CUS, COMPUTER USERS TAPE SYSTEM

ASSEMBLY and TEST INSTRUCTIONS
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PROCESSOR TECHNOLOGY CORPORATION
CUTS, COMPUTER USERS TAPE SYSTEM

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SECTION I

INTRODUCTION and

GENERAL INFORMATION

CUTS, COMPUTER USERS TAPE SYSTEM
1.1 INTRODUCTION

This manual supplies the information needed to assemble, test and use the CUTS, Computer Users Tape System. 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 2-1) in Section II. 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 CUTS Description

CUTS, The Computer Users Tape System is a high speed, simple to use audio cassette interface that operates at 300 and 1200 bps data rates under program control. The recording technique used is asynchronously Manchester coded at 1200 or 2400 Hz and is CUTS/Byte/Kansas City Standard compatible.

Two separate tape transport control outputs and two common audio inputs and outputs are provided to drive one or two recorders. In addition, CUTS has provision for selecting 1) a low level audio output signal for driving the microphone input to an audio recorder, 2) a high level audio output signal for driving the auxiliary input to an audio recorder, and 3) a 5-volt peak-to-peak square wave output for driving a digital recorder. A fully automatic gain control operates in the read mode. Unlike other cassette interfaces, CUTS has absolutely no critical adjustments that must be preset or adjusted during operation.

NOTE

All Processor Technology software is available on CUTS cassettes at lower cost than equivalent paper tapes.

1.2.2 Receiving Inspection

When your kit arrives, examine 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 module to Processor Technology should it become necessary to do so.) If your CUTS 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 that 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, 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 products. Before returning the unit to Processor Technology, 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.)
SECTION II

ASSEMBLY

and

TEST

CUTS, COMPUTER USERS TAPE SYSTEM
2.1 PARTS AND COMPONENTS

Check all parts and components against the "Parts List" (Table 2-1 on Page II-2). If you have difficulty in identifying any parts by sight, refer to Figure 2-1 on Page II-3.

2.2 ASSEMBLY TIPS

1. Scan Section II in its entirety before you start to assemble your CUTS kit.

2. In assembling your CUTS, you will be following a step-by-step assembly procedure. FOLLOW THE 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 CUTS PC board and the assembly drawing. (These aids are designed to assist you in correctly installing the components.)

   a. The circuit reference (R3, C10 and U7, for example) for each component is silk screened on the PC board near the location of its installation.

   b. Both the circuit reference and value or nomenclature (1.5K and 74LS08, for example) for each component are included on the assembly drawing near the location of its installation.

5. To simplify reading resistor values after installation, install resistors so that their color codes read from left-to-right and top-to-bottom as appropriate (board oriented as defined in Paragraph 2.5 on Page II- ).

6. Unless specified otherwise in the instructions, install components--especially disc capacitors--as close to the board as possible.

7. Should you encounter any problem during assembly, call on us for help if needed.
### Table 2-1. Cuts Parts List

<table>
<thead>
<tr>
<th>INTEGRATED CIRCUITS</th>
<th>TRANSISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1458 or 5558 (U6)</td>
<td>3 2N2222 (Q1, Q3 &amp; Q4)</td>
</tr>
<tr>
<td>2 4013 (U3 &amp; U4)</td>
<td>1 2N2907 (Q5)</td>
</tr>
<tr>
<td>1 4019 (U9)</td>
<td>1 2N4360 (Q2)</td>
</tr>
<tr>
<td>1 4023 (U1)</td>
<td></td>
</tr>
<tr>
<td>1 4024 (U10)</td>
<td></td>
</tr>
<tr>
<td>1 4027 (U2)</td>
<td></td>
</tr>
<tr>
<td>1 4030 (U19)</td>
<td></td>
</tr>
<tr>
<td>1 4046 (U11)</td>
<td></td>
</tr>
<tr>
<td>1 4049 (U22)</td>
<td></td>
</tr>
<tr>
<td>1 4520 (U8)</td>
<td></td>
</tr>
<tr>
<td>1 6011 (U18)</td>
<td></td>
</tr>
<tr>
<td>1 74LS04 (U24)</td>
<td></td>
</tr>
<tr>
<td>2 74LS08 (U25 &amp; U26)</td>
<td></td>
</tr>
<tr>
<td>1 74LS109 (U20)</td>
<td></td>
</tr>
<tr>
<td>1 74LS132 (U21)</td>
<td></td>
</tr>
<tr>
<td>2 74LS136 (U14 &amp; U15)</td>
<td></td>
</tr>
<tr>
<td>1 74LS155 (U23)</td>
<td></td>
</tr>
<tr>
<td>1 74LS163 (U12)</td>
<td></td>
</tr>
<tr>
<td>1 74LS175 (U13)</td>
<td></td>
</tr>
<tr>
<td>2 74367 (U16 &amp; U17)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REGULATORS</th>
<th>2 DIP Reed, Sigma 191TE1A1-55 (K1 &amp; K2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 7805UC or LM340T-5.0 (U7)</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>1 78L12 (U5)</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>1 N4148 (D1, D2 &amp; D4)</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>1 N5242 (D3)</td>
<td>------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIODES</th>
<th>RELAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 N4148 (D1, D2 &amp; D4)</td>
<td>2 DIP Reed, Sigma 191TE1A1-55 (K1 &amp; K2)</td>
</tr>
<tr>
<td>1 N5242 (D3)</td>
<td>------------------------------------------</td>
</tr>
</tbody>
</table>

**II-2**
Table 2-1. CUTF Parts List (Continued).

<table>
<thead>
<tr>
<th>RESISTORS</th>
<th>CAPACITORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 39 ohm, 2 watt, 5%</td>
<td>1 470 pfd, disc</td>
</tr>
<tr>
<td>1 100 ohm, 1/4 watt, 5%</td>
<td>4 .001 uf, disc</td>
</tr>
<tr>
<td>2 470 ohm, 1/4 watt, 5%</td>
<td>1 .001 uf, Mylar tubular</td>
</tr>
<tr>
<td>3 1.5K ohm, 1/4 watt, 5%</td>
<td>1 .01 uf, Mylar tubular</td>
</tr>
<tr>
<td>9 10 K ohm, 1/4 watt, 5%</td>
<td>19 .1 uf, disc</td>
</tr>
<tr>
<td>4 100 K ohm, 1/4 watt, 5%</td>
<td>2 1 uf, tantalum dipped</td>
</tr>
<tr>
<td>2 150 K ohm, 1/4 watt, 5%</td>
<td>3 15 uf, tantalum dipped</td>
</tr>
<tr>
<td>2 1 M ohm, 1/2 watt, 5%</td>
<td></td>
</tr>
<tr>
<td>1 2.2M ohm, 1/4 watt, 5%</td>
<td></td>
</tr>
<tr>
<td>1 50 K ohm Potentiometer</td>
<td></td>
</tr>
<tr>
<td>2 2.2K ohm Resistor Network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Molex Crimp Pins for Female</td>
</tr>
<tr>
<td></td>
<td>Mating Connector</td>
</tr>
<tr>
<td>11 14-pin DIP Socket</td>
<td>3 Augat Pin</td>
</tr>
<tr>
<td>11 16-pin DIP Socket</td>
<td>1 Length #24 Bare Wire</td>
</tr>
<tr>
<td>1 40-pin DIP Socket</td>
<td>1 Length Solder</td>
</tr>
<tr>
<td>1 8-position DIP Switch</td>
<td>3 6-32 x 1/2 Screw</td>
</tr>
<tr>
<td>2 Right Angle Molex Connector,</td>
<td>3 #6 Lockwasher</td>
</tr>
<tr>
<td>Male (J1 &amp; J2)</td>
<td>3 6-32 Hex Nut</td>
</tr>
<tr>
<td>2 Mating Connector for Above,</td>
<td>1 Manual</td>
</tr>
<tr>
<td>Female (P1 &amp; P2)</td>
<td></td>
</tr>
</tbody>
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## Figure 2-1. Identification of components.

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRANSISTOR</strong> TO-18 Package (Metal Can)</td>
<td><img src="image1.png" alt="Image of TO-18 Package" /></td>
</tr>
<tr>
<td><strong>TRANSISTOR</strong> TO-92 Package (Plastic)</td>
<td><img src="image2.png" alt="Image of TO-92 Package" /></td>
</tr>
<tr>
<td><strong>TRANSISTOR, POWER or REGULATOR IC</strong> TO-220 Package</td>
<td><img src="image3.png" alt="Image of TO-220 Package" /></td>
</tr>
<tr>
<td><strong>CARBON RESISTOR</strong></td>
<td><img src="image4.png" alt="Image of Carbon Resistor" /></td>
</tr>
<tr>
<td><strong>METAL FILM PRECISION RESISTOR (1% Tolerance)</strong></td>
<td><img src="image5.png" alt="Image of Metal Film Resistor" /></td>
</tr>
<tr>
<td><strong>RESISTOR NETWORK</strong></td>
<td><img src="image6.png" alt="Image of Resistor Network" /></td>
</tr>
</tbody>
</table>

5% (gold), 10% (silver)

See Appendix III for Color Code
Figure 2-1. Identification of components.
2.3 ASSEMBLY PRECAUTIONS

2.3.1 Handling MOS Integrated Circuits

Many of the IC's used in the CUTS 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 handling these IC's.

2.3.2 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 it.

6. The CUTS circuit board has 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 CUTS circuit board 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. DO, however, check all solder joints for possible bridges.

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

2.3.3 Installing and Removing CUTS Module

NEVER install the CUTS in, or remove it from the computer with the power on. To do so can damage the module.

2.3.4 Installing and Removing Integrated Circuits.

NEVER install or remove integrated circuits while power is applied to the CUTS. To do so can damage the IC.
2.3.5 Use of Clip Leads

NEVER attach clip leads to the top edge of the CUTS PC board. To do so can short the +8, +16 and -12 V dc buses to one another.

2.4 REQUIRED TOOLS, EQUIPMENT AND MATERIALS

The following tools, equipment and materials are recommended for assembling and testing the CUTS Module:

1. Needle nose pliers
2. Diagonal cutters
3. Scredriver
4. Sharp knife
5. Controlled heat fine tip soldering iron, 25 watts
6. 60-40 rosin-core solder (supplied)
7. #24 bare wire (supplied)
8. Volt-ohm meter

2.5 ORIENTATION

The heat sink area (large foil area) will be located in the upper right-hand corner of the board when the edge connector is at the bottom. In this position, the component (front) side of the board is facing up and the solder (back) side is facing down. In addition the IC legends (U1 through U4, U8 through U15, etc.) will read from left to right. Subsequent position references in the instructions related to the CUTS PC board assume this orientation.

2.6 ASSEMBLY-TEST

Refer to the assembly drawing in Section VI.

CAUTION

THE CUTS MODULE USES MANY MOS AND CMOS 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 THESE IC's. (STATIC CHARGE PROBLEMS ARE MUCH WORSE IN LOW HUMIDITY CONDITIONS.)
2.6.1 Circuit Board Check

(✓) Visually check CUTS PC board for solder bridges (shorts) between traces, broken traces and similar defects.

(✓) Check board to insure that the +8-volt line, +16-volt line, +5-volt bus, +12-volt bus and -12-volt bus are not shorted to one another or to ground. Using an ohmmeter, make the following measurements (refer to CUTS assembly drawing in Section VI.):

(✓) +8-volt Line Test. Measure between edge connector pin 1 or 51 (left end of connector) and pin 50 or 100 (right end of connector). There should be no continuity.

(✓) +16-volt Line Test. Measure between edge connector pin 2 or 52 and pin 50 or 100. There should be no continuity.

(✓) 8/16 Volt Line Test. Measure between edge connector pin 1 or 51 and pin 2 or 52. There should be no continuity.

(✓) +5-volt Bus Test. Measure between the upper mounting pad for D2 (to the left of location K2) and pin 50 or 100 of the edge connector. There should be no continuity.

(✓) +12-volt Bus Test. Measure between upper mounting pad for C9 (in upper right corner below C8) and pin 50 or 100 of edge connector. There should be no continuity.

(✓) -12-volt Bus Test. Measure between upper mounting pad for C18 (between U16 and U17) and pin 50 or 100 of edge connector. There should be no continuity.

(✓) 5/12/(-12) Volt Bus Test. Measure between upper mounting pad for C21 (lower left corner) and upper pad for C9, between upper pad for C21 and upper mounting pad for C18, and between upper pad for C9 and upper pad for C18. You should measure no continuity in any of the three 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, go on to next paragraph.
2.6.2 Assembly-Test Procedure

Step 1. Install heat sink. Position the large, black heat sink (flat side to board) over the square foil area in the upper right corner. Orient the sink so that the two triangles of mounting holes in the board are under the two triangular cutouts in the sink. Using two 6-32 screws, lockwashers and nuts, attach heat sink to board. Insert the screws from back (solder) side of board. (See Figure 2-2.)

Step 2. Install U7 (7805UC or LM340T-5.0). Position U7 over left-hand cutout in heat sink and observe how the leads must be bent to fit the mounting holes. Note that the center lead (3) must be bent downwards at a point approximately 0.2 inches further from the body than the other two leads. Bend the leads so that no contact is made with the heat sink when U7 is flat against the sink and its mounting hole is aligned with the hole in the sink. Fasten U7 to sink using a 6-32 screw, lockwasher and nut. Insert screw from back (solder) side of board. Solder and trim leads. (Refer to Figure 2-2.)

Figure 2-2. Heat sink and U7 installation.
Step 3. Install male Molex right angle connectors in locations J1 and J2. Position connector with longer pins facing the top of the board, insert leads in mounting holes and solder.

Step 4. Install diodes D1, D2 and D4 (1N4148) in their respective locations. Position D1 and D2 with their dark band mark (cathode) at the top and position D4 with its band at the right. Solder and trim leads.

Step 5. Install diode D3 (1N5242) in its location. Position D3 with its dark band mark (cathode) at the right.

Step 6. Install transistors Q1, Q3 and Q4 (2N2222) in their respective locations. Position Q1 with its emitter lead (closest to tab on can) at the top and its base lead at the left. Position both Q3 and Q4 with their emitter leads at the right and their base leads at the top. Insert leads and push straight down on transistor until it is 3/16" above the surface of the board. Solder and trim leads.

Step 7. Install transistor Q2 (2N4360) in its location. Position Q2 with its flat side at the bottom, insert leads and push straight down on transistor until it is 3/16" above the surface of the board. Solder and trim leads.

Step 8. Install transistor Q5 (2N2907) in its location. Position Q5 with its emitter lead (closest to tab on can) at the right and its base lead at the top. Insert leads and push straight down on transistor until it is 3/16" above the surface of the board. Solder and trim leads.

Step 9. Install all resistors in numerical order in the indicated locations. Bend leads to fit distance between mounting holes, insert leads, pull down snug to board, bend leads outward on solder (back) side of board, solder and trim.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>VALUE (ohms)</th>
<th>COLOR CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>100 K</td>
<td>brown-black-yellow</td>
</tr>
<tr>
<td>R2</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R3</td>
<td>1.5K</td>
<td>brown-green-red</td>
</tr>
<tr>
<td>R4</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R5</td>
<td>1.5K</td>
<td>brown-green-red</td>
</tr>
<tr>
<td>R6</td>
<td>1.5K</td>
<td>&quot;</td>
</tr>
<tr>
<td>R7</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R8</td>
<td>150 K</td>
<td>brown-green-yellow</td>
</tr>
<tr>
<td>R9</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R10</td>
<td>1 M</td>
<td>brown-black-green</td>
</tr>
<tr>
<td>R11</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
</tbody>
</table>

Continued on Page II-11.
Step 9 continued.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>VALUE (ohms)</th>
<th>COLOR CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R12</td>
<td>2.2M</td>
<td>red-red-green</td>
</tr>
<tr>
<td>R13</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R14</td>
<td>150 K</td>
<td>brown-green-yellow</td>
</tr>
<tr>
<td>R15</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R16</td>
<td>470</td>
<td>yellow-violet brown</td>
</tr>
<tr>
<td>R17</td>
<td>100</td>
<td>brown-black-brown</td>
</tr>
<tr>
<td>R18</td>
<td>100 K</td>
<td>brown-black-yellow</td>
</tr>
<tr>
<td>R19</td>
<td>10 K</td>
<td>brown-black-orange</td>
</tr>
<tr>
<td>R20</td>
<td>10 K</td>
<td>&quot;</td>
</tr>
<tr>
<td>R21</td>
<td>470</td>
<td>yellow-violet-brown</td>
</tr>
<tr>
<td>R22</td>
<td>39,2 watt</td>
<td>orange-white-black</td>
</tr>
<tr>
<td>R23</td>
<td>100 K</td>
<td>brown-black-yellow</td>
</tr>
<tr>
<td>R24</td>
<td>100 K</td>
<td>&quot;</td>
</tr>
<tr>
<td>R25</td>
<td>1 M</td>
<td>brown-black-green</td>
</tr>
<tr>
<td>VR1</td>
<td>50 K</td>
<td>Potentiometer</td>
</tr>
</tbody>
</table>

Step 10. Install resistor networks RX1 and RX2 (2.2K ohms) in their respective locations. Position RX1 so that the dot on its package is at the right end. Position RX2 with its dot at the left end.

**CAUTION**

THESE RESISTOR NETWORKS ARE DELICATE. HANDLE WITH CARE.

Step 11. Install the five tantalum capacitors in the following locations. Take care to observe proper values and the correct orientation.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>VALUE (ufd)</th>
<th>ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C7</td>
<td>15</td>
<td>&quot;+&quot; lead left</td>
</tr>
<tr>
<td>C8</td>
<td>15</td>
<td>&quot;+&quot; lead top left</td>
</tr>
<tr>
<td>C21</td>
<td>1</td>
<td>&quot;+&quot; lead top</td>
</tr>
<tr>
<td>C24</td>
<td>15</td>
<td>&quot;+&quot; lead right</td>
</tr>
<tr>
<td>C29</td>
<td>1</td>
<td>&quot;+&quot; lead top</td>
</tr>
</tbody>
</table>

Step 12. 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.

Continued on Page II-12.
Step 12 continued.

**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. Re-insert and install.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>VALUE (ufd)</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>.1</td>
<td>Disc</td>
</tr>
<tr>
<td>C2</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C3</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C4</td>
<td>.01</td>
<td>Mylar tubular</td>
</tr>
<tr>
<td>C5</td>
<td>.1</td>
<td>Disc</td>
</tr>
<tr>
<td>C6</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C7</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C8</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C9</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C10</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C11</td>
<td>.001</td>
<td>&quot;</td>
</tr>
<tr>
<td>C12</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C13</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C14</td>
<td>.001</td>
<td>&quot;</td>
</tr>
<tr>
<td>C15</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C16</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C17</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C18</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C19</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C20</td>
<td>.001</td>
<td>&quot;</td>
</tr>
<tr>
<td>C21</td>
<td>.001</td>
<td>&quot;</td>
</tr>
<tr>
<td>C22</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C23</td>
<td>.1</td>
<td>&quot;</td>
</tr>
<tr>
<td>C24</td>
<td>.001</td>
<td>Mylar tubular</td>
</tr>
<tr>
<td>C25</td>
<td>470</td>
<td>pfd</td>
</tr>
</tbody>
</table>

**Step 13.** Install Augat pins in mounting holes A, B and C. (These three holes are located to the left of U16, just below the lower mounting hole for R17.)

**NOTE**

You will find it helpful to hold the board between two objects so that it stands on edge.

Step 13 continued.

To install an Augat pin, insert it into the mounting hole from the component (front) side of board and solder the pin from the solder (back) side of the board so the solder "wicks up" to the front side. (This will hold the pin firmly in place.)

Then insert a component lead into the 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.

**NOTE**

If the cooled solder is mottled or crystallized, a "cold joint" is indicated, and the solder should be reheated.

**Step 14.** Install DIP switch in location Sl. Position switch so Switch No. 1 is at the left. (With this orientation, the ON position of each switch is up.) Note that only the first seven switches are active.

**Step 15.** Install DIP reed relays in locations Kl and K2. Be sure to position each relay with its end notch at the top (pin 1 in upper left corner). These relays are soldered to the board. (Refer to "Loading DIP Devices" in Appendix IV.)

**Step 16.** Install U6 (1458 or 5558) in its location. Position U6 with its end notch at the top (pin 1 in upper left corner) and solder to board. (Refer to "Loading DIP Devices" in Appendix IV.)

**Step 17.** Install U5 (78L12) in its location just above U6. Position U5 with its flat side at the bottom, insert leads and push straight down until it is 3/16" above the surface of the board. Solder and trim leads.

**Step 18.** 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
Step 18 continued.

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. Solder the unbent pins on all sockets. Then straighten the bent pins to their original position and solder.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TYPE SOCKET</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>14 pin</td>
</tr>
<tr>
<td>U2</td>
<td>16 pin</td>
</tr>
<tr>
<td>U3</td>
<td>14 pin</td>
</tr>
<tr>
<td>U4</td>
<td>14 pin</td>
</tr>
<tr>
<td>U8</td>
<td>16 pin</td>
</tr>
<tr>
<td>U9</td>
<td>16 pin</td>
</tr>
<tr>
<td>U10</td>
<td>14 pin</td>
</tr>
<tr>
<td>U11</td>
<td>16 pin</td>
</tr>
<tr>
<td>U12</td>
<td>16 pin</td>
</tr>
<tr>
<td>U13</td>
<td>16 pin</td>
</tr>
<tr>
<td>U14</td>
<td>14 pin</td>
</tr>
<tr>
<td>U15</td>
<td>14 pin</td>
</tr>
<tr>
<td>U16</td>
<td>16 pin</td>
</tr>
<tr>
<td>U17</td>
<td>16 pin</td>
</tr>
<tr>
<td>U18</td>
<td>40 pin</td>
</tr>
<tr>
<td>U19</td>
<td>14 pin</td>
</tr>
<tr>
<td>U20</td>
<td>16 pin</td>
</tr>
<tr>
<td>U21</td>
<td>14 pin</td>
</tr>
<tr>
<td>U22</td>
<td>16 pin</td>
</tr>
<tr>
<td>U23</td>
<td>16 pin</td>
</tr>
<tr>
<td>U24</td>
<td>14 pin</td>
</tr>
<tr>
<td>U25</td>
<td>14 pin</td>
</tr>
<tr>
<td>U26</td>
<td>14 pin</td>
</tr>
</tbody>
</table>

Step 19. Using #24 bare wire, install jumpers according to your selection of the options described in Section III.

Step 20. Set DIP switches (S1) to select port address as described in Section III.

NOTE

All Processor Technology software is written with a CUTS port of FA (hex). To set the DIP switches for port FA, place Switch No. 2 in OFF position and the remaining switches in the ON position.
**Step 21.** Check operation of the regulators. This check is made to prevent potential damage to the IC's from incorrect voltages.

Using an ohmmeter, make the following measurements:

<table>
<thead>
<tr>
<th>SUPPLY</th>
<th>MEASUREMENT POINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 5 V dc</td>
<td>Ground to right-hand lead of U7</td>
</tr>
<tr>
<td></td>
<td>Ground to left-hand lead of U7</td>
</tr>
<tr>
<td>+12 V dc</td>
<td>Ground to positive (+) lead of C8</td>
</tr>
<tr>
<td></td>
<td>Ground to Pin 8 of U6 socket</td>
</tr>
<tr>
<td>-12 V dc</td>
<td>Across C21</td>
</tr>
</tbody>
</table>

You should measure some resistance in all three measurements. Zero resistance indicates a short. If required, find and correct the problem before proceeding.

**Install** CUTS in computer. (The use of a Processor Technology EXB Extender Board is recommended.)

**CAUTION**

NEVER INSTALL OR REMOVE CIRCUIT BOARD WITH POWER ON.

**Turn** power on and make the following voltage measurements:

<table>
<thead>
<tr>
<th>MEASUREMENT POINTS</th>
<th>VOLTAGE (±5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground to Pin 1 of U18 Socket</td>
<td>+ 5 V dc</td>
</tr>
<tr>
<td>Ground to Pin 8 of U6 Socket</td>
<td>+12 V dc</td>
</tr>
<tr>
<td>Ground to Pin 2 of U18 Socket</td>
<td>-12 V dc</td>
</tr>
</tbody>
</table>

If any voltage is incorrect, determine and correct the cause before proceeding.

If voltages are correct, turn power off, remove CUTS from computer and go on to Step 22.

**Step 22.** Install the following IC's in the indicated locations. Pay careful attention to the proper orientation.

Continued on Page II-16.
Step 22 Continued.

NOTE

Pin 1 is positioned at the upper left corner of each IC location, and is indicated by a dot on the PC board and assembly drawing.

<table>
<thead>
<tr>
<th>IC NO.</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1*</td>
<td>4023*</td>
</tr>
<tr>
<td>U2*</td>
<td>4027*</td>
</tr>
<tr>
<td>U3*</td>
<td>4013*</td>
</tr>
<tr>
<td>U4*</td>
<td>4013*</td>
</tr>
<tr>
<td>U8*</td>
<td>4520*</td>
</tr>
<tr>
<td>U9*</td>
<td>4019*</td>
</tr>
<tr>
<td>U10*</td>
<td>4024*</td>
</tr>
<tr>
<td>U11*</td>
<td>4046*</td>
</tr>
<tr>
<td>U12</td>
<td>74LS163</td>
</tr>
<tr>
<td>U13</td>
<td>74LS175</td>
</tr>
<tr>
<td>U14</td>
<td>74LS136</td>
</tr>
<tr>
<td>U15</td>
<td>74LS136</td>
</tr>
<tr>
<td>U16</td>
<td>74LS367</td>
</tr>
<tr>
<td>U17</td>
<td>74LS367</td>
</tr>
<tr>
<td>U18*</td>
<td>6011*</td>
</tr>
<tr>
<td>U19*</td>
<td>4030*</td>
</tr>
<tr>
<td>U20</td>
<td>74LS109</td>
</tr>
<tr>
<td>U21</td>
<td>74LS132</td>
</tr>
<tr>
<td>U22*</td>
<td>4049*</td>
</tr>
<tr>
<td>U23</td>
<td>74LS155</td>
</tr>
<tr>
<td>U24</td>
<td>74LS04</td>
</tr>
<tr>
<td>U25</td>
<td>74LS08</td>
</tr>
<tr>
<td>U26</td>
<td>74LS08</td>
</tr>
</tbody>
</table>

*MOS device. Refer to CAUTION on Page II-7.

( ) Step 23. Adjust VR1.

NOTE

If you do not have a voltmeter, set arrow on VR1 to the "10 o'clock" position (as viewed from front side of board when VR1 is at the top) and go on to Step 24. (In nearly all cases CUTS operates with VR1 at 10 o'clock.)
Step 23 continued.

(✓) If you selected either the digital or microphone audio output options in Step 19, remove the jumper and install a jumper between Augat pins A and B.

(✓) If you selected the auxiliary option in Step 19, leave the jumper between Augat pins A and B installed.

(✓) Connect pin 2 of J1 (IN) to pin 4 of J1 (OUT).

(✓) Install CUTS in computer and turn power on.

(✓) Set VR1 fully clockwise (CW).

(✓) Measure the DC voltage at pin 2 of U2 and write the measured voltage down. (Call this Voltage A.)

(✓) Set VR1 fully counterclockwise (CCW).

(✓) Measure the DC voltage at pin 2 of U2 and write the measured voltage down. (Call this Voltage B.)

(✓) Add Voltages A and B and divide the sum by 2. (Call the result Voltage C.) An example follows:

Voltage A (VR1 fully CW): 3.45 V dc
Voltage B (VR1 fully CCW): 1.80 V dc

\[ A + B = 5.25 \text{ V dc} \]

Voltage C = 5.25 V dc/2 = 2.63 V dc

(✓) Adjust VR 1 so that the voltage at pin 3 of U2 equals Voltage C. (In the preceding example this would be 2.63 V dc.)

(✓) Step 24. Disconnect pin 2 of J1 from pin 4 of J1.

(✓) Step 25. If required by your option selection, remove the A-to-B jumper and re-install the A-to-D or A-to-C jumper as appropriate. Otherwise, leave the A-to-B jumper in and go on to Step 26.

(✓) Step 26. Using the two female mating connectors supplied for J1 and J2, fabricate one or two, as required by your needs, CUTS-to-Recorder interconnect cables as shown in Figure 2-3 on Page II-18.
Coaxial Cables (e.g., Audiotex (GC) 30-415-S)

Twisted Pair (e.g., Speaker Cable)

1 - Transport
2 - Audio In
3 - Ground
4 - Audio Out
5 - Transport Return

(A) Miniature Phone Plug
(B) Subminiature Phone Plug

Figure 2-3. CUTS-transport interconnect cabling.
SECTION III

OPTION SELECTION

CUTS, COMPUTER USERS TAPE SYSTEM
3.1 OPTION SELECTION

Jumper options that control two operating parameters, data rate and audio output, are provided on the CUTS Module. The port address for the module is selectable with seven switches. Use the following selection instructions along with the assembly drawing in Section VI.

3.2 PORT ADDRESS SELECTION (DIP Switch, S1)

One of 130 possible port addresses, from 0 through FA (hex), 254 (decimal), for the CUTS is selectable with the first seven DIP switch positions in location S1.

All Processor Technology software is written for a CUTS port assignment of FA (hex). To configure your CUTS for this port, set Switch No. 2 (S1-2) to OFF and Switch No's. 1 (S1-1) and 3 through 7 (S1-3 through S1-7) to ON.

To select another port, set S1-1 through S1-7 as required for the desired address. With these switches the address increases from 0 (all seven switches open) in a binary fashion to 254, decimal, (all seven switches closed). When setting these switches, keep in mind that 1) S1-7 and S1-1 are the most and least significant bits respectively and 2) a closed switch is equivalent to a binary 1.

3.3 AUDIO OUTPUT SELECTION

The A, B, C, D jumper arrangement (to the left of U16) determines the audio output signal supplied to J1 and J2. Three choices are available: 1) a 5 V peak-to-peak signal for driving digital recorders, 2) a 250 mV signal for driving the auxiliary input to an audio cassette recorder, and 3) a 50 mV signal for driving the microphone input to an audio cassette recorder.

NOTE

For audio cassette recorders, the auxiliary input is preferred and recommended over the microphone input.

To select the digital recorder output, install a jumper (#24 bare wire is recommended) between Augat pin A and the mounting pad labeled D.

To select the auxiliary output to drive the auxiliary input (the recommended input) to an audio cassette recorder, install a jumper (#24 bare wire is recommended) between Augat pins A and B.
To select the microphone output to drive the microphone input to an audio cassette recorder, install a jumper (#24 bare wire is recommended) between Augat pins A and C.

3.4 DATA RATE SELECTION

Your CUTS is presently wired for both 1200 and 300 Baud operation, with the selection being program controlled. CUTS is designed, however, for operating at data rates up to 9600 Baud. The pad labeled AA, K, L, Q, R, S, T, U, V, W, X, Y and Z are provided for increasing the data rate. How the board is configured for higher rates will be the subject of a future addendum to this manual.

At this point in time Processor Technology does not recommend operation higher than 1200 Baud.
SECTION IV

OPERATING PROCEDURES

CUTS, COMPUTER USERS TAPE SYSTEM
4.1 TAPE RECORDER

Any standard cassette tape recorder can be used with CUTS providing it has the following features:

- ALC (automatic level control) in record mode
- "Remote" on-off control input jack
- "Monitor" or "earphone" output jack

Though not required, the following recorder features will be useful:

- Tone control
- Tape counter
- "Cue", "Pause" or "Instant Stop" control

**NOTE**

Processor Technology currently uses the Panasonic Model RQ-413S with consistently good results.

4.2 CUTS-RECORDER INTERCONNECT (Single Recorder)

Using the interconnect cabling you fabricated in Step 26 of the "Assembly-Test Procedure" (Section II), make the following connections: (Refer to Figure 4-1 on Page IV-3. You may use either output connector J1 or J2 on the CUTS.)

1. Plug transport cable (Pins 1 and 5 of J1 or J2) to remote jack on recorder.

2. Connect "audio out" cable (Pin 4 of J1 or J2) to microphone or auxiliary jack on recorder, with the choice depending on the audio output selection you made. (Refer to Paragraph 3.3 in Section III.) The auxiliary input is preferred and recommended over the microphone input.

3. Connect "audio in" cable (Pin 2 of J1 or J2) to monitor or earphone jack on recorder.

4.3 CUTS-RECORDER INTERCONNECT (Two Recorders)

Two recorders, under program control, can be driven by CUTS. In this case you will need two sets of the interconnect cabling described in Step 26 of the "Assembly-Test Procedure" (Section II).
Using these interconnect cables, connect the CUTS and recorders as shown in Figure 4-1.

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 provides a "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.

4.4 RECORDER ADJUSTMENTS

4.4.1 Volume Control

Since CUTS incorporates AGC (automatic gain control) circuitry in the read mode and the recorder has ALC in the record mode, the Volume Control setting should not be critical for either read or write operations. Simply set the control at midrange and forget it.

4.4.2 Tone Control

If your recorder has a Tone Control, set it at the top (high end) of its range. Tone controls usually have little effect, but it is safer to obtain a fairly high frequency response by setting the control as just described.
Figure 4-1. CUTS-recorder interconnect (two recorders).
4.5 WRITE OPERATIONS

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

4.6 READ OPERATIONS

When reading tapes, you must start the tape at least two seconds ahead of the data block you want to read. (CUTS tapes have a standardized header before each data block.) This two second delay is needed to allow the recorder playback electronics and the CUTS circuitry to stabilize after power is turned on.

Use the following procedure for loading tapes:

1. Disconnect monitor and remote plugs from recorder. (On most recorders this must be done in order to listen to the tape.)

2. Load prerecorded cassette and play tape until you hear data. (Data sounds like noise in CUTS format.)

   NOTE

   Absence of data is indicated by a pure 1200 Hz or 2400 Hz tone if recorded at 1200 bps or 300 bps respectively in the Byte/Kansas City Standard format.

3. Rewind tape far enough so it will take two seconds to reach the data block you want to read after the recorder is placed in the playback mode. STOP RECORDER AT THIS POINT.

4. Set Volume Control as specified in Paragraph 4.4.1 if necessary.

5. Reconnect monitor and remote plugs to recorder.

6. Place "play" control on recorder in play position.

7. Type in appropriate command on your keyboard. After you strike the RETURN key (in most programs), the recorder will automatically start and data will be read into memory at the locations specified by the CUTS data header or, in the case of BASIC-5 or Processor Technology 8K BASIC, into the proper File or READ statement.
SECTION V

THEORY OF OPERATION

CUTS, COMPUTER USERS TAPE SYSTEM
5.1 INTRODUCTION

The CUTS module functions to transfer data bidirectionally between a computer and one or two audio cassette recorders. To perform its function, the module contains circuitry related to:

1. port address recognition,
2. computer-CUTS buffering,
3. computer input/output command decoding,
4. timing,
5. status reporting,
6. recorder on/off control,
7. parallel-to-serial and digital-to-audio conversions in the write mode,
8. audio-to-digital and serial-to-parallel conversions in
9. and conversion of read data to NRZ (non-return to zero) format.

5.2 BLOCK DIAGRAM ANALYSIS

A simplified block diagram of the CUTS module is provided in Figure 5-1.

An address selector defines the port address for the CUTS module. It works with the address decoder to determine if the address on A1-7 matches the port address for the module. If it does, the decoder produces the indicated CARD SELECT output to enable the status in/out and strobe decoders.

Once an input or output request from the processor is recognized, the status in/out decoder enables a PRDY line driver in the wait state generator. This generator inserts one wait state into every input or output request from the processor.

The strobe decoder decodes the indicated inputs from the processor to produce the STATUS WRITE, READ STATUS, DATA READ and DATA WRITE strobe signals.

On an input cycle when \( A\bar{0} \) is low, \( A\bar{0} \) enables status outputs from the UART, and the strobe decoder outputs a READ STATUS signal. READ STATUS produces a delayed DRIVER ENABLE which gates the UART status to the DI bus. Should \( A\bar{0} \) be high, however, the strobe decoder outputs a DATA READ to indicate to the UART that its data has
been accepted. It also resets the driver enable generator to immediately enable the DI bus drivers.

If the cycle is an output cycle and $A\phi$ is high, the strobe decoder outputs a DATA WRITE which transfers D0 bus data into the UART and initiates serial transmission by the UART. Should $A\phi$ be low, the strobe decoder outputs a STATUS WRITE. STATUS WRITE strobes the data on D04-7 into the status latch.

The four status bits in this latch are concerned with recorder motor control and data rate. One output turns one recorder motor on and off, another turns a second recorder motor on and off, a third selects a low data rate, and the fourth selects a high data rate.

Timing for the CUTS module is supplied by the clock circuits and read clock. Clock circuitry manipulates $\phi2$ to supply WRITE CLOCK as well as various other timing signals required to obtain two data rates. Read clock uses NRZ data transitions and one of two clock signals to generate READ CLOCK for use in the read mode.

When CUTS is in the write mode, parallel data on D00-7 is serialized in the UART and applied to a synchronizer in the NRZ format. The synchronizer in turn establishes the time at which the bit cell from the UART starts. The digital-to-audio converter converts the data bit levels into corresponding audio signals. These signals are then fed through a driver to the audio output jacks.

In the read mode, inputs from the recorders are mixed and amplified, with an AGC circuit operating on the second stage. Following amplification the audio signals are converted into digital signals, the transitions of which are detected and converted into the NRZ format. NRZ data is applied to the UART which performs the required serial-to-parallel conversion and supplies the parallel data to the DI bus drivers.

5.3 THEORY OF OPERATION

Refer to CUTS schematic in Section VI.

5.3.1 Timing

All timing for the CUTS module is derived from, or related to, the 2 MHz $\phi2$ clock from the computer. As can be seen on the schematic, $\phi2$ is received on pin 24 of the S-100 bus by a hysteresis receiver, U21. The inverted $\phi2$ directly clocks both sections of U20 as well as U12. One half of U20 (clock pin 12) serves as the wait state generator; the other half generates the DRIVER ENABLE signal.

U12, preset to count 3, divides $\phi2$ by 13 to produce a 153.85 KHz signal on pin 11. The output of U12 is in turn counted down in
Figure 5-1. CUTS, simplified block diagram.
U10, a seven-stage binary counter, to provide 38.4 KHz on Q2, 19.2 KHz on Q3, 4800 Hz on Q5, 2400 Hz on Q6 and 1200 Hz on Q7. The clocks on Q6 and Q7 are used in the write data synchronizer (U3) and and the digital-to-audio converter (U2).

The remaining outputs from U10 are fed to two sections of U9, a quad multiplexer or select gate. All four sections of U9 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 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 the complementary outputs of one section in U13, the status latch.

The output of the second section of U9 is 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 U8 in the NRZ data conversion circuit.

READ CLOCK is produced by U11 (a phase locked loop), U8 (a binary counter) and the remaining two sections in U9. The signal input (pin 14) to U11 is supplied from pin 1 of U3 in the NRZ data conversion circuit. 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 counter (U8) in the NRZ conversion circuit. A phase comparator in U11 compares the signal input to the output of a voltage controlled oscillator (VCO) in U11 (pin 4). By feeding the VCO output through a counter (the other half of U8) before feeding the counter output back to the compare input (pin 3) of U11, 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 U11.

The output of U11 is nominally 19.2 KHz. Remember that 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 VR1 (connected to pin 12 of U11).

On high speed, the divide by four output of U8 (pin 12) is selected as RECEIVE CLOCK. The VCO output of U11 is selected for the low speed RECEIVE CLOCK.

5.3.2 Control

Basically the wait state generator (½ of U20), address selector and decoder (S1, U14 and U15), strobe decoder (U23), driver enable generator (½ of U20), the status latch (U13), the status in/out decoder (U14 and 24), motor control (K1 and 2), and power on clear (U21) comprise the CUTS control circuitry.
The address selector and decoder consists of seven open collector exclusive-OR gates, the inputs of which are connected to A1-7, RX1 and S1. RX1 and S1 function as the selector which is configured to reflect the complement of the module address. That is, a response to a high on an address line is generated by the applicable gate by grounding the other input by closing the appropriate DIP switch position. When the decoder senses an address match, all the gates respond true and RX2-4 pulls the outputs up to a high level CARD SELECT signal.

CARD SELECT enables the output gate (U21) in the status in/out decoder. This gate is satisfied if, and only if, SOUT or SINP is active to indicate either an input or output operation is under way. The output (pin 6) of U21 enables the PRDY line driver.

The input to this driver is provided on pin 10 of U20, the wait state generator which is clocked by \( \phi_2 \) and reset by PSYNC. Thus, pin 10 of U20 goes high on the falling edge of \( \phi_2 \) after PSYNC. This is the time during which the processor tests for wait requests. The purpose of this half of U20, therefore, is to insert one wait state into every input or output request by the processor. This is required to lengthen the data strobes to durations required by the UART.

U23, the strobe decoder, decodes SINP, PDBIN, SOUT, PWR and AØ to produce STATUS WRITE, READ STATUS, DATA READ STROBE, and DATA WRITE STROBE. The truth table for U23 is provided in Table 5-1 on Page V-6. All outputs from U23 are low active.

READ STATUS is applied to the J and K inputs to the other half of U20 which is clocked by \( \phi_2 \). Thus, an active READ STATUS signal produces a DRIVER ENABLE which is delayed from the strobe by one-half a \( \phi_2 \) cycle. This signal enables the tri-state buffers (U16 and 17) to place data on the DI bus. Note that a DATA READ STROBE resets U20 to immediately enable the DI bus buffers.

The status latch, U13, latches data present on DO4-7. (Note that the data on DO4 is not used.) Data is loaded into U13 when the strobe decoder outputs a STATUS WRITE STROBE. Four output bits from this latch select data rate and control the tape recorders. A low on pin 14 energizes K2 to turn recorder #1 on; a high on this pin de-energizes K2 to turn recorder #1 off. The output on pin 11 of U13 does the same thing for K1 which controls recorder #2. (D1 and D2, which shunt K2 and K1 respectively, prevent damage to the logic circuitry due to inductive kickback.) The remaining two outputs from U13, the complementary outputs associated with DO5, select either low or high speed operation by selecting the appropriate clocks out of U9. Low speed is selected when pins 3 and 2 of U13 are high and low respectively. When the converse relationship exists, high speed is selected.
Table 5-1. Strobe Decoder (U23) Truth Table.

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>ACTIVE OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0* CARD SELECT PDBIN* SINP* PWR* SOUT*</td>
<td>(Low)</td>
</tr>
<tr>
<td>L H   H   H   H   -    -</td>
<td>READ STATUS</td>
</tr>
<tr>
<td>H H   H   H   H   -    -</td>
<td>DATA READ STROBE</td>
</tr>
<tr>
<td>L H   -   -   L   H</td>
<td>STATUS WRITE STROBE</td>
</tr>
<tr>
<td>H H   -   -   L   H</td>
<td>DATA WRITE STROBE</td>
</tr>
</tbody>
</table>

*Inputs to CUTS module.

The remaining control circuit, POC (power on clear), initializes the CUTS whenever power is applied. When power is applied, POC on S-100 bus pin 99 goes low. POC is inverted in one section of U21 to clear the logic in the UART (U18). In addition, the inverted POC is again inverted in one section of U24 to clear the status register, U13. This clear sets both motor control outputs as well as the high speed select bit high.

5.3.3 Write Mode

When the CUTS is in the write mode, data is input to the UART (U18) under control of the DATA WRITE STROBE signal from U23. Upon completion of this strobe, the transmit sequence is initiated within the UART, with the transmission rate being governed by 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, with the number of bits being fixed by the connections to pins 34 through 39 of U18. This data stream is called NRZ data (non-return to zero) because the data never returns to zero until the next bit cell.

NRZ data from U18 is applied to the D input of U3, a D-type flip-flop which is clocked at 1200 Hz. Consequently, the output on pin 13 of U3 follows the input data on pin 9 after the rising edge of the 1200 Hz clock. This output is connected to the reset (pin 12) of U2, so when the data out of the UART is high, the first section in U2 is forced to a reset condition. In this condition the J and K inputs to the second stage of U2 are held high which allows the flip-flop to change state on the rising edge of the clock.
The clock for U2 is 2400 Hz in the high speed mode or 4800 Hz in the low speed mode. This clock is derived from the 2400 Hz output of U10 in conjunction with the low speed select signal NAND gate U1 and exclusive-OR gate U19.

In the high speed mode, pins 4 and 5 of U1 are held low, thus holding pin 6 of U1 high. As a result the 2400 Hz signal is inverted in U19 to become the clock for U2.

Pins 4 and 5 of U1 are held high, however, in the low speed mode to enable U1. In this case R19 and C20 provide a delay in the U1 gate. When the 2400 Hz signal on pin 9 of U19 changes state, so does pin 10 of U19. Also, C20 charges through R19 for several hundred nanoseconds, at which point pin 6 of U1 is brought to the opposite polarity. The output from U19 then goes high. A series of positive pulses, with a pulse width approximately equal to the R19, C20 time constant and occurring at every transition of the 2400 Hz signal, appears on pin 10 of U19. This circuit thus operates as a frequency doubler in the low speed mode to provide a 4800 Hz clock for U2.

The 2400 Hz signal from which the U2 clocks are derived also produces the 1200 Hz clock signal for U3 by toggling the flip-flop in U10. As a result the 1200 Hz signal changes state following a propagation delay after the 2400 Hz signal falls.

As previously stated, the second stage of U2 is allowed to change state on the positive going transitions of the U2 clock as long as the data out of the synchronizer is a "1". The end result is an output on pin 2 of U2 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, U3 will reset with Q low and Q high. A low reset on pin 12 of U2 enables the first U2 stage to toggle on the next rising edge of the U2 clock which occurs 1/2400 second after the synchronizer output falls. Remember that the U2 clock moves from a low to a high shortly before the 1200 Hz signal did. The reset on pin 12 of U2 is thus removed slightly after the U2 clock occurred. With the J and K inputs to the first U2 stage high, its output will change state on each succeeding low to high transition of U2 clock. The second U2 stage in turn can only toggle on the positive going transition of U2 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 U2 stage, the second U2 stage toggles at one-fourth the clock rate.

The two sections of U2, therefore, operate as a frequency divider, dividing the 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 Hz represents a "0".

The output on pin 2 of U2 is applied to one section in U22 which provides sufficient current drive for the R15, 16 and 17 divider network. This divider and a jumper arrangement allow selecting one of three outputs to be fed to the audio output jack *J1-4 and J2-4). The A-to-D jumper selects a 4-volt peak-to-peak square wave output for a digital recorder; the A-to-B jumper selects a 270 mv signal for the auxiliary input to an audio recorder; the A-to-C jumper selects a 50 mv signal for the microphone input to an audio recorder.

5.3.4 Read Mode

When CUTS is in the read mode, data from the recorders enters on J1-2 and J2-2. These two inputs are mixed through a resistive mixer (R3, 4 and 6) and fed to Q1, an emitter follower, the output of which is applied to the negative input (pin 2) of operational amplifier U6.

The first section of U6 is a high gain amplifier, with its gain being determined by R9 and R10. The output from this amplifier is coupled to the input (pin 6) of the following U6 stage and the base of a Darlington pair (Q3 and 4) which provides high current gain.

Current into the base of Q3 causes C29 to discharge. (C29 charges through R25 to 5 V dc.) The voltage on C29 in turn controls the gate of FET (field effect transistor) Q2. Q2 functions as a variable resistor which can be changed by its gate voltage. Since Q2 is connected between ground and the input network to the first U6 stage, it serves as a variable shunt. A low gate voltage on Q2 decreases the shunt resistance and the input to U6. In a like manner, a high voltage on C29 results in an increased input to U6. Q2, 3 and 4 with their associated circuitry, therefore, serve as an AGC circuit which limits the input to the second U6 stage to approximately a 2 volt peak signal.

The second stage of U6 performs the needed audio to digital conversion. Feedback resistor R12, in conjunction with R13, establishes the level on the positive input (pin 5) of U6. This level, be it positive or negative, is the threshold which the negative input (pin 6) must exceed in order for the output of U6 to switch levels, positive to negative and the converse. Since the feedback loop is regenerative, U6 switches at its maximum rate, and U6 switches on each transition of the audio signal input. It is in this manner that U6 performs the audio to digital conversion.

The digital output of U6 is inverted in one section of U22 and applied to pin 2 of U19, an exclusive-OR gate which is connected as a buffer without inversion. If the output of U22 is low, the
output on pin 3 of U19 is also low and the output on pin 11 of U19 is high. The voltage across C22 under this condition is minimal. When the output of U22 goes high, C22 starts to charge through R20 until pin 2 of U19 crosses the threshold of that gate. At this point pin 3 of U19 goes high, and since the two inputs to the second exclusive-OR gate are both high, pin 11 of U19 goes low. C22 now discharges because pins 2 and 3 of U19 are at the same level so that the circuit can repeat the operation on the next high to low transition at pin 4 of U22. R20, C22 and U19 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 U22, regardless of the polarity of the transition.

Transition pulses from U19 clock ¾ of U3 and ¼ of U4, both of which are D-type flip-flops. A transition pulse clocks U3 to set Q high and ¼ low to enable a binary counter, U8. The Q output of U3 is applied to pin 5 of U4 and the circuit remains in this state until one of two things occurs: 1) a second transition pulse arrives before U8 reaches count 12 or 2) U8 reaches count 12.

If a second transition pulse arrives before count 12, the first U4 stage is set and presents a "1" to pin 9 of U4. This is clocked by the reset of U3 as a low to pin 12 of U4.

If a transition pulse does not arrive before count 12, the first U4 stage presents a "0" to pin 9 of U4. On count 12, the C and D outputs of U8 go high to reset U3 through U1. As a result the U4 second stage clock goes high, as does pin 12 of U4. The output on pin 12 of U4, in the NRZ format, is inverted by U22 and applied to the receive input of the UART.

The Q output of U3, 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 placed on the RO1-8 data outputs of the UART when ROD (pin 4 of the UART) is low. The received data is then gated through U16 and 17 to the DI bus.

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). They are also gated through U16 and 17 to DI3, 4, 6 and 7 respectively by a delayed READ STATUS signal.
CUTS TIMING, WRITE MODE (1200 Baud Operation)

13
1 0 1 1 0 1 1 1 0 0 1 1

UART (NRZ Data)

12
DATA WRITE STROBE

14
2400 Hz

15
1 0 1 1 0 1 1 1 0 0 1 1

NRZ DATA (Synchronized to 1200 Hz Clock)

16

17

18

MANCHESTER ENCODED DATA

FILTERED MANCHESTER ENCODED DATA

NOTE: 1200 Baud NRZ data (13) is not necessarily synchronized with 1200 Hz clock. Signal at 15 and its complement on pin 12 of U3 are.

CUTS TIMING, READ MODE (1200 Baud Operation)

1

2

3

DC level between 0.5 and 5 V dc depending on input signal amplitude. DC level varies inversely with input amplitude.

4

0 V

(Approximately 20 V p-p)

5

MANCHESTER ENCODED DATA (CMOS Level)

Pulse Width Approximately 0.3-6 usec

6

Pulse Width may Jitter ±9% with Respect to Negative Edge

(Approximately 1200 Hz)

7

Approximately 500 nsec

8

9

10

1 0 1 1 0 1 1 0 0 0 0 1 1 0

RECOVERED NRZ DATA

11

Approximately 19,200 Hz (16X Data Rate)

Average DC level set by VRL to approximately 3.5 V dc

19

AUDIO IN (0.5 to 8 V p-p)

FILTERED AUDIO

(Approximately 2 V p-p)
APPENDICES

I  Statement of Warranty
II  8080 Operating Codes
III Standard Color Code
IV Loading DIP Devices, Soldering Tips and Installing Augat Pins
V IC Pin Configurations

Processor Technology Corporation
6200 Hollis Street
Emeryville CA 94608
Warranty

PROCESSOR TECHNOLOGY CORPORATION, in recognition of its responsibility to provide quality components and adequate instruction for their proper assembly, warrants its products as follows:

All components sold by Processor Technology Corporation are purchased through normal factory distribution and any part which fails because of defects in workmanship or material will be replaced at no charge for a period of 3 months for kits, and one year for assembled modules, following the date of purchase. The defective part must be returned postpaid to Processor Technology Corporation within the warranty period.

Any malfunctioning module, purchased as a kit directly from Processor Technology and returned to the factory within the three-month warranty period, which in the judgement of PTC has been assembled with care and not subjected to electrical or mechanical abuse, will be restored to proper operating condition and returned, regardless of cause of malfunction, without charge. Kits purchased from authorized PTC dealers should be returned to the selling dealer for the same warranty service.

Any modules purchased as a kit and returned to PTC, which in the judgement of PTC are not covered by the above conditions, will be repaired and returned at a cost commensurate with the work required. In any case, this charge will not exceed $20.00 without prior notification and approval of the owner.

Any modules, purchased as assembled units are guaranteed to meet specifications in effect at the time of manufacture for a period of at least one year following purchase. These modules are additionally guaranteed against defects in materials or workmanship for the same one year period. All warranted factory assembled units returned to PTCO postpaid will be repaired and returned without charge.

This warranty is made in lieu of all other warranties expressed or implied and is limited in any case to the repair or replacement of the module involved.
**DELPHI TABLE**

<table>
<thead>
<tr>
<th>DEC</th>
<th>HEX-ASCII TABLE</th>
<th>Characters</th>
<th>Printing</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 N0</td>
<td>NOP</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>01 N1</td>
<td>DAD H</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>02 N2</td>
<td>STA X</td>
<td>2A</td>
<td></td>
</tr>
<tr>
<td>03 N3</td>
<td>INX B</td>
<td>2B</td>
<td></td>
</tr>
<tr>
<td>04 N4</td>
<td>INR B</td>
<td>2C</td>
<td></td>
</tr>
<tr>
<td>05 N5</td>
<td>DCR B</td>
<td>2D</td>
<td></td>
</tr>
<tr>
<td>06 N6</td>
<td>MVI B.D8</td>
<td>2E</td>
<td></td>
</tr>
<tr>
<td>07 N7</td>
<td>RLC</td>
<td>2F</td>
<td></td>
</tr>
<tr>
<td>08 N8</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>09 N9</td>
<td>DAD B</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>0A NA</td>
<td>LDAX B</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>0B NB</td>
<td>DCX B</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>0C NC</td>
<td>INR C</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>0D ND</td>
<td>DCR C</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>0E NE</td>
<td>MVI C.D8</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>0F NF</td>
<td>RRC</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>11 NL</td>
<td>LDXI D.D16</td>
<td>39</td>
<td></td>
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<td>12 NM</td>
<td>STAX D</td>
<td>3A</td>
<td></td>
</tr>
<tr>
<td>13 NO</td>
<td>INX D</td>
<td>3B</td>
<td></td>
</tr>
<tr>
<td>14 NP</td>
<td>INR D</td>
<td>3C</td>
<td></td>
</tr>
<tr>
<td>15 NQ</td>
<td>DCR D</td>
<td>3D</td>
<td></td>
</tr>
<tr>
<td>16 NR</td>
<td>MVI D.D8</td>
<td>3E</td>
<td></td>
</tr>
<tr>
<td>17 NS</td>
<td>RAL</td>
<td>3F</td>
<td></td>
</tr>
<tr>
<td>18 NT</td>
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<td>19 NU</td>
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<tr>
<td>1A NV</td>
<td>LDAX D</td>
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<tr>
<td>1B NW</td>
<td>DCX D</td>
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<td></td>
</tr>
<tr>
<td>1C NX</td>
<td>INR E</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>1D NY</td>
<td>DCR E</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>1E NZ</td>
<td>MVI E.D8</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>1F NA</td>
<td>RAR</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>20</td>
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<td>48</td>
<td></td>
</tr>
<tr>
<td>21 NB</td>
<td>LDXI H.D16</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>22 NC</td>
<td>SHLD Adr</td>
<td>4A</td>
<td></td>
</tr>
<tr>
<td>23 ND</td>
<td>INX H</td>
<td>4B</td>
<td></td>
</tr>
<tr>
<td>24 NE</td>
<td>INR H</td>
<td>4C</td>
<td></td>
</tr>
<tr>
<td>25 NF</td>
<td>DCR H</td>
<td>4D</td>
<td></td>
</tr>
<tr>
<td>26 NG</td>
<td>MVI H.D8</td>
<td>4E</td>
<td></td>
</tr>
<tr>
<td>27 NH</td>
<td>DAA</td>
<td>4F</td>
<td></td>
</tr>
</tbody>
</table>

**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.**

**Adr = 16 bit address**
The electrical value of many types of resistors and capacitors is printed on the component. Other types, however, are identified by color coding which gives all the information needed to correctly identify the component. In most cases color coding conforms with the EIA (Electronic Industries Association) Standard Color Code. In other cases a manufacturer will adapt the standard to fit his particular requirement. Both the Standard Color Code and a code used to identify tantalum dipped capacitors are provided below.

### STANDARD COLOR CODE FOR RESISTORS AND CAPACITORS

<table>
<thead>
<tr>
<th>COLOR</th>
<th>SIGNIFICANT FIGURE</th>
<th>DECIMAL MULTIPLIER</th>
<th>TOLERANCE (%)</th>
<th>VOLTAGE RATING*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Brown</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>Red</td>
<td>2</td>
<td>100</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>Orange</td>
<td>3</td>
<td>1,000</td>
<td>50</td>
<td>400</td>
</tr>
<tr>
<td>Yellow</td>
<td>4</td>
<td>10,000</td>
<td>100</td>
<td>500</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
<td>100,000</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>Blue</td>
<td>6</td>
<td>1,000,000</td>
<td>1,000,000</td>
<td>700</td>
</tr>
<tr>
<td>Violet</td>
<td>7</td>
<td>10,000,000</td>
<td>10,000,000</td>
<td>800</td>
</tr>
<tr>
<td>Gray</td>
<td>8</td>
<td>100,000,000</td>
<td>100,000,000</td>
<td>900</td>
</tr>
<tr>
<td>White</td>
<td>9</td>
<td>1,000,000,000</td>
<td>1,000,000,000</td>
<td>1000</td>
</tr>
<tr>
<td>Gold</td>
<td>-</td>
<td>0.1</td>
<td>5</td>
<td>1000</td>
</tr>
<tr>
<td>Silver</td>
<td>-</td>
<td>0.01</td>
<td>10</td>
<td>2000</td>
</tr>
<tr>
<td>None</td>
<td>-</td>
<td>---</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>

*Applies to capacitors only.

### COLOR CODE FOR TANTALUM DIPPED CAPACITORS

<table>
<thead>
<tr>
<th>Rated Voltage VDC 25°C</th>
<th>Color</th>
<th>CODE FOR CAPACITANCE IN PICOFARADS</th>
<th>TOLERANCE (%)</th>
<th>VOLTAGE RATING*</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>Black</td>
<td>0 0 1</td>
<td>0.1</td>
<td>5</td>
</tr>
<tr>
<td>3-6</td>
<td>Brown</td>
<td>1 0 10</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>3-10</td>
<td>Red</td>
<td>2 2 100</td>
<td>1000</td>
<td>20</td>
</tr>
<tr>
<td>3-15</td>
<td>Orange</td>
<td>3 3 1,000</td>
<td>10,000</td>
<td>50</td>
</tr>
<tr>
<td>3-20</td>
<td>Yellow</td>
<td>4 4 10,000</td>
<td>100,000</td>
<td>100</td>
</tr>
<tr>
<td>3-25</td>
<td>Green</td>
<td>5 5 100,000</td>
<td>1,000,000</td>
<td>200</td>
</tr>
<tr>
<td>3-35</td>
<td>Blue</td>
<td>6 6 1,000,000</td>
<td>10,000,000</td>
<td>500</td>
</tr>
<tr>
<td>3-50</td>
<td>Violet</td>
<td>7 7 10,000,000</td>
<td>100,000,000</td>
<td>1000</td>
</tr>
<tr>
<td>3</td>
<td>Gray</td>
<td>8 8</td>
<td>20</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>9 9</td>
<td>500</td>
<td></td>
</tr>
</tbody>
</table>
LOADING DIP (DUAL IN-LINE PACKAGE) DEVICES

Most DIP devices have their leads spread so that they cannot 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 re-heated 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.
APPENDIX V

74LS136

74LS155

74LS163

74LS175

74367

7805UC

78L12

AV-3
CUTS (Applies only to Rev B and below circuit boards)

ASSEMBLY PROCEDURE CHANGE NOTICE #2

Rev B and below CUTFs circuit boards have an error that was introduced during their manufacture: A trace was connected to pin 8 of U11 which shorts the voltage controlled oscillator (VCO) output on pin 4 of U11 to ground. CORRECT THIS ERROR AS SHOWN BELOW BEFORE YOU CHECK THE BOARD AND START ASSEMBLY.

[Diagram showing pin locations and suggested cut.]
CUTS (Applies only to Rev B and below circuit boards)

ASSEMBLY PROCEDURE CHANGE NOTICE #1

Reference Section II, Step 12, Page II-

Capacitor C31 is a new addition to the CUTS circuitry made after the manufacture of Rev B circuit boards.

On Rev B and below boards, install C31 on the solder (back) side of the board as shown below.
Reference Step 23 on Page II-17

The sixth paragraph should read as follows:

( ) Measure the DC voltage at pin 9 of U11 and write the measured voltage down. (Call this Voltage A.)

The eighth paragraph should read as follows:

( ) Measure the DC voltage at pin 9 of U11 and write the measured voltage down. (Call this Voltage B.)

MAKE THESE CORRECTIONS IN YOUR MANUAL BEFORE YOU START TO ASSEMBLE YOUR CUTS MODULE.
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

PROCESSOR TECHNOLOGY CORP.
6200 HOLLIS STREET
EMERYVILLE, CALIF. 94608

TAPE READ AND WRITE ROUTINES FOR CUTS BOARDS

0001 *
0002 *
0003 *
0004 *
0005 *
0006 *
0007 * THESE ROUTINES WERE EXTRACTED FROM "SOLOS" AND "CUTER"
0008 * TO ILLUSTRATE THE REQUIREMENTS OF THE CUTS BOARD FOR
0009 * READING AND WRITING TO THE CASSETTE TAPE. BOTH SOLOS AND
0010 * CUTER ALSO HAVE FILE BUFFERING ROUTINES TO PROVIDE BYTE
0011 * BY BYTE TRANSFERS TO THE CASSETTE TAPE.
0012 *
0013 * CUTER resides on cassette tape and is available at your
0014 * local Processor Technology Dealer for $11.00 or ROM
0015 * resident for use on the GPM module. The CUTER program
0016 * requires 2K of memory plus 1k of RAM work area. A short
0017 * bootstrap program is used to load CUTER from cassette
0018 *
0019 * CUTER is relocatable to any 256 byte boundary and has a
0020 * built in command processor and support for serial,
0021 * parallel, keyboard and VDM I/O as well as CUTS cassette
0022 * routines. The CUTER software is necessary for all major
0023 * Processor Technology or Software Technology programs.
0024 *
0025 * CUTER COMMAND LIST
0026 *
0027 *
0028 * DUMP Dump memory
0029 * ENTER Enter to memory
0030 * EXECUTE Execute a program
0031 * LOAD Load programs or data from cassette
0032 * TSAVE Save programs or data to cassette
0033 * TXEQ Load and run program from tape
0034 * TCAT List names of files on tape
0035 * CUST Enter or delete custom command name
0036 * SET di Set display speed
0037 * SET nu Set output nulls
0038 * SET ta Set tape speed
0039 * SET in Set input port (0-3)
0040 * SET out Set output port (0-3)
0041 * SET cin Set custom input driver address
0042 * SET cout Set custom output driver address
0043 * SET xeq Set auto execute address to header
0044 * SET type Set type in header
0045 *
0046 *
0047 *
0048 *
0049 *
0050 *
0051 *

<<-- TAPE READ ROUTINES -->>

PAGE 1
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

MANUAL DATA
CUTS READ AND WRITE ROUTINES

0052 *
0053 *
0054 * ON ENTRY: A - HAS UNIT AND SPEED
0055 * HL - POINT TO HEADER BLOCK
0056 * DE - HAVE OPTIONAL PUT ADDRESS
0057 *
0058 * ON EXIT: CARRY IS SET IF ERROR OCCURRED
0059 * DE HAVE SIZE OF BLOCK READ
0060 * TAPE UNITS ARE OFF
0061 *
0062 *
0063 RTAPE PUSH D SAVE OPTIONAL ADDRESS
0064 MVI B,3 SHORT DELAY
0065 CALL TON
0066 IN TDATA CLEAR THE UART FLAGS
0067 * LOOP HERE UNTIL VALID HEADER IS FOUND
0068 PTAPI PUSH H HEADER ADDRESS
0069 CALL RHEAD GO READ HEADER
0070 POP H
0071 JC TERR IF AN ERROR OR ESC WAS RECEIVED
0072 JN PTAPI IF VALID HEADER NOT FOUND
0073 * FOUND A VALID HEADER NOW DO COMPARE
0074 PUSH H GET BACK AND RESAVE ADDRESS
0075 LXI D,THEAD
0076 CALL DHCPMP COMPARE DE-HL HEADERS
0077 POP H
0078 JNZ PTAPI DIDN'T COMPARE...GO BACK TO LOOP
0079 * FOUND IT...NOW ADJUST REGISTERS FOR READ
0080 D1 POP D OPTIONAL PUT" ADDRESS
0081 POP A,D
0082 ORA E SEE IF DE IS ZERO
0083 LXI D,BLOCK GET BLOCK SIZE
0084 XCHG ..TO DE
0085 * DE HAS HBLOCK...HL HAS USER OPTION
0086 JNZ RTAP IF DE WAS ZERO GET TAPE LOAD ADDRESS
0087 LHLD LOADR GET TAPE LOAD ADDRESS
0088 *
0089 *
0090 * THIS ROUTINE READS "DE" BYTES FROM THE TAPE
0091 * TO ADDRESS HL. THE BYTES MUST BE FROM ONE
0092 * CONTIGUOUS PHYSICAL BLOCK ON THE TAPE.
0093 *
0094 * HL HAS "PUT" ADDRESS
0095 * DE HAS SIZE OF TAPE BLOCK
0096 *
0097 RTAP PUSH D SAVE SIZE FOR RETURN TO CALLING PROGRAM
0098 *
0099 LOLOOP MOV A,D GET COUNT
0100 ORA E RTOFF COUNT IS ZERO-TURN OFF TAPE AND RETURN
0101 JZ RTOFF GET COUNT TO HL
0102 * XCHG
0103 *
0104 LXI B,-256 THIS MANY PRIOR TO CRC TEST
**ALS-8 PROGRAM DEVELOPMENT SYSTEM**

**MANUAL DATA**

CUTS READ AND WRITE ROUTINES

**PROCESSOR TECHNOLOGY CORP.**

6200 HOLLIS STREET

EMERYVILLE, CALIF.  94608

0035 09 0105  DAD  B
0036 D2 4E 00 0106  JNC  LBLK
0039 06 00 0107  MVI  B,0
003B D3 FC 0108  OUT  @PCH
003D 0E 00 0109  *  
003F EB 0110  RDBLK  MVI  C,0
0040 CD 7D 00 0111  XCHG  .
0043 DA 49 00 0112  *  
0046 CA 2C 00 0113  RTLOP  CALL  RHED1
0049 AF 0114  JC  TERR
004A 37 0115  JZ  LOOPL
004B C3 5B 00 0116  *  
004C 45 0117  *  
004D 21 00 00 0118  *  
0052 C3 3D. 00 0119  TERR  XRA  A
0055 06 01 0120  STC  .
0057 CD 1F 01 0121  JMP  RTOFI
005A AF 0122  *  
005B D1 FA 0123  *  
005D D1 0124  *  
005E C9 0125  LAST BLOCK--PUT FINAL COUNT IN B
005F 06 0A 0126  MVI  B,0
0061 CD 8F 00 0127  CALL  STAT
0064 D0 0128  *  
0065 DB FB 0129  *  
0067 B7 0130  TOFF  MVI  B,1
0069 CD 1F 01 0131  CALL  DELAY
006B D5 FB 0132  *  
006D C2 5F 00 0133  RTOFF  XRA  A
006E 05 0134  RTOFI  OUT  STAPT
006F C2 61 00 0135  POP  D
0070 0A 0136  RET
0072 D8 0137  *  
0073 3D 0138  *  
0074 C2 6F 00 0139  *  
0075 0A 0140  READ THE HEADER
0077 0A 0141  *  
0079 CD 8F 00 0142  RHEAD  MVI  B,10
007C D9 0143  RHEAD1  CALL  STAT
007D D0 0144  RC  .
007E D8 FB 0145  IN  TDATA
0080 B7 0146  ORA  A
0082 C2 5F 00 0147  JNZ  RHEAD
0083 05 0148  DCR  B
0084 C2 61 00 0149  JNZ  RHEAD1
0085 0A 0150  LOOP UNTIL 10 IN A ROW
0087 0A 0151  *  
0089 CD 8F 00 0152  *  
008C D9 0153  SOHL  CALL  TAPIN
008F D8 0154  RC  .
0090 3D 0155  DCR  A
0091 C2 6F 00 0156  JNZ  SOHL
0092 0A 0157  *  

PAGE  3
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

MANUAL DATA
CUTS READ AND WRITE ROUTINES

0158 * NOW GET THE HEADER
0159 *
0077 21 2D 01 0161 LXI H,THEAD POINT TO BUFFER
007A 01 00 10 0162 LXI B,HLEN*256 LENGTH OF HEADER IN B,C,<>0
0163 *
007D CD 9D 00 0164 RHEO CALL TAPIN GET BYTE
0080 DB 0165 RC
0081 77 0166 MOV M,A STORE IT
0082 23 0167 INX H INCREMENT ADDRESS
0083 CD E6 00 0168 CALL UDCRC NOW CALCULATE THE CRC
0086 05 0169 DCR B WHOLE HEADER YET?
0087 C2 7D 00 0170 JNZ RHEO LOOP UNTIL DONE
0171 *
0172 * THIS ROUTINE GETS THE NEXT BYTE AND COMPARES IT
0173 * TO THE VALUE IN REGISTER C. THE FLAGS ARE SET ON
0174 * RETURN.
0175 *
0176 * THIS ROUTINE GETS THE NEXT AVAILABLE BYTE FROM THE
0177 * TAPE. WHILE WAITING FOR THE BYTE THE KEYBOARD IS TESTED
0178 * FOR AN ESC COMMAND. IF RECEIVED THE TAPE LOAD IS
0179 * TERMINATED AND A RETURN TO THE COMMAND MODE IS MADE
0180 *
008A CD 9D 00 0181 CRCCK CALL TAPIN GET CRC BYTE
0182 D9 0183 XRA C COMPARISON WITH CALCULATED (CLEAR CARRY)
0184 *
008E C9 0185 STAT IN STAPT
0186 DB FA 0187 ANI TDR
0188 E6 40 0188 RNS *
0090 DB 00 0189 IN KDATA
0091 01 01 0190 CPI MODE ESC ?
0094 DB 01 0191 JNZ STAT
0095 C0 0192 STC . SET ERROR FLAG
0096 FE 1B 0193 RET AND RETURN
0194 *
009F C9 0195 *
0196 *
00A0 CD 8F 00 0197 TAPIN CALL STAT WAIT UNTIL A CHARACTER IS AVAILABLE
0198 DB 0199 *
00A1 DB FA 0200 TREDY IN STAPT
00A3 E6 18 0201 ANI TPE+TOE DATA ERROR?
00A5 DB FB 0202 IN TDATA GET THE DATA
00A7 C9 0203 RZ * IF NO ERRORS
00A8 37 0204 STC . SET ERROR FLAG
00A9 C9 0205 RET
0206 *
0207 *
0208 *
0209 *
0210 *

WRITE TAPE BLOCK ROUTINE
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

PROCESSOR TECHNOLOGY CORP
6200 HOLLIS STREET
EMERYVILLE CALIF. 94608

MANUAL DATA
CUTS HEAD AND WRITE ROUTINES

0211 *
0212 * ON ENTRY: A - HAS UNIT AND SPEED
0213 * HL - HAVE POINTER TO HEADER
0214 *
0215 *

00AA E5
0216 WTAPE PUSH H SAVE HEADER ADDRESS
00AB CD ED 00
0217 CALL WHEAD WRITE THE HEADER
00AE H1
0218 POP H
00AF 11 07 00
0219 LXI D BLOKF OFFSET TO BLOCK SIZE IN HEADER
00B2 19
0220 DAD D HL POINT TO BLOCK SIZE
0221 * GET ADDRESS AND SIZE FROM HEADER

00B3 5E
0222 MOV E,M DE HAVE SIZE
00B4 23
0223 INX H DE HAVE SIZE
00B5 56
0224 MOV D,M DE HAVE SIZE
00B6 23
0225 INX H POINT TO STARTING ADDRESS
00B7 7E
0226 MOV A,M
00B8 23
0227 INX H
00B9 66
0228 MOV H,M
00BA 6F
0229 MOV L,A HL HAVE STARTING ADDRESS
00BB E5
0230 WRLO1 PUSH H FOR STACK CLEAN UP ON TURN OFF
0231 *
0232 *
0233 * THIS ROUTINE WRITES ONE PHYSICAL BLOCK ON THE
0234 * TAPE "DE" BYTES LONG FROM ADDRESS "HL ".
0235 *

00BC 7A
0236 WRLOP MOV A,D TEST IF COUNT IS ZERO
00BD 83
0237 ORA E
0238 JZ TOFF
00BE CA 55 00
0239 LXI B,256 SUBTRACT 256 FROM IT
00C1 01 00 FF
0240 XCHG
00C4 E8
0241 DAD B
00C5 09
0242 JNC WLBLK IF 256 WEREN'T LEFT
00C6 D2 04 00
0243 MVI B,0
0244 *

00C9 06 00
0245 WDBLK MVI C,0 CRC STARTS WITH ZERO
00CD E8
0246 XCHG RESTORE COUNT TO DE, ADDRESS TO HL
00CE CD 02 01
0247 WDBL1 CALL WLOOP WRITE OUT THE BLOCK
00D1 C3 BC 00
0248 JMP WRLOP AND GO BACK TO MAJOR LOOP
0249 *

00D4 45
0250 WLBLK MOV B,L REMAINDER OF COUNT
00D5 21 00 00
0251 LXI H,0 TELL DE WE ARE DONE
00D8 C3 CB 00
0252 JMP WDBLK
0253 *

00D9 F5
0254 WRBYT PUSH PSW SAVE CHARACTER
00DC DB FA
0255 WRWAT IN @FAH GET UART STATUS
00DE E6 00
0256 ANI $0H
00E8 CA DC 00
0257 JZ WRWAT WAIT UNTIL IT IS READY
00E9 F1
0258 POP PSW
00E4 D3 PB
0259 OUT @FBH OUTPUT THE CHARACTER
0260 *
0261 * THIS ROUTINE UPDATES THE CRC
0262 *

00E6 91
0263 UDCRC SUB C FORM PARTIAL
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

** CUES READ AND WRITE ROUTINES **

<table>
<thead>
<tr>
<th>Address</th>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00E7 4F</td>
<td>MOV C,A</td>
<td>SAVE IT</td>
</tr>
<tr>
<td>00E8 A9</td>
<td>XRA C</td>
<td>NOW BEND IT OUT</td>
</tr>
<tr>
<td>00E9 2F</td>
<td>CMA</td>
<td>GET A FP</td>
</tr>
<tr>
<td>00EA 91</td>
<td>SUB C</td>
<td>CRC+1-1 IS NOT THE SAME</td>
</tr>
<tr>
<td>00EB 4F</td>
<td>MOV C,A</td>
<td>AND RESAVE IT</td>
</tr>
<tr>
<td>00EC C9</td>
<td>RET</td>
<td></td>
</tr>
</tbody>
</table>

0270 * 0271 * 0272 * THIS ROUTINE WRITES THE HEADER POINTED TO BY
0273 * HL TO THE TAPE.
0274 *

00E0 CD 1B 01 | MOV C,A | SAVE IT |
00F8 16 32 | MOV C,A | SAVE IT |
00F2 AF | NULOP | |
00F3 CD DB 00 | CALL WRBYT | |
00F6 15 | DCR D | |
00F7 C2 F2 00 | JNZ NULOP | |
00FA 3E 01 | MOV A,1 | 50 ZEROS FOLLOWED BY A ONE |
00FC CD DB 00 | CALL WRBYT | |
00FF 01 00 10 | LXI B,HLEN*256 HEADER LENGTH TO B, ZERO TO C |
0102 7E | MOV A,M | GET CHARACTER |
0103 CD DB 00 | CALL WRBYT | WRITE IT TO THE TAPE |
0106 05 | DCR B | |
0107 23 | INX H | |
0108 C2 02 01 | JNZ WLOOP | |
010B 79 | MOV A,C | GET CRC |
010C C3 00 00 | JMP WRBYT | PUT IT ON THE TAPE AND RETURN |
010F 06 05 | DBCMP MVI B,5 | COMPARE FIVE CHARACTERS |
0111 1A | DHALOP | GET ONE PART |
0112 8E | CMP M | COMPARE IT WITH THE OTHER |
0113 C0 | RNZ . | RETURN IF NOT THE SAME |
0114 05 | DCR B | |
0115 C8 | ZX | |
0116 23 | INX H | COMPARE THE NEXT |
0117 13 | INX D | |
0118 C3 11 01 | JMP DHLOP | |
011B 06 04 | WTON MVI B,4 | SET LOOP DELAY |
011D D3 FA | TON OUT STAPT | TURN ON THE SELECTED DRIVE |
011F 11 00 00 | DELAY LXI D,0 | |
0122 1B | DLOP1 DCX D | |
0123 7A | MOV A,D | |
0124 B3 | ORA E | |

** PAGE 6 **
** ALS-8 PROGRAM DEVELOPMENT SYSTEM **

PROCESSOR TECHNOLOGY CORP
6200 HOLLIS STREET
EMERYVILLE, CALIF. 94668

MANUAL DATA
CUTS READ AND WRITE ROUTINES

0125 C2 22 01 0317 JNZ DLOP1 LOOP HERE UNTIL DE ARE ZERO
0128 05 0318 DCR B
0129 C2 1F 01 0319 JNZ DELAY LOOP HERE UNTIL B IS ZERO
012C C9 0320 RET

0321 *
0322 *
0323 *
0324 *
0325 *
0326 *
0327 *
0328 *

PORT ASSIGNMENTS

00 FA 0329 STAPT EQU 0FAH STATUS PORT GENERAL
00 FB 0330 TDATA EQU 0FBH TAPE DATA
00 01 0331 KDATA EQU 1 KEYBOARD DATA PORT FOR ESCAPE TEST
00 1B 0332 MODE EQU 1BH ESCAPE KEY

0333 *
0334 *
0335 *
0336 *
0337 *
0338 *

BIT ASSIGNMENT MASKS

00 08 0339 TFE EQU 8 TAPE FRAMING ERROR
00 10 0340 TOE EQU 16 TAPE OVERFLOW ERROR
00 40 0341 TDR EQU 64 TAPE DATA READY
00 80 0342 TTBE EQU 128 TAPE TRANSMITTER BUFFER EMPTY

0343 *

00 40 0344 TAPE1 EQU 64 TAPE ONE OFF BIT
00 80 0345 TAPE2 EQU 128 TAPE TWO OFF BIT

0346 *
0347 *
0348 *
0349 *
0350 *
0351 *
0352 *
0353 *
0354 *
0355 *
0356 *
0357 *

GLOBAL AREA

SYSTEM PARAMETER AREA

012D 0358 THEAD DS 5 NAME
0132 0359 DS 1 THIS BYTE MUST BE ZERO FOR AUTO EXECUTE
0133 0360 HTYPE DS 1 TYPE
0134 0361 BLOCK DS 2 BLOCK SIZE
0136 0362 LOADR DS 2 LOAD ADDRESS
0138 0363 XEQAD DS 2 AUTO EXECUTE ADDRESS
013A 0364 HSPR DS 3 SPARES

0365 *

00 10 0366 HLEN EQU $THEAD LENGTH OF HEADER
00 07 0367 BLKOF EQU BLOCK-THEAD OFFSET TO BLOCK SIZE

0368 *
0369 *

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**. ALS-8 PROGRAM DEVELOPMENT SYSTEM.**

Processor Technology Corp.
6200 Hollis Street
Emeryville, Calif. 94608

Manual Data
Cuts Read and Write Routines

0370 *

BLKOF 0007 0219
BLOCK 0134 0083 0367
CRCCK 008A
DELAY 011F 0131 0319
DHCMP 010P 0076
DHLOP 0111 0307
DLOP1 0122 0317
HLEN 0010 0162 0284
HSPH 013A
HTYPE 0133
KDATA 0001 0189
LBLK 004E 0186
LOADR 0136 0087
LOLOQ 002C 0115
MODE 001B 0190
NULLP 00F2 0280
PTAP1 008B 0072 0078
RDBLK 003D 0127
RHEAD 0061 0149
RHEAD1 007D 0113 0170
RTAPI 0000
RTAPE 0000
RTLGP 0040
RTOFF 005B 0121
SOHL 005A 0181
STAT 0000 0186 0200 0311
STAT 008F 0143 0191 0197
TAE2 0040
TAPE2 0080
TaPIN 0009D 0153 0164 0176
TDATA 00FB 0066 0145 0202
TDR 0040 0187
TERM 0049 0071 0114
TPE 0008 0201
THEAD 012D 0075 0161 0366 0367
TOE 0010 0201
TOFF 0055 0238
TUN 011D 0065
TREDY 00A1
UTBE 0080
UDDRC 00E6 0168
WDBLK 00CE
WDBLBK 00CB 0252
WHEAD 00ED 0217
WLBK 00D4 0242
WLOOP 0102 0247 0290
WRBYT 00DB 0278 0283 0287 0292
WRLOL 00BB
WRLOF 00BC 0248
MANUAL DATA
CUTS READ AND WRITE Routines

WRRAT  00DC  0257
WTAPE  00AA
WTON  011B  0275
XEQAD  0138