(d) Using a branch telephone
Communication is established when a number is dialed from a branch telephone and the A or O command is executed after the counterpart answered. The handset must be hooked on after command execution so that it will not puck up noise.

Communication through a branch telephone can also be established by dialing a number with the D command with W option. In this case, the line is not disconnected even when the handset is hooked on. It can be disconnected only by executing the H command and hanging up the handset.

(e) How to answer
When the S2 register is nonzero, the modem answers the phone automatically (auto answering); it counts rings to the value sepcifeid in the S2 register and executes the A command automatically. Therefore, the line is always connected in the ANS mode when the auto answering function is enabled.

The auto answering function is disabled when the S2 register is loaded with Ø. Even in this state, the modem informs the main unit of ring detection by sending it return code 8. When a ring is detected, execute the A or O command to establish communication.

(f) Handset
The handset can be turned on or off using the V command. Since whether the handset is on or off does not affect the communication function of the modem, the communication line can be monitored by turning on the handset during data transmission. However, noises caught by the handset microphone may enter the line and disturb communication.

(g) Acoustic coupler
The modem cartridge serves as an acoustic coupler when furnished with an optional acoustic coupler unit. In this case, the telephone line is disconnected from the modem.

The only differences between the coupler and modem are that 1) with the coupler, the computer sends data through the telephone mouthpiece while the modem sends it directly via the telephone line, and 2) with the coupler, the computer receives data through the telephone earpiece, while the modem gets it directly from the telephone line. The function of commands are the same for both couplers and modems except that the coupler is not provided with the dialing function.

If both the handset and coupler are connected at the same time, neither of them can be used.

5.1.7.3 DMM cartridge

(1) General
The Digital MultiMeter (DMM) cartridge is an intelligent measuring unit which incorporates an A/D conversion IC and 4-bit CMOS CPU.

The DMM cartridge transfers data and commands via the PINE cartridge interface in 600-bps asynchronous serial communication mode. The cartridge interface is set to the IO mode and used as the control signal line (Power ON/OFF, RDY).

(2) Structure
(a) DMM cartridge I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	P10H	CIOR	Output port contents							CDB0	
	P11H	Not used (access inhibited)									
	P12H										
	P13H										
Write	P10H	CIOR	0	0	0	CDB4	Don't care				
	P11H	Not used (access inhibited)									
	P12H										
	P13H										

CIOR: Cartridge IO register
CDB0: Command (Range switch command) RDY signal
= 0: Ready
= 1: Busy
CDB4: Power-on/off control signal
= 0: Power-on
1: Power-off

In addition to the above signal lines, CTXD and CRXD are used for asynchronous serial communication (600 bps, 8 data bits, no parity, 1 stop bit). In actual operation, data is sent or received via ARTDOR (P14H) or ARTDIR (P14H). The serial switch must be set to the cartridge SIO mode.

```
                        ;       ***************************************************
                        ;               MODEM SAMPLE PROGRAM
                        ;       ***************************************************
                        ;
                        ;       NOTE :
                        ;               This sample program is for using MODEM
                        ;               cartridge.
                        ;
                        ;       <> assemble condition <>
                        ;
                        ;       .Z80
                        ;
                        ;       <> loading address <>
                        ;
                        ;       .PHASE  100H
                        ;
                        ;       <> constant values <>
                        ;
                        ;       IO registers
0018                    ZSWR            EQU     18H             ; Switch register
0002                    ZCSW1           EQU     02H             ;  Cartridge switch 1
0001                    ZCSW0           EQU     01H             ;  Cartridge switch 2
0019                    ZIOCTLR         EQU     19H             ; IO control register
0003                    BZCRS           EQU     3               ;  CRS signal bit
                        ;
                        ;       System area
F005                    RZSWR           EQU     0F005H          ; SWR data setting area
F006                    RZIOCTLR        EQU     0F006H          ; IOCTLR data setting area
F53F                    CRGDEV          EQU     0F53FH          ; Cartridge device code
                        ;
                        ;       BIOS entry (RBIOS2)
EB03                    WBOOT           EQU     0EB03H          ; Warm Boot
EB54                    RSIOX           EQU     WBOOT   +51H    ; Serial Input/Output
EB06                    CONST           EQU     WBOOT   +03H    ; Console status
EB09                    CONIN           EQU     WBOOT   +06H    ; Console in
EB0C                    CONOUT          EQU     WBOOT   +09H    ; Console out
                        ;
                        ;       RSIOX parameter
0010                    RSOPN           EQU     10H             ; Open code
0020                    RSCLS           EQU     20H             ; Close code
0030                    RSIST           EQU     30H             ; Input status code
0040                    RSOST           EQU     40H             ; Oltput status code
0050                    RSGET           EQU     50H             ; Get code
0060                    RSPUT           EQU     60H             ; Put code
                        ;
0001                    RS232           EQU     01H             ; RS-232C using
0002                    SIO             EQU     02H             ; SIO using
0003                    CSIO            EQU     03H             ; Cartridge SIO using
                        ;
                        ;       Cartridge mode.
                        ;
0000                    DBMODE          EQU     00000000B       ; DB mode
0040                    HSMODE          EQU     01000000B       ; HS mode
0080                    IOMODE          EQU     10000000B       ; IO mode
00C0                    OTMODE          EQU     11000000B       ; OT mode
                        ;
000F                    DVMDM           EQU     00001111B       ; Device code for Modem
                        ;
000D                    CR              EQU     0DH             ; Carriage return.
000A                    LF              EQU     0AH             ; Line feed.
                        ;
0200                    RCVSZ           EQU     200H            ; Receive buffer size.
                        ;
                        ;       ***************************************************
                        ;               MAIN PROGRAM
                        ;       ***************************************************
                        ;
                        ;       NOTE :
                        ;
                        ;       CAUTION :
                        ;               If you use resident BIOS, change
                        ;               RBIOS1 to RBIOS2.
                        ;               If Your program is ROM execute program,
                        ;               you must use RBIOS2.
                        ;
0100                    START:
0100    C3 01AE                 JP      PSTART
                        ;
                        ;       Message
                        ;
0103    53 74 61 72     MSG1:   DB      'Start of Modem communication.',CR,LF,00H
0107    74 20 6F 66
010B    20 4D 6F 64
010F    65 6D 20 63
0113    6F 6D 6D 75
0117    6E 69 63 61
011B    74 69 6F 6E
011F    2E 0D 0A 00
0123    4D 6F 64 65     MSG2:   DB      'Modem cartridge check.',CR,LF,00H
0127    6D 20 63 61
012B    72 74 72 69
012F    64 67 65 20
0133    63 68 65 63
0137    6B 2E 0D 0A
013B    00
013C    53 65 6E 64     MSG3:   DB      'Send initial data.',CR,LF,00H
0140    20 69 6E 69
0144    74 69 61 6C
0148    20 64 61 74
014C    61 2E 0D 0A
0150    00
0151    52 65 63 65     MSG4;   DB      'Receive answer code.',CR,LF,00H
0155    69 76 65 20
0159    61 6E 73 77
015D    65 72 20 63
0161    6F 64 65 2E
0165    0D 0A 00
```

```
0168    21 21 21 20         MSG5:   DB      '!!! Start of Modem !!!',CR,LF,00H
016C    53 74 61 72
0170    74 20 6F 66
0174    20 4D 6F 64
0178    65 6D 20 21
017C    21 21 0D 0A
0180    00
0181    21 21 21 20         MSG6:   DB      '!!! End of Modem !!!',CR,LF,00H
0185    45 6E 64 20
0189    6F 66 20 4D
018D    6F 64 65 6D
0191    20 21 21 21
0195    0D 0A 00
0198    43 6F 6D 6D         MSG7:   DB      'Communication error',CR,LF,00H
019C    75 6E 69 63
01A0    61 74 69 6F
01A4    6E 20 65 72
01A8    72 6F 72 0D
01AC    0A 00
                            ;
                            ;
                            ;       Main program
                            ;
01AE                        PSTART:
01AE    31 4000                     LD      SP,4000H        ; Set stack pointer.
01B1    21 0103                     LD      HL,MSG1         ; 'Start of Modem communication'
01B4    CD 02BC                     CALL    MSGDSP          ; Message display.
                            ;
01B7    21 0123                     LD      HL,MSG2         ; 'Modem cartridge check'
01BA    CD 02BC                     CALL    MSGDSP          ; Message display.
01BD    3A F53F                     LD      A,(CRGDEV)      ; Get cartridge device code.
01C0    47                          LD      B,A
01C1    E6 3F                       AND     03FH            ; Get device code only.
01C3    FE 0F                       CP      DVMDM           ; Modem cartridge?
01C5    C2 EB03                     JP      NZ,WBOOT        ; No. then WBOOT.
01C8    78                          LD      A,B             ; Restore CRGDEV.
01C9    FE 8F                       CP      IOMODE+DVMDM    ; Already IO mode?
01CB    C4 0289                     CALL    NZ,SETMODE      ; No. then set into IO mode.
                            ;
01CE                        CRESET:
01CE    CD 029D                     CALL    CRST02          ; CRS line on and wait 10 msec.
01D1    CD 0296                     CALL    CRST01          ; CRS line off and wait 10 msec.
                            ;
01D4                        MDMOPN:
01D4    21 02F2                     LD      HL,OPNDAT       ; Copy RSIOX open parameters.
01D7    11 0305                     LD      DE,OPNPRM       ;
01DA    01 0009                     LD      BC,9            ;
01DD    ED B0                       LDIR                    ;
                            ;
01DF    21 0305                     LD      HL,OPNPRM       ; RSIOX open.
01E2    06 13                       LD      B,RSOPN+CSIO    ; Using Cartridge SIO.
01E4    CD EB54                     CALL    RSIOX           ;
01E7    B7                          OR      A               ; Already opened?
01E8    C2 026F                     JP      NZ,ERREND       ; Yes.
                            ;
01EB                        PUTINIT:
01EB    21 013C                     LD      HL,MSG3         ; 'Send initial data.
01EE    CD 02BC                     CALL    MSGDSP          ; Display message.
                            ;
01F1    21 0305                     LD      HL,OPNPRM       ; Send initial data.
01F4    3A 02FB                     LD      A,(INITDATA)    ;  Initial data --> A
01F7    4F                          LD      C,A             ;
01F8    06 60                       LD      B,RSPUT         ;  Using PUT function of RSIOX.
01FA    CD EB54                     CALL    RSIOX           ;
01FD    20 70                       JR      NZ, ERREND      ;  Error return, then retry.
                            ;
01FF                        GETANS:
01FF    21 0151                     LD      HL,MSG4         ; 'Receive answer code.'
0202    CD 02BC                     CALL    MSGDSP          ; Display message.
                            ;
0205                        GETANS1:
0205    21 0305                     LD      HL,OPNPRM       ; Receive answer code.
0208    06 50                       LD      B,RSGET         ;  Using GET function of RSIOX.
020A    CD EB54                     CALL    RSIOX           ;
020D    C2 026F                     JP      NZ,ERREND       ;  Error return, then Warm Boot.
                            ;
0210    CD 02C8                     CALL    CHARDSP         ; Display receiving character.
0213    FE 0D                       CP      CR              ; Recive char. is CR?
0215    20 EE                       JR      NZ,GETANS1      ; No. (Loop until receivig CR code.)
                            ;
0217    06 20                       LD      B,RSCLS         ; Close RSIOX.
0219    CD EB54                     CALL    RSIOX           ;
021C    21 0168                     LD      HL,MSG5         ; '!!! Start of modem !!!'
021F    CD 02BC                     CALL    MSGDSP          ; Display message.
                            ;
0222    21 02FC                     LD      HL,MDMDAT       ; Copy initial data parameter for RSIOX.
0225    11 0305                     LD      DE,OPNPRM       ;
0228    01 0009                     LD      BC,9            ;
022B    ED B0                       LDIR                    ;
022D    21 0305                     LD      HL,OPNPRM       ; Open RSIOX.
0230    06 13                       LD      B,RSOPN+CSIO    ;  Using OPEN function of RSIOX.
0232    CD EB54                     CALL    RSIOX           ;
0235    B7                          OR      A               ; Error return?
0236    C2 026F                     JP      NZ,ERREND       ; Yes. (then Warm Boot)
                            ;
0239                        KEYCHK:
0239    CD EB06                     CALL    CONST           ; Get console status.
023C    3C                          INC     A               ; Exist inputing key data?
023D    28 0E                       JR      Z,PUT           ; Yes.
                            ;
023F    21 0305                     LD      HL,OPNPRM       ; Get RSIOX receiving status.
0242    06 30                       LD      B,RSIST         ;  Using INSTS function of RSIOX.
0244    CD EB54                     CALL    RSIOX           ;
0247    3C                          INC     A               ; Exist receiving data?
0248    28 18                       JR      Z,GET           ; Yes.
024A    76                          HALT                    ;
024B    18 EC                       JR      KEYCHK          ; Loop to Key Check.
                            ;
```

```
024D                            PUT:
024D    CD EB09                         CALL    CONIN           ; Get inputed key code.
0250    FE 03                           CP      03H             ; STOP key?
0252    28 21                           JR      Z,PEND          ; Yes.
0254    CD 02C8                         CALL    CHARDSP         ; Display inputed key data.
                                ;
0257    21 0305                         LD      HL,OPNPRM       ; Send inputed key data.
025A    4F                              LD      C,A             ;
025B    06 60                           LD      B,RSPUT         ;  Using PUT function of RSIOX.
025D    CD EB54                         CALL    RSIOX           ;
0260    18 D7                           JR      KEYCHK          ; Loop to Key Check.
                                ;
0262                            GET:
0262    21 0305                         LD      HL,OPNPRM       ; Get reciving data.
0265    06 50                           LD      B,RSGET         ;  Using GET function of RSIOX.
0267    CD EB54                         CALL    RSIOX           ;
026A    CD 02C8                         CALL    CHARDSP         ; Display receiving data.
026D    18 CA                           JR      KEYCHK          ; Loop to Key Check.
                                ;
026F                            ERREND:
026F    21 0198                         LD      HL,MSG7         ; 'Communication error.'
0272    CD 02BC                         CALL    MSGDSP          ; Display message.
0275                            PEND:
0275    21 0181                         LD      HL,MSG6         ; '!!! End of modem !!!'
0278    CD 02BC                         CALL    MSGDSP          ; Display message.
027B    21 02FE                         LD      HL,CLSCMD       ; Modem close parameter --> HL
027E    CD 02AB                         CALL    PUTDATA         ; Send modem close parameter.
                                ;
0281    06 20                           LD      B,RSCLS         ; Close RSIOX.
0283    CD EB54                         CALL    RSIOX           ;
0286    C3 EB03                         JP      WBOOT           ; Jump to Warm Boot.
                                ;
                                ;
                                ;       **************************************************
                                ;               SELECT IO MODE
                                ;       **************************************************
                                ;
                                ;       NOTE :
                                ;               Select IO mode (Cartridge mode)
                                ;
                                ;       <> entry parameter <>
                                ;               NON
                                ;       <> return parameter <>
                                ;               NON
                                ;       <> preserved registers <>
                                ;               NON
                                ;
0289                            SETMODE:
0289    3A F005                         LD      A,(RZSWR)               ; Get switch register data.
028C    E6 FC                           AND     0FFH-ZCSW1-ZCSW0        ; Clear CSW1,0 bit.
028E    F6 01                           OR      ZCSW0                   ; Set IO mode.
0290    32 F005                         LD      (RZSWR),A               ; Store to memory.
0293    D3 18                           OUT     (ZSWR),A                ; Output to IO port.
0295    C9                              RET                             ;
                                ;
                                ;       **************************************************
                                ;               CRS LINE CONTROL SUBROUTINE
                                ;       **************************************************
                                ;
                                ;       NOTE :
                                ;               There are two routine, one is setting
                                ;               CRS high, and one is setting CRS low.
                                ;
                                ;       <> entry parameter <>
                                ;               NON
                                ;       <> return parameter <>
                                ;               NON
                                ;       <> preserved registers <>
                                ;               NON
                                ;
0296                            CRST01:
0296    3A F006                         LD      A,(RZIOCTLR)    ; Get IO control register data.
0299    CB DF                           SET     BZCRS,A         ; Set CRS high.
029B    18 05                           JR      CRST            ;
029D                            CRST02:
029D    3A F006                         LD      A,(RZIOCTLR)    ; Get IO control register data.
02A0    CB 9F                           RES     BZCRS,A         ; Reset CRS low.
02A2                            CRST:
02A2    32 F006                         LD      (RZIOCTLR),A    ; Store data to memory.
02A5    D3 19                           OUT     (ZIOCTLR),A     ; Out put to IO port.
02A7    CD 02DE                         CALL    WAIT10          ; Wait about 10 msec.
02AA    C9                              RET                     ;
                                ;
                                ;       **************************************************
                                ;               SEND DATA TO RSIOX
                                ;       **************************************************
                                ;
                                ;       NOTE :
                                ;               Send data to RSIOX until finding
                                ;               00h code.
                                ;
                                ;       <> entry parameter <>
                                ;               HL : Data top address.
                                ;       <> return parameter <>
                                ;               NON
                                ;       <> preserved registers <>
                                ;               NON
                                ;
                                ;       CAUTION :
                                ;               If error happend, then stop this
                                ;               this program.
02AB                            PUTDATA:
02AB    4E                              LD      C,(HL)          ; Get sending data. (1 byte)
02AC    0C                              INC     C               ;
02AD    0D                              DEC     C               ; Data is 00h?
02AE    C8                              RET     Z               ; Yes. (then return)
                                ;
```

```
02AF     E5                     PUSH    HL              ; Save parameter.
02B0     21 0305                LD      HL,OPNPRM       ; Send data to RSIOX.
02B3     06 60                  LD      B,RSPUT         ;  Use PUT function of RSIOX.
02B5     CD EB54                CALL    RSIOX           ;
02B8     E1                     POP     HL              ; Restore parameter.
02B9     23                     INC     HL              ; Pointer update.
02BA     18 EF                  JR      PUTDATA         ; Loop.
                        ;
                        ;       **************************************************
                        ;               DISPLAY MESSAGE UNTIL FIND 00H
                        ;       **************************************************
                        ;
                        ;       NOTE :
                        ;
                        ;       <> entry parameter <>
                        ;               HL : Message data top address
                        ;       <> return parameter <>
                        ;               NON
                        ;       <> preserved registers <>
                        ;               NON
                        ;
                        ;       CAUTION :
02BC                    MSGDSP:
02BC     4E                     LD      C,(HL)          ; Get displaying data.
02BD     0C                     INC     C               ;
02BE     0D                     DEC     C               ; Getting data is 00h?
02BF     C8                     RET     Z               ; Yes. (then return)
                        ;
02C0     E5                     PUSH    HL              ; Save parameter.
02C1     CD EB0C                CALL    CONOUT          ; Console out data.
02C4     E1                     POP     HL              ; Restore parameter.
02C5     23                     INC     HL              ; Update parameter.
02C6     18 F4                  JR      MSGDSP          ; Loop.
                        ;
                        ;       **************************************************
                        ;               DISPLAY A CHARACTER
                        ;       **************************************************
                        ;
                        ;       NOTE :
                        ;
                        ;       <> entry parameter <>
                        ;               A  : Character code.
                        ;          return parameter <>
                        ;               NON
                        ;       <> preserved registers <>
                        ;               All registers.
                        ;
                        ;       CAUTION :
                        ;               If character code is CR, then console
                        ;               out CR with LF.
02C8                    CHARDSP:
02C8     F5                     PUSH    AF              ; Save all registers.
02C9     C5                     PUSH    BC              ;
02CA     D5                     PUSH    DE              ;
02CB     E5                     PUSH    HL              ;
02CC     F5                     PUSH    AF              ;
02CD     4F                     LD      C,A             ; Console out data.
02CE     CD EB0C                CALL    CONOUT          ;
02D1     F1                     POP     AF              ; Get inputed parameter,
02D2     FE 0D                  CP      CR              ; Is it CR?
02D4     0E 0A                  LD      C,LF            ; If so, then console out LF.
02D6     CC EB0C                CALL    Z,CONOUT        ;
02D9     E1                     POP     HL              ; Restore all registers.
02DA     D1                     POP     DE              ;
02DB     C1                     POP     BC              ;
02DC     F1                     POP     AF              ;
02DD     C9                     RET                     ;
                        ;
                        ;       **************************************************
                        ;               WAIT ABOUT 100 MILI SECOND
                        ;       **************************************************
                        ;
                        ;       NOTE :
                        ;
                        ;       <> entry parameter <>
                        ;               NON
                        ;       <> return parameter <>
                        ;               NON
                        ;       <> preserved registers <>
                        ;               NON
                        ;
                        ;       CAUTION :
02DE                    WAIT10:
02DE     01 0002                LD      BC,2            ;
02E1     F5                     PUSH    AF              ;
02E2                    WT10:
02E2     3E E6                  LD      A,230           ;
02E4                    WT20:
02E4     3D                     DEC     A               ;
02E5     20 FD                  JR      NZ,WT20         ;
                        ;
02E7     0B                     DEC     BC              ;
02E8     78                     LD      A,B             ;
02E9     B1                     OR      C               ;
02EA     20 F6                  JR      NZ,WT10         ;
02EC     F1                     POP     AF              ;
02ED     C9                     RET                     ;
                        ;
                        ;       Constant data & Work area
                        ;
02EE                    CLSCMD:
02EE     25 5A 0D 00            DB      '%Z',CR,00H     ; Modem close command data.
                        ;
                        ;       RSIOX first open parameter.
                        ;
```

```
02F2                          OPNDAT:
02F2    030E                          DW      RCVBUF          ; Receive buffer top address.
02F4    0200                          DW      RCVSZ           ; Receive buffer size.
02F6    06                            DB      006H            ; Baud rate. (300 bps)
02F7    03                            DB      003H            ; Bit length. (8 bits/character)
02F8    00                            DB      000H            ; Parity. (non parity)
02F9    01                            DB      001H            ; Stop bit. (1 stop bit)
02FA    FF                            DB      0FFH            ; Special parameter.
                              ;
                              ;       Modem initial data.
                              ;               (8 bits, non parity, 1 stop bit)
02FB                          INITDATA:
02FB    58                            DB      01011000B
                              ;
                              ;       RSIOX second open parameter.
                              ;               (This parameters are matched with initial data.)
02FC                          MDMDAT:
02FC    030E                          DW      RCVBUF          ; Receive buffer top address.
02FE    0200                          DW      RCVSZ           ; Receive buffer size.
0300    06                            DB      006H            ; Baud rate.
0301    03                            DB      003H            ; Bit length.
0302    00                            DB      000H            ; Parity.
0303    01                            DB      001H            ; Stop bit.
0304    FF                            DB      0FFH            ; Special parameter.
                              ;
                              ;       RSIOX parameter area (for calling & return)
                              ;
0305                          OPNPRM:
0305                                  DS      9
                              ;
                              ;       Receiving buffer area.
                              ;
030E                          RCVBUF:
030E                                  DS      RCVSZ
                              ;
                                      END
```

(3) Use
The DMM cartridge is used following the steps shown below using BIOS RSIOX:

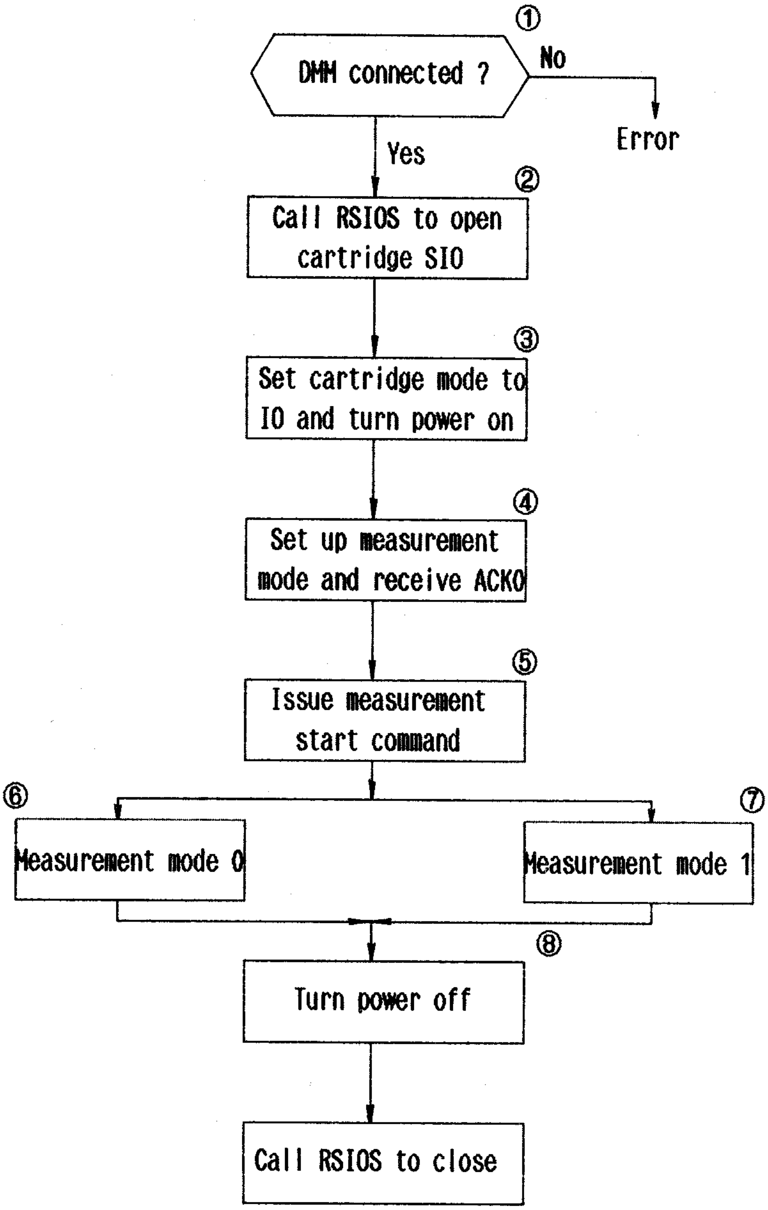
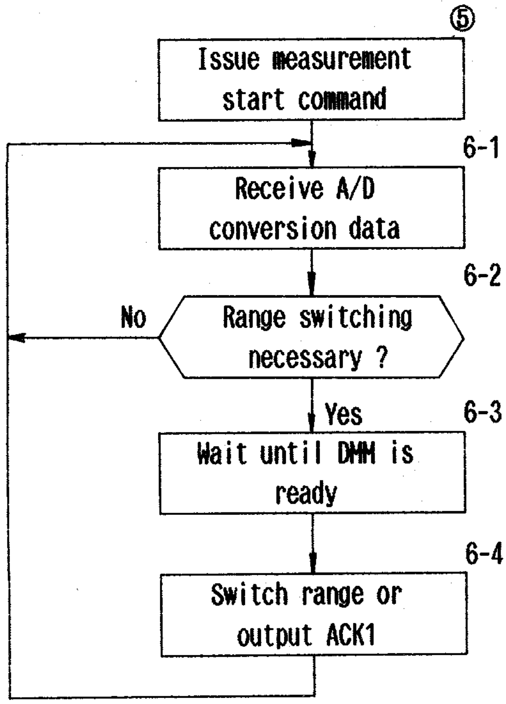
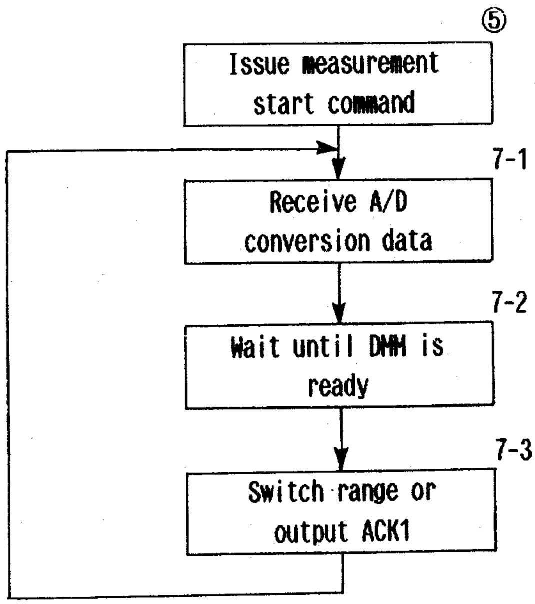


Fig. 5.1.16 DMM Processing Procedure

The measurement procedure in measurement mode Ø is as follows:



The measurement procedure in measurement mode 1 is shown below.



The difference between modes Ø and 1 is as follows:
In measurement mode Ø, the DMM cartridge automatically starts sending A/D conversion data if the range switch command is not sent within a specified period after the DMM cartridge is ready (approximately 1/1Ø of the sampling period).
In measurement mode 1, the DMM cartridge keeps waiting until either a Range Switch command or ACK1 is received.

Step 1: DMM cartridge connected?
Check whether or not a DMM cartridge is connected to the cartridge interface. This can be checked with CRGDEV (ØF53FH).
CRGDEV, bits 3 - Ø
= ØEH: DMM cartridge connected
= Other than ØEH: Another type of cartridge connected.

Step 2: Call RSIOX to open cartridge SIO.
Open cartridge SIO with BIOS RSIOX. The open parameters are: cartridge SIO as I/O device, 6ØØ bps, 8 data bits, no parity, 1 stop bit.

Step 3: Set cartridge to IO and turn power on.
Set the cartridge mode to IO through the following procedure:

```
LD    A, (RZSWR)
AND   ØFCH
OR    Ø1H
LD    (RZSWR), A
OUT   (18H), A
```

RZSWR (ØFØØ5H) is the area that stores the SWR (P19H) output status.

After setting up the IO mode, turn power on by writing ØØH to P1ØH. After power-on, the system waits approximately three seconds to allow for DMM reset processing.

Step 4: Set up measurement mode and receive ACKØ.
After power-on, send a measurement mode command to the DMM using RSIOX PUT. The measurement command has the following format:

7	6	5	4	3	2	1	0
1	m2	m1	m0	n3	n2	n1	n0

m2 : Selects measurement mode
= 0 : Measurement mode 0
1 : Measurement mode 1

m1 : Don't care

m0 : Selects voltage/resistance
= 0 : Measure voltage
1 : Measure resistance

n3 : Selects DCV/ACV or ohm/LP(Low Power)-Ohm
= 0 : DCV or ohm
1 : ACV or LP-ohm

n2~n0 : Selects range

n2 n1 no Measurement mode	000	001	010	011	100	101	100
DCV	AUTO		300mV	3V	30V	300V	500V
ACV	AUTO			3V	30V	300V	350V
Ω	AUTO		300Ω	3kΩ	30KΩ	300 KΩ	3000 KΩ
LPΩ	AUTO			3KΩ	30KΩ	300 KΩ	3000 KΩ

After sending the measurement command, receive ACKØ using RSIOX GET.
The values in the measurement command, except that of ml, are returned unchanged as ACKØ.

```
ml = Ø: 5Ø Hz sampling rate
        Approx. 5 times/second
   = 1: 6Ø Hz sampling rate
        Approx. 4 times/second
```

Step 5: Send measurement start command.
Send a measurement start command to the DMM using RSIOX PUT. The data to be sent the DMM may be of any value. On receiving a data byte, the DMM starts measurement in the mode specified in step 4.

Step 6-1 or 7-1: Receive A/D conversion data.
Receive A/D conversion data using RSIOX GET. A/D conversion data is three bytes in length. See (4) for details.

Step 6-2: Range switching necessary?
If the measurement mode is other than AUTO, determine in the application program whether or not range switching is necessary, according to the results of 6-1 or 7-1.

Step 6-3 or 7-2: Wait until DMM is ready.
Examine P1ØH, bit Ø, and identify whether or not the DMM is ready. If not (P1ØH, bit Ø = 1), wait until it gets ready.

Step 6-4 or 7-3: Switch range or send ACK1.
Send a range switch command or send ACK1 to the DMM using RSIOX PUT. Send a range switch command when switching the range, or ACK1 when not. See (4) for the range switch command and ACK1.

Step 8: Turn power off.
Turn off DMM power when measurement is completed. Power is turned off by writing Ø1ØH to P1ØH.

Note:
The DMM is automatically turned off if a power-off signal is received while the DMM is measuring voltage or resistance. Even if power is turned off in the continue mode, the DMM remains offline when power is turned on again. That is, DMM processing DMM cannot be continued. In such a case, follow the above procedure starting at step 1.

If measurement is found to be unsuccessful, carry out power-off processing in step 8 and begin agaom frp, step 1. When turning on the DMM immediately after turning it off, be srue to wait at least three seconds after power-off before switching power on again.

(4) Command, ACK, conversion data

(a) Range switch command

7	6	5	4	3	2	1	0
0	0	0	0	n3	n2	n1	n0

n3 : Selects DCV/ACV or ohm/LP-Ohm.
= 0 : DCV or ohm
1 : ACV or LP-ohm

n2 - n0 : Selects range

n2 n1 n0 / Measurement mode	000	001	010	011	100	101	110
DCV	AUTO		300mV	3V	30V	300V	500V
ACV	AUTO			3V	30V	300V	350V
Ω	AUTO		300Ω	3KΩ	30KΩ	300KΩ	3000KΩ
LPΩ	AUTO			3KΩ	30KΩ	300KΩ	3000KΩ

(b) ACK1

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

An asterisk (*) stands for 'Don't care'.

(c) A/D conversion data

A/D conversion data consists of three bytes and has the following format:

First byte

7	6	5	4	3	2	1	0
D^1_2	D^1_2	D^1_1	D^1_0	D^0_3	D^0_2	D^0_1	D^0_0

Bits 7–4: BCD data, tens place. Bits 3–0: BCD data, ones place.

Second byte

7	6	5	4	3	2	1	0
0	S	D^3_1	D^3_0	D^2_3	D^2_2	D^2_1	D^2_0

Bits 5–4: BCD data, thousands place. Bits 3–0: BCD data, hundreds place.

Third byte

7	6	5	4	3	2	1	0
A	M	K	B	0	P1	P2	P3

Bits 2–0: Decimal point

B : Battery low bit
- = 1 : Battery low
- 0 : Battery OK

Replace the battery when voltage gets low.

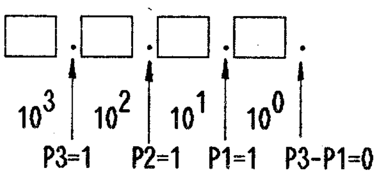
K : K units (during measurement of voltage or resistance)
- = 1 : K-ohm
- = 0 : Not K-ohm units

M : m units (during measurement of voltage or resistance)
- = 1 : mV units
- = 0 : Not mV units

A : Auto range
- = 1 : Auto range
- = 0 Manual range

S : Sign bit
- = 1 : Minus
- = 0 : plus

P1 - P3 : Decimal point



(5) Miscellaneous

(a) Auto range

When Auto range is specified, the DMM cartridge automatically selects the range appropriate to the measured value.

The DMM cartridge selects the 1-level higher or lower range as follows:

Higher range: When the count exceeds 1999

Example: If the resistance exceeds 19.99K ohms when measured at the 3ØK-ohm range, the 3ØØK-ohm range is automatically selected.

Lower range: When the count is below 179

Example: If the resistance is less than 1.79K ohms when measured at the 3ØK-ohm range, the 3K-ohm range is automatically selected.

(b) Power-off

The DMM cartridge must always be turned off when it is not to be used. Otherwise, its battery will be quickly be drained.

(c) Battery low

When the voltage of the DMM battery falls within the range 1.32V - Ø.8V through 1.32V + Ø.8V, the A/D conversion data 13 bits are set to 1. In this case, the battery must be replaced.

(d) Changing the reset time

AC noise can be offset by setting the reset time according to the power (AC) frequency (5ØHz/6ØHz) of the area where the DMM is used.

The reset time can be set by turning the switch placed under the lid of the battery box.

ACKØ, bit 5 is loaded with the currently specified reset time. PINE software can identify the specified reset time.

5.2 Serial Interfaces

5.2.1 General

The PINE supports RS-232C, SIO, and cartridge SIO as serial communication devices. In principle, these serial devices are switched by a serial controller and cannot be used simultaneously.

5.2.2 Setting Up Serial Interface

5.2.2.1 Switching serial modes

The serial interface modes (RS-232C, SIO, and cartridge SIO) can be switched through SWR (P18H), bits 3 and 2.

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Write	18H	SWR					SSW1	SSW0			Bits other than 3 and 2 are used for other purposes

Serial mode	SSW1	SSW2	R×D	T×D	Devices
0	0	0	Cartridge SIO	Cartridge SIO	
1	0	1	SIO	SIO	
2	1	0	RS-232C	RS-232C	Printer, acoustic coupler
3	1	1	RS-232C	SIO	

5.2.2.2 Setting up parameters

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	14H	ARTDIR	7 or 8 bit data								
	15H	ARTSR	RDSR		FE	OE	PE	Tx empty	Rx RDY	Tx RDY	
	16H	IOSTR			RCTS	RCD	RXD	SIN			Bits other than 5 through 2 are used for other purposes
Write	00H	CTLR1	BRG3	BRG2	BRG1	BRG0					Bits other than 3 through 0 are used by purposes
	14H	ARTDOR	7 or 8 bit data								
	15H	ARTMR	STOP		EVEN	PEN		DATA			
	16H	ARTCR			RRTS	ER	SBRK	RXE	RDTR	TXE	
	19H	IOCTLR						SOUT			Bits other than 2 are used for other purpose

See FIRMWARE, CHAPTER 2, "I/O REGISTERS" for register contents.

5.2.3 System Support

5.2.3.1 Switching serial interfaces

The PINE supports three types of serial interface configurations: SIO for FDDs, RS-2232C or SIO for list devices, and RS-232C, SIO, or cartridge SIO for by the user. PINE OS automatically controls the serial switch to allow these configurations to operate independently.

Figure 5.2.1 illustrates the serial interface configurations.

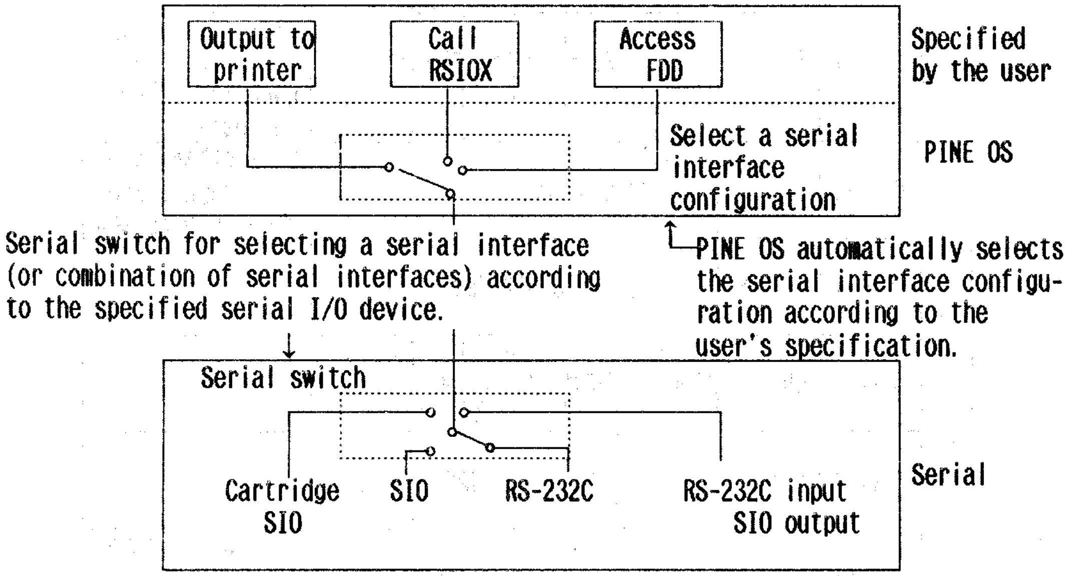


Fig. 5.2.1 Serial Interface Configurations

The OS selects a serial interface configuration as follows:

1) Loads the current configuration into SRMODE (ØF33CH).
2) Checks whether or not the the serial interface configuration to be used matches the current serial interface configuration.
3) If they match, performs the subsequent processing without changing the current configuration.
   If not, performs the subsequent processing after changing to the newthe configuration.

The parameters for changing the serial interface configuration are stored in the 15-byte area, SRTABL (ØF279H).

SRMODE (ØF33CH) 1 byte
Indicates the current serial interface configuration.
= ØFFH: Not used.
= ØØH: Used by the system (list device).
= Ø1H: Used by the user (RSIOX).
= Ø2H: Used by FDD (floppy disk drive).
The initial value is ØFFH. It is initialized by a warm boot.

SRTABL (ØF279H) ØFH bytes
Serial interface configuration switching table

Name	Length	Contents
SYSCTLR1	1	CTLR1 for LIST
SYSARTMR	1	ARTMR for LIST
SYSSWR	1	SWR for LIST
SYSARTCR	1	ARTCR for LIST
SYSSOUT	1	SOUT for LIST
RS2CTLR1	1	CTLR1 for RSIOX
RS2ARTMR	1	ARTMR for RSIOX
RS2SWR	1	SWR for RSIOX
RS2ARTCR	1	ARTCR for RSIOX
RS2SOUT	1	SOUT for RSIOX
HSCTLR1	1	CTLR1 for FDD
HSARTMR	1	ARTMR for FDD
HSSWR	1	SWR for FDD
HSARTCR	1	ARTCR for FDD
HSSOUT	1	SOUT for FDD

- This table is divided into 5-byte units. Each entry in the table corresponds to I/O register CTLR1, ARTMR, SWR, ARTCR, or IOCTLR.
- Bits not associated with serial interfaces must be set to Ø.
- RS2CTLR1 through RS2SOUT are set when RSIOX OPEN is executed.

5.2.3.2 How serial interfaces are used

Although the PINE is furnished with three types of serial interfaces for serial communication, only one is available at a time. Consequently, the system selects the serial interface to be used according to the module to be executed.

The modules that use the seial interfaces are divided into the following groups:

1) System modules
   Modules that communicate with the device selected through the I/O byte (PUN:, RDR:, or CON:). (RS-232C)
2) User modules
   Modules that use serial interfaces. (RS-232C, SIO, or cartridge SIO)
3) Disk and list device modules
   Modules that use terminal floppy disks. (SIO)
   System modules that use list devices. (RS-232C, SIO)

Since these devices operate independently, the I/O mode must be specified separately for each module.

Table 5.2.2 shows how one module can use a serial interface while another module is using it.

Table 5.2.2 Interrelationships among Serial Interfaces and Modules

Module to use serial device \ Module currently using serial device		DISK/LST module	System module	User module			
				RS-232C	SIO	Cartridge SIO	RS-232C input SIO output
DISK/LST module		○	○	○	○	○	○
System module (PUN:, RDR:, CON:)		○	○	×	×	×	×
User module	RS-232C	○	△	○	×	×	×
	SIO	○	×	×	○	×	×
	Cartridge SIO	○	×	×	×	○	×
	RS-232C input SIO output	○	×	×	×	×	○

○ : Availabe
↑ : Available only in the current mode
× : Not available

Programming notes

1) Relationship between the system and user modules and DISK or LST devices
System modules resets the parameters for the DISK or LST device (RS-232C or SIO) before accessing it when it is being used by a user module. Accordingly, the validity of the data received after the active serial device has been switched to the DISK or LST device that is being used by a system or user module. When the system or user module attempts to access the DISK or LST device again, the device is automatically restored into the previous state.

2) Relationship between system and user modules
When one module is using a serial device, another module cannot use even a different serial device. When a serial device is used by two or more modules:
1. While a user modlue is using the serial device, a system module can use it in the mode set up for the user module.
2. An error will be generated if a user module attempts to access a serial device which is being used by a system module. To use the same serial device, the user module must once close the serial device and clear the mode established by the system module.

5.3 Disk Drive Unit

5.3.1 General

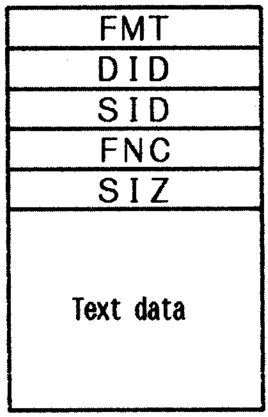
The PINE can connect to external floppy disk drive units via the SIO interface. Data is read from or written onto a floppy disk in 1K-byte units.

Disk drive units TF-20, TF-15, and PF-10 are available. Communication between the PINE and the FDD (floppy disk drive unit) is established in accordance with the EPSON Serial Communication Protocol (EPSP).

5.3.2 EPSON Serial Communication Protocol (EPSP)

Data is transferred between the PINE and the FDD according to a protocol called EPSP (EPSON Serial Communication Protocol).

EPSP has the general format shown below.



FMT: Identifies the header block format.
- 00H: Indicates message transmission from the main unit (PINE).
- 01H: Indicates message transmission from the FDD.

DID: Destination device ID.
- 31H: First FDD (Drive D: or E:)
- 32H: Second FDD (Drive F: or G:)

SID: Source device ID
This field contains 23H if the message (command) is from the PINE.

FNC: Command for FDD.

SIZ: Indicates the text data length. The value in this field is the length of the actual text data minus 1.

Text data returned from the FDD ends with a return code.

Tables 5.3.1 and 5.3.2 show the floppy disk drive commands and return codes, respectively.

Table 5.3.1 Commands

No.	Command name	FNC	Function
1	RESET	ØDH	Reset terminal floppy
2	READ	77H	Read disk directly
3	WRITE	78H	Write disk directly
4	WRITEHST	79H	Flush buffer
5	COPY	7AH	Copy volume
6			
7	FORMAT	7CH	Format disk

Table 5.3.2 Return Codes

Return code	Meaning
ØØH	Normal termination
ØFAH	BDOS error (read error)
ØFBH	BDOS error (write error)
ØFCH	BDOS error (drive select error)
ØFDH	BDOS error (write protect error)
ØFEH	

(1) RESET
Function: Resets the disk drive floppy.
Send data:

< Send data >

+0	00H	(FMT)
1	SS	(DID)
2	MM	(SID)
3	0DH	(FNC)
4	00H	(SIZ)
5	00H	

< Receive data >

+0	01H	(FMT)
1	MM	(DID)
2	SS	(SID)
3	0DH	(FNC)
4	00H	(SIZ)
5	Return code	

Description:
The RESET command causes the FDD to initialize itself and wait for an ENQ block. The FDD sends return code ØØH to the main unit.

(2) READ
Function: Reads a disk directly.
Send data:

< Send data >

+0	00H	(FMT)
1	SS	(DID)
2	MM	(SID)
3	77H	(FNC)
4	02H	(SIZ)
5	Drive code	
6	Track number	
7	Sector number	

Drive code = 1 or 2
Track number = 0 - 39
Sector number = 1 - 64

< Receive data >

+00H	01H	(FMT)
01H	MM	(DID)
02H	SS	(SID)
03H	77H	(FNC)
04H	80H	(SIZ)
05H	Read data	
06H	Read data	
		128 bytes
85H	Read data	
86H	Return code	

Description:
The READ command causes the FDD to transfer to the system the data (128 bytes) read from the specified sector on the specified logical track of the disk as well as a return code.

(3) WRITE
Function: Writes a disk directly.
Send data:

< Send data >

+00H	00H	(FMT)
01H	SS	(DID)
02H	MM	(SID)
03H	78H	(FNC)
04H	83H	(SIZ)
05H	Drive code	
06H	Track number	
07H	Sector number	
08H	Write type	
09H	Write data	128 bytes
0AH	Write data	
	⋮	
+88H	Write data	

< Receive data >

01H	(FMT)
MM	(DID)
SS	(SID)
78H	(FNC)
00H	(SIZ)
Return code	

Drive code = 1 or 2
Track number = 0 - 39
Sector number = 1 - 64
Write type = 0 - 2

Description:
The WRITE command causes the FDD to write the specified data (128 bytes) to the location on the disk addressed by the specified logical track and sector numbers.

Write type = ØØH: Standard write (The FDD blocks data before a write.)
= Ø1H: Flush buffer (The FDD immediately writes data on the FDD without blocking.)
= Ø2H: Sequential write (The FDD simply blocks data for a high-speed write.)

(4) WRITEHST
Function: Flushes the buffer.
Send data:

< Send data >

+00H	00H	(FMT)
01H	SS	(DID)
02H	MM	(SID)
03H	79H	(FNC)
04H	00H	(SIZ)
05H	00H	

< Receive data >

+00H	01H	(FMT)
01H	MM	(DID)
02H	SS	(SID)
03H	79H	(FNC)
04H	00H	(SIZ)
05H	Return code	

Description:
The WRITEHST command causes the FDD to flush the contents of the 1K-byte host buffer (filled by the WRITE command) onto the disk.

(5) COPY
Function: Copies a volume.
Send data:

< Send data >

+00H	00H	(FMT)
01H	SS	(DID)
02H	MM	(SID)
03H	7AH	(FNC)
04H	00H	(SIZ)
05H	Drive code	

< Receive data >

01H	(FMT)
MM	(DID)
SS	(SID)
7AH	(FNC)
02H	(SIZ)
Track number of the currently copying track (high-order byte)	
Track number of the currently copying track (low-order byte)	
Return code	

Track number of the currently copying track = Ø - 39
ØFFFFH: End

Description:
The COPY command causes the FDD to copy the entire disk in the specified drive onto another disk in the same drive unit. This command is not available if the unit has only one drive.

(6) FORMAT
Function: Format disk
Send data:

< Send data >

+00H	00H	(FMT)
01H	SS	(DID)
02H	MM	(SID)
03H	7CH	(FNC)
04H	00H	(SIZ)
05H	Drive code	

Drive code = 0 or 1

< Receive data >

+00H	01H
01H	MM
02H	SS
03H	7CH
04H	02H
05H	Track number of the currently formatting track (high-order byte)
06H	Track number of the currently formattng track(low-order byte)
07H	Return code

Track number of the currently formatting track = Ø - 39
ØFFFFH: End

Description:
The FORMAT command causes the FDD to format two tracks and return the corresponding track number (logical number) and a return code to the system. The FDD continues formatting in two track units and sets the logical track number in the return message to ØFFFFH when it completes formatting.

5.3.3 Use

In PINE OS, data is read from or written to the FDD through BIOS. However, the user can communicate directly with the FDD through application programs.

Use the following system-supplied utilities when communicating directly with the FDD through application programs:

EPSPSND (Utility for sending EPSP data)
EPSPRCV (Utility for receiving EPSP data)

See Section 4.2, "Jump Tables" for the use of these utilities.

5.4 External RAM Disk

5.4.1 General

The PINE external RAM disk is an optional external read/write storage device. It connects to the PINE main unit via the system bus interface.

The external RAM disk can contain up to 128K bytes of RAM and a 1M-bit CMOS mask ROM or EPROM. ROM is installed as a capsule and can be replaced from the exterior of the PINE.

In operation mode (i.e, when PINE power is on), the external RAM disk draws power from the battery in the PINE main unit. In non-operation mode (when PINE power is off), it draws backup power from the battery in the external RAM disk.

The external RAM disk is always attached to the PINE main unit. Its contents cannot be guaranteed if it is removed from the main unit.

5.4.2 Hardware General

5.4.2.1 Block diagram

The block diagram of the external RAM disk is shown in Figure 5.4.1.

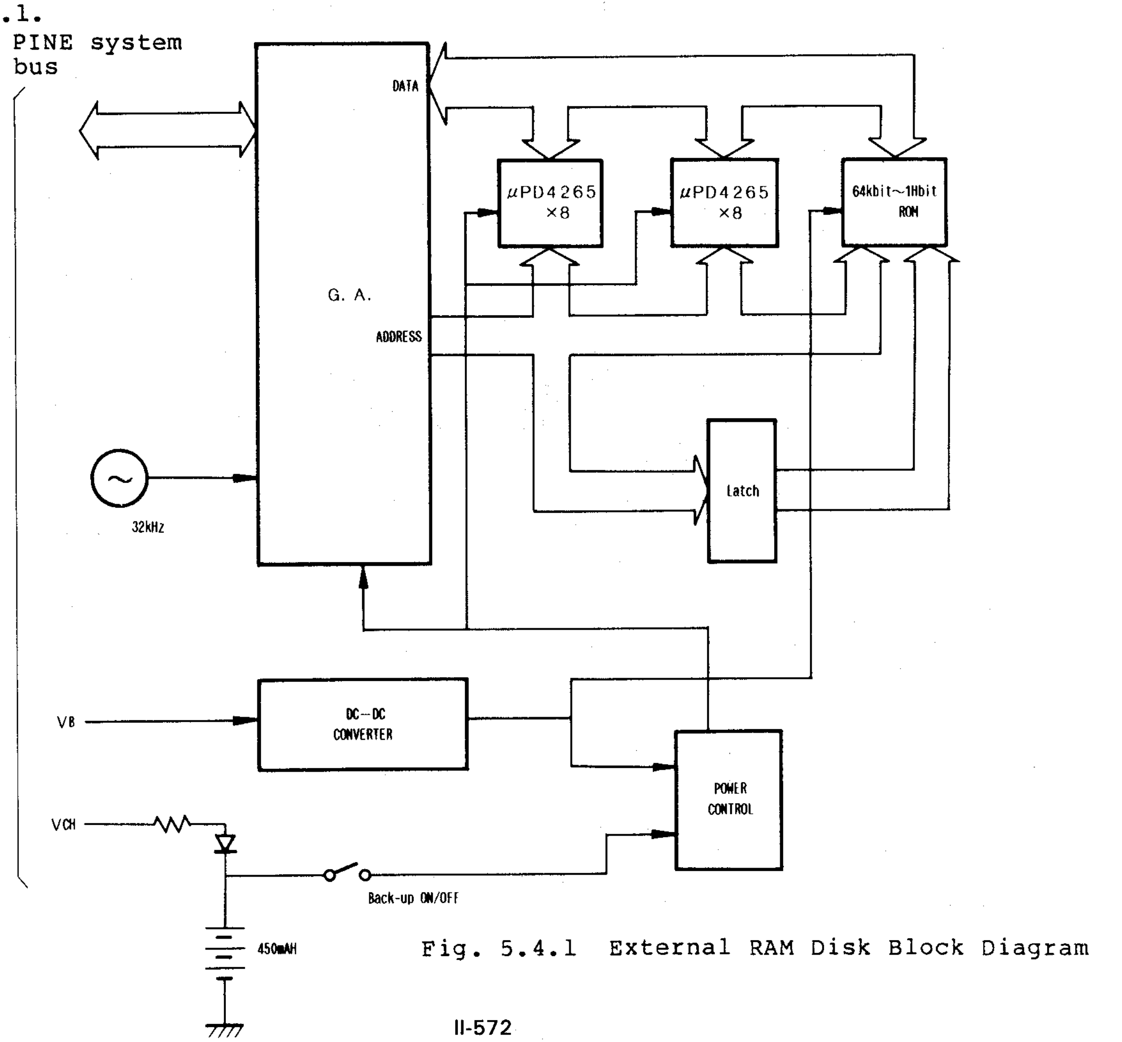


Fig. 5.4.1 External RAM Disk Block Diagram

5.4.2.2 Interface with the main unit

The external RAM disk connects to the main unit via the following signal lines out of the system bus:

Signal name	IN/OUT	Number of pins	Logic	Description
DB7 - Ø	IN/OUT	8	Positive	Data bus
AB7 - Ø	IN	8	Positive	Address bus
$\overline{MRQ}$	IN	1	Negative	Z-8Ø memory request signal
$\overline{IORQ}$	IN	1	Negative	Z-8Ø I/O request signal
$\overline{RD}$	IN	1	Negative	Z-8Ø read signal
$\overline{WR}$	IN	1	Negative	Z-8Ø write signal
$\overline{WAIT}$	OUT	1	Negative	Z-8Ø wait signal
$\overline{HLTA}$	IN	1	Negative	Z-8Ø halt signal
$\overline{M1}$	IN	1	Negative	Z-8Ø M1 signal
$\overline{CLK}$	IN	1	Negative	System clock reverse signal
DW	IN	1	-	DRAM refresh control signal
DCAS	IN	1	-	DRAM refresh control signal
$\overline{RS}$	IN	1	Negative	System reset signal
PON	IN	1	Positive	Power-on signal (turns on the DD converter.)
OFF	IN	1	Positive	Off signal
VCH	IN	1	-	Battery charge power
VBK	IN/OUT	1	-	Backup power
VB1	IN	1	-	Main battery power
GND	-	1	-	Signal ground

5.4.3 Structure

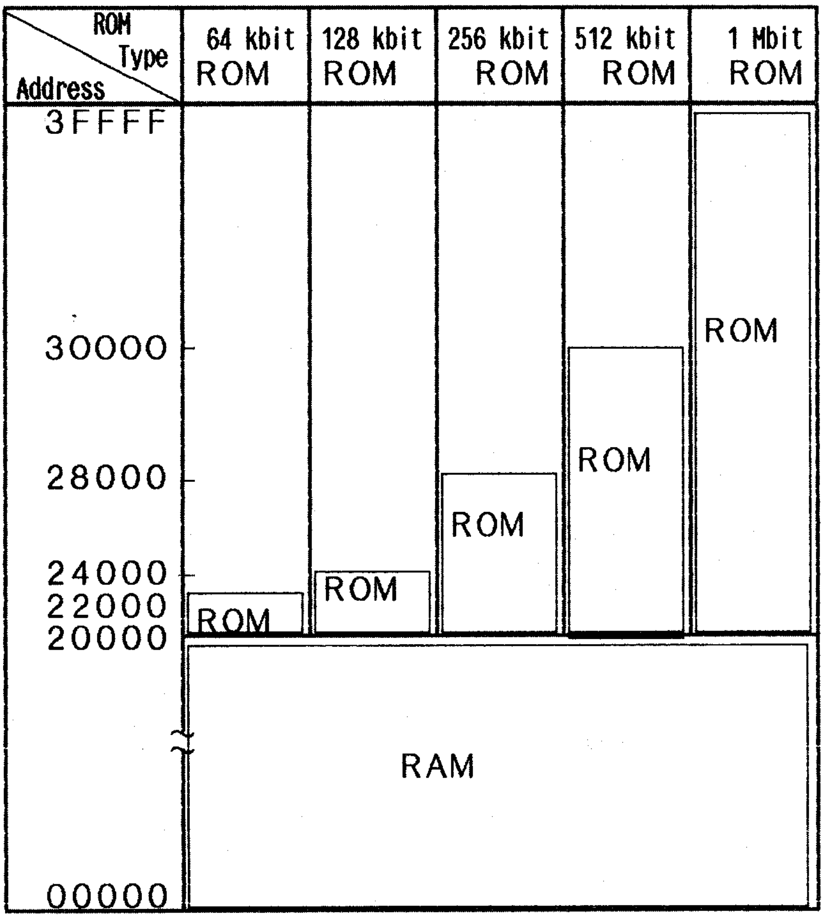
5.4.3.1 External RAM disk I/O address map

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	90H										
	91H										
	92H										
	93H	EXTIR	8 bit data								
	94H	EXTSR	EXT						(OPN)	(WP)	
Write	90H	EXTAR	A7	A6	A5	A4	A3	A2	A1	A0	
	91H	EXTAR	A15	A14	A13	A12	A11	A10	A9	A8	
	92H	EXTAR	×	×	×	×	×	A18	A17	A16	
	93H	EXTOR	8 bit data								
	94H	EXTCR	×	×	×	×	×	×	OPN	WP	

The x mark stands for "Don't care."

EXTIR: External RAM disk input register
EXTSR: External RAM disk status register
OPN = 1: RAM opened
= Ø: RAM closed
WP = 1: Write protected
= Ø: Write enabled
EXT = 1: No external RAM disk installed
= Ø: External RAM disk installed
EXTAR: External RAM disk address register
EXTOR: External RAM disk output register
EXTCR: External RAM disk command register (WP and OPN have the same meaning as for EXTSR.)

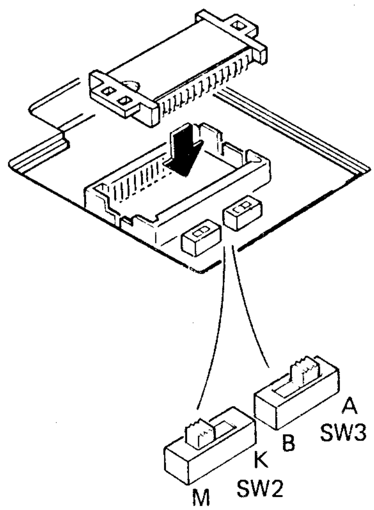
5.4.3.2 External RAM disk memory map



5.4.3.3 Miscellaneous

(1) Switch settings
The external RAM disk has two switches, SW2 and SW3, in the box on its rear. These switches are used to select ROM capacities.

ROM type	SW2	SW3
64K bit (e.g., 27C64)	K	B
128K bit	K	B
256K bit (e.g., 27C256)	K	B
512K bit	M	B
1M bit (e.g., HN62301)	M	A



(2) Addresses in 256K-bit ROM
In ROMs excluding 256K-bit ROMs, logical ROM addresses have a one-to-one correspondence with physical ROM addresses. Therefore, data are written into ROM sequentially from lower to higher addresses. In 256K-bit ROMs, however, the first half of the logical address space is mapped into the second half of the physical address space, and the second half of the logical address space is mapped into the first half of the physical address space (see the figure below).

Address on external RAM disk	Physical ROM address
20000H	4000H
|	|
23FFFH	7FFFH
24000H	0000H
|	|
27FFFH	3FFFH

(3) Backup battery ON/OFF switch
The external RAM disk is furnished with a switch for turning on or off the connection with a backup battery. When this switch is on, the external RAM disk is always supplied with a small quantity of power from the battery.

(4) Power
When the PINE main unit power is on, PINE battery power is regulated by the DC to DC convertor in the external RAM disk unit and applied to the circuit. When the main unit power is off, power is applied to the circuit from the backup battery in the external unit.

The battery in the external RAM disk is charged at the same time as the NiCd battery in the main unit. Note that charging of the battery in the external RAM disk is not guaranteed if the battery in the main unit is an Mn battery and used without being connected to an AC adaptor.

When the main unit power is off, the main unit and the external RAM disk are each supplied with power from their own backup batteries, respectively. If, however, the voltage of either battery drops below a specified value, that battery is supplied with power from the other battery. Therefore, both the main unit and the optional RAM disk are guaranteed a similar backup time.

5.4.4 Use

Memory (RAM or ROM) can be accessed by loading the desired address into EXTAR (P9ØH - P92H) and reading or writing the data in EXTIR (P93H) or EXTOR (P93H), respectively.

The address counter is automatically incremented after each read or write. Only the lowest 8 bits of the address counter are incremented; the higher bits remain unchanged. Therefore, once an address is specified, up to 256 contiguous data bytes can be read from or written into RAM or ROM, without respecifying the address.

5.4.4.1 Reading/writing RAM

Figure 5.4.2 shows the procedure for reading/writing RAM.

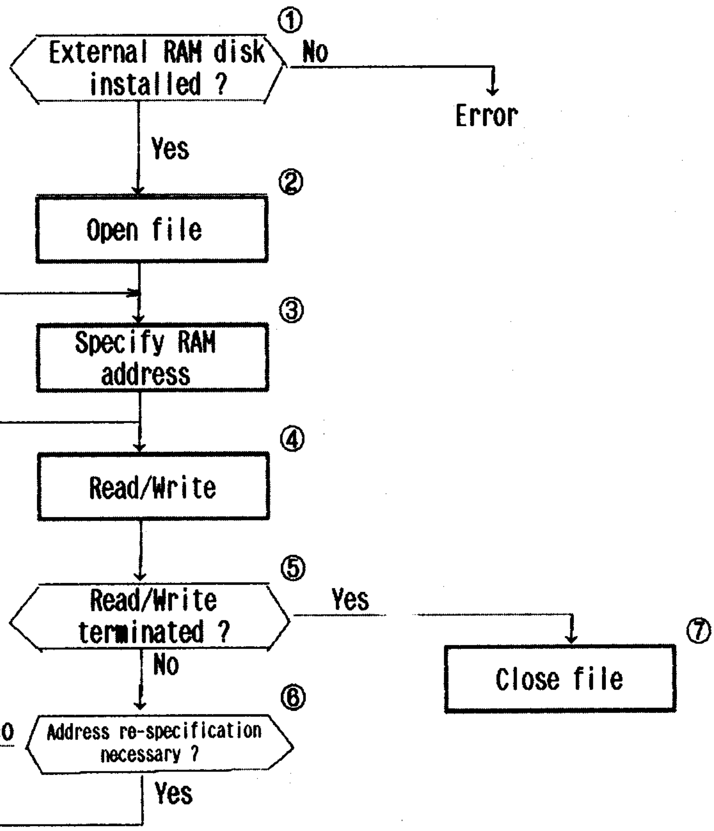


Fig. 5.4.2 Procedure for Reading/writing RAM

Step 1: External RAM disk installed?
Check whether or not an external RAM disk is installed by reading I/O port address 94H. The MSB indicates the presence or absence of an external RAM disk.
MSB = 1: External RAM disk installed.
= Ø: No external RAM disk installed.

Step 2: Open file.
Write 1 to I/O port address 93H, bit 1 to open the external RAM disk for read or write. Cancel write protection of RAM, if necessary.

Step 3: Specify RAM address.
Load I/O port addresses 9ØH through 92H with the address to be read or written. The RAM address may be in the range of ØØØØØH through 1FFFFH.

Step 4: Read or write.
Access the I/O port address 93H for read or write.

Steps 5 and 6: Loop.
Determine whether or not read/write processing has been terminated in the application program. During sequential read/write, the external RAM disk auto increment function allows up to 256 bytes of data to be read/written without address re-specification.

Step 7: Close file.
When read/write processing is completed, set I/O port address 93H, bit 1 to Ø to close the external RAM disk. Write-protect the RAM, if necessary.

5.4.4.2 Reading ROM

Figure 5.4.3 illustrates the procedure for reading ROM.

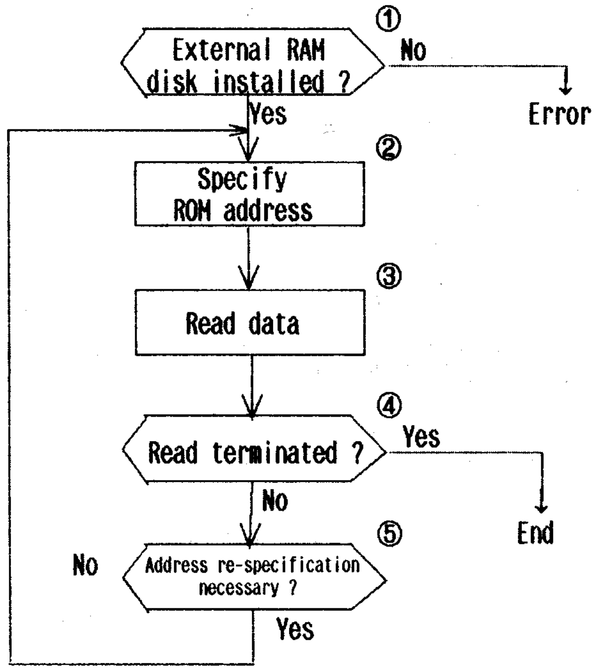


Fig. 5.4.3 Procedure for Reading ROM

Step 1: External RAM disk installed?
Check whether or not an external RAM disk is installed by reading I/O port address 94H. The MSB identifies the presence or absence of an external RAM disk.
MSB = 1: External RAM disk installed.
= 0: No external RAM disk installed.

Step 2: Specify ROM address.
Load I/O port addresses 90H through 92H with the address from which data is to be read. The ROM address must be 20000H or up.

Step 3: Read data.
Access I/O port address 93H to read data.

Steps 4 and 5: Loop.
Determine whether or not read processing has been terminated in the application program. During sequential read, the external RAM disk auto increment function allows up to 256 bytes of data to be read without address re-specification.

5.4.4.3 Notes

(1) RAM open/close processing
To save power, the external RAM disk must be opened only when it is being accessed. While RAM is closed, it is refreshing itself and cannot be accessed.

ROM need not be opened for access.

(2) RAM write protection
When RAM is write protected, a write operation causes no actual write to RAM and does not increment the address register. However, RAM can be read, in which case the address register is incremented accordingly. Reading of ROM is not affected by write protection, either.

5.4.5 System Support

PINE OS supports the RAM portion of the external RAM disk as a read/write disk drive. See Section 3.8, "Disk Storage" for detailed information.

The OS does not support the ROM portion of the external RAM disk. Application programs must read data from this area for themselves.

5.4.5.1 Installation check

The OS checks for presence or absence of an external RAM disk at power-on or reset time. It examines the MSB of EXTSR (P94H) and, if an external RAM disk is found to be installed, treats the RAM in the external RAM disk as a RAM disk.

5.4.5.2 Opening/closing RAM

The OS opens and closes the RAM in the external RAM disk before and after a read or write. Therefore, the RAM is always closed after the OS performs a read/write operation.

5.4.5.3 RAM write protection

The OS automatically cancels write protection of RAM when reading/writing the RAM in the external RAM disk. Therefore, the RAM is not write protected after the OS performs a read/write operation.

5.4.5.4 Resetting during write to RAM

Write operation is not guaranteed if the RESET button is pressed during a write to the external RAM disk. The OS displays a "RAM DISK FORMAT" message to warn against possible destruction of RAM contents.

```
                        ;       **************************************************
                        ;               1 M BIT ROM READ PROGRAM
                        ;       **************************************************
                        ;
                        ;       NOTE :
                        ;               This sample program is reading 1 Mbit ROM,
                        ;               and displaying the data.
                        ;
                        ;       <> assemble condition <>
                        ;
                                .Z80
                        ;
                        ;       <> loading address <>
                        ;
                                .PHASE  100H
                        ;
                        ;       <> constant values <>
                        ;
                        ;       BIOS entry
                        ;
EB03                    WBOOT           EQU     0EB03H          ; Warm Boot entry
EB09                    CONIN           EQU     WBOOT   +06H    ; Console input entry
EB0C                    CONOUT          EQU     WBOOT   +09H    ; Console out entry
                        ;
                        ;       System area
                        ;
F294                    LSCRVRAM        EQU     0F294H          ; VRAM top address.
                        ;
0003                    STOP            EQU     03H
000D                    CR              EQU     0DH
000A                    LF              EQU     0AH
000C                    CLS             EQU     0CH
001B                    ESC             EQU     1BH
0020                    SPACE           EQU     20H
                        ;
0090                    P90             EQU     90H             ; I/O port 91H
0091                    P91             EQU     91H             ; I/O port 91H
0092                    P92             EQU     92H             ; I/O port 92H
0093                    P93             EQU     93H             ; I/O port 93H
0094                    P94             EQU     94H             ; I/O port 94H
                        ;
                        ;       **************************************************
                        ;               MAIN PROGRAM
                        ;       **************************************************
                        ;
                        ;       NOTE :
                        ;               This program is reading 1 Mbit ROM,
                        ;               and displaying kanji font.
                        ;
0100                    MAIN:
0100    31 1000                 LD      SP,1000H        ; Set stack pointer.
                        ;
0103    CD 0177                 CALL    CHKROM          ; Connect external RAM disk?
0106    DA EB03                 JP      C,WBOOT         ; No.
                        ;
0109    CD 0188                 CALL    CUSROFF         ; Cursor off.
                        ;
010C                    MAIN10:
010C    0E 0C                   LD      C,CLS           ; Clear screen & home.
010E    CD EB0C                 CALL    CONOUT          ;
                        ;
0111    2A F294                 LD      HL,(LSCRVRAM)   ; VRAM top addr --> HL
0114    06 04                   LD      B,4             ; Loop counter (4 lines)
                        ;
0116                    MAIN20:
0116    E5                      PUSH    HL              ; Save registers
0117    C5                      PUSH    BC              ;
0118    06 0F                   LD      B,15            ; Loop counter (15 characters)
011A                    MAIN30:
011A    E5                      PUSH    HL              ; Save registers
011B    C5                      PUSH    BC              ;
011C    06 10                   LD      B,16            ; Loop counter (16 dot lines)
                        ;
011E                    MAIN40:
011E    CD 014C                 CALL    READROM         ; Read 1 Mbit ROM.
0121    CD 017B                 CALL    WRTVRAM         ; Write the data to VRAM directly.
                        ;
0124    23                      INC     HL              ; VRAM pointer increment.
0125    CD 014C                 CALL    READROM         ; Read 1 Mbit ROM.
0128    CD 017B                 CALL    WRTVRAM         ; Write the data to VRAM directly.
                        ;
012B    11 001F                 LD      DE,31           ; Get next dot line address in VRAM.
012E    19                      ADD     HL,DE           ;
012F    10 ED                   DJNZ    MAIN40          ; Loop.
                        ;
0131    C1                      POP     BC              ; Restore registers.
0132    E1                      POP     HL              ;
0133    23                      INC     HL              ; Get nect column address in VRAM.
0134    23                      INC     HL              ;
0135    10 E3                   DJNZ    MAIN30          ;
                        ;
0137    C1                      POP     BC              ; Restore registers
0138    E1                      POP     HL              ;
0139    11 0200                 LD      DE,32*16        ; Get next line address in VRAM.
013C    19                      ADD     HL,DE           ;
013D    10 D7                   DJNZ    MAIN20          ; Loop.
                        ;
013F    CD EB09                 CALL    CONIN           ; Key input wait.
0142    FE 03                   CP      STOP            ; STOP key?
0144    20 C6                   JR      NZ,MAIN10       ; No.
                        ;
0146    CD 017D                 CALL    CUSRON          ; Cursor on.
0149    C3 EB03                 JP      WBOOT           ; End.
                        ;
```

```
                         ;        **************************************************
                         ;                READ DATA FROM 1 M BIT ROM
                         ;        **************************************************
                         ;
                         ;        NOTE :
                         ;                Read a data from 1 Mbit ROM.
                         ;                This routine uses the function of auto
                         ;                increment.
                         ;
                         ;        <> entry parameter <>
                         ;                NON
                         ;        <> return parameter <>
                         ;                A   : Read data.
                         ;           preserved registers <>
                         ;                NON
                         ;
                         ;        CAUTION :
014C                     READROM:
014C      3A 0193                 LD      A,(P90DT)        ; Last 8 bits data.
014F      3C                      INC     A                ; 256 bytes read?
0150      32 0193                 LD      (P90DT),A        ;  Set the new address.
0153      20 1F                   JR      NZ,READ50        ; No.
                         ;
0155      3A 0194                 LD      A,(P91DT)        ; Middle 8 bits data.
0158      3C                      INC     A                ; 256*256 bytes read?
0159      32 0194                 LD      (P91DT),A        ;  Set the new address.
015C      20 07                   JR      NZ,READ40        ; No.
                         ;
015E      3A 0195                 LD      A,(P92DT)        ; Top 3 bits data.
0161      3C                      INC     A                ; Count up.
0162      32 0195                 LD      (P92DT),A        ; Set the new ROM address.
                         ;
0165                     READ40:
0165      3A 0193                 LD      A,(P90DT)        ; I/O port output for setting next address.
0168      D3 90                   OUT     (P90),A          ;  Last 8 bits
016A      3A 0194                 LD      A,(P91DT)        ;
016D      D3 91                   OUT     (P91),A          ;  Middle 8 bits.
016F      3A 0195                 LD      A,(P92DT)        ;
0172      D3 92                   OUT     (P92),A          ;  Top 8 bits.
                         ;
0174                     READ50:
0174      DB 93                   IN      A,(P93)          ; Read ROM data.
0176      C9                      RET                      ;
                         ;
                         ;        **************************************************
                         ;                CHECK CONNECTING EXTERNAL RAM DISK
                         ;        **************************************************
                         ;
                         ;        NOTE :
                         ;
                         ;        <> entry parameter <>
                         ;                NON
                         ;        <> return parameter <>
                         ;                CY : Return information.
                         ;                   =0 -- Connected RAM disk.
                         ;                   =1 -- Not connected RAM disk.
                         ;        <> preserved registers <>
                         ;                NON
                         ;
                         ;        CAUTION :
                         ;
0177                     CHKROM:
0177      DB 94                   IN      A,(P94)          ; Get external status.
0179      17                      RLA                      ; MSB --> CY
017A      C9                      RET                      ;
                         ;
                         ;                WRITE VRAM AT THE HL ADDRESS.
                         ;
017B                     WRTVRAM:
017B      77                      LD      (HL),A
017C      C9                      RET
                         ;
                         ;                CURSOR ON
                         ;
017D                     CUSRON:
017D      0E 1B                   LD      C,ESC
017F      CD EB0C                 CALL    CONOUT
0182      0E 33                   LD      C,'3'
0184      CD EB0C                 CALL    CONOUT
0187      C9                      RET
                         ;
                         ;                CURSOR OFF
                         ;
0188                     CUSROFF:
0188      0E 1B                   LD      C,ESC
018A      CD EB0C                 CALL    CONOUT
018D      0E 32                   LD      C,'2'
018F      CD EB0C                 CALL    CONOUT
0192      C9                      RET
                         ;
                         ;
0193                     P90DT:
0193      FF                      DB      0FFH
0194                     P91DT:
0194      FF                      DB      0FFH
0195                     P92DT:
0195      01                      DB      001H
                         ;
                                  END
```

5.5 Barcode Reader and External Cassettes

5.5.1 General

The PINE is furnished with barcode reader and external cassette interfaces. The barcode reader interface has +5V power output and the barcode reader input (BCRD). The external cassette interface handles the motor drive signal (RMT) for cassettes with a remote terminal, the record signal (MIC) to cassettes, and the earphone signal (EAR) from cassettes.

Neither barcode reader nor external cassette is supported by PINE OS.

5.5.2 Structure

5.5.2.1 Barcode reader/external cassette I/O address map

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	P02H	ICRL.B	ICR on state transition of the signal (low-order byte)								
Read	P03H	ICRH.B	ICR on state transition of the signal (high-order byte)								
Read	P04H	ISR						ICF			Bits other than bit 2 are used for other purposes.
Read	P05H	STR							BCRD	EAR	Bits other than bits 1 and 0 are used for other purposes.
Write	P00H	CTLR1					SW BCR	BCR1	BCR0	SL BCR	Bits other than bits 3 through 0 are used for other purposes.
Write	P02H	CTLR2	Don't Care						RMT	MIC	
Write	P04H	IER						IER2			Bits other than bit 2 are used for other purposes.

ICRL.B, ICRH.B: 16 bit data latched from FRC to ICR by transition in the state of the signal from the barcode reader or external cassette.

ISR (Interrupt Status Register):
- ICF: Interrupt signal generated when the FRC value is latched to ICR by transition in the state of the signal from the barcode reader or external cassette.

STR (Status Register):
- BCRD: Barcode reader input signal
- EAR: External cassette EAR input signal

CTLR1 (Control Register 1)

SWBCR: Turns on/off power (+ 5V) to the barcode reader.
- = Ø: Power off.
- = 1: Power on.

BCR1, BCRØ: Selects the latch trigger polarity.
- = ØØ: Trigger inhibited.
- = Ø1: Falling trigger ( )
- = 1Ø: Rising trigger ( )
- = 11: Rising and falling triggers ( )

SLBCR: Selects the trigger signal that is to latch the FRC value to ICR.
- = Ø: External cassette EAR input signal
- = 1: Barcode reader input signal

CTLR2 (Control Register 2)

RMT: External cassette remote ON/OFF signal
- = Ø: Remote OFF
- = 1: Remote ON

MIC: External cassette write signal (output to microphone)

IER (Interrupt Enable Register)

IER2: Controls INT2 (ICF) interrupts.
- = Ø: Interrupts disabled.
- = 1: Interrupts enabled.

5.5.3 Use

This subsection discusses the method of determining the wave form of the input signal from the barcode reader or external cassette, as well as the method of sending signals to the external cassette.

5.5.3.1 Selecting the barcode reader or external cassette

The barcode reader or external cassette is initialized in the following steps:

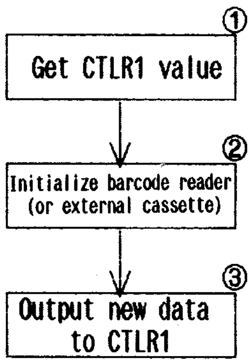


Fig. 5.5.1 Initialize Procedure

Step 1: Get CTLR1 value.
Read the current CTLR1 (PØØH) value from the system area RZCTLR1 (ØFØØ1H).

Step 2: Initialize barcode reader (or external cassette).
Manipulate the value read in step (1) as follows:
- Bits 7 - 4: Do not change.
- Bits 3 - Ø: Specify whether power to the barcode reader is to be turned on or off, the trigger polarity, and the trigger signal.

Step 3: Output data to CTLR1.
Load the value specified in step (2) into RZCTLR1 (ØFØØ1H) and output it to CTLR1 (PØØH).

5.5.3.2 Data input

Whether or not data is input from the barcode reader or external cassette is determined by measuring the input signal 1 or Ø state time. The time can be measured by the procedure shown in Figure 5.5.2 (the procedure for measuring the time of the mark signal).

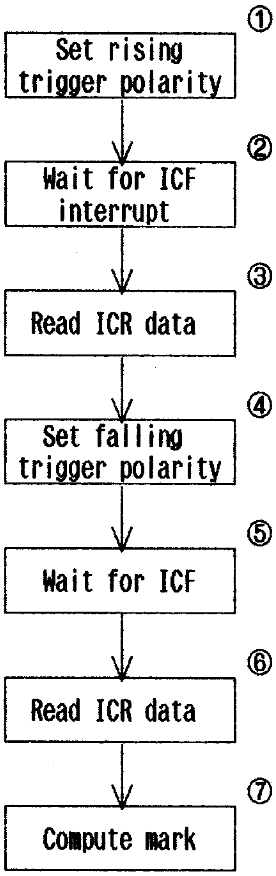


Fig. 5.5.2 Time Measuring Procedure

Step 1: Set rising trigger polarity.
Set CTLR1 (PØØH), bits 2 and 1 to 1 and Ø, respectively, using the procedure shown in Figure 5.5.1. Make a dummy read or ICRH.B (PØ3H), if necessary, and reset the ICF interrupt.

Step 2: Wait for ICF interrupt.
Read the value of ISR (PØ4H) to check for an ICF interrupt. ISR, bit 2 identifies the presence or absence of an ICF interrupt.
ISR (PØ4H), bit 2 = Ø: No ICF interrupt generated.
= 1: ICF interrupt generated.
If no ICF interrupt has been generated, repeat this until one is generated.

Step 3: Read ICR data.
Read ICRL.B (PØ2H) and ICRL.B (PØ3H) and get the FRC value at input signal rise time.

Step 4: Set falling trigger polarity.
Set CTLR1 (PØØH), bits 2 and 1 to Ø and 1, respectively, using the procedure shown in Figure 5.5.1.

Steps 5 and 6:
Same as steps (2) - (3).

Step 7: Compute mark signal time.
Compute the mark signal time from the formula
(T2 - T1)/614.6 ms.
where T1 and T2 are the values obtained in steps (3) and (6), respectively. If T2 -1 T1 <= Ø, add 65536 to the result to get a positive value.

Note: Since FRC is set to approximately 1Ø6.6 ms. frequency, time exceeding one frequency (more than 1Ø6.6 ms.) may elapse while waiting for an ICF interrupt in step (2). Therefore, an application program must include frequency count check and timeout processing routines in its wait processing routine. The frequency count can be checked using the OVF interrupt.

5.5.3.3 Data output (output to MIC of the external cassette)

Data can be output to the MIC terminal of the external cassette by setting CTLR2 (PØ2H), bit Ø to 1 or Ø and outputting mark or space signals.

The REMOTE terminal can also be controlled through CTLR2 (PØ2H), bit 1.

5.5.4 System Support

PINE OS supports neither the barcode reader nor the external cassette. For the ICF interrupt, however, a hook is provided in the corresponding interrupt processing routine to allow expansion of ICF interrupt processing.

The external cassette is supported by BASIC.

5.6 ROM Capsules

5.6.1 General

The PINE can house up to two capsule ROMs in memory, in addition to OS ROM (32K bytes) and RAM (64K bytes). ROM capsules may be 8K-, 16K-, or 32K-byte mask ROMs. Data in these capsules can be accessed immediately through bank switching.

5.6.2 Structure

5.6.2.1 ROM capsule I/O address map

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	P05H	STR	BANK3	BANK2	BANK1	BANK0	Bits 3 through 0 are used for other purposes.				
Write	P05H	BANKR	BANK3	BANK2	BANK1	BANK0	Bits 3 through 0 are used for other purposes.				

STR (Status Register)
    BANK3 - Ø: Indicate the current bank status.
BANKR (Bank Register)
    BANK3 - Ø: Select a bank.

5.6.2.2 Memory map

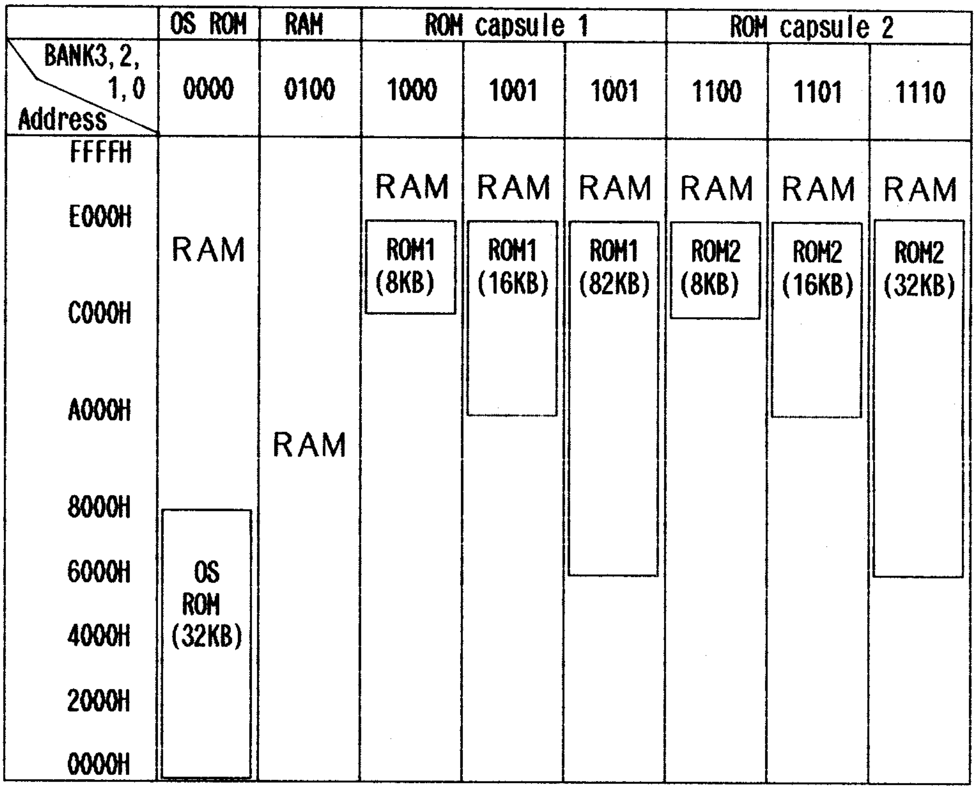


Fig. 5.6.1 PINE ROM Capsule Memory Map

5.6.2.3 ROM addresses

In ROMs 1 and 2 in the ROM capsule, the relationship between logical and physical addresses differs depending on the ROM capacity.

(1) Addresses in 64K-bit ROM
In 64K-bit ROMs, logical ROM addresses have a one-to-one correspondence with physical ROM addresses.

Memory address	Physical ROM address
ØCØØØH | ØDFFFH	ØØØØH | 1FFFH

(2) Addresses in 128K-bit ROM
In 128K-bit ROMs, the first half of the logical address space is mapped into the econd half of the physical address space, and the second half of the logical address space is mapped into the first half of the physical address space (see the figure below).

Memory address	Physical ROM address
ØAØØØH | ØBFFFH	2ØØØH | 3FFFH
ØCØØØH | ØDFFFH	ØØØØH | 1FFFH

(3) Addresses in 256K-bit ROM
In 256K-bit ROMs, the first half of the logical address space is mapped into the econd half of the physical address space, and the second half of the logical address space is mapped into the first half of the physical address space (see the figure below).

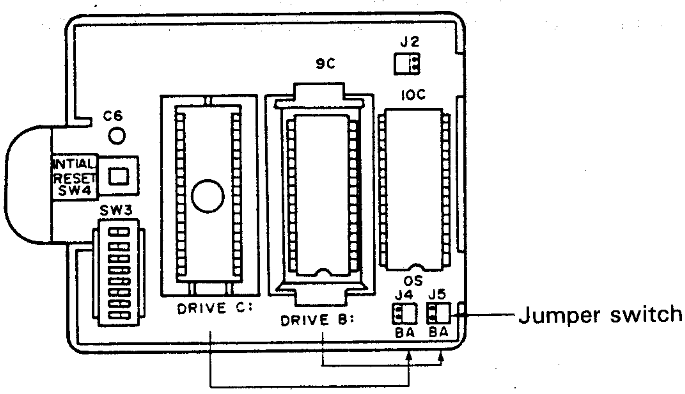
Memory address	Physical ROM address
6ØØØH | 7FFFH	6ØØØH | 7FFFH
8ØØØH | DFFFH	ØØØØH | 5FFFH

5.6.2.4 ROM switch jumper

When installing 64K-, 128K-, or 256K-bit ROM devices in ROM capsules, change the settings for J4 and J5 according to the ROM type.

Table 5.6.2 ROM Capacity and Jumpers

J4 and J5	ROM type
A	128K bit (PROM)
B	64K bit
B	128k bit (Mask ROM)
B	256K bit



Jumper J4 is for ROM capsule 1 (drive C) use and Jumper J5 is for ROM capsule 2 (drive B) use.

5.6.3 Use

Figure 5.6.1 shows the procedure for reading data in ROM capsule through bank switching.

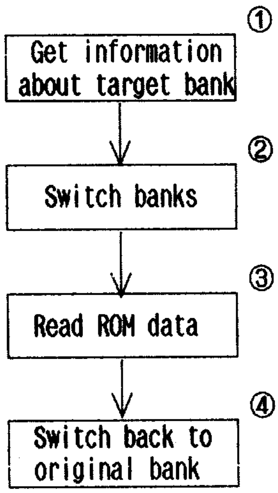


Fig. 5.6.1 Procedure for Reading ROM Data

See Section 4.4, "Bank Switching" for steps (1), (2), and (4).

5.6.4 System Support

PINE OS supports ROM capsules as read-only disks or executable programs. See Section 3.8, "Disk Storage" for the method of supporting ROM capsules as disks. See Section 4.6, "Executing a ROM Program" for the executing ROM programs.

5.6.4.1 Installation check

PINE OS checks whether or not a ROM capsule is installed at power-on or reset time.

At power-on or reset time, PINE OS determines whether or not a ROM capsule is installed by checking for a ROM header.

5.7 Centronics Interface

5.7.1 General

The PINE employs the Centronics interface which allows the PINE to print on an ordinary terminal printer (MP, RP, or FP) without processing print data.

5.7.2 Structure

5.7.2.1 Centronics interface I/O address map

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	16H	IOSTR							PERR	PBSY	Bits 7 through 2 are used for other purposes
Write	17H	PDR	8-bit data								
	19H	IOCTLR							$\overline{\text{PINI}}$	PSTB	Bits 7 through 2 are used for other purposes

IOSTR (I/O Status Register)
PERR: Printer error signal
= Ø: Normal state.
= 1: Error occurred.
PBSY: Printer busy signal
= Ø: Printer ready.
= 1: Printer busy.
PDR (Printer Data Register)
Used to output data to the printer. Loaded with ØFFH when not in use.
IOCTLR (I/O Control Register)
$\overline{\text{PINI}}$: Printer initial reset signal
PSTB: Data strobe signal

Note: The printer can be reset by holding the *PINI signal in the Ø state for more than 5Ø us.

5.7.3 Use

Figure 5.7.1 shows the procedure for using the Centronics interface.

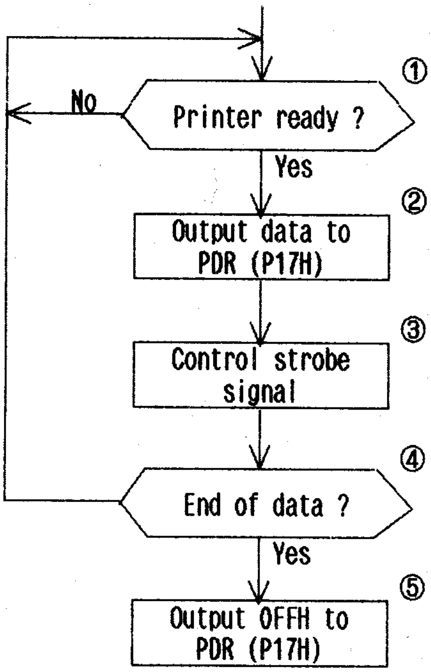


Fig. 5.7.1 Data Transmission Procedure

Step 1: Printer ready?
Check whether or not the printer is ready by examining PBSY and PERR (IOSTR, bits Ø and 1). Ø in both bits indicates that the printer is ready.

Step 2: Output data.
Write to PDR (P17H) the data to be output to the printer.

Step 3: Control strobe signal.
Generate the strobe signal to cause the printer to read data. To do this, set PSTB (IOCTLR, bit Ø) to 1 and then restore it to Ø.

Steps 4 and 5: Termination processing.
When outputting data continuously, return to step (1). When data output processing is completed, send ØFFH to PDR (P17H) to save power.

5.7.4 System Support

In PINE OS, the Centronics interface is manipulated through the LIST and LISTST functions. See Section 3.4, "BIOS Details" for BIOS functions.

5.7.4.1 Centronics interface initial signal

The PINE initially resets the printer at power-on or reset time by sending an initial signal to the Centronics interface. Even if power is turned off in the continue mode during printing, the printer is reset the next time power is turned on; print operation cannot be continued, once power is turned off.

5.8 Printer

5.8.1 General

PINE OS supports printers incorporating the Centronics or RS-232C interface. Any type of printer connects to the PINE Centronics, RS-232C, or SIO interface. The cartridge printer, which is one of the PINE cartridge options, is always connected to the cartridge interface.

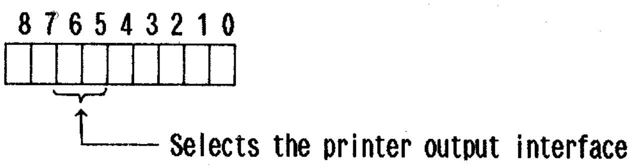
See Section 5.1, "Cartridges" for the cartridge printer, and Section 5.7, "Centronics Interface" for the Centronics interface. For the RS-232C and SIO interfaces, see Section 5.2, "Serial Interfaces."

The following pages discuss printers in general.

5.8.2 System Support

5.8.2.1 Selecting printer interface

The PINE can connect to a printer via four types of interfaces: Centronics, RS-232C, SIO, and cartridge SIO. The interface to which the printer is to be connected is determined by bits 5 and 6 of the DIP switch on the PINE main unit rear panel.

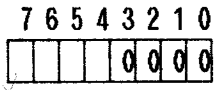


Bit 6	Bit 5	Output interface
OFF	OFF	SIO
OFF	ON	Cartridge
ON	OFF	RS-232C
ON	ON	Printer

5.8.2.2 Printer interface parameters

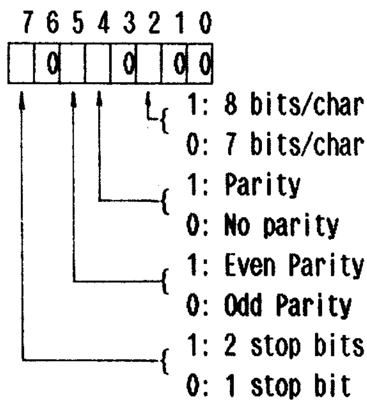
The bit rate must be specified when outputting print data to the RS-232C or SIO. In PINE OS, the initial settings are 4800 bps, 8 data bits, no parity, and 2 stop bits. These parameter values can be changed by rewriting the following areas:

SYSCTLR1 (ØF279H) 1 byte
Specifies the bit rate.



bit 7	bit 6	bit 5	bit 4	Transmission speed	bit 7	bit 6	bit 5	bit 4	Transmission speed	bit 7	bit 6	bit 5	bit 4	Transmission speed
0	0	0	0	110	0	1	0	1	2400	1	0	0	0	1200
0	0	0	1	150	0	1	1	0	4800	1	0	0	1	75
0	0	1	0	300	0	1	1	1	9600	1	1	×	×	200
0	0	1	1	600	1	0	1	0	19200					
0	1	0	0	1200	1	0	1	1	38400					

SYSARTMR (ØF27AH) 1 byte
Specifies the send and receive parameters.



5.8.2.3 Output to the printer

Data is output to the printer through the BIOS LIST and LISTST functions. See Section 3.4, "BIOS Details" for further information.

5.8.2.4 Screen dump

In PINE OS, the data on the LCD screen can be output on the printer in bit image by pressing the CTRL/PF5 keys or by calling the BIOS SCRNDUMP function.

5.8.2.5 International character set specification processing

PINE OS automatically specify the international character set (ESC + 'R') for the printer.

The international character set specification is output when data is sent to the printer for the first time after:
- The LST: field of the I/O byte is changed,
- A warm boot is performed,
- Power is turned on, or
- The display character generator is changed.

5.8.3 Printer Types

Table 5.8.1 lists the printers available for the PINE.

Table 5.8.1 Available Printers

Printer type	PINE graphics character	PINE screen dump	Connectable interface
MX-8ØII, III	$ *	$ **	Centronics (RS-232C, SIO)
MX-1ØØII, III	x	o	Centronics (RS-232C, SIO)
MX-8Ø, 1ØØ	o	o	Centronics (RS-232C, SIO)
FX-8Ø, 1ØØ	Down load	o	Centronics (RS-232C, SIO)
LQ15ØØ	x	o	Centronics
SQ2ØØØ	x	o	Centronics
DX-1ØØ	x	x	Centronics ***
C-4Ø	x	o	RS-232C, SIO
P-4ØP	o	o	Centronics
P-4ØS	o	o	RS-232C, SIO
P-8Ø	o	o	RS-232C, SIO
Cartridge printer	o	o	Cartridge

*: The $ marks indicate that the corresponding functions are available if PROM for the HC-2Ø is used.

**: The screen dump function is not available for the MP-8Ø I.

***: The optional printer adaptor must be used.

Notes:

1) Characters EØH, E1H, and 7FH cannot be printed on any of the above printers.
2) The user is advised to use the Centronics interface for ordinary terminal printers (MP, FP, and RP).