PACKET NUMBER 1

EXTENSIONS AND MODIFICATIONS TO THE MARK-8

THE DIGITAL GROUP &
DR. ROBERT SUDING WØLMD

Sept MARCH 1976

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PREFACE

What we and Dr. Suding have tried to accomplish with this packet is provide:

1. Significant hardware modifications for usability
2. A small 1K operating system to help you get started
3. A reliable cassette medium to allow loading of all software in one step
4. As many comments, recommendations, etcetera that we thought might also help people get going.

If you use a point-to-point wiring apporach, you should be able to build directly from the schematics as pin number callouts are included. Please do it slowly and carefully, as this method is very error-prone.

We have tried to be as accurate as possible in reproducing Dr. Suding's documentation but there are bound to be some errors or unclear areas. As you discover the errors or make improvements, please let us know so we can pass them on to others and update future copies. If you have questions on the packet, send them to us and we will try to answer them as quickly as possible or refer them to Dr. Suding. Dr. Suding requests that you write him through us rather than directly as he is not set up to handle any volume of mail and we are.

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MARK-8 ENHANCEMENTS

Some have claimed that the Mark-8 Microcomputer is a toy. It definitely isn't. It is almost unlimited in potential applications. However, its original capabilities can be vastly enhanced. This pack of information and schematics presents the modifications and enhancements made to the original Mark-8 as well as some additional units.

Several enhancement categories have been investigated and implemented. First, improved abilities to get data and software in and out of the Mark-8 were investigated. Next, better methods of displaying the software and data handling hardware were designed. Finally, software was written which would provide effective support of these enhancements, as well as provide a core of operations subroutines.

The initial modification was the use of plug-in sockets in place of those board-to-board wires which were breaking after many fold-opens. I had some old 47-pin second generation computer cards and sockets. After cutting off the top part of each card, leaving only about 1" of card bearing the pins, I epoxied these 47-pin stumps to each original microprocessor card. #30 Teflon wire was used to connect the new pins to the old lines, maintaining the same numbering sequence. Since the output and the input card have 7 to 8 ports, each port containing 8 bits, a dual set was used on these cards. These dual sets were made by bolting a second 47-pin stub to the original, spaced the socket spacing away. The input and output cards now have 94 pins, eliminating the need for those clumsy Molex connectors. The extra pin set is noted by an "x" following the pin number on the schematics.

The output card was modified by adding another 7402 and six 7475's in the unused card areas near the pin end of the card. This provided a total of seven 8-bit output ports from this card. The eighth output port (Port 7) is included on the LED readout pegboard. A similar number of ports extension on the input card was implemented.

A pegboard mounted set of twelve 7-segment LED's (MAN-1) and 7447 drivers is mounted behind the window formerly occupied by the LED lamp boards. The six address LED's are wired for leading zero blanking except for the least significant LED. The three memory LED's do not have leading zero blanking. Output port 7 is now used for the front panel output port instead of the original port Ø. The port 7 LED's are wired for complete leading zero blanking so that a ØØØ can be outputed to port 7 and completely blanked to reduce readout clutter.

A surplus desk top style 16-key calculator keyboard was purchased for key input of functions and data. Nine of the keys were assembled in a 3 x 3 block for Octal code entry. The rightmost column has a 1, 2, and 4 key, corresponding to the bit value of the least

significant digit of the Octal number. The middle column also has a 1, 2, and 4 key, corresponding to the bit value of the middle digit. The leftmost column contains a 1 & 2 key with a common clear key at the bottom. Operation of this key set consists of punching the needed bits while watching the accumulating value in three 7-segment LED readouts above the keyblock. Eight R-S flip-flops made from four 7400's hold the value as entered. After a given value is utilized to load address or data, the CLEAR key is pressed to reset the eight flipflops to ØØØ Octal. Three more keyswitches are mounted to the left of the Octal number block. These three are INTERRUPT, EXAMINE, and DEPOSIT, reading from top to bottom. To the right of the Octal number block are four more keyswitches: LOAD HIGH ADDRESS, LOAD LOW ADDRESS, RUN, and SINGLE STEP. Notice that the JAM switch is no longer used since JAM is logically generated in the switch pulse forming circuitry.

The address latch card has been radically changed due to the use of the very "bouncy" SPST keyswitches. Everything except the 74193's was stripped off the address latch board. The new circuitry shown on the address latch schematic was then added in the card area immediately above the 74193's. The 1/3 of the card to the side of 74193's is used for cassette interface logic now.

The cassette interface consists of four IC's. A 566 voltage controlled oscillator (VCO) is used to convert the Ø and 1 output of the least significant bit of output Port 1 to a frequency shift output. A 1 output gives 2125 HZ output and Ø output results in 2975 HZ from the VCO. The triangular wave output of the VCO is fed through a 47K resister to the microphone input of a $30 cassette recorder. A special program, LOAD CASSETTE (included), serializes the 8-bit parallel bytes and outputs them to Port 1 asyncronously at a rate of 1K/25 seconds. The receive portion of the cassette interface consists of a 741 limiter, a 5558 dual band-pass active filter for 2125 and 2975 HZ, and 741 output comparator giving the TTL compatible serial output to the least significant bit of input Port 1. After attaching the limiter's input to the phone jack output of my cassette, I start my recorder and a special deserializer program called DUMP CASSETTE (included). The cassette then loads the prerecorded operating system and operational program into storage. The cassette interface circuits were designed to operate on standard Teletype frequencies which allows them to be also used for sending and receiving Teletype signals. Since the programming establishes the encoding and decoding, almost any 850 HZ shift RTTY station can be copied, whether ASCII, BAUDOT, etc., at any speed.

Finally, a special TV readout circuit was built on the former LED board after completely stripping off the previous circuitry. This TV readout is built around a special character generator, the MCM 6571L from Motorola, which gives both upper and lower case alpha characters, as well as numbers, special characters, math symbols, and even the Greek alphabet. Cost is $27.50 from a distributor, and the characters are generated with a 7 x 12 dot

matrix format vastly easier to read than the 5 x 7 upper case-only R & E Typrwriters. The remaining IC's should cost about $32.00 at current surplus prices. The character memories are seven 1101's which result in 8 lines with 32 characters in each line. While this is less than the R & E TV Typewriter 1's 512 characters, it loads the screen apparently instantaneously, instead of taking 17 seconds. The circuit is much simpler, and the large line-to-line spacing is great for keeping the characters apart in such things as storage dumps, etc.

The TV readout has a few unusual features. All output is via a single output port, in my case, Port 6. The most significant bit is used as a data strobe line. Bits Ø - 6 define which of the 128 possible characters are to be printed, with one important exception. The solid block character (■) consists of all ones. I don't need this character, so when a bit pattern of all ones (including the strobe line) comes from Port 6, the 7430 detects this, and presets the 74193 address counter. The next character entry is then loaded at the upperleftmost screen position controlled by the RAM's. Each character will increment the address counter when entered, also eliminating the need for another port for address output. If you need the capability of random addressing, an output port could be used instead of the 74193 address latches.

My keyboard uses a re-encoded Microswitch keyboard with Hal Effect keyswitches, giving the 128 potential characters. Other 64-character ASCII keyboards could be used if special shifting key(s) and logic are added.

The power supply should have considerably greater potential on the +5 supply when running these modifications. Being rather conservative, and hating to blow CPU chips, I have built in a supply which can easily supply the required voltages. The +5 pass transistor dissapates considerable heat, so use as large a heat sink as possible.

Packaging is inside of a CO-1 LMB cabinet which is horrible over-priced, but looks nice. The output ports are available through some 16-pin second generation IBM computer card sockets (SMS), although 17 or slightly more pins would be better since at least a ground pin is generally needed. I use a separate bananna plug for common grounding.

Several basic software routines were required to support my enhanced Mark-8. First, routines for loading and dumping the cassettes were required. Since the data are stored serially on the cassettes, the loading and dumping routines were designed as parallel/serial and serial/parallel converters. Several short subroutines were designed to support the TV readout hardware by a "Erase/Home" subroutine, "Space Over" subroutine, and a "Write Long Character String" subroutine. Basic operational routines have been written

such as a "TV Storage Dump" which displays the memory contents in Octal code.

After evaluating the enclosed circuits and hardware, you can pick those improvements which would seem most worthwhile yourself. You may not feel any need for the modified front panel as well as the TV readout and keyboard entry. You may have already built the TVT circuitry and wish to use it instead of the enclosed circuitry. I would strongly recommend that you build the cassette hardware and software, however.

Some port reassignments have taken place. Port Ø, input and output, is now dedicated to the keyboard, although presently only port Ø input is used. Port 1, input and output, is dedicated to serial devices, presently using only bit Ø for the cassette recorder's interface. Ports 2, 3, 4, and 5 are brought out to the rear for external usage. Port 6 output is used for interfacing to the TV readout board. Port 7 output is used to drive a set of 7-segment readouts on the front panel in place of the Mark-8 use of port Ø output.

Dr. Robert Suding

THE DIGITAL GROUP PACKET #1 NARRATIVE

We'd like to recommend a way to get started implementing Dr. Suding's or your own modifications. First and foremost, make all the boards pluggable. To do this, find a surplus set of PC boards and sockets or a card rack containing cards and connectors. Or buy a new set of PC card headers and connectors. The more pins the better. You'll need about 10 sets. (47-pin double-tier Elco/Varicon sockets and cards are ideal as they are very solid and self-supporting in any plane, but are very expensive new.) Crop off the connectors that are on the surplus card leaving about an extra 1" of card length behind the connector. Bolt the card connectors onto the Mark-8 boards (after stripping off appropriate circuitry). If you can't find 47-pin or larger sockets and connectors (a very likely possibility) and don't want to buy new ones (see note #1), then use 2 22-pin connectors and sockets or equivalent per Mark-8 card. Be aware that the input and output port cards will then require 4 22-pin connectors so physical mounting gets a little bit tricky.

Attach connecting wires between the old pads and new connectors on the boards in the same relative position as on the old board. Next, wire up the octal display and front panel keyboard which will replace the front panel and LED display board. (Please note that the front panel keyboard also requires the modifications to the address latch board for proper operation.) You might want the keyboard and display on a separate module with about a 2-foot cable plugging into the new Mark-8.

Build an extender card. Either convert one of your surplus cards or use a piece of flat metal, rods, bars or whatever for the mechanical mounting of the plug and socket and then interconnect with wires. Then wire up the cassette interface on the address latch card and, after debugging, you're ready for some software. At this point you're pretty free to choose whichever modification or extension you wish to implement next. Our choice of a typical implementation sequence is as follows:

1. TV Typewriter (including full keyboard) - Dr. Suding's or equivalent
2. Output port extensions
3. Input port extensions
4. Typewriter/teletype printer
5. Cassette tape drives

Note #1--If you do want to buy new ones, drop us a SASE for some more ideas on it--there are several ways to go.

MODIFYING THE BOARDS

In order to reclaim space on the PC board, you need to strip off the old circuitry. The recommended method:

1. If you need to remove only part of a line, cut it at the stopping point with an x-acto knife.

2. Heat the end of the circuit line (usually at a pad) with a small or medium wattage soldering iron and flick up the end of the PC-circuit line with an x-acto knife. What you are trying to do is create what's known as a foil separation.

3. Grab the raised end of the circuit with a pair of needle-nose pliers and pull gently. The line should come away easily and cleanly until you reach the breakpoint you cut in #1 (if any).

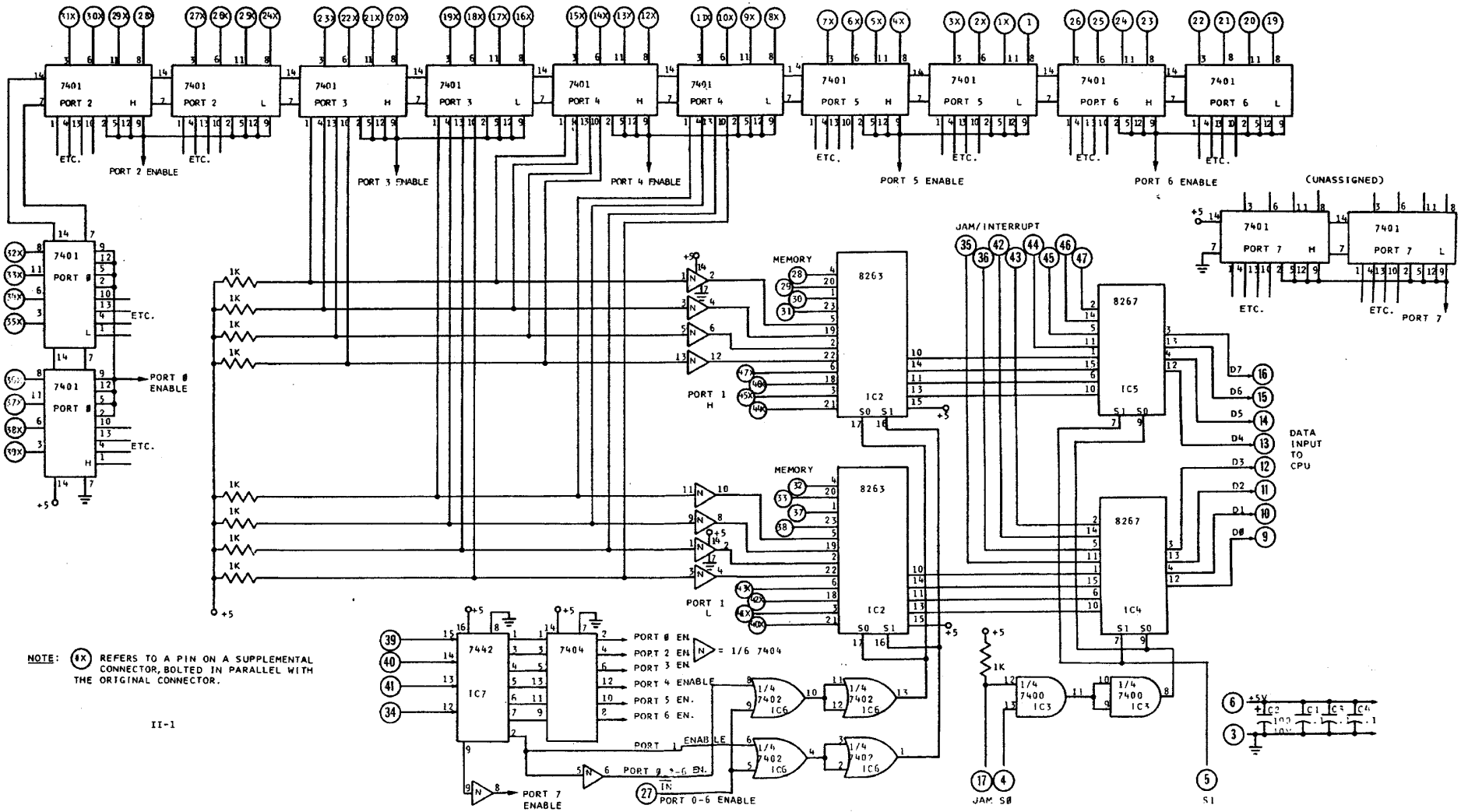
4. Continue in this manner until you reclaim all the desired area on both sides of the board.

Building a circuit on the board using a point-to-point approach is as follows:

Lay out a pattern. Drill a 14- or 16-pin DIP pattern with a small drill bit for each IC. Drill appropriate holes near the IC for components. Install the ICs and components in the same direction (front to back) as the other ICs that are already on the board. On the bottom, bend the pins slightly outward to retain the component. Interconnect the ICs and components using thin wire (#30 works well) and soldering directly to the IC pins. Then inter-connect (tie to IC pins on bottom) the circuit to the remaining parts of the old circuit (if any) and the circuit board connector as required. Attach to the old soldered ICs on the bottom of the board via their pins.

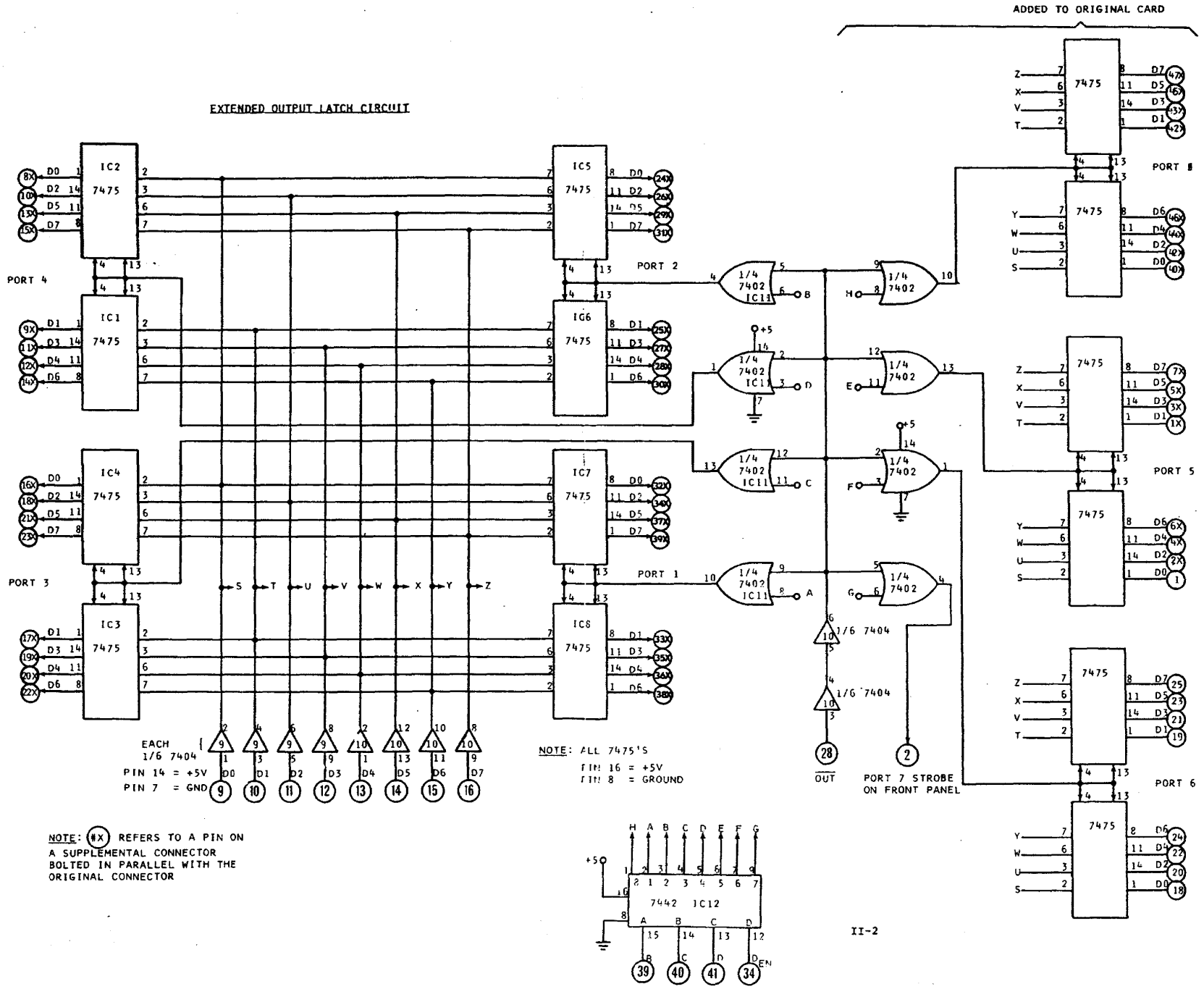
An alternative approach would be to wire up the new circuit on Vero or Vectorboard and bolt it to the old board and then connect it to the old circuit and the circuit board connector. This approach is not as dense in terms of component packing that can be achieved with the first approach but can sometimes be easier and quicker.

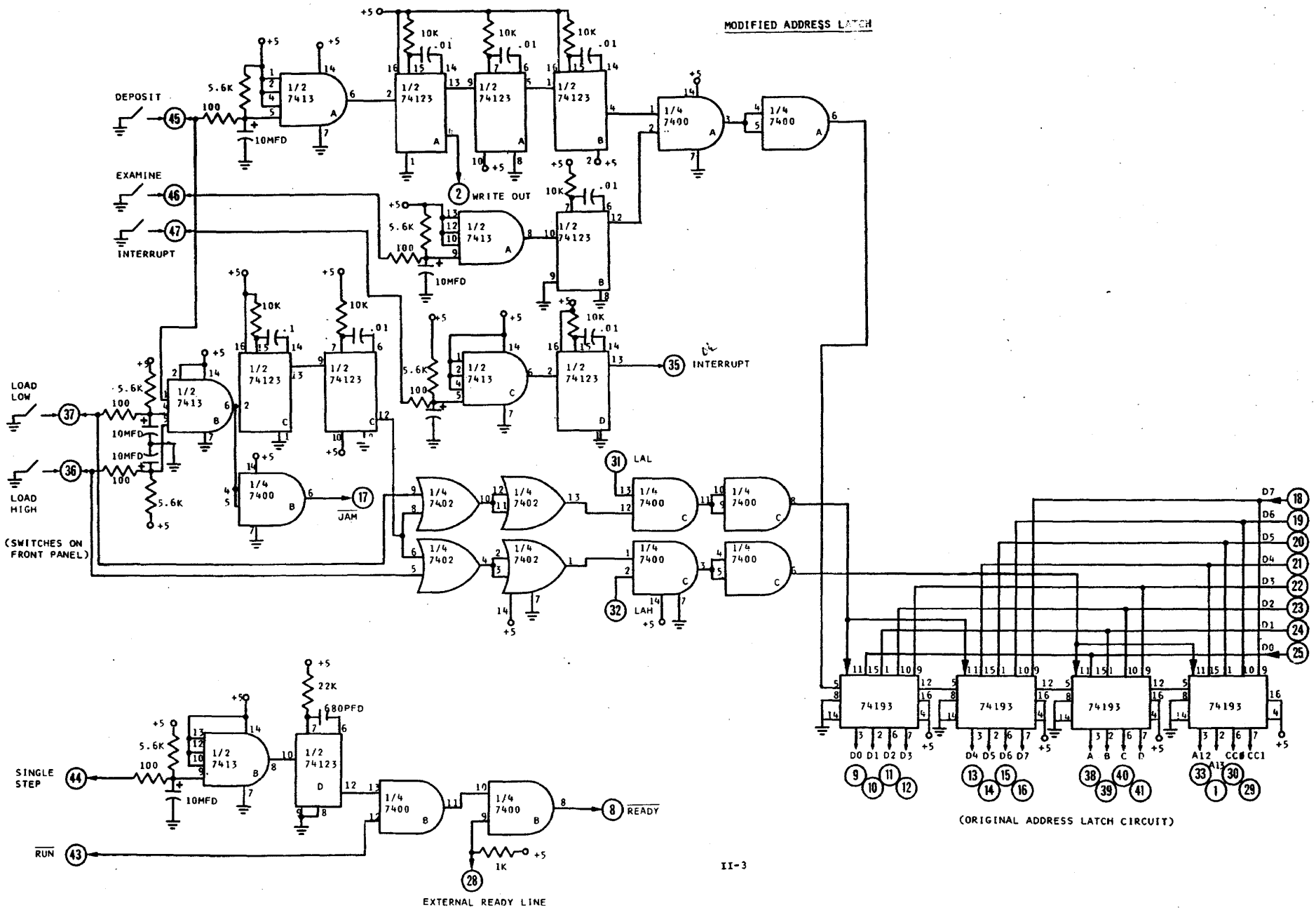
EXTENDED INPUT MULTIPLEXER

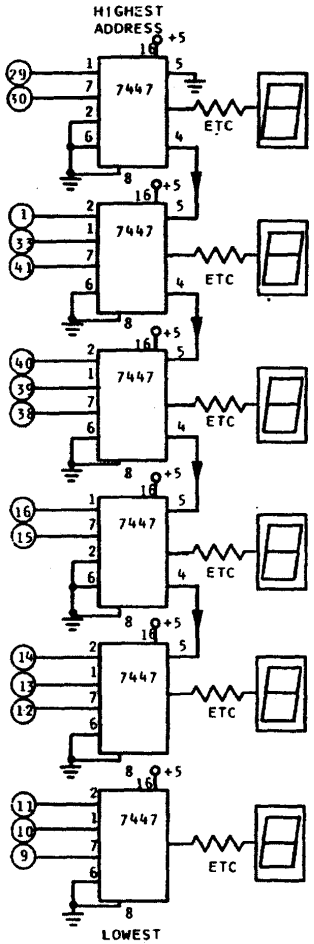


NOTE: (#X) REFERS TO A PIN ON A SUPPLEMENTAL CONNECTOR, BOLTED IN PARALLEL WITH THE ORIGINAL CONNECTOR.

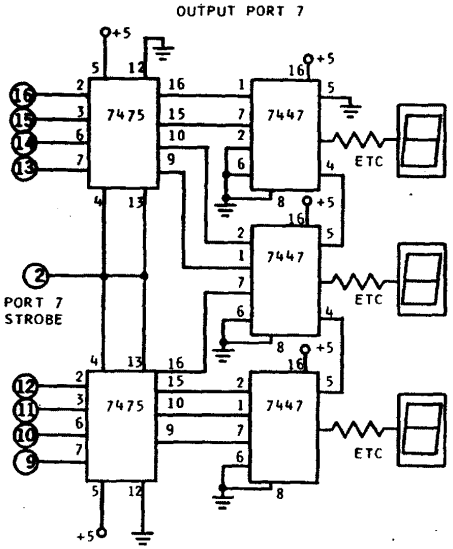
EXTENDED OUTPUT LATCH CIRCUIT



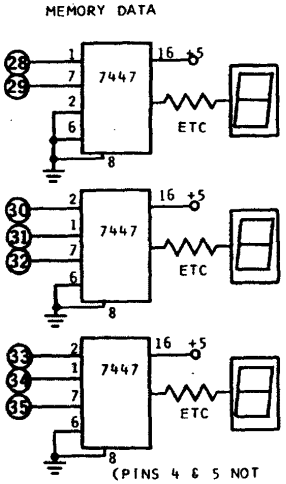

MODIFIED ADDRESS LATCH
DEPOSIT
EXAMINE
INTERRUPT
LOAD LOW
LOAD HIGH
(SWITCHES ON FRONT PANEL)
WRITE OUT
INTERRUPT
LAL
LAH
JAM
SINGLE STEP
RUN
READY
EXTERNAL READY LINE
74193
(ORIGINAL ADDRESS LATCH CIRCUIT)



*LEADING ZEROES BLANKED

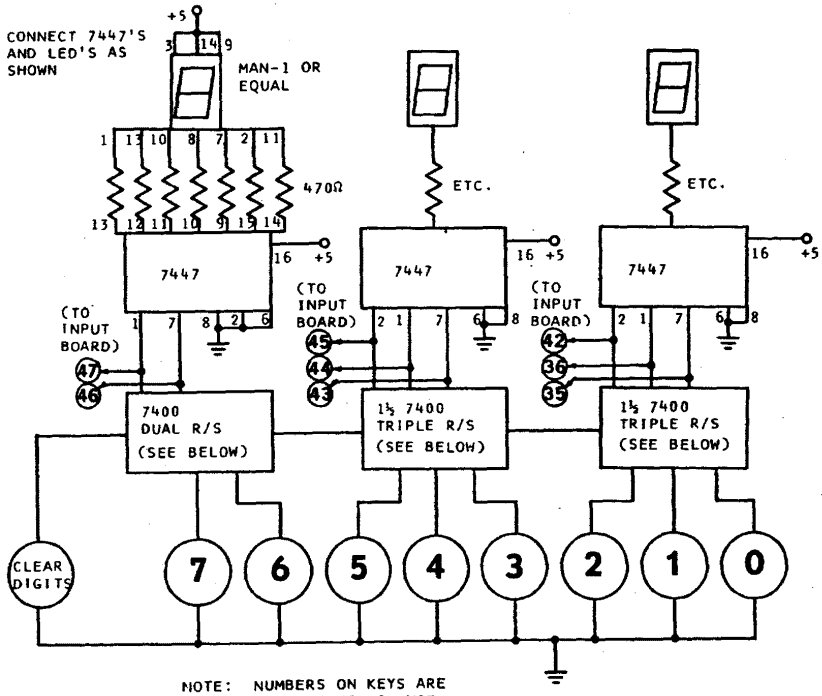


*LEADING ZEROES & ZERO VALUE BLANKED

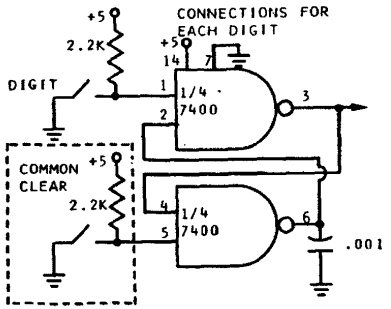


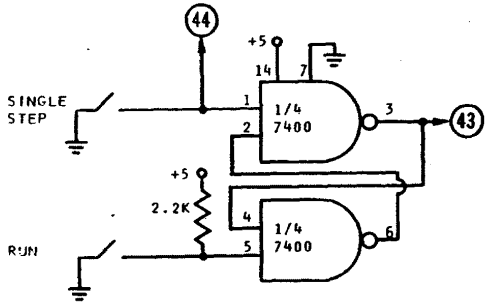
(PINS 4 & 5 NOT CONNECTED ON MEMORY 7447'S)

*NO BLANKING USED

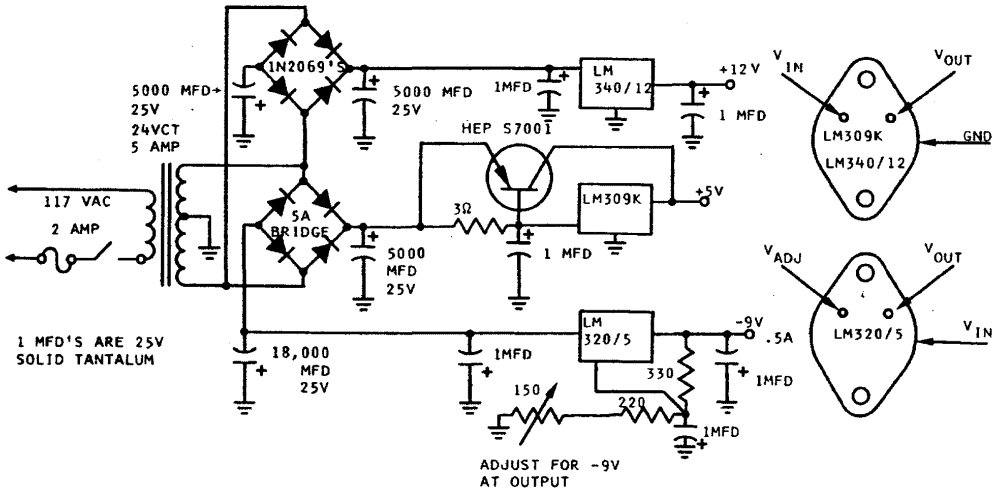


NOTE: NUMBERS ON KEYS ARE BIT POSITIONS, NOT OCTAL VALUES.

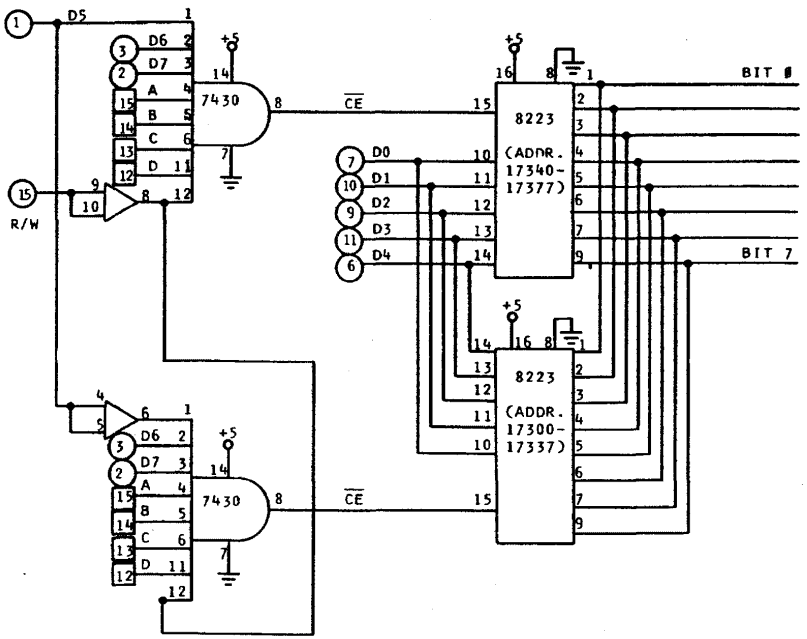




FRONT PANEL OCTAL DISPLAY AND OCTAL KEYBOARD



POWER SUPPLY



8223 ROM CIRCUIT ON 1101 MEMORY BOARD

R/W & D0 TO D7 CIRCLED NUMBERS ARE 1101 PINS.

A B C D SQUARED NUMBERS ARE 7442 PINS.

THE INVERTERS SHOWN ARE TWO SECTIONS OF IC34 ON MEMORY BOARD 1. THE 1/4 7400 SECTION USING PINS 8,9, & 10 IS CUT LOOSE FROM ITS PRESENTLY USED PATTERN AND WIRED AS SHOWN.

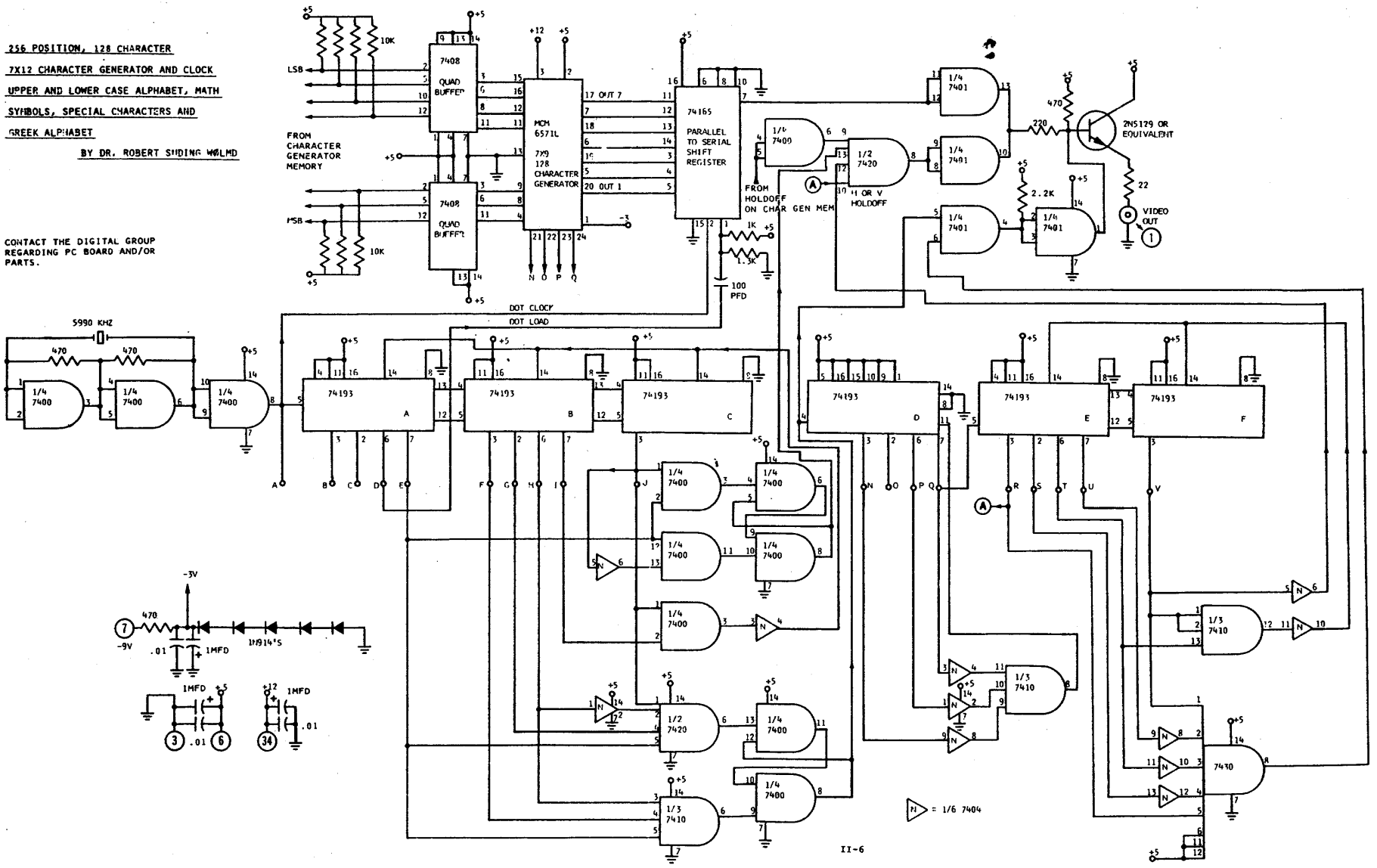
256 POSITION, 128 CHARACTER

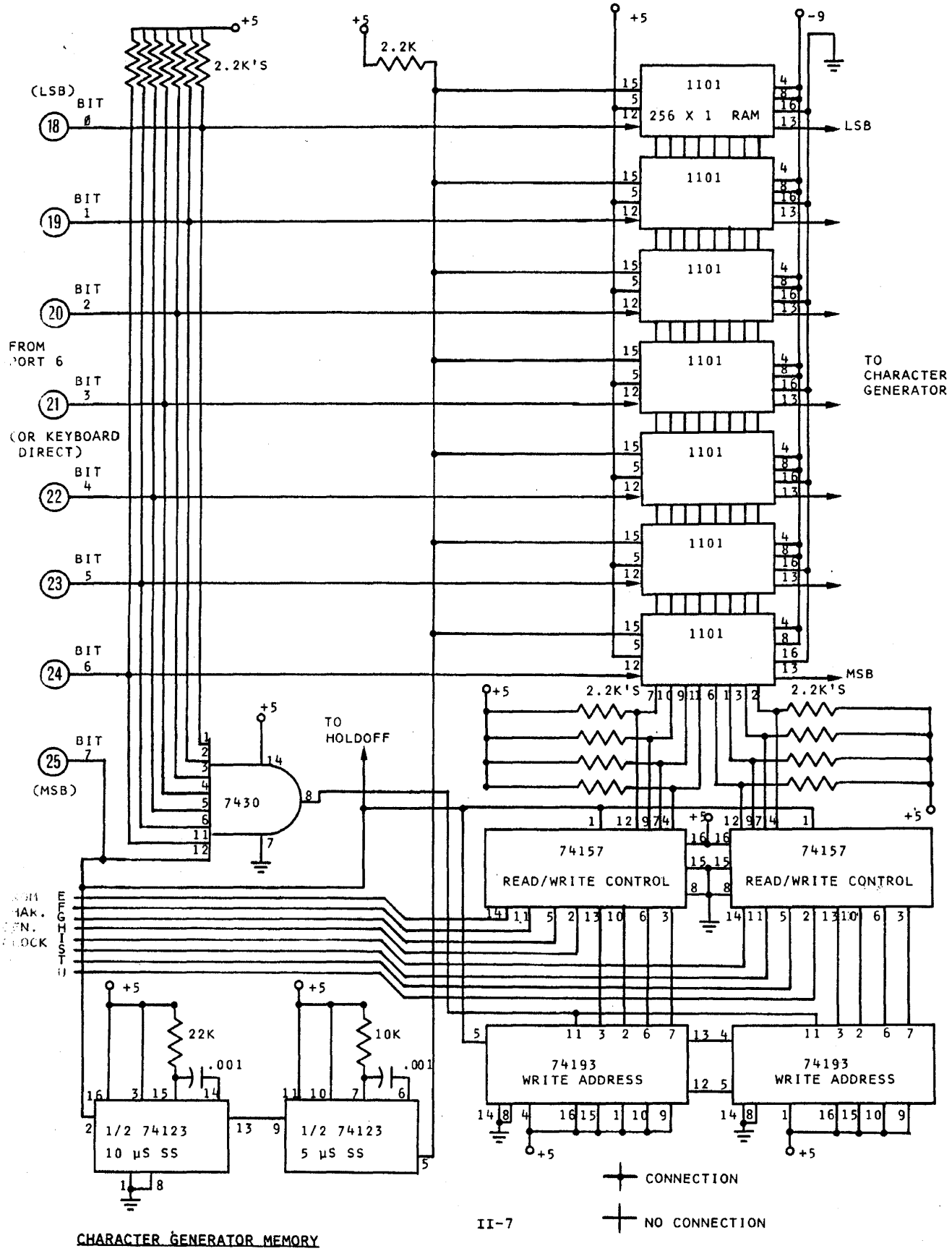
7X12 CHARACTER GENERATOR AND CLOCK

UPPER AND LOWER CASE ALPHABET, MATH SYMBOLS, SPECIAL CHARACTERS AND GREEK ALPHABET

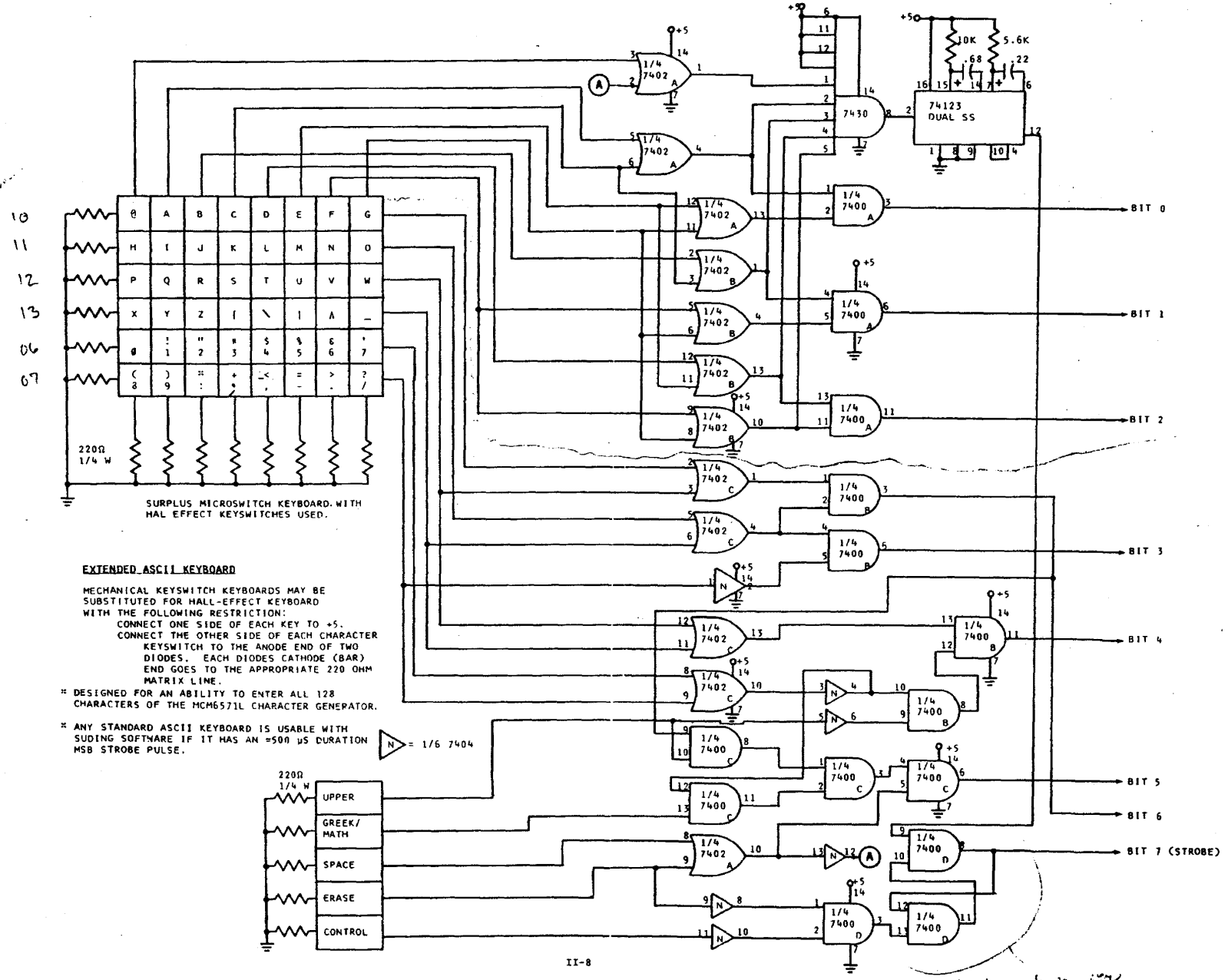
BY DR. ROBERT SUDING WØLMD

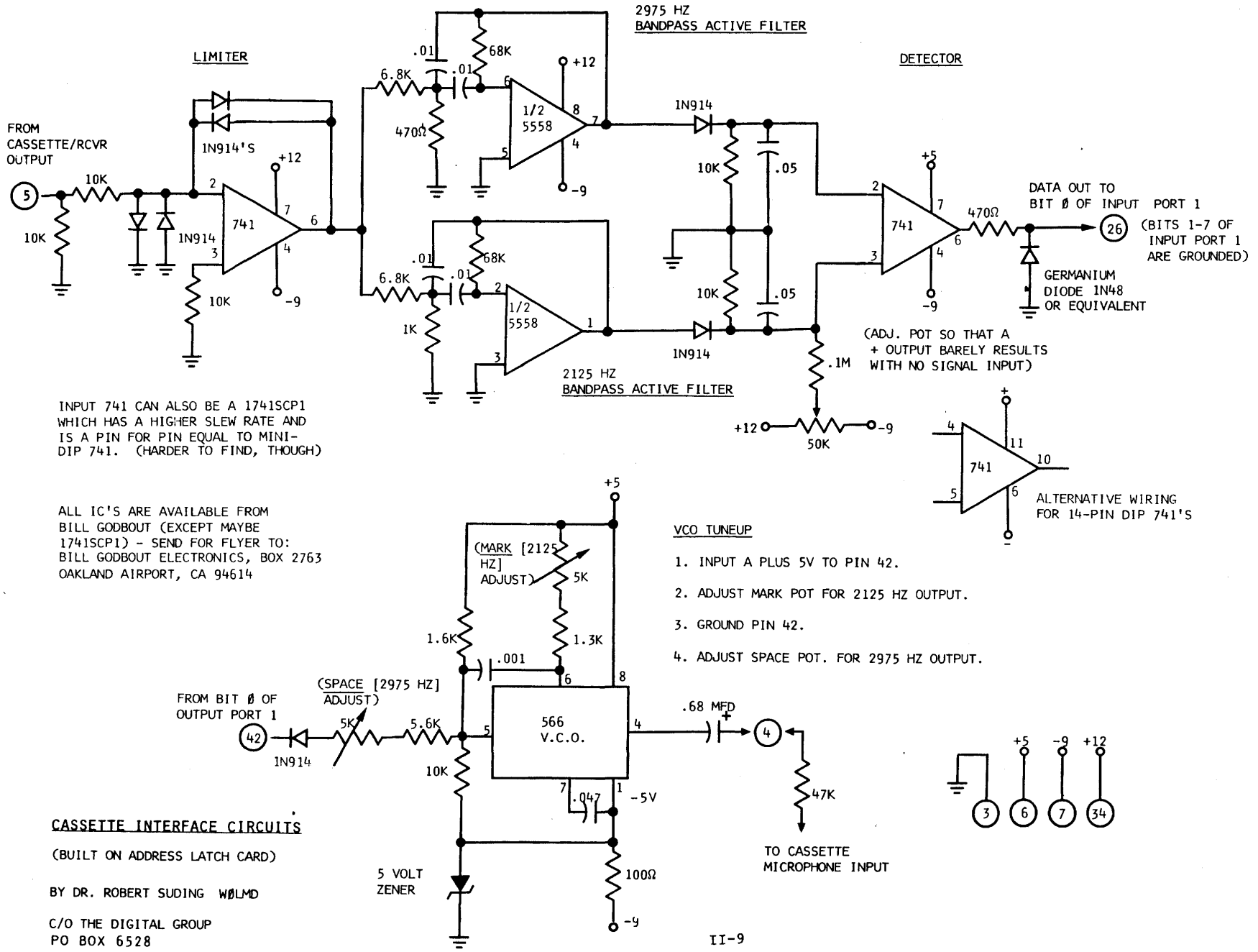
CONTACT THE DIGITAL GROUP REGARDING PC BOARD AND/OR PARTS.





CHARACTER GENERATOR MEMORY


10
11
12
13
06
07
220Ω
1/4 W
SURPLUS MICROSWITCH KEYBOARD. WITH
HAL EFFECT KEYSWITCHES USED.
EXTENDED ASCII KEYBOARD
MECHANICAL KEYSWITCH KEYBOARDS MAY BE
SUBSTITUTED FOR HALL-EFFECT KEYBOARD
WITH THE FOLLOWING RESTRICTION:
CONNECT ONE SIDE OF EACH KEY TO +5.
CONNECT THE OTHER SIDE OF EACH CHARACTER
KEYSWITCH TO THE ANODE END OF TWO
DIODES. EACH DIODES CATHODE (BAR)
END GOES TO THE APPROPRIATE 220 OHM
MATRIX LINE.
* DESIGNED FOR AN ABILITY TO ENTER ALL 128
CHARACTERS OF THE MCM6571L CHARACTER GENERATOR.
* ANY STANDARD ASCII KEYBOARD IS USABLE WITH
SUDING SOFTWARE IF IT HAS AN =500 µS DURATION
MSB STROBE PULSE.
= 1/6 7404
UPPER
GREEK/
MATH
SPACE
ERASE
CONTROL
7430
74123
DUAL SS
10K
5.6K
.68
.22
BIT 0
BIT 1
BIT 2
BIT 3
BIT 4
BIT 5
BIT 6
BIT 7 (STROBE)


LIMITER
2975 HZ
BANDPASS ACTIVE FILTER
DETECTOR
FROM
CASSETTE/RCVR
OUTPUT
1N914'S
+12
10K
741
1N914
10K
-9
.01
68K
6.8K
470Ω
1/2
5558
1K
2125 HZ
BANDPASS ACTIVE FILTER
.05
DATA OUT TO
BIT Ø OF INPUT PORT 1
(BITS 1-7 OF
INPUT PORT 1
ARE GROUNDED)
GERMANIUM
DIODE 1N48
OR EQUIVALENT
(ADJ. POT SO THAT A
+ OUTPUT BARELY RESULTS
WITH NO SIGNAL INPUT)
.1M
50K
INPUT 741 CAN ALSO BE A 1741SCP1
WHICH HAS A HIGHER SLEW RATE AND
IS A PIN FOR PIN EQUAL TO MINI-
DIP 741. (HARDER TO FIND, THOUGH)
ALTERNATIVE WIRING
FOR 14-PIN DIP 741'S
ALL IC'S ARE AVAILABLE FROM
BILL GODBOUT (EXCEPT MAYBE
1741SCP1) - SEND FOR FLYER TO:
BILL GODBOUT ELECTRONICS, BOX 2763
OAKLAND AIRPORT, CA 94614
VCO TUNEUP
1. INPUT A PLUS 5V TO PIN 42.
2. ADJUST MARK POT FOR 2125 HZ OUTPUT.
3. GROUND PIN 42.
4. ADJUST SPACE POT. FOR 2975 HZ OUTPUT.
(MARK [2125
HZ]
ADJUST)
5K
1.6K
1.3K
.001
(SPACE [2975 HZ]
ADJUST)
FROM BIT Ø OF
OUTPUT PORT 1
5.6K
566
V.C.O.
.68 MFD
1N914
10K
.047
-5V
47K
TO CASSETTE
MICROPHONE INPUT
5 VOLT
ZENER
100Ω
CASSETTE INTERFACE CIRCUITS
(BUILT ON ADDRESS LATCH CARD)
BY DR. ROBERT SUDING WØLMD
C/O THE DIGITAL GROUP
PO BOX 6528
DENVER, COLORADO 80206
II-9

8008 MICROPROCESSOR BACK-PLANE BOARD INTERCONNECTIONS

CPU	IN	IN-X	ADDRESS	MEM-1	MEM-2	OUT	OUT-X	TV	LED
1 X	ØPORT5	1	X	R-1		ØPORT5	1	VIDEO	X
2		|	W	W	R-1	G	|		G
3 X	X	|	X	X	X	X	|	X	X
4 X	X	PORT5	CASS IN				PORT5		
5 X	X	|	CASS OUT				|		
6 X	X	|	X	X	X	X	|	X	X
7 X		7	X	X	X		7	X	
8 X		Ø	X				Ø		
9 X	X	|	Y	Y	Y	Y	|		Y
10 X	X	|	Y	Y	Y	Y	|		Y
11 X	X	PORT4	Y	Y	Y	Y	PORT4		Y
12 X	X	|	Y	Y	Y	Y	|		Y
13 X	X	|	Y	Y	Y	Y	|		Y
14 X	X	|	Y	Y	Y	Y	|		Y
15 X	X	7	Y	Y	Y	Y	7		Y
16 X	X	Ø	Y	Y	Y	Y	Ø		Y
17	J	|	J				|		Q-1
18 X		|	X	X	X	Z	|	Z	Q-2
19 X	Ø	PORT3	X	X	X	Z	PORT3	Z	Q-3
20 X	|	|	X	X	X	Z	|	Z	Q-4
21 X	|	|	X	X	X	Z	|	Z	Q-5
22 X	PORT6	|	X	X	X	Z	|	Z	Q-6
23 X	|	7	X	X	X	Z	7	Z	Q-7
24 X	|	Ø	X	X	X	Z	Ø	Z	Q-8
25 X	|	|	X	X	X	Z	|	Z	X-1
26 X	7	|	DATA OUT	X	X		|		X-2
27 X	X	PORT2					PORT2		X-3
28 X	M	|	XTRNRDY	M	M	X	|		M
29 X	M	|	X-1	M	M		|		M
30 X	M	|	X-2	M	M		|		M
31 X	M	7	X	M	M		7		M
32 X	M	Ø	X	M	M		Ø		M
33 X	M	|	X-3	M	M		|		M
34 X	X	|	+12	M-1	M-1	X	|	+12	M-1
35 X	Q-1	PORT1	X	M-2	M-2		PORT1		M-2
36 X[1]	Q-2	|	A				|		A
37 X[1]	M-1	|	A				|		A
38	M-2	|	X	X	X		|		X
39	X	7	X	X	X	X	7		X
40	X	Ø	X	X	X	X	Ø		X
41	X	|	X	X	X	X	|		X
42	Q-3	|	DATA IN				|		
43	Q-4	PORTØ	A				PORTØ		A
44	Q-5	|	A				|		A
45	Q-6	|	A				|		A
46	Q-7	|	A				|		A
47	Q-8	7	A				7		A

BACKPLANE WIRING INTERCONNECTION NOTES

THIS BACKPLANE DIAGRAM IS BASED ON THE DIGITAL GROUP'S CONFIGURATION WHICH EVOLVED FROM DR. SUDING'S. IT IS INCLUDED FOR INFORMATIONAL PURPOSES ONLY. YOU WILL HAVE TO ADAPT TO YOUR OWN CONNECTOR SYSTEM. AS YOU DO SO WE WOULD HIGHLY RECOMMEND EITHER ADAPTING OUR DIAGRAM OR CONSTRUCTING YOUR OWN. IT IS PROBABLY THE MOST SIGNIFICANT SINGLE DOCUMENT YOU CAN HAVE ABOUT YOUR SYSTEM FOR LATER REFERENCE.

AS FAR AS POSSIBLE WE TRIED TO MAINTAIN COMPATABILITY WITH THE ORIGINAL MARK-8 PINOUT. ALSO, MOST CONNECTIONS WERE MADE IN PARALLEL BETWEEN CONNECTORS. LIKE SINGLE LETTERS (HORIZONTALLY) ARE CONNECTED TOGETHER. LETTERS WITH NUMBERS (Q-1, ETC.) ARE CONNECTED TO THE SAME LETTER-NUMBER PAIR (Q-1 TO Q-1, ETC.) AND MAY NOT NECESSARILY BE IN PARALLEL. INPUT AND OUTPUT PORTS ARE BROUGHT OUT TO A PADDLE BOARD CONNECTOR ON THE REAR OF THE CHASSIS.

[1]BROUGHT OUT BUT NOT USED

MODIFICATIONS AND EXTENSIONS PARTS LISTS

TV Typewriter Character Generator

Qty	Part
3	7400
1	7401
2	7404
2	7408
1	7410
1	7420
2	7430
1	74123
2	74157
1	74165
8	74193
7	1101
1	MCM6571L
1	5990 KHz crystal
8	1N914 diodes
1	22 ohm ¼w resis.
1	220 ohm
4	470 ohm
1	1K
1	1.3K
16	2.2K
1	2.4K
8	10K
1	22K
1	100 pfd capacitor
2	.001 mfd capac.
3	.01 mfd
3	1 mfd Tantalum caps.

Input Port Extensions

Qty	Part
14	7401
3	7404
8	1K ¼w Resis.

Output Port Extensions

Qty	Part
1	7402
6	7475

Extended ASCII Keyboard Encoder

Qty	Part
4	7400
3	7402
1	7404
1	7430
1	74123
19	220 ohm resis.
1	5.6K
1	10K
1	.68 mfd tantalum capacitor
1	.22 mfd tantalum capacitor

Cassette Interface

Qty	Part
1	5558
1	556
2	741
7	1N914 diodes
1	1N48 Germanium diode or equivalent
1	5V Zener diode
1	100 ohm ¼w resis.
2	470 ohm
1	1K
1	1.3K
1	1.6K
1	5.6K
2	6.8K
6	10K
1	47K
2	68K
1	100K
1	50K Trimpot
2	5K Trimpot
1	.001 mfd capacitor
4	.01 mfd
1	.047 mfd
2	.05 mfd
1	.68 mfd electrolytic capacitor

Address Latch

Qty	Part
3	7400
1	7402
3	7413
4	74123
6	110 ohm resis.
1	1K
6	5.6K
7	10K
1	22K
1	680 pfd capac.
6	.01 mfd
1	.1 mfd
6	10 mfd elec. cap.

Front Panel Keyboard

Qty	Part
5	7400
3	7447
3	Man-1 or equal
21	100 - 470 ohm resistors
9	2.2K
1	16-key keyboard

7-Segment Octal Display

Qty	Part
12	7447
2	7475
12	Man-1 or equal
84	100 - 470 ohm resis.

Power Supply

Qty	Part
4	1N2069 or equal
1	5Amp Bridge
1	HEP S7001
1	LM 309K
1	LM 340/12
1	LM 320/5
1	24 VCT 8Amp Transforme
1	2 Amp Fuse
1	18,000 Mfd 25V Cap or Larger
3	5,000 Mfd 25V Caps
6	1 Mfd 25V solid Tant.
1	3 ohm
1	220 ohm
1	150 ohm trimpot

IC AND MAJOR PARTS SUMMARY FOR ALL MODIFICATIONS AND EXTENSIONS

for bulk orders if desired (does not include power supply)

Quantity	Part
15	7400
15	7401
5	7402
6	7404
2	7408
1	7410
3	7413
1	7420
3	7430
15	7447
8	7475
6	74123
2	74157
1	74165
8	74193
1	5558
1	556
2	741
1	MCM6571L
15	Man-1 or equal
1	5990 KHz Crystal
1	16-key keyboard
7	1101

hardware things to do 10/1/76

1) order parts for front panel display (see other side) and 256 byte ram + prom
2) modify boards for plug in.
3) get tape to work again (probably works already
4) fix keyboard strobe
5) build multiplex display with 0.3" displays I bought today
6) invert keyboard output with HEX buffer
7) cassette recorder fix!

Software 1) program mini monitor using
   a) multiplex display
   b) keyboard
   c) option for tape I/O
2) assembler on SOS/3
3) simulator on CYBER
4) assembler on CYBER
6) calculator (octal and decimal)

SOFTWARE NARRATIVE

The software programs and routines are all sequentially contained on the cassette. They are designed to fit into a 1K system. To dump the cassette into memory, hand enter the program "Cassette Dumper for Cold Start" at location 003000 (and following) from the documentation (page IV-16). Enter "104" (jump unconditional) at location 000000, "000" at 000001, and "003" at 000002. Do a Restart "005" which is the following:

Enter "005" on the data register
Press STOP
Press INTERRUPT

Begin playing the cassette. After the constant leader tone stabilizes, press RUN and the Cassette Dumper program should begin dumping the cassette into storage from address 000000 to 003377.

The cassette will return to a constant tone at the end of the data. The computer should halt and display 003056 at that time. Stop the cassette. Do a Restart to the program you wish to execute. If the Cassette Dumper program halted before the data stopped playing, the load was bad and should be redone. (After the interface is completed and debugged this is very rare and is usually due to a mistake in entering the Cassette Dumper program, a failing memory chip, or dirty heads on the recorder.) After you have successfully loaded the distribution cassette into your system, and verified its contents, we would recommend writing a new cassette with the "Cassette Loader" program. This will negate any speed discrepencies between systems and recorders and will also provide a form of backup.

Cassette Contents and 1K Storage Map as Distributed

Address	Program/Routine
000000 - 000046	Restart to Programs
000047 - 000071	Memory Clear
000100 - 000147	Memory Checker
000150 - 000176	Bit Reverse
000200 - 000220	TV Character Generator Test
000230 - 000270	Keyboard to Memory
000300 - 000336	Number Sorting
001000 - 001137	Running TV Display
001240 - 001373	TV Character Demonstration
002000 - 002077	Keyboard to TV
002100 - 002351	TV Storage Dump
003000 - 003056	Cassette Dumper
003100 - 003120	Home Erase Subroutine
003122 - 003133	Spacer Subroutine
003135 - 003146	Writer Subroutine
003150 - 003160	"Dumped ok" constant
003162 - 003176	Timer Subroutine
003200 - 003327	Cassette Loader

Compatability

If your system does not match our configuration (a very real possibility) you will have to modify the software package and/or upgrade the hardware. The major changes will involve different I/O devices and Port assignments. After you have made the appropriate changes, save them on a different cassette and you're in business. Note also that the TVT is supported in a modular fashion via subroutines. If you are using a TVT I or a TVT II, you should only have to change the subroutines and their call addresses within the programs if they change. The Suding TVT is, of course, fully supported.

Clock Syncronization

The cassette was written with a 4 Mhz crystal clock which is the frequency specified for the original Mark-8. If your system is not based on a 4 Mhz crystal (or equivalent with different divisors) you may have trouble reading the cassette in. To recover, use the documentation and hand enter the programs and write your own cassette which will then be in sync with your system.

Port Assignments

Dr. Suding's and the digital group's modified Micros have the following configuration which is supported by the 1K system:

```
Input Port Ø           = Keyboard
Input Port 1 (Bit Ø)   = Cassette In
Output Port 1 (Bit Ø)  = Cassette Out
Output Port 6          = TVT
Output Port 7          = Front Panel LEDs
```

Cassette Recorder Note

There are no required modifications to the cassette deck. However, your cassette recorder may have an automatic speaker cutoff when a plug is inserted into the auxilary output. We would recommend bypassing the cutoff so you can hear the cassette in operation. Bypass usually involves shorting two pins on the auxiliary output jack.

Keyboard Program Loader

The Keyboard Program Loader is not included in this original distribution of Packet #1. Some bugs developed which we are in the process of shooting plus we wanted to incorporate a number of new features. A copy of the new program will be distributed to all purchasers of Packet #1 without charge at a later time.

PROGRAM: RESTART TO PROGRAMS

OCTAL ADDRESS	OCTAL CODE	OPERATION
000000	104	Jump unconditional
000001	LLL	
000002	00H	(Beginning point of
000003	}	operational program)
000004	}	
000005	}→	Reserved for ROM
000006		Operating System
000007		
000010	104	Jump unconditional
000011	200	
000012	003	Load Cassette
000013		
000014		
000015		
000016		
000017		
000020	104	Jump unconditional
000021	000	
000022	003	Dump Cassette
000023		
000024		
000025		
000026		
000027		
000030	104	Jump unconditional
000031	000	
000032	002	TV Keyboard
000033		
000034		
000035		
000036		
000037		
000040	104	Jump unconditional
000041	100	
000042	002	TV Storage Dump
000043		
000044		
000045		
000046		

PROGRAM: MEMORY CLEAR - Sets all of storage above this routine to zero.

OCTAL ADDRESS	OCTAL CODE	OPERATION
000047	016	Load B with 000
000050	000	
000051	056	Load H with 000
000052	000	
000053	066	Load L with 071
000054	071	
000055	371	Store B in memory
000056	060	Increment L
000057	110	Jump not zero
000060	055	
000061	000	
000062	050	Increment H
000063	305	Load A with H
000064	074	Compare A with 004*
000065	004	
000066	110	Jump not equal
000067	055	
000070	000	
000071	000	Halt

COMMENTS: *Set to byte above highest available address
1K= 004
1.5K= 006
2.0K= 010, etc.

Start this program by loading "047" at 000001 and "000" at 000002, then do a Restart "005". The program should halt with a "000071" in the address registers and "000" in all memory positions above 072. All routines in storage above 072 will be lost! This routine is helpful when all storage is to be set to zero prior to initially building a program. Setting all of unused storage to zero can greatly aid in finding bad jumping and calling routines, since a "000" is a halt instruction, and the halting address will be displayed. Comparing this address with your code will usually show the error.

PROGRAM: MEMORY CHECKER - Exercise those surplus 1101's!

OCTAL ADDRESS	OCTAL CODE	OPERATION	OCTAL ADDRESS	OCTAL CODE	OPERATION
000100	016	Load B with 000	000124	110	Jump if not equal
000101	000		000125	106	
000102	056	Load H with 000	000126	000	
000103	000		000127	301	Load A with B
000104	066	Load L with 150	000130	074	Compare A with 377
000105	150		000131	377	
000106	371	Store B in memory	000132	150	Jump if equal
000107	307	Load A from memory	000133	100	
000110	271	Compare A to B	000134	000	
000111	110	Jump not equal	000135	010	Increment B
000112	141		000136	104	Jump uncond
000113	000		000137	102	
000114	060	Increment L	000140	000	
000115	110	Jump not zero	000141	137	Out 7
000116	106		000142	000	Halt
000117	000		000143	305	Load A with H
000120	050	Increment H	000144	137	Out 7
000121	305	Load A with H	000145	306	Load A with L
000122	074	Compare A with	000146	137	Out 7
000123	004*	004*	000147	000	Halt

COMMENTS: All routines above 000147 will be lost. Enter "100" at 000001 and "000" at 000002. Do a restart 005. Address and Memory Data LED's continually "twinkle" if every bit OK. If the program stops, out 7 has the failing bit. Doing a restart to 000143 and single stepping will show the failing address.

*Set address at 123 according to your storage capacity:

256 bytes - 001
512 bytes - 002
768 bytes - 003
1K bytes - 004 etc.

PROGRAM: BIT REVERSE by John Nall, Tallahassee, FL

OCTAL ADDRESS	OCTAL CODE	OPERATION
000150	006	Load # in A
000151	#	(01001001 now) (111 Octal)
000152	066	Load L with 000
000153	000	
000154	016	Load B with 8
000155	010	
000156	350	Load H with A
000157	305	Load A with H
000160	012	Shift A right
000161	350	Load H with A
000162	044	AND A with 200
000163	200	
000164	206	ADD L to A
000165	002	Shift left
000166	360	Load L with A
000167	011	Decrement B
000170	301	Load A with B
000171	110	Jump if not zero
000172	157	
000173	000	
000174	306	Load A with L
000175	137	Out 7 (10010010 will be displayed)
000176	000	Halt (222 octal)

COMMENTS: Load a byte into the A register.
This routine does a bit for bit swap, LSB through MSB.
Start by entering a sample # at 000151. Enter "150"
at 000001 and a "000" at 000002, then do a Restart 005.

PROGRAM: TV CHARACTER GENERATOR TEST

OCTAL ADDRESS	OCTAL CODE	OPERATION
000200	006	Load A with 377
000201	377	
000202	135	Out 6
000203	220	Clear A
000204	135	Out 6
000205	310	Load B with A
000206	301	Load A with B
000207	064	OR A with 200
000210	200	
000211	135	Out 6
000212	220	Clear A
000213	135	Out 6
000214	010	Increment B
000215	110	Jump not zero
000216	206	
000217	000	
000220	000	Halt

COMMENTS: The 127 valid characters of the MCM6571L character generator will be displayed on the TV set sequentially. In addition, a random pattern of 128 characters will follow with a ■ ending.
Start by loading "200" at 000001 and "000" at 000002. Restart 005 will then display the characters. This is a very handy routine for initially testing the TV readout generator system - all functions are exercised by this routine.

PROGRAM: KEYBOARD TO MEMORY

OCTAL ADDRESS	OCTAL CODE	OPERATION	FUNCTION
000230	066	Load L with 000	Starting address
000231	000		
000232	056	Load H with 001	
000233	001		
000234	101	Input Ø	Get character
000235	074	Compare A with 200	
000236	200		
000237	140	Jump if less	
000240	234		
000241	000		
000242	300	NOP	
000243	300	NOP	
000244	370	Store A	Delay to clear strobe bit
000245	016	Load B with 000	
000246	000		
000247	010	Increment B	
000250	110	Jump not zero	
000251	247		
000252	000		
000253	306	Load A with L	Byte counter display
000254	137	Out 7	
000255	060	Increment L	512 character load
000256	110	Jump not zero	
000257	234		
000260	000		
000261	050	Increment H	
000262	305	Load A with H	
000263	074	Compare A with 003	
000264	003		
000265	110	Jump not equal	
000266	234		
000267	000		
000270	000	Halt	

COMMENTS: Start by loading "230" at 000001 and "000" at 000002. Then do a Restart 005. The 512 bytes of memory from 001000 to 002377 are used for character storage, so the routines formerly occupying those locations will have to be restored by redumping the cassette.

PROGRAM: NUMBER SORTING - ASCENDING ORDER

OCTAL ADDRESS	OCTAL CODE	OPERATION	OCTAL ADDRESS	OCTAL CODE	OPERATION
000300	056	Load H with 001	000320	110	Jump not zero
000301	001	(Starting Page)	000321	306	
000302	066	Load L with 000	000322	000	
000303	000	(Starting Address)	000323	000	Halt
000304	026	Load C with	000324	317	Load B with Mem
000305	XXX	(Ending addr to be sorted)	000325	061	Decrement L
			000326	307	Load A with Mem
000306	307	Load A with Memory	000327	371	Load Mem with B
000307	060	Increment L	000330	060	Increment L
000310	277	Compare Mem with A	000331	370	Load Mem with A
000311	150	Jump if equal	000332	306	Load A with L
000312	317		000333	121	Out 7
000313	000		000334	104	Jump unconditional
000314	100	Jump if not less	000335	300	
000315	324		000336	000	
000316	000				
000317	021	Decrement C			

COMMENTS: This is a slight modification of Dr. George Haller's sorting routine. Bytes 001000 to 001377 will be sorted into ascending order. Restore the original programs by redumping the cassette. Start this program by loading byte 000001 with "300" and 000002 with "000" Then do a Restart 005.

PROGRAM: RUNNING (RIGHT TO LEFT) TV DISPLAY
Simulates an alphanumeric self-scan panel.

OCTAL ADDRESS	OCTAL CODE	OPERATION
001000	106	Call (Name Erase)
001001	100	
001002	003	
001003	046	Load F with 150
001004	150	
001005	106	Call Spacer
001006	122	
001007	003	
001010	056	Load H with 001
001011	001	
001012	066	Load L with 116
001013	116	
001014	046	Load E with 022
001015	022	
001016	106	Call Writer
001017	135	
001020	003	
001021	106	Call Timer
001022	162	
001023	003	
001024	056	Load H with 000
001025	000	
001026	006	Load A with 240
001027	240	
001030	066	Load L with 340
001031	340	
001032	370	Store A
001033	060	Increment L
001034	110	Jump not zero
001035	032	
001036	001	
001037	036	Load D with 341
001040	341	
001041	101	Input Ø
001042	074	Compare A with 200
001043	200	
001044	140	Jump if less
001045	040	
001046	001	
001047	340	Load E with A
001050	363	Load L with D
001051	307	Load A with Mem
001052	061	Decrement L
001053	370	Store A
001054	030	Increment D
001055	300	NOP
001056	300	NOP
001057	300	NOP
001060	110	Jump not zero
001061	050	
001062	001	
001063	066	Load L with 377
001064	377	
001065	374	Store E
001066	300	NOP
001067	300	NOP
001070	006	Load A with 377
001071	377	
001072	135	Out 6
001073	220	Clear A
001074	135	Out 6
001075	066	Load L with 340
001076	340	
001077	307	Load A with Mem
001100	135	Out 6
001101	220	Clear A
001102	135	Out 6
001103	060	Increment L
001104	110	Jump not zero
001105	077	
001106	001	
001107	104	Jump uncond.
001110	037	
001111	001	
001112	000	Halt
001113	000	
001114	000	
001115	000	
001116	322	R
001117	365	u
001120	356	n
001121	356	n
001122	351	i
001123	356	n
001124	347	g
001125	240	

OCTAL ADDRESS	OCTAL CODE	OPERATION
001126	324	T
001127	326	V
001130	240	
001131	304	D
001132	351	i
001133	363	s
001134	360	p
001135	354	l
001136	341	a
001137	371	y

COMMENTS: Entered characters from the keyboard appear at the right hand side of the screen. Subsequent characters push the previous character one position to the ~~right~~ left. After 32 characters, the leftmost character is pushed off the screen.

Start by loading "000" at 000001 and "001" at 000002. Then do a Restart 005.

PROGRAM: TV CHARACTER DEMONSTRATION

OCTAL ADDRESS	OCTAL CODE	OPERATION
001240	106	Call Home Erase
001241	100	
001242	003	
001243	056	Load H with 001
001244	001	
001245	066	Load L with 330
001246	330	
001247	046	Load E with 033
001250	033	
001251	106	Call Writer
001252	135	
001253	003	
001254	046	Load E with 045
001255	045	
001256	106	Call Spacer
001257	122	
001260	003	
001261	046	Load E with 170
001262	170	
001263	304	Load A with E
001264	135	Out 6
001265	220	Clear A
001266	135	Out 6
001267	026	Load C with 360
001270	360	
001271	016	Load B with 000
001272	000	
001273	010	Increment B
001274	110	Jump not zero
001275	273	
001276	001	
001277	020	Increment C
001300	110	Jump not zero
001301	271	
001302	001	
001303	040	Increment E
001304	304	Load A with E
001305	074	Compare A with 377
001306	377	
001307	110	Jump not equal
001310	263	
001311	001	
001312	046	Load E with 050
001313	050	
001314	106	Call Spacer
001315	122	
001316	003	
001317	046	Load E with 012
001320	012	
001321	106	Call Writer
001322	135	
001323	003	
001324	000	Halt
001325		
001326		
001327		
001330	324	T
001331	326	V
001332	240	
001333	303	C
001334	310	H
001335	301	A
001336	322	R
001337	301	A
001340	303	C
001341	324	T
001342	305	E
001343	322	R
001344	240	
001345	304	D
001346	305	E
001347	315	M
001350	317	O
001351	316	N
001352	323	S
001353	324	T
001354	322	R
001355	301	A
001356	324	T
001357	311	I
001360	317	O
001361	316	N
001362	240	
001363	316	N
001364	305	E
001365	301	A
001366	324	T
001367	240	
001370	310	H
001371	325	U
001372	310	H
001373	277	?

COMMENTS: Start by loading "240" at 000001 and "001" at 000002. Then do a Restart 005. This routine contains timing loops to slow it down. For a full speed version, NOP (enter 300) for bytes 001267 - 001302.

PROGRAM: KEYBOARD TO TV

OCTAL ADDRESS	OCTAL CODE	OPERATION
002000	106	Call unconditional -
002001	100	Home Erase
002002	003	
002003	046	Load E with 150
002004	150	
002005	106	Call unconditional -
002006	122	Spacer
002007	003	
002010	056	Load H with 002
002011	002	
002012	066	Load L with 062
002013	062	
002014	046	Load E with 16
002015	016	
002016	106	Call unconditional -
002017	135	Writer
002020	003	
002021	016	Load B with 000
002022	000	
002023	026	Load C with 000
002024	000	
002025	020	Increment C
002026	110	Jump not zero
002027	025	
002030	002	
002031	010	Increment B
002032	110	Jump not zero
002033	023	
002034	002	
002035	106	Call unconditional -
002036	100	Home Erase
002037	003	
002040	101	Input Ø
002041	074	Compare A with 200
002042	200	
002043	140	Jump if less
002044	040	
002045	002	
002046	135	Out 6
002047	220	Clear A
002050	135	Out 6
002051	016	Load B with 000
002052	000	
002053	010	Increment B
002054	110	Jump not zero
002055	053	
002056	002	
002057	104	Jump unconditional
002060	040	
002061	002	
002062	324	T
002063	326	V
002064	240	
002065	313	K
002066	345	E
002067	371	Y
002070	342	B
002071	357	O
002072	341	A
002073	362	R
002074	344	D
002075	240	
002076	317	O
002077	316	N

COMMENTS: Begin this program by doing a Restart 035.

PROGRAM: TV STORAGE DUMP - Dumps storage in octal onto TV screen

OCTAL ADDRESS	OCTAL CODE	OPERATION
002100	106	Call unconditional -
002101	100	Home Erase
002102	003	
002103	046	Load E with 050
002104	050	
002105	106	Call unconditional -
002106	122	Spacer
002107	003	
002110	056	Load H with 002
002111	002	
002112	066	Load L with 300
002113	300	
002114	046	Load E with 020
002115	020	
002116	106	Call unconditional -
002117	135	Writer
002120	003	
002121	046	Load E with 114
002122	114	
002123	106	Call unconditional -
002124	122	Spacer
002125	003	
002126	046	Load E with 037
002127	037	
002130	106	Call unconditional -
002131	135	Writer
002132	003	
002133	056	Load H with ø
002134	000	
002135	066	Load L with ø
002136	000	
002137	101	Input ø
002140	074	Compare A with 240
002141	240	
002142	110	Jump not equal
002143	137	
002144	002	
002145	106	Call unconditional -
002146	100	Home Erase
002147	003	
002150	300	NOP
002151	300	NOP
002152	300	NOP
002153	345	Load E with H
002154	106	Call unconditional -
002155	240	Character
002156	002	
002157	346	Load E with L
002160	106	Call unconditional -
002161	240	Character
002162	002	
002163	026	Load C with 004
002164	004	
002165	046	Load E with 001
002166	001	
002167	106	Call unconditional -
002170	122	Spacer
002171	003	
002172	347	Load E from memory
002173	106	Call unconditional -
002174	240	Character
002175	002	
002176	060	Increment L
002177	021	Decrement C
002200	110	Jump not zero
002201	165	
002202	002	
002203	046	Load E with 012
002204	012	
002205	106	Call unconditional -
002206	122	Spacer
002207	003	
002210	306	Load A with L
002211	044	AND A with 037
002212	037	
002213	300	NOP
002214	074	Compare A with 000
002215	000	
002216	110	Jump not equal
002217	153	
002220	002	
002221	306	Load A with L
002222	074	Compare A with 000
002223	000	
002224	110	Jump not equal
002225	137	
002226	002	
002227	050	Increment H
002230	305	Load A with H
002231	074	Compare A with 004*
002232	004*	
002233	110	Jump not equal
002234	137	
002235	002	
002236	000	Halt
002237	000	

PROGRAM: TV STORAGE DUMP (CONT'D)

OCTAL ADDRESS	OCTAL CODE	OPERATION	OCTAL ADDRESS	OCTAL CODE	OPERATION
002240	304	Load A with E	002305	317	O
002241	044	AND A with 300	002306	322	R
002242	300		002307	301	A
002243	002	Shift left	002310	307	G
002244	002	Shift left	002311	305	E
002245	064	OR with 260	002312	240	
002246	260		002313	304	D
002247	135	Out 6	002314	325	U
002250	220	Clear A	002315	315	M
002251	135	Out 6	002316	320	P
002252	304	Load A with E	002317	240	
002253	044	AND A with 070	002320	320	P
002254	070		002321	362	r
002255	012	Shift right	002322	345	e
002256	012	Shift right	002323	363	s
002257	012	Shift right	002324	363	s
002260	064	OR with 260	002325	240	
002261	260		002326	323	S
002262	135	Out 6	002327	320	P
002263	220	Clear A	002330	301	A
002264	135	Out 6	002331	303	C
002265	304	Load A with E	002332	305	E
002266	044	AND A with 007	002333	240	
002267	007		002334	353	k
002270	064	OR with 260	002335	345	e
002271	260		002336	371	y
002272	135	Out 6	002337	240	
002273	220	Clear A	002340	346	f
002274	135	Out 6	002341	357	o
002275	007	Return uncond.	002342	362	r
002276	000		002343	240	
002277	000		002344	360	p
002300	324	T	002345	341	a
002301	326	V	002346	347	g
002302	240		002347	351	i
002303	323	S	002350	356	n
002304	324	T	002351	347	g

COMMENTS: *Set A comparison to byte address higher than highest byte of your storage capacity:

1K = 004 (shown)
1.5K= 006
2K = 010

Begin this program by doing a Restart 045.

PROGRAM: CASSETTE DUMPER FOR COLD START - SHORT FORM

OCTAL ADDRESS	OCTAL CODE	OPERATION
003000	056	Load H with 000
003001	000	
003002	066	Load L with 000
003003	000	
003004	026	Load C with 010
003005	010	
003006	036	Load D with 000
003007	000	
003010	103	Input 1
003011	044	AND A with 001
003012	001	
003013	110	Jump if not zero
003014	010	
003015	003	
003016	016	Load B with 060
003017	060	
003020	011	Decrement B
003021	110	Jump not zero
003022	020	
003023	003	
003024	103	Input 1
003025	203	Add D to A
003026	012	Shift right
003027	330	Load D with A
003030	016	Load B with 040
003031	040	
003032	011	Decrement B
003033	110	Jump not zero
003034	032	
003035	003	
003036	021	Decrement C
003037	110	Jump not zero
003040	024	
003041	003	
003042	373	Store D in mem
003043	060	Increment L
003044	110	Jump not zero
003045	004	
003046	003	
003047	050	Increment H
003050	305	Load A with H
003051	074	Compare A with 004
003052	004	
003053	110	Jump not equal
003054	004	
003055	003	
003056	000	Halt

COMMENTS: This routine is hand keyed into the upper portion of the 1K 8008 microprocessor when power is first applied. The program deserializes the output of the cassette, and loads the 8-bit bytes into memory starting at byte Ø. The speed is approximately 40 bytes/second (1K in 25 sec.)

Begin this program by doing a Restart 025 while the cassette is playing the constant tone leader prior to the data portion. The timing constants at 003017 and 003031 assume the 20μs cycle time of the Mark-8 (use of a 4Mhz crystal).

PROGRAM: TV - HOME ERASE, SPACER, TIMER, and WRITER SUBROUTINES

OCTAL ADDRESS	OCTAL CODE	OPERATION
	"Home Erase"	
003100	006	Load A with 377
003101	377	
003102	135	Out 6
003103	220	Clear A
003104	310	Load B with A
003105	135	Out 6
003106	137	Out 7
003107	006	Load A with 240
003110	240	
003111	135	Out 6
003112	220	Clear A
003113	135	Out 6
003114	010	Increment B
003115	110	Jump not zero
003116	107	
003117	003	
003120	007	Return uncond.
	"Spacer"	
003122	006	Load A with 240
003123	240	
003124	135	Out 6
003125	220	Clear A
003126	135	Out 6
003127	041	Decrement E
003130	110	Jump not zero
003131	122	
003132	003	
003133	007	Return uncond.
	"Writer"	
003135	307	Load A from Mem.
003136	135	Out 6
003137	220	Clear A
003140	135	Out 6
003141	060	Increment L
003142	041	Decrement E
003143	110	Jump not zero
003144	135	
003145	003	
003146	007	Return uncond.
003147		
003150	304	D
003151	365	u
003152	355	m
003153	360	p
003154	345	e
003155	344	d
003156	240	
003157	317	O
003160	313	K
	"Timer"	
003162	016	Load B with 000
003163	000	
003164	026	Load C with 000
003165	000	
003166	020	Increment C
003167	110	Jump not zero
003170	166	
003171	003	
003172	010	Increment B
003173	110	Jump not zero
003174	164	
003175	003	
003176	007	Return uncond.

COMMENTS:
- 003100 - 003106 = Homes counter
- 003107 - 003115 = Enters 256 blanks
- 003122 - 003133 = E Register should contain the number of blanks when calling this subroutine
- 003135 - 003145 = Enters desired character. H & L should first storage address; E should contain the number of sequential characters starting at this address.
- 003162 - 003176 = Timer is a 5 second delay. By entering at 003164 with the B Register preset by the calling routine, a controlled delay of about 19.5 milliseconds per count decrementing from B = 377 can be obtained (B = 377 gives a 19.5 ms delay, B = 376 gives a 39 ms delay, ...).

PROGRAM: CASSETTE LOADER (loads storage contents onto cassette)- SHORT FORM

OCTAL ADDRESS	OCTAL CODE	OPERATION
003200	006	Load A with 001
003201	001	
003202	123	Out 4
003203	125	Out 2
003204	026	Load C with 377
003205	377	
003206	016	Load B with 377
003207	377	
003210	011	Decrement B
003211	110	Jump not zero
003212	210	
003213	003	
003214	021	Decrement C
003215	110	Jump not zero
003216	206	
003217	003	
003220	056	Load H with 000
003221	000	
003222	066	Load L with 000
003223	000	
003224	036	Load D with 003*
003225	003*	
003226	046	Load E with 377
003227	377	
003230	026	Load C with 011
003231	011	
003232	302	Load A with C
003233	022	Rotate left thru car.
003234	307	Load A from memory
003235	022	Rotate left thru car.
003236	123	Out 4
003237	016	Load B with 040
003240	040	
003241	011	Decrement B
003242	110	Jump not equal
003243	241	
003244	003	
003245	032	Rotate rht thru car.
003246	021	Decrement C
003247	110	Jump not zero
003250	236	
003251	003	
003252	006	Load A with 001
003253	001	

OCTAL ADDRESS	OCTAL CODE	OPERATION
003254	123	Out 4
003255	016	Load B with 100
003256	100	
003257	011	Decrement B
003260	110	Jump not zero
003261	257	
003262	003	
003263	305	Load A with H
003264	273	Compare A with D
003265	150	Jump if equal
003266	300	
003267	003	
003270	060	Increment L
003271	110	Jump not zero
003272	230	
003273	003	
003274	050	Increment H
003275	104	Jump unconditional
003276	230	
003277	003	
003300	306	Load A with L
003301	274	Compare A with E
003302	150	Jump if equal
003303	311	
003304	003	
003305	060	Increment L
003306	104	Jump unconditional
003307	230	
003310	003	
003311	026	Load C with 377
003312	377	
003313	016	Load B with 177
003314	177	
003315	011	Decrement B
003316	110	Jump not zero
003317	315	
003320	003	
003321	021	Decrement C
003322	110	Jump not zero
003323	313	
003324	003	
003325	220	Clear A
003326	125	Out 2
003327	000	Halt

COMMENTS: *Set byte 003225 to the address of the highest byte page in your system:

1K = 003 (shown)
1.5K = 005
2K = 007

Begin this program by doing a Restart 015 after having placed the cassette in record and running clear of the leader

PROGRAM: 8223 ROM PROGRAMMING FOR CASSETTE DUMPER

OCTAL ADDRESS	OCTAL CODE	BINARY CODE Bit7 (ROM1) Bit$\emptyset$
017300	056	0 0 1 0 1 1 1 0
017301	000	0 0 0 0 0 0 0 0
017302	066	0 0 1 1 0 1 1 0
017303	000	0 0 0 0 0 0 0 0
017304	026	0 0 0 1 0 1 1 0
017305	010	0 0 0 0 1 0 0 0
017306	036	0 0 0 1 1 1 1 0
017307	000	0 0 0 0 0 0 0 0
017310	103	0 1 0 0 0 0 1 1
017311	044	0 0 1 0 0 1 0 0
017312	001	0 0 0 0 0 0 0 1
017313	110	0 1 0 0 1 0 0 0
017314	310	1 1 0 0 1 0 0 0
017315	017	0 0 0 0 1 1 1 1
017316	016	0 0 0 0 1 1 1 0
017317	060	0 0 1 1 0 0 0 0
017320	011	0 0 0 0 1 0 0 1
017321	110	0 1 0 0 1 0 0 0
017322	320	1 1 0 1 0 0 0 0
017323	017	0 0 0 0 1 1 1 1
017324	103	0 1 0 0 0 0 1 1
017325	203	1 0 0 0 0 0 1 1
017326	012	0 0 0 0 1 0 1 0
017327	330	1 1 0 1 1 0 0 0
017330	016	0 0 0 0 1 1 1 0
017331	040	0 0 1 0 0 0 0 0
017332	011	0 0 0 0 1 0 0 1
017333	110	0 1 0 0 1 0 0 0
017334	332	1 1 0 1 1 0 1 0
017335	017	0 0 0 0 1 1 1 1
017336	021	0 0 0 1 0 0 0 1
017337	11o	0 1 0 1 0 0 0 0

OCTAL ADDRESS	OCTAL CODE	BINARY CODE Bit7 (ROM2) Bit$\emptyset$
017340	324	1 1 0 1 0 1 0 0
017341	017	0 0 0 0 1 1 1 1
017342	373	1 1 1 1 1 0 1 1
017343	060	0 0 1 1 0 0 0 0
017344	110	0 1 0 0 1 0 0 0
017345	304	1 1 0 0 0 1 0 0
017346	017	0 0 0 0 1 1 1 1
017347	050	0 0 1 0 1 0 0 0
017350	305	1 1 0 0 0 1 0 1
017351	074	0 0 1 1 1 1 0 0
017352	010*	0 0 0 0 1 0 0 0
017353	110	0 1 0 0 1 0 0 0
017354	304	1 1 0 0 0 1 0 0
017355	017	0 0 0 0 1 1 1 1
017356	104	0 1 0 0 0 1 0 0
017357	003	0 0 0 0 0 0 1 1
017360	000	0 0 0 0 0 0 0 0

* Schedule of storage capacity byte 017352:

1K	004	0 0 0 0 0 1 0 0
1.5K	006	0 0 0 0 0 1 1 0
2K	010	(shown & recommended)

COMMENTS: This ROM set is located on memory board 1 with its pair of 7430's and 2/4 7400 already on this board. The ROM's address is at the top most end of the total 4K potential. The ROM directs control back to position 000003 following a successful load. Set byte 017352 to byte above top RAM position available. Placing a 000 at address 000003 in RAM will produce a halt after the dump. Placing a Jump, Call, or Restart instruction at address 000003 will enable a load and go operation.

PROGRAM _____

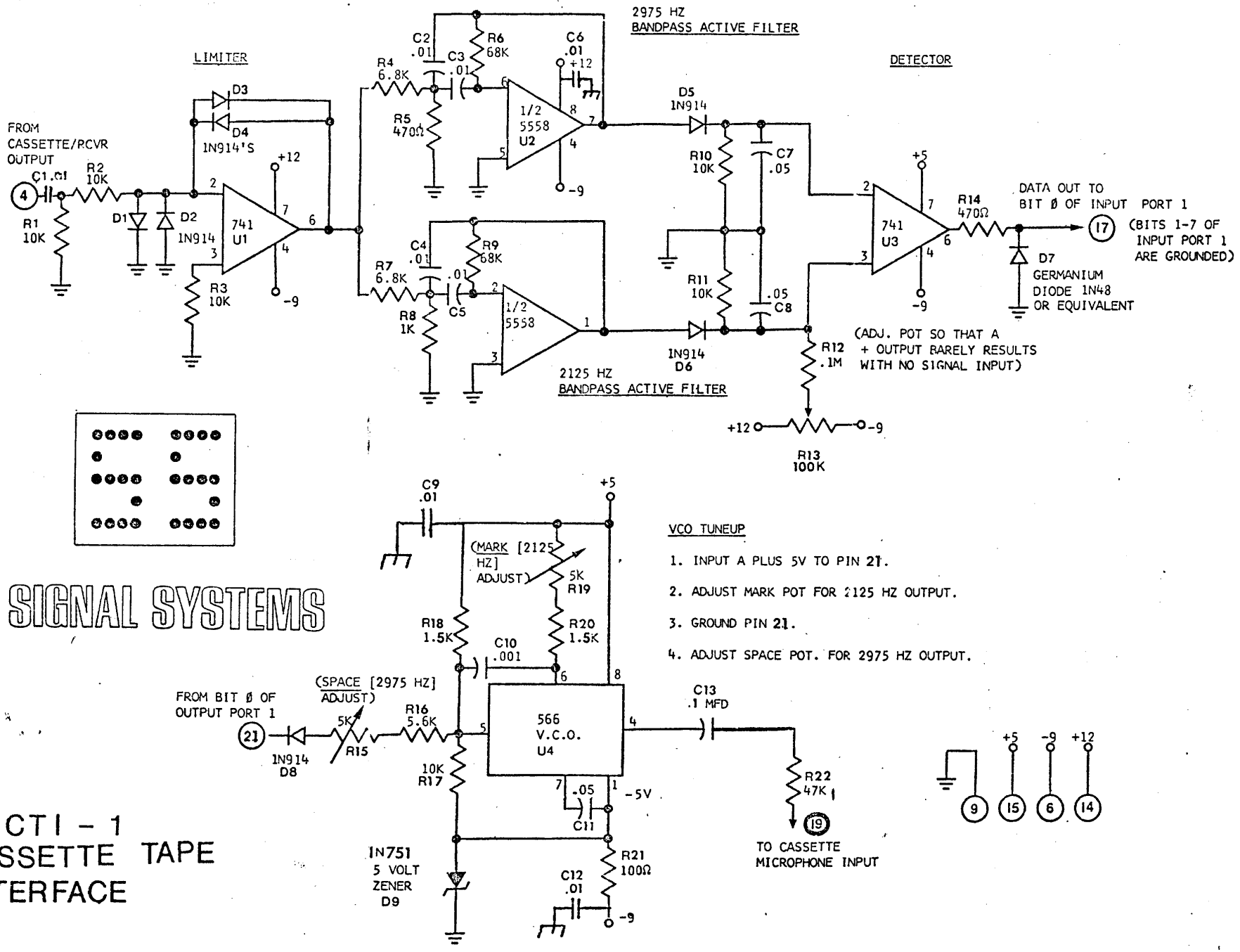
MICROPROCESSOR CODING SHEET PAGE __ OF __

OCTAL ADDRESS	OCTAL CODE	OPERATION	OCTAL ADDRESS	OCTAL CODE	
00 000			00 040		
00 001			00 041		
00 002			00 042		
00 003			00 043		
00 004			00 044		
00 005			00 045		
00 006			00 046		
00 007			00 047		
00 010			00 050		
00 011			00 051		
00 012			00 052		
00 013			00 053		
00 014			00 054		
00 015			00 055		
00 016			00 056		
00 017			00 057		
00 020			00 060		
00 021			00 061		
00 022			00 062		
00 023			00 063		
00 024			00 064		
00 025			00 065		
00 026			00 066		
00 027			00 067		
00 030			00 070		
00 031			00 071		
00 032			00 072		
00 033			00 073		
00 034			00 074		
00 035			00 075		
00 036			00 076		
00 037			00 077		

COMMENTS:

DECIMAL/OCTAL CONVERSION CHART

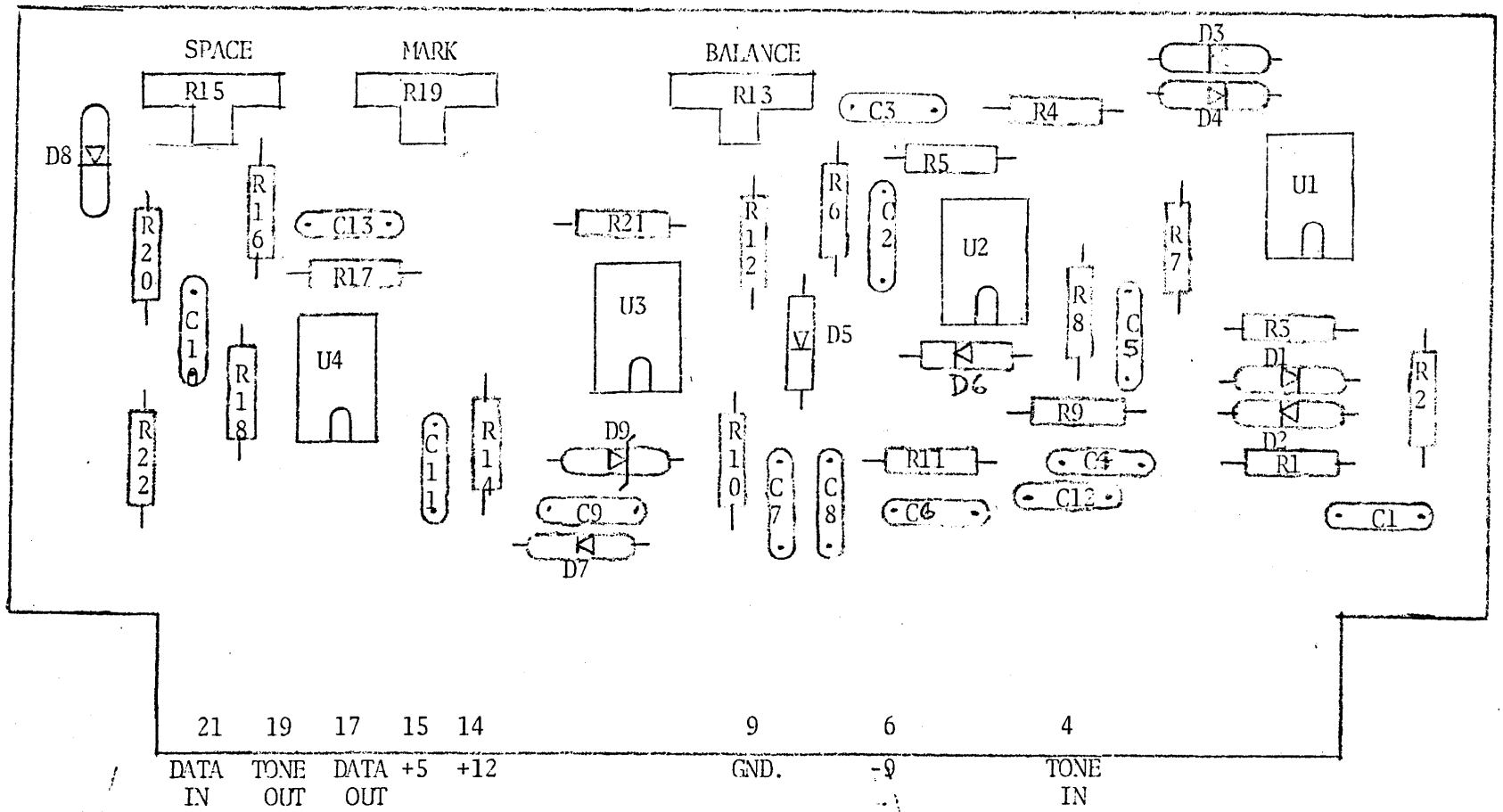
Dec	Oct	Dec	Oct	Dec	Oct	Dec	Oct	Dec	Oct	Dec	Oct
0	0	51	63	101	145	151	227	201	311	251	373
1	1	52	64	102	146	152	230	202	312	252	374
2	2	53	65	103	147	153	231	203	313	253	375
3	3	54	66	104	150	154	232	204	314	254	376
4	4	55	67	105	151	155	233	205	315	255	377
5	5	56	70	106	152	156	234	206	316	256	1000
6	6	57	71	107	153	157	235	207	317		
7	7	58	72	108	154	158	236	208	320		
8	10	59	73	109	155	159	237	209	321		
9	11	60	74	110	156	160	240	210	322		
10	12	61	75	111	157	161	241	211	323		
11	13	62	76	112	160	162	242	212	324		
12	14	63	77	113	161	163	243	213	325		
13	15	64	100	114	162	164	244	214	326		
14	16	65	101	115	163	165	245	215	327		
15	17	66	102	116	164	166	246	216	330		
16	20	67	103	117	165	167	247	217	331		
17	21	68	104	118	166	168	250	218	332		
18	22	69	105	119	167	169	251	219	333		
19	23	70	106	120	170	170	252	220	334		
20	24	71	107	121	171	171	253	221	335		
21	25	72	110	122	172	172	254	222	336		
22	26	73	111	123	173	173	255	223	337		
23	27	74	112	124	174	174	256	224	340		
24	30	75	113	125	175	175	257	225	341		
25	31	76	114	126	176	176	260	226	342		
26	32	77	115	127	177	177	261	227	343		
27	33	78	116	128	200	178	262	228	344		
28	34	79	117	129	201	179	263	229	345		
29	35	80	120	130	202	180	264	230	346		
30	36	81	121	131	203	181	265	231	347		
31	37	82	122	132	204	182	266	232	350		
32	40	83	123	133	205	183	267	233	351		
33	41	84	124	134	206	184	270	234	352		
34	42	85	125	135	207	185	271	235	353		
35	43	86	126	136	210	186	272	236	354		
36	44	87	127	137	211	187	273	237	355		
37	45	88	130	138	212	188	274	238	356		
38	46	89	131	139	213	189	275	239	357		
39	47	90	132	140	214	190	276	240	360		
40	50	91	133	141	215	191	277	241	361		
41	51	92	134	142	216	192	300	242	362		
42	52	93	135	143	217	193	301	243	363		
43	53	94	136	144	220	194	302	244	364		
44	54	95	137	145	221	195	303	245	365		
45	55	96	140	146	222	196	304	246	366		
46	56	97	141	147	223	197	305	247	367		
47	57	98	142	148	224	198	306	248	370		
48	60	99	143	149	225	199	307	249	371		
49	61	100	144	150	226	200	310	250	372		
50	62										



SIGNAL SYSTEMS

CTI - 1
CASSETTE TAPE INTERFACE

Design by Dr. Robert Suding



Connector - Amphenol 143-022-01 or equivalent

R1, 2, 3, 10, 11, 17 - 10K 1/4w (Brn, Blk, Orn)
~~R4, 7 - 6.8K~~ (Blu, Gry, Red)
~~R5, 14~~ - 470 (Ylo, Vio, Brn)
~~R6, 9~~ - 68K (Blu, Gry, Orn)
~~R8~~ - 1K (Brn, Blk, Red)
~~R12~~ - 100K (Brn, Blk, Ylo)
R13 - 100K Pot (Mouser 32RV)
~~R15, 19~~ - 5K Pot (Mouser 32RV)
~~R16~~ - 5.6K (Grn, Blu, Red)
~~R18, 20~~ - 1.5K (Brn, Grn, Red)
~~R21~~ - 100 (Brn, Blk, Brn)
~~R22~~ - 47K (Ylo, Vio, Orn)
~~C13~~ - .1 Disc (104)
~~C2, 5~~ .01 Mylar (Green) (2)
C4 C5

~~C6, 10, 12~~ - .01 Disc
~~C7, 8~~ - .05 Disc (503)
~~C10~~ - .001 Disc
(1) C11 - .05 Mylar (Green)
D1-6, ~~8~~ - Silicon 1N914, 1N4148, etc.
~~D7~~ - Germanium 1N48
~~D9~~ - Zener 1N751
U1, 3 - Op. Amp. LM741CN
U2 - Dual Op. Amp. N5558V, RE4558
U3 - Volt. Cont. Osc. LM566CN, N566V

CTI-1