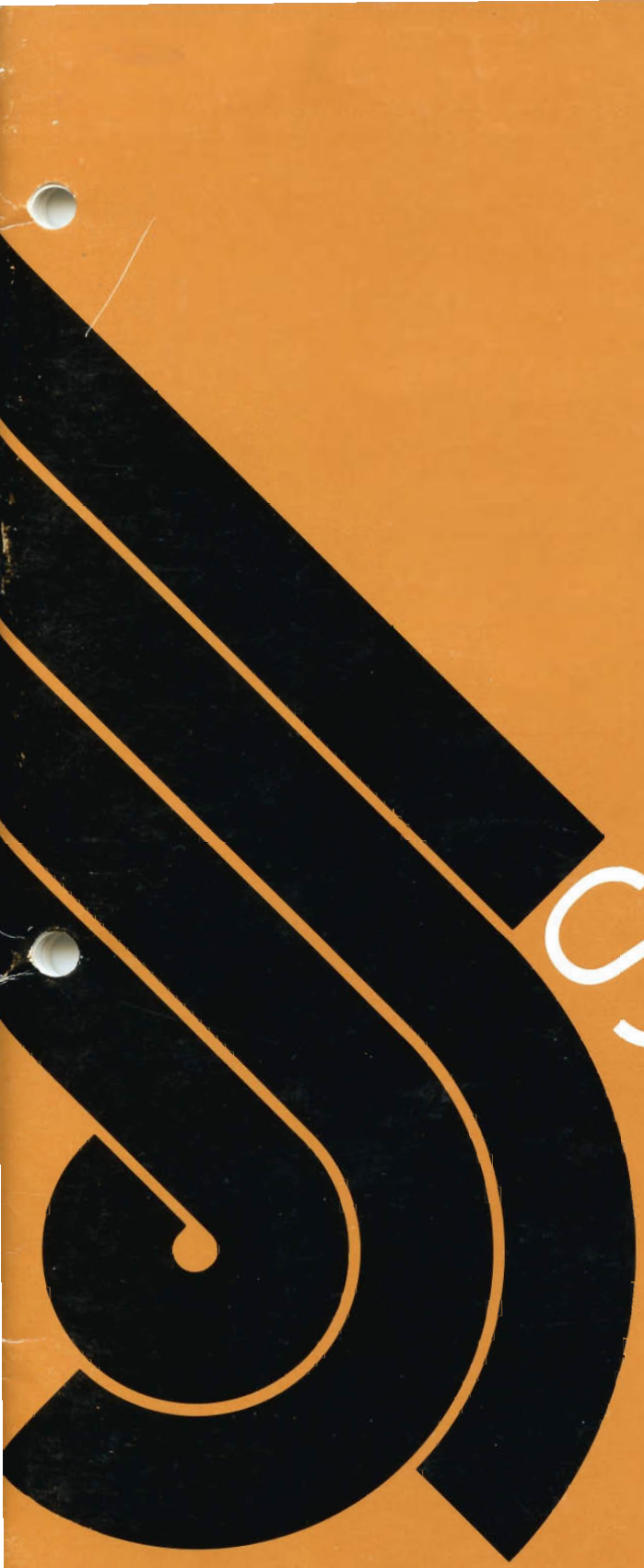

Sol® Terminal Computer

User's Manual

Processor Technology

Sol®
Terminal Computer
User's Manual

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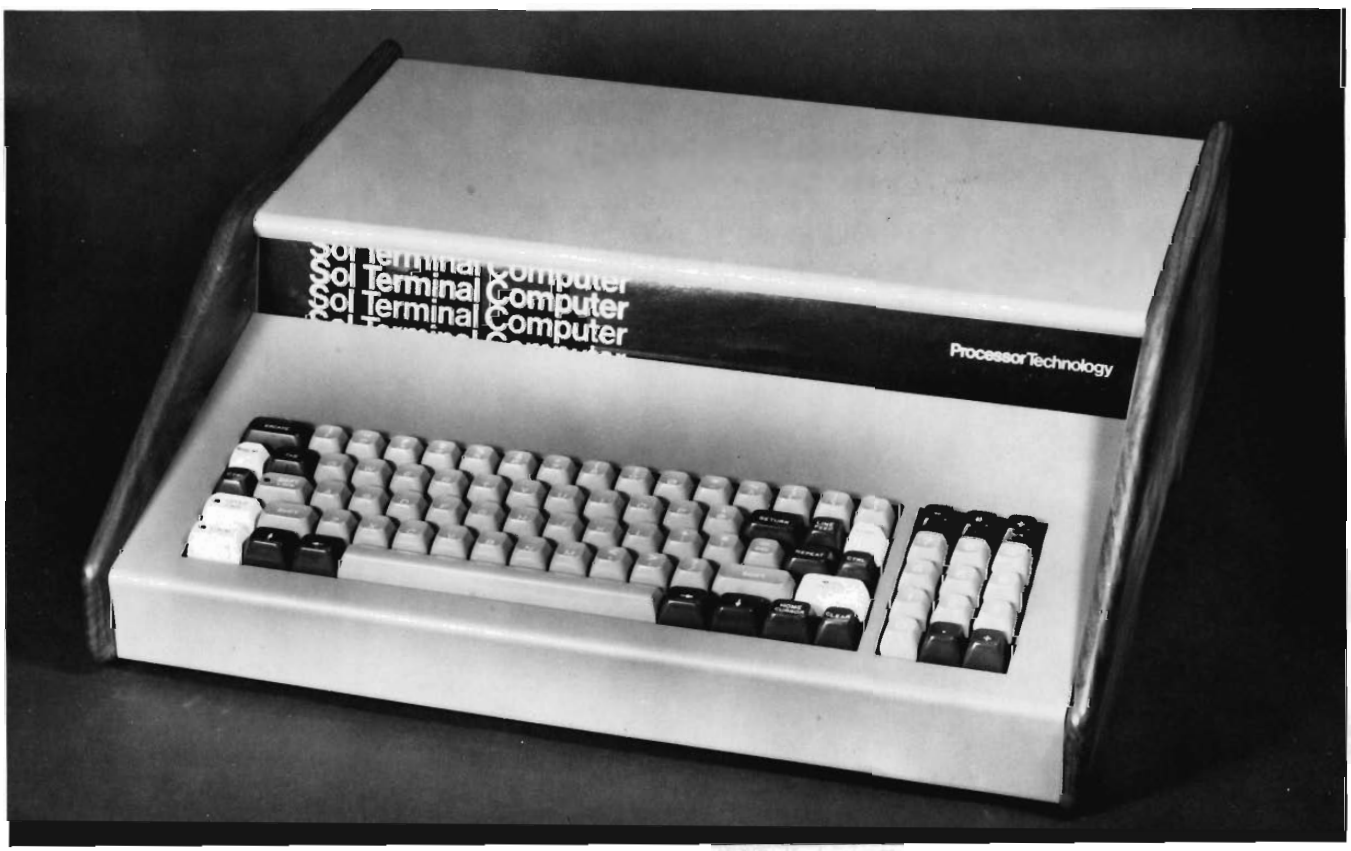

The Sol Terminal Computer

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SECTION 1

EXPLORING THE Sol SYSTEM

1.1 THE SCOPE OF THIS MANUAL

If you have obtained your Sol still in the shipping carton(s) please read Section 6, "Unpacking and Installation" before unpacking any further and before you start using your Sol. If you find yourself so anxious to unpack your Sol that you intend to skip the introduction, you may go directly to Section 6, but please read Section 1.1, "The Scope of this Manual".

This manual is a light operating guide and reference handbook for all Sol users. Just as the Sol is a simple yet sophisticated small computer that you can use for elementary applications such as playing video games, learning programmed lessons, as a desk-top computer system to write programs, as the host computer in a somewhat more complex business system, or as a terminal in a network of computer systems, so also, this manual can serve as a novice's learning book or as the more experienced user's introduction to the full capability of the Sol Terminal Computer.

The purpose of the first four sections is to get you quickly "up and running" with your Sol Terminal Computer. The sections and the information in them are presented in a sequence of steps especially designed for the purpose. Please follow the instructions up to the end of Section 4; then we turn you loose.

The rest of this section 1 presents a thumbnail sketch of the typical small computer system, with the spotlight on the Sol Terminal Computer System.

Section 2 is a briefing on the Sol user controls and other preliminary information on the "hardware" in your Sol system. Section 3 is an introduction to software. The object of having a computer, after all, is to run programs; therefore this manual will introduce you to the software manuals you have received with this manual. They are: SOLOS/CUTER User's Manual, Extended Cassette BASIC User's Manual (or Extended Disk BASIC User's Manual if you have a Helios).

Once you have progressed to the end of Section 4, you will have learned to load Extended Cassette BASIC from cassette and performed a few "basic" operations, including some simple programming.

After that, you can refer to the remainder of this manual for more detailed information that you may need from time to time as you gain more experience using your Sol. For example, Section 5 is all about the Sol keyboard. Section 7 contains maintenance and trouble-shooting tips for the qualified experts who are responsible for your system.

The appendices contain brief descriptions of hardware and software products to enhance your Sol. The appendices also contain additional technical information about the Sol.

If you have need for more technical information than this manual provides, for example, theory of operation and schematic drawings, you may order a more technical manual through your dealer, who uses such a manual to help keep your Sol in top condition.

You are cordially invited to participate in the future improvement of this book by sending us your comments and suggestions. A postpaid form is provided at the back of the manual.

1.2 WHAT'S A COMPUTER?

A computer is a manmade tool that extends the powers of the human mind. It does its work by manipulating vast numbers of symbols at tremendous speeds. In a digital computer like the Sol, the smallest, most basic symbol with which the computer works is called a "bit." A bit is a unit of information that answers the question, "Yes or No." In other words, a bit is either on or off. These two states are represented in mathematical notation as "1" for on, "Ø" for off. The two states of a bit are represented in the computer by two different electrical voltage levels. The computer has a myriad of minuscule electronic circuits that can alternate from one of these voltage levels to the other. By arranging these circuits into particular formations, information, also represented in bits, can be made to flow through the computer in a controlled fashion to answer questions and make statements of a mathematical and logical nature.

There are seemingly countless "logic circuits" in even a small computer, but they are always arranged in three basic functional groups, much as the cells of our brain are organized into parts of the brain. The first group functions as the control center, comparable to our thinking center. It is called the Central Processing Unit (CPU). The CPU directs the operations of the other two functional units, the memory an the input/output (I/O), which can be compared to our own memory and to the input/output functions of our senses and organs of communication. This similarity of the computer to the human nervous system is the basis for the study of cybernetics.

1.2.1 Clockwork 8080

It is in the CPU that the user's instructions to the computer are processed. The Sol's CPU is a single large scale integrated circuit named the 8080, which has become a standard in small computer systems and microprocessor-based systems. (An integrated circuit is single "chip" of semiconductor material upon which thousands of interconnected electronic circuits are fabricated by building up alternating layers of variously conducting materials in microscopic patterns.)

The 8080 microprocessor is ensconced on a large rectangular circuit board at the base of the Sol. This circuit board is called the Sol-PC. Making up the other two functional blocks of a computer,

Memory and the Input/Output (I/O), are about a hundred other integrated circuits on the Sol-PC. Memory and I/O support the control functions of the CPU.

The Sol-PC belongs to a category of computers called "Single Board Computers." The Sol-PC is available as a separate product from Processor Technology.

A crystal-controlled clock synchronizes the 8080's operations based on a rate of 2 MHz (two million cycles per second). The Sol attains an overall speed of between 100,000 and 500,000 instructions per second, depending on the type of instruction. The instruction referred to here is a machine language instruction. The "machine" is the microprocessor, whose prefix "micro" distinguishes the species "micro-computer." The 8080 microprocessor speaks a machine language made up of 8-bit words. An 8-bit word is called a "byte."

The second functional grouping of circuits within a computer is the memory. The CPU stores data in the memory prior to and after the data has been processed. Also stored in the memory are programs" which consist of lists of machine language instructions that are executed by the CPU section. In the Sol, the bulk of the memory function is performed by S-100 plug-in modules such as the 32KRA-1. The Sol's memory will be explained further in a succeeding paragraph.

The third and final functional grouping within a computer is the input/output circuits. I/O circuits coordinate the movement of data in and out of the computer. They create a circuit path between the CPU and external devices which perform other data processing or communicating. The circuits in the Sol which form a path between the CPU and a cassette recorder are part of the I/O function. (The Sol I/O interfaces will be discussed further in 1.4). With a CPU to direct the movement of data, a memory in which to store the data, and an input/output (I/O) interface to transfer data in and out of the computer, your Sol is ready to communicate with the outside world of other devices, other computers and with you, the user.

1.3 A COMPUTER WITH A BUILT-IN TERMINAL

Perhaps the most distinctive feature of a Sol is that it is a small computer with built-in "terminal." That is why the Sol is called a "Terminal Computer." A terminal is a device that enables the user to communicate with the computer. It usually consists of a keyboard and video display. The keyboard is used to enter data and commands; the video display is used to monitor the computer operations and display the data and commands being entered and received.

Technically speaking, the terminal is not part of a computer as such; rather it an input/output device and more specifically, a control console for human interaction with the computer. Other input/output devices, such as cassette recorders, collectively are called peripherals. Peripherals are equipment which aid the computer by loading, storing or displaying data, usually under the control of a computer.

An "intelligent" terminal is one that can perform some processing of the data in addition to entering and receiving it. Terminals and computers are often connected by telephone or other telecommunications lines to "time-share" or to form a "network." The Sol can be programmed to act as an intelligent terminal or as a free-standing computer. Most computers need a separate terminal for the user to communicate with it. A terminal consisting of the keyboard, video display and a standard communications interface are already built into every Sol. The Sol is its own terminal.

Despite its sophistication, the Sol is one of the easiest computers to operate. At the beginning you will be using the Sol as a "stand alone" computer, and you will use the keyboard to communicate with your Sol system as you enter and control programs and data.

1.3.1 "Play a Little Sol Music"

Like the keyboard on a piano, the keyboard is an important part of a terminal because it is the interface through which the user communicates with the computer. The Sol's more than ample keyboard compares with keyboards supplied with larger minicomputer systems. It has a 70-key main keyboard with color-coded keys that generate all 128 ASCII code characters. (ASCII is a standard code used by most computer manufacturers.) The ASCII character set includes the standard typewriter upper and lower case characters, plus a set of control characters that are activated when the CTRL (control) key is pressed at the same time as a character key. In addition to the ASCII keys, which are programmable, there are several "hard-wired" (permanent wired) special function keys. These function keys are handy for console operation of the computer, as well as for programming and word processing.

Conveniently located to the right of the main keyboard is a separate 15-key calculator pad provided so that the user does not have to stretch for the numerical keys at the top of the keyboard, when

making lengthy numeric entries. Both keyboards are designed for ease of operation and reliability. There is a built-in memory and scanning circuit that prevents simultaneous key activation and allows you to press any number of keys as fast a you can without losing a character. There are two keyboard status indicator lights to tell you whether the keyboard is set for upper case characters or shifted upper case. A third light indicates whether a Sol being used as a terminal is set for local operation or for transmission of the keyboard entries.

1.3.2 "Sol-a-vision"

The Sol Terminal Computer is self-contained insofar as all it needs to run is to be plugged in and turned on, but we humans need to see what we are entering on its keyboard what it is communicating to us. We need to monitor its operations and its communications with other devices. It needs a "display" for the video output of the Sol. The display is provided for in a separate I/O device, a "video monitor," which is a black and white TV adapted for this use or a similar but specially designed monitor.

The Sol video display generates 16 lines of text, each line 64 characters long. The display can be reversed by the user to show white characters out of black, or black on white.

1.4 "INTER-Sol-ar" SYSTEM COMMUNICATION

(Refer to Fig. 1-1, Sol-PC Simplified Block Diagram.)

"Software" is a broad term that refers to programs that are run on a computer. These programs are lists of instructions that tell the computer how the "data" are to be manipulated. Data is the information upon which the CPU operates. Data and instructions can be intermixed throughout a program; the program keeps track of whether a given bit, byte, line or block of information is to be treated as data or executed as an instruction. In a broader sense, a program is also "data" that the computer understands as a set of instructions. Programs can be stored in various ways. They can be stored outside the computer on magnetic or other media. A record of a program on a sheet of paper is called a "listing."

Programs can be executed only when they are in the computer's memory. Since memory is limited in storage capacity, programs are often stored outside memory until the time comes to load one or more of these programs into the Sol; there must be an I/O "interface" to transfer the program from its external storage medium to the memory in the Sol. Since programs and data generated in the Sol may also have to be moved out of the Sol to more permanent media, most interfaces are bidirectional. An interface, in this instance then, is circuitry that adapts one device having a specific function to another device having a different function (or at least a different design) when both the dissimilar devices have a common boundary where they must interconnect to perform an overall system function.

Thus an interface is used when the CPU is instructed to transfer its internally stored programs and data to an external device and/or

media. The Sol is splendidly equipped with three of these input-output interfaces (in addition to the built-in terminal interfaces for the keyboard and video display). These interfaces are:

The Audio Cassette Interface (ACI)
The Serial Communications Interface (Serial Port)
The Parallel Data Interface (Parallel Port)

If the data (including programs) is to be transferred in a string of bits one at a time, the data goes in or out the Serial Communication Interface. An example of serial data transfer is the Sol communicating via a modem over telephone wires or using its serial port to send data to a SolPrinter 3. The data can also be transferred eight bits at a time, when the Sol uses the Parallel Data Interface. The Sol can use this parallel I/O port to send data to a Solprinter 2. (The serial and parallel interfaces, together with the internal keyboard interface, are called "ports," as in a "seaport" where items of trade go in and out.) The serial and parallel port connectors J1 and J2 can be readily seen on the rear panel of the Sol.

The third I/O interface is the Audio Cassette Interface, which is a specialized serial interface that can load from and store to cassette tape. Two recorders can be used at the same time, one being read from, the other being written to; or the CPU can read or write alternately to two recorders. But there is still another type of interface employed by the Sol, the "bus interface"!

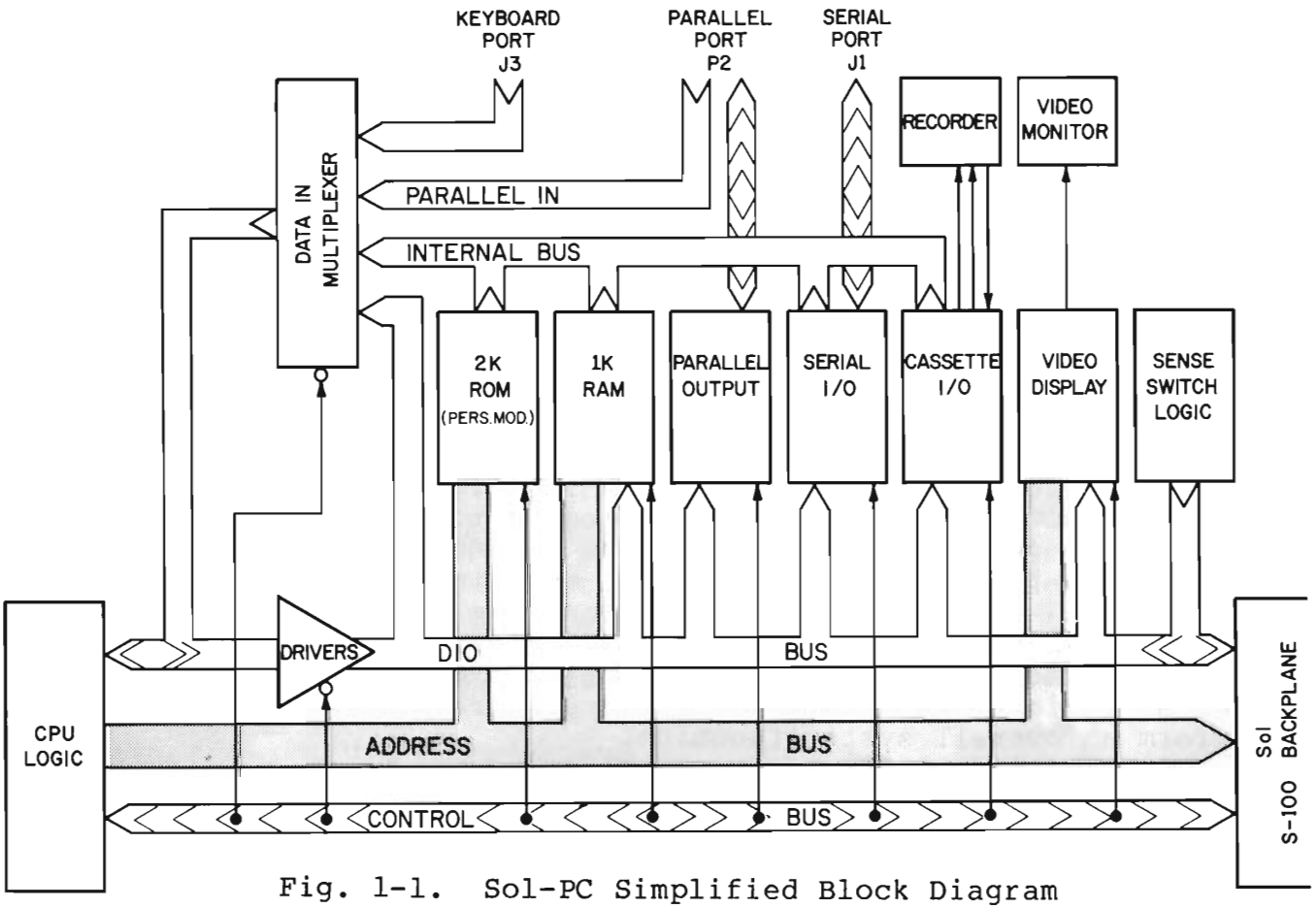


Fig. 1-1. Sol-PC Simplified Block Diagram

1.4.1 The Coming of the Sol S-100 Backplane

One of the most significant and effective characteristics of the Sol computer is a "plug-to-plug compatible" method of interfacing. Plug-to-plug compatible refers to devices having identical connectors and performance specifications so that they are direct replacements for each other. Similarly, a bus interface provides for additional memory modules, special purpose I/O modules, peripheral devices and even other small computers, all having the same connector specifications, to be plugged into a "bus." A bus is a number of parallel wires carrying control, address and data signals in common to all devices connected to the bus. The different bus devices, each plugged into a bus connector, share access to the bus, being synchronized by common control signals, much as the bus used in human transportation enables many people to arrive at their individual destinations via the same vehicle. A big advantage of a bus is that the various devices in a bus system do not need dedicated wiring to each of the other devices with which they must communicate, just as a real bus vehicle obviates the need for many individual cars to get the riders to where they are going. Bus design coupled with the large scale integration of the CPU accounts for much of the small computer's low cost.

Sometimes buses become more or less industry standards and different manufacturers can thereby produce a host of compatible devices. The most widely used bus standard in the small computer industry is the "S-100 bus." This is the bus used by the Sol and its associated peripherals. The S-100 bus is built around the 8080, certain wires being assigned to carry certain signals. It consists of 100 parallel wires; hence its name "Standard-100."

The Sol has a built-in S-100 bus that extends upward from the main circuit board. It is in the form of a "backplane" that can accept five expansion modules. This arrangement is often called a "cardcage" or "expansion chassis." Probably you ordered your Sol with additional memory modules. These come packaged separately. The memory modules are S-100 devices that you will later plug into the Sol's backplane. If you purchased a Helios II, it has interface modules that also plug into the backplane.

1.5 MEMORIES ARE MADE OF THIS

The plug-in memory modules are easily added to the Sol cardcage as needed. Computers are made with plug-in memories because different users want different amounts of memory, because they may want to increase the amount of their memory, because they might want obtain a later model of memory module; and it is convenient to test and maintain modular memory.

But even before any S-100 memory modules are added, the Sol has a limited amount of memory that is built into the Sol-PC. This memory is required for the Sol's basic functions, one of which is to manage the add-on memory. The Sol's 4,096 byte built-in memory, is permanently addressed at reserved memory locations (consecutive

addresses). This memory is divided into 2,048 bytes of Read Only Memory (ROM) and 2,048 bytes of Random Access Memory (RAM). First we shall explore the Read Only Memory.

1.5.1 Psychoanalyzing the Sol Personality Module

The Sol's 2K Read Only Memory (a "K" is 1,024 bytes) is in the form of a plug-in memory module that rides piggy-back on the main circuit board (the Sol-PC). This little module, which should already be installed in your Sol, is the Personality Module. The size of this memory module belies its importance, for without it there would be utter chaos when data begins to stream into the computer from outside devices and is "blitzed" from one circuit to another on the Sol circuit board. For, just as our own personalities program our behavior by selecting, interpreting, and organizing the vast amounts of clamoring data impinging upon our senses from the outside world, so does the Sol Personality Module control the interaction between the user and the Sol system resources: the CPU, the memory and the I/O interfaces.

When humans wake up in the morning, somehow they find themselves with the same personality, more or less, that they had when they went to bed. They don't usually "forget" their personalities. So too, Read Only Memory has a permanent program already manufactured into it. Unlike a magnetic memory and the RAM in S-100 memory modules, ROM can only be read and not over-written or erased by the computer. There is no need to change or modify the program stored in this ROM because of the nature of the program as we shall see below.

A even more important correlary quality of ROM is the fact that it is a "non-volatile" storage medium. Non-volatility means that the program stored in the ROM is not lost when the power supply is turned off. This feature is a convenience to the user who does not have to reload the program stored in the ROM each time the Sol is turned on.

SOLOS

Just what is the program that the user would want to load each time he or she turns on the Sol? What is the Sol's personality? The program that is embodied in the Personality Module is a 2,048 byte program named SOLOS. As manager of the system resources on behalf of the user, and being instantly available when the Sol is turned on, SOLOS is like an executive who is always on the job. In fact, it is called an "executive" or "monitor" program. It is the "operating system" supplied with a Sol. The job of an operating system is to make the system resources readily accessible to the user through a set of "console commands," that you can type in from the keyboard, to engineer the transfer of data among the system resources and external devices, and to act as a "master of ceremonies" during the transition of control from one program to another.

The Sol is able to change it personality modules without becoming schizoid! One module is used by a Sol in a cassette system; another by a Sol in a diskette system, and another can be fitted with a ROM programmed for the user's application. SOLOS and the three available personality modules are described in Section 3, "Introduction to Software." The SOLOS/CUTER User's Manual which comes with the Sol will familiarize you with the SOLOS commands.

1.5.2 The Sol's Built-in Read/Write Memory

Besides its ROM memory, the other section of Sol's built-in memory is read/write memory, called Random Access Memory (RAM). (This is the type of memory used in the additional S-100 memory modules.) Unlike ROM memory, RAM memory can be altered by the CPU. RAM is more versatile than ROM because many different programs can be loaded successively into the same RAM. ROM on the other hand cannot be altered by the CPU and can contain only the information placed in it when it is manufactured.

As a converse of its alterability, however, RAM is volatile. When the power supply is turned off, poof! This property of RAM is usually no disadvantage because the Sol's RAM is really a "workspace" for the CPU to manipulate the data and to store it temporarily until it is transferred to more permanent media if necessary. Most of a computer's memory is of the read/write type because the computer is always changing the contents of its memory, either by moving different blocks of data in or out or by operating on the data stored in memory.

Sol has 2K (2,048 bytes) of built-in RAM, located on the Sol-PC. 1K is used by SOLOS as a scratch pad to keep track of the ever-changing notes and records necessary for SOLOS' executive duties. While the CPU is loading data from cassette, the built-in RAM is sometimes used as a storage buffer. The second 1K stores the current video image ("frame" or "page") being generated by the video display circuitry.

1.6 PRERECORDED SOFTWARE

Instructions and even whole programs can be entered by hand into the Sol through the keyboard, but it is extremely convenient and efficient to have stored programs prerecorded on audio cassettes or floppy diskettes to be fed quickly into the Sol. In conjunction with a cassette recorder or disk memory system, the Sol can load and store any compatible programs and programs or data that you yourself may write or enter on the Sol. As an example, we will be loading Extended Cassette BASIC which comes with the Sol. Section 3 discusses software in general and the Sol software in particular. Some of the games and other programs that are available from Processor Technology are described in Appendix 1.

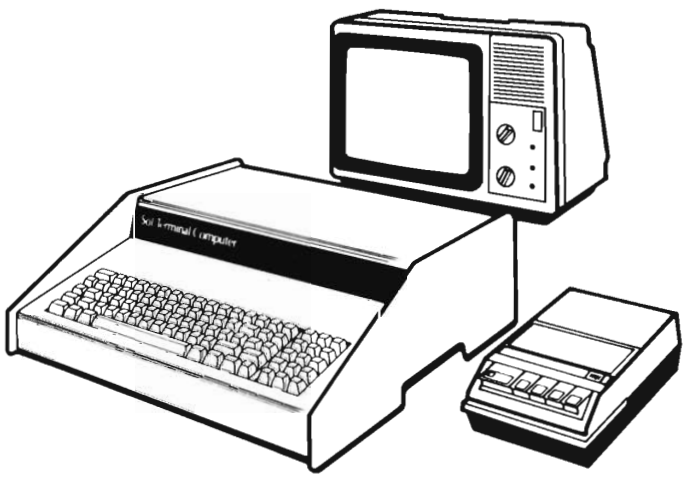
1.7 THE EXPANDING "Sol-ar" SYSTEM

The Sol together with a 16K memory module, a video monitor and a cassette recorder constitute the most fundamental Sol System (Sol System I-A). This system can be expanded by adding plug-in modules to the Sol backplane and/or replacing the memory module(s) with one of larger capacity, available from Processor Technology. The Sol has "slots" in its backplane for five plug-in S-100 modules which can be memories, I/O modules or interface modules such as the Processor Technology Helios II floppy disk controller.

You can also expand your Sol system by adding peripherals such as a second cassette recorder, a Helios II Disk Memory System or a Solprinter. Other useful S-100 devices are available from some manufacturers: if you require additional S-100 backplane connectors, there are add-on cardcages; if you want to add a little color to your "Sol-ar" spectrum, there are S-100 color graphics modules; a modem module can be used to communicate with other Sols and other computers anywhere in the world over telephone lines and satellites.

Refer to Appendix 1 for descriptions of additional equipment for your Sol System.

For further study of small computer systems and software, refer to the bibliography in the appendices of Extended Cassette BASIC User's Manual.



SECTION 2

AT THE CONTROLS

2.1 INTRODUCTION

Information in this section will help you to become familiar with the operation of your Sol Terminal Computer. You will be given brief explanations of the requirements and the operating controls. This section and the following one, Section 3, "Introduction to Software," will acquaint you with the Sol, so that you will feel at ease when, in the Section 4 section, you proceed to load Extended Cassette BASIC and experiment with a simple program.

Certain control switches are inside the Sol; however, these controls are already set for ordinary operation of the Sol. If it becomes necessaary to reset these switches, qualified service persons may refer to Appendix 3, "Internal Controls."

2.2 REQUIREMENTS NEEDED FOR THE EXPEDITION

Available Sol and Sol System configurations are listed in Table 6-1, "Sol System Component Lists." Assemble the items in the following list. You will need these items to load and run Extended Cassette BASIC as presented in Section 4:

1) A Sol Terminal Computer connected according to Section 6, "Unpacking and Installation."

2) A SOLOS or BOOTLOAD personality module installed in the Sol. The instructions in this section assume that your Sol is equipped with a SOLOS or BOOTLOAD personality module, one of which is supplied as a standard item with a Sol or a Sol System.

3) A minimum of 16K of RAM memory addressed continuously from Ø. 32K is recommended. (Refer to the appropriate memory module user's manual for address settings.)

4) Video monitor or black and white TV converted for video input. (For TV conversion instructions, see your dealer. As a substitute, a serial output device such as a teletypewriter may be connected to the Sol's Serial Communication Interface connector on the rear panel.)

5) A cassette recorder with motor and audio cables. (If you have not yet selected a recorder, see the appendix, "Cassette Recorder Supplement.")

   OR: A Helios II Disk Memory System, in which case you will be loading Extended Disk BASIC.

6) A cassette prerecorded with Extended Cassette BASIC.

OR: If you have a Helios II, the PTDOS system diskette. (The PTDOS system diskette contains Extended Disk BASIC.)

7) Manuals:

a) Sol Terminal Computer User's Manual (this manual).

b) The appropriate memory module user's manual.

c) SOLOS/CUTER User's Manual.

d) Extended Cassette BASIC User's Manual.

e) (and, if you have a Helios:")

Helios II User's Manual
PTDOS User's Manual
Extended Disk BASIC User's Manual

2.3 POWER TO THE Sol (Refer to Fig. 2-1, Sol Rear Panel.)

On the rear panel of the Sol is a square red button that has two positions. This switch is pushed IN to turn on the Sol. (Do not turn on the Sol yet.) In the ON position, a detent holds the switch in. To turn OFF the Sol, push the button again. The detent releases the switch and it pops out to the OFF position.

When turned on, later models of the Sol will have UPPER CASE set as indicated by the red light-emitting diode (LED) in the key.

It is recommended that you turn off your Sol if you are not using it for an extended period of time. This should help extend the life of the memory modules. The Sol needs no warmup time. When the Sol is turned off, the data contained in RAM will be lost.

Fig. 2-1. Sol Rear Panel

2.4 THE VIDEO DISPLAY

1) Turn ON the Sol.

2) Turn on POWER to your video monitor by touching its power switch. (The monitor has its own manual if you need to reference it.)

3) The SOLOS prompt character followed by the cursor (>■) should appear at the upper left corner of the screen. The greater-than sign is the SOLOS prompt character; it means "now you can type a SOLOS command." The cursor is the solid vertical rectangle which occupies the character position in the display where the next character is to be printed or the point at which the next operation is to start. Of itself, the cursor does not affect any characters in the display. A prompt character is a distinctive symbol that reminds you which program the computer is running.

4) Adjust the CONTRAST and BRIGHT controls on your video monitor to optimize the display of the cursor.

The SOLOS monitor program automatically takes control in its Command Mode when the Sol is turned on. This sequence is called the power-on initialization. In the Command Mode, which is the primary mode, the Sol is waiting for a command. The two operating modes of SOLOS will be discussed in Section 3, "Introduction to Software."

If the prompt does not appear, refer to Section 7, "TLC For Your Sol."

Your video display, which is controlled by the Sol, is usually set by the factory to display black characters on a white background. If you prefer, a qualified person can reverse the display by using the polarity switch inside the Sol. For details refer to Appendix 3, "Internal Controls."

The lines of program instruction or text are rolled up off the top of the display to make room for a new line at the bottom. This is action is called "scrolling."

2.5 KEYBOARD CONTROLS AND KEYBOARD RESTART

(A detailed reference to the keyboard is provided in Section 5, "At the Keyboard." This section contains only the information that you will need to perform the steps in Section 4, "Loading Programs from Cassette.")

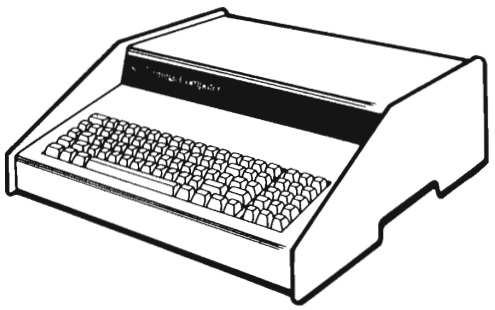
When UPPER CASE and REPEAT are pressed simultaneously, a keyboard restart is executed with the result that UPPER CASE resets to lower case letters and the Sol is reset as if it were powered-up (power-on initialization).

Use the keyboard restart to return to SOLOS from:

1) A program that does not have an exit command or does not recognize its Exit command.

2) A program that is caught in an endless loop as indicated by its inability to respond as it is supposed to. For example, when the program "locks up" the keyboard so that there is no response to pressing any of the keys (except UPPER CASE and REPEAT).

3) A program that has been otherwise rendered defective by an error.



SECTION 3

INTRODUCTION TO SOFTWARE

3.1 WHAT IS SOFTWARE?

A computer serves little purpose by itself. However complex its physical components, however ingenious the design of its circuitry, a computer is useless unless there is a way for a person to tell it what to do.

Control of a computer is achieved by means of "programs" which are lists of instructions written by people in languages that both people and computers can understand. (Actually, the computer does not "understand" anything; rather, it is designed to follow instructions that are expressed in a certain way.) The programs associated with a computer constitute its SOFTWARE. The physical components of the computer constitute its HARDWARE.

Software varies in its complexity. When you type your first BASIC program on the Sol keyboard, you will have created an example of software. The software required to orchestrate and monitor a successful lunar landing is much more complicated than your BASIC program, but it is the same in kind: a person or a group of people write instructions for the computer to follow. Some programs make it possible for other programs to run. For example, your BASIC program will run because a larger program called BASIC is interpreting it for the 8080. BASIC will run because SOLOS (or PTDOS) is regulating the operation of the Sol and its peripherals. (BASIC "makes calls" to SOLOS to perform certain functions so that the functions need not be repeated in BASIC.) When you communicate with the computer, whether by typing on its keyboard or by loading information from a cassette or disk, the computer responds according to instructions that people have given it. The apparent intelligence of the computer is determined by the care that you and other people have taken in instructing it.

A set of instructions that you type on the keyboard is not very permanent: it exists only in the volatile read-write memory of the Sol. If the power fails in your building, or if you turn the computer off, the program disappears. If a program is very short, you might not mind the time it takes to type it on the keyboard every time you want to use it. Most programs, however, are much too long for such a practice to be convenient. Entering a program manually is time-consuming and likely to introduce errors. You might spend hours typing the instructions and then execute them, only to find that you have omitted or mistyped something and accidentally destroyed a part of your program. (Remember that a computer will act only on what you have actually told it, not on what you might have meant to tell it.) Recording software on a medium like cassette tape, disk, or read-only memory is a way of giving permanence to a correct version of the software; it also reduces the amount of time required to load the program into memory. A program that would take hours to type into the computer correctly can be "read" from a cassette in minutes, from

a diskette in a second. A program recorded in read-only memory need not be "read" into memory at all, because it is already there.

Software may be classified according to its function:

The most important program associated with a computer is its OPERATING SYSTEM. The function of an operating system is to provide an interface between all other programs and the computer hardware. Processor Technology Corporation offers two operating systems for the Sol: SOLOS for cassette systems and PTDOS for diskette systems.

A program designed to solve a specific kind of problem -- for example, to keep records of inventory, perform statistical analyses, or process text -- is called an APPLICATION PROGRAM. Most of the programs that you will write, at least at first, will fall into this category.

Programs that help a programmer to develop other programs are called PROGRAM DEVELOPMENT SOFTWARE. Programs in this category include editors, assemblers, interpreters, compilers, and debuggers.

Appendix 1 contains a partial list of prerecorded programs that you can buy for your Sol.

3.2 COMPUTER LANGUAGE AND LANGUAGE TRANSLATORS

Computers are good at arithmetic. This fact has led many people to believe that only mathematicians can "talk" to computers. Anyone who has ever "spoken" to either a computer or a mathematician will realize that, although all computers and most mathematicians are good at arithmetic, language remains the primary vehicle for communication.

Computer languages are simpler than "natural" languages for several important reasons. When people communicate with one another, the meaning of a sentence is conveyed not only by the individual words and their order, but also by the context in which those words occur. (In spoken language, intonation and various physical factors also contribute to context.) A person can guess at the meaning of an unfamiliar word by looking at surrounding words, sentences, and paragraphs. The meaning of an entire sentence can be dependent on context; we have all heard people accused of "taking words out of context" to confuse or mislead others. A computer is not as well equipped to handle context as a human being is. To eliminate ambiguity, a computer language must consist of a limited number of statement types and a carefully defined vocabulary. A computer language, by contrast to a "natural" language, is "context-free," i.e., a statement must have the same meaning, regardless of its context.

In order for statements in a computer language to be understood by a computer, they must be reduced to a pattern of binary codes directly intelligible to the computer hardware. ("Binary" means "in base 2.") This binary "language" is called MACHINE LANGUAGE. Programs that translate statements from other languages into MACHINE LANGUAGE are called LANGUAGE TRANSLATORS.

The language that requires the least translation for a given processor is called its ASSEMBLY LANGUAGE. An assembly language is the symbolic form of the corresponding machine language; it uses symbols to represent operations and memory addresses. Because the Sol is based on an 8080 microprocessor, its assembly language is called 8080 Assembly Language. A language translator that translates programs from assembly language to machine language is called an ASSEMBLER.

Writing programs in assembly language is more difficult than writing programs in other computer languages, because the programmer must understand how the central processor is structured and how memory is addressed. It takes longer to write a program in assembly language than in a "higher level" language, but the resulting machine language program can be shorter and more efficient.

The easiest computer languages for people to learn and use are the HIGHER-LEVEL LANGUAGES. These languages, e.g., FORTRAN, BASIC, and PILOT, are closer to natural languages than is assembly language. For example, the way to say

```
PRINT "HELLO"
```

in BASIC is

```
PRINT "HELLO"
```

The structure of a higher-level language does not reflect (or reflects only dimly) the structure of a particular computer. To write a program in FORTRAN, BASIC, or PILOT, you do not have to know anything about the 8080; you DO have to know exactly what you want to accomplish and how you are going to explain it. A language translator that translates higher-level language programs to machine language is called either an INTERPRETER or a COMPILER. For an entertaining and informative discussion of interpreters and compilers, read the article entitled "Your Personal Genie" in the May/June 1977 issue of Personal Computing Magazine.

3.3 SOLOS

SOLOS was introduced in Section 1.5 as the "personality" of the Sol. This program provides the Sol user with a convenient means of accessing and managing the system resources and controlling execution of all other programs that run on the Sol.

SOLOS is available on either of two Personality Modules. (Recall that a Personality Module is a plug-in circuit board containing a read-only memory chip.) If you have a Sol System I-A or II-A, your system has the SOLOS Personality Module; if you have a Sol System III-A, III-B, IV-A, or IV-B, your system has the BOOTLOAD Personality Module.

The two versions of SOLOS are almost identical. Each has 19 commands that allow you to examine and change the contents of memory, control one or two cassette recorders, determine the source of input and destination of output, and execute other programs. Some of the commands perform "housekeeping" functions such as setting the rate at which data are read from tape, or the rate at which characters are

displayed on the video monitor. The respects in which the versions differ are few but important. The version of SOLOS on the SOLOS Personality Module has two possible operating modes: Command Mode, in which the Sol operates as a stand-alone computer, and Terminal Mode, in which the Sol functions as a video terminal for connection to another computer. On the BOOTLOAD Personality Module SOLOS has only one operating mode, the Command Mode; the command to enter Terminal Mode is replaced by a command that loads PTDOS, the Processor Technology Disk Operating System. (For details on PTDOS, refer to PTDOS User's Manual.)

3.3.1 Command Mode

In the SOLOS Command Mode, Sol operates as a stand-alone computer under control of the program contained in the personality module. SOLOS can "hand over" control to other programs that have been loaded into the Sol, usually from cassette tape or diskette. For detailed information about the SOLOS operating system, including a complete discussion of the commands, refer to the SOLOS/CUTER User's Manual, Second Edition.

With the SOLOS Personality Module installed, the computer is in the Command Mode when power is applied to the Sol. The > that you see on the screen is a "prompt" character; it tells you that SOLOS is waiting for you to type a command.

All of the instructions in this section refer to operations in the SOLOS Command Mode. Terminal Mode is described in the Sol technical manual.

3.3.2 "Try It"

In this section you will try out a few SOLOS commands. Follow all instructions exactly. If you make a typing error while entering a command, use the DELete key to backspace and erase characters.

1) Turn on the Sol and the video monitor. Look at the keyboard; if the UPPER CASE key is not illuminated, press it once. (When you type a SOLOS command, you must always use upper case letters; otherwise the command will not be "understood.")

2) Type the following command:

   DUMP CØØØ CØEØ

   The DUMP command displays the contents of memory on the video monitor or other output device. The "CØØØ" and the "CØEØ" in the command are hexadecimal numbers: that is, they are numbers in base 16. In this command, the numbers identify addresses in memory. CØØØ is the beginning address of SOLOS.

3) Press RETURN to show that you have finished typing the command. Lines of hexadecimal data will scroll (move) rapidly up the screen. The display will stop scrolling after the contents of all locations from CØØØ to CØEØ, inclusive, have been displayed. The numbers that you see are part of the SOLOS program, in machine language form.

4) Type the following command:

    ENTR C9ØØ

   The ENTR command is used to enter hexadecimal data from the keyboard into the read-write memory of the Sol. The "C9ØØ" in the command identifies the address at which the first entry will be stored.

5) Press RETURN to show that you have finished typing the command. A colon (:) prompt character will appear at the start of the next line.

6) Type the following data, including blanks. If you make a typing error, use the DELete key to backspace. (The data represent a little program that prints the word "Hello" on the screen. You will be typing the instructions in machine language form; the original assembly language program is printed at the end of this section.)

    21 11 C9 7E FE ØØ CA Ø4 CØ 47 CD 19 CØ 23 C3 Ø3 and RETURN

   When the colon reappears, type

    C9 2Ø 2Ø 48 45 4C 4C 4F ØØ/ and RETURN

   (The slash (/) shows that you have finished entering the data.)

   The program you have just typed should now occupy addresses C9ØØ to C918, inclusive, in the read-write memory of the Sol.

7) To verify that the program is in memory, give the DUMP command:

    DUMP C9ØØ C918

   Then press RETURN key. The output should look just like what you typed in step 6, except that the entries will be arranged 16 per line, and each line will begin with the address of its first entry.

8) Type the following command:

    EXEC C9ØØ

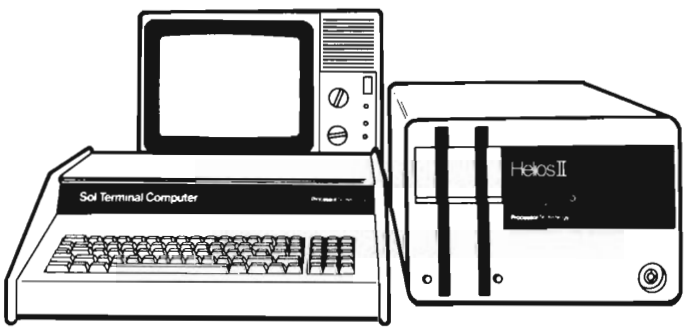
   The EXEC command executes (or "runs") the program that starts at address C9ØØ.

9) Press RETURN to show that you have finished typing the command. The word "HELLO" should appear on the screen. If it does not appear, or if something else happens, you made a typing error in step 6. Press UPPER CASE and REPEAT together, and try again.

10) Using your SOLOS/CUTER User's Manual, experiment with the other console commands until you feel at home with your Sol.

```
* PROGRAM TO PRINT "HELLO" FOR Sol USER'S MANUAL

  ORG ØC9ØØH
  LXI H,HELO
SHOW MOV A,M
  CPI Ø
  JZ ØCØØ4H
  MOV B,A
  CALL SOUT
  INX H
  JMP SHOW
HELO ASC '  HELLO'
  DB Ø
SOUT EQU ØCØ19H
```



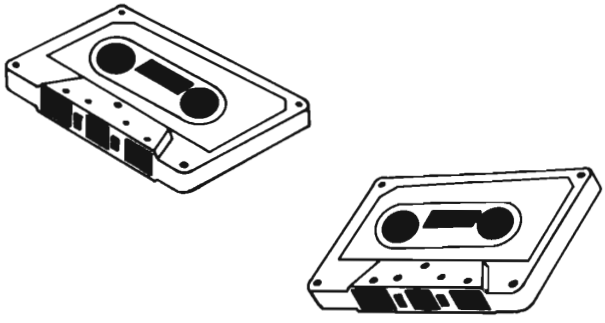
SECTION 4

LOADING PROGRAMS FROM CASSETTE

4.1 INTRODUCTION

In this section you will load from cassette the program Extended Cassette BASIC that is supplied with the Sol. Then, using Extended Cassette BASIC, you will enter a miniature demonstration program, as if you had just programmed it yourself, and write it back out to cassette. Finally, you will load the program back in from cassette and run it again to complete the cycle that applies to all the programs you will compose from here on.

The instructions given in this section are intended to get you started in using your Extended Cassette BASIC User's Manual, which is a handbook for the programming language BASIC when used with a Sol and a cassette recorder. (The edition referred to in this section is the first printing, January, 1978. If you have a Helios II Disk Memory System, use the Extended Disk BASIC User's Manual.



4.2 AUDIO CASSETTE RECORDERS (Preliminary Information)

Refer to your SOLOS/CUTER User's Manual, Appendix 1, "About Cassette Recorders and Cassette Files," for important information related to this section.

A complete procedure for reading and writing on cassette is given in Section 4.3, "Getting into BASIC." The following paragraphs in this section are preliminary notes.

4.2.1 Operating A Cassette Recorder

This section assumes that you have the standard cassette recorder supplied with the Sol System I-A, the RQ-413A. If you do not have a recorder or have a different recorder, refer to the Appendix, "Cassette Recorder Supplement."

If you plan to operate two recorders, also refer to the Appendix, "Cassette Recorder Supplement."

If you have problems loading from or storing to cassette, refer to Section 7.5, "Trouble-shooting Cassette Operations."

4.2.2 Cassette Recorder Operating Tips

For best results when using audio cassette recorders with the Sol, observe these tips:

Set the volume control to number 6 (about 2/3 full volume). Set the tone control at number 10 (maximum). The Sol has automatic gain control that compensates for a wide range of levels; but the above settings give the most reliable results. If you have a recorder different from the one supplied in a Sol System, experiment to find the optimum setting for the volume and tone controls.

CAUTION

> The MICROPHONE input can be live when you are recording through the AUXILIARY input on some recorders other than the one supplied with a Sol system. De-activate the MICROPHONE input according to the manufacturer's instructions. (In some cases, you can de-activate the MICROPHONE input by plugging a termination plug into the MICROPHONE jack.)

4.2.3 Notes on Writing to Cassette

In the case of two recorders, Unit 1 and 2 must be specified in the SAVE command in order to select the desired recorder. A default selects Unit 1. Refer to your SOLOS/CUTER User's Manual for instructions on how to use tape commands.

To make file retrieval much easier, keep a record of where individual files are recorded. After recording the last file on a side, rewind the tape, set the tape counter to zero, and issue a CATalog command (see SOLOS/CUTER User's Manual). As each file header is displayed, make a note of the following and mark the cassette with this information:

1) Tape counter reading.

2) Exact file name.

3) Load address.

4) File length.

4.2.4 Notes on Reading from Cassette

In order to read a specific file from tape, you must start the tape at least two seconds ahead of that file. This delay allows the Sol audio cassette interface circuitry and the recorder playback electronics to stabilize after power is turned on. Because all file searches are in the forward direction, the simplest approach is to rewind the cassette(s) completely before a read operation, unless you know that the file of interest is recorded at least two seconds into the tape from where the head is currently positioned.

4.3 GETTING INTO BASIC (Procedure for Using A Cassette Recorder)

1) Be sure you have connected your system according to Section 6, "Unpacking And Installation," and have familiarized yourself with the information in Section 2, "At the Controls" and Section 3, "Introduction to Software."

2) Turn on your Sol.

3) Select from your system components the cassette labeled "Extended Cassette BASIC."

4) Insert the cassette, label up, into the recorder.

5) Initially, adjust the following controls on the recorder:

   (If you have a recorder other than the one supplied with the Sol System I-A, try different volume settings until you find a reliable setting.)

   a) VOLUME: Set to 6 (about 2/3 full volume).

   b) TONE: Set to 10 (maximum for sensitivity to the higher frequencies).

   c) COUNTER: Reset to Zero.

6) Turn on POWER to your video minitor.

7) The SOLOS prompt character followed by the cursor (>▮) should appear on the left of the screen.

8) When the prompt appears, set UPPER CASE by pressing the UPPER CASE key so that its indicator light comes on. Type on the Sol keyboard the command: CA and press RETURN.

   This command allows the recorder motor to operate under local control. (Alternately, you can disconnect the REMOTE plug from the recorder.)

9) Press REVIEW (REWIND) on the recorder, to rewind the cassette to the starting position. All the tape should be on the left reel of the cassette. Press STOP on the recorder.

6) The statements for the entry of the cost of the fuel take the same form as those for miles and gallons:

```
50 P.  "ENTER COST IN PENNIES";
60 IN.  C
```

7) Now we program the answer and calculation for the miles per gallon. Enter the statement:

```
70 P."MILES PER GALLON=", M/G
```

As described in your Extended Cassette BASIC User's Manual, 2.3.3, "Expressions," "M/G" means "the value entered for M divided by the value entered for G." The comma that follows the PRINT statement signifies that the answer to the expression is to be printed out on the same line.

8) The final statement takes the same form as statement 70. Enter:

```
80 P."COST PER MILE IN CENTS", C/M
90 END
```

As described in the Extended Cassette BASIC User's Manual, 4.3, "Stopping or Delaying Execution," we terminate the program with the END statement.

9) To see the program you have entered and check it over before running, enter the command: LIST and press RETURN.

(Note that commands do not need line numbers since they are not part of the program.) BASIC will list your program on the screen as follows:

```
10 PRINT "ENTER MILES";
20 INPUT M
30 PRINT "ENTER GALLONS";
40 INPUT G
50 PRINT "ENTER COST IN PENNIES";
60 INPUT C
70 PRINT "MILES PER GALLON=", M/G
80 PRINT "COST PER MILE IN CENTS=", C/M
90 END
```

10) If you wish to correct an error or change a statement in your program, you may do so by simply retyping it including the line number. To insert an additional statement, number it with one of the intervening line numbers.

11) To see that your program runs as it should, enter the command RUN and press RETURN. (In the process of debugging a program, you can run the program starting at any instructions by including the line number of the instruction. For example, RUN 40.)

Enter data as called for by the program to make it continue along.

4.4.2 Saving a Program To Cassette

When you are satisfied with the program, try saving it to cassette as follows:

1) Enter the BASIC command: SAVE MPG,T

and press RETURN.

"MPG" is the name of the program (to become a file on cassette).

The "T" is "Text Mode" in which the program is to be saved.

The SAVE command is described in detail in your Extended Cassette BASIC User's Manual, 3.4.3, "Read or Writing on Tape."

BASIC displays the message:

Prepare Tape Unit 1 for writing to: MPG.

2) Load the recorder with a blank cassette. Do not use your cassette copy of Extended Cassette BASIC.

3) REWIND the cassette if necessary.

4) Play the tape for about 5 seconds to stabilize the recorder.

6) Depress the RECORD and PLAY buttons on the recorder.

7) Press any key to tell BASIC to start recording.

When the program has been recorded, BASIC returns the cursor with the message: READY.

8) Press STOP on the recorder.

4.4.3 Recalling a Program from Tape

(These instructions assume you are still in BASIC, although programs can be recalled from tape while in SOLOS.)

1) Type in the command: GET MPG,T

and press RETURN.

The GET command is described in your Extended Cassette Basic User's Manual in Section 3.4.3. (GET in BASIC is not the same command as GET in SOLOS.)

BASIC displays the message:

Prepare Tape Unit 1 for Reading: MPG.

2) REWIND the cassette if necessary.

3) Press PLAY on the recorder.

4) Press any key to tell BASIC to start reading.

5) Check the tape to see that it is moving. When the program is loaded, BASIC displays the name of the program and its beginning and ending addresses.

6) Press STOP on the recorder.

7) Run the program by entering the command: RUN and press RETURN.

To exit from BASIC, type the command B. and press RETURN. "B." is short for BYE. This command returns control of the computer to SOLOS.

BASIC is still in memory starting at address Ø. To re-enter, type the command: EXEC Ø

4.5 THE Sol ALSO RISES

Having read the previous four sections you are now considered a Sol fledgling and are, therefore, presented with the following choices of how to proceed with this manual. If you are anxious to start writing your own programs, you can start reading your SOLOS/CUTER and Extended Cassette BASIC manuals, using this manual as a reference as the need may arise. If you are interested in obtaining pre-recorded software, or additional equipment, you might read Appendix 1 of this manual. Or if you want more in depth background on the Sol, just read on to Section 5, which is all about the Sol keyboard.

SECTION 5

AT THE KEYBOARD

5.1 THE KEYBOARD, GENERAL INFORMATION

This section is a detailed reference for using the keyboard when the SOLOS monitor program is resident in the Sol, for the display of characters and symbols associated with SOLOS, and for programming the Sol's response to the keyboard output.

The keyboard is an input device that produces ASCII encoded data. (ASCII = American Standard Code for Information Interchange.) The keyboard output is hardwired to the Sol keyboard port. Under the direction of SOLOS or another program currently in control, the ASCII code generated by the keyboard is decoded by a 6574 character generator ROM which generates a dot pattern for the video display.

The Sol Terminal Computer has an ASCII 96-character keyboard. Its key arrangement conforms to the standard typewriter format. The ASCII character set, which includes alphanumerics, punctuation marks and control codes is shown in Appendix 4, Table A4-1, "Sol Keyboard Characters Keys." There are 22 function keys (including ASCII functions and five cursor controls); these are given in Table A4-2, "Sol Keyboard Function Keys." A separate 15-key arithmetic pad is also provided.

5.1.1 Key Functions are Programmable

The exact function of most keys on the Sol keyboard is determined by the software used (for example, the program contained in the Personality Module). Except for the keys that are "hardwired," any other program can also control the response of the system to the codes produced by the keyboard. Any key that generates a code can be redefined by a program to perform a specific function. (The codes are given in the tables in Appendix 4.) However, the high order bit of the binary code (the eighth bit) of some of the function keys is set by the Sol keyboard as determined by the Sol rather than by the ASCII standard. For example, the function key RETURN generates the code 8D, whereas the control character CTRL/M generates ØD. (Control keys and the transmission of keyboard codes are explained in 5.4.)

In this section, each key function is described in terms of its role in the SOLOS Terminal Mode unless otherwise specified. SOLOS in the LOCAL Terminal Mode allows most of the symbols generated by the character generator to be seen when their corresponding keys are activated, whereas SOLOS in the Command Mode is programmed to recognize the keyboard codes according to its own purposes. Many keys, especially control keys, do not serve the same functions in Terminal Mode that they serve in SOLOS Command Mode, or in BASIC, PTDOS, ALS-8, etc. Control keys are discussed in Section 5.4.

For purposes of exposition in this section, the Sol keyboard keys are divided into three categories:

1) Character keys which are similar to typewriter keys which print characters.

2) Function keys which primarily perform functions rather than print characters.

3) Control keys which are the character keys generating a different code when pressed with the key CTRL.

A separate subsection is devoted to each. Regardless of their type, nearly all the keys generate an ASCII code. Keys that are hard-wired (internally connected) do not generate ASCII codes. As will be seen in this section, some of the keys in one category generate the same ASCII code as some keys in another category. This overlap is especially the case with control keys and function keys.

5.1.2 Operating Features and Keyboard Indicators

The Sol keyboard features N-key rollover. That is, several keys can be pressed at the same time without loss of characters or commands; key entries are made in the order of actual key closures. (A scanning circuit prevents simultaneous key operation.)

Three keys (SHIFT LOCK, UPPER CASE and LOCAL) have indicator lights to indicate keyboard/terminal status. When any of these keys is pressed to turn an indicator light on, the light remains on after the key is released to show that the status persists. Pressing UPPER CASE and LOCAL again turns the light out to indicate the alternate status. SHIFT LOCK is turned off by pressing SHIFT. The indicators are further described under the individual key description.

5.1.3 Using Table A4-1

In Table A4-1, there are three major columns, one for the key when UNSHIFTED (lower case), one for the key UPPER CASE or SHIFTED (shifted dual character) and one labeled "CONTROL" for when CTRL is pressed simultaneously with a character key. Each of these three columns is broken down into two sub-headings. The column headed by "KEY/SYMBOL" gives the labels marked on top of the character keys, in the sequence found on the keyboard. (In the case of control keys, only the symbol displayed is given.) "HEX CODE" gives the hexadecimal form of the code generated by the keyboard when the key is pressed while being shifted, unshifted or "control." In response to the code, the Sol character generator can provide for the display circuitry, a symbol given in the columns "KEY/SYMBOL" and "SYMBOL." Except for control characters, the symbol displayed is generally the same as that on the keytop. (Some keys are programmed by SOLOS to move the cursor without displaying a symbol.)

EXAMPLE:

Looking at the "W" entry in Table A4-1, and reading across the table, we see that:

1) Pressing "w" unshifted generates the code 77 producing a lower case "w."

2) Pressing "W" shifted generates the code 57 producing an upper case "W."

3) Pressing CTRL (control) and "W" together, whether shifted or unshifted, generates the code 17 producing the control character graphic symbol for the ASCII "end of transmission block:" (┤)

5.2 CHARACTER KEYS (Refer to Table A4-1.)

The character keys include upper and lower case alphanumerics, punctuation marks, and special graphic symbols. They are arranged for the most part as on a standard typewriter. Pressing one of these keys causes the associated character to be entered into the Sol. They can be activated in either the unshifted, shifted, or control modes. If there are two characters labeled on a key, the upper character is typed when the key is pressed simultaneously with the SHIFT key. When unshifted, the keyboard generates the lower character. (See also Section 5.3.2, "Upper Case.")

If you wish to see the character set displayed at this time, use the procedure at Section 5.4.3, "Familiarization with the Control Symbols," but press each of the alphanumeric, punctuation and symbol keys without pressing the control key. As each is pressed, the corresponding character in Table A4-1 should appear on the screen.

5.3 FUNCTION KEYS

(Refer to Table A4-2, "Sol Keyboard Function Keys.")

The primary purpose of the function keys is to perform special functions rather than print characters; however, many functions keys do generate standard codes which can be transmitted in Terminal Mode and can print or display their associated graphic symbol, if they are so directed by the program that controls them. (Refer to Table A4-2 to see whether a code and symbol are generated.) An example of a function key that is similar to the carriage return on a typewriter is the RETURN key. Except for DEL, the function keys are unaffected by the SHIFT key.

The function keys generally are distinguished from the character keys by their size and color. They are either black or white, whereas the character keys are grey. The function keys are also mostly larger than the character keys. (There are a few exceptions.)

The ASCII codes of some function keys overlap the codes of some control keys. Control keys are discussed in Section 5.4.

Fig. 5-1. Sol Keyboard

5.3.1 Cursor Control Keys

The cursor is the solid vertical rectangle that occupies the character position in the display where the next character is to be printed or the point at which the next operation is to start. In itself, the cursor does not affect any characters in the display. (The display of the cursor is controlled by internal switches described in the appendix "Internal Controls.")

Five keys control the movement of the cursor (excluding the space bar). They are: HOME CURSOR and the four small black keys marked with directional arrows. They are located in the lowest row of the keyboard, on either side of the space bar.

To move the cursor up, down, left or right, press the applicable cursor control key. Each time you press a key, the cursor moves one unit in the direction you indicate--one space horizontally or one line vertically. These keys may be used with REPEAT to continuously move the cursor. In the Terminal Mode, when the cursor comes to the end of a 64-character line, it moves to the extreme edge of the adjoining line, above or below depending on its direction. In the Command Mode, the cursor returns to the beginning of the same line.

Pressing HOME CURSOR moves the cursor to its home position--the first character position in the upper left corner of the screen; it does not otherwise affect the display.

None of the cursor control keys are affected by SHIFT status. None are displayed or transmitted. (Refer to Section 5.4.2, "Transmission and Display of Control Keys.")

5.3.2 Individual Descriptions of Function Keys

Keys are described here generally in the order found on the keyboard, first in a group on the left side, then in a group on the right side.

SPACE BAR

Pressing the Space Bar moves the cursor one space to the right; a character occupying a position from which the cursor moves is replaced with a space.

ESCAPE

The display of the ESCAPE symbol is masked off (not displayed) in SOLOS. (Refer to SOLOS/CUTER User's Manual.)

BREAK

Pressing BREAK forces the Serial Communication Interface (SCI) output line to a space level for as long as the key is depressed. (Some communications systems use this feature.)

TAB (See Table A4-2.)

CTRL (Control) See the special section on Control Keys, 5.4.

SHIFT LOCK and SHIFT LOCK Key/Indicator

This large grey key on the left of the keyboard works like the LOCK key on a standard typewriter. The SHIFT key is a direct internal operation (hardwired). When pressed it shifts lower case letters to upper case letters and lower dual characters to upper dual characters. The keyboard remains in upper case as long as SHIFT is held down. SHIFT is active independently of the status of UPPER CASE.

Pressing SHIFT LOCK so that the indicator light goes on, locks the SHIFT key electronically in the upper dual character position. Pressing SHIFT again returns the keyboard to lower dual character position and causes the SHIFT LOCK indicator to go out.

UPPER CASE Key/Indicator

This is a large white key on the lower left side of the keyboard. Pressing this key so that the indicator light goes on activates the upper case keyboard function so that all alphabetic characters entered from the keyboard, regardless of SHIFT key status, are produced as upper case characters. Dual character keys are not shifted. (Dual character keys, however, do respond to the SHIFT key.) With the indicator light on, the Sol keyboard essentially simulates a Teletype (TTY ASR 33) keyboard. ("Teletype" is a registered trademark of TeleType Corp. ASR= Automatic Send/Receive.)

Pressing UPPER CASE to turn the indicator light off return the keyboard to normal SHIFT key operation.

UPPER CASE and REPEAT (See Section 2.5, "Keyboard Restart".)

LOCAL Key/Indicator

Pressing LOCAL, so that the indicator light goes on, sets the Sol for local operation in which keyboard entries are not transmitted, but they are "looped back" to the Serial Communication Interface (SCI) input for display. When set, the LOCAL key, through internal circuitry, connects the serial output to the serial input and disables serial transmission external to the Sol. That is, the Sol is not "on line." Pressing LOCAL again, so that the light turns off, ends local operation. (This corresponds to the local/line switch on a TTY.)

RETURN

RETURN is a large black key in the upper right corner of the keyboard. The function of the RETURN key is similar to that of the carriage return on a typewriter. (This is the same action as a TTY carriage return.)

In the Command Mode, RETURN is used to enter a command after it is typed; the command is thereupon executed by SOLOS. All characters on the line to the left of the cursor are interpreted as the command. After the command is executed, the cursor is returned to the left margin on the next line. If more than one command line is on the screen, one can execute any one of them as follows: position the cursor to the right of the desired command and press RETURN. (This procedure will work even if the command has already been executed, as long as the command has not scrolled off the screen.)

In Terminal Mode, when RETURN is pressed, an ASCII CR character is sent to the remote computer and the cursor is moved to the beginning of the line on which it resides.

In either mode RETURN also erases all data in the line to the right of the original cursor position.

LINE FEED

Pressing LINE FEED moves the cursor vertically downward one line. (This is the same action as a TTY line feed.) In the Command Mode, LINE FEED function exactly like RETURN, except that it does not erase any data in the line to the right of the original cursor position.

LOAD

The LOAD key character is displayed but causes no other action in Command Mode.

DEL (Delete)

The delete key is a small grey key labeled "DEL," located on the right side of the keyboard. The delete key is active when unshifted. When the cursor is positioned over a character and the delete key is pressed, the character is replaced with a space and the cursor moves one space to the left. Used in conjunction with the REPEAT key, DEL can be useful in deleting a string of characters to the left of the cursor.

The DEL key is also a dual character key; when shifted, it generates an underline. It is also a control key. Because the DEL key has aspects of both a character key and a function key it is included in both Table A4-1 and A4-2.

REPEAT

This is a medium-sized black key on the right of the keyboard. When pressed at the same time as another key, it repeats the function of the other key until either key is released. For example, when REPEAT is pressed together with the space bar, spaces will be cleared of characters as the cursor moves to the right; when used with the cursor directional keys, REPEAT moves the cursor continuously until released. With a character key, it repeats the character. The rate of repetition is approximately 15 times per second.

REPEAT is a hardwired function that does not generate a code.

When UPPER CASE and REPEAT are pressed simultaneously, a keyboard restart is executed (SOLOS is re-initialized) As a secondary result, UPPER CASE resets to lower case letters. (See 2.5, "Keyboard Restart.")

CTRL (See special section on control keys, 5.4.)

MODE SELECT

This is the large white key in the lower right corner of the main keyboard. If the MODE SELECT key is pressed, while SOLOS is in either mode, the Sol will be re-initialized to the SOLOS Command Mode and display the prompt character followed by the cursor.

HOME CURSOR (See 5.3.1, "Cursor Control Keys.")

CLEAR

In both modes, pressing CLEAR erases the entire screen and moves the cursor to its "home" position (upper left corner of the screen).

5.4 THE CONTROL KEYS

5.4.1 General Information

CTRL is used with character keys to initiate functions or generate control characters defined in Table A4-1. A control character is an ASCII standard character whose code specifies an operation to be performed, rather than a symbol to be displayed. Usually the operation is to be performed by a peripheral such as a printer. For example, a Line Feed (ØA), when transmitted to a printer, causes the printer, which recognizes the ASCII code, to move the paper platen up one line. If the resident program calls for it, the control character can cause the Sol to produce a graphic symbol representing the control character.

A control character is generated when CTRL is held down while pressing a character key (regardless of the status of UPPER CASE AND SHIFT LOCK). For example, CTRL plus J produces ASCII ØA, Line Feed.

Some control characters overlap some of the function keys. For example, the LINE FEED function key is the same as CTRL/J and CTRL/*. Certain ASCII codes are output by two different control keys; for example: Ø8, Backspace is produced by CTRL/H and CTRL/(.

5.4.2 Transmission and Display of Control Keys

A control procedure causes the keyboard to generate a 7-bit code. In the Terminal Mode of SOLOS, with the LOCAL key off, this code is sent to the Serial Communications Interface (SCI) for transmission. Certain function keys which have an eighth bit set by the Sol keyboard are sent directly to the VDM for display and consequently are not transmitted.

When the Sol is in the Terminal Mode and the LOCAL key is activated, the outward bound serial data is connected back to the Serial Interface input and displayed on the video monitor as the corresponding control symbol. In the Command Mode, control characters are not displayed.

The display of control characters can be surpressed by an internal switch setting. (Refer to Appendix 3, "Internal Controls.")

In Table A4-1, the three columns under the heading "CONTROL" give the symbol that can be generated by the corresponding control sequence, the code generated by the keyboard, and the ASCII function.

If you wish to see the control characters displayed at this time, follow Table A4-1 to generate the indicated control characters. Use the following exercise, if helpful.

5.4.3 Familiarization with the Control Symbols

This optional exercise requires that a SOLOS Personality Module be installed in the Sol, and that the control character display option be enabled (a switch setting described in Appendix 3, "Internal Controls").

1) Turn on the Sol and monitor.

2) Enter Terminal Mode as follows:

   a) Set UPPER CASE.

   b) Type TERM and press RETURN.

      "TERM" will appear on the screen as you type, and the cursor will disappear when you press the RETURN key. The Sol is in Terminal Mode.

3) Set for local operation by pressing the LOCAL key so that the indicator light goes on. Local operation enables the keyboard entries to be seen on the display screen. UPPER CASE may be in either state.

4) Test the symbol generation of the Terminal Mode by pressing each character key simultaneously with CTRL. As each is pressed, the control character symbol shown in Table A4-1 should appear on the screen.

5.5 ARITHMETIC PAD KEYS

The keys on the numeric pad and the hex codes generated by them are the same as the arithmetic keys on the main keyboard. They are repeated in the standard calculator pad arrangement for convenience in entering large amounts of numerical data.

Except for the division symbol key (÷), pressing these keys causes the Sol to produce the symbol labeled on the key. The division symbol key enters a forward slash (/) character. UPPER CASE, SHIFT, AND CTRL do not affect these keys.

SECTION 6

UNPACKING AND INSTALLATION

Refer to this section when you need to install or move and reconnect a Sol system. This section contains instructions and procedures.

If your dealer has installed and checked out your system or if you are going to use an already installed system, you can skip this section.

6.1 RECEIVING INSPECTION

1) Examine the shipping container(s) for signs of possible damage to the contents during transit.

2) Carefully open the container and take out the components. Save the shipping materials for use in returning your Sol unit to your dealer in case he needs to ship it to the factory.

3) Inspect the contents for damage. If anything is damaged, please contact the carrier and your dealer immediately. Describe to them the condition of both the container and its contents so that they can take appropriate action.

4) Check the contents against Table 6-1, "Sol Systems Component Lists," to make sure you have received everything. Select the list for the system you ordered. If you special-ordered your Sol, you may be able to add or subtract items from the most similar list; otherwise, obtain a list from your dealer. If anything is missing, please contact your dealer at once so that he can take appropriate action. Refer to items by part number and name.

5) Fill out the warranty cards and mail them. Be sure to fill out each and every warranty card completely. There should be one card for each product you have received (other than software). When registered with Processor Technology, the warranty cards establish you as the owner of the product, and allow Processor Technology to send you important information.

6) When you have unpacked and checked your Sol system, continue reading this section.

6.2 INSTALLATION OF S-100 MODULES

(Refer to Fig. 6-1, "Installing An S-100 Module.")

WARNING

Before reading further, please the warning at Section 7.2.

BEFORE PERFORMING ANY SERVICE, DISCONNECT THE AC LINECORD OF THE Sol FROM THE REAR PANEL.

Before installing your S-100 modules, refer to the appropriate user's manual for instructions and precautions. Set the address switches on the memory modules according to the memory manual module before installing the modules.

S-100 modules(s) are installed in the expansion chassis (the cardcage for the backplane located in left rear three quarters of Sol as viewed from the front).

S-100 modules are installed in the Sol as follows:

(You may install any module in any of the five card slots, except for the Helios Controller modules; see the Helios II User's Manual.)

1) Be sure that AC power to the Sol is turned off. The square red button on the rear panel should be out. Disconnect the AC linecord from the rear panel.

2) On the Sol rear panel, unscrew about two turns the two knurled thumbscrews that hold the top cover in place.

3) Remove the top cover of the Sol by lifting it carefully from the rear and unhooking it from the back edge of the keyboard cover. Set it aside.

4) Being careful not to mar the walnut sides, swing the Sol keyboard cover up, unhook it from the front edge of the main chassis, and set it aside.

5) Touch the Sol chassis to discharge any static electricity from your body.

6) If you are going to use the Sol as a terminal, or connect the serial port to a SolPrinter, refer to the Sol Technical Manual and the SolPrinter User's Manual or consult your dealer.

7) If you want to change the polarity of the display or make the cursor blink, refer to the appendix "Internal Controls."

8) With the component side up, insert the edge connector side of module in the card guides. (Refer to Fig. 6-1, "Installing An S-100 Module.")

9) Carefully slide the module in until its edge connector is fully seated in the backplane connector. (The backplane is the vertical circuit board on the front side of the expansion chassis.)

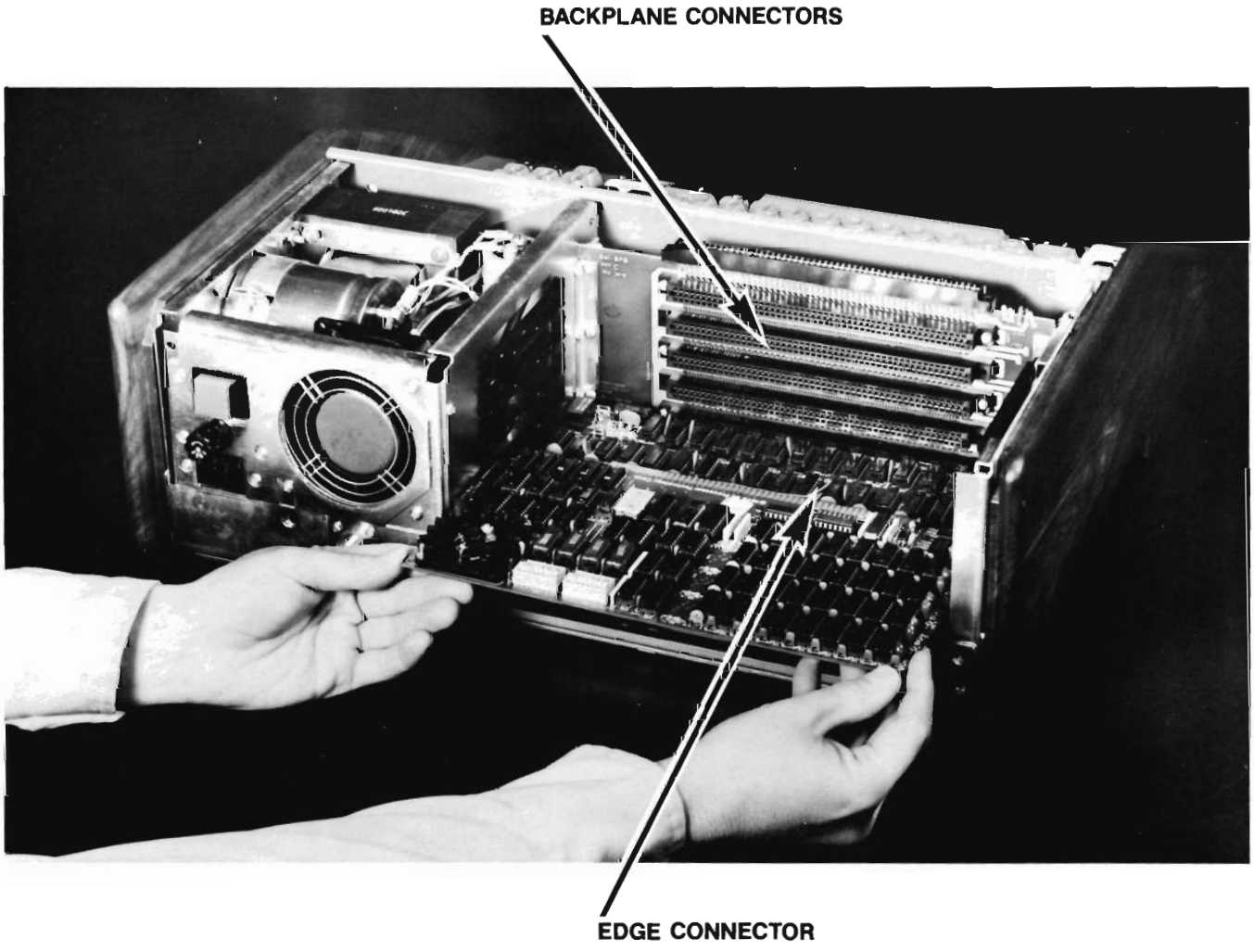


Fig. 6-1. Installing An S-100 Module

6.3 BUTTONING UP THE Sol AND INSTALLING THE FUSE

(Refer to Fig. 6-2., "Sol System Interconnections.")

1) Replace the covers on the Sol:

   Hook the keyboard cover under the front edge of the main chassis and lower it over the keyboard.

   Hook the top cover over the back edge of the keyboard cover and lower the top cover down into place over the rear of the chassis.

   Re-install the two knurled thumbscrews fastening the rear panel.

   Do not re-install the AC linecord yet.

2) Insert one of the two supplied 3.2A Slo-Blo fuses in the fuse cap, push the assembled cap-and-fuse into the fuse holder in the rear panel of the Sol, and turn the cap one-quarter turn clockwise.

3) With the AC linecord still disconnected from the 110 VAC outlet, connect the other end of the linecord to AC connector on Sol rear panel.

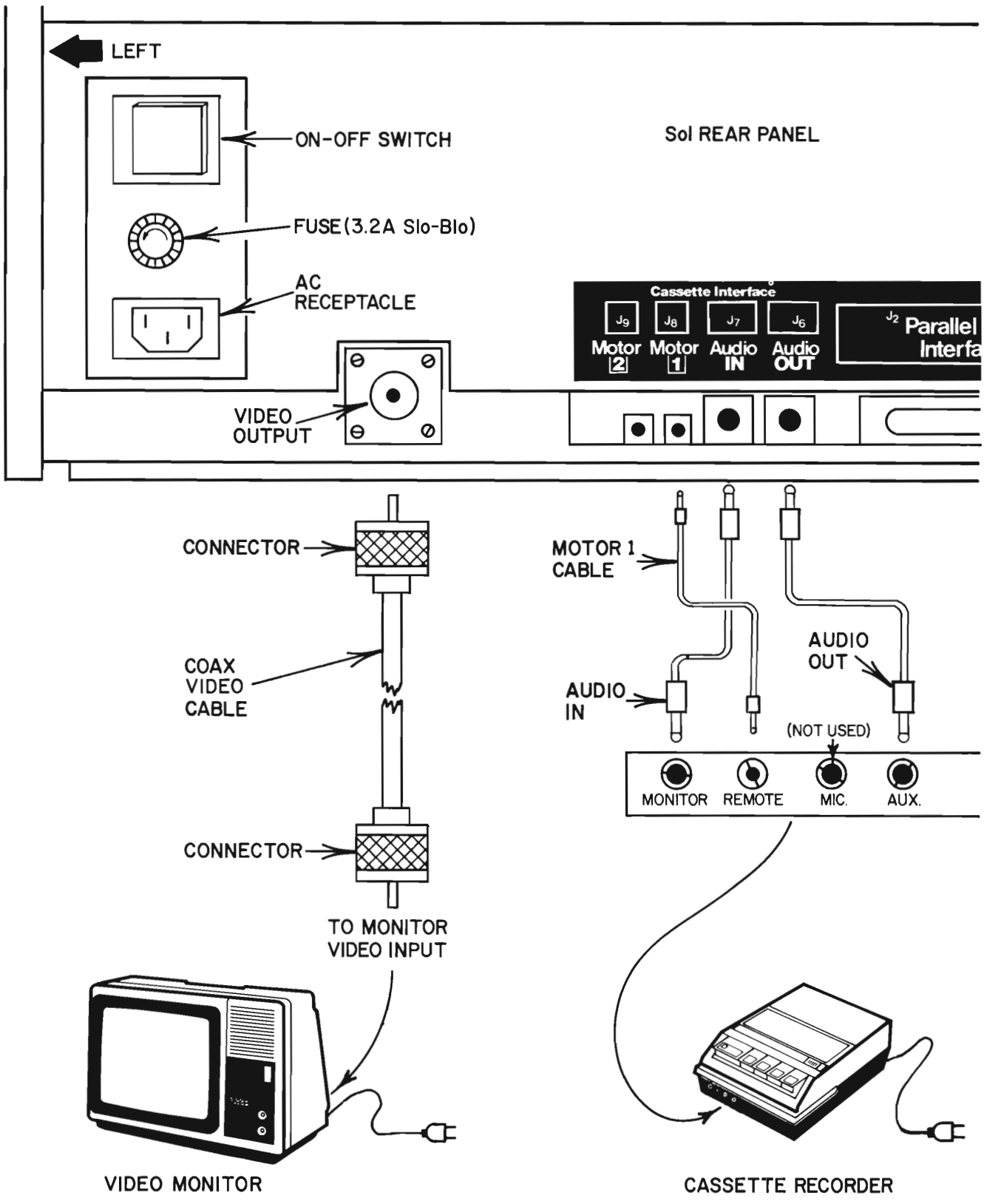


Fig. 6-2. Sol System Interconnections

6.4 CONNECTING THE VIDEO

(Refer to Fig. 6-2, "Sol System Interconnections.")

1) Position your video monitor on top of the Sol's built-in video monitor platform or in a location such that the screen will be conveniently visible from your position at the Sol keyboard.

2) From your Sol system components, select the coaxial video cable. This cable is about one meter long with identical male video coaxial connectors on both ends.

3) Insert the hollow male prong of the connector on one end of the cable into the mating video output connector on the Sol rear panel and screw on the connector securely.

4) In the same manner, connect the other end of the cable to the video input connector on the rear panel of the TV monitor.

5) There is a miniature two-position toggle switch on the rear panel of the PT-872 video monitor that is supplied with Sol systems. This toggle switch is just beneath the video cable input connector. It selects the input signal for the monitor from either the TV antenna or from the video input connector. Push the switch's lever in toward the center of the monitor. This position selects the video input.

6.5 THE CASSETTE CONNECTION

(If you have a Helios II floppy disk memory system in place of a cassette recorder, skip this and go to the Helios II User's Manual.)

(Refer to Fig. 6-2, Sol System Interconnections.)

NOTE

Refer to Section 4.2, "Audio Cassette Recorders" and the appendix "Cassette Recorder Supplement" for more detailed information on cassette recorders in a Sol system.

1) Place your cassette recorder on a flat accessible surface 1 to 3 feet from your Sol, and at least a foot from any equipment that contains transformers or devices that may generate magnetic fields. The Helios and the Sol do contain such devices.

2) Select the two audio cables from your Sol system components. (These have miniature phone plugs at both ends.)

3) Let the first audio cable be the "Audio IN" cable. ("IN" is with reference to the computer.) Plug one end of the Audio IN cable into Audio IN jack (J7) on Sol rear panel. Plug the other end into MONITOR or EARPHONE jack on the recorder connector panel.

4) Let the second audio cable be the "Audio OUT" cable. Plug one end of the Audio OUT Cable into the Audio OUT jack (J6) on the Sol's rear panel. Plug the other end into the AUX IN (AUXILIARY IN) jack on the recorder.

NOTE

The use of the MICROPHONE input is not recommended.

5) Select from your Sol system components the motor control cable. (This is thinner than the audio cables, fitted with subminiature phone plugs at both ends.) Let this cable be the "Motor 1" cable. (A second "Motor 2" cable is needed if your system uses two recorders. If you are installing two recorders, refer to the appendix, "Cassette Recorder Supplement.")

6) Plug one end of Motor 1 cable into the Motor 1 jack (J8) on Sol rear panel.

7) Plug the other end into the REMOTE jack on recorder.

6.6 CONNECTING THE AC POWER

1) Be sure the Sol covers are in place.

2) Be sure that the AC power switches for the Sol, the video monitor and the recorder are OFF.

3) Connect their AC linecords to their rear panel receptacles.

4) Plug the linecords into convenient AC outlets.

Your system is now installed and ready. Return to Section 1 of this manual, or if you already read Section 1, please go to Section 2, "At the Controls."

Table 6-1. Sol System Component Lists

ORDER NO.	DESCRIPTION	QUANTITY	(✓)
400410	Sol-20 Terminal Computer		
107000	SOLOS Personality Module	1	( )
727019	Extended Cassette BASIC (cassette)	1	( )
730024	Sol Terminal Computer User's Manual	1	( )
727034	SOLOS/CUTER User's Manual	1	( )
727018	Extended Cassette BASIC User's Manual	1	( )
723018	Fuse, 3.2A Slo-Blo	2	( )
part of 724007	Cap, Fuse Holder	1	( )
718001	Cord, AC Power, 3-Wire	1	( )
400500	Sol-20/16		
400410	Sol-20 Terminal Computer (See list above)	1	( )
214010	16KRA-1 Memory Module	1	( )
730026	32KRA-1 User's Manual	1	( )
730034	"16KRA-1 Product Description"	1	( )
400600	Sol-20/32		
400410	Sol-20 Terminal Computer (See list above)	1	( )
214020	32KRA-1 Memory Module	1	( )
730026	32KRA-1 User's Manual	1	( )
400700	Sol System I-A		
400500	Sol-20/16 Terminal Computer (See list above)	1	( )
722016	PT-872 video monitor (with manual)	1	( )
718005 or 101034	Video Cable Assembly	1	( )
722019	RQ-413A Cassette Recorder	1	( )
718006 or 101041	Audio Cable Assembly	2	( )
718007 or 101042	Motor Control Cable Assembly	1	( )

Table 6-1. Sol System Packing Lists (continued)

ORDER #	DESCRIPTION	QUANTITY	(✓)
400800	Sol System II-A		
	(Same as I-A, except that the Sol model is:)		
400500	Sol-20/32 Terminal Computer (See list above)	1	( )
400310	Sol System III-A		
400410	Sol-20 Terminal Computer (See list above)		
107015	BOOTLOAD Personality Module	1	( )
-	Memory module(s) containing 65,536 bytes of memory		
300000	Helios II, Model 2 (See list in Helios II User's Manual)		
722016	PT-872 video monitor (with manual)	1	( )
718005 or	Video Cable	1	( )
101034	(alternate video cable)		
-	appropriate memory module manual(s)		
730031	Helios II User's Manual	1	( )
731029	PTDOS User's Manual	1	( )
727037	Extended Disk BASIC User's Manual (instead of Cassette BASIC)	1	( )
727010	Trek-80 User's Manual	1	( )
400311	Sol System III-B		
	(Same as III-A without video video monitor and cable)		
400350	Sol System IV-A		
	(Same as III-A except that Helios II is a double dual drive model:)		
304000	Helios II, Model 4	1	( )
400351	Sol System IV-B		
	(Same as IV-A without video monitor and cable)		

SECTION 7

TLC FOR YOUR Sol

7.1 SERVICE AND ORDERING PARTS

A convenient and economical way to arrange for preventative maintenance and to be prepared for eventual adjustments as well as unexpected problems, is to purchase a maintenance contract if your dealer has it available to you.

Do not replace devices thought to be defective in a Sol that is still under warranty. To do so may void the warranty. Refer the problem to your factory-authorized dealer, even if the warranty has expired.

Order replacement parts or additional equipment and manuals from your factory-authorized dealer. Be sure to include the Processor Technology order number or part number, the quantity you want to order and a complete description of the item. For example: one (1) Sol Technical Manual, PT-730038. Your dealer has a list of part numbers. He may have a stock of some replacement parts on hand.

7.2 CARE AND EXTERIOR CLEANING OF YOUR Sol

It is recommended that you turn off your Sol if you are not using it for an extended period of time. This practice should help extend the life of certain components. The Sol needs no warmup time.

When required, clean the keyboard and exterior covers of your Sol with a cloth dampened in a mild detergent solution. Be sure to turn off the power first and disconnect the AC linecord from the rear panel.

Once a year, a thin coating of linseed oil applied with a clean cloth will preserve and beautify those famous walnut side panels.

WARNING

Do not remove the cover(s) from the Sol. For your protection the Sol is designed so that the AC linecord must be disconnected before the top cover can be removed. Never reconnect the linecord when the top cover is off.

If you encounter a problem, first reread those parts of this manual which pertain to the operation you were attempting when the problem occurred. If you are still unable to solve the problem or if you have subsequent hardware or software failures, ask help from qualified technical personnel.

WARNING (Continued)

If you yourself are the qualified person finally responsible for the hardware in the system, you may use the following sections to trouble-shoot the problem. If you are still unable to solve the problem, ask your dealer for help. Service on all Processor Technology products, in or out of warranty, is the reponsiblity of the factory-authorized dealer.

The following sections are to be used only by qualified personnel as basic aid in determining whether a problem warrants calling upon the factory-authorized dealer for service.

BEFORE PERFORMING ANY SERVICE, DISCONNECT THE AC LINECORD OF THE Sol FROM THE REAR PANEL.

7.3 TROUBLE-SHOOTING the Sol INSTALLATION

7.3.1 Checking and Installing the Fuse

(See Figure 6-2, "Sol System Interconnections.")

1) Is the fan running? Put your hand at the fan output if you cannot hear the fan running. If the fan is not running, is the AC linecord plugged into a power receptacle? If it is plugged in, the fuse should be checked. The Sol is protected by a 3.2 amp Slo-Blo fuse housed on the rear panel. Check the fuse as follows:

   a) Turn Sol's AC power switch OFF.

   b) Disconnect the AC linecord from the rear panel.

   c) Turn the fuse holder cap one quarter turn counterclockwise; pull straight out and remove the fuse from the cap.

   d) Inspect the finer fuse element that should be connected to the end of the thicker spiral element; it looks like a small "bobby pin", and it should be in one piece connected all the way to the other end of the fuse. If it is broken in the middle, it is blown. A spare fuse is shipped with each Sol.

   e) To install a fuse, insert the fuse into the cap, push the cap containing the fuse into the fuse holder and turn one quarter turn clockwise.

7.3.2 Removing The Covers Prior to Checkout of the Interior

1) Be sure that AC power to the Sol is turned off. The square red button on the rear panel should be out. The fan should be stopped.

   Disconnect the AC linecord from the Sol rear panel.

2) On the Sol rear panel, unscrew the two knurled thumbscrews that hold the top cover in place (about two turns).

3) Remove the top cover of the Sol by lifting it carefully from the rear and unhooking it from the back edge of the keyboard cover. Set it aside.

4) Being careful not to mar the walnut sides, swing the Sol keyboard cover up, unhook it from the front edge of the main chassis, and set it aside.

5) Proceed to the next section.

7.3.3 Checkout of Cables, Connectors, Sol-PC and Personality Module

1) Touch the Sol chassis to discharge any static electricity from your body.

2) Connectors and Cables. The mechanical contacts of connectors must be in proper position. In order to provide versatility and serviceability, a number of connectors are used in the system. Be sure that they are all inserted properly. Secure any loose cable connectors. On the Sol-PC there is a coax connector at the video display circuitry and a ribbon cable connecting the keyboard to the Sol-PC.

   Helios Cables. If you are using a Helios Disk System, be sure that when the cover is placed on the Sol, the cables are not pulled from their sockets.

3) S-100 Cards. Pull the cards back from the backplane and reseat them.

4) Personality Module. Grasping its handle, remove and reseat the personality module located on the rear of the main printed circuit board. (Refer to Fig. 2-1, "Sol Rear Panel.")

7.3.4 Buttoning the Sol Back Up

To replace the covers on the Sol:

1) Hook the keyboard cover under the front edge of the main chassis and lower it over the keyboard.

2) Hook the top cover over the back edge of the keyboard cover and lower the top cover down into place over the rear of the chassis.

3) Re-install the two knurled thumbscrews fastening the cover to the chassis.

4) Reconnect the AC linecord to the rear panel.

7.4 TROUBLE-SHOOTING THE VIDEO

1) Turn ON the AC power switches of the Sol and video monitor.

2) If the monitor display raster is out of sync (a black horizontal bar moves slowly down screen, numerous black lines cut across the raster, or both), adjust monitor vertical and horizontal hold controls for a stable raster.

3) You should see the SOLOS Command mode prompt character followed by thu cursor (>■) in the upper left corner of the screen. If you don't, recheck the video cable connection as in Section 6, "Unpacking And Installation." If still no cursor, go to 7.3.2, "Removing The Covers" and 7.3.3, the checkout of cables, etc.

If control characters do not appear in the SOLOS Terminal mode, check the setting of the internal switch that controls the display of control characters. (See Appendix 3, "Internal Controls".)

7.5 TROUBLE-SHOOTING CASSETTE OPERATIONS

NOTE

The tape head must be clean in order to read or write a tape reliably.

7.5.1 Problems Encountered When Loading

1) If the tape moves while the cassette is under SOLOS control, there is a malfunction in the remote control circuitry or cabling. The recorder is under SOLOS control when MODE SELECT has been pressed to reset any tape commands. With the Sol power OFF, there should be no continuity between the MOTOR 1 jack on the Sol and the REMOTE plug on the cassette. Check to see that the Motor cable for each recorder is pushed in until you feel the stop in the jack (the detent position for the jack; this is not necessarily all of the way in).

2) With certain cassette recorders or cassettes there may be a misreading of the tape when the splice joining the leader to the tape passes the tape head. In this case an ERROR message will appear and the tape will stop. To resume tape loading, position the tape past the leader and retype the command used to load the program.

3) If you continue to have difficulty in loading, check the recorder controls for proper settings and make sure you have followed all appropriate instructions and operating tips in Section 4.2, "Audio Cassette Recorders" and 4.3, "Getting Into BASIC." Try different cassette recorder volume settings until a reliable setting is found.

4) Usually Processor Technology cassettes have the same program recorded more than once on the same cassette to provide against accidental damage or erasure. If you have difficulty loading a program, try the same procedure with the redundant recording.

5) Check all cassette interconnect cables for intermittent connections and shorts. Try substituting cables to detect defective cables.

7.5.2 Possible Faulty Tape?

1) Note the exact tape counter reading at the time of the read error.

2) Rewind the tape and try to read the same part of the tape in which the error occurred. If there is no read error at the same point, the error was not recorded on the tape. If there is, the error was recorded on the tape.

3) Rewind the tape and record a file on the same part of the tape in which the read error occurred. Then read this file. If there is no read error, the original error was generated during the initial recording process. If a read error occurs at the same point, the cassette is faulty.

APPENDIX 1

PRODUCTS AVAILABLE from Processor Technology

A1.1 EQUIPMENT

MEMORY MODULES

Dynamic Read/Write Random Access Memory modules are available from Processor Technology in the following models: (The first two digits give the memory capacity in kilobytes.)

16KRA-1
32KRA-1
48KRA-1
64KRA-1

GENERAL PURPOSE MEMORY MODULE (GPM)

The GPM module is used to store any frequently-accessed programs as firmware in its 10,240 bytes of ROM. The programs thus stored can be ready to accept commands as soon as power is applied to the Sol. Included with this subsystem is 1,024 bytes of RAM for use as scratch-pad memory.

DISKETTE MEMORY SYSTEMS

The Helios II dual diskette drive systems include one or two dual drives, complete with power supply and indicator panel in a single attractive cabinet. An S-1ØØ bus compatible controller is provided in the system. Software includes PTDOS operating system and Extended Disk BASIC. PTDOS operates up to four dual drives. PTDOS contains Extended Disk BASIC, ASSM, DEBUG, EDIT, and TREK-8Ø, plus many other powerful software tools.

The single dual drive model can be upgraded to a double dual drive model. Both models are available in 22Ø/24Ø VAC 5Ø Hz versions.

PRINTERS

SolPrinter 2 is a word processing printer by a Diablo (a Xerox company.) It has a changeable metal print wheel. The interface to the Sol parallel port and power supply is included.

SolPrinter 2-E is an impact printer like the SolPrinter 2 but with a plastic print wheel.

Forms tractors are available for the SolPrinter 2 and 2-E.

SolPrinter 3 is a 200 characters per second dot matrix printer with an RS-232 serial interface. This SolPrinter includes a power supply and forms tractor.

The "engineering geniuses" at Processor Technology are continually developing new products for the Sol system. Ask your dealer for the latest releases.

Fig. A1-1. Sol System IV-A

A1.2 SOFTWARE AVAILABLE FROM Processor Technology

PROGRAM DEVELOPMENT SOFTWARE ON CASSETTE

Processor Technology cassette software is designed to run either on a Sol Terminal Computer, with SOLOS, or on another 8080 computer using CUTER software and CUTS format cassette tape.

EDIT

EDIT is a line-oriented text editor that allows the creation or modification of ASCII files such as source files coded in BASIC or assembly language. EDIT allows editing on character, string, line, and page levels; at any of these levels, additions, insertions, substitutions, and deletions of text may be made. Additionally, EDIT offers the option to retain a command string as a macro and execute it repeatedly.

EDIT requires approximately 4K bytes of memory.

ASSM

ASSM is an assembler that translates a symbolic 8080 assembly language program ("source code") into the binary instructions required by the computer to execute the program.

The assembler itself occupies almost 8K bytes of memory; an additional 2K of memory is required for the symbol table. Two cassette recorders are also required.

Also included on the cassette are two other programs, PACK and UNPAC. These programs convert a cassette file from either of the two SOLOS/CUTER file formats (single-block and multiple block) to the other.

DEBUG

DEBUG is an aid for debugging a machine language program. DEBUG permits you to set as many as fifteen "breakpoints" in a program. When that program is executed under control of DEBUG, execution will be interrupted at each breakpoint address so that CPU registers, flags, and specified memory locations may be examined and modified.

DEBUG requires 8K bytes of memory.

ALS-8

The ALS-8 assembly language development system is an operating system that facilitates the writing, editing, assembling and debugging of your own programs. It includes a resident assembler, simulator, and text editor.

The ALS-8 program requires 8K bytes of memory plus 4K for the symbol tables and system global area. ALS-8 is also available in a ROM on a GPM module (see A1.1). In that form, the system requires a minimum of 2K of RAM.

Software#1

Software #1 is a program development system, more limited than ALS-8, but requiring less memory. Included in the package are an executive to handle memory files, an assembler, and a line-oriented editor.

Software #1 requires at least 6K bytes of memory.

Extended Cassette BASIC

Extended Cassette BASIC is an adaptation of BASIC, a straightforward language combining interactive features and mathematical capabilities. BASIC includes an interactive editor and an interpreter.

Extended Cassette BASIC requires a minimum of 16K bytes of memory. The recommended amount of memory is 24K.

PILOT

PILOT is an interpretive language designed for writing interactive programs. It is suitable for writing educational applications programs, other interactive programs and games.

PILOT requires 16K bytes of memory.

8080 FOCAL

FOCAL is an adaptation of the original FOCAL, a math language written for the PDP-8 mini-computer. "FOCAL" and "PDP-8" are registered trademarks of Digital Equipment Corporation. Many thousands of FOCAL programs exist and can now run in the Sol. A disk version of FOCAL is included on the PTDOS system disk that comes with a Helios II system.

FOCAL requires 10K bytes of memory.

VIDEO GAMES ON CASSETTE

GAMEPAC 1 and GAMEPAC 2 are two anthologies of games including:

Target - an arcade-type "shooting" game.
Hangman - the traditional word game.
QUBIC - a three-dimensional version of TIC-TAC-TOE. ("QUBIC" is a registered trademark of Parker Bros.)

Each game requires 4K bytes of memory.

TREK-80

TREK-80 is a space war game based on the NBC television series Star Trek. This program simulates a real time war with the Klingons. (You can warp through hyperspace and fire phasers, photon torpedos, or experimental rays. If you "just can't make it," you can self-destruct.)

TREK-80 requires 8K bytes of memory.

8080 CHESS

8080 CHESS is the ancient game of pure skill and fathomless variety, adapted to run on the Sol. 8080 CHESS turns your computer into a worthy opponent. A variable difficulty control matches your skill level.

8080 CHESS requires 16K bytes of memory.

FLOPPY DISK SOFTWARE

Extended Disk BASIC

Extended Disk BASIC has all the features of Extended Cassette BASIC and also the advantages of the Helios II floppy disk and PTDOS.

Many dealers offer Optional Precision BASIC, allowing the user to request a version of Extended Disk BASIC with 6, 8, 10, 12, 14, or 16 digits of precision. (Standard BASIC has 8-digit precision.)

Extended Disk BASIC requires 32K bytes of memory, and is supplied on the PTDOS system disk.

Extended Disk FORTRAN

Extended Disk FORTRAN is both a subset and a superset of ANSI standard FORTRAN, a widely used algebraic language. Extended Disk FORTRAN is written to take advantage of the Helios II Disk Memory System and PTDOS.

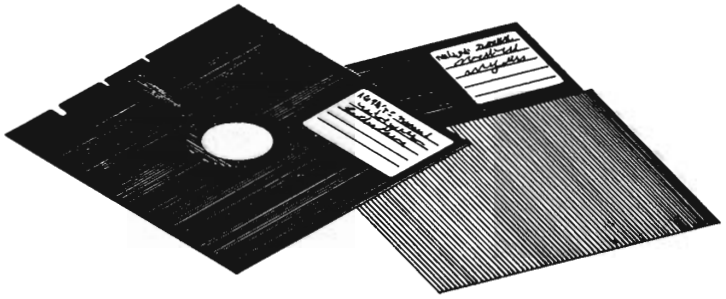
Extended Disk FORTRAN requires 32K bytes of memory.

WordWizard

WordWizard is an electronic typing program that turns your Sol, Helios, and SolPrinter into a powerful office or home tool for composing, correcting, editing and updating letters and other literature. WordWizard can print a file while you are editing a second file.

WordWizard requires 48K bytes of memory.

New software for the Sol is constantly being developed at Processor Technology. Ask your dealer about the latest releases.



APPENDIX 2

CASSETTE RECORDER SUPPLEMENT

A2.1 SELECTING A CASSETTE RECORDER

Not all audio cassette recorders are suitable for data storage use with the Sol. Two models tested and approved by Processor Technology for such use are the Panasonic RQ-413AS and Realistic CTR-21. (Some users report unsuccessful results with the Panasonic RQ-309 and the J. C. Penney recorder, Catalog #851-0018.) Should you wish to use a different recorder than those approved by Processor Technology, it should have the following features:

Auxiliary Input

Though the Sol can be configured for use with the microphone input, such configuration is no longer recommended.

Digital (Tape) Counter

The counter is needed to locate files on the tape.

Tone Control

The existence of a tone control is one indication of high quality electronics.

Monitor Output in Record Mode

Recorders on which the "monitor" jack is labeled MONITOR usually provide a monitor output in the Record Mode. If the jack is labeled EAR or EAR PHONE, the recorder usually does not provide a monitor output in the record mode.

To determine whether the recorder provides a monitor output in the Record mode:

1) Install a blank tape.

2) Plug a headset or earphone into the MONITOR jack.

3) Plug a microphone into the MICROPHONE jack.

4) Set the recorder controls to record.

5) Speak into microphone while listening with the earphone. If you hear yourself through the earphone, the recorder does provide a monitor output in the record mode.

Even if a recorder has the preceding features, there is no guarantee it will work properly with the Sol. Recorders vary greatly in the quality of their electronics. When selecting a "non-approved" recorder, it is recommended that you test it before purchase, if possible, with a long file. Test it in both the record mode (Write) using the SAVE command and in the playback mode (Read) using the GET or XEQ commands. If the recorder is unsatisfactory, you will either:

1) Get an error message in the read mode.

2) Find the differences, upon playback, in what you recorded in the write mode.

3) Both of the above.

A2.2 INTERCONNECT REQUIREMENTS FOR TWO RECORDERS

Your Sol is capable of controlling one or two recorders. (The interconnect requirements for one recorder were previously covered in Section 4.3, "Getting into BASIC.") Since the Sol has only one audio input and one audio output jack, the interconnect requirements for two recorders are somewhat different than for one.

In the case of two recorders, Unit 1 and 2 must be specified in the SAVE command in order to select the desired recorder. A default selects Unit 1.

Reading from One Recorder and Writing to the Second Recorder

1) Let recorder 1 be the unit read from; connect the Sol's Audio IN cable to the recorder's MONITOR output. Connect MOTOR 1 cable to the recorder's REMOTE jack.

2) Let recorder 2 be the unit written to; connect the Sol's Audio OUT cable to the recorder's AUX input. Connect MOTOR 2 cable to the recorder's REMOTE JACK.

Reading and Writing to Both Recorders

For this setup, you will need two "Y" adapters, one to feed the single Sol audio output to the AUXILIARY input of two recorders and the other to feed the MONITOR output of two recorders to the single Sol audio input. (If you intend to use the Audio In and Out cables described in Section 6.5, "The Cassette Connection," miniature phone jack-to-two miniature phone plug adapters are required.)

Because the recorder outputs should not be connected together directly, it is recommended that you wire a 1000 ohm resistor in series between the MONITOR adapter and the MONITOR output of each recorder.

APPENDIX 3

INTERNAL CONTROLS

A3.1 GENERAL INFORMATION

(First Read the Warning" at 7.2.)

Your Sol will work normally without having to reset the control switches described in this section. They have been set at the factory. If you need to change the functions controlled by these switches, the switches must be accessed when the top cover and keyboard cover of the Sol are removed. They are located on the Sol-PC in DIP switch pack S1. In this section, the switch controls are described separately by function. They are summarized with their recommended settings in Table A3-1, "Sol Internal Controls in Numerical Order." Internal switch settings for the terminal mode and other internal controls are treated in the Sol Technical Manual.

Refer to Fig. A3-1, "Sol Internal Controls in Numerical Order," for the location of S1.

WARNING

BEFORE PERFORMING ANY SERVICE, DISCONNECT THE AC LINECORD OF THE Sol FROM THE REAR PANEL.

A3.2 REMOVING THE Sol COVERS

To access S1, remove the Sol top cover and keyboard cover as instructed in Section 7.3, "Trouble-shooting the Sol Installation."

A3.3 VIDEO DISPLAY SWITCHES

CAUTION

Since each switch lever is extremely small, it may not be practical to use one's finger to set them. As a convenience, you might use the pointed end of a nonconductive tool shaped like a pencil. Do not use a metal object.

Video Display (POLARITY) Switch, S1-4

If you want a normal video display (white characters on a black background), set S1-4 switch to ON. If the switch is in the OFF position, black characters will be displayed on a white background (reverse video display).

Cursor Display (S1-5 and S1-6)

The cursor that appears in SOLOS as the prompt character is usually a solid, non-blinking cursor.

CAUTION

Never put S1-5 and S1-6 ON at the same time. To do so may damage your Sol.

To make it blink on and off at the rate of approximately twice per second:

1) Set the SOLID Switch (S1-6) to OFF.

2) Set the BLINK Switch (S1-5) to ON.

3) To reset the cursor to a solid display, reverse the above settings.

With both S1-5 and S1-6 in their OFF positions, there will be no cursor display.

Blanking Out the Display of Control Characters (S1-3)

Blank out the display of control characters by setting the BLANK Switch (S1-3) to ON. Any control characters generated should not appear on the screen. To display control characters, set S1-3 to OFF. (Control characters are explained in Section 5, "At the Keyboard.")

A3.4 RESTART (RST) SWITCH, S1-1

This switch permits you to restart your Sol without turning the power off. You should normally leave it in its OFF, or run, position. Set it to ON and then OFF to reset the 8080 and restart the Personality Module program. (A manual restart with this switch performs the same function as turning the power on or pressing a keyboard generated restart: UPPER CASE key with REPEAT key. See "Keyboard Restart" in Section 2.5.)

A3.5 REPLACING THE Sol COVERS

(Refer to 7.3.4, "Buttoning the Sol Back Up.")

A3.6 TERMINAL MODE SWITCH SETTINGS

Instructions for setting the Terminal mode switches are in the Sol Technical Manual. Consult your dealer if you intend to use the Terminal mode.

A3.7 PARALLEL DATA INTERFACE (PDI)

Instruction for connecting devices to the Sol's PDI are in the Sol Technical Manual. Consult your dealer for help.

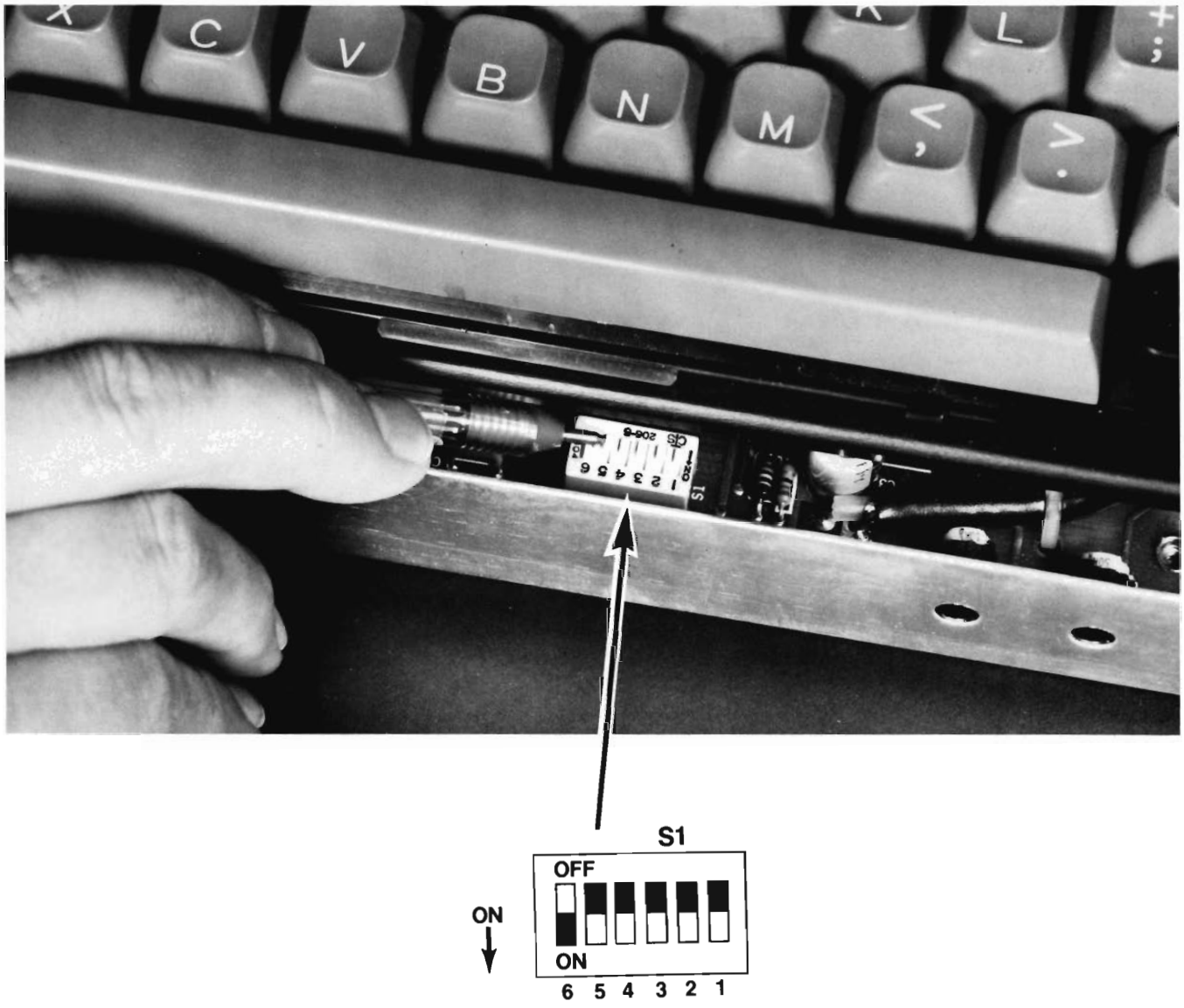


Fig. A3-1. Sol-PC Internal Control Switches (S1)

Table A3-1. Sol Internal Controls in Numerical Order

CONTROL	FUNCTION	FACTORY PRESET
RST (Restart) S1-1	Permits manual restart of Sol without turning power off. (Useful for test purposes.)	OFF
S1-2	Spare	OFF
BLANK CTRL S1-3	Determines whether control characters are displayed or not.	OFF
POLARITY S1-4	Selects normal (white characters on black background) or reverse video display.	OFF
CURSOR BLINK S1-5	Selects blinking cursor.	OFF
SOLID CURSOR S1-6	Selects solid cursor.	ON

APPENDIX 4

KEYBOARD TABLES

Table A4-1. Sol Keyboard Character and Control Keys

(The keys in this table are arranged as found on the keyboard, left to right, top to bottom.)

UNSHIFTED		SHIFTED		CONTROL		
KEY/ SYMBOL	HEX. CODE	KEY/ SYMBOL	HEX. CODE	SYMBOL	HEX. CODE	ASCII CONTROL FUNCTION
1	31	!	21	┌[1]	Ø1	Start of Heading (SOH)
2	32	"	22	⊥	Ø2	Start of Text (STX)
3	33	#	23	┘	Ø3	End of Text (ETX)
4	34	$	24	↙	Ø4	End of Transmission (EOT)
5	35	%	25	⊠	Ø5	Enquiry (ENQ)
6	36	&	26	✓	Ø6	Acknowledge (ACK)
7	37	'	27	Ω	Ø7	Bell (BEL)
8	38	(	28	↰	Ø8	Backspace (BS)
9	39	)	29	→	Ø9	Horizontal Tab (HT)[2]
Ø	30	Ø[3]	20[2]	□[4]	ØØ	Null (NUL)
-	2D	=	3D	←[4]	ØD	Return (CR)[2]
^	5E	~	7E	◪	1E	Record Separator (RS)
[	5B	{	7B	⊖[4]	1B	Escape (ESC)[2]
\	5C	|	7C	◰	1C	File Separator (FS)
]	5D	}	7D[5]	◱	1D	Group Separator (GS)
q	71	Q	51	◷	11	Device Control 1 (DC1) (X-ON)
w	77	W	57	┤	17	End of Transmission Block (ETB)
e	65	E	45	⊠	Ø5	Enquiry (ENQ)
r	72	R	52	◶	12	Device Control 2 (DC2) (TAPE)
t	74	T	54	◴	14	Device Control 4 (DC4)
y	79	Y	59	▮	19	End of Medium (EM)
u	75	U	55	✗	15	Negative Acknowledge (NAK)

[1] SOLOS cursor left. (Symbols shown are displayed by the 6574 character generator.)

[2] Same as function keys (see Table A4-2).

[3] Space function (SP); Ø is not displayed.

[4] Not displayed in SOLOS.

[5] Alternate mode.

Table A4-1. Sol Keyboard Character and Control Keys (Continued)

UNSHIFTED KEY/ SYMBOL	HEX. CODE	SHIFTED KEY/ SYMBOL	HEX. CODE	CONTROL SYMBOL	HEX. CODE	ASCII CONTROL FUNCTION
i	69	I	49	→	Ø9	Horizontal Tab (HT) [1]
o	6F	O	4F	⊙	ØF	Shift In (SI)
p	70	P	50	⊟	1Ø	Data Link Escape (DLE)
@	40	`	60	□ [2]	ØØ	Null (NUL)
a	61	A	41	⌜ [3]	Ø1	Start of Heading (SOH)
s	73	S	53	ⓢ	13	Device Control 3 (DC3) (X-OFF)
d	64	D	44	↯	Ø4	End of Transmission (EOT)
f	66	F	46	✓	Ø6	Acknowledge (ACK)
g	67	G	47	Ω	Ø7	Bell (BEL)
h	68	H	48	↰	Ø8	Backspace (BS)
j	6A	J	4A	≡ [2]	ØA	Line Feed (LF) [1]
k	6B	K	4B	↓	ØB	Vertical Tab (VT)
l	6C	L	4C	⏚	ØC	Form Feed (FF)
;	3B	+	2B	↓	ØB	Vertical Tab (VT)
:	3A	*	2A	≡ [2]	ØA	Line Feed (LF) [1]
DEL [4]	7F	_ [2]	5F	⌐	1F	Unit Separator (US)
z	7A	Z	5A	⚲	1A	Substitute (SUB)
x	78	X	58	⧖	18	Cancel (CAN)
c	63	C	43	⌋	Ø3	End of Text (ETX)
v	76	V	56	⎍	16	Synchronous Idle (SYN)
b	62	B	42	⊥	Ø2	Start of Text (STX)
n	6E	N	4E	⊗	ØE	Shift Out (SO)
m	6D	M	4D	← [2]	ØD	Return (CR) [1]
'	2C	<	3C	⏚	ØC	Form Feed (FF)
.	2E	>	3E	⊗	ØE	Shift Out (SO)
/	2F	?	3F	⊙	ØF	Shift In (SI)

[1] Same as function keys (see Table A4-2).

[2] Not displayed (masked off) in SOLOS.

[3] SOLOS cursor left.

[4] DEL, 7F, Delete symbol (▨) is not displayed in SOLOS. Delete functions in Terminal Mode when shifted.

Table A4-2. Sol Keyboard Function Keys

(The keys are ordered in this table as found on the keyboard in two groups, left and right.)

KEY	HEX. CODE	SHIFTED, UNSHIFTED OR CONTROL SYMBOL DISPLAYED
ESCAPE (ESC)	1B	⊖ PTDOS Only.
BREAK	-	
TAB (HT)	Ø9	⟩ Both SOLOS and PTDOS.
CTRL	-	
SHIFT LOCK	-	
UPPER CASE	-	
SHIFT	-	
LOCAL	-	
SPACE BAR (SP)	20	
RETURN (CR)	ØD	← Masked Off in SOLOS.
LINE FEED (LF)	ØA	≡ Masked Off in SOLOS.
DELETE (DEL)	7F	⊟ CTRL Only (1F); 7F displays no symbol.[1]
LOAD	8C	⇩ Both SOLOS and PTDOS.
REPEAT	-	
CTRL	-	
SHIFT	-	
MODE SELECT	80	⟩ SOLOS Terminal Mode Prompt is a programmed display of SOLOS.
CURSOR CONTROL ↑	97	⊣ Not transmitted in SOLOS. PTDOS Only
CURSOR CONTROL ←	81	⌜
CURSOR CONTROL →	93	⊙
CURSOR CONTROL ↓	9A	⌡
HOME CURSOR	8E	⊗
CLEAR	8B	⌟

[1] See DEL in Table A4-1.

Table A4-3. Names of Graphic Characters on Keytops

(The names given here are industry-standard terms.)

SP	Space	<	Less Than
!	Exclamation Point	=	Equals
|	Logical OR (not used in the Sol)	>	Greater Than
"	Quotation Marks	?	Question Mark
#	Number Sign	@	Commercial At
$	Dollar Sign	[	Opening Bracket
%	Percent	\	Reverse Slant
&	Ampersand	]	Closing Bracket
'	Apostrophe	^	Circumflex
(	Opening Parenthesis	¬	Logical NOT
)	Closing Parenthesis	_	Underline
*	Asterisk	`	Grave Accent
+	Plus	{	Opening Brace
,	Comma	¦	Vertical Line (This graphic is stylized to distinguish it from Logical OR)
-	Hyphen (Minus)		
.	Period (Decimal Point)	}	Closing Brace
/	Slant	~	Tilde
:	Colon		
;	Semicolon		

APPENDIX 5

Sol SPECIFICATIONS

Keyboard:

85 key upper/lower case with separate numeric keypad. Upper-case shift, shift-lock, cursor control and repeat keys provided. System reset performed by simultaneous depression of control keys. Indicator lights (LED) for local, upper case and shift.

Character set:

96 printable ASCII upper and lower case characters plus 32 optionally displayable control characters.

Cursor:

Switch-selectable blinking. Block video inversion. Program controlled positioning standard. Cursors may occupy at any or all character locations.

CPU:

8080A - Uses same machine language as other 8080 systems. 2 MHz clock cycle time. 78 instructions.

Cassette Interface:

1200 Baud CUTS format or 300 Baud Kansas City format, selected by software. Recorder remote start-stop connector. AGC for level insensitivity. Phase-locked data recovery tracks with speed variations. Software performs CRC data integrity check each 256 characters.

Serial Interface:

RS-232 and 20 mA current loop, 75 to 9600 baud, asynchronous. 25 pin female "D-type" connector on card.

Parallel Interface:

Eight data bits for input and output; output bus is tristate for bidirectional interfaces; levels are standard TTI. 25 pin male "D-type" connector on card.

External memory:

Expandable to 65,536 bytes total ROM, PROM and RAM. (More than 64K with the extended addressing capability of Processor Technology Memory Modules.) Uses S-100 standard modules.

Video Signal Output:

1.0 to 2.5 volts peak-to-peak. Nominal bandwidth is 7 MHz.

Power Requirements:

117 volts AC, 50/60 Hertz, 250 Watts. 220/240 Volt, 50/60 Hertz option available.

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