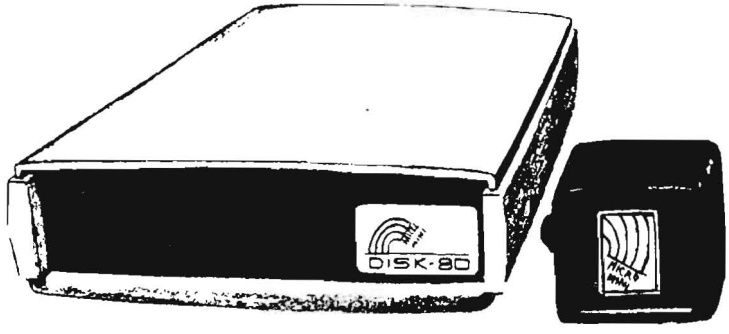


DISK-80 EXPANSION INTERFACE

OWNERS MANUAL AND ASSEMBLY INSTRUCTIONS

MICRO MINT
917 MIDWAY
WOODMERE, NY 11598

The DISK-80 is Radio Shack Hardware and software compatible. Factory manufactured and tested DISK-80's carry a 60 day warrantee including parts and labor. The MICROMINT makes no warantee on user assembled DISK-80 systems, power supply kits, or blank boards. The MICROMINT will, however, offer an inspection and repair service for purchasers of full DISK-80 kits. Prices for this service are available on request. Under no circumstances is any hardware to be returned to the MICROMINT without prior authorization. The MICROMINT will assume no liabilities for unauthorized returns.

The MICROMINT, Inc. reserves the right to change any specification at any time.

TRS-80 is a trade mark of Tandy Corp.

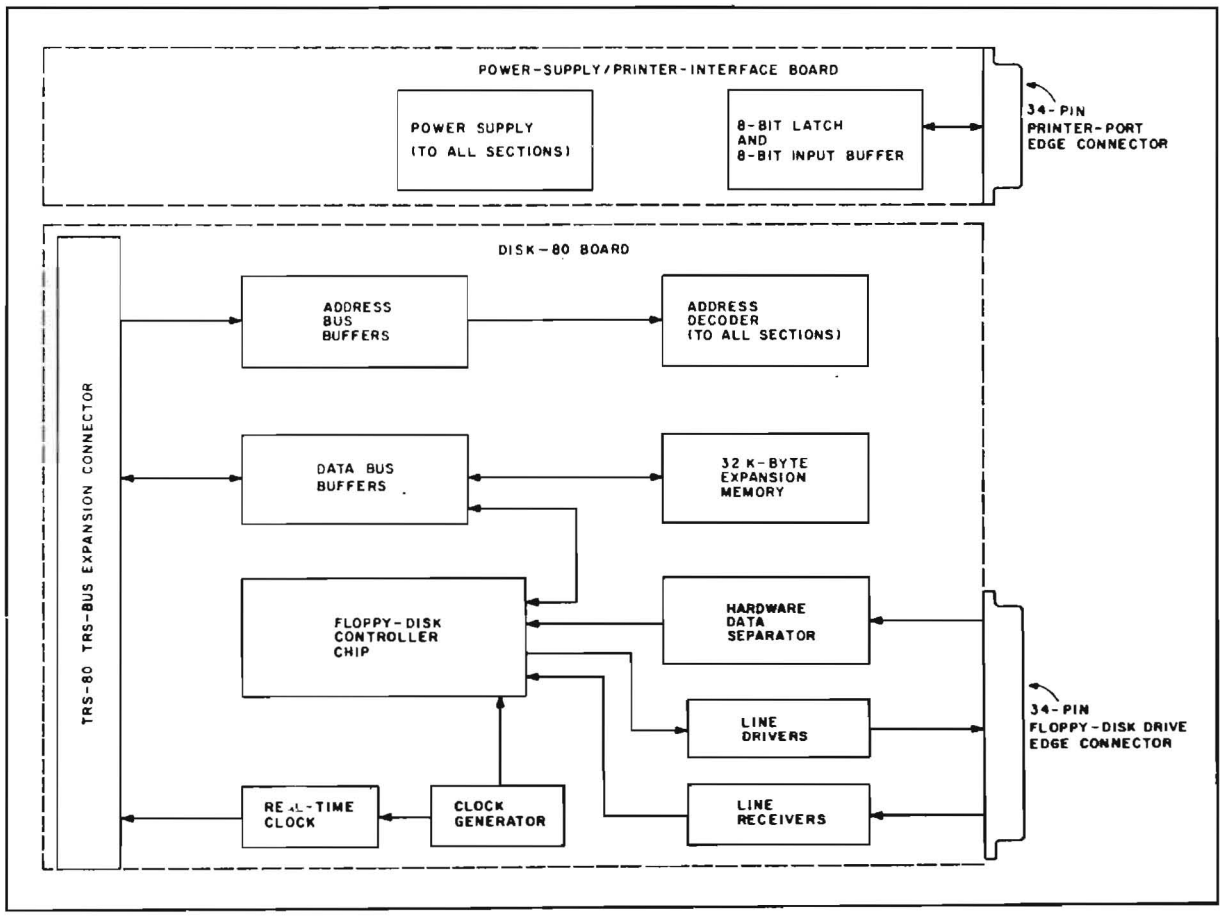
THE MICROMINT INC DISK-80 EXPANSION INTERFACE OWNER'S MANUAL AND ASSEMBLY INSTRUCTIONS

 Revision A

The MICROMINT DISK-80 Expansion Interface is completely hardware and software compatible with the TRS-80 Model I and includes hardware enhancements for increased reliability. It attaches to the keyboard through the 40 pin TRS-BUS connector and provides the following optional capabilities: 32K RAM memory expansion, Centronics compatible parallel printer port (full 8 bits), real time clock, 4 drive mini-disk controller, hardware data separator, buffered TRS-BUS to other peripherals, and power supply.

The DISK-80 system is divided into two circuits boards. The main board contains the memory expansion, mini-disk controller, real time clock, data separator, and address buffers. The second board can be either the standard Power Supply Interface Board or the optional Power Supply/Printer Interface.

DISK-80 BLOCK DIAGRAM *(figure 1)*



DISK-80 ADDRESSING

The disk controller, printer, and real time clock are decoded as parallel ports through IC28. Eight strobes are produced by decoder chip IC28 between the range of 37E0 hex and 37EC hex (the range 37ED thru 37EF is decoded by the disk controller chip IC42 directly) to coordinate these peripherals. Their functions are as follows:

Write Strobes
- 37E0 --- Disk Drive Select (1 of 4)
- 37E4 --- Not Used
- 37E8 --- Printer Data Out
- 37EC thru 37EF --- Set Disk Controller Registers

Read Strobes
- 37E0 --- Read Real Time Clock/Reset Interrupt
- 37E4 --- Not Used
- 37E8 --- Read Printer Status
- 37EC thru 37EF --- Read Disk Controller Registers

IC's 26 and 27 function as memory bank decoders. They produce 2 strobes. One, designated 32K, is the enable strobe for expansion memory between hex addresses 8000 and BFFF (32K enable). The second strobe, 48K, controls the bank of memory between C000 and FFFF (48K enable).

THE DISK-80 DYNAMIC MEMORY SECTION

The DISK-80 uses 4116 type memory chips in the memory expansion section. The 4116 is a 16K dynamic RAM. The 14 address bits required to specify one of the 16,384 cell locations are multiplexed into seven shared pins.

During a memory read or write instruction, a 16 bit address is present on the processor's address bus. If the memory address is between 8000 and FFFF then the processor will try to find that device on the DISK-80 memory expansion section. Decoding A14 and A15 determines whether it is the 32K or the 48K memory range and enables the appropriate bank.The remaining 14 bits are multiplexed directly into the 4116's. IC'S 1 thru 8 are the 32K memory bank and IC's 9 thru 16 are the 48K memory bank.

IC's 20 and 21, 74LS157 quad 2 to 1 line multiplexors, apply the first seven row-address bits to the device when the MUX (multiplex) and RAS (row-address strobe) signals are low. This latches the row address into the 4116. Next, the MUX signal goes high, applying the 7 column address bits to the 4116, and CAS (column-address strobe) goes low. At the conclusion of this sequence, memory is either written into or read from the 4116 depending upon the polarity of the WRITE ENABLE input. The READ ENABLE line in turn controls the direction of data flow through the memory data buffers, IC's 17 and 18 (74LS244 octal buffers).

One of the less desirable characteristics of dynamic memory is "memory refresh". Unlike static memory, the 4116 stores its ones and zeroes in single transistor cells which simulate capacitors. Like a capacitor, the charge slowly drains off unless it is "refreshed". Refreshing is accomplished by addressing all (or a required minimum) memory cells on a regular basis.

The 4116 is a RAS-only refresh device. This type of refresh is achieved in less time and uses only the RAS signal. Since the MUX and CAS pulses are not used, the memory is not enabled and does not interfere with other system operations. Instead of addressing all 16,384 locations, only the 128 rows are cycled. However, all 128 rows must be addressed at least every 2 msec to avoid loss of data.

Refresh circuits are generally counters that generate sequential addresses that are applied to the chips.The TRS-80's Z-80 CPU includes a built in RAS-only refresh register. During an opcode instruction fetch, the refresh register contents are placed on the address bus and the RAS line is strobed. In effect, the CPU accomplishes "hidden refresh" as it executes its normal program. For more information on this capability, refer to the Zilog Z-80 Technical Reference Manual.

The memory chips supplied by the MICROMINT are 200 nsec prime components specifically selected to meet all the necessary requirements for proper operation. The MICROMINT will not guarantee operation of the DISK-80 with memory chips not supplied by the MICROMINT.

The memory section of the DISK-80 is independent from the disk controller section (they share common address decoding and power supply). The DISK-80 can be used as a simple memory expansion unit for the TRS-80 by not inserting IC's used in the disk controller section.

THE DISK-80 POWER SUPPLY

Unfortunately, in addition to refreshing dynamic memory, a designer has to be concerned about sequencing the power supplies. While some brands of 4116's are more tolerant than others, THE -5 VOLT SUPPLY (VBB) MUST BE APPLIED TO THE 4116 BEFORE +12 V (VDD) AND THE -5 VOLT SUPPLY MUST REMAIN ON UNTIL THE +12 V HAS BEEN REMOVED. Power sequencing is important because many power supplies overshoot when they are turned on. If VBB (-5V) is not turned on and VDD (+12V) overshoots to more than +15V, the 4116 will blow. Applying VBB first provides an extra margin to prevent device destruction. Also VBB must never go positive with respect to any other input.

The DISK-80 power supply (standard or with the optional printer interface) meets these requirements. It is designed such that the time constants of the various sections produce a phased start up and shut down. This sequential operation is primarily accomplished by choosing filter components that are matched to the transformer impedance. Also, because the transformer secondary voltage is specifically designed for this use, the DISK-80 power supply is very efficient and produces relatively little heat. The nominal capabilities of the power supply are 1 amp at +5V, 0.4 amps at +12V, and 0.05 amps at -5V. A typical, fully loaded DISK-80 generally loads the power supply to about 50% of capacity.

OPTIONAL PRINTER PORT

A Centronics compatible printer port is optionally available on the power supply board. The optional Power Supply/Printer Interface differs from the standard Power Supply board by providing a 34 pin edge card connector for a Centronics compatible parallel printer. The address of the parallel

printer port is hardwired to hexadecimal 37E8 (14312 decimal) and is compatible with LPRINT and LLIST commands in BASIC. The printer interface board is connected to the DISK-80 controller board through a 14 pin dip connector cable attached between a socket on each board labeled IC51.

REAL TIME CLOCK

To be compatible with TRS-80 hardware, the DISK-80 contains a real time clock. It provides an interrupt to the Z-80, 40 times a second (every 25 msec). When the non-maskable interrupt is enabled, the clock produced interrupts cause the Z-80 to vector to a specific ROM address for further instructions. Unless there is a user supplied routine to be executed, the Z-80 simply returns from the interrupt sequence and continues where it left off. Various disk operating systems for the TRS-80 use this interrupt logic to increment a time of day clock or event timer.

MINI-DISK CONTROLLER

The DISK-80 also contains a mini-disk controller. The controller is implemented using an LSI floppy disk controller chip. The DISK-80 uses a Western Digital FD1771-B01 single-density disk controller chip. It is second sourced by National Semiconductor as an INS1771D-1. This one chip does the encoding, decoding, pattern recognition, serial/parallel and parallel/ serial conversion, CRC character generation and disk drive control.

The standard single-density mini-floppy gives 110K bytes per diskette distributed on 35 tracks (if you use a disk drive with 40-77 tracks you can expect to store more data proportionally). Using standard IBM 3740 format, each track is divided into 16 sectors of 128 bytes. The mini-floppy transfers data at 125 Kbits/sec (an 8" drive transfers data at 250 Kbits/sec).

Drive selection is handled by IC's 32 and 33. Only one drive is selected at a time and the drive motor is turned off between disk accesses. To address a particular drive, a one of four drive code is loaded into IC 32 during an output to port 37E0 hex. This action starts a 5 sec "motor on" timer which turns on whichever drive is selected. It also activates the Head Load Time control (HLT) line on the 1771. The disk operating system software takes into account that it takes about 1 second for the motor to come up to speed and 80 msec for head loading. Unless another call is made to this same drive, the motor will shut off after 5 seconds.

All data, commands and control for the 1771 are handled through conventional I/O instructions. Eight ports (4 in and 4 out) handle all the communication. The range of addresses are 37EC to 37EF. The commands and data are communicated to the 1771 by setting the appropriate signals on A0 and A1 (IC42 pins 5 and 6) and strobing either the read or write enable inputs (IC42 pins 4 and 2).

Many commands require a parameter such as a track or sector address. This data must first be loaded into the appropriate register in the 1771. To send a track address for example, the 8 bit track address is set in the Z-80 accumulator and an OUT to port 37ED hex is executed. The contents of the accumulator

will be stored in the track register. The following is a partial summary of register functions:

Address	A1	A0	Read Enable	Write Enable
37EC	0	0	Status	Command
37EC	0	1	Track read	Track set
37EC	1	0	Sector read	Sector set
37EC	1	1	Data read	Data set

Of the 1771's 16 control lines, seven interface directly to the disk drive through drivers and receivers (7416's and 74LS14's). The Write Data line transmits the digitized serial composite data to be written on the diskette. The Write Gate line enables the actual writing process. The Index input indicates the beginning of a track and the Write Protect line indicates when a write-protected diskette has been inserted into the drive. The Track 00 line indicates when the read/write head is positioned over track 0 (the outermost track). The Direction Select line defines the direction in which the head will move when the Step line is pulsed. Each pulse moves the head one track.

DISK-80 EXTERNAL DATA SEPARATOR

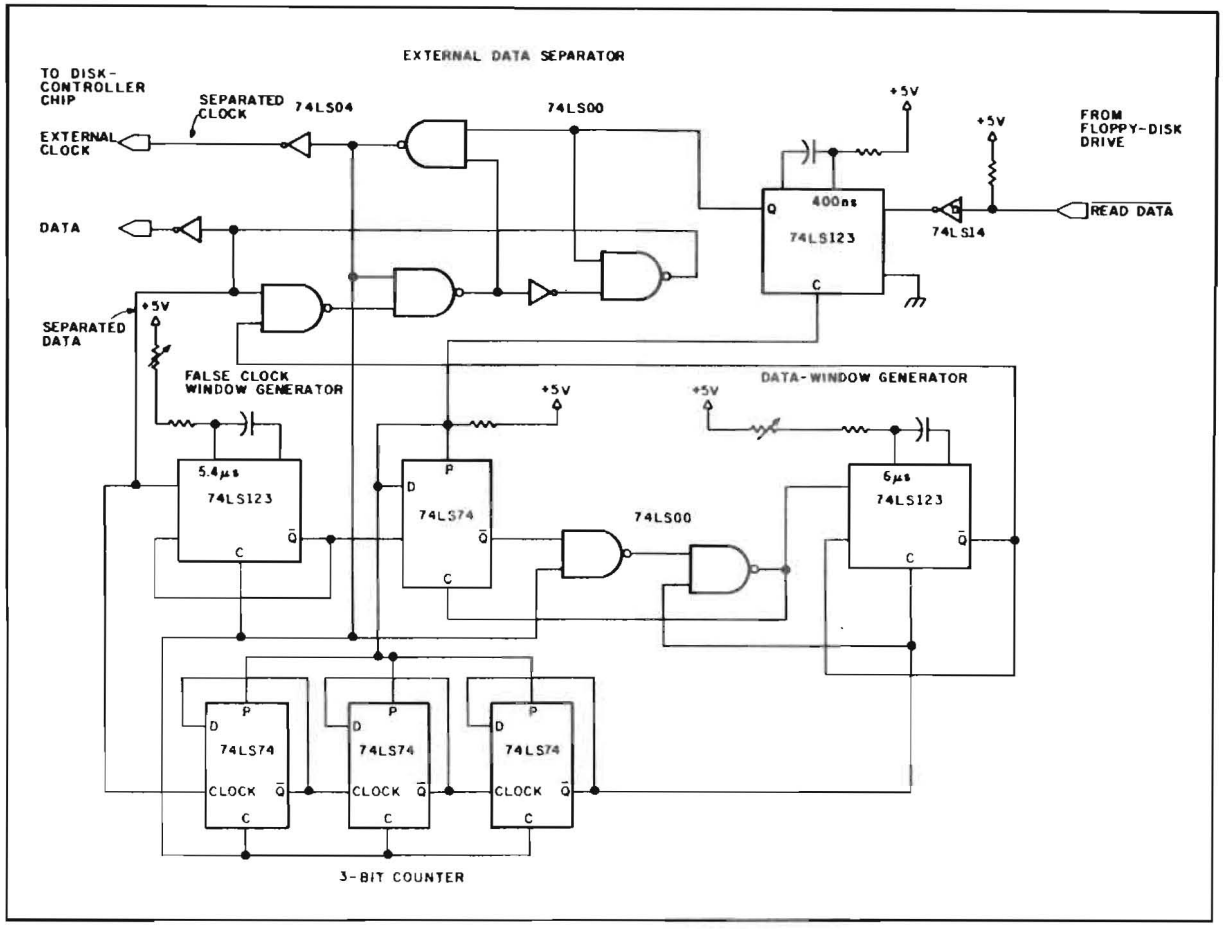
As previously mentioned, the mini-disk transfers data at 125 Kbits/sec while an 8 inch floppy runs at 250 Kbits/sec. The difference in data rates affects the data separator's timing values as well as the clock rate used by the controller chip. The mini-floppy requires a 1 MHz clock while a standard floppy uses a 2 MHz clock.

Data received from the mini-floppy is a multiplexed combination of data and clock pulses. The 1771's internal data separator separates the data and clock bits but THE INTERNAL DATA SEPARATOR IS NOT RECOMMENDED WHERE HIGH RELIABILITY IS REQUIRED. AN EXTERNAL DATA SEPARATOR MUST BE ADDED to maintain a soft-error rate better than 1 in 10 to the 8th.

The 1771's internal separator operates from the 1 MHz system clock which is nonsynchronous with the disk data. Due to the mechanical variations and other factors, sometimes a bit of data can arrive at a point in time "outside the data window", that is, when the controller is not expecting it. The data window's 1 microsecond resolution can move with respect to a data bit's arrival by enough that the data bit can actually fall outside the data window. This would be interpreted as an error.

To help eliminate what has been a major problem for TRS-80 disk users, THE DISK-80 DESIGN INCLUDES AN EXTERNAL DATA SEPARATOR.

EXTERNAL DATA SEPARATOR SCHEMATIC *(figure 2)*



A one-shot reduces the Read Data input pulse width from 1.2 microseconds to 400 nano-seconds. When configured for external clock and data separation, the 1771 requires pulse widths between 300 and 700 nanoseconds. The narrower the pulse width, the better the data separator's resolution.

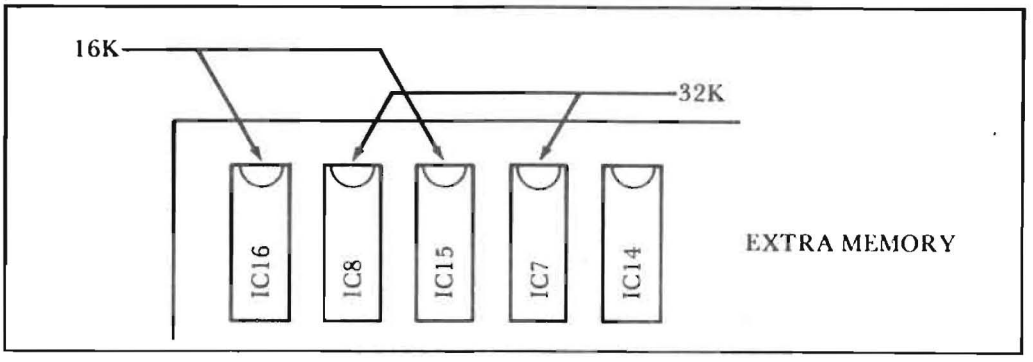
To produce the separator's data window, a 6 microsecond one-shot is triggered by the leading edge of the clock pulse. Since the time between clock pulses is 8 microseconds, a data bit is expected within 4 microseconds after the leading edge. The extra 2 microseconds allows for shifts in the data or clock bits.

IBM 3740 format used in the Model I creates a unique addressing mark by dropping three clock pulses during the address-mark clock pattern. To produce data windows during missing clocks, a false clock is generated with a 5.4 microsecond one-shot. If the 5.4 microsecond one-shot times out past the expected point of the next clock pulse, its trailing edge triggers the 6 microsecond one-shot, generating a data window.

A 3 bit counter distinguishes between missing clocks and address marks. If the separator is already in phase, it is constantly reset by the separated clock output. When the separator encounters the address mark, the counter is incremented by the separated data line. On the forth missing clock pulse the data window is reset. The separator becomes in phase again on the next true clock pulse.

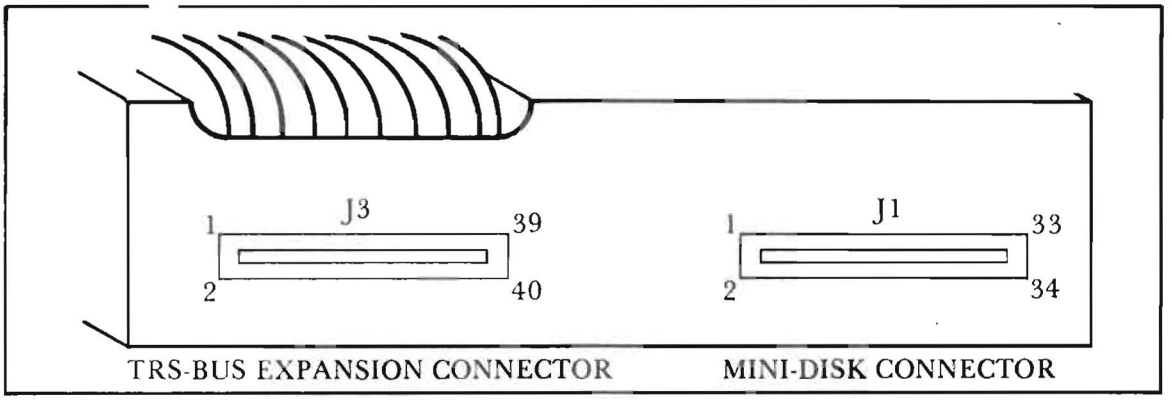
The DISK-80 Expansion Interface in either kit or assembled form contains 16K of expansion memory. The DISK-80 also has provision for an additional 16K (total 32K) of memory. There are 8 sockets provided on the board to insert the extra 8 4116 chips. Addressing for the extra 16K is already provided and no other changes are required. Only 200 nsec type 4116 dynamic RAMs should be used (they are available from THE MICROMINT).

EXTRA MEMORY SKETCH *(figure 3)*



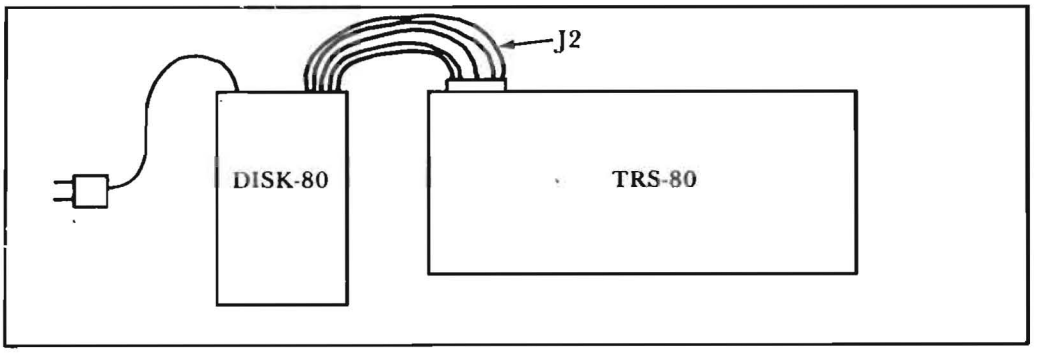
The standard DISK-80 has one ribbon cable and two edge connectors on the rear panel:

STANDARD UNIT REAR CONNECTOR LAYOUT *(figure 4)*



The ribbon cable, J2, plugs into the TRS-80 keyboard connector (note the "THIS SIDE UP" orientation.

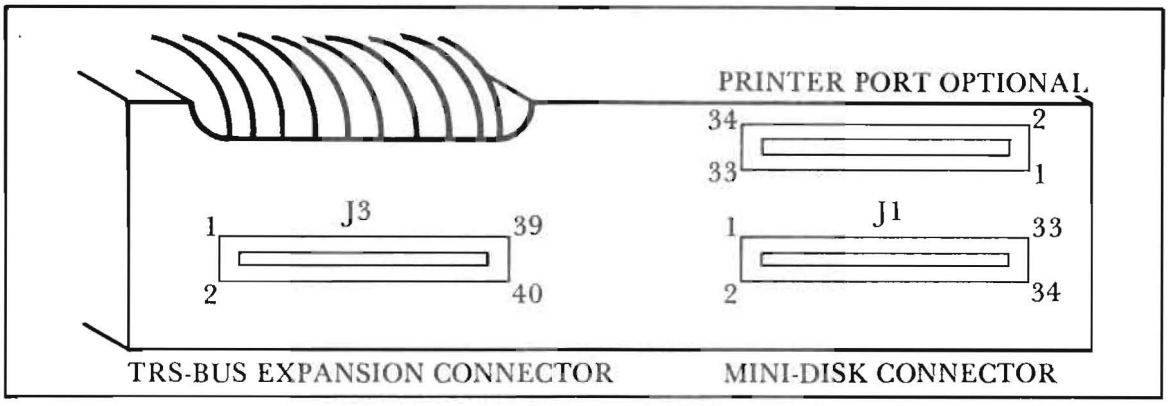
RIBBON CABLE CONNECTION *(figure 5)*



The 40 pin edge card connector (J3, on the lower left) is a buffered TRS-BUS connector. Peripherals such as the CHATTERBOX or COMM-80 would plug into this connector. The 34 pin edge card connector (J1, on the lower right) is for the cable from the mini-disk drives. When the disk drive cable connector is inserted, the ribbon cable should hang down.

The Printer Port version of the DISK-80 has an extra 34 pin edge card connector (on the upper right). The address is 37E8 hex (14312 decimal) and it will work directly with the LPRINT and LLIST BASIC commands. The connection between the controller and power supply boards is via an internal 6" ribbon cable. If this cable is not inserted, or inserted incorrectly, the printer port will not work.

PRINTER PORT VERSION
REAR CONNECTOR LAYOUT *(figure 6)*



The wires on all cables should hang down when they are inserted. The DISK-80 should always be unpowered when connecting and unconnecting cables. Generally, it is a good idea to power up the DISK-80 simultaneously or before the rest of computer system.

RUNNING THE DISK-80 IN A MODEL I SYSTEM

The DISK-80 should be attached to the TRS-80 keyboard and a mini-disk drive attached to J1 as described above. A disk containing a valid TRS-80 operating system such as TRS-DOS or NEW-DOS should be inserted into the drive and the door left open. Apply AC power to all system components except the keyboard unit.

While holding the BREAK key down, turn on power to the TRS-80 keyboard, and release the BREAK key. This will boot the system into BASIC and either "MEM SIZE?" or "MEMORY SIZE?" will appear. Answer the question by pressing the ENTER button and the system will respond with "READY >". Next, type "?MEM" and press the ENTER button. This will determine how much memory is available on the system. If the DISK-80 has 32K installed, it will respond "48338" available bytes. If the DISK-80 has 16K installed, it will respond "31954" available bytes. This procedure indicates that the DISK-80 memory is working.

Next, close the door on the mini-disk drive (with the disk inserted) and press the TRS-80 reset button on the rear of the

keyboard. This will cause the disk drive access indicator to light and the drive motor to start. The screen will momentarily clear (when initialized from a cold start rather than with the reset key, the screen will first fill with random characters before clearing) and then reappear with the introduction to the disk operating system. For the operating system to appear, the DISK-80's disk controller section must be functioning properly. The mini-disk drive will shut off automatically after about 5 seconds unless another disk access is initiated.

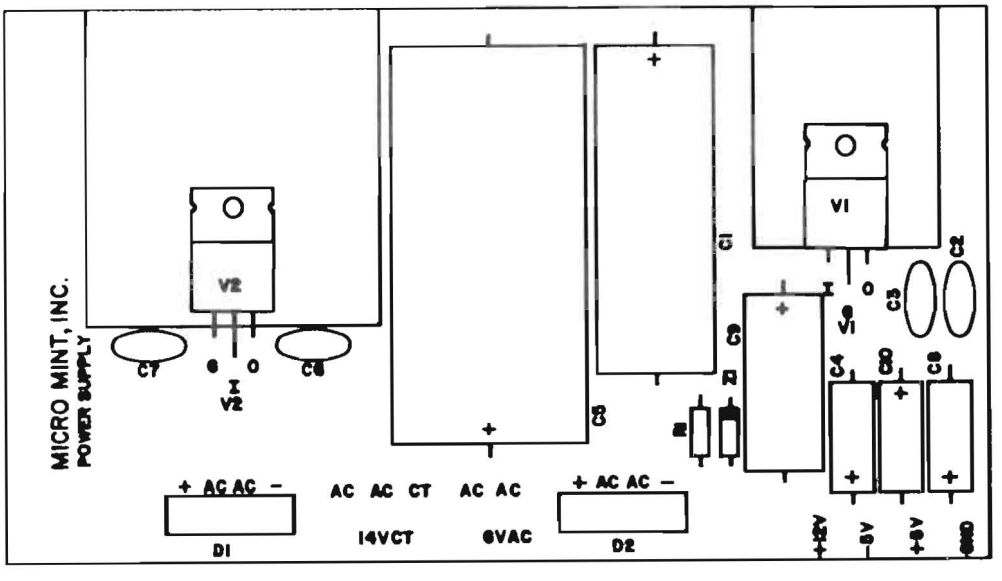
At this point, the DISK-80 is essentially checked out. The real time clock can be exercised by simply typing "CLOCK" and ENTER while in the disk operating system. In most systems, a 6 digit clock will appear in the upper right corner of the screen which will start incrementing by the second. Follow the directions in the operating system manual for using the clock capability with your programs.

BUILDING THE DISK-80 POWER SUPPLY

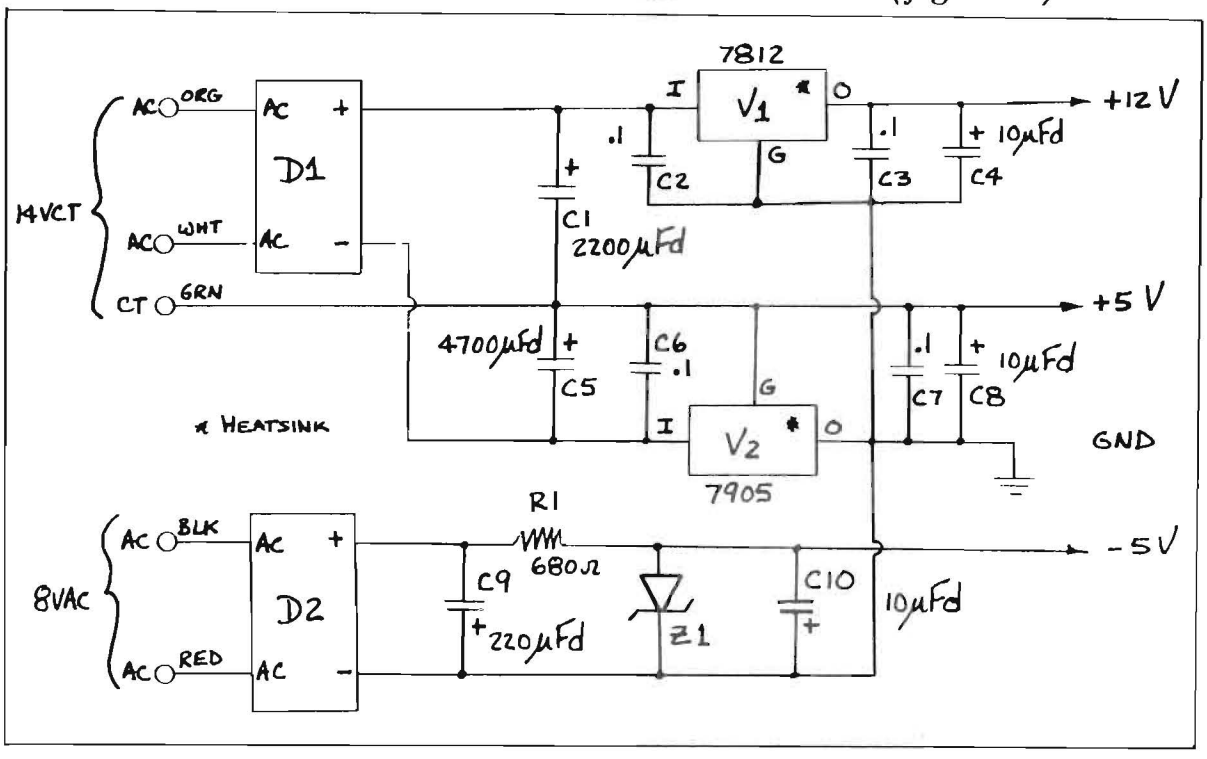
The kit contains approximately 200 components. While all components could be inserted in any order, the preferred procedure is to insert and solder the components and subsystems in stages. The best place to start is by building the power supply first. It is the easiest assembly and the rest of the circuit cannot work without it. Since both supplies are similar (the difference being additional features on one), they will be assembled and tested in common. Two separate parts lists are provided for convenience. During testing, certain aspects of the test will only apply to the printer interface section.

The DISK-80 power supply section is the same on both the standard and optional printer interface versions of the power supply. The component location is noted in the silkscreen on the board and the component value is listed in the standard power supply kit parts list.

DISK-80 POWER SUPPLY BOARD LAYOUT *(figure 7)*



DISK-80 POWER SUPPLY SCHEMATIC *(figure 8)*

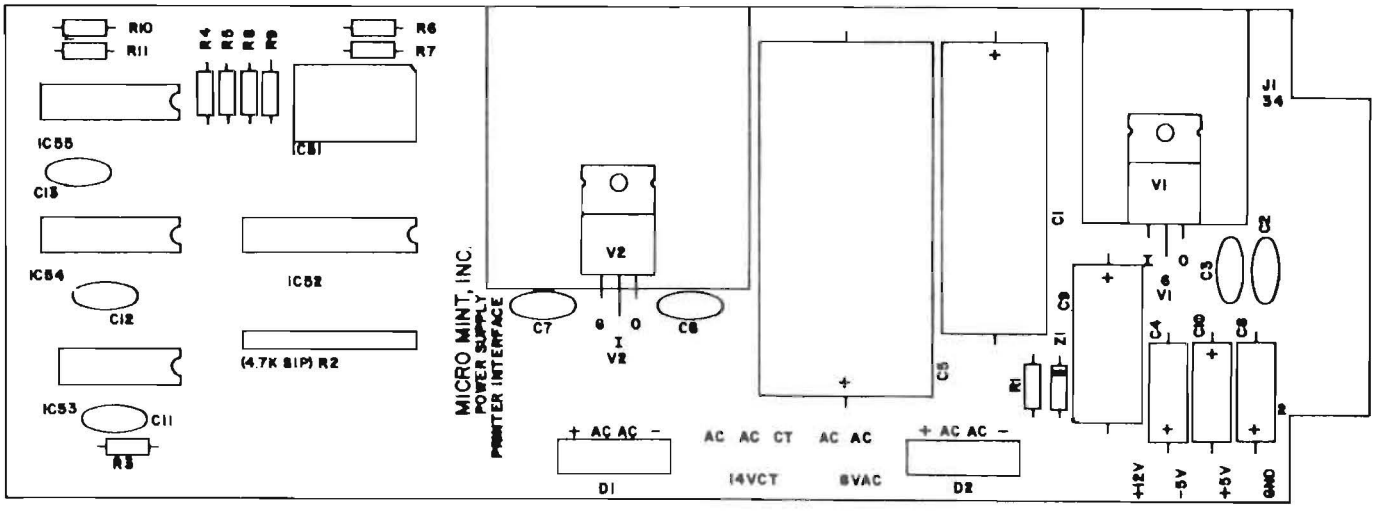


STANDARD POWER SUPPLY PARTS LIST (no printer port)

PART #	VALUE or DESIGNATION
PC Board	PWR SUP PCB
AC Transformer (14VCT & 8VAC)	PITB-119
V1	MCM7812 Regulator
V2	MCM7905 Regulator
V3	1N4733A Zener Diode
D1-D2	Full Wave Bridge 1.5A/200 PIV
Heatsink (V1)	THM 6106B-13
Heatsink (V2)	THM 6072B and 6071B (2 pieces)
C2	.1 Mfd. 50V Ceramic
C3,C6,C7	.1 Mfd. 12V Ceramic
C4,C8,C10	10 Mfd. Electrolytic
C9	220 Mfd. Electrolytic
C1	2200 Mfd. Electrolytic
C5	10000 Mfd. (4700 Mfd.inserted on production units)
C11	220 Pfd. Ceramic
R1	680 Ohm (BLUE, GREY, BROWN)
Misc Hwdr	2 #6 screws & nuts

The optional Power Supply/Printer Interface combines the power section of the standard supply with 4 additional IC's and a 34 pin edge connector to provide an 8 bit (in and out) Centronics compatible printer port. These 4 chips serve as the input buffer and output latch for data transfers. The address decoding (37E8 hex) for the printer port is done on the controller board. The component location is noted in the silk screen on the board and the component value is listed in the Power Supply/ Printer Interface parts list.

DISK-80 POWER SUPPLY/PRINTER INTERFACE BOARD LAYOUT *(figure 9)*



POWER SUPPLY/PRINTER INTERFACE PARTS LIST

PART #	VALUE or DESIGNATION
PC Board	PWR SUP/PRINTER PCB
AC Transformer (14VCT & 8VAC)	PITB-119
V1	MCM7812 Regulator
V2	MCM7905 Regulator
V3	1N4733A Zener Diode
IC 52	74LS244
IC 53	74121
IC 54-55	74LS75
D1-D2	Full Wave Bridge 1.5A/200 PIV
Heatsink (V1)	THM 6106B-13
Heatsink (V2)	THM 6072B and 6071B (2 pieces)
C2	.1 Mfd. 50V Ceramic
C3,C6,C7,C12,C13	.1 Mfd. 12V Ceramic
C4,C8,C10	10 Mfd. Electrolytic
C9	220 Mfd. Electrolytic
C1	2200 Mfd. Electrolytic
C5	4700 Mfd. Electrolytic
C11	220 Pfd. Ceramic
R3	20K Ohm (RED,BLACK,ORANGE)
R2	4.7K Ohm SIP
R1	680 Ohm (BLUE,GREY,BROWN)
R4-R11	1K Ohm (BROWN,BLACK,RED)
Misc Hwdr	4 screws (1/2 inch) *
	4 spacers (1/4 inch) *
	2 #6 screws & nuts
14 pin IC socket	2 pieces
16 pin IC socket	2 pieces
20 pin IC socket	1 piece
14 Pin Ribbon cable	1 (6 inches) *

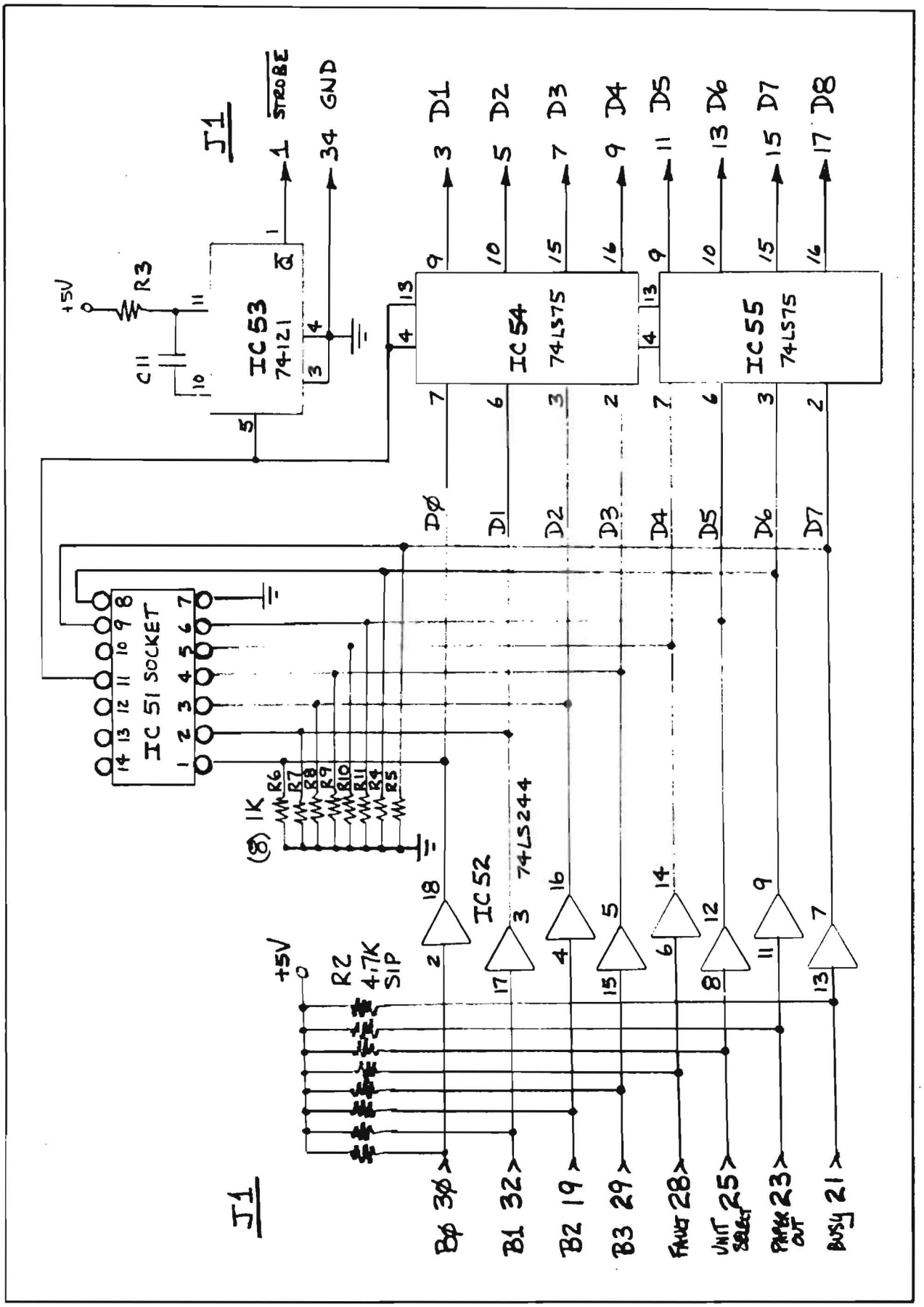
* supplied only with full DISK-80 kit

Kit Assembly and Test

STEP 1 --- Insert and solder all resistors and capacitors. The best procedure is to find the location of each resistor or capacitor on the board and then insert the correct component value as listed in the Parts List. The color code of each resistor is also provided as an aid. Note that on the SIP (R2) that pin 1 is labelled on the device with a numeral 1. This pin should be inserted in the hole with the dot etched on the board next to it.

The electrolytic capacitors are tubular. They have the negative side of the capacitor designated (usually with a minus sign and arrows pointing in that direction). The opposite side

DISK-80 PRINTER INTERFACE SCHEMATIC *(figure 10)*



is positive. When inserting these components into the board, the positive lead of the capacitor should be inserted into the pad with the "+" mark. When the capacitors are installed on the board, the polarities are not necessarily all in the same physical direction.

The ceramic capacitors are generally disk shaped. They have no polarities but you may want to orient the printing on the components to all face the same direction for aesthetics.

STEP 2 --- Insert and solder all IC sockets. Pin 1 is designated on the board by the notch shown on the silk screen.

STEP 3 --- Insert D1, D2, and Z1. The bar side of Z1 indicated on the board. It should be inserted to correspond with this designation. When inserting D1 and D2, note that the "+" on each device should line up with "+" painted on the board.

STEP 4 --- Insert V1 and V2 with their appropriate heat sinks. Note that V2 has 2 sinks which are stacked. Solder these components and tighten the heat sink bolts.

STEP 5 --- Attach the transformer to the 5 pads labeled "14VCT" and "8VAC". The 5 wires are color coded and should be soldered according to the schematic description.

Testing

With no IC's inserted in the board, plug in the power pack. Using a voltmeter set on the 0-20V scale, check that +5, +12, and -5 volt supplies are operating. The readings should be within +/- 5% of the nominal values. Sometimes it is necessary to apply a minimum load to the output to make 3 terminal regulators such as V1 and V2 regulate properly. A 220-470 Ohm resistor (1 Watt) should suffice. The -5 V should not need a resistor applied to it.

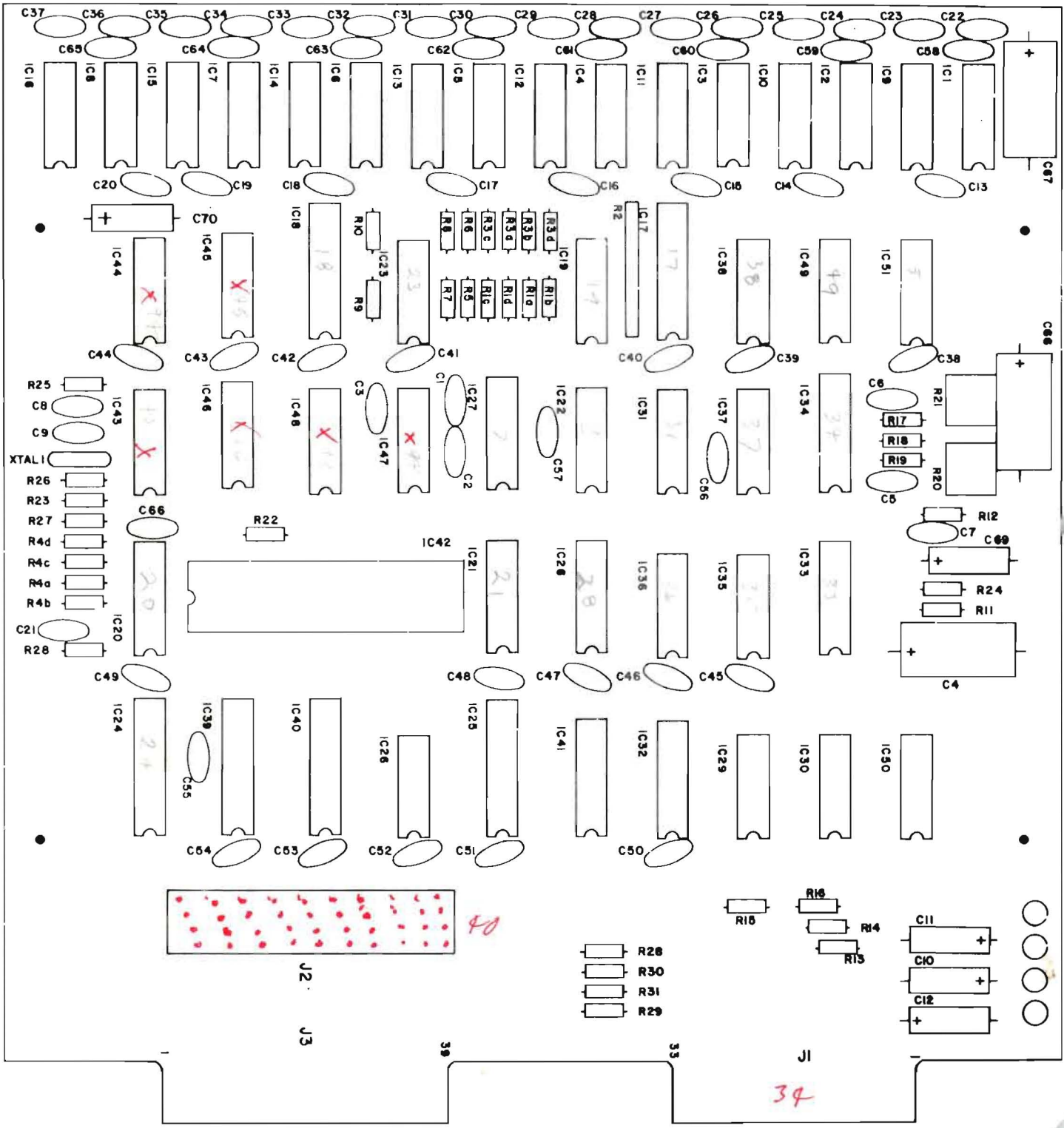
If the three voltages read properly, then the power supply test is complete. Unplug the power pack and plug in the printer port IC's. The printer port can only be checked under program control when the controller board is assembled.

BUILDING THE DISK-80 CONTROLLER

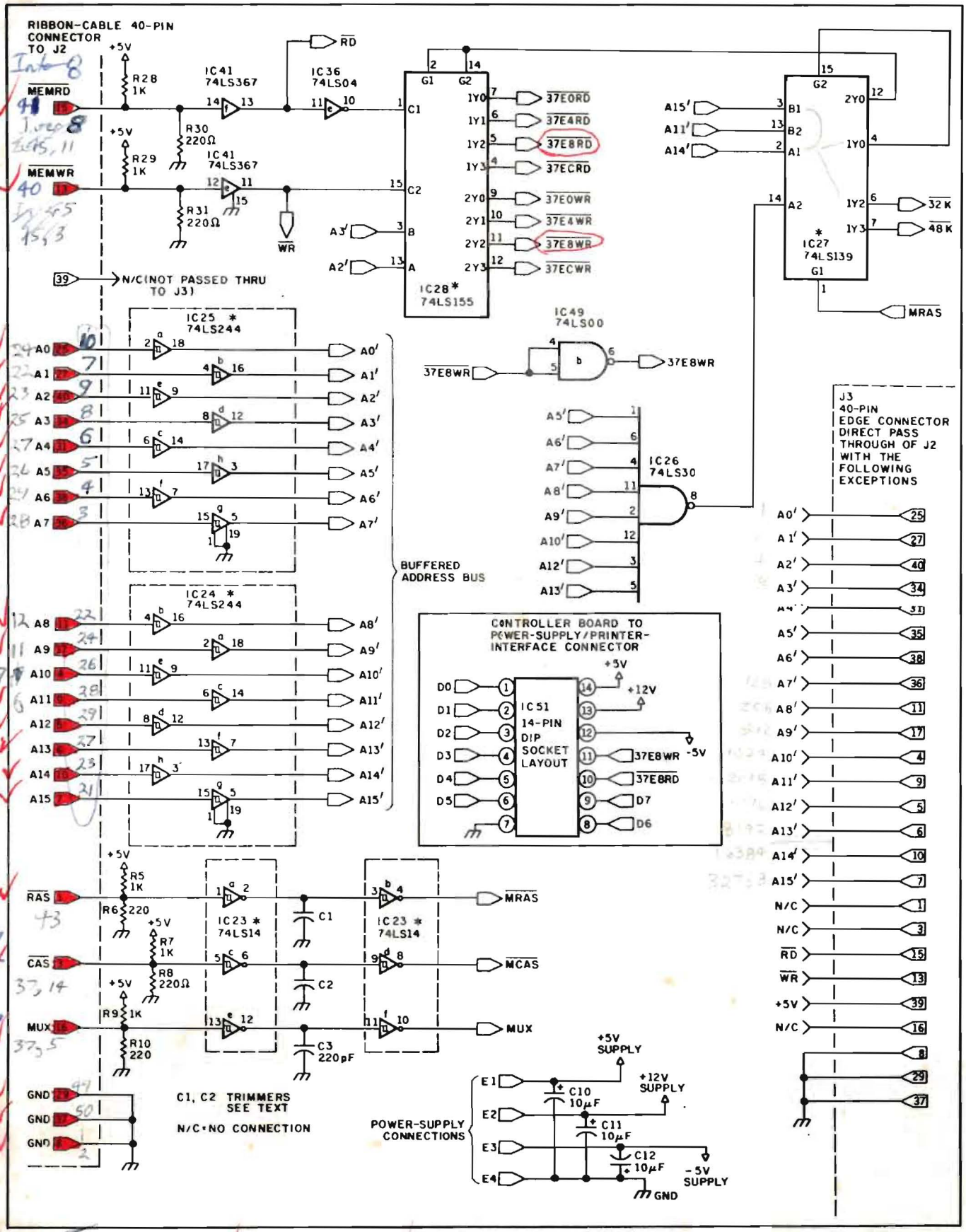
Assembling the DISK-80 as a kit is not an easy task. It is offered as a kit to those people who wish to save money by constructing it themselves. It should be cautioned however, the considerable difference in price between the assembled and tested DISK-80 and the kit version is for a reason. Only people with a relatively high level of technical expertise should attempt assembling a DISK-80 kit.

There are approximately 200 parts on a DISK-80 board. The component locations are indicated on the silk screen and the component values are listed in the parts list. Do not remove the IC's from their shipping container until instructed to insert them into the sockets.

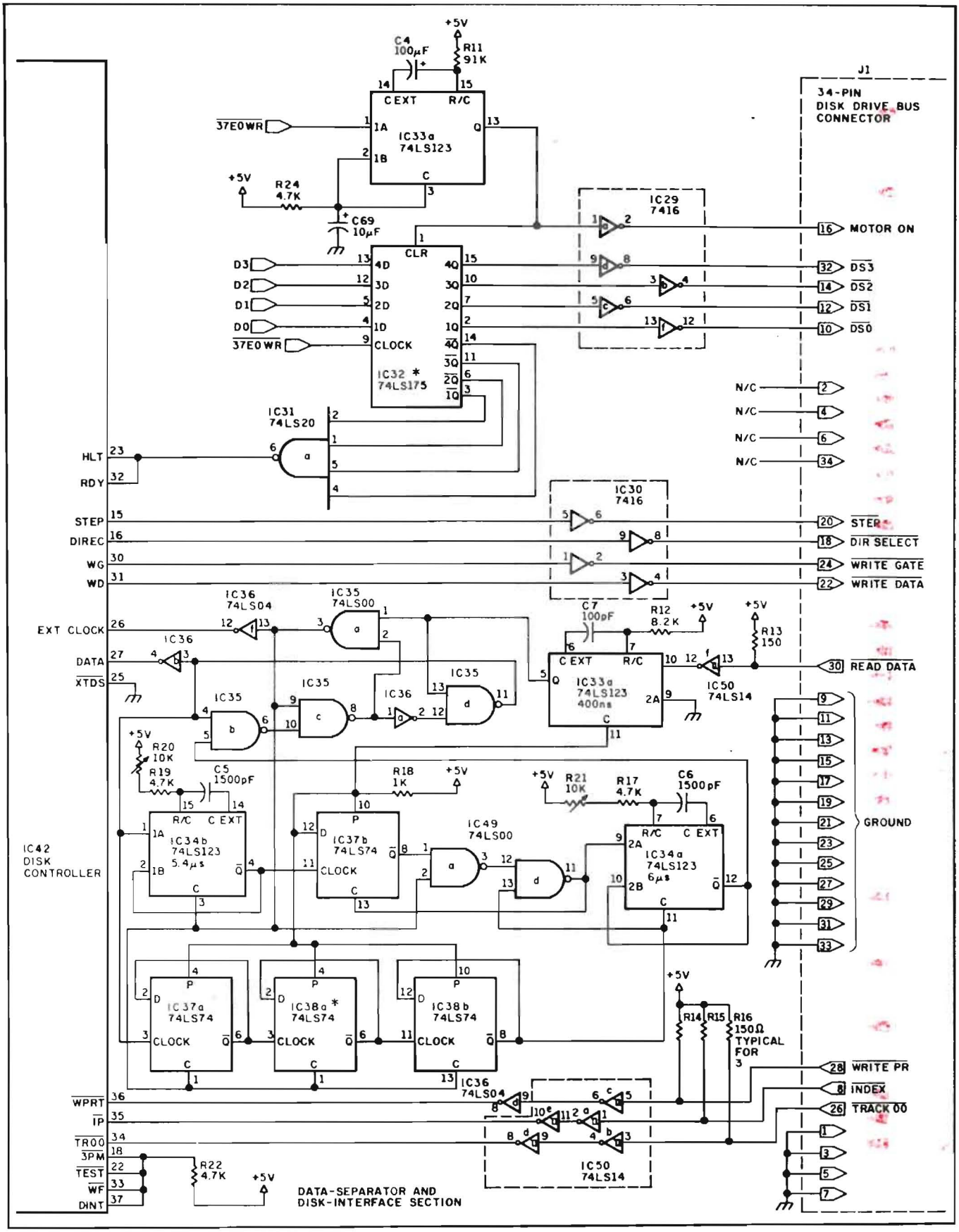
DISK-80 CONTROLLER BOARD LAYOUT *(figure 11)*



DISK-80 CONTROLLER BOARD SCHEMATIC *(figure 12)*

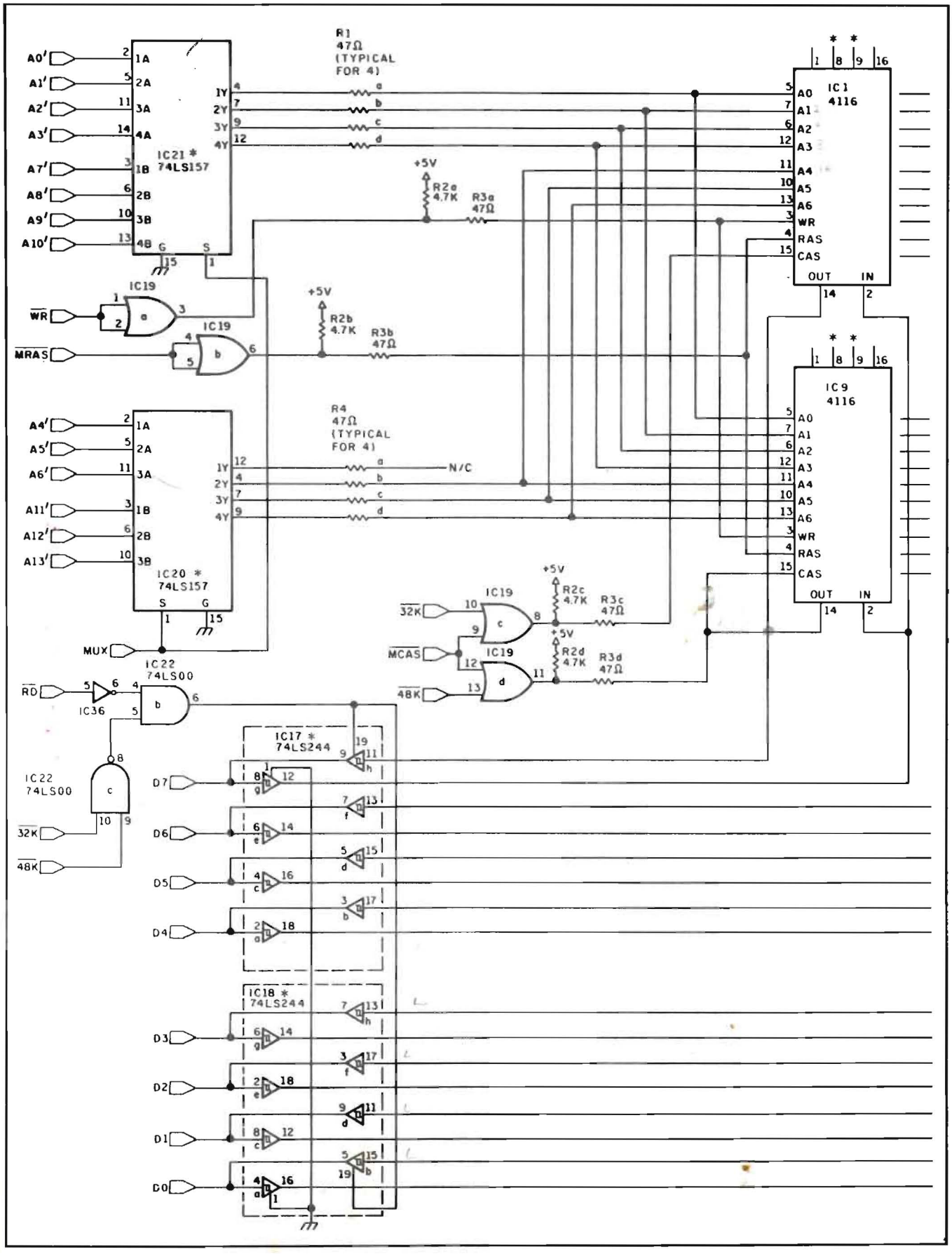


DISK-80 CONTROLLER BOARD SCHEMATIC *(figure 13)*

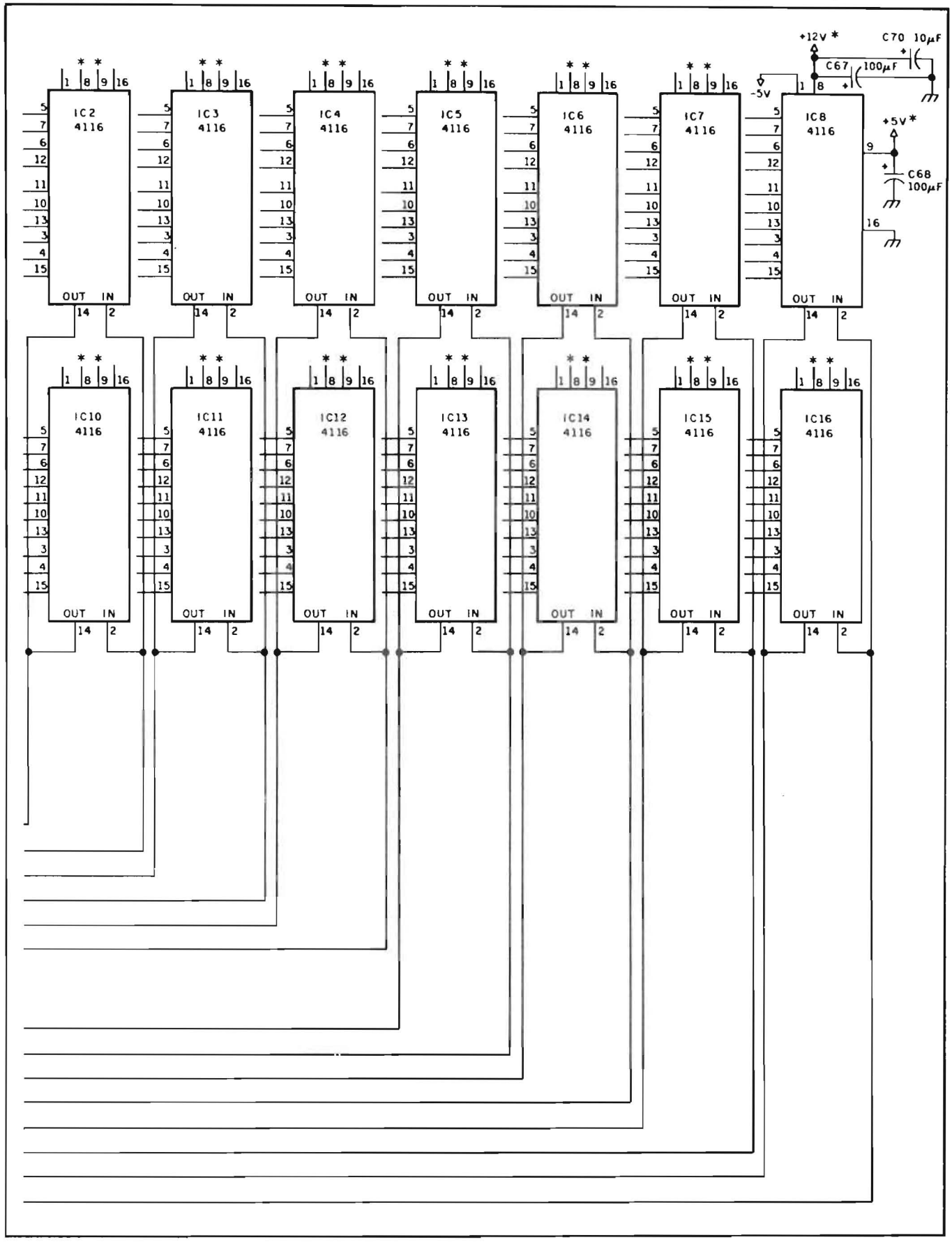


When printer plugged back to front check U21 and U20

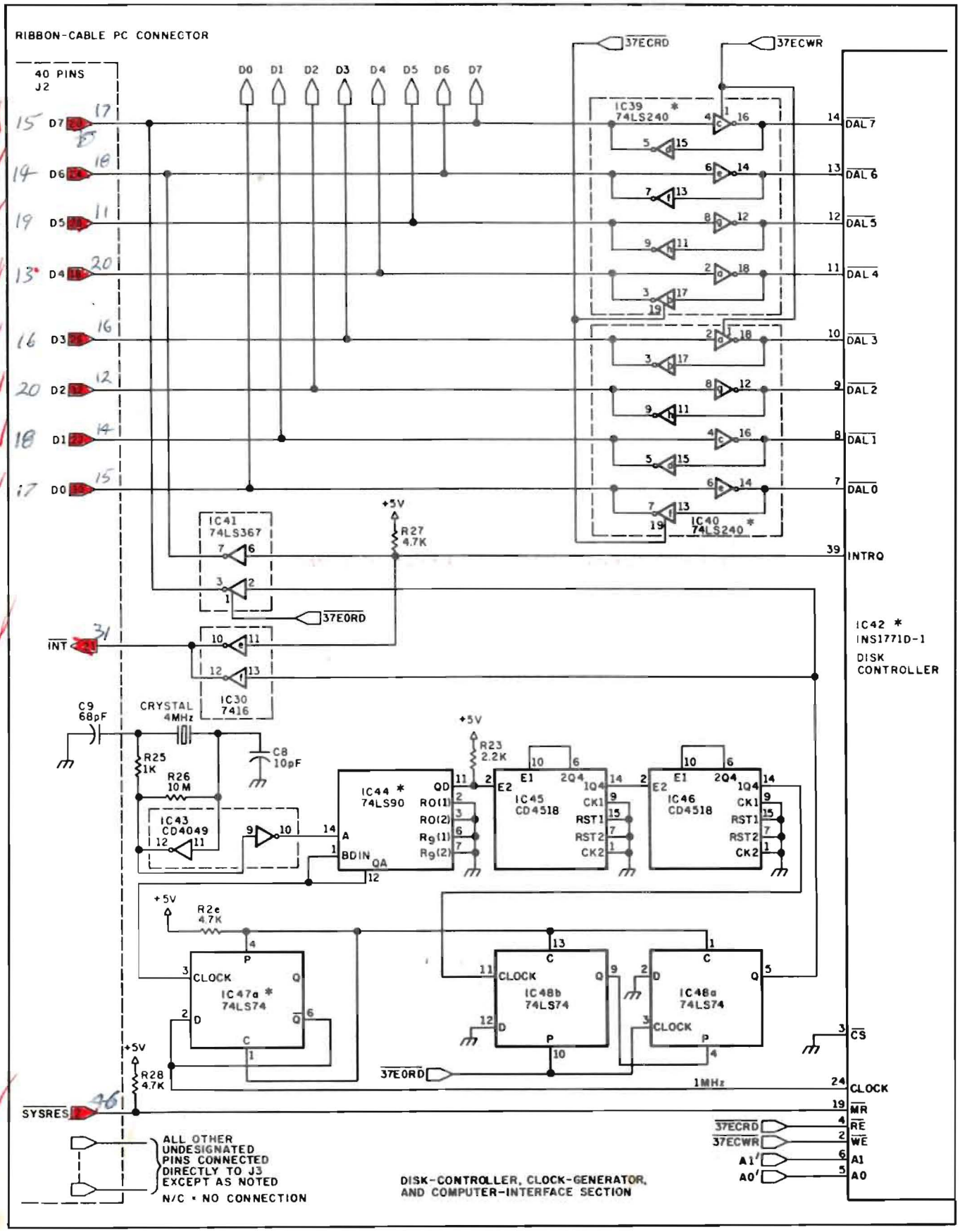
DISK-80 CONTROLLER BOARD SCHEMATIC *(figure 14)*



DISK-80 CONTROLLER BOARD SCHEMATIC *(figure 15)*



DISK -80 CONTROLLER BOARD SCHEMATIC *(figure 16)*



Resistors and Capacitors

PART #	VALUE	COLOR CODE		
R1a-R1d	47 Ohm	YELLOW	VIOLET	BLACK
R2a-R2h	4.7K Ohm	10 pin SIP		
R3a-R3d	47 Ohm	YELLOW	VIOLET	BLACK
R4a-R4d	47 Ohm	YELLOW	VIOLET	BLACK
R5,R7,R9,R18,R25,R28,R29	1K Ohm	BROWN	BLACK	RED
R6,R8,R10,R30,R31	220 Ohm	RED	RED	BROWN
R11	91K Ohm	WHITE	BROWN	ORANGE
R12	8.2K Ohm	GRAY	RED	RED
R13-R16	150 Ohm	BROWN	GREEN	BROWN
R17,R19,R22,R24,R27,R28a	4.7K Ohm	YELLOW	VIOLET	RED
R20,R21	10K Ohm	Potentiometer		
R23	2.2K Ohm	RED	RED	RED
R26	10M Ohm	BROWN	BLACK	BLUE
C1,C2	N/A			
C3	220 Pfd.	Ceramic		
C4,C67,C68	100 Mfd.	Electrolytic		
C5,C6	.0015 Mfd.	Mylar		
C7	100 Pfd.	Ceramic		
C8	10 Pfd.	Ceramic		
C9	68 Pfd.	Ceramic		
C10-C12,C69,C70	10 Mfd.	Electrolytic		
C13-C66	.1 Mfd.	Ceramic		

all capacitors are 12V disc ceramic unless otherwise specified

MISC	VALUE or DESIGNATION
Case,screws and end plates	MMB-001
PC Board	DISK-80 PCB
XTAL	4 MHz Crystal
Mounting Hdwr	4 screws (1/4 inch)
40 cond Ribbon Cable/Connector	1 foot TRS-80/40-8 Cable
IC Socket (40 pin)	1
IC Socket (14 pin)	17
IC Socket (16 pin)	27
IC Socket (20 pin)	6

DISK CONTROLLER/MEMORY EXPANSION BOARD PARTS LIST

Integrated Circuits

IC #	TYPE	+5V	GND	+12V	-5V
1 thru 16	4116 (200 nsec)	9	16	8	1
17	74LS244	20	10		
18	74LS244	20	10		
19	74LS32	14	7		
20	74LS157	16	8		
21	74LS157	16	8		
22	74LS00	14	7		
23	74LS14	14	7		
24	74LS244	20	10		
25	74LS244	20	10		
26	74LS30	14	7		
27	74LS139	16	8		
28	74LS155	16	8		
29	7416	14	7		
30	7416	14	7		
31	74LS20	14	7		
32	74LS175	16	8		
33	74LS123	16	8		
34	74LS123	16	8		
35	74LS00	14	7		
36	74LS04	14	7		
37	74LS74	14	7		
38	74LS74	14	7		
39	74LS240	20	10		
40	74LS240	20	10		
41	74LS367	16	8		
42	INS1771D-1	21	20	40	1
43	CD4049	1	8		
44	74LS90	5	10		
45	CD4518	16	8		
46	CD4518	16	8		
47	74LS74	14	7		
48	74LS74	14	7		
49	74LS00	14	7		
50	74LS14	14	7		
51	*				

* note: IC51 is a 14 pin ribbon cable between the Power Supply/Printer interface and Disk Controller boards.

KIT ASSEMBLY AND TEST PROCEDURE

STEP 1 --- Insert and solder all resistors and capacitors. The best procedure is to find the location of each resistor or capacitor on the board and then insert the correct component value as listed in the Parts List. The color code of each resistor is also provided as an aid. Note that on the SIP (R2) that pin 1 is labeled on the device with a numeral 1. This pin should be inserted in the hole with the dot etched on the board next to it. R20 and R21 are 10K potentiometers.

The electrolytic capacitors are tubular. They have the negative side of the capacitor designated usually with a minus sign and arrows pointing in that direction. The opposite side is positive. When inserting these components into the board, the positive lead of the capacitor should be inserted into the pad with the "+" mark. When the capacitors are installed on the board, the polarities are not necessarily all in the same physical direction.

The mylar capacitors are rectangular and the ceramic capacitors are generally disk shaped. They have no polarities but you may want to orient the printing on the components to all face the same direction for aesthetics.

STEP 2 --- Insert and solder all IC sockets. Pin 1 is designated on the board by the notch shown on the silk screen. Pin 1 on all IC's (except IC42) point toward the connector side of the circuit board. Do not insert any IC's.

STEP 3 --- Insert and solder the crystal (Xtal) and the ribbon cable (J2). The cable portion of J2 should extend out over J3 and not toward the center of the circuit board.

STEP 4 --- All discrete components should be inserted and soldered by this point. Next, attach the 4 power wires (+5V, +12V, -5V, and Gnd) from the power supply board to the controller board. Four seperate colors of stranded insulated wire (preferably #16 or #18) should be used. The typical choices would be red for +5, blue for +12, yellow for -5, and black for Gnd. If you have the optional printer port version, the dip jumper cable will be installed later.

TESTING AND CALIBRATION

To properly check out the DISK-80 you will need a voltmeter for general testing and an oscilloscope to set the data separator one-shots. A frequency counter and function generator would be helpful but not absolutely necessary.

STEP 1 --- Check the power supply connections

You should at this point have the power supply connected to the controller board and no IC's inserted. Plug in the power supply.

Locate IC42 on the controller board and verify that +5V is on pin 21, Gnd on pin 20, +12V on pin 40, and -5V on pin 1. If you read anything different than these values, check your power supply wiring or look for solder bridges.

As a final safety check when this is completed, plug the DISK-80 into the keyboard connector and power up the computer.

There should be no effect on normal computer operation. If the computer performs erratically then examine the DISK-80 cable for shorts and the DISK-80 board for solder bridges.

STEP 2 --- Check the oscillator and interrupt clock frequencies

Turn off the power and insert IC's 43 thru 48 (IC's 43, 45, and 46 are CMOS devices and should be handled with care. They should be taken from the shipping container and inserted directly into the board. Do not lay the chips on any surface that would contribute to an accumulation of static charge). These chips form the oscillator and clock circuit for the DISK-80. These same precautions should be taken when the disk controller chip, IC42, is inserted later.

Turn on the power and using either an oscilloscope or frequency counter, verify that a 1 MHz signal is present on IC47 pin 2 and a 40 Hz signal on IC48 pin 11. If the 1 MHz is not present, then check for a 4 MHz clock at IC44 pin 14. In cases where there is no 4 MHz clock, check IC43. For no 1 MHz clock, check IC's 44 or 47. For no 40 Hz clock, check IC's 45 and 46. Turn off the power when this is completed.

STEP 3 --- Set the data separator one-shot periods

Next, we set the data separator one-shot periods. Insert IC34 with pins 2 and 10 bent out so that these pins do not plug into the socket. An alternative method is to put the 74LS123 into a second IC socket with pins 10 and 2 removed. The combination would then be inserted into the socket for IC34.

Attach a lead from IC45 pin 4 (power should always be turned off when you are placing jumpers and be extra careful since IC45 is CMOS) to IC34 pin 1 (there are other points along this same wire that may be more convenient and you might refer to the schematic) and turn the power on. This jumper provides an 80 KHz clock signal which negative-edge triggers the one-shot. To set the period, attach a scope probe to IC34 pin 13 (Q output) and set the scope to trigger on the positive edge of the 80 KHz clock. Since there is often a delay between the actual trigger and the display on some scopes, this will center the one-shot pulse on the screen where it is easier to view. The pattern is repeatable and should easily lock in on the scope. Adjust R20 such that the positive pulse width seen at pin 13 is exactly 5.4 microseconds.

Next, move the 80 KHz clock signal from IC34 pin 1 to IC34 pin 9. The scope probe should be moved from pin 13 to pin 5. Using the same technique described above, set R21 to produce a pulse width of exactly 6.0 microseconds.

When you have set both potentiometers, apply some nail polish to the tops of R20 and R21 to keep them from moving. Then, turn off the power, remove and reinsert the 74LS123 correctly into the socket for IC34. IC's 35 thru 38 and IC49 can be inserted at this time.

NOTE: This essentially completes the data separator calibration. If at a later point in the test procedure you are not able to properly read from a disk, most likely incorrect data separator settings are the cause. If you are unable to set them properly because of inadequate test facilities, one alternative as a last resort is to totally eliminate the data separator. This can be accomplished with the following:

1. Remove IC's 34 and 35
2. Jumper together IC36 pins 13, 3, and 7

3. Solder a jumper between IC33 pin 10 and IC42 pin 27
4. Cut the trace between IC42 pin 25 and Gnd

Remember, this is a drastic measure which defeats one of the main features of the DISK-80. The disk controller will still work but it will be more prone to data transfer errors.

STEP 4 --- Memory test

With the power off, insert IC's 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, and 41. Connect the DISK-80 to the keyboard connector as previously described, and apply the power to the TRS-80 and the DISK-80 (hereafter referred to as the System). There should be no operational change in the function of the TRS-80. Turn off the power.

Next insert 8 4116 memory chips (treat them like CMOS) into IC locations IC1 thru IC8. These would be the lower bank of 16K expansion memory.

Turn on power to the system. This will boot the computer into BASIC and either "MEM SIZE?" or "MEMORY SIZE?" will appear. Answer the question by pressing the ENTER button and the system will respond with "READY >". Next, type "?MEM" and press the ENTER button. This will determine how much memory is available on the system. With the 16K installed, it will respond "31954" available bytes.

If you intend upon having 32K of expansion memory, repeat the proceedure by adding another 8 4116's for the upper bank of memory in locations IC9 thru 16. It will respond "48338" available bytes to "?MEM" this time. This procedure indicates that the DISK-80 memory is working.

STEP 5 --- Disk controller

With the system power off, insert the remaining IC's with the exception of the disk controller chip, IC42. Connect the DISK-80 to the keyboard and turn on the system power. Repeat the tests in STEP 4 and note that computer operation is still the same. Turn off system power.

Carefully insert IC42 (treat it like CMOS). The DISK-80 should be attached to the TRS-80 keyboard and a mini-disk drive attached to J1. A disk containing a valid TRS-80 operating system such as TRS-DOS or NEW-DOS should be inserted into the drive and the door left open. Apply AC power to all system components except the keyboard unit.

While holding the BREAK key down, turn on power to the TRS-80 keyboard, and release the BREAK key. This will boot the system into BASIC and either "MEM SIZE?" or "MEMORY SIZE?" will appear. Answer the question by pressing the ENTER button and the system will respond with "READY >". Next, type "?MEM" and press the ENTER button. The computer should respond with whatever value was obtained in STEP 4 above. This procedure indicates that the DISK-80 expansion memory is still working.

Next, close the door on the mini-disk drive (with the disk inserted) and press the TRS-80 reset button on the rear of the keyboard. This will cause the disk drive access indicator to light and the drive motor to start (both must occur by command from the computer. Failure to obtain either or both conditions indicates that the computer is not communicating properly with the DISK-80). The screen will momentarily clear (when

initialized from a cold start rather than with the reset key, the screen will first fill with random characters before clearing) and then reappear with the introduction to the disk operating system. For the operating system to appear, the DISK-80's disk controller section must be functioning properly. The mini-disk drive will shut off automatically after about 5 seconds unless another disk access is initiated.

If the drive indicator and the drive motor come on but no operating system appears on the screen, listen carefully to the disk drive. If a clicking sound occurs (a couple times is OK) repeatedly but nothing is displayed on the screen, the controller is having trouble reading the disk. This failure can be the result of a bad or improperly inserted diskette. More than likely however, it is the result of a misadjustment in the data separator section. Refer to the data separator calibration procedure to rectify the problem.

CRC Errors are Often an Indicator of Other Problems

The final test of the DISK-80 is to format and copy a disk under program control. To do this you would either use two drives and the "FORMAT" and "COPY" commands or, "BACKUP" (if available in your operating system software) with a single drive.

Writing a disk in this manner often points out problems that would otherwise go unnoticed or be attributed to another circuit section. Frequently the tolerances of components (memory speed and decoupling capacitors particularily) can affect circuit operation. The components supplied with the DISK-80 kit should not produce these problems. However, since the DISK-80 is also being constructed in many cases with user supplied components, you should be aware of an important symptom.

If when copying and formatting a disk you are advised of multiple CRC errors, assuming that you have not used slow memory chips (200 nsec only!) this could be a memory decoupling problem rather than a disk controller failure. It is also more likely to occur with 32K of expansion memory or with an excessively long cable attached to the J3 expansion connector (the DISK-80 is designed to allow peripheral connection to J3, however, The MICROMINT cannot guarantee that all peripherals sold for the TRS-80 Model I will function correctly from this connector).

Should this occur, turn off the system power and remove any peripherals plugged into J3 and then try formatting and copying again. If the error persists, turn off the power and remove the top bank of expansion memory. With a 32K system, you would remove the upper bank (IC's 9-16) of memory chips (put them into the shipping container). If you have a 16K system, you would remove IC's 1-8. Try formatting and copying again.

If the error is remedied through these actions, then additional decoupling capacitance is indicated (if it is not, it is a controller problem). Locate C70 on the board. This capacitor is attached between the +12V and Gnd bus that runs under the memory chips. One solution is to add another 10 MFd capacitor in parallel with C70. Better yet, is to solder one or two additional 100 MFd capacitors under the board at other

points along the +12V and Gnd bus. While you have the unit apart, you may also want to add a 100 MFd capacitor between +5V and Gnd as well.

STEP 6 --- Testing the Real Time Clock

The real time clock can be exercised by simply typing "CLOCK" and ENTER while in the disk operating system. In most operating systems, a 6 digit clock will appear in the upper right corner of the screen which will start incrementing by the second. Follow the directions in the operating system manual for using the clock capability with your programs.

STEP 7 --- Testing the Printer Port

The printer port section should already have been constructed in the section describing the Power Supply/Printer Interface board. The printer section is connected to the controller board with a 6" dip Jumper cable (see the section on the DISK-80 enclosure for power supply and controller board mounting directions). The cable plugs into socket IC51 on the Power Supply/Printer Port board and loops directly down to plug into socket IC51 on the controller board (there should be no twists in the cable).

The easiest way to test the printer port is with a printer. Power up the system but hold the BREAK key when powering up the keyboard unit. This will boot the system into the usual ROM BASIC. Plug the printer cable into the 34 pin printer port edge connector (Note the pin numbering. Remember, the Power Supply/ Printer Port mounts upside down inside the case. All references to the fact that inserted cables hang down pertain to a final assembled DISK-80). Write a short BASIC program and then type LLIST. This should dump it to the printer.

If you do not have a printer but wish to check the printer port operation anyway, it can be done with PEEK and POKE commands. The port address is 14312 in BASIC. A number can be written to the port by executing a "POKE 14312,X" (X is any value between 0 and 255). Reading an input from the printer port is accomplished with "PRINT PEEK(14312)". By using either a meter to monitor the output bits or a grounding wire (inputs have pull-up resistors already attached) to exercise input bits, the printer port hardware can be easily checked. Refer to the Printer Port edge connector layout diagram or the Power Supply/Printer Port schematic for pertinent pin numbers.

THE DISK-80 ENCLOSURE

There are 6 components that make up the DISK-80 Expansion Interface enclosure: top cover (no holes in it), bottom cover (4 mounting holes), 2 side rails (exactly the same), and 2 end plates (one blank and one with either 4 or 5 cutouts).

With the side rails removed, lay the controller board in the bottom cover. Insert the side rails (tight fit) so that they press down on the controller board and hold it in the cover. Insert the 4 mounting screws and feet through the bottom cover mounting holes. They should go through the 4 holes provided on the controller board and extend up through the side rails.

Use 4 screws and 4 1/4" spacers to attach the power supply to the top cover. It should be mounted with the solder side to the top cover. When the top cover is placed over the bottom cover, the power supply will be upside down. In this position, the printer port edge connector should be directly above and parallel to the controller board J1 connector. Placement of a non printer port power supply is not as critical but locating it directly over C68 is still the best place.

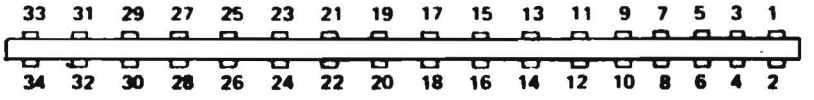
Insert the 2 end plates and insert the top cover into the side rails. The power supply cord should extend out through the notch cutout in the connector side end plate. Press down on the top cover (make sure the printer port edge connector is in the correct slot first) until it fits firmly over the bottom cover. Tighten the 4 mounting screws to secure the entire enclosure.

MINI-DISK EDGE CARD CONNECTOR J1

PIN	SIGNAL	DESCRIPTION
1	GND	Signal Ground
2	N/C	Not Connected
3	GND	Signal Ground
4	N/C	Not Connected
5	GND	Signal Ground
6	N/C	Not Connected
7	GND	Signal Ground
8	$\overline{\text{INDEX}}$	Pulse at beginning of track
9	GND	Signal Ground
10	$\overline{\text{DS0}}$	Selects drive 0
11	GND	Signal Ground
12	$\overline{\text{DS1}}$	Selects drive 1
13	GND	Signal Ground
14	$\overline{\text{DS2}}$	Selects drive 2
15	GND	Signal Ground
16	MOTOR	Turns on all drive motors
17	GND	Signal Ground
18	$\overline{\text{DIRECTION}}$	Defines direction of R/W head
19	GND	Signal Ground
20	$\overline{\text{STEP}}$	Moves R/W head one step
21	GND	Signal Ground
22	$\overline{\text{WRITE DATA}}$	Data to be written on diskette
23	GND	Signal Ground
24	$\overline{\text{WRITE GATE}}$	Enables WRITE DATA
25	GND	Signal Ground
26	$\overline{\text{TRACK 00}}$	Indicates track 0 head position
27	GND	Signal Ground
28	$\overline{\text{WRITE PROTECT}}$	Indicates write protected diskette
29	GND	Signal Ground
30	$\overline{\text{READ DATA}}$	Raw data read from drive
31	GND	Signal Ground
32	$\overline{\text{DS3}}$	Selects drive 3
33	GND	Signal Ground
34	N/C	Not Connected

NOTE: $\overline{}$ Means Negative (logical"0") True Input or Output

VIEWED FACING THE CONNECTOR



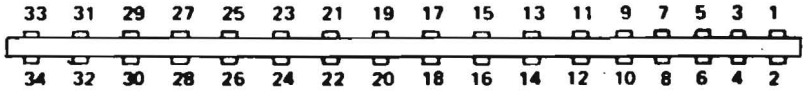
(figure 17)

34 PIN PARALLEL PRINTER PORT EDGE CONNECTOR

PIN	SIGNAL	DESCRIPTION
1	$\overline{\text{DATA STROBE}}$	Data ready strobe (1 microsecond)
2	GND	Signal Ground
3	D1	Data Bus Bit 0 Latched Output
4	GND	Signal Ground
5	D2	Data Bus Bit 1 Latched Output
6	GND	Signal Ground
7	D3	Data Bus Bit 2 Latched Output
8	GND	Signal Ground
9	D4	Data Bus Bit 3 Latched Output
10	GND	Signal Ground
11	D5	Data Bus Bit 4 Latched Output
12	GND	Signal Ground
13	D6	Data Bus Bit 5 Latched Output
14	GND	Signal Ground
15	D7	Data Bus Bit 6 Latched Output
16	GND	Signal Ground
17	D8	Data Bus Bit 7 Latched Output
18	GND	Signal Ground
19	BIT 2	Input B2
20	$\overline{\text{GND}}$	Signal Ground
21	$\overline{\text{BUSY}}$ (Bit 7)	Printer busy input
22	$\overline{\text{Gnd}}$	Signal Ground
23	$\overline{\text{PAPER}}$ (Bit 6)	Out of paper signal input
24	$\overline{\text{GND}}$	Signal Ground
25	$\overline{\text{SELECT}}$ (Bit 5)	Indicates that printer is ready
26	PRIME	
27	$\overline{\text{GND}}$	Signal Ground
28	$\overline{\text{FAULT}}$ (Bit 4)	Indicates a printer fault
29	BIT 3	Input B3
30	BIT 0	Input B0
31	GND	Signal Ground
32	BIT 1	Input B1
33	GND	Signal Ground
34	GND	Signal Ground

NOTE: $\overline{}$ Means Negative (logical"0") True Input or Output

VIEWED FACING THE CONNECTOR



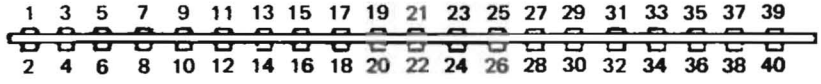
(figure 18)

DISK-80 BUFFERED EXPANSION CONNECTOR J3

PIN	SIGNAL	DESCRIPTION
1	N/C	No Connection
2	SYSRES	System reset output
3	N/C	No Connection
4	A10	Bidirectional Data Bus
5	A12	Bidirectional Data Bus
6	A13	Bidirectional Data Bus
7	A15	Bidirectional Data Bus
8	GND	Signal Ground
9	A11	Bidirectional Data Bus
10	A14	Bidirectional Data Bus
11	A8	Bidirectional Data Bus
12	OUT	Peripheral Write Output Strobe
13	WR	Memory Write Output Strobe
14	INTAK	Interrupt Acknowledge Output
15	RD	Memory Read Input Strobe
16	N/C	No Connection
17	A9	Bidirectional Data Bus
18	D4	Bidirectional Data Bus
19	IN	Peripheral Read Input Strobe
20	D7	Bidirectional Data Bus
21	INT	Interrupt Input
22	D1	Bidirectional Data Bus
23	TEST	Bus Tri-state Input
24	D6	Bidirectional Data Bus
25	A0	Bidirectional Data Bus
26	D3	Bidirectional Data Bus
27	A1	Bidirectional Data Bus
28	D5	Bidirectional Data Bus
29	GND	Signal Ground
30	D0	Bidirectional Data Bus
31	A4	Bidirectional Data Bus
32	D2	Bidirectional Data Bus
33	WAIT	Processor Wait Input
34	A3	Bidirectional Data Bus
35	A5	Bidirectional Data Bus
36	A7	Bidirectional Data Bus
37	GND	Signal Ground
38	A6	Bidirectional Data Bus
39	+5V	5 volt limited current output
40	A2	Bidirectional Data Bus

NOTE: ___ Means Negative (logical"0") True Input or Output

VIEWED FACING THE CONNECTOR



(figure 19)