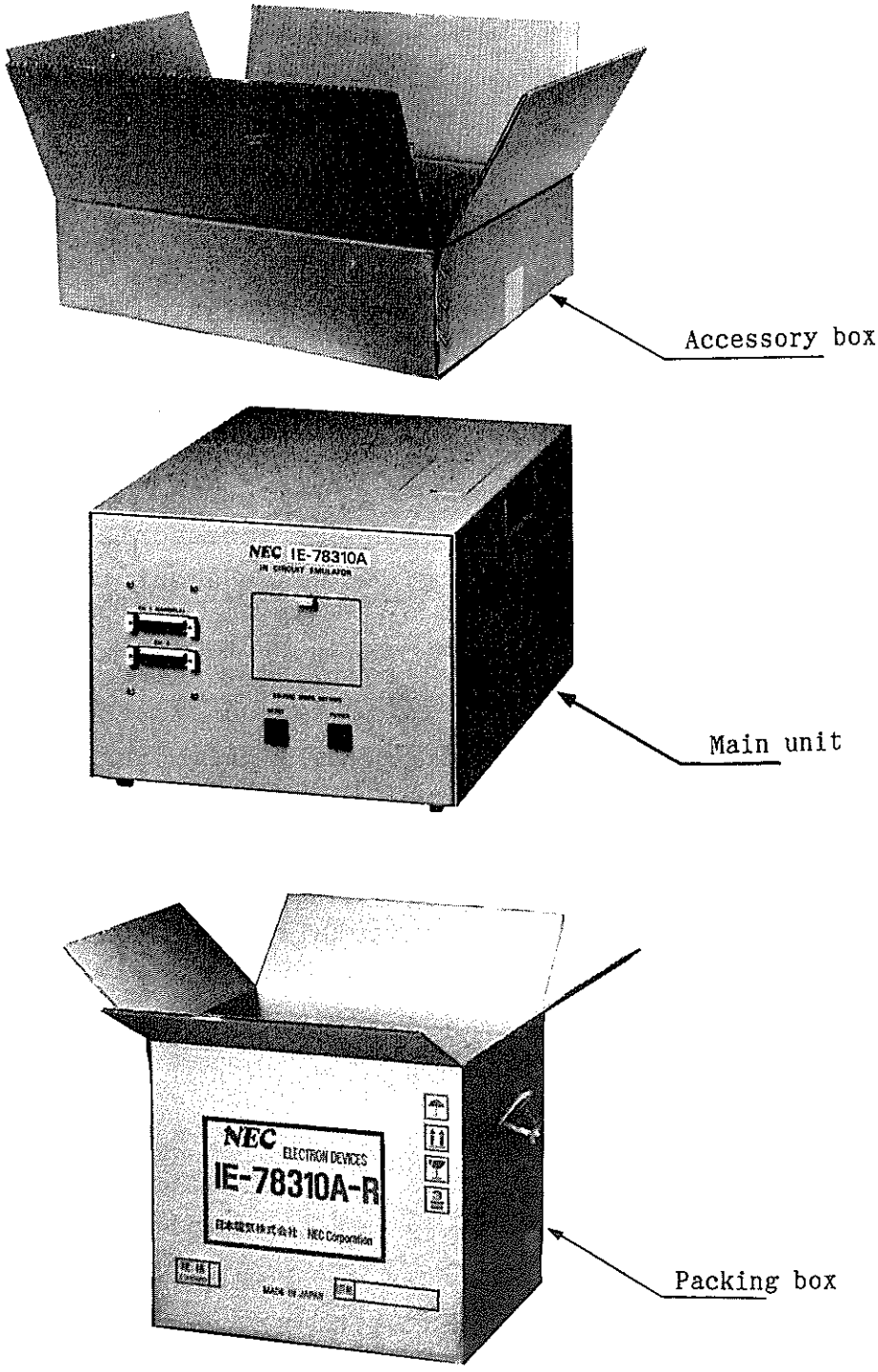
Section 3.5 explains the setting method and functions of the switches on the IE-78310A-R main unit, and describes the setting method using commands.

Section 3.6 explains the setting of jumpers on the control/trace board. Normally, this section may be skipped.

3.2 Unpacking

The IE-78310A-R main unit and accessory box are packed in a box (refer to Figure 3-1).

Fig. 3-1 Package



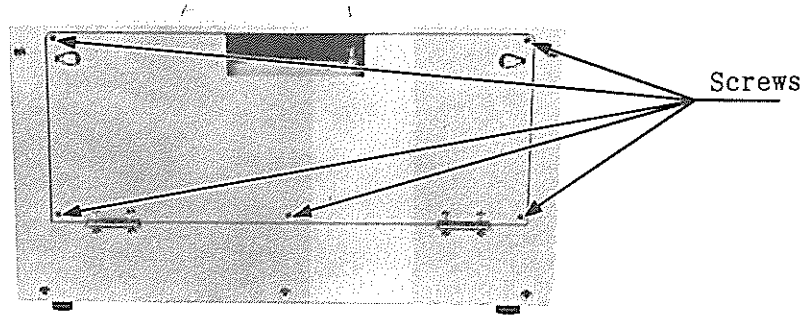
3.3 Confirmation

Confirm that the box contains the following parts.

1. Main unit

Remove the five screws on the right side of the IE-78310A-R main unit to open the cover.

Fig. 3-2 Right-Side View of IE-78310A-R



a) Self-check board: 1
b) Emulation board: 1
c) Break board: 1
d) Control/interface board: 1
e) Control/trace board: 1

Fig. 3-3 Location of the Boards

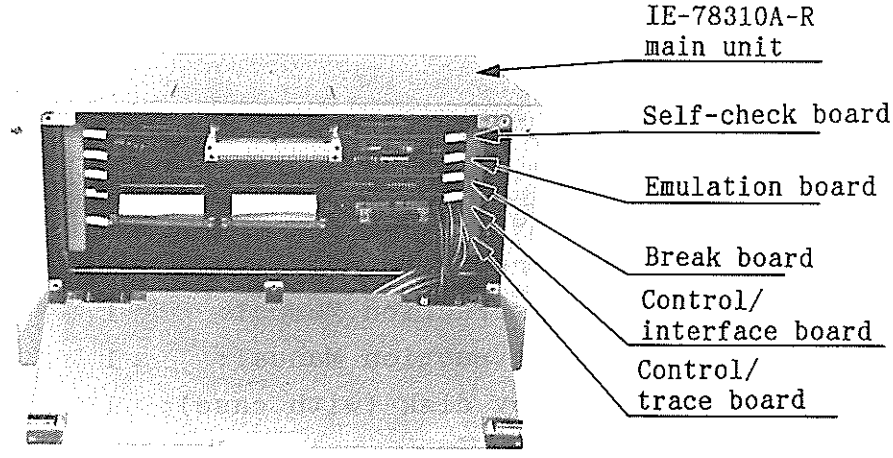
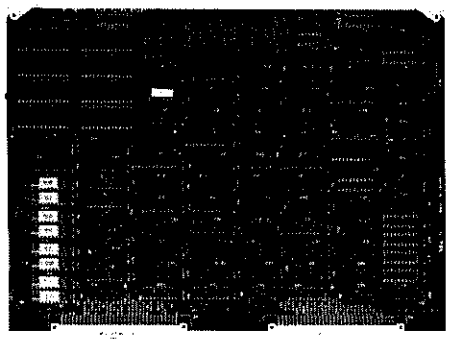
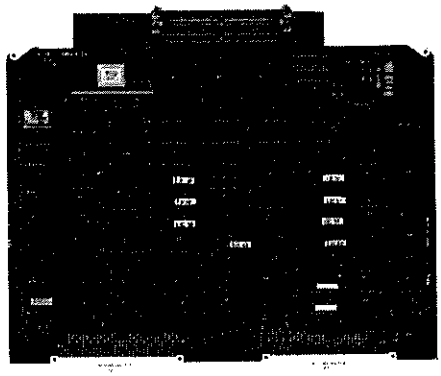


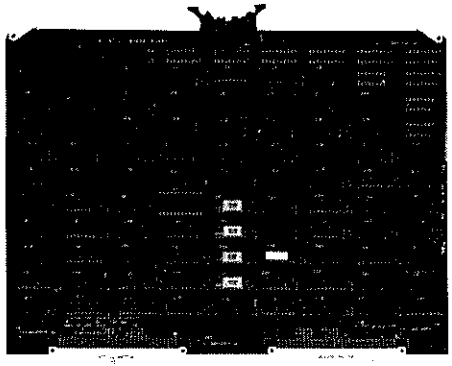
Fig. 3-4 Boards of Main Unit



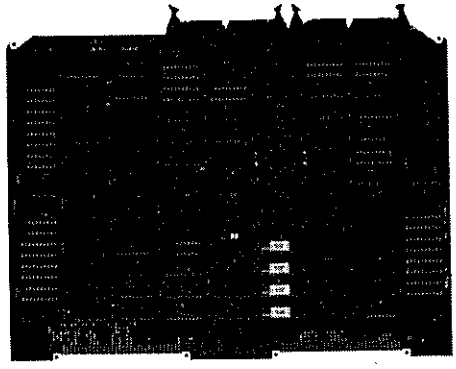
Self-check board



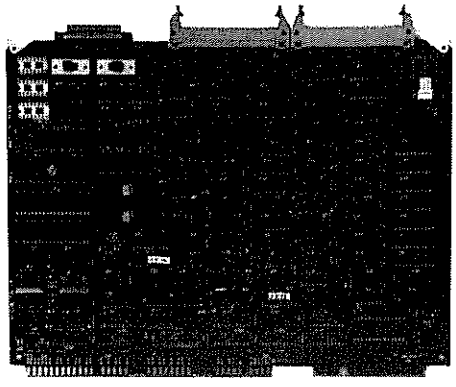
Emulation board



Break board



Control/interface board

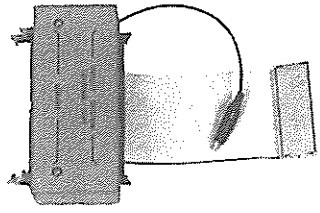


Control/trace board

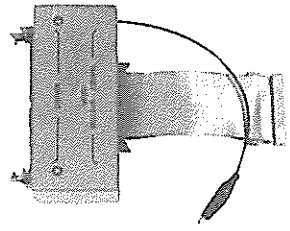
2. a) SHRINK DIP target probe: 1
   b) QUIP target probe: 1
   c) Target probe cable: 2
   d) External sense clip unit: 1
   e) Hardware Instruction Manual: 1
   f) Software Instruction Manual: 1
   g) System floppy disk (with case): 1

h)	Program product contract form:	1
i)	Power cord:	1
j)	RS-232-C interface cable:	1
k)	Ground lead:	1
l)	Spare fuse:	1
m)	Part base:	2
n)	AC adapter:	1
o)	Accessory list:	1
p)	Check certificate:	1
q)	Warranty:	1
r)	List of packed contents:	1

Fig. 3-5 Accessories



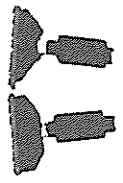
For SHRINK DIP



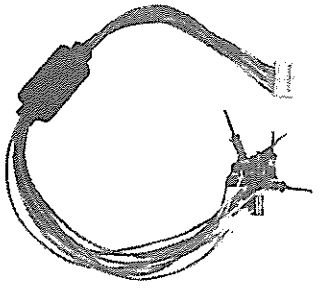
For QUIP

Target probe units

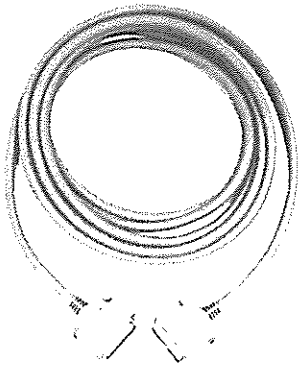
(SHRINK DIP,QUIP)



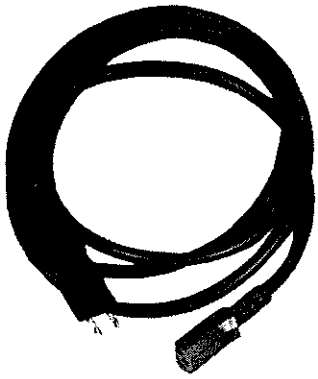
Target probe cable



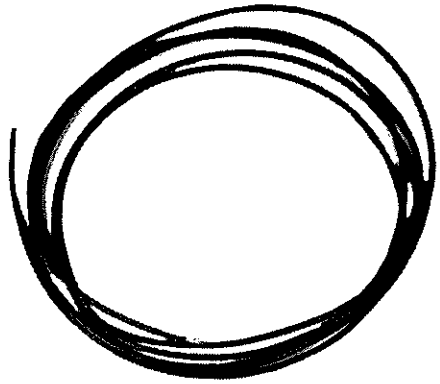
External sense clip



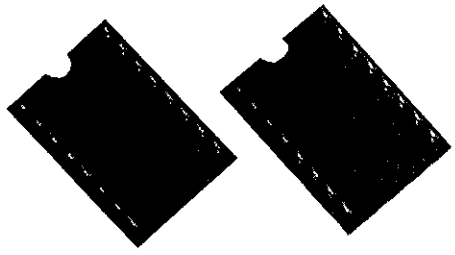
RS-232-C cable



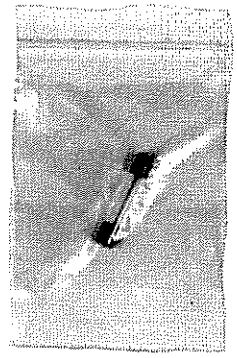
Power cord (AC adapter)



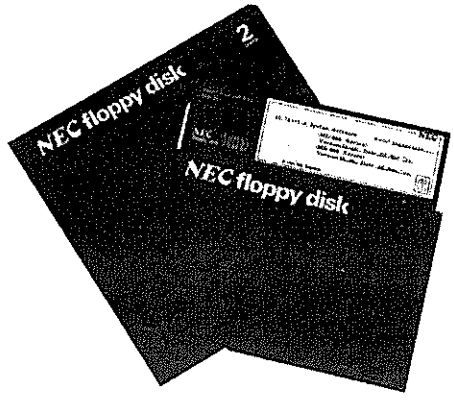
Ground lead



Part base



Fuse



System floppy disk

3.4 Installation

First, connect accessories to the IE-78310A-R main unit.

(1) Connecting the target probe

- Probe cable
- SHRINK DIP probe unit
- QUIP probe unit

The type of probe unit used (SHRINK DIP or QUIP) depends upon the type of package of the target system (uPD78312A or uPD78310A).

① Remove the five screws on the right side of the IE-78310A-R main unit to open the cover, and remove the fittings securing the drawer to dismount the emulation board (second board from the top). To dismount the board, pull the card pullers on either side of the board toward you.

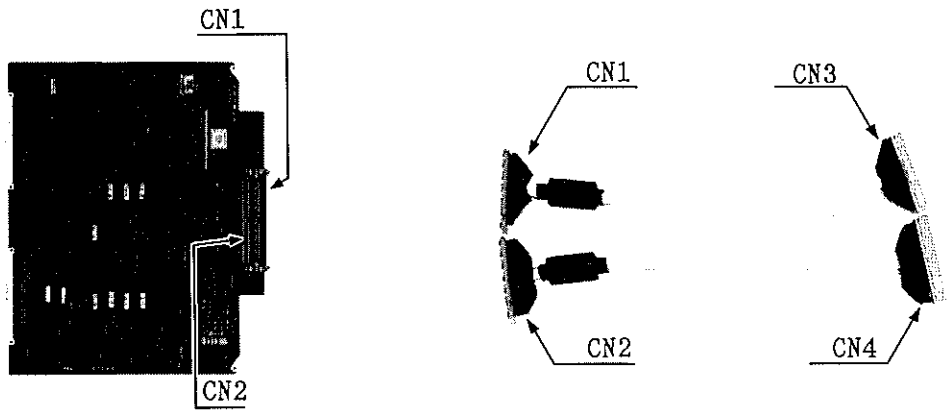
② Insert the connectors (CN1 and CN2) of the target probe cable into the connectors (CN1 and CN2) on the emulation board (refer to the figure below).

Emulation board [CN1 ← → CN1 / CN2 ← → CN2] Target probe

Be sure that the connectors are connected correctly.

If an incorrect connection is made, the IE-78310A-R main unit may be damaged.

Fig. 3-6 Connection Diagram of the Target Probe Cable



③ Connect the probe cable to the probe unit.

. When a SHRINK DIP probe is used, connect it as follows.

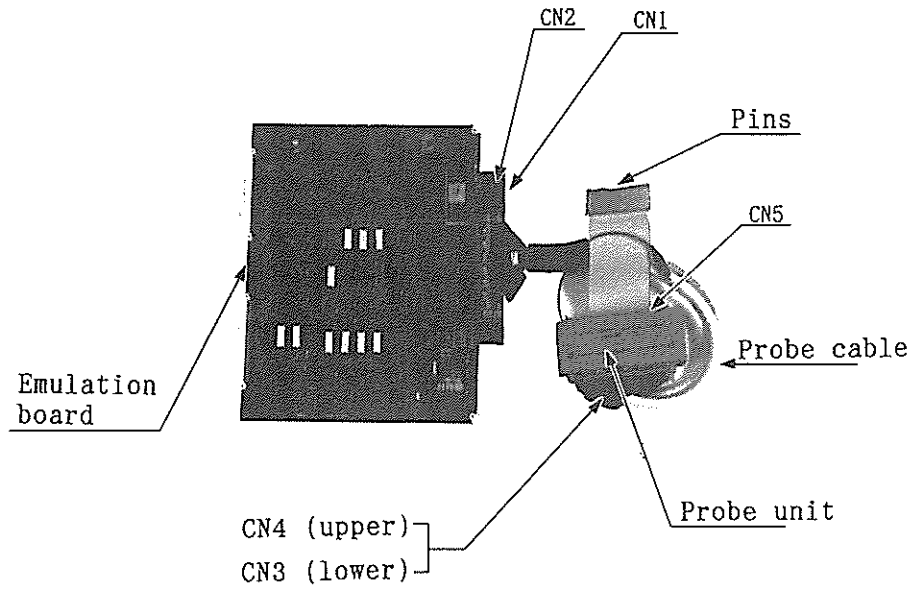
Probe cable [CN3 ← → CN3 (lower) / CN4 ← → CN4 (upper)] Probe unit

Probe unit [CN5 ← → CN5] Pin terminal

Be sure that the connection is correct.

If an incorrect connection is made, the IE-78310A-R main unit may be damaged.

Fig. 3-7 Connection Diagram of SHRINK DIP Probe Unit



. When a QUIP DIP probe is used, connect it as follows.

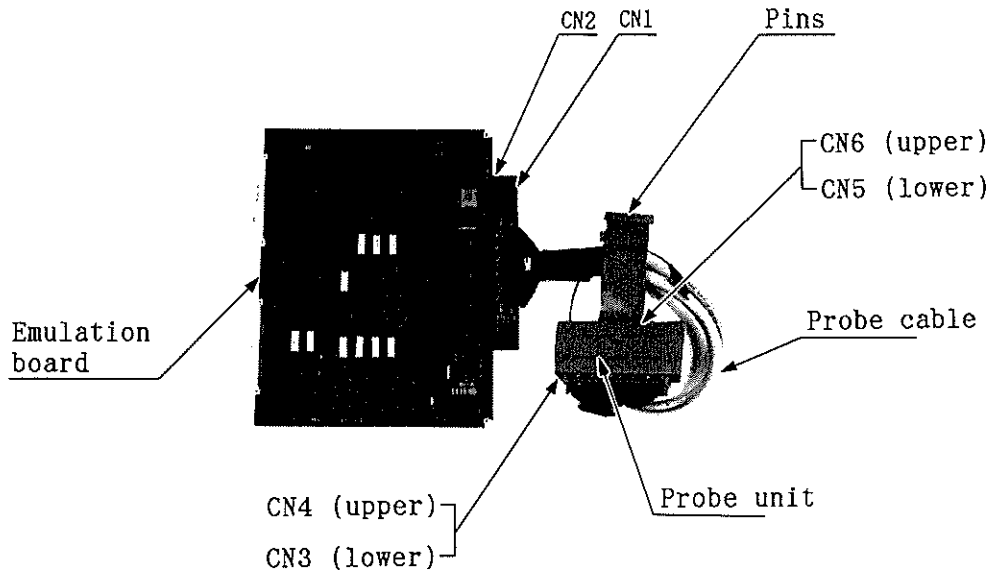
Probe cable [CN3 ← → CN3 (lower)
CN4 ← → CN4 (upper)] Probe unit

Probe unit [CN5 (lower) ← → CN5
CN6 (upper) ← → CN6] Pin

Be sure that the connection is correct.

If an incorrect connection is made, the IE-78310A-R main unit may be damaged.

Fig. 3-8 Connection Diagram of the QUIP Probe Unit



④ Insert the emulation board into the IE-78310A-R.

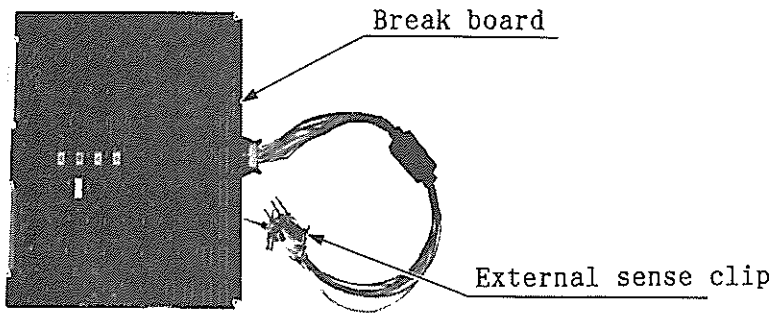
(2) Connecting the external sense clip

① Remove the five screws on the right side of the IE-78310A-R main unit to open the cover, and remove the fittings securing the drawer to dismount the break board (third board from the top). To dismount the board, pull the card pullers on either side of the board toward you.

② Insert the connector of the external sense clip into the connector (CN1) on the break board.

③ Insert the break board into the IE-78310A-R.

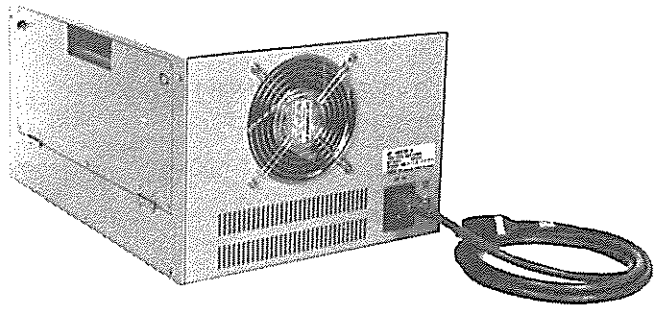
Fig. 3-9 Connection Diagram of External Sense Clip



(3) Connecting the power cord

Connect the AC adapter (power cord) to the AC IN jack on the rear of the IE-78310A-R main unit.

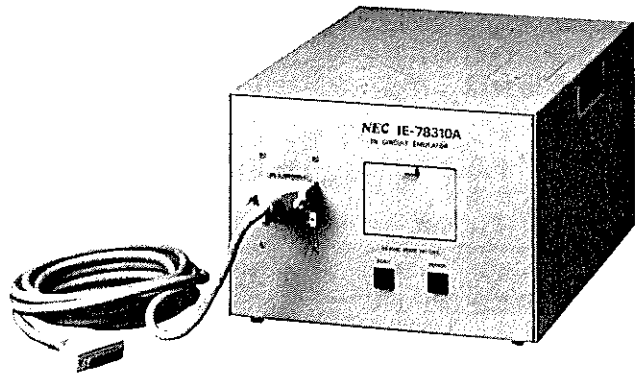
Fig. 3-10 Connection Diagram of Power Cord



(4) Connecting the RS-232-C interface cable

Connect the RS-232-C interface cable to the CH1 or CH2 connector on the front of the IE-78310A-R main unit.

Fig. 3-11 Connection Diagram of RS-232-C Interface Cable



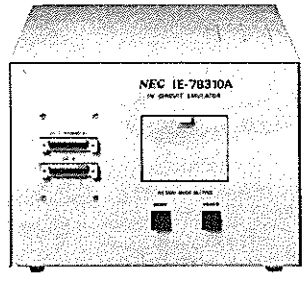
(5) Location

Install the IE-78310A-R main unit in a place free from dust.

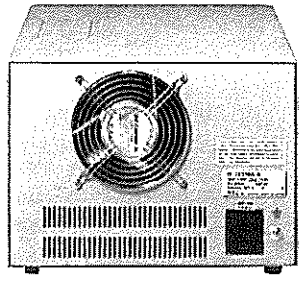
Do not place any obstructions near the air intake.

3.5 Setting

Fig. 3-12 IE-78310A-R



Front



Rear

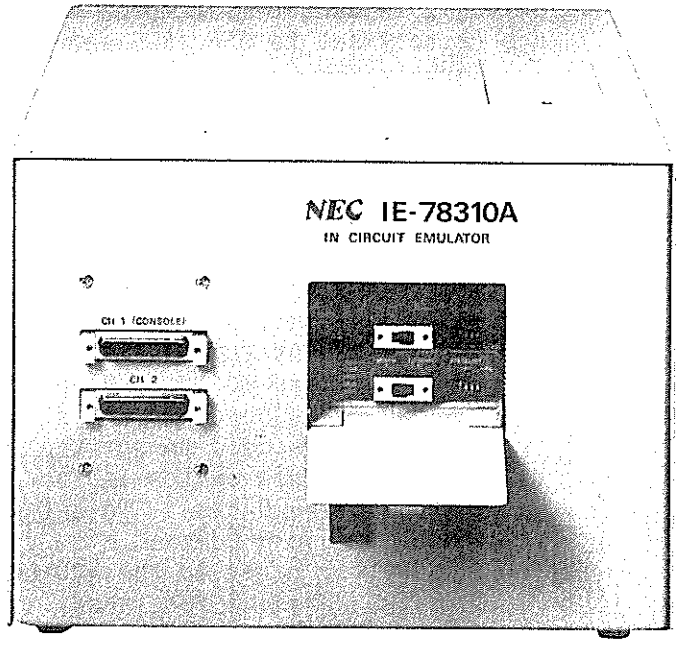
Power cord	When connecting the AC adapter to a wall outlet, the power switch of the IE-78310A-R main unit must be turned off.
Power switch	This is a push button switch having a power-on display LED. Pressing this switch when the LED is off turns on the power of the IE-78310A-R main unit and lights the LED. Pressing this switch in the on state turns off the power of the IE-78310A-R main unit and turns off the LED.
Reset switch	This is also a push-button switch. Pressing this switch resets the IE-78310A-R.
To set the following RS-232-C mode setting switches, open the front cover.	
Terminal/modem mode setting switch	This is a slide switch. Sliding the switch from right to left, when viewed from the front panel, sets the modem mode. Sliding the switch from left to right sets the terminal mode. This switch is factory-set to the modem mode.
RTS setting switch	This is a DIP switch. Sliding the switches upward sets them ON. Sliding the switches downward sets them OFF. RTS is set by switches 1 to 3. Switch 1 is factory-set to ON and switches 2 and 3 are factory-set to OFF (RTS selection).
Frame ground (FG) setting switch	This is a DIP switch. Sliding the switch upward sets it ON. Sliding the switch downward set it OFF. FG is set by switch 4. Switch 4 is factory-set to OFF. (The frame ground (FG) and signal ground (SG) are in the open state.)
Baud rate setting switch	. This is a micro DIP switch. Turning the switch clockwise or counterclockwise sets the baud rate. . This switch has 10 (0 to 9) positions. Position 7, which corresponds to 0 bps, must not be used. . This switch is used to set the baud rate of channel 1. This switch is factory-set to position 5 (9600 bps). To set the baud rate of channel 2, use a command. For details, refer to the MOD command in the IE-78310A-R Manual (Software).

(to be continued)

(Cont'd)

Handshaking setting switch	Channel 1 is set for both hardware (single character) handshaking and software (flow control) handshaking. Channel 2 is set for either hardware (single character) handshaking or software (flow control) handshaking using a command. For details, refer to the explanation of the MOD command in the IE-78310A-R Manual (Software).
Character specifications setting switch	Setting for channel 1 Character length: 8 bits Parity bit: None Stop bit length: 2 bits Channel 2 can be set using a command. Character length: 7 or 8 bits Parity bit: Even, odd, none Stop bit length: 1 or 2 bits For details, refer to the explanation of the MOD command in the IE-78310A-R Manual (Software).

Fig. 3-13 RS-232-C Mode Setting Switches on IE-78310A-R Front Panel



3.6 Setting of Jumpers on Control/Trace Board

Normally, skip this chapter. Do not change the factory-set jumpers on the control/trace board.

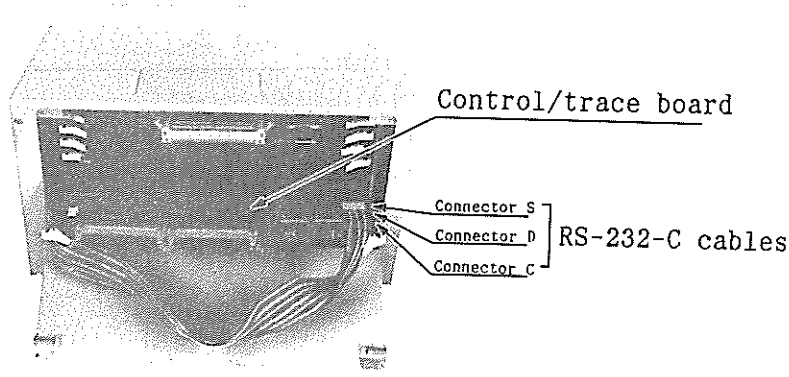
If the settings are changed, the IE-78310A-R may not operate normally.

① Remove the five screws on the right side of the IE-78310A-R main unit to open the cover, and remove the fittings securing the drawer.

② Disconnect the three RS-232-C cables and two flat cables connecting the control/interface board and control/trace board.

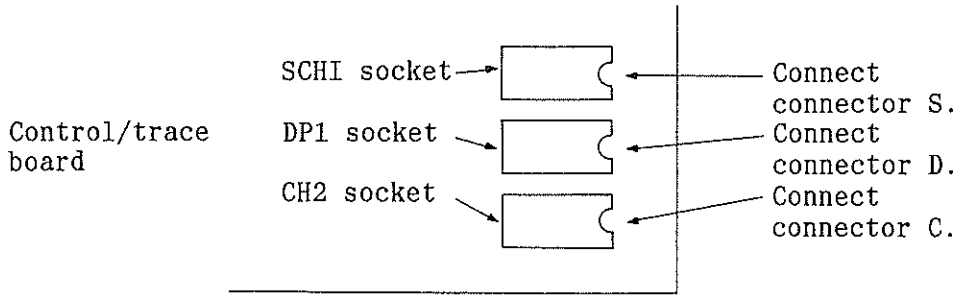
③ Dismount the control/trace board (fifth board from the top). To dismount the board, pull the card pullers on either side of the board toward you.

Fig. 3-14 Location of Control/Trace Board



Note: When connecting the RS-232-C cables, follow the figure below.

Fig. 3-15 Location of RS-232-C Sockets on the Control/Trace Board

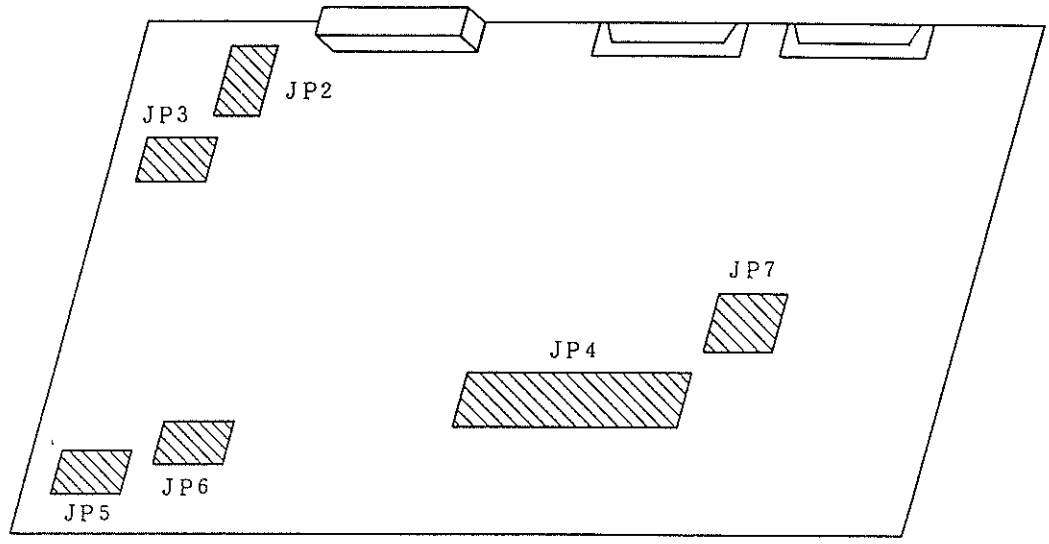


④ Factory settings of jumpers

Jumper number	Setting
JP2	Short 1 and 6.
JP3	Short 1 and 6.
JP4	Open
JP5	Open between 1 and 6(Note)
	Open between 2 and 5(Note)
	Short 3 and 4.
JP6	Short 1 and 2.
JP7	Short 1 and 2.

Note: When a memory board other than the SB-0512 is used for an expansion slot, short 1 and 6, and 2 and 5 of JP5.

Fig. 3-16 Location of Jumpers on the Control/Trace Board



CHAPTER 4 CONFIGURING THE SYSTEM

4.1 Overview

Chapter 4 explains the methods for connecting the IE-78310A-R and peripheral equipment. Read this chapter before starting connection.

The chapter illustrates the connection methods with explanations of actual host machines and PROM programmers. This chapter also explains action to be taken in the event of a failure.

Section 4.2 outlines peripheral equipment that can be connected to the IE-78310A-R.

Section 4.3 deals in detail with the methods of connecting the IE-78310A-R and each of the peripheral equipment mentioned in Section 4.2.

Section 4.4 illustrates procedures for handling failures with flow charts.

4.2 Peripheral Equipment

The following equipment may be connected to the IE-78310A-R:

- Host machine: MD-116FD-20/HD-21
  MD-116FD(HD)-10
  MD-086FD(HD)-10
  MD-086FD
  PC-9800 Series(Note)
  IBM PC/AT
- PROM programmer: PG-1500
- Terminal: MD-910TM

Note: The following models can be used as a host machine in the PC-9800 series.

Models Usable as a Host Machine in the PC-9800 Series

Support models \ CPU	8086/V30™	80286	80386
PC-9801	No mark E $F_{1/2/3}$ $M_{2/3}$ VF_2 $VM_{0/2/4/21/11}$ U_2 $UV_{2/21/11}$ CV_{21} $UR_{/20}$ UF $XL_{\text{model } 1/2/4}$ $VX_{0/2/4/01/21/41}$	$XL_{\text{model } 1/2/4}$ $VX_{0/2/4/01/21/41}$ $UX_{21/41}$ $RX_{2/4/21/51}$ $EX_{2/4}$ $DX_{2/5/U2/U5}$ $LX_{2/4/5/5C}$	XL^2 $RL_{2/5/21/51}$ $RA_{2/5/21/51}$ $ES_{2/5}$ $RS_{21/51}$ $T_{\text{model W2/W5 W7/S5/F5/F51/F71}}$ $DS_{2/5/U2/U5}$ $DA_{2/5/7/U2/U5/U7}$ $CS_{2/5/5W}$ $US_{/40/80}$

(to be continued)

(Cont'd)

CPU / Support models	8086/V30™	80286	80386
PC-9801	UX21/41 RX2/4/21/51 EX2/4 XL2 RL2/5/21/51 RA2/5/21/51 ES2/5 RS21/51 Tmodel W2/W5/W7/ S5/F5/F51/F71 LV21/22 LX2/4/5/5C LS2/5 N NV NL		FS2/5/7/U2/U5/ U7 FX2/5/U2/U5 LS2/5 NS/20 NS/E/20/40 NS/T/20/40 NS/L/20/40 NC/40
PC-H98			model70-002/100 model60-002/ 040/100 modelU60-002/ 040/100

Remark: Products in the above table can be used with the emulator only in the normal mode.

Caution: 640K bytes or more are required for internal memory.

[PC-9800 Series software products]

Media \ OS	MS-DOS™	CP/M-86™
8" 2D	uS5A1IE78310-P01	uS6A1IE78310-P01
5.25" 2HD	uS5A10IE78310-P01	uS6A10IE78310-P01
3.5" 2HD	uS5A13IE78310	-

MD-910TM

Character display terminal MD-910TM is a standard CRT terminal that may be used as a system console for the MD Series Model 10, as an additional console of the MD-116/086 Series host machine, or as an EVAKIT or IE Series console.

The MD-910TM has the ANSI.x3.64 control sequence, DEC's VT52 control sequence, and Anritsu Electric's DDY86B control sequence facilities.

MD-116FD-20 and MD-116HD-21

The MD-116FD-20/HD-21 is a powerful microcomputer development system. It has the uPD70116, a 16-bit microprocessor (with a clock rate of approximately 10 MHz), and uses concurrent CP/M™ (called CCP/M), an operating system that enables multitasking and accommodates multiple users.

In addition, the system has another processor (I/O processor) to control various system I/O devices. The system controls the system console separately from I/O control, which reduces the I/O processor load, allowing high-speed operation.

MD-116FD(HD)-10
MD-086FD(HD)-10

The MD-086FD(HD)-10 is a microcomputer development system. It has the uPD8086, a 16-bit microprocessor (with a clock rate of 5 MHz), and uses CCP/M, an operating system that enables multitasking and accommodates multiple users.

In addition, the system has another processor (I/O processor) to control various system I/O devices. The MD-086FD-10 controls the system console separately from I/O control, which reduces the I/O processor load, allowing high-speed operation.

The MD-116FD(HD)-10 uses the uPD70116-10, a faster 16-bit microprocessor (with a clock rate of approximately 10 MHz) with a special bus for memory, to speed up operation.

MD-086FD

The MD-086FD is a powerful microcomputer development system. It has the uPD8086, a 16-bit microprocessor (with a clock rate of 5 MHz) and uses CCP/M, an operating system that enables multitasking and accommodates multiple users.

In addition, the system has a special I/O processor (8-bit microprocessor uPD780) to control various system I/O devices.

The MD-086FD is equipped with a green monitor display, JIS keys, a ten-key pad, screen control keys, and functions keys.

PG-1500

When the PG-1500 is connected to a supplied board or optional socket board, it can be used as a program writer for typical 256K-bit to 4M-bit PROMs, and 4/8/16-bit single-chip microcomputers.

The PG-1500 has key panel switches and a serial interface, so it can operate as a stand-alone PROM programmer or can be operated through a console connected to the serial interface. When connecting the PG-1500 to the IE-78310A-R, use the RS-232-C interface cable supplied with the PG-1500.

PG-2000

The PG-2000 has 32K bytes of write buffer memory, and can be used as a PROM writer for up to 256K-bit PROMs.

The PG-2000 has key panel switches and a serial interface, so it can operate as a stand-alone PROM programmer or can be operated through a console connected to the serial interface. When connecting the PG-2000 to the IE-78310A-R, use the RS-232-C interface cable supplied with the PG-2000.

4.3 Connecting Peripheral Equipment

The IE-78310A-R is connected to peripheral equipment via the RS-232-C interface.

The IE-78310A-R has two RS-232-C interfaces, one of which is used according to the peripheral equipment connected.

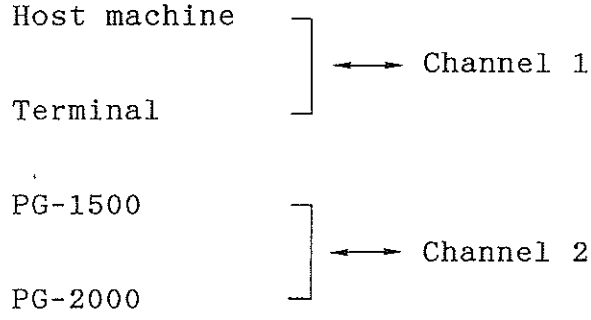


Table 4-1 lists the features of channel 1, and Table 4-2 lists the features of channel 2. (For details, see Chapter 5.)

Table 4-1 Features of Channel 1

Item			Setting
Mode selection		Set by switches	Terminal/modem mode
Baud rate			300, 600, 1200, 2400, 4800, 9600, 19200 (bps)
Handshaking			Hardware (1 character) and software (flow control) handshaking
Character specifications	Character length		8 bits Most significant bit (MSB) is set to 0 if output, and is ignored if input.
	Parity bit		None
	Stop bit length		2 bits

Table 4-2 Features of Channel 2

Item			Setting
Mode selection			Terminal/modem mode, switch-selected
Baud rate		Set by software	300, 600, 1200, 2400, 4800, 9600, 19200 (bps)
Handshaking			Hardware (1 character) or software (flow control) handshaking mode
Character specifications	Character length		7 or 8 bits When 8-bit length is specified, most significant bit (MSB) must be 0 if output and is ignored if input.
	Parity bit		Even parity/odd parity/none
	Stop bit length		1 bit/2 bits

The subsequent sections explain how to connect individual equipment to the IE-78310A-R. In these explanations, the baud rate is assumed to be 9600 bps.

4.3.1 Connecting MD-910TM

When connecting the MD-910TM to the IE-78310A-R, follow the following procedure:

① Turn off power to the IE-78310A-R and MD-910TM.

② Set channel 1 of the IE-78310A-R as shown in Table 4-3 to connect the MD-910TM to this channel.

Table 4-3 IE-78310A-R Channel 1 Setting

Item	Switch No.	Switch setting
Mode selection	MODE	Modem mode
Baud rate	BAUDRATE	Position 5
Frame ground	FG	Set pin 4 to OFF.
RTS select	RTS SELECT	Set pin 1 to ON, and pins 2 and 3 to OFF.

③ Set the MD-910TM as shown in Table 4-4, to connect the MAIN PORT connector of the MD-910TM to the IE-78310A-R.

Table 4-4 MD-910TM Setting

Item		Setting
Bit configu-ration	Data length	8 bits
	Parity	None
	Stop bit length	2 bits
Modem control		Full duplex without modem control
Baud rate		9600 bps
MAIN PORT interface		RS-232-C interface

④ Connect the MD-910TM to the IE-78310A-R.

Connect the MAIN PORT connector of the MD-910TM and channel 1 of the IE-78310A-R with the RS-232-C interface cable supplied with the MD-910TM.

⑤ Turn on the MD-910TM, then turn on the IE-78310A-R.

Settings in the MD-910TM and the IE-78310A-R are explained below in detail.

(1) Setting the MD-910TM

The settings for the MD-910TM are performed in the setup mode in which terminal parameters are entered from the keyboard.

There are four setup modes: SETUP A to SETUP D modes. Some items that must be set are selected from these setup modes and explained below:

(a) Setting bit configuration (data length, parity, stop bit length)

The bit configuration is set in the SETUP B mode.

Table 4-5 Setting of Bit Configuration

<table>
<tr><th>Group name</th><th>Key operation</th><th>Description</th></tr>
<tr><td>P</td><td>Press [SHIFT] and [P] simultaneously.</td><td>Changes data length and parity.
<table>
<tr><th>P=</th><th>Data length</th><th>Parity</th></tr>
<tr><td>7M</td><td>7</td><td>Mark</td></tr>
<tr><td>7S</td><td>7</td><td>Space</td></tr>
<tr><td>7O</td><td>7</td><td>Odd</td></tr>
<tr><td>7E</td><td>7</td><td>Even</td></tr>
<tr><td>7N</td><td>7</td><td>None</td></tr>
<tr><td>8O</td><td>8</td><td>Odd</td></tr>
<tr><td>8E</td><td>8</td><td>Even</td></tr>
<tr><td>8N</td><td>8</td><td>None</td></tr>
</table></td></tr>
<tr><td>STOP BIT</td><td>Position cursor at this item, then press [6] on the keyboard.</td><td>Selects one of the three stop bit lengths, 1, 1.5, or 2.</td></tr>
</table>

For connection to the IE-78310A-R, select 8N and 2.

(b) Setting modem control

The modem control method is set in the SETUP B mode.

Table 4-6 Modem Control Setting

Group name	Key operation	Description
MODEM CONTROL	Press [SHIFT] and [M] simultaneously.	Modem control method FDX A: Full duplex without modem control FDX B: Full duplex with modem control HDX: Half duplex Line is switched by control code.

For connection to the IE-78310A-R, select FDX A.

(c) Selecting the baud rate

The baud rate is selected in the SETUP B mode.

Table 4-7 Baud Rate Setting

Group name	Key operation	Description
T	Press [7] on the keyboard.	Changes the transmission baud rate. One of the following baud rates may be selected: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 9600, or 19200
R	Press [8] on the keyboard.	Changes the transmission baud rate. One of the following baud rates may be selected: 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 9600, or 19200

For connection to the IE-78310A-R, a baud rate of up to 9600 bps must be selected.

(d) MAIN PORT interface

The interface is selected in the SETUP C mode.

Table 4-8 Interface Setting

Group name		Key operation	Description
I	INTERFACE	Position cursor at this item, then press [6] on the keyboard.	Selects interface. . RS-232-C . Current loop . TTL serial

Select RS-232-C.

Figure 4-1 shows the MD-910TM, and Figures 4-2 and 4-3 give examples of SETUP B and SETUP C setting.

Fig. 4-1 MD-910 TM

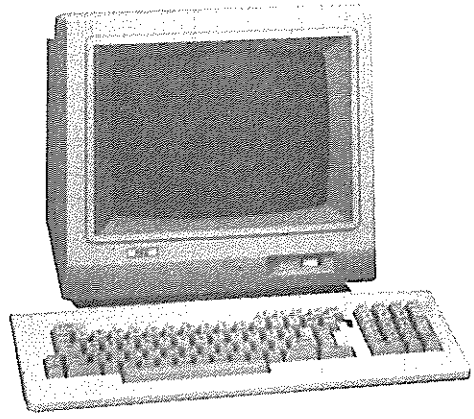


Fig. 4-2 SETUP B

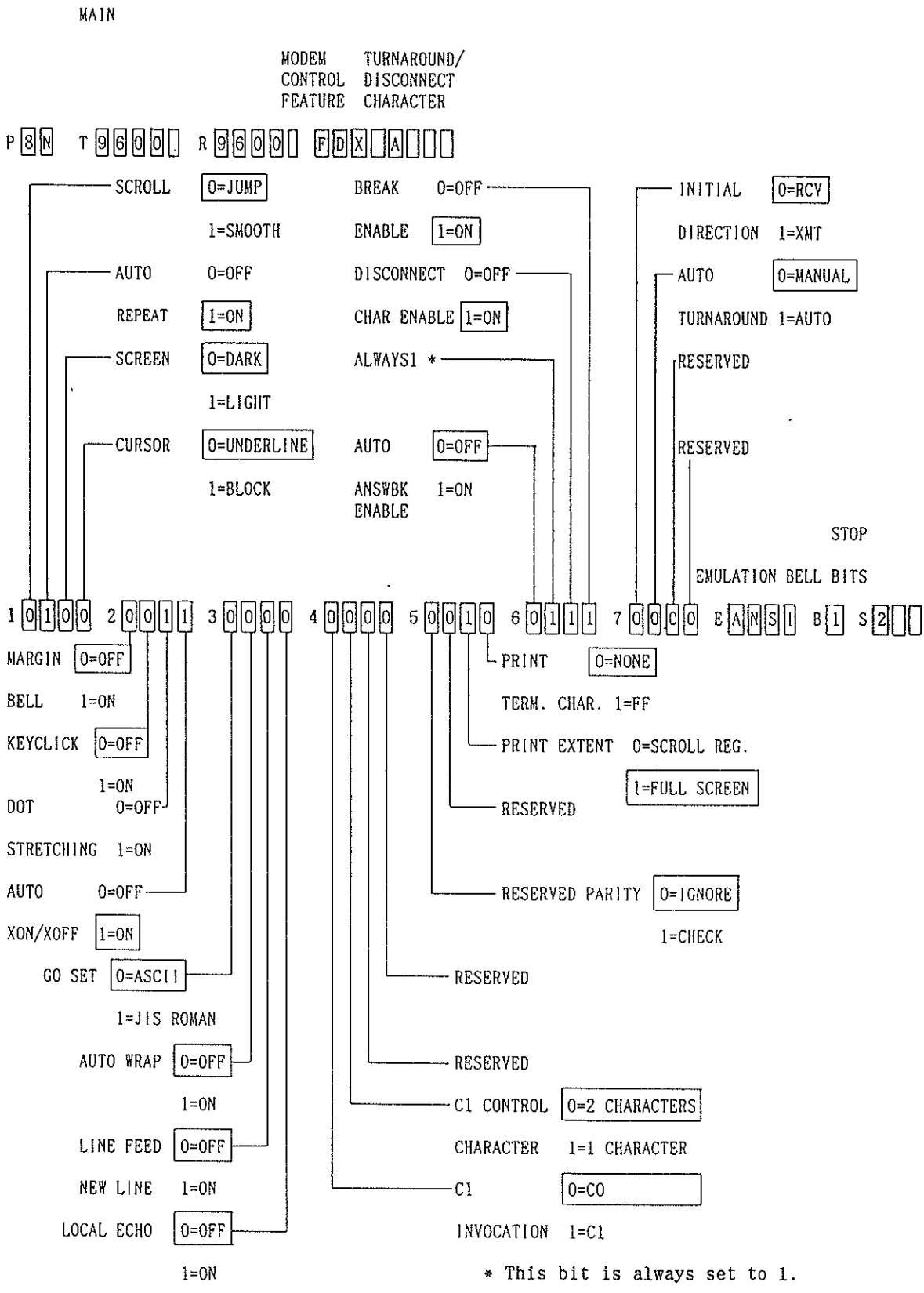
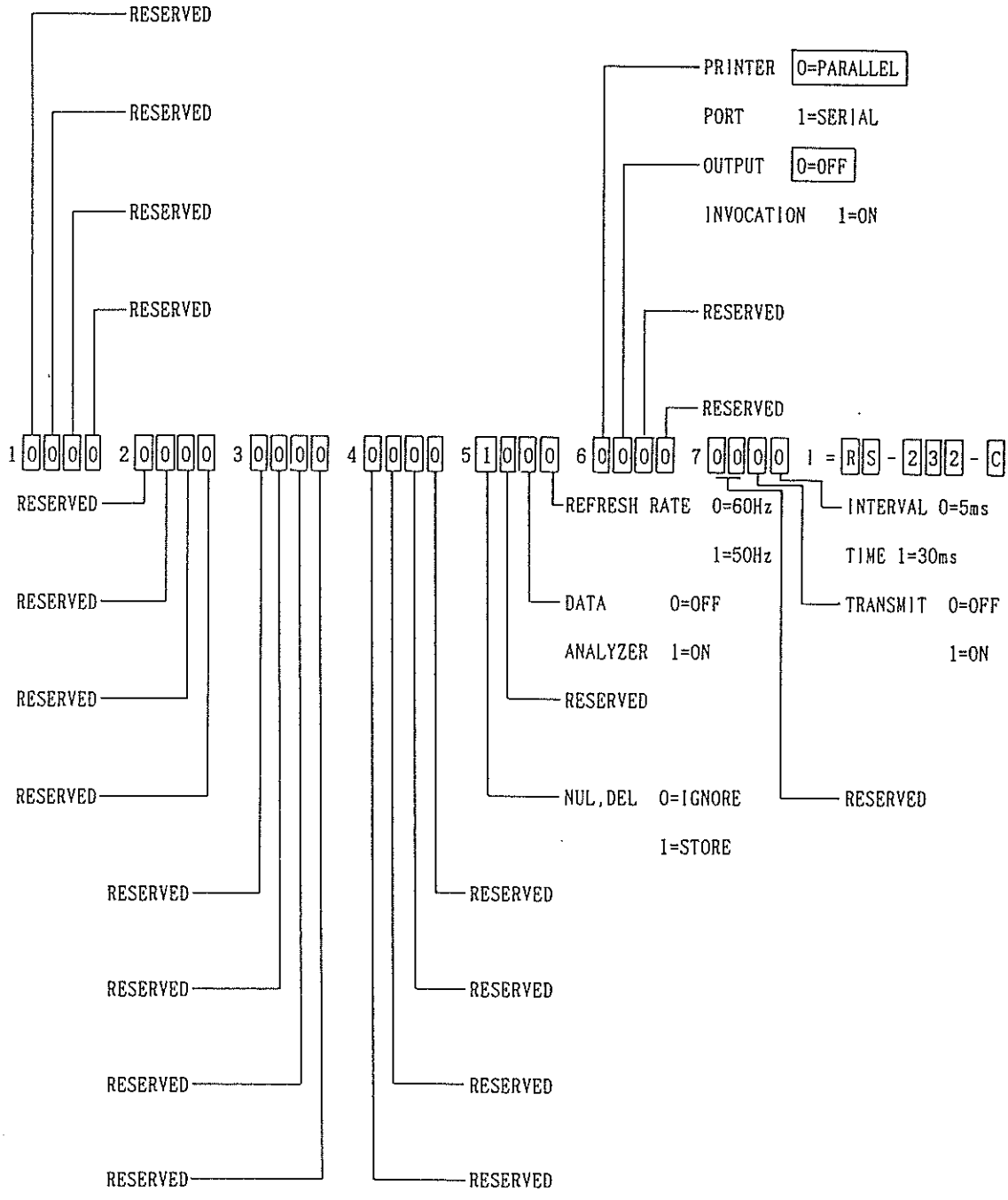


Fig. 4-3 SETUP C



(2) Setting IE-78310A-R

For connection to the MD-910TM, use channel 1 of the IE-78310A-R.

(a) Setting the terminal/modem mode

The terminal/modem mode is switched with the CHANNEL1 MODE slide switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-910TM which operates in the terminal mode, the modem mode must be set for the IE-78310A-R.

(b) Setting the baud rate

The baud rate is set with the micro DIP switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-910TM, the same baud rate must be set for the MD-910TM and the IE-78310A-R.

Table 4-9 shows micro DIP switch settings and the corresponding baud rates.

Table 4-9 Baud Rate Settings

Switch No.	Baud rate (bps)
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	0
8	300
9	600

(c) Setting the frame ground

Set whether the frame ground and signal ground are connected or open.

The frame ground is set with the CHANNEL1 FG DIP switch (pin 4 switch) on the front panel of the unit.

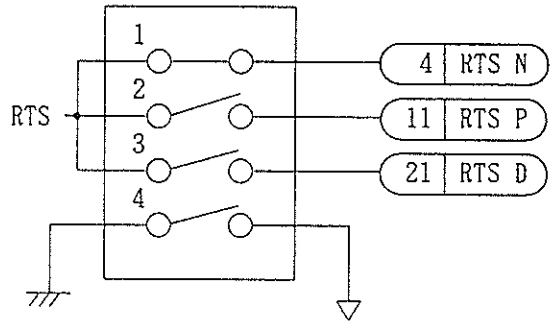
When connecting the IE-78310A-R to the MD-910TM, the switch must be set for the open state.

(d) Setting RTS

One of the pins 4, 11, or 21 of the RS-232-C interface cable is selected so that RTS is to be connected to that pin.

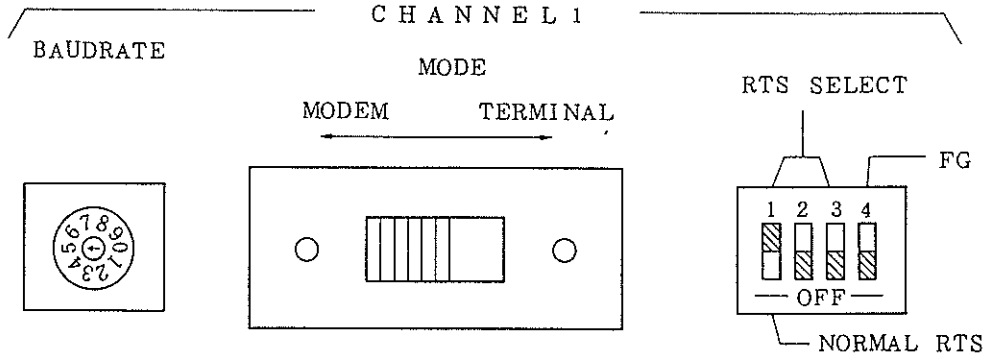
For connection to the MD-910TM, connect RTS to pin 4.

Fig. 4-4 CHANNEL1 DIP Switch Setting



Pin No.	Screen output	Printer output
1	ON	OFF
2	OFF	OFF
3	OFF	ON
4	OFF	OFF

Fig. 4-5 Setting CHANNEL1 on IE-78310A-R Front Panel



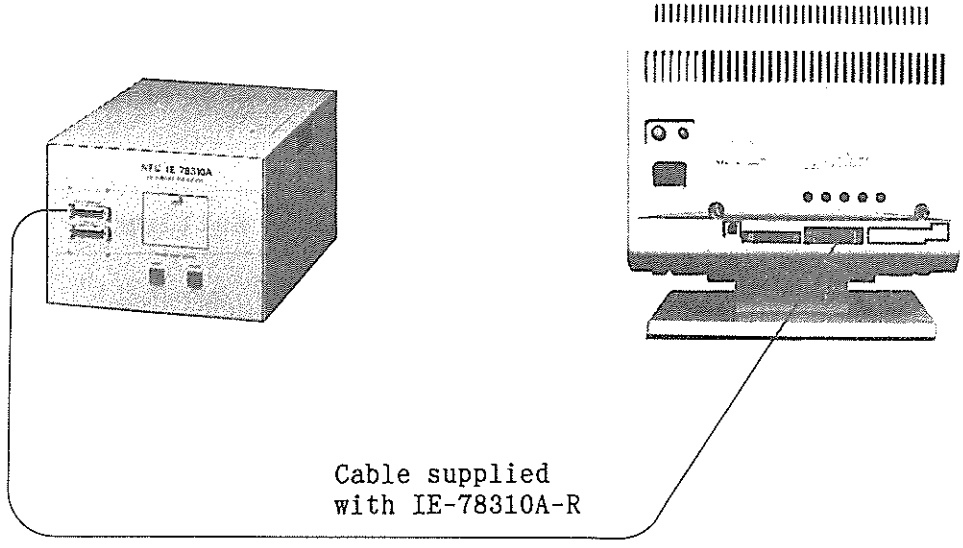
Settings in the IE-78310A-R are then completed.

Next, connection is performed.

Use the RS-232-C interface cable to connect the IE-78310A-R and MD-910TM.

Connect the MAIN PORT connector of the MD-910TM to channel 1 of the IE-78310A-R. Then, turn the power on.

Fig. 4-6 Connecting IE-78310A-R and MD-910TM



The power-on/off sequence is explained below.

(3) Power-on sequence

Either of the MD-910TM or IE-78310A-R may be turned on first.

(4) Power-off sequence

Either of the MD-910TM or IE-78310A-R may be turned off first.

4.3.2 Connecting MD-116FD-20/HD-21

Channel 1 or channel 2 of the MD-116FD-20/HD-21 is connected to channel 1 of the IE-78310A-R.

① Turn off the IE-78310A-R and the MD-116FD-20/HD-21.

② Set channel 1 of the IE-78310A-R as shown in Table 4-10.

Table 4-10 IE-78310A-R Channel 1 Setting

Item	Switch name	Setting
Mode selection	MODE	Terminal mode
Baud rate	BAUDRATE	Position 5
Frame ground	FG	Set pin 4 to OFF.
RTS select	RTS SELECT	Set pin 1 to ON and pins 2 and 3 to OFF.

③ Set channel 1 or 2 of the MD-116FD-20/HD-21 as shown in Table 4-11.

Table 4-11 MD-116FD-20/HD-21 Setting

Item	Channel 1	Channel 2	Switch/jumper setting
RS-232-C/TTL selection	SW1	SW1	OFF RS-232-C
Mode selection	JP3	JP6	Short 1-2, 3-4, 5-6, 7-8, 9-10, and 11-12
Baud rate	Set by the software		
Frame ground	JP1	JP4	Open
RTS select (SC2 board)	SW1	SW1	OFF RxRDY supply

④ Connect the MD-116FD-20/HD-21 to the IE-78310A-R.

Connect channel 1 of the IE-78310A-R to channel 1 or 2 of the MD-116FD-20/HD-21 with the RS-232-C interface cable supplied with the IE-78310A-R.

⑤ Turn on the MD-116FD-20/HD-21, then turn on the IE-78310A-R.

Below is a detailed explanation of how to set the MD-116FD-20/HD-21 and the IE-78310A-R, with the relevant circuit diagram and other illustrations.

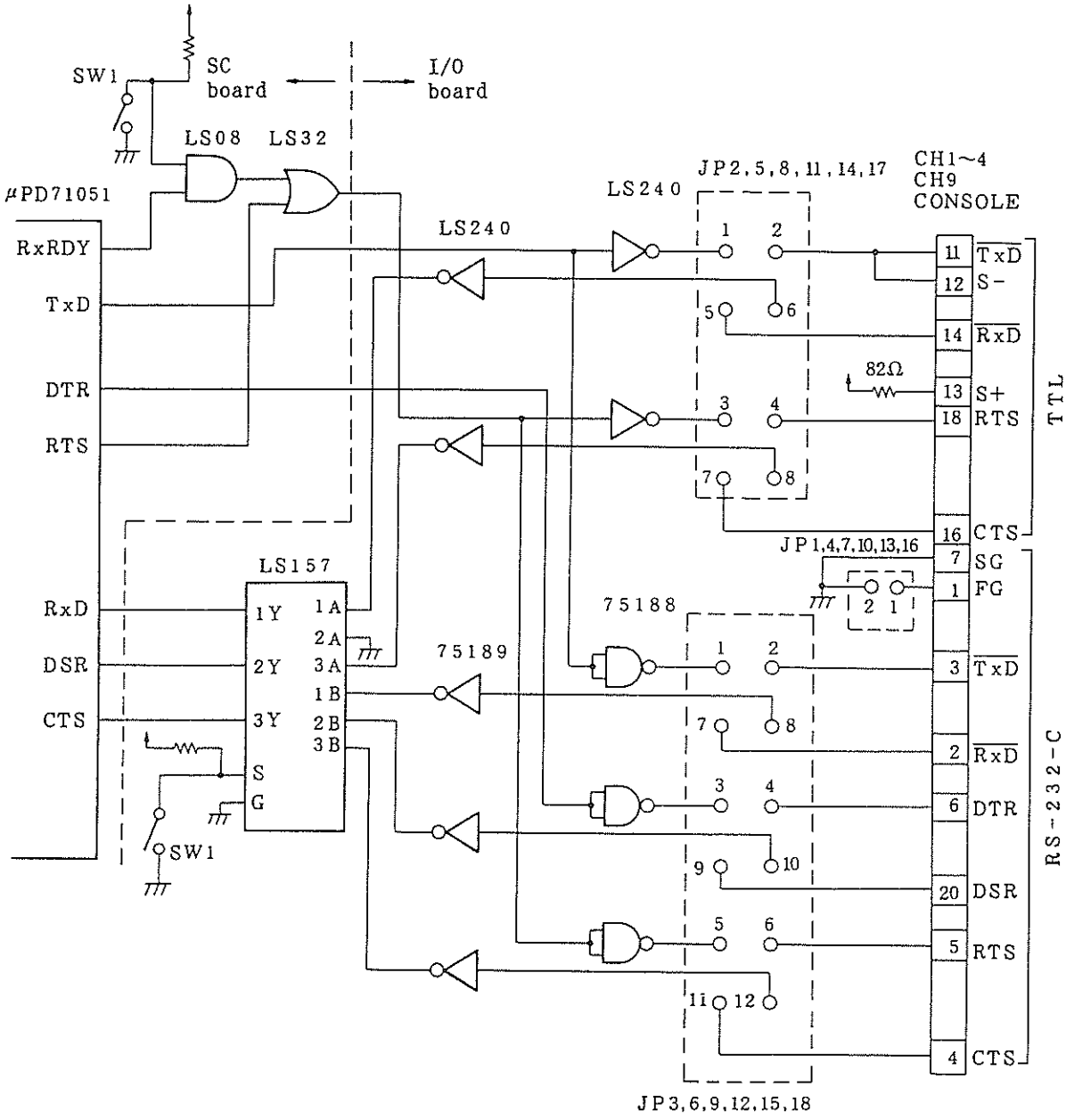
(1) Setting the MD-116FD-20/HD-21

The MD-116FD-20/HD-21 has four serial interfaces, each for a channel (channel 1 to channel 4). Each interface has RS-232-C and TTL-compatible interface circuits.

When IE-78310A-R is connected, channel 1 or 2 of the MD-116FD-20/HD-21 is used.

Figure 4-7 gives a circuit diagram for these channels.

Fig. 4-7 MD-116FD-20/HD-21 Channel 1/2 Circuit Diagram



First, the interface selection switch SW1 is explained.

(a) RS-232-C/TTL-compatible selection switch

Either RS-232-C or TTL-compatible interface can be selected as the standard serial interface.

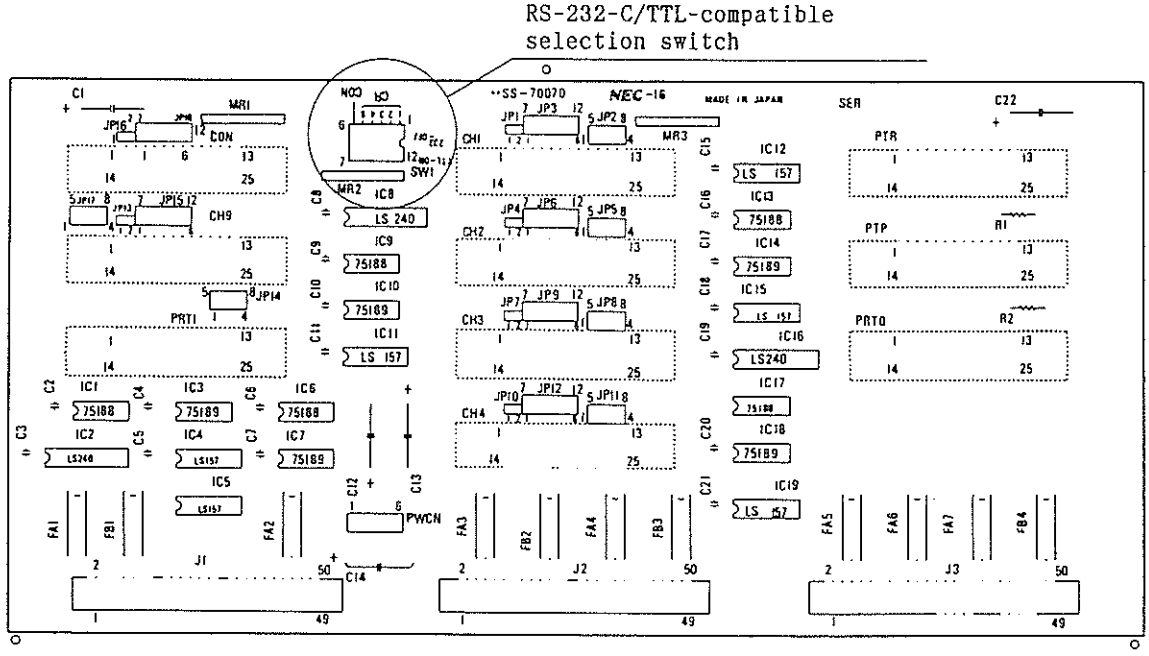
To connect to the IE-78310A-R, select RS-232-C.

The switch on the board must be set to OFF.

Channel No.	Switch	Setting
1, 2	SW1	OFF

Figure 4-8 shows the location of the switch on the I/O interface board.

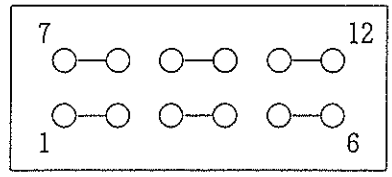
Fig. 4-8 Location of the Switch on I/O Interface Board



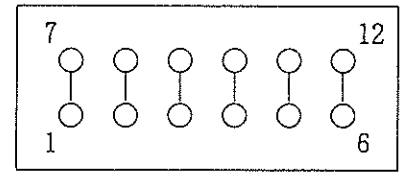
The mode is set according to the jumper connections.

(b) Mode selection jumpers

The mode selection jumpers set the mode of the MD-116FD-20/HD-21, either the terminal or modem mode. To connect the equipment to the IE-78310A-R, select the modem mode.



(Modem mode)



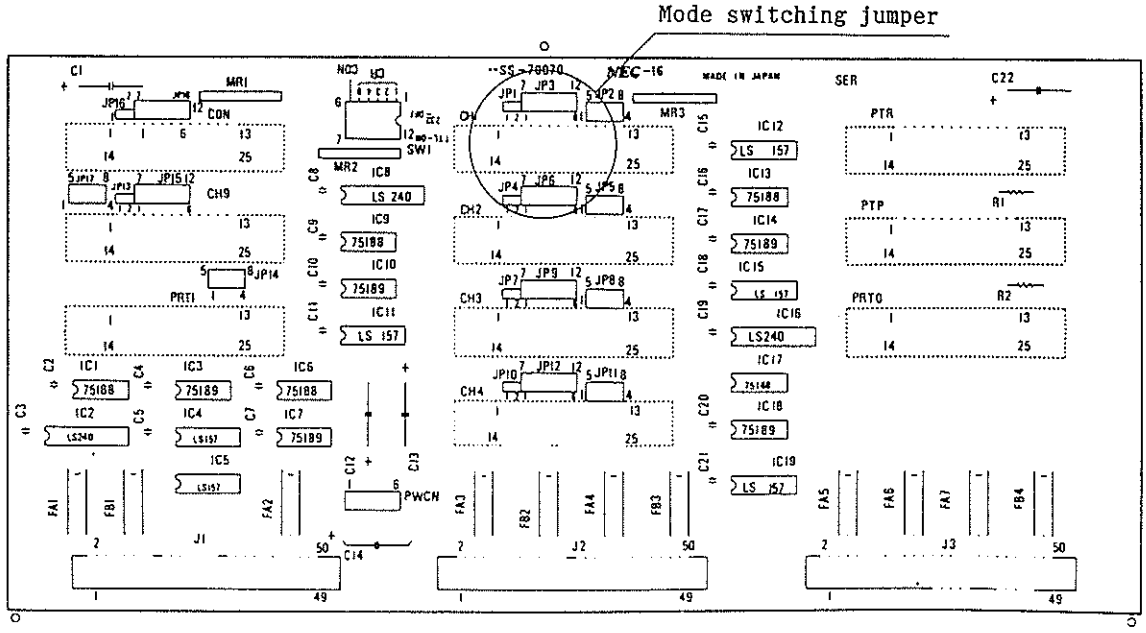
(Terminal mode)

Use an appropriate jumper as follows for the jumper connections:

Channel No.	Mode selection jumper
1	JP3
2	JP6

Figure 4-9 shows the locations of the jumpers on the I/O interface board.

Fig. 4-9 Locations of the Mode Selection Jumpers



The baud rate is switched by the software.

For details, refer to the software manual for the MD-116FD-20/HD-21.

The frame ground jumper is connected as follows:

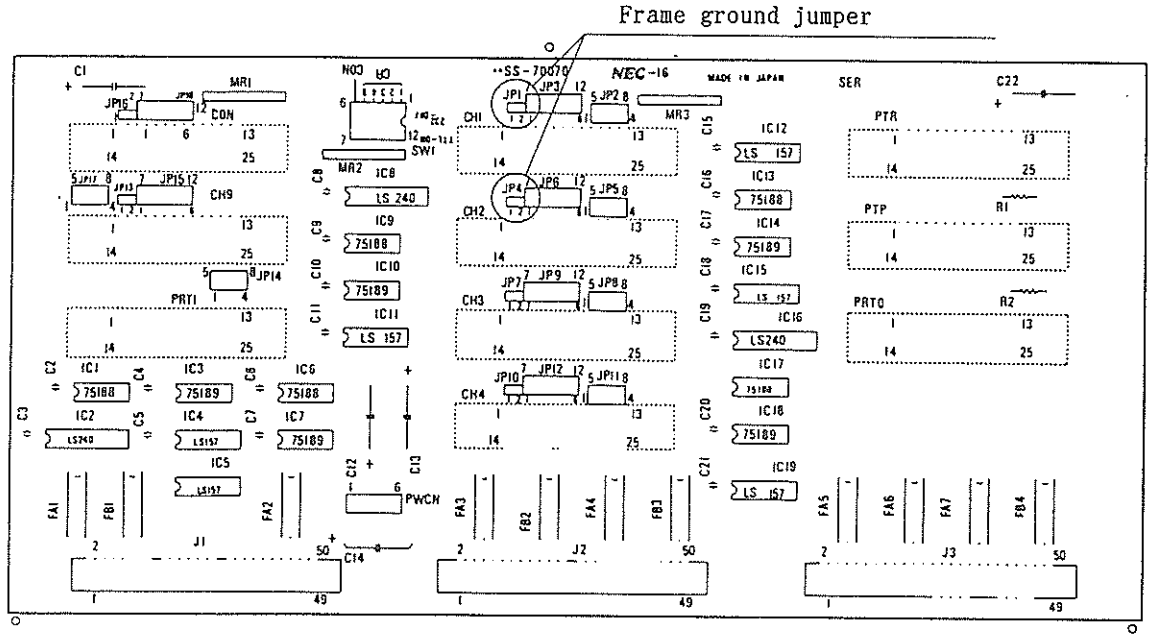
(c) Frame ground jumpers

Whether the frame ground signal and signal ground signal are connected is determined according to the state of the state of the frame ground jumper.

Generally, JP1 or JP4 on the I/O interface board is set to the open state.

Channel No.	Jumper	Connection
1	JP1	Open
2	JP4	Open

Fig. 4-10 Locations of the Frame Ground Jumpers



The RTS select jumper is set as follows:

(d) RTS select jumper

The RTS select jumper is used to determine whether RxRDY is applied to RTS derived from the uPD71051 when RTS is connected to the CTS output in the modem mode or to the RTS output in the terminal mode.

To connect the equipment to the IE-78310A-R, set SW1 on the SC board to OFF to supply RxRDY.

Channel No.	Switch	Setting
1, 2	SW1	OFF

Fig. 4-11 Location of the RTS Select Jumper

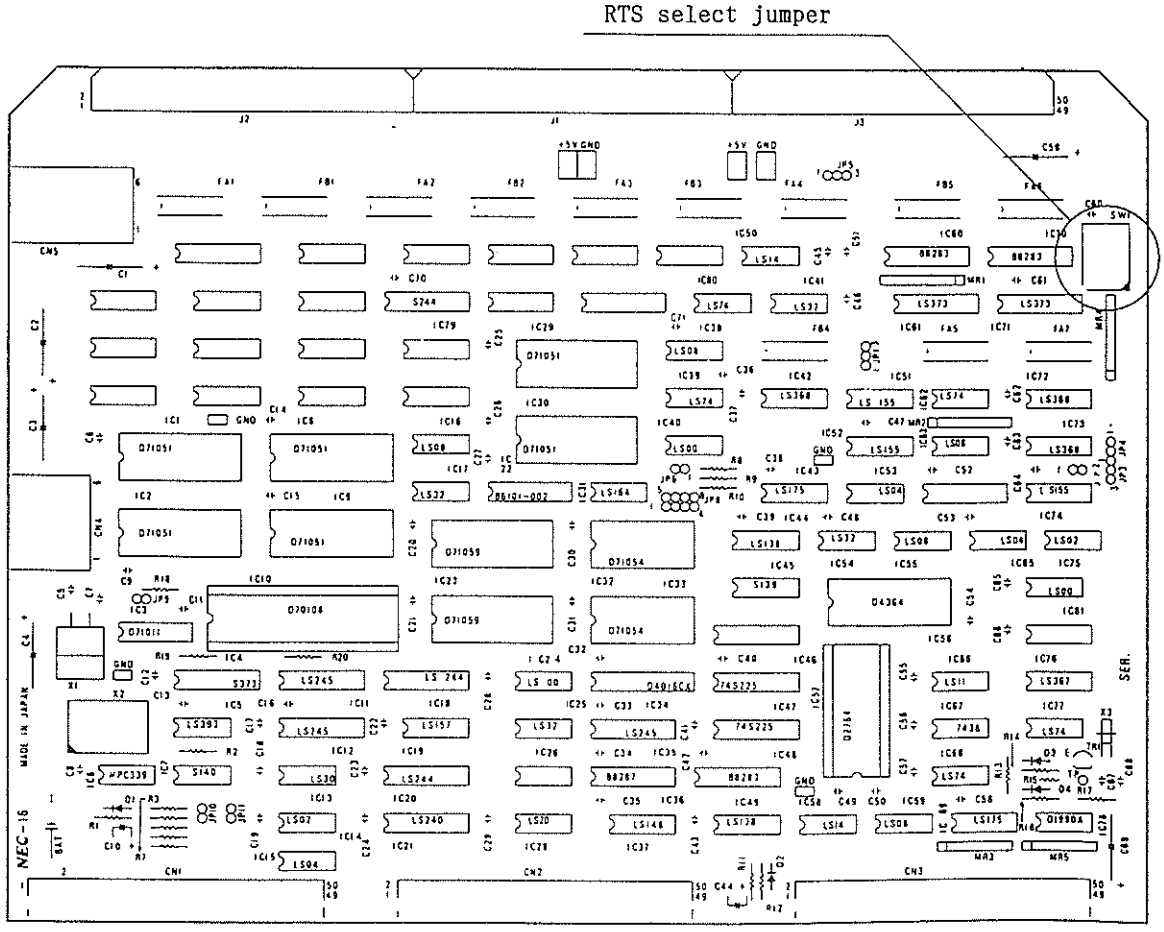
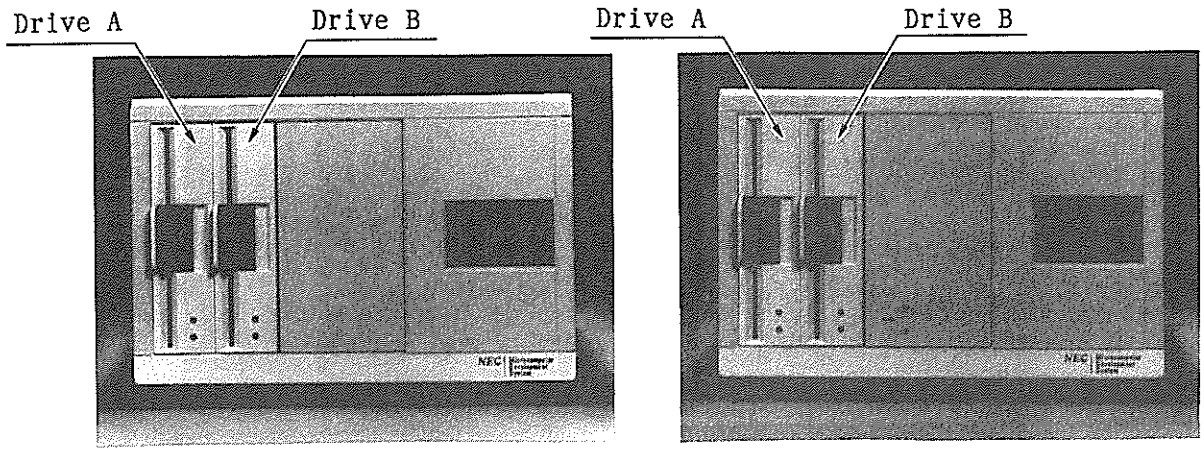


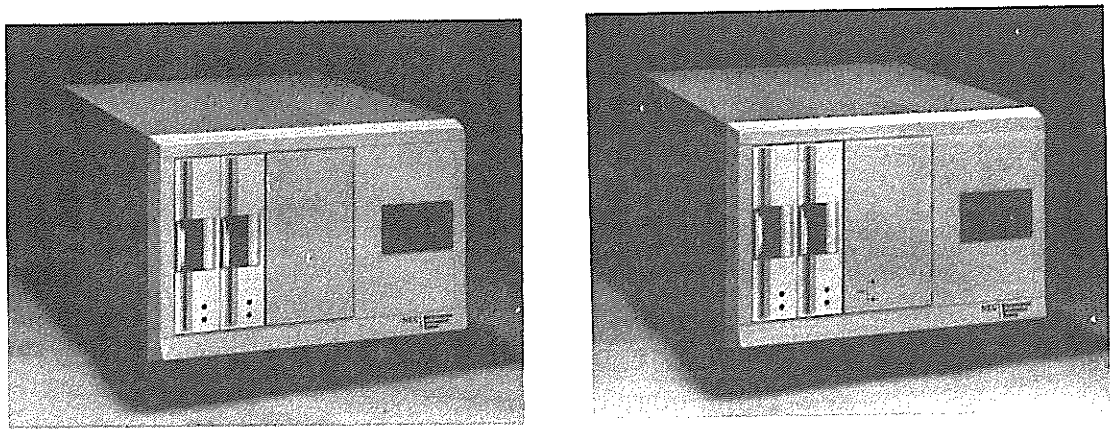
Fig. 4-12 MD-116FD-20/HD-21



MD-116FD-20 MD-116HD-21

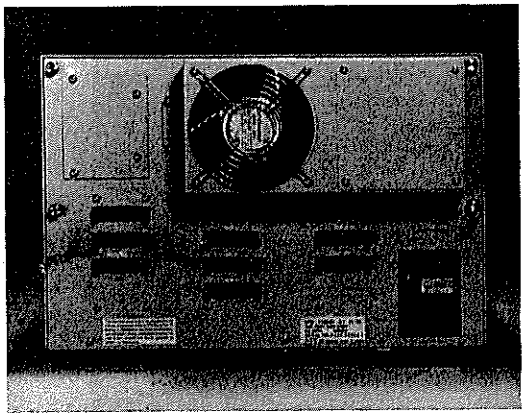
MD-116FD-20/HD-21

External view

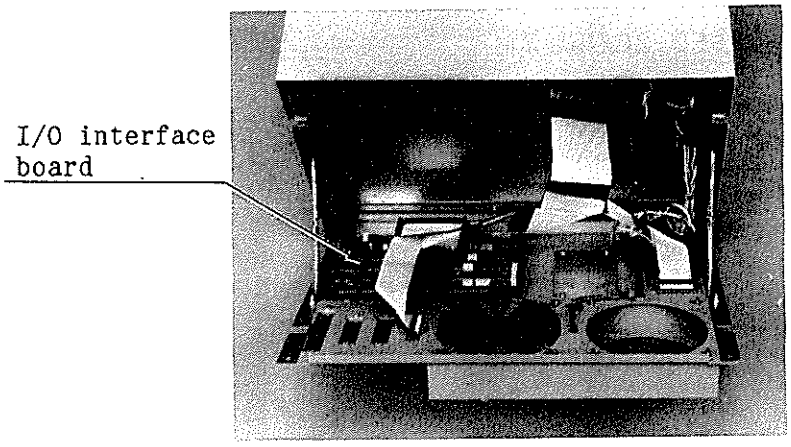


MD-116FD-20 MD-116HD-21

Back



When the back panel is opened



Settings for channel 1 or 2 of the MD-116FD-20/HD-21 are then completed.

After the connection is completed, supply the power.

When turning on the devices connected, be careful of the power-on sequence.

(2) Power-on sequence

① Turn on the power switch of the MD-116FD-20/HD-21.

② Turn on the power switch of the IE-78310A-R.

③ Turn on the power switch of the target system.

(3) Power-off sequence

① To terminate the system, execute the EXT command to exit the system software and return to the OS.

② Turn off the power switch of the target system.

③ Turn off the power switch of the IE-78310A-R.

④ Remove the floppy disk from the MD-116FD-20/HD-21.

⑤ Turn off the power switch of the MD-116FD-20/HD-21.

Caution: To disconnect the target system temporarily, follow the procedure below:

① Execute an RES_H command.

② The following message appears. (Do not enter anything.)

Power on target system (Y/N)

③ Turn off the power switch of the target system, then disconnect the target system.

④ Connect the target system, then turn on the power switch.

⑤ Enter Y <cr>.

4.3.3 Connecting MD-116FD-10 or MD-086FD(HD)-10

This section explains the procedure for connecting channel 1 of the IE-78310A-R to one of the channels 1 to 4 of the MD-116/086FD(HD)-10.

① Turn off the IE-78310A-R and MD-116/086FD(HD)-10.

② Set channel 1 of the IE-78310A-R as shown in Table 4-12.

Table 4-12 IE-78310A-R Channel 1 Setting

Item	Switch name	Setting
Mode selection	MODE	Terminal mode
Baud rate	BAUDRATE	Position 5
Frame ground	FG	Set pin 4 to OFF.
RTS select	RTS SELECT	Set pin 1 to ON and pins 2 and 3 to OFF.

③ Set channel 1 or 2 of the MD-086FD-10 as shown in Table 4-13.

Table 4-13 MD-086FD-10 Setting

Item	Channel 1	Channel 2	Jumper connection
RS-232-C/TTL selection	J10	J15	Open (RS-232-C)
Mode selection	J22	J24	Short 1-2, 3-4, 5-6, 7-8, 9-10, and 11-12
Baud rate	Row 0	Row 1	Short 1-9
Frame ground	J21	J20	Open
RTS select	J4	J3	Short pins 1-2 RxRDY supply

④ Connect the MD-116/086FD(HD)-10 to the IE-78310A-R.

Connect channel 1 of the IE-78310A-R to one of the channels 1 to 4 of the MD-116/086FD(HD)-10.

Use the RS-232-C interface cable supplied with the IE-78310A-R for connection.

⑤ Turn on the IE-78310A-R, then turn on the MD-116/086FD(HD)-10.

The following explains how to set the MD-116/086FD(HD)-10 and the IE-78310A-R in detail, giving the relevant circuit diagram and other illustrations.

(1) Setting the MD-116/086FD(HD)-10

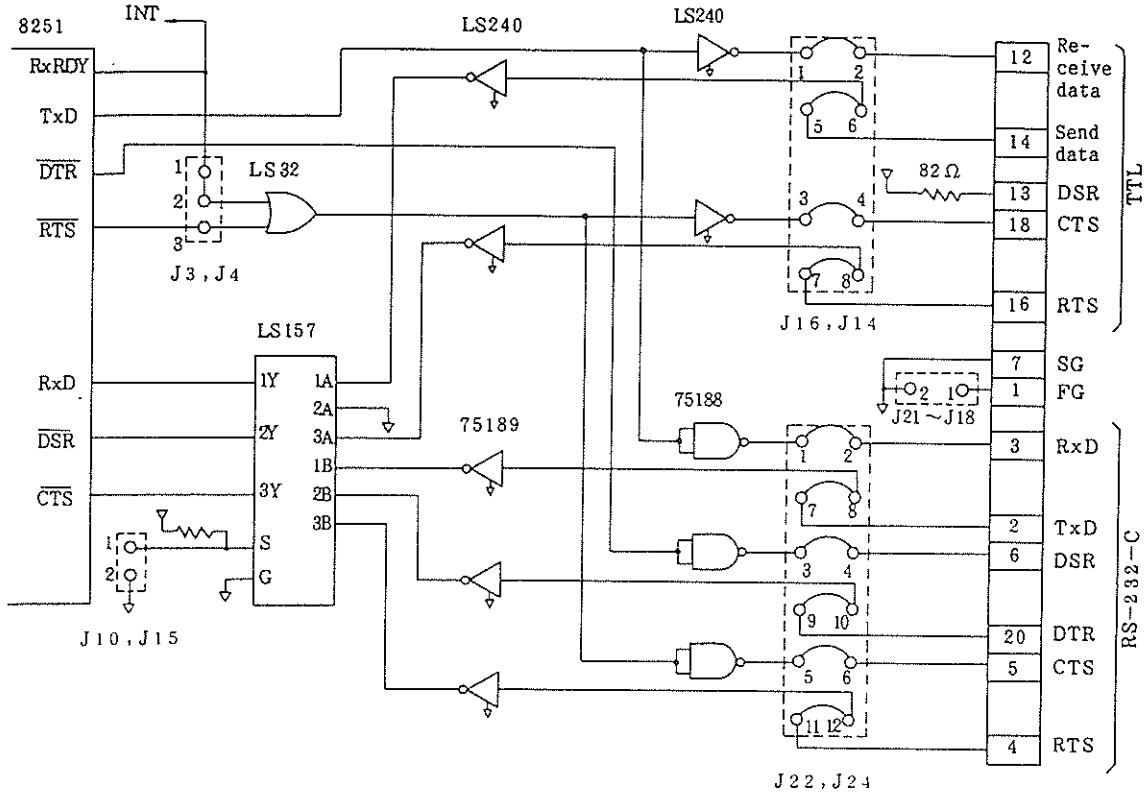
The MD-116/086FD(HD)-10 has four serial interfaces, each for one channel (channel 1 to channel 4). Each interface has RS-232-C and TTL-compatible interface circuits. When an optional expansion board is installed, four additional RS-232-C interfaces (for channel 5 to channel 8) are available.

In addition, another RS-232-C interface is provided for channel 9.

Channel 1 to channel 4 of the MD-116/086FD(HD)-10 may be used for connecting the equipment to the IE-78310A-R. Note that a channel other than these channels cannot be used for connection to the IE-78310A-R.

For these channels, interface selection, baud rate change, and mode selection are set by jumper connections. Figure 4-7 shows a circuit diagram of channels 1 to channel 4 of the MD-116/086FD(HD)-10.

Fig. 4-13 Circuit Diagram of Channel 1 to Channel 4 of MD-116/086FD(HD)-10



First, the interface selection jumpers (J10 and J15) are explained.

(a) RS-232-C/TTL-compatible selection jumper

Either RS-232-C or TTL-compatible interface can be selected as the standard serial interface.

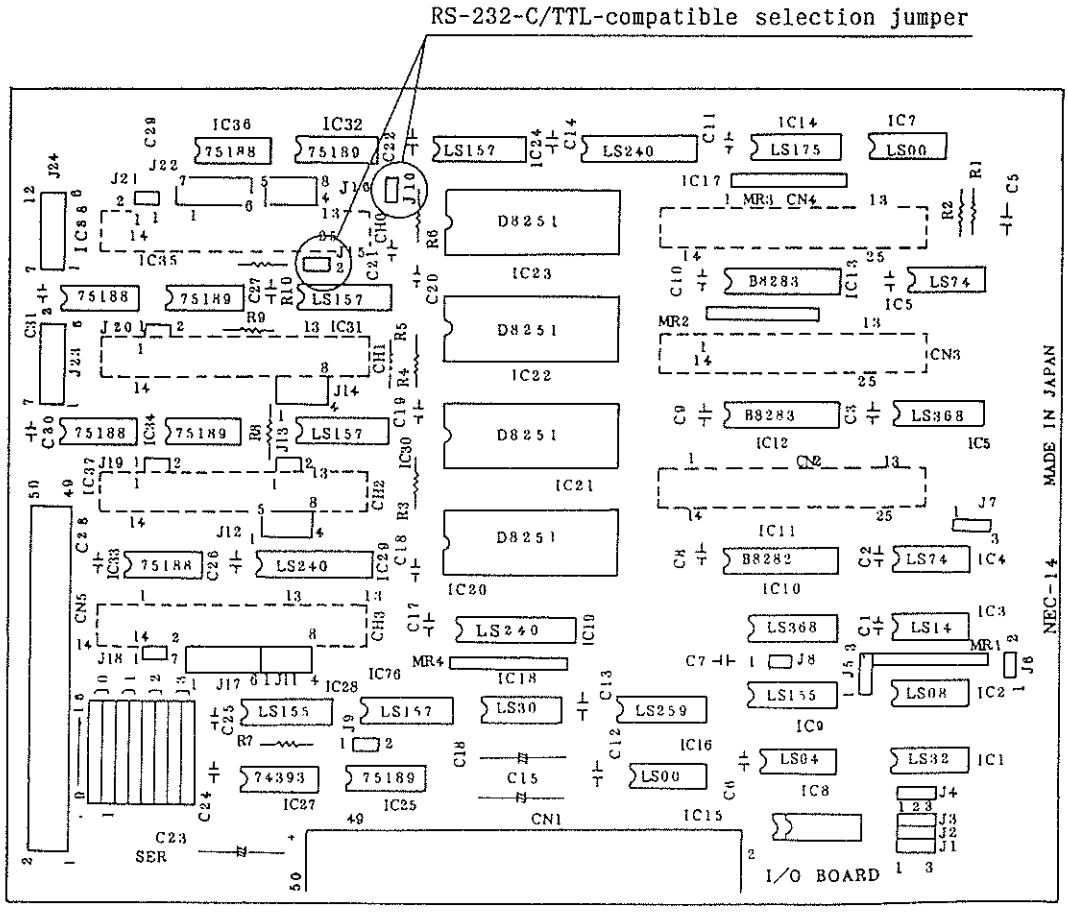
To connect the equipment to the IE-78310A-R, select RS-232-C.

Set the relevant jumper to the open state.

Channel No.	Jumper	Connection
1	J10	Open
2	J15	Open

Figure 4-14 shows the locations of the jumpers on the I/O interface board.

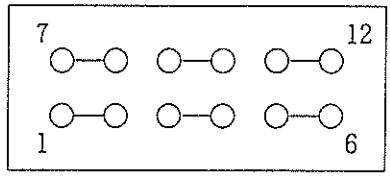
Fig. 4-14 Locations of the Jumpers on the I/O Interface Board



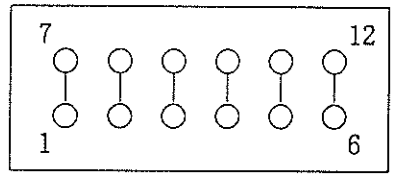
The mode is set according to the jumper connections.

(b) Mode selection jumpers

The mode selection jumpers are used to set the MD-116/086FD(HD)-10 to either the terminal or modem mode. To connect the equipment to the IE-78310A-R, select the modem mode.



(Modem mode)



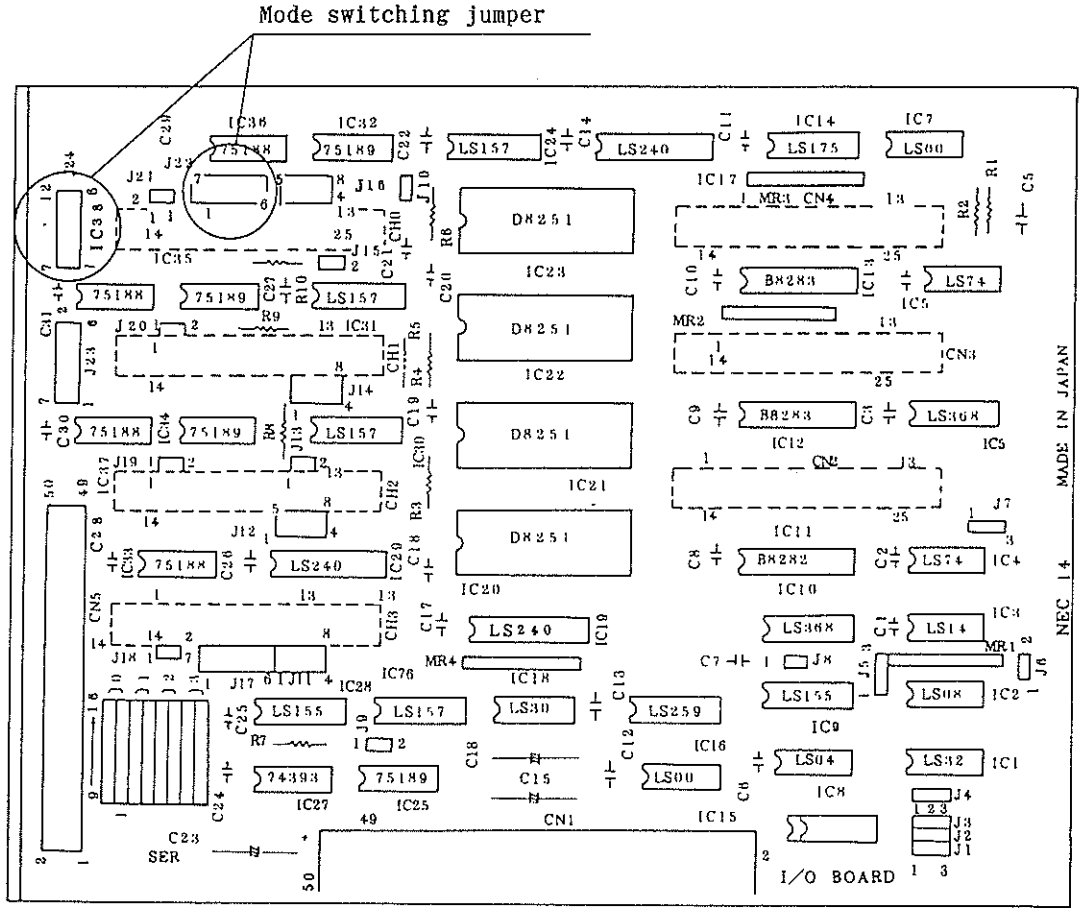
(Terminal mode)

Use the appropriate jumper for jumper connections:

Channel No.	Mode selection jumper
1	J22
2	J24

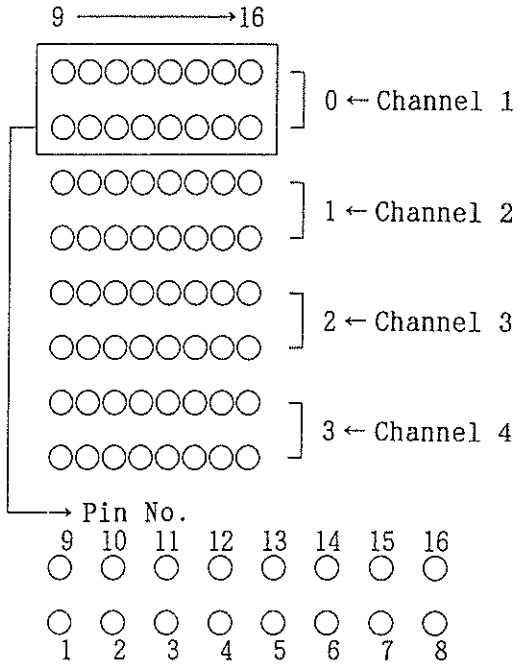
Figure 4-15 shows the locations of the jumpers on the I/O interface board.

Fig. 4-15 Location of the Mode Selection Jumpers on the I/O Interface Board



The baud rate is set by jumper connections.

(c) Baud rate select jumper



Jumper pins are arranged as shown in the figure on the left. Pins 9 to 16 are used for reception, and pins 1 to 8 are for clock input.

Connect only one pair of jumper pins according to the desired baud rate. If there are more than one pair of pins connected, a malfunction may result. Before connecting the jumpers, be sure to disconnect the current connection. The same baud rate as for the IE-78310A-R must be selected.

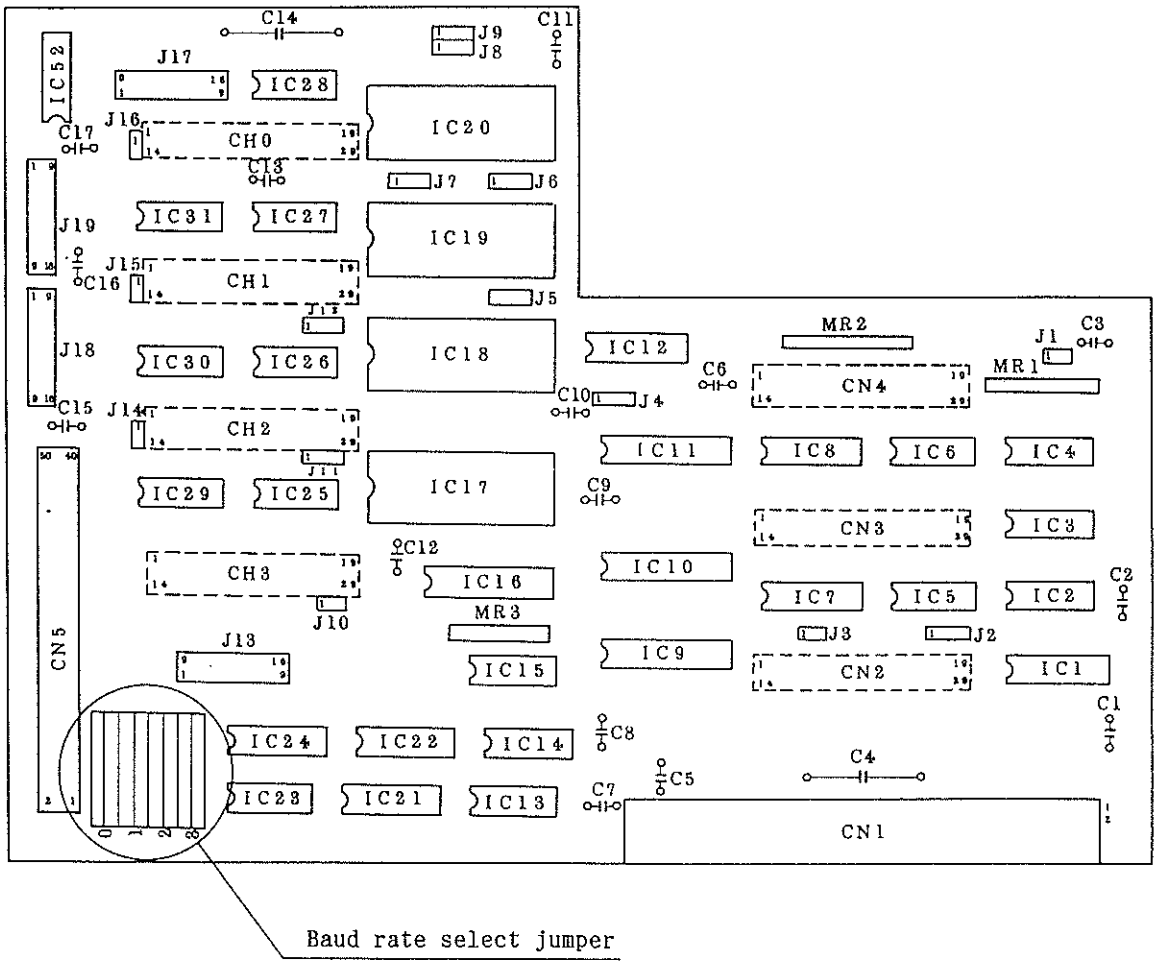
The baud rate is determined according to the jumper connection as follows:

Jumper	1-9	2-10	3-11	4-12	5-13	6-14	7-15	8-16
Baud rate (bps)	9600	4800	2400	1200	600	300	150	75

Channel No.	Row
1	0
2	1

Figure 4-16 shows the jumper locations on the I/O interface board.

Fig. 4-16 Location of the Baud Rate Select Jumpers on the I/O Interface Board



The frame ground jumper connections are explained below.

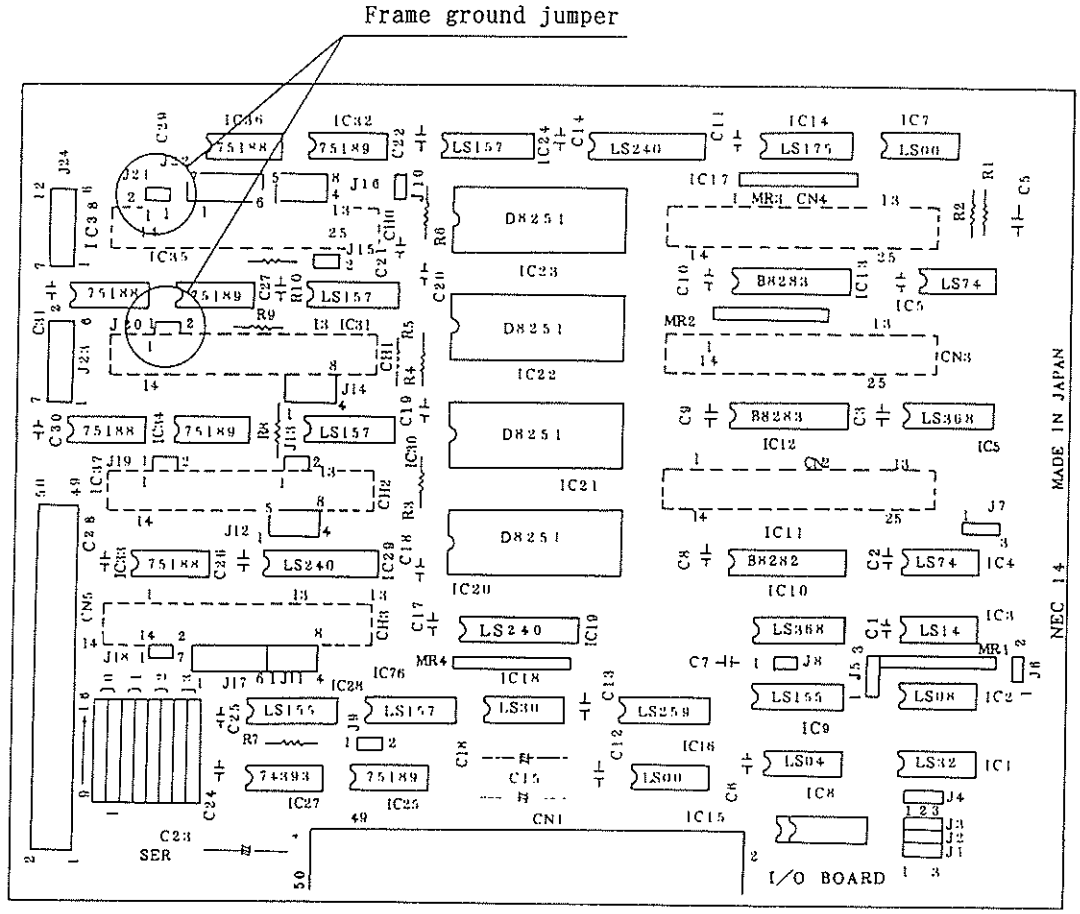
(d) Frame ground jumper

Whether the frame ground signal and signal ground signal are connected is set with a frame ground jumper.

Generally, the jumper is set in the open state.

Channel No.	Jumper	Connection
1	J21	Open
2	J20	Open

Fig. 4-17 Location of the Frame Ground Jumpers on the I/O Interface Board



RTS select jumper connections are explained below.

(e) RTS select jumpers

The RTS select jumper is used to determine whether RxRDY is applied to RTS derived from the uPD8251AFC when RTS is connected to the CTS output in the modem mode or to the RTS output in the terminal mode.

To connect the equipment to the IE-78310A-R, connect pins 1 and 2 in J3 or J4 to supply RxRDY.

Channel No.	Jumper	Connection
1	J4	Short 1-2
2	J3	Short 1-2

Fig. 4-18 Location of RTS Select Jumper on the I/O Interface Board

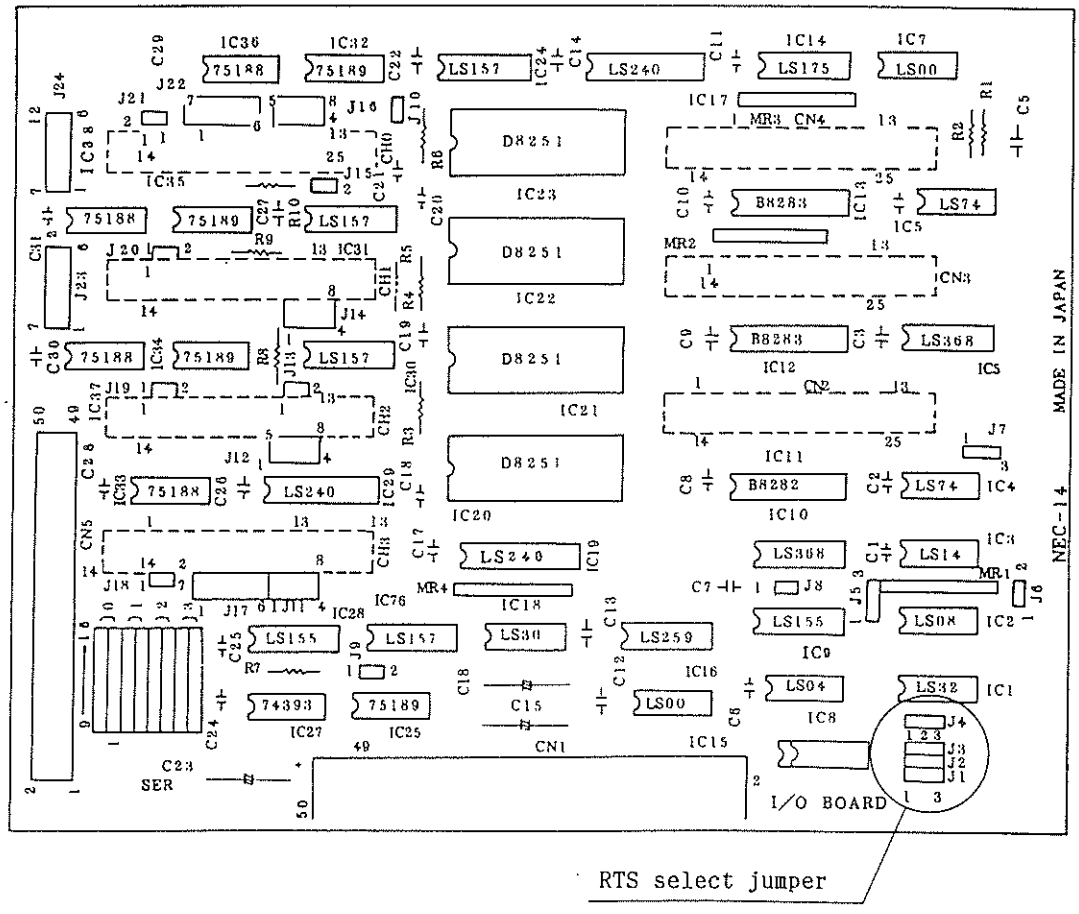
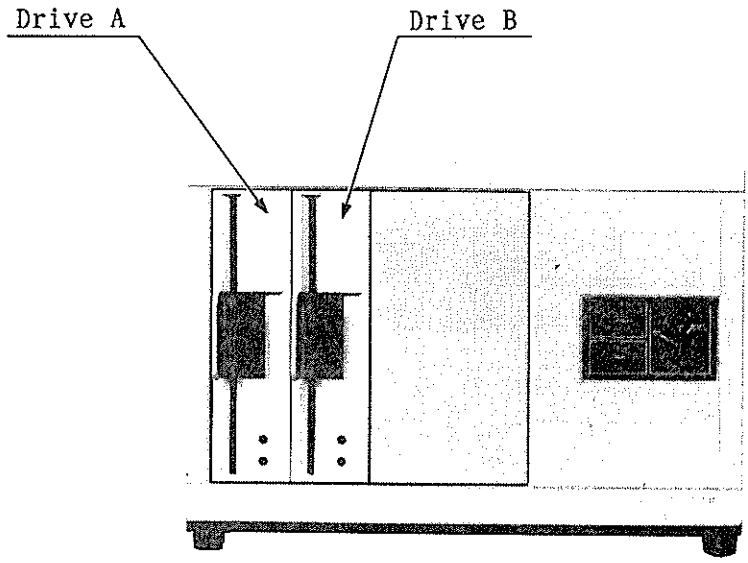
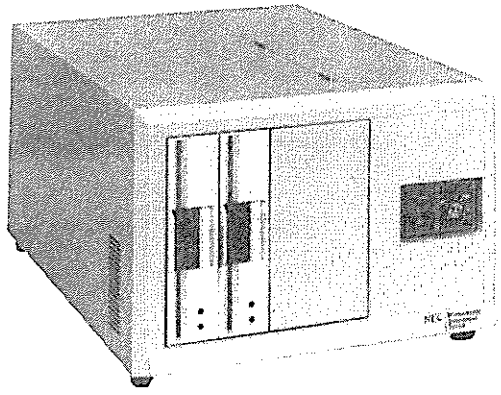


Fig. 4-19 MD-116/086FD(HD)-10

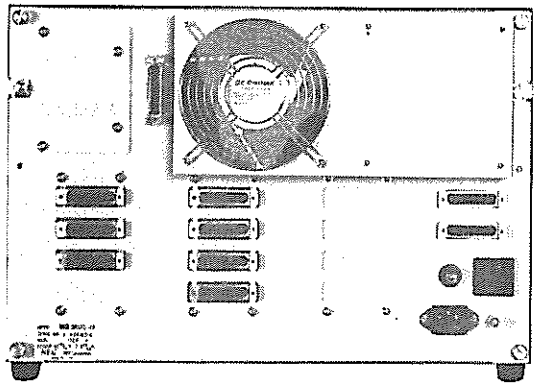


MD-116/086FD(HD)-10

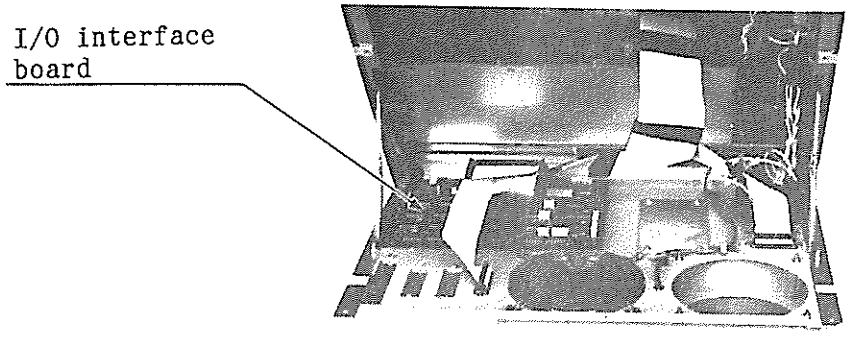
External view



Back



When the back panel is opened



Settings for channel 1 to 4 of the MD-116/086FD(HD)-10 are then completed.

(2) Setting IE-78310A-R

Use channel 1 of the IE-78310A-R to connect it to the MD-116/086FD(HD)-10.

(a) Setting the terminal/modem mode

The terminal/modem mode is switched with the CHANNEL1 MODE slide switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-116/086FD(HD)-10 which operates in the modem mode, the terminal mode must be set for the IE-78310A-R.

(b) Setting the baud rate

The baud rate is set with the micro DIP switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-116/086FD(HD)-10, the same baud rate must be set for the MD-116/086FD(HD)-10 and the IE-78310A-R.

Table 4-14 shows micro DIP switch settings and selected baud rates.

Table 4-14 Baud Rate Setting

Switch No.	Baud rate (bps)
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	0
8	300
9	600

(c) Setting the frame ground

Set whether the frame ground and signal ground are connected or open.

The frame ground is set with the DIP switch (pin 4 switch) on the front panel of the unit.

When connecting the IE-78310A-R to the MD-116/086FD(HD)-10, the switch must be set for the open state.

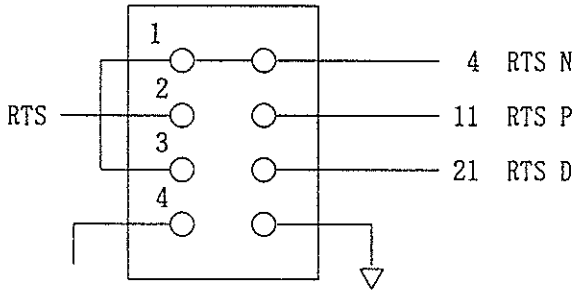
(d) Setting RTS

One of the pins 4, 11, or 21 of the RS-232-C interface cable is selected so that RTS is connected to that pin.

For connection to the MD-116/086FD(HD)-10, set the pins 1 to 3 of the DIP switch on the front panel of the unit so that RTS is connected to pin 4.

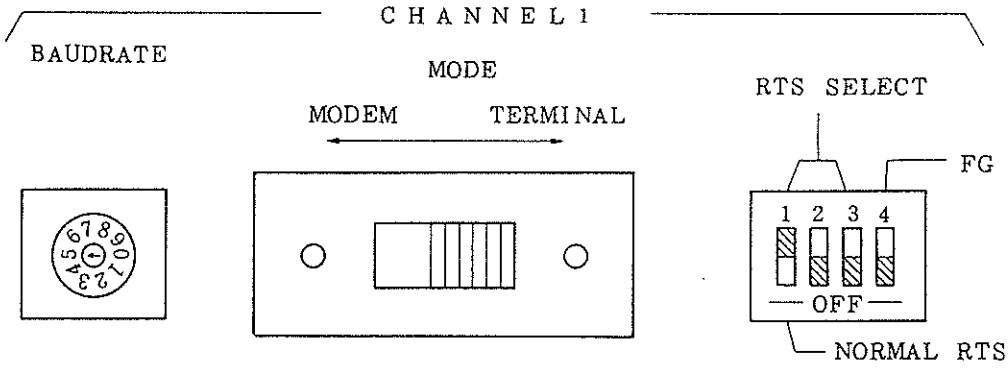
Figure 4-20 shows how to set the DIP switch.

Fig. 4-20 CHANNEL1 DIP Switch Setting



Pin No.	Setting
1	ON
2	OFF
3	OFF
4	OFF

Fig. 4-21 Setting CHANNEL1 on the IE-78310A-R Front Panel

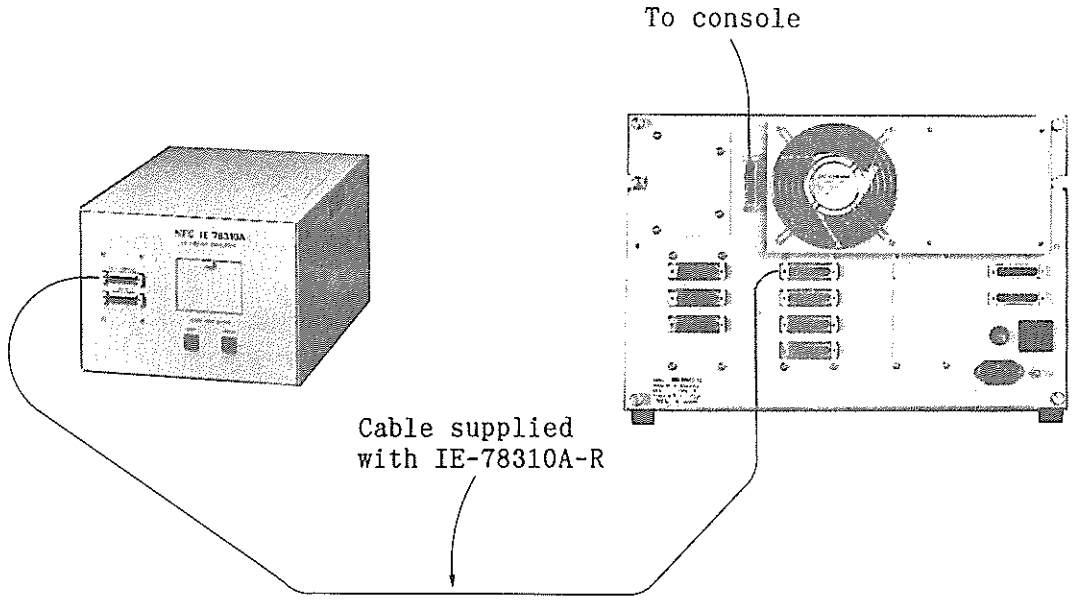


Settings in the IE-78310A-R are then completed.

Next, connection is performed.

Connect channel 1 of the IE-78310A-R to one of the channels, channel 1 to channel 4, of the MD-116/086FD(HD)-10 with the RS-232-C interface cable supplied with the IE-78310A-R.

Fig. 4-22 Connecting IE-78310A-R and MD-116/086FD(HD)-10



When the units are connected, turn on the power.

When supplying power, be careful of the power sequence as follows:

(3) Power-on sequence

① Turn on the power switch of the IE-78310A-R.

② Turn on the power switch of the MD-116/086FD(HD)-10.

(4) Power-off sequence

① Remove the floppy disk from the MD-116/086FD(HD)-10.

② Turn off the power switch of the MD-116/086FD(HD)-10.

③ Turn off the power switch of the IE-78310A-R.

4.3.4 Connecting MD-086FD

Channel 1 of the IE-78310A-R is connected to channel 1 or 2 of the MD-086FD.

Connect them in the following sequence:

① Turn off power to the IE-78310A-R and the MD-086FD.

② Set channel 1 of the IE-78310A-R as shown in Table 4-15 to connect the MD-086FD to this channel.

Table 4-15 IE-78310A-R Channel 1 Setting

Item	Switch	Setting
Mode selection	MODE	Terminal board
Baud rate	BAUDRATE	Position 5
Frame ground	FG	Set pin 4 to OFF.
RTS select	RTS SELECT	Set pin 1 to ON, and pins 2 and 3 to OFF.

③ Connect the IE-78310A-R to MD-086FD channel 1 or 2 which has a serial interface. Set channel 1 or 2 of the MD-086FD as shown in Table 4-16.

Table 4-16 MD-086FD Setting

Item	Channel 1	Channel 2	Jumper connection
Mode selection	J17	J19	Short 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14 and 15-16
Baud rate	Row 0	Row 1	Short 1-9
Frame ground	J16	J15	Open
RTS select	J9	J7	Short 1-2 to supply RxRDY
External clock	J8	J6	Short 2-3

④ Connect the MD-086FD to the IE-78310A-R.

Connect channel 1 of the IE-78310A-R to one of the channels 1 and 2 of the MD-086FD. Use the RS-232-C interface cable supplied with the IE-78310A-R.

⑤ Turn on the IE-78310A-R, then turn on the MD-086FD.

The following explains how to set the MD-086FD and the IE-78310A-R in detail, giving the relevant circuit diagram and other illustrations.

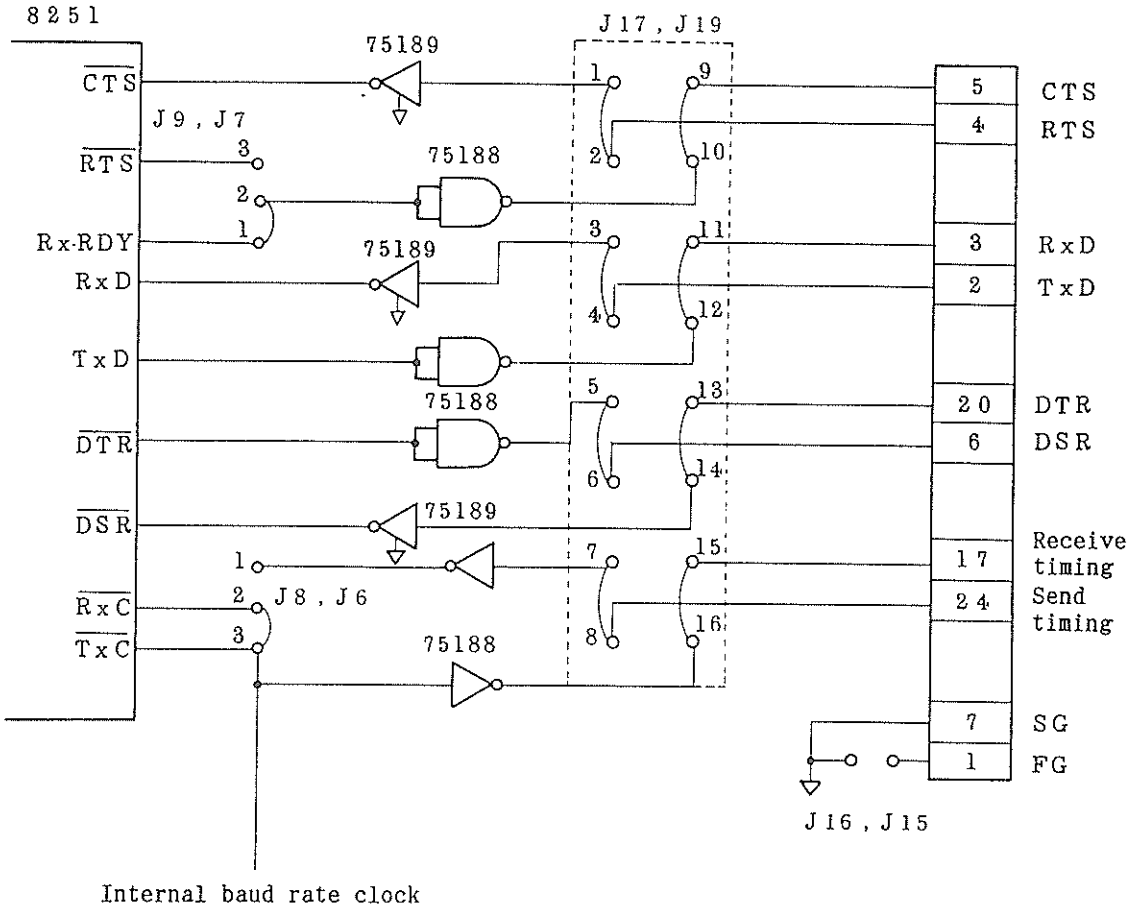
(1) Setting the MD-086FD

The MD-086FD has five serial interfaces, each for one channel (channel 1 to channel 4, and channel 9). In addition, there are four optional channels.

Channel 1 or channel 2 of the MD-086FD may be used for connecting the equipment to the IE-78310A-R. Note that a channel other than these channels cannot be used for connection to the IE-78310A-R.

For these channels, mode selection, baud rate change, and other settings are made by jumper connections. Figure 4-23 shows a circuit diagram of channels 1 and 2 of the MD-086FD.

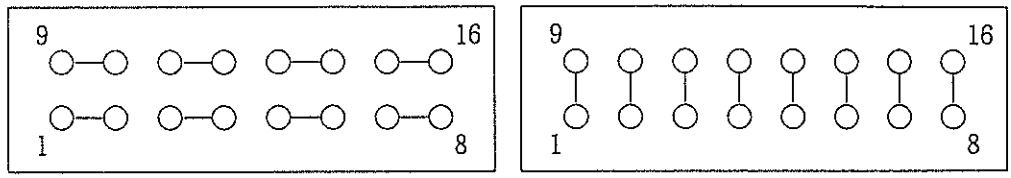
Fig. 4-23 Circuit Diagram of Channels 1 and 2 of MD-086FD



The mode is set according to the jumper connections.

(a) Mode selection jumpers

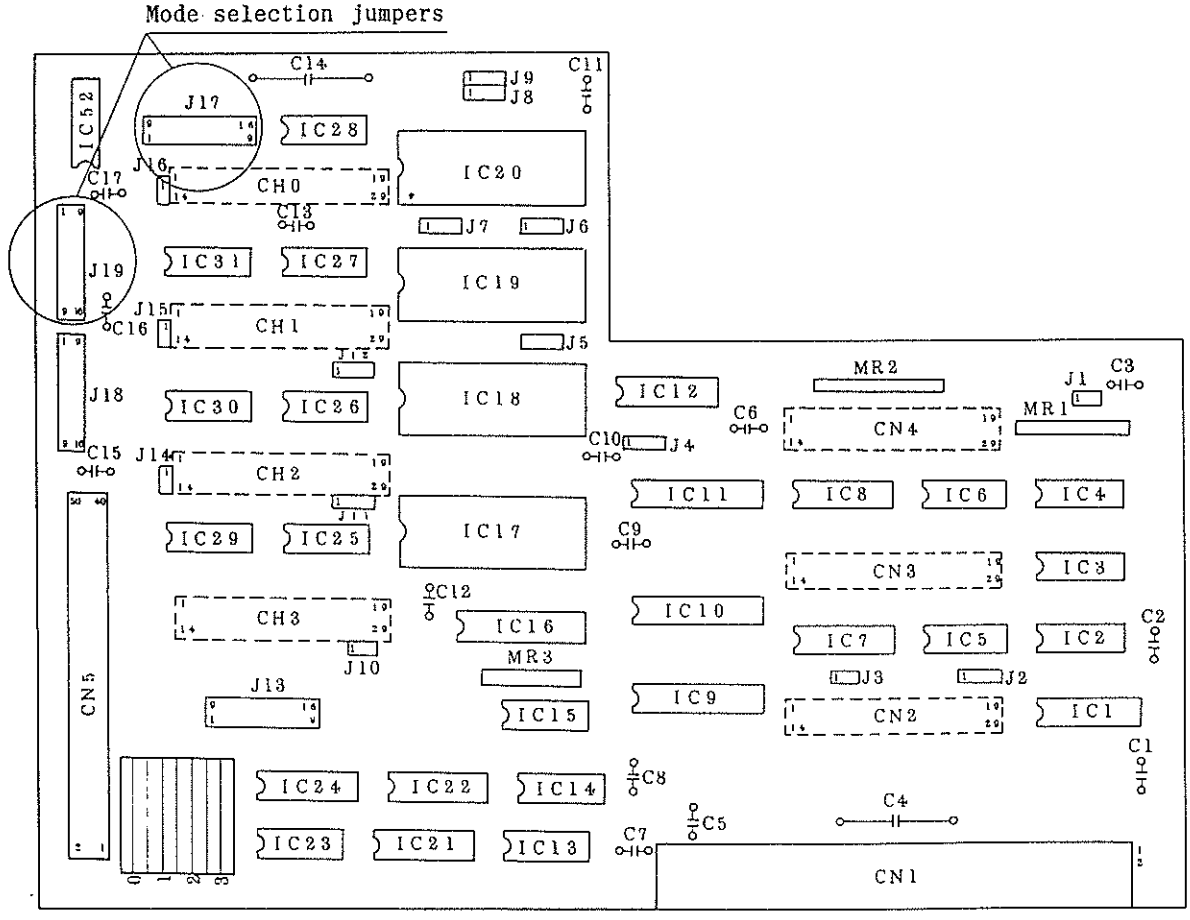
The mode selection jumpers are used to set the MD-086FD to either the terminal or modem mode. To connect the equipment to the IE-78310A-R, select the modem mode.



(Modem mode) (Terminal mode)

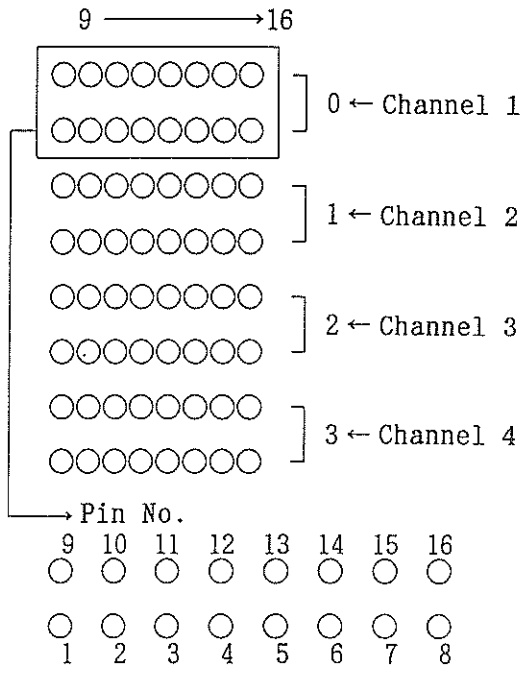
Channel No.	Mode selection jumper
1	J17
2	J19

Fig. 4-24 Locations of the Mode Selection Jumpers on the I/O Interface Board



The baud rate is set by jumper connections.

(b) Baud rate select jumper



Jumper pins are arranged as shown in the figure on the left. Pins 9 to 16 are used for reception, and pins 1 to 8 are for clock input.

Connect only one pair of jumper pins according to the desired baud rate. If there are more than one pair of pins connected, a malfunction may result. Before connecting the jumpers, be sure to disconnect the current connection. The same baud rate as for the IE-78310A-R must be selected.

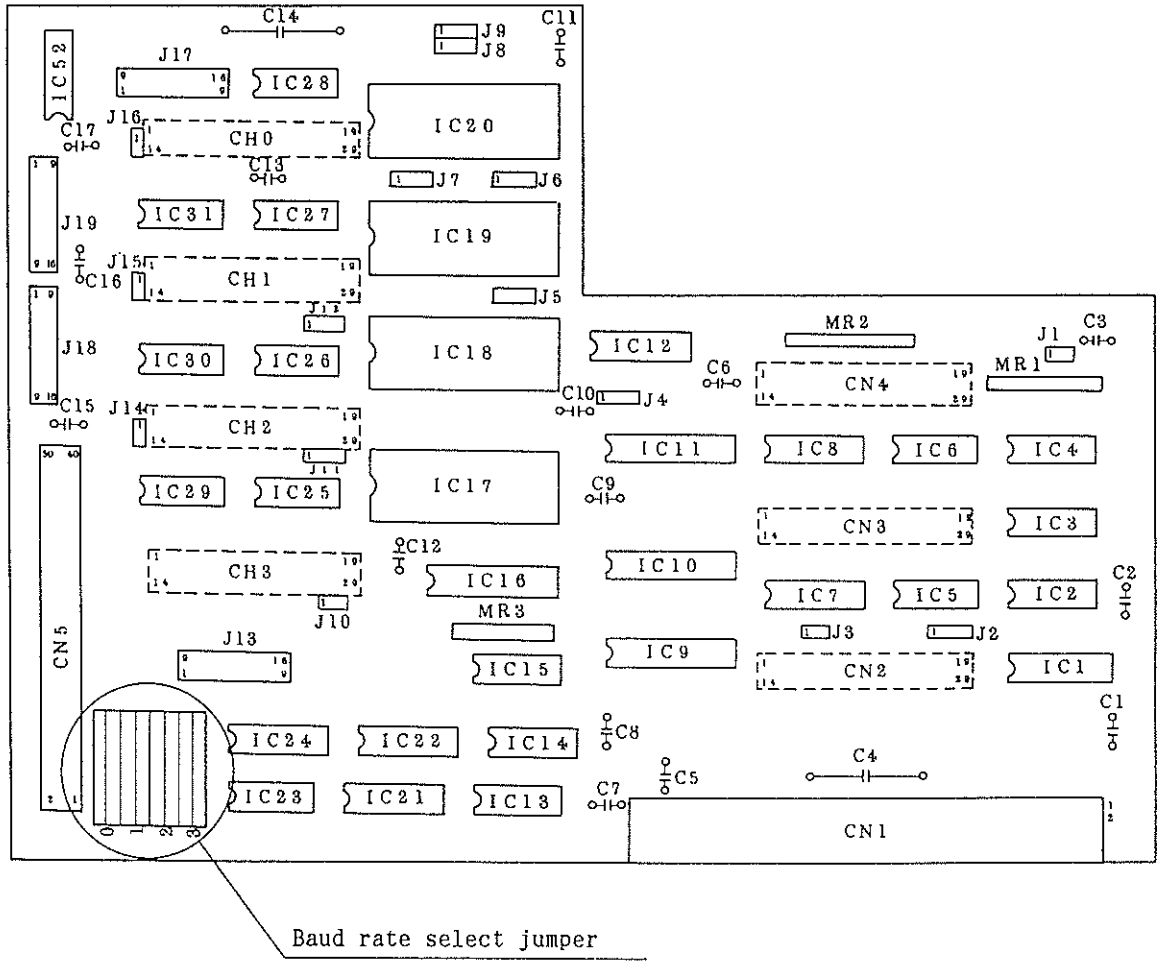
The baud rate is determined according to the jumper connection as follows:

Jumper	1-9	2-10	3-11	4-12	5-13	6-14	7-15	8-16
Baud rate (bps)	9600	4800	2400	1200	600	300	150	75

Channel No.	Row
1	0
2	1

Figure 4-25 shows the jumper locations on the I/O interface board.

Fig. 4-25 Location of the Baud Rate Select Jumpers on the I/O Interface Board



The frame ground jumper connections are explained below.

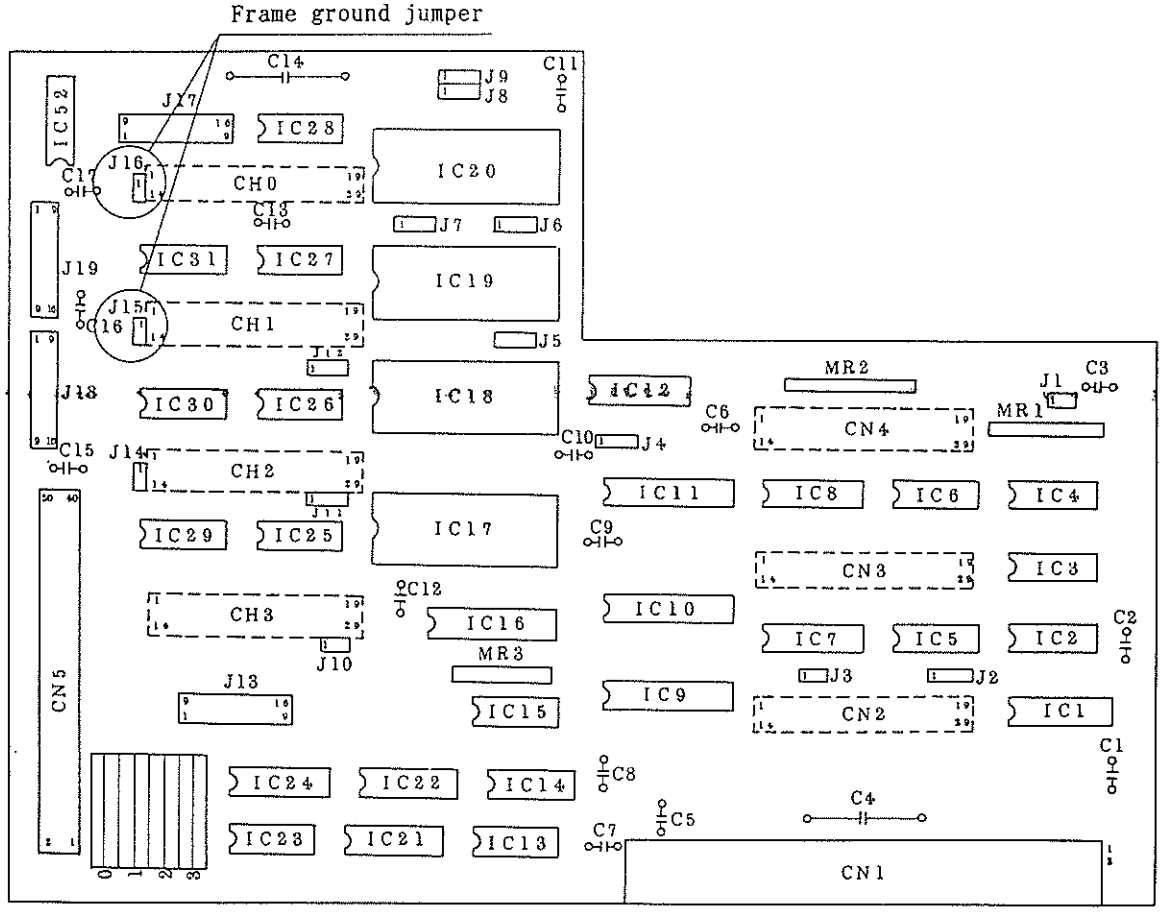
(c) Frame ground jumper

Whether the frame ground signal and signal ground signal are connected is set with a frame ground jumper.

Generally, the jumper is set in the open state.

Channel No.	Jumper	Connection
1	J16	Short 1-2
2	J15	Short 1-2

Fig. 4-26 Locations of the Frame Ground Jumpers on the I/O Interface Board



RTS select jumper connections are explained.

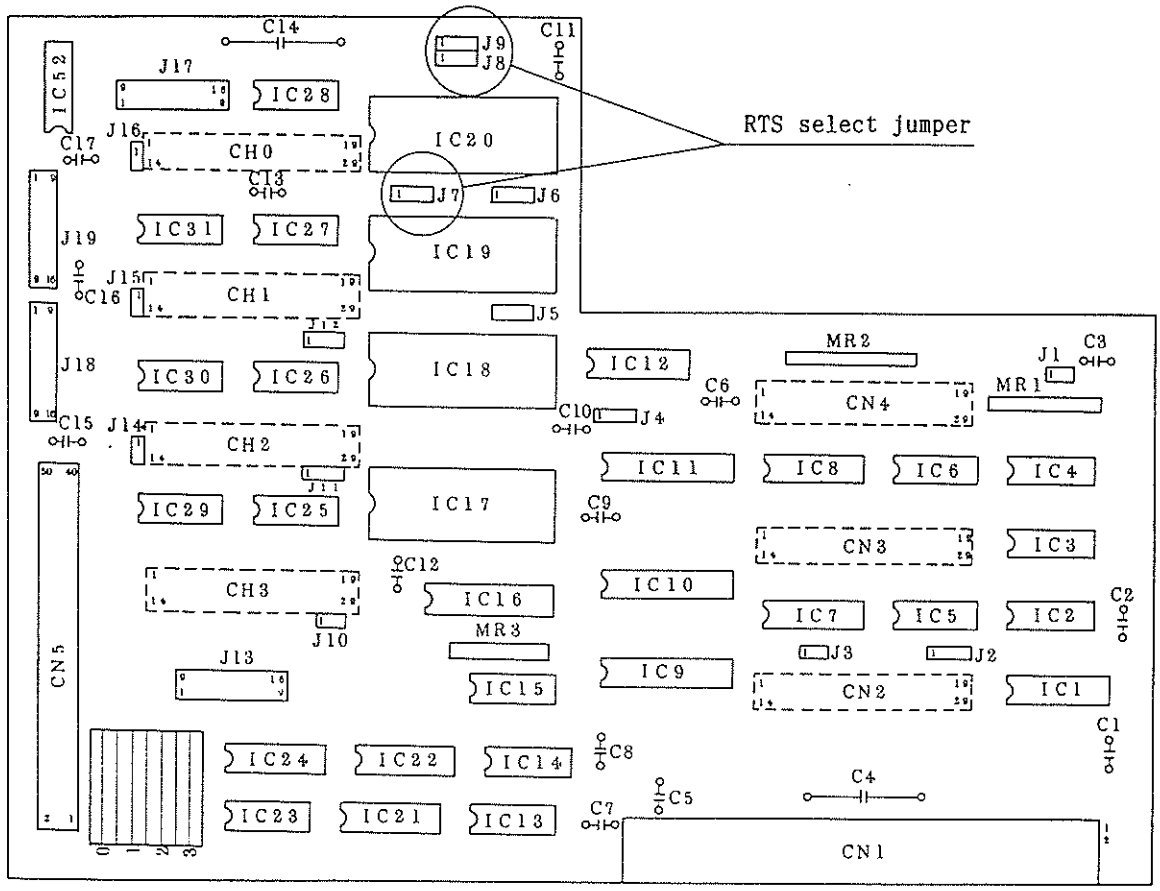
(d) RTS select jumpers

The RTS select jumper is used to determine whether RxRDY is applied to RTS derived from the uPD8251AFC when RTS is connected to the CTS output in the modem mode or to the RTS output in the terminal mode.

To connect the equipment to the IE-78310A-R, connect pins 1 and 2 in J7 or J9 to supply RxRDY.

Channel No.	Jumper	Connection
1	J9	Short 1-2
2	J7	Short 1-2

Fig. 4-27 Locations of RTS Select Jumpers on the I/O Interface Board



External clock jumper connections are explained below.

(e) External clock jumpers

The external clock jumpers are used to select a clock, for supplying clock pulses to USART, either an internal or external clock.

To connect the equipment to the IE-78310A-R, connect pins 2 and 3 in J8 or J6 to use the internal clock.

Channel No.	Jumper	Connection
1	J8	Short 2-3
2	J6	Short 2-3

Fig. 4-28 Locations of External Clock Jumpers on the I/O Interface Board

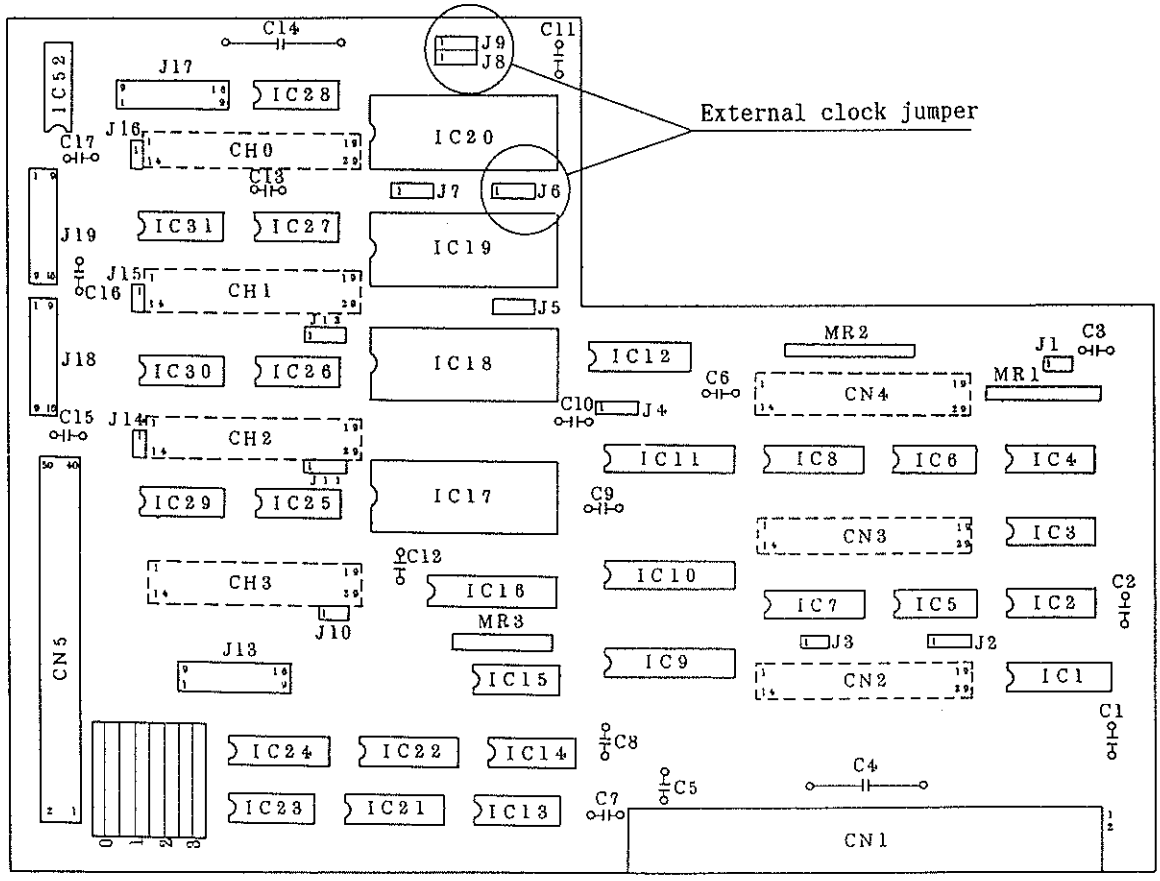
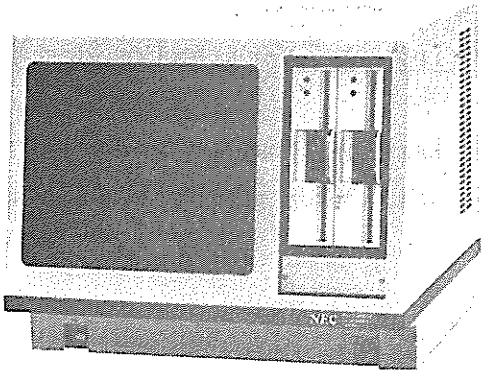


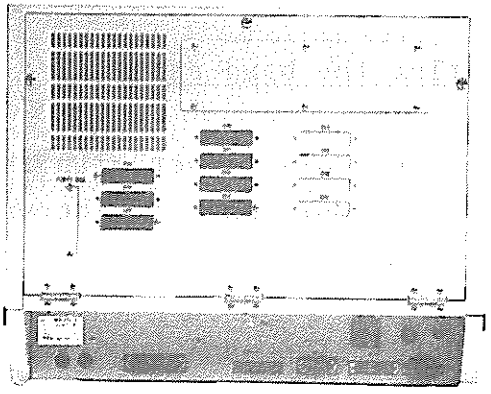
Fig. 4-29 MD-086FD

MD-086FD

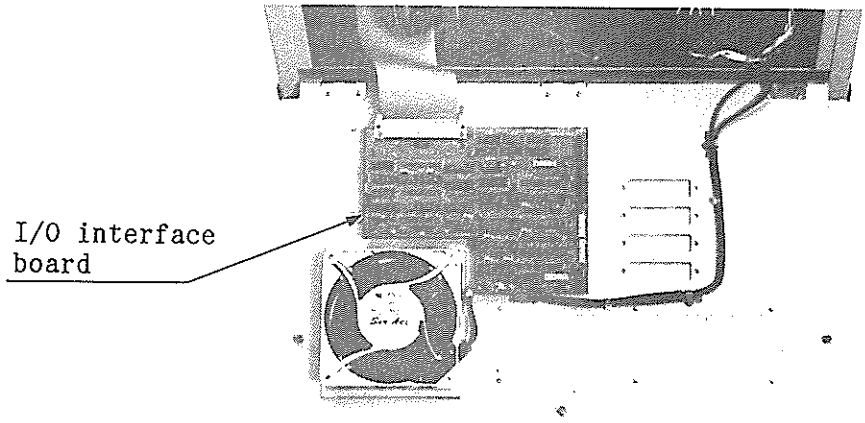
(i) External view



(ii) Back



(iii) When the back panel is opened



Settings for channel 1 or 2 of the MD-086FD are then completed.

(2) Setting IE-78310A-R

Use channel 1 of the IE-78310A-R to connect it to the MD-086FD.

(a) Setting the terminal/modem mode

The terminal/modem mode is switched with the CHANNEL1 MODE slide switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-086FD which operates in the modem mode, the terminal mode must be set for the IE-78310A-R.

(b) Setting the baud rate

The baud rate is set with the micro DIP switch on the front panel of the unit.

When connecting the IE-78310A-R to the MD-086FD, the same baud rate must be set for the MD-086FD and the IE-78310A-R. Table 4-17 shows micro DIP switch settings and selected baud rates.

Table 4-17 Baud Rate Setting

Switch No.	Baud rate (bps)
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	0
8	300
9	600

(c) Setting the frame ground

Set whether the frame ground and signal ground are connected or open.

The frame ground is set with the CHANNEL1 FG DIP switch (pin 4 switch) on the front panel of the unit.

When connecting the IE-78310A-R to the MD-086FD, the DIP switch must be set for the open state.

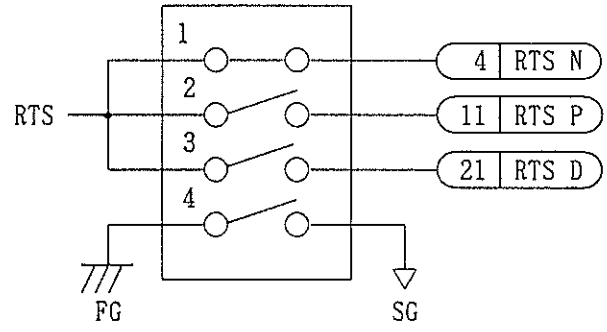
(d) Setting RTS

One of the pins 4, 11, or 21 of the RS-232-C interface cable is selected so that RTS is connected to that pin.

For connection to the MD-086FD, set the pins 1 to 3 of the DIP switch on the front panel of the unit so that RTS is connected to pin 4.

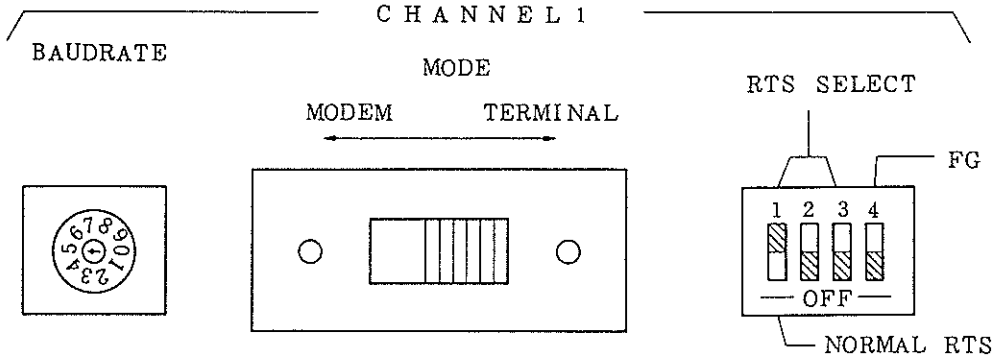
Figure 4-30 shows how to set the DIP switch.

Fig. 4-30 CHANNEL1 DIP Switch Setting



Pin No.	Setting
1	ON
2	OFF
3	OFF
4	OFF

Fig. 4-31 Setting CHANNEL1 on the IE-78310A-R Front Panel



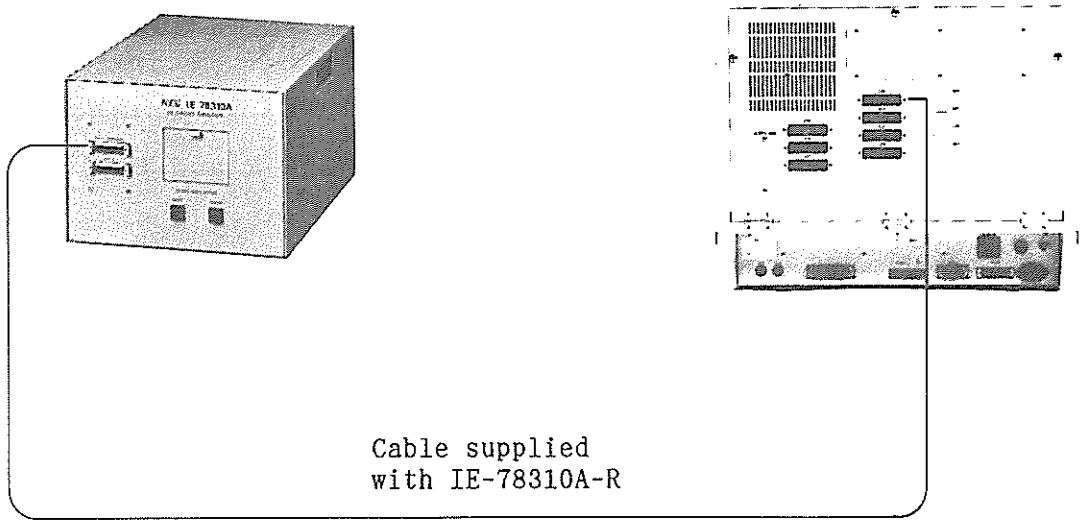
Settings in the IE-78310A-R are then completed.

Next, connection is performed.

Use the RS-232-C interface cable supplied with the IE-78310A-R.

Connect channel 1 of the IE-78310A-R to channel 1 or 2 of the MD-086FD.

Fig. 4-32 Connecting IE-78310A-R and MD-086FD



When the units are connected, turn on the power.

When supplying power, be careful of the power sequence as follows:

(3) Power-on sequence

① Turn on the power switch of the IE-78310A-R.

② Turn on the power switch of the MD-086FD.

(4) Power-off sequence

① Remove the floppy disk from the MD-086FD.

② Turn off the power switch of the MD-086FD.

③ Turn off the power switch of the IE-78310A-R.

4.3.5 Connecting PG-1500

When connecting the PG-1500 to the IE-78310A-R, follow the following procedure:

① Turn off power to the IE-78310A-R and PG-1500.

② Set channel 2 of the IE-78310A-R as shown in Table 4-18.

Table 4-18 IE-78310A-R Channel 2 Setting

Item		Switch	Setting
Mode selection		MODE	Terminal mode
Frame ground		RTS, FG SELECT	Set pin 4 to OFF.
RTS select			Set pin 1 to ON, and pins 2 and 3 to OFF.
Handshaking		Set by software	CHAR
Baud rate			9600
Character specifications	Data length		8
	Parity bit		NON
	Stop bit		2

③ Connect the PG-1500 to the IE-78310A-R.

Connect channel 2 of the IE-78310A-R to the serial interface connector of the PG-1500 with the RS-232-C cable.

④ Turn on the PG-1500, then turn on the IE-78310A-R.

Settings in the PG-1500 and the IE-78310A-R are explained below in detail.

⑤ Set the mode of the PG-1500 by entering keys on the PG-1500 panel.

Table 4-19 PG-1500 Mode Setting

Item			Setting
Baud rate		BR	9600
Character specifi-cations	Parity bit	P	NON
	Data length	B	8
	Stop bit	SB	2
Handshaking		XN	OFF
Pre-check function		PC	OFF

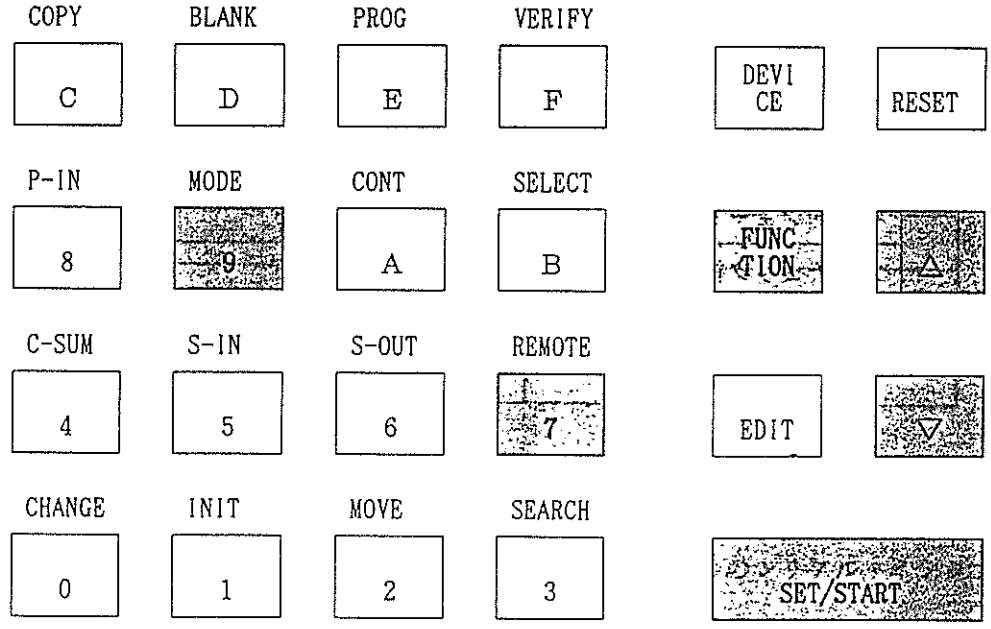
(1) Setting PG-1500

The settings for the PG-1500 are performed by pressing keys on the panel of the unit.

(a) PG-1500 key switch section

Figure 4-33 shows the key switch section. Use keys indicated by [ ] to set the PG-1500 mode.

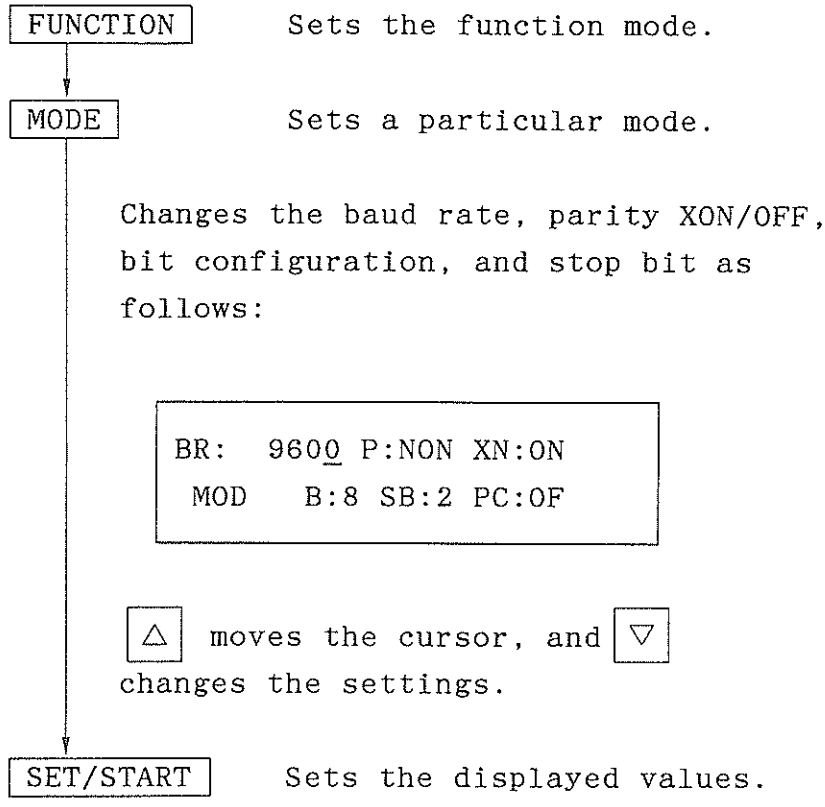
Fig. 4-33 PG-1500 Key Switch Section



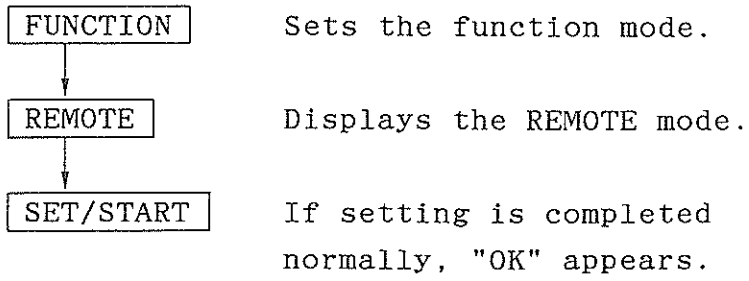
(b) Setting procedure

The following is an example for mode setting with keys.

. Mode setting

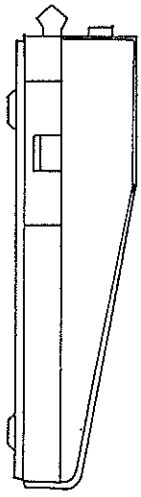


. Remote control mode setting

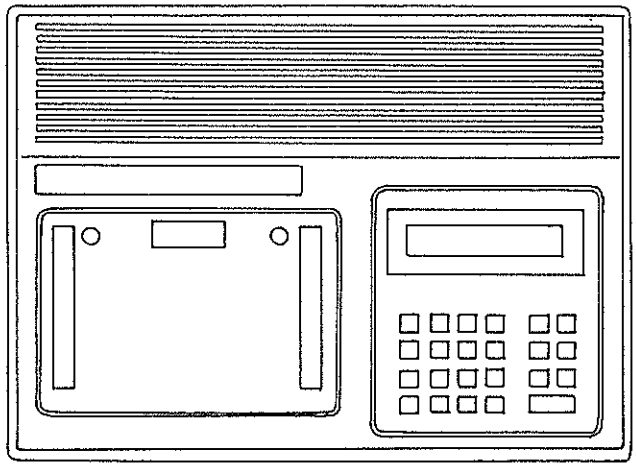


The PG-1500 will then be controlled by the IE-78310A-R.

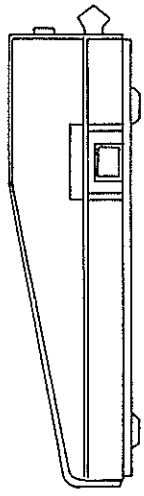
Fig. 4-34 PG-1500



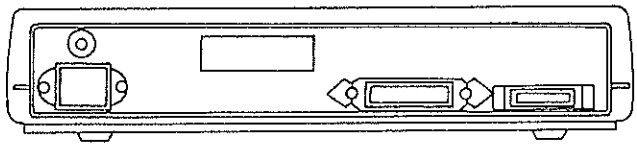
Left side



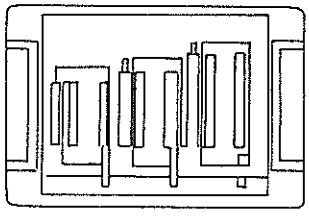
Front panel



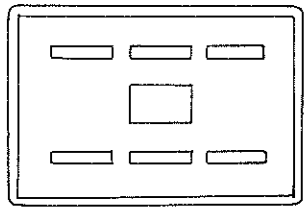
Right side



Rear panel



27A adapter



04A adapter

27A adapter

The 27A adapter is a socket adapter designed for typical 256K- to 4M-bit, PROM (27xxx) products. □

To write a program into a 78K Series PROM product, mount the 27A adapter on the PG-1500 front panel.

04A adapter

To write a program into a 4-bit single-chip microprocessor containing PROM, mount the 04A adapter on the PG-1500 front panel.

(2) Setting IE-78310A-R

For connection to the PG-1500, use channel 2 of the IE-78310A-R.

(a) Setting the terminal/modem mode

The terminal/modem mode is switched with the CHANNEL2 MODE switch on the front panel of the unit.

When connecting the IE-78310A-R to the PG-1500, the terminal mode must be set for the IE-78310A-R.

(b) Setting the frame ground

Set whether the frame ground and signal ground are connected or open.

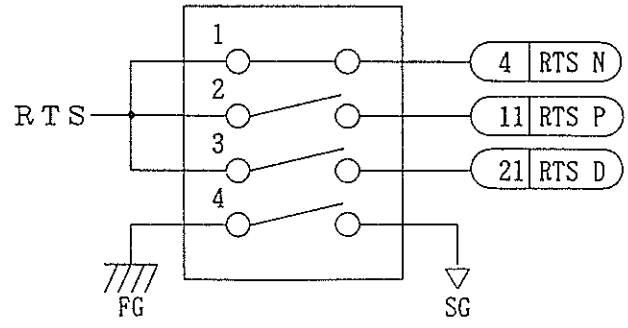
The frame ground is set with the CHANNEL2 FG DIP switch (pin 4 switch) on the front panel of the unit. When connecting the IE-78310A-R to the PG-1500, the DIP switch must be set for the open state.

(c) Setting RTS

One of the pins 4, 11, or 21 of the RS-232-C interface cable is selected so that RTS is to be connected to that pin.

For connection to the PG-1500, set the pins 1 to 3 of the DIP switch on the front panel of the unit so that RTS is connected to pin 4.

Fig. 4-35 CHANNEL2 DIP Switch Setting



Pin No.	Setting
1	ON
2	OFF
3	OFF
4	OFF

(d) Setting handshaking

Whether hardware handshaking (CHAR) or software handshaking (FLOW) is performed is set with a command. For the PG-1500, select hardware handshaking.

For how to set the handshaking, see "Setting Channel 2 Mode."

(e) Setting the baud rate

The baud rate is set with a command. The same baud rate must be set for the PG-1500 and the IE-78310A-R.

For how to set the baud rate, see "Setting Channel 2 Mode."

(f) Character specifications (data, parity bit, stop bit)

Character specifications are set with a command.

Set the data length to 8 bits, and set the same parity bit as for the PG-1500.

Set the stop bit length to 2 bits.

For how to set the character specifications, see "Setting Channel 2 Mode."

Setting channel 2 mode

$$\text{MOD}[\_\text{MODE}=\begin{Bmatrix}\text{CHAR}\\ \\ \text{FLOW}\end{Bmatrix}][\_\text{BAUD}=\begin{Bmatrix}19200\\ 9600\\ 4800\\ 2400\\ 1200\\ 600\\ 300\end{Bmatrix}][\_\text{LONG}\begin{Bmatrix}7\\ \\ 8\end{Bmatrix}][\_\text{PAR}=\begin{Bmatrix}\text{NON}\\ \text{EVEN}\\ \text{ODD}\end{Bmatrix}][\_\text{STOP}=\begin{Bmatrix}1\\ \\ 2\end{Bmatrix}]$$

MODE: Select handshaking mode.
BAUD: Select the baud rate.
LONG: Select the character length.
PAR: Select the parity bit.
STOP: Select the stop bit length.

The MOD command sets the operating conditions of serial channel 2. If operands in the command are omitted, the conditions may be set interactively.

Initially, 1-character handshaking, 9600 baud, 8-bit character without parity bit, and 2 stop bits are set.

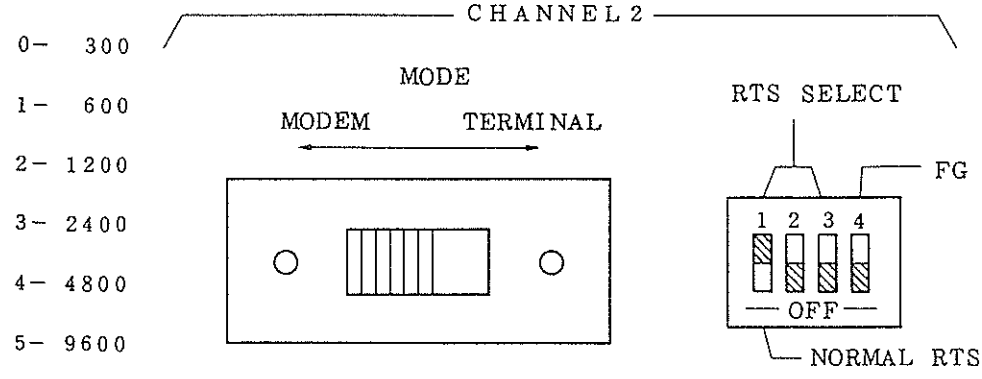
Example

```
*MOD MODE=CHAR BAUD=4800 LONG=8 PAR=NON STOP=2 <cr>
*
```

1-character handshaking, 4800 baud, character of 8 bits, no parity bit, and 2 stop bits are set.

```
*MOD <cr>                    ← Sets channel 2 operating conditions interactively.
_MODE__CHAR_=_FLOW <cr>      ← Changes the mode to the buffer control mode.
_BAUD__4800_=_9600 <cr>      ← Changes the baud rate to 9600 baud.
_LONG_____8_=_<cr>           ← The character length remains unchanged.
_PAR____NON_=_EVEN <cr>      ← Changes to even parity check.
_STOP_____2_=_1 <cr>         ← Changes the stop bit length to 1.
*
```

Fig. 4-36 Setting CHANNEL2 on the IE-78310A-R Front Panel



When supplying power, be careful of the power-on sequence.

(3) Power-on sequence

① Turn on the power switch of the PG-1500.

② Turn on the power switch of the IE-78310A-R.

(4) Power-off sequence

① Turn off the power switch of the PG-1500.

② Turn off the power switch of the IE-78310A-R.

4.3.6 Connecting PG-2000

When connecting the PG-2000 to the IE-78310A-R, follow the following procedure:

① Turn off power to the IE-78310A-R and PG-2000.

② Set channel 2 of the IE-78310A-R as shown in Table 4-23.

Table 4-23 IE-78310A-R Channel 2 Setting

Item		Switch	Setting
Mode selection		MODE	Modem mode
Frame ground		RTS, FG SELECT	Set pin 4 to OFF.
RTS select			Set pin 1 to ON, and pins 2 and 3 to OFF.
Handshaking		Set by software	CHAR
Baud rate			9600
Character specifications	Data length		8
	Parity bit		NON
	Stop bit		2

③ Connect the serial interface connector of the PG-2000 to the IE-78310A-R. Settings in the PG-2000 are set with an 8-bit and 4-bit DIP switches located at the bottom of the PG-2000 (see Table 4-24).

Table 4-24 PG-2000 Setting

Baud rate	1 to 3	1: OFF, 2-3: ON
Parity check	4, 5	4: OFF 5: ON/OFF
Stop bit length	6, 7	6-7 ON
Handshaking	8	OFF

④ Connect the PG-2000 to the IE-78310A-R.

Connect channel 2 of the IE-78310A-R to the serial interface connector of the PG-2000 with a cable supplied with the PG-2000 (be sure not to use a cable other than the supplied cable).

⑤ Turn on the PG-2000, then turn on the IE-78310A-R.

Settings in the PG-2000 and the IE-78310A-R are explained below in detail.

(1) Setting PG-2000

Set the 8-bit DIP switch on the bottom of the PG-2000.

(a) Setting the baud rate

The baud rate is set with switches 1 to 3 of the 8-bit DIP switch, as shown in Table 4-25.

Table 4-25 Baud Rate Setting

Switch No. / Baud rate	1	2	3
110	OFF	OFF	OFF
300	ON	OFF	OFF
600	OFF	ON	OFF
1200	ON	ON	OFF
2400	OFF	OFF	ON
4800	ON	OFF	ON
9600	OFF	ON	ON

For connection to the IE-78310A-R, the same baud rate as for the IE-78310A-R must be set for the PG-2000.

(b) Setting the parity check

The parity check is set with switches 4 and 5 of the 8-bit DIP switch as shown in Table 4-26.

Table 4-26 Parity Check Setting

Switch No. / Parity check	4	5
Even	ON	ON
Odd	ON	OFF
None	OFF	ON/OFF (Note)

Note: Either ON/OFF may be set.

For connection to the IE-78310A-R, the same parity as for the IE-78310A-R must be set.

(c) Setting the stop bit length

The stop bit length is set with switches 6 and 7 of the 8-bit DIP switch as shown in Table 4-27.

Table 4-27 Stop Bit Length Setting

Switch No. / Stop bit length	6	7
1 bit	ON	OFF
1.5 bits	OFF	ON
2 bits	ON	ON

The same stop bit length as for the IE-78310A-R must be set.

(d) Setting the handshaking mode

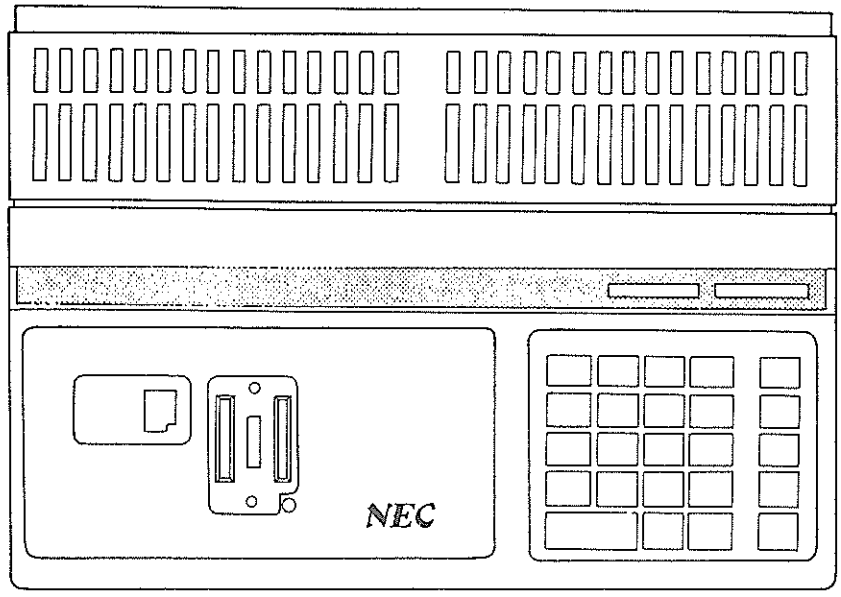
The handshaking mode is set with switch 8 of the 8-bit DIP switch as shown in Table 4-28.

Table 4-28 Setting of Handshaking

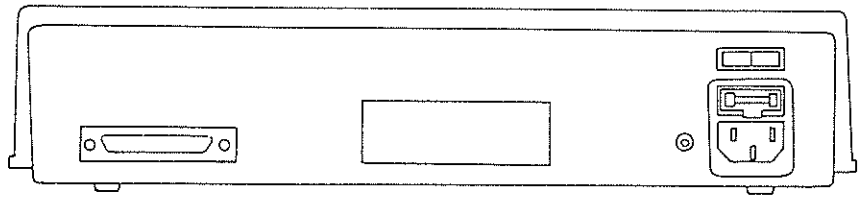
Switch No. / Hand shaking	8
CHAR (without X-ON/X-OFF)	OFF
FLOW (with X-ON/X-OFF)	ON

Set CHAR (without X-ON/X-OFF).

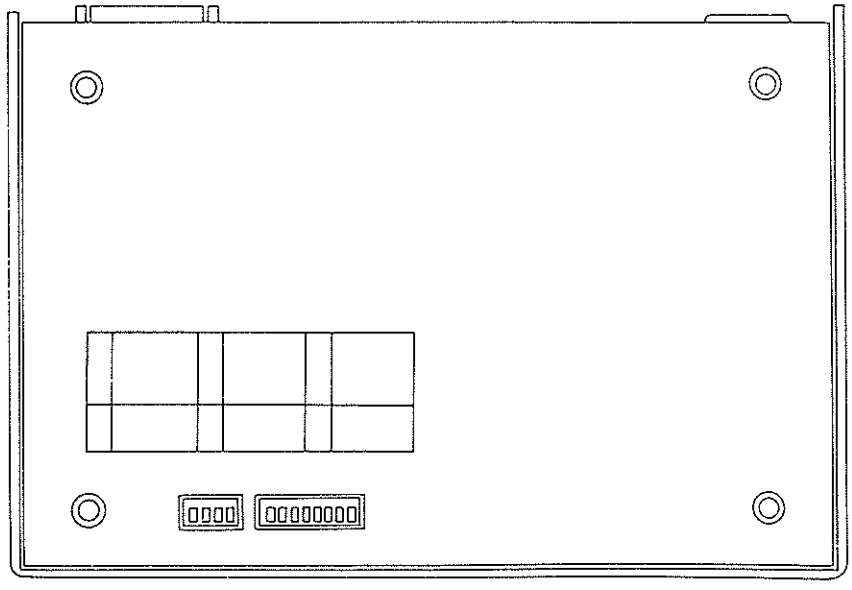
Fig. 4-37 PG-2000



Front panel

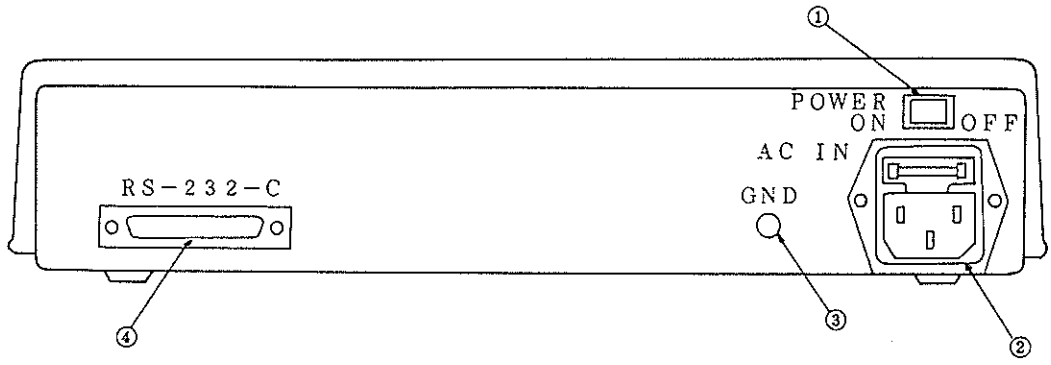


Rear panel



Bottom panel

Fig. 4-38 Rear Panel



① Power switch

Rocker switch. Pressing the left side of the switch on the rear panel turns power off.

② AC input connector

1A fuses are provided in the AC input connector and fuse holder.

③ GND terminal

④ Serial interface connector

This connector is designed for the RS-232-C interface. The mating connector is a 25-pin D-SUB connector.

Fig. 4-39 Bottom

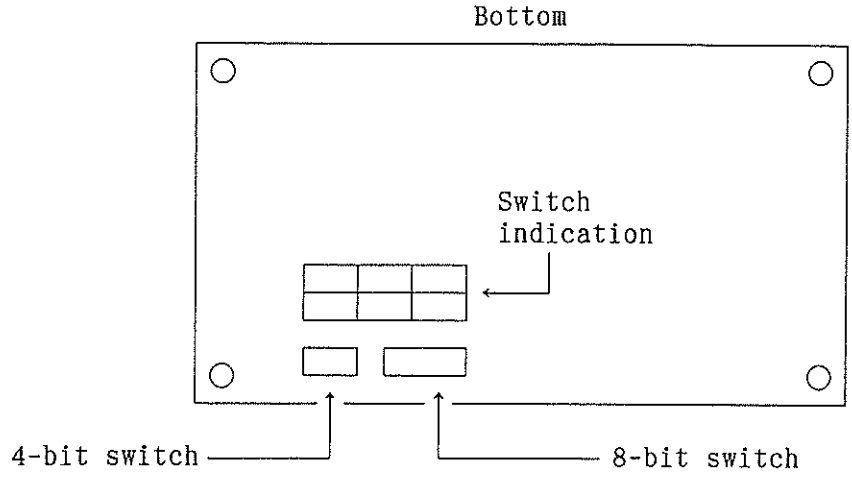
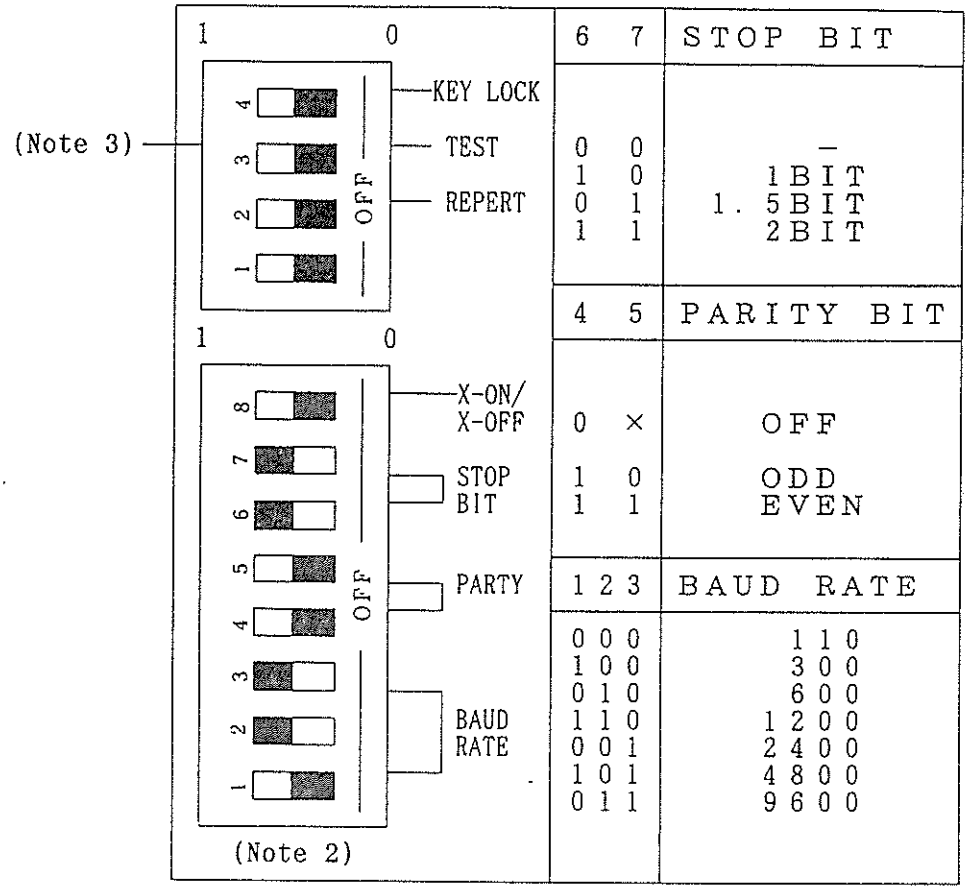


Figure 4-39 shows the switches on the bottom of the PG-2000. These switches are used to change the serial interface operating mode.

Fig. 4-40 Switches on Bottom



(Note 1)

Notes 1. 1 indicates that a switch is in the ON position (the switch is turned left), and 0 indicates that a switch is in the OFF position (the switch is turned right). x may be either ON or OFF position.

2. The figure shows the factory-set switch state.

3. The 4-bit DIP switch is used for factory inspection. All the switches in that DIP switch must be set in the OFF position.

Settings for the PG-2000 are then completed. Next, the IE-78310A-R is set.

(2) Setting IE-78310A-R

Use channel 2 of the IE-78310A-R to connect it to the PG-2000.

(a) Setting the terminal/modem mode

The terminal/modem mode is switched with the CHANNEL2 MODE switch on the front panel of the unit.

When connecting the IE-78310A-R to the PG-2000, set the modem mode for the IE-78310A-R.

(b) Setting the frame ground

Set whether the frame ground and signal ground are connected or open.

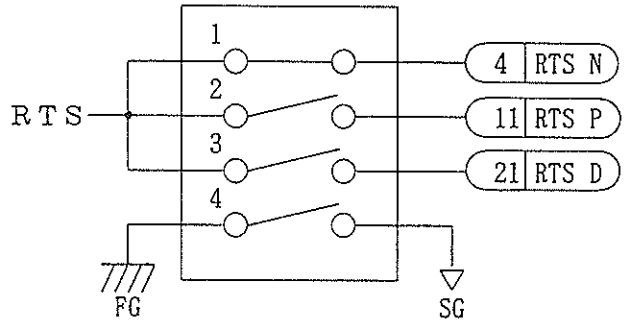
The frame ground is set with the CHANNEL2 FG DIP switch (pin 4 switch) on the front panel of the unit. When connecting the IE-78310A-R to the PG-2000, the switch must be set for the open state.

(c) Setting RTS

One of the pins 4, 11, or 21 of the RS-232-C interface cable is selected so that RTS is connected to that pin.

For connection to the PG-2000, set the pins 1 to 3 of the DIP switch on the front panel of the unit so that RTS is connected to pin 4.

Fig. 4-41 CHANNEL2 DIP Switch Setting



Pin No.	Setting
1	ON
2	OFF
3	OFF
4	OFF

(d) Setting the handshaking mode

Select the handshaking mode, either hardware handshaking (CHAR) or software handshaking (FLOW), with a command.

For the PG-2000, select the hardware handshaking mode.

For how to set the handshaking, see "Setting Channel 2 Mode."

(e) Setting the baud rate

Set the baud rate with a command. The same baud rate must be set for the PG-2000 and the IE-78310A-R.

For how to set the baud rate, see "Setting Channel 2 Mode."

(f) Character specifications (data length, parity bit, stop bit)

Character specifications are set with a command.

Set the data length to 8 bits, and set the same parity bit and stop bit length as for the PG-2000.

For how to set the character specifications, see "Setting Channel 2 Mode."

Setting channel 2 mode

MOD[_MODE={CHAR / FLOW}][_BAUD={19200 / 9600 / 4800 / 2400 / 1200 / 600 / 300}][_LONG{7 / 8}][_PAR={NON / EVEN / ODD}][_STOP={1 / 2}]

MODE: Select handshaking mode.
BAUD: Select the baud rate.
LONG: Select the character length.
PAR: Select the parity bit.
STOP: Select the stop bit length.

The MOD command sets the operating conditions of serial channel 2. If operands in the command are omitted, the conditions may be set interactively.

Initially, 1-character handshaking, 9600 baud, 8-bit character without parity bit, and 2 stop bits are set.

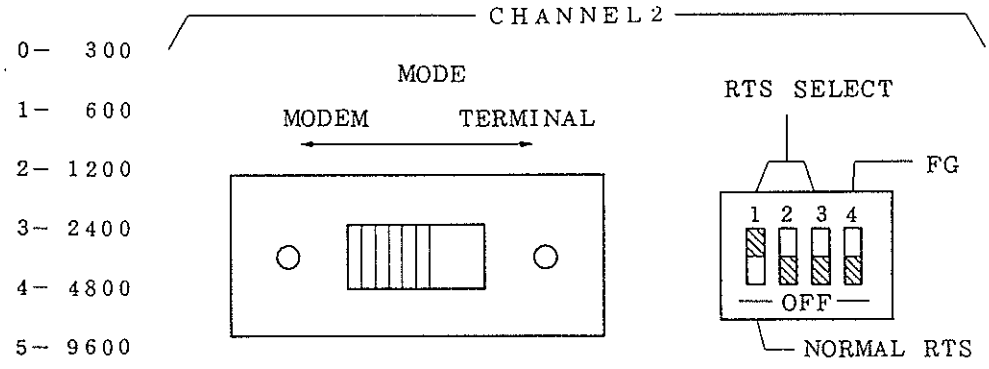
Example

```
*MOD MODE=CHAR BAUD=4800 LONG=8 PAR=NON STOP=2 <cr>
*
```

1-character handshaking, 4800 baud, character of 8 bits, no parity bit, and 2 stop bits are set.

```
*MOD <cr>                  ← Sets channel 2 operating conditions interactively.
_MODE__CHAR_=_FLOW <cr>    ← Changes the mode to the buffer control mode.
_BAUD__4800_=_9600 <cr>    ← Changes the baud rate to 9600 baud.
_LONG_____8_=_<cr>         ← The character length remains unchanged.
_PAR____MON_=_EVEN <cr>    ← Changes to even parity check.
_STOP_____2_=_1 <cr>       ← Changes the stop bit length to 1.
*
```

Fig. 4-42 Setting CHANNEL2 on the IE-78310A-R Front Panel



When supplying power, be careful of the power-on sequence.

(3) Power-on sequence

① Turn on the power switch of the PG-2000.

② Press the REM key, then press the START key on the front panel of the PG-2000.

③ Turn on the power switch of the IE-78310A-R.

(4) Power-off sequence

① Turn off the power switch of the PG-2000.

② Turn off the power switch of the IE-78310A-R.

CHAPTER 5 FUNCTIONS OF THE SC-232-C INTERFACE

5.1 Overview

This chapter describes in detail the functions of the RS-232-C interface (channel 1 and channel 2) for the IE-78310A-R. The instructions given in Section 4.3 are sufficient for operating the RS-232-C interface connected to the host machine or PROM program.

Read this chapter to learn more about the functions of channel 1 and channel 2.

Section 5.2 differentiates terminal mode from modem mode, which are often confused by Users of the RS-232-C interface.

Section 5.3 describes the RS-232-C interface signal lines used by the IE-78310A-R.

Section 5.4 describes the channel 1 functions in detail.

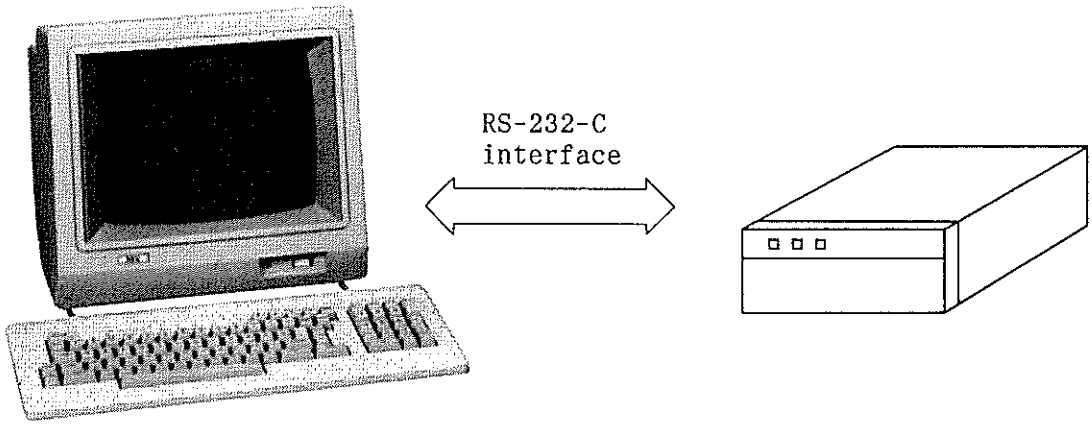
Section 5.5 describes the channel 2 functions in detail.

This chapter does not cover any RS-232-C interface standards. It only presents the functions of the RS-232-C interface for the IE-78310A-R.

5.2 Terminal Mode & Modem Mode

The RS-232-C interface was originally designed to connect a terminal to a modem. (See Figure 5-1.)

Fig. 5-1 The RS-232-C Interface

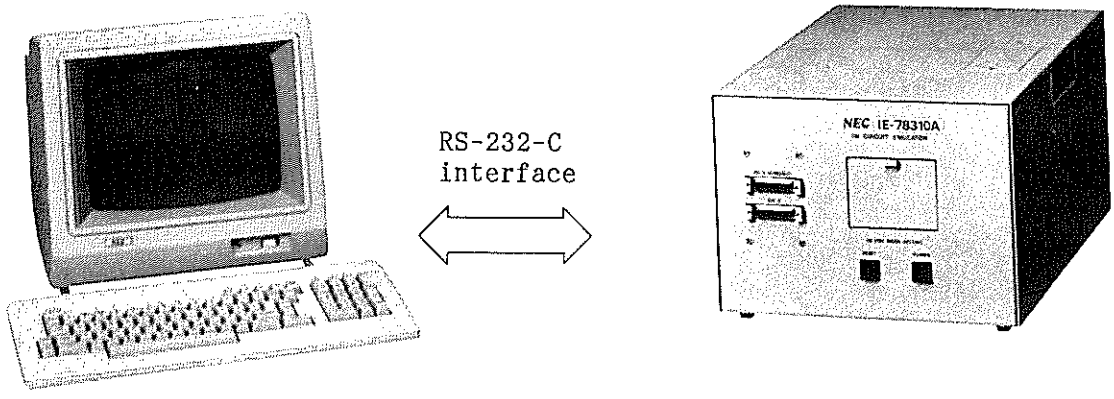


(Terminal) (Modem)

In addition, the RS-232-C interface is used to connect a terminal to a microcomputer system or to connect two microcomputer systems.

The RS-232-C interface serves the IE-78310A-R in the following way.

Fig. 5-2 Connecting the IE-78310A-R in the Stand-alone Mode



Terminal
(Terminal)

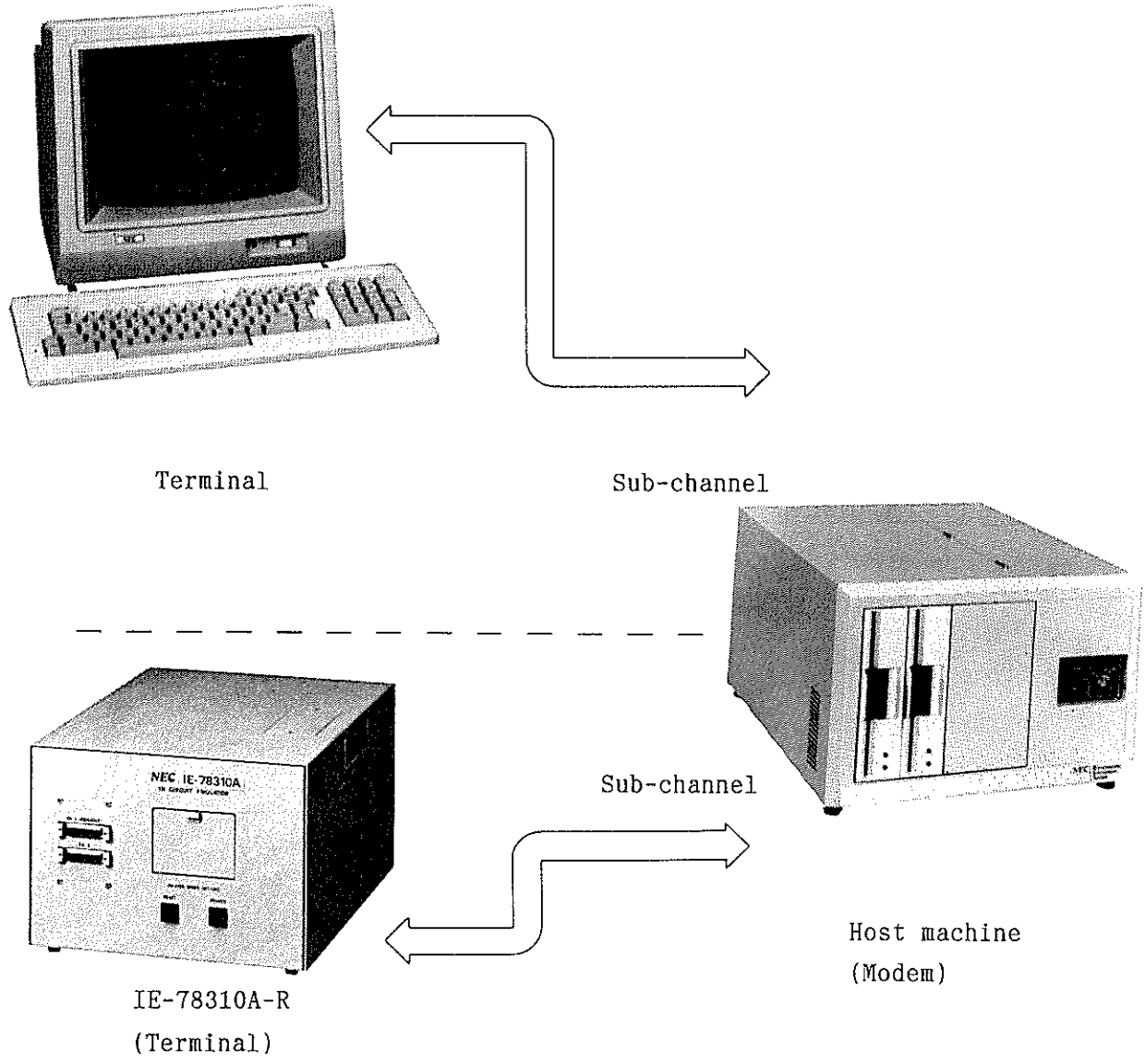
IE-78310A-R
(Modem)

Figure 5-2 shows how to connect the IE-78310A-R in the stand-alone mode. This is an example of connecting a terminal to a microcomputer system through the RS-232-C interface.

Compare Figure 5-1 with Figure 5-2 and study the devices hooked up to the RS-232-C interface. The terminal in Figure 5-1 corresponds to the terminal in Figure 5-2, and the modem in Figure 5-1 corresponds to the IE-78310A-R in Figure 5-2. In other words, the IE-78310A-R is functioning as a modem.

In such situations, the IE-78310A-R is said to be in modem mode.

Fig. 5-3 Connecting the IE-78310A-R in the System Mode



This is an example of connecting a microcomputer system to another microcomputer system through the RS-232-C interface.

Compare Figure 5-1 with Figure 5-3 and study the devices hooked up to the RS-232-C interface.

First take a look at the part above the dotted lines in Figure 5-3.

The host machine is connected in this manner because it is frequently used with a terminal via a sub-channel.

The terminal in Figure 5-1 corresponds to the terminal in Figure 5-3, and the modem in Figure 5-1 corresponds to the host machine in Figure 5-3.

In other words, the host machine is functioning as a modem. In such situations, the host machine is said to be in modem mode.

Next take a look at the part below the dotted lines in Figure 5-3.

The IE-78310A-R in the system mode is connected to the host machine via the sub-channel.

The terminal in Figure 5-1 corresponds to the IE-78310A-R in Figure 5-3 and the modem in Figure 5-1 corresponds to host machine in Figure 5-3.

In other words, the IE-78310A-R is functioning as a terminal and the host machine is functioning as a modem. In such situations, the IE-78310A-R is said to be in terminal mode and the host machine is said to be in modem mode.

Thus, the RS-232-C interface is used to connect a terminal to a modem or a microcomputer system in the terminal mode to another microcomputer system in the modem mode.

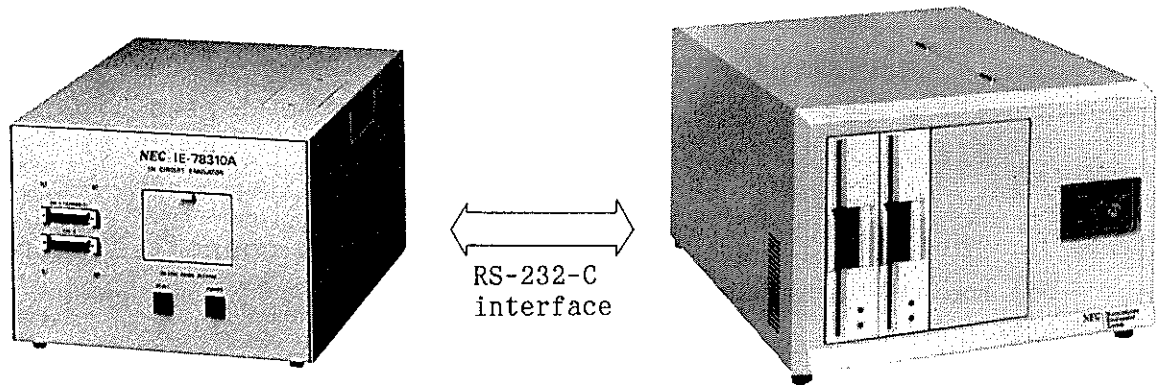
Keep in mind that ordinary microcomputer systems provide selection between terminal mode and modem mode.

For instance, the IE-78310A-R is in the modem mode in Figure 5-2 and the terminal mode in Figure 5-3.

Let's see what is going to happen if the IE-78310A-R in Figure 5-3 is erroneously set to the modem mode.

Since the host machine is in the modem mode, the RS-232-C interface ends up with two modems at both ends. (See Figure 5-4.)

Fig. 5-4 Example of Erroneous Connection



IE-78310A-R

(Modem)

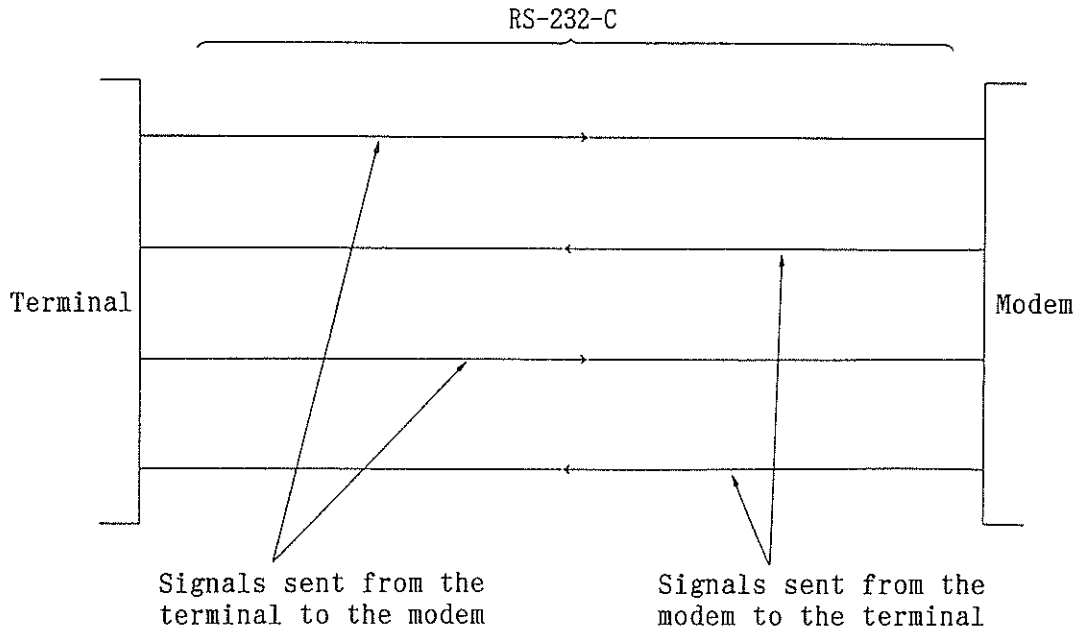
Host machine

(Mode)

The RS-232-C is erroneously connected, resulting in abnormal operation.

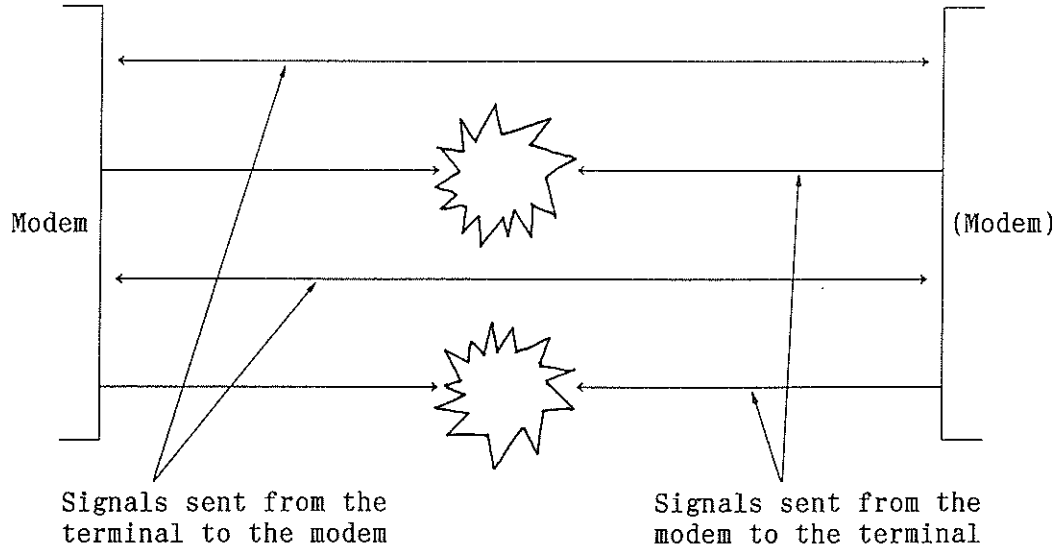
Another factor causing abnormal operation is that the individual RS-232-C signals only accept one-way transmission, thus carrying signals either from a modem to a terminal or vice versa. (See Figure 5-5.) This is further described in Section 5.3.

Fig. 5-5 Individual Signal Lines of the RS-232-C Interface



Now let's see what is going to happen if a modem is connected to another modem as shown in Figure 5-4. (See Figure 5-6.)

Fig. 5-6 Example of Erroneous Connection



Signals sent from the two modems, both destined for a terminal, clash with each other, resulting in a breakdown of one of the two interface drivers.

An erroneous terminal-to-terminal connection also results in a breakdown similar to the above modem-to-modem case.

Always connect a device in the terminal mode to a device in the modem mode through the RS-232-C interface. Never connect two devices both in the terminal mode or both in the modem mode.

The above section introduces the two modes, terminal and modem, provided in the IE-78310A-R.

The paragraph below clarifies how one device could function both as a terminal and modem, though the two are entirely different types of devices.

The signals sent from the terminal to the modem and the signals sent from the modem to the terminal can be paired because they have exactly the same meaning (except that the transmitter and receiver are switched around).

The pair of signal lines are symmetrical thus enabling the IE-78310A-R to switch with ease between the terminal mode and the modem mode.

The next section explains the RS-232-C signal lines used by the IE-78310A-R and also covers the terminal mode and modem mode.

5.3 Signal Lines Used by IE-78310A-R

In this section, a device in the terminal mode is called a terminal and a device in the modem mode is called a modem.

Table 5-1 summarizes the signal lines used by the IE-78310A-R.

Table 5-1 Signal Lines

Line	Signal name	Symbol	Function	Direction		Pin Number
				Modem	Terminal	
1	Frame Ground	FG	Ground for safety			1
	Signal Ground	SG	Ground for signal			7
2	Transmitted Data	TxD	Line for transmitting data from terminal to modem	←		2
	Received Data	RxD	Line for transmitting data from modem to terminal	→		3
3	Data Set Ready	DSR	Line for reporting modem ready state	→		6
	Data Terminal Ready	DTR	Line for reporting terminal ready state	←		20
4	Request To Send	RTS	Line permitting modem to transmit data to terminal	←		4*
	Clear To Send	CTS	Line permitting terminal to transmit data to modem	→		5

* The signals are divided into three groups in an actual circuit depending on the connected devices. See Sections 5.4 and 5.5 for details.

Pin number	Signal name	Device connected
4	RTSN	Host machine, PROM programmer, MD-910TM
11	RTSP	Pro-typer
21	RTSD	DDY-86

The IE-78310A-R transfers data on these eight signals. Signal lines are classified into four types.

1. Ground
2. Data
3. Static handshake
4. Dynamic handshake

Signal lines belonging to data, static handshake, or dynamic handshake work in pairs. The paired lines carry signals having the same meaning except that the transmitter and receiver are switched around.

The IE-78310A-R can transfer data, if the ground signal lines and the data signal lines are connected correctly, through software handshaking, which is further described in Sections 5.4 and 5.5.

When the static handshake signal lines and the dynamic handshake signal lines are connected in addition to the ground and data signal lines, the IE-78310A-R transfers data through hardware handshaking, which is further described in Sections 5.4 and 5.5.

The IE-78310A-R linked to an NEC machine (host machine or PROM programmer) performs hardware handshaking with all four types of lines connected.

The IE-78310A-R linked to a non-NEC machine may not be able to connect its two handshake lines.

Nevertheless, the IE-78310A-R can transfer data through software handshaking.

A description of each signal is set out below.

The ground type signals are classified into frame ground (FG) and signal ground (SG).

The FG signal equalizes the potential of the device chassis. Different FG values do not affect the RS-232-C interface transferring data.

The SG signal equalizes the potential of device signal line grounds. In order for the RS-232-C to successfully transfer data, this signal must be connected for making the ground voltage uniform, which is the basic signal between devices.

The SG signal is a very important basic signal for the RS-232-C interface.

Now let's move on to the data type signals.

The data signals are classified into transmit data (TxD) and receive data (RxD).

The TxD signal transmits data from a terminal to a modem.

The RxD signal transmits data from a modem to a terminal.

The three signals, TxD and RxD, which transmit/receive data, plus the SG make data transmission/reception possible. Faster and more accurate data transmission/reception between the IE-78310A-R and the host machine or PROM programmer can be realized by means of the static handshake signals and dynamic handshake signals, which are explained below.

The static handshake signals are classified into data set ready (DSR) and data terminal ready (DTR).

The DSR signals report to the terminal that the modem is ready, and the DST signals report to modem that the terminal is ready.

Set both static handshake signals to valid at initialization and maintain that status, otherwise data cannot be transmitted or received.

The dynamic handshake signals are classified into request to send (RTS) and clear to send (CTS).

The RTS signal reports to the modem that the terminal is ready to receive data, and the CTS signal reports to the terminal that the modem is ready to receive data.

The crucial factor discriminating the two handshake signals is that the DSR and DTR signals indicate the state of the devices, and the RTS and CTS signals give permission to transfer data one by one. Control the RTS and CTS signals to transfer data by handshaking.

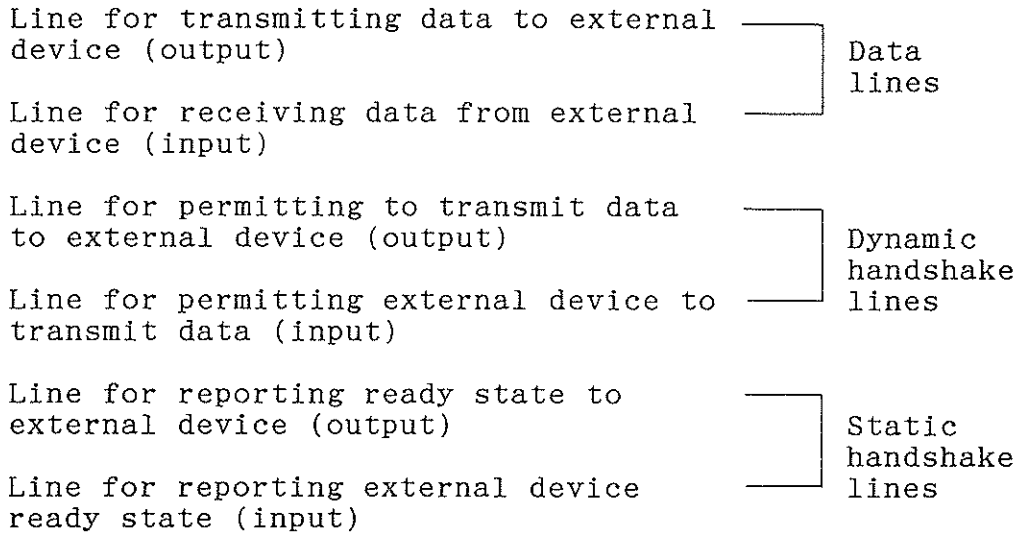
The above description indicates that

TxD and RxD (data signals)
RTS and CTS (dynamic handshake signals)
DTR and DSR (static handshake signals)

mean the same thing except that the transmitter and receiver are switched around.

The following part explains how to set the IE-78310A-R to the terminal mode or modem mode.

The following signal lines are provided in the RS-232-C interface of the IE-78310A-R.



Using data lines as an example, to set the IE-78310A-R to the terminal mode, connect the "line for transmitting data to external device" to the RS-232-C's TxD and the "line for receiving data from external device" to the RS-232-C's RxD. To set the IE-78310A-R to the modem mode, connect the "line for transmitting data to external device" to the RS-232-C's RxD and the "line for receiving data from external device" to the RS-232-C's TxD.

Fig. 5-7 Connecting Modem Mode IE-78310A-R

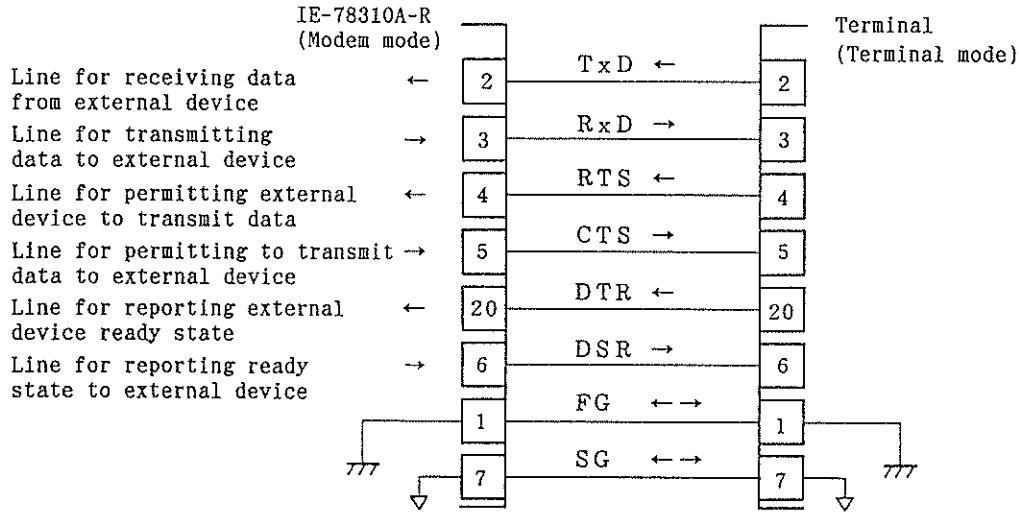
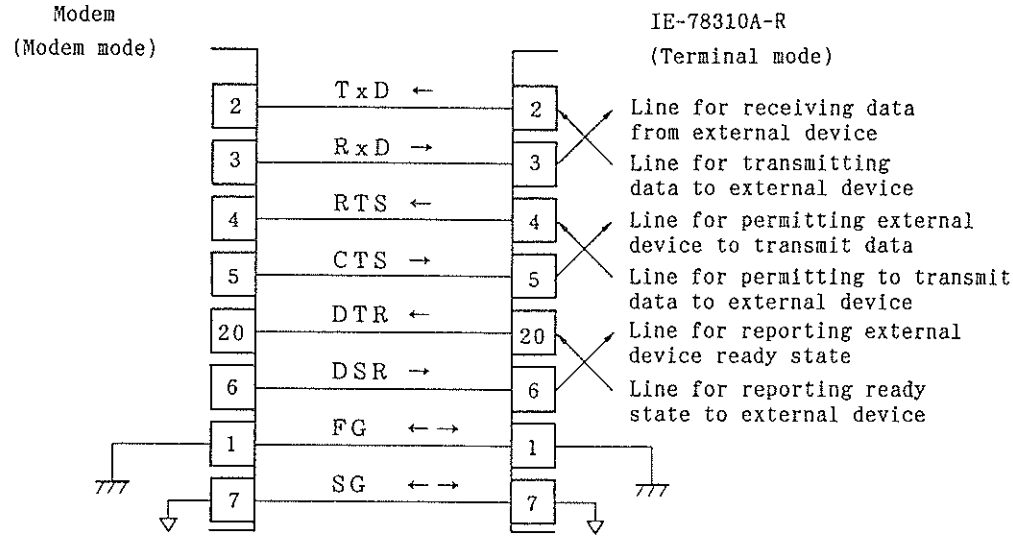


Fig. 5-8 Connecting Terminal Mode IE-78310A-R



The symmetrically paired signal lines facilitate mode selection between terminal and modem. Specific selection instructions are given in Sections 5.4 and 5.5.

5.4 Channel 1 Functions

Function		Setting
Mode selection	by switch	Terminal/modem mode
Baud rate		300, 600, 1200, 2400, 4800, 9600, 19200 (bps)
Handshaking		Hardware (1 character)/software (flow control) handshaking
Character specifications: Character length		8 bits. The most significant bit (MSB) is 0 at output and ignored at input.
Character specifications: Parity bit		None
Character specifications: Stop bit length		2 bits

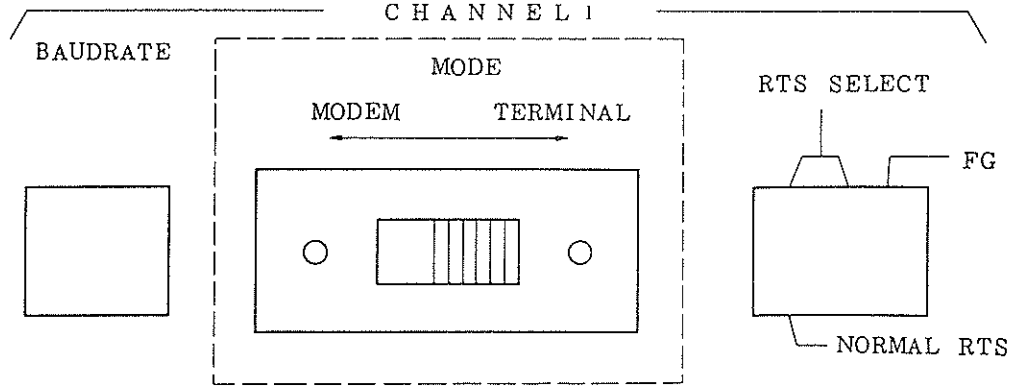
Use channel 1 to connect the IE-78310A-R to the terminal (console) or host machine through the RS-232-C interface cable.

Each table column is explained in detail.

Terminal mode/modem mode selection

Select the terminal mode or modem mode by sliding the switch on the front panel of the IE-78310A-R. (See Figure 5-9.)

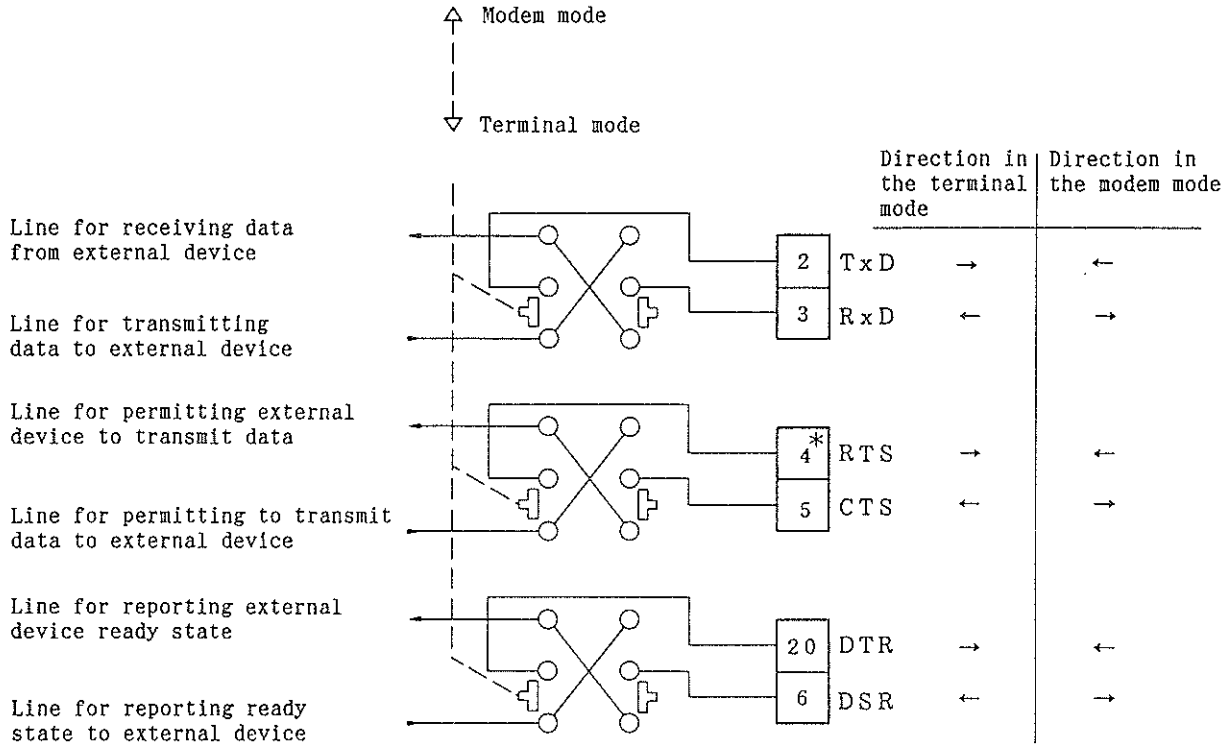
Fig. 5-9 Channel 1 Setting on the Front Panel of the IE-78310A-R



Device connected	IE-78310A-R mode
Terminal (MD-910TM, etc.)	Modem
Host machine (MD-086FD, etc.)	Terminal

Figure 5-10 is an example of a circuit diagram showing how the slide switch works.

Fig. 5-10 Channel 1 Circuit



* See Section 5.5.2.

5.4.1 RTS setting

Pin #4 is assigned for RTS in the RS-232-C interface. But in other devices, pin No.4 is left active and another pin is assigned for signal lines having the equivalent RTS function.

Pins other than #4 should be able to be connected to RTS for hardware handshaking with such devices.

The IE-78310A-R accepts connection to a pro-typer, one of such devices.

Follow Figure 5-11 for RTS setting.

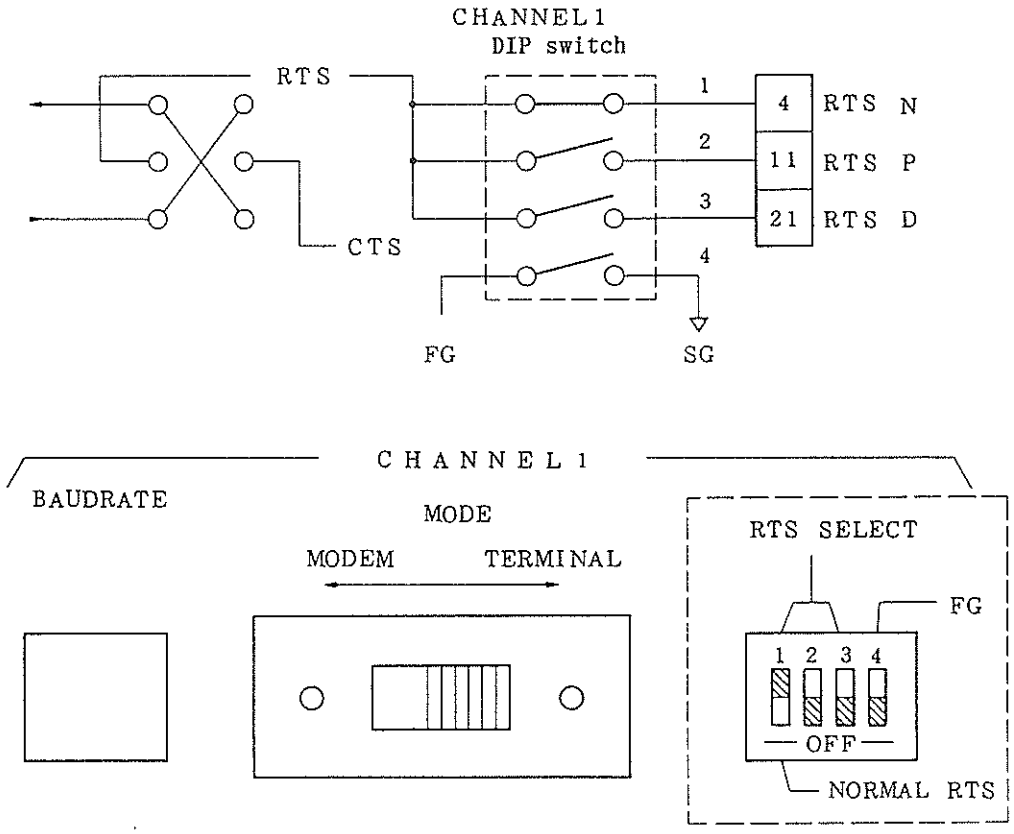
Always set the corresponding DIP switch to the RTSN setting except when a pro-typer is connected.

Set to RTSN for MD-910TM connection.

The baud rate for this particular connection is up to 9600 bps.

To conclude, fixed setting to RTSN is satisfactory for connecting the host machine to the IE-78310A-R in system mode using the MD-910TM console in the stand-alone mode.

Fig. 5-11 Channel 1 Setting on IE-78310A-R Front Panel



RTS name selection	RTS, FG setting (CH 1)				Device connected
	1	2	3	4*	
RTSN	ON	OFF	OFF	OFF	Host machine, PROM programmer, MD-910TM
RTSP	OFF	ON	OFF	OFF	Pro-typer
RTSD	OFF	OFF	ON	OFF	DDY-86

Use this setting for ordinary use.

* Channel 1 DIP switch #4 sets signal ground (SG) and frame ground (FG) to common (ON) or open (OFF). Ordinary setting is open (OFF).

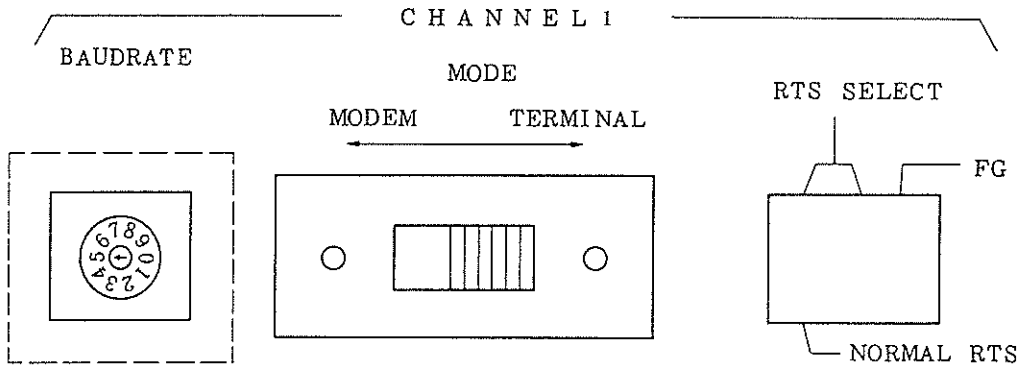
5.4.2 Baud rate selection

Use the same baud rate for the IE-78310A-R and the terminal or host machine to be connected.

Select the baud rate by sliding the micro DIP switch.

Figure 5-12 shows how to select the baud rate.

Fig. 5-12 Channel 1 Baud Rate Setting on the Front Panel of the IE-78310A-R



Switch position	Baud rate (bps)
0	300
1	600
2	1200
3	2400
4	4800

Switch position	Baud rate (bps)
5	9600
6	19200
7	0*
8	300
9	600

* Do not set to this position as data cannot be transferred because no pulse is generated.

5.4.3 Handshaking

This section describes the hardware handshaking function with the CTS, DSR, and DTR handshake signals connected and the software handshake function with those signals disconnected, taking modem-mode operation as an example.

(a) Hardware handshaking

Data transmission

When both RTS and DTR are active, the IE-78310A-R assumes that the terminal is ready to receive data and transmits data to RxD.

Data reception

Always keep DSR in the active state. Set CTS to the inactive state while data reception is not yet ready. Reset CTS to the active state when data can be accepted. The IE-78310A-R then receives data from TxD.

The IE-78310A-R reverses the RxRDY pin on the uPD8251AF IC, which is used as the RS-232-C interface, and outputs the data to CTS.

When the data is transferred from the RS-232-C to the reception buffer, the RxRDY pin is set to 1. When the data is transferred from this buffer to the IE-78310A-R CPU, the RxRDY pin is reset to 0.

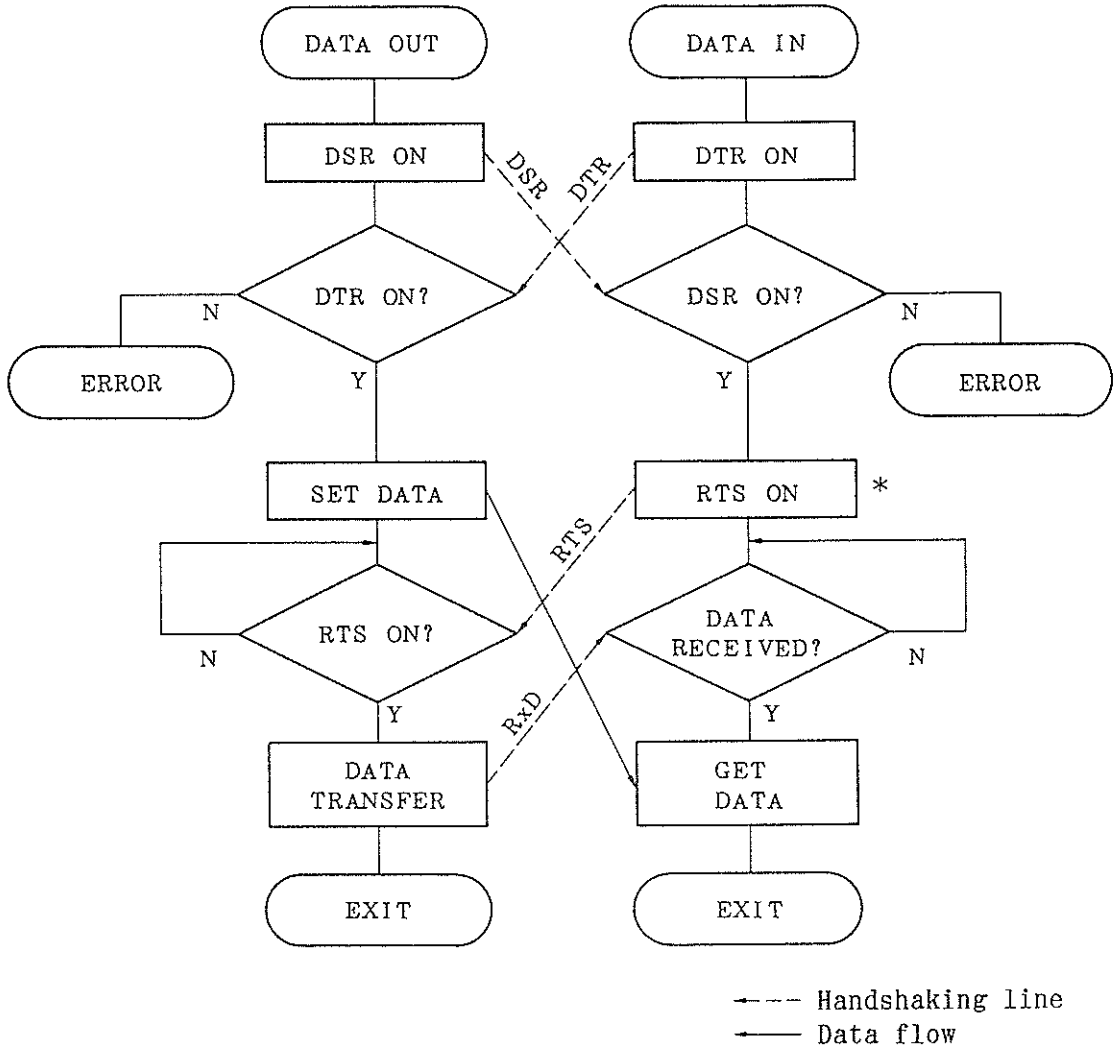
This function controls CTS so that the terminal does not transmit the succeeding data until the reception buffer is emptied.

The dynamic handshake signals, which are used to control data byte by byte, are also called 1-character handshake signals.

Figure 5-13 and Figure 5-14 are flowcharts for hardware handshaking.

Fig. 5-13 Handshaking

Modem-to-terminal transfer

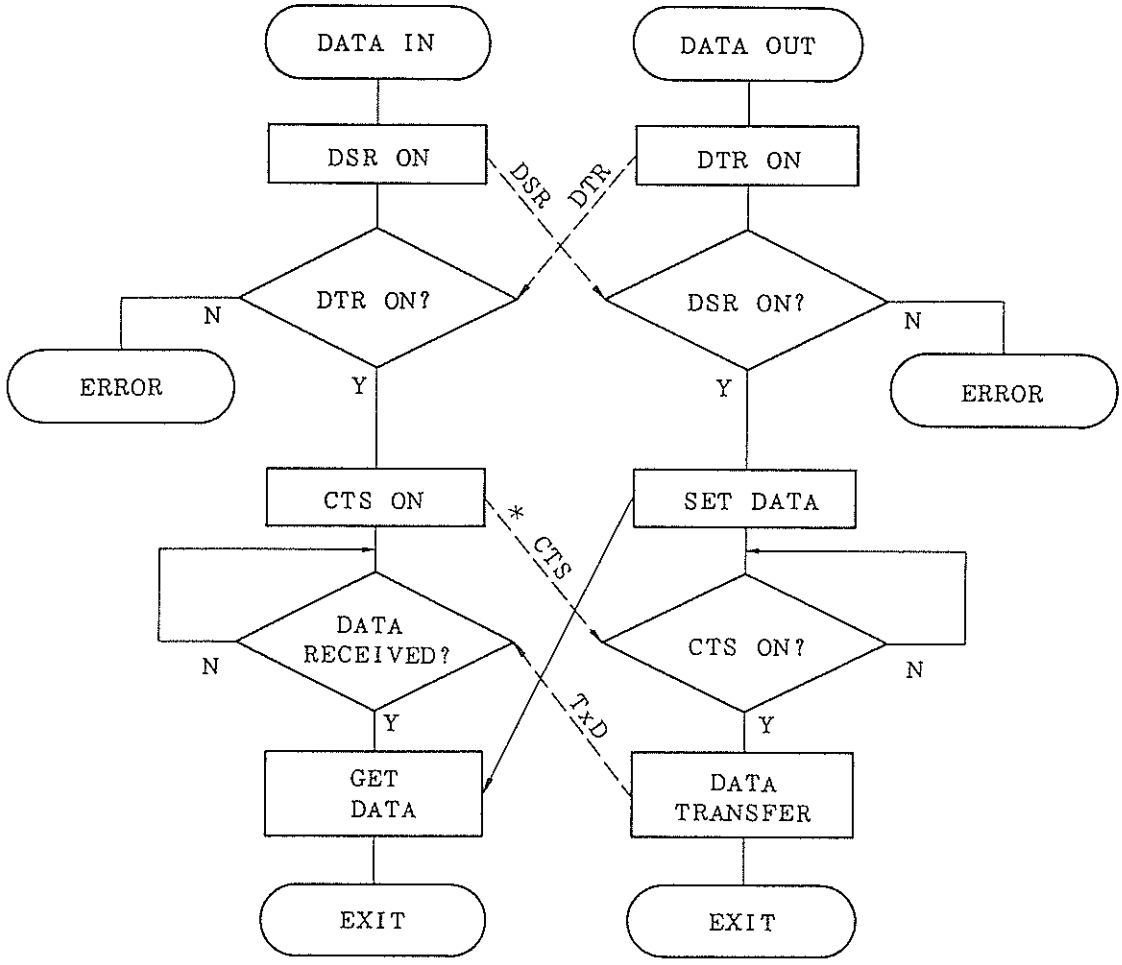


① Turn on the power to turn DSR on.	① Turn on the power to turn DTR on.
② Monitor the DTR pin. OFF is error and ON means go to the next step.	② Monitor the DTR pin. OFF is error and ON means go to the next step.
③ Set the data to be transferred.	③ Turn RTS on and permit data to be transferred to the external device.
④ Do not start transferring data until the RTS comes on.	④ Check by polling to see if data reception is completed.
⑤ Transfer the data.	⑤ Read the data.

* Turn RTS on to pulse.

Fig. 5-14 Handshaking

Terminal-to-modem transfer



① Turn on the power to turn DSR on.

② Monitor the DTR pin. OFF is error and ON means go to the next step.

③ Turn CTS on and permit data to be transferred to the external device.

④ Check by polling to see if data reception is completed.

⑤ Read the data.

① Turn on the power to turn DTR on.

② Monitor the DTR pin. OFF is error and ON means go to the next step.

③ Set the data to be transferred.

④ Do not start transferring the data until CTS comes on.

⑤ Transfer the data.

* Turn CTS on to pulse.

(b) Software handshaking

Data transmission

The IE-78310A-R assumes that the terminal is always ready to receive data and transmits data to RxD. It stops transmitting data when it receives Ctrl-S from the terminal via TxD.

Channel 1 of the IE-78310A-R stops transmitting data 4 or 5 characters after receiving Ctrl-S.

The IE-78310A-R resumes data transmission when it receives Ctrl-Q from the terminal via TxD.

Data reception

The IE-78310A-R always accepts data. It receives data by interrupt processing and saves the received data in the buffer. When the buffer is about to overflow, it transmits Ctrl-S to the terminal via RxD requesting to stop transmitting data for a while. The data transmitted immediately after this request is accepted in the buffer.

Then the IE-78310A-R transfers the buffer data to its CPU. When the buffer is almost empty, it transmits Ctrl-Q to the terminal via RxD requesting the resumption of data transmission.

The IE-78310A-R channel 1 issues Ctrl-S when its 128-byte buffer is 50% full.

Then the IE-78310A-R channel 1 issues Ctrl-Q when the buffer is 35% filled with data.

Therefore, some data may be lost when the terminal connected to channel 1 is the kind that transmits 128/2 bytes or more data, after receiving Ctrl-S.

Unlike hardware handshaking, which controls data byte by byte, the software handshaking function controls data by blocks.

The software handshaking is also called flow control.

Channel 1 employs both hardware handshaking and software handshaking to transfer data. Channel 1 is provided with a 128-byte data buffer for saving serial data. When the buffer is 50% full, channel 1 issues Ctrl-S requesting to stop data transmission, and when the buffer is 35% full it issues Ctrl-Q requesting the resumption data transmission.

The hardware handshaking function eliminates overwriting of data by adjusting the hardware. Moreover, it manipulates CTS signals to completely stop the hardware from transferring data when the buffer is almost full.

Therefore, when the handshake signals are connected, the data will never be lost.

When the hardware signals are disconnected, the software handshaking function alone is effective. Be aware of the buffer capacity, which cannot hold 128/2 bytes or more data transferred after receiving Ctrl-S. In this case, some data may be lost.

5.4.4 Character specifications

The character specifications at data transmission/reception are as follows.

(a) Character length

The character length is fixed to 8 bits.

The most significant bit (MSB) is always 0 for IE-78310A-R output.

The most significant bit (MSB) is ignored and always assumed to be 0 for IE-78310A-R input.

(b) Parity bit

No parity bit is provided.

(c) Stop bit

The stop bit is fixed to 2 bits.

5.5 Channel 2 Functions

Function		Setting	
Mode selection		Terminal/modem mode by switching	
Baud rate		Software switching	300, 600, 1200, 2400, 4800, 9600, 19200 (bps)
Handshaking			Hardware (1-character) handshaking or software (flow-control) handshaking
Character specifications	Character		7 bits or 8 bits. For 8-bit specification, the most significant bit (MSB) is 0 at output and ignored at input.
	Parity bit		Even parity/odd parity/no parity
	Stop bit length		1 bit/2 bits

Use channel 2 to connect the IE-78310A-R to the PROM programmer.

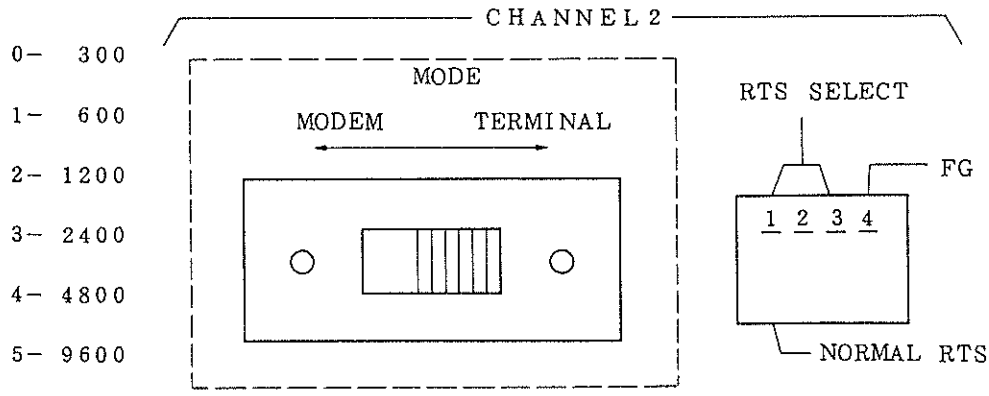
All channel 2 settings, except for the terminal mode/modem mode selection, can be done by means of software (commands), thus enhancing the choice of devices to be connected.

Each table column is explained in detail.

5.5.1 Terminal mode/modem mode selection

Select the terminal mode or modem mode by sliding the switch on the front panel of the IE-78310A-R. (See Figure 5-15.)

Fig. 5-15 Channel 2 Setting on the Front Panel of the IE-78310A-R



Mode setting instructions are given supposing that the PROM programmer (PG-2000) is connected. (This also applies to PG-1500.)

The PG-2000 is a device with the modem mode interface function.

Use the attached cable to connect the PG-2000 to the IE-78310A-R in the modem mode.

Caution:	The IE-78310A-R can be connected to the PG-2000 both in the modem mode because the cable attached to the PG-2000 is internally modified to accommodate such connection. Be sure to use the cable attached to the PG-2000 to connect them. Never use other cables.

Figure 5-16 shows connection by the cable attached to the PG-2000.

Fig. 5-16 Connection by the Cable Attached to PG-2000

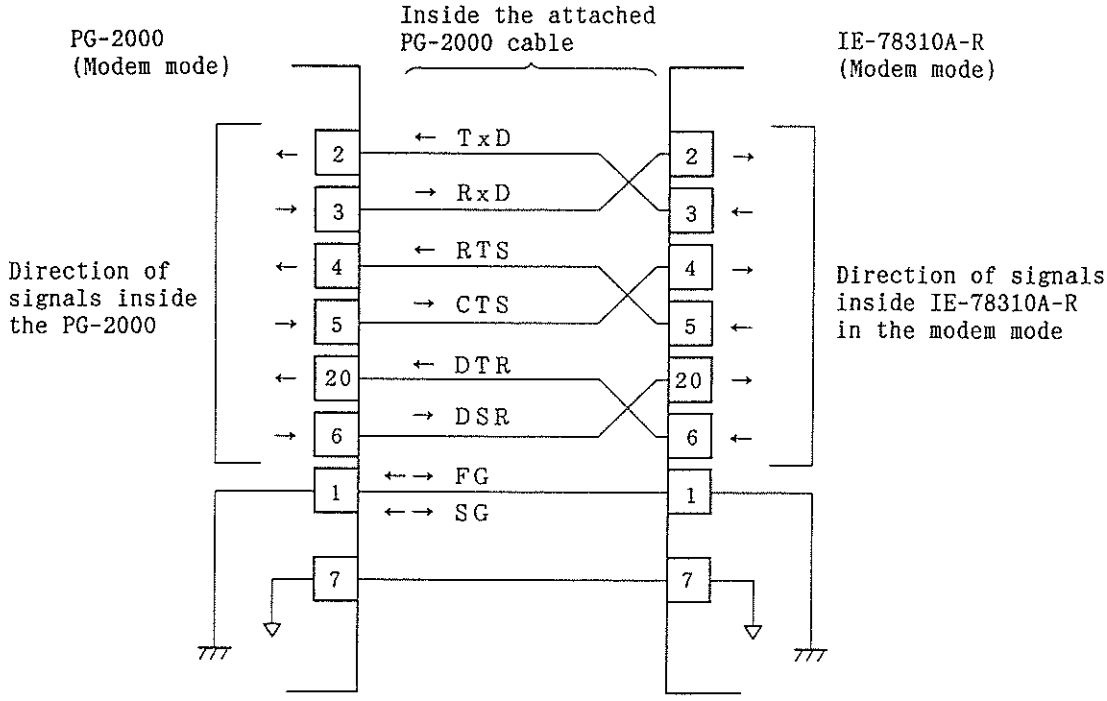
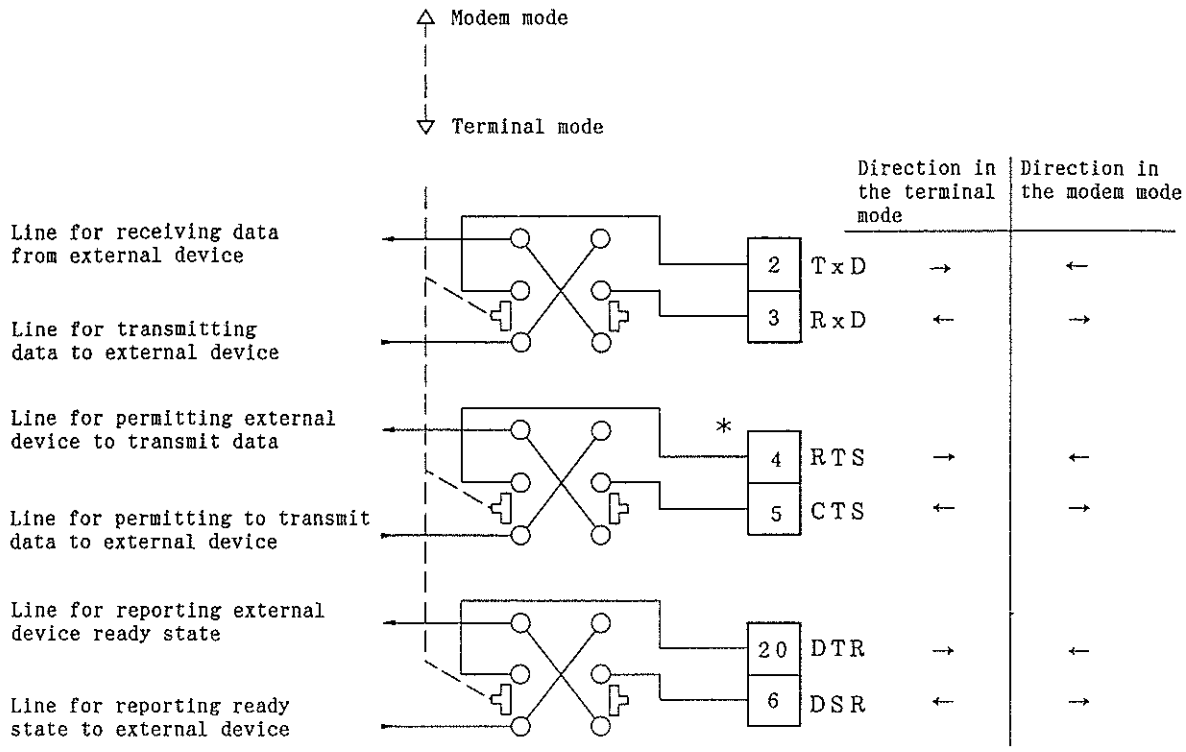


Figure 5-17 is an example of a circuit diagram showing how the slide switch works.

Fig. 5-17 Channel 2 Circuit



* See Section 5.5.2.

5.5.2 RTS setting

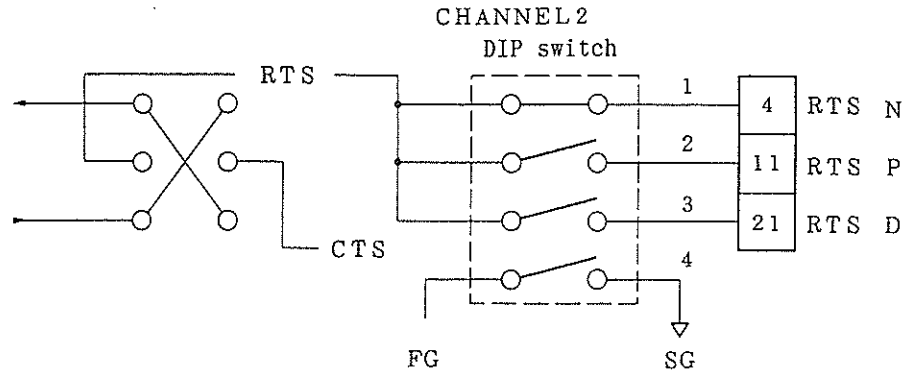
Pin #4 is assigned for RTS in the RS-232-C interface. But in other devices, pin No.4 is left active and another pin is assigned for signal lines having the equivalent RTS function. Pins other than #4 should be able to be connected to RTS for hardware handshaking with such devices.

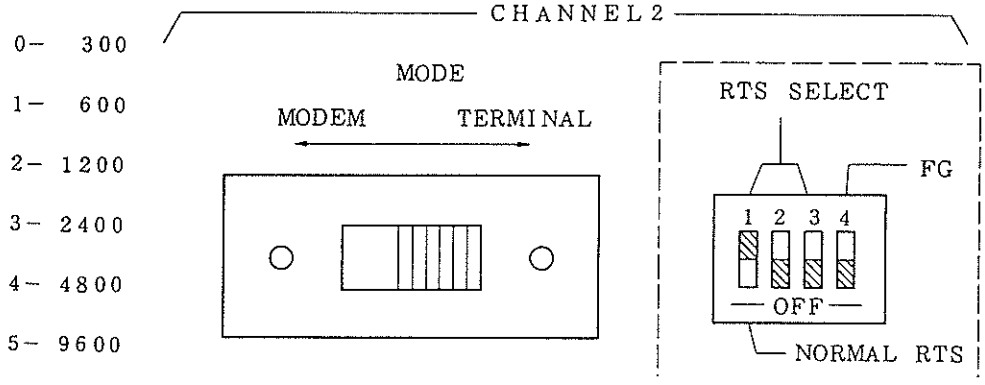
The IE-78310A-R accepts connection to a pro-typer, one of such devices.

Follow Figure 5-18 for RTS setting.

Always set the corresponding DIP switch to the RTSN setting except when a pro-typer is connected.

Fig. 5-18 Channel 2 Setting on IE-78310A-R Front Panel





RTS name selection	RTS, FG setting (CH 2)				Device connected
	1	2	3	4*	
RTSN	ON	OFF	OFF	OFF	Host machine, PROM programmer, MD-910TM
RTSP	OFF	ON	OFF	OFF	Pro-typer
RTSD	OFF	OFF	ON	OFF	DDY-86

Use this setting for ordinary use.

* Channel 2 DIP switch #4 sets signal ground (SG) and frame ground (FG) to common (ON) or open (OFF). Ordinary setting is open (OFF).

5.5.3 Baud rate selection

Use the same baud rate for the IE-78310A-R and the terminal or host machine to be connected.

Select the baud rate by means of software (commands).

Enter commands in the terminal (console) connected to the IE-78310A-R channel 1.

The following shows the baud rate setting.

Channel 2 mode setting command

MOD[_MODE={CHAR / FLOW}][_BAUD={19200 / 9600 / 4800 / 2400 / 1200 / 600 / 300}][_LONG={7 / 8}][_PAR={NON / EVEN / ODD}][_STOP={1 / 2}]

MODE: Handshaking mode selection
BAUD: Baud rate selection
LONG: Character length selection
PAR: Parity bit selection
STOP: Stop bit length selection

Use the MOD command to specify the operating state of serial channel 2. If the command operand has been omitted, the interactive mode is available for setting the operating state.

The initial settings are 1-character handshaking, 9600 bauds, 8-bit length, no parity bit, and 2 stop bits.

Example:

```
*MOD MODE=CHAR BAUD=4800 LONG=8 PAR=NON STOP=2 <cr>
*
```

This command sets character handshaking to 1, the baud rate to 4800, the character length to 8 bits, the parity bit to unavailable, and the stop bit to 2 .

```
*MOD <cr>                  ← Sets channel 2 operating state by interactive
                             mode
_MODE__CHAR_= FLOW <cr>    ← Resets to buffer control mode
_BAUD__4800_= 9600 <cr>    ← Resets baud rate to 9600
_LONG_____8_= <cr>         ← Does not reset character length
_PAR____NON_= EVEN <cr>    ← Resets to even parity check
_STOP_____2_= 1 <cr>       ← Resets stop bit length to 1
*
```

5.5.4 Handshaking

This section describes the hardware handshaking function with the CTS, DSR, and DTR handshake signals connected and the software handshake function with those signals disconnected, taking modem-mode operation as an example.

(a) Hardware handshaking

Data transmission

When both RTS and DTR are active, the IE-78310A-R assumes that the terminal is ready to receive data and transmits data to RxD.

Data reception

Always keep DSR in the active state. Set CTS to the inactive state while data reception is not yet ready. Reset CTS to the active state when data can be accepted. The IE-78310A-R then receives data from TxD.

The IE-78310A-R reverses the RxRDY pin on the uPD8251AF IC, which is used as the RS-232-C interface, and outputs the data to CTS.

When the data is transferred from the RS-232-C to the reception buffer, the RxRDY pin is set to 1. When the data is transferred from this buffer to the IE-78310A-R CPU, the RxRDY pin is reset to 0.

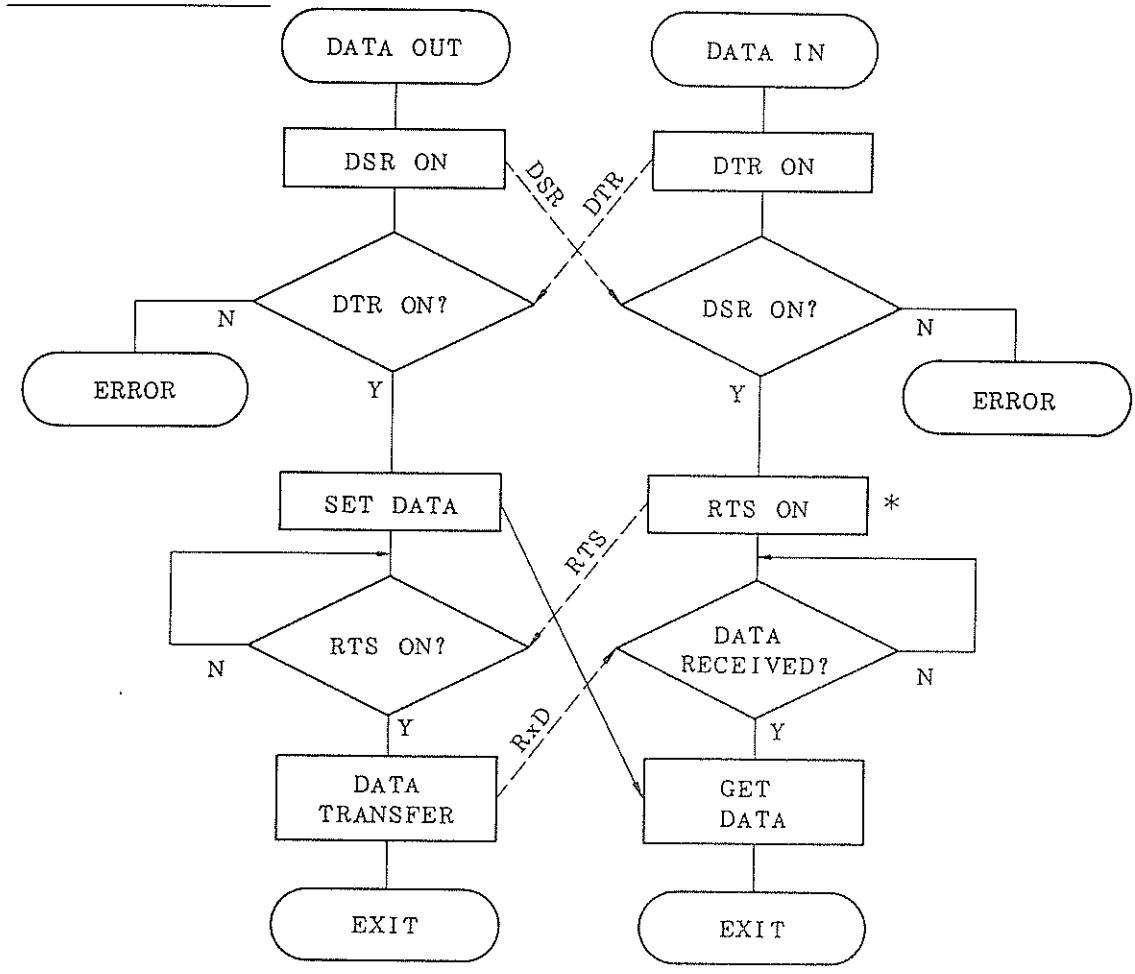
This function controls CTS so that the terminal does not transmit the next data until the reception buffer is emptied.

The dynamic handshake signals, which are used to control data byte by byte, are also called 1-character handshake signals.

Figure 5-19 and Figure 5-20 are flowcharts for hardware handshaking.

Fig. 5-19 Handshaking

Modem-to-terminal transfer



① Turn on the power to turn DSR on.

② Monitor the DTR pin. OFF is error and ON means go to the next step.

③ Set the data to be transferred.

④ Do not start transferring data until the RTS comes on.

⑤ Transfer the data.

① Turn on the power to turn DTR on.

② Monitor the DTR pin. OFF is error and ON means go to the next step.

③ Turn RTS on and permit data to be transferred to the external device.

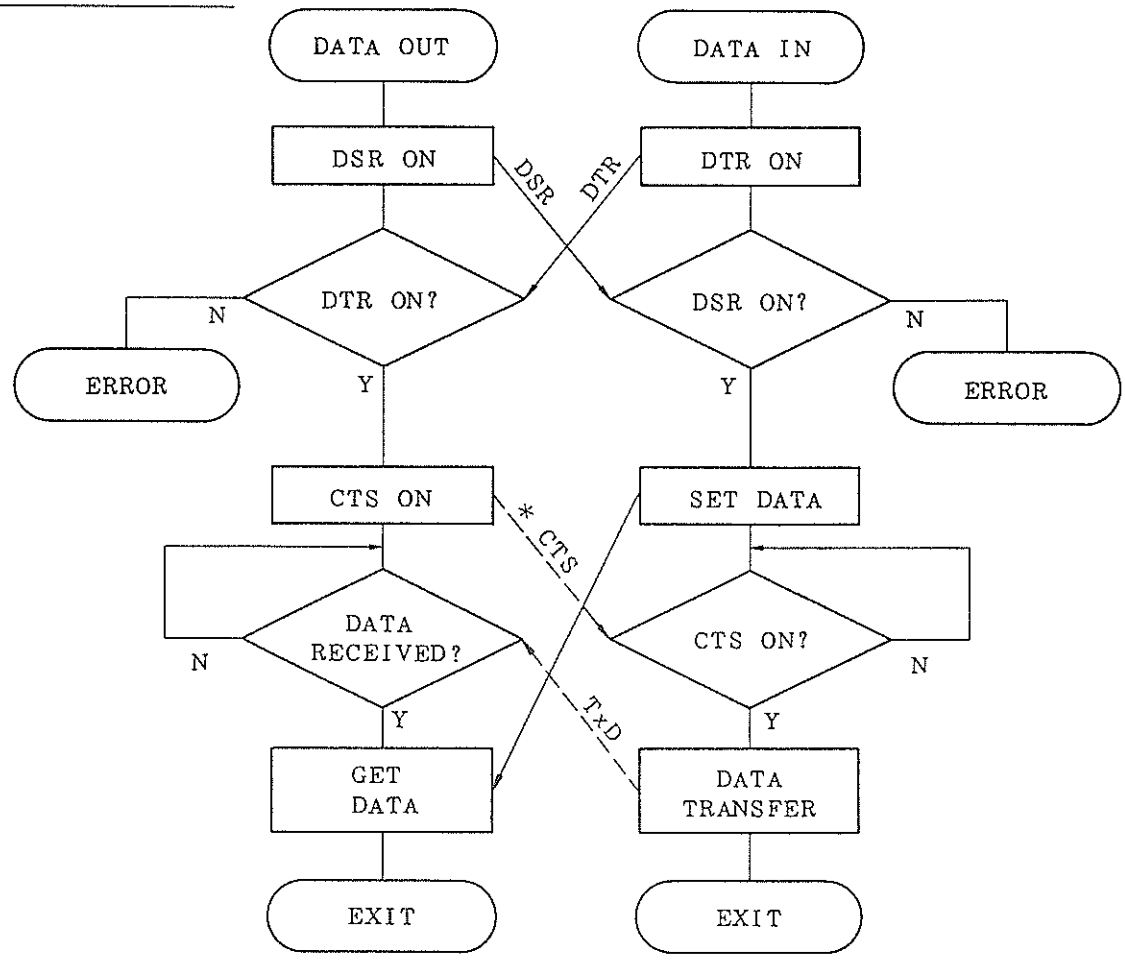
④ Check by polling to see if data reception is completed.

⑤ Read the data.

* Turn RTS on to pulse.

Fig. 5-20 Handshaking

Terminal-to-modem transfer



① Turn on the power to turn DSR on.

② Monitor the DTR pin. OFF is error and ON means go to the next step.

③ Turn CTS on and permit data to be transferred to the external device.

④ Check by polling to see if the data reception is completed.

⑤ Read the data.

① Turn on the power to turn DTR on.

② Monitor the DSR pin. OFF is error and ON means go to the next step.

③ Set the data to be transferred.

④ Do not start transferring the data until CTS comes on.

⑤ Transfer the data.

* Turn CTS on to pulse.

(b) Software handshaking

Data transmission

The IE-78310A-R assumes that the terminal is always ready to receive data and transmits data to RxD. It stops transmitting data when it receives Ctrl-S from the terminal via TxD.

Channel 2 of the IE-78310A-R stops transmitting data 4 or 5 characters after receiving Ctrl-S.

The IE-78310A-R resumes data transmission when it receives Ctrl-Q from the terminal via TxD.

Data reception

The IE-78310A-R always accepts data. It receives data by interrupt processing and saves the received data in the buffer. When the buffer is about to overflow, it transmits Ctrl-S to the terminal via RxD requesting to stop transmitting data for a while. The data transmitted immediately after this request is accepted in the buffer.

Then the IE-78310A-R transfers the buffer data to its CPU. When the buffer is almost empty, it transmits Ctrl-Q to the terminal via RxD requesting the resumption of data transmission.

The IE-78310A-R channel 2 issues Ctrl-S when its 96-byte buffer is 50% full. It issues Ctrl-Q when the buffer is 35% filled with data.

Therefore, some data may be lost when the terminal connected to channel 2 is the kind that transmits 96/2 bytes or more data after receiving Ctrl-S.

Unlike hardware handshaking, which controls data byte by byte, the software handshaking function controls data by blocks.

The software handshaking is also called flow control.

Channel 2 employs either hardware handshaking or software handshaking to transfer data.

The two handshaking methods can be specified in the command setting shown below.

Channel 2 mode setting command

MOD[_MODE={CHAR / FLOW}][_BAUD={19200 / 9600 / 4800 / 2400 / 1200 / 600 / 300}][_LONG={7 / 8}][_PAR={NON / EVEN / ODD}][_STOP={1 / 2}]

MODE: Handshaking mode selection
BAUD: Baud rate selection
LONG: Character length selection
PAR: Parity bit selection
STOP: Stop bit length selection

Use the MOD command to specify the serial channel 2 operating state. If the command operand has been omitted, interactive mode is available for setting the operating state.

The initial settings are 1-character handshaking, 9600 bauds, 8 bit length, no parity bit, and 2 stop bits.

Example:

```
*MOD MODE=CHAR BAUD=4800 LONG=8 PAR=NON STOP=2 <cr>
*
```

This command sets character handshaking to 1, the baud rate to 4800, the character length to 8 bits, the parity bit to unavailable, and the stop bit to 2.

```
*MOD <cr>                  ← Sets channel 2 operating state by interactive
                             mode
_MODE__CHAR_=_FLOW <cr>    ← Resets to buffer control mode
_BAUD__4800_=_9600 <cr>    ← Resets baud rate to 9600 baud
_LONG_____8_=_<cr>         ← Does not reset character length
_PAR____NON_=_EVEN <cr>    ← Resets to even parity check
_STOP_____2_=_1 <cr>       ← Resets stop bit length to 1
*
```

Be aware that the hardware handshaking (1-character handshaking: CHAR) does not have any buffer. So if this is selected without connecting the handshake signals, handshaking cannot be executed correctly.

Always connect handshake signals before selecting hardware handshaking.

When the software handshaking (flow (buffer) control: FLOW) is selected, the 96-byte buffer is available for saving serial data. When the buffer is 50% filled with data, channel 2 issues Ctrl-S requesting to stop data transmission, and when the buffer is 35% full, it issues Ctrl-Q requesting the resumption of data transmission.

When 96/2 bytes or more data are transferred after receiving Ctrl-S, which is over the buffer capacity, some data may be lost.

5.5.5 Character specifications

(a) Character length

Select 7 bits or 8 bits by means of software (commands).

When 8 bits is selected, the most significant bit (MSB) is always 0 for IE-78310A-R output and is ignored and assumed to be always 0 for IE-78310A-R input.

(b) Parity bit

Select even parity/odd parity/no parity by means of software (commands).

(c) Stop bit length

Select 1 bit or 2 bits by means of software (commands).

CHAPTER 6 CONNECTING THE TARGET SYSTEM

6.1 Overview

Chapter 6 explains the method for connecting the target system using the uPD78312A or uPD78310A to the IE-78310A-R.

Be sure to read this chapter before connecting the target system.

Chapter 6 consists of the following sections.

6.2 Debugging Software
6.3 Connecting the Target System
6.4 Differences between Real Device and Target Interface Circuit of IE-78310A-R
6.5 Latch-up

If the hardware of the target system is not developed at all, debugging logic can be used for the software in the IE-78310A-R.

Section 6.2 describes how to set the IE-78310A-R for debugging only software.

To debug the developed hardware or both the software and hardware of the target system, connect the target probe of the IE-78310A-R to the target system.

Section 6.3 describes how to set the IE-78310A-R for debugging the hardware or both the software and hardware of the target system.

If debugging is started after the target system is connected to the IE-78310A-R, the IE-78310A-R emulates the target system as if the real device (uPD78312A or uPD78310A) operates.

In particular, since the target interface circuit of the IE-78310A-R emulates the operation of the real device, both will differ in small points.

Section 6.4 describes the differences between the real device and the target interface circuit of the IE-78310A-R.

Section 6.5 describes latch-up.

6.2 Debugging Software

When the IE-78310A-R is used to debug software, the same signal as the clock signal to be used in the target system can be set as the basic clock signal of the IE-78310A-R.

If the same element as the oscillator used in the target system is connected to the part base on the emulation board, software operation can be emulated at the same frequency as in the target system.

When the clock is already set internally by software (commands), the basic clock signal is generated from the crystal oscillator (12 MHz) on the emulation board of the IE-78310A-R.

Since the $\overline{EA}$ terminal goes high while the software is being debugged, emulation in the ROMLESS mode cannot be performed.

The following setting procedure shall be performed to debug the software:

① Turn off the power switch of the IE-78310A-R.

② Set the basic clock of the IE-78310A-R.

③ Connect the target probe of the IE-78310A-R to the self-diagnostic socket of the IE-78310A-R. (Use the target probe for SHRINK DIP.)

The ground clip of the target probe need not be connected to pin GND.

Caution

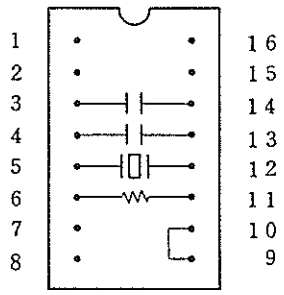
At shipment, the basic clock is set so as to use an external clock (input at pin 30 of the target probe).

When an external clock is not used, set the clock by software (commands) so as to use the internal clock.

6.2.1 Setting the basic clock of the IE-78310A-R

(1) Using a ceramic or crystal oscillator

① Connect the pins with resistor Rx, capacitor Ca, and capacitor Cb which conform to the oscillator to be used for the accessory base and the oscillating frequency.



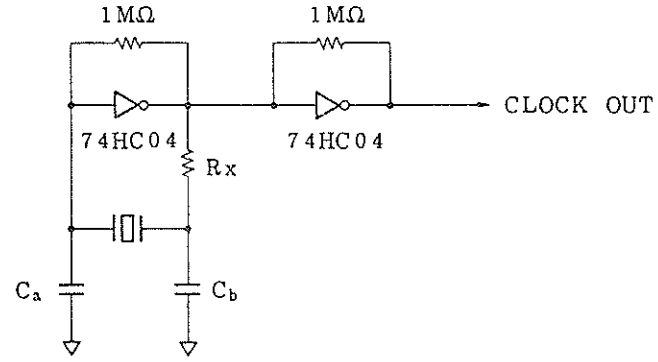
[Part base]

Pin combination number

Ceramic or crystal oscillator	5-12
Resistor Rx	6-11
Capacitor Ca	4-13
Capacitor Cb	3-14
Jumper lead	9-10

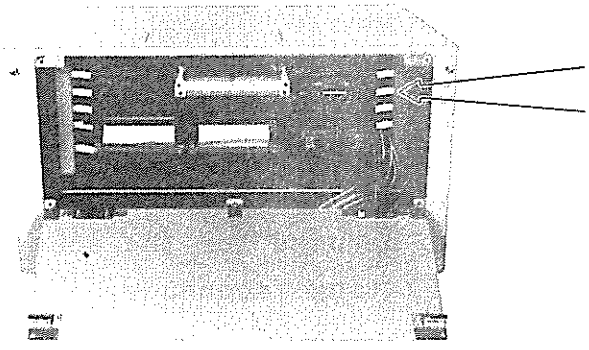
[Connection]

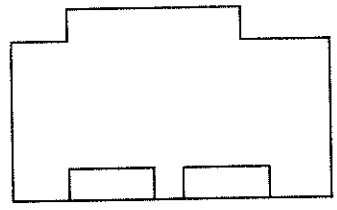
The circuit diagram for the above connection is as follows:



② Turn off the power switch of the IE-78310A-R.

③ Open the cover at the right of the IE-78310A-R and remove the emulation board.

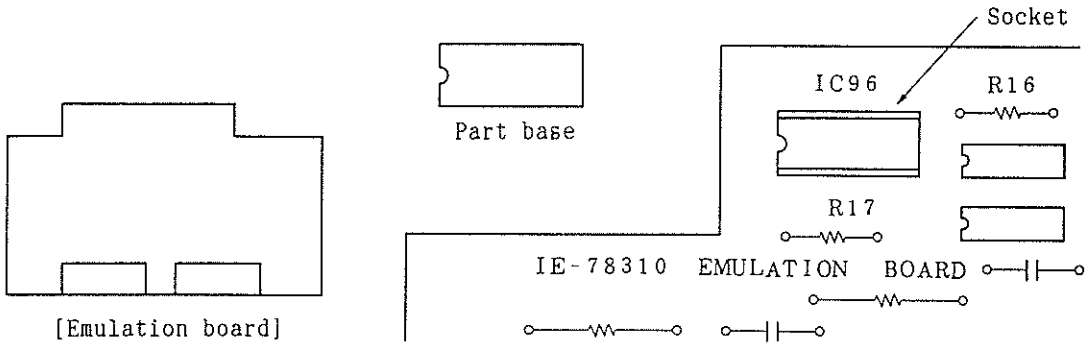




[Emulation board]

④ Fit the part base into the socket (IC96) on the emulation board.

Note: Pay careful attention to the direction of the IC mark in this step.



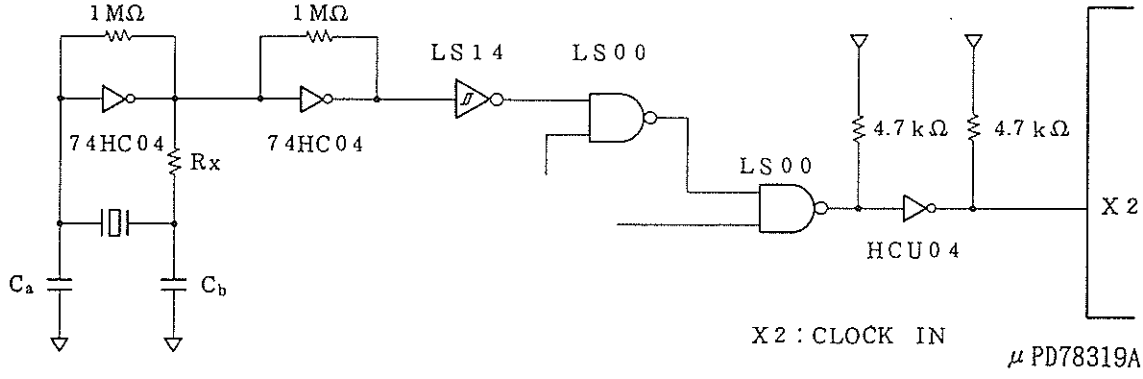
[Enlargement of emulation board]

⑤ Install the emulation board in the IE-78310A-R.

This completes the setting procedure. Turn on the power to the IE-78310A-R.

The oscillator fitted by the above setting generates the basic clock signal to the IE-78310A-R.

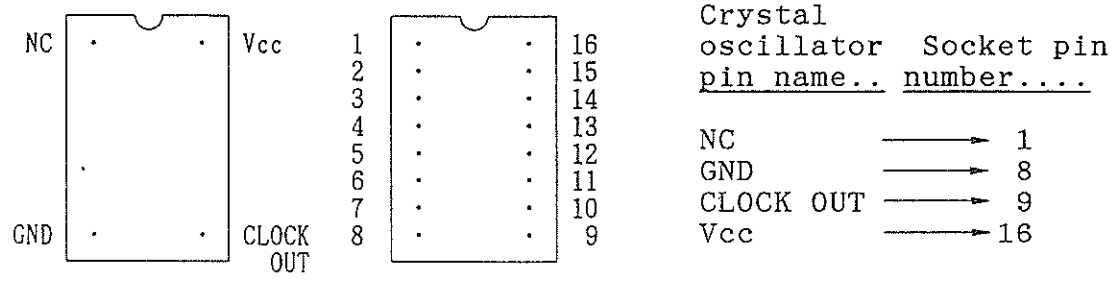
This circuit diagram is as follows:



(2) Using a crystal oscillator

① Check whether the pins of the crystal oscillator to be used correspond to the socket pins as shown in the following figure.

Note: Be sure to use the crystal oscillator whose pins are arranged as shown in the following figure.



[Crystal oscillator] [Socket] [Connection]

② Turn off the power switch of the IE-78310A-R.

③ Open the cover at the right of the IE-78310A-R and remove the emulation board.

④ Fit the crystal oscillator to be used into the socket on the emulation board.

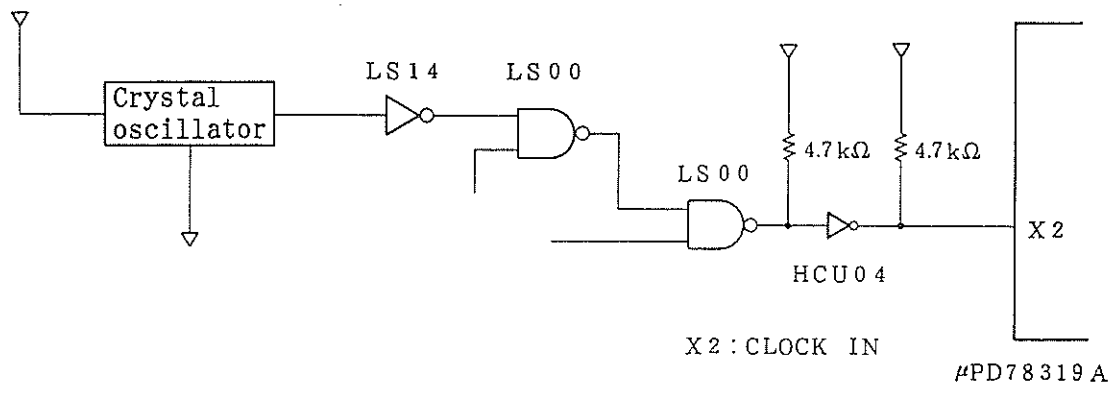
Note: Pay careful attention to the direction of the IC mark in this step.

⑤ Install the emulation board in the IE-78310A-R.

This completes the setting procedure. Turn on the power to the IE-78310A-R.

The oscillator fitted by the above setting generates the basic clock signal to the IE-78310A-R.

This circuit diagram is as follows:



6.2.2 Connecting the target probe

Since the self-diagnostic socket on the self-check board is a SHRINK DIP type, use the target probe which is a SHRINK DIP type.

① Turn off the power switch of the IE-78310A-R.

② Open the cover at the top of the IE-78310A-R and pull the lever at the left of the self-diagnostic socket.

③ Fit the target probe into the self-diagnostic socket and push the lever.

This completes the connection procedure. Turn on the power to the IE-78310A-R.

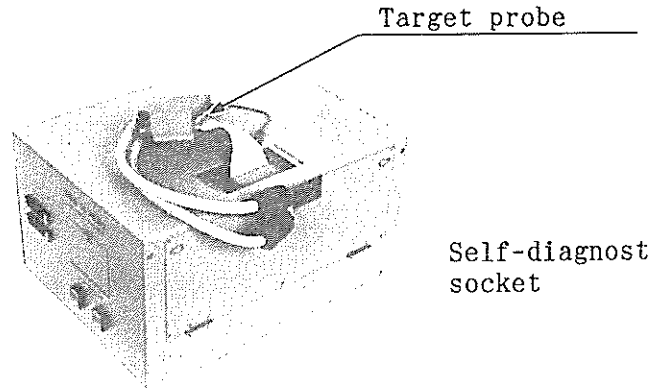
Caution

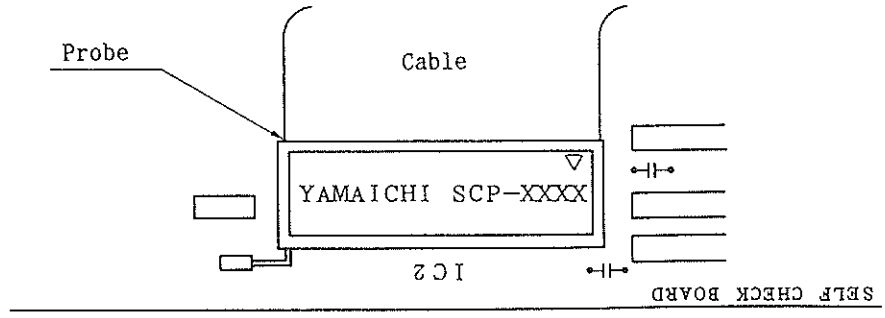
A ▽ mark, which indicates the position of pin 1, is marked on the SHRINK DIP type target probe. Fit the target probe into the self-diagnostic socket so that the mark is aligned with pin 1 of the self-diagnostic socket. (See Figure 6-1.)

The ground clip of the target probe need not be connected to pin GND.

Great care should be taken that the target probe is not fitted in reverse and the pins are not broken or bent. Otherwise, the target interface circuit of the IE-78310A-R will be destroyed.

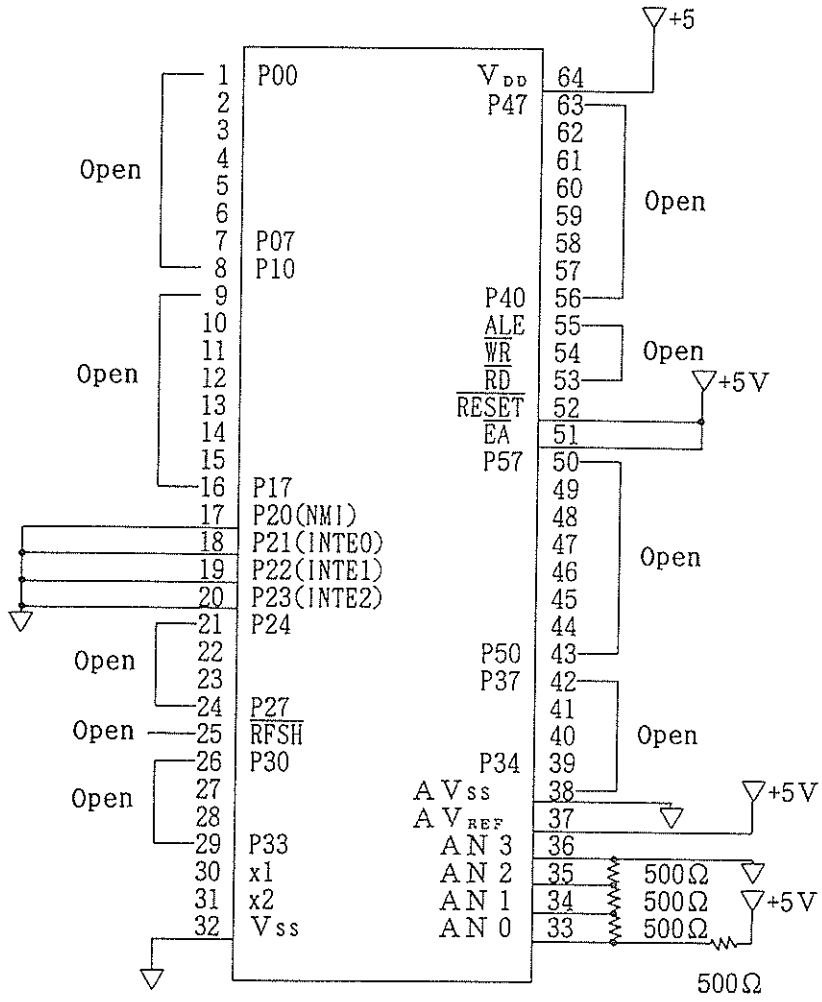
Fig. 6-1 Debugging Software





The pin status during software debugging is as shown in Figure 6-2.

Fig. 6-2 Pin Status during Software Debugging



6.3 Connecting the Target System

The same clock generating source as used in the target system can be set as the basic clock signal of the IE-78310A-R when the IE-78310A-R is used to debug both the hardware and software of the target system.

If the same oscillating element as in the target system is connected to the part base on the emulation board, operation can be emulated at the same frequency as in the target system.

If the clock signal existing in the target system is used by the uPD78312A or uPD78310A, it can be generated as is.

When the clock pulse is already set internally by software (commands), the basic clock signal is generated from the crystal oscillator (12 MHz) on the emulation board to the IE-78310A-R.

This section describes how to set the basic clock generating source of the IE-78310A-R and gives the required information to connect the target probe to the target system. Be sure to follow the caution given below. Otherwise there is danger of serious problems, such as destruction of the target system. The target system is connected in the same way whether the CPU of the target system is uPD78312A or uPD78310A.

Caution

At shipment, the part base which contains the wiring for the external clock signal (input at pin 30 of the target probe) is already fitted on the emulation board. Using this base, the clock signal used in the target system can also be used as the basic clock signal in the IE-78310A-R.

When the crystal oscillator is directly connected to pins X1 and X2 (pins 30 and 31) of the uPD78312A or uPD78310A in the target system, this oscillation signal cannot be supplied to the IE-78310A-R. In this case, install a crystal oscillator on the emulation board using the part base.

To debug both hardware and software, follow the following procedure.

① Turn off the power switch of the IE-78310A-R.

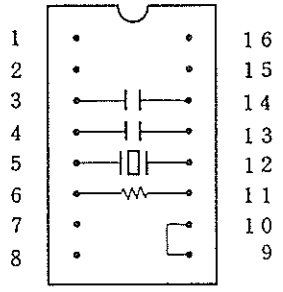
② Set the basic clock signal of the IE-78310A-R. The default in hardware is the clock signal (input at pin 30 of the target probe) in the target system.

③ Fit the target probe of the IE-78310A-R into the self-diagnostic socket of the IE-78310A-R.

6.3.1 Setting the basic clock of the IE-78310A-R

(1) Using a ceramic or crystal oscillator in the target system

① Connect the pins with resistor Rx, capacitor Ca, and capacitor Cb, which conform to the oscillator to be used for the accessory part base and the oscillating frequency.

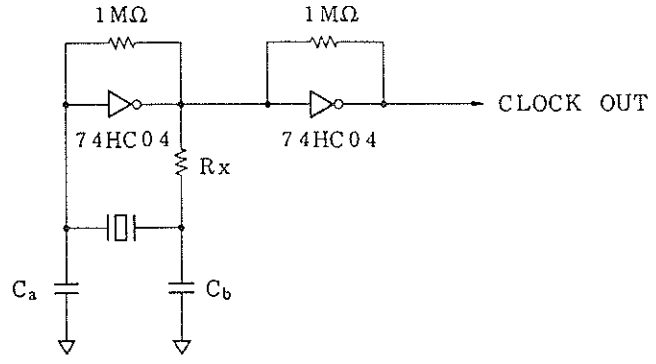


[Part base]

	Pin combination umber
Ceramic or crystal oscillator	5-12
Resistor Rx	6-11
Capacitor Ca	4-13
Capacitor Cb	3-14
Jumper lead	9-10

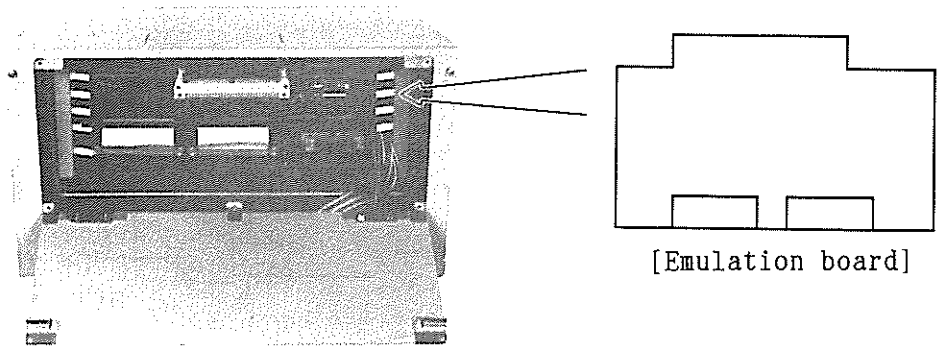
[Connection]

The circuit diagram for the above connection is as follows:



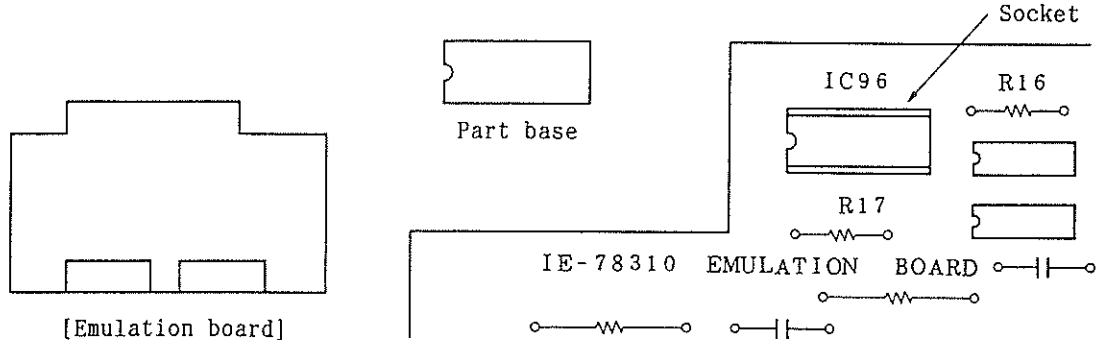
② Turn off the power switch of the IE-78310A-R.

③ Open the cover at the right of the IE-78310A-R and remove the emulation board.



④ Fit the part base into the socket (IC96) on the emulation board.

Note: Pay careful attention to the direction of the IC mark in this step.



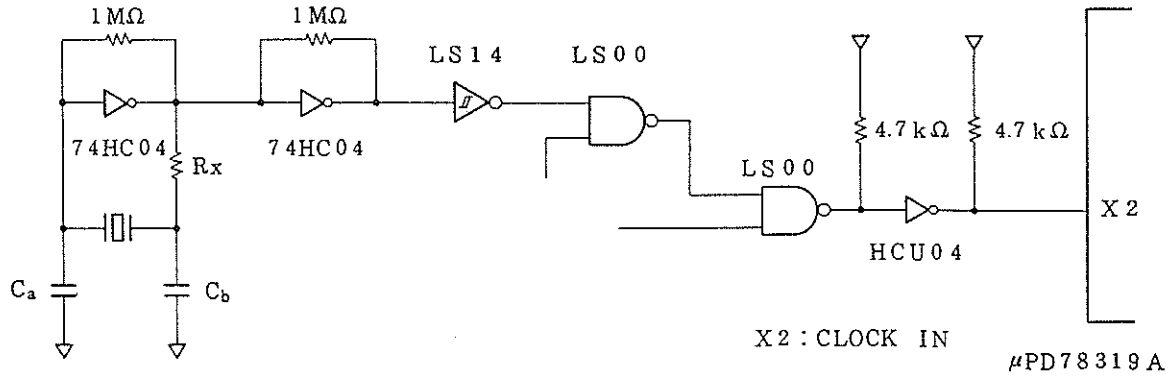
[Enlargement of emulation board]

⑤ Install the emulation board in the IE-78310A-R.

This completes the setting procedure. Turn on the power to the IE-78310A-R.

The oscillator fitted by the above setting generates the basic clock signal to the IE-78310A-R.

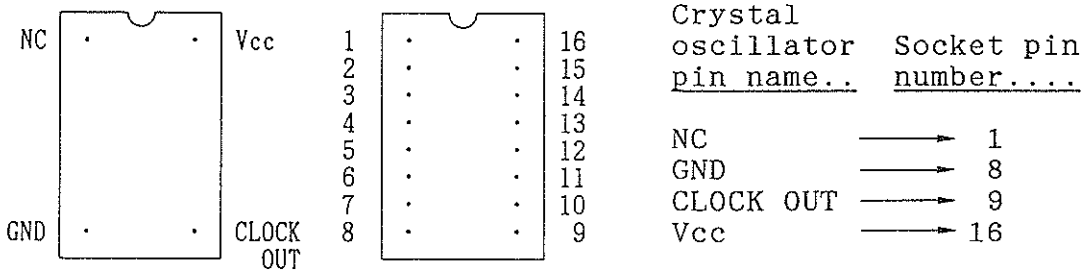
This circuit diagram is as follows:



(2) Using a crystal oscillator

① Check whether the pins of the crystal oscillator to be used correspond to the socket pins as shown in the following figure.

Note: Be sure to use the crystal oscillator whose pins are arranged as shown in the following figure.



[Crystal oscillator] [Socket] [Connection]

② Turn off the power switch of the IE-78310A-R.

③ Open the cover at the right of the IE-78310A-R and remove the emulation board.

④ Fit the crystal oscillator to be used into the socket on the emulation board.

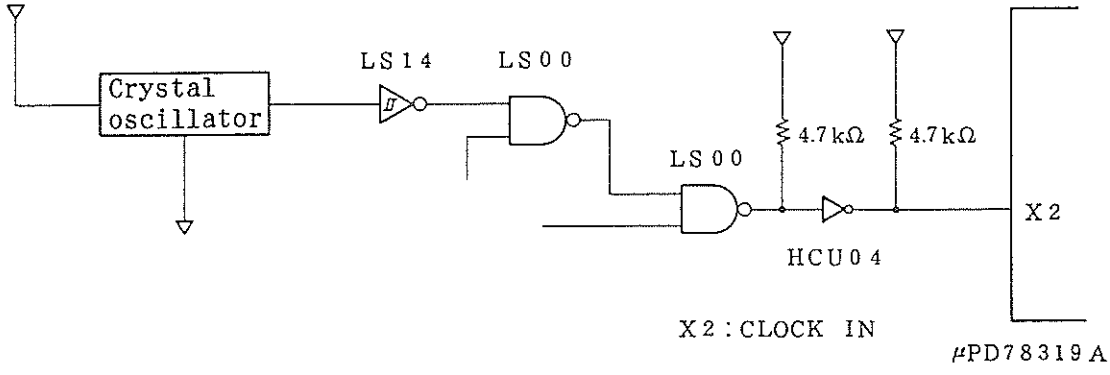
Note: Pay careful attention to the direction of the IC mark in this step.

⑤ Install the emulation board in the IE-78310A-R.

This completes the setting procedure. Turn on the power to the IE-78310A-R.

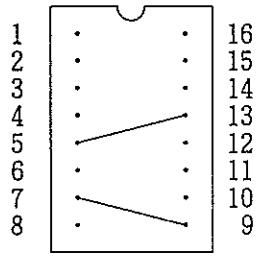
The oscillator fitted by the above setting generates the basic clock signal to the IE-78310A-R.

This circuit diagram is as follows:



(3) Using an external clock signal

① Connect the pins of the accessory part base using leads as shown in the figure below:



[Part base]

	Pin combination number
Lead	7-9
	5-13

[Connection]

Note: The part base for which wiring is performed as shown in the figure at the left is already mounted on the board at delivery.

② Turn off the power switch of the IE-78310A-R.

③ Open the cover at the right of the IE-78310A-R and remove the emulation board.

④ Fit the part base into the part base socket on the emulation board.

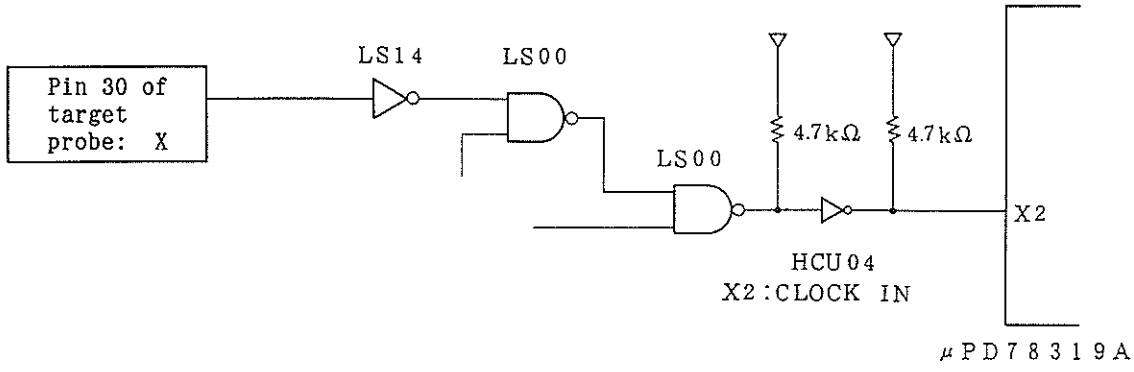
Note: Pay careful attention to the direction of the IC mark in this step.

⑤ Install the emulation board in the IE-78310A-R.

This completes the setting procedure. Turn on the power to the IE-78310A-R.

The clock signal in the target system is used as the basic clock signal of the IE-78310A-R in accordance with the above setting.

This circuit diagram is as follows:



6.3.2 Connecting the target probe

The following parts are provided for the target probe.

- Probe cable
- SHRINK DIP probe unit
- QUIP probe unit

Use the parts appropriate to the uPD78312A or uPD78310A package.

① When the SHRINK DIP type probe is used

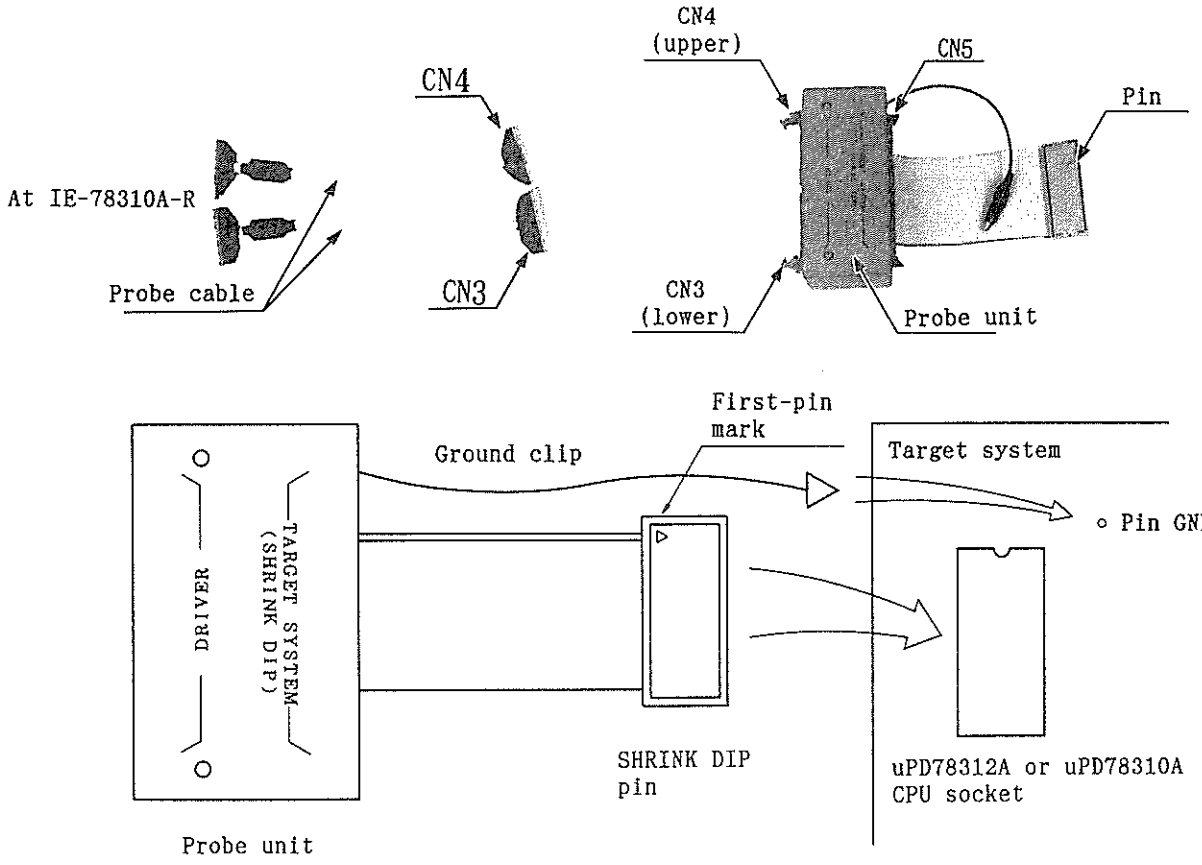
Make the following connections:

Probe cable [CN3 ⟷ CN3 (lower) / CN4 ⟷ CN4 (upper)] Probe unit

Probe unit [CN5 ⟷ CN5] Pin terminal

Do not connect the wrong connectors, otherwise the IE-78310A-R may be destroyed.

Fig. 6-3 Connecting the Target Probe (SHRINK DIP Type)



② When the QUIP type probe is used

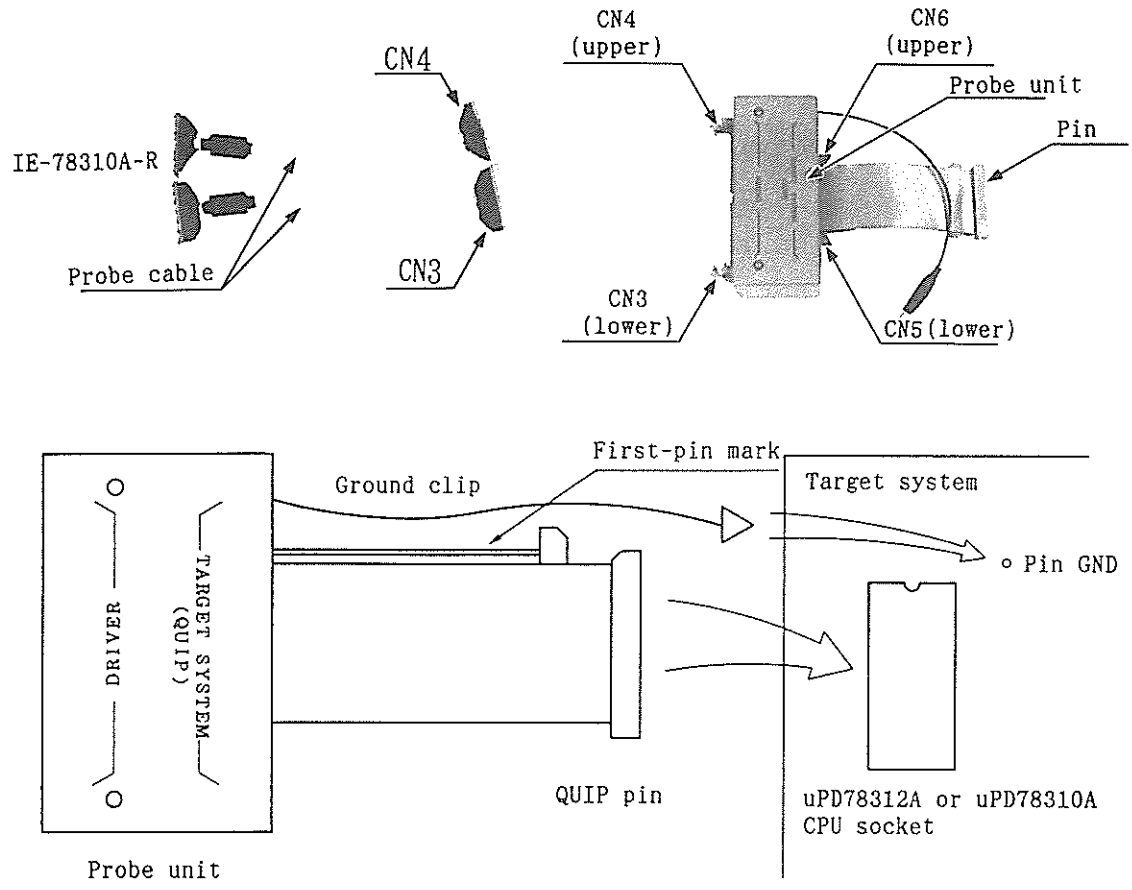
Make the following connections:

Probe cable [CN3 ⟷ CN3 (lower) ; CN4 ⟷ CN4 (upper)] Probe unit

Probe unit [CN5 (lower) ⟷ CN5 ; CN6 (upper) ⟷ CN6] Pin terminal

Do not connect the wrong connectors, otherwise the IE-78310A-R may be destroyed.

Fig. 6-4 Connecting the Target Probe (QUIP Type)



6.3.3 Connecting the external sense clips

The signals at the pins of the CPU (uPD78312A or uPD78310A) as well as any signal line in the target system can be observed in real time by the IE-78310A-R.

This signal line can be broken as a trigger signal and the trace can be qualified.

The status of the signal line can be traced while the real-time tracer operates.

For this purpose, the IE-78310A-R has eight external sense clips.

These sense clips shall be connected only to the TTL-level signal lines.

> If the sense clips are connected to other level signal lines, the IE-78310A-R cannot sense signal lines correctly and the sensor of the IE-78310A-R may be destroyed, depending on the voltage level.

Connect the external sense clips as follows:

① Turn off power to the IE-78310A-R and the target system.

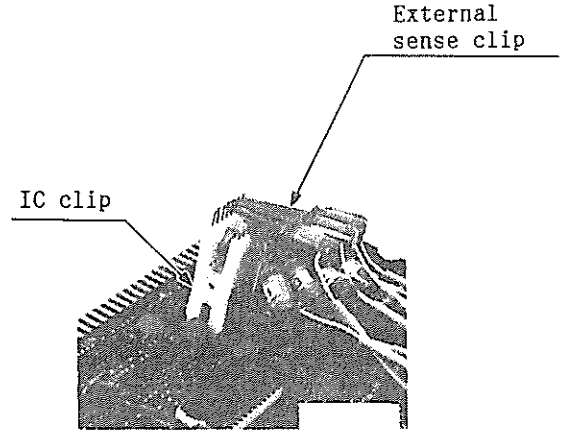
② Set an IC clip at the IC to be sensed in the target system.

③ Connect the external sense clips to the set IC clip.

Use the IC clip as often as possible to connect sense clips.

Figure 6-5 shows the above connection.

Fig. 6-5 Connecting the External Sense Clips



This completes the connection between the target probe and the target system. Turn on power. Note the power-on sequence below:

6.3.4 Power-on sequence

① Turn on the power switch to the IE-78310A-R.

② The following message is then displayed.

Power on target system (Y/N)

③ Turn on the power switch of the target system.

④ Enter Y <cr> and press the return key.

Be careful of this sequence, because the IE-78310A-R does not operate normally or may be destroyed if the sequence is wrong.

6.3.5 Power-off sequence

① Turn off the power switch of the target system.

② Turn off the power switch of the IE-78310A-R.

Be careful of this sequence, because the IE-78310A-R may be destroyed if the sequence is wrong.

Cautions for connection

(1) When the target probe is fitted into the CPU socket of the target system

① Fit the target probe into the CPU socket of the target system so that the IC mark of the target probe is aligned with the first-pin mark. Care should be taken that the target probe is not fitted in reverse. Otherwise, the target interface circuit of the IE-78310A-R will be destroyed.

② Care must be taken that the pins of the target probe are not broken or bent.

③ The ground clip of the target probe shall be connected to pin GND.

(2) When the external sense clips are connected to the target system

① Be sure to connect an external sense clip to a signal line. If it is connected to a power line, a failure occurs.

② Use an IC clip to connect the external sense clips.

6.4 Differences between the Real Device and Target Interface Circuit of the IE-78310A-R

The target interface circuit consists of the evaluation chip (uPD78319A) and the emulation circuit including the TTL.

Signal lines of the target interface are classified into three types. Section 6.4 describes the individual differences between the types and the corresponding signal lines of the real device.

Figure 6-6 shows the circuit equivalent to the emulation circuit.

(1) Signals sent out directly from the evaluation chip (Port 0, port 2, port 3, analog-to-digital converter related, and refresh signals)

These signal lines operate in completely the same way as those in the real device.

Note: 100-Ω resistors are inserted in series for signals other than analog-to-digital converter related signals

(2) Signals sent out from the evaluation chip through gates
($\overline{\text{RESET}}$, clock input, $\overline{\text{RD}}$, $\overline{\text{WR}}$, and ALE signals)

1) The input signal from the target system is received by the TTL gate of the emulation circuit and input to the evaluation chip.

The target interface circuit therefore differs a little in its DC characteristics from the real device.

They differ also in the AC characteristics, as the signal is delayed through the TTL. (The signal must be input to the target interface circuit at a faster timing than to the real device.)

2) The output signal to the target system is output from the evaluation chip through the TTL gate of the emulation circuit.

The target interface circuit therefore differs a little in its DC characteristics from the real device.

They differ also in the AC characteristics, as the signal is delayed through the TTL.

The target interface circuit must be more strictly designed than the real device to provide the appropriate timing of these signals.

(3) Signals set out from the emulation circuit (V_{DD}, $\overline{EA}$, P1, P4, and P5)

The signals at terminals V_{DD} and $\overline{EA}$ are sensed by the TTL of the emulation circuit.

The power to the evaluation chip is supplied from the power source in the IE.

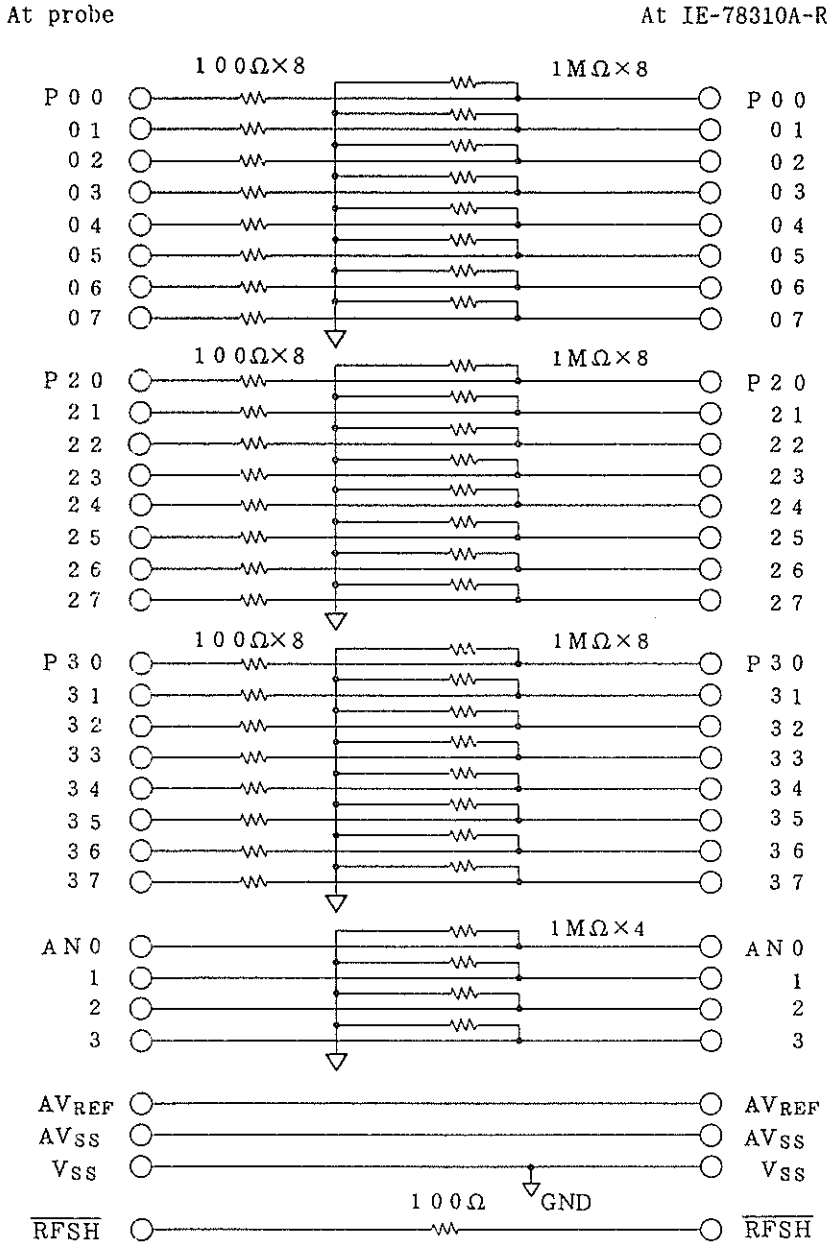
The V_{DD} signal of the target system is not connected to the evaluation chip.

The P1, P4, and P5 signals are sent out from each port emulator of the emulation circuit. The output to the target system is the LS TTL. The input from the target system is the HCT logic.

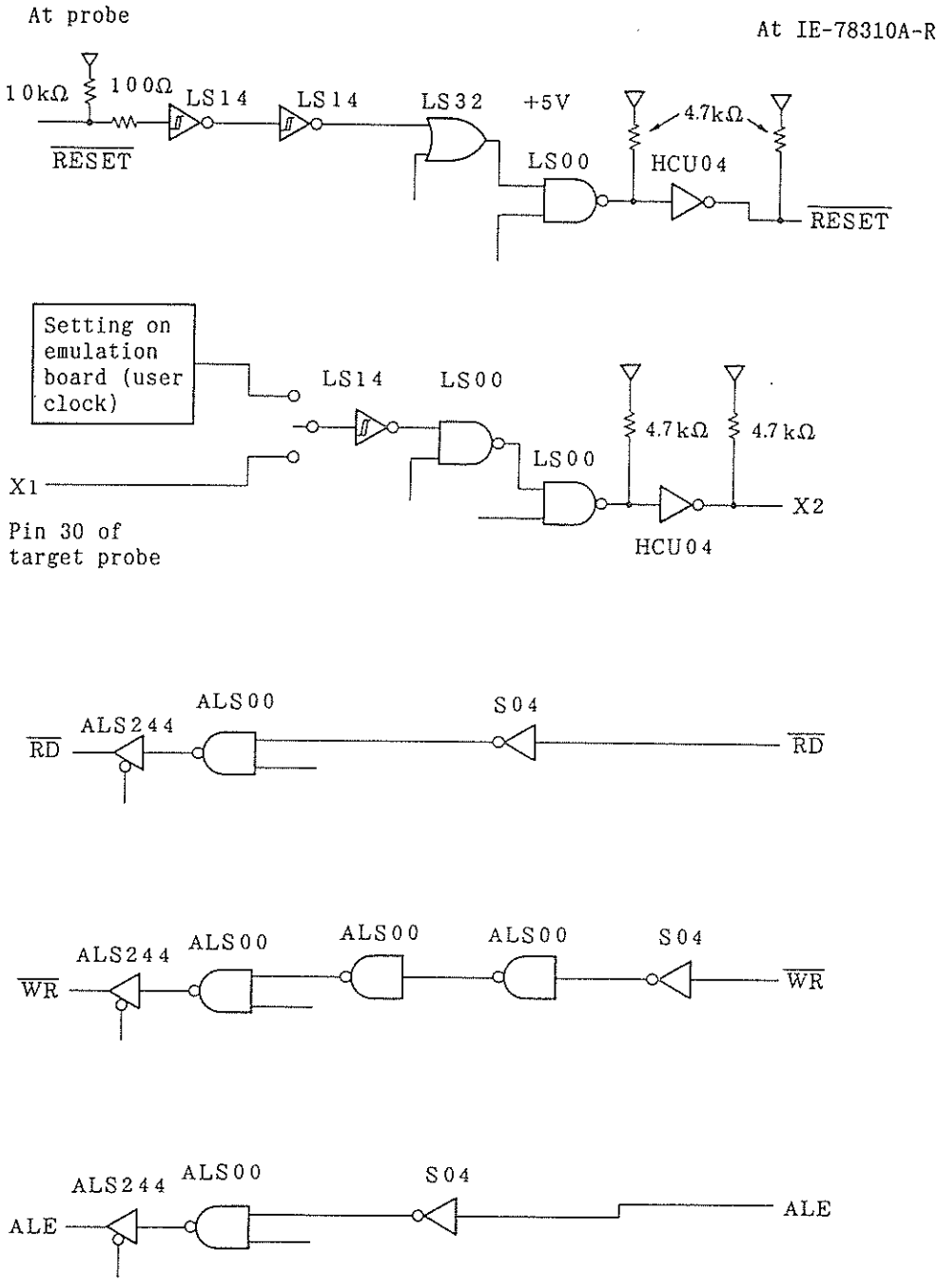
The target interface circuit differs a little in both DC and AC characteristics from the real device.

Fig. 6-6 Diagram of Equivalent Circuit to Emulation Circuit

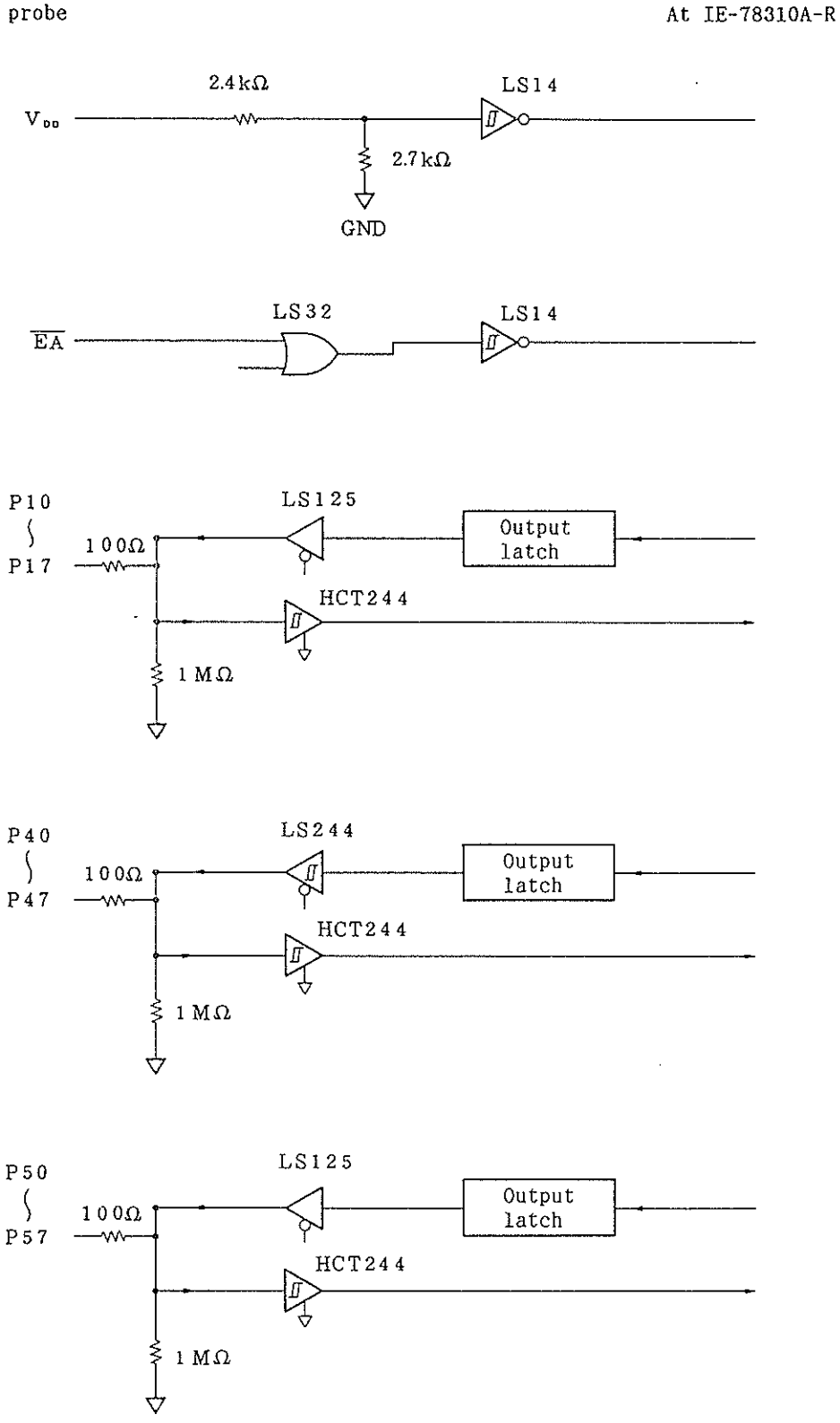
(1) Signals sent out directly from the evaluation chip



(2) Signals sent out from the evaluation chip through gates



(3) Signals sent out from the emulation circuit



6.5 Latch-up

When latch-up occurs in the evaluation chip and the neighboring CMOS, the power is turned off to the evaluation chip, the neighboring CMOS, and the TTL before the CMOS. This is done by the latch-up warning circuit in the IE-78310A-R.

When the latch-up warning circuit operates, the following message is displayed at the terminal (console):

Emulation CPU latchup!

As soon as this message is displayed, turn off power first to the target system and then to the IE-78310A-R.

APPENDIX A

(1) Overview of installation

Attaching the accessories to the IE-78310A-R main unit

- To connect the target probe to the IE-78310A-R main unit, draw the emulation board (the second board from the top) from the right side of the IE-78310A-R main unit, and insert the connector of the target probe into connectors CN1 and CN2 on the emulation board.

- To connect the external sense clip to the IE-78310A-R main unit, draw the break board (the third board from the top) from the right side of the IE-78310A-R main unit, and insert the connector of the external sense clip into connector CN1 on the break board.

- Insert the power cable into the AC inlet on the back of the IE-78310A-R main unit.

- Insert the RS-232-C interface cable into CH1 or CH2 on the front panel of the IE-78310A-R main unit.

When accessories have been attached, install the IE-78310A-R in place.

Small quantities of foreign particles and dust may be allowed at the installation place.

Do not place anything around the air intake.

(2) Connectable peripheral equipment

Host machines: MD-116HD-21, MD-116FD-20, MD-086HD-10, MD-086FD-10, and MD-086FD
PC-9800 series
IBM PC/AT

PROM programmers: PG-1500 and PG-2000

Terminal: MD-910TM

(3) Functions and the setting of switches on the main unit

. Power switch: Turns the IE-78310A-R power on and off.

. Reset switch: Resets the IE-78310A-R.

. Terminal/modem mode selection switch:
Puts the RS-232-C interface in the terminal or modem mode.

. RTS setting switch:
DIP switch for switching the RTS pin number of the RS-232-C interface.
Normally, switch number 1 is set to ON, and 2 and 3 are set to OFF.

. Frame ground setting switch:
DIP switch for setting whether the frame and signal grounds of the RS-232-C interface are common or open.
Normally, this switch is set to open.
Switch number 4 is set to OFF.

. Baud rate selection switch:

Micro DIP switch for setting the baud rate for channel 1 of the RS-232-C interface

(4) Jumper connections on the control/trace board

Use jumpers on the control/trace board factory-connected as they are.

If a connection is changed, the jumpers may operate abnormally.

Table A-1 Jumper Connections on the Control/Trace Board on Shipment

Jumper number	Connection
JP 2	1-6 short
JP 3	1-6 short
JP 4	Open
JP 5	1-6 open(Note)
	2-5 open(Note)
	3-4 short
JP 6	1-2 short
JP 7	1-2 short

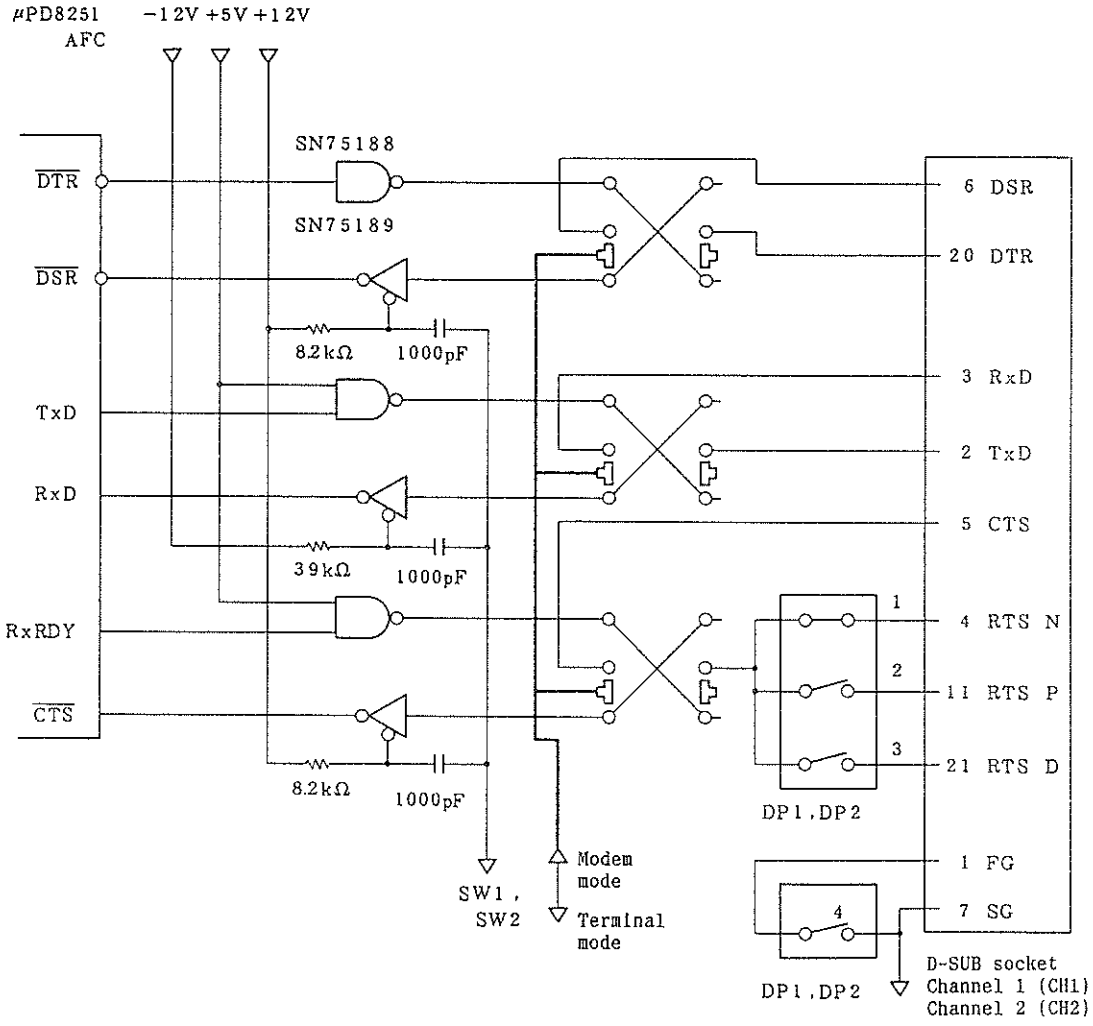
Note: Short 1-6 and 2-5 of JP5 when a memory board other than SB-0512 is used in the expansion slot.

(5) RS-232-C interface circuit

The IE-78310A-R incorporates two channels (channels 1 and 2) of the RS-232-C interface connectors on the front panel of the main unit. The following figure is an internal circuit diagram of the channels.

The interface circuits of channels 1 and 2 are the same.

Fig. A-1 RS-232-C Interface Circuit Diagram



(6) Connecting the target system

o Inserting the target probe in the CPU socket of a target system

. Insert the target probe in the CPU socket of a target system with the IC mark and No.1 pin mark aligned.

. Connect the ground clip of the target probe to the signal ground line of the target system.

o Connecting the external sense clip to a target system

. Connect the external sense clip to the signal line and signal ground line.

. Use an IC clip for connection.

o Power-on procedure

① Turn on the IE-78310A-R power switch.

② Turn on the target system power switch.

Note that the IE-78310A-R may not operate normally or may be destroyed if the power-on procedure is not performed properly.

o Power-off procedure

① Turn off the target system power switch.

② Turn off the IE-78310A-R power switch.

Note that the IE-78310A-R may be destroyed if the power-off procedure is not performed properly.

(7) Commands

The tables on the following pages list commands.

A command whose command body is marked with * is valid only when system software is used.

A command whose command body is marked with ** is valid only in the stand-alone mode.

Command type		Command body	Subcommand	Operand
Line assembler		ASM	None	[word] (Assembler starting address)
Physical break condition setting	Hardware break condition setting	BRA	None	[A=addrs][V=mask][C=(OP (Operand fetch) / RW (Data read/write) / R (Data read) / W (Data write) / RWP (Data read/write by program) / RP (Data read by program) / WP (Data write by program) / RWM (Data read/write by macro service) / RM (Data read by macro service) / WM (Data write by macro service) / NC (All read/write including operand fetch))][L=byte] (Break address) (Break data) (Break status) (Number of loop counts) (Input operands separated by _.)
	External signal break condition setting	BRD	None	[mask] (Break data of external sense signal)
	Instruction count break condition setting	BRE	None	[word] (Number of fetch instructions)
	Timer break condition setting	BRT	None	[word] (Execution time. Unit: 10 us)

(to be continued)

(Cont'd)

Command type	Command body	Subcommand	Operand
Logical break condition setting	BRM	None	[BRA][BRD][BRE][BRT][BR0][BR1][BR2][BR3] (Break register name)
	BR0 BR1 BR2 BR3	None	[BRA][BRD][BRE][BRT] (Physical break register name)
Clock selection	CLK	[{U / I}]	None (U: User system clock; I: IE internal clock)
Command file creation	COM *	None	[{LST: / CON: / file (Command file name)}]
Disassembler	DAS	None	[{word (Disassembler starting address) / partition (Disassembler starting and ending addresses)}]
Self-diagnosis	DIG	None	None
Directory display	DIR *	None	[file] (File name)
System mode end	EXT *	None	None
Command history display	HIS *	None	None
Help	HLP *	None	[command] (Command body of command on which information is to be displayed)
Object load	LOD**	None	[{TTY1 (Channel 1) / TTY2 (Channel 2)}]
Object/symbol load	LOD *	None	file(Object/symbol file name)[module name\...] (Module name) [{C(Object specification) / S(Symbol specification)}]
Output device redirect	LST *	None	[{LST: / CON: / file (output file name)}]
Mapping	MAP	[{W / R / U / K}]	[partition] (Mapping range) (W: Internal mapping; R: Write-protected internal mapping; U: User mapping; K: Mapping release)
Arithmetic	MAT	None	word (Normally write an expression.)

(to be continued)

(Cont'd)

Command type	Command body	Subcommand	Operand
Mode register operation	MDR	[D] (Display)	[mode register name]
		C (Change)	[mode register name]
Memory Operation	MEM	C (Change)	[word] (Change starting address)
		[D] (Display)	[{word (Display starting address) / partition (Display starting and ending addresses)}]
		F (Initialize)	partition_data string → (Setting of initialize data (8 bits)) → (Initialize starting and ending addresses)
		G (Search)	partition_data string → (Setting of search data (8 bits)) → (Search starting and ending addresses)
		M (Copy)	partition_word → (Copy destination starting address) → (Copy source starting and ending addresses)
		X (Exchange)	partition_word → (Exchange destination starting address) → (Exchange source starting and ending addresses)
		V (Compare)	partition_word → (Compare destination starting address) → (Compare source starting and ending addresses)
		E (Test)	[partition] (Test starting and ending addresses)
Channel 2 mode setting	MOD	None	[MODE={CHAR / FLOW}] [BAUD={19200 / 9600 / 4800 / 2400 / 1200 / 600 / 300}] [LONG={7 / 8}] [PAR={NON / EVEN / ODD}] [STOP={1 / 2}] (Handshaking mode) (Baud rate) (Character length) (Parity bit) (Stop bit length)
Internal-to-user/user-to-internal memory transfer	MOV	{I / U}	partition_word → (Copy destination starting address) → (Copy source starting and ending addresses) (U: Internal to user; I: User to internal)
Terminal mode	PGM	None	None

(to be continued)

(Cont'd)

Command type	Command body	Subcommand	Operand
Register Operation	REG	C (Change)	[register name]
		[D] (Display)	[register name]
Emulation Operation	RUN	N	[word] (Execution starting address) (N: Real-time execution with no break)
		B	[word] (Execution starting address) (B: Real-time execution with breaks)
		S	[word][,word] (S: Real-time execution with number of steps specified) [,word] → (Number of steps) [word] → (Execution starting address)
		T	[word][,{* / word}][_TRD][_REG]] [_REG] → (Register display specification) [_TRD] → (Trace display specification) {* / word} → (Break condition; *: Register condition word: Number of steps) * : register name {= / > / < / => / >= / =< / <= / >< / <>} {mask / wmask} (T: Trace execution)
Reset	RES	[H]	None (H: When omitted, resets only evaluation chip. When specified, resets all IEs.)
Object save	SAV**	None	{TTY1 (Channel 1) / TTY2 (Channel 2)} [_partition][_partition]...[_partition] └── Up to five ──┘
	SAV *	None	file (Input file name)[_partition][_partition]...[_partition] └── Up to five ──┘
Special register operation	SPR	C (Change)	[special register name]
		[D] (Display)	[special register name]
Input device redirect	STR *	None	file (Input file name)
Suffix specification	SUF	None	[{H (Hexadecimal) / T (Decimal) / Q (Octal) / Y (Binary)}]

(to be continued)

(Cont'd)

Command type	Command body	Subcommand	Operand
Append symbol operation	SYM	[D] (Display)	None
		K (Delete)	None (Deletes all append symbols.)
		A (Append)	symbol_word └→(Symbol value) └→(Append symbol name)
		C (Change)	symbol_word └→(Change symbol value) └→(Append symbol name)
		E (Delete)	[symbol] └→(Append symbol name to be deleted)
	SYM *	L (Load)	None
		S (Save)	None
Symbol operation	SYM *	[D] (Display)	[{module (Module specification) / PUBLIC (Public specification)}]
Current module modification	SYM	M (Modify)	None
Trase mode setting	TRM	None	[{NON (Non-trace) / ALL (All trace) / TRX (Qualify trace)}]
Qualify condition setting	TRX	None	[A=addrs] (Qualify address) [V=mask] (Qualify data) [C={OP (Operand fetch) / RW (Data read/write) / R (Data read) / W (Data write) / RWP (Data read/write by program) / RP (Data read by program) / WP (Data write by program) / RWM (Data read/write by macro service) / RM (Data read by macro service) / WM (Data write by macro service) / NC (All read/write including operand fetch)} (Qualify status)] [TRQ=mask] (Qualify port/external data)

(to be continued)

(Cont'd)

Command type	Command body	Subcommand	Operand
Qualify data selection	TRQ	None	[{TRS (Port selection) / EXT (External signal selection)}]
Trace/qualify port selection	TRS	None	[{P0 (Port 0) / P1 (Port 1) / P2 (Port 2) / P3 (Port 3) / P4 (Port 4) / P5 (Port 5)}]
Trace pointer operation	TRP	None	[{word (Distance pointer is to be moved) / 0 (Places pointer at the beginning.) / N (Places pointer at the end.)}]
Trace display	TRD	[{F / I / M}]	[{word (Number of steps to be displayed) / ALL (Displays all trace results.)}] (F: Frame mode; I: Instruction mode; M: Instruction mode with macro service)
Object verify	VRY**	None	{TTY1 (Channel 1) / TTY2 (Channel 2)}
	VRY *	None	file (Input file name)

(8) Error messages

The error messages are given below.

(1) Unrecognized command

A command keyword is invalid.

(2) Command format error

Command keywords are valid, but an operand is invalid.

(3) Command/Data too long

An entered command or data line consists of 128 characters or more.

(4) Mapping error

An unmapped memory area was found in the specified address range.

(5) Input data error

Invalid data was entered.

(6) System mode command

A command in the system mode was entered in the stand-alone mode.

(7) Non map area access

An attempt was made to access an unmapped memory area during execution of a command.

(8) Check sum error

A checksum error was detected while loading/saving an object.

(9) Bad character

An invalid character was detected while loading/saving an object.

(10) aborted

The INTERRUPT key was pressed while loading/saving an object.

(11) Warning double define

A module name was specified by the LOD command twice or more.

(12) Bad file entry

An invalid file name was described.

(13) File overflow

The number of symbol files specified in the LOD command exceeded the limit.

(14) Illegal record

A symbol table file with an invalid record format was specified in the LOD command.

(15) load failed

An error was detected while loading a symbol by the LOD command.

(16) module overflow

The number of modules specified in the LOD command exceeded the limit.

(17) Not loaded symbol

No symbol has been loaded.

(18) Not found module record

The module name specified by the LOD command cannot be found in the symbol table file.

(19) file not found

A nonexistent file name was specified.

(20) Slave CPU communication error

No command can be written for the slave CPU (8742) at channel 2.

(21) double define append symbol symbol-name

A registered symbol was loaded as an append symbol by the LOD command. (The append symbol will be deleted.)

(22) double define append symbol

An attempt was made to register a registered symbol by the SYM A or SYM L command.

(23) symbol table full

There is no free symbol save area for the LOD command.

(24) append symbol table full

There is no free append symbol save area for the SYM A or SYM L command.

(25) double define loaded symbol

A loaded symbol was loaded by the LOD, SYM A, or SYM L command.

(26) symbol record format error

A symbol table file with an invalid record format was specified in the LOD or SYM L command.

(27) reserved word symbol

A reserved word was defined as a symbol by the SYM A command.

(28) double define module name module-name

The displayed module name has been already loaded.

(29) module buffer full

The number of modules specified in the LOD command exceeded the limit.

(30) not found symbol

A nonexistent symbol was specified by the SYM C or SYM E command.

(31) no symbol of append

There is no append symbol for the SYM D or SYM S command.

(32) Can not execute HLP command !

The help file (IE78310.HLP) or help overlay file (IE78310.0V2) cannot be found on the current disk.

(33) No .HLP file on the default drive

While executing the HLP command, the help file (IE78310.HLP) or help overlay file (IE78310.0V2) could not be found on the current disk.

(34) Keyword Error

An invalid command keyword was specified by the HLP command.

(35) Can not use command abbreviation !

The abbreviated overlay file (IE78310.0V2) cannot be found on the current disk.

(36) File already exists.

An attempt was made to create a file having a SYS or R/O attribute with the same name.

(37) Reserved file name

A file name reserved for the system software was specified.

(38) File name is used by other process

The name of a file already opened was specified.

(39) Can not close file-name

The file displayed could not be closed.

(40) Disk write error file-name

A write error was detected in the displayed file.

(41) Disk read error file-name

A read error was detected in the displayed file.

(42) Can not open file-name

The specified file could not be opened.

(43) File make error file-name

The displayed file could not be created.

(44) Can not close file-name.Cancel xxx command

The displayed file could not be closed during execution of command xxx. (xxx: STR, LST, or COM)

(45) Disk write error file-name.Cancel xxx command

A write error was detected in the displayed file during execution of command xxx. (xxx: LST or COM).

(46) Disk read error file-name.Cancel STR command

A read error was detected in the displayed file during execution of the STR command.

(47) List device is used by other process

Another process is using the list device. (The list device was specified by both the COM and LST commands, or for CCP/M, a process other than an IE-78310A-R process is using the list device.)

(48) Append symbol file not found

For the SYM L command, the append symbol file (IE78310.SYM) could not be found on the current disk.

(49) Illegal append symbol file

An append symbol file in an invalid format was specified by the SYM L command.

(50) Communication error

The IE could not communicate normally with the host machine.

(51) Not found memories

Although an external memory area was specified, it could not be used.

(52) Non map area access!

An attempt was made to access an unmapped memory area during execution of the ASM command.

(53) Assemble area over!

The range of memory accessed by the ASM command exceeded the limit.

(54) Disassemble area over!

The range of memory accessed by the DAS command exceeded the limit.

(55) Caution!

A generic object was created. This message is displayed in other cases if the system is cautioning the user.

(56) Error!

No object code could be generated. This message is displayed in other cases if an error occurs.

(9) Differences between the IE-78310A-R and real devices

The real devices, uPD78312A and uPD78310A, are CMOS products. The IE-78310A-R target interface circuit consists of the evaluation chip (uPD78319A) and emulation circuit containing TTL and others.

The target interface signal lines are divided into three types. The signals differ from those for the real devices in operation, as follows.

① Signals sent out directly from the evaluation chip

The refresh signal and signals related to ports 0, 2, and 3 and A/D converter operate as in the real devices.

Note: Except for signals related to the A/D converter, signals are sent out through a 100-Ω resistor in series.

② Signals sent out from the evaluation chip through gates

The $\overline{\text{RESET}}$, Clock Input, $\overline{\text{RD}}$, $\overline{\text{WR}}$, and ALE signals are delayed when compared with those for the real devices because the signals are sent out through TTLs.

③ Signals sent out from the emulation circuit

The V_{DD} and $\overline{\text{EA}}$ pins are detected by TTL in the emulation circuit. The emulation chip power is supplied by the IE. V_{DD} in the target system is not connected to the evaluation chip.

P1, P4, and P5 are sent out from each port emulator in the emulation circuit. Signals are output from LS TTL to the target, and input from the target to HCT logic.

Therefore, the IE is slightly different from the real device in both DC and AC characteristics.

(10) Notes on using the debugger

o RS-232-C interface

. Do not connect a terminal to a terminal nor a modem to a modem. When PG-1500 or PG-2000 is connected, put the IE-78310A-R in the modem mode. Use the RS-232-C interface cable attached to PG-1500 or PG-2000 to connect it.

. Set RTS to RTSN, except for the Pro-typer. Handshaking is divided into hardware handshaking and software handshaking. Channel 1 is shared by both hardware handshaking and software handshaking.

For channel 2, hardware handshaking can be switched to software handshaking and vice versa by a command. Adjust the handshaking to suit the device connected.

. Adjust the baud rate to that for a device connected.

o Target probe

. Connect the ground clip of the target probe to the signal ground line of the target system.

o External sense clip

. Connect the external sense clip only to the TTL-level signal line.

(11) Execution examples

The execution examples in Chapter 3 in Software Instruction Manual are given below.

In these examples, data input from the keyboard is underlined.

```
A>IE78310 <cr>
XX:XX:XX A:IE78310.CMD

  IE-78310 CONTROLLER    (MD-086/116  SERIES) Vx.x  [Dd Mmm Yy]
       Copyright  (C) 1985 by NEC Corporation

  Do you want to use COMMAND LINE EDITOR (Y or N) : Y <cr>
  Window off !
  Select port NO. (1 to 4) :  1 <cr>
  IE-78310A Monitor Vx.x [Dd Mmm Yy]
              Copyright (C) 1985 by NEC Corporation

  Power on target system (Y/N) Y <cr>
  Create new set up mode (Y or N) : N <cr>
  Internal ROM size (4K,8K,16K) = 8K <cr>
  Tracer initialize           (Message indicating trace memory initialization)
  Breaker initialize          (Message indicating initialization of break
                              condition and others)
  Do you have Memory Board on IE-78310A? (Y/N)= N <cr>
1>CLK I <cr>
1>RES <cr>
1>MAP <cr>
  0000-1FFF R/O   2000-FDFF Non
1>MAP W 2000,0FDFF <cr>
1>MAP <cr>
  0000-1FFF R/O   2000-FDFF R/W
1>MEM F 0,1FFF 00 <cr>
1>LOD SORT <cr>
  object load complete
  symbol table loading
  MODULE01   load complete
1>LOD SORT.HEX C <cr>
  object load complete
1>SYM K <cr>
1>LOD SORT.SYM S <cr>
  symbol table loading
  MODULE01   load complete
1>MEM D 100,12F <cr>
  0100   3A 20 01 3A 21 00 20 4A 9F 21 80 08 6F 20 00 00    : .:!. J.!..o ..
  0110   00 00 14 FB B8 00 67 42 FE D8 88 E8 59 16 5F 83    ......gB....Y._.
  0120   07 81 05 16 34 55 26 20 26 21 14 DA 00 00 00 00    ....4U& &!......
```

```
1>MEM D 100 <cr>
  0100   3A 20 01 3A 21 00 20 4A 9F 21 80 08 6F 20 00 00   : .:!. J.!..o ..
  0110   00 00 14 FB B8 00 67 42 FE D8 88 E8 59 16 5F 83   ......gB....Y._.
  0120   07 81 05 16 34 55 26 20 26 21 14 DA 00 00 00 00   ....4U& &!......
  0130   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0140   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0150   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0160   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0170   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0180   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0190   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  01A0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
1>MEM D <cr>
  01B0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  01C0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  01D0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  01E0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  01F0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0200   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0210   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0220   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0230   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0240   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0250   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
1>MEM <cr>
  0260   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0270   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0280   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0290   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02A0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02B0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02C0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02D0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02E0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  02F0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  0300   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
1>MAP <cr>
  0000-1FFF R/O   2000-FDFF R/W
1>MAP K 2000,0FDFF <cr>
1>MAP <cr>
  0000-1FFF R/O   2000-FDFF Non
1>MEM D 2000,0FDFF <cr>
  Mapping error
```

```
1>DAS 100,12B <cr>
  Addr  Object          Mnemonic
                        ORG     MODULE01\SORT
                      MODULE01\SORT:
  0100  3A 20 01        MOV     0FE20H,#1H
  0103  3A 21 00        MOV     0FE21H,#0H
                      MODULE01\COMP:
  0106  20 4A           MOV     A,0FE4AH
  0108  9F 21           CMP     A,0FE21H
  010A  80 08           BNZ     $CONT
  010C  6F 20 00        CMP     0FE20H,#0H
                      MODULE01\STOP:
  010F  00              NOP
  0110  00              NOP
  0111  00              NOP
  0112  14 FB           BR      $STOP
                      MODULE01\CONT:
  0114  B8 00           MOV     R1,#0H
  0116  67 42 FE        MOVW    RP7,#0FE42H
  0119  D8              XCH     A,R0
  011A  88 E8           ADDW    RP7,RP0
  011C  59              MOV     A,[HL+]
  011D  16 5F           CMP     A,[HL]
  011F  83 07           BC      $INCI
  0121  81 05           BZ      $INCI
  0123  16 34           XCH     A,[HL-]
  0125  55              MOV     [HL],A
  0126  26 20           INC     0FE20H
                      MODULE01\INCI:
  0128  26 21           INC     0FE21H
  012A  14 DA           BR      $COMP
                        END
1>DAS 100 <cr>
  Addr  Object          Mnemonic
                        ORG     MODULE01\SORT
                      MODULE01\SORT:
  0100  3A 20 01        MOV     0FE20H,#1H
  0103  3A 21 00        MOV     0FE21H,#0H
                      MODULE01\COMP:
  0106  20 4A           MOV     A,0FE4AH
  0108  9F 21           CMP     A,0FE21H
  010A  80 08           BNZ     $CONT
  010C  6F 20 00        CMP     0FE20H,#0H
                          END
```

```
1>DAS <cr>
  Addr    Object          Mnemonic
                          ORG     MODULE01\STOP
                        MODULE01\STOP:
  010F   00               NOP
  0110   00               NOP
  0111   00               NOP
  0112   14 FB            BR      $STOP
                        MODULE01\CONT:
  0114   B8 00            MOV     R0,#0H
  0116   67 42 FE         MOVW    RP7,#0FE42H
                          END
1>SYM A SW 0FE20 <cr>
1>SYM A I 0FE21 <cr>
1>SYM A STACK 0FE80 <cr>
1>SYM A LIST 0FE42 <cr>
1>SYM A N 0FE4A <cr>
1>MEM F 0FE00,0FE7F 0 <cr>
1>MEM C 0FE42 <cr>
  FE42  00 05 <cr>
  FE43  00 03 <cr>
  FE44  00 04 <cr>
  FE45  00 0A <cr>
  FE46  00 08 <cr>
  FE47  00 82 <cr>
  FE48  00 0A <cr>
  FE49  00 04 <cr>
  FE4A  00 08 <cr>
  FE4B  00 .  <cr>
1>MEM D 0FE20,0FE4A <cr>
  FE20   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE40   00 00 05 03 04 0A 08 82 0A 04 08                  ...........
1>MEM D SW,N <cr>
  FE20   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE40   00 00 05 03 04 0A 08 82 0A 04 08                  ...........
1>MEM D 0FE20,N <cr>
  FE20   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE40   00 00 05 03 04 0A 08 82 0A 04 08                  ...........
1>MEM D SW,0FE4A <cr>
  FE20   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
  FE40   00 00 05 03 04 0A 08 82 0A 04 08                  ...........
```

```
1>BRA <cr>
  A 0H,0FFFFH = MODULE01\STOP <cr>
  V 0XXXXXXXXY = <cr>
    OPcode fetch                  (OP)
    Read Write                    (RW)
    Read                          (R)
    Write                         (W)
    Read Write by Program         (RWP)
    Read by Program               (RP)
    Write by Program              (WP)
    Read Write by Macro service   (RWM)
    Write by Macro service        (WM)
    No Condition                  (NC)
  C NC = OP <cr>
  L 1H =    <cr>
1>BRM BRA <cr>
1>BRM <cr>
  BRA <cr>
1>REG C PC <cr>
  PC       0000 = 100 <cr>
  SP       FE72 = 0FE80 <cr>
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Standard break  terminated
   PC    SP   PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V  SUB  CY
  0112  FE80        0    0    0    0    0    0    0    0    0    0    1    0
    R0   R1    R2   R3   R4   R5   R6   R7       RP4      RP5      RP6     RP7
     X    A     C    B                           VP       UP       DE      HL
    00   00    CB   F7   FF   FF   FF   FB      FFFF     F6FF     FFFF    FE43
  One step emulation standby  Press the ESC key.
1>MEM D SW,N <cr>
  FE20   03 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00      ................
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00      ................
  FE40   00 00 03 05 04 0A 08 82 0A 04 00                     ...........
1>MEM C LIST <cr>
  FE42  03 05 <cr>
  FE43  05 03 <cr>
  FE44  04 <cr>
  FE45  0A <cr>
  FE46  08 <cr>
  FE47  82 <cr>
  FE48  0A <cr>
  FE49  04 <cr>
  FE4A  00 08 <cr>
  FE4B  08 00 <cr>
  FE4C  00 .  <cr>
1>REG C PC <cr>
  PC       0112 = 100 <cr>
  SP       FE80 = . <cr>
```

```
1>RUN T ,6 REG <cr>
  User-system Vcc-ON      Emulation start at 0100
   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0103   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    00    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0106   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    00    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0108   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    08    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  010A   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    08    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0114   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    08    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0116   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    08    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE43

    terminated
  Frame Status Address Data Label  Mnemonic                              P0 EX
                                MODULE01\ CONT:                         B0 FF
  0000          0114              MOV     R0,#0H
  One step emulation standby  Press the ___ key.
  Frame Status Address Data Label  Mnemonic                              P0 EX
  0000          0116              MOVW    RP7,#LIST
   PC     SP   PSW: RBS2 RBS1 RBS0 IE     S     Z    RSS   AC    UF    P/V   SUB    CY
  0119   FE80        0    0    0    0     0     0     0     0     0     0     1      0
    R0    R1    R2    R3    R4    R5    R6    R7         RP4       RP5       RP6       RP7
     X     A     C     B                                 VP        UP        DE        HL
    00    08    CB    F7    FF    FF    FF    FB       FFFF      F6FF      FFFF      FE42
  One step emulation standby  Press the ESC key.
```

```
1>ASM MODULE01  CONT <cr>
  0114  MODULE01\CONT: <cr>
  0114                  MOV     R0,#0H
                = BR $12C <cr>
        14 16
  0116                  MOVW    RP7,#LIST
                = ORG 12CH <cr>
  012C                  NOP
                = MOV A,I <cr>
        20 21
  012E                  NOP
                = MOV R0,#0H <cr>
        B8 00
  0130                  NOP
                = BR $116 <cr>
        14 E4
  0132                  NOP
                = END <cr>
1>DAS 114,116 <cr>
  Addr  Object              Mnemonic
                            ORG     MODULE01\CONT
                          MODULE01\CONT:
  0114  14 16               BR      $12CH
  0116  67 42 FE            MOVW    RP7,#LIST
                            END
1>DAS 12C,131 <cr>
  Addr  Object              Mnemonic
                            ORG     12CH
  012C  20 21               MOV     A,I
  012E  B8 00               MOV     R0,#0H
  0130  14 E4               BR      $116H
                            END
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Non map area access break    terminated
   PC    SP   PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  011D  FE80       0    0    0    0    1    0    1    0    1    0     0    1
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6       RP7
                     X    A    C    B       VP       UP       DE        HL
    BD   FE   CB   F7   FF   FF   FB   FF      FFFF     FFF6     FFFF      FD00
  One step emulation standby  Press ESC key.
1>MEM D SW,N <cr>
  FE20   73 BD 00 00 00 00 00 00 00 00 00 00 00 00 00 00      s...............
  FE30   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00      ................
  FE40   00 00 03 04 05 08 0A 0A 04 08 00                     ...........
1>REG C RSS <cr>
  RSS        1 = 0 <cr>
1>REG <cr>
   PC    SP   PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  011D  FE80       0    0    0    0    1    0    0    0    1    0     0    1
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6       RP7
     X    A    C    B                           VP       UP       DE        HL
    BD   FE   CB   F7   FF   FF   FB   FF      FFFF     FFF6     FFFF      FD00
```

```
1>ASM 10C <cr>
  010C                                CMP     SW,#0H
                                = BR $132 <cr>
        14 24
  010E                                NOP
                                = NOP <cr>
        00
  010F  MODULE01\STOP: <cr>           NOP
                                = END <cr>
1>ASM 132 <cr>
  0132                                NOP
                                = CMP SW,#0H <cr>
        6F 20 00
  0135                                NOP
                                = BNZ  $MODULE01\CONT <cr>
        80 DD
  0137                                NOP
                                = BR $MODULE01\STOP <cr>
        14 D6
  0139                                NOP
                                = END <cr>
1>DAS 10C,10E <cr>
  Addr  Object                      Mnemonic
                                    ORG     10CH
  010C  14 24                       BR      $132H
  010E  00                          NOP
                                    END
1>DAS 132,138 <cr>
  Addr  Object                      Mnemonic
                                    ORG     132H
  0132  6F 20 00                    CMP     SW,#0H
  0135  80 DD                       BNZ     $CONT
  0137  14 D6                       BR      $STOP
                                    END
1>DAS MODULE01\CONT <cr>
  Addr  Object                      Mnemonic
                                    ORG     MODULE01\CONT
                                MODULE01\CONT:
  0114  14 16                       BR      $12CH
  0116  67 42 FE                    MOVW    RP7,#LIST
  0119  D8                          XCH     A,R0
  011A  88 E8                       ADDW    RP7,RP0
  011C  59                          MOV     A,[HL+]
  011D  16 5F                       CMP     A,[HL]
  011F  83 07                       BC      $INCI
                                    END
1>MEM F LIST,N 5,3,4,0A,8,82,0A,4,8 <cr>
1>BRA A=11F C=0P <cr>
```

```
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  0125  FE80       0    0    0    0    0    0    0    0     1    0     1    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4     RP5     RP6     RP7
     X    A    C    B                          VP      UP      DE      HL
    00   03   CB   F7   FF   FF   FB   FF      FFFF    FFF6    FFFF    FE42
  One step emulation standby  Press the ___key.
  Frame Status Address Data Label  Mnemonic                    P0 EX
  0000          0125               MOV     [HL],A
  0004   WR     FE42    03                                     B0 FF
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  0126  FE80       0    0    0    0    0    0    0    0     1    0     1    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4     RP5     RP6     RP7
     X    A    C    B                          VP      UP      DE      HL
    00   03   CB   F7   FF   FF   FB   FF      FFFF    FFF6    FFFF    FE42
  One step emulation standby  Press the ____key.
  Frame Status Address Data Label  Mnemonic                    P0 EX
  0000          0126               INC     SW
  0003   RD     FE20    01                                     B0 FF
  0004   WR     FE20    02                                     B0 FF
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  0128  FE80       0    0    0    0    0    0    0    0     1    0     1    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4     RP5     RP6     RP7
     X    A    C    B                          VP      UP      DE      HL
    00   03   CB   F7   FF   FF   FB   FF      FFFF    FFF6    FFFF    FE42
  One step emulation standby  Press the ____key.
  Frame Status Address Data Label  Mnemonic                    P0 EX
                             MODULE01\ INCI:                   B0 FF
  0000          0128               INC     I
  0003    RD    FE21    00                                     B0 FF
  0004    WR    FE21    01                                     B0 FF
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  012A  FE80       0    0    0    0    0    0    0    0     1    0     0    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4     RP5     RP6     RP7
     X    A    C    B                          VP      UP      DE      HL
    00   03   CB   F7   FF   FF   FB   FF      FFFF    FFF6    FFFF    FE42
  One step emulation standby  Press the ESC key.
1>MEM D LIST.LIST+7 <cr>
  FE42          03 05 04 0A 08 82 0A 04                        ........
1>MEM D I,I <cr>
  FE21      01                                                  .
```

```
1>RUN T ,1 <cr>
  User-system Vcc-ON     Emulation start at 012A
      terminated
  Frame Status Address Data Label  Mnemonic                    P0 EX
  0000          012A               BR        $COMP
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0106  FE80       0    0    0    0    0    0    0    0    1    0     0    0
    R0   R1   R2   R3   R4   R5   R6   R7        RP4      RP5      RP6      RP7
     X    A    C    B                             VP       UP       DE       HL
    00   03   CB   F7   FF   FF   FB   FF       FFFF     FFF6     FFFF     FE42
  One step emulation standby  Press the <cr> key.
  Frame Status Address Data Label  Mnemonic                    P0 EX
                             MODULE01\ COMP:                   B0 FF
  0000          0106               MOV       A,N
  0003    RD    FE4A    08                                     B0 FF
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0108  FE80       0    0    0    0    0    0    0    0    1    0     1    0
    R0   R1   R2   R3   R4   R5   R6   R7        RP4      RP5      RP6      RP7
     X    A    C    B                             VP       UP       DE       HL
    00   08   CB   F7   FF   FF   FB   FF       FFFF     FFF6     FFFF     FE42
  One step emulation standby  Press the ESC key.
1>BRA A=MODULE01\ INCI C=0P <cr>
1>RUN B <cr>
  User-system Vcc-ON     Emulation start at 0108
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0106  FE80       0    0    0    0    0    0    0    0    1    0     0    0
    R0   R1   R2   R3   R4   R5   R6   R7        RP4      RP5      RP6      RP7
     X    A    C    B                             VP       UP       DE       HL
    01   04   CB   F7   FF   FF   FB   FF       FFFF     FFF6     FFFF     FE43
  One step emulation standby  Press the ESC key.
1>MEM D I,I <cr>
  FE21      02
1>MEM D LIST,LIST+7 <cr>                                        .
  FE42         03 04 05 0A 08 82 0A 04                         ........
1>RUN T ,1 <cr>
  User-system Vcc-ON     Emulation start at 0106
      terminated
  Frame Status Address Data Label  Mnemonic                    P0 EX
                             MODULE01\ COMP:                   B0 FF
  0000          0106               MOV      A,N
  0003    RD    FE4A    08                                     B0 FF
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0108  FE80       0    0    0    0    0    0    0    0    1    0     0    0
    R0   R1   R2   R3   R4   R5   R6   R7        RP4      RP5      RP6      RP7
     X    A    C    B                             VP       UP       DE       HL
    01   08   CB   F7   FF   FF   FB   FF       FFFF     FFF6     FFFF     FE43
  One step emulation standby  Press the ESC key.
```

```
1>RUN B <cr>
  User-system Vcc-ON     Emulation start at 0108
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  0106  FE80       0    0    0    0    0    0    0    0     1    0     0    1
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6      RP7
     X    A    C    B                           VP       UP       DE       HL
    02   05   CB   F7   FF   FF   FB   FF      FFFF     FFF6     FFFF     FE45
  One step emulation standby  Press the ESC key.
1>MEM D I,I <cr>
  FE21      03                                                    .
1>MEM D LIST,LIST+7 <cr>
  FE42         03 04 05 0A 08 82 0A 04                            ........
1>BRA A=MODULE01\STOP 132 C=0P <cr>
1>RUN B <cr>
  User-system Vcc-ON     Emulation start at 0106
  Non map area access break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  011D  FE80       0    0    0    0    1    0    1    0     1    0     0    1
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6      .RP7
                      X    A    C    B           VP       UP       DE       HL
    BD   FE   CB   F7   FF   FF   FF   FF      F6FF     FFFF     FFFF     FD00
  One step emulation standby  Press the ESC key.
1>MEM D LIST,N <cr>
  FE42         03 04 05 08 0A 0A 04 08 00                         .........
1>REG C RSS <cr>
  RSS          1 = 0
1>REG <cr>
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  011D  FE80       0    0    0    0    1    0    0    0     1    0     0    1
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6      RP7
                      X    A    C    B           VP       UP       DE       HL
    BD   FE   CB   F7   FF   FF   FF   FF      F6FF     FFF6     FFFF     FD00
1>MEM F LIST,N 5,3,4,0A,8,82,0A,4,8 <cr>
1>DAS 126,12B <cr>
  Addr  Object              Mnemonic
                            ORG     126H
  0126  26 20               INC     SW
                          MODULE01\INCI:
  0128  26 21               INC     I
  012A  14 DA               BR      $COMP
                            END
1>BRA A=126 C=0P <cr>
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  012A  FE80       0    0    0    0    0    0    0    0     1    0     0    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6      RP7
     X    A    C    B                           VP       UP       DE       HL
    00   03   CB   F7   FF   FF   FF   FF      F6FF     FFFF     FFFF     FE42
  One step emulation standby  Press the ESC key.
1>MEM D I,I <cr>
  FE21      01
```

```
1>MEM D LIST,LIST+7 <cr>
  FE42          03 05 04 0A 08 0A 04                    ........
1>RUN T ,1 <cr>
  User-system Vcc-ON      Emulation start at 012A
      terminated
  Frame Status Address Data Label  Mnemonic                    PO EX
  0000           012A                BRC      $COMP
   PC     SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0106   FE80       0    0    0    0    0    0    0    0    1    0     0    0
    R0    R1    R2    R3    R4    R5    R6    R7        RP4      RP5      RP6      RP7
     X     A     C     B                                VP       UP       DE       HL
    00    03    CB    F7    FF    FF    FF    FF       F6FF     FFFF     FFFF     FE42
  One step emulation standby  Press the ESC key.
1>RUN B <cr>
  User-system Vcc-ON      Emulation start at 0106
  Standard break     terminated
   PC     SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  012A   FE80       0    0    0    0    0    0    0    0     1    0     0    0
    R0    R1    R2    R3    R4    R5    R6    R7        RP4      RP5      RP6      RP7
     X     A     C     B                                VP       UP       DE       HL
    01    04    CB    F7    FF    FF    FF    FF       F6FF     FFFF     FFFF     FE43
  One step emulation standby  Press the ESC key.
1>MEM D I,I <cr>
  FE21       02
1>MEM D LIST,LIST+7 <cr>
  FE42          03 04 05 0A 08 82 0A 04                 ........
1>RUN T ,1 <cr>
  User-system Vcc-ON      Emulation start at 012A
      terminated
  Frame Status Address Data Label  Mnemonic                    PO EX
  0000           012A                BR       $COMP
   PC     SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC   UF   P/V   SUB  CY
  0106   FE80       0    0    0    0    0    0    0    0    1    0     0    0
    R0    R1    R2    R3    R4    R5    R6    R7        RP4      RP5      RP6      RP7
     X     A     C     B                                VP       UP       DE       HL
    01    04    CB    F7    FF    FF    FF    FF       F6FF     FFFF     FFFF     FE43
  One step emulation standby  Press the ESC key.
1>RUN B <cr>   User-system Vcc-ON      Emulation start at 0106
  Standard break     terminated
   PC     SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  012A   FE80       0    0    0    0    0    0    0    0     1    0     0    0
    R0    R1    R2    R3    R4    R5    R6    R7        RP4      RP5      RP6      RP7
     X     A     C     B                                VP       UP       DE       HL
    03    08    CB    F7    FF    FF    FF    FF       F6FF     FFFF     FFFF     FE45
  One step emulation standby  Press the ESC key.
1>MEM D I,I <cr>
  FE21       04
1>MEM D LIST,LIST+7 <cr>
  FE42          03 04 05 08 0A 82 0A 04                 ........
1>MEM D SW,SW <cr>
  FE20  04
```

```
1>ASM 135 <cr>
  0135                              BNZ     $COMP
                          = BNZ  $MODULE01\SORT <cr>
         80 C9
  0137                              BR      $STOP
                          = END <cr>
1>DAS 135,136 <cr>
  Addr  Object              Mnemonic
                            ORG     135H
  0135  80 C9               BNZ     $SORT
                            END
1>MEM F LIST,N 5,3,4,0A,8,82,0A,4,8 <cr>
1>TRM ALL <cr>
1>BRA A=MODULE01\COMP L=9 C=0P <cr>
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z    RSS  AC    UF   P/V   SUB  CY
  010A  FE80       0    0    0    0    0    0    0    1     1    1     1    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4      RP5      RP6      RP7
     X    A    C    B                           VP       UP       DE       HL
    07   82   CB   F7   FF   FF   FF   FF      F6FF     FFFF     FFFF     FE49
  One step emulation standby  Press the ESC key.
1>MEM D N,N <cr>
  FE4A                                82                                .
1>MEM D I,I <cr>
  FE21     08                                                          .
1>MEM D LIST,LIST+7 <cr>
  FE42          03 04 05 08 0A 0A 04 08                                ........
1>TRD I ALL <cr>
  Frame Status Address Data Label  Mnemonic
                               MODULE01\SORT:
  0000          0100                 MOV     SW,#1H
  0004    WR    FE20    01
  0003          0103                 MOV     I,#0H
  0008    WR    FE21    00
                               MODULE01\COMP:
  0007          0106                 MOV     A,N
  0011    RD    FE4A    08
  0010          0108                 CMP     A,I
  0014    RD    FE21    00
  0013          010A                 BNZ     $CONT
                               MODULE01\CONT:
  0018          0114                 BR      $12CH
  0022          012C                 MOV     A,I
  0025    RD    FE21    00
  0024          012E                 MOV     R0,#0H
  0027          0130                 BR      $116H
  0031          0116                 MOVW    RP7,#LIST
  0034          0119                 XCH     A,R0
  0035          011A                 ADDW    RP7,RP0
  0037          011C                 MOV     A,[HL+]
  0041    RD    FE42    05
  0038          011D                 CMP     A,[HL]
```

```
0043    RD    FE43    03
0040          011F              BC        $INCI
0044          0121              BZ        $INCI
0046          0123              XCH       A,[HL-]
0050    RD    FE43    03
0051    WR    FE43    05
0048          0125              MOV       [HL],A
0054    WR    FE42    03
0049          0126              INC       SW
0055    RD    FE20    01
0056    WR    FE20    02
                          MODULE01\ INCI:
0053          0128              INC       I
0059    RD    FE21    00
0060    WR    FE21    01
0058          012A              BR        $COMP
                          MODULE01\ COMP:
0064          0106              MOV       A,N
0067    RD    FE4A    08
0066          0108              CMP       A,I
0070    RD    FE21    01
0069          010A              BNZ       $CONT
                          MODULE01\ CONT:
0074          0114              BR        $12CH
0078          012C              MOV       A,I
0081    RD    FE21    01
0080          012E              MOV       R0,#0H
0083          0130              BR        $116H
0087          0116              MOVW      RP7,#LIST
0090          0119              XCH       A,R0
0091          011A              ADDW      RP7,RP0
0093          011C              MOV       A,[HL+]
0097    RD    FE43    05
0094          011D              CMP       A,[HL]
0099    RD    FE44    04
0096          011F              BC        $INCI
0100          0121              BZ        $INCI
0102          0123              XCH       A,[HL-]
0106    RD    FE44    04
0107    WR    FE44    05
0104          0125              MOV       [HL],A
0110    WR    FE43    04
0105          0126              INC       SW
0111    RD    FE20    02
0112    WR    FE20    03
                          MODULE01\ INCI:
0109          0128              INC       I
0115    RD    FE21    01
0116    WR    FE21    02
0114          012A              BR        $COMP
                          MODULE01\ COMP:
0120          0106              MOV       A,N
0123    RD    FE4A    08
0122          0108              CMP       A,I
```

```
0126    RD    FE21    02
0125          010A              BNZ       $CONT
                              MODULE01\ CONT:
0130          0114              BR        $12CH
0134          012C              MOV       A,I
0137    RD    FE21    02
0136          012E              MOV       R0,#0H
0139          0130              BR        $116H
0143          0116              MOVW      BP7,#LIST
0146          0119              XCH       A,R0
0147          011A              ADDW      RP7,RP0
0149          011C              MOV       A,[HL+]
0153    RD    FE44    05
0150          011D              CMP       A,[HL]
0155    RD    FE45    0A
0152          011F              BC        $INCI
                              MODULE01\ INCI:
0158          0128              INC       I
0161    RD    FE21    02
0162    WR    FE21    03
0160          012A              BR        $COMP
                              MODULE01\ COMP:
0166          0106              MOV       A,N
0169    RD    FE4A    08
0168          0108              CMP       A,I
0172    RD    FE21    03
0171          010A              BNZ       $CONT
                              MODULE01\ CONT:
0176          0114              BR        $12CH
0180          012C              MOV       A,I
0183    RD    FE21    03
0182          012E              MOV       R0,#0H
0185          0130              BR        $116H
0189          0116              MOVW      RP7,#LIST
0192          0119              XCH       A,R0
0193          011A              ADDW      RP7,RP0
0195          011C              MOV       A,[HL+]
0199    RD    FE45    0A
0196          011D              CMP       A,[HL]
0201    RD    FE46    08
0198          011F              BC        $INCI
0202          0121              BZ        $INCI
0204          0123              XCH       A,[HL-]
0208    RD    FE46    08
0209    WR    FE46    0A
0206          0125              MOV       [HL],A
0212    WR    FE45    08
0207          0126              INC       SW
0213    RD    FE20    03
0214    WR    FE20    04
                              MODULE01\ INCI:
0211          0128              INC       I
0217    RD    FE21    03
0218    WR    FE21    04
```

```
0216            012A                BR      $COMP
                                MODULE01\ COMP:
0222            0106                MOV     A,N
0225    RD      FE4A    08
0224            0108                CMP     A,I
0228    RD      FE21    04
0227            010A                BNZ     $CONT
                                 MODULE01\ CONT:
0232            0114                BR      $12CH
0236            012C                MOV     A,I
0239    RD      FE21    04
0238            012E                MOV     R0,#0H
0241            0130                BR      $116H
0245            0116                MOVW    RP7,#LIST
0248            0119                XCH     A,R0
0249            011A                ADDW    RP7,RP0
0251            011C                MOV     A,[HL+]
0255    RD      FE46    0A
0252            011D                CMP     A,[HL]
0257    RD      FE47    82
0254            011F                BC      $INCI
                                MODULE01\ INCI:
0260            0128                INC     I
0263    RD      FE21    04
0264    WR      FE21    05
0262            012A                BR      $COMP
                                MODULE01\ COMP:
0268            0106                MOV     A,N
0271    RD      FE4A    08
0270            0108                CMP     A,I
0274    RD      FE21    05
0273            010A                BNZ     $CONT
                                MODULE01\ CONT:
0278            0114                BR      $12CH
0282            012C                MOV     A,I
0285    RD      FE21    05
0284            012E                MOV     R0,#0H
0287            0130                BR      $116H
0291            0116                MOVW    RP7,#LIST
0294            0119                XCH     A,R0
0295            011A                ADDW    RP7,RP0
0297            011C                MOV     A,[HL+]
0301    RD      FE47    82
0298            011D                CMP     A,[HL]
0303    RD      FE48    0A
0300            011F                BC      $INCI
0304            0121                BZ      $INCI
0306            0123                XCH     A,[HL-]
0310    RD      FE48    0A
0311    WR      FE48    82
0308            0125                MOV     [HL],A
0314    WR      FE47    0A
0309            0126                INC     SW
0315    RD      FE20    04
```

```
0316    WR    FE20    05
                              MODULE01\ INCI:
0313          0128                INC     I
0319    RD    FE21    05
0320    WR    FE21    06
0318          012A                BR      $COMP
                              MODULE01\ COMP:
0324          0106                MOV     A,N
0327    RD    FE4A    08
0326          0108                CMP     A,I
0330    RD    FE21    06
0329          010A                BNZ     $CONT
                              MODULE01\ CONT:
0334          0114                BR      $12CH
0338          012C                MOV     A,I
0341    RD    FE21    06
0340          012E                MOV     R0,#0H
0343          0130                BR      $116H
0347          0116                MOVW    RP7,#LIST
0350          0119                XCH     A,R0
0351          011A                ADDW    RP7,RP0
0353          011C                MOV     A,[HL+]
0357    RD    FE48    82
0354          011D                CMP     A,[HL]
0359    RD    FE49    04
0356          011F                BC      $INCI
0360          0121                BZ      $INCI
0362          0123                XCH     A,[HL-]
0366    RD    FE49    04
0367    WR    FE49    82
0364          0125                MOV     [HL],A
0370    WR    FE48    04
0365          0126                INC     SW
0371    RD    FE20    05
0372    WR    FE20    06
                              MODULE01\ INCI:
0369          0128                INC     I
0375    RD    FE21    06
0376    WR    FE21    07
0374          012A                BR      $COMP
                              MODULE01\ COMP:
0380          0106                MOV     A,N
0383    RD    FE4A    08
0382          0108                CMP     A,I
0386    RD    FE21    07
0385          010A                BNZ     $CONT
                              MODULE01\ CONT:
0390          0114                BR      $12CH
0394          012C                MOV     A,I
0397    RD    FE21    07
0396          012E                MOV     R0,#0H
0399          0130                BR      $116H
0403          0116                MOVW    RP7,#LIST
0406          0119                XCH     A,R0
```

```
  0407           011A                ADDW    RP7,RP0
  0409           011C                MOV     A,[HL+]
  0413    RD     FE49    82
  0410           011D                CMP     A,[HL]
  0415    RD     FE4A    08
  0412           011F                BC      $INCI
  0416           0121                BZ      $INCI
  0418           0123                XCH     A,[HL-]
  0422    RD     FE4A    08
  0423    WR     FE4A    82
  0420           0125                MOV     [HL],A
  0426    WR     FE49    08
  0421           0126                INC     SW
  0427    RD     FE20    06
  0428    WR     FE20    07
                             MODULE01\ INCI:
  0425           0128                INC     I
  0431    RD     FE21    07
  0432    WR     FE21    08
  0430           012A                BR      $COMP
                             MODULE01\ COMP:
  0436           0106                MOV     A,N
  0439    RD     FE4A    82
  0438           0108                CMP     A,I
  0442    RD     FE21    08
1>DAS 106,109 <cr>
  Addr  Object                       Mnemonic
                                     ORG     MODULE01\ COMP
                                   MODULE01\ COMP:
  0106  20 4A                        MOV     A,N
  0108  9F 21                        CMP     A.I
                                     END

1>ASM 106 <cr>
  0106  MODULE01\ COMP: <cr>
  0106                       MOV     A,I
                  = BR $139 <cr>
        14 31
  0108                       CMP     A,I
                  = END <cr>
```

```
1>ASM 139
  0139                  NOP
                  = MOV A,N <cr>
        20 4A
  013B                  NOP
                  = DEC R1 <cr>
        C9
  013C                  NOP
                  = CMP A,I <cr>
        9F 21
  013E                  NOP
                  = BNZ  $MODULE01\CONT <cr>
        80 D4
  0140                  NOP
                  = BR $10C <cr>
        14 CA
  0142                  NOP
                  = END <cr>
1>ASM MODULE01\SORT <cr>
  0100  MODULE01\SORT:
  0100                  MOV     SW,#1H
                  = MOV SW,#0H <cr>
        3A 20 00
  0103                  MOV     I,#0H
                  = END <cr>
1>SYM C LIST 0FE22 <cr>
1>SYM C N 0FE2A <cr>
1>SYM E STACK <cr>
1>MEM C 117 <cr>
  0117  42 22 <cr>
  0118  FE . <cr>
1>MEM C 13A <cr>
  013A  4A 2A <cr>
  013B  C9 . <cr>
1>DAS  100,141 <cr>
  Addr  Object          Mnemonic
                        ORG     MODULE01\SORT
                      MODULE01\SORT:
  0100  3A 20 00        MOV     SW,#0H
  0103  3A 21 00        MOV     I,#0H
                      MODULE01\COMP:
  0106  14 31           BR      $139H
  0108  9F 21           CMP     A,I
  010A  80 08           BNZ     $CONT
  010C  14 24           BR      $132H
  010E  00              NOP
                      MODULE01\STOP:
  010F  00              NOP
  0110  00              NOP
  0111  00              NOP
  0112  14 FB           BR      $STOP
                      MODULE01\CONT:
  0114  14 16           BR      $12CH
  0116  67 22 FE        MOVW    RP7,#LIST
```

```
  0119  D8                    XCH     A,R0
  011A  88 E8                 ADDW    RP7,RP0
  011C  59                    MOV     A,[HL+]
  011D  16 5F                 CMP     A,[HL]
  011F  83 07                 BC      $INCI
  0121  81 05                 BZ      $INCI
  0123  16 34                 XCH     A,[HL-]
  0125  55                    MOV     [HL],A
  0126  26 20                 INC     SW
                        MODULE01\ INCI:
  0128  26 21                 INC     I
  012A  14 DA                 BR      $COMP
  012C  20 21                 MOV     A,I
  012E  B8 00                 MOV     R0,#0H
  0130  14 E4                 BR      $116H
  0132  6F 20 00              CMP     SW,#0H
  0135  80 C9                 BNZ     $SORT
  0137  14 D6                 BR      $STOP
  0139  20 2A                 MOV     A,N
  013B  C9                    DEC     R1
  013C  9F 21                 CMP     A,I
  013E  80 D4                 BNZ     $CONT
  0140  14 CA                 BR      $10CH
                              END
1>MEM F LIST,N 5,3,4,0A,8,82,0A,4,8 <cr>
1>BRA A=MODULE01\ STOP C=0P <cr>
1>RUN B 100 <cr>
  User-system Vcc-ON     Emulation start at 0100
  Standard break    terminated
   PC    SP  PSW: RBS2 RBS1 RBS0 IE    S    Z   RSS  AC    UF   P/V   SUB  CY
  0112  FE80       0    0    0    0    0    1    0    0     1    0     1    0
    R0   R1   R2   R3   R4   R5   R6   R7       RP4     RP5     RP6      RP7
     X    A    C    B                           VP      UP      DE       HL
    06   07   CB   F7   FF   FF   FF   FF      F6FF    FFFF    FFFF     FE29
  One step emulation standby  Press the ESC key.
1>MEM D LIST,LIST+7 <cr>
  FE22         03 04 04 05 08 0A 0A 82                          ........
1>MEM D N,N <cr>
  FE2A                                 08                             .
1>MEM D SW,I <cr>
  FE20   00 07
1>SAV SORT01.HEX 100,141 <cr>                                     ..
  object save complete
1>VRY SORT01.HEX <cr>
  object verify complete
1>
```

APPENDIX B

This appendix describes how the system software for use under CP/M-86, MS-DOS, and PC DOS™ differs from that designed for use under MD-086/116 when a host computer other than the MD Series (PC-9800 Series, IBM PC/AT) is used.

Appendix B is divided into three parts:
Part I: System Software for PC-9800 Series (CP/M-86)
Part II: System Software for PC-9800 Series (MS-DOS)
Part III: System Software for IBM PC/AT (PC DOS)

When a series or model name, listed in the left-hand column of the table below, appears in this manual, it should be substituted with the corresponding series or model name listed on the right.

. PC-9800	->	PC-9800 Series
. IBM PC Series . IBM PC	->	IBM PC/AT
. IE-78310-R	->	IE-78310A-R

PART I SYSTEM SOFTWARE FOR PC-9800 SERIES (CP/M-86)

CHAPTER 1 OVERVIEW

The system software runs under CP/M-86 on the PC-9800 Series, and enables the PC-9800 Series to provide the same development environment as that supported by the conventional MD-086/116 Series.

This instruction manual describes how this software differs from the system software for the MD-086/116 Series, distributed with the IE-78310-R. For details of the commands, refer to the instruction manual provided with the IE-78310-R.

1.1 System Configuration

To run the system software, the system must be configured as follows.

(1) Host computer

PC-9800 Series, other than PC-98XA

(2) Operating system (OS)

CP/M-86 V1.1, or CP/M-86 V1.1, Japanese language version

(3) Console

Keyboard and CRT display unit provided with the PC-9801

(4) Connection with the IE-78310-R

RS-232-C interface built into the PC-9801 main unit

1.2 System Software Distribution

(1) File names

The system software includes the following files:

- IE78310.CMD (Main system software for the PC-9800 Series)
- IE78310.OV1
- IE78310.OV2
- IE78310.HLP

(System software overlay files)

(2) Distribution media

- 8" 2D (Product name: uS6A1IE78310-P01)
- 5" 2HD (Product name: uS6A10IE78310-P01)

CHAPTER 2 CONNECTION

This chapter describes how to connect the PC-9801 to the IE-78310-R.

(1) Turn off the power of the PC-9801 and IE-78310-R.

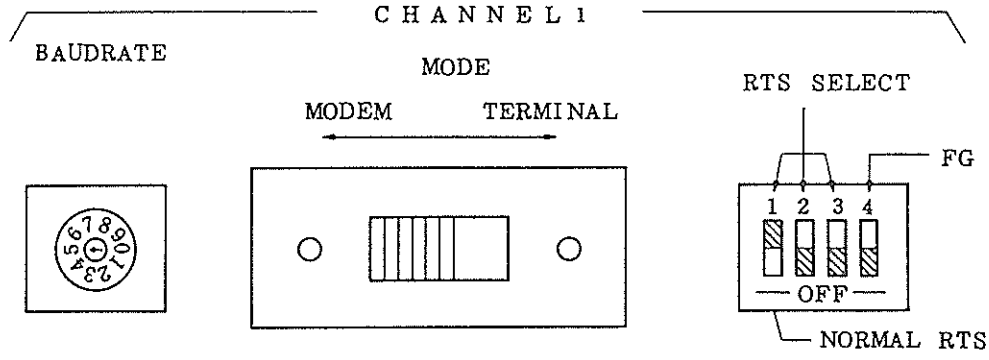
(2) Set CH1 on the IE-78310-R as shown in Figure 2-1.

Then, set the following:
Baud rate: 9600 bps
Mode: Modem
RTS: Standard

(3) Connect the standard RS-232-C interface on the back of the PC-9801 main unit to CH1 of the IE-78310-R, using the cable supplied with the IE-78310-R.

(4) Turn on the power of the PC-9801 and IE-78310-R.

Fig. 2-1 Setting CH1



CHAPTER 3 STARTING THE SYSTEM SOFTWARE

Start the system software as described below.

(1) Start CP/M-86 on the PC-9801.

(2) Set the RS-232-C channel mode by executing the SPEED command of CP/M-86.

Set the RS-232-C channel as follows:
Baud rate: 9600 bps
Character length: 8 bits
Parity: None
Stop bits: 2
XON/XOFF: Either XON or XOFF

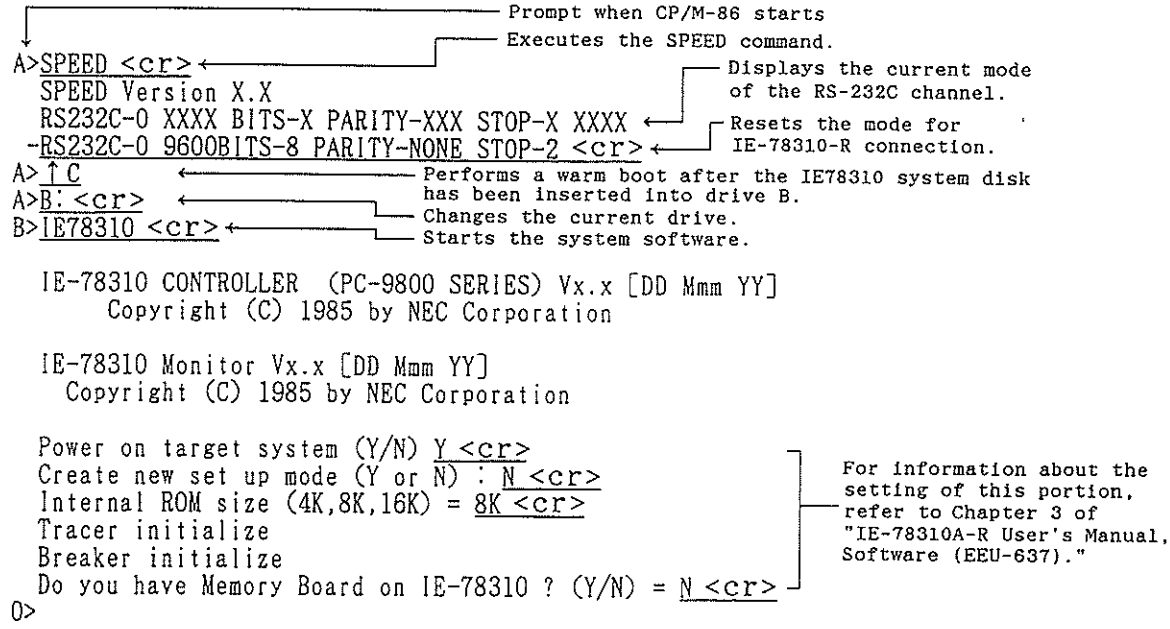
(3) Insert the IE78310 system disk into a floppy drive.

(4) Perform a warm boot by pressing Ctrl-C.

(5) Change the current drive to that into which the IE78310 system disk is inserted.

(6) Key in "IE78310 <cr>". Then, the system software starts.

An example of starting the system software is given below.
In this example, the SPEED command is entered from drive A, and the IE78310 system disk is in drive B.



Even when the IE-78310-R is connected, the following indication will appear if there is an RS-232-C interface mismatch between the IE-78310-R and PC-9801:

```
No connect!
 Abort (Y/N):
```

In this case, type "Y" to abort connection to the IE78310 and return to CP/M-86. Then, by executing the SPEED command, match the mode setting with that of the RS-232-C interface of the IE-78310-R.

CHAPTER 4 NOTES ON USE

When using the IE78310 with CP/M-86 running on the PC-9801, pay particular attention to the following.

4.1 Terminating the IE78310

4.1.1 RS-232-C mode alteration

The changed RS-232-C interrupt mode is used in the IE-78310. So, reset the RS-232-C channel mode by executing the SPEED command when the RS-232-C channel is to be used with another application program after the IE78310 is terminated.

When, however, the IE78310 is to be reexecuted after being terminated once, the SPEED command need not be executed.

4.1.2 Key code alteration

The changed key codes are used for keys, DEL, <—, and —>, in the IE78310. When the default key codes are needed for these keys after terminating the IE78310, reset the key codes by using suitable supported key commands.

The following key codes are set when the IE78310 is terminated:

DEL: 7FH
<— : 1DH
—> : 1CH

CHAPTER 5 DIFFERENCES FROM SYSTEM SOFTWARE RUNNING UNDER MD-086/116

The IE78310 for CP/M-86 running on the PC-9801 differs from the IE78310 for MD-086/116, as described below.

(1) The console detach/attach function is not supported.

The console detach/attach function is a Concurrent CP/M™ function. CP/M-86, running on the PC-9801, is a single-task operating system. Therefore, this function is not supported.

(2) Channel number setting is not required.

With the MD-086/116, four RS-232-C channels are provided as standard, and up to eight RS-232-C channels can be used. The PC-9801, however, allows only one RS-232-C channel to be used (as standard). Only this one standard channel is used, eliminating the need for channel number setting.

PART II SYSTEM SOFTWARE FOR PC-9800 SERIES (MS-DOS)

CHAPTER 1 OVERVIEW

The system software runs under MS-DOS on the PC-9800 Series, and enables the PC-9800 Series to provide the same development environment as that supported by the conventional MD-086/116 Series.

This instruction manual describes how this software differs from the system software for the MD-086/116 Series, distributed with the IE-78310-R. For details of the commands, refer to the instruction manual provided with the IE-78310-R.

1.1 System Configuration

To run the system software, the system must be configured as follows.

(1) Host computer

PC-9800 Series, other than PC-98XA

(2) Operating system (OS)

MS-DOS V3.30/3.30A/3.30B/3.30C/3.30D/5.00(Note)/
5.00A(Note)

Note: The task swapping function of V5.00 and V5.00A cannot be used with the system software.

(3) Console

Keyboard and CRT display unit provided with the PC-9801

(4) Connection with the IE-78310-R

RS-232-C interface built into the PC-9801 main unit

1.2 System Software Distribution

(1) File names

The system software includes the following files:

- IE78310.COM (Main system software for the PC-9800 Series)
- IE78310.OM0
- IE78310.OV1
- IE78310.OV2
- IE78310.HLP

(System software overlay files)

(2) Distribution media

- 8" 2D (Product name: uS5A1IE78310-P01)
- 5" 2HD (Product name: uS5A10IE78310-P01)
- 3.5" 2HD (Product name: uS5A13IE78310)

CHAPTER 2 CONNECTION

This chapter describes how to connect the PC-9801 to the IE-78310-R.

(1) Turn off the power of the PC-9801 and IE-78310-R.

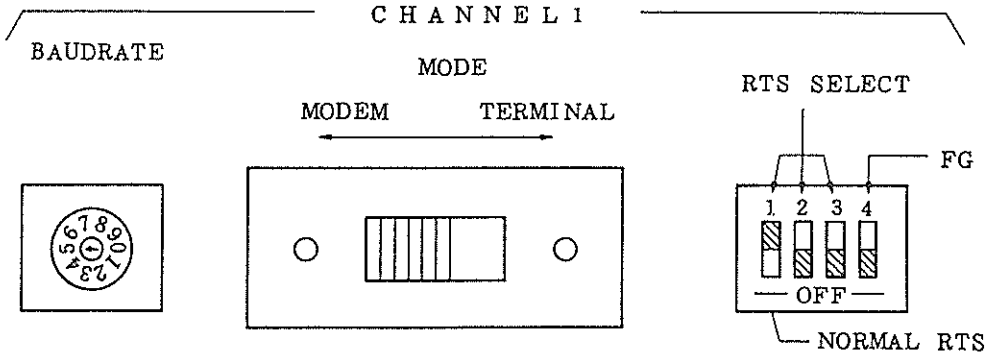
(2) Set CH1 on the IE-78310-R as shown in Figure 2-1.

Then, set the following:
Baud rate: 9600 bps
Mode: Modem
RTS: Standard

(3) Connect the standard RS-232-C channel on the back of the PC-9801 main unit to CH1 of the IE-78310-R, using the cable supplied with the IE-78310-R.

(4) Turn on the power of the PC-9801 and IE-78310-R.

Fig. 2-1 Setting CH1



CHAPTER 3 STARTING THE SYSTEM SOFTWARE

Start the system software as described below.

(1) Start MS-DOS on the PC-9801.

(2) Set the RS-232-C channel mode by executing the SPEED command of MS-DOS.

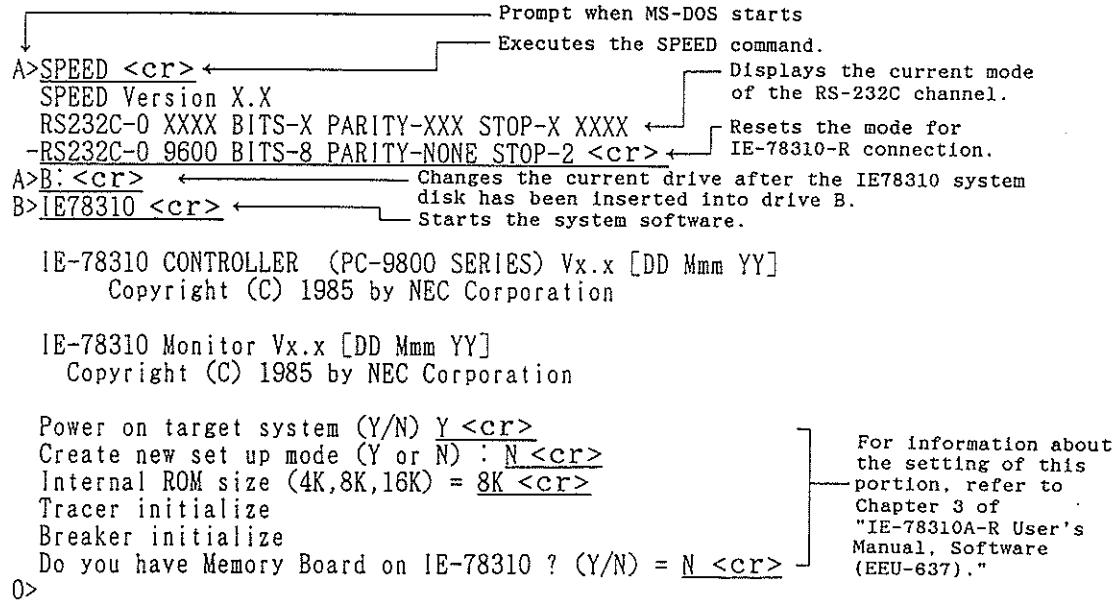
Set the RS-232-C channel as follows:
Baud rate: 9600 bps
Character length: 8 bits
Parity: None
Stop bits: 2
XON/XOFF: Either XON or XOFF.

(3) Insert the IE78310 system disk into a floppy drive.

(4) Change the current drive to that into which the IE78310 system disk is inserted.

(5) Key in "IE78310 <cr>". Then, the system software starts.

An example of starting the system software is given below.
In this example, the SPEED command is entered from drive A, and the IE78310 system disk is in drive B.



Even when the IE-78310-R is connected, the following indication will appear if there is an RS-232-C interface mismatch between the IE-78310-R and PC-9801:

```
No connect!
 Abort (Y/N):
```

In this case, type "Y" to abort connection to the IE78310 and return to MS-DOS. Then, by executing the SPEED command, match the mode setting with that of the RS-232-C interface of the IE-78310-R.

CHAPTER 4 NOTES ON USE

When using the IE78310 with MS-DOS running on the PC-9801, pay particular attention to the following.

4.1 Terminating the IE78310

4.1.1 RS-232-C mode alteration

The changed RS-232-C interrupt mode is used in the IE-78310. So reset the RS-232-C channel mode by executing the SPEED command when the RS-232-C channel is to be used with another application program after the IE78310 is terminated.

When, however, the IE78310 is to be reexecuted after being terminated once, the SPEED command need not be executed.

4.1.2 Key code alteration

The changed key codes are used for keys, DEL, <—, and —>, in the IE78310. When the default key codes are needed for these keys after terminating the IE78310, reset the key codes by using suitable supported commands.

The following key codes are set when the IE78310 is terminated:

DEL: 7FH
<— : 1DH
—> : 1CH

4.2 Using the DIR Command

The DIR command allows only the contents of the current directory, present when the IE78310 is started, to be referenced.

4.3 Using File Manipulation Commands

With a file manipulation command such as LOD, SAV, VRY, LST, or STR, only the files under the current directory, present when the IE78310 is started, can be referenced. Files can be created only under the current directory.

4.4 Creating an STR File

In most cases, an STR file created under MS-DOS should operate normally. However, if a problem occurs near the last line of an STR file, perform the following check.

An STR file is a text file created using an editor.
A fault will occur if any text ends with other than an EOF code (1AH). Ensure that EOF codes are always present at the end of any text. Add an EOF code if necessary.

4.5 Control Keys

Some control keys used with the system software differ from those used with the system software for the MD-086/116.
For details, see Chapter 5.

CHAPTER 5 DIFFERENCES FROM SYSTEM SOFTWARE RUNNING UNDER MD-086/116

The IE78310 for MS-DOS running on the PC-9801 differs from the IE78310 for the MD-086/116, as described below.

(1) The console detach/attach function is not supported.

The console detach/attach function is a Concurrent CP/M™ function. MS-DOS, running on the PC-9801, is a single-task operating system. Therefore, this function is not supported.

(2) Channel number setting is not required.

With the MD-086/116, four RS-232-C channels are provided as standard, and up to eight RS-232-C channels can be used. The PC-9801, however, allows only one RS-232-C channel to be used (as standard). Only this one standard channel is used, eliminating the need for channel number setting.

(3) Some control keys are different.

Two key sequences, Ctrl-C and Ctrl-S, used with the MD-based system software are used by MS-DOS itself. So, these key sequences cannot be used with the system software for MS-DOS. Instead, the key sequences listed below are used.

Key sequence	Function
↑B (↑C)	Aborts the system software.
↑T (↑S)	Suspends command execution.

The key sequences in parentheses are the corresponding MD-based key sequences.

PART III SYSTEM SOFTWARE FOR IBM PC/AT (PC DOS)

CHAPTER 1 OVERVIEW

The system software runs under PC DOS on the IBM PC Series, and enables the IBM PC Series to provide the same development environment as that supported by the conventional MD-086/116 Series.

1.1 System Configuration

To run the system software, the system must be configured as follows.

(1) Host computer

IBM PC/AT

(2) Operating system (OS)

PC DOS V3.10

(3) Console

Keyboard and CRT display unit provided with the IBM PC

(4) Connection with the IE-78310-R

Asynchronous communications adapter, available as an option for the IBM PC

1.2 System Software Distribution

(1) File names

The system software includes the following files:

- IE78310.COM (Main system software for the IBM PC Series)
- IE78310.OM0
- IE78310.OV1
- IE78310.OV2
- IE78310.HLP

(IE78310.OM0, IE78310.OV1, IE78310.OV2, IE78310.HLP: System software overlay files)

(2) Distribution media

5" 2HC (Product name: uS7B10IE78310)

CHAPTER 2 CONNECTION

This chapter describes how to connect the IBM PC to the IE-78310-R.

(1) Turn off the power of the IBM PC and IE-78310-R.

(2) Set CH1 on the IE-78310-R as shown in Figure 2-1.

Then, set the following:
Baud rate: 9600 bps
Mode: Modem
RTS: Standard

(3) Set the asynchronous communications adapter as shown in Figure 2-2.

The system software supports the first serial port (No. 0) only.

(4) Connect the RS-232-C interface on the asynchronous communications adapter of the IBM PC to CH1 of the IE-78310-R, using the RS-232-C cable for the IBM PC. (See Figure 2-3.)

(5) Turn on the power of the IBM PC and IE-78310-R.

Fig. 2-1 Setting CH1

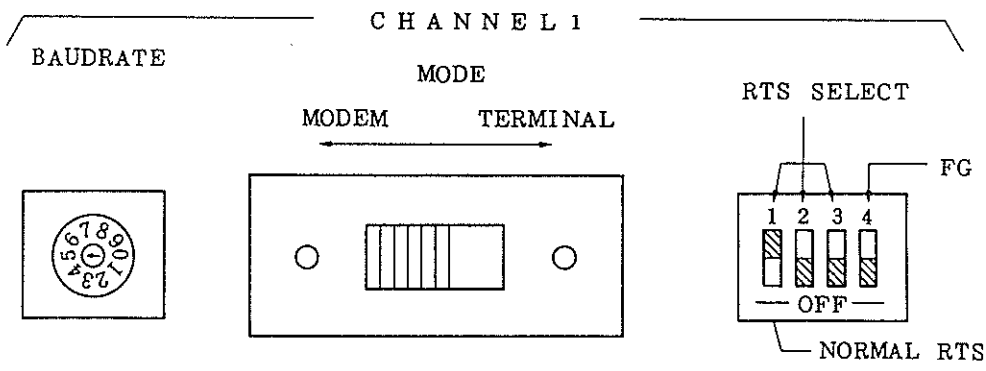


Fig. 2-2 Setting the Asynchronous Communications Adapter

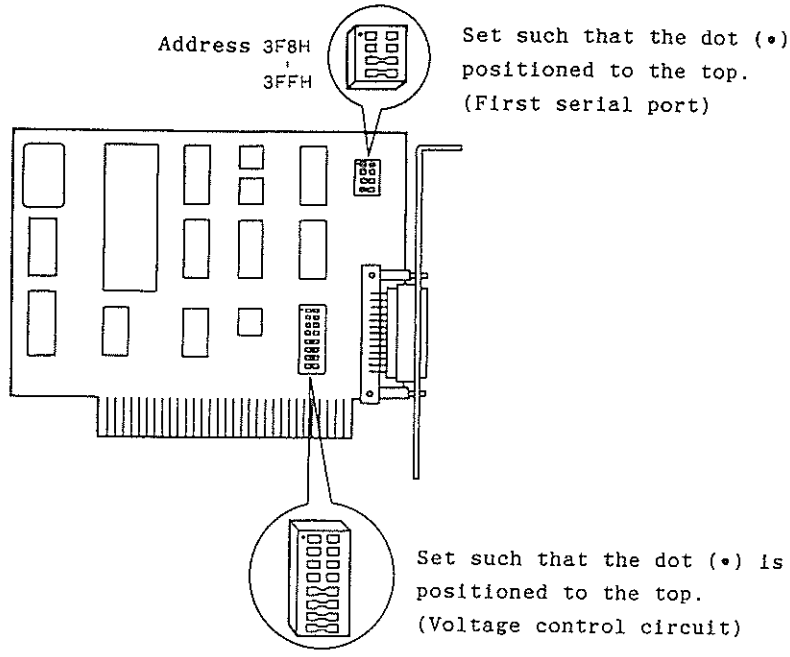
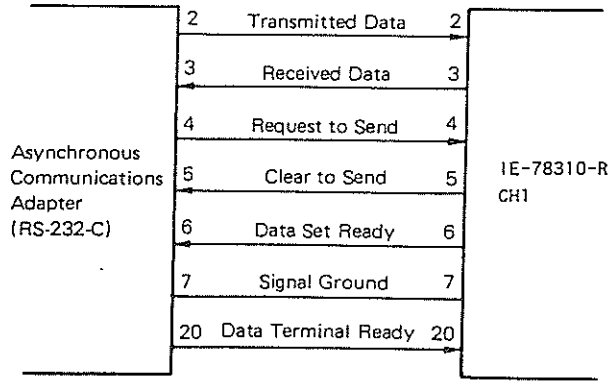


Fig. 2-3 Cable Connection



CHAPTER 3 STARTING THE SYSTEM SOFTWARE

Start the system software as described below.

(1) Start PC DOS on the IBM PC.

(2) Set COM1 by executing the MODE command of PC DOS.

Set COM1 as follows:
Baud rate: 9600 bps
Character length: 8 bits
Parity: None
Stop bits: 2

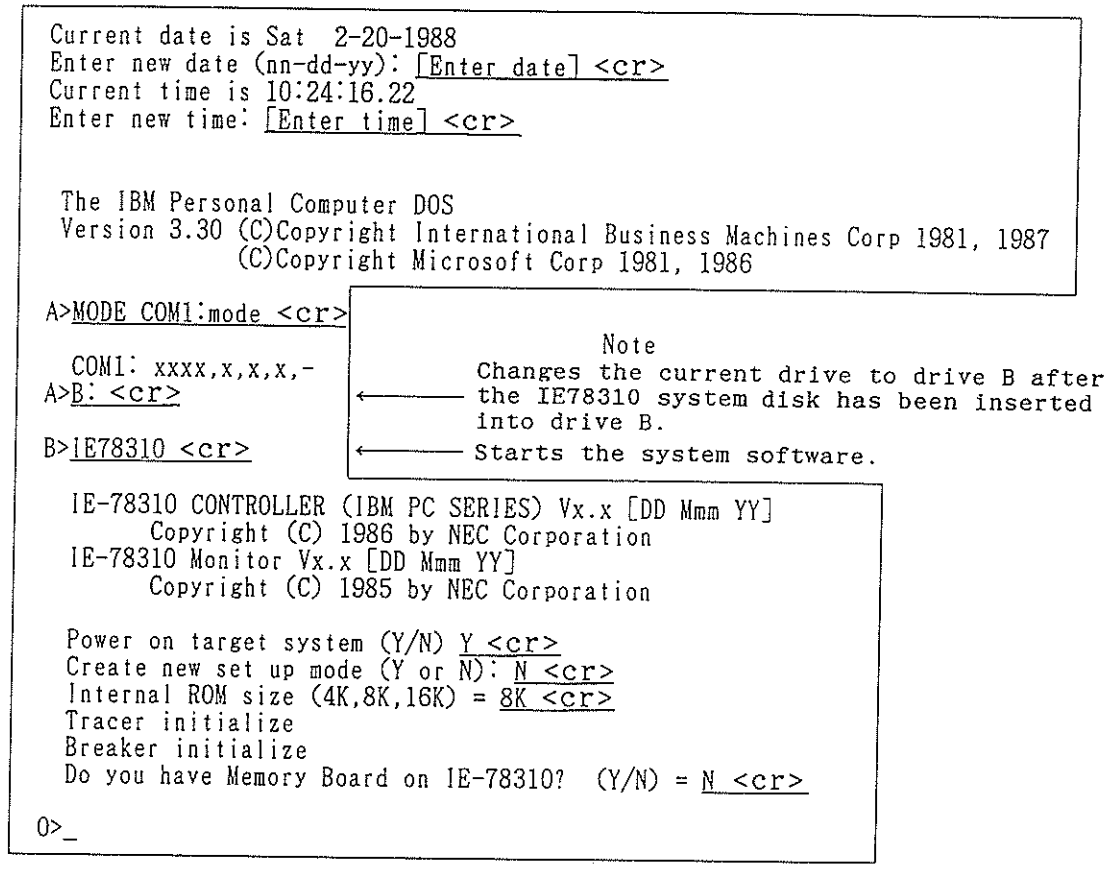
(3) Insert the IE78310 system disk into a floppy drive.

(4) Change the current drive to that into which the IE78310 system disk is inserted.

(5) Key in "IE78310 <cr>". Then, the system software starts.

An example of starting the system software is given below.
In this example, the MODE command is entered from drive A, and the IE78310 system disk is in drive B.

Start the PC DOS system.



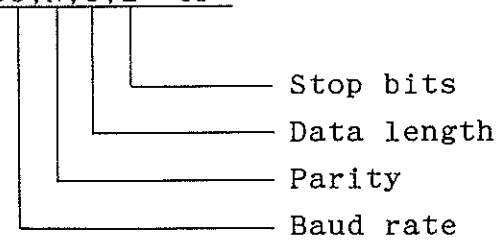
Even when the IE-78310-R is connected, the following indication will appear if there is an RS-232-C interface mismatch between the IE-78310-R and IBM PC:

No connect!
Abort (Y/N):

In this case, type "Y" to abort the connection to the IE78310, and return to PC DOS. Then, by executing the MODE command, match the mode setting with that of the RS-232-C interface of the IE-78310-R.

Remark: Mode setting (for a baud rate of 9600 bps, no parity, a data length of 8 bits, and 2 stop bits)

Enter "MODE COM1:96,N,8,2 <cr>"



CHAPTER 4 NOTES ON USE

When using the IE78310 with PC DOS running on the IBM PC, pay particular attention to the following.

4.1 Creating an STR File

In most cases, an STR file created under PC DOS should operate normally. However, if a problem occurs near the last line of an STR file, perform the following check.

An STR file is a text file created using an editor.
A fault will occur if any text ends with other than an EOF code (1AH). Ensure that EOF codes are always present at the end of any text. Add an EOF code if necessary.

4.2 Control Keys

Some control keys used with the system software differ from those used with the system software for the MD-086/116.
For details, see Chapter 5.

CHAPTER 5 DIFFERENCES FROM SYSTEM SOFTWARE RUNNING UNDER MD-086/116

The IE78310 for PC DOS running on the IBM PC differs from the IE78310 for the MD-086/116, as described below.

(1) The console detach/attach function is not supported.

The console detach/attach function is a Concurrent CP/M™ function. PC DOS, running on the IBM PC, is a single-task operating system. Therefore, this function is not supported.

(2) Channel number setting is not required.

With the MD-086/116, four RS-232-C channels are provided as standard, and up to eight RS-232-C channels can be used. The IBM PC, however, allows only one RS-232-C channel to be used (as standard). Only this one standard channel is used, eliminating the need for channel number setting.

(3) Some control keys are different.

Two key sequences, Ctrl-C and Ctrl-S, used with the MD-based system software are used by PC DOS itself. So, these key sequences cannot be used with the system software for PC DOS. Instead, the key sequences listed below are used.

Key sequence	Function
↑B (↑C)	Aborts the system software.
↑T (↑S)	Suspends command execution.

The key sequences in parentheses are the corresponding MD-based key sequences.

(4) Of the command line edit functions, the addition mode function cannot be used.