CONSTRUCTION OF MIDWEST ENGINEERING RAMDISK BOARD

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(Revision A)

CAUTION: Static Electricity can Damage Chips.
Be Sure to Take Adequate Precautions

Congratulations on your purchase of a new Midwest Ramdisk Board! Many hours have gone into perfecting a quality, easy to build memory card for your TI 99/4A Computer. We will attempt to make your efforts to construct the new board as easy as possible. In particular once you get started it is difficult to stop until it is completely finished! You will need the following tools: 1) A good volt ohmmeter, 2) a needlenose plyers, 3) a soldering iron (40 watts), and 4) good solder (please use good solder 60/40 mix, fine gauge). The solder is the important part because it has to flow in easily and leave a shiny appearance else you will have trouble with cold solder joints and "bridging".

Here are the instructions to build your card :

A) Put the IC Sockets on the Board (Figure 1)

Obtain 13 - 28 pin IC sockets, 2 - 24 pin sockets, 3 - 20 pin sockets, 7 -16 pin sockets and 1 - 14 pin socket. Put them in the board with the notch facing upward and solder them in. It usually works best to place a piece of rigid cardboard on top of the sockets and then flip the assembly over. Then remove the cardboard by sliding it away from underneath. As you solder the IC's be particularly careful not to bridge adjacent pins. The most common problems are inadvertent bridges of solder and missed solder. If you take care now you will save much time later!

B) Put the Capacitors on the Board (Figure 2)

Obtain 27 - .1 uf ceramic capacitors with .2 inch lead spacing. Insert them in C3, C4, C30-C34, and C10-C29. Insert a 1 uf to 4 uf capacitor in C1 so that the positive polarity end faces right if it has a polarity. This is the power reset cap. Now put 2 - 10 uf (or up to 220 uf) caps with their polarities facing right in C2 and C5 slots. Make sure they are pushed solidly down into the board (without breaking them) because they have a tendency to be used as "handles" when removing the board which can easily bend and break them. (Note: If using a lithium cell, C18 should be 220 uF @ 10 V. with polarity facing right.)

C) Put the Diodes In (See Figure 3)

Obtain 7-1N34A diodes (if building the 32K ram expansion) or 5-1N34A diodes (if not building the 32K ram expansion). For either board place diodes in slots CR4-CR7 and CR16 (where the lithium battery goes -- NOTE: If using nicad batteries insert a 51 ohm resistor in slot CR16 instead). For those building the 32K ram expansion place the diodes in slots CR17 and CR18 as well.

Obtain 1 - 1N4004 power diode and place it in CR8 slot. Place 3 - 1N914 diodes in slots CR3, CR9 and CR10 for either board. If building the 32K ram expansion place 3 - 1N914 diodes in slots

CR11 - CR13. BE VERY CAREFUL TO PLACE THE DIODES IN WITH THE CORRECT POLARITY (BLACK BAND OR WHITE BAND ON DIODE FACES THE SAME WAY AS THAT ON THE BOARD). If CR16 is placed in backwards the lithium battery will be charged and may degas. Do not put CR16 in backwards!

D) Put the Resistors in Place (See Figure 4)

First put in the resistor networks if you plan to use 74LS154 parts in the U2A and U2B slots. You need to get the 10 leaded kind that have a common terminal and nine resistors linking the common terminal to the outputs. The value can be 1K - 2.2K (2.2K ohm is preferred to save power). The white band or dot on the resistor network must be placed next to pin 1 shown on the board. Put 4 - 2.2K resistor networks in slots RN1-RN4. These replace the discrete resistors that used to go underneath a previously designed board marketed by another company. If you plan to use the 74HC154 types (High Speed CMOS) then the resistor networks are not needed. Instead you merely place one single 2.2K resistor from pin 1 to pin 5 of the RN3 slot (pin 1 is marked, pin 5 is just the fifth hole down in RN3, you'll see a trace going to U2B...).

Now for those using 74LS154 parts put a jumper and solder it in where +5VA jumper slot appears (upper left on board). Do not put a jumper in +5VB jumper slot. If you use the 74HC154 parts put the jumper in +5VB jumper slot but not in +5VA slot. This supplies power from either the battery or normal regulated supply to these parts. If you do it wrong the lithium battery or nicads will be depleted rapidly when you plug them in. For those building ONLY the single layer ram chip version boards (384K or less) resistor networks RN2 and RN3 are not needed but the 2.2K resistor from RN3 pin 1 to pin 5 must still be added. Also unnecessary in that circumstance is U2B the IC that feeds all the upper layer chips.

If you plan to build the 32K ram expansion then place 4 - 10K resistors in positions R14-R17 otherwise leave them blank. For all boards place 1 - 51 ohm in R2, 2 - 10K ohm in R5 and R20, 4 - 2.2K ohm in R21-R24, and 2.2K ohm resistors in R4, R6, R8, and R10. NOTE: Do not place any resistor in R7 - it is no longer used. If you plan on only having one LED for your ramdisk indicator (CR2 LED's) then the value of R2 should be increased to 100 ohms.

E) Insert the Transistors and LED's (See Figure 4)

Insert a 2N3904, 2N4401 or 2N2222 in the Q1 slot with the flat side facing downwards or facing you. Make sure the emitter is to the left, base in the middle and collector on the right if you use a nonstandard transistor. Put one LED in slot CR1 with the anode towards the bottom (the anode is the LONGEST LEAD) of the board. In all discussions the bottom of the board is where the gold contacts come out so that you can read the legends. Now you have an option. If you want a double bright indication when the ramdisk is on then place 2 LED's in the CR2 slots. The anodes of these two diodes face upward toward the top of the board (the longest leads). The cathode of the diode is the big fat pedestal when you look inside the LED. If you put these diodes in backwards you won't damage them but you won't get any light indications when you go to try the ramdisk. If you only plan to use a single diode

indicator then place a jumper in one of the two CR2 slots and change the resistor value of R20 as explained in the previous section.

F) Put in the Regulator, Switch and Jumpers (Figure 6)

Transistor Q2, the power regulator, is the same as before - a National or equivalent 7805 linear. It must have a heat sink and can be bolted down on the board with a 4-40 screw. A THM 6045 heat sink is adequate. Make absolutely certain the regulator goes in so that the writing on the device faces you (metal tab lays flat onto the heatsink. Every chip will be fried if you don't get that detail correct!

Put in the Dip Switch SW1. The number 1 on the switch should match the number 1 on the PC board. Place all switches in the "off" (non contacting) position except switch #1 which should be contacting (selecting CRU 1000). If all is done correctly you should see alot of parts inserted except the battery, R7, and, if you do not want the 32K expansion, some parts on the lower left side will be empty. Note that a jumper has been missed though! See that little one up near U20C pins 3 and 4...betcha missed that one!!! That little jumper is shorted (do it now) for all current configurations. It was previously an option that has been obsoleted by software changes.

G) Install the Integrated Circuits (See Figure 7)

Install one 6264LP-15 chip (8K static ram) in the socket U11. Do not insert any other ram chips at this time because it is critical that this chip works first. Install a 74LS245 in U23, two 74LS244's in U21-U22, an 74LS156 in U18, four 74LS138 chips in U20A-C and U19, two 74LS154 or 74HC154 (.6 inch spacing) chips in U2A-B, two type 74LS259 or 74HC259 chips in U9A-B and a 74LS86 in U24 if you are building the 32K ram expansion. Now that all the parts are in, clean away flux from the bottom of the board using flux cleaner or alcohol. If it leaves a sticky appearance you can use a toothbrush, toothpaste and water to clean the residue off.

H) Ohm the +5 Volt Supply and Visually Inspect the Board

Take your ohmmeter and see if there is a short to ground on either the +5VA line or +5VB line. It will normally flicker low ohms first and then high ohms as the capacitors charge up. Do not go on if the resistance reads less than 1000 ohms. Check the polarities of the diodes. Look for solder microshorts between the pads.

Now take out the lithium battery or 3 nicads and wire them in but DO NOT CONNECT them to +5VB. Instead put the meter in its lowest current range (100 ua or less) and see how much current is being taken by +5VB. You merely wire the meter in series. Does the current exceed 50 ua?? If so a problem exists. Most boards take only 25 ua or less with the board fully populated... There definitely is a problem if the current reads more than .5 ma. In that case check to see if R7 is out, if the resistor appears between pins 1 and 5 of RN3 (if you are using 74HC154 parts in U2A and U2B), if any microshorts exist, or if one of the resistor

networks is in backwards. It may also indicate one of the bypass capacitors is bad. This step is extremely critical -- do not go to the next step unless the +5VB current is very low.

OK now you can test the board. Insert the board into the P Box in the correct orientation with the power off. With the board securely snapped in (make a special check to make sure) power on the P Box very carefully. Does CR1 LED light up??? If not POWER DOWN THE P BOX IMMEDIATELY. Remove the card and see if the CR1 diode is in the correct direction. If so then troubleshoot that board since it indicates a radically wrong problem with the power supply chip Q2 or distribution circuits.

Load up the TESTER PROGRAM after checking what CRU address you have set your switch to (should be #1 on, others off). Select the U11 test. Does the light on the front flicker on and off? Does the test pass? If not then something is wrong with one of the small chips or diodes. You have to pass this test before you put any more memory chips in... Often times you may find a cold solder joint or even a missed solder connection... Just remember never pull that card (or any other card) out of the P Box without shutting down the power first if you check on something!

I) Load in the Memory Chips

If you are building a bigger ramdisk than 384K then you have to stack chips and pull pin 20 of each stacked memory chip outward to attach jumper wires to the pads next to U2A and U2B. You must wire the open pads by U2B first to the pin 20's of these chips as a flying connection. A 1 Megabit board uses all 32 possible connections (20 flying connections and 12 on the board). Ribbon cable is a very neat way of wiring these flying connections -- take some time to do it neatly as it directly affects the appearance of the board.

Load in TESTER PROGRAM again. Select the CRU base you desire and the correct option for how many chips you have. Remember if you do not build the full 1 Meg ramdisk you have to follow the building convention shown in the schematic -- the incremental correct order is shown from left to right on the schematic (i.e. U17, U8, U16, U7, etc.). If you put, say, U5 and U12 in but then skip U4 the Tester program will never see it because it was expecting to see U5, U13, U4, and U12 in that order!

J) Building the 32K Ram Expansion

Now that your ramdisk is working properly you have an excellent opportunity to further enhance its capabilities and save a few bucks in the process. You see with just two extra chips and a few discrete parts you can replace all the functions of the old 32K memory board!! Heres how...

First if you have not already done so insert all the parts around U24 as we had described earlier and insert a 74LS86 chip in U24 slot. Look to the immediate left of U24, you will seen seven feedthru holes number 1 to 7 from top to bottom. Similarly look to the right of U24 - you see four feedthru holes... number them as

holes 8 to 11 from top to bottom. Now examine U20A. On the left side you see one feedthru hole labeled "A" and three to the right labeled as "B", "C", and "D".

Remove the 8K chip (6264LP-15) from the U11 slot. Prepare a a piggyback chip such that the 8K is on the bottom and the 32K chip (62256LP-12) is on the top. Before soldering carefully bend out the following pins on the 32K chip - 1, 20, 22, 26 and 28. Do not bend any pins on the 8K chip. Solder the two chips together...make sure no two adjacent pins are soldered together.

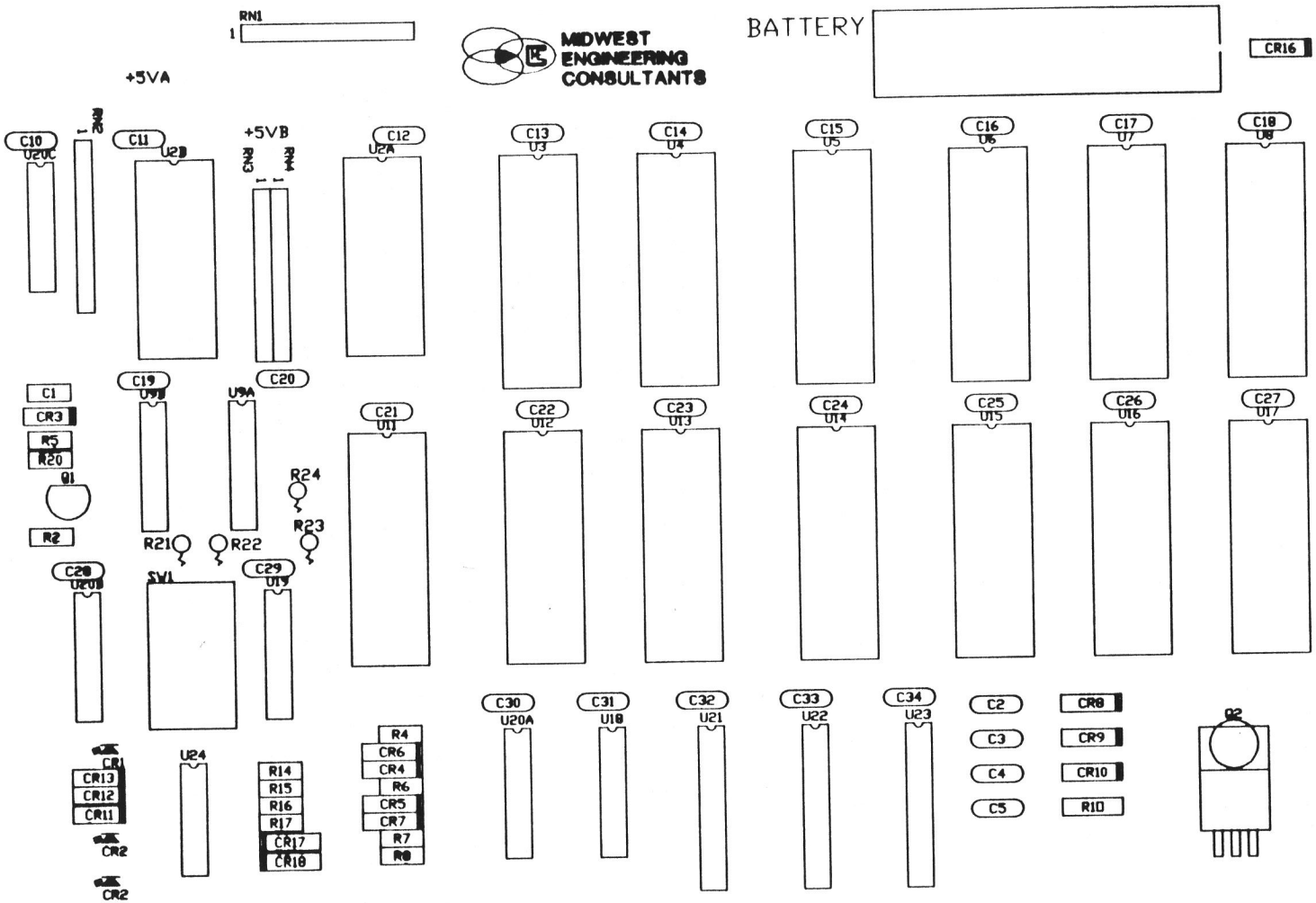
Now follow the interconnection diagram shown below. Checkoff each step very carefully:

(checkoff)	32K Interconnection Diagram
_____	AA) Hole 2 to Hole 3
_____	BB) Hole 1 to Hole A
_____	CC) Hole 2 to Hole B (double connection point)
_____	DD) Hole 4 to Hole C
_____	EE) Hole 5 to Hole D
_____	FF) Hole 9 to U11B (62256LP-12) pin 1
_____	GG) U11B pin 20 to U11B pin 22
_____	HH) Hole 10 to U11B pin 26
_____	II) Hole 11 to U11B pin 20 (double connection)
_____	JJ) U11B pin 28 to +5v (right side of capacitor C20 -- do not jumper to Battery +5v!!)

To test your new 32K, first remove the old 32K card, and then use the SBUG6 or other DEBUG utility to test the 32K. You must use something obviously that does not use the 32K -- this is where the SuperCart comes in very handy because it loads your debugger into ram at >6000. Anyway use the move command ("N") to move lower rom locations into ram. Then use the verify command ("P") to check that all bits are correct. For instance let us assume I want to check out locations >2000 to >3FFF. I first use the move command to get lower rom into ram >N0000,2000,2000. Then I use the P command to check it >P0000,2000,2000. There should be no errors. Similarly check location from >A000 TO >BFFF, >C000 TO >DFFF, and >E000 to >FFFF. If that is successful then load in any assembly language program -- if it crashes then there still is a wiring problem.

This completes the construction sequence.

Midwest Engineering Consultants
203 Arcadia Drive
Vernon Hills, Illinois 60061



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CHK BY:	DATE: 3-8-88	
APVD:	REV A	# OF SHTS:

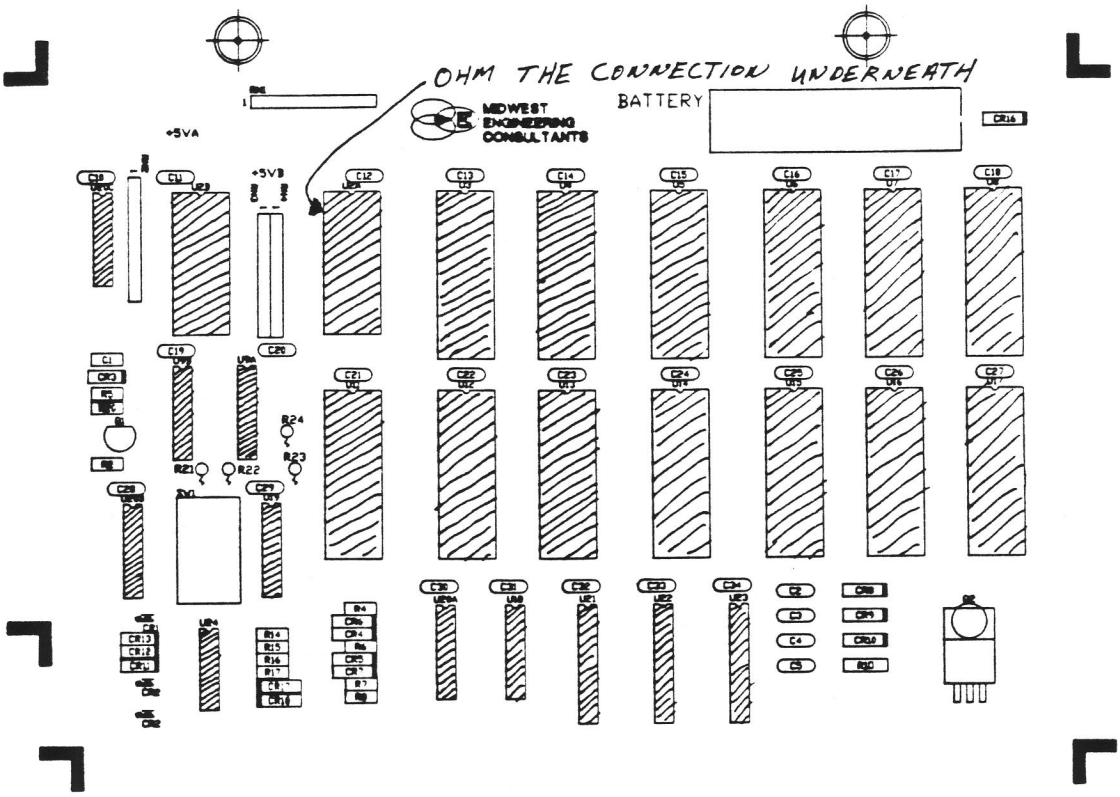

Fig. 1
Sockets

MIDWEST ENGINEERING
CONSULTANTS VERNON HILLS ILLINOIS
TITLE LEGEND-1MMEMORY
DWN BY: TJW SCALE 2=1 DWG #
CHK BY: DATE 3-8-88
APVD REV A

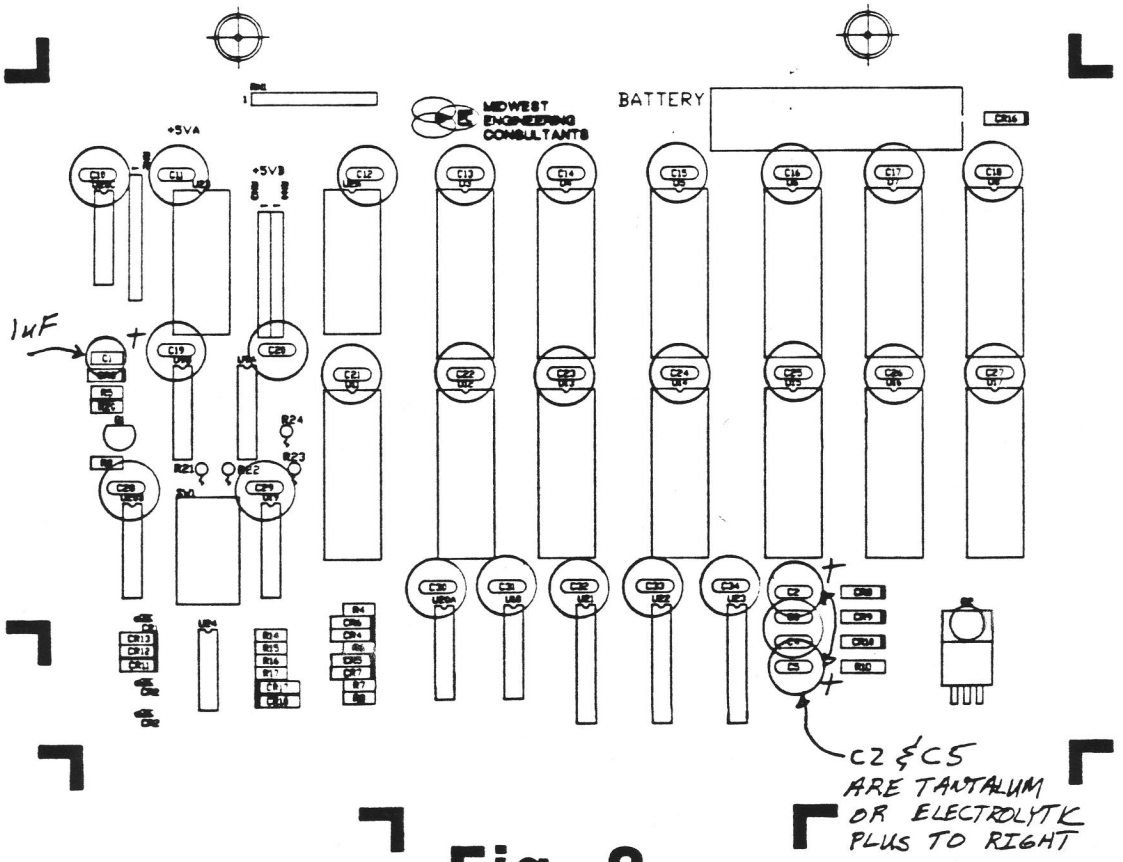

Fig. 2
Caps

MIDWEST ENGINEERING
CONSULTANTS VERNON HILLS ILLINOIS
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CHK BY: DATE 3-8-88
APVD REV A

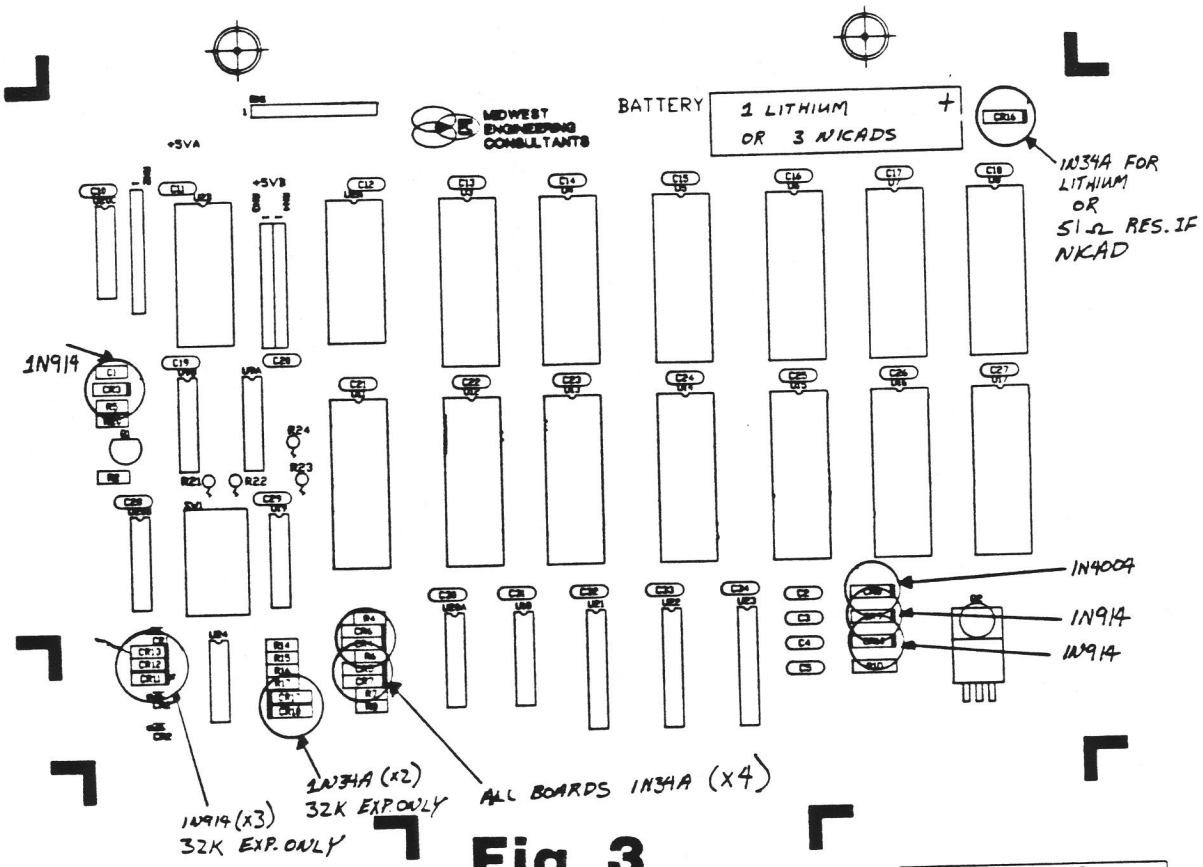

Fig. 3 Diodes

MIDWEST ENGINEERING CONSULTANTS VERNON HILLS ILLINOIS
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CHK BY: DATE: 3-8-84
APVD REV A

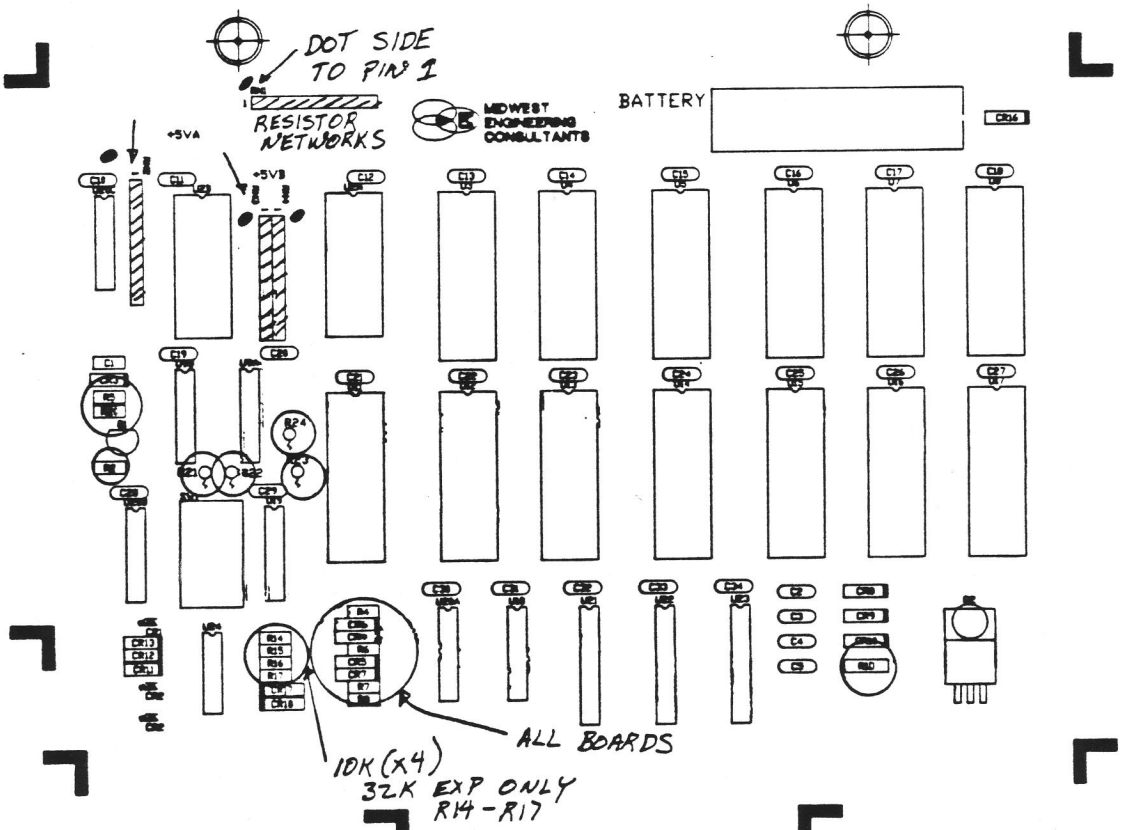

Fig. 4 Res.

MIDWEST ENGINEERING CONSULTANTS VERNON HILLS ILLINOIS
TITLE LEGEND-1MMEMORY
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CHK BY: DATE: 3-8-84
APVD REV A

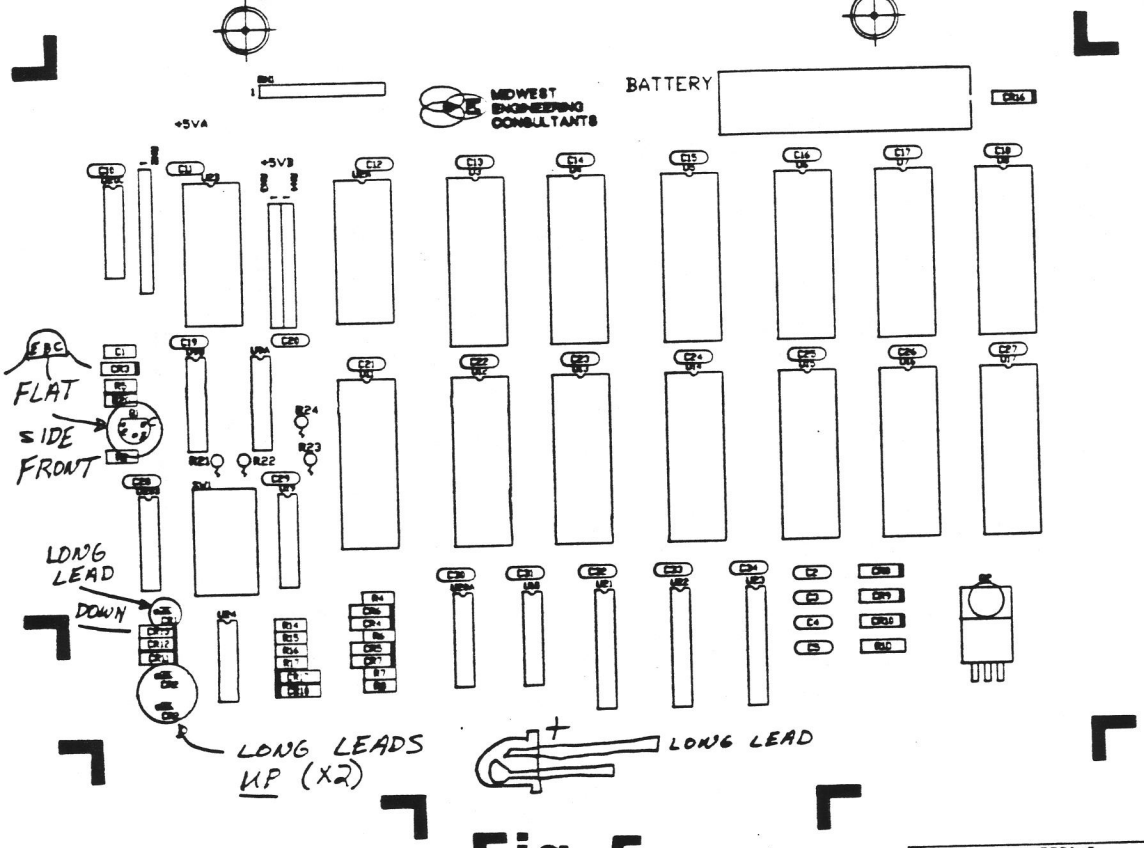

Fig. 5
L.E.D.'s

MIDWEST ENGINEERING CONSULTANTS VERNON HILLS ILLINOIS
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CHK BY | DATE 3-8-88
APVD | REV A

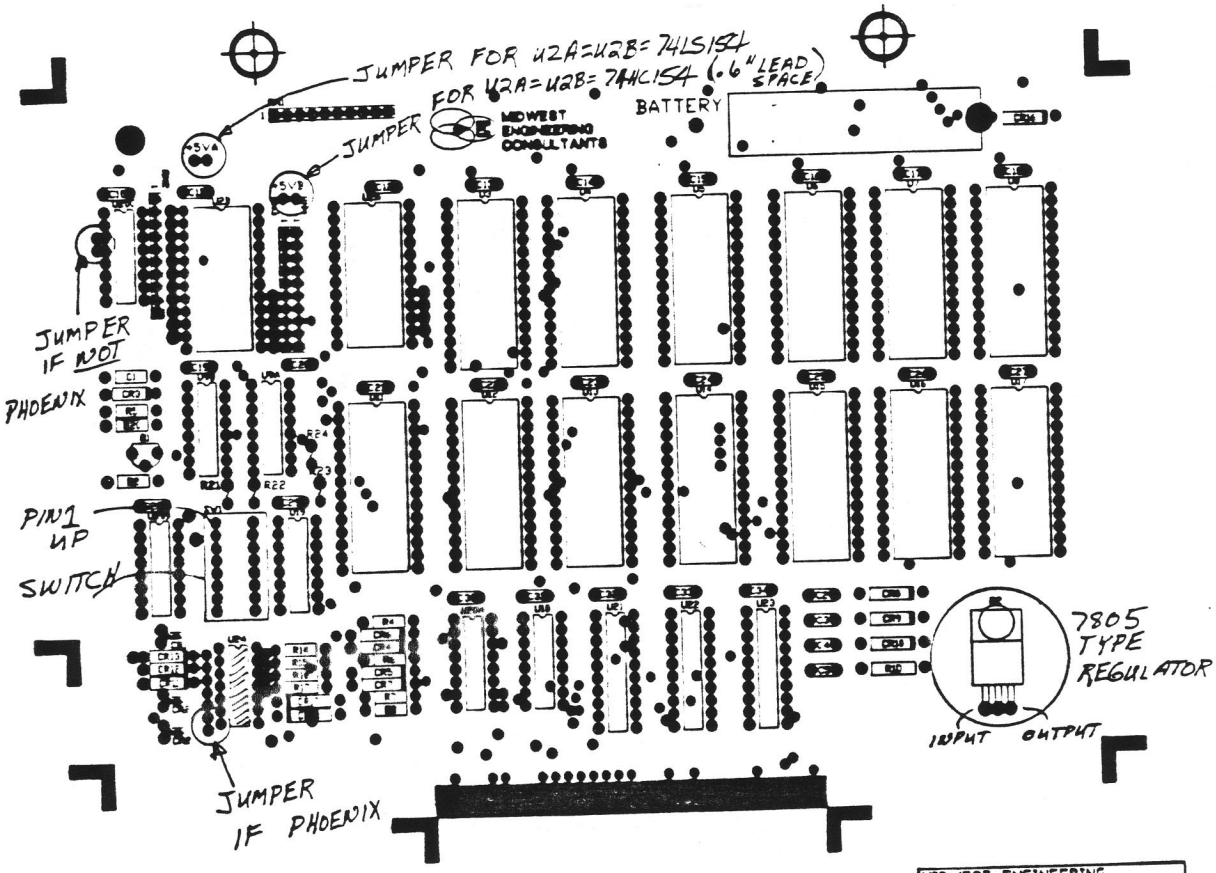

Fig. 6
Jumpers

CAUTION: YOU HAVE TO GET .6" LEAD SPACE 74HC154 PARTS NOT .3" LEAD SPACE

MIDWEST ENGINEERING CONSULTANTS VERNON HILLS ILLINOIS
TITLE SPEEDERMASTER-1mMEMORY
DWN BY TJW | SCALE 2=1 | DWG #
CHK BY | DATE 3-8-88
APVD | REV A

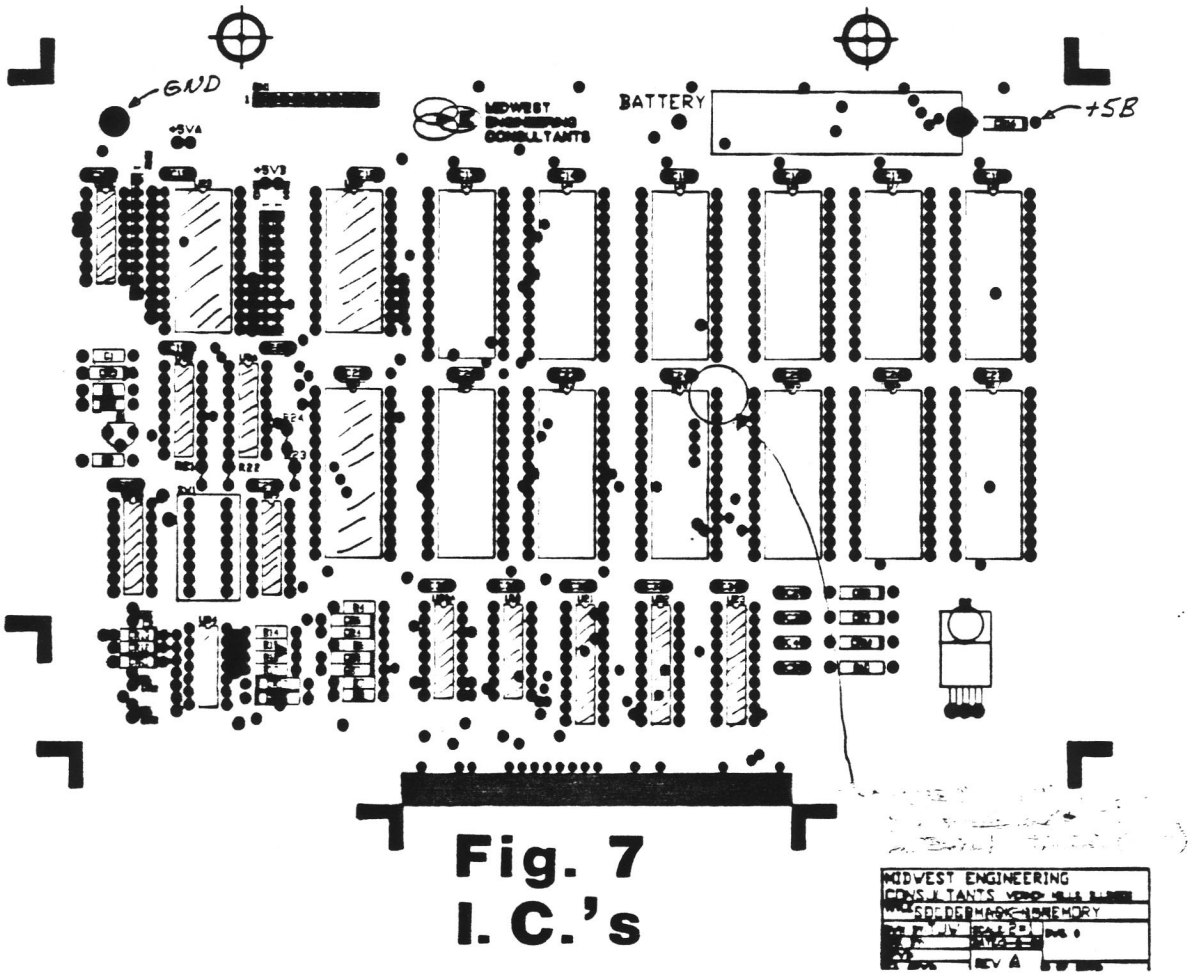

Fig. 7
I. C.'s

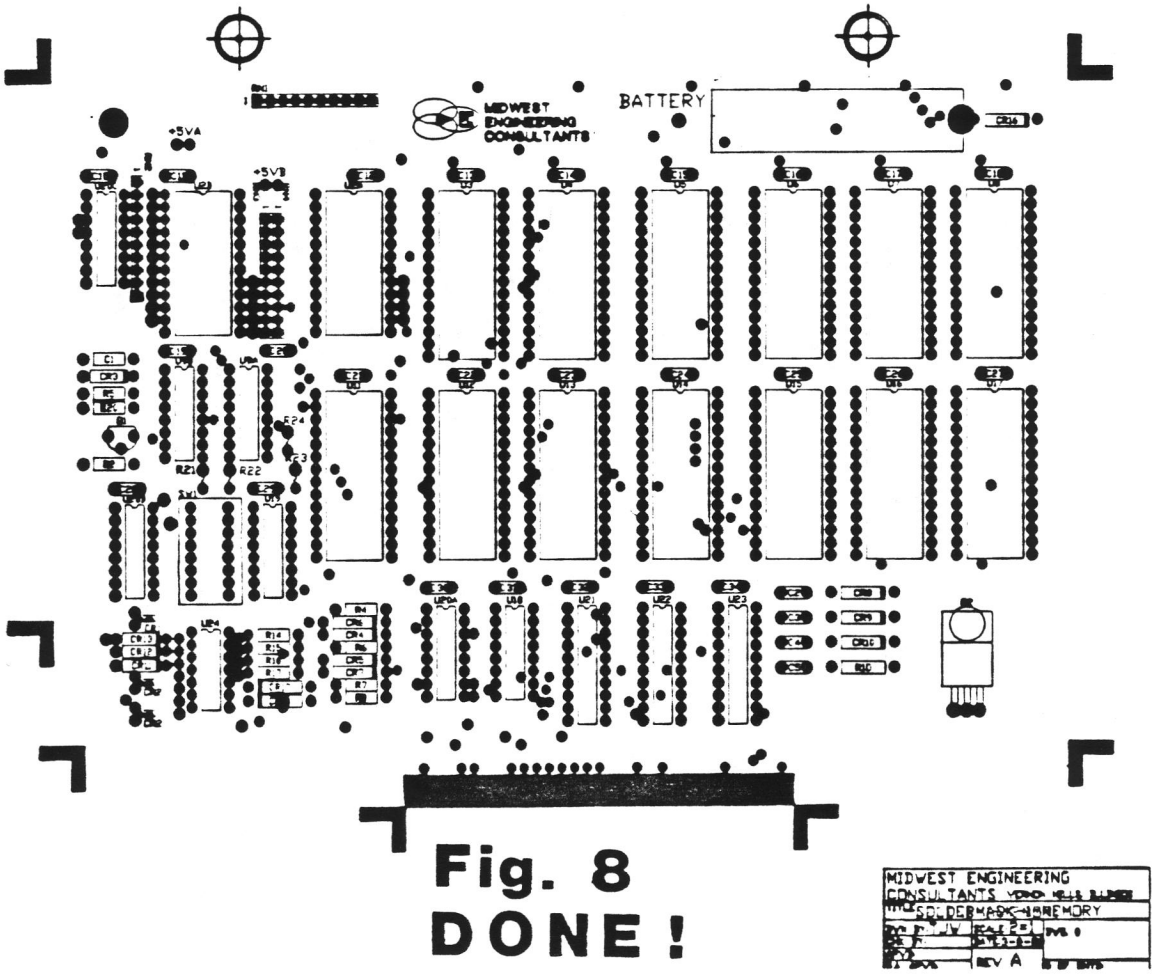

Fig. 8
DONE!

BUILDING AND TESTING 32K EXPANSION AND PARTS LIST

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This list contains information that applies both to the normal TI ramdisks and to those with a 32K Ram addition. Your ramdisk is easily expandable to include the 32K and with the advent of modern faster ramdisk chips will increase the speed of the computer and saves you a card slot! Your Chicago Ramdisk exclusively has trace positions available and circuitry on the PC board for adding the 32K memory. It uses the same chips that the ramdisk memory uses --- one 32K chip replaces a whole board on the old TI 99/4A. Such static ram chips were not available when the TI 99/4A was first introduced. If you have followed the instructions carefully the paragraphs below will explain how to test your 32K memory.

To test the 32K expansion use the supplied "SBUG" utility. It is easiest to use a Supercart to test the 32K and load the "SBUG6" utility. Since SBUG is loaded into the 8K of the Supercart it cannot be affected if something was wired incorrectly on the 32K. As a simple example in order to access 32K memory merely use the M2000, MA000, MC000, ME000 commands to reveal the first memory position in each 8K block. For instance if I want to see if Memory location >2000 works I type M2000 then it shows me what is in there. I then type (on the same line) say >AAAA. If I then do a >M2000 again I should see >AAAA. You can also dump memory locations using the D command to your printer. SBUG is a very powerful freeware utility. The full manual to SBUG can be purchased from Edgar Dohmann, Rt. 5, Box 84, Alvin TX 77511 as a FAIRWARE utility. SBUG also can test the entire ramdisk with ease as you will see!

Here is the exact sequence I use to test the 32K Ram Expansion. Load "DSK1.SBUG6" into the Supercart. It asks if you want Bitmap Screen and you type "N" for no. It asks you for the list device...since I have a parallel printer Gemini SG-10 I type... "PIO.LF". A period (.) appears. I type N 0000,2000,2000 to move 2000 bytes of ROM based memory into the low mem (>2000->3FFF) of the 32K. Then I type P 0000,2000,2000 to check if the memory is EXACTLY the same. (P means "Compare"). If ANY locations come up as not EXACTLY the same then I have a BAD MEMORY. You will see the bad memory as a display of something like this... 0000=83 2000=A0. This means memory location 2000 had a different byte than memory location 0000. Similarly let's test the WHOLE Hi Mem block of memory locations using "N" and "P". Type "N 0000,A000,6000" and "P 0000,A000,6000". If any memory locations show up as different check your wiring on the 32K carefully again! Please get the whole manual from Edgar as it is full of useful information!

PARTS LIST INFORMATION

This list is to serve as an aid to the kit builder in determining if sufficient parts are included in the kit. We have made every effort to assure your kit is complete but it is always possible a part can fall out or be broken during construction.

PARTS LIST FOR MIDWEST RAMDISK
(excluding capacitors and single resistors)

DESCRIPTION	QUANTITY	DESIGNATOR	DESCRIPTION
	Integrated Circuit Chips		
74LS154	2	U2A,U2B	MULTIPLEXER
74LS156	1	U18	1 OF 4 DECODER
74LS244	2	U21,U22	OCTAL BUFFER
74LS245	1	U23	OCTAL BUS XCVR
74LS138	4	U19,U20AB U20BC,U20C	1 OF 8 DECODER
74LS259	2	U9A,U9B	8 BIT ADD. LATCH
74LS00 OR 74LS86	1	U24 (U9C)	(32k) OR (MMRE)
MEMORY-6264LP15	1	U11	ROS MEMORY

(IF BUILDING 32K, A 62256LP-12 IS PIGGYBACKED ON TOP) MEMORY

MEMORY-62256LP15 ? U3-U17 EXCEPT U11 RAMDISK MEMORY (SIZE/32K=CHIPS)
(To figure how many Chips you need approximately divide the number of Sectors you want by 130. If I want 1000 sectors I need about 8 chips, if I want 4000 sectors I need about 32 memory chips)

Other Piece parts

Board	1	MIDWEST RAMDISK	
Batteries	1 or 3	n/a	lithium or nicads (AA CELLS)

(note CR16 is a germanium diode if using lithium batteries or is a 51 ohm resistor if using nicads)

SOCKETS	12-28pin,	1 or 2-24 pin, 7-16pin, 1-14pin, 3-20pin	
RESISTOR NETWORKS	4	RN1-RN4	2.2K 9 elements, COMMON CATHODE
(or)	2	RN1 & RN4	2.2K (FOR RAMDISKS <384k)
2N3904	1	T1	TRANSISTOR
1N914	3 OR 6	CR9-CR13,CR3	DIODES
1N4001	1	CR8	POWER DIODE
7805CT	1	Q2	POWER REGULATOR
SWITCH	1	SW1	8 POS DIP SWITCH
RED DIODES	3	CR1,CR2 (2)	LIGHT EMITTING DIODES
LARGE CAPS	3	C18,C2,C5	220 UF ELECTROLYTICS (OR TANT.)
GERMANIUM DIODES	5 OR 7	CR4-CR7,CR16,CR17-CR18	(1N34A TYPES)

WIRE JUMPERS AT U20C PIN 3 AND 4
WIRE JUMPER +5VA IF USING 74LS154 TYPES OR +5VB IF USING 74HC154 TYPES. DO NOT USE RESISTOR NETWORKS RN1-RN4 IF USING 74HC154 TYPES INSTEAD WIRE A 2.2K RESISTOR BETWEEN RN3 PIN 1 AND PIN 5.
IF ONLY BUILDING A RAMDISK LESS THAN 384k THEN IC U2B IS NOT NEEDED AND RESISTOR NETWORKS RN3 AND RN4 ARE NOT NEEDED.
DO NOT USE RESISTOR R7, LEAVE BLANK.
USE R14-R17, CR11-CR13, CR17-CR18 IF BUILDING 32K ELSE LEAVE BLANK.
REFER TO DETAIL DRAWING ON REVERSE SIDE OR SCHEMATIC.

32K RAM EXPANSION DETAIL DRAWING

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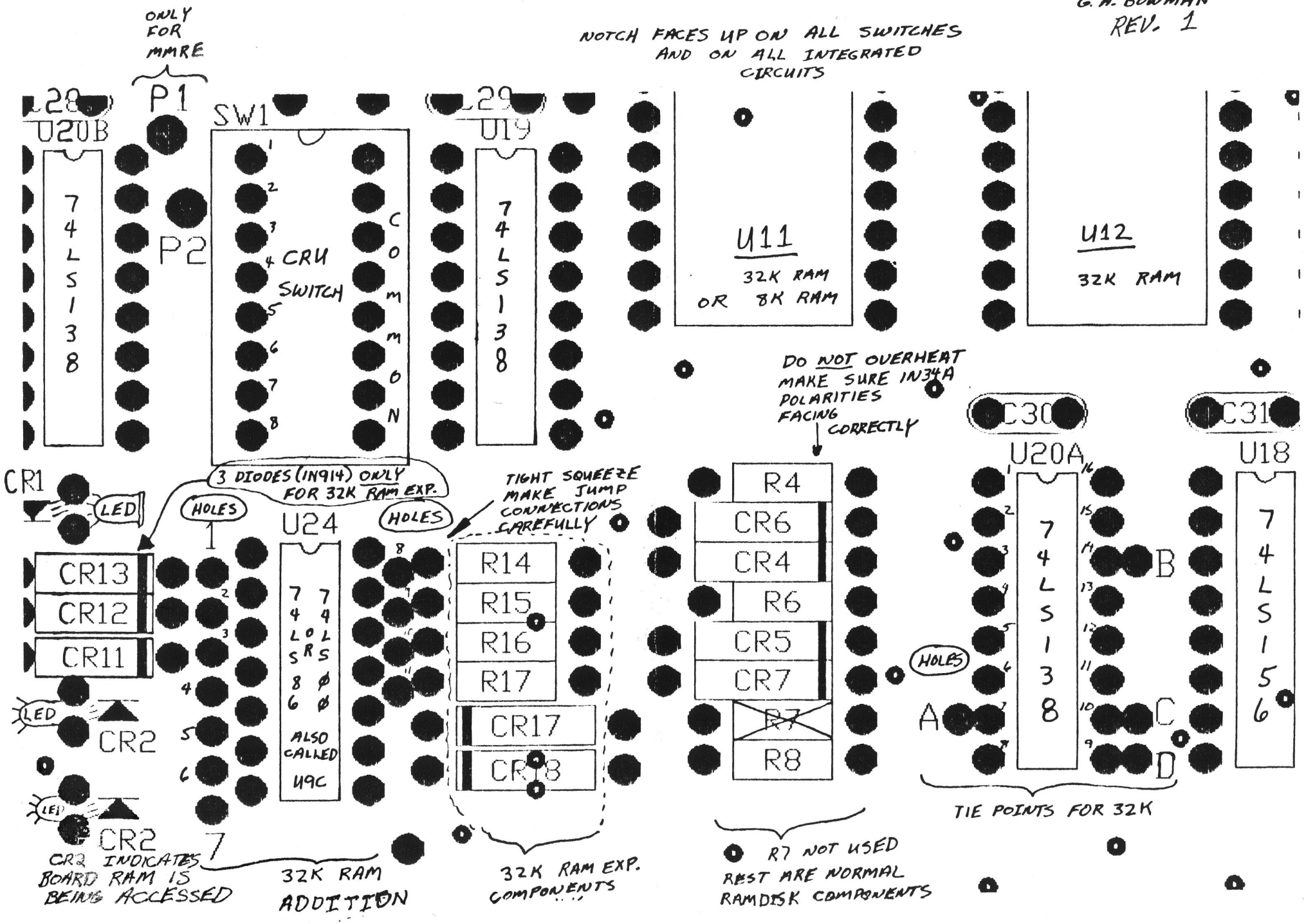
G. A. BOWMAN
REV. 1

NOTCH FACES UP ON ALL SWITCHES AND ON ALL INTEGRATED CIRCUITS