

COI

Terminal  
Computer

ProcessorTechnology

Sol SYSTEMS MANUAL

**Processor Technology  
Corporation**

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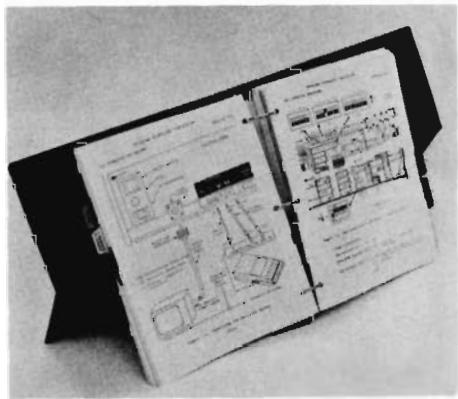
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## PREFACE

This new edition of the Sol Systems Manual contains many revisions and additions made to the third printing. Information which accumulated in the Updates Section was integrated into the text. Parts lists were revised to include Processor Technology parts numbers for all parts, and to include new alternate parts. Several new and revised drawings were included in Section X, which should make assembly even easier. The keyboard, previously a kit, is now supplied as a complete tested subassembly. Sol 10, which consisted of a Sol 20 without the back-plane, and with a lighter power supply, has been discontinued. Assembly procedures have improved from the experience of thousands of kit-builders. An overall parts list for the entire kit has been included to facilitate receiving inspection.

Much effort has gone towards making this manual complete and accurate. The process of updating and revision always continues, however, and we invite your input. If you should find an error, or have suggestions for improving any of our manuals, please submit your suggestions in writing to our Technical Publications Department, and they will be given thorough consideration.

The three-ring binder you are reading from is an "easel" binder. The cover is hinged from side to side, as well as down the spine, so that it may form into an "easel" stand. To use this feature, lay the manual open on a table. Bend the full width of the manual along the creased hinge, until a resistance to further bending is felt. Then set the manual up on the table, with the bottom of the pages down against the table, and the top inclining away from you. In this position your hands are free for building, making measurements, or troubleshooting. A binder set up in this manner is shown below.



### IMPORTANT

The first part of this manual you should read is at the very end: the Updates Section. If updates sheets have been inserted in this section, make sure to integrate them before you begin building or using your Sol.

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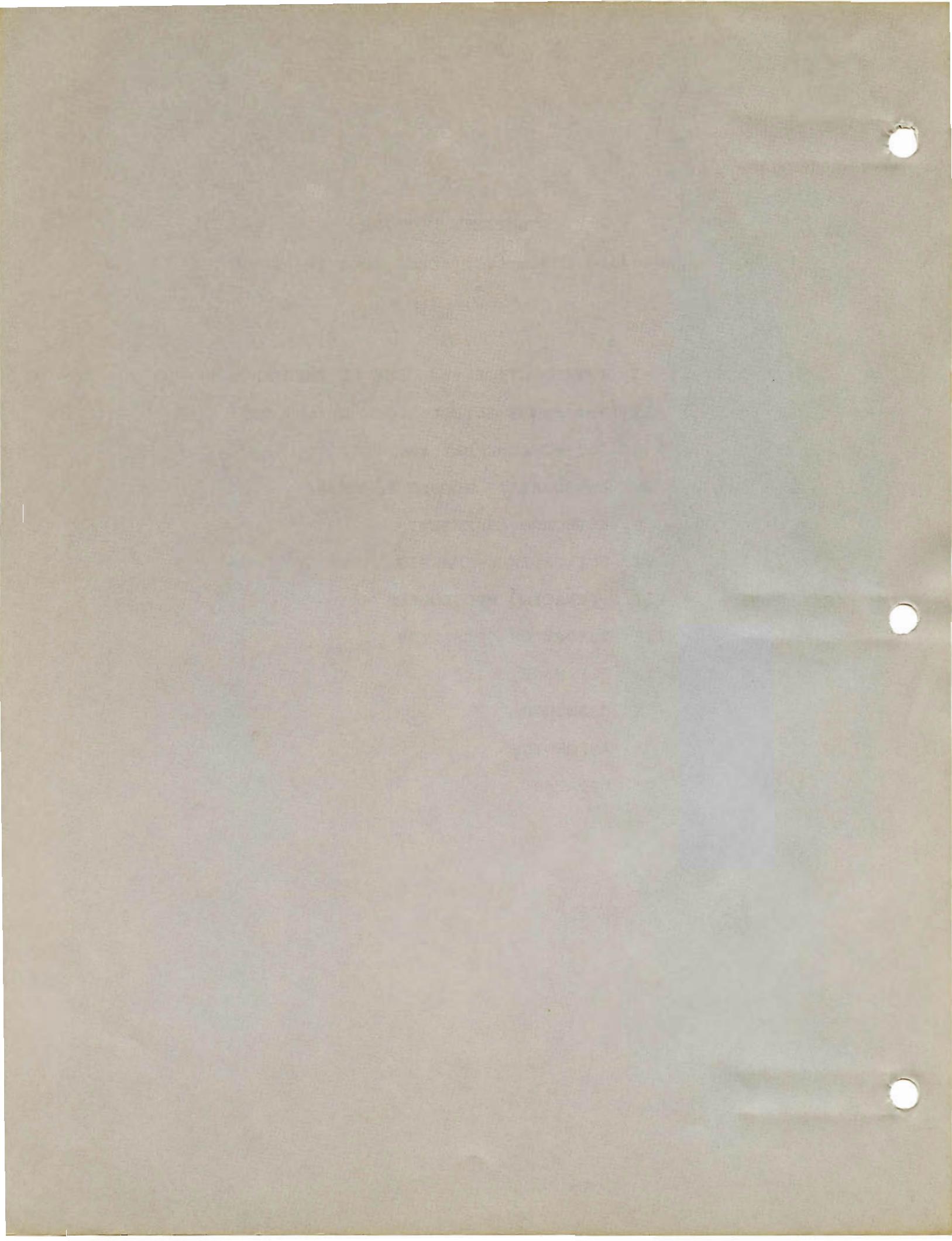
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## PROCESSOR TECHNOLOGY CORPORATION

Sol TERMINAL COMPUTER<sup>TM</sup>

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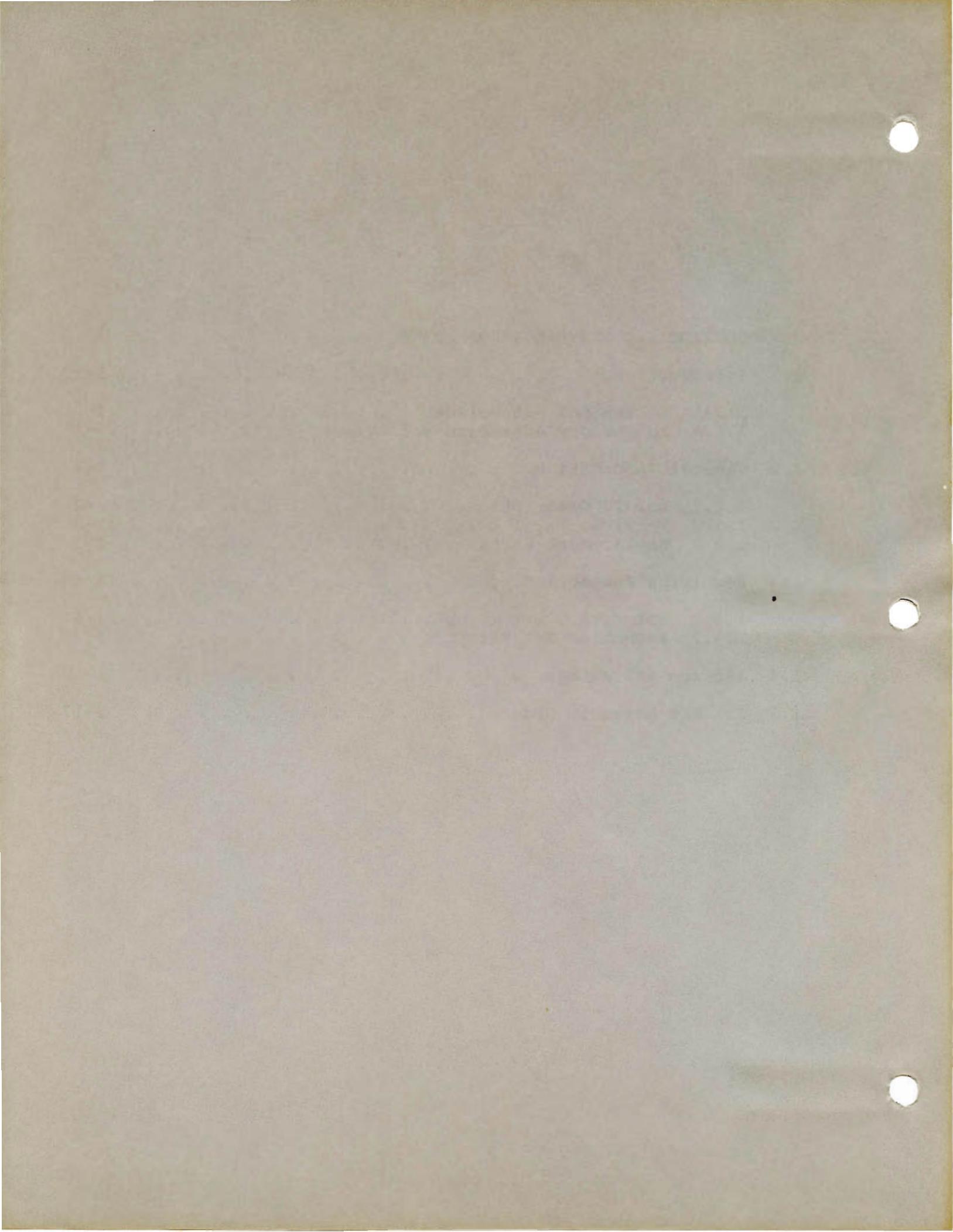
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I. Intro  
and General

## I INTRODUCTION and GENERAL INFORMATION

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## 1.1 INTRODUCTION

This manual supplies the information needed to assemble, test and use the Sol-PC Single Board Terminal Computer. We suggest that you first scan the entire manual before starting assembly. Then make sure you have all the parts and components listed in the "Parts List" (Table 3-1) in Section III. When assembling the module, follow the instructions in the order given.

Should you encounter any problem during assembly, call on us for help if necessary. If your completed module does not work properly, recheck your assembly step by step. Most problems stem from poor soldering, backward installed components, and/or installing the wrong component. Once you are satisfied that the module is correctly assembled, feel free to ask for our help.

## 1.2 GENERAL INFORMATION

### 1.2.1 Sol-PC Description

The Sol-PC is a single board microcomputer/terminal built around an 8080 microprocessor. Support circuitry permits full implementation of every 8080 function.

It features both parallel and serial communications interfaces, a keyboard interface, an audio cassette interface, a video display generator, 1024 8-bit words of system RAM (random access memory), 1024 8-bit words of display RAM, and a plug-in personality module with up to 2048 bytes of ROM (read only memory) stored program, and bus compatibility with all Processor Technology hardware and firmware products. Power requirements for the Sol-PC are +5 V dc  $\pm 5\%$  at 2.5 A, +12 V dc  $\pm 5\%$  at 150 mA and -12 V dc  $\pm 5\%$  at 200 mA.

Parallel interfacing is eight bits each for input and output plus control handshaking signals, and the output bus is tristated TTL for bidirectional interfaces. The serial interface circuit includes both asynchronous RS-232 and 20 mA current loop provisions, 75 to 9600 baud (switch selectable).

Seven-level ASCII encoded, TTL keyboard interfacing requires a 2 to 10 usec strobe pulse after data is stable. The dual rate, 300 or 1200 bps (bits per second), audio cassette interface is program controlled and self clocking with phase-lock loop. It includes automatic level control in both the record and playback modes. Recording is CUTS/Byte standard compatible, asynchronously Manchester coded at 1200/2400 Hz or 600/1200 Hz.

The video display circuitry generates sixteen 64 character lines from data stored in an on-card 1024 8-bit word display RAM. Alphanumeric and control characters (the full 128 upper and lower case plus control ASCII character set) are displayed black on white

## PROCESSOR TECHNOLOGY CORPORATION

Sol-PC SINGLE BOARD TERMINAL COMPUTER<sup>TM</sup>

## SECTION I

or reverse (switch selectable). Solid video inversion cursors, with switch selectable blink, are programmable. The display output is standard EIA, 1.0 to 2.5 V p-p with composite negative sync, with a nominal bandwidth of 7 MHz. It can consequently be used to drive any standard video monitor. (A monochrome TV, converted for video input, can also be used. See Appendix VI.)

Included on the card are 1024 words of static, low power system RAM capable of full speed operation and a plug-in personality module which contains the software control program. Three personality modules are available for Sol:

CONSOL<sup>TM</sup>--allows simple terminal operations plus direct control of the basic computer functions for entering or examining data in any memory location, or executing a program stored at a known location in memory.

SOLED<sup>TM</sup>--allows advanced terminal operations with CONSOL plus screen, file and cassette tape editing/transmission operations.

SOLOS<sup>TM</sup>--allows full stand-alone terminal-computer operation.

#### 1.2.2 Receiving Inspection

When your kit arrives, examine the shipping container for signs of possible damage to the contents during transit. Then inspect the contents for damage. (We suggest you save the shipping materials for use in returning the kit to Processor Technology should it become necessary to do so.) If your Sol-PC kit is damaged, please write us at once describing the condition so that we can take appropriate action.

#### 1.2.3 Warranty Information

In brief, parts which fail because of defects in materials or workmanship are replaced at no charge for 3 months for kits, and one year for assembled products, following the date of purchase. Also, products assembled by the buyer are warranted for a period of 3 months after the date of purchase; factory assembled units carry a one year warranty. Refer to Appendix I for the complete "Statement of Warranty".

#### 1.2.4 Replacement Parts

Order replacement parts by component nomenclature (DM8131 IC or 1N2222 diode, for example) and/or a complete description (680 ohm,  $\frac{1}{4}$  watt, 5% carbon resistor, for example).

## 1.2.5 Factory Service

In addition to in-warranty service, Processor Technology also provides factory repair service on out-of-warranty Processor Technology products. Before returning the unit to us, first obtain our authorization to do so by writing us a letter describing the problem. After you receive our authorization to return the unit, proceed as follows:

1. Write a description of the problem.
2. Pack the unit with the description in a container suitable to the method of shipment.
3. Ship prepaid to Processor Technology Corporation, 6200 Hollis Street, Emeryville, CA 94608.

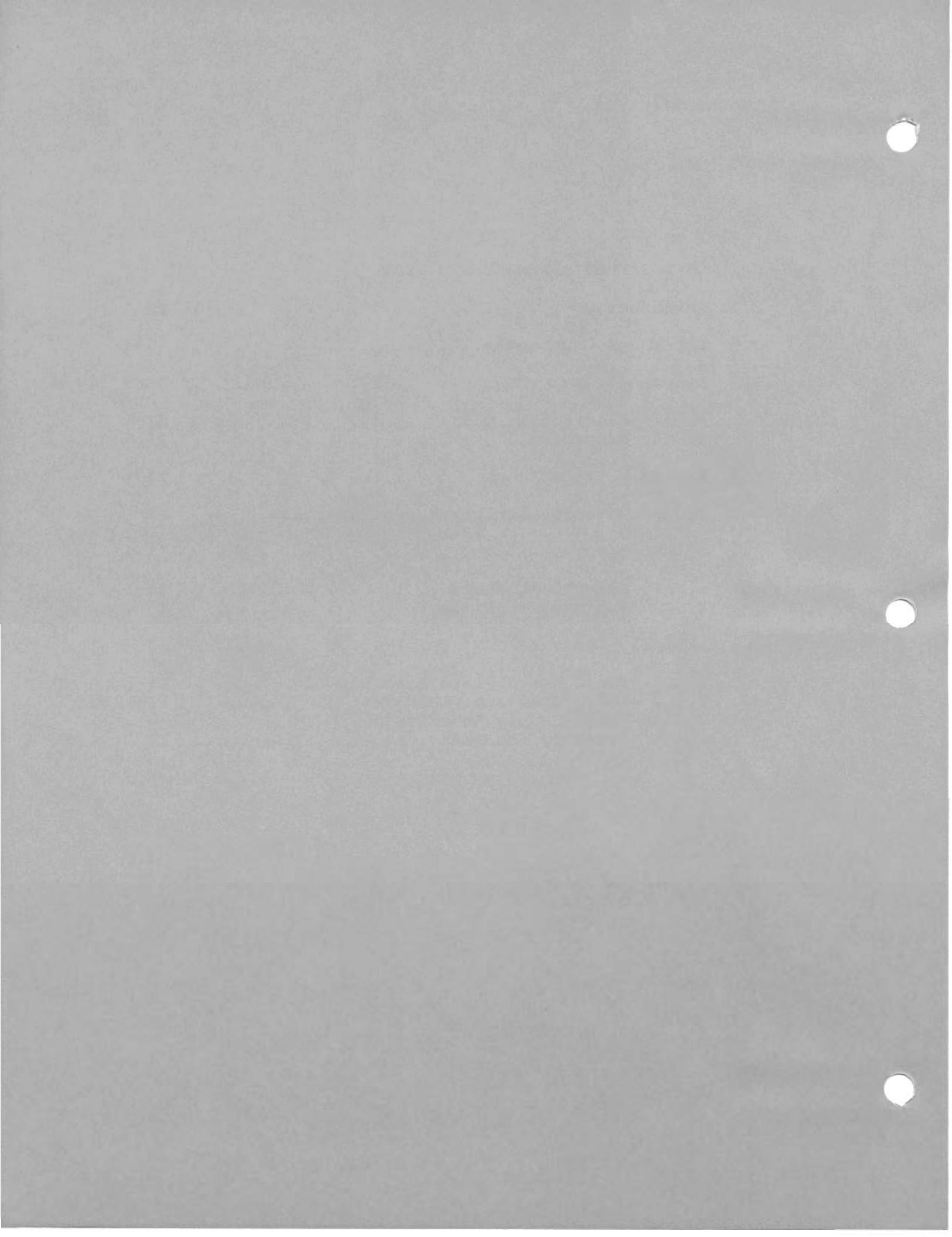
Your unit will be repaired as soon as possible after receipt and return shipped to you prepaid. (Factory service charges will not exceed \$20.00 without prior notification and your approval.)



II. Power  
Supply

## II Sol POWER SUPPLY ASSEMBLY and TEST

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## Sol POWER SUPPLY

## SECTION II

### 2.1 INTRODUCTION

The Sol power supply consists of a regulator board plus additional chassis-mounted components. This section covers assembly and test of the complete power supply.

### 2.2 PARTS AND COMPONENTS

You will need the parts listed in Table 2-1 to assemble your Sol power supply. Select and separate the needed parts from those supplied with your Sol kit before starting assembly. If you have any difficulty in identifying any parts by sight, refer to Figure 3-1 in Section III, Figure 6-1 in Section VI and the "Standard Color Code for Resistors and Capacitors" chart in Appendix III. The assembly drawings in Section X will also be useful in identifying parts.

To guide you in selecting and identifying parts, Table 2-1 lists each part, its description, quantity and reference designation on the drawing(s) you will use in assembling the power supply. You will encounter two types of reference designators in Table 2-1 (and parts lists in Section III, IV and VI as well): alphanumeric and encircled numeric designators.

Alphanumeric designators (C1, R5, U3, D4, etc.) are used to identify electronic components such as capacitors, resistors, integrated circuits and diodes. Encircled designators (①, ⑥, ⑨, etc.) are used to identify the other parts used in the Sol (chassis, cables, screws, washers, covers, heat sinks, etc.). Two examples of how to use the information in Table 2-1 follow:

1. Alphanumeric Designators. The first integrated circuit (IC) entry in Table 2-1 indicates its reference designator is U2 and that U2 will be installed using Drawing X-2 in Section X. In looking at Drawing X-2, we can see that U2 (a 1458) is an 8-pin dual inline package (DIP) IC that will be installed in the near center of the Sol-REG board.
2. Encircled Numeric Designators. The next to last entry in Table 2-1, a #10 lug, has a reference designator 12 and indicates that the two lugs will be installed using Drawing X-3 in Section X. In looking at Drawing X-3, we can see what these lugs look like and determine that they will be installed on resistor leads.

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Sol POWER SUPPLY

SECTION II

Table 2-1. Sol Power Supply Parts List.

| <u>PART</u>   | <u>DESCRIPTION</u>            | <u>QUANTITY</u> | <u>REFERENCE</u>   |                   |
|---------------|-------------------------------|-----------------|--------------------|-------------------|
|               |                               |                 | <u>Drawing No.</u> | <u>Designator</u> |
| Circuit Board | Sol-REG                       | 1               | X-2                | 1                 |
| IC            | 1458 or 72558                 | 1               | X-2                | U2                |
| IC            | 7812                          | 1               | X-2                | U1                |
| IC            | 7912                          | 1               | X-2                | U3                |
| Transistor    | TIP41                         | 1               | X-2                | Q1                |
| Transistor    | 2N2222                        | 2               | X-2                | Q2&3              |
| Diode         | 1N270                         | 1               | X-2                | D5                |
| Diode         | 1N4001                        | 2               | X-2                | D3&4              |
| Diode         | 1N4148 or 1N914               | 1               | X-2                | D2                |
| Diode         | 1N5231                        | 1               | X-2                | D1                |
| SCR           | 106-2 or 10632                | 1               | X-2                | SCR1              |
| Bridge Rect.  | 101                           | 1               | X-2                | FWB2              |
| Bridge Rect.  | 970-1                         | 1               | X-2                | FWB1              |
| Bridge Rect.  | 980-1                         | 1               | X-3                | FWB3              |
| Resistor      | 0.1 ohm, Wire Wound, 5W       | 1               | X-2                | R1                |
| Resistor      | 39 ohm, 2W, 5%                | 1               | X-3                | 10                |
| Resistor      | 68 ohm, 1/4W, 5%              | 1               | X-2                | R6                |
| Resistor      | 100 ohm, 1/4W, 5%             | 1               | X-2                | R14               |
| Resistor      | 330 ohm, 1/4W, 5%             | 2               | X-2                | R2&13             |
| Resistor      | 1K ohm, 1/4W, 5%              | 2               | X-2                | R5&8              |
| Resistor      | 1690 ohm, 1/4W, 1%            | 1               | X-2                | R11               |
| Resistor      | 4020 ohm, 1/4W, 1%            | 1               | X-2                | R12               |
| Resistor      | 10K ohm, 1/4W, 5%             | 4               | X-2                | R3,4,7&10         |
| Resistor      | 56K ohm, 1/4W, 5%             | 1               | X-2                | R9                |
| Capacitor     | .047 $\mu$ f, Disc Ceramic    | 1               | X-2                | C8                |
| Capacitor     | .1 $\mu$ f, Disc Ceramic      | 2               | X-2                | C2&3              |
| Capacitor     | 15 $\mu$ f, Tantalum, 20V     | 3               | X-2                | C1,6&7            |
| Capacitor     | 2500 $\mu$ f, Aluminum, 25V   | 2               | X-2                | C4&5              |
| Capacitor     | 18,000 $\mu$ f, Aluminum, 10V | 1               | X-3                | 8                 |
| Capacitor     | 54,000 $\mu$ f, Aluminum, 15V | 1               | X-3                | 9                 |

## PROCESSOR TECHNOLOGY CORPORATION

## Sol POWER SUPPLY

## SECTION II

Table 2-1. Sol Power Supply Parts List (Continued)

| <u>PART</u>  | <u>DESCRIPTION</u>                             | <u>QUANTITY</u> | <u>REFERENCE</u>   |                   |
|--------------|--|-----------------|--------------------|-------------------|
|              |  |                 | <u>Drawing No.</u> | <u>Designator</u> |
| Transformer  | Power, Sol T-2                                 | 1               | X-3                | 6                 |
| Transformer* | Power, Sol 220/240*                            | 1*              | X-3                | 6                 |
| Fan Assembly | Rotron 428056 or<br>Peewee Boxer PWS2107FL-2-M | 1               | X-5                | 5                 |
| Connector    | AC Power Receptacle                            | 1               | X-1                | 3                 |
| Socket       | Coax, 75 ohm                                   | 2               | X-1                | 55                |
| Holder       | Fuse   | 1               | X-1                | 9                 |
| Switch       | AC Power, Alternate Action                     | 1               | X-1                | 4                 |
| Block        | Commoning, 5 Position                          | 2               | X-1                | 10                |
| Fuse         | 3.2A, Slo-Blo                                  | 1               | -                  | -                 |
| Heat Sink    | Bar, For SCRL, Q1 & FWBL                       | 1               | X-2                | 5                 |
| Heat Sink    | Rectangular, For U1 & U3                       | 1               | X-2                | 40                |
| Heat Sink    | Circular, For Q2                               | 1               | X-2                | 41                |
| Cable        | Coaxial, 75 ohm                                | 15"             | X-1                | 2                 |
| Cable        | C8 Cable Assembly, 2-Wire                      | 1               | X-2                | 4                 |
| Cable        | Sol-PC Power, 4-Wire                           | 1               | X-2                | 2                 |
| Cable        | Sol 20 DC Power, 5-Wire                        | 1               | X-4                | 5                 |
| Cord         | AC Power, 3-Wire                               | 1               | X-10               | 36                |
| Lead         | Fuse Lead to AC Switch, 3"                     | 1               | X-1                | 7                 |
| Lead         | Neutral Lead, AC Switch, 3-1/4"                | 1               | X-1                | 8                 |
| Guard        | Finger   | 1               | X-1                | 6                 |
| Cable Tie    | Plastic  | 4               | X-4                | 13                |
| Clamp        | C-8, 1-1/2"                                    | 1               | X-3                | 31                |
| Clamp        | C-9, 2-1/2"                                    | 1               | X-3                | 32                |
| Insulator    | Mica Washer                                    | 1               | X-2                | 20                |
| Insulator    | Mica Washer, TO-220                            | 2               | X-2                | 19                |
| Plate        | Fan Closure                                    | 1               | X-1                | 1                 |
| Subchassis   | Power Supply                                   | 1               | X-3                | 1                 |

\* Supplied only with 220 and 240 Vac versions of Sol.

## PROCESSOR TECHNOLOGY CORPORATION

Sol POWER SUPPLY

SECTION II

Table 2-1. Sol Power Supply Parts List (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>         | <u>QUANTITY</u> | REFERENCE         |                |
|-------------|----------------------------|-----------------|-------------------|----------------|
|             |                            |                 | Drawing No.       | Designator     |
| Screw       | Machine, 4-40 x 3/16       | 2               | X-3               | 20             |
| Screw       | Machine, 4-40 x 5/16       | 6               | X-1<br>X-3        | 14<br>18       |
| Screw       | Machine, 4-40 x 7/16       | 1               | X-2               | 44             |
| Screw       | Machine, 4-40 x 5/8        | 1               | X-2               | 45             |
| Spacer      | Tapped, 4-40 x 1/4         | 2               | X-3               | 30             |
| Lockwasher  | Internal Tooth, #4         | 9               | X-1<br>X-2<br>X-3 | 18<br>48<br>29 |
| Hex Nut     | 4-40                       | 6               | X-1<br>X-2        | 16<br>50       |
| Lug         | #4                         | 2               | X-1               | 58             |
| Screw       | Machine, Metal, 6-32 x 1/2 | 16              | X-1<br>X-2<br>X-3 | 13<br>47<br>16 |
| Screw       | Machine, Nylon, 6-32 x 1/2 | 2               | X-2               | 46             |
| Screw       | Machine, Metal, 6-32 x 3/4 | 1               | X-3               | 19             |
| Screw       | Self-tapping, #6 x 5/16    | 4               | X-3               | 17             |
| Lockwasher  | Internal Tooth, #6         | 22              | X-1<br>X-2<br>X-3 | 17<br>52<br>28 |
| Hex Nut     | 6-32                       | 22              | X-1<br>X-2<br>X-3 | 15<br>51<br>24 |
| Screw       | Machine, Metal, 8-32 x 1/2 | 3               | X-3               | 15             |
| Lockwasher  | Internal Tooth, #8         | 3               | X-3               | 27             |
| Hex Nut     | 8-32                       | 3               | X-3               | 23             |
| Lug         | #10                        | 2               | X-3               | 12             |
| Compound    | Heatsink                   | 1               | -                 | -              |
| Solder      | 60/40, 20 SWG              | -               | -                 | -              |

## 2.3 ASSEMBLY TIPS

## 2.3.1 Electrical

For the most part the assembly tips given in Paragraph 3.2 of Section III (Page III-1) apply to assembling the Sol regulator board and power supply.

In addition, scan Section II completely before you start to assemble the power supply.

## 2.3.2 Mechanical

1. If you do not have the proper screwdrivers (see Paragraph 2.5), we recommend that you buy them rather than using a knife point, a blade screwdriver on a Phillips screw, and other makeshift means. Proper screwdrivers minimize the chances of stripping threads, disfiguring screw heads and marring decorative surfaces.

2. To assure a correct fit and tight assembly, be sure you use the screws specified in the instructions.

3. Lockwashers are widely used in the power supply assembly so that screws will not loosen when subjected to stress or vibration. When a lockwasher is specified, do not omit it and make sure you install it correctly.

4. Some instructions call for prethreading holes. This is done to make assembly easier by giving you maximum working space for installing relatively hard-to-drive sheet metal screws. If you bypass prethreading instructions you will only make subsequent cabinet-chassis assembly more difficult.

To prethread a hole, insert specified screw in the hole and position it as straight as possible. While holding the screw in this position, drive it into the metal with the proper screwdriver. If started straight the screw will continue to go straight into the metal so that the head and sheet metal surfaces are in full contact.

5. The diameter of the shank (threaded portion) of a screw increases in relation to its number. For example, a 6-32 screw is larger in diameter than a 4-40 screw. Also, a #8 lockwasher is larger than a #4 lockwasher.

6. Heat sink compound is supplied with this kit in a small clear plastic package. It is a thick white substance which improves heat transfer between components and their heat sinks. To use the compound, pierce a small hole near the edge of the top surface of the plastic package, using a pin or sharp knife point. Squeezing the package will cause a small amount of the compound to ooze out

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out of the hole, which may then be applied with a toothpick or small screwdriver blade. Spread a thin film of the compound on the mating surfaces of both the heat-generating component and the heat sink surface which it will contact. Then assemble as directed.

2.4 ASSEMBLY PRECAUTIONS

The precautions concerning soldering and the installation and removal of integrated circuits given in Paragraph 3.3 of Section III (Page III-9) also apply to assembling the Sol regulator board.

2.5 REQUIRED TOOLS, EQUIPMENT AND MATERIALS

The following tools, equipment and materials are recommended for assembling the Sol regulator board:

1. Needle nose pliers
2. Diagonal cutters
3. Sharp knife
4. Screwdriver, thin 1/4" blade
5. Screwdriver, #2 Phillips
6. Controlled heat soldering iron, 25 watt
7. Volt-ohm meter
8. Ruler

2.6 ORIENTATION

2.6.1 Sol-REG PC Board

Location C5 (2500 ufd capacitor) will be located in the lower right-hand corner of the circuit board when locations SCR1, Q1 and FWB1 are positioned along the top of the board. In this position the component (front) side of the board is facing up and the horizontal legends will read from left to right; the other legends will read from bottom to top. Subsequent position references related to the Sol-REG board assume this orientation.

2.6.2 Fan Closure Plate

The large circular cutout will be located in the upper right quadrant of the plate when the heavy gauge doubler plate is facing up. In this position the rectangular cutouts are on the left, the front side of the plate is facing down, the back side is facing up, and the small circular cutout is at the bottom. We suggest you label the two sides.

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2.7 ASSEMBLY-TEST

2.7.1 Fan Closure Plate Assembly

Refer to Assembly Drawings on Pages X-1 and 4 in Section X.  
(Figure 2-1 shows a completed fan closure plate assembly.)

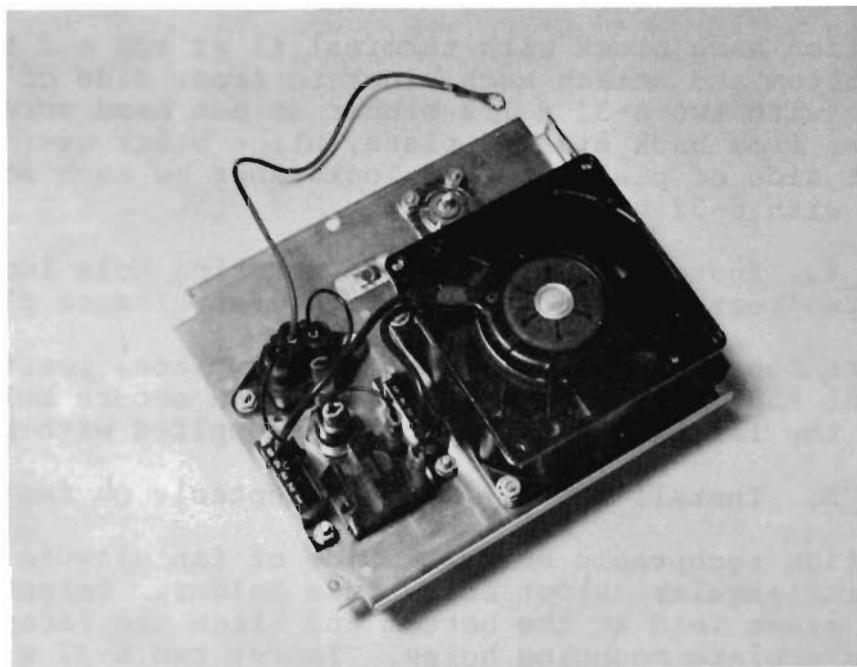


Figure 2-1. Sol-20 fan closure plate assembly.  
(Top of plate in foreground.)

- ( ) Step 1. Mount cooling fan and guard to fan closure plate.

Insert four 6-32 x 1/2" binder or pan head screws from back side (side with doubler plate) of fan closure plate. (Use the holes positioned in each quadrant of the large circular cut-out.) Slip fan guard over screws on front side of plate (side without doubler plate side). Position fan with motor support struts away from front side of closure plate and with its leads next to the rectangular cutouts in the plate. Place #6 lockwasher on each screw and secure with 6-32 hex nut.

WARNING

FAILURE TO INSTALL FAN GUARD MAY RESULT  
IN DAMAGE TO THE SOL AND/OR PERSONAL  
INJURY.

- ( ) Step 2. Install power on-off switch in upper rectangular cut-out in fan closure plate.

(Step 2 continued on Page II-8.)

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Bend four retainer tabs on switch in and position switch with terminals facing front side of fan closure plate. Push switch unit from back side of plate through mounting hole and bend retainer tabs outward if needed to hold switch in place.

- ( ) Step 3. Install commoning blocks (Item 10 on drawing on Page X-1) on front side of fan closure plate, one on each side of on-off switch.

Position each block with terminal #1 at top and terminal #5 at bottom and attach each block to front side of fan closure plate with two 6-32 x 1/2 binder or pan head screws. Insert screws from back side of plate, place block over screws, on front side of plate, put #6 lockwasher on each screw and secure with 6-32 hex nut.

- ( ) Step 4. Install fuse holder in mounting hole located between the two rectangular cutouts in the fan closure plate.

Insert fuse holder from back side of plate, position large tab at top, next to on-off switch, and secure holder to plate with the large lockwasher and nut supplied with holder.

- ( ) Step 5. Install AC Power cord receptacle on fan closure plate.

Position receptacle on front side of fan closure plate over the rectangular cutout below fuse holder. Orient receptacle with green lead at the bottom and align the receptacle and closure plate mounting holes. Insert two 6-32 x 1/2 binder or pan head screws from back side of plate through each mounting hole, put #6 lockwasher on each screw and secure with 6-32 hex nut. Be sure receptacle is properly seated in cutout before tightening to avoid damage.

- ( ) Step 6. Install female coaxial connector on fan closure plate.

Insert connector from front side of plate so that the threaded end projects through to the back side. Then insert four 4-40 x 5/16 binder or pan head screws from back side of plate through the four connector and plate mounting holes. Place #4 lockwasher on each screw except the upper one which is closest to the AC receptacle. Secure with 4-40 hex nuts. (Leave upper nut closest to receptacle loose.)

- ( ) Step 7. Prepare RG59/U coaxial cable. (See Figure 2-2.)

Cut a 15" piece of coaxial cable from that supplied. Strip away 1-1/2 inch of the outer insulation at both ends to expose shield. Unbraid shield at one end and loosely twist it into a single lead. Do the same thing at the other end. Tin shield lead at each end and solder a #4 lug to each lead. Then remove one inch of the inner conductor insulation at both ends and cut inner conductor to 3/8" length.

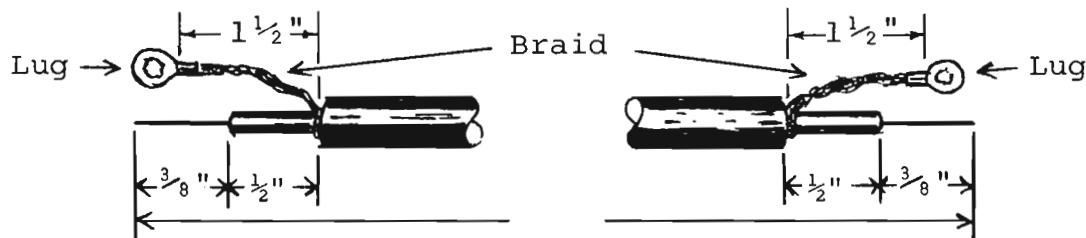


Figure 2-2. Coaxial cable preparation.

- ( ) Step 8. Connect coaxial cable to coaxial connector installed in Step 6.

Solder inner conductor on one end to the pin of the connector. Remove hex nut on upper connector mounting screw closest to AC receptacle, place lug (coaxial shield) on screw and reinstall hex nut.

- ( ) Step 9. Connect fan closure plate wiring. (See Drawing X-4.)

- ( ) Install the 3" power switch-to-commoning block cable. Connect the female spade lug end to the upper terminal of the on-off switch and the commoning block lug end to the #1 terminal of the commoning block closest to the fan.

NOTE: To install commoning block lugs, position lug with its open side facing away from the terminal numbers on the block. Then gently push lug into appropriate terminal receptacle until it is fully seated.

- ( ) Install the 3-1/4" fuse holder-to-power switch cable. (This cable has female spade lugs at both ends.) Connect one end to the bottom terminal of the on-off switch and the other to the longer male spade lug on the fuse holder.

- ( ) Connect the AC receptacle wire closest to the fan to the other fuse holder lug. NOTE: The green AC receptacle wire will be connected later.

- ( ) Connect other AC receptacle wire to terminal #4 on the commoning block furthest away from the fan (TB2).

- ( ) Connect upper wire of fan cord to terminal #3 of the commoning block closest to fan (TBL).

- ( ) Connect lower wire of fan cord to terminal #5 of commoning block furthest from fan.

- ( ) Put fan closure assembly aside.

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NOTE

Disc capacitor leads are usually coated with wax during the manufacturing process. After inserting leads through mounting holes, remove capacitor and clear the holes of any wax. Reinsert and install.

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u> | <u>ORIENTATION</u> |
|-----------------|--------------------|-------------|--------------------|
|-----------------|--------------------|-------------|--------------------|

|        |    |          |                       |
|--------|----|----------|-----------------------|
| ( ) C1 | 15 | Tantalum | "+" lead bottom right |
| ( ) C2 | .1 | Disc     | None                  |
| ( ) C3 | .1 | Disc     | None                  |
| ( ) C6 | 15 | Tantalum | "+" lead right        |
| ( ) C7 | 15 | Tantalum | "+" lead left         |

- ( ) Step 15. Install 2500 ufd capacitors in locations C4 and C5. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim. Be sure to install C4 with its "+" lead to the right and C5 with its "+" lead to the left.
- ( ) Step 16. Install Q2 and Q3 (2N2222) in their locations. The emitter lead (closest to tab on can) of Q2 is oriented toward the left and the base lead toward the bottom. The emitter lead of Q3 is oriented toward the bottom and the base lead toward the right.
- ( ) Step 17. Read assembly tip 6, on page II-5. Apply heat sink compound to the inside of the small black "star-shaped" cooling fin, and install it, with the cylindrical grip down, on Q2 by slipping it down onto the can. Be sure heat sink does not touch any other component on the board.
- ( ) Step 18. Install bridge rectifier FWB 2 (101) in its location at the bottom of the board. Apply heat sink compound, per Assembly tip 6 on page II-5. Position FWB2 with its "+" lead at the top and its "-" lead at the bottom, insert leads, solder and trim.
- ( ) Step 19. Install large heat sink, U1 and U3 in their locations on the bottom left corner of the circuit board.
  - ( ) Position large black heat sink, (flat side to board) over the square foil area in the lower left corner of the PC board. Orient sink so that the two triangular cutouts in the sink are over the two triangles of mounting holes in the board.
  - ( ) Position U1 (7812) on heat sink and observe how leads must be bent to fit mounting holes. Note that the center lead must be bent down approximately 0.2 inches.

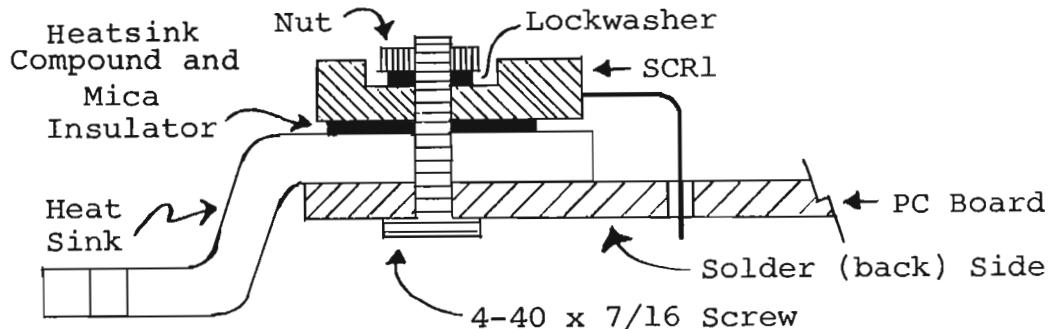
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further from the body than the other two leads. Bend leads so that no contact is made with the heat sink when U1 is flat against the sink and its mounting hole is aligned with the holes in the sink and PC board. Apply heat sink compound per Assembly Tip 6, on page II-5. Fasten U1 and sink to board using a 6-32 x  $\frac{1}{2}$  metal screw, lockwasher and nut. Insert screw from back (solder) side of board and drive nut finger tight.

- ( ) Position U3 (7912) on heat sink, determine how leads must be bent as you did for U1, and bend leads. Place a rectangular mica insulator over the leads of U3 so that it fully covers the bottom side of the U3 package. Apply heat sink compound to U3, the heat sink, and both sides of the mica insulator. Bend the two outside leads of U3 slightly in toward the center lead, insert leads in mounting holes as you did for U1, and fasten U3 to heat sink and PC board using a 6-32 x  $\frac{1}{2}$  Nylon screw, lockwasher and nut. Insert screw from back (solder) side of board and drive nut finger tight.
- ( ) Position heat sink, U1 and U3 as needed to obtain correct fit and tighten the U1 and U3 mounting screws. REMEMBER, NO LEADS CAN CONTACT THE SINK. Solder all leads and trim if required.
- ( ) Step 20. Install aluminum heat sink, SCR1, Q1 and bridge rectifier FWB1.
- ( ) Position aluminum heat sink (see Figure 2-3) along top of PC board so that the three holes in one side of the sink are aligned with the SCR1, Q1 and FWB1 mounting holes in the PC board.



(Left end, cross-section view)

Figure 2-3. Aluminum heat sink installation.

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- ( ) Position Q1 (T1P41), with component nomenclature up, on heat sink so hole in Q1 package is aligned with the holes in sink and PC board. Observe how the leads of Q1 must be bent down to fit the pads for Q1 and bend them accordingly. Apply heat sink compound to Q1, the heat sink, and both sides of the rectangular mica insulator. Place mica insulator between heat sink and Q1, insert leads (emitter lead to right) and fasten Q1, insulator and heat sink to board with a 6-32 x 1/2 Nylon screw, lockwasher and nut. Insert screw from back (solder) side of board and drive nut finger tight.
- ( ) Position FWB1 (970-1), with "+" lead to the right, on heat sink, determine how leads must be bent as you did for Q1, and bend leads. Apply heat sink compound. Insert leads ("+" lead to right) and fasten FWB1 and heat sink to PC board with a 4-40 x 5/8 screw, lockwasher and nut. Insert screw from back (solder) side of board and drive nut finger tight.
- ( ) Position SCR1 (106-2 or 10632) on heat sink with component nomenclature up and prepare it for installation as you did Q1 and FWB1. Apply heat sink compound to SCR1, the heat sink, and both sides of the circular mica insulator. Place the mica insulator between the heat sink and SCR1, insert leads and fasten SCR1, insulator and heat sink to PC board with a 4-40 x 7/16" screw, lockwasher and nut. Insert screw from back (solder) side of board and drive nut finger tight.
- ( ) Check alignment of heat sink, SCR1, Q1 and FWB2 and tighten the three mounting screws. Solder all leads and trim if required. Wipe off excess heat sink compound, if necessary. NOTE: The heat sink may have to be repositioned when you mount the Sol-REG on the power supply subchassis. This will require that you loosen the mounting screws for SCR1, Q1 and FWB2 and retighten them after repositioning the heat sink.
- ( ) Step 20A. Install C8 (0.47 ufd disc capacitor), R14 (100 ohm, 1/2 watt resistor, color code brown-black-brown), R13 (330 ohm, 1/4 watt resistor, color code orange-orange-brown) and diode D5 (1N270) as follows (see Drawing X-2 in Section X):
  - ( ) Connect C8 in parallel with R2 (330 ohm, 5 watt resistor installed in Step 11). Pass both C8 leads under the two leads of R2, bend leads of C8 around leads of R2 close to its body, solder and trim excess lead lengths.
  - ( ) Wrap one lead of R14 around right-hand lead of SCR1 and the other around the right-hand lead of R2. Dress R14 leads as shown on Drawing X-2. BE SURE R14 LEADS DO NOT SHORT TO OTHER LEADS OF SCR1 OR LEAD OF D1 (1N5231). Solder ONLY the R14-SCR1 connection and trim excess lead length.

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- ( ) Wrap one lead of R13 around right-hand lead of R2. Physically position R13 parallel to D1 as shown on Drawing X-2. Solder R13-R14-R2 connection and trim excess lead lengths.
- ( ) Wrap anode lead of D5 (1N270), the lead opposite the banded end lead, around anode lead of D1 (lead opposite banded end lead). Also wrap cathode lead (banded end) of D5 and loose lead of R13 together. Solder D1-D5 and D5-R13 connections and trim excess lead lengths.
- ( ) Check lead dress and inspect for possible shorts and/or solder bridges.
- ( ) Refer to Drawing X-2. On the solder (back) side of the board, the trace that connects R2 to the anode lead of D1 and the trace that connects the anode lead of D1 to the right-hand lead (as viewed from front (component) side of board) of SCR1 should have been cut at the factory. If they were not, cut these two traces as follows:

Using an Xacto knife or razor blade, make two cuts in each trace approximately 1/8" apart, cutting across each trace down to the epoxy base. Insert blade tip beneath one of the cut sections and gently work it away from the board. Do the same with the other cut section. Be sure both "breaks" are free of solder.

- ( ) Step 21. See Detail A on Drawing X-4 in Section X. Connect two wire cable assembly (C8 to Regulator Board cable) to regulator. Tin ends without lugs and solder green-white (+) lead to pad X2 and white (-) lead to pad X3.
- ( ) Step 22. Test Sol-REG for short circuits. Check for continuity between FWB1 (970-1) mounting screw and the following points: (The resistance should be greater than 20 ohms in all cases.)

|             |                     |                  |
|-------------|---------------------|------------------|
| X2          | Q1, Base            | D3, top lead     |
| T2          | Q1, Collector       | D4, top lead     |
| T1          | D1, right-hand lead | *D3, bottom lead |
| Q1, Emitter | R1, left-hand lead  | *D4, bottom lead |

\*Resistance will be initially low due to C4 and C5, but it should increase to greater than 20 ohms after a few seconds.

- ( ) Step 23. Set Sol-REG to one side.

## 2.7.3 Power Supply Subchassis Assembly and Test

Refer to Drawings X-3 and X-4 in Section X.

- ( ) Step 24. Mount transformer T2 on power supply subchassis (L-shaped chassis).

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Position transformer as shown in drawing on Page X-3 and attach it to the subchassis with three 8-32 x 1/2 binder or pan head screws, #8 lockwashers and 8-32 hex nuts. Insert screws from bottom and outer side of chassis as shown. Place lockwasher on each screw and secure loosely with hex nuts. Slide transformer as close as possible to the edge of the chassis and tighten nuts.

NOTE

Only one of the holes in the side wall is used. Use the one that lines up with the transformer mounting tab.

- ( ) Step 25. Prepare transformer leads.
  - ( ) Twist two black leads (black and black-red leads and black-white and black-yellow leads on Sol 20/220 transformer, black and black-yellow leads and black-white and black-red leads on Sol 20/240 transformer) together except for the last two inches at the commoning block lug end.
  - ( ) Twist the two green wires together for their full length.
  - ( ) Twist the two yellow wires together for their full length.
  - ( ) Twist the two blue wires together for their full length.
- ( ) Step 26. First check that wire color coding in Sol-PC power cable conforms with that shown in Figure 2-6 on Page II-21. Then connect Sol-PC power cable (4-wire cable which connects to J10 on Sol-PC) to Sol-REG. Tin ends of cable and solder green lead to pad X9, white lead to pad X1, red lead to pad X7 and white-yellow lead to pad X8.
- ( ) Step 27. See Detail C on Drawing X-4. Connect Sol-20 DC power cable (5-wire) to Sol-REG. Tin ends of cable and solder white lead to pad X10 (to right of T3), red-white lead to pad X5 (between C5 and FWB2) and yellow-white lead to pad X6 (left of C5).
- ( ) Step 28. Connect transformer leads to Sol-REG.
  - ( ) See Detail A on Drawing X-4. Solder green leads to pads T1 and T2, white-yellow lead to pad T3 and yellow leads to pads T4 and T5 on Sol-REG circuit board.
- ( ) Step 29. Prethread the three Sol-REG heat sink mounting holes in the power supply subchassis shown in drawing on page X-3 with #6 x 5/16 sheet metal screws. Remove screws.

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- ( ) Step 30. Place #4 lockwashers on two 4-40 x 3/16 binder or pan head screws. Insert these screws from the bottom side of the power supply subchassis through the two mounting holes located near the middle of the bottom of the power supply subchassis, one on each side. Drive each screw tightly into a 4-40 x 1/4 tapped spacer.
- ( ) Step 31. Position Sol-REG PC board with top edge over the previously installed spacers. Place #4 lockwashers on two 4-40 x 5/16 binder or pan head screws and drive screws through Sol-REG board into spacers.
- ( ) Step 32. Attach heat sink on Sol-REG to power supply subchassis as shown in drawing on Page X-3. At this point use only the two side screws which you used in Step 29 to prethread the holes. (The middle screw will be installed later.) Place a #6 lockwasher on each screw before driving it through the sink into the subchassis. Figure 2-4 shows a partially assembled Sol-20 power supply subchassis.

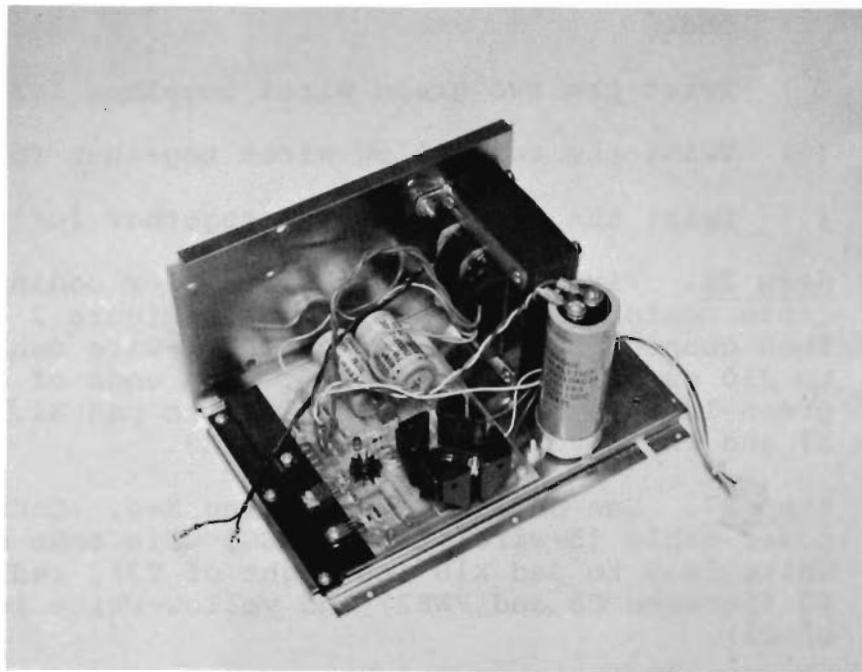


Figure 2-4. Partially assembled Sol-20 power supply subchassis assembly. (Rear of subchassis at left.)

- ( ) Step 33. Install bridge rectifier FWB3 on power supply subchassis.

(Step 33 continued on Page II-17.)

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Position FWB3 (980-1) on power supply subchassis as shown in drawing on Page X-3. BE SURE NEGATIVE (-) TERMINAL OF FWB3 is next to transformer. Insert a 6-32 x 3/4 binder or pan head screw from bottom of subchassis, place #6 lockwasher on screw and secure with 6-32 hex nut.

- ( ) Step 34. Connect blue transformer wires to unmarked terminals of FWB3.
- ( ) Step 35. Install large (2½") mounting ring for C9 (54,000 ufd capacitor) on side wall of power supply subchassis as shown in drawing on Page X-3.

Position ring over the three mounting holes in the side wall of subchassis so the clamping screw faces the bottom of subchassis and so it will be accessible from the Sol-REG end of the subchassis. Insert three 6-32 x ½ binder or pan head screws from outer side of side wall through the mounting holes. Place #6 lockwasher on each screw and secure with 6-32 hex nut. Figure 2-5 shows an assembled Sol-20 power supply subchassis.

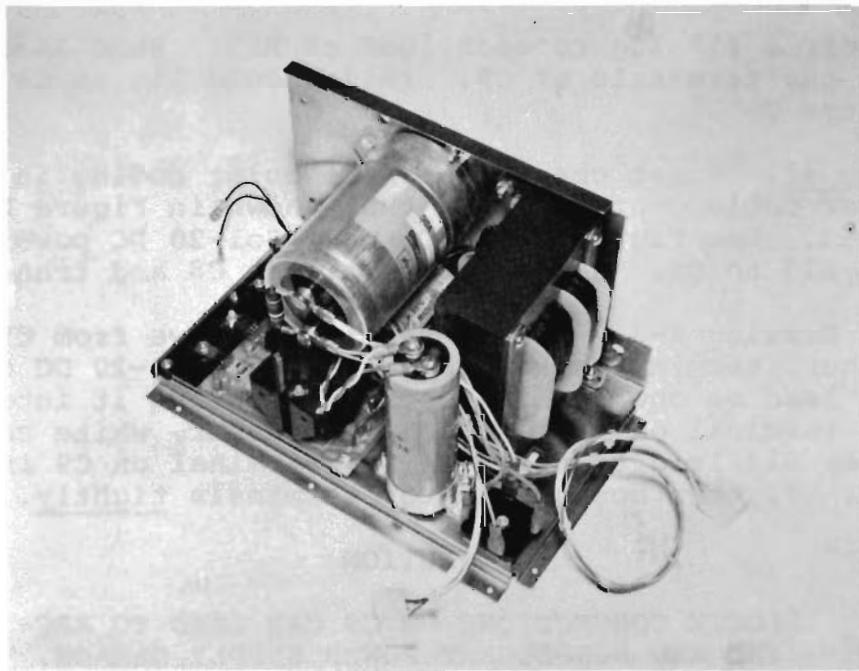


Figure 2-5. Sol-20 power supply subchassis assembly.  
(Rear of subchassis at left.)

- ( ) Step 36. Install small (1½") mounting ring for C8 (18,000 ufd capacitor) as shown in drawing on Page X-3.  
(Step 36 continued on Page II-18.)

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- ( ) Step 43. Connect green lead from AC receptacle (mounted on fan closure plate) to power supply subchassis assembly. (Use the #6 x 5/16" sheet metal screw with which you prethreaded the middle Sol-REG heat sink mounting hole in Step 29.) Place lug on screw and drive screw into the middle Sol-REG heat sink mounting hole.
- ( ) Step 44. Route transformer T2 primary leads along side wall of power supply subchassis out toward the Sol-REG heat sink. (See Figure 2-4.) If you ordered your Sol for 110 V ac operation, T2 will have two black primary leads. If you ordered your Sol for 220 or 240 V ac operation, T2 will have one black, one black-red, one black-yellow and one black-white lead. Connect the primary leads of T2 as follows:
  - ( ) 110 V ac Operation. Refer to Detail B1 on Drawing X-4 in Section X. Connect one black lead of T2 to pin 2 of commoning block TB1 (nearest to fan). Connect other black lead to pin 3 of other commoning block (TB2).
  - ( ) 220 V ac Operation. Refer to Detail B2 on Drawing X-4 in Section X. Connect black-yellow lead of T2 to pin 2 and black-white lead to pin 4 of commoning block TB1 (nearest to fan). Connect black-red lead to pin 1 and black lead to pin 5 of other commoning block (TB2).
  - ( ) 240 V ac Operation. Refer to Detail B3 on Drawing X-4 in Section X. Connect black-red lead to pin 2 and black-white lead to pin 4 of commoning block TB1 (nearest to fan). Connect black-yellow lead to pin 1 and black lead to pin 5 of other commoning block (TB2).
- ( ) Step 45. Install cable tie wraps.
  - ( ) Install one wrap around the wires that connect to Sol-REG pads T1,2,3,X2 and X3 as shown in the Detail A - Wiring portion of the drawing on Page X-4.
  - ( ) Install another wrap around the leads from C9 as shown in Detail C of drawing on Page X-4.

Two other wraps are supplied with your kit. Use them as appropriate to make your power supply cabling neater.
- ( ) Step 46. Using a #6 x 5/16 sheet metal screw, attach fan closure plate to power supply subchassis as shown in Drawing X-3.
- ( ) Step 47. Push on-off switch in and out to determine the OFF position (switch mechanically out). With switch in OFF position, connect AC power cord to AC receptacle.

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- ( ) Step 48. Test power supply for proper operation.
- ( ) Make sure on-off switch is in OFF position.
- ( ) Install fuse in fuse holder. CAUTION: NEVER INSTALL OR REMOVE FUSE WITH POWER ON.
- ( ) Check connector on Sol-PC power cable (4-wire) to insure it is wired as shown in Figure 2-6.
- ( ) Check connector on Sol-20 power cable (5-wire) to insure it is wired as shown in Figure 2-7.
- ( ) Plug power cord into 110 V ac outlet.
- ( ) Turn on-off switch ON. Fan should start.
- ( ) Measure the voltages at the Sol-PC connector at the points indicated in Figure 2-6. The voltages must be as given in Figure 2-6. NOTE: Do not take voltage measurements at any other points in the power supply, even though they may be more accessible. It is important that the indicator voltages be available at the connector.
- ( ) Measure the voltages at the Sol-20 connector at the point indicated in Figure 2-7. The voltages must be within the ranges given in Figure 2-7. (See preceding NOTE.)
- ( ) If the power supply fails any of the preceding tests, locate and correct the cause before proceeding.

If the power supply is operating correctly, turn on-off switch OFF, disconnect power cord, set power supply to one side and go on to Section III.

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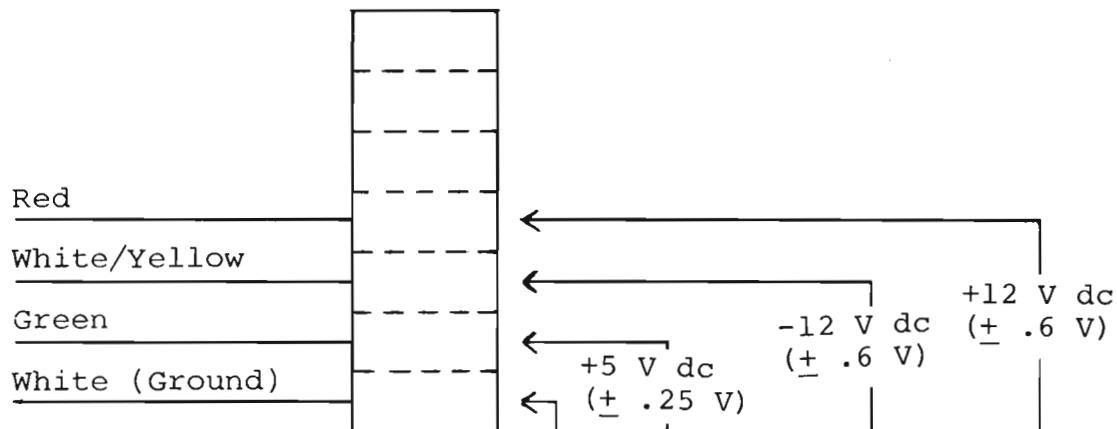


Figure 2-6. Sol-PC power connector and voltage measurements.

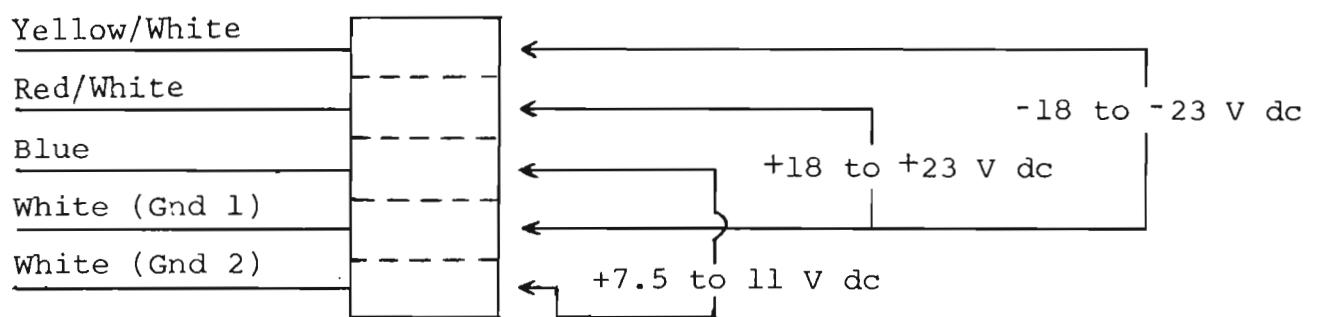


Figure 2-7. Sol-20 power connector and voltage measurements.



III. Sol-PC  
IV. P.M.

### III Sol-PC ASSEMBLY and TEST

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SECTION III

3.1 PARTS AND COMPONENTS

You will need the parts listed in Table 3-1 to assemble your Sol-PC. Select and separate the needed parts from those supplied with your Sol kit before starting assembly. If you have any difficulty in identifying any parts by sight, refer to Figure 3-1 and the "Standard Color Code for Resistors and Capacitors" chart in Appendix III. Table 3-1 lists each part, its description, quantity and reference designation on the drawing(s) you will use in assembling the Sol-PC. The assembly drawings in Section X will also prove useful in identifying parts.

3.2 ASSEMBLY TIPS

1. Scan Sections III and IV in their entirety before you start to assemble your Sol-PC kit.
2. In assembling your Sol-PC, you will be following an integrated assembly-test procedure. Such a procedure is designed to progressively insure that individual circuits and sections in the Sol-PC are operating correctly. IT IS IMPORTANT THAT YOU FOLLOW THE STEP-BY-STEP INSTRUCTIONS IN THE ORDER GIVEN.
3. Assembly steps and component installations are preceded by a set of parentheses. Check off each installation and step as you complete them. This will minimize the chances of omitting a step or component.
4. When installing components, make use of the assembly aids that are incorporated on the circuit boards and the assembly drawings. (These aids are designed to assist you in correctly installing the components.)
  - a. The circuit reference (R3, C10 and U20, for example) for each component is silk screened on the PC boards near the location of its installation.
  - b. Both the circuit reference and value or nomenclature (1.5K and 74H00, for example) for each component are included on the assembly drawings near the location of its installation.
5. To simplify reading resistor values after installation, install resistors so that the color codes or imprints read from left to right and top to bottom as appropriate (boards oriented as defined in Paragraph 3.5 on Page III-10).
6. Unless specified otherwise, install components, especially disc capacitors, as close as possible to the boards.
7. Should you encounter any problem during assembly, call on us for help if needed.

## PROCESSOR TECHNOLOGY CORPORATION

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## SECTION III

Table 3-1. Sol-PC Parts List.

| <u>PART</u>   | <u>DESCRIPTION</u>       | <u>QUANTITY</u> | <u>REFERENCE</u>   |                                  |
|---------------|--------------------------|-----------------|--------------------|----------------------------------|
|               |                          |                 | <u>Drawing No.</u> | <u>Designator</u>                |
| Circuit Board | Sol-PC                   | 1               | -                  | -                                |
| IC            | 0026 or 75369            | 1               | X-5                | U104                             |
| IC            | 4N26                     | 1               | X-5                | U39                              |
| IC            | 1458 or 72558            | 2               | X-5                | U56&108                          |
| IC            | 1489 or 75189            | 1               | X-5                | U38                              |
| IC            | 4001 or 14001            | 1               | X-5                | U102                             |
| IC            | 4013 or 1413             | 2               | X-5                | U100&113                         |
| IC            | 4019                     | 1               | X-5                | U111                             |
| IC            | 4023 or 14023            | 1               | X-5                | U98                              |
| IC            | 4024 or 14024            | 1               | X-5                | U86                              |
| IC            | 4027 or 14027            | 1               | X-5                | U101                             |
| IC            | 4029                     | 3               | X-5                | U1,11&84                         |
| IC            | 4030                     | 1               | X-5                | U99                              |
| IC            | 4046 or 14046            | 2               | X-5                | U85&110                          |
| IC            | 4049 or 14049            | 2               | X-5                | U88&109                          |
| IC            | 4520 or 14520            | 1               | X-5                | U112                             |
| IC            | 6011, 1602, 2017 or 1013 | 2               | X-5                | U51&69                           |
| IC            | 6574 or 6575             | 1               | X-5                | U25                              |
| IC            | 74H00                    | 1               | X-5                | U91                              |
| IC            | 74LS00                   | 3               | X-5                | U44,48&55                        |
| IC            | 74LS02 or 9LS02          | 2               | X-5                | U53&60                           |
| IC            | 74LS04                   | 4               | X-5                | U24,45,<br>49&54                 |
| IC            | 74S04                    | 1               | X-5                | U92                              |
| IC            | 7406                     | 2               | X-5                | U57&87                           |
| IC            | 74LS10                   | 2               | X-5                | U47&61                           |
| IC            | 74LS20                   | 3               | X-5                | U23,59&83                        |
| IC            | 74LS86                   | 1               | X-5                | U74                              |
| IC            | 74LS109                  | 8               | X-5                | U43,52,63,<br>64,70,72,<br>73&75 |

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## SECTION III

Table 3-1. Sol-PC Parts Lists. (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>   | <u>QUANTITY</u> | <u>REFERENCE</u> |  |
|-------------|----------------------|-----------------|------------------|--|
|             |                      |                 | Drawing<br>No.   |  |
|             |                      |                 | Designator       |  |
| IC          | 74LS136              | 1               | X-5              | U22                                      |
| IC          | 74LS138              | 3               | X-5              | U34, 35&36                               |
| IC          | 74LS157              | 3               | X-5              | U12, 30&32                               |
| IC          | 74LS163 or 25LS163   | 4               | X-5              | U28, 31,<br>33&40                        |
| IC          | 74166                | 1               | X-5              | U41                                      |
| IC          | 74173 or 8T10        | 2               | X-5              | U95&96                                   |
| IC          | 74175                | 1               | X-5              | U97                                      |
| IC          | 74LS175 or 25LS175   | 9               | X-5              | U2, 13, 26, 27,<br>42, 76, 90,<br>93&106 |
| IC          | 74LS253              | 4               | X-5              | U65, 66,<br>78&79                        |
| IC          | 74LS367              | 7               | X-5              | U29, 37, 50,<br>71, 89, 94<br>&107       |
| IC          | 8T94                 | 1               | X-5              | U58                                      |
| IC          | 8T97, 8097 or 74367  | 5               | X-5              | U67, 68, 77,<br>80&81                    |
| IC          | 8T380 or 8836        | 1               | X-5              | U46                                      |
| IC          | 8080A, 9080 or 8080  | 1               | X-5              | U105                                     |
| IC          | 91L02, 2102 or 21L02 | 16              | X-5              | U3 thru 10<br>& 14 thru 21               |
| IC          | 93L16                | 1               | X-5              | U62                                      |
| Transistor  | 2N2222               | 2               | X-5              | Q4&5                                     |
| Transistor  | 2N2907               | 2               | X-5              | Q1&2                                     |
| Transistor  | 2N4360               | 1               | X-5              | Q3                                       |
| Diode       | 1N4001               | 4               | X-5              | D2, 12,<br>13&14                         |
| Diode       | 1N4148 or 1N914      | 9               | X-5              | D1 &<br>D3 thru 10                       |
| Diode       | 1N5231               | 1               | X-5              | D11                                      |
| Crystal     | 14.31818 MHz         | 1               | X-5              | XTAL                                     |

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## SECTION III

Table 3-1. Sol-PC Parts Lists. (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>  | <u>QUANTITY</u> | <u>Drawing No.</u> | <u>REFERENCE</u>   |
|-------------|---------------------|-----------------|--------------------|--|
| Relay       | DIP, 500 ohm Reed   | 2               | X-5                | K1&2   |
| Resistor    | 6.8 ohm, 1/2 W, 5%  | 2               | X-5                | R155&156   |
| Resistor    | 47 ohm, 1/4 W, 5%   | 3               | X-5                | R137,138<br>&160   |
| Resistor    | 75 ohm, 1/4 W, 5%   | 1               | X-5                | R81  |
| Resistor    | 100 ohm, 1/4 W, 5%  | 1               | X-5                | R149   |
| Resistor    | 100 ohm, 1/2 W, 5%  | 3               | X-5                | R131,<br>132&133   |
| Resistor    | 200 ohm, 1/4 W, 5%  | 1               | X-5                | R82  |
| Resistor    | 270 ohm, 1/4 W, 5%  | 1               | X-5                | R21  |
| Resistor    | 330 ohm, 1/4 W, 5%  | 13              | X-5                | R45,58,<br>64 thru 71,<br>87,133&134   |
| Resistor    | 330 ohm, 1/2 W, 5%  | 1               | X-5                | R80  |
| Resistor    | 470 ohm, 1/4 W, 5%  | 1               | X-5                | R150   |
| Resistor    | 470 ohm, 1/2 W, 5%  | 2               | X-5                | R22&23   |
| Resistor    | 680 ohm, 1/4 W, 5%  | 9               | X-5                | R72 thru<br>79&88  |
| Resistor    | 1.5K ohm, 1/4 W, 5% | 63              | X-5                | R1 thru 17,<br>19,20,24,<br>30 thru 38,<br>40 thru 44,<br>49 thru 57,<br>59 thru 61,<br>83,85,86,<br>89,90,93,<br>96,97,99,<br>101,105,106,<br>115,116,124<br>&125 |
| Resistor    | 3.3K ohm, 1/4 W, 5% | 1               | X-5                | R128   |
| Resistor    | 4.7K ohm, 1/4 W, 5% | 1               | X-5                | R27  |
| Resistor    | 5.6K ohm, 1/4 W, 5% | 6               | X-5                | R39,46,62,<br>63,92&151  |

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Table 3-1. Sol-PC Parts Lists. (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>         | <u>QUANTITY</u> | <u>REFERENCE</u>   |  |
|-------------|----------------------------|-----------------|--------------------|--|
|             |                            |                 | <u>Drawing No.</u> | <u>Designator</u>  |
| Resistor    | 10K ohm, 1/4 W, 5%         | 31              | X-5                | R18,25,26,<br>28,47,48,94,<br>98,100,104,<br>107 thru 114,<br>117 thru 119,<br>121,122,127,<br>129,135,136,<br>140,142,<br>145&146 |
| Resistor    | 15K ohm, 1/4 W, 5%         | 2               | X-5                | R29&95   |
| Resistor    | 39K ohm, 1/4 W, 5%         | 2               | X-5                | R123&126   |
| Resistor    | 47K ohm, 1/4 W, 5%         | 2               | X-5                | R144&154   |
| Resistor    | 50K ohm, Variable          | 2               | X-5                | VR1&2  |
| Resistor    | 100K ohm, 1/4 W, 5%        | 3               | X-5                | R120,<br>148&153   |
| Resistor    | 100K ohm, Variable         | 1               | X-5                | VR3  |
| Resistor    | 150K ohm, 1/4 W, 5%        | 2               | X-5                | R141&152   |
| Resistor    | 1M ohm, 1/4 W, 5%          | 2               | X-5                | R139&143   |
| Resistor    | 2.2M ohm, 1/4 W, 5%        | 1               | X-5                | R147   |
| Resistor    | 3.3M ohm, 1/4 W, 5%        | 2               | X-5                | R84&102  |
| Capacitor   | 10 pf, Disc Ceramic        | 1               | X-5                | C64  |
| Capacitor   | 330 pf, Disc Ceramic       | 1               | X-5                | C30  |
| Capacitor   | 470 pf, Disc Ceramic       | 1               | X-5                | C74  |
| Capacitor   | 680 pf, Disc Ceramic       | 3               | X-5                | C34,43<br>&44  |
| Capacitor   | .001 $\mu$ f, Disc Ceramic | 6               | X-5                | C47,49,<br>54,55,<br>61&71   |
| Capacitor   | .001 $\mu$ f, Mylar        | 2               | X-5                | C52&72   |
| Capacitor   | .01 $\mu$ f, Mylar         | 2               | X-5                | C50&53   |

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## SECTION III

Table 3-1. Sol-PC Parts Lists. (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>         | <u>QUANTITY</u> | <u>REFERENCE</u>   |  |
|-------------|----------------------------|-----------------|--------------------|--|
|             |                            |                 | <u>Drawing No.</u> | <u>Designator</u>  |
| Capacitor   | .047 $\mu$ f, Disc Ceramic | 37              | X-5                | C1 thru 14,<br>16 thru 28,<br>33,38,41,<br>42,45,46,<br>48,56,<br>65&73  |
| Capacitor   | .1 $\mu$ f, Disc Ceramic   | 12              | X-5                | C29,32,36,<br>37,39,51,57,<br>63,66,68,<br>69&70   |
| Capacitor   | .1 $\mu$ f, Mylar          | 1               | X-5                | C35  |
| Capacitor   | .68 $\mu$ f, Mono Ceramic  | 1               | X-5                | C62  |
| Capacitor   | 1 $\mu$ f, Tantalum        | 1               | X-5                | C67  |
| Capacitor   | 15 $\mu$ f, Tantalum       | 5               | X-5                | C15,40<br>58,59&60   |
| Capacitor   | 100 $\mu$ f, Aluminum      | 1               | X-5                | C31  |
| Socket      | DIP, 8-pin                 | 2               | X-5                | U56&108  |
| Socket      | DIP, 14-pin                | 29              | X-5                | U22 thru 24,<br>38,44 thru 49,<br>53 thru 55,<br>57 thru 61,<br>74,83,86,87,<br>91,92,98<br>thru 100,102,<br>&113  |
| Socket      | DIP, 16-pin                | 74              | X-5                | U1 thru 21,<br>26 thru 37,<br>40 thru 43,<br>50,52<br>62 thru 68,<br>70 thru 73,<br>75 thru 81,<br>84,85,<br>88 thru 90,<br>93 thru 97,<br>101,106,<br>107 &<br>109 thru 112 |

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## SECTION III

Table 3-1. Sol-PC Parts Lists. (Continued)

| <u>PART</u>  | <u>DESCRIPTION</u>            | <u>QUANTITY</u> | <u>REFERENCE</u>   |                   |
|--------------|-------------------------------|-----------------|--------------------|-------------------|
|              |                               |                 | <u>Drawing No.</u> | <u>Designator</u> |
| Socket       | DIP, 24-pin                   | 1               | X-5                | U25               |
| Socket       | DIP, 40-pin                   | 3               | X-5                | U51,69&105        |
| Socket       | Female, 25-pin                | 1               | X-5                | J1                |
| Socket       | Male, 25-pin                  | 1               | X-5                | J2                |
| Socket       | Phone Jack, Miniature         | 2               | X-5                | J6&7              |
| Socket       | Phone Jack, Subminiature      | 2               | X-5                | J8&9              |
| Header       | Male, 20-pin                  | 2               | X-5                | J3&4              |
| Header       | Male, 7-pin                   | 1               | X-5                | J10               |
| Connector    | PC, 100-pin                   | 1               | X-5                | J11               |
| Connector    | PC, 30-pin                    | 1               | X-5                | J5                |
| Switch       | DIP, 6 Section                | 2               | X-5                | S1&4              |
| Switch       | DIP, 8 Section                | 2               | X-5                | S2&3              |
| Cable        | Coax, 75 ohm                  | 33"             | X-6                | 2                 |
| Cable Tie    | Plastic                       | 1               | X-6                | 129               |
| Tubing       | PVC                           | 3"              | -                  | -                 |
| Bracket      | Mounting, Sol-PC, 2"          | 2               | X-6                | 4                 |
| Card Guide   | 2-1/2"                        | 2               | X-6                | 128               |
| Pins         | Augat                         | 15              | -                  | -                 |
| Screw        | Machine, 4-40 x 1/4           | 4               | X-6                | 122               |
| Screw        | Machine, 4-40 x 7/16          | 6               | X-6                | 124               |
| Screw        | Machine, 4-40 x 5/8           | 2               | X-6                | 125               |
| Washer       | Nylon, #4                     | 2               | X-6                | 127               |
| Lockwasher   | Internal Tooth, #4            | 10              | X-6                | 126               |
| Hex Nut      | 4-40                          | 10              | X-6                | 123               |
| Wire         | 24 AWG                        | 1'6"            | -                  | -                 |
| Solder       | 60/40, 20 SWG                 | -               | -                  | -                 |
| Power Supply | Sol-20                        | 1               | -                  | -                 |
| Assembly     | Keyboard                      | 1               | -                  | -                 |
| Assembly*    | 2708/9216 Personality Module* | 1*              | -                  | -                 |

\* Not needed until Step 50 of Sol-PC assembly.

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SECTION III

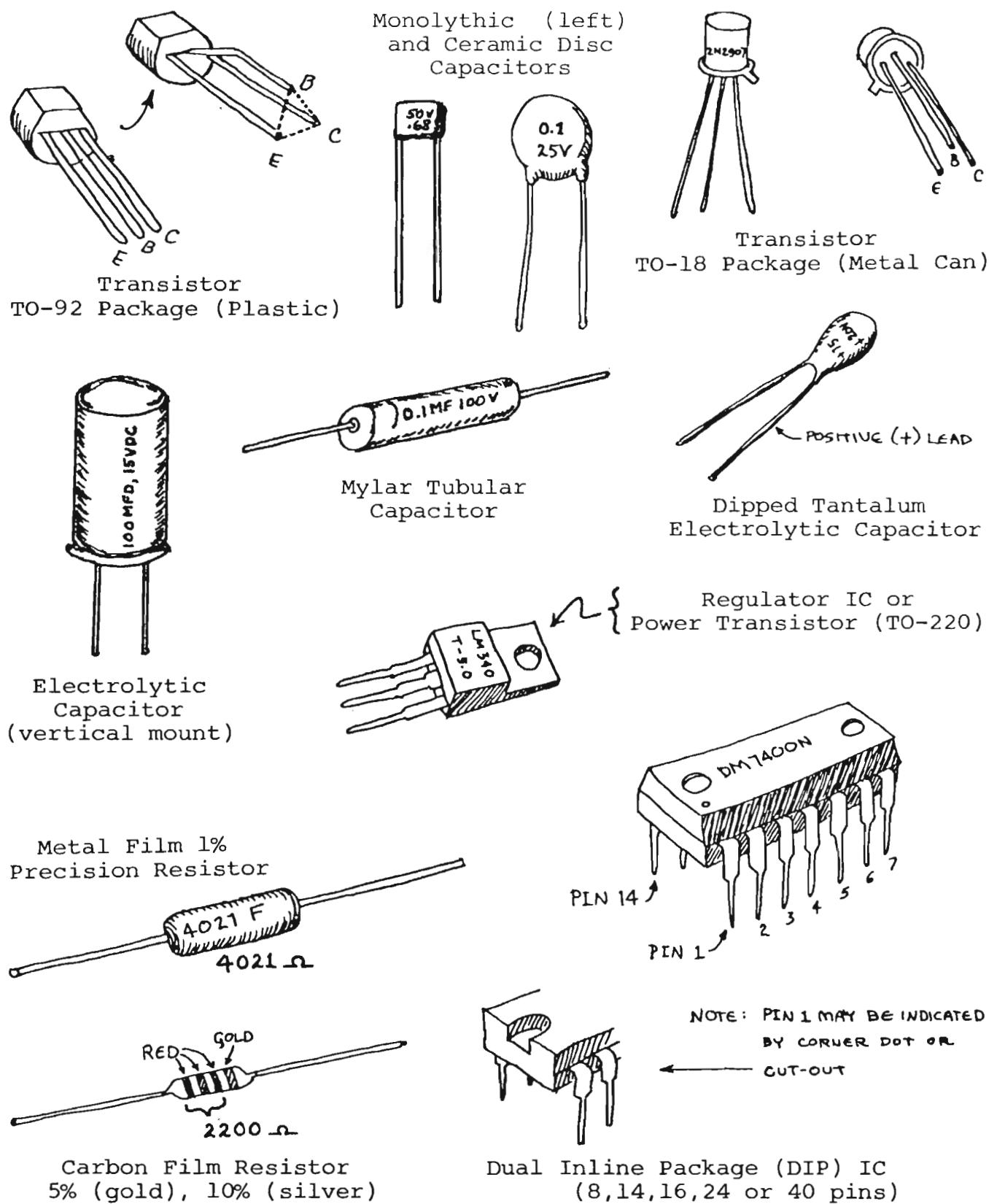


Figure 3-1. Identification of components.

## 3.3 ASSEMBLY PRECAUTIONS

## 3.3.1 Handling MOS Integrated Circuits

Many of the IC's used in the Sol-PC are MOS devices. They can be damaged by static electricity discharge. Always handle MOS IC's so that no discharge will flow through the IC. Also, avoid unnecessary handling and wear cotton--rather than synthetic--clothing when you do handle these IC's.

3.3.2 Soldering \*\*IMPORTANT\*\*

1. Use a fine tip, low-wattage iron, 25 watts maximum.

2. DO NOT use excessive amounts of solder. DO solder neatly and as quickly as possible.

3. Use only 60-40 rosin-core solder. NEVER use acid-core solder or externally applied fluxes.

4. To prevent solder bridges, position iron tip so that it does not touch adjacent pins and/or traces simultaneously.

5. DO NOT press tip of iron on pad or trace. To do so can cause the pad or trace to "lift" off the board and permanently damage the board.

6. The Sol-PC uses circuit boards with plated-through holes. Solder flow through to the component (front) side of the board can produce solder bridges. Check for such bridges after you install each component.

7. The Sol-PC circuit boards have integral solder masks (a lacquer coating) that shield selected areas on the boards. This mask minimizes the chances of creating solder bridges during assembly. DO, however, check all solder joints for possible bridges.

8. Additional pointers on soldering are provided in Appendix IV of this manual.

## 3.3.3 Power Connection (J10)

NEVER connect the DC power cable to the Sol-PC when power supply is energized. To do so can damage the Sol-PC.

## 3.3.4 Installing and Removing Integrated Circuits

NEVER install or remove integrated circuits when power is applied to the Sol-PC. To do so can damage the IC.

## 3.3.5 Installing and Removing Personality Module

NEVER install or remove the plug-in personality module when power is applied to the Sol-PC. To do so can damage the module.

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3.3.6 Use of Clip Leads

TAKE CARE when using a clip lead to establish a ground connection when testing the Sol-PCB circuit board. Make sure that the clip makes contact only with the ground bus on the perimeter of the board.

3.4 REQUIRED TOOLS, EQUIPMENT AND MATERIALS

The following tools, equipment and materials are recommended for assembling and testing the Sol-PC:

1. Needle nose pliers
2. Diagonal cutters
3. Screwdriver
4. Sharp knife
5. Controlled heat soldering iron, 25 watt
6. Volt-ohm meter
7. Video monitor or monochrome TV converted for video input
8. IC test clip (optional)
9. Oscilloscope with calibrated time base

3.5 ORIENTATION (Sol-PCB)

Location J5 (personality plug-in module connector) will be located in the upper right-hand area of the circuit board when location J10 (power connector) is positioned at the bottom of the board. In this position the component (front) side of the board is facing up and all IC legends (U1 through U10, U22 through U24, etc.) will read from left to right. Subsequent position references related to the Sol-PCB assume this orientation.

3.6 Sol-PC ASSEMBLY-TEST PROCEDURE

The Sol-PC is assembled and tested in sections and/or circuits. You will first test the Sol-PCB circuit board for shorts (solder bridges) between the power buses and ground. After assembling

the personality module (see Section IV), the clock and display control circuits are assembled. The bus, CPU, decoder and memory circuits are then assembled, followed by the parallel and serial input/output (I/O) and audio cassette I/O sections.

#### CAUTION

THE Sol-PC USES MANY MOS INTEGRATED CIRCUITS. THEY CAN BE DAMAGED BY STATIC ELECTRICITY DISCHARGE. HANDLE THESE IC's SO THAT NO DISCHARGE FLOWS THROUGH THE IC. AVOID UNNECESSARY HANDLING AND WEAR COTTON, RATHER THAN SYNTHETIC, CLOTHING WHEN YOU DO HANDLE MOS IC's. (STATIC CHARGE PROBLEMS ARE MUCH WORSE IN LOW HUMIDITY CONDITIONS.)

#### 3.6.1 Circuit Board Check

- ( ) Visually check Sol-PCB board for solder bridges (shorts) between traces, broken traces and similar defects.
- ( ) Check board to insure that the +5-volt-bus, +12 volt-bus and -12-volt bus are not shorted to each other or to ground. Using an ohmmeter, on "OHMS X 1K" or "OHMS X 10K" scale, make the following measurements (refer to Sol-PC Assembly Drawing X-3).
  - ( ) +5-volt Bus Test. Measure between positive and negative mounting pads for C58. There should be no continuity. (Meter reads close to "infinity" ohms.)
  - ( ) +12-volt Bus Test. Measure between positive and negative mounting pads for C59. There should be no continuity.
  - ( ) -12-volt Bus Test. Measure between positive and negative mounting pads for C60. There should be no continuity.
  - ( ) 5/12/(-12) Volt Bus Test. Measure between positive mounting pads for C58 and C59, between positive pad for C58 and negative pad for C60, and between positive pad for C59 and negative pad for C60. You should measure no continuity in any of these measurements.

If visual inspection reveals any defects, or you measure continuity in any of the preceding tests, return the board to Processor Technology for replacement. If the board is not defective, proceed to next paragraph.

## 3.6.2 Personality Module Assembly

Since the personality module is required for testing the Sol-PC in the later stages of its assembly, we suggest that you assemble the personality module first. In so doing, your Sol-PC assembly will proceed uninterrupted. Assembly instructions for the personality module are provided in Section IV of this manual.

If you wish to wait to assemble the personality module until it is needed, go on to Paragraph 3.6.3.

## 3.6.3 Sol-PCB Assembly and Test

Refer to Sol-PC assembly drawings X-5 and X-6.

- ( ) Step 1. Install DIP sockets. Install each socket in the indicated location with its end notch oriented as shown on the circuit board and assembly drawing. Take care not to create solder bridges between the pins and/or traces. (Refer to footnotes at end of this step before installing U105.)

INSTALLATION TIP

Insert socket pins into mounting pads of appropriate location. On solder (back) side of board, bend pins at opposite corners of socket (e.g., pins 1 and 9 on a 16-pin socket) outward until they are at a 45° angle to the board surface. This secures the socket until it is soldered. Repeat this procedure with each socket until all are secured to the board. Then solder the unbent pins on all sockets. Now straighten the bent pins to their original position and solder.

| <u>LOCATION</u>    | <u>TYPE SOCKET</u> |
|--------------------|--------------------|
| ( ) U1 through 21  | 16 pin             |
| ( ) U22 through 24 | 14 pin             |
| ( ) U25            | 24 pin             |
| ( ) U26 through 37 | 16 pin             |
| ( ) U38            | 14 pin             |
| ( ) U39            | None               |
| ( ) U40 through 43 | 16 pin             |
| ( ) U44 through 49 | 14 pin             |
| ( ) U50            | 16 pin             |
| ( ) U51            | 40 pin             |
| ( ) U52            | 16 pin             |
| ( ) U53 through 55 | 14 pin             |
| ( ) U56            | 8 pin              |
| ( ) U57 through 61 | 14 pin             |

(Continued on Page III-13.)

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| <u>LOCATION</u>      | <u>TYPE SOCKET</u> |
|----------------------|--------------------|
| ( ) U62 through 68   | 16 pin             |
| ( ) U69*             | 40 pin             |
| ( ) U70 through 73   | 16 pin             |
| ( ) U74              | 14 pin             |
| ( ) U75 through 81   | 16 pin             |
| ( ) U82#             | None#              |
| ( ) U83              | 14 pin             |
| ( ) U84,85           | 16 pin             |
| ( ) U86,87           | 14 pin             |
| ( ) U88 through 90   | 16 pin             |
| ( ) U91,92           | 14 pin             |
| ( ) U93 through 97   | 16 pin             |
| ( ) U98 through 100  | 14 pin             |
| ( ) U101             | 16 pin             |
| ( ) U102             | 14 pin             |
| ( ) U103#            | None#              |
| ( ) U104             | None               |
| ( ) U105**           | 40 pin             |
| ( ) U106,107         | 16 pin             |
| ( ) U108             | 8 pin              |
| ( ) U109 through 112 | 16 pin             |
| ( ) U113             | 14 pin             |

\*Especially make sure you solder pin 40.

#Spare locations, not used.

\*\*Note that U105 notch is positioned at the top.

- ( ) Step 2. Install the following capacitors in the indicated locations. Take care to observe the proper value, type and orientation, if applicable, for each installation. Bend leads outward on solder (back) side of board, solder and trim.

NOTE

Disc capacitor leads are usually coated with wax during the manufacturing process. After inserting leads through mounting holes, remove capacitor and clear the holes of any wax. Reinsert and install.

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u> | <u>ORIENTATION</u> |
|-----------------|--------------------|-------------|--------------------|
| ( ) C1          | .047               | Disc        | None               |
| ( ) C2          | .047               | "           | "                  |
| ( ) C3          | .047               | "           | "                  |
| ( ) C4          | .047               | "           | "                  |
| ( ) C5          | .047               | "           | "                  |
| ( ) C6          | .047               | "           | "                  |
| ( ) C7          | .047               | "           | "                  |
| ( ) C8          | .047               | "           | "                  |

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## SECTION III

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u> | <u>ORIENTATION</u> |
|-----------------|--------------------|-------------|--------------------|
| ( ) C10         | .047               | Disc        | None               |
| ( ) C11         | .047               | "           | "                  |
| ( ) C13         | .047               | "           | "                  |
| ( ) C14         | .047               | "           | "                  |
| ( ) C15         | 15                 | Tantalum    | "+" lead bottom    |
| ( ) C16         | .047               | Disc        | None               |

- ( ) Step 3. Check for +5-volt bus to ground shorts. Using an ohmmeter, measure between positive and negative mounting pads for C58. There should be no continuity. If there is, find and correct the problem before proceeding to Step 4.
- ( ) Step 4. Install the following capacitors in the indicated locations. Take care to observe the proper value, type and orientation, if applicable, for each installation. Bend leads outward on solder (back) side of board, solder and trim. (refer to NOTE in Step 2.)

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u> | <u>ORIENTATION</u> |
|-----------------|--------------------|-------------|--------------------|
| ( ) C19         | .047               | Disc        | None               |
| ( ) C20         | .047               | "           | "                  |
| ( ) C21         | .047               | "           | "                  |
| ( ) C24         | .047               | "           | "                  |
| ( ) C25         | .047               | "           | "                  |
| ( ) C26         | .047               | "           | "                  |
| ( ) C33         | .047               | "           | "                  |
| ( ) C38         | .047               | "           | "                  |
| ( ) C40         | 15                 | Tantalum    | "+" lead bottom    |
| ( ) C41         | .047               | Disc        | None               |
| ( ) C42         | .047               | "           | "                  |
| ( ) C45         | .047               | "           | "                  |
| ( ) C56         | .047               | "           | "                  |
| ( ) C58         | 15                 | Tantalum    | "+" lead top       |
| ( ) C59         | 15                 | Tantalum    | "+" lead top       |
| ( ) C60         | 15                 | Tantalum    | "+" lead top       |
| ( ) C65         | .047               | Disc        | None               |

- ( ) Step 5. Check for +5-volt bus to ground shorts. Using an ohmmeter, measure between the positive and negative leads of C58. You should measure at least 100 ohms. Less than 100 ohms indicates a short. If required, find and correct the problem before proceeding to Step 6. NOTE: In this and subsequent resistance measurements, any value greater than the minimum may normally occur, even much higher, unless otherwise indicated.
- ( ) Step 6. Install the following capacitors in the indicated locations. Take care to observe the proper value and type for each installation. Bend leads outward on solder (back) side of board, solder and trim. (Refer to NOTE in Step 2.)

(Step 6 continued on Page III-15.)

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| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u> | <u>ORIENTATION</u> |
|-----------------|--------------------|-------------|--------------------|
| ( ) C9          | .047               | Disc        | None               |
| ( ) C12         | .047               | "           | "                  |
| ( ) C17         | .047               | "           | "                  |
| ( ) C18         | .047               | "           | "                  |
| ( ) C22         | .047               | "           | "                  |
| ( ) C23         | .047               | "           | "                  |
| ( ) C27         | .047               | "           | "                  |
| ( ) C28         | .047               | "           | "                  |
| ( ) C46         | .047               | "           | "                  |

- ( ) Step 7. Check for +5-volt bus to ground shorts. Using an ohmmeter, measure between the positive and negative leads of C58. You should measure some resistance. Zero resistance indicates a short. If required, find and correct the problem before proceeding to Step 8.
- ( ) Step 8. Install diodes D8 (1N4148 or 1N914), D11 (1N5231) and D12 (1N4001) in their locations (in the area below U90 through U92). Position D8 with its dark band (cathode) to the right, D11 with its band at the bottom, and D12 with its band at the top.
- ( ) Step 9. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u>     | <u>COLOR CODE</u>   |
|-----------------|-------------------------|---------------------|
| ( ) R104        | 10 K                    | brown-black-orange  |
| ( ) R105        | 1.5K                    | brown-green-red     |
| ( ) R106        | 1.5K                    | " " "               |
| ( ) R130        | 100, $\frac{1}{2}$ watt | brown-black-brown   |
| ( ) R131        | 100, $\frac{1}{2}$ watt | " " "               |
| ( ) R132        | 100, $\frac{1}{2}$ watt | " " "               |
| ( ) R133        | 330                     | orange-orange-brown |
| ( ) R134        | 330                     | " " "               |
| ( ) R135 & 136  | 10 K                    | brown-black-orange  |
| ( ) R137 & 138  | 47                      | yellow-violet-black |

- ( ) Step 10. Install the following capacitors in the indicated locations. Take care to observe the proper value and type for each installation. Bend leads outward on solder (back) side of board, solder and trim. (Refer to NOTE in Step 2.)

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| <u>LOCATION</u> | <u>VALUE</u> | <u>TYPE</u>        |
|-----------------|--------------|--------------------|
| ( ) C39         | .1 ufd       | Disc               |
| ( ) C43         | 680 pfd      | Monolithic or Disc |
| ( ) C44         | 680 pfd      | Monolithic or Disc |
| ( ) C61         | .001 ufd     | Disc               |
| ( ) C62         | .68 ufd      | Monolithic         |
| ( ) C63         | .1 ufd       | Disc               |
| ( ) C64         | 10 pfd       | Disc               |

- ( ) Step 11. Install 14.318 MHz crystal in its location just above C61. Insert leads and pull down until the case is 1/16" above the front surface of the board. Solder quickly and trim.
- ( ) Step 12. Install male Molex connector in location J10. Position connector so the locking clip is next to the crystal (XTAL), insert shorter pins in mounting holes and solder.
- ( ) Step 13. In the jumper area labeled CLK on the assembly drawing (between U90 and U91), install Augat pins in mounting holes A,B,C,D and E. (Refer to "Installing Augat Pins" in Appendix IV.) Using #24 bare wire, install a jumper between the A and B pins and another jumper between the D and E pins. DO NOT SOLDER JUMPERS TO AUGAT PINS.
- ( ) Step 14. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation. DO NOT SUBSTITUTE FOR ANY OF THESE IC's.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>         |
|---------------|---------------------|
| ( ) U77       | 8T97, 8097 or 74367 |
| ( ) U90       | 74LS175 or 25LS175  |
| ( ) U91*      | 74H00*              |
| ( ) U92*      | 74S04*              |
| ( ) U104**    | 0026 or 72558*      |

\*Take care not to interchange these.

\*\*Solder this IC in its location.

See "Loading DIP Devices" in Appendix IV.

- ( ) Step 15. Connect power to power connector J10. Power and interconnection requirements are as follows:

(Step 15 continued on Page III-17.)

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## SECTION III

CAUTION 1

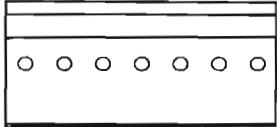
WHENEVER POWER IS APPLIED TO THE Sol-PC WHEN IT IS NOT INSTALLED IN THE CHASSIS, IT MUST REST ON A CLEAN NONCONDUCTING SURFACE. DO NOT PLACE IT ON TOP OF PIECES OF WIRE AND/OR SOLDER.

CAUTION 2

NEVER CONNECT POWER CABLE TO J10 WITH POWER SUPPLY ENERGIZED.

CAUTION 3

MAKE SURE POWER CABLE CONNECTOR MATES EXACTLY WITH J10. IF CONNECTOR AND J10 ARE OFFSET (e.g., PIN 2 CONNECTED TO PIN 1, 3 TO 2, ETC.), THE IC'S WILL "BLOW".

|  | <u>J10 PIN NO.</u> | <u>POWER</u>                    |
|--|--------------------|---------------------------------|
|  | 1                  | Ground                          |
| 1 2 3 4 5 6 7<br>(J10, Top View)   | 2 and 6            | +5 V dc $\pm 5\%$ , 2 A max     |
|  | 3 and 5            | -12 V dc $\pm 5\%$ , 300 mA max |
|  | 4                  | +12 V dc $\pm 5\%$ , 100 mA max |
|  | 7                  | Ground                          |

NOTE

Though not labeled on the connector, J10 pins are designated 1 through 7, reading from left to right.

( ) Step 16. Check clock circuits.

( ) Using an oscilloscope, check for the waveforms given in Figure 3-2 on Page III-18 at the indicated observation points and in the order given. The waveforms shown in Figure 3-2 approximate actual waveforms. If any waveforms are incorrect, determine and correct the cause before proceeding with assembly.

( ) Turn off power supply and disconnect power connector.

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| <u>CHECK POINT</u> | <u>SIGNAL</u>              | <u>WAVEFORM</u>  |
|--------------------|----------------------------|--|
| ( ) U77,<br>Pin 7  | Oscillator<br>Output       | 14.3 MHz square wave. (This is not a perfect square wave. It in fact more resembles a poor sine wave.) |
| ( ) U91,<br>Pin 6  | Clock<br>Divider<br>Output | U91, PIN 6<br>4V<br>GND<br>140ns 350ns   |
| ( ) U91,<br>Pin 11 | Clock<br>Divider<br>Output | U91, PIN 11<br>4V<br>GND<br>210ns 280ns  |
| ( ) U104,<br>Pin 7 | CPU<br>Clock<br>$\phi_1$   | UI04, PIN 7<br>12V<br>GND<br>140ns 350ns   |
| ( ) U104,<br>Pin 5 | CPU<br>Clock<br>$\phi_2$   | UI04, PIN 5<br>12V<br>GND<br>210ns 280ns   |

Figure 3-2. Clock circuit waveforms.

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( ) Step 17. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u>     | <u>COLOR CODE</u>   |
|-----------------|-------------------------|---------------------|
| ( ) R1          | 1.5K                    | brown-green-red     |
| ( ) R2          | 1.5K                    | " " "               |
| ( ) R3          | 1.5K                    | " " "               |
| ( ) R4          | 1.5K                    | " " "               |
| ( ) R5          | 1.5K                    | " " "               |
| ( ) R6          | 1.5K                    | " " "               |
| ( ) R7          | 1.5K                    | " " "               |
| ( ) R8          | 1.5K                    | " " "               |
| ( ) R9          | 1.5K                    | " " "               |
| ( ) R10         | 1.5K                    | " " "               |
| ( ) R11         | 1.5K                    | " " "               |
| ( ) R16         | 1.5K                    | " " "               |
| ( ) R17         | 1.5K                    | " " "               |
| ( ) R19         | 1.5K                    | " " "               |
| ( ) R30         | 1.5K                    | " " "               |
| ( ) R80         | 330, $\frac{1}{2}$ watt | orange-orange-brown |
| ( ) R81         | 75                      | violet-green-black  |
| ( ) R82         | 200                     | red-black-brown     |
| ( ) R83         | 1.5K                    | brown-green-red     |
| ( ) R84         | 3.3M                    | orange-orange-green |
| ( ) R85         | 1.5K                    | brown-green-red     |
| ( ) R86         | 1.5K                    | " " "               |
| ( ) R87         | 330                     | orange-orange-brown |
| ( ) R88         | 680                     | blue-gray-brown     |
| ( ) R89         | 1.5K                    | brown-green-red     |
| ( ) R90         | 1.5K                    | " " "               |
| ( ) R96         | 1.5K                    | " " "               |
| ( ) R97         | 1.5K                    | " " "               |
| ( ) R98         | 10 K                    | brown-black-orange  |
| ( ) R99         | 1.5K                    | brown-green-red     |
| ( ) R100        | 10 K                    | brown-black-orange  |
| ( ) R101        | 1.5K                    | brown-green-red     |
| ( ) R102        | 3.3M                    | orange-orange-green |
| ( ) R103        | 1.5K                    | brown-green-red     |
| ( ) R120        | 100 K                   | brown-black-yellow  |
| ( ) R121        | 10 K                    | brown-black-orange  |
| ( ) R122        | 10 K                    | " " "               |
| ( ) R123        | 39 K                    | orange-white-orange |
| ( ) R124        | 1.5K                    | brown-green-red     |
| ( ) R125        | 1.5K                    | " " "               |
| ( ) R126        | 39 K                    | orange-white-orange |
| ( ) R127        | 10 K                    | brown-black-orange  |
| ( ) R128        | 3.3K                    | orange-orange-red   |
| ( ) R129        | 10 K                    | brown-black-orange  |
| ( ) VR1 & VR2   | 50 K                    | Potentiometer       |

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- ( ) Step 18. Install the following capacitors in the indicated locations. Take care to observe the proper value and type for each installation. Bend leads outward on solder (back) side of board, solder and trim. (Refer to NOTE in Step 2.)

CAUTION

REFER TO FOOTNOTE AT END OF THIS STEP BEFORE  
INSTALLING C31.

| <u>LOCATION</u> | <u>VALUE</u> | <u>TYPE</u>           |
|-----------------|--------------|-----------------------|
| ( ) C31*        | 100 ufd      | Aluminum Electrolytic |
| ( ) C32         | .1 ufd       | Disc                  |
| ( ) C34         | 680 pfd      | Monolithic or Disc    |
| ( ) C35         | .1 ufd       | Mylar Tubular         |
| ( ) C36         | .1 ufd       | Disc                  |
| ( ) C37         | .1 ufd       | Disc                  |
| ( ) C52         | .001 ufd     | Mylar Tubular         |
| ( ) C53         | .01 ufd      | Mylar Tubular         |
| ( ) C54         | .001 ufd     | Disc                  |
| ( ) C55         | .001 ufd     | Disc                  |
| ( ) C57         | .1 ufd       | Disc                  |

\*Install C31 with "+" lead at the top.

- ( ) Step 19. Install Q2 (2N2907) in its location below and to the right of U88. The emitter lead (closest to tab on can) is oriented toward the left of the board and the base is oriented toward the bottom. Push straight down on transistor until it is stopped by the leads. Solder and trim.
- ( ) Step 20. Install diodes D9 and D10 (1N4148 or 1N914) in their locations below U88. Position D9 with its dark band (cathode) to the left and D10 with its band to the right.
- ( ) Step 21. Install remaining length of coaxial cable (33"), composite video output. (See Figure 3-4 for details on how to prepare cable.)
- ( ) Strip away about 1-1/4" of the outer insulation to expose shield. Unbraid shield, gather and twist into a single lead. Then strip away the inner conductor insulation, leaving about 1/4" at the shield end.

CAUTION

WHEN PREPARING AND INSTALLING SHIELD, BE  
SURE BITS OF BRAID DO NOT FALL ONTO BOARD.  
SUCH DEBRIS CAN CREATE HARD-TO-FIND SHORT  
CIRCUITS.

- ( ) Insert inner conductor in mounting hole P1 (left side of board), solder and trim.

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SECTION III

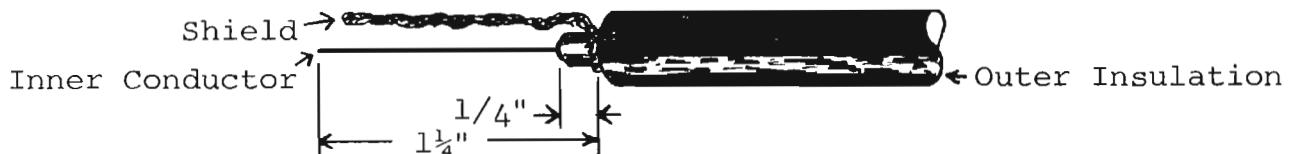


Figure 3-4. Coaxial cable preparation.

- ( ) Refer to Detail E on Drawing X-6. Insert twisted shield in mounting hole P2, solder and trim. Using the two large holes to the right of VR1 and VR2, tie cable to board with tie wrap (see CAUTION below).

CAUTION

AFTER INSTALLATION, FINE BITS OF THE BRAID FROM THE SHIELD MAY WORK LOOSE AND FALL ONTO THE BOARD AND CREATE HARD-TO-FIND SHORT CIRCUITS. TO PREVENT THIS, COAT ALL EXPOSED BRAID WITH AN ADHESIVE AFTER SOLDERING AND TIEING. USE AN ADHESIVE SUCH AS SILICONE, CONTACT CEMENT OR FINGERNAIL POLISH. DO NOT USE WATER BASE ADHESIVES.

- ( ) Step 22. Install 6-position DIP switch in location S1 on left end of board. Position Switch No. 1 at the bottom.
- ( ) Step 23. Install 20-pin header in location J4 (video expansion connector) between U28 and U29. Position header so pin 1 is in the lower right corner. (An arrow on the connector points to pin 1.)
- ( ) Step 24. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>        |
|---------------|--------------------|
| ( ) U28       | 74LS163 or 25LS163 |
| ( ) U31       | 74LS163 or 25LS163 |
| ( ) U33       | 74LS163 or 25LS163 |
| ( ) U40       | 74LS163 or 25LS163 |
| ( ) U43       | 74LS109            |
| ( ) U47       | 74LS10             |
| ( ) U49       | 74LS04             |

(Step 24 continued on Page III-22.)

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| <u>IC NO.</u> | <u>TYPE</u>     |
|---------------|-----------------|
| ( ) U59       | 74LS20          |
| ( ) U60       | 74LS02 or 9LS02 |
| ( ) U62       | 93L16           |
| ( ) U74       | 74LS86          |
| ( ) U75       | 74LS109         |
| ( ) U87       | 7406            |
| ( ) U88*      | 4049 or 14049*  |
| ( ) U102*     | 4001 or 14001*  |

\*MOS device. Refer to CAUTION on Page III-11.

- ( ) Step 25. Apply power to Sol-PC and check display section timing chain operation.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

- ( ) Using an oscilloscope, check for the waveforms given in Figure 3-5 at the indicated observation points and in the order given. The waveforms shown in Figure 3-5 approximate actual waveforms. If any waveforms are incorrect, determine and correct the cause before proceeding with assembly.

( ) Turn off power supply and disconnect power connector.

- ( ) Step 26. Check synchronization circuits.

( ) Set all S1 switches to OFF.

( ) Connect Sol-PC video output cable to video monitor.

SEE CAUTION ON PAGE III-24 BEFORE CONNECTING MONITOR.

(Step 26 continued on Page III-24.)

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## SECTION III

| <u>CHECK POINT</u> | <u>WAVEFORM</u> |
|--------------------|-----------------|
|--------------------|-----------------|

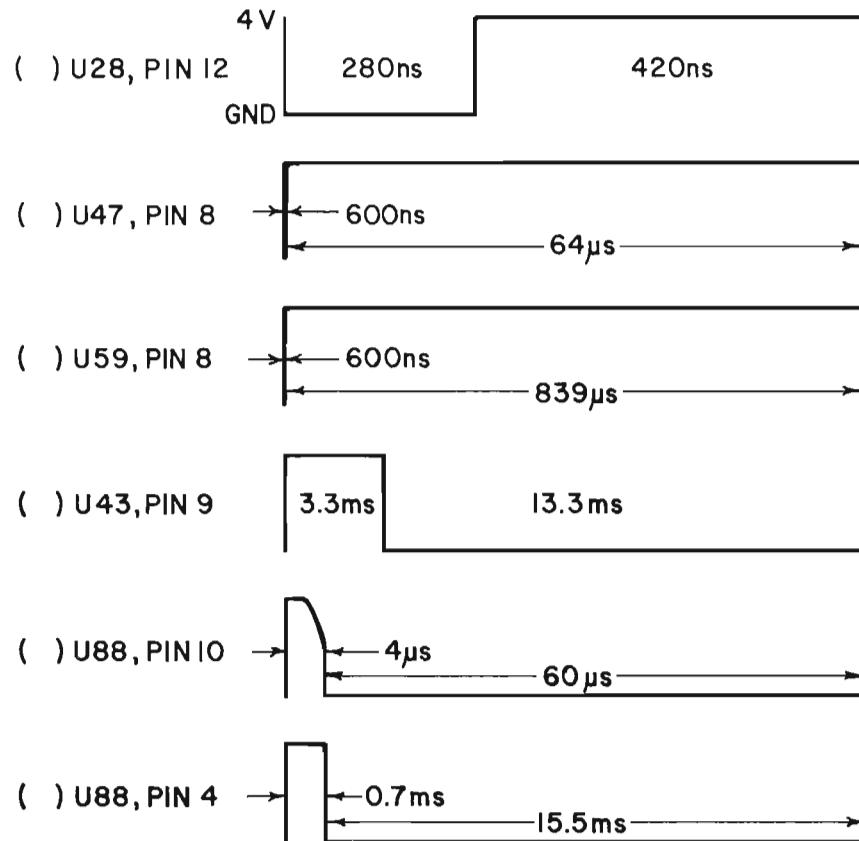


Figure 3-5. Display section timing waveforms.

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SECTION III

CAUTION

DO NOT CONNECT THE Sol-PC VIDEO OUTPUT TO A MONITOR OR TV RECEIVER THAT IS NOT EQUIPPED WITH AN ISOLATION TRANSFORMER.  
(SEE PAGE AVI-7 IN APPENDIX VI.)

- ( ) Set VR2 (VERT) and VR1 (HORIZ) on the Sol-PC to their mid-range settings. Turn monitor on and apply power to the Sol-PC.
  
- ( ) The display raster will be pulled in. Using the monitor Vertical Hold, you should be able to obtain a slow roll (black horizontal bar moves slowly down the screen) and a stationary raster. Using the monitor Horizontal Hold, you should be able to adjust for an out of sync raster (numerous black lines cutting across the raster) and a stable raster. If you cannot obtain these conditions, locate and correct the cause before proceeding.

NOTE

For a stable presentation, a few monitors (especially modified TV sets) may require a higher sync amplitude than that supplied by the Sol-PC. In such cases, increase sync amplitude by reducing the value of R80. DO NOT DECREASE R80 BELOW 225 OHMS.

- ( ) If the synchronization circuits are operating correctly, turn monitor and power supply off, disconnect the power cable and go on to Step 27.
  
- ( ) Step 27. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

(Step 27 continued on Page III-25.)

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## SECTION III

| <u>IC NO.</u> | <u>TYPE</u>        |
|---------------|--------------------|
| ( ) U1*       | 4029*              |
| ( ) U2        | 74LS175 or 25LS175 |
| ( ) U11*      | 4029*              |
| ( ) U12       | 74LS157            |
| ( ) U13       | 74LS175 or 25LS175 |
| ( ) U25*      | 6574 or 6575*      |
| ( ) U26       | 74LS175 or 25LS175 |
| ( ) U27       | 74LS175 or 25LS175 |
| ( ) U29       | 74LS367            |
| ( ) U30       | 74LS157            |
| ( ) U32       | 74LS157            |
| ( ) U41       | 74166              |
| ( ) U42       | 74LS175 or 25LS175 |
| ( ) U44       | 74LS00             |
| ( ) U61       | 74LS10             |
| ( ) U89       | 74LS367            |

\*MOS device. Refer to CAUTION on Page III-11.

( ) Step 28. Check display circuits.

( ) Set S1 switches as follows:

No. 1 through 5: OFF

No. 6: ON

( ) Remove U42 and bend pin 6 out 45° to its normal position.  
(See Figure 3-6.) Re-install U42 with pin 6 out of the socket.

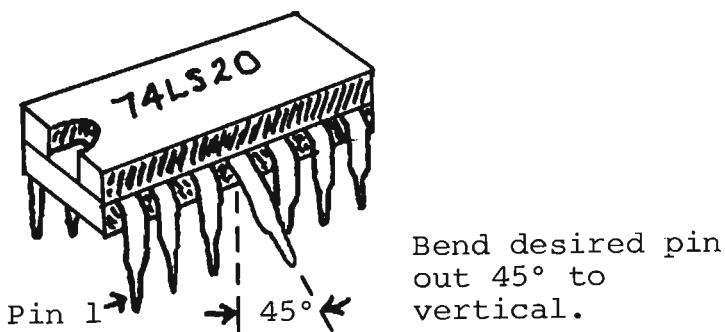


Figure 3-6. Bending selected pins on U42, 59 and 75 (U59 shown).

( ) Remove U59 and bend pin 4 in same manner as U42. Re-install U59 with pin 4 out of the socket.

(Step 28 continued on Page III-26.)

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- ( ) Remove U75 and bend pin 5 in same manner as U42. Re-install U75 with pin 5 out of the socket.
- ( ) Using #24 wire, NOT CLIPPED COMPONENT LEADS, install the following TEMPORARY jumpers in the sockets for U14 through U21. Double check jumpers after installing for correctness. (See Figure 3-7.)

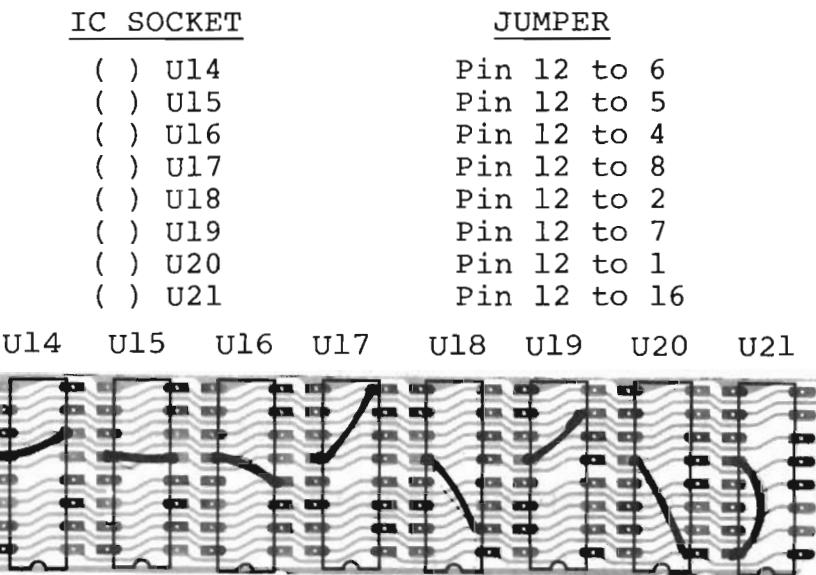


Figure 3-7. U14 through U21 socket jumpers.

- ( ) Turn monitor on and apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

- ( ) Momentarily ground pin 1 of U2 and pin 5 of U75. The display shown in Figure 3-8 should appear on the monitor screen. Adjust VR1 and VR2 to center display if needed.
- ( ) If the display circuits do not pass this test, determine and correct the cause before proceeding with assembly.
- ( ) If the display circuits are operating correctly:
  - ( ) Turn monitor and power supply off and disconnect the power cable.
  - ( ) Remove jumpers from U14 through U21 sockets.
  - ( ) Bend pin 6 on U42, pin 4 on U59 and pin 5 on U75 back to their normal position and re-install these three IC's in their appropriate sockets.

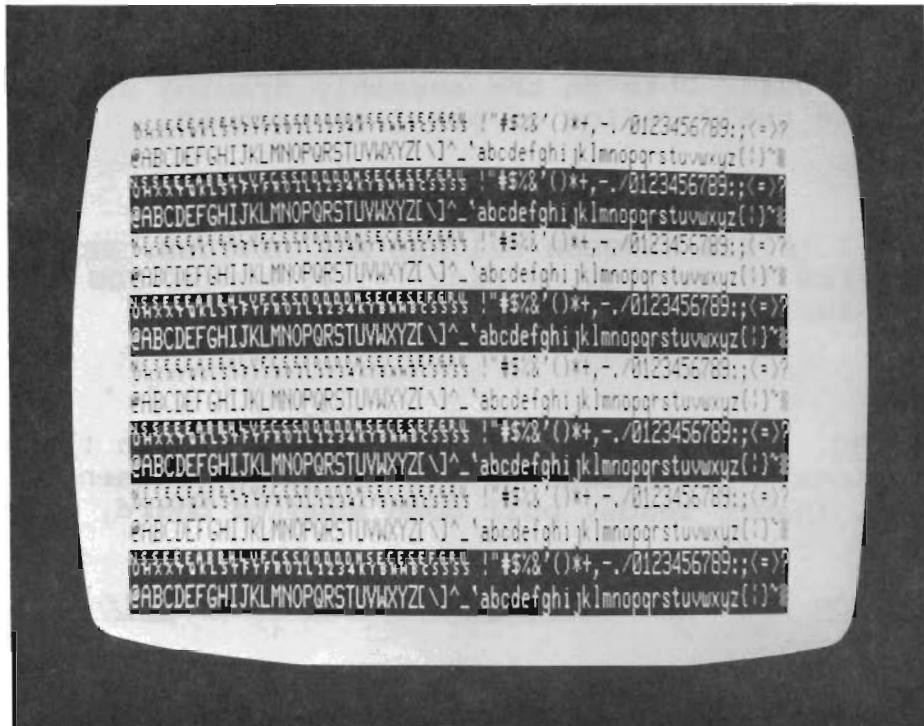
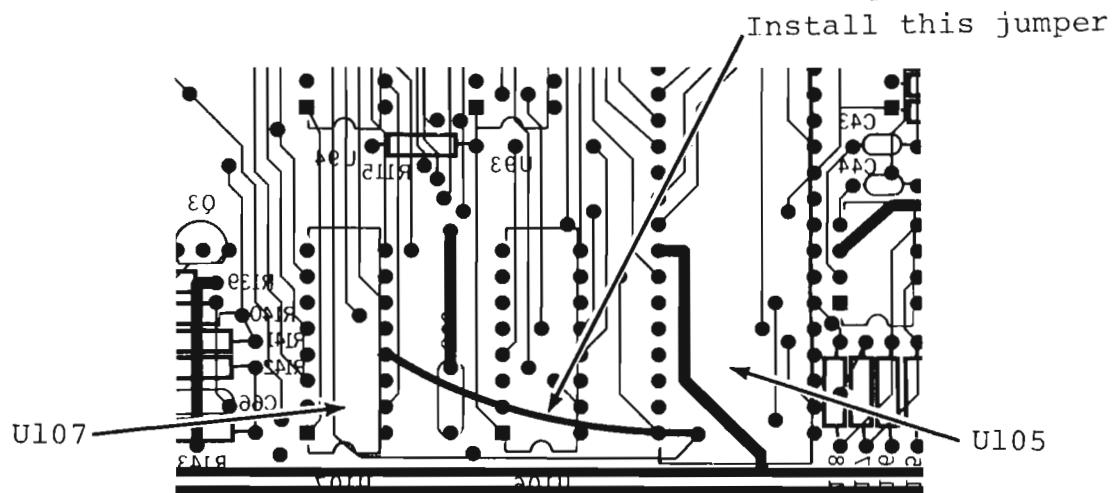


Figure 3-8. Display circuits test pattern with 6575 character generator as U25. 6574 is the same except graphic control characters are displayed.

- ( ) Step 28A. Install a permanent jumper (#24 insulated wire) on solder (back) side of board between pin 13 of U107 and the feedthrough hole next to pin 21 of U105. Solder jumper in place, check for solder bridges and trim wire ends if needed. The installed jumper is shown in Figure 3-8A.



Solder side of board shown

Figure 3-8A. Step 28A jumper installation.

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- ( ) Step 29. Install 91L02, 2102 or 21L02 IC's in locations U14 through U21. Dots on the assembly drawing and PC board legend indicate the location of pin 1 of each IC.

CAUTION

IC's U14 THROUGH U21 ARE MOS DEVICES. REFER TO CAUTION ON PAGE III-11 BEFORE YOU INSTALL THESE IC'S.

- ( ) Step 30. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u> | <u>COLOR CODE</u>   |
|-----------------|---------------------|---------------------|
| ( ) R12         | 1.5K                | brown-green-red     |
| ( ) R18         | 10 K                | brown-black-orange  |
| ( ) R20         | 1.5K                | brown-green-red     |
| ( ) R31         | 1.5K                | " " "               |
| ( ) R32         | 1.5K                | " " "               |
| ( ) R33         | 1.5K                | " " "               |
| ( ) R34         | 1.5K                | " " "               |
| ( ) R35         | 1.5K                | " " "               |
| ( ) R36         | 1.5K                | " " "               |
| ( ) R41         | 1.5K                | " " "               |
| ( ) R50         | 1.5K                | " " "               |
| ( ) R51         | 1.5K                | " " "               |
| ( ) R52         | 1.5K                | " " "               |
| ( ) R53         | 1.5K                | " " "               |
| ( ) R54         | 1.5K                | " " "               |
| ( ) R55         | 1.5K                | " " "               |
| ( ) R56         | 1.5K                | " " "               |
| ( ) R57         | 1.5K                | " " "               |
| ( ) R58         | 330                 | orange-orange-brown |
| ( ) R107        | 10 K                | brown-black-orange  |
| ( ) R108        | 10 K                | " " "               |
| ( ) R109        | 10 K                | " " "               |
| ( ) R110        | 10 K                | " " "               |
| ( ) R111        | 10 K                | " " "               |
| ( ) R112        | 10 K                | " " "               |
| ( ) R113        | 10 K                | " " "               |
| ( ) R114        | 10 K                | " " "               |
| ( ) R115        | 1.5K                | brown-green-red     |

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- ( ) Step 31. Install diode D7 (1N4148 or 1N914) in its location between U46 and U47. Position D7 with its dark band (cathode) at the bottom.
- ( ) Step 32. Install 20-pin header in location J3 (keyboard inter-connect) between U64 and U65. Position header so pin 1 is in the upper left corner. (An arrow on the connector points to pin 1.)
- ( ) Step 33. In the jumper area labeled PHTM on the assembly drawing (below U64), install Augat pins in mounting holes F and G. (Refer to "Installing Augat Pins" in Appendix IV.) Using #24 bare wire, install a jumper between pins F and G. DO NOT SOLDER JUMPER TO AUGAT PINS.
- ( ) Step 34. In the jumper area labeled RST on the assembly drawing (between U76 and U77), install Augat pins in mounting holes N and P. (Refer to "Installing Augat Pins" in Appendix IV.) Using #24 bare wire, install a jumper between pins N and P. DO NOT SOLDER JUMPER TO AUGAT PINS.
- ( ) Step 35. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>         |
|---------------|---------------------|
| ( ) U45       | 74LS04              |
| ( ) U46       | 8T380 or 8836       |
| ( ) U48       | 74LS00              |
| ( ) U50       | 74LS367             |
| ( ) U54       | 74LS04              |
| ( ) U63       | 74LS109             |
| ( ) U64       | 74LS109             |
| ( ) U67       | 8T97, 8097 or 74367 |
| ( ) U68       | 8T97, 8097 or 74367 |
| ( ) U76       | 74LS175 or 25LS175  |
| ( ) U93       | 74LS175 or 25LS175  |
| ( ) U94       | 74LS367             |
| ( ) U106      | 74LS175 or 25LS175  |
| ( ) U107      | 74LS367             |

- ( ) Step 36. Apply power to Sol-PC and make the following voltage measurements:

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CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC WHEN IT IS NOT INSTALLED IN THE CHASSIS, IT MUST REST ON A CLEAN NONCONDUCTING SURFACE. DO NOT PLACE IT ON TOP OF PIECES OF WIRE AND/OR SOLDER.

MEASUREMENT POINT                    VOLTAGE\*

|                       |                     |
|-----------------------|---------------------|
| Pin 11 of U105 Socket | -5 V dc $\pm$ .25 V |
| Pin 20 of U105 Socket | +5 V dc $\pm$ .25 V |
| Pin 28 of U105 Socket | +12 V dc $\pm$ .6 V |
| Pin 1 of U51 Socket   | +5 V dc $\pm$ .25 V |
| Pin 2 of U51 Socket   | -12 V dc $\pm$ .6 V |

\*All voltages referenced to ground.

- ( ) If any voltages are incorrect, locate and correct the cause before going on to Step 37.
- ( ) If voltages are correct, turn power supply off, disconnect power cable and go on to Step 37.
- ( ) Step 37. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

IC NO.                    TYPE

|             |                           |
|-------------|---------------------------|
| ( ) U51*    | 6011, 1602, 2017 or 1013* |
| ( ) U105* # | 8080, 8080 or 9080*#      |

\*MOS device. Refer to CAUTION on Page III-11.

#Note that pin 1 of this IC is in the upper left corner.

- ( ) Step 38. Perform Functional Test No. 1 of CPU circuits.

- ( ) Set S1 switches as follows:

No. 1 through 5: OFF

No. 6: ON

- ( ) Turn monitor on and apply power to Sol-PC.

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CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC,  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

- ( ) Momentarily ground pin 1 of U2. You should see a full display (64 characters x 16 lines) on the monitor as shown in Figure 3-9.
- ( ) Momentarily ground pin 2 of U75. The display should blank while pin 2 of U75 is grounded. When you remove the ground, the display shown in Figure 3-9 should appear.

NOTE

The pattern shown in Figure 3-9 (delete characters) results from all bits of the DIO Bus being high. If you do not see the delete characters, one or more bits of the DIO bus are low. Consult the MCM6575 or MCM6574 pattern, as appropriate, in Section VIII of this manual to determine which bits are low.

- ( ) If the test fails, determine and correct the cause before proceeding with assembly.
- ( ) If the Sol-PC passes this test, turn monitor and power supply off, disconnect power cable and proceed to Step 39.
- ( ) Step 39. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>         |
|---------------|---------------------|
| ( ) U80       | 8T97, 8097 or 74367 |
| ( ) U81       | 8T97, 8097 or 74367 |

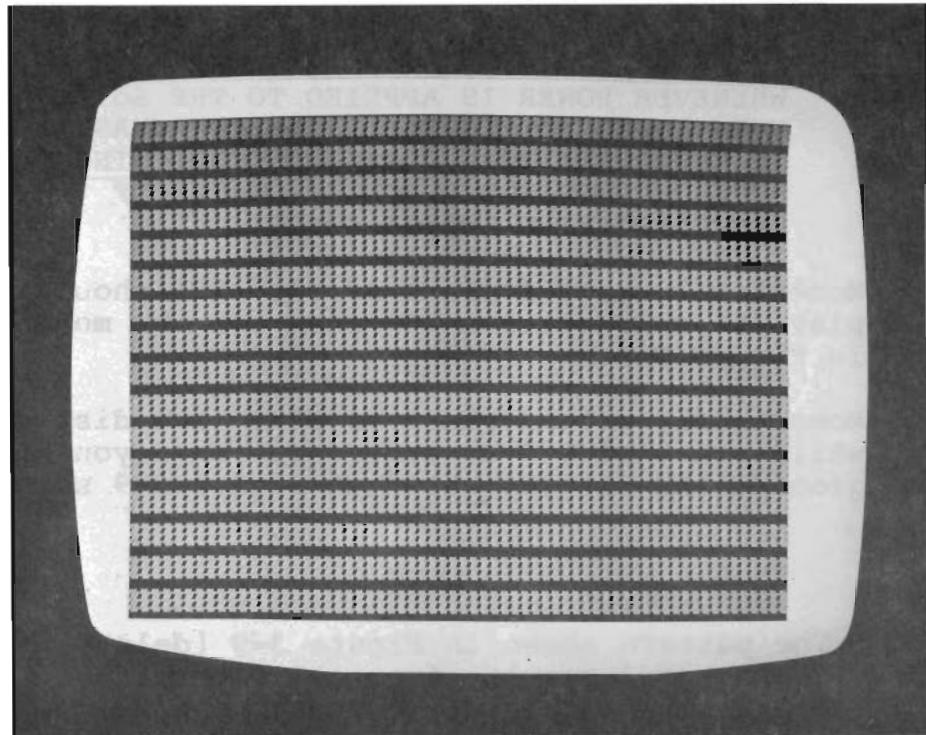


Figure 3-9. CPU Functional Test No. 1 display,  
6574 or 6575 character generator (U25).

- ( ) Step 40. Perform Functional Test No. 2 of CPU circuits.
- ( ) Check that S1 switches are set as specified in Step 38.
- ( ) Turn monitor on and apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

- ( ) Momentarily ground pin 1 of U2 and pin 2 of U75. The display shown in Figure 3-10 on Page III-34 should appear on the monitor.
- ( ) If the test fails, determine and correct the cause before proceeding with assembly.
- ( ) If the Sol-PC passes this test, turn monitor and power supply off, disconnect power cable and proceed to Step 41.
- ( ) Step 41. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

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NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u> |
|---------------|-------------|
| ( ) U65       | 74LS253     |
| ( ) U66       | 74LS253     |
| ( ) U78       | 74LS253     |
| ( ) U79       | 74LS253     |
| ( ) U70       | 74LS109     |

- ( ) Step 42. Turn monitor on, apply power to Sol-PC and perform the test described in Step 40, except ground pin 5 of U75 instead of pin 2. You should get the same results.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC WHEN IT IS NOT INSTALLED IN THE CHASSIS, IT MUST REST ON A CLEAN NONCONDUCTING SURFACE. DO NOT PLACE IT ON TOP OF PIECES OF WIRE AND/OR SOLDER.

- ( ) If the test fails, determine and correct the cause before proceeding with assembly.
- ( ) If the Sol-PC passes this test, turn monitor and power supply off, disconnect power cable and proceed to Step 43.
- ( ) Step 43. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u> | <u>COLOR CODE</u> |
|-----------------|---------------------|-------------------|
| ( ) R13         | 1.5K                | brown-green-red   |
| ( ) R14         | 1.5K                | " " "             |
| ( ) R15         | 1.5K                | " " "             |
| ( ) R60         | 1.5K                | " " "             |

- ( ) Step 44. See Detail A on Drawing X-6. Using two 4-40 x 5/8 binder head screws, two #4 insulating washers, two lockwashers and hex nuts, install 30-pin right-angle edge connector in location J5. Insert screws from back (solder) side of board and place an insulating washer on each screw on front (component) side of board. Position connector with socket side facing right, place over screws and seat pins in mounting holes. MAKE SURE ALL PINS ARE THROUGH HOLES. Then place lock-washer on each screw, start nuts and tighten. DO NOT OVERTIGHTEN. Solder pins to board.

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- ( ) Step 45. See Detail D on Drawing X-6. Using 4-40 x 1/4 binder head screws, lockwashers and hex nuts, install two brackets for personality module in area to right of J5. Position brackets over the mounting holes as shown in Figure 3-11. Insert screws from front (component) side of board, place lockwasher on each screw on back (solder) side of board, start nuts and tighten.

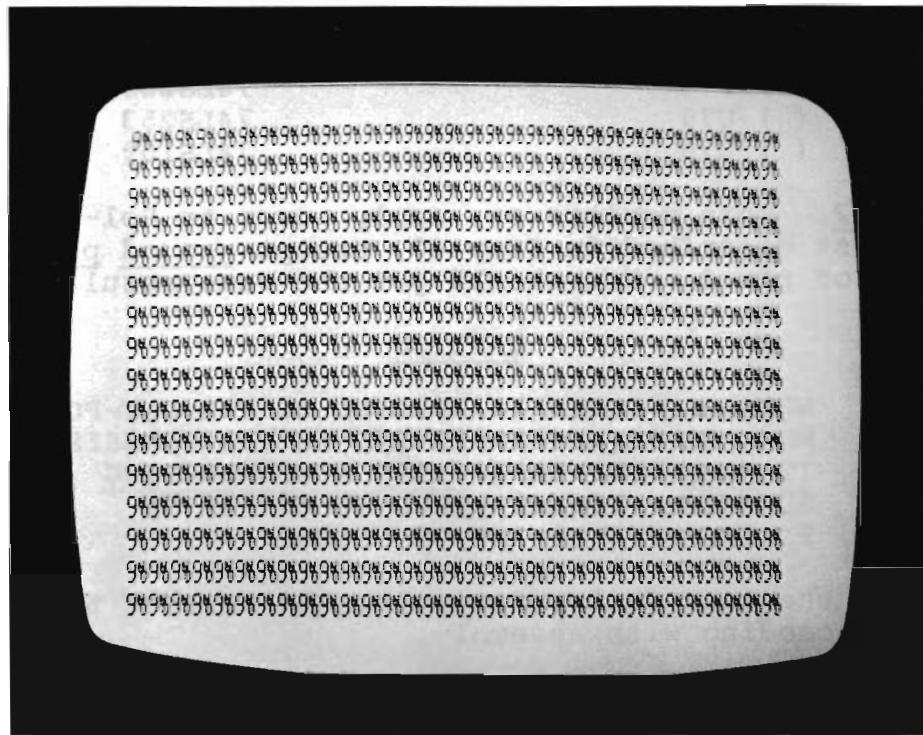


Figure 3-10. CPU Functional Test No. 2 display,  
6575 character generator (U25).  
6574 displays: 9 □ 9 □ 9 □ etc.

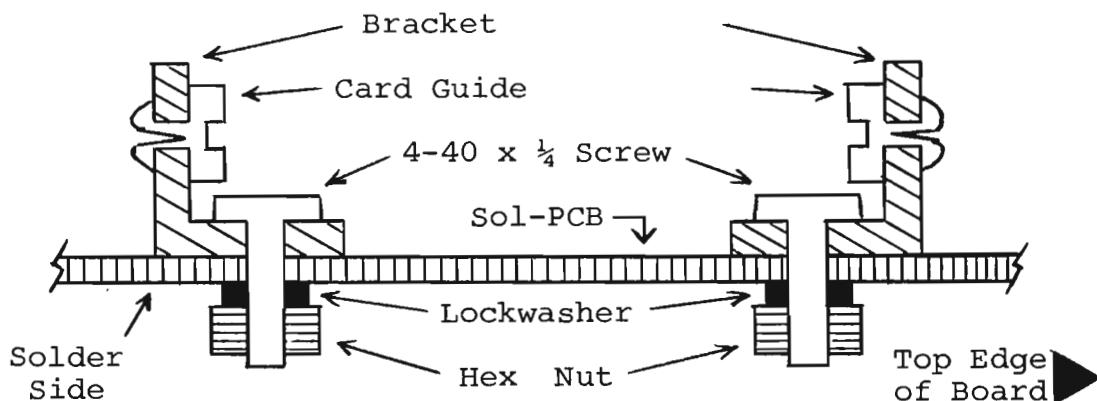


Figure 3-11. Personality module bracket/guide  
installation (Viewed from right  
end of Sol-PCB).

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- ( ) Step 46. Refer to Detail D on Drawing X-6. Attach plastic card guide to each of the brackets installed in Step 45. (See Figure 3-11.) Insert posts on guides into bracket holes and push in until they snap into place. Be sure open end of guide is away from connector J5.
- ( ) Step 47. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>          |
|---------------|----------------------|
| ( ) U3*       | 91L02, 2102 or 21L02 |
| ( ) U4*       | 91L02, 2102 or 21L02 |
| ( ) U5*       | 91L02, 2102 or 21L02 |
| ( ) U6*       | 91L02, 2102 or 21L02 |
| ( ) U7*       | 91L02, 2102 or 21L02 |
| ( ) U8*       | 91L02, 2102 or 21L02 |
| ( ) U9*       | 91L02, 2102 or 21L02 |
| ( ) U10*      | 91L02, 2102 or 21L02 |
| ( ) U22       | 74LS136              |
| ( ) U23       | 74LS20               |
| ( ) U24       | 74LS04               |
| ( ) U34       | 74LS138              |
| ( ) U35       | 74LS138              |
| ( ) U36       | 74LS138              |
| ( ) U53       | 74LS02 or 9LS02      |
| ( ) U71       | 74LS367              |
| ( ) U83       | 74LS20               |

\*MOS device. Refer to CAUTION on Page III-11.

- ( ) Step 48. Test memory and decoder circuits.
- ( ) Set S1 switches as specified in Step 38.
- ( ) Turn monitor on and apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC WHEN IT IS NOT INSTALLED IN THE CHASSIS, IT MUST REST ON A CLEAN NONCONDUCTING SURFACE. DO NOT PLACE IT ON TOP OF PIECES OF WIRE AND/OR SOLDER.

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- ( ) Ground pin 1 of U2. You should see the same display as shown in Figure 3-10 on Page III-34. In this case, however, there should be a vertical "flickering" movement with an apparent flicker rate of approximately three times per second.
- ( ) Turn Switch No. 1 of S1 to ON. The flicker should stop.
- ( ) If the test fails, determine and correct the cause before proceeding with assembly.
- ( ) If the Sol-PC passes this test, turn monitor and power supply off, disconnect power cable, set Switch No. 1 of S1 to OFF and go on to Step 49.
- ( ) Step 49. Assemble personality module if you have not yet done so. (See Section IV.) If you have started assembly, go to Step 9 in Section IV and complete it.
- ( ) Step 50. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u>     | <u>COLOR CODE</u>   |
|-----------------|-------------------------|---------------------|
| ( ) R21         | 270                     | red-violet-brown    |
| ( ) R22         | 470, $\frac{1}{2}$ watt | " " "               |
| ( ) R23         | 470, $\frac{1}{2}$ watt | " " "               |
| ( ) R24         | 1.5K                    | brown-green-red     |
| ( ) R25         | 10 K                    | brown-black-orange  |
| ( ) R26         | 10 K                    | " " "               |
| ( ) R27         | 4.7K                    | yellow-violet-red   |
| ( ) R28         | 10 K                    | brown-black-orange  |
| ( ) R37         | 1.5K                    | brown-green-red     |
| ( ) R38         | 1.5K                    | " " "               |
| ( ) R39         | 5.6K                    | green-blue-red      |
| ( ) R40         | 1.5K                    | brown-green-red     |
| ( ) R42         | 1.5K                    | " " "               |
| ( ) R43         | 1.5K                    | " " "               |
| ( ) R44         | 1.5K                    | " " "               |
| ( ) R45         | 330                     | orange-orange-brown |
| ( ) R46         | 5.6K                    | green-blue-red      |
| ( ) R47         | 10 K                    | brown-black-orange  |
| ( ) R48         | 10 K                    | " " "               |
| ( ) R49         | 1.5K                    | brown-green-red     |
| ( ) R59         | 1.5K                    | " " "               |
| ( ) R61         | 1.5K                    | " " "               |
| ( ) R62         | 5.6K                    | green-blue-red      |
| ( ) R63         | 5.6K                    | " " "               |

(Step 50 continued on Page III-37.)

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| <u>LOCATION</u> | <u>VALUE (ohms)</u> | <u>COLOR CODE</u>   |
|-----------------|---------------------|---------------------|
| ( ) R64         | 330                 | orange-orange-brown |
| ( ) R65         | 330                 | " " "               |
| ( ) R66         | 330                 | " " "               |
| ( ) R67         | 330                 | " " "               |
| ( ) R68         | 330                 | " " "               |
| ( ) R69         | 330                 | " " "               |
| ( ) R70         | 330                 | " " "               |
| ( ) R71         | 330                 | " " "               |
| ( ) R72         | 680                 | blue-gray-brown     |
| ( ) R73         | 680                 | " " "               |
| ( ) R74         | 680                 | " " "               |
| ( ) R75         | 680                 | " " "               |
| ( ) R76         | 680                 | " " "               |
| ( ) R77         | 680                 | " " "               |
| ( ) R78         | 680                 | " " "               |
| ( ) R79         | 680                 | " " "               |
| ( ) R92         | 5.6K                | green-blue-red      |
| ( ) R93         | 1.5K                | brown-green-red     |
| ( ) R94         | 10 K                | brown-black-orange  |
| ( ) R95         | 15 K                | brown-green-orange  |
| ( ) R116        | 1.5K                | brown-green-red     |

- ( ) Step 50A. Install R29, a 15K ohm, 1/4 watt resistor (color code brown-green-orange). Make right angle bend in one lead approximately 1/8" from resistor body. Insert bent lead in right-hand mounting hole (next to left mounting hole for D3), solder and trim. Slip 0.9" length of insulation tubing over left-hand lead of R29. Cut lead 0.1" longer than tubing. Route lead as shown on Sol-PC assembly drawing X-5 in Section X, hook it around left-hand lead of R23 (470 ohm, 1/2 watt resistor), solder and trim.
- ( ) Step 51. Install the following capacitors in the indicated locations. Take care to observe the proper value and type for each installation. Bend leads outward on solder (back) side of board, solder and trim. (Refer to NOTE in Step 2.)

| <u>LOCATION</u> | <u>VALUE</u> | <u>TYPE</u> |
|-----------------|--------------|-------------|
| ( ) C29         | .1 ufd       | Disc        |
| ( ) C30         | 330 pfd      | Disc        |

- ( ) Step 52. Install diodes D1 (1N4148 or 1N914), D2 (1N4001) and D3 through D6 (1N4148 or 1N914) in their locations in the area of U39. Position all diodes with their dark band (cathode) to the right.
- ( ) Step 53. Install the following DIP switches in the indicated locations. Take care to observe proper orientation.

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- | <u>LOCATION</u>  | <u>TYPE</u> | <u>ORIENTATION</u>  |
|--|-------------|---------------------|
| ( ) S2   | 8-position  | Switch No. 1 at top |
| ( ) S3   | 8-position  | Switch No. 1 at top |
| ( ) S4   | 6-position  | Switch No. 1 at top |
| ( ) <u>Step 54.</u> Install Q1 (2N2907) in its location between U55 and U56. The emitter lead (closest to tab on can) is oriented toward the bottom and the base lead toward the right. Push straight down on transistor until it is stopped by the leads. Solder and trim.  |             |                     |
| ( ) <u>Step 55.</u> See Detail B on Drawing X-6. Using two 4-40 x 7/16 binder head screws, hex nuts and lockwashers, install 25-pin female connector in location J1 (serial I/O interface). Position connector with socket side facing right and insert pins into their holes in the circuit board. Insert screws from back (solder) side of board, place lockwasher on each screw, start nuts and tighten. Then solder connector pins to board. |             |                     |
| ( ) <u>Step 56.</u> See Detail B on Drawing X-6. Using two 4-40 x 7/16 binder head screws, hex nuts and lockwashers, install 25-pin male connector in location J2 (parallel I/O interface). Install J2 in the same manner as you did J1.   |             |                     |
| ( ) <u>Step 57.</u> Install Augat pins in mounting holes K, L and M. (Refer to "Installing Augat Pins" in Appendix IV.) These holes are located between U85 and U86. No jumper will be installed.  |             |                     |
| ( ) <u>Step 58.</u> Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.  |             |                     |

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>    |
|---------------|----------------|
| ( ) U37       | 74LS367        |
| ( ) U38*      | 1489 or 75189* |
| ( ) U39#      | 4N26#          |
| ( ) U52       | 74LS109        |
| ( ) U55       | 74LS00         |
| ( ) U56       | 1458 or 72558  |
| ( ) U57       | 7406           |
| ( ) U58       | 8T94           |
| ( ) U72       | 74LS109        |
| ( ) U73       | 74LS109        |
| ( ) U84*      | 4029*          |
| ( ) U85*      | 4046 or 14046* |
| ( ) U86*      | 4024 or 14024* |
| ( ) U95       | 74173 or 8T10  |
| ( ) U96       | 74173 or 8T10  |
| ( ) U97       | 74175          |

\*MOS device. Refer to CAUTION on Page III-11.

#Solder this IC in its location. See "Loading DIP Devices" in Appendix IV.

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- ( ) Step 58A. Install R160 (47 ohm resistor, color code yellow-violet-black) as follows:
  - ( ) Wrap one R160 lead around pin 1 of U39 (4N26) and the other around the cathode lead (banded end) of D3 (1N4148), dressing the leads as shown on Drawing X-5 in Section X.
  - ( ) Solder both R160 leads in place and trim excess lead lengths.
  - ( ) Inspect for possible shorts or solder bridges, especially between pins 1 and 2 of U39.
  - ( ) On the back (solder) side of the board, the trace that connects pin 1 of U39 to the cathode lead of D3 must be cut. Using an Xacto knife or a razor blade, make two cuts approximately 1/8" apart, cutting across the trace down to the epoxy base. Insert blade tip beneath the cut section and gently work it away from the board. Be sure the "break" is free of solder.
- ( ) Step 59. Check input/output (I/O) circuits.

NOTE

The parallel I/O interface should be tested with the device you will be using. Refer to "I/O Interfacing" in Section VII.

To check the serial I/O circuits, proceed as follows:

- ( ) Set S1 as in previous test,  
Set S2 switches all OFF,  
Set S3 switches all OFF, except S3-1 ON,  
Set S4 switches all OFF
- ( ) Set all S4 switches to OFF.
- ( ) Connect Sol keyboard assembly to Sol-PC. Using the supplied 20-conductor ribbon cable, connect J1 on keyboard to J3 on Sol-PC as shown in Drawing X-10 in Section X.
- ( ) Connect Sol-PC video output cable to monitor, turn monitor on and apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC AND KEYBOARD WHEN THEY ARE NOT INSTALLED IN THE CHASSIS, THEY MUST REST ON A CLEAN NONCONDUCTING SURFACE. BE SURE NEITHER ASSEMBLY IS PLACED ON TOP OF PIECES OF WIRE AND/OR SOLDER.

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- ( ) Set Sol-PC to local by depressing LOCAL key on keyboard to turn keyboard indicator light on.
- ( ) Data entered from the keyboard should appear on the monitor.
- ( ) If the Sol-PC fails this test, locate and correct the cause before proceeding.
- ( ) If the Sol-PC passes this test, turn monitor and power supply off, disconnect power cable, video output cable, keyboard and go on to Step 60.
- ( ) Step 60. Install the following resistors in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, solder and trim.

| <u>LOCATION</u> | <u>VALUE (ohms)</u>     | <u>COLOR CODE</u>    |
|-----------------|-------------------------|----------------------|
| ( ) R117        | 10 K                    | brown-black-orange   |
| ( ) R118        | 10 K                    | " " "                |
| ( ) R119        | 10 K                    | " " "                |
| ( ) R139        | 1.0M                    | brown-black-green    |
| ( ) R140        | 10 K                    | brown-black-orange   |
| ( ) R141        | 150 K                   | brown-green-yellow   |
| ( ) R142        | 10 K                    | brown-black-orange   |
| ( ) R143        | 1 M                     | brown-black-green    |
| ( ) R144        | 47 K                    | yellow-violet-orange |
| ( ) R145        | 10 K                    | brown-black-orange   |
| ( ) R146        | 10 K                    | " " "                |
| ( ) R147        | 2.2M                    | red-red-green        |
| ( ) R148        | 100 K                   | brown-black-yellow   |
| ( ) R149        | 100                     | brown-black-brown    |
| ( ) R150        | 470                     | yellow-violet-brown  |
| ( ) R151        | 5.6K                    | green-blue-red       |
| ( ) R152        | 150 K                   | brown-green-yellow   |
| ( ) R153        | 100 K                   | brown-black-yellow   |
| ( ) R154        | 47 K                    | yellow-violet-orange |
| ( ) R155        | 6.8, $\frac{1}{2}$ watt | blue-grey-gold       |
| ( ) R156        | 6.8, $\frac{1}{2}$ watt | blue-grey-gold       |
| ( ) VR3         | 100 K                   | Potentiometer        |

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- ( ) Step 61. Install the following capacitors in the indicated locations. Take care to observe the proper value and type for each installation. Bend leads outward on solder (back) side of board, solder and trim. (Refer to NOTE in Step 2.)

CAUTION

REFER TO FOOTNOTE AT END OF THIS STEP  
BEFORE INSTALLING C67.

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u>   |
|-----------------|--------------------|---------------|
| ( ) C47         | .001               | Disc          |
| ( ) C48         | .047               | "             |
| ( ) C49         | .001               | "             |
| ( ) C50         | .01                | Mylar Tubular |
| ( ) C51         | .1                 | Disc          |
| ( ) C66         | .1                 | "             |
| ( ) C67*        | 1                  | Tantalum      |
| ( ) C68         | .1                 | Disc          |
| ( ) C69         | .1                 | "             |
| ( ) C70         | .1                 | "             |
| ( ) C71         | .001               | "             |
| ( ) C72         | .001               | Mylar Tubular |
| ( ) C73         | .047               | Disc          |
| ( ) C74         | 470 pfd            | "             |

\*Install C67 with "+" lead at top right.

- ( ) Step 62. Install miniature phone jacks in locations J6 and J7 located to the right of U101. Position J6 and J7 with jack facing right, insert pins in mounting holes and solder.
- ( ) Step 63. Install subminiature phone jacks in locations J8 and J9 in lower right corner of board. Install J8 and J9 as you did J6 and J7.
- ( ) Step 64. Install Q3 (2N4360) in its location to the left of C67. Install Q3 with its flat "side" at the bottom. Push straight down on transistor until it is stopped by the leads, solder and trim.

CAUTION

THE 2N4360 IS STATIC SENSITIVE. REFER TO  
CAUTION ON PAGE III-11.

- ( ) Step 65. Install Q4 and Q5 (2N2222) in their locations above and to the left of U108. For both transistors, the emitter lead (closest to tab on can) is oriented toward the left and the base lead toward the right. Push straight down on transistor until it is stopped by the leads, solder and trim.

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## SECTION III

- ( ) Step 66. Install diodes D13 and D14 (1N4001) in their locations in the lower right corner of the board. Position both diodes with their dark band (cathode) at the bottom.
- ( ) Step 67. Install DIP reed relays in locations K1 and K2 to the right of U113. Be sure to install K1 and K2 with their end notch at the bottom (pin 1 in lower right corner). These relays are soldered to the board. (Refer to "Loading DIP Devices" in Appendix IV.)
- ( ) Step 68. Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

NOTE

Dots on the assembly drawing and PC board indicate the location of pin 1 of each IC.

| <u>IC NO.</u> | <u>TYPE</u>               |
|---------------|---------------------------|
| ( ) U69*      | 6011, 1602, 2017 or 1013* |
| ( ) U98*      | 4023 or 14023*            |
| ( ) U99*      | 4030*                     |
| ( ) U100*     | 4013 or 1413*             |
| ( ) U101*     | 4027 or 14027*            |
| ( ) U108      | 1458 or 72558             |
| ( ) U109*     | 4049 or 14049*            |
| ( ) U110*     | 4046 or 14046*            |
| ( ) U111*     | 4019*                     |
| ( ) U112*     | 4520 or 14520*            |
| ( ) U113*     | 4013 or 1413*             |

\*MOS device. Refer to CAUTION on Page III-11.

- ( ) Step 69. Install Augat pins in mounting holes H, I and J (located to left of C70). (Refer to "Installing Augat Pins" in Appendix IV.) Using #24 bare wire, install a jumper between pins I and J. DO NOT SOLDER JUMPER TO AUGAT PINS.
- ( ) Step 70. Adjust VR3.
- ( ) Ground ACI audio input (J7) on Sol-PC.
- ( ) Apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

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## SECTION III

- ( ) Using an oscilloscope with a calibrated time base (a frequency counter is preferred) and a high-impedance probe, monitor the VCO (voltage controlled oscillator) frequency on pin 4 of U110.
- ( ) Adjust VR3 for a frequency of 14.0 KHz (71.4 usec period).
- ( ) Disconnect power and remove ACI audio input (J7) ground.
- ( ) Step 71. If your recorder has only a microphone input, remove the I-to-J jumper you installed in Step 69 and install a jumper (#24 bare wire is recommended) between the I and H pins. DO NOT SOLDER JUMPER TO AUGAT PINS.

NOTE

Microphone inputs are not recommended.

Otherwise, leave the I-to-J jumper in and go on to Step 72.

- ( ) Step 72. See Detail C on Drawing X-6. Install 100-pin edge connector, J11. Using two 4-40 x 7/16 binder head screws, install 100-pin edge connector in location J11 (center of PC board). Seat the pins in the mounting holes. Then thread screws from front (component) side of board into the threaded inserts that are pre-installed in the J11 mounting holes. Tighten screws and solder pins to board.

## 3.7 OPTIONS

## 3.7.1 625 Line Video, 50 Hz

The European televisions standard defines a raster of 625 lines at a field rate of 50 Hz. The horizontal rate of the U.S. standard, 15,750 Hz., is maintained. Only the number of scan lines on the screen is increased.

The Video Display Generator section may be modified for the 50 Hz. standard by following the additional steps below. The effect of the modification is to increase the modulus of the counter U62 to eight during VDISP. This results in four extra character lines (52 scan lines) between the bottom and top of the display area, for a total of 312 scan lines per field and 624 scan lines per frame.

The field rate should be close enough to 50 Hz. to reduce any swim effects to less than 0.1 Hz. Some difficulty may be encountered in obtaining centering of the display within the frame. This is because the stand-off time to VSYNC from the bottom of the display is unchanged from the 60 Hz. standard. If objectionable, increase the value of resistor R100 which is in series with the VPOS control.

To convert for 50 Hz., perform these additional steps:

- ( ) Locate U62 on the component side legend. Find pin 5 of this IC on the component (front) side of the board. Cut the "V"-shaped trace connecting pin 5 to the nearby pad designated "AF", using a sharp exacto blade or scribe, so that there is no continuity between these pads.
- ( ) Bend a small piece of bare wire, such as a resistor clipping, into a loop to form a jumper between pad "AF", and the adjacent pad "AG". Insert the jumper, pull close to the board, solder, and trim the leads.

If this modification is made, change the schematic, X-18, to show that pin 5 of U62 now connects to pin 4 (ground), instead of pin 6 as shown.

### 3.7.2 Vectored Interrupt

Though the 8080A microprocessor used in the Sol Computer has the vectored interrupt capability, Processor Technology software for the Sol and S-100 modules built by Processor Technology do not use it. A jumper arrangement in the Sol, however, is provided to implement vectored interrupt when the interrupt signal is made available on the S-100 bus by a circuit board that is plugged into it.

If you wish to use vectored interrupt, you must supply an interrupt controller card.

To modify the Sol-PC for vectored interrupt, two jumpers (AB-to-AD and AC-to-AE) must be installed to enable the SINTA signal (interrupt acknowledge, S-100 bus pin 96) to reach the memory decoder circuit. These jumpers may be added at any time, either during assembly or after the Sol-PC is completely assembled.

#### NOTE

Vectored interrupt jumpers may be left in place, even if no S-100 board generates interrupts. S-100 bus pin 96 (SINTA) may float with no interference.

To install the two vectored interrupt jumpers, proceed as follows (see Figure 3-12):

- ( ) Cut two eight-inch lengths of #24 solid, insulated wire (not supplied).

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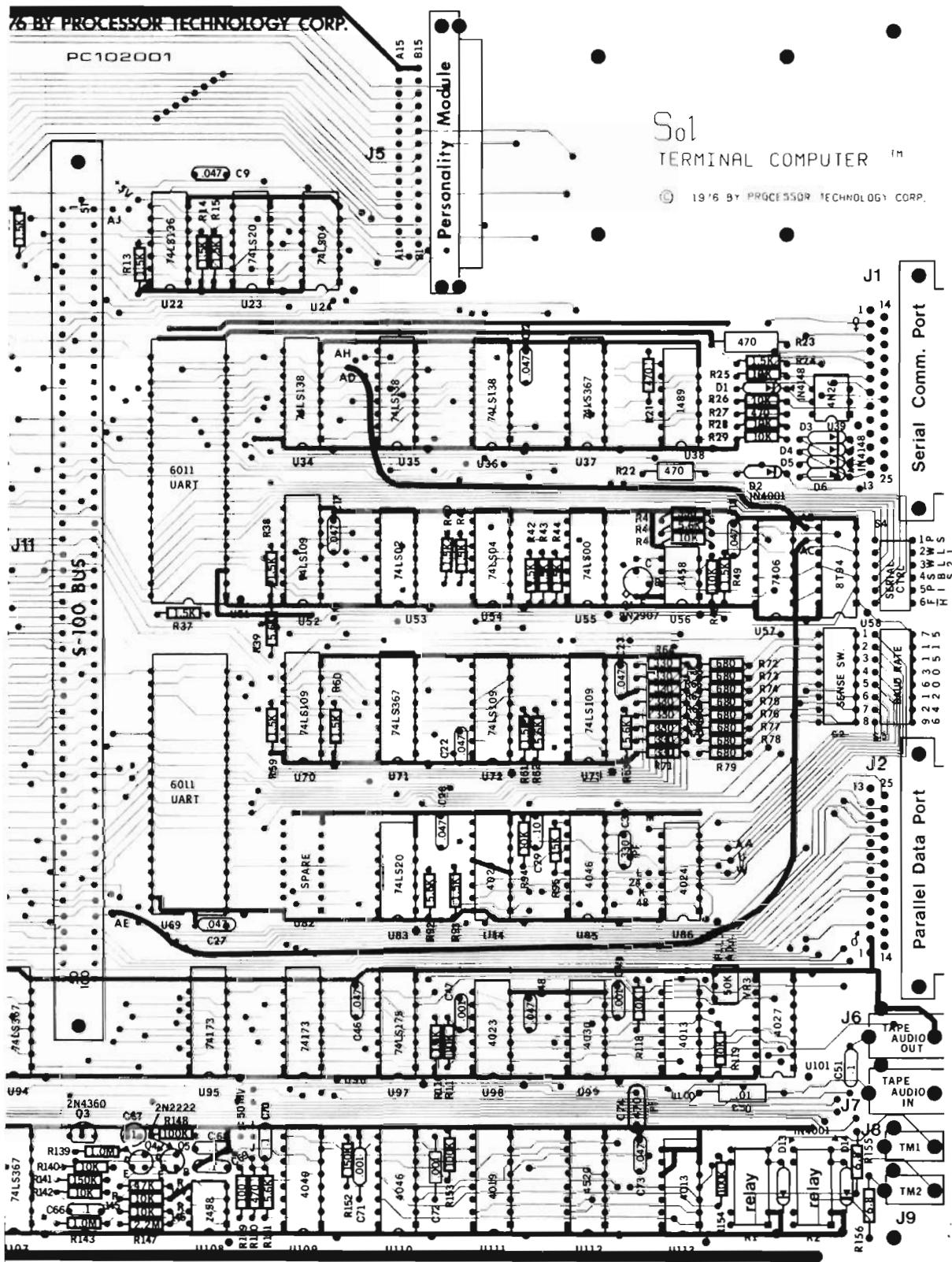
SECTION III

- ( ) Strip 0.1" of insulation from both ends of each wire.
- ( ) From component (front) side of Sol-PC, insert one end of one wire into pad AC (to left of pin 9 of U58) and solder. Insert one end of other wire into pad AB (to left of pin 8 of U58) and solder. Check for solder bridges.
- ( ) Dress wires as shown in Figure 3-12.
- ( ) From component (front) side of Sol-PC, insert loose end of wire from pad AB into pad AD (to left of pin 11 of U35) and loose end of wire from pad AC into pad AE (to right of pin 96 of S-100 bus, J11). Solder and check for solder bridges.
- ( ) Fix long runs of wire to board with silicon compound or tape.

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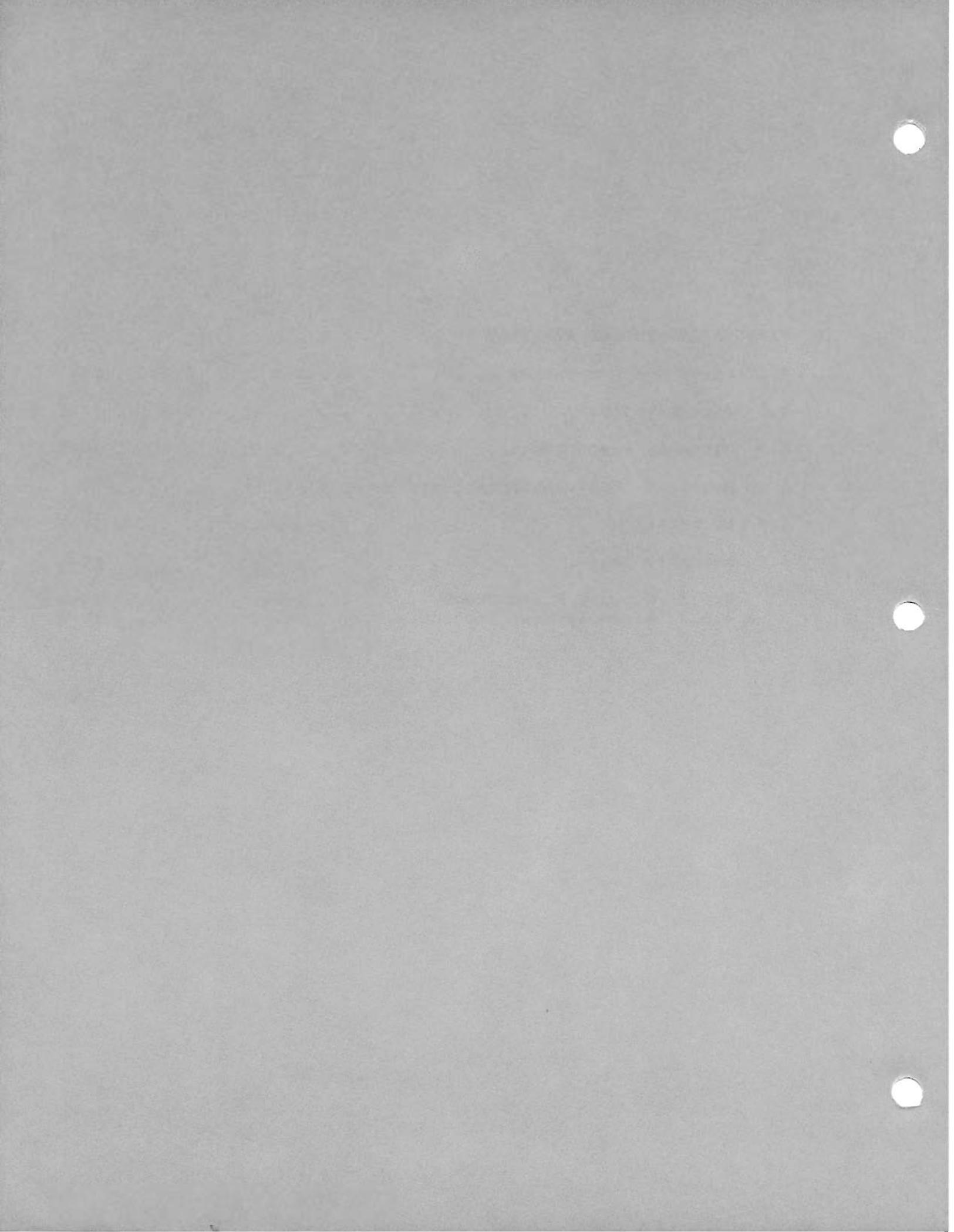
SOL-PC SINGLE BOARD TERMINAL COMPUTER™

### SECTION III



#### IV PERSONALITY MODULE ASSEMBLY

|       |   |      |
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9216 AND 2708 PERSONALITY MODULES

SECTION IV

4.1 PARTS AND COMPONENTS

The standard Sol uses a Personality Module based on the 9216 masked ROM containing the SOLOS monitor program. The kit version is Part No. 107000-04, and the assembled version is Part No. 107000-02. If you are intending to use a monitor program other than SOLOS, you will have a Personality Module based on the 2708 EPROM (not supplied) which may be programmed to contain a custom monitor. The kit version of the 2708 module is Part No. 107000-03, and the assembled and tested module is 107000-01. All four of these modules use the same circuit board, designated ASSY 107001 in white on the component side of the board.

You will need the parts listed in Table 4-1 to assemble your personality module. Select and separate the needed parts from those supplied with your Sol kit before starting assembly. (Note that several parts are not necessary for the 9216 module.) If you have any difficulty identifying any parts by sight, refer to Figure 3-1 in Section III and the "Standard Color Code for Resistors and Capacitors" chart in Appendix III. Table 4-1 lists each part, its description, quantity and reference designation on the drawing(s) you will use in assembling the personality module. The assembly drawings in Section X will also prove useful in identifying parts.

4.2 ASSEMBLY TIPS

For the most part the assembly tips given in Paragraph 3.2 of Section III (Page III-1) apply to assembling the personality module.

4.3 ASSEMBLY PRECAUTIONS

For the most part the assembly precautions given in Paragraph 3.3 in Section III (Page III-9) apply.

4.4 REQUIRED TOOLS, EQUIPMENT AND MATERIALS

The following tools, equipment and materials are recommended for assembling the personality module.

1. Needle nose pliers
2. Diagonal cutters
3. Screwdriver
4. Soldering iron, 25 watt
5. Video monitor

4.5 ORIENTATION

Capacitor location C2 will be located in the upper left-hand corner of the board when the edge connector is positioned at the

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## 9216 AND 2708 PERSONALITY MODULES

## SECTION IV

Table 4-1. 2708/9216 Personality Module Parts List.

| <u>PART</u>   | <u>DESCRIPTION</u>                 | <u>QUANTITY</u> |                | <u>REFERENCE</u>   |                   |
|---------------|------------------------------------|-----------------|----------------|--------------------|-------------------|
|               |                                    | <u>9216 PM</u>  | <u>2708 PM</u> | <u>Drawing No.</u> | <u>Designator</u> |
| Circuit Board | Personality Module 2708/9216       | 1               | 1              | X-7                | 1                 |
| IC            | 74LS08                             | 1               | 1              | X-7                | U3                |
| IC            | 9216 ROM                           | 1               | 0              | X-7                | U1                |
| Diode         | 1N5231                             | 0               | 2              | X-7                | Z1&2              |
| Resistor      | 130 ohm, 1/2 W, 5%                 | 0               | 2              | X-7                | R1&2              |
| Resistor      | 10K ohm, 1/4 W, 5%                 | 3               | -              | X-7                | R3,5&6            |
| Resistor      | 10K ohm, 1/4 W, 5%                 | -               | 4              | X-7                | R3,4,5&6          |
| Capacitor     | .047 µf, Disc Ceramic              | 1               | 1              | X-7                | C5                |
| Capacitor     | 1 µf, Tantalum, 35V                | -               | 4              | X-7                | C1,2,3&4          |
| Capacitor     | 1 µf, Tantalum, 35V                | 1               | -              | X-7                | C2                |
| Socket        | DIP, 14-pin                        | 1               | 1              | X-7                | U3                |
| Socket        | DIP, 24-pin                        | -               | 2              | X-7                | U1&2              |
| Socket        | DIP, 24-pin                        | 1               | -              | X-7                | U1                |
| Handle        | Personality Module Handle Bracket  | 1               | 1              | X-7                | 2                 |
| Screw         | Machine, 2-56 x 3/16               | 2               | 2              | X-7                | 13                |
| Lockwasher    | Internal Tooth, #2                 | 2               | 2              | X-7                | 14                |
| Assembly      | Keyboard                           | 1               | 1              | X-10               | 3                 |
| Cable         | Flat, 20-wire                      | 1               | 1              | X-10               | 23                |
| Wire          | Bus, 24 AWG                        | 0               | 1"             | X-7                | 15                |
| Solder        | 60/40, 20 SWG                      | -               | -              | -                  | -                 |
| Subassembly   | Sol Power Supply                   | 1               | 1              | -                  | -                 |
| Subassembly   | Sol-PC (assembled through Step 48) | 1               | 1              | -                  | -                 |

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9216 AND 2708 PERSONALITY MODULES

SECTION IV

left end of the board. In this position the component (front) side of the board is facing up. Subsequent position references related to the personality module circuit board assume this orientation.

4.6 ASSEMBLY-TEST

4.6.1 Circuit Board Check

- ( ) Visually check circuit board for broken traces, shorts (solder bridges) between traces and similar defects.
- ( ) Check circuit board to insure that the +5-volt bus, +12 volt bus and -12-volt bus are not shorted to each other or to ground. Using an ohmmeter, make the following measurements (refer to personality module assembly drawing in Section X):
  - ( ) +5 volt Bus Test. On U1, measure between pin 12, (ground) and pin 24 (+5 volts). There should be no continuity.
  - ( ) -5 volt Bus Test. On U1 and U2, measure between pin 12 (ground) and pin 21 (-5 volts). There should be no continuity.
  - ( ) +12 volt Bus Test. Also on U1, measure between pin 12 (ground) and the bottom edge connector pin on the component side of the board marked A1.
  - ( ) Inter-bus Test. On U1, measure between pins 12 and 21, then between edge connector pin A1 and pins 21, then 12. There should be no continuity in any of these measurements.

If visual inspection reveals any defect, or you measure continuity in any of the preceding tests, return the board to Processor Technology for replacement. If the board is not defective, proceed to next paragraph.

4.6.2 Assembly-Test Procedure

Refer to personality module assembly drawing X-7 in Section X.

CAUTION

THE MEMORY IC'S USED ON THE PERSONALITY MODULE ARE MOS DEVICES. THEY CAN BE  
(CAUTION continued on Page IV-3)

## PROCESSOR TECHNOLOGY CORPORATION

## 9216 AND 2708 PERSONALITY MODULES

## SECTION IV

DAMAGED BY STATIC ELECTRICITY DISCHARGE.  
HANDLE THESE IC'S SO THAT NO DISCHARGE  
FLOWS THROUGH THE IC. AVOID UNNECESSARY  
HANDLING AND WEAR COTTON, RATHER THAN  
SYNTHETIC, CLOTHING WHEN HANDLING MOS  
IC's. (STATIC DISCHARGE PROBLEMS ARE MUCH  
WORSE IN LOW HUMIDITY CONDITIONS.)

- ( ) Step 1. Install DIP sockets. Install each socket in the indicated location with its end notch oriented as shown on the circuit board and assembly drawing. Take care not to create solder bridges between the pins and/or traces.

INSTALLATION TIP

Insert socket pins into mounting pads of appropriate location. On back (solder) side of board, bend pins at opposite corners of socket (e.g. pins 1 and 9 on a 16-pin socket) outward until they are at a 45° angle to the board surface. This secures the socket until it is soldered. Repeat this procedure with each socket until all are secured to the board. Then solder the pins on all sockets.

| <u>LOCATION</u> | <u>TYPE SOCKET</u> |
|-----------------|--------------------|
| ( ) U1          | 24 pin             |
| ( ) U2*         | 24 pin*            |
| ( ) U3          | 14 pin             |

\*Used on 2708 version only.

- ( ) Step 2. Install the following resistors in the indicated locations. Install these resistors parallel with the board. Bend leads by using needle nose pliers to grip the resistor lead right next to the resistor body, and bend the portion of the lead on the other side of the pliers with your finger. The bend must be the right distance from the resistor body for the resistor to fit easily into its two holes. Insert the leads into the two holes, and from the opposite side of the board pull the leads to bring the resistor body down to touch the board. Bend the leads outward on the solder (back) side of the board so the resistors do not slip out of position.

## PROCESSOR TECHNOLOGY CORPORATION

## 9216 AND 2708 PERSONALITY MODULE

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| <u>LOCATION</u> | <u>VALUE</u> | <u>COLOR CODE</u>  |
|-----------------|--------------|--------------------|
| ( ) R1*         | 130 ohms     | brown-orange-brown |
| ( ) R2*         | 130 ohms     | brown-orange-brown |
| ( ) R3          | 10K          | brown-black-orange |
| ( ) R4*         | 10K          | brown-black-orange |
| ( ) R5          | 10K          | brown-black-orange |
| ( ) R6          | 10K          | brown-black-orange |

\*not used on 9216 version

- ( ) Step 3. Install 1N5231 Zener Diodes in locations Z1, and Z2 if you have the 2708 version. Form the leads as in Step 2. Insert the diodes so that the white band on the diode is in the position indicated by the legend. Bend the leads outward to retain the diodes, then solder and trim the leads.
- ( ) Step 4. Install the following capacitors in the indicated locations. Take care to observe the proper value, type and orientation for each installation. On the dipped tantalum capacitors, the "+" lead is the one which is closest to the "+" marking on the body of the capacitor. Insert this lead in the hole marked "+" on the PC board legend. After inserting C5, remove it from the board before soldering to clear wax from the leads and holes. After inserting all capacitors, pull them close to the board and bend the leads outward to secure them. Solder and trim all leads.

| <u>LOCATION</u> | <u>VALUE (ufd)</u> | <u>TYPE</u>     |
|-----------------|--------------------|-----------------|
| ( ) C1*         | 1                  | Dipped Tantalum |
| ( ) C2          | 1                  | Dipped Tantalum |
| ( ) C3*         | 1                  | Dipped Tantalum |
| ( ) C4*         | 1                  | Dipped Tantalum |
| ( ) C5          | .047               | Disc Ceramic    |

\*not used on 9216 version

- ( ) Step 5. Check for +5, +12, and -12 volt bus-to-ground shorts. Using an ohmmeter on OHMS times 1K or OHMS times 10K scale, make the following measurements. A typical reading is 1 Megohm. A reading less than 10K indicates a short.
  - ( ) Measure between edge connector pins A2 and A15.
  - ( ) Measure between edge connector pins A14 and A15.
  - ( ) Measure between edge connector pins A1 and A15.
  - ( ) If any measurement indicates a short, find and correct the problem before proceeding.
- ( ) Step 6. Using two 2-56 x 3/16" binder head screws, install

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## 9216 AND 2708 PERSONALITY MODULE

## SECTION IV

handle bracket. Position bracket on back (trace) side of board at the right end as shown in Figure 4-1. Align bracket holes with mounting holes in board, insert screws with lockwashers from back (solder) side of board and drive into bracket. No nuts are needed since the bracket holes are tapped.

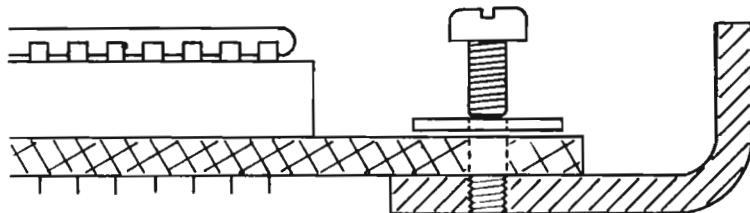


Figure 4-1. Handle bracket installation.

- ( ) Step 7. If you have a 9216 version with the 9216 ROM (windowless), omit this step. If you have the 2708 version, find the area above the U1 socket where the legend reads "-5V 21 CO 19 +12V." This legend designates five PC pads in a row directly underneath. On the back (solder) side of the board, there is a small trace which connects the "CO" and "21" pad. Cut this trace with a sharp knife or scribe point so there is no longer continuity between these pads. Form the clipping from a resistor lead, or other small bare wire into a loop and insert this jumper between the "-5V" pad and the "21" pad. Solder and trim the leads. Next find the two pads between C2 and R6, with legend "-16" under the right pad of the pair. On the back (solder) side of the board, cut the trace which connects these pads.
- ( ) Step 8. Stop assembly at this point if you are building a Sol kit and proceed with Sol-PC assembly and test up through Step 48. (See Section III.) Then go on to Step 9 of this procedure.
- ( ) Step 9. Plug personality module into J5 on Sol-PC, apply power to Sol-PC and make the following voltage measurements on the personality module, with respect to chassis ground:

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC  
WHEN IT IS NOT INSTALLED IN THE CHASSIS,  
IT MUST REST ON A CLEAN NONCONDUCTING  
SURFACE. DO NOT PLACE IT ON TOP OF  
PIECES OF WIRE AND/OR SOLDER.

| <u>MEASUREMENT POINT</u> | <u>VOLTAGE</u> |
|--------------------------|----------------|
| Pin 24 of U1, U2         | +5 V dc ± 5%   |
| Pin 14 of U3             | +5 V dc ± 5%   |
| Pin 21* of U1, U2        | -5 V dc ± 5%   |
| Pin 12 of U1, U2         | Ground         |
| Pin 7 of U3              | Ground         |

\*For 2708 version only.

- ( ) Measure between edge connector pin B14 and pin B15. You should measure more than 1M ohms. A reading less than 10K ohms indicates a short.
- ( ) If any voltages are incorrect, locate and correct the cause before proceeding to Step 10.
- ( ) If the voltages are correct, turn power off, disconnect power cable, unplug personality module and go on to Step 10.
- ( ) Step 10. Install IC's in the sockets numbered U1 through U3 as indicated in the table below. Make sure the dot or notch indicating pin 1 on the IC package is in the correct position as indicated on the PC board component legend and the assembly drawing X-7. Socket U2 is left empty on 9216 versions (9216 ROM with no window). 2708 EPROMs (not supplied) may be inserted in sockets U1 and U2.

|                 | <u>IC NO.</u> | <u>TYPE</u> |
|-----------------|---------------|-------------|
| 2708<br>version | ( ) U1*       | 2708        |
|                 | ( ) U2*       | 2708        |
|                 | ( ) U3        | 74LS08      |
| 9216<br>version | ( ) U1*       | 9216        |
|                 | ( ) U2        | Empty       |
|                 | ( ) U3        | 74LS08      |

\*MOS devices. See CAUTION on pages IV-3, 4.

- ( ) Step 11. Plug personality module into J5 on Sol-PC and connect Sol-PC video output cable to video monitor. (Refer to CAUTION on Page III-24 in Section III.)
- ( ) Connect Sol keyboard assembly to Sol-PC. Using the supplied 20-conductor ribbon cable, connect J1 on keyboard to J3 on Sol-PC as shown in Drawing X-10 in Section X.

( ) Set S1 switches on Sol-PC as follows:

No. 1 through 4: OFF

No. 5: ON

No. 6: OFF

( ) Turn monitor on and apply power to Sol-PC.

CAUTION

WHENEVER POWER IS APPLIED TO THE Sol-PC AND KEYBOARD WHEN THEY ARE NOT INSTALLED IN THE CHASSIS, THEY MUST REST ON A CLEAN NONCONDUCTING SURFACE. BE SURE NEITHER ASSEMBLY IS PLACED ON TOP OF PIECES OF WIRE AND/OR SOLDER.

- ( ) With a SOLOS module, you should see the cursor, preceded by a prompt character, like this: **X**
- ( ) If you do not see a cursor, locate and correct the problem before proceeding.
- ( ) If a blinking cursor is present, the ENter and DUMP commands should operate as described in Section IX of this manual.
- ( ) If the ENter and DUMP commands do not operate correctly, locate and correct the problem before proceeding.
- ( ) If the personality module is operating correctly, turn the monitor and power off, disconnect power cable, video output cable and keyboard, and if you are building a Sol kit go on to Step 50 in Section III. (The personality module can be left plugged in.)

V. Keyboard  
VI. Cabinet

V KEYBOARD ASSEMBLY

|                                    |     |
|------------------------------------|-----|
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| 5.2 Keyboard Installation. . . . . | V-1 |



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Sol KEYBOARD

SECTION V

5.1 KEYBOARD ASSEMBLY

The Sol keyboard is now supplied pre-assembled and tested (Part No. 104000). Consequently, no assembly is required. An assembly drawing and a schematic (Drawings X-23 and 22 respectively in Section X) are provided, however, to facilitate maintenance and repair should they become necessary.

5.2 KEYBOARD INSTALLATION

Installation instructions for the Sol keyboard are provided in Steps 37 through 42 in Section VI. The keyboard cannot be installed, however, before you complete Steps 1 through 36 in Section VI. (Note that use of the keyboard is made in Step 59 of the Sol-PC assembly procedure (Section III) and Step 11 of the personality module assembly procedure (Section IV). The keyboard need not be installed in the cabinet chassis for this purpose.)

Having completed your Sol power supply, Sol-PC and personality module, you are now ready to assemble the Sol cabinet-chassis. Complete cabinet-chassis assembly instructions are given in Section VI.



## VI Sol CABINET-CHASSIS ASSEMBLY

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| 6.6   | Assembly-Test . . . . .                           | VI-6 |
| 6.6.1 | Backplane Board (Sol-BPB) Assembly . . . . .      | VI-6 |
| 6.6.2 | Sol Assembly . . . . .                            | VI-9 |



### 6.1 INTRODUCTION

This section covers assembly of the Sol-20 chassis and cabinet. The instructions contained herein assume that you have already assembled the power supply and Sol-PC Single Board Terminal Computer™... including the personality module.

### 6.2 PARTS AND COMPONENTS

You will need the parts listed in Table 6-1 to assemble your Sol cabinet-chassis. At this point in assembly, Table 6-1 should reflect the remaining parts in your Sol kit. (Note that you may have been supplied extra pieces of some hardware items, so do not panic should you have a few pieces of hardware left over after you have completed assembling your Sol-20.) If you have any difficulty in identifying individual pieces of hardware, refer to Figure 6-1 and 6-2. Table 6-1 lists each part, its description, quantity and reference designation on the drawing(s) you will use in assembling the cabinet-chassis. The assembly drawings in Section X will also prove useful in identifying parts.

### 6.3 ASSEMBLY TIPS

#### 6.3.1 General

1. Scan Section VI in its entirety before you start to assemble your Sol cabinet-chassis.

2. IT IS IMPORTANT that you follow the step-by-step instructions in the order given when assembling the Sol cabinet-chassis if your assembly is to be done correctly and with minimum effort.

3. Assembly steps and component installations are preceded by a set of parentheses. Check off each installation and step as you complete them. This will minimize the chances of omitting a step or component.

4. Should you encounter any problem during assembly, call on us for help if needed.

#### 6.3.2 Electrical

1. Use a low-wattage soldering iron, 25 watts maximum, for all soldering.

2. Solder neatly and as quickly as possible.

3. Use only 60-40 rosin-core solder. NEVER use acid-core solder or externally applied fluxes.

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Table 6-1. Sol-20 Cabinet-Chassis Parts List.

| <u>PART</u>    | <u>DESCRIPTION</u>                  | <u>QUANTITY</u> | <u>REFERENCE</u>     |                   |
|----------------|-------------------------------------|-----------------|----------------------|-------------------|
|                |                                     |                 | <u>Drawing No.</u>   | <u>Designator</u> |
| Circuit Board  | Sol Backplane                       | 1               | X-8                  | 4                 |
| Cable Assembly | Sol Backplane, 3", 5-wire           | 1               | X-10                 | 1                 |
| Connector      | PC, 100-pin                         | 1               | X-8                  | 5                 |
| Connector      | PC, 100-pin                         | 5               | X-8                  | 6                 |
| Plug           | Coax, 75 ohm                        | 1               | Fig. 6-5<br>Sect. VI | -                 |
| Sleeve         | Coax Adapter                        | 1               | Fig. 6-5<br>Sect. VI | -                 |
| Chassis        | Main                                | 1               | X-8                  | 11                |
| Subchassis     | Expansion                           | 1               | X-9                  | 12                |
| Bracket        | Connecting, Power Supply Subchassis | 1               | X-9                  | 13                |
| Bracket        | Keyboard Support                    | 2               | X-9                  | 14                |
| Bracket        | Backplane, Right Angle              | 2               | X-8                  | 16                |
| Bracket        | Backplane, Left Gusset              | 1               | X-8                  | 17                |
| Bracket        | Backplane, Right Gusset             | 1               | X-8                  | 18                |
| Card Guide     | Plastic, 4"                         | 10              | X-8                  | 34                |
| Assembly       | Left Side Panel                     | 1               | X-9                  | 5                 |
| Assembly       | Right Side Panel                    | 1               | X-9                  | 6                 |
| Cover          | Keyboard                            | 1               | X-10                 | 10                |
| Cover          | Top                                 | 1               | X-10                 | 22                |
| Cover          | Logo, Plexiglass                    | 1               | X-10                 | 20                |
| Label*         | Sol Logo*                           | 1*              | X-10                 | 21                |
| Label          | Fingerwell, Black                   | 2               | X-9                  | 28                |
| Label          | Connector Identification            | 1               | X-8                  | 29                |
| Label          | Serial Number                       | 1               | X-8                  | 26                |
| Foot           | Rubber, Adhesive                    | 4               | Fig. 6-8<br>Sect. VI | -                 |
| Screw          | Machine, 4-40 x 3/16                | 2               | X-8                  | 44                |
| Screw          | Machine, 4-40 x 5/16                | 16              | X-8&9                | 39                |
| Screw          | Machine, 4-40 x 5/8                 | 6               | X-8                  | 38                |

\*May be packaged under logo cover.

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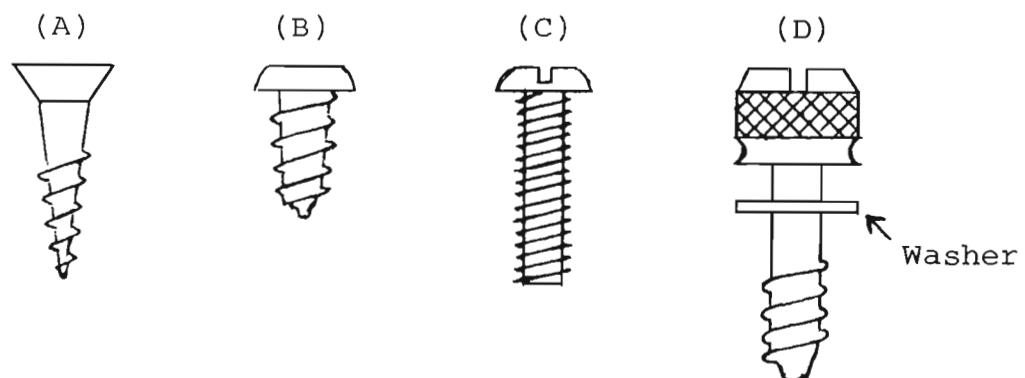
Table 6-1. Sol-20 Cabinet-Chassis Parts List. (Continued)

| <u>PART</u> | <u>DESCRIPTION</u>           | <u>QUANTITY</u> | <u>REFERENCE</u>   |                   |
|-------------|------------------------------|-----------------|--------------------|-------------------|
|             |                              |                 | <u>Drawing No.</u> | <u>Designator</u> |
| Lockwasher  | Internal Tooth, #4           | 16              | X-8&9              | 48                |
| Lockwasher  | Spring, #4                   | 8               | X-8                | 56                |
| Hex Nut     | 4-40                         | 16              | X-8&9              | 51                |
| Screw       | Machine, metal, 6-32 x 1/2   | 8               | X-9&10             | 40                |
| Screw       | Self-tapping, 6-32 x 5/16    | 1               | X-9                | 43                |
| Screw       | Sheetmetal, #6 x 1/4         | 32              | X-8&9              | 45                |
| Lockwasher  | Internal Tooth, #6           | 8               | X-8&10             | 49                |
| Washer      | Flat, #6                     | 18              | X-8&9              | 56                |
| Screw       | Machine, 10-24 x 3/8         | 8               | X-9                | 42                |
| Screw       | Machine, 10-24 x 1           | 2               | X-9                | 41                |
| Screw       | Quick Connect, Knurled       | 2               | X-10               | 33                |
| Cable       | Flat, 20-wire                | 1               | X-10               | 23                |
| Assembly    | Keyboard                     | 1               | X-10               | 3                 |
| Cable       | AC Power, 3-wire             | 1               | X-10               | 36                |
| Subassembly | Sol Power Supply             | 1               | X-9                | 1                 |
| Subassembly | Sol-PC                       | 1               | X-10               | 2                 |
| Subassembly | 2708/9216 Personality Module | 1               | X-10               | 8                 |

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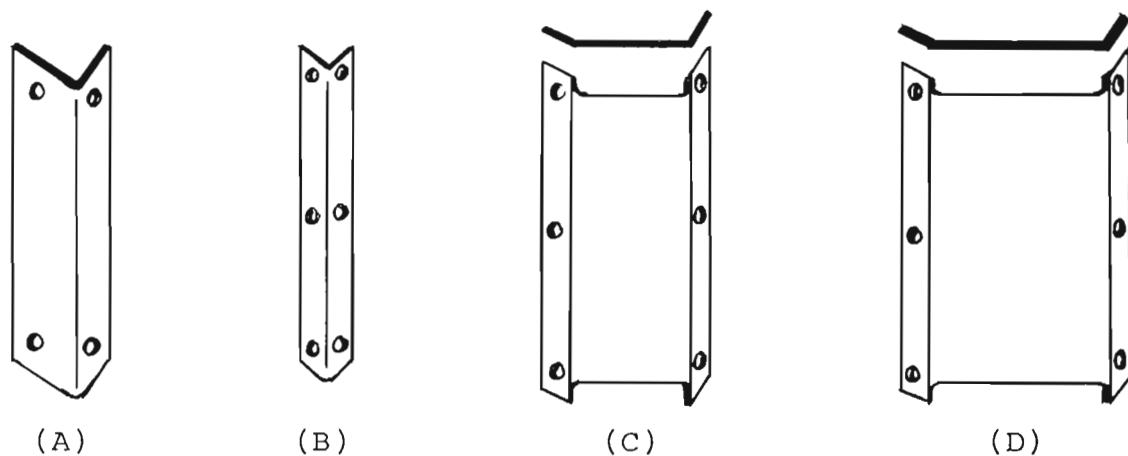
(A) Flat Head Wood Screw

(B) Sheet Metal Screw

(C) Binder or Pan Head Screw

(D) Thumb Screw

Figure 6-1. Types of screws used in Sol cabinet-chassis assembly.



(A) Keyboard Bracket

(B) Backplane Bracket, Right Angle

(C) Gusset Bracket, Left

(D) Gusset Bracket, Right

(E) Power Supply Subchassis Bracket

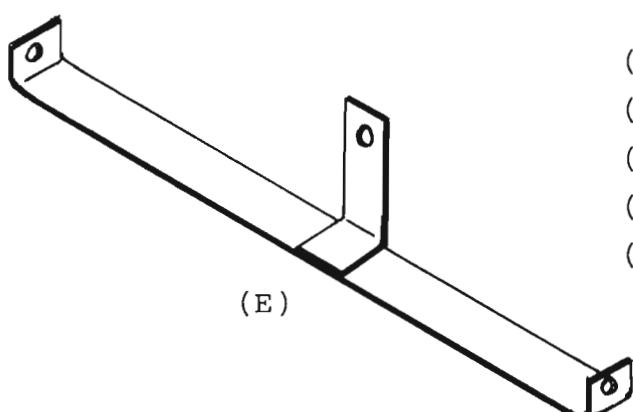


Figure 6-2. Brackets used in Sol cabinet-chassis assembly.

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6.3.2 Electrical (continued)

4. DO NOT press the tip of the soldering iron on pads or traces when installing components and/or attaching leads to a PC board. To do so can cause the pad or trace to "lift" off the board and permanently damage it.

5. The Backplane PC board (Sol-BPB) has plated-through holes. Solder flow through to the component side of the board can produce solder bridges (shorts). Check for such bridges after you install each component or wire.

6. The Backplane PC board (Sol-BPB) has an integral solder mask (a lacquer coating) that shields selected areas on the board. This mask minimizes the chances of creating solder bridges during assembly.

6.3.3 Mechanical

1. If you do not have the proper screwdrivers (see Paragraph 6.4), we recommend that you buy them rather than using a knife point, a blade screwdriver on a Phillips screw, and other makeshift means. Proper screwdrivers minimize the chances of stripping threads, disfiguring screw heads and marring decorative surfaces.

2. To assure a correct fit and tight assembly, be sure you use the screws specified in the instructions.

3. Lockwashers are widely used in the Sol cabinet-chassis assembly so that screws will not loosen when subjected to stress or vibration. When a lockwasher is specified, do not omit it and make sure you install it correctly.

4. Some instructions call for prethreading holes. This is done to make assembly easier by giving you maximum working space for installing relatively hard-to-drive sheet metal screws. If you bypass prethreading instructions you will only make your cabinet-chassis assembly more difficult.

To prethread a hole, insert specified screw in the hole and position it as straight as possible. While holding the screw in this position, drive it into the metal with the proper screwdriver. If started straight the screw will continue to go straight into the metal so that the head and sheet metal surfaces are in full contact.

5. The diameter of the shank (threaded portion) of a screw increases in relation to its number. For example, a 6-32 screw is larger in diameter than a 4-40 screw. Also, a #8 lockwasher is larger than a #4 lockwasher.

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6.4 REQUIRED TOOLS, EQUIPMENT AND MATERIALS

The following tools, equipment and materials are recommended for assembling the Sol cabinet-chassis. (Unless indicated otherwise, none of the following items are supplied with your kit.)

1. Needle nose pliers
2. Diagonal cutters
3. Screwdriver, thin 1/4" blade
4. Screwdriver, #2 Phillips
5. Controlled heat soldering iron, 25 watt
6. Ohmeter
7. Masking tape
8. Transparent tape
9. Rubber mallet or small hammer

6.5 ORIENTATION

6.5.1 Sol Backplane Board, Sol-BPB

When the side without the solder mask (no green lacquer) is facing you, the PC board identification (Sol-BPB) and revision level will be located in the upper left-hand corner of the board when the edge connector (gold contacts) is positioned at the bottom of the board. In this position, the component (front) side of the board (no solder mask) is facing up. Subsequent position references related to the Sol-BPB assume this orientation.

6.5.2 Sol Cabinet-Chassis

Unless specified otherwise, all position references (e.g., left, right, front, back, bottom and top) in the cabinet-chassis assembly instructions assume the Sol cabinet is viewed from the front (keyboard) when it is sitting in its normal position (keyboard up).

6.6 ASSEMBLY-TEST

6.6.1 Backplane Board (Sol-BPB) Assembly

Refer to Detail B on Drawing X-8 in Section X.

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- ( ) Step 1. Visually inspect Sol-BPB PC board for obvious flaws such as solder bridges (shorts) between traces, broken traces and similar defects.

If visual inspection reveals any defects, return the board to Processor Technology for replacement. If the board passes inspection, go on to Step 2.

- ( ) Step 2. Install 100-pin edge connector (Item 5 on Drawing X-8) on top edge of PC board. (This edge has silver (not gold) contacts.)

NOTE

This connector is supplied as a troubleshooting aid. It is not critical to normal operation of the Sol-20.

Position connector on PC board so that its #1 trace is aligned with the #1 trace on the board, and push connector fully onto board. Bend the connector pins slightly so that both rows of pins are in light contact with the traces on the board. DO NOT CLOSE CONNECTOR PINS SO MUCH THAT YOU WILL DAMAGE THE TRACES WHEN PLACING THE CONNECTOR OVER THE EDGE OF THE BOARD. While holding the connector and board together, place board solder side down on a book, or other flat surface that is higher than your work surface, so the connector extends fully over the edge. That is, the connector should not rest on the book. Reposition connector if needed to align the pins and traces. On the component (front) side of board, solder a pair of traces. On the component (front) side of board, solder a pair of pins at each end of the connector to their respective traces on the board. Then solder the remaining 46 pins on the component side to traces.

The connector must be perpendicular to the edge of the board. If it is not, bend the pins you just soldered to obtain the required alignment. Then solder the other 50 pins to the traces.

- ( ) Step 3. Install the other five 100-pin edge connectors. Position connector on front side of board (the side without the green solder mask) and insert pins. On solder (back) side of board (the side with the green solder mask), solder pins at opposite corners of the connector to hold it in place while making sure the entire connector is seated firmly. Then solder the remaining 98 pins.

- ( ) Step 4. First check that wire color code in Sol backplane cable assembly (3" 5-wire cable) conforms with that given below and in Figure 2-7 on Page II-21 in Section II. Then connect cable to circuit board to upper-most pads in top right corner: Insert wires from solder (back) side of board (green

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solder mask side) and solder on component (front) side of board. If a wire is too large for the mounting hole, snip off as many individual strands as needed to obtain a fit. Connect cable leads as follows:

| <u>CABLE LEAD</u> | <u>PAD</u>                        |
|-------------------|-----------------------------------|
| White             | Ground (fifth hole from right)    |
| White             | Ground (fourth hole from right)   |
| Blue              | +8 V dc (third hole from right)   |
| Red-White         | +16 V dc (second hole from right) |
| Yellow-White      | -16 V dc (first hole from right)  |

NOTE

Pad orientations given above are as viewed from component (front) side of circuit board, the side without the green solder mask.

- ( ) Step 5. Fill feedthrough holes on right-hand side of board with solder. Fill only those that are exposed (not covered with green lacquer) on the solder mask (back) side. Fill these holes from the solder mask side so that no solder protrudes above the back of the board.
- ( ) Step 6. Check +8-volt, +16-volt and -16-volt buses to insure they are not shorted to each other or to ground. Using an ohmmeter, make the following measurements on one of the edge connectors:
  - ( ) +8-volt Bus Test. Measure between pins 1 or 51 and 50 or 100. There should be no continuity (meter reads close to "infinity" ohms).
  - ( ) +16-volt Bus Test. Measure between pins 2 and 50 or 100. There should be no continuity.
  - ( ) -16-volt Bus Test. Measure between pins 52 and 50 or 100. There should be no continuity.
  - ( ) 8/16/(-16) Volt Bus Test. Measure between pins 1 or 51 and 2, between pins 1 or 51 and 52, and between pins 2 and 52. There should be no continuity in any of the three measurements.

If you measure continuity (indication of a short) in any of the preceding tests, check your work for solder bridges.

If you measure no continuity in any of the tests, you have completed the backplane board assembly. Set it to one side for later installation in the cabinet-chassis.

NOTE

Since the Sol right and left side panels are now supplied as pre-assembled units, Steps 7 through 12 have been eliminated.

#### 6.6.2 Sol Assembly

Refer to Drawings X-8 through X-10 in Section X. Figure 6-3 and 6-4 show complete Sol assemblies without covers.

- ( ) Step 13. Mount keyboard support bracket (heavy gauge right angle brackets) to each side of the main chassis as shown in Drawing X-9. These are mounted with the narrower side of the bracket at the top.

Attach each bracket to main chassis with two 6-32 x  $\frac{1}{2}$  binder or pan head screws and #6 lockwashers. Place lockwasher on screw, insert screw from outer surface of main chassis side wall and drive into the threaded bracket mounting holes.

- ( ) Step 14. Attach power supply subchassis bracket (short leg "T" shaped bracket) to top front of power supply subchassis as shown in Drawing X-9. (Note that leg of "T" is closer to side wall of subchassis. This leg is for mounting a "power on" indicator light--not supplied.) Insert #6 x  $\frac{1}{4}$  sheet metal screw from right side of side wall and drive into bracket.

- ( ) Step 15. To gain access to the rear area of the power supply subchassis side wall, remove the #6 x 5/16 sheet metal screw that attaches the fan closure plate to the subchassis. You should not have to disconnect the transformer (black wires) or AC receptacle ground (green wire) leads since they have sufficient slack to permit moving the closure plate out of the way. (Set screw to one side for use in re-installing the fan closure plate.)

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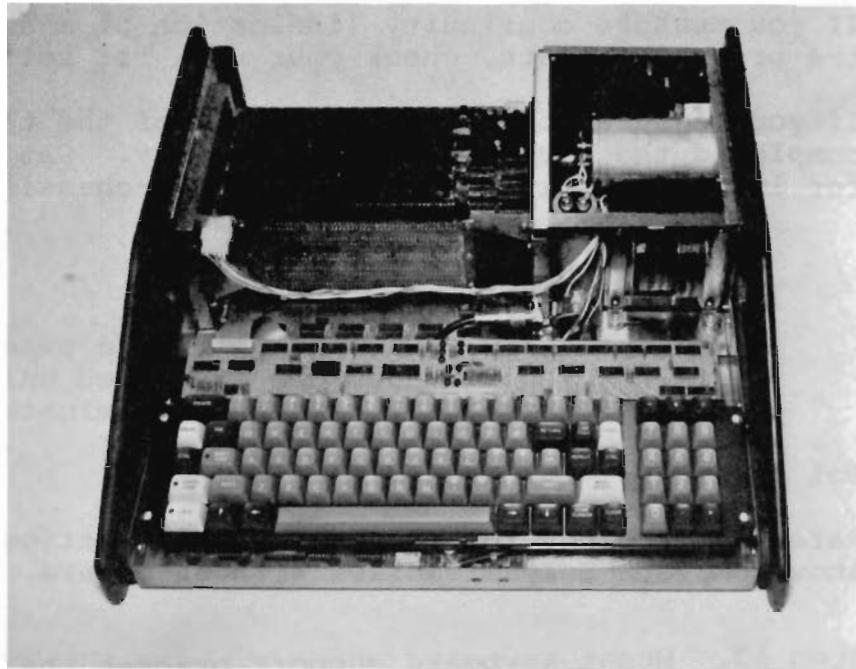


Figure 6-3. Sol-20 with covers removed. Front (or keyboard) is in foreground, power supply is in right rear corner, expansion chassis (with 8KRA Memory installed) is to left of power supply. The vertical board just behind white connector on left is the backplane board.

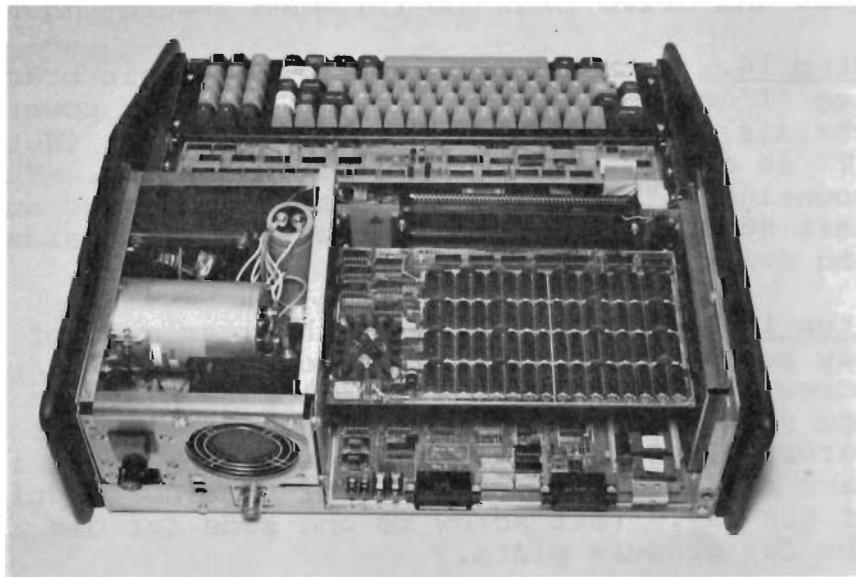


Figure 6-4. Sol-20 with covers removed. Rear side of assembly is in foreground and Sol-PC is just visible at lower right rear of assembly. 8KRA Memory is installed in expansion chassis above Sol-PC.

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- ( ) Step 16. Install power supply subchassis in main chassis as shown in Drawing X-9.

Place subchassis over the right rear corner of main chassis and lower it almost vertically into position. Attach subchassis to main chassis using seven #6 x 1/4 and one #6 x 5/16 sheet metal screws and five #6 flat washers. Five #6 x 1/4 screws, fitted with #6 flat washers, are driven through the bottom of the main chassis into the subchassis. The #6 x 5/16 screw is driven through the rear hole in the right side of the main chassis into the subchassis. The remaining #6 x 1/4 screws are driven through the main chassis into the subchassis.

- ( ) Step 17. Place right side walnut-masonite assembly in proper position against right side of main chassis and outline the finger well on the chassis. Remove backing from one black finger well label and affix it to the right side of main chassis. Position label to cover the finger well outline you made. Be sure label extends beyond all edges of the outline.

- ( ) Step 18. Using five 10-24 x 3/8 binder or pan head screws, attach right side assembly to main chassis and power supply subchassis as shown in Drawing X-9. Insert screws from inside surface of chassis and drive into the plastic inserts. Note that the two front screws are driven through the main chassis, the two lower rear screws are driven through both the power supply subchassis and main chassis, and the upper rear screw is driven through the power supply subchassis.

- ( ) Step 19. Assemble expansion chassis ("U" shaped chassis).

- ( ) Prethread 12 mounting holes (six on each side) on expansion chassis side walls for backplane brackets with #6 x 1/4 sheet metal screws. Three of these holes on each side are located near the front edge of the main chassis. The remaining three holes on each side are about 1-1/2 to 2 inches behind the front three. Leave screws installed.

- ( ) Install female coaxial connector on the tab that extends out from the lower right front of the expansion chassis. Insert connector through tab so threaded end faces left as shown in Drawing X-9. Insert three 4-40 x 5/16 binder or pan head screws from left side of tab through the two front and lower rear mounting holes. Place #4 lockwasher on each and secure with 4-40 hex nuts. Insert another 4-40 x 5/16 binder or pan head screw through upper rear mounting hole and install 4-40 hex nut. (Leave this nut loose.)

- ( ) See Details C and D on Drawing X-8. Install 10 plastic card guides (five on each side) on inside surface of both side walls of the expansion chassis.

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These are installed over the ventilation cutout with the gripper fingers pointing towards the backplane board. To install, simply insert posts on guide into appropriate mounting holes and push in until they snap into place.

- ( ) Step 20. Install expansion chassis on main chassis as shown in Drawing X-9.

Position expansion chassis with coaxial connector at the front (near FWB3 on power supply subchassis) over left rear area of main chassis and lower into place. Attach expansion chassis to main chassis using nine #6 x 1/4 sheet metal screws and five #6 flat washers. Five screws, fitted with #6 flat washers, are driven through the bottom of the main chassis into the expansion chassis, three are driven through the left side of the main chassis into the expansion chassis, and one is driven through the lower left corner of the back side of the main chassis into the expansion chassis.

- ( ) Step 21. Attach left end of power supply subchassis bracket to expansion chassis as shown in Drawing X-9. Drive one 6 x 1/4 sheet metal screw through expansion chassis into bracket.

- ( ) Step 22. Route coaxial cable from connector on fan closure plate along left side of power supply subchassis to connector on expansion chassis.

- ( ) Step 23. Using the #6 x 1/4 sheet metal screw you removed in Step 15, re-attach fan closure plate to power supply subchassis. (Make sure side lip on plate is on right side of expansion chassis side wall.

- ( ) See Drawing X-9. Attach fan closure plate to expansion chassis with two #6 x 1/4 sheet metal screws. Drive screws through expansion chassis into fan closure plate.

NOTE

If lip on fan closure plate and expansion chassis are not in contact, insert one or two 1/2" flat washers as needed between the two surfaces. Place washers so screws pass through them.

- ( ) Step 25. Connect free end of coaxial cable from connector on fan closure plate to connector on expansion chassis. Solder inner conductor to pin of connector. Remove hex nut on upper rear connector mounting screw, place lug (coaxial shield) and #4 lockwasher on screw, in that order, and secure with nut.

- ( ) Step 26. Install male coaxial connector on free end of coaxial cable that is connected to Sol-PC (the composite video output cable). Install connector as follows (refer to Figure 6-5):

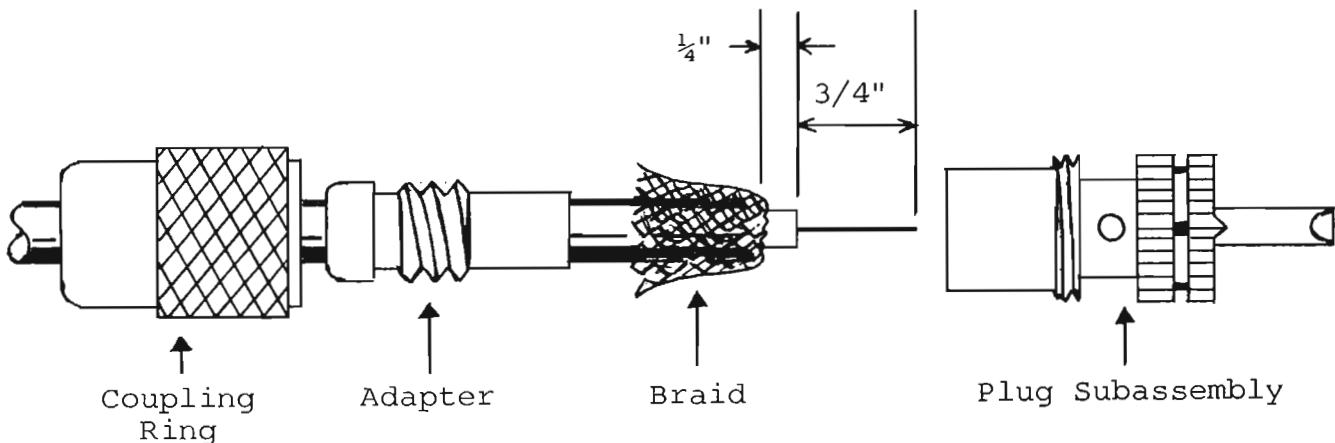


Figure 6-5. Sol-PC coaxial cable connector assembly.

- ( ) Slide coupling ring and adapter on cable in that order and cut end of cable even.
- ( ) Remove one inch of outer insulation.
- ( ) Fan braid slightly and fold back over outer insulation as shown.
- ( ) Slide adapter fully up under braid and press braid down over adapter body.
- ( ) Trim braid so that it does not interfere with adapter threads.
- ( ) Remove 3/4" of inner conductor insulation and tin exposed conductor.
- ( ) Slide cable fully into plug subassembly and screw subassembly on adapter.
- ( ) Solder braid to plug subassembly shell through solder holes. (Use enough heat to create a good bond between braid and shell.)
- ( ) Solder center conductor to plug contact by filling contact with solder. Cut off excess conductor.
- ( ) Slide coupling ring over plug subassembly and screw it onto plug.

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( ) Step 27. Install Sol-PC in expansion chassis.

Position Sol-PC on bottom of expansion chassis with J1, J2 and J6 through J9 at the rear. Align threaded standoffs on bottom of Sol-PC with the oblong holes in the bottom of the main chassis.

Attach Sol-PC board to chassis with two 4-40 x 3/16 and six 4-40 x 5/16 binder or pan head screws, eight #6 flat washers and eight #4 spring lockwashers as shown in Detail F on Drawing X-8 in Section X. (Note that the two shorter screws attach to the same standoffs to which S100 connector, J11, is attached.) Place lockwasher and flat washer on screw in that order and drive screw loosely into standoff from bottom of main chassis. Leave all eight screws loose.

( ) Step 28. Connect Sol-PC composite video output cable to expansion chassis coaxial connector.

( ) Step 29. Affix black finger well label to left side of main chassis in same manner as you did the right side. (See Step 17.) **MAKE SURE LABEL DOES NOT OBSTRUCT COOLING CUTOUT.**

( ) Step 30. Using three 10-24 x 3/8 and two 10-24 x 1 binder or pan head screws, attach left side assembly to main chassis as shown in Drawing X-9. Insert screws from inside surface of chassis and drive into plastic inserts. Note that the two front screws (10-24 x 3/8) are driven through the main chassis, the uppermost screw (10-24 x 3/8) is driven through the expansion chassis, and the two lower rear screws (10-24 x 1) are driven through both the expansion chassis and main chassis.

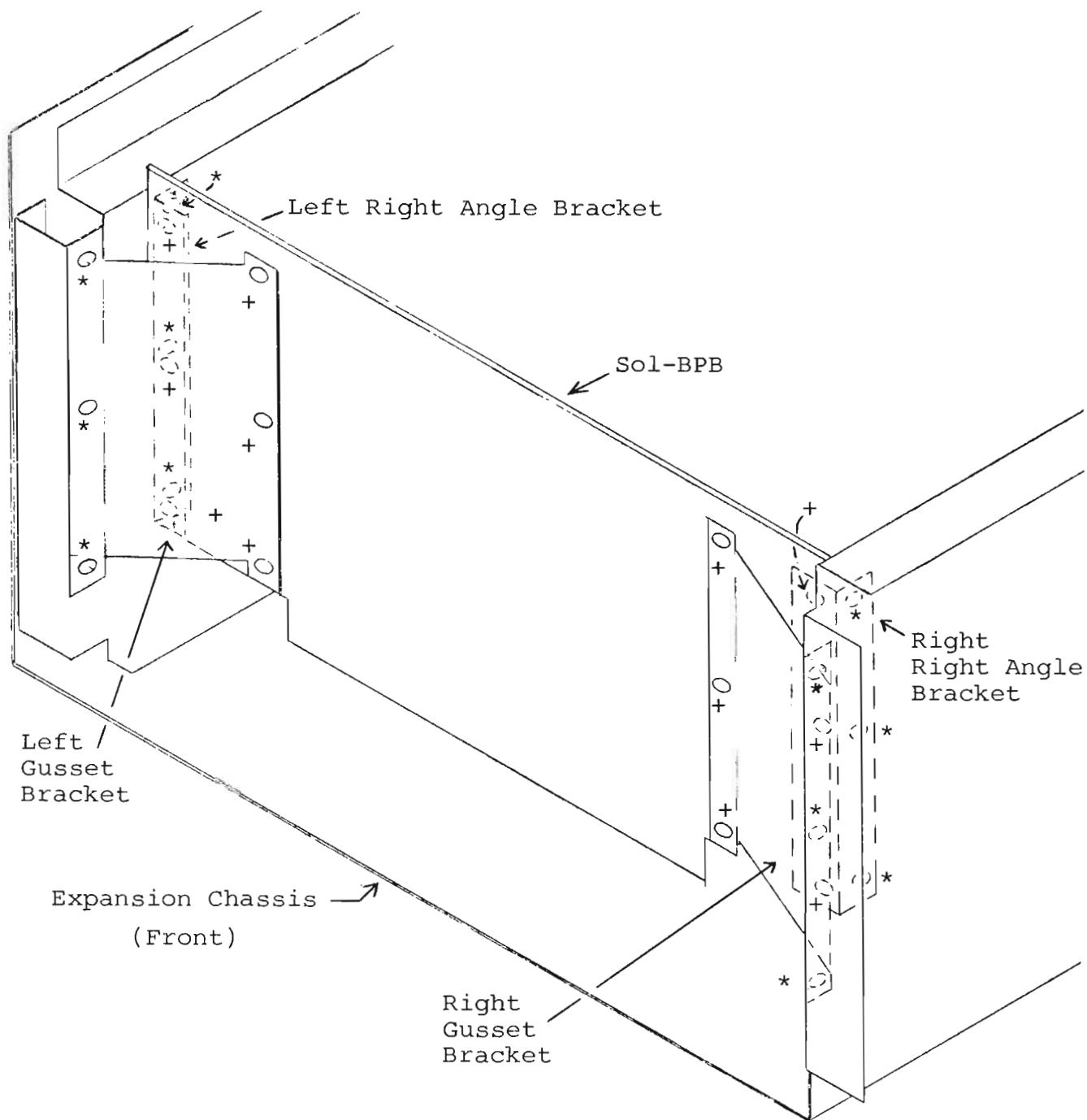
( ) Step 31. Install left and right backplane right angle brackets (light gauge brackets) on expansion chassis side walls. Refer to Figure 6-6 on Page VI-15.) These two brackets are installed just to the front of the card guides and should be positioned as shown in Figure 6-6. Attach each bracket to the chassis with three #6 x 1/4 sheet metal screws. **USE THE SCREWS YOU USED IN STEP 19 TO PRETHREAD THE HOLES.**

( ) Step 32. See Detail B on Drawing X-8. Install backplane circuit board (Sol-BPB). The photograph in Figure 6-7 on Page VI-16 shows the backplane board installed.

( ) Position Sol-BPB with 100-pin male edge connector down and the five female edge connectors facing the card guides. The board should rest against the front face of the right angle brackets as shown in Figure 6-6. Adjust position of Sol-PC as needed so that you can plug the Sol-BPB edge connector into J11 on the Sol-PC.

( ) Align holes on left and right ends of Sol-BPB with those in right angle brackets.

(Step 32 continued on Page VI-16.)



\* #6 x  $\frac{1}{4}$  sheet metal screw

+ 4-40 x 5/8 binder or pan head screw,  
#4 lockwasher and 4-40 hex nut

Figure 6-6. Backplane board (Sol-BPB) installation.

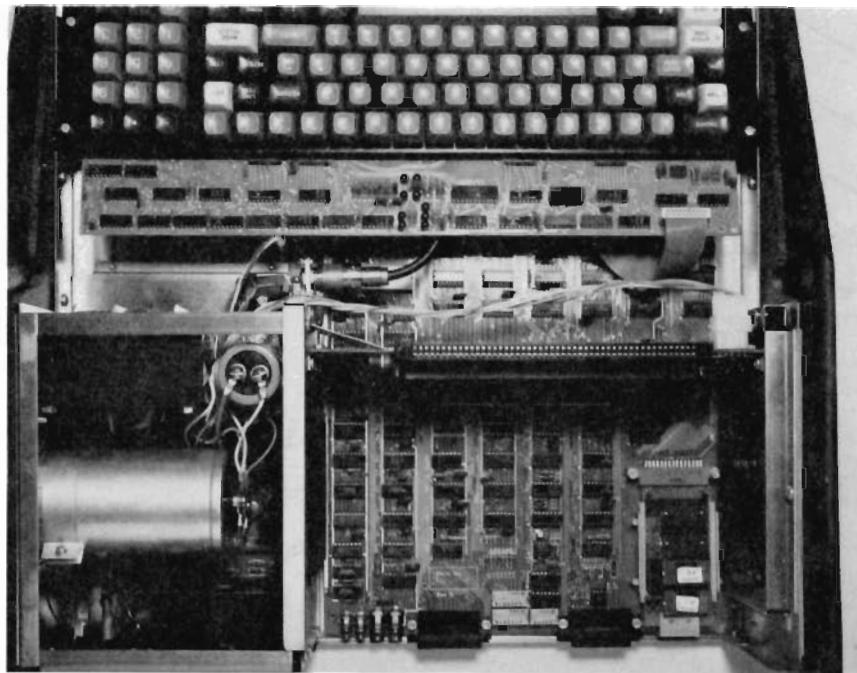


Figure 6-7. Backplane board (Sol-BPB) installation.  
Rear of Sol is at bottom and Sol-BPB is  
to right of power supply subchassis in  
line with C8 and transformer.

(Step 32 continued)

- ( ) See Detail E on Drawing X-8. Attach Sol-BPB to brackets with three 4-40 x 5/16 binder or pan head screws, #4 lockwashers and 4-40 hex nuts on each side. Insert screws from the back side of bracket through Sol-BPB, place lockwasher on each screw and secure each with nut.
- ( ) Step 33. Install left and right gusset brackets as shown in Figure 6-6 on Page VI-15.
  - ( ) Fit narrower gusset bracket on left side so that its flanges are flat against the expansion chassis side wall and the backplane board. (You may have to bend the flange slightly to obtain a proper fit.)
  - ( ) Attach bracket to expansion chassis side wall with the three #6 x  $\frac{1}{4}$  sheet metal screws you used in Step 19 to prethread the holes.

\*\*See WARNING on Page VI-17.\*\*

(Step 33 continued on Page VI-17.)

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(Step 33 continued.)

WARNING

IT IS QUITE EASY TO SCRATCH OR CUT YOUR HAND ON THE SOLDER SIDE OF THE BACKPLANE BOARD WHEN DRIVING THESE SCREWS. PLACE A SUITABLE PROTECTIVE BARRIER, SUCH AS CARDBOARD, AGAINST SOLDER SIDE OF BACK-PLANE BOARD DURING INSTALLATION TO PREVENT SUCH INJURY.

- ( ) See Detail E on Drawing X-8. Attach bracket to backplane board with three 4-40 x 5/8 binder or pan head screws, #4 lockwashers and 4-40 hex nuts. Insert screws from front side of bracket through Sol-BPB, place lockwasher on each screw and secure each with nut.
- ( ) Install wider gusset bracket on right side in the same manner as you did the left bracket. THE PRECEDING WARNING ALSO APPLIES TO INSTALLING THIS BRACKET.
- ( ) Step 34. Connect Sol-20 DC power cable from power supply subchassis to the Sol-BPB power cable you installed in Step 4.
- ( ) Step 35. Check that Sol-PC is in optimum position and tighten the eight screws holding the Sol-PC to the expansion-main chassis assembly. (See Step 27.)
- ( ) Step 36. Connect Sol-PC power cable (4-wire) to J10 on Sol-PC.  
CAUTION: Make sure cable connector mates exactly with J10.
- ( ) Step 37. See Drawing X-10. Position keyboard (Sok-KBD) near its mounting brackets and connect 20-conductor ribbon cable supplied with Sol keyboard between J1 on keyboard and J3 on Sol-PC. With the cable connected properly, the cable will run away from the keys from J1 on the keyboard, and towards the keys from J3 on Sol-PC.
- ( ) Step 38. See Drawing X-10. Attach keyboard to keyboard brackets with two 6-32 x 1/2 binder or pan head screws and #6 lockwashers on each side. Place washer on each screw and drive screws loosely into threaded holes in brackets.

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SECTION VI

- ( ) Step 39. See Drawing X-10. Remove protective cover from one side of Plexiglass strip and attach "Sol Terminal Computer" trim plate to Plexiglass with small pieces of transparent tape. Place trim plate with printed side against Plexiglass.
- ( ) Step 40. See Drawing X-10. Remove protective cover from other side of Plexiglass and slide it into the channel above the keyboard cutout.

NOTE

A hole is provided in the sheet metal behind the trim plate. This may be used for a "power on" indicator light if desired.

- ( ) Step 41. Refer to Drawing X-10. Install keyboard cover. Hook front of cover under front edge of main chassis and lower it over the keyboard. (A slight adjustment of the keyboard position may be needed to obtain a proper fit.)

Position keyboard within cutout in cover if needed and tighten keyboard mounting screws.

- ( ) Step 42. Install top cover.

( ) Be sure power cord is not plugged into 110 V ac outlet and disconnect cord from fan closure plate receptacle.

( ) Remove fuse holder cap and fuse.

CAUTION

NEVER REMOVE OR INSTALL FUSE WITH POWER ON.

- ( ) See Drawing X-10. Hook top cover over back edge of keyboard cover and lower it down into place over the rear of the main chassis. Install the two thumb screws (one at the lower left corner and the other to the right of the fan closure plate coaxial connector) to attach cover to rear of main chassis.
- ( ) Step 43. Re-install fuse and plug power cord into receptacle. BE SURE POWER CORD IS NOT PLUGGED INTO 110 V ac OUTLET.

See CAUTION on Page VI-19.

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(Step 43 continued.)

CAUTION

NEVER REMOVE OR INSTALL FUSE WITH POWER ON.

- ( ) Step 44. Remove backing from connector identification label and affix it to rear of top cover. Position label just above Sol-PC connector opening in cover so that "J9" is aligned with left-most (as viewed from rear of Sol) subminiature phone jack and "J1" is aligned with right-most 25-pin female connector.
- ( ) Step 45. See Detail A on Drawing X-8. Remove backing from serial number label and affix it to rear of top cover. Position label to right (as viewed from rear of Sol) of fan opening in cover.
- ( ) Step 46. Affix self-stick protective pads to bottom of Sol as shown in Figure 6-8.

You have now completed assembly of your Sol Terminal Computer<sup>TM</sup>. It is ready for use as a stand-alone computer or CRT terminal. Congratulations on a job well done. Proceed now to Section VII to test and learn to operate your Sol.

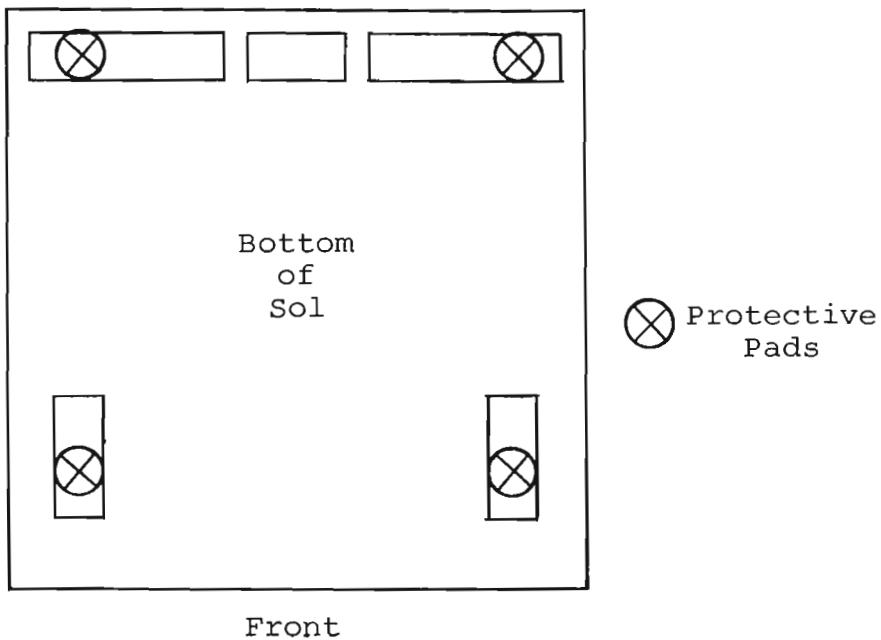


Figure 6-8. Protective foot pad installation.



VII. Operating  
Procedures

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## SECTION VII, Sol OPERATING PROCEDURES

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### 7.1 INTRODUCTION

Information in this section will help you to become familiar with the operation of your Sol Terminal Computer<sup>TM</sup>. Following brief explanations of the operating controls and the two basic operating modes, you will put your Sol through some simple operations. This should sufficiently acquaint you with the keyboard and control switches so that you will feel at ease with your Sol. In addition, you will have performed functional tests of all Sol sections except the parallel data interface.

Detailed descriptions of the control switches are also provided to allow you to gain greater proficiency in their use. For the same reason, individual keyboard key descriptions are also given. They are intended to be used along with the BASIC/5 and SOLOS Users' Manuals.

The balance of this section supplies instructions for 1) connecting typical peripheral devices to the serial and parallel data interfaces (J1 and J2), 2) using audio cassette recorders, and 3) changing the fuse.

### 7.2 THE OPERATING CONTROLS

Sol operating controls are identified and their functions briefly defined in Table 7-1 on Page VII-2. Unless noted otherwise, the location of each control is shown on the Sol-PC assembly drawing in Section X, Page X-5.

### 7.3 BASIC OPERATING MODES

#### 7.3.1 Command Mode

In this mode Sol operates as a stand alone computer under control of the program (software) contained in the personality module and additional software that is stored in the Sol, stored either in a read only memory (ROM) that is plugged into the computer or the Sol random access memory (RAM). For a description of the SOLOS monitor program, refer to SOLOS/CUTER User's Manual respectively.

With the SOLOS Personality Module installed, the computer is in the command mode when power is applied to the Sol. Command mode is a sort of "home base" from which excursions may be made into other programs. An analysis of three levels of programs will make the concept of command mode more understandable.

At the lowest level of software are the instructions which the 8080 CPU (central processing unit), the brains of the computer,

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Table 7-1. Sol Operating Controls and Their Functions.

| CONTROL                               | FUNCTION   |
|---------------------------------------|--|
| ON-OFF Switch<br>(See Figure 7-1)     | Connects and disconnects primary power to Sol.                                       |
| RST (Restart) Switch, S1-1            | Permits manual restart of Sol without turning power off. (Useful for test purposes.) |
| BLANK Switch, S1-3                    | Determines if control characters are displayed or not.                               |
| POLARITY Switch, S1-4                 | Selects normal (white characters on black background) or reverse video display.      |
| BLINK-SOLID Switches, S1-5 & 6        | Selects blinking, nonblinking or no cursor.  |
| SSW $\emptyset$ - 7<br>S2-1 through 8 | Permits direct data entry to processor.  |
| BAUD RATE Switches, S3-1 through 8    | Sets operating speed of serial data interface (SDI).                                 |
| PS & PI Switches<br>S4-1 & 5          | Selects no parity, even parity or odd parity for SDI.                                |
| WLS-1 & 2 Switches,<br>S4-2 & 3       | Selects number of data bits in transmitted word for SDI.                             |
| SBS Switch,<br>S4-4                   | Determines number of stop bits in transmitted word for SDI.                          |
| F/H Switch,<br>S4-6                   | Selects half or full duplex operation for SDI.                                       |
| Keyboard<br>(See Drawing X-20)        | Data entry, mode selection, command input and cursor control.                        |

can understand and run. All programs must ultimately be reduced to this basic level to be operated on by the computer. In the case of the 8080 microprocessor, the program is in an "object code" or "machine language", since the "machine" or 8080 CPU understands it. The SOLOS program contained in the personality module is stored in this machine language form, and the computer can therefore run directly from this program. Since the SOLOS program is contained in permanent ROM which is plugged directly into the computer, the SOLOS program is always available, and is automatically selected whenever the power switch of the Sol is turned on. There is also provision for returning at all times to the command mode of SOLOS. From the command mode other programs may be brought in for various operations or stored on cassette tape. The contents of the computer's memory may be displayed or changed. The command mode also performs "housekeeping" functions such as setting the rate at which data is read from tape, or the rate at which characters are displayed on the video monitor.

The command mode allows the introduction of the second level of software. This level includes higher-level language programs such as BASIC/5 or FOCAL in which complex application programs may be more easily written. These are called higher level languages because they permit the user to write programs in a form much closer to human languages such as English. However, programs written in these languages must be translated into the more basic machine language before they can be run. Besides higher level languages, this second level of software includes programs such as the TREK 80 and GAMEPAC video games and the ALS-8 program (a software package used for developing programs), all of which are offered by Processor Technology Corporation. Through the facilities of the command mode, these second level programs are transferred (loaded) into memory from cassette tape or other storage media, and then "executed" (used). These programs may also exist in ROM or EPROM (erasable programmable ROM) memory which is plugged into the computer to make them instantly available like the SOLOS program. All first and second level programs are stored in the computer as binary object code.

Let us illustrate the concept of the second level of programs with an example, BASIC/5. Using the "XEQ" command available in the SOLOS command mode, we load the BASIC/5 program into the computer's memory from cassette tape. With this command BASIC/5 is ready for use as soon as the tape has stopped moving. The control of the computer is now taken over by the BASIC/5 program now in memory, and SOLOS is no longer in command. All the features of BASIC/5 language are now available to us, with a new set of commands and rules. Since the CPU of the computer only understands the machine language of the first level of software, the BASIC/5 program must translate the commands and data we enter to this lower level. BASIC/5 does this as we go. While we are using BASIC/5, we still have access to some of the commands and features of SOLOS, although they may have a modified form while we are in BASIC/5. We will load and use BASIC/5 later in this section.

The third level of software consists of programs written using the higher order languages of the second level programs. A program written in BASIC/5 is on this third level. This program only makes sense to the computer while the computer has BASIC/5 in memory and control has been transferred to the BASIC/5 program. Third level programs written in any high level language are often called "applications programs" since they are usually written in order to fit a specific application need.

The ALS-8 Program Development System is another second level program. A program to be developed within ALS-8 would then be a third-level application program. The ALS-8 also includes an Assembler which takes a program written on the third level in "assembly" language, and translates it to object code which the computer can run. The object code version then resides in memory and can be run in another operation. For a further discussion of types of software see the article "Your Personal Genie" in Appendix VIII of this manual.

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## 7.3.2 Terminal Mode

Sol operates as a CRT terminal in this mode, capable of sending keyboard data to an output port and displaying data received at the serial input port on an external video monitor via the Sol video display circuitry. When Sol is "hard-wired" to another computer or connected to a modem, the terminal mode is used for data entry, data retrieval, inquiry/response and monitoring and control applications.

SOLOS Personality Modules permit operation as a CRT terminal. SOLOS 1) enters the terminal mode when given the "TERM" (terminal) command and 2) sends keyboard data to any output port available with the "SET O" (set out) command.

## 7.4 GETTING ACQUAINTED WITH Sol

One of the best ways to get acquainted with your Sol is to use it. After connecting a cassette recorder and video monitor to your Sol, you will operate the system in the terminal mode to become familiar with the keyboard and the functions of the video display switches. You will then switch to the command mode and perform some of the basic computer operations.

## 7.4.1 Monitor and Cassette Recorder Connections

The basic Sol system consists of the Sol, a video monitor for display (e.g., the Processor Technology PT-872 TV-Video Monitor by Panasonic) and a cassette recorder for external storage (e.g., the Panasonic Model RQ-413S or Realistic CTR-21).

NOTE

Refer to Paragraph 7.9.1 on Page VII-26 before connecting your cassette recorder into the basic Sol system.

To connect these three system components, you will need the following cables:

Audio In & Out Cables--two cables of shielded wire fitted with miniature phone plugs at both ends.

Motor 1 Cable--one cable pair, such as speaker wire, fitted with subminiature phone plugs at both ends. (An identical cable for Motor 2 is needed if you use two recorders.)

Video Cable--one RG59/U coaxial cable fitted with a PL259 UHF male connector on one end and a monitor-compatible connector on the other.

Connect the basic Sol system as follows (refer to Figure 7-1 on Page VII-6):

- ( ) Step 1. Remove top and keyboard covers from Sol.
- ( ) Step 2. Plug one end of Audio In Cable into Audio IN jack (J7) on Sol rear panel, and plug other end into MONITOR or EARPHONE jack on recorder.
- ( ) Step 3. Plug one end of Audio Out Cable into Audio OUT jack (J6) on Sol rear panel, and plug other end into AUXILIARY jack on recorder.

NOTE

The use of the MICROPHONE input is no longer recommended.

- ( ) Step 4. Plug one end of Motor 1 Cable into Motor 1 jack (J8) on Sol rear panel, and plug other end into REMOTE jack on recorder.
- ( ) Step 5. Connect PL259 UHF connector on Video Cable to video output connector on Sol rear panel, and connect other end to video monitor input connector.
- ( ) Step 6. Make sure monitor, recorder and Sol power switches are in their OFF position. Then connect AC power cord to AC receptacle on Sol rear panel and connect Sol, monitor and recorder to appropriate power source.

#### 7.4.2 Terminal Mode Operation

The following procedure assumes your Sol is equipped with a SOLOS personality module.

- ( ) Step 7. Set Sol control switches as follows (see Figure 7-2 on Page VII-7):

RST Switch (S1-1): OFF

S1-2 (spare): OFF

BLANK Switch (S1-3): OFF (display control characters)

POLARITY Switch (S1-4): OFF (reverse video display)

BLINK Switch (S1-5): OFF (solid cursor)

SOLID Switch (S1-6): ON (solid cursor)

(Step 7 continued on Page VII-7.)

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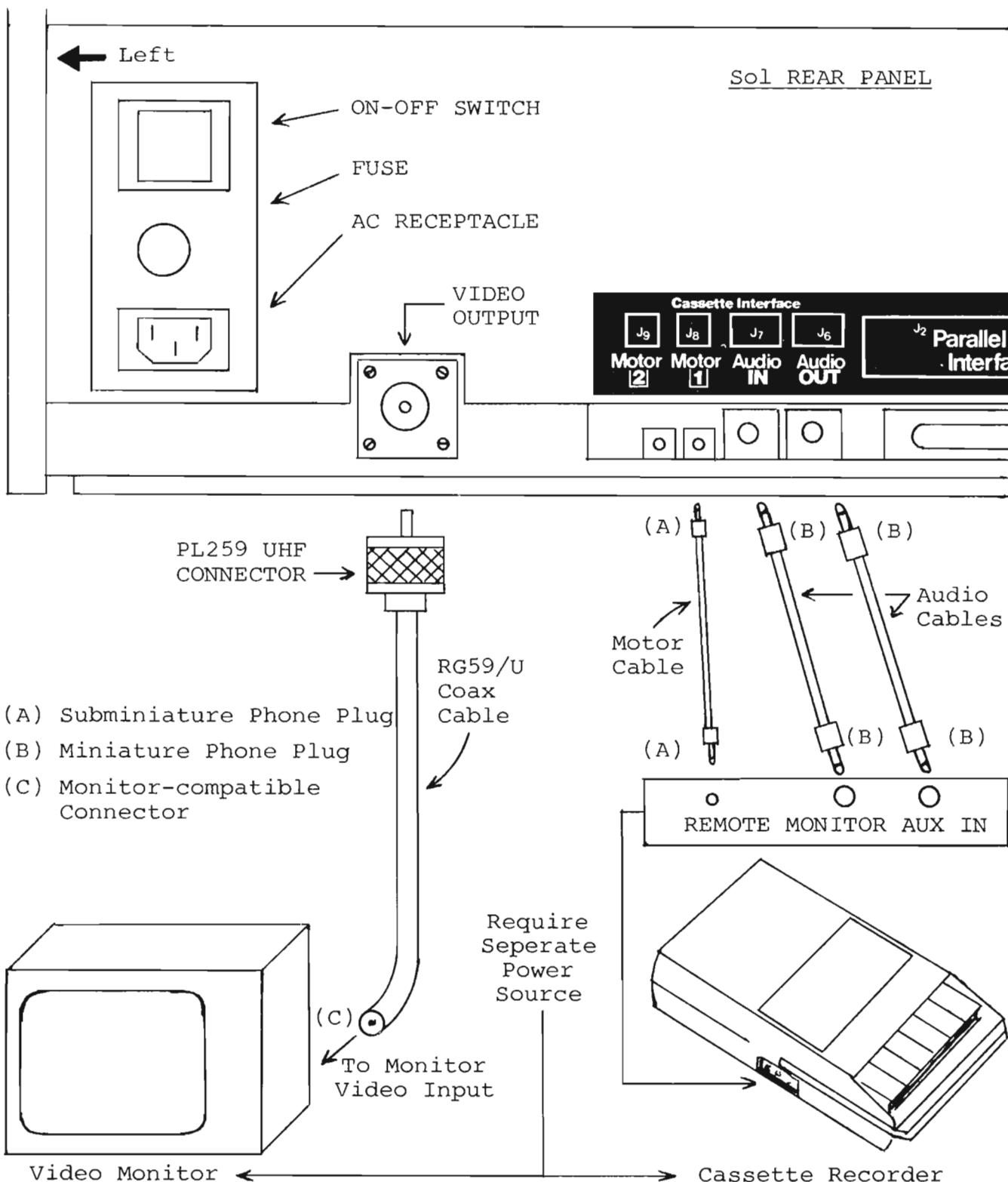


Figure 7-1. Connecting the basic Sol system.

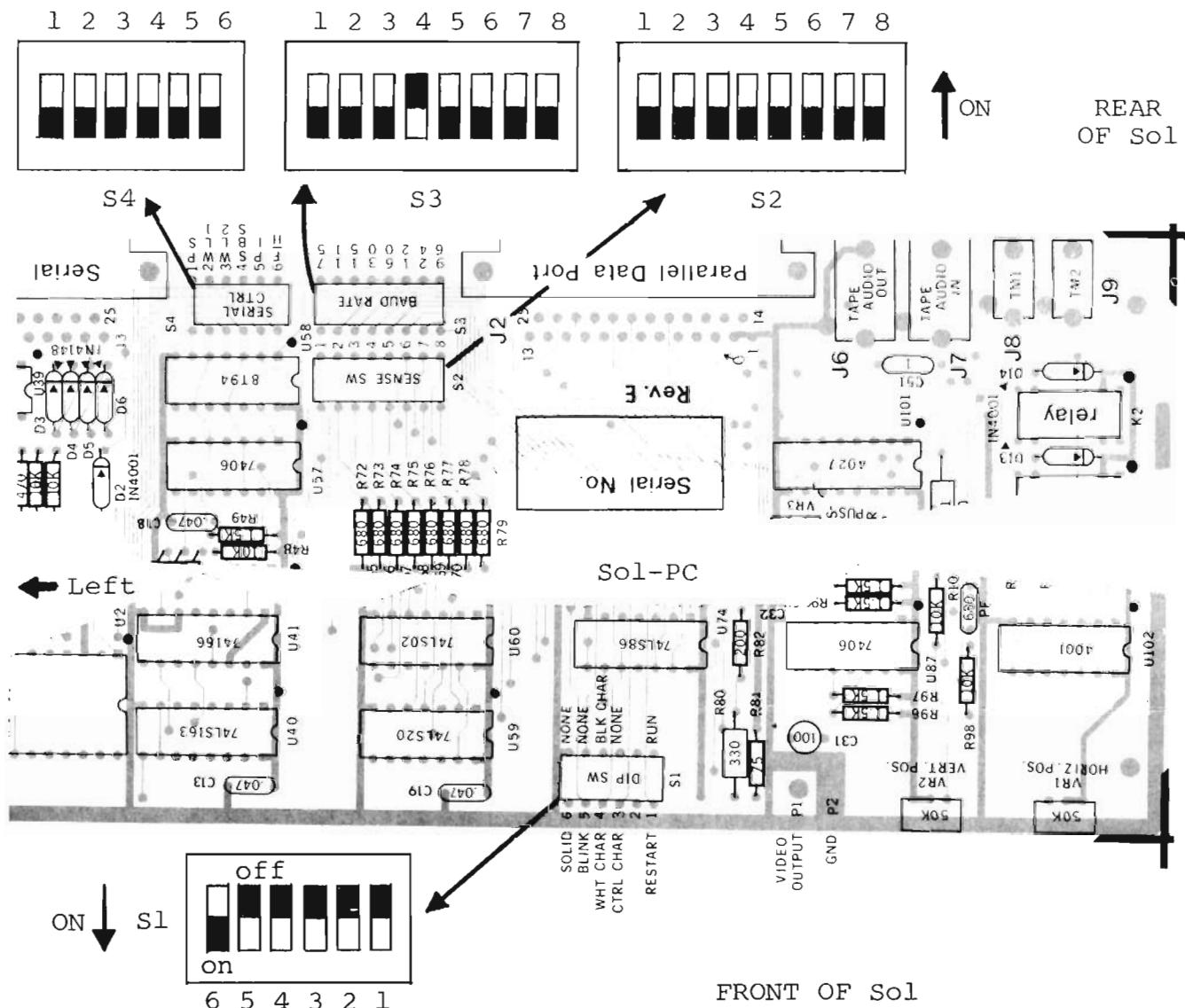


Figure 7-2. Sol control switch settings for terminal mode.

(Step 7 continued.)

SSW Switches (S2-1 - 8): OFF

BAUD RATE Switches (S3-1 - 8): S3-4 ON, all others OFF  
(300 Baud)

SDI Switches (S4-1 - 6): OFF (selects full duplex operation,  
8 data bits, 2 stop bits and no parity)

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- ( ) Step 8. Turn Sol and monitor on.
  - ( ) Step 9. If the monitor display raster is out of sync (black horizontal bar moves slowly down screen, numerous black lines cut across raster, or both), adjust monitor vertical and horizontal hold controls for a stable raster.
  - ( ) Step 10. You should see a prompt character followed by the cursor (>) in the upper left corner of the screen. If you don't, adjust VR1 and VR2 (see Figure 7-3) to move the prompt character and cursor onto the screen.

## NOTE

Use VR1 (horizontal position) and VR2 (vertical position) to center the display page (16 lines, 64 characters/line) on the screen.

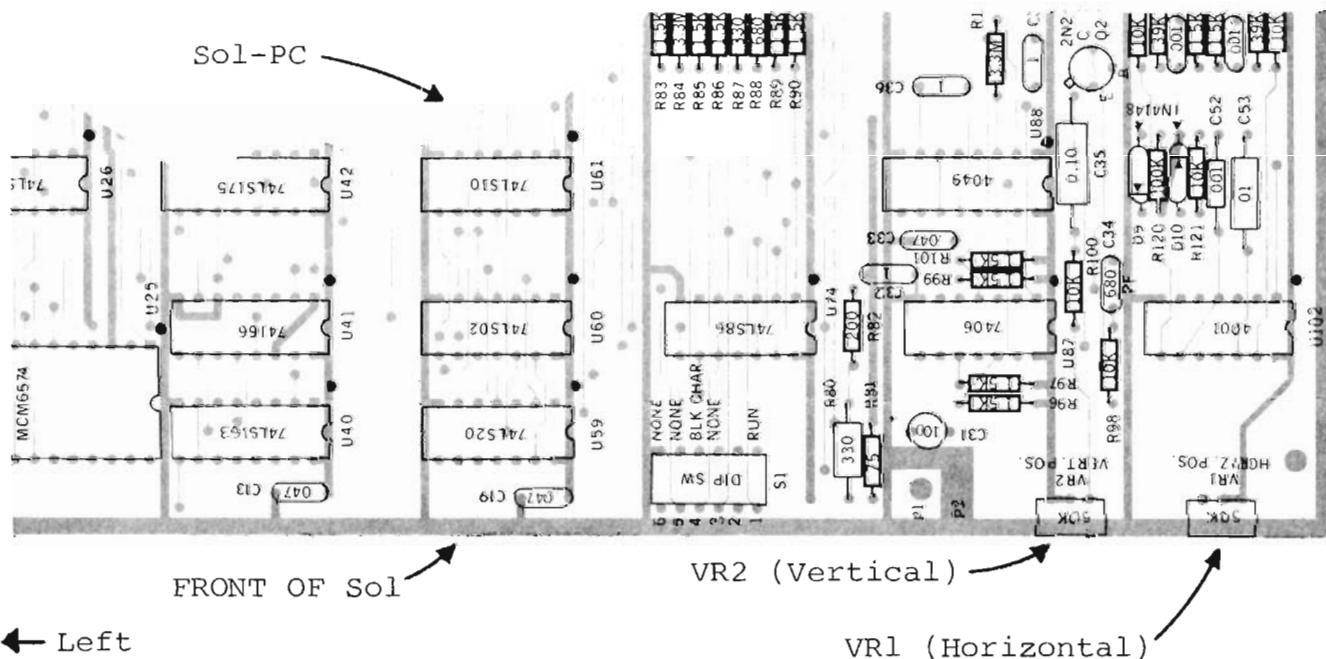


Figure 7-3. Location of positioning adjustments, VR1 and VR2.

- ( ) Step 11. Enter terminal mode by 1) pressing UPPER CASE key to turn the indicator light on (Alphabetic characters are now entered as upper case, regardless of SHIFT key status, but dual character keys do respond to SHIFT key.), 2) typing TERM and 3) pressing RETURN key. "TERM" will appear on the screen as you type, and the cursor will disappear when you press the RETURN key.

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NOTE: All commands must be given in upper case characters in order to be recognized, and the RETURN key must be pressed after a command so that SOLOS can execute the command (MODE SELECT excepted).

- ( ) Step 12. Set for local operation by pressing LOCAL key to turn indicator light on. Set for lower case operation by pressing UPPER CASE again (indicator light out).
- ( ) Step 13. Press each of the alphanumeric, punctuation and symbol keys. As each is pressed, the lower case character in the UNSHIFTED column of Table 7-4 should appear on the screen. Read Section 7.7 on page VII-17 to become familiar with Table 7-4.

NOTE: If the MODE SELECT key is pressed, SOLOS will return to the command mode and display a prompt character followed by the cursor. In this case return to terminal mode by typing "TERM" in upper case letters, followed by a carriage return.

- ( ) Step 14. Press SHIFT LOCK key to return keyboard to shifted operation (indicator light will go out) and repeat Step 13. Each corresponding upper case character should appear from the SHIFTED column of Table 7-4.
- ( ) Step 15. Use the control sequences given in Table 7-4 on Page VII-18 to generate the indicated control characters. Control characters are generated by pressing the CTRL (control) key and, while holding it depressed, pressing the desired key given in the first column of the table. As the table shows in the last two columns, the symbol generated by a control sequence depends on whether a 6574 or 6575 character generator (U25) is installed in your Sol. Two examples follow:

| <u>CONTROL SEQUENCE</u> | <u>6574 SYMBOL</u> | <u>6575 SYMBOL</u> |
|-------------------------|--------------------|--------------------|
| CTRL and I              | →                  | H <sub>T</sub>     |
| CTRL and 5 or %         | ☒                  | E <sub>Q</sub>     |

- ( ) Step 16. Change video display polarity by setting POLARITY Switch (S1-4) to ON and observe the effect on the display. It should change from black characters on a white background to white characters on a black background.
- ( ) Step 17. Switch from non-blinking cursor to a blinking cursor by setting SOLID Switch (S1-6) to OFF and BLINK Switch (S1-5) to ON in that order. You should see a rectangular solid cursor that blinks on and off approximately two times per second. Never put S1-5 and S1-6 ON at the same time.
- ( ) Step 18. Blank control characters by setting BLANK Switch (S1-3) to ON. Any control characters generated (refer to Step 15) should not appear on the screen.

Up to this point, keyboard data has been processed by the CPU, transmitted out through the serial channel output, looped back

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to the serial channel input and then displayed on the video monitor. You have consequently just "tested" the CPU, serial channel and display section functions in your Sol.

7.4.3 Command Mode Operation

The following operations assume your Sol is equipped with a SOLOS personality module.

Using the Cassette Recorder. The following procedure for loading a program from cassette tape into Sol memory provides a good example of how to use an audio cassette recorder with Sol. In this example you will use the BASIC/5 cassette supplied with your Sol. Other cassettes supplied by Processor Technology, such as Extended Cassette BASIC, TREK-80, etc., may be loaded using this procedure also.

Often the same program may be recorded more than once on the same cassette to provide protection against accidental damage or erasure. If difficulty is experienced loading a program, try the same procedure with the other redundant recordings. Cassettes supplied by other manufacturers must be recorded in "CUTS" format to be read using SOLOS commands. Check the format of cassettes before purchasing or using them.

CAUTION

Most software provided by Processor Technology and other manufacturers is subject to legal protection, including copyright. Unauthorized duplication and purchase or use of unauthorized copies may constitute a crime.

- ( ) Step 19. Set POLARITY (S1-4) and BLANK (S1-3) Switches as desired.
- ( ) Step 20. Replace top and keyboard covers.
- ( ) Step 21. Load BASIC/5 cassette in recorder. If required, fully rewind tape. (This can be done by disconnecting the REMOTE plug from the recorder and using the REWIND control on the recorder.) After rewinding, reconnect REMOTE plug.
- ( ) Step 22. Set the following recorder controls and indicator, if so equipped, as indicated:

Transport: press STOP control

Volume: 2/3 full volume

Tone: midrange

Tape Counter: Ø

- ( ) Step 23. Press PLAY control on recorder. The tape should not move. If it does, there is a malfunction in the remote control circuitry or cabling. (With Sol off, there should be no continuity between the REMOTE plug contacts.)

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NOTE

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

- ( ) Step 24. SOLOS initializes in the command mode whenever Sol is turned on. You should see a prompt character followed by the cursor (█) on the left of the screen.
- ( ) Step 25. Type the XEQ command as follows:

XEQ BASIC

- ( ) Step 26. Press the RETURN key on Sol. The cursor should disappear and the tape should advance. The display should not change otherwise. NOTE: 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," retype the XEQ BASIC command. If further difficulty is encountered, try different cassette recorder volume settings until a reliable setting is found.
- ( ) Step 27. If the tape has loaded successfully, in approximately two minutes BASIC/5 will display five lines of text ending with:

SOL BASIC 5

READY

- ( ) Step 28. BASIC/5 is now ready for use. Refer to your BASIC/5 User's Manual. Become familiar with both BASIC/5 and the Sol keyboard. Try some exercises in BASIC/5.

Dump Operation. The dump operation displays memory data in hexadecimal on the video monitor. It can also be used with the appropriate SET command to output memory data to a hard-copy device (e.g., a printer). As an example, dump the first part of the SOLOS personality module (CØØØ through CØEØ) as follows:

- ( ) Step 29. Set UPPER CASE key so that the indicator is on. If you are still in BASIC/5, type the BASIC/5 command "BYE" at the beginning of a command line to re-enter SOLOS command mode. BASIC/5 remains in memory and may be returned to by typing a command line: "EXEC Ø".
- ( ) Step 30. Type the DUMP command as follows:

DUMP CØØØ CØEØ

- ( ) Step 31. Press RETURN key. Lines of 16 bytes of hexadecimal data will scroll (move) rapidly up the screen until the last address (CØEØ) is displayed. At this point the display will stop scrolling.

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Enter Operation. The enter operation is used to enter hexadecimal data from the keyboard into available Sol memory. As an example, enter 16 bytes of data, starting at address C900 and ending at address C90F, as follows:

- ( ) Step 32. Type the ENTER command as follows:

ENTER C900

- ( ) Step 33. Press RETURN key. The monitor should display a colon (:) prompt character at the start of the next line.

- ( ) Step 34. Type the following data:

11 22 33 44 55 66 77 88 99 00 AA BB CC DD EE FF/

NOTE

The slash (/) terminates the enter function.

- ( ) Step 35. If you made a mistake in typing the above line of data, refer to Paragraph 7.8.3 on Page VII-25. If you made no mistakes, press RETURN key.

The data entered in Step 34 now resides in locations C900 through C90F in the Sol memory.

- ( ) Step 36. To verify that the data did indeed enter Sol memory, simply give your Sol this DUMP command:

DUMP C900 C90F

Then press RETURN key. The line of data you entered in Step 35 should be displayed on the monitor screen, preceded by the starting address.

- ( ) Step 37. Using your SOLOS User's Manual, experiment with the other commands until you feel at home with your Sol.

The preceding command mode operations used the CPU, personality module, audio cassette interface (ACI) and the Sol RAM. You have consequently just tested the functions of these sections.

## 7.5 OPERATING CONTROLS IN DEPTH

Unless indicated otherwise, the location of the controls described in this paragraph are shown on the Sol-PC assembly drawing in Section X, Page X-5.

## 7.5.1 ON-OFF Switch (See Figure 7-1 on page VII-6.)

Push this switch in to turn your Sol on. In the ON position the switch remains locked in its "in" position. To turn your Sol off, push the switch again. This releases the locking mechanism, and the switch will return to its OFF ("out") position.

## 7.5.2 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 initialize the Sol circuitry and reset the CPU program counter to zero. (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.)

## 7.5.3 Control Character Blanking (BLANK) Switch, S1-3

Set this switch to its ON position if you do not want control characters (see Table 7-4 on Page VII-18) to be displayed on the screen. In the OFF position, control characters are displayed.

## 7.5.4 Video Display (POLARITY) Switch, S1-4

If you want a normal video display (white characters on a black background), set this switch to its ON position. In the OFF position, black characters will be displayed on a white background (reverse video display).

## 7.5.5 Cursor Selection (BLINK, SOLID) Switches, S1-5 &amp; 6

CAUTION

DO NOT SET S1-5 AND S1-6 TO THEIR ON POSITIONS AT THE SAME TIME. TO DO SO MAY DAMAGE YOUR SOL.

If you want the cursor to blink, set S1-6 to OFF and S1-5 to ON. The cursor will blink on and off about two times per second.

Set S1-5 to OFF and S1-6 to ON if you want a non-blinking (solid) cursor.

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

7.5.6 Sense (SSW $\emptyset$  - 7) Switches, S2-1 through S2-8

These eight switches are normally left in the OFF position. They are used to manually enter data into the CPU. (They serve the same function as the front panel sense switches on the Altair 8800 and IMSAI 8080.)

S2-1 is the least significant data bit (DIO $\emptyset$ ) and S2-8 is the most significant data bit (DIO7). To pull a DIO bit low (when the program tests SSW $\emptyset$  - 7), set the switch associated with the bit to ON. An open (OFF) switch pulls the associated DIO bit high when the program tests SSW $\emptyset$  - 7.

NOTE

The configuration of SSW $\emptyset$  - 7 is tested by the CPU only when it executes an input port FF instruction. Otherwise, the Sense Switches have no bearing on Sol operation.

#### 7.5.7 Baud Rate Switches, S3-1 through S3-8

The setting of the Baud Rate Switches determines the operating speed of the Serial Data Interface (SDI). Assuming you have not installed any of the K, L and M jumper options, you can select any one of eight Baud rates. Table 7-2 on page VII-15 defines Baud rate as a function of S3-1 through S3-8.

CAUTION

DO NOT SET MORE THAN ONE S3 SWITCH TO THE  
ON POSITION AT THE SAME TIME. TO DO SO  
CAN DAMAGE YOUR Sol.

#### 7.5.8 Parity (PS, PI) Switches, S4-1 & 5

With these two switches you can select no parity, parity, even parity or odd parity for data handled through the SDI (J1).

Set S4-5 (PI) to its ON position if you want a parity bit. When OFF, there will be no parity bit. (A stop bit immediately follows the data if no parity bit is selected.)

S4-1 (PS) selects even or odd parity if S4-5 is ON. It otherwise has no affect. For even parity, set S4-1 to OFF. Set S4-1 ON for odd parity.

#### 7.5.9 Data Word Length (WLS-1 & 2) Switches, S4-2 & 3

Use these two switches to select the number of bits, excluding parity, in the transmitted word for the SDI. You have a choice of 5, 6, 7 or 8 bits. Table 7-3 defines word length as a function of S4-2 and S4-3.

#### 7.5.10 Stop Bit Selection (SBS) Switch, S4-4

Set this switch to ON if you want one stop bit transmitted out of the SDI. In the OFF position, two stop bits are transmitted unless you have selected a five bit word length. In that case 1.5 stop bits are transmitted.

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Table 7-2. Baud Rate Selection With Switch S3.

| BAUD RATE | SWITCH S3 CONFIGURATION* |
|-----------|--------------------------|
| 75        | S3-1 ON, all others OFF  |
| 110**     | S3-2 ON, all others OFF  |
| 150       | S3-3 ON, all others OFF  |
| 300       | S3-4 ON, all others OFF  |
| 600       | S3-5 ON, all others OFF  |
| 1200      | S3-6 ON, all others OFF  |
| 2400      | S3-7 ON, all others OFF  |
| 9600***   | S3-8 ON, all others OFF  |

\*Set no more than one switch to ON at the same time.

\*\*Rate required by standard 8-level TTY's (Teletype machine).

\*\*\*Assumes K-to-M jumper on Sol-PC is not installed. With K-M jumper in and L-M trace on back side of Sol-PC cut, SDI operates at 4800 Baud when S3-8 is ON and all others OFF.

Table 7-3. Word Length Selection With S4-2 &amp; 3.

| WORD LENGTH<br>(Number of Bits) | SWITCH SETTINGS |      |
|---------------------------------|-----------------|------|
|                                 | S4-2            | S4-3 |
| 5                               | ON              | ON   |
| 6                               | OFF             | ON   |
| 7                               | ON              | OFF  |
| 8                               | OFF             | OFF  |

## 7.5.11 Full/Half Duplex (F/H) Switch, S4-6

Set this switch to ON if you want half duplex operation in the terminal mode. In half duplex operation, data transmitted out the SDI (J1) is "looped back" and received by the SDI for subsequent

display on the monitor. Use this type of operation when your Sol works with an external computer that does not "echo" data back to the Sol.

For full duplex operation in the terminal mode, set S4-6 to OFF. Only received data is displayed in full duplex operation. Use full duplex when Sol's transmitted data need not be displayed. (Note that transmitted data from the Sol, if echoed back, is displayed as received data.)

#### NOTE

If no Baud rate is selected, data will not be transmitted out of the SDI.

#### 7.5.12 Keyboard

The keyboard is an output device that produces ASCII (American Standard Code for Information Interchange) encoded data. It is hard-wired to an input port on the Sol and is used for data entry. ASCII data is interpreted by the Sol as data and/or commands as determined by the current system monitor program. The monitor program may be in the personality module, ALS-8, Sol RAM memory or some memory.

### 7.6 THE KEYBOARD, GENERAL DESCRIPTION

The Sol Terminal Computer has an ASCII 96-character keyboard. Its key arrangement conforms with the QWERTY (standard typewriter) format. As shown in the photo on page X-20 in Section X, there are also 12 control keys (including five basic cursor controls) and seven special function keys. A 15-key arithmetic pad is also provided on the Sol-20.

#### 7.6.1 Operating Features

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, however, are in the order of actual key closures. (The keyboard circuitry includes a scanning circuit that prevents simultaneous key operation.)

#### 7.6.2 Keyboard Indicators

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 the key again turns the light out to indicate the change in status.

## 7.7 INDIVIDUAL KEY DESCRIPTIONS

The exact function of most keys on the Sol keyboard is determined by the software used (e.g., the personality module). Others have predefined functions that are common to the SOLOS Personality Modules. (Note that any key that generates a code can be redefined by a program to perform a specific function.) The code generated by each key on the keyboard and the corresponding character, or symbol, produced by the Sol's character generator (U25) are given in Table 7-4 on Pages VII-18 through VII-21.

Table 7-4 has two main headings: 1) KEY which identifies the keys on the Sol keyboard and 2) HEXADECIMAL CODE/CHARACTER GENERATION which specifies for each key the hexadecimal code generated by the keyboard and the symbol produced by the Sol's character generator. The second heading is divided into three major categories: UNSHIFTED, SHIFTED and CONTROL. UNSHIFTED defines the results when operating the keys unshifted (lower case), SHIFTED provides the same information when they are operated shifted (upper case), and CONTROL defines the results of control sequences (refer to Paragraph 7.7.7 on Page VII-22). Within each of these three categories you will find the hexadecimal code generated and the symbol displayed in response to that code by either of the two possible character generators that can be supplied with your Sol, the 6574 and 6575. Some keys move the cursor without displaying a new character.

Looking at the "W" entry on Page VII-18 and reading across the table, we see that:

1. Pressing "W" unshifted would generate the code 77 and either character generator (6574 or 6575) produces a lower case "W" (w). Do not actually press the keys at this point.
2. Pressing "W" shifted would generate the code 57 and either character generator would produce an upper case "W" (W).
3. Pressing CTRL (control) and "W", whether shifted or unshifted, generates the code 17 which causes the 6574 to produce the graphic symbol  for the ASCII "end of transmission block" control character and the 6575 to produce a two-character mnemonic (E<sub>B</sub>) for that same control character.

In the following paragraphs, each key function is described in terms of its role in the terminal mode only and assumes the control character display option is enabled and the LOCAL indicator light is on. Many key functions differ from these descriptions in SOLOS command modes BASIC/5, ALS-8, etc. As an aid to learning each key location, we suggest that you keep the keyboard photo, X-20, in view as you study these functions.

## 7.7.1 Alphanumeric-Punctuation-Symbol Keys

These keys enter the applicable character into the Sol.

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Table 7-4. Sol Keyboard Assignments.

| KEY #         | HEXADECIMAL CODE/CHARACTER GENERATION |                      |      |              |                      |      |              |                      |         |  |
|---------------|---------------------------------------|----------------------|------|--------------|----------------------|------|--------------|----------------------|---------|--|
|               | UNSHIFTED                             |                      |      |              | SHIFTED              |      |              |                      | CONTROL |  |
|               | Hex.<br>Code                          | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |         |  |
|               |                                       | 6574                 | 6575 |              | 6574                 | 6575 |              | 6574                 | 6575    |  |
| STANDARD KEYS |                                       |                      |      |              |                      |      |              |                      |         |  |
| ESCAPE        | 1B                                    | None                 | None | 1B           | None                 | E_C  | 1B           | None                 | None    |  |
| 1   !         | 31                                    | 1                    | 1    | 21           | !                    | !    | 01           | └                    | S_H     |  |
| 2   "         | 32                                    | 2                    | 2    | 22           | "                    | "    | 02           | └                    | S_X     |  |
| 3   #         | 33                                    | 3                    | 3    | 23           | #                    | #    | 03           | └                    | E_X     |  |
| 4   \$        | 34                                    | 4                    | 4    | 24           | \$                   | \$   | 04           | └                    | E_T     |  |
| 5   %         | 35                                    | 5                    | 5    | 25           | %                    | %    | 05           | └                    | E_Q     |  |
| 6   &         | 36                                    | 6                    | 6    | 26           | &                    | &    | 06           | └                    | A_K     |  |
| 7   '         | 37                                    | 7                    | 7    | 27           | '                    | '    | 07           | └                    | B_L     |  |
| 8   (         | 38                                    | 8                    | 8    | 28           | (                    | (    | 08           | └                    | B_S     |  |
| 9   )         | 39                                    | 9                    | 9    | 29           | )                    | )    | 09           | └                    | H_T     |  |
| Ø             | 30                                    | Ø                    | Ø    | 20           | None                 | None | 00           | None                 | None    |  |
| -   =         | 2D                                    | -                    | -    | 3D           | =                    | =    | 0D           | Return               | Return  |  |
| ^   ~         | 5E                                    | ^                    | ^    | 7E           | ~                    | ~    | 1E           | └                    | R_S     |  |
| [   {         | 5B                                    | [                    | [    | 7B           | {                    | {    | 1B           | None                 | None    |  |
| \   :         | 5C                                    | \                    | :    | 7C           | :                    | :    | 1C           | └                    | F_S     |  |
| ]   }         | 5D                                    | ]                    | ]    | 7D           | }                    | }    | 1D           | └                    | G_S     |  |
| BREAK         | None                                  | None                 | None | None         | None                 | None | None         | None                 | None    |  |
| TAB           | 09                                    | →                    | H_T  | 09           | →                    | H_T  | 09           | →                    | H_T     |  |
| Q             | 71                                    | q                    | q    | 51           | Q                    | Q    | 11           | ⊕                    | D_1     |  |
| W             | 77                                    | w                    | w    | 57           | w                    | w    | 17           | └                    | E_B     |  |
| E             | 65                                    | e                    | e    | 45           | E                    | E    | 15           | └                    | E_Q     |  |
| R             | 72                                    | r                    | r    | 52           | R                    | R    | 12           | ⊕                    | D_2     |  |
| T             | 74                                    | t                    | t    | 54           | T                    | T    | 14           | ⊕                    | D_4     |  |
| Y             | 79                                    | y                    | y    | 59           | Y                    | Y    | 19           | •                    | E_M     |  |
| U             | 75                                    | u                    | u    | 55           | U                    | U    | 15           | └                    | N_K     |  |
| I             | 69                                    | i                    | i    | 49           | I                    | I    | 09           | →                    | H_T     |  |

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Table 7-4. Sol Keyboard Assignments. (Continued)

| KEY #                     | HEXADECIMAL CODE/CHARACTER GENERATION |                      |                |              |                      |                |              |                      |                |  |
|---------------------------|---------------------------------------|----------------------|----------------|--------------|----------------------|----------------|--------------|----------------------|----------------|--|
|                           | UNSHIFTED                             |                      |                | SHIFTED      |                      |                | CONTROL      |                      |                |  |
|                           | Hex.<br>Code                          | Symbol<br>Displayed* |                | Hex.<br>Code | Symbol<br>Displayed* |                | Hex.<br>Code | Symbol<br>Displayed* |                |  |
|                           |                                       | 6574                 | 6575           |              | 6574                 | 6575           |              | 6574                 | 6575           |  |
| STANDARD KEYS (Continued) |                                       |                      |                |              |                      |                |              |                      |                |  |
| O                         | 6F                                    | o                    | o              | 4F           | O                    | O              | 0F           | o                    | S <sub>I</sub> |  |
| P                         | 70                                    | p                    | p              | 50           | P                    | P              | 10           | █                    | D <sub>L</sub> |  |
| @   ,                     | 40                                    | @                    | @              | 60           | ,                    | ,              | 00           | None                 | None           |  |
| RETURN                    | 0D                                    | ←                    | C <sub>R</sub> | 0D           | ←                    | C <sub>R</sub> | 0D           | Return               | Return         |  |
| LINE FEED                 | 0A                                    | Line Feed            | Line Feed      | 0A           | Line Feed            | Line Feed      | 0A           | Line Feed            | Line Feed      |  |
| CTRL                      | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| SHIFT LOCK                | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| A                         | 61                                    | a                    | a              | 41           | A                    | A              | 01           | Γ                    | S <sub>H</sub> |  |
| S                         | 73                                    | s                    | s              | 53           | S                    | S              | 13           | ⊕                    | D <sub>3</sub> |  |
| D                         | 64                                    | d                    | d              | 44           | D                    | D              | 04           | ↙                    | E <sub>T</sub> |  |
| F                         | 66                                    | f                    | f              | 46           | F                    | F              | 06           | ↙                    | A <sub>K</sub> |  |
| G                         | 67                                    | g                    | g              | 47           | G                    | G              | 07           | ⤻                    | B <sub>L</sub> |  |
| H                         | 68                                    | h                    | h              | 48           | H                    | H              | 08           | ⤻                    | B <sub>S</sub> |  |
| J                         | 6A                                    | j                    | j              | 4A           | J                    | J              | 0A           | Line Feed            | Line Feed      |  |
| K                         | 6B                                    | k                    | k              | 4B           | K                    | K              | 0B           | ↓                    | V <sub>T</sub> |  |
| L                         | 6C                                    | l                    | l              | 4C           | L                    | L              | 0C           | ↓                    | F <sub>F</sub> |  |
| ;                         | 3B                                    | ;                    | ;              | 2B           | +                    | +              | 0B           | ↓                    | V <sub>T</sub> |  |
| :                         | 3A                                    | :                    | :              | 2A           | *                    | *              | 0A           | Line Feed            | Line Feed      |  |
| DEL   _                   | 7F                                    | None                 | None           | 5F           | Delete               | Delete         | 1F           | □                    | U <sub>S</sub> |  |
| REPEAT                    | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| CTRL                      | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| UPPER CASE                | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| SHIFT                     | None                                  | None                 | None           | None         | None                 | None           | None         | None                 | None           |  |
| Z                         | 7A                                    | z                    | z              | 5A           | Z                    | Z              | 1A           | \$                   | S <sub>B</sub> |  |
| X                         | 78                                    | x                    | x              | 58           | X                    | X              | 18           | ✗                    | C <sub>N</sub> |  |
| C                         | 63                                    | c                    | c              | 43           | C                    | C              | 03           | ⤻                    | E <sub>X</sub> |  |

\*See notes at end of this table, Page VII-21.

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Table 7-4. Sol Keyboard Assignments. (Continued)

| KEY #                     | HEXADECIMAL CODE/CHARACTER GENERATION |                      |      |              |                      |      |              |                      |                |  |
|---------------------------|---------------------------------------|----------------------|------|--------------|----------------------|------|--------------|----------------------|----------------|--|
|                           | UNSHIFTED                             |                      |      |              | SHIFTED              |      |              |                      | CONTROL        |  |
|                           | Hex.<br>Code                          | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |                |  |
|                           |                                       | 6574                 | 6575 |              | 6574                 | 6575 |              | 6574                 | 6575           |  |
| STANDARD KEYS (Continued) |                                       |                      |      |              |                      |      |              |                      |                |  |
| V                         | 76                                    | v                    | v    | 56           | V                    | V    | 16           |                      | S <sub>Y</sub> |  |
| B                         | 62                                    | b                    | b    | 42           | B                    | B    | 02           |                      | S <sub>X</sub> |  |
| N                         | 6E                                    | n                    | n    | 4E           | N                    | N    | 0E           |                      | S <sub>O</sub> |  |
| M                         | 60                                    | m                    | m    | 40           | M                    | M    | 0D           | Return               | Return         |  |
| ,                         | 2C                                    | ,                    | ,    | 3C           | <                    | <    | 0C           |                      | F <sub>F</sub> |  |
| .                         | 2E                                    | .                    | .    | 3E           | >                    | >    | 0E           |                      | S <sub>O</sub> |  |
| / ?                       | 2F                                    | /                    | /    | 3F           | ?                    | ?    | 0F           |                      | S <sub>I</sub> |  |
| SHIFT                     | None                                  | None                 | None | None         | None                 | None | None         | None                 | None           |  |
| LOCAL                     | None                                  | None                 | None | None         | None                 | None | None         | None                 | None           |  |
| Space Bar                 | 20                                    | None                 | None | 20           | None                 | None | 20           | None                 | None           |  |
| ARITHMETIC PAD KEYS       |                                       |                      |      |              |                      |      |              |                      |                |  |
| -                         | 2D                                    | -                    | -    | 2D           | -                    | -    | 2D           | -                    | -              |  |
| *                         | 2A                                    | *                    | *    | 2A           | *                    | *    | 2A           | *                    | *              |  |
| ÷                         | 2F                                    | /                    | /    | 2F           | /                    | /    | 2F           | /                    | /              |  |
| 7                         | 37                                    | 7                    | 7    | 37           | 7                    | 7    | 37           | 7                    | 7              |  |
| 8                         | 38                                    | 8                    | 8    | 38           | 8                    | 8    | 38           | 8                    | 8              |  |
| 9                         | 39                                    | 9                    | 9    | 39           | 9                    | 9    | 39           | 9                    | 9              |  |
| 4                         | 34                                    | 4                    | 4    | 34           | 4                    | 4    | 34           | 4                    | 4              |  |
| 5                         | 35                                    | 5                    | 5    | 35           | 5                    | 5    | 35           | 5                    | 5              |  |
| 6                         | 36                                    | 6                    | 6    | 36           | 6                    | 6    | 36           | 6                    | 6              |  |
| 1                         | 31                                    | 1                    | 1    | 31           | 1                    | 1    | 31           | 1                    | 1              |  |
| 2                         | 32                                    | 2                    | 2    | 32           | 2                    | 2    | 32           | 2                    | 2              |  |
| 3                         | 33                                    | 3                    | 3    | 33           | 3                    | 3    | 33           | 3                    | 3              |  |
| Ø                         | 30                                    | Ø                    | Ø    | 30           | Ø                    | Ø    | 30           | Ø                    | Ø              |  |
| .                         | 2E                                    | .                    | .    | 2E           | .                    | .    | 2E           | .                    | .              |  |
| +                         | 2B                                    | +                    | +    | 2B           | +                    | +    | 2B           | +                    | +              |  |

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Table 7-4. Sol Keyboard Assignments. (Continued)

| KEY#         | HEXADECIMAL CODE/CHARACTER GENERATION |                      |      |              |                      |      |              |                      |         |              |
|--------------|---------------------------------------|----------------------|------|--------------|----------------------|------|--------------|----------------------|---------|--------------|
|              | UNSHIFTED                             |                      |      |              | SHIFTED              |      |              |                      | CONTROL |              |
|              | Hex.<br>Code                          | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |      | Hex.<br>Code | Symbol<br>Displayed* |         | Hex.<br>Code |
|              |                                       | 6574                 | 6575 |              | 6574                 | 6575 |              | 6574                 | 6575    |              |
| SPECIAL KEYS |                                       |                      |      |              |                      |      |              |                      |         |              |
| LOAD         | 8C                                    | None                 | FF   | 8C           | None                 | FF   | 8C           | None                 | FF      |              |
| MODE SELECT  | 80                                    | None                 | None | 80           | None                 | None | 80           | None                 | None    |              |
| ↑            | 97                                    | None                 | None | 97           | Ncne                 | None | 97           | None                 | None    |              |
| ←            | 81                                    | None                 | None | 81           | None                 | None | 81           | None                 | None    |              |
| →            | 93                                    | None                 | None | 93           | None                 | None | 93           | None                 | None    |              |
| ↓            | 9A                                    | None                 | None | 9A           | None                 | None | 9A           | None                 | None    |              |
| HOME CURSOR  | 8E                                    | None                 | None | 8E           | None                 | None | 8E           | None                 | None    |              |
| CLEAR        | 8B                                    | None                 | None | 8B           | None                 | None | 8B           | None                 | None    |              |

#Vertical line between characters indicates dual character key.

\*Character generated is displayable and transmittable. "None" means no code is generated or no symbol is displayed. Return is defined in Section 7.7.11, and line feed in Section 7.7.12, on page VII-24.

## 7.7.2 Space Bar

Pressing the Space Bar, shifted or unshifted, generates the ASCII space code (20) and moves the cursor one space to the right.

## 7.7.3 Arithmetic Pad Keys

Except for the division symbol key (÷), these keys enter the applicable character into the Sol. The division symbol key enters a forward slash (/) character. SHIFT does not affect these keys.

The arithmetic pad is useful for entering large amounts of numerical data. Each key in the pad duplicates its corresponding numeric, period (decimal point), dash (minus), plus (addition), asterisk (multiplication) and forward slash (division) key in the "typewriter" group of keys. That is, pressing one of the pad keys does the same thing as pressing its corresponding key in the "typewriter" group.

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7.7.4 ESCAPE Key

Pressing ESCAPE, shifted or unshifted, generates the ASCII escape character (1B). The character is displayed.

7.7.5 BREAK Key

Pressing BREAK, shifted or unshifted, forces the SDI output line to a space level for as long as the key is depressed. No character is displayed. (Some communications systems use this feature.)

7.7.6 TAB Key

Pressing TAB, shifted or unshifted, generates the ASCII horizontal tab character (09). The character is displayed.

7.7.7 Control (CTRL) Key

CTRL, shifted or unshifted, is used with alphanumeric, punctuation and symbol keys to initiate functions or generate the characters defined in Table 7-4. Table 7-5 defines the ASCII control characters. The characters in Table 7-5 are not always displayed on the video monitor.

A control sequence (e.g., CTRL plus J, which produces ASCII line feed) requires that CTRL be pressed first and held down while the other key or keys are pressed in sequence.

7.7.8 SHIFT Key and SHIFT LOCK Key/Indicator

The SHIFT key generates no code and is thus not displayed. It is interpreted as a direct internal operation, and when pressed specifically shifts the keyboard from lower case to upper case and from the lower to upper character on dual character keys as on a typewriter. The keyboard remains in upper case as long as SHIFT is held down.

Pressing SHIFT LOCK to turn the indicator light on electronically locks the SHIFT key in the upper case position. Again, no code is generated and no character is displayed. Pressing SHIFT returns the keyboard to lower case and causes the SHIFT LOCK indicator light to go out.

7.7.9 UPPER CASE Key/Indicator

Pressing this key, shifted or unshifted, to turn the indicator light on activates the upper case keyboard function so that all alphabetic characters entered from the keyboard, regardless of SHIFT key status, are transmitted as upper case characters. (Dual character keys, however, do respond to the SHIFT key.) With the indicator light on, the SOL keyboard essentially simulates a teletype (TTY) keyboard.

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

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Table 7-5. Control Character Symbols and Definitions.

| HEXADECIMAL<br>CODE | SYMBOL GENERATED BY |                | DEFINITION                |
|---------------------|---------------------|----------------|---------------------------|
|                     | 6574 Generator      | 6575 Generator |                           |
| 06                  | ✓                   | AK             | Acknowledge               |
| 07                  | ¤                   | BL             | Bell                      |
| 08                  | ↶                   | BS             | Backspace                 |
| 18                  | ☒                   | CN             | Cancel                    |
| 0D                  | ←                   | CR             | Carriage Return           |
| 11                  | ⌚                   | D1             | Device Control 1          |
| 12                  | ⌚⌚                  | D2             | Device Control 2          |
| 13                  | ⌚⌚⌚                 | D3             | Device Control 3          |
| 14                  | ⌚⌚⌚⌚                | D4             | Device Control 4          |
| 7F                  | ☒☒                  | DL             | Delete                    |
| 10                  | □                   | EB             | Data Link Escape          |
| 17                  | —                   | EC             | End of Transmission Block |
| 1B                  | ⊖                   | EM             | Escape                    |
| 19                  | •                   | EQ             | End of Medium             |
| 05                  | ☒                   | ET             | Enquiry                   |
| 04                  | ↙ ↘ ↙ ↘             | EX             | End of Transmission       |
| 03                  | ↙ ↘ ↙ ↘             | FF             | End of Text               |
| 0C                  | □□                  | FS             | Form Feed                 |
| 1C                  | □□                  | GS             | File Separator            |
| 1D                  | □□                  | HT             | Group Separator           |
| 09                  | →                   | LF             | Horizontal Tab            |
| 0A                  |                     | NK             | Line Feed                 |
| 15                  | ✗                   | NU             | Negative Acknowledge      |
| 00                  | □                   | RS             | Null                      |
| 1E                  | ☒                   | SB             | Record Separator          |
| 1A                  | \$                  | SH             | Substitute                |
| 01                  | └                   | SI             | Start of Heading          |
| 0F                  | ◎                   | SO             | Shift In                  |
| 0E                  | ⊗                   | SX             | Shift Out                 |
| 02                  | ↑                   | SY             | Start of Text             |
| 16                  | └                   | US             | Synchronous Idle          |
| 1F                  | ·□                  | VT             | Unit Separator            |
| 0B                  | ↓                   |                | Vertical Tab              |

#### 7.7.10 LOCAL Key/Indicator

The LOCAL key internally connects the SDI output to the SDI input and disables serial transmission. No character is displayed. Pressing LOCAL, shifted or unshifted, to turn the indicator light on sets Sol for local operation. Keyboard entries are not transmitted, but they are "looped back" to the SDI input for display. That is, Sol is not on "line". Pressing LOCAL to turn the light off ends local operation. This corresponds to the local/line operation of a TTY.

#### 7.7.11 RETURN Key

Pressing RETURN, shifted or unshifted, generates the ASCII carriage return character ( $\emptyset D$ ), which is not displayed, and moves the cursor to the start of the line on which it resided prior to RETURN being depressed. (This is the same action as a TTY carriage return.) RETURN also erases all data in the line to the right of the cursor.

#### 7.7.12 LINE FEED Key

Pressing LINE FEED, shifted or unshifted, generates the ASCII line feed character ( $\emptyset A$ ), which is not displayed, and moves the cursor vertically downward one line. (This is the same action as a TTY line feed.) Line feed action does not erase any data in the line to the right of the cursor.

#### 7.7.13 LOAD Key

The LOAD key character is displayed, but the key is non-functional with SOLOS. The code generated by this key is 8C, and it may be used by a program to meet a specific need.

#### 7.7.14 REPEAT Key

The REPEAT key generates no character and is consequently not displayed. Pressing REPEAT, shifted or unshifted, and another key at the same time causes the other key to repeat at an approximate rate of 15 times per second as long as both keys are held down. Pressing REPEAT at the same time as UPPER CASE performs a restart. See Section 7.5.2 on page VII-13.

#### 7.7.15 MODE SELECT Key

Pressing this key, shifted or unshifted, generates the code 8Ø and causes Sol to enter the command mode.

#### 7.7.16 CLEAR Key

Pressing CLEAR, shifted or unshifted, erases the entire screen and moves the cursor to its "home" position (upper left corner of the screen).

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7.7.17 Cursor Control (HOME CURSOR and Arrows) Keys

Five keys control basic cursor movement. They are HOME CURSOR and the four keys with arrows. None are affected by SHIFT status, and none are displayed or transmitted.

Pressing HOME CURSOR moves the cursor to its home position--the first character position in the upper left corner of the screen.

To move the cursor up, down, left or right, press the applicable "arrow" key. Each time you press a key the cursor moves one unit in the direction you wish--one space horizontally or one line vertically. These keys may be used with REPEAT. The cursor will not move across any margin of the screen with these four keys.

7.8 BASIC OPERATIONS

7.8.1 Switching From Terminal To Command Mode

To switch from terminal to command mode, simply press the MODE SELECT key. Sol enters the command mode, issues a prompt character (>) and waits for a command input.

7.8.2 Switching From Command To Terminal Mode

To switch from command to terminal mode, press UPPER CASE, type TERM, and press RETURN in that order. Sol enters the terminal mode and all keyboard data will be sent to the SDI output and all data received (including "looped back" data) will appear on the screen.

7.8.3 Entering Commands in The Command Mode

The various commands for SOLOS are described in the SOLOS/CUTERS User's Manual.

You can place more than one command on the screen. For each command, use the arrowed cursor control keys to position the cursor at the start of a new line and begin the new command line with a prompt character (>).

A command is executed when you press the RETURN key, and all characters on the line to the left of the cursor are interpreted as the command. This means that if more than one command line is on the screen, you can execute any one of them as follows: position the cursor with the arrowed cursor control keys to the right of the desired command and press RETURN.

Should you make a mistake when entering a command, there are two ways to correct it:

(Paragraph 7.8.3 continued on Page VII-26.)

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1. If you see the error immediately (the error is to the immediate left of the cursor), press the DEL key (unshifted) to erase the mistake. Then make the correction.
2. If the error is more than one character position to the left of the cursor, use the arrowed cursor control keys to position the cursor over the mistake. Then make the correction.

### 7.8.4 Keyboard Restart

To perform a keyboard restart, press the UPPER CASE and REPEAT keys at the same time. This key combination performs the same function as a power on initialization or setting the RST switch to ON. Use the keyboard restart to return to SOLOS from 1) a program which does not recognize the MODE SELECT key or 2) a program that is stuck in an endless loop.

## 7.9 Sol-PERIPHERAL INTERFACING

### 7.9.1 Audio Cassette Recorders

Recorder Selection. 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:

1. Auxiliary Input. Though the Sol can be configured for use with the microphone input, such configuration is no longer recommended.
2. Digital (Tape) Counter. The counter is needed to locate files on the tape.
3. Tone Control. The existence of a tone control is one indication of high quality electronics.

#### NOTE

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, we suggest you test it before purchase, if possible, with a long file. Test it in both the record, or write, (SAVE) and playback, or read, (GET or XEQ) modes. If the recorder is unsatisfactory, you will either 1) get an error message in the read mode, 2) find differences, upon playback, in what you recorded in the write mode, or 3) both.

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

1. Use high quality brand-name tape. Cheap tape can wear down the recorder heads and give erratic results.
2. Bulk erase tapes before use.
3. Store cassettes in their protective plastic cases in a cool place when not in use. Cassettes are easily harmed by dirt, high temperatures, liquids and physical abuse.
4. Keep recorder heads cleaned and demagnetized in accordance with the manufacturer's instructions.
5. Keep the recorder at least a foot away from the Sol or any other equipment which can generate magnetic fields. The recorder can pick up hum which may cause errors.
6. Set volume control to about 2/3 full volume and the tone control at midrange. The Sol has automatic gain control that compensates for a wide range of levels, and operation in the middle of this range gives the most reliable results. Experiment to find the optimum setting for the volume and tone controls.

Interconnect Requirements. Your Sol is capable of controlling one or two recorders. The interconnect requirements for one recorder were previously covered in Paragraph 7.4.1 in this section.

Since the Sol has only one audio input and one audio output jack, however, the interconnect requirements for two recorders are somewhat different than for one.

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 Paragraph 7.4.1 in this section, miniature phone jack-to-two miniature phone plug adapters are required.) Since the recorder outputs are most likely unbalanced, we also suggest that you incorporate 1000 ohm resistors in the MONITOR adapter as shown in Figure 7-5 on Page VII-29. Figure 7-5 also illustrates, in schematic form, how to connect two recorders to your Sol.

When using two recorders you may read or write to both under program control as well as read one tape while writing on the other.

If you intend to read one tape while writing on the other, however, you may have to disconnect the MONITOR plug from the write unit, with the need for disconnect being determined by the recorder design. The MONITOR disconnect must be made if the recorder has a

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"monitor" output in the record mode. (Panasonic RQ-413S and RQ-309DS do, for example.)

NOTE 1

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 EARPHONE, the recorder usually does not provide a monitor output in the record mode.

NOTE 2

To determine if your recorder provides a monitor output in the record mode, install a blank tape, plug earphone into "monitor jack and microphone into MICROPHONE jack, set recorder controls to record, and speak into microphone while listening with the earphone. If you hear yourself through the earphone, your recorder does provide a monitor output in the record mode.

Write Operations. Other than placing the recorder(s) in the record mode, loading the cassette(s) and making sure that the head(s) is on tape (not leader), no manual operations are needed to write on tape.

NOTE

The MICROPHONE input can be live when recording through the AUXILIARY input on some recorders. Deactivate the MICROPHONE input according to the manufacturer's instructions. (In some cases this can be done by plugging a dummy plug into the MICROPHONE jack.)

In the case of two recorders, however, 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 User's Manual for instructions on how to use tape commands.

When recording more than one file on a tape side, we suggest you record (SAVE) a special file after the files of interest. This file, which could be named END, lets you know when you have read the last file of interest. Also, rewind the tape after recording the last file on a side, 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 1) tape counter reading, 2) exact file name, 3) load address and 4) file length. Then mark the cassette with this information to make file retrieval much easier.

Read Operations. In order to read a specific file on 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. Since all file searches are in the forward direction, the simplest approach is to fully rewind the cassette(s) before a read operation unless you know

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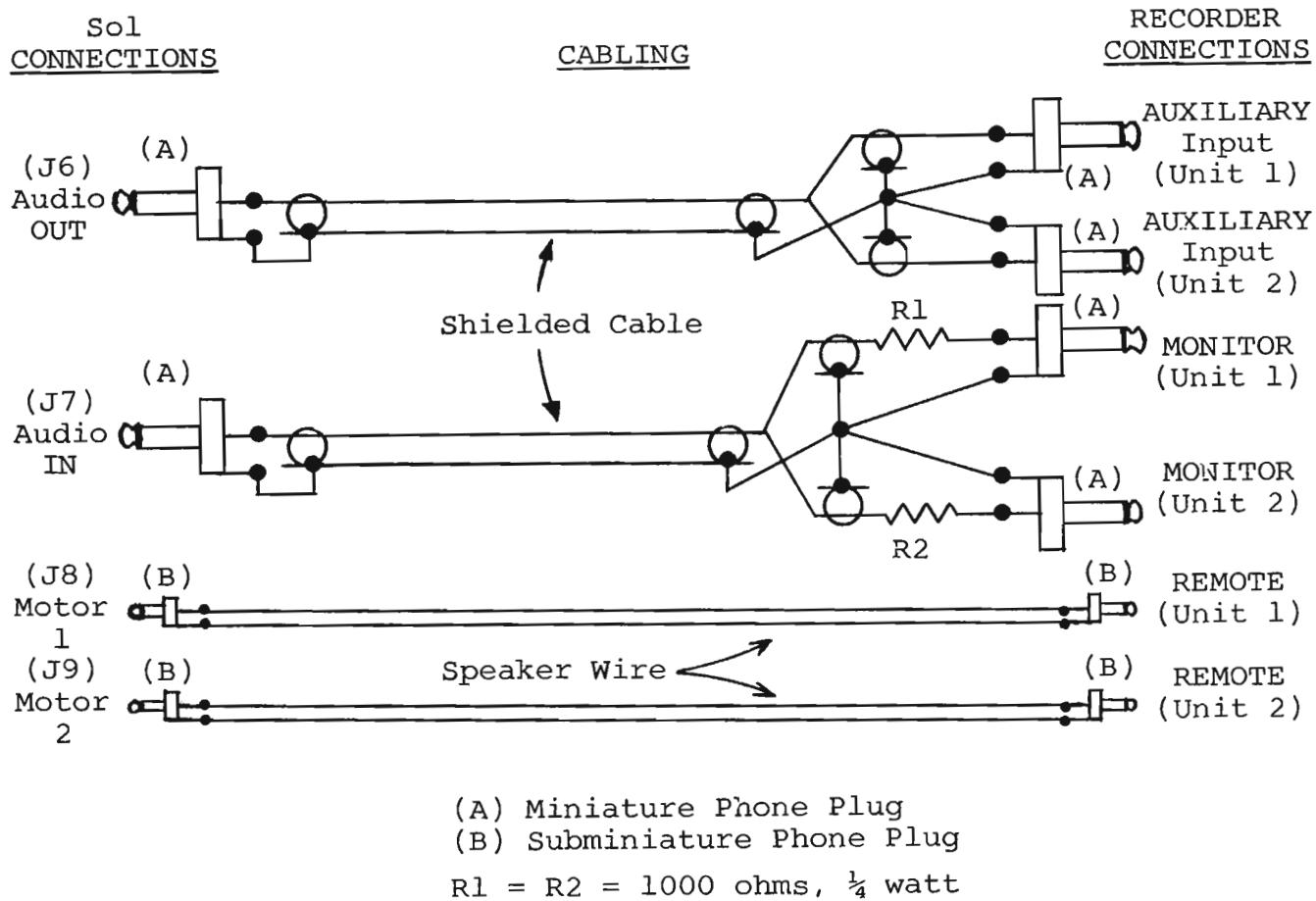


Figure 7-5. Connecting Sol to two cassette recorders.

that the file of interest is advanced at least two seconds. (See Paragraph 7.4.3, Step 21 for instructions on how to rewind the tape.)

For a read operation, proceed as follows:

1. Load cassette(s) as just described.
2. If only one recorder is used, set its volume control at 2/3 full volume. With two recorders, set both volume controls slightly higher than 2/3 full volume.
3. Set recorder(s) tone control(s) at midrange.
4. Set PLAY control(s) for playback mode.
5. Give Sol the GET or "GET, then Execute" command as appropriate. (Refer to your SOLOS/CUTERS User's Manual for instructions on how to use tape commands.)

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If you experience a read error, use the following procedure to isolate the problem:

1. Check recorder controls for proper settings and make sure you have followed all appropriate instructions and operating tips in Paragraph 7.9.1.
2. Check all interconnect cables for intermittent connections and shorts.
3. Note exact tape counter reading at the time of the error.
4. Rewind tape and again 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.
5. Rewind 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.

7.9.2 Serial Data Interface (SDI)

The Sol Serial Data Interface (J1) is capable of driving an RS-232 device, such as a modem, or a current loop device, such as the ASR33 TTY.

S3 (Baud Rate) and S4 (Parity, Word Length, Stop Bits and Full/Half Duplex) are used to select the various serial interface options as described in Paragraphs 7.5.7 through 7.5.11 in this section.

Set S3 switches to select the Baud rate required by the modem or current loop device. (Standard 8-level TTY's operate at 110 Baud, S3-2 ON and all other S3 switches OFF.) For standard 8-level TTY's and most modems, set all S4 switches OFF. (This selects eight data bits, two stop bits, no parity bit and full duplex operation for the SDI.)

Figures 7-6 and 7-7 show examples of current loop and modem interconnections to the Sol SDI connector (J1). The ASR33 TTY is used to illustrate a current loop interconnect, and the Bell 103 modem is used to illustrate a modem interconnect.

When operating in the terminal mode and full duplex, Sol keyboard data is transmitted out on Pin 2 of J1 and date received on Pin 3 of J1 is displayed on the video monitor. In the command mode, SOLOS set in and out commands can be used to channel output data and input data through the SDI. (Refer to your SOLOS/CUTERS User's Manual for instructions on how to use the set commands.)

In either mode, the LOCAL key directly controls the SDI. With the LOCAL indicator light on, received data is ignored and keyboard data is not transmitted. It is, however, looped back for display on the video monitor. With the LOCAL light off, received data is displayed and keyboard data is transmitted but not displayed unless it is echoed back.

#### 7.9.3 Parallel Data Interface (PDI)

The Sol Parallel Data Interface (J2) is used to drive parallel devices such as paper tape readers/punches and line printers. It provides eight output data lines, eight input data lines, four handshaking signals and three control signals. The latter allow up to four devices to share the PDI connector. (See Appendix VII for J2 pinouts.)

The port address for parallel input and output data is FD (hexadecimal), and the control port address for the PDI is FA (hexadecimal). PXDR is available at bit 2 of port FA. When this bit is set to  $\emptyset$ , the external device is ready to receive a byte of data. PDR is available at bit 1 of port FA, with  $\emptyset$  indicating the external device is ready to send a byte of data. Parallel Unit Select (PUS) is controlled by bit 4 of port FA. The input and output enable lines are available for tri-stating an external two-way data bus.

Use of the three control signals is optional and is unnecessary when only one device is connected to the PDI connector.

(Paragraph 7.9.3 continued on Page 33.)

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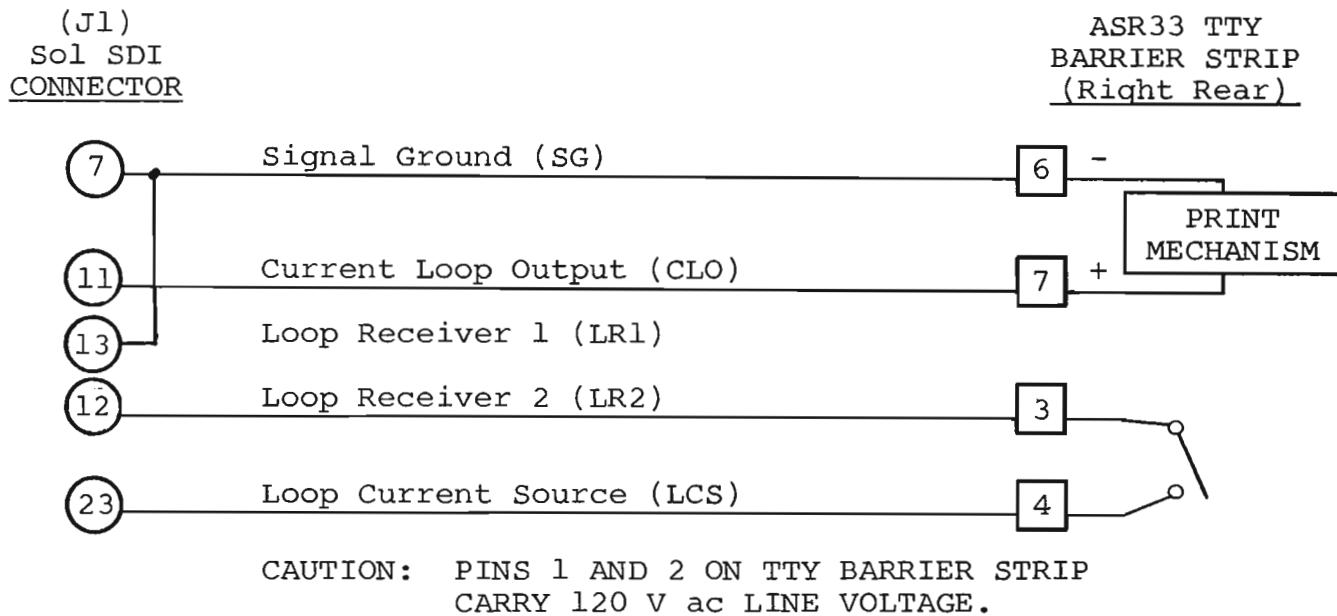
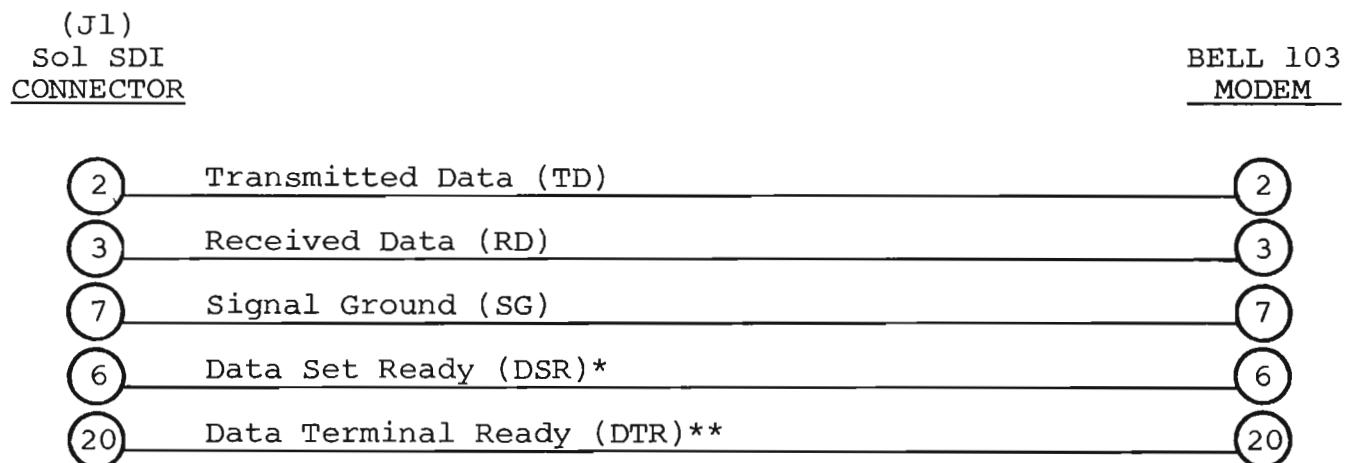


Figure 7-6. Connecting Sol SDI to current loop device such as TTY.



\*Available at bit 1 of port F8. Terminal mode software (SOLOS et al) does not use this signal and transmits data whether or not the modem is ready.

\*\*Sol is wired so that DTR indicates a ready condition whenever power is on.

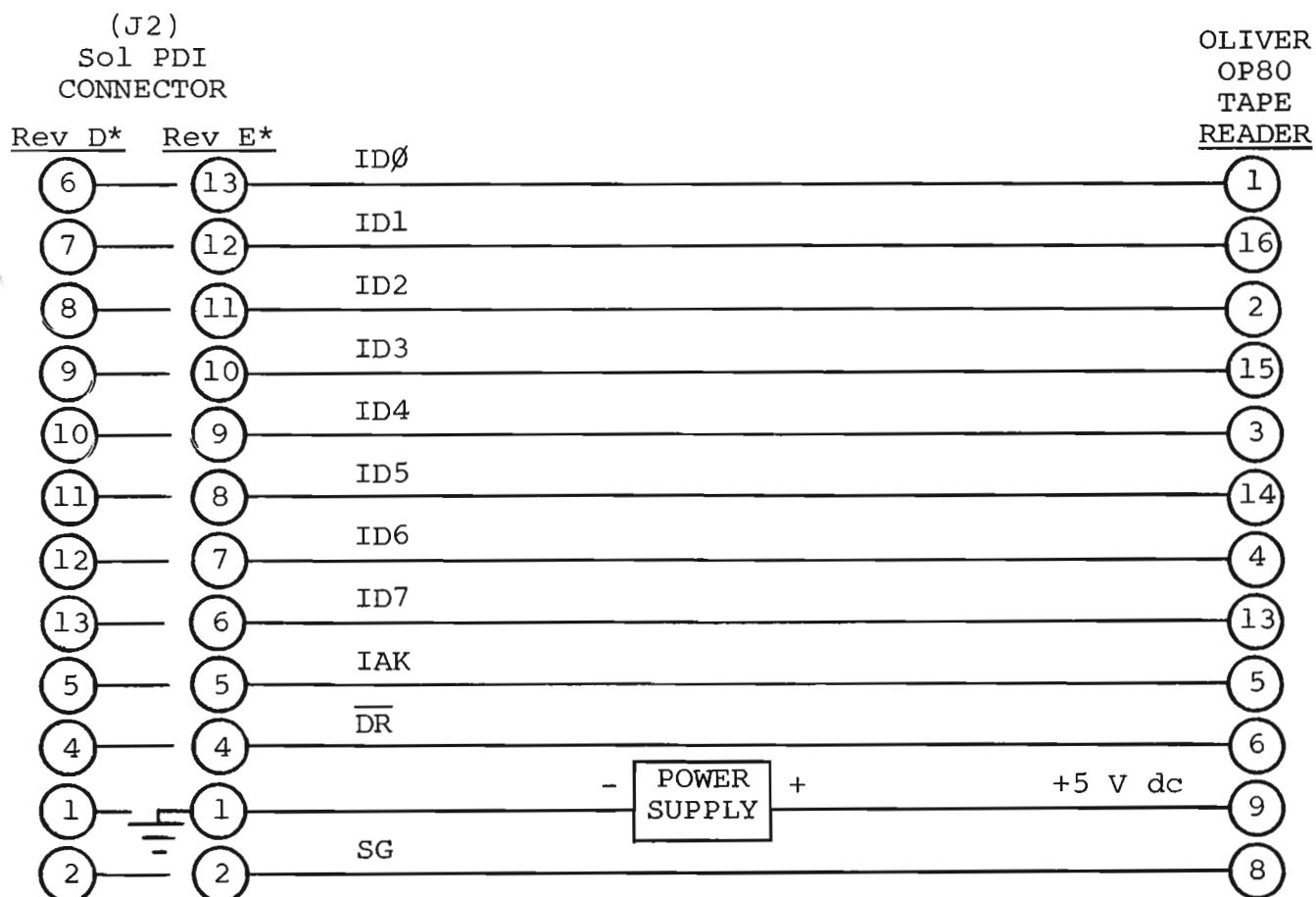
Figure 7-7. Connecting Sol SDI to communications modem.

In Figure 7-8, the Oliver OP80 Manual Paper Tape Reader is used to illustrate a typical PDI interconnect.

#### 7.10 CHANGING THE FUSE

Sol is protected with a 3.2 amp Slo-Blo fuse housed on the rear panel (see Figure 7-1 on Page VII-6). To remove the fuse, turn Sol off, disconnect power cord, turn fuse post cap one quarter turn counterclockwise, pull straight out and remove fuse from cap.

To install a fuse, insert fuse in cap, push in and turn one-quarter turn clockwise.



NOTE: +5 V dc is not available at J2. The use of an external +5 V dc power supply with its ground connected to Pin 1 of J2 (Sol chassis ground) is recommended.

\*Sol-PC Board

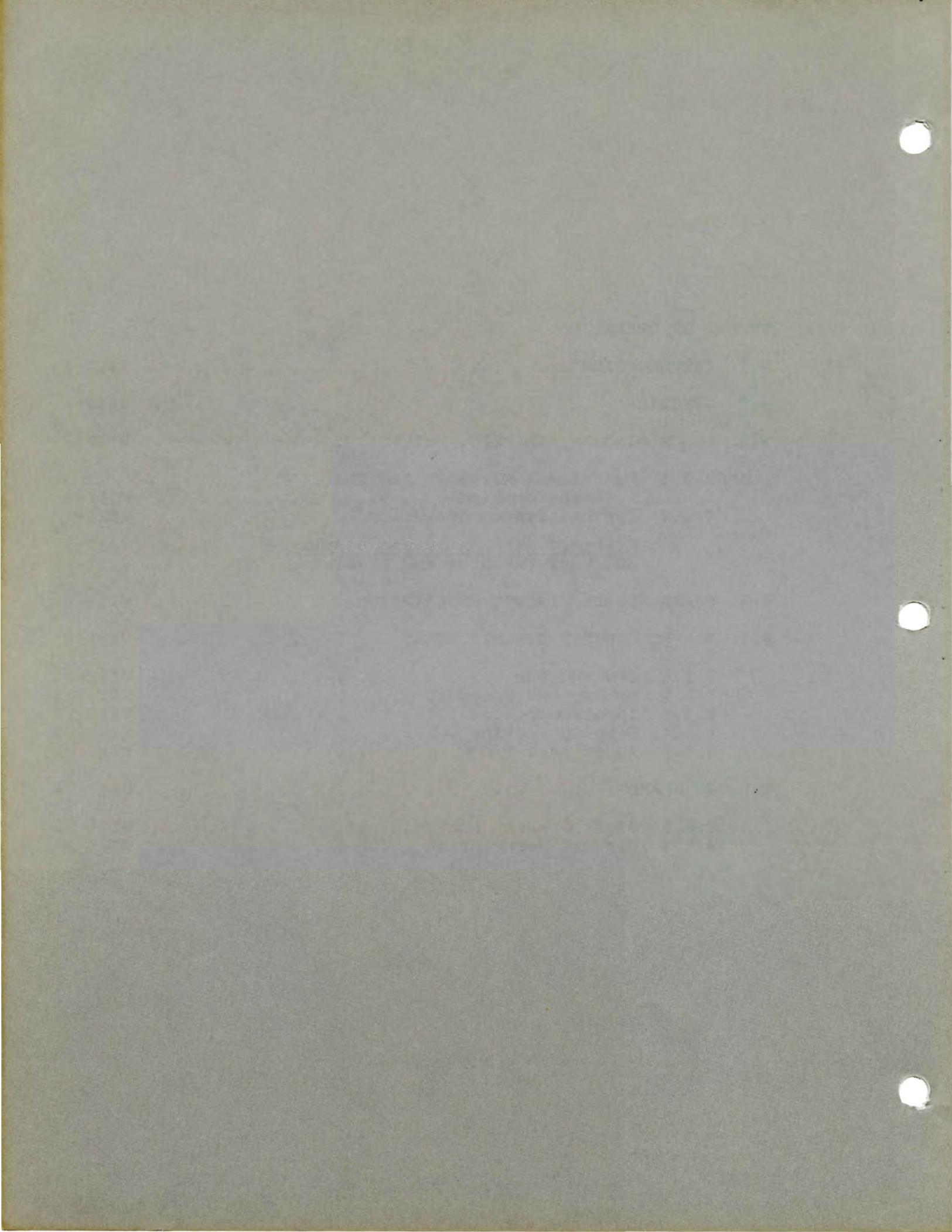
Figure 7-8. Connecting Sol PDI to parallel device.



VIII. Theory  
of Operation

## VIII THEORY OF OPERATION

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### 8.1 INTRODUCTION

This section concerns itself with the hardware aspects of the Sol Terminal Computer<sup>T.M.</sup>. It specifically deals with the operation of the power supply and the logic associated with the Sol-PC and keyboard. Descriptions of software and the operation of the circuitry contained in the multitude of integrated circuits (IC's) used in the Sol fall outside the scope of this section. In some cases, references to other publications or sections in this manual are provided when it is felt that additional information will contribute to a better understanding of how Sol operates. Should the reader wish to delve further into the operation of a specific IC, we suggest that he study the appropriate data sheet for that IC.

The section begins with an overview of the Sol design. A block diagram analysis then provides the reader with an understanding of the relationship between the functional elements of the Sol-PC. This analysis sets the stage for detailed descriptions of the circuitry that makes up these elements. The section concludes with a block diagram analysis and circuit description of the keyboard.

### 8.2 OVERVIEW

The Sol Terminal Computer<sup>T.M.</sup>, as the name implies, is both a terminal and computer. It is designed around the S-100 bus structure used in other 8080 microprocessor-based computers and incorporates all of the circuitry needed to perform either function. In essence, Sol combines a central processor unit (CPU) with several S-100 peripheral modules--memory, keyboard input interface (including the keyboard), video display output interface plus audio cassette tape, parallel, and serial input/output (I/O) interfaces. Sol-20 also includes a five-slot backplane board for adding other memory and I/O modules that are compatible with the S-100 bus.

An 8080 microprocessor (the CPU) is the "brain" of the Sol. It controls the functions performed by the other system components, obtains (fetches) instructions stored in memory (the program), accepts (inputs) data, manipulates (processes) data according to the instructions and communicates (outputs) the results to the outside world through an output port. (For information on 8080 operation, refer to the "Intel<sup>®</sup> 8080 Microcomputer Systems User's Manual.")

As shown in the Sol Simplified Block Diagram on Page X-24 in Section X, data and control signals travel between the CPU and the rest of the Sol over three buses: 1) a 16-line Address Bus, 2) an eight-line Bidirectional Data Bus, and 3) a 28-line Control Bus which is interfaced to the CPU with support logic circuitry. (Note that the use of a bidirectional data bus permits eight lines to do the work of 16, eight input and eight output.) These three buses account for the bulk of the S-100 Bus which connects the Sol to expansion memory and I/O modules.

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In the Sol-20, the S-100 Bus structure takes the form of a five-slot backplane board. It consists of a printed circuit board with 100 lines (50 on each side) and five edge connectors on which like-numbered pins are connected from one connector to another. Functionally, the Sol version of the S-100 Bus is comprised of:

1. Sixteen output address lines from the CPU which are input to all external memory and I/O circuitry. (Direct memory access (DMA) devices must generate addresses on these lines for DMA transfers.)
2. Eight data input/output lines that transfer data between external memory and I/O devices and the CPU or DMA devices. (These eight lines are paralleled with eight other bus lines.)
3. Eight status output lines from the CPU support logic: Memory and I/O devices use status signals to obtain information concerning the nature of the CPU cycle. (DMA devices must generate these signals for DMA transfers.)
4. Nine processor command and control lines: Six of these are output signals from the CPU support logic; three of them are input signals to the CPU support logic from memory and I/O devices. (In a DMA transfer, the DMA device assumes control of these lines.)
5. Five disable lines: Four of these are supplied by a DMA device to disable the tri-state drivers on the CPU outputs during DMA transfers. The fifth is a derivative of the DBIN output from the CPU, and it is used to disable any memory addressed in Page Ø. Use of this disable is optional with a jumper.
6. Two input lines to the CPU support logic which are used for requesting a wait period. One is used by memory and I/O devices and the other by external devices.
7. Six power supply lines which supply power to expansion modules.
8. Three clock lines.
9. Four special purpose signal lines.
10. Thirty-one unused lines.

Definitions for each S-100 Bus line, as used in the Sol, are provided on Pages AVII-3 through AVII-6 in Appendix VII.

In addition to the S-100 Bus structure, Sol also uses an eight-line keyboard input port, an eight-line parallel input port,

an eight-line parallel output port, an eight-line sense switch logic input port, and a unidirectional eight-line internal data bus.

The use of a unidirectional (input) data bus accommodates Sol's internal low-drive memory and I/O devices that do not meet the heavy drive requirement of the bidirectional data bus. The low-drive requirement of the internal bus also allows using the tri-state capabilities of the UART's (Universal Asynchronous Receiver/Transmitter) in the serial and audio cassette I/O circuits without additional drivers.

All CPU data and address lines are buffered through tri-state drivers to support a larger array of memory and I/O devices than would otherwise be possible with the 8080 output drive capability. Data input to the CPU is selected by a four-input multiplexer from the Keyboard Port, Parallel Port, Bidirectional Data Bus and Internal Data Bus. The Internal Data Bus is the source of all data input to the CPU from Sol's internal memory, the serial interface and the cassette interface. The Bidirectional Data Bus is the source of all data fed to memory and I/O, both internal and external. It is also the source of data input to the CPU from eight internal sense switches as well as from external memory and I/O.

### 8.3 BLOCK DIAGRAM ANALYSIS, Sol-PC

#### 8.3.1 Functional Elements And Their Relationships

As can be seen in the Sol block diagram on Page X-11 in Section X, timing signals for Sol are derived from a crystal controlled oscillator that produces a "dot clock" frequency of 14.31818 MHz. (This frequency, four times that of the NTSC color burst, provides compatibility with color graphics devices.) The dot clock is applied directly to the Video Display Generator circuit and divided in the Clock Generator to provide  $\phi_1$ ,  $\phi_2$  and CLOCK. CLOCK synchronizes all control inputs to the 8080;  $\phi_1$  and  $\phi_2$  are the nonoverlapping, two phase clocks required by the 8080.

Memory internal to the Sol is divided between 2K of ROM (Read Only Memory), 1K of System RAM (Random Access Read/Write Memory) and 1K of Display RAM. The ROM permanently stores the instructions that direct the CPU's activities. (To enhance Sol's versatility, this particular memory is on a plug-in "personality module". Thus, Sol can be easily optimized for a particular application by plugging in a personality module that contains a software control program designed for the task. The CONSOL and SOLOS programs, which are described in Section IX, are examples of such personality modules.) Display RAM stores data for display on a video monitor, and the System RAM provides temporary storage for programs and data. All memories are addressed on the Address Bus (ADR $\phi$ -15) and, except for the Display RAM, input data to the CPU on the Internal Data Bus (INT $\phi$ -7). Data entry into both RAM's is done on the Bidirectional Data Bus (DIO $\phi$ -7).

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As can be seen, Sol's internal memory consists of four contiguous 1024-byte pages. There are two pages (C0 and C4, hexadecimal or hex) of ROM, with Page C0 at hex addresses C000 through C3FF and Page C4 at hex addresses C400 through C7FF. System RAM (Page C8) is at hex addresses C800 through CBFF, and Display RAM (Page CC) is at hex addresses CC00 through CFFF.

The six high order bits of the address are decoded in the Address Page and I/O Port Decoder to supply the required four memory page selection signals. The I/O Port Decoder portion of this circuit decodes the eight high order address bits to provide outputs that control Data Input Multiplexer switching, Data Bus Driver enablement and I/O port selection.

The video display section consists of the Video Display Generator and Display RAM. The RAM is a two-port memory, with the CPU having the higher priority. Screen refresh circuitry in the Video Display Generator controls the second port to call up data as needed for conversion by a character generator ROM into video output signals. Other circuitry generates horizontal and vertical sync and blanking signals as well as cursor and video polarity options.

A 1200 Hz signal, extracted from dot clock by a divider in the Video Display Generator, drives the Baud Rate Generator. This generator supplies the receive and transmit clocks for the serial data interface (SDI/UART) and provides all frequencies required for Baud rates between 75 and 9600. It also supplies clock signals to the Cassette Data Interface (CDI).

A UART controls data flow through the Serial Data Interface (SDI/UART) and provides for compatibility between the Sol and a data communications system, be it RS-232 standard or a 20 ma current loop device. In the transmit mode, parallel data on the Bidirectional Data Bus is converted into serial form for transmission. Received serial data is converted in the receive mode into parallel form for entry into the CPU on the Internal Data Bus. SDI/UART status is also reported to the CPU on the Internal Data Bus. The SDI/UART channel is enabled by the port strobe from the Address Page and I/O Port Decoder.

Circuitry within the CDI derives timing signals from clocks supplied by the Baud Rate Generator. The Cassette Data UART functions to 1) convert parallel data on the Bidirectional Data Bus into serial audio signals for recording on cassette tape, and 2) convert serial audio signals from a cassette recorder into parallel data for entry into the CPU from the Internal Data Bus. Note that Cassette Data UART status is also reported to the CPU on the Internal Data Bus. Again, a UART performs the necessary parallel-to-serial and serial-to-parallel conversions. Other CDI circuitry performs the needed digital-to-audio and audio-to-digital conversions and provides the signals that allow motor control for two recorders. As with the SDI/UART, the Cassette Data UART is enabled by a port strobe from the Address Page and I/O Port Decoder.

Output data from the CPU that is channeled through the Parallel Port (PP) is latched from the Bidirectional Data Bus by the parallel strobe from the Address Page and I/O Port Decoder. This data is made available at P2, the PP connector. Parallel input data (PID<sub>0</sub>-7) on P2, however, is fed directly to the Data Input Multiplexer for entry into the CPU.

As can be seen, keyboard data (KBD<sub>0</sub>-7) from J3 is also fed directly to the Data Input Multiplexer. The keyboard data ready flag, though, is input to the CPU on the internal data bus.

The remaining internal source of data input to the CPU is the Sense Switch Logic, with the data being input on the Bidirectional Data Bus. This is an eight-switch Dual Inline Package (DIP) array that lets the CPU read an eight-bit word when it issues the sense switch strobe via the Address Page and I/O Port Decoder. The sense switch data source is available to interact with the user's software.

CPU Support Logic accepts six control outputs from the CPU, status information from the CPU's data bus and control signals from the Control Bus. It controls traffic on the data buses by generating signals to 1) select the type of internal or external device (memory or I/O) that will have bus access and 2) assure that the device properly transfers data with the CPU.

### 8.3.2 Typical System Operation

Basic Sol system operation is as follows: The CPU fetches an instruction and in accordance with that instruction issues an activity command on the Control Bus, outputs a binary code on the Address Bus to identify the memory location or I/O device that is to be involved in the activity, sends or receives data on the data bus with the selected memory location or I/O device, and upon completion of the activity issues the next activity command.

Let's now look at some typical operating sequences.

Keyboard Data Entry and Display. Assume the "A" and SHIFT keys on the keyboard are pressed. The keyboard circuitry converts the key closures into the 7-bit ASCII (American Standard Code for Information Interchange) code for an "A" (1000001) and sends a keyboard-data-ready status signal to the CPU on the Internal Data Bus. The monitor program in ROM repetitively "looks" for the status signal. When it finds this signal the program enters its keyboard routine and enables the transfer by switching the Data Input Multiplexer to the keyboard bus via the Address Page and I/O Port Decoder.

Following program instructions, the CPU addresses the Display RAM on the Address Bus to determine where the next character is to appear on the screen. It then stores the ASCII code for the "A" at the appropriate location in the Display RAM and adds one to the cursor position in readiness for the next character. (Addressing is

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done over the Address Bus; cursor position and the "A" enter the Display RAM on the Bidirectional Data Bus.) The CPU is now finished with the transfer, and will issue the next activity command.

When the refresh control circuitry calls up (addresses) the "A" from the Display RAM, the character generator ROM decodes the ASCII-coded "A" that is input from the Display RAM and generates the "A" dot pattern (see Figure 8-5 and 6) in parallel form. The ROM output is serialized into a video signal and combined with a composite sync signal to provide an Electronic Industries Association (EIA) composite video signal for display on an external video monitor.

SDI/UART Transfer and Display. A data transfer through the SDI/UART is similar to a keyboard entry, but data can be transferred in either direction.

Assume the SDI/UART wants to transfer an "A" from a modem to the CPU for display on a video monitor. The ASCII code for the "A", received in serial form from the modem on the serial data input of the SDI connector (J1), is fed to the SDI/UART. In the receiver section of the UART the serial data is converted into parallel form and placed in the UART's output register. The UART also sends a "received data ready" status signal to the CPU on the Internal Data Bus. When the program in ROM checks and finds the status signal, the program enters the SDI routine, and enables the transfer by switching the Data Input Multiplexer to the Internal Data Bus. The "A" enters the CPU on the Internal Data Bus and is sent to the Display RAM on the Bidirectional Data Bus. Operations involved in displaying the "A" are identical to a keyboard entry.

Now assume the CPU wants to send an "A" to the SDI/UART for transmission. The CPU, under program control, sends the SDI/UART status input port strobe via the Address Page and I/O Port Decoder to the UART. In turn, the UART responds with its status on the Internal Data Bus. Assuming the UART is ready to transmit, the CPU places the ASCII code for the "A" on the Bidirectional Data Bus and sends the SDI/UART data output port strobe which loads the Bidirectional Data Bus content into the UART's transmitter section. The "A" is serialized by the UART and sent out the transmitted data pin of J1.

#### 8.4 POWER SUPPLY CIRCUIT DESCRIPTION

Refer to the Sol-REG and Sol-20 Power Supply Schematics in Section X, Pages X-12 and 13.

The Sol power supply consists of the Sol-REG regulator and the Sol-20 power supply components.

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Fused primary power is applied through S5 to T2. FWB1, a full-wave bridge rectifier, is connected across the 8-volt secondary (green leads). The rectified output is filtered by C8 and applied to the collector of Q1. Q1, a pass transistor, is driven by Q2, with the two connected as a Darlington pair. The output of Q1 is connected to R1 which serves as an overload current sensor.

An overload current (approximately 4 amps) increases the voltage drop across R1. The difference is amplified in one-half of U2 (an operational amplifier) and the output on pin 7 turns Q3 on. Q3 in turn "steals" current from Q1-Q2 and diverts current from the output on pin 1 of U2. This in effect turns the supply off to reduce the current and voltage. Note that the circuit is not a constant current regulator since the current is "folded back" by R6 and R8. The current is reduced to about 1 amp as the output voltage falls to zero.

Divider network R11 and R12, which is returned to -12 volts, senses changes in the output voltage. If the output voltage is 5 volts, the input on pin 2 of U2 is at zero volts. U2 provides a positive output on pin 1 if pin 3 is more positive than pin 2 and a negative output for the opposite condition.

When the output voltage falls below 5 volts, pin 2 of U2 goes more negative than pin 3. This means pin 1 of U2 goes positive to supply more current to the base of Q1. The resulting increase in current to the load causes the output voltage to rise until it stabilizes at 5 volts. Should the output voltage rise above 5 volts, the circuit operates in a reverse manner to lower the voltage.

Protection against a serious over-voltage condition (more than 6 volts) is provided by SCR1, D1, D5, R2, R13, R14 and C8. Zener diode, (D1), with a 5.1 zener voltage, is connected in series with R13 and R2. When the output voltage exceeds about 6 volts, the resulting voltage drop across R2 triggers SCR1 to short the foldback current to ground. Since the overload current circuit is also working, the current through SCR1 is about 1 amp. Once the current is removed, this circuit restores itself to its normal condition; that is, SCR1 turns off. R13, R14, C8 and D5 serve to slightly desensitize the circuit so that it will not respond to small transient voltage spikes.

Bridge rectifier FWB2, connected across the other T2 secondary, supplies +12 and -12 V dc. The positive output of FWB2 is filtered by C5 and regulated by IC regulator U1. The negative output is filtered by C4 and regulated by U3. Shunt diodes D3 and D4 protect U1 and U3 against discharge of C6 and C7 when power is turned off. (Note that should the -12 volt supply short to ground, the +5 volt supply turns off by the action of U2.

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Unregulated -16 and +16 V dc, at 1 amp, from the filtered outputs of FWB2 are made available on terminals X6 and X5. These are supplied to the backplane board to drive S-100 Bus modules.

Power transformer (T2) has an additional 8-volt secondary winding and a third bridge rectifier (FWB3) to supply +8 V dc at 8 amps. The output of FWB3 is filtered by C9 and controlled by bleeder resistor R13. Again, this voltage is supplied to the backplane board.

The Sol power supply also includes a cooling fan powered by the AC line voltage.

8.5 SOL-PC CIRCUIT DESCRIPTIONS

8.5.1 CPU and Bus

Refer to the CPU and Bus Schematic in Section X, Page X-14.

A crystal, two inverter sections in U92 and four D flip-flops (U90) and associated logic make up the Clock Generator.

The two U92 sections function as a free-running oscillator that runs at the crystal frequency of 14.31818 MHz. R133 and R134 drive these two sections of U92 into their linear regions, and C61 and 64 provide the required feedback loop through the crystal. U77, a permanently enabled tri-state non-inverting buffer/amplifier, furnishes a high drive capability.

This fundamental clock frequency is fed directly to the Video Display Generator and to the clock inputs of U90. U90 is a four-stage register connected as a ring counter that is reset to zero when power is applied to the Sol. This reset is accomplished with D8, R104 and C39.

The bits contained in the ring counter shift one to the right with every positive-going clock transition, but the output of the last stage is inverted or "flipped" before being fed back to the input. In a simple four-stage "flip-tail" ring counter, the contents would progress from left to right as follows: 1000, 1100, 1110, 1111, 0111, 0011, 0001, 0000--on the first through eighth clocks respectively. The hypothetical counter would go through eight states, dividing the clock by eight.

The Sol counter, however, is a modified flip-tail ring counter that can be configured to divide by one of three divisors--5, 6 or 7. This is made possible by using a two-input NAND gate (U91) in the feedback path and three jumper options (no jumper, D-to-C and D-to-E) to alter the feedback path. Let's see how it works.

Sol is normally configured with the D-to-E jumper installed to meet the clock requirements of the 8080A CPU. With this jumper installed, the outputs of the third and fourth U90 stages are applied to pins 9 and 10 of U91. Assuming U90 is reset to zero, pin 8 of U91 is high, and on the first clock pulse the counter contents change to 1000. (Refer to 2.045 MHz Clocks portion of Figure 8-1 on Page VIII-11.) Pin 8 of U91 cannot change until the fourth state (1111), at which time it goes to zero. On the fifth clock pulse the counter changes to 0111. Again, pin 8 of U91 cannot change from zero until one of its inputs changes. As shown in Figure 8-1, the third U90 stage (C) changes on the seventh clock. The counter now stands at 0001, and on the eighth clock the counter flips to 1000 and the count cycle repeats. The pattern is thus 1000, 1100, 1110, 1111, 0111, 0011, 0001. U90 consequently goes through seven states. We have a 3.5-stage counter that divides DOT CLOCK by seven to supply a 2.045 MHz output.

With no jumper installed, pin 10 of U91 is pulled high by R105, and U91 operates as a simple inverter for feeding back the output of the third U90 stage. In effect we have a three-stage counter that operates in a similar manner to that described in the preceding paragraph. It goes through six states (100, 110, 111, 011, 001, 000) to divide DOT CLOCK by six which produces a 2.386 MHz output. The timing for this option is also shown in Figure 8-1.

Let's now put the D-to-C jumper in. The feedback in this case is the NAND combination of the outputs from the second (B) and third (C) U90 stages. This gives us a 2.5-stage counter that divides DOT CLOCK by five. As can be determined from the 2.863 MHz portion of Figure 8-1, the counter has five states with this option, and the count pattern is: 100, 110, 111, 011, 001.

Outputs from U90 are applied to the logic comprised of the remaining three sections in U91. This logic and the A-to-B jumper option permits extracting clock pulses of varying widths and relationships to each other from various points within the counter. We extract two clock signals: Ø1 on pin 6 of U91 and Ø2 on pin 11 of U91. (The ability to select the frequency and pulse width for Ø1 and Ø2 permits the use of either the 8080A, 8080A-1 or 8080A-2 CPU for U105. The "A" version is the slowest speed unit, the "A-2" has an intermediate speed, and the "A-1" is the fastest.) Let's now see how the pulse width of Ø1 and Ø2 are determined.

Ø1 on pin 6 of NAND gate U91 is low only when its two inputs are high, and this happens only when there is a 1 in the second and fourth stages of U90. This occurs during the time between the fourth and sixth fundamental clocks for 2.04 MHz operation--the fourth and fifth clocks for 2.38 MHz and 2.86 MHz. Keeping in mind that the fundamental clock period is 70 nsec, it is readily seen that the low frequency pulse train on pin 6 of U91 has a pulse width of 140 nsec and the two higher frequency pulse trains have a pulse width of 70 nsec. (Refer to Figure 8-1 on Page VIII-11.)

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The A-to-B jumper is installed when the 8080A or 8080A-1 CPU is used in the Sol. Note that the output ( $\phi_2$ ) on pin 11 of NAND gate U91 is low only when the output on pin 3 of NOR gate U91 is high. (This section in U91 is actually a two-input NAND gate which is functionally the same as a two-input NOR gate.) Pin 3 of U91, with the A-to-B jumper in, is high when either the second (B) or third (C) U90 stage is at zero. As shown in Figure 8-1, this occurs between the sixth and tenth DOT CLOCKS, or 280 nsec ( $4 \times 70$  nsec), for 2.04 MHz operation. For 2.863 MHz, it occurs between the fifth and eighth DOT CLOCKS for 210 nsec. The section of NAND gate U91 with its output on pin 11 inverts the output on pin 3 of U91 and introduces a slight delay to insure there is no overlap between  $\phi_1$  and  $\phi_2$ .

With the A-to-B jumper out, pin 11 of U91 is low only when the second stage (B) of U90 is at zero. At 2.386 MHz, this occurs between the fifth and eighth DOT CLOCKS for 210 nsec. This configuration is used for the 8080A-2 CPU.

In summary, we have two non-overlapping pulse trains which represent the  $\phi_1$  and  $\phi_2$  clocks required by the 8080 CPU, and the pulse widths of these two clocks vary with frequency as follows:

| <u>FREQUENCY</u> | <u><math>\phi_1</math> PULSE WIDTH</u> | <u><math>\phi_2</math> PULSE WIDTH</u> | <u>CPU</u> |
|------------------|--|--|------------|
| 2.045 MHz        | 140 nsec                               | 280 nsec                               | 8080A      |
| 2.386 MHz        | 70 nsec                                | 210 nsec                               | 8080A-2    |
| 2.863 MHz        | 70 nsec                                | 210 nsec                               | 8080A-1    |

$\phi_1$  and  $\phi_2$  are applied to S-100 Bus pins 25 and 24 respectively through inverters (U92) and bus drivers (U77). They are also capacitively coupled to pins 2 and 4 respectively of driver U104, the phase clock conditioner.

An additional clock, called CLOCK, is taken from pin 8 of NAND gate U91. It occurs 70 nsec after  $\phi_2$ . It is used on the Sol-PC and is also made available on S-100 Bus pin 49 as a general 2.04, 2.38 or 2.86 MHz clock signal.

Three J-K flip-flops (U63 and 64) are used to synchronize the READY, RESET and HOLD inputs to the CPU. All three are connected as D-type flip-flops so that their outputs follow their inputs on the low-to-high transition of the clock. The READY flip-flop input on pins 2 and 3 of one section in U63 is either PRDY or XRDY from the S-100 Bus; these are normally pulled high by R34 and R12 respectively. S-100 Bus signal PRESET, which is normally pulled high by R55, inputs the RESET flip-flop, the other section of U63. The HOLD flip-flop (U64) input is  $\bar{P}\text{ HOLD}$ , normally pulled high by R56, from the S-100 Bus. Pull up resistors R51, R50 and R53 insure that the high states of these three flip-flops are adequate for the CPU.

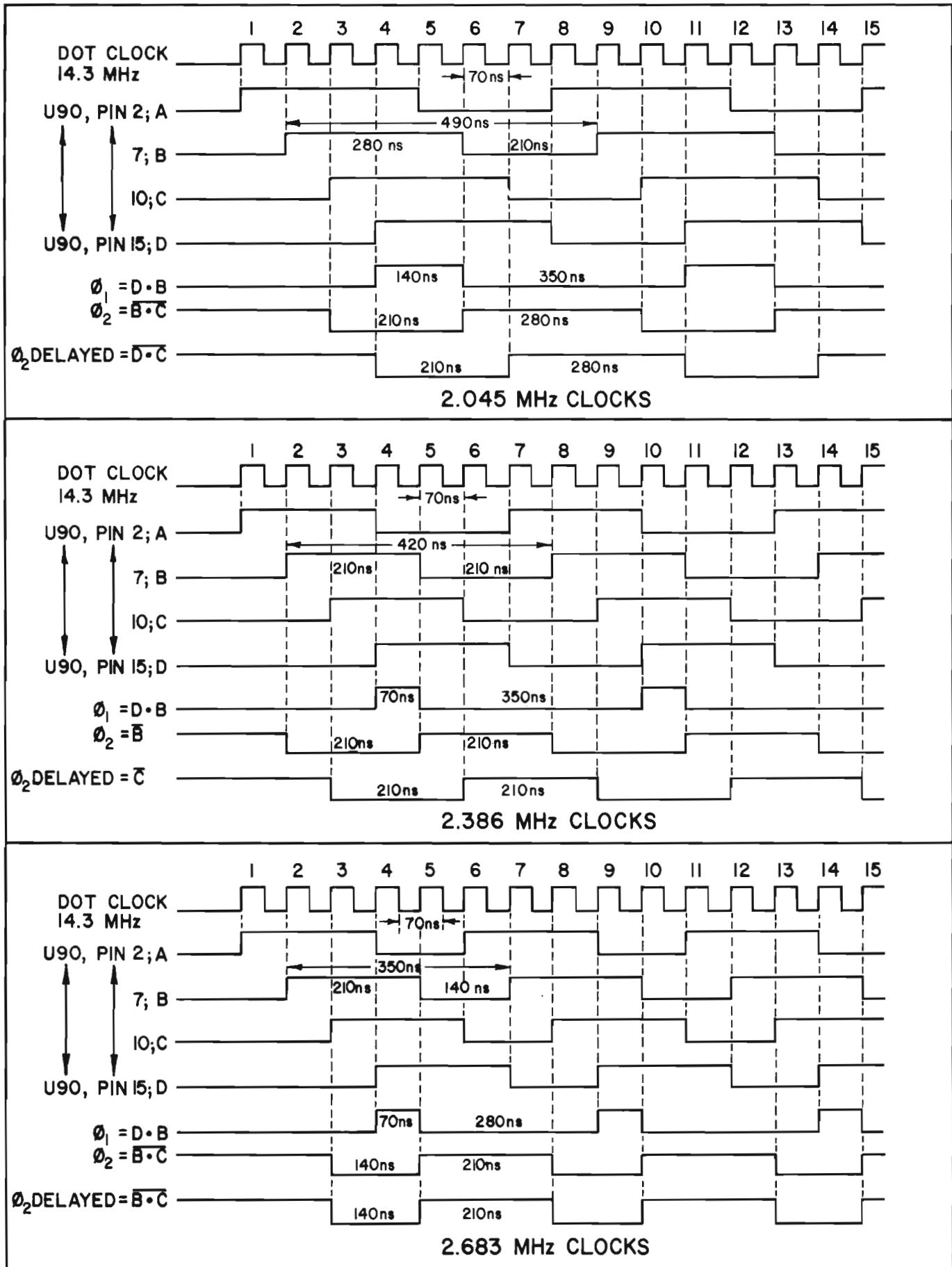


Figure 8-1. CLOCK GENERATOR TIMING

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Diode D7, C15 and R18 make up the POC (power on clear) circuit. When power is applied, C15 starts to charge slowly until it reaches the threshold on pin 6 of U46, a Schmitt trigger. (By this time the logic and 5 volt supply have stabilized.) When the threshold is reached, pin 2 of U46 suddenly goes low. The resulting output on pin 8 of inverter U92 is initially low and then rapidly goes high. This signal is passed through a section of U77, a permanently enabled noninverting tri-state driver, as POC to S-100 Bus pin 99. It is also inverted in a section of U45 to become POC.

The output on pin 8 of U92 is also connected to pin 15 of U63. Thus, pin 9 (RESET) of U63 is high to start the CPU in the reset condition when the Sol is initially turned on.

When POC goes high, the RESET flip-flop section of U63 is free to clock. Assuming PRESET is not active, it will change state on the first CLOCK transition. The resulting high on pins 10 and 5 of U63 cause pin 7 (READY) of U63 to go low to place the CPU in the not ready or wait state. This state is subsequently removed on the CLOCK transition following the transition which removed the low from pin 5 of U63. This helps prevent the CPU from starting in a crash condition.

The HOLD flip-flop (U64), however, is not affected by the POC circuit, and was clocked to a low on pin 7 well before the RESET and READY signals became active.

Operation of the POC circuit can also be initiated, without turning the power off, by a keyboard restart signal on pin 13 of J3 or by closing S1-1 if the N-P jumper is in. In either case, C15 is discharged through R58 and then allowed to recharge after KBD RESTART is removed or S1-1 is opened.

POC also resets all stages of D flip-flop U76 (the phantom start-up circuit) to zero. On initial start-up, the CPU performs four fetch machine cycles (refer to Intel® 8080 Microcomputer Systems User's Manual) in accordance with program instructions. For each fetch, the CPU outputs a DBIN on pin 17. U76, connected as a four-stage shift register, is clocked by the inverted DBIN signal on pin 3 of NOR gate U46. Thus, PHANTOM, on S-100 Bus pin 67, is active low (assuming the F-to-G jumper is in) for the first four fetches or machine cycles. After the fourth DBIN, PHANTOM goes high. PHANTOM is used to 1) disable any memory addressed in Page Ø that has Processor Technology's exclusive "Phantom Disable" feature and 2) cause the Sol program memory (ROM), which normally responds to Page CØ (hex) to respond to Page ØØ (hex). The second function is discussed in Paragraph 8.5.2.

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The inverted DBIN on pin 3 of U46 is also applied to pin 12 of NOR gate U46 and inverted to appear as PDBIN on S-100 Bus pin 78. This section of U46 also allows DIGI (bus pin 57) to override DBIN. (DIGI is used when an external DMA device replaces the CPU in terms of writing into and reading from memory.) The other CPU control signals (SYNC, INTE, HLDA, WR and WAIT) are also fed to the S-100 Bus pins as indicated. These, as well as DBIN or DIGI, are placed on the bus through tri-state drivers which are enabled by C/C DSB on S-100 Bus pin 19. Note that this signal is normally pulled high by R20.

The data lines of the CPU ( $D_0-7$ ) are bidirectional and are used for several functions. One of these is to output status at the start of each cycle which is marked by the SYNC output of the CPU. Status on  $D_0-7$  is latched in U93 and U106 (each of which contains four D flip-flops) when pin 8 of inverter U45 goes high. Status information, as identified on the schematic, is then buffered through tri-state drivers U94 and U107 to the S-100 Bus. The status latch strobe on pin 8 of U45 is extracted in the middle of the SYNC pulse by gating PSYNC and  $\bar{\phi}_2$  in NAND gate U44. STAT DSB on S-100 Bus pin 18 is used to disable the U94 and U107 buffers when a DMA device or another processor assumes control of the S-100 Bus.

A second function of  $D_0-7$  is to output data from the CPU to the Bidirectional Data Bus. Data out of the CPU is placed on this bus through tri-state drivers (U80 and U81). Note that these drivers are normally enabled unless this bus is in the input mode or an external device has control of the bus. In the latter case, DO DSB on S-100 Bus pin 23 would be pulled low to make pin 8 of NOR gate U48 high. In the input mode pin 8 of U48 is high because OUT DSB is low. This signal is generated by decoding PAGE CC, MEM SEL, PORT IN FC, PORT IN FD, INT SEL to produce MPX ADR A and MPX ADR B on pins 3 and 11 respectively of two NOR gates in U48. MPX ADR A and MPX ADR B are decoded with DBIN on pin 5 of NAND gate U47.

The  $D_0-7$  bus lines are also used to input data to the CPU. Data input to the CPU is multiplexed from four data buses with four 4-to-1 line multiplexers (U65, 66, 70 and 79). These four buses are the: 1) Keyboard Data Bus, KDB $_0-7$ , 2) Parallel Input Data Bus, PID $_0-7$ , 3) Internal Data Bus, INT $_0-7$ , and 4) Bidirectional Data Bus, DIO $_0-7$ .

These data multiplexers are tri-state devices, with their outputs pulled up by R107 through R114 to a level that satisfies the input requirements of the CPU. Their outputs are active only when both their E1 and E2 (pins 1 and 15) are low. As can be seen, this occurs only when DBIN on pin 3 of NOR gate U46 is low; that is, when the DBIN output of the CPU is active to indicate its data bus is in the input mode.

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Input selection to the multiplexers is done with the A and B inputs to U65, 66, 78 and 79. These two inputs are driven by MPX ADR A on pin 3 of NOR gate U48 and MPX ADR B on pin 11 of NOR gate U48. There are four possible states for the combination of MPX ADR A and B, and their relation to input selection is as follows:

1. If both are active (high), the multiplexers select the Bidirectional Data Bus.
2. When the keyboard is called up by the CPU, only PORT IN FC is active (low) to make MPX ADR A low. This selects the Keyboard Data Bus.
3. When the parallel port is called up by the CPU, only PORT IN FD is active (low) to make MPX ADR B low. This selects the Parallel Input Data Bus.
4. When the CPU selects any I/O port that uses the Internal Data Bus, only INT SEL (pin 2 of U47 and U61) is active. Thus, both MPX ADR A and B are low to select the Internal Data Bus.

Two other conditions, defined by PAGE CC on pin 2 and MEM SEL on pin 1 of NAND gate U44, are possible. When any of the four memory pages in the Sol are accessed, MEM SEL goes high and an inversion in U44 (PAGE CC is normally high) appears as a low MPX ADR A and B to select the Internal Data Bus. Should Page CC (the Display RAM) be addressed, PAGE CC also goes active (low) to override MEM SEL. MPX ADR A and B are consequently high to select the Bidirectional Data Bus. These two conditions are required since the ROM and System RAM use the Internal Data Bus and the Display RAM uses the Bidirectional Data Bus.

The address outputs of the CPU ( $A_0-15$ ) are placed on the Address Bus via tri-state drivers (U67, 68 and 81). These drivers are normally enabled since pin 3 of inverter U49 is pulled high by R36. ADD DSB on S-100 Bus pin 22 is used to disable the address drivers when a DMA device or another CPU takes over the bus.

A 5.1 volt zener diode, D11, and a divider network composed of R130, 131 and 132 derive -5 V dc from the -12 V dc supply for use by the CPU. Diode D12 and the same divider supply -12 V dc to pin 3 of U104, the phase clock conditioner.

## 8.5.2 Memory and Decoder

Refer to the Memory and Decoder Schematic in Section X, Page X-15.

The System RAM consists of eight 1K by 1 bit static memory chips, U3 through U10, and it is assigned addresses C800-CBFF (hex). When the CPU wants to write data into memory, it addresses the System RAM on ADR0-15. ADR0-4 select the row inside the RAM chips, ADR5-9 select the column, and ADR10-15 select the page (in this case Page C8, hex). Page selection enables the eight RAM chips on pin 13. For a read operation, MWRITE on S-100 Bus pin 68 is low, and the resulting high on pin 3 (WE) of the RAM chips keeps them in the read mode. Thus, data on the Bidirectional Data Bus is read into the RAM's on their DI (pin 11) inputs. MWRITE is high, however, during the time the CPU wants to write data into memory. In this case, pin 3 of the RAM's is low to enable them to accept data from the Bidirectional Data Bus.

The ROM is also addressed on ADR0-15 as is the System RAM. Since there can be two pages, however, two enable lines (one for Page C0, hex, and the other for C4, hex) are provided. The C0 and C4 enables are connected to pins A6 and A5 respectively of J5, the Personality Module connector. Unlike the RAM, the ROM can only read data into the CPU, so the previously discussed MWRITE signal is not needed. Data out of the ROM is output on the Internal Data Bus on pins A3, A4 and B5-10 of J5.

ADR10-15 are input to the Address Page and Port Decoder (U34, 35, 36 and their associated logic). U34 (Address Page), U35 (Output Port) and U36 (Input Port) are 3-to-8 line decoders which have three enable inputs (G1, G2A and G2B). G1 must be high and both G2A and B must be low in order to obtain an active output.

Let's look at the Address Page Decoder, U34, first. It must be able to decode four pages: C0 and C4 (ROM), C8 (System RAM) and CC (Display RAM). (Note that these are the hexadecimal digits of the six high order address bits, ADR10-15).

The high order four bits (ADR12-15) must be 1100 (C, hex) in all cases by virtue of the U22 exclusive OR logic. If they are not, the G1 enable on U34 is low to disable that decoder. Bits ADR10 and 11 (The A and B inputs to U34) are the high order bits of the second hexadecimal digit which must be 00 (0, hex), 01 (4, hex), 10 (8, hex) or 11 (12, hex) if U34 is to have an active output. For C0, pin 11 of U34 is active (low); for C4, pin 10 is active; for C8 pin 9 is active; and for CC pin 7 is active. These outputs are applied to the appropriate memories and also provide the MEM SEL signal on pin 6 of one section in U23. (This section is actually a 4-input NAND gate which is functionally the same as a 4-input NOR gate.)

Note that the U22 logic input with ADR14 and 15 is also connected to PHANTOM. When this signal is active (low), the output on pins 3 and 11 will be low to disable U34 when ADR12-15 represent a C. If Page 0 is addressed, however, pins 3 and 11 of U22 are high, and this, coupled with lows on ADR10-13, are decoded by U34 as an active output on pin 11. The ROM will consequently respond to addresses in Page 0 and C0 (hex) as long as PHANTOM is active.

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The other two enables on U34 (G2A and G2B) are connected to SINP and SOUT. These two status signals indicate an input or output operation during the CPU cycle. U34 is therefore disabled during these operations.

SINP and SOUT are also fed to pins 5 and 6 of NOR gate U53 which detects an input or output operation. Its output is inverted by U54 and applied to pin 9 of another U53 NOR gate. The other input (pin 8) to U53 is MEM SEL. So during a memory reference, input operation or output operation, pin 10 of U53 is active to enable the PRDY driver, U71. The low on pin 10 of U53 is also clocked by  $\phi_2$  as a high to pin 7 of U70, a J-K flip-flop that is connected as a D flip-flop. Note that the PSYNC •  $\bar{\phi}_2$  signal on pin 5 of U70 forces U70 to set during the middle of PSYNC (refer to CPU and Bus discussion). U70 cannot clock until pin 5 is released, and this occurs simultaneously with the low-to-high transition of  $\phi_2$ . PRDY is thus low immediately after pin 10 of U53 goes low and remains in that state from the middle of PSYNC to the first positive-going  $\phi_2$  after PSYNC. This is the time the CPU tests the status of the ready lines (PRDY and XRDY). If either is low, the CPU enters a WAIT state. U53, 70 and 71 thus guarantees that the CPU enters one WAIT state during cycles in which an input, output or memory reference is made.

U35 and 36, the Output and Input Port Decoders respectively, decode the higher order eight address bits (ADR8-15).

All Sol ports have a hexadecimal F (1111) in their high order four bits (ADR12-15 are 1's). The second hexadecimal digit is also never less than eight. This means that ADR11 is always 1 for a port address. These five address bits are thus NAND gated in U23 to provide one of the enables on U35 and 36. Note that the ADR14-15 combination is derived from the output on pins 3 and 11 of the U22 exclusive OR logic. This is permissible since no I/O operations are performed during the first four start-up cycles of the CPU.

The A, B, and C inputs to U35 and 36 (ADR8, 9 and 10 respectively) specify the second hexadecimal digit in the port address and are decoded to supply the indicated outputs. These outputs and their functions are defined in Table 8-1. U36 is enabled to decode when PDBIN and SINP are active; that is, during an input operation. U35 is enabled when SOUT and PWR are active; that is, during an output operation.

INT SEL on pin 8 of inverter U83 is the remaining signal generated by the Input Port Decoder circuit. This signal is active when either input port F8, F9, FA or FB is decoded by U36.

Both the address page and input/output decoders can be disabled by SINTA (S-100 Bus pin 96) when the AE-to-AC and AB-to-AD jumpers are installed. SINTA is active (high) when the CPU is responding to an interrupt. Should an external device issue addresses during this time, any memory response would interfere with the

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Table 8-1. Port Decoder (U35 &amp; U36) Outputs and Their Functions.

| PORT DECODER OUTPUT   | FUNCTION  |
|---|---|
| P <small>ORT</small> O <small>UT</small> F <small>E</small>     | Loads starting row address and first display line position information from Bidirectional Data Bus into Video Display scroll circuit. |
| <u>P<small>ORT</small> O<small>UT</small> F<small>D</small></u> | Clocks data from Bidirectional Data Bus to output data pins of PP connector.  |
| P <small>ORT</small> O <small>UT</small> F <small>B</small>     | Loads data from Bidirectional Data Bus into Cassette Data UART.   |
| P <small>ORT</small> O <small>UT</small> F <small>A</small>     | Clocks PP and CDI control bits from Bidirectional Data Bus.   |
| P <small>ORT</small> O <small>UT</small> F <small>9</small>     | Loads data from Bidirectional Data Bus into SDI UART.   |
| P <small>ORT</small> O <small>UT</small> F <small>8</small>     | Clocks RTS (request to send) from bit 4 of Bidirectional Data Bus to pin 4 of SDI connector.  |
| P <small>ORT</small> I <small>N</small> F <small>F</small>      | Permits CPU to read data byte entered from Sense Switches.  |
| P <small>ORT</small> I <small>N</small> F <small>E</small>      | Places Video Display scroll timer and screen position status on bits 0 and 1 of Bidirectional Data Bus.                               |
| P <small>ORT</small> I <small>N</small> F <small>D</small>      | Switches Data Input Multiplexer to input data pins of PP connector and resets PP at end of a transfer to ready it for another.        |
| P <small>ORT</small> I <small>N</small> F <small>C</small>      | Switches Data Input Multiplexer to Keyboard Data Bus.   |
| P <small>ORT</small> I <small>N</small> F <small>B</small>      | Strobes received data in CDI UART to Internal Data Bus.   |
| P <small>ORT</small> I <small>N</small> F <small>A</small>      | Places PP, keyboard and CDI UART status on Internal Data Bus.   |
| P <small>ORT</small> I <small>N</small> F <small>9</small>      | Strobes received data in SDI UART to Internal Data Bus.   |
| <u>P<small>ORT</small> I<small>N</small> F<small>8</small></u>  | Places SDI UART status on Internal Data Bus.  |

interrupt operation. To prevent this, SINTA is inverted in U58 to 1) disable U34 on pin 6 and 2) force pin 8 of NAND gate U23 high to disable U35 and U36 on pin 5. (This feature is provided to enable future versions of Sol to operate with a vectored interrupt system.)

#### 8.5.3 Input/Output

Refer to the Input/Output Schematic In Section X, Page X-16.

This section in the Sol has five functional circuits: 1) Parallel I/O Logic, 2) Sense Switch Logic, 3) Keyboard Flag Logic, 4) SDI/UART and 5) Baud Rate Generator.

The PP uses U95 and 96 (4-bit D-type registers) and their related logic. Data output to the PP connector (J2) is latched from DIO $\emptyset$ -7 by U95 and U96. Data is strobed into these registers on the leading edge of an inverted active PORT OUT FD signal on pin 4 of inverter U54. This strobe is also applied to pin 2 of U73 which functions as a J-K flip-flop that is clocked by  $\emptyset 2$ . When the  $\emptyset 2$  goes from low to high 200 to 300 nsec after PORT OUT FD, pin 7 of U73 goes low to become POL on pin 17 of J2. (This delay allows U95 and 96 to stabilize.) U73 is reset in the middle of the following PSYNC which means POL is active for the balance of the cycle.

The outputs of U95 and 96 are tri-state outputs that are enabled by a low on pin 2. In the absence of POE at pin 15 of J2, pin 2 of U95 and 96 are low by virtue of the output on pin 8 of inverter U55. Note that the input to U55 is normally pulled up through R63. The POE provision permits tri-stating an external bidirectional data bus.

As discussed in Paragraph 8.5.1, parallel input data on J2 is fed directly to the Data Input Multiplexer (see Page X-15). The strobe that indicates the presence of input data, PDR on pin 4 of J2, is applied to pins 2 and 3 of one section in U72, a J-K flip-flop which is connected as a D flip-flop. When PDR goes active (low), pin 7 of U72 will go high on the next low-to-high transition of  $\emptyset 2$  to toggle the following U72 stage. At this point pins 9 and 10 of the second section in U72 go high and low respectively. Pin 9 supplies PIAK on pin 5 of J2. When high, PIAK signals the external device that Sol has yet to complete acceptance of the data. The state of pin 10 of U72 is transmitted to INT1 of the Internal Data Bus through a U71 tri-state noninverting buffer. U71 is enabled only for the duration of PORT IN FA (auxiliary status). During the time U71 is enabled, the CPU reads the Internal Data Bus. A high INT1 indicates the parallel input data is not ready; a low indicates the data is ready.

The second U72 flip-flop is preset by PORT IN FD or POC. PORT IN FD is active to read data in from the PP; POC occurs only when Sol is restarted or power is turned on. Thus the PP is reset and ready for another transfer at the end of a transfer or when POC is active.

PXDR on pin 16 of J2 is supplied by the external device. It indicates the device is ready to receive data. PXDR is buffered to INT2 and will effect the transfer of data to the Internal Data Bus during the status input to the CPU. PXDR is analogous to the previously discussed PIAK signal.

Sense Switches S2-1 through 8 are driven by PORT IN FF when it is low. Thus, the DIO lines connected to closed switches are driven low, and those connected to open switches are pulled high.

U97 (a 4-bit D-type register) and one section of U52 (a J-K flip-flop connected as a D flip-flop) latch five bits of data on DIO3-7 when PORT OUT FA goes active. These bits, which supply the indicated outputs, control conditions in both the PP and CDI. With respect to the PP, PIE enables parallel input, and PUS selects the parallel device for the transfer. The data in these two latches remains until either a new word is read out or POC goes active.

Also during PORT OUT FA, the keyboard flag is reported. KEYBOARD DATA READY on pin 3 of J3 is a low going pulse 1 to 10 usec in duration. It is applied to pin 13 of J-K flip-flop U70. Some time after pin 13 of U70 goes low, but before 500 nsec, U70 is set by  $\phi_2$  and pin 10 goes low. This low is buffered through U71 to INT $\phi$  to indicate the keyboard is ready to send data. Reset of U70 occurs with a POC or by PORT IN FC. The latter occurs when data is accepted from the keyboard.

The other half of flip-flop U52, with its output on pin 6, latches one bit of status, DIO4, when PORT OUT F8 is active. Its output is applied to pin 5 of one operational amplifier section in U56 to become the SRTS (request to send) signal on pin 4 of J1, the SDI connector.

The SDI/UART centers around a UART, U51. The UART transmission conditions (parity, word length and stop bits) are determined by the settings of S4-1 through 5. (Refer to Paragraphs 7.5.8 through 7.5.10 in Section VII for descriptions of the switch settings and their effect on transmission.)

Data destined to leave Sol through the SDI/UART enters the UART on its TIL-6 inputs from the Bidirectional Data Bus when TBRL (pin 23) is low; that is, when PORT OUT F9 goes active. Circuitry within the UART serializes the input data, which is in parallel form, and outputs it on pin 25 at a rate determined by the clock on pin 40. The binary states at pin 25 are low for a zero and high for a one. Assuming Sol is not in local operation ("off line"), the output on pin 25 of the UART is applied to pins 2 and 11 of J1 via two gates in U55 and the other half of U56.

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Data that enters Sol through the SDI/UART on pins 3, 12 or 13 of J1 is input to the SDI UART on pin 20 by way of U38, an inverting level converter that converts data levels of up to  $\pm 25$  volts to TTL levels. (Note that current loop data on pin 12 or 13 of J1 is first rectified before it is applied to U38.) The UART converts this serial data into parallel form and outputs it on R01 through R08 (pins 12 through 5 respectively) to the Internal Data Bus when ROD (pin 4) is low; that is, when PORT IN F9 goes active.

The receive-transmit clock for the SDI UART is supplied by the Baud Rate Generator (U84, U85, U86 and their associated circuitry). U85 is a phase locked loop, U86 is a 7-stage binary counter and U84 is connected as a divide-by-11 counter. The 1200 Hz reference signal applied to pin 14 of U85 is supplied from the Video Display Generator. A phase comparator in U85 compares this signal to the output of a voltage controlled oscillator (VCO) in U85. By feeding an output from U86 (in this case the 1200 Hz output on pin 3) back to the compare input (pin 3) of U85, the circuit acts as a frequency multiplier. The output (pin 4) of U85 remains locked, therefore, to a multiple of its input on pin 14. In this case we have a 128X multiplier to generate 153.6 KHz which is counted down in U86. Since U86 is a 7-stage binary counter, the first stage output (pin 12) is 76.8 KHz (one-half of 153.6 KHz, the clock for U86), the second stage output (pin 11) is 38.4 KHz (one-fourth of 153.6 KHz), the third stage output (pin 9) is 19.2 KHz (one-eighth of 153.6 KHz), and so on to the seventh stage output (pin 3) which is 1.2 KHz (1/128 of 153.6 KHz).

With the exception of outputs on pins 12 and 9, the outputs of U86 are connected to S3, the Baud Rate Switch. The 19.2 KHz output on pin 9 is divided by 11 in U84 to supply 1745 Hz to S3-2. The 38.4 KHz on pin 12 can be connected to S3-8 instead of the 153.6 Hz clock by cutting the L-M connection and installing a jumper between K and M.

Let's now translate the frequencies input to S3 into Baud rates. The Baud rate of a UART is 1/16 of its clock rate. Thus, a 1200 Hz clock equates to a 75 Baud transmission rate, a 1745 Hz clock equates to a 109.1 (110) Baud rate, etc. It is now readily seen that the Baud rate available with S3-8 is 9600 assuming the L-M connection is made ( $153.6 \text{ KHz} \div 16 = 9600$ ). (The L-M connection is default wired on the Sol-PC; that is, there is a trace between L and M on the circuit board.) If the L-M trace is cut and a jumper is installed between K and M, the Baud rate with S3-8 is 4800 ( $76.8 \text{ KHz} \div 16 = 4800$ ).

We can thus select any one of eight clock frequencies for the SDI UART with S3, with the highest being determined by the K, L and M jumper arrangement. The selected clock is applied to both the receive and transmit clock inputs (pins 17 and 40 respectively) of the UART. This means, of course, that the UART always receives and transmits at the same Baud Rate.

Returning to the SDI UART, we see that its transmitter output on pin 25 is applied to pin 5 of U55, a two-input NAND gate that is functionally a NOR gate. It is normally enabled on pin 4 by pull-up resistor R44. A low on pin 5 represents a binary  $\emptyset$ ; a high represents a binary 1. The inverted output on pin 6 of U55 is again inverted (assuming Sol is not operating in Local) by the following U55 NAND gate. One-half of operational amplifier U56, operating open loop, converts TTL levels to RS-232 levels (5 to 15 volts). Pin 3 of U56 is held at +2.5 V dc by the R47 and R48 divider network. When pin 2 is more negative than pin 3, the output on pin 1 of U56, which is fed to pin 2 of J1, is at approximately +10 volts. For the opposite condition, pin 2 of J1 is about -10 volts. Thus, U56 also inverts, and a high or low on pin 2 of J1 represent a binary 1 and  $\emptyset$  respectively.

Two conditions can override transmitted data: a keyboard break (BRK) or local (KBD LOC) command. For a break command, BRK on pin 4 of J3 and pin 4 of NOR gate U55, is low to hold pin 6 of U55 high for the duration of the BRK signal. This appears as a "space", or high level, on pin 2 of J1. (A space, or break, condition requires that the space level exist for a period longer than the normal length of a character.) In the case of a KBD LOC command from the keyboard, pins 1 and 13 of the other two U55 sections are low. Thus, data cannot be transmitted to pin 3 of NAND gate U55, and pin 11 of NOR gate U55 is held high to enable tri-state driver U37 at pin 15. Data on pin 6 of U55 is consequently looped back by way of U37 and R21 to pin 12 of U38. Data on pin 12 of U38 overrides any data arriving at pin 13 of U38. In local operation, therefore, data from pin 25 of the UART does not appear at pin 2 of J1, but it is looped back to the receiver input (pin 20) of the UART via U37, R21 and U38.

Notice that data on pin 25 of the UART will also be looped back if S4-6 is closed (half duplex operation). But in this case, data from the UART is also fed to pin 2 of J1.

Serial data from the UART that appears at pin 1 of U56 also drives transistor Q1 by way of R45 and R46 to supply the serial current loop output (SCLO) on pin 11 of J1. Q1 supplies 20 ma. (max.) current for a binary 1 and no current for a binary  $\emptyset$ .

Pin 23 of J1 (connected through R23 to +12 V dc) is the serial loop current source (SLCS). It can supply up to 20 ma of current to ground and is used when the external current loop device has no current source.

Data received from a current loop device enters Sol on pins 12 and 13 of J1 in the form of no current for a  $\emptyset$  and 20 ma of current for a 1. This input is rectified by bridge rectifier D3-D6 and applied to a light emitting diode (LED) in optical isolator U39. As its name implies, U39 electrically isolates the current loop circuit from the rest of the Sol. (This isolation permits a high offset voltage on pins 12 and 13 of J1.) For a 1, the LED is energized, and

the light is optically coupled to the base of a photo transistor in U39 to cause the transistor to conduct. Conduction translates to a low, or mark, level at the input (pin 13) of U38. Since both the current loop and RS-232 received data (SLR1/SLR2 and SRD respectively) share the input to U38, both should not be used simultaneously.

There are five external control signals in the RS-232 section of the SDI/UART: two are sent to the external device (SRTS and SDTR), and three are received from the device (SCTS, SCD and SDSR).

SRTS on pin 4 of J1 was discussed earlier. SDTR (serial data terminal ready) is simply tied to +12 V dc through R24. This indicates to the external device that Sol is connected to it.

SCTS (serial clear to send), SCD (serial carrier detect) and SDSR (serial data set ready) indicate status of the external device. They enter Sol on pins 5, 8 and 6 of J1 respectively, and all three are active high. Following level conversion and inversion in line receivers U38, data on these lines is gated through noninverting tri-state buffers U37 to the Internal Data Bus when PORT IN F8 is active.

PORT IN F8 also enables five bits of UART status to be reported over the Internal Data Bus. These are PE, FE, OE, DR and TBRE on pins 13, 14, 15, 19 and 22 respectively of the UART. They are defined as follows:

- PE: Parity Error--received parity does not compare to that programmed. (Bit INT2)
- FE: Framing Error--valid stop bit not received when expected. (Bit INT3)
- OE: Overrun Error--CPU did not accept data before it was replaced with additional data. (Bit INT4)
- DR: Data Ready--data received by UART is available when requested. (Bit INT6)
- TBRE: Transmitter Buffer Register Empty--UART is ready to accept another word from the Bidirectional Data Bus. (Bit INT7)

#### 8.5.4 Display Section

An understanding of how characters are formed on the video monitor will help you follow operation of the display section.

The monitor screen can be thought of as a large matrix of small light elements, or dots, that can be turned on and off. In this context the overall video presentation consists of light and dark dots.

In the Sol, the display format is 64 characters maximum per character row, with a maximum of 16 rows per frame (page). Thus, up to 1024 characters can be displayed per page.

A 9 x 13 (columns by lines) dot area, or character position, is allotted on the monitor screen for each displayed character (see Figures 8-2 and 8-3 on Page VIII-24). Consequently, each character row consisting of sixty-four 9 x 13 dot areas requires 13 horizontal scan lines. To provide spacing between both characters and rows, only 12 dot lines and seven dot columns within the 9 x 13 matrix are used for character display. Only nine of the available 12 dot lines, however, are used for any given character.

Let's take a closer look at how the 9 x 13 dot matrix is used. The first seven dot columns are available for all character displays; the last two are used to provide a space between characters. The first dot line in a character row is always blank to provide a space between character rows. As shown in Figure 8-2, the second through tenth dot lines are available for all upper case (capital) and control characters, all symbol and punctuation marks (except the comma and semicolon), and all lower case characters (except the g, j, p, q and y). As shown in Figure 8-3, dot lines five through 13 are available to display characters that normally extend below the base line--lower case g, j, p, q and y plus the comma and semicolon.

Now that we have a feeling for how characters are formed on the video monitor screen, we will move on to the circuit description.

Refer to Display Section Schematic in Section X, Page X-17.

The 14.31818 MHz DOT CLOCK, which defines the period of one dot (69.8 nsec) in a character display matrix, controls all timing in the Video Display Generator. DOT CLOCK is applied to pin 2 of U28, a four-bit binary counter that is preset to count from seven through 15 to divide DOT CLOCK by nine. Two 1.591 MHz outputs are supplied by U28: LOAD CLOCK on pin 11 and CHARACTER CLOCK on pin 12. Pin 11 is a low-active pulse of one DOT CLOCK duration. Pin 12 is high for five and low for four DOT CLOCK periods. Both the LOAD and CHARACTER CLOCK low-to-high transitions occur synchronously on the same DOT CLOCK.

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CHARACTER CLOCK, which defines the period of one character position (628 nsec), is inverted in U49 to become CHARACTER CLOCK. It performs most of the clocking functions in the Video Display Generator and is made available on pin 4 of J4 for use by external graphic display devices.

CHARACTER CLOCK is in turn divided in U31 and U33, both of which are presetable four-bit binary counters. Both start at count 3 when pin 8 of NAND gate U47 is low, and together they count 102 CHARACTERCLOCKS to define horizontal timing at 64 usec (102 x 628 nsec = 64 usec).

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| CHARACTER ADDRESS* | LINE ADDRESS | SCAN LINE NO. | COLUMN NO.          | VIDEO INFORMATION BITS |
|--------------------|--------------|---------------|---------------------|------------------------|
|                    |              |               | 1 2 3 4 5 6 7 8 9   |                        |
| 1001001            | 1111         | 1             | 0 0 0 0 0 0 0 0 0   | 000000000 (blank)      |
|                    | 0000         | 2             | 0 ● ● ● ● ● 0 0 0   | 011111000              |
|                    | 0001         | 3             | 0 0 0 ● 0 0 0 0 0   | 000100000              |
|                    | 0010         | 4             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 0011         | 5             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 0100         | 6             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 0101         | 7             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 0110         | 8             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 0111         | 9             | 0 0 0 0 ● 0 0 0 0 0 | 000100000              |
|                    | 1000         | 10            | 0 ● ● ● ● 0 0 0 0   | 011111000              |
|                    | 1001         | 11            | 0 0 0 0 0 0 0 0 0   | 000000000 (blank)      |
|                    | 1010         | 12            | 0 0 0 0 0 0 0 0 0   | 000000000 (blank)      |
| 1001001            | 1011         | 13            | 0 0 0 0 0 0 0 0 0   | 000000000 (blank)      |

\*7-bit ASCII code for I

● = illuminated dot

Figure 8-2. Example of uppercase character (I) display.

| CHARACTER ADDRESS* | LINE ADDRESS | SCAN LINE NO. | COLUMN NO.        | VIDEO INFORMATION BITS |
|--------------------|--------------|---------------|-------------------|------------------------|
|                    |              |               | 1 2 3 4 5 6 7 8 9 |                        |
| 1110000            | 1111         | 1             | 0 0 0 0 0 0 0 0 0 | 000000000 (blank)      |
|                    | 0000         | 2             | 0 0 0 0 0 0 0 0 0 | 000000000 (blank)      |
|                    | 0001         | 3             | 0 0 0 0 0 0 0 0 0 | 000000000 (blank)      |
|                    | 0010         | 4             | 0 0 0 0 0 0 0 0 0 | 000000000 (blank)      |
|                    | 0011         | 5             | ● 0 ● ● ● 0 0 0 0 | 101110000              |
|                    | 0100         | 6             | ● ● 0 0 0 ● 0 0 0 | 110001000              |
|                    | 0101         | 7             | ● ● 0 0 0 0 ● 0 0 | 100001000              |
|                    | 0110         | 8             | ● ● 0 0 0 0 0 ● 0 | 100001000              |
|                    | 0111         | 9             | ● ● 0 0 0 0 0 0 ● | 110001000              |
|                    | 1000         | 10            | ● ● ● ● 0 0 0 0 0 | 101110000              |
|                    | 1001         | 11            | ● 0 0 0 0 0 0 0 0 | 100000000              |
|                    | 1010         | 12            | ● 0 0 0 0 0 0 0 0 | 100000000              |
| 1110000            | 1011         | 13            | ● 0 0 0 0 0 0 0 0 | 100000000              |

\*7-bit ASCII code for p

● = illuminated dot

Figure 8-3. Example of lowercase character (p) display.

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As indicated in Figure 8-4 on Page VIII-27, Subgroup Counter U31 and Group Counter U33 are preset to a count of 3 at the start of each horizontal scan line. U31 counts from 3 through 15 (13 character positions) and enables U33 for one count. U31 then counts  $\emptyset$  through 15 and enables U33 for the second count. The sequence continues through four more groups of 16 character positions, and at this point U33 is at its sixth count (a binary 9). Thus, pins 11 and 14 are high at pins 10 and 11 of U47. U31 continues to count from  $\emptyset$ , and on the ninth count (a binary 8) pin 9 of U47 goes high. The resulting low on output pin 8 of U47 loads three into U31 and U33, and the cycle repeats. The U31-U33 cycle, from preset, is then 13, 16, 16, 16, 16 and 9 character position counts for a total of 102.

The QD output on pin 11 of U33 is SCAN ADV, and the QC output on pin 12 is HDISP. SCAN ADV is used to generate horizontal synchronization signals, and HDISP defines the start of the display portion of the horizontal scan line.

Four outputs from U31 and the two low order outputs of U33 (pins 13 and 14) are input to the Character Address Multiplexer, U30 and U32, which supplies the low order six address bits to the Display RAM (U14 through U21). The second address source for the Display RAM is the Address Bus, bits ADR $\emptyset$ -5. Address source selection is controlled by the output on pin 7 of D flip-flop U75. Pin 7 of U75 goes high when PAGE CC (the Display RAM) is active and PSYNC •  $\emptyset$ 2 goes high (which it does in the middle of PSYNC). Pin 7 of U75 remains high for the rest of the memory access cycle.

The preset signal (pin 8 of U47) to U31 and U33 is applied to the Scan Counter (U40) via inverter U87. U40 counts the horizontal scan lines that make up a row of characters and supplies the line number to U25, the Character Generator ROM. (This ROM is discussed later.) U40 is preset to a count of 15 for the first scan line in the character row. It then counts from  $\emptyset$  through 11. On count 11, SCAN ENABLE on pin 8 of U47 is inverted in U87 to disable the Scan Counter. A decoder, comprised of NAND gates U59 and U60, decodes the 13th count (count 11) in U40 and SCAN ENABLE to supply a load pulse to pin 9 of U40. This resets U40 to a count of 15, and the cycle repeats. (Presetting the Scan Counter to a count of 15 permits the Character Generator ROM to provide a blank spacer line between character rows since line 15 in the ROM is always blank.)

The output on pin 8 of NAND gate U59, after inversion in U87, becomes the OVERFLOW LINE signal. This signal occurs after each character row and appears at pins 7 and 10 of Text Counter U62 to enable it to count. Thus, the Text Counter counts character rows. It resets itself with its carry output (pin 15) through another inverter in U87, with the reset count being determined by the state on pin 10 (VDISP) of J-K flip-flop U43. If VDISP is low, the Text Counter resets to a count of  $\emptyset$ ; if VDISP is high, it resets to a count of 12.

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Assume VDISP is active (low), which it is during the vertical display portion of the displayable area on the screen. (Refer to Figure 8-4.) U62 is then preset to a count of  $\emptyset$  and will count from  $\emptyset$  through 15 (16 character rows). The resulting carry output on count 15 of the Text Counter causes the U43 VDISP flip-flop to toggle. It also appears as a low on the load input of the Text Counter. The Text Counter is also enabled to reset by virtue of the OVERFLOW LINE going low after the reset of the Scan Counter. Since VDISP is now high, the Text Counter is reset to a count of 12 and will count 12 through 15 (four character rows). The carry output from the Text Counter then causes the U43 VDISP flip-flop to toggle, and the Text Counter is reset to a count of  $\emptyset$ . We can now see that the Text Counter counts 16 character rows when the display is active (VDISP is low) and four character rows when the display is blanked (VDISP is high). The total of 20 character rows represents a full display of 260 scan lines for 60 Hz operation (13 scan lines/row  $\times$  20 rows = 260 scan lines per page).

Horizontal and vertical synchronization signals are generated by two one-shot multivibrators consisting of three two-input NOR gates in U102. Horizontal sync is triggered by SCAN ADVANCE and vertical sync by VDISP. Both circuits generate fixed-length sync pulses with adjustable starting times. C52 determines the length of the horizontal sync pulse and C53 the length of the vertical sync pulse. The starting times, with respect to triggering, are variable with variable resistors VR1 (HORIZ) and VR2 (VERT) to provide continuous adjustment of the display position on the screen. An exclusive OR gate in U74 combines the two sync pulses into a composite sync (COMP SYNC) signal. Note that the use of the exclusive OR inverts the horizontal sync pulses when the vertical sync pulse appears. Since vertical sync information is extracted in a monitor by an integrating, or averaging, process, this technique maintains horizontal synchronization during the vertical sync period.

Two types of blanking are available: control character blanking and video blanking. The first blanks control characters and causes cursor information to be displayed in their place. Video blanking forces portions of the video display to a white or black level, depending on whether normal or reverse video is selected with S1-4.

Control character blanking, switch selectable with S1-3, is accomplished with one NAND gate in U60 and one NAND gate in U61. When a control character is present in the Data Latch (U26 and U27), pins 3 and 15 of U26 are high. Assuming the blanking option is selected (S1-3 closed), the output of U60 (LOAD CLOCK) is gated with the control character bits by U61 to clear the video parallel-to-serial converter, U41. U41 then loads all zeros instead of the character.

Video blanking is initiated by the PRE BLANK or COMP BLANK (pin 14 of Blank Latch U42) inputs to U59, a three-input NOR gate. The third input, the video output on pin 6 of exclusive OR gate U74, is blanked when any of the two blanking inputs is active.

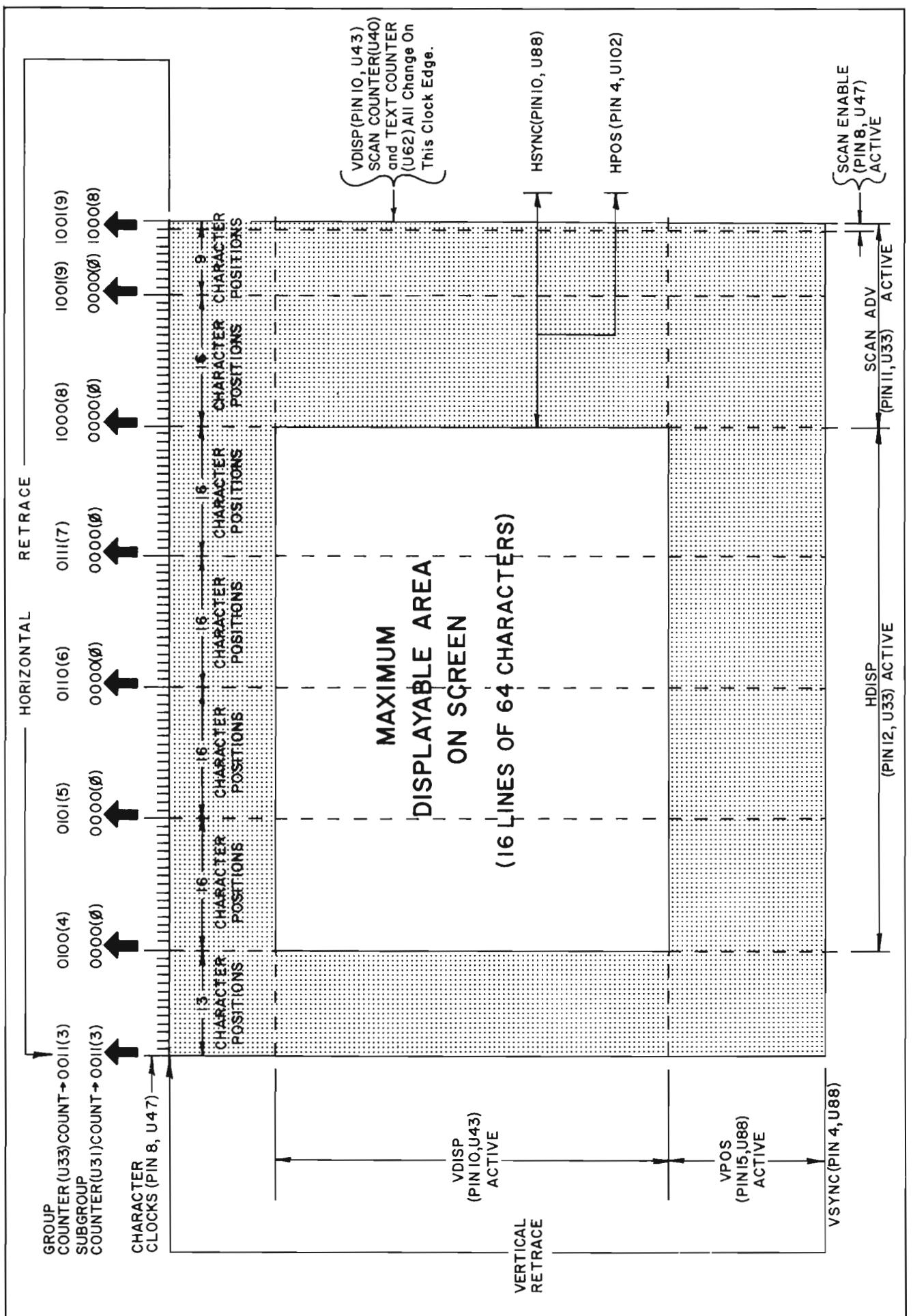


Figure 8-4. VIDEO DISPLAY TIMING

DISPLAYABLE PORTION OF SCREEN

The timing diagram illustrates the logic levels of three signals over time. The vertical axis represents logic levels, and the horizontal axis represents time. The **SCAN ADV** signal (top) is active during the scan period. The **SCAN ENABLE** signal (middle) is active during the entire frame period. The **HDISP** signal (bottom) is active during the horizontal display period.

HPOS (PIN 4, UI02)

H SYNC(PIN10, U88)

VERTICAL  
RETRACE

VIII-27

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The PRE BLANK input provides "window shade" blanking which is analogous to pulling a window shade down from the top of the display. PRE BLANK is generated in one half of J-K flip-flop U43. U43 is reset by the TC output of First Screen Position Counter, U11, and set by VDISP. The output on pin 7 of U11 is generated by the scrolling circuitry (to be discussed later) and defines the character row for which the "window shade" ends. It may begin with any character row from zero through 14.

The remaining video blanking function concerns the output on pin 14 of D flip-flop U42. This signal, COMP BLANK, is a composite of HDISP and VDISP.

Since there is a two character time delay between Display RAM addressing and the corresponding video output on pin 6 of exclusive OR gate U74, the horizontal and vertical blanking signals must be delayed an equal amount. U42, connected as a two-stage shift register, functions to shift the blanking into synchronization with the video. Since U42 is clocked by LOAD CLOCK (which has a period equal to one character time), COMP BLANK is delayed two character times from the input on pin 4 of U42. COMP BLANK is active low during nondisplayable portions of the video scan to override any video input data on pins 1 and 2 of NOR gate U59. The display is thus blanked.

The Display RAM consists of eight 1K x 1 bit RAM (random access memory) chips, U14 through U28. All chips are held permanently enabled by connecting their CE (pin 13) inputs to ground. Memory addressing is provided through two-to-one multiplexers (U30, U32 and U12) which select one of two display address sources: 1) an external address on Address Bus bits ADR0-9 and 2) an internal address supplied by the Subgroup Counter (U31), Group Counter (U33) and the Beginning Address Counter (U1). The function of the address bits associated with each address source is as follows:

1. External address bits ADR0-5 specify the character position (one of 64) in the character row.
2. External address bits ADR6-9 specify the character row position (one of 16) on the display screen.
3. Internal address bits, a total of six outputs from U31 and U33, specify the character position (one of 64) in the character row.
4. Internal address bits, the four outputs from U1, specify the character row position (one of 16) on the display screen.

Normally the internal display address is multiplexed to the Display RAM. When the CPU or a DMA device requests access (PAGE CC active), the multiplexers switch to the external address lines, ADR $\emptyset$ -9.

Seven-bit ASCII-coded data is written into RAM chips U14 through U20 from bits DIO $\emptyset$ -6 of the Bidirectional Data Bus, and the cursor bit (DIO7) is written into RAM chip U21. This writing occurs when the write enable (WE) input to the RAM chips is low. This occurs when the Display RAM is addressed (PAGE CC active low) and MWRITE on S-100 Bus pin 68 is high. The enable is supplied on output pin 8 of NAND gate U44. Data is read out of the Display RAM when pin 8 of U44 is high. Data out of the Display RAM is placed on the Bidirectional Data Bus via tri-state drivers U29 and U89 when PAGE CC and PDBIN (S-100 Bus pin 78) are active. U29 and U89 are enabled by a low output on pin 11 of another U44 NAND gate.

Data out of the Display RAM is also strobed into Data Latches U26 and U27 by LOAD CLOCK. Seven outputs from these latches are used to address the Character Generator ROM, U25. Note that the output from RAM chip U19 is inverted in exclusive OR gate U74 before being applied to the C input (pin 13) of U26, and the complement (pin 14) of the QC output of U26 is used in addressing U25. This is done so that the Data latches will output the space code ( $\emptyset 1\emptyset\emptyset\emptyset\emptyset\emptyset$ ) to the Character Generator ROM when the latches are reset. These latches are reset each time PAGE CC is active by way of U75, a J-K flip-flop connected as a D flip-flop, and D flip-flop U42 ( $\bar{Q}$  output pin 6). By outputting the space code on reset, the Data Latches insure a blank character position on the screen.

The Character Generator ROM, U25, has seven character address inputs (A $\emptyset$  through A7), four scan line inputs (RS1 through RS4) and seven data outputs (B $\emptyset$  through B7). It is programmed to generate seven bits (dots) of character information for the selected scan line of the character row. U25 also automatically blanks scan lines that are not a part of the character and shifts the g, j, p, q, y, comma and semicolon to the fifth through 13th scan lines in the dot matrix (refer to Figures 8-2 and 8-3 on Page VIII-24). Complete patterns for the 6574 and 6575 Character Generator ROM's are provided in Figures 8-5 and 8-6 respectively. Note that the address bits A $\emptyset$  through A6 in Figures 8-4 and 8-5 correspond to the A $\emptyset$  through A7 inputs to U25 on the schematic, scan lines R $\emptyset$  through R8 are specified by the RS1 through RS4 inputs to U25 on the schematic, and the data output bits D $\emptyset$  through D6 correspond to the B $\emptyset$  through B7 outputs from U25 on the schematic.

Let's see how the Character Generator ROM produces a character using an uppercase "C" and "T" as an example. In this example, these two characters are to be displayed in the first and second character positions respectively on the third character row of the display screen. Remember that the character position and row parameters are contained in the Display RAM since the 7-bit ASCII-coded

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|     |    | A3..A0 | 0000   | 0001   | 0010   | 0011   | 0100   | 0101   | 0110   | 0111   | 1000   | 1001   | 1010   | 1011   | 1100   | 1101   | 1110   | 1111 |
|-----|----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
|     |    | A6..A4 | D6..D0 |      |
| 000 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 001 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 010 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 011 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 100 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 101 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 110 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
| 111 | R0 |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |
|     | RS |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |      |

▀ = Shifted character. The character is shifted three rows to R3 at the top of the font and R11 at the bottom.

Figure 8-5. 6574 Character Generator ROM pattern.

"C" and "T" were stored in the RAM in the proper character positions in the third character row.

After the first two character rows have been displayed, the Scan Counter (U40) is reset to a binary count of 15 (1111) and the Character and Line Address Multiplexers (U30, U32 and U12) call up the "C" in the Display RAM. The Scan Counter output specifies line 15 in the Character Generator ROM on RS1 through RS4. As previously mentioned, this line in the ROM is blank. Thus, the first scan line of the third character row is blank.

The 7-bit ASCII code for the "C" (10000011) is input from the Display RAM to address the Character Generator ROM by way of the Data Latches (U26 and U27). This address is applied to ROM inputs A7 through A1 (A6 through A0 in Figures 8-5 and 8-6). The Scan Counter changes to a count of zero which specifies scan line R0 in the Character Generator ROM. As shown in Figures 8-5 and 8-6, the ROM in turn outputs a 7-bit word, 0011110, on D6 through D0 respectively (B7 through B1 on the schematic).

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| A3..A0 | 0000      | 0001      | 0010      | 0011      | 0100      | 0101      | 0110      | 0111      | 1000      | 1001      | 1010      | 1011      | 1100      | 1101      | 1110      | 1111      |
|--------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| A6..A4 | D6..D0    |
| 000    | R0<br>... |
| 001    | R0<br>... |
| 010    | R0<br>... |
| 011    | R0<br>... |
| 100    | R0<br>... |
| 101    | R0<br>... |
| 110    | R0<br>... |
| 111    | R0<br>... |

▀ Shifted character. The character is shifted three rows to R3 at the top of the font and R11 at the bottom.

Figure 8-6. 6575 Character Generator ROM pattern.

For the second character position the Character and Line Address Multiplexers call up the "T" in the Display RAM. The resulting ASCII code for a "T" (1010100) ultimately appears on the address inputs to the Character Generator ROM. Since the Scan Counter is still at a count of zero, the ROM outputs 1111111. This process continues for the balance of the displayable portion of the video scan line.

At the end of the horizontal scan line, the Scan Counter changes to a binary count of 0001 which specifies scan line R1 in the Character Generator ROM. The "C" and "T" are again called up from the Display RAM for the first and second character position respectively. The ROM consequently outputs 0100001 and then 0001000. This sequence continues through scan line R8 when the Scan Counter is at a count of 8 (1000) to produce the "C" and "T".

As discussed earlier, the Scan Counter cycles through 13 counts or scan lines. For the "C" and "T" in our example, the Scan Counter has counted ten lines (15, 0, 1, 2, 3, 4, 5, 6, 7 and 8). The remaining three scan lines are not used in forming the "C" or "T", so on counts 9, 10 and 11 of the Scan Counter the Character

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Generator ROM automatically outputs all zeros for these two character positions. After the last scan line in the third character row, the Scan Counter is reset to a count of 15 to start the fourth character row.

The Character Generator ROM output is converted from parallel to serial form in an 8-bit shift register (U41) that is clocked by the rising edges of DOT CLOCK. Shift and load control is provided by LOAD CLOCK. Parallel input bit PH (pin 14) and serial input (pin 1) are connected to ground to generate the two horizontal spacer dots between characters. Following the first seven data bits, the eighth DOT CLOCK shifts a zero from the grounded serial input into QH to supply the first spacer dot. The ninth DOT CLOCK, which arrives when LOAD CLOCK is low, loads the next parallel dot pattern. QH, however, remains low during the next DOT CLOCK period since PH is at ground, thus supplying the second spacer dot. LOAD CLOCK then goes high and the sequence repeats.

A blink oscillator (two inverter sections in U88), a latch (one section in U42) and their associated components comprise the cursor circuit. The blink oscillator runs continuously at a rate set by R84 and C36. Its output has a nominal 0.5 sec period. If the blink option is selected with S1-5, the blink signal is applied to one input of a gate in U60. The other input to this gate is provided by the blink latch, one section in U41. If the cursor bit QA out of Data Latch U26 is high, D flip-flop U42 sets for the time the ROM is active on the character and remains set during the period when video data is shifted out of U41. The output of U42 is gated high through NAND gate U60 when BLINK (pin 6 of U88) is low. BLINK is held low when the blink option is not selected. The output of U60 is in turn gated with the video output of U41 in U74, an exclusive OR gate. U74 thus inverts the video if the output of U60 is high, and no inversion takes place if the output of U60 is low.

The video signal including the cursor, is gated to pin 9 of another U74 exclusive OR gate in the absence of any blanking signals at the other two inputs to NOR gate U59. If S1-4 is open, U74 inverts the video signal to produce a reverse (black on white) display. Raw video on pin 8 of U74 is supplied to pin 15 of J4. Video out on pin 6 of inverter U87 is combined with COMP SYNC on pin 8 of another U87 inverter in a resistive mixer, R80-R82, to meet EIA composite video signal standards, and coupled to P1 for use by a video monitor. This mixer has a 61-ohm output impedance.

Both Beginning Address Counter U1 and First Screen Position Counter U11 are enabled to advance their counts when pin 9 of J-K flip-flop U75 is low, which it is for about 600 nsec following OVERFLOW LINE; that is, after the Scan Counter (U40) is loaded. This, of course, occurs at the end of every scan line in the character row.

The scroll circuit consists of U1, U11, Scroll Control Latch U2 and Screen Position Control Latch U13 and their associated circuitry. U1 and U11 are up and down counters respectively that are pre-

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set to the outputs of latches U2 and U13. U2 latches the starting row address from DIO $\emptyset$ -3 and U13 latches the data on DIO4-7, with PORT OUT FE being the strobe. Data on DIO4-7 specifies where the first line will be displayed. Thus, the number loaded into U1 is the address of the first displayable scan line, and the number loaded into U11 defines the character row ( $\emptyset$  through 15).

U11 is preset by VDISP from pin 9 of J-K flip-flop U43. This means U11 is forced to its preset condition from the end of the displayed text to the top of the next character row. During this time, pin 6 of another U43 J-K flip-flop is set high to preset U1. If U11 is preset to  $\emptyset$ , its TC output on pin 7 is low and pin 6 of U43 is reset to a low. This allows U1 to count with each horizontal scan line.

If U11 is preset to any number other than  $\emptyset$ , pin 6 of U43 cannot be reset low until U11 reaches zero. Assume U11 is preset to two. It must count down two character rows before U1 starts counting. During this time, pin 7 of U43 (PRE BLANK) is low, and as previously discussed, the display is blanked.

We can now see that the PRE BLANK time, often called "window shade", is variable with the number loaded into U11. Therefore, scrolling is performed by changing the numbers in U2 and U13 without the need to reposition the text within the Display RAM.

The remaining circuit in the Display Section consists of transistor Q2, one section of U87, 89 and 102. U88 and U102 are connected as a one-shot 250 msec timer that is triggered when PORT OUT FE goes active (pin 1 of inverter U87 goes high). Thus, when data is loaded into U2 and U13, this timer starts. Tri-state driver U89, which is enabled by PORT IN FE, transmits the state of this timer to DIO $\emptyset$  on the Bidirectional Data Bus. The CPU can consequently test the timer status by looking for a high on DIO $\emptyset$ . This timing allows a 250 msec scroll rate without the need for complex timing routines in the CPU. Q2, R102 and C37 serve to speed up timer reset.

#### 8.5.5 Audio Tape I/O

Refer to Audio Tape I/O Schematic in Section X, Page X-18.

Timing for the Audio Tape I/O is derived from the 1200, 2400, 4800, 19,200 and 38,400 Hz signals received from the Baud Rate Generator in the Input/Output section of Sol. The first two are used by the write data synchronizer (U100) and the digital-to-audio converter (U101).

The remaining three signals are fed to two sections of U111, a quad multiplexer or select gate. All four sections of U111 are used to select clocks for low speed or high speed operation according to the select inputs, pins 9 (A) and 14 (B). The states of these two select inputs must be complementary to each other in order to select

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the high or low speed clocks. Specifically, A must be high and B low to select high speed clocks; the converse condition selects low speed clocks. The select inputs are supplied by TAPE HI SPEED and TAPE HI SPEED.

The output of the second section on pin 11 of U111 is BYTE WRITE CLOCK, 4800 Hz on low speed and 19.2 KHz on high speed. The third section outputs a 19.2 KHz (high speed) or 38.4 KHz (low speed) timing signal to input pin 10 of binary up counter (U112).

RECOVER CLOCK is produced by a phase locked loop (U110), another U112 binary up counter and the first and fourth sections of U111. The signal input (pin 14) to U110 is supplied from output pin 1 of D flip-flop U113. It is a constant frequency, regardless of whether one or two transitions are detected in the read data during the count out time (12 counts) of the U112 counter with outputs on pins 13 and 14. A phase comparator in U110 compares the signal input to the output of a voltage controlled oscillator (VCO) in U110 (pin 4). By feeding the VCO output through a counter (the other half of U112) before feeding the counter output back to the compare input (pin 3) of U110, the circuit acts as a frequency multiplier. The output of this circuit remains locked, therefore, to a multiple of the signal input on pin 14 of U110.

The output of U110 is nominally 19.2 KHz. The actual output is determined by the signal input which in turn is a function of tape speed. In other words, the phase lock loop circuit tracks input frequency variations. And it will track such variations within its locking range which is determined by the setting of variable resistor VR3 (connected to pin 12 of U110).

For high speed, the divide-by-four output of U112 (pin 4) is selected as RECOVER CLOCK. For low speed, the VCO output of U110 is selected for RECOVER CLOCK. This clock serves as read clock for the CDI UART, U69.

CDI control involves PORT IN FA, PORT IN FB, PORT OUT FB, TAPE CONTROL 1 and 2, POC (power on clear), TAPE HIGH SPEED and TAPE HI SPEED. The last two were previously explained in the discussion of U111. PORT IN FA strobes the CDI UART status (DR, TBRE, OE and FE--refer to Page VIII-22 for definitions) to the Internal Data Bus, INT3-7. PORT IN FB strobes received data on pins 5-12 of U69 to the Internal Data Bus, INT0-7. PORT OUT FB loads data from the Bidirectional Data Bus (DIO0-7) into U69. POC simply resets U69 whenever power is applied to the Sol.

TAPE CONTROL 1 and 2 are used to turn one or two recorder motors on and off. An active low TAPE CONTROL 1 energizes K1 to close its contacts and turn recorder #1 on; a high de-energizes K1 to turn the recorder off. TAPE CONTROL 2 does the same thing with K2 to control another recorder. Diodes D13 and 14, which shunt K1 and K2

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respectively, prevent damage to the logic circuitry in the Input/Output section due to inductive kickback. R155 and 156 are current limiters that keep the relay contacts from "welding" together.

When the CDI is in the write mode, data is input to the UART (U69) under control of ~~PORT OUT FB~~. Upon completion of this strobe, the transmit sequence is initiated within the UART, with the transmission rate being governed by BYTE WRITE CLOCK.

The transmission sequence begins with a start bit, a low (data zero) on the UART's TO output. It is followed by eight data bits and two stop bits (high on the UART's TO output), with the number of bits being fixed by the connections to pins 34 through 39 of U69.

The data from U69 is applied to the D input of D flip-flop U100 which is clocked at 1200 Hz. Consequently, the output on pin 1 of U100 follows the input data on pin 5 after the rising edge of the 1200 Hz clock. This output is connected to the reset (pin 4) of U101, so when the data out of the UART is high, the first section in U101 is forced to a reset condition. In this condition the J and K inputs to the second stage of U101 are held high which allows the flip-flop to change state on the rising edge of the clock.

The clock for U101 (OUTPUT CLOCK) is 2400 Hz in the high speed mode or 4800 Hz in the low speed mode. This clock is derived from 2400 Hz in conjunction with the low speed select signal in NAND gate U98 and exclusive-OR gate U99.

In the high speed mode, pins 12 and 13 of U98 are held low, thus holding pin 10 of U98 high. As a result the 2400 Hz signal is inverted in U99 to become the clock for U101.

Pins 12 and 13 of U98 are held high, however, in the low speed mode to enable U98. In this case R117 and C47 provide a delay in the U98 gate. When the 2400 Hz signal on pin 2 of U99 changes state, so does pin 3 of U99. Also, C47 charges through R117 for several usec, at which point pin 10 of U98 is brought to the opposite polarity. The output from U99 then goes high. A series of positive pulses, with a pulse width approximately equal to the R117, C47 time constant (10 usec) and occurring at every transition of the 2400 Hz signal, appears on pin 3 of U99. This circuit thus operates as a frequency doubler in the low speed mode to provide a 4800 Hz clock for U101.

The 2400 Hz signal from which the U101 clocks are derived also produces the 1200 Hz clock signal for U100. As a result the 1200 Hz signal changes state following a propagation delay after the 2400 Hz signal falls.

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As previously stated, the second stage of U101 is allowed to change state on the positive going transitions of the OUTPUT CLOCK as long as the data out of the synchronizer is a "1". The end result is an output on pin 14 of U101 that is one-half the clock frequency (1200 Hz and 2400 Hz in the high and low speed modes respectively).

Assume the data stream out of the UART goes low ("0"). On the next rising edge of the 1200 Hz signal, U100 will reset with Q low and  $\bar{Q}$  high. A low reset on pin 4 of U101 enables the first U101 stage to toggle on the next rising edge of the OUTPUT CLOCK which occurs 1/2400 second after the synchronizer output falls. Remember that OUTPUT CLOCK moves from a low to a high shortly before the 1200 Hz signal did. The reset on pin 4 of U101 is thus removed slightly after the OUTPUT CLOCK occurred. With the J and K inputs to the first U101 stage high, its output will change state on each succeeding low to high transition of OUTPUT CLOCK. The second U101 stage in turn can only toggle on the positive going transition of OUTPUT CLOCK when its J and K inputs are high. Since the inputs are high at one-half the clock rate, by virtue of the first U101 stage, the second U101 stage toggles at one-fourth the OUTPUT CLOCK rate.

The two sections of U101, therefore, operate as a frequency divider, dividing the OUTPUT CLOCK by two when the write data is a "1" and by four when the data is a "0". Thus, in the low speed mode, four cycles of the 1200 Hz represent a "0" and eight cycles of 2400 Hz represent a "1". In the high speed mode, one cycle of 1200 Hz represents a "1" and one-half cycle of 600 represents a "0".

The output on pin 14 of U101 is applied to one section in U109 which provides sufficient current drive for the divider network. This divider and a jumper arrangement allow selecting one of three outputs to be fed to the audio output jack J6. The I-to-J jumper selects a 500 mv signal for the auxiliary input to an audio recorder; the I-to-H jumper selects a 50 mv signal for the microphone input to an audio recorder.

When the CDI is in the read mode, data from the recorders enters on J7. This input is fed to the negative input (pin 6) of operational amplifier U108.

The first section of U108 is a high gain amplifier, with its gain (approximately 100) being determined by R142 and R143. The output from this amplifier is coupled to input pin 2 of the following U108 stage and the base of a Darlington pair (Q4 and Q5) which provides high current gain.

Current into the base of transistor Q5 causes C67 to discharge. (C67 charges through R39 to 5 V dc.) The voltage on C67 in turn controls the gate of field effect transistor (FET) Q3. Q3 functions as a variable resistor which can be changed by its gate voltage. Since Q3 is connected between ground and the input network to the

first U108 stage, it serves as a variable shunt. A low gate voltage on Q3 decreases the shunt resistance and the input to U108. In a like manner, a high voltage on C67 results in an increased input to U108. Q3, Q4 and Q5 with their associated circuitry, therefore, serve as an automatic gain control (AGC) circuit which limits the input to the second U108 stage to approximately a positive 2 volt peak signal.

The second stage of U108 is a comparator with hysteresis that performs the needed audio to digital conversion. Feedback resistor R147, in conjunction with R145, establishes the level on the positive input (pin 3) of U108. This level, be it positive or negative, is the threshold voltage,  $\pm 50$  mv, which the negative input (pin 2) must exceed in order for the output of U108 to switch levels, positive to negative and the converse. Since the feedback loop is regenerative, U108 switches at its maximum rate, and U108 switches on each transition of the audio signal input. It is in this manner that U108 performs the audio to digital conversion.

The digital output of U108 is inverted in one section of inverter U109 and applied to pin 9 of exclusive OR gate U99 which is connected as a buffer without inversion. If the output of U109 is low, the output on pin 10 of U99 is also low and the output on pin 4 of another U99 exclusive OR gate is high. The voltage across C49 under this condition is minimal. When the output of U109 goes high, C49 starts to charge through R118 until pin 9 of U99 crosses the threshold of that gate. At this point pin 10 of U99 goes high, and since the two inputs to the second exclusive-OR gate are both high, pin 4 of U99 goes low. C49 now discharges because pins 9 and 10 of U99 are at the same level so that the circuit can repeat the operation on the next high to low transition at pin 4 of U109. R118, C49 and U99 consequently serve as a transition detector that produces a pulse less than one microsecond long for each transition of the output on pin 4 of U109, regardless of the polarity of the transition.

Transition pulses from U99 clock both D flip-flops in U113. A transition pulse clocks the top U113 at pin 3 which sets Q (pin 1) high and Q (pin 2) low to enable up binary counter U112 on pin 15. Pin 1 is applied to the D input (pin 9) of the lower U113 and the circuit remains in this state until one of two things occurs: 1) a second transition pulse arrives before U112 reaches count 12 or 2) U112 reaches count 12.

If a second transition pulse arrives before count 12, the bottom U113 stage is set and presents a "1" to the D input (pin 9) of flip-flop U100. This is clocked by the  $\bar{Q}$  output on pin 2 of U113 as a low to pin 12 of U100.

If a transition pulse does not arrive before count 12, the bottom U113 stage outputs a " $\emptyset$ " to input pin 9 of U100. On count 12, the C and D outputs of U112 go high to reset U113 by way of U98 at pin 4. As a result the U100 clock goes high, as does pin 12 of

U100. The output on pin 12 of U100 is inverted by U109 and applied to the receive input (pin 20) of the UART.

The Q output on pin 1 of U113, which occurs at the actual bit rate of the incoming data, is also used by the receive clock circuitry to reconstruct the receive clock from the data signal.

Received data undergoes serial-to-parallel conversion in the UART and is placed on the R01-8 data outputs of the UART when ROD (pin 4 of the UART) is low (PORT IN FB active) and onto INT $\emptyset$ -7.

Four status outputs from the UART can also be enabled when SFD (pin 16) is low. These four bits are FE (framing error), OE (overrun error), DR (data ready) and TBRE (transmitter buffer register empty).

## 8.6 KEYBOARD

### 8.6.1 Block Diagram Analysis

A simplified block diagram of the keyboard is provided on Page X-21 in Section X.

The Clock Oscillator produces the basic timing signals for the keyboard, and they are distributed as indicated.

At the heart of the keyboard is a Key Switch Capacitive Matrix which can be viewed as a 16 x 16 X-Y matrix, with X being the column and Y the row. Conceptually, a key depression increases the capacitance between the X and Y coordinates that uniquely define that key.

The Column Scanner supplies a pulse train to the X lines in the matrix, with only one line being pulsed at any given point in time. When a key is depressed to increase the capacitance between the Column Scanner output and a Row Scanner input, the X-Y coordinates for that key are detected to provide an input to the Sense Circuit.

The Sense Circuit in turn generates an input to the Sequence Detector when a key closure occurs. This detector basically detects key closures and count cycles of the Row Scanner to discriminate against false key signals and insure that valid closures are serviced in order.

In the absence of key closures, the Sequence Detector feeds PKD to the Sense Circuit to increase its threshold. This action serves to increase the circuit's noise immunity. On valid key closures, the PKD input is such as to decrease the Sense Circuit's threshold. When valid key closures exist, the Sequence Detector strobes data into the Output Latch. The low order four bits to this latch are supplied by the Row Scanner; the high order four bits are

supplied by the Encoding ROM, with the data being determined by inputs from the Column Scanner and Function Latch Decoder. This strobe (Data Out) also enables the Strobe Generator to output STROBE, a 6 usec pulse that signals the Sol CPU that the Keyboard is ready to send data.

Eight bits of keyboard data (KBD0 through KBD7) are stored in the Output Latch. KBD0 through KBD6 represent the ASCII code for the character associated with the key closure, or closures, that initiated the Data Out strobe from the Sequence Detector. KBD7 is used only for special control characters (e.g. MODE SELECT, CLEAR and cursor movement) that are recognized by the Sol program. The data on KBD0-7 is input to the Sol CPU when it issues PORT IN FC (refer to Paragraph 8.5.2 on Page VIII-14).

The Repeat Counter is enabled when the REPEAT key and a character key in the Key Switch Capacitive Matrix are pressed at the same time. When this occurs, Key Out (initiated by the character key closure) is active, and the Repeat Counter generates a periodic Repeat Strobe. This strobe disables the Sequence Detector and causes the Strobe Generator to output repetitive STROBE pulses. Column 30 also prevents the Sequence Detector from strobing additional data into the Output Latch.

The Function Latch and Decoder latches and decodes the Low Order Count from the Row Scanner when the "function key" column in the Switch Matrix is selected by the Column Scanner. It then outputs, as appropriate, LOCAL, RST and BRK to J1 and SHIFT/SWIFT LOCK, UPPER CASE and CONTROL bits to the Encoding ROM. The latter three supply three of the seven address bits to the ROM which specify the high order four KBD bits (KBD4-7).

All keyboard outputs are supplied to J1 which is connected to J3 on the Sol-PC.

#### 8.6.2 Circuit Description

Refer to the Keyboard schematic in Section X, Page X-22.

Keyboard operation is controlled by a 3 usec clock circuit consisting of NAND gate U7, R7 and C7. U7 is connected as a Schmitt trigger inverter with negative feedback through R7 and C7. The output on pin 11 of U7, a square wave with a 3 usec period, is inverted in U4 (a NAND gate connected as a simple inverter) and applied to the clock input (pin 11) of U8. U8 operates in a toggle mode by virtue of feeding its  $\bar{Q}$  output on pin 8 to the D input on pin 12. Thus, its output state changes on each clock to produce a 6 usec and an inverted 6 usec clock on pins 9 and 8 respectively.

Each of these outputs is connected to a section of U7 where each is AND'ed with the 3 usec clock. This generates two negative going clocks at pins 8 and 6 of U7. These outputs are called  $\bar{D}I$  and

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$\overline{\phi}2$  respectively. This circuit thus generates a symmetrical two phase clock, with each phase having a 6 usec period with a 1.5 usec negative going pulse.

$\overline{\phi}1$  advances the cascaded ripple counter, U5 and 6, in the Column Scanner circuit (U5, U6, NAND gates U4 and decoders U17 and U21). U6 divides  $\overline{\phi}1$  by two on each advance. The output on pin 12 is consequently a square wave with a 12 usec period, the output on pin 9 is a square wave with a 24 usec period, and so on to pin 11 which has a 96 usec period. The output on pin 11 is then divided by two in U5 to provide 192, 384, 768 and 1536 usec periods. We will call these Clock 1 for the 12 usec period, Clock 2 for the 24 usec period, Clock 4 for the 48 usec period, and so on from Clock 8, 16, 32, 64 and 128.

Clocks 16, 32 and 64 are applied to the A, B and C inputs of binary-to-decimal decoders U17 and U21. In order for these decoders to yield outputs, their D inputs (pin 12) must be low. U4 is used to enable one or the other of these inputs, with Clock 128 being the determining factor. When Clock 128 is low, U17 is selected through U4 when  $\overline{\phi}1$  is high at pin 4 of U4. U21 is selected when Clock 128 is high and  $\overline{\phi}1$  is high at pin 13 of U4. By AND'ing  $\overline{\phi}1$  and Clock 128, neither decoder is selected when  $\overline{\phi}1$  is low, the time U5 and U6 count. During this time false binary signals can appear on the outputs of U5 and 6.

The net effect is that only one of the 15 outputs from U17 and 21 will be low, and this low advances on each count advance. The low outputs of U17 and 21 drive the column lines in the key switch matrix.

Clocks 1 through 8 are connected to analog multiplexers U19 and U22. Only one channel from input to output is connected at one time. Note that Clock 8 and  $\overline{\text{Clock 8}}$  from U6 enable U19 and U22 respectively. U19 and U22 (the Row Scanner) thus scan through the 16 rows in the sequence indicated by the numbers contained within the "boxes" of the key switch matrix. An entire scan of the rows is made before the next column is selected by U17 and 21.

We now have U17 and U21 driving the column lines and U19 and U22 testing each row line by connecting it to an input to the Capacitance Keyswitch (KTC) Detector. These two inputs are normally high at 5 volts. Within the switch matrix there is a small capacitance connected between each column and row line; that is, there is a capacitance associated with each key on the keyboard. When a key is depressed on the keyboard, the capacitance associated with that key increases. When the column and row lines associated with that key are selected, there is a significant voltage difference between the two and the capacitance charges to produce a small negative going spike at the input to the Capacitance Keyswitch Detector.

This detector circuit consists of three transistors, Q7, Q8, and Q9 (connected as a linear amplifier with negative feedback) followed by Q4 and Q2. Q4 and Q2 are large signal amplifiers biased in their cut-off region. The input to the detector is selectively connected to +5 V dc by way of the analog multiplexers (U19 and U22), the row matrix wires, and the 33K resistors. A key depression causes a negative current pulse through R16 to the base of the input amplifier transistor, Q8, which is biased near cut-off. The pulse is then amplified by Q8 with inversion to appear as a positive pulse at the input of Q7. Q7 is an emitter follower circuit which gives a positive pulse at its output, across R18, at a low impedance. This signal is coupled back to the input through transistor Q9, a common base amplifier which has its base clamped to 2.5 V dc by zener diode CR4. When the positive pulse appears at the emitter of Q9, it is amplified without inversion and applied to the input of Q8. Since the original input was a negative pulse, the positive pulse constitutes negative feedback. The output across R18, a positive pulse, is further amplified by pulse amplifier transistor Q4, a common base amplifier that is normally biased off. The output stage Q2 is biased in the cut-off region also, but a sufficient positive pulse from Q4 will cause Q2 to conduct to give a negative pulse output across R12.

Transistors Q1, Q6, Q5 and Q3, represent a second pulse amplifier circuit that is analogous to transistors Q9, Q8, Q7 and Q4 respectively. The output of this second amplifier, which appears at the collector of Q3, is also connected to the base of the output transistor Q2. An input pulse from either U19 or U22 will therefore supply an amplified negative pulse to pin 13 of NOR gate U14.

The  $\overline{PKD}$  signal through R24 helps to set the threshold at the base of Q4 and Q3. This threshold is normally high when  $\overline{PKD}$  is high, so the output from Q7 and Q5 has to overcome a higher threshold at the emitter of Q4 and Q3 in order to cause conduction of Q4 and Q3. On the second such pulse on the same count address,  $\overline{PKD}$  goes low to reduce the threshold at the bases of Q4 and Q3. This sensitizes the circuit, acting as a positive feedback path, and gives an output. Thus two consecutive detections of a key stroke are necessary to give an output. This feature provides noise immunity since a single noise pulse will not pass through the amplifier. The complete key switch matrix is scanned at a very high rate compared to the time it takes to physically press and release a key. Thus a key closure will be detected, even though the key is not held down for any appreciable time.

Two sections of NOR gate U14 are connected as a cross-coupled flip-flop. A low on pin 13 of U14 sets output pin 11 of U14 high, providing that the low is longer than 1.5 usec (which it is when a valid key closure is detected). That is because  $\overline{Q1}$  is applied to pin 9 of U14.  $\overline{Q1}$  effectively prevents switching noise, which is short in duration, from being interpreted as a key closure. The high, let's call it KEY, on pin 11 of U14 will remain until  $\overline{Q1}$  again goes low about 4.5 usec later.

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KEY is fed to pin 5 of 8-input NAND gate U25, pin 9 of ROM U20 and pin 1 of NAND gate U27. Let's examine the other inputs to U25.

KEY, as mentioned, is fed to pin 9 of U20 which is a 256 x 4 bit static ROM. Only two bits are used. For each possible row-column combination, there is one storage location in U20. D1l and D0l (pins 9 and 11) are the input and output respectively of one bit location; D12 and D02 serve the same functions for the other bit location. The row count is applied to A $\emptyset$ -4 and the column count is applied to A5-7 to address U20.

When a key closure is detected, the counts are presented to U20 continuously. When the counts change shortly after the falling edge of  $\emptyset$ 1, U20 outputs the status of the address that is already stored in the ROM about 1 usec later on pin 10. On the rising edge of  $\emptyset$ 1 after the address change, the status on pin 10 is latched in one-half of D flip-flop U26 and presented at output pins 9 and 8. About 1.5 usec later the R/W signal on pin 20 of U20 goes low, and the KEY signal on pin 9 enters the specified location in U20. Note that this KEY is related with the new count address. The key stored in U26 represents the preceding address. We consequently call the KEY in U26 "KEY minus 1", and it is applied to pin 11 of U25.

The remaining inputs to U25 are 1)  $\emptyset$ 2 (an inverted  $\emptyset$ 2) on pin 12, 2) a repeat strobe signal on pin 4 (supplied by pin 11 of NAND gate U16 which is high without a repeat command), 3) PKD minus 1 on pin 6 (supplied on pin 3 of U26 which is low if three or more count cycles have occurred since one key closure), and 4) the column output on pin 4 of U17 which is applied to pins 1, 2 and 3. The last signal drives the column associated with the special function keys on the keyboard (SHIFT, SHIFT LOCK, LOCAL, BREAK, UPPER CASE, REPEAT and CONTROL).

In order for U25 to output a low on pin 8, therefore, we need a current KEY, a KEY from the preceding count cycle, no repeat function, no drive on pin 4 (column 3 $\emptyset$ , hexadecimal), and we must be on the second count cycle during the current key depression.

With these conditions satisfied output pin 8 of U25 goes low. It is inverted by U10 to a high on pin 11. This signal then clocks the output latches, U1 and 2. On this signal, the data present on the inputs are latched into U1 and 2, and it remains latched until the next output on pin 8 of U25 occurs.

A low on pin 8 of U25 also resets one-half of D flip-flop U11 at pin 13 which causes output pin 9 to go low. On the rising edge of the inverted 6 usec clock from U8, the second U11 stage sets and out-

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put pin 5 goes low to clear the first stage. The high on output pin 6 is inverted by NAND gate U10 to supply a low active STROBE on pin 3 of J1. (Note that J1 on the keyboard connects to J3 on the Sol-PC.) The next inverted 6 usec clock resets the second U11 stage. We thus have a 6 usec strobe pulse following the latching of data into U1 and U2.

The complement of KEY minus 1 on output pin 8 of U26 is fed to input pin 10 of NAND gate U16 and is translated to a high on pin 8. The other input on pin 9 is high at this time since it is driven by the signal which indicates the third count cycle. A three-input NAND gate, U27, thus has a high on pin 2. A second input on pin 1 is KEY which is active (high) from the first count cycle of the key closure. The remaining input on pin 13 is supplied by pin 11 of U16, and it is low only when the repeat function is operating. U27 is consequently satisfied and outputs a low on pin 12.

This low appears at pin 5 of NOR gate U16. Pin 4 of U5 is high at this point by virtue of a low on pin 1 of U16 which indicates the third count. Thus, the high on pin 6 of U16 will be stored in the second bit location U20 when  $\overline{\emptyset 2}$  goes low at pin 20 of U20. When this happens DO2 (pin 12) of U20 goes high to indicate the new status of this bit.

The DO2 output is inverted in U10 and applied to input pin 2 of another U26 D flip-flop and to the Capacitance Keyswitch Detector as PKD. PKD serves to lower the detector threshold; that is, the detector offers less "resistance" to its input. This is positive feedback that allows the detector to discriminate between noise and a key closure. Note that two key closures are required before the detector threshold is lowered.

The inverted DO2 output from U20 also appears at the D input (pin 2) of U26. Since this flip flop is clocked by  $\overline{\emptyset 1}$ , the prior status of PKD, called "PKD minus 1", is already present in this latch on output pin 5. If we are on the second count cycle of a key closure, pin 5 is high. If we are on the third count or more, it is low to inhibit U25. As previously mentioned, PKD minus 1 is also connected to the NOR gate (U16) used to feed data to pin 11 of U20 from KEY minus 1.

When the current KEY signal is released, pin 12 of NAND gate U27 and pin 5 of NAND gate U16 go high. The U16 NAND gate that inputs to pin 4 of U16 looks at KEY minus 1 on pin 2 and the complement of PKD minus 1 on pin 1. Thus, pin 1 is high for the first one and a half counts and pin 2 is high for the first count. Upon release of KEY, therefore, pin 3 of U16 is low for the first count. On the second count, KEY minus 1 goes low--as do pin 6 of U16 and pin 12 of U20. On the next  $\overline{\emptyset 2}$  clock, the data is read into U20. The output on pin 12 of U20 changes to remove PKD which increases the Capacitance Keyswitch Detector threshold for greater noise immunity. It also sets PKD minus 1 on pin 5 of U26 on the third count cycle.

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following release of KEY. On the third cycle the circuit reverts to its original state.

This circuit, comprised of U20, U26, U16 and U17 serves two functions. By requiring two events during two consecutive count cycles before generating a KEY, it discriminates against false key closures. It also insures that multiple key strokes are serviced in order. (This is the n-key rollover feature.) That is because the row-column addresses are continuously presented to U20 and this circuit's cycle can occur for each possible key closure. U20 can thus contain data for all possible key closures, and the data will enter U1 and U2 on the KEY generated for each closure as the row-column count progresses.

The previously mentioned column 3Ø output on pin 4 of U17 drives the keyboard control key "switches". Data for these key closures, present on pins 1, 2 and 3 of addressable latch U12 is latched in U12 during Clock 8 and Ø2 when column 3Ø is driven. Pin 13 of U12 is connected to the complement of PKD minus 1. Thus, the data (active low) is strobed into U12 on the first count cycle. During the third count it will be strobed again and a high is read in. When the key is released, a low is strobed in again. As a result, a high active pulse appears on the output line related to the key that was closed for the duration of the key closure.

SHIFT and SHIFT LOCK, on pins 11 and 10 respectively, are applied through U23 inverter stages to NOR gates U13 and U14. These are connected as a cross-coupled flip-flop. An active SHIFT sets this flip-flop at pin 5 of U13 to make output pin 6 of U13 and output pin 3 of U14 high. The latter is connected to pin 3 of U18, a 512 x 4 bit ROM. U18 is programmed to output the high-order four bits of the data to U1 according to the states of pins 1, 2 or 3.

The U13-14 flip-flop is set to a high on pin 6 if SHIFT LOCK is active. As can be seen, the shift bit to U18 is high by virtue of the low on pin 6 of U13 and it will remain so until SHIFT again causes U13-14 to change state. When output pin 6 of U14 is high, pin 12 of U24 is low to turn light emitting diode LED1 on. This LED is located in the SHIFT LOCK key and indicates the keyboard is in a locked shift condition.

When UPPER CASE is active, pin 7 of U12 goes high to clock D flip-flop U15 on pin 3. This flip-flop is connected to operate in a toggle mode. On the UPPER CASE "clock", pin 5 of U15 goes to make pin 2 of U18 low. The high on pin 6 of U15 is inverted by U24 to turn on LED2. LED2 is located in the UPPER CASE key. A second closure of this key toggles U15 to the opposite condition.

Now assume the LOCAL key is depressed, the output on pin 5 of U12 goes active high to clock the other D flip-flop U15 stage at pin 11. This stage also operates as a toggle, and output pin 9 goes low to become LOCAL on pin 14 of J1. Again, the high on output pin 8

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causes LED3, the LOCAL light, to turn on. A second closure of the LOCAL key toggles this section of U15 to the opposite condition. Note that LOCAL has no affect on keyboard data.

The other outputs from U12 are BREAK (pin 12), CONTROL (pin 6) and REPEAT (pin 9). BREAK is inverted in U23 to become BRK on pin 4 of J1. CONTROL is applied directly to input pin 1 of U18 so that the control character related to the low order bits enters U1 and U2.

REPEAT is applied to pins 10 and 11 of NAND gate U27 and pin 13 of NAND gate U16. The input to U27 is gated with UPPER CASE to generate RST at pin 13 of J1. This means, of course, that REPEAT and UPPER CASE must be depressed at the same time to generate RST.

On pin 13 of U16, REPEAT enables that gate so that U16 transmits the output on pin 9 of U9. U9 is connected as a two-stage shift register whose input (pin 2) is ground. It is clocked by clock 128 from U5.

U9 is initially set with output pins 5 and 9 high during the third count cycle by PKD minus 1. This is also the time when U12 outputs data. If the key is released, U9 clears to a low on pin 9 five count cycles following KEY. If the key is held down, U9 cannot shift since PKD minus 1 remains on preset input pins 4 and 10.

When REPEAT exists at pin 13 of U16, pin 11 of U16 is low to inhibit U25 and U27 at pin 13. This prevents further KEY signals and disables the n-key rollover circuitry. The low on pin 11 of U16 is also inverted by open collector inverter U24 to enable the repeat oscillator (timer U3, R4, R5 and C3). U3 generates a square wave on pin 3 with a period determined by the RC network.

This clocks the first stage of D flip-flop U11, the STROBE generator, and U11 produces the previously discussed 6 usec STROBE. U11 continues to generate STROBE at the repeat oscillator rate until either the REPEAT or character key is released. And with each STROBE, of course, the data associated with the character key is latched into U1 and U2.

Eight ASCII-coded data bits are output by U1 and U2 to J1 as indicated. Seven bits (0-6) are used for ASCII characters, and the eighth bit (7) is set only for certain control characters that are recognized by the Sol program. These are used for control functions such as MODE SELECT and cursor movement.

The remaining circuit, R32 and C14, initializes the keyboard when power is applied. That is, it resets the output latches and the SHIFT/SOFT LOCK, UPPER CASE and LOCAL flip-flops. It also inhibits STROBE at pin 1 of NAND gate U10.





## IX SOFTWARE

**SOLOS<sup>TM</sup>/CUTER<sup>TM</sup> USER'S MANUAL**  
(Separately bound. May be inserted here.)

**BASIC 5 USER'S MANUAL**  
(Separately bound. May be inserted here.)

**SOLOS<sup>TM</sup> Monitor Program Source Listing**



SOLOS<sup>TM</sup> Monitor Program Source Listing



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PROGRAM DEVELOPMENT SYSTEM  
SOFTWARE TECHNOLOGY CORP.  
P.O. BOX 5260  
SAN MATEO, CA 94402

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SYSTEM SOFTWARE

NOTE: CONSOL, SOLOS AND SOLED ARE REGISTERED  
TRADEMARKS OF:  
PROCESSOR TECHNOLOGY CORP.  
EMERYVILLE, CALIF.

VERSION 1.3  
RELEASE 77-03-27

=====  
SOLOS =====

THIS 2048 BYTE PROGRAM IS THE STANDARD Sol STAND  
ALONE OPERATING SYSTEM. IT IS CONFIGURED TO OPTIMIZE  
THE CONVENIENCE AND POWER OF THE Sol-20 AND ONE OR TWO  
CASSETTE RECORDERS IN STAND ALONE COMPUTER APPLICATIONS.

AUTO-STARTUP CODE

0039 START DB 0 FOUR PHASE WONDER  
0040 INIT JMP SYSTEM RESTART ENTRY POINT

ENTRY POINTS

0045 THESE JUMP POINTS ARE PROVIDED TO ALLOW COMMON ENTRY  
0046 LOCATIONS FOR ALL VERSIONS OF SOLOS. THEY ARE USED  
0047 EXTENSIVELY BY Sol SYSTEM PROGRAMS AND IT IS RECOMMENDED  
0048 THAT USER ROUTINES ACCESS SOLOS THROUGH THESE POINTS.  
0049 \* THIS ROUTINE IS A MODEL OF ALL INPUT ROUTINES WITHIN  
0050 \* SOLOS. EACH ROUTINE FIRST TESTS THE STATUS INPUT FOR  
0051 RETRN JMP COMMND RETURN TO SYSTEM ENTRY POINT

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PROGRAM DEVELOPMENT SYSTEM  
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PAGE 1

C007 C3 E0 C5  
C00A C3 03 C6  
C00D C3 48 C6  
C010 C3 83 C6  
C013 C3 CB C6  
C016 C3 7F C7  
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SYSTEM I/O ENTRY POINTS

0052 FOPEN JMP BOPEN FILE OPEN ENTRY  
0053 FCLOSE JMP PCLOS FILE CLOSE ENTRY  
0054 RDYT JMP RWTYT CASSETTE READ BYTE ENTRY  
0055 WRYT JMP RWTPE CASSETTE WRITE BYTE ENTRY  
0056 RBLK JMP RWTPE CASSETTE READ BLOCK ENTRY  
0057 WRBLK JMP RWTPE CASSETTE WRITE BLOCK ENTRY  
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0089 \*

0090 TPRC ANI 3 KEEP REGISTER "A" TO FOUR VALUES  
0091 RLC - COMPUTE ENTRY ADDRESS  
0092 ADD L,A  
0093 MOV L,A  
0094 JMP DISPT WE HAVE ADDRESS  
0095 \*  
0096 \*  
0097 \*  
0098 \*  
0099 \*  
0100 \*  
0101 \*  
0102 \*  
0103 \*  
0104 \*

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----- Sol SYSTEM I/O ROUTINES -----  
----- HAVE THE PROPER DISPATCH TABLE.

THIS ROUTINE PROCESSES THE I/O REQUESTS BY DISPATCHING  
TO THE DRIVER REQUESTED IN REGISTER "A". ON ENTRY HL

THIS ROUTINE IS A MODEL OF ALL INPUT ROUTINES WITHIN  
SOLOS. EACH ROUTINE FIRST TESTS THE STATUS INPUT FOR

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0105 * DATA AVAILABLE. IF NO CHARACTER HAS BEEN RECEIVED THE
0106 * ROUTINE RETURNS WITH THE ZERO FLAG SET. OTHERWISE THE
0107 * CHARACTER IS INPUT AND A RETURN MADE WITH THE CHARACTER
0108 * IN THE ACCUMULATOR AND THE ZERO FLAG RESET.
0109 *
0110 *
0111 * KEYBOARD INPUT DRIVER
0112 * KSTAT IN STAPT GET STATUS WORD
0113   CMA INVERT IT FOR PROPER RETURN
0114   ANI KDR TEST KEYBOARD BIT
0115   RZ . ZERO IF NO CHARACTER RECEIVED
0116 *
0117 *
0118 IN KDATA GET CHARACTER
0119 RET GO BACK WITH IT
0120 *
0121 *
0122 THIS JUMP IS PART OF THE AUTO START UP CODE
0123 *
0124 DB 0 VERIFY ADDR=C037 SO NEXT INSTRUCTION IS AT C038
0125 INIT
0126 C038 C3 01 C0
0127 *
0128 JUMP TABLE OUTPUT ROUTINES
0129 *
0130 THIS ROUTINE SETS UP THE DISPATCH TABLE FOR OUTPUT*
0131 * ROUTINES. THE CHARACTER FOR OUTPUT IS IN REGISTER "R".
0132 * OUTPUT IS MADE TO THE DRIVER POINTED TO BY THE REGISTER
0133 * "A". THE DEVICE DRIVERS ARE DEFINED AS FOLLOWS:
0134 *
0135 *
0136 0 - DISPLAY SCREEN
0137 1 - SERIAL OUTPUT PORT
0138 2 - PARALLEL OUTPUT PORT
0139 3 - USER DEFINED OR ERROR FLAG
0140 *
0141 ENTRY AT: SOUT SELECTS CURRENT OUTPUT DEVICE
0142 * AUT SELECTS DEVICE IN REGISTER 'A'.
0143 * OUTPR PUSH H
0144 OUTPR LXI H, OTAB POINT TO OUTPUT TABLE
0145 JMP IOPRC AND DISPATCH TO OUTPUT ROUTINE
0146 *
0147 *
0148 *
0149 *
0150 * SERIAL INPUT DRIVER
0151 *
0152 * SSTAT IN SERST GET SERIAL STATUS WORD
0153 SSTAT ANI SDR TEST FOR SERIAL DATA READY
0154 RZ .
0155 *
0156 IN SDATA GET DATA BYTE
0157 *

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0158 RET . WE HAVE IT
0159 *
0160 *
0161 * SERIAL DATA OUTPUT
0162 * SERST GET PORT STATUS
0163 SDROT IN RAL
0164 SDROT IN CJC
0165 SDROT IN MOV
0166 SDROT OUT
0167 SDROT OUT
0168 SDROT OUT
0169 *
0170 *
0171 *
0172 *
0173 *
0174 * VIDEO DISPLAY ROUTINES
0175 *
0176 * THESE ROUTINES ALLOW FOR STANDARD VIDEO TERMINAL
0177 * OPERATIONS. ON ENTRY, THE CHARACTER FOR OUTPUT IS IN
0178 * REGISTER B AND ALL REGISTERS EXCEPT "A" AND FLAGS ARE
0179 * UNALTERED ON RETURN.
0180 *
0181 *
0182 *
0183 VDMOT* PUSH H
0184 VDMOT* PUSH D
0185 VDMOT* PUSH B
0186 VDMOT* PUSH B
0187 * TEST IF ESC SEQUENCE HAS BEEN STARTED
0188 *
0189 * LDA ESCFL GET ESCAPE FLAG
0190 ORA JNZ
0191 ORA JNZ
0192 ORA JNZ
0193 *
0194 *
0195 CHPCX MOV A,B
0196 ANI THF CLR PARITY TO LOCATE IN TBL
0197 MOV B,A KEEP IT W/OUT PARITY IN R TWO
0198 GOBK DO A QUICK EXIT IF A NULL
0199 LXI H,TBL POINT TO SPECIAL CHARACTER TABLE
0200 CALL TSCH CALL
0201 * GOBACK CALL VIADD GET SCREEN ADDRESS
0202 GOBACK CALL VIADD GET PRESENT CURSOR CHARACTER
0203 MOV A,M
0204 ORI 80H
0205 MOV M,A
0206 LHLD CURSOR IS BACK ON
0207 INR SPEED-1 GET DELAY SPEED
0208 XRA L MAKE SURE IT IS NON-ZERO
0209 DCX A DELAY WILL END WHEN H=0
0210 CMP H TIMER DELAYS HERE
0211 * DONE WITH DELAY YET

C049 C9
C04A DB F8
C04C 17
C04D D2 4A C0
C050 78
C051 D3 F9
C053 C9
C054 E5
C055 DS
C056 C5
C057 3A OC C8
C058 B7
C05B C2 5F C1
C05E 78
C05F E6 7F
C061 47
C062 CA 7C C0
C065 21 73 C2
C068 CD 82 C0
C06B CD 1C C1
C06E 7E
C06F F6 80
C071 77
C072 2A OA C8
C075 2C
C076 AF
C077 2B
C078 BC

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C079 C2 77 C0      0211    JNZ    TIMER KEEP DELAYING
C07C C1           0212    GOBK   POP B
C07D D1           0213    POP D
C07E E1           0214    POP H
C07F C9           0215    RET    EXIT FROM VDMOT
C080 23           0216    *      INX H
C081 23           0217    NEXT   INX H
C082 7E           0218    INX H
C084 CA 94 C0      0219    *      THIS ROUTINE SEARCHES THROUGH A SINGLE CHARACTER
C087 B8           0220    *      TABLE FOR A MATCH TO THE CHARACTER IN "B". IF FOUND
C088 23           0221    *      FOUND ONE. SAVE ADDRESS
C089 C2 80 C0      0222    *      REMOVE CURSOR POINT FORWARD
C08C E5           0223    *      CALL CREM
C08D CD 36 C1      0232    *      PUSH HL
C090 E3           0233    *      CALL XTHL
C091 C3 27 C2      0234    *      GET DISPATCH ADDRESS 'HL'
C094 78           0235    *      DISPT DISPATCH NOW
C095 FE 7F           0236    *      CALL CRIM
C097 C8           0237    *      GET CHARACTER TO SCREEN
C098 CD 1C C1      0238    *      MOV A,B
C099 08 C8           0240    CHAR  CPI 7FH
C09A C2 0F           0241    *      IS IT A DEL?
C097 C8           0242    RZ    .
C098 CD 1C C1      0243    *      GO BACK IF SO
C099 08 C8           0244    *      INX H
C098 CD 1C C1      0245    OCHAR  EQU $DADD
C098 70           0246    *      ACTUALLY PUT CHAR TO SCREEN NOW
C09C 3A 08 C8           0247    CALL VDADD
C09F FE 3F           0248    MOV M,B
C0A1 DA C1 C0      0249    *      GET CHARACTER POSITION
C0A4 3A 09 C8           0250    CPI 63
C0A7 FE 0F           0251    JC  OK
C0A9 C2 C1 C0      0252    LDA LINE
C0A9 C2 C1 C0      0253    LDA LINE
C0A9 C2 C1 C0      0254    CPI 15
C0A9 C2 C1 C0      0255    JNZ OK
C0A9 C2 C1 C0      0256    *      END OF SCREEN...ROLL UP ONE LINE
C0AC AF           0257    *      SCROLL XRA
C0AD 32 08 C8           0258    *      A
C0B0 4F           0259    STA NCHAR
C0B1 CD 23 C1           0260    SROL C,A
C0B4 AF           0261    MOV A
C0B4 AF           0262    CALL XRA
C0B4 AF           0263    CALCULATE LINE TO BE BLANKED

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C0B5 CD FA C0      0264    CALL CLIN1
C0B8 3A 0A C8           0265    LDA BOT
C0B9 3C           0266    INR A
C0BC 86 0F           0267    ANI ORH
C0BE C3 EE C0           0268    JMP ERAS3
C0C1 3A 08 C8           0270    *      INCREMENT LINE COUNTER IF NECESSARY
C0C4 3C           0271    *      INCR
C0C5 E6 3F           0272    OK
C0C7 32 08 C8           0273    LDA NOCHAR
C0CA COCB           0274    INR GET CHR POSITION
C0CB COCB           0275    STA MOD 64 AND WRAP
C0CC 3A 09 C8           0276    STA 3FH
C0CB COCB           0277    PDOWN EQU $, DIDN'T HIT END OF LINE, OR
C0CE 3C           0278    LDA CURSOR DOWN ONE LINE HERE
C0CF E6 0F           0279    INR GET THE LINE COUNT
C0D1 32 09 C8           0280    CURSC ANI
C0D4 C9           0281    CUR LINE
C0D4 C9           0282    RET MOD 15 INCREMENT
C0D5 21 00 CC           0283    *      STORE THE NEW
C0D8 36 A0           0284    *      LINE
C0D9 00 00             0285    *      ERASE SCREEN
C0D9 00 00             0286    PERSE LXI H, VDHEM
C0D9 00 00             0287    MVI M, 80H+. THIS IS THE CURSOR
C0D9 00 00             0288    *      BUMP 1ST
C0D9 00 00             0289    INX LOOPS HERE TO ERASE SCREEN
C0D9 00 00             0290    ERAS1 EQU $, -
C0D9 00 00             0291    MVI BLANK IT OUT
C0D9 00 00             0292    INX NEXT
C0D9 00 00             0293    MOV A, H SEE IF END OF SCREEN YET
C0D9 00 00             0294    ODOR ? CPI
C0D9 00 00             0295    JC ERAS1 NO-KEEP BLANKING
C0D9 00 00             0296    STC CARRY WILL SAY COMPLETE ERASE
C0D9 00 00             0297    *      RESET CURSOR--CARRY=ERASE, ELSE HOME
C0D9 00 00             0298    PHOME MVI A,0
C0D9 00 00             0299    STA LINE
C0D9 00 00             0300    STA NCHAR
C0D9 00 00             0301    RNC .
C0E1 DA DB C0           0295    *      DSTAT
C0E4 37           0296    OUT RESET SCROLL PARAMETERS
C0E5 3E 00             0297    STA BEGINNING OF TEXT OFFSET
C0E7 32 09 C8           0298    STA BOT
C0EA 32 08 C8           0299    STA DSTAT
C0ED DO           0300    *      RET
C0E6 D3 FE           0303    ERAS3 OUT
C0F0 32 0A C8           0304    STA DSTAT
C0F3 C9           0305    *      RET
C0F4 CD 1C C1           0306    *      DSTAT
C0F7 3A 08 C8           0307    CLINE CALL VDADD GET CURRENT SCREEN ADDRESS
C0FA FE 40           0308    CPI CURRENT CURSOR POSITION
C0FC DO           0309    LDA 64 NO MORE THAN 63
C0FD 36 20           0310    CLIN1 CPI ALL DONE
C0FF 23           0311    RNC I, - ALL SPACED OUT
C100 3C           0312    INX H
C101 C3 FA C0           0313    INR A
C101 C3 FA C0           0314    JMP CLIN1 LOOP TO END OF LINE
C101 C3 FA C0           0315    *      INR

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0317 * ROUTINE TO MOVE THE CURSOR UP ONE LINE
0318 * LDA LINE GET LINE COUNT
0319 * PUP DCR A
0320 * LDA LINE MERGE TO HANDLE CURSOR
0321 * JMP CURSC
0322 * MOVE CURSOR LEFT ONE POSITION
0323 * LDA NCHAR
0324 * PLEFT DCR A
0325 * MOVE CURSOR LEFT ONE POSITION
0326 * PCUR EQU $ CURSOR ON SAME LINE
0327 * DCR A 3FH LET CURSOR WRAP
0328 * PCUR ANI STA NCHAR UPDATED CURSOR
0329 * RET
0330 * LDA NCHAR
0331 * PLEFT DCR A
0332 * MOVE CURSOR RIGHT ONE POSITION
0333 * LDA NCHAR
0334 * PRIT INR A
0335 * PLEFT DCR A
0336 * PCUR
0337 * JMP PCUR
0338 * ROUTINE TO CALCULATE SCREEN ADDRESS
0339 * ENTRY AT: RETURNS:
0340 * LDA NCHAR GET CHARACTER POSITION
0341 * MOV C,A C,A KEYS IT
0342 * VDADD LDA LINE POSITION INTO 'L'
0343 * CURRENT SCREEN ADDRESS OF CURRENT LINE, CHAR 'C'
0344 * VDAD LINE 'A', CHARACTER POSITION 'C'
0345 * VDAD LDA LINE POSITION INTO 'L'
0346 * VDAD LDA LINE POSITION INTO 'L'
0347 * VDADD LDA LINE POSITION INTO 'L'
0348 * VDAD LDA LINE POSITION INTO 'L'
0349 * VDAD LDA LINE POSITION INTO 'L'
0350 * VDAD LDA LINE POSITION INTO 'L'
0351 * VDAD LDA LINE POSITION INTO 'L'
0352 * ADD L ADD IT TO THE LINE POSITION
0353 * ADD L ADD IT TO THE LINE POSITION
0354 * RRC TIMES TWO
0355 * RRC MAKES FOUR
0356 * MOV L,A HAS IT
0357 * ADD L,3 MOD THREE FOR LATER
0358 * MOV H,A NOW H IS DONE
0359 * MOV A,L TWIST L'S ARM
0360 * ADD OCOH
0361 * ADD C
0362 * MOV L,A H & L ARE NOW PERVERTED
0363 * RET
0364 * ROUTINE TO REMOVE CURSOR
0365 * CALL VDADD GET CURRENT SCREEN ADDRESS
0366 * CALL VDADD GET CURRENT SCREEN ADDRESS
0367 * CREM MOV A,M STRIP OFF THE CURSOR
0368 * ANI 7FH
0369 * ANI 7FH

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C13C 77
C13D C9
0370 MOV H,A
0371 RET
0372 * ROUTINE TO BACKSPACE
0373 * C13E CD QB C1
0374 * C141 CD 1C C1
0375 * C144 36 20
0376 * C146 C9
0377 * PBACK CALL PLEFT
0378 * CALL VDADD GET SCREEN ADDRESS
0379 * MVI H, PUT A BLANK THERE
0380 * ROUTINE TO PROCESS A CARRIAGE RETURN
0381 * LDA PCR CALL CLINE CLEAR FROM CURRENT CURSOR TO END OF LINE
0382 * PCR CALL CLINE CLEAR FROM CURRENT CURSOR TO END OF LINE
0383 * REG A COMES BACK W/64 AND WILL BE CLEARED BY PCUR
0384 * PCUR AND STORE THE NEW VALUE
0385 * ROUTINE TO PROCESS LINEFEED
0386 * LDA PLF LINE GET LINE COUNT
0387 * INR A
0388 * PESC MVI A,'1'
0389 * JNZ 15 SEE IF IT WRAPPED AROUND
0390 * CUR NO--NO NEED TO SCROLL
0391 * SROL JMP YES--THEN SCROLL
0392 * ROUTINE TO PROCESS PROCESS FLAG
0393 * SET ESCAPE PROCESS FLAG
0394 * LDA PESCI MVI A,'1'
0395 * SET ESCAPE PROCESS FLAG
0396 * PESCI MVI A,'1'
0397 * STA ESCFL SET FLAG
0398 * RET
0399 * PROCESSED ESCAPE SEQUENCE
0400 * C15F CD 36 C1
0401 * C162 CD 68 C1
0402 * C165 C3 6B C0
0403 * ESCSP CALL CREM REMOVE CURSOR
0404 * JNZ GOSACK PROCESS THE NEXT PART OF SEQUENCE
0405 * ESCSP LDA ESCFL GET ESCAPE FLAG
0406 * CPI -1 TEST FLAG
0407 * CPI JZ SECOND
0408 * CPI JZ SECOND
0409 * PROCESSED THIRD CHR OF ESC SEQUENCE
0410 * CPI 2
0411 * LXI H,ESCFL
0412 * MVI M,0 NO MORE PARTS TO THE SEQUENCE
0413 * CPI 2
0414 * SETX JC SET X IF IS ONE
0415 * JZ SETY SET Y IF IS TWO
0416 * CPI 8
0417 * CPI 9
0418 * CPI 9
0419 * CPI 9
0420 * CPI 9
0421 * CPI 9
0422 * CPI 9

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THIS ROUTINE READS A COMMAND LINE FROM THE SYSTEM
0423 * TAB ABSOLUTE TO VALUE IN REG B
0424 * GET CHARACTER
0425 SETX MOV A,B
0426 JMP PCUR
0427 * SET CURSOR TO LINE "B"
0428 * SET CURSOR TO LINE "B"
0429 * SETY MOV A,B
0430 SETY MOV A,B
0431 JMP CURSC
0432 *
0433 *
0434 * PROCESS SECOND CHR OF ESC SEQUENCE
0435 * GET WHICH
0436 SECOND MOV A,B
0437 CPI 3
0438 JZ CURET RETURN CURSOR PARAMETERS
0439 CPI 4
0440 JNZ ARET2
0441 *
0442 ESC <4> RETURN ABSOLUTE SCREEN ADDRESS
0443 * PRESENT SCREEN ADDRESS TO RC FOR RETURN
0444 RET MOV B,H
0445 MOV C,L
0446 * RETURN ADDRESS
0447 RET1 POP H
0448 POP D OLD B
0449 PUSH B
0450 PUSH H
0451 XRA A
0452 ARET2 STA ESCFL
0453 CMA2 32 OC C8
0454 RET
0455 * RETURN PRESENT SCREEN PARAMETERS IN BC
0456 *
0457 * CURET LXI H,NCHAR CHARACTER POSITION
0458 MOV B,M
0459 INX H
0460 MOV C,M LINE POSITION
0461 MOV ARET1
0462 JMP
0463 *
0464 *
0465 *
0466 *
0467 * CLEAR SCREEN AND THE FIRST 256 BYTES OF GLOBAL RAM
0468 * THEN ENTER THE COMMAND MODE.
0469 * START UP SYSTEM
0470 STRTA XRA A
0471 MOV C,A
0472 LXI H,SYSRAM CLEAR THE FIRST PAGE
0473 * CLERA MOV M,A
0474 CLERA MOV H,A
0475 INX H
0476 INR C
0477 JNZ CLERA
0478 * SP,SYSTP SET UP THE STACK FOR CALL
0479 LXI CALL PERSE
0480 CALL XRA
0481 COMM1 XRA
0482 OUT STA
0483 OUT STA
0484 STA
0485 STA
0486 STA
0487 STA
0488 STA
0489 STA
0490 STA
0491 * THIS ROUTINE GETS AND PROCESSES COMMANDS
0492 * SP,SYSTP SET STACK POINTER
0493 COMM1 LXI OPORT GET PORT
0494 LDA PSW
0495 PUSH XRA
0496 POP A
0497 STA OPORT FORCE SCREEN OPERATIONS
0498 CALL PROMPT ON SCREEN
0499 CALL GCLIN GET COMMAND LINE
0500 POP PSW
0501 STA OPORT RESTORE DEFAULT PORT
0502 CALL COFRC PROCESS THE LINE
0503 CALL COMND OVER AND OVER
0504 JMP
0505 *
0506 *
0507 * KEYBOARD
0508 *
0509 * C/R TERMINATES THE SEQUENCE ERASING ALL CHARS TO THE
0510 * RIGHT OF THE CURSOR
0511 * L/F TERMINATES THE SEQUENCE
0512 * MODE RESTARTS THE COMMAND LINE.
0513 *
0514 GCLIN CALL SINP READ INPUT DEVICE
0515 GCLIN CALL SINP READ INPUT DEVICE
0516 GCLIN CALL SINP READ INPUT DEVICE
0517 ANI JZ TFW CLEAR PARITY BIT
0518 JZ COMM1 THIS WAS A MODE (OR EVEN CTL-E)
0519 MOV B,A
0520 CPI CR CARRIAGE RETURN
0521 JZ CLINE YES--DONE WITH LIN
0522 CPI LF LINE FEED
0523 R2 CPI YES--DONE WITH LINE, LEAVE AS IS
0524 CPI TFW DELETE CHR?
0525 JNZ CONT
0526 MVI B,BACKS REPLACE IT
0527 * SOUT
0528 CONT CALL
0529 CD 19 CO
C1BF CD 19 CO

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C202 C3 E4 C1      0529    JMP     GCLIN
                                FIND AND PROCESS COMMAND
0530    *          0531    *          0532    *          0533    *          0534    COPRC
                                CALL    CREM   REMOVE THE CURSOR
                                MVI   C,1    SET FOR CHARACTER POSITION
                                CALL    VDAD2 GET SCREEN ADDRESS
                                XCHG
                                H,START MAKE SURE HL PT TO SOLOS START
                                H,SAVE IT FOR LATER DISPT
                                PUSH
                                CALL    SCAN PAST BLANKS
                                JZ     ERV1  NO COMMAND?
                                XCHG
                                .       HL HAS FIRST CHR
                                LXI   D,CORTAB POINT TO COMMAND TABLE
                                FDCOU SEE IF IN PRIMARY COMMAND TABLE
                                C219 C4 0541    CALL    CZ     FDCOU SEE IF IN PRIMARY COMMAND TABLE NEXT
                                C21C CD 0542    CALL    CZ     HERE TO SEE IF ERROR OR DISP
                                C21E C2 0543    CALL    CZ     ERV2  NOT VALID, ERROR
                                C222 CA 0544    EQU    D      $ BUMP TO PTR OF RTN
                                C225 13 0545    EQU    JZ     HL PT TO RTN ADDR
                                C226 BB 0546    EQU    INX
                                C227 7E 0547    DISPO  XCHG
                                C228 23 0548    EQU    JZ     HL PT TO RTN ADDR
                                C229 66 0549    EQU    INX
                                C22A 6F 0550    EQU    D      HL PT TO RTN ADDR
                                C22B E3 0551    EQU    INX
                                C22C 7D 0552    EQU    D      THIS IS THE DISPATCH ROUTINE.
                                C22D C9 0553    EQU    INX
                                C22E 11 0554    EQU    D      HL PT TO RTN ADDRESS, HL WILL BE RESTORED FM STACK
                                C22F 1A 0555    EQU    INX
                                C230 22 0556    EQU    D      SO THAT HL ARE RESTORED BEFORE DISPATCH.
                                C231 23 0557    DISPT  EQU    $      OFF TO A ROUTINE
                                C232 24 0558    EQU    A,M   LO ADDR
                                C233 25 0559    EQU    H,M   HI ADDR
                                C234 26 0560    MOV    H,M   HL NOW COMPLETE
                                C235 27 0561    MOV    L,A   HERE TO GO OFF TO HL
                                C236 28 0562    DISP1  EQU    $      XCHG HL W/HL ON STACK
                                C237 29 0563    XTHL
                                C238 30 0564    MOV    A,L   ALSO COPY HERE FOR SETS
                                C239 31 0565    RET
                                C240 32 0566    *          THIS ROUTINE SEARCHES THROUGH A TABLE, POINTED TO
                                C241 33 0567    *          BY 'DE', FOR A DOUBLE CHARACTER MATCH OF THE 'HL'.
                                C242 34 0568    *          MEMORY CONTENT.  IF NO MATCH IS FOUND THE SCAN ENDS
                                C243 35 0569    *          WITH HL POINTING TO ORIGINAL VALUE AND ZERO FLAG SET.
                                C244 36 0570    *          THIS ROUTINE TESTS FOR A DOUBLE CHARACTER MATCH OF THE 'HL'.
                                C245 37 0571    *          IF NO MATCH IS FOUND THE SCAN ENDS
                                C246 38 0572    *          WITH HL POINTING TO ORIGINAL VALUE AND ZERO FLAG SET.
                                C247 39 0573    FDCOU LXI   D,CUTAB HERE TO SCAN CUSTOM TBL ONLY
                                C248 40 0574    *          THIS ROUTINE TESTS FOR A DOUBLE CHARACTER MATCH OF THE 'HL'.
                                C249 41 0575    FDCOM LDAX
                                C250 42 0576    ORA    A      TEST FOR TABLE END
                                C251 43 0577    RZ
                                C252 44 0578    PUSH
                                C253 45 0579    CMP    H      NOT FOUND. COMMAND ERROR
                                C254 46 0580    INX
                                C255 47 0581    NJZ
                                C256 48 0582    INX
                                C257 49 0583    INX
                                C258 50 0584    LDAX
                                C259 51 0585    CMP    H      SAVE START OF SCAN ADDRESS
                                C260 52 0586    JNZ
                                C261 53 0587    *          TEST FIRST CHR
                                C262 54 0588    POP   H      RESTORE ORIGINAL SCAN ADDR
                                C263 55 0589    ORA    A      SET NON-ZERO FLAG SAYING FOUND
                                C264 56 0590    RET
                                C265 57 0591    *          WITH NON-ZERO SET
                                C266 58 0592    *          GO TO NEXT ENTRY
                                C267 59 0593    NCOM
                                C268 60 0594    INX
                                C269 61 0595    INX
                                C270 62 0596    POP   H      GET BACK ORIGINAL ADDRESS
                                C271 63 0597    JMP
                                C272 64 0598    *          FDCOM CONTINUE SEARCH
                                C273 65 0599    *          COMMAND TABLE
                                C274 66 0600    *          THIS TABLE DESCRIBES THE VALID COMMANDS FOR SOLOS
                                C275 67 0601    *          COMMAND TABLE
                                C276 68 0602    *          THIS TABLE DESCRIBES THE VALID COMMANDS FOR SOLOS
                                C277 69 0603    *          COMMAND TABLE
                                C278 70 0604    COMTAB ASC
                                C279 71 0605    'TE'  TERMINAL MODE
                                C280 72 0606    DW
                                C281 73 0607    ASC
                                C282 74 0608    'DN'
                                C283 75 0609    DW
                                C284 76 0610    ASC
                                C285 77 0611    DW
                                C286 78 0612    ASC
                                C287 79 0613    DW
                                C288 80 0614    ASC
                                C289 81 0615    DW
                                C290 82 0616    ASC
                                C291 83 0617    DW
                                C292 84 0618    ASC
                                C293 85 0619    DW
                                C294 86 0620    ASC
                                C295 87 0621    DW
                                C296 88 0622    ASC
                                C297 89 0623    DW
                                C298 90 0624    DB
                                C299 91 0625    *          END OF TABLE MARK
                                C300 92 0626    *          DISPLAY DRIVER COMMAND TABLE
                                C301 93 0627    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C302 94 0628    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C303 95 0629    *          GOES TO THE SCREEN.
                                C304 96 0630    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C305 97 0631    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C306 98 0632    *          GOES TO THE SCREEN.
                                C307 99 0633    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C308 00 0634    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C309 01 0635    *          GOES TO THE SCREEN.
                                C310 02 0636    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C311 03 0637    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C312 04 0638    *          GOES TO THE SCREEN.
                                C313 05 0639    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C314 06 0640    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C315 07 0641    *          GOES TO THE SCREEN.
                                C316 08 0642    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C317 09 0643    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C318 10 0644    *          GOES TO THE SCREEN.
                                C319 11 0645    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C320 12 0646    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C321 13 0647    *          GOES TO THE SCREEN.
                                C322 14 0648    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C323 15 0649    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C324 16 0650    *          GOES TO THE SCREEN.
                                C325 17 0651    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C326 18 0652    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C327 19 0653    *          GOES TO THE SCREEN.
                                C328 20 0654    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C329 21 0655    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C330 22 0656    *          GOES TO THE SCREEN.
                                C331 23 0657    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C332 24 0658    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C333 25 0659    *          GOES TO THE SCREEN.
                                C334 26 0660    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C335 27 0661    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C336 28 0662    *          GOES TO THE SCREEN.
                                C337 29 0663    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C338 30 0664    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C339 31 0665    *          GOES TO THE SCREEN.
                                C340 32 0666    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C341 33 0667    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C342 34 0668    *          GOES TO THE SCREEN.
                                C343 35 0669    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C344 36 0670    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C345 37 0671    *          GOES TO THE SCREEN.
                                C346 38 0672    *          THIS TABLE DEFINES THE CHARACTERS FOR SPECIAL
                                C347 39 0673    *          PROCESSING.  IF THE CHARACTER IS NOT IN THE TABLE
                                C348 40 0674    *          GOES TO THE SCREEN.

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|            |     |           |                                  |
|------------|-----|-----------|----------------------------------|
| C276 17    | DB  | UP-BOH    | CURSOR                           |
| C277 04 C1 | DW  | PUP       |                                  |
| C279 1A    | DB  | DOWN-80H  |                                  |
| C27A 0B CO | DW  | PDOWN     |                                  |
| C27C 01    | DB  | LEFT-80H  |                                  |
| C27D 0B C1 | DW  | PLEFT     |                                  |
| C27F 12    | DB  | RIGHT-80H |                                  |
| C280 15 C1 | DW  | PRIT      |                                  |
| C282 0E    | DW  | HOME-80H  |                                  |
| C283 E5 CO | DW  | PHONE     |                                  |
| C285 0D    | DW  | CR        | CARRIAGE RETURN                  |
| C286 71    | DW  | LF        | LINE FEED                        |
| C288 0A    | DW  | PLF       |                                  |
| C289 4D C1 | DB  | BACKS     | BACK SPACE                       |
| C28B 5F    | DB  | PBACK     |                                  |
| C28C 3E C1 | DW  | ESC       | ESCAPE KEY                       |
| C28E 1B    | DW  | PESC      |                                  |
| C28F 59 C1 | DW  | O         | END OF TABLE                     |
| C291 00    | DB  |           |                                  |
| 0654       | DB  |           |                                  |
| 0655       | DB  |           |                                  |
| 0656       | DB  |           |                                  |
| 0657 *     | DW  | VDMOT     | VDM DRIVER                       |
| C294 4A    | DW  | SDROUT    | SERIAL OUTPUT                    |
| C296 E6 C2 | DW  | PROUT     | PARALLEL OUTPUT                  |
| C298 D2 C2 | DW  | ERRORT    | ERROR OR USER DRIVER HANDLER     |
| 0661       | DW  |           |                                  |
| 0662       | DW  |           |                                  |
| 0663       | DW  |           |                                  |
| 0664       | DW  |           |                                  |
| 0665       | DW  |           |                                  |
| 0666       | DW  |           |                                  |
| 0667       | DW  | KSTAT     | KEYBOARD INPUT                   |
| C290 42 CO | DW  | SSTAT     | SERIAL INPUT                     |
| C291 DD C2 | DW  | PSTAT     | PARALLEL INPUT                   |
| C2A0 CB C2 | DW  | ERRIT     | ERROR OR USER DRIVER HANDLER     |
| 0670       | DW  |           |                                  |
| 0671       | DW  |           |                                  |
| 0672       | DW  |           |                                  |
| 0673       | DW  |           |                                  |
| C29A 2E CO | DW  | 'TA'      | SET TAPE SPEED                   |
| C29C 42 CO | DW  | 'SS'      | SET DISPLAY SPEED                |
| C29E DD C2 | DW  | 'DISPD'   |                                  |
| C2A0 CB C2 | DW  | 'I='      | SET INPUT PORT                   |
| 0674 SETAB | ASC | 'SETIN'   | SET INPUT PORT                   |
| 0675 DW    |     | 'O='      | SET OUTPUT PORT                  |
| 0676 ASC   |     | 'SETOT'   | SET OUTPUT PORT                  |
| 0677 DW    |     | 'N='      | NULLS                            |
| 0678 ASC   |     | 'SETNU'   | SET CUSTOM DRIVER ADDRESS        |
| 0679 DW    |     | 'SCI'     | SET CUSTOM DRIVER ADDRESS        |
| 0680 ASC   |     | 'CO'      | SET CUSTOM OUTPUT DRIVER ADDRESS |
| 0681 DW    |     |           |                                  |
| 0682 ASC   |     |           |                                  |
| 0683 DW    |     |           |                                  |
| 0684 ASC   |     |           |                                  |
| 0685 ASC   |     |           |                                  |
| 0686 DW    |     |           |                                  |
| 0687 DW    |     |           |                                  |

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|                  |    |         |   |
|------------------|----|---------|---|
| C2BE 58          | C5 | 'XE'    | SET HEADER XEQ ADDRESS                        |
| C2C0 B1          | C5 | 'SETIQ  | DW  |
| C2C2 54          | C5 | 'TY'    | SET HEADER TYPE                               |
| C2C4 AD          | C5 | 'SETTY' | DW  |
| C2C6 43          | C5 | 'CR'    | SET CRC TO ALLOW IGNORING OF CRC ERRORS       |
| C2C8 B9          | C5 | 'SETCR' | DW  |
| C2CA 00          |    | 'END'   | END OF TABLE MARK                             |
| 0688 ASC         |    |         |   |
| 0689 DW          |    |         |   |
| 0690 ASC         |    |         |   |
| 0691 DW          |    |         |   |
| 0692 ASC         |    |         |   |
| 0693 DW          |    |         |   |
| 0694 DB          |    |         |   |
| 0695 DB          |    |         |   |
| 0696 *           |    |         |   |
| 0697 *           |    |         |   |
| 0698 *           |    |         |   |
| 0699 ERRIT       |    |         |   |
| 0700 LHLD        |    |         |   |
| 0701 JMP         |    |         |   |
| 0702 *           |    |         |   |
| 0703 ERROT       |    |         |   |
| 0704 LHLD        |    |         |   |
| 0705 ERRO1       |    |         |   |
| 0706 MOV         |    |         |   |
| 0707 JZ          |    |         |   |
| 0708 XTHL        |    |         |   |
| 0709 RET         |    |         |   |
| 0710 *--*        |    |         |   |
| 0711 COPY        |    |         |   |
| 0712 *           |    |         | THIS ROUTINE IS THE PARALLEL DEVICE HANDLER   |
| 0713 *           |    |         | NO PROVISION IS MADE FOR CONTROLLING THE PORT |
| 0714 *           |    |         | CONTROL BIT.                                  |
| 0715 *           |    |         |   |
| 0716 *           |    |         |   |
| 0717 *           |    |         |   |
| 0718 *           |    |         |   |
| 0719 PASTAT IN   |    |         |   |
| 0720 CMA         |    |         |   |
| 0721 ANI         |    |         |   |
| 0722 RZ          |    |         |   |
| 0723 IN          |    |         |   |
| 0724 RET         |    |         |   |
| 0725 *           |    |         |   |
| 0726 *           |    |         |   |
| 0727 *           |    |         |   |
| 0728 PROUT IN    |    |         |   |
| 0729 PXDR        |    |         |   |
| 0730 JNZ         |    |         |   |
| 0731 MOV         |    |         |   |
| 0732 A,B         |    |         |   |
| 0733 OUT         |    |         |   |
| 0734 RET         |    |         |   |
| 0735 *           |    |         |   |
| 0736 *           |    |         |   |
| 0737 *           |    |         |   |
| 0738 PROMPT CALL |    |         |   |
| 0739 CRLF        |    |         |   |
| MVI B,'>         |    |         | THE PROMPT                                    |

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C2F6 C3 19 CO 0740 ■ JMP SOUT PUT IT ON THE SCREEN

C2F9 06 0A 0741 ■

C2FB 0D 19 CO 0742 ■ CRLF MVI B,LF LINE FEED

C2FE 06 0D 0743 ■ SOUT MVI B,CR CARriage RETURN

C300 CD 19 CO 0744 ■ CALL SOUT

C307 0D 0745 ■ NOW OUTPUT THE NULLS

C303 3A 10 C8 0747 ■ LDA NUCNT GET DESIRED COUNT

C306 4F 0748 ■ MOV C,A STORE IN C

C307 0D 0749 ■ NULOT DCR C

C308 FB 0750 ■ RETURN WHEN PAST ZERO

C309 AF 0751 ■ RM XRA A

C30A CD 1F C4 0752 ■ CALL OUTH GET A NULL

C30D C3 07 C3 0753 ■ CALL NULOT JMP

0754 ■

0756 ■ SCAN OF OPTIONAL PARAMETER. IF PRESENT RETURN WITH VALUE IN HL AND COPY OF "L" IN "A". IF NOT PRESENT RETURN WITH A "1" IN "A" AND HL UNTOUCHED.

0758 ■

C310 CD 1B C3 0759 ■ PSCAN CALL SBLK

C315 C8 0760 ■ MVN A,1 DEFAULT VALUE

C316 CD 40 C3 0761 ■ RZ IF NONE

C319 7D 0762 ■ CALL SHEX CONVERT VALUE

C31A 99 0763 ■ A,L GET LOWER HALF RET

0764 ■

0765 ■

0766 ■

0767 ■

0768 ■ SCAN OVER UP TO 12 CHARACTERS LOOKING FOR A BLANK

0771 ■ SBLK MVI C,12 MAXIMUM COMMAND STRING

0772 ■ SBKL1 LDAX D

C31D 1A 0773 ■ BLANK CPI GOT A BLANK NOW SCAN PAST IT

C320 CA 2E C3 0774 ■ INX D

C324 33 0775 ■ ALSO ALLOW AN EQUAL TO STOP US

C322 4E 3D 0776 ■ CPI IF SO, PTR AT CHAR FOLLOWING

C326 CA 2E C3 0777 ■ DCR C NO MORE THAN TWELVE

C329 0D 0778 ■ JNZ SBKL1 GO BACK WITH ZERO FLAG SET

C32A C2 1D C3 0779 ■

C32D C9 0780 ■

0781 ■

0782 ■ SCAN PAST UP TO 10 BLANK POSITIONS LOOKING FOR A NON BLANK CHARACTER.

0783 ■

0784 ■

C32E 0E 0A 0785 ■ SCHR MVI C,10 SCAN TO FIRST NON BLANK CHR WITHIN 10

C330 1A 0786 ■ SCHR1 LDAX D GET NEXT CHARACTER

C331 FE 20 0787 ■ CPI SPACE WE'RE PAST THEM

C333 CO 0788 ■ RNZ INX D NEXT SCAN ADDRESS

C334 13 0789 ■ DCR C COMMAND ERROR

C335 0D 0790 ■ RZ .

0791 ■

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C337 C3 30 C3 0793 ■

C33A CD 1B C3 0794 ■

C33D CA 80 C4 0795 ■ THIS ROUTINE SCANS OVER CHARACTERS, PAST BLANKS AND FINDS THE FOLLOWING VALUE TO HEX. ERRORS RETURN TO THE ERROR HANDLER.

0796 ■

0797 ■ Converts the present value to hex. Abort to error if none

0798 ■

0799 ■ THIS ROUTINE CONVERTS ASCII DIGITS INTO BINARY FOLLOWING A STANDARD HEX CONVERSION. THE SCAN STOPS WHEN AN ASCII SPACE IS ENCOUNTERED. PARAMETER ERRORS REPLACE THE ERROR MARK.

0800 ■

0801 ■

0802 ■

0803 ■

0804 ■

0805 ■

0806 ■

0807 ■ CHARACTER ON THE SCREEN WITH A QUESTION MARK.

0808 ■

0809 ■ CLEAR H & L

0810 ■ SHEX

0811 ■ LDAX D

0812 ■ CPI 20H

0813 ■ RZ IF SO

0814 ■ CPI '/'

0815 ■ RZ SLASH IS ALSO LEGAL

0816 ■ CPI ':' EVEN THE COLON IS ALLOWED

0817 ■ RZ

0818 ■ HCONV

0819 ■ DAD H

0820 ■ DAD H

0821 ■ DAD H

0822 ■ CALL JCNC

0823 ■ ADD H

0824 ■ MOVE IT IN BUMP THE POINTER

0825 ■ INX D

0826 ■ JMP SHE1

0827 ■

0828 ■ HC0V1

0829 ■ CPI 10

0830 ■ RC 7

0831 ■ SUI 10H

0832 ■ CPI 10H

0833 ■ CPI .

0834 ■ RET

0835 ■

0836 ■

0837 ■ TERM COMMAND

0838 ■

0839 ■ THIS ROUTINE GETS CHARACTERS FROM THE SYSTEM KEYBOARD AND OUTPUTS THEM TO THE SELECTED OUTPUT PORT. IT IS INTENDED TO CONFIGURE THE SOI AS A STANDARD VIDEO TERMINAL. COMMAND KEYS ARE NOT OUTPUT TO THE OUTPUT PORT BUT ARE INTERPRETED AS DIRECT SOI COMMANDS.

0840 ■

0841 ■

0842 ■

0843 ■

0844 ■

0845 ■ THE MODE COMMAND, RECEIVED BY THE KEYBOARD, PUTS THE SOI IN THE COMMAND MODE.

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0846 *          0846 *          0846 *
0847 *          0847 *          0847 *
0848 *          0848 *          0848 *          THE VALUES FROM ADDR1 TO ADDR2 ARE THEN OUTPUT TO THE
0849 TERM          CALL PSCAN           FIND IF INPUT PARAMETER IS PRESENT
0850 STA           IPORT SINK WILL USE THIS DRIVER (DEFAULT IS 1)
0851 CALL PSCAN           NOW FOR THE OUTPUT DRIVER
0852 STA           OPORT
0853 *          0853 *          0853 *          OUTPUT DEVICE, IF ONLY ADDR1 IS SPECIFIED THEN THE
0854 TERM1         CALL KSTAT           VALUE AT THAT ADDRESS IS OUTPUT.
0855 TERM1         CALL TIN             SCAN TO FIRST ADDRESS AND CONVERT IT
0856 MOV B,A          MOV B,A           CALL DUMP
0857 CPI           MODE IS IT MODE      PUSH H
0858 JZ            TIN IF NOT          CALL PSCAN
0859 JC            COMM1 YES--RESET AND QUIT TERM   SEE IF SECOND WAS GIVEN
0860 CALL VDMOT           JC TOUT NON-CURSOR KEY---SEND TO TERM PORT
0861 JMP TIN          PROCESS IT
0862 *          0862 *          0862 *          GET BACK START,
0863 TOUT          CALL SOUT           HL HAS START, DE HAS END
0864 TIN           CALL SINP           SCAN TO FIRST ADDRESS
0865 TOUT          CALL GET INPUT STATUS    SAVE THE VALUE
0866 TIN           CALL LOOP IF NOT     SCAN TO FIRST ADDRESS
0867 JZ            TERM1 NO HIGH BITS FROM HERE
0868 MOV B,A          MOV B,A           CALL DUMP
0869 CPI           IS IT A CONTROL CHAR TO RF IGNORED
0870 JNC 1BH          TERM2 NO--TO VDM AS IS THEN
0871 CPI           CR OR LF ARE SPECIAL CASES THROUGH
0872 JZ            TERM2 AND MUST BE PASSED STD MODE TO VDM DRIVER
0873 CPI           LF
0874 JZ            TERM2
0875 LDA           ESCFL A CTL CHAR---ARE WE W/IN AN ESC SEQUENCE?
0876 ORA           A IF YES, THEN OUTPUT CTL CHAR DIRECTLY TO VDM
0877 JNZ TERM2         WE SURE ARE, LET VDM DRIVER HANDLE IT
0878 PUSH B           SAVE THE CHAR
0879 MVI B,ESC          CALL VDMOT           B,ESC CTL CHAR TO VDM VIA ESC SEQUENCE
0880 CALL VDMOT           SAY TO PUT OUT NEXT CHAR AS IS
0881 MVI B,7           CALL VDMOT           ALMOST READY
0882 POP B           RESTORE CHAR
0883 EQU TERM2         EQU $ VDMOT           ALL READY TO OUTPUT THE CHAR
0884 TERM2         CALL VDMOT           PUT IT ON THE SCREEN
0885 CALL VDMOT           LOOP OVER AND OVER
0886 *          0886 *          0886 *
0887 *          0887 *          0887 *
0888 *          0888 *          0888 *
0889 *          0889 *          0889 *          DUMP COMMAND
0890 *          0890 *          0890 *          THIS ROUTINE DUMPS CHARACTERS FROM MEMORY TO THE
0891 *          0891 *          0891 *          CURRENT OUTPUT DEVICE. ALL VALUES ARE DISPLAYED AS
0892 *          0892 *          0892 *          ASCII HEX.
0893 *          0893 *          0893 *          THE COMMAND FORM IS AS FOLLOWS:
0894 *          0894 *          0894 *          DUMP addr1 addr2
0895 *          0895 *          0895 *          MOVE THE HIGH FOUR DOWN
0896 *          0896 *          0896 *          MOVE THE HIGH FOUR DOWN

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0899 *          0899 *          0899 *
0900 *          0900 *          0900 *          THE VALUES FROM ADDR1 TO ADDR2 ARE THEN OUTPUT TO THE
0901 *          0901 *          0901 *          OUTPUT DEVICE, IF ONLY ADDR1 IS SPECIFIED THEN THE
0902 *          0902 *          0902 *          VALUE AT THAT ADDRESS IS OUTPUT.
0903 *          0903 *          0903 *          CALL DUMP
0904 DUMP          CALL SCONV           SCAN TO FIRST ADDRESS AND CONVERT IT
0905 *          0905 *          0905 *          PUSH H
0906 *          0906 *          0906 *          SAVE THE VALUE
0907 *          0907 *          0907 *          CALL PSCAN
0908 *          0908 *          0908 *          SEE IF SECOND WAS GIVEN
0909 *          0909 *          0909 *          GET BACK START,
0910 DLOOP          CALL XCHG           HL HAS START, DE HAS END
0911 *          0911 *          0911 *          CALL CRUF
0912 *          0912 *          0912 *          CALL ADOUT
0913 *          0913 *          0913 *          CALL BOUT
0914 *          0914 *          0914 *          CALL C,16
0915 DLP1          MOV A,M           GET THE CHR
0916 *          0916 *          0916 *          PUSH H
0917 *          0917 *          0917 *          SAVE IT OUT WITH A BLANK
0918 *          0918 *          0918 *          CALL HBTOUT
0919 *          0919 *          0919 *          SEND IT OUT WITH A BLANK
0920 *          0920 *          0920 *          CALL E,L
0921 *          0921 *          0921 *          COMPARE DE & HL
0922 *          0922 *          0922 *          MOV A,H
0923 *          0923 *          0923 *          MOV B,SBB
0924 *          0924 *          0924 *          POP B
0925 *          0925 *          0925 *          INX DCR
0926 *          0926 *          0926 *          POP B
0927 *          0927 *          0927 *          INX DLP1
0928 *          0928 *          0928 *          NOT ZERO IF MORE FOR THIS LINE
0929 *          0929 *          0929 *          DO A LFCR BEFORE THE NEXT
0930 *          0930 *          0930 *          DLOOP
0931 *          0931 *          0931 *          CALL JZ
0932 *          0932 *          0932 *          MOV A,H
0933 *          0933 *          0933 *          CALL HEOUT
0934 *          0934 *          0934 *          MOV A,L
0935 *          0935 *          0935 *          THEN "L" FOLLOWED BY A SPACE
0936 *          0936 *          0936 *          HBOUT
0937 *          0937 *          0937 *          CALL SIMP
0938 *          0938 *          0938 *          CALL JZ
0939 *          0939 *          0939 *          MOV ANI
0940 *          0940 *          0940 *          CALL JZ
0941 *          0941 *          0941 *          CPI
0942 *          0942 *          0942 *          BOUT
0943 *          0943 *          0943 *          CALL WTLPI
0944 *          0944 *          0944 *          JZ
0945 *          0945 *          0945 *          BOUT
0946 *          0946 *          0946 *          MVI B
0947 *          0947 *          0947 *          SOUT
0948 *          0948 *          0948 *          PUT IT OUT
0949 *          0949 *          0949 *          MOV RRC
0950 *          0950 *          0950 *          RRC
0951 *          0951 *          0951 *          RRC

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C40F OF      0952   RRC          C459 E3      1005 ENL03  XTHL
                           CALL         C45A 13      1006 INX       PUT NEW ADDRESS ON STACK
                           MOV          C45B C3      1007 JMP       MOVE SCAN PAST TERMINATOR
                           A,C          C4 C4      1008 *
                           HEOU1     FOUR ON THE FLOOR
                           MOV          OFH        EXECUTE COMMAND
                           ANI          48        1010 *
                           ADI          CPI 58      THIS ROUTINE GETS THE FOLLOWING PARAMETER AND DOES A
                           CPI 0-9?    JC  OUTH     PROGRAM JUMP TO THE LOCATION GIVEN BY IT. IF PROPER
                           TUP!        ADI 7       STACK OPERATIONS ARE USED WITHIN THE EXTERNAL PROGRAM
                           MAKE IT A LETTER
                           B,A        MOV  JMP      IT CAN DO A STANDARD 'RET'URN TO THE SOLOS COMMAND MODE.
                           OUTH      H        1014 * THE STARTING ADDRESS OF SOLOS IS PASSED TO THE PROGRAM
                           SOUT      ENL01    IN REGISTER PAIR HL SO IT CAN ADJUST INTERNAL PARAMETERS
                           0963 *
                           0964 *
                           0965 * FOR SOLOS OPERATION.
                           0966 *
                           0967 * THIS ROUTINE GETS VALUES FROM THE KEYBOARD AND ENTERS
                           THEM INTO MEMORY. THE INPUT VALUES ARE SCANNED FOLLOWING
                           0968 * A STANDARD 'GC LIN' INPUT SO ON SCREEN EDITING MAY TAKE
                           PLACE PRIOR TO THE LINE TERMINATOR. A BACK SLASH '\'
                           0969 * ENDS THE ROUTINE AND RETURNS CONTROL TO THE COMMAND MODE.
                           0970 * A COLON ':' SETS THE PREVIOUS VALUE AS A NEW ADDRESS FOR
                           0971 * ENTER.
                           0972 * A colon ':' SETS THE CHARACTER FOLLOWING AS TAKEN
                           0973 * AS THE CASSETTE UNIT SPECIFICATION.
                           0974 * ENTER CALL SCONV  SCAN OVER CHARS AND GET ADDRESS
                           0975 ENTER PUSH  XRA   SAVE ADDRESS
                           0976 STA   A
                           0977 OPORT ENTER VALUES TO SCREEN BUFFER
                           0978 STA   A
                           0979 * CRLF
                           0980 ENL0P CALL  MVI B,':'
                           0981 ENL0P CALL  CALL  GET LINE OF INPUT
                           0982 CALL  MVI C,1:  CONT  REMOVE THE CURSOR
                           0983 CALL  MVI C,1:  CRET  START SCAN
                           0984 CALL  MVI YDAD2 GET ADDRESS
                           0985 CALL  XCHG   . . . TO DE
                           0986 CPI   C,3      NO MORE THAN THREE SPACES BETWEEN VALUES
                           0987 * SCHR1 SCAN TO NEXT VALUE
                           0988 * ENL01 MVI C,3      LAST ENTRY FOUND START NEW LINE
                           0989 CALL  JZ      COMMAND TERMINATOR?
                           0990 CALL  JZ      IF SO . . RETURN TO STANDARD INPUT
                           0991 CALL  JZ      SHEX
                           0992 * CPI   JZ      CONVERT VALUE
                           0993 CPI   JZ      ADDRESS TERMINATOR?
                           0994 CPI   JZ      CPI   JZ      SOLOS ERROR HANDLER
                           0995 CALL  JZ      GO PROCESS IF SO
                           0996 CPI   JZ      ENL03 GET LOW PART AS CONVERTED
                           0997 MOV  A,L      POP  H      GET MEMORY ADDRESS
                           0998 MOV  H       POP  H      PUT IN THE VALUE
                           0999 MOV  H       INX  H      BACK GOES THE ADDRESS
                           1000 MOV  H       PUSH H      CONTINUE THE SCAN
                           1001 INX  H       ENL01 HERE WE HAVE SCANNED OFF THE NAME. ZERO FILL FOR
                           1002 PUSH H      1003 * NAMES LESS THAN FIVE CHARACTERS.
                           1004 * PAGE 10

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C410 CD 14 C4      0953   RRC          C459 E3      1005 ENL03  XTHL
                           CALL         C45A 13      1006 INX       PUT NEW ADDRESS ON STACK
                           MOV          C45B C3      1007 JMP       MOVE SCAN PAST TERMINATOR
                           A,C          C4 C4      1008 *
                           HEOU1     FOUR ON THE FLOOR
                           MOV          OFH        EXECUTE COMMAND
                           ANI          48        1010 *
                           ADI          CPI 58      THIS ROUTINE GETS THE FOLLOWING PARAMETER AND DOES A
                           CPI 0-9?    JC  OUTH     PROGRAM JUMP TO THE LOCATION GIVEN BY IT. IF PROPER
                           TUP!        ADI 7       STACK OPERATIONS ARE USED WITHIN THE EXTERNAL PROGRAM
                           MAKE IT A LETTER
                           B,A        MOV  JMP      IT CAN DO A STANDARD 'RET'URN TO THE SOLOS COMMAND MODE.
                           OUTH      H        1014 * THE STARTING ADDRESS OF SOLOS IS PASSED TO THE PROGRAM
                           SOUT      ENL01    IN REGISTER PAIR HL SO IT CAN ADJUST INTERNAL PARAMETERS
                           0963 *
                           0964 *
                           0965 * FOR SOLOS OPERATION.
                           0966 *
                           0967 * THIS ROUTINE GETS A NAME OF UP TO 5 CHARACTERS
                           THEM INTO MEMORY. IF THE TERMINATOR IS A
                           0968 * SLASH (/) THEN THE CHARACTER FOLLOWING IS TAKEN
                           A STANDARD 'GC LIN' INPUT SO ON SCREEN EDITING MAY TAKE
                           PLACE PRIOR TO THE LINE TERMINATOR. A BACK SLASH '\'
                           0969 * ENDS THE ROUTINE AND RETURNS CONTROL TO THE COMMAND MODE.
                           0970 * A colon ':' SETS THE PREVIOUS VALUE AS A NEW ADDRESS FOR
                           0971 * ENTER.
                           0972 * A colon ':' SETS THE CHARACTER FOLLOWING AS TAKEN
                           0973 * AS THE CASSETTE UNIT SPECIFICATION.
                           0974 * ENTER CALL SCONV  SCAN OVER CHARS AND GET ADDRESS
                           0975 ENTER PUSH  XRA   SAVE ADDRESS
                           0976 STA   A
                           0977 OPORT ENTER VALUES TO SCREEN BUFFER
                           0978 STA   A
                           0979 * CRLF
                           0980 ENL0P CALL  MVI B,':'
                           0981 ENL0P CALL  CALL  GET LINE OF INPUT
                           0982 CALL  MVI C,1:  CONT  REMOVE THE CURSOR
                           0983 CALL  MVI C,1:  CRET  START SCAN
                           0984 CALL  MVI YDAD2 GET ADDRESS
                           0985 CALL  XCHG   . . . TO DE
                           0986 CPI   C,3      NO MORE THAN THREE SPACES BETWEEN VALUES
                           0987 * SCHR1 SCAN TO NEXT VALUE
                           0988 * ENL01 MVI C,3      LAST ENTRY FOUND START NEW LINE
                           0989 CALL  JZ      COMMAND TERMINATOR?
                           0990 CALL  JZ      IF SO . . RETURN TO STANDARD INPUT
                           0991 CALL  JZ      SHEX
                           0992 * CPI   JZ      CONVERT VALUE
                           0993 CPI   JZ      ADDRESS TERMINATOR?
                           0994 CPI   JZ      CPI   JZ      SOLOS ERROR HANDLER
                           0995 CALL  JZ      GO PROCESS IF SO
                           0996 CPI   JZ      ENL03 GET LOW PART AS CONVERTED
                           0997 MOV  A,L      POP  H      GET MEMORY ADDRESS
                           0998 MOV  H       POP  H      PUT IN THE VALUE
                           0999 MOV  H       INX  H      BACK GOES THE ADDRESS
                           1000 MOV  H       PUSH H      CONTINUE THE SCAN
                           1001 INX  H       ENL01 HERE WE HAVE SCANNED OFF THE NAME. ZERO FILL FOR
                           1002 PUSH H      1003 * NAMES LESS THAN FIVE CHARACTERS.
                           1004 * PAGE 10

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C486 36 00    1058 ■      MVI H,0          PUT IN AT LEAST ONE ZERO
C488 23      1059 NFIL    INX H           A,T
C489 05      1060 DCR B     DCR B           TAERR THE BYTE MUST BE ZERO FOR AUTO XEO
C48A C2 86 C4 1062 NFIL    LOOP UNTIL B IS ZERO
C48B C2 86 C4 1063 ■      CPI '/          IS THERE A UNIT SPECIFICATION?
C48D FE 01    1064 MVI A,1          PRETEND NOT TO BE A UNIT
C48F 3E 01    1065 JNZ D         DEFLT MOVE PAST THE TERMINATOR
C491 C2 9A C4 1066 INX D         CALL SCHR GO GET UNIT SPEC
C494 13      1067 CALL SCHR REMOVE ASCII BIAS
C495 CD 2E C3 1068 SUI '0
C498 D6 30    1069 ■      MOVE OVER TO INTERNAL REPRESENTATION
C49A          1070 ■      EQU $1          JUST BIT ZERO
C49C 3E 80    1071 ANI H,1          A,TAPE1 ASSUME TAPE ONE
C49E C2 A2 C4 1072 MVI JNZ STUNT IF NON-ZERO, ITS ONE
C4A1 1F      1073 RAR JNZ STUNT
C4A2 32 54 C8 1074 CALL FNUMF SET IT IN
C4A5 C9      1075 STUNT STA RET
C4A8          1076 ■      RET
C4A9          1077 ■      THIS ROUTINE PROCESSES THE XEO AND GET COMMANDS
C4A9          1078 ■      THIS ROUTINE IS USED TO SAVE PROGRAMS AND DATA ON
C4A9          1079 ■      THE CASSETTE UNIT.
C4A9          1080 ■      THIS ROUTINE READS THE TAPE UNITS ARE OFF
C4A9          1081 ■      THIS ROUTINE IS USED TO SAVE PROGRAMS AND DATA ON
C4A9          1082 ■      THE CASSETTE UNIT.
C4A9          1083 ■      THIS ROUTINE PROCESSES THE XEO AND GET COMMANDS
C4A9          1084 TXEQ DB 3EH          THIS BEGINS "ENV A,DAFH"
C4A9          1085 TLOAD XRA DB 3EH          A,O MEANS TLORD, ELSE TXEO
C4A9          1086 PUSH PSW          SAVE FLAG FOR LATER
C4A9          1087 LXI H,DHEAD          PLACE DUMMY HEADER HERE
C4A9          1088 CALL NAME          SET IN NAME AND UNIT
C4A9          1089 CALL H,O          PRETEND NO SECOND VALUE
C4A9          1090 LXI H,DHEAD          GO GET THE ADDRESS (IF PRESENT)
C4A9          1091 ■      CALL XCHG          PUT ADDRESS IN DE
C4A9          1092 TLOAD2 LXI H,DHEAD          PT TO DUMMY HEADER W/ NAME TO LOAD
C4A9          1093 MOV A,M          SEE IF NAME WAS ENTERED
C4A9          1094 ORA JNZ TLOA3          IS THERE A NAME?
C4A9          1095 ■      LXI H,THEAD          YES--SEARCH FOR IT
C4A9          1096 ■      CALL C50F D1          NO NAME, LOAD 1ST FILE
C4A9          1097 ■      PUSH H          SAVE PTR TO NAME TO LOAD
C4A9          1098 ■      CALL C510 E1          LOAD GET UNIT AND SPEED
C4A9          1099 ■      POP H          RESTORE PTR TO HDR TO LOAD
C4A9          1100 ■      CALL C511 C3          READ IN THE TAPE.
C4A9          1101 ■      CALL C512 C0          CALL RTAPE READ IN THE TAPE.
C4A9          1102 ■      JC TAERR          TAERR TAPE ERROR?
C4A9          1103 ■      CALL NAOUT          PUT OUT THE HEADER PARAMETERS
C4A9          1104 ■      POP PSW          RESTORE FLAG FROM ORIGINAL ENTRY
C4A9          1105 ■      ORA A          AUTO XEO NOT WANTED
C4A9          1106 ■      RZ HTYPE          CHECK TYPE
C4A9          1107 ■      LDA A          SET FLAGS
C4A9          1108 ■      POP H          TAERR TYPE IS NON XEO
C4A9          1109 ■      JMP C4D6          CALL C513 C0          OUTPUT ERROR AND HEADER
C4CC CD 50 C5 1103 ■      CALL C514 CD F9 C2          CRLF
C4CF F1      1104 ■      POP D6          TAERR CALL C517 16 06
C4DO B7      1105 ■      ORA MVI H          POINT TO ERROR MESSAGE
C4D1 C8      1106 ■      RZ LXI H,ERRM          AUTO XEO NOT WANTED
C4D2 3A 22 C8 1107 ■      LDA CALL C519 21 25 C5          NLOOP OUTPUT ERROR
C4D2 B7      1108 ■      POP H          THEN THE HEADER
C4D6 FA 1u C5 1109 ■      ORA CALL C51C CD 6A C5          COH1 AND BE SURE THE TAPE UNITS ARE OFF
C4D6 FA 1u C5 1110 ■      JMP C51F CD 50 C5          CALL C522 C3 C0 C1          1111 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1112 ■      ORA C519 21 25 C5          1113 ■      JNZ LHLD XLOAD GET THE TAPE ADDRESS
C4D6 FA 1u C5 1113 ■      POP H          EXEC1 AND GO TO IT
C4D6 FA 1u C5 1114 ■      CALL C51E 2A 27 C8          1115 ■      JMP 1116 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1115 ■      POP H          1116 ■      CALL C518 C3 61 C4          1117 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1116 ■      CALL C519 21 25 C5          1118 ■      POP H          1119 ■      CALL C51A C3 61 C4          1119 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1117 ■      POP H          1120 ■      CALL C51B C3 61 C4          1120 ■      POP H          1121 ■      CALL C51C C3 61 C4          1121 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1118 ■      CALL C51D C3 61 C4          1122 ■      POP H          1122 ■      CALL C51E C3 61 C4          1122 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1119 ■      POP H          1123 ■      CALL C51F C3 61 C4          1123 ■      LDA TAERR CALL C517 16 06
C4D6 FA 1u C5 1120 ■      CALL C51G C3 61 C4          1124 ■      TSAVE CALL C518 C3 61 C4          1124 ■      NAMES GET NAME AND UNIT
C4D6 FA 1u C5 1121 ■      POP H          1125 ■      CALL C519 C3 61 C4          1125 ■      SCONV GET START ADDRESS
C4D6 FA 1u C5 1122 ■      CALL C51A C3 61 C4          1126 ■      PUSH H USE THE STACK AS A REGISTER
C4D6 FA 1u C5 1123 ■      CALL C51B C3 61 C4          1127 ■      CALL C51C C3 61 C4          1127 ■      SCONV GET END ADDRESS
C4D6 FA 1u C5 1124 ■      CALL C51D C3 61 C4          1128 ■      CALL C51E C3 61 C4          1128 ■      XTHL PUT END ON STACK, GET BACK START
C4D6 FA 1u C5 1125 ■      POP H          1129 ■      PUSH H SAVE START ON TOP OF STACK
C4D6 FA 1u C5 1126 ■      CALL C51F C3 61 C4          1130 ■      CALL C51G C3 61 C4          1129 ■      PSCAN SEE IF OPTIONAL HEADER WAS GIVEN
C4D6 FA 1u C5 1127 ■      POP H          1131 ■      CALL C51H C3 61 C4          1131 ■      SHLD LOADR PUT HEADER ADDRESS IN PLACE
C4D6 FA 1u C5 1128 ■      CALL C51I C3 61 C4          1132 ■      CALL C51J C3 61 C4          1132 ■      POP H "FROM" ADDRESS TO HL
C4D6 FA 1u C5 1129 ■      POP H          1133 ■      POP H GET BACK "END" ADDRESS
C4D6 FA 1u C5 1130 ■      CALL C51K C3 61 C4          1134 ■      POP H SAVE FROM AGAIN FOR LATER
C4D6 FA 1u C5 1131 ■      POP H          1135 ■      PUSH H NOW CALCULATE SIZE
C4D6 FA 1u C5 1132 ■      CALL C51L C3 61 C4          1136 ■      SUB L, E SIZE=END-START+1
C4D6 FA 1u C5 1133 ■      POP H          1137 ■      MOV H,A
C4D6 FA 1u C5 1134 ■      POP H          1138 ■      MOV H,A
C4D6 FA 1u C5 1135 ■      POP H          1139 ■      MOV H,A
C4D6 FA 1u C5 1136 ■      POP H          1140 ■      MOV H,A
C4D6 FA 1u C5 1137 ■      POP H          1141 ■      MOV H,A
C4D6 FA 1u C5 1138 ■      POP H          1142 ■      INX H,BLOCK STORE THE SIZE
C4D6 FA 1u C5 1139 ■      POP H          1143 ■      SHLD B,LBLOCK SAVE IT FOR THE READ ALSO
C4D6 FA 1u C5 1140 ■      POP H          1144 ■      PUSH H
C4D6 FA 1u C5 1141 ■      POP H          1145 ■      CALL ALLOAD, GET UNIT AND SPEED
C4D6 FA 1u C5 1142 ■      POP H          1146 ■      LXI H,THEAD POINT TO HEADER
C4D6 FA 1u C5 1143 ■      POP H          1147 ■      CALL WHRD, WRITE IT OUT
C4D6 FA 1u C5 1144 ■      POP H          1148 ■      CALL WHRD, WRITE OUT THE DATA
C4D6 FA 1u C5 1145 ■      POP H          1149 ■      NOW WRITE OUT THE DATA
C4D6 FA 1u C5 1146 ■      POP H          1150 ■      POP H,GET SIZE TO DE
C4D6 FA 1u C5 1147 ■      POP H          1151 ■      POP H,GET BACK "FROM" ADDRESS
C4D6 FA 1u C5 1148 ■      POP H          1152 ■      POP H,WRLD1 WRITE OUT THE DATA AND RETURN
C4D6 FA 1u C5 1149 ■      POP H          1153 ■      CALL C513 C0 C1          1154 ■      OUTPUT ERROR AND HEADER
C4D6 FA 1u C5 1150 ■      POP H          1155 ■      CALL C514 CD F9 C2          1156 ■      CALL C515 16 06
C4D6 FA 1u C5 1151 ■      POP H          1157 ■      TAERR CALL C516 06 06
C4D6 FA 1u C5 1152 ■      POP H          1158 ■      LXI H,ERRM POINT TO ERROR MESSAGE
C4D6 FA 1u C5 1153 ■      POP H          1159 ■      CALL C517 16 06
C4D6 FA 1u C5 1154 ■      POP H          1160 ■      CALL C518 21 25 C5          1161 ■      CALL C519 21 25 C5          1162 ■      CALL C51A C3 61 C4          1163 ■      CALL C51B C3 61 C4

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C525 45 52 52 4F             C525 45 52 52 4F             C525 45 52 52 4F
C525 52 20                  1164 ERRM  ASC  !ERROR !
                           1165
                           1166 THIS ROUTINE READS HEADERS FROM THE TAPE AND OUTPUTS
                           1167 THEM TO THE OUTPUT DEVICE. IT CONTINUES UNTIL THE
                           1168 MODE KEY IS DERESSED.
                           1169 * "SET" COMMAND
                           1170 TLIST CALL NAMES SET UP UNIT IF GIVEN
                           1171 C2 CALL CRLF
                           1172 CALL
                           1173
                           1174
                           1175 LLIST CALL ALOAD
                           1176 MVI B,1
                           1177 CALL TON TURN ON THE TAPE
                           1178 *
                           1179 LIST1 CALL RHEAD
                           1180 JC COMM1 TURN OFF THE TAPE UNIT
                           1181 JNZ LIST1
                           1182 CALL NAOUT OUTPUT THE HEADER
                           1183 CALL JMP LIST LOOP UNTIL MODE IS DERESSED
                           1184
                           1185
                           1186 THIS ROUTINE GETS THE CASSETTE UNIT NUMBER AND
                           SPEED TO REGISTER "A" FOR THE TAPE CALLS
                           1187
                           1188
                           1189 ALOAD LXI H,FNUMF POINT TO THE UNIT SPECIFICATION
                           1190 LDA M,TSPD GET THE TAPE SPEED
                           1191 ORA M PUT THEM TOGETHER
                           1192 RET .
                           1193
                           1194
                           1195 THIS ROUTINE OUTPUTS THE NAME AND PARAMETERS OF
                           THREAD TO THE OUTPUT DEVICE.
                           1196
                           1197
                           1198 NAOUT MVI D,8
                           1199 LXI H,THEAD-1 POINT TO THE HEADER
                           1200 NLOOP CALL BOUT ANOTHER BLANK
                           1201 CALL LHLD LOAD NOW THE LOAD ADDRESS
                           1202 CALL ADOUT PUT IT OUT
                           1203 CALL LHLD BLOCK AND THE BLOCK SIZE
                           1204 CALL ADOUT
                           1205 CALL CRLF DO THE CRLF AND RETURN
                           1206 CALL
                           1207 JMP
                           1208
                           1209 NLOOP MOV A,M GET CHARACTER
                           1210 ORA A,1 IF IT ISN'T A ZERO
                           1211 JNZ 1212
                           1212 MVI A,1
                           1213 CALL CHRLI OUTPUT CHAR NOW
                           1214 INX H
                           1215 CALL CHRLI
                           1216 SETCI SHLD UPRT
                           1217 RET
                           1218 DCR D
                           1219 NLLOOP
                           1220
                           1221
                           1222
                           1223
                           1224 THIS ROUTINE GETS THE ASSOCIATED PARAMETER AND
                           DISPATCHES TO THE PROPER ROUTINE FOR SETTING
                           GLOBAL VALUES.
                           1225
                           1226
                           1227
                           1228
                           1229 SET EQU $ THIS IS THE SET COMMAND
                           1230 CALL SELK
                           1231 JZ ERR1 MUST HAVE AT LEAST SOMETHING!
                           1232 PUSH D
                           1233 SCNV SAVE SCAN ADDRESS
                           1234 XTHL GET SCAN ADDRESS BACK,SAVE VALUE ON STACK
                           1235 LXI D,SETUP SECONDARY COMMAND TABLE
                           1236 PFCOM SEE IF IN TABLE
                           1237 CALL DISPO
                           1238
                           1239
                           1240 THIS ROUTINE SETS THE TAPE SPEED
                           1241 TASP0 ORA A,32 IS IT ZERO?
                           1242 TASP1 JZ SETSP
                           1243 MVI A,32 YES--THAT'S A VALID SPEED
                           1244 SETSP STA
                           1245 TSPD STA
                           1246 RET SPEED IS STORED HERE
                           1247
                           1248
                           1249 STSPD MOV A,B ESCAPE COMES HERE TO SET SPEED
                           1250 DISPD STA SPEED
                           1251 RET
                           1252
                           1253 SET INPUT DRIVER
                           1254
                           1255 SETIN EQU $ IPORT
                           1256 STA RET
                           1257
                           1258
                           1259
                           1260 SET OUTPUT DRIVER
                           1261 SETOT EQU $ OPORT
                           1262 STA RET
                           1263
                           1264
                           1265 SET USERS CUSTOM INPUT DRIVER ADDRESS
                           1266
                           1267 SETCI SHLD UPRT
                           1268 RET

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1269 * SET USERS CUSTOM OUTPUT DRIVER ADDRESS
1270 * C5A9 22 02 C8
1271 * C5AC C9
1272 SETCO SILD UOPRT
1273 RET
1274 * SET TYPE BYTE INTO HEADER
1275 * C5AD 32 22 C8
1276 SETTY STA HTYPE
1277 RET
1278 * C5B0 C9
1279 * SET EXECUTE ADDRESS INTO HEADER
1280 * C5B1 22 27 C8
1281 * C5B4 C9
1282 SETXQ SILD XEQAD
1283 RET
1284 * C5B5 32 10 C8
1285 * C5B8 C9
1286 SETNU STA NUCNT SET THE NULL COUNT
1287 RET THAT'S DONE
1288 * C5B9 32 11 C8
1289 SETCR EQU $ SET TO IGNORE CRC ERRORS
1290 STA IGNCR FF=IGNORE ERRORS, ELSE=NORMAL
1291 RET
1292 C5BC C9
1293 RET
1294 * C5BD CD 66 C4
1295 * C5CC 21 C9 C1
1296 * C5C3 CD 10 C3
1297 * C5C6 E5
1298 CUSET CALL NAMES CUSTOM COMMAND ENTRY/REMOVAL
1299 LXI H.COMD DEFAULT ADDR IF NONE GIVEN
1300 CALL PSCAN GET RTN ADDR
1301 PUSH H SAVE RTN ADDR
1302 LXI H.THEAD PT AT NAME TO SEARCH
1303 FDCQA SEARCH IT IN CUSTOM TABLE
1304 CALL D2Z CUSE2 NOT IN TABLE-ENTER IT
1305 DCX D IN TABLE, REMOVE IT
1306 MWI M,O CHANGE NEW NAME TO BE ZERO
1307 CUSE2 MOV A,M GET 1ST CHAR OF NAME
1308 STAX D ENTER IT TATO TABLE
1309 INY D AND THE 2ND NAME
1310 INY D
1311 MOV A,M NAME NOW ENTERED
1312 STAX D GET SET TO ENTER ADDRESS
1313 INY D RESTORE RTN ADDR
1314 POP H
1315 XCHG H,E SET ADDR IN NOW
1316 MOV H,E AND HI BYTE OF ADDR
1317 INY H,D NAME IS NOW ENTERED OR CLEARED
1318 MOV H,D
1319 RET . RET

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C645 C9          1480    RET
                  1481 *
                  1482 *
                  1483 *
                  1484 *
                  1485 * READ TAPE BYTE ROUTINE
                  1486 * ENTRY: NORMAL - A - HAS FILE NUMBER
                  1487 * EXIT: NORMAL - A - HAS BYTE
                  1488 * ERROR
                  1489 * CARRY SET - IF FILE NOT OPEN OR
                  1490 * PREVIOUS OPERATIONS WERE WRITE
                  1491 * CARRY & MINUS - END OF FILE ENCOUNTERED
                  1492 *
                  1493 *
                  1494 *
                  1495 *
                  1496 * 1497 RTBYT CALL LFCB LOCATE THE FILE CONTROL BLOCK
                  1498 RZ             INR TEST IF FF
                  1499 INR JM             TERO
                  1500 MVI H,-1           ERROR WAS WRITING
                  1501 INX H             SET IT AS READ (IN CASE IT WAS JUST OPENED)
                  1502 MOV A, H           GET READ COUNT
                  1503 PUSH H            SAVE COUNT ADDRESS
                  1504 INX H            CALL PLOAD GET THE OTHER PARAMETERS
                  1505 CALL POP H          JC JN2
                  1506 ORA H            GTBYT IF NOT EMPTY GO GET BYTE
                  1507 JC JN2
                  1508 ORA H
                  1509 JC JN2
                  1510 * CURSOR POSITION WAS ZERO... READ A NEW BLOCK INTO
                  1511 * THE BUFFER.
                  1512 * 1513 * RDNBBLK PUSH D BUFFER POINTER
                  1514 RDNBBLK PUSH H TABLE ADDRESS
                  1515 INX H             CALL PHEAD PREPARE THE HEADER FOR READ
                  1516 INX H             CALL RFBLK READ IN THE BLOCK
                  1517 CALL TERE2 ERROR POP OFF STACK BEFORE RETURN
                  1518 JC TERE2
                  1519 POP H             A,E LOW BYTE OF COUNT (WILL BE ZERO IF 256)
                  1520 MOV H             D SEE IF BOTH ARE ZERO
                  1521 MOV H             JZ EOFER
                  1522 ORA D             INX H NEW COUNT (.ZERO IS 256 AT THIS POINT)
                  1523 MOV H             INX H BUFFER LOCATION POINTER
                  1524 MOV H             M,E EOFER
                  1525 MOV H             INX H BUFFER COUNT WAS ZERO...END OF FILE
                  1526 MOV H             MVI H
                  1527 DCX H             H,O
                  1528 MOV H             A,E COUNT TO A
                  1529 POP D             D GET BACK BUFFER ADDRESS
                  1530 *
                  1531 *
                  1532 *

C65C D5          C660 CD BF C6
C65D E5          C661 E1
C65E 23          C662 CD C8 C6
C65F CD A6 C6
C660 DA FA C5
C662 CD C8 C6
C663 E1
C664 7B
C665 B2
C666 CA FF C5
C667 73
C668 E1
C669 7B
C670 36 00
C672 2B
C673 7B
C674 D1

C65C D5          C660 CD BF C6
C65D E5          C661 E1
C65E 23          C662 CD C8 C6
C65F CD A6 C6
C660 DA FA C5
C662 CD C8 C6
C663 E1
C664 7B
C665 B2
C666 CA FF C5
C667 73
C668 E1
C669 7B
C670 36 00
C672 2B
C673 7B
C674 D1
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C675 3D          1533 * THIS ROUTINE GETS ONE BYTE FROM THE BUFFER
C676 77          P.O. BOX 5260 AND RETURNS IT IN REGISTER "A". IF THE END
C677 23          SAN MATEO, CA 94402 PAGE 15
C678 7E          1534 * OF THE BUFFER IS REACHED IT MOVES THE POINTER
C679 34          1535 * TO THE BEGINNING OF THE BUFFER FOR THE NEXT
C680 1A          1536 * LOAD.
C681 B7          1537 * 1538 *
C682 C9          1539 GTBYT DCR A, M BUMP THE COUNT
C67B 5F          1540 MOV H,A RESTORE IT
C67C D2          1541 INX H,M
C67F 14          1542 MOV H,M GET BUFFER POSITION
C680 1A          1543 INR H BUMP IT
C681 B7          1544 * 1545 ADD E, A DE NOW POINT TO CORRECT BUFFER POSITION
C682 C9          1546 MOV E,A
C683 CD 33 C6      1547 JNC RT1
C684 C8          1548 INR D
C685 C6          1549 RT1 LDAX D GET CHARACTER FROM BUFFER
C686 C8          1550 ORA A CLEAR CARRY
C687 3C          1551 RET .
C688 C8          1552 *
C689 3E          1553 *
C68A 23          1554 *
C68B 23          1555 *
C68C 23          1556 *
C68D 78          1557 * THIS ROUTINE IS USED TO WRITE A BYTE TO THE FILE
C68E F5          1558 * ON ENTRY: A - HAS FILE NUMBER
C68F E5          1559 * B - HAS DATA BYTE
C690 CD BF C6      1560 *
C691 E1          1561 * 1562 WTBYT CALL LFCB GET CONTROL BLOCK
C692 7E          1563 RZ INR A FILE WASN'T OPEN
C693 83          1564 INR RZ
C694 7E          1565 INR A FILE WAS READ
C695 83          1566 MVI H, OFEH SET IT TO WRITE
C696 5F          1567 INX H
C697 D2 9B C6      1568 INX H
C698 14          1569 MOV H,A GET CHARACTER
C699 F1          1570 PUSH PSW
C700 12          1571 PUSH H SAVE CONTROL ADDRESS+2
C701 12          1572 * 1573 * NOW DO THE WRITE
C702 12          1574 * 1575 CALL PLOAD BC GETS HEADER ADDR, DE BUFFER ADDRESS
C703 12          1576 POP H
C704 12          1577 MOV H,M COUNT BYTE
C705 12          1578 ADD E,A
C706 12          1579 MOV H,W
C707 12          1580 JNC WT1
C708 12          1581 TNR D
C709 12          1582 WT1 PSW
C710 12          1583 POP PSW
C711 12          1584 ORA A CHARACTER PUT CIR IN BUFFER
C712 12          1585 INR H CLEAR FLAGS
C713 34          1586 INR H INCREMENT THE COUNT
```

```

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```

THIS ROUTINE SETS THE CORRECT UNIT FOR SYSTEM READS

THIS ROUTINE SETS THE CORRECT UNIT FOR SYSTEM READS

```

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C739 DA 33 C7          1745      SOHL STILL A NULL, KEY
C739 C2 33 C7          1746      JC RHEAD NON-ZERO, START
C739 C2 33 C7          1747      JNZ RHEAD
C739 C2 33 C7          1748      * NOW GET THE HEADER
C739 C2 33 C7          1749      *
C73F 21 1C C8          1750      LXI H,THEAD POINT TO BUFFER
C73F 21 1C C8          1751      MVI B,HLEN LENGTH TO READ
C73F 21 1C C8          1752      * RD A BLOCK INTO
C744 OE 00          1753      RHED1 EQU $ C,O INIT THE CRC
C744 OE 00          1754      MVI C,O
C746 CD 6F C7          1755      RHED2 EQU $ LOOP HERE
C746 CD 6F C7          1756      TAPIN CALL GET A BYTE
C749 D8          1757      RC
C74A 77          1758      MOV M,A STORE IT
C74B 23          1759      INX H INCREMENT ADDRESS
C74C CD A8 C7          1760      CALL DOCRC GO COMPUTE THE CRC
C74D F0 05          1761      DCR WHOLE HEADER YEAR
C750 C2 46 C7          1762      JNZ RHED2 DO ALL THE BYTES
C750 C2 46 C7          1763      *
C750 C2 46 C7          1764      * THIS ROUTINE GETS THE NEXT BYTE AND
C750 C2 46 C7          1765      * TO THE VALUE IN REGISTER C. THE FILE
C750 C2 46 C7          1766      * RETURN.
C750 C2 46 C7          1767      *
C753 CD 6F C7          1768      CALL TAPIN GET CRC BYTE
C756 A9          1769      XRA CLR CARRY AND SET
C757 C8          1770      RZ CRC
C758 3A 11 C8          1771      LDA CRC WAS FINE
C758 3A 11 C8          1772      INR GET POSSIBLE OVERFLOW
C75C C9          1773      A FF=IGNORE CRC ERROR
C75C C9          1774      RET

C775 21 1C C8          1775      * THIS ROUTINE GETS THE NEXT AVAILABLE
C775 21 1C C8          1776      * TAPE. WHILE WAITING FOR THE BYTE
C775 21 1C C8          1777      * FOR AN ESC COMMAND. IF RECEIVED THEN
C775 21 1C C8          1778      * TERMINATED AND A RETURN TO THE COMMAND
C775 21 1C C8          1779      *
C775 DB FA          1780      STAT IN TAPPT TAPE STATUS PORT
C775 DB FA          1781      ANI TDR
C775 E6 40          1782      *
C775 E6 40          1783      CALL SINP CHECK INPUT
C775 E6 40          1784      JZ STAT NOTHING THERE YET
C775 E6 40          1785      ANI CLR PARITY 1ST
C775 E6 40          1786      JNZ STAT NOT A MODE (OR E)
C775 E6 40          1787      STC SET ERROR FLAG
C775 E6 40          1788      RET AND RETURN
C775 E6 40          1789      *
C775 E6 40          1790      *
C775 E6 40          1791      * STAT WAIT UNTIL A CHANGE
C775 E6 40          1792      TAPIN CALL
C775 E6 40          1793      RC
C775 E6 40          1794      *
C775 E6 40          1795      TREDY IN TAPPT TAPE STATUS
C775 E6 40          1796      ANI TFEATOE DATA ERROR?
C775 E6 40          1797      TDATA GFT DATA

```

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C779 C8          1798    RZ      *   IF NO ERRORS
C77A 37          1799    STC     .   SET ERROR FLAG
C77B C9          1800    RET     .
1801 *          1802 * THIS ROUTINE GETS THE CORRECT UNIT FOR SYSTEM WRITES
1803 *          1804    WFBLK CALL GTUNT SET UP A WITH UNIT AND SPEED
1805 *          1806 * WRITE TAPE BLOCK ROUTINE
1807 *          1808 * ON ENTRY: A HAS UNIT AND SPEED
1809 *          1810    H     HAS UNIT AND SPEED
1811 *          1812    HL    HAS POINTER TO HEADER
1813 *          1814    WTAP EQU $ HERE TO WRITE TAPE
1815    PUSH H SAVE HEADER ADDRESS
1816    CALL HHEAD TURN ON, THEN WRITE HDR
1817    POP H
1818    LXI D,BLKOF OFFSET TO BLOCK SIZE IN HEADER
1819    DAD D,HL POINT TO BLOCK SIZE
1820    MOV E,M
1821    INX H
1822    MOV D,H DE HAVE SIZE
1823    INX H
1824    MOV A,M
1825    INX H
1826    MOV H,M
1827    MOV L,A HL HAVE STARTING ADDRESS
1828 *          1829 * THIS ROUTINE WRITES ONE PHYSICAL BLOCK ON THE
1830 *          1831 * TAPE "DE" BYTES LONG FROM ADDRESS "HL".
1832 *          1833    WRLO1 EQU $ HERE FOR THE EXTRA PUSH
1834    PUSH H A DUMMY PUSH FOR LATER EXIT
1835    WTAP2 EQU $ LOOP HERE UNTIL ENTIRE AMOUNT READ
1836    CALL DCRT COUNT IN DE AND SET UP B W/LEN THIS BLK
1837    JZ TOF RETURNS ZERO IF ALL DONE
1838    CALL WTB1 WRITE BLOCK FOR BYTES IN B (256)
1839    JMP WTAP2 LOOP UNTIL ALL DONE
1840 *
1841 *          1842    WRTP PUSH PSW
1842    IN TAPPT TAPE STATUS
1843    WRWAT ANI TTBE IS TAPE READY FOR A CHAR YET
1844    JZ WRHAT NO--WAIT
1845    POP PSW SEE WHICH UNIT
1846    OUT TDATA SEND CHAR TO TAPE
1847    *          1848 * A COMMON CRC COMPUTATION ROUTINE
1849    DOCRC EQU $ C
1850    SUB C

C79D F5          1851    MOV C,A HERE TO 1ST TURN ON THE TAPE
C79E DB FA          1852    XRA C CALL WTON TURN IT ON, THEN WRITE HEADER
C7A0 E6 80          1853    CMX C
C7A2 C4 9E C7          1854    SUB C
C7A5 F1          1855    MOV C,A
C7A6 D3 FB          1856    RET . ONE BYTE NOW WRITTEN
1857 *          1858 * THIS ROUTINE WRITES THE HEADER POINTED TO BY
1859 *          1860 * HL TO THE TAPE.
1861 *          1862    WHEAD EQU $ HERE TO 1ST TURN ON THE TAPE
1863    CD ED C7          1864    CALL WTON LENGTH TO WRITE OUT
1864    C7B2 16 32          1865    MVI D,50 WRITE 50 ZEROS
1865    AF          1866    NUOP CALL WRTAP
1866    C7B5 CD 9D C7          1867    DCR D
1867    C7B8 15          1868    JNZ NULOP
1868    C7B9 C2 B4 C7          1869 * MVI A,1
1869    C7BC 3E 01          1870    CALL WRTAP
1870    C7BE CD 9D C7          1871    MVI B,HLEN LENGTH TO WRITE OUT
1871    C7C1 06 10          1872    CALL WRTAP
1872    C7C5 0E 00          1873 * MVI C,0 RESET CRC BYTE
1873    C7C6 7E          1874    WTBL MVI A,M GET CHARACTER
1874    C7C7 9D C7          1875    WLOOP CALL WRTAP
1875    C7C9 05          1876    DCR B WRITE IT TO THE TAPE
1876    C7CA 23          1877    INX H
1877    C7CB C2 C5 C7          1878    JNZ WLOOP
1878    C7CE 79          1879    MOV A,C GET CRC
1879    C7CF C3 9D C7          1880    WRTAP PUT IT ON THE TAPE AND RETURN
1880 *          1881 * JMP
1881 *          1882 * THIS ROUTINE COMPARES THE HEADER IN THED TO
1883 *          1884 * THE USER SUPPLIED HEADER IN ADDRESS HL.
1885 *          1886 * ON RETURN IF ZERO IS SET THE TWO NAMES COMPARED
1886    DHCMP MVI B,5
1887 *          1888    DHLDP MVI D
1888    C7D2 06 05          1889    CHP M
1889    C7D4 1A          1890    RNZ
1890    C7D5 BE          1891    DCR B
1891    C7D6 CO          1892    RZ -
1892    C7D7 05          1893    INX H
1893    C7D8 C8          1894    INX D
1894    C7D9 23          1895    DHLDP
1895    C7DA 13          1896    JHP
1896    C7DB C3 D4 C7          1897 * SET A=SPEED + UNIT
1897    C7DE 3A 54 C8          1898    GTUNT EQU $ LDA
1898    C7E1 B7          1899    ORA A
1899    C7E2 3A 0D C8          1900    LDA TSPP SEE WHICH UNIT
1900    C7E5 C2 EA C7          1901    JNZ CTRN2 BUT 1ST GET SPEED
1901    C7E6 C6 40          1902    ADI MAKE IT UNIT TWO
1902    C7E7 C6 40          1903    JNZ TFE2 THIS ONCE=UNIT 2, TWICE=UNIT 1

```

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C7EA C6 40          1904 GTUN2 ADI      TAPE2 UNIT AND SPEED NOW SET IN A
C7EC C9              1905    RET      ALL DONE
C7ED 06 04          1906 *           B,4      SET LOOP DELAY (BIT LONGER ON A WRITE.)
C7EF D3 FA          1907 WTON MVI      B,4      HERE TO TURN A TONE ON THEN DELAY
C7EF D3 FA          1908 TON EQU      $       GET TAPE MOVING, THEN DELAY
C7EF D3 FA          1909 OUT TAPPT   OUT
C7EF D3 FA          1910 *           TAPPT   GET TAPE MOVING, THEN DELAY
C7F1 11 00 00        1911 DELAY LXI    D,0      TAPE STATUS PORT
C7F4 1B              1912 DLOP1 DCX    D
C7F5 7A              1913 MOV      A,D
C7F6 B3              1914 ORA      E
C7F7 C2 F4 C7        1915 JNZ      DLOOP1
C7FA 05              1916 DCR      B
C7FB C2 F1 C7        1917 JNZ      DELAY
C7FE C9              1918 RET
C7F1 11 00 00        1919 *
C7F4 1B              1920 **** -- END OF PROGRAM--
C7F5 7A              1921 **** -- END OF PROGRAM--
C7F6 B3              1922 *
C7F7 C2 F4 C7        1923 *
C7F8 C2 F1 C7        1924 *
C7F9 11 00 00        1925 *
C7FA 05              1926 *
C7FB C2 F1 C7        1927 *
C7FD 11 00 00        1928 *
C7FE C9              1929 VDM PARAMETERS
C7F0 11 00 00        1930 *
C7F1 11 00 00        1931 VDHEM EQU      OCOCOH VDM SCREEN MEMORY
C7F2 11 00 00        1932 *
C7F3 11 00 00        1933 *
C7F4 11 00 00        1934 *
C7F5 11 00 00        1935 *   KEYBOARD SPECIAL KEY ASSIGNMENTS
C7F6 11 00 00        1936 *   THESE DEFINITIONS ARE DESIGNED TO ALLOW
C7F7 11 00 00        1937 *   COMPATABILITY WITH CUTE(TM). THESE ARE THE
C7F8 11 00 00        1938 *   SAME KEYS WITH BIT 7 (X 80') STRIPPED OFF.
C7F9 11 00 00        1939 *
C7F0 11 00 00        1940 DOWN EQU      9AH
C7F1 11 00 00        1941 UP EQU      97H
C7F2 11 00 00        1942 LEFT EQU      81H
C7F3 11 00 00        1943 RIGHT EQU     93H
C7F4 11 00 00        1944 CLEAR EQU     8BH
C7F5 11 00 00        1945 HOME EQU      8EH
C7F6 11 00 00        1946 HOME EQU      80H
C7F7 11 00 00        1947 BACKS EQU     5FH
C7F8 11 00 00        1948 LF EQU      10
C7F9 11 00 00        1949 CR EQU      13
C7F0 11 00 00        1950 BLANK EQU     .'
C7F1 11 00 00        1951 SPACE EQU     BLANK
C7F2 11 00 00        1952 CX EQU      'X'-80H
C7F3 11 00 00        1953 ESC EQU      1BH
C7F4 11 00 00        1954 *
C7F5 11 00 00        1955 *   PORT ASSIGNMENTS
C7F6 11 00 00        1956 *

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00FA 1957 STAPT EQU      OFAH STATUS PORT GENERAL
00F8 1958 SENST EQU     OF8H SERIAL DATA PORT
00F9 1959 SDATA EQU     OF9H SERIAL DATA
00FD 1960 PDATA EQU     OFDH PARALLEL DATA
00FC 1961 KDATA EQU     OFCH KEYBOARD DATA
00FE 1962 DDATA EQU     OFEH VDM CONTROL PORT
00FF 1963 TAPPT EQU     OFAH TAPE STATUS PORT
00FA 1964 TDATA EQU     OFBH TAPE DATA PORT
00FB 1965 SENSE EQU     OFFH SENSE SWITCHES
00FF 1966 *
00FA 1967 *
00FB 1968 *
00FF 1969 *
00FA 1970 *
0001 1971 SCDR EQU     1 SERIAL CARRIER DETECT
0002 1972 SDR EQU     2 SERIAL DATA SET READY
0004 1973 SPE EQU     4 SERIAL PARITY ERROR
0008 1974 SFE EQU     8 SERIAL FRAMING ERROR
0010 1975 SOE EQU     16 SERIAL OVERRUN ERROR
0020 1976 SCTS EQU     32 SERIAL CLEAR TO SEND
0040 1977 SDR EQU     64 SERIAL DATA READY
0080 1978 SIBE EQU     128 SERIAL TRANSMITTER BUFFER EMPTY
0001 1980 KDR EQU     1 KEYBOARD DATA READY
0002 1981 PDR EQU     2 PARALLEL DATA READY
0004 1982 PYDR EQU     4 PARALLEL DEVICE READY
0008 1983 TFE EQU     8 TAPE FRAMING ERROR
0010 1984 TOE EQU     16 TAPE OVERFLOW ERROR
0040 1985 TDR EQU     64 TAPE DATA READY
0080 1986 TIBE EQU     128 TAPE TRANSMITTER BUFFER EMPTY
0001 1987 *
0080 1988 SOK EQU     1 SCROLL OR FLAG
0080 1989 *   1=TURN TAPE ONE ON
0080 1990 TAPE1 EQU     80H 1=TURN TAPE TWO ON
0040 1991 TAPE2 EQU     40H
1992 *
1993 *
1994 *
1995 *
1996 *
1997 *
1998 *
1999 *
2000 SYSRAM EQU     $ START OF SYSTEM RAM
2001 STSIP EQU     SYSRAM+3FFFH STACK WORKS FM TOP DOWN
2002 *
2003 *
2004 *   PARAMETERS STORED IN RAM
2005 *
2006 UIPRT DS      2 USER DEFINED INPUT RTN IF NON ZERO
2007 UOPRT DS      2 USER DEFINED OUTPUT RTN IF NON ZERO
2008 DFOTS DS      2 DEFAULT PSUEDO I/O PORTS (ALWAYS ZERO IN SOLOS)
2009 IPORT DS      1 CRNT INPUT PSUEDO PORT

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2010 OPORT DS 1 CRNT OUTPUT PSUEDO PORT
2011 NCHAR DS 1 CURRENT CHARACTER POSITION
2012 LINE DS 1 CURRENT LINE POSITION
2013 BOT DS 1 BEGINNING OF TEXT DISPLACEMENT
2014 SPEED DS 1 SPEED CONTROL BYTE
2015 ESCFL DS 1 ESCAPE FLAG CONTROL BYTE
2016 TSPD DS 1 CURRENT TAPE SPEED
2017 INPTR DS 2 FOR COMPATIBILITY W/ CUTER
2018 NUCNT DS 1 NUMBER OF NULLS AFTER CRLF
2019 IGNCR DS 1 FF=IGNORE CRC ERRORS, ELSE NORMAL
2020 * DS 10 ROOM FOR FUTURE EXPANSION
2021 * DS 5 NAME
2022 * THIS IS THE HEADER LAYOUT
2023 * THIS IS THE HEADER LAYOUT
2024 * THIS IS THE HEADER LAYOUT
2025 * THIS IS THE HEADER LAYOUT
2026 * THIS IS THE HEADER LAYOUT
2027 THEAD DS 1 THIS BYT MUST BE ZERO
2028 TYPE DS 1 BLOCK SIZE
2029 BLOCK DS 2 LOAD ADDRESS
2030 LODR DS 2 AUTO EXECUTE ADDRESS
2031 XEQAD DS 3 SPARES
2032 HLEN EQU $-THEAD LENGTH OF HEADER
2033 BLKOF EQU $-BLOCK-THEAD OFFSET TO BLOCK SIZE
2034 DHEAD DS HLEN A DUMMY HDR FOR COMPARES WHILE RD'ING
2035 * DS 6#4 ROOM FOR UP TO 6 CUSTOM USER COMMANDS
2036 * DS 6#4
2037 * DS 6#4
2038 * DS 6#4
2039 * DS 6#4
2040 * DS 6#4
2041 * DS 6#4
2042 * DS 6#4
2043 FNUMF DS 1 FOR CURRENT FILE OPERATIONS
2044 FCBAS DS 7 1ST FILE CONTROL BLOCK
2045 FCBA2 DS 7 2ND FILE CONTROL BLOCK
2046 FBUF1 DS 2#256 SYSTEM FILE BUFFER BASE
2047 DS 81 THIS IS AN AREA USED BY CUTER
2048 USARE EQU $-START OF USER AREA
2049 * REMEMBER THAT THE STACK WORKS ITS WAY DOWN FROM
2050 * THE END OF THIS 1K RAM AREA.
2051 * -*-
```

CABU

C83C

C854

C855

C856

C863

CA63

ADOUT

A1NP

AINP

ARET

BLANK

BLOK

BOT

CHRLL

CLINE

CONT

CRLF

CUSE2

C5D3

C19B

C022

C19D

C007

C006

C08B

C014

C010

C1FF

C0DF

C00D

C146

C00F

C00C

C03C

C018

C042

C000

C05F

C05E

C05A

C05B

C05C

C05D

C05E

C05F

C05G

C05H

C05I

C05J

C05K

C05L

C05M

C05N

C05O

C05P

C05Q

C05R

C05S

C05T

C05U

C05V

C05W

C05X

C05Y

C05Z

C05A

C05B

C05C

C05D

C05E

C05F

C05G

C05H

C05I

C05J

C05K

C05L

C05M

C05N

C05O

C05P

C05Q

C05R

C05S

C05T

C05U

C05V

C05W

C05X

C05Y

C05Z

C05A

C05B

C05C

C05D

C05E

C05F

C05G

C05H

C05I

C05J

C05K

C05L

C05M

C05N

C05O

C05P

C05Q

C05R

C05S

C05T

C05U

C05V

C05W

C05X

C05Y

C05Z

C05A

C05B

C05C

C05D

C05E

C05F

C05G

C05H

C05I

C05J

C05K

C05L

C05M

C05N

C05O

C05P

C05Q

C05R

C05S

C05T

C05U

C05V

C05W

C05X

C05Y

C05Z

C05A

C05B

C05C

C05D

C05E

C05F

C05G

C05H

C05I

C05J

C05K

C05L

C05M

C05N

C05O

C05P

C05Q

C05R

C05S

C05T

C05U

C05V

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C05F

C05G

C05H

C05I

C05J

C05K

C05L

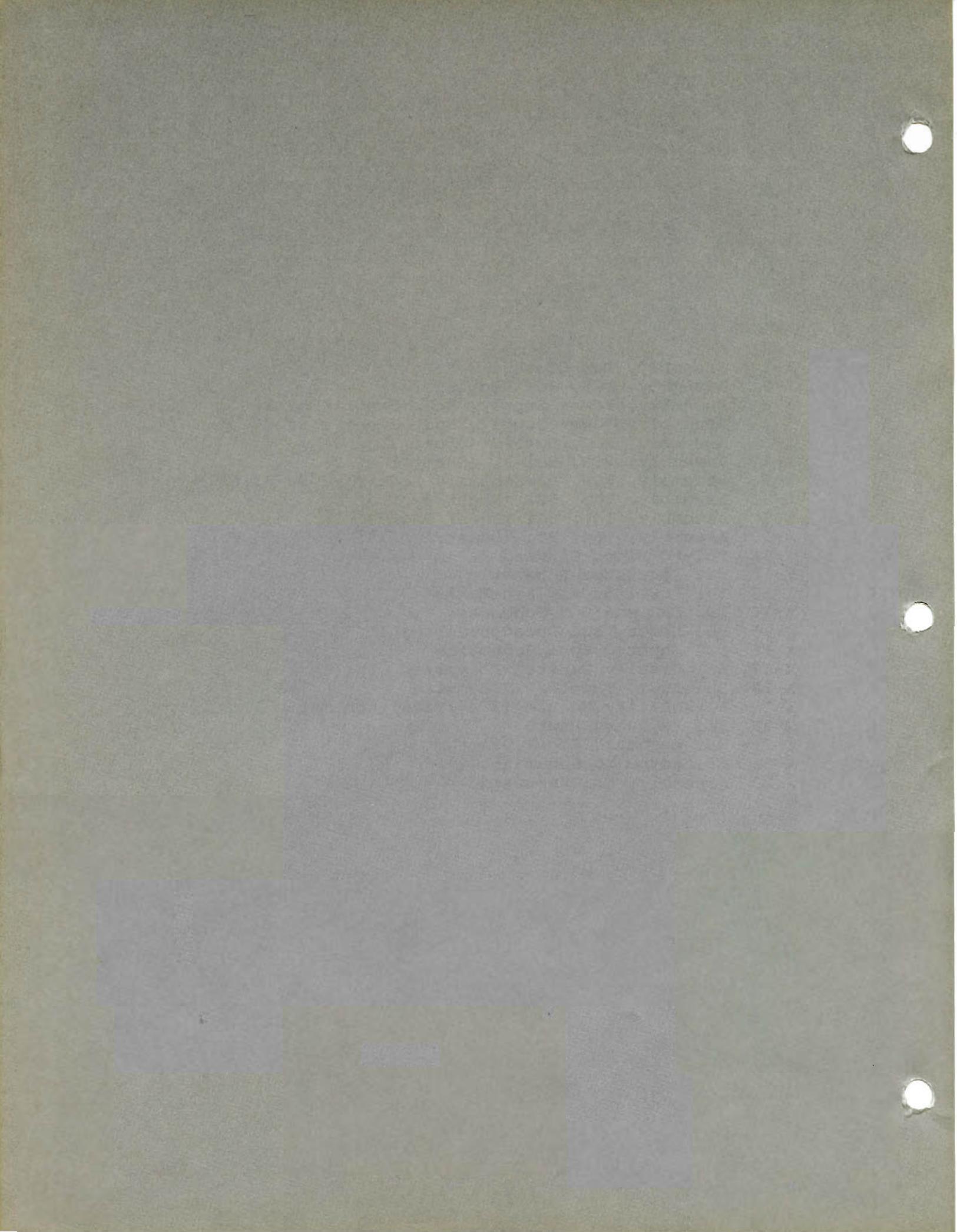
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|                    |          |                            |      | PAGE: 21 |      |
| TDE                | 0010     | TOFF                       | C70B | TON      | C7EF |
| TREDY              | C773     | TSAVE                      | C1E6 | TSPD     | C80D |
| TTBE               | 0080     | TSEQ                       | C1A6 | UBUF     | C5F5 |
| UOPRT              | C802     | UP                         | 0097 | USARE    | CAB4 |
| VDAD2              | C120     | VDADD                      | C11C | VDMEM    | CC00 |
| WFBLK              | C77C     | WREAD                      | C7AF | WLOOP    | C7C5 |
| WRBIT              | C010     | WRLO1                      | C790 | WRTAP    | C79D |
| WT1                | C698     | WTLP2                      | C791 | WTAPE    | C77F |
| WTBLT              | C683     | WTLP1                      | C400 | WTON     | C7ED |
|                    |          |                            |      | XEQD     | C827 |

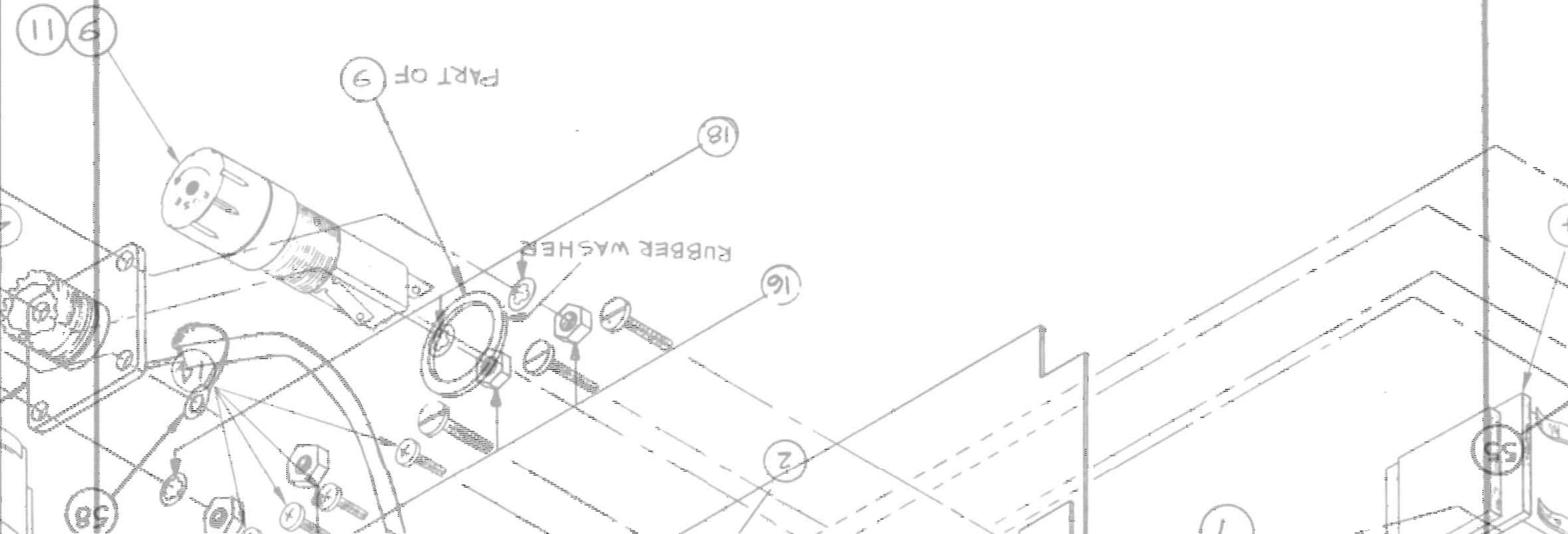


X. Drawings

X DRAWINGS

X-1 Assembly, Fan Closure  
X-2 Assembly, PCB, Sol Regulator  
X-3 Assembly, Power Supply, Sol (Sheet 1 of 2)  
X-4 Assembly, Power Supply, Sol (Sheet 2 of 2)  
X-5 Assembly, PCB, Sol-PC (Sheet 2 of 2)  
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X-8 Assembly, Top, Sol (Sheet 3 of 3)  
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X-12 Sol Regulator Schematic  
X-13 Sol Power Supply Schematic  
X-14 Sol CPU and Bus Schematic  
X-15 Sol Memory and Decoder Schematic  
X-16 Sol Input/Output Schematic  
X-17 Sol Display Control Schematic  
X-18 Sol Audio Tape I/O Schematic  
X-19 Personality Module (2708/9216) Schematic  
X-20 Sol Keyboard Photo  
X-21 Sol Keyboard Block Diagram  
X-22 Sol Keyboard Schematic  
X-23 Assembly, Sol Keyboard





2

4

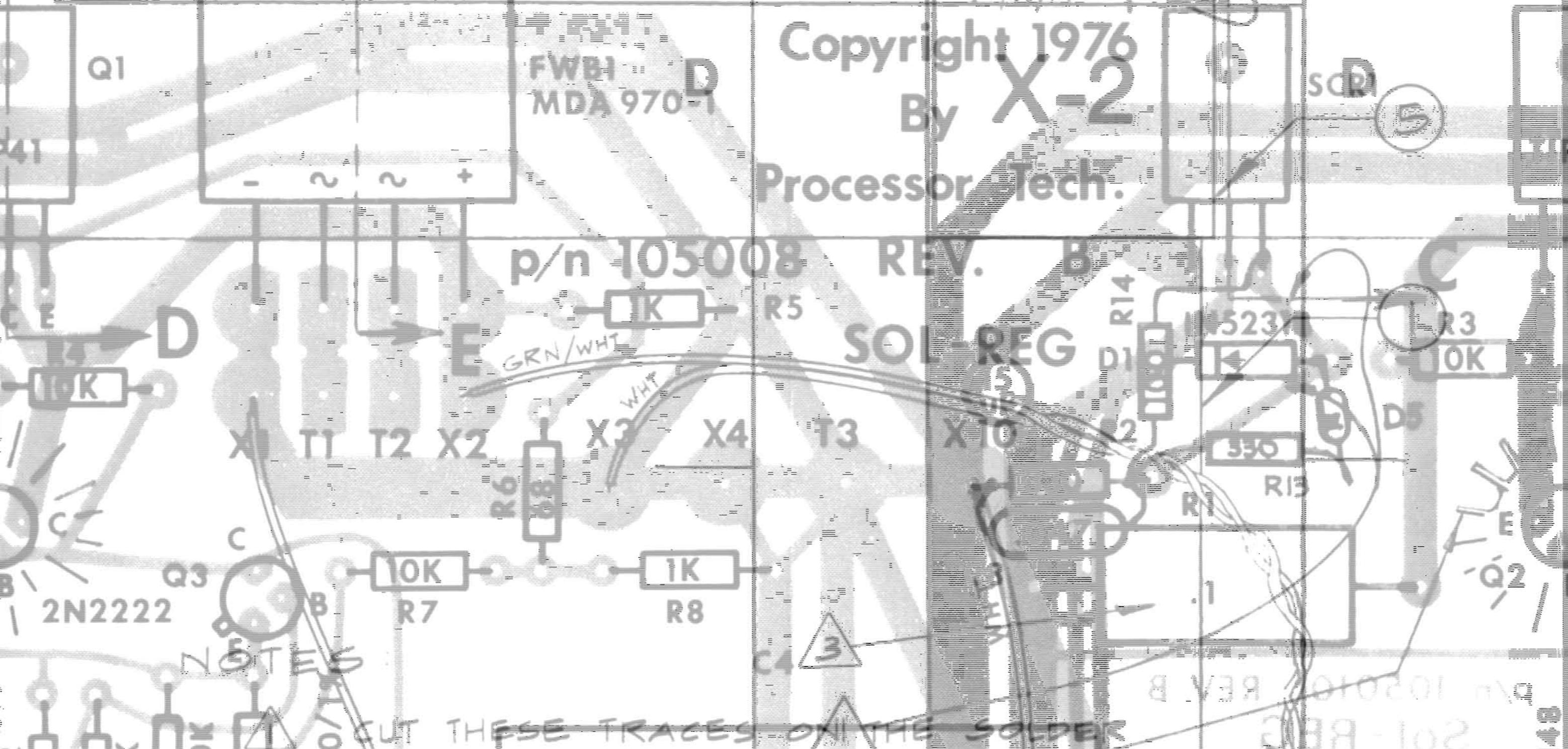
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## REVISIONS

| ZONE | LTR | DESCRIPTION         |
|------|-----|---------------------|
| D    | C   | ECN 10242 (REDRAWN) |
| D    | C   | ECN 10242, 10244    |

| DATE    | APPROVED |
|---------|----------|
| 9/26/79 | MM       |
| 10/1/79 | LD       |

Copyright 1976  
By X-2  
Processor Tech.



8 5 2 7 4 1 6 3

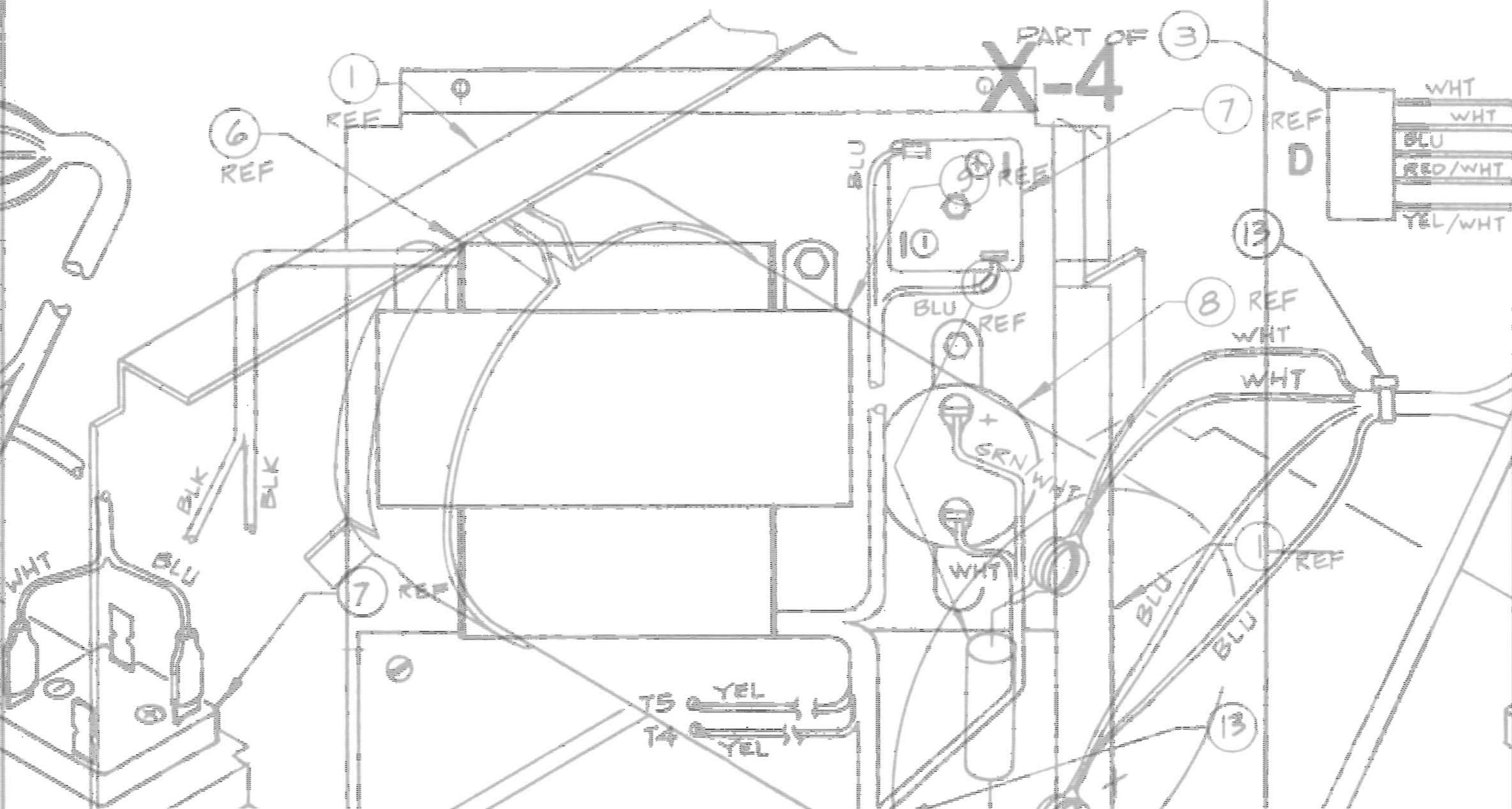
REVISIONS

| ZONE | LTR | DESCRIPTION                                      | DATE   | APPROVED |
|------|-----|--|--------|----------|
| -    | E   | ECN 10248, 10199, 10244 (REDRAWN) PART OF 1/1/21 | 1/1/21 | Ally     |

PART OF 1/1/21

Ally

8 | 5 | 2 | 7 | 4 | 1 | 6 | 3





36

258

147

## REVISIONS

| ZONE | LTR | DESCRIPTION                     | DATE    | APPROVED |
|------|-----|---------------------------------|---------|----------|
| -    | G   | ECN 10124, 10131, 10136 REDRAWN | 6-21-77 | J.W.     |
| -    | H   | ECN 10253                       | 2-3-78  | KR/SW    |

D

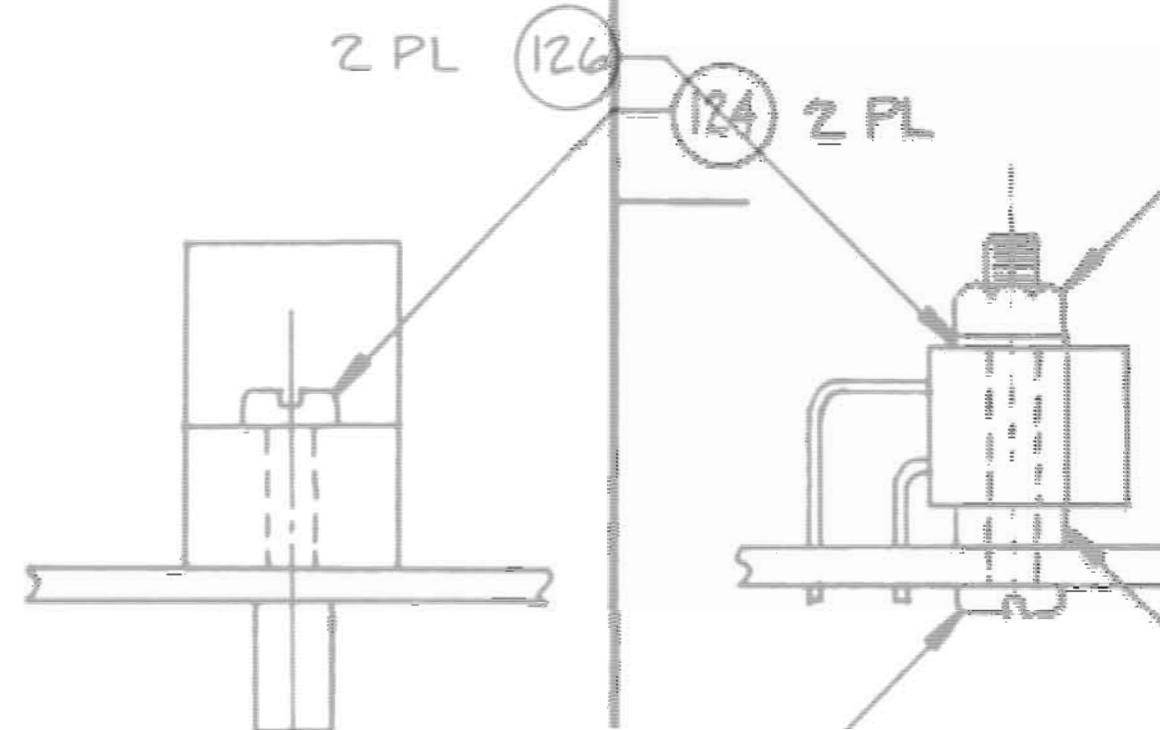
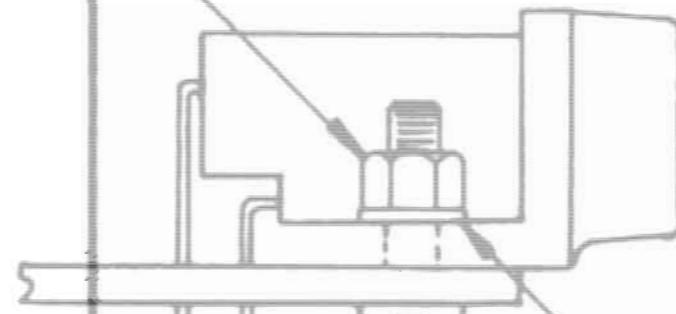
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D

123 2 PL

4 PL

123



3

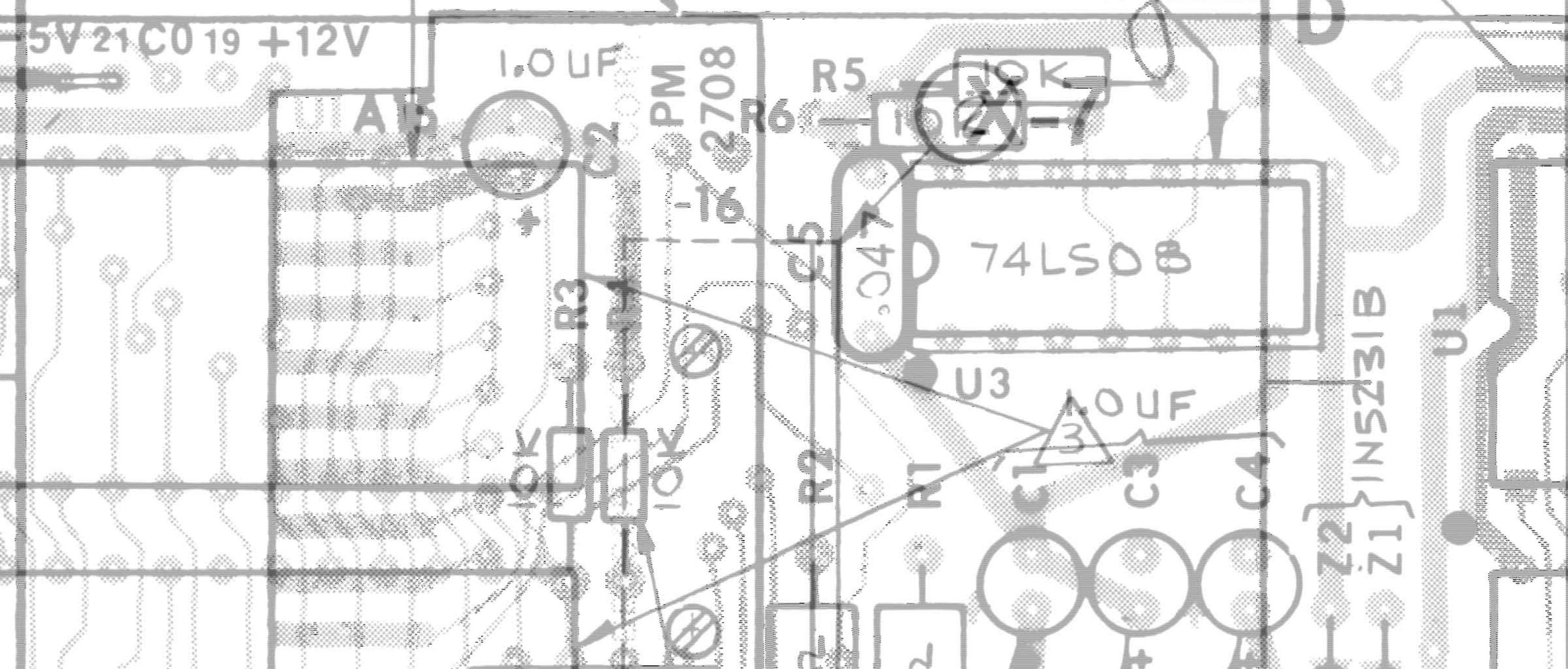
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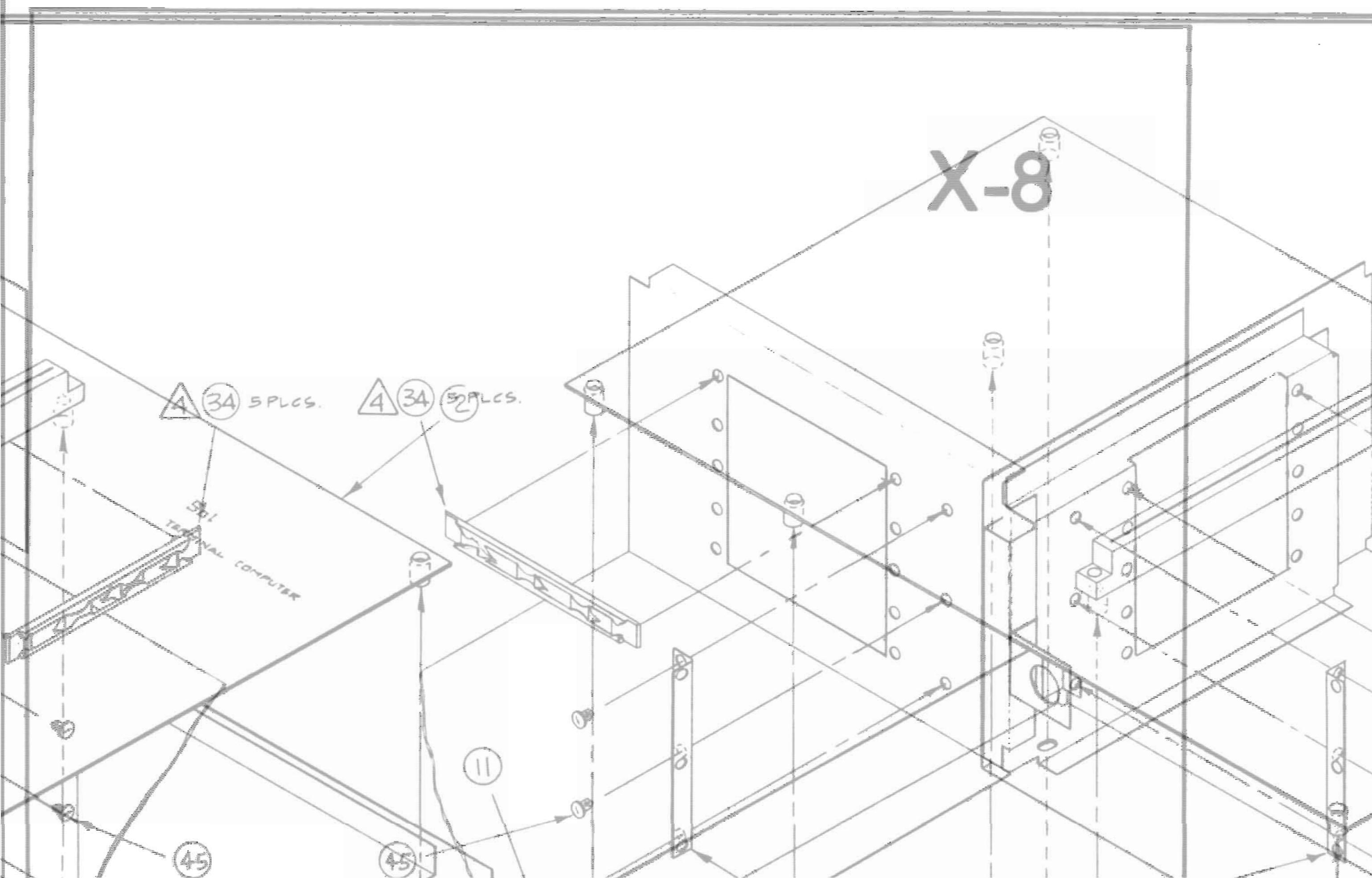
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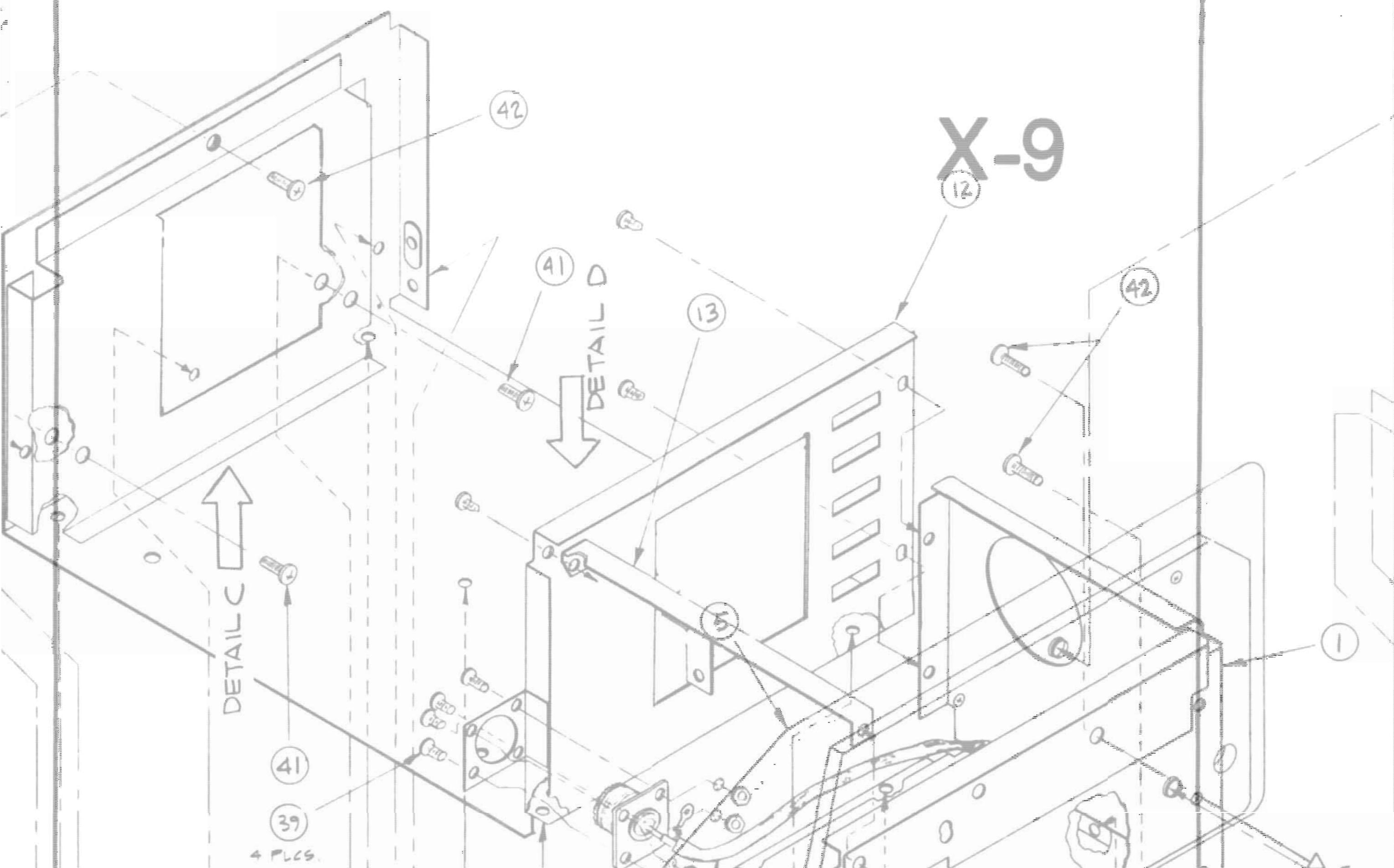
## REVISIONS

| DESCRIPTION           | DATE                 | APPROVED ZONE | LTR           |
|-----------------------|----------------------|---------------|---------------|
| 10124, 10148<br>10231 | 11-29-72<br>12-30-72 | mm            | AB ECN<br>ECN |





**X-9**



NOTES:

UNLESS OTHERWISE SPECIFIED

1. ALL SCREWS ARE PART

~~(A) ECN 10197 DOCUMENTATION ONLY  
J ECN 10211 DOCUMENTATION ONLY  
K ECN 10241 10248~~

WITHIN AREA BOUNDED BY BROKEN LINE

~~3~~ INSERT ~~4~~ INTO J11 ON ~~12~~, FASTEN TO ~~16~~  
~~ON EACH SIDE, THEN INSTALL 18 AND 17~~  
TIGHTEN MOUNTING SCREWS ON ~~12~~ AFTER  
INSTALLATION IS COMPLETE.

~~4~~ USED ON -02 AND -03 VERSIONS ONLY

| ITEM | REVISION DESCRIPTION           | DATE     | APPROVED   |
|------|--------------------------------|----------|------------|
| F    | ECN 10124 (DOCUMENTATION ONLY) | 9-27-77  | RHM        |
|      |                                | 11-17-77 | RHM        |
|      |                                | 11-23-77 | RHM        |
|      |                                | 12-21-77 | Mug<br>Mug |

X-10

10

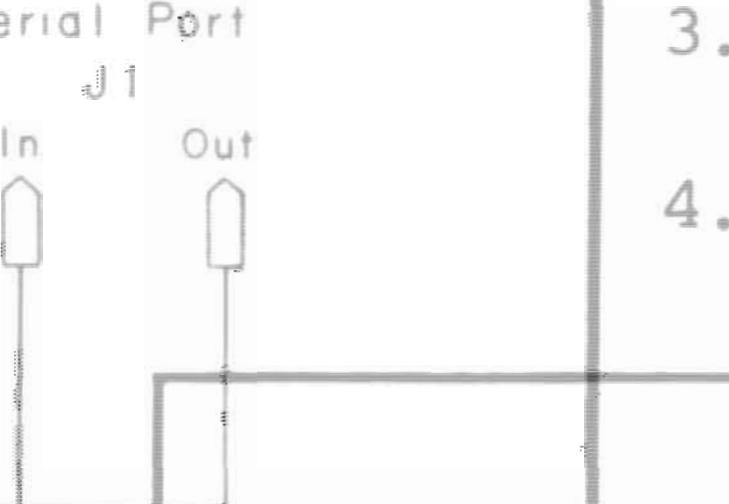
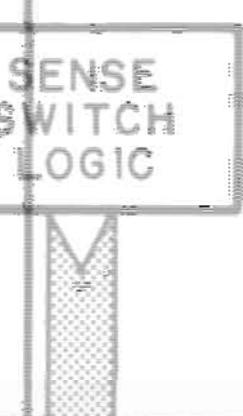
33

22

8

AM- Rev. D, E

# S641 PC. BLOCK DIAGRAM

| BLOCK FUNCTIONS<br>(in alphabetic order)   | SCHEMATIC<br>PAGE | USES IC NO's   |
|--|-------------------|--|
| 1. ADDRESSES BUS DRIVERS   | X14               | Keyboard Port<br>J 3<br>(from Keyboard) U67, 68, 81  |
| 2. ADDRESS PAGE/I/O PORT DECODER   | X14, X15          | Parallel Port<br>P2 Out<br>POD φ-7<br>U22, 23, 24, 34, 35,<br>36, 44, 47, 48, 53<br>61, 83 |
| 3. BAUD RATE GENERATOR   | X16               |  |
| 4. CASSETTE DATA INTERFACE   | X18               |  |
| Serial Port<br>J 1<br>     |                   |  |
| SENSE<br>SWITCH<br>LOGIC<br> |                   |  |
| ADDRESS<br>               |                   |  |

B R13, R14, C8 ADDED PER ECO 10018

6-1-77

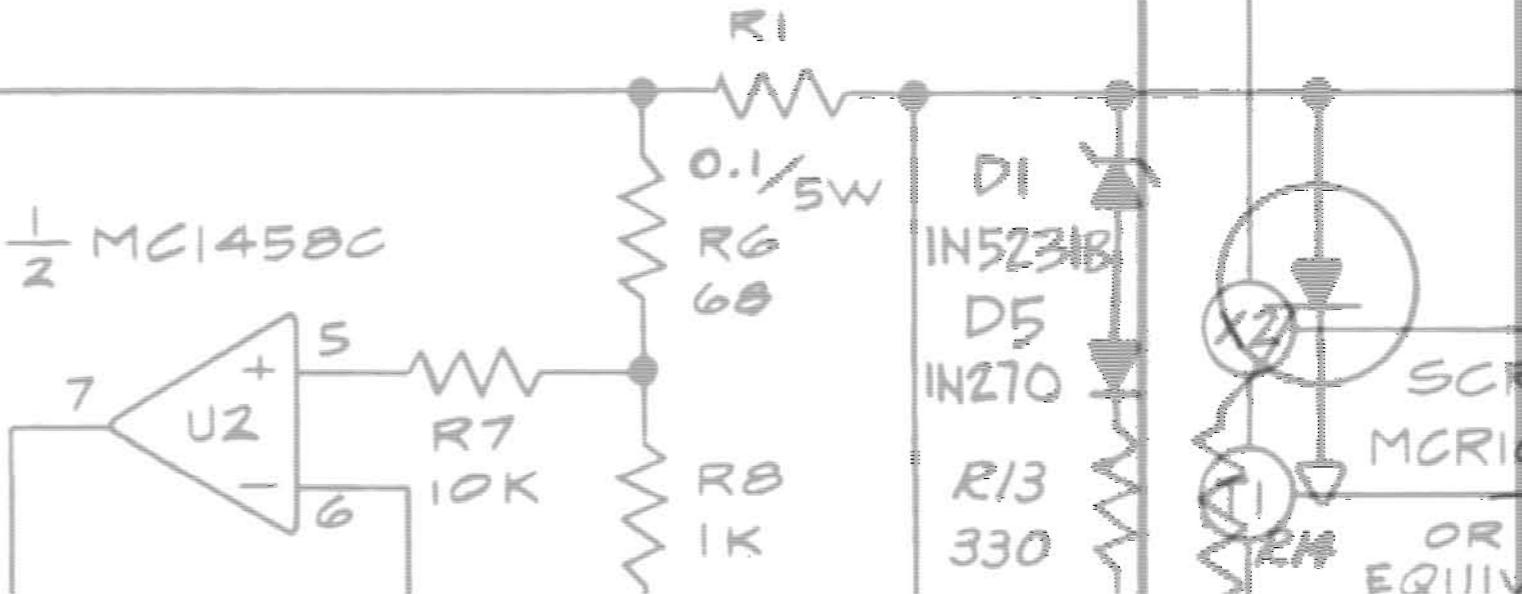
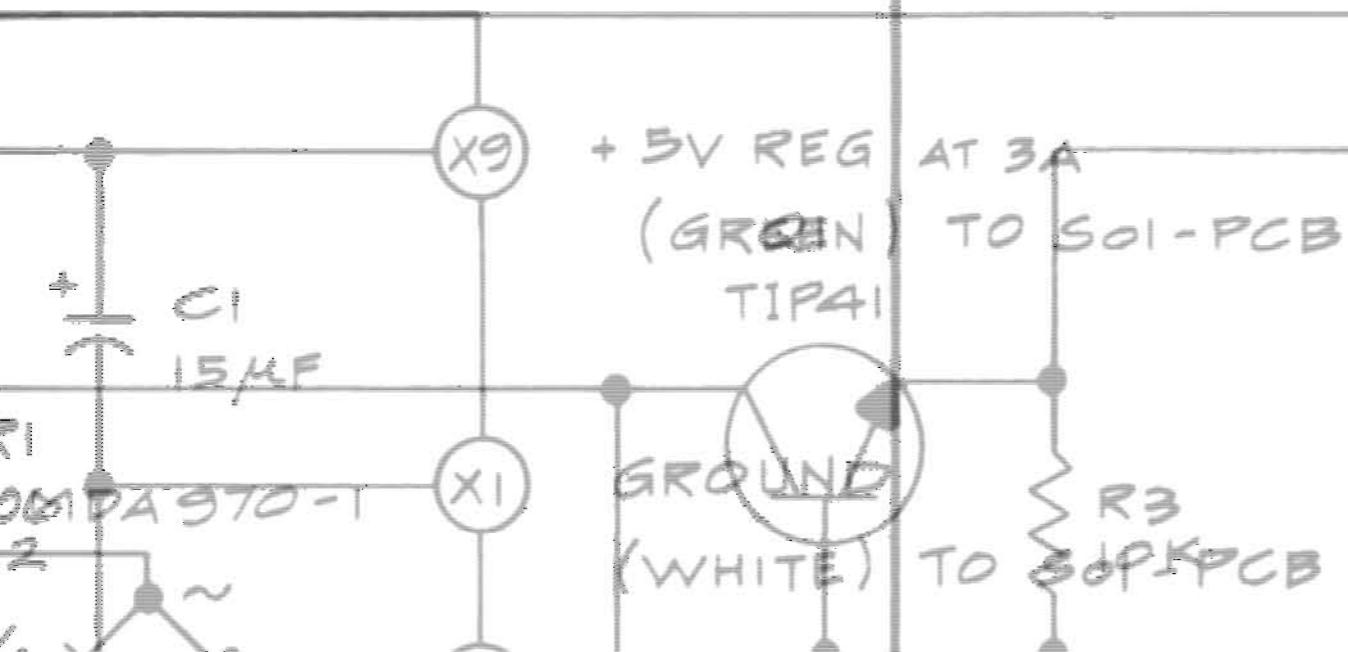
X. L.

C ECN 10242

1/4/78

Rev. A

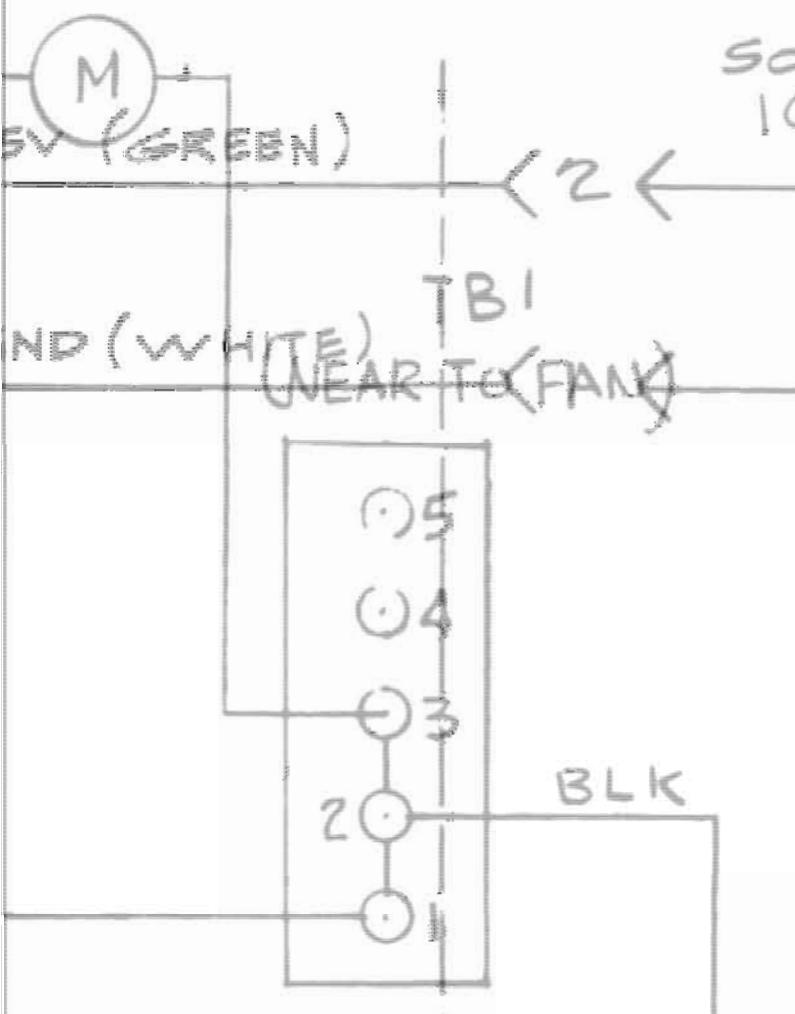
# X-12



| LTR | REVISION DESCRIPTION           | DATE    | APPROD. |
|-----|--------------------------------|---------|---------|
| B   | RELEASED AS REV B. (ECO 10003) | 8-23-77 | CJ      |
| C   | ECN 10114                      | 10-6-77 | TOL     |
| D   | ECN 10124 (DOCUMENTATION ONLY) | 10-7-77 | RCM     |

X-13

FAN ASSY, 105033-01  
ASSY 105012



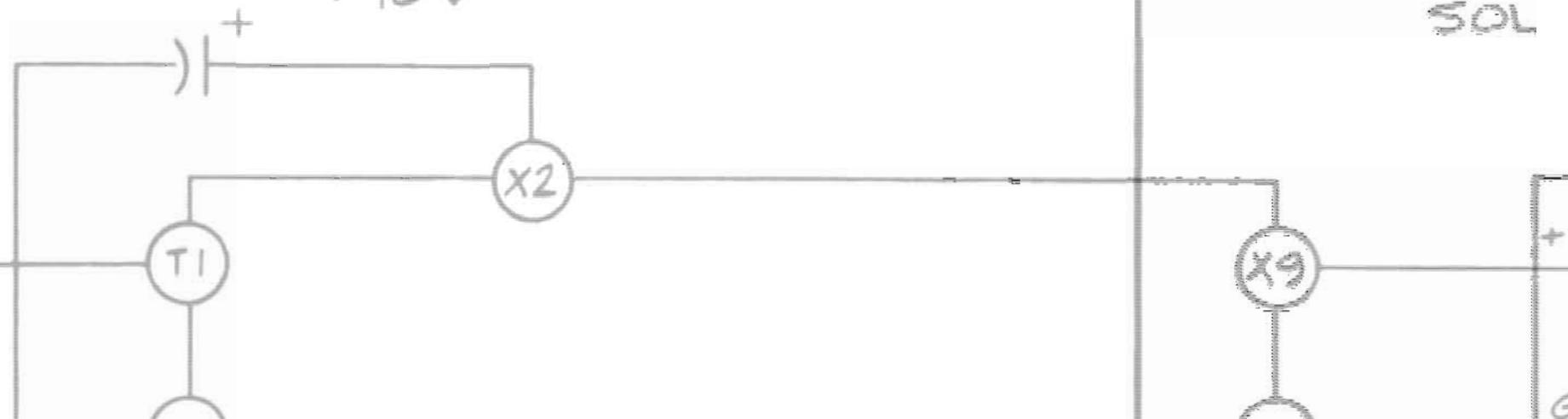
SOL-T2  
105028

GREEN

GREEN

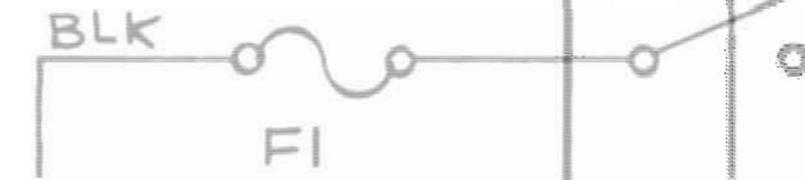
SOL PC  
DC POWER

CB 707047  
18000  $\mu$ F / 10V



SOL-REG. PCB  
105008

(REV B)

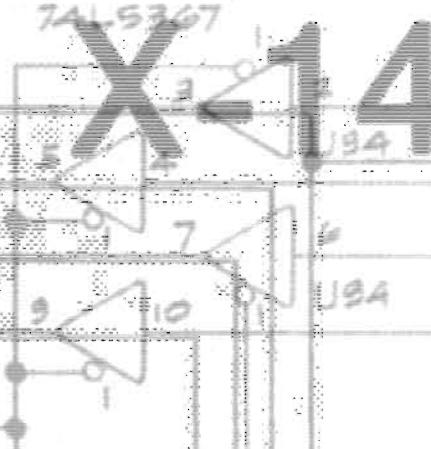
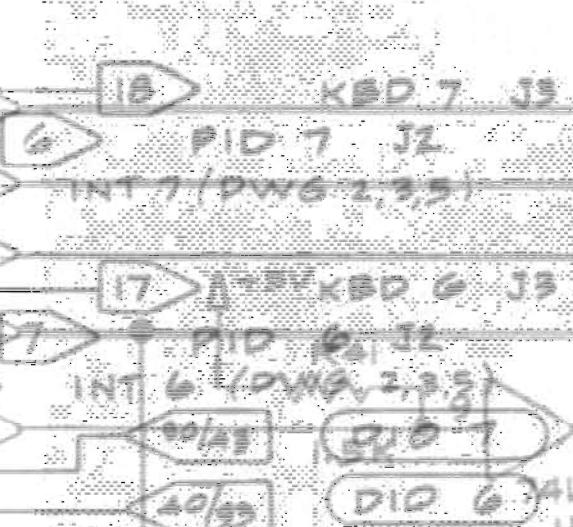
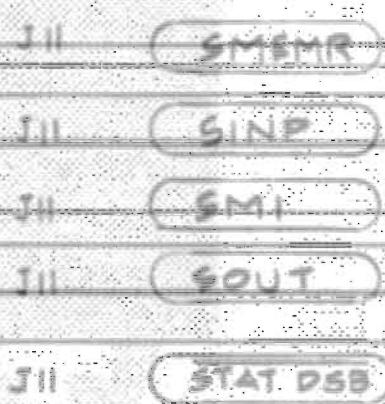
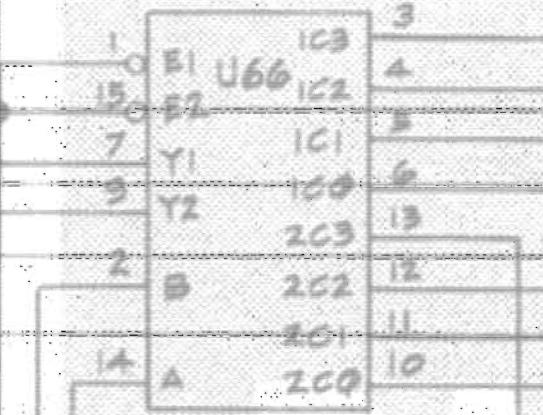


SEE DRAWING 5

| LTR | REVISION                | DESCRIPTION                        | DATE APPD          |
|-----|-------------------------|------------------------------------|--------------------|
| -   |                         | SEE HISTORY FILE FOR PREVIOUS REV. | - -                |
| G   | ECN 10129, 10136, 10124 | H ECN 10253                        | 2-3-78 6/24 U.S.A. |

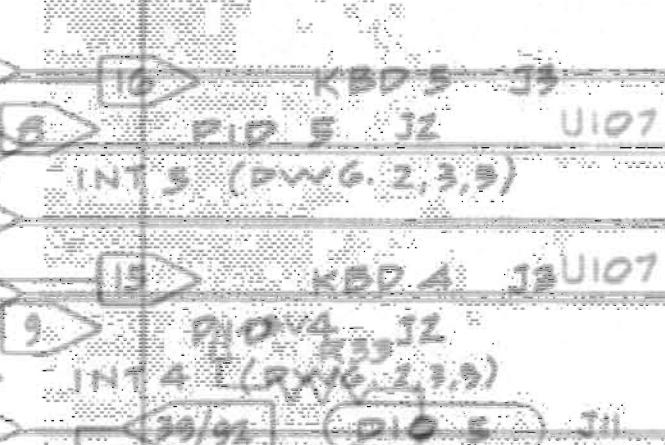
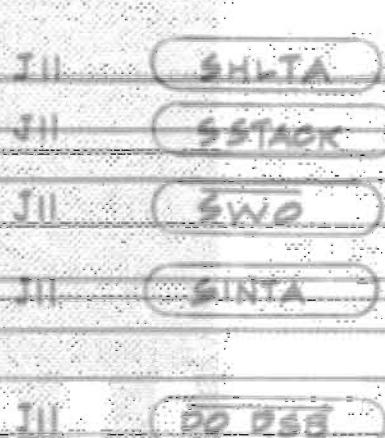
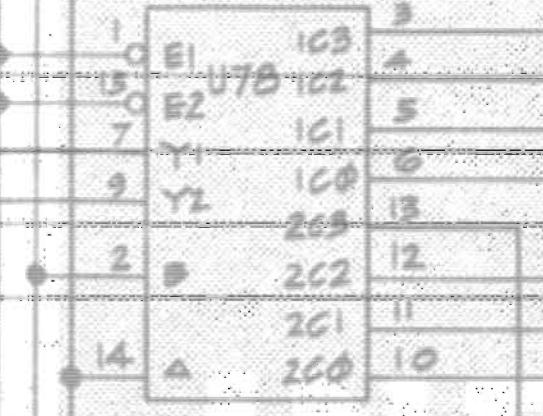
NOTE

74LS253



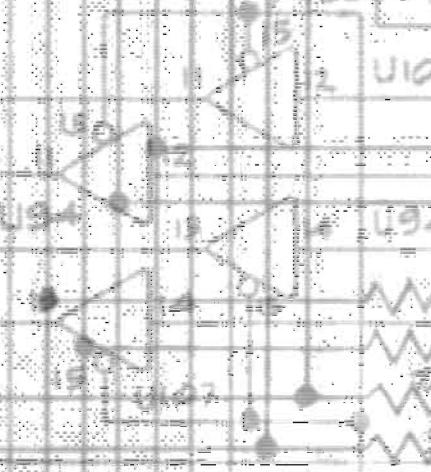
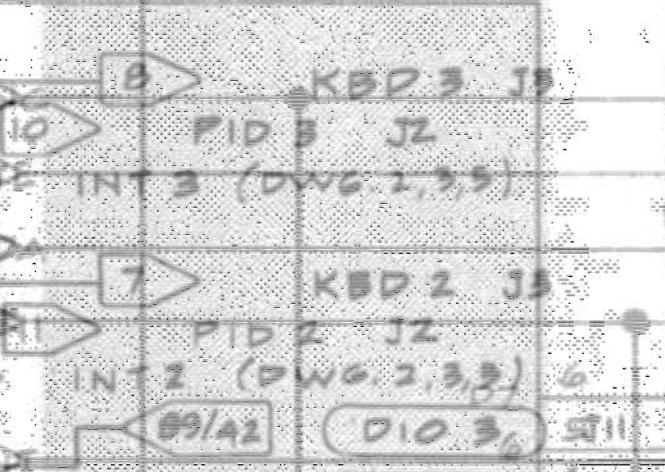
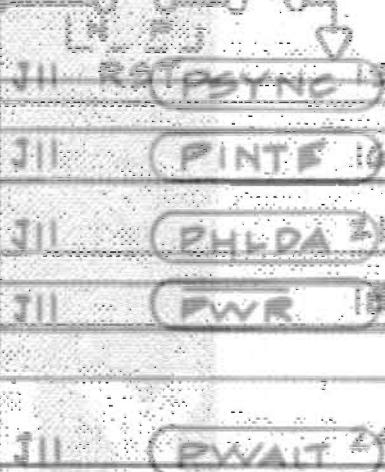
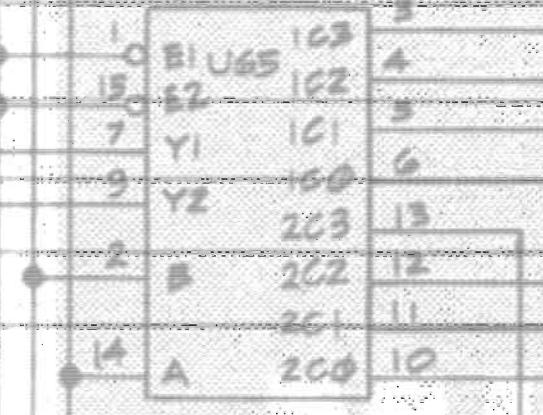
UBO  
BT97

74LS253

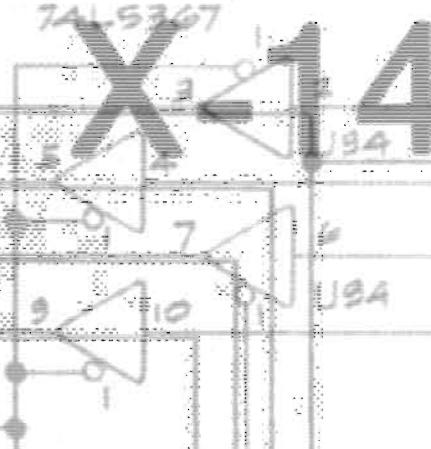


UBO  
BT97

74LS253



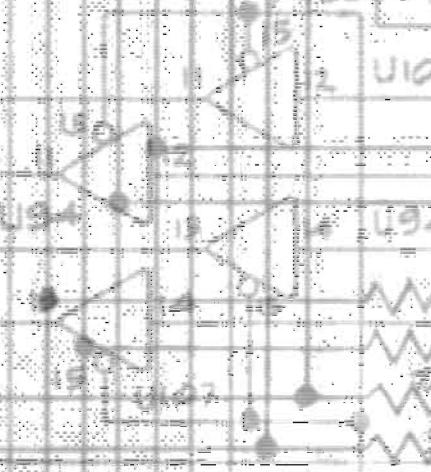
UBI  
BT97



UBO  
BT97



UBO  
BT97

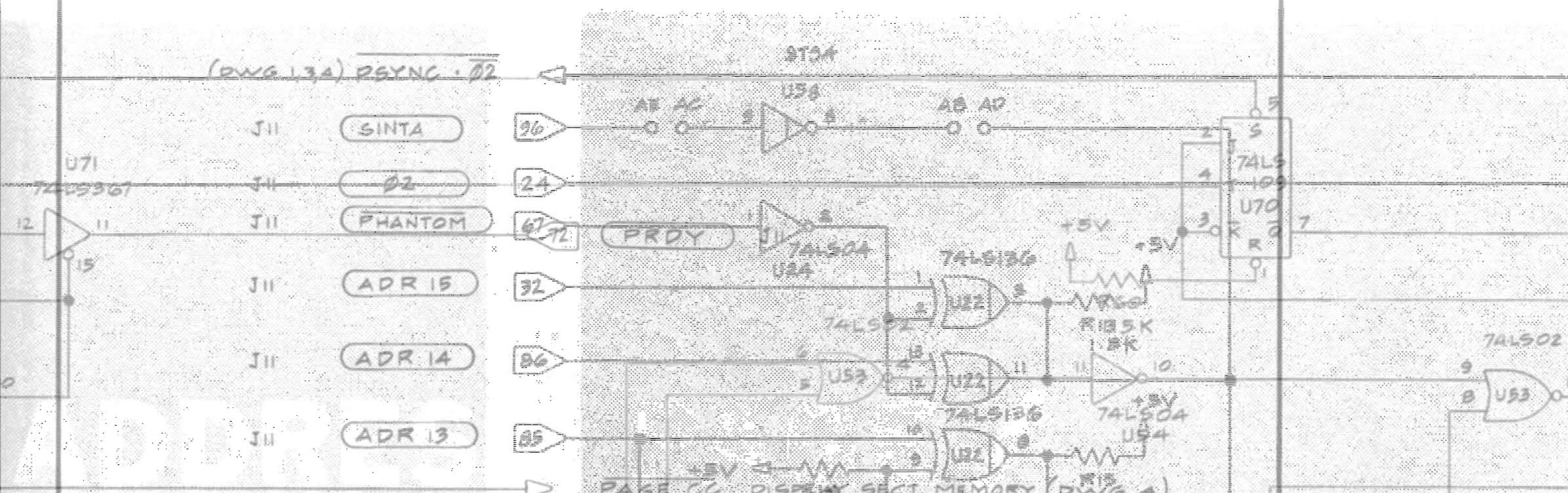


UBI  
BT97

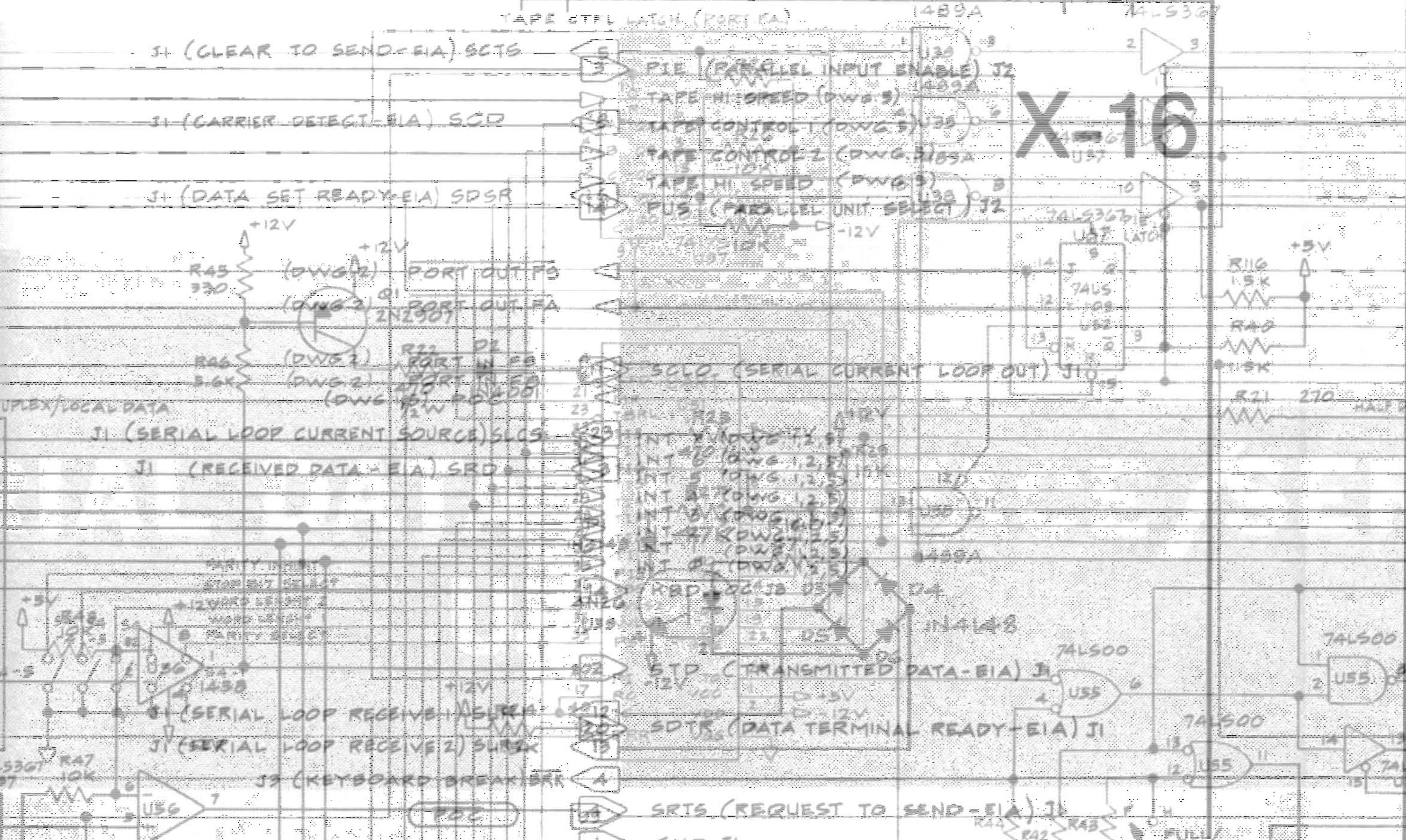
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|-----|----------------------|------|------|
| -   | SEE SHT. I           | -    | -    |

X-15

NOTE: SEE DRAWING 5



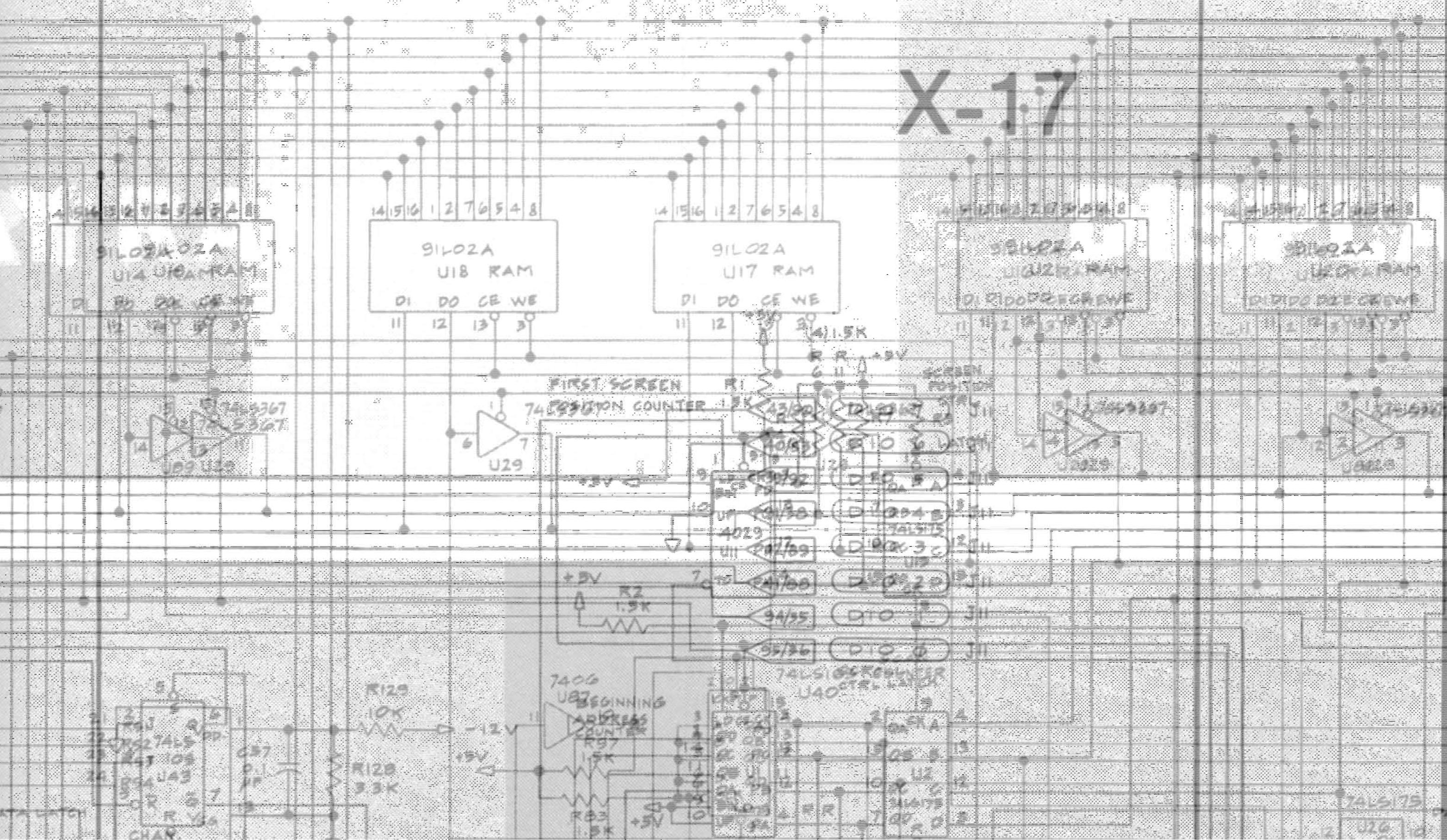
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|-----|----------------------|---------------|
| -   | SEE SHT. 1           | -             |



NOTE SEE DRAWING 5

| LTR | REVISION DESCRIPTION | DATE | APPD |
|-----|----------------------|------|------|
| -   | SEE SHT. I           | -    | -    |

X-17



| LTR | REVISION DESCRIPTION | DATE | APPD |
|-----|----------------------|------|------|
| -   | SEE SHT. 1           | -    | -    |

NOTES:

\* DO NOT SUBSTITUTE

2. (ADR 2) S-100 BUS SIGNAL NAME

3. S-100 BUS PINS

4. S-100 BUS PINS

5. I/O CONNECTORS, POWER SUPPLY, PERSONALITY MODULE

6. I/O CONNECTORS, POWER SUPPLY, PERSONALITY MODULE 2NE222

7. ON CARD CONNECTION 4013

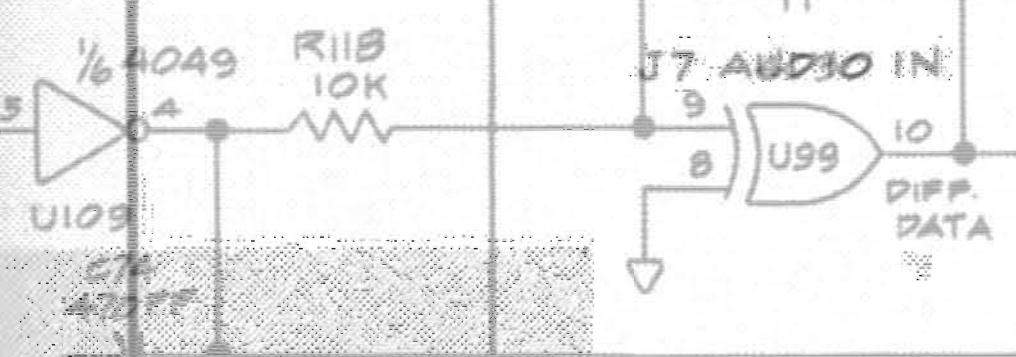
8. ON CARD CONNECTION U109

9. CAPACITORS IN MICROFARADS UNLESS NOTED OTHERWISE

10. ALL RESISTORS 1/4 W UNLESS MARKED OTHERWISE.

RESISTANCE IN OHMS.

C49  
.001 DISC



(DWG 2) PORT INPUT

DIO 0

DIO 1

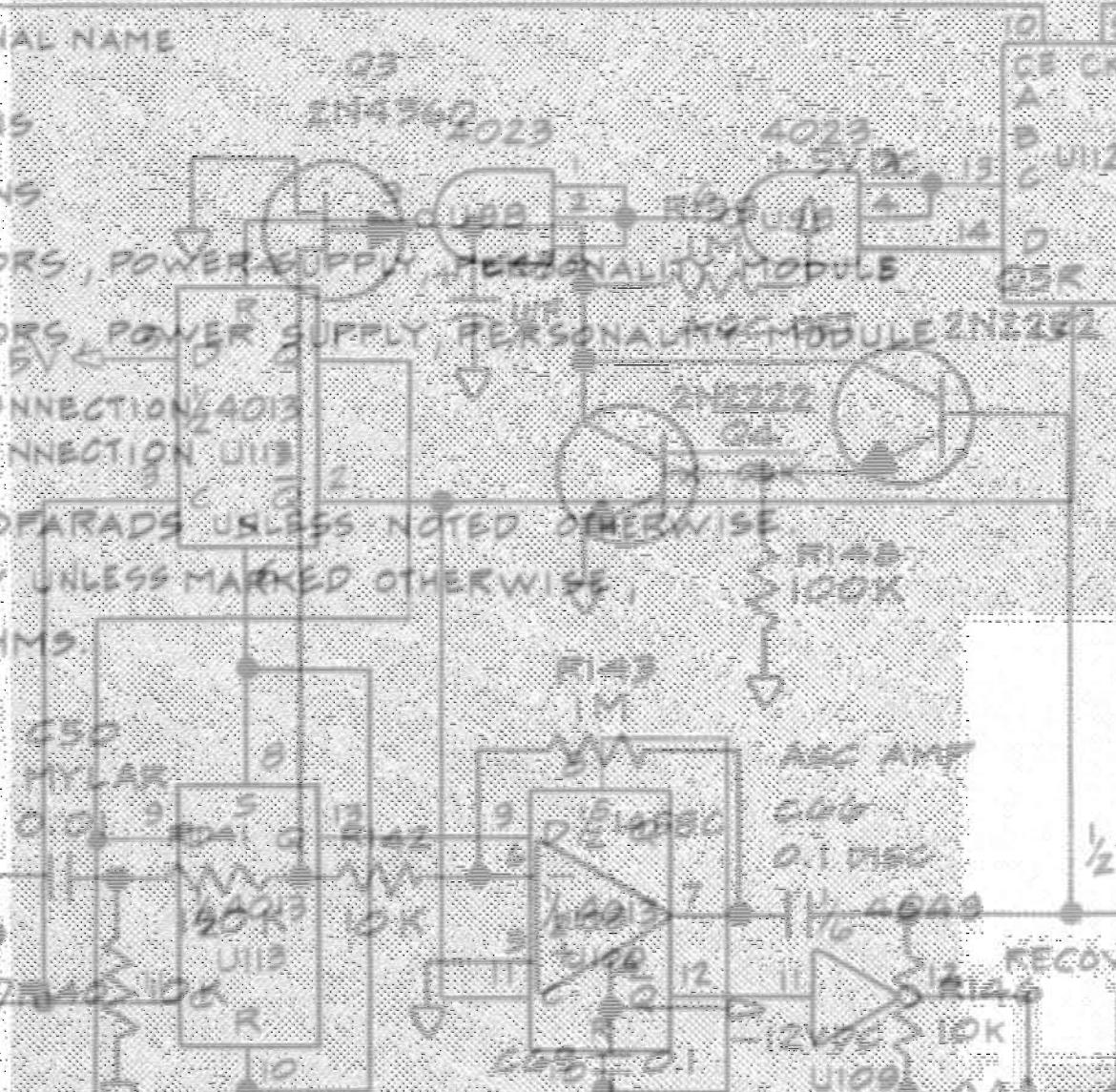
INT 0 (DWG 1,2,3)

INT 1

INT 2

INT 3

# X-18



12VDC  
CGB  
0.1 DISC

1/2 1490C  
1490C  
21222

R149  
1490C  
21222

R149  
1490C  
21222

R149  
1490C  
21222

R149  
1490C  
21222

X-19

+ 5 V  
5 V  
+ 12 V

C4

A6

P1

P1

R6  
OK

ADR 9

B13

+ 5 V

GND  
GND

- 12 V

P1

A14  
B14  
A1

A15  
B15

A13

A9

A10

A11

A12

A8

A7

A12

A13

A9

A10

A11

A12

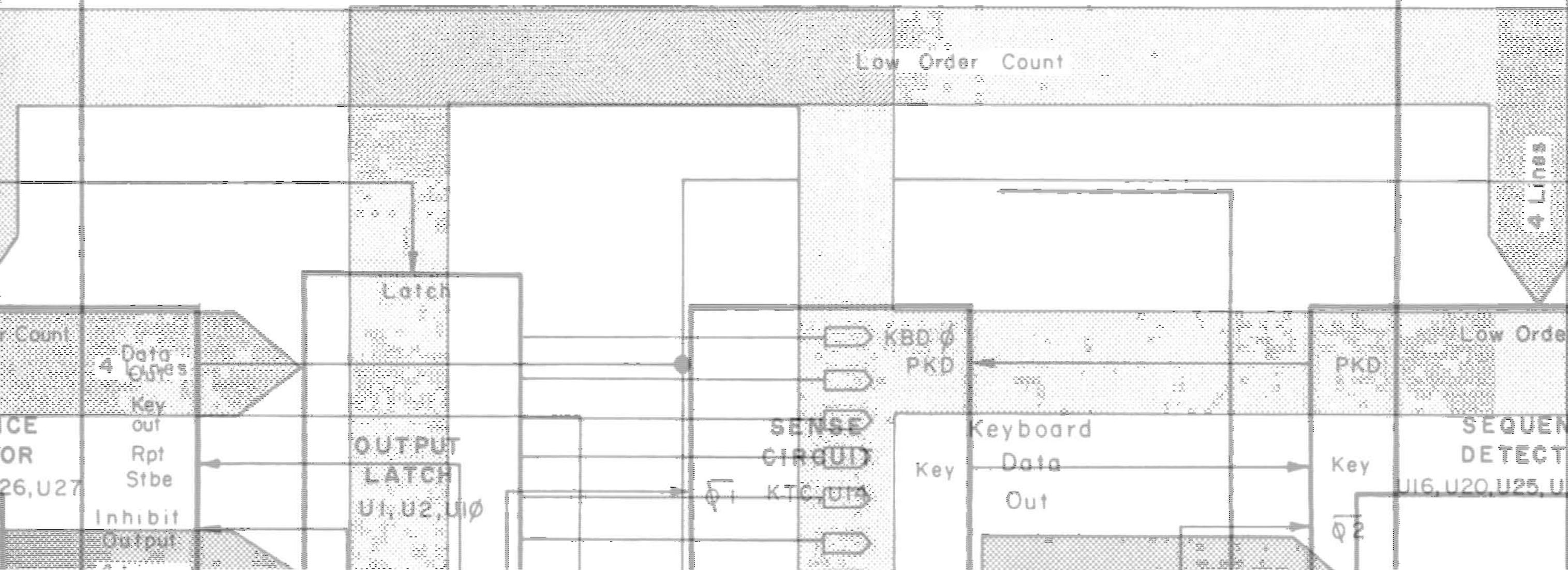
A13

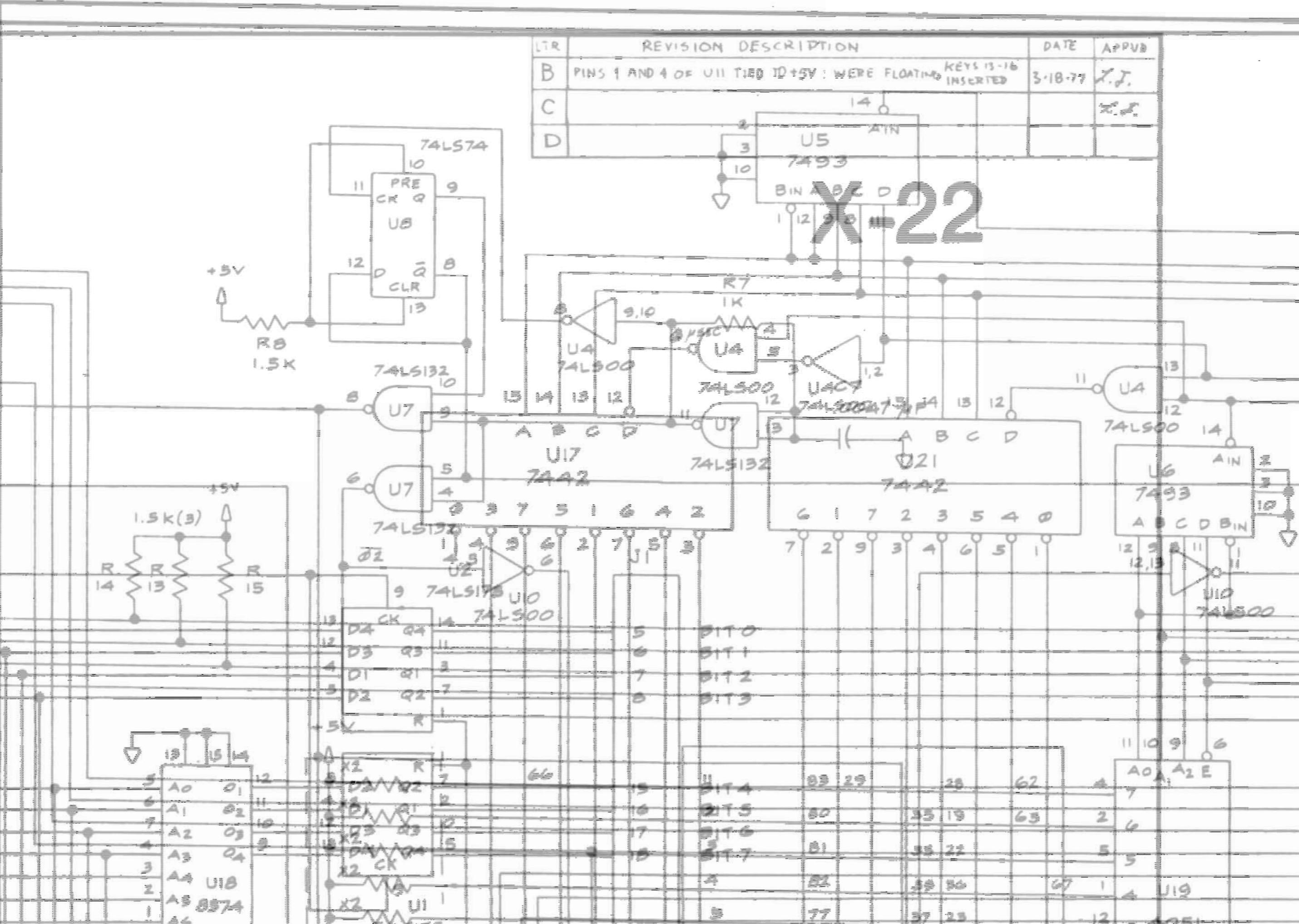
A9

A10

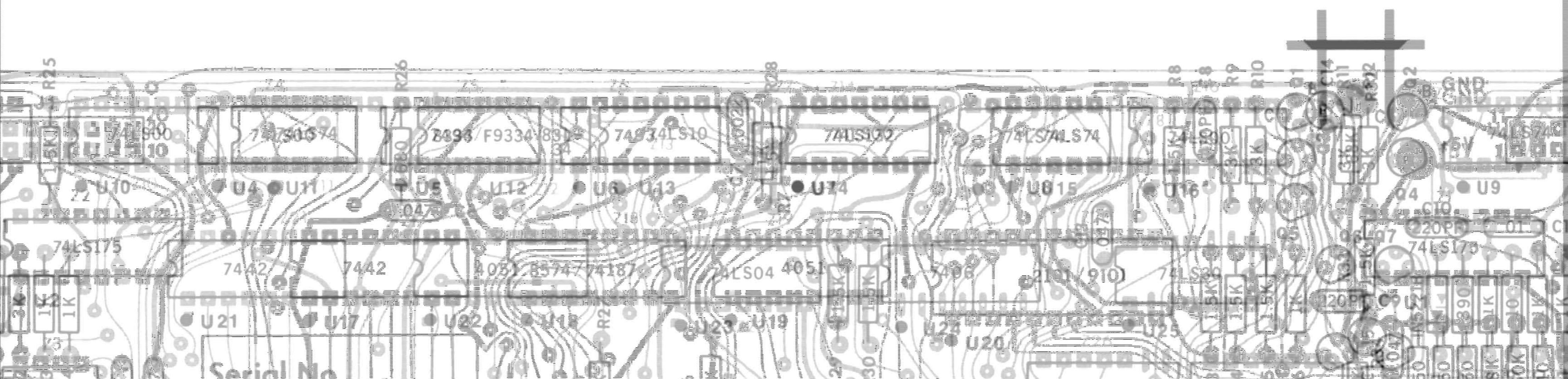
X-20

# 501 - KEYBOARD BLOCK DIAGRAM - Rev. B, S





X-23



Appendices

## APPENDICES

- AI      Deleted
- AII     8080 Operating Codes
- AIII    Standard Color Code
- AIV     Loading DIP Devices, Soldering Tips,  
          and Installing Augat Pins
- AV      IC Pin Configurations
- AVI     TV Interface
- AVII    Pin-outs for Connectors  
          S-100 Bus Definitions, Switch Functions,  
          and Bit Assignments
- AVIII   "Your Personal Genie,"  
          (An Article on Types of Software)

- D8 : constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.
- all Flags (C,Z,S,P) affected

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.  
† = only CARRY affected

*Addr = 16 bit address*

= all Flags except CAHY affected;  
(exception: INX & DCX affect no Flags)

## APPENDIX II

**D8** = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

Addr = 16 bit address

## PROCESSOR TECHNOLOGY CORPORATION

Sol TERMINAL COMPUTER™

APPENDIX III

## STANDARD COLOR CODE FOR RESISTORS AND CAPACITORS

| COLOR    | SIGNIFICANT FIGURE | DECIMAL MULTIPLIER | TOLERANCE (%) | VOLTAGE RATING* |
|----------|--------------------|--------------------|---------------|-----------------|
| Black    | 0                  | 1                  |               | --              |
| Brown    | 1                  | 10                 |               | 100             |
| Red      | 2                  | 100                |               | 200             |
| Orange   | 3                  | 1,000              |               | 300             |
| Yellow   | 4                  | 10,000             |               | 400             |
| Green    | 5                  | 100,000            |               | 500             |
| Blue     | 6                  | 1,000,000          |               | 600             |
| Violet   | 7                  | 10,000,000         |               | 700             |
| Gray     | 8                  | 100,000,000        |               | 800             |
| White    | 9                  | 1,000,000,000      |               | 900             |
| Gold     | -                  | 0.1                | 5             | 1000            |
| Silver   | -                  | 0.01               | 10            | 2000            |
| No Color | -                  | ---                | 20            | 500             |

\*Applies to capacitors only.

LOADING DIP (DUAL IN-LINE PACKAGE) DEVICES

Most DIP devices have their leads spread so that they can not be dropped straight into the board. They must be "walked in" using the following procedure:

- (1) Orient the device properly. Pin 1 is indicated by a small embossed dot on the top surface of the device at one corner. Pins are numbered counterclockwise from pin 1.
- (2) Insert the pins on one side of the device into their holes on the printed circuit card. Do not press the pins all the way in, but stop when they are just starting to emerge from the opposite side of the card.
- (3) Exert a sideways pressure on the pins at the other side of the device by pressing against them where they are still wide below the bend. Bring this row of pins into alignment with its holes in the printed circuit card and insert them an equal distance, until they begin to emerge.
- (4) Press the device straight down until it seats on the points where the pins widen.
- (5) Turn the card over and select two pins at opposite corners of the device. Using a fingernail or a pair of long-nose pliers, push these pins outwards until they are bent at a 45° angle to the surface of the card. This will secure the device until it is soldered.

SOLDERING TIPS

- (1) Use a low-wattage iron--25 watts is good. Larger irons run the risk of burning the printed-circuit board. Don't try to use a soldering gun, they are too hot.
- (2) Use a small pointed tip and keep it clean. Keep a damp piece of sponge by the iron and wipe the tip on it after each use.
- (3) Use 60-40 rosin-core solder ONLY. DO NOT use acid-core solder or externally applied fluxes. Use the smallest diameter solder you can get.

NOTE: DO NOT press the top of the iron on the pad or trace. This will cause the trace to "lift" off of the board which will result in permanent damage.

- (4) In soldering, wipe the tip, apply a light coating of new solder to it, and apply the tip to both parts of the joint, that is, both the component lead and the printed-circuit pad. Apply the solder against the lead and pad being heated, but not directly to the tip of the iron. Thus, when the solder

melts the rest of the joint will be hot enough for the solder to "take", (i.e., form a capillary film).

- (5) Apply solder for a second or two, then remove the solder and keep the iron tip on the joint. The rosin will bubble out. Allow about three or four bubbles, but don't keep the tip applied for more than ten seconds.
- (6) Solder should follow the contours of the original joint. A blob or lump may well be a solder bridge, where enough solder has been built upon one conductor to overflow and "take" on the adjacent conductor. Due to capillary action, these solder bridges look very neat, but they are a constant source of trouble when boards of a high trace density are being soldered. Inspect each integrated circuit and component after soldering for bridges.
- (7) To remove solder bridges, it is best to use a vacuum "solder puller" if one is available. If not, the bridge can be reheated with the iron and the excess solder "pulled" with the tip along the printed circuit traces until the lump of solder becomes thin enough to break the bridge. Braid-type solder remover, which causes the solder to "wick up" away from the joint when applied to melted solder, may also be used.

#### INSTALLING AUGAT PINS

Augat pins are normally supplied on carriers (e.g., 8-pin and 16-pin carriers). In many cases the PC board layout permits Augat pins to be installed while still attached to the carrier or a portion of the carrier. In other cases the pins must be installed singly.

To install two or more pins that are still attached to the carrier, proceed as follows:

#### NOTE

It is perfectly alright to appropriately cut a carrier to accommodate the installation. For example, an 8-pin carrier can be cut in half (4 pins each) across the short dimension to fit a 4-pin, 4-corner layout. It may also be cut in half along the long dimension to fit a 4-pin, inline layout.

- (1) Insert pins in the mounting holes from the front (component) side of board. (The carrier will hold the pins perpendicular to the board.)
- (2) Solder all pins from back (solder) side of board so the solder "wicks up" to the front side.

(3) Check for solder bridges.

(4) Remove carrier.

To install single pins, proceed as follows:

(1) Hold board between two objects so that it stands on edge.

(2) Insert pins in the mounting holes from front (component) side of board.

(3) Solder pins from back (solder) side of board so the solder "wicks up" to the front side. (This will hold the pins firmly in place.)

(4) Insert a component lead into one pin and reheat the solder. Using the component lead, adjust pin until it is perpendicular to board. Allow solder to cool while holding the pin as steady as possible. Remove component lead. Repeat this procedure with other pins.

NOTE

If cooled solder is mottled or crystallized, a "cold joint" is indicated, and the solder should be reheated.

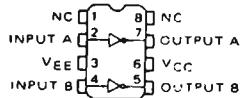
(5) Check each installation for cold joints and solder bridges.

PROCESSOR TECHNOLOGY CORPORATION

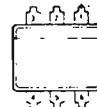
Sol TERMINAL COMPUTER™

APPENDIX V

0026

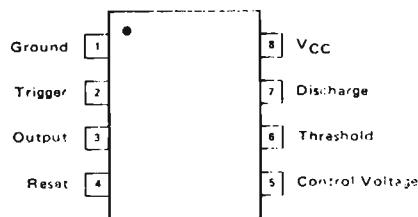


4N26

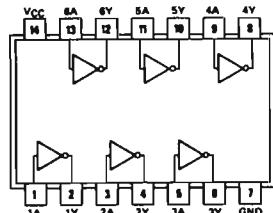


PIN : ANODE  
1 CATHODE  
2 NC  
3 NC  
4 DIODE  
5 COLLECTOR  
6 BASE

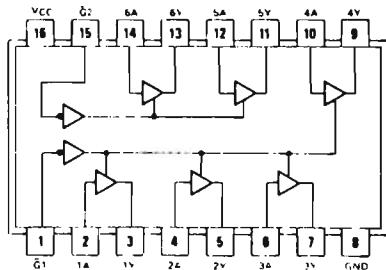
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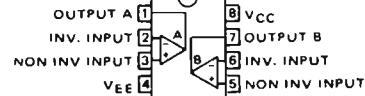
8T94



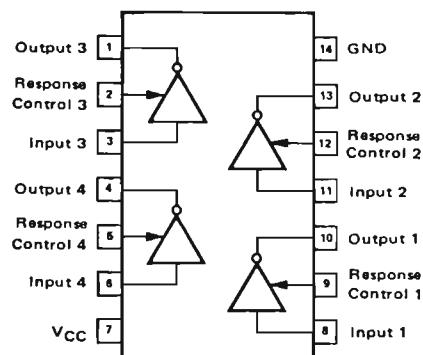
8T97 or 74367



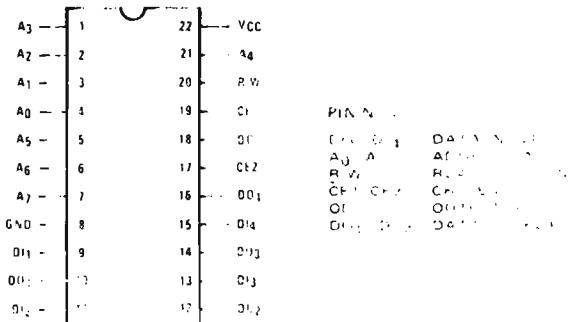
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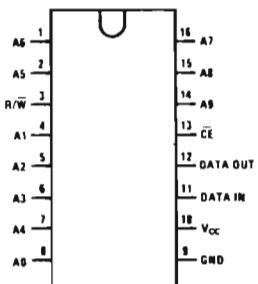
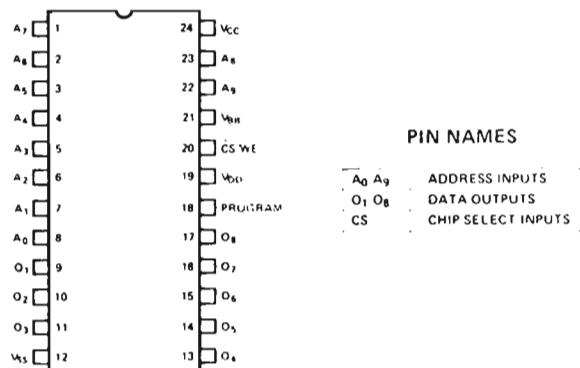
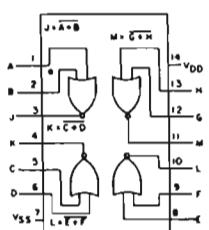
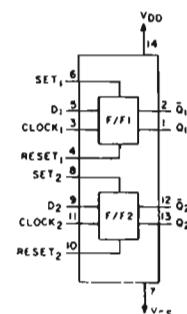
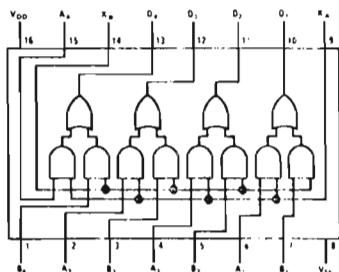
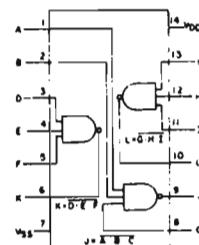


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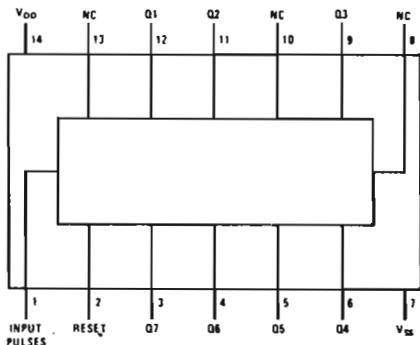
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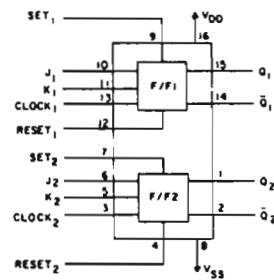
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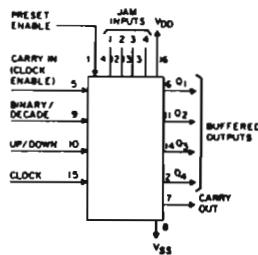
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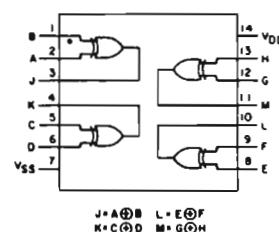
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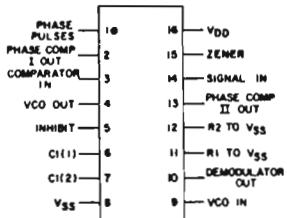
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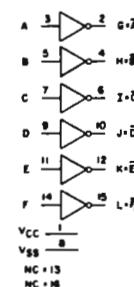
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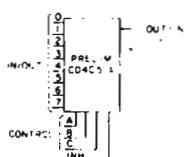
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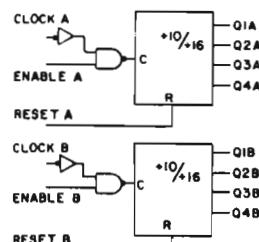
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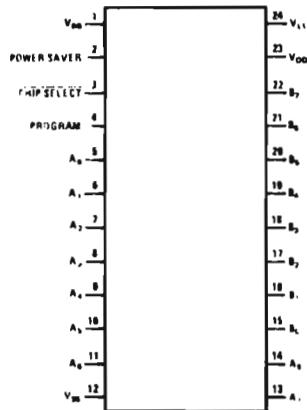


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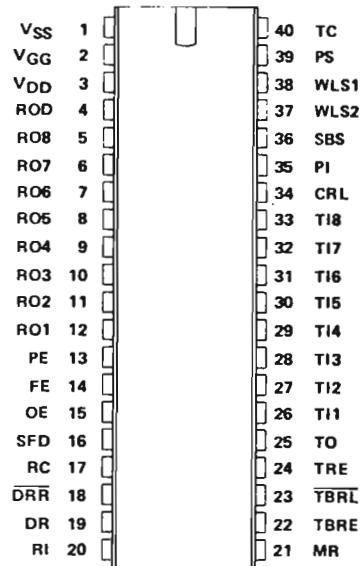
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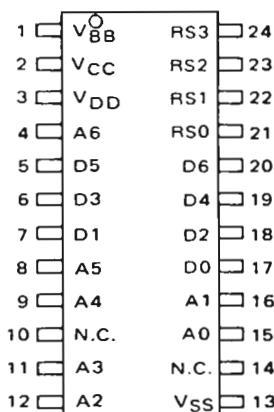
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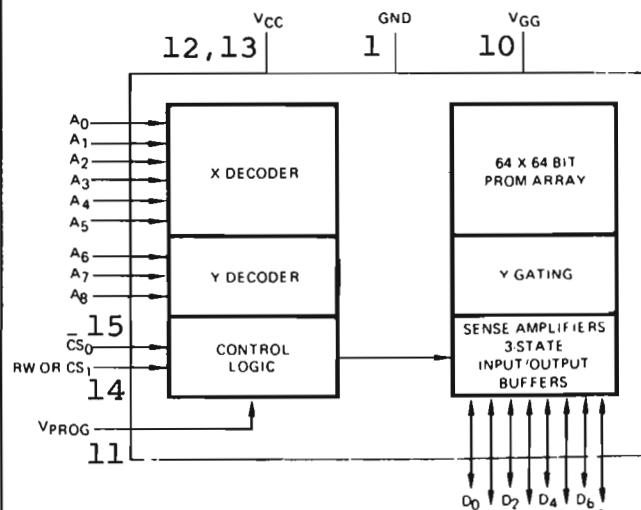
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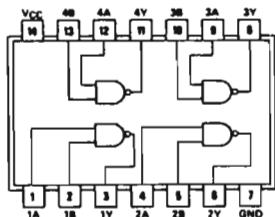


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| A <sub>1</sub> | - 23 | A <sub>6</sub> | - 18 | D <sub>2</sub> | - 4 | D <sub>7</sub> | - 9 |
| A <sub>2</sub> | - 22 | A <sub>7</sub> | - 17 | D <sub>3</sub> | - 5 |                |     |
| A <sub>3</sub> | - 21 | A <sub>8</sub> | - 16 | D <sub>4</sub> | - 6 |                |     |
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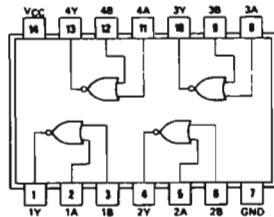
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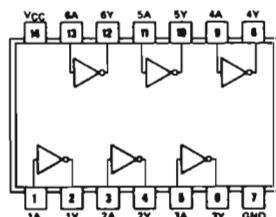
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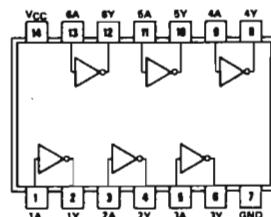
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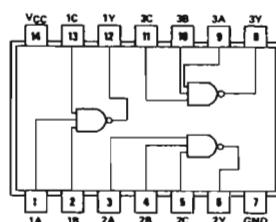
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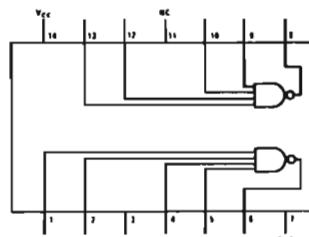
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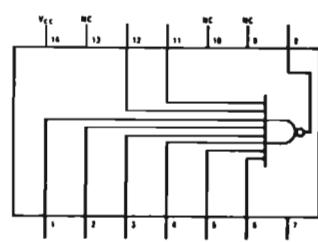
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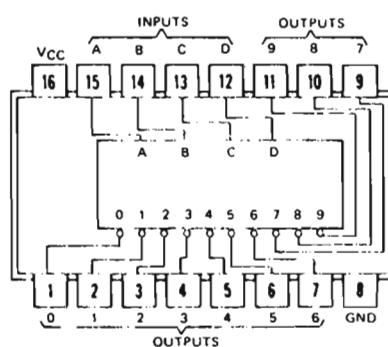
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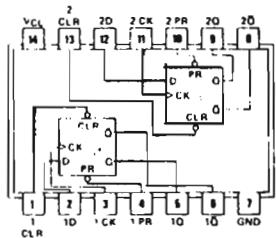


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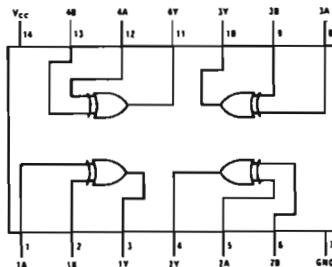
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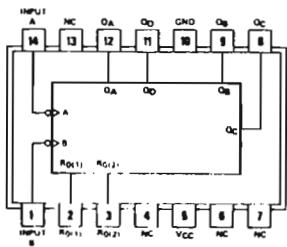
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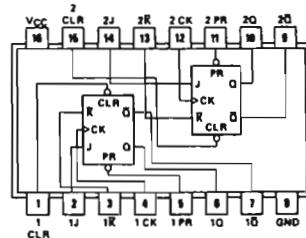
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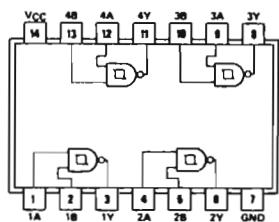
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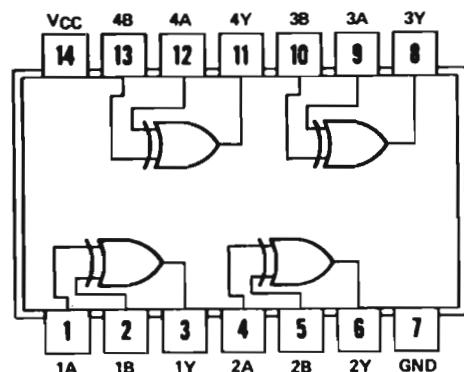
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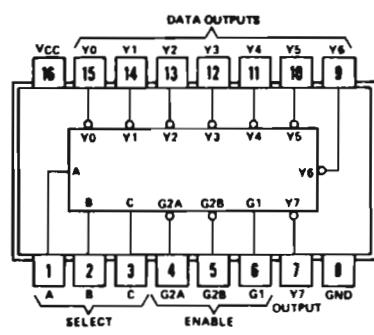


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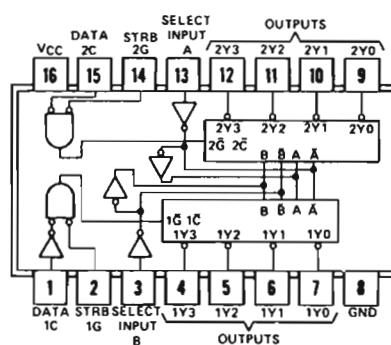
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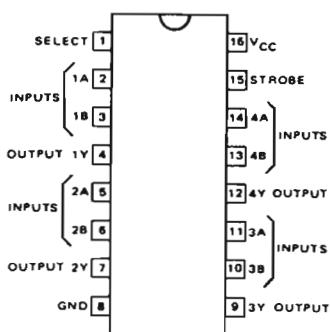
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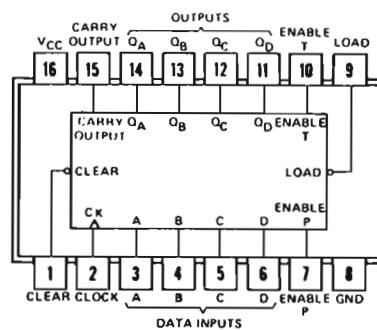
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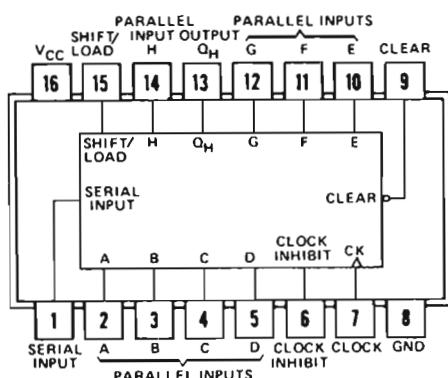


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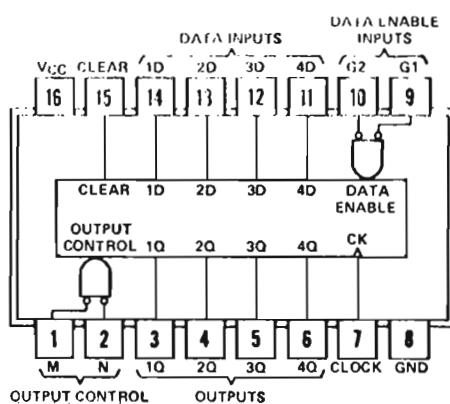
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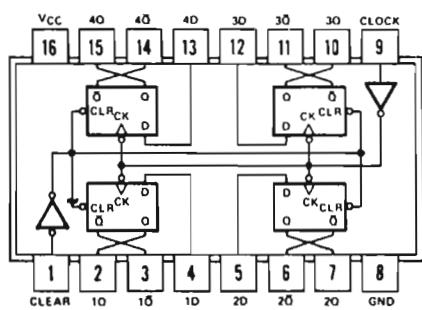
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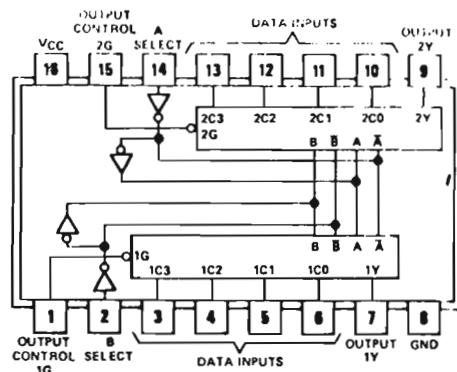
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74253



7812 and 7912

Pin 1 Input (Base)  
Pin 2 Output (Emitter)  
Pin 3 Ground (Collector)

Heat sink surface connected to pin 3

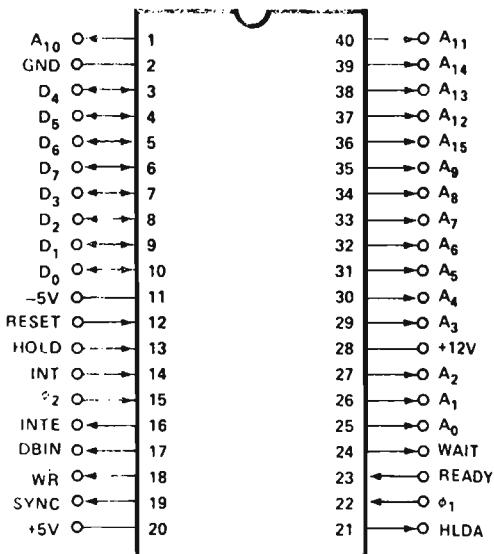


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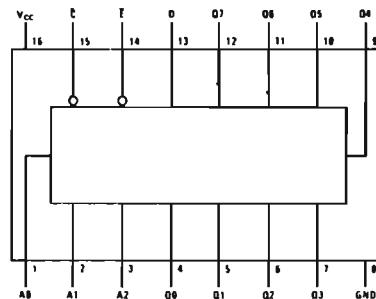
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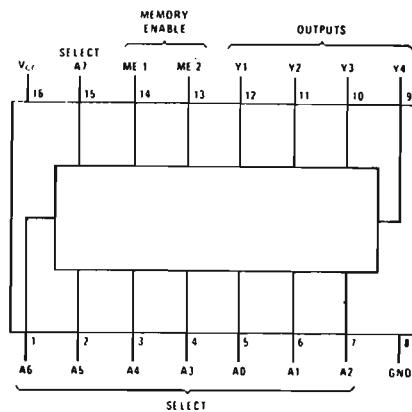
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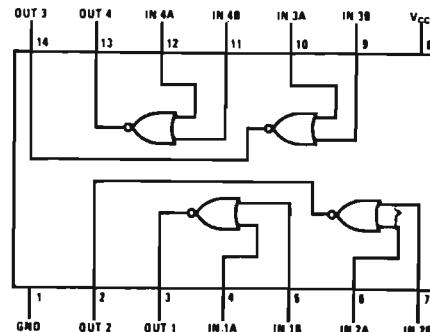
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# Television Interface

Anyone with a bunch of memory circuits, control logic and a wire wrap gun can whip up a digital video generator with TTL output levels. The problem as I see it is to get that digital video signal into a form that the TV set can digest. The care and feeding of digital inputs to the TV set is the subject of Don Lancaster's contribution to BYTE 2 — an excerpt from his forthcoming book, *TV Typewriter Cookbook*, to be published by Howard W. Sams, Indianapolis, Indiana.

... CARL

We can get between a TV typewriter and a television style display system either by an rf modulator or a direct video method.

In the rf modulator method, we build a miniature, low power, direct wired TV transmitter that clips onto the antenna terminals of the TV set. This has the big advantage of letting you use any old TV set and ending up with an essentially free display that can be used just about anywhere. No set modifications are needed, and you have the additional advantage of automatic safety isolation and freedom from hot chassis shock problems.

There are two major restrictions to the rf modulator method. The first of these is that transmitters of this type must meet

certain exactly spelled out FCC regulations and that system type approval is required. The second limitation is one of bandwidth. The best you can possibly hope for is 3.5 MHz for black and white and only 3 MHz for color, and many economy sets will provide far less. Thus, long character line lengths, sharp characters, and premium (lots of dots) character generators simply aren't compatible with clip-on rf entry.

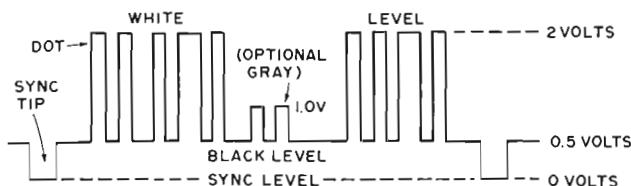
In the direct video method, we enter the TV set immediately following its video detector but before sync is picked off. A few premium TV sets and all monitors already have a video input directly available, but these are still expensive and rare. Thus, you usually have to modify your TV set, either

adding a video input and a selector switch or else dedicating the set to exclusive TV typewriter use. Direct video eliminates the bandwidth restrictions provided by the tuner, if strip, and video detector filter. Response can be further extended by removing or shorting the 4.5 MHz sound trap and by other modifications to provide us with longer line lengths and premium characters. No FCC approval is needed, and several sets or monitors are easily driven at once without complicated distribution problems.

There are two limitations to the direct video technique. One is that the set has to be modified to provide direct video entry. A second, and far more severe, restriction, is that many television sets are "hot chassis" or ac-dc sets with one side of their chassis connected to the power line. These sets introduce a severe shock hazard and cannot be used as TV typewriter video entry displays unless some isolation technique is used with them. If the TV set has a power transformer, there is usually no hot chassis problem. Transistor television sets and IC sets using no vacuum tubes tend to have power transformers, as do older premium tube type sets. All others (around half the sets around today) do not.

by  
Don Lancaster  
Box 1112  
Parker AZ 85344

Fig. 1. Standard video interface levels. (Source impedance = 72 or 100 Ohms.)



## Direct Video Methods

With either interface approach, we usually start by getting the dot matrix data, blanking, cursor, and sync signals together into one composite video signal whose

form is useful to monitors and TV sets. A good set of standards is shown in Fig. 1. The signal is dc coupled and always positive going. Sync tips are grounded and blacker than black. The normal open circuit black level is positive by one-half a volt, and the white level is two volts positive. In most TV camera systems, intermediate levels between the half volt black level and the two volt white level will be some shade of gray, proportionately brighter with increasing positive voltage. With most TV typewriter systems, only the three states of zero volts (sync), half a volt (black), and two volts (white dot) would be used. One possible exception would be an additional one volt dot level for a dim but still visible portion of a message or a single word.

The usual video source impedance is either 72 or 100 Ohms. Regardless of how far we travel with a composite video output, some sort of shielding is absolutely essential.

For short runs from board to board or inside equipment, tightly twisted conductors should be OK, as should properly guarded PC runs. Fully shielded cables should be used for interconnections between the TTV and the monitor or TV set, along with other long runs. As long as the total cable capacitance is less than 500 pF or so (this is around 18 feet of RG178-U

miniature coax), the receiving end of the cable need not be terminated in a 72 or 100 Ohm resistor. When terminated cable systems are in use for long line runs or multiple outputs, they should be arranged to deliver the signal levels of Fig. 1 at their output under termination. Generally, terminated cable systems should be avoided as they need extra in the way of drivers and supply power.

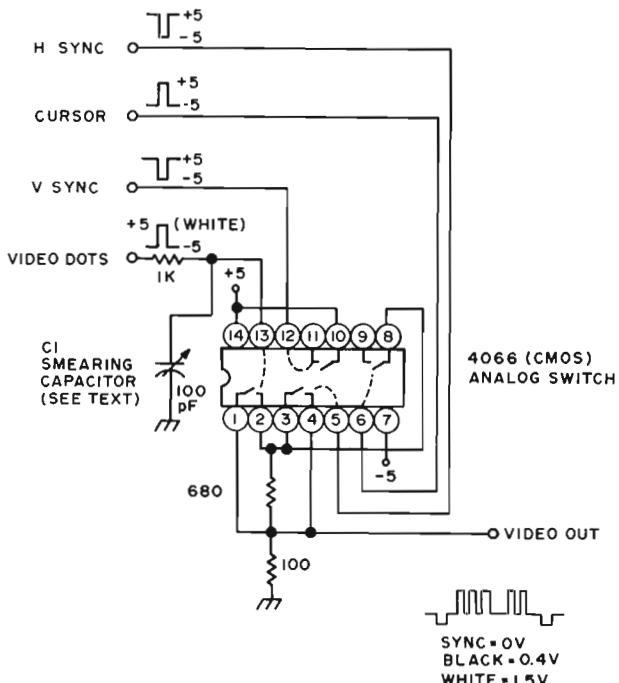
The exact width of the horizontal and vertical sync pulses isn't usually too important, so long as the shape and risetime of these pulses are independent of position control settings and power supply variations. One exception to this is when you're using a color receiver and a color display. Here, the horizontal sync pulse should be held closely to 5.1 microseconds, so the receiver's color burst sampling does in fact intercept a valid color burst. More on this later.

#### Intentional Smear

Fig. 2 shows us a typical composite video driver using a 4066 quad analog switch. It gives us a 100 Ohm output impedance and the proper signal levels. Capacitor C1 is used to purposely reduce the video rise and fall times. It is called a smearing capacitor.

Why would we want to further reduce the bandwidth and response of a TV system that's already hurting to begin with? In the case of a quality video monitor, we wouldn't. But if we're using an ordinary run-of-the-mill TV set, particularly one using rf entry, this capacitor can

**Fig. 2. Analog switch combiner generates composite video.**



very much improve the display legibility and contrast. Why?

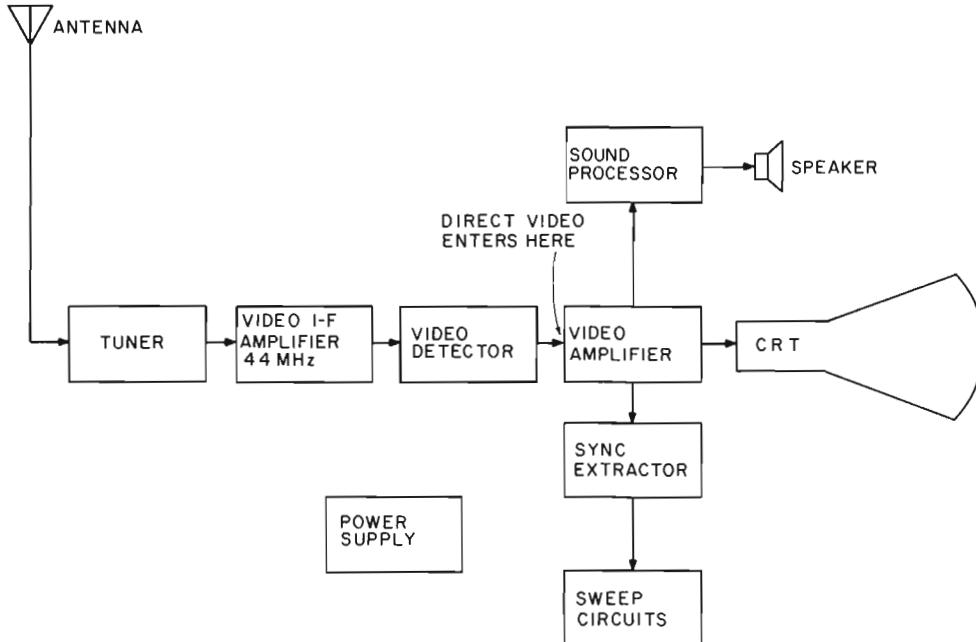
Because we are interested in getting the most legible character of the highest contrast we can. This is not necessarily the one having the sharpest dot rise and fall times. Many things interact to determine the upper video response of a TV display.

These include the tuner settings and the i-f response and alignment, the video detector response, video peaking, the sound trap setting, rf cable reflections, and a host of other responses. Many of these stages are underdamped and will ring if fed too sharp a risetime input, giving us a ghosted,

shabby, or washed out character. By reducing the video bandwidth going into the system, we can move the dot matrix energy lower in frequency, resulting in cleaner characters of higher contrast.

For most TV displays, intentional smearing will help the contrast, legibility, and overall appearance. The ultimate limit to this occurs when the dots overlap and become illegible. The

Fig. 3. Block diagram of typical B and W television.



optimum amount of intentional smear is usually the value of capacitance that is needed to just close the inside of a "W" presented to the display.

#### Adding a Video Input

Video inputs are easy to add to the average television set, provided you follow some reasonable cautions. First and foremost, you must have an accurate and complete schematic of the set to be modified, preferably a Sams Photofact or something similar. The first thing to check is the power supply on the set. If it has a power transformer and has the chassis properly safety isolated from the power line, it's a good choice for a TVT monitor. This is particularly

true of recent small screen, solid state portable TV sets. On the other hand, if you have a hot chassis type with one side of the power line connected to the chassis, you should avoid its use if at all possible. If you must use this type of set, be absolutely certain to use one of the safety techniques outlined later in Fig. 8.

A block diagram of a typical TV set appears in Fig. 3. UHF or VHF signals picked up by the tuner are downconverted in frequency to a video i-f frequency of 44 MHz and then filtered and amplified. The output of the video i-f is transformer coupled to a video detector, most often a small signal germanium diode. The video detector output is filtered to

remove the carrier and then routed to a video amplifier made up of one or more tubes or transistors.

At some point in the video amplification, the black and white signal is split three ways. First, a reduced bandwidth output routes sync pulses to the sync separator stage to lock the set's horizontal and vertical scanning to the video. A second bandpass output sharply filtered to 4.5 MHz extracts the FM sound subcarrier and routes this to a sound i-f amplifier for further processing. The third output is video, which is strongly amplified and then capacitively coupled to the cathode of the picture tube.

The gain of the video amplifier sets the contrast of the display, while the bias setting on the cathode of the picture tube (with respect to its grounded control grid) sets the display brightness. Somewhere in the video amplifier, further rejection of the 4.5 MHz sound subcarrier is usually picked up to minimize picture interference. This is called a sound trap. Sound traps can be a series resonant circuit to ground, a parallel resonant circuit in the video signal path, or simply part of the transformer that is picking off the sound for more processing.

The video detector output is usually around 2 volts peak to peak and usually subtracts from a white level bias setting. The stronger the signal, the more negative the swing, and the blacker the picture. Sync tips are blacker than black, helping to blank the display during retrace times.

Fig. 4 shows us the typical video circuitry of a transistor black and white television. Our basic circuit consists of a diode detector, a unity gain emitter follower, and a variable gain video output stage that is capacitively coupled to the picture tube. The cathode bias sets the brightness, while the video gain sets the contrast. Amplified signals for sync and sound are removed from the collector of the video driver by way of a 4.5 MHz resonant transformer for the sound and a low pass filter for the sync. A parallel resonant trap set to 4.5 MHz eliminates sound interference. Peaking coils on each stage extend the bandwidth by providing higher impedances

and thus higher gain to high frequency video signals.

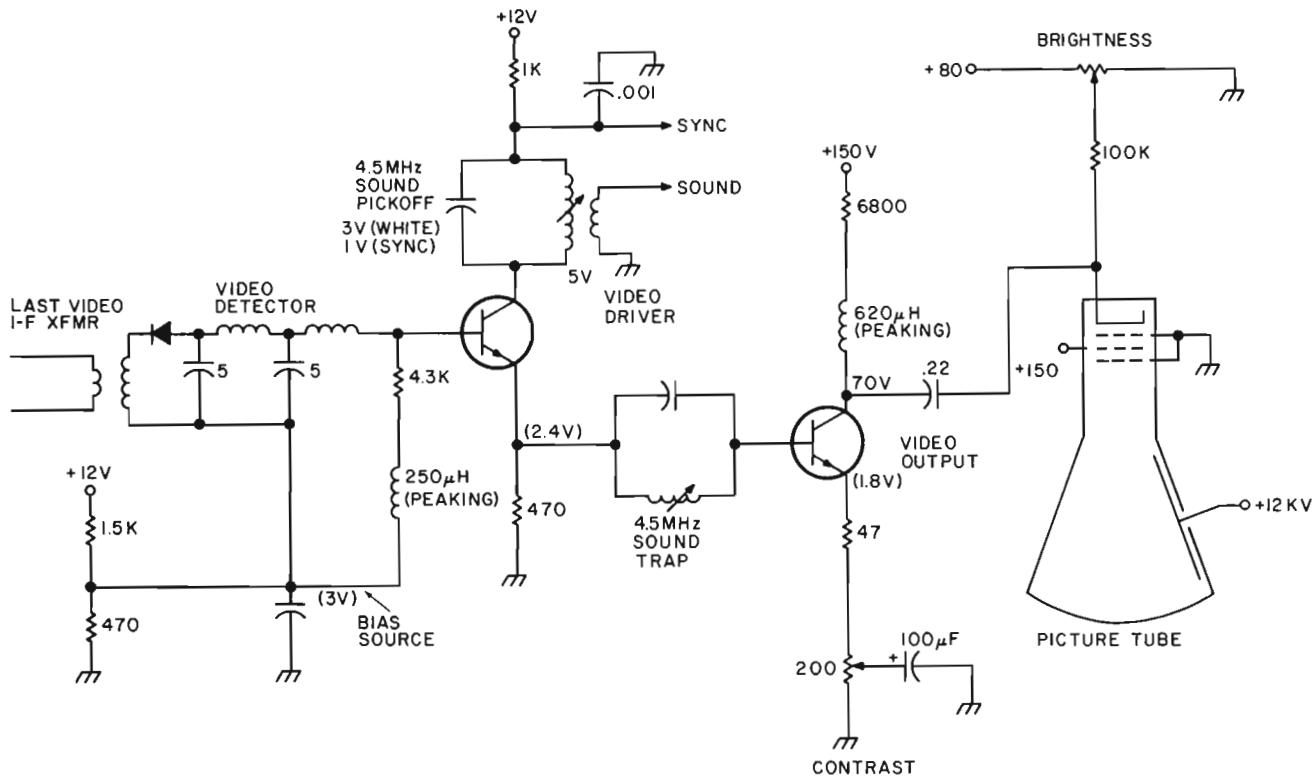
Note particularly the biasing of the video driver. A bias network provides us with a stable source of 3 volts. In the absence of input video, this 3 volts sets the white level of the display, as well as establishing proper bias for both stages. As an increasing signal appears at the last video output transformer, it is negatively rectified by the video detector, thus lowering the 3 volts proportionately. The stronger the signal, the blacker the picture. Sync will be the strongest of all, giving us a blacker than black bias level of only one volt.

The base of our video driver has the right sensitivity we need for video entry,

accepting a maximum of a 2 volt peak to peak signal. It also has the right polarity, for a positive going bias level means a whiter picture. *But, an unmodified set is already biased to the white level, and if we want to enter our own video, this bias must be shifted to the black level.*

We have a choice in any TV of direct or ac coupling of our input video. Direct coupling is almost always better as it eliminates any

Fig. 4. Typical video circuitry of transistor B and W TV set.

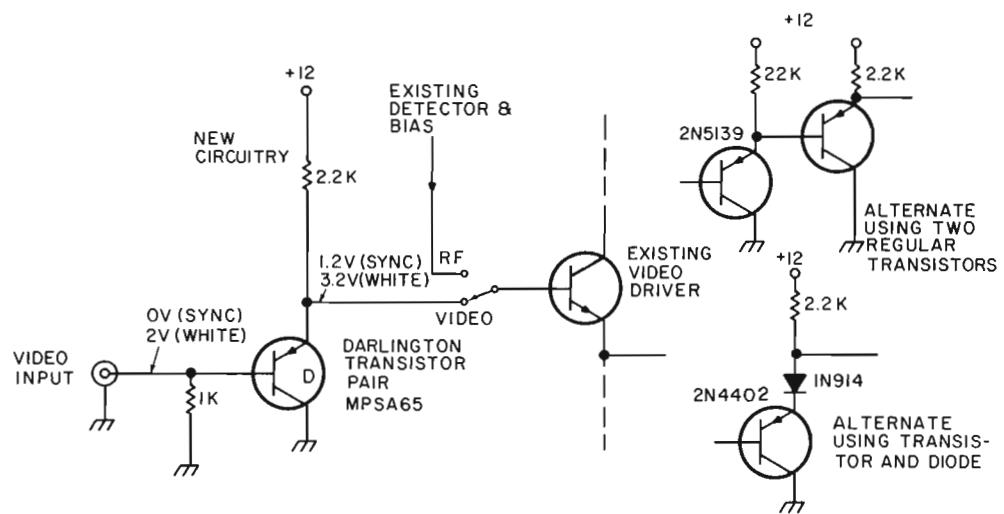


*Fig. 5. Direct coupled video uses 1.2 volt offset of Darlington transistor as bias.*

shading effects or any change of background level as additional characters are added to the screen. Fig. 5 shows how we can direct couple our video into a transistor black and white set. We provide a video input, usually a BNC or a phono jack, and route this to a PNP Darlington transistor or transistor pair, borrowing around 5 mils from the set's +12 volt supply. This output is routed to the existing video driver stage through a SPDT switch that either picks the video input or the existing video detector and bias network.

The two base-emitter diode drops in our Darlington transistor add up to a 1.2 volt positive going offset; so, in the absence of a video input or at the base of a sync tip, the video driver is biased to a blacker than black sync level of 1.2 volts. With a white video input of 2 volts, the video driver gets biased to its usual 3.2 volts of white level. Thus, our input transistor provides just the amount of offset we need to match the white and black bias levels of our video driver. Note that the old bias network is on the other side of the switch and does nothing in the video position.

Two other ways to offset our video input are to use two ordinary transistors connected in the Darlington configuration, or to use one transistor and a series diode



to pick up the same amount of offset, as shown in Fig. 5. If more or less offset is needed, diodes or transistors can be stacked up further to pick up the right amount of offset.

The important thing is that the video driver ends up with the same level for white bias and for black bias in either position of the switch.

Ac or capacitively coupled video inputs should be avoided. Fig. 6 shows a typical circuit. The TV's existing bias network is lowered in voltage by adding a new parallel resistor to ground to give us a voltage that is 0.6 volts more positive than the blacker than black sync tip voltage. For instance, with a 3 volt white level, and

2 volt peak to peak video, the sync tip voltage would be 1 volt; the optimum bias is then 1.6 volts. Input video is capacitively coupled by a fairly large electrolytic capacitor in parallel with a good high frequency capacitor. This provides for a minimum of screen shading and still couples high frequency signals properly. A clamping diode constantly clamps the sync tips to their bias value, with the 0.6 volt drop of this diode being taken out by the extra 0.6 volts provided for in the bias network. This clamping diode automatically holds the sync tips to their proper value, regardless of the number of white dots in the picture. Additional bypassing of the bias network by a large electrolytic may be needed for proper operation of the clamping diode, as shown in Fig. 6. Note that our bias network is used in both switch positions — its level is shifted as needed for the direct video input.

Tube type sets present about the same interface problems as the solid state versions do. Fig. 7 shows a typical direct coupled tube interface. In the unmodified

*Fig. 6. Ac coupled video needs shift of bias to black level plus a clamping diode.*

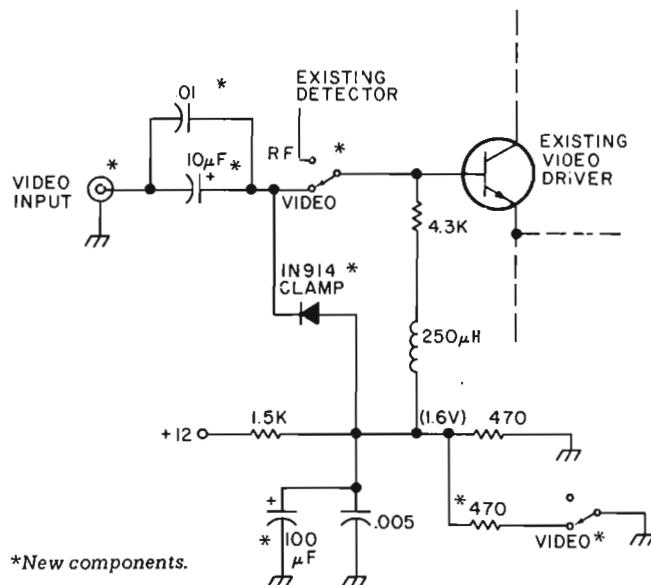
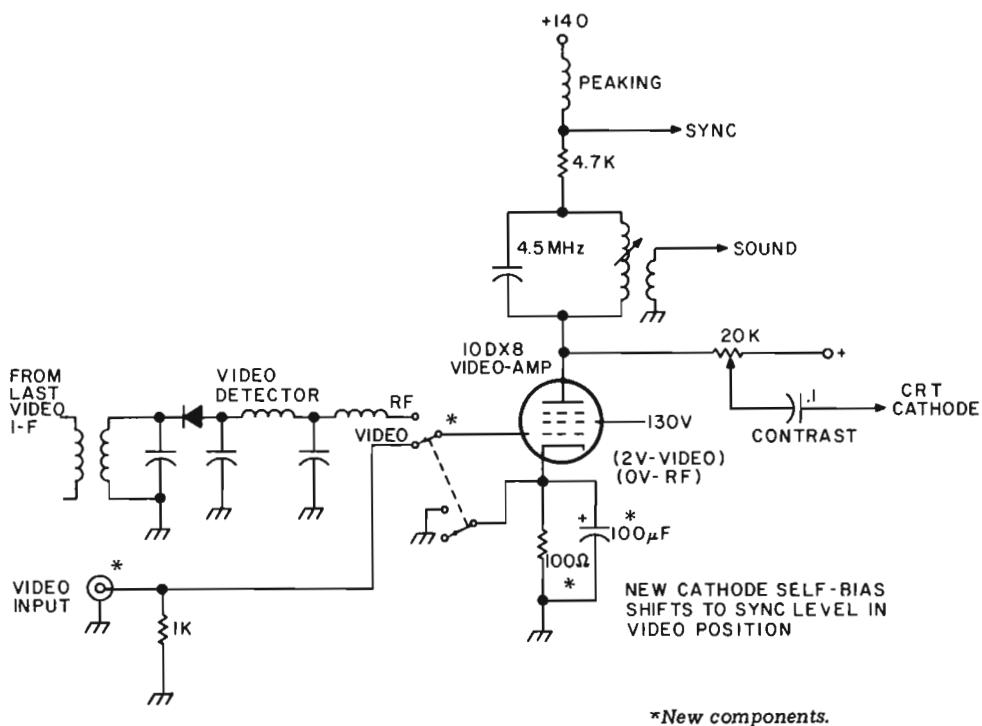


Fig. 7. Direct coupled video added to tube type B and W television.



\*New components.

circuit, the white level is zero volts and the sync tip black level is minus two volts. If we can find a negative supply (scarce in tube type circuits), we could offset our video in the negative direction by two volts to meet these bias levels.

Instead of this, it is usually possible to self bias the video amplifier to a cathode voltage of +2 volts. This is done by breaking the cathode to ground connection and adding a small resistor (50 to 100 Ohms) between cathode and ground to get a cathode voltage of +2 volts. Once this value is found, a heavy electrolytic bypass of 100 microfarads or more is placed in parallel with the resistor. Switching then grounds the cathode in the normal rf mode and makes it +2 volts in the video entry mode.

In the direct video mode, a sync tip grounded input presents zero volts to the grid, which is self biased

minus two volts with respect to the cathode. A white level presents +2 volts to the grid, which equals zero volts grid to cathode.

Should there already be a self bias network on the cathode, it is increased in value as needed to get the black rather than white level bias in the direct video mode.

#### Hot Chassis Problems

There is usually no shock hazard when we use clip-on rf entry or when we use a direct video jack on a transformer-powered TV. A very severe shock hazard can exist if we use direct video entry with a TV set having one side of the

power line connected to the chassis. Depending on which way the line cord is plugged in, there is a 50-50 chance of the hot side of the power line being connected directly to the chassis.

Hot chassis sets, particularly older, power hungry tube versions, should be avoided entirely for direct video entry. If one absolutely must be used, some of the suggestions of Fig. 8 may ease the hazard. These include using an isolation transformer, husky back-to-back filament transformers, three wire power systems, optical coupling of the video input,

and total package isolation. Far and away the best route is simply never to attempt direct video entry onto a hot chassis TV.

### Making the Conversion

Fig. 9 sums up how we modify a TV for direct video entry. Always have a complete schematic on hand, and use a transformer style TV set if at all possible. Late models, small screen, medium to high quality solid state sets are often the best display choice. Avoid using junk sets, particularly very old ones. Direct coupling of video is far preferable to ac capacitor coupling. Either method has to maintain the black and white bias levels on the first video amplifier stage. A shift of the first stage quiescent bias from normally white to normally black is also a must. Use short, shielded leads between the video input jack and the rest of the circuit. If a changeover switch is used, keep it as close to the rest of the video circuitry as you possibly can.

### Extending Video and Display Bandwidth

By using the direct video input route, we eliminate any bandwidth and response restrictions of an rf

modulator, the tuner, video i-f strip, and the video-detector filter. Direct video entry should bring us to a 3 MHz bandwidth for a color set and perhaps 3.5 MHz for a black and white model, unless we are using an extremely bad set. The resultant 6 to 7 million dot per second rate is adequate for short character lines of 32, 40, and possibly 48 characters per line. But the characters will smear and be illegible if we try to use longer line lengths and premium (lots of dots) character generators on an ordinary TV. Is there anything we can do to the set to extend the video bandwidth and display response for these longer line lengths?

In the case of a color TV, the answer is probably no. The video response of a color set is limited by an essential delay line and an essential 3.58 MHz trap. Even if we were willing to totally separate the chrominance and luminance channels, we'd still be faced with an absolute limit set by the number of holes per horizontal line in the shadow mask of the tube. This explains why video color displays are so expensive and so rare. Later on, we'll look at what's involved in adding color to the shorter line lengths.

With a black and white TV, there is often quite a bit

*Fig. 8. Getting Around a Hot Chassis Problem.*

Hot chassis problems can be avoided entirely by using only transformer-powered TV circuits or by using clip-on rf entry. If a hot chassis set must be used, here are some possible ways around the problem:

#### 1. Add an isolation transformer.

A 110 volt to 110 volt isolation transformer whose wattage exceeds that of the set may be used. These are usually expensive, but a workable substitute can be made by placing two large surplus filament transformers back to back. For instance, a pair of 24 volt, 4 Amp transformers can handle around 100 Watts of set.

#### 2. Use a three wire system with a solid ground.

Three prong plug wiring, properly polarized, will force the hot chassis connection to the cold side of the power line. This protection is useful only when three wire plugs are used in properly wired outlets. A severe shock hazard is reintroduced if a user elects to use an adaptor or plugs the system into an unknown or improperly wired outlet. The three wire system should NOT be used if anyone but yourself is ever to use the system.

#### 3. Optically couple the input video.

Light emitting diode-photocell pairs are low in cost and can be used to optically couple direct video, completely isolating the video input from the hot chassis. Most of these optoelectronic couplers do not have enough bandwidth for direct video use; the Litronix IL-100 is one exception. Probably the simplest route is to use two separate opto-isolators, one for video and one for sync, and then recombine the signals inside the TV on the hot side of the circuit.

#### 4. Use a totally packaged and sealed system.

If you are only interested in displaying messages and have no other input/output devices, you can run the entire circuit hot chassis, provided everything is sealed inside one case and has no chassis-to-people access. Interface to teletypes, cassettes, etc., cannot be done without additional isolation, and servicing the circuit presents the same shock hazards that servicing a hot chassis TV does.

we can do to present long lines of characters, depending on what set you start out with and how much you are willing to modify the set.

The best test signal you can use for bandwidth extension is the dot matrix data you actually want to display, for the frequency response, time delay, ringing, and overshoot all get into the act. What we want to end up with is a combination that gives us reasonably legible characters.

A good oscilloscope (15 MHz or better bandwidth) is very useful during bandwidth extension to show where the signal loses its response in the circuit. At any time during the modification process, there is usually one response bottleneck. This, of course, is what should be attacked first. Obviously the better a TV you start with, the easier will be the task. Tube type gutless wonders, particularly older ones, will be much more difficult to work with than with a modern, small screen, quality solid state portable.

Several of the things we can do are watching the control settings, getting rid of the sound trap, minimizing circuit strays, optimizing spot size, controlling peaking, and shifting to higher current operation. Let's take a look at these in turn.

#### Control Settings

Always run a data display at the lowest possible contrast and using only as much brightness as you really need. In many circuits, low contrast means a lower video amplifier gain, and thus less of a gain-bandwidth restriction.

#### Eliminate the Sound Trap

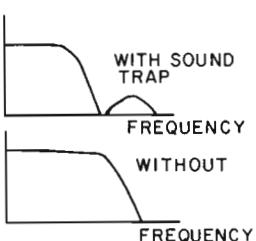
The sound trap adds a notch at 4.5 MHz to the video response. If it is eliminated or switched out of the circuit, a wider video bandwidth automatically

Fig. 9. How to Add a Direct Video Input to a TV Set.

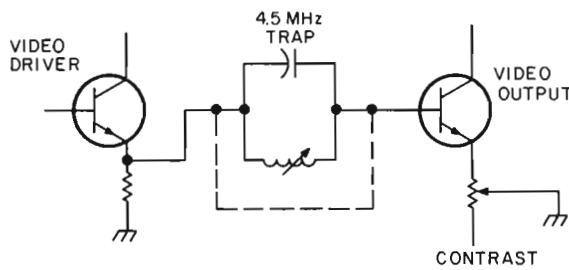
1. Get an accurate and complete schematic of the set — either from the manufacturer's service data or a Photofact set. Do not try adding an input without this schematic!
2. Check the power supply to see if a power transformer is used. If it is, there will be no shock hazard, and the set is probably a good choice for direct video use. If the set has one side of the power line connected to the chassis, a severe shock hazard exists, and one of the techniques of Fig. 8 should be used. Avoid the use of hot chassis sets.
3. Find the input to the first video amplifier stage. Find out what the white level and sync level bias voltages are. The marked or quiescent voltage is usually the white level; sync is usually 2 volts less. A transistor TV will typically have a +3 volt white level and a +1 volt sync level. A tube type TV will typically have a zero volt white level and a -2 volt sync level.
4. Add a changeover switch using minimum possible lead lengths. Add an input connector, either a phono jack or the premium BNC type connector. Use shielded lead for interconnections exceeding three inches in length.
5. Select a circuit that couples the video and biases the first video amplifier stage so that the white and sync levels are preserved. For transistor sets, the direct coupled circuits of Fig. 5 may be used. For tube sets, the circuit of Fig. 7 is recommended. Avoid the use of ac coupled video inputs as they may introduce shading problems and changes of background as the screen is filled.
6. Check the operation. If problems with contrast or sync tearing crop up, recheck and adjust the white and sync input levels to match what the set uses during normal rf operation. Note that the first video stage must be biased to the white level during rf operation and to the sync level for direct video use. The white level is normally two volts more positive than the sync level.

**Fig. 10. Removing the sound trap can extend video bandwidth.**

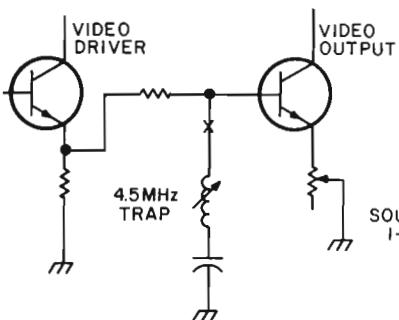
(a) Response



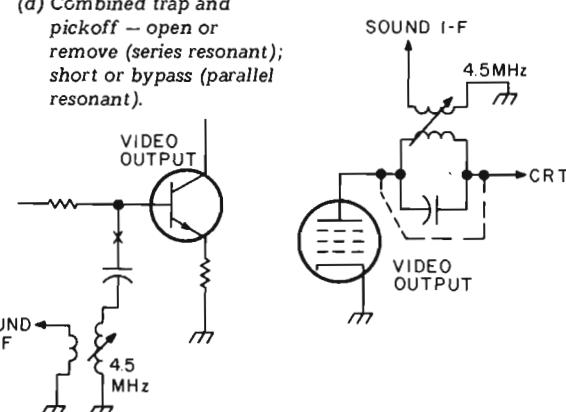
(b) Parallel resonant trap – short or bypass.



(c) Series resonant trap – open or remove.



(d) Combined trap and pickoff – open or remove (series resonant); short or bypass (parallel resonant).



results. Fig. 10 shows us the response changes and the several positions for this trap. Generally, series resonant traps are opened and parallel resonant traps are shorted or bypassed through suitable switching or outright elimination. The trap has to go back into the circuit if the set is ever again used for ordinary program reception. Sometimes simply backing the slug on the trap all the way out will improve things enough to be useful.

#### Minimizing Strays

One of the limits of the video bandwidth is the stray capacitance both inside the video output stage and in the external circuitry. If the contrast control is directly in the signal path and if it has long leads going to it, it may be hurting the response. If you are using the TV set exclusively for data display, can you rearrange the control location and simplify and shorten the video output to picture tube interconnections?

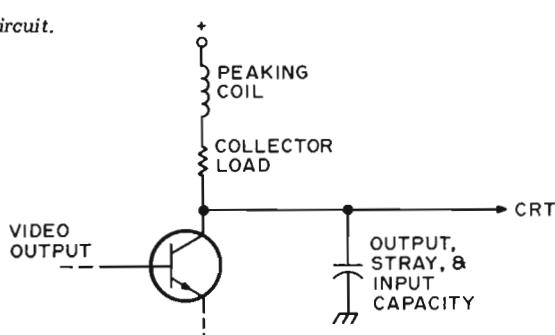
#### Additional Peaking

Most TV sets have two peaking networks. The first of these is at the video detector output and compensates for the vestigial sideband transmission signal that makes sync and other

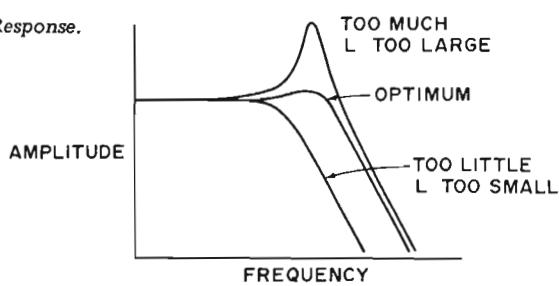
low frequency signals double the amplitude of the higher frequency ones. The second of these goes to the collector or plate of the video output stage and raises the circuit impedance and thus the effective gain for very high

**Fig. 11. Adjusting the peaking coil can extend video response.**

(a) Circuit.



(b) Response.



frequencies. Sometimes you can alter this second network to favor dot presentations. Fig. 11 shows a typical peaking network and the effects of too little or too much peaking. Note that the stray capacitance also enters into the peaking, along with the video amplifier output capacitance and the picture tube's input capacitance. Generally, too little peaking will give you low contrast dots, while too much will give you sharp dots, but will run dots together and shift the more continuous portions of the characters objectionably. Peaking is changed by increasing or decreasing the series inductor from its design value.

#### Running Hot

Sometimes increasing the operating current of the video output stage can increase the system bandwidth – IF this stage is in fact the limiting response, IF the power supply can handle the extra current, IF the stage isn't already parked at its gain-bandwidth peak, and IF the extra heat can be gotten rid of without burning anything up. Usually, you can try adding a resistor three times the plate or collector load resistor in parallel, and see if it increases bandwidth by 1/3. Generally, the higher the current, the wider the bandwidth, but watch

carefully any dissipation limits. Be sure to provide extra ventilation and additional heatsinking, and check the power supply for unhappiness as well. For major changes in operating current, the emitter resistors and other biasing components should also be proportionately reduced in value.

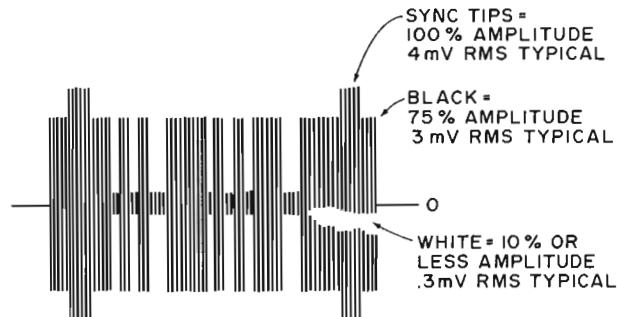
### Spot Size

Even with excellent video bandwidth, if you have an out-of-focus, blooming, or changing spot size, it can completely mask character sharpness. Spot size ends up the ultimate limit to resolution, regardless of video bandwidth.

Once again, brightness and contrast settings will have a profound effect, with too much of either blooming the spot. Most sets have a focus jumper in which ground or a positive voltage is selected. You can try intermediate values of voltage for maximum sharpness. Extra power supply filtering can sometimes minimize hum and noise modulation of the spot.

Anything that externally raises display contrast will let you run with a smaller beam current and a sharper spot. Using circularly polarized filters, graticule masks, or simple colored filters can

*Fig. 13. Standard rf interface levels. Impedance = 300Ω Carrier frequency per Fig. 14.*



*Fig. 12. Contrast Enhancing Filter Materials.*

#### Circularly polarized filters:

Polaroid Corp.  
Cambridge MA 02139

#### Anti-reflection filters:

Panelgraphic Corp.  
10 Henderson Dr.  
West Caldwell NJ 07006

#### Light control film:

3M Visual Products Div.  
3M Center  
St. Paul MN 55101

#### Acrylic plexiglas filter sheets:

Rohm and Haas  
Philadelphia PA 19105

minimize display washout from ambient lighting. Fig. 12 lists several sources of material for contrast improvement. Much of this is rather expensive, with pricing from \$10 to \$25 per square foot being typical. Simply adding a hood and positioning the display away from room lighting will also help and is obviously much cheaper.

#### Direct Rf Entry

If we want the convenience of a "free" display, the freedom from hot chassis problems, and "use it anywhere" ability, direct rf entry is the obvious choice. Its two big limitations are the need for FCC type approval, and a limited video bandwidth that in turn limits the number of characters per line and the number of dots per character.

An rf interface standard is shown in Fig. 13. It consists of an amplitude modulated carrier of one of the standard television channel video frequencies of Fig. 14. Channel 2 is most often used

with a 55.250 MHz carrier frequency, except in areas where a local commercial Channel 2 broadcast is intolerably strong. Circuit cost, filtering problems, and stability problems tend to increase with increasing channel number.

The sync tips are the strongest part of the signal, representing 100% modulation, often something around 4 millivolts rms across a 300 Ohm line. The black level is 75% of the sync level, or about 3 millivolts for 4 millivolt sync tips. White level is less than 10% of maximum. Note that the signal is weakest when white and strongest when sync. This is the exact opposite of the video interface of Fig. 1.

Rf modulators suitable for clip-on rf entry TV typewriter use are called Class 1 TV Devices by the FCC. A Class 1 TV device is supposed to meet the rules and regulations summarized in Fig. 15.

Fig. 16 shows us a block diagram of the essential parts of a TV modulator. We start

*Fig. 14. Television Picture Carrier Frequencies.*

|           |       |           |
|-----------|-------|-----------|
| Channel 2 | ..... | 55.25 MHz |
| Channel 3 | ..... | 61.25 MHz |
| Channel 4 | ..... | 67.25 MHz |
| Channel 5 | ..... | 77.25 MHz |
| Channel 6 | ..... | 83.25 MHz |

*Fig. 15. FCC Regulations on Class 1 TV Devices. More complete information appears in subpart H of Part 15 and subpart F of Part 2 of the Federal Communications Commission Rules and Regulations. It is available at many large technical libraries.*

A Class 1 TV device generates a video modulated rf carrier of a standard television channel frequency. It is directly connected to the antenna terminals of the TV set.

The maximum rms rf voltage must be less than 6 millivolts using a 300 Ohm output line.

The maximum rf voltage on any frequency more than 3 MHz away from the operating channel must be more than 30 dB below the peak in-channel output voltage.

An antenna disconnect switch of at least 60 dB attenuation must be provided.

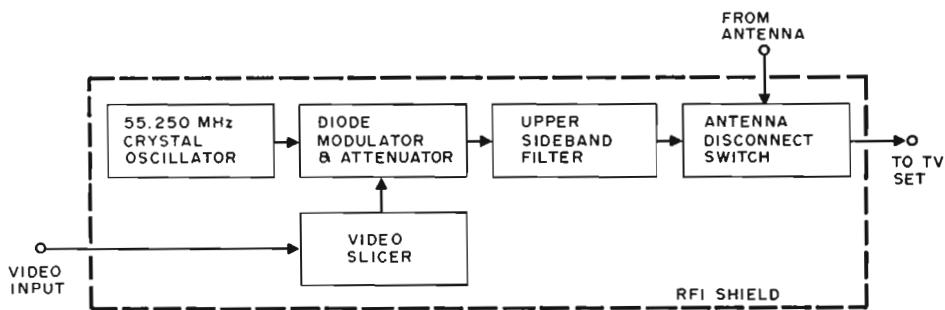
No user adjustments are permitted that would exceed any of the above specifications.

Residual rf radiation from case, leads and cabinet must be less than 15 microvolts per meter.

A Class 1 TV device must not interfere with TV reception.

Type approval of the circuit is required. A filing fee of \$50 and an acceptance fee of \$250 is involved.

Fig. 16. Block diagram of rf modulator.



with a stable oscillator tuned to one of the Fig. 14 frequencies. A crystal oscillator is a good choice, and low cost modules are widely available. The output of this oscillator is then amplitude modulated. This can be done by changing the bias current through a silicon small signal diode. One milliamper of bias current makes the diode show an ac and rf impedance of 26 Ohms. Half a mil will look like 52 Ohms, and so on. The diode acts as a variable resistance attenuator in the rf circuit, whose bias is set and changed by the video circuit.

Since diode modulators are non-linear, we can't simply apply a standard video signal to them and get a standard rf signal out. A differential amplifier circuit called a video slicer may be used to compensate for this non-linearity. The video slicer provides three distinct currents to the diode modulator. One of these is almost zero for the white level, while the other two provide the black and sync levels. A contrast control that sets the slicing level lets you adjust the sync tip height with respect to the black level. The video slicer also minimizes rf getting back into the video. An attenuator to reduce the size of the modulated signal usually follows the diode modulator.

An upper side band filter removes most of the lower sideband from the AM modulated output, giving us a

vestigial sideband signal that stays inside the channel band limits. This same filter eliminates second harmonic effects and other spurious noise. The filter's output is usually routed to an antenna disconnect switch and the TV's antenna terminals. A special switch is needed to provide enough isolation.

Some of the actual circuitry involved is shown in Fig. 17. The video slicer consists of a pair of high gain, small signal NPN transistors, while the oscillator is a commercially available module.

Rf entry systems always must be direct coupled to the antenna terminals of the set and should never provide any more rf than is needed for a minimum snow-free picture. They should be permanently tuned to a single TV channel. Under no circumstances should an antenna or cable service hook up remain connected to the set during T.V.T. use, nor should radiation rather than a direct rf cable connection ever be used.

#### Color Techniques

We can add a full color capability to a TV typewriter system fairly easily and cheaply — provided its usual

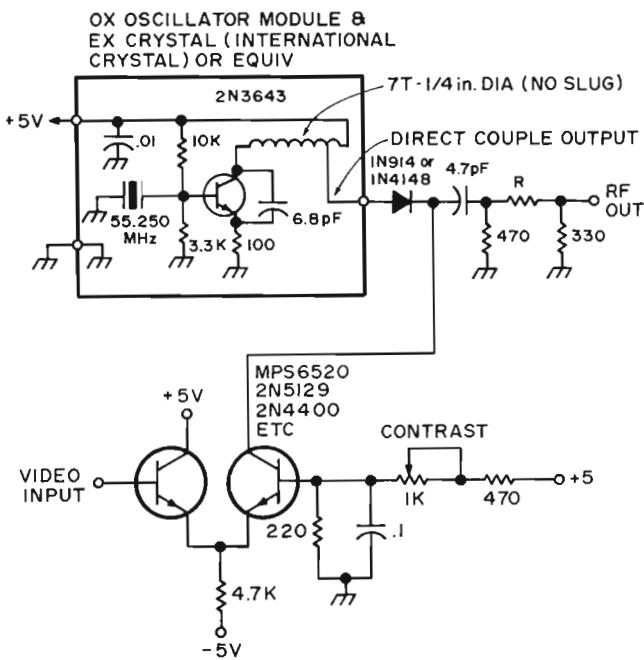
black and white video dot rate is low enough in frequency to be attractively displayed on an ordinary color TV. Color may be used to emphasize portions of a message, to attract attention, as part of an electronic game, or as obvious added value to a graphics display. Color techniques work best on TV typewriter systems having a horizontal frequency very near 15,735 Hertz.

All we basically have to do is generate a subcarrier sine wave to add to the video

output. The phase of this subcarrier (or its time delay) is shifted with respect to what the phase was immediately after each horizontal sync pulse to generate the various colors.

Fig. 18 shows us the differences between normal color and black and white operation. Black and white baseband video is some 4 MHz wide and has a narrow 4.5 MHz sound subcarrier. The video is amplitude modulated, while the sound is narrow band frequency

Fig. 17. Channel two oscillator, modulator, video slicer and attenuator. R sets output level.



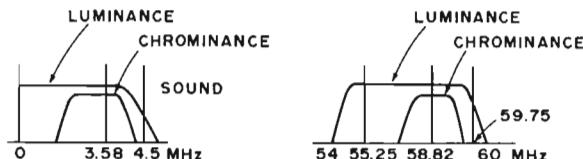
*Fig. 18. Differences between color and black and white spectra.*

(a) Black and white – baseband video.



(b) Black and white – Channel two rf.

(c) Color – baseband video.



(d) Color – Channel two rf.

modulated. This translates up to a 6 MHz rf channel with a vestigial lower sideband as shown in Fig. 18(b).

To generate color, we add a new pilot or subcarrier at a magic frequency of 3.579545 MHz — see Fig. 18(c). What was the video is now called the luminance, and is the same as the brightness in a black and white system. The new subcarrier and its modulation is called the chrominance signal and determines what color gets displayed and how saturated the color is to be.

Since the black and white information is a sampled data system that is scanned at the vertical and horizontal rates, there are lots of discrete holes in the video spectrum that aren't used. The color subcarrier is designed to stuff itself into these holes (exactly in a NTSC color system, and pretty much in a TVT display). Both chrominance and luminance signals use the

same spectral space, with the one being where the other one isn't, overlapping comb style.

The phase or relative delay of the chrominance signal with respect to a reference determines the instantaneous color, while the amplitude of this signal with respect to the luminance sets the saturation of the color. Low amplitudes generate white or pastel shades, while high amplitudes of the chrominance signal produce saturated and deep colors.

At least eight cycles of a reference or burst color phase are transmitted immediately following each horizontal sync pulse as a timing reference, as shown in Fig.

19. The burst is around 25% of maximum amplitude, or about the peak to peak height of a sync pulse.

The TV set has been trained at the factory to sort all this out. After video detection, the set splits out the chrominance channel with a bandpass amplifier and then synchronously demodulates it with respect to an internal 3.58 MHz reference. The phase of this demodulation sets the color and the amplitude sets the saturation by setting the

ratios of electron beam currents on the picture tube's red, blue and green guns.

Meanwhile, the luminance channel gets amplified as brightness style video. It is delayed with a delay line to make up for the time delay involved in the narrower band color processing channel. It is then filtered with two traps — the 4.5 MHz sound trap, and a new trap to get rid of any remaining 3.58 MHz color subcarrier that's left. The luminance output sets the overall brightness by modulating the cathodes of all three color guns simultaneously.

Just after each horizontal sync pulse, the set looks for the reference burst and uses this reference in a phase

*Fig. 19 Adding a color reference burst to the back porch of the horizontal sync pulses.*

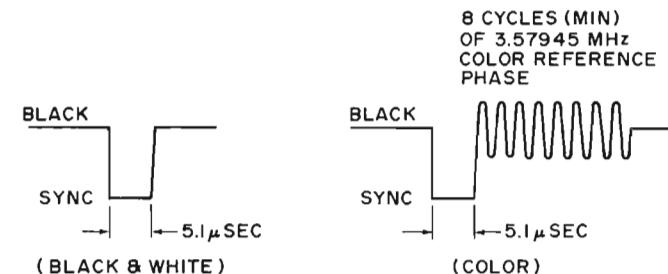


Fig. 20. Colors Are Generated by Delaying or Phase Shifting the Burst Frequency.

| Color   | Approximate Phase | Approximate Delay |
|---------|-------------------|-------------------|
| Burst   | 0°                | 0                 |
| Yellow  | 15°               | 12 nanoseconds    |
| Red     | 75°               | 58 nanoseconds    |
| Magenta | 135°              | 105 nanoseconds   |
| Blue    | 195°              | 151 nanoseconds   |
| Cyan    | 255°              | 198 nanoseconds   |
| Green   | 315°              | 244 nanoseconds   |

detector circuit to keep its own 3.58 MHz reference locked to the version being transmitted.

Fig. 20 shows us the phase angles related to each color with respect to the burst phase. It also shows us the equivalent amount of delay we need for a given phase angle. Since we usually want only a few discrete colors, it's far easier to digitally generate colors simply by delaying the reference through gates or buffers, rather than using complex and expensive analog phase shift methods.

Strictly speaking, we should control both the chrominance phase and amplitude to be able to do both pastel and strongly saturated colors. But simply keeping the subcarrier amplitude at the value we used for the burst — around 25% of video amplitude — is far simpler and will usually get us useful results.

A circuit to add color to a TV typewriter is shown in Fig. 21. A 3.579545 MHz crystal oscillator drives a string of CMOS buffers that make up a digital delay line. The output delays caused by the propagation delay times in each buffer can be used as

is, or can be trimmed to specific colors by varying the supply voltage.

The reference phase and the delayed color outputs go to a one-of-eight data selector. The data selector picks either the reference or a selected color in response to a code presented digitally to the three select lines. The logic that is driving this selector must return to the

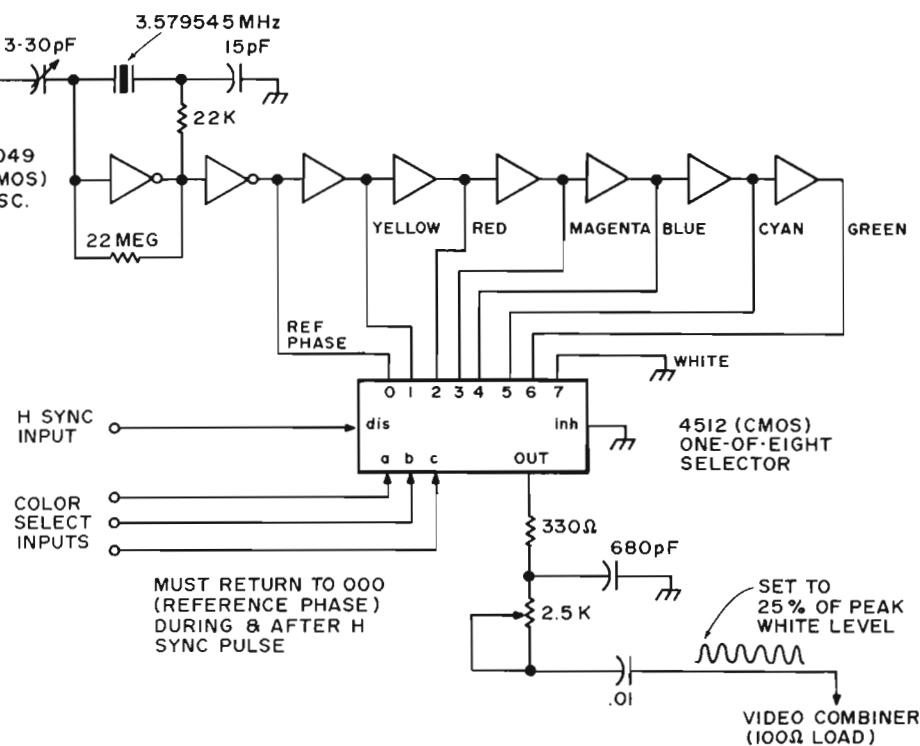
reference phase position (000) immediately before, during and for a minimum of a few microseconds after each horizontal sync pulse. This gives the set a chance to lock and hold onto the reference color burst.

The chrominance output from the data selector should be disabled for the duration of the sync pulses and any time a white screen display is

wanted. The output chrominance signal is RC filtered to make it somewhat sinusoidal. It's then cut down in amplitude to around one-quarter the maximum video white level and is capacitively coupled to the 100 Ohm video output of Fig. 2 or otherwise summed into the video or rf modulator circuitry. For truly dramatic color effects, the amplitude and delay of the chrominance signal can be changed in a more complex version of the same circuit.

More information useful in solving television interface appears in the *Television Engineering Handbook*, by Donald Fink, and in various issues of the *IEEE Transactions on Consumer Electronics*.

Fig. 21. Color subcarrier generator. Hex buffer used as delay line. Use supply voltage variation on 4050 to trim colors.



Pinouts: Parallel Data Interface (PDI) as  
used on Processor Tech. Sol System

Sept. 30, 1976

MASTER UNIT-Male connector

| J2 Pin # | Signal mnemonic | Signal name       | J2 pin# | Signal mnemonic | Signal name           |
|----------|-----------------|-------------------|---------|-----------------|-----------------------|
| 1        | CG              | Chassis Ground    | 14      | US              | Unit Select           |
| 2        | SG              | Signal Ground     | 15      | OE              | Output Enable         |
| 3        | IE              | Input Enable      | 16      | XDR             | eXternal Device Ready |
| 4        | DR              | Data Ready        | 17      | OL              | Output Load           |
| 5        | IAK             | Input Acknowledge | 18      | OD7             | Output Data, bit 7    |
| 6        | ID7             | Input Data, bit 7 | 19      | OD6             | Output Data, bit 6    |
| 7        | ID6             | Input Data, bit 6 | 20      | OD5             | Output Data, bit 5    |
| 8        | ID5             | Input Data, bit 5 | 21      | OD4             | Output Data, bit 4    |
| 9        | ID4             | Input Data, bit 4 | 22      | OD3             | Output Data, bit 3    |
| 10       | ID3             | Input Data, bit 3 | 23      | OD2             | Output Data, bit 2    |
| 11       | ID2             | Input Data, bit 2 | 24      | OD1             | Output Data, bit 1    |
| 12       | ID1             | Input Data, bit 1 | 25      | OD0             | Output Data, bit 0    |
| 13       | ID0             | Input Data, bit 0 |         |                 |                       |

Pinouts: Serial Data Interface (SDI) as  
used on Processor Tech. Sol System

Female connector-DB25S

| J1 pin# | Signal mnemonic | Signal name     | J1 pin# | Signal mnemonic | Signal name         |
|---------|-----------------|-----------------|---------|-----------------|---------------------|
| 1       | CG              | Chassis Ground  | 8       | CD              | Carrier Detect      |
| 2       | TD              | Transmit Data   | 11      | CLO             | Current Loop Output |
| 3       | RD              | Receive Data    | 12      | LR1             | Loop Receiver 1     |
| 4       | RTS             | Request To Send | 13      | LR2             | Loop Receiver 2     |
| 5       | CTS             | Clear To Send   | 20      | DTR             | Data Terminal Ready |
| 6       | DSR             | Data Set Ready  | 23      | LCS             | Loop Current Source |
| 7       | SG              | Signal Ground   |         |                 |                     |

Note 1: Many pins not specified here are used in EIA RS-232C specification.  
USE THEM WITH CAUTION.

Note 2: Terminals output on pins 2,4 & 20 and input on pins 3,5 & 6 for EIA type hookups. Modems and computer mainframes output on pins 3,5 & 6 and input on pins 2,4 & 20.

Note 3: Current loop hookups are the same for terminals, modems,mainframes.

## J3 Keyboard Connector (between U64 and U65)

Sol-PC, Rev. 2,E  
10/18/76

| pin no. | Signal name    | pin no. | Signal name |
|---------|----------------|---------|-------------|
| 1       | ground         | 11      | ground      |
| 2       | +5v            | 12      | +5v         |
| 3       | Kbd Data Ready | 13      | Restart     |
| 4       | Break          | 14      | Local       |
| 5       | Kbd Data Ø     | 15      | KBd Data 4  |
| 6       | Kbd Data 1     | 16      | KBd Data 5  |
| 7       | Kbd Data 2     | 17      | KBD Data 6  |
| 8       | Kbd Data 3     | 18      | KBD Data 7  |
| 9       | +5v            | 19      | +5v         |
| 10      | ground         | 20      | ground      |

## J4 Display Expansion Connector (between U28, 29)

| pin no. | Signal name     | pin no. | Signal name            |
|---------|-----------------|---------|------------------------|
| 1       | ground          | 11      | ground                 |
| 2       | N.C.            | 12      | N.C.                   |
| 3       | Char. addr. 4   | 13      | Dot Clock, 14.318MHz   |
| 4       | Character clock | 14      | Composite sync. out    |
| 5       | Char. addr. Ø   | 15      | TTL Serial Data Out    |
| 6       | Char. addr. 1   | 16      | Composite blanking out |
| 7       | Char. addr. 2   | 17      | Scan advance out       |
| 8       | Char. addr. 3   | 18      | Char. addr. 5          |
| 9       | N.C.            | 19      | N.C.                   |
| 10      | ground          | 20      | ground                 |

## J5 Personality Module Edge Connector

| pin no. | Signal name | pin no.   | Signal name |
|---------|-------------|-----------|-------------|
| B15     | S           | Ground    | Ground      |
| B14     | O           | +5VDC     | +5VDC       |
| B13     | T           | Addr. 9   | Addr. Ø     |
| B12     | T           | Addr. 8   | Addr. 4     |
| B11     | T           | Addr. 7   | Addr. 3     |
| B10     | O           | INT Bus Ø | Addr. 2     |
| B9      | M           | INT Bus 1 | Addr. 1     |
| B8      |             | INT Bus 2 | Addr. 5     |
| B7      | R           | INT Bus 3 | Addr. 6     |
| B6      | O           | INT Bus 4 | C4          |
| B5      | M           | INT Bus 5 | CØ          |
| B4      |             | Program Ø | INT Bus 6   |
| B3      | P           | Program 1 | INT Bus 7   |
| B2      | I           | Program 2 | -12VDC      |
| B1      | N           | Program 3 | +12VDC      |
|         | S           |           |             |

J6 Audio Out for CUTS Cassette Interface: Mini-phone jack at rear panel

J7 Audio In for CUTS Cassette Interface: Mini-phone jack at rear panel

J8 Tape Motor Control 1: (See output port FA, bit 7) Sub-mini jack at rear panel

J9 Tape Motor Control 2: (See output port FA, bit 6) Sub-mini jack at rear panel

Rev A

## J10 DC Power Connector, Sol-PC

|         |   |
|---------|---|
| Ground  | O |
| +5VDC   | O |
| -12 VDC | O |
| +12 VDC | O |
| -12 VDC | O |
| +5 VDC  | O |
| Ground  | O |

## S-100 Bus Definitions

| PIN NUMBER | SYMBOL          | NAME                       | FUNCTION  |
|------------|-----------------|----------------------------|---|
| 1          | +8V             | +8 Volts                   | Unregulated voltage on bus, supplied to PC boards and regulated to 5V, supplied by Sol-20 supply  |
| 2          | +16V            | +16 Volts                  | Positive unregulated voltage supplied by Sol-20 power supply  |
| 3          | XRDY            | EXTERNAL READY             | External ready input to CPU ready circuitry   |
| 4          | VI0             | Vectored Interrupt Line #0 |   |
| 5          | VI1             | Vectored Interrupt Line #1 |   |
| 6          | VI2             | Vectored Interrupt Line #2 |   |
| 7          | VI3             | Vectored Interrupt Line #3 |   |
| 8          | VI4             | Vectored Interrupt Line #4 |   |
| 9          | VI5             | Vectored Interrupt Line #5 |   |
| 10         | VI6             | Vectored Interrupt Line #6 |   |
| 11         | VI7             | Vectored Interrupt Line #7 |   |
| 12         | XRDY2           | EXTERNAL READY #2          | not used by Sol-PC  |
| 13         |                 | TO BE DEFINED              |   |
| 17         |                 |                            |   |
| 18         | <u>STAT DSB</u> | STATUS DISABLE             | - Allows the buffers for the 8 status lines to be tri-stated  |
| 19         | <u>C/C DSB</u>  | COMMAND/CONTROL DISABLE    | - Allows the buffers for the 6 output command/control lines to be tri-stated  |
| 20         | <u>UNPROT</u>   | UNPROTECT                  | - not used by Sol-PC electronics  |
| 21         | <u>SS</u>       | SINGLE STEP                | - not used by Sol-PC  |
| 22         | <u>ADD DSB</u>  | ADDRESS DISABLE            | - Allows the buffers for the 16 address lines to be tri-stated  |
| 23         | <u>DO DSB</u>   | DATA OUT DISABLE           | - Allows the buffers for the 8 data output lines to be tri-stated   |
| 24         | Ø2              | PHASE 2 CLOCK              |   |
| 25         | Ø1              | PHASE 1 CLOCK              |   |
| 26         | PHLDA           | HOLD ACKNOWLEDGE           | Processor command/control output signal that appears in response to the HOLD signal; indicates that the data and address bus will go to the high impedance state and processor will enter HOLD state after completion of the current machine cycle. |

S-100 Bus Definitions-continued

| PIN NUMBER | SYMBOL | NAME                   | FUNCTION   |
|------------|--------|------------------------|--|
| 27         | PWAIT  | WAIT                   | -Processor command/control output signal that indicates the processor is in the wait state in response to a low READY signal or a HALT instruction.  |
| 28         | PINTE  | INTERRUPT ENABLE       | -Processor command/control output signal; indicates interrupts are enabled, as determined by the contents of the CPU internal interrupt flip-flop. When the flip-flop is set (Enable Interrupt instruction), interrupts are accepted by the CPU; when it is reset (Disable Interrupt instruction), interrupts are inhibited. |
| 29         | A5     | Address Line #5        |  |
| 30         | A4     | Address Line #4        |  |
| 31         | A3     | Address Line #3        |  |
| 32         | A15    | Address Line #15 (MSB) |  |
| 33         | A12    | Address Line #12       |  |
| 34         | A9     | Address Line #9        |  |
| 35         | DIO1   | Data In/Out line #1    | same as pin 94   |
| 36         | DIO0   | Data In/Out line #0    | same as pin 95   |
| 37         | A10    | Address Line #10       |  |
| 38         | DIO4   | Data In/Out Line #4    | same as pin 91   |
| 39         | DIO5   | Data In/Out Line #5    | same as pin 92   |
| 40         | DIO6   | Data In/Out Line #6    | same as pin 93   |
| 41         | DIO2   | Data In/Out Line #2    | same as pin 88   |
| 42         | DIO3   | Data In/Out Line #3    | same as pin 89   |
| 43         | DIO7   | Data In/Out Line #7    | same as pin 90   |
| 44         | SM1    | MACHINE CYCLE 1        | -Status output signal that indicates that the processor is in the fetch cycle for the first byte of an instruction   |
| 45         | SOUT   | OUTPUT                 | -Status output signal that indicates the address bus contains the address of an output device and the data bus will contain the output data when PWR is active   |
| 46         | SINP   | INPUT                  | -Status output signal that indicates the address bus contains the address of an input device and the input data should be placed on the data bus when PDBIN is active  |
| 47         | SMEMR  | MEMORY READ            | -Status output signal that indicates the data bus will be used to read memory data   |
| 48         | SHLTA  | HALT ACKNOWLEDGE       | - Status output signal that acknowledges a HALT instruction  |
| 49         | CLOCK  | CLOCK                  | - Inverted output of the Ø2 CLOCK  |
| 50         | GND    | GROUND                 |  |
| 51         | +8V    | +8 Volts               | Unregulated input to 5 volt regulators supplied by Sol-20 power supply   |
| 52         | -16V   | -16 Volts              | Negative unregulated voltage supplied by Sol-20 power supply   |

S-100 Bus Definitions-continued

| PIN NUMBER | SYMBOL         | NAME                     | FUNCTION  |
|------------|----------------|--------------------------|---|
| 53         | <u>SSWI</u>    | SENSE SWITCH INPUT       | not used by Sol   |
| 54         | <u>EXT CLR</u> | EXTERNAL CLEAR           | not used by Sol-PC electronics  |
| 55         | <u>RTC</u>     | REAL TIME CLOCK          | not used by Sol-PC electronics  |
| 56         | <u>STSTB</u>   | STATUS STROBE            | not used by Sol   |
| 57         | <u>DIGI</u>    | DATA INPUT GATE #1       | When low forces PDBINS low and forces CPU input multiplexers to the DIO bus. During CPU DBIN cycle, disables CPU DIO bus drivers<br>-When low disables MWRITE driver  |
| 58         | FRDY           | FRONT PANEL READY        |   |
| 59         |                |                          |   |
| to         |                |                          |   |
| 64         |                | TO BE DEFINED            |   |
| 65         | <u>MREQ</u>    | MEMORY REQUEST           | - Z 80 signal not used by Sol-PC electronics  |
| 66         | <u>REF</u>     | REFRESH                  | - Z 80 signal not used by Sol-PC electronics  |
| 67         | <u>PHANTOM</u> | PHANTOM DISABLE          | -Output from CPU section used to disable RAM or ROM during power on initialization program execution  |
| 68         | <u>MWRITE</u>  | MEMORY WRITE             | -Indicates that the data present on the Data Out Bus is to be written into the memory location currently on the address bus   |
| 69         | <u>PS</u>      | <u>PROJECT STATUS</u>    | -not used by Sol-PC electronics   |
| 70         | <u>PROT</u>    | PROTECT                  | -not used by Sol-PC electronics   |
| 71         | <u>RUN</u>     | RUN                      | - not used by Sol-PC electronics  |
| 72         | <u>PRDY</u>    | PROCESSOR READY          | - Memory and I/O input to the CPU Board wait circuitry  |
| 73         | <u>PINT</u>    | <u>INTERRUPT REQUEST</u> | - The processor recognizes an interrupt request on this line at the end of the current instruction or while halted. If the processor is in the HOLD state or the Interrupt Enable flip-flop is reset, it will not honor the request.<br>-Processor command/control input signal that requests the processor enter the HOLD state; allows an external device to gain control of address and data buses as soon as the processor has completed its use of these buses for the current machine cycle |
| 74         | <u>PHOLD</u>   | <u>HOLD</u>              |   |
| 75         | <u>PRESET</u>  | <u>RESET</u>             | -Processor command/control input; while activated, the content of the program counter is cleared and the instruction register is set to 0   |
| 76         | <u>PSYNC</u>   | SYNC                     | -Processor command/control output; provides a signal to indicate the beginning of each machine cycle  |
| 77         | <u>PWR</u>     | <u>WRITE</u>             | -Processor command/control output; used for memory write or I/O output control. Data on the data bus is stable while the PWR is active  |
| 78         | <u>PDBIN</u>   | DATA BUS IN              | -Processor command/control output; indicates to external circuits that the data bus is in the input mode  |

S-100 Bus Definitions-continued

| PIN NUMBER | SYMBOL | NAME                  | FUNCTION   |
|------------|--------|-----------------------|--|
|            |        |                       | (LSB)  |
| 79         | A0     | Address Line #0       |  |
| 80         | A1     | Address Line #1       |  |
| 81         | A2     | Address Line #2       |  |
| 82         | A6     | Address Line #6       |  |
| 83         | A7     | Address Line #7       |  |
| 84         | A8     | Address Line #8       |  |
| 85         | A13    | Address Line #13      |  |
| 86         | A14    | Address Line #14      |  |
| 87         | A11    | Address Line #11      |  |
| 88         | DI02   | Data In/Out Line #2   | same as pin 41   |
| 89         | DI03   | Data In/Out Line #3   | same as pin 42   |
| 90         | DI07   | Data In/Out Line #7   | same as pin 43   |
| 91         | DI04   | Data In/Out Line #4   | same as pin 38   |
| 92         | DI05   | Data In/Out Line #5   | same as pin 39   |
| 93         | DI06   | Data In/Out Line #6   | same as pin 40   |
| 94         | DI01   | Data In/Out Line #1   | same as pin 35   |
| 95         | DI00   | Data In/Out Line #0   | same as pin 36   |
| 96         | SINTA  | INTERRUPT ACKNOWLEDGE | -Status output signal; acknowledges signal for INTERRUPT request   |
| 97         | SWO    | WRITE OUT             | -Status output signal; indicates that the operation in the current machine cycle will be a WRITE memory or output function |
| 98         | SSTACK | STACK                 | -Status output signal indicates that the address bus holds the pushdown stack address from the Stack Pointer               |
| 99         | POC    | POWER-ON CLEAR        |  |
| 100        | GND    | GROUND                |  |

SWITCH FUNCTION DEFINITION -- Display Ctrl--Schematic Drawing #4

| Switch No. | Mnemonic | Function              |                        |
|------------|----------|-----------------------|------------------------|
|            |          | ON                    | OFF                    |
| S1-1       | RST      | Restart to Zero       | RUN ( Dwg. #1)         |
| S1-2       | not used |                       |                        |
| S1-3       | BLANK    | Blank Ctrl Characters | Display Ctrl Char.     |
| S1-4       | Polarity |                       |                        |
| S1-5       | BLINK    | Blinking cursor       | *Solid or NO cursor    |
| S1-6       | SOLID    | Solid cursor          | *Blinking or NO cursor |

\*NO cursor if S1-5 and S1-6 are off at same time.  
Both switches should not be on at the same time.

Drawing #3 -- Sense Switch

| Switch No.     | Mnemonic | Function       |      |      |
|----------------|----------|----------------|------|------|
|                |          | ON             | ON   | OFF  |
| S2-1           | SSW0     | LSB, data bit  | 0=LO | 1=HI |
| S2-2 thru S2-7 |          | etc.           | LO   | HI   |
| S2-8           | SSW7     | MSB data bit 7 | LO   | HI   |

SERIAL I/O BAUD RATE SWITCH -- Schematic Drawing #3  
Function

| Switch No. | Mnemonic | ON  | OFF   |
|------------|----------|---|---|
| S3-1       | 75       | 75 BAUD   | * Do not turn more than one switch on at a time |
| S3-2       | 11       | 110 BAUD  |   |
| S3-3       | 15       | 150 BAUD  |   |
| S3-4       | 30       | 300 BAUD  |   |
| S3-5       | 60       | 600 BAUD  |   |
| S3-6       | 12       | 1200 BAUD   |   |
| S3-7       | 24/48    | 2400 or 4800 (normally 2400 if not jumpered K to M) |   |
| S3-8       | 96       | 9600 BAUD   |   |

SERIAL I/O CONTROL -- Schematic Drawing #3

| Switch No. | Mnemonic | ON               | OFF   |
|------------|----------|------------------|---|
| S4-1       | PS       | Parity odd       | Parity even (if S4-5 on)                                      |
| S4-2       | WLS 1    | Data word length | { 8bits 7bits 6bits 5bits }<br>Off On Off On<br>Off Off On On |
| S4-3       | WLS 2    |                  |   |
| S4-4       | SBS      | 1 stop bit       | 2 stop bits (1.5 if 5bits/word)                               |
| S4-5       | PI       | Parity           | No parity   |
| S4-6       | F/H      | Half duplex      | Full duplex   |

MEMORY ALLOCATION: ON CARD

| Hexidecimal Address | Function                                    |
|---------------------|---|
| C000 - C7FF         | Personality Module ROM or PROM (2048 words) |
| C800 - CBFF         | System RAM (1024 words)                     |
| CC00 - CFFF         | Display RAM Memory (1024 characters)        |

ON CARD INPUT PORT ALLOCATION

| Hexidecimal Port Address | Function   |
|--------------------------|--|
| F8                       | Status, Serial Comm. channel                                       |
| F9                       | Serial Communication Channel Data                                  |
| FA                       | Aux. Status, Cassette tape interface, parallel I/O, keyboard input |
| FB                       | Audio Cassette (CUTS) Data   |
| FC                       | Keyboard Data (from J3)  |
| FD                       | Parallel Port Data (from J2)                                       |
| FE                       | Display Status   |
| FF                       | Sense Switch (S2-1 thru S2-8)                                      |

OUTPUT PORTS

| Hex Port Address | Function                                 |
|------------------|--|
| F8               | Control, Serial Comm. Channel            |
| F9               | Data, Serial Comm. Channel               |
| FA               | Control, Parallel I/O, CUTS Cassette I/O |
| FB               | Data, CUTS audio cassette Interface      |
| FC               | Alarm (optional)                         |
| FD               | Data, Parallel output Data channel       |
| FE               | Scroll control, Display Section          |
| FF               | not used in Sol-PC                       |

STATUS PORT INPUT BIT ASSIGNMENTS

PORT F8 (STATUS, SERIAL COMM. CHANNEL)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>                   | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|-----------------------------------|-------------------------|
| 0          | SCD                | Serial Carrier Detect (EIA)       | l carrier               |
| 1          | SDSR               | Serial Data Set Ready (EIA)       | Ø link ok               |
| 2          | SPE                | Serial Parity Error               | l error                 |
| 3          | SFE                | Serial Framing Error              | l error                 |
| 4          | SOE                | Serial Overrun Error              | l error                 |
| 5          | SCTS               | Serial Clear to Send (EIA)        | Ø clear                 |
| 6          | SDR                | UART Serial Data Ready            | l ready                 |
| 7          | STBE               | UART Serial Transmit Buffer Empty | l empty                 |

PORT FA (AUX. STATUS, CASSETTE TAPE INTERFACE, PARALLEL I/O, KEYBOARD INPUT)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>                | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|--------------------------------|-------------------------|
| 0          | KDR                | Keyboard Data Ready            | Ø ready                 |
| 1          | PDR                | Parallel Data Ready            | Ø ready                 |
| 2          | PXDR               | Parallel eXternal Device Ready | Ø ready                 |
| 3          | TFE                | Tape Framing Error             | l error                 |
| 4          | TOE                | Tape Overrun Error             | l error                 |
| 5          | not used           |                                |                         |
| 6          | TDR                | Tape Data Ready                | l ready                 |
| 7          | TTBE               | Tape Transmitter Buffer Empty  | l empty                 |

PORT FE (DISPLAY STATUS)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>                                   | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|---|-------------------------|
| Ø          | SOK                | Scroll OK; $\frac{1}{4}$ sec timeout after scroll | Ø time complete         |

CONTROL PORT OUTPUT BIT ASSIGNMENTS

PORT F8 (CONTROL, SERIAL COMM. CHANNEL)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>        | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|------------------------|-------------------------|
| 4          | SRTS               | Serial Request to Send | l request               |

PORT FA (CONTROL, PARALLEL I/O, CUTS CASSETTE I/O)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>           | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|---------------------------|-------------------------|
| 3          | PIE                | Parallel Input Enable     | l pin 3 J2 low          |
| 4          | PUS                | Parallel Unit Select      | 0 pin 14 J2 low         |
| 5          | TBR                | Tape Baud Rate (300/1200) | 0 1200 Baud             |
| 6          | TT2                | Tape Transport 2          | 0 run tape              |
| 7          | TT1                | Tape Transport 1          | 0 run tape              |

PORT FE (SCROLL CONTROL, DISPLAY SECTION)

| <u>BIT</u> | <u>SIGNAL NAME</u> | <u>FUNCTION</u>                         | <u>ACTIVE DIRECTION</u> |
|------------|--------------------|---|-------------------------|
| Ø - 3      | BDLA               | Beginning Display Line Absolute address | 4-bit data nybble       |
| 4 - 7      | FDSP               | First Displayed Line Screen Position    | 4-bit data nybble       |

CONNECTOR DESIGNATION

|    |                        |     |                         |
|----|------------------------|-----|-------------------------|
| J1 | Serial data            | J6  | Cassette Tape Audio Out |
| J2 | Parallel Data          | J7  | Cassette Tape Audio In  |
| J3 | Keyboard               | J8  | Tape Motor 1            |
| J4 | Display Expansion      | J9  | Tape Motor 2            |
| J5 | ROM Personality Module | J10 | PC Power                |
|    |                        | J11 | S-100 Bus Expansion     |

# YOUR PERSONAL GENIE

by Tom Munnecke

It helps you with your income tax, then it takes you in the Starship Enterprise on an outer space crusade against the Klingons. It teaches you Boolean logic, then it becomes an opponent at checkers. It draws vivid pictures on your television set, then telephones a distant computer to calculate the value of your personal stock portfolio.

What is this personal genie? How can it take on so many personalities? It is the personal computer, and its personalities are the unique products of its programmer. The computer is capable of nothing more, nothing less than the programmer instructing it. For all the precision and rigidity associated with a computer, the programmer's work is still a uniquely personal reflection of himself.

The fundamental connection between the programmer and the computer is the computer language. The increasing number and sophistication of computer languages bring the power of the personal computer to the non-professional.

Computers are simple to deal with once certain fundamentals are understood. After that, learning becomes a trial and error experience. A person learning to walk does not need to understand each muscle, joint, and bone; he simply tries to walk and corrects his mistakes. So it is with computer programming. The novice programmer does not need to know the intricacies of the computer. He needs only: to know the fundamentals of the language, to know what his errors are and how to correct them, and to have time enough to try out his ideas.

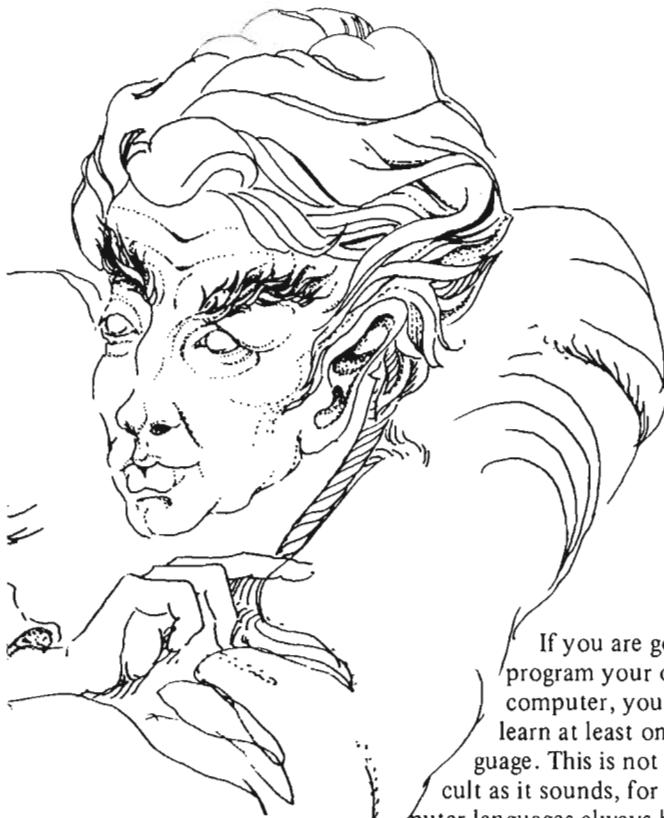
The personal computer is a tool — the most powerful tool ever put in the hands of the private individual. Its potential is limited only by its owner's capacity to apply it.

This article provides a head start on learning any computer language, discussing the merits and drawbacks of many of the computer languages available to the personal computing enthusiast.

## *What is a Computer Language?*

Computers operate in sequences of primitive decisions made in millionths of seconds. People think in terms of vague concepts derived over days and months. The computer language is the means of linking these vague human concepts to the primitive computer decision.





If you are going to program your own computer, you need to learn at least one language. This is not as difficult as it sounds, for computer languages always have a very respectable teacher — the computer itself. After you learn one language, the second and third are learned easily. It is not unusual for a professional programmer to use four or five languages regularly.

Computers have a reputation for being rigid and inflexible in their ways. This may be so, but consider the poor language processor which has to try to interpret

FORK=STOP

when the programmer meant

FOR K=S TO P

Most of the rigidity of the computer is there for a purpose. If you learn how they interpret things, some apparent inflexibility will fade away.

In order for the computer and the programmer to communicate, they must have some common physical medium for communicating. Usually, this is a keyboard/printer or video display. The programmer enters his programs in whatever language he is using, in his version of the language, known as the source language. He then asks a language processor to prepare it for the computer to process it.

There are two types of language processors — translators and interpreters. The translator accepts the source language and translates it to an object language, which is then loaded into the computer to be executed. Translators are further broken down into assemblers and compilers. The assembler is a means of manipulating machine-level operations for a specific computer, while the compiler translates higher-level, or more human-oriented languages. Interpreters execute the source language directly without the intermediate process of translating to an object language.

Languages are classified into two vaguely defined classifications: high-level and low-level. A low-level language is

one in which each of the source code instructions corresponds to a machine-level operation. Source code in a high-level language may generate many machine-level instructions.

#### *Assemblers, Compilers, and Interpreters*

Each of the types of language processors has its merits and drawbacks — assemblers give the programmer great power but require very detailed instructions; compilers support higher-level languages, but sacrifice machine efficiency; and interpreters are easy to use, but are not as efficient as compilers.

#### *Assemblers*

The assembler is the simplest form of computer language. It accepts source code and translates it one-for-one into machine-level instructions or object code. Thus, the programmer has detailed control (and responsibility) of each instruction. For example, the programmer might write a line in assembler such as:

NEXT JSR INCHAR ; Jump to subroutine to get a character.

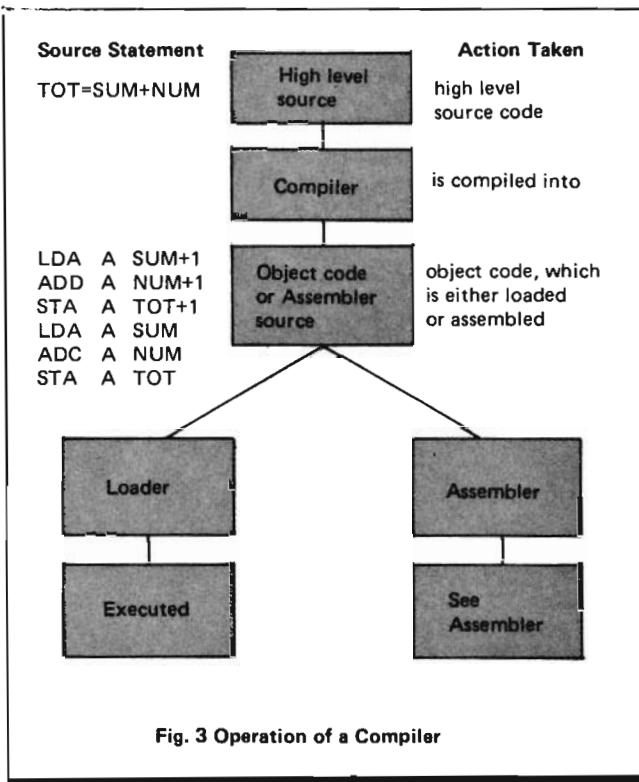
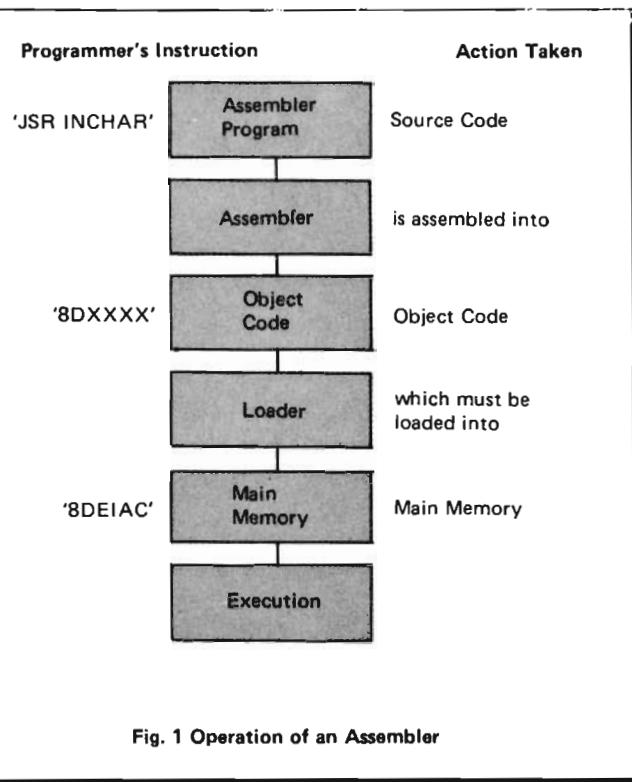
'NEXT' is a label for the line. 'JSR' is a mnemonic for the Motorola 6800 instruction 'Jump to subroutine'. 'IN-CHAR' represents the address of the subroutine to be used. 'Jump . . .' is a comment inserted by the programmer to explain the instruction for documentation.

The assembler (for the 6800) will assemble this instruction into the hexadecimal '8DXXXX' where '8D' is the operation code for branch to subroutine, and 'XXXX' is the address of subroutine INCHAR. See Fig. 1.

Since the assembler may not know where the INCHAR subroutine is to be located when the program is executed, it must be resolved at a later time by the *loader* program.

#### *Compilers*

The compiler acts much like the assembler, but works with higher level languages. The compiler understands more



complex expressions, and does much more work than the assembler. Figure 2 illustrates a single high level language expression which would require 6 lines to write in assembler.

| Compiler    | Assembler   |
|-------------|-------------|
| TOT=SUM+NUM | LDA A SUM+1 |
|             | ADD A NUM+1 |
|             | STA A TOT+1 |
|             | LDA A SUM   |
|             | ADC A NUM   |
|             | STA A TOT   |

**Fig. 2 Comparison of high-level expression and its low-level language equivalent.**

This is a simple example, but a more complex example, such as:

$TOT = (\text{SUM} + \text{NUM}/1.238 * \text{COS}(\text{ARC}/360))^{** 2}/7.32$

could give the assembler language programmer a tremendous amount of difficulty.

Typically, a compiler produces assembly language code, which is then passed through the assembler.

### Interpreters

The interpreter is a departure from the techniques of the assembler or compiler. While the translators create a program which must be loaded and executed later, the interpreter executes source instructions directly. The source remains in its original form.

Many languages may be either compiled or interpreted, although some features of a language may make compilation difficult, if not impossible. The interpreted language can change its interpretation as it receives new data, while the compiler does not know what data the program will receive until after it has finished its work.

### Comparison of the Methods:

Each of the methods is used in the commercial computing world, indicating that there is sound economic need for each. The methods may intermingle, as in compilers that accept assembler language code, incremental compilers, which are a cross between interpreting and compiling, and compilers which produce interpretive object code. Fig. 5 illustrates many common considerations of the various language processors.

### Disadvantages of Assemblers

Because the programmer must detail each operation of the computer, his workload is much greater than with higher level languages. His chances for making an error are much greater than in high-level languages. The programmer can easily become enmeshed in the maze of details he must remember. Modifying an intricate assembler language program may be very difficult, if not impossible. Assemblers are not usually interactive, requiring the entire program to be re-assembled when an error is made.

### Advantages of Compilers

The compiler is capable of supporting much higher level languages than assembler or macro assembler. The programmer can work faster, make fewer errors, and learn the language faster than he can assembler. The compiler's object code may be executed much faster than an interpreter could execute the program (between 5 and 10 times faster). Programs written in the higher level language may be recompiled on a new type of computer, without modifying the program.

### Disadvantages of Compilers

Compilers are usually large, complex programs which require some time to compile a program, in addition to a significant amount of off-line storage. Compilers are not

usually interactive, because they require an entire program to be recompiled when a single change must be made.

Due to the internal workings of the compiler, data types must be fixed during compilation. This process, known as binding, reduces the program's ability to adapt to new data as the program is executed. An interpreter, however, does not bind its variables until execution.

### Advantages of the Interpreter

Since the interpreter executes its source code directly, the programmer may interact more directly with the computer. Usually, the interpreter provides a direct mode, where the programmer may execute statements directly as he enters them, and an indirect mode, where his commands are stored in a program for later execution. The programmer can usually stop the program, examine variables, and resume execution. Some interpreters (such as APL and MUMPS) provide an EXECUTE command, which allows the program to execute a character string as if it were program text. Conversely, some interpreters (MUMPS) allow a program to treat its own text as data. Interpreters are useful for systems where the language processor needs to be 'built in' to the computer, as in intelligent terminals.

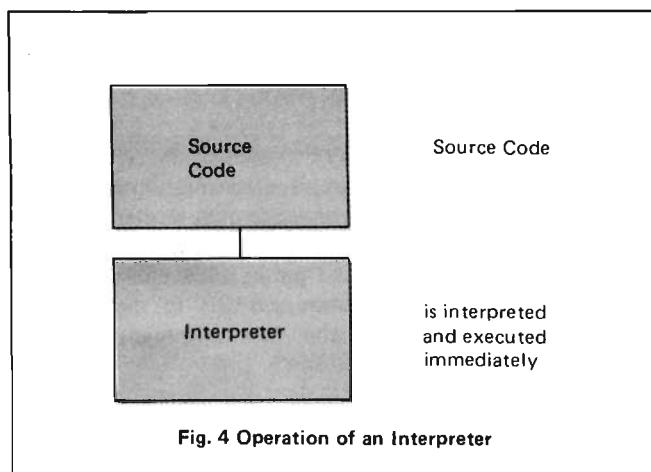


Fig. 4 Operation of an Interpreter

| Characteristic                 | Compiler     | Interpreter           | Assembler     |
|--------------------------------|--------------|-----------------------|---------------|
| Binding Time                   | Compile much | Execution little/none | Assembly much |
| Off line Storage               | medium       | low                   | high          |
| CPU Efficiency                 | medium       | high                  | low           |
| Programmer Efficiency          | medium       | medium                | small         |
| Program Size                   | large        | source                | machine       |
| Error Detection                | machine      | source                | machine       |
| Language                       |              |                       |               |
| Interactive                    |              |                       |               |
| Debugging                      | no           | yes                   | no            |
| Language Processing Efficiency | low          | medium                | high          |

Fig 5 Comparison of the features of the various types of language processors.

- Binding time — the point when the program's data types are fixed.
- Offline Storage — the amount of storage such as floppy disks, cassettes, etc, required for the language processor to work.
- CPU Efficiency — of the program being processed.
- Programmer Efficiency — of the programmer writing the program to be processed.
- Program Size — of the object code, or source code, in the case of the interpreter.
- Error Detection Language — the language in which run time errors are detected.

### Disadvantages of the Interpreter

Interpreters tend to be slower than compilers, between 5 and 10 times slower, as a rule of thumb. This slowness is due to the interpreter's need to analyze each statement every time it sees it, whereas the compiler need analyze it only once. The interpreter program must remain in memory for even a small program.

### A Bit of History

The first computers were large, expensive devices requiring a roomful of air conditioning just to keep them cool. Programming them was very difficult, and they ran quite slow:

"...the machine will then continue in operation hour after hour, completely checking its own results until either the problem is solved, or a breakdown occurs" (A Manual of Operation for the Automated Sequence Controlled Calculator, Harvard University, 1946).

At that time, a computer cost millions of dollars, and a programmer cost a few hundred dollars per month. Today, a computer costs hundreds of dollars, and the programmer costs thousands of dollars per month. To put it in another way, in 1946 a computer cost the equivalent of 250 programmers, today the programmer costs the equivalent of 100 computers.

Everyone agrees that computers should be used 'efficiently'. The problem is that people think of making the CPU efficient, not the person using it. The microcomputer has undermined the conventional wisdom of computer efficiency. The person who spends several month's rent on a personal computer wants to see it do something for him immediately, regardless of whether it uses the CPU 'efficiently'. Chances are he uses the computer only a few hours a day. On the other hand, the professional programmer who works as one of a score of programmers using a large computer must contend with CPU efficiency in order to keep from overloading the computer.

The microcomputer user needs to worry about CPU efficiency only when he reaches some limit — not enough memory response not fast enough, etc. Since no one else is waiting to use his computer, he does not have to worry about inefficiencies which do not force him beyond his limits.

The large computer programmer, however, must constantly worry about sharing the computer with all the other users. Even if a program works fast enough for him, and uses little enough memory, it still must be made 'efficient' for the other users of the system.

As a result of this historical concern for CPU efficiency, people are fixated on "making the computer run efficiently". Language design has been heavily weighted in favor of making the computer efficient, not the programmer.

The personal computing software scene was a completely unforeseen turn of events. None of the language designers ever thought that the programmer would be working alone on his own computer. As a result, the design tradeoffs were heavily slanted in favor of the commercial user.

### Which language is Best?

"I speak Spanish to God, Italian to women, French to men, and German to my horse".

Charles V of France

What is the best language? BASIC? Assembler? PL/M,

|   |   |  |
|---|---|--|
| <b>PROGRAM</b><br><b>LINE</b><br><br><b>LINE NUMBER</b><br><b>COMMANDS</b><br><b>ARGUMENTS</b>            | <b>PROGRAM</b><br><b>STATEMENTS</b><br><br><b>LABEL</b><br><b>OPERATION CODE</b><br><b>OPERANDS</b>                         | <b>PROGRAM</b><br><b>BLOCK</b><br><br><b>STATEMENTS</b><br><br><b>EXPRESSIONS</b>              |
| <b>Fig. 6 BASIC Program Elements</b>  | <b>Fig. 7 Assembler Program Elements</b>  | <b>Fig. 8 PL/M Program Elements</b>  |
| <b>PROGRAM</b><br><b>ROUTINE</b><br><br><b>LINE</b><br><b>LABEL</b><br><b>COMMAND</b><br><b>ARGUMENTS</b> | <b>WORKSPACE</b><br><b>FUNCTION</b><br><b>LINE</b><br><br><b>OPERATORS</b><br><b>LITERALS</b><br><b>FUNCTION REFERENCES</b> | <b>PROGRAM</b><br><b>GROUP</b><br><br><b>LINE NUMBER</b><br><b>COMMAND</b><br><b>ARGUMENTS</b> |
| <b>Fig. 9 MUMPS Program Elements</b>  | <b>Fig. 10 APL Program Elements</b>   | <b>Fig. 11 FOCAL Program Elements</b>  |

MUMPS, APL, PASCAL, FORTRAN, SNOBOL, COBOL, LISP, COMIT, MAD, or any of the hundreds of others? And after the best language is chosen, which dialect is best? Consider the dialects of BASIC: Tiny BASIC, Extended BASIC, BASIC Plus, Business BASIC, ANSI BASIC . . .

Perhaps a good analogy could be drawn between computer languages and spoken languages. Which spoken language is best? English? French? Chinese? Italian? It all depends on what you want to do with it. If you are in Paris, French would be a good contender for the 'best' language. Suppose you are in Kansas, and believed Charles' statement above that Italian is best for speaking to women. Romantic pretensions aside, you would probably have better luck with English.

The "best" computer language is not selected on the basis of its syntax or grammar. It is a very pragmatic decision based on what is available, what the programmer knows, whether it can perform the task at hand, and what programs are available to him from other sources.

The selection of a computer language is an important decision to the personal programmer for many reasons beyond the above pragmatic ones. The language a programmer uses profoundly affects the way he sees a problem. As Whorf said, "We dissect nature along lines laid down by our native language". The APL programmer thinks in terms of vectors, the MUMPS programmer thinks in terms of data bases, and the Assembly language programmer thinks in terms of individual bytes of memory.

Therefore, in reviewing each of the languages, the reader must apply them to his own needs. The following list is a sample of some of the languages available (or may be soon) to the micro-computer user.

**BASIC** – (Beginner's All purpose Symbolic Instruction Code). This is the most common high-level language used on personal computers. It is a very simple, easy to learn language. There is a large library of programs available,

since BASIC is used in many universities and schools. Because it is a simple language, it is somewhat limited and difficult to use for some complex problems. BASIC is usually interpreted on microcomputers, although some compilers exist. Programs written in BASIC for one computer can often be run on another with only slight changes.

**Assembler** – Assembler language is commonly used on personal computers. Since many personal computers have neither the memory or Input/Output capability to run an assembler, the programmer often manually assembles his program and enters it through the switches on the panel. Assembler language is unique to each computer, so program exchange is limited to one particular computer type.

Assembler language is the common denominator of all programs – eventually, all programs are just a sequence of assembler-level instructions. Therefore, any one wishing to really know how his computer works must learn at least a little Assembler. Often, a program is written in a high-level language which calls an Assembler language subroutine for difficult or critical portions of logic. This can be a very economical mix for programs which exceed the limits of a high-level language.

**PL/M** – (A program name copyrighted by Intel Corp.) is a compiled language derived from IBM's PL/I. Versions exist for the 8080, 6800, and Signetics 2650. Some high speed, mass storage (floppy disk, for example) is required. It is an alternative to assembler, producing slightly less efficient programs in much less programming time. A basic user would find PL/M difficult to use for simple problems, but easier to use for more complex problems. There is no extensive library of programs in PL/M as with BASIC.

**MUMPS** – (Massachusetts General Hospital Utility Multi-Programming System) is an interpretive language oriented towards interactive data management applications. MUMPS has many characteristics of BASIC, FOCAL, and IBM's PL/I. It differs from all these in that it has built-in data base capabilities for handling data on mass storage devices. Although not widely available on microcomputers now, the National Bureau of Standards published a standard version (NBS Handbook 118) which details how one would write an interpreter for MUMPS.

MUMPS has extensive data handling capabilities, suited for applications such as personal accounting, word processing, and general information systems. Since the development of MUMPS was federally supported, much MUMPS software is in the public domain.

**APL** – (A Programming Language) is a computer language derived from Iverson's elegant mathematical notation. It is a very powerful mathematical tool, having primitive functions for matrix inversion, inner products, sorting, and many other areas. Although initially developed for large scale computers, it is now available for portable commercial computers. APL is usually interpreted, and therefore well suited for interactive personal computing.

**FOCAL** – (Formulating On-Line Calculations in Algebraic Language) is a language brought out as an early on-line language for calculations. Its syntax is similar to MUMPS, although its functions are closer to BASIC. FOCAL is available on the 8080 and has a modest programming library.

#### *Learning a Computer Language*

Your first task in learning a new language is to build up a basic understanding of the language. This can be gained from the reference manual for the language distributed with the software. Magazines such as Personal Computing carry many articles on the more popular languages. There is a variety of books available in libraries and computer stores, and more advertised in professional data processing magazines.

When studying a language, it is helpful to divide the project into three areas:

SYNTAX – How you say something

SEMANTICS – What you mean

PRAGMATICS – How you make the language do what you want

**Syntax.** The syntax of the language is usually the quickest part to learn. How does the language distinguish between a number and a variable? Do you need a number before each line? What characters are allowed by the language?

**Semantics.** The semantic aspects of the language are more difficult to learn, but you do not have to understand everything to use the language. What are arithmetic functions in the language? How do you retrieve data from the terminal? How do you format output?

**Pragmatics.** This is the most difficult portion to learn, yet it is the skill most easily carried over to other languages. How do you make the language solve your problem? How do you create, change, and delete programs? Can you stop the program while it is executing, examine the state of things, then resume execution?

These three classifications are very useful for comparing languages. For example, BASIC, FOCAL and FORTRAN have similar semantics but different syntaxes. MUMPS and

FOCAL have similar syntaxes, but different semantics.

With this background, you should be able to modify a simple program to make it do increasingly complex tasks. Each time you modify the program, use some new aspect of the language, being careful to add one aspect at a time. Then, try the new version to see if it does what you expect.

Each step of the way, you will be informed of your mistakes by your friendly adversary, the computer.

#### *The Importance of Making Errors*

"Nine times out of ten, in the arts as well as life, there is actually no truth to be discovered; there is only error to be exposed."

H.L. Mencken

Making an error in a computer program is a fundamental source of learning. You tried something and the computer told you it didn't work. The programmer who proudly announces "my last program worked the first time without any bugs" is a programmer who probably did not learn anything new writing it.

| BASIC MUMPS APL FOCAL PL/M FORTRAN |   |   |   |   |   |   |
|------------------------------------|---|---|---|---|---|---|
| Integer<br>(16 Bit)                | X | X | X | X | X | X |
| Byte                               |   |   | X |   | X |   |
| Character<br>String                | X | X |   |   |   |   |
| Floating<br>Point                  | X | X | X | X |   | X |
| Logical                            |   | X | X |   |   | X |
| Labels                             | X |   |   |   |   |   |

Fig. 12 Cross Index of Data Element Types

| BASIC MUMPS APL FOCAL PL/M FORTRAN |       |       |    |      |        |        |
|------------------------------------|-------|-------|----|------|--------|--------|
| Assignment                         | LET   | SET   | ←  | SET  | =      | =      |
| Read<br>from<br>Console            | INPUT | READ  | ←□ | ASK  | INPUT  | INPUT  |
| Write to<br>Console                | PRINT | WRITE | □← | TYPE | OUTPUT | OUTPUT |

Fig. 13 Cross Index of Data Movement

| BASIC MUMPS APL FOCAL PL/M FORTRAN |              |      |      |      |      |        |
|------------------------------------|--------------|------|------|------|------|--------|
| Uncondi-<br>tional<br>Branch       | GOTO         | GOTO | →    | GO   | GOTO | GOTO   |
| Condi-<br>tional<br>Branching      | IF           | IF   | →    | IF   | IF   | IF     |
| Invola-<br>tion                    | GO<br>SUB    | DO   | NAME | DO   | CALL | CALL   |
| Return<br>from<br>Invola-<br>tion  | RE-<br>TURN  | QUIT | →0   | QUIT | END  | RETURN |
| Looping                            | FOR/<br>NEXT | FOR  |      | FOR  | DO   | DO     |

Fig. 14 Cross Index of Control of Flow

|                          | BASIC | MUMPS | APL | FOCAL | PL/M | FORTRAN |
|--------------------------|-------|-------|-----|-------|------|---------|
| And                      | &     | ^     |     |       |      |         |
| Or                       | l     | v     |     |       |      |         |
| Not                      | '     | ~     |     |       |      |         |
| Greater                  |       |       |     |       |      |         |
| Than >                   | >     | >     | >   | *     |      |         |
| Less                     |       |       |     |       |      |         |
| Than <                   | <     | <     | <   | *     |      |         |
| Equal =                  | =     | =     | =   | *     |      |         |
| Not Equal <>             |       |       |     | *     |      |         |
| Less Than                |       |       |     | *     |      |         |
| Than <=                  |       |       | <=  | *     |      |         |
| Or Eq.                   |       |       |     |       |      |         |
| Greater Than or Equal => |       |       | >   | *     |      |         |

Fig. 15 Logical and Arithmetic Comparison Function

\*handled by IF statement structure.

|                            | BASIC | MUMPS | APL | FOCAL | PL/M |  |
|----------------------------|-------|-------|-----|-------|------|--|
| Addition                   | +     | +     | +   | +     | +    |  |
| Subtraction                | -     | -     | -   | -     | -    |  |
| Divide                     | /     | /     | +   | /     | /    |  |
| Multiply                   | *     | *     | X   | *     | *    |  |
| Exponentiation             | ↑     |       | *   | FExP  |      |  |
| Square root                | SQR   |       | .5  | FSQT  |      |  |
| Cosine                     | COS   |       | 2°  | FCOS  |      |  |
| Tangent                    | TAN   |       | 3°  |       |      |  |
| SINE                       | SIN   |       | 1°  | FSIN  |      |  |
| e <sup>x</sup> Exponential | EXP   |       | *   | EXP   |      |  |
| Natural log                | LOG   |       | @   | FLOG  |      |  |
| Absolute Val               | ABS   |       | I   | FABS  |      |  |
| Greatest Integer           | INT   | \$R   | ◻   | FITR  |      |  |
| Random Number              | RND   |       | ?   | FRAN  |      |  |
| Signum                     | SGN   |       | X   | FSGN  |      |  |
| Modulo                     | #     |       | I   |       |      |  |

Fig. 16 Cross Index of Arithmetic Functions

The absence of an error when writing a program indicates only that a situation new to the programmer did not come up — not that the programmer has learned the language.

There are generally four types of errors: syntax, semantic, pragmatic, and covert.

### Syntax errors

The syntax error is the most common error which faces the beginning programmer. A syntax error is a statement that violates the language's basic rule for expression. Typically, they are caused by:

- typing errors — a finger slips to the wrong key, a zero instead of the letter O, etc.
- misunderstanding the syntax. The new programmer may not understand that he has to put a comma between variables in a print statement, or put apostrophes around literals.
- confusing the syntax. The programmer might confuse a colon and the comma, or, he might carry over some syntax from another language he knows.

One thing in common with all these errors is that the computer can detect them. In most interpreters, the programmer may directly enter and execute any questionable statements.

The lesson is clear: When in doubt, try it. Let the computer tell you whether it will accept the statement. Many manuals are not reliable enough to trust anyway.

The above advice flies directly in the face of conventional computer programming wisdom. In the past, there was considerable stigma attached to anyone found 'letting the computer do his debugging'. The theory was, that the computer is a valuable resource, and that a programmer should not waste computer time. Instead, he should carefully desk-check his program before each submission. In the microcomputer world, this philosophy is radically altered. It makes no sense for the programmer to check his work on paper when his computer is waiting for him to enter it.

### Semantic errors

These errors are also common in the early stages of learning a new language, but continue to plague the programmer throughout the use of the language. These errors are statements which are syntactically correct, but do not perform the function desired by the programmer. Some typical semantic errors are:

- Mode errors — the programmer tries to add a number to a character string, but the language does not handle the conversion.
- Binding errors — the programmer names the wrong variable, label or subroutine.
- Juxtaposition or sequencing errors. An end of a loop is placed too far down in the program, or a variable is used before it is initialized.

Most of the same advice for syntax errors applies to grammatical errors. Sometimes, grammatical errors can slip through and only be detected by erratic program behavior.

### Pragmatic errors

The pragmatic error is a statement which is syntactically and semantically correct, but does not do what the programmer wants it to. These cannot be caught by the language processor. Typical pragmatic errors are:

- wrong function or command — the programmer uses a sine function instead of cosine.
- an improper formula — the programmer thought that Interest was Principal divided by Rate instead of Principal times Rate.

Pragmatic errors tend to be the last errors in a program to be detected, if only because the programmer will not see them until he cleans up the syntax and semantic errors and the program executes.

Pragmatic errors can be very difficult to detect, particularly in programs which are time dependent or involve much

|                          | BASIC | MUMPS                | APL              | FOCAL PL/M   |
|--------------------------|-------|----------------------|------------------|--------------|
| Search Extract           |       | MID\$ LEFT\$ RIGHT\$ | \$FIND \$EXTRACT | ? SUBSCRIPTS |
| Concatenation            |       |                      | -                |              |
| Convert String to Number |       |                      | \$ASCII          |              |
| Convert Number to String |       |                      | \$CHAR           |              |
| Length                   | LEN\$ |                      | \$LENGTH         |              |

Fig. 17 Cross Index String Functions

logic. Pragmatic errors are generally discovered with what the computing world euphemistically calls "testing". "I'll test this program to make sure it won't blow up," is an often heard phrase. Unfortunately after he completes his testing, he all too often says "my program blew up".

Testing can confirm the existence of an error, not that one doesn't exist. Just because 99 combinations of input data were tried does not guarantee that the hundredth combination will not fail.

#### Covert errors

When a program is tested and declared correct by the programmer, any remaining errors are by definition covert. These are insidious problems that appear only when events combine to form some previously untried condition. Some covert errors are:

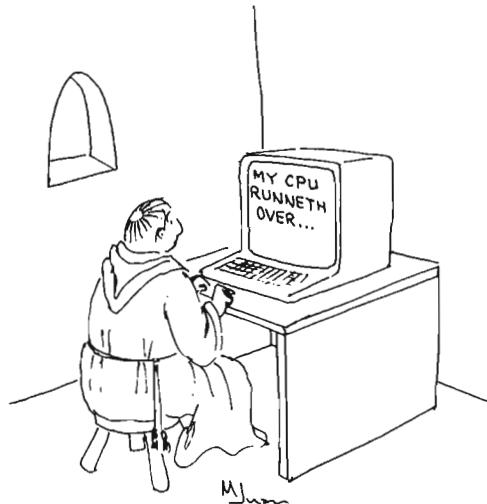
- a) An angle in a trigonometric equation goes to zero, causing a zero divide error in a later division.
- b) Improper data is entered, which the program does not reject as invalid. Recently, a program sent out a letter to the Emmet County Jail, "Dear Emmet C. Jail, you are among a select group of persons . . ." As the saying goes — garbage in, garbage out.
- c) The programmer leaves room for only 3 digits of a number, but the number grows past 999.

Covert errors always have and always will exist in computer software. However, a great deal of attention in computer science circles has been given to writing programs which may be "proved" correct. These efforts, named "structured programming", "software engineering", and "composite design" will be covered in a future article. The

fundamental principles common to these are:

- a) Break the big problem into clusters of independent little problems.
- b) Link the clusters together in a hierarchical manner such that each cluster is independently testable.
- c) Limit the number of paths the program may take. This is accomplished by limiting the use of the GOTO statement.

The programmer should learn to improve his skills by analyzing the errors he makes. When he meets that benevolent dictator of linguistic purity — the error message — he should treat it as a means of learning a little more about the language.



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Updates