

CHAPTER 5 I/O OPERATIONS

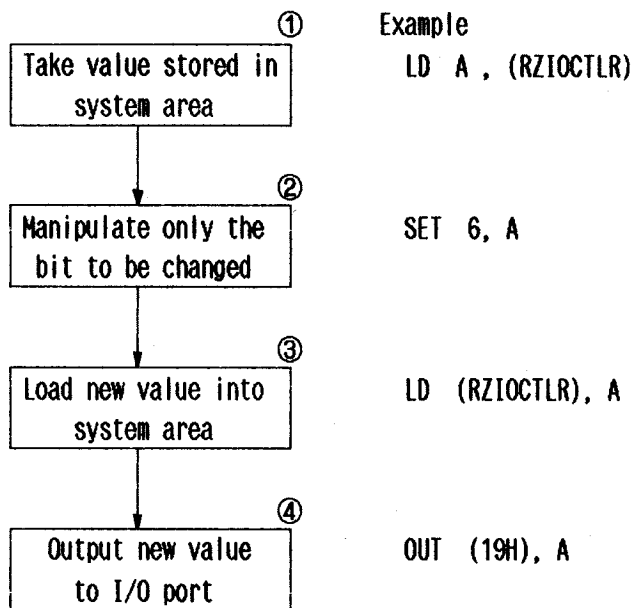
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CHAPTER 5 I/O OPERATIONS

This chapter describes PINE I/O devices such as cartridges and serial interfaces.

This chapter also covers I/O registers. Points to be noted when rewriting I/O registers are shown below.

PINE OS stores the current contents of the output registers in the system area. An application program can write to an I/O register through the following procedure:



The following registers must be written to by this procedure:

I/O address	Register name	System area address	Variable name	Remarks
P00H	CTLR1	0F001H	RZCTLR1	
P04H	IER	0F53EH	RZIER	Disable interrupt during writes.
P05H	BANKR	0F53DH	RZBANKR	
P15H	ARTMR	0F003H	RZARTMR	
P16H	ARTCR	0F004H	RZARTCR	
P18H	SWR	0F005H	RZSWR	
P19H	IOCTLR	0F006H	RZIOCTLR	

The PINE provides the following I/O registers for display processing:

I/O address	Register name	System area address	Variable name	Remarks
P08H	VADR	0F295H	LSCRVRAM+1	The value must be 80H or higher.
P09H	YOFF	0F2A0H	LVRAMYOFF	DSPFLAG indicates bit 7, and LVRAMYOFF bits 6 - 0.
P05H		0EFB6H	DSPFLAG	

The PINE I/O map is as follows:

Table 5.1.1 I/O Map

I/O port	Description
P00H - P0FH	Reserved by the system.
P10H - P13H	Reserved by the system for expansion cartridges.
P14H - P1FH	Reserved by the system.
P20H - P8FH	Not used.
P90H - P94H	Reserved by the system for external RAM disks.
P95H - PFFH	Not used.

See Part I, "Firmware" for details of individual registers.

5.1 Cartridges Interface

5.1.1 General

Optional devices such as microcassette, ROM, and RAM cartridges can be connected to the PINE cartridge interface. The cartridge interface runs in different modes depending on the type of device connected. It automatically switches to the correct mode for a given device.

This section describes how PINE OS controls cartridges. See Part I Section 4.1, "Cartridge Interface" for cartridge interface.

When using expansion cartridges, the user must not assign the following device codes because they are assigned to the cartridges supported by the system as standard:

- DB mode 01H (ROM cartridge)
- 02H (RAM cartridge)
- HS mode 08H (Microcassette Drive)
- 09H (Cartridge printer)

5.1.2 Modes and Mode Setting

The PINE cartridge interface operates in four modes: HS, IO, DB, and OT. The operation mode is switched depending on the cartridge type. Cartridges are assigned a device code identifying the cartridge type.

The relationship between the modes and the cartridges that can be used on the PINE is shown in Table 5.1.2.

Table 5.1.2 Cartridges and Modes

Cartridge	Mode	Remarks
ROM cartridge	DB	
RAM cartridge	DB	
Microcassette Drive	HS	
Cartridge printer	HS	
Modem cartridge	IO	Not supported by OS.
DMM cartridge	IO	Not supported by OS.
PROM WRITER cartridge	IO	Not supported by OS.

PINE OS checks for the presence or absence of a cartridge at power-on or reset time and selects the cartridge mode automatically.

The cartridge mode is determined by the CSEL signal (IOSTR (P16H), bit 6) and the device code (P13H, bits 7 - 4). The mode and the device code are loaded into the system area CRGDEV (0F53FH).

Figure 5.1.3 illustrates the mode setting flow.

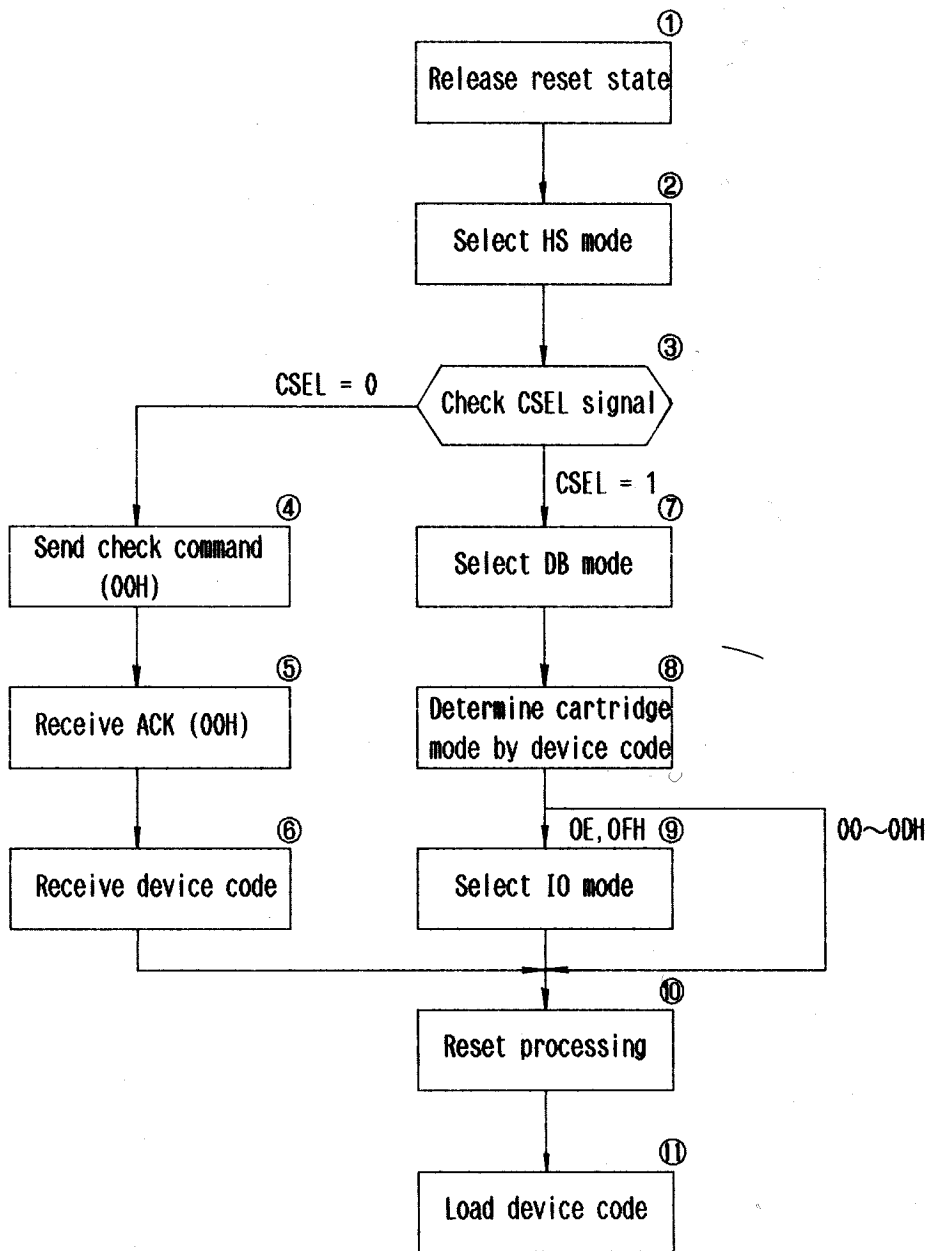


Fig. 5.1.3 Mode Setting Flow

Step 1: Release reset state.

Release the cartridge reset signal (\overline{CRS}) to check the identity cartridge option. The system sets the IOCTLR \overline{CRS} (P19H, bit3) high and waits approximately 10 msec.

Step 2: Select HS mode.

Set the cartridge mode to HS using the SWR CSW1,0 (P18H, bits 1,0).

Step 3: Check CSEL signal.

Check the CSEL signal to determine whether or not the cartridge mode is HS. 0 in the IOSTR CSEL (P16H, bit 6) indicates HS mode 1 indicates any other mode.

Steps 4 through 6: Identify HS mode.

Identify the HS mode option in the option following sequence:

1) Send 00H (Option Check command) to the cartridge.

2) Receive 00H (ACK) from the cartridge.

3) Receive a device code from the cartridge.

If no ACK is received from the cartridge, send the Option Check command again.

Step 7: Select DB mode.

Set the cartridge mode to DB.

Step 8: Determine cartridge mode by device code.

Read the cartridge device code from I/O port address 13H and determine the cartridge mode (other than the HS mode). The cartridge mode is identified by the high-order bits of the device code.

High-order bits = 00H - 0DH: DB mode

= 0EH - 0FH: IO mode

Step 9: Select IO mode.

If the device code is 0EH or 0FH, set the cartridge mode to IO.

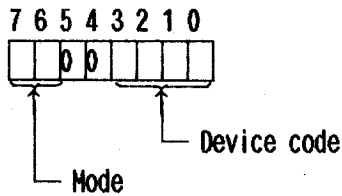
Step 10: Reset processing.

Perform reset processing. Specify reset again based on the value of CRSTPTN (0EF1H).

Step 11: Load device code.

Load the cartridge mode and device code into CRGDEV (0F53FH).

CRGDEV (0F53FH) 1 byte
Cartridge device code



Bits		Mode
7	6	
0	0	DB mode
0	1	HS mode
1	0	IO mode
1	1	(OT mode)

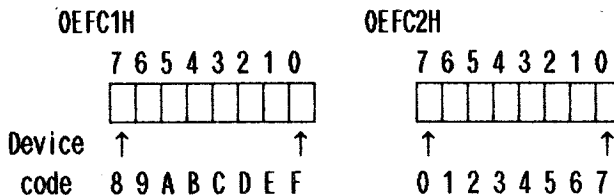
Bits				Cartridge
3	2	1	0	
0	0	0	0	No cartridge
0	0	0	1	ROM cartridge
0	0	1	0	RAM cartridge
1	0	0	0	Microcassette drive
1	0	0	1	Cartridge printer
1	1	1	0	(DMM cartridge)
1	1	1	1	(Modem cartridge)

The OS does not support the OT mode, DMM, or Modem cartridge. The user can specify codes other than the device codes listed above.

CRSTPTN (0EFC1H) 2 bytes

Specifies the cartridge reset signal ($\overline{\text{CRS}}$) to be generated after the cartridge is checked.

Each bit of CRSTPTN corresponds to a cartridge device.



A 0 indicates that the $\overline{\text{CRS}}$ is set low. A 1 indicates that $\overline{\text{CRS}}$ is set high. The initial values are 41H and 40H.

5.1.3 ROM Cartridge

5.1.3.1 Outline

The PINE ROM cartridge is an optional read-only external storage which connects to the PINE main unit via the PINE cartridge interface. The ROM cartridge can contain up to two mask ROMs or 2764-, 27128-, or 27256-compatible EPROMs, which are installed as capsules.

The ROM cartridge runs in the DB mode. Its device code is 01H.

5.1.3.2 Structure

(1) ROM cartridge I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks	
Read	P10H	Not used (access inhibited)										
	P11H	Not used (access inhibited)										
	P12H	CDBIR2	8bit data									
	P13H										Used to identify device	
Write	P10H	CDBOR0	8bits data (ROM lower-order address)									
	P11H	CDBOR1	8bits data (ROM higher-order address)									
	P12H	Not used (access inhibited)										
	P13H	CDBOR3	Don't care							PWON		

CDBIR2: Loaded with the ROM data from the specified address of the ROM cartridge.

CDBOR0: Specifies the lower address of the ROM cartridge ROM.

CDBOR1: Specifies the higher address of the ROM cartridge ROM.

CDBOR3: PWON -- Specifies whether or not the ROM cartridge power is on.

= 0: ROM cartridge power off.

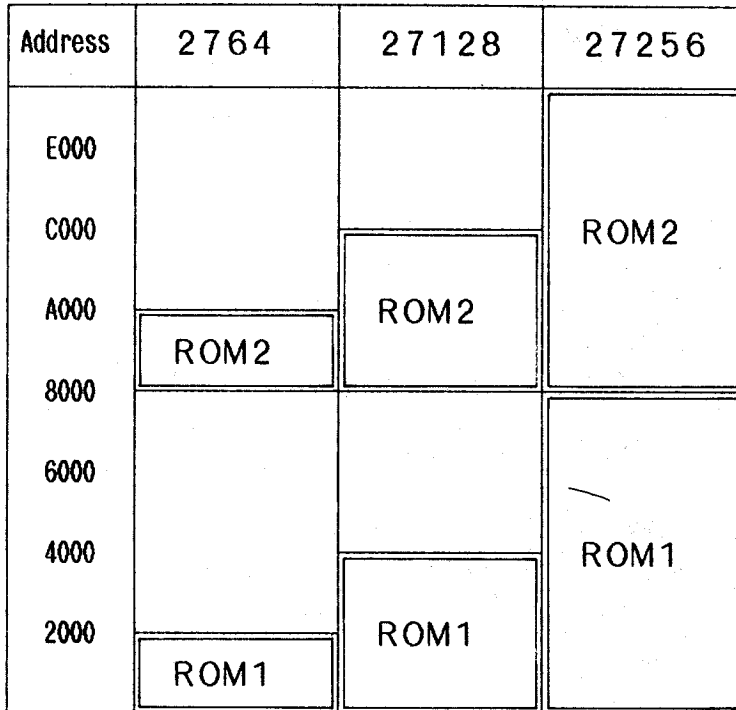
= 1: ROM cartridge power on.

Note: The ROM cartridge is accessible 60 msec. after power-on.

(2) ROM memory map

Figure 5.1.4 shows the memory map of ROM installed in the ROM cartridge. A ROM cartridge can contain up to two 64K-, 128K-, or 256K-bit ROMs.

Fig. 5.1.4 ROM memory map



(3) Addresses on 256K-bit ROM

In 64K-bit or 128K-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 ROM cartridge	Physical ROM address
0000H (8000H)	4000H
⎋	⎋
3FFFH (0BFFFH)	7FFFH
4000H (0C000H)	0000H
⎋	⎋
7FFFH (0FFFFH)	3FFFH

Addresses enclosed in parentheses are for ROM2.

5.1.3.3 Use

Figure 5.1.4 shows the ROM cartridge processing flow.

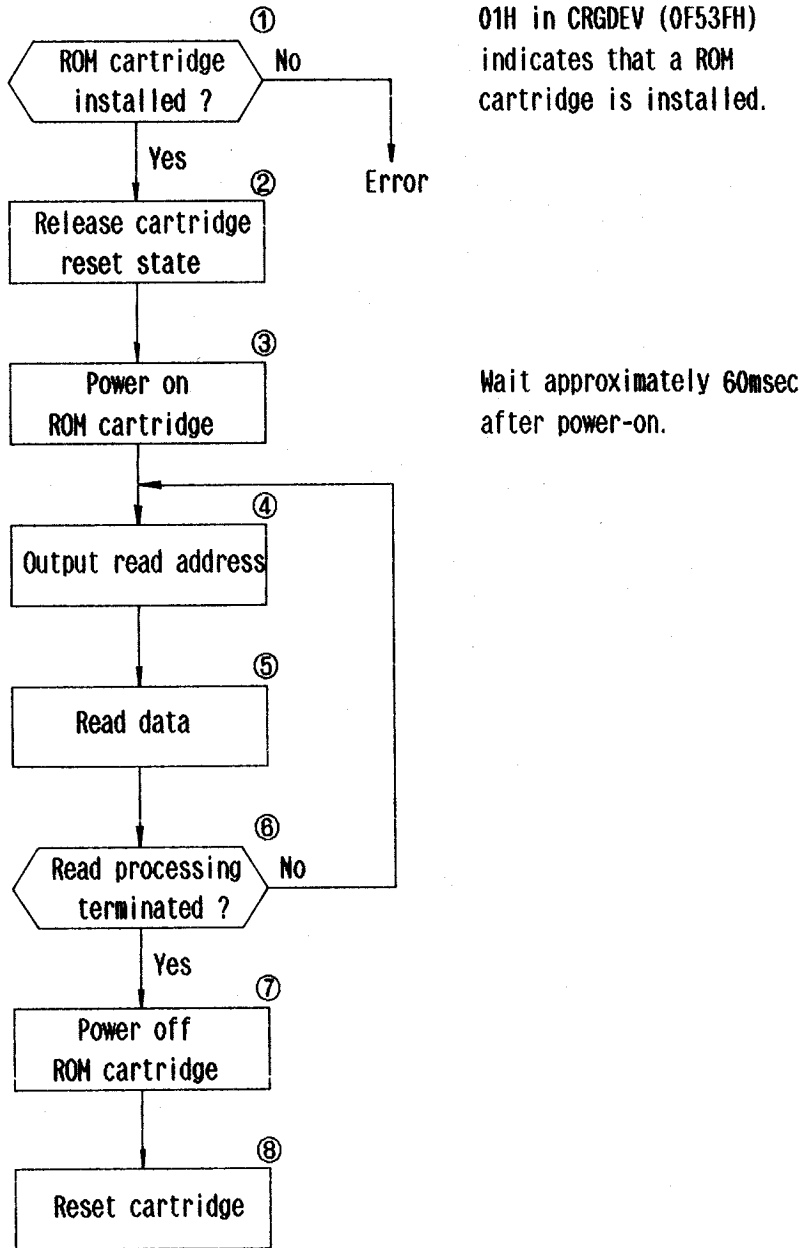


Fig. 5.1.5 ROM Cartridge Processing Flow

Step 1: ROM cartridge installed?

Check whether or not a ROM cartridge is installed. CRGDEV (0F53FH) identifies the presence or absence of a ROM cartridge.

CRGDEV = 01H: ROM cartridge installed.

= Others: No ROM cartridge installed.

Step 2: Release cartridge reset state.

Reset the cartridge reset signal ($\overline{\text{CRS}}$) by setting IOCTLR (P19H), bit 6 ($\overline{\text{CRS}}$) to 1. The system waits approximately 10 ms. before actual reset.

Step 3: Power on ROM cartridge.

Power on the ROM cartridge by setting P13H, bit 0 (PWON) to 1. The system waits approximately 60 ms. before actual power-on.

Steps 4 through 6: Read ROM data

Read ROM data from the specified address, following the steps below.

1) Write the lower address (8 bits) to P10H,

2) Write the higher address (8 bits) to P11H, and

3) Read ROM data from P12H.

Step 7: Power off ROM cartridge

Power off the ROM cartridge by setting P13H, bit 0 (PWON) to 0. The system waits approximately 60 ms. before actual power-off.

Step 8: Reset cartridge

Reset the ROM cartridge by setting IOCTLR (P19H), bit 6 ($\overline{\text{CRS}}$) to 0. The system waits approximately 10 ms. before actual reset.

5.1.3.4 System support

PINE OS supports the ROM cartridge as a read-only disk drive. See Section 3.8, "Disk Storage" for further information.

(1) Installation check

The OS checks whether or not a ROM cartridge is installed at power-on or reset time. Since the OS supports three types of ROM (8 KB, 16 KB, and 32 KB), it also identifies the ROM capacity by the following procedure:

- Read the header area (23 bytes from 0000H) of ROM cartridge ROM1 and check for a format mismatch.
- If no mismatch is found, calculate the ROM1 capacity from the ROM capacity specified in the header area.
- If a mismatch is found, ROM1 is not installed.
- Read and check the header area (23 bytes from 8000H) of ROM2 in the same way as with ROM1.

5.1.3.5 Miscellaneous

(1) Power control

PINE OS controls ROM cartridge power as follows:

- Power-on: Turns power on if the ROM cartridge power is off when data is to be read.
- Power-off: Turns power off if no data is read within two seconds after the last data was read.

Time is measured using the 7508 1-second interrupt. Power-off processing is performed by PSTBIOS.

(2) Reset ($\overline{\text{CRS}}$) signal control

Since setting or releasing of the cartridge reset state requires a wait period, a considerable amount of time would be wasted if they had to be performed at every data read. To avoid this, the OS controls resetting of the ROM cartridge in the same way as it controls ROM cartridge power.

5.1.4 RAM Cartridge

5.1.4.1 Outline

The PINE RAM cartridge is an optional external storage for read and write. It connects to the PINE main unit via the cartridge interface.

The RAM cartridge can incorporate up to two 64K-bit static RAMs. Data on the static RAMs can be accessed through I/O instructions from the PINE main unit. The RAM cartridge is backed up by a battery and its contents are retained for up to three years, even if it is removed from the main unit.

The RAM cartridge runs in the DB mode. Its device code is 02H.

5.1.4.2 Structure

(1) RAM cartridge I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks	
Read	P10H	Not used (access inhibited)										
	P11H	Not used (access inhibited)										
	P12H	CDBIR2	8bit data									
	P13H										Used to identify device.	
Write	P10H	CDBOR0	8bit data (RAM lower-order address)									
	P11H	CDBOR1	8bit data (RAM higher-order address)									
	P12H	CDBOR2	8bit data									
	P13H	Not used (access inhibited)										

CDBIR2: Loaded with the read data from the specified address of the RAM cartridge.

CDBOR0: Specifies the lower address of the RAM cartridge RAM.

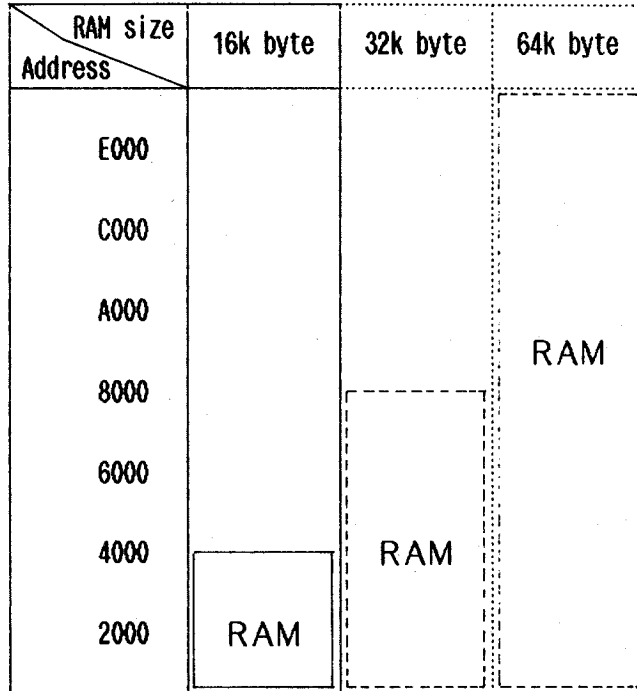
CDBOR1: Specifies the higher address of the RAM cartridge RAM.

CDBOR2: Loaded with the write data from the specified address of the RAM cartridge.

(2) RAM memory map

Figure 5.1.6 shows the memory map of RAM installed in the RAM cartridge. PINE OS supports 16 KB, 32 KB, and 64 KB RAM cartridges.

Fig. 5.1.6 RAM memory map



5.1.4.3 Use

Figure 5.1.7 shows the RAM cartridge processing flow.

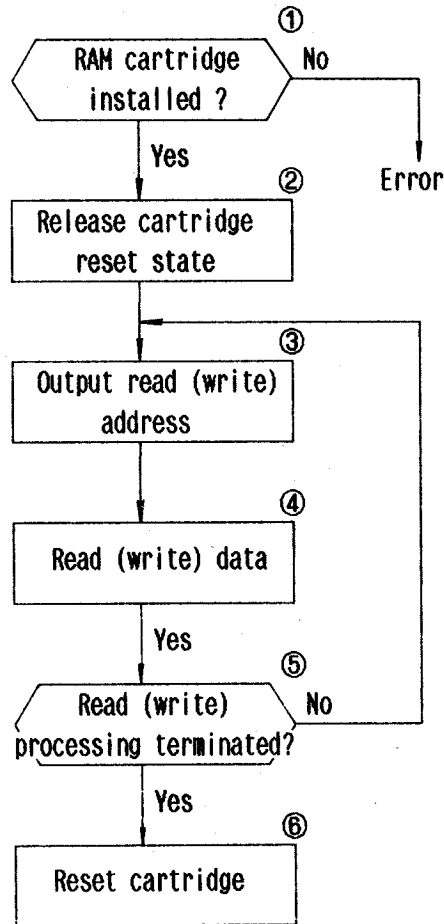


Fig. 5.1.7 RAM Cartridge Processing Flow

Note: System actions in each step are the same as for the ROM cartridge. See Subsection 5.1.3.

5.1.4.4 System support

PINE OS supports the RAM cartridge as a read/write disk drive. See Section 3.8, "Disk Storage" for further information.

(1) Installation check

The OS checks whether or not a RAM cartridge is installed at power-on or reset time. Since the OS supports three types of RAM (16 KB, 32 KB, and 64 KB), it also identifies the RAM capacity by the following procedure:

- Rewrite address 4000H of the RAM cartridge. If the attempt fails, identify the RAM cartridge capacity as 16 KB.
- Rewrite address 8000H of the RAM cartridge. If the attempt fails, identify the RAM cartridge capacity as 32 KB.
- If the rewrite of address 8000H was successful, identify the RAM capacity as 64 KB.

However, only 16 KB RAM cartridges are available as products.

5.1.4.5 Miscellaneous

(1) Reset ($\overline{\text{CRS}}$) signal control

Since setting or releasing of the cartridge reset state requires a wait period, a considerable amount of time would be wasted if they had to be performed at every data read. To avoid this, the PINE OS controls resetting of the RAM cartridge as follows:

Releasing reset state: Release the reset state if the RAM cartridge is reset when data is to be read or written.

Setting reset state: Reset the cartridge if no data is read or written within two seconds after the last read or write.

Time is measured using the 7508 1-second interrupt. Reset state setting processing is performed by PSTBIOS.

5.1.5 Microcassette Drive

5.1.5.1 Outline

The PINE microcassette drive (MCT) is an optional external storage for read and write. It connects to the PINE main unit via the PINE cartridge interface.

The microcassette drive is an intelligent cartridge option incorporating CMOS MCU 6301V1 for controlling. It runs in the HS mode. device code is 08H.

5.1.5.2 Structure

(1) Microcassette drive I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Flag state changed by
Read	10H	CHSIR	8bit command/data								IBF reset
	11H	CHSSR	CAB1 IBF OBF								
	12H	Not used (access inhibited)									
	13H	Not used (access inhibited)									
Write	10H	CHSOR	8bit data								OBF set
	11H	CHSOR	8bit command								OBF set
	12H	Not used (access inhibited)									
	13H	Not used (access inhibited)									

CHSIR: Cartridge HS mode input register
(CAB1=0 identifies data entry. CAB1=1 identifies command entry.)

CHSSR: Cartridge HS mode status register

CHSOR: Cartridge HS mode output register.

5.1.5.3 Use

The microcassette drive interfaces to the PINE main unit through commands, data, and the ACK signal.

The PINE main unit controls the microcassette drive by sending commands or commands and parameters (data) to the microcassette drive via the HS interface. An ACK signal, or data and an ACK signal, corresponding to the commands is returned to the main unit during or after operation.

The following routines are provided to manipulate command and data transmission between the main unit and the HS mode cartridge:

- HSRST
- HSSCOM
- HSSDAT
- HSRCV
- HSSBL
- HSRBL
- HSBRK

See Section 4.2, "Jump Tables" for details.

(1) Protocol

The PINE uses the protocol shown in Figure 5.1.8. Every communication, as viewed from the main unit, starts with transmission of a command (for data transmission), followed by reception of an ACK signal (for data reception). During tape reads, however, data is received before an ACK signal. If these procedures are not followed, a protocol error occurs during processing of commands other than the break or cold start commands.

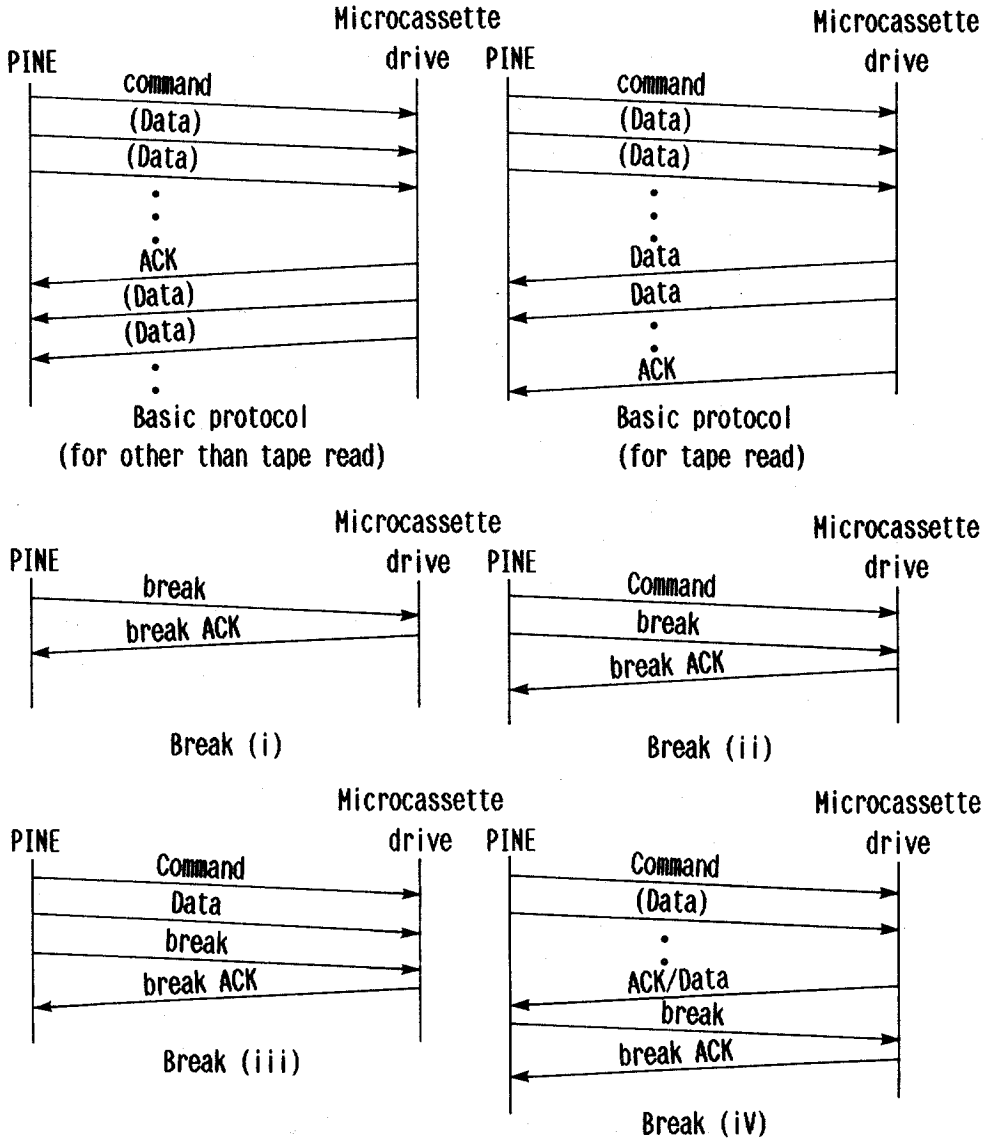


Fig. 5.1.8 Protocol

(2) Command directory

Code	Function	Page
00H	Read drive code of installed option	II-518
01H	Read monitor data	II-518
02H	Write monitor data	II-519
03H	Spare	II-519
0BH	Cold start	II-519
0FH	Break	II-519
40H	Read microcassette status	II-519
41H	Turn head on	II-520
42H	Turn head off	II-520
43H	Rewind n count	II-520
44H	Fast feed n count	II-521
45H	Rewind	II-521
46H	Fast feed	II-521
47H	Slow rewind	II-522
48H	Slow wind	II-522
49H	Turn on erase and record head and wind slow	II-522
4AH	Stop capstan motor	II-522
4BH	Read write protect tab status	II-523
4CH	Read counter	II-523
4DH	Set counter	II-523
4EH	Spare	II-523
4FH	Spare	II-523
50H	Verify (CRC check)	II-524
51H	Write in nonstop mode	II-524
52H	Write in stop mode	II-525
53H	Read in nonstop mode	II-525
54H	Read in stop mode	II-526
55H	Set rewind count	II-526
56H	Release rewind count	II-526
57H	Set interblock gap length	II-526
58H	Set bit rate	II-527
59H	Enable/disable CRC check	II-527
5AH	Turn on/off tape removable LED	II-528
5BH	Send internal-RAM data to main unit	II-528
5CH	Write data to internal RAM	II-528
5DH	Spare	II-528
5EH	Spare	II-528
5FH	Self diagnosis	II-529

(3) Command details

The following pages list the functions and parameters of the microcassette commands. Send parameters are sent from the main unit to the microcassette drive ACK and receive parameters are returned from the microcassette drive to the main unit.

Return codes shown in the ACK field have the following meanings:

ACK code	Value(hex)	Description
RCD00	00	Normal termination
RCD01	01	Cold start executed
RCD02	02	Break executed
RCD03	03	Command error
RCD04	04	Protocol error
RCD05	05	FIFO full (First in First out buffer)
RCD06	06	FIFO empty
RCD07	41	Head error (time over)
RCD08	42	Tape stop error or no tape error
RCD09	43	Write protect error
RCD10	44	Data error (time over)
RCD11	45	CRC error
RCD12	46	(not used)
RCD13	47	Protected area encountered
RCD14	07	Monitor write inhibited

(a) Read device code of Installed Option

- Command code: 00H
 - Send parameter: None
 - ACK: RCD00
 - Receive parameter: Device code (08H) of the microcassette drive
- Function:

Reads the device code of the optional device installed. No IRQ1 interrupts are accepted during processing.

(b) Monitor commands

1) Read Monitor Data

- Command code: 01H
- Send parameters:
 - SP1: Address at which read is to start (low-order)
 - SP2: Address at which read is to start (high-order)
 - SP3: Read n data bytes ($1 \leq n \leq 40$)
- ACK: RCD00
- Receive parameters:
 - RP1: Data 1
 - .
 - .
 - .
 - .
 - RPn: Data n

Function:

Reads the number of bytes specified in SP3 (maximum of 40 bytes) from the address specified in SP1 and SP2, and sends them to the main unit.

*1 During execution of processing, the sending of commands other than break and cold start, results in protocol error and abnormal end (RCD04).

In the case of break, processing is halted, and break ACK (RCD02) is returned. In the case of cold start, the following processes are executed, and a return made to the initialization state. (reset state).

1. Motor stop
2. Head OFF
3. Reception of ACK (RCD01)

2) Write Monitor Data

- Command code: 02H

- Send parameters:

SP1: Address at which write is to start (low-order)

SP2: Address at which write is to start (high-order)

SP3: Write n data bytes (n=0: 256 bytes, 1: 1 byte, ...)

SP4: Write data 1

.

SPn+3: Write data n

- ACK: RCD00

RCD14 (An attempt was made to write to an address outside the range of 80H - 0FFH.)

- Receive parameter: None

Function:

Writes data SP4 through SPn+3 to the address specified in SP1 and SP2. An error occurs if an attempt is made to write to an address outside the range of 80H to 0FFH.

For commands accepted during execution refer to 1) Read Monitor Data *1.

3) Spare

- Command code: 03H

- Send parameter: None

- ACK: RCD03

- Receive parameter: None

(c) Cold Start

- Command code: 0BH

- Send parameter: None

- ACK: RCD01

- Receive parameter: None

Function:

Initializes the microcassette drive and the MCU6301.

(d) Break

- Command code: 0FH

- Send parameter: None

- ACK: RCD02

- Receive parameter: None

Function:

Terminates microcassette drive processing and puts the device into the command mode.

(e) Microcassette commands

1) Read Microcassette Status

- Command code: 40;H

- Send parameter: None

- ACK: RCD00

- Receive parameter:

- RPl: Microcassette status (MCSTS)
- Bit 7: Head on (0: No, 1: Yes)
- Bit 6: Motor rotate (0: No, 1: Yes)
- Bit 5: Fast feed backward (REW) (0: No, 1: Yes)
- Bit 4: Fast feed forward (FF) (0: No, 1: Yes)
- Bit 3: Slow feed forward (play) (0: No, 1: Yes)
- Bit 2: Slow feed backward (0: No, 1: Yes)
- Bit 1: Erase (0: No, 1: Yes)
- Bit 0: Feed forward enable flag set (0: No, 1: Yes)

Function:

Reads the microcassette status.

For commands accepted during execution refer to (b) Monitor Command.

2) Turn Head On

- Command code: 41H
- Send parameter: None
- ACK: RCD00,
RCD07 (Head error: Time over)
- Receive parameter: None

Function:

When the head is off the tape, this command drives the head motor and places the read/write head on the tape. When the head is already on the tape, the command does nothing but returns an ACK.

An head error occurs if the specified head state is not established within 1.6 seconds after this command is issued. No interrupts are accepted until the operation is completed. The command sets the polarity of the input edge. The default setting is from positive (H) to negative (L). The speaker audio output is held off while the head motor is running.

3) Turn Head Off

- Command code: 42H
- Send parameter: None
- ACK: RCD00
RCD07 (Head error: Time over)
- Receive parameter: None

Function:

This command performs the same function as the Turn Head On command except that it turns off the head if it is on, and it does nothing but return an ACK if the head is already off.

4) Rewind n Counts

- Command code: 43H
- Send parameters:
 - SP1: Counter value (high-order)
 - SP2: Counter value (low-order)
 - SP3: Head on/off (0: OFF, Nonzero: ON)
- ACK: RCD00
RCD07 (Head error)
RCD08 (Tape stop or no tape error)
RCD13
- Receive parameter: None

Function:

Moves the tape backward the number of tape counts specified in SP1 and SP2. If the capstan motor is rotating forward and the head is on when the command is received, the command rewinds the tape after stopping the motor and turning off the head.

If a nonzero value is specified in SP3, the command turns the head on after finishing rewinding.

A no-tape error occurs after approximately one second if no tape is mounted. A tape stop error occurs if the tape end is reached before tape is rewound by n counts.

For commands accepted during execution refer to (b) Monitor Command *1.

5) Fast Feed n Counts

- Command code: 44H

- Send parameters:

SP1: Counter value (high-order)

SP2: Counter value (low-order)

SP3: Head on/off (0: OFF, Nonzero: ON)

- ACK: RCD00

RCD07 (Head error)

RCD08 (Tape stop error)

RCD13

- Receive parameter: None

Function:

Moves the tape forward the number of tape counts specified in SP1 and SP2 at a high speed.

If the head is on and the capstan motor is rotating backward when this command is issued, the command feeds tape after stopping the motor and turning off the head. If a nonzero value is specified in SP3, the command turns the head on after finishing the operation.

Even when no tape is mounted, the command executes as if one were and terminates normally. A tape stop error occurs if the tape end is reached before the tape is wound by n counts.

For commands accepted during execution refer to (b) Monitor Command *1.

6) Rewind

- Command code: 45H

- Send parameter: None

- ACK: RCD00

RCD07 (Head error)

- Receive parameter: None

Function:

Rotates the motor in the reverse direction (rewind). If the motor is rotating forward or the head is on when this command is received, the command stops the motor or turns off the head before rewinding.

7) Fast Feed

- Command code: 46H

- Send parameter: None

- ACK: RCD00

RCD07 (Head error)

- Receive parameter: None

Function:

Rotates the motor forward at a high speed. If the motor is rotating backward or the head is on when this command is received, the command stops the motor or turns off the head before rotating the motor fast forward.

The command drives the motor normally even if no tape is mounted but automatically stops it when the tape end is reached.

8) Slow Rewind

- Command code: 47H
- Send parameter: None
- ACK: RCD00
RCD07 (Head error)
- Receive parameter: None

Function:

Rotates the motor in the reverse direction (rewind) at a low speed. If the motor is rotating forward or the head is on when this command is received, the command stops the motor or turns off the head before rotating the motor in reverse.

The command automatically stops the motor approximately one second after a no tape error or tape stop error is detected.

9) Slow Wind

- Command code: 48H
- Send parameter: None
- ACK: RCD00
- Receive parameter: None

Function:

Rotates the motor forward at a low speed. If the motor is rotating backward when this command is received, the command stops the motor before rotating it forward.

When the tape end is reached, the command automatically stops the motor and turns off the head after approximately one second. When the head is on, the read signal is transmitted from the head output line.

10) Turn On Erase or Record Head and Wind Slow

- Command code: 49H
- Send parameter: None
- ACK: RCD00
- Receive parameter: None

Function:

If the microcassette write protect tab is broken, or if a cassette has not been inserted RCD09 is immediately returned. If the microcassette write protect tab is not broken or the cassette holder is open, if the motor is rotating backward when this command is received, the command stops the motor and rotates it forward.

Data already on the tape will be erased if the read/write head is on. Data will be written on the tape if signals are output to the record head.

It automatically stops the motor and turns off the head approximately one second after the tape end is reached.

11) Stop Capstan Motor

- Command code: 4AH
- Send parameter: None
- ACK: RCD00
- Receive parameter: None

Function:

Stops the motor and, 0.6 seconds later, stops the counter. This action does not change the head position.

12) Read Write-Protect Tab Status

- Command code: 4BH
- Send parameter: None
- ACK: RCD00
- Receive parameter:
 - RP1: Write-protect tab status
 - 00H: Write protected (tab removed)
 - 08H: Write enabled

Function:

Used to check whether the current microcassette tape is write protected.

13) Read Counter

- Command code: 4CH
- Send parameter: None
- ACK: RCD00
- Receive parameters:
 - RP1: Counter value (high-order)
 - RP2: Counter value (low-order)

Function:

Reads the current counter value.

14) Set Counter

- Command code: 4DH
- Send parameters:
 - SP1: Counter value (high-order)
 - SP2: Counter value (low-order)
- ACK: RCD00
- Receive parameter: None

Function:

Sets the counter to the value specified in SP1 and SP2.

15) Spare

- Command code: 4EH
- Send parameters:
 - SP1, SP2
- ACK: RCD03
- Receive parameter: None

16) Spare

- Command code: 4FH
- Send parameters:
 - SP1, SP2, SP3
- ACK: RCD03
- Receive parameter: None

17) Verify (CRC check)

- Command code: 50H
- Send parameters:
 - SP1: Number of data bytes to be verified (high-order)
 - SP2: Number of data bytes to be verified (low-order)
- ACK: RCD00
 - RCD07
 - RCD08
 - RCD10
 - RCD11
 - RCD13
- Receive parameters: Same as for the Read in Nonstop Mode command (53H).

Function:

Reads the number of data bytes specified in SP1 and SP2 in the stop mode (stops at every block end) starting at the current tape position, checks for CRC, and sends the whole data to the main unit.

The read signal is sent to the speaker during verify processing. For commands accepted during execution refer to (b) Monitor Command *1.

18) Write in Nonstop Mode

Command code: 51H

- Send parameters:
 - SP1: Data length (high-order)
 - SP2: Data length (low-order)
 - SP3: Data 1
 - SP4: Data 2
 - .
 - .
 - SPn+2: Data n
- ACK: RCD00
 - RCD07
 - RCD08
 - RCD09
 - RCD13
- Receive parameters:
 - RP1: Block start counter (high-order)
 - RP2: Block start counter (low-order)

Function:

Writes the number of data bytes specified in SP1 and SP2 onto tape. Data blocks shorter than 40 bytes cannot be written. Data bytes are sent at intervals of up to 5 ms/byte.

When the same data is to be written n times, it must be sent from the main unit to the microcassette drive n times. Since the microcassette writes the received data as is, without checking, the main unit must send the correct data, checking block numbers.

The tape does not stop after the last write is completed. It does stop when an error occurs.

The head is turned off when an RCD08, RCD09, or RCD13 error occurs.

An ACK is returned from the microcassette before RP1 and RP2. If the command is sent before the sending of specified byte data to the microcassette drive has been completed, a protocol error occurs. However break and cold start commands are accepted and respective processing carried out.

19) Write in Stop Mode

- Command code: 52H
- Send parameters:
 - SP1: Data length (high-order)
 - SP2: Data length (low-order)
 - SP3: Data 1
 - SP4: Data 2

.

SPn: Data n-2

- ACK: RCD00
RCD07
RCD08
RCD09
RCD13
- Receive parameters:
 - RP1: Block start counter (high-order)
 - RP2: Block start counter (low-order)

Function:

This command performs the same function as Write in Nonstop Mode except that it stops the tape after writing data.

20) Read in Nonstop Mode

- Command code: 53H
- Send parameters:
 - SP1: Data length (high-order)
 - SP2: Data length (low-order)

- ACK: RCD00
RCD05
RCD07
RCD08
RCD10
RCD11
RCD13

- Receive parameters:
 - RP1: Counter value set when a block synchronous bit is detected (high-order)
 - RP2: Counter value set when a block synchronous bit is detected (low-order)
 - RP3: Data 1

.

RPn: Data n-2

Function:

Reads the number of data bytes specified in SP1 and SP2, starting at the current tape position.

An FIFO full error occurs if the FIFO becomes full before reading is completed. If the specified number of data bytes are read with no errors, the command terminates reading without stopping the motor. If an error occurs during processing, it stops the motor and turns off the head. Data bytes are sent at intervals of up to 5 ms per byte.

The read signal is sent to the loudspeaker during processing. An ACK is sent to the main unit after transmission of data is completed.

For commands accepted during execution refer to (b) Monitor Command *1.

21) Read in Stop Mode

- Command code: 54H
- Send parameters:
 - SP1: Data length (high-order)
 - SP2: Data length (low-order)
- ACK: RCD00
 - RCD05
 - RCD07
 - RCD08
 - RCD10
 - RCD11
 - RCD13
- Receive parameters:
 - RP1: Counter value set when a block synchronous bit is detected (high-order)
 - RP2: Counter value set when a block synchronous bit is detected (low-order)
 - RP3: Data 1
 - .
 - .
 - RPn: Data n-2

Function:

This command has the same function as Read in Nonstop Mode except that it stops the motor after reading data.

22) Set Rewind Count

- Command code: 55H
- Send parameters:
 - SP1: Counter value (high-order)
 - SP2: Counter value (low-order)
- ACK: RCD00
- Receive parameter: None

Function:

Sets the maximum count by which the tape can be rewound from the current position as well as the flag for enabling the rewind count. When the flag is set, the tape stops and the head turns off automatically if the rewind count reaches 0.

23) Reset Rewind Count

- Command code: 56H
- Send parameter: None
- ACK: RCD00
- Receive parameter: None

Function:

- Resets the rewind count flag.

24) Set Interblock Gap Length

- Command code: 57H
- Send parameters:
 - SP1: Short interblock gap length SBIGIN
 - SP2: Long interblock gap length LBIGIN
- ACK: RCD00
- Receive parameter: None

Function: Sets the short and long interblock gap lengths.

25) Set Bit Rate

- Command code: 58H

- Send parameters:

SP1: 1 bit half period (high-order)	B1TIME
SP2: 1 bit half period (low-order)	
SP3: 0 bit half period (high-order)	B0TIME
SP4: 0 bit half period (low-order)	
SP5: Bit threshold level (high-order)	MCTTHR
SP6: Bit threshold level (low-order)	
SP7: Noise threshold level (high-order)	MCT0TH
SP8: Noise threshold level (low-order)	

- ACK: RCD00

- Receive parameter: None

Function:

Sets the half period of 1 and 0 bits during writes, the bit threshold level during reads, and the noise threshold level.

The half periods of 1 and 0 bits are obtained by multiplying the MCU6301V1 machine cycle by (SP1, SP2) and (SP3, SP4), respectively. Since the machine cycle for the PINE is 1 μ s, each parameter value equals the corresponding half period. The default values are 500 μ s and 250 μ s, respectively. The upper and lower limits are as follows:

	Upper limit (μ s)	Lower limit (μ s)
1 bit	750	500
0 bit	375	250

The bit threshold level defaults to 750 μ s. When redefining the bit threshold level with this command, set it to the arithmetic or geometrical mean value of the periods of the 1 and 0 bits.

It is desirable that the noise threshold level be set to the 0 bit half period. The default value is 250 μ s.

26) Enable/Disable CRC Checking

- Command code: 59H

- Send parameters:

SP1: 0 (Disable), Nonzero (Enable)
SP2: CRC multinomial expression (high-order)
SP3: CRC multinomial expression (low-order)

- ACK: RCD00

- Receive parameter: None

Function:

Suppresses generation of a CRC check bit during reads when SP1 is set to 0. Any CRC multinomial expression can be specified when SP1 is a nonzero value. The default value is CRC-CCITT. Once an expression is specified, it is not restored to the default value until a cold start is performed.

SP2 and SP3 must be sent even when CRC checking is disabled in SP1.

27) Turn ON/OFF Tape Removable LED

- Command code: 5AH
- Send parameter:
 SP1: 0 (OFF), Nonzero (ON)
- ACK: RCD00
- Receive parameter: None

Function

Turns off the green LED when SP1 is 0 and turns it on when SP1 is 1. When this LED is on, it indicates that a microcassette drive is loaded, but not mounted, in the PINE cartridge space.

28) Send Internal-RAM Data to Main Unit

- Command code: 5BH
- Send parameter: None
- ACK: RCD00
 RCD02
 RCD04
- Receive parameters:
 RP1: Data 1
 RP2: Data 2
 .
 .
 RP32: Data 32

Function:

Transfers internal-RAM data to the main unit. The data length is fixed at 32 bytes.

For commands accepted during execution refer to (b) Monitor Command *1.

29) Write Data to Internal RAM

- Command code: 5CH
- Send parameters:
 SP1: Data 1
 SP2: Data 2
 .
 .
 SP32: Data 32
- ACK: RCD00
 RCD04 (Protocol error)
 RCD02 (Break)
- Receive parameter: None

Function:

Writes data into internal RAM. The data length is fixed at 32 bytes.

For commands accepted during execution refer to (b) Monitor Command *1.

30) Spare

- Command code: 5DH
- Send parameter: None
- ACK: RCD03
- Receive parameter: None

31) Spare

- Command code: 5EH
- Send parameter: None
- ACK: RCD03
- Receive parameter: None

32) Self Diagnosis

- Command code: 5FH
- Send parameter: None
- ACK: RCD00, RCD07, RCD08, RCD09
- Receive parameter: None

Function:

Performs self diagnosis on the microcassette drive by the following procedure:

1. Release the FF (Feed Forward enable) area.
2. Rewind tape to the tape start.
3. Reset the counter.
4. Turn on the green LED.
5. Set the FF area (30H).
6. Wait in the head-on/play mode until the drive stops.
7. Reset the FF area.
8. Turn off the green LED.
9. Feed tape forward by 200H counts.
10. Set the FF area (30H)
11. Wait in the head-on/erase mode until the drive stops.
12. Set the FF area (100H).
13. Write a block in the stop mode.
14. Set the FF area (100H).
15. Write a block in the stop mode.
16. Set the FF area (30H).
17. Wait in the head-on/erase mode until the drive stops.
18. Reset the FF area.
19. Rewind tape to the tape start.
20. Turn on the green LED.
21. Feed tape forward by 260H counts.
22. Set the FF area (30H).
23. Wait in the head-on/erase mode until the drive stops.
24. Reset the FF area.
25. Rewind tape to the tape start.
26. Reset the counter.
27. Flash the green LED on and off.

This command immediately returns an ACK when an error occurs.

Break processing

The PINE main unit can put the microcassette drive into the command mode by sending a break or cold start command to it.

A break command interrupts current command processing, and puts the microcassette drive into the command mode. A cold start command interrupts current command processing, and resets the microcassette drive and RAM to their initial settings. The actual content of break processing differs depending on the current microcassette drive status. Break processing in individual cases is described below.

1) Command mode

When receiving a break command in this mode, the microcassette drive returns an ACK and enters the command mode again. If the motor and head are on, the microcassette drive turns them off.

When receiving a cold start command in this mode, the microcassette drive returns an ACK and enters the command mode again. The microcassette drive and RAM are restored to their initial settings*.

2) During data reception ** (except during writes)

A break command received during data reception is invalid; the microcassette drive does not accept the subsequent data, but instead returns an ACK and enters the command mode. If the motor and head are on, the microcassette drive turns them off.

When receiving a cold start command during data reception, the microcassette drive returns an ACK and enters the command mode. The microcassette drive and RAM are restored to their initial settings.

3) During data transmission ** (except during reads)

When receiving a break command during data transmission, the microcassette drive does not transmit the subsequent data, but instead returns an ACK and enters the command mode.

When receiving a cold start command during data transmission, the microcassette drive returns an ACK and enters the command mode. The microcassette drive and RAM are restored to their initial settings. Since an ACK has already been sent, the main unit must read another ACK.

*: "Initial settings" refers to the following:

- Power, head, LEDs (green, red), capstan motor -- OFF
- FIFO -- Empty
- RAM data = ROM data
- Work area -- Cleared

** : "Transmission" and "reception" are from the viewpoint of the microcassette drive.

4) Between termination of command processing and transmission of an ACK

When receiving a break command in this state, the microcassette drive returns an ACK and enters the command mode. Any data to be transmitted is ignored. If the motor and head are on, the microcassette drive turns them off.

When receiving a cold start command in this state, the microcassette drive returns an ACK and enters the command mode again. The microcassette drive and RAM are restored to their initial settings.

5) During command processing

When receiving a break command, the microcassette drive operates differently depending on the command being currently executed.

- When the Fast feed n count, read, or write commands are in execution:

The microcassette drive terminates processing, returns an ACK, and enters the command mode. If the motor and head are on, it turns them off.

- When a command other than the above is in execution:

The microcassette drive terminates processing and accepts the break command (the subsequent operation is the same as described in 4) above.)

Note: After execution of a break command, the register contents are retained but FIFO is emptied.

5.1.5.4 System support

PINE OS supports the microcassette drive as a disk drive for read and write. See Section 3.7, "MTOS/MIOS Operations" for further information.

- Break processing

Upon receiving a request to terminate microcassette processing, PINE OS completes the current operation, and then interrupts processing by sending a break command to the microcassette drive.

Microcassette processing is interrupted when:

- The CTRL/STOP keys are pressed.
- The power switch is turned off or a power failure occurs.
- An alarm or wake condition occurs.

5.1.6 Cartridge Printer

5.1.6.1 Outline

The PINE cartridge printer is a mechanical dot printer which connects to the PINE main unit via the PINE cartridge interface. The cartridge printer employs an M-164 micro-dot printer, which can print 40 characters (6-by-8 font) per line. The cartridge printer is furnished with a print buffer of 2 K bytes (8 lines)

The cartridge printer runs in the HS mode. Its device code is 09H.

5.1.6.2 Structure

(1) Block diagram

Figure 5.1.9 shows the block diagram for the cartridge printer.

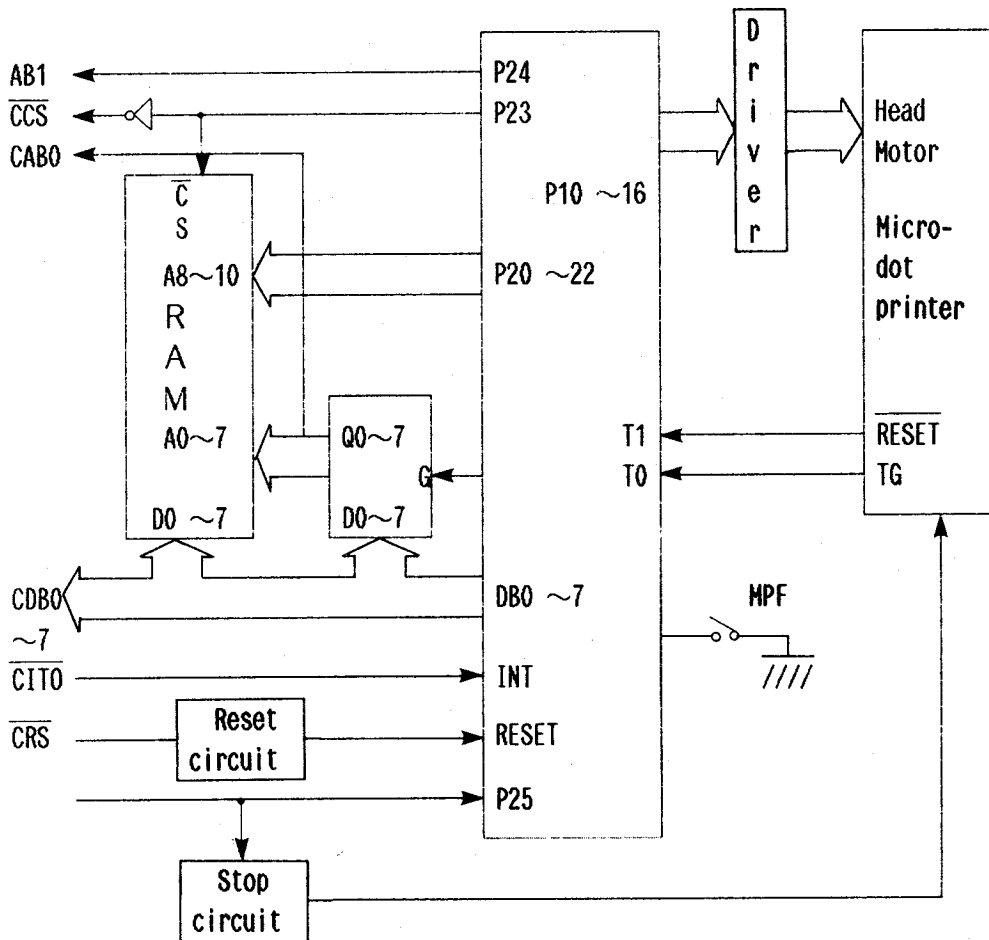


Fig. 5.1.9 Cartridge Printer Block Diagram

(2) Cartridge printer I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Flag state changed by	
Read	P10H	CHSIR	8bits data								IBF reset	
	P11H	CHSSR	Non used (access inhibited)						CAB1	IBF	OBF	
	P12H											
	P13H											
Write	P10H	CHSOR	8bits data								OBF set	
	P11H	CHSOR	8bits command								OBF set	
	P12H		Non used (access inhibited)									
	P13H											

CHSIR: Cartridge HS mode input register
 CHSSR: Cartridge HS mode status register
 (CAB1=0: Printer ready, CAB1=1: Printer busy)
 CHSOR: Cartridge HS mode output register

(3) Power supply

The cartridge printer draws power from the PINE main unit via a connector. To protect the main unit from heavy voltage fluctuations during printing, the cartridge printer is designed to stop immediately when the voltage drops below approximately 3.5 V. If the printer stops for this reason, it accepts nothing but an ID check or break command.

5.1.6.3 Use

The PINE main unit determines whether or not to send data to the printer by examining CAB1 (printer status flag).

Figure 5.1.10 shows the cartridge printer processing flow.

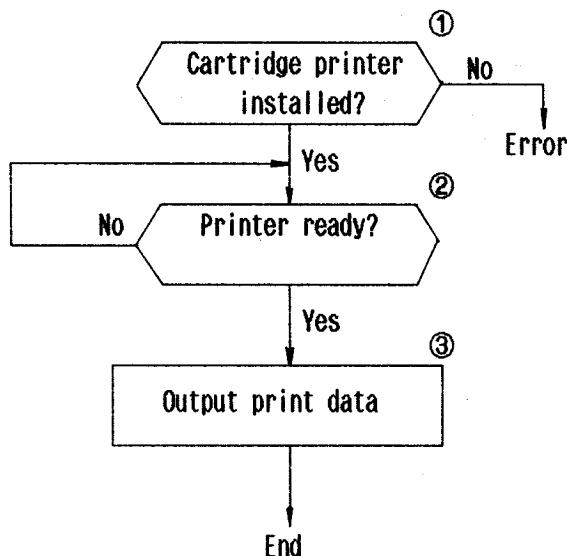


Fig. 5.1.10 Cartridge Printer Processing Flow

Step 1: Cartridge printer installed?

Check whether or not a cartridge printer is installed.
CRGDEV (0F53FH) indicates the presence or absence of a
cartridge printer.

CRGDEV = 49H: Cartridge printer installed.

= Other than 49H: No cartridge printer installed.

Step 2: Printer ready?

Determine whether or not the cartridge printer is ready by
examining bits 2 (CAB1) and 0 (OBF) of CHSSR (P11H).

CAB1 = 0: Ready

= 1: Busy

OBF = 0: Output buffer empty

= 1: Output buffer full

Output to the printer is allowed only when both CAB1 and OBF
are 0.

Step 3: Output print data.

Output print data to CHSOR (P10H).

5.1.6.4 System support

PINE OS supports the cartridge printer as a list output device using the BIOS LIST, LISTST, and SCRNDUMP functions. See Section 3.4, "BIOS Details" for individual functions.

(1) Break processing

Upon receiving a request to terminate cartridge printer processing, PINE OS immediately terminates processing by sending a break command to the cartridge printer.

Cartridge printer processing is terminated when:

- The CTRL/STOP keys are pressed.
- The power switch is turned off or a power failure occurs.

(2) Commands

The cartridge printer accepts ID check and break commands sent from the PINE main unit.

1) ID check (00H)

On receiving the command 00H from the main unit, the cartridge printer returns 00H as an ACK, followed by the device code 09H.

2) Break (0FH)

On receiving the command 0FH from the main unit, the cartridge printer returns 02H as an ACK and initializes all states except the universal character mode.

(3) Control codes

Table 5.1.11 lists the control codes for the cartridge printer.

Table 5.1.11 Printer Control Codes

Control code	Description
STX (02H)	Enable double height mode.
ETX (03H)	Disable double height mode.
BS (08H)	Back space.
LF (0AH)	Line feed.
CR (0DH)	Carriage return.
S0 (0EH)	Enable double width mode with auto reset.
DC4 (14H)	Disable double width mode with auto reset.
DEL (7FH)	Delete.
ESC (1BH)	Start ESC sequence.
ESC 1 (31H)	Set paper feed to 8 dots.
ESC 2 (32H)	Set paper feed to 10 dots.
ESC A+n (41H+n)	Set paper feed to n dots.
ESC R+n (52H+n)	Enable universal character mode.
ESC K+n1+n2 (4BH+n1+n2)	Specify single density bit image.
ESC W+0 (57H+0)	Disable double width mode.
ESC W+1 (57H+1)	Enable double width mode.

5.1.7 Modem/DMM Cartridge

5.1.7.1 Outline

The PINE modem cartridge is an optional modem unit which has the direct modem, acoustic coupler, and auto dialing functions, and allows communication through a handset.

The PINE DMM cartridge is an intelligent measuring unit incorporating the A/D conversion IC and 4-bit COMS CPU.

Since PINE OS supports neither modem nor DMM cartridge, they must be interfaced to the main unit through application programs. Both modem and DMM cartridges run in the IO mode. The device code of the modem cartridge is 0FH and that of the DMM cartridge is 0EH.

5.1.7.2 Modem cartridge

(1) Outline

The PINE Modem cartridge is an optional modem unit which has the direct modem, acoustic coupler, and auto dialing functions, and allows communication through a handset.

The modem cartridge has the following features:

(a) Modem communication function

Full-duplex communication (Bell 103) at speeds up to 300 bps is possible.

(b) Direct modem feature that allows direct connection to a telephone line

Acoustic coupler function is made available by connecting a speaker and microphone to the modem unit.

(c) Communication function

Audio communication using the optional handset is possible.

(d) Auto dialing and answering

Both pulse and tone dialing are possible. Auto answering is possible using a telephone-ring detection circuit.

(2) Structure

(a) Modem cartridge I/O address space

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	P10H	CIOR					0	CDB2	CDB1	CDB0	
	P11H	Non used (access inhibited)									
	P12H										
	P13H										
Write	P10H	Non used (access inhibited)									
	P11H										
	P12H										
	P13H										

CIOR: Cartridge IO-mode input register
 CDB2 = 0: Carrier detected from communication line
 1: Normal state
 CDB1 = 0: Indicates that data on CRXD is data received from
 the communication line.
 1: Indicates that data on CRXD is a return code.
 CDB0 = 0: Ring detected
 1: Normal state

The modem cartridge uses the following registers as well:

R/W	I/O address	Register name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Remarks
Read	P14H	ARTDIR	7 or 8 bit data								
	P16H		CAUD	CSEL							Bits 5-0 are used for other purposes.
Write	P14H	ARTDIR	7 or 8 bit data								
	P19H	IOCTLR						CRS			

ARTDIR: ART data input register
 Loaded with a return code received from the modem through RXD, or data received from the communication line.
 IOSTR: IO status register
 CAUD: Normally fixed at 0 or 1.
 Used when monitoring signals from the communication line. In such a case, a signal to or from the communication line, which is shaped into a TTL level square wave, is present at this terminal.
 CSEL: Always 1.
 ARTDOR: ART data output register
 Loaded with a command to the modem which is to be output to TXD, or data to the communication line.
 IOCTLR: IO control register
 CRS: Software reset signal sent from the main unit to the modem.

Note: When using ARTDIR or ARTDOR, the serial switch must be in the cartridge-SIO mode.

(b) Communication line interface

The communication line interfaces with the modem cartridge as shown in Figure 5.1.12.

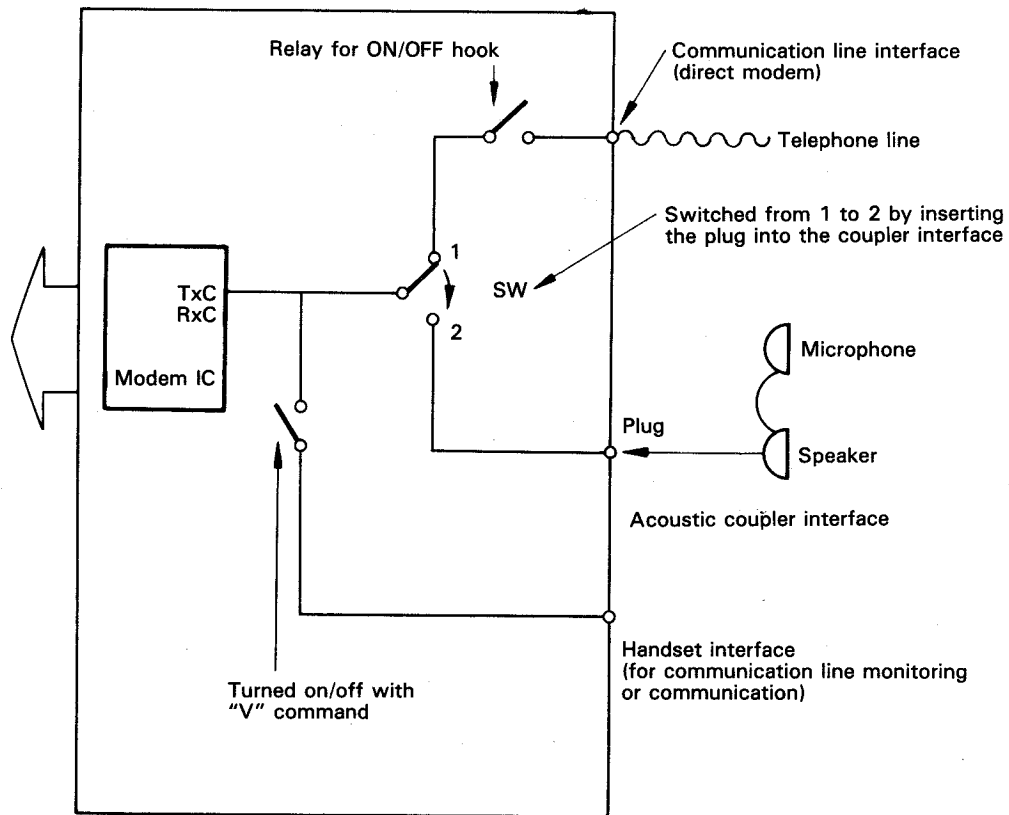


Fig. 5.1.10 Communication Line Interface

(3) Use
The modem cartridge can be processed using BIOS RSIOX as shown below.

(a) Modem open processing

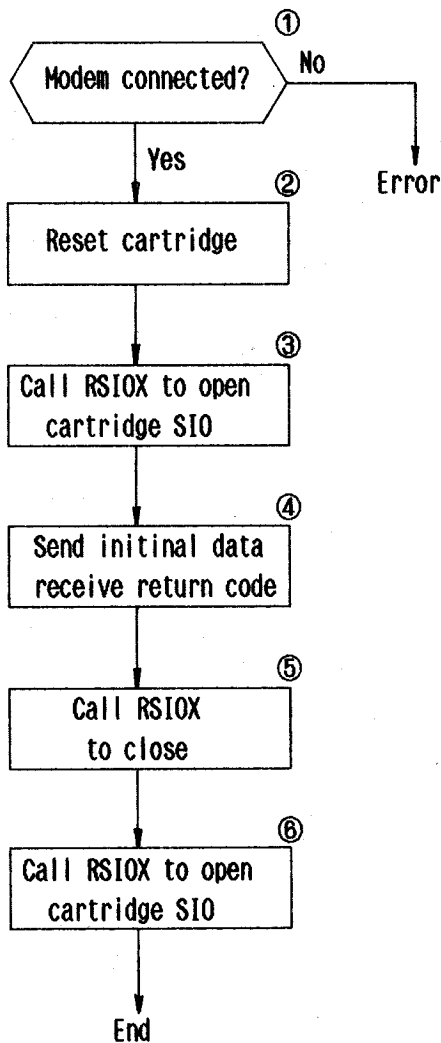
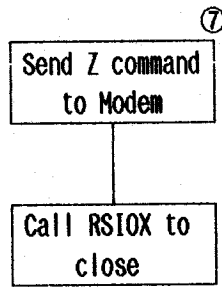


Fig. 5.1.13 Modem Open Processing

(b) Data transmission/reception processing
Transmission/reception processing of data, commands, and return codes are performed using the BIOS RSIOX GET or PUT command.

(c) Modem close processing



(d) Note

Communication via the modem is interrupted when a power-off condition occurs. That is, communication via the modem is not restored even if power is turned off in the continue mode and then turned on again (the modem remains in the halt state).

Step 1: Modem cartridge connected?

Check whether or not a modem is connected to the cartridge interface when using a modem. It can be checked with CRGDEV (0F53FH).

CRGDEV = 8FH: Modem cartridge connected.

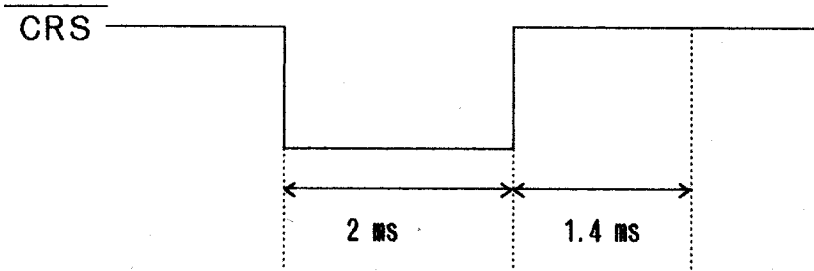
= Other than 8FH: Another type of cartridge connected.

Step 2: Reset cartridge.

Reset the modem to change it from the halt mode to the initial-data wait mode. It can be reset by the procedure below.

1) Set $\overline{\text{CRS}}$ to 0 and wait 2 ms.

2) Set $\overline{\text{CRS}}$ to 1 and wait 1.4 ms.



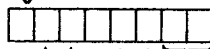
Step 3: Call RSIOX to open cartridge SIO.

Open cartridge SIO with BIOS RSIOX to send initial data to the modem. The open parameters are: cartridge SIO as I/O device, 300 bps, 8 bit data, no parity, 1 stop bit.

Step 4: Send initial data.

Send initial data to the modem using RSIOX PUT. Initial data is 1 byte in length and has the following format:

7 6 5 4 3 2 1 0



Parity = 00 : No parity

= 01 : Even

= 11 : Odd

Stop bits = 0 : 1 bit

= 1 : 2 bits

Data length = 0 : 7 bits

= 1 : 8 bits

Auto answering = 0 : ON

= 1 : OFF

Command character = 0 : '%'

= 1 : CTRL/N

Echo back = 0 : No

= 1 : Yes

Receive a return code using RSIOX GET. Normally, command character + '0' + 0DH is returned.

Step 5: Call RSIOX to close.

After receiving a return code normally, close the cartridge SIO using BIOS RSIOX.

Step 6: Call RSIOX to reopen.

Call RSIOX OPEN to transfer data between the modem and the communication line. Open parameters must be specified in the same communication format specified in the initial data that was sent to the modem in step 4. The communication speed is fixed at 300 bps. After the cartridge SIO is opened, communication with the modem through BIOS RSIOX commands is possible.

Step 7: Send Z command to modem.

When communication with the modem is completed, send character code + 'Z' + 0DH to the modem to put it into the halt state and save power. After this, the entire procedure must be followed again to communicate with the modem.

(4) Modem commands and return codes

The modem cartridge enters the active mode (operable mode) when modem open processing is completed. After the modem cartridge is activated, application programs can control it by sending it commands.

(a) Command character <CC>

A command character is always required at the beginning of a command line. Two types of command characters, '%' (25H) and CTRL/N (0EH), are provided by default. Which type is to be used in a given session is specified in the initial data.

A command character is also placed at the beginning of a return code to allow application programs to identify it as a return code instead of as receive data.

When processing a command character as send data, that character must be sent twice in succession. In this way, the receiver can recognize the second command character as send data.

(b) Command line

A command line begins with a command character and ends with a carriage return (0DH). It can contain more than one command provided that its entire length does not exceed 41 characters, including the command character and carriage return.

The following four characters are ignored in command lines:

'(' (28H)
)' (29H)
'-' (2DH)
' ' (Space) (20H)

The modem cartridge does not start execution of a command until the command line ends with a carriage return. When detecting an error in a command, the modem cartridge returns '6' to the main unit to signal a syntax error, and does not execute the commands that follow. Since commands in a command line are executed sequentially from the first one, valid commands preceding an invalid one are executed normally.

(c) Return codes

After termination of command execution, the modem cartridge sends a return code to the main unit.

A return code begins with a command character and ends with a carriage return, so that it can be distinguished from receive data. The format of the return code is as follows:

<CC> + One-digit number in ASCII code + CR

Table 5.1.14 shows the return codes and their meaning.

Table 5.1.14 Return Codes

ASCII code	HEX	Meaning
0	30H	Normal termination.
1	31H	Framing or parity error detected in input from the main unit.
2	32H	Carrier from the counterpart modem detected and communication established.
3	33H	Carrier from the counterpart turned off and the communication line disconnected (handset is ON HOOK.)
4	34H	No carrier from the counterpart was detected in the specified period of time after the communication line was established.
5	35H	Line busy.
6	36H	Syntax error detected in the command line.
7	37H	Command cancelled.
8	38H	Ring detected.

(d) Control codes

The modem cartridge uses the following three control codes:

CR (0DH): Carriage return. Used to identify the end of a command line or return code.

BS (08H): Back space. Used in command lines to make corrections.

CAN (18H): Cancel. Used to cancel command lines or terminate command execution.

(e) Commands

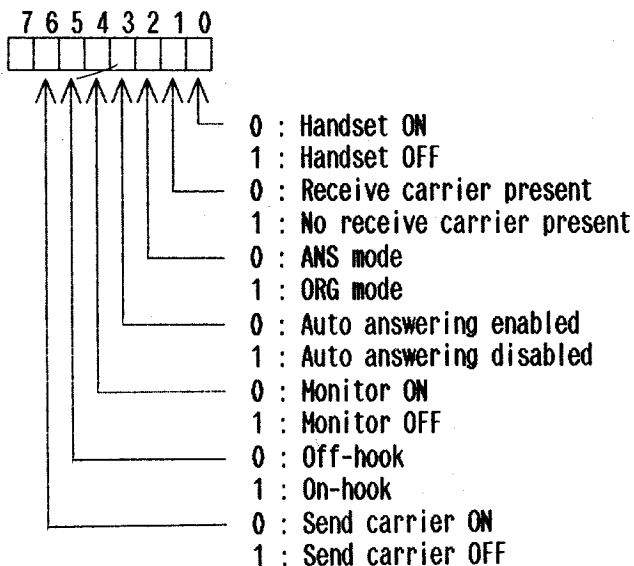
Commands for the modem cartridge are listed in Table 5.1.15. Commands and parameters in the table are specified with ASCII data.

Table 5.1.15 Commands

Command	Parameter	Function
A	None.	Connects the line in the ANS (auto answering) mode.
B	None.	Turns off the send carrier.
Cn	n = 0 or 1	n = 0: Send carrier at the space level frequency = 1: Send carrier at the mark level frequency
Ds	s = A combination of T, P, R, W, comma, 0 - 9, #, and *	Hooks off the handset and dials (auto dialing). T: Enable tone dialing. P: Enable pulse dialing. R: Switch between ORG and ANS modes. W: Dial two seconds after off-hook. Comma: Create dialing interval. 0 - 9, #, *: Phone number
Fh	h = Bit pattern whose lower-order four bits are significant	Sets up the data length, parity, and stop bits. Bit 0 = 0: No parity = 1: Parity 1 = 0: Even parity = 1: Odd parity 2 = 0: 1 stop bit = 1: 2 stop bits 3 = 0: 7-bit data = 1: 8-bit data
F?	None	Outputs the current data length, parity, and stop bit settings.
G	None	R-executes the previous command line.
H	None	Hooks on the handset.
Ln	n = 0 or 1	Makes an analog loop-back test. n = 0: Normal operation = 1: Analog loop-back test
Mn	n = 0 or 1	Controls the monitor. n = 0: Monitor OFF = 1: Monitor ON
Ns	s = character	Changes the command character. <CC>
O	None	Connects the line in the ORG mode.

Command	Parameter	Function
P	None	Enables pulse dialing.
R	None	Switches between ORG and ANS modes.
Sr=n	r = 0 - 3, n = 0 - 127	Rewrites the S registers. S0: Abort time (in seconds) S1: Time corresponding to the comma sent during dialing (in seconds) S2: Interval between carrier shut-off and line disconnection (in 0.1- second increments) S3: Number of rings after which the auto answering function is invoked
Sr?	r = 0 - 4	Outputs the S register contents. The contents of S0 through S4 are the same as those for Sr=n. See Note 1 for S4.
T	None	Enables tone dialing.
Vn	n = 0 or 1	Controls the handset. n = 0: Handset OFF = 1: Handset ON
Z	None	Pits the modem cartridge into the power save mode.

Note 1: The S4 register has the format shown below.



Note 2: The following code is returned for the Sr? and F? commands.

<CC> + '=' + status + CR

(5) Miscellaneous

The pages that follow give points to be noted when using the modem cartridge.

(a) Opening the modem

Open the modem by the procedure described in (3)-(a).

The modem enters the halt state when the master reset signal is input from the main unit (by power-on or reset). It exits from the halt state and waits for initial data when the modem reset signal (CRS) is input.

(b) Closing the modem

Close the modem by the procedure described in (3)-(c).

When modem processing ends, send the Z command to put the modem into the halt state. Hold the modem in the halt state when it is not being used, because it consumes less power in this state.

(c) How to call

1) Calling in the ORG mode

Example: %D123-4567<CR>



When this command line is executed, the modem dials the specified phone number and waits in the ORG mode for a carrier from the counterpart.

2) Calling in the ANS mode

Example: %DR987-6543<CR>

When this command line is executed, the modem dials the specified phone number and waits in the ANS mode for a carrier from the counterpart.

3) Sending 0 with pulse dial and then dialing a number with tone dial

Example: %DP0, T975-3124<CR>

4) Monitoring the time signal (In Japan)

Example: %M1D117W<CR>

M1 specifies that the monitor be set to ON.

5) After dialing, communicating first through the handset, and then through the modem

Example: %V1D52-2552W<CR> -- Dial after turning handset on.

%0<CR> ----- Return code for V command

%0<CR> ----- Return code for D command

(Communication through handset)

%0<CR> or %A<CR> --

%2<CR> ----- Detect the carrier from the counterpart.

(Communication)