HB-G900AP

SERVICE MANUAL

AEP Model
UK Model

See MP-F53W Service Manual separately issued for the information of disc drive built-in this set.

SPECIFICATIONS

CPU

Processor used	Z80A
Clock frequency	3.579545 MHz ±5% (GENLOCK ON) 3.579545 MHz (GENLOCK OFF)
WAIT	1 WAIT at CPU M1 cycle, V9938 access cycle
Interrupt	Maskable interrupt Z80A mode 1 interrupt enable
Resetting	Automatic at power on/Manual (Memory contents are not maintained.)

Memory

Main memory	512K bytes RAM
Video memory	128K bytes RAM
ROM	MSX2-BASIC: 48k bytes MSX-Disk BASIC: 16K bytes Video Utility: 16K bytes RS-232C: 14K bytes

CRT display

CRT controller	V9938
Display screen	Character display, graphic display, and border area
Character display	Screen 0: Max. 80 characters×24 lines 16 colors out of 512 colors (Initial state in MSX2-BASIC is set to this mode, 37 characters×24 lines) Screen 1: Max. 32 characters×24 lines 16 colors out of 512 colors
Graphic display	Screen 2: 256 (horizontal)×192 (vertical) dots 16 colors out of 512 colors Screen 3: 64×48 dots 16 colors out of 512 colors Screen 4: 256×192 dots 16 colors out of 512 colors Screen 5: 256×212 dots 16 colors out of 512 colors, 4 pages Screen 6: 512×212 dots 4 colors out of 512 colors, 4 pages Screen 7: 512×212 dots 16 colors out of 512 colors, 2 pages Screen 8: 256×212 dots 256 colors, 2 pages
Border area	16-color display

I/O interface

Keyboard	Separate keyboard Software scanning Total number of keys: 75 Control keys: 12 Function keys: 5 Edit keys: 8 Numeric keys: 16
RGB input/output	21-pin multi connector (see page 39)
Reference input	BNC connector 1 Vp-p, 75 ohms terminate, sync negative
Video interface	36-pin connector (See page 40)
Audio input	Phono jack Input impedance: more than 10K ohms
Audio output	Phono jack Output impedance: less than 1K ohms
Sound generator	8-octave, 3 tones and 1 noise output
Audio cassette interface	8-pin DIN jack Baud rate: 1200/2400 bps Remote control function provided
Printer interface	14-pin connector TTL level Standard 8-bit parallel transfer
RS-232C interface	25-pin connector RS-232C standards Baud rate: 75-19200 bps (selectable)
General purpose interface	9-pin connector (2) For connection of track ball, etc.
MSX cartridge slot	2

—Continued on page 2—

SAFETY-RELATED COMPONENT WARNING!!

COMPONENTS IDENTIFIED BY SHADING AND MARK ⚠ ON THE SCHEMATIC DIAGRAMS AND IN THE PARTS LIST ARE CRITICAL TO SAFE OPERATION. REPLACE THESE COMPONENTS WITH SONY PARTS WHOSE PART NUMBERS APPEAR AS SHOWN IN THIS MANUAL OR IN SUPPLEMENTS PUBLISHED BY SONY.

PERSONAL COMPUTER

SONY®

Part 1

HB-G900AP

Disk drive section

Disk used	3.5" micro floppydisk
Disk type	Double- or single-sided
Recording capacity (double-sided)	Unformatted: 1M bytes Formatted: 720K bytes Bytes/sector: 512 Sectors/track: 9 Tracks/cylinder: 2 Tracks/disk: 160 Bytes/disk: 720K
Recording density	8717 bits/inch
Track density	135 tracks/inch
Total no. of cylinders	80 cylinders
Total no. of tracks	160 tracks
Recording method	MFM (Modified-Frequency Modulation)
Disk rotation speed	300 rpm
Data transfer rate	250K bits/sec
Average latency time	100 msec
Access time	Average: 350 msec Between tracks: 12 msec Settling time: 30 msec

General

Power requirement	220 V–240 V AC ±10%, 50 Hz
Power consumption	35 W (main unit only)
Operating conditions	Temperature: 5°C to 35°C (41°F to 95°F) Humidity: 20 to 80%
Storage temperature	−15°C to +60°C (5°F to 140°F)
Dimensions	Main unit: Approx. 355×80×325 mm (w/h/d) (14×3¼×12⅞ inches) Keyboard: Approx. 405×30×180 mm (w/h/d) (16×1³⁄₁₆×7⅛ inches)
Weight	approx. 6.5 kg (14 lb 15 oz)
Accessories supplied	Graphic decals MSX-DOS/Character Font System, RAM Disk Utility and Font Disk (1) Operating Instructions (1) MSX-BASIC Version 2.0 Programming Reference Manual (1) Reference chart (1) Video Utility manual (1) RAM Disk Utility manual (1) A Guide to RS-232C Communication (1)

Note
This appliance conforms with EEC Directives 76/889 and 82/499 regarding interference suppression.

TABLE OF CONTENTS

SECTION 1
OPERATION

FEATURES

Computer of MSX Version 2.0
This computer is designed on the MSX standards Version 2.0, the powerful version of MSX, especially on graphics.
To display clear pictures, this computer is equipped with an analog RGB connector for a color monitor.
The built-in MSX-BASIC Version 2.0[1] has many commands, statements and functions which give the use of the features of the MSX Version 2.0.

Extended MSX2-BASIC commands for controlling a videodisc player (Video Utility)
The built-in MSX2-BASIC has extended commands which allow you to control a Sony LDP-180P or LDP-1500P videodisc player from the computer.

RAM Disk Utility Program
Using the RAM disk utility program, data can be recorded in the volatile dynamic RAM, allowing high-speed data transmission.

"Genlock" synchronization capability
This computer utilizes a circuit that allows GENLOCK synchronization of the computer video output with an external video signal. When the computer video signal is gen-locked to an external video signal, video and color synchronization problem do not occur, and the computer images can be overlayed (superimposed) onto the video images or these images can be switched. When this computer is used in conjuction with a Sony HBI-G900P Videotizer, the superimposed images can be recorded.

Built-in floppydisk drive
The built-in disk drive allows you to read or write data/programs on a 3.5-inch micro floppydisk, either single- or double-sided.
A Sony HBD-G900 micro floppydisk drive unit can be built in this computer as the second disk drive.

Resident RS-232C interface
This computer is equipped with an RS-232C interface connector which enables the communication between this computer and other apparatus. The built-in MSX2-BASIC also has extended commands for RS-232C communication.

1) In this manual, MSX-BASIC Version 2.0 is referred to as MSX2-BASIC.

SUPPLIED MANUALS AND A DISK

MANUALS

The following manuals are supplied with this computer. Please refer to the appropriate manuals according to your intended use of the computer.

Operating Instruction (this manual)
Provides a system outline and basic handling instructions. Please read this manual first.

MSX-BASIC Version 2.0 Programming Reference Manual
Provides a detailed explanation of each MSX2-BASIC command and gives program examples so that MSX2-BASIC can be fully utilized by the BASIC user.
Explanation of MSX-DOS is also included in this manual.

Reference Chart
All MSX2-BASIC commands are briefly explained. Please use this chart as a handy reference during daily programming.

Video Utility
Provides the usage and detailed explanation of the extended MSX2-BASIC commands which control a videodisc player.

A Guide to RS-232C Communication
Explains the RS-232C standards for communication between this computer and other apparatus and explains in detail the commands for communication.

RAM Disk Utility
Provides the usage and explanation of the RAM disk utility program.

DISK

MSX-DOS/Character Font System, RAM Disk Utility and Font Disk
MSX disk operating system, MSX-DOS, for use with the softwares to be commercially available in the future is included. For explanation of MSX-DOS and its commands, refer to the MSX-BASIC Version 2.0 Programming Reference Manual.
This disk also includes the character font files for the Video Utility built-in the computer, and the RAM disk utility program. Refer to the supplied Video Utility manual and RAM disk utility manual.

PRECAUTIONS

On safety

- Operate the unit on 220 V–240 V AC.
- Should any solid object or liquid fall into the cabinet, turn the power off and have the unit checked by qualified personnel before operating it any further.
- Unplug the unit from the wall outlet if it is not to be used for an extended period of time.
- Do not place or drop heavy objects on the power cord. Use of a damaged cord is dangerous. To disconnect the cord, pull it out by the plug—never pull the cord itself.
- The nameplate indicating operating voltage, power consumption, etc. is located on the bottom.
- The caution labels are located on the bottom of the unit.

On installation

- The computer consists of high-precision electronic parts. Do not drop it or bump it against other objects. Do not place it in a place subject to vibration or on an unstable bases.
- Do not install the unit near heat sources such as a radiator or an air duct, or in a place subject to direct sunlight, excessive dust, and/or moisture.
- Provide adequate air circulation to prevent internal heat build-up. Do not place the unit on surfaces (rugs, blankets) or near materials (curtains, draperies) that may block the ventilation slots.
- Use only the specified peripheral equipment; otherwise, trouble may result. Before connecting peripheral equipment, be sure to turn the power off or the internal IC chip may be damaged.
- Do not place an electric equipment which incorporates an electro-magnet, such as a TV set or a speaker, near this unit. If affected by an electromagnetic field, it may malfunction.
- Since the computer handles high-frequency signals, use of the computer near a radio, TV, audio tuner, etc., may cause noise in the operation of such equipment. In such cases, move the computer and the equipment in question away from each other.

On cleaning

- Clean the cabinet and keyboard with a soft, dry cloth, or a soft cloth lightly moistened with a mild detergent solution. Do not use any type of solvent, such as alcohol or benzine, which might damage the finish.

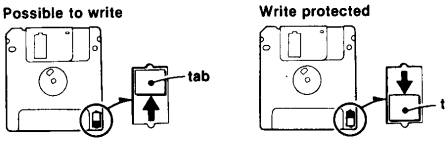
DISK CARE

Disk handling

- Use only 3.5-inch micro floppydisks, either single- or double-sided v an 80-track per side system. Manual-shutter type disks cannot be u
- Before using a new (unused) disk, be sure to "format" the disk to prepare it to store and read data by using a fixed format. See "FORMAT" command in the MSX-BASIC Version 2.0 Programming Reference Manual. Note that formatting of a disk erases all previou information stored on that disk.
- Never touch the exposed surface of the disk. Even minor dirt or du may adversely affect contact with the head or cause a disk read/wr error.
- Keep disks away from equipment with magnets, such as speakers amplifiers, because their magnets could cause erasure or dropouts stored data.
- Do not expose disks to direct sunlight, extremely cold temperature moisture.
- Protect disks from dust by storing them in their case or a box.

Write protect tab

- A write-protect tab is attached to the back of the disk to protect yc recorded information. Make sure that this tab is in upper position t record data on the disk. To prevent the loss of recorded data due t cidental erasure, slide the tab downwards as shown.



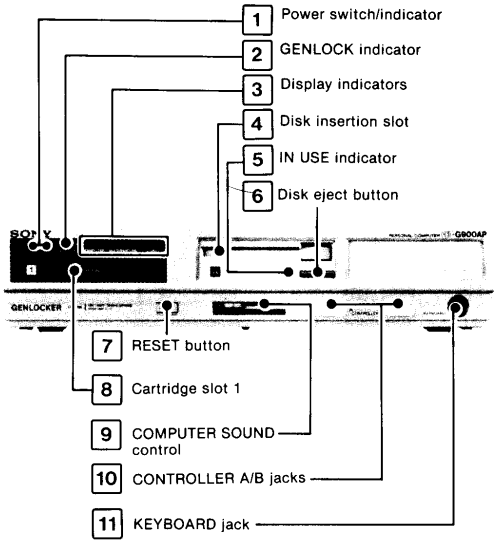
Label

- Use the specified labels.
- If there is no space to write on a label, peel the label off, and attac new label. Do not attach a new label over the old one, because the cumulative thickness may cause a read/write error or trouble with t micro floppydisk unit.

If trouble occurs, unplug the unit, and contact your designated Sony dealer.

PARTS IDENTIFICATION

Front panel



[1] Power switch/indicator
Press to turn on the power, and the indicator lights. Press again to turn off the power.

[2] GENLOCK indicator
This indicates the current genlock mode. It lights when the computer output is in the external synchronization mode and goes off when in the internal synchronization mode.

[3] Display indicators
These indicate the image(s) displayed on the color monitor connected to the computer. The image to be displayed is selected by specifying the "mode" parameter of the MSX2-BASIC SET VIDEO command.

COMPUTER:	Lights when the computer output is to be displayed. (When "mode" is 0.)
SUPERIMPOSE:	Lights when the computer output is superimposed over the external video signal. (When "mode" is 1 or 2. However, only the computer output is visible in mode 1.)
VIDEO:	Lights when the external video signal is to be displayed. (When "mode" is 3.)

For details, refer to "SUPERIMPOSE FUNCTION".

[4] Disk insertion slot
Insert a disk here.

[5] IN USE indicator
The indicator lights while data is being read or written on the disk. Do not turn off the power of the computer, press the RESET button or eject the disk while this indicator in on.

[6] Disk eject button
Press to eject a disk.

[7] RESET button
Press to reset the computer to the initial state. When the computer is reset, the contents of the built-in memory will be destroyed.

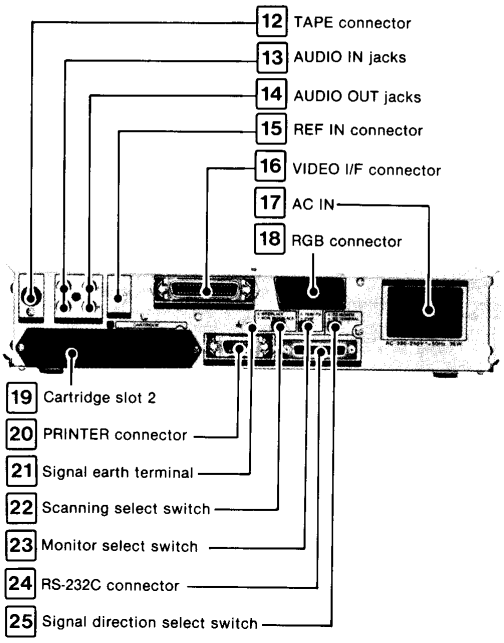
[8] Cartridge slot 1
Insert an MSX ROM, RAM or interface cartridge.

[9] COMPUTER SOUND control
Slide to adjust the volume of the computer sound.
The volume of the sound input from the AUDIO IN jacks [13] or RGB connector [18] and output from the AUDIO OUT jacks [14] and RGB connector is not changed using this control.

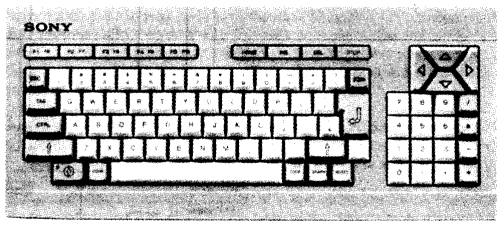
[10] CONTROLLER A/B jacks
Connect a trackball or a mouse.

[11] KEYBOARD jack
Connect the supplied keyboard.

Rear panel



Keyboard



Use to enter programs and data into the computer.

12 TAPE connector (8-pin DIN)
Connect to a tape recorder to save or load a program or data.

13 AUDIO IN jacks (phono)
Connect to the audio output of the external video equipment. The audio signal from these jacks can be mixed with the computer sound and can be output from the AUDIO OUT jacks 14 and the RGB connector 18 .

14 AUDIO OUT jacks (phono)
Connect to the audio input of the color monitor or audio equipment. The computer sound and/or the external audio sound is output through these jacks. The MSX2-BASIC SET VIDEO command selects the output sound signal.
When the computer's power is off, the sound from the AUDIO IN jacks will be output from these jacks.

15 REF IN connector (BNC)
Connect to the video output of the external video equipment. The computer's video output signal can be synchronized with the video signal input from this connector. The computer picture can be superimposed over the video picture of the signal input from this connector.

16 VIDEO I/F connector (36-pin)
Connect a Sony HBI-G900P Videotizer.

17 AC IN
Connect to a wall outlet using the supplied ac power cord.

18 RGB connector (21-pin)
Connect a color monitor equipped with a peri-TV connector (21-pin) or a Sony PVM monitor equipped with an RGB connector (25-pin).

19 Cartridge slot 2
Insert an MSX ROM, RAM or interface cartridge.

20 PRINTER connector (14-pin)
Connect an 8-bit parallel transfer printer of MSX specifications.

21 Signal earth terminal

22 Scanning select switch
This switch is effective only when the internal synchronization is selected by the MSX2-BASIC SET VIDEO command.
Depress and lock the switch (NON INTERLACE) to select noninterlace scanning.
Press again and release (INTERLACE) to select interlace scanning.
Normally, select interlace scanning mode. When the characters displayed on the screen is invisible, select non-interlace scanning.

23 Monitor select switch
Depress and lock the switch (PVM) when a Sony PVM monitor equipped with an RGB connector (25-pin) is connected.
Press again and release (PERI-TV) when a color monitor equipped with a peri-TV connector (21-pin) is connected.

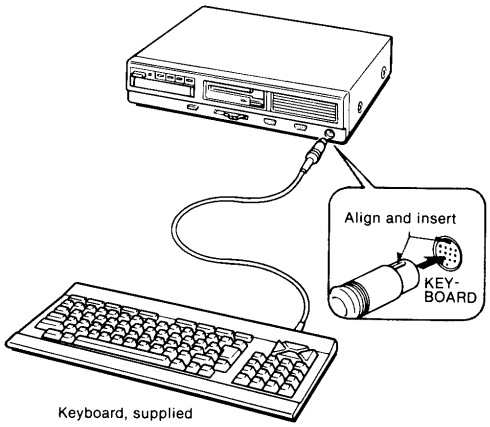
24 RS-232C connector (25-pin)
This connector is used for serial data communication with other computer systems or peripherals equipped with an RS-232C connector.

25 Signal direction select switch
Depress and lock the switch (TO TERMINAL) to connect to a terminal device (DTE) for RS-232C communications.
Press again and release (TO MODEM) to connect to a modem (DCE).

CONNECTIONS

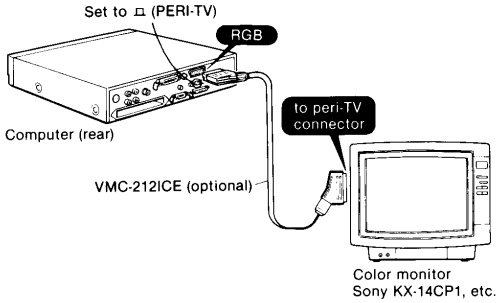
Before making connections, be sure to turn off the computer and all the devices to be connected.

CONNECTING THE KEYBOARD

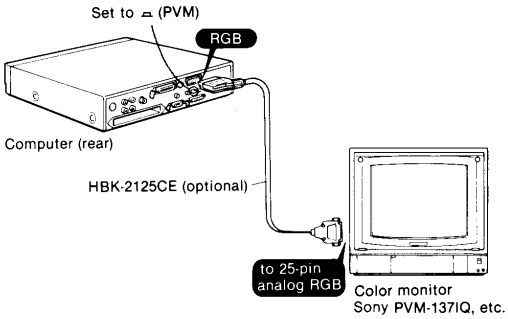


CONNECTING A COLOR MONITOR

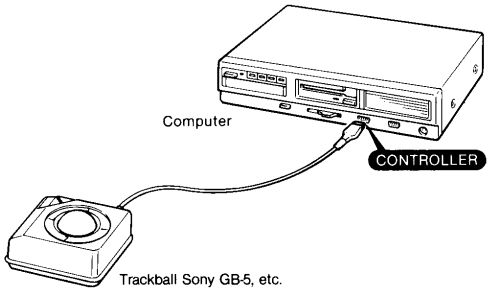
To connect a color monitor equipped with a peri-TV connector (21-pin)



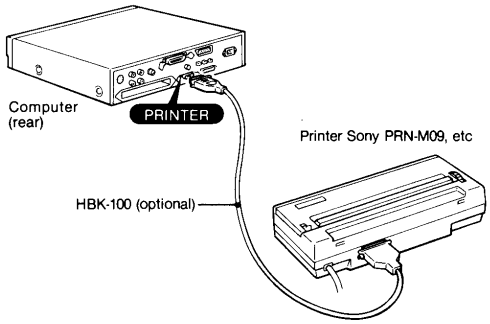
To connect a Sony PVM color monitor equipped with an RGB connector (25-pin)



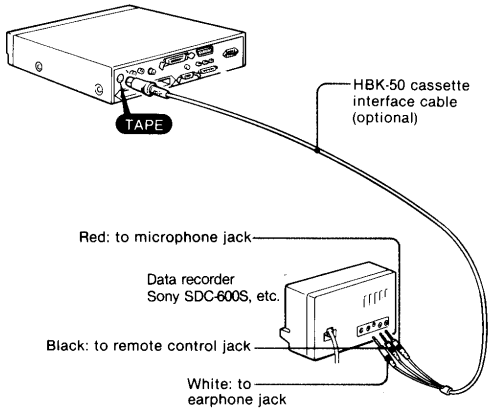
CONNECTING A TRACKBALL OR A MOUSE



CONNECTING A PRINTER



CONNECTING A TAPE RECORDER FOR USE AS AN EXTERNAL MEMORY

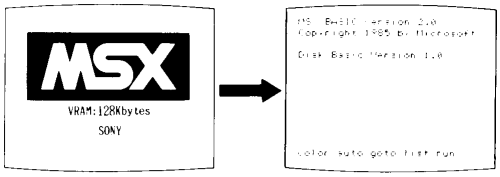


• If the recorder does not have a remote control jack, leave the black play unconnected.

HOW TO START UP

TO START MSX-DISK BASIC

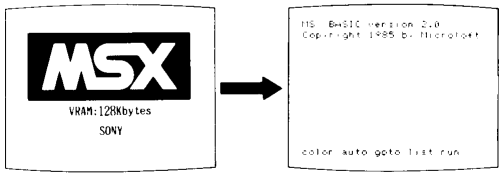
1 Remove any program cartridges and floppydisks from the cartridge and disk slots.
2 Turn on the color monitor and computer.



The computer enters the MSX-Disk BASIC command state.
You can now enter BASIC program or use commercially available BASIC programs.
MSX-Disk BASIC includes all MSX2-BASIC commands and the commands which allow you to make use of floppydisks at the same time.
You can also use the extended commands for controlling a videodisc player (Video Utility) and for RS-232C communication.
When programming your own BASIC program, refer to the "MSX-BASIC Version 2.0 Programming Reference Manual". For the video utility commands, refer to the Video Utility manual supplied. For RS-232C communication, refer to "A Guide to RS-232C Communication". When using the RAM Disk Utility Program, refer to the RAM Disk Utility manual supplied. When using commercially available BASIC programs, refer to the manual supplied with the program.

- Some commercially available BASIC programs may not be used with the MSX-Disk BASIC. It can only be used with the MSX2-BASIC. To start the MSX2-BASIC:

1 Remove any program cartridges or floppydisks from the cartridge and disk slots.
2 Turn on the color monitor.
3 While pressing the ⇧ key, turn on the computer. Keep pressing the ⇧ key until the following screen is displayed.



Now the MSX2-BASIC is started. The MSX2-BASIC does not have the commands which allow you to make use of floppydisks.

TO START PROGRAMS IN A FLOPPYDISK

1 Remove any program cartridges from the cartridge slots.
2 Insert the floppydisk into the disk insertion slot.
3 Turn on the color monitor and computer.

For details about starting and using the program, refer to the instruction manual of the program.

Do not remove the disk, press the RESET button, or turn the power switch off while the IN USE indicator is on. The contents of the disk may be destroyed.

TO START PROGRAMS IN AN MSX CARTRIDGE

1 Remove any program disks from the disk insertion slots.
2 Insert the cartridge into a cartridge slot. When cartridge slot 1 (front) is used, insert the cartridge with the label facing downwards. When the cartridge slot 2 (rear) is used, insert with the label facing upward.
3 Turn on the color monitor and computer.

The program will start. If cartridges are inserted both in the slots 1 and 2, the program in the cartridge in the slot 1 will start.
For details about starting and using the program, refer to the instruction manual of the program.

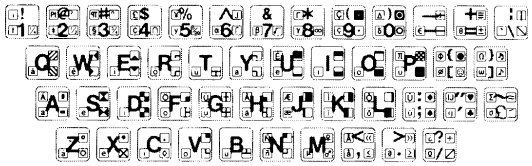
Do not insert or remove the cartridge while the computer's power is on.

THE COMPUTER DOES NOT START UP

If the display below appears, you must enter a password. The system will not start up until you have entered the correct password.

If you have forgotten the password, you can start the system by holding down the GRAPH and the STOP keys and pressing the RESET button until the display changes.

KEYBOARD



To enter a graphic character or symbol
The following graphic characters and symbols can be entered.

CHARACTER INPUT

To enter characters (Normal mode)

Character to be entered	Key(s) to press	Example	
		Character	Key(s)
Capital letter	[⇧] + Alphabet key	A	[⇧] + [A]
Small letter	Alphabet key	a	[A]
Symbol on the upper part of keytop	[⇧] + Key	"	[⇧] + [2]
Symbol on the lower part of keytop	Key	'	[7]

"Key 1 + Key 2" in the table indicates pressing Key 2 while pressing Key 1.

To enter capital letters continuously
Press the Ⓒ key to light up the indicator on the key. In this mode (cap lock mode), capital letters will be entered by pressing the alphabet keys. Numbers and symbols will be entered in the same way as in the normal mode. To return to the normal mode, press the Ⓒ key to turn off the indicator.

To put an accent mark on a character
Key [:] is used to put an accent mark on a character.

1 Enter an accent mark.
To enter `, press [:].
To enter ´, press [⇧] + [:].
To enter ^, press [CODE] + [:].
To enter ¨, press [CODE] + [⇧] + [:].

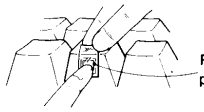
2 Press the key for the letter needing the accent mark.

To enter δ, Δ, ○ and ●, for example,

δ	[CODE] + [↓]
Δ	[CODE] + [⇧] + [↓]
○	[GRAPH] + [↓]
●	[GRAPH] + [⇧] + [↓]

Graphic pattern decals

Graphic pattern decals are supplied for your convenience when entering graphic patterns. Place the decal on the front of the corresponding key. Rub the decal and peel the backing sheet off.



Rub the pattern and peel the sheet off.

NUMERIC KEYS

The numeric keys are located to the right of the keyboad. The characters on the numeric keys can be entered whether the Ⓒ or [⇧] key is pressed or not.

Note
When some commericially available programs are applied, the numeric keys cannot be used. In this case, use the number input keys on the left of the keyboard to enter numbers.

HOW TO SET THE CALENDAR-CLOCK

A calendar clock is incorporated in the HB-G900AP, which is backed up by a nickel-cadmium battery so that the contents of the calendar-clock will not be erased, even when the power switch is turned off.

TO SET THE DATE

1 Start up MSX-Disk BASIC, referring to page 8.
2 Enter **SET DATE "DD/MM/YY"** from the keyboard.
DD is a 2-digit day number, MM a 2-digit month number, and YY a 2-digit year number.
For example, to set 10th January, 1986, you must type **SET DATE "10/01/87"** on the keyboard.
3 Press the ⏎ key.
The date will be set.

TO SET THE TIME

1 Start up MSX-Disk BASIC, referring to page 8.
2 Enter **SET TIME "HH:MM:SS"** from the keyboard.
HH is a 2-digit hour number (24-cycle), MM a 2-digit minute number, and SS a 2-digit second number.
For example, to set 2:30 pm and 00 seconds, you must type **SET TIME "14:30:00"** on the keyboard.
3 Press the ⏎ key.
The time will be set and the clock will start.

If you make a mistake while setting the calendar-clock
If you have not pressed the ⏎ key, correct the required part with the INS or DEL key.
If you have already pressed the ⏎ key, start from step 1 again.

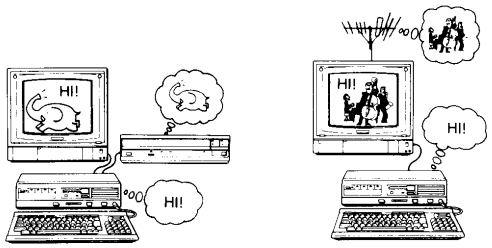
LIFE OF THE BACK-UP BATTERY

The nickel-cadmium battery inside the computer is charged while the computer's power is on. After the computer's power is on for 8 hours, the battery will last for 1 week when the power is turned off. A fully charged battery will last for approximately 2 months.
When the battery becomes weak, the calendar-clock will not operate properly and the contents of the memory switch function (such as those set by the title and prompt statements, screen statement, beep statement) will be erased. Therefore, when the computer is used for the first time or, if it has not been operated for a long time, the battery may be weak and/or the memory switch function may not operate properly. It is recommended that the HB-G900AP be turned on from time to time to recharge the battery.

SUPERIMPOSE FUNCTION

With this computer, the computer picture can be superimposed over the video picture from external sources.

Two types of color monitors, a monitor equipped with a peri-TV connector (21-pin) or a Sony PVM monitor equipped with an RGB connector (25-pin), can be used for superimposing. When a monitor with a peri-TV connector is used, the computer picture can be superimposed over the picture of the external video equipment connected to the REF IN connector, or can be superimposed over the picture received by the tuner built-in the monitor TV.
When a Sony PVM monitor is used, the computer picture can be superimposed only over the picture of the external video equipment connected to the computer's REF IN connector.



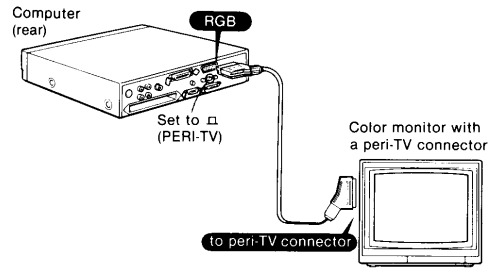
The picture to be displayed can be selected computer picture only, video picture only or superimposed picture, by executing an MSX2-BASIC SET VIDEO command.

When the Sony HBI-G900P Videotizer (optional) is used with this computer, the superimposed picture can be recorded on a video cassette recorder. For details about use with the Videotizer, refer to the Videotizer's manual.

TO SUPERIMPOSE THE COMPUTER PICTURE OVER THE PICTURE RECEIVED BY THE TUNER BUILT-IN THE MONITOR

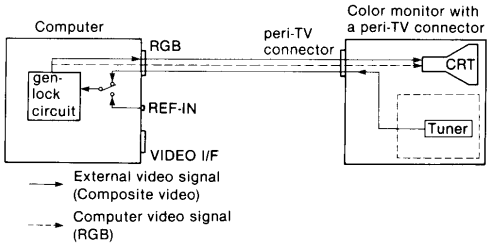
When a color monitor with a peri-TV connector (21-pin) is used (System 1)

Connection



Video signal flow of this system

In this system, the video signal received by the tuner built-in the monitor will be input to the computer through the RGB connector.
The computer video signal will be gen-locked with this video signal and will be output from the RGB connector.
The picture of the computer will be superimposed over the picture of the video signal received by the tuner in the monitor.



Selecting of the display

The picture to be displayed on the monitor screen will be selected by executing the MSX2-BASIC SET VIDEO command as follows:

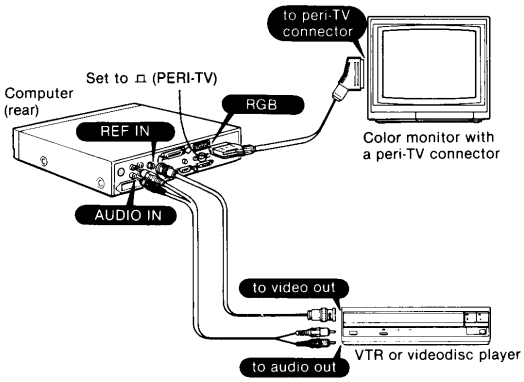
Picture to be displayed	Statement to be executed
Computer	SET VIDEO 0,0,0,0,*,0,1 (internal sync)
	SET VIDEO 1,0,0,1,*,0,1 (external sync)
Superimposed Video	SET VIDEO 2,0,0,1,*,0,1
	SET VIDEO 3,0,0,1,*,0,1

• Refer to page 12.
• * is the parameter to select the audio output

TO SUPERIMPOSE THE COMPUTER PICTURE OVER THE EXTERNAL VIDEO PICTURE

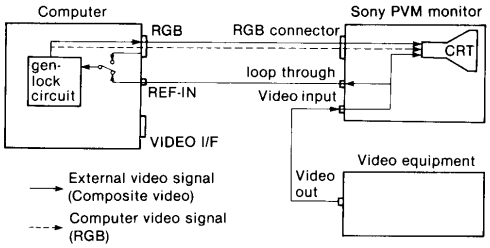
When a color monitor with a peri-TV connector (21-pin) is used (System 2)

Connection



Video signal flow of this system

In this system, the video signal from the external video equipment will be input to the computer through the REF IN connector.
The computer video signal will be gen-locked with this video signal.
The computer video signal and the video signal from the external video equipment will be output from the RGB connector.
The picture of the computer will be superimposed over the picture of the external video equipment in the monitor.



Selecting of the display

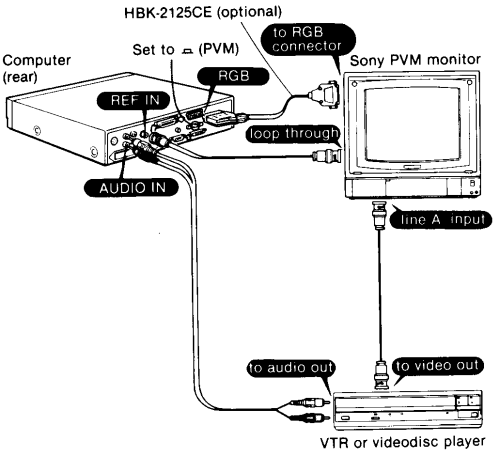
The picture to be displayed on the monitor screen will be selected by executing the MSX2-BASIC SET VIDEO command as follows:

Picture to be displayed	Statement to be executed
Computer	SET VIDEO 0,0,0,0,*,1,1 (internal sync)
	SET VIDEO 1,0,0,1,*,1,1 (external sync)
Superimposed Video	SET VIDEO 2,0,0,1,*,1,1
	SET VIDEO 3,0,0,1,*,1,0

• Refer to page 12.
• * is the parameter to select the audio output.

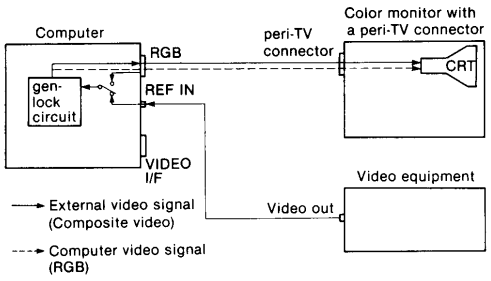
When a Sony PVM color monitor with an RGB connector (25-pin) is used (System 3)

Connection



Video signal flow of this system

In this system, the video signal from the external video equipment will be input to the computer through the REF IN connector.
The computer video signal will be gen-locked with this video signal.
The computer video signal and the video signal from the external video equipment will be output from the RGB connector. The picture of the computer will be superimposed over the picture of the external video equipment in the monitor.



Selecting of the display

The picture to be displayed on the monitor screen will be selected by executing the MSX2-BASIC SET VIDEO command as follows:

Picture to be displayed	Statement to be executed
Computer	SET VIDEO 0,0,0,0,*,1,1 (internal sync)
	SET VIDEO 1,0,0,1,*,1,1 (external sync)
Superimposed Video	SET VIDEO 2,0,0,1,*,1,1
	SET VIDEO 3,0,0,1,*,1,1

• * is the parameter to select the audio output.

SELECTING OF THE PICTURE TO BE DISPLAYED —SET VIDEO COMMAND—

Parameter / Function / System	Mode: Picture to be displayed is:	YM: No function	CB: VDP color bus stale is:	Sync: Computer's video output is gen-locked with:
1 page 11	0: Computer 1: Computer 2: Superimposed 3: Picture of the video signal received by the tuner			0: Internal 1: Video signal connected to RGB (video signal received by the tuner.)
2 page 11	0: Computer 1: Computer 2: Superimposed 3: Picture of the video equipment connected to REF IN		0: Output state	0: Internal 1: Video signal connected to REF IN
3 page 12				

Information on specifying "mode"

When "0" is to be specified as "mode" (mode 0), select the internal sync by specifying "0" as "Sync".
When the mode 1, 2 or 3 is specified, select the external sync by specifying "1" as "Sync". The computer's video output signal will be gen-locked with the external video signal selected by "video input".

When mode 2 is specified, the picture of the computer is superimposed over the picture of the external video signal and the SUPERIMPOSE

SET VIDEO [mode],[YM],[CB],[sync],[sound],[video input],[AV control]

Sound	Video input	AV control
Audio output from RGB and AUDIO OUT is:	Video signal input to the computer is:	
0: Computer 1: Audio from audio R input of RGB is mixed with computer sound. 2: Audio from audio input of RGB is mixed. 3: Audio from audio R and L input of RGB is mixed.	0: Video signal input from RGB	1
0: Computer 1: Audio from AUDIO R IN (phono) is mixed with computer sound 2: Audio from AUDIO L IN (phono) is mixed with computer sound. 3: Audio from AUDIO R and L IN(phono) is mixed with computer sound.	1: Video signal input from REF IN	0: Specify when only the picture of the external video equipment is to be displayed. "mode" can be any value. 1 Specify when "mode"is 0, 1 or 2.

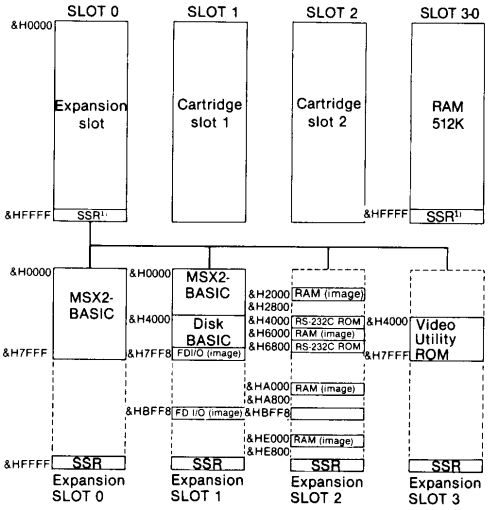
indicator on the front of the computer lights.
When mode 1 is specified, the picture of the computer is superimposed over the picture of the external video signal and the SUPERIMPOSE indicator on the front of the computer lights. However, the picture of the external video signal is invisible and only the computer's picture can be seen. In mode 1, the computer's video output is gen-locked with the external video signal. Therefore, the displayed picture can smoothly be switched to the superimposed picture or the picture of the external video signal.

SAMPLE PROGRAM

The following is the sample program for the system 2 (page 11).
By executing this program, red, green and blue boxes are drawn and the picture on the screen will then be selected.

```
10 REM ============================================
20 REM          SAMPLE-PROGRAM for HB-G900AP
30 REM                  : RGB-BOX
40 REM                  : MODE-SELECT
50 REM ============================================
60 '
70 SCREEN 5:COLOR ,0,0
80 SET VIDEO 0,,,0,,1,1
90 '
100 '-------------------------------------------------
110 '       DRAW RGB-BOX
120 '-------------------------------------------------
130 LINE (  0,  0)-(255,211),0,BF
140 LINE ( 80,  50)-(130,100),8,BF
150 LINE (105,  75)-(155,125),2,BF
160 LINE (130,100)-(180,150),4,BF
170 '
180 '-------------------------------------------------
190 '       MODE-SELECT
200 '           0 : COMPUTER MODE
210 '           1 : SUPER MODE ( TRANSPARENT = COMPUTER )
220 '           2 : SUPER MODE ( TRANSPARENT = VIDEO )
230 '           3 : EXT-VIDEO MODE
240 '-------------------------------------------------
250 '
260 A$=INKEY$:IF A$="" THEN GOTO 260
270 '
280 IF A$="0" THEN SET VIDEO 0,,,0,,1,1
290 '
300 IF A$="1" THEN SET VIDEO 1,,,1,,1,1
310 '
320 IF A$="2" THEN SET VIDEO 2,,,1,,1,1
330 '
340 IF A$="3" THEN SET VIDEO 3,,,1,,1,1
350 '
360 GOTO 260
```

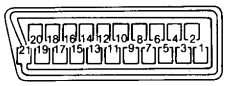
MEMORY MAP



The capacity of the free area (RAM capacity excluding the system area) can be checked by the FRE function.

1) SSR: Slot Select Register

Pin assignment



RGB

Pin No.	Signal	Signal level	Impedance
1	Audio (R) output	nominal: 0.5 V maximum: 2 V	less than 1 K ohm
2	Audio (R) input	nominal: 0.5 V maximum: 2 V	more than 10 K ohms
3	Audio (L) output	nominal: 0.5 V maximum: 2 V	less than 1 K ohm
4	Audio common return		
5	Blue return		
6	Audio (L) input	nominal: 0.5 V minimum: 0.2 V maximum: 2 V	more than 10 K ohms
7	Blue input/output	0.7 Vp-p	75 ohms
8	Function switching[1]	logical "0": 0.2 V logical "1": 9.5 V-12 V	
9	Green return		
10	—		
11	Green output	0.7 Vp-p	75 ohms
12	—		
13	Red return		
14	Intercommunication data line common return		
15	Red output	0.7 Vp-p	75 ohms
16	Blanking output[1]	logical "0": 0-0.4 V logical "1": 1-3 V	75 ohms
17	Video return		
18	Blanking return		
19	Video output[2]	1 Vp-p (composite video)	75 ohms
20	Video input	1 Vp-p (composite video)	75 ohms
21	Common return		

1) When a PVM monitor is connected, the signal level will be:
logical "0": 0 V
logical "1": 5 V
2) When a PVM monitor is connected, the signal level will be: 1 Vp-p (composite sync)

VIDEO I/F

Pin No.	Signal	Signal level
1	Video input	1.0 Vp-p, 75 ohm term.
2	Video output	1.0 Vp-p, 75 ohm term.
3	R	0.7 Vp-p, 75 ohm term.
4	G	0.7 Vp-p, 75 ohm term.
5	B	0.7 Vp-p, 75 ohm term.
6	Ys	TTL
7	Ym	No-connect
8	SYNC	TTL
9	BF	TTL
10	SYM0	TTL
11	VIDEO/NO VIDEO	TTL
12	C0 (B1)	TTL
13	C2 (R0)	TTL
14	C4 (R2)	TTL
15	C6 (G1)	TTL
16	RCA/21 pin	TTL
17	SC	TTL
18	DLCLK	TTL
19	GND	
20	GND	
21	GND	
22	GND	
23	GND	
24	GND	
25	Computer sync	TTL
26	ALT	TTL
27	BLK	TTL
28	SYM1	TTL
29	GND	
30	C1 (B2)	TTL
31	C3 (R1)	TTL
32	C5 (G0)	TTL
33	C7 (G2)	TTL
34	GND	
35	GND	
36	GND	

MSX-BASIC Version 2.0

REFERENCE CHART

COMMANDS AND STATEMENTS

COMMANDS FOR PROGRAMMING

format	function	example
AUTO [starting line number] [, increment]	Generate line numbers automatically.	AUTO 100, 10
DELETE [line number] [- line number]	Delete lines in a program.	DELETE 30-60
LIST [starting line number] [-] [end line number]	Display program list.	LIST
NEW	Erase program.	
RENUM [new starting line number], [old starting line number], [increment]	Renumber lines.	RENUM 100, 10, 10
REM or '	Insert a comment.	REM---PROGRAM 1---
KEY LIST	Display the function key contents.	

COMMANDS FOR DEFINITION AND SETTING

format	function	example
CLEAR [size of character area] [, highest address]	Initialize all variables and set the size of the character string area and the highest memory to be used by BASIC.	CLEAR 400, 55296
DIM variable name (maximum value of a subscript [, maximum value of a subscript] ...) [, variable name ( ), ...]	Declare the name, type, size and dimension of array.	DIM A$ (100)
DEF {INT / SNG / DBL / STR} character [- character] [, character [- character]] ...	Define matching between the first character of a variable name and the type of variable. (INT: integer, SNG: single precision, DBL: double precision, STR: string)	DEFINT I-N
DEF FN function name [(parameter [, parameter] ...)] =expression	Define user functions.	DEF FNA (X)=A * X^ 2+B * X+C
ERASE [array variable name] [, array variable name] ...	Erase arrays	ERASE A, B, C
KEY function key number, character string	Define strings for function keys.	KEY 1, "LLIST"+CHR$ (13)
SET VIDEO [mode], [brightness], [color bus], [sync], [sound], [video input], [AV control]	Specify superimposing and other modes. (used only with computers that have the superimpose function) Mode 0: computer signal (internal sync only) 1: computer signal 2: superimpose 3: TV signal Brightness 0: normal brightness 1: half-brightness Color Bus 0: VDP color bus input 1: VDP color bus output Simultaneous 0: internal sync 1: external sync Sound 0: external sound signal not mixed 1: right channel external sound signal mixed 2: left channel external sound signal mixed 3: both channels external sound signal mixed Video Input 0: select RGB multiconnector input 1: select external video input connector input AV Control 0: TV signal 1: External video	SET VIDEO 2

MEMORY SWITCH FUNCTION COMMANDS

format	function	example
SET ADJUST (X, Y)	Change the location of the display on the screen	SET ADJUST (-4, 3)
SET BEEP [sound], [volume]	Select the BEEP sound.	SET BEEP 2, 3
SET TITLE ["title"], [color]	Set the title to be displayed on the initial screen display.	SET TITLE "SONY"
SET PROMPT "prompt"	Set the prompt statement to be displayed when BASIC is in a command-wait status.	SET PROMPT "Ready"
SET PASSWORD "password"	Set the system password.	SET PASSWORD "BASIC"
SET SCREEN	Set the current SCREEN values as the initial start-up values.	

COMMANDS FOR DATA INPUT/OUTPUT

format	function	example
DATA constant [, constant] [, constant] ...	Give data to be read with a READ statement.	DATA 3, 4, 5, 6, ABC, "C, D"
INPUT ["prompt statement";] variable [, variable] [, variable] ...	Give value of variable from the keyboard.	INPUT "A$=";A$
LINE INPUT ["prompt statement";] variable	Give string of up to 254 characters from the keyboard to the string type variable	LINE INPUT "C$=";C$
[LET] variable=x	Assign data to the variable.	LET A=A+5
MID$ (X$, M[, N])	Replace characters beginning with the Mth character of the string X$ with characters from the beginning to Nth character of Y$.	MID$ (A$, 2, 5)=B$
PRINT [expression] [separator] [expression] [separator] ... or ? [expression] [separator] [expression] [separator] ...	Output data onto display screen. A separator is a semi-colon (;), a comma (,) or a space.	PRINT A;B;C
PRINT USING format symbol; expression [, expression] ...	Output data onto display screen in the specified format. Format symbols: "!" Output the first character. "\n spaces \" Outputs n+2 characters. "&" Output the entire string. "#" Specify the number of display digits of the numeric data. "+" Add + or - before (after) numeric data. "-" Add - after negative numeric data. "**" Fill space befor numeric data with *. "$$" Put $ in front of numeric data. "**$" Put $ in front of numeric data and fill space in front of it with *. "," Put, after every third digit to the left of the decimal point. "^^^^" Output with floating decimal points.	10 A$="ABCDEFG" 20 PRINT USING "!";A$ 30 PRINT USING "\ \";A$ 40 PRINT USING "SSS&TTT";A$ PRINT USING "###.##";123.45,10.5 PRINT USING "+###";100,-200 PRINT USING "###-";100,-200 PRINT USING "****##";100,-200 PRINT USING "$$###";100,-200 PRINT USING "**$###";10,-20 PRINT USING "#####,##";1234.56 PRINT USING "#.####^^^^";123.98
READ variable [, variable] [, variable] ...	Read data in DATA statement.	READ A%
RESTORE [line number]	Specify the DATA statement to be read with a READ statement executed next.	RESTORE100
SWAP variable, variable	Exchange values of two variables.	SWAP A,B

COMMANDS FOR CONTROLLING PROGRAM EXECUTION AND FLOW

format	function	example
RUN [line number]	Start program execution.	RUN 100
💾 RUN "[drive name] file name [, type name]" [, R]	Load program and execute it	RUN "PROG.BAS"
STOP	Interrupt program execution.	
CONT	Restart program execution.	
END	Terminate program execution.	
TRON	Display line number that was executed.	
TROFF	Cancel TRON.	
FOR variable=initial value TO end value [STEP increment] NEXT [variable]	Repeat the program execution between FOR and NEXT.	FOR I=1 TO 10 STEP 2 NEXT I
GOSUB line number RETURN [line number]	Transfer control to the specified subroutine. Return to the main routine with RETURN.	100 GOSUB 1000 1000 1100 RETURN
GOTO line number	Transfer control to the specified line.	GOTO 100
IF expression {THEN {statement / line number} / GOTO line number} [ELSE {statement / line number}]	Branch control according to the expression value.	IF X=0 THEN 100 ELSE 200
ON expression GOTO line number [, line number] ...	Branch control according to the expression value.	ON A GOTO 100, 200, 300
ON expression GOSUB line number [, line number] ...	Branch control according to the expression value.	ON SGN (A)+2 GOSUB 1000, 2000, 3000

COMMANDS FOR DISPLAY SCREEN

format	function	example
SCREEN [mode], [sprite size], [key click switch], [baud rate], [printer type], [interlace mode]	Specify the screen display mode. Mode 0: 80×24 character text mode 1: 32×24 text mode 2: 256×192 dot, 16-color graphic mode 3: 64×48 dot, 16-color multicolor mode 4: 256×192 dot, 16-color graphic mode, sprite enhanced 5: 256×212 dot, 16-color graphic mode, sprite enhanced 6: 512×212 dot, 4-color graphic mode, sprite enhanced 7: 512×212 dot, 16-color graphic mode, sprite enhanced 8: 256×212 dot, 256-color graphic mode, sprite enhanced Sprite size 0: 8×8 dot unmagnified 1: 8×8 dot magnified 2: 16×16 dot unmagnified 3: 16×16 dot magnified Key click switch 0: Supress key click sounds. 1: Produce key click sounds. Baud rate 0: 1200 baud 1: 2400 baud Printer type 0: MSX printer 1: Non-MSX printer Interlace mode 0: non-interlace 1: interlace 2: interlace, even/odd page change display 3: interlace, even/odd page change display	SCREEN 2, 0,0
SET PAGE [display page], [active page]	Specify the display page and the active page.	SET PAGE 0, 1
WIDTH number of characters	Specify the number of characters per line in the text mode.	WIDTH 28
CLS	Erase all displays on the screen.	
KEY {ON / OFF}	Display or erase the contents of function keys.	KEY OFF
LOCATE [x-coordinate], [y-coordinate], [cursor switch]	Move the cursor. Cursor switch 0: Not display the cursor. 1: Display the cursor.	LOCATE 10, 12, 1
COLOR [foreground color], [background color], [border color]	Specify colors of the foreground, background and the border.	COLOR 8, 15, 2
COLOR=(palette number, red brightness, green brightness, blue brightness)	Assign colors to the color palette	COLOR=(2, 0, 3, 7)
COLOR=RESTORE	Assign the content of the color lookup table in the video RAM to the VDP color palette register.	
COLOR[=NEW]	Return color palette to initial default settings	
PUT SPRITE sprite plane number, [[STEP] (x-coordinate, y-coordinate)], [color], [sprite number]	Display the specified sprite pattern at the specified position on the specified sprite plane.	PUT SPRITE 0, (100, 50), 7, 2
COLOR SPRITE$ (sprite plane no.)="character expression"	Specify the color of each line of a sprite. Significance of each character bit: B7 B6 B5 B4 B3 B2 B1 B0 B7: For 1, moves sprite 32 dots to the left. B6: For 1, ignores sprite priority position and overlap, and displays the color whose code is the result of OR of the overlapping colors. B5: For 1, ignores sprite overlap. B4: Not used. B3—B0: color code	COLOR SPRITE$(0) =CHR$(1)+CHR$(7)
COLOR SPRITE (sprite plane no.)=palette no.	Change the color of the sprite on the specified sprite plane.	COLOR SPRITE (1)=4
Logical Operations	PSET, PRESET, AND, OR, XOR, TPSET, TPRESET, TAND, TOR, TXOR	

COMMANDS FOR GRAPHIC DISPLAY

format	function	example
CIRCLE [STEP] (x-coordinate, y-coordinate), radius, [color code], [start angle], [end angle], [aspect ratio]	Draw a circle.	CIRCLE (80, 60), 15, 8
DRAW "graphic subcommands"	Draw an arbitrary graphic.	DRAW "S4U5R5D5L5"
LINE [[STEP] (x-coordinate, y-coordinate)]-[STEP] (x-coordinate, y-coordinate), [color code] {[, B] / [, BF]} [, logical operation]	Draw a line or a square.	LINE -STEP (20, 50),, B
PAINT [STEP] (x-coordinate, y-coordinate), [display color], [border line color code]	Color the area inside the border line.	PAINT (120, 100)
PSET [STEP] (x-coordinate, y-coordinate), [color code], [logical operation]	Mark a dot.	PSET STEP (10, 10), 14
PRESET [STEP] (x-coordinate, y-coordinate), [color code], [logical operation]	Mark or erase a dot.	PRESET (100, 100)

COMMANDS FOR SCREEN DATA PROCESSING

format	function	example
COPY (X1, Y1)–(X2, Y2) [, source page] TO (X3, Y3), [destination page], [logical operation]	Transfer image data in the VRAM to other sectors in the VRAM	COPY (20, 30)–(70, 50), 1 TO (90, 60), 0, AND
COPY (X1, Y1)–(X2, Y2) [, source page] TO array variable name	Transfer image data in the VRAM to an array variable	COPY (20–30)–(70,50), 0 TO S
COPY array variable name [, direction] TO (X3, Y3), [destination page], [logical operation]	Transfer image data in an array variable to the VRAM	COPY S,1 TO (100, 100), 1, XOR
💾 COPY (X1, Y1)–(X2, Y2) [, source page] TO "[drive name] file name [. type name]"	Save the image data in the VRAM to the disk file.	COPY (10, 10)–(120, 90) TO "PORTRAIT.PIC"
💾 COPY "[drive name] file name [. type name]" [, direction] TO (X3, Y3), [destination page], [logical operation]	Load image data in the disk file to the VRAM	COPY "PORTRAIT.PIC" TO (10, 10)
💾 COPY "[drive name] file name [. type name]" TO array variable name	Load image data in the disk file to the array variable	COPY "PORTRAIT.PIC" TO S
💾 COPY array variable name TO "[drive name] file name [. type name]"	Save the image data in an array variable to the disk file.	COPY S TO "PORTRAIT.PIC"
COPY SCREEN [mode], [mask]	Digitize an external video signal and write it in the VDP. (used only with computers that have the digitize function) Mode 0: the signal of 1 field is digitized and written on the display page 1: signals of 2 fields (1 frame) are digitized: one is written on the display page, and one is written on the page whose page number is smaller than that of the display page by one.	

Graphic subcommands

(When B is added, a subcommand changes the starting point only without drawing lines. If N is added, it draws lines but does not move starting point.)

subcommand	function	initial value	subcommand	function	initial value
Mx, y	To an absolute position (x, y)		Fn	Move down to the right.	n=1
M±x, ±y	Move by ±x, ±y from current position.		Gn	Move down to the left.	n=1
Un	Move up.	n=1	Hn	Move up to the left.	n=1
Dn	Move down.	n=1	An	Rotate the coordinate system.	
Rn	Move to the right.	n=1	Cn	Specify a color.	n=15
Ln	Move to the left.	n=1	Sn	Specify the unit number of dots.	n=4
En	Move up to the right.	n=1	X string type variable;	Execute the subcommand assigned to the string type variable.	

COMMANDS FOR MUSIC PERFORMANCE

format	function	example
BEEP	Generate a beep sound.	BEEP: BEEP: BEEP
SOUND PSG register number, expression	Write data into PSG register.	SOUND 7, 7
PLAY "music subcommands" [, "music subcommands"] [, "music subcommands"]	Play music.	PLAY "O4L4CEGEL1C"

Music subcommands

subcommand	function and range	initial value	subcommand	function and range	initial value
A [#] [+] [–] G [#] [+] [–]	Music notes		Tn	Tempo 32≦n≦255	n=120
On	Octave 1≦n≦8	n=4	Vn	Volume 0≦n≦15	n=8
Nn	Pitch 0≦n≦96		Mn	Envelope frequency 1≦n≦65535	n=255
Ln	Length 1≦n≦64	n=4	Sn	Envelope pattern 1≦n≦15	n=1
Rn	Rest 1≦n≦64	n=4		Dot	
X string type variable;	Execute the subcommand assigned to the string type variable.				

COMMANDS FOR PROGRAM AND DATA FILES

format	function	example
MAXFILES=expression	Set the number of files that can be opened in a program.	MAXFILES=3
OPEN "[device name] [file name [. type name]]" [FOR mode] AS [#] file number [LEN=record length]	Open a file and specify a mode. Modes: OUTPUT.. Write INPUT..... Read When the mode is specified a sequential file is opened. When the mode is not specified, a random access file is opened.	OPEN "CRT: TEST" FOR OUTPUT AS #1
PRINT # file number, [expression] [separater] [expression]	Write data into sequential file in sequence.	PRINT #1, "ABC"
PRINT # file number, USING format symbol; expression [, expression] ...	Write data into sequential file in sequence in the specified format. (See PRINT USING.)	PRINT #1, USING "\ \";A$
INPUT # file number, variable [, variable] ...	Read data from sequential file in sequence and assign them to variables.	INPUT #1, A, B, C
LINE INPUT # file number, string type variable	Read string up to 254 characters from sequential file and assign them to variable.	LINE INPUT #1, A$
CLOSE [#] [file number] [, file number] ...	Close files.	CLOSE #1, 2
SAVE "[device name] [file name]"	Save an ASCII format program (other than disk).	SAVE "CAS:PROGRAM"
💾 SAVE "[drive name] file name [. type name]" [,A]	Save a program on the disk. The program is saved in the ASCII format when the A option is specified, and in intermediate language when the A option is omitted.	SAVE "GAME1.BAS" SAVE "GAME2.ASC",A
LOAD "[device name] [file name]"	Load an ASCII format program (other than disk).	LOAD "CAS:PROGRAM"
💾 LOAD "[drive name] file name [. type name]" [,R]	Load a program from the disk.	LOAD "GAME1.BAS",R
MERGE "[device name] [file name]"	Load an ASCII format program and merge it with the program in memory.	MERGE "CAS:PROG2"

MERGE "[drive name] [file name [. type name]]"	Load a program from the disk saved in the ASCII format and merge it with a program in memory.	MERGE "GAME2.ASC"
BSAVE "[device name] [file name]", start address, end address [, execution starting address]	Save the contents of memory within the specified range (other than disk).	BSAVE "CAS:GAME", &H3000, &H3FFF
BSAVE "[drive name] [file name [. type name]]", start address, end address {[, execution start address] / [,S]}	Save the content of the main memory (without S option) or the video RAM on the disk (with S option).	BSAVE "PROG.BIN", &HE000, &HE8000 BSAVE "CHART", 0, &H3FFF,S
BLOAD "[device name] [file name]" [, R] [, offset]	Load machine language program (other than disk). Load and execute program when, R is added. The offset is one for the memory address at the time of loading.	BLOAD "CAS:GAME", R
BLOAD "[drive name] [file name [. type name]]" {[,R] / [,S]} [, offset]	Load a machine language program from the disk. When the R option is specified, loads the program and executes it. When the S option is specified, loads the file data to the video RAM.	BLOAD "PROG.BIN",R BLOAD "CHART",S
CSAVE "file name" [, baud rate]	Save a program onto cassette tape in intermediate language. Baud rate: 1. 1200 baud 2. 2400 baud	CSAVE "STAR"
CLOAD ["file name"]	Load program from cassette tape.	CLOAD "STAR"
CLOAD? ["file name"]	Compare program saved on cassette tape and program in memory.	CLOAD? "STAR"
FIELD [#] file number, character length AS string variable [,character length AS string variable]	Define 1 random access file record.	FIELD #1, 12, AS NAM$, 14 AS TEL$
LSET string variable= string expression RSET string variable= string expression	Write the content of a string expression to the string variable defined in the record. (LSET provides left justification; RSET provides right justification)	LSET TEL$=B$ RSET NAM$="TOM"
PUT [#] file number [, record number]	Write the content of a record to a random access file on the disk.	PUT #1,1
GET [#] file number [, record number]	Read 1 record from a random access file on the disk.	GET #1, 10

Device name

CAS:..... Cassette tape
CRT:..... Text mode screen
GRP:..... Graphic mode screen
LPT:..... Printer
MEM:..... Memory disk
A:..... Floppy disk drive names
B:..... Floppy disk drive names
C:..... Floppy disk drive names
D:..... Floppy disk drive names
E:..... Floppy disk drive names
F:..... Floppy disk drive names
G:..... Floppy disk drive names
H:..... Floppy disk drive names

COMMANDS FOR FLOPPY DISK AND MEMORY DISK MANAGEMENT

format	function	example
CALL FORMAT	Format a disk.	
FILES ["[drive name] [file name [. type name]]"]	Display file names saved on the disk.	FILES FILES " * .BAS"
KILL "[drive name] file name [. type name]"	Erase a file on the disk.	KILL "TEST.BAS"
NAME "[drive name] old file name [. old type name]" AS "new file name [. new type name]"	Change the name of a file on the disk.	NAME "OLD.DAT" AS "NEW.DAT"
COPY "[drive name 1] file name [.type name]" [TO "[drive name 2] file name [.type name]"]	Copy a file on the disk to the same disk or to another disk.	COPY "ABC.BAS" TO "XYZ.BAS" COPY "A:ABC.BAS" TO "B:"
CALL MEMINI [(size)]	Allocate a section of memory to be used as a memory disk, and initialize it.	CALL MEMINI (20000)
CALL MFILES	Display file names on the memory disk.	
CALL MKILL ("file name [.type name]")	Erase a file on the memory disk.	CALL MKILL ("ADRS.DAT")
CALL MNAME ("old file name [. old type name]" AS "new file name [. new type name]")	Change a file name on the memory disk.	CALL MFILES ("OLD.DAT" AS "NEW.DAT")

COMMANDS FOR INTERRUPT

format	function	example
ON KEY GOSUB line number [, line number] ...	Interrupt with a function key.	ON KEY GOSUB 1000, 2000, 3000
KEY (function key number) ON	Enable an interrupt with a function key.	KEY (1) ON
KEY (function key number) OFF	Disable an interrupt with a function key.	KEY (2) OFF
KEY (function key number) STOP	Hold an interrupt with a function key.	KEY (3) STOP
ON STRIG GOSUB line number [, line number] ...	Interrupt with a trigger button of the joystick.	ON STRIG GOSUB 1000., 2000
STRIG (pointing device number) ON	Enable an interrupt with a joystick. Joystick number: 0..... space bar 1..... joystick 1 2..... joystick 2	STRIG (1) ON
STRIG (pointing device number) OFF	Disable an interrupt with a joystick.	STRIG (2) OFF
STRIG (pointing device number) STOP	Hold an interrupt with a joystick.	STIRG (0) STOP
ON STOP GOSUB line number	Interrupt with the CTRL and STOP keys.	ON STOP GOSUB 1000
STOP ON	Enable an interrupt with the CTRL and STOP keys.	
STOP OFF	Disable an interrupt with the CTRL and STOP keys.	
STOP STOP	Hold an interrupt with the CTRL and STOP keys.	
ON SPRITE GOSUB line number	Interrupt with an overlap of sprite patterns.	ON SPRITE GOSUB 1000
SPRITE ON	Enable an interrupt with an overlap of sprite patterns.	
SPRITE OFF	Disable an interrupt with an overlap of sprite patterns.	
SPRITE STOP	Hold an interrupt with an overlap of sprite patterns.	
ON INTERVAL=interval time GOSUB line number	Interrupt after an interval. Time between interrupts is the interval × 1/50 second.	ON INTERVAL=120 GOSUB 1000
INTERVAL ON	Enable intervalled interrupts.	
INTERVAL OFF	Disable intervalled interrupts.	
INTERVAL STOP	Hold intervalled interrupts.	

COMMANDS FOR CONNECTED DEVICES

format	function	example
LPRINT [expression] [separator] [expression] [separator] [expression] ...	Output data on the printer.	LPRINT A, B, C
LPRINT USING format symbol; expression [separater] [expression] [separater] ...	Output data on the printer in the specified format. (See PRINT USING.)	LPRINT USING "# # #"; A, B
LLIST [starting line number] [–] [end line number]	Print program list on a connected printer.	LLIST 100-200
MOTOR [{ON / OFF}]	Turn the tape recorder motor on or off.	MOTOR OFF

COMMANDS FOR INTERNAL CLOCK

format	function	example
SET DATE "DD/MM/YY" [,A]	Set the date on the internal clock.	SET DATE "05/10/85"
GET DATE D$ [,A]	Assign the current-date to a variable.	GET DATE D$
SET TIME "HH:MM:SS" [,A]	Set the time on the internal clock.	SET TIME "14:05:00
GET TIME T$ [,A]	Assign the current time to a variable.	GET TIME T$

COMMANDS FOR ERROR PROCESSING

format	function	example
ERROR error number	Generate an error of the specified error code. Define error codes.	ERROR 3 IF A>100 THEN ERROR 250
ON ERROR GOTO line number	Transfer control to the specified line when an error occurs.	ON ERROR GOTO 1000
RESUME [{ 0 / line number / NEXT }]	Return control to the main program after executing an error processing routine.	RESUME 10

COMMANDS FOR MACHINE LANGUAGE SUBROUTINES

format	function	example
DEFUSR [integers]=starting address	Define the starting address of user subroutine.	DEFUSR0=53248
POKE address, expression	Write data into memory.	POKE &HA400, &HFF

COMMANDS FOR I/O PORT AND MEMORY

format	function	example
OUT port number, expression	Output data to the I/O port.	OUT &H90, 3
WAIT port number, expression 1 [, expression 2]	Hold program execution until the input data form the I/O port reaches a certain value.	WAIT &H90, 255
VPOKE address, expression	Write one bit of data to the video RAM.	VPOKE 263, 01

COMMANDS FOR EXTENDED COMMANDS

format	function	example
CALL subroutine name or _subroutine name CALL extended command [argument, argument ...] or _extended command [argument, argument ...]	Transfer control to the machine language subroutine, or transfer control to an extended command of the ROM cartridge.	CALL SUB

COMMAND FOR SHIFTING CONTROL TO MSX-DOS

format	function	example
💾 CALL SYSTEM	Shift control to MSX-DOS.	

FUNCTIONS

NUMERICAL FUNCTIONS

ABS (X) : Give an absolute value.
ATN (X) : Give arc tangent.
CDBL (X) : Convert to the double precision type.
CINT (X) : Convert to the integer type. ($-32768 \leqq X \leqq 32767$)
COS (X) : Give cosine of X radians.
CSNG (X) : Convert to the single precision type.
ERL : Give the number of the line with an error.
ERR : Give the error code.
EXP (X) : Give e^x.
FIX (X) : Give the integer part of X
INT (X) : Give the maximum integer less than or equal to X
LOG (X) : Give natural logarithm.
RND (X) : Give random number.
SGN (X) : Give 1 if X>0, 0 if X=0 and −1 if X<0
SIN (X) : Give sine of X radians.
SQR (X) : Give square root.
TAN (X) : Give tangent of X radians.

STRING FUNCTIONS

LEFT$ (X$, N) : Give N characters from the left of X$.
MID$ (X$, M [, N]) : Give N characters beginning with the Mth character from the left of X$.
RIGHT$ (X$, N) : Give N characters from the right of X$.
SPACE$ (N) : Give N spaces.
STRING$ (N, J) : Give N characters whose character code is J.
STRING$ (N, X$) : Give N times the first character of X$.
TAB (N) : Move the cursor to the Nth position.
SPC (N) : Give N spaces.

FUNCTION FOR CONVERSION BETWEEN NUMERICAL AND STRING TYPES

ASC (X$) : Give the character code of the first character of X$.
BIN$ (X) : Give a binary expression of X as a string type data. ($-32768 \leqq X \leqq 65535$)
CHR$ (X) : Give a character whose character code is X.
HEX$ (X) : Give a hexadecimal expression of X as a string type data. ($-32768 \leqq X \leqq 65535$)
INSTR ([N,] X$, Y$) : Give the position of Y$ after the Nth character of X$.
LEN (X$) : Give a number of characters of X$.
OCT$ (X) : Give an octal expression of X as a string type data. ($-32768 \leqq X \leqq 65535$)
STR$ (X) : Convert to the string type.
VAL (X$) : Convert to the numeric type.
💾 CVI, CVS, CVD : Change character string data in a random access file to numeric data.
💾 MKI$, MKS$, MKD$: Change numeric data into string data to write in a random access file.

OTHER FUNCTION

PLAY (N) : Check if music is playing.
When N=1, 2 or 3 it gives −1 when music is playing; otherwise it gives 0. When N=0, the status (−1 or 0) of each music subcommand are ORed and the result is given.

FUNCTIONS FOR DATA INPUT

From the screen
CSRLIN : Give y-coordinate of the cursor.
POS (X) : Give x-coordinate of the cursor.
POINT (X, Y) : Give color code at point (X, Y).

From data file
EOF (file number) : Give −1 when last data in file is read; otherwise give 0.
INPUT$ (N, [#] file number) : Input and give N characters from the file.
💾 LOF (file number) : Give the file length (bytes).
LOC (file number) : Give the current location in the file.

From the printer
LPOS (X) : Give the position of the print head in the printer buffer.

From memory
FRE (0) : Give unused area in memory.
FRE (" ") : Give unused part or string area.
PEEK (address) : Give the memory contents of the address.
VARPTR (variable) : Give the starting address of the memory area storing the variable.
💾 VARPTR (# file number) : Give the first address of the file control block to which the specified file is assigned.
VPEEK (address) : Give the video RAM contents of the address.

From the keyboard
INKEY$: Give the character corresponding to the pressed key.
INPUT$ (X) : Input X characters from the keyboard.
💾 From the disk DSKF (drive number) : Give the space remaining in the disk in cluster units.

From I/O port
INP (port number) : Input data from the I/O port.

From machine language subroutine
USR {0 to 9} (X) : Give the value from the user subroutine.

From joystick, paddle or touch pad

STICK (N) : Give the direction of the joystick. (N=0 for cursor move keys)
(Center=0, Up=1, Right up=2, Right=3, Right down=4, Down=5, Left down=6, Left=7, Left up=8)

STRIG (N) : Give −1 when the joystick trigger button is pressed; otherwise, give 0. (N=0 for the space bar)

PDL (N) : Input data from the paddle.

PAD (N) : Give status of the touch pad, light pen, mouse, or track ball.
When N=0 or 4: Give −1 if the touch pad is touched; otherwise, give 0.
When N=1 or 5: Give the x-coordinate of the position where the touch pad is touched.
When N=2 or 6: Give the y-coordinate of the position where the touch pad is touched.
When N=3 or 7: Give −1 if the touch pad switch is touched; otherwise, give 0.
N=8: −1 if light pen data is valid; 0 if invalid
N=9: light pen X-coordinate
N=10: light pen Y-coordinate
N=11: −1 if light pen switch is pressed; 0 if not pressed
N=12 or 16: request mouse or track ball input (−1 is always returned)
N=13 or 17: mouse or track ball X-coordinate
N=14 or 18: mouse or track ball Y-coordinate
N=15 or 19: 0 is always returned

CONSTANTS AND VARIABLES

Constant	String type	Character string of 0 to 255 characters (enclosed in quotation marks)
	Integer type	−32768 to +32767
	Floating-point type	Significant digits: 6 (single precision) or 14 (double precision) Exponent part: −64 to +62
	Hexadecimal expression	Takes a prefix "&H"
	Octal expression	Takes prefix "&O" or "O"
	Binary expression	Takes a prefix "&B"

Variable	Variable name	First two characters are effective.
	Type declarator	Written after variable name % : Integer type ! : Single precision # : Double precision $: String type

SPECIAL VARIABLES

TIME : Retain a value in the timer. Can be rewritten.
SPRITE$ (sprite number) : Retain the sprite pattern.
[Example] SPRITE$(1)=CHR$(&H18)+CHR$(&H3C)+CHR$(&H7E)+CHR$(&HFF)+CHR$(&H18)+CHR$(&H18)+CHR$(&H18)+CHR$(&H18)

●Special commands and functions for VDP (Video Display Processor)

BASE (expression) : Used to read or write the base address of the VDP table.
VDP (numeric value) : Used to read or write the contents of the VDP register.

ERROR MESSAGES

1 NEXT without FOR	: No FOR statement corresponding to NEXT statement.
2 Syntax error	: Syntax error in the statement.
3 RETURN without GOSUB	: No GOSUB statement corresponding to RETURN statement.
4 Out of DATA	: No more data to be read.
5 Illegal function call	: Illegal specification in function or command.
6 Overflow	: Too big or too small data.
7 Out of memory	: No more memory.
8 Undefined line number	: Undefined line number was specified.
9 Subscript out of range	: Array subscript outside defined range.
10 Redimensioned array	: Array in DIM statement was already specified.
11 Division by zero	: Divided by zero.
12 Illegal direct	: The command can not be used in direct command mode.
13 Type mismatch	: Data type mismatch.
14 Out of string space	: No more string variable area.
15 String too long	: String is too long.
16 String formula too complex	: String is too complex.
17 Can't CONTINUE	: Impossible to continue program execution.
18 Undefined user function	: A function which is not defined by DEF FN statement was used.
19 Device I/O error	: Error in connected equipment.
20 Verify error	: Program in cassette tape and program in memory differ.
21 No RESUME	: No RESUME statement that corresponds to ON ERROR statement.
22 RESUME without error	: No ON ERROR statement that corresponds to RESUME statement.
23 Unprintable error	: An error without an error message has occurred.
24 Missing operand	: Operand is missing.
25 Line buffer overflow	: The entered program exceeds the buffer size.
50 FIELD overflow	: The specified area of a FIELD statement has exceeded the length of the record.
51 Internal error	: Memory content or text is not normal.
52 Bad file number	: Incorrect file number.
53 File not found	: The specified file does not exist.
54 File already open	: The file is already open.
55 Input past end	: Last data has been already read.
56 Bad file name	: Incorrect file specification.
57 Direct statement in file	: Command in direct command mode was entered during file loading.
58 Sequential I/O only	: When a GET statement or PUT statement is attempted for a sequential file.
59 File not OPEN	: The file needs to be opened.
60 Bad FAT	: The disk has not been formatted.
61 Bad file mode	: Sequential file, random access file command or function mistake.
62 Bad drive name	: Disk drive not in use was specified.
63 Bad sector number	: Record specified in PUT or GET statement is 0 or larger than 32767.
64 File still open	: File has not been closed.
65 File already exists	: New file name specified in a NAME, CALL MNAME statement already exists.
66 Disk full	: No more space on the disk.
[RAM] disk full	: No space on the memory disk.
67 Too many files	: The number of files has exceeded 255.
68 Disk write protected	: Writing was performed on a write-protected diek.
69 Disk I/O error	: An error occurred which makes recovery impossible at the time of disk input or output.
70 Disk offline	: Disk drive is not connected.
[RAM] disk offline	: Memory disk use was attempted without executing CALL MEMINI.
71 Rename across disk	: NAME statement was attempted between different disk drives.

COLOR CODE

code	color	code	color
0	Transparent	8	Medium red
1	Black	9	Light red
2	Medium green	10	Dark yellow
3	Light green	11	Light yellow
4	Dark blue	12	Dark green
5	Light blue	13	Magenta
6	Dark red	14	Gray
7	Sky blue	15	White

OPERATORS

Arithmetic operators	^	power
	−	change signs
	*,/	multiplication, division
	\	integral division
	MOD	integral residue
	+,−	addition, subtraction
	(Priority increases from bottom to up)	
Relational operators	<>=	comparison
Logical operators	NOT	negation
	AND	logical product
	OR	logical sum
	XOR	exclusive logical sum
	EQV	negation of exclusive logical sum
	IMP	implication

SECTION 2
DISASSEMBLY

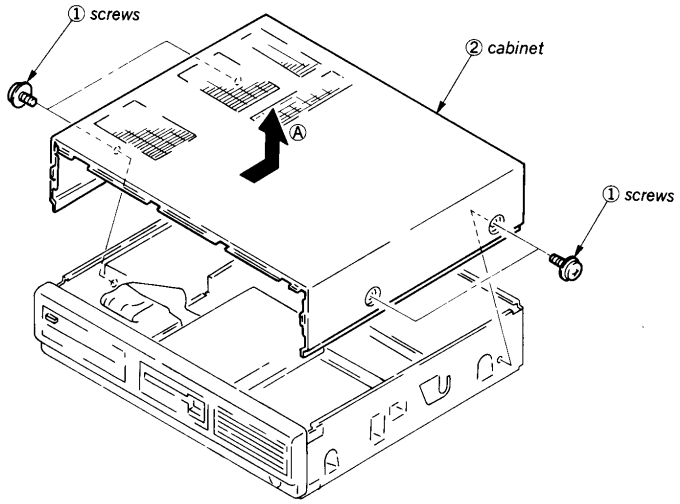
2-1. REMOVAL OF CABINET AND BOTTOM COVER

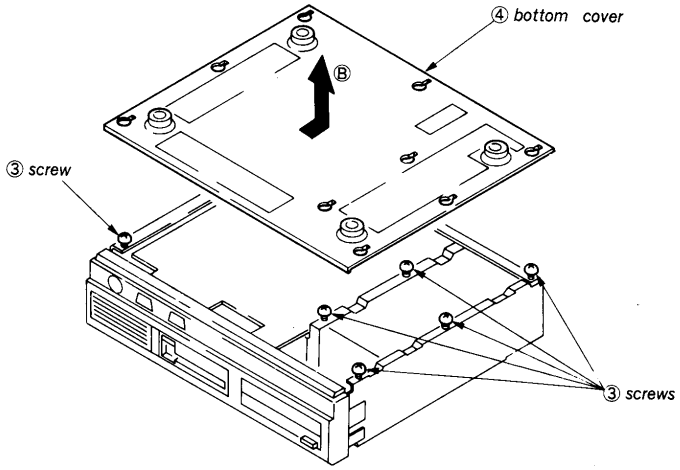
① Remove the four screws.

② Lift up the backward of the cabinet as direction Arrow Ⓐ.

③ LOOSEN the nine screws of the bottom cover.

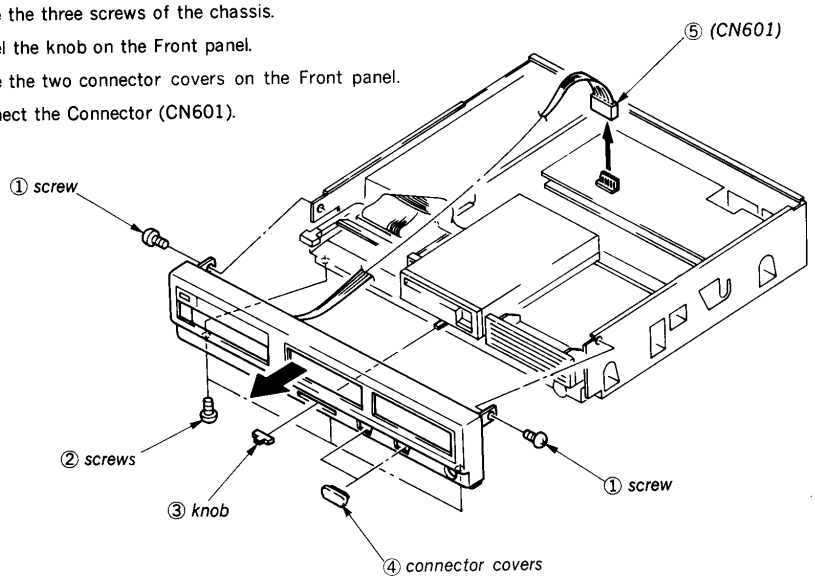
④ Remove the cabinet in the direction indicated by the Arrow Ⓑ.





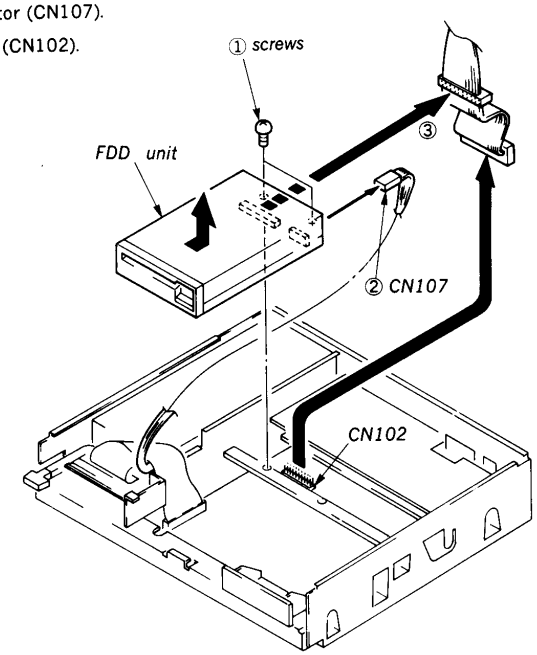
2-2. REMOVAL OF THE FRONT PANEL

① Remove the two screws of the chassis.
② Remove the three screws of the chassis.
③ Removel the knob on the Front panel.
④ Remove the two connector covers on the Front panel.
⑤ Disconnect the Connector (CN601).



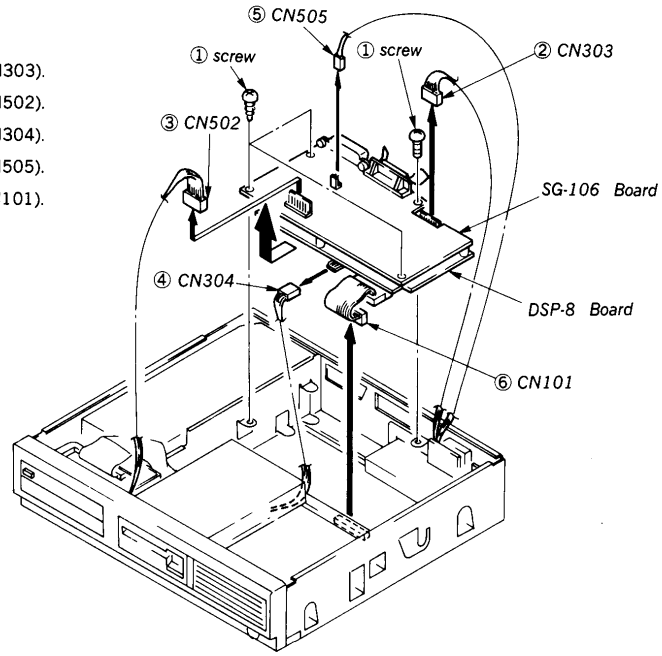
2-3. REMOVAL OF MFD UNIT

① Remove the two screws.
② Disconnect the Power Connector (CN107).
③ Disconnect the I/O Connector (CN102).
④ Remove the MFD Unit.

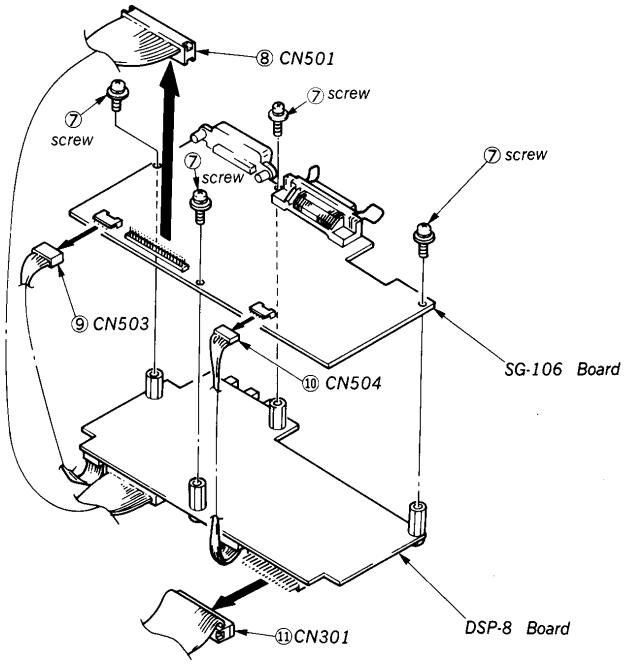


2-4. REMOVAL SG-106 BOARD AND DSP-8 BOARD

① Remove the four screws.
② Disconnect the Connector (CN303).
③ Disconnect the Connector (CN502).
④ Disconnect the Connector (CN304).
⑤ Disconnect the Connector (CN505).
⑥ Disconnect the Connector (CN101).

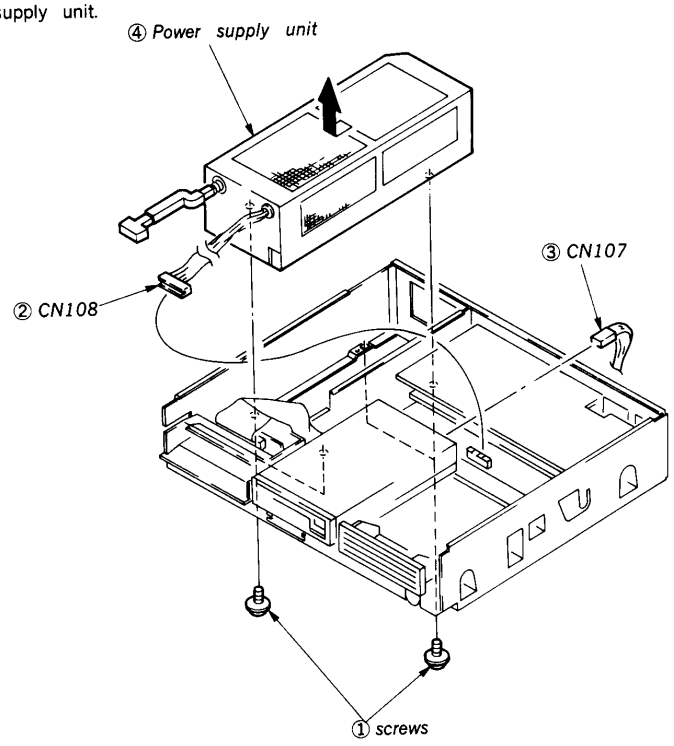


⑦ Remove the four screws.
⑧ Disconnet the Connector (CN501).
⑨ Disconnect the Connector (CN503).
⑩ Disconnect the Connector (CN504).
⑪ Disconnect the Connector (CN301).



2-5. REMOVAL OF THE POWER SUPPLY UNIT

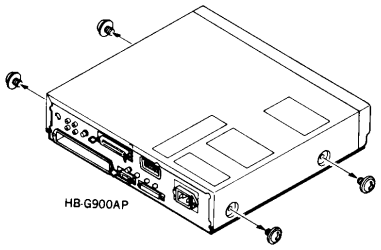
① Remove the four screws.
② Disconnect the Connector (CN108).
③ Disconnect the Connector (CN107).
④ Remove the Power supply unit.



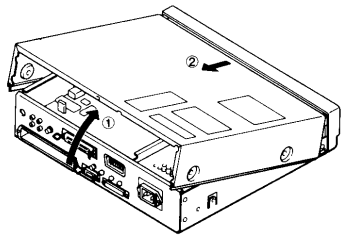
2-6. INSTALLATION OF HBD-G900

This drive is designed to be installed in a Sony personal computer HB-G900AP.

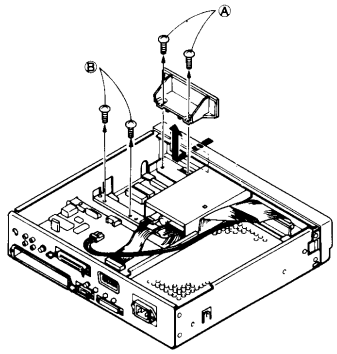
1



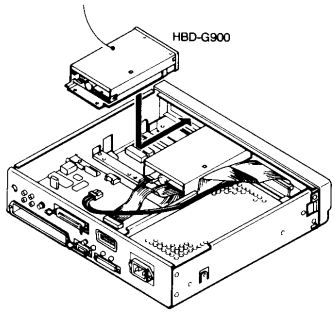
2



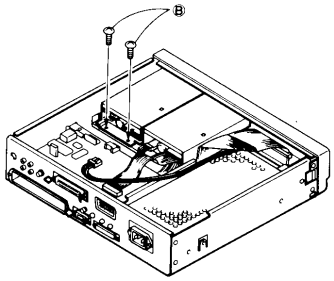
3



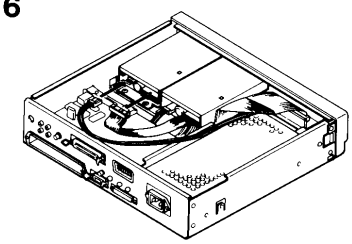
4 Slide the unit toward the front until it stops.



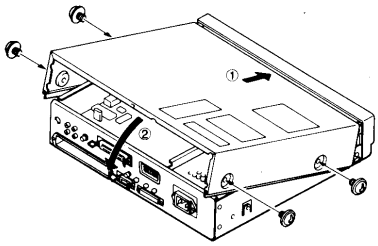
5



6

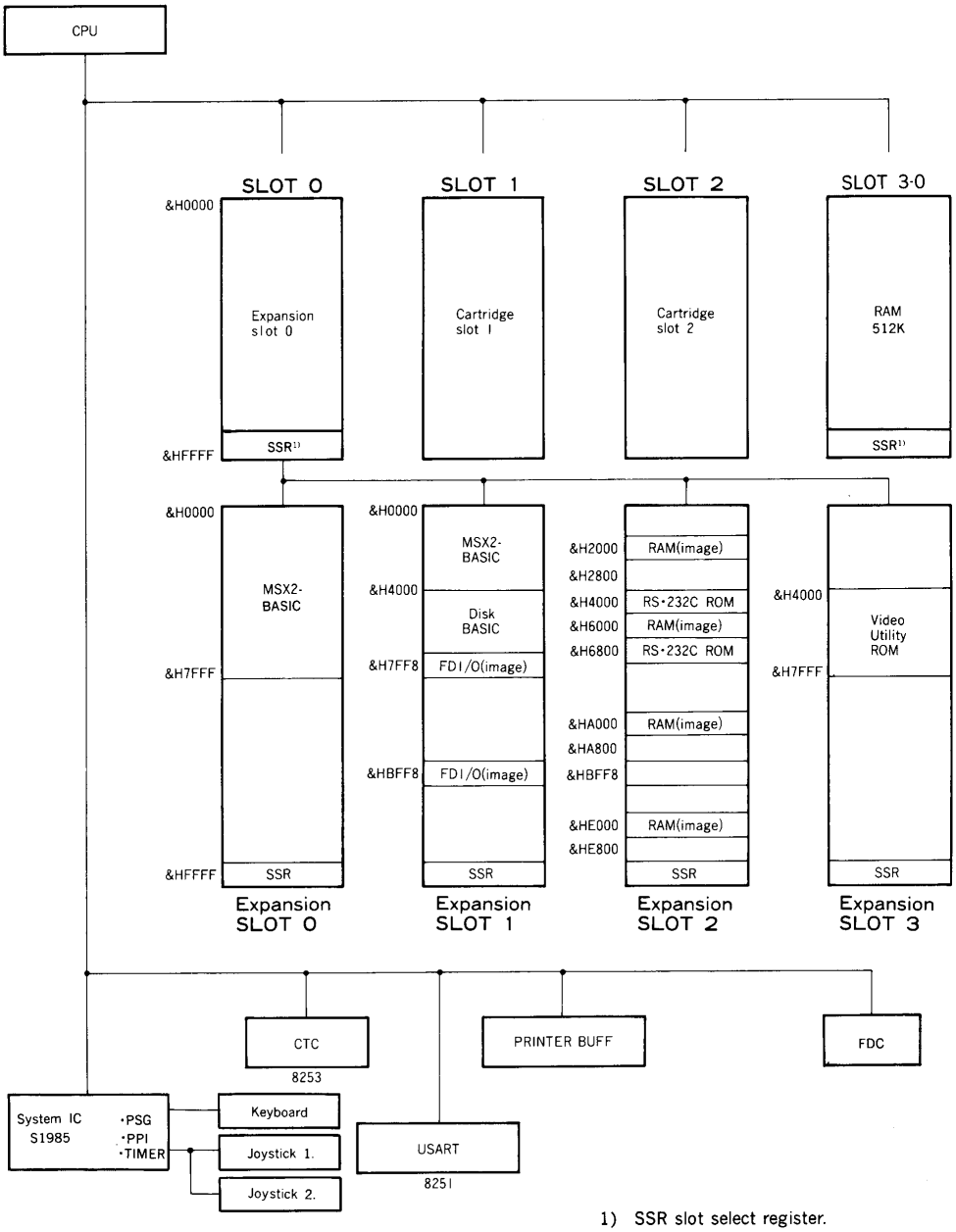


7 Replace the cover and tighten the screws.



SECTION 3
CIRCUIT DESCRIPTION

Block diagram of PU-7 board



1) SSR slot select register.

Circuit Description

The circuit is described here based on the schematic diagram.

PU-7 (1) (CPU, memory block)

(1) CPU (IC138)
The CPU uses a Z80A or equivalent. One WAIT status is established during MI cycle and VDP access, with a clock frequency of 3.579545 MHz.

(2) MSX2 BASIC ROM (IC109)
The 32 k-byte MSX2 BASIC ROM is located in page 0, 1 of extended slot 00.

(3) MSX2 BASIC EX (IC112)
The MSX BASIC EX is mounted on 16 k-byte in the first half of a 32 k-byte ROM and located in page 0 of extended slot 01.

(4) DISK BASIC (IC117)
The DISK BASIC ROM is mounted on a 16 k-byte ROM and located in page 1 of extended slot 01.

(5) RS-232C ROM + utility ROM (IC123)
The RS-232C ROM and utility ROM are mounted on a 32 k-byte ROM. The RS-232C ROM is located in page 1 of extended slot 02, and the utility ROM in page 1 of extended slot 03.

(6) RS-232C RAM (IC129)
The RS-232C RAM is used to support a multichannel RS-232C interface and enlarge the receive buffer capacity. The RAM can be accessed at either addresses 6000 H-67 FFH or A000-A7 FFH of extended slot 02 to improve the execution speed.

PU-7 (2) S1985

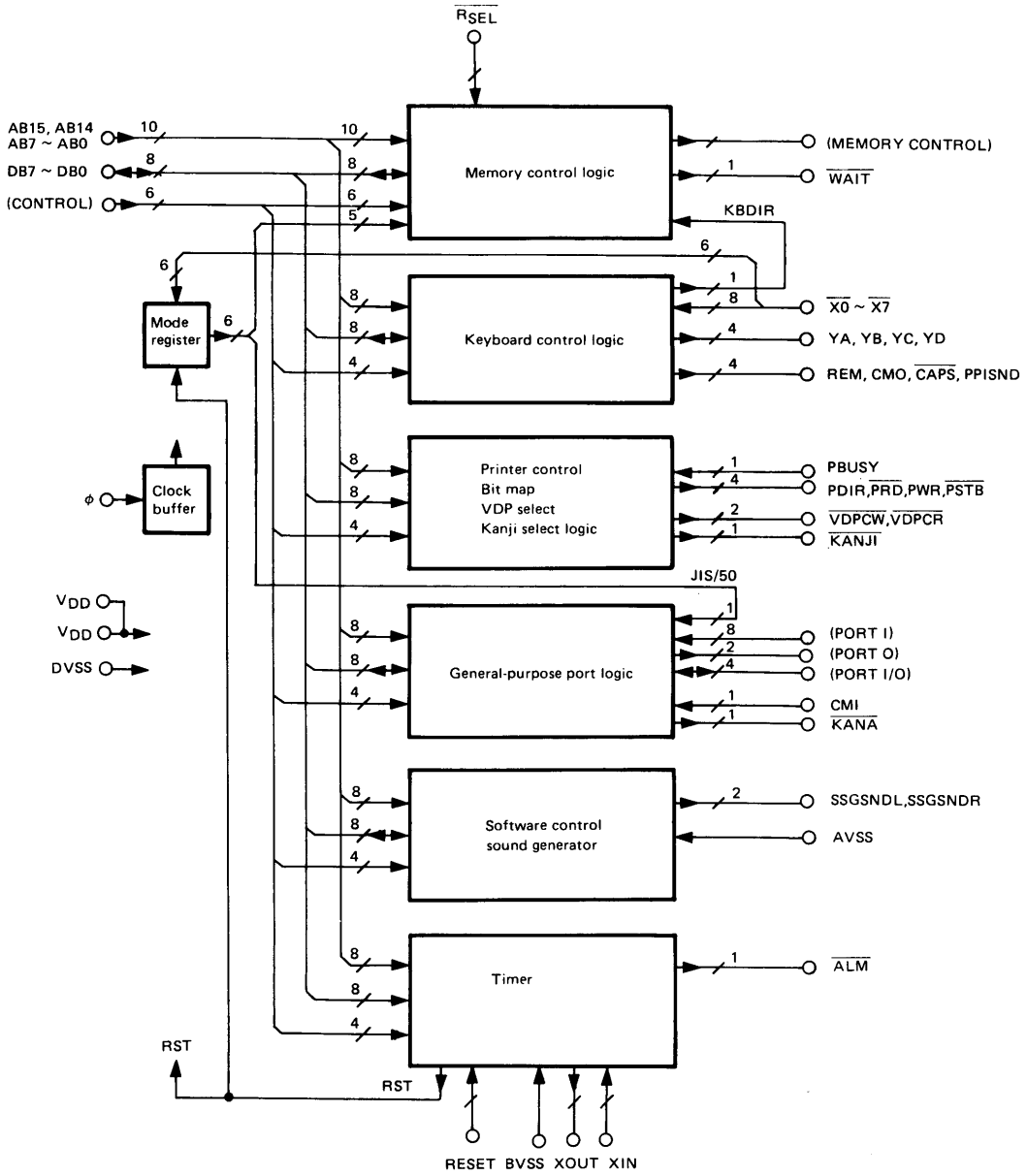
Yamaha S1985 is an LSI developed for the MSX2 computer. The S1985, which can be extended based on the MSX2 specification, is used to control peripherals such as a memory control, VDP, keyboard, and printer. It is also internally provided with a sound signal generator (SSG) to generate a tone signal and a timer.

PIN FUNCTION

Pin name	I/O	Function
AB15, AB14, AB7-AB0 10 – 19	I	Z80A CPU address bus input (10 bit)
DB7-DB0 20 – 27	I/O	Z80A CPU data bus input/output (8-bit)
$\overline{M1}$ 32	I	Z80A CPU $\overline{M1}$ input
$\overline{RFSH}$ 33	I	Z80A CPU $\overline{RFSH}$ input
$\overline{MREQ}$ 34	I	Z80A CPU $\overline{MREQ}$ input
$\overline{IORQ}$ 35	I	Z80A CPU $\overline{IORQ}$ input
$\overline{RD}$ 36	I	Z80A CPU $\overline{RD}$ input
$\overline{WR}$ 37	I	Z80A CPU $\overline{WR}$ input
$\overline{WAIT}$ 38	O	WAIT signal output to Z80 CPU (wired logic possible)
MPX 41	O	DRAM address multiplex signal output
$\overline{RAS}$ 39	O	DRAM $\overline{RAS}$ signal output
$\overline{CAS}$ 42	O	DRAM $\overline{CAS}$ signal output
$\overline{WE}$ 43	O	DRAM $\overline{WE}$ signal output
$\overline{SLT33}$ 56	O	SLOT #33 select signal output
$\overline{SLT32}$ 55	O	SLOT #32 select signal output
$\overline{SLT31}$ 54	O	SLOT #31 select signal output
$\overline{SLT3/30}$ 53	O	SLOT #3 or SLOT #30 select signal output
$\overline{SLT2}$ 52	O	SLOT #2 select signal output
$\overline{SLT1}$ 51	O	SLOT #1 select signal output
$\overline{SLT03}/\overline{CS01}$ 50	O	SLOT #03 select or ROM select 0000H-7FFFH signal output
$\overline{SLT02}/\overline{CS0}$ 49	O	SLOT #02 select or ROM select 0000H-3FFFH signal output
$\overline{SLT01}$ 48	O	SLOT #01 select signal output
$\overline{SLT0/00}$ 47	O	SLOT #0 or SLOT #00 select signal output
$\overline{CS2}$ 45	O	ROM select 8000H-BFFFH signal output
$\overline{CS1}$ 44	O	ROM select 4000H-7FFFH signal output
$\overline{CS12}$ 46	O	ROM select 4000H-BFFFH signal output
MA18/KBDIR 3	O	Mapper address or keyboard bus direction signal output
MA17-14 4 – 7	O	Mapper address signal output
YD-YA 81 – 84	O	Keyboard drive signal input

Pin name	I/O	Function
$\overline{X7}$-$\overline{X0}$ 73 – 80	I	Keyboard return signal input
$\overline{CAPS}$ 71	O	CAPS LED signal output
$\overline{KANA}$ 72	O	KANA LED signal output
CMI 96	I	Cassette read signal input
CMO 97	O	Cassette write signal output
REM 98	O	Cassette control signal output
PBUSY 95	I	Printer busy signal input
$\overline{PSTB}$ 94	O	Printer strobe signal output
PWR 93	O	Printer write signal output
$\overline{PRD}$ 92	O	Printer read signal output
PDIR 91	O	Printer direction signal output
FWD1, FWD2 57 , 64	I	Joystick FWD signal input (general-purpose port input)
BACK1, BACK2 58 , 65	I	Joystick BACK signal input (general-purpose port input)
LEFT1, LEFT2 59 , 66	I	Joystick LEFT signal input (general-purpose port input)
RIGHT1, RIGHT2 60 , 67	I	Joystick RIGHT signal input (general-purpose port input)
TRGA1, TRGA2 61 , 68	I/O	Joystick TRGA signal input/output (general-purpose port input/output)
TRGB1, TRGB2 62 , 69	I/O	Joystick TRGB signal input/output (general-purpose port input/output)
STB1, STB2 63 – 70	O	General-purpose port output
$\overline{VDPCW}$ 8	O	VDP write signal output
$\overline{VDPCR}$ 9	O	VDP read signal output
$\overline{KANJI}$ 29	O	Kanji ROM select signal output
$\overline{RSEL}$ 28	I	Extended slot assigned register control signal input
RESET 85	I	Reset signal input
PPISND 2	O	PPI sound signal output
SSGSNDL 99	O	SSG sound LEFT signal output
SSGSNDR 100	O	SSG sound RIGHT signal output
ϕ IN 30	I	Clock signal input
VDD 40		+5V
DVSS 31		0V (GND)
AVSS 1		Sound GND
XIN 89	I	Input from crystal timer
XOUT 88	O	Output to crystal timer
$\overline{ALM}$ 87	O	Alarm signal output
BVSS 86		Timer backup power supply

BLOCK DIAGRAM



(CONTROL) : $\overline{MI}$, $\overline{RFSH}$, $\overline{MREQ}$, $\overline{IORQ}$, $\overline{RD}$, $\overline{WR}$
(MEMORY CONTROL): $\overline{RAS}$, MPX, $\overline{CAS}$, $\overline{WE}$, $\overline{CS1}$, $\overline{CS2}$, $\overline{CS12}$, $\overline{SLT0/00}$, $\overline{SLT01}$, $\overline{SLT02/CS0}$, $\overline{SLT03/CS01}$, $\overline{SLT1}$, $\overline{SLT2}$, $\overline{SLT3/30}$, $\overline{SLT31}$, $\overline{SLT32}$, $\overline{SLT33}$, MA14, MA15, MA16, MA17, MA18/KBDIR
(PORTI) : FWD1, FWD2, BACK1, BACK2, LEFT1, LEFT2, RIGHT1, RIGHT2
(PORTO) : STB1, STB2
(PORTI/O) : TRGA1, TRGA2, TRGB, TRGB2

FUNCTION DESCRIPTION

Selecting the Functions

Each function is selected by latching the signal level added to the keyboard return input terminal using a reset signal which is internally loaded during the reset signal input.

Levels and Functions during Initialization

Pin name	Level	Function
$\overline{X2}$	0	Enters the RAS Only Refresh mode.
	1	Enters the Hydon Refresh mode.
$\overline{X5}$	0	The MA18/KBDIR pin outputs a mapper address signal.
	1	The MA18/KBDIR pin outputs a keyboard bus direction signal.
$\overline{X6}$	0	Kana JIS array
	1	Kana syllabary array
$\overline{X7}$	0	Requests one wait cycle during the VDP read or write operation.
	1	Not request one wait cycle during the VDP read or write operation.
$\overline{X3}$	0	The $\overline{SLT03}/\overline{CS01}$ and $\overline{SLT02}/\overline{CS0}$ pins output a slot select signal.
	1	The $\overline{SLT03}/\overline{CS01}$ and $\overline{SLT02}/\overline{CS0}$ pins output a ROM select signal.
$\overline{X1}$	0	Extends slot 0.
	1	For $\overline{X3}$ = 1, slot 0 is not extended.

Extended Slot Register

The extended slot register has a set of registers used for slots 0 and 3 which can be extended at the same time. This register outputs inverted data during the read operation.

Since address FFFF is high, the slot can be extended when a NANDed signal at addresses AB8 through AB13 is input to the RSEL terminal; no extended slot select signal is output during access to address FFFF(H).

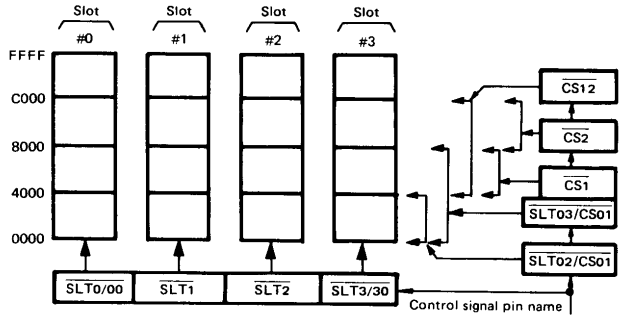
Extended slot	Address	R/W	B7	B6	B5	B4	B3	B2	B1	B0
Slot 0	FFFF (8H)	R/W								
Slot 3	FFFF (8H)	R/W								
				*4		*3		*2		*1

*1 Extended slot designation at addresses 0000 (H) through 3FFF (H)
*2 Extended slot designation at addresses 4000 (H) through 7FFF (H)
*3 Extended slot designation at addresses 8000 (H) through BFFF (H)
*4 Extended slot designation at addresses C000 (H) through FFFF (H)

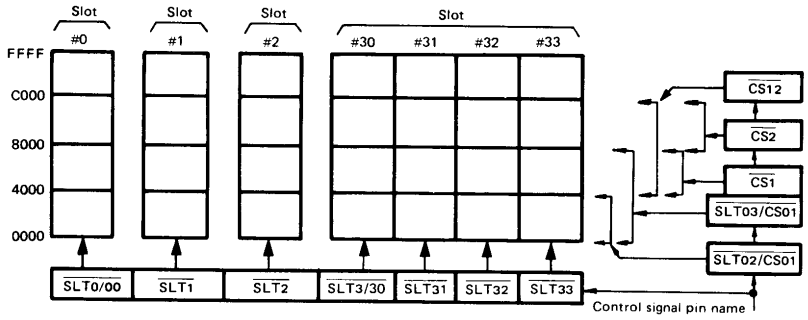
The function for extending each slot is controlled depending on the signal level at X1 and X3 terminals during the reset operation.

Address Map and Slot Extension

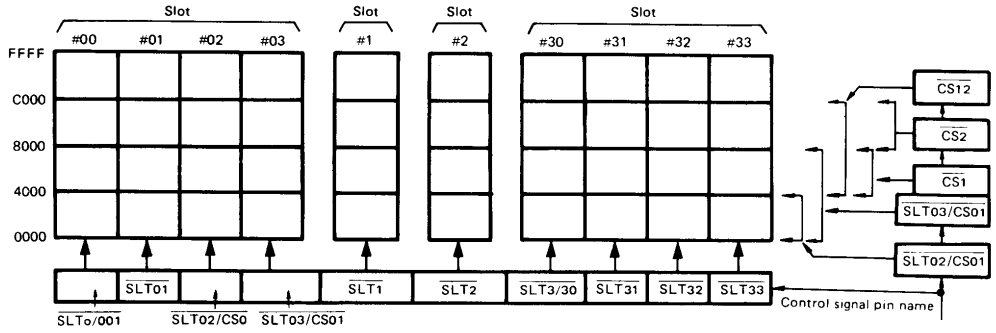
When no slot is extended



When slot 3 is extended



When slots 0 and 3 are extended



I/O Address and Function

Function	I/O address	W/R	Description
Backup RAM	40 (H)	W/R	Maker ID number register
	41	W	Backup RAM address latch
	42	W/R	Backup RAM write/read
Bit map	46	W	Foreground/background color write
	47	W/R	Pattern write, foreground/background color read
Printer	90	W/R	Printer strobe write Printer status read
	91	W/R	Printer data write/read
	93	W	Printer bus direction
VDP	98-9F	W	VDP write
	98-9F	R	VDP read
SSG	A0	W	SSG address latch
	A1	W	SSG data write
	A2	R	SSG data read
Keyboard and slot designation	A8	W/R	Slot designated register
	A9	R	Keyboard return signal read
	AA	W/R	Keyboard drive, cassette, PPI sound write/read
	AB	W	Mode selection
Timer and slot designation	B4	W	Timer and backup RAM address latch
	B5	W/R	Timer and backup RAM data write/read
Kanji	D8, D9	W/R	Kanji write/read
System control	F5	W	System control
Mapper	FC	W/R	Mapper register page 0
	FD	W/R	Mapper register page 1
	FE	W/R	Mapper register page 2
	FF	W/R	Mapper register page 3

Bit Assignment of Keyboard and Slot-Designated Register

Function	Bit	W/R	Description
Slot-designated register	0	W/R	Slot-designated signal at addresses 0000 (H) through 3FFF (H)
	1		
	2		Slot-designated signal at addresses 4000 (H) through 7FFF (H)
	3		
	4		Slot-designated signal at addresses 8000 (H) through BFFF (H)
	5		
	6		Slot-designated signal at addresses C000 (H) through FFFF (H)
	7		
Keyboard return	0	R	$\overline{X0}$ Keyboard return signal
	1		$\overline{X1}$
	2		$\overline{X2}$
	3		$\overline{X3}$
	4		$\overline{X4}$
	5		$\overline{X5}$
	6		$\overline{X6}$
	7		$\overline{X7}$
Keyboard drive register	0	W/R	YA Keyboard drive signals YA through YD
	1		YB
	2		YC
	3		YD
	4		Cassette control REM signal
	5		Cassette write CMO signal
	6		CAPS signal for $\overline{\text{CAPS}}$ lamp
	7		Sound PPISND signal
Mode selection	0	W	0 The level shown on the left allows all of the slot-designated registers and keyboard drive registers to be cleared. This function is the same as that in which ports PA and PC are set to the output position and port PB to the input position in MODE 0 of 8255A.
	1		1
	2		0
	3		0
	4		0
	5		0
	6		0
	7		1
	0	W	B0 The level shown on the left enables the keyboard drive register bit to be set or reset. B1 through B3 indicate the bit number. Set when B0 is "1" and reset when it is "0".
	1		B1
	2		B2
	3		B3
	4		0
	5		0
	6		0
	7		0

Backup RAM (8 bits x 16)

When I/O address 40 (H) is read after ASCII ID number FF (H) is written into I/O address 40 (H), inverted data 01 (H) is obtained. This indicates that the backup RAM (8 bits x 16) and bit map function are ready to be used. When RAM addresses X0 (H) through XF (H) are set using low-order four bits of the address data in I/O address 40 (H), data can be written or read using I/O address 42 (H).

Bit Map Function

As described above, after I/O address 40 (H) is accessed, data is written into I/O address 46 (H) two times (or more), then written into I/O address 47 (H). When I/O address 47 (H) is read, the last data written into I/O address 47 (H) is obtained if bit 7 of data written into I/O address 47 (H) is "0", and the preceding data last written into I/O address 46 (H) is obtained if bit 7 is "1". After that, data written into I/O address 47 (H) is shifted by one bit to the high-order digit, and data of bit 7 is shifted to bit 0. Therefore, data can be obtained in accordance with the data level acquired every time I/O address 47 (H) is read.

Printer

PBUSY: When a signal is input to the PBUSY pin for read operation, the same signal level as that input to B1 is output.

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0
90 (H)	R								

$\overline{\text{PSTB}}$: When data is written as B0=0, the $\overline{\text{PSTB}}$ pin becomes "0" when the WR signal is returned to "1". After that, when data is written as B0=1, the $\overline{\text{PSTB}}$ pin is returned to "1".

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0
90 (H)	W								

PWR: If data is written when the PDIR pin is "1" (in the output state), a positive PWR signal corresponding to the $\overline{\text{WR}}$ signal's pulse width is output to the PWR pin. When this PWR signal is returned to "0", the external circuit latches and outputs the data. When the PDIR pin is "0" (in the input state), the PWR pin remains "1". When the PDIR pin is returned again to the output state, the PWR pin remains unchanged. After I/O address 91 (H) is accessed, the PWR pin becomes "0".

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0
91 (H)	W	Data							

$\overline{\text{PRD}}$: If data is read when the PDIR pin is "0" (in the input state), a negative $\overline{\text{PRD}}$ signal corresponding to the $\overline{\text{RD}}$ signal's pulse width is output to the $\overline{\text{PRD}}$ pin. Using this $\overline{\text{PRD}}$ signal, the external gate is opened and data can be read.

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0
91 (H)	R	Data							

PDIR: When data is written as B1=1 and B0=1, "1" is continuously output from the PDIR pin. MSX then enters the output state. When data is written as B1=1 and B0=0, "0" is continuously output from the PDIR pin. MSX then enters the input state.

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0	
93 (H)	W							1	1	*1
								1	0	*2
								0	1	*3
								0	0	*4

*1 Output state or $\overline{PRST}$ canceled
*2 Input state or $\overline{PRST}$ canceled
*3 $\overline{PRST}$ output
*4 $\overline{PRST}$ canceled

The $\overline{PRST}$ signal can be generated using an external circuit.

When data is written as B1=0 and B0=1 during the reset operation, "0" is continuously output from the $\overline{PRD}$ pin and "1" from the PDIR pin. The $\overline{PRST}$ signal is produced using the resultant two signals. When data is set to and written into the level other than B1=0 and B0=1, the $\overline{PRST}$ signal is canceled.

Mapper

I/O addresses FC (H) through FF (H) have mapper register pages 0 through 3. Their effective number of bits is five (B4 through B0) which correspond to mapper addresses MA18 through MA14. Mapper register pages 0 through 3 are selected using addresses AB15 and AB14, and the resultant content is output as an address.

For a 512k-byte RAM using mapper addresses MA18 through MA14, the 16k-byte area obtained by dividing the 512k-byte capacity which the mapper register content indicates is selectively accessed using addresses AB15 and AB14 by 32. As a result, the function appears if the address is extended.

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0	Register	AB15	AB14
FC (H)	R/W									Mapper register page 0	0	0
FD	R/W									Mapper register page 1	0	1
FE	R/W									Mapper register page 2	1	0
FF	R/W									Mapper register page 3	1	1

Mapper address	MA18	MA17	MA16	MA15	MA14	

Keyboard Bus Direction

When data is written into I/O addresses AA (H) and AB (H), the keyboard bus direction signal is output at a period of one and a half cycles at the completion of the I/O cycle.

SSG and General-Purpose Port

The SSG is controlled using 14 registers which are capable of reading or writting (the registers can be read without being influenced by sound).

Sound is generated by the following: an 8-octave, 3-sequence rectangular wave generator; a one-sequence pseudo random noise generator; an envelope generator for 5-bit single attenuation and repeated attenuation; a volume controller; a mixer for mixing music and noise; and a 5-bit DA converter. The general-purpose port consists of output and input port portions through a register which is capable of reading or writting.

Register Array

When high-order bits DB7 through DB4 of 8-bit address data are "0 (H)", low-order bits DB3 through DB0 select 15 registers. The address data which has been loaded is held until the next address is loaded and is not influenced by the data write/read operation.

The register array is shown in the table below.

Register Array Table

Register	Address (H)	Function \ Bit	B7	B6	B5	B4	B3	B2	B1	B0
R0	00	Frequency of channel A	Fine adjustment of 8-bit tone							
R1	01		××				Coarse adjustment of 4-bit tone			
R2	02	Frequency of channel B	Fine adjustment of 8-bit tone							
R3	03		××				Coarse adjustment of 4-bit tone			
R4	04	Frequency of channel C	Fine adjustment of 8-bit tone							
R5	05		××				Coarse adjustment of 4-bit tone			
R6	06	Noise frequency Setting	××				5-bit noise frequency			
R7	07	emixer and general port	* Port			Noise		Tone		
			"1"	"0"	C	B	A	C	B	A
R8	08	Volume of channel A	××			M	L3	L2	L1	L0
R9	09	Volume of channel B	××			M	L3	L2	L1	L0
RA	0A	Volume of channel C	××			M	L3	L2	L1	L0
RB	0B	Envelope frequency	8-bit fine adjustment							
RC	0C		8-bit coarse adjustment							
RD	0D	Envelope shape	××				CONT ATT ALT HOLD			
××	0E	General input port data	See the general port bit assignment table.							
RF	0F	General output port data								

* The port of register R7 should always be set to the level shown in the table.

General-Purpose Port

The input and output ports are controlled by output port data holding register RF which is operated at address 0E (H) (input) and address 0F (H) (output). The relationship between the bits and input/output pins is shown in the general-purpose port bit assignment table.

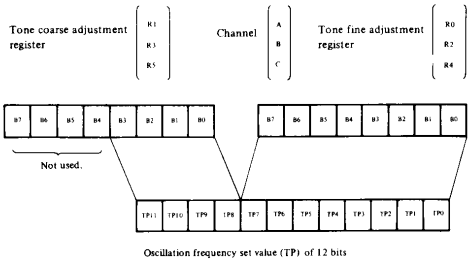
GENERAL-PURPOSE PORT BIT ASSIGNMENT TABLE

Port	Bit	I/O	Pin name connected
Input	B0	I	FWD1 or FWD2
	B1		BACK 1 or BACK 2
	B2		LEFT1 or LEFT2
	B3		RIGHT1 or RIGHT2
	B4		TRGA1 or TRGA2
	B6		JIS/50
	B7		CM1
			FWD1 and FWD2 are selected using B6 at the output port. For B6="1",
Output	B0	O	TRGA1
	B1		TRGB1
	B2		TRGA2
	B3		TRGB2
	B4		STB1
	B5		STB2
	B6		Input select of input ports B0 through B5 (not output externally)
	B7		$\overline{\text{KANA}}$

Setting the Tone Frequency (controlled using registers R0 through R5)

The rectangular wave frequency produced by a 3-sequence tone generator in channels A, B, and C is set using registers R0 through R5. R0 and R1 control channel A, R2 and R3 channel B, and R4 and R5 channel C. Oscillation frequency FT is determined by register value TP (decimal) as shown below. In this case, Fϕ indicates the clock frequency.

$$FT = \frac{F\phi}{32TP}$$

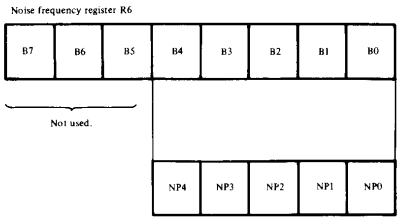


Oscillation frequency set value (TP) of 12 bits

Setting the Noise Frequency (controlled by register R6)

Noise frequency FN is determined by register value NP (decimal) as shown below. In this case, Fϕ indicates the clock frequency.

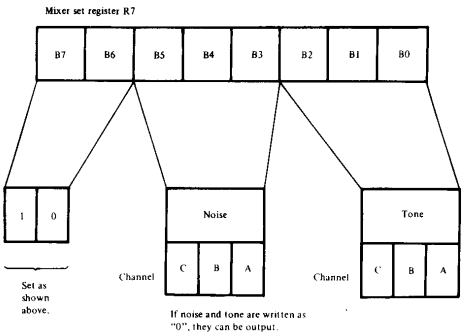
$$FN = \frac{F\phi}{32NP}$$



Noise frequency set value (NP) of 5 bits

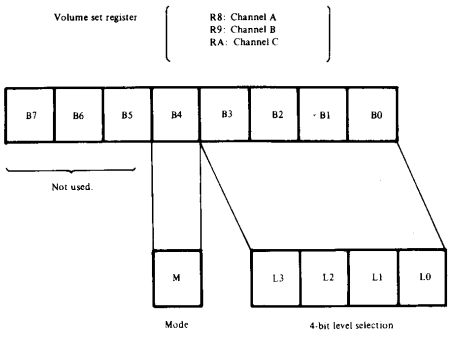
Setting the Mixer (controlled by register R7)

The mixer is used to mix a tone and noise. Mixing is determined by bits B5 through B0 of register R7. If "0" is written into the register, sound is output. Therefore, if both noise and tone are written as "0", they are mixed and output. If either noise or tone is written as "0", only the sound written as "0" is output. If both noise and tone are written as "1", they are not output.



Volume Control (controlled by registers R8 through RA)

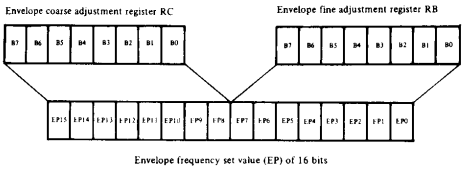
The volume in channels A, B, and C is controlled using registers R8 through RA. Whether the volume is fixed (M=0) or changed (M=1) is selected in mode M. For M=0, one of the 16 combined levels is selected using 4-bit level select signals L3, L2, L1, and L0 to generate a sound. To change the volume, change select signals L3, L2, L1, and L0. For M=1, the volume is controlled using 5-bit signals E4, E3, E2, E1, and E0 which are produced by an internal envelope generator. In this case, signals E4, E3, E2, E1, and E0 are changed with the lapse of time, so the volume is also changed.



Setting the Envelope Frequency (controlled by registers RB and RC)

Envelope repeated frequency FE is determined by envelope frequency set value EP (decimal) as shown below. In this case, Fϕ indicates the clock frequency.

$$FE = \frac{F\phi}{512EP}$$



Using the CONT, ATT, ALT, and HOLD signals, the envelope has various shapes as shown below.

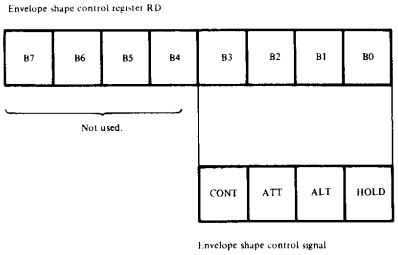
Envelope Shape Table

B3	B2	B1	B0	Envelope shape
CONT	ATT	ALT	HOLD	
0	0	X	X	
0	1	X	X	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

→| 1/fE |← Repeated period of envelope

Envelope Shape Control (controlled by register RD)

The envelope level is determined by a 5-bit (L4, L3, L2, L1, and L0) envelope generator. The envelope shape is produced by incrementing or decrementing the count of the envelope generator and by stopping or repeating it at one cycle. The resultant shape is controlled by bits B3 through B0 of register RD.



Sound Outputs (SSGSNDL, SSGSNDR)

Among the 3-sequence tone signals in channels A, B, and C which are generated by data set in each register, channel B outputs the tone signal to the SSGSNDL pin and channel C outputs it to the SSGSNDR pin. Channel A outputs the tone signal to the SSGSNDL and SSGSNDL and SSGSNDR pins for mixing. As described above, the sound output is used as a stereophonic output with the outputs in the right and left channels. It can also be used as a monaural output by strapping between the SSGSNDL and SSGSNDR pins.

Timer and RAM (4 bits x 26)

The timer block consists of a counter in the next stage of the crystal oscillation circuit; a timer counter indicating seconds, minutes, hours, day of the week, days, month, and year; and an alarm register for minutes, hours, day of the week, and day. Setting or reading the time, calendar timer data, or alarm data is controlled through a mode register. All data can be backed up. The RAM (4 bits x 26) block can also be backed up as in the timer block.

Address Assignment and Initial Condition of Each Counter and Register

If the high-order 4-bits of 8-bit address data are set to any value, the function is selected by the four modes which are indicated using the low-order 4-bits (DB3 through DB0) and address XD (H) mode registers M1 and M0. Addresses X0 (H) through XC (H) can be read and written. Addresses XD (H) through XF (H) can be written only irrespective of their mode state.

Counters and registers have no fixed value during the power-on sequence.

Address Assignment and Function

Mode	0					1					2	3
Address (H)	Bit / Function	B3	B2	B1	B0	Bit / Function	B3	B2	B1	B0	Function	Function
x 0	1 sec counter											
x 1	10 sec counter	X										
x 2	1 min counter					1 min alarm register						
x 3	10 min counter	X				10 min alarm register	X					
x 4	1 hr counter					1 hr alarm register						
x 5	10 hr counter	X	X			10 hr alarm register	X	X			RAM	RAM
x 6	Week counter	X				Week alarm register	X				4 bits x 13	4 bits x 13
x 7	1 day counter					1 day alarm register						
x 8	10 day counter	X	X			10 day alarm register	X	X				
x 9	1 month counter											
x A	10 month counter	X	X			12/24 hr selector	X	X				
x B	1 year counter					Leap year counter	X	X				
x C	10 year counter											

Address (H)	Bit / Function	B3	B2	B1	B0
X D	Mode register	Timer EN	Alarm EN	Mode M1	Mode Mo
X E	Test register	Test T3	Test T2	Test T1	Test T0
X F	Reset controller 16.1Hz register	1Hz ON	16Hz ON		Alarm

Note: The week counter counts from 0 to 6 with the relationship with respect to the day of the week defined voluntarily.

Mode Setting and Alarm and Timer EN Functions (Address XD (H))

The 4-bit mode register consists of mode selectors M1 and M2, timer EN, and alarm EN. The function is as shown in the table below.

Mode	M1	M0	Description
0	0	0	Enables setting and reading of the time and calendar.
1	0	1	Enables setting and reading of the alarm, 12/24 hour, and leap year.
2	1	0	Enables writing and reading of the RAM (4 bits x 13).
3	1	1	Enables writing and reading of the RAM (4 bits x 13).

Function	Level	Description
Alarm EN	0	No alarm signal is output to the $\overline{ALM}$ pin.
	1	An alarm signal is ready to be output to the $\overline{ALM}$ pin.
Timer EN	0	Stops the counter operation after second.
	1	Starts counting.

Reset Controller Function and 16Hz/1Hz Register Setting (Address XF (H))

The alarm and time RESET functions are activated during the write operation, and they have no register.

The 16Hz ON and 1Hz ON functions provided with registers are shown below.

Function	Level	Description
Alarm RESET	1	All the alarm registers are reset during the write operation.
Time RESET	1	The counter operation before second is reset during the write operation.
16Hz ON	0	A 16Hz signal is output to the $\overline{ALM}$ pin.
1Hz ON	0	A 1Hz signal is output to the $\overline{ALM}$ pin.

Test Register (Address x E (H))

The test register consists of T3 through T0. The register is used for testing (except test 0). To activate the timer for the first time, therefore, set each bit to 0 to obtain test 0.

Test	T3	T2	T1	T0	Description
0	0	0	0	0	Activated as a timer.
1	0	0	0	1	Enters the test 1 state.
2	0	0	1	0	Enters the test 2 state.
3	0	0	1	1	Enters the test 3 state. Output to the $\overline{ALM}$ pin.
4	0	1	0	0	Enters the test 4 state.
8	1	0	0	0	Enters the test 8 state.

Setting the 12/24-Hour Selector (Mode 1, Address XA (H))

Whether a 12-hour timer or 24-hour timer is set when the level shown in the table below is written into this register can be determined. The timer should be set after this setting.

Function	Level	Description
12/24-hour selector	0	Activated as a 12-hour timer. In this case, the 10-hour counter and alarm register B1 indicate AM and PM. For B1=0, it indicates AM. For B1=1, it indicates PM.
	1	Activated as a 24-hour timer.

Setting the Leap Year Counter (Mode 1, Address XB(H))

When the level shown in the table below is set in this counter, the counter corresponds to a leap year. The time and calendar should be set after this setting. This counter is also counted up simultaneously with a year counter.

Function	B1	B0	Description
Leap year counter	0	0	Activated as a leap year this year.
	0	1	Activated as a leap year three years later.
	1	0	Activated as a leap year two years later.
	1	1	Activated as a leap year next year.

Setting and Reading the Time and Calendar (Mode 0, Addresses X0 (H) through XC (H))

The timer counter is set by setting the address and writing a valid value into the required bits as time and calendar timer data, in accordance with the address assignment and function table. During the read operation, the timer data can also be obtained by setting and reading the address. Invalid bit levels are always set to "0".

Setting and Reading the Alarm (Model 1, Addresses X2 (H) through X8 (H))

The alarm register is set by setting the address and writing a valid value into the required bits as time and calendar alarm, in accordance with the address assignment and function table. During the read operation, data in the alarm register can also be obtained by setting and reading the address.

When the alarm register indicating minutes, hours, day of the week, day, and year coincides with those of the timer counter (the alarm EN register is in the output enable state), level "0" is output to the $\overline{ALM}$ pin.

When the alarm register is reset using an alarm RESET bit, the consequent written alarm register data coincides with the timer counter. Assume that the alarm register data which has not been written has already coincided with the timer counter. The alarm register data is output to the $\overline{ALM}$ pin. Therefore, the output level at the $\overline{ALM}$ pin is "0" at all times while the alarm register is reset using the alarm RESET bit.

PU-7 (3) (Memory mapper register)

Z80 CPU has an address space of 64 k-bytes. In the MSX system, the bank is selected every page, and the address space can be extended up to 4 M bytes.

For HB-G900AP, a standard main RAM of 512 k-bytes is provided. The main RAM can be extended up to 1 M bytes. The bank is selected using this memory mapper register.

Four mapper registers are provided at I/O addresses FC (H) through FF (H). FC (H) corresponds to page 0, FD (H) to page 1, FE (H) to page 2, and FF (H) to page 3.

The HB-G900AP employs mapper addresses MA18 through MA14, the 16 k-byte area obtained when a 512 k-byte RAM is divided by 1/32 and is accessed using addresses A14 and A15.

I/O address	R/W	B7	B6	B5	B4	B3	B2	B1	B0	Register	A15	A14
FC(H)	R/W									Page 0	0	0
FD	R/W									Page 1	0	1
FE	R/W									Page 2	1	0
FF	R/W									Page 3	1	1
				MA 19	MA 18	MA 17	MA 16	MA 15	MA 14			

Used when extended up to 1M bytes.

PU-7 (4) (RAM)

Four 256k × 4 bit RAMs (1 M-bit RAM) are provided as standard. An additional four RAMs enable the capacity to be extended up to 1 M bytes.

PU-7 (5) (slot block)

Slot pin assignment is show below.

Cartridge Bus

○ LIST OF SIGNAL PINS

PIN NO.	NAME	I/O*	PIN NO.	NAME	I/O*
1	$\overline{CS1}$	O	26	A13	O
2	$\overline{CS2}$	O	27	A1	O
3	$\overline{CS12}$	O	28	A0	O
4	$\overline{SLTSL}$	O	29	A3	O
5	Reserved #	—	30	A2	O
6	$\overline{RFSH}$	O	31	A5	O
7	$\overline{WAIT}$%	I	32	A4	O
8	$\overline{INT}$%	I	33	D1	I/O
9	$\overline{M1}$	O	34	D0	I/O
10	$\overline{BUSDIR}$	I	35	D3	I/O
11	$\overline{IORQ}$	O	36	D2	I/O
12	$\overline{MERQ}$	O	37	D5	I/O
13	$\overline{WR}$	O	38	D4	I/O
14	$\overline{RD}$	O	39	D7	I/O
15	$\overline{RESET}$	O	40	D6	I/O
16	Reserved #	—	41	GND	—
17	A9	O	42	CLOCK	O
18	A15	O	43	GND	—
19	A11	O	44	SW1	—
20	A10	O	45	+5 V	—
21	A7	O	46	SW2	—
22	A6	O	47	+5 V	—
23	A12	O	48	+12 V	—
24	A8	O	49	SOUNDIN	I
25	A14	O	50	−12 V	—

* The Input/output directions are relative to the main unit.

\# Do not use the Reserved PINs.

% OPEN COLLECTOR output

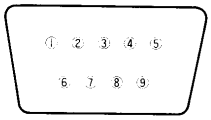
○ LIST OF SIGNAL PINS

PIN NO.	NAME	DESCRIPTION
1	$\overline{CS1}$	ROM 4000 to 7FFFF, selected signal
2	$\overline{CS2}$	ROM 8000 to BFFF, selected signal
3	$\overline{CS12}$	ROM 4000 to BFFF, selected signal (for 256 K ROM)
4	$\overline{SLTSL}$	Slot select signal
5	Reserved	Reserved for future expansion. Do not use this pin.
6	$\overline{RFSH}$	Refresh signal
7	$\overline{WAIT}$	Wait signal to CPU
8	$\overline{INT}$	Interrupt request signal
9	$\overline{M1}$	Fetch cycle signal of CPU
10	$\overline{BUSDIR}$	This signal controls the direction of the external data bus butter when the cartridge is selected. It is LOW when the data is sent by the cartridge.
11	$\overline{IORQ}$	I/O request signal
12	$\overline{MERQ}$	Memory request signal
13	$\overline{WR}$	Write signal
14	$\overline{RD}$	Read signal
15	$\overline{RESET}$	System reset signal
16	Reserved	Reserved for future expansion. Do not use this pin.
17~32	A0~A15	Address bus
33~40	D0~D7	Data bus
41	GND	Ground
42	CLOCK	CPU clock, 3.579 MHz
43	GND	Ground
44, 46	SW1, SW2	Detect Insert/Remove for protection
45, 47	+5 V	+5 V power supply
48	+12 V	+12 V power supply
49	SOUNDIN	Sound input (−5 dbm)
50	−12 V	−12 V power supply

NOTE
The CS signals imply a memory request and a read signal.
Thus they cannot be used as chip select for writable devices such as RAMs.

PU-7 (6)

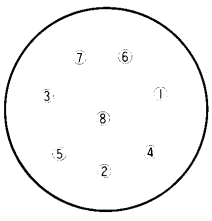
(1) Joystick port (MSX1 compatible)
Two ports are provided for the joystick port. A scan signal is output from S1985, then input through a joystick switching circuit to S1985.
Pin assignment of a 9-pin D-SUB connector and the joystick switching circuit block diagram are shown below.

PIN NO.	SIGNAL NAME	DIRECTION	PIN CONNECTION
1	FWD	Input	
2	BACK	Input	
3	LEFT	Input	
4	RIGHT	Input	
5	+5 V*	———	
6	TRG 1	Input/Output	
7	TRG 2	Output	
8	OUTPUT	Output	
9	GND	———	

* Current capacity: 50 mA each

(2) Cassette interface (MSX1 compatible)
During data loading, data is input from CN107 CMTIN and input through comparator IC150 to S1985 (CMI).
During data saving, data is output from S1985 (CMO) and saved from CN107 CMTOUT to the data recorder through a filter. The remote terminal of the data recorder is controlled using S1985 (REM).
Pin assignment of an 8-pin DIN connector is shown below.

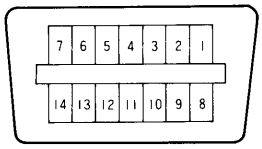
○ TABLE OF SIGNAL PINS

PIN NO.	SIGNAL NAME	DIRECTION	PIN CONNECTION
1	GND	———	
2	GND	———	
3	GND	———	
4	CMTOUT	OUTPUT	
5	CMTIN	INPUT	
6	REMOTE +	OUTPUT	
7	REMOTE −	OUTPUT	
8	GND	———	

(3) Keyboard (MSX1 compatible) + numeric keypad
A keyboard scan signal is output from S1985. The signal corresponding to the key is input through a Keyboard matrix circuit to S1985.
The CAP LOCK LED signal is output from S1985.

(4) Printer (MSXI compatible)

The CPU reads a busy signal from the printer and outputs 8-bit parallel data to the printer through handshaking. Pin assignment of a 14-pin Amphenol connector is shown below.

PIN NO.	SIGNAL NAME	I/O	PIN CONNECTION
1	PSTB	O	
2	PDB0	O	
3	PDB1	O	
4	PDB2	O	
5	PDB3	O	
6	PDB4	O	
7	PDB5	O	
8	PDB6	O	
9	PDB7	O	
10	N.C.	—	
11	BUSY	I	
12	N.C.	—	
13	N.C.	—	
14	GND	—	

PU-7 (7) (RS-232C block)

(1) RS-232C memory and I/O maps

The RS-232C I/O bolck can be accessed at both addresses 80 H through 87 H of the I/O address space and addresses BFF8 H through BFFFH of the memory address space. To keep compatibility with MSX1, memory map or I/O map selection can be controlled using b4 in address BFFAH of the memory address space.

Access from the I/O space is inhibited when the power is turned on or during reset. However, existence of RS-232C in the I/O space is checked when a control signal is input to the RS-232C support software. If the RS-232C is not present, access from the I/O space can be performed by writting "1" into b4 in address BFFAH.

During reset, RS-232C on the I/O map is disabled. When "1" is written into b4 in address BFFAH of slot 02, the I/O map is enabled.

(2) USART (IC147) 8251AFC

The 8-bit parallel data from the CPU is converted into serial data, and the serial data into parallel data .

Moreover, start and stop bits are added and transfer errors are checked. Operations are set using an RS-232C ROM. For further details, refer to the individual manufacturer's operation manual.

(3) CTC (IC153) 8253

The CTC has three independent 16-bit counters and can produce any program is accordance with a mode control command from the CPU. For MSX, CH0 is used for a receiving clock, and CH1 for a transmitting clock. CH2 can be read from b6 in address 82H on the I/O map. Bit assignment in read operation at address 82 H is shown below.

82H Read: Get System Status

Data Bit	Description
D7	CTS (Clear To Send) 0: CTS Asserted 1: CTS Negated
D6	Timer/Counter Output-2 from i8253
D5 D4 D3 D2	Reserved
D1	+ RI (Ring Indicator) 0: RI Asserted 1: RI Negated
D0	+ CD (Carrier Detect) 0: CD Asserted 1: CD Negated

NOTE: The signals with the plus (+) sign are optional.
If only one signal is chosen, it must be 'CD'.

The baud rate list is shown below. The baud rate can be easily changed using an extended command from the RS-232C ROM.

A. CRYSTAL FREQUENCY

The crystal frequency is 1.8432 MHz.

Baud rate (Baud)	Scale Factor and Error (x16)		
50	2304		
75	1536		
110	1047	110.0287	+0.3%
150	768		
300	384		
600	192		
1200	96		
1800	64		
2000	58	1986.2	−0.7%
2400	48		
3600	32		
4800	24		
7200	16		
9600	12		
19200	6		

(4) RS-232C

The HB-G900AP has an internal RS-232C interface.
Therefore, the unit can be connected to an LDP, printer, character display, or MODEM which has an RS-232C interface.
However, the signal direction at the 25-pin D-SUB connector pin is reversed depending on whether the destination to be connected is a terminal or MODEM.
To select the signal direction, turn the relay on the connector board (CN-4 board) on or off using the HB-G900AP rear switch.
Pin assignment of a 25-pin D-SUB connector is shown below.

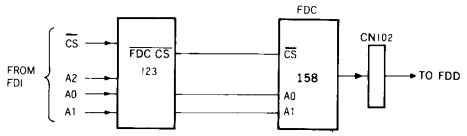
Pin	Signal	Pin	Signal
1	Frame Ground	14	
2	Transmit Data	15	
3	Receive Data	16	
4	Request To Send	17	
5	Clear To Send	18	
6	Data Set Ready	19	
7	Signal Ground	20	Data Terminal Ready
8	Carrier Detect	21	
9		22	Ring Indicator
10		23	
11		24	
12		25	
13			

PU-7 (8) (FDC)

Memory Map Det

Address Port	Write Mode of CPU	Read Mode of CPU
7FF8H	Command Register	Status Register
7FF9H	Track Register	Track Register
7FFAH	Sector Register	Sector Register
7FFBH	Data Register	Data Register
7FFCH	SideSelect	SideSelect
7FFDH	DriveSelect	Drive Select
7FFFH		IRQ/DRQ Status

Selection of Individual FDC (IC158) Registers
Individual registers of the FDC (IC158) have been allocated to addresses 7FFBH, and are selected by address signals A0 through A2 and signal CS.



CR ; COMMAND REGISTER
DR ; DATA REGISTER
DSR ; DATA SHIFT REGISTER
SCR ; SECTOR REGISTER
TR ; TRACK REGISTER
STR ; STATUS REGISTER

REGISTER SELECTION

CS	A1	A0	RE = 0	WE = 0
1	X	X	NON SELECT	DAL = HI-Z
0	0	0	STR	CR
0	0	1	TR	TR
0	1	0	SCR	SCR
0	1	1	DR DR	

0 : LOW LEVEL
1 : HIGH LEVEL
X : DON'T CARE
HI-Z : HIGH IMPEDANCE

PU-7 (9)

(1) Audio mixer block (Q102)
The PSG and PPI sounds in S1985 are mixed with the sound from cartrige slots 1 and 2.

(2) DSP board interface block
PU-7 and DSP-8 boards are connected using connector CN101.

Switching Specifications

1. INTERLACE/NONINTERLACE

Output of an RGB multiconnector composite sync signal from CX-773B (INTERLACE only) or VDP-9938 (INTERLACE and NONINTERLACE selected using software) is selected. When the switch is set to INTERLACE, a correct PAL signal is output.
When the switch is set to NONITERLACE, an NTSC signal is output instead of the PAL signal.
The switch is set to INTERLACE at the factory.

2. PERI TV/PVM

The output signal from a 21-pin RGB connector into the CENELEC or PVM specifications is selected. The selected signal is shown in the table below.
The switch is set to PERI TV as the factory.

	PERI TV	PVM
AVC	0~+12 V	0~+5 V
YS	0.7 V_{P-P}	TTL level
C.SYNC	0.3 V_{P-P} or video signal	TTL level

3. TO MODEM/TO TERMINAL

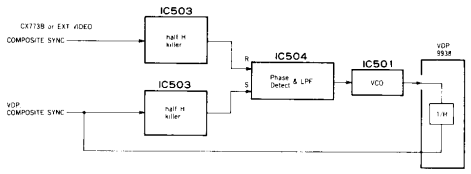
The signal line is selected depending on whether the destination device connected to the RS-232C connector is a terminal or a MODEM. The selected signal is shown below.

Transmitted data ←——→ Received data
CTS ←——→ RTS
DTR ←——→ DSR

The signal line is set to MODEM at the factory.
(4) Color bus, DLCLK
When the HBI-G900 is connected for digitization, the A/D-converted data is loaded into VDP through the color bus.
The timing signal for loading is a DLCLK.
(5) YS
This is switching signal used to superimpose the computer graphics and video signal.

SG-106 Board

(1) PLL circuit (TC5081, 74LS628)
The block diagram is shown below.

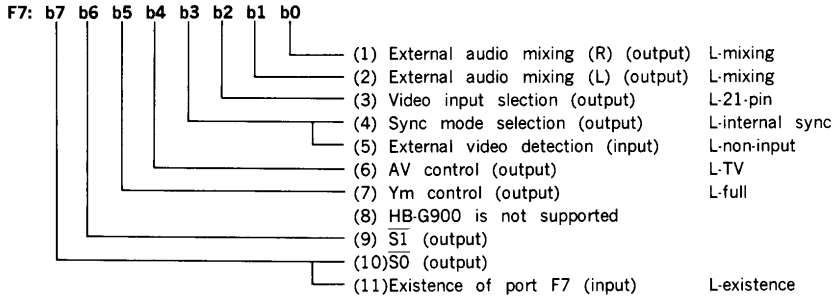


In the internal sync mode, the PLL circuit is constituted using the composite sync signal output from CX-773B as the reference signal. The phase detector is used to compare the edges of the composite sync signals input to terminals R and S and to output the resultant error signals to the PD OUT terminal. The error signals are then input to the AIN terminal and fed through a low-pass filter to VCO IC501 . The Y output from the VCO is input to the VDP clock terminal. The clock is varied from 20.26 MHz (min.) to 22.55 MHz (max.). In the external sync mode, the PLL circuit is constituted using the AFC (IC520) H OUT signal as the reference signal.

DSP-8 board

(1) VDP, VRAM (IC313, IC309, IC310, IC311, IC312)
The VDP uses V9938 and has a screen display function.
The VRAM has a capacity of 128 k bytes.

(2) F7 port latch (IC307)



Bit contents

Inverted negative logics C0 and C1 in bits 4 and 5 of VDP register 9 are output to bits 7 and 6. The relationship between bits 6 and 7 and the display mode is shown in the table below. Bit 7 indicates existence of port F7 during signal input. When bit 7 is set to low (0), the F7 port is present.

b7	b6	Display mode
0	0	Not defined
0	1	Television screen
1	0	Computer display/Superimpose
1	1	Computer display

The Ym of bit 5 is not supported because it does not conform to the CENELEC specifications. For the AV control of bit 4, when the output is high or the RGB multiconnector video input is low, a broadcast wave video signal is selected. Bit 3 detects the video input during signal input and indicates existence of an input signal from the input terminal selected using bit 2. When signal input is detected, output is 1 (high). Bit 3 is not influenced by the mode set using bits 6 and 7. The sync mode is selected during signal output.
Bit 2 is used to select video and audio input terminals. An RGB multiconnector is selected when the input is 0, and a BNC connector is selected when it is 1.
Bit 1 indicates external audio input mixing the left channel. Bit 0 indicates external audio input mixing in the right channel. For 0, the computer sound is mixed with an external input sound since mixing is on. For 1, only the computer sound is output since mixing is off.

Initialized value

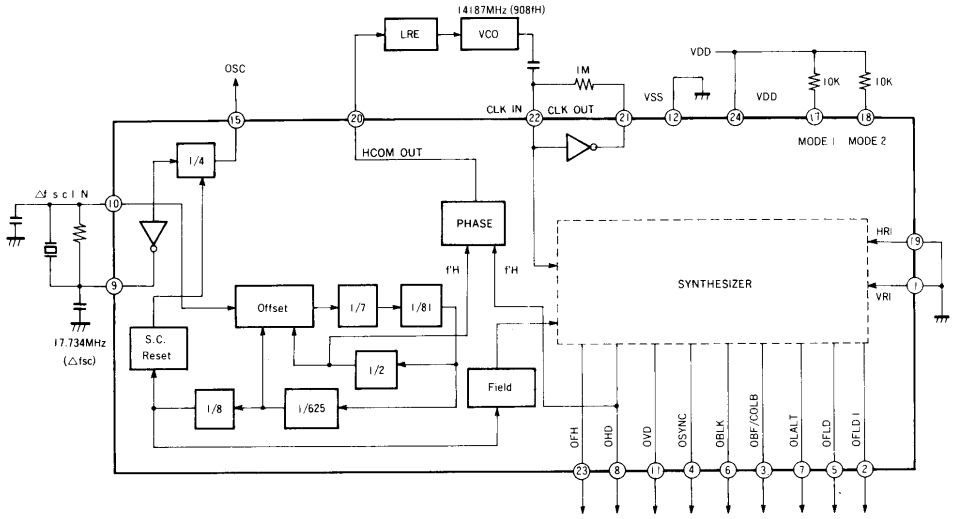
Initializing is performed using a system program.

Initalizing

Initializing is performed using an MSX-BASIC version 2 set video command.

(3) Audio mixer
The computer sound and external input sound mixed using the audio mixer.
Use bit 2 at port F7 to input the external sound from either an RGB multiconnectror a pin jack. The mixing mode can be selected using bits 1 and 0 at port F7. The above selection can be set using a set video command.
The volume control on the front panel is used to adjust the computer volume. The external sound cannot be controlled using the volume control.
The pin jack block is through-output using relays RY301 and RY302 when the power is turned off.

(2) Video signal generator (CX-773B)



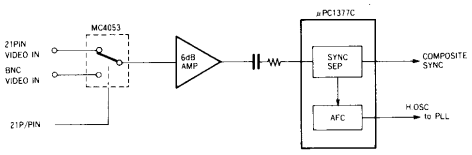
The video signal generator configuration is shown above.

In the internal sync mode, the generator functions primarily as follows:

- Outputs the composite sync signal as a PLL reference signal.
- Outputs various signals (subcarrier, alternating-current pulse, etc.) to the 36-pin Amphenol connector to generate an encoded video signal when the HBI-G900 is connected.

(3) Sync separator (μPC1377C) IC520

The block diagram is shown below.

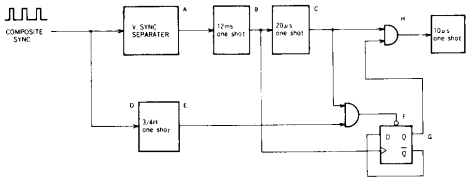


The selected video signal is amplified by 6 dB using a set video command and fed to the sync separator (μPC1377C).

The sync-separated composite sync signal is used in a first field detector. In the external sync mode, the composite sync signal is also used as a PVM monitor composite sync signal. The sync separator has an internal AFC circuit. The H signal output through the AFC circuit is used as a PLL reference signal in the external sync mode. Use of the AFC circuit can suppress computer graphics distortion caused by the VTR faulty playback.

(4) First field detetector

The block diagram is shown below.

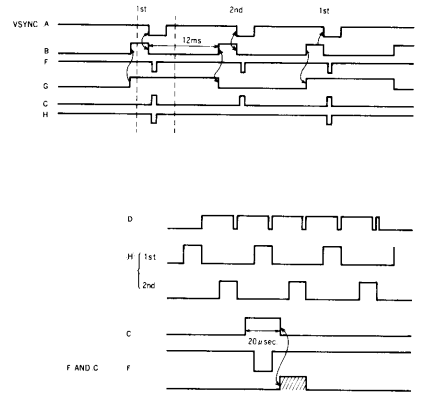


The timing chart is shown on the next page.

The first field detector operation is described here. A V sync signal is detectd from the sync-separated composite sync signal. V reset pulse C is generated after 20 μsec from the trailing edge of the V sync signal (the trailing edge is adjusted using RV). However, in this case, V reset operations cannot be performed in the first field. Threfore, masking is required so that the V reset pulse is not generated in the second field. Frame signal G is obtained by inserting a V sync signal into the flip-flop and frequency-dividing the signal by two.

The frame signal is reset every first field. First field signal F is obtained by ANDing a 3/4 H one-shot pulse and a 20 μsec pulse. (The fimst field signal can be distinguished from the second field signal by applying the 3/4 one-shot pulse.) A 12 msec one-shot multivibrator is used to prevent the computer graphics from being vertically distorted by using the false V sync signal and V sync signal from the VTR.

First Field Detector Timing Chart



(5) INTERLACE/NONINTERLACE select switch
Refer to the Switching Specifications.

(6) GENLOCK ON/OFF select switch
When external synchronization is selected using a set video command an external video signal is input, the select switch is set to the external sync mode. The sync block is separated from signal generator CX-773B and switched to the external video block.

A/V Control F7H Port

	Write	Read
b7	$\overline{S0}$	F7 port ID L: ACTIVE
6	$\overline{S1}$	*
5	Ym Control L: Full	*
4	AV Control L: TV	*
3	Sync Mode L: Internal	Video sense L: NON
2	Video Input Select L: 21 pin	*
1	Audio L L: Mix On	*
0	Audio R L: Mix On	*

System Control F5H Port

	Write
b7	*
6	*
5	*
4	*
3	F7 port EN L: Enable
2	*
1	*
0	*

Floppy Disk Controller D0~D3H
+Memory Map

Calender Clock B4H, B5H Port

B4 Address Latch

	Write
b7	*
6	*
5	*
4	*
3	A3
2	A2
1	A1
0	A0

B5 Data

	Write	Read
b7	*	*
6	*	*
5	*	*
4	*	*
3	D3	D3
2	D2	D2
1	D1	D1
0	D0	D0

PPI (8255) A8~ABH

	A8H Aport	A9H Bport
b7	D7	D7
6	D6	D6
5	D5	D5
4	D4	D4
3	D3	D3
2	D2	D2
1	D1	D1
0	D0	D0

ABH COMMAND REGISTER
WRITE

b7	1	
6	PAGP	0,0 } model 0,1 } model1 1,1 1,0 } model2
5		
4	PA0-7	0: Output
3	PA4-7	0: Output
2	PBGP	0: model0 1: model1
1	PB0-7	0: Output
0	PC0-3	0: Output

PSG (AY-3-8910) A0-A2H

A0H ADDRESS LATCH
Write

b7	AD7
6	AD6
5	AD5
4	AD4
3	AD3
2	AD2
1	AD1
0	AD0

PS-232C 80-87H port

80H 8251 Write/Read — Data port

b7 | b0	D7-D0

81H 8251 Write — Command/port

			Read
b7	Stop bit	*	DSR
6		reset	Break charactor
5	even parity	RTS	Framing error
4	parity enable	⇨ error reset	Over run error
3	charactor length	B reak charactor	parity error
2		Receive enable	TXD
1	baudrate	DTR	RX ready
0		Tramsmit enabae	TX ready

82H Read

b7	CTS	0: enable
6	Counter2	
5	*	
4	*	
3	*	
2	*	
1	RI	0: Asserted
0	CD	0: Asserted

83H Write

b7 | b1	*	
b0	Rx ready	0: enable interrupt

84H — Counter0, 85 H— Counter1,
86H — Counter2, data Write/read
87H Mode Registor
Write

b7	Select Count
b6	
b5	Read/load
b4	
3	mode
2	
1	
0	BDD

A1H	DATA WRITE WRITE (A1H only)	A2H DTAT READ READ (A2H only)
b7	D7	D7
6	D6	D6
5	D5	D5
4	D4	D4
3	D3	D3
2	D2	D2
1	D1	D1
0	D0	D0

VDP (9938) 98-9BH

98H	Video RAM data	R/W
99H	Command & Status Register	R/W
9AH	Color palette Register data	W
9BH	Indirect assignment data	W

For bit assignment, refer to the VPP technical data book. because of its many registers.

PRINTER 90H-91H

90H	Write	Read
b7 | b2	*	*
b1	*	Busy state 1 : Not busy
b0	Strobe output L : enable	*

91H	Write
b7 | b0	D7-D0