# CUTS, COMPUTER USERS TAPE SYSTEM

# ASSEMBLY and TEST INSTRUCTIONS

**Processor Technology**

ERRATA   SHEET   #1

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.

ES1-3/77

CUTS   (Applies only to Rev B and below
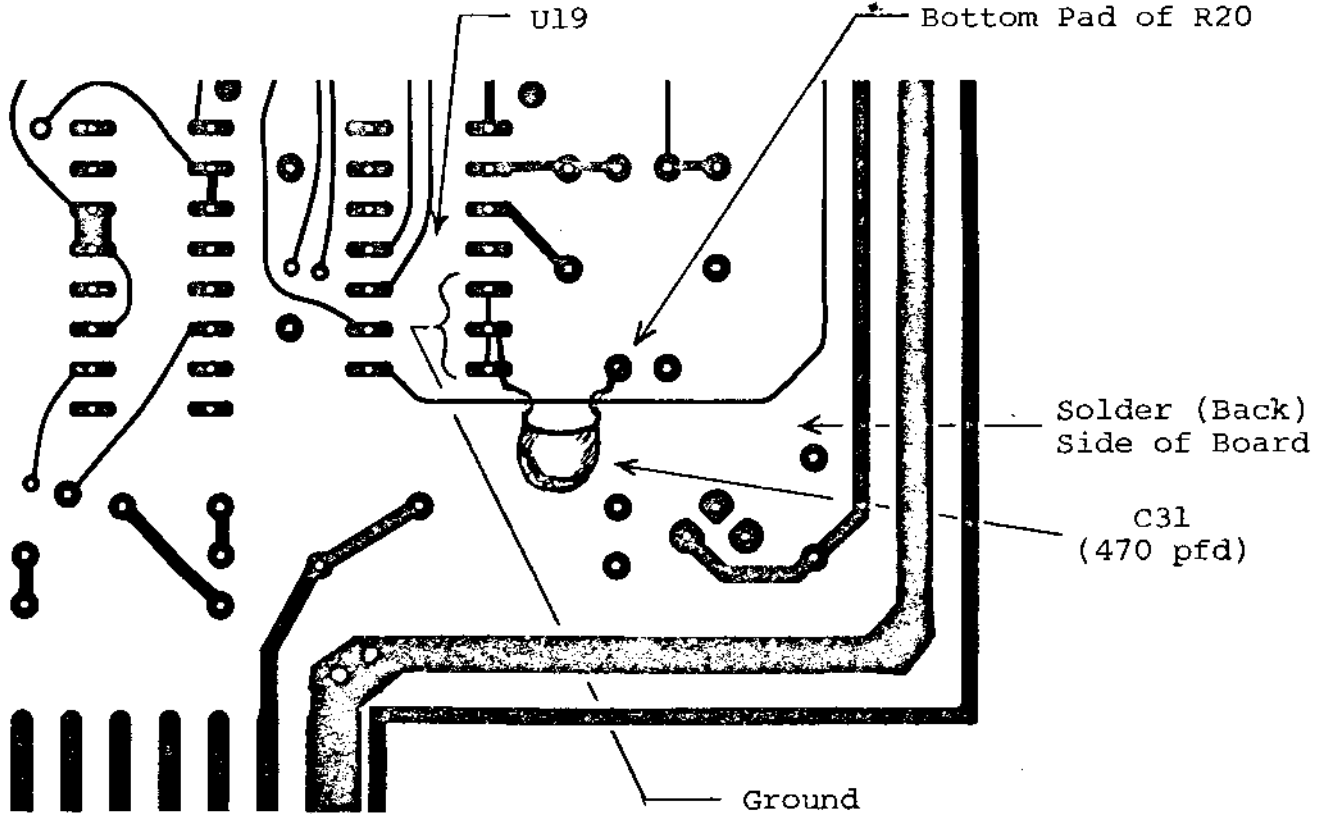          circuit boards)                          PD Processor
                                                      Technology

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
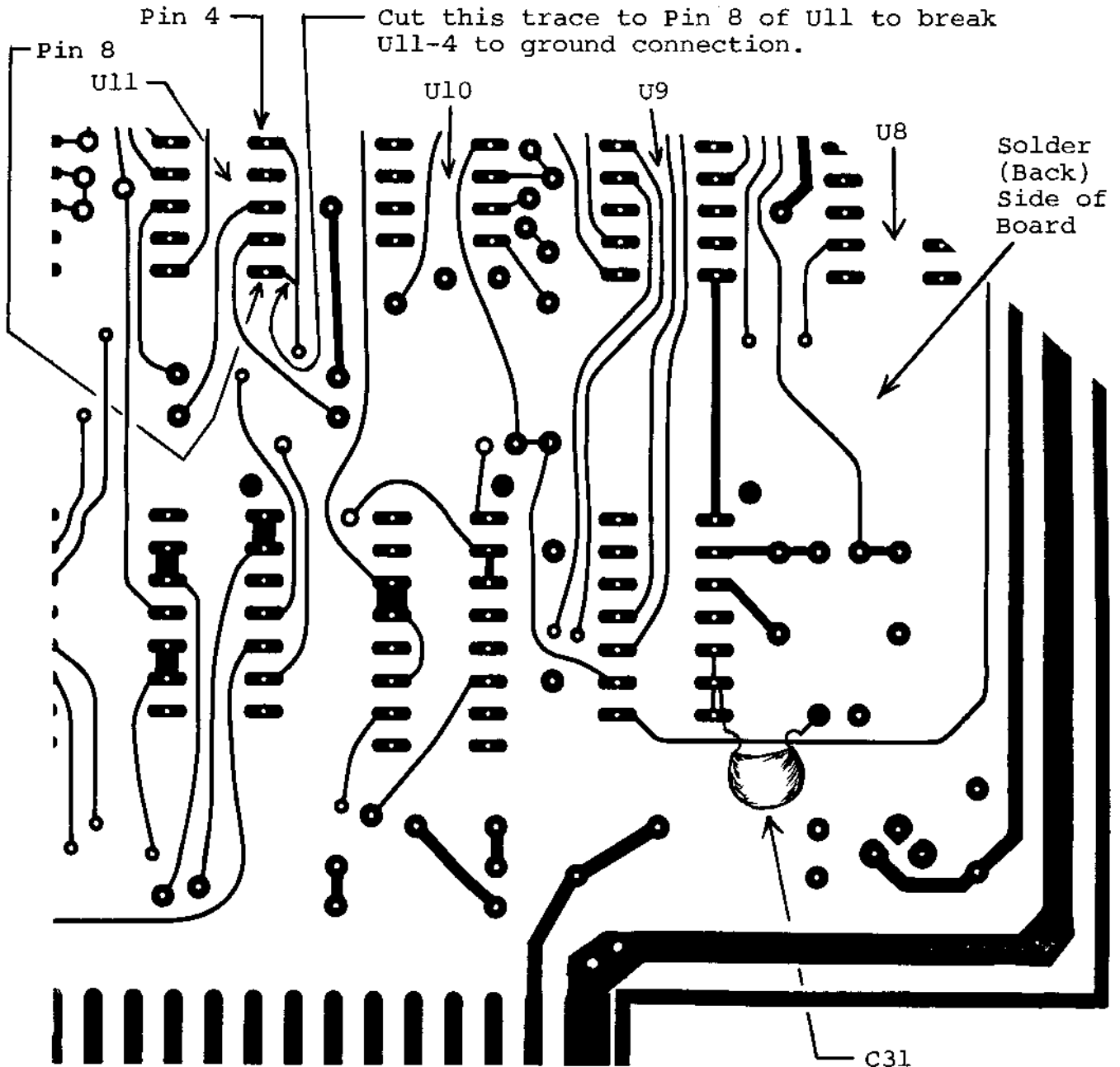of the board as shown below.



PROCESSOR TECHNOLOGY CORPORATION   6200 HOLLIS STREET   EMERYVILLE CA 94608   (415) 652-8080
CABLE ADDRESS "PROCTEC"

**Processor
Technology**

## ASSEMBLY PROCEDURE CHANGE NOTICE #2

Rev B and below CUTS circuit boards have an error that was intro-
duced 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 <u>BEFORE</u>
YOU CHECK THE BOARD AND START ASSEMBLY.

Pin 4 — ⌐ Cut this trace to Pin 8 of U11 to break
U11-4 to ground connection.

⌐Pin 8

U11 —

U10          U9          U8

Solder
(Back)
Side of
Board

C31

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 save 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.

<u>NOTE</u>

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, ¼ 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 pre-
ceded 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 in-
stalling 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 loca-
                    tion 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 Para-
graph 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

INTEGRATED CIRCUITS

| | | | | |
|---|---|---|---|---|
| 1 | 1458 or 5558 (U6) | | 1 | 6011 (U18) |
| 2 | 4013 (U3 & U4) | | 1 | 74LS04 (U24) |
| 1 | 4019  (U9) | | 2 | 74LS08 (U25 & U26) |
| 1 | 4023 (U1) | | 1 | 74LS109 (U20) |
| 1 | 4024 (U10) | | 1 | 74LS132 (U21) |
| 1 | 4027 (U2) | | 2 | 74LS136 (U14 & U15) |
| 1 | 4030 (U19) | | 1 | 74LS155 (U23) |
| 1 | 4046 (U11) | | 1 | 74LS163 (U12) |
| 1 | 4049 (U22) | | 1 | 74LS175 (U13) |
| 1 | 4520 (U8) | | 2 | 74367 (U16 & U17) |

REGULATORS

    1   7805UC or LM340T-5.0 (U7)

    1   78L12 (U5)

TRANSISTORS

    3   2N2222 (Q1, Q3 & Q4)

    1   2N2907 (Q5)

    1   2N4360 (Q2)

DIODES

    3   1N4148 (D1, D2 & D4)

    1   1N5242 (D3)

RELAYS

    2   DIP Reed, SIGMA 191TE1A1-55
        (K1 & K2)

Table 2-1.  CUTS Parts List  (Continued).

| RESISTORS | | CAPACITORS | |
|---|---|---|---|
| 1 | 39 ohm, 2 watt, 5% | 1 | 470 pfd, disc |
| 1 | 100 ohm, ¼ watt, 5% | 4 | .001 ufd, disc |
| 2 | 470 ohm, ¼ watt, 5% | 1 | .001 ufd, Mylar tubular |
| 3 | 1.5K ohm, ¼ watt, 5% | 1 | .01 ufd, Mylar tubular |
| 9 | 10 K ohm, ¼ watt, 5% | 19 | .1 ufd, disc |
| 4 | 100 K ohm, ¼ watt, 5% | 2 | 1 ufd, tantalum dipped |
| 2 | 150 K ohm, ¼ watt, 5% | 3 | 15 ufd, tantalum dipped |
| 2 | 1 M ohm, ¼ watt, 5% | | |
| 1 | 2.2M ohm, ¼ watt, 5% | | |
| 1 | 50 K ohm  Potentiometer | | |
| 2 | 2.2K ohm  Resistor Network | | |

| MISCELLANEOUS | | | |
|---|---|---|---|
| 1 | CUTS  PC Board | 10 | Molex Crimp Pins for Female Mating Connector |
| 1 | Heat Sink | | |
| 11 | 14-pin DIP Socket | 3 | Augat Pin |
| 11 | 16-pin DIP Socket | 1 | Length #24 Bare Wire |
| 1 | 40-pin DIP Socket | 1 | Length Solder |
| 1 | 8-position DIP Switch | 3 | 6-32 x ½ Screw |
| 2 | Right Angle Molex Connector, Male (J1 & J2) | 3 | #6 Lockwasher |
| | | 3 | 6-32 Hex Nut |
| 2 | Mating Connector for Above, Female (P1 & P2) | 1 | Manual |

| TRANSISTOR<br>TO-18 Package (Metal Can) | TRANSISTOR<br>TO-92 Package (Plastic) |
|---|---|
| TRANSISTOR, POWER or<br>REGULATOR IC<br>TO-220 Package | CARBON RESISTOR<br><br>5% (gold), 10% (silver)<br>See Appendix III for Color Code |
| METAL FILM PRECISION RESISTOR<br>(1% Tolerance) | RESISTOR NETWORK |
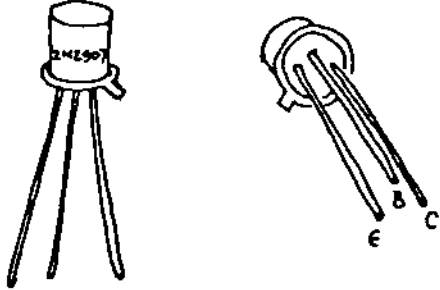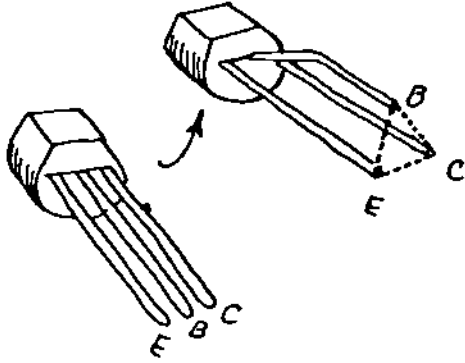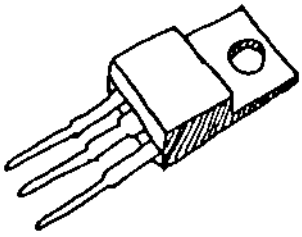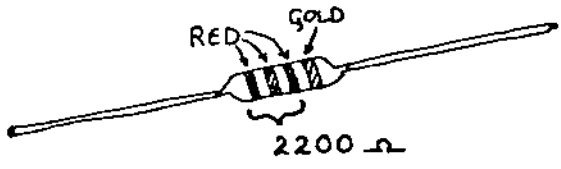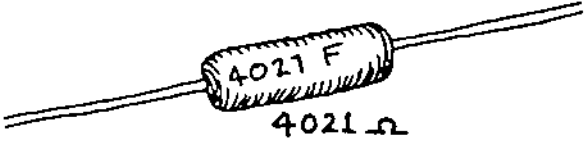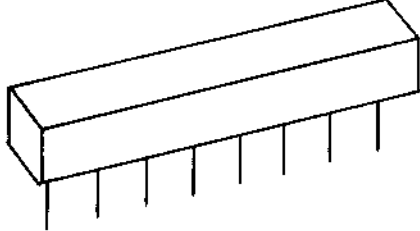
Figure 2-1.  Identification of components.

ELECTROLYTIC CAPACITOR
(Vertical Mount)

DIPPED TANTALUM ELECTROLYTIC
CAPACITOR

YELLOW → ← BROWN
← GREEN
← BLUE

15 μfd

POSITIVE (+) LEAD

See Appendix III for Color Code

DISC CAPACITOR

50V
.68

0.1
25V

Monolythic    (left)    and Ceramic

MYLAR TUBULAR CAPACITOR

0.1MF 100V

INTEGRATED CIRCUIT, Dual Inline Package (DIP)
(6,8,14,16,24 and 40 pin)

NOTE: PIN 1 MAY BE INDICATED
BY CORNER DOT
OR NOTCH

DM7400N

PIN 14

PIN 1
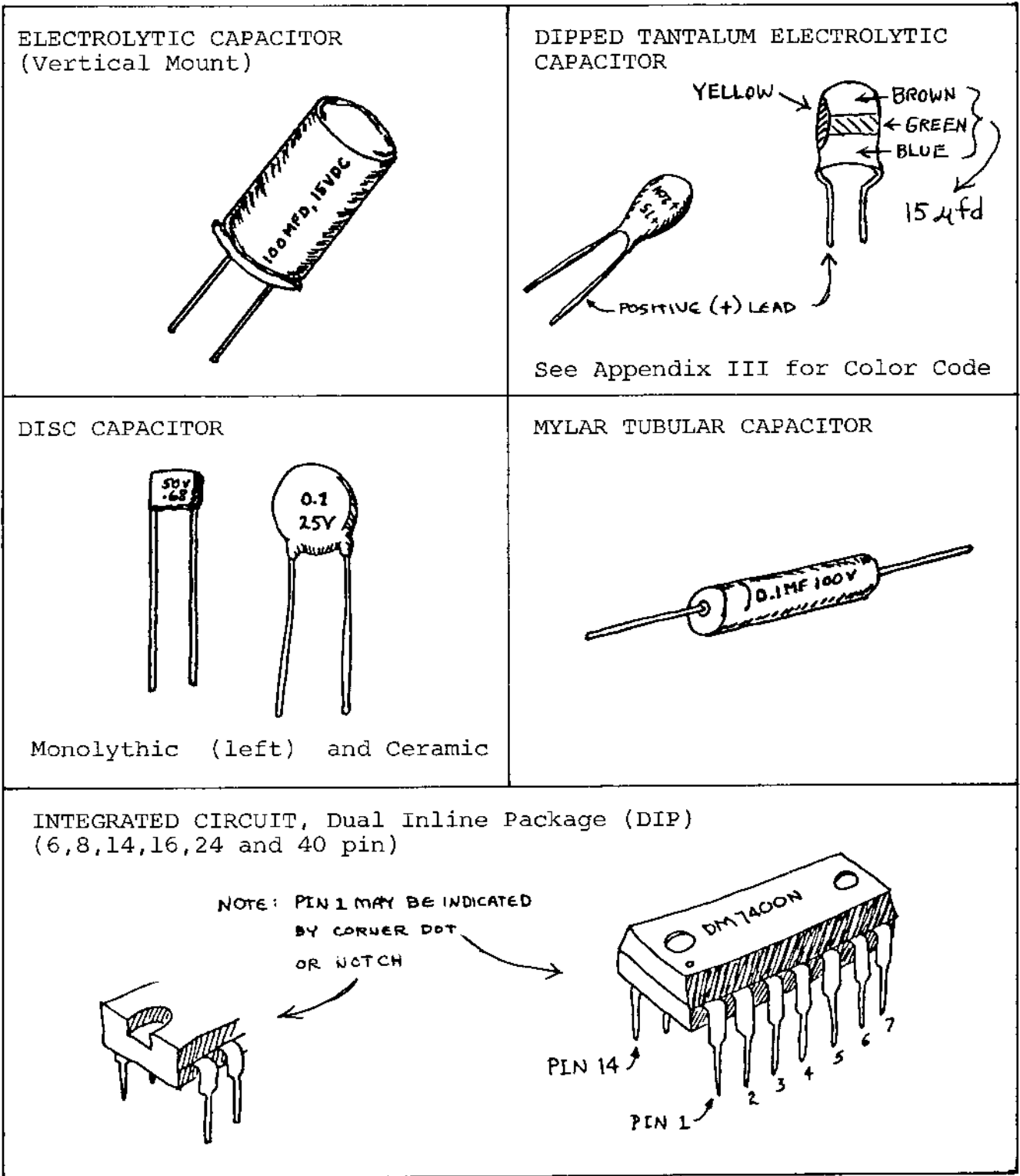
Figure 2-1.  Identification of components.

## 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 <u>no</u> <u>discharge</u> will flow <u>through</u> 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 <u>fine</u> <u>tip</u>, low-wattage iron, 25 watts maximum.

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

3.   Use <u>only</u> 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 <u>touch</u> <u>adjacent</u> <u>pins</u> <u>and/or</u> <u>traces</u> <u>simultaneously</u>.

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.  <u>Check</u> <u>for</u> <u>such</u> <u>bridges</u> <u>after</u> <u>you</u> <u>install</u> <u>each</u> <u>component</u>.

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 <u>all</u> 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 in-
structions related to the CUTS PC board assume this orientation.

2.6      ASSEMBLY-TEST

        Refer to the assembly drawing in Section VI.

<u>CAUTION</u>

        THE CUTS MODULE USES MANY MOS AND CMOS
        INTEGRATED CIRCUITS.  THEY CAN BE DAM-
        AGED BY STATIC ELECTRICITY DISCHARGE.
        HANDLE THESE IC's SO THAT <u>NO DISCHARGE</u>
        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 conti-
          nuity 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 tri-
     angles 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.)

Heat Sink

U7

Upper right-hand
corner of board
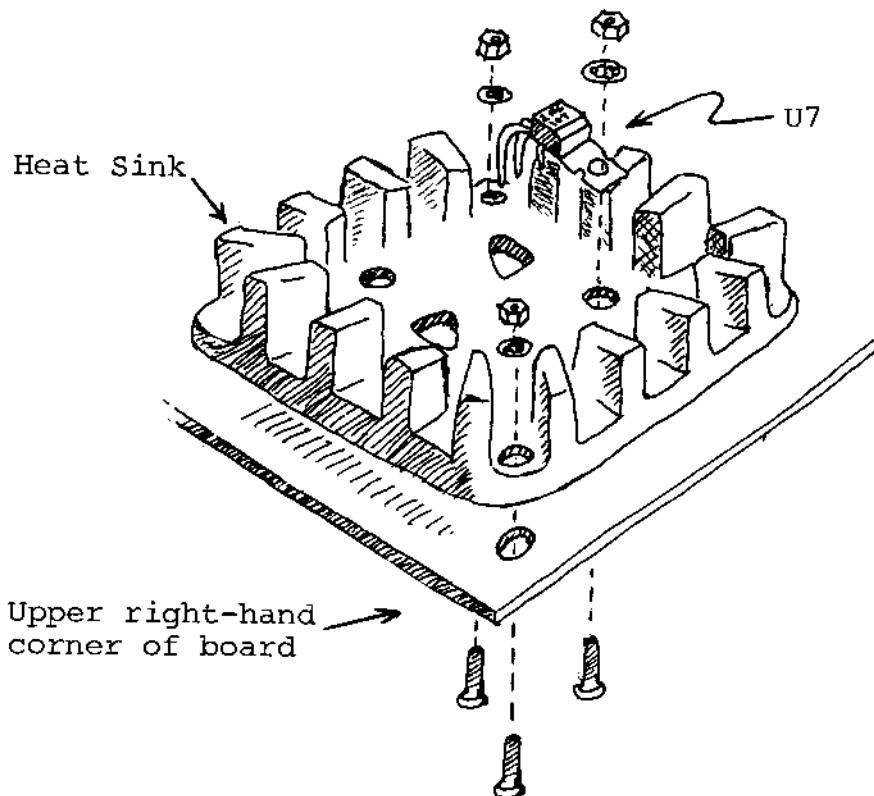
Figure 2-2.  Heat sink and U7 installation.

( ) <u>Step 3</u>.  Install male Molex right angle connectors in loca-
tions J1 and J2.  Position connector with longer pins facing
the top of the board, insert leads in mounting holes and
solder.

( ) <u>Step 4</u>.  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.

( ) <u>Step 5</u>.  Install diode D3 (1N5242) in its location.  Posi-
tion D3 with its dark band mark (cathode) at the right.

( ) <u>Step 6</u>.  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.

( ) <u>Step 7</u>.  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.

( ) <u>Step 8</u>.  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.

( ) <u>Step 9</u>.  Install all resistors in numerical order in the in-
dicated locations.  Bend leads to fit distance between mount-
ing holes, insert leads, pull down snug to board, bend leads
outward on solder (back) side of board, solder and trim.

| | LOCATION | VALUE (ohms) | COLOR CODE |
|---|---|---|---|
| ( ) | R1 | 100 K | brown-black-yellow |
| ( ) | R2 | 10 K | brown-black-orange |
| ( ) | R3 | 1.5K | brown-green-red |
| ( ) | R4 | 10 K | brown-black-orange |
| ( ) | R5 | 1.5K | brown-green-red |
| ( ) | R6 | 1.5K | "     "     " |
| ( ) | R7 | 10 K | brown-black-orange |
| ( ) | R8 | 150 K | brown-green-yellow |
| ( ) | R9 | 10 K | brown-black-orange |
| ( ) | R10 | 1 M | brown-black-green |
| ( ) | R11 | 10 K | brown-black-orange |

Step 9 continued.

| LOCATION | VALUE (ohms) | COLOR CODE |
|---|---|---|
| ( ) R12 | 2.2M | red-red-green |
| ( ) R13 | 10 K | brown-balck-orange |
| ( ) R14 | 150 K | brown-green-yellow |
| ( ) R15 | 10 K | brown-black-orange |
| ( ) R16 | 470 | yellow-violet brown |
| ( ) R17 | 100 | brown-black-brown |
| ( ) R18 | 100 K | brown-black-yellow |
| ( ) R19 | 10 K | brown-black-orange |
| ( ) R20 | 10 K | "        "        " |
| ( ) R21 | 470 | yellow-violet-brown |
| ( ) R22 | 39, 2 watt | orange-white-black |
| ( ) R23 | 100 K | brown-black-yellow |
| ( ) R24 | 100 K | "        "        " |
| ( ) R25 | 1 M | brown-black-green |
| ( ) VR1 | 50 K | Potentiometer |

( ) <u>Step 10</u>.  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.

<u>CAUTION</u>

THESE RESISTOR NETWORKS ARE DELICATE.
HANDLE WITH CARE.

( ) <u>Step 11</u>.  Install the five tantalum capacitors in the following locations.  Take care to observe proper values and the correct orientation.

| LOCATION | VALUE (ufd) | ORIENTATION |
|---|---|---|
| ( ) C7 | 15 | "+" lead left |
| ( ) C8 | 15 | "+" lead top left |
| ( ) C21 | 1 | "+" lead top |
| ( ) C24 | 15 | "+" lead right |
| ( ) C29 | 1 | "+" lead top |

( ) <u>Step 12</u>.  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.

Step 12 continued.

### NOTE

Disc capacitor leads are usually coated
with wax during the manufacturing pro-
cess.  After inserting leads through
mounting holes, remove capacitor and
clear the holes of any wax.  Re-insert
and install.

| | LOCATION | VALUE (ufd) | TYPE |
|---|---|---|---|
| ( ) | C1 | .1 | Disc |
| ( ) | C2 | .1 | " |
| ( ) | C3 | .1 | " |
| ( ) | C4 | .01 | Mylar tubular |
| ( ) | C5 | .1 | Disc |
| ( ) | C6 | .1 | " |
| ( ) | C9 | .1 | " |
| ( ) | C10 | .1 | " |
| ( ) | C11 | .001 | " |
| ( ) | C12 | .1 | " |
| ( ) | C13 | .1 | " |
| ( ) | C14 | .001 | " |
| ( ) | C15 | .1 | " |
| ( ) | C16 | .1 | " |
| ( ) | C17 | .1 | " |
| ( ) | C18 | .1 | " |
| ( ) | C19 | .1 | " |
| ( ) | C20 | .001 | " |
| ( ) | C22 | .001 | " |
| ( ) | C23 | .1 | " |
| ( ) | C25 | .001 | Mylar tubular |
| ( ) | C26 | .1 | Disc |
| ( ) | C27 | .1 | " |
| ( ) | C28 | .1 | " |
| ( ) | C30 | .1 | " |
| ( ) | C31 | 470    pfd | " |

( ) 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 S1. 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 K1 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. Posi-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.

| LOCATION | TYPE SOCKET |
|----------|-------------|
| U1 | 14 pin |
| U2 | 16 pin |
| U3 | 14 pin |
| U4 | 14 pin |
| U8 | 16 pin |
| U9 | 16 pin |
| U10 | 14 pin |
| U11 | 16 pin |
| U12 | 16 pin |
| U13 | 16 pin |
| U14 | 14 pin |
| U15 | 14 pin |
| U16 | 16 pin |
| U17 | 16 pin |
| U18 | 40 pin |
| U19 | 14 pin |
| U20 | 16 pin |
| U21 | 14 pin |
| U22 | 16 pin |
| U23 | 16 pin |
| U24 | 14 pin |
| U25 | 14 pin |
| U26 | 14 pin |

( ) 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 writ-
ten 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.

( ) <u>Step 21</u>.  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:

| SUPPLY | MEASUREMENT POINTS |
|---|---|
| + 5 V dc | Ground to right-hand lead of U7<br>Ground to left-hand lead of U7 |
| +12 V dc | Ground to positive (+) lead of C8<br>Ground to Pin 8 of U6 socket |
| -12 V dc | Across C21 |

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.)

<u>CAUTION</u>

NEVER INSTALL OR REMOVE CIRCUIT BOARD
WITH POWER ON.

( ) Turn power on and make the following voltage measurements:

| MEASUREMENT POINTS | VOLTAGE (±5%) |
|---|---|
| Ground to Pin 1 of U18 Socket | + 5 V dc |
| Ground to Pin 8 of U6 Socket | +12 V dc |
| Ground to Pin 2 of U18 Socket | -12 V dc |

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.

( ) <u>Step 22</u>.  Install the following IC's in the indicated locations.  Pay careful attention to the proper orientation.

Step 22 Continued.

## NOTE

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

| IC NO. | TYPE |
|--------|------|
| ( ) U1* | 4023* |
| ( ) U2* | 4027* |
| ( ) U3* | 4013* |
| ( ) U4* | 4013* |
| ( ) U8* | 4520* |
| ( ) U9* | 4019* |
| ( ) U10* | 4024* |
| ( ) U11* | 4046* |
| ( ) U12 | 74LS163 |
| ( ) U13 | 74LS175 |
| ( ) U14 | 74LS136 |
| ( ) U15 | 74LS136 |
| ( ) U16 | 74LS367 |
| ( ) U17 | 74LS367 |
| ( ) U18* | 6011* |
| ( ) U19* | 4030* |
| ( ) U20 | 74LS109 |
| ( ) U21 | 74LS132 |
| ( ) U22* | 4049* |
| ( ) U23 | 74LS155 |
| ( ) U24 | 74LS04 |
| ( ) U25 | 74LS08 |
| ( ) U26 | 74LS08 |

*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 3 of U2 and write the measured voltage down.  (Call this Voltage A.)

( ) Set VR1 _fully_ counterclockwise (CCW).

( ) Measure the DC voltage at pin 3 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 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.
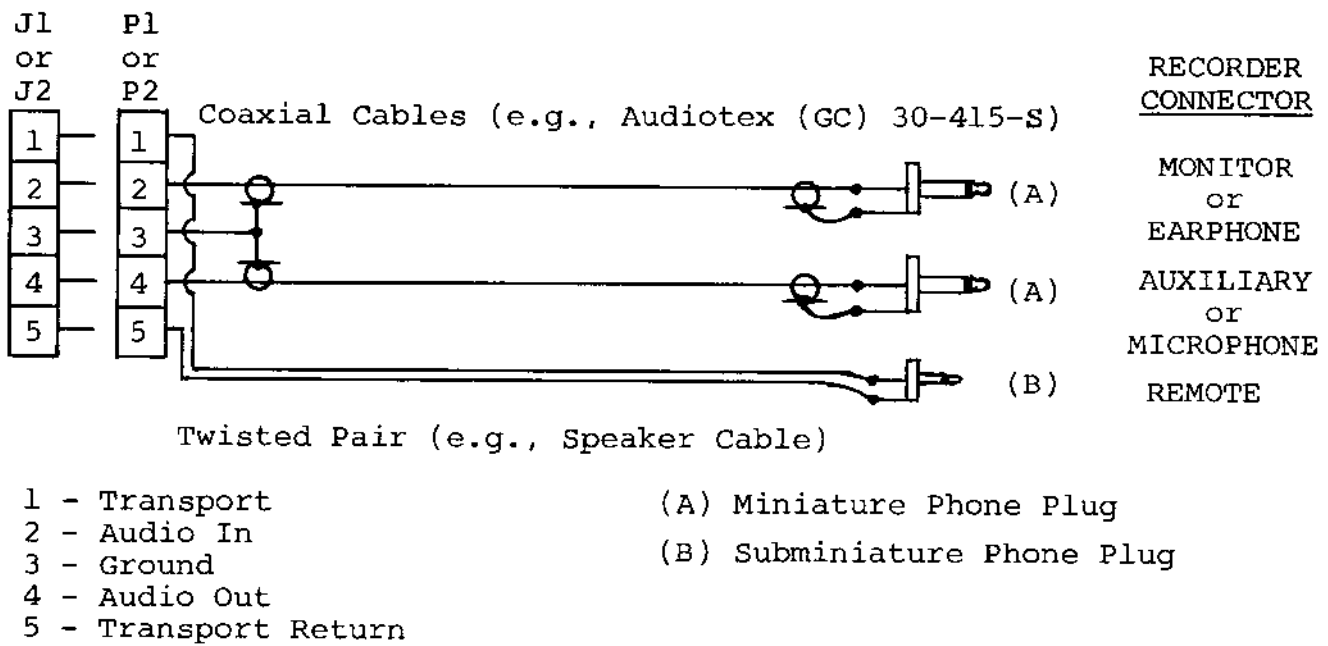
Figure 2-3.  CUTS-transport interconnect cabling.

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

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

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, Sl)

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

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 (Sl-2) to OFF and Switch No's. 1 (Sl-1) and 3 through 7 (Sl-3 through Sl-7) to ON.

To select another port, set Sl-1 through Sl-7 as required for the desired address. With these switches the address increases from Ø (all seven switches open) in a binary fashion to 254, decimal, (all seven switches closed). When setting these switches, keep in mind that 1) Sl-7 and Sl-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 Jl 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 in-
put 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 recom-
mend 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.
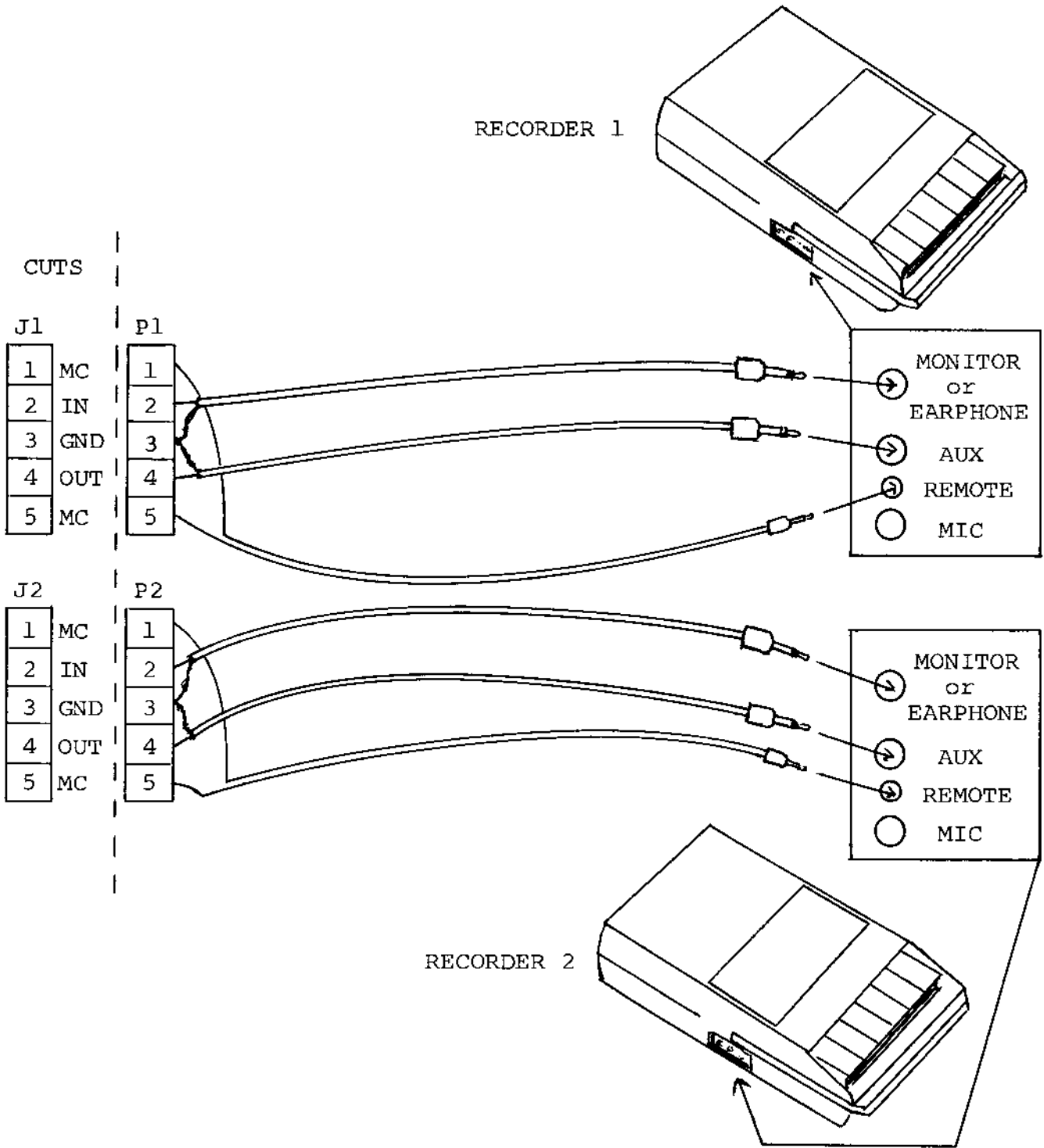
Figure 4-1.  CUTS-recorder interconnect (two recorders).

## 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 AØ is low, AØ 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 AØ 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 imme-
diately enable the DI bus drivers.

     If the cycle is an output cycle and AØ is high, the strobe
decoder outputs a DATA WRITE which transfers DO bus data into the
UART and initiates serial transmission by the UART.  Should AØ be
low, the strobe decoder outputs a STATUS WRITE.  STATUS WRITE
strobes the data on DO4-7 into the status latch.

     The four status bits in this latch are concerned with record-
er 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 Ø2 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 DOØ-7 is
serialized in the UART and applied to a synchronizer in the NRZ for-
mat.  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.  Fol-
lowing 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 Ø2 clock from the computer.  As can be seen on the
schematic, Ø2 is received on pin 24 of the S-100 bus by a hysteresis
receiver, U21.  The inverted Ø2 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 $\overline{\text{DRIVER ENABLE}}$ signal.

     U12, preset to count 3, divides Ø2 by 13 to produce a 153.85
KHz signal on pin 11.  The output of U12 is in turn counted down in
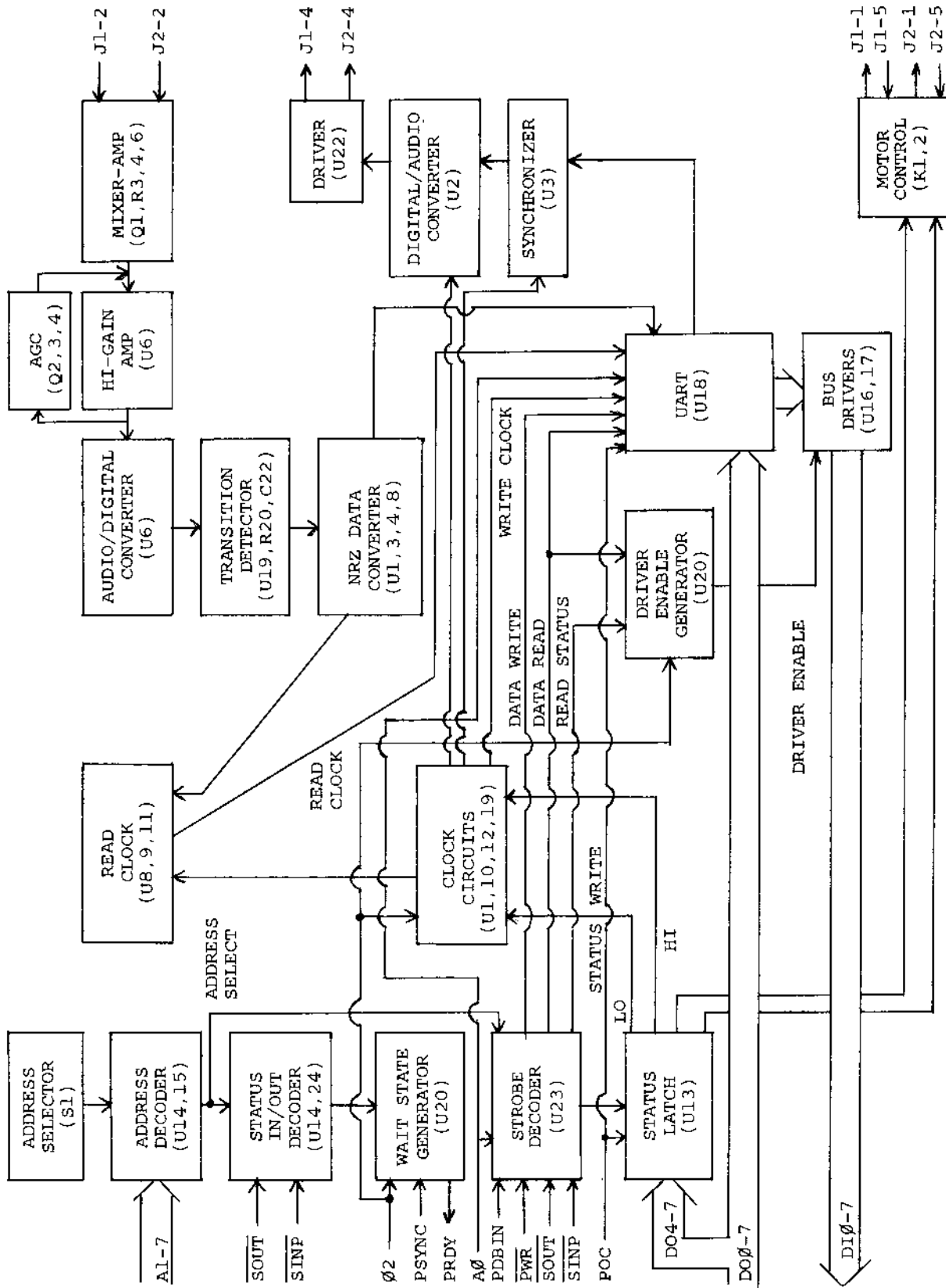
Figure 5-1.  CUTS, simplified block diagram.

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 out-
puts 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 whe-
ther 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) be-
fore 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 varia-
tions 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 se-
lector 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 col-
lector exclusive-OR gates, the inputs of which are connected to Al-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 $\emptyset$2 and reset by PSYNC.
Thus, pin 10 of U20 goes high on the falling edge of $\emptyset$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, $\overline{PWR}$
and A$\emptyset$ to produce $\overline{STATUS\ WRITE}$, $\overline{READ\ STATUS}$, $\overline{DATA\ READ\ STROBE}$, and
$\overline{DATA\ WRITE\ STROBE}$. The truth table for U23 is provided in Table
5-1 on Page V-6. All outputs from U23 are low active.

$\overline{READ\ STATUS}$ is applied to the J and $\overline{K}$ inputs to the other
half of U20 which is clocked by $\emptyset$2. Thus, an active $\overline{READ\ STATUS}$
signal produces a $\overline{DRIVER\ ENABLE}$ which is delayed from the strobe by
one-half a $\emptyset$2 cycle. This signal enables the tri-state buffers
(U16 and 17) to place data on the DI bus. Note that a $\overline{DATA\ READ}$
$\overline{STROBE}$ 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 $\overline{STATUS\ WRITE\ STROBE}$. 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.

| INPUTS | | | | | | ACTIVE OUTPUT (Low) |
|---|---|---|---|---|---|---|
| AØ* | CARD SELECT | PDBIN* | SINP* | $\overline{PWR}$* | SOUT* | |
| L | H | H | H | - | - | $\overline{READ\ STATUS}$ |
| H | H | H | H | - | - | $\overline{DATA\ READ\ STROBE}$ |
| L | H | - | - | L | H | $\overline{STATUS\ WRITE\ STROBE}$ |
| H | H | - | - | L | H | $\overline{DATA\ WRITE\ STROBE}$ |

*Inputs to CUTS module.

The remaining control circuit, POC (power on clear), ini-
tializes the CUTS whenever power is applied.  When power is applied,
$\overline{POC}$ on S-100 bus pin 99 goes low.  $\overline{POC}$ is inverted in one section of
U21 to clear the logic in the UART (U18).  In addition, the inverted
$\overline{POC}$ is again inverted in one section of U24 to clear the status re-
gister, 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 $\overline{DATA\ WRITE\ STROBE}$ 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.

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 $\frac{1}{2}$ of U3 and $\frac{1}{2}$ of U4, both of which are D-type flip-flops.  A transition pulse clocks U3 to set Q high and $\overline{Q}$ 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 $\overline{\text{READ STATUS}}$ signal.

SECTION VI

DRAWINGS

CUTS, COMPUTER USERS TAPE SYSTEM

**Processor Technology**

+16V

VR1

R1 100K

U1 4023

U2 4027 · C1 .1

U3 4013 · C2 .1

U4 4013

D1 IN4148

K1 RELAY

D2 IN4148

K2 RELAY

S1

10K R2

2.2K

RX1

Z

Y

R14 150K

RX2 2.2K

.001 C14

U8 4520 · C12 .1

U9 4019

K
L
V
U
AA
Q
R

T  S

U10 4024 · C13 .1

U11 4046

U12 74LS163 · C15 .1

U13 74LS175

U14 74LS136

U15 74LS136

PROCESSOR TECHNOLOGY

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100K R23

.001 C25

Serial N

X W

C20 .001  R19 10K  R20 10K  C22 .001

U19 4030 · C23 .1

U20 74LS109

U21 74LS132

U22 4049 · C26 .1

U23 74LS155

U24 74LS04

C2

C21 1uf

B
Q5
C   E
2N2907

470 R21

39/2W R22

C24 15 uf

+ IN5242B

D3

IN4148

D4

0.3"

5.0"

1.5"

6.375"

COMPONENT  WIRING

+8
+16
-16
XRDY
VI0
PTC
STSTB
DI01
FRDY
VI1
VI2
VI3
VI4
VI5
VI6
VI7
XRDY2

STA DSB
C/C DSB
UNPROC
SS
ADD DSB
DO DSB
PHANTOM
MWRT
PS
PROC
RUN
PRDY
PINT
PWAIT
PINTE

10.0"

S1

R2 10K

R3 1.5K

2.2K
RX1

R4 10K

.01
C4

C3
Q1
2N2222

78L12AC

MC IN GND OUT MC
J1

MC IN GND OUT MC
J2

U5
3 2 1

C7 15 uf
C8 15 uf

U6
1458

C9 .1

7805
U7

1.5K R5
1.5K R6

C5 .1    .1 C6

C10 .1

10K  150Ω  10K  1M  10K  2.2K  10K
R7   R8    R9   R10 R11  R12   R13

.001
C11

U14          U15
74LS136      74LS136

C16 .1

Serial No.

2N4360  Q2   Q3   Q4
        D    B    B
      S   G  C    C
        G    E    E
2N2222

U16        U17
10K  470  100  100K
R15  R16  R7   R18
C17

74367      74367
C18 .1

C19 .1    U18

U24
74LS04

C27 .1

U25        U26
.1  100K  1M  1uf
C28 R24 R25 C29
D
A
B

74LS08     74LS08
C30 .1

UART
TMS6011

CUTS
rev. B

← SHEAR POINT

2.125"

PGWAIT PWR POSIN A0 A5 A4 A3 A2 A6 A7 A8 A13 A14 A11 DO3 DO2 DO7 DI4 DI5 DI6 SM1 DI7 SOUT SIND SINTA SMER SWO SSTACK SHLTA POC CLOCK GND

30-90  35-85  40-90  45-95  80-100

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     MANCHESTER ENCODED DATA

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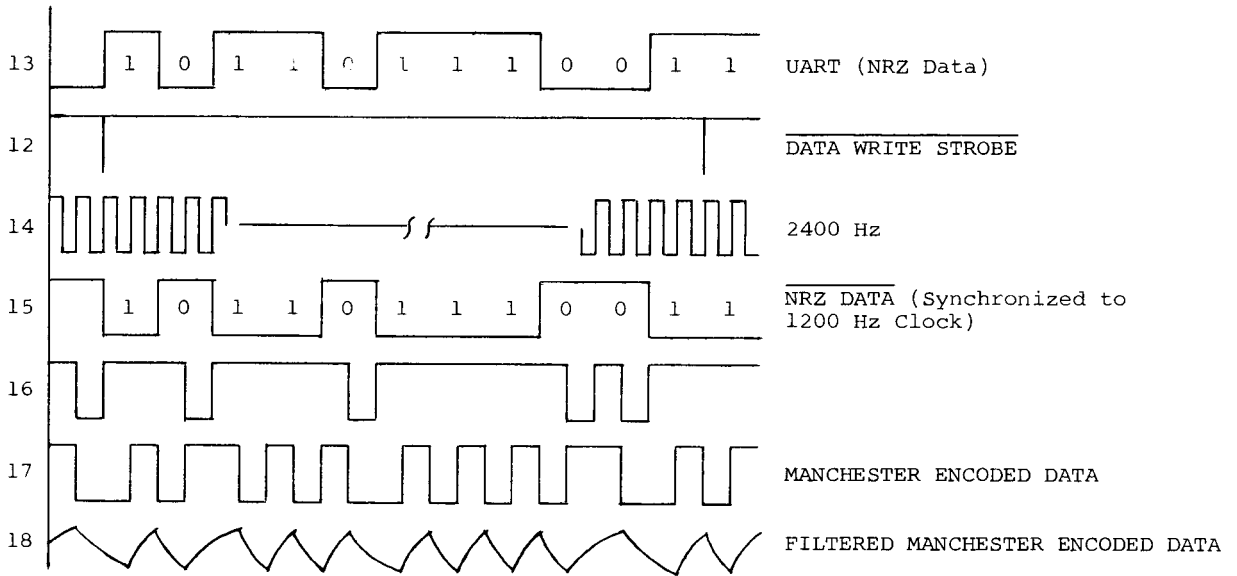
NOTE: 1200 Baud NRZ data (13) is not necessarily synchronized with 1200 Hz clock. Signal at 15 and its complement on pin 12 of U3 are.

CUTS TIMING, READ MODE (1200 Baud Operation)
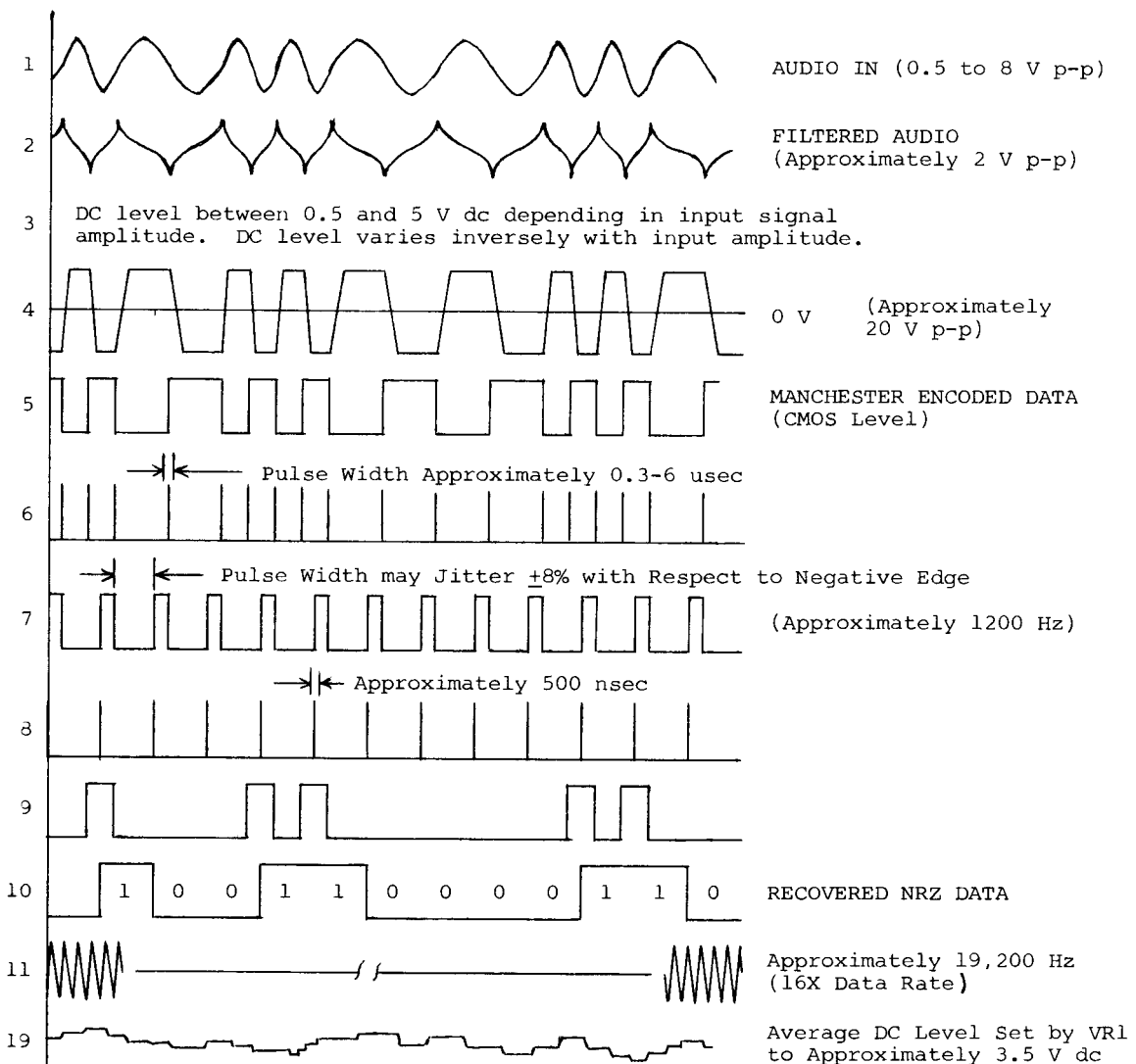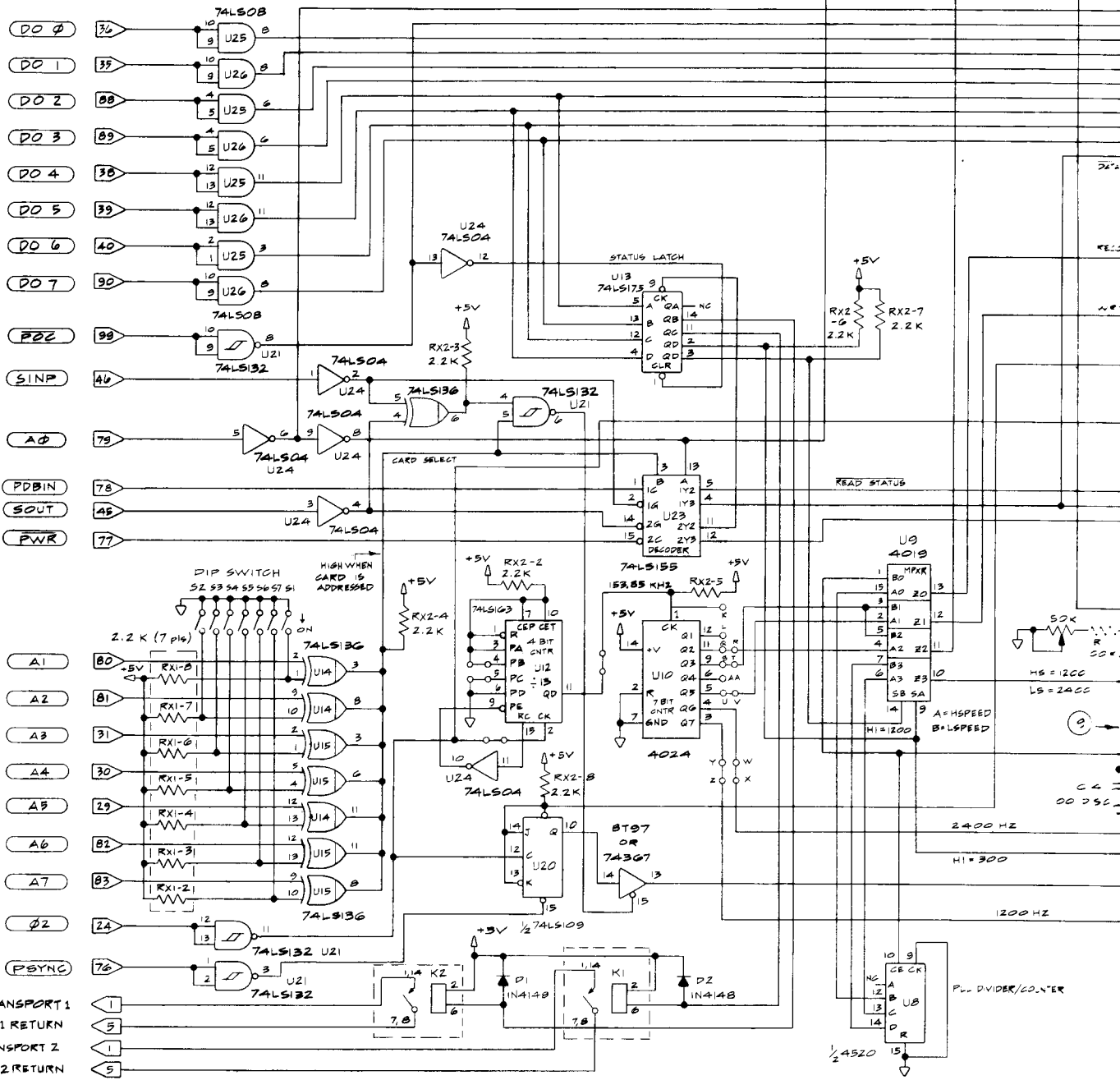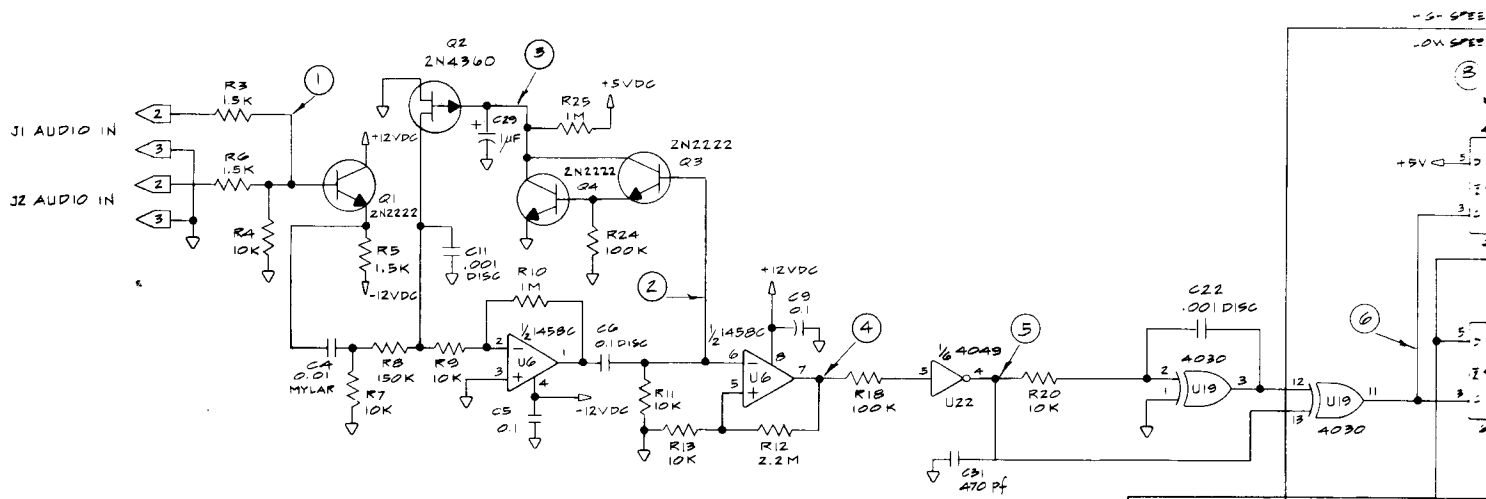
1     AUDIO IN (0.5 to 8 V p-p)

2     FILTERED AUDIO (Approximately 2 V p-p)

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

4     0 V     (Approximately 20 V p-p)

5     MANCHESTER ENCODED DATA (CMOS Level)

6     Pulse Width Approximately 0.3-6 usec

7     Pulse Width may Jitter ±8% with Respect to Negative Edge     (Approximately 1200 Hz)

8     Approximately 500 nsec

9

| 10 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | RECOVERED NRZ DATA |

11     Approximately 19,200 Hz (16X Data Rate)

19     Average DC Level Set by VR1 to Approximately 3.5 V dc

NOTES:

1. �─▷ IS I/O CONNECTOR
2. ◁─ IS S-100 CONNECTION
3. ▷─ IS S-100 CONNECTION

HIGH SPEED = 19.2 KHZ
LOW SPEED = 38.4 KHZ
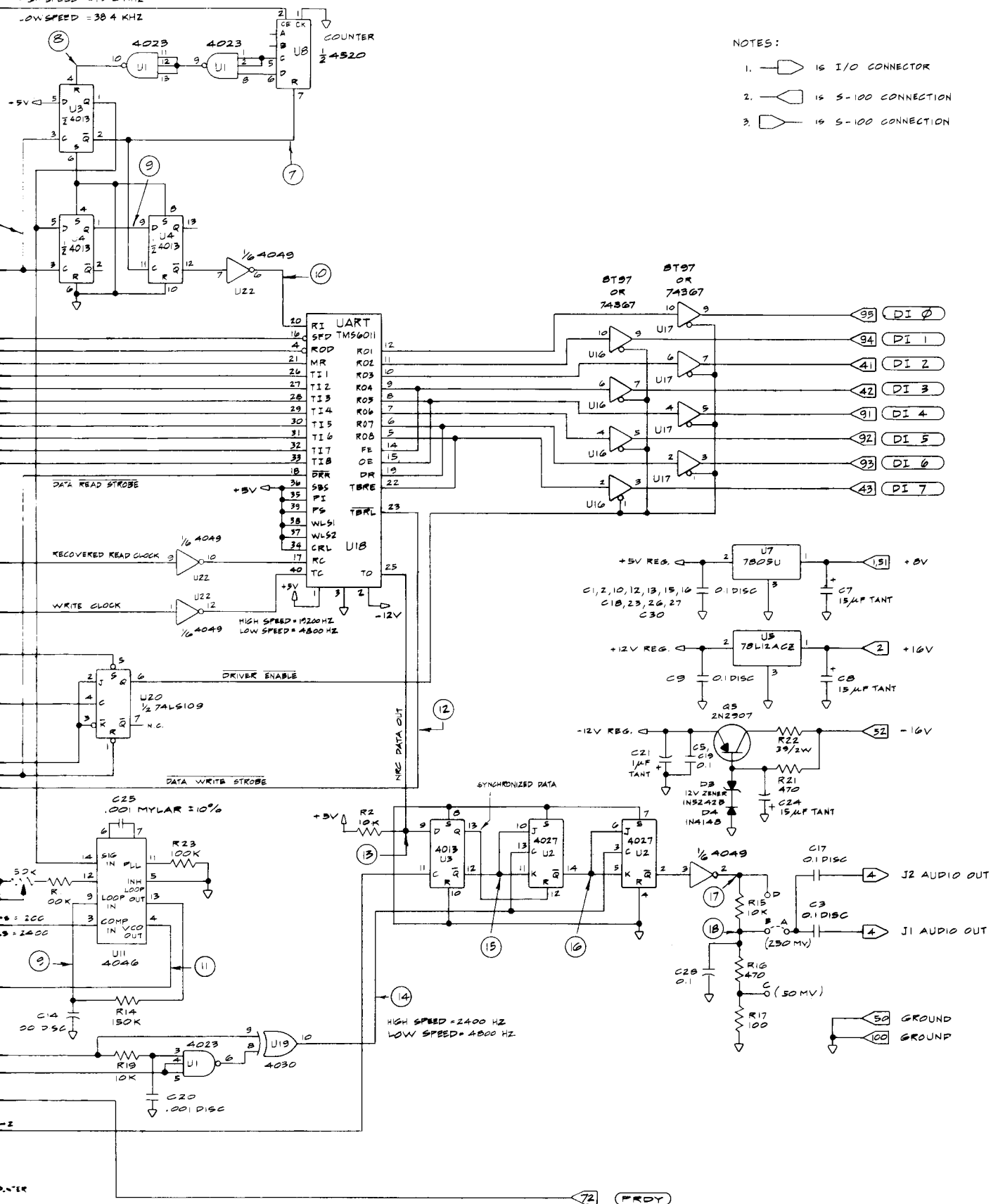
| | | | DRAWN BY LITO |
|---|---|---|---|
| SCHEMATIC, S-100 CUTS | | | |
| SCALE: | APPROVED BY: R. MARSH | | REVISED 02-3-77 |
| DATE: 9-21-76 | | | |
| PROCESSOR TECHNOLOGY | | | |
| Rev. B | | | DRAWING NUMBER |

## APPENDICES

# 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.

## 8080 Opcode Table

| Hex | Mnemonic | Hex | Mnemonic | Hex | Mnemonic | Hex | Mnemonic |
|-----|----------|-----|----------|-----|----------|-----|----------|
| 00 | NOP | 40 | MOV B,B | 80 | ADD B | C0 | RNZ |
| 01 | LXI B,D16 | 41 | MOV B,C | 81 | ADD C | C1 | POP B |
| 02 | STAX B | 42 | MOV B,D | 82 | ADD D | C2 | JNZ Adr |
| 03 | INX B | 43 | MOV B,E | 83 | ADD E | C3 | JMP Adr |
| 04 | INR B | 44 | MOV B,H | 84 | ADD H | C4 | CNZ Adr |
| 05 | DCR B | 45 | MOV B,L | 85 | ADD L | C5 | PUSH B |
| 06 | MVI B,D8 | 46 | MOV B,M | 86 | ADD M | C6 | ADI D8 |
| 07 | RLC | 47 | MOV B,A | 87 | ADD A | C7 | RST 0 |
| 08 | --- | 48 | MOV C,B | 88 | ADC B | C8 | RZ |
| 09 | DAD B | 49 | MOV C,C | 89 | ADC C | C9 | RET |
| 0A | LDAX B | 4A | MOV C,D | 8A | ADC D | CA | JZ Adr |
| 0B | DCX B | 4B | MOV C,E | 8B | ADC E | CB | --- |
| 0C | INR C | 4C | MOV C,H | 8C | ADC H | CC | CZ Adr |
| 0D | DCR C | 4D | MOV C,L | 8D | ADC L | CD | CALL Adr |
| 0E | MVI C,D8 | 4E | MOV C,M | 8E | ADC M | CE | ACI D8 |
| 0F | RRC | 4F | MOV C,A | 8F | ADC A | CF | RST 1 |
| 10 | --- | 50 | MOV D,B | 90 | SUB B | D0 | RNC |
| 11 | LXI D,D16 | 51 | MOV D,C | 91 | SUB C | D1 | POP D |
| 12 | STAX D | 52 | MOV D,D | 92 | SUB D | D2 | JNC Adr |
| 13 | INX D | 53 | MOV D,E | 93 | SUB E | D3 | OUT D8 |
| 14 | INR D | 54 | MOV D,H | 94 | SUB H | D4 | CNC Adr |
| 15 | DCR D | 55 | MOV D,L | 95 | SUB L | D5 | PUSH D |
| 16 | MVI D,D8 | 56 | MOV D,M | 96 | SUB M | D6 | SUI D8 |
| 17 | RAL | 57 | MOV D,A | 97 | SUB A | D7 | RST 2 |
| 18 | --- | 58 | MOV E,B | 98 | SBB B | D8 | RC |
| 19 | DAD D | 59 | MOV E,C | 99 | SBB C | D9 | --- |
| 1A | LDAX D | 5A | MOV E,D | 9A | SBB D | DA | JC Adr |
| 1B | DCX D | 5B | MOV E,E | 9B | SBB E | DB | IN D8 |
| 1C | INR E | 5C | MOV E,H | 9C | SBB H | DC | CC Adr |
| 1D | DCR E | 5D | MOV E,L | 9D | SBB L | DD | --- |
| 1E | MVI E,D8 | 5E | MOV E,M | 9E | SBB M | DE | SBI D8 |
| 1F | RAR | 5F | MOV E,A | 9F | SBB A | DF | RST 3 |
| 20 | --- | 60 | MOV H,B | A0 | ANA B | E0 | RPO |
| 21 | LXI H,D16 | 61 | MOV H,C | A1 | ANA C | E1 | POP H |
| 22 | SHLD Adr | 62 | MOV H,D | A2 | ANA D | E2 | JPO Adr |
| 23 | INX H | 63 | MOV H,E | A3 | ANA E | E3 | XTHL |
| 24 | INR H | 64 | MOV H,H | A4 | ANA H | E4 | CPO Adr |
| 25 | DCR H | 65 | MOV H,L | A5 | ANA L | E5 | PUSH H |
| 26 | MVI H,D8 | 66 | MOV H,M | A6 | ANA M | E6 | ANI D8 |
| 27 | DAA | 67 | MOV H,A | A7 | ANA A | E7 | RST 4 |
| 28 | --- | 68 | MOV L,B | A8 | XRA B | E8 | RPE |
| 29 | DAD H | 69 | MOV L,C | A9 | XRA C | E9 | PCHL |
| 2A | LHLD Adr | 6A | MOV L,D | AA | XRA D | EA | JPE Adr |
| 2B | DCX H | 6B | MOV L,E | AB | XRA E | EB | XCHG |
| 2C | INR L | 6C | MOV L,H | AC | XRA H | EC | CPE Adr |
| 2D | DCR L | 6D | MOV L,L | AD | XRA L | ED | --- |
| 2E | MVI L,D8 | 6E | MOV L,M | AE | XRA M | EE | XRI D8 |
| 2F | CMA | 6F | MOV L,A | AF | XRA A | EF | RST 5 |
| 30 | --- | 70 | MOV M,B | B0 | ORA B | F0 | RP |
| 31 | LXI SP,D16 | 71 | MOV M,C | B1 | ORA C | F1 | POP PSW |
| 32 | STA Adr | 72 | MOV M,D | B2 | ORA D | F2 | JP Adr |
| 33 | INX SP | 73 | MOV M,E | B3 | ORA E | F3 | DI |
| 34 | INR M | 74 | MOV M,H | B4 | ORA H | F4 | CP Adr |
| 35 | DCR M | 75 | MOV M,L | B5 | ORA L | F5 | PUSH PSW |
| 36 | MVI M,D8 | 76 | HLT | B6 | ORA M | F6 | ORI D8 |
| 37 | STC | 77 | MOV M,A | B7 | ORA A | F7 | RST 6 |
| 38 | --- | 78 | MOV A,B | B8 | CMP B | F8 | RM |
| 39 | DAD SP | 79 | MOV A,C | B9 | CMP C | F9 | SPHL |
| 3A | LDA Adr | 7A | MOV A,D | BA | CMP D | FA | JM Adr |
| 3B | DCX SP | 7B | MOV A,E | BB | CMP E | FB | EI |
| 3C | INR A | 7C | MOV A,H | BC | CMP H | FC | CM Adr |
| 3D | DCR A | 7D | MOV A,L | BD | CMP L | FD | --- |
| 3E | MVI A,D8 | 7E | MOV A,M | BE | CMP M | FE | CPI D8 |
| 3F | CMC | 7F | MOV A,A | BF | CMP A | FF | RST 7 |

## HEX-ASCII TABLE

### Characters

| Hex | Char | Hex | Printing |
|-----|------|-----|----------|
| 40 | @ | 30 | 0 |
| 20 | space | 31 | 1 |
| 21 | ! | 32 | 2 |
| 22 | " | 33 | 3 |
| 23 | # | 34 | 4 |
| 24 | $ | 35 | 5 |
| 25 | % | 36 | 6 |
| 26 | & | 37 | 7 |
| 27 | ' | 38 | 8 |
| 28 | ( | 39 | 9 |
| 29 | ) | 41 | A |
| 2A | * | 42 | B |
| 2B | + | 43 | C |
| 2C | , | 44 | D |
| 2D | - | 45 | E |
| 2E | . | 46 | F |
| 2F | / | 47 | G |
|   |   | 48 | H |
|   |   | 49 | I |
|   |   | 4A | J |
|   |   | 4B | K |
|   |   | 4C | L |
|   |   | 4D | M |
|   |   | 4E | N |
|   |   | 4F | O |
|   |   | 50 | P |
|   |   | 51 | Q |
|   |   | 52 | R |
|   |   | 53 | S |
|   |   | 54 | T |
|   |   | 55 | U |
|   |   | 56 | V |
|   |   | 57 | W |
|   |   | 58 | X |
|   |   | 59 | Y |
|   |   | 5A | Z |

### HEX-ASCII TABLE — Non-Printing

| Hex | Name |
|-----|------|
| 00 | NULL |
| 07 | BELL |
| 09 | TAB |
| 0A | LF |
| 0B | VT |
| 0C | FORM |
| 0D | CR |
| 11 | X-ON |
| 12 | TAPE |
| 13 | X-OFF |
| 14 | --- |
| 1B | ESC |
| 7D | ALT MODE |
| 7F | RUB OUT |

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

## CONSTANT DEFINITION

- 0BDH } Hex
- 1AH }
- 105D } Decimal
- 105 }
- 72O } Octal
- 72Q }
- 11011B } Binary
- 00110B }
- 'TEST' } ASCII
- 'A' 'B' }

## OPERATORS

+ -

## STANDARD SETS

- A SET 7
- B SET 0
- C SET 1
- D SET 2
- E SET 3
- H SET 4
- L SET 5
- M SET 6
- SP SET 6
- PSW SET 6

## JUMP

- C3 JMP
- C2 JNZ
- CA JZ
- D2 JNC
- DA JC
- E2 JPO
- EA JPE
- F2 JP
- FA JM
- E9 PCHL

(Adr)

## CALL

- CD CALL
- C4 CNZ
- CC CZ
- D4 CNC
- DC CC
- E4 CPO
- EC CPE
- F4 CP
- FC CM

(Adr)

## RETURN

- C9 RET
- C0 RNZ
- C8 RZ
- D0 RNC
- D8 RC
- E0 RPO
- E8 RPE
- F0 RP
- F8 RM

## RESTART

- C7 RST 0
- CF RST 1
- D7 RST 2
- DF RST 3
- E7 RST 4
- EF RST 5
- F7 RST 6
- FF RST 7

## ROTATE†

- 07 RLC
- 0F RRC
- 17 RAL
- 1F RAR

## CONTROL

- 00 NOP
- 76 HLT
- F3 DI
- FB EI

## MOVE

- 40 MOV B,B
- 41 MOV B,C
- 42 MOV B,D
- 43 MOV B,E
- 44 MOV B,H
- 45 MOV B,L
- 46 MOV B,M
- 47 MOV B,A
- 48 MOV C,B
- 49 MOV C,C
- 4A MOV C,D
- 4B MOV C,E
- 4C MOV C,H
- 4D MOV C,L
- 4E MOV C,M
- 4F MOV C,A
- 50 MOV D,B
- 51 MOV D,C
- 52 MOV D,D
- 53 MOV D,E
- 54 MOV D,H
- 55 MOV D,L
- 56 MOV D,M
- 57 MOV D,A

## MOVE (cont)

- 58 MOV E,B
- 59 MOV E,C
- 5A MOV E,D
- 5B MOV E,E
- 5C MOV E,H
- 5D MOV E,L
- 5E MOV E,M
- 5F MOV E,A
- 60 MOV H,B
- 61 MOV H,C
- 62 MOV H,D
- 63 MOV H,E
- 64 MOV H,H
- 65 MOV H,L
- 66 MOV H,M
- 67 MOV H,A
- 68 MOV L,B
- 69 MOV L,C
- 6A MOV L,D
- 6B MOV L,E
- 6C MOV L,H
- 6D MOV L,L
- 6E MOV L,M
- 6F MOV L,A
- 70 MOV M,B
- 71 MOV M,C
- 72 MOV M,D
- 73 MOV M,E
- 74 MOV M,H
- 75 MOV M,L
- 77 MOV M,A
- 78 MOV A,B
- 79 MOV A,C
- 7A MOV A,D
- 7B MOV A,E
- 7C MOV A,H
- 7D MOV A,L
- 7E MOV A,M
- 7F MOV A,A

## ACCUMULATOR*

- 80 ADD B
- 81 ADD C
- 82 ADD D
- 83 ADD E
- 84 ADD H
- 85 ADD L
- 86 ADD M
- 87 ADD A
- 88 ADC B
- 89 ADC C
- 8A ADC D
- 8B ADC E
- 8C ADC H
- 8D ADC L
- 8E ADC M
- 8F ADC A
- 90 SUB B
- 91 SUB C
- 92 SUB D
- 93 SUB E
- 94 SUB H
- 95 SUB L
- 96 SUB M
- 97 SUB A
- 98 SBB B
- 99 SBB C
- 9A SBB D
- 9B SBB E
- 9C SBB H
- 9D SBB L
- 9E SBB M
- 9F SBB A
- A0 ANA B
- A1 ANA C
- A2 ANA D
- A3 ANA E
- A4 ANA H
- A5 ANA L
- A6 ANA M
- A7 ANA A
- A8 XRA B
- A9 XRA C
- AA XRA D
- AB XRA E
- AC XRA H
- AD XRA L
- AE XRA M
- AF XRA A
- B0 ORA B
- B1 ORA C
- B2 ORA D
- B3 ORA E
- B4 ORA H
- B5 ORA L
- B6 ORA M
- B7 ORA A
- B8 CMP B
- B9 CMP C
- BA CMP D
- BB CMP E
- BC CMP H
- BD CMP L
- BE CMP M
- BF CMP A

## PSEUDO INSTRUCTION

- ORG Adr
- END
- EQU D16
- DS D16
- DB D8 [ ]
- DW D16 [ ]

## MOVE IMMEDIATE

- 06 MVI B
- 0E MVI C
- 16 MVI D
- 1E MVI E
- 26 MVI H
- 2E MVI L
- 36 MVI M
- 3E MVI A

(D8)

## LOAD IMMEDIATE

- 01 LXI B
- 11 LXI D
- 21 LXI H
- 31 LXI SP

(D16)

## STACK OPS

- C5 PUSH B
- D5 PUSH D
- E5 PUSH H
- F5 PUSH PSW
- C1 POP B
- D1 POP D
- E1 POP H
- F1 POP PSW
- E3 XTHL
- F9 SPHL

## IMMEDIATE Acc

- C6 ADI
- CE ACI
- D6 SUI
- DE SBI
- E6 ANI
- EE XRI
- F6 ORI
- FE CPI

(D8)

## DOUBLE ADD†

- 09 DAD B
- 19 DAD D
- 29 DAD H
- 39 DAD SP

## LOAD/STORE

- 0A LDAX B
- 1A LDAX D
- 2A LHLD Adr
- 3A LDA Adr
- 02 STAX B
- 12 STAX D
- 22 SHLD Adr
- 32 STA Adr

## SPECIALS

- EB XCHG
- 27 DAA*
- 2F CMA
- 37 STC†
- 3F CMC†

## INPUT/OUTPUT

- D3 OUT D8
- DB IN D8

## INCREMENT**

- 04 INR B
- 0C INR C
- 14 INR D
- 1C INR E
- 24 INR H
- 2C INR L
- 34 INR M
- 3C INR A

## DECREMENT**

- 05 DCR B
- 0D DCR C
- 15 DCR D
- 1D DCR E
- 25 DCR H
- 2D DCR L
- 35 DCR M
- 3D DCR A

## INCREMENT**

- 03 INX B
- 13 INX D
- 23 INX H
- 33 INX SP

## DECREMENT**

- 0B DCX B
- 1B DCX D
- 2B DCX H
- 3B DCX SP

---

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

Adr = 16 bit address

** = all Flags except CARRY affected; (exception: INX & DCX affect no Flags)

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

| 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 |
| None | – | --- | 20 | 500 |

*Applies to capacitors only.

### COLOR CODE FOR TANTALUM DIPPED CAPACITORS

| Rated Voltage VDC 25°C | Color | CODE FOR CAPACITANCE IN PICOFARADS | | |
|-------|-------|-----|-----|-----|
| | | 1st Figure | 2nd Figure | Multiplier uuF |
| 3-4 | Black | 0 | 0 | 1 |
| 3-6 | Brown | 1 | 1 | 10 |
| 3-10 | Red | 2 | 2 | 100 |
| 3-15 | Orange | 3 | 3 | 1,000 |
| 3-20 | Yellow | 4 | 4 | 10,000 |
| 3-25 | Green | 5 | 5 | 100,000 |
| 3-35 | Blue | 6 | 6 | 1,000,000 |
| 3-50 | Violet | 7 | 7 | 10,000,000 |
| | Gray | 8 | 8 | |
| 3 | White | 9 | 9 | |

Polarity & Voltage
1st Figure
2nd Figure
Multiplier
+
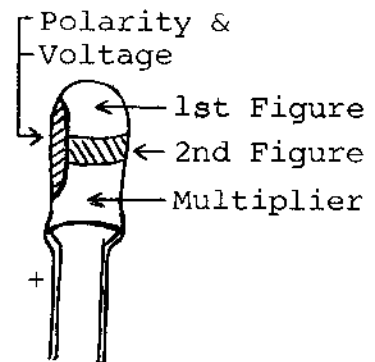
melts the rest of the joint will be hot enough for the solder
to "take", (i.e., form a capillary film).

(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 sol-
der bridges look very neat, but they are a constant source of
trouble when boards of a high trace density are being sol-
dered.  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 instal-
lation.  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 perpendicu-
lar to the board.)

(2) Solder all pins from back (solder) side of board so the sol-
der "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.

<u>NOTE</u>

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

(5) Check each installation for cold joints and solder bridges.

### 1458 or 5558
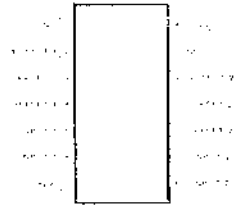
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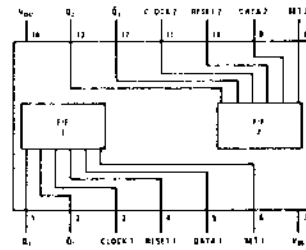
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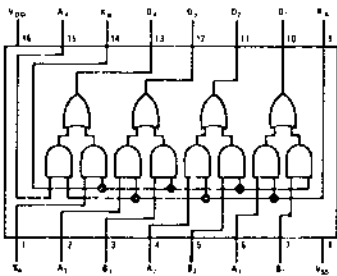
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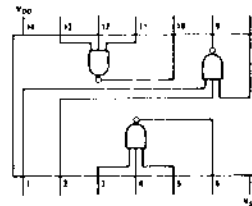
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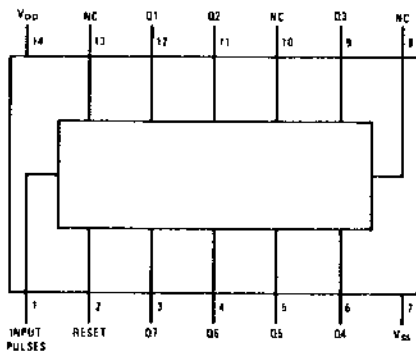
### 4027

### 4030

### 4046

## 4049



## 4520



## 6011



| | | | |
|---|---|---|---|
| V$_{SS}$ | 1 | 40 | TC |
| V$_{GG}$ | 2 | 39 | PS |
| V$_{DD}$ | 3 | 38 | WLS1 |
| ROD | 4 | 37 | WLS2 |
| RO8 | 5 | 36 | SBS |
| RO7 | 6 | 35 | PI |
| RO6 | 7 | 34 | CRL |
| RO5 | 8 | 33 | TI8 |
| RO4 | 9 | 32 | TI7 |
| RO3 | 10 | 31 | TI6 |
| RO2 | 11 | 30 | TI5 |
| RO1 | 12 | 29 | TI4 |
| PE | 13 | 28 | TI3 |
| FE | 14 | 27 | TI2 |
| OE | 15 | 26 | TI1 |
| SFD | 16 | 25 | TO |
| RC | 17 | 24 | TRE |
| $\overline{DRR}$ | 18 | 23 | $\overline{TBRL}$ |
| DR | 19 | 22 | TBRE |
| RI | 20 | 21 | MR |
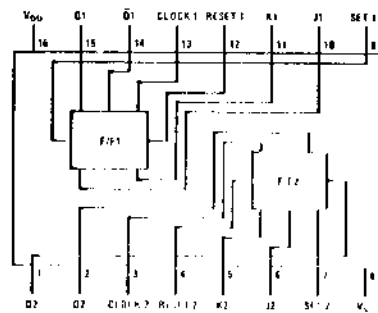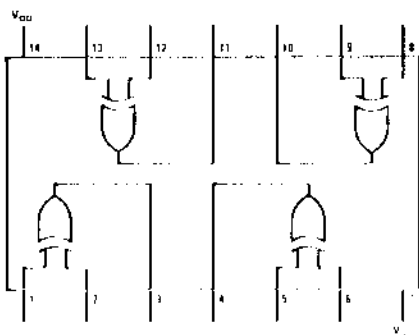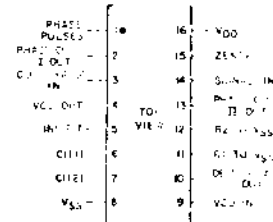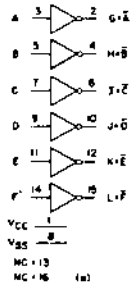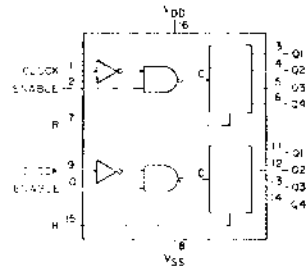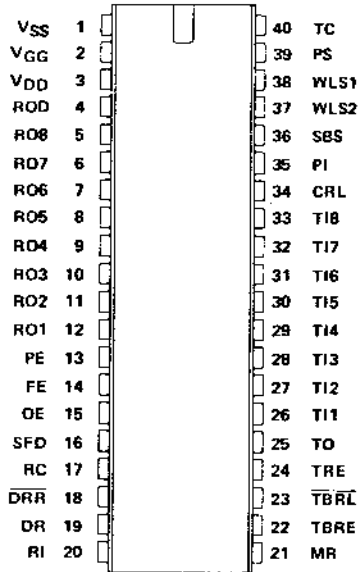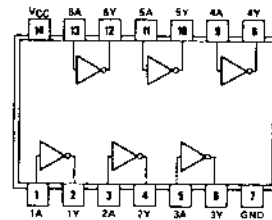
## 74LS04



## 74LS08
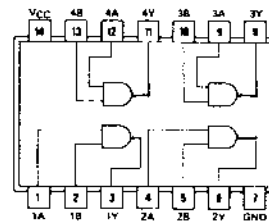


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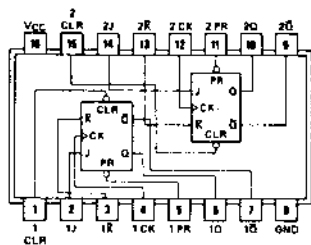


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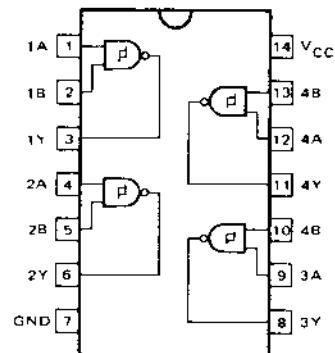
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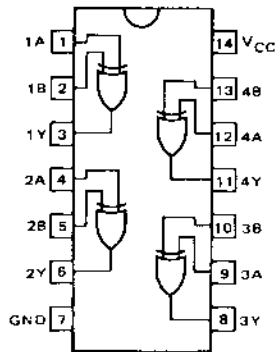


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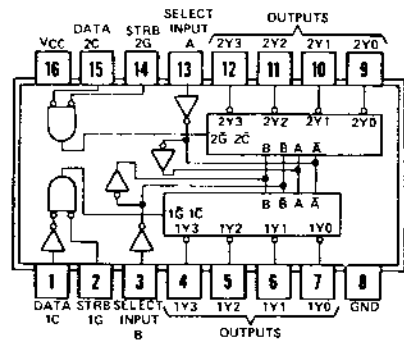


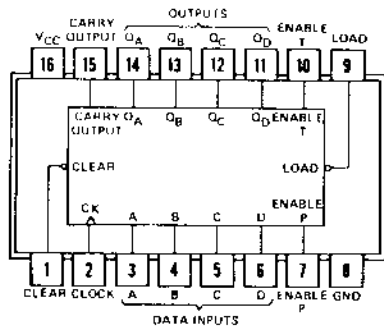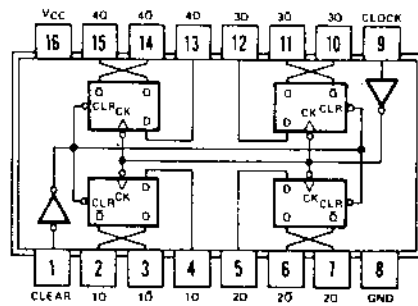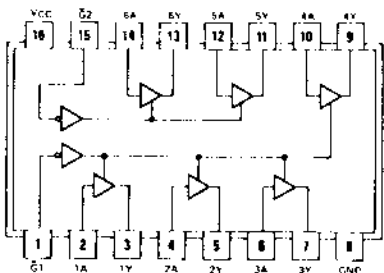## 74LS163



## 74LS175



## 74367



## 7805UC

**P SUFFIX**
PLASTIC PACKAGE
CASE 199-04

Pin 1 Input (Base)
Pin 2 Output (Emitter)
Pin 3 Ground (Collector)

Heat sink surface connected
to pin 3.



## 78L12



BOTTOM VIEW