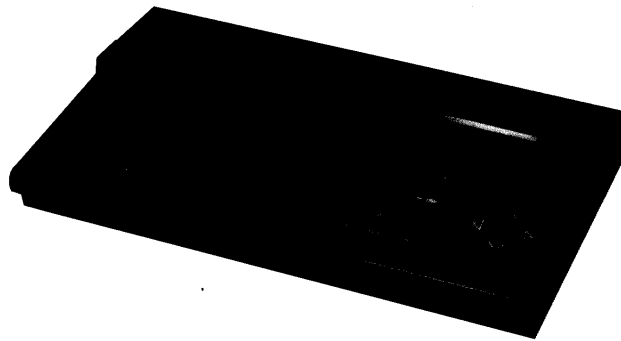


HB-55P/75P/75B

SERVICE MANUAL



HOME COMPUTER
SONY[®]

*Scanned and converted to PDF by HansO, 2003
Original supplied by David J Haslett*

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CHAPTER 1 OPERATION

1-1. FEATURES

Possible to connect any monitor TV

The HB-55P/75P/75B has an RF connector and a 6-pin DIN-type VIDEO/AUDIO connector for video/audio output. In addition to this, the HB-75P/75B has an analog RGB connector, so that any type of monitor TV can be connected to the computer.

Various graphic patterns and characters input

Combinations of normal alphanumeric keys and control keys allow you to easily input up to 252 kinds of characters, symbols and graphic patterns from the keyboard.

Built-in MSX-BASIC

The built-in MSX-BASIC has 119 commands which allow you easy program development. With the MSX-BASIC sprite function, you can make and move the different patterns on each of the 32 sprite planes. The sound generator makes it possible to output three tones and one noise simultaneously, so that you can generate various effect sound or music by using the PLAY and SOUND command of the MSX-BASIC. Two supplied manuals for the MSX-BASIC will tell you not only how to use the MSX-BASIC but also the pleasure of programming.

Easy-to-use Personal Data Bank

The Personal Data Bank, which is the other built-in software, makes it easy to handle personal data such as addresses, phone numbers, and so on. Convenient to use, you are sure to find many uses for it.

Various peripherals for the HB-55P/75P/75B

Various peripherals can be connected: MSX-BASIC program and data and the Personal Data Bank data can be saved on an audio cassette tape, a data cartridge, or a micro floppydisk. To print out data or graphics, the color plotter printer is useful. When playing a computer game, you can use up to two joystick controllers to make the game more exciting.

Peripheral devices for HB-55P/75P/75B

Device name	Major features
HBD-50 Micro Floppydisk Drive	<ul style="list-style-type: none"> High-density information storage Easy-to-operate Fast recall of data
JS-55 Joystick	<ul style="list-style-type: none"> Designed for left- or right handed players Shoot buttons on both left and right
JS-75 Wireless Joystick	<ul style="list-style-type: none"> No cords to get tangled Can be operated from up to 7 meters away
TCM-3000D Datacarder	<ul style="list-style-type: none"> Easy to operate with any computer High-speed data transfer
PRN-C41 Color Plotter Printer	<ul style="list-style-type: none"> Four-color printer: black, blue, green and red Light weight and compact Can use any paper up to 114mm in width

1-2. SPECIFICATIONS

CPU

Processor used Z-80A
Clock frequency 3.579545MHz
WAIT 1 WAIT at CPU M1 cycle
Interrupt Maskable interrupt
Z-80A mode 0
mode 1
mode 2

Resetting

Automatic at power on/Manual
(Memory contents are not saved.)

Memory

Main memory HB-55P
16K bytes RAM
Expansion is possible up to 32K bytes or
64K bytes with Sony Expansion Memory
Cartridge HBM-16/HBM-64.
HB-75P/75B
64K bytes RAM
ROM 48K bytes
MSX-BASIC: 32K bytes
Utility Program: 16K bytes

CRT display

CRT controller TMS9929ANL
Display screen Character display, graphic display and border area

Character display

8×8 dot matrix/character
37 characters×24 lines, 16 colors
(max. 40×24)

(The initial state in MSX-BASIC is set to this mode.)

Graphic display

16 colors
Graphic I II
256 (horizontal) × 192 (vertical) dots
Multi-color
64 blocks (horizontal) × 48 blocks (vertical)
Sprite function

Border area

Number of sprite plane: 32

Output interface

16-color display
PAL video output: composite video signal
1 V p-p, 75 ohms, sync negative
RGB video output: RGB analog signal, 0–0.7 V,
RF signal: TV UHF 36ch
Audio output: –5 dBs

I/O interface

Keyboard

Software scanning
Total number of keys: 73 (HB-55P)
74 (HB-75P/75B)
Control keys: 11 (HB-55P)
12 (HB-75P/75B)
Function keys: 5
Edit keys: 8

Audio cassette interface

8-pin DIN jack
Baud rate: 1200/2400 bauds
Baud rate is selectable with the CSAVE
command or the SCREEN command of
MSX-BASIC.

Sound generator

Remote control function provided
8-octave, 3 tones and 1 noise output

Printer interface

14-pin connector
TTL level
Standard 8-bit parallel transfer
9-pin connector (2)

Joystick interface

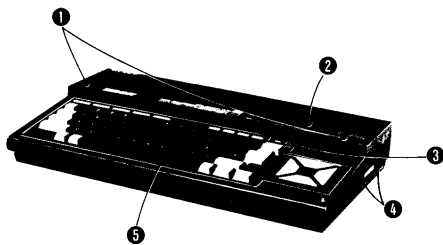
MSX cartridge slot (2)

General

Power requirement HB-55P/75P
220 V ac ±10%, 50/60 Hz
HB-75B
240 V ac ±10%, 50/60 Hz
Power consumption 24W (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 Approx. 405×67×245 mm (w/h/d)
(16×2⁷/₄×9⁹/₄ inches)
main unit only, including projecting parts and controls
Weight Approx. 3.5 kg (7 lb 12 oz)
main unit only
Accessories supplied
75-ohm coaxial cable (1)
Cassette interface cable (1)
Antenna selector (1)
Receptacle for Cartridge slot B (1)
Operating Instructions (1)
How to use Personal Data Bank (1)
Introduction to MSX-BASIC (1)
MSX-BASIC Programming Reference Manual (1)
Graphic pattern sheet (1)
Graphic pattern decal (only HB-75P/75B) (1)

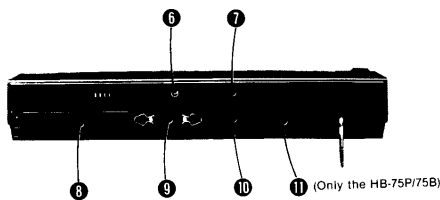
While the information given is true at the time of printing, small production changes in the course of our company's policy of improvement through research and design might necessarily be indicated in the specifications. We would ask you to check with your appointed Sony dealer if clarification on any point required.

1-3. LOCATION AND FUNCTION OF PARTS AND CONTROLS



(This photo is the HB-75P.)

Rear



1 POWER switch and indicator

Press the switch to turn on the computer. To turn off, press the switch again. The indicator lights up while the power is on.

2 Cartridge slot A

Accepts a ROM cartridge or a RAM cartridge here.

3 RESET button

Press this button if there is a program overrun to reset the computer to the initial state. When the button is pressed, the built-in memory contents will be destroyed.

4 CONTROLLER A and B connectors

Accepts joystick controllers. When using only one joystick controller, connect it to the CONTROLLER A connector.

5 Keyboard

Is used to input the program and the data into the computer.

6 RF (RF output) connector

When using a normal TV receiver, connect this connector to the TV antenna terminal with a 75-ohm coaxial cable.

7 VIDEO/AUDIO (video/audio output) connector (6-pin DIN connector)

Connect to the monitor TV with a 6-pin DIN connector. This connector outputs both the video and the audio signals.

8 Cartridge slot B

This slot can be used to insert a ROM cartridge or a RAM cartridge (an expansion memory cartridge, a game cartridge and so on) as the secondary slot. This slot is the same as cartridge slot A. Before using this slot, the receptacle should be installed.

9 PRINTER connector (14-pin connector)

Connect an 8-bit parallel transfer printer with MSX specifications such as the Sony PRN-C41 color plotter printer.

10 TAPE connector (8-pin DIN connector)

Connect to a tape recorder to save a program or data on a cassette tape or to load them into the computer from a tape.

11 RGB (RGB output) connector (21-pin connector)

The HB-55P is not equipped with this connector. Connect to the monitor TV having an analog RGB input connector.

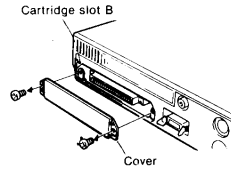
1-4. CONNECTION

Make sure to turn off the computer and all the devices to be connected.

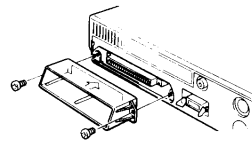
INSTALLING THE RECEPTACLE FOR CARTRIDGE SLOT B

When cartridge slot B is to be used, install the receptacle supplied.

1. Loosen the two screws, and remove the slot cover.



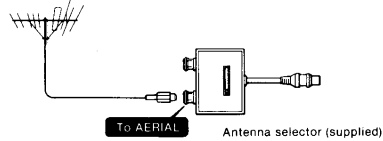
2. Fix the receptacle with screws.



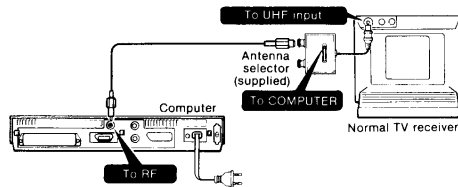
CONNECTING A MONITOR TV

Connecting a normal TV receiver

1. Connect the TV antenna terminal to the supplied antenna selector.



2. Connect a TV receiver to the computer.

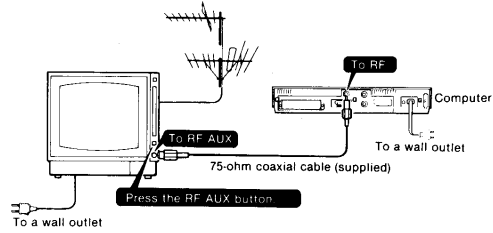


Notes

- Set the switch of the antenna selector to the COMPUTER position when using the computer; To watch TV, set it to the AERIAL position.
- Select the channel UHF 36 for the computer.

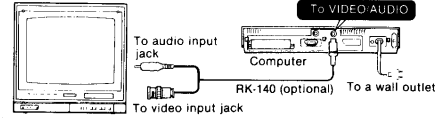
HB-55P/75P/75B(AE/UK)

Connecting a monitor TV with RF AUX connector in front

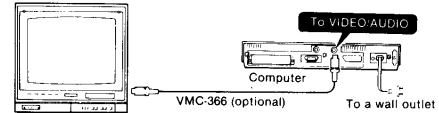


If your monitor TV has a composite video signal input (BNC-type or 6-pin DIN type)

BNC-type

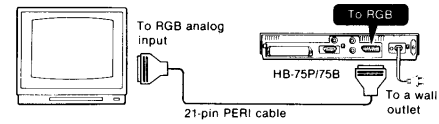


6-pin DIN type



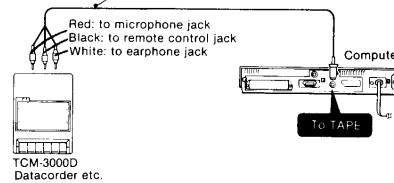
Connecting a color monitor

Connect a color monitor having a 21-pin analog RGB signal input.



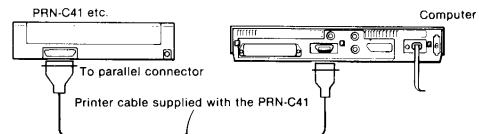
CONNECTING A TAPE RECORDER AS AN EXTERNAL MEMORY

Cassette interface cable (supplied)



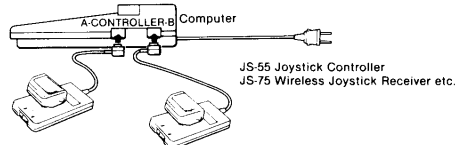
CONNECTING A PRINTER

PRN-C41 etc.



CONNECTING A JOYSTICK CONTROLLER

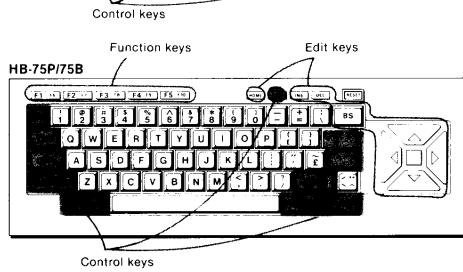
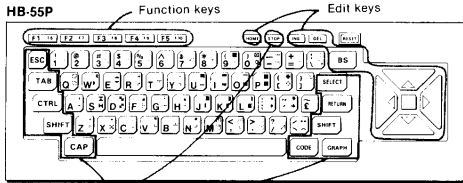
A-CONTROLLER B Computer



1-5. KEYBOARD OPERATION

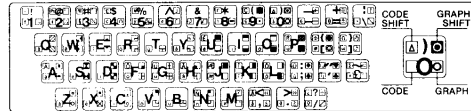
KEY ARRANGEMENT

Alphanumeric characters are arranged in the standard QWERTY type-writer keyboard, as shown below.



In the HB-55P, the graphic patterns are printed on the keyboard, while in the HB-75P/75B, graphic pattern decal can be affixed to the keyboard.

The supplied graphic pattern sheet is as follows:



To enter these patterns or characters.

The keyboard has character input, control, edit and function keys. When a character input key is pressed, the corresponding character is entered into the computer. When a control key is pressed, the corresponding operation is performed.

Character input keys: A to Z, 0 to 9, +, ?, -, ", and so forth.

The space bar generates a blank space.

Edit keys: HOME, INS, DEL, BS and cursor move keys (←, →, ↑, ↓).

Control keys: SHIFT, CAP, CODE, GRAPH, CTRL, TAB, RETURN, ESC, STOP, and SELECT.

Function keys: F1 (F6) to F5 (F10).

CHARACTER INPUT

To enter characters

When a character input key is pressed, the small letter or symbol printed on the lower part on the key top is entered.

Pressed key	Character or symbol to be entered	
	t	(HB-55P)
	6	(HB-75P/75B)

When a character input key is pressed with the SHIFT key, the capital letter or symbol printed on the upper part of the key top is entered.

Pressed key	Character or symbol to be entered	
SHIFT +	S	(HB-55P)
SHIFT +	+	(HB-75P/75B)

To enter only capital letters

Depress the CAP key. When this key is pressed, it will lock; when pressed again, it will unlock. While this key locks, the CAP indicator lights up, and the 26 alphabet letters are entered in caps (just as when the SHIFT key is pressed in the normal mode), but numbers and symbols are entered in the normal mode.

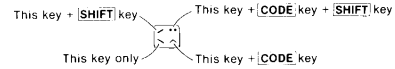
Locked key	Pressed key	Character or symbol to be entered	
CAP		K	(HB-55P)
CAP		7	(HB-75P/75B)

To put an accent mark on a character

Key is used to put an accent mark on a character.

To put the accent mark printed on the lower-left of the key () on a character, first, press key (in this step, no symbol is displayed on the screen). Then, press the character input key needing an accent mark. The character with an accent mark is displayed.

In the same way, to put the accent mark on the upper-left of the key ('), press the key while pressing the SHIFT key. To put the accent mark on the lower-right of the key ("), press the key together with the CODE key. To put the accent mark on the upper-right of the key ("), press the key while pressing the SHIFT key and the CODE key.



To enter a character or symbol printed on the graphic pattern sheet

The procedure to enter a character or symbol printed on the supplied graphic pattern sheet is as follows:

To enter graphic patterns

To enter the graphic pattern printed on the lower-right part of the key on the graphic pattern sheet, press the corresponding keyboard character input key while pressing the GRAPH key.

Pressed key	Graphic pattern to be entered	
GRAPH +		(HB-55P)
GRAPH +		(HB-75P/75B)

To enter the graphic pattern printed on the upper-right part of the key on the graphic pattern sheet, press the corresponding keyboard character input key while pressing the GRAPH key and the SHIFT key.

Pressed key	Graphic pattern to be entered	
GRAPH + SHIFT +		(HB-55P)
GRAPH + SHIFT +		(HB-75P/75B)

To enter special characters

To enter the character or symbol printed on the lower-left part of the key on the graphic pattern sheet, press the corresponding keyboard character input key while pressing the CODE key.

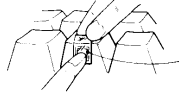
Pressed key	Character or symbol to be entered	
CODE +	ø	(HB-55P)
CODE +	ï	(HB-75P/75B)

To enter the character or symbol printed on the upper-left part of the key on the graphic pattern sheet, press the corresponding keyboard character input key while pressing the **[CODE]** key and the **[SHIFT]** key.

Pressed key	Character or symbol to be entered	
[CODE] + [SHIFT] +	¥	(HB-55P)
[CODE] + [SHIFT] + [N]	Ñ	(HB-75P/75B)

Notes

- When using the **[CODE]** key, release the **[CAP]** lock state.
- In the HB-75P/75B, graphic pattern decal, which can be affixed to the keyboard, is supplied.



Align the line on the decal with the end of the key.
Putting your finger on the pattern, remove the upper decal.

EDIT KEY FUNCTIONS

Keys **[HOME]**, **[INS]**, **[DEL]**, **[BS]** and cursor move keys are mainly used for editing a line or screen. Each function is determined by the software used, so read the relevant Software Guide for details. Under MSX-BASIC, the edit keys function as follows:

[HOME] key

When this key is pressed, the cursor moves to the upper-left corner of the display screen. The characters displayed on the screen remain. When pressing this key together with the **[SHIFT]** key, the cursor moves to the upper-left corner of the screen, while any character displayed on the screen is erased.

[INS] (insert) key

Once this key is pressed, the computer is set to the insert mode. In this mode, the cursor becomes smaller and the character at the cursor position and the followings are moved one space to the right when a key is pressed, and you can insert as many characters as you want. When pressing this key again or moving the cursor with cursor move keys, the insert mode will be released.

[DEL] (delete) key

The character at the cursor position is deleted. All characters after the deleted character are moved one space to the left.

[BS] (back space) key

When this key is pressed, the cursor moves one space to the left and the character in that position is deleted.

(cursor move) keys

These keys are used to move the cursor one space in the direction of the triangle: to the right, to the left, up or down. Any character which the cursor moves over does not change.

CONTROL KEY FUNCTIONS

[SHIFT] key

When this key is pressed together with a character input key, the corresponding symbol in the shift position (upper-left symbol on the key) or corresponding capital letter is entered.

[CAP] key

When this key is pressed, it will lock so that all letters are entered in capitals. Numbers and symbols will be entered normally even if this key locks. When the key is pressed again, it will unlock. While this key is locked, the CAP indicator lights up.

[CODE] key

When this key is pressed together with a character input key, the lower-left character or symbol printed on the graphic pattern sheet (supplied) is entered.

When this key is pressed together with a character input key and the **[SHIFT]** key, the upper-left character or symbol on the graphic pattern sheet is entered.

[GRAPH] key

When this key is pressed together with a character input key, the lower-right graphic pattern printed on the graphic pattern sheet is entered. When this key is pressed together with a character input key and the **[SHIFT]** key, the upper-right graphic pattern printed on the graphic pattern sheet is entered. In the HB-55P, graphic patterns are also printed on the keyboard.

[CTRL] (control) key

When this key is pressed together with certain keys, a special operation is performed. The key function is determined by the software used. Under MSX-BASIC, the following key combinations are available:

- CTRL + B** : moves the cursor to the beginning of the word at the cursor position. When the cursor is positioned at the beginning of a word, the cursor moves to the beginning of the preceding word.
- CTRL + C** : releases to input wait state or automatic line number generation.
- CTRL + E** : deletes the character between the cursor position and the end of the line.
- CTRL + F** : moves the cursor to the beginning of the next word.
- CTRL + G** : generates a beep sound.
- CTRL + H** : has the same function as the **[BS]** key.
- CTRL + I** : has the same function as the **[TAB]** key.
- CTRL + J** : moves the cursor one line down.
- CTRL + K** : has the same function as the **[HOME]** key.
- CTRL + L** : has the same function as the **[SHIFT]** key + **[HOME]** key.
- CTRL + M** : has the same function as the **[RETURN]** key.
- CTRL + N** : moves the cursor to a position next to the last character in the line.
- CTRL + R** : has the same function as the **[INS]** key.
- CTRL + U** : deletes the characters of the line at the cursor position.
- CTRL + X** : has the same function as the **[SELECT]** key.
- CTRL + >** : moves the cursor to the right.
- CTRL + <** : moves the cursor to the left.
- CTRL + ^** : moves the cursor up.
- CTRL + _** (underline) : moves the cursor down.

[TAB] key

This key is used to move the cursor to the next tab position. In MSX-BASIC, tabs are set at every eight characters. Any characters which the cursor goes over are deleted when the cursor moves to the next tab position.

[RETURN] key

Press this key to indicate the end of a line of data or commands input from the keyboard. Press this key every time you finish entering a line.

[ESC] (escape) key

The function of this key is determined by the software used. Under MSX-BASIC, this key is inoperative.

[STOP] key

Press this key to interrupt program execution or listing. You can restart the program by pressing this key again. Pressing this key together with the **[CTRL]** key does the same. In this case, however, you can restart program execution with the **CONT** command, but listing cannot be continued.

[SELECT] key

The function of this key is determined by the software used. Under MSX-BASIC, this key is not used.

FUNCTION KEYS

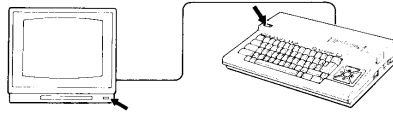
Keys **[F1]** to **[F5]** (**[F6]** to **[F10]**) are called function keys. The functions of these keys are determined by the software. Therefore, read the relevant Software Guide for their functions. In MSX-BASIC, keys **[F1]** to **[F5]** function as follows (When these key are pressed while pressing the **[SHIFT]** key, they function as keys **[F6]** to **[F10]**.):

Function key only	Function key + [SHIFT] key
[F1] color	[F6] color 15, 4, 4 RETURN
[F2] auto	[F7] cload"
[F3] goto	[F8] cont RETURN
[F4] list	[F9] list. RETURN
[F5] run	[F10] clis: run RETURN

1-6. HOW TO START UP

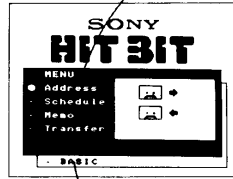
TO START UP THE PERSONAL DATA BANK OR MSX-BASIC

1. Turn on the monitor TV and the computer.



2. Move the mark \blacklozenge to the desired program of the Personal Data Bank or MSX-BASIC to be executed by using the cursor move keys. Then press the **[RETURN]** key.

For further operation, refer to "How to use the Personal Data Bank".



For further operation, refer to "Introduction to MSX-BASIC" and "MSX-BASIC Programming Reference Manual".

TO START UP A GAME

Insert the game cartridge into cartridge slot A with the illustration side toward you, or into the cartridge slot B with the illustration side up. Then turn on the monitor TV and the computer. For details, refer to the game instruction manual.

Note

To power on the computer again, wait more than 10 seconds after it is turned off.

1-7. TO SAVE AND LOAD A MSX-BASIC PROGRAM

The MSX-BASIC program or data entered from the keyboard can be saved on a cassette tape, a data cartridge or a micro floppydisk. This chapter explains how to save a program on a cassette tape and load it from the tape. As to save or load the program using a data cartridge, refer to the instruction manual of the Sony HBI-55 Data Cartridge.

TO SAVE A PROGRAM

1. Insert a cassette tape into the cassette tape recorder, and adjust the volume and tone control to a center position.
2. Type the save command of MSX-BASIC from the keyboard.
CSAVE "program name"
Define the program name within six characters. The first character must be a letter.
3. Press the REC (record)/SAVE button of the recorder. The tape starts as soon as the button is pressed.
4. Press the **[RETURN]** key of the computer. The program is then saved on the tape.
5. When a program has been saved and message "OK" is displayed on the screen, press the STOP button of the recorder.

Note

When the remote control plug is connected to the recorder, the tape start and stop functions of the recorder are controlled from the computer.

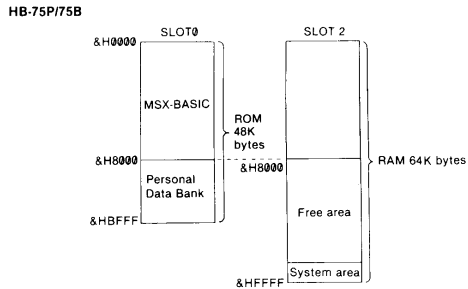
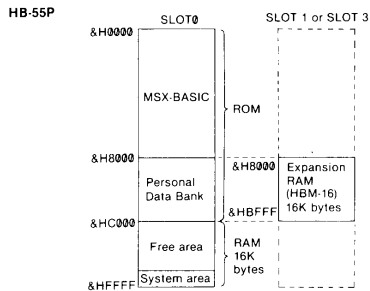
TO LOAD A PROGRAM

1. Insert the cassette tape containing the desired program into the cassette tape recorder and rewind the tape. Then adjust the volume and tone controls to an appropriate position.
2. Type the load command of MSX-BASIC from the keyboard.
CLOAD "program name"
3. Press the **[RETURN]** key of the computer.
4. Press the PLAY/LOAD button of the recorder.
5. When loading is finished, press the STOP button of the recorder.

Note

If the program is not loaded, readjust the volume and tone controls and try again.

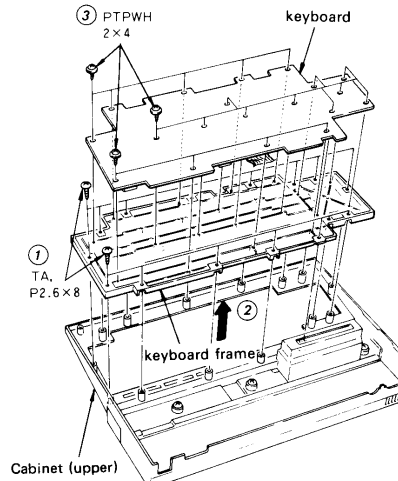
1-8. MEMORY MAP



The capacity of the free area can be checked by the FRE function.

2-1-3. Disassembly of Keyboard

- CAUTION**
- HB-55P All the keytops are not locked, therefore remove the keyboard temporarily and taping it.
 - HB-75P/75B The function key and cursor key are not locked, therefore remove the keyboard temporarily and taping it.



2-2. PROVIDING OF BASIC ROM AND FIRMWARE ROM

2-2-1. Basic ROM (IC42, 43)

Basic ROM (IC42 and IC43) provides one MASK ROM (MSM38256-70RS). To mount it to IC42, and switch JW5, JW7 to JW10 of MASK/EP switching jumpers to MASK ROM side. (remove IC43)

2-2-2. Firmware ROM (IC44)

Firmware ROM (IC44) provides MASK ROM (MSM38128A-77RS). Remove the jumper JW6 for EP ROM.

2-3. REPAIR PARTS

1. **Safety Related Components Warning.**
Components identified by shading marked with Δ on the schematic diagrams, exploded views and electrical spare parts list are critical to safe operation. Replace these components with Sony parts whose part numbers appear in this manual or in service bulletins and service manual supplements published by Sony.
2. **Replacement Parts supplied from Sony Parts Center** will sometimes have a different shape from the original parts. This is due to "accommodating the improved parts and/or engineering changes" or "standardization of genuine parts".
This manual's exploded views and electrical spare parts list indicate the parts numbers of "the standardized genuine parts at present".
Regarding engineering part changes in our engineering department, refer to Sony service bulletins and service manual supplements.
3. **Printed Components in Bold-Face type** on the exploded views and electrical spare parts list are normally stocked for replacement purposes. The remaining parts are not normally required for routine service work. Orders for parts not shown in Bold-Face type will be processed, but allow for additional delivery time.
4. **Abbreviations**

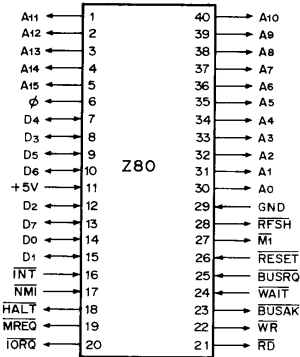
Ref. No.	Description
C□□, CV□□	CAPACITOR
CN□□	CONNECTOR
CP□□	COMBINATION PARTS
D□□	DIODE
DL□□	DELAY LINE
F□□	FUSE
FL□□	FILTER
H□□	HEAD
IC□□	IC
L□□, LV□□	INDUCTOR
M□□	MOTOR
ME□□	METER
PL□□	LAMP
PM□□	SOLENOID
Q□□	TRANSISTOR
R□□, RV□□	RESISTOR
RY□□	RELAY
S□□	SWITCH
SB□□	SOLAR BATTERY
T□□	TRANSFORMER
TH□□	THERMISTOR
X□□	CRYSTAL

5. **Units for Capacitors, Inductors and Resistors**
The following units are assumed in schematic diagrams, electrical parts list and exploded views unless otherwise specified:
Capacitors: μ F
Inductors: μ H
Resistors: ohm

CHAPTER 3 THEORY OF OPERATION

3-1. Z80 (CPU)

The Z80 has 40 pins, and they are arranged as follows:



3-1-1. Functions of Pins

- ① **A0 to A15 (Address bus)**
A bus line which outputs addresses when reading and writing of the memories and input/output operations.
- ② **D0 to D7 (Data bus)**
A bus line which reads and outputs the data.
- ③ **MREQ and IORQ**
MREQ is output when accessing to memory, and IORQ is output when accessing to I/O port. The I/O port is an address for controlling the printer and PSG.
- ④ **RFSH**
Dynamic RAM (for example 4116) is not able to memorize unless it is refreshed at certain time intervals. RFSH is the timing signal for this refreshing purpose.
- ⑤ **M1**
It indicates a cycle in which the CPU reads out a command to the exterior.
- ⑥ **HALT**
It is signal which informs the outside that the HALT (STOP) command has been executed and that CPU has ceased the carrying out of the program. This HALT will continue until it is interrupted or reset.
- ⑦ **WAIT**
This is a signal which awaits the CPU processing until the peripheral device has completed its operation, since the peripheral device cannot catch up with the processing speed of the CPU.
- ⑧ **INT and NMI**
They are input pins for interruptions.
NMI enables interruption at any time.
INT enables prohibition of interruption in accordance with contents of a program.
- ⑨ **RESET**
A pin which initializes the CPU.

⑩ **BUSRQ and BUSAK**

BUSRQ is a pin which requests the CPU to disconnect addresses and data buses from the CPU.

BUSAK is a pin which informs the exterior that the CPU accepts the BUSRQ.

⑪ **RD and WR**

WR signal is output when writing is performed for the memory or I/O devices.

RD signal is output when reading is performed for the memory or I/O devices.

3-1-2. Operation of Z80

When power supply of the Z80 is turned ON, RESET signal is fed to it to clear out its internal memory contents.

The RESET pin of the Z80 becomes active when set at "L". Therefore, when "L" signal is applied to it, the pins of the Z80 are established as follows:

[Address and data bus]

Both become "H" level. (Floating condition)

[Control pins]

All the control pins output non-active signals.

The signal level of these pins when the Z80 is in active mode is "L" level; therefore, in this state, the Z80 outputs "H" level.

[Program counter]

The contents of the program counter become 0000H.

[Interruption enabling flip-flop]

Becomes zero and becomes prohibition of interruption.

[Interruption mode]

The interruption mode becomes zero.

[Interruption page address register]

The contents of I register become 00H.

[Refresh register]

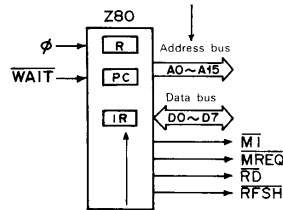
The contents of R register become 00H.

[Register file]

The contents of all registers such as A, B, C, D, E, F, A', B', C', D', E', F', IX, IY, H, L, and R become 00H.

When RESET becomes "H" from "L", the Z80 starts to execute operation of the program; however, the contents of the program counter (PC) become command fetch address. This means that the operation code comes from the 0000H address. The Z80 fetches the operation codes when it internally becomes into "a condition to execute operation fetch codes".

At first, the contents of the program counter (PC) are output, and then the contents of the refresh register (R) are output after the Z80 fetches the operation code.

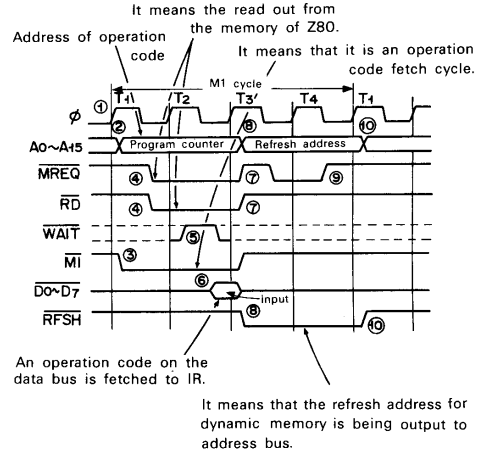


From the address of the memory, which is specified by the program counter, a part of the operation code is fetched to the command register (IR).

3-1-3. M1 Cycle

A sequence to fetch an operation code is called M1 cycle.

- ① When the Z80 becomes M1 cycle.
- ② During the interval between the arrivals of the first clock signal and the second clock signal (it is called T₁ state), the contents of the program counter are output to the address bus.
- ③ When it is also in the T₁ state, "L" is output to $\overline{M1}$. At this time, the Z80 is operating in M1 cycle, and it plays a role to inform the outside that an address to fetch the operation code on the address bus is being output.
- ④ When it is also in the T₁ state, "L" is output to \overline{MREQ} and \overline{RD} .
Access the memory with these signals and fetch the operation code (to the command register).
- ⑤ When it is in T₂ state, if an external input to \overline{WAIT} pin of the Z80 is "H", the Z80 moves to T₃ state. If the \overline{WAIT} pin is in "L" level, the Z80 does not move to T₃, but it becomes in wait state (TW), and waits until it becomes "H".
- ⑥ At a point when the Z80 moves to T₃ state from T₂ state, it fetches the operation code, which is read out on data bus (D₇ to D₀) from the memory, to the command register (when the clock of T₃ is being raised up).
- ⑦ In T₃ state, \overline{MREQ} becomes at first "H" and then returns to "L" again.
- ⑧ In T₃ state, the contents of the refresh register are output to the address bus. However, among the 8 bits of the refresh register, the lower 7 bits are output to the lower 7 bits of the address bus.
To indicate that the refresh address is being output to the address bus, "L" is output to \overline{RFSH} pin.
- ⑨ When the Z80 becomes in T₄ state, the \overline{MREQ} signal returns to "H" from "L".
It becomes possible to refresh the dynamic memory with the \overline{MREQ} , \overline{RFSH} and the address bus.
- ⑩ In the following Fig., up to the T₄ state shows an operation code fetch cycle. The place marked 10 denotes the T₁ state in a cycle whichever comes next. (It depends on the command fetched immediately before.)
Up to this point, the refresh address has been output to the address bus, and \overline{RFSH} signal which indicates the above-mentioned state has been set at "L". However, the \overline{RFSH} signal also becomes "H" simultaneously when the refresh address on the address bus disappears.



Command OP code fetch cycle (M1 cycle)

3-1-4. Refresh Cycle

Refresh cycle is an indispensable and troublesome operation for DRAM. The memorized contents of the memory will be erased unless the specified row address is not accessed within the determined length of time. The term of row address access used here means that only row address and \overline{RAS} are necessary. Accordingly, even in a normal read cycle and a write cycle, refresh has been completed against their row addresses. The Z80 CPU outputs address in T₁ and T₂ of the OP code fetch cycle and indicates the output to the memory, and it fetches OP code at the clock rising up of T₃, and performs refresh of the dynamic memory at the rest of 2 states (T₃ and T₄). There are two methods of refreshing. The first method is to refresh the 128 row addresses continuously (Burst mode refreshing) and the other is a dispersing method to refresh each row within 2ms (Single mode refreshing). The Z80 is so designed as to be refreshed by conveniently using the latter method. For the Z80, refreshment is performed so that a row address is refreshed once every M1 cycle. During the refreshing operation, \overline{CAS} output is kept at H level. Simultaneous refreshing is possible even if the data outputs of several memories are connected with the wired OR. The refreshing operation is a quasi read operation, and data in the memory is not output at that time. The refreshing operation using only \overline{RAS} is called \overline{RAS} only refreshment. Driving of refreshing cycle of the dynamic memory can be performed by the \overline{RFSH} and \overline{MREQ} signals.

3-2. OPERATION WHEN POWER SUPPLY IS TURNED ON

When the power supply is turned ON, "L" signal is applied to pin 3 of IC26 during several hundreds msec with a time constant of R106 and C49. This "L" signal is inverted to "H", and applied to pin 35 (RESET) of IC16 (PPI). Furthermore, this "H" signal is inverted to "L" signal, and it is applied to pin 26 (RESET) of IC41 (CPU). (IC26 is an inverter of the Schmitt trigger type.) When resetting signal is applied to IC41 (CPU), the CPU turns all of its controlling pins and address data buses to "H" levels. Pin 6 of IC21 is at "H" level. Pin 6 becomes "H" level, since "L" level is applied to pin 1 of IC21 with RESET signal. IC16 (PPI) is initially set, and this condition continues until something is written into A port. When pin 6 of IC21 turns to "H", it turns pins 1 and 15 of IC17 to "H". When pins 1 and 15 of IC17 become "H", pins 7 and 9 both become "L".

When pin 26 of IC41 turns to "H" from "L", this releases the resetting of the CPU, and it outputs 0000H into the address bus and turns MREQ signal to "L". Furthermore, pin 2 of IC37 turns to "H" with the inverter of IC38.

RFSH signal ("H") is applied to pin 1 of IC37. The output of "H" of IC37 is inverted with IC38 and "L" signal is applied to pin 1 of IC23. This turns pin 4 to "L". This "L" signal is applied to pins 1 and 4 of IC53.

On the other hand, MREQ signal and signals of the address bus AB14 and 15 are applied to pins 1, 2 and 3 of IC18, respectively.

Pin 4 becomes "L", as "L" level signal is applied to pins 2 and 3 of IC18.

Owing to this, pins 9 and 12 of IC33 become "L". However, pin 2 of IC31 is set at "L" and pin 3 of IC31 is set at "H" by the RESET signal "H", and "L" level of pin 12 of IC33 turns pin 5 of IC53 to "L". By turning BRD signal to "L", pins 3, 4, and 5 of IC53 are all turned to "L".

Consequently, pin 22 of IC44 becomes "L", and a program stored in MASK ROM of FIRMWARE starts to run. (At this point, BASIC has not started yet.)

This program is a PLL Setting Data Sending Out Program which sends the data to IC31. Signals are fed from pins 7, 10, and 15 of IC31 to pins 2, 3, and 4 of IC7, and then the PLL starts to operate. Subcarrier of 4.43MHz of PAL signal is oscillated.

After that pin 3 of IC31 is set at "L" and pin 2 is set at "H". Accordingly, pin 8 of IC33 becomes "L", and pin 4 of IC32 also becomes "L", and output of pin 6 becomes "L". Pins 1, 2, and 13 of IC53 become "L", and pins 22 of IC42 and IC43, also become "L". IC42 (BASIC ROM) is selected and is entered into BASIC program.

Pin 20 (CE) of IC42 is connected to AB14 of the address bus. When AB14 becomes "H", ROM of IC42 is unable to be selected. (IC42 has a capacity of 16K bytes from 0000H to 3FFFH.)

Since AB14 is inverted and connected to pin 20 (CE) of IC43, when AB14 becomes "H", pin 20 (CE) of IC43 becomes "L".

At the same time, AB14 and AB15 of the address bus are connected to the inputs of pins 2 and 3 of IC18, and because AB14 is at "H" and AB15 is at "L", output of pin 5 becomes "L" and pin 6 of IC32 becomes "L". This causes pin 22 (OE) of IC43 to become "L" through IC53 and IC38, and to select ROM of IC43.

(IC43 has a capacity of 16K bytes from 4000H to 7FFFH.) When address becomes 8000H next to 7FFFH, AB15 becomes "H" and AB14 becomes "L".

This address data is applied to IC17 and IC18, and the contents of pins 4 (X2), and 12 (Y2) are output to pins 7 (XC) and 9 (YC). However, as they have all become "L", thus the output of pin 4 of IC23 becomes "L".

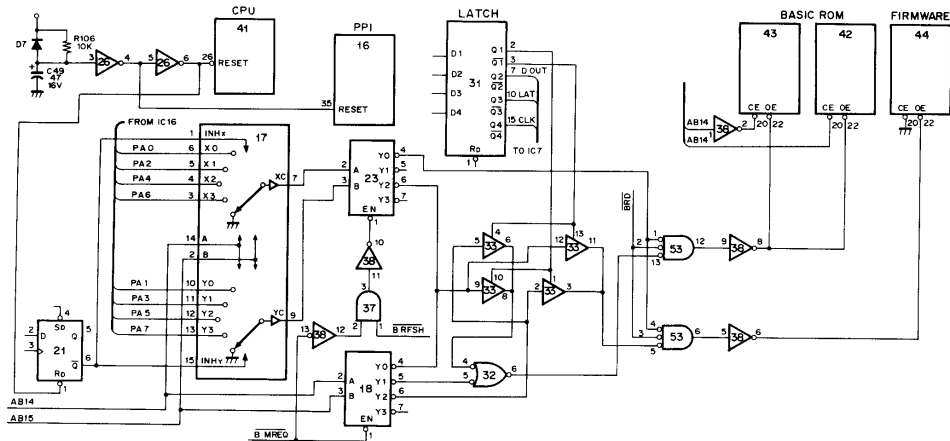
This signal is applied to pins 1 and 4 of IC53.

On the other hand, as address data AB15 ("H") and AB14 ("L") are applied to pins 2 and 3 of IC18, output of pin 6 becomes "L" and outputs of others become "H". As pins 4 and 5 of IC18 become "H", "H" is output to pin 6 of IC32.

Accordingly, "H" is applied to pin 13 of IC53, so that pin 12 of IC53 becomes "L" and output of pin 9 of IC38 becomes "H", and ROMs of IC42 and IC43 cannot be selected. On the other hand, output "L" of pin 6 of IC18 is input to pin 2 of IC33 and "L" is output to pin 3 (pin 1 of GATE is at "H"). Then pins 3, 4, and 5 of IC53 all become "L", and output "H" of pin 6 of IC53 is inverted with IC38, and thus pin 6 of IC38 becomes "L".

The pin 6 of IC38 is connected to pin 22 (OE) of IC44 and it selects IC44 (FIRMWARE ROM). The ROM of IC44 is continuously selected until pin 6 of IC53 becomes "L" (9000H).

Accordingly, IC44 is capable of using 8000H to 8FFFH.



3-3. CHECKING SLOT

When the MSX-BASIC program starts operation, it executes initial setting and then checks the slot. The checking is performed in sequential order beginning with slot 0.

In this system, slot 0 is the memory stored within this system, and slot 1 is the upper cartridge slot and slot 3 is the rear cartridge slot.

In the HB-75, MAIN RAM 64K is assigned to slot 2.

When IC44 is selected, the program of IC44 is performed. During the performance of this program, check to see what kind of items are inserted into this cartridge slot. At this time, if instantaneously executable ROMs such as game cartridge are inserted, execution of controlling is shifted to them.

Selection of the slots is performed with IC23. IC23 is controlled with data from the PPI(IC16).

When pin 4 of IC23 is "L", slot 0 is selected.

When pin 5 of IC23 is "L", slot 1 is selected.

When pin 6 of IC23 is "L", slot 2 is selected.

When pin 7 of IC23 is "L", slot 3 is selected.

Selection of the memories is performed with IC18, and it works as follows:

When pins 4 and 5 of IC18 are "L" (addresses 0000H to 7FFFH), MSX-BASIC ROMs of IC42 and IC43 are selected.

When pin 6 is "L" (addresses 8000H to 8FFFH), IC44 is selected.

When pin 7 of IC18 is "L" (address over C000H), MAIN RAM is selected. (HB-55P).

IC23 (2/2) selects ROM of the cartridge slot.

IC23 (2/2) operates only when the MREQ and RD are "L", and selects ROM of the cartridge slot.

Interchange of data between cartridge slots and external I/O is carried out through IC40, and IC40 is controlled by IC52, IC37, and IC38.

When pin 19 of IC40 is "H", it becomes in the OFF state, and interchange of data is accordingly not carried out. When the CPU is accessed to PPI, PSG, and VDP, it turns pin 19 to "H" and closes the gate. The circuit diagram at that time is as shown in Fig. 1.

- When pin 19 of IC40 becomes "H":
 1. When the IORQ signal is at "L" level, and either one of PPI, PSG, and VDP is at "L" level.
 2. When either one of the M1 signal or IORQ signal is at "H" level.
 3. When the slot 0 is selected. (The ICs 29 and 30 are so designed as to input "L" level always to pin 10 of IC27 when addresses are 0000H to FFFH.)

When one of the conditions is applicable to the above-mentioned 1 to 3, the data coming through IC39 are not carried out.

- When pin 19 of IC40 becomes "L", interchange of data is carried out, and the direction of the interchange of data is determined by pin 1.

When pin 19 becomes "L":

1. Any slot except slot 0 is selected.
2. When access is not performed to the internal I/O device (PPI, PSG and VDP).

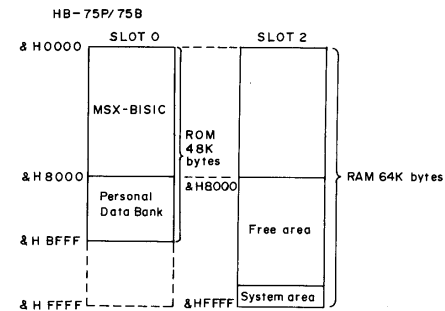
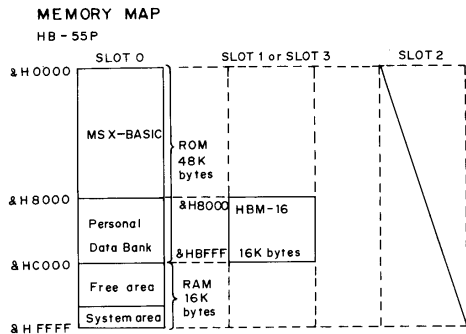
When the above-mentioned two conditions are coincided.

- When pin 19 is at "L" level and pin 1 is at "H" level, data are sent out from interior of the system.

When pin 1 is at "L" level:

When RD is at "L" level, or M1 and IORQ are simultaneously at "L" level. Except for the above, they are all "H" level.

When pin 1 is at "L" level, data are read into the system from the exterior.



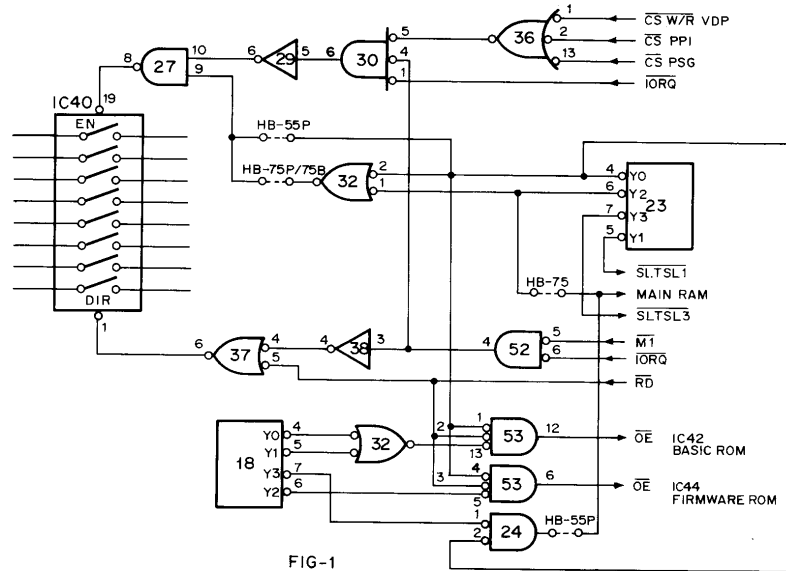


FIG-1

Each pin of the cartridge slot

Pin No.	Name	Content
1	$\overline{CS1}$	Address selecting signal of memory 4000H to 7FFFH
2	$\overline{CS2}$	Address selecting signal of memory 8000H to BFFFH
3	$\overline{CS12}$	Address selecting signal of memory 4000H to BFFFH (for 256K ROM)
4	\overline{SLTSL}	It is a slot selecting signal, which applies selecting signals peculiar to each of the respective slots.
5	Spare	Spare signal line for future use (Prohibited to be used)
6	\overline{RFSH}	Refreshing cycle signal
7	\overline{WAIT}	\overline{WAIT} request signal for CPU (Timing should be taken at the interior of the system.)
8	\overline{INT}	Interruption request signal for CPU
9	$\overline{M1}$	Indicating signal of fetch cycle of CPU
10	\overline{BUSDIR}	Direction control signal of external data bus buffer
11	\overline{IORQ}	Request signal of I/O
12	\overline{MREQ}	Request signal of memory
13	\overline{WR}	Write timing signal
14	\overline{RD}	Read timing signal
15	\overline{RESET}	System reset signal
16	Spare	Spare signal line for future use (Prohibited to be used)
17 to 32	A0 to A15	Address bus signal
33 to 40	D0 to D7	Data bus signal
41 and 43	GND	Ground
42	CLOCK	CPU CLOCK (3.579545MHz)
44 and 46	SW1 and SW2	Protection for plugging in and out
45 and 47	+5V	Power supply of +5V
48	+12V	Power supply of +12V
49	SUNDIN	Sound input signal (-5 dBm)
50	-12V	Power supply of -12V

3-4. I/O PORT

For selecting of I/O port, address decoder of IC23 is used. The following operations are performed in order that the CPU accesses to the I/O port.

3-4-1. Selection of I/O Port

When reading out

- ① Number of input port is output to the address bus.
 - ② When it is in T₂ state, "L" is output to $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$. This means to access input port.
 - ③ When $\overline{\text{WAIT}}$ is either "L" or "H", the Z80 moves automatically to T_w.
 - ④ If in T_w state, if the input to $\overline{\text{WAIT}}$ is at "H" level, the Z80 extricates itself from the T_w state and shifts into T₃ state.
 - ⑤ The data which are read out from the input port on the data bus are read into interior of the Z80.
- At this time, the $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ return to "H" from "L".

When writing in

- ① Number of output port is output to an address.
- ① Data to be written onto the output port is output to the data bus.
- ② In T₂ state, "L" is output to the $\overline{\text{IORQ}}$ and $\overline{\text{WR}}$. This means to access output port.
- ③ Whether the $\overline{\text{WAIT}}$ is "L" or "H", the Z80 moves automatically to T_w.
- ④ In T_w state, if the $\overline{\text{WAIT}}$ is "L", the T_w state is continuously inserted; however, if the $\overline{\text{WAIT}}$ is "H", the Z80 moves to T₃ state.
- ⑤ In T₃ state, the $\overline{\text{IORQ}}$ and $\overline{\text{WR}}$ return to "H" from "L". This means that the data has been written out to the output port.

The signal on the address bus of the input and output commands are output to the lower 8 bits of input and output port numbers, and the contents of the accumulator or B register are output to the upper 8 bits of the signal. A₃ and A₄ of the address bus are applied to input pins 13 and 14 of address decoder of IC23. Furthermore, A₄ to A₇ of the address bus are applied to pin 15 ($\overline{\text{EN}}$) through IC25, IC27, IC28, IC29, and IC37. Depending on this signal, it is determined that which I/O device is selected. The selection can be made as follows:

A7	A6	A5	A4	A3	I/O port address
1	0	0	1	0	PRINTER 90H, 91H
1	0	0	1	1	VDP 98H, 99H
1	0	1	0	0	PSG A0H~A3H
1	0	1	0	1	PPI A8H~ABH

These are all selected when the $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ or $\overline{\text{WR}}$ signals are output.

3-4-2. Operation of Each Port

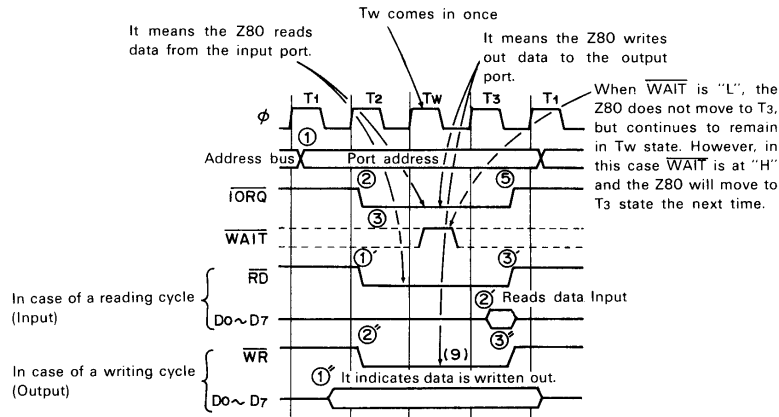
PRINTER: It sets data at 91H and outputs data at 90H (strobe pulse and BUSY pulse).

VDP: 99H means time to transfer address, and 98H means time to transfer data.

PSG: A0H Specifies register.
A1H Write data into register.
A2H Contents of register are output to data bus.
A3H Not operated

PPI: When $\overline{\text{RD}}$ is "L":
A8H Contents of port A are output to data bus.
A9H Contents of port B are output to data bus.
AAH Contents of port C are output to data bus.
ABH is prohibited.

When $\overline{\text{WR}}$ is "L":
A8H Contents of data bus are output to port A.
A9H Contents of data bus are output to port B.
AAH Contents of data bus are output to port C.
ABH Contents of data bus are written into control register.



3-5. ACCESS TO MAIN RAM (HB-55P)

In the HB-55P system, a RAM of 16K bytes is mounted. Access to the is RAM can be carried out when the address data becomes over C00H.

3-5-1. When Data is Read Out from RAM (HB-55P)

Address data is applied to input pins of IC49 and IC57, and at this time, the pins 1 (A) of IC49 and IC57 become "L"; accordingly, the contents of the 0 group are output to the output pins. These form a ROW address. Nextly, when pin 19 ($\overline{\text{MREQ}}$) of IC41 (CPU) becomes "L", the signal is applied to pin 12 of IC37. Accordingly, "L" is output to pin 11 of IC37. This signal is applied to pin 2 (D) of IC51. A clock signal is applied to pin 3 of IC51, and with the rising up of this clock signal the contents of pin 2 are output to pin 5. Owing to this, "L" is applied to each RAS pin of the dynamic RAM of IC58 to IC61 and IC65 to IC68.

Consequently, the ROW address is latched into the memory. $\overline{\text{MREQ}}$ signal from IC41 (CPU) is applied to pin 1 of IC18. At this time, since signals of AB14 and AB15 of the address data are applied to pins 2 and 3 of IC18, all these pins become "H"; accordingly, pin 7 of IC18 becomes "L". This signal is applied to pin 1 of IC24. At this time, pin 2 of IC24 is also "L" and therefore, pin 3 of IC24 becomes "L", and the signal is also applied to pin 12 of IC50.

As IC50 operates in just the same manner as the above-mentioned IC51, pin 9 of IC50 becomes "L". At this time, pin 8 of IC50 becomes "H" and the signal is applied to pins 1 of IC49 and IC57. Accordingly, contents of 1 group are output to the outputs of IC49 and IC57. (It becomes COLUMN address.) The signal from pin 9 of IC50 is applied to pin 12 of IC51, and its contents are output to pin 9 of IC50 with the clock signal. It takes 10ns for this process. (10ns delayed).

During this time interval, the address data depending on outputs of IC49 and IC57 becomes stable. The pin 9 of IC51 is connected to pin 15 (CAS) of the dynamic memory, and by setting it to "L" the COLUMN address is latched into memory. When $\overline{\text{MREQ}}$ signal becomes "H" from "L", pin 2 of IC51 becomes "H" from "L", and pin 5 (Q) also becomes "H". Accordingly, pin 4 (RAS) of the memory becomes "H" from "L". Pin 6 of IC51 becomes "L" from "H", and this signal is applied to pins 10 ($\overline{\text{PRESET}}$) of IC50 and IC51 to shift the output of pin 9 of IC51 to "H".

As a result, pin 15 (CAS) of the memory becomes "H" and the contents of the previously set address becomes to be read out from the memory.

When $\overline{\text{RFSH}}$ signal of "L" level is applied to pin 13 of IC37 from the CPU, pin 11 of IC37 also becomes "L", and the signal is also applied to pin 2 of IC51. Therefore, "L" is output to pin 5 of IC51 and the refreshing of the dynamic memory is carried out.

When pin 13 (signal of $\overline{\text{RFSH}}$) and pin 12 (signal of $\overline{\text{MREQ}}$) of IC37 all become "H", pin 5 of IC51 becomes "H" and pin 4 (RAS) of the memory becomes "H".

3-5-2. When Data is Written into RAM (HP-55P)

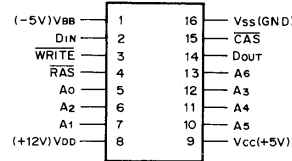
When data is written in, $\overline{\text{MREQ}}$ signal and $\overline{\text{WR}}$ signal of "L" level are output from the CPU. The process to set an address to the memory is the same as in the data reading out.

Output timing of $\overline{\text{WR}}$ signal from the CPU is slightly later than that of $\overline{\text{MREQ}}$ signal. Therefore, during this time interval, setting of address is carried out.

$\overline{\text{WR}}$ signal is applied to pin 9 of IC24 and $\overline{\text{MREQ}}$ signal is applied to pin 10.

When pins 9 and 10 are "L", pin 8 becomes "L", and shift pin 3 ($\overline{\text{WE}}$) of the memory to "L" to write in the data to the address which has previously been set.

3-5-3. Dynamic RAM (4116) (HB-55P)



$A_0 - A_6$	Address input
CAS	Column address strobe
DIN	Data input
DOUT	Data output
RAS	ROW address strobe
WRITE	Read/write input
VBB	Power supply (-5V)
Vcc	Power supply (+5V)
VDD	Power supply (+12V)
Vss	GND

The above shows the pin connection diagram of dynamic RAM (4116).

The memory cells of 16384 (1024×6) are composed of 128 rows×128 columns.

To select each memory cell, 7 bits of ROW address and 7 bits of column address are necessary. However, there are only 7 (A_0 to A_6) address input pins on the memory chip.

As a result, to input 14 bits of an address to the memory chip, input has to be carried out twice, that is by dividing the 14 bits of address into two parts of 7 bits each.

3-5. ACCESS TO MAIN RAM (HB-75P/75B)

In the HB-75P/75B system, a RAM of 64K bytes is mounted. Access to this RAM can be carried out when the slot 2 is selected.

3-5-1. When Data is Read Out from RAM (HB-75P/75B)

Address data is applied to input pins of IC49 and IC57, and at this time, the pins 1 (A) of IC49 and IC57 become "L"; accordingly, the contents of the 0 group are output to the output pins. These form a ROW address. Next, when pin 19 ($\overline{\text{MREQ}}$) of IC41 (CPU) becomes "L", the signal is applied to pin 12 of IC37. Accordingly, "L" is output to pin 11 of IC37. This signal is applied to pin 2 (D) of IC51. A clock signal is applied to pin 3 of IC51, and with the rising up of this clock signal the contents of pin 2 are output to pin 5. Owing to this, "L" is applied to each $\overline{\text{RAS}}$ pin of the dynamic RAM of IC58 to IC61 and IC65 to IC68.

Consequently, the ROW address is latched into the memory. $\overline{\text{MREQ}}$ signal from IC41 (CPU) is applied to pin 1 of IC18. At this time, since signals of AB14 and AB15 of the address data are applied to pins 2 and 3 of IC18, all these pins become "H"; accordingly, pin 7 of IC18 becomes "L". This signal is applied to pin 1 of IC24. At this time, pin 2 of IC24 is also "L" and therefore, pin 3 of IC24 becomes "L", and the signal is also applied to pin 12 of IC50.

As IC50 operates in just the same manner as the above-mentioned IC51, pin 9 of IC50 becomes "L". At this time, pin 8 of IC50 becomes "H" and the signal is applied to pins 1 of IC49 and IC57. Accordingly, contents of 1 group are output to the outputs of IC49 and IC57. (It becomes COLUMN address.) The signal from pin 9 of IC50 is applied to pin 12 of IC51, and its contents are output to pin 9 of IC50 with the clock signal. It takes 10ns for this process. (10ns delayed).

During this time interval, the address data depending on outputs of IC49 and IC57 becomes stable. The pin 9 of IC51 is connected to pin 15 ($\overline{\text{CAS}}$) of the dynamic memory, and by setting it to "L" the COLUMN address is latched into memory. When $\overline{\text{MREQ}}$ signal becomes "H" from "L", pin 2 of IC51 becomes "H" from "L", and pin 5 (Q) also becomes "H". Accordingly, pin 4 ($\overline{\text{RAS}}$) of the memory becomes "H" from "L". Pin 6 of IC51 becomes "L" from "H", and this signal is applied to pins 10 ($\overline{\text{PRESET}}$) of IC50 and IC51 to shift the output of pin 9 of IC51 to "H".

As a result, pin 15 ($\overline{\text{CAS}}$) of the memory becomes "H" and the contents of the previously set address becomes to be read out from the memory.

When $\overline{\text{RFSH}}$ signal of "L" level is applied to pin 13 of IC37 from the CPU, pin 11 of IC37 also becomes "L", and the signal is also applied to pin 2 of IC51. Therefore, "L" is output to pin 5 of IC51 and the refreshing of the dynamic memory is carried out.

When pin 13 (signal of $\overline{\text{RFSH}}$) and pin 12 (signal of $\overline{\text{MREQ}}$) of IC37 all become "H", pin 5 of IC51 becomes "H" and pin 4 ($\overline{\text{RAS}}$) of the memory becomes "H".

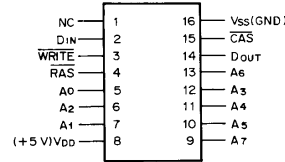
3-5-2. When Data is Written into RAM (HP-75P/75B)

When data is written in, $\overline{\text{MREQ}}$ signal and $\overline{\text{WR}}$ signal of "L" level are output from the CPU. The process to set an address to the memory is the same as in the data reading out. Output timing of $\overline{\text{WR}}$ signal from the CPU is slightly later than that of $\overline{\text{MREQ}}$ signal. Therefore, during this time interval, setting of address is carried out.

$\overline{\text{WR}}$ signal is applied to pin 9 of IC24 and $\overline{\text{MREQ}}$ signal is applied to pin 10.

When pins 9 and 10 are "L", pin 8 becomes "L", and shift pin 3 ($\overline{\text{WE}}$) of the memory to "L" to write in the data to the address which has previously been set.

3-5-3. Dynamic RAM (3764) (HB-75P/75B)



A0 - A7	Address input
CAS	Column address strobe
DIN	Data input
DOUT	Data output
$\overline{\text{RAS}}$	ROW address strobe
WRITE	Read/write input
VDD	Power supply (+5V)
VSS	GND

The above shows the pin connection diagram of dynamic RAM (3764).

The memory cells of 65536 (4096×16) are composed of 512 rows ×512 columns.

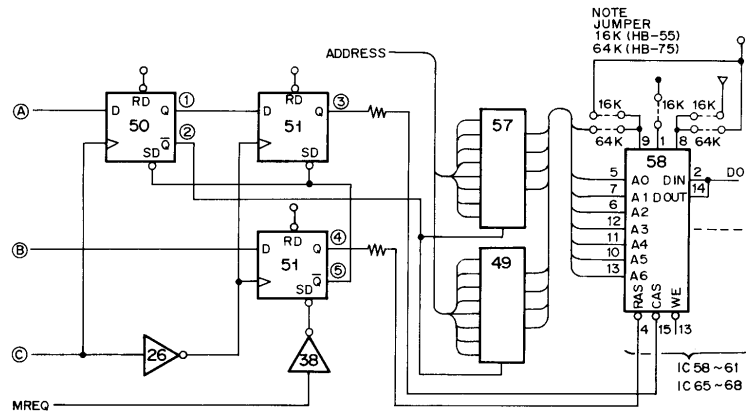
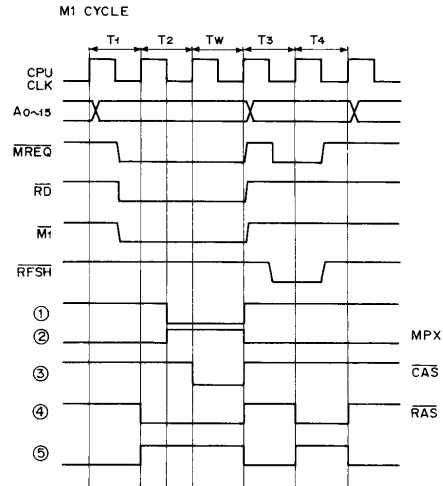
To select each memory cell, 8 bits of ROW address and 8 bits of column address are necessary. However, there are only 8 (A0 to A7) address input pins on the memory chip.

As a result, to input 16 bits of an address to the memory chip, input has to be carried out twice, that is by dividing the 16 bits of address into two parts of 8 bits each.

3-5-4. Read Cycle Procedure

- (1) Determine the row address.
- (2) Drop $\overline{\text{RAS}}$. (Internally latch the 7-bit (HB-55)/8-bit (HB-75) row address.)
- (3) Determine the column address.
- (4) Drop $\overline{\text{CAS}}$. (Internally latch the 7-bit (HB-55)/8-bit (HB-75) column address.)
- (5) Raise $\overline{\text{RAS}}$.
- (6) Raise $\overline{\text{CAS}}$ after reading data.

The write cycle, excluding $\overline{\text{WRITE}}$, is carried out in the same manner as the read cycle. There are 2 write modes. One is called the early write mode in which $\overline{\text{WRITE}}$ falls before $\overline{\text{CAS}}$ falls. The other is called the delay write mode in which $\overline{\text{WRITE}}$ falls while $\overline{\text{CAS}}$ is being low. The read cycle is normally carried out in the early write mode.

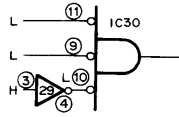


- (A) : When the signal in line (A) is set at "L" by Memory Select, a read/write operation can be done for the memory.
- (B) : When the signal in line (B) is set at "L" by Memory Select/Refresh, RAS is issued.
- (C) : The signal in line (C) indicates the same clock as CPU CLOCK.

3-6. PRINTER

IC30 is a 3-input NOR gate. When all input signals are "L", the output signal at pin 8 of IC30 is "H". Pin 8 of IC30 is connected to pin 11 of IC39. When the signal at pin 8 of IC30 is "H", data can be IC39. The following signals are applied to IC30.

- When both \overline{IORQ} and \overline{WR} are "L", the signal at pin 11 of IC30 is "L".
- When pin 9 of IC30 is selected by address decoder, the signal at pin 9 of IC30 becomes "L".
- When ABO in the address bus is "H", the signal at pin 10 of IC30 is "L".



In the above state, data can be issued on the printer. Thereafter, the printer starts printing data when a strobe signal is issued to the printer.

Select 91H at the I/O port, latch the print data, and send a strobe signal in 90H. Then, control accesses the printer.

The strobe signal is issued in the following manner. Signals identified by a, b, and c are fed to inverter IC29 and NOR gate IC28.

The I/O port is set in 90H at this time. ABO in the address bus is low and the address decoder (at pin 10 of IC23) selects the printer. Thus, both \overline{IORQ} and \overline{WR} become "L".

The input signals at pins 11 and 12 of IC28 are "L" and the output signal at pin 13 of IC28 is "H". The input signal at pin 13 of IC29 is "L" and the output signal at pin 12 of IC29 is "H". The signals at pin 13 of IC28 and pin 12 of IC29 are fed to pins 13 and 12 of IC27, respectively. The signal at pin 11 of IC27 becomes "L" and it is fed to pin 3 of IC34. When either \overline{IORQ} or \overline{WR} becomes "H", the signal at pin 13 of IC29 becomes "H". The signal at pin 12 of IC27 becomes "L" and the signal at pin 11 of IC27 becomes "H".

It causes the signal at pin 3 of IC34 becomes "H" from "L". Data fed to pin 2 of IC34 is issued to pin 6 of IC34 while the signal at pin 3 of IC34 rises. Data at pin 2 of IC34 is "L" at that time, and the signal at pin 6 of IC34 becomes "H". Thus, the signal at pin 8 of IC25 becomes "H" to turn on Q27. Thus, \overline{PSTB} causes the printer to start printing data.

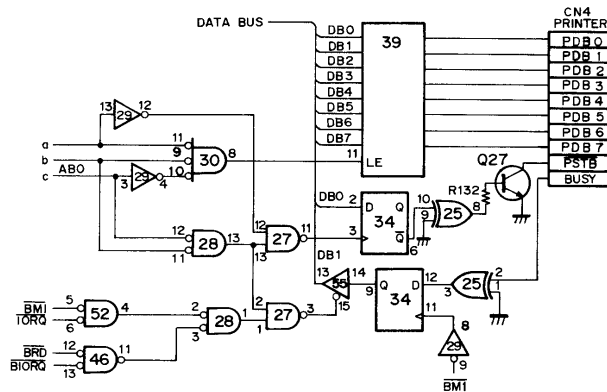
Data cannot be received by the printer when the printer is performing a printing operation. In this state, the printer issues BUSY to the controller. BUSY is used to decide whether or not data is to be sent to the printer. BUSY is fed to pin 12 of IC34 through IC25. In this state, $\overline{M1}$ is fed to pin 9 of IC12 (1/4). $\overline{M1}$ informs the controller that operation codes are being fetched by the CPU. The inverted $\overline{M1}$ is fed to pin 11 of IC34. Data appearing at pin 12 of IC34 is issued to pin 9 (Q) of IC34 and then fed to pin 14 of IC55. (BUSY)

\overline{IORQ} is fed to pin 6 of IC52. When the signals at pins 5 and 6 of IC52 become "H", the signal at pin 4 of IC52 becomes "L". $\overline{M1}$ becomes "H" speedily, and thus the signal at pin 4 of IC52 becomes "L" at the end of $\overline{M1}$. It is then fed to pin 2 of IC28.

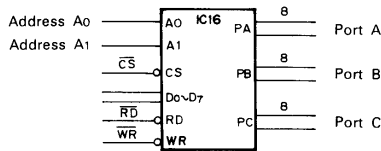
When both \overline{IORQ} and \overline{RD} are "L", the signal at pin 3 of IC28 is "L". When the signals at pins 2 and 3 of IC28 become "L", the signal at pin 1 of IC28 becomes "H" and then it is fed to pin 1 of IC27.

Pin 13 of IC28 is connected to pin 2 of IC27. Both the input signals at pins 11 and 12 of IC28 are "L" since the I/O port is set in 90H.

Both the signals at pins 1 and 2 of IC27 become "H", the signal at pin 3 of IC27 becomes "L", and the signal at pin 15 of IC55 becomes "L" to send data from pin 14 to pin 13 of IC55. Data is input to microprocessor Z80 so as to check whether or not data is BUSY.



3-7. PROGRAMMABLE PERIPHERAL INTERFACE (PPI) IC16



The diagram above shows the functions of 8255A. The 8255A is a programmable, general-purpose I/O device designed to construct a 8-bit microcomputer system, and it is characterized by the followings:

- (1) An arbitrary function can be selected at the 24 bit I/O terminal by program specification.
- (2) Power is supplied from a single 5V power supply.
- (3) The direct bit set/reset function is provided.

When \overline{RD} is set active by making it "L" in the read mode or when \overline{WR} is set active by making it "L" in the write mode, data can be transferred between the data bus and each port.

CS (CHIP SELECT): By setting \overline{CS} at "L", communication of 8255A with the CPU is permitted. When \overline{CS} set at "H", the data bus has high impedance and control from the CPU is disregarded.

WR (WRITE): \overline{WR} is a write enable signal for the 8255A. When \overline{WR} is "L", data or control words can be written into the 8255A.

A0 and A1 (PORT ADDRESS): They are used to select and control port A, port B, port C, or the control register when combined with \overline{RD} or \overline{WR} . They are also used as low order 2 bits (A0 and A1) for the CPU address bus.

RESET: When RESET is "H", data in all registers (including the control register) within the 8255A is cleared. All the ports are set in the input mode after register contents are cleared.

A1	A0	\overline{CS}	\overline{WR}	\overline{RD}	OPERATION
0	0	0	1	0	PORT A → DATA BUS
0	1	0	1	0	PORT B → DATA BUS
1	0	0	1	0	PORT C → DATA BUS
1	1	0	1	0	NO OPERATION
0	0	0	0	1	DATA BUS → PORT A
0	1	0	0	1	DATA BUS → PORT B
1	0	0	0	1	DATA BUS → PORT C
1	1	0	0	1	DATA BUS → CONTROL REGISTER
X	X	1	X	X	HIGH IMPEDANCE

0 ; LOW LEVEL A0, A1 ; PORT SELECT ADDRESS
 1 ; HIGH LEVEL CS ; CHIP SELECT
 X ; DONT CASE D0~7 ; DATA BUS
 PA0~7 ; PORT A IN/OUT
 PB0~7 ; PORT B IN/OUT
 PC0~7 ; PORT C IN/OUT
 RD ; READ
 WR ; WRITE

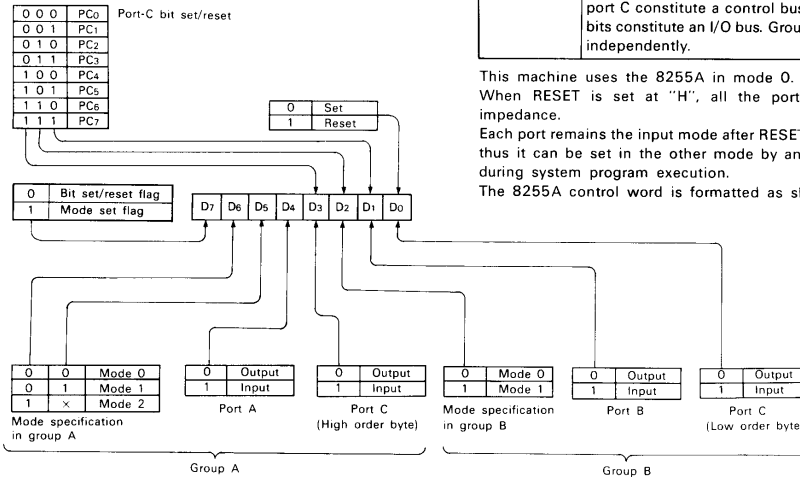
The 8255A provides 3 basic modes one of which can be selected by system software.

(1) Mode 0	Port A	Port B	Port C	
	I/O	I/O	High order byte I/O	Low order byte I/O
(2) Mode 1	Group A		Group B	
	Port A I/O	Port C High order byte I/O (Interrupt control)	Port B I/O	Port C Low order byte I/O (Interrupt control)
(3) Mode 2	Valid only for group A. 8 bits at port A constitute a bidirectional bus. 5 bits in the high order byte at port C constitute a control bus and the remaining bits constitute an I/O bus. Group B can be specified independently.			

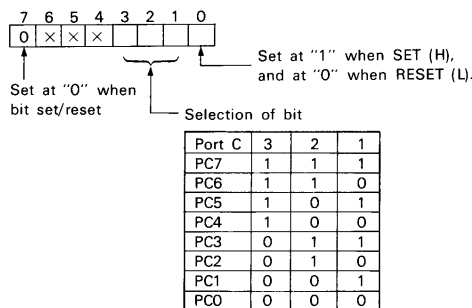
This machine uses the 8255A in mode 0. When RESET is set at "H", all the ports are set at high impedance.

Each port remains the input mode after RESET becomes "L", and thus it can be set in the other mode by an output instruction during system program execution.

The 8255A control word is formatted as shown below.



When using C port as an output port, any 1 bit only out of the 8 bits in the C port may be SET (H level)/RESET (L level) with the control word from the CPU. In this way, the program or data may be SAVED to the TAPE.

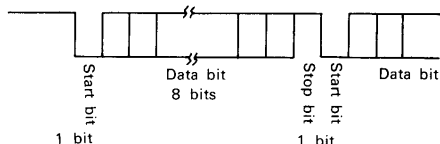


The signal system when recording tape with MSX is performed by FSK modulation and start-stop synchronization (non-synchronization) system. This signal is already generated in the software.

The FSK modulation is a system whereby the frequency of carrier wave may be increased or decreased when the data is either "1" or "0". In the MSX, when the transmitting speed is 1200 bauds, it is 1200Hz at "0", and 2400Hz at "1". These are all performed in the software of the MSX. Usually when transmitting or receiving data, it is necessary to set the rules beforehand by the transmitting side and receiving side regarding the data system and the transmission and receiving procedures. The start-stop synchronization system is a system whereby the start bit is firstly placed at the head of the data, and nextly comes the data of the predetermined number of bits and the parity bit, and followed lastly by the stop bit.

In the MSX, a single data is transmitted by 10 bits which are comprised of 1 bit of start bit, 8 bits of data bits and 1 bit of stop bit.

The CPU sends these signals through PPI (IC16).



3-8. PROGRAMMABLE SOUND GENERATOR (PSG) IC48

The IC48 at PSG is possible to make sounds through 3 channels with a single IC, and may also generate noise.

The interior of the PSG is arranged in the manner shown in the diagram on the next page.

Register 0 to 5 determine the frequency of each respective channels and are called channel A, channel B and channel C. As registers 1, 3, and 5 are divided by 4 bits, the values of 0 to 15 are input into these registers. As registers 0, 2, and 4 are divided by 8 bits, the values of 0 to 255 are input into these registers. Register 6 determines the noise frequency and is divided by 5 bits, the values of 0 to 31 are input into this register.

Register 7 is a switch, and it performs the ON/OFF of the sound of the respective channels or generates noise only.

As this register is negative logic, it becomes activated at "L". When all are turned ON they become 00H, and when all are turned OFF they become 3FH.

Registers 8, 9, and 10 are for use in adjusting the volume of the respective channels, and when bit 4 is "0" volume adjustment in 16 stages may be performed with bits 0 to 3.

When bit 4 is at "1", bits 0 to 3 are ignored and the volume and output systems of the respective channels will vary with the use of an envelope oscillator.

Registers 11 and 12 determine the envelope frequency. Adjustments are performed respectively with 8 bits each.

Register 13 is a place where the system of the envelope waveforms are altered, and as it is comprised of 4 bits the values of 0 to 15 are input.

In order to write in the value to the respective registers or to read out the values of same, they are controlled by signals A₀ and A₁ which are added to pin 29 (BC1) and pin 27 (BDIR).

Register 14 controls I/O port A, and register 15 controls I/O port B.

The combinations of A₀ and A₁ are as follows:

A ₁	(27) (BDIR)	A ₀	(29) (BC1)	
0	(1)	0	(1)	Specifies register.
0	(1)	1	(0)	Writes in value to register.
1	(0)	0	(1)	The contents of the register are output to data bus.
1	(0)	1	(0)	Not operated.

The output signals are output to the respective channels from pins 3, 4 and 38.

These signals are combined together and amplified with Q26. The output from the address decoder is connected to pin 4 of IC24, and when PSG is selected it becomes "L". In addition, pin 5 is connected to \overline{IORQ} and when it becomes "L", pin 6 becomes "L".

Therefore, pin 9 of IC52 and pin 11 of IC52 become "L", and operates in the manner stated in the prior clause by A₀ and A₁ of the address bus.

3-8-1. I/O Port of PSG (IC48)

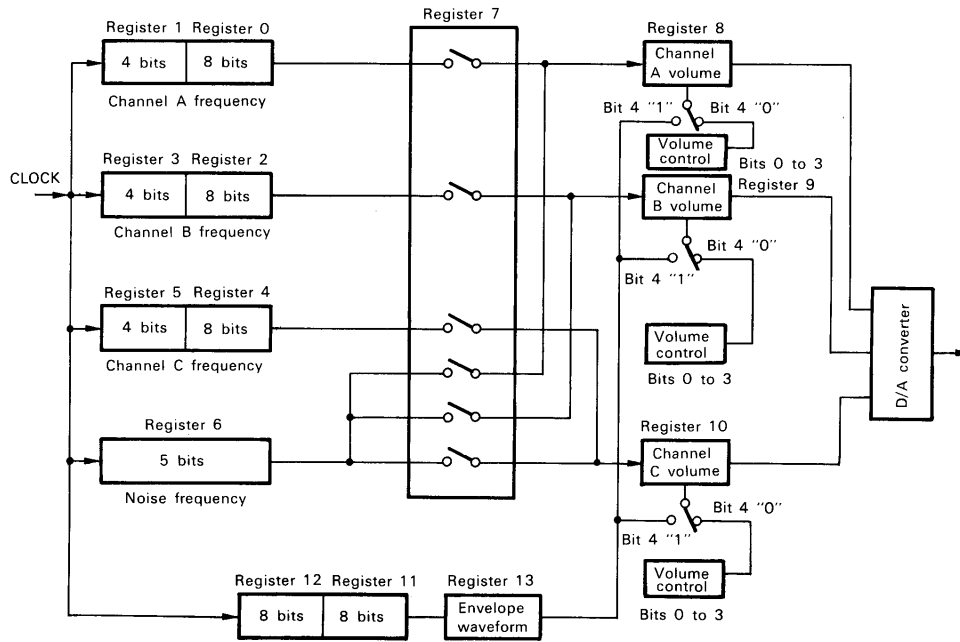
There are 2 I/O ports in IC48 and port A is used for input, and port B for output.

These I/O ports may be used as a connector when the joystick is being used.

When the number 7th bit (pin 7) of port B is set at "L", it selects the input from CN8, and when set at "H" it selects the input from CN9.

When the pins 1 of IC62 and IC63 are set at "L", the V0 to Y0 signals appear at the output, and these signals are added to port A of IC48.

When the pins 1 of IC62 and IC63 are set at "H", the V1 to Y1 signals are added to IC48.



3-9. VIDEO DISPLAY PROCESSOR (VDP) IC6

The functions of this IC are as follows:

- Resolution of 256×192 bits
- Uses 4K, 8K, and 16K dynamic RAMs.
- Function of automatic refresh of dynamic video RAM
- Displays 16 colors including black, white and transparent
- Color difference signal output of PAL system
- Occurrence of interruption of each frame is possible.
- Automatic processing of superimposition of pictures

This IC controls display screens of the family color television and color monitor television. It outputs all video signals, control signals, synchronizing signals, etc., which are based on the PAL system, and performs read/write to VRAM as also refresh.

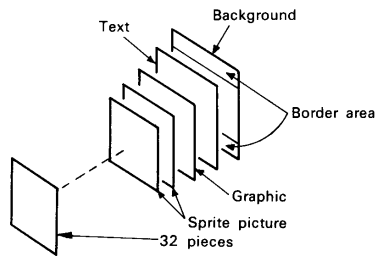
The most distinguished feature of the VDP is the display function of 32 pieces of sprites (graphic pattern of animation pictures). The sprite data registered in the V-RAM are displayed on the sprite surfaces.

These are 8×8 bits or 16×16 bits, and they can be enlarged to twice the sizes of their original sizes.

The color specification (1 color of the 16 colors) of the sprite and the display position are also designated on the VRAM.

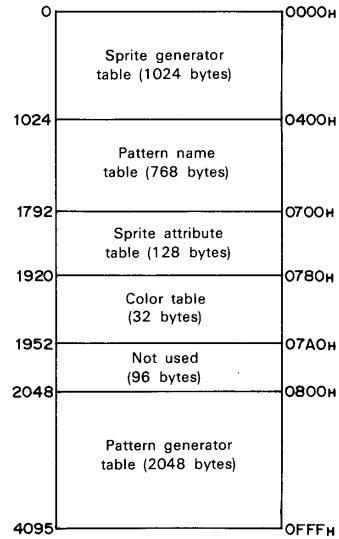
By rewriting this display position coordinates, it can be run at a high speed within the picture.

In accordance with the priority order (#0 is 1st priority) on the surface of the sprite, the low order sprite is erased by the high order sprite, and a 3-dimensional depth effect can be obtained.



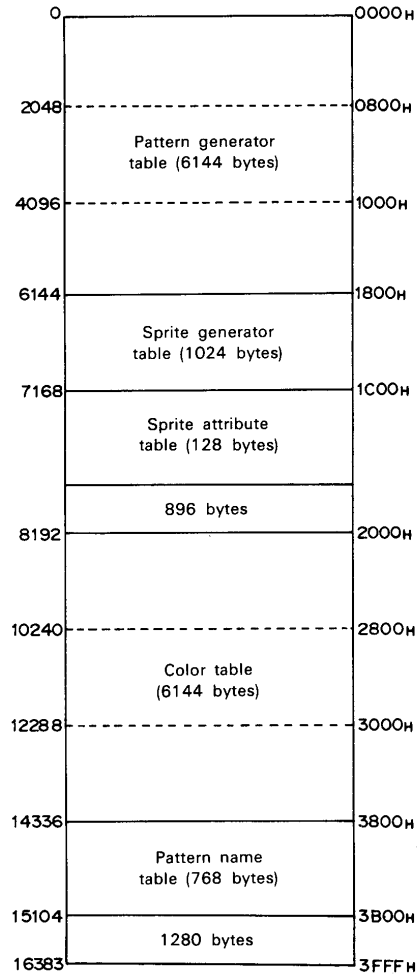
3-9-1. VRAM Mapping

The figure below shows an example of the mapping of the VRAM when the sprite and graphic I mode are used. (When used with the MSX, there are some differences according to the types of software used.)



- ① Data area of Graphic I
 - 1) 8×8 bits (8 bytes)
 - Maximum 256 kinds
 - Maximum 2048 bytes (8 bytes×256)
 - 2) Pattern name table
 - A table which displays pattern on screen and to store the data which specifies its position.
 - 3) Color table
 - A table which stores the color codes of the picture.
- ② Data area of sprite
 - 1) Sprite attribution table
 - Coordinates of sprite
 - Selection of display sprite
 - Color code specification of sprite
 - 2) Sprite generator table
 - Picture data of sprite
 - Maximum 256 kinds
 - Maximum 2048 bytes (8 bytes×256)

The figure below shows an example of 16K bytes VRAM mapping when graphic II is used. (When used with the MSX, there are some differences according to the types of software used.)



- ① Data area of Graphic II
- 1) Pattern generator table
 - 8×8 bits (8 bytes)
 - Maximum 768 (256×3) kinds
 - Maximum 6144 (2048×3) bytes
 - 2) Pattern name table
 - 768 (256×3) bytes
 - 3) Color table
 - Maximum 6144 (2048×3) bytes

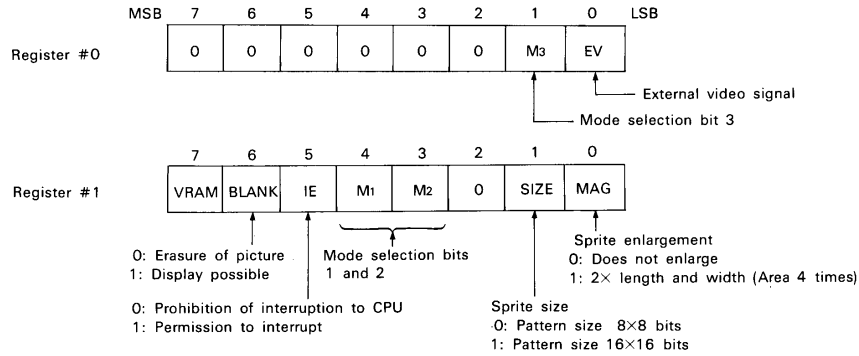
3-9-2. VDP Register

In the VDP register, there are a register used exclusively for 8 writing ins and one status register (exclusive to reading out) indicating the state of the VDP.

The picture display is performed by setting data necessary to VDP register, and by writing in picture data to VRAM (dynamic video refresh RAM).

Setting of respective registers:

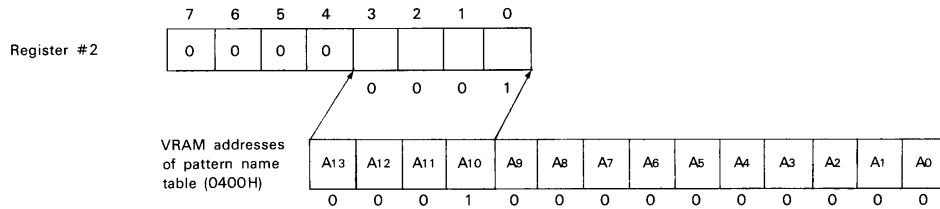
① Register #0 and #1



M1	M2	M3	Display mode
0	0	0	Graphic I
0	0	1	Graphic II
0	1	0	Multi-color
1	0	0	Text

② Register #2

Initial setting of pattern name table

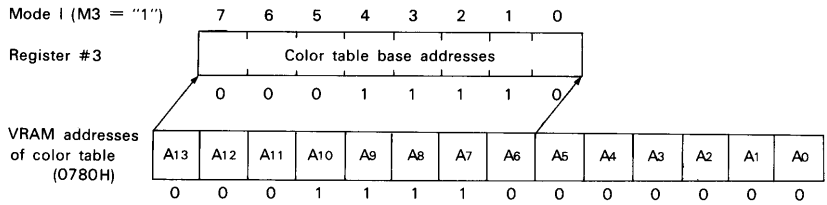


As the VRAM of VDP is up to 16K bytes (3FFH) only and can be shown with 14 bits, the VRAM addresses become as shown in above figure.

Set the upper 4 bits of the VRAM addresses to the lower 4 bits of Register #2. When the pattern name table starts from address >400H (1024)₁₀, the content of Register #2 becomes 01.

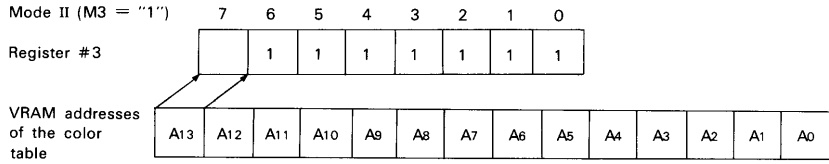
③ Register #3

Initial setting of color table



Set upper 8 bits at the head of the addresses of the VRAM color table to Register #3.

When the color table starts from address >780H (1290)₁₀, the value of register #3 becomes 1E.

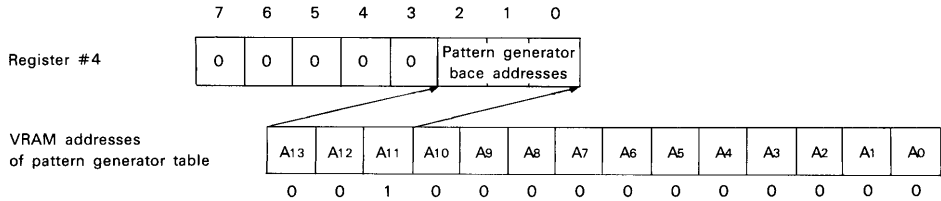


Set the uppermost bit of the head address of VRAM color table to the uppermost bit of Register #3, and set the rest of the 7 bits all to "1".

When color table is above 2000H, Register #3 becomes FFH. When it is below 2000H, it becomes 7FH.

④ Register #4

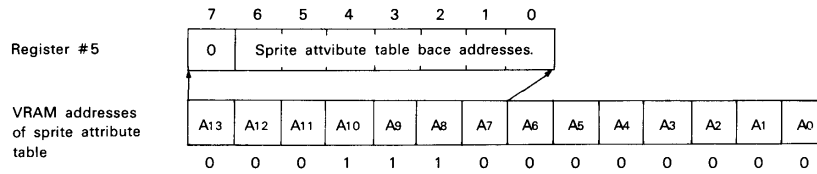
Initial setting of pattern generator table



Set upper 3 bits of the head address of VRAM pattern generator table to lower 3 bits of register #4.

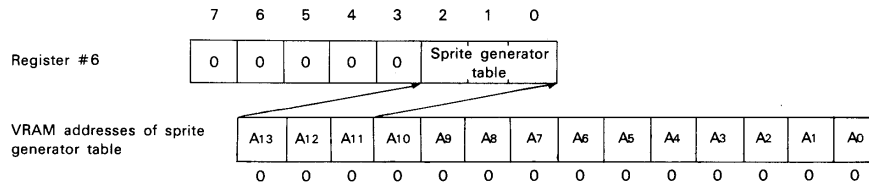
When the pattern generator table starts from address >800H (2048)₁₀, the value of register #4 becomes >01.

⑤ **Register #5**
Initial setting of sprite attribution table



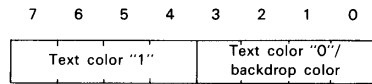
Set upper 7 bits of the head address of VRAM sprite attribution table to lower 7 bits of register #5.
When the sprite attribution table starts from address >700H (1792)10, the value of register #5 becomes >0E.

⑥ **Register #6**
Sprite generator table



Set upper 3 bits of the head address of VRAM sprite generator table to lower 3 bits of register #6.
When the sprite generator table starts from address 0, the value of register #6 becomes >00.

⑦ **Register #7**
Setting of text color/backdrop color



Performs the specification of colors when the text mode is selected.
The upper 4 bits specify the color of character data "1", the lower 4 bits specify the color of character data "0" and the color of the backdrop.
When mode other than text mode is specified, the lower 4 bits become backdrop color specification. The VDP color specification is carried out by 16 kinds of codes; namely, from \$0 to \$F. The correspondence of the respective codes and colors is as follows:

Code	Color	Code	Color
0	Transparent	8	Medium red
1	Black	9	Light red
2	Medium green	A	Dark yellow
3	Light green	B	Light yellow
4	Dark blue	C	Dark green
5	Light blue	D	Magenta
6	Dark red	E	Gray
7	Sky blue	F	White

3-9-3. VDP Status Register (for reading out only)

7	6	5	4	3	2	1	0
F	5S	C	No. 5 sprite number				

① **Interruption flag (F)**

When IE (No.5 bit) of register #1 is set at "1", the INT output of VDP becomes active ("L") when the scanning of the picture has ended.

② **5S and No.5 sprite number**

When sprites of more than 5 exist in the same horizontal line and the interruption flag (F) is "0", the "5S" bit will be set at "1".

In addition, the number of the No.5th sprite surface will be maintained at lower 5 bits.

③ **Collision flag (C)**

When 1 picture element of more than 2 sprites collide (in accord), it is set at "1".

3-9-4. Reset of VDP Status Register

The status register is reset in the following cases.

- 1) Input of external reset signal.
- 2) Reading out of status register
When the flag is once set, it is continuously set unless the reading out of the next status register is performed.

3-9-5. Writing In to the VDP Register

Write in data such as function selection of display mode of the VDP register (for writing in only) and establishment of the respective base addresses.

The transmission of data from the CPU is carried out in the following way.

	Bits								Control signals		
	7	6	5	4	3	2	1	0	$\overline{\text{CSW}}$	$\overline{\text{CSR}}$	MODE
No.1 byte: Data	D7	D6	D5	D4	D3	D2	D1	D0	L	H	H
No.2 byte: Selection of register	1	0	0	0	0	RS0	RS1	RS0	L	H	H

Transmit data with No. 1 byte.

The No.2 byte specifies the register of the receiving end of data at lower 3 bits. The uppermost bit should be "1", and the next 4 bits should be "0".

Control signals

$\overline{\text{CSW}}$: When writing in to VDP the 8 bits data (D0 to D7) from the CPU, it becomes active ("L").
The data is set to VDP during the rising time of this signal.

$\overline{\text{CSR}}$: When it is active ("L"), the VDP outputs the 8 bits (D0 to D7) to bus line.

MODE: Set at "L" when transferring data from CPU to VRAM, or when transferring data from VRAM to CPU. In cases other than above, set at "H".

3-9-6. Writing In to VRAM

The CPU transfers data to VRAM after going through VDP, with the 14 bit automatic increment address register stored within the VDP.

It is necessary to use 2 bytes in setting up this address register. Figure below shows how to set up this address register and perform data transfer.

		Control signal		
		$\overline{\text{CSW}}$	$\overline{\text{CSR}}$	MODE
No.1 byte: Address set up	A7 A6 A5 A4 A3 A2 A1 A0	L	H	H
No.2 byte: Address set up	0 1 A13 A12 A11 A10 A9 A8	L	H	H
No.3 byte: Data	D7 D6 D5 D4 D3 D2 D1 D0	L	H	L

Set up the lower 8 bits of VRAM address with No.1 byte.

Set up upper 6 bits with No.2 bytes.

At this time, the upper 2 bits are (01). Transmit data with No.3 byte.

Once the address register is set up, it is automatically incremented every time the next No.3 byte transfers data. The MODE signal is set at "H" when transferring address, and at "L" when transferring data.

3-9-7. Reading Out of Status Register

The CPU performs the reading out with 1 byte the contents of the status register. The respective control signals at this time are as follows:

	Bits								Control signals		
	7	6	5	4	3	2	1	0	$\overline{\text{CSW}}$	$\overline{\text{CSR}}$	MODE
Status register data	D7	D6	D5	D4	D3	D2	D1	D0	H	L	H

3-9-8. Reading Out from the VRAM

The CPU reads out the data from VRAM after going through VDP. Addresses are automatically incremented.

		Control signals		
		$\overline{\text{CSW}}$	$\overline{\text{CSR}}$	MODE
No.1 byte: Address set up	A7 A6 A5 A4 A3 A2 A1 A0	L	H	H
No.2 byte: Address set up	0 0 A13 A12 A11 A10 A9 A8	L	H	H
No.3 byte: Data	D7 D6 D5 D4 D3 D2 D1 D0	H	L	L

This device employs the I/O ports 98H to 99H for VDP use. The control signals $\overline{\text{CSW}}$ and $\overline{\text{CSR}}$ of IC6 (VDP) become active when $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ or $\overline{\text{WR}}$ become "L" when the address bus signal is 98H or 99H.

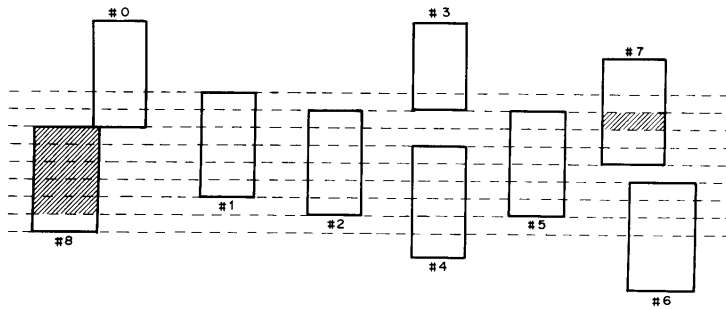
When $\overline{\text{IORQ}}$ and $\overline{\text{RD}}$ are "L", $\overline{\text{CSR}}$ becomes active.

When $\overline{\text{IORQ}}$ and $\overline{\text{WR}}$ are "L", $\overline{\text{CSW}}$ becomes active.

When the address bus signal is 98H, it is accessed to VRAM. When the address bus signal is 99H, it is accessed to VDP register.

3-9-9. Display Limitation of Sprite

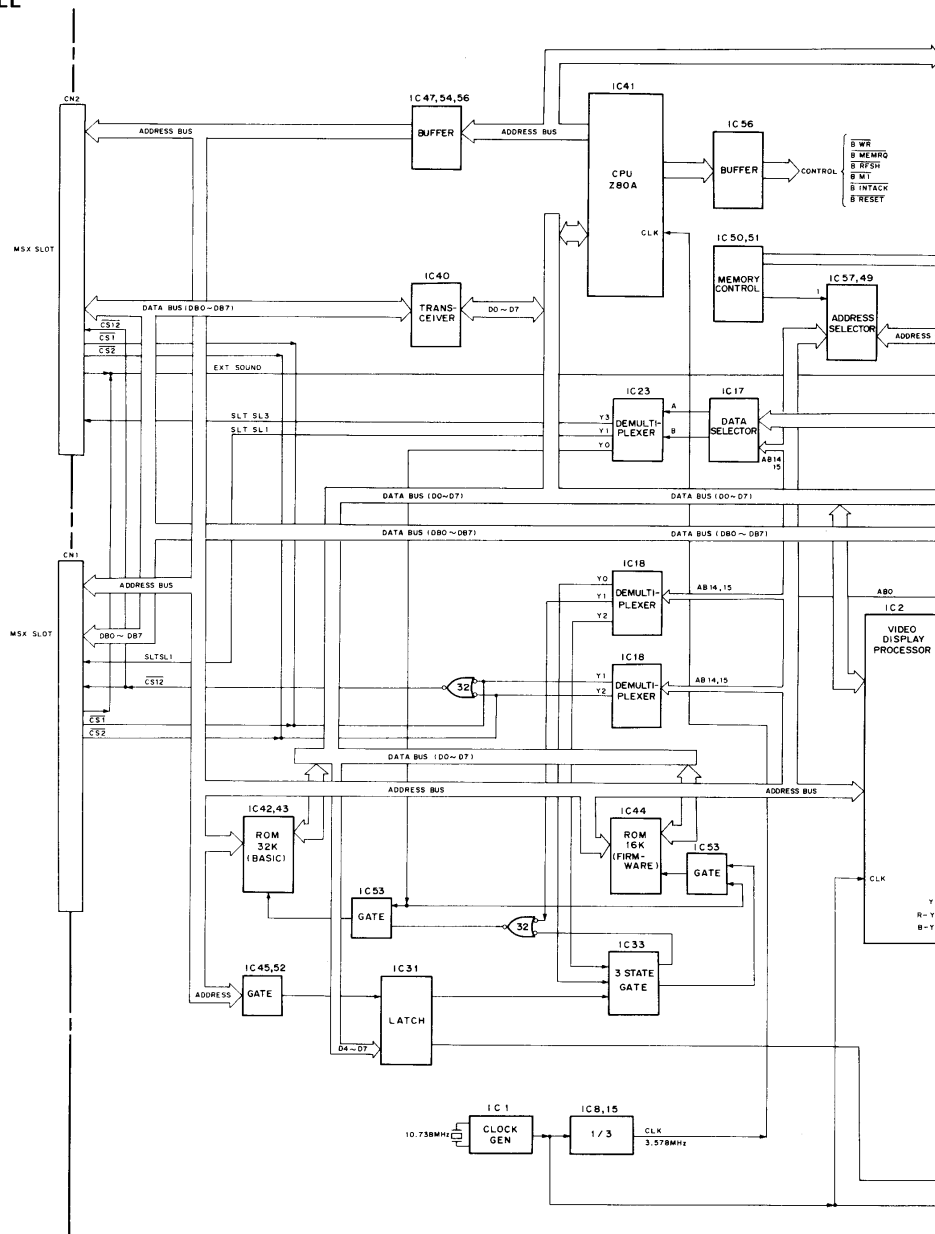
The hatched portion becomes transparent and the background pattern is displayed.



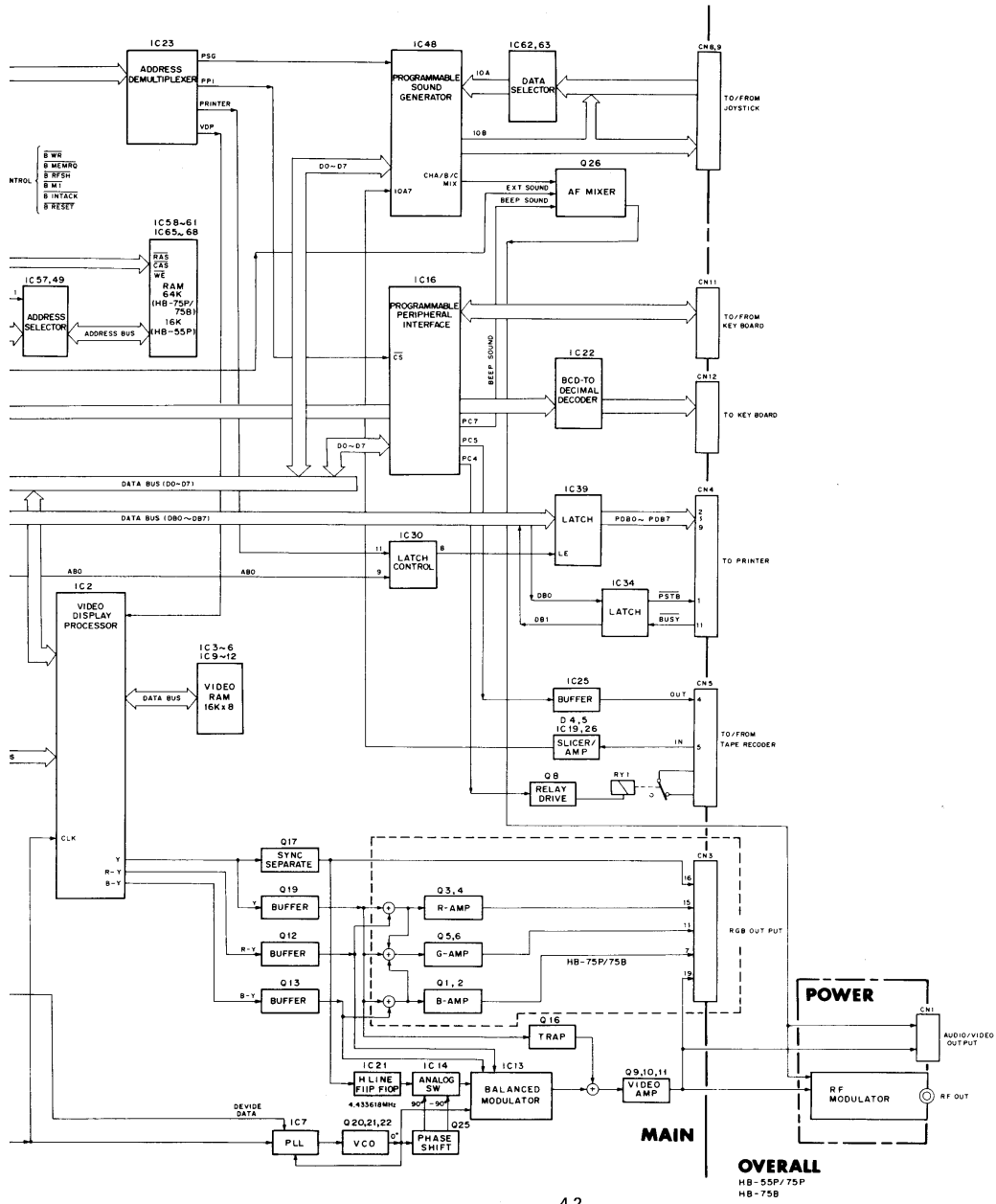
- ① The sprites up to 4 can take place on a same horizontal line.
- ② When the sprites of more than 5 take place on the same horizontal line, 4 sprites that have high priority (in the order of #0, #1 #32) are displayed and the sprite from 5 and above are not displayed.
- ③ The state of the sprites can be ascertained by referring to the status register.

CHAPTER 4 BLOCK DIAGRAM

OVERALL



OVERALL OVERALL



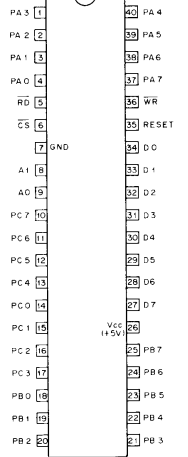
CHAPTER 5

SCHEMATIC DIAGRAM AND PRINTED CIRCUIT BOARD

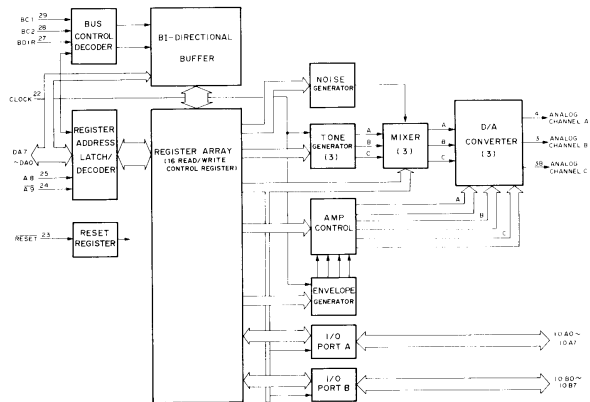
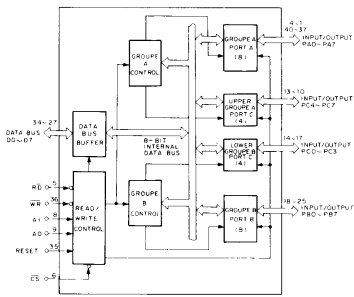
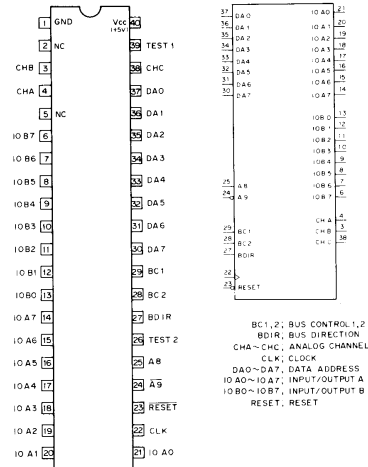
SEMICONDUCTOR PIN ASSIGNMENTS

TYPE	PAGE	TYPE	PAGE	TYPE	PAGE
10E-2	5-12	MB74LS00	5-7	SN74LS245N	5-9
1N4148H	5-12	MB74LS02	5-7	SN74LS27N	5-8
1S1555	5-12	MB74LS04	5-7	SN74LS32N	5-8
1S2076	5-12	MB74LS08	5-7	SN74LS367AN	5-8
1S2473	5-12	MB74LS09	5-7	SN74LS373N	5-9
1SS119	5-12	MB74LS10	5-9	SN74LS645N	5-10
1SS133	5-12	MB74LS11	5-9	SN74LS74AN	5-8
1SS148	5-12	MB74LS126A	5-10	SN74LS86N	5-9
1SS202	5-12	MB74LS139	5-9	TMS9929ANL	5-11
2SA1027R	5-12	MB74LS14	5-7	US1035	5-12
2SA1048	5-12	MB74LS145	5-7	uPC311C	5-11
2SA1115	5-12	MB74LS153	5-8	uPD4066BC	5-6
2SA1175	5-12	MB74LS157	5-8	uPD416C-2	5-4
2SA733	5-12	MB74LS175	5-10	uPD780C-1	5-4
2SC1364	5-12	MB74LS27	5-8	uPD8255AC-5	5-2
2SC2001	5-12	MB74LS32	5-8	YM-2149	5-4
2SC2120	5-12	MB74LS367A	5-8		
2SC2458	5-12	MB74LS373	5-9		
2SC2603	5-12	MB74LS74A	5-8		
2SC2785	5-12	MB74LS86	5-9		
2SC641K	5-12	MBM27128	5-3		
2SC945	5-12	MCM4116BP20	5-4		
2SD1012	5-12	MSM3764-15RS	5-6		
2SD1020	5-12	MSM3764-20RS	5-6		
2SK30A	5-12	MSM38128ARS	5-5		
AY-3-8910	5-2	MSM38256RS	5-5		
CX7925A	5-6	NJM79L??A	5-11		
HD14066BP	5-6	RB402	5-12		
HD74LS157P	5-8	RD??EL	5-12		
HD74LS74AP	5-8	SI-3052V	5-11		
HD74LS86P	5-9	SI-3122V	5-11		
HD74LS373P	5-9	SLP-171D	5-12		
HD74LS645P	5-10	SN74LS00N	5-7		
HM4864P-2	5-6	SN74LS02N	5-7		
HM4864P-3	5-6	SN74LS04N	5-7		
HN4827128G	5-3	SN74LS08N	5-7		
KV1320	5-12	SN74LS09N	5-7		
LH0080A	5-4	SN74LS10N	5-9		
LM1889N	5-6	SN74LS11N	5-9		
		SN74LS126N	5-10		
		SN74LS139N	5-9		
		SN74LS14N	5-7		
		SN74LS145N	5-7		
		SN74LS153N	5-8		
		SN74LS157N	5-8		
		SN74LS175N	5-10		

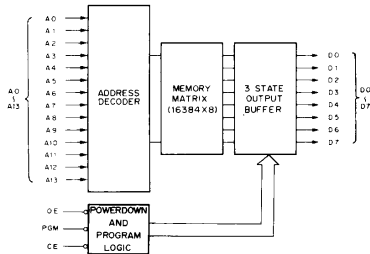
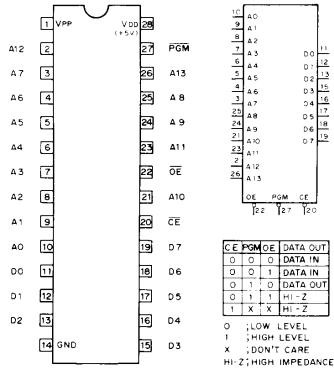
UPD8255AC-5 (NEC)
PROGRAMMABLE PERIPHERAL INTERFACE
— TOP VIEW



AY-38910 (GENERAL INSTRUMENT)
YM-2149 (YAMAHA)
PROGRAMMABLE SOUND GENERATOR
— TOP VIEW

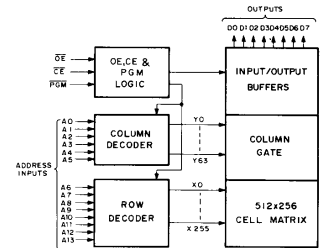
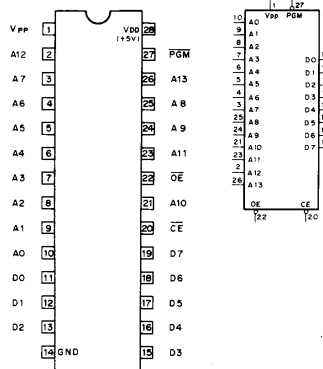


HN4827128G-25 (HITACHI) (ACCESS TIME = 250ns)
 HN4827128G-30 (HITACHI) (ACCESS TIME = 300ns)
 N-MOS ERASABLE AND PROGRAMMABLE ROM 128K-BIT (16384x8)
 — TOP VIEW —



A0-A13 : ADDRESS INPUT
 CE : CHIP ENABLE
 D0-7 : DATA
 OE : OUTPUT ENABLE
 PGM : PROGRAM

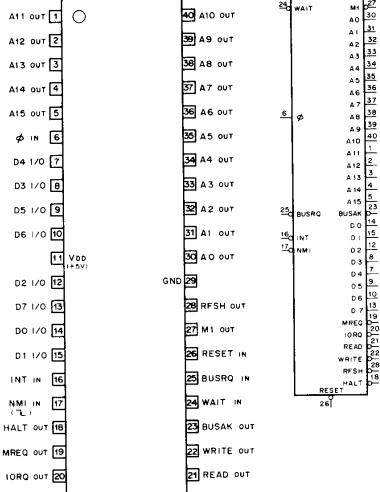
MBM27128 (FUJITSU)
 N-MOS UV EPROM 128K-BIT (16384x8)
 — TOP VIEW —



TERMINAL	CE	OE	PGM	Vpp	Vcc	OUTPUTS
READ	0	0	1	+5V	+5V	DATA OUT
STAND-BY	1	X	X	+5V	+5V	HIGH IMPEDANCE
PROGRAMMING	0	1	0	+21V	+21V	DATA IN
PROGRAM VERIFY	0	0	1	+21V	+5V	DATA OUT
PROGRAM INHIBIT	1	X	X	+21V	+5V	HIGH IMPEDANCE
HIGH SPEED PROGRAMMING	0	1	0	+21V	+6V	DATA IN

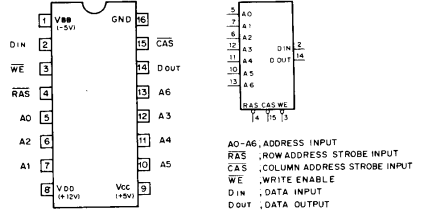
1 ; TTL LEVEL HIGH VOLTAGE IN
 0 ; TTL LEVEL LOW VOLTAGE IN
 X ; DONT CARE (1 OR 0)

LH0080A (SHARPI)
uPD780C-1 (NEC)
N-MOS 8-BIT MICROPROCESSOR
— TOP VIEW —

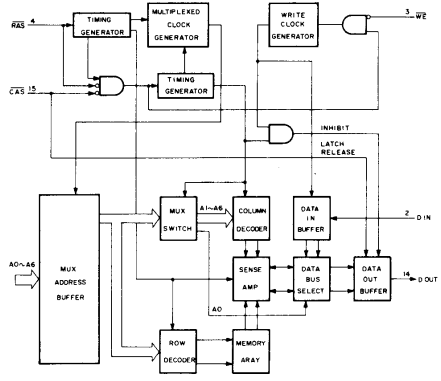


- phi : CLOCK
- A0-A15 : 3-STATE ADDRESS OUTPUT
- BUSAK : BUS ACKNOWLEDGE
- BUSRQ : BUS REQUEST
- D0-D7 : 3-STATE DATA INPUT/OUTPUT
- HALT : HALT STATE
- INT : INTERRUPT REQUEST
- IORQ : 3-STATE I/O REQUEST
- M1 : MACHINE CYCLE 1
- MREQ : 3-STATE MEMORY REQUEST
- NMI : NON-MASKABLE INTERRUPT (DOWN EDGE TRIGGER)
- READ : 3-STATE MEMORY READ
- RFSH : REFRESH
- WRITE : 3-STATE MEMORY WRITE

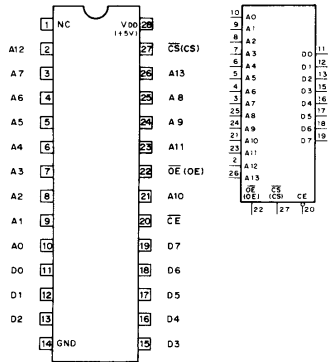
MCM4116BP20 (MOTOROLA) (ACCESS TIME = 200 nS)
uPD416C-2 (NEC) (ACCESS TIME = 200 nS)
N-MOS 16384-WORD BY 1-BIT DYNAMIC RAM
— TOP VIEW —



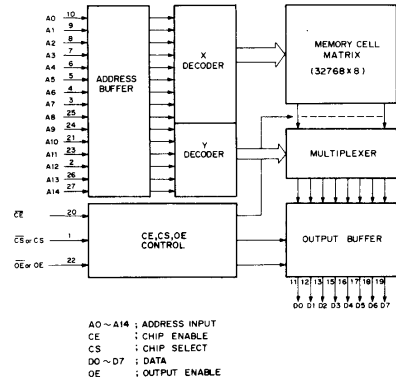
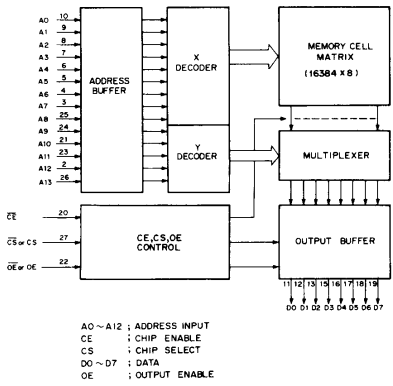
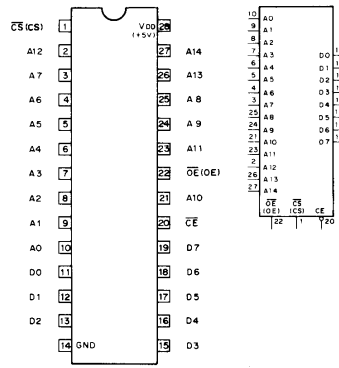
- A0-A6, ADDRESS INPUT
- RAS, ROW ADDRESS STROBE INPUT
- CAS, COLUMN ADDRESS STROBE INPUT
- WE, WRITE ENABLE
- D1N, DATA INPUT
- DOUT, DATA OUTPUT

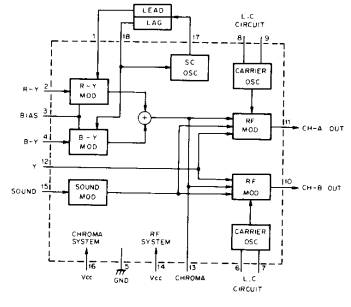
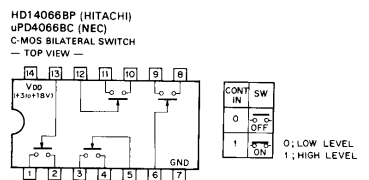
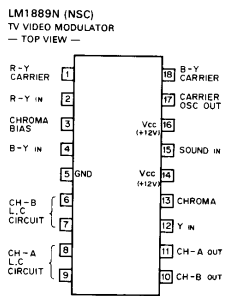
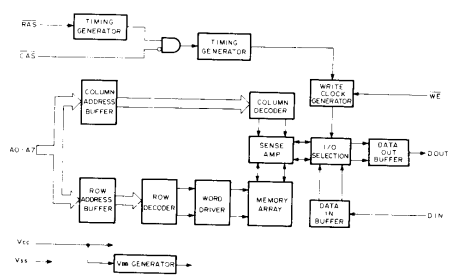
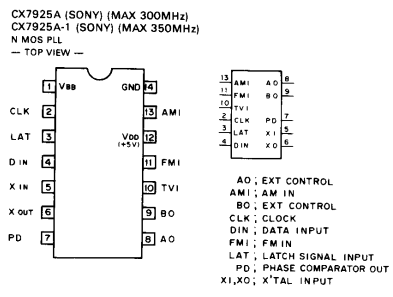
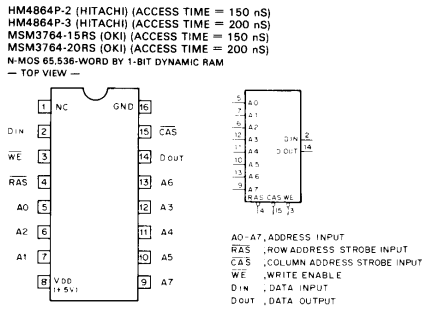


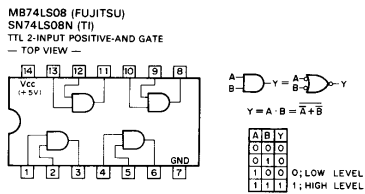
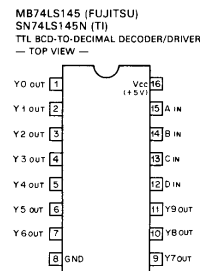
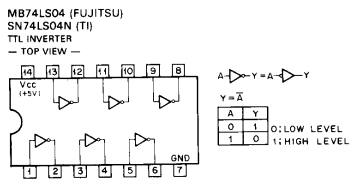
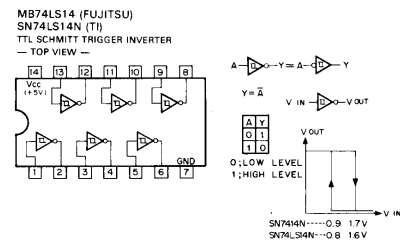
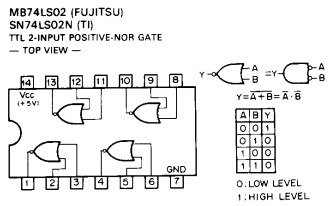
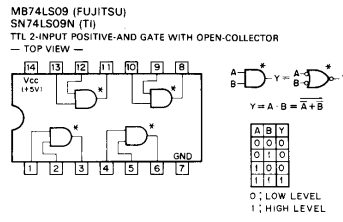
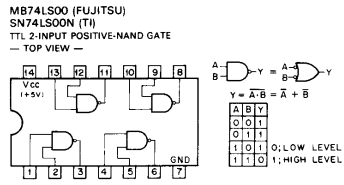
MSM38128ARS (OKI)
N-MOS MASK PROGRAMMABLE ROM 128K-BIT (16384x8)
— TOP VIEW —



MSM38256RS (OKI)
N-MOS MASK PROGRAMMABLE ROM 256K-BIT (32768x8)
— TOP VIEW —



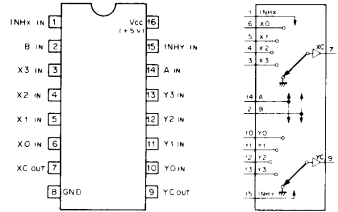




STATE	INPUTS				OUTPUTS									
	0	1	2	3	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1	1	1	1	1	1	1	1
2	0	0	1	0	1	1	1	1	1	1	1	1	1	1
3	0	0	1	1	1	1	1	1	1	1	1	1	1	1
4	0	1	0	0	1	1	1	1	1	1	1	1	1	1
5	0	1	0	1	1	1	1	1	1	1	1	1	1	1
6	0	1	1	0	1	1	1	1	1	1	1	1	1	1
7	0	1	1	1	1	1	1	1	1	1	1	1	1	1
8	1	0	0	0	1	1	1	1	1	1	1	1	1	0
9	1	0	0	1	1	1	1	1	1	1	1	1	1	0
INVALID	1	0	1	0	1	1	1	1	1	1	1	1	1	1
	1	1	0	0	1	1	1	1	1	1	1	1	1	1
	1	1	0	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	0	1	1	1	1	1	1	1	1	1	1

0; LOW LEVEL
1; HIGH LEVEL

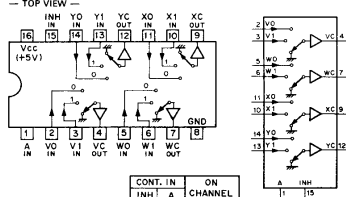
MB74LS153 (FUJITSU)
SN74LS153N (TI)
TTL 4-LINE-TO-1-LINE DATA SELECTOR/MULTIPLEXER
— TOP VIEW —



CONTROL	INH	A	EN	CHANNEL
0	0	0	0	0
0	0	1	0	1
0	1	0	0	2
0	1	1	0	3
1	X	X	X	GND

0: LOW LEVEL
1: HIGH LEVEL
X: DON'T CARE

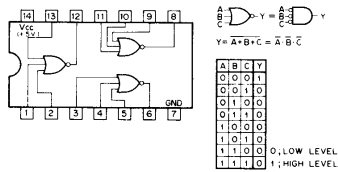
HD74LS157P (HITACHI)
MB74LS157 (FUJITSU)
SN74LS157N (TI)
TTL 2-LINE-TO-1-LINE DATA SELECTOR/MULTIPLEXER
— TOP VIEW —



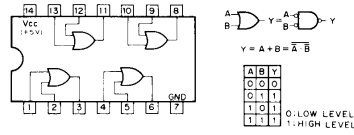
CONT. IN	INH	A	EN	CHANNEL
0	0	0	0	0
0	0	1	0	1
0	1	0	0	2
0	1	1	0	3
1	X	X	X	GND

0: LOW LEVEL
1: HIGH LEVEL
X: DON'T CARE

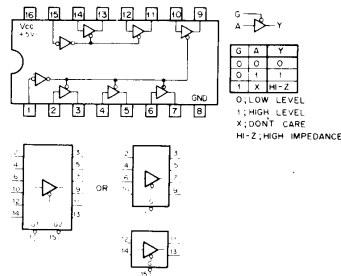
MB74LS27 (FUJITSU)
SN74LS27N (TI)
TTL 3-INPUT POSITIVE-NOR GATE
— TOP VIEW —



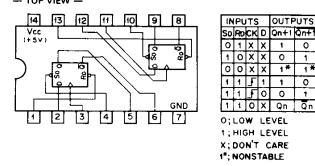
MB74LS32 (FUJITSU)
SN74LS32N (TI)
TTL 2-INPUT POSITIVE-OR GATE
— TOP VIEW —

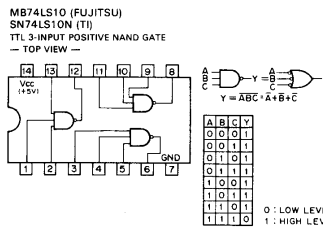
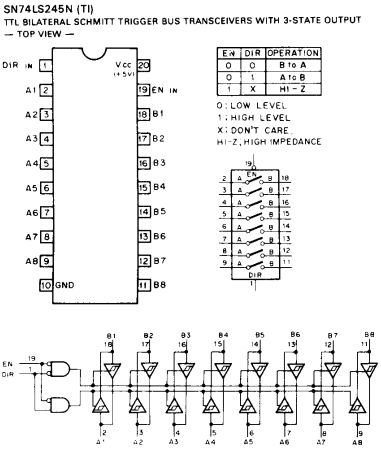
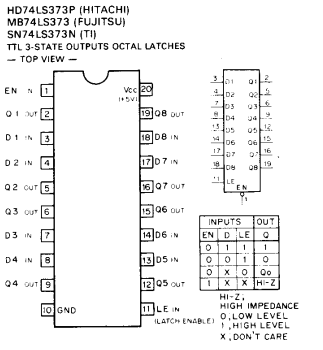
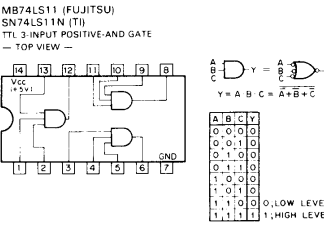
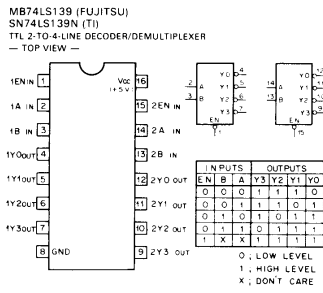
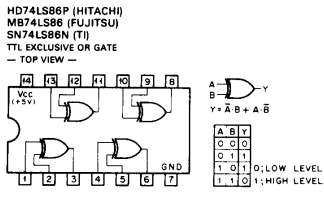


MB74LS367A (FUJITSU)
SN74LS367AN (TI)
TTL BUS DRIVER WITH 3-STATE OUTPUTS
— TOP VIEW —

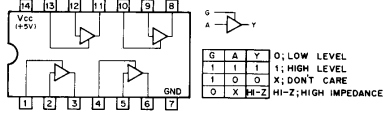


HD74LS74AP (HITACHI)
MB74LS74A (FUJITSU)
SN74LS74AN (TI)
TTL D-TYPE FLIP FLOP WITH DIRECT SET/RESET
— TOP VIEW —

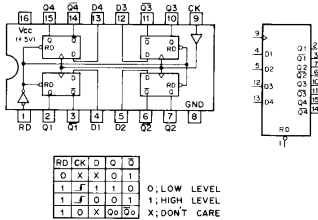




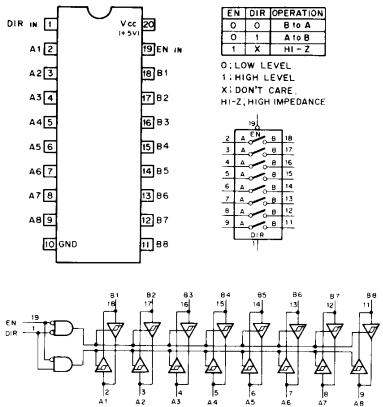
**MB74LS126A (FUJITSU)
SN74LS126AN (TI)**
TTL BUS BUFFER GATE WITH 3-STATE OUTPUT
— TOP VIEW —



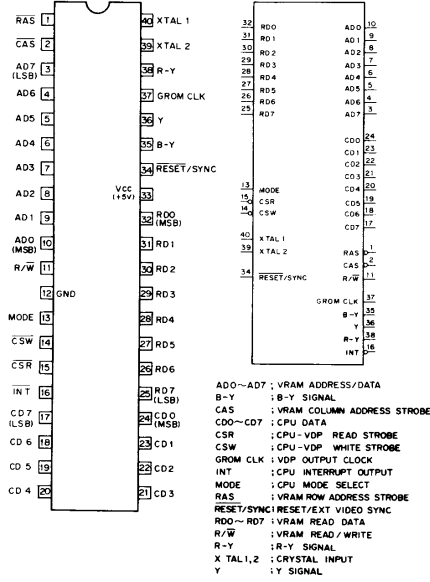
**MB74LS175 (FUJITSU)
SN74LS175N (TI)**
TTL D-TYPE FLIP-FLOP WITH CLEAR
— TOP VIEW —



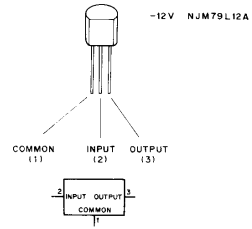
**HD74LS645P (HITACHI)
SN74LS645N (TI)**
TTL BILATERAL SCHMITT TRIGGER BUS TRANSCEIVERS WITH 3-STATE OUTPUT
— TOP VIEW —



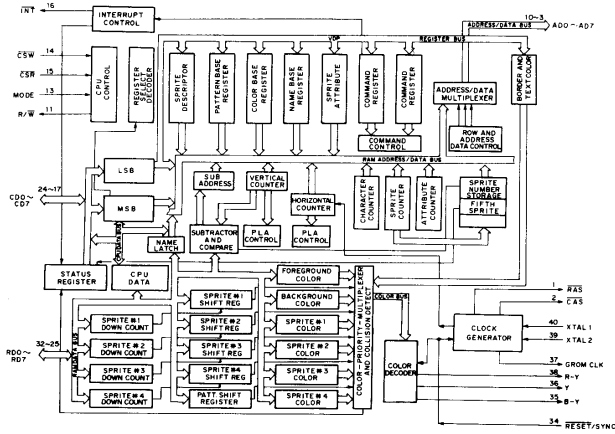
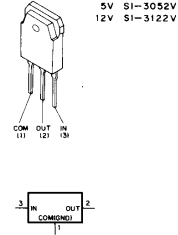
TMS9929ANL (TI) (PAL COLOR-DIFFERENCE SIGNAL)
 N-MOS VIDEO DISPLAY PROCESSOR
 - TOP VIEW -



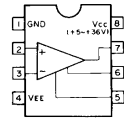
NJM79L77A (JRC)
 NEGATIVE VOLTAGE REGULATOR (40mA)
 - FRONT VIEW -

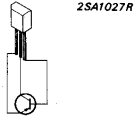


SI-3052V (SANKEN)
 SI-3122V (SANKEN)
 POSITIVE VOLTAGE REGULATOR (2A)

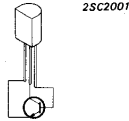


uPC311C (NEC)
 VOLTAGE COMPARATOR
 - TOP VIEW -

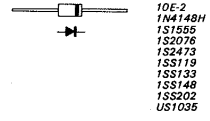




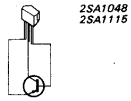
2SA1027R



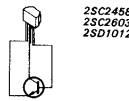
2SC2001



10E-2
1N4148H
1S1555
1S2076
1S2473
1SS119
1SS133
1SS148
1SS202
1S1035



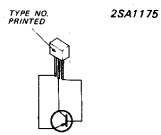
2SA1048
2SA1115



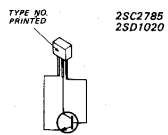
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2SC2603
2SD1012



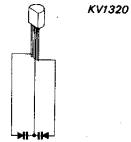
RD 7 7EL



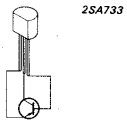
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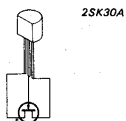
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2SD1020



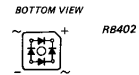
KV1320



2SA733

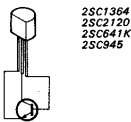


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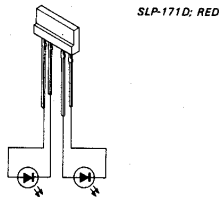


BOTTOM VIEW

RB402



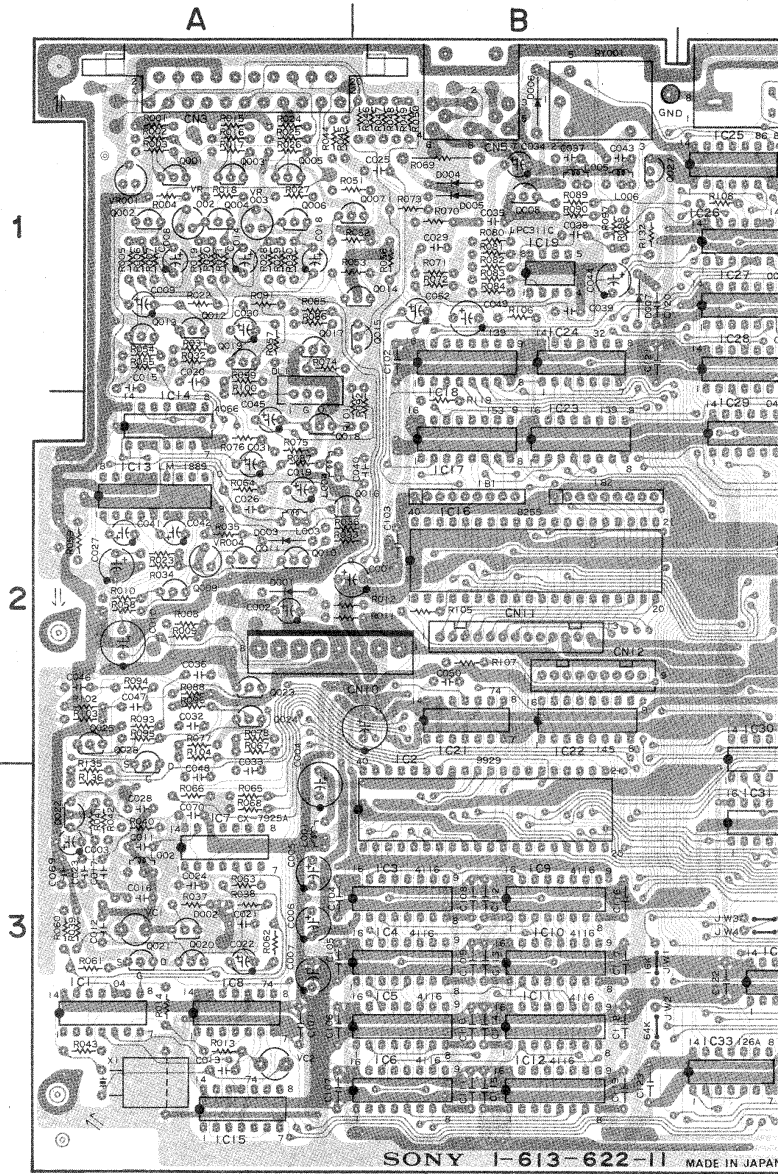
2SC1364
2SC2120
2SC641K
2SC945



SLP-171D, RED

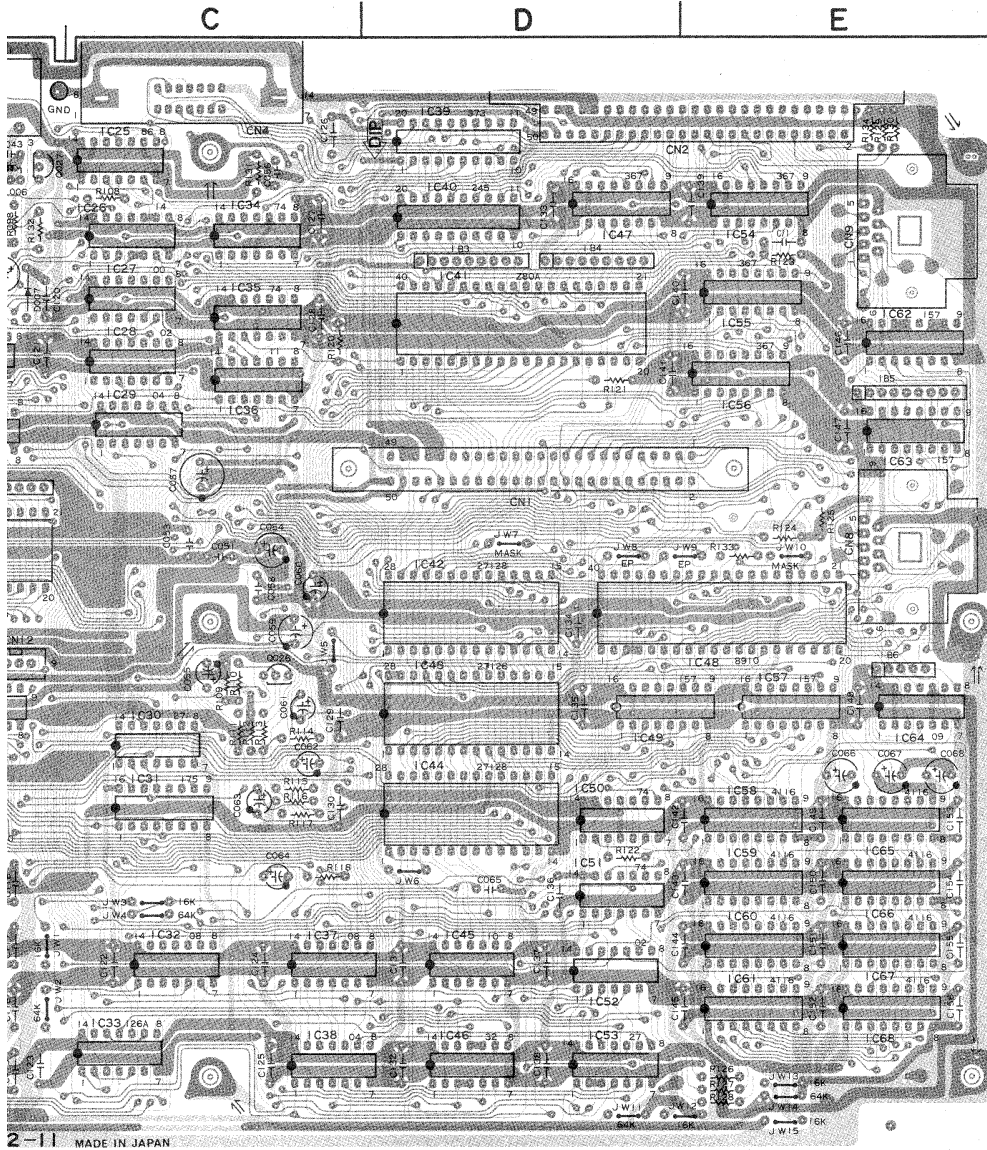
MAIN

MAIN BOARD



Note: The blue pattern on board layout is COMPONENT SIDE.
The gray pattern on board layout is SOLDERING SIDE.

MAIN

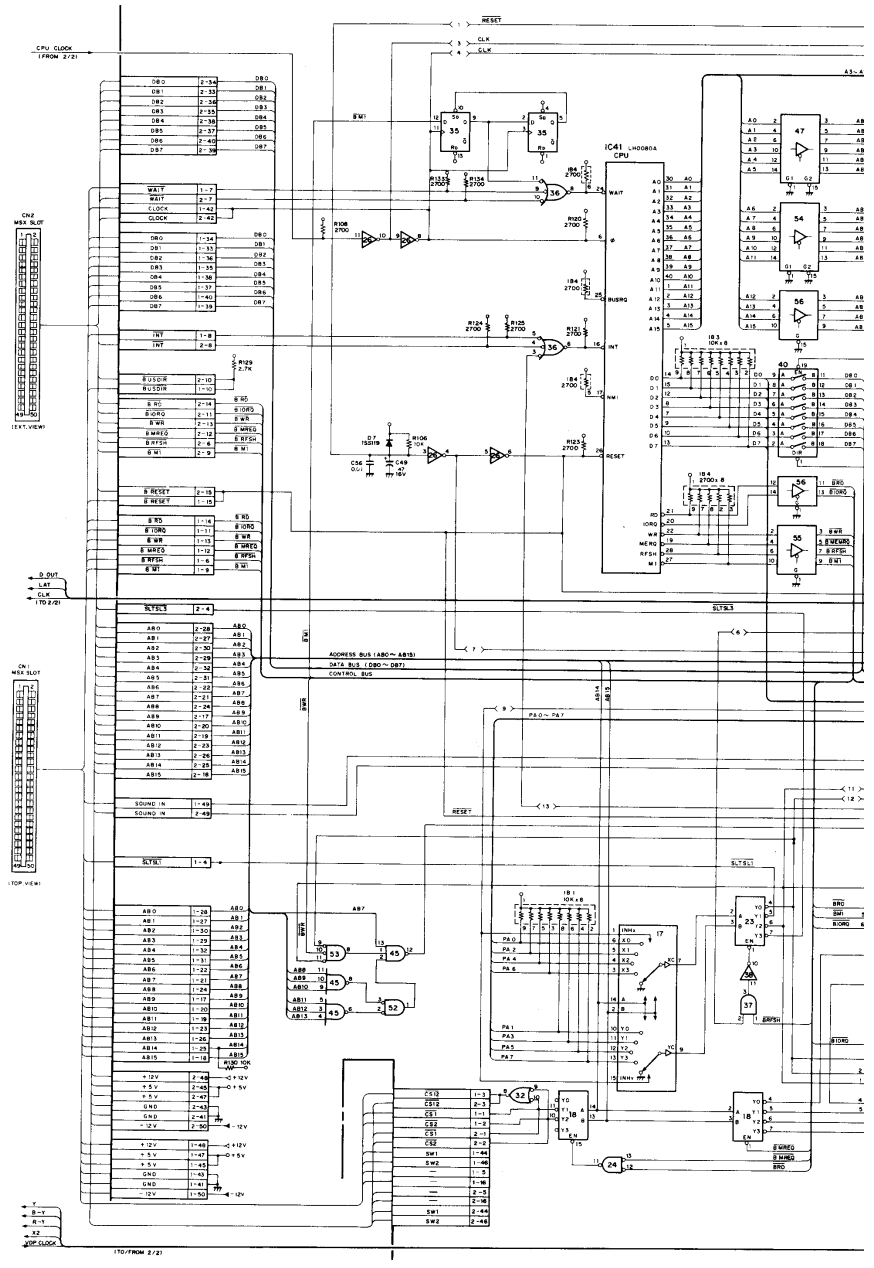


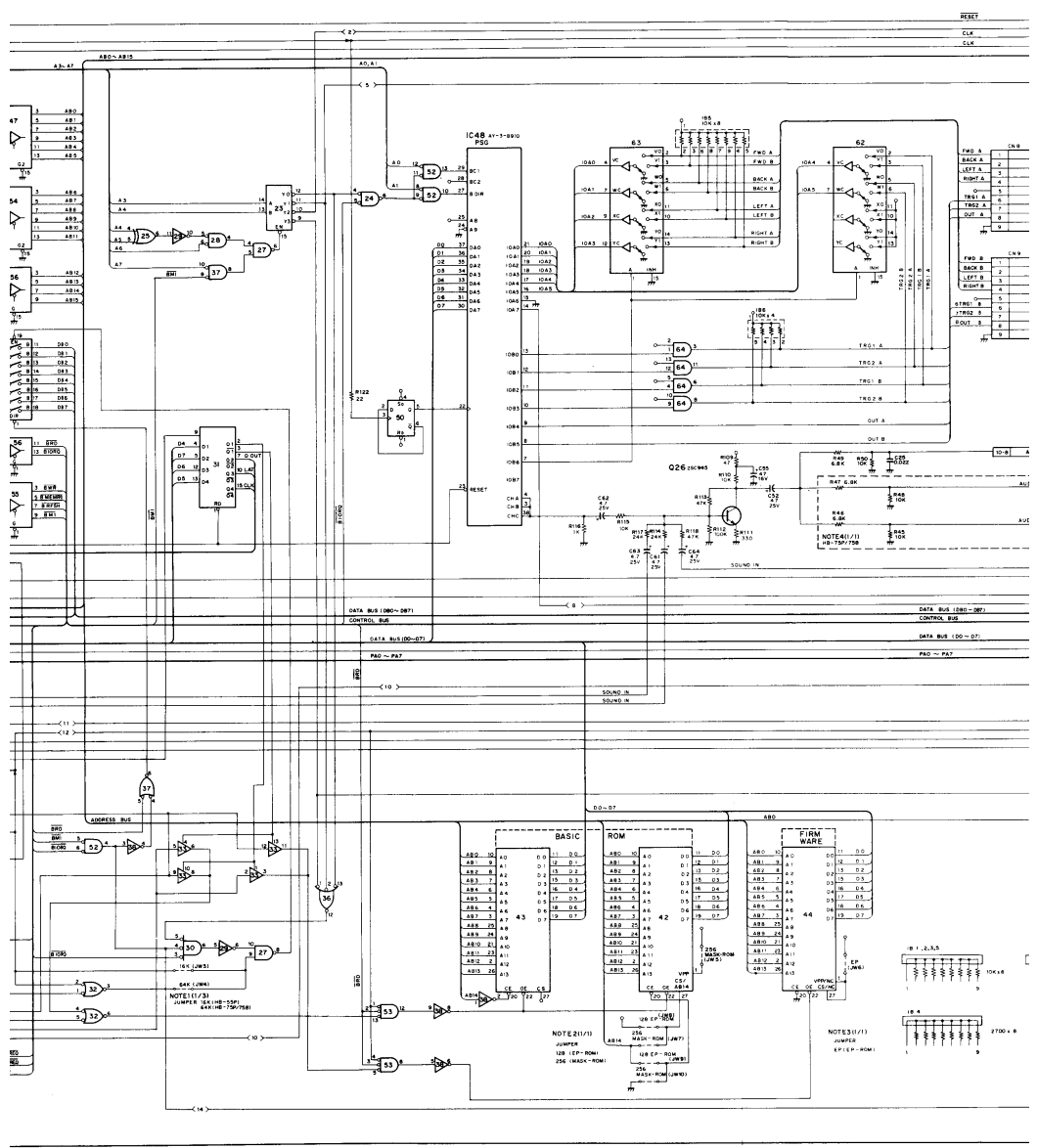
MAIN BOARD - COMPONENT SIDE -

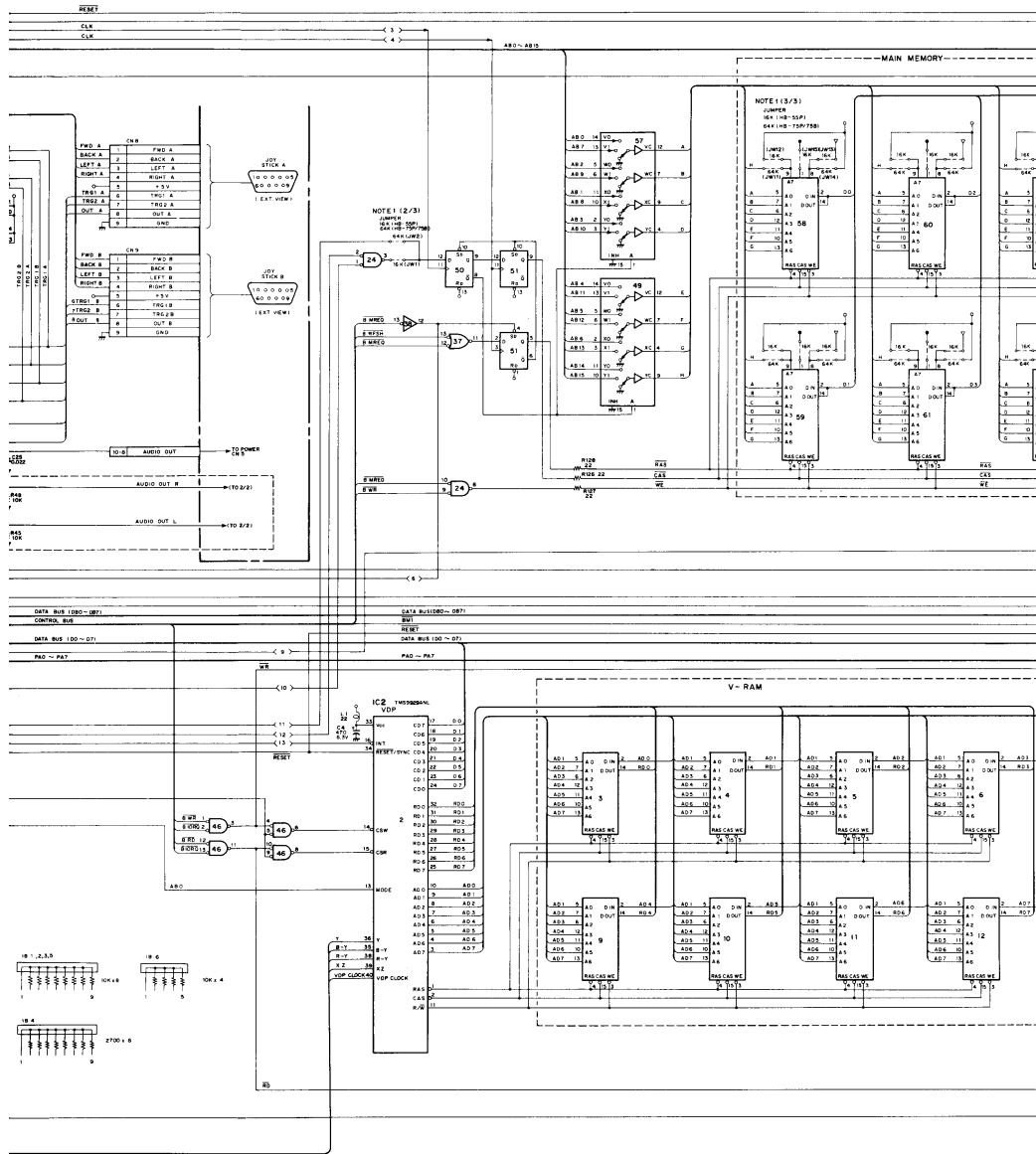
1-613-622-11
HB-55P/75P(AE)
HB-75B(UK)

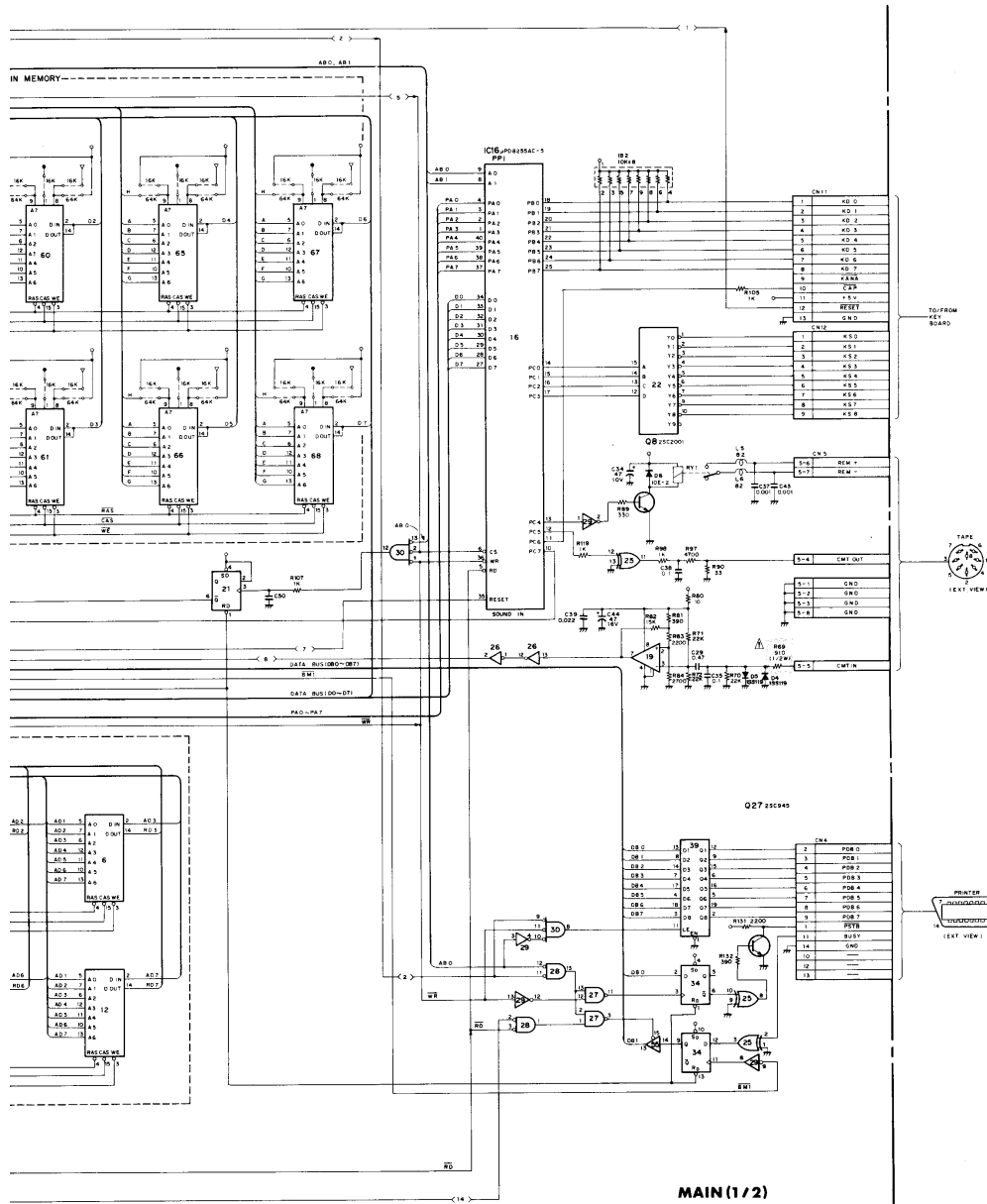
MAIN

C001	B - 2	C066	E - 3	CN1	D - 2	IC31	C - 3	Q001	A - 1	R036	A - 2	R100	A - 1
C002	A - 2	C067	E - 3	CN2	E - 1	IC32	C - 3	Q002	A - 1	R037	A - 3	R101	A - 2
C003	A - 3	C068	E - 3	CN3	A - 1	IC33	C - 3	Q003	A - 1	R038	A - 3	R102	A - 2
C004	A - 3	C069	A - 3	CN4	C - 1	IC34	C - 1	Q004	A - 1	R039	A - 3	R103	A - 2
C005	A - 3	C070	A - 3	CN5	B - 1	IC35	C - 1	Q005	A - 1	R040	A - 3	R104	A - 2
C006	A - 3	C071	E - 1	CN8	E - 2	IC36	C - 1	Q006	A - 1	R041	A - 3	R105	B - 2
C007	A - 3	C101	A - 3	CN9	E - 1	IC37	C - 3	Q007	B - 1	R042	A - 3	R106	B - 1
C008	A - 1	C102	B - 1	CN10	A - 2	IC38	C - 3	Q008	B - 1	R043	A - 3	R107	B - 2
C009	A - 1	C103	B - 2	CN11	B - 2	IC39	D - 1	Q009	A - 2	R044	A - 1	R108	C - 1
C010	A - 2	C104	A - 3	CN12	B - 2	IC40	D - 1	Q010	A - 2	R045	A - 1	R109	C - 2
C011	A - 3	C105	A - 3			IC41	D - 1	Q011	A - 2	R046	B - 1	R110	C - 2
C012	A - 3	C106	A - 3			IC42	D - 2	Q012	A - 1	R047	B - 1	R111	C - 2
C013	A - 3	C107	A - 3			IC43	D - 2	Q013	A - 1	R048	B - 1	R112	C - 2
C014	A - 1	C108	B - 3	D001	A - 2	IC44	D - 3	Q014	B - 1	R049	B - 1	R113	C - 2
C015	A - 1	C109	B - 3	D002	A - 3	IC45	D - 3	Q015	B - 1	R050	B - 1	R114	C - 2
C016	A - 3	C110	B - 3	D003	A - 2	IC46	D - 3	Q016	A - 2	R051	A - 1	R115	C - 3
C017	A - 3	C111	B - 3	D004	B - 1	IC47	D - 1	Q017	A - 1	R052	A - 1	R116	C - 3
C018	A - 1	C112	B - 3	D005	B - 1	IC48	E - 2	Q018	A - 2	R053	A - 1	R117	C - 3
C019	A - 2	C113	B - 3	D006	B - 1	IC49	D - 2	Q019	A - 1	R054	A - 1	R118	C - 3
C020	A - 1	C114	B - 3	D007	B - 1	IC50	D - 3	Q020	A - 3	R055	A - 1	R119	B - 2
C021	A - 3	C115	B - 3			IC51	D - 3	Q021	A - 3	R056	B - 1	R120	C - 1
C022	A - 3	C116	B - 3			IC52	D - 3	Q022	A - 3	R057	A - 1	R121	D - 1
C023	A - 3	C117	B - 3			IC53	D - 3	Q023	A - 2	R058	A - 2	R122	D - 3
C024	A - 3	C118	B - 3	DL1	A - 1	IC54	E - 1	Q024	A - 2	R059	A - 2	R123	E - 1
C025	B - 1	C119	B - 3			IC55	E - 1	Q025	A - 2	R060	A - 3	R124	E - 2
C026	A - 2	C120	B - 1			IC56	E - 1	Q026	C - 2	R061	A - 3	R125	E - 2
C027	A - 2	C121	B - 1			IC57	E - 2	Q027	B - 1	R062	A - 3	R126	E - 3
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C030	A - 1	C124	C - 3	IB3	D - 1	IC60	E - 3			R065	A - 3	R129	E - 1
C031	A - 2	C125	C - 3	IB4	D - 1	IC61	E - 3			R066	A - 3	R130	E - 1
C032	A - 2	C126	C - 1	IB5	E - 2	IC62	E - 1	R001	A - 1	R067	A - 2	R131	C - 1
C033	A - 3	C127	C - 1	IB6	E - 2	IC63	E - 2	R002	A - 1	R068	A - 3	R132	B - 1
C034	B - 1	C128	C - 1			IC64	E - 2	R003	A - 1	R069	B - 1	R133	E - 2
C035	B - 1	C129	C - 2			IC65	E - 3	R004	A - 1	R070	B - 1	R134	E - 1
C036	A - 2	C130	C - 3			IC66	E - 3	R005	A - 1	R071	B - 1	R135	A - 3
C037	B - 1	C131	D - 3	IC1	A - 3	IC67	E - 3	R006	A - 1	R072	B - 1	R136	A - 3
C038	B - 1	C132	D - 3	IC2	B - 3	IC68	E - 3	R007	A - 1	R073	B - 1		
C039	B - 1	C133	D - 1	IC3	B - 3			R008	A - 2	R074	A - 1		
C040	B - 2	C134	D - 2	IC4	B - 3			R009	A - 2	R075	A - 2		
C041	A - 2	C135	D - 2	IC5	B - 3			R010	A - 2	R076	A - 2	RY001	B - 1
C042	A - 2	C136	D - 3	IC6	B - 3	JW1	B - 3	R011	A - 2	R077	A - 2		
C043	B - 1	C137	D - 3	IC7	A - 3	JW2	B - 3	R012	A - 2	R078	A - 2		
C044	B - 1	C138	D - 3	IC8	A - 3	JW3	C - 3	R013	A - 3	R080	B - 1		
C045	A - 2	C139	E - 1	IC9	B - 3	JW4	C - 3	R014	A - 3	R081	B - 1	VC1	A - 3
C046	A - 2	C140	E - 1	IC10	B - 3	JW5	C - 2	R015	A - 1	R082	B - 1	VC2	A - 3
C047	A - 2	C141	D - 1	IC11	B - 3	JW6	D - 3	R016	A - 1	R083	B - 1		
C048	A - 3	C142	E - 3	IC12	B - 3	JW7	D - 2	R017	A - 1	R084	B - 1		
C049	B - 1	C143	E - 3	IC13	A - 2	JW8	D - 2	R018	A - 1	R085	A - 1		
C050	B - 2	C144	E - 3	IC14	A - 2	JW9	E - 2	R019	A - 1	R086	A - 1	VR001	A - 1
C051	C - 2	C145	E - 3	IC15	A - 3	JW10	E - 2	R020	A - 1	R087	A - 2	VR002	A - 1
C052	B - 1	C146	E - 1	IC16	B - 2	JW11	D - 3	R021	A - 1	R088	A - 2	VR003	A - 1
C053	C - 2	C147	E - 2	IC17	B - 2	JW12	E - 3	R022	A - 1	R089	B - 1	VR004	A - 2
C054	C - 2	C148	E - 2	IC18	B - 1	JW13	E - 3	R023	A - 2	R090	B - 1		
C055	C - 2	C149	E - 3	IC19	B - 1	JW14	E - 3	R024	A - 1	R091	A - 1		
C056	C - 1	C150	E - 3	IC21	B - 2	JW15	E - 3	R025	A - 1	R092	B - 2		
C057	C - 2	C151	E - 3	IC22	B - 2			R026	A - 1	R093	A - 2	X1	A - 3
C058	C - 2	C152	E - 3	IC23	B - 2			R027	A - 1	R094	A - 2		
C059	C - 2	C153	E - 3	IC24	B - 1			R028	A - 1	R095	A - 2		
C060	C - 2	C154	E - 3	IC25	C - 1	L001	A - 3	R029	A - 1	R096	A - 2		
C061	C - 2	C155	E - 3	IC26	C - 1	L002	A - 3	R030	A - 1	R097	B - 1		
C062	C - 3	C156	E - 3	IC27	C - 1	L003	A - 2	R031	A - 1	R098	B - 1		
C063	C - 3			IC28	C - 1	L004	A - 2	R032	A - 1	R099	A - 1		
C064	C - 3			IC29	C - 2	L005	B - 1	R033	A - 2				
C065	D - 3			IC30	C - 2	L006	B - 1	R034	A - 2				
								R035	A - 2				



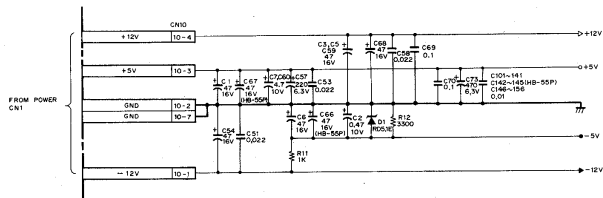
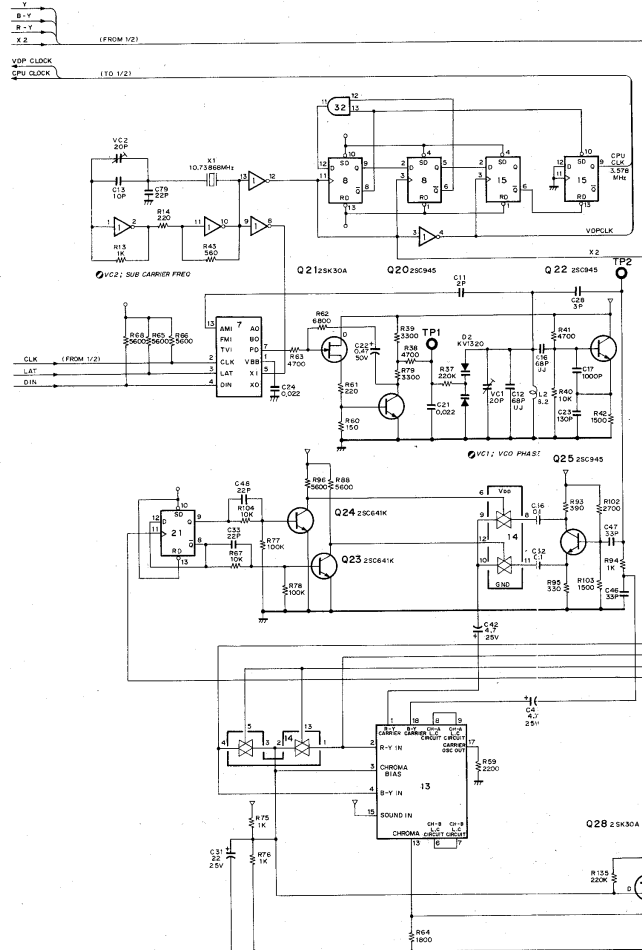


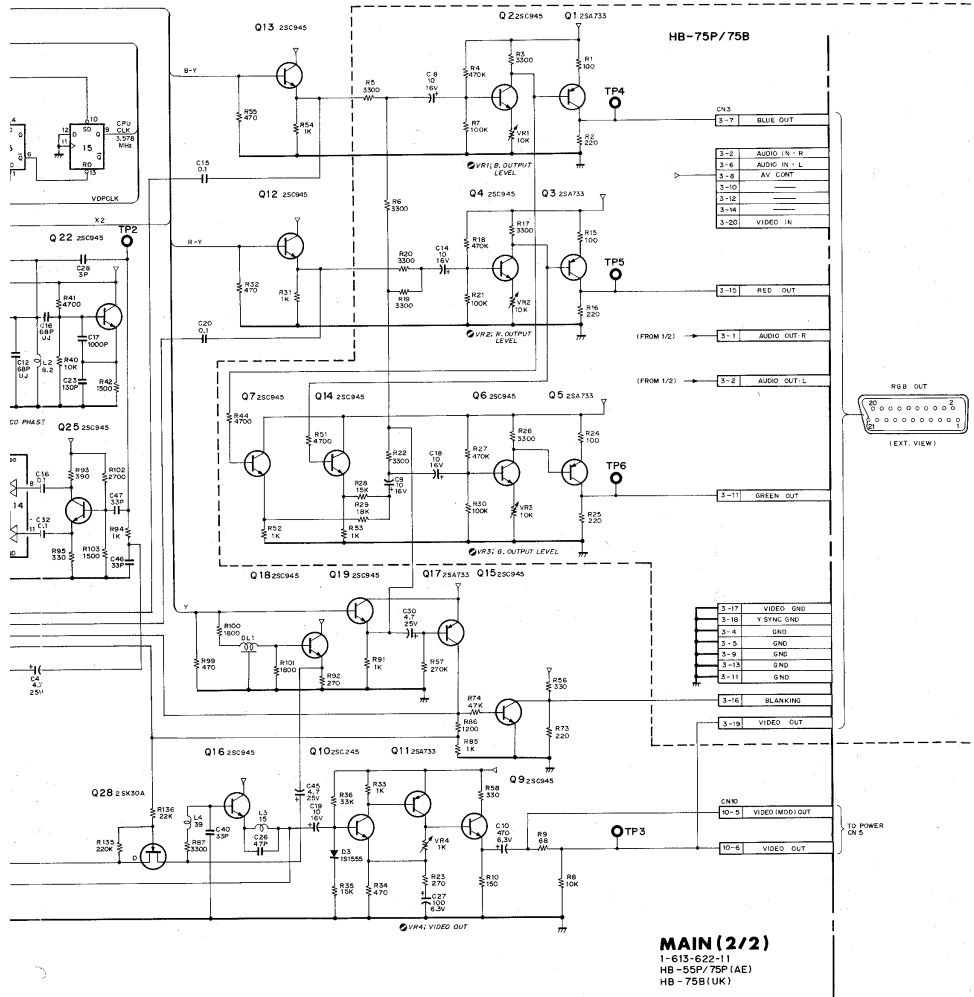




MAIN(2/2)

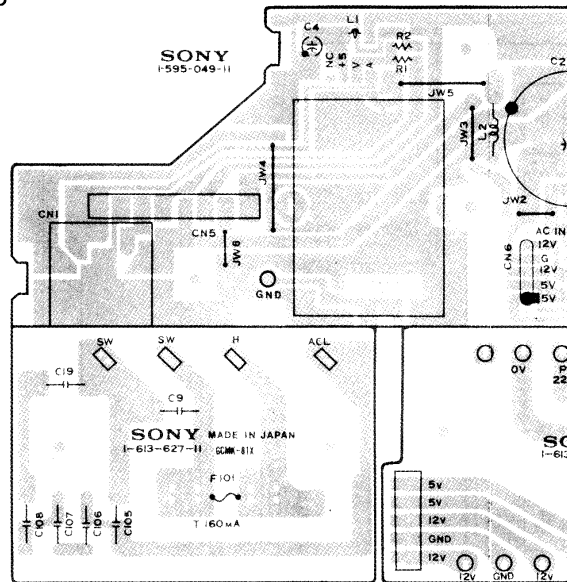
REF. NO.	TYPE NO.	PIN NO.	+1.2V	+5V	GND	-5V
IC1	SN74LS04N,MB74LS04	14				
IC2	7M93929AN	33	12			
IC3	KCM4116BP20,UPD416C-2	8	9	16	1	
IC4	KCM4116BP20,UPD416C-2	8	9	16	1	
IC5	KCM4116BP20,UPD416C-2	8	9	16	1	
IC6	KCM4116BP20,UPD416C-2	8	9	16	1	
IC7	CK7925A-1,CK7925A	12	14			
IC8	SN74LS74AN,MB74LS74A	14	7			
IC9	KCM4116BP20,UPD416C-2	8	9	16	1	
IC10	KCM4116BP20,UPD416C-2	8	9	16	1	
IC11	KCM4116BP20,UPD416C-2	8	9	16	1	
IC12	KCM4116BP20,UPD416C-2	8	9	16	1	
IC13	LMI8009	14	7			
IC14	UPD4066BC,HD14066BP	14	7			
IC15	SN74LS74AN,MB74LS74A	14	7			
IC16	UPD8255A-3	26	7			
IC17	SN74LS153N,MB74LS153	16	8			
IC18	SN74LS139N,MB74LS139	16	8			
IC19	UPC311C	8	1			
IC20						
IC21	SN74LS74AN,MB74LS74A	14	7			
IC22	SN74LS149N,MB74LS145	16	8			
IC23	SN74LS139N,MB74LS139	16	8			
IC24	SN74LS32N,MB74LS32	14	7			
IC25	SN74LS86N,MB74LS86	14	7			
IC26	SN74LS04N,MB74LS04	14	7			
IC27	SN74LS00N,MB74LS00	14	7			
IC28	SN74LS02N,MB74LS02	14	7			
IC29	SN74LS04N,MB74LS04	14	7			
IC30	SN74LS27N,MB74LS27	14	7			
IC31	SN74LS175N,MB74LS175	16	8			
IC32	SN74LS08N,MB74LS08	14	7			
IC33	SN74LS36AN	14	7			
IC34	SN74LS74AN,MB74LS74A	14	7			
IC35	SN74LS74AN,MB74LS74A	14	7			
IC36	SN74LS11N,MB74LS11	14	7			
IC37	SN74LS08N,MB74LS08	14	7			
IC38	SN74LS04N,MB74LS04	14	7			
IC39	SN74LS37N,MB74LS37	20	10			
IC40	SN74LS645B,MB74LS645	20	10			
IC41	LH0090A,UPD79C-3	13	29			
IC42	MSM38256-70RS	28	14			
IC43						
IC44	MSM3128A-77RS	28	14			
IC45	SN74LS10N,MB74LS10	14	7			
IC46	SN74LS29N,MB74LS29	14	7			
IC47	SN74LS367AN,MB74LS367A	16	8			
IC48	RY-3-8916,MB74LS149	40	1			
IC49	SN74LS157N,MB74LS157	16	8			
IC50	SN74LS74AN,MB74LS74A	14	7			
IC51	SN74LS74AN,MB74LS74A	14	7			
IC52	SN74LS02N,MB74LS02	14	7			
IC53	SN74LS07N,MB74LS07	14	7			
IC54	SN74LS367AN,MB74LS367A	16	8			
IC55	SN74LS367AN,MB74LS367A	16	8			
IC56	SN74LS367AN,MB74LS367A	16	8			
IC57	SN74LS157N,MB74LS157	8	16	1		
IC58	UPD416C-2 (HB-55P)	8	9	16	1	
IC59	MSM3764-158S(HB-75P/75B)	8	9	16	1	
	UPD416C-2 (HB-55P)	8	9	16	1	
IC60	MSM3764-158S(HB-75P/75B)	8	9	16	1	
	UPD416C-2 (HB-55P)	8	9	16	1	
IC61	MSM3764-158S(HB-75P/75B)	8	9	16	1	
	UPD416C-2 (HB-55P)	8	9	16	1	
IC62	SN74LS175N,MB74LS175	16	8			
IC63	SN74LS157N,MB74LS157	16	8			
IC64	SN74LS09N,MB74LS09	14	7			
IC65	UPD416C-2 (HB-55P)	8	9	16	1	
	MSM3764-158S(HB-75P/75B)	8	9	16	1	
IC66	UPD416C-2 (HB-55P)	8	9	16	1	
	MSM3764-158S(HB-75P/75B)	8	9	16	1	
IC67	UPD416C-2 (HB-55P)	8	9	16	1	
	MSM3764-158S(HB-75P/75B)	8	9	16	1	
IC68	UPD416C-2 (HB-55P)	8	9	16	1	
	MSM3764-158S(HB-75P/75B)	8	9	16	1	





MAIN(2/2)
1-613-622-11
HB-55P/75P(AE)
HB-75B(UK)

FUSE, LED, POWER, TRANS, 5V, 12V BOARD

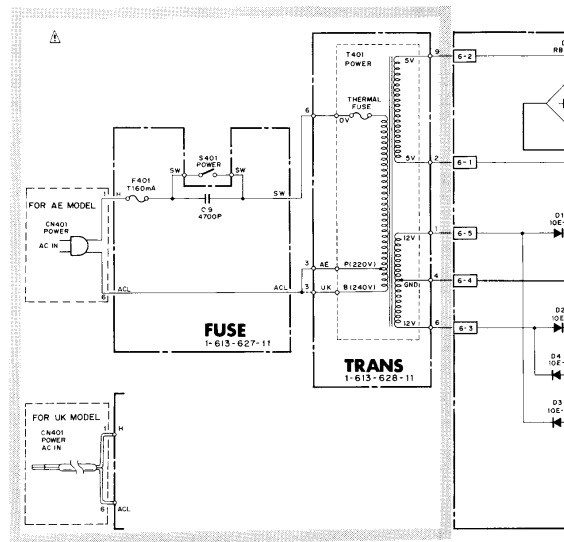


FUSE - COMPONENT SIDE -

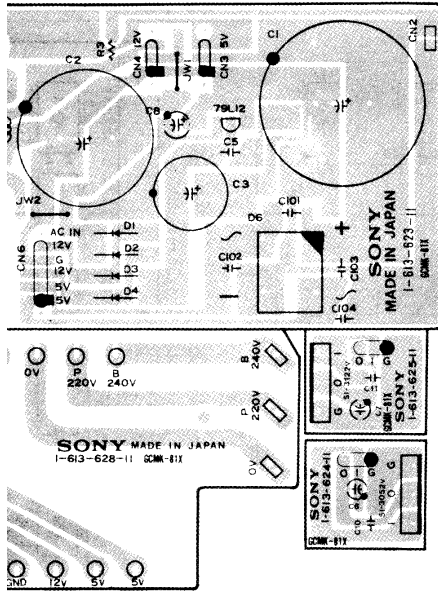
1-613-627-11
 HB-55P/75P(AE)
 HB-75B(UK)

TRANS - COMPO

1-613-628-11
 HB-55P/75P(AE)
 HB-75B(UK)



FUSE, LED, POWER, TRANS, 5V, 12V



POWER -- COMPONENT SIDE --

1-613-623-11
HB-55P/75P(AE)
HB-75B(UK)

LED -- COMPONENT SIDE --

1-613-626-11
HB-55P/75P(AE)
HB-75B(UK)

12V -- COMPONENT SIDE --

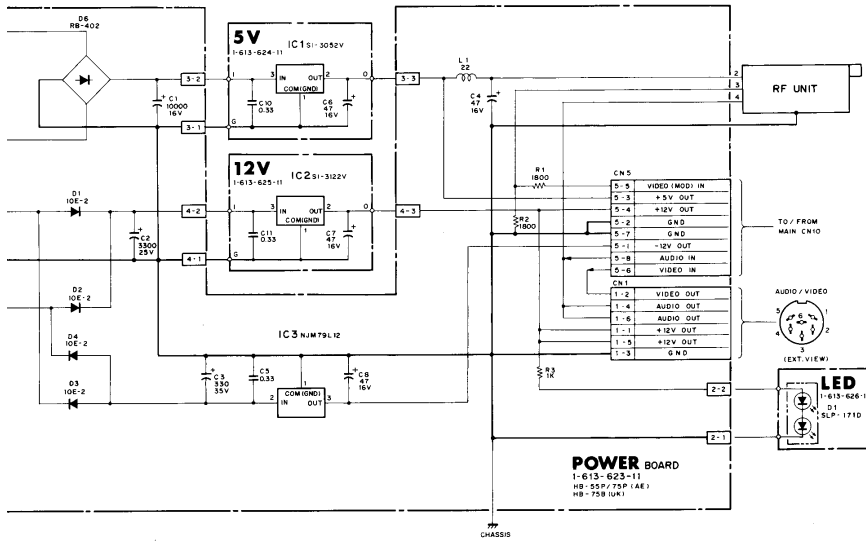
1-613-625-11
HB-55P/75P(AE)
HB-75B(UK)

5V -- COMPONENT SIDE --

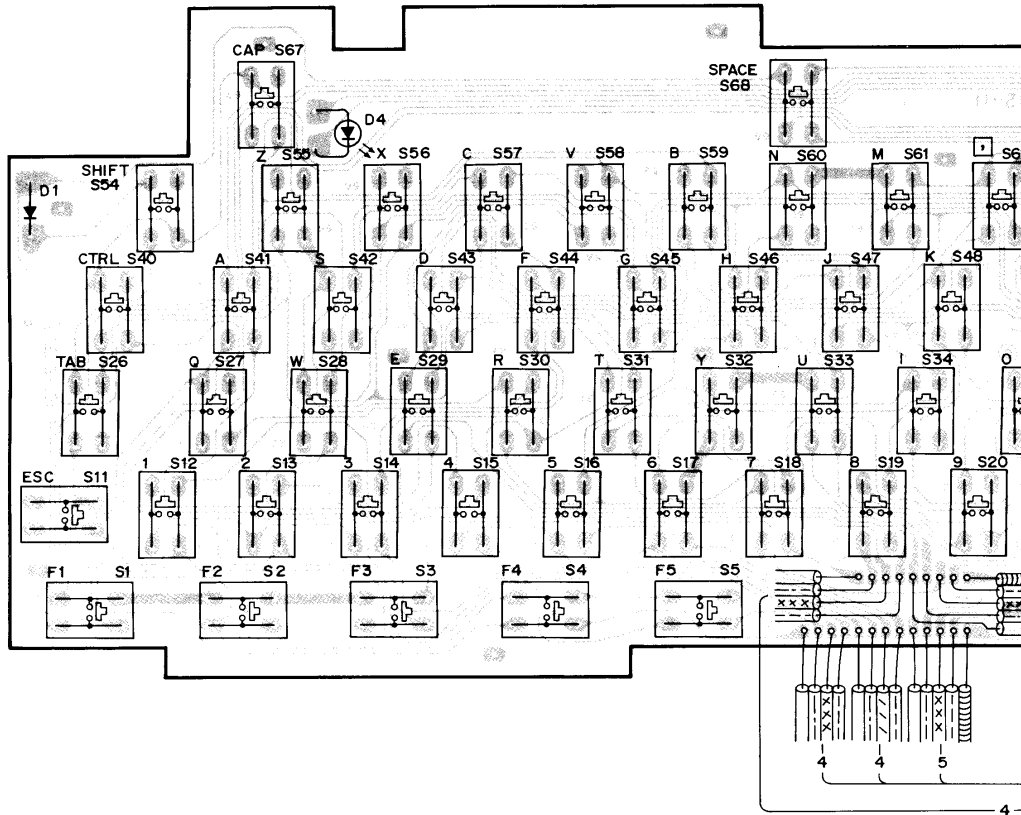
1-613-624-11
HB-55P/75P(AE)
HB-75B(UK)

-- COMPONENT SIDE --

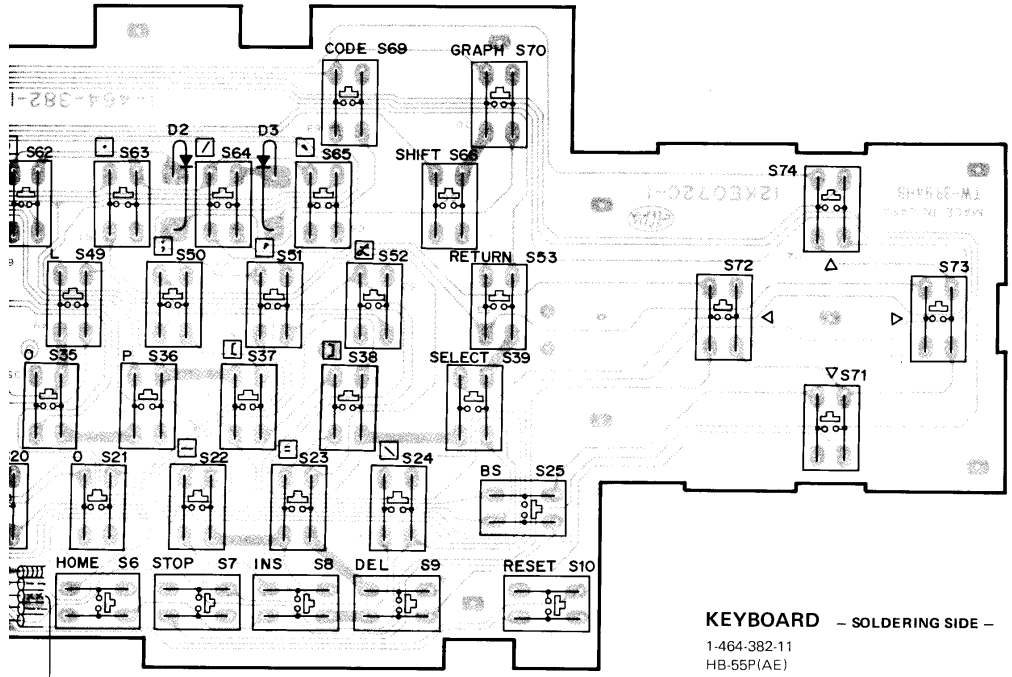
-11
5P(AE)
K)



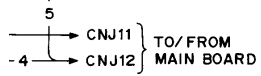
KEYBOARD (HB-55P)

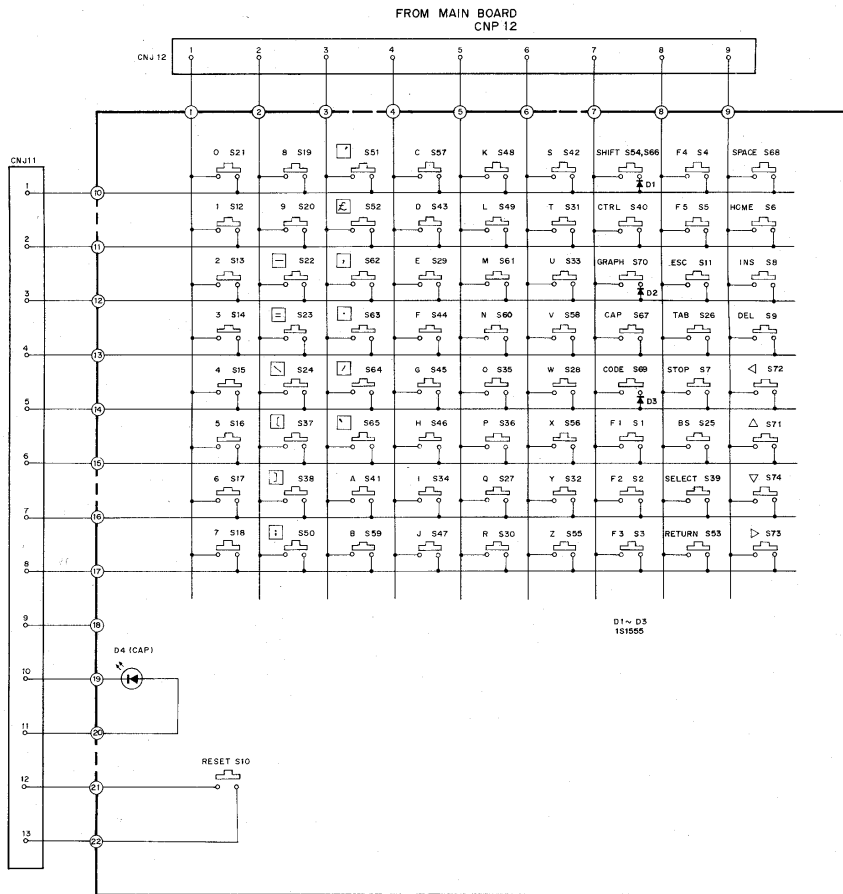


5P KEYBOARD HB-55P



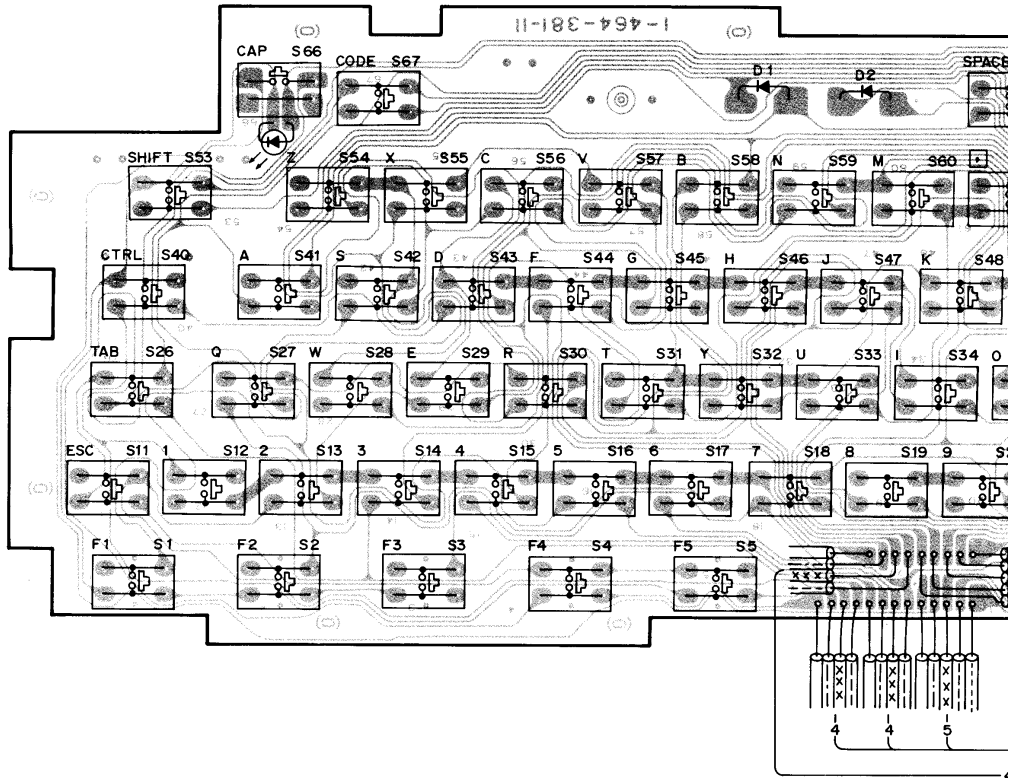
KEYBOARD - SOLDERING SIDE -
1-464-382-11
HB-55P(AE)

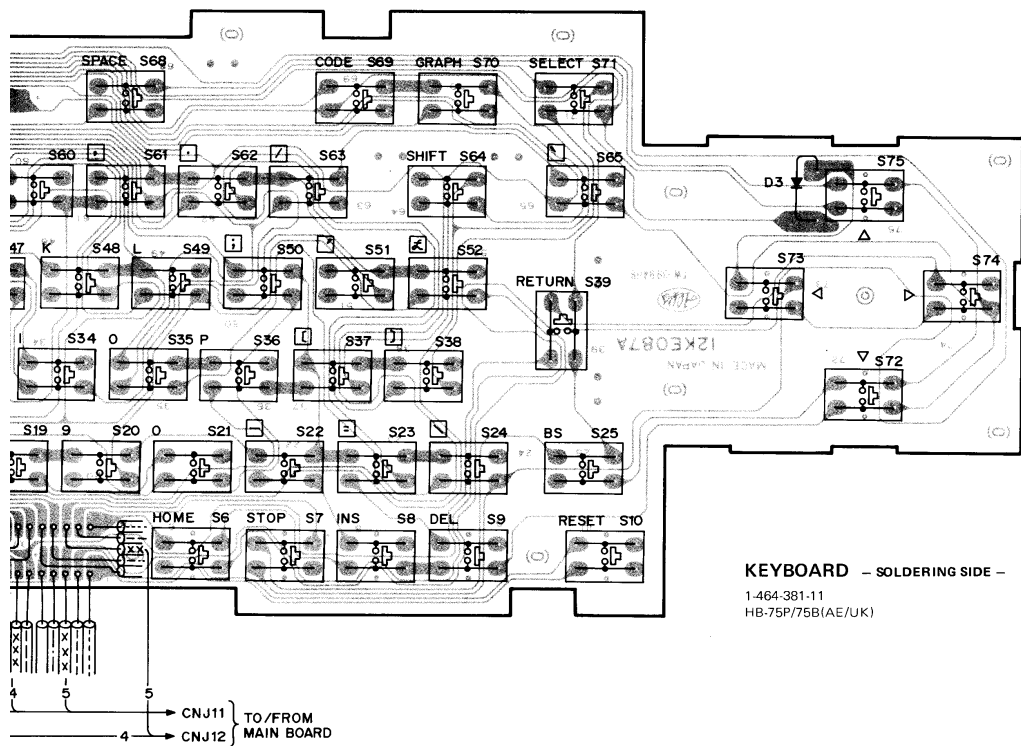




KEY
1-464-362-11
HB-55P

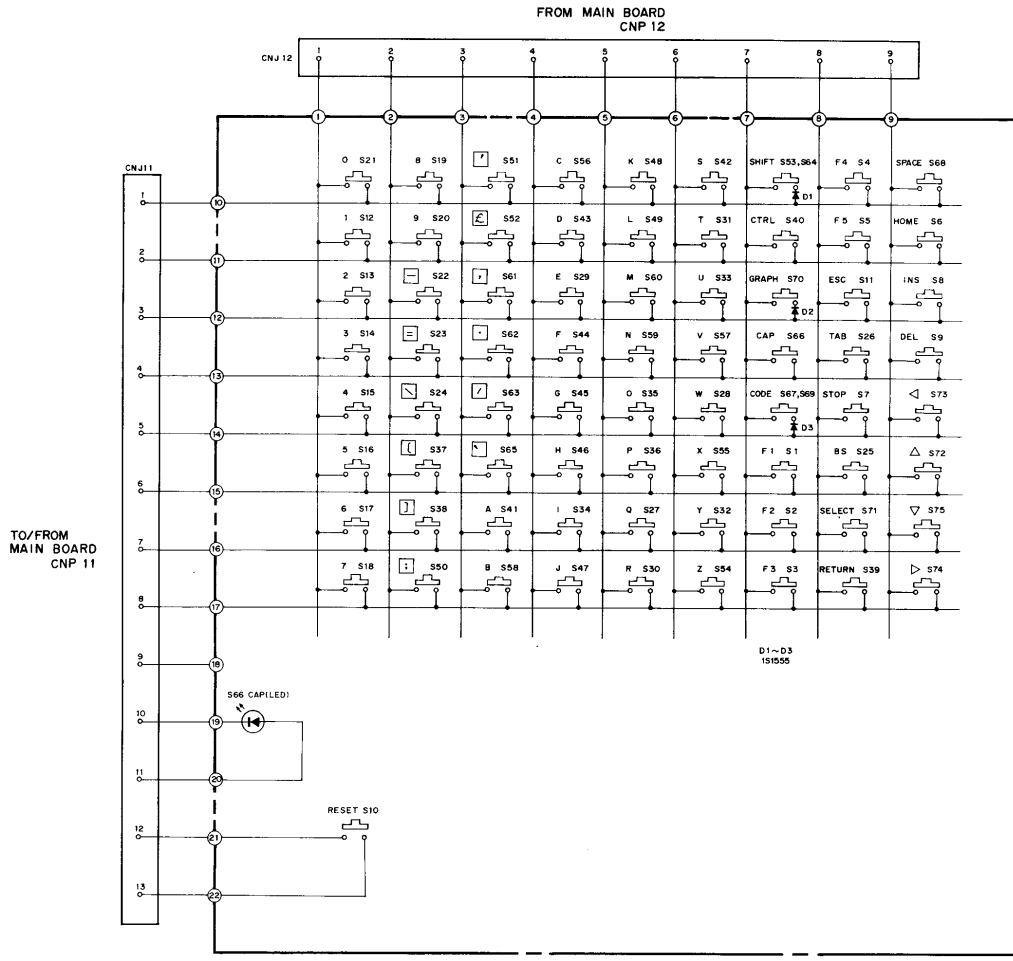
KEYBOARD (HB-75P/75B)





KEYBOARD - SOLDERING SIDE -
 1-464-381-11
 HB-75P/75B(AE/UK)

BOARD HB-75P/75B



KEY
1-464-381-11
HB-75P/75B

CHAPTER 6 ALIGNMENT

6-1. HB-55P/75P/75B ADJUSTMENT

Note: Adjustment should be performed in the order mentioned below.

6-1-1. VCO Phase Adjustment

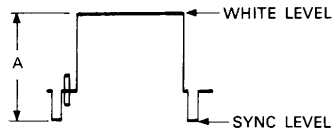
Equipment Required: Digital Volt Meter
 Check Point : TP1 (Junction Point of R37 and R38)/MAIN
 Specification : $7.0V \pm 0.1V$
 Adjustment : VC1/MAIN

6-1-2. SUB Carrier Frequency Adjustment

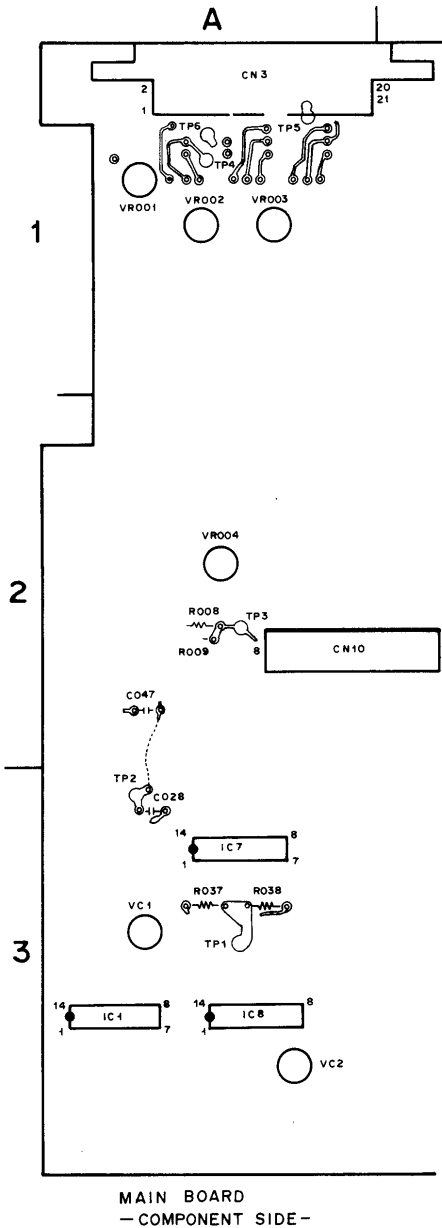
Equipment Required: FREQUENCY COUNTER
 Check Point : TP2 (Junction Point of C28 and C47)/MAIN
 Specification : $4.433618 \text{ MHz} \pm 10 \text{ Hz}$
 Adjustment : VC2/MAIN

6-1-3. Video Output Level Adjustment

Equipment Required: OSCILLOSCOPE
 Condition : ① Terminated pin 2 of CN1 (AUDIO/VIDEO OUTPUT)/POWER between GND with 75Ω , or connect the Monitor TV (75Ω INPUT) to CN1/POWER. But, do not connect to CN3 (RGB OUTPUT)/MAIN.
 ② Example
 BASIC will have the list programmed and run.
 10 COLOR \square 15, 15
 20 END
 Check Point : TP3 (pin 2 of CN1)/POWER
 Specification : $A = 1V \pm 0.1 \text{ Vp-p}$



Adjustment : VR4/MAIN



MAIN BOARD
- COMPONENT SIDE -

6-2. HB-75P/75B RGB ADJUSTMENT

Note 1: After adjusting step 6-1, the following adjustment should be performed.

Note 2: Adjustment should be performed by terminating each test point between GND with 75Ω or , connect the Monitor TV (75Ω INPUT) to CN3 (RGB OUTPUT)/MAIN. But do not connect to CN1 (AUDIO/VIDEO OUTPUT)/POWER.

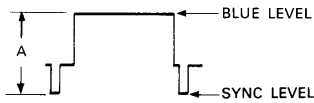
Note 3: Example
 BASIC will have the list programmed and run
 10 COLOR _ 15, 15
 20 END

6-2-1. Blue Output Level Adjustment

Equipment Required: OSCILLOSCOPE

Check Point : TP4 (pin 3 of CN3 or collector of Q1)/MAIN

Specification : A = $0.7V \pm 0.1 V_{p-p}$



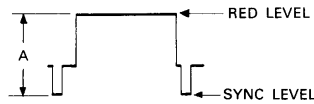
Adjustment : VR1/MAIN

6-2-2. Red Output Level Adjustment

Equipment Required: OSCILLOSCOPE

Check Point : TP5 (pin 15 of CN3 or collector of Q3)/MAIN

Specification : A = $0.7V \pm 0.1 V_{p-p}$



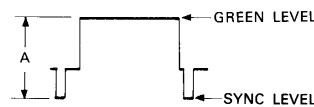
Adjustment : VR2/MAIN

6-2-3. Green Output Level Adjustment

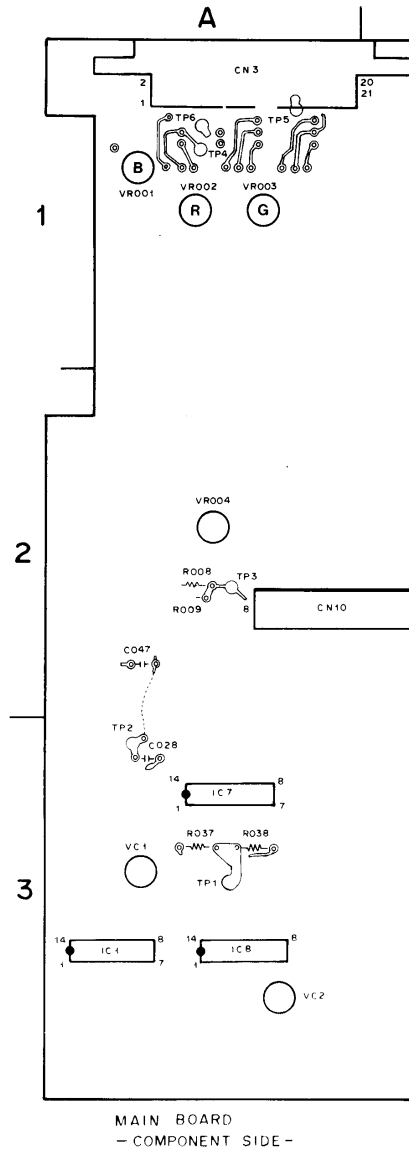
Equipment Required: OSCILLOSCOPE

Check Point : TP6 (pin 11 of CN3 or collector of Q5)/MAIN

Specification : A = $0.7V \pm 0.1 V_{p-p}$



Adjustment : VR3/MAIN



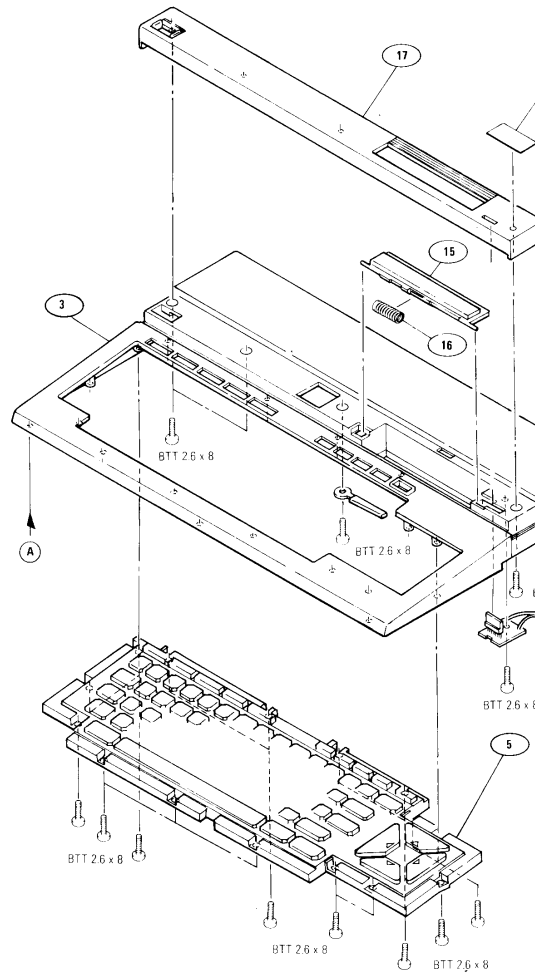
MAIN BOARD
 - COMPONENT SIDE -

CHAPTER 7 REPAIR PARTS AND FIXTURE

7-1. EXPLODED VIEW

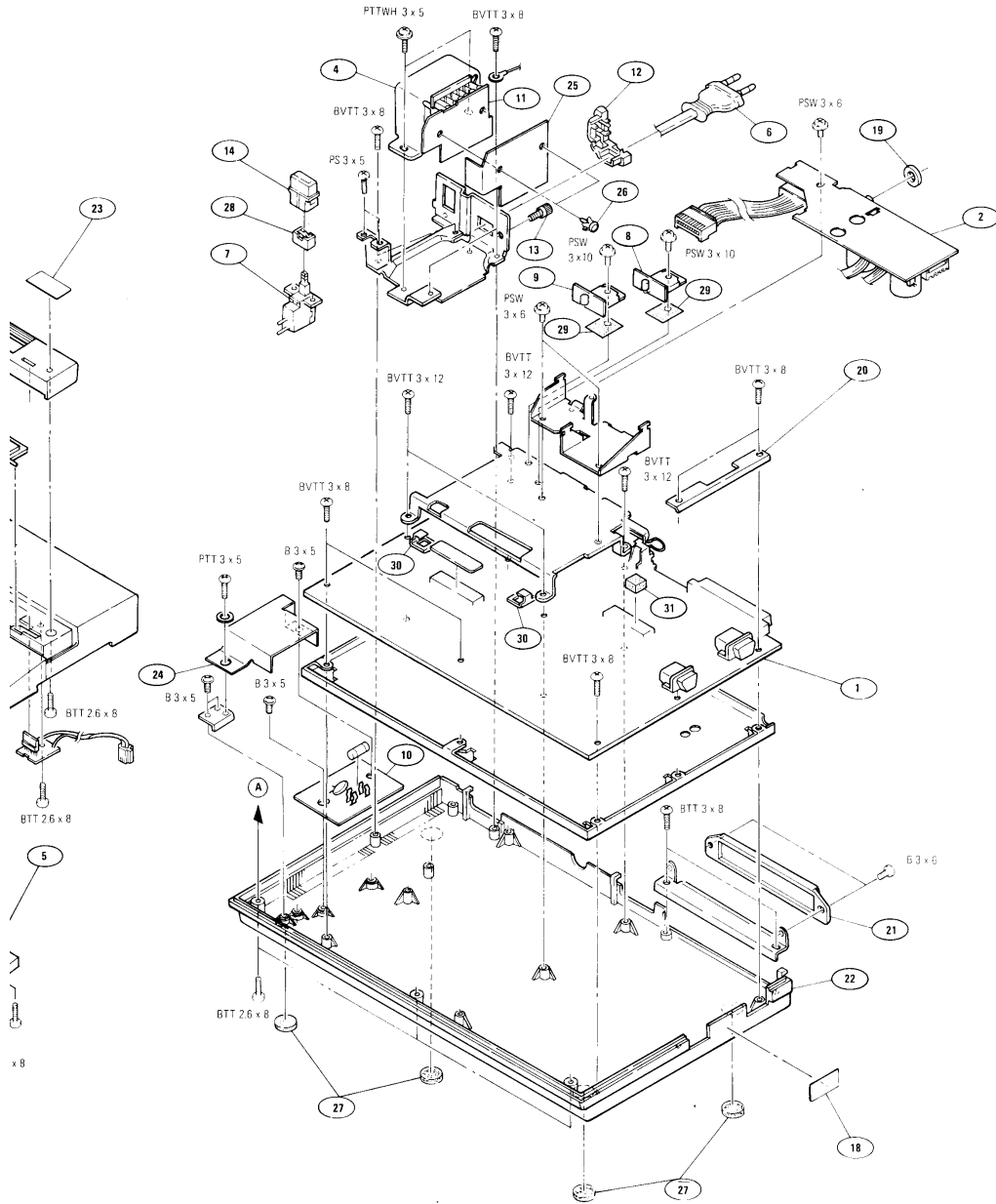
MAIN ASSEMBLY (HB-55P)

No.	Part No.	Description
▲ 1	A-8050-100-A	MOUNTED CB. MAIN
2	A-8050-102-A	MOUNTED CB. POWER (WITH 5V, 12V BOARD)
3	X-4604-316-1	CABINET (UPPER) ASSY
▲ 4	1-447-939-11	TRANSFORMER, POWER
5	1-464-382-11	KEYBOARD UNIT
▲ 6	1-534-817-XX	CORD, POWER, EULO PLUG
▲ 7	1-553-318-00	SWITCH, PUSH (AC POWER)(1 KEY)
8	1-613-624-11	PC BOARD, 5V
9	1-613-625-11	PC BOARD, 12V
10	1-613-627-11	PC BOARD, FUSE
11	1-613-628-11	PC BOARD, TRANSFORMER
▲ 12	3-703-244-00	BUSHING, CORD
13	3-706-165-00	SCREW
14	4-604-301-00	BUTTON, POWER SWITCH
15	4-604-302-00	LID, CARTRIDGE
16	4-604-303-00	SPRING
17	4-604-306-31	PLATE, ORNAMENTAL
18	4-604-332-01	LABEL, CONTROL
19	4-604-335-01	PLATE, BLIND (A)
20	4-604-337-01	PLATE, BLIND (C)
21	4-604-386-01	COVER, CARTRIDGE
22	4-604-394-02	PLATE, BOTTOM
23	4-605-103-01	LABEL, CAUTION
24	4-605-131-01	INSULATOR, FUSE, PC BOARD
25	4-605-132-01	INSULATOR, TRANSFORMER PCB
26	4-812-134-11	RIVET NYLON, 3.5
27	4-860-711-00	FELT
28	4-864-307-00	RING
29	4-875-726-00	SHEET, INSULATING
30	4-886-557-00	CLIP (B), IC
31	4-886-865-00	CUSHION (A)



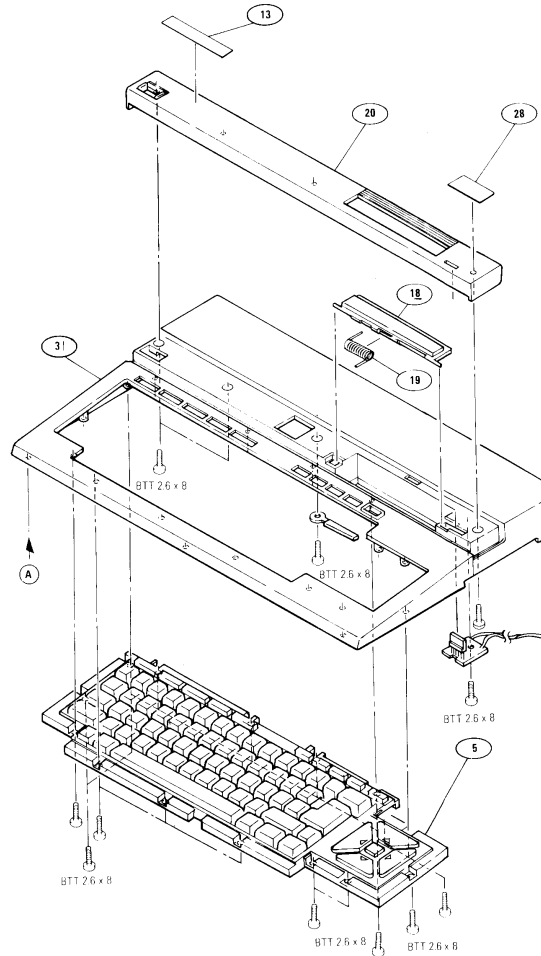
NOTE:

1. The shaded and **▲**-marked components are critical to safety. Replace only with same components as specified.
2. Parts printed in Bold-Face type are normally stocked for replacement purposes. The remaining parts shown in this manual are not normally required for routine service work. Orders for parts not shown in Bold-Face type will be processed, but allow for additional delivery time.
3. Item with no part number and/or no description are not stocked because they are seldom required for routine service.



MAIN ASSEMBLY (HB-75P/75B)

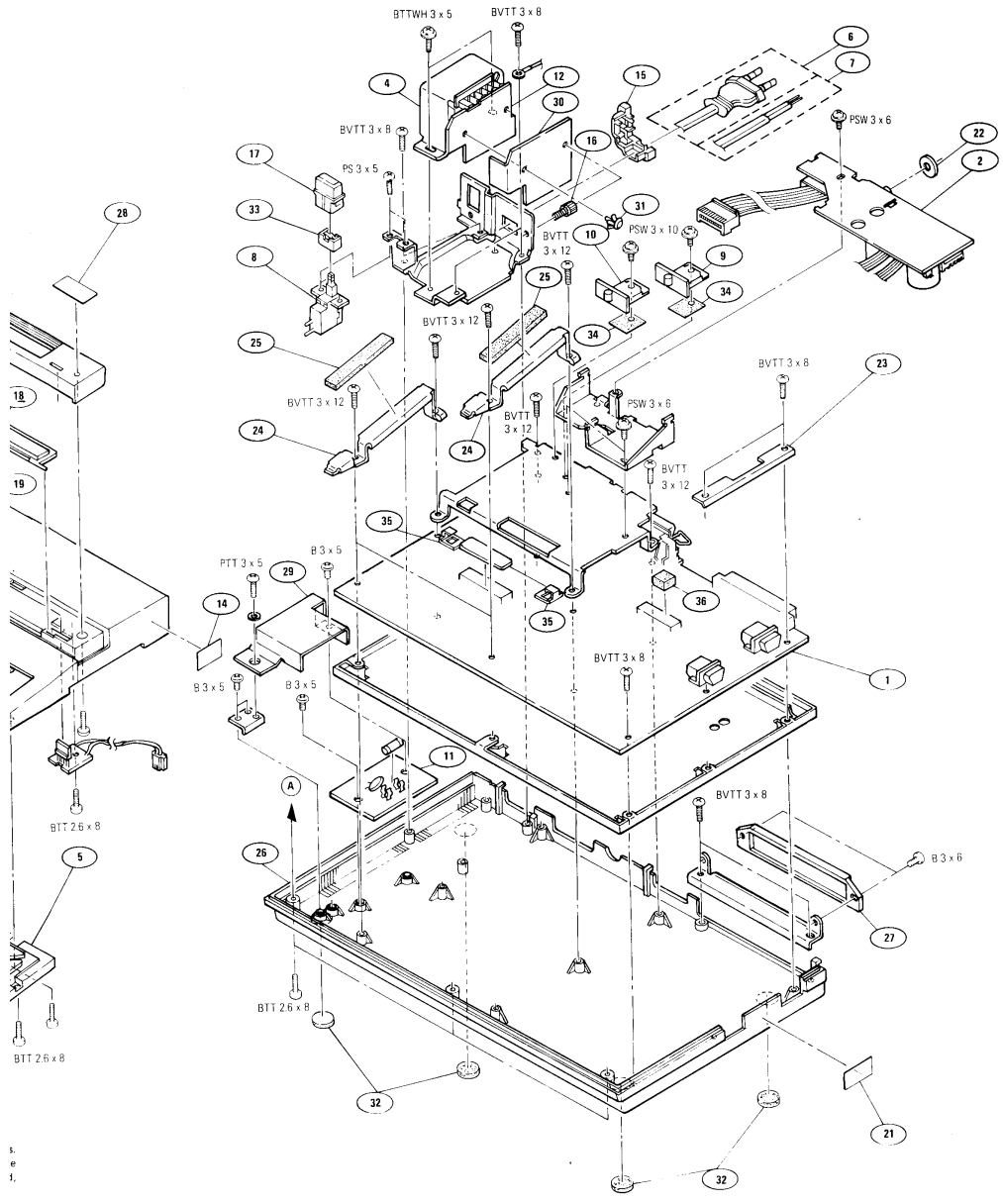
No.	Part No.	Description
▲ 1	A-8050-098-A	MOUNTED CB. MAIN
2	A-8050-102-A	MOUNTED CB. POWER (75P) (WITH 5V, 12V BOARD)
	A-8050-103-A	MOUNTED CB. POWER (75B) (WITH 5V, 12V BOARD)
3	X-4604-313-1	CABINET (UPPER) ASSY (75B)
	X-4604-314-1	CABINET (UPPER) ASSY (75P)
▲ 4	1-447-939-11	TRANSFORMER, POWER
5	1-464-381-11	KEYBOARD UNIT
▲ 6	1-534-817-XX	CORD POWER, EULO PLUG (75P)
▲ 7	1-551-884-00	CORD, POWER (75B)
▲ 8	1-553-318-00	SWITCH, PUSH (AC POWER)
9	1-613-624-11	PC BOARD, 5V
10	1-613-625-11	PC BOARD, 12V
11	1-613-627-11	PC BOARD, FUSE
12	1-613-628-11	PC BOARD, TRANS
13	3-701-690-00	LABEL (MADE IN JAPAN) (75B)
14	3-703-082-21	LABEL, CAUTION (75B)
▲ 15	3-703-244-00	BUSHING, CORD
16	3-706-165-00	SCREW
17	4-604-301-00	BUTTON, POWER SWITCH
18	4-604-302-00	LID, CARTRIDGE
19	4-604-303-00	SPRING
20	4-604-306-41	PLATE, ORNAMENTAL (75P)
	4-604-306-51	PLATE, ORNAMENTAL (75B)
21	4-604-332-01	LABEL, CONTROL
22	4-604-335-01	PLATE, BLIND (A)
23	4-604-337-01	PLATE, BLIND (C)
24	4-604-355-01	REINFORCEMENT
25	4-604-356-02	CUSHION, RUBBER
26	4-604-382-02	PLATE, BOTTOM
27	4-604-386-01	COVER, CARTRIDGE
28	4-605-103-01	LABEL, CAUTION
29	4-605-131-01	INSULATOR, FUSE PC BOARD
30	4-605-132-01	INSULATOR, TRANSFORMER PCB
31	4-812-134-11	RIVET NYLON, 3.5
32	4-860-711-00	FELT
33	4-864-307-00	RING
34	4-875-726-00	SHEET, INSULATING
35	4-886-557-00	CLIP (B), IC
36	4-886-865-00	CUSHION (A)



NOTE:

1. The shaded and **▲**-marked components are critical to safety. Replace only with same components as specified.
2. Parts printed in Bold-Face type are normally stocked for replacement purposes. The remaining parts shown in this manual are not normally required for routine service work. Orders for parts not shown in Bold-Face type will be processed, but allow for additional delivery time.
3. Item with no part number and/or no description are not stocked because they are seldom required for routine service.


MAIN

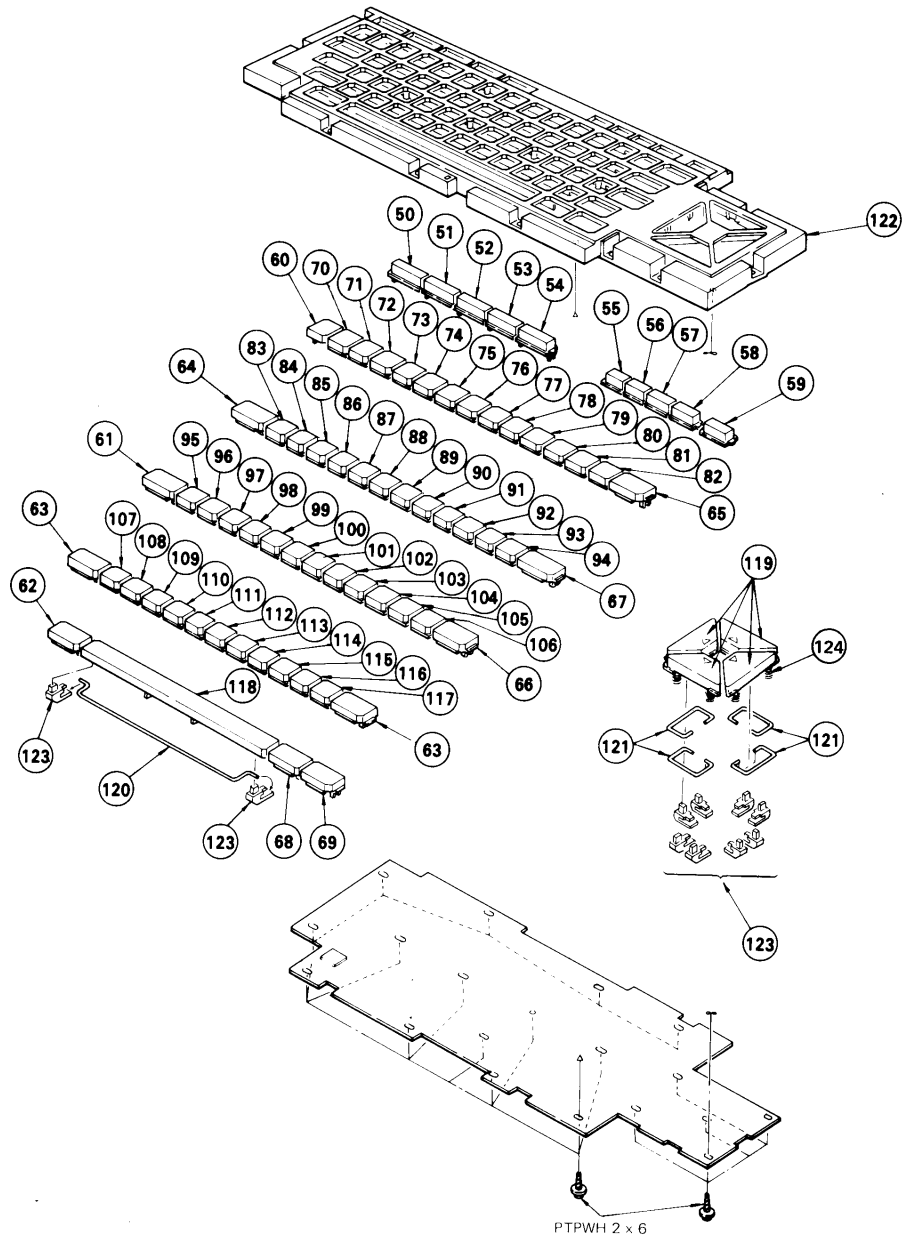


KEYBOARD (HB-55P)

No.	Parts No.	Description	No.	Parts No.	Description
50	9-983-716-01	KEY TOP (1) F1	95	9-985-289-01	KEY TOP (3) A
51	9-983-717-01	KEY TOP (1) F2	96	9-985-290-01	KEY TOP (3) S
52	9-983-718-01	KEY TOP (1) F3	97	9-985-291-01	KEY TOP (3) D
53	9-983-719-01	KEY TOP (1) F4	98	9-985-292-01	KEY TOP (3) F
54	9-983-720-01	KEY TOP (1) F5	99	9-985-293-01	KEY TOP (3) G
55	9-983-721-01	KEY TOP (2) HOME	100	9-985-294-01	KEY TOP (3) H
56	9-983-722-01	KEY TOP (2) STOP	101	9-985-295-01	KEY TOP (3) J
57	9-983-723-01	KEY TOP (2) INS	102	9-985-296-01	KEY TOP (3) K
58	9-983-724-01	KEY TOP (2) DEL	103	9-985-297-01	KEY TOP (3) L
59	9-983-725-01	KEY TOP (2) RESET	104	9-985-298-01	KEY TOP (3) ;
60	9-983-726-01	KEY TOP (3) ESC	105	9-985-299-01	KEY TOP (3) '
61	9-983-727-01	KEY TOP (4) CTRL	106	9-985-300-01	KEY TOP (3) £
62	9-983-728-01	KEY TOP (5) CAP	107	9-985-301-01	KEY TOP (3) Z
63	9-983-729-01	KEY TOP (4) SHIFT	108	9-985-302-01	KEY TOP (3) X
64	9-983-730-01	KEY TOP (4) TAB	109	9-985-303-01	KEY TOP (3) C
65	9-983-731-01	KEY TOP (4) BS	110	9-985-304-01	KEY TOP (3) V
66	9-983-733-01	KEY TOP (4) RETURN	111	9-985-305-01	KEY TOP (3) B
67	9-983-735-01	KEY TOP (4) SELECT	112	9-985-306-01	KEY TOP (3) N
68	9-985-313-01	KEY TOP (4) CODE	113	9-985-307-01	KEY TOP (3) M
69	9-983-734-01	KEY TOP (4) GRAPH	114	9-985-308-01	KEY TOP (3) ,
70	9-985-264-01	KEY TOP (3) 1	115	9-985-309-01	KEY TOP (3) .
71	9-985-265-01	KEY TOP (3) 2	116	9-985-310-01	KEY TOP (3) /
72	9-985-266-01	KEY TOP (3) 3	117	9-985-311-01	KEY TOP (3)
73	9-985-267-01	KEY TOP (3) 4	118	9-983-784-01	KEY TOP (6) SPACE
74	9-985-268-01	KEY TOP (3) 5	119	9-983-785-01	KEY TOP (7) CURSOR
75	9-985-269-01	KEY TOP (3) 6	120	9-983-786-01	SPACE BAR
76	9-985-270-01	KEY TOP (3) 7	121	9-983-787-01	CURSOR BAR
77	9-985-271-01	KEY TOP (3) 8	122	9-983-788-01	FRAME, KEYBOARD
78	9-985-272-01	KEY TOP (3) 9	123	9-983-789-01	BAR HOLDER
79	9-985-273-01	KEY TOP (3) 0	124	4-605-117-01	SPRING
80	9-985-274-01	KEY TOP (3) -			
81	9-985-275-01	KEY TOP (3) =			
82	9-985-276-01	KEY TOP (3) \			
83	9-985-277-01	KEY TOP (3) Q			
84	9-985-278-01	KEY TOP (3) W			
85	9-985-279-01	KEY TOP (3) E			
86	9-985-280-01	KEY TOP (3) R			
87	9-985-281-01	KEY TOP (3) T			
88	9-985-282-01	KEY TOP (3) Y			
89	9-985-283-01	KEY TOP (3) U			
90	9-985-284-01	KEY TOP (3) I			
91	9-985-285-01	KEY TOP (3) O			
92	9-985-286-01	KEY TOP (3) P			
93	9-985-287-01	KEY TOP (3) [
94	9-985-288-01	KEY TOP (3)]			

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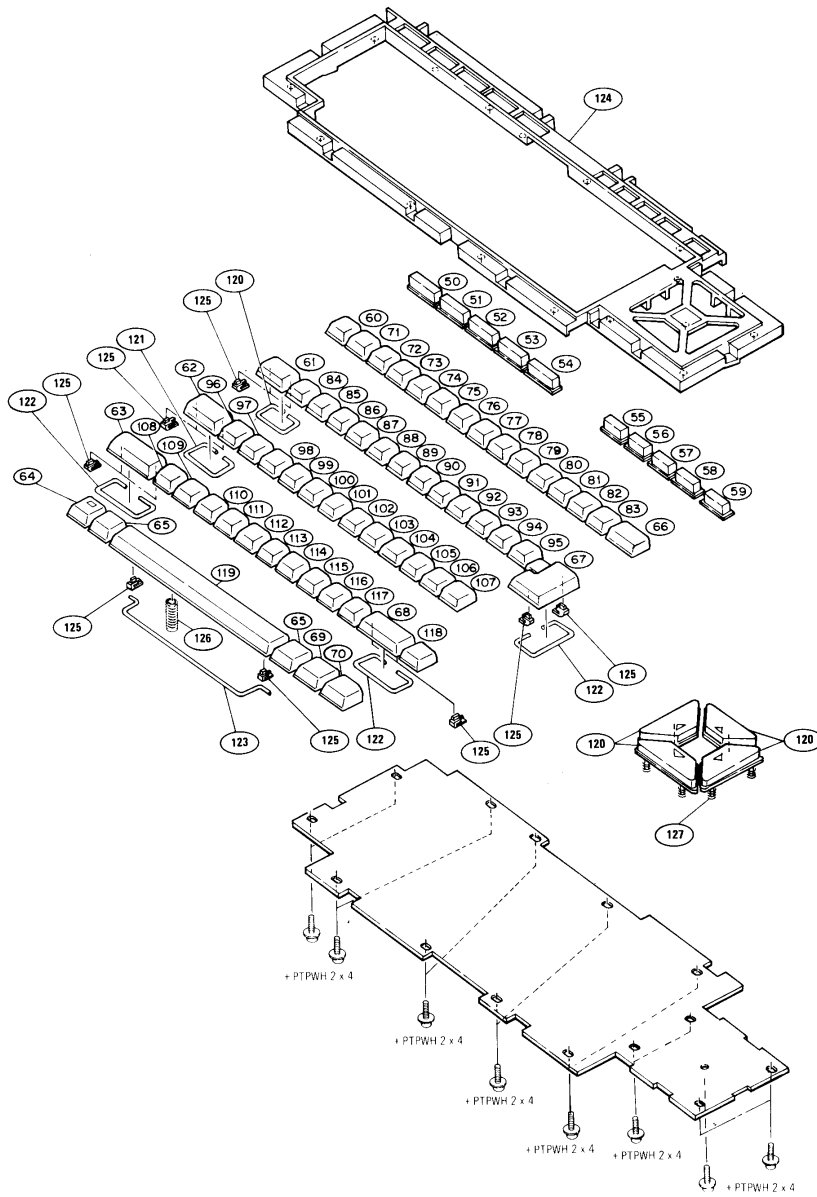
KEYBOARD (HB-75P/75B)

No.	Parts No.	Description	No.	Parts No.	Description
50	9-983-716-01	KEY TOP (1) F1	95	9-985-236-01	KEY TOP (3)]
51	9-983-717-01	KEY TOP (1) F2	96	9-985-237-01	KEY TOP (3) A
52	9-983-718-01	KEY TOP (1) F3	97	9-985-238-01	KEY TOP (3) S
53	9-983-719-01	KEY TOP (1) F4	98	9-985-239-01	KEY TOP (3) D
54	9-983-720-01	KEY TOP (1) F5	99	9-985-240-01	KEY TOP (3) F
55	9-983-721-01	KEY TOP (2) HOME	100	9-985-241-01	KEY TOP (3) G
56	9-983-722-01	KEY TOP (2) STOP	101	9-985-242-01	KEY TOP (3) H
57	9-983-723-01	KEY TOP (2) INS	102	9-985-243-01	KEY TOP (3) J
58	9-983-724-01	KEY TOP (2) DEL	103	9-985-244-01	KEY TOP (3) K
59	9-983-725-01	KEY TOP (2) RESET	104	9-985-245-01	KEY TOP (3) L
60	9-984-250-01	KEY TOP (4) ESC	105	9-985-246-01	KEY TOP (3) ;
61	9-984-251-01	KEY TOP (5) TAB	106	9-985-247-01	KEY TOP (3) ' ,
62	9-984-252-01	KEY TOP (6) CTRL	107	9-985-248-01	KEY TOP (3) £
63	9-984-253-01	KEY TOP (7) SHIFT	108	9-985-249-01	KEY TOP (3) Z
64	9-984-254-01	KEY TOP (8) CAP	109	9-985-250-01	KEY TOP (3) X
65	9-985-314-01	KEY TOP (4) CODE	110	9-985-251-01	KEY TOP (3) C
66	9-984-256-01	KEY TOP (5) BS	111	9-985-252-01	KEY TOP (3) V
67	9-984-257-01	KEY TOP (9) RETURN	112	9-985-253-01	KEY TOP (3) B
68	9-984-258-01	KEY TOP (10) SHIFT	113	9-985-254-01	KEY TOP (3) N
69	9-984-255-01	KEY TOP (11) GRAPH	114	9-985-255-01	KEY TOP (3) M
70	9-984-260-01	KEY TOP (11) SELECT	115	9-985-256-01	KEY TOP (3) ,
71	9-985-212-01	KEY TOP (3) 1	116	9-985-257-01	KEY TOP (3) .
72	9-985-213-01	KEY TOP (3) 2	117	9-985-258-01	KEY TOP (3) /
73	9-985-214-01	KEY TOP (3) 3	118	9-985-259-01	KEY TOP (3))
74	9-985-215-01	KEY TOP (3) 4	119	9-985-260-01	KEY TOP (11) SPACE
75	9-985-216-01	KEY TOP (3) 5	120	9-984-310-01	KEY TOP (12) CURSOR
76	9-985-217-01	KEY TOP (3) 6	121	9-984-312-01	CURSOR BAR (1)
77	9-985-218-01	KEY TOP (3) 7	122	9-984-313-01	CURSOR BAR (2)
78	9-985-219-01	KEY TOP (3) 8	123	9-985-261-01	SPACE BAR
79	9-985-220-01	KEY TOP (3) 9	124	9-984-315-01	FRAME, KEYBOARD
80	9-985-221-01	KEY TOP (3) 0	125	9-984-316-01	BAR HOLDER
81	9-985-222-01	KEY TOP (3) -	126	9-984-341-01	SPRING
82	9-985-223-01	KEY TOP (3) =	127	4-605-117-01	SPRING
83	9-985-224-01	KEY TOP (3) \			
84	9-985-225-01	KEY TOP (3) Q			
85	9-985-226-01	KEY TOP (3) W			
86	9-985-227-01	KEY TOP (3) E			
87	9-985-228-01	KEY TOP (3) R			
88	9-985-229-01	KEY TOP (3) T			
89	9-985-230-01	KEY TOP (3) Y			
90	9-985-231-01	KEY TOP (3) U			
91	9-985-232-01	KEY TOP (3) I			
92	9-985-233-01	KEY TOP (3) O			
93	9-985-234-01	KEY TOP (3) P			
94	9-985-235-01	KEY TOP (3) [


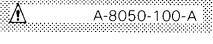
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KEYBOARD



7-2. ELECTRICAL PARTS LIST

Ref. No.	Parts No.	Description	Ref. No.	Parts No.	Description
MAIN BOARD					
	 A-8050-098-A	MOUNTED CB, MAIN (75P/75B)	C36	1-108-603-00	MYLAR 0.1 5% 50V
	 A-8050-100-A	MOUNTED CB, MAIN (65P)	C37	1-102-074-00	CERAMIC 0.001 5% 50V
	4-886-557-00	CLIP (B), IC	C38	1-108-603-00	MYLAR 0.1 5% 50V
C1	1-123-332-00	ELECT 47 20% 25V	C39	1-108-587-00	MYLAR 0.022 5% 50V
C2	1-123-379-00	ELECT 0.47 20% 100V	C40	1-102-518-00	CERAMIC 33P 5% 50V
C3	1-123-332-00	ELECT 47 20% 25V	C41	1-123-369-00	ELECT 4.7 20% 63V
C4	1-123-298-00	ELECT 470 20% 6.3V	C42	1-123-369-00	ELECT 4.7 20% 63V
C5	1-123-332-00	ELECT 47 20% 25V	C43	1-102-074-00	CERAMIC 0.001 10% 50V
C6	1-123-332-00	ELECT 47 20% 25V	C44	1-123-332-00	ELECT 47 20% 25V
C7	1-123-332-00	ELECT 47 20% 25V	C45	1-123-369-00	ELECT 4.7 20% 63V
C8	1-123-356-00	ELECT 10 20% 50V (75P/75B)	C46	1-102-518-00	CERAMIC 33P 5% 50V
C9	1-123-356-00	ELECT 10 20% 50V (75P/75B)	C47	1-102-518-00	CERAMIC 33P 5% 50V
C10	1-123-310-00	ELECT 470 20% 10V	C48	1-102-514-00	CERAMIC 22P 5% 50V
C11	1-102-935-00	CERAMIC 2P 50V	C49	1-123-332-00	ELECT 47 20% 25V
C12	1-102-760-00	CERAMIC 68P 5% 50V	C50		
C13	1-102-508-00	CERAMIC 10P 50V	C51	1-108-587-00	MYLAR 0.022 5% 50V
C14	1-123-356-00	ELECT 10 20% 50V (75P/75B)	C52	1-123-369-00	ELECT 4.7 20% 63V
C15	1-108-603-00	MYLAR 0.1 5% 50V	C53	1-108-587-00	MYLAR 0.022 5% 50V
C016	1-102-760-00	CERAMIC 68P 5% 50V	C54	1-123-332-00	ELECT 47 20% 25V
C017	1-102-074-00	CERAMIC 0.001 5% 50V	C55	1-123-332-00	ELECT 47 20% 25V
C018	1-123-356-00	ELECT 10 20% 50V (75P/75B)	C56	1-108-579-00	MYLAR 0.01 5% 50V
C019	1-123-356-00	ELECT 10 20% 50V	C57	1-123-308-00	ELECT 220 20% 10V
C020	1-108-603-00	MYLAR 0.1 5% 50V	C58	1-108-587-00	MYLAR 0.022 5% 50V
C021	1-108-587-00	MYLAR 0.022 5% 50V	C59	1-123-332-00	ELECT 47 20% 25V
C022	1-123-379-00	ELECT 0.47 20% 100V	C60	1-123-332-00	ELECT 47 20% 25V
C023	1-102-905-00	CERAMIC 130P 5% 50V	C61	1-123-369-00	ELECT 4.7 20% 63V
C024	1-108-587-00	MYLAR 0.022 5% 50V	C62	1-123-369-00	ELECT 4.7 20% 63V
C025	1-108-587-00	MYLAR 0.022 5% 50V	C63	1-123-369-00	ELECT 4.7 20% 63V
C026	1-102-852-00	CERAMIC 47P 5% 50V	C64	1-123-369-00	ELECT 4.7 20% 63V
C027	1-123-307-00	ELECT 100 20% 10V	C66	1-123-332-00	ELECT 47 20% 25V (55P)
C028	1-102-936-00	CERAMIC 3P 50V	C67	1-123-332-00	ELECT 47 20% 25V (55P)
C029	1-130-640-00	FILM 0.47 5% 50V	C68	1-123-332-00	ELECT 47 20% 25V
C030	1-123-369-00	ELECT 4.7 20% 63V	C69	1-161-974-00	CERAMIC 0.1 16V
C031	1-123-330-00	ELECT 22 20% 25V	C70	1-161-974-00	CERAMIC 0.1 16V
C032	1-108-603-00	MYLAR 0.1 5% 50V	C73	1-123-298-00	ELECT 470 20% 6.3V
C033	1-102-514-00	CERAMIC 22P 5% 50V	C79	1-102-514-00	CERAMIC 22P 5% 50V
C034	1-123-332-00	ELECT 47 20% 25V	C101	1-162-113-00	CERAMIC 0.01 30% 16V
C035	1-108-603-00	MYLAR 0.1 5% 50V	C102	1-162-113-00	CERAMIC 0.01 30% 16V
			C103	1-162-113-00	CERAMIC 0.01 30% 16V
			C104	1-162-113-00	CERAMIC 0.01 30% 16V
			C105	1-162-113-00	CERAMIC 0.01 30% 16V
			C106	1-162-113-00	CERAMIC 0.01 30% 16V
			C107	1-162-113-00	CERAMIC 0.01 30% 16V
			C108	1-162-113-00	CERAMIC 0.01 30% 16V
			C109	1-162-113-00	CERAMIC 0.01 30% 16V

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MAIN

Ref. No.	Parts No.	Description	Ref. No.	Parts No.	Description
C110	1-162-113-00	CERAMIC 0.01 30% 16V	CN1	1-562-383-00	50P
C111	1-162-113-00	CERAMIC 0.01 30% 16V	CN2	1-562-626-11	50P
C112	1-162-113-00	CERAMIC 0.01 30% 16V	CN3	1-561-534-00	21P (75P/75B)
C113	1-162-113-00	CERAMIC 0.01 30% 16V	CN4	1-564-373-11	14P
C114	1-162-113-00	CERAMIC 0.01 30% 16V	CN5	1-561-468-00	8P
C115	1-162-113-00	CERAMIC 0.01 30% 16V	CN8	1-564-372-00	9P
C116	1-162-113-00	CERAMIC 0.01 30% 16V	CN9	1-564-372-00	9P
C117	1-162-113-00	CERAMIC 0.01 30% 16V	CN10	1-564-674-11	8P
C118	1-162-113-00	CERAMIC 0.01 30% 16V	CN11	1-564-376-11	13P
C119	1-162-113-00	CERAMIC 0.01 30% 16V	CN12	1-564-377-11	9P
C120	1-162-113-00	CERAMIC 0.01 30% 16V			
C121	1-162-113-00	CERAMIC 0.01 30% 16V	D1	8-719-101-49	RD5.1EL1
C122	1-162-113-00	CERAMIC 0.01 30% 16V	D2	8-719-901-59	KV1320
C123	1-162-113-00	CERAMIC 0.01 30% 16V	D3	8-719-815-55	1S1555
C124	1-162-113-00	CERAMIC 0.01 30% 16V	D4	8-719-815-55	1S1555
C125	1-162-113-00	CERAMIC 0.01 30% 16V	D5	8-719-815-55	1S1555
C126	1-162-113-00	CERAMIC 0.01 30% 16V	D6	8-719-200-02	10E-2
C127	1-162-113-00	CERAMIC 0.01 30% 16V	D7	8-719-815-55	1S1555
C128	1-162-113-00	CERAMIC 0.01 30% 16V			
C129	1-162-113-00	CERAMIC 0.01 30% 16V			
C130	1-162-113-00	CERAMIC 0.01 30% 16V	DL1	1-415-374-11	DELAY LINE (Y-DL)
C131	1-162-113-00	CERAMIC 0.01 30% 16V			
C132	1-162-113-00	CERAMIC 0.01 30% 16V			
C133	1-162-113-00	CERAMIC 0.01 30% 16V			
C134	1-162-113-00	CERAMIC 0.01 30% 16V			
C135	1-162-113-00	CERAMIC 0.01 30% 16V	IC1	8-759-900-04	SN74LS04N
C136	1-162-113-00	CERAMIC 0.01 30% 16V	IC2	8-759-908-94	TMS9929ANL
C137	1-162-113-00	CERAMIC 0.01 30% 16V	IC3	8-759-101-91	UPD416C-2
C138	1-162-113-00	CERAMIC 0.01 30% 16V	IC4	8-759-101-91	UPD416C-2
C139	1-162-113-00	CERAMIC 0.01 30% 16V	IC5	8-759-101-91	UPD416C-2
C140	1-162-113-00	CERAMIC 0.01 30% 16V	IC6	8-759-101-91	UPD416C-2
C141	1-162-113-00	CERAMIC 0.01 30% 16V	IC7	8-757-925-00	CX-7925A
C142	1-162-113-00	CERAMIC 0.01 30% 16V (55P)	IC8	8-759-900-74	SN74LS74AN
C143	1-162-113-00	CERAMIC 0.01 30% 16V (55P)	IC9	8-759-101-91	UPD416C-2
C144	1-162-113-00	CERAMIC 0.01 30% 16V (55P)	IC10	8-759-101-91	UPD416C-2
C145	1-162-113-00	CERAMIC 0.01 30% 16V (55P)	IC11	8-759-101-91	UPD416C-2
C146	1-162-113-00	CERAMIC 0.01 30% 16V	IC12	8-759-101-91	UPD416C-2
C147	1-162-113-00	CERAMIC 0.01 30% 16V	IC13	8-759-938-89	LM1889N
C148	1-162-113-00	CERAMIC 0.01 30% 16V	IC14	8-759-140-66	UPD4066BC
C149	1-162-113-00	CERAMIC 0.01 30% 16V	IC15	8-759-900-74	SN74LS74AN
C150	1-162-113-00	CERAMIC 0.01 30% 16V	IC16	8-759-182-55	UPD8255AC-5
C151	1-162-113-00	CERAMIC 0.01 30% 16V	IC17	8-759-901-53	SN74LS153N
C152	1-162-113-00	CERAMIC 0.01 30% 16V	IC18	8-759-901-39	SN74LS139N
C153	1-162-113-00	CERAMIC 0.01 30% 16V	IC19	8-759-131-11	UPC311C
C154	1-162-113-00	CERAMIC 0.01 30% 16V	IC21	8-759-900-74	SN74LS74AN
C155	1-162-113-00	CERAMIC 0.01 30% 16V			
C156	1-162-113-00	CERAMIC 0.01 30% 16V			

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IC22	8-759-901-45	SN74LS145N	IC62	8-759-901-57	SN74LS157N
IC23	8-759-901-39	SN74LS139N	IC63	8-759-901-57	SN74LS157N
IC24	8-759-900-32	SN74LS32N	IC64	8-759-900-09	SN74LS09N
IC25	8-759-900-86	SN74LS86N	IC65	8-759-905-75	MSM3764-15RS (75P/75B)
IC26	8-759-900-04	SN74LS04N		8-759-101-91	UPD416C-2 (55P)
IC27	8-759-900-00	SN74LS00N	IC66	8-759-905-75	MSM3764-15RS (75P/75B)
IC28	8-759-900-02	SN74LS02N		8-759-101-91	UPD416C-2 (55P)
IC29	8-759-900-04	SN74LS04N	IC67	8-759-905-75	MSM3764-15RS (75P/75B)
IC30	8-759-900-27	SN74LS27N		8-759-101-91	UPD416C-2 (55P)
IC31	8-759-901-75	SN74LS175N	IC68	8-759-905-75	MSM3764-15RS (75P/75B)
				8-759-101-91	UPD416C-2 (55P)
IC32	8-759-900-08	SN74LS08N	L1	1-408-413-00	22
IC33	8-759-901-26	SN74LS126AN	L2	1-410-222-11	8.2
IC34	8-759-900-74	SN74LS74AN	L3	1-408-411-00	15
IC35	8-759-900-74	SN74LS74AN	L4	1-408-416-00	39
IC36	8-759-900-11	SN74LS11N	L5	1-408-420-00	82
			L6	1-408-420-00	82
IC37	8-759-900-08	SN74LS08N	Q1	8-729-612-77	2SA1027R (75P/75B)
IC38	8-759-900-04	SN74LS04N	Q2	8-729-663-47	2SC1364 (75P/75B)
IC39	8-759-903-73	SN74LS373N	Q3	8-729-612-77	2SA1027R (75P/75B)
IC40	8-759-906-45	SN74LS645N	Q4	8-729-663-47	2SC1364 (75P/75B)
IC41	8-759-916-80	LH0080A	Q5	8-729-612-77	2SA1027R (75P/75B)
IC42	8-759-915-71	MSM38256-70RS	Q6	8-729-663-47	2SC1364 (75P/75B)
IC43			Q7	8-729-663-47	2SC1364 (75P/75B)
IC44	8-759-915-23	MSM38128A-77RS	Q8	8-729-100-13	2SC2001
IC45	8-759-900-10	SN74LS10N	Q9	8-729-663-47	2SC1364
IC46	8-759-900-32	SN74LS32N	Q10	8-729-663-47	2SC1364
IC47	8-759-903-67	SN74LS367N	Q11	8-729-612-77	2SA1027R
IC48	8-759-908-60	AY-3-8910	Q12	8-729-663-47	2SC1364
IC49	8-759-901-57	SN74LS157N	Q13	8-729-663-47	2SC1364
IC50	8-759-900-74	SN74LS74AN	Q14	8-729-663-47	2SC1364 (75P/75B)
IC51	8-759-900-74	SN74LS74AN	Q15	8-729-663-47	2SC1364
IC52	8-759-900-02	SN74LS02N	Q16	8-729-663-47	2SC1364
IC53	8-759-900-27	SN74LS27N	Q17	8-729-612-77	2SA1027R
IC54	8-759-903-67	SN74LS367N	Q18	8-729-663-47	2SC1364
IC55	8-759-903-67	SN74LS367N	Q19	8-729-663-47	2SC1364
IC56	8-759-903-67	SN74LS367N	Q20	8-729-663-47	2SC1364
IC57	8-759-901-57	SN74LS157N	Q21	8-729-203-04	2SK30A
IC58	8-759-905-75	MSM3764-15RS (75P/75B)	Q22	8-729-663-47	2SC1364
	8-759-101-91	UPD416C-2 (55P)	Q23	8-729-364-12	2SC641K
IC59	8-759-905-75	MSM3764-15RS (75P/75B)	Q24	8-729-364-12	2SC641K
	8-759-101-91	UPD416C-2 (55P)	Q25	8-729-663-47	2SC1364
IC60	8-759-905-75	MSM3764-15RS (75P/75B)			
	8-759-101-91	UPD416C-2 (55P)			
IC61	8-759-905-75	MSM3764-15RS (75P/75B)			
	8-759-101-91	UPD416C-2 (55P)			

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R61	1-247-815-00	CARBON 220 5% 1/6W	R106	1-247-855-00	CARBON 10K 5% 1/6W
R62	1-247-851-00	CARBON 6.8K 5% 1/6W	R107	1-247-831-00	CARBON 1K 5% 1/6W
R63	1-247-847-00	CARBON 4.7K 5% 1/6W	R108	1-247-841-00	CARBON 2.7K 5% 1/6W
R64	1-247-837-00	CARBON 1.8K 5% 1/6W	R109	1-247-799-00	CARBON 47 5% 1/6W
R65	1-247-849-00	CARBON 5.6K 5% 1/6W	R110	1-247-855-00	CARBON 10K 5% 1/6W
R66	1-247-849-00	CARBON 5.6K 5% 1/6W	R111	1-247-819-00	CARBON 330 5% 1/6W
R67	1-247-855-00	CARBON 10K 5% 1/6W	R112	1-247-879-00	CARBON 100K 5% 1/6W
R68	1-247-849-00	CARBON 5.6K 5% 1/6W	R113	1-247-871-00	CARBON 47K 5% 1/6W
R69	1-247-239-00	CARBON 910 5% 1/2W	R114	1-247-863-00	CARBON 22K 5% 1/6W
R70	1-247-863-00	CARBON 22K 5% 1/6W	R115	1-247-855-00	CARBON 10K 5% 1/6W
R71	1-247-863-00	CARBON 22K 5% 1/6W	R116	1-247-831-00	CARBON 1K 5% 1/6W
R72	1-247-863-00	CARBON 22K 5% 1/6W	R117	1-247-863-00	CARBON 22K 5% 1/6W
R73	1-247-815-00	CARBON 220 5% 1/6W	R118	1-247-871-00	CARBON 47K 5% 1/6W
R74	1-247-871-00	CARBON 47K 5% 1/6W	R119	1-247-831-00	CARBON 1K 5% 1/6W
R75	1-247-831-00	CARBON 1K 5% 1/6W	R120	1-247-841-00	CARBON 2.7K 5% 1/6W
R76	1-247-831-00	CARBON 1K 5% 1/6W	R121	1-247-841-00	CARBON 2.7K 5% 1/6W
R77	1-247-879-00	CARBON 100K 5% 1/6W	R122	1-247-791-00	CARBON 22 5% 1/6W
R78	1-247-879-00	CARBON 100K 5% 1/6W	R123	1-247-841-00	CARBON 2.7K 5% 1/6W
R79	1-247-843-00	CARBON 3.3K 5% 1/6W	R124	1-247-841-00	CARBON 2.7K 5% 1/6W
R80	1-247-783-00	CARBON 10 5% 1/6W	R125	1-247-841-00	CARBON 2.7K 5% 1/6W
R81	1-247-821-00	CARBON 390 5% 1/6W	R126	1-247-791-00	CARBON 22 5% 1/6W
R82	1-247-859-00	CARBON 15K 5% 1/6W	R127	1-247-791-00	CARBON 22 5% 1/6W
R83	1-247-839-00	CARBON 2.2K 5% 1/6W	R128	1-247-791-00	CARBON 22 5% 1/6W
R84	1-247-841-00	CARBON 2.7K 5% 1/6W	R129	1-247-841-00	CARBON 2.7K 5% 1/6W
R85	1-247-831-00	CARBON 1K 5% 1/6W	R130	1-247-855-00	CARBON 10K 5% 1/6W
R86	1-247-833-00	CARBON 1.2K 5% 1/6W	R131	1-247-839-00	CARBON 2.2K 5% 1/6W
R87	1-247-843-00	CARBON 3.3K 5% 1/6W	R132	1-247-821-00	CARBON 390 5% 1/6W
R88	1-247-849-00	CARBON 5.6K 5% 1/6W	R133	1-247-841-00	CARBON 2.7K 5% 1/6W
R89	1-247-819-00	CARBON 330 5% 1/6W	R134	1-247-841-00	CARBON 2.7K 5% 1/6W
R90	1-247-795-00	CARBON 33 5% 1/6W	R135	1-247-887-00	CARBON 220K 5% 1/6W
R91	1-247-831-00	CARBON 1K 5% 1/6W	R136	1-247-863-00	CARBON 22K 5% 1/6W
R92	1-247-817-00	CARBON 270 5% 1/6W	RY1	1-515-520-00	RELAY
R93	1-247-821-00	CARBON 390 5% 1/6W	VC1	1-141-227-00	TRIMAR, CERAMIC 20P
R94	1-247-831-00	CARBON 1K 5% 1/6W	VC2	1-141-227-00	TRIMAR, CERAMIC 20P
R95	1-247-819-00	CARBON 330 5% 1/6W	VR1	1-226-710-00	ADJ. SOLID 10K(75P/75B)
R96	1-247-849-00	CARBON 5.6K 5% 1/6W	VR2	1-226-710-00	ADJ. SOLID 10K(75P/75B)
R97	1-247-847-00	CARBON 4.7K 5% 1/6W	VR3	1-226-710-00	ADJ. SOLID 10K(75P/75B)
R98	1-247-831-00	CARBON 1K 5% 1/6W	VR4	1-226-707-00	ADJ. SOLID 1K
R99	1-247-823-00	CARBON 470 5% 1/6W	X1	1-567-161-00	CRYSTAL, 10.73868MHz
R100	1-247-837-00	CARBON 1.8K 5% 1/6W			
R101	1-247-837-00	CARBON 1.8K 5% 1/6W			
R102	1-247-841-00	CARBON 2.7K 5% 1/6W			
R103	1-247-835-00	CARBON 1.5K 5% 1/6W			
R104	1-247-855-00	CARBON 10K 5% 1/6W			
R105	1-247-831-00	CARBON 1K 5% 1/6W			

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FUSE, LED, POWER, 5V, 12V

Ref. No.	Parts No.	Description
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FUSE BOARD

	1-533-162-00	HOLDER, FUSE
	1-613-627-11	PC BOARD, FUSE

△C9	1-161-953-00	CERAMIC 0.0047 20% 400V
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F401	1-532-612-00	TIME-LAG 160mA
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LED BOARD

D1	8-719-908-47	SLP171D
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POWER BOARD

A-8050-103-A	MOUNTED CB, POWER (75B) (WITH +5V, 12V BOARD)
A-8050-102-A	MOUNTED CB, POWER (55P/75P) (WITH +5V, 12V BOARD)
1-464-383-11	MODULATOR, RF (75B)
1-464-384-11	MODULATOR, RF (55P/75P)

C1	1-125-375-11	ELECT(BLOCK) 10000 20% 16V
C2	1-125-376-11	ELECT(BLOCK) 3300 20% 25V
C3	1-123-362-00	ELECT 330 20% 50V
C4	1-123-332-00	ELECT 47 20% 25V
C5	1-136-171-00	FILM 0.33 5% 50V
C8	1-123-332-00	ELECT 47 20% 25V

CN1	1-562-121-00	6P
CN2	1-560-200-00	2P
CN3	1-562-327-00	3P
CN4	1-562-327-00	3P
CN5	1-564-675-11	8P
CN6	1-562-250-00	5P

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Ref. No.	Parts No.	Description
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D1	8-719-200-02	10E2
D2	8-719-200-02	10E2
D3	8-719-200-02	10E2
D4	8-719-200-02	10E2
D6	8-719-300-57	RB402

IC3	8-759-700-69	NJM79L12A
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L1	1-408-413-00	MICRO INDUCTOR 22
L2	1-543-184-00	BEAD, FERRITE

R1	1-247-837-00	CARBON 1.8K 5% 1/6W
R2	1-247-837-00	CARBON 1.8K 5% 1/6W
R3	1-247-831-00	CARBON 1K 5% 1/6W

5V BOARD

1-613-624-11	PC BOARD, +5V
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C6	1-123-332-00	ELECT 47 20% 25V
C10	1-136-171-00	FILM 0.33 5% 50V

IC1	8-749-930-52	SI-3052V
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12V BOARD

1-613-625-11	PC BOARD, +12V
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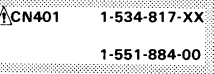
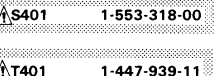
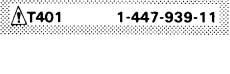
C7	1-123-332-00	ELECT 47 20% 25V
C11	1-136-171-00	FILM 0.33 5% 50V

IC2	8-749-931-22	SI-3122V
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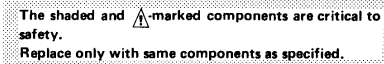

KEYBOARD, FRAME

Ref. No.	Parts No.	Description
KEYBOARD (HB-55P)		
	1-464-382-11	KEYBOARD UNIT (HB-55P)
D1~D3	8-719-815-55	1S1555
D4	9-983-904-01	LN01201C
S1~S9	9-983-791-01	KEY BOARD
S10	9-984-704-01	KEY BOARD (RESET)
S11~S53	9-983-791-01	KEY BOARD
S54	9-984-704-01	KEY BOARD (SHIFT)
S55~S65	9-983-791-01	KEY BOARD
S66	9-984-704-01	KEY BOARD (SHIFT)
S67	9-983-791-01	KEY BOARD
S68, S69	9-984-704-01	KEY BOARD (SPACE. CODE)
S70~S74	9-983-791-01	KEY BOARD

Ref. No.	Parts No.	Description
FRAME (HB-55P/75P/75B)		
 △CN401	1-534-817-XX	CORD. POWER, FULO PLUG
	1-551-884-00	CORD. POWER (75B)
 △S401	1-553-318-00	POWER
 △T401	1-447-939-11	POWER

Ref. No.	Parts No.	Description
KEYBOARD (HB-75P/75B)		
	1-464-381-11	KEYBOARD UNIT (HB-75P/75B)
D1~D3	8-719-815-55	1S1555
S1~S10	1-552-539-11	KEY BOARD (1)
S11~S65	9-985-263-01	KEY BOARD (2)
S66	9-984-340-01	KEY BOARD (3) WITH LED
S67~S71	9-985-263-01	KEY BOARD (2)
S72~S75	1-552-539-11	KEY BOARD (1)

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MAIN

Ref. No.	Parts No.	Description	Ref. No.	Parts No.	Description
Q26	8-729-663-47	2SC1364	R26	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)
Q27	8-729-663-47	2SC1364	R27	1-247-895-00	CARBON 470K 5% 1/6W (75P/75B)
Q28	8-729-203-04	2SK30A	R28	1-247-859-00	CARBON 15K 5% 1/6W (75P/75B)
R1	1-247-807-00	CARBON 100 5% 1/6W (75P/75B)	R29	1-247-861-00	CARBON 18K 5% 1/6W (75P/75B)
R2	1-247-815-00	CARBON 220 5% 1/6W (75P/75B)	R30	1-247-879-00	CARBON 100K 5% 1/6W (75P/75B)
R3	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R31	1-247-831-00	CARBON 1K 5% 1/6W
R4	1-247-895-00	CARBON 470K 5% 1/6W (75P/75B)	R32	1-247-823-00	CARBON 470 5% 1/6W
R5	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R33	1-247-831-00	CARBON 1K 5% 1/6W
R6	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R34	1-247-823-00	CARBON 470 5% 1/6W
R7	1-247-879-00	CARBON 100K 5% 1/6W (75P/75B)	R35	1-247-859-00	CARBON 15K 5% 1/6W
R8	1-247-855-00	CARBON 10K 5% 1/6W	R36	1-247-867-00	CARBON 33K 5% 1/6W
R9	1-247-803-00	CARBON 68 5% 1/6W	R37	1-247-887-00	CARBON 220K 5% 1/6W
R10	1-247-811-00	CARBON 150 5% 1/6W	R38	1-247-847-00	CARBON 4.7K 5% 1/6W
R11	1-247-831-00	CARBON 1K 5% 1/6W	R39	1-247-843-00	CARBON 3.3K 5% 1/6W
R12	1-247-843-00	CARBON 3.3K 5% 1/6W	R40	1-247-855-00	CARBON 10K 5% 1/6W
R13	1-247-831-00	CARBON 1K 5% 1/6W	R41	1-247-847-00	CARBON 4.7K 5% 1/6W
R14	1-247-815-00	CARBON 220 5% 1/6W	R42	1-247-835-00	CARBON 1.5K 5% 1/6W
R15	1-247-807-00	CARBON 100 5% 1/6W (75P/75B)	R43	1-247-825-00	CARBON 560 5% 1/6W
R16	1-247-815-00	CARBON 220 5% 1/6W (75P/75B)	R44	1-247-847-00	CARBON 4.7K 5% 1/6W (75P/75B)
R17	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R45	1-247-855-00	CARBON 10K 5% 1/6W (75P/75B)
R18	1-247-895-00	CARBON 470K 5% 1/6W (75P/75B)	R46	1-247-851-00	CARBON 6.8K 5% 1/6W (75P/75B)
R19	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R47	1-247-851-00	CARBON 6.8K 5% 1/6W (75P/75B)
R20	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R48	1-247-855-00	CARBON 10K 5% 1/6W (75P/75B)
R21	1-247-879-00	CARBON 100K 5% 1/6W (75P/75B)	R49	1-247-851-00	CARBON 6.8K 5% 1/6W
R22	1-247-843-00	CARBON 3.3K 5% 1/6W (75P/75B)	R50	1-247-855-00	CARBON 10K 5% 1/6W
R23	1-247-817-00	CARBON 270 5% 1/6W	R51	1-247-847-00	CARBON 4.7K 5% 1/6W (75P/75B)
R24	1-247-807-00	CARBON 100 5% 1/6W (75P/75B)	R52	1-247-831-00	CARBON 1K 5% 1/6W (75P/75B)
R25	1-247-815-00	CARBON 220 5% 1/6W (75P/75B)	R53	1-247-831-00	CARBON 1K 5% 1/6W (75P/75B)
			R54	1-247-831-00	CARBON 1K 5% 1/6W
			R55	1-247-823-00	CARBON 470 5% 1/6W
			R56	1-247-819-00	CARBON 330 5% 1/6W
			R57	1-247-889-00	CARBON 270K 5% 1/6W
			R58	1-247-831-00	CARBON 1K 5% 1/6W
			R59	1-247-839-00	CARBON 2.2K 5% 1/6W
			R60	1-247-811-00	CARBON 150 5% 1/6W

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