Canon

X-07

USER'S GUIDE

HAND HELD COMPUTER

Canon

X-07

HAND HELD COMPUTER

USER'S GUIDE

CANON will not take responsibility for monetary damages, loss of pro-
fits, and any claims from a third party due to the use of the program
samples in this manual.

This manual explains the functions of the Hand Held Computer X-07 (hereinafter called the X-07), its accessories, adaptors, software, etc. This manual gives detailed explanations starting with how to turn on the power and how to use the keyboard. For those of you who already have a little knowledge of BASIC and computers, please use this book along with the BASIC Reference Manual and the Programming Guide for Beginners.

ATTENTION

Turn OFF the power when connecting or disconnecting the connectors or when placing the X-07 facing downwards.

• When transmitting/receiving data or program using an input/output device such as a cassette recorder, optical coupler, etc., verify after each operation, that the data or grogram was transmitted/received correctly.

• Please note that the timer function inside the X-07 might deviate according to frequency of use and the program used.

FCC REGULATION

This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

"How to Identify and Resolve Radio-TV Interference Problems".

This booklet is available from the U.S. Government Printing Office, Washington. DC 20402, Stock No. 004-000-00345-4.

Warning: This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC Rules. Only peripherals (computer input/output devices, terminals, printers, etc.) certified to comply with the Class B limits may be attached to this computer. Operation with non-certified peripherals is likely to result in interference to radio and TV reception.

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☞ Index

How to use this manual

The User's Guide is an explanation manual for the X-07, its accessories, peripheral devices, software, etc. There are various peripheral devices and software available with the X-07. This manual is a guide book for answering questions such as "What can the X-07 do, and what adaptors are necessary to execute such operations?", and takes the following form:

1. Learning how to use the X-07

Explains how to use the X-07. If you have very little knowledge of computers, please read this chapter carefully first.

2. Special functions and peripheral devices

Explains the various perihperal devices (printer, RS-232C level convertor, optical coupler, etc.) which can be connected to the X-07, and its software. You will learn about the special features of the X-07 system here.

3. Appendix

Gives a simple explanation of the structure of memory map of the X-07, addresses of subroutines, and software (BASIC).

On the BASIC Reference Manual and the Programming Guide for Beginners

This manal explains not only the X-07 itself, but also the various parts of the X-07 as a system. Therefore, it does not fully explain the BASIC language incorporated in the X-07. To actually create BASIC programs, please read the BASIC Reference Manaul which explains in detail how to use BASIC instructions and functions, and the Programming Guide for Beginners which explains how to create programs as well.

1
Learning how to operate the X-07
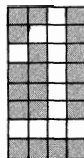
Table of contents for Chapter 1

The X-07 is so compact that it can be placed on the palm of a hand. Yet, inside this compact body, there is a potential to surpass a personal computer. This chapter explains only a part of the functions of the X-07, but it is important that you become familiar with the equipment. The special functions of the X-07 are explained in Chapter 2.

1.1   Before using the X-07

make sure that the X-07 came with the following items. Should an item be missing or defective, please contact your dealer.

I) X-07

①   X-07
②   CANON X-07 User's Guide (this manual)
③   BASIC Reference Manual
④   Programming Guide for Beginners
⑤   Reference Card
⑥   Batteries (AA × 4)
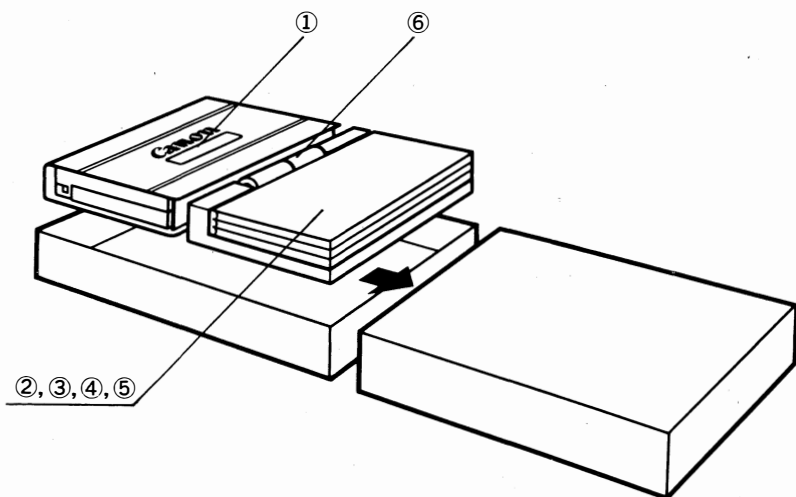
1.2   The X-07

This section explains and names each part of the X-07. Please refer to the illustration as you read.

① **Power switches** These keys are the X-07 power switches. Even when the power of the X-07 is turned OFF, the power to the timer function, etc. is not turned OFF.

② **Keyboard** The keys are arranged in the same manner as a typewriter.

③ **Liquid Crystal Display (LCD)** 80 characters (20 characters × 4 lines) can be displayed. Also functions as a graphic display (120 dots × 32 dots).

④ **Mini magnet speaker** For playback of alarm and melodies.

⑤ **Cassette interface** A 5-pin terminal for connecting a cassette recorder. Please refer to the illustration for the pin arrangement.

⑥ **LCD brightness control** Turn this control to adjust the brightness of the LCD. Set it to the desired brightness.

⑦ **AC adaptor terminal** For connecting the AC Adaptor AD-4II.

⑧ **Parallel input/ output terminal** For connecting a printer, etc. This terminal conforms to the Centronics specifications.

⑩ Bus line

EXPANTION PORT

SPEAKER

⑨ Mini magnet speaker
volume control

⑨   **Mini magnet speaker**   For adjusting the volume of the mini magnet
    volume control   speaker. Set it to the desired level.

⑩   **Bus line**   For using a CRT or an extended BASIC.
    Output from the bus line to a CRT, etc. is
    via a connected interface unit.

⑪ Serial input/output
terminal

⑪   **Serial input/**   For connecting an optical coupler, RS-232C
    output terminal   level convertor, or another X-07. This ter-
    minal conforms to the RS-232 C
    specifications.

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⑫	**Battery compartment**	Four AA batteries are needed. Refer to the markings and insert the batteries with their polarities $(+, -)$ aligned correctly.
⑬	**Utility card compartment**	Insert an utility card here. Programs and data can be memorized on memory cards.
⑭	**Memory extension compartment**	Insert a memory IC here to extend memory for an extended system. However, please consult your dealer for the appropriate IC. Please note that should an accident, etc. arise because you have selected an inappropriate IC, CANON will not take responsibility.
⑮	**Reset switch**	The reset switch is used as the last resort when the X-07 malfunctions. Do not use this switch carelessly. Please note that when the reset switch is depressed, programs and data might be erased.

⑯ **Lock switch**   Use this switch when inserting or removing a utility card. When this switch is set to OFF, the power cannot be turned ON.

Programs are created and data are input by typing on the keyboard. The contents of a program, and the result of program execution are displayed on the LCD.

Even when the power is turned OFF, programs and data are retained as long as the batteries remain charged. Programs and data can also be memorized on memory cards. With several memory cards, programs and data can be exchanged quickly (with back-up battery).

Programs and data can also be memorized on a cassette tape by using a cassette recorder. With optical couplers, cableless communication (no need for bothersome cables) can be performed.

The X-07 has a built-in alarm timer (timer and calendar). Set the alarm to a desired time, and it will sound an alarm on the desired date, day of the week, and time, or play back a melody you have programmed.

The above features are explained in detail in their relative sections.

1.3 Commencing to operate the X-07

1.3.1 Before turning on the power

First, insert the batteries. Refer to the illustations below, and insert four AA batteries into the battery compartment. Make sure that you do not mix up the polarities (+ ,   )

① While depressing the part of the cover marked ➡,
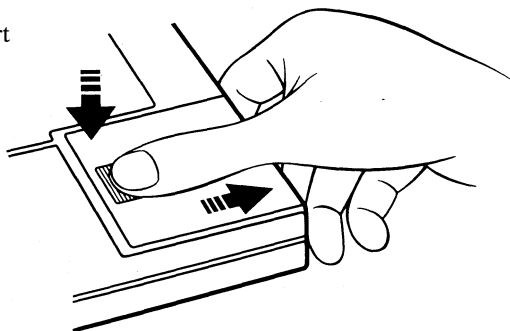
② slide the cover to the right.
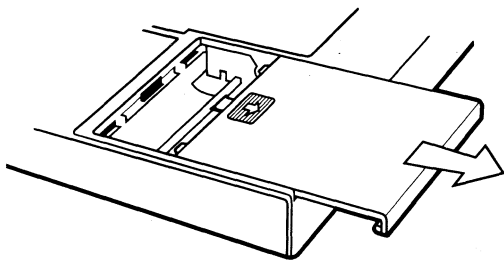
③ Insert the batteries with their polarities (+ , −) aligned correctly, as shown.
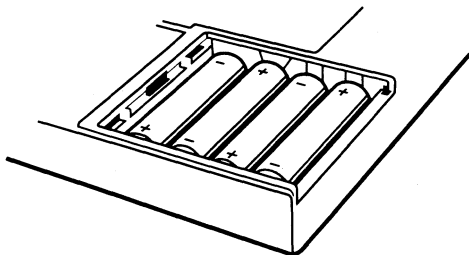
The batteries are disconnected when the AC adaptor is connected.

1.3.2 Turning ON the power ...

The power switches are located at the upper right corner of the keyboard. There you will find a ON/BREAK key and an OFF key. The power is turned on when you depress the ON/BREAK key if the batteries are loaded. If the power is not turned on, check the following items before assuming that the X-07 has malfunctioned.

1. Batteries are loaded.
2. Batteries have not run down.
3. The lock switch of the utility card compartment cover is set to ON.
4. LCD brightness control is set properly.
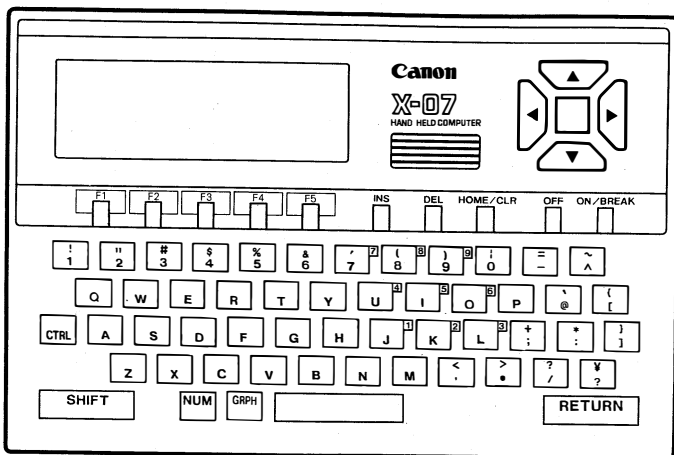
Now, let's actually operate the keyboard. Depress the ON/BREAK key to turn ON the power ... The following appears on the LCD.
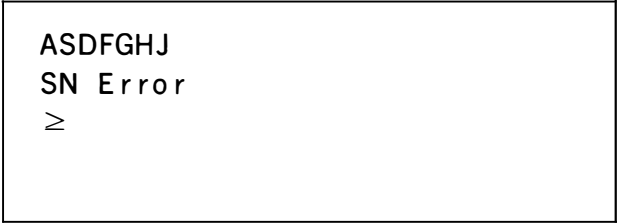
```
Copyright (C) 1983 by
   Microsoft & Canon
6748 Bytes Free
  ≥
```

The flashing "＿" is called a "cursor". Characters typed on the keyboard are displayed where the cursor is located. Let's try typing some characters (they can be any characters). ASDFGHE......

Did you notice that the "≥" turned into "＿"? ">" indicates the beginning of a line, and is called a "prompt".

Next, depress the ⎢RETURN⎥ key. It is located at the lower right corner of the keyboard. This is a very important key. Before learning about this key, let's see what happend when you depress this key. (If you depress a wrong key by mistake, please refer to "1.4.2 Making corrections".)

```
ASDFGHJ
SN  Error
≥
```

... is displayed. The **RETURN** key is used to give a command to the computer or to indicate the end of a line when creating a program. In the above example, when you depressed the **RETURN** key, you commanded the computer to "ASDFGJ." This command is meaningless to the X-07. Therefore, it replied "SN Error (syntax error)." In other words, the X-07 is saying, "Please give me a proper command that I can understand."

We will learn about the **RETURN** key and the use of commands, in detail, in the next section. Next, depress the OFF key. A "pip" is heard, the power is turned off, and the characters are erased from the LCD.

The power ON/BREAK and OFF keys of the X-07 have a sligtly different purpose than the power switches we generally know. Turning OFF the power does not cut the power to all the circuits of the X-07. Only the power to the LCD and the parts which perform calculations (these parts consume much power) is cut. Memory, the timer and the parts which control the keyboard continue to function.

Moreover, if you forget to turn OFF the power, don't worry. When the prompt is displayed on the LCD, and the keyboard is not used for more than 15 minutes, the power is automatically turned OFF.

1.3.3　BASIC language

The X-07 incorporates BASIC as the program language. Many of you might already have some knowledge of BASIC, but in this section BASIC is explained with people entirely new to BASIC in mind.

With a calculator, to calculate $5 + 8$, for example, all you have to do is

5 + 8 =

and the answer

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is displayed on the LCD. With the X-07 which operates on BASIC, when "$5 + 8 =$" is typed, nothing happens. In order to perform this calcualtion, the following must be typed.

PRINT 5+8 `RETURN`

　　　　　　(`RETURN` means depress the RETURN key.)

The above means type P, R, I, N, T, (space), 5, +, 8, RETURN key in the shown order.

"PRINT" is a command meaning "display". Therefore, "PRINT $5 + 8$" means "Add 5 and 8, and display the result on the LCD." In other words, you must accurately instruct the X-07 to calculate "$5 + 8$", and what to do with the result.
The BASIC language consists of groups of such logical commands. Each command is explained in detail in the BASIC Reference Manual.

Attention:　　Hereinafter, in the illustrations, depressing the RETURN key is indicated by ↵.

On operating the keyboard

Here is an explanation of the keys for people who are not used to the typewriter-type keyboard. To type " + ", depress the **SHIFT** key along with the $\begin{array}{c}+\\;\end{array}$ key. Same thing applies for "*", "(", " , ", ")", etc.

Examples:

$\boxed{\begin{array}{c}+\\;\end{array}}$ Display   Operation

•Just depress the key .... ; $\boxed{\begin{array}{c}+\\;\end{array}}$

•Depress along with the SHIFT key. .... + $\boxed{\textbf{SHIFT}}$ + $\boxed{\begin{array}{c}+\\;\end{array}}$

•Depress after depressing the GRPH key. .. ♣ $\boxed{\textbf{G R P H}}$, $\boxed{\begin{array}{c}+\\;\end{array}}$

$\boxed{\begin{array}{c}?\\/\end{array}}$

•Just depress the key..................... / $\boxed{\begin{array}{c}?\\/\end{array}}$

•Depress along with the SHIFT key. .... ? $\boxed{\textbf{SHIFT}}$ + $\boxed{\begin{array}{c}?\\/\end{array}}$

•Depress after depressing the GRPH key. .. ♠ $\boxed{\textbf{G R P H}}$, $\boxed{\begin{array}{c}?\\/\end{array}}$

Attention: The SHIFT key is effective only while it is depressed. However, when the GRPH or the NUM key is depressed once, it is effective until it is depressed once again. Therefore, to type "áwëpú", depress $\boxed{\text{GRPH}}$, $\boxed{\text{Q}}$, $\boxed{\text{W}}$, $\boxed{\text{E}}$, $\boxed{\text{R}}$, $\boxed{\text{T}}$. Don't forget to depress the GRAPH key once at the end to return to the original mode.

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1.3.4   Using the X-07 as a calculator

As the X-07 is a handy personal computer, you must master programming to make the maximum use of all its capabilities. However, to execute simple calculations, there is no need to create a program. And, some of you who are used to handling calculators might want to use the X-07 first as a calculator. This section explains how to use the X-07 as a calculator.

As explained in the previous section, the PRINT command is used to execute addition, subtraction, multiplication and division. For example:

```
PRINT   158 + 333   ↵
491
≥
```

A question mark (?) can be used instead of the instruction word "PRINT". Using this notation, the above example becomes:

```
?   158 + 333   ↵
491
≥
```

Please think of the question mark as asking the X-07 for the result of "158 + 333".

Eample:
$15 \times 15 = 225$

```
?   15 * 15   ↵
    225
≥
```

("*" is used to indicate multiplication (x).)

$100 \div 25 = 4$

```
?   100/25   ↵
    4
≥
```

("/" is used to indicate division (÷).)

$367 - 167 = 200$

```
?   367 - 167   ↵
    200
≥
```

Such functions as cosine, sine, and logarithm can also be used. Unlike calculators which have keys for such functions, each function must be typed on the keyboard.

```
?   COS( 0 )   ↵
    1
≥
```

(The answer is in radians.)

Example:

COS 0.5 = 0.87758256189037

```
?   COS(0.5)    ↵
    .87758256189037
≥
```

LOG 3520 = 8.166212685919

```
?   LOG(3520)    ↵
    8.1662162685919
≥
```

| 456 | = 456

```
?   ABS(− 456)    ↵
    456
≥
```

(ABS is a function which calculates the absolute value.)

```
?   INT(15.67)    ↵
    15
≥
```

(INT is a function which corrects a numeric value into an integer.)

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A calculator has memory which is used to temporarily store values. The X-07 also has similar memory called "variables".
First, type the following:

X = 150 **RETURN**

Now, whenever X is used, its value is set to 150.

Example:

```
?   X + 100   ↵
   250
≥
```

```
?   X * 4   ↵
   600
≥
```

To change the value of X (memory), just perform the same operation.

X = 330 **RETURN**

Now, the value of X is 330. A calculator has M + and M which adds to and subtracts from the value in memory. The X-07 can also perform such operations. For example, to add 100 to X,

X = X + 100 RETURN

To subtract 100 from X,

X = X − 100 RETURN

Variables can be a letter from A to Z, or a string of letters and numbers (XA, A1, A2,...). Names which represent variables are called "variable names". There are rules concerning variable names, and for these rules, please refer to the BASIC Reference Manual. Here, just remember that they must start with a letter.

With the X-07, you can give memory any names you wish. And accordingly, it is best to use variable names which have   For example:

PRICE = 150 RETURN
UNITS SOLD = 30 RETURN
? PRICE*UNITS SOLD RETURN
4500

Meaningful variable names are very useful when using many variables.

How do you like the X-07 as a high class function calculator?.

1.4 BASIC programming

1.4.1 What is a program?

The X-07 is no more than a calculator if the BASIC language is used as in the previous section. Of course there is a reason for the BASIC language in the X-07. In BASIC, each command can be given a line number. Commands with line numbers are called "statements". Statements are not executed immediately when input. Series of statements are collectively called a "program". For example:

```
10  REM PROGRAM + − */
20  INPUT "A, B"; A, B
30  PRINT "A + B"; A + B;
40  PRINT "A − B"; A − B
50  PRINT "A*B"; A*B;
60  PRINT "A/B"; A/B
```

In this program, values are read into the variables A and B, and A + B, A − B, A*B, and A/B, in other words, addition, subtraction, multiplication, and division are executed. And results are displayed on the LCD.

To make the X-07 memorize the above program, type,

```
10  REM PROGRAM + − */ RETURN
20  INPUT "A, B"; A, B RETURN

              .
              .
              .
```

After typing all the statements, type,

RUN RETURN
(RETURN means depress the RETURN key.)

```
A , B ? 150, 50   ↵
A + B   200  A−B   100
A * B  7500 A／B   3
≧
```

RUN is a command to the computer meaning "run" according to the program. When the computer receives this command, it executes the program in sequence according to the line numbers.

In this program, by the INPUT statement of Line 20, values input from the keyboard by the user are read into the variables A and B. And, from Line 30 to 60, addition, subtraction, multiplication and division are executed on the values of the variables A and B, and the results are displayed on the LCD. For example, Line 30 is,

30	**PRINT**	**A + B**
(Line number)	(Displays the result)	(Calculation)

By creating a program in this way, a job can be executed automatically. Do you now understand what a program is?

1.4.2 Making corrections

When inputting a program you are always bound to make typing mistakes. The following keys are used to correct typing mistakes:
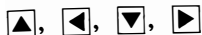
$\boxed{\blacktriangle}$, $\boxed{\blacktriangleleft}$, $\boxed{\blacktriangledown}$, $\boxed{\blacktriangleright}$ Cursor keys
These keys move the cursor in the direction of the arrow on their keys.

$\boxed{\text{INS}}$ This key inserts a space.

$\boxed{\text{DEL}}$ This key deletes an unnecessary character.
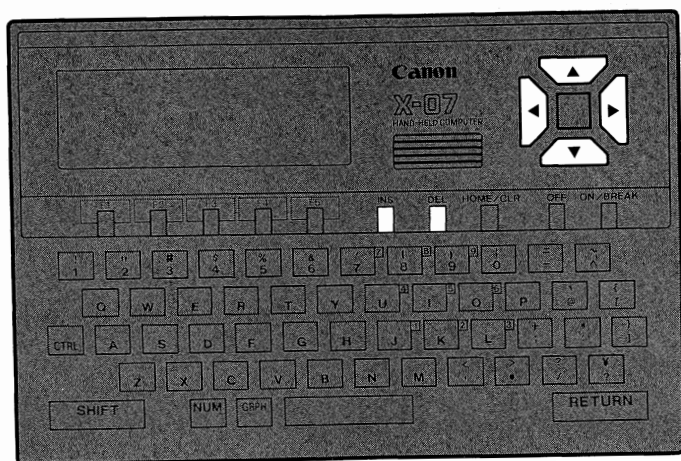
First, comfirm where these keys are located on the keyboard. After memorizing where these keys are, let's correct some typing mistakes.

1) Making corrections before depressing the RETURN key

10 REN PPRGRAM + − ∗/

There are many mistakes in this line. Don't depress the RETURN key yet. This line should have been typed,

10 REM PROGRAM + − ∗/

REN must be changed to REM, and PRRGRAM to PROGAM. When the ◀ key is depressed, the cursor moves towards the beginning of the line. Therefore, if you depress the ◀ key 9 times, ◀ ...◀,

☞ | ◀ |

10 REN PPR̲GRAM + − ∗/

the cursor moves to G. Here, depress the INS key.

| INS |

10 REN PPR GRAM + − ∗/

Next, type O, and the above becomes,

| O |

10 REN PPRO̲GRAM + − ∗/

Next, there is one too many P, so depress the ◀ key 3 times, ◀, ◀, ◀,

| ◀ |

10   REN P̲PROGRAM + − ∗/

To delete the extra P, depress the **DEL** key.

| DEL |

10 REN P̲ROGRAM + − ∗/

Next, correct REN to REM. ◀, ◀, ◀, and,

| ◀ |

10 RE̲N PROGRAM + − ∗/

next, type M.

| M |

10 REM̲ PROGRAM + − ∗/

Here, depress the RETURN key.

| RETURN |

10 REM PROGRAM + − ∗/

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2) Use the LIST command after a statement has scrolled off the LCD.

LIST 10 RETURN

(The above displays Line 10 statement.)

10 REN PROGRAM + − */

Use the ▲ and the ▶ keys to move the cursor to the characters you want to correct, and the rest is same as ''1) Making corrections before depressing the RETURN key''.
Always depress the RETURN key after making corrections. If you move to another program line with the cursor keys without depressing the RETURN key, the corrections you made might not be executed.

3) Use the LIST @ command when a program line is longer then 60 characters.

When a program line is longer than 60 characters, even if you LIST it, the beginning of the program line will be scrolled off the LCD. In such a case, execute the LIST @ command, and depress the ON/BREAK key when necessary, and then, make corrections. However, if a program line is longer than 80 characters, unless a CRT (TV screen) is connected, the input cannot be corrected. Even if you try to input, the beginning of the program line will scroll off the LCD, and it will not be registered as a program line (SN Error or other error will be generated).

1.4.3 Using the CTRL + E keys

When making corrections using the screen editor, the next program line might be inserted into the previous program line.
For example, let's say the following was displayed when LIST 100-110 was executed.

```
100  PRINT
110  IF A>0 THEN 200
≥
```

Here, move the cursor to the position after "PRINT" of Line 100, and add "THE PRICE OF X-07 = ", A as the contents to be displayed.


```
100  PRINT "THE PRICE
OF  X-07=", A THEN 200
```
Left over from Line 110.

Here, if the RETURN key is depressed, THEN 200, which is not needed, is included in Line 100.
You can delete each character with the space key, but it is more convenient to use the CTRL + E keys (depress the E key while depressing the   key).
The CTRL + E keys delete all characters of a program line after the cursor position.
In the above example, when the CTRL + E keys are depressed,

```
100  PRINT "THE PRICE
OF X-07=", A
```

occurs. Please try it.

The situation is a little different, but the following is an example of two statements beging added together.

```
100  IF A>0  THEN A=1 _
```

After inputting the above statement, let's say that the RETURN key was not depressed, and Line 110 was input after depressing the ▶ key.

```
100  IF A>0  THEN A=1
110  X=A+10  ⏎
```

In this case, the following statement is input.

100 IF A>0 THEN A = 1 110 X = A + 10

When this program line is listed using the LIST command, it will look normal. However, when it is executed, SN Error will occur. Such mistakes are hard to detect, so please be careful when inputting program lines.

Summary of "Making corrections"

1) Move the corsor to the character you want to correct with the $\boxed{\blacktriangle}$, $\boxed{\blacktriangleleft}$, $\boxed{\blacktriangleright}$, and $\boxed{\blacktriangledown}$ keys.

2) Depress the **DEL** key to delete the unnecessary character.

3) To insert a character, depress the **INS** key, and then type the character you want.

4) To change a character to another character, type the desired character.

5) To correct a statement you have already input, execute

   LIST (line number) $\boxed{\text{RETURN}}$

   to call the statement you want to correct, and then correct it.

6) After making corrections, always depress the RETURN key.

1.4.4 How to use the LIST command

As the LIST commnd is used often for correcting programs, this section will explain it in more detail.

The most basic use of the LIST command is as follows:

LIST   `RETURN`

```
10  REM  PROGRAM  + − ∗ ∕
20  INPUT"A , B" ; A , B
30  PRINT"A+B" ; A+B ;
```
```
40  PRINT"A−B" ; A−B
50  PRINT"A ∗ B" ; A ∗ B ;
60  PRINT"A ∕ B" ; A ∕ B
≥
```

The program you have input is listed. When a program is long, all of it cannot be listed on the LCD. In such a case, when you come to the program line you want to see, depress the `ON/BREAK` key.

☞   `O N`

```
10  REM  PROGRAM  + − ∗ ∕
```
```
20  INPUT"A, B" ; A , B
30  PRINT"A+B" ; A+B ;
Break
≥
```
```
40  PRINT"A−B" ; A−B
50  PRINT"A ∗ B" ; A ∗ B;
60  PRINT"A ∕ B" ; A ∕ B
```

When the ON/BREAK key is depressed, the LIST command is canceled, and listing cannot be resumed even if you want to list the next program line. To list the program again, the LIST command must be input again. This is very inconvenient.

In such a case, use the |CTRL| + |s| key instead of the |OI| keys. Listing of program is stopped, and when you want to see the next program line, depress the |RETURN| key to resume listing the program.

☞ |CTRL| + |S|

```
10  REM  PROGRAM  + − * ╱
```
```
20  INPUT"A , B" ; A , B
30  PRINT"A+B" ; A+B;
40  PRINT"A−B" ; A−B
```
```
50  PRINT"A * B" ; A * B ;
60  PRINT"A╱B" ; A╱B
```

It takes time to get the knack of using the |CTRL| + |s| keys so that listing will stop at the program line you want. Use the LIST@ command to list program lines one at a time so that you can study them in detail.

Type,

LIST@ **|RETURN|**

and the first program line is displayed. To display the next program line, depress a key (it can be any key, for example, the RETURN key). Depress a key again to display the next program line, and so on.

Now, if you list with LIST@ < line number > command, and depress the |ON/BREAK| key, "Break" is not displayed and the LCD is not scrolled. Use this method to correct a program line with more than 60 characters.

The LIST command can also be used to display only certain range of program lines.

If you type,

28

LIST 20-30 `RETURN`

Lines 20 to 30 of the program are listed.

```
LIST   20-30
20  INPUT "A , B" ; A , B
30  PRINT "A + B" ; A + B
≥
```

LIST 50- `RETURN`

```
LIST   50-
50  PRINT "A * B" ; A * B
60  PRINT "A ╱ B" ; A ╱ B
≥
```

LSIT -30 `RETURN`

```
10  REM  PROGRAM  + − * ╱
20  INPUT "A , B" ; A , B
30  PRINT "A + B" ; A + B
≥
```

LIST 50- lists program lines from Line 50 to the end. LIST   30 lists program lines from the beginning to Line 30. And, as explained before, if you do as below, only Line 20 is listed.

LIST 20 |RETURN|

```
LIST  20
20 INPUT`A , B" ; A , B
≥
```

1.4.5 Endless loop and out of control program execution

Please type the following program

```
10   PRINT "CANON"   |RETURN|
15   PRINT "X-07"   |RETURN|
20   GO TO 10   |RETURN|
RUN|RETURN|
```

The cursor disappers, "CANON" and "X-07" are displayed continuously, and nothing is accepted when typed from the keyboard. This is known as an "endless loop" of a program. In such a case, depress the |ON/BREAK| key.

Break in 10 (or Break in 15 or Break in 20)

Is displayed, and program execution is terminated.
When, for some reason, program execution goes wrong, use the |ON/BREAK| key in this way to terminate program execution. Sometimes, an endless loop might not be terminated when the |ON/BREAK| key is depressed. In such a case, depress the reset switch as the last resort. However, please keep in mind the following points:

30

How to use the reset switch

The reset switch puts into effect a very serious operation. When the reset switch is depressed, the CPU is reset, and memory is cleared entirely. Something which might be difficult to fully grasp, but please be sure to remember the following points.

When the reset switch is depressed, programs and data that were stored in the RAM file (explained later) might be lost. Also, the efforts you spent in setting graphic characters and user defined keys will all be wasted. Therefore, the reset switch should be used only as the last resort.

When an endless loop occurs, or program execution runs out of control, or when the X-07 malfunctions, first perform the following 2 steps.:

1. **Depress the ON/BREAK key to stop program execution.**
2. **Depress the OFF key. Wait for a while, and then, depress the ON/BREAK key.**

If the problem still remains, depress the reset switch. Refer to the illustration below for how to depress the reset switch.
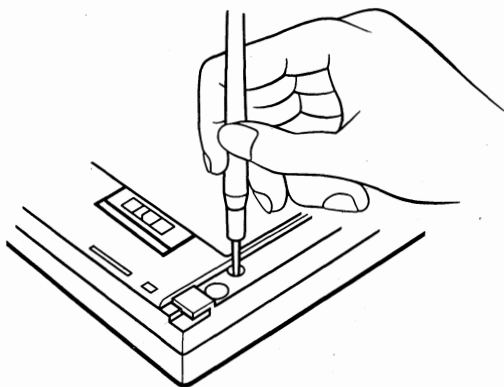
If the batteries have been changed without using the AC adaptor, the X-07 might malfunction. If so depress the reset switch.

1.5   Memory of the X-07

1.5.1   Saving programs

The previous sections explained the BASIC language and programs. Once a program has been created, it can be executed many times by using the RUN command. Accordingly, it is necessary to save the program in some way.
The contents of memory are not erased even when the power of the X-07 is turned OFF (they are not saved if the batteries are changed without using the AC adaptor). Therefore, at least one program can be saved. However, most of the time you would like to save several or even many programs.
With the X-07, such programs can be saved by using the following methods:

1)   Save programs in the RAM file.
2)   Save programs in 4K memory cards.
3)   Use a cassette recorder to record programs onto cassette tapes.

Methods 2) and 3) are explained in the later sections. This section explains how to save programs in the RAM file (1).

1.5.2 The RAM file and the text area

The area of memory which you can use is divided into the text area and the RAM file. The text area is where a program is edited and executed. We have not paid particular attention to this area, but all the previous programs were created and executed in this area. the RAM file is the area in memory for saving programs.

Let's save the previously created program into the RAM file.

```
10   REN PROGRAM + − */
20   INPUT "A , B"; A, B
30   PRINT "A + B";  A + B;
40   PRINT "A—B";A—B
50   PRINT "A*B"; A* B;
60   PRINT "A/B"; A/B
```

To save this program into the RAM file, first the size of the RAM file must be set.

FSET 1024 |RETURN|

Next, the program is saved with a name (called a "file name"). (Always save a program with a file name.)

SAVE "PROG1" |RETURN|

Now, the program is saved in the RAM file with the file name "PROG1".
The DIR command is used to make sure that the program has been saved in the RAM file.

DIR |RETURN|

The following is displayed on the LCD.

33

```
┌─────────────────────────────────┐
│                                 │
│  RAM :                          │
│  PROG 1      P                  │
│  1024╱889                       │
│  ≧                              │
│                                 │
└─────────────────────────────────┘
```

PROG1   P means that a program ("P") with the file name "PROG1" is sav-
ed in the RAM file. 1 0 2 4/8 8 9 means that the maximum size of the RAM
file is 1024 bytes, and that 889 bytes of unused area remains. A byte is an unit
of memory capacity, and one byte equals one character (alphabet, number,
etc.).
The size of the RAM file can be freely changed up to a certain range with the
FSET command.
Execute the FSET command as follows,

    FSET 4000 |**RETURN**|

and then, execute the DIR command.

    DIR|**RETURN**|

```
┌─────────────────────────────────┐
│                                 │
│  RAM :                          │
│  PROG 1      P                  │
│  4000╱3865                      │
│  ≧                              │
│                                 │
└─────────────────────────────────┘
```

The RAM file is as shown above.
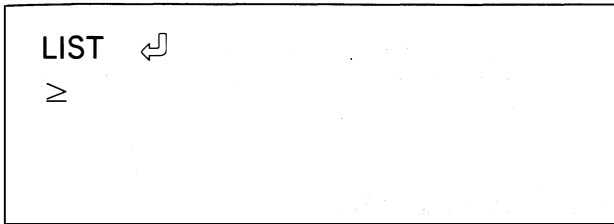
1.5.3 Erasing an old program

Even after a program has been saved in the RAM file, it is still retained in the text area. In order to create a new program, the old program in the text area must first be erased. This is accomplished with the NEW command.

NEW **RETURN**

Next, use the LIST command to check whether the program has been erased.

```
LIST  ↵
≥
```

Nothing is displayed; therefore, the program has been erased. Now, you can create another program. As the contents of the text area are retained even when the power is turned OFF, don't forget to erase an old program. If an old program is not erased, an unexpected trouble might arise. So, please be careful.

1.5.4 Loading from the RAM file

The LOAD command is used to load a saved program into the text area.

LOAD "PROG1" **RETURN**

Now, contents of PROG1 should have been loaded in the text area. To make sure, please execute the LIST command.
A program saved in the RAM file can also be executed without first loading it into the text area by using the RUN command.

```
RUN"PROG 1"  ↵
A, B?
```

With the RUN command, a program is not loaded into the text area.
Therefore, you can keep one program in the text area, and execute a program
in the RAM file.

1.5.5   Deleting unnecessary files

When programs are saved one after another into the RAM file, it will even-
tually become full, and a new program cannot be saved. Old, unnecessary files
must be deleted. For this purpose, the DELETE commands is used.

DELETE "PROG1", "P" RETURN

Next, use the DIR command to make sure that the program has been deleted.
The DELETE command, unlike the SAVE and the LOAD commands, is not
executed when

DELETE "PROG1" RETURN

So, please be careful.

1.5.6　File names and file types ·

In the X07-BASIC, a file is specified using the following format:

< file name > , [< file type >]

A file name is a string of up to 6 characters, and must be enclosed with double
quotation marks (" "). A file type is a letter from A to Z, also enclosed with
double quotation marks. (Please refer to the BASIC Reference Manual for the
meaning of the < > , [ ] symbols.)

"PROG1", "P"
"FILE", "D"
"CANON", "A"
"CIRCLE", "Z"

With the SAVE and the LOAD commands, when the < file type > is omitted,
it is assumed to be "P". With the DELETE command, it is assumed to be
"D".
It is convenient to classfy "P" as program files, "D" as data files, "A" as ...
yourself.

Note:　This section dealt only with filing programs. To file data, please refer
to the BASIC Reference Manual.

1.5.7　File related commands

Here is a summary of commands introduced in this section.

SAVE "file name"
Saves the program in the text area into the RAM file with a "file name".

LOAD "file name"

Loads a program in the RAM file indicated by a "file name" into the text area.

DELETE "file name", "< file type >"

Deletes an unnecessary file in the RAM file.

DIR

Lists the files saved in the RAM file.

RUN "file name"

Directly executes a program in the RAM file without loading it into the text area.

FSET < byte number>

Sets the size of the RAM file.

NEW

Erases the program in the text area.

1.6 The Keyboard and the LCD

1.6.1 The keyboard

The layout of the keyboard is as shown below.
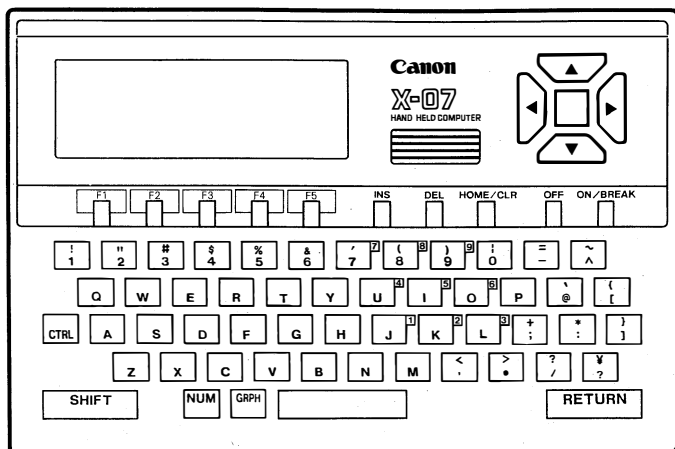
With exceptions, when a key is depressed, the letter or the symbol written on it is displayed at the cursor position on the LCD. Keys which do not write characters on the LCD have somewhat different purposes, and are called ''special keys''.

Keys which write characters have auto repeat functions (there are exceptions). When a key is depressed, approximately 1 second, the auto repeat function automatically inputs a character repeated at a fixed speed for as long as the character is depressed. Please try depressing the $\boxed{A}$ key for a short period.

Also, when a key is depressed, a "pip" is heard. This is called a "key click". This is for checking whether or not a key has been depressed completely. The key click function can be terminated and restored with the X07-BASIC CONSOLE command. For example,

CONSOLE „, 0 RETURN

Now, the key click has been terminated. To restore it, type

CONSOLE „, 1 RETURN

1.6.2 Functions of the special keys

The following explains the functions of the special keys.
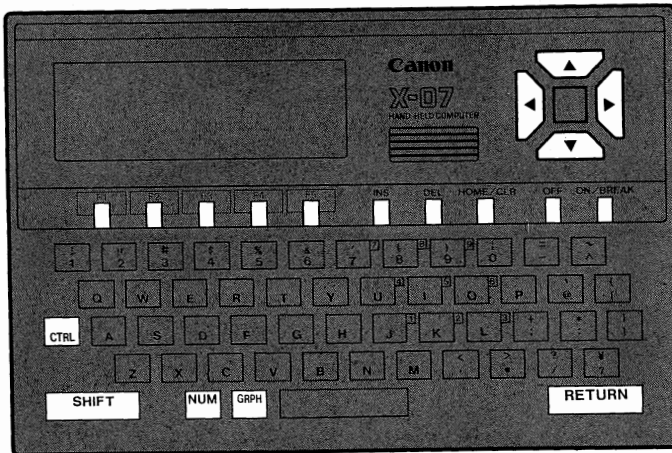
ON/BREAK	1) Turns ON the power, and starts the BASIC. 2) This is the Break key to be used during program execution and when program execution runs out of control. When this key is depressed, the X-07 goes into the first command waiting state.
OFF	Turns OFF the power.
SHIFT	Depress along with another key. For example, if you depress the **SHIFT** key along with the ⎢¦⎥ key, "!" is displayed. This key is same as the shift key of a typewriter.
CTRL	When depressed along with certain keys, it gives a command to the X-07 to move the cursor or cancel a command, etc. For details, please refer to the BASIC Reference Manual.
INS	Inserts a space between characters. Unlike ⎢ ⎥ (blank), characters are moved.
DEL	Deletes a character. The remaining characters are moved.
▶, ◀, ▲, ▼,	Move the cursor in the direction of the arrows. They have auto repeat functions.
HOME/CLS	Moves the cursor to the upper left corner. When it is depressed along with the SHIFT key , the LCD is cleared.
NUM	Puts the keyboard into the ten-key mode.
GRPH	Puts the keyboard into the graphic mode.
F1 to **F6** (**F7** to **F12**)	Function keys. Often used commands can be executed by depressing a function key. You can define which command corresponds to which key (use KEY$ function). Thus, they are also called ''user defined keys''. The F6 key is the square key at the middle of the cursor keys.
RETURN	Indicates input of commands or statements. The contents of a line are commands to the computer when this key is depressed.

1.6.3 Changing the mode of the keyboard

To input many different types of character with a compact keyboard, each key is set with several types of character. Which key is set to which character is referred to as the ''key mode''. A key will write a character in one key mode, and a different character in another key mode.

1) Alphanumeric mode
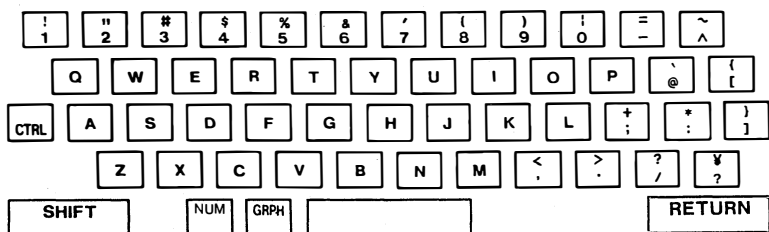
2) Graphic mode
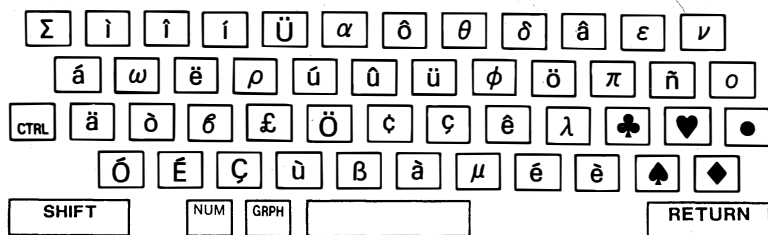
Note: In the graphic mode, the SHIFT, the F6 to F12 and the CLR keys do not function.

3) Ten-key mode
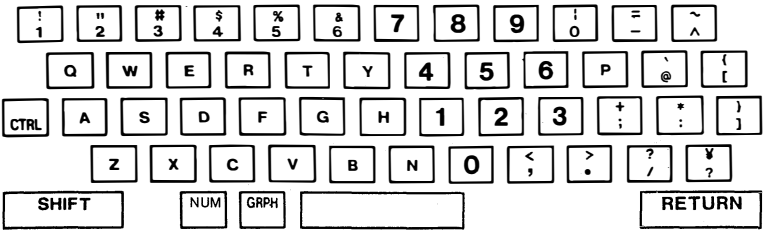
When the BASIC starts, the keyboard is set to the alphanumeric mode. The keyboard can be set to each mode by depressing the **GRPH** key (graphic mode) and the **NUM** key (ten-key mode). These keys need not be held depressed like the SHIFT key.

The key mode can be changed as follows.
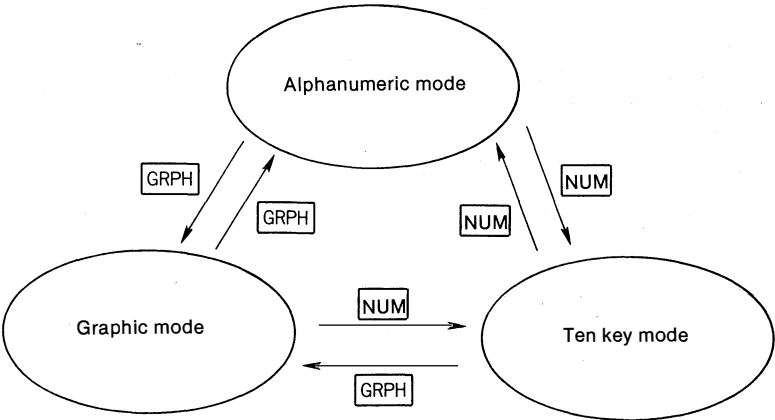
The CONSOLE @ command can also be used to change the key mode.

Alphanumeric mode CONSOLE @,,0
Graphic mode CONSOLE @,,2
Ten-key mode CONSOLE @,,3

Please refer to the BASIC Reference Manual for details.

1.6.4 The LCD

The LCD can function as a character display (20 characters × 4 lines) and as a graphic display (120 dots × 32 dots).

1) Text screen
When the screen displays characters, it is called a "text screen". The coordinates of the text screen are set as follows:
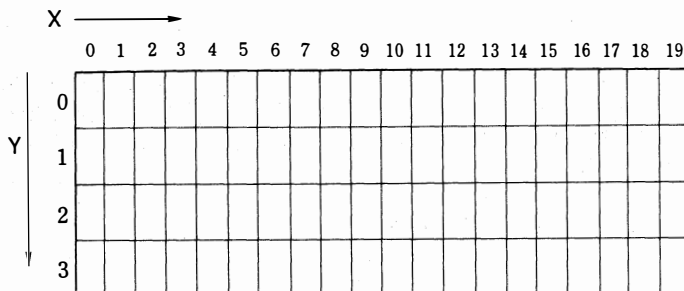
2) Graphic screen
The screen for drawing diagrams on the LCD is called a "graphic screen". The coordinates of the graphic screen are set as follows:
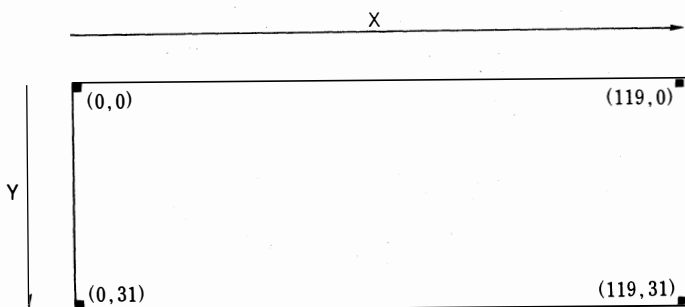
The upper left corner is the start point for both the text screen and the graphic screen. The LCD can also be used simultaneously as a text screen and as a graphic screen. Diagrams can be drawn over characters.

1.10.1 Graphic commands

Graphic commands of the BASIC language are used to draw diagrams on the LCD. Graphic related commands are as follows:

1) Draws a dot ....PSET (X, Y)
2) Erases a dot ....PRESET (X, Y)
3) Draws a line ....LINE (X$_1$, Y$_1$)   (X$_2$, Y$_2$)
4) Draws a circle........................CIRCLE (X, Y), R

The PSET and the PRESET commands draws and erases a dot at the specified X, Y coordinates, respectively. Basically, any diagram can be drawn with these two commands.

The LINE command draws a line between two specified sets of coordinates, (X$_1$, Y$_1$) and (X$_2$, Y$_2$). The CIRCLE command draws a circle with center at (X, Y) and radius of R.

Please execute the following commands.

1) **LINE (0, 0) − (119, 31)** $\boxed{\textbf{RETURN}}$
2) **CIRCLE (20, 20), 10** $\boxed{\textbf{RETURN}}$
3) **FOR N = 1 TO 31: PSET (30, N): NEXT N** $\boxed{\textbf{RETURN}}$

Please refer to the BASIC Reference Manual for details.

1.7 How to use a cassette recorder

1.7.1 Selecting a cassette recorder

By using a cassette recorder, files (programs, etc.) can be recorded onto and read from a cassette tape. The cassette recorder need not be of high class quality, but please make sure that it transports tape at a steady speed.

1.7.2 Connecting the cassette recorder

Please refer to the illustrations below, and connect the cassette recorder to the X-07.

Cassette recorder with a REMOTE jack
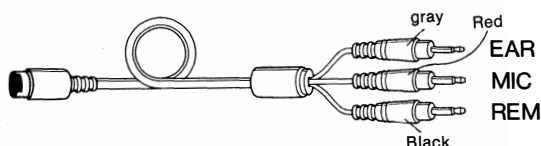
Cassette recorder without a REMOTE jack
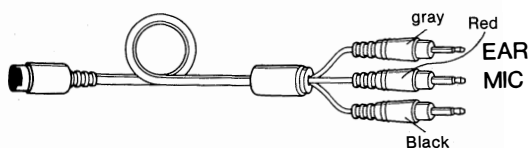
The connection cable should be connected to the X-07 with the arrow mark on the plug facing downwards.

1.7.3 A cassette recorder and the BASIC commands

The following commands are used to load, save, etc., a program using a cassette recorder.

1. CSAVE "file name"
Saves the program in the text area onto a cassette tape.

2. CLOAD "file name"
Loads a program saved on a cassette tape into the text area.

3. CLOAD? "file name"
Compares the program in the text area with a program on the cassette tape.

4. MOTOR $\left[\ \left|\begin{array}{l} \textbf{ON} \\ \textbf{OFF} \end{array}\right|\ \right]$

Controls the a cassette recorder motor with a REMOTE jack.

The above commands are generally used in the following order.

1. Save a program with the CSAVE command.
2. Rewind the tape, and then, execute the CLOAD? command to make sure that the program has been saved correctly.
3. Load the program with the CLOAD command.

1.7.4 Saving a program

Only the program in the text area can be saved onto a cassette tape. To save a program other than a just created program, load it first into the text area from the RAM file. For example, if there is a "CANON" file in the RAM file, type,

LOAD "CANON" RETURN
Next, ready the cassette recorder.

1) Rewind the cassette tape to the beginning.
2) Reset the tape counter.
3) Fast forward the tape a little (until the counter reads between 5 and 8) to avoid the transparent section of the cassette tape.

The beginning of a cassette tape is transparent (i.e. leader section), and nothing can be recorded on this section. This is why the tape must be fast forwarded. However, there are cassette tapes specially made for recording programs, and these cassette tapes do not have a transparent section. Such tapes need not be fast forwarded.

When using a partially recorded cassette tape, fast forward the tape to the blank portion, and make sure that you note the tape counter position.

Next, set the cassette recorder to the recording mode, and then, execute the CSAVE command.

CSAVE "FILE" **RETURN**

In this procedure, the "CANON" file which was saved in the RAM file was loaded into the text area, and then, saved onto the cassette tape with the file name "FILE".

When the program has been saved, the cassette recorder is stopped, and the cursor ($\geq$) is displayed on the LCD.

```
CSAVE"FILE"  ⏎

≥
```

1.7.5   On the REMOTE jack

The previous procedure was for a cassette recorder with a REMOTE jack.

There are many different types of cassette recorder, from cassette recorders exclusively for recording data to simple cassette recorders without a REMOTE jack.

When using a cassette recorder without a REMOTE jack, first put it into the recording mode, and then, type,

CSAVE "FILE" **RETURN**

Next, after the program has been saved, stop the cassette recorder when the cursor is displayed on the LCD.

This extra procedure is not necessary when using a cassette recorder with a REMOTE jack. Just fast forward the tape a little, and then, depress the

"REC" button. The cassette recrder starts recording as soon as the CSAVE command is executed, and stops recording automatically when a program is saved.

There are cassette recorders which cannot fast forward or rewind the tape when it is in the REMOTE mode. In such a case, the MOTOR command is quite useful.

When,

MOTOR ON RETURN

is typed, the tape can be rewound or fast forwarded even when the REMOTE jack is connected. In other words, the REMOTE mode is canceled when this command is executed. After fast forwarding or rewinding the tape to the desired position, return to the REMOTE mode by typing,

MOTOR OFF RETURN

and,

CSAVE "FILE" RETURN

Once the program has been saved, the cassette recorder is automatically stopped, and the cursor is displayed on the LCD.

1.7.6 How to verify a program

Once a program is saved, it should be checked to make sure that it was saved correctly. This is because cassette recorders and cassette tapes are not made to record programs, and distortions can be added when they are used to perform such functions.

The CLOAD? command is used to verify a program.

First, rewind the tape to a position a little before the beginning of the program. Next, set the cassette recorder to the playback mode. If the REMOTE jack is connected, the cassette recorder will remain in the stop mode. Next, type,

CLOAD?   **"FILE"**   **RETURN**

             File name

The cassette tape begins to move, and soon, the following is displayed:

```
Found : FILE
```

The above display means that the program with the file name "FILE" has been saved correctly.

If a program has been saved correctly, no message is displayed, the cassette recorder is stopped (if in the REMOTE mode), and the cursor is displayed. If the saved program does not match the program in the text area, "Bad" is displayed and the cassette recorder is stopped. In such a case, you must resave the program.

To execute the CLOAD? command when using a cassette recorder without a REMOTE jack, type,

CLOAD? **RETURN**

and then, put the cassette recorder into the playback mode.

1.7.7 Loading a program

The CLOAD command is used to load a saved program from a cassette tape. First, load the cassette tape into the cassette recorder. Use the tape counter, and fast forward the tape to a position a little before the beginning of the program you want to load. Next, set the cassette recorder to the playback mode (when the REMOTE jack is connected). Then next, type,

CLOAD   **"FILE"**   **RETURN**

                 File name

The cassette tape begins to move, and a little later, the following is dislayed:

```
Found : FILE
```

After the program has been loaded, the cassette recorder is automatically stopped, and the cursor is displayed on the LCD.
When using a cassette recorder without a REMOTE jack, proceed in the same way as when saivng a program.

1.7.8 Troubleshooting

Ordinary cassette recorders and cassette tapes are not made to be used for recording programs. Therefore, please keep the following points in mind in order to avoid problems.

On cassette recorders

1) Set the volume and the recording level controls a little beyond their center positions. If they are set too low, distortion might result, and if they are set too high, there might be oversaturation.

2) Loading and saving should be executed at same signal level.

3) During playback, the high tone control should be set relatively high in order to pick up information in the high frequencies.

4) Use the same cassette recorder for saving and loading. Different cassette recorders transport the tape at slightly different speeds. You may not be able to load a program if they do not match.

5) Same thing might be true when using a cassette recorder with new batteries and when using the same cassette recorder with old batteries.

6) Noise might result from the MIC jack of some cassette recorders with automatic recording level control. In such a case, unplug the MIC jack.

7) Some REMOTE jacks do not match the REMOTE plug of the connection cable. In such a case, follow the procedure for a cassette recorder without a REMOTE jack.

On cassette tapes

You can buy, on the market, cassette tapes made exclusively for recording programs. Such cassette tapes have no leader tape section and are short, so there is no need to search for a program. They also have other features which make them suitable for recording programs. However, it is recommended that you buy cassette tapes made by a reputable maker.
When using ordinary cassette tapes, please keep the following points in mind.

1) Use cassette tapes of good quality, made by reputable makers. They need not be chrome or metal tapes.

2) It is more convenient to use short cassette tapes. C30 cassette tapes are better than C120 cassette tapes.

3) Use new cassette tapes. Old cassette tapes might have scratches which can distort signals.

4) When reusing an already recorded cassette tape, make sure that you erase the tape completely. Unexpected error might result when there are signals left from previous recording.

Other problems

Here are some points you should keep in mind when recording a program.

1) Make an extra copy of important recordings. If you damage or lose one copy, you will still have the spare copy.

2) Store cassette tapes in a cool place, relatively free of dust and humidity. High temperature, humidity and dust might warp the cassette tapes. Also, keep them away from magnetic fields and motors which can scramble the signals.

3) The life of a cassette tape is several hundred times of use. Please keep this in mind when using an often used program.

4) If a program cannot be loaded properly, use another cassette recorder. And, if it is loaded properly, resave it with your cassette recorder again.

Programs are valuable assets. Please take good care of them.

2
Special functions
and
peripheral devices
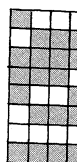
Table of contents for Chapter 2

This chapter explains how to use the special functions (timer, alarm, etc.) of the X-07 and its peripheral devices (printers, utility cards, optical coupler,etc.). When using a peripheral device, please read its instruction manual carefully.

2.1 Special functions of the X-07

2.1.1. The timer

There is a timer inside the X-07 which functions even when the power is turned OFF. To read the contents of the timer, type

```
PRINT  TIME$   ↵
15 : 33 : 36
 ↓   ↓   ↓
Hr. Min. Sec.
```

The BASIC processes the values of the timer as values of function. Therefore, to process values of the timer, use character string functions such as MID$, RIGHT$, LEFT$, VAL, etc.

The assignment instruction is used to set the timer. For example, let's set the timer to a.m. 11 hours, 26 minutes and 33 seconds.

TIME$ = "11:26:33" RETURN

The timer can be set directly from the keyboard or as a statement in a program with a line number. The time is assigned to the TIME$ function when the RETURN key is depresed.

When setting the timer, the hours, the minutes, and the seconds can be omitted as follows.

TIME$ = "13: :" (Hours)
TIME$ = ":23:" (Minutes)
TIME$ = ": :33" (Seconds)

2.1.2. The calendar

The X-07 has a built-in calendar which functions in conjunction with the timer.
To read the contents of the calendar, type,

```
PRINT  DATE$    ↵
83/03/03, THU
 ↓    ↓    ↓      ↓
Yr. Mon. Day. Day of wk.
```

DATE$, like TIME$, is handled as a function, and again, the assignment
instruction is used to set the calendar.

DATE$ = "1983/5/5" RETURN

Please note that when the year is set, it must be typed fully in 4 digits.
However, it is displayed in 2 digits. Also, you do not have to set the day of the
week. It is automatically calculated by the X-07.

2.1.3   The alarm

The X-07 also has a built-in alarm which functions in conjunction with the calendar and the timer. It can be set as a wake-up alarm or to automatically turn ON the power.

In order to use the alarm, the alarm switch must first be turned ON. This is accomplished by executing CONSOLE @ 1.

Next, let's set the alarm. For example, type

ALM$ = "1983/3/3/255/12/30" RETURN

<div style="padding-left:5em;">Year　Month　Day　Day of week　Hours　Minutes</div>

and the alarm will sound at 12:30 a.m. of March 3, 1983.

However, the years, the month, the hours, the day, the day of the week, the hours, and the minutes can be omitted.

ALM$ = "/////30" RETURN

In the above example, the alarm will sound at 30 minutes of every hour of the clock.

ALM$ = "////12/30" RETURN

In this example, the alarm will sound every day at 12:30 a.m.

The alarm sounds for one minute. To stop the alarm, depress the CTRL + S keys.

To check the time at which the alarm is set, type

PRINT ALM$ RETURN
//**,****, 12:30

Setting the alarm is somewhat complicated. So, let's look at each parameter in detail.

< **year** >　Type a number 4 digit long.
< **month** >　Type a number between 1 and 12.
< **day** >　　Type a number between 1 and 31.

< day of week >

This is somewhat complicated.

	Decimal form	Hexadecimal form
Sunday	64	&H40
Monday	32	&H20
Tuesday	16	&H10
Wednesday	8	&H08
Thursday	4	&H04
Friday	2	&H02
Saturday	1	&H01

should be typed. For example, to sound the alarm on Monday, Tuesday and Wednesday, type 56 (32 (Mon.) + 16 (Tues.) + 8 (Wed.)).

< **hours** >　Type a number between 0 and 23.
< **minutes** >

Type a number between 0 and 59.

The parameters may be separated by commas (,), semi-colons (;) or slashes (/). You can also use a combination of these symbols. However, all the parameters must be enclosed with double quotation marks (" "). For example, to sound the alarm Monday through Friday, every week at 7:20 a.m., type,

ALM$ = "///62/7/20" RETURN

2.1.4. Start program

The X-07 can be set to execute a program when the power is turned ON. Such a program is called a "start program". The functions and the command related to the start program are as follows:

SLEEP
START$
OFF

Please refer to the BASIC Reference Manual for details about these functions and command. Here, only a simple example of how to set a start program is given.

First, with the power turned ON, input the following program.

10 CLS
20 PRINT "WELCOME TO X-07"
30 PRINT DATE$
40 PRINT TIME$

Next, type,

START$ = "RUN" + CHR$(13) `RETURN`
OFF 1 `RETURN`

The power is turned OFF, and the display is erased off the LCD. Now, turn ON the power.

```
WELCOME TO X-07
    83/03/03,  THU
    13 : 01 : 33
```

is displayed. In this way, the program in the text area can be automatically executed when the power is turned ON.

Let's look at this operation in detail. START$ is a function which gives to the X-07 the commands to be executed when the power is turned ON. In the above example,

START$ = "RUN" + CHR$(13)

When the power is turned ON, it is same as typing,

RUN`RETURN`

In other words, it is as though the character string stored in the START$ function is typed on the keyboard for you. (CHR$(13) is the control code for carriage return.)

The OFF 1 command is a command which instructs the X-07 to execute the start program. If the OFF 2 command is typed, when the power is turned ON, nothing happens even if the START$ function is set. The OFF 1 and the OFF 2 commands do not change when the OFF key is depressed.

2.1.5   User defined keys (function keys)
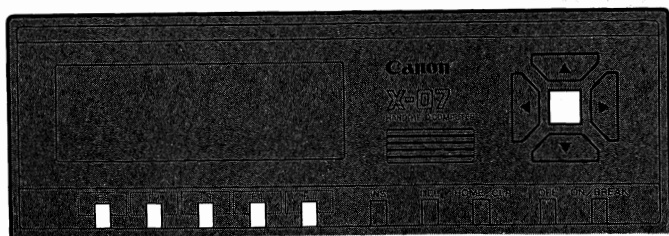
The `F1` to `F6` keys are at the upper part of the keyboard. These keys execute often used commands when depressed once. When the `F1` to `F6` keys are depressed along with the `SHIFT` key, they become `F7` to `F12` keys. In other words, there are total of 12 user defined keys.

F1	**?TIME$ + CHR$(13)**	Displays the actual time on the LCD.
F2	**CLOAD"**	Complete this command by typing the file name, and then, depress the RETURN key to execute the CLOAD command.
F3	**LOCATE**	Moves the position of the cursor.
F4	**LIST**	This is the LIST command. The RETURN key must be depressed.
F5	**RUN + CHR$(13)**	Executes the program in the text area.
F6		This key is not set.
F7	**?DATE$ + CHR$(13)**	Displays today's date on the LCD
F8	**CSAVE"**	Complete this command by typing the file name, and then, depress RETURN key to execute the CSAVE command.
F9	**PRINT**	Complete this command by typing what you want calculated or displayed, and then, depress the RETURN key to execute the PRINT command, This key is same as the $\boxed{?}$ key.
F10	**SLEEP**	Next, depress the RETURN key, and variables and displays are retained even when the power is turned OFF.
F11	**CONT**	This is the CONT command.
F12		This key is not set.

Try the $\boxed{\text{F1}}$ key. Next, try the $\boxed{\text{F7}}$ key ($\boxed{\text{SHIFT}}$ + $\boxed{\text{F1}}$). If there is a program in the text area, depress the $\boxed{\text{F4}}$ key, and then the $\boxed{\text{RETURN}}$ key. Would you like to try the $\boxed{\text{F5}}$ key?

You can quickly find out which key is set with which command by executing the following command.

CONSOLE ,,1 $\boxed{\text{RETURN}}$

```
◆tim      ◆cld      ◆loc      ◆lst      ◆run
```
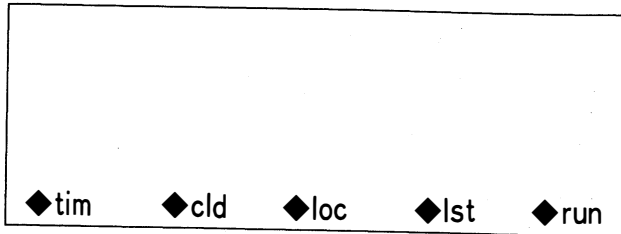
Next, keep depressing the $\boxed{\text{SHIFT}}$ KEY.

```
◆dat      ◆csv      ◆prt      ◆slp      ◆cnt
```
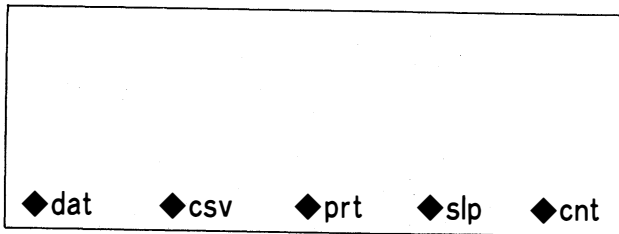
It's nice to be able to see the command of each key. However, you can now use only 3 lines of the LCD. To erase the display, type,

CONSOLE ,4,0 $\boxed{\text{RETURN}}$

The functions of the user defined keys can be changed freely by the user. For example, when the **F4** key is depressed,

LIST_

is displayed on the LCD. However, in order to execute this command, you must depress the RETURN key. Let's change the **F4** key, so that when it is depressed, it will automatically execute the LIST command. Type,

KEY$(4) = "lstLIST" + CHR$(13) **RETURN**

Now, try the **F4** key. This time, the LIST command is executed without depressing the RETURN key. Let's look at the KEY$ funtion in detail.

KEY$(4) = "lst LIST" + CHR$(13)

Control code for carriage return

Key number   Command
          Characters displayed on the LCD
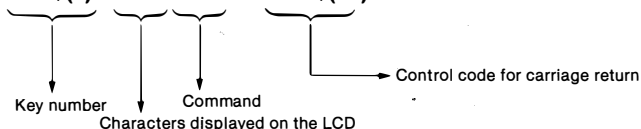
The KEY$ function is as shown above. The argument of the KEY$ function is the number of the user defined key. The first three characters of the character string enclosed in double quotation marks are displayed at the bottom of the LCD when the CONSOLE command is executed to display which user defined keys are set with which commands. The rest of the characters constitute a command, and are displayed at the cursor position on the LCD when the user defined key is depressed. The CHR$(13) is the control code for carriage return. When this is omitted, you must **F4** **RETURN** as before to execute the LIST command.
The definition of the KEY$ function can be confirmed by using the PRINT command.

PRINT KEY$(4) **RETURN**

The user defined keys can be set not only with often used commands, but also with often used statements or numeric values.

2.1.6 Playing back a melody (BEEP)

The mini magnetic speaker of the X-07 can playback various tones, and even the length of each tone can be set. Therefore, you can compose a melody and use the X-07 as an electronic music box.
The BEEP command makes the speaker generate sound. Try the following:

BEEP 13,20 RETURN

The BEEP command changes the sound generated by the speaker according to two parameters.

BEEP <tone>,<length>
When the tone is 0, sound is not generated, and 1 to 48 correspond to the do, re, mi, fa, so la, si, and do of the music scale, and increase by a half-tone. As for the length of the tone, greater the value of the parameter, longer the length of the tone.

```
C~B  C  C#  D  D#  E  F  F#  G  G#  A  A#  B  C~B
do~si do     re     mi fa     so     la     si do~si
       :   :   :   :   :   :   :   :   :   :   :
       13  14  15  16  17  18  19  20  21  22  23  24
                    First parameter of BEEP
```
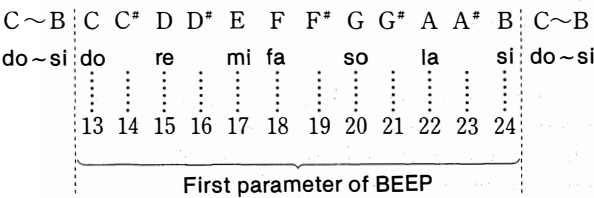
The relationship between the first parameter of the tone and BEEP is as shown above. The first parameter is as shown above for 1 to 48, and sound can be generated in 4 octave ranges.
The second parameter specifies the length of the tone, The actual length is set as follows:

<length> = <second parameter> x50 msec

Accordingly, when the value of the second parameter is 20, 20x50 msec = 1000 msec. In other words, one second.
Therefore, BEEP 13,20 generates "do" for one second. Also, BEEP 0,n can be used as "rest".
For details, please refer to the BEEP command program sample in the BASIC Reference Manual.

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2.1.7 How to use graphic characters

You can define a character (symbol) yourself by using the FONT$ function.
You can define character codes between 128 and 159, and between 224 and 255.
The FONT$ function is used as follows:

**FONT$ (< expression >) = "< variable 1 >, < variable 2 >, ...
< variable 8 >"**

The < expression > specifies the character code to be defined.
To define the character code 128, type,

FONT$(128) = "< variable 1 >, ...,< variable 8 >" RETURN

As the < variable 1 > to < variable 8 > (< data 1 > to < data 8 >) can usually
be constants, they are decided with a diagram.

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
< data 1 >	0	0	0	0	0	0	0	0
< data 2 >	1	1	1	1	1	0	0	0
< data 3 >	1	0	1	0	1	0	0	0
< data 4 >	1	1	1	1	1	0	0	0
< data 5 >	1	0	1	0	1	0	0	0
< data 6 >	1	1	1	1	1	0	0	0
< data 7 >	0	0	0	0	0	0	0	0
< data 8 >	0	0	0	0	0	0	0	0

Part which is displayed.
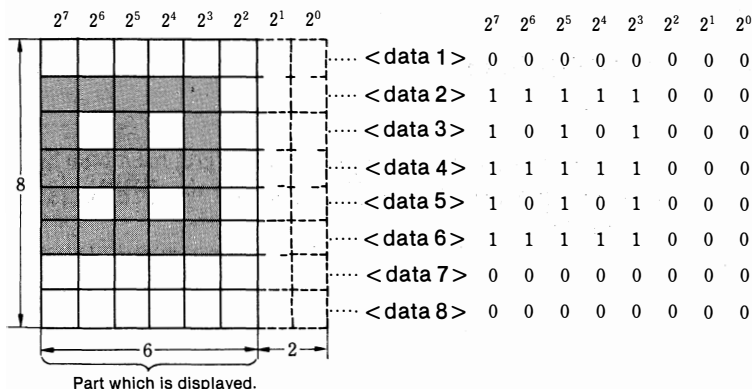
In the above example,

	Binary form	Hexadecimal form	Decimal form
< variable 1 >	= 00000000 (2)	= &H00 =	0
< variable 2 >	= 11111000 (2)	= &HF8 =	248
< variable 3 >	= 10101000 (2)	= &HA8 =	168
< variable 4 >	= 11111000 (2)	= &HF8 =	248

. . . .

Accordingly, to define such a character, type

FONT$(128) = "&H00, &HF8, &HA8,
                 &HF8, &HA8, &HF8,
                 &H00, &H00" RETURN

Use the CHR$ function to make sure that the character was defined correctly.

PRINT CHR$(128) RETURN

The FONT$ function can be in a statement, and if variables are used instead of constants to define the FONT$ function, it can be used in many interesting ways.

The CONSOLE @ command is used to clear the once defined character, and restore the previous character.

CONSOLE @ ,1 RETURN

Let's check.

PRINT CHR$(128) RETURN

♠

The character code 128 corresponds to the ?/ key in the graphic mode. Set the character code to another character, and then, depress the **GRPH** , ?/ keys. How did it turn out?

2.2 Peripheral devices

2.2.1 Many peripheral devices can be connected

Many peripheral devices can be connected to the X 07, such as a printer, an optical coupler, a RS-232C level convertor, utility cards, etc., to further extend its functions. This chapter gives a summary of these peripheral devices.

2.2.2 The list of main peripheral devices

Here is a list all the optional peripheral devices which are available or will be available with the X-07.

* Please note that the peripheral devices described here not yet available might be different when they actually come on the market.

Optical Coupler (X 721)

Thermal Printer (X-711)

Extension bus line

RS-232C Level Convertor (X-722)

80 unit standard printer which conforms to Centronics specifications

Color Graphic Printer (X-710)

Data recorder

Utility card
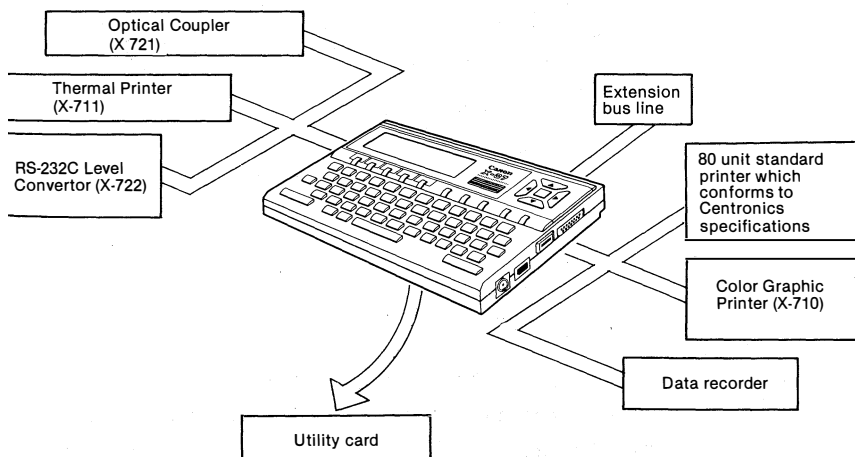
2.2.3 The main peripheral devices

This section goes into some details about the representative perhipheral devices of the X-07.

1. Color Graphic Printer (X-710)

This is a 4-color switchable X-Y plotter type printer. It is compact and can be carried anywhere.

Not only does the X-710 print out program lists and results of calculations, but as a X-Y plotter, it draws various diagrams
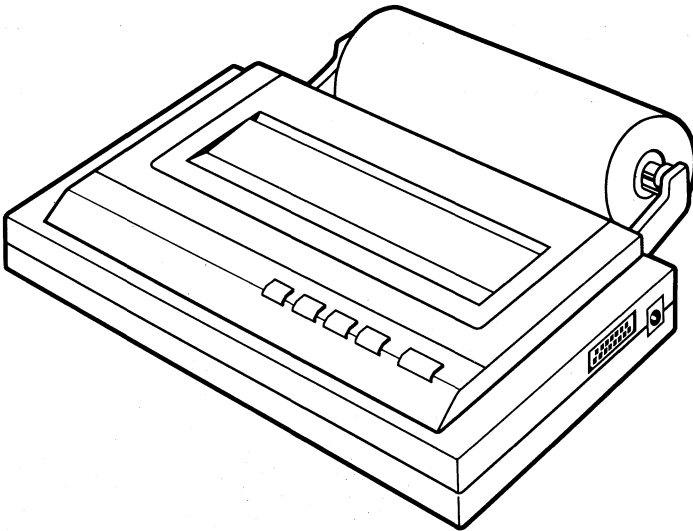
Specifications

Paper	**Conventional 114 mm width printer paper**
Printing	**16 modes (smallest character: 80 characters/line)**
Graphics	**X-Y plotter**
Interface	**Centronics specifications**
Batteries	**Ni-Cd**
Printing speed	**10 chracters/second (smallest character)**
Dimensions	**200 (W) $\times$ 35.5 (H) $\times$ 120 (D) mm**
Weight	**570 g.**

2. Thermal Printer (X-711)

This is a compact thermal printer which is used to print out program lists and results of calculations.
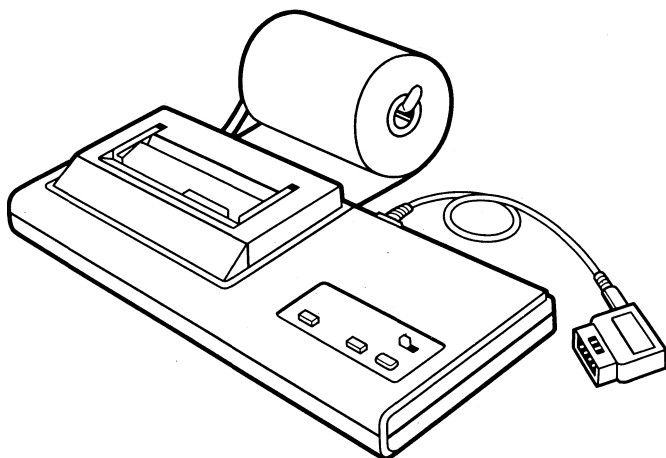
Specifications

System	**Thermal printer**
Printing	**10 characters/line (large), 20 characters/line (standard), 35 characters/line (small)**
Printing speed	**20 characters/second**
Paper	**Exclusive 57 mm width thermal roll paper**
Batteries	**Ni-Cd**
Dimensions	**194.5(W) × 30(H) × 87.5(D) mm**
Weight	**420g.**

3. Utility cards

Inside the compact cards, the size of a credit card, there are 8K byte ROM or RAM (planned). 4K memory cards (4K RAM cards) have a lithium battery for back-up power. Therefore, their contents are retained even when they are taken out of the X-07. Application cards (ROM cards) are available as mask ROM for each type of application. CANON program cards (ROM/RAM cards) which incorporate both ROM and RAM are also available.

Dimensions   **85.5(W) x 2.9(H) x 54(D) mm (applicable to all cards)**
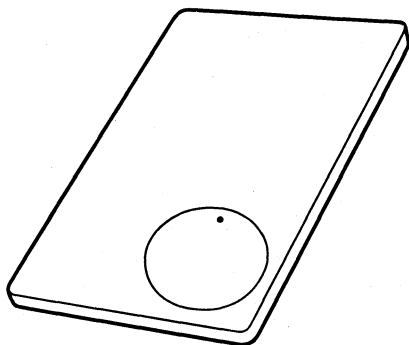
1) CANON program cards (ROM/RAM cards)
The CANON program cards incorporate 8K mask ROM and 4K CMOS RAM. They also include application software and work area.

Specifications
8Kbyte mask ROM
4K byte CMOS RAM
Lithium battey (Life: over 1 1/2 yr.)

2) Memory cards (RAM cards)
The memory cards are used to store your programs and data. There are two types: 4K RAM (with battery back-up) and 8K RAM (with battery back-up, planned). Programs and data can be saved and loaded much faster than with a cassette recorder. They are also compact so that they can be carried around easily. The RAM cards have a battery back-up so that their contents are retained even when they are removed from the X-07.

Specifications
4K byte CMOS RAM
Lithium battery (Life: over 1 1/2 yr.)

8K byte CMOS RAM (for memory extension)
Lithium battery

3) Application cards (ROM cards)

Application cards contain application programs. These programs can be used simply by inserting a card into the X-07.

Specifications
8K byte mask ROM

4. Optical Coupler (X-721)

This device changes the output from the serial terminal into infrared rays for cableless communication with another X-07 or other peripheral devices.
The transmitting/receiving section is designed so that its directivity can be changed easily.

Specifications
System

Possible area of communication	**Infrared ray data transmission/reception Indoor, 5m in direct Line**
Data format	**Asynchronous serial method**
Baud rate	**Serial 1200 (standard), switchable**
Power supply	**From X-07**
Dimensions	**60 (W) x 98 (H) x 45 (D) mm**
Weight	**80 g.**
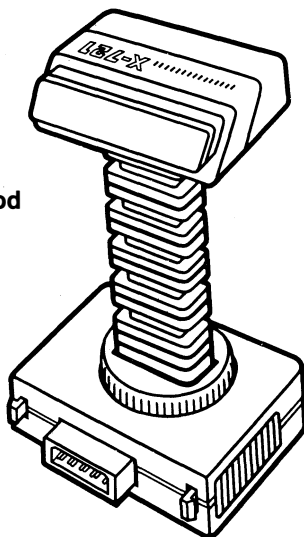
5. RS-232C Level Convetor (X-722)

This device converts the outputs of the Optical Coupler X-721 or of the serial terminal to RS-232C signals.
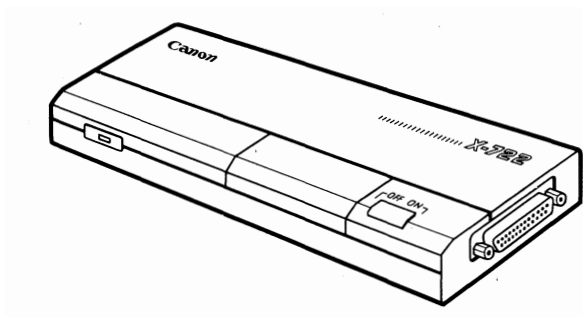
Specifications

Power supply	AA x 4 batteries or AC Adaptor AD-4
Dimensions	200 (W) x 26.5 (H) x 86 (D) mm
Weight	190 g.

2.3　How to use utility cards

2.3.1　Four types of utility card

The compact utility cards hold a special place among the peripheral devices of
the X-07. There are four types of utility card: 4K memory cards (4K RAM
cards), 8K memory cards (8K RAM cards), CANON program cards
(ROM/RAM cards), and application cards (8K ROM cards). This section
covers the usage of these cards.

2.3.2　How to insert a utility card

The utility card compartment is located on the bottom of the X-07.
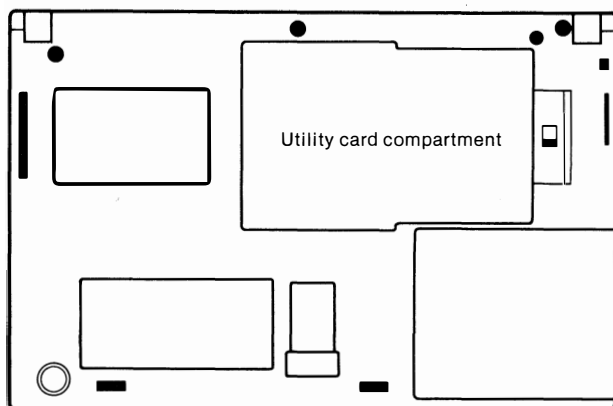
*Remove the utility card before changing the batteries of the X-07.

First turn OFF the power, and then, proceed as follows:

1) Set the lock switch to OFF.
*When this switch is set to OFF, the
power is turned OFF.
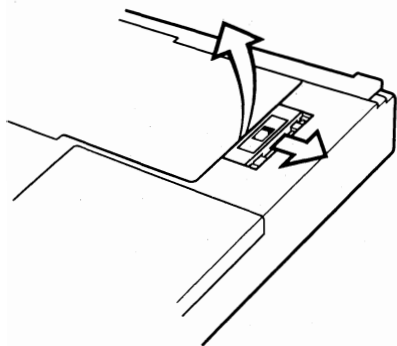
2) Pull the lock switch in the
driection of the arrow, and
3) remove the cover.

4) The utility card
compartment is as
shown.
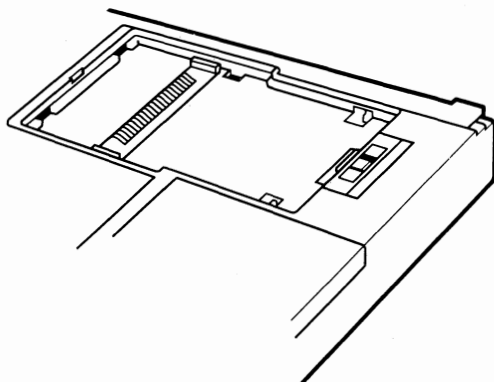
5) Insert a utility card with the battery side facing up.
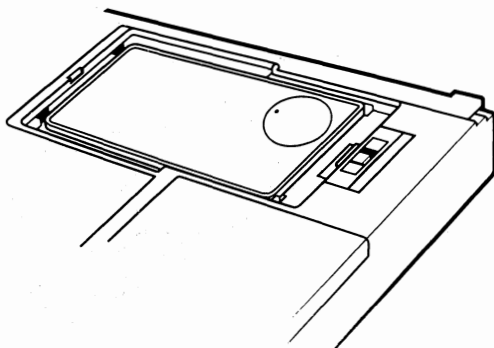
6) To replace the cover, push down the cover and set the lock switch to ON.
   Caution: Make sure that you insert the utility card properly. If it is inserted improperly, the contents of memory might be destroyed.

2.3.3   How to change the battery of a memory card

The procedure for changing the lithium battery of a 4K memory card (4K RAM card) is as follows:
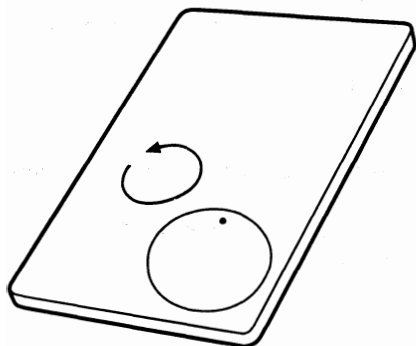
1) Remove one of the screws on the card.

2) Push in the round battery compartment cover, and turn it counterclockwise (↺) until the cover lifts. Remove the cover and change the battery. Replace the cover and turn it clockwise(↻).

3) Replace the screw.

Battery compartment cover

Lithium battery
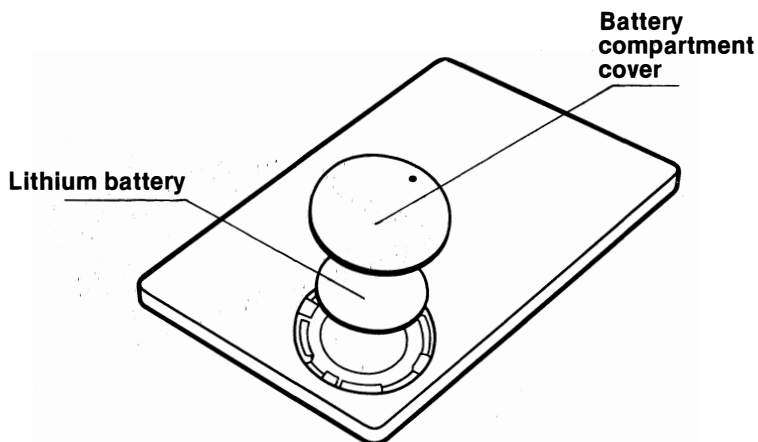
Attention: When the battery level of the memory card is low, the following message is displayed on the LCD.

Card Low battery

In such a case, change the battery.

2.3.4 How to use memory cards

The 4K memory cards (4K RAM cards) have 4K CMOS RAM,and a battery for back-up power. Therefore, stored programs and data are retained even when they are removed from the X-07.
We will now explain how to use these cards.

RAM file
We quickly covered the RAM file in Chapter 1. Let's now look at it in more detail.
Please keep in mind that an ''address'' is used to find out what is stored in which part of memory. An address is very similar to a city address.

The size of the RAM area of the X-07 is 8K bytes when the X-07 is used by itself. The RAM area is the area in memory which the CPU can freely write into. The area from the upper part of the RAM area (from the youngest address) is reserved for the text area. The RAM file is reserved an area specified by the FSET command from the lower part of the RAM area.
Please look at the diagram below.
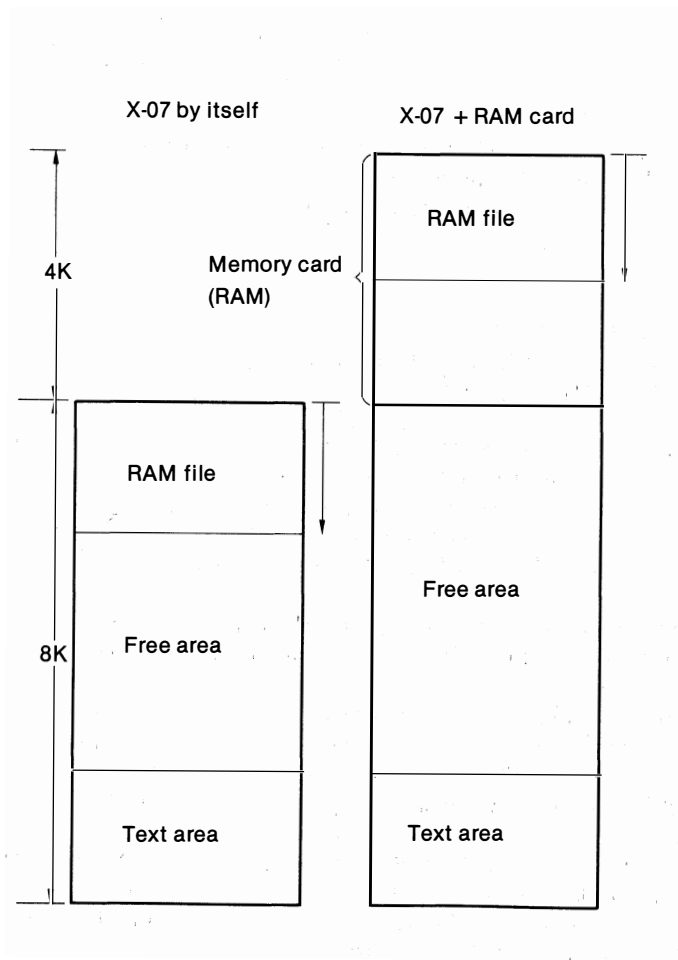
As shown in the diagram, when a RAM card is inserted, addresses are reserved in continuation with the 8K RAM area of the X-07.
Previously, we reserved 1024 bytes for the RAM file.

FSET 1024 `RETURN`

The location of the reserved RAM file is different when a RAM card is inserted and when it is not. When a RAM card is not inserted, the area for the RAM file is reserved from the highest address of the RAM area. When a RAM card is inserted, it is reserved from the highest address of the RAM card.

To file into a RAM card
To store programs and data into a RAM card, the RAM file must be created with the RAM card inserted inside the X-07.
Here is the procedure for saving a program from the text area into a RAM card.

1. Insert the RAM card.
2. **FSET 4096** `RETURN`
3. Create a program or load a program into the text area.
4. **SAVE "PROG1"** `RETURN`

In step 2, we set the RAM file to 4096 bytes. However, it can by any number as long as it is less than 4096. But, don't make it so small that the set area cannot accommodate a program. On the other hand, if you set it too large, you won't be able to read the contents of the RAM card afterwards. To avoid such problems, please keep the following points in mind.

Points to keep in mind when using a RAM card
The size of the RAM file is set by the amount specified by the FSET command.
This area is reserved from the highest address of the RAM area. Accordingly, everything is fine as long as the status of the RAM area is always the same (i.e. same type of memory card is always used). However, problems can arise if you use the X-07 sometimes with a memory card and other times without a memory card.
For example, let's say that you created a RAM file without inserting a RAM card. Then, you inserted a RAM card which already contains a RAM file. What you have now is two RAM files. The RAM file in the RAM card and the old RAM file you created before you inserted the RAM card.

When the RAM card has just been inseted | When FSET is more than 4096

X-07 by itself

4K — 4096 (4K) bytes

RAM file of RAM card

Just inserted RAM card

More than 4096 bytes of RAM file area

RAM file

Old RAM file

Part of X 07's RAM area

8K
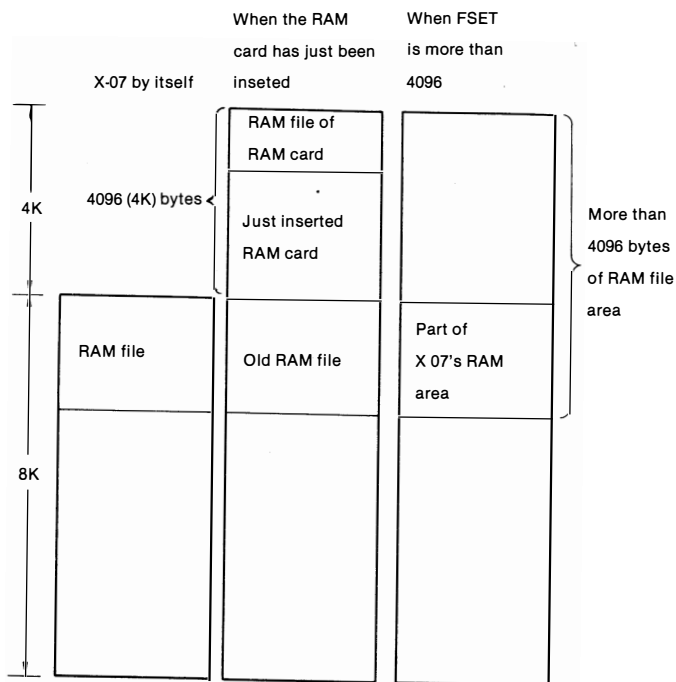
The BASIC system searches for the RAM file from the highest address of the RAM card's RAM area, and therefore, it will not be able to locate a program. At this point, when the power is turned ON, the following message is displayed.

Create System?

The above message indicates that the structure of the RAM file is odd, and that the BASIC system cannot process the RAM file. In such a case, input Y, and depress the RETURN key to destroy the old RAM file in the X-07.
If you do not want to destroy the contents of the RAM file, turn OFF the power, and then, remove the RAM card. Save the contents of the old RAM file onto a cassette tape, and then, reinsert the RAM card.

Create System?

is again displayed. Next,

Y RETURN

Now, the old RAM file has been cleared, and you can reserve a RAM file in the RAM card.

The "Create System?" message is also displayed if a different card with a different size of RAM file area is inserted. Depress Y RETURN when "Create System?" is displayed, and the RAM file will be reserved according to the size memorized inside the card. "Create System?" will again be displayed if a key other than Y is depressed. Depress the OFF key, and the RAM file inside the card will be destroyed.

However, when the RAM file is set to over 4096 with the FSET command, as shown in the previous diagram, the RAM card is not large enough, and the beginning of the RAM file takes up part of the X 07's RAM area. If you remove the RAM card, and then, turn ON the power, the following is displayed.

 # FS Error
Create System?

This means that latter half of the RAM file (inside the card) is missing.
In this state, the RAM file is initialized and the former half of the RAM file is destroyed. Please remember that when the set size of the RAM file area is greater than the size of the RAM card (4K), contents of the RAM file cannot be read when the card is removed.

Also, during program execution if the power is turned OFF with the SLEEP instruction, and you remove the RAM card, the following message is displayed when the power is turned ON again.

 # MC Error
Create System?

If you input Y, "Create System?" is redisplayed, and the BASIC system will start when you input Y again.

2.3.5 Application cards and CANON program cards

When an application card is inserted, the X 07 is controlled by the software contained in the application card. When the power is turned ON with an application card inserted, an utility program other than the BASIC might start. This also applies when a CANON program card is inserted.

Therefore, before using an application or a CANON program card, always read its instruction manual.

2.4 How to use the Color Graphic Printer X-710

2.4.1 Color Graphic Printer X-710

The Color Graphic Printer X 710, the Thermal Printer X-711, or a 80 unit standard printer which conforms to the Centronics specifications can be connected to the X-07. Of these three printers, the Color Graphic Printer X-710 is very portable, can print out in 4 colors, can be used as a graphic plotter, and has many other outstanding features. This section explains how to use the X-710 in may different ways.

2.4.2 How to setup the X-710

Reset
Pen change
Color change
Paper feed
Power switch

To printer
To X 07
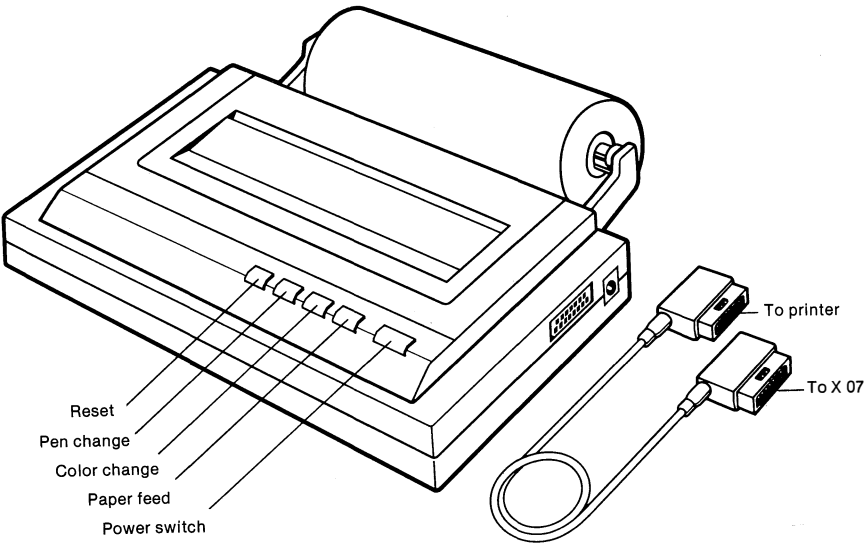
First, attach the roll paper to the X-710. Then, pull out the end of the paper and insert it into the slot at the back of the X-710. Turn ON the power to the X-710. Next, depress the paper feed button to feed the paper, and hold down the paper with the holder axes.

For details on how to use the X-710, please refer to its instruction manual. Now, connect the X-710 to the X-07 using the connection cable. When the X-710 is connected to the X-07 with the power of the X-07 turned ON, the power might be cut temporarily, and "Low battery" might be displayed on the LCD. This is due to noise from the power supply, and there is no need to change the batteries. If this bothers you, connect with the power of the X-07 turned OFF.

After connecting the X-710, depress its reset button, and you are ready to use the X-710.

2.4.3   Printing out a text

The following commands are used to output a program list or the result of a calculation to the X-710.

LPRINT
LLIST

For example, please type the following:

LPRINT"CANON" ‎ ‎‎ **RETURN**

"CANON" is printed out on the X-710. As the X-710 is a color printer, you can specify the color. Execute the following program.

```
100    REM TEST PRINT 1
110    REM **********
120    FOR N = 0 TO 3
130    LPRINT [1, N]"CANON"
140    NEXT N
```

RUN ‎ ‎ **RETURN**

Did the printer print out "CANON" 4 times in different colors (black, blue, green and red).

You can also change the size of the characters. ____ execute the following pro-brem.**(Don't forget to type NEW RETURN   first!)**

```
100   REM TEST PRINT 2
110   REM **********
120   FOR N = 1 TO 16
130   LPRINT [N, 1]"CANON"
140   NEXT N
```

RUN   RETURN

CANON
CANON
CANON
CANON
CANON
CANON

"CANON" is printed out in 16 different sizes. Some of you might have been surprised by some of the sizes.

Let's now go into detail about how to use the LPRINT command.

LPRINT [I, J]"CANON";X,Y

Character size   Color

Two parameters are placed in "[,]" following the instruction word "LPRINT". The first parameter is between 1 and 16, and indicates the size of the characters. To find out how many characters can be printed out on a line, divide 80 by the parameter. The second parameter is specified by 0 to 3. The color code is as follows:

0 ..... black
1 ..... blue
2 ..... green
3 ..... red

Please note that the legal range of the first parameter starts at 1, and that of the second parameter starts at 0.

Also, [I, J] can be omitted. When they are omitted, characters are printed out according to the last specified parameters. For example,

LPRINT [2,2] "CANON" |RETURN|
LPRINT "GOOD COMPUTER" |RETURN|

The LLIST command is used to print out a program in the text area. After creating or loading a program into the text area, type,

LLIST |RETURN|

How was it?

Ignore the parameters, and the LPRINT and the LLIST commands are similar to the PRINT and the LIST commands. For details on these   please refer to the BASIC Reference Manual.

2.4.4 How to use the X-710 as a graphic printer

The X-710 is an X-Y-plotter-type intelligent printer. Accordingly, the control commands of the X-710 are exclusively to the printer, and therefore, the plotter cannot be controlled using the BASIC commands of the X-07. The plotter is controlled by transmitting a string of characters using the LPRINT command. To change from the text mode to the graphic mode, ASCII code 18, which represents mode change code DC2, is sent to the X-710. This is accomplished by sending CHR$ (18) with the LPRINT command.

LPRINT CHR$(18) $\boxed{\text{RETURN}}$

After typing the above command, if you type the LLIST command, listing will not be executed properly. You must reset the X-710 to the text mode. This is accomplished by performing carriage return, and then, by sending the ASCII code 17 which stands for control code DC1.

LPRINT CHR$(13);CHR$(17) $\boxed{\text{RETURN}}$

Now, you can use the LLIST command.

2.4.5   Graphic commands

For detials of all the commands related to the X-710, please refer to Chapter 3 Reference or the instruction manual for the X-710. This section describes only the main graphic commands.
As the X-710 is a plotter-type printer, the basic commands are pen up, pen down and the position of the pen. For example, the DRAW command draws a line between two set of coordinates.

LPRINT"D 0, 0, 100, 100"

When a command such as above is executed, the pen is moved to and settled on the (0,0) coordinates, and then, a line is drawn to the (100, 100)   coordinates. You can think of ''D'' as standing for ''DRAW'' or ''DOWN''. They both mean the same. After the D command has been executed, unless you execute the pen-up command, the pen remains lowered.
The pen is raised with the M (MOVE) command.

LPRINT"M 200, 200"

Execute this command, and the pen is raised and moved to the (200, 200) coordinates.

The X-Y coordinates in the D and the M commands can also be set to variables by using the STR$ function.

LPRINT"D" + STR$(X) + "," + STR$(Y)

Please note that "," must be included between "STR$(X)" and "STR$(Y)".
The positions of the coordinates can be set by the user by executing

LPRINT"I"

This sets the current position of the pen as the star point. And, all other co-ordinates are positioned from that point.

●**Program sample**
This is an example of a program in which the X-07 is used as a plotter.

First reset the X-710 by depressing its reset button, and execute the following program on the X-07. A4 mm matrix is drawn on the X-710.

```
10   LPRINT CHR$(18)
20   LPRINT"M 240, 0"
30   LPRINT"I"
40   FOR X = − 200 TO 200 STEP 20
50   LPRINT"M" + STR$(X) + "," + "200"
60   LPRINT"D" + STR$(X) + "," + " − 200"
70   NEXT X
80   FOR Y = − 200 TO 200 STEP 20
90   LPRINT"M 200," + STR$(Y)
100  LPRINT"D − 200," + STR$(Y)
110  NEXT Y
RUN   RETURN
```

2.5 How to use the Optical Coupler X-721

2.5.1 The Optical Coupler X-721

One X-721 can be connected to the X-07 and another X-721 to another X-07 or to the RS-232C Level Convertor X-722 for cableless communication. There is no need for bothersome cable connections for transmitting/receiving programs and data.

The signals sent by the X-721 conforms to the specifications of the asynchronous serial signals. Accordingly, softwarewise, the signals are processed as access of the serial port. Therefore, this section covers not only the X-721, but also the asynchronous serial signal specifications (RS-232C) and serial communication.

2.5.2 How to connect the X-721

Connect the X-721 to the X-07, as shown below.
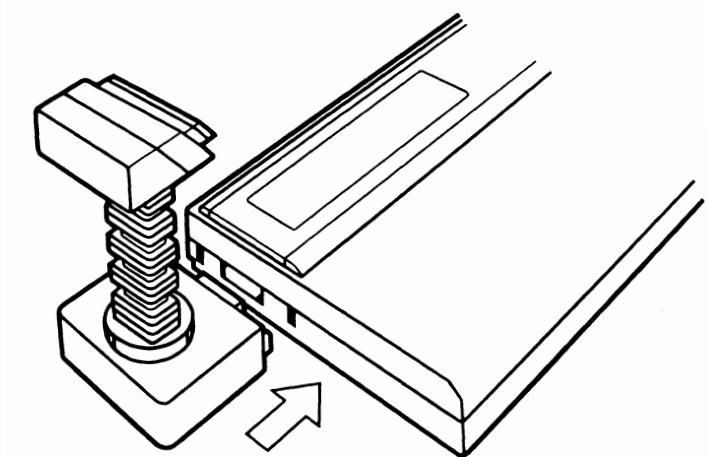
To output signals through the X-721, the following instructions are used in a program.

INIT #	Defines the file number of the X-721.
INPUT #	Inputs signals through the X-721.
PRINT #	Outputs signals through the X-721.
INP (#)	
OUT #	
SNS (#)	

The INIT # instruction specifies which file number (#1 to #5) is assigned to which I/O device. For example, to set the X-721 to file number #1, type

INIT # 1, "OPT:", 2400, "A"

" #1" means that file number 1 is defined. "OPT:" is the device name for optical coupler. "2400" means that the transmission rate (baud rate) is 2400 baud (bits/second). "A" is the ACIA transmission mode. Please refer to Chapter 3 Reference for deatils on baud rates and transmission modes.
The INIT # instruction assigns the file number #1 to the X-721, and also sets the rule for communicating with the X-721.
If the above instruction is executed during a program, the INPUT #1 and the PRINT #1 instructions inputs/outputs signals through the X-721.
Let's consider a cableless communication between two X-07s. Create the following programs.

Transmitting X-07

```
10   INIT # 1, "OPT:"
20   INPUT A$
30   PRINT # 1 , A$
40   GOTO 20
```

Receiving X-07

```
10   INIT # 1, "OPT:"
20   INPUT # 1, A$
30   PRINT A$;
40   GOTO 20
```

The input from the keyboard of the transmitting X-07 is stored in the variable A$, and then, the input is transmitted through the optical coupler by the PRINT # 1 statement.

In the receiving X-07, the input from the optical coupler is stored in the variable A$ by the INPUT # 1 statement. Then the contents of the variable A$ are displayed on the LCD by the PRINT statement.

2.5.3   RS-232C communication

RS-232C is the interface specifications for serial communication set by the American EIA. In Europe there is an interface specification called V. 24. This specification is identical to the RS 232C specifications. Originally, the RS-232C specifications were set for interface between modem and terminal devices. The specifications are covered in Chapter 3 Reference. This section explains the general concept behind RS-232C and serial communication. Serial communication is a method used to transmit/receive one line of communicating data. This method is the most basic form of communicating data. Telephone, radio, TV, etc. use serial communication.

However, inside the X-07, several (8 units) data are handled in parallel. Accordingly, such parallel data must be converted to serial data. The form of this conversion is set by the transmission mode. In the previous section, ACIA transmission mode was mentioned. This referred to a conversion form.

Also, in serial communication, the timing of the signals is very important. To do so, it is necessary to know the transmission rate of the signals. The transmission rate of signals is referred to as the "baud rate", and it is in bits/second. This denotes how many bits (the smallest unit of information) can be transmitted in one second.

By changing the baud rate and the transmission mode while conforming to the RS-232C specifications, data can be transmitted to and received from various I/O devices (for example modem of an acoustic coupler)..

Please refer to Chapter 3 Reference for details on baud rates and transmission modes.

2.5.4 RS-232C Level Convertor X-722

The RS-232C Level Convertor X-722 can be connected to the X-07 and the
Optical Coupler X-721.
One optical coupler can be connected to the X-07 and another to the RS-232C
Level Convertor, and data can be transmitted from the X-07 and received by
the RS-232C Level Convertor X-722 through the optical couplers. Then the
data can be transmitted through an acoustic coupler.
The serial input/output terminal of the X-07 has only 9 pins which is the min-
mum number of pins needed to conform to the RS-232C specifications.
Therefore, it cannot be connected to many RS-232C terminal connectors
which have 25 pins. The RS-232C Level Convertor X-722 is used to connect
the X-07 to standard connectors. It is also used to supply power to the optical
coupler.
The diagram below gives an example of how to connect the RS-232C Level
Convertor X-722.
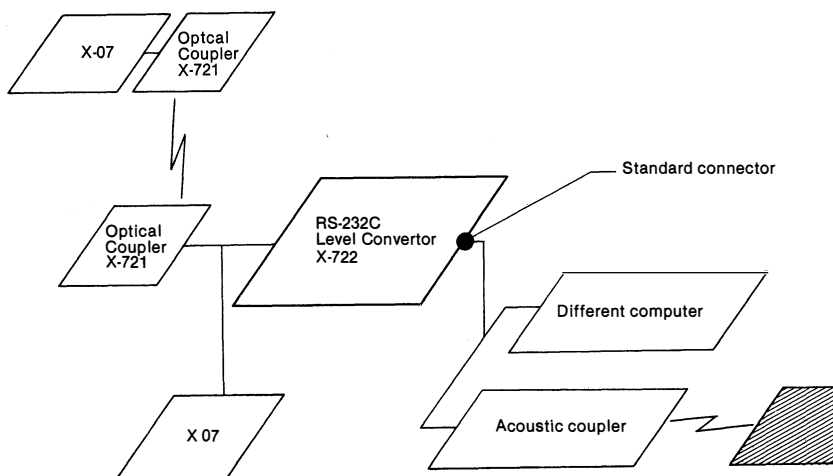
2.6 How to control peripheral devices

2.6.1 Operation of peripheral devices

This section describes how to control peripheral devices using the INIT # com
mand. It is the general rule that, softwarewise, all peripheral devices are con-
trolled in the same manner. However, when controlling hardwares, each hard-
ware is controlled differently.

A cassette recorder (CASI, CASO), an optical coupler (OPT), a serial I/O
(COM) device and a serial I/O printer (PRT) cannot be controlled
simultaneously.

CASI: Loads from a cassette tape.   The input buffer is cleared at INIT #

CASO: Saves onto a cassette tape.

OPT: Inputs/outputs to an optical   The input buffer is cleared at INIT #
coupler.

COM: Inputs/outputs to a serial I/O   The input buffer is cleared at INIT #
device.

PRT: Inputs/outputs to a serial printer.

These five devices use the ACIA (Asynchronous Communication Interface
Adopter) and baud rate generators. The X-07 has only one ACIA and one
baud rate generator. Therefore, it cannot open all these devices at the same
time.

Following is an explanation of other devices, and what happens at INIT # .

GPR: After the character size to a graphic printer is set to 2, the CR
(carriage return) code and then the LF (line feed) code are sent.

LPT: Initializes a parallel I/O device and CR/LF are sent.

KBD: When this device is initialized, the key buffer is cleared.

RAM: When initialized, the specified program or data is searched for, and
can be located in the RAM file.

CON: When initialized, no function is executed.

2.6.2 INIT # and BEEP

As mentioned before, CASI, CASO, OPT, COM, and PRT devices use the
same ACIA and baud rate generator. For this reason, an unexpected error
might be generated if a program is not created carefully. Let's examine the
following program.

```
10   INIT # 1, "COM:"
20   INIT # 2, "OPT:"
30   OUT # 1, 65
```

At Line 10, file number # 1 is assigned to a serial I/O device. At Line 20, you probably think that file number # 2 is assigned to an optical coupler. However, when this program is executed, an error message is displayed. This is because, when file number # 2 is assigned to the serial I/O device, file number # 1 is canceled.

Now, the X-07 uses the baud rate generator to output sound through the compact magnetic speaker. For this reason, when the INIT # instruction is used along with the BEEP instruction, an error similar to the above example occurs.

```
10   INIT # 1, "COM:"
20   BEEP 5, 10
30   A = INP ( # 1)
```

At Line 10, file number # 1 is assigned to a serial I/O device. However, at Line 20, when the BEEP statement is executed, the assigned file number # 1 is canceled, and an error is generated at Line 30.
Same thing occurs when the BEEP instruction is executed before the INIT # instruction.

```
10   BEEP 5,10
20   INIT # 1, "COM:"
30   A = INP ( # 1)
```

In the above example, no sound is heard. The BEEP statement specifies the tone and the length of the tone that the baud rate generator should produce. When the X-07 has finished specifying these parameters, it executes the following statement. It does not wait for the sound to be output before executing the following statement. Therefore, the above example should be:

```
10   BEEP 5,10
20   BEEP 0,1
30   INIT # 1, "COM:"
40   A = INP( # 1)
```

The BEEP statement at Line 20 is a "dummy" statement which delays the execution of Line 30.

2.6.3　Device chart

This chart shows the devices and their device names, and the restrictions of IN-IT # instructions's parameters.

Device charat

Device name	Meaning	Input	Output	1st parameter	2nd parameter
CON:	Console	○	○		
KBD:	Keyboard	○			
COM:	Serial I/O device (RS-232C)	○	○	Baud rate: 100 to 8000 Default: 4800	ACIA mode: A to H Default: B
OPT:	Optical coupler I/O	○	○	Buad rate: 100 to 24000 Default: 1200	ACIA mode: A to H Defualt: B
GPR:	Color graphic printer		○		—
LPT:	Centronics-type printer		○		—
PRT:	Thermal printer		○	300 baud fixed	
CASI:	Cassette recorder input	○		1200 baud fixed	Mode B fixed
CASO:	Cassette recorder output		○	1200 baud fixed	Mode B fixed
RAM:	RAM file	○	○	Size: No. of bytes	Data type: A to Z Default: D

3

Reference
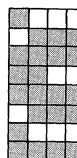
Table of contents for Chapter 3

3.1 Hardware specifications for the X-07

3.1.1 System block diagram of the X-07
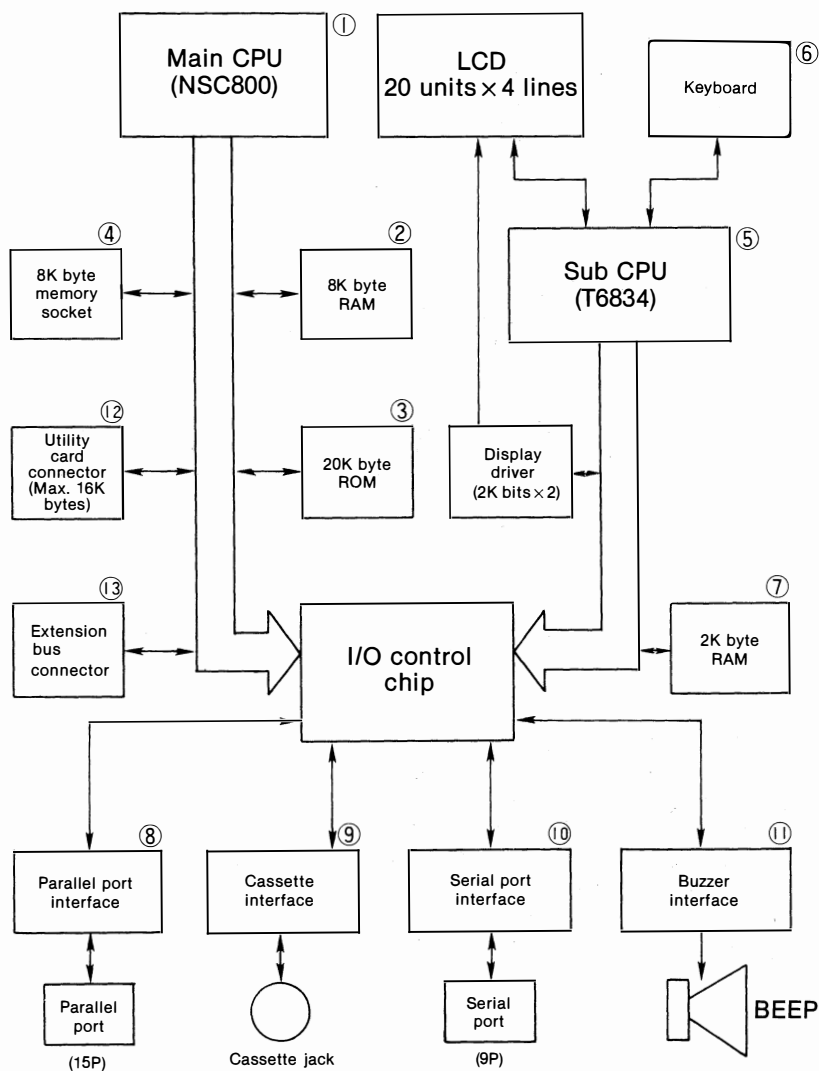
3.1.2 System structure

① **Main CPU: NSC800**
- Z80 CPU and software compatible
- 8085 and bus line compatible
- CMOS CPU

② **8K RAM:** Incorporated 8K byte RAM

2K byte CMOS RAM × 4

$$\text{Used as} \begin{cases} \text{System area} \\ \text{Text area} \\ \text{File area} \end{cases}$$

③ **20K ROM:** The BASIC interpreter is written in this ROM.

④ **8K byte memory socket**

To extend memory, an 8K byte ROM, EPROM, RAM, etc. can be connected to this 28 pin DIP socket. The X-07 comes already connected with an 8K byte extended RAM.

> Caution: This socket is for extending memory. However, do not use this socket carelessly. If an inappropriate memory IC is connected, it might damage the X-07. Do not use this socket by yourself. Consult your dealer.

⑤ **Sub CPU**

The 8 bit CPU controls the keyboard, the timer, the LCD, etc. Even when the power is turned OFF, it keeps functioning on power supplied by the bateries.

⑥ **Keyboard**
- 49 keys (numbers, letters and symbols)
- 6 user defined keys (F1 to F6)
- SHIFT key and CTRL (control) key
- 7 display control keys (INS , DEL , ▲, ▶, ▼, ◀, and HOME/CLS)
- 2 mode keys (GRPH and NUM)
- 2 power keys (ON/BREAK and OFF)

For a total of 68 keys.

⑦ **2K byte RAM**

Work area of the sub CPU. Following information is stored.
1) User defined keys (512 bytes)
2) User defined characters (512 bytes)
3) 127 key stroke buffer (256 bytes)
4) Start program (512 bytes)
5) For future extension (256 bytes)

⑧ **Parallel interface port**

Port for interface with a printer, etc. It is constructed of CMOS IC shift register and transistor array for buffer. Basically, it can handle only 8 parallel signal lines, BUSY signals and strobe signals. Communication with a printer uses 15 pin parallel port, and it conforms to the Centronics specifications.

⑨ **Cassette interface**

Interface for recording and playing back programs on a cassette tape. It employs the FSK modulation method which converts data "1" to 2400 Hz and data "0" to 1200 Hz. Transmission rate is fixed at 1200 baud.

⑩ **Serial interface**

This is a 9-pin serial I/O port which conforms to the RS-232C specifications. When used as a conventional communication port, the transmission rate can be set from 100 baud to 8000 baud. When an optical coupler is connected, the transmission rate can be set from 100 baud to 2400 baud. The signals are represented in T.T.L level (5V).

⑪ **Buzzer interface**

The buzzer interface is controlled with the BASIC BEEP instruction. The speaker has 200 ohm impedance, and is driven by 50% of duty cycle short waves.

(12) **Utility card connector**

4K byte or 8K byte RAM or RAM/ROM card can be connected.

(13) **Extension bus connector**

An address bus, a data bus and a timing bus can be used.

3.1.3 Structure of memory

The main CPU in the X-07 consists of a NSC-800, which is bus compatible with the intel 8085. 64K bytes of memory area can be accessed directly. In the X-07, memory area is reserved as follows:

When ROM is connected to memory socket

When RAM is connected to memory socket

Address		
FFFF		
	System ROM 20K	BASIC interpreter
B000		
	TV ROM 4K	Extension station
A000	2K	
9800	V RAM 6K	
8000	Application card ROM 8K	
6000	Memory socket (ROM) 8K	Memory card (RAM) 8K
4000	Memory card RAM 8K	Memory socket (RAM) 8K
2000	C3H	Internal RAM
0000		

File area
System area
Text area
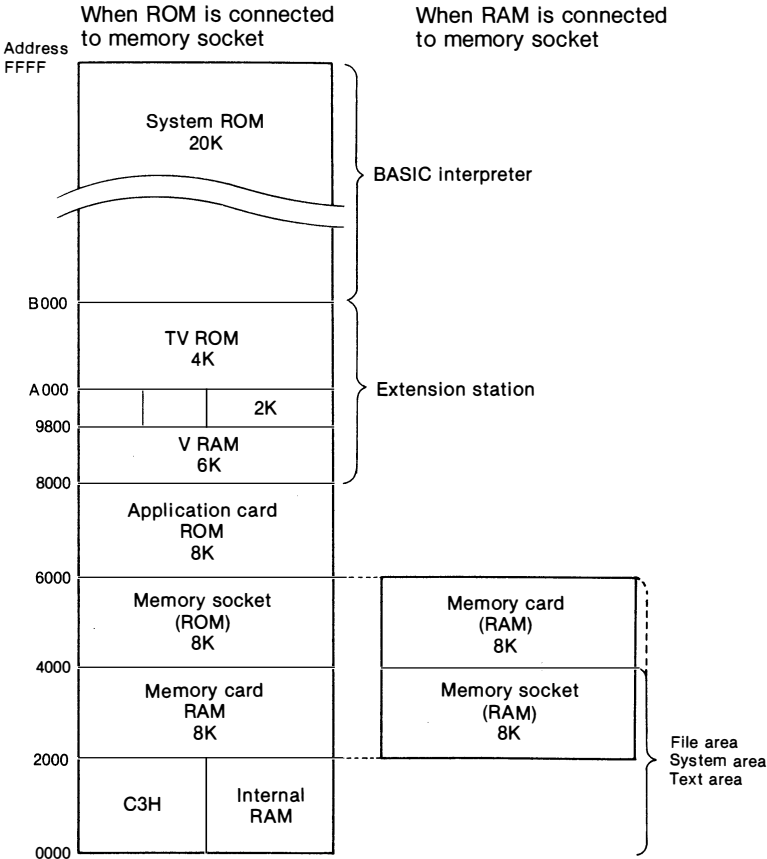
Memory reservation

0000 ~ 1 FFFH (8K bytes)

This is the 8K byte RAM area incorporated in the X-07. Selection of the left or right space depends on the hardware of the I/O control chip. When the CPU is reset, access is switched to the left side of the space. The left side includes "jump to C3C3" instruction.

0000 H is the first address accessed when the CPU is reset. In this way, the CPU executes "jump to C3C3" as its first instruction. (C3C3 is the ROM area). From then on, when specified instructions are executed in the ROM area, 0000 ~ 1 FFF switches to the right side, and is used as RAM.

2000 ~ 3 FFF (8K bytes)

Is reserved as the RAM area for an optional memory card. The RAM of a memory card is 0 (ROM only), 2K, 4K, or 8K.

4000 ~ 5 FFF

This is the address range of the memory socket. This area is reserved for a special use by 8K byte CMOS EPROM or mask ROM.

(2000 ~ 5 FFF)

4000 ~ 5 FFF area is for ROM. However, when a RAM is connected to the memory socket, address range of the memory socket is 2000 ~ 3 FFF, and that of the memory card is 4000 ~ 5 FFF. This is so that the RAM area can be used continuously. Switching of this address range is performed with a DIP switch. In this way, the X-07 can be extended to a 16K RAM (connect a RAM to the memory socket) or a 24K RAM (further connect a 8K RAM memory card) system.

6000 ~ 7 FFF (8K bytes)

This is the area for a ROM application card. It is reserved for application programs (BASIC or machine language).

8000 ~ 97 FF (6K bytes)

This area is reserved for Video-RAM extension memory for output to a TV.

9800 ~ 9 FFF (2K bytes)

This area is reserved for the control ROM of an extension station and an extension pack (RS 232C, I/O pack, etc.). This area can be divided into 4 areas with the bank switch.

A 000 ~ AFFF (4K bytes)

This area is part of the BASIC interpreter and is for a TV screen control ROM. It exists in an extension station and not in the X-07, and functions along with the BASIC ROM of the X-07.

B 000 ~ FFFF (20K bytes)

This area is for the BASIC interpreter inside the X-07. The address C3C3, mentioned in the section on 0000 ~ 1 FFF, is in this area.

3.1.4 I/O map

The main CPU NSC 800 has, besides the memory space, a 256 byte I/O space using the address bus and the data bus. This space is used to control I/O devices such as a printer and the speaker. The following describes this I/O map.

I/O address

00 ~ 7 F: Area which can be used by the user.
           (The user cannot use the area over 80 ~ FF.)
80 ~ 8 F: CGROM area
           Contents of a character generator for TV are read into this area.
90:        Space for TV control.
BB: Space used by the CPU NSC 800. This port enables/disabls restart inputs ($\overline{\text{RSTA}}$, $\overline{\text{RESB}}$, $\overline{\text{RSTC}}$) and interpreter requests $\overline{\text{(IRQ)}}$ which are control by the hardware.
F0 ~ F7:   space inside I/O control chip.

3.2 Internal structure of BASIC

3.2.1 Internal addresses

The internal structure of BASIC and the representative pointers of each
section are shown below.

FFFF

	Pointer
ROM 2 FILE	←— RO2END
	←— RO2STRT
ROM 1 FILE	←— RO1END
	←— RO1STRT
RAM FILE	←— RAMEND
	←— RAMSTRT
Machine language area	
	←— MEMSIZ
Contents of string variables (Used) (Unused)	←— FRETOP
	←— STKTOP
Stack	
	←— STREND
Array	
	←— ARYTAB
Variables	
	←— VARTAB
Program (midway code)	
	←— TXTTAB
SYSTEM WORK	

0000
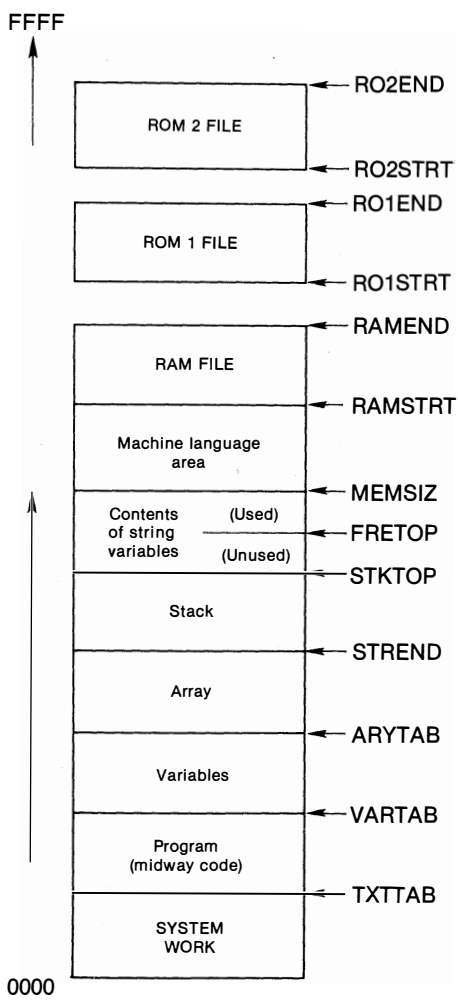
3.2.2 Address for each pointer

	Pointer	Address (HEX)
(1)	TXTTAB	00B2
(2)	VARTAB	0322
(3)	ARYTAB	0324
(4)	STREND	0326
(5)	STKTOP	01DD
(6)	FRETOP	0204
(7)	MEMSIZ	01DF
(8)	RAMSTRT	0210
(9)	RAMEND	0212
(10)	RO1STRT	000C
(11)	RO1END	0013
(12)	RO2STRT	0024
(13)	RO2END	0026

3.2.3 On the interior of BASIC

1. SYSTEM WORK area
    - The area covers $0 \sim 551$.

2. Program (intermediate code) area
    - The start of this area is indicated by TXTTAB (00 B2H).
    - The format of the midway code is as follows:

| Pointer | Line # | Program line | 00 | Pointer | Line # | Program line | 00 | Pointer | |
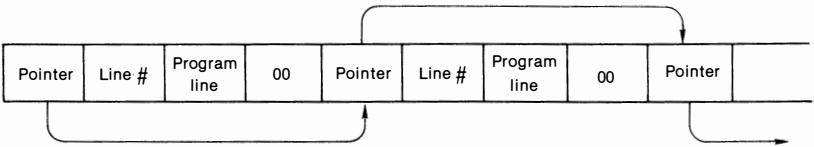
3. Variable area
   - The start of this area is indicated by VARTAB (0322 H).
   - The pattern and the format of variable is as follows:

Variable pattern
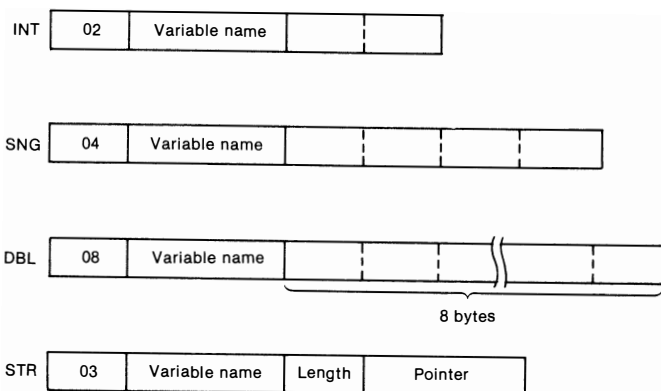
4. Array area
   - The range of this area is indicated by ARYTAB (0324 H) and STREND (0326 H).
   - The contents of arrays are input here.

5. Stack area
   - The start of this area is indicated by STKTOP (01 DDH)
   - The BASIC system constantly monitors STREND and the present stack (SP) to make sure that the stack area does not destroy the array area.

6. String area
   - The range of this area is indicated by STKTOP (0324 H) and MEMSIZ (01 DFH).
   - The size of this area is set by the first parameter of the CLEAR instruction. However, when a default occurs, it is set to 50 bytes.
   - When the string area is occupied, the first location of its contents is indicated by FRETOP (0204 H). When it is not occupied, FRETOP (0204 H) indicates the same location as MEMSIZ.

7. Machine language area
   - The range of this area is indicated by MEMSIZ (01 DFH) and RAMSTRT (0210 H).
   - The size of this area can be freely changed by changing the value of MEMSIZ, which is set with the second parameter of the CLEAR instruction.

8. RAM file area
   - The range of this area is indicated by RAMSTRT (0210 H) and RAMEND (0212 H).

9. ROM 1 file area
   - The range of this area is indicated by RO1STRT (000 CH) and RO1END (0013 H).

10. ROM 2 file area
   - The range of this area is indicated by RO2STRT (0024 H) and RO1END (0026 H).

3.2.4 Structure of the RAM file area

The text area is reserved from the lower part (0000 side) of the RAM area, and the RAM file is reserved from the upper part (near FFFF side) of the RAM area. The size of the RAM file is set with the BASIC FSET instruction. Each file in the RAM file is automatically reserved an area according to its size.
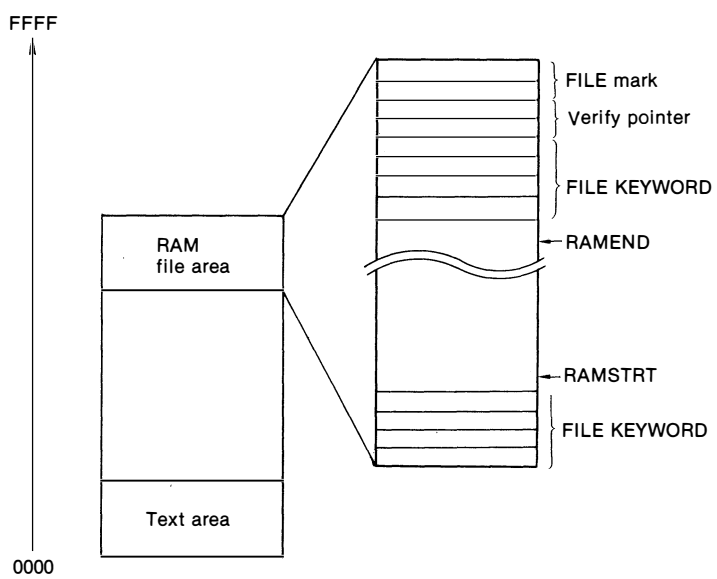
Reservation of files in the RAM file
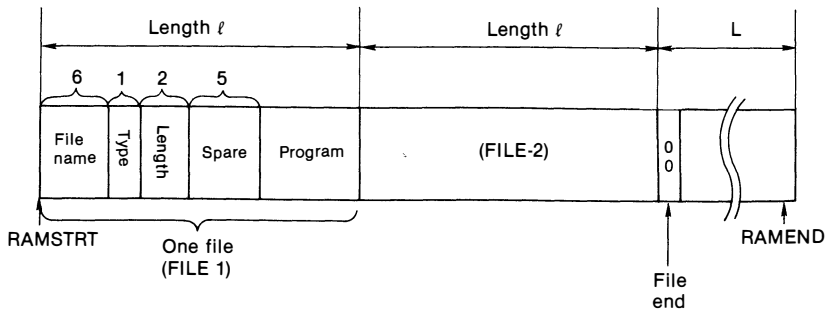
1) The contents of the RAM file are inserted between two 4 byte FILE KEYWORDs. When the OFF key is depressed, the KEYWORDs causes the day and the time (hours, minutes and seconds) at which this operation took place to be memorized.

2) RAMSTRT and RAMEND pointers indicate the starting and end locations of the RAM file, respectively.

3) The verify pointer is created from 2 bytes, and indicates the same start as RAMSTRT.

4) There is a 2 byte area called FILE mark. It contains 5AH, and A5H.

5) When the RAM file is initialized, RAMSTRT and RAMEND indicate the same area, and its content is 00. And also, the size of the RAM file is set to $4 + 1 + 4 + 2 + 2 = 13$ bytes.

6) File name uses 6 bytes, file type 1 byte, length 2 bytes and spare 5 bytes.

7) Files are condensed inside the RAM file. "00", if included at the beginning of a file, indicates the end of the preceding file.

8) L is the remaining length. This is same as the unused area shown when the DIR instruction is executed.

3.2.5 ROM and BASIC

The interface between the BASIC system and ROM is created from a 4 character keyword ("love") and 3 entry addresses.
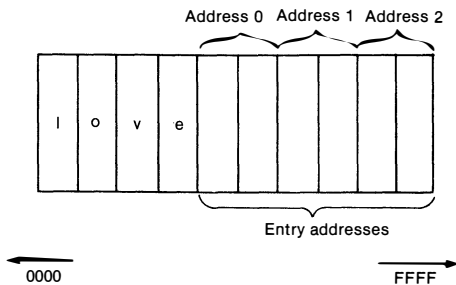
1) The keyword is created from 4 bytes.

   "l"   "o"   "v"   "e"
   ↓   ↓   ↓   ↓
   $6C_H$ $6F_H$ 76_H 65_H

2) Entry addresses 0 to 2 are created from 2 bytes. By writing in an address, the control can be moved to that address.

3) Entry address 0 is the entry address when the BASIC system initializes the I/O control chip and the minimum amount of work area. The interpreter is masked.

4) Entry address 1 is the entry address just before when the BASIC system displays the Copyright message.

5) Entry address 2 is the entry address when the power is turned on from a SLEEP condition.

6) Keyword is scanned from 2000 H ~ B 000 H.

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3.2.6 Power ON sequencer

One of the following messages might be displayed when the BASIC system is in the start mode.

1. #MC Error
    Create system?

    This is displayed when the KEYWORDs written during SLEEP OFF do not match the KEYWORDs in the current RAM file when the BASIC system starts from sleep.
    To initialize the BASIC system, input Y $\boxed{\textbf{RETURN}}$.

2. #FS Error
    Create system?

    This is displayed when the KEYWORD above the current RAM file's verify pointer does not match the KEYWORD after the current RAM file. The RAM file can be recreated (initialized condition) by inputting Y $\boxed{\textbf{RETURN}}$.

3. Create system?

    This is displayed when the start and the end of the current RAM file do not match the addresses indicated by RAMSTRT and RAMEND. When Y $\boxed{\textbf{RETURN}}$ is input, RAMSTRT and RAMEND are rewritten to the addresses of the current start and end.

When "5A" and "A5" file marks are not written in the upper part of the RAM file (near FFFF), the BASIC system writes in these file marks, and the RAM file is initialized.

```
        ┌─────────────────┐
        (   POWER ON      )
        └────────┬────────┘
                 │
        ┌────────┴────────┐
        │ Sets ROM constant│
        │ to RAM           │
        └────────┬────────┘
                 │
        ┌────────┴────────┐
        │ Searches for MAX of│
        │ RAM area         │
        └────────┬────────┘
                 │
              ◇ "5A, "A5"       N
              ◇ FILE marks ──────────────────────────┐
              ◇ OK?                                   │
                 │ Y                                  │
              ◇ FILE      N                           ◇ From      N
              ◇ Keywords ──────┐                      ◇ RESET? ──────────┐
              ◇ match          │                         │ Y             │
                 │ Y           ▼                         │           ( Create )
        ┌────────┴────────┐  ( #FS Error )               │           ( system? )
        │ Check addresses  │  ( Create system? )          │               │
        │ indicated by SYS │      │                      │            ◇ "Y"    Y
        │ area's RAMSTRT   │      ◇ "Y"                   │         N ◇ ────────┐
        │ and RAM-END and  │   N ◇ ─── Y                 │           │
        │ addresses indica-│      │                      │           │
        │ ted by current   │      │                      │           │
        │ verify pointer   │      │          ┌───────────┴────┐      │
        │ and end          │      │          │ Write in        │◀─────┘
        └────────┬────────┘      │          │ FILE marks      │
                 │                │          └───────┬────────┘
              ◇ Addresses  N      │          ┌───────┴────────┐
              ◇ match ──────┐     │          │ Initialize      │
                 │ Y        ▼     │          │ RAM FILE        │
                 │      ( Create )│          └───────┬────────┘
                 │      ( system?)│                  │
                 │          │     │                  │
                 │       ◇ "Y"    │                  │
                 │    N ◇ ── Y    │                  │
                 │          │     │                  │
                 │   ┌──────┴─────┐                  │
                 │   │ Write in   │                  │
                 │   │ values of  │                  │
                 │   │ current    │                  │
                 │   │ file into  │                  │
                 │   │ RAMSTRT    │                  │
                 │   │ and RAMEND │                  │
                 │   └──────┬─────┘                  │
                 ◀──────────┘                        │
        ┌────────┴────────┐
        │ Initial screen   │
        └────────┬────────┘
                 ▽
```

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3.2.7 Work area

The work area used by the BASIC system can be divided into 4 types.

① Conventionally initialized area.
② Area initialized when the power is turned ON.
③ Area initialized when the BASIC system is reset.
④ General work area.

| ① | ② | ③ | ④ |
| 0000 | 00AE | 00B4 | 00BE | 0552 |
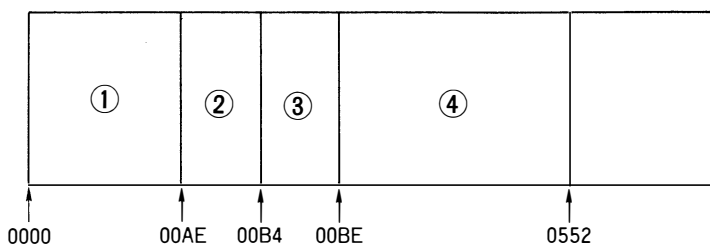
There are three methods for starting the BASIC system.
a)   Start from reset.
     Initializes areas ① , ② and ③ of the above diagram.
b)   Start when the power is turned on.
     Initializes areas ① and ② of the above diagram.
c)   Start from sleep.
     Initializes area ① of the above diagram
Each area of ① , ② and ③ has images which initialize ROM, and are
transmitted to RAM.

3.2.8 Console change

File number #5 functions a little differently from #1 to #4. Learn how to use this file number and you can do many interesting things.
Here are some examples of how to use it:

Example 1
Sets serial I/O device (''COM:'') as the console input device.

> INIT #5, "COM:" `RETURN`
> EXEC & HEE1F `RETURN`

When the above is typed, the X-07 will not accept inputs from the keyboard, and will handle inputs from the serial I/O device as though they were from the keyboard (i.e. becomes the console device). The X-07 can be remote controlled from afar through the RS-232C Level Convertor.
To cancel this state:

1. Turn OFF the power, and then turn it ON again.
2. Excute the following instruction from the console device (the serial I/O device).

> EXEC & HEE33

Example 2: To merge programs (to copy two or more programs into one)
Load a program into the text area. Next, type

> INIT #5, "LIST", 500 `RETURN`
> LIST #5 `RETURN`

500 (file size) of the first INIT# is just an example. It must be changed according to the size of the program.

Load another program into the text area, and just as before, type

> INIT #5, "LIST" `RETURN`
> EXEC & HEE1F `RETURN`

Now, two programs are merged in the text area.

When the RAM file is set as the console, the keyboard automatically returns to being the console when the RAM file is input to the end.

The device assigned file number #5 can be specified as the input console device by executing EXEC &HEE1F. Accordingly, besides the above two examples, you can use file number #5 in many other ways. For example,

1. To delete or to load part of a program.
2. To search for or dump a specific string (cross reference and variable name search)
3. Code conversion of contents of a PRINT instruction (capital letters ↔ small letters).
4. To use other serial-type keyboard.

Caution: When CON: or a device which is not an input device (GPR:, CASO:, LPT: and PRT:) is specified, it will not function properly.
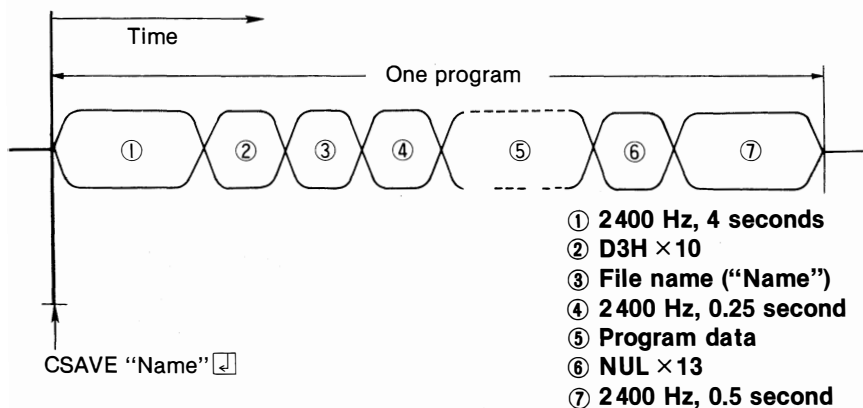
3.3 Interface specifications

3.3.1 Cassette interface

As the name suggests, this is the interface for using an audio cassette recorder as an external storage device. The FSK modulation method is used to modulate data "1" to 2400 Hz and date "0" to 1200 Hz, and the transmission rate is fixed at 1200 baud.

Sequence of data transmission

Below is the timing chart of the X 07 when a program is recorded (CSAVE) on a cassete tape.

① 2 400 Hz, 4 seconds
② D3H ×10
③ File name ("Name")
④ 2 400 Hz, 0.25 second
⑤ Program data
⑥ NUL ×13
⑦ 2 400 Hz, 0.5 second

CSAVE "Name"⏎

① This is a header until the motor of the cassette recorder stabilizes. As it lasts for 4 seconds, you can search for the beginning of a program by sound.
② This is an 8-bit code with ten D3H.
③ File name can be up to 6 characters. If fewer than 6 characters are used, the remaining spaces are shortened.
④ This is the period for the X-07 to clear the text area.
⑤ The program data are written in the midway code form.
⑥ Thirteen 8-bit code 00 H are written.
⑦ Separates one program from another.

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Communication format

One byte (8 bits) of data is transmitted/received with one start bit and two stop bits for a total of 11 bits.

FSK modulation
0...1200 Hz 1 cycle
1...2400 Hz 2 cycles
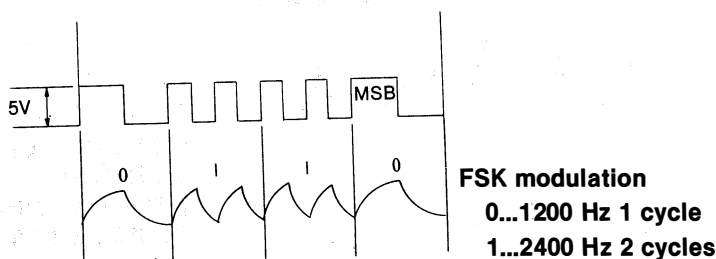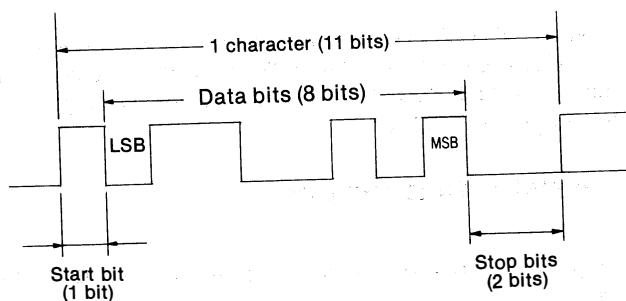
3.3.2 Serial port specifications

The serial port is a input/output terminal for asynchronous serial transmission. Except for the signal level and the shape of the connector, it conforms to the EIA RS-232C specifications.
This section gives a simple explanation of ACIA transmission modes and terms related to the serial port. For details on asynchronous serial transmission please refer to books on this subject.

Serial transmission method	Data are transmitted/received in one signal line. The maximum and minimum voltage of the signal line is timely set to 1 and 0, respectively.
Baud rate	Is a figure indicating how many bits of data can be transferred per second (1 baud = 1 bit/second).
Word length	A data is transmitted grouped in number of bits. One group of bits is called a "word". Word length indicates the number of bits in a group. A word can consist of 7 or 8 bits.
Stop bits	Two bits are used to separate one word from another.
Parity	One bit is used to test for errors (for example, due to noise from signal line). There are two types of parity bit: even and odd.
Transmission modes	Various commnication methods can be set by combining the settings of the baud rate, word length, stop bits and parity bit. These combinations are called "transmission modes".

Following is a summary of serial port specifications.

|	
Connector	9 pin
Word length	7 or 8 bits
Parity	None, even or odd
Stop bits	2 bits
Baud rate	COM 100 ~ 8000
	OPT 100 ~ 2400

3.3.3 Parallel port specifications

The parallel port is the output terminal for parallel dara transmission, and it conforms to the Centronics specifications. Eight signal lines are lined up in parallel, and one byte (= 8 bits) of data can be sent at one time. Various types of printer can be connected. For details on Centronics specifications please consult books on this subject.

3.3.4 Connector and cable of each interface

• Cassette connector
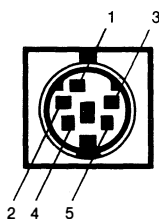
Pin no.	Signal name	Cassette recorder
1	REM⁺	One way to REMOTE jack
2	GND	Signal ground
3	REM⁻	One way to REMOTE jack
4	MON	Connect to playback (EAR) jack
5	MIC	Connect to recording jack

• Serial port connector
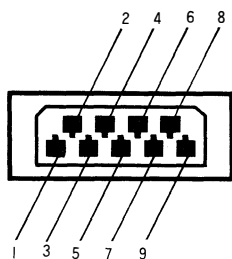
Pin no.	Signal name	Direction	Contents
1	LTxD	→	OPT transmission DATA
2	FG		Frame ground
3	N.C.		
4	TxD	→	Transmitted DATA
5	RxD	←	Received DATA
6	CTS	←	Other device receiving
7	RTS	→	X-07 receiving
8	SG		Signal ground
9	VBB	→	Unstable power supply

• Parallel port connector
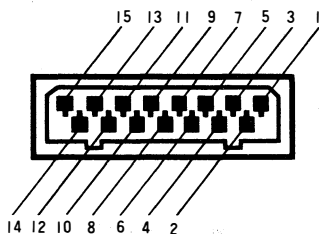
Pin no.	Singal name	Direction	Contents
1	DATA1	→	
2	DATA2	→	
3	DATA3	→	
4	DATA4	→	Output data to printer.
5	DATA5	→	DATA 1 is LSB and DATA 8 is MSB.
6	DATA6	→	
7	DATA7	→	
8	DATA8	→	
9	STROBE	→	Strobe signal for printer to read DATA
10	GND		
11	BUSY	←	Printer is busy. Transmission not possible.
12	GND		
13	VPR	←	Power supplied to X 07 (+ 5V)
14	GND		
15	GND		

• 40 pin extension connector
(back of X-07)
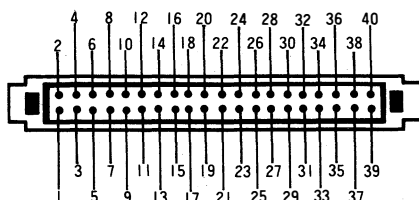
Pin no.	Signal name	Pin no.	Signal name	Pin no.	Signal name	Pin no.	Signal name
1	GND	11	$\overline{WR}$	21	D7	31	A15
2	GND	12	$\overline{RD}$	22	D6	32	A14
3	GND	13	KACL	23	D5	33	A13
4	GND	14	$\overline{MAB}$	24	D4	34	A12
5	$\overline{RESET}$	15	$\overline{INTA}$	25	D3	35	A11
6	BUZZ	16	SI	26	D2	36	A10
7	VEX	17	SO	27	D1	37	A9
8	VEX	18	INTR	28	D0	38	A8
9	ALE	19	RSTC	29	CLK	39	VCC2
10	$\overline{WAIT}$	20	NMI	30	IO/M	40	VCC2

• Cassette cable

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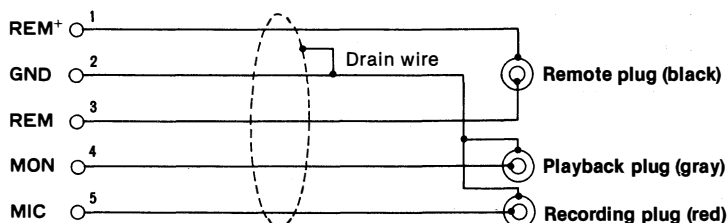
- **Serial cable**
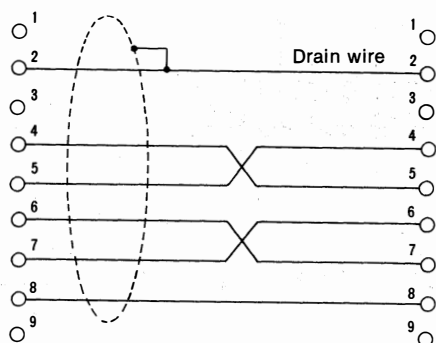
- **Printer cable (15 pin, 12 core)**

Drain wire
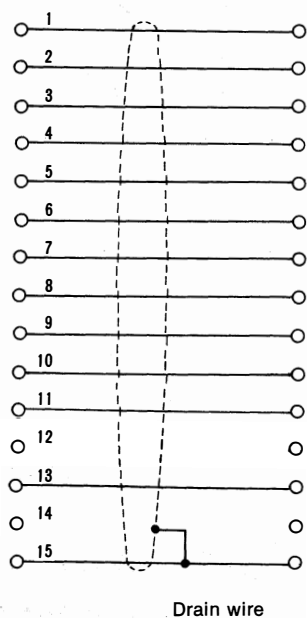
- **Parallel Centronics cable**

< Centronics method >

Pin	Signal
1	$\overline{\text{STROBE}}$
2	DATA1
3	DATA2
4	DATA3
5	DATA4
6	DATA5
7	DATA6
8	DATA7
9	DATA8
10	$\overline{\text{ACKNOWLEDGE}}$
11	BUSY (READY)
12	PE (PAPER EMPTY)
13	PRINTER ENABLE (PRINTER POWER ON)
14	S.GND
15	N.C
16	S.GND
17	F.GND
18	+ 5V
19	
20	} GND when signal lines are twisted pair
28	
29	
30	} N.C
31	$\overline{\text{INIT}}$ (initialize printer)
32	ERROR (printer is abnormal)
33	S.GND
34	
35	} N.C
	$\overline{\text{SLCT}}$ INSELECT (DATA entry to printer possible when signal is LOW.)

3.4 How to use the Color Graphic Printer X-710

3.4.1 Hardware

- X-Y plotter with 4 colored ball point pens
- Minimum X-Y division (minimum step): 0.2mm each
- Text mode
    Number of printing characters: 64 types (ASCII codes)
    Number of printing units: 16 types (80 characters/line to 5 characters/line)
- Graphic mode
    X-axis: 480 steps
    Y-axis: ± 2048 steps (± 409 mm)
    Drawing speed: 52mm/second (max.) in X or Y direction
    73mm/second (max.) in 45° direction

3.4.2 Control codes and graphic commands

- **Control codes**

BS (back space)	CHR$ (8)
LF (line feed)	CHR$ (10)
LU (line up)	CHR$ (11)
CR (carriage return)	CHR$ (13)
DC 1 (text mode)	CHR$ (17)
DC 2 (graphic mode)	CHR$ (18)

- **Graphic commands**

    A......ALL INITIALIZE
        Moves the pen to the upper left corner, and returns to the text mode with that position as the start point.

    C......COLOR CHANGE
        Color pen corresponding to the color code Cn ($n = 0 \sim 3$) is set.
        0......black
        1......blue
        2......green
        3......red

D......DRAW

      $Dx_1, y_1, x_2, y_2, \ldots\ldots , xn, yn$

      Draws a line from one point $(x_1, y_1,)$ to the next point (xn, yn)

F......NEW LINE

      Executes CR/LF only when the alpha rotate (Q) is zero.

H......HOME

      The pen is raised and returned to the start point.

I......INITIALIZE

      The current position of the pen is set as the start point.

J......RELATIVE DRAW

      $J \Delta x_1, \Delta y_1, \Delta x_2, \Delta y_2, \ldots\ldots , \Delta xn, \Delta yn$

      Starting from the current pen position, lines are drawn one by one
      to the relative position $(\Delta xn, \Delta yn)$.

L......LINE TYPE

      Ln $(n = 0 \sim 15)$

      When $n = 0$, a solid line is drawn. When $n = 1 \sim 15$, pitch of a
      dotted line is set.

M......MOVE

      M x, y

      The pen is raised and moved to (x, y)

P......PRINT

      P $c1$ $c2$ $c3$ ... cn $(n \le 256)$

      Prints characters during the graphic mode.

Q......ALPHA ROTATE

      Qn $(n = 0 \sim 3)$

      Changes the angle of characters.

R......RELATIVE MOVE

      $R \Delta x, \Delta y$

      The pen is raised and moved by $\Delta x, \Delta y$ from the current pen
      position.

S......SCALE SET

      Sn $(n = 0 \sim 15)$

      Sets the size of characters.

3.5. List of BASIC instructions and functions

Instructions	Functions

Graphics

Instructions	Functions
CIRCLE	POINT
CLS	
LINE	
PSET	
PRESET	

Variables

Instructions	Functions
CLEAR	CDBL
DEFINT	CINT
DEFSNG	CSNG
DEFDBL	VARPTR
DEFSTR	
DEFFN	
DIM	
ERASE	
LET	

Files

Instructions	Functions
CLOAD	
CLOAD?	
CSAVE	
DELETE	
DIR	
DIR #	
FSET	
LOAD	
SAVE	

Instructions	Functions

Error recovery, debug

ERROR	ERL
ON ERROR GOTO	ERR
RESUME	
TRON	
TRON #	
TROFF	

Program control

CONT
END
FOR TO STEP~NEXT
GOTO
GOSUB~RETURN
IF THEN ELSE
ON GOTO
ON GOSUB
RUN
STOP

Input/output

INIT #	INKEY$
INPUT	INP
INPUT #	SCREEN
LINE INPUT	SNS
LINE INPUT #	STICK
LPRINT	STRIG
OUT #	TKEY
PRINT (?)	
PRINT USING	
PRINT #	
PRINT # USING	

Instructions   Functions

Data

DATA
READ
RESTORE

Memory and machine language

EXEC	FRE
OUT	PEEK
POKE	USR

Editing commands

LIST
LLIST
LIST #
LIST @
NEW

Power switch

OFF

Console•cursor control

CONSOLE	CSRLIN
CONSOLE@	FONT $
LOCATE	KEY $
	POS

Instructions	Functions

Character strings

ASC
CHR $
INSTR
LEFT $
LEN
MID $
RIGHT $
STR $
STRING$
VAL

Calculations

ATN
COS
EXP
LOG
RND
SIN
SQR
TAN

Timer

ALM $
DATE $
TIME $

Instructions	Functions
Others	
BEEP	ABS
MOTOR	FIX
REM(')	HEX $
	INT
	SGN
	START $
	TAB

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