EPSON

PORTABLE COMPUTER

HX-20

OPERATION MANUAL

H8294011-2
Y201990030

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OPERATION MANUAL

FOREWORD

Congratulations on your decision to purchase an EPSON HX-20 Portable Computer.

Your HX-20 is a compact (A4 size), yet powerful battery-operated portable computer designed to meet the computing needs of post-industrial society. The HX-20's unique mix of the portability of a pocket computer and the functions of a desktop personal computer is made possible by its state-of-the-art miniaturisation and consumer-oriented design.

The HX-20 is a well-balanced, general purpose computer which will stimulate the creativity of the hobbyist while satisfying the demands of the business and engineering user. The HX-20's dual CPUs enhance I/O processing, for excellent expandability and communications capability.

Please read this manual carefully and operate the computer correctly so that your HX-20 can display its functions to the maximum extent.

— CAUTION —

The AC voltage of the power supply available varies from country to country. Therefore, when using your HX-20 with an AC adapter, please use an AC adapter suitable for the voltage of your country.

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1.2 HX-20 Components

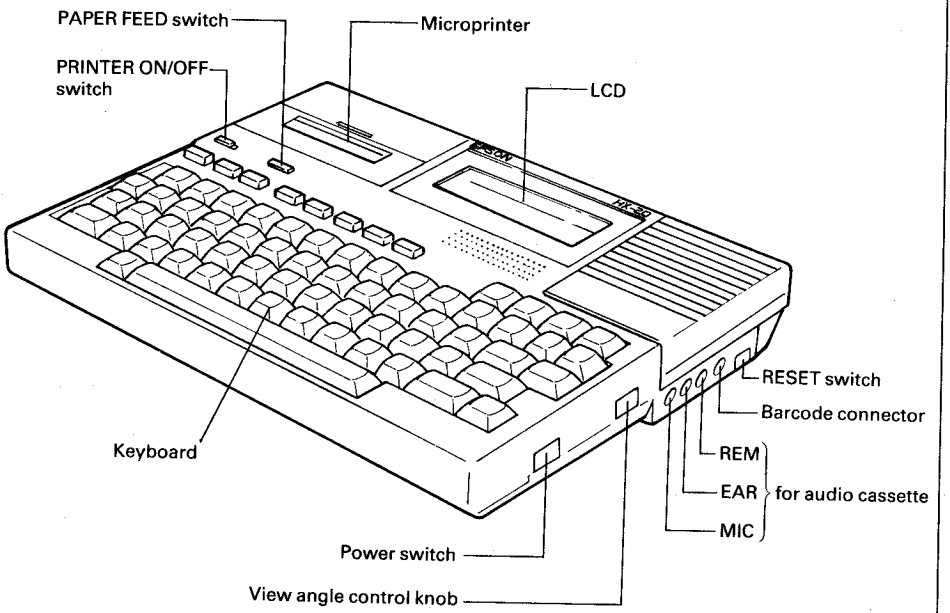


Fig. 1-2 Names of HX-20 Components

POWER switch: Used to turn ON and OFF the power supply of the HX-20.

VIEW angle control knob: Used to adjust the view angle of LCD.

The following connectors are for interfacing an external audio cassette to the HX-20.

MIC (microphone): Signal line for data write

EAR (earphone): Signal line for data read

REM (remote): Signal line for motor control of the cassette recorder.

Barcode connector: An interface connector for connection of a barcode reader to the HX-20.

RESET switch: Used to reset the hardware of the HX-20.

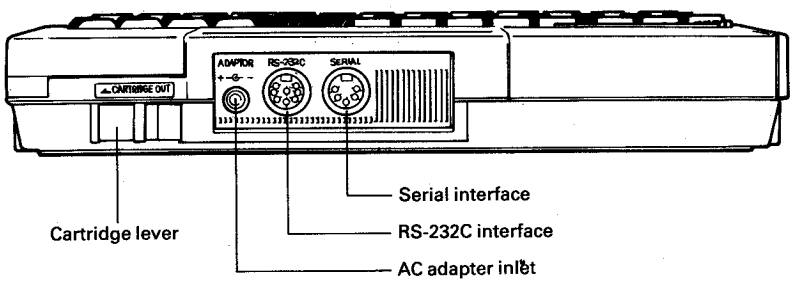


Fig. 1-3 Rear View of HX-20

Cartridge lever: Used to allow the dismounting of an optional unit (ROM cartridge or microcassette) from the HX-20. To remove the optional unit, push the lever to the left.

RS-232C interface connector: Used to connect a printer, acoustic coupler or another HX-20 to the HX-20.

AC adapter inlet: Used to connect the AC adapter for battery charging.

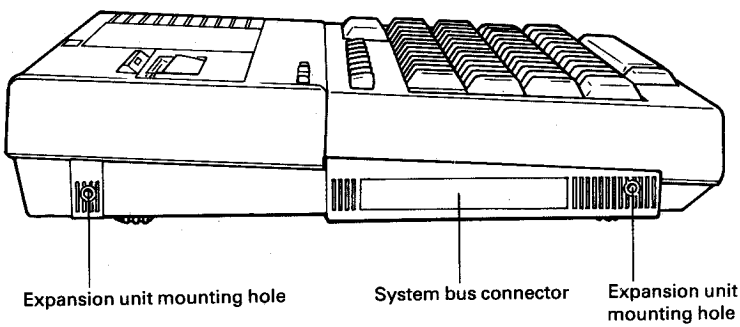


Fig. 1-4 Side View of HX-20

Expansion unit mounting holes: Two screw (M3) mounting holes are provided to secure the expansion unit.

System bus connector: Used to connect the expansion unit to the HX-20.

1.3 Setting the Roll Paper

STEP 1

Remove the new roll paper supplied as an accessory from the vinyl cover and pull out the leading edge of the paper as shown in Fig. 1-5. To reuse a roll which has already been cut, recut the leading edge of the roll cleanly at a right angle as shown in Fig. 1-5.

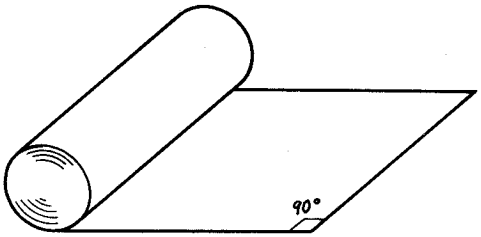


Fig. 1-5 Cutting Paper Edge

STEP 2

Open the paper cover behind the built-in microprinter by pushing the cover back with your fingers.

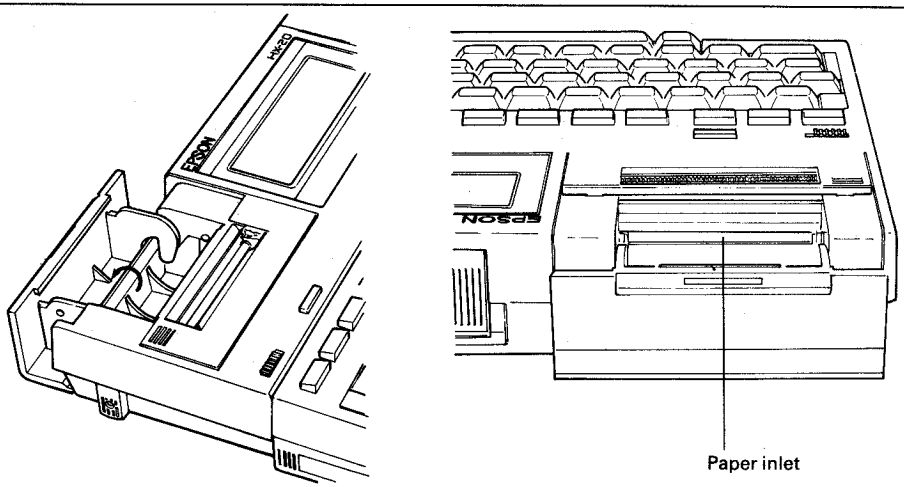


Fig. 1-6 Paper Inlet Cover

STEP 3

First, turn the power switch ON. Then turn the printer switch ON and insert the leading edge of the roll into the paper inlet. Keep on pressing the PAPER FEED button and the paper will automatically feed into the printer and emerge from the top of the printer in about 15 seconds.

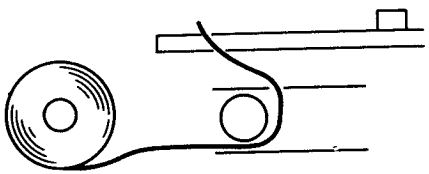


Fig. 1-7 Paper Feeding Course

1.4 Setting the Ribbon Cassette

Press the upper left-hand corner of the printer cover (where "PUSH" is inscribed) gently with your finger to remove the cover. Place the ribbon cassette in the position indicated by the dotted line in Fig. 1-9. Then, press both edges of the cartridge gently with your finger to secure the ribbon cassette.

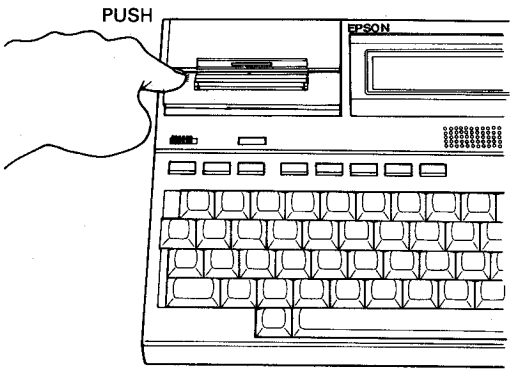


Fig. 1-8 Ribbon Cassette Setting

After mounting the ribbon cassette, check that the printing paper and the inked ribbon are correctly positioned as shown in Fig. 1-9. Be sure that the inked ribbon is not twisted and is free from creasing.

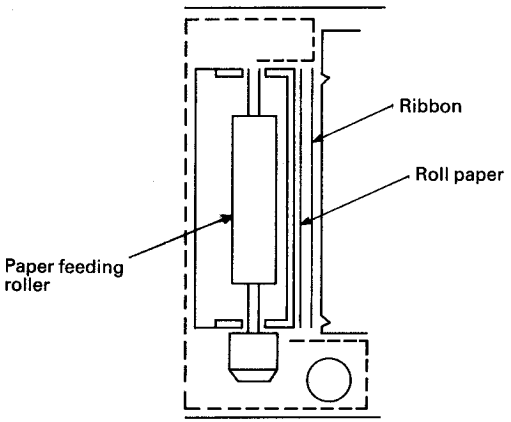


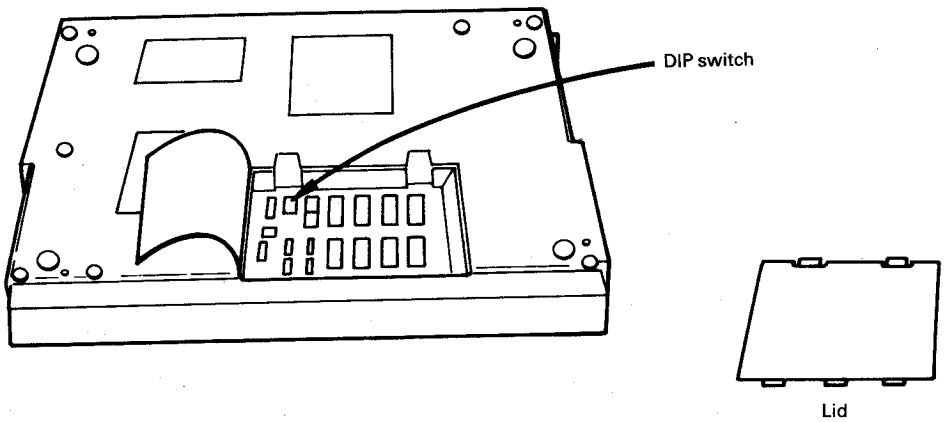
Fig. 1-9 Positions of Paper and Inked Ribbon

2. DIP SWITCH SETTING

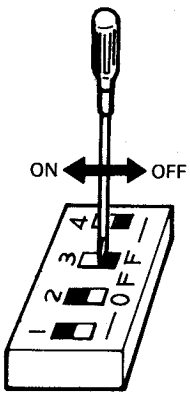
Your HX-20 is equipped with a 4-pin DIP switch in order to meet user's specific requirements.

To gain access to the DIP switch, observe the following procedure.

1. Turn the power OFF.
2. Turn the HX-20 upside down on a soft surface.
3. Open the lid located at the lower right-hand of the HX-20.
4. Position your HX-20 as follows:



5. Set these DIP switch pins. (Switch pins set to the left are ON, those set to the right are OFF. See figure below.)

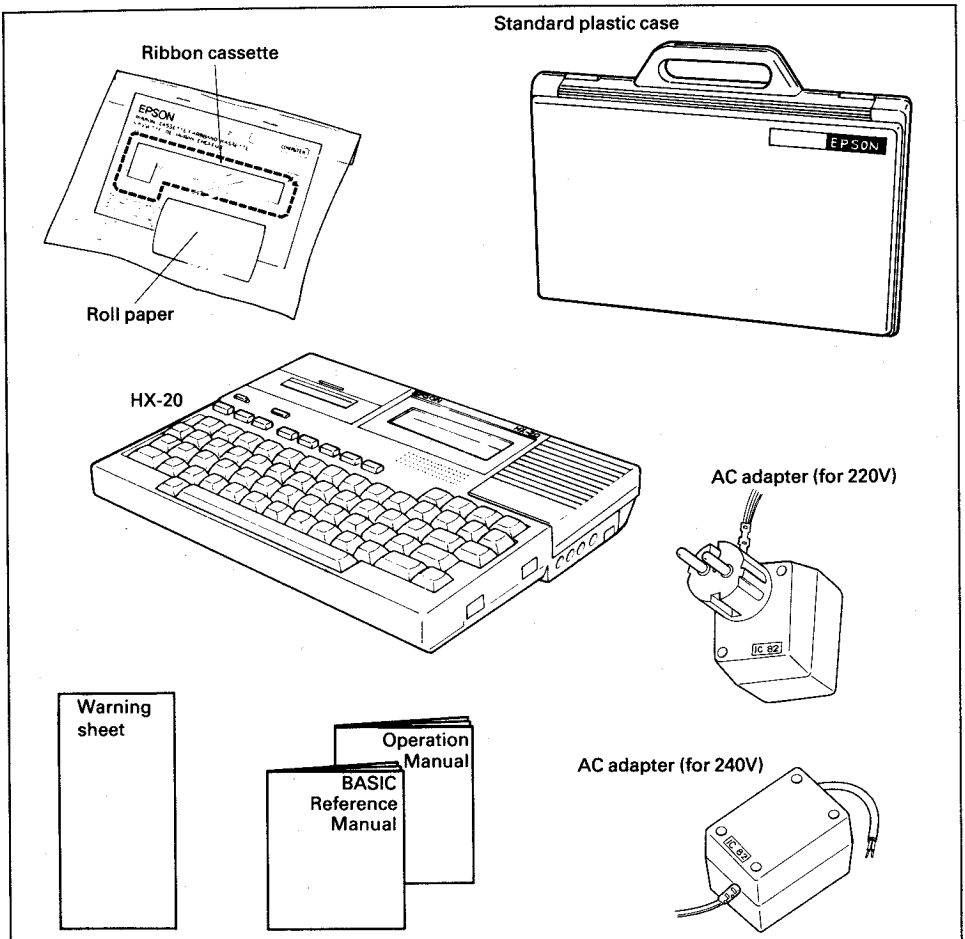


NOTE:
DIP SW pin No.4 is set to OFF at factory. Character set is selectable regardless of its ON/OFF position. To use Disk Drive Unit, set the SW pin No. 4 to ON.

1. BEFORE OPERATION

1.1 Unpacking

Upon unpacking, please make sure that everything shown in Fig. 1-1 is in the carton box. If you notice any of the listed contents missing or damaged, contact the store where you purchased your HX-20.

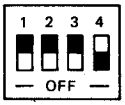


NOTES:
1. It is recommended that all packing materials be saved in case the HX-20 requires reshipment in the future.
2. To customers using the 240V AC adapter: Please purchase a commercially available plug and attach it to your AC adapter.

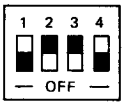
Fig. 1-1 Contents of Carton Box

By changing the DIP switch setting as shown below, you can select 8 different character sets.

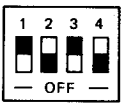
USASCII



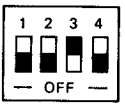
France



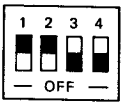
Germany



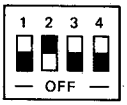
England



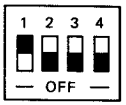
Denmark



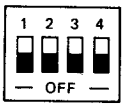
Sweden



Italy



Spain



International character sets are shown below:

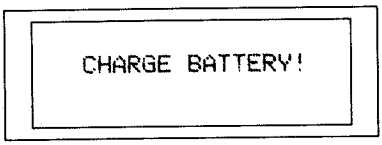
Country / Dec.code	U.S.A.	France	Germany	England	Denmark	Sweden	Italy	Spain
35 (23)	#	#	#	£	#	#	#	Pt
36 (24)	$	$	$	$	$	¤	$	$
64 (40)	@	à	§	@	@	É	@	@
91 (5B)	[	°	Ä	[	Æ	Ä	°	í
92 (5C)	\	ç	Ö	\	Ø	Ö	\	Ñ
93 (5D)	]	§	Ü	]	Å	Å	é	¿
94 (5E)	^	^	^	^	^	Ü	^	^
96 (60)	`	`	`	`	`	é	ù	`
123 (7B)	{	é	ä	{	æ	ä	à	¨
124 (7C)	¦	ù	ö	¦	ø	ö	ò	ñ
125 (7D)	}	è	ü	}	å	å	è	}
126 (7E)	~	¨	ß	~	~	ü	ì	~

NOTE: Numbers in parentheses are hexadecimal codes.

You can also select each character set by software. (See POKE in the BASIC Reference Manual for details.)

3. BUILT-IN BATTERY

Your HX-20 is powered by a built-in rechargeable Ni-Cd battery. When the battery discharges and its output voltage falls below the specified value, the message "**CHARGE BATTERY!**" will appear on the LCD screen. This message flashes 60 times and then causes the power supply of the HX-20 to turn off automatically. In this state, all operations of the HX-20 are put in the halt state. Recharge the battery as soon as possible, noting the following. The built-in battery can be charged before the "**CHARGE BATTERY!**" message is displayed. However, charging it repeatedly for long periods of time will overcharge it and shorten its service life. Pay careful attention to the charging time of the battery. You can, of course, use the HX-20 while the batteries are being charged.



3.1 Specifications of Built-in Battery

(1) Battery voltage
- (a) Operating : 4.5 to 6.0V
- (b) Data retention : 4.0 to 6.0V
- (c) Low voltage detection : 4.5V

(2) Battery capacity
The effective output capacity in the fully charged state is approx. 1,000 mAH. (The effective output capacity refers to the battery capacity to sustain operation until the message "CHARGE BATTERY!" will be displayed.)

(3) Battery life
The service life of the battery is influenced by such operating conditions as ambient operating temperature, charging method (length and timing of charging), etc. However, the rated service life of the built-in battery is three years and it is recommended that you replace the battery soon after the expiration of this period. Also, replace the battery if you notice that, even though it has been fully charged, the time duration you can operate the HX-20 is getting shorter.

(4) Replacing the battery

If your programmes are stored in the RAM, save them to a microcassette or audio cassette file before replacing the battery. When you replace the battery, be sure to disconnect the AC adapter.

NOTES:

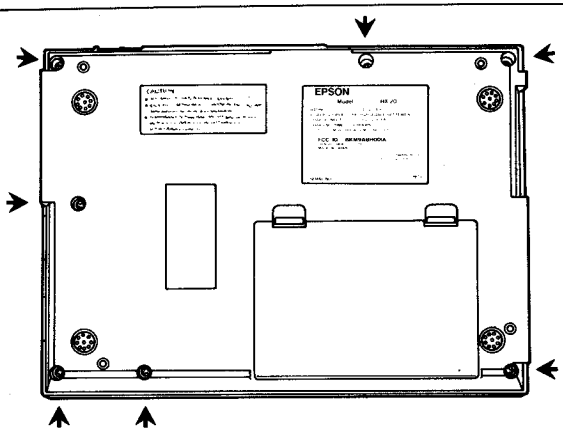
1. *If the battery is removed when the AC adapter is connected to the HX-20, a voltage exceeding the rated supply voltage will be applied to the HX-20. This excess voltage will result in shortening of the service life of the circuit elements and may, in some cases, damage the circuit elements.*
2. *Removing the built-in battery causes the loss of the programmes stored in the RAM.*

Replace the battery according to the following procedure.

1. Save the programmes stored in the RAM to a cassette tape file or its equivalent.
2. Disconnect the AC adapter from the HX-20.
3. Remove the bottom housing of the HX-20 by loosening the seven screws and disconnecting the FPC cable for the plug-in option ROM cartridge.
4. Loosen the screw securing the battery holder and remove the battery holder containing the old battery from the battery compartment.
5. Disconnect the battery connector on the control circuit board.
6. Remove the old battery from the battery holder and insert the new battery into the battery holder.

NOTE:

Mount the battery holder with the new battery in the order of steps 4, 5 and 3 above except that the mounting procedure is the exact reverse of the disassembly procedure.



Remove the seven screws indicated by the arrows in the figure.

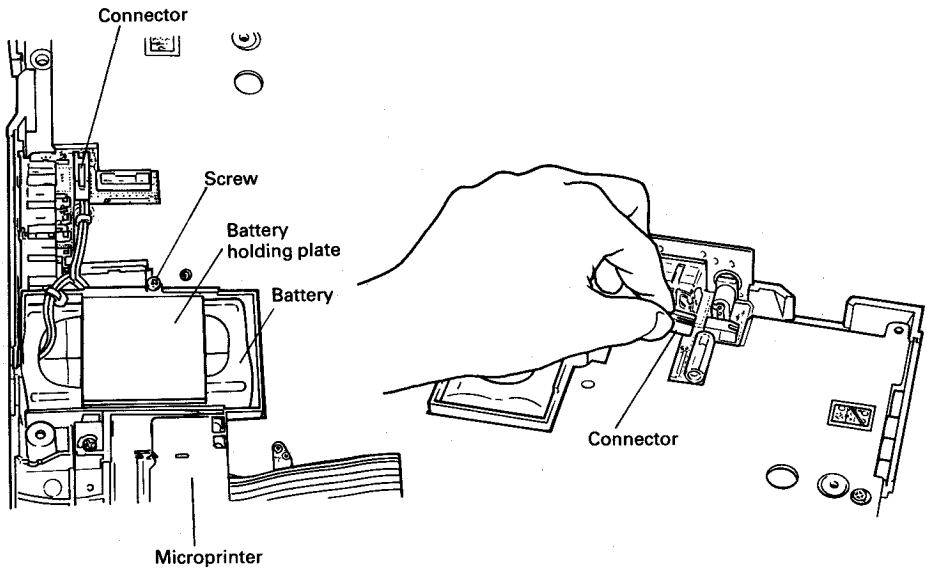


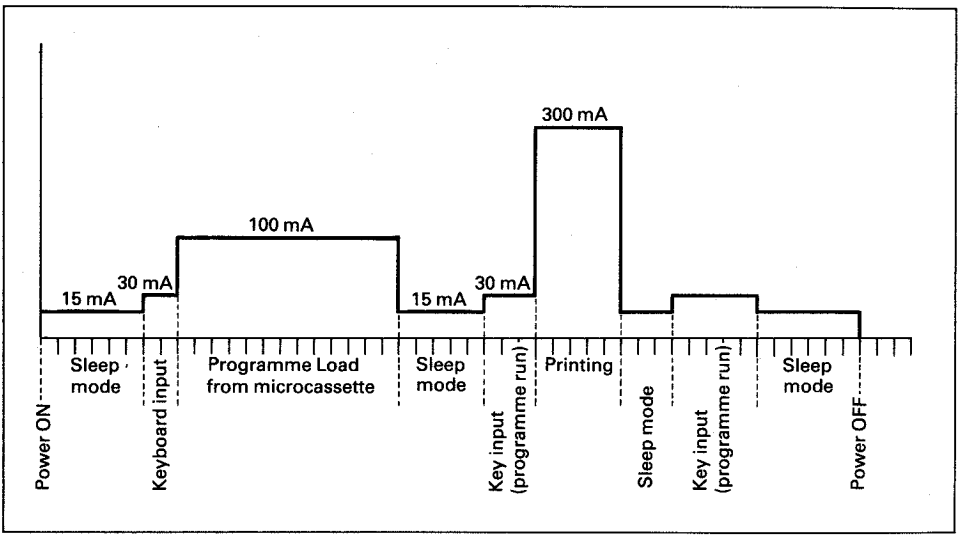
Fig. 3-1 Replacing the Battery

(5) Charging characteristics
When the AC adapter is used, the battery can be charged at the rate of approx. 125 mAH. Thus, the battery capacity of approx. 1,000 mAH can be realised by charging for 8 hours (125 mAH×8H).

(6) How to determine the charging time
(a) When the message "CHARGE BATTERY!" appears on the LCD screen, charge the battery for eight hours.
(b) Determine the required charging time by using the following formula if the batttery is to be charged before the "CHARGE BATTERY!" display appears.

$$\text{Charging time} = \frac{\text{Current consumption (mAH)}}{\text{125 (mAH)}}$$

Determine the current consumption based on the product of the operation mode of the HX-20 by its operating time. (See (5) Charging characteristics.)
[Example]



With each division on the above scale taken as 1 minute.

1. 15×6/60
2. 30×2/60
3. 100×13/60
4. 15×5/60
5. 30×3/60
6. 300×5/60
7. 15×3/60
8. 30×5/60
9. 15×6/60

Charging time $X = \frac{56.7}{125}$ (hours)

$X = 0.45$ hours

1, 4, 7, 9	$15 \times \frac{20}{60}$	= 5.0 mAH
2, 5, 8	$30 \times \frac{10}{60}$	= 5.0 mAH
3	$100 \times \frac{13}{60}$	= 21.7 mAH
6	$300 \times \frac{5}{60}$	= 25.0 mAH

Current consumption total 56.7 mAH

3.2 Charging the Built-in Battery

STEP 1

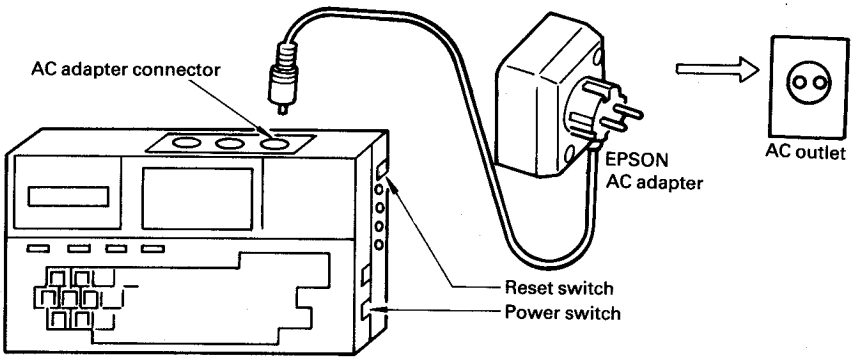
Turn the power switch OFF and check that the LCD display is extinguished. If the display is not extinguished, press the RESET switch.

STEP 2

Plug the AC Adapter (included as an accessory) into an AC outlet and insert the plug of the adapter into the AC adapter connector of the HX-20. The battery will be fully charged in about 8 hours. If you continue to charge the battery after it has reached the fully charged state, it will be overcharged and its service life will be shortened. (During charging, the battery will become slightly warm. This is normal and should not cause concern.)

CAUTIONS

- *Use the exclusive AC adapter for charging. After the battery is fully charged, unplug the adapter from the AC outlet and the adapter connector of the HX-20 and store it.*
- *If you notice an abnormal rise in the temperature of the battery, stop the charging immediately.*
- *Charge the battery in the normal operating temperature range (between 5°C and 35°C).*
- *Avoid continuous use of the HX-20 with the AC adapter connected. Continuous charging of the battery will result in overcharging. Overcharging can shorten the service life of the battery and, in some cases, can cause damage to the battery.*
- *If you leave the battery in a completely discharged state, its service life will be shortened. When you see the "**CHARGE BATTERY!**" message, stop operating the HX-20 and charge the battery as soon as possible.*



Note: To customers using the 240V AC adapter: Please purchase a commercially available plug and attach to your AC adapter.

Fig. 3.2 Connecting AC Adapter for Battery Charging

3.3 Hints on Use of AC Adapter

- Be sure to use the special EPSON AC adapter supplied as an accessory.
- If you use an adapter other than the special EPSON adapter, deterioration of the battery and the internal circuit elements may result as well as damage to the circuit components.
- Use an AC outlet of the voltage rating specified on the AC adapter.
- Do not connect the AC adapter when the battery is not in the HX-20. Excess voltage will occur in the HX-20, causing deterioration of, or even damage to, the circuit elements.
- When the adapter is not in use, unplug it from the AC outlet and the adapter connector of the HX-20 and store it safely.
- Do not connect the AC adapter to any equipment other than the HX-20 as the difference in voltage or current capacity may damage the connected equipment or the AC adapter.

3.4 Monitoring the Battery Voltage

The HX-20 constantly monitors the battery voltage from the time the power switch is turned on through its operation. When the battery discharges and its output voltage falls below the specified voltage (approx. 4.5V), the message "CHARGE BATTERY!" will be immediately displayed on the LCD screen.
This message will flash 60 times and then cause the power supply of the HX-20 to automatically turn off to protect the programmes from possible data loss or destruction.

- In this state, programme execution will stop and you cannot operate the HX-20.
  Countermeasures:
  Turn the power switch off at once and charge the battery with the exclusive AC adapter.
  If you leave the battery in an uncharged state, the programmes stored in the RAM may be lost.

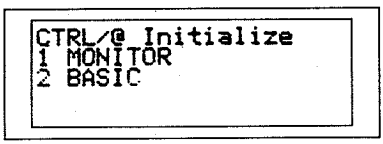
4. BASIC OPERATION OF HX-20

In this chapter, the basic operating procedures for using the HX-20 are explained.

4.1 Power Application

(1) Applying power to peripheral equipment
Be sure to check the peripheral device for proper connection before applying power to the HX-20. First, turn on the power switch of the peripheral device.

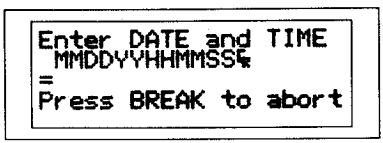
(2) Applying power to the HX-20
Next, turn on the power switch of the HX-20. You will hear the pip sounds issued by the built-in piezoelectric speaker and see the following menu information on the LCD screen.



4.2 Selecting a System Programme from the Menu

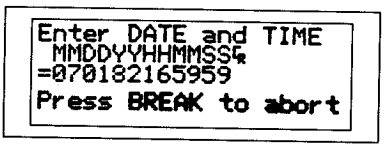
4.2.1 System initialisation

One of the features of the HX-20 is that the contents of the memory will not be lost when the power is turned OFF. Therefore, you must clear any unnecessary data still remaining in the memory. You can do this by following the instruction message "CTRL/@ Initialize" displayed at the top of the menu display. Press @ key, while holding down the CTRL key, and the following message will appear on the LCD and the HX-20 will enter a wait state for your key input.

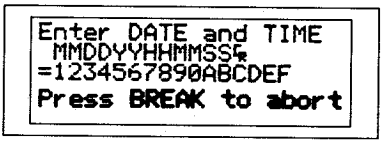


Then, you must set the current date and time by entering month, day, year, hours, minutes, and seconds from the keyboard as indicated by the message "MMDDYYHHMMSS" below the message "Enter DATE and TIME". "CR" stands for "Carriage Return", indicating that you must press the **RETURN** key.

For example, if the current date and time are July 1, 1982 and 4:59:59 P.M.,



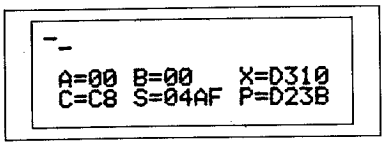
you must input the date and time as shown above, using the numeric keys from 1 to 0 at the top rows of the full keyboard. Input of the data and time information is completed when you finally press the **RETURN** key.
The HX-20 then clears the entire memory contents, and sets the necessary variables to predetermined values (i.e., default values), and returns to the menu display. (This state is called "Cold start".) The date and time you just entered are written into the internal calculator clock of the HX-20. So, you are no longer required to set the date and time again.



If you have made a mistake in data input, press the INS DEL key at the rightmost position above the top row of the full keyboard to clear all the previous data entry. You can now enter the correct data again.
The system initialisation is a very important, yet risky procedure. As mentioned earlier, if important data have been stored in the memory, special attention must be paid since the system initialisation will clear all the memory contents.
If you input "CTRL/@" by mistake, press the **BREAK** key immediately but without haste and the HX-20 will return to the initial menu display. Also, note that if you press the **RETURN** key after input of 12 or more characters, the HX-20 will be initialised. Remember, if you press the **MENU** key instead of the **BREAK** key, the HX-20 will also return to the menu display.

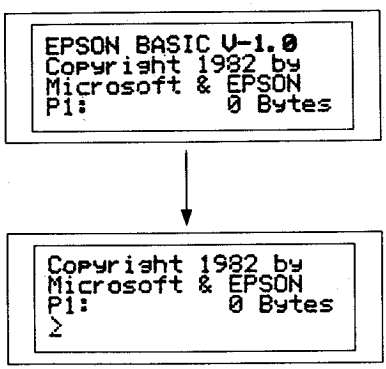
4.2.2 Branching to MONITOR

With the HX-20, you can write programmes or check the memory contents under the system monitor which controls the system. If you select "1" on the menu display, control is transferred to the system monitor. To be more specific, if you press the numeric key **1** at the leftmost position on the first row of the keyboard, the HX-20 will display the following messages and wait for command input. (For details, refer to Chapter 9, HOW TO USE THE MONITOR.)



4.2.3 Branching to BASIC

In addition to the system monitor, the HX-20 is provided with BASIC. In other words, using a programming language called "BASIC", you can write programmes and execute them. To start-up BASIC, you must select "2" from the menu display by pressing the numeric key **2** in the same manner as explained in the previous section. The menu will then disappear from the LCD screen and change to the following messages. The mark "≥" appearing at the lower left-hand corner of the LCD is called a "prompt sign" and indicates that the HX-20 is in a wait state for your input of a BASIC command. (This state is referred to as BASIC being returned to "command level". For details, refer to the BASIC Reference Manual.)



5. KEYBOARD

In order to make full use of the HX-20's compact keyboard, data entry from the keyboard can be made as follows.

5.1 Selecting Key Input Mode

(1) Uppercase mode
When the power switch is turned ON, the HX-20 keyboard is always in this mode. The characters which you can input in this mode are uppercase letters, numbers and special symbols. To enter lowercase letters in this mode, the desired letter key must be input while holding down the SHIFT key.

(2) Numeric key mode
This mode is selected by pressing the NUM key. Since only numeric keys are operable in this mode, only numeric data entry can be performed. Numeric keys 0 to 6 arranged like a numeric pad on the center right of keyboard, as well as numeric keys 0 to 9 at the top of the keyboard, are available. The symbols +, −, *, /, ., , and ? can also be input in this mode. (For details, refer to the key assignments for each mode in Section 5.2.) To release this mode, depress the NUM key a second time.

(3) Input of graphic characters
Graphic characters can be input while the GRPH key is being pressed when in uppercase mode or in lowercase mode. (For details, refer to the key assignments for each mode in Section 5.2.) By releasing this key, the HX-20 returns to uppercase mode or lowercase mode.

(4) Lowercase mode
This mode is selected by pressing the CAPS LOCK key located at the bottom left of the keyboard next to the space bar. In this mode, characters are input as lowercase letters, and symbols are input just the same as in uppercase mode. To return to uppercase mode, press the CAPS LOCK key a second time.

(5) Examples of key input
The following are specific examples of how to input characters and symbols from the keyboard.

Example 1) When 2 key is used.

Character input	Procedure
2	Press the 2 key alone.
"	Press the 2 key while holding down the SHIFT key.

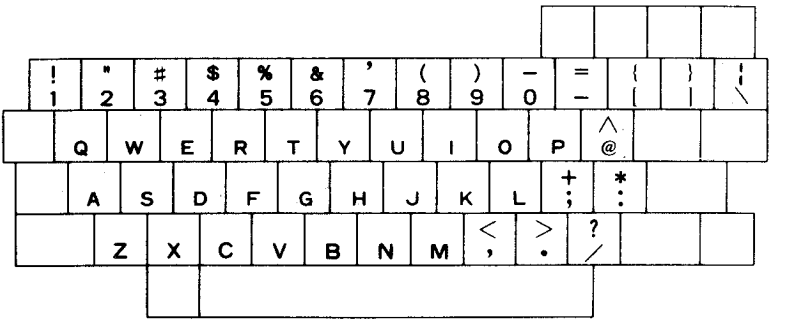
Example 2) When **M** key is used

Character input	Procedure
M	Press the **M** key alone.
m	Press the **M** key while holding down the **SHIFT** key.
♯	Press the **M** key while holding down the **GRPH** key.
0	Press the **NUM** key and then the **M** key.

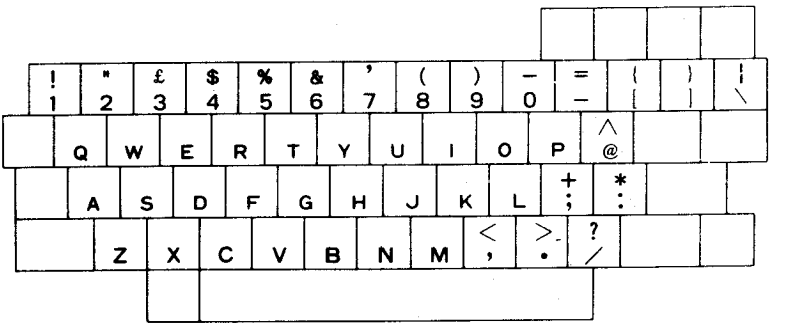
5.2 Key Assignments

(1) Uppercase mode and Lowercase mode

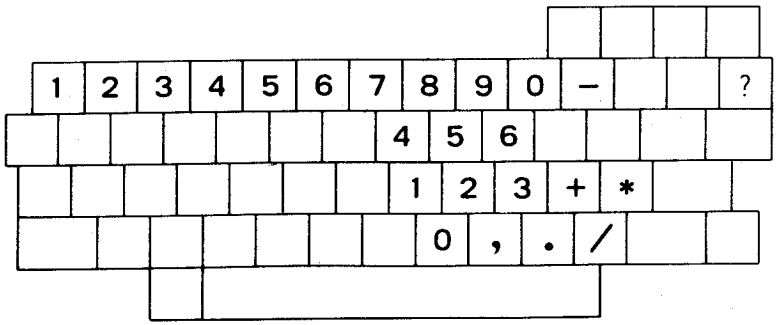
USASCII



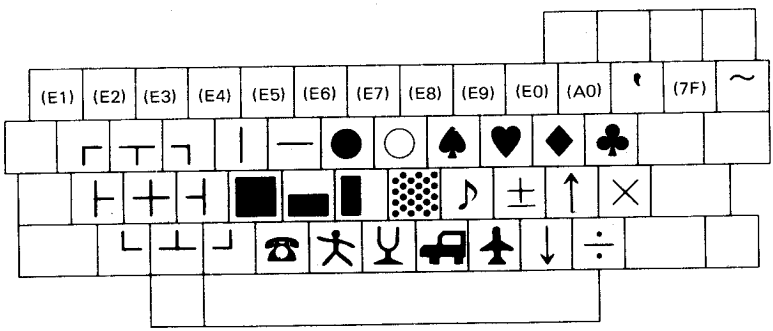
England



(2) Numeric key mode



(3) Graphic characters



NOTE:
E0 through E9, A0 and 7F shown in parentheses in the above figure are character codes in hexadecimal numbers and can be input by pressing the corresponding keys while holding down the **GRPH** *key. The character codes for ‘ and ~ are 60 and 7E, respectively. (See Chapter 8, "Definition of Graphic Patterns".)*

5.3 Special Keys

5.3.1 Input from special keys

When BASIC is started up, the HX-20 accepts inputs from the following keys and the space bar in any mode. (Refer to the BASIC Reference Manual.)

[ ], [ ], [HOME CLR], [SC : RN], [INS DEL], [TAB], [RETURN], [PF 1] – [PF 5], [MENU], [BREAK], [PAUSE]

5.3.2 Special key codes

Each function key code consists of 2 bytes as shown below.

F1 : FE, F1
F2 : FE, F2
F3 : FE, F3
↓
F10: FE, FA

[BREAK] and [PAUSE] do not have any character code.
The character code for [MENU] is FC.

5.4 Key Input

5.4.1 Auto-repeat function

All the keys of the HX-20 except the following have an auto-repeat function which is convenient for continuous input.

[MENU], [BREAK], [PAUSE], [PF1] – [PF5]
[SHIFT], [CTRL], [CAPS LOCK], [GRPH], [NUM]

5.4.2 Key input buffer

The HX-20 is equipped with an 8-byte buffer (for 8 characters) to facilitate your key input operations.

6. USING CASSETTE TAPES

6.1 External Cassette

The HX-20 is provided as standard equipment with an interface for an external audio cassette to be used as an auxiliary memory. Therefore, by using the optional interface cable (cable set #702) for audio cassette, you can write and read programmes and data to and from the external audio cassette. This chapter explains these procedures, using BASIC. (For detailed information about the BASIC Commands and Statements, refer to the BASIC Reference Manual.)

6.1.1 Interfacing with the HX-20

Your HX-20 must be set in the following conditions when you want to save the programmes stored in the memory of the HX-20 to the external audio cassette or to load programmes from the audio cassette into the memory of the HX-20.

(1) MIC (microphone) jack. This is an output line from the HX-20. The MIC jack must be connected to the MIC (input) terminal of the external audio cassette.
(2) EAR (earphone) jack. This is an input line to the HX-20. The EAR jack must be connected to the EAR (output) terminal of the external audio cassette.
(3) REM (remote) jack. This is a line to remotely control the motor of the external audio cassette. The REM jack should be connected to the REM terminal of the cassette tape recorder, if applicable.

6.2 Saving, Checking and Loading of Programmes

6.2.1 Confirmation before Programme Save or Load operation

You must check if the external audio cassette connects with the HX-20 in the following conditions before you start to save the programmes stored in the memory of the HX-20 to an audio cassette or to load programmes from the audio cassette into the memory of the HX-20.

(1) BASIC is under execution.
(2) BASIC is at command level.
(3) Programmes to be saved exist in the memory, or the programme area into which a programme is to be loaded has been logged in.
(4) Some tape recorders are not equipped with FF function. In this case, either disconnect the REM terminal and operate the recorder manually or use the BASIC command MOTOR ON/OFF to operate the recorder.

6.2.2 Programme Save operation

Transferring a programme from the memory of the HX-20 to the external memory is referred to as "Programme Save".

Operation at HX-20	Operation at External Audio Cassette
STEP 1 Place the HX-20 in the conditions described in paragraph 6.2.1.	**STEP 2** Check that the interface cable is properly connected between the HX-20 and the audio cassette tape recorder and insert a cassette tape in the audio cassette recorder. Rewind the tape all the way to its beginning (BOT position). **STEP 3** Reset the counter of the audio cassette tape recorder to 0. **STEP 4** Push the PLAYBACK or FF button of the tape recorder and advance the tape slightly forward. Make a written record of the tape counter reading on the index card contained in the cassette. (Since most audio cassette tapes cannot be recorded from the very beginning, you must wind the tape forward past those sections.) **STEP 5** When a tape recorder is connected to the HX-20 via the REM terminal, it cannot be operated simply by pushing the PLAYBACK button. This button should remain in the locked position for the duration of the Save or Load operation. **STEP 6** Set the recording level to a desired value. It will vary from one tape recorder to another. However, as a rule, a recording level slightly higher than normal is recommended.

STEP 7

If the tape recorder is connected to the HX-20 via the REM terminal, set to record. If the REM terminal is not connected, execute **STEP 8** before operating PLAYBACK and RECORD buttons.

STEP 8

Name the programme which you wish to save. In this example, the name "PROG" is used.

```
SAVE"CAS1:PROG"_
```

Input the programme statement as shown above and press **RETURN** key.

STEP 9

Then, check if the tape recorder begins recording (i.e., Programme Save operation).

STEP 10

Confirm that the prompt sign ">" is displayed on the LCD, indicating that the HX-20 has returned to command level. Programme Save operation is now complete.

```
SAVE"CAS1:PROG"
>
```

STEP 11

When the REM terminal is connected for remote motor control, the tape will stop automatically upon completion of **STEP 10**, but will not when the REM terminal is not connected.
In either case, push the STOP button of the tape recorder.

STEP 12

Check the tape counter value when the tape has stopped and enter the reading on the index card, together with the programme name. This is the complete procedure for Programme Save.

6.2.3 Programme Save Check operation

STEP 1

Rewind the tape to the tape counter reading at which Programme Save began.

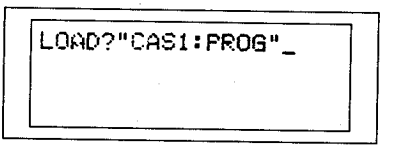
STEP 2

Adjust the playback level. (Playback level differs depending upon the tape recorder.)

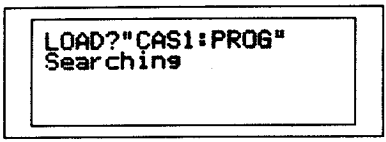
STEP 3

Push the PLAYBACK button. If your tape recorder has no REM terminal, execute **STEP 4** before pushing the PLAYBACK button.

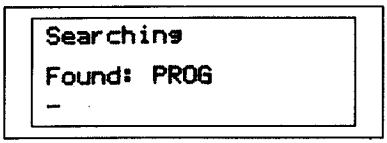
STEP 4



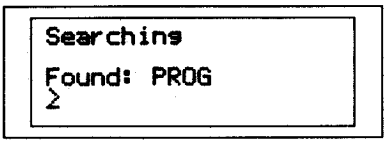
Input the programme statement as shown above and press the **RETURN** key. The message "Searching" appears on the LCD.



When the target programme is found, the following message will be displayed.



When the programme check is completed, the prompt sign ">" will be displayed and BASIC will return to command level.



STEP 5

When the REM terminal is connected for remote motor control, the tape will stop upon completion of **STEP 4**, but will not when the REM terminal is not connected. In either case, push the STOP button of the tape recorder.

NOTE:
*The tape counter value at this time will be smaller than the tape counter value in **STEP 12** of the Save operation. This is because at the end of the file (when ">" is displayed) there are two marks and a tape feed of approx. 5 sec. At this time, the tape has stopped after the first end mark.*
*When performing the next Save, wind the tape forward to the tape counter value in **STEP 12**.*

This completes the procedure for checking that the saved programme has been correctly written into the cassette tape.

- If the saved programme name cannot be found or an I/O error occurs, return to **STEP 1** and repeat the entire procedure. In doing so, pay special attention to the adjustment of playback level in **STEP 2**.

- If the programme check still fails after several attempts to find the saved programme, it means that the programme has not been correctly saved to the cassette tape. If this happens, perform Programme Save a second time, carefully re-adjusting the recording level. It is recommended that the same external audio cassette recorder be used for both recording and playback and that a written record be kept of the recording and playback level settings. The procedure mentioned does not compare the programme contents on the tape with those in the memory of the HX-20. It only checks whether or not the programme written is available.

6.2.4 Programme Load

Transferring programmes from an external storage to the memory of the HX-20 is referred to as "Programme Load".

STEP 1

Place the HX-20 in the conditions described in paragraph 6.2.1.

(Example 1)

Turn on the power switch of the HX-20 and branch to BASIC. Login the programme area into which you wish to load a programme from the cassette tape.

(Example 2)

If a programme is being executed in the target programme area, press the BREAK key and return BASIC to command level.
NOTE: *If a programme already named exists in the target programme area into which the programme on the tape is to be loaded, that programme area is protected and execution of commands such as LOAD, NEW, etc., will become impossible. To cancel this protection input TITLE "" and press the* RETURN *key.*

STEP 2

Wind the cassettte tape to the tape counter value at which the programme begins. Adjust the playback level as you did in the Programme Check operation.

STEP 3

If the REM terminal is used, press the PLAYBACK button of the tape recorder. If REM terminal is not used, push the PLAYBACK button after completion of **STEP 4**.

STEP 4

To load a programme with the name "PROG", input the following programme statement and press the **RETURN** key.

```
LOAD?"CAS1:PROG"_
```

STEP 5

Check that the tape recorder has started playback (Programme Load starts).

STEP 6

Simultaneously with the start of playback in STEP 5, the message "Searching" appears on the LCD screen.

```
LOAD?"CAS1:PROG"
Searching
```

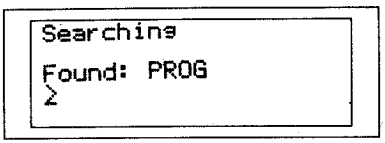
When the target programme is found, the following message will be displayed.

```
Searching

Found: PROG
-
```

STEP 7

When the Programme Load operation has been completed, the prompt sign is displayed and the HX-20 returns to command level.



STEP 8

If the REM terminal is connected for remote motor control, the tape will stop automatically upon completion of **STEP 6**, but if the REM terminal is not connected, the tape will not stop. In either case, push the STOP button of the tape recorder.

NOTE:
Before performing the next Save operation, wind the cassette tape slightly forward. (This is because the data end mark remains on the cassette tape even after the Programme Load operation has been completed.)

This completes the execution of the Programme Load operation.

- If the programme name cannot be found or an I/O error occurs, return to **STEP 1** and repeat the entire procedure, carefully re-adjusting the playback level as described in **STEP 2**.

- If the Programme Load still fails after several attempts to find the programme name, refer to Section 6.5, If There Are Problems Reading a Cassette, and retry from **STEP 1**.

6.3 The Microcassette Drive

Your HX-20 can also use a microcassette drive available as an option.
The microcassette drive operations such as REW (Rewind), FF (Fast Forward) as well as Programme Save, Load and Check can all be controlled under BASIC.
This chapter explains the basic operations of the microcassette.

6.3.1 Manual mode operation

The procedure for manual mode operation of the microcassette is described below.

STEP 1

Insert a microcassette as follows. Open the cassette holder by operating the eject lever of the microcassette drive.
Place the microcassette tape in the drive with the open side of the tape facing you and close the holder.

STEP 2

Press the **PF1** key while holding down the **CTRL** key to cause the tape counter value to be displayed in the upper right-hand corner of the LCD screen. The tape counter value displayed will be in the range of −32767 to 32767.

STEP 3

When the microcassette drive enters manual mode, its operations can be controlled by the following keys.

(1) **PF1** : Fast forward (FF)
Fast forwards the tape.
(2) **PF2** : Slow forward
Advances the tape at about half the speed of the fast forward.
(3) **PF3** : STOP
Stops the tape rewind, fast forward or slow forward operation.
(4) **PF4** : Rewind
Rewinds the tape at the same speed as fast forward.
(5) **PF5** : End of manual mode operation
Causes the cassette to escape from manual mode and return to the original state.
(6) PF6 : Reset
The tape counter will be reset to 00000 when PF6 is input by pressing the **PF1** key while holding down the **SHIFT** key.

6.3.2 Cautions for manual mode operation

(1) While the microcassette is in manual mode, the built-in microprinter will not operate.
(2) Do not employ manual mode operation while write or read operation into the microcassette tape is being performed under software control (i.e., when CAS0: is OPENed at BASIC start-up).
(3) Manual operations should be performed when BASIC or MONITOR are at command level.

6.3.3 Saving, checking, and loading of programmes

Basically, these operations are the same as Programme Save, Check, and Load operations of the external audio cassette tape. Note, however, the following differences. (For details of BASIC commands and statements, refer to the BASIC Reference Manual.)

(1) Programme Save operation

Set the tape in the microcassette drive.
When you do this, BASIC must have been started up and be at command level.

STEP 1

LOGIN the programme area which contains the programme to be saved.

STEP 2

Input a WIND command and press the **RETURN** key, and the tape will be rewound and the tape counter value will be reset to 00000.

STEP 3

To name the programme, input following programme statement and press the **RETURN** key. The tape begins to move, indicating that Save has started. At this time, the LED indicator on the microcassette drive lights.

NOTE:
The LED may go out before the prompt sign (">") is displayed. However, this does not mean that Programme Save has been completed.

```
SAVE"CAS0:ABC"_
```

The tape will run for a while and then the prompt sign "≥" will appear on the LCD screen.

```
SAVE"CAS0:ABC"
≥
```

This means that the Programme Save operation has been completed. Check the tape counter value and write down the programme name and the tape counter value on the index card contained in the cassette. (e.g., 0–123 "ABC")

- You can find the tape counter value by either of the following 2 methods.

(a) Using BASIC

Input the programme statement "PRINT TAPCNT" and press the **RETURN** key. The counter value will then be displayed.

```
SAVE"CAS0:ABC"
PRINT TAPCNT_
```

(b) Using manual mode operation

Press the **PF1** key while holding down the **CTRL** key. The counter value will be displayed in the upper right-hand corner of the LCD screen.

(2) Programme Check operation

STEP 1

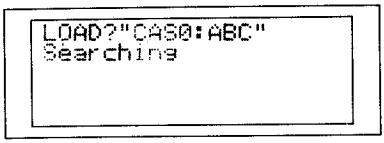
Rewind the tape to the tape counter value at which Save began.

- Input a WIND 0 command and press the **RETURN** key.
- Rewind the tape by manual mode operation.

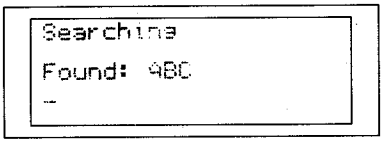
```
LOAD?"CAS0:ABC"_
```

STEP 2

Input the following programme statement and press the **RETURN** key.



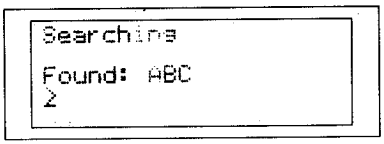
The message "Searching" will appear on the LCD screen and programme search begins.



When the programme is found, the Programme Check operation starts.

STEP 3

The prompt sign will be displayed on the LCD screen and the tape will stop. The Programme Check operation is now completed.



STEP 4

Advance the tape up to the tape counter value at which the Programme Save was terminated. For instance, if Programme Save was completed at tape counter value 123, input a WIND123 command and press the **RETURN** key. This is done to clearly distinguish the programme previously saved from the programme to be saved next.

(3) Programme Load operation

STEP 1

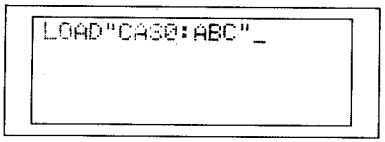
Input a WIND command and press the **RETURN** key.

STEP 2

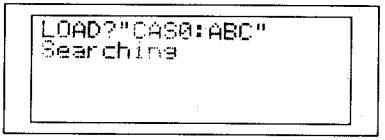
Wind the tape forward to the tape counter value at which the programme to be loaded begins. For example, if the target programme on the tape begins at tape counter value 123, input a WIND123 command and press the **RETURN** key.

STEP 3

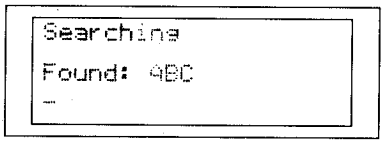
When the prompt sign ">" is displayed on the LCD screen, input the following programme statement and press the **RETURN** key.



Then, programme search begins.

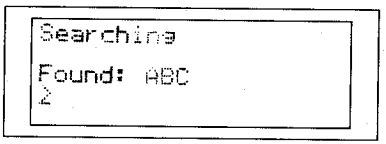


When the programme is found, the following message will be displayed.



STEP 4

The prompt sign ">" is then displayed and the microcassette drive stops, indicating that the Programme Load operation has been completed.



If an I/O error occurs while loading the programme or the programme name cannot be found, return to STEP 2 and repeat the procedure. If the programme loading is still not performed, refer to Section 6.5, If There Are Problems Reading a Cassette.

NOTE:

Before replacing a microcassette tape, always input a WIND command and press the **RETURN** *key to rewind the tape. By so doing, you need not execute a WIND command at the beginning of subsequent Save, Check, or Load operation.*

There may be some error in the tape counter value due to tape elasticity and digital conversion. It is therefore a good practice to leave gaps between files and to start reading before the file start position.

6.4 Write and Read Format for Data

Files stored in a tape are divided into units of a certain fixed length. These units are called blocks and there are three different types of blocks. The 80-byte block at the top of the file is called the header and contains the filename, date of file creation and other data pertinent to the file. Next are the data blocks, each of which is 256 bytes long. As the data is divided into units of 256 bytes, the number of data blocks is determined by the number of bytes of data. Finally, there is the 80-byte EOF (End of file) block which signifies that the file has been read to its end. In order to improve the reliability of the data and file-related information written into the file, each block is written twice.
The speed of data write by BASIC commands SAVE and SAVEM is approx. 64 char/sec. The header block and EOF block each require approx. 8 seconds to write.

6.5 If There Are Problems Reading a Cassette

If the data file cannot be correctly read from the cassette, use the following procedures to obtain a correct data read.

(1) When using the built-in microcassette to read a file written by the microcassette drive.

For data that was originally written into the file using the built-in microcassette, change the data of bits 2 and 3 of address 7E(hex) to 0. (Refer to 9.5 (1) S command for details concerning how to change data.)

1) Call the Monitor.
2) Use the S command to display and change the contents of address 7E (hex). Change the LSD (least significant, or rightmost, digit) of the data displayed according to the following table.

If the LSD is,	change it to	If the LSD is,	change it to
4	0	5	1
6	2	7	3
8	0	9	1
A	2	B	3
C	0	D	1
E	2	F	3

NOTE:
There is no need to change the LSD if it is already 0, 1, 2 or 3.

(2) When using the built-in microcassette to read data written by the external cassette.

For data that was originally written by an external audio cassette, change bits 2 and 3 of the data stored in address 7E(hex) to 0. (Use the same procedure as described above for the microcassette.)
If, even after you have executed the above procedure, you are still unable to obtain a correct read from the cassette, change bit 2 to 0 and bit 3 to 1, following the procedure described below.

1) Call the Monitor command S to display and change the contents of address 7E(hex). (As the procedure is essentially the same as for the microcassette, refer to the description above.)
2) Change the LSD of the data displayed by the S command according to the following table.

If the LSD is,	change it to	If the LSD is,	change it to
0	8	1	9
2	A	3	B
4	8	5	9
6	A	7	B
C	8	D	9
E	A	F	B

NOTE:
There is no need to change the LSD if it is already 8, 9, A or B.

If neither of the above procedures produces successful results, change the data of both bits 2 and 3 to 1.

1) Call the Monitor S command to change the contents of address 7E(hex).

If the LSD is,	change it to	If the LSD is,	change it to
0	C	1	D
2	E	3	F
4	C	5	D
6	E	7	F
8	C	9	D
A	E	B	F

NOTE:
There is no need to change the LSD if it is already C, D, E or F.

(3) Read data using an external audio cassette

If you cannot obtain a correct data read from a cassette (data written using either the built-in microcassette or an external cassette) using an external cassette unit, change bits 0 and 1 of the contents of address 7E(hex) to 0.

1) Display and change the contents of 7E(hex) using the monitor S command. (Refer to the procedure for the microcassete or to 9.5 (1), S command.)
2) Change the LSD of the data displayed by the S command according to the following table.

If the LSD is,	change it to	If the LSD is,	change it to
1	0	2	0
3	0	5	4
6	4	7	4
9	8	A	8
B	8	D	C
E	C	F	C

NOTE:
There is no need to change the LSD if it is already 0, 4, 8 or C.

If, even after you have performed the above changes, you still cannot obtain correct data read, change bit 0 to 0 and bit 1 of address 7E(hex) to 1.

1) Call the Monitor command S to confirm and change the contents of 7E(hex). (Refer to the example for the microcassette or to 9.5 (1), S command.)
2) Change the LSD of the data displayed by the S command according to the following table.

If the LSD is,	change it to	If the LSD is,	change it to
0	2	1	2
3	2	4	6
5	6	7	6
8	A	9	A
B	A	C	E
D	E	F	E

NOTE:
There is no need to change the LSD if it is already 2, 6, A or E.

If, even after you have performed the above changes, you still cannot obtain satisfactory data read, change both bits 1 and 0 of the contents of address 7E(hex) to 1.

1) Call the monitor command S to confirm and change the contents of 7E(hex).
2) Change the LSD of the data displayed by the S command according to the following table.

If the LSD is,	change it to	If the LSD is,	change it to
0	3	1	3
2	3	4	7
5	7	6	7
8	B	9	B
A	B	C	F
D	F	E	F

NOTE:
There is no need to change the LSD if it is already 3, 7, B or F.

6.6 Interchangeability of the Built-in Microcassette with an External Cassette

Since the bit rate and data format of the microcassette and an external cassette are the same, data can be read irrespective of the device on which it was written. However, depending on the type of tape used and the configuration of the microcassette, there may be cases when a programme cannot be read.

7. HOW TO USE THE MICROPRINTER

Your HX-20 is equipped with two switches and two keys which are related to the manual mode operation of the built-in microprinter: PRINTER ON/OFF, PAPER FEED and CTRL + PF2.

(1) PRINTER ON/OFF switch
This switch controls the output to the built-in microprinter. Data will be output to the microprinter when the switch is set to the "ON" position, and the microprinter will not operate when the switch is set to the "OFF" position. (When this switch is in the OFF position, data will not be output to the microprinter even if a statement such as LPRINT "ABC" RETURN is executed in BASIC.)

(2) PAPER FEED switch
Press this switch to feed the paper. Paper feed will continue while this switch is being pressed. When the PRINTER ON/OFF switch is in the "OFF" position, the paper will not feed into the printer even if the PAPER FEED switch is pressed.

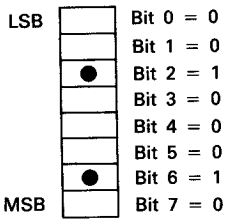
(3) CTRL and PF2 keys
Press the PF2 key while holding down the CTRL key to output the entire contents of the LCD screen on the microprinter. This screen copy function may not be executed when either the external audio cassette or the microcassette is being operated. When the Printer ON/OFF switch is in the "OFF" position, the contents of the LCD screen cannot be copied on the printer.

NOTE:

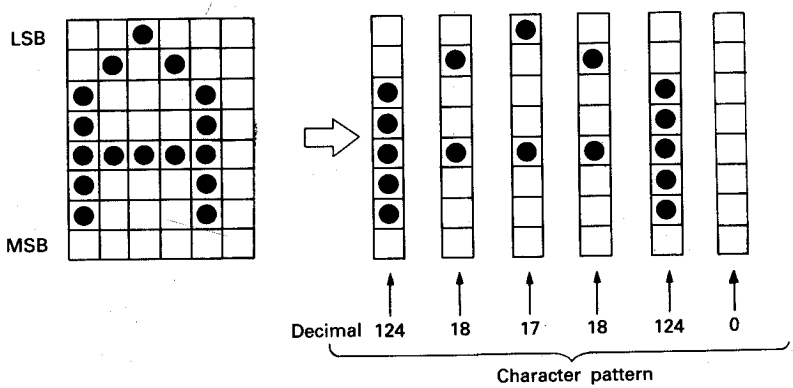
If an operation to output data on the built-in microprinter using a BASIC programme is executed while data is being input to the RS-232C port, data input to the RS-232C port will be interrupted during the printing operation causing the data in the RS-232C port to be lost.

8. DEFINITION OF GRAPHIC PATTERNS

Character patterns can be defined freely by the user into the codes 224 through 255 (dec). In the following example, ● denotes a bit with logic 1 and a blank denotes a bit with logic 0. Only bits with logic 1 will be printed as dots. The LSB of the data corresponds to the uppermost dot position.



This data can be expressed as binary 01000100, 44(hex) or 68(dec).
In Appendix C, the lower four bits are listed in the column at the side and the upper four bits in the row at the top of the Character Code Table. For example, the character pattern for the letter "A" is formed in the following manner.



The 6-byte data shown above are sent in the following order: 124, 18, 17, 18, 124 and 0 (decimal).
User-defined character patterns are stored in the memory starting from address 11E(hex). Data stored in code 224 are sent first and data stored in code 255, last.

[Example]

Address		(Decimal)
011E	←	16
011F	←	0
1000	←	124
1001	←	18
1002	←	17
1003	←	18
1004	←	124
1005	←	0
1006	←	127
1007	←	73
1008	←	73
1009	←	73
100A	←	54
100B	←	0

Assume that two character patterns (two 6-byte data) are stored in the addresses shown on the left. When you press numeric key **0** while holding down the **GRPH** key, letter "A" is displayed. Press numeric key **1** while holding down the **GRPH** key and letter "B" will be displayed.

(Pay attention to the bottom address of memory set by a MEMSET command in BASIC.)

Programme example in BASIC:

```
10 REM Defined Character
20 MEMSET &H1010
30 POKE &H011E,16
40 POKE &H011F,0
50 POKE &H1000,124
60 POKE &H1001,18
70 POKE &H1002,17
80 POKE &H1003,18
90 POKE &H1004,124
100 POKE &H1005,0
110 POKE &H1006,127
120 POKE &H1007,73
130 POKE &H1008,73
140 POKE &H1009,73
150 POKE &H100A,54
160 POKE &H100B,0
170 END

RUN_
```

Press **GRPH** and **0** key. A_

Press **GRPH** and **1** key. B_

To call user-defined characters using the keyboard, the following modes are used.

(1) Control key mode

The following keys corresponding to 00 through 1F and E1 through FF (except FC and FE) can be input while holding down the CTRL key. For example, for E1, press the 1 key while holding down the CTRL and SHIFT keys.

00 (00)	@	10 (16)	P
01 (01)	A	11 (17)	Q
02 (02)	B	12 (18)	R
03 (03)	C	13 (19)	S
04 (04)	D	14 (20)	T
05 (05)	E	15 (21)	U
06 (06)	F	16 (22)	V
07 (07)	G	17 (23)	W
08 (08)	H	18 (24)	X
09 (09)	I	19 (25)	Y
0A (10)	J	1A (26)	Z
0B (11)	K	1B (27)	[
0C (12)	L	1C (28)	¥
0D (13)	M	1D (29)	]
0E (14)	N	1E (30)	^
0F (15)	O	1F (31)	_

E0 (224)		F0 (240)	0
E1 (225)	!	F1 (241)	1
E2 (226)	"	F2 (242)	2
E3 (227)	#[£]	F3 (243)	3
E4 (228)	$	F4 (244)	4
E5 (229)	%	F5 (245)	5
E6 (230)	&	F6 (246)	6
E7 (231)	'	F7 (247)	7
E8 (232)	(	F8 (248)	8
E9 (233)	)	F9 (249)	9
EA (234)	*	FA (250)	:
EB (235)	+	FB (251)	;
EC (236)	,	FC (252)	
ED (237)	-	FD (253)	=
EE (238)	.	FE (254)	
EF (239)	/	FF (255)	?

NOTE:
Numbers in parentheses are decimal codes and the character in brackets is available on the English Keyboard.

(2) Graphic mode

The numeric keys 0 through 9 while holding down the GRPH key correspond to E0 through E9.

E0 (224)	0
E1 (225)	1
E2 (226)	2
E3 (227)	3
E4 (228)	4
E5 (229)	5
E6 (230)	6
E7 (231)	7
E8 (232)	8
E9 (233)	9

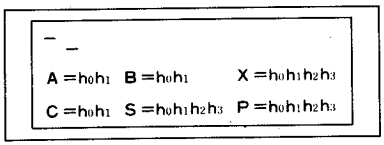
9. HOW TO USE THE MONITOR

9.1 Running the Monitor

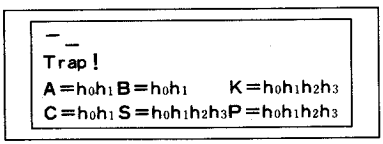
You can run the Monitor in the following three cases.
(1) When you select the monitor from the menu display.
(2) When a MON command is executed in BASIC. (MON RETURN.)
(3) When a trap interrupt is generated due to programme overrun.

9.2 Monitor Display

The display of data by the monitor is always on the physical screen. During the data display by the monitor, the virtual screen data used by BASIC is retained. When the HX-20 enters Monitor mode under condition (1) or (2) described in Section 9.1 above, the monitor display is as follows.



A, B, X, C, S, and P show the contents of the accumulator A, accumulator B, Index register, condition code register, stack pointer and programme counter, respectively. h_0h_1 represents a value in two-digit hex numbers and $h_0h_1h_2h_3$, a value in four-digit hex numbers. The "–" sign at the top line on the screen is a prompt sign, indicating that you can enter a command from the position of the cursor.
When the HX-20 enters Monitor mode under condition (3) described in Section 9.1 above, the message "Trap!" will appear on the second line of the screen as shown below.



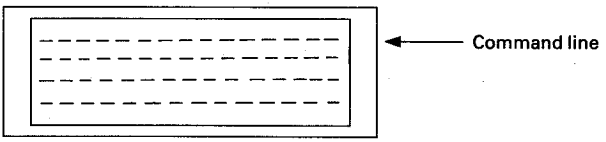
9.3 Types of Commands

In the Monitor, there are 10 types of commands.

(1)	**S**	(Set)	: Displays and changes the contents of the memory.
(2)	**D**	(Dump)	: Displays the contents of the memory.
(3)	**G**	(Go)	: Executes a programme.
(4)	**X**	(Examine)	: Displays and changes the content of each register.
(5)	**R**	(Read)	: Loads a programme or data into the memory from an external storage.
(6)	**W**	(Write)	: Saves the contents of the memory to an external storage.
(7)	**V**	(Verify)	: Verifies the data output to an external storage.
(8)	**A**	(Address)	: Specifies the range of the memory space when loading from an external storage or saving data to an external storage.
(9)	**K**	(Key)	: Specifies the data for automatic key input when the power switch is turned on.
(10)	**B**	(Back)	: Returns control to the procedure by which the monitor was called.

9.4 Command Input

Monitor commands can be input at any column between the 2nd and the 20th column following the prompt sign (–) at the leftmost end of the first line. The first line where the prompt sign exists is called a "command line". The first character of the command line is significant as a command and each command may be followed by one or more arguments.



All the codes in the character code table except DEL code (&H08) are acceptable as key inputs at the command line. (When the INS DEL key is pressed, it is accepted as the INS DEL key. All other character codes are accepted as codes. However, there are some character codes which are not displayed. The DEL code moves the display back one character space. The space key is not ignored but is taken to indicate a space.)

9.5 Description of Each Monitor Command

(1) **S** (Set) command
This command is used to display and change the memory contents.

$-Sa_{16}$ RETURN (a_{16} = address in hex numbers of 4 or less digits)

Following this command, you must enter the address of the memory containing the data to be changed in hexadecimal numbers of 4 or less digits. After you press the RETURN key, the current contents of memory are displayed and the cursor is positioned next to the memory contents being displayed.
To change the memory contents, you must input the new data in hex numbers and then press the RETURN key. The contents of memory will then be rewritten as specified, and the memory contents of the next address will be displayed for your rewriting if required. In this manner, you can change the memory contents continuously.

There are two methods to cancel the S command. One is to enter any character exclusive of hexadecimal numbers, comma (,) and space. In this method, use of slash (/) or full stop (.) is preferred. The other method is to input a new command in the position where the S command is displayed by moving the cursor back one position to the left with the INS DEL key.

[Example]
In this example, the contents of addresses 1000 (hex) through 1006 (hex) will be changed as follows.

Address	Contents before change	Contents after change
1000	00	02
1001	02	54
1002	3A	3A
1003	57	57
1004	84	00
1005	95	81
1006	23	

Input and display of data will be as follows. (Command line)

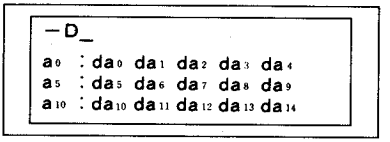
Input		Display
-S1000	RETURN	-S1000 00 _
	02 RETURN	-S1001 02 _
	54 RETURN	-S1002 3A _
	RETURN	-S1003 57 _
	RETURN	-S1004 84 _
	00 RETURN	-S1005 95 _
	81 RETURN	-S1006 23 _
	/ RETURN	-_

(2) **D** (Dump) command

This command is used to display the contents of the memory.

$-Da_{16}$ **RETURN** (a_{16} = address in hex numbers of 4 or less digits)

Following this command, you must enter the memory address containing the data to be displayed in hex numbers of 4 or less digits. After you press the **RETURN** key, 15 bytes of data starting from the specified address will be displayed in the following format.



a_0 indicates the specified address, which is displayed as a 4-digit hex number. Da_0 indicates the content of the specified number, displayed as a 2-digit hex number. If the address is not specified with the D command, the previously specified address +15(dec) will be assumed. Also, after the execution of the D command, "D" will remain on the screen followed by the cursor. Therefore, to display the content of the next address, press only the **RETURN** key.

NOTE:

Addresses 0000(hex) through 004D(hex) are for I/O ports. If you attempt to read/write any of these ports, an overrun may occur in the system. Therefore, if you specify any of these addresses, the message "Protected" will be displayed to disable the memory read/write operation.

(3) **G** (Go) command

This command sets the programme counter to a specified address value for programme execution from the address specified by the programme counter.

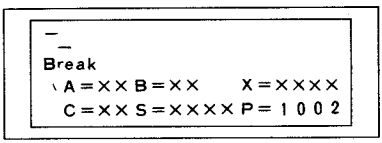
$-Ga_{16},b_{16}$ **RETURN** (a_{16},b_{16} = addresses in hex numbers of 4 or less digits.)

a_{16} indicates the execution starting address and b_{16} indicates the breakpoint address. A breakpoint refers to the point from which the HX-20 returns to the monitor mode agair after the execution of a programme has started. The HX-20 will return to the monitor mode before the address specified as a breakpoint is executed.

[Example]
With the contents of addresses 1000(hex) through 1003(hex) as shown below.

1000	01	("01" indicates NOP which is a machine
1001	01	language command instructing the HX-20 to
1002	01	do nothing but to proceed to the next
1003	01	instruction in sequence.)

If you input G1000,1002 and press the **RETURN** key, the following will be displayed.



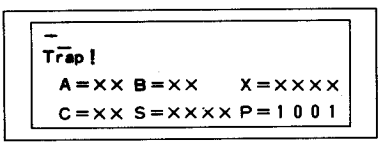
XX and XXXX are the predetermined values before the execution of the G command and P=1002 indicates that the next address to be executed is 1002(hex).

This is because the programme execution was started from address 1000(hex), continued until just before the execution of address 1002(hex) and the HX-20 entered monitor mode again.

- On Trap

The HX-20 will enter the monitor mode when a command which is not defined for the 6301 CPU is executed. Should this happen, the monitor will display the message "Trap!" on the 2nd line, and the values of the respective registers on the 3rd and the 4th lines.

[Example]
In the preceding example of the G command, if you execute G1000 **RETURN** by changing the content of address 1001(hex) from "01" (NOP) to "00" (which is not defined as a command), the following message is displayed, indicating that a trap interrupt is generated as a result of the execution of address 1001(hex).

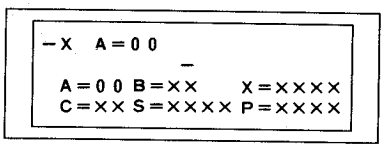


(4) **X** (Examine) command

This command is used to display and change the content of each register.

–X **RETURN**

After your input of X **RETURN**, the contents of the Accumulator A will be displayed on the command line.



You may now change the contents of the Accumulator A. To do so, you must enter the data in hex numbers and press the **RETURN** key. (If only the **RETURN** key is pressed, the value of the Accumulator A will not be changed.) You will know the change in the value of the Accumulator A by the value displayed on the third line. Next, the content of the Accumulator B will be displayed for possible data change. In this manner, you can change the contents of all the registers successively (from X to C, C to S, S to P, and back to A).

To cancel the X command, input any character exclusive of hexadecimal numbers, comma (,) and space, or enter a new command at the position where the X command is displayed.

(5) **R** (Read) command

This command is used to transfer data from an external storage such as a cassette or ROM cartridge to the memory of the HX-20.

–Rd,fn.ft **RETURN**, or
–Rd.fn.ft, R **RETURN**

"d" denotes the input device and "fn.ft" denote the name and type of the file to be loaded. You can use the following alphabetic characters to specify the input device.

M: Microcassette drive
C: External audio cassette
P: ROM cartridge

The data to be loaded must be in the format specified by a BASIC SAVEM command or a Monitor W command. Also, the A (Address) command of the Monitor must be executed prior to the execution of the command.

The values for T, L and O are specified by the A command and represent, respectively, the address information for the Top address, the Last address and the Offset value.

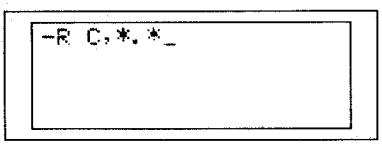
T (Top address) specifies the top address of the range of data for programme read and L (Last address), the last address of the range of available memory.
This address data is included in the data input by the R command and the programme is loaded into the memory of the HX-20 within this range. The range specified by T and L is reserved for programme load and data cannot be stored outside of this range. (If an attempt is made to store data outside of this range, the input processing will be forced to halt by Return Code 8C.) The offset value is the value added to the address data during programme load.
For example, if the data at address 1000(hex) is AA, when the Offset value is specified as 500(hex), this data will be loaded, not at 1000(hex) but at address 1500(hex), or 1000 + 500(hex).
E (Entry point) uses the value written into the file and will ignore any setting written for E in the A command. The value specifed as the Offset value will be added to the Entry point address.
If the R command is accepted, the LCD screen will be cleared and upon completion of the data transfer the message "OK" will be displayed on the second line. If the data transfer from the external storage fails, the message "Error" will be displayed.
If the R option is specified (by adding ",R" to the file type), execution of the programme loaded into the memory will start from the address specified as the starting address after the completion of the data transfer.
The value of the Accumulator A after execution is a return code. (Return code "00" indicates that the data transfer has been completed normally.)

- About filename and file type

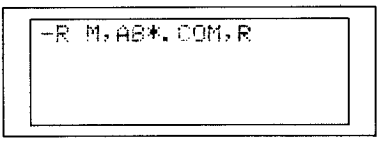
A filename must be a string of 8 or less alphanumeric characters and a file type, a string of 3 alphanumeric characters. You can omit the file type. If you do so, a space is assumed as the file type. You cannot omit the filename. If the R option is used, the file type cannot be omitted. When "*" is used in a filename, any characters following the "*" will be accepted as the filename. This applies as well to the file type specification.

[Example]

If you want to load the first data file in an audio cassette, enter **R C,*.***.



If you enter "R M,AB*.COM,R," the data file with the filename beginning with letters "AB" and file type "COM" will be loaded from the microcassette drive into the memory and the programme execution will start from the specified address after the completion of the data transfer.



(6) **W** (Write) command

This command is used to transfer data from the memory of the HX-20 to an external storage (cassette).

-Wd,fn.ft **RETURN**

"d" denotes the output device and "fn.ft" denotes the name and type of the file to be saved. The following alphabetic characters can be used to specify the device name.

M: Microcassette drive
C: External audio cassette

You must specify the range of memory space for data output using the A command of the Monitor prior to the execution of the W command.
For example, if you specify T (Top address) as 1000(hex) and L (Last address) as 2000(hex), the contents of memory from address 1000(hex) to address 2000(hex) will be output to the specified output device. If O (Offset value) is specified as 500(hex), the data written into the file will be the contents of memory from address 1500(hex) to 2500(hex) that is, address 1000 + 500(hex) to 2000 + 500(hex). Also, if E (Entry point) has been written into the file to indicate the execution starting address, the Offset value will be added to that address and output.
If the W command is accepted, the LCD screen will be cleared and the message "OK" will be displayed on the second line upon the completion of the data transfer to the external storage. If the data transfer fails, the message "Error" will be displayed.
The filename must be a string of 8 or less alphanumeric characters, and the file type, a string of 3 alphanumeric characters.
With the W command, the data output to the cassette are not verified after the completion of the data transfer. So, it is suggested that you perform data verification using the V command of the monitor.

(7) **V** (Verify) command

This command is used to verify that the data output to an external storage (cassette) are correct.

–Vd,fn.ft, **RETURN**

"d" denotes the output device and "fn.ft" denote the name and type of the file to be checked. The following alphabetic characters can be used to specify the device name.

M: Microcassette drive
C: External audio cassette

In verification, the data file in the cassette tape will not actually be compared with the contents of the memory. Only the error-detecting code (2-byte CRC) written into the cassette tape is checked.

Return codes for R, W, and V commands

00	Normal completion of data transfer
01	End of file: The file reached its end as a result of the data input.
80	Microcassette is not connected to the HX-20.
81	There are errors in inputting.
82	The specified file failed to be found (in external audio cassette or microcassette drive)
83	An incorrect data was input.
86	Data format error
8B	A file other than that specified was found.
8C	Data input was not in the specified range of memory space.
91	An error occurred during data output
99	An incorrect I/O device was specified.
A0	A ROM cartridge is not mounted.
A1	The specified file failed to be found. (ROM cartridge)
A4	An error in the header of the ROM cartridge.
A5	An error in the header address designation of the ROM cartridge.

(8) **A** (Address) command

This command specifies the range of memory space within which data can be input by the R command, or output by the W command.

–A **RETURN**

The following four values can be specified as arguments with the A command.

T (Top address)
L (Last address)
O (Offset value)
E (Entry point)

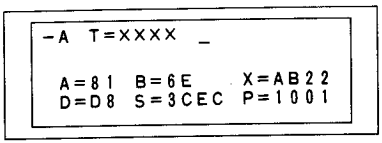
With the W command, the values specified by the A command denote the following.

T: The top address of the data to be output to an external storage.
L: The last address of the data to be output to an external storage.
O: The offset value for the address value of the data to be output to an external storage.
The offset value is a value to be added to the address value and to be output as the resulting address value. For example, 1000(hex) is added as an offset value to the address value when the content of address 1000(hex) is to be output and then is output as if it were the data of address 2000(hex) and not as the data of address 1000(hex). The offset value is effective for the address value specified by T, L, or E.
E: The execution starting address if the data to be output is a programme. If the R option is specified with the R command, execution of the programme will begin from this address when the programme loading is completed.

With the R command, the value specified by the A command denote the following.

T: The top address of the range of memory space available for data input.
L: The last address of the range of memory space available for data input.
O: The offset value for the address value of the data to be input.

The purpose of specifying T and L is to check the top and bottom addresses of memory space allocated for data input for protection of the current memory contents from destruction.
With the R command the value E need not be specified by the A command. If you input –A* **RETURN**, all of the address values specified by the A command will be set to 0.
As for the data input and display, after you input –A **RETURN**, the message "–A T=XXXX _" will appear to show the current T value. The monitor will then wait for input. To change the T value, press the **RETURN** key following the input of the new value.



If you do not wish to change the T value, just press the **RETURN** key. When the T value has been set, the values of L, O, E, T..... will be displayed and the monitor will be ready for your input. To cancel the A command, you can input any character exclusive of hex numbers, comma (,) and space, or input a new command at the position where the A command is displayed.
In the following examples, the contents of addresses 1000(hex) through 1FFF (hex) will be output from the memory to the microcassette drive (filename: DUMP. BIN), data will be input to addresses 2000(hex) through 2FFF(hex) of the memory from the microcassette drive and then the programme execution will start from address 2000(hex).

(Example 1)

	Key input	Display
STEP 1	-A **RETURN**	-A T =0000 _
	1000 **RETURN**	-A L =0000 _
	1FFF **RETURN**	-A O =0000 _
	1000 **RETURN**	-A E =0000 _
	1000 **RETURN**	-A T =1000 _
	/ **RETURN**	-
STEP 2	-W M, DUMP.BIN **RETURN**	
STEP 3	-A **RETURN**	-A T =1000 _
	2000 **RETURN**	-A L =1FFF _
	2FFF **RETURN**	-A O =1000 _
	0000 **RETURN**	-A E =1000 _
	/ **RETURN**	-
STEP 4	R M, DUMP.BIN,R **RETURN**	

(Example 2)

Key input	Display
STEP 1 A RETURN	–A T =0000_
1000 RETURN	–A L =0000_
1FFF RETURN	–A O =0000_
RETURN	–A E =0000_
/ RETURN	–A T =1000_
STEP 2 W M,DUMP.BIN RETURN	
STEP 3 A RETURN	–A T =1000_
2000 RETURN	–A L =1FFF_
2FFF RETURN	–A O =0000_
1000 RETURN	–A E =1000_
/ RETURN	–
STEP 4 –R M,DUMP.BIN, R RETURN	

In both examples 1 and 2, the contents of addresses 1000(hex) through 1FFF(hex) are saved to the microcassette drive and data are loaded into addresses 2000(hex) through 2FFF(hex) of the memory from the microcassette drive. However, they differ in the way of recording the address values on the tape.

(9) **K** (Key set) command

This command specifies the data for automatic key input when the power switch is turned ON. If this command is used to specify in advance the data to be input, when the power switch is turned ON, the data will be processed as if it were actually input from the keyboard.

The maximum length of the data string is 18 characters. However, function keys will count as two characters. RETURN counts as one character and is displayed as $_{CR}$ on the screen.

When you have finished inputting data, press @ key while holding down the CRTL key.

To cancel a previously input K command, input the following.

– K CTRL + @

If you do not wish the K command to be executed when the power switch is turned ON, turn on the power switch while holding down the **BREAK** key. Below is an example of an actual K command.

(1) -K2PRINT"HX-20"↵ press **CTRL** + **α** key

```
A=00 B=00   X=D310
C=C8 S=04AF P=D23B
```

(2) Turn the power switch OFF.
(3) Turn the power switch ON.
(4)
```
P1:              0 Bytes
PRINT"HX-20"
HX-20
2
```

The above be displayed on the screen of the HX-20.

(5) When the power switch is turned ON, the data which you input in (1) is processed as if it were actually input from the keyboard.
- 2 immediately following K selects BASIC from the menu.
- Then, the BASIC command PRINT "HX-20" followed by **RETURN** is input.
- The above command is then executed and the characters HX-20 are displayed on the screen.

NOTE:
Depending on the DIP switch setting of your HX-20, different characters may be used instead of **α**. *See Chapter 2, DIP Switch Setting.*

(10) **B** (Back) command
This command returns control to the procedure by which the Monitor was called.

-B **RETURN**

With this command, the HX-20 will return from Monitor mode to the menu display when the Monitor was called by the menu, and to BASIC mode when called by BASIC.

10. HARDWARE DESCRIPTION

10.1 Basic Configuration of the HX-20

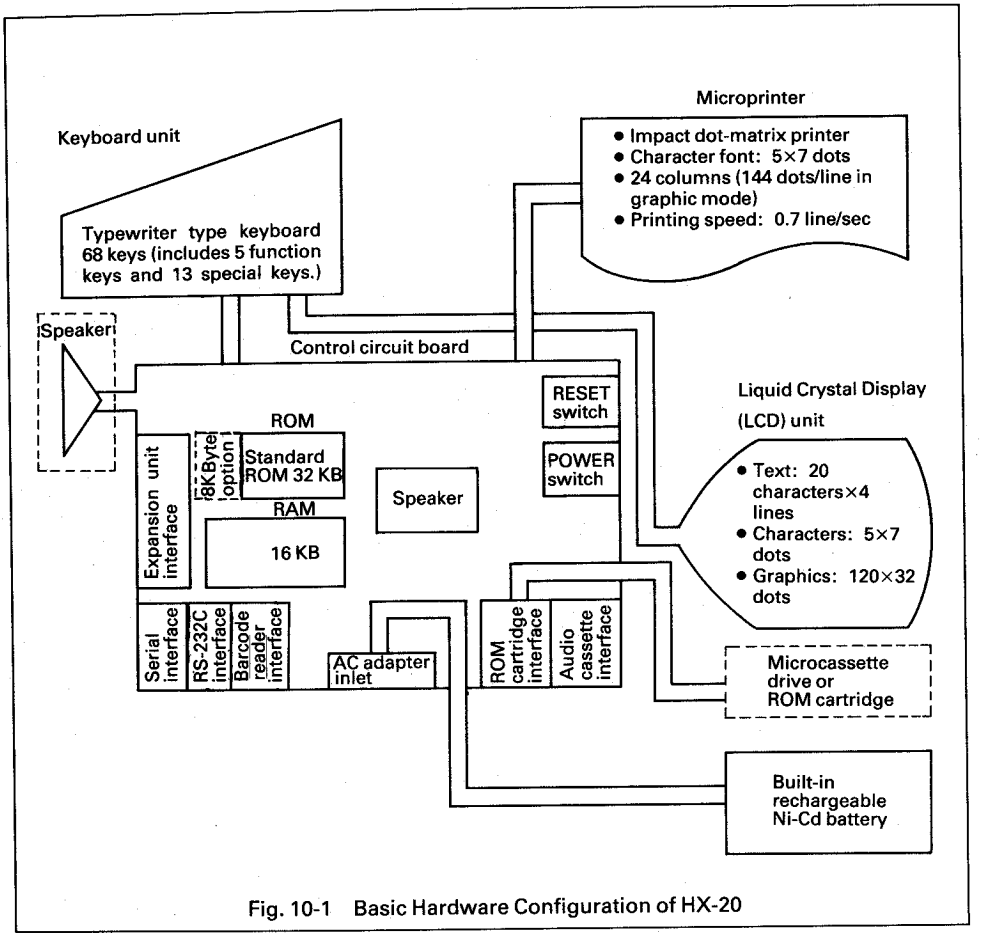


Fig. 10-1 Basic Hardware Configuration of HX-20

Your HX-20 comprises six major blocks as shown in the block diagram above; namely, a control circuit board, a keyboard unit, a microprinter, an LCD unit, a speaker, and a battery power supply. Each block is connected to the control circuit board and is neatly housed in the HX-20. The HX-20 is also equipped with an RS-232C interface, a serial interface and an expansion unit interface as standard equipment to permit system expansion through use of these interfaces.

10.2 Relationship between CPUs and Input/Output Operations

The relationship between the CPUs and I/O operations is as illustrated below.

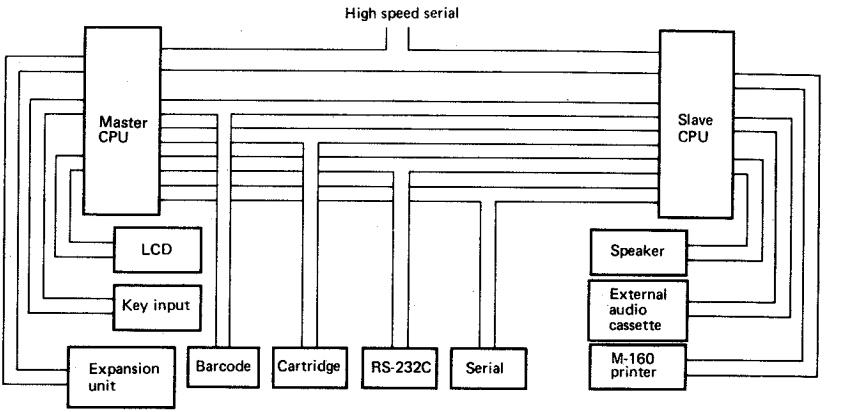
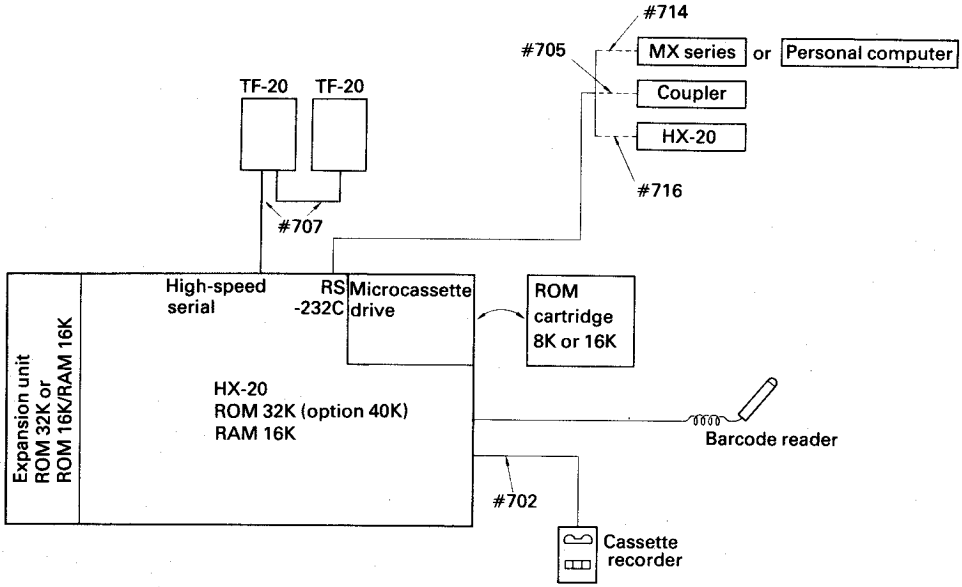


Fig. 10-2 Relationship between CPUs and I/O

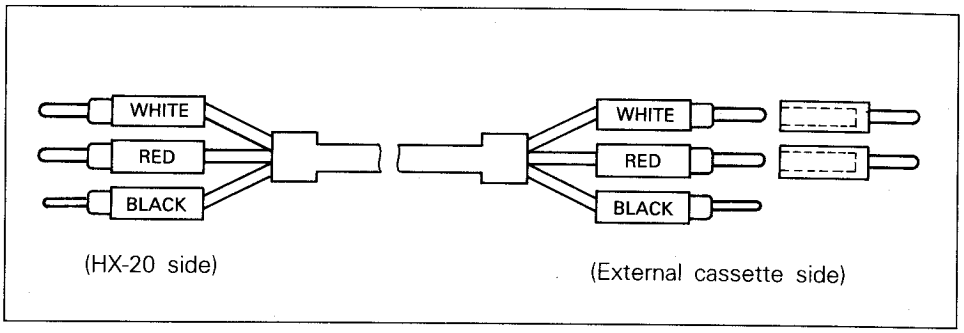
10.3 Cable List of Interface Cables



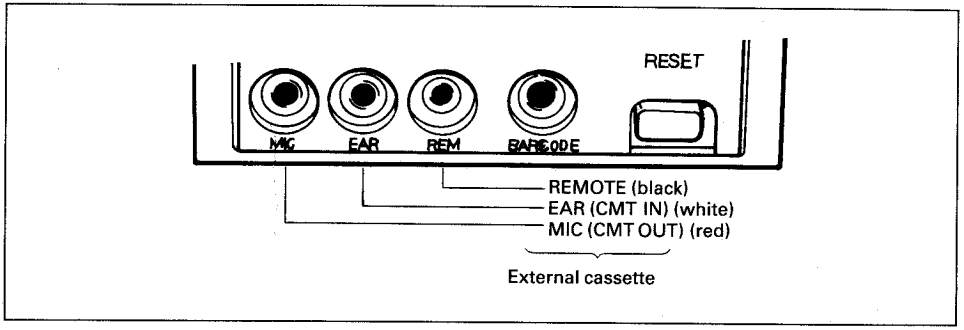
Cable set	Connection between	Part number	Connector
#702	HX-20 and External audio cassette	Y201302000	Two 3.5 dia. plugs and two 2.5 dia. plug adapters
#705	HX-20 and Coupler	Y201305000	One 8-pin DIN connector and one DB-25 connector
#707	HX-20 and TF-20	Y201307000	One 5-pin DIN connector and one 6-pin DIN connector
#714	HX-20 and Terminal printer (MX series)	Y201309000	One 8-pin DIN connector and one DB-25 connector
#716	HX-20 and HX-20	Y201311000	Two 8-pin DIN connectors

10.3.1 Interface cable description

(1) Cable set #702 with two 2.5 dia. jack adapters
1) Use: To connect the HX-20 to an external cassette tape recorder.
2) Plugs: 3.5 (white and red) and 2.5 dia. (black)

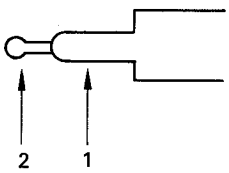


3) Connection
Connect the HX-20 to the external cassette tape recorder as shown below.

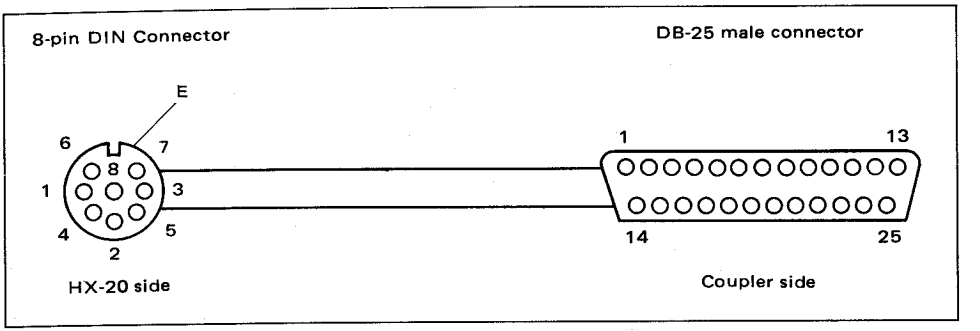


4) Signal names

	Pin No.	Signal name	Colour
HX-20 and Cassette	1	Ground	White
	2	Input	White
	1	Ground	Red
	2	Output	Red
	1	Remote	Black
	2	Remote	Black



(2) Cable set #705
1) Use: To connect the HX-20 to the acoustic coupler
2) Connectors: HX-20 side: 8-pin DIN connector
Coupler side: DB-25 connector



3) Connection
Plug the DIN connector into the RS-232C interface connector on the rear panel of the HX-20 and the DB-25 connector into the interface connector of the acoustic coupler. Then, tighten the two mounting screws with a screwdriver to secure the DB-25 connector to the acoustic coupler.

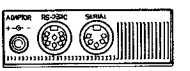
4) Signal names

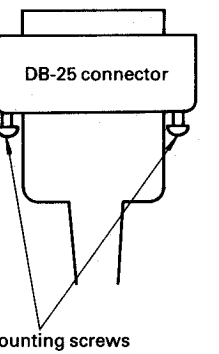
DB-25 connector

Pin No.	Signal name	Colour
1	CG	(Shield)
2	$\overline{TX}$	Red
3	$\overline{RX}$	Gray
4	RTS	Yellow
5	CTS	Green
6	DSR	Brown
7	GND	Black
8	CD	White
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20	DTR	Blue
21		
22		
23		
24		
25		

8-pin DIN connector

Pin No.	Signal name	Colour
1	GND	Black
2	$\overline{TX}$	Red
3	$\overline{RX}$	Gray
4	RTS	Yellow
5	CTS	Green
6	DSR	Brown
7	DTR	Blue
8	CD	White
E	CG	(Shield)



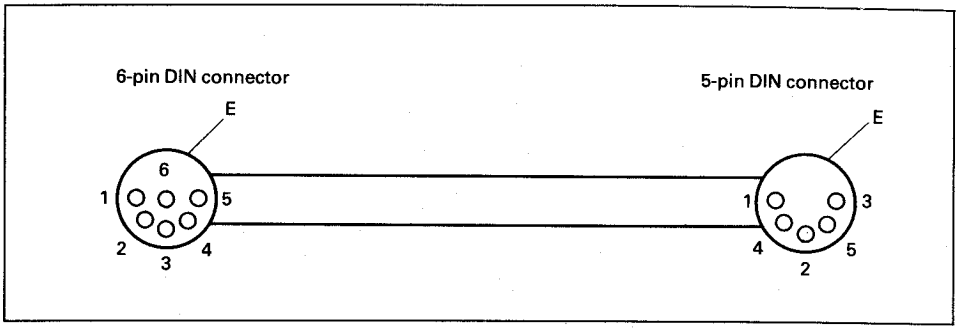


(3) Cable set #707

1) Use: To connect the HX-20 to the flexible disk unit.

2) Connectors:

$$\frac{\text{5-pin DIN}}{\text{HX-20}} \leftrightarrow \frac{\text{6-pin DIN}}{\text{Flexible disk unit}}$$



3) Connection

Plug the DIN connectors on both sides into the corresponding interface connectors.

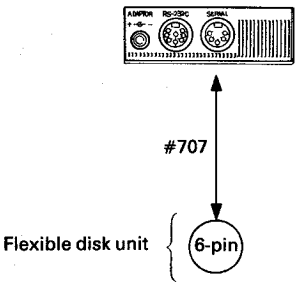
4) Signal names

6-pin DIN connector

Pin No.	Signal name	Colour
1	PRX	White
2	PIN	Green
3	PTX	Red
4	POUT	Yellow
5	SG (Signal ground)	Black
6	Unused	–
E	FG	(Shield)

5-pin DIN connector

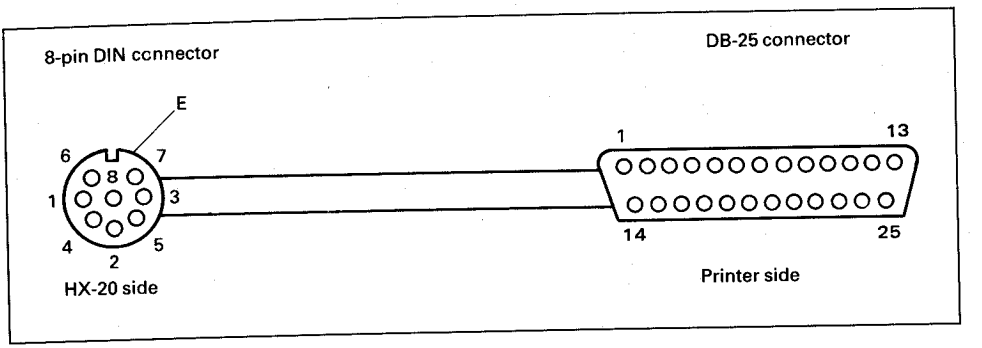
Pin No.	Signal name	Colour
1	SG (Signal ground)	Black
2	PTX	Red
3	PRX	White
4	POUT	Yellow
5	PIN	Green
E	FG	(Shield)



(4) Cable set #714

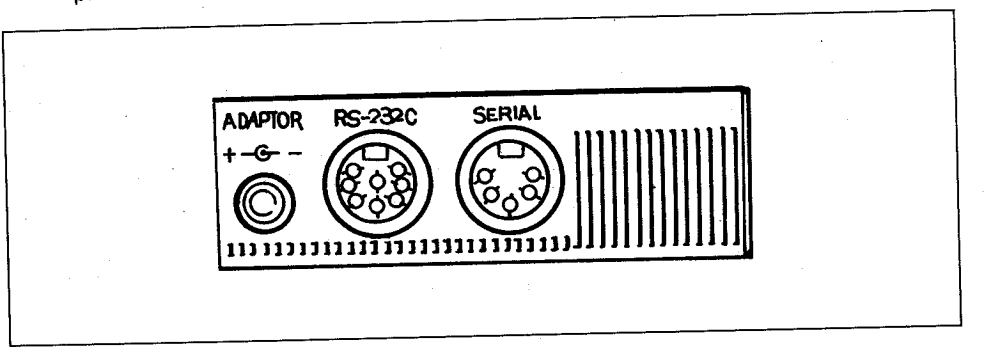
1) Use: To connect the HX-20 to the MX-series terminal printer

2) Connectors: HX-20 side: 8-pin DIN connector
Printer side: DB-25 connector



3) Connection

Plug the DIN connector into the RS-232C interface connector on the rear panel of the HX-20 and the DB-25 connector to the interface connector of the terminal printer.



4) Signal names

8-pin DIN connector

Pin No.	Signal name	Colour
1	GND (Signal ground)	Black
2	$\overline{TX}$	Red
3	$\overline{RX}$	White
4	RTS	Brown
5	CTS	Brown
6	DSR	Yellow
7	DTR	Green
8	CD	Blue
E	CG	(Shield)

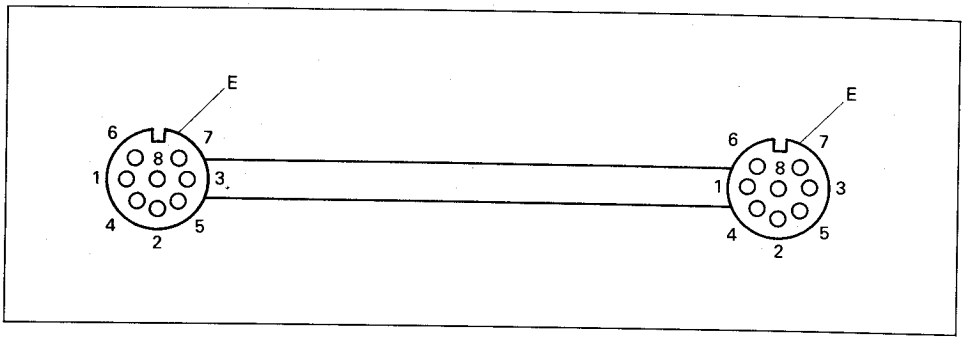
DB-25 connector

Pin No.	Signal name	Colour
1	CG	(Shield)
2	$\overline{TX}$	White
3	$\overline{RX}$	Red
4		Blue
5		Blue
6	DSR	Green
7	GND	Black
8		Brown
9–19		
20	DTR	Yellow
21–25		

(5) Cable set #716

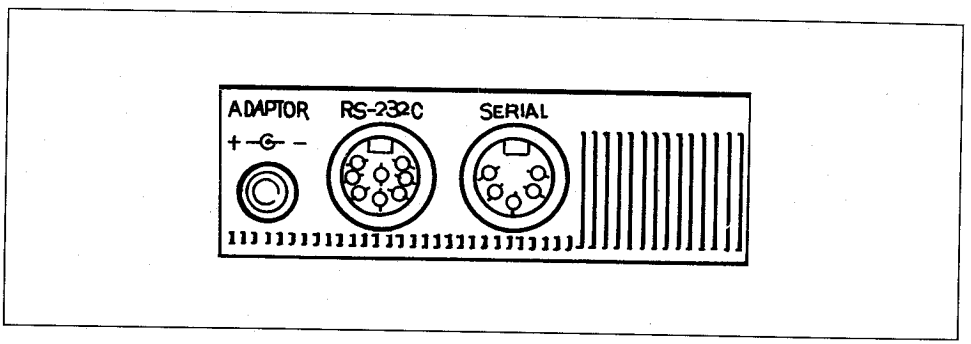
1) Use: To connect two HX-20 units through the RS-232C interface.

2) Connectors: Two 8-pin DIN connectors



3) Connection

Plug the DIN connectors into the RS-232C interface connector on the rear panel of each HX-20 unit.



4) Signal names

Pin No.	Signal name	Colour
1	GND (Signal ground)	Black
2	TXD	Red
3	RXD	White
4	RTS	Brown
5	CTS	Brown
6	DSR	Yellow
7	DTR	Green
8	CD	Blue
E	FG	(Shield)

Pin No.	Signal name	Colour
1	GND (Signal ground)	Black
2	TXD	White
3	RXD	Red
4	RTS	Blue
5	CTS	Blue
6	DSR	Green
7	DTR	Yellow
8	CD	Brown
E	FG	(Shield)

NOTE:

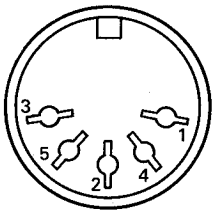
Pin Nos. 4 and 5 are connected to pin No. 8 at the other end of the connector.

10.3.2 Interface connector description

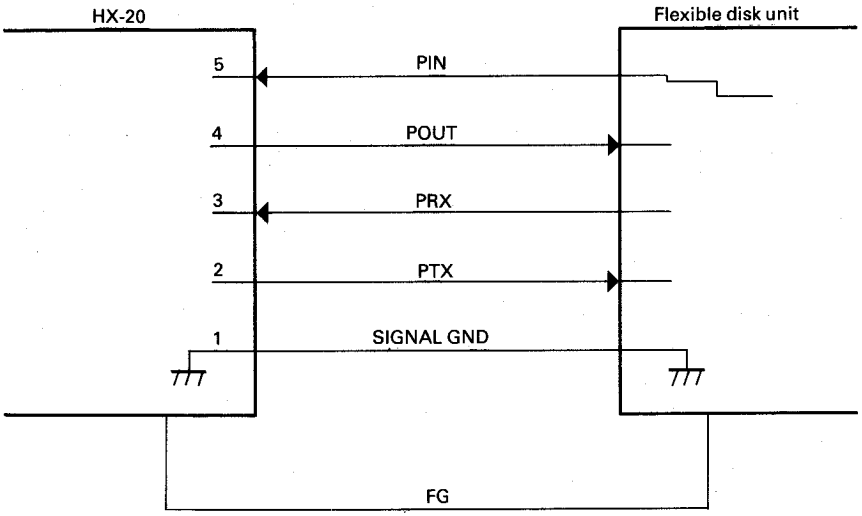
(1) Serial interface

1) Use: A high-speed serial interface connector for data transmission/reception between the HX-20 and the flexible disk unit.

2) Connector: 5-pin DIN, TCS 4450



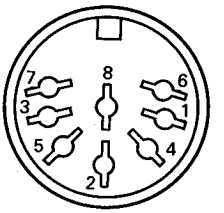
Signal pin No.	Signal name	Direction of signal	Description
1	GND	–	Signal Ground
2	PTX	Out	Transmitted data
3	PRX	In	Received data
4	POUT	Out	Transmit mode
5	PIN	In	Receive mode
E	FG	–	Protective Ground



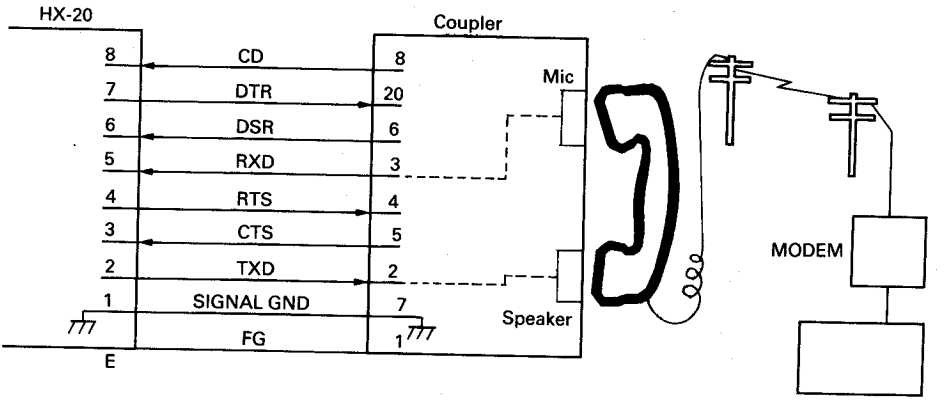
(2) RS-232C interface

1) Use: An interface connector for data transmission/reception between the HX-20 and the acoustic coupler or other external device.

2) Connector: 8-pin DIN, TCS4480



Signal pin No.	Signal name	Direction of signal	Description
1	GND	–	Signal Ground
2	TXD	Out	Transmitted data
3	RXD	In	Received data
4	RTS	Out	Request to send
5	CTS	In	Clear to send
6	DSR	In	Data set ready
7	DTR	Out	Data terminal ready
8	CD	In	Carrier detect
E	FG	–	Protective Ground



10.4 Specifications of the HX-20

(1) Outline dimensions and weight
1) Outline dimensions: 290 (W)×215 (D)×44 (H) mm
2) Weight: Approx. 1.7 kg

(2) Environmental requirements
1) Ambient temperature
- Operating : 5 to 35°C
- Storage : −20 to 60°C (below 30°C for extended storage)
- Charging : 5 to 35°C
- Data storage : −5 to 40°C

2) Humidity
- Operating : 10 to 80% (without condensation)
- Storage : 10 to 80% (without condensation)

3) Vibration
- Operating : 0.25G 55 Hz max.
- Non-operating : Must be free of any abnormality under the following test conditions.

	With HX-20 in unpacked state	With HX-20 in packed state
Amplitude	: 2 mm	2 mm
Frequency	: 1,000 CPM	600 to 1,300 CPM
Direction	: 3 directions (X, Y, Z)	Up and down
Time	: 30 min.	30 min.

4) Shock resistance
- Operating : 1G 1 ms max.
- Non-operating : Must be free of any abnormality under the following test conditions.
  In unpacked state:
  The HX-20 is placed on a 3-cm-thick flat board and is subjected to shock by dropping the HX-20 with one side of the unit lifted 10 cm above the flat board. This process is repeated five times.
  In packed state:
  The HX-20 is dropped from a height of 50 cm above a concrete surface. This process is repeated 3 times for each side of the container.

(3) Current consumption
The current consumption of the HX-20 varies depending on the method of its operation but the average current consumption is as follows.

1) When the HX-20 is not connected with a peripheral device during programme running ..... 30 mAH
   Non-operating state (but with the power switch turned ON) ..... 15 mAH
2) When the HX-20 is connected with any peripheral device
   - Microprinter
     During printing (with character "K" printed for 24 columns) ..... 300 mAH
     During paper feeding ..... 100 mAH
   - RS-232C ..... 100 mAH
   - Microcassette drive
     During execution of WIND, LOAD, or SAVE ..... 100 mAH

(4) AC adapter
1) Power consumption : 8W
2) Insulation resistance : 10MΩ min. (between the chassis and AC power circuit)
3) Dielectric strength : 1,000V for 1 min. (between the chassis and AC power circuit)

11. MAINTENANCE

11.1 Operating Environments

(1) Avoid use or storage in extremely humid locations.
(2) Avoid use or storage in locations subject to extremely hot or cold temperatures, as well as to rapid temperature changes. (Also, do not use or store under direct sunlight or near heaters or coolers.)
(3) Avoid violent shocks or vibrations while in use or storage.

11.2 Handling

11.2.1 Storage and operating conditions

- When using your HX-20, place it on a flat surface such as a desk.
- Do not pile or stack things on top of the machine while in storage or during transportation.
- Do not apply any shocks to the HX-20, and avoid use when the HX-20 is partially dismounted, as the machine is made of precision electronic parts. Dust, static electricity, etc., may also cause the machine to malfunction.

11.2.2 Power supply

- Normally, operate your HX-20 on the built-in battery power supply (without connecting it to the AC adapter).
- Your HX-20 can also be used with the AC adapter connected. Please note that if you use the machine connected to the AC adapter continuously for a long time, the service life of the battery may be shortened due to overcharging.
- If your HX-20 is left unused for a long period, the built-in battery will be completely discharged. If this occurs, the programmes stored in the RAM may be lost and the battery may deteriorate. Therefore, occasionally turn on the power switch to check the battery for proper operation (by checking that the HX-20 operates normally or the message "CHARGE BATTERY !" does not appear).
- For details about how to charge the battery or to use the AC adapter, refer to Chapter 3 of this manual.

11.2.3 Maintenance

- To clean the housing of your HX-20, wipe it gently with a dry soft cloth. Avoid use of alcohol or volatile solvents.
- If any optional units or interface cables are connected to your HX-20, check them occasionally for proper connection.

11.2.4 Consumables

- Use only the consumables (roll paper, ribbon cartridge, etc.) specified by EPSON.
- For replacement, refer to Chapter 1 of this manual.

11.2.5 Abnormalities

- Should any abnormality occur in your HX-20, turn off the power switch at once and press the RESET switch.
- For troubleshooting or repair, contact your nearest EPSON distributer.

11.2.6 Optional units

- Use only the options specified by EPSON.
  Use of other optional units may cause damage to your HX-20. To install the EPSON specified options, refer to the appropriate chapters of this manual.

APPENDIX A Memory Map

The memory of the HX-20 is divided into the following areas.

Address	
0000 to 004D	I/O port
004E to 007F	RAM. This area is used by I/O routines as a flag and work area.
0080 to 00FF	RAM. This area is used as a work area for BASIC.
0100 to 04AF	RAM. This area is used by I/O routines as a work area and I/O buffer.
04B0 to 0A3F	RAM. This area is used as a work area for BASIC.
0A40 to 3FFF	RAM.
4000 to 5FFF	Not used.
6000 to 7FFF	ROM. (ROM 5) Option 8K byte ROM.
8000 to 9FFF	ROM. (ROM 4) BASIC interpreter.
A000 to BFFF	ROM. (ROM 3) BASIC interpreter.
C000 to DFFF	ROM. (ROM 2) C000 to CFFF is the BASIC interpreter and D000 to DFFF contains the Menu, Monitor and virtual screen routines.
E000 to FFFF	ROM. (ROM 1) I/O routines.

The ROM contains of the following vectors.

Address	
FFD0 to FFD1	Shows the address where the result of key scan is stored.
FFD2 to FFD3	Shows the address where the amount of data in the print buffer of the microprinter is stored. Amount of data is shown in units of one byte and can be in the range 0 to 24 (dec).
FFD4 to FFD5	Shows the address where the amount of data in the I/O buffer for the external cassette is stored. Data amount is in units of two bytes for both I and O and can be in the range 0 to 256.
FFD6 to FFD7	Shows the address where the amount of data in the I/O buffer for the built-in microcassette is stored. Data amount is in units of two bytes for both I and O and can be in the range of 0 to 256.
FFD8 to FFD9	Shows the address where the amount of data in the I/O buffer for the RS-232C port is stored. Data amount is shown in units of two bytes.
FFDA to FFDB	Shows the top address of the buffer for the physical screen of the LCD display. The size of the buffer is 80 bytes.
FFDC to FFDD	Shows the top address of the 260-byte I/O routine buffer.
FFDE to FFDF	Shows the address where the scroll speed data for the virtual screen is stored. The scroll speed data is shown in one byte and can have a value in the range 0 to 9.
FFE0 to FFE1	Shows the top address where the header data for the external cassette is stored.
FFE2 to FFE3	Shows the top address where the header data for the built-in microcassette is stored.

The RAM contains the following vectors.

Address	
011E, 011F	Shows the top address where the display patterns for character codes E0 to FF are stored.
012C, 012D	Shows the final address plus one where the RAM is installed.

The following I/O flags exist in memory area 004E to 00FF.

Address	
0078	Sets the BASIC and Menu programmes for cold start or warm start. Bits are assigned to each programme with logic 0 setting for cold start and logic 1 setting for warm start. This value does not change when the power is turned ON. When the HX-20 is cold started these bits are set to logic 0. Bit 0: Menu Bit 1 to Bit 5: Unused Bit 6: BASIC application programmes Bit 7: BASIC interpreter
0079	Bits 0 through 2 indicate which of the plug-in options is currently connected to the HX-20. Bit 2 1 0 Value 0 0 0 ROM cartridge 0 0 1 Reserved 0 1 0 Nothing connected 0 1 1 Reserved 1 × × Microcassette (x: don't care.) Bits 3 through 6 are undefined. Bit 7: Sets whether the driver of the RS-232C port will be turned off when the BREAK key is pressed. 0 indicates that the driver will not be turned off and 1, that it will. Bit 7 is set for logic 0 when the power switch is turned ON. The other bits at this address are not changed.

Address

<table>
<tr><td>007E</td><td>Bits 0 and 1 set the mode of the external cassette.

<table>
<tr><th>Bit</th><th>1</th><th>0</th><th></th></tr>
<tr><td></td><td>0</td><td>×</td><td>Decided automatically</td></tr>
<tr><td></td><td>1</td><td>0</td><td>Normal mode</td></tr>
<tr><td></td><td>1</td><td>1</td><td>Reverse mode</td></tr>
</table>
(×: don't care)
Bits 2 and 3 set the mode of the built-in microcassette.

<table>
<tr><th>Bit</th><th>3</th><th>2</th><th></th></tr>
<tr><td></td><td>0</td><td>×</td><td>Decided automatically</td></tr>
<tr><td></td><td>1</td><td>0</td><td>Normal mode</td></tr>
<tr><td></td><td>1</td><td>1</td><td>Reverse mode</td></tr>
</table>
(×: don't care)

Bit 4: Shows the currently selected memory bank. 0 indicates bank 0 and 1, bank 1.
Bit 5: Shows the memory bank most recently chosen for use by the menu routine.
Bit 6: Shows the memory bank in which the BASIC interpreter is located.
Bit 7: The value of this bit determines whether or not addresses 0000 through 004D can accessed by BASIC commands POKE and PEEK and Monitor commands S and D.
0: cannot be accessed.
1: can be accessed.</td></tr>
<tr><td>007F</td><td>The bits at this address are used to force set the switches.
The actual settings of the switches will be ignored and the setting will be from software.
Bits 0 through 4 concern the setting of the DIP switches.
Bit 0: Sets DIP switch 1 (0: OFF, 1: ON)
Bit 1: Sets DIP switch 2
Bit 2: Sets DIP switch 3
Bit 3: Sets DIP switch 4
Bit 4: Determines whether the actual settings of the DIP switches will be used or not. Logic 0 indicates that the actual DIP switch setting will be used and logic 1, that the settings of bits 0 through 3 will be used.
Bits 5 and 7 control the printer ON/OFF switch.
Bit 5: Determines whether the value of bit 7 will control the printer or not. Logic 0 indicates the actual setting of the Printer ON/OFF switch and logic 1, that bit 7 will control the function.
Bit 7: Turns the printer ON and OFF. (0: OFF, 1: ON)
Bits 4 and 5 are set to logic 0 when the power switch is turned ON. The settings of the other bits do not change.</td></tr>
</table>

APPENDIX B
RS-232C Serial Communication

The HX-20 uses asynchronous serial communication as described below.

(1) With asynchronous data transmission, a start bit (0) is attached to the beginning of the send data to indicate that transmission has begun. As shown in Fig. B-1, the line level is held to "1" when no data is present; the beginning of data transmission is indicated by the dropping of the line level to "0".
This is followed by the bits of the send byte, starting from the least significant bit (LSB), and terminating with a stop bit ("1"). The stop bit indicates that transmission of one character has been completed. Stop bits may be either 1 or 2 bits in length.
The duration of each bit depends on the bit rate.
For example, if the bit rate is 300bps (bits per second), the duration of each bit is 3.3 msec.

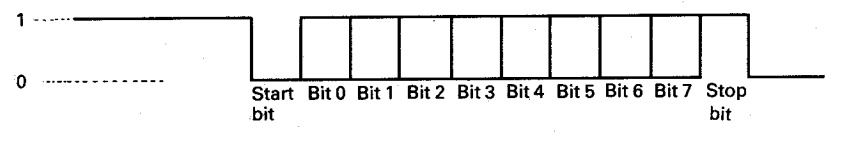


Fig. B-1 Data Format for Asynchronous Communication

Thus, the hex number 3A would be transmitted at 300bps as the 8-bit word shown in Fig. B-2.

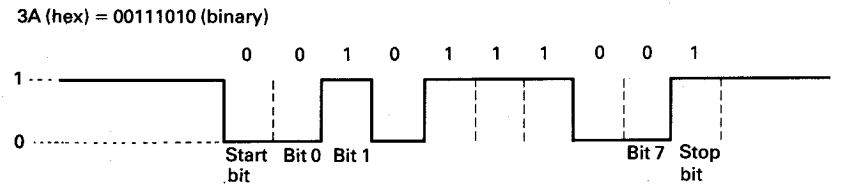


Fig. B-2 Asynchronous Communication Data

Actually, −8V (−3 to −15V) is output when the line level is "1" and +8V (+3 to +15V) is output when it is "0". Therefore, the relationship between the bit states and the line voltages is as shown below.

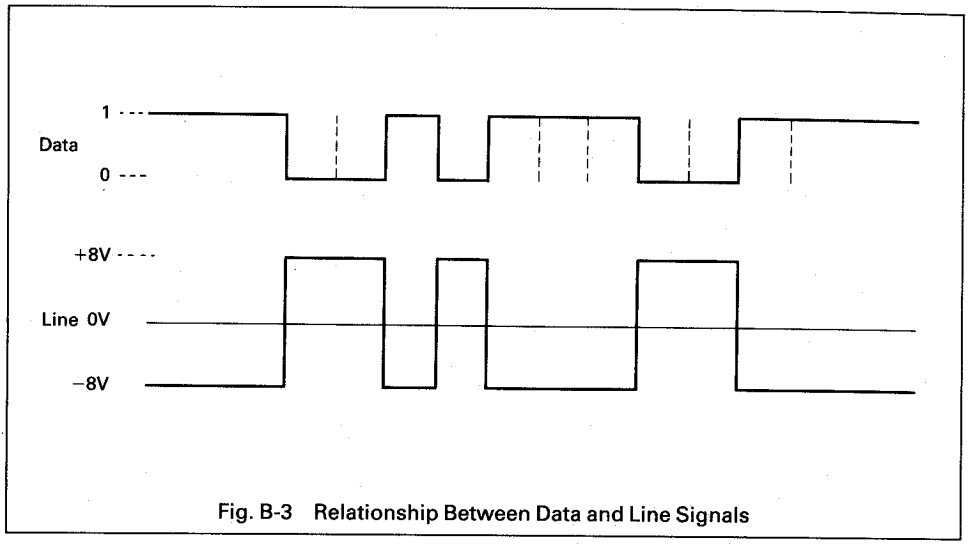


Fig. B-3 Relationship Between Data and Line Signals

(2) Restrictions on Serial Communications with the HX-20
Because the HX-20 is designed to conserve the charge in its battery, current is normally applied to the serial line only when communication is actually being performed. Therefore, the signal is unstable for a certain period of time while the voltage rises at the beginning of communcation. This is shown in Fig. B-4.

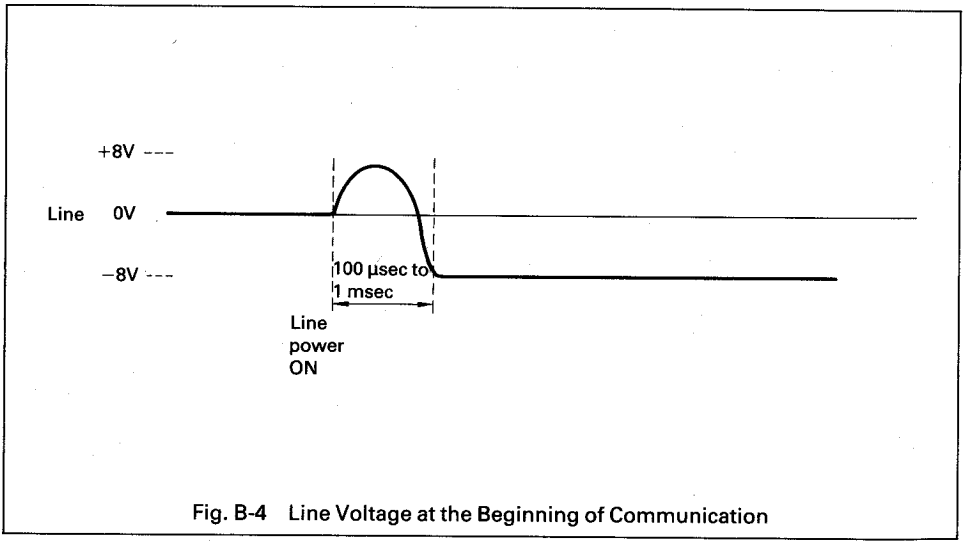


Fig. B-4 Line Voltage at the Beginning of Communication

When the RS-232C is used to transmit data serially, TXD rises as shown in Fig. B-5. This may result in incorrect reception by the receiving side depending on the bit rate and other conditions.

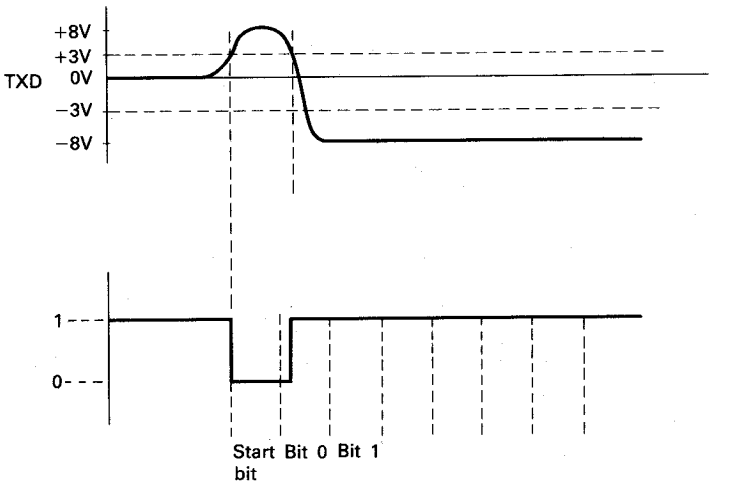


Fig. B-5 Data When Line Power Is Turned ON

As a result, one incorrect bit may be received at the beginning of a data transmission when a programme list is serially output to the MX-80 by BASIC command LIST"COM0:". When programmes are transferred from one HX-20 to another (one using LIST"COM0:" and the other using LOAD"COM0:"), this incorrect bit can prevent the expected results from being obtained.

There are several countermeasures for this problem.
(1) Use a bit rate that is slow enough for the incorrect bit to be ignored.
(2) Apply current to the line ahead of time to avoid signal instability during voltage rise.
(3) Synchronise the receiving and sending sides.

The sequence for applying current ahead of time is as follows.

Sending side	Receiving side
(1) OPEN "I", #1, "COM0:(28N2B)" (Line power ON) (2) WIDTH "COM0:",255	
	(3) LOAD"COM0:(28N2B)" (Start programme reception)
(4) LIST "COM0:(28N2B)" (Start programme transmission) (5) CLOSE #1	

A procedure which can be used to synchronise the sending and receiving sides is shown in Example 1.

The sending side sends the character "A" (synchronisation character), then the receiving side responds with "A" when the synchronisation character is received. The sending side begins transmission after it receives the synchonisation character from the receiving side.

[Example 1] Opening for Data Transfer

Sending side	Receiving side
10 OPEN "I",#1,"COM0:(68N2B)"	10 OPEN "O",#2,"COM0:(68N2B)"
20 OPEN "O",#2,"COM0:(68N2B)"	20 OPEN "I",#1,"COM0:(68N2B)"
30 PRINT #2,"A";	30 IF LOF(1)=0 THEN 30
40 FOR I=1 TO 300: NEXT I	40 A$=INPUT$(LOF(1),1)
50 IF LOF(1)=0 THEN 30	50 IF A$<>"A" THEN 30
60 A$=INPUT$ (LOF(1),1)	60 PRINT #2,"A";
70 IF A$<>"A" THEN 30	

Another method is to have both the sending and receiving sides check one another's status before beginning data communication. This is shown in Example 2.

[Example 2]

Sending side	Receiving side
10 OPEN "I",#1,"COM0:(68N2B)"	10 OPEN "O",#2,"COM0:(68N2B)"
20 A$=INPUT$(1)	20 A$=INPUT$(1)
(Waits for key input)	(Waits for key input)
30 OPEN "O",#2,"COM0:(68N2B)"	30 OPEN "I",#1,"COM0:(68N2B)"

Here, the data transfer begins after a key has been pressed on both the sending and receiving sides.
Voltage fluctuation when power is first applied to the line can affect the RTS and DTR control lines in a similar manner.

All operations of the slave CPU are controlled by commands from the master CPU. For this reason, some operations cannot be performed simultaneously. For example, data input through the RS-232C port will be interrupted if data is output to the printer.

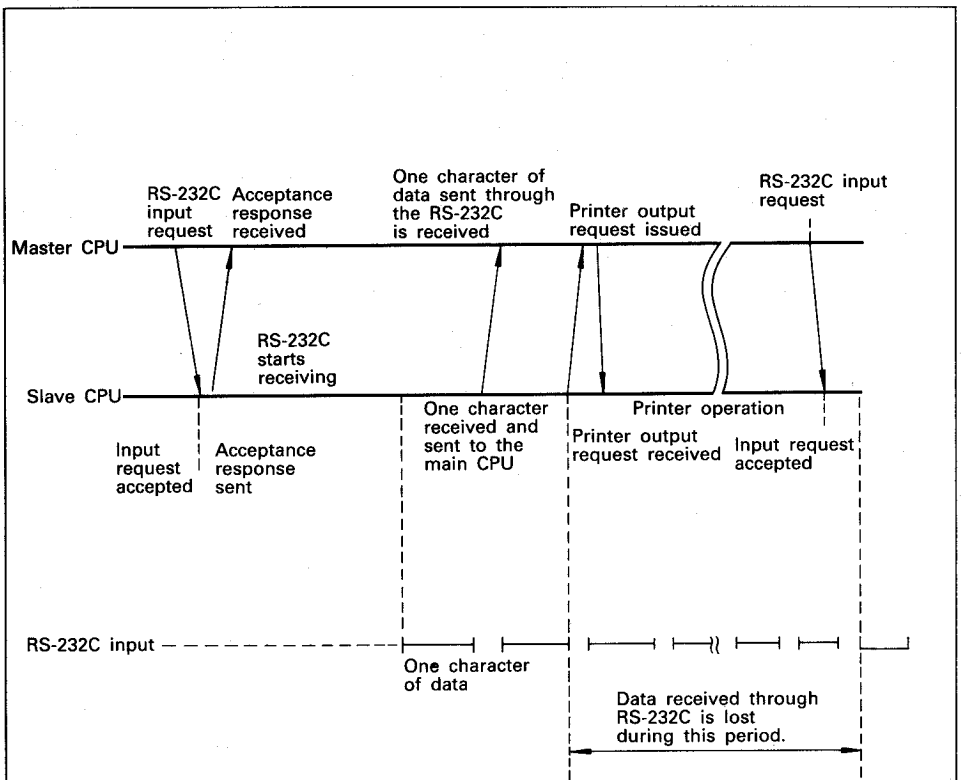


Fig. B-6 Loss of Data Received through RS-232C

Table B-1 Simultaneous I/O operations

Item number	Master CPU interrupt		Master CPU	Slave CPU
1	Keyboard input interrupt	Battery voltage interrupt, etc.	Microcassette input	
2			Microcassette output	
3			External cassette input	
4			External cassette output	
5			LCD (input)	Speaker output
6			LCD (input)	Printer output
7			LCD (input)	RS-232C input
8			RS-232C output	Speaker output
9			RS-232C output	Printer output
10			RS-232C output	RS-232C input
11			High-speed serial operation	Not operational

Simultaneous I/O operations which are possible are shown in Table B-1. Those combinations which are possible are shown on the same line. For example, during input from the microcassette drive (line 1 in the table), both the master and the slave CPUs are occupied. Therefore, operations such as output to the speaker are not possible, although input from the keyboard is accepted.

On line 11 of the table, the slave CPU does not operate during high-speed serial communication because this mode is used for exchange of data with the master CPU; i.e., the link between the master CPU and the slave CPU is severed during high-speed serial communication. (However, if a command is issued to the slave CPU to sound the speaker, say, for 10 seconds, high-speed serial communication can be started while the speaker is sounding.) With the standard I/O routines provided, sounding the speaker after RS-232C has been opened for input using BASIC COM0: statements will cause the input to be interrupted.

However, RS-232C input automatically resumes after the specified operation has been completed.

APPENDIX C Character Code Tables

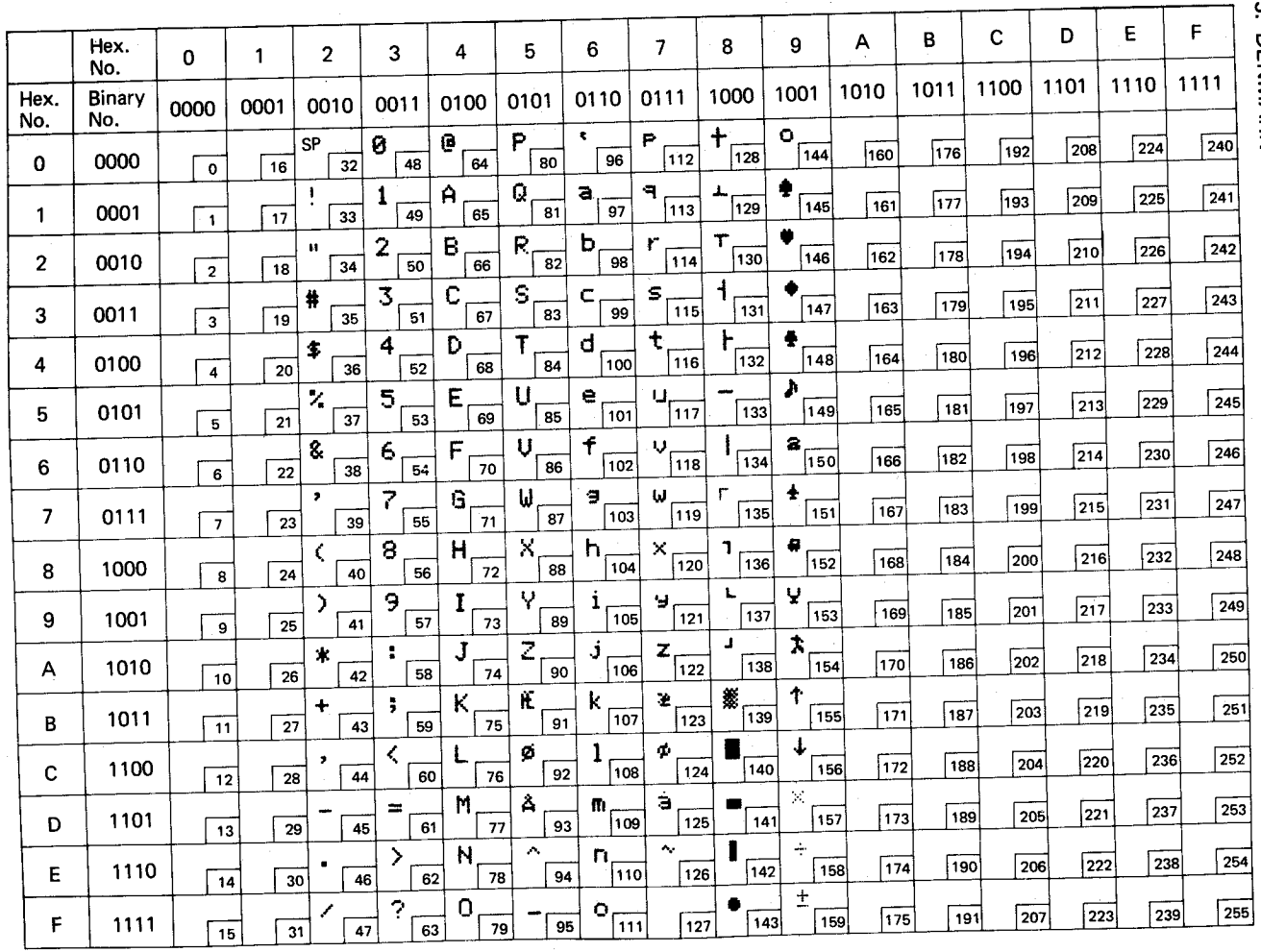
1. USASCII

	Hex. No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	@ 64	P 80	‘ 96	p 112	┼ 128	○ 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♣ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♠ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	[illegible] 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	┌ 135	✝ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	[illegible] 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	¥ 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	[illegible] 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	[91	k 107	{ 123	▒ 139	↑ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	\ 92	l 108	¦ 124	█ 140	↓ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	] 93	m 109	} 125	▬ 141	× 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	~ 126	▌ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

	Hex. No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	Ø 48	@ 64	P 80	‘ 96	p 112	┼ 128	o 144	160	176	192	208	224	240
1	0001	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♠ 145	161	177	193	209	225	241
2	0010	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	19	£ 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ä 150	166	182	198	214	230	246
7	0111	23	’ 39	7 55	G 71	W 87	g 103	w 119	┌ 135	↑ 151	167	183	199	215	231	247
8	1000	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	↓ 152	168	184	200	216	232	248
9	1001	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	Ü 153	169	185	201	217	233	249
A	1010	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	ö 154	170	186	202	218	234	250
B	1011	27	+ 43	; 59	K 75	[91	k 107	{ 123	▒ 139	→ 155	171	187	203	219	235	251
C	1100	28	, 44	< 60	L 76	\ 92	l 108	¦ 124	■ 140	← 156	172	188	204	220	236	252
D	1101	29	- 45	= 61	M 77	] 93	m 109	} 125	▬ 141	⁄ 157	173	189	205	221	237	253
E	1110	30	. 46	> 62	N 78	^ 94	n 110	~ 126	▌ 142	÷ 158	174	190	206	222	238	254
F	1111	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

Hex. No.	Binary No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	à 64	P 80	` 96	p 112	+ 128	o 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	⊥ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	T 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ä 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	┌ 135	↓ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	ü 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	Ü 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	↑ 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	° 91	k 107	é 123	▒ 139	→ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	ç 92	l 108	ù 124	■ 140	← 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	§ 93	m 109	è 125	▬ 141	⁜ 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	¨ 126	▌ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

Hex. No.	Hex. No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	§ 64	P 80	‘ 96	p 112	┼ 128	○ 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ä 150	166	182	198	214	230	246
7	0111	7	23	’ 39	7 55	G 71	W 87	g 103	w 119	┌ 135	↓ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	ö 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	Ü 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	ü 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	Ä 91	k 107	ä 123	▒ 139	↑ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	ö 92	l 108	ö 124	■ 140	↓ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	Ü 93	m 109	ü 125	▬ 141	× 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	ß 126	▌ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255



Hex. No.	Binary No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	@ 64	P 80	` 96	p 112	┼ 128	O 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ª 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	┌ 135	± 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	ª 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	¥ 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	₧ 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	Æ 91	k 107	ä 123	▒ 139	↑ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	ø 92	l 108	ö 124	▌ 140	↓ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	Å 93	m 109	å 125	▬ 141	× 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	~ 126	▐ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

Hex. No.	Binary No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0000	0	16	SP 32	0 48	É 64	P 80	é 96	p 112	┼ 128	○ 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	¤ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ä 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	┌ 135	↑ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	å 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	Ö 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	Ü 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	Ä 91	k 107	ä 123	▒ 139	↑ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	Ö 92	l 108	ö 124	▉ 140	↓ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	Å 93	m 109	å 125	■ 141	× 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	Ü 94	n 110	ü 126	▌ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

	Hex. No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	@ 64	P 80	ù 96	p 112	+ 128	o 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	⊥ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	T 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	┼ 134	a 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	╞ 135	↓ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	╗ 136	↑ 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	╚ 137	Y 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	╝ 138	→ 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	[91	k 107	à 123	▒ 139	← 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	\ 92	l 108	ò 124	▌ 140	↓ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	é 93	m 109	è 125	▬ 141	× 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	ì 126	▐ 142	÷ 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

	Hex. No.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Hex. No.	Binary No.	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0	0000	0	16	SP 32	0 48	@ 64	P 80	` 96	p 112	┼ 128	○ 144	160	176	192	208	224	240
1	0001	1	17	! 33	1 49	A 65	Q 81	a 97	q 113	┴ 129	♠ 145	161	177	193	209	225	241
2	0010	2	18	" 34	2 50	B 66	R 82	b 98	r 114	┬ 130	♥ 146	162	178	194	210	226	242
3	0011	3	19	# 35	3 51	C 67	S 83	c 99	s 115	┤ 131	♦ 147	163	179	195	211	227	243
4	0100	4	20	$ 36	4 52	D 68	T 84	d 100	t 116	├ 132	♣ 148	(164	180	196	212	228	244
5	0101	5	21	% 37	5 53	E 69	U 85	e 101	u 117	─ 133	♪ 149	165	181	197	213	229	245
6	0110	6	22	& 38	6 54	F 70	V 86	f 102	v 118	│ 134	ª 150	166	182	198	214	230	246
7	0111	7	23	' 39	7 55	G 71	W 87	g 103	w 119	┌ 135	↓ 151	167	183	199	215	231	247
8	1000	8	24	(40	8 56	H 72	X 88	h 104	x 120	┐ 136	¿ 152	168	184	200	216	232	248
9	1001	9	25	) 41	9 57	I 73	Y 89	i 105	y 121	└ 137	⌐ 153	169	185	201	217	233	249
A	1010	10	26	* 42	: 58	J 74	Z 90	j 106	z 122	┘ 138	¬ 154	170	186	202	218	234	250
B	1011	11	27	+ 43	; 59	K 75	[91	k 107	{ 123	▒ 139	½ 155	171	187	203	219	235	251
C	1100	12	28	, 44	< 60	L 76	Ñ 92	l 108	| 124	■ 140	¡ 156	172	188	204	220	236	252
D	1101	13	29	- 45	= 61	M 77	] 93	m 109	} 125	▬ 141	« 157	173	189	205	221	237	253
E	1110	14	30	. 46	> 62	N 78	^ 94	n 110	~ 126	▌ 142	» 158	174	190	206	222	238	254
F	1111	15	31	/ 47	? 63	O 79	_ 95	o 111	127	● 143	± 159	175	191	207	223	239	255

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