SYSTEM 80

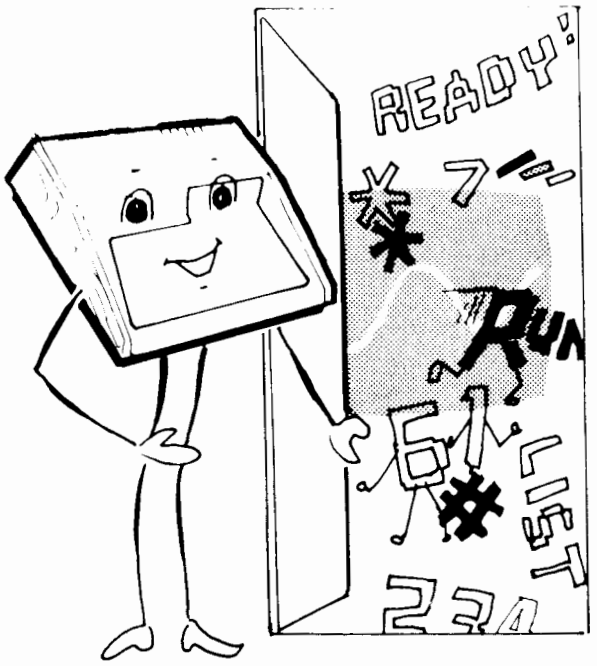
USER'S MANUAL

2ND REVISION

PREFACE

This manual is a guide that helps you to get familiar with the S-80 in the quickest manner. It helps you to set up the system and to operate it efficiently. An overview of the S-80 family is discussed so that you will find no difficulty in understanding and expanding your system. If you are beginner of programming, the manual 'PROGRAMMING FOR BEGINNERS' would introduce you the concept of computer programming. However, programming is an art that can only be learnt by doing; beginners shouldn't be frightened by the 'ERROR' messages. Try all commands and functions of the system; you will discover a lot fascinating features of the S-80.

`You are welcome!´



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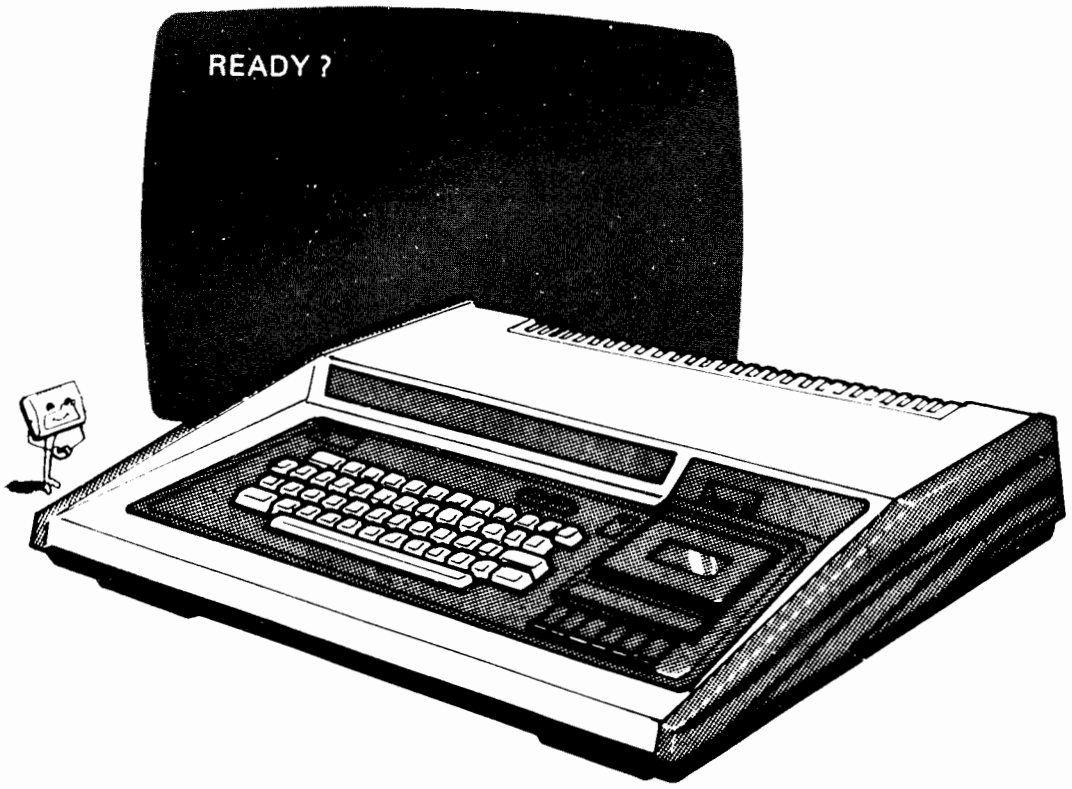
INTRODUCTION 1

S - 80 is a general purpose microcomputer system using a Z80 CPU. 16 Kbytes of memory are available for user's program storage. The **S - 80** also has a keyboard, a video interface, a resident cassette recorder and 13.5K ROM.

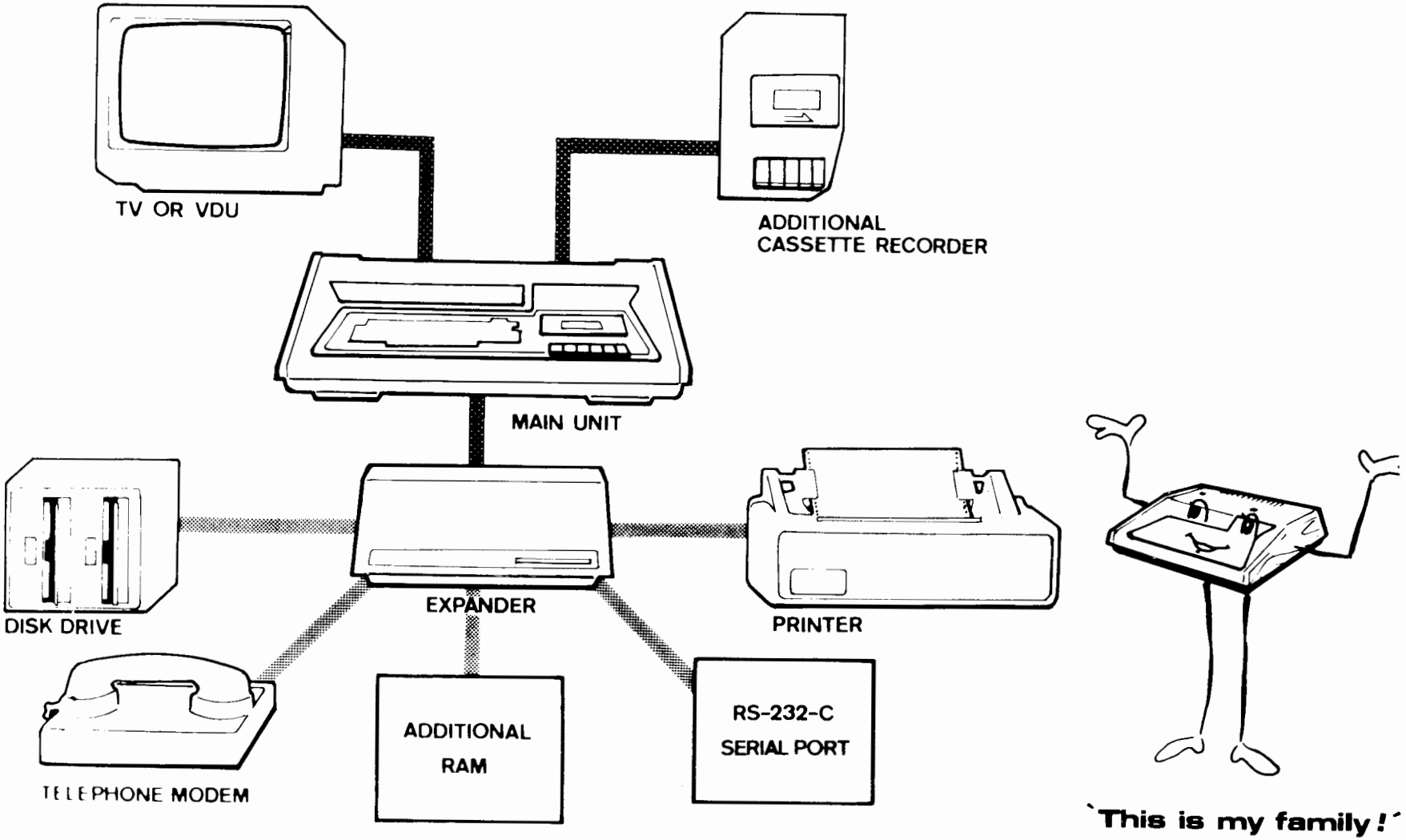
Programs, commands or data can be input to the computer through the keyboard. It will display the response on the screen. The display unit can be a high resolution video monitor or just an ordinary TV set. Since the memory cannot retain any information after the machine is turned off, program has to be saved on a mass storage device which is a cassette tape or a floppy disk.

The 13.5K ROM consists of 12K Microsoft BASIC interpreter and 1.5K for extended keyboard and display features and a machine language monitor.



1.1 The System 80 (S-80) Family

The main unit X-4005 of the System 80 is supported by many peripherals and interfaces. Through the S-80 expander X-4020, printer, minifloppy disk drives, RS232C serial interface, S-100 bus interface can be linked to the system. In addition, user's memory can be expanded up to 48K. If you are satisfied with the cassette and just need a printer for hardcopy, the low cost X-4026 printer interface is most suitable.



POWER ON PREPARATION 2

2.1 Set up the System 80

- After unpacking the S-80 , ensure the power switch is in the 'OFF' position and the 'Video Cut' switch at the back panel is at the out position.
- Connect a Video Display unit to the computer. If the unit is a monitor, find out the video cable in a plastic bag and plug the 'DIN plug' end into the back of the computer. Plug the other end to the monitor. If you use a TV set, there is a TV cable at the back of the computer for the connection.

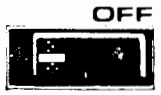
2.2 Initialization

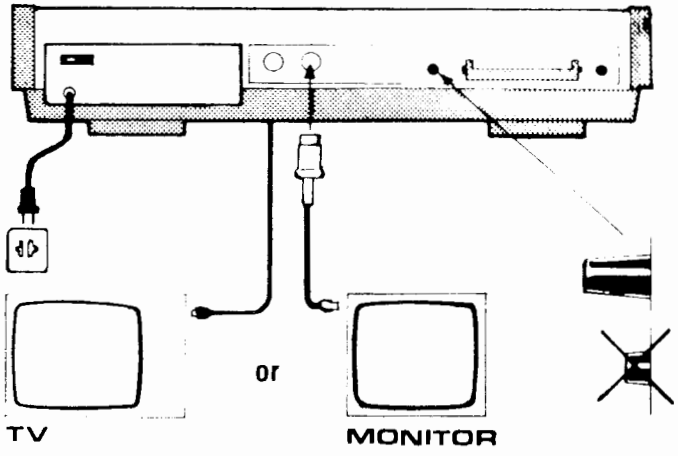
- Turn on power of the display unit and peripherals first, then, the S-80.
- A message 'READY?' will display on the top left corner of the screen. The computer is asking whether you want to have any memory protected from access by the BASIC. If no memory has to be reserved, just hit NEWLINE. To protect memory, the highest memory location (in decimal) available for BASIC should be entered.

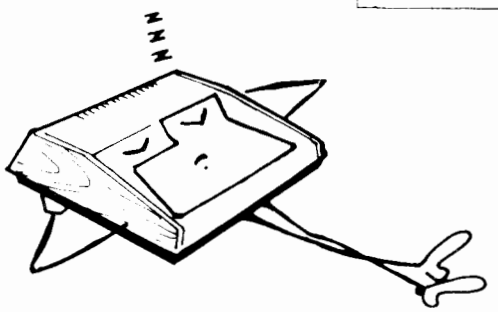
  e.g. enter '24000 NEWLINE' will reserve about 8K of memory for user. The user can then use the memory for storage of machine language programs or data.
- After the 'READY?' question has been answered, the computer displays another 'READY' message at the bottom of the screen. Now, the computer is in the BASIC Active Command level. Your commands will be appreciated. Any input statement with numbers at the beginning is recognised as a BASIC statement and will be stored into the memory. Otherwise, the statement is treated as a direct command.
- At this stage, only the 12K BASIC is activated. Remember the S-80 has extended keyboard and display features, and a machine language monitor inside a 1.5K ROM. To activate those functions, the initialization procedure should be

  i) type SYSTEM|NEWLINE|
  ii) reply *?
  iii) type /12288

  The cursor is flashing. The ROM is activated. Two other entry points could be used in Step (iii) if only part of extended function is needed, /12299 will retain all features except the flashing cursor. /12294 will enable upper/ lower case characters only.







2.3 Initialization with disk operating system. (DOS)

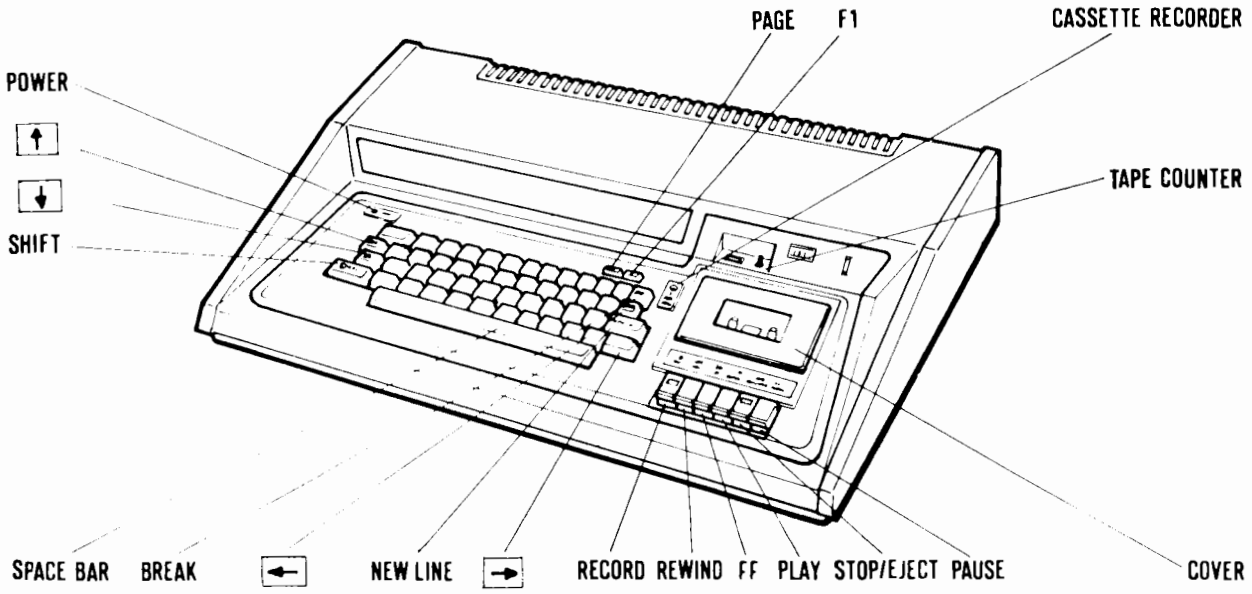
- If your system has an expander and minifloppy disk drives, you should also has a diskette with a DOS on it. Turn on power for the system. The screen will be full of garbage. Insert a DOS diskette into drive 0. Press the reset switch. The lamp on drive 0 will light up. After a second, the operating system will be loaded into your computer. The next step is to command the computer in the way as mentioned by your DOS manual.

Explanation: DOS is a piece of system software that handles the access of data on a disk. It is not a language interpreter. To enter BASIC from DOS, just type in BASIC.

There are two groups of keys on the keyboard. One is the alphanumeric keys and the other is the function keys.

3.1 Alphanumeric keys

Alphanumeric keys are those representing characters A-Z, 0-9, etc. Hitting such key will return the corresponding ASCII code into the computer. Normally the character will be echoed onto the screen.



3.2 Function keys

Hitting such keys, the computer will perform a certain function.

PAGE	– Select page for display (refer to previous section).
F1	– turn on power for resident cassette enabling tape winding.
BREAK	– break away from a running program and return to the Active Command Level. Mostly, the key is used to terminate a process.
CLEAR	– clear screen and locate the cursor at the top left corner.
NEWLINE	– enter a line of command or data into the computer.
[←]	– backspace, cancel the character previously typed.
[→]	– tab, move the cursor eight positions to the right.
[↓]	– move the cursor to the beginning of next line.
[↑]	– display a [sign which is an exponent sign used by the computer.
SHIFT	– display lower case characters when used with alphanumeric keys. e.g. SHIFT – A gives 'a'.
SHIFT - [→]	– same as print CHR$(23). See previous section.
SHIFT - [←]	– delete line.

3.3 Extra Keyboard functions

The following functions will be enabled only after the 1.5K ROM initialization has been done.

1. Repeat Key

   After pressing a key longer than one second, the computer automatically repeats entering the character until the key is released.

2. Print Screen

   By hitting SHIFT -- ↓ -- P, the computer will transfer the information displayed on the screen to the printer. If no printer is connected or the printer is turned off, the computer will skip the printing process instead of locking up itself in waiting. Once the SCREEN PRINT function is activated, both alphanumeric and graphic characters on the screen will transfer to the printer. Only those printers that can recognise S-80 or TRS-80 graphic characters are able to print the graphics. Otherwise, only alphanumeric characters can be printed.

3. Disabled flashing cursor

   A flashing cursor can attract the operator's attention, however, somebody may feel it frustrating.

   In order to disable the flashing cursor, hit SHIFT-BREAK. To enable it, hit SHIFT-BREAK again. If you don't want a flashing cursor at the start, please enter 12299 instead of 12288 during ROM initialization.

4. Renumber command

   An existing BASIC program in memory can be renumbered for you automatically, by typing in the command

   RE m, n (NEWLINE)

   where m is the number you want given to the first line, and n is the increment you want given between all subsequent line numbers. For example RE 1ØØ, 1Ø will renumber the program with the first line becoming line 1ØØ, and following lines 11Ø, 12Ø, 13Ø and so on.

   NOTE: If renumbering results in a line number of greater than 65529, the routine will renumber successfully up to this but will then stop and display an "OM ERROR". Any remaining lines of the original program will be lost.

VIDEO DISPLAY FORMAT 4

The system allows two display formats, that is, (1) 64 characters per line by 16 lines and (2) 32 characters per line by 16 lines. The purpose of the latter is to permit an enlarged and clear character display when a TV set is used.

4.1 64 characters/ line format

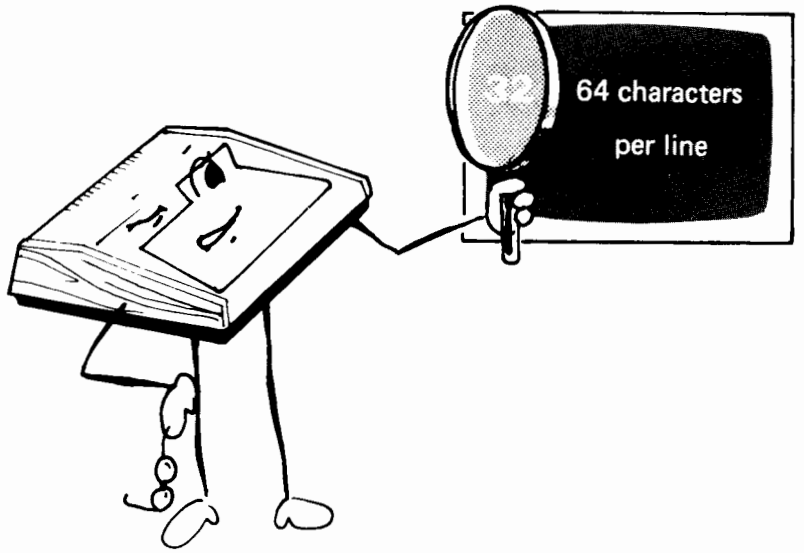
This format is selected when the VIDEO CUT switch at the back panel is at the 'out' position.

4.2 32 characters/ line format

The format is selected with the VIDEO CUT switch depressed. The former 64 characters/ line page is chopped into two. If the PAGE switch on the keyboard is depressed, the right page will be displayed. Otherwise, left page is on the screen.

4.3 Space insertion

Type in PRINT CHR$(23). Then, the computer will insert a space between characters. The mode can be reset by NEW or CLS command. Hitting the SHIFT – [→] keys functions the same.



'That's better !'

VIDEO CUT

ON

PAGE

64 characters per line

32 characters per line

VIDEO

CUT

5. CASSETTE PROGRAM – LOADING & SAVING

After you are familiar with the power up procedure and successfully get the BASIC interpreter works for you, you will certainly write your own programs. However, you finally found out that your program vanished everytime you turned off the computer. The cassette saves your time to type in the program again. You can now save the program onto a cassette tape and reload it at any time you want. The cassette transfers the program into the computer at a rate of 500 bit/second.

Now, please follow the procedures below and try to load the demonstration programs supplied with your system.

5.1 Loading a program from the resident cassette

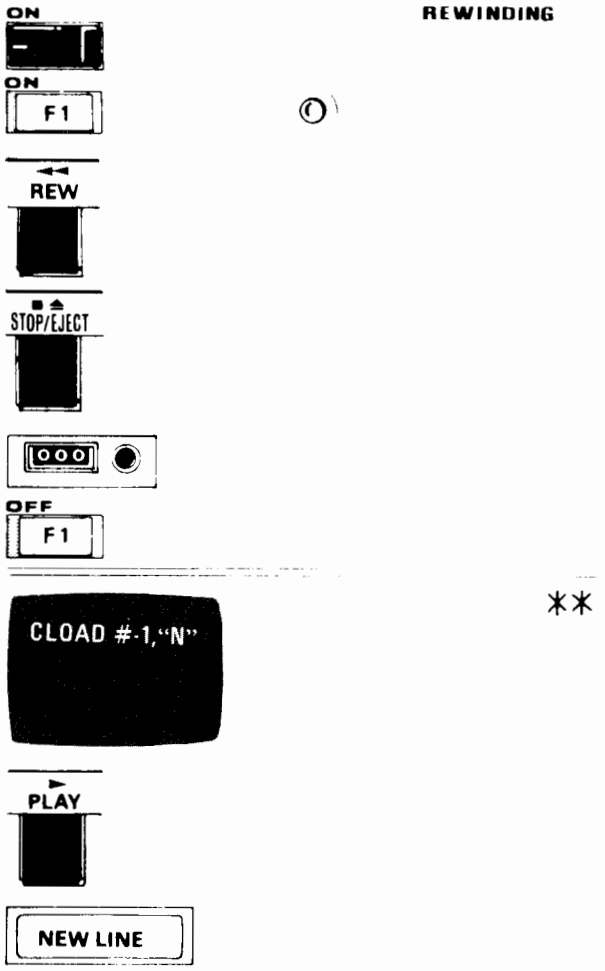
1. Insert a cassette into the recorder.
2. Close the recorder cover.
3. Press the F1 switch.
4. Rewind the tape if necessary. (See rewinding procedure).
5. Reset the counter.
6. Wind the tape until the counter indicates the position of the program's beginning.
7. Turn the cassette volume towards the 'HIGH' side.
8. When the program signal occurs, the meter deflects, and the volume should be adjusted until the meter falls around regional 2 – 3.
9. Step 7, 8 could be omitted if the volume level has already been adjusted.
10. Rewind the tape to the program's beginning again.
11. Release the F1 switch.
12. Type in CLOAD #-1, "N" (where N represents the name of the program) or, just type in CLOAD. The former command tells the computer to search for the program file named "N", while the latter load the first file encountered.
13. Press the PLAY key.
14. Hit the NEWLINE key.

The computer starts searching the program; once it is found, two asterisks appear at the top right corner of the display. One of the asterisk will be flashing periodically indicating that the program is loading. Once the loading has completed, the computer displays a READY message.

When loading error occurs, the results may be the flashing asterisk stops and the system locks up; or, lots of garbage are found when listing the program. In such cases, we have to load the program again using a higher or lower level. If it still fails, the tape may be permanently damaged.

CASSETTE PROGRAM 5

LOADING & SAVING



5.2 Rewinding Procedure

1. Press the F1 key (the red light next to the cassette should then be on).
2. Press the REWIND button on the cassette drive.
3. Wait till rewinding stops.
4. Press the STOP/EJECT button to stop all operations physically.
5. Reset the cassette counter to 000.
6. Turn off the F1 button.

* *
or
BAD

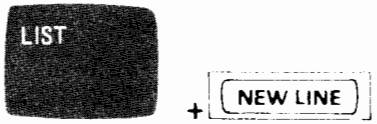
5.3 Checking a Program

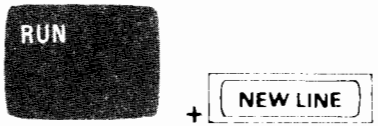
1. Read the CLOAD command (section 1.5 in the BASIC Manual.)
2. Rewind the cassette tape to the starting point of the program.
3. Press the PLAY button on the cassette drive.
4. Type in the command CLOAD? from the keyboard.
5. Hit the NEW LINE key.

Once the computer finds the program, two asterisks will appear on the top right corner of the display, the one on the right will be flashing if comparison is successful. A READY message will appear if the comparison has been completed. Otherwise, the word BAD will be displayed.

5.4 Listing and Executing a Program

1. Read the LIST and RUN commands (section 1.9 and 1.11 in the BASIC Manual.)
2. Type in LIST and hit the NEW LINE key (The entire program will be listed on the display).
3. Type in RUN and hit the NEW LINE key (The computer starts executing the program).





5.5 Program Saving

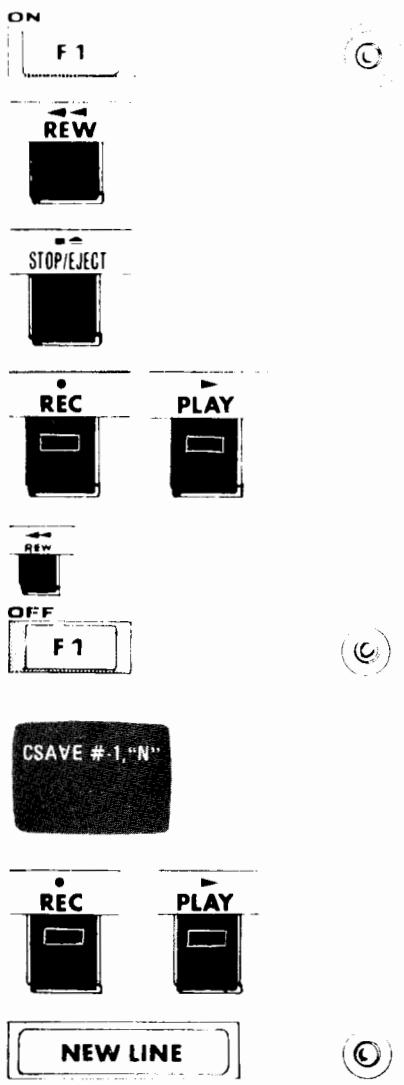
Winding the Tape to the Proper Location

1. Press the F1 key (the red light labelled CASSETTE RECORDER should be on as well).
2. Press the REWIND or FAST FORWARD key and set the tape to the location where program saving starts.
3. Press the STOP/EJECT key to physically stop tape winding operations.
4. Press the RECORD and PLAY keys simultaneously, to clear a part of the tape before actual saving.
5. Rewind the tape a little to ensure the entry point for program saving is clear.
6. Release the F1 key (the red light labelled CASSETTE RECORDER should be off.)

Program Saving

1. Type in CSAVE # −1, "N" (where N represents a file name).
2. Press the RECORD and PLAY key simultaneously.
3. Hit the NEW LINE key.

The red light labelled CASSETTE RECORDER should be turned on automatically, and the cassette should be recording the signal from the computer. However, no asterisk will appear on the display. A ready message will be displayed after the saving has completed.



5.6 Sound Output

Since the S-80 includes a sound circuit and a built-in loudspeaker, we can enjoy the sound effect or music played by the computer. It is very interesting and exciting to hear the sound effect of a computer game such as the sound of explosion of missiles.

The sound signal is derived from the data bit D0 and D1 of the output port of the cassette interface. The port address is FF in hexadecimal. Since the CPU will output data to this output port during cassette program saving, we might hear the digital sound of the program. Somebody may feel it annoying, and therefore the sound circuit is designed such that the sound output is disabled during cassette program saving.

You may play around with the sound circuit by writing your own programs to output various data streams to the port FF. Listed below is an example of simple sound program.

```
10 OUT 255, 0 : OUT 255, 1: OUT 255, 0 : GOTO 10
```

SECOND CASSETTE RECORDER 6

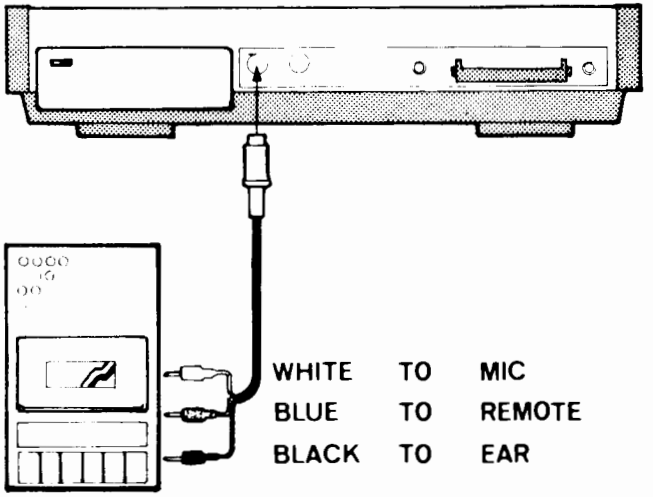
Two cassette recorders are required in some applications such as payroll and accounting. In these applications, old data have to be read into the computer sequentially from one file and output to another file after processing or updating. The main unit already has the interface for one more cassette recorder. Signal input/output is through the DIN jack at the back panel. A cassette recorder cable is packed with the System.

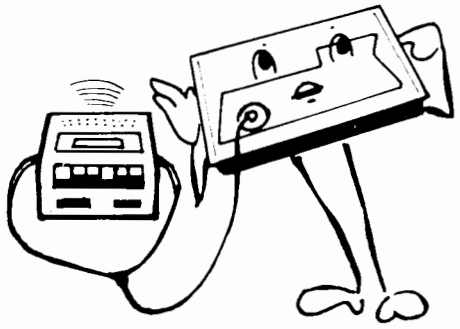
Active Commands and instructions are provided to handle this extra cassette. These are:—

i) CLOAD #—2, "M" — load a program called M from cassette '2'.
ii) CSAVE #—2, "M" — save a program onto cassette '2'.
iii) PRINT #—2, A, B, C$ — store the variables A, B and character string C$ onto cassette '2'.
iv) INPUT #—2, A, B, C$ — input the variables A, B and character string C$ from cassette '2'.

For further programming details, please refer to the BASIC Manual. The operating procedure of the cassette "2" for playing (reading in data) or recording (outputting data onto the tape) is same as that described in 5.1 to 5.5.

Note:—The user may have to adjust output volume of his cassette until no error occurs during cassette loading. The System may have to be reset if invalid data is read and causes a dead loop.





`That's my heart-beat!!'

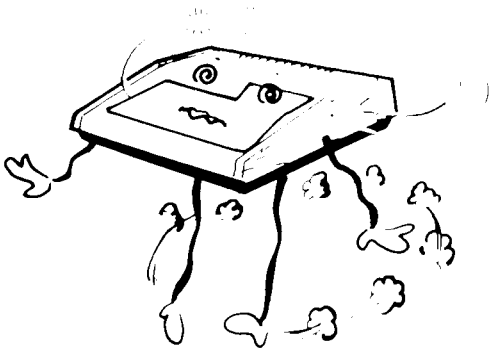
SYSTEM RESET 7

The system must be reset in such cases as the S-80 is running in a dead loop. A dead loop here means that the computer is out of our control and we cannot communicate with the computer through the keyboard and the display unit. The RESET switch can be found at the right side of the back panel. Pressing the RESET switch will lead the computer back to the 'READY' mode without changing the memory contents.

The system will run in a dead loop in case of:

1. loading a program from the cassette which contains an invalid file, or when the volume of the recorder is poorly adjusted.
2. executing LPRINT or LLIST command without hooking up a printer to the system or having not turned ON the printer.
3. executing an inappropriate POKE instruction.

Besides the system reset by the RESET switch, the CPU is reset everytime when the power is on. Turning the main unit OFF and ON immediately is not a good practice because the CPU may be improperly initialized, and garbage may appear on the screen. So, the user should wait for about 15 seconds before turning on the S-80 again. Refer to section 2.3 on initialization with disk operating system.



`Help!´

SOFTWARE 8

The S-80 operates on a high level language, BASIC. The system's EXTENDED BASIC is compatible with that of TRS-80 Level II BASIC. Therefore, TRS-80's tapes can be loaded into the system and executed. Details of the BASIC language are explained in the BASIC Manual.

The S-80 can also load binary tapes that contains Z80 machine codes. For loading such tapes and executing the machine code programs, refer to the command, SYSTEM discussed in the BASIC Manual. Read also the following section on the Machine Language Monitor.

MACHINE LANGUAGE MONITOR 9

This machine language monitor allows you to enter, modify, display and execute (with break-points) Z80 machine code which is displayed and entered in hexadecimal format.

To enter the monitor mode, type SYSTEM NEWLINE and then /12710 NEWLINE. The display will then show the current status of the CPU registers.

Example:

```
IY = FFEF
IX = FFF8
AF = 0050
BC = 0320
DE = 41EE
HL = 2883
AF' = FDFE
BC' = FBFC
DE' = 6283
HL' = F5E6
SP = F422
PC = F3CB
```

There are five commands available:

1) **B – Return to BASIC**

Typing B will return the machine to BASIC without altering the memory contents.

2) **D – Display Memory**

This command has the form Dnnnn where nnnn is an address in hexadecimal.

Example:

D4545 will display the contents of 16 memory locations starting from address 4545.

Use of the down arrow key ↓ will then display successive sets of 16 locations, the up arrow key ↑ will step back through the memory.

Press any other key to exit to the display of register contents.

3) **R – Modify Registers**

This command allows modification of any of the Z80 registers. Press R to display the first register pair (IY) and the next four characters typed will be entered into the register.

Hit the X key to skip to the next register pair.

Example:

type	R
display	IY 8999/
type	5ABF
display	IY 8999/ 5ABF
	IX 4025/

Register pair IY now contains 5ABF and IX is ready to be modified. An automatic exit is done after the Program Counter (PC) has been modified.

4) **M – Modify Memory**

This command allows modification of any RAM memory location. It has the form

Mnnnn where nnnn is the first address to be modified in hexadecimal.

Example:

type	M4000
display	4000 C3-
type	FF
display	4000 C3-FF
	4001 96-

Location 4000 has now been modified to FF, and the next location 4001 and its content will be displayed for modification. Press the X key to exit when all memory modifications have been done.

5) G – Start Execution

This command starts execution of a program. The format is Gnnnn, xxxx NEWLINE

where nnnn is the starting address, and xxxx is the breakpoint address in hexadecimal.

Example:

G0000 (will boot up the machine.)

G8000, 81AB (the machine starts execution from address 8000 and return to the monitor mode when it runs to the address 81AB.)

The monitor creates a breakpoint by inserting an instruction 'CALL 3347H' into the breakpoint location. When the instruction is executed, all registers will be saved and the former instruction in the breakpoint location will then be restored. Very often in program debugging, the program runs into a dead loop or other happenings, the breakpoint is not encountered.

The user has to reset the computer to start again. However, the three bytes CALL instruction still remains in the user program. The only way to restore the original code is by using the M command or by using the POKE instruction in BASIC.

APPENDIX A TECHNICAL SPECIFICATIONS

(1) ELECTRICAL CHARACTERISTICS

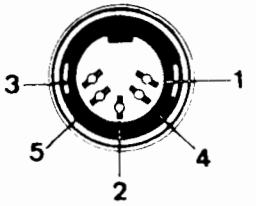
POWER CONSUMPTION	–	25W (MAX.)
CASSETTE INPUT LEVEL	–	1 V peak to peak
COMPUTER OUTPUT RECORDING LEVEL	–	0.3 V peak to peak
REMOTE SWITCHING CAPACITY	–	0.5 A max at 6 V DC
VIDEO OUTPUT	–	2V peak to peak (Negative sync pulse)

(2) CONNECTORS PIN ASSIGNMENTS

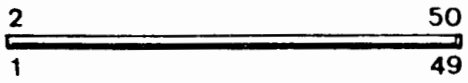
DIN JACK PIN CONNECTIONS FOR ADDITIONAL CASSETTE
1 – REMOTE
2 – SIGNAL GROUND
3 – REMOTE
4 – INPUT
5 – OUTPUT

DIN JACK PIN CONNECTIONS FOR VIDEO INTERFACE
1 – +5 V
4 – VIDEO OUTPUT
5 – GROUND

DIN JACK VIEWED FROM REAR SIDE OF THE SYSTEM.



EXPANSION PIN EDGE VIEWED FROM REAR SIDE



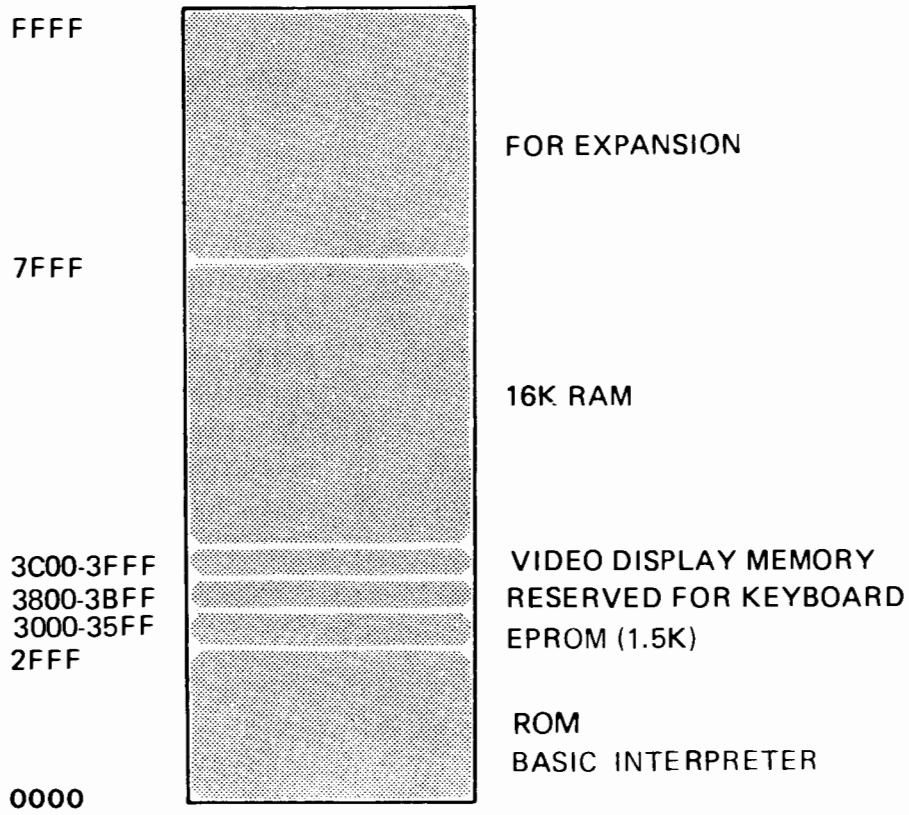
PIN CONNECTIONS FOR EXPANSION INTERFACE

PIN	SIGNAL	DESCRIPTION
1	GND	GROUND
2	GND	GROUND
3	A7	
4	A6	
5	A5	
6	A4	
7	A1	
8	A3	
9	A2	
10	A0	
11	D5	
12	D2	
13	NC	
14	D1	
15	D0	
16	D3	
17	D7	
18	D6	
19	VCC	+5V SUPPLY
20	D4	
21	A15	
22	A8	
23	A14	
24	A9	
25	NC	NO CONNECTION

PIN	SIGNAL	DESCRIPTION
26	A10	
27	A13	
28	A11	
29	A12	
30	PHI	1.79 MHz clock
31	$\overline{\text{PINT}}$	INTERRUPT
32	NC	NO CONNECTION
33	NC	NO CONNECTION
34	$\overline{\text{PHLDA}}$	PROCESSOR HOLD ACKNOWLEDGE
35	$\overline{\text{PHANTOM}}$	PHANTOM
36	$\overline{\text{HALT}}$	HALT ACKNOWLEDGE
37	$\overline{\text{PWAIT}}$	PROCESSOR WAIT
38	$\overline{\text{IORQ}}$	INPUT/OUTPUT REQUEST
39	$\overline{\text{PHOLD}}$	PROCESSOR HOLD
40	$\overline{\text{WR}}$	PROCESSOR WRITE
41	$\overline{\text{RD}}$	PROCESSOR READ
42	$\overline{\text{CCDBS}}$/$\overline{\text{STADBS}}$	CONTROL AND STATUS BUS DISABLE
43	$\overline{\text{MREQ}}$	MEMORY REQUEST
44	$\overline{\text{DODBS}}$/$\overline{\text{ADDBS}}$	DATA AND ADDRESS BUS DISABLE
45	$\overline{\text{M1}}$	FIRST STATE OF INSTRUCTION CYCLE
46	$\overline{\text{RESET}}$	CPU RESET
47	$\overline{\text{RFSH}}$	DYNAMIC MEMORY REFRESH
48	$\overline{\text{NMI}}$	NON-MASKABLE INTERRUPT
49	GND	
50	GND	

APPENDIX B
MEMORY MAP & I/O MAP

MEMORY MAP



I/O PORT ASSIGNMENT

CASSETTE INTERFACE – FF, FE
PRINTER INTERFACE – FD

APPENDIX C
ASCII TABLE

LSD \ MSD		0 000	1 001	2 010	3 011	4 100	5 101	6 110	7 111
0	0000			SP	0	@	P	`	p
1	0001	BREAK		!	1	A	Q	a	q
2	0010			"	2	B	R	b	r
3	0011			#	3	C	S	c	s
4	0100			$	4	D	T	d	t
5	0101			%	5	E	U	e	u
6	0110			&	6	F	V	f	v
7	0111			'	7	G	W	g	w
8	1000	BS	←	(	8	H	X	h	x
9	1001		→	)	9	I	Y	i	y
A	1010		↓	*	:	J	Z	j	z
B	1011		↑	+	;	K	[	k	{
C	1100	FF	HOME	,	<	L	\	l	|
D	1101	CR		-	=	M	]	m	}
E	1110			.	>	N	↑	n	~
F	1111		CLS	/	?	O	-	o	

NOTES

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