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H A R D W A R E M A N U A L

JANUARY, 1982 REV. A

MTU-130 COMPUTER HARDWARE MANUAL

TABLE OF CONTENTS

NOTE: See separate manuals for detail information about the CPU board and disk controller board.

1. INTRODUCTION

A complete MTU-130 computer system consists of three major components. These are the Keyboard Unit (also called an MTU-100) which also contains the computer board and disk controller, the Disk Unit which contains one or two floppy disk drives with power supply, and the Display Monitor which is the CRT display. The first two components are manufactured by MTU.

1.1 KEYBOARD UNIT

The MTU-130 Keyboard Unit consists of a 96 key keyboard, 5 slot card file, Monomeg single board computer with 64K RAM, disk controller with 16K RAM and DMA, light pen board, power supply, cooling fan, large speaker, and cabinet. The cabinet is easily separated into a top portion holding the keyboard, fan, and speaker, and a bottom portion holding the other components.

The keyboard consists of 6 separate key clusters totaling 96 keys in all and is constructed on a single printed circuit board. It is connected through a 16 wire ribbon cable and connector which plugs directly onto the CPU board. The cooling fan receives its operating power from a connector on the power supply through a 3 wire cable. A pair of wires with quick-connect lugs connect the speaker to the volume control on the back panel.

The 5 slot card file holds the CPU board and disk controller board with 3 slots remaining for expansion. Each slot is electrically identical and presents an MTU modified version of the original MOS Technology KIM-1 bus (called the MTU-130 bus) to the boards. The boards also receive their operating power through this bus. The slots differ physically however in that the lower slots accept deeper boards than do the upper slots. All boards are 11" wide however. The power supply is sufficiently large to power up to 3 accessory boards (plugged into the empty card file slots) as well as the standard CPU and disk controller boards. The light pen board is mounted separately outside of the card file in order to minimize noise pickup. All user I/O connectors (parallel I/O, serial I/O, video output, cassette input and output, external speaker, disk unit cable, and switched AC outlets) are mounted on the rear panel of the base portion of the cabinet. The power switch, fuse, light pen jack, and volume control are also mounted there.

1.2 DISK UNIT

The MTU-130 Disk Unit consists of one or two 8 inch disk drives, a power supply, a cabinet, and a signal cable. In operation, the 50 wire flat ribbon signal cable is plugged into a jack in the Keyboard Unit and the AC power cord is plugged into one of the switched AC outlets. The disk drives may be either single sided units capable of storing 512K bytes of formatted data each or double sided units with a 1024K byte capacity. This gives a system capacity of 1.024M or 2.048M bytes of formatted data. Disk units with only one drive installed are also available. With a special cable available on special order, two disk units may be connected to a single MTU-130 for up to 4.1M bytes of on-line capacity.

1.3 DISPLAY MONITOR

The display monitor is a monochrome unit with high resolution and a DC coupled video amplifier. It has been selected from numerous units available on the market to make the most of the MTU-130's display capability and to complement its styling. It has also been MTU factory adjusted to provide a sharp, stable image with the proper aspect ratio (width:height). The monitor is connected to the video output jack and switched AC output on the Keyboard Unit's back panel.

2. KEYBOARD UNIT MECHANICS

2.1 EXTERNAL PARTS IDENTIFICATION

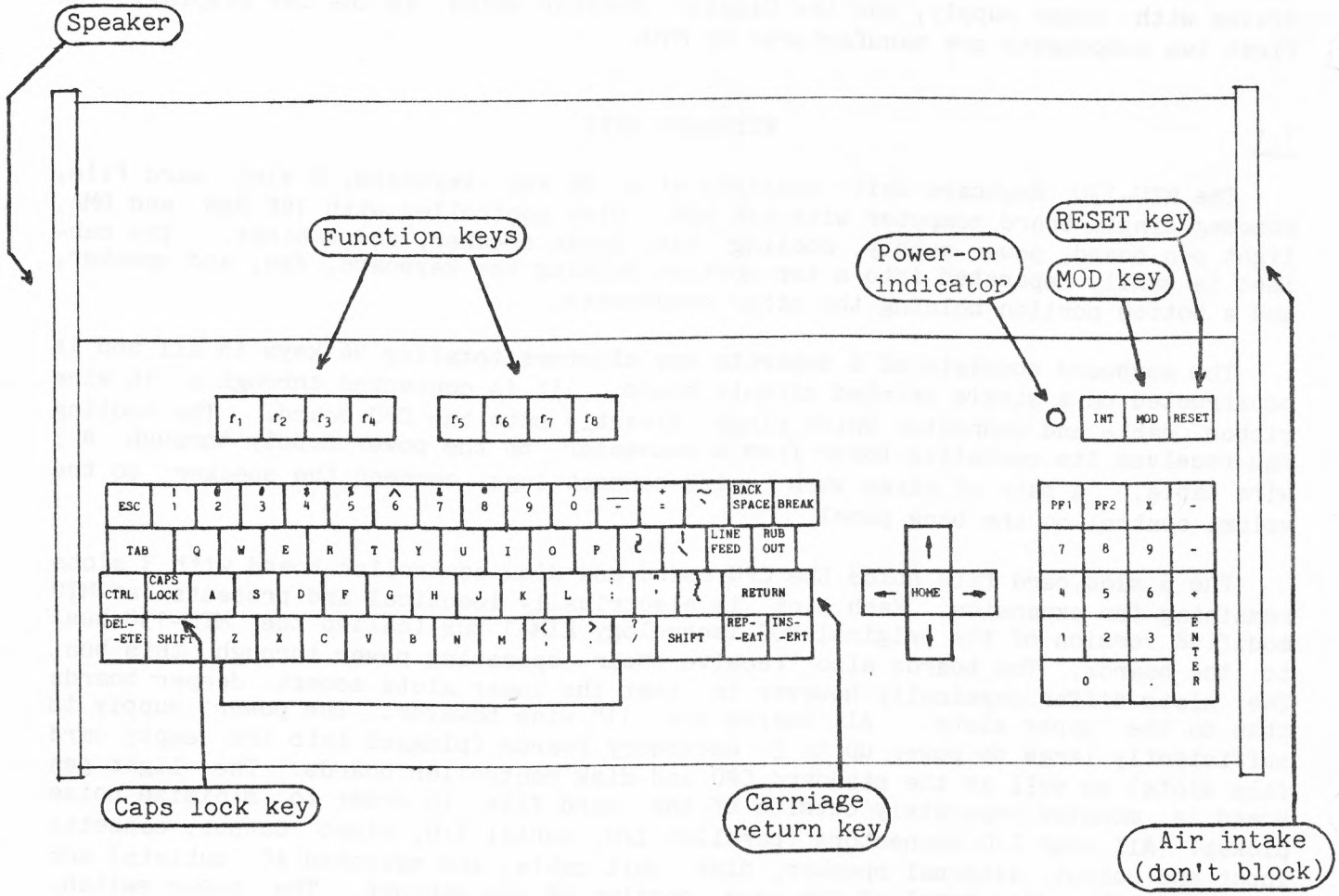


Figure 2-1. Keyboard Unit, Top-Front View

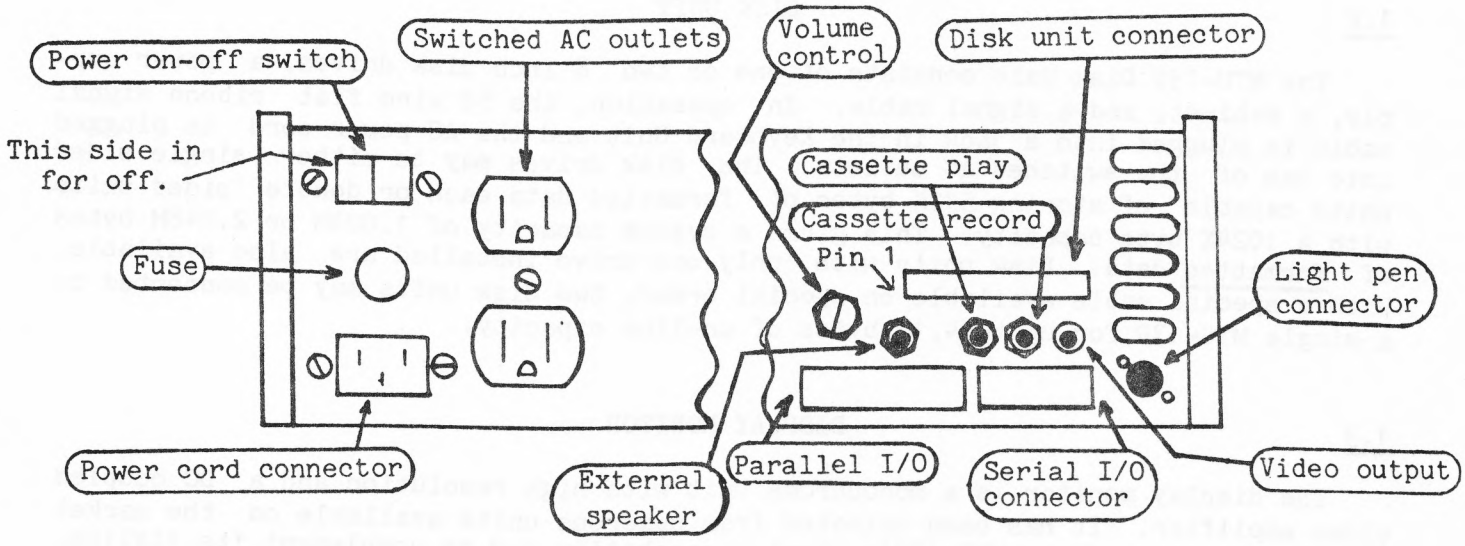


Figure 2-2. Keyboard Unit, Rear View

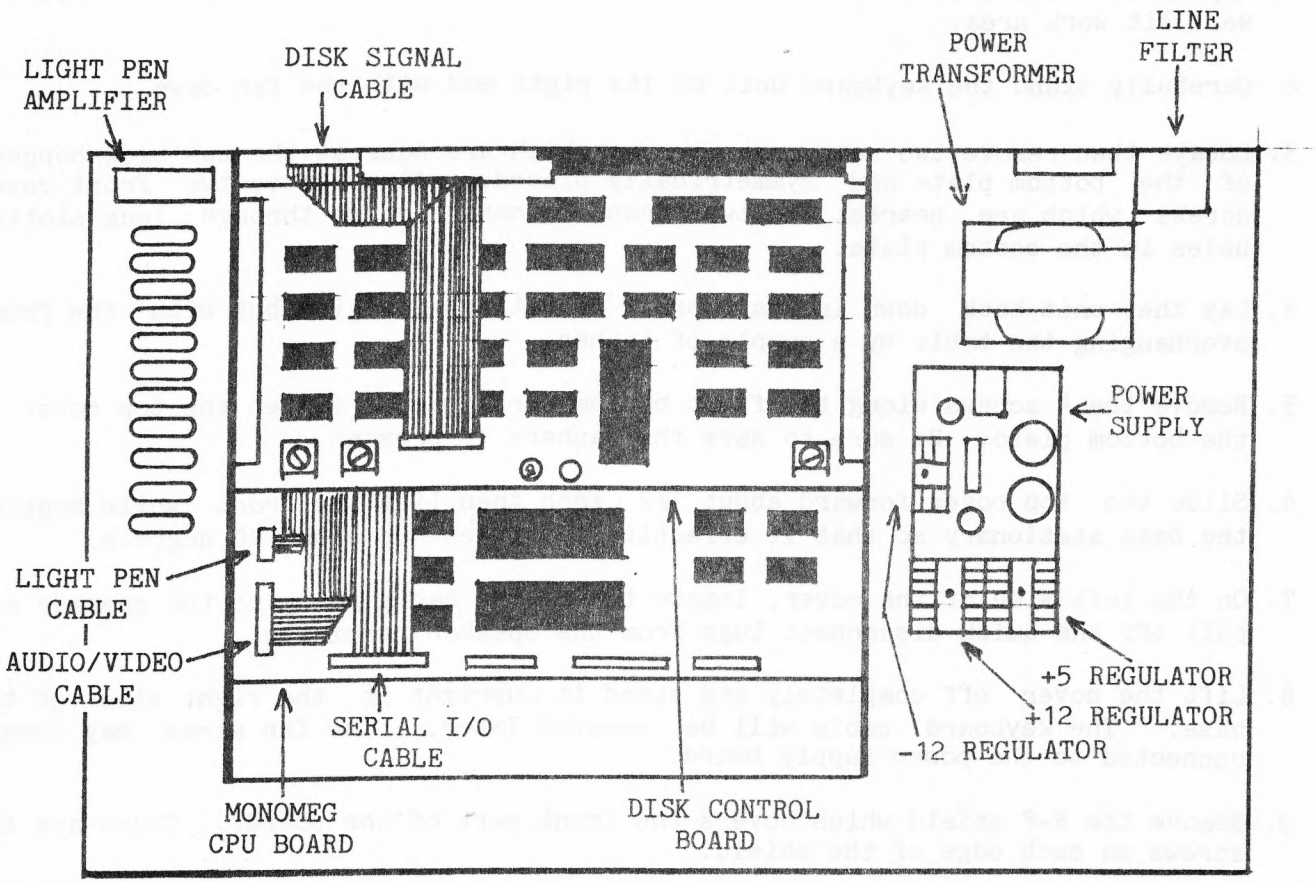


Figure 2-3 Top View

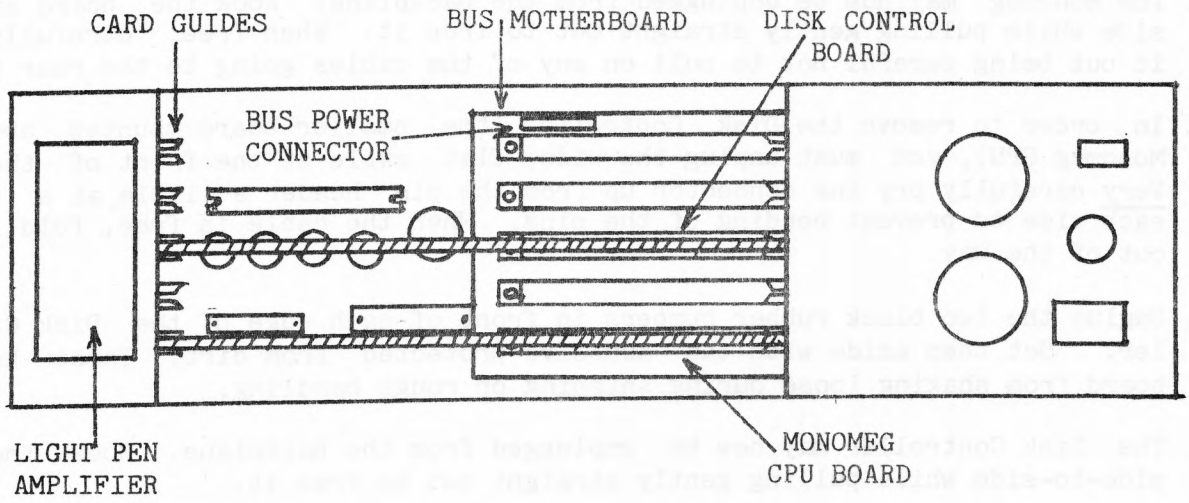


Figure 2-4 Front-on View
(power supply removed)

2.3 DISASSEMBLY INSTRUCTIONS

1. Unplug all cables from the MTU-130 keyboard unit and move it to an uncluttered, well lit work area.

2. Carefully stand the keyboard unit on its right end with the fan down.

3. Locate then remove two rear cover screws which are nearest the two back corners of the bottom plate and symmetrically placed. Also remove two front cover screws which are nearest the two front corners and go through long slotted holes in the bottom plate.

4. Lay the unit back down in its normal operating position but with the front overhanging the table by a couple of inches.

5. Remove the 4 screws along the front bottom surface that fasten the top cover to the bottom plate. Be sure to save the washers if present.

6. Slide the top cover forward about 1/2 inch then lift the front while keeping the back stationary so that it effectively "hinges" up about 40 degrees.

7. On the left side of the cover, locate the 2-wire cable going to the speaker and pull off the quick-disconnect lugs from the speaker terminals.

8. Lift the cover off completely and stand it upright at the right side of the base. The keyboard cable will be removed later. The fan wires may remain connected to the power supply board.

9. Remove the R-F shield which covers the front part of the boards. There are two screws on each edge of the shield.

10. Gently unplug the keyboard cable from its connector on the bottom PC board (use a small screwdriver to pry it up).

11. In order to remove the Monomeg CPU (the bottom board in the card file), you must unplug the 4 cables that connect it to the back panel. Very carefully pry the connectors up from the pin headers on the board with a screwdriver blade. Grabbing and pulling them with your fingers will surely result in bent pins (and broken fingernails) when they suddenly let go.

12. The Monomeg may now be unplugged from the backplane. Rock the board side-to-side while pulling gently straight out to free it. When free, carefully slide it out being careful not to pull on any of the cables going to the rear panel.

13. In order to remove the Disk Controller (the smaller board mounted above the Monomeg CPU), you must unplug the wide, flat cable at the front of the board Very carefully pry the connector up from the pin header a little at a time on each side to prevent bending of the pins. When the cable is free, fold it back out of the way.

14. Unglue the two black rubber bumpers in front of each edge of the Disk Controller. Set them aside with the adhesive protected from dirt. These keep the board from shaking loose during shipping or rough handling.

15. The Disk Controller may now be unplugged from the backplane. Rock the board side-to-side while pulling gently straight out to free it.

16. If necessary during troubleshooting, you may temporarily plug the Monomeg CPU into one of the upper slots above the disk controller. While troubleshooting it is only necessary to plug in the audio/video cable (the 10 pin connector that plugs in at the far left edge of the Monomeg) and the keyboard connector.

17. Always wait a full 15 seconds after switching power off before plugging or unplugging any board to allow time for the power supply filter capacitors to discharge.

2.4 REASSEMBLY INSTRUCTIONS

1. To reinstall the Monomeg CPU board, hold the cables that run underneath it down and then slide the board gently into the bottom slot. Be on the lookout for sharp component leads "catching" on the cables. If a catch is felt, back the board out slightly and wiggle the cables while pushing it back in. Forcing the board past a catch may damage the insulation on the cable or bend the protruding lead and possibly short it against another lead. You should feel a definite "snap" when the edge fingers on the board seat into the backplane connector.

2. Re-attach the 4 cables going to the back panel. Common sense and keys in the cable connectors should make it easy to match each cable with the proper connector. Note that the rightmost 2 connectors are unused and the keyboard cable will be attached later.

3. To reinstall the Disk Controller board, hold the wide disk controller cable out of the way and then insert the disk controller board into the third slot (from the bottom) of the card file (use the second slot if you have an accessory board in the third slot). Re-attach the wide cable to the connector on the board being careful to align the connector so all 50 pins are engaged. Press the rubber bumpers in their original position against the front edge of the Disk Controller board.

4. Find the top cover and re-attach the keyboard cable to the Monomeg CPU board.

5. Find the R-F shield and install it with its 4 screws. Insert each screw only part way until all 4 have been inserted. Then push the shield up and back as far as it will go and tighten the screws.

6. Position the top cover in the "hinged up" position it was in step 6 and re-attach the two speaker lugs.

7. Lower the cover and slide it back until the top rear edge is flush with the back panel. The short tabs under the rear of the top panel should hook under the lip of the back panel. It may be necessary to bend the top panel flat while doing this.

8. While holding the two halves together with your hands, stand the unit on its right end like it was in step 2 of the disassembly instructions.

9. Carefully manipulate the cover as necessary to make the rear corner holes in the bottom plate match up with the internal cover mounting brackets and install the two rear corner screws (these were the ones that were removed in disassembly step 3). Also install the two front corner screws.

10. Set the unit back down with the front overhanging the tabletop edge and re-install the 4 front cover screws that were removed in disassembly step 5.

11. Reconnect the keyboard unit to the disk drives, monitor, and power cord.

3. DISK UNIT MECHANICS

3.1 EXTERNAL PARTS IDENTIFICATION

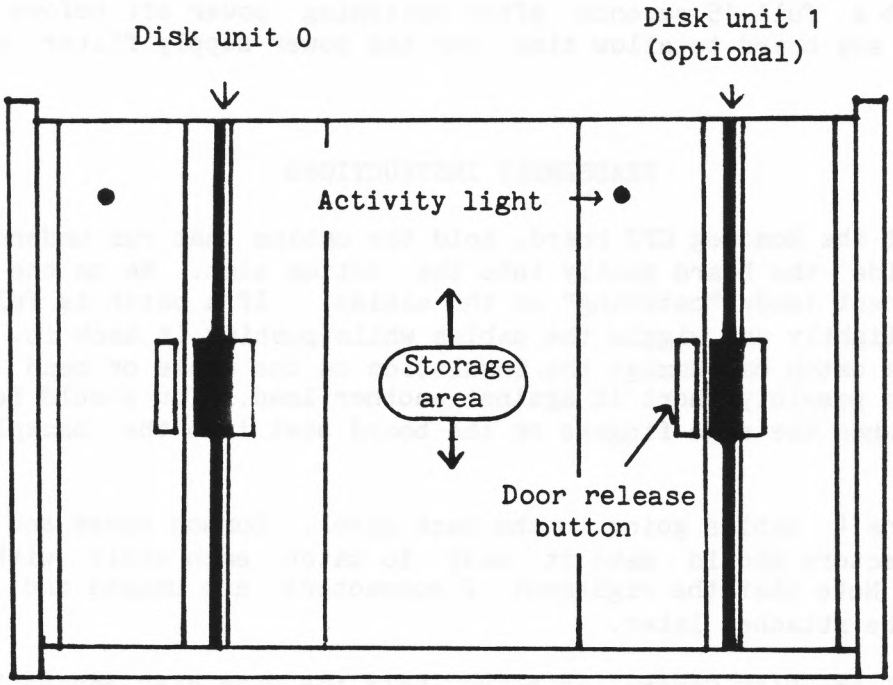


Figure 3-1. Disk Unit, Front View

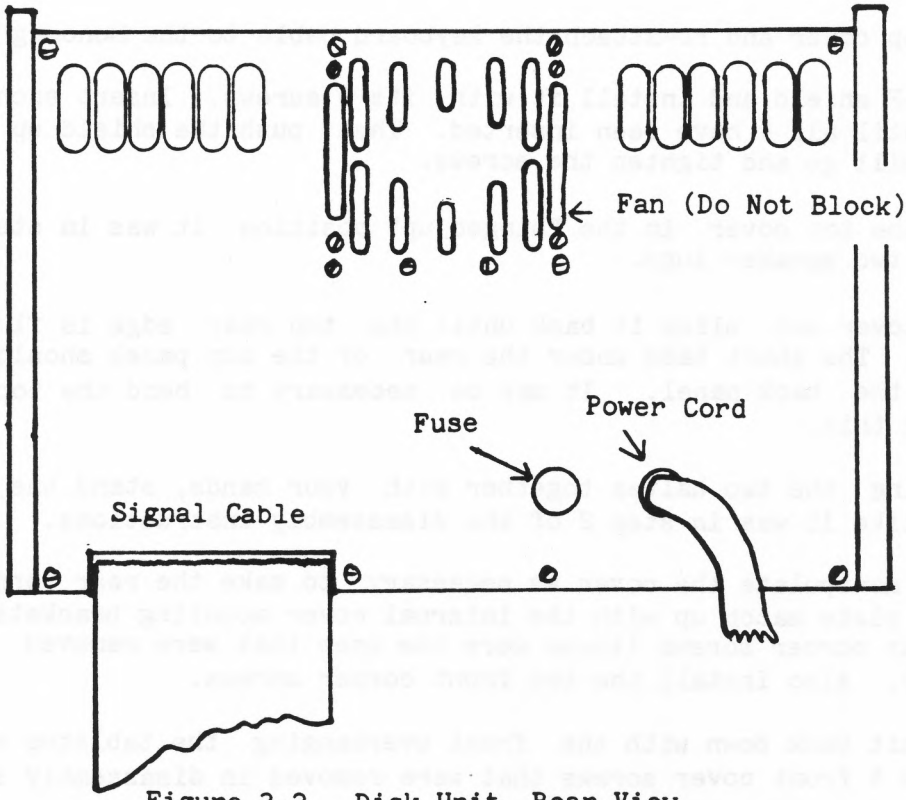


Figure 3-2. Disk Unit, Rear View

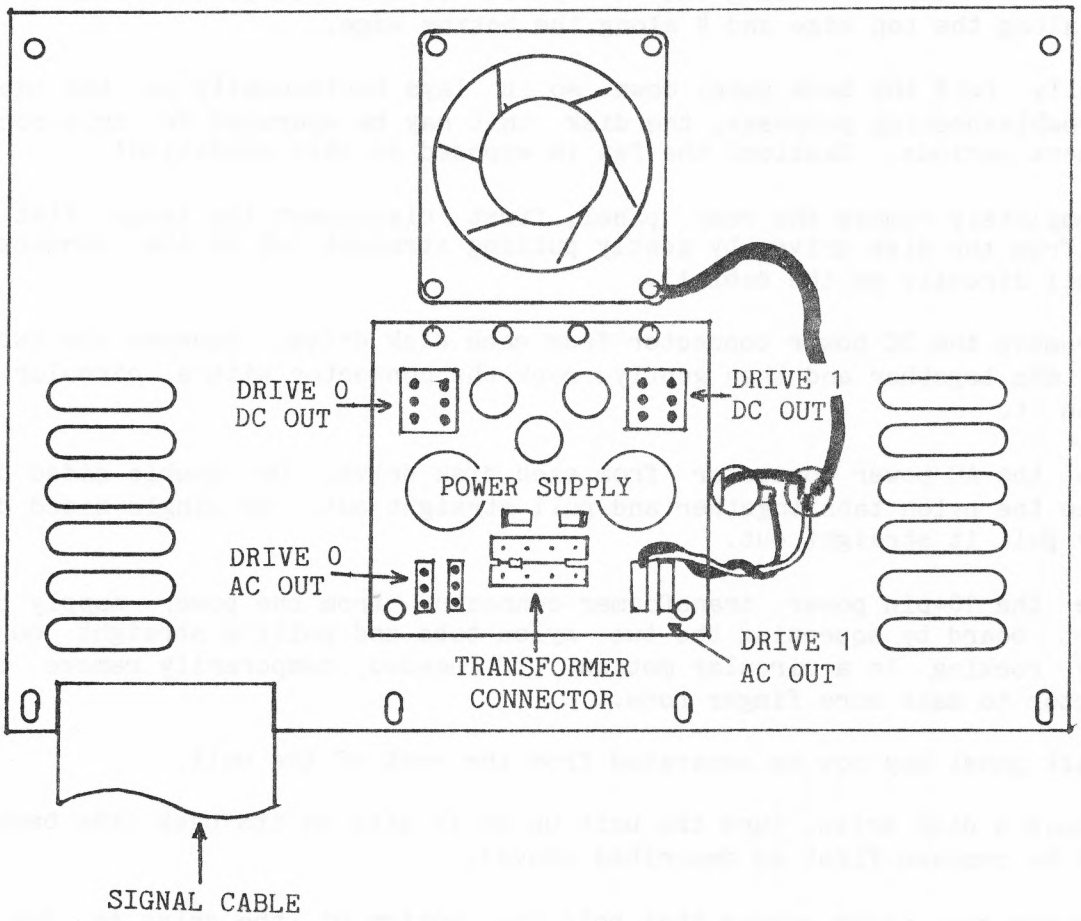


Figure 3-3. Inside Back Panel View

3.3 DISASSEMBLY INSTRUCTIONS

1. Disconnect the wide flat signal cable from the Keyboard Unit by spreading the locking tabs apart to unlock them and pulling straight out gently. Disconnect the AC line cord as well.

2. Open both disk drive doors and remove any diskettes inside the drives or the storage area. Turn the unit around so you are facing the rear panel.

3. Remove the 8 screws holding the back panel to the rest of the cabinet. There are 4 along the top edge and 4 along the bottom edge.

4. Carefully fold the back panel down so it lays horizontally on the tabletop. For troubleshooting purposes, the disk unit may be operated in this condition for short periods. Caution: the fan is exposed in this condition!

5. To completely remove the rear panel, first disconnect the large flat signal cable from the disk drives by gently pulling straight out on the connector (do not pull directly on the cable!).

6. Next remove the DC power connector from each disk drive. Squeeze the two white nylon tabs together and then gently rock the connector with a circular motion to free it.

7. Remove the AC power connector from each disk drive. On double-sided drives, squeeze the nylon tabs together and pull straight out. On single-sided drives, simply pull it straight out.

8. Remove the 10-pin power transformer connector from the power supply printed circuit board by squeezing the two nylon tabs and pulling straight out while gently rocking in a circular motion. If needed, temporarily remove the fan connector to make more finger room.

9. The back panel may now be separated from the rest of the unit.

10. To remove a disk drive, turn the unit up so it sits on its back (the back panel should be removed first as described above).

11. Remove the two large screws that hold the bottom of the drive to the bottom plate.

12. Carefully turn the unit back down to its normal horizontal operating position.

13. Remove the two black, hex socket screws that hold the top of the drive to the top plate. Be careful not to mar the paint.

14. Slide the disk drive out the rear of the cabinet being careful not to rub any part of the drive against the power transformer.

3.4 REASSEMBLY INSTRUCTIONS

1. If you are upgrading a single drive disk unit to a dual drive unit, please read the instructions that come with MTU supplied disk drives. If you have purchased a drive elsewhere, it will have to be configured to meet the requirements of the MTU-130. Please refer to the Disk Controller manual for configuration information.

2. To install a new disk drive, make sure the back panel has been removed (see disassembly steps 1-9) and the disk unit is resting horizontally on the tabletop in its normal operating position.

3. Slide the disk drive in from the back. Be careful not to rub any part of the drive against the power transformer. Note that tapped mounting holes on the top and bottom surface of the drive are not centered left-to-right. If the drive is upsidedown, these holes will not match the two mounting holes in the top cover. Remove the drive, turn it over, and reinsert it if upsidedown.

4. Line up the tapped holes in the disk drive with the two countersunk holes in the top cover of the unit. Insert the special black oxide hex keyed screws into the holes and tighten them. Be careful not to mar the paint.

5. Very carefully, turn the unit upwards so it rests on its back. The two large holes on the bottom plate should line up with two tapped holes in the disk drive. Insert standard 8-32 by 3/8" machine screws into the holes and tighten.

6. Turn the unit back down horizontally to its normal operating position.

7. To reconnect the back plate electrically, first plug the power transformer into the power supply circuit board. Push the connector in until both locking tabs have "snapped" into place.

8. Reconnect the AC power cable to each disk drive (3-pin connector). On double-sided drives, make sure the tabs have locked.

9. Reconnect the DC power cable to each disk drive. Push the connector in until both locking tabs have "snapped" into place.

10. Plug the wide flat signal cable onto the edge fingers of each drive. Note that there is a slot near one edge of the fingers and a corresponding key in the cable connector. The key will fit into the slot when the connector is correctly positioned on the edge fingers.

11. Double-check all connectors. Is AC power connected to each drive? Is DC power connected to each drive? Is the signal cable plugged onto each drive and is it straight? Is the power transformer plugged into the power supply board?

12. Carefully fold up the back panel. Position the cables away from the fan if necessary. Remove any kinks that may form in the flat signal cable while the back panel is being positioned.

13. Loosely insert one screw in the top and bottom edge of the back panel to hold it stationary. Now insert the other 6 screws and then tighten all 8 screws.

14. Reconnect the disk unit to the Keyboard Unit (see instructions in the Setup and Installation manual).

4. LIGHT PEN SUBASSEMBLY

4.1 DESCRIPTION

The light pen subassembly consists of three major parts which are the fiber-optic wand, the photodetector/amplifier printed circuit board, and the connecting cable to the Monomeg CPU board. In conjunction with latching circuitry on-board the Monomeg, a running program can not only determine when the pen sees light from the display screen, but it can also determine in microseconds where on the screen light was seen to 1 pixel resolution. The light pen subassembly is normally a standard feature of the MTU-130 computer.

The fiber-optic wand is the portion of the light pen system the user interacts with. It consists of a long, thin barrel much like a standard ball-point pen with a fiber-optic light pipe leaving the rear. The other end of the fiber-optic cable connects to the back panel of the MTU-130 keyboard unit. The connector used is a standard Amp fiber-optic connector. There is no conventional (electric) wiring to the light pen wand.

The photodetector/amplifier printed circuit board is mounted inside the MTU-130 keyboard unit and supported by the rear of the fiber-optic connector. The mounting location was chosen to be away from major sources of electrical noise in the cabinet. The detector is a PIN photodiode which is necessary to achieve the speed needed for direct X-Y coordinate latching. The amplifier is a high speed, high gain, low noise unit that amplifies and shapes the nano-amp output of the detector into a TTL compatible pulse.

The connecting cable carries +12 volt power to the amplifier board from the Monomeg and returns the TTL compatible pulse the amplifier generates. Only 3 conductors are needed; the fourth position in each connector is used as a key.

4.2 PRINCIPLES OF OPERATION

Light pens are very convenient data input devices that are used in conjunction with CRT displays. Light pens are typically used to point out "menu items" or objects displayed by a program and to actually "draw" lines and curves directly on the CRT screen. With a suitable amount of programming effort, a very simple light pen interface can be successfully used for the first application provided the number of "menu" items is relatively small (less than 20). For very large menus, many objects, direct drawing, and light pen "tracking" applications, it is necessary that the light pen report the X-Y location of the light it saw as well as the fact that it saw light.

Since every pixel (dot) of a raster scan display is drawn sequentially, very precise measurement of the time between sweep beginning and the first response to light is sufficient to establish the screen position of that response. Since the MTU-130 display draws a pixel every 100NS, detector response speed must be of the same order to give an accurate and repeatable time measurement. CRT phosphor response time however is significant (100-200NS for P4 and P31) so there is a limit to how precise the measurement can be. Speeds in this range at the low light levels typically emitted by a CRT require use of a photodiode as the detector. Unfortunately, photodiodes have a very low signal output which requires high amplifier gain. This high gain makes the amplifier very susceptible to electrical noise. If the amplifier was in the wand, it would have to be carefully shielded from the electrical noise typically emitted by CRT monitors. Placing the amplifier in the cabinet and using a fiber-optic cable was found to be a cost-effective solution to the noise problem.

Construction of the wand is very simple. The barrel is actually that of a fine point "flair" type of writing pen. The light conducting portion of the fiber-optic cable is relatively large (1mm dia.) and when the jacket is stripped back, will fit snugly into the small metal cylinder that originally held the writing tip. The light conductor is recessed approximately 2mm from the end of the tip which serves to protect it and restrict the field of view. The sensitivity of the detector is sufficient to eliminate need for a lens. The cable is anchored in place with epoxy and exits the rear of the pen barrel.

Section 4.5 shows a schematic of the amplifier board itself. The 12 volt power input is heavily filtered and decoupled by C8, R12, C5, and C4 since the circuit is sensitive to power supply noise. The photodetector is D1 which is biased by +12 volts filtered further by R1 and C1. A strong reverse bias materially enhances the speed of the detector by lowering its junction capacitance and somewhat improving its quantum efficiency.

Transistors Q1 and Q2 and their associated biasing components form what is known as a "transimpedance" preamplifier or current-to-voltage converter. A photodiode essentially acts like a light variable current source with a large parallel capacitance. To minimize the slowdown effect of the capacitance, the amplifier must have a low input impedance, i.e., be current sensitive. Actually the circuit is much like an inverting operational amplifier circuit with R2 being the feedback resistor and the base of Q1 being the summing junction. Operational amplifier theory shows that the impedance at the summing junction will be very low(100-200 ohms here). The gain of the preamplifier is approximately 50 millivolts per microamp of photocurrent.

Biasing of the preamplifier is accomplished by the method known as "N-Vbe". Since Q1 is biased in its linear region, the voltage at its base will be pretty close to +.6 volt with respect to ground. If the current gain of Q1 is assumed to be high, then there will be little voltage drop across R2 and the voltage at the junction of R4 and R5 will be around +.7 volt. Since R5 is about twice as large as R4, applying the voltage divider equation in reverse will lead to the conclusion that the voltage at the emitter of Q2 is 3 times +.7 or about +2.1 volts. The voltage at the collector of Q1 will be about +.6 volts higher or +2.7 volts. At high frequencies, C2 bypasses R4 and thus reduces the amount of feedback through R2. This partially counteracts the normal gain decrease at high frequencies and therefore improves high frequency response.

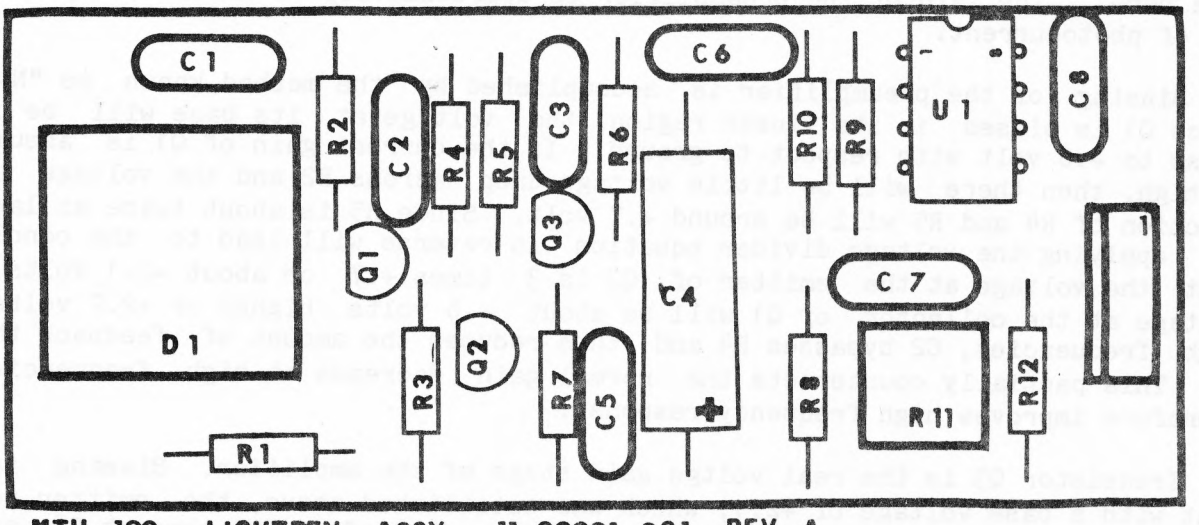
Transistor Q3 is the real voltge gain stage of the amplifier. Biasing is such that with a base voltage of +2.1, which was established above, the emitter voltage will be .6 volt lower and establish a current flow of 2.2MA through R6 and R7. This current gives rise to a 5 volt drop across R7 and thus a voltage of +7 volts at the collector of Q3. At those frequencies to which light pen response is desired, C3 thoroughly bypasses R6 thus giving a high stage voltage gain of 100 or more. Low frequencies and DC variations from room light on the other hand are amplified only by a factor of 3 and effectively rejected.

Comparator U1 detects the final amplifier output, which is still only about 200MV, and converts it to a TTL compatible signal. Voltage divider R8+R11 and R9 provides a bias voltage of +5.5 volts which is filtered by C6 and applied through R10 to the comparator's inverting input. R11 provides a slightly higher, adjustable voltage to the non-inverting input which will keep the comparator output high. When a light pulse is detected by the amplifier, it will couple a positive pulse through C7 to the inverting input. If the pulse amplitude exceeds the overvoltage on the non-inverting input, the comparator output will switch low for the duration of the pulse. The light pen input to the Monomeg CPU driven by the comparator has a 1K pullup resistor to +5.

4.3 PARTS LIST

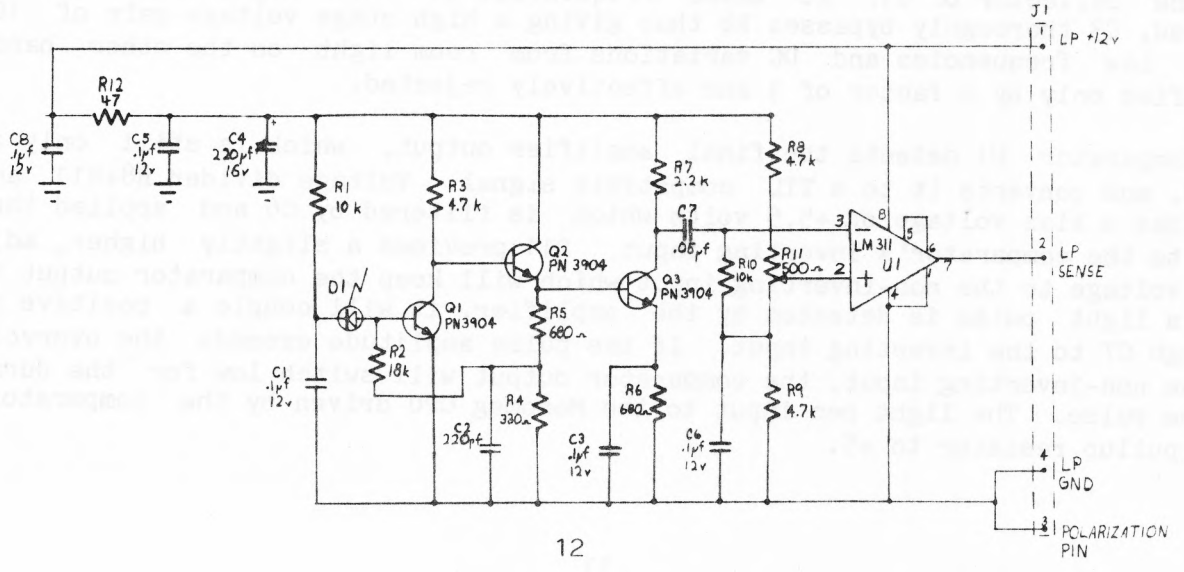
QTY	DESCRIPTION		DESIGNATION
1	LOGIC,LM311 OP AMP		U1
3	TRANS,PN3904		Q1,2,3
1	DIODE,MFD500,PHOTO		D1
1	RES,47	1/4W 5%	R12
1	RES,330	1/4W 5%	R4
2	RES,680	1/4W 5%	R5,6
1	RES,2.2K	1/4W 5%	R7
3	RES,4.7K	1/4W 5%	R3,8,9
2	RES,10K	1/4W 5%	R1,10
1	RES,18K	1/4W 5%	R2
1	RES,TRIMPOT,500		R11
1	CAP,DISK,Y5F 220PF 12V		C2
1	CAP,DISK,Z5U .05UFD 12V		C7
5	CAP,DISK,Z5U .1UFD 12V		C1,3,5,6,8
1	CAP,ELECT,220UFD 16V		C4
1	CONN,REC,FIB OP		
1	CONN,HDR,SIL 4 PIN		J1
1	SOCKET,8 PIN PC		

4.4 PARTS LAYOUT



MTU-100 LIGHTPEN ASSY. 11-00001-021 REV. A

4.5 SCHEMATIC DIAGRAM



5. KEYBOARD SUBASSEMBLY

5.1 DESCRIPTION

The keyboard subassembly consists of a single large printed circuit board on which are mounted a number of various sized keyswitch modules and a small amount of TTL logic. The keyswitch modules include the main array (62 keys), the numeric pad array (18 keys), the cursor array (5 keys) two function key arrays (4 keys each), and the system control array (3 keys). All except 4 of the 96 keys are wired into a 16x6 matrix. The keyswitches themselves are standard size full travel types with 4 parallel redundant normally open contacts per key. The logic consists of a 4 bit counter and 1-of-16 decoder. A high brightness LED serves as a pilot light. All keyboard signals terminate in 16 pin double row header which is connected through a short ribbon cable to a mating connector on the Monomeg CPU board. Software in the 6502 microprocessor on-board the Monomeg performs the actual keyboard scanning.

5.2 PRINCIPLES OF OPERATION

For maximum flexibility, software scanning of the keyboard is employed. Thus the keyboard logic need only provide a way for the scanning program to uniquely address every key. For this purpose, 92 of the 96 keys are wired into a matrix with 6 rows and 16 columns as shown on the schematic in section 5.5. The 4 remaining keys are wired individually to trigger specific circuits. In the matrix configuration, the 16 columns function as "inputs" to the matrix while the 6 rows function as "outputs". The rows are connected to 6 bits of an input port on-board the Monomeg CPU. The columns are connected to a decoder which drives them one-at-a-time. By suitable program control of the decoder, the columns are driven in sequence and the status of each key in each column can be determined by the scan program. The arrangement of keys in the matrix was chosen to simplify the printed circuit board. The pairing of upper and lower case characters was chosen to conform to typewriter standards. The scanning software is responsible for translating between a matrix address and the desired character code. Note that the Shift, Caps Lock, Control, and Repeat keys are wired into the matrix along with the other keys. In order to avoid a "phantom key" effect when these are pressed simultaneously with other keys in the matrix, diodes are placed in series with these keys. The space bar also has a series diode to allow its future use as a command shift.

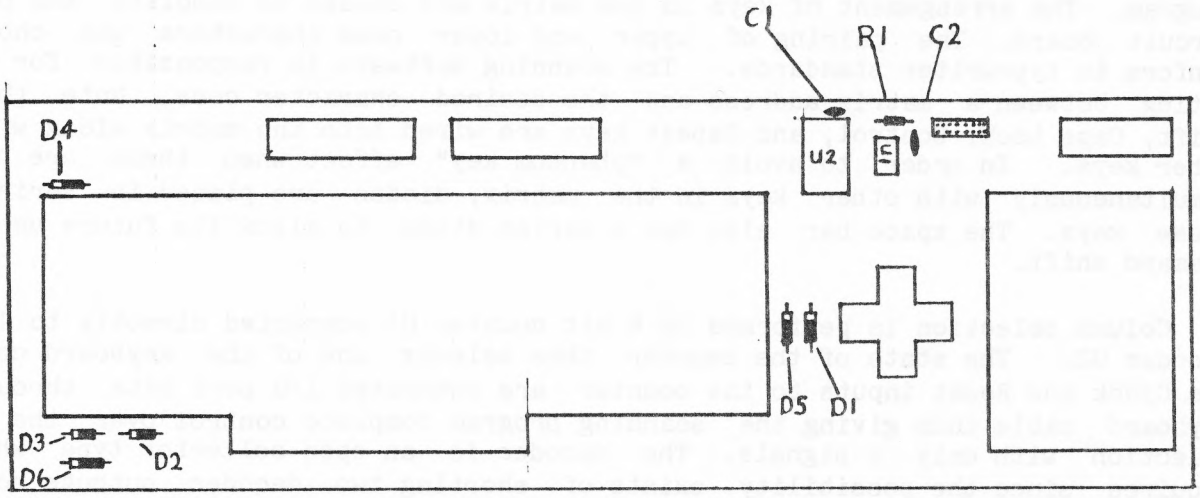
Column selection is performed by 4 bit counter U1 connected directly to 1-of-16 decoder U2. The state of the counter thus selects one of the keyboard columns. The Clock and Reset inputs to the counter are connected I/O port bits through the keyboard cable thus giving the scanning program complete control over the column selection with only 2 signals. The decoder is an open-collector type which is required since the possibility exists of shorting two decoder outputs together through two key contacts. The pullup resistors are inside the interface chip on-board the Monomeg. Note that the mode control keys mentioned earlier are all connected to column zero. This allows the scan program to quickly access these keys by simply resetting the counter. R2 and C2 act as a noise filter to prevent spurious resetting by noise coupled from the row outputs to the reset line in the connecting cable.

The pilot light is a high brightness LED. Resistor R1 sets the diode current at approximately 20MA which provides ample light output. The 4 keys which are not in the matrix are simply connected to ground their associated cable lines when they are pressed. Four positions in the keyswitch matrix are unused and are therefore available for future expansion.

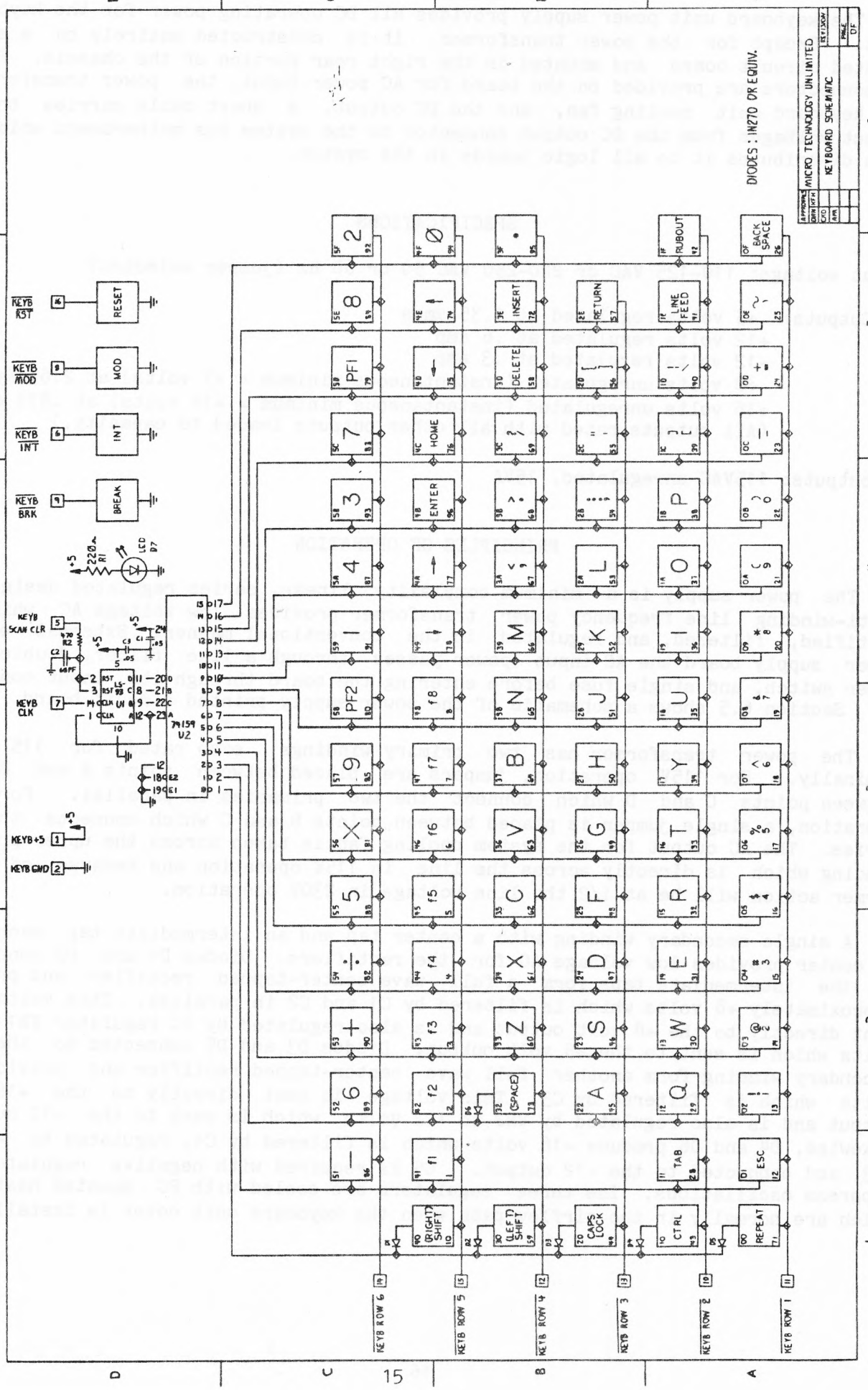
5.3 PARTS LIST

QTY	DESCRIPTION	DESIGNATION
1	SWITCH,62-KEY ARRAY	
1	SWITCH,18-KEY ARRAY	
2	SWITCH,4-BY-1 KEY ARRAY	
1	SWITCH,3-BY-1 KEY ARRAY	
1	SWITCH,3-BY-3 KEY ARRAY	
1	KEYTOP,96 KEY SET/ENGRAVING	
1	LOGIC,74LS93	U1
1	LOGIC,74159	U2
1	RES,470 OHM .25W 5%	R2
1	RES,220 OHM .25W 5%	R1
2	CAP,DISK,Z5U .05UFD 12V	C1,3
1	CAP,DISK,68 PF	C2
6	DIODE,1N270	D1-6
1	SOCKET,PC 14 PIN	
1	SOCKET,PC 24 PIN	
1	CONN,HDR,DIL 16 PIN	
63	JUMPER, .450" 24AWG	
1	LED,RED	D7

5.4 PARTS LAYOUT



SCHEMATIC DIAGRAM



6. KEYBOARD UNIT POWER SUPPLY

The keyboard unit power supply provides all DC operating power for the keyboard unit. Except for the power transformer, it is constructed entirely on a small printed circuit board and mounted in the right rear portion of the chassis. Plug-in connectors are provided on the board for AC power input, the power transformer, the keyboard unit cooling fan, and the DC output. A short cable carries the DC output voltages from the DC output connector to the system bus motherboard which in turn distributes it to all logic boards in the system.

6.1 SPECIFICATIONS

Input voltage: 110-125 VAC or 220-250 VAC 50 or 60 Hz (jumper selected)

DC Outputs: +5 volts regulated at 1.35 amps
+12 volts regulated at .6 amp
-12 volts regulated at .3 amp
+8 volts unregulated (instantaneous minimum = +7 volts) at 2.6 amps
+16 volts unregulated (instantaneous minimum = +14 volts) at .875 amp
(All outputs rated with all other outputs loaded to capacity.)

AC outputs: 115VAC unregulated, 15VA

6.2 PRINCIPLES OF OPERATION

The power supply is a minimum complexity linear, series regulated design. A multi-winding line frequency power transformer provides low voltage AC which is rectified, filtered, and regulated in the conventional manner. External of the power supply board the AC input power passes through a line filter, double-pole power switch, and single fuse before entering the board through its input connector. Section 6.5 shows a schematic of the power supply printed circuit board.

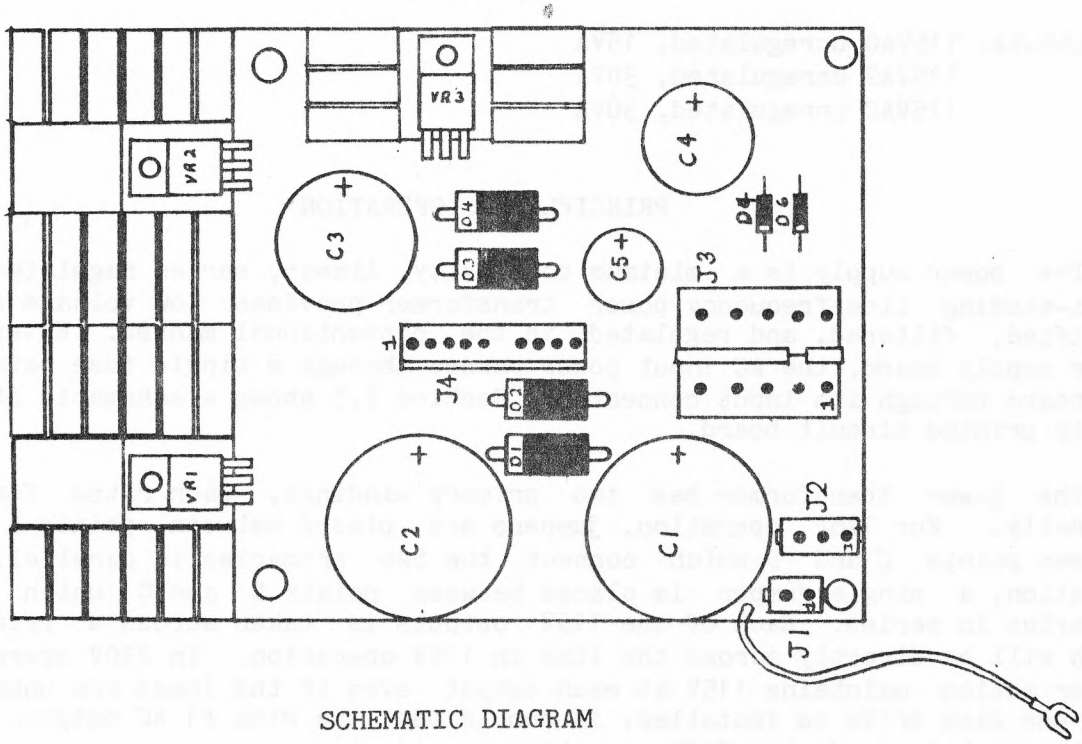
The power transformer has two primary windings, each rated for 115 volts nominally. For 115V operation, jumpers are placed between points A and B, and between points C and D which connect the two primaries in parallel. For 230V operation, a single jumper is placed between points B and C which connects them in series. The AC output for the system cooling fan is taken across the upper primary winding which is directly across the line in 115V operation and because of auto-former action will be at 1/2 the line voltage in 230V operation.

A single secondary winding with a center tap and an intermediate tap each side of center provides low voltage AC for the rectifiers. Diodes D1 and D2 connected to the intermediate taps form a full wave center-tapped rectifier and provide approximately +8 volts which is filtered by C1 and C2 in parallel. This voltage is sent directly to the +8 volt output and is also regulated by IC regulator VR1 to +5 volts which is sent to the +5 volt output. Diodes D3 and D5 connected to the full secondary winding form another full wave center-tapped rectifier and provide +16 volts which is filtered by C3. This voltage is sent directly to the +16 volt output and is also regulated by VR2 to +12 volts which is sent to the +12 output. Likewise, D4 and D6 produce -16 volts which is filtered by C4, regulated to -12 by VR3, and connected to the -12 output. C5 is required with negative regulators to suppress oscillations. The three regulators are cooled with PC mounted heatsinks which are normally in the airflow path when the keyboard unit cover is installed.

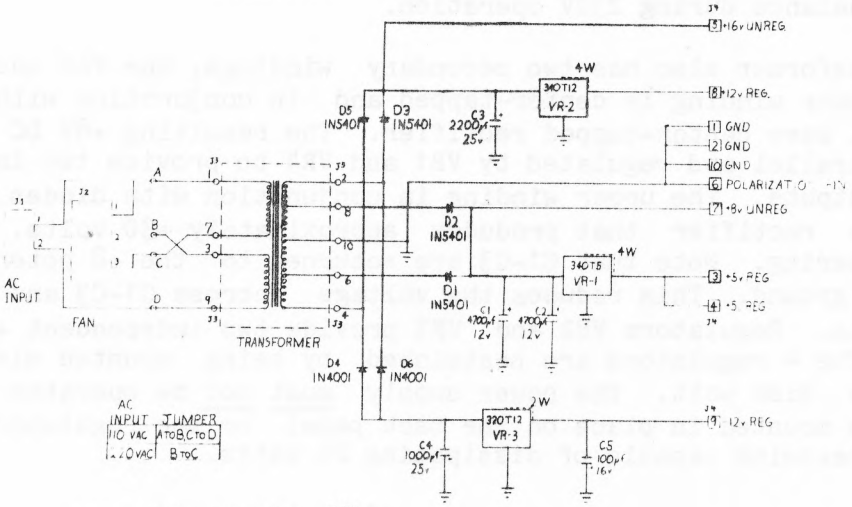
6.3 PARTS LIST

QTY	DESCRIPTION	DESIGNATION
4	DIODE,1N5401	D1,2,3,5
2	DIODE,1N4001	D4,6
1	VOLT REG,LM340-T5	VR1
1	VOLT REG,LM340-T12	VR2
1	VOLT REG,LM320-T12	VR3
1	CAP,ELECT,16V 100UFD RD	C5
2	CAP,ELECT,16V 4700UFD RD	C1,2
1	CAP,ELECT,25V 1000UFD RD	C4
1	CAP,ELECT,25V 2200UFD RD	C3
1	CONN,PC 2 PIN UML	J1
1	CONN,PC 3 PIN UML	J2
1	CONN,PC 10 PIN CML	J3
1	CONN,HDR 10 PIN SIL	J4
1	HEATSINK,2W	HVR3
2	HEATSINK,4W	HVR1,2

6.4 PARTS LAYOUT



6.5 SCHEMATIC DIAGRAM



(X REF. AREAS REPRESENT CONNECTORS NOT ON BOARD COMPONENTS)

7. DISK UNIT POWER SUPPLY

The disk unit power supply provides all DC operating power for the disk unit. Except for the power transformer and regulator heatsink, it is constructed entirely on a small printed circuit board and is mounted on the rear panel of the disk unit. Plug-in connectors are provided on the board for AC power input, the power transformer, the disk unit cooling fan, and a DC and AC output connector for each disk drive. Short cables carry the DC and AC output voltages from the output connectors to the disk drive power input connectors. Note that the power supply is designed to power the specific disk drive type used and therefore may not properly power an arbitrary substitute drive.

6.1 SPECIFICATIONS

Input voltage: 105-125 VAC or 210-250 VAC 50 or 60 Hz (jumper selected)

DC Outputs: +5 volts regulated at 1.2 amp
+5 volts regulated at 1.2 amp
+24 volts regulated at 1.2 amp.
+24 volts regulated at 1.2 amp.
(All outputs rated with all other outputs loaded to capacity.)

AC outputs: 115VAC unregulated, 15VA
115VAC unregulated, 30VA
115VAC unregulated, 30VA

6.2 PRINCIPLES OF OPERATION

The power supply is a minimum complexity, linear, series regulated design. A multi-winding line frequency power transformer provides low voltage AC which is rectified, filtered, and regulated in the conventional manner. External of the power supply board, the AC input power passes through a single fuse before entering the board through its input connector. Section 7.5 shows a schematic of the power supply printed circuit board.

The power transformer has two primary windings, each rated for 115 volts nominally. For 115V operation, jumpers are placed between points A and B, and between points C and D which connect the two primaries in parallel. For 230V operation, a single jumper is placed between points B and C which connect the primaries in series. Each of the 115V outputs is taken across a primary winding which will be directly across the line in 115V operation. In 230V operation, autoformer action maintains 115V at each output even if the loads are unbalanced. If only one disk drive is installed, it should use the Disk #1 AC output to minimize the load imbalance during 230V operation.

The transformer also has two secondary windings, one for each DC output voltage. The lower winding is center-tapped and in conjunction with diodes D1 and D2 forms a full wave center-tapped rectifier. The resulting +8V DC is filtered by C4 and C5 in parallel and regulated by VR1 and VR4 to provide two independent +5 volt regulated outputs. The upper winding in conjunction with diodes D3-D6 forms a full wave bridge rectifier that produces approximately +30 volts. Capacitors C1-C3 provide filtering. Note that C1-C3 are returned to the +8 potential on C4 and C5 rather than ground. This reduces the voltage accross C1-C3 and allows the use of 25 volt units. Regulators VR2 and VR3 provide two independent +24 volt regulated outputs. The 4 regulators are heatsinked by being mounted directly to the back panel of the disk unit. The power supply must not be operated under load unless the board is mounted in place on the back panel or the regulators are bolted to a substitute heatsink capable of dissipating 25 watts.

7.3

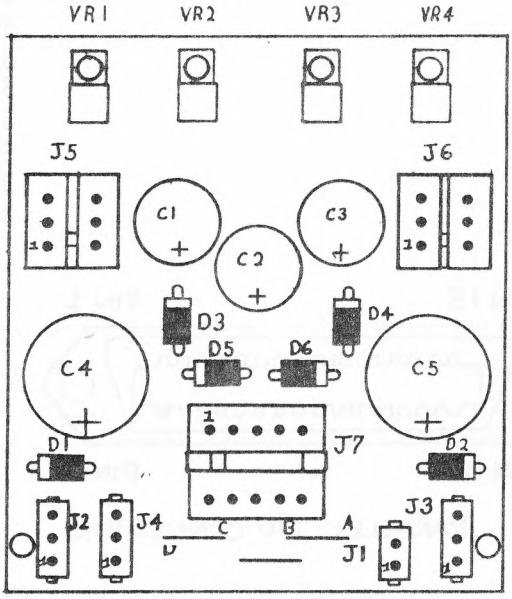
PARTS LIST

QTY	DESCRIPTION	DESIGNATION
6	DIODE,1N5401	D1-6
2	VOLT REG,LM340-T5	VR1,4
2	VOLT REG,LM340-T24	VR2,3
2	CAP,ELECT,16V. 4700UFD	C4,5
3	CAP,ELECT,25V. 2200UFD	C1-3
1	CONN,PC 2 PIN UML	J1
3	CONN,PC 3 PIN UML	J2-4
2	CONN,PC 6 PIN CML	J5,6
1	CONN,PC 10 PIN CML	J7

7.4

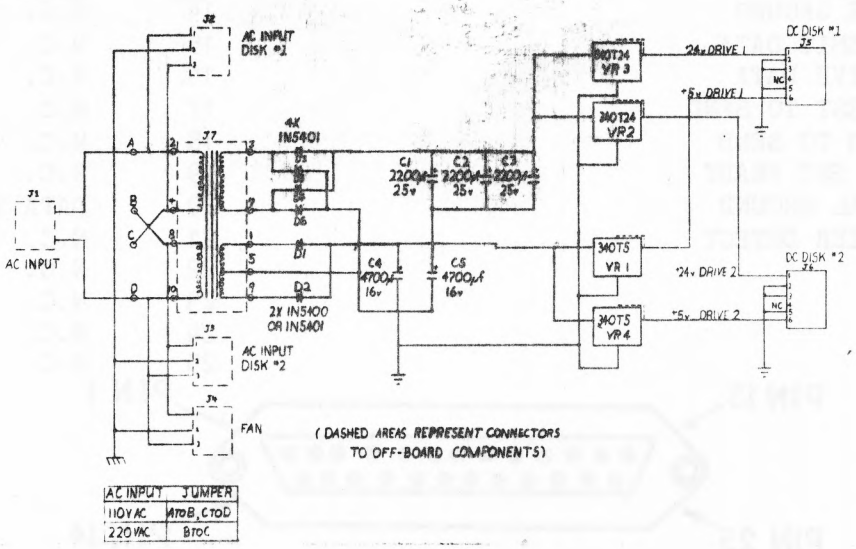
PARTS LAYOUT

(UNDER BOARD)



7.5

SCHEMATIC DIAGRAM

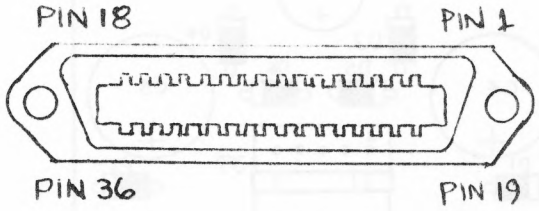


8. CONNECTOR PIN ASSIGNMENTS

8.1 KEYBOARD UNIT BACK PANEL CONNECTORS

8.1.1 Parallel Connector

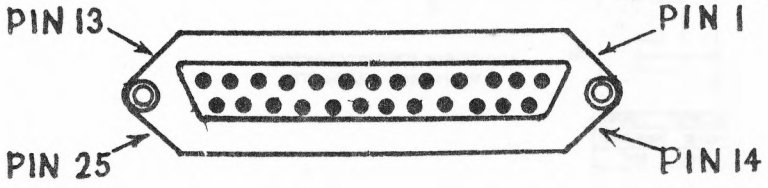
PIN	SIGNAL	PIN	SIGNAL
1	USER +5 VOLTS	19	USER GROUND
2	CB2 SOUND OFF (ground to suppress	20	USER +12 VOLTS
3	USER RESET CB2 sound)	21	USER -12 VOLTS
4	CA2	22	CA1
5	PA1	23	PA0
6	PA3	24	PA2
7	PA5	25	PA4
8	PA7	26	PA6
9	PB1	27	PB0
10	PB3	28	PB2
11	PB5	29	PB4
12	PB7	30	PB6
13	CB2	31	CB1
14	N.C.	32	N.C.
15	N.C.	33	N.C.
16	N.C.	34	N.C.
17	N.C.	35	N.C.
18	N.C.	36	N.C.



PARALLEL I/O CONNECTOR

8.1.2 Serial Connector

PIN	SIGNAL	PIN	SIGNAL
1	FRAME GROUND	14	N.C.
2	TRANSMIT DATA	15	N.C.
3	RECEIVE DATA	16	N.C.
4	REQUEST TO SEND	17	N.C.
5	CLEAR TO SEND	18	N.C.
6	DATA SET READY	19	N.C.
7	SIGNAL GROUND	20	DATA TERM. READY
8	CARRIER DETECT	21	N.C.
9	N.C.	22	N.C.
10	N.C.	23	N.C.
11	N.C.	24	N.C.
12	N.C.	25	N.C.
13	N.C.		

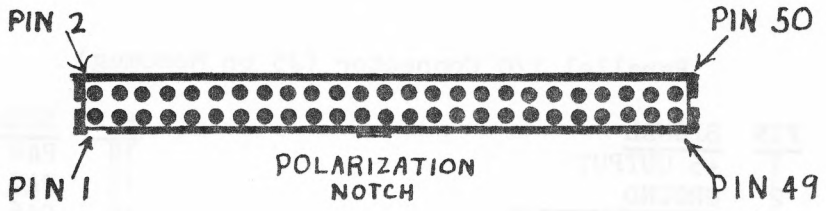


RS 232 CHASSIS CONNECTOR

8.1.3 Disk Unit Connector

PIN	SIGNAL	PIN	SIGNAL
2	LOW WRITE CURRENT	28	DRIVE SELECT 1
4	N.C.	30	DRIVE SELECT 2
6	N.C.	32	DRIVE SELECT 3
8	N.C.	34	STEP DIRECTION=IN
10	2-SIDED SENSE	36	STEP
12	N.C.	38	WRITE DATA
14	HEAD SELECT	40	WRITE ENABLE
16	N.C.	42	TRACK 0 SENSE
18	HEAD LOAD	44	WRITE PROTECT
20	INDEX	46	RAW READ DATA
22	READY	48	N.C.
24	N.C.	50	N.C.
26	DRIVE SELECT 0		

NOTE: All odd numbered pins are ground.



DISK UNIT CONNECTOR

8.1.4 External Speaker Jack

This jack accepts a miniature (1/8") phone plug. When the plug is inserted, the internal speaker is disconnected. The output signal is suitable for use with any 8 ohm or greater speaker or an external amplifier (use the AUX input). The volume control on the MTU-130 will have no effect when an external speaker or amplifier is used.

8.1.5 Video Output

This jack accepts a standard RCA phono plug and provides a 2V P-P video amplitude into a high impedance or 1V P-P into 75 ohms. Sync is negative and the signal is D-C coupled with an offset voltage of about +1.5 volts. Horizontal sync frequency is slightly higher than normal (16.13KHz) which may require horizontal hold adjustment on the monitor.

8.1.6 Cassette Output

This jack accepts a miniature (1/8") phone plug. The output amplitude is 1V rms and may be connected directly to the AUX input of a cassette recorder. The output impedance is 10K ohms. A microphone input may be used if a 100 ohm resistor is connected across the connecting cable to attenuate the signal.

8.1.7 Cassette Input

This jack accepts a miniature (1/8") phone plug. The input sensitivity is 1V rms protected to 25V rms. The input impedance is 18K at normal audio frequencies dropping to 2.2K at very high frequencies.

8.2 KEYBOARD UNIT INTERNAL CONNECTORS

8.2.1 Light Pen Connector (J7 on Monomeg)

PIN	SIGNAL
1	+12 VOLTS
2	LP SENSE
3	-key-
4	GROUND

8.2.2 Audio-Video Connector (J6 on Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	CASSETTE WRITE	6	VIDEO GROUND
2	CASSETTE READ	7	COMP. VIDEO OUTPUT
3	CASSETTE GROUND	8	-key-
4	SEP. HORIZ. SYNC	9	AUDIO GROUND
5	SEP. VERT. SYNC	10	AUDIO OUTPUT

8.2.3 Parallel I/O Connector (J5 on Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	+5 OUTPUT	14	PA4
2	GROUND	15	PA7
3	CB2 SOUND OFF	16	PA6
4	+12 OUTPUT	17	PB1
5	RESET	18	PB0
6	-12 OUTPUT	19	PB3
7	CA2	20	PB2
8	CA1	21	PB5
9	PA1	22	PB4
10	PA0	23	PB7
11	PA3	24	PB6
12	PA2	25	CB2
13	PA5	26	CB1

8.2.4 Serial I/O Connector (J4 on Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	CLEAR TO SEND	6	DATA TERMINAL READY
2	CARRIER DETECT	7	REQUEST TO SEND
3	DATA SET READY	8	-polarize-
4	RECEIVED DATA	9	N.C.
5	TRANSMITTED DATA	10	GROUND

8.2.5 Keyboard Connector (J3 on Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	+5	9	BREAK KEY
2	GROUND	10	ROW 2
3	N.C.	11	ROW 1
4	N.C.	12	ROW 4
5	SCAN CLEAR	13	ROW 3
6	INT KEY	14	ROW 6
7	SCAN CLOCK	15	ROW 5
8	MOD KEY	16	RESET KEY

8.2.6 MTU Tape Connector (J1 on Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	+5 VOLTS	8	WAFER IN PLACE (SYS2 PB5)
2	+12 VOLTS	9	WRITE PROTECT (SYS2 PB4)
3	-12 VOLTS	10	B.O.T. (SYS2 PB3)
4	GROUND	11	WRITE ENABLE (SYS2 PB2)
5	-polarize-	12	FAST (SYS2 PB1)
6	N.C.	13	GO (SYS2 PB0)
7	DATA (SYS2 CB2)	14	CLOCK (SYS2 CB1)

8.2.7 MTU Net Connector (J1 ON Monomeg)

PIN	SIGNAL	PIN	SIGNAL
1	+5 VOLTS	6	N.C.
2	-12 VOLTS	7	TALK (SYS2 PB6)
3	+12 VOLTS	8	NET ACTIVE (SYS2 CA1)
4	GROUND	9	DATA (SYS1 CB2)
5	-polarize-	10	CLOCK (SYS1 CB1)

8.2.8 Power Supply Connector

PIN	SIGNAL	PIN	SIGNAL
1	GROUND	6	-polarize-
2	GROUND	7	+8 UNREG
3	+5 REG	8	+12 REG
4	+5 REG	9	-12 REG
5	+16 UNREG	10	GROUND

8.2.9 Backplane Bus Connector

PIN	SIGNAL	PIN	SIGNAL
1	I/O SELECT	A	ADDRESS 0
2	ADDRESS 16	B	ADDRESS 1
3	ADDRESS 17	C	ADDRESS 2
4	IRQ	D	ADDRESS 3
5	SET OVERFLOW	E	ADDRESS 4
6	NMI	F	ADDRESS 5
7	RESET	H	ADDRESS 6
8	DATA BUS 7	J	ADDRESS 7
9	DATA BUS 6	K	ADDRESS 8
10	DATA BUS 5	L	ADDRESS 9
11	DATA BUS 4	M	ADDRESS 10
12	DATA BUS 3	N	ADDRESS 11
13	DATA BUS 2	P	ADDRESS 12
14	DATA BUS 1	R	ADDRESS 13
15	DATA BUS 0	S	ADDRESS 14
16	-12 VOLTS	T	ADDRESS 15
17	+12 VOLTS	U	PHASE 2
18	+8 VOLTS UNREGULATED	V	READ/WRITE
19	N.C.	W	READ/WRITE
20	N.C.	X	+16 VOLTS UNREGULATED
21	+5 VOLTS	Y	PHASE 2
22	GROUND	Z	RAM WRITE

8.3 DISK DRIVE CONNECTORS

8.3.1 Signal I/O Connector

PIN	SIGNAL	PIN	SIGNAL
2	LOW WRITE CURRENT	28	DRIVE SELECT 1
4	N.C.	30	DRIVE SELECT 2
6	N.C.	32	DRIVE SELECT 3
8	N.C.	34	STEP DIRECTION=IN
10	2-SIDED SENSE	36	STEP
12	N.C.	38	WRITE DATA
14	HEAD SELECT	40	WRITE ENABLE
16	N.C.	42	TRACK 0 SENSE
18	HEAD LOAD	44	WRITE PROTECT
20	INDEX	46	RAW READ DATA
22	READY	48	N.C.
24	N.C.	50	N.C.
26	DRIVE SELECT 0		

NOTE 1: All even numbered pins are ground.
NOTE 2: A keying slot is placed between pins 3-4 and 5-6.

8.3.2 Disk Drive DC Power Connector

PIN	SIGNAL
1	+24
2	+24 RETURN
3	-do not use-
4	-do not use-
5	+5
6	+5 RETURN