THE EXPANDER

INSTALLATION GUIDE

AND

TECHNICAL DESCRIPTION

Manu-Tronics, Inc.
9115 - 26th Avenue
Kenosha, WI 53140
(414) 694-7700

TABLE OF CONTENTS

========================

EXPANDER SPECIFICATIONS

========================

EXPANDER	Dimensions: 17.5 " wide 4.5 " high 16.75" deep Shipping Weight: 32 lbs.
Power Requirements	115 VAC, 200 W maximum
Display	24 X 80 characters in black/white; 24 X 40, color mode.
Graphics	72 X 160 in black & white; 72 X 80 in color.
Video	RS-170 composite sync (negative sync); NTSC color
Memory	64K of RAM: 65,536 8-bit bytes on S-100 card.
CPU	Z80A (3.58 MHz)
I/O Ports	One serial RS-232C with 25-pin DB25 connector; 300 and 1200 bps baud rates. One parallel port: Centronics style printer compatible. 8 bits inport, 8-bits outport with handshaking.
Expansions	Internal IEEE-696 standard bus (S-100) for expansion of memory or other peripheral functions. Internal ME-50 bus for expansion of memory and peripheral functions (except DMA Masters).

CHAPTER ONE.

UNPACKING AND INITIAL SET-UP

Congratulations. You are now the owner of an Expander(tm) computer. You have one carton containing an Expander and a power supply. You will also need: a video monitor and a cassette recorder, floppy disk(s) or hard disk. For list of compatible peripherals, see Appendix I.

1. Unpacking the Expander.

The Expander comes in two sections packed inside one carton. The computer is on top, and the power supply is in a separate box on the bottom.

a. Open the outside carton and lift out the Expander. Put it on a table or desk which has enough clear area for you to work. To ensure proper ventilation, leave at least eight inches of space between the right side of the computer and the nearest solid object.

b. After lifting out the Expander, grasp the inner cardboard shelf on which the Expander was sitting and pull up. This may take a bit of wiggling. Open the bottom carton and lift out the power supply and its cord.

N.B.: Save all packing materials and cartons, for future storage or in case you ever need to ship your Expander computer and power supply.

2. Connecting the Power Supply.

With the power supply switch is in the "Off" position, plug power supply cord into the "Power" connector on the rear panel.

The power cable both plugs in and locks on the back of the computer. To lock it in, depress the left silver tab to the side of the connector until you hear a click. You can see the operation of the lock on the cord by looking at it straight on. Note that when the lock is in the "open" position, the holes on either side of the cord holder are lined up so that they fit over the pins on either side of the connector. When locked, the metal clips click into place over the pins, holding the cord securely in place. Pressing the red painted end of each locking clip will unlock the power cable from the Expander.

3. Attaching the Video Monitor.

Connect the video monitor to the back of the Expander using a coaxial cable with an "RCA phono" plug connector. The video monitor can be any standard 60 Hertz /525 line monitor. Use a 75 Ohm coax cable (preferably), and check to see that the monitor has a 75 Ohm termination. The Expander generates RS-170 compatible video.

After you have attached the monitor, turn on the computer at the power supply. Also turn on the video monitor if it has a separate "ON" switch, and adjust brightness and contrast on the monitor if necessary.

4. Your Living Expander.

The Expander should now exhibit signs of life by displaying a Dot prompt and block cursor at the extreme upper left edge of the screen. Test this by pushing the red "RESET" button at the back of the computer. The Reset button must be pressed firmly until it clicks.

If there are no signs of life, move the TV, open the Expander by removing the five chrome screws (two on each side and one at the rear), lift off the plastic cover, and check to see if the memory card is firmly inserted into its connector at the S100 card cage at the rear of the computer. There should be a gap of less than 1/16 inch between the card edge and the Expander chassis. (See also "INSIDE the Expander" in Chapter II.1). Replace cover, after you have checked the power supply and video cable connections.

If the fan in the computer is not running, the computer is not getting any power. In this case, the circuit breaker on the back of the power supply should be checked. If the circuit breaker has been activated, the button in the middle of the circuit breaker knob will be sticking out. You can reset the circuit breaker by pushing the button back in.

If you do have a dot prompt and cursor, you can now use the Monitor routines (see Chapter III: Monitor Routines) which are automatically available when the Expander is powered up. To use additional software, you will need to install floppy disk(s) or hard disk.

CHAPTER TWO.

INSTALLING TAPE CASSETTE, FLOPPY DISKS OR HARD DISK

1. INSIDE the Expander.

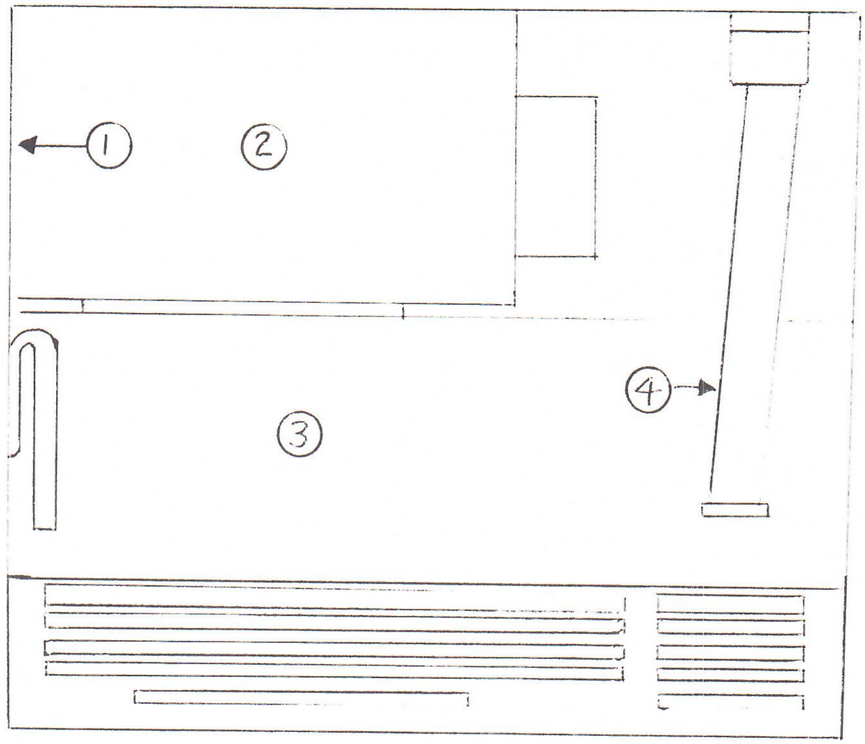
To install a floppy disk or hard disk, and in any case just to get to know your computer better, you will need to open the Expander up and look inside.

a. Opening the Expander.

First, power down by turning off the power supply.

Next, remove the five screws in the cover and carefully lift it off. The plastic cover is flexible and can be eased off without catching on the keyboard or anything else inside.

Here's what you're looking at:



(1) S100 card cage, with four slots.

(2) The memory board (64K) is in one of the bottom slots.

(3) Main PC board, with Z-80A chip in center, speaker to right, and ME-50 bus expansion connector to left. If you are a U.S.A. user of the Expander, you will see the character generator ROM circuit labeled "U.S. Font" just right of center of the board.

(4) Other features.

The parallel port cable is attached to the computer at the far right foreground, and is attached at its other end to the slot labeled "PARALLEL DATA" in the rear panel of the computer. The parallel port can be used to attach a Centronics-type printer or other printer (see Chapter IV: Printer Installation).

2. Installing Floppy Disk or Hard Disk Controller.

Set your floppy disk or hard disk close to the Expander. Your S-100 bus floppy or hard disk comes with a disk controller card which is of the same dimensions as the Expander's memory card.

The disk controller card can be installed in any of the four slots in the S-100 card cage. A convenient arrangement is to have the memory card or cards on the bottom and the disk controller card in one of the top slots.

To install a disk controller card, first make sure that the floppy disk or hard disk is not turned on. At this point, it is not necessary even to plug it in. The Expander must also be turned off if you have not done this already. NEVER install or remove S-100 or ME-50 bus cards with the power on.

With the component side up, hold the metallized edge of the disk controller card toward you as you are facing the keyboard.

Line the card up with the side card guides, keeping it level. Then carefully insert the card into (not on top of) the slots in the side card guides and move the card into the S100 bus connector slot. Keep pushing firmly until the gold edge contacts are no longer visible. Check to make sure the card has been pushed in evenly.

You can now attach the ribbon cable to the disk controller card (if it is not already attached). Be sure to check that pin 1 of the cable matches pin 1 of the card connector. The pin 1 end of the disk cable connector may be indicated on a gray ribbon cable by one red edge. The pin 1 position may also be indicated on the cable connector itself by a small triangle or other distinctive mark.

Now that the disk controller card has been installed and the cable connects the floppy or hard disk to the Expander, you can plug in the floppy or hard disk. (Don't turn it on yet).

To test function of the disk, turn on the Expander and the video monitor. Then turn on the disk and attempt to boot it up with one of the following letters :

M = if you are using Micropolis floppy disks

N = if you are using North Star floppy disks

J (address) of your ROM boot code = Hard disk.

If the disk boots successfully, you will see an appropriate prompt on the video screen. Owners of CP/M licenses will boot directly into CP/M, which displays the

A>

prompt on the video screen.

3. <u>What to Do If Disk Fails to Boot</u>

If nothing happens, turn off the disk, then the computer, and check the card and cable connections. Then power up again in proper sequence.

4. Proper Sequence for Powering Up and Powering Down Computer and Disk Drive(s).

Turning the computer on or off while the disk is running may damage the disk drive or cause you to lose some data. There are slightly different protocols for floppy disks and hard disks.

Floppy Disks

Turn the computer on before you turn on the floppy disk drive(s) if computer and disk drives are on separate circuits. Never leave diskettes in the drives when powering up or down.

Hard Disk

With a hard disk, the computer should be kept running until the disk is off, if they are on separate circuits. Always turn the computer on before you turn the disk drive on; and turn the disk drive off before you turn the computer off.

For extra safety when powering down a hard disk, you can create a special dummy text file called, for example, "LANDING.PAD". Before powering down use the command "TYPE LANDING.PAD", then type Control-S to stop the display of the file in the middle. Now power down. This dummy text file should fill one entire track, namely about 8K bytes. Using the dummy file assures that no valuable data will be affected during the powering down process.

5. Attaching Tape Recorder.

Plug tape cassette recorder into the Phillips standard connector in the Expander's rear panel. Turn on computer and recorder, and use monitor routines (see below) to load and run.

CHAPTER THREE.

EXP MONITOR ROUTINES

The EXP Monitor program is permanently installed in the Expander; and can be run as soon as the computer powers on. These Monitor routines and commands can be used for testing software or diagnosing hardware, or to change the characteristics of the system to suit different applications.

1. DUMP:

   D <addr1> [<addr2>]

   Display memory from <addr1> to <addr2> (if present).

2. ENTER:

   ```
   E <addr>
     <data list(s)>
     <blank line>
   ```

   Enter into memory starting at <addr>. <data list(s)> are zero or more lines of data to write to memory. A line of data cannot extend past column 64 of the display, i.e. data entered in columns 65 to 80 will be ignored. Lines of data consist either of hexadecimal numbers optionaly followed by a colon. If a colon is seen at the end of a value, the value is interpreted as the new address for the location counter.

   To exit the enter command, carriage return must be entered at the start of a new line.

3. JUMP:

   J <addr>

   Begin execution at <addr>. This is accomplished as though it were a CALL and if the stack is not trashed the execution of a RETurn (or equivalent) instruction will reenter the monitor.

4. TERMINAL:

T

This command causes the monitor to act as a rather dumb terminal to the host connected to the serial port. The only baud rate available is 300 bits per second, full duplex.

NOTE: Terminal mode uses these status/control bits differently, depending on whether the RS-232 Port shorting plug is placed in H1 (Expander looks like a terminal to RS-232 world) or in H2 (Expander looks like a modem to RS-232). H1 & H2 are on the Regulator PCB assembly near J4.

If the Expander is acting as a terminal, with the plug in H1, the following pin-out is applicable for hooking in a modem:

Expander RS-232 connector Pin Number	Signal Name	Modem Pin Number
1	Chassis Ground	1
2	T D	2
3	R D	3
6	D S R	6
7	Signal Ground	7
20	D T R	20

RS-232 status/control signals on J4 are as shown:

	EIA control out	EIA status input
Term config.	DTR (pin 20)	DSR
Modem config.	DSR (pin 6)	DTR

5. Boot Commands for Floppy Disks

NORTHSTAR BOOT: N

This command transfers control to location 0E800(hex).

MICROPOLIS BOOT: M

This command transfers control to location 0EC00(hex).

REMEMBER: if there isn't a Micropolis or North Star controller there, the system will probably crash.

6. Cassette Commands.

SAVE:

S <file_name> <start_addr> <end_addr>

This command saves a file onto cassette tape. The file is given the name <file_name>: only the first six characters are significant and lower and upper case is equivalent. The data written to the file are those bytes from <start_addr> to <end_addr> inclusive.

The format of the file is a 13 bytes header followed by its checksum and then (<end_addr> - <start_addr> + 1) bytes of data followed by a checksum.

The format of the header is as follows:

6 bytes of name, left justified, null padded
1 null
start address (2 bytes - low byte first)
byte count (2 bytes - low byte first)
2 bytes of spare

Pressing the escape key will stop the save but the file will not be valid and you should not try to load it.

NOTE: The cassette circuitry is designed around the Radio Shack model CTR-80A Cassette Recorder.

LOAD:

L [<files_name> [<load_addr>]]

Load a file into memory. If <file_name> is present, search for and load this file and if <load_addr> is present, use this value as the load address (not the address in the header). Pressing escape aborts the load.

NOTE: For most reliable operation set the Play volume level to between 5 and 8 on the CTR-80A dial.

CATALOG:

C

Catalog prints a list of the files on a tape. Pressing the escape key aborts this function.

7. PARALLEL DOWN LOAD:

P

Parallel Down Load allows one computer system to down load programs or data to another using the Expander parallel port. The data transfer format provided by the transmitting device should be as follows:

```
8 bytes  00h (null)
1   "    A5h sync character
2   "    load address (in hex, low address byte 1st)
2   "    byte count   (in hex, low byte 1st)
1   "    checksum for header (adds together address & count,
          one byte at a time, ignoring overflow)
n   "    data to be transmitted (8 bits/byte, no parity)
1   "    checksum for data (calculated as for header)
```

8. BAUD:

B <rate_flag>

Selects the baud rate of the serial port. The two avaliable baud rates are:

```
<rate_flag> = 1     1200 baud
<rate_flag> = 0      300 baud
```

The serial port always uses 1 start bit, 8 data bits, no parity and 2 stop bits.

Even though you can select a baud rate of 1200 baud, the video driver of the monitor cannot process some characters at this rate, so 1200 baud should only be used for half-duplex transmission or printer output.

NOTE: On all monitor commands only the first 64 character positions of the screen are used. All commands are scanned directly off of the video memory, so, "what you see is what you get."

9. VIDEO DISPLAY DRIVER:

The screen driver in the monitor is configured to appear as a Lear Siegler ADM-3A / TeleVideo 912/920 terminal. Control codes are as follows:

<control-H> - non-destructive backspace
<control-L> - non-destructive forespace
<control-J> - move cursor down, scroll if at bottom of screen
<control-K> - cursor up, wrap around top of screen
<control-Z> - clear screen
<control-^> - home cursor
<control-I> - non-destructive tab, does not alter any characters tabbed over (i.e. if inverted mode is on, characters do not have the hi bit set or if color mode is on, the color bytes are not changed)

10. STANDARD ESCAPE SEQUENCES

The escape sequence to position the cursor is:

<ESC>=<row+32><column+32>

For example, <ESC>=<space> <space> is row 0, column 0, the same as "home cursor".

To erase to end-of-line send:

<ESC>T

To erase to end-of-page send:

<ESC>Y

To start inverted (highlighted) printing send:

<ESC>J

To stop inverted video mode send:

<ESC>K

In addition to the standard sequences we have:

To turn color mode on send:

<ESC>C

Color mode also may be used for a large-character black and white display.

To turn color mode off send:

<ESC>O

To set the "color value" send:

<ESC>V<color value>

where <color value> is any eight bit value.

To put a character on the screen "as is" send

<ESC>A<data>

where <data> is any eight bit value which will be placed on the screen at the current cursor position. The cursor will be incremented to the next position and if color mode is on, the color byte of that cell will be set to the current value.

To turn graphics mode on send:

<ESC>G

to turn it off send:

<ESC>N

To diddle a graphics bit send:

<ESC><diddle type><Y coordinate + 32><X coordinate + 32>

where:

<diddle type> consists of:

R - Reset the pixel addressed,
S - Set the pixel addressed or
X - Flip the addressed pixel.

The upper left corner of the screen is location x=0,y=0 and the lower right corner of the screen is location x=159, y=71. The x and y coordinates are eight bit values. This ESC sequence addresses the screen similarly to the <ESC>= sequence, but at the pixel level instead of at the character cell level.

11.MONITOR ENTRY POINTS:

The monitor contains the following entry points to allow access to some of the more important subroutines of the monitor.

address	name	description
System reentry		
0F000h	RESET	Cold Start, complete reset of everything
0F003h	RESTART	Warm Start, leave the screen alone
		NOTE: During interrupts the monitor ROM is switched to its upper 2K Byte page. User-generated interrupt handling routines (i.e. interrupts generated by VIO & INT lines of the S-100 or the IRQ lines of the ME-50 bus) may use this same monitor call to return to the normal state. The monitor ROM will return to its lower 2K Byte page.
Console I/O		
0F006h	KSTAT	Returns 0FF(hex) in A if a character is available from the keyboard; otherwise it returns 0 in A
0F009h	KBREAD	Returns a character from the keyboard in A
0F00Ch	PUTCHAR	Print the character in C on the video display
Parallel port I/O		
0F00Fh	PSTAT	same as kstat except with parallel port
0F012h	PREAD	same as kbread " " " "
0F015h	POUT	same as putchar " " " "
Serial port I/O		
0F018h	SERSTAT	Serial port status
0F01Bh	SERIN	Serial port input
0F01Eh	SEROUT	Serial port output
0F021h	SERSEL	Select serial baud rate A == 0 for 300 baud A == 1 for 1200 baud

Cassette port I/O

0F024h	CASSTAT	Cassette status
0F027h	CASIN	Cassette input (1 byte at a time)
0F02Ah	CASOUT	Cassette output (1 byte at a time)
0F02Dh	RFILE	Read a cassette file. hl points to the null terminated name of the file to read or hl == -1 to read "next" file. If carry flag is set on exit then the abort key was hit. If zero flag is set then the checksum was correct.
0F030h	WFILE	Write a cassette file. hl points to a header as described under Save. Address of data and byte count are read out of the header.
0F033h	RBLOCK	Read a block of data from the cassette de contains byte count. hl contains address of data. If carry flag is set on return then the abort key was hit. If zero flag is set on return the check-sum was ok.
0F036h	WBLOCK	Write a block of data to the cassette de contains byte count. hl contains address of data.
0F039h	SYNC	Cassette sync on header Initialize cassette stuff for read sync on tape header. A header consists of at least 64 zero BITS followed by a 0a5h sync byte. Must be called before RBLOCK and cannot be called again before calling RTAIL. If carry set on return then abort key was hit.
0F03Ch	WSYNC	Cassette write sync. Initialize cassette stuff for write and write sync header of 80 000h BYTES and 0a5h sync character. Must be called before WBLOCK and cannot be called again before calling WTAIL.
0F03Fh	RTAIL	End cassette read. Stops tape and uninitializes cassette stuff from read. Must be called after bad call to SYNC or last call to RBLOCK.
0F042h	WTAIL	End cassette write. Stops tape and uninitializes cassette stuff from write. Must be called after last call to WBLOCK.

RE: Cassette Entry Points:

NOTE!!!! NOTE!!!! NOTE!!!! If anyone has set up the interrupt vectors 1 and/or 2 to trap to their own routines BE ADVISED that the cassette outines reset level one to KTIMER and level 2 to SEINT!! If needed they must be reset after the last call to RTAIL/WTAIL!!

12. EXPANDER MONITOR KEYBOARD CODES

This is a chart of EXPANDER Monitor keyboard codes. These codes are returned by the Expander's KBREAD routine when a key is pressed. All codes are hexadecimal. The codes are stored by the monitor at memory location FE38 (hex).

a. Main Keyboard

KEY	Unshifted "Caps Lock" off	Shifted "Caps Lock" on	Control Key Down	Control & Shift Key Down
ESC	1B	1B	1B	1B
1 !	31	21	11	01
2 "	32	22	12	02
3 #	33	23	13	03
4 $	34	24	14	04
5 %	35	25	15	05
6 &	36	26	16	06
7 '	37	27	17	07
8 (	38	28	18	08
9)	39	29	19	09
0	30	20	10	00
- =	2D	3D	0D	1D
^ ~	5E	7E	1E	1E
[{	5B	7B	1B	1B
\		5C	7C	1C	1C
] }	5D	7D	1D	1D
TAB	09	09	09	09
q Q	71	51	11	11
w W	77	57	17	17
e E	65	45	05	05
r R	72	52	12	12
t T	74	54	14	14
y Y	79	59	19	19
u U	75	55	15	15
i I	69	49	19	19
o O	6F	4F	0F	0F
p P	70	50	10	10
@ `	40	60	00	00
RETURN	0D	0D	0D	0D
F2	82	83	02	03

KEY	Unshifted "Caps Lock" off	Shifted "Caps Lock" on	Control Key Down	Control & Shift Key Down
a A	61	41	01	01
s S	73	53	13	13
d D	64	44	04	04
f F	66	46	06	06
g G	67	47	07	07
h H	68	48	08	08
j J	6A	4A	0A	0A
k K	6B	4B	0B	0B
l L	6C	4C	0C	0C
; +	3B	2B	1B	0B
: *	3A	2A	1A	0A
_ DEL	5F	7F	1F	1F
UP Arrow	0B	0B	0B	0B
DOWN "	0A	0A	0A	0A
F1	80	81	0D	01
z Z	7A	5A	1A	1A
x X	78	58	18	18
c C	63	43	03	03
v V	76	56	16	16
b B	62	42	02	02
n N	6E	4E	0E	0E
m M	6D	4D	0D	0D
, <	2C	3C	0C	1C
/ ?	2F	3F	0F	1F
LEFTArrow	08	08	08	08
RIGHT "	0C	0C	0C	0C
SPACE	20	20	00	00

18-Key Keypad Codes

These keys generate the same codes regardless of CAPS LOCK, CTRL, or SHIFT.

Key	Code
0	30
1	31
2	32
3	33
4	34
5	35
6	36
7	37
8	38
9	39
+	2B
-	2D
*	2A
/	2F
TAB	09
PRINT	3F
RETURN	0D

NOTE:
1. The division sign on the calculator keypad produces a slash mark (/).
2. The "PRINT" key produces a question mark (?), for the "PRINT" statement in BASIC.

CHAPTER FOUR.

INSTALLING PRINTERS AND OTHER PERIPHERALS

The following is a description of the pin-outs for the serial and parallel ports, and instructions for making up cables and connectors for some common printers and other peripherals. Here is the pinout for the serial port. For the standard RS-232 pinout, see Appendix 2.

1. The Serial Data Port.

The Expander's RS-232 port on the back panel may be used for a printer, a modem, or other RS-232 compatible peripherals. See also notes on Terminal Mode under Monitor Routines, Ch.III.

J1 Pinout, 25-pin Connector (DB-25 Female) signals.

Pin #	Signal Name	EIA	Terminal mode	Modem mode
1	Chassis Ground	CG		
2	Transmit Data	TD	Output	Input
3	Receive Data	RD	Input	Output
4	Request To Send	RTS	+12V	n.c.
5	Clear To Send	CTS	+12V	n.c.
6	Data Set Ready	DSR	Input	Output
7	Signal Ground	SG		
8	Carrier Detect	CD	n.c.	+12V
9	+12 Volts DC		+12V	+12V
20	Data Terminal Ready	DTR	Output	Input

NOTES:
1. The modes shown above are set by the position of the 16-pin shorting plug, i.e. plugged into either H1 or H2, on the Regulator PCB, next to the 25-pin RS-232 connector.
2. +12VDC is connected through a 1000 ohm resistor.
3. "n.c." means not connected.
4. Only two baud rates are available: 300 full duplex, and 1200 baud simplex. Baud rate is selected from the Monitor using the "B 0" (300 baud), or "B 1" (1200 baud) commands.
5. In Terminal mode, pin 6 must be positive (RS-232 logic one) in order to transmit data. In Modem mode, pin 20 must be positive.

2. RS-232 Cable for TI-810 or TI-820 Printer

Expander DB-25 female connector		TI-810 DB-25 female connector	
Pin Number	Signal Name	Pin Number	Signal Name (if different)
1	Chassis Ground	1	
2	Transmit Data	2	
3	Receive Data	3	
6	Data Set Ready	6	
7	Signal Ground	7	
8	+12 VDC	8	Carrier Det
20	Data Terminal Rdy	20	

NOTE: 1. This chart assumes that the Expander is configured as a "Modem", i.e. shorting plug is in H2 on Regulator PCB.

2. Use all seven wires called for.

3. <u>The Parallel Data Port</u>.

The Expander's parallel data port may be used either to attach a Centronics-type printer or to download or upload data between two Expanders.

The following pinouts are for using a 25-pin connector and cable.

Rear Panel 25-pin Connector (DB-25 male) signals.

Pin #	Signal Name	Direction/type of signal
1	Signal Ground	
2	Output Strobe*	Output, low active, 1 usec pulse
3	Output Acknowledge	Input, Monitor doesn't test this bit so user must provide his own driver if he needs this signal; use Output Device busy.
4	PDO7	Parallel outport, bit 7 (msb)
5	Output Device Busy	Input, HIGH=busy
6	PDO0	
7	PDO1	
8	PDO2	
9	PDO3	
10	PDO4	
11	PDO5	
12	PDO6	
13	+5VDC	Via 470 ohm resistor
14	Signal Ground	
15	Input Strobe*	Input, low active, edge trig.
16	Input Acknowledge	Output, HIGH=Expander busy LOW =ready for input
17	n.c.	
18	PDI0	Parallel inport, bit 0 (lsb)
19	PDI1	
20	PDI2	
21	PDI3	
22	PDI4	
23	PDI5	
24	PDI6	
25	PDI7	Parallel inport, bit 7 (msb)

NOTES:
1. The Parallel Output and Input Ports have port address BF(hex).
2. The Status/Control bits, e.g. Output Busy, are part of input port BE(hex).

4. The OKI m-80 Series Printer Cable.

EXPANDER		OKI m-80	
DB-25 male connector		36-pin Centronics-style connector	
Signal Name	Pin Number	Pin Number	Signal Name
Signal Ground	1	14	Signal Ground
Signal Ground	14	9	DO 7
DO 7	4	1	Input Strobe
Out Acknowledge	3	10	Out Acknowledge
Out Busy	5	11	Out Busy
DO 0	6	2	DO 0
DO 1	7	3	DO 1
DO 2	8	4	DO 2
DO 3	9	5	DO 3
DO 4	10	6	DO 4
DO 5	11	7	DO 5
DO 6	12	8	DO 6

5. <u>The Paper Tiger Printer</u>.

Making up a parallel port cable for the IDS 440 Paper Tiger printer may be done according to the following pinouts:

EXPANDER		Paper Tiger	
DB-25 Male Connector		DB-25 Male Connector	
Signal Name	Pin Number	Pin Number	Signal Name
Chassis Ground	1	1	Protective Gnd.
OUT STB	2	3	Strobe*
	n.c.	4	Online
Signal Ground	14	7	Signal Ground
DO 6	12	15	DB 6
DO 5	11	9	DB 5
DO 4	10	10	DB 4
DO 3	9	11	DB 3
DO 2	8	12	DB 2
DO 1	7	13	DB 1
DO 0	6	14	DB 0
Out Busy	5	19	BUSY*
Out Acknowledge tie to signal ground	3		

6. Download Cable for Parallel Port

Two Expanders may be connected together by their parallel ports in order to upload or download data.

Computer #1		Computer #2	
DB-25 male Pin No.	Signal Name	Signal Name	DB-25 malePin No.
Transmit #1:		Receive #2:	
1 & 14	Signal Gnd.	Signal Gnd.	1 & 14
2	Out Strobe	In Strobe	15
4	DO 7	DI 7	25
5	Out Busy	In Ack	16
6	DO 0	DI 0	18
7	DO 1	DI 1	19
8	DO 2	DI 2	20
9	DO 3	DI 3	21
10	DO 4	DI 4	22
11	DO 5	DI 5	23
12	DO 6	DI 6	24

[If these below are omitted, cable will be uni-directional from #1 to #2.]

Receive #1:		Transmit #2:	
15	In Stb.	Out Stb.	2
25	DI 7	DO 7	4
16	In Ack.	Out Busy	5
18	DI 0	DO 0	6
19	DI 1	DO 1	7
20	DI 2	DO 2	8
21	DI 3	DO 3	9
22	DI 4	DO 4	10
23	DI 5	DO 5	11
24	DI 6	DO 6	12

CHAPTER FIVE

MEMORY MAP AND INTERNAL ADDRESSES of I/O PORTS

1. Memory Map.

```
 ------------------------------  FFFF (hex)
|         Video RAM &          |
|      misc. storage for       |
|         monitor              |
|           (2K bytes)         |
|------------------------------| F800
|         Monitor ROM,         |
|      two 2K byte pages,      |
|       bank switched          |
|            (2K bytes)        |
|------------------------------| F000
|   Micropolis Disk Controller |
|            (1K byte)         |
|------------------------------| EC00
|     Typical location of      |
|     CBIOS for CP/M 2.2,      |
|     59K configuration        | E600
|                              |
|     Typical location of      |
|     bottom of CP/M CCP,      |
|     59K configuration        |
|------------------------------| C900
|                              |
|     User allocated area      |
|     approx. 50K bytes        |
|                              |
~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
|                              |
|------------------------------| 07FF
|                              |
|    During the 4 Z-80 machine |
|     cycles after power on,   |
|     or after Manual Reset,   |
|     the Monitor ROM is       |
|     relocated from 0000 to   |
|     07FF, overlaying other   |
|     RAM or ROM in the system |
|                              |
|------------------------------| 0100
|     Reserved area for CP/M   |
|          (256 bytes)         |
 ------------------------------  0000 (hex)
```

2. Expander Internal I/O Port Addresses.

Address	Input Port Function	Output Port Function
BC(hex)	Keyboard Matrix Data	Keyboard Scan Address & Bank Switch Port
BD	Real Time Clock Count	RTC Count Load
BE	Status Port	Control Port
BF	Parallel Data Inport	Parallel Data Outport

3. Keyboard Matrix Data (Input port BC).

bit 7 = LOW if one or more keys have been pressed

bits 0-2 = Binary address of keyboard rows

bits 3-6 = Binary address of keyboard columns

NOTE: Normally the keyboard decoding hardware continuously scans the entire matrix. When a key is pressed the scanning is stopped with the current key matrix address available on input port BC.
Execution of an IN BC instruction by the Z-80A will restart scanning.

4. Output Port BC Function Selection.

bit 7 Selects between two ports, BOTH on this address:
LOW = Keyboard Scan port
HIGH = Bank Switch port
POWER UP = LOW

5. Keyboard Scan Port

bits 0-2 = Binary address of key rows

bits 3-6 = Binary address of key columns
Using these addresses, the monitor software can access an individual key in the matrix.

6. Bank Switch Port

NOTE: All bits on this port have dramatic effects on hardware, since the Interrupt latch, U2, when set will swap pages, i.e. switch banks of the Monitor ROM from lower to upper halves.
It is extremely risky to access these bits except via existing Monitor routines.

bit 0 = Interrupt Service Done
LOW = normal
HIGH = Resets the Interrupt vector latch, U2, so that normal operation can proceed. This bit must be set high, then reset by software just before returning from an interrupt handling routine.
POWER UP = LOW

bit 1 = Monitor ROM Bank Select
LOW = normal
HIGH = Override Interrupt swapping of ROM halves and switch to upper half.
POWER UP = LOW

bit 2 = NOT USED, reserved

bit 3 = Monitor ROM/Video RAM Disable
LOW = normal
HIGH = Disable all Expander ROM and Video RAM; optionally used by CP/M CBIOS to allow full 64K RAM access by CP/M.
POWER UP = LOW

bits 4-7 NOT USED

7. Real Time Clock Count (Input port BD).

bit 7 = used by Serial Data port as status signal, e.g. EIA DTR signal, and by cassette port to indicate correct operation
POWER UP = LOW

bit 6 = RTC Interrupt
LOW = no interrupt present
HIGH = RTC interrupt present/not yet serviced
POWER UP = HIGH

bits 0-5 = RTC count at time of "IN BD" instruction
POWER UP = All bits reset to 0

8. Real Time Clock Load (Output port BD).

```
bit 7      = RTC Enable
                LOW  = disable RTC counting
                HIGH = enable RTC counting
                POWER UP = LOW

bit 6      = not used

bits 0-5 = Binary count to be pre-set into RTC counter
```

9. Status Port (Input port BE).

```
bit 7      = Serial Interrupt*
                LOW  = Serial or Cassette bit transition has
                       occurred (transition is low to high)
                HIGH = normal, i.e. no transition
                POWER UP = HIGH

bit 6      = Parallel Input Port Data Ready
                LOW  = Data available
                HIGH = no data ready yet
                POWER UP = HIGH

bit 5      = Parallel Output Port Device Busy(DB-25,pin 9)
                LOW  = Device ready
                HIGH = Device busy, not ready
                POWER UP = unknown

bit 4      = Parallel Output Port Acknowledge(DB-25,pin 5)
                LOW  = Data received, OK
                HIGH = device not ready
                POWER UP = unknown

bit 3      = Keyboard; LOW = Swedish keyboard
                       HIGH = USA keyboard

bit 2      = Keyboard; LOW = "CAPS LOCK" key pressed

bit 1      = Keyboard; LOW = "CTRL" key pressed

bit 0      = Keyboard; LOW = "SHIFT" key pressed
```

9. Control Port (Output port BE).

```
bit 7     = Serial Interrupt Enable
               LOW  = Disable Serial/Cassette port interrupts
               HIGH = Enable    "        "       "       "
               POWER UP = LOW

bit 6     = Speaker Enable
               LOW  = Disable Speaker sound output
               HIGH = Enable Speaker, this signal is gated
                      with the overflow output of the RTC
                      counter to produce square waves of
                      software programmable frequency.

bit 4-5   = Cassette Data Output B/Serial Control Output
               POWER UP= bit 4 is LOW, bit 5 is HIGH

Cassette Operation (bit 3 = HIGH)
               Bits 4 and 5 are combined to form the Cassette
               analog output signal, via what is, in effect
               a two-bit Digital to Analog converter.

Serial Port Operation (bit 3 = LOW)
bit 5  LOW  = EIA (RS-232) control "0" output
       HIGH =  "     "     control "1" output

bit 4  LOW  = EIA serial data "1" output
       HIGH =  "    "    data "0" output

bit 3     = Cassette Relay Enable (Cassette/Serial select)
          This bit selects between two modes, as well as
          turning the cassette recorder motor relay on
          or off. This bit must be set LOW to allow
          serial (RS-232) port operation of any kind.
       LOW  = Relay off, Serial input/output mode
       HIGH = Relay on, Cassette mode
       POWER UP = LOW
```

V.9, cont'd.

bit 2 = Cursor Mode
LOW = Block cursor, i.e. inverted video which makes the character at the current cursor position black-on-white instead of the normal white-on-black. To invert video of any character on the screen the most significant bit of the ASCII code stored in video RAM must be set HIGH.

HIGH = Graphics mode, i.e. cursor is underline character which replaces any character at current cursor position on screen. In this mode if the most significant bit of any ASCII code in video RAM is HIGH then a graphic character will be displayed at that screen position.

POWER UP = LOW

bit 1 = Color/Black and White Select
LOW = Black and White video output screen format is 24 lines X 80 columns
HIGH = Color video output
POWER UP = LOW

bit 0 = Character Set Selection
LOW = normal, i.e. standard 128 character set
HIGH = Expanded, used with 32K ROM to allow two character sets, depending on the state of the msb. To properly use this mode the following conditions must be met:

1. most significant bit in video RAM must be set HIGH for each position where the second character set is to be used.
2. Graphics mode must be disabled, i.e. bit 2 must be LOW.
3. H6 must be shorted for 32K ROM/EPROM
4. An appropriately programmed ROM/EPROM must be installed in the U47 socket.

10. Parallel Data Port (Input and Output ports BF).

The input port data is not latched and must be stable at the time the actual IN BF instruction is executed.

The output port data is latched, and is stable during the output strobe pulse.

On Power-Up all bits are reset.

CHAPTER SIX.

ADJUSTMENTS, HEADERS, AND CONNECTORS ON EXPANDER MAIN PC BOARD

A diagram of the Main PC Board follows the text of this chapter.

1. Adjustments on Expander Main PC Board.

VR1 Vertical display position

VR2 Horizontal display position

VR3 Black Level Factory Adjustment.

In Color mode, VR 3 is adjusted so that normal background (with color bytes in video RAM all = 00 hex) is black. Requires good quality 10 MHz oscilloscope for adjustment. Misadjustment will dramatically affect color video output.

C47 Factory Adjustment.

Frequency adjustment of color subcarrier. Adjust for output on U24, pin 12 of:

NTSC units - 14.31818 MHz (+/- 200 Hz).

PAL units - 15.51766 MHz (+/- 100 Hz).

2. Description of Main PCB Headers.

Name	# of Pins	Description
H1	14	Interrupt Request Options. This header permits connection of the IRQ0-2 Interrupt Request lines from the ME-50 bus to the Vector Interrupt lines (VI0-7) of the S-100 bus. All pins normally open.
	Pins 1,2, 11-14	not used
	3 VI0*	S-100
	4 VI3*	S-100
	5 IRQ0*	ME-50
	6 IRQ1*	ME-50
	7 IRQ2*	ME-50
	8 VI4*	S-100
	9 VI5*	S-100
	10 VI7*	S-100
H2	2	INT.ENB. When shorted, priority encoded interrupts, including all internal Expander interrupts, are enabled. Normally shorted.
H3	3	BUS/NO-BUS. When S-100 bus is installed pins 1 and 2 are shorted.
H4	16	PAL video (625 line/ 50 Hz). 16 pin short plug is placed in either H4 or H5 depending on type of video desired.
H5	16	NTSC video (525 line/60 Hz)
H6	3	16K/32K character generator. Normally set to 16K, i.e., pins 2 and 3 shorted, for standard character generator.

3. Description of Connectors on Expander Main PCB.

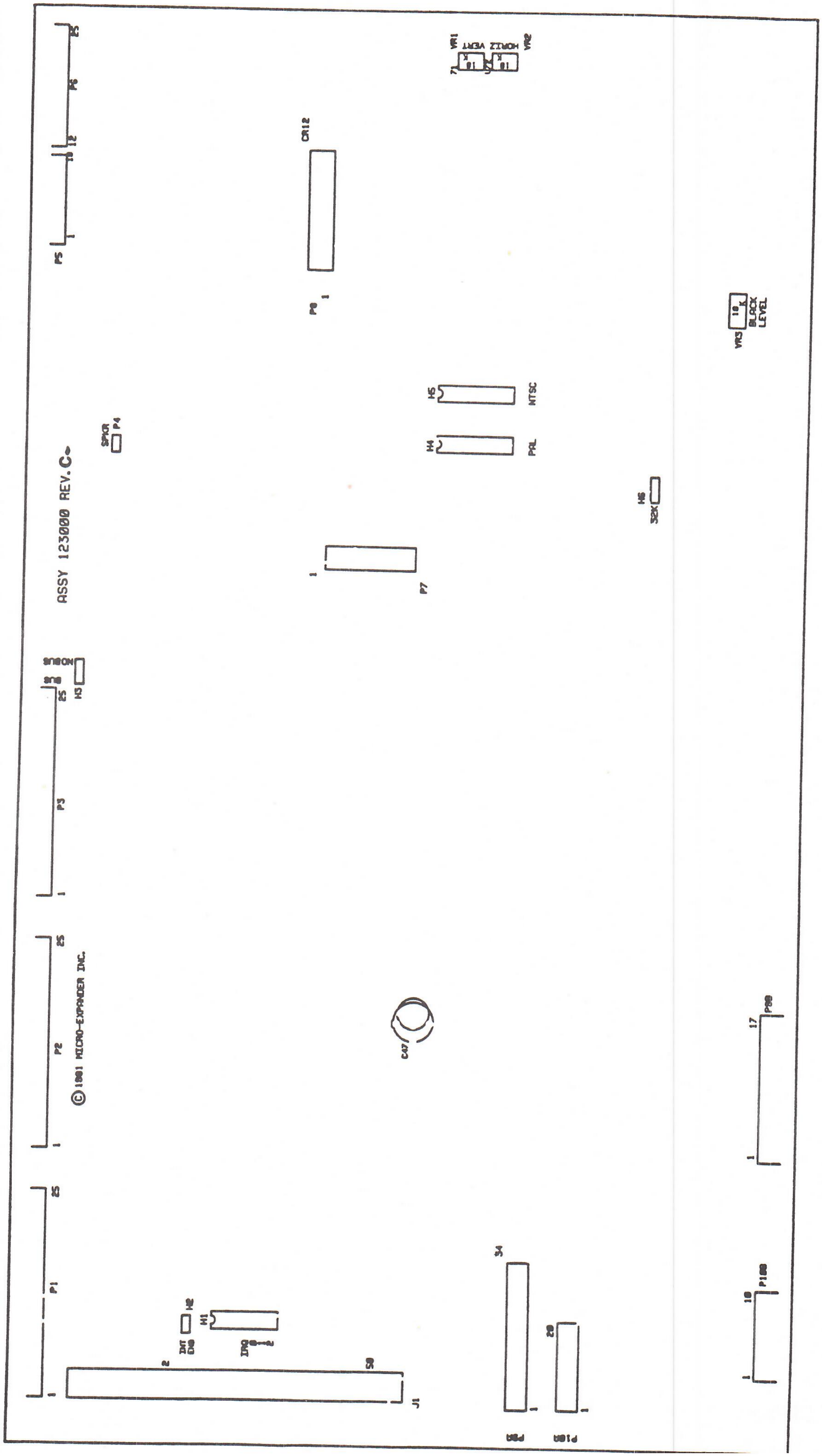
Plug Name	# of Pins	Function
P1-P3	25 each	Connection to S-100 bus
P4	2	Speaker, for 8-16 Ohm speaker
P5	10	Power & Reset signals
P6	14	I/O signals to rear panel
P7	20	Video Expansion connector (see below), for future enhancements such as high-resolution color graphics.
P8	26	Parallel input/output ports
P9A	34	Keyboard connector
P10A	20	Keyboard connector
P9B	17	Not used - reserved
P10B	10	Not used - reserved
J1	50	ME-50 Expansion bus (see Chapter VII).

4. Video Expansion Pin-Out, Technical Description.

P7 Signal Description

P7 Pin #	Signal Name	Functional Description
1,3,5,7,9,11, 13,15,17,19	SIG. GND.	SIGNAL GROUND
2	VIDSUM	Analog voltage corresponding to video luminance signal. In Black/white mode, translates directly to video output. Signal varies from ~ 1 VDC to 11 VDC.
4	VRESET B*	Vertical Reset Pulse, TTL level
6	HRESET B*	Horizontal Reset Pulse, TTL level
8	VDISP	VDISP is active during the portion of each vertical scan (16.67 msec) during which the video RAM is accessed for data to be displayed on the CRT, TTL level HI=active.
10	HDISP	HDISP is active during the portion of each horizontal scan (63 msec) during which the video RAM is accessed for data to be displayed, TTL level, HI=active.
12	COLOR	HI = Color TTL level, LO = Black/White
14	CHARACTER	This signal changes state at the end of each CRT character cell. In NTSC it is 1.78 MHz square wave, In PAL it is 1.94 MHz square wave. TTL level.

16	LOAD	Negative going pulse which is true at beginning of each CRT character cell.
18	SUBCARRIER	Color subcarrier NTSC = 3.579545 MHz PAL = 4.433167 MHz
20	not used	Reserved.


ASSY 123000 REV.C
© 1981 MICRO-EXPANDER INC.

CHAPTER SEVEN.

ME-50 BUS DESCRIPTION

Signal List.

ME-50 Pin #	Signal Name	Functional Description
1	GND	Signal & Power Ground
2	DOT CLK	Video dot clock, Master clock for Expander NTSC = 14.318 MHz PAl = 15.516 MHz
3	02	CPU clock, i.e. Dot Clock / 4
4	+5VDC	Power (+/- 5%)
5	SLV CLR*	Slave Clear, (1)
6	POC*	Power-on-Clear, (1)
7	WAIT*	CPU Wait Acknowledge (1)
8	RESET*	System Reset (1)
9	MSTVAL*	When S-100 bus is used, ME-50 MSTVA1* = S-100 PSTVAL*. Otherwise MSTVAL is pulse following rising edge of Z-80A clock during each CPU cycle.
10	PSYNCH	(1)
11	PHANTOM	(1)
12	M1	(1)
13	MEM ENB*	Memory Enable, active only during Memory references. With S-100: From backplane NO S-100: Z-80A MREQ sig.
14	IO ENB*	I/O Enable, active only during I/O cycles. With S-100: From backplane NO S-100: Z-80A IORQ sig.
15	WRST*	Write Strobe With S-100: S-100 PWR* (1) NO S-100: Z-80A WR Signal

ME-50 Pin #	Signal Name	Functional Description
16	RDST*	Read Strobe With S-100: S-100 PDBIN (1) NO S-100: Z-80A RD Signal
17	DVR ENB*	ME-50 Driver Enable, Open Collector signal TTL Low when ME-50 bus drivers (to Z-80A) are enabled.
18	INT ACK	Interrupt Acknowledge, Active during Z-80A Int. ack. cycle, when MI and IORQ are true.
19	IRQ0*	Interrupt request 0, highest priority vectored interrupt request, LO=active. HI allows jumpering to UI Interrupt encoder.
20	IRQ1*	Interrupt Request 1
21	GND	Same as Pin 1
22	IRQ2*	Interrupt Request 2
23	A0	Address bus, LSB (1)
24	A1	" "
25	A2	" "
26	A3	" "
27	A4	" "
28	A5	" "
29	A6	" "
30	A7	" "
31	A8	" "
32	A9	" "
33	A10	" "
34	A11	" "

ME-50 Pin #	Signal Name	Functional Description
35	A12	" "
36	A13	" "
37	A14	" "
38	A15	Address Bus, MSB
39	D0	Data Bus, Bidirectional LSB
40	D1	" "
41	D2	" "
42	D3	" "
43	D4	" "
44	D5	" "
45	D6	" "
46	D7	Data Bus, Bidirectional, MSB
47	-16VDC	Unregulated power
48	+12VDC	(+/-5% power)
49	GND	Same as pins 1 & 21
50	+5VDC	Same as pin 4

Note (1): Same as S-100 bus definition.

The ME-50 bus is a simplified expansion bus for the Expander Computer. ME-50 cards stack on top of each other, up to 3 high inside the cabinet. These cards may be used with the S-100 bus installed in the Expander, or without it.

Most common features of the S-100 bus are available on the ME-50 bus, except for those capabilities listed below:

1. ME-50 does not support extended addressing.
2. ME-50 does not supprt 16-bit data paths.
3. DMA slaves can reside on the ME-50, but not DMA Masters.

APPENDIX 1 - LIST OF COMPATIBLE PERIPHERALS

The following peripherals have been tested with the Expander:

Disks

CP/M 2.2 on:
1. North Star 5.25" floppy, double-sided, quad density.
2. Micropolis 1053 Mod II 5.25" floppy
3. Shugart/Data Technology 10 MByte Winchester / 8" IBM floppy disk

Cassette Recorders

Radio Shack CTR80-A (Catalog No. 26-1206)
Cable is Catalog No. 26-1207

I/O Boards

Godbout Interfacer II

Memory

1. Central Data (see Appendix 2)
2. Godbout RAM XVII.
3. Godbout RAM XX.
4. North Star 32K Dynamic RAM.

Modems/Clocks

1. DC Hayes Micromodem 100
2. DC Hayes Smartmodem
3. DC Hayes Chronograph

Printers

1. Epsom MX-80
2. Centronics 739
3. Okidata microline 83A
4. Okidata microline 84
5. Qume Sprint 9/45

1.0 Warrantee

The Central Data 64K RAM Board is fully warranteed for a period of one year following the date of shipment. All units returned to Central Data Corporation postpaid during this period will be repaired and returned without charge.

This warrantee does not apply to boards which have been damaged, abused, or modified. Central Data reserves the right to change the design of the RAM Board without having to change any previously manufactured units.

2.0 Description

The Central Data 64K RAM Board is a random access read/write memory module designed to expand the memory capacity of S-100 computers. The Board is configured as four sections of 16K x 8 bits. The sections are seperately addressable.

The memory integrated circuits used on the 64K RAM board are 4116-25 16K (or equivalent) dynamic RAMs for 2MHz boards, 4116-20 RAMs for 4MHz boards. These RAM's use considerably less power than static RAM as well as using less PC board space.

The circuitry has been designed to be independent of the processor type. This manual shows how to set up the board to be accessed by S-100 systems using the 8080, Z80, or 2650 microprocessors. It will work with other types of bus masters as long as they simulate the memory access timing of the processor for which the board is strapped.

3.0 Processor Selection

First, there are two straps numbered 14 and 15 soldered on the board which determine which S-100 line is used for reset in your system. Strap 14 selects pin 75 as the reset source, and strap 15 selects pin 99 as the reset source. Normally, the board will work as strapped at the factory (for pin 75), but if you find that your board will not hold data during reset operations, you can change the strap to fix the problem. The strap locations can be found on the parts placement diagram at the end of this manual.

Two 16 pin DIP headers are used to program the RAM Board for use with various processors. Wires must be soldered in place connecting across these headers. The correct connections are shown in figure 1.

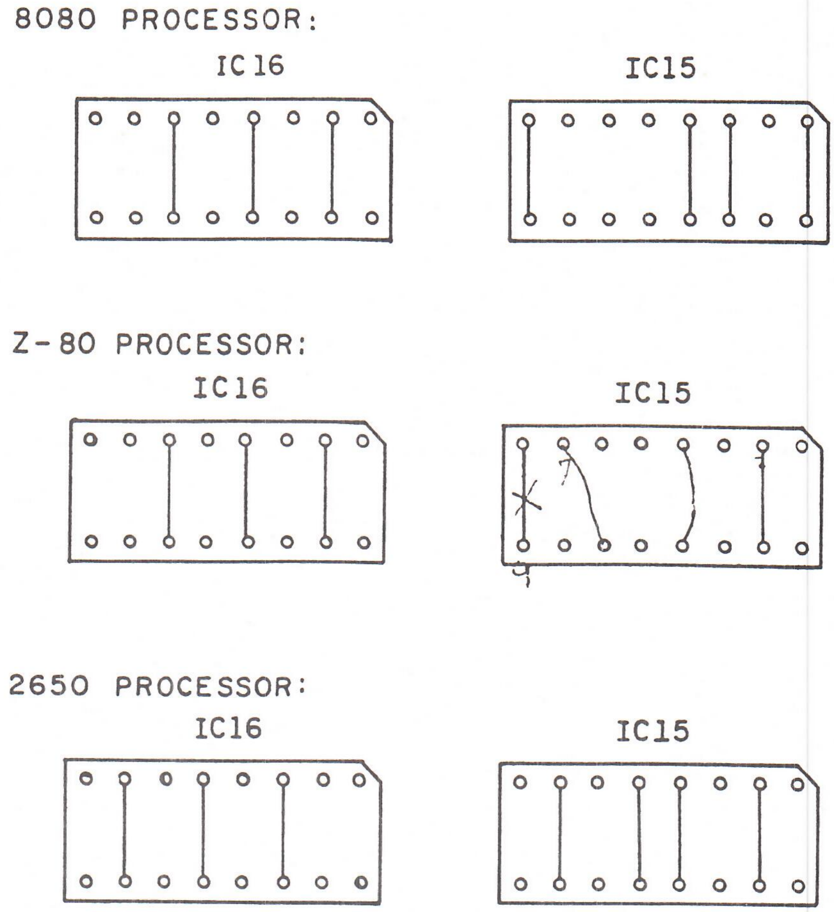


Figure 1

Two alternates for the Z-80 processor would be: on IC15, take out the wire between pins 8 and 9 and add a wire between pins 7 and 10. Then also add a wire between either pins 6 and 11 or pins 5 and 12, depending on which alternate you try. This changes the clock used in the refresh circuit.

4.0 Address Selection

When the RAM Board is used in an 8080 or Z80 system it will be addressable on 16K boundries. When strapped for use in a 2650 system, it will be addressable on 8K boundries. Two sets of address selection instructions are given below. Follow the instructions that correspond to the processor type being used.

4.1 Address Selection Instructions for 8080 or Z80 Systems

When strapped for 8080 or Z80 bus masters, the 64K RAM Board consists of up to four seperate 16K sections. Each section can be addressed independently and can occupy any 16K block of memory address space.

For each 16K section there will be one blue "minijump" connector bridging the address selection area (16K boards will use one address strap minijump, 32K boards will use two, etc.). Refer to Figure 2 for the location of this area on the board. The exact placement of the minjumps will vary depending on whether you have a board with 16K or 32K of memory or one with 48K or 64K of memory. The detail on how to address the board is presented below in two sections, depending on the size of board that you have.

4.1.1 Addressing 16K/32K Boards with 8080 or Z80 Systems

For a 16K or 32K board, you will need to place one or two minijumps (depending on the board size) in the address selection strap area. The minijump for the top row of chips should be placed in the top row of the address selection strap area (see Figure 2). The minijump should be placed over the set of pins marked 0, 1, 2, or 3 to address the top row of RAMs to start at 0, H4000, H8000, or HC000. For a 32K board the second row of RAMs can be addressed in the same way, but with the minijump placed in the bottom row of the address selection strap area. Figure 2 shows the addressing for a 32K board whose top row of RAM's is addressed to start at H8000, and its second row of RAMs is addressed to start at HC000. The deselection straps shown in the figure have no effect on the basic addressing of the board and are explained in section 5.

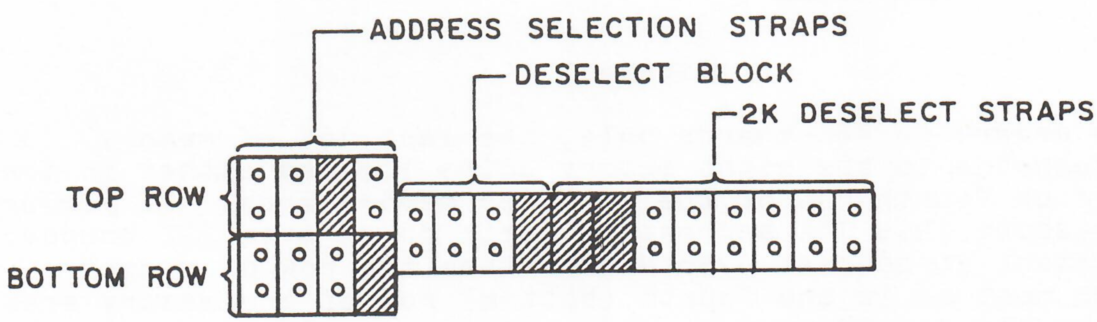


Figure 2

4.1.2 Addressing for 48K/64K Boards on 8080 or Z80 Systems

For a 48K or 64K board, you will have to place three or four minijumps (depending on the board size) in the address selection strap area. One minijump will be used for each 16K block that you address To address the first 32K of the board (the top two rows of RAMs), you will place two minijumps on the top row of the address selection strap area (see Figure 3). Fach minijump should be placed to select where a corresponding 16K block of memory should be addressed. A minijump is placed in column 0, 1, 2, or 3 to start addressing for the 16K section at address 0, H4000, H8000, or HC000. There is one restriction: the two minijumps must be adjacent. This means that the allowable combinations for addressing the first 32K of your board are:

0,1	(address 0 to H7FFF)
1,2	(address H4000 to HBFFF)
2,3	(address H8000 to HFFFF)
3,0	(address HC000 to H3FFF)

At this point, the remaining memory on the board can be addressed. To address the last 16K of a 48K board, a single minijump is placed in the correct column of the bottom row of the address selection strap area. For a 64K board, two minijumps are placed on the bottom row, addressing the bottom 32K of memory on the board. Note that these two minijumps must be adjacent as in selecting the top 32K of memory. Figure 3 shows a 48K board addressed from 0 to HBFFF.

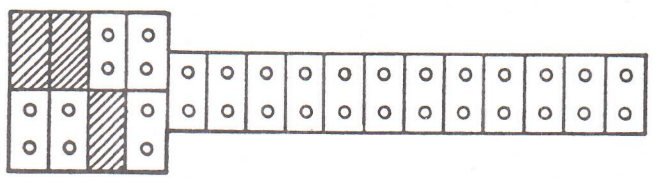


Figure 3

With regard to 48K boards only, the last 16K of memory corresponds to the eight memory chips located either in the third or fourth row of the socketed memory area. If you are addressing this 16K segment to begin on an even 32K boundary (to start at address 0 or H8000) then the row of memory chips must be in the fourth (bottom) row of the memory area on the board. If you are addressing this 16K segment to begin at either H4000 or HC000 then the memory devices must be placed in the third row of sockets in the memory area (adjacent to the top 32K of memory). When the boards are shipped from Central Data they contain the memory on the third row for 4MHz boards, or the bottom row for 2MHz bds.

4.2 Addressing Instructions for 2650 Processors

To address a 16K board to be used in a 2650 system, put a minijump in positions 1 and 2 of the top row of the address selection strap area (see Figure 4). This addresses the board to have a continuous 16K of memory starting at address H2000.

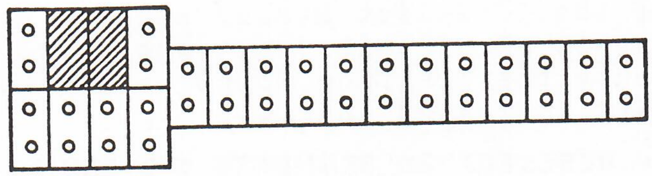


Figure 4

To address a 32K board for a 2650 system, you will have to deselect the portions of page zero which are used by the CPU board. The straps should be set up as shown in Figure 5 for this configuration.

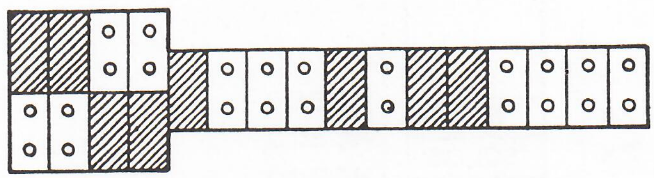


Figure 5

5.0 Address Deselect Straps

In order to have the RAM Board fit around ROM monitors or other dedicated areas of memory, from one to eight 2K segments of any 16K address space can be deselected. The instructions for setting these straps are given for all non-2650 systems. Any 2650 users which need this feature should consult the factory.

Use a minijump to select the 16K area in which the gap will occur. Place the minjump in the column of the "Deselect Block" area that corresponds to this block of memory. Now place a minijump in each column of the "Deselect Strap" area that you wish to have deselected.

Example:

You have a SOL-20 computer and wish to use the ALS-8 program which requrires 12K of memory from HD000 to HFFFF. A full 16K of RAM (HC000 to HFFFF) won't work because the monitor (SOLOS) occupies 2K of memory space between HC000 and HC7FF. Also, the SOL-20 has 2K of RAM between HC800 and HCFFF.

A Central Data RAM Board can be used for this purpose by deselecting the occupied areas. Put a minijump in the address selection area to address the 16K of the board from HC000 to HFFFF (see section 4.1). Since the area to be deselected is in the top 16K put a minijump in column 3 of the "Deselect Block." Now put a minjump in both column 0 and column 1 of the "Deselect Strap" section of the board to deselect the lowest 4K of this 16K. The board is now strapped to occupy the 12K from HD000 to HFFFF. Figure 2 shows a RAM Board addressed this way.

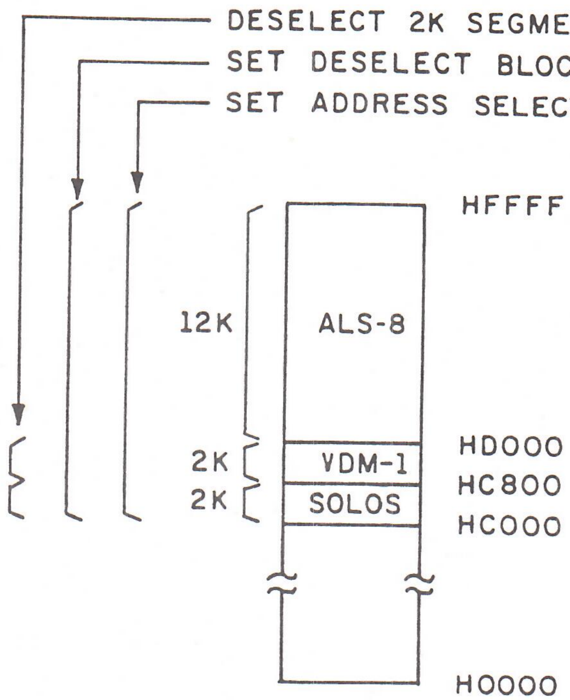


Figure 6

6.0 Installation

Before plugging the RAM Board into an S-100 card slot, make certain that the power has been off long enough to allow the power supply capacitors to discharge. Whenever any S-100 board is plugged in or removed, care should be taken to make sure that the edge connector lines up with the printed circuit board fingers.

Keeping these precautions in mind, put the board into the S-100 mainframe. Make sure the board faces the right direction. The power may now be applied. The RAM Board is ready for use.

7.0 Increasing your Memory Size

To increase the memory capacity of your board, you can purchase a set of memory ICs and capacitors from Central Data. The memory circuits should be carefully plugged into the next available row of sockets from the top of the board. The only exception to this is when you are upgrading to a 48K board where you may need to skip the third row in order to address the board correctly (see section 4.1.2 for information concerning this).

The capacitors should be soldered in according to the parts placement diagram making sure of the polarity on the tantalum capacitors. The capacitors in the memory area of the parts placement diagram are numberd to indicate which ones are to be put in for the different sizes of boards. Capacitors with the number '1' should all be in for 16K boards, while 32K board should have capacitors for both numbers '1' and '2', etc.

Finally, if you upgraded a 16K or 32K board to a 48K or 64K board, you will have to change two jumper straps on the board. These are the straps numbered 1, 2, 3, and 4 on the parts placement diagram, and they should be wired as follows for the different sizes of boards:

16K,32K 48K,64K

8.0 Specifications

Storage Capacity	16K, 32K, 48K, or 64K
Addressing	16K boundaries
Buffering	On all I/O lines
Access Time - 2MHz Bd.	450ns(max)
4MHz Bd.	250ns(max)
Cycle Time	480ns(max)
Refresh Period	15us(max)
Wait States Generated	None
DMA Rate	1MHz Max

Power Consumption (16K, typ.):	
+16	150ma
+8	300ma
-16	20ma

Power Consumption (each add'l 16K, typ.):	
+16V.	20ma
+8V.	0ma
-16V.	3ma

9.0 8080 Memory Test Program

The memory test program listed below can be used to test a 16K memory segment addressed for Block 1 (H4000-H7FFF). When an error is found the program stores information about the error and then halts. The error information is stored as follows:

Address	Information
H0003	High byte of address
H0002	Low byte of address
H0001	Data written to byte
H0000	Data read from byte

A 32K memory segment can be tested by addressing the board for blocks 1 and 2 and changing the values at locations H16 and H2C to HC0.

This memory test program occupies memory starting at H0000 so a working RAM board must be at this part of memory.

```
                       BEG     EQU     4000      HEX STARTING
ADDRESS
                       END     EQU     80        TOP BYTE OF
END ADDR
                       *
                               ORG     4
0004 31 04 00          START   LXI     SP,4
0007 AF                        XRA     A
0008 47                        MOV     B,A       CLEAR A,B
0009 21 00 40          OVER    LXI     H,BEG     STARTING ADDR
000C 48                        MOV     C,B
000D 71                WRITE   MOV     M,C       STORE DATA
000E 23                        INX     H         BUMP ADDRESS
000F 0C                        INR     C         BUMP DATA
0010 C2 14 00                  JNZ     SKIP
0013 0C                        INR     C         OFFSET PATTERN

0014 7C                SKIP    MOV     A,H
0015 FE 80                     CPI     END
0017 C2 0D 00                  JNZ     WRITE
                       *
                       *       READ BACK LOOP
                       *
001A 78                        MOV     A,B
0018 21 00 40                  LXI     H,BEG
001E 5E                READ    MOV     E,M
001F BB                        CMP     E
0020 C2 35 00                  JNZ     ERROR
0023 23                        INX     H
0024 3C                        INR     A
0025 C2 29 00                  JNZ     NDINC
0028 3C                        INR     A
0029 4F                NDINC   MOV     C,A
002A 7C                        MOV     A,H
002B FE 80                     CPI     END
002D 79                        MOV     A,C
002E C2 1E 00                  JNZ     READ
0031 04                        INR     B
0032 C3 09 00                  JMP     OVER
                        *
                        *       ERROR ROUTINE
                        *
0035 E5                 ERROR   PUSH    H
0036 57                         MOV     D,A
0037 D5                         PUSH    D
0038 76                         HLT
```

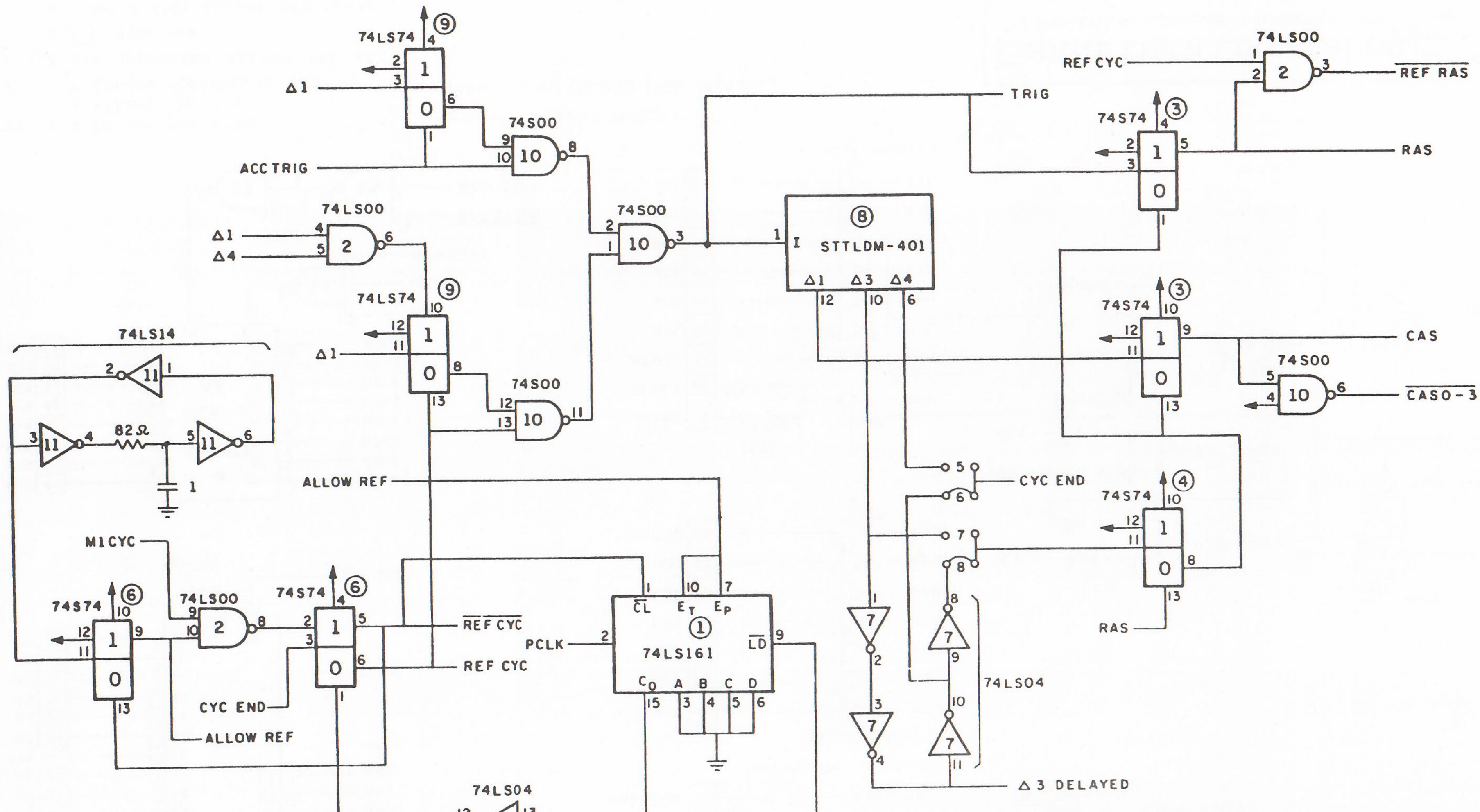
10.0 2650 Memory Test Program

A memory test program for the 2650 is listed here. The program loads into display memory at H1510 and occupies about HA0 bytes. To set the address range to test, simply set the two bytes labeled STARTT and ENDT to the high bytes of the starting and ending addresses. For example, if you wanted to test memory between H2000 and H5FFF, you would change STARTT to H20 and ENDT to H60. Then just execute at 1510, and the test will begin. Since the program occupies display RAM, the screen will be broken up when it is being executed. The program terminates when a key is pressed. Errors are displayed on the screen in the following format:

```
     +------------------------Address of the error
     !    +-------------------Data that was written there
     !    !    +--------------Data that was read back
     !    !    !
   XXXX  XX  XX
```

```
0000                      PRNT
0000               *
0000               *
0000               *
0000               *      MEMORY TEST
0000               *
0000               *
0000               *
0000               EQ     EQU         0         POSSIBLE CONDITIONS
0000               GT     EQU         1
0000               LT     EQU         2
0000               UN     EQU         3
0000               R0     EQU         0         REGISTER DEFINITIONS
0000               R1     EQU         1
0000               R2     EQU         2
0000               R3     EQU         3
0000               HXOT   EQU         006A
0000               LFCR   EQU         0024
0000               WCHR   EQU         0396
0000               RETU   EQU         0083
0000               *
0000               *
0000               *
1510                      ORG         1510
1510 1B 02                BCTR,UN     START     BRANCH OVER POINTERS
1512 00            STARTT RES         1         HIGH BYTE OF START ADDRESS
1513 00            ENDT   RES         1         HIGH BYTE OF END ADDRESS+1
1514 04 00         START  LODI,R0     0
1516 93                   LPSL                  SETUP PSL
1517 3F 00 24             BSTA UN     LFCR      DO LINEFEED AT BEGINNING
151A 20            STRT   EORZ,R0               GET READY TO CLEAR LOW BYTE O
151B 09 75                LODR,R1     STARTT    GET HIGH BYTE OF START ADDRES
151D C9 29                STRR,R1     RAMPTR    STORE INTO POINTER
151F C8 28                STRR,R0     RAMPTR+1   ZERO LOW BYTE OF POINTER
1521 05 FF                LODI,R1     FF        SETUP STARTING DATA
1523 85 01         WRT    ADDI,R1     1         ADD 1 TO STARTING DATA
1525 01                   LODZ,R1               PUT IT IN R0 FOR USE
1526 06 00         WSTL   LODI,R2     0         SETUP INDEX REGISTER
1528 CE F5 48      WRTLP  STRA,R2    *RAMPTR,I  STORE NEXT BYTE
152B 84 01                ADDI,R0     1         INCREMENT DATA
152D 98 02                BCFR,EQ     WTSKP     IF ZERO  DONT BRANCH
152F 84 01                ADDI,R0     1         DONT LET ZERO BE STORED
1531 DA 75         WTSKP  BIRR,R2     WRTLP     DO 256 TIMES
1533 72                   REDD,R2               READ THE KEYBOARD
1534 9E 00 83             BCFA,LT     RETU      RETURN IF KEY IS PRESSED
1537 0A 0F                LODR,R2     RAMPTR    INCREMENT POINTER
1539 86 01                ADDI,R2     1
153B CA 0B                STRR,R2     RAMPTR
153D EE 15 13             COMA,R2     ENDT      SEE IF END OF TEST AREA
1540 98 64                BCFR,EQ     WSTL      IF NOT, BRANCH
1542 0A 4E                LODR,R2     STARTT    SETUP FOR START OF TEST AREA
1544 CA 02                STRR,R2     RAMPTR
1546 1B 02                BCTR,UN     RD        START READ LOOP
```

```
1548                  *
1548                  *
1548                  *
1548 00 00            RAMPTR RES          2
154A                  *
154A                  *
154A                  *
154A 01               RD      LODZ,R1                LOAD THE STARTING DATA VALUE
154B C3                       STRZ,R3                SAVE IT IN R3
154C 06 00            RSTL    LODI,R2     0          SETUP INDEX REGISTER
154E 0E F5 48         RDLP    LODA,R2    *RAMPTR,I   GET NEXT DATA BYTE
1551 E3                       COMZ,R3                COMPARE TO WHAT IT SHOULD BE
1552 B8 23                    BSFR,EQ     ERROR      IF NOT THE SAME, GOTO ERROR
1554 87 01                    ADDI,R3     1          INCREMENT DATA
1556 98 02                    BCFR,EQ     RDSKP      DONT ALLOW ZERO AGAIN
1558 87 01                    ADDI,R3     1
155A DA 72            RDSKP   BIRR,R2     RDLP       DO THIS LOOP 256 TIMES
155C 72                       REDD,R2                READ KEYBOARD
155D 9E 00 83                 BCFA,LT     RETU       RETURN IF KEY IS PRESSED
1560 0A 66                    LODR,R2     RAMPTR     INCREMENT RAM POINTER
1562 86 01                    ADDI,R2     1
1564 CA 62                    STRR,R2     RAMPTR
1566 EE 15 13                 COMA,R2     ENDT       SEE IF END OF TEST AREA
1569 98 61                    BCFR,EQ     RSTL       IF NOT, BRANCH
156B 0E 15 12                 LODA,R2     STARTT     REDO THE WHOLE THING AGAIN
156E CA 58                    STRR,R2     RAMPTR
1570 1F 15 23                 BCTA,UN     WRT
1573                  *
1573                  *
1573                  *
1573 00 00 00         TMP0    RES         4
1577                  *
1577                  *
1577                  *
1577 C8 7A            ERROR   STRR,R0     TMP0       SAVE THE REGISTERS
1579 C9 79                    STRR,R1     TMP0+1
157B CA 78                    STRR,R2     TMP0+2
157D CB 77                    STRR,R3     TMP0+3
157F 0A 47                    LODR,R2     RAMPTR     LOAD THE HIGH BYTE
1581 3F 00 6A                 BSTA,UN     HXOT       WRITE IT
1584 0A 6F                    LODR,R2     TMP0+2     WRITE THE LOW BYTE
1586 3F 00 6A                 BSTA,UN     HXOT
1589 07 20                    LODI,R3     20         WRITE A SPACE
158B 3F 03 96                 BSTA,UN     WCHR
158E 0A 66                    LODR,R2     TMP0+3     WRITE THE DATA WRITTEN
1590 3F 00 6A                 BSTA,UN     HXOT
1593 07 20                    LODI,R3     20         WRITE A SPACE
1595 3F 03 96                 BSTA,UN     WCHR
1598 0A 59                    LODR,R2     TMP0       WRITE THE DATA READ
159A 3F 00 6A                 BSTA,UN     HXOT
159D 3F 00 24                 BSTA,UN     LFCR
15A0 08 51                    LODR,R0     TMP0       RESTORE THE REGISTERS
15A2 09 50                    LODR,R1     TMP0+1
15A4 0A 4F                    LODR,R2     TMP0+2
15A6 0B 4E                    LODR,R3     TMP0+3
15A8 17                       RETC,UN                RETURN
```



Central Data Corporation

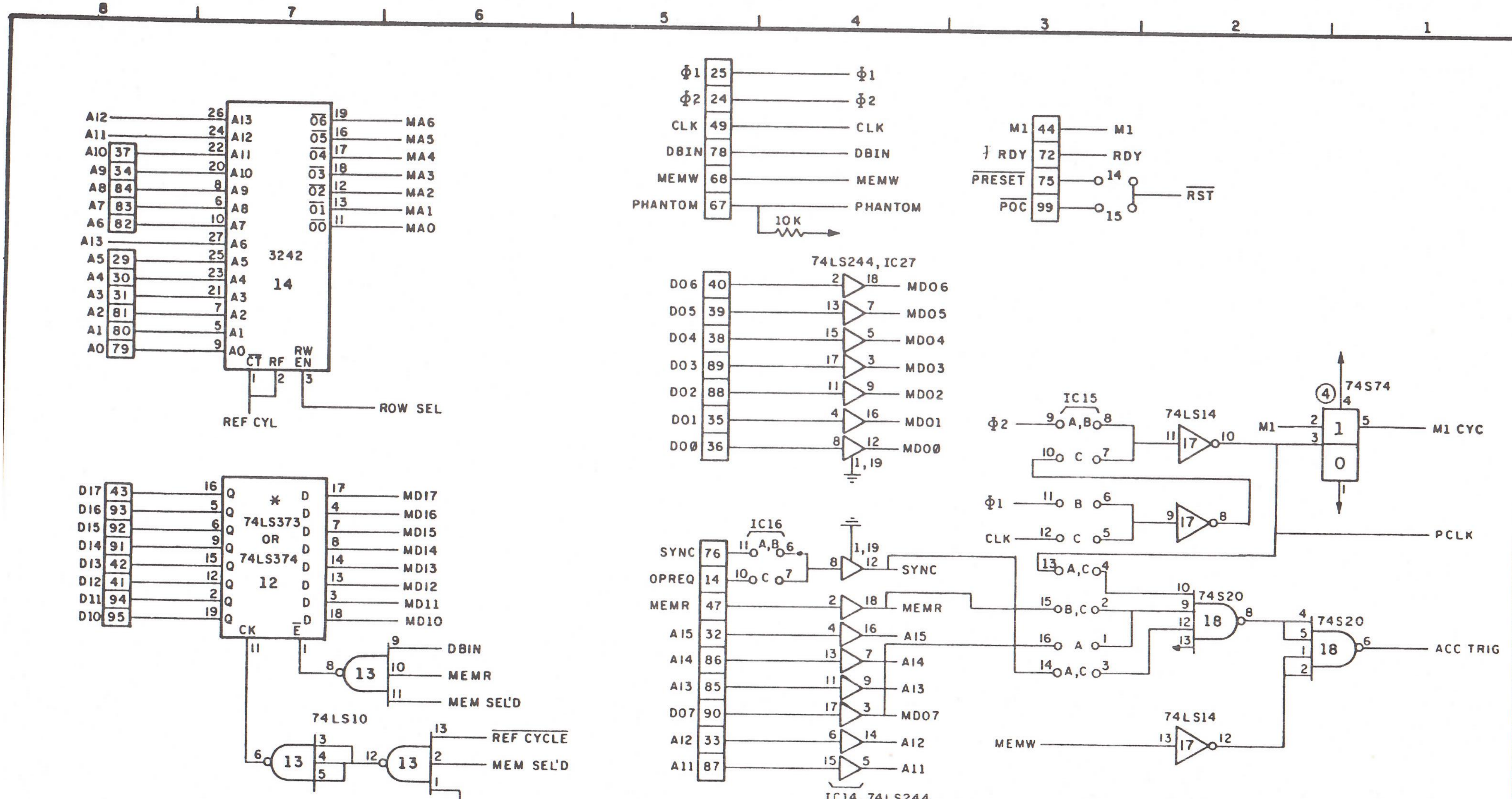
P.O. Box 2530, Sta. A, Champaign, IL 61820 (217) 359-8010

NO. A1065

SHEET 1 OF 5

64 K RAM BOARD

TIMING / REFRESH



NOTES: 1: 'A' STRAPS FOR 8080
'B' STRAPS FOR Z-80
'C' STRAPS FOR SPECIAL USE
2: ALL UNLABELED ARROWS ARE +5V
3: □ = S100 PIN
*: 4 MHz BOARDS REQUIRE 74S' PARTS

Central Data Corporation

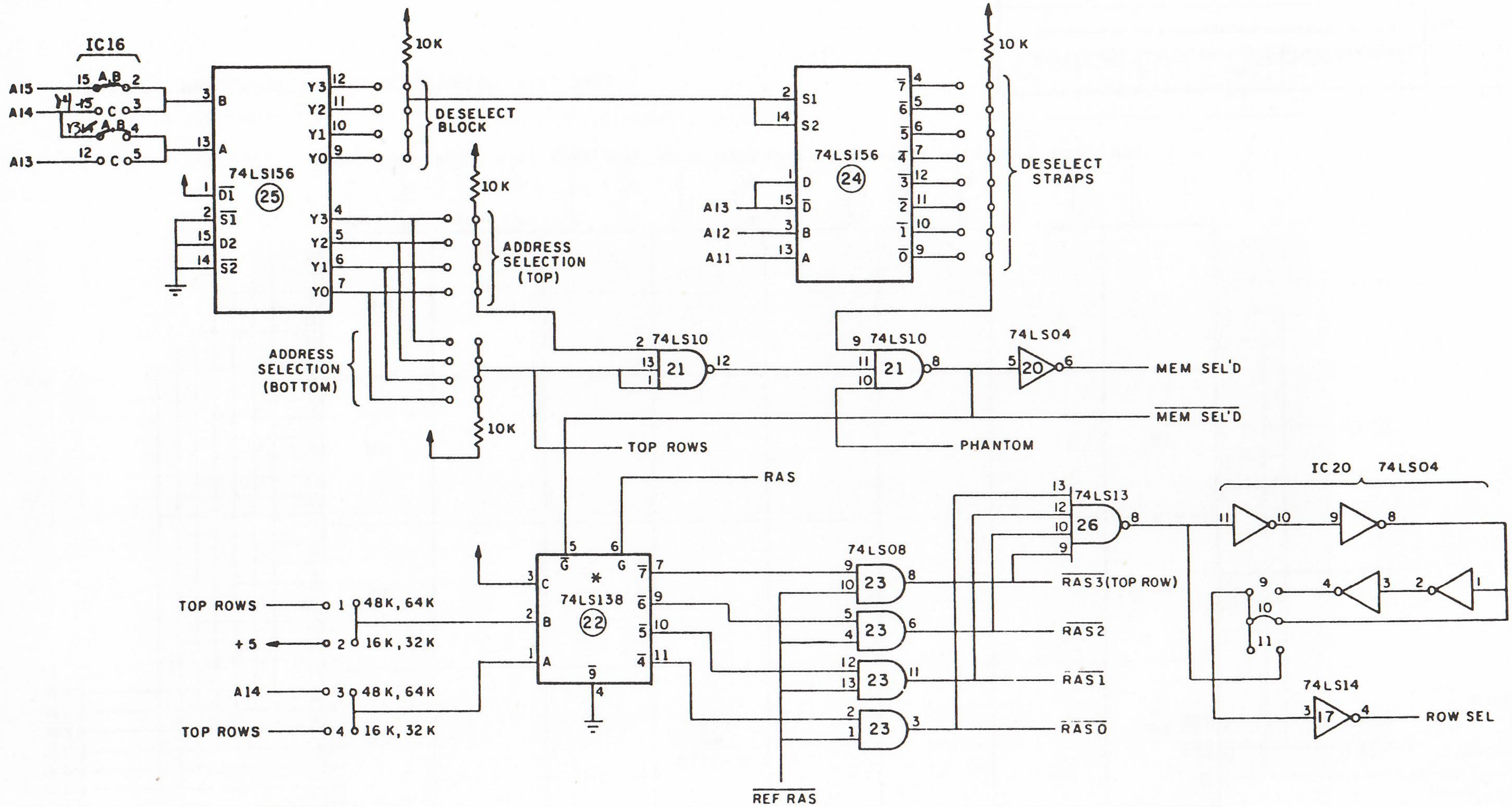
P.O. Box 2530, Sta. A, Champaign, IL 61820 (217) 359-8010

NO. A1066

SHEET 2 OF 5

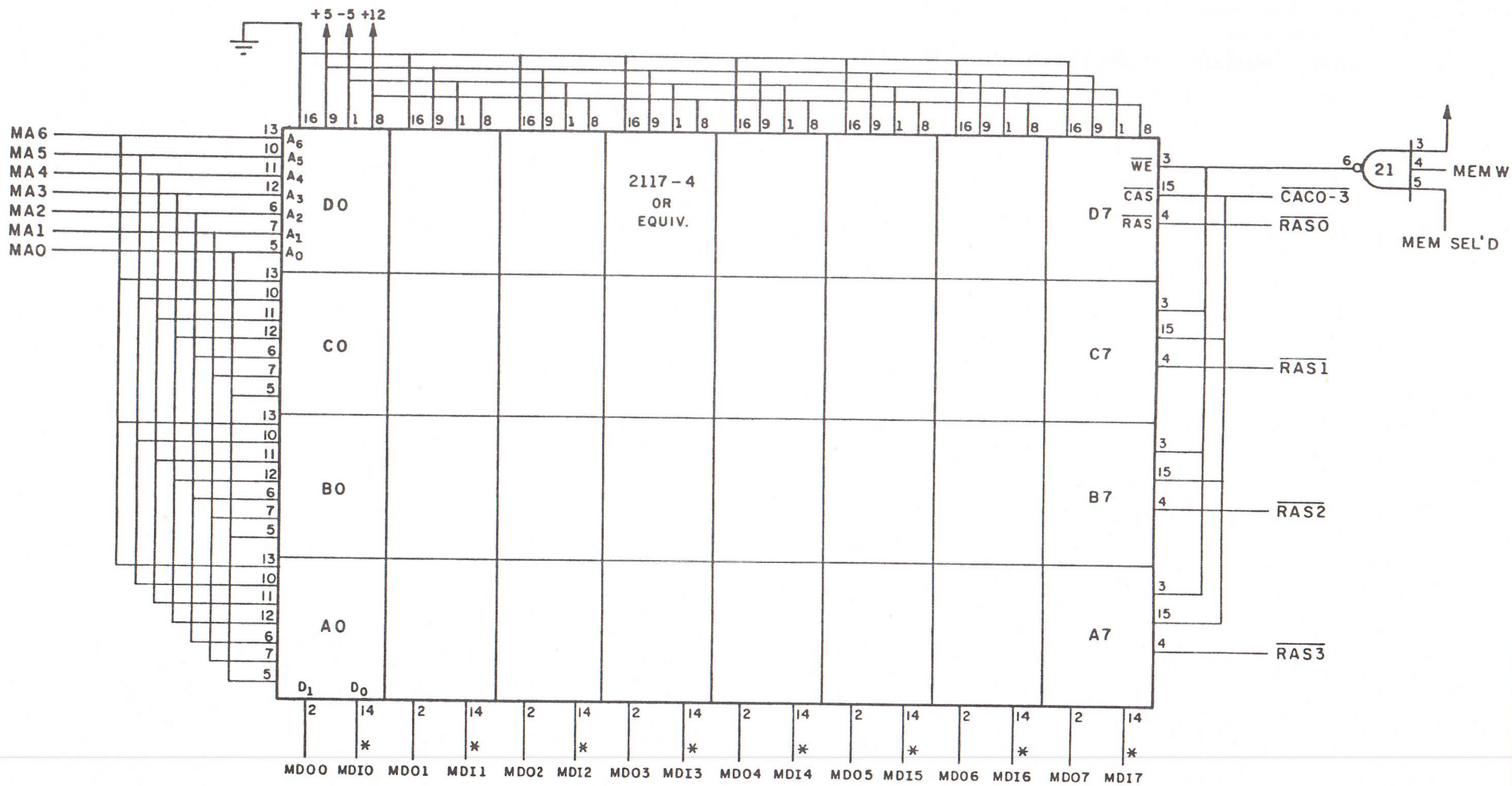
64 K RAM BOARD

BUFFERS



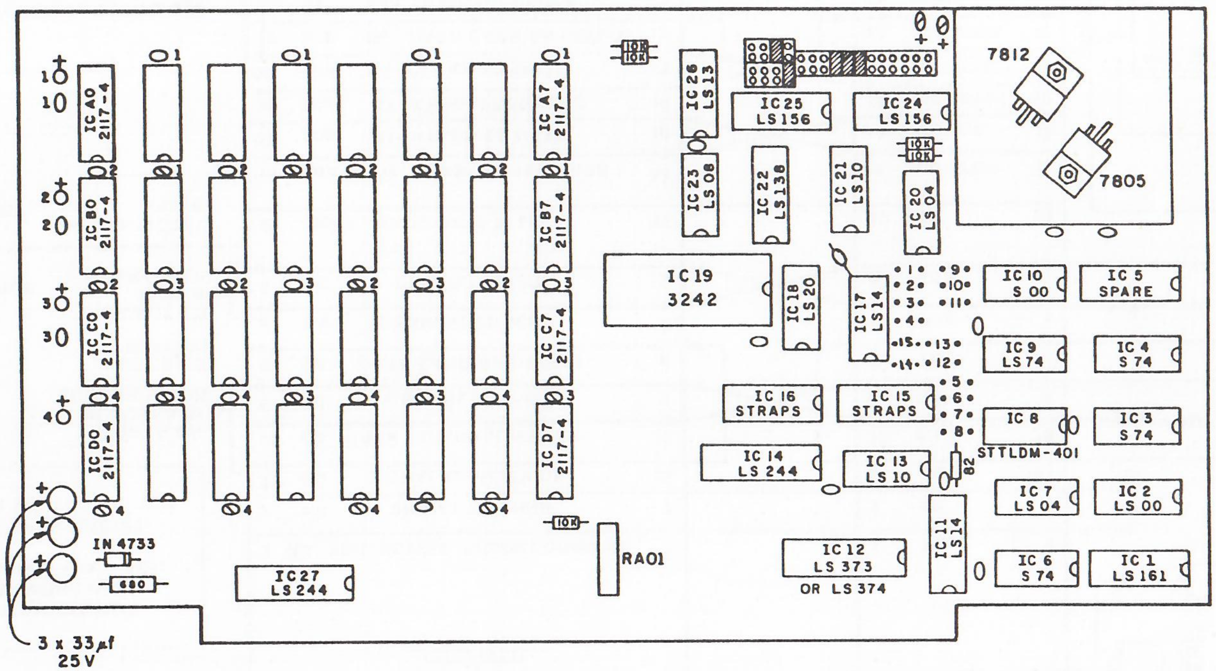
NOTE: 'A' STRAPS FOR 8080
'B' STRAPS FOR Z-80
'C' STRAPS FOR SPECIAL USE
*: 4 MHz BOARDS REQUIRE 74S' PARTS

Central Data Corporation P.O. Box 2530, Sta. A, Champaign, IL 61820 (217) 359-8010	NO. A1067 SHEET 3 OF 5
64K RAM BOARD	
RAS GATING	



* LINES PULLED-UP WITH 10K RESISTOR PAK, RA01

Central Data Corporation P.O. Box 2530, Sta. A, Champaign, IL 61820 (217) 359-8010	NO. A1068 SHEET 4 OF 5
64 K RAM BOARD	
MEMORY ARRAY	



NOTES: ⬭ = .1 µf / 25 V

⊘ = .33 µf / 25 V

O = 4.7 µf / 16 V

Central Data Corporation P.O. Box 2530, Sta. A, Champaign, IL 61820 (217) 359-8010	NO. A1069 SHEET 5 OF 5
64 K RAM BOARD	
PARTS LOCATION	

RS-232 SERIAL DATA COMMUNICATION