

(1)

FREQ-II ASSEMBLY INSTRUCTIONS - JAW 3/75

MAIN P.C. CARD ASSEMBLY (RE: FIGS 1 & 2)

- A. CUT M1-M4 JUMPER ✓
CUT R1 → TRANSISTOR JUMPER
CUT T1-T2 PAD JUMPER ✓
CUT T3-T4 PAD JUMPER ✓
CUT TWO CONNECTIONS TO X3 PAD + RECONNECT ✓
BYPASSING X3 ✓
- B. ADD JUMPER SITOWN NEXT TO CHIP R. ✓
ADD JUMPER FROM EC-2 TO PAD GG (GROUND) ✓
- C. INSERT ALL RESISTORS, CAPACITORS, & DIODES. ✓
(NOTE R-C-D ASSEMBLY NEXT TO 2N3391) ✓
- D. INSERT TWO TRANSISTORS. ✓
- E. INSERT 5 LSI SOCKETS. ✓
- F. INSERT 13 IC'S. ✓
- G. ON BACK ADD JUMPERS.
CHIP M-1 TO M-2 ✓
CHIP M-6 TO M-5 ✓
2N2222-E TO PAD SHOWN IN FIG-2. ✓
CHIP C-8 TO CHIP D-2. ✓
- H. ON BACK ADD .005μF FROM CHIP J-2 TO CHIP R-3 ✓
- I. INSERT TWO RELAYS. ✓
- J. ATTACH 6 SPACERS AS SHOWN (⊗) ✓
- K. ASSEMBLE PLASTIC SIDE PANEL JACKS + SWITCHES (LABEL PANEL FIRST). SEE FIG 3. ✓
ATTACH TO MAIN P.C. CARD + SOLDER EC-A... & PINS TO MAIN CARD PADS. ✓

(2)

M. MOUNT 20-PIN AC SOCKET (FIG-2)

N SOLDER TONE DETECTOR CARD TO MAIN CARD.
CONNECT RED XFORMER WIRE TO PAD ~~X3~~ X3

O RE: FIGURE 4

CONNECT "RUN" JACK S, C TO PADS X1, X2.
JUMPER FOLLOWING TOGETITER. (GROUND)

"IN" JACK-C.

"WR" JACK-C.

"FF" JACK-C.

"T" SWITCH-U1

VOLUME-C (BOTTOM TERM.).

"H" SWITCH-C

P CONNECT "FF" JACK-C TO EC-2 PAD (GROUND).

" " "IN" JACK-S TO X3 PAD

" " VOL-A TO X4 "

" " "X" SWITCH-C TO S1 "

" " " -NO TO S2 "

" " " -NC TO S3 "

" " "H" SWITCH-D TO S5 "

" " "K" SWITCH-U TO S6 "

" " " -C TO S7 "

" " " -D TO S8 "

" " "T" SWITCH-C1 TO T1 "

" " " -DI TO T2 "

" " " -C2 TO T3 "

" " " -D2 TO T4 "

" " " -U2 TO +5 "

" " JACK "FF"-S TO I "

CONNECT EC-9 PIN TO B PAD [Sx(P)]

MAIN BOARD ASSEMBLY COMPLETED

TOP PANEL ASSEMBLE

- A LABEL PANEL
- B ASSEMBLE LIGHTS, SWITCHES. RE. FIG. 5.
- C CONNECT 8 WIRE CABLE TO DISPLAY
(FOR LED'S CONNECT ANODES COMMON).
- D CONNECT 6 WIRE CABLE TO LIGHTS & SWITCHES
(RE: FIG. 6). CONNECT +5 & GROUND JUMPERS AS SHOWN.
- E. ADJUST POWER SUPPLY TO 5 VOLTS.
MOUNT POWER SUPPLY ASSEMBLY (INCLUDES KEYBOARD, SPEAKER, & ON-OFF SWITCH) TO TOP PANEL.
- F. CONNECT DISPLAY +5 TO POWER SUPPLY.
CONNECT DISPLAY GROUND TO P.S. (IF HEX DISPLAY USED)
CONNECT SWITCH GROUND TO P.S.
CONNECT LAMP +5 TO POWER SUPPLY.
- G. LAY MAIN P.C. BOARD ON TOP PANEL.
ATTACH 6 WIRE SWITCH CABLE TO PADS.
ATTACH 10 WIRE KEYBOARD CABLE TO PADS.
ATTACH DISPLAY CABLE TO PADS.
ATTACH VOLUME B,C TERMINALS TO SPEAKER
ATTACH POWER SUPPLY +5, GND TO PADS XX, YY
- H. ASSEMBLE MAIN BOARD TO TOP PANEL

~~THIS IS A TEST PAGE~~

FINAL ASSEMBLY

(4)

- A. PLUG IN TIE 5 LSI CHIPS.
- B. ATTACH TV LINE BUFFER CARD + ADD 2 JUMPERS TO TV JACK.
- C. ATTACH RAM P.C. CARD.

CHECK OUT

- A. POWER ON : +5 CURRENT SHOULD BE 600-800 mA. TPA, B SHOULD BE PRESENT WITH "LD" UP.
- B. ADJUST CLOCK BY SETTING V-SYNC TO GON
- C. CHECK OUT HEX + BYTE KEYBOARD LOAD MODES
- D. WITH "T" UP SET TV CHANNEL FREQUENCY AND CHECK TV PICTURE.
- E. SET TONE DETECTOR TO 4.16 KC AND CHECK CASSETTE LOAD MODE.
- F. LOAD + RUN PROGRAMS.

00 00
01 E2
02 E2
03 E2
04 E2
05 3Φ
06 Φ1

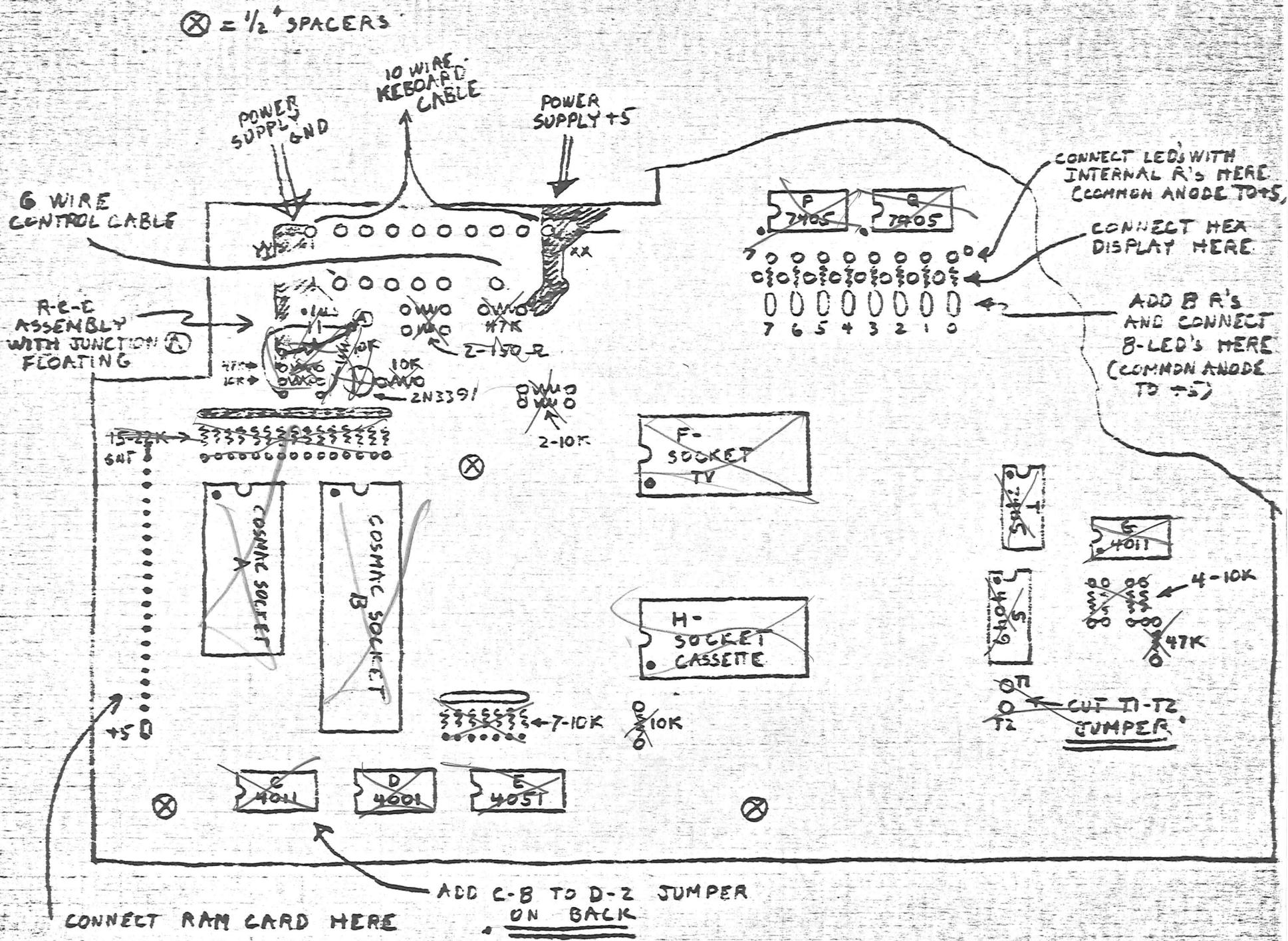


FIG-1

JAW 3-75

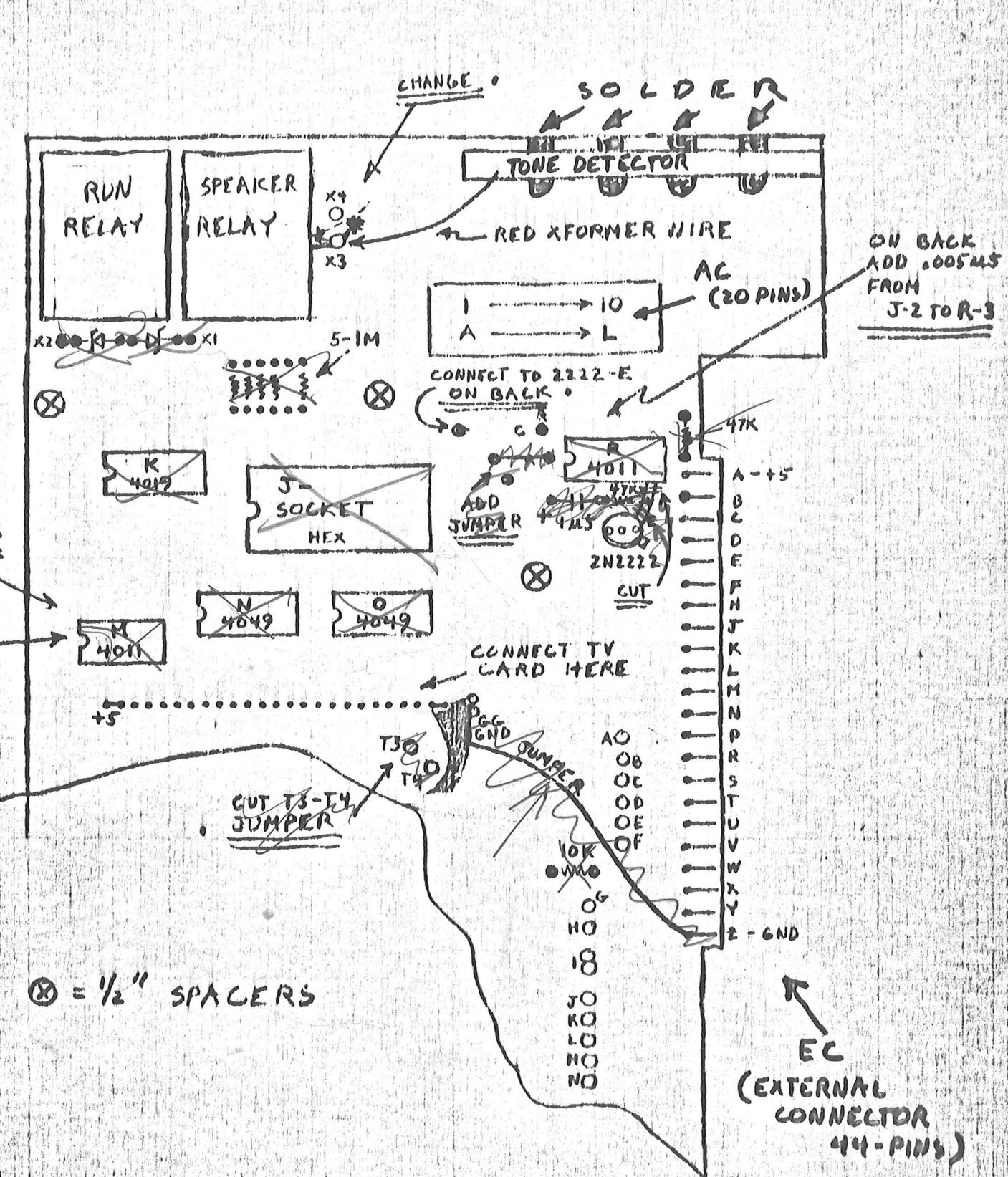


FIG - 2

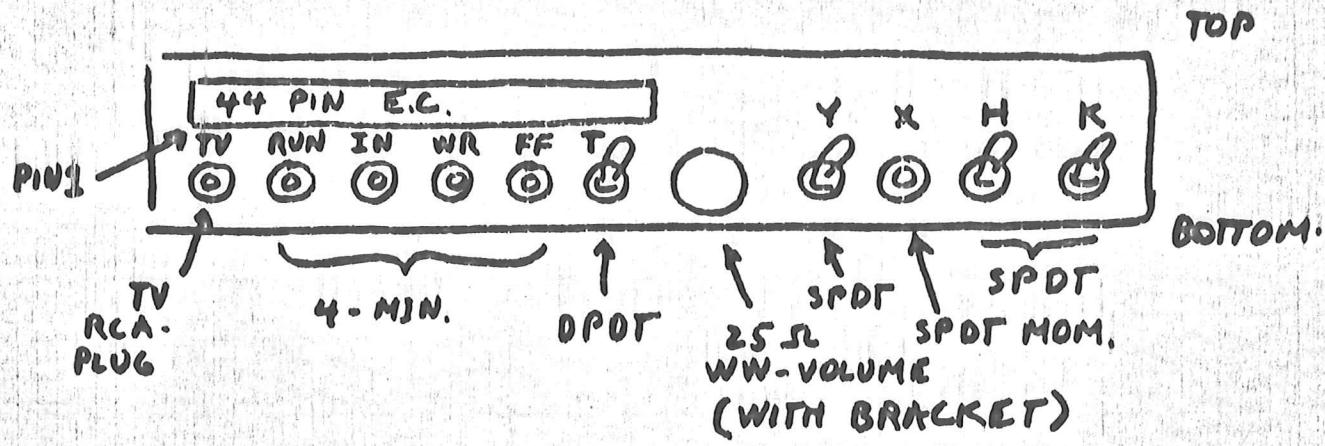


FIG. 3.

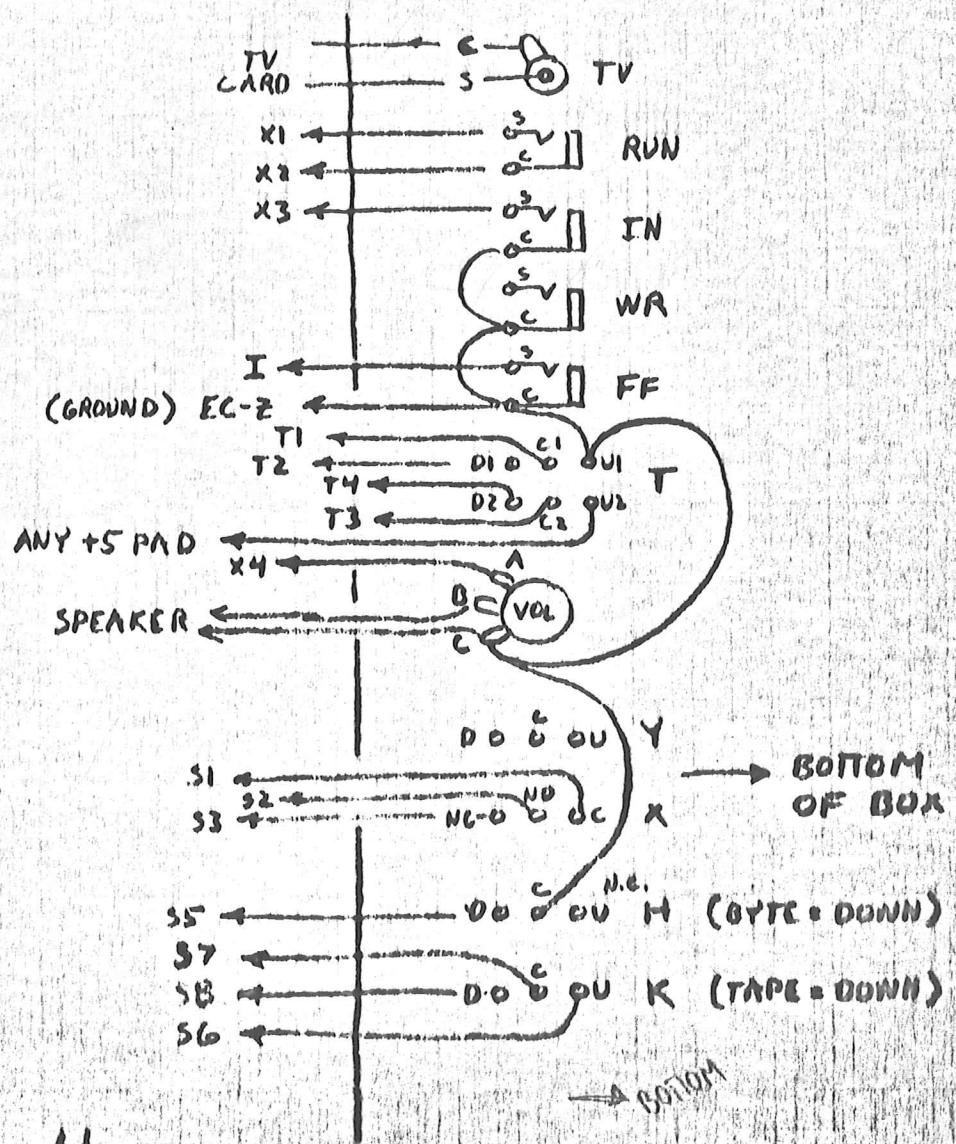


FIG. 4

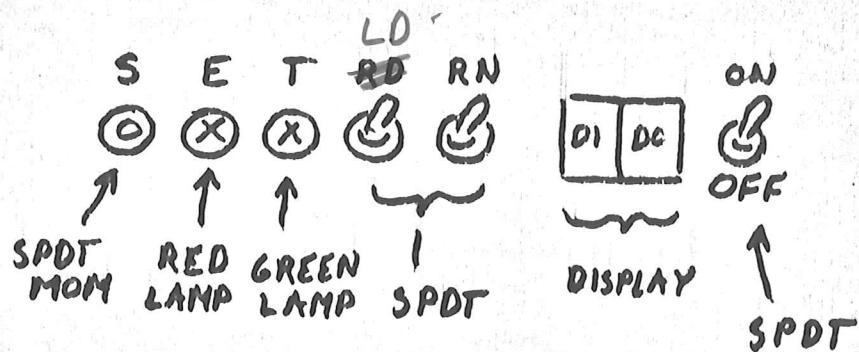


FIGURE 5

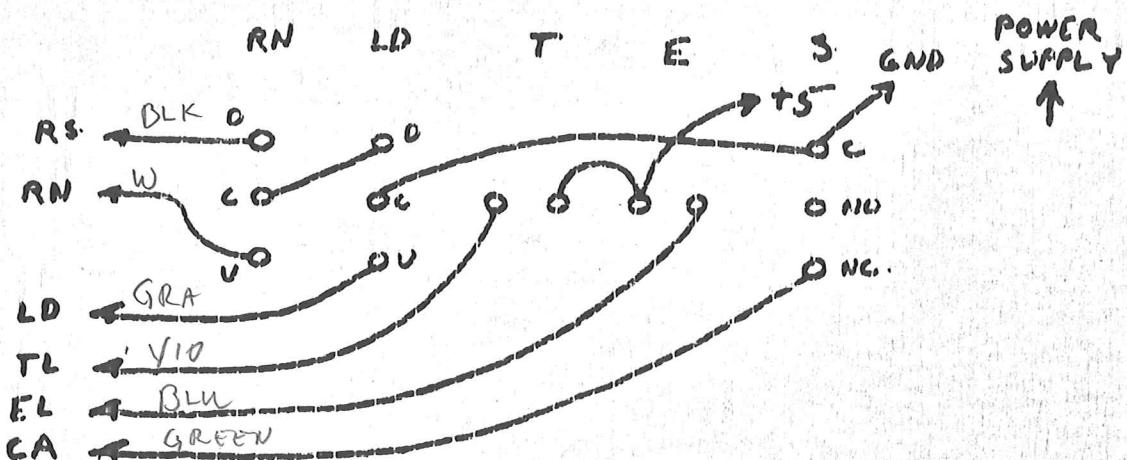
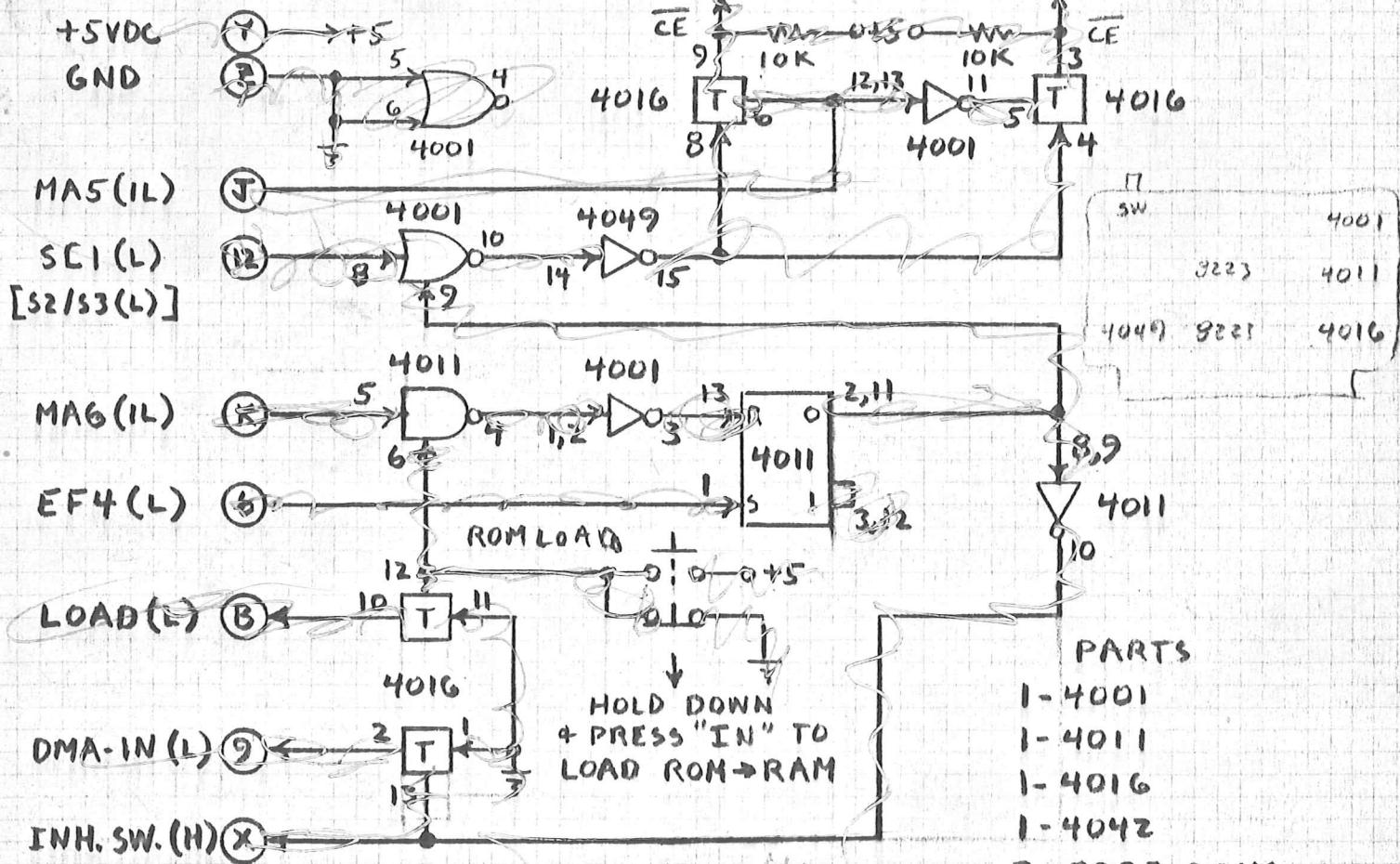
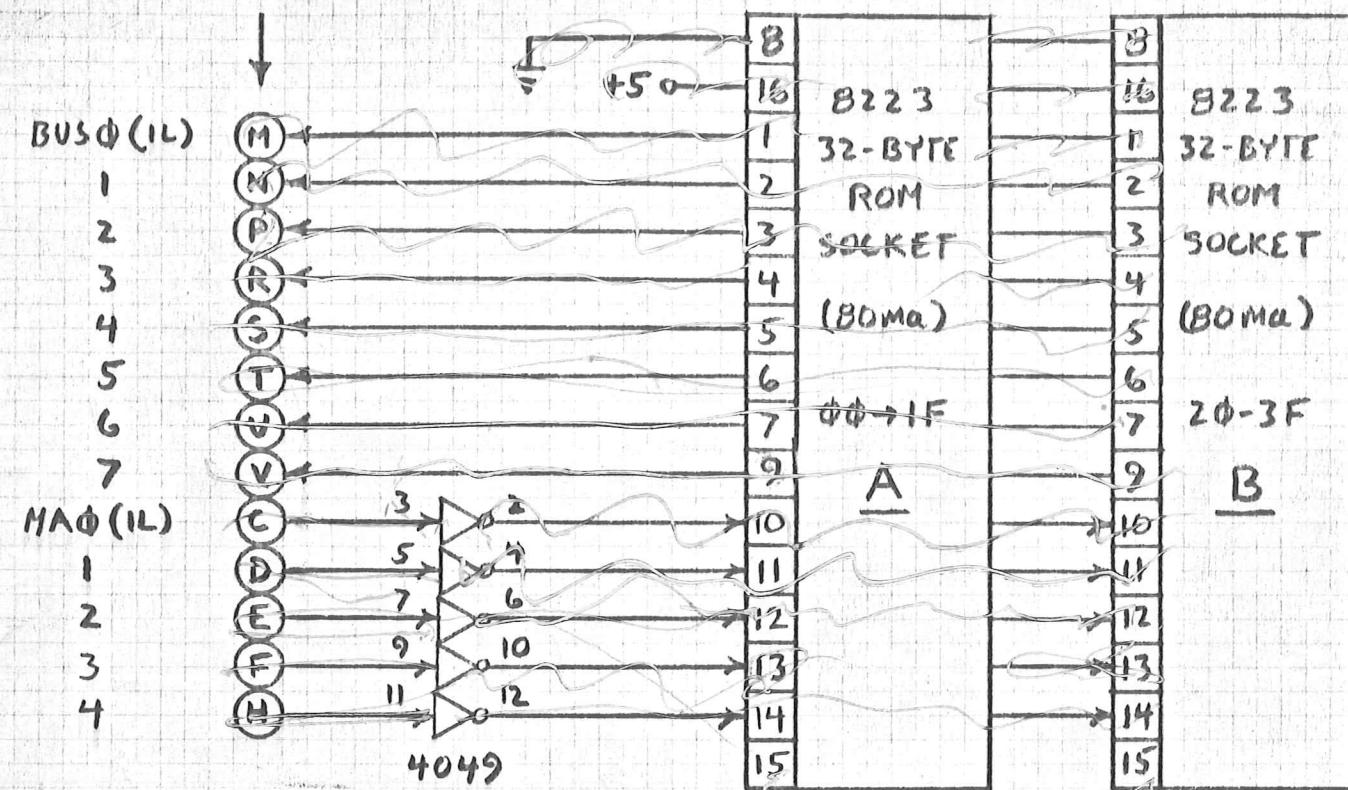


FIGURE 6

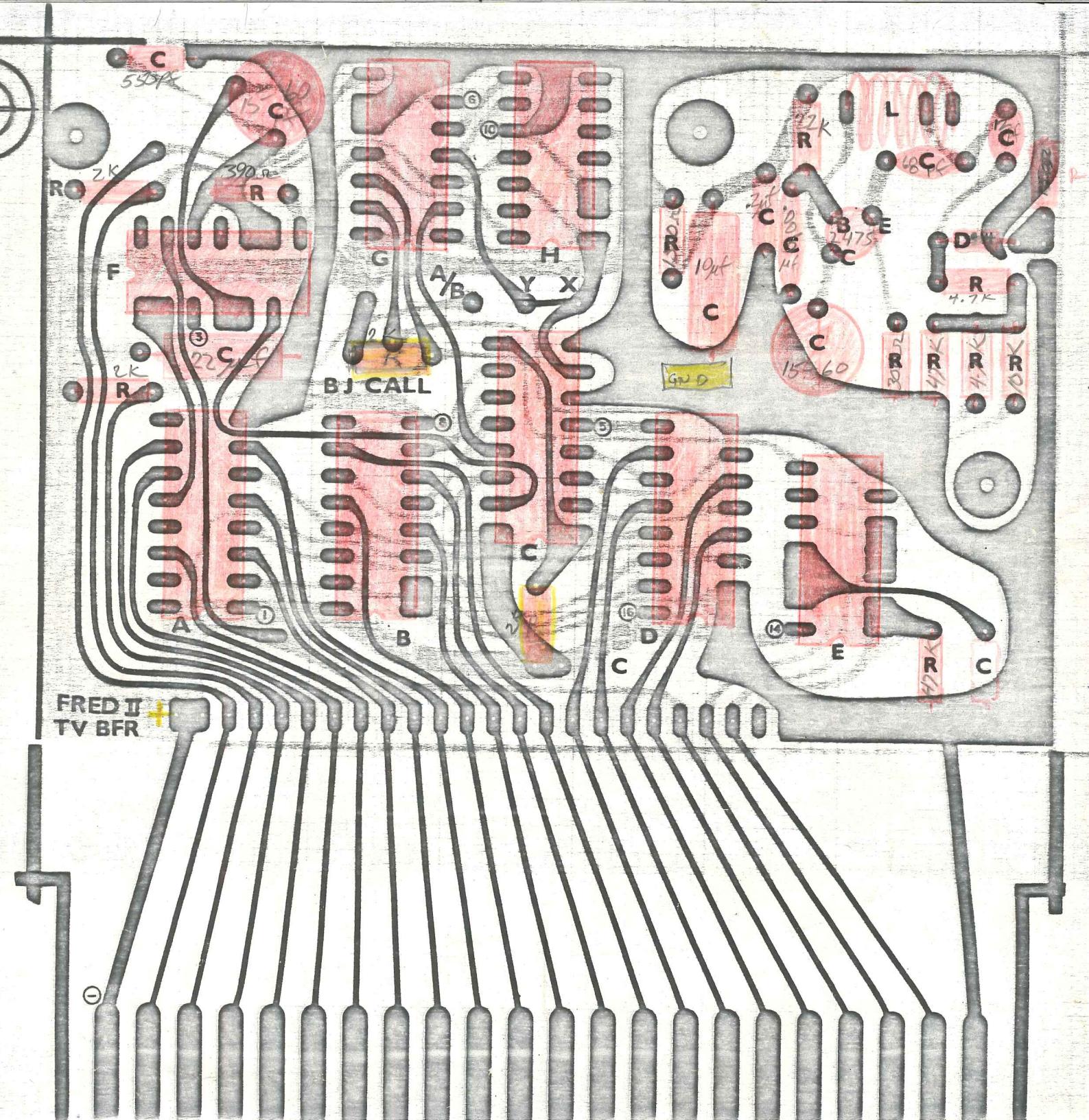
BIT	
0	VIO
1	GRA
2	WHITE
3	BLK
4	OR
5	Y
6	GRN
7	BLU

MICROTUTOR - EXTERNAL ROM CARD

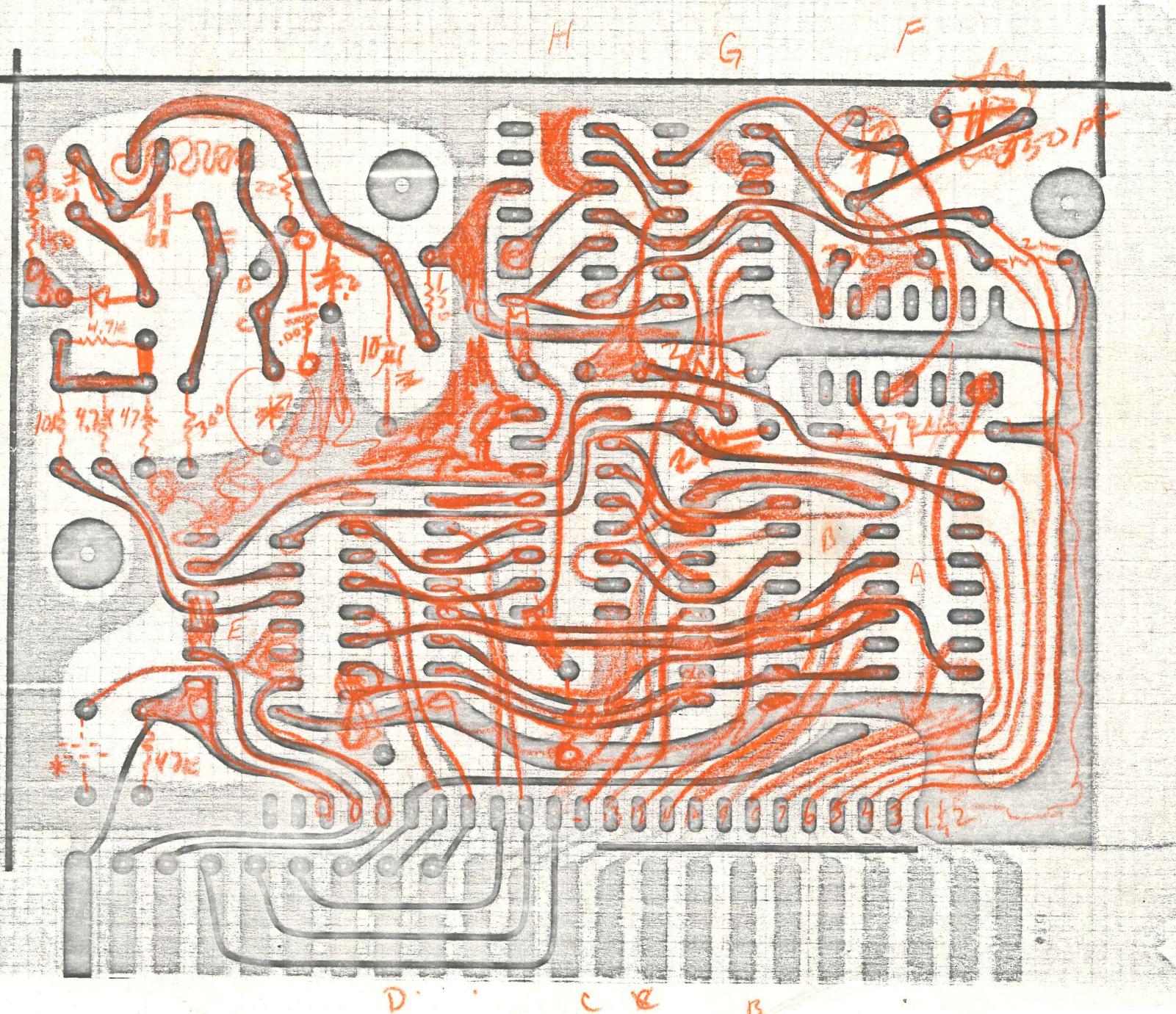
E-PINS



JAW 2-75

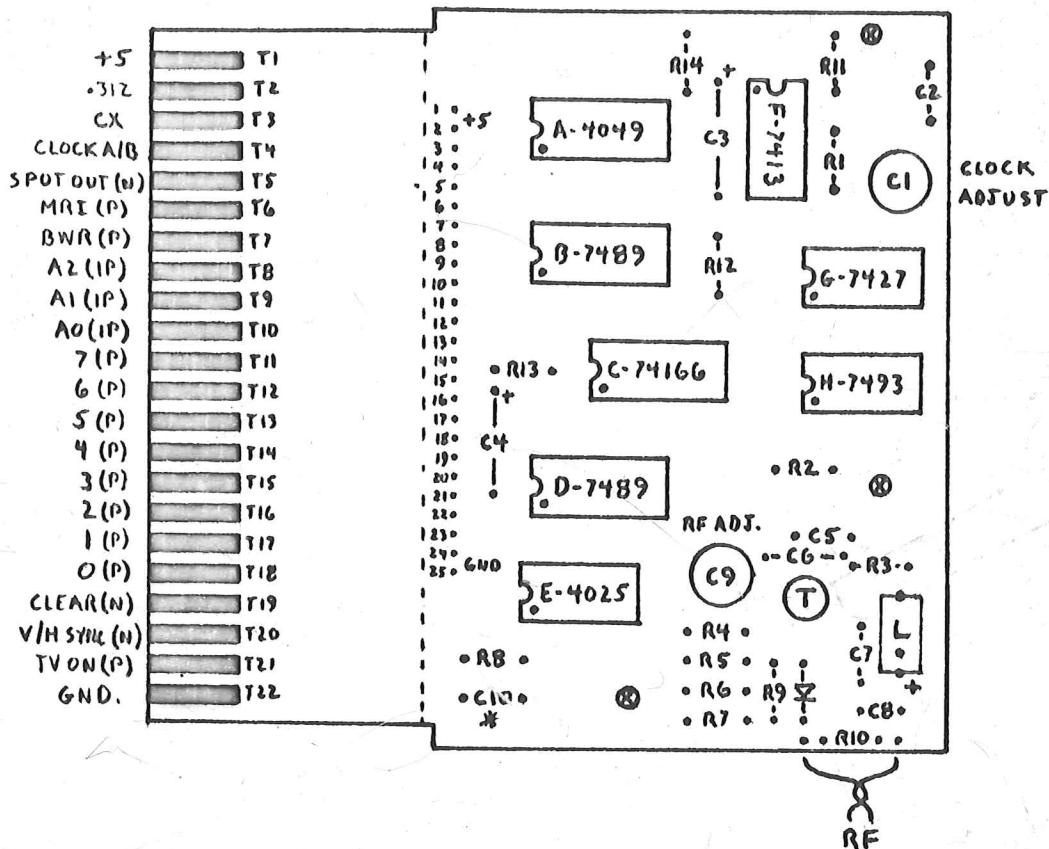


FRED II
TV BFR



FRED II TV LINE BUFFER P.C. CARD.

CUT HERE AFTER TEST



R1 - 390360

R2 - 150

R3 - 22K

R4 - 330

R5 - 47K

R6 - ~~#~~751K

R7 - 10K

R8 - 47K

R9 - ~~#~~751K

R10 - 150

R11 - 2K

R12 - 2K

R13 - 2K

R14 - 2K

C1 - 15-60pS TRIMMER

C2 - 550pF

C3 - 22uF

C4 - 10 uF

C5 - .2 uF

C6 - .005 uF

C7 - 68 pF

C8 - 12 pF

C9 - 15-60pS TRIMMER

C10 - OPTIONAL HORIZ. SHIFT.

T - 2.475

L - 4.5 TURNS #20, 1/4" O.D.

TAP 1-TURN FROM + END.

ADJUST C1 FOR VSYNC = 60Hz. (COSMAC MACHINE CYCLE = 10uS)
ADJUST C9 FOR TV CHANNEL #4

JAW

FRED-II - ASSEMBLY

MAIN P.C. CARD (RE: FIGS. 1&2).

- A. ADD HEAVY JUMPER FROM EC-Z TO PAD GG (GROUND)
- ~~B. ADD HEAVY JUMPER FROM PAD GG TO POWER SUPPORT GROUND~~
- C. INSERT ALL RESISTORS, CAPACITORS, & DIODES.
- D. INSERT TWO TRANSISTORS (2N2222 & 2N3391)
- E. INSERT 5 LSI SOCKETS.
- F. INSERT 13 IC's. (WATCH OUT FOR SHORTS)
- G. INSERT TWO RELAYS (INSULATE BOTTOMS WITH TAPE)
- H. INSERT 9 SPACERS AS SHOWN. (①)
- I. ASSEMBLE PLASTIC SIDE PANEL JACKS + SWITCHES
(LABEL PANEL FIRST) SEE FIG. 3. ATTACH TO MAIN
P.C. CARD & SOLDER EC-A...Z PINS TO MAIN CARD PADS.
- J. MOUNT 20 PIN AC SOCKET (FIG. 2).
- K. SOLDER TONE DETECTOR CARD TO MAIN CARD.
CONNECT RED XFORMER WIRE TO PAD X3.
- L. RE: FIG. 4.
CONNECT "RUN" JACK-S,C TO PADS X1,X2.
JUMPER FOLLOWING TOGETHER (COMMON GROUND)
 "IN" JACK-C
 "FF" JACK-C
 "T" SWITCH-U1
 "VOLUME"-C (BOTTOM TERMINAL)
 "H" SWITCH-C
- M. CONNECT "FF" JACK-C TO EC-Z PAD (GROUND)
 " " "IN" JACK-S TO X3 PAD
 " " VOLUME-A TO X4 "
 " " "X"SWITCH-C TO S1 "
 " " - NO TO S2 "
 " " - NC TO S3 "
 " " "H"SWITCH-D TO S5 "
 " " "K"SWITCH-U TO S6 "
 " " - C TO S7 "
 " " - D TO S8 "

CONNECT "T" SWITCH - C1 TO T1 PAD

" - D1 TO T2 "

" - C2 TO T3 "

" - D2 TO T4 "

" - U2 TO +5 "

" JACK "FF"-S TO I "

" EC-9 PIN TO B " [SX(P)]

TOP PANEL ASSEMBLY

A - LABEL PANEL

B - ASSEMBLE LIGHTS, SWITCHES. RE: FIG.5

C - CONNECT 8 WIRE CABLE TO DISPLAY

(FOR LED'S CONNECT ANODES COMMON TO +5)

D - CONNECT 6 WIRE CABLE TO LIGHTS & SWITCHES.

(RE: FIG.6). CONNECT +5 & GND. JUMPERS AS SHOWN.

E - ADJUST POWER SUPPLY TO 5 VOLTS. MOUNT POWER SUPPLY ASSEMBLY (INCLUDES KEYBOARD, SPEAKER, ON-OFF SWITCH) TO TOP PANEL.

F - CONNECT DISPLAY +5 & GND. TO POWER SUPPLY (DEPENDS ON DISPLAY). CONNECT SWITCH GROUND TO P.S.

CONNECT LAMP +5 TO POWER SUPPLY.

G - LAY MAIN P.C. BOARD ON TOP PANEL.

ATTACH 10 WIRE KEYBOARD CABLE TO PADS.

ATTACH 6 WIRE SWITCH CABLE TO PADS.

ATTACH DISPLAY CABLE TO PADS.

ATTACH VOLUME B,C TERMINALS TO SPEAKER

ATTACH POWER SUPPLY +5 TO PAD XX (HEAVY STRANDED)

ATTACH POWER SUPPLY GND. TO PADS Y,GG (" ")

H - ASSEMBLE MAIN BOARD TO TOP PANEL.

FINAL ASSEMBLY.

A - PLUG IN THE 5 LSI CHIPS

B - ATTACH TV LINE BUFFER CARD + ADD 2 JUMPERS TO TV JACK. ADD 1000uS FROM +5 TO GND AT CARD.

C - ATTACH RAM P.C. CARD.

TH-



FRED-II INITIAL CHECK OUT.

- A. POWER ON: +5 CURRENT SHOULD BE 600-800mA.
TPA/B SHOULD APPEAR WITH "LD" UP.
- B. ADJUST CLOCK BY SETTING V SYNC = 60Hz
- C. CHECK HEX & BYTE KEYBOARD LOAD MODES.
- D. WITH "T" UP SET TV CHANNEL FREQUENCY (CHANNEL 4)
AND CHECK TV PICTURE.
- E. WITH CASSETTE PLAYER & STD. 4.17KLTONE TAPE
ADJUST TONE DETECTOR CARD.
- F. LOAD & RUN PROGRAMS INCLUDING M TEST.

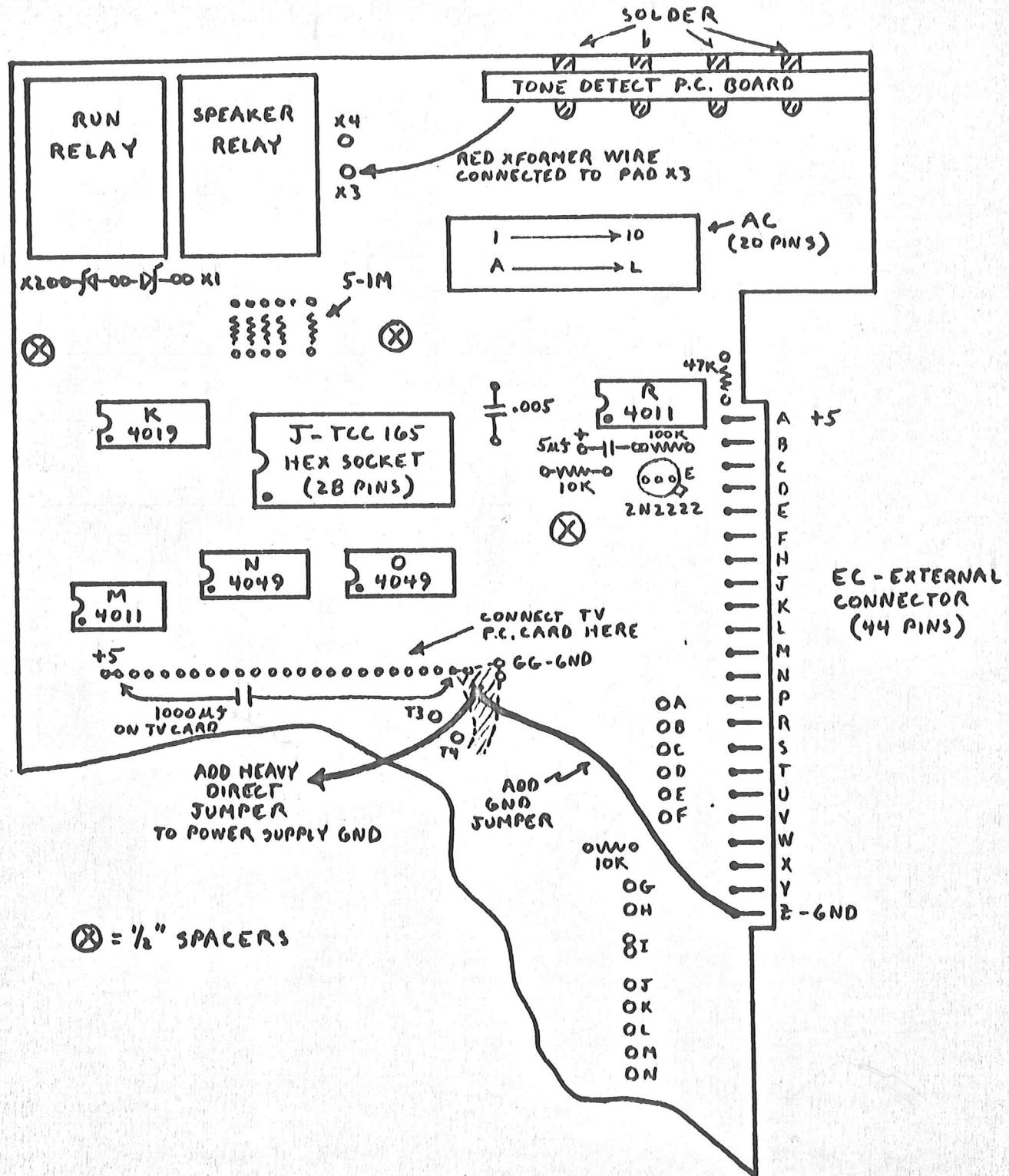
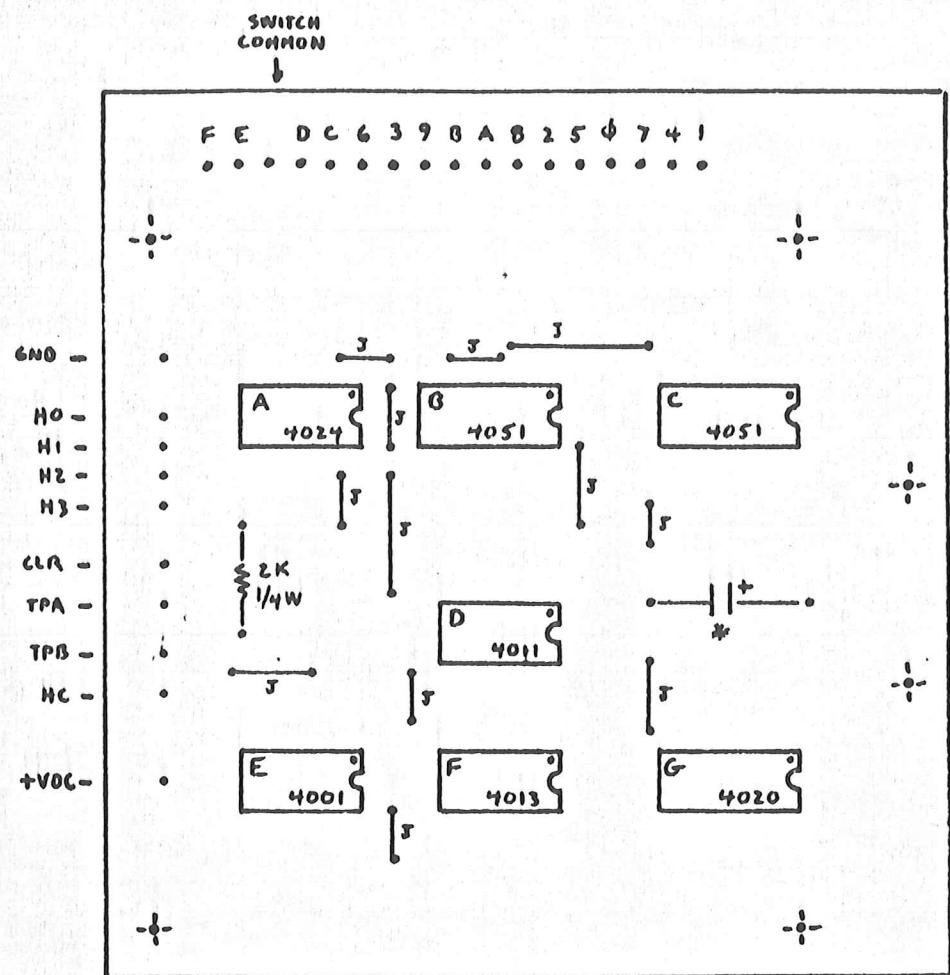


FIGURE 2

JAW 5-75



HEX KEYBOARD DECODE AND DEBOUNCE
COMPONENT SIDE
* OPTIONAL FILTER CAP.

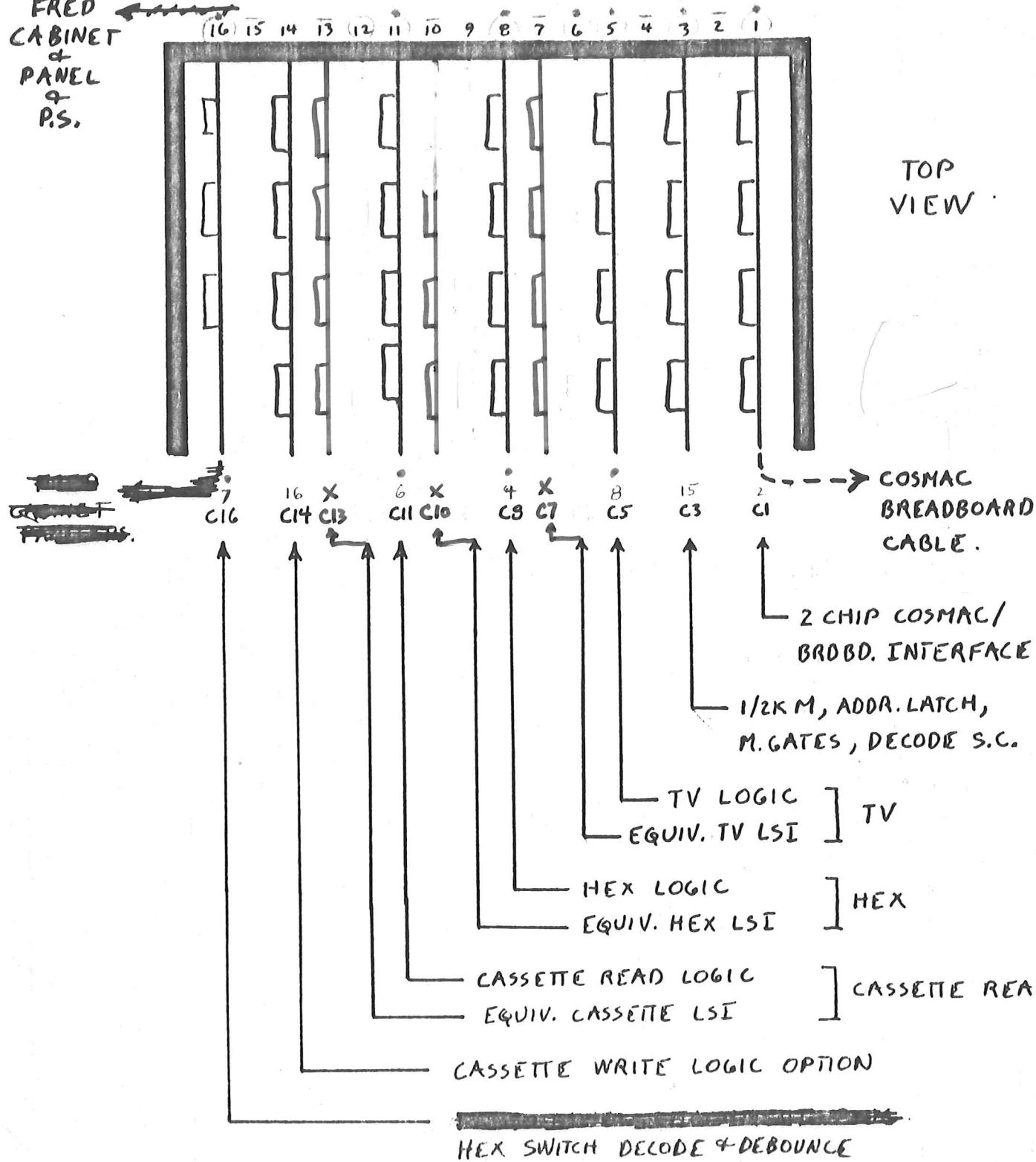
* NOTE ADD JUMPER BETWEEN PINS 8-9
ON CHIP D

JAW 8-1-74

FRED - CARD NEST

BACK PANEL WIRING

FRED
CABINET
&
PANEL
&
P.S.



$$21 - Y = +5$$

$$22 - Z = GND$$

JAW 4-14-74

Signetics

FULLY DECODED, 1024-BIT
STATIC RANDOM ACCESS MEMORY

2602
2602-1

6-79-665-5071

JOE RUPNIK

1-24 24

10000 - \$14.83

ORDER FROM
HAMILTON AVENUE
(CHERRY HILL)

DESCRIPTION

The Signetics 2602 is a medium speed, static random access memory offering a 1024x1 organization. Fabricated with low threshold N-Channel silicon gate technology, the 2602 yields an access and read cycle time of less than 1 μ s for the standard version and 500ns for the -1 version. Write cycle time is 500ns.

The 2602 is fully static, requiring no clocks and is completely DTL/TTL compatible including the single +5V power supply requirement.

FEATURES

- 1024x1 STATIC OPERATION
- 100% TTL COMPATIBLE
- LOW ACCESS AND CYCLE TIME: 2602 1 μ s
2602-1 500ns
- LOW POWER DISSIPATION 0.2mW/BIT
- STANDARD PACKAGE 16-PIN DIP
- V_{CC} = +5V
- SIGNETICS N-CHANNEL SILICON GATE TECHNOLOGY
- TRI-STATE OUTPUT

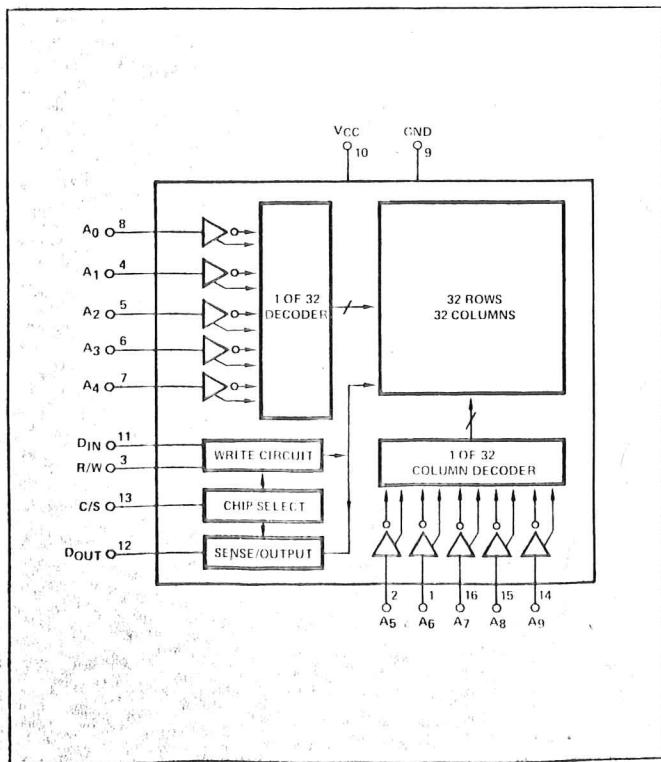
APPLICATIONS

PERIPHERAL MEMORIES

BUFFER MEMORIES

MINICOMPUTER MEMORY

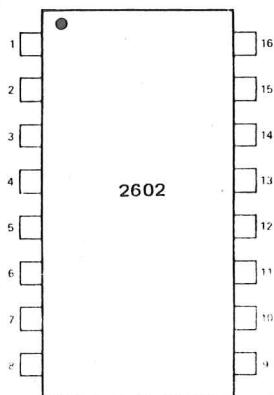
BLOCK DIAGRAM



ADVANCED SPECIFICATION
SILICON GATE MOS 2600 SERIES

PIN CONFIGURATION

B & I PACKAGES

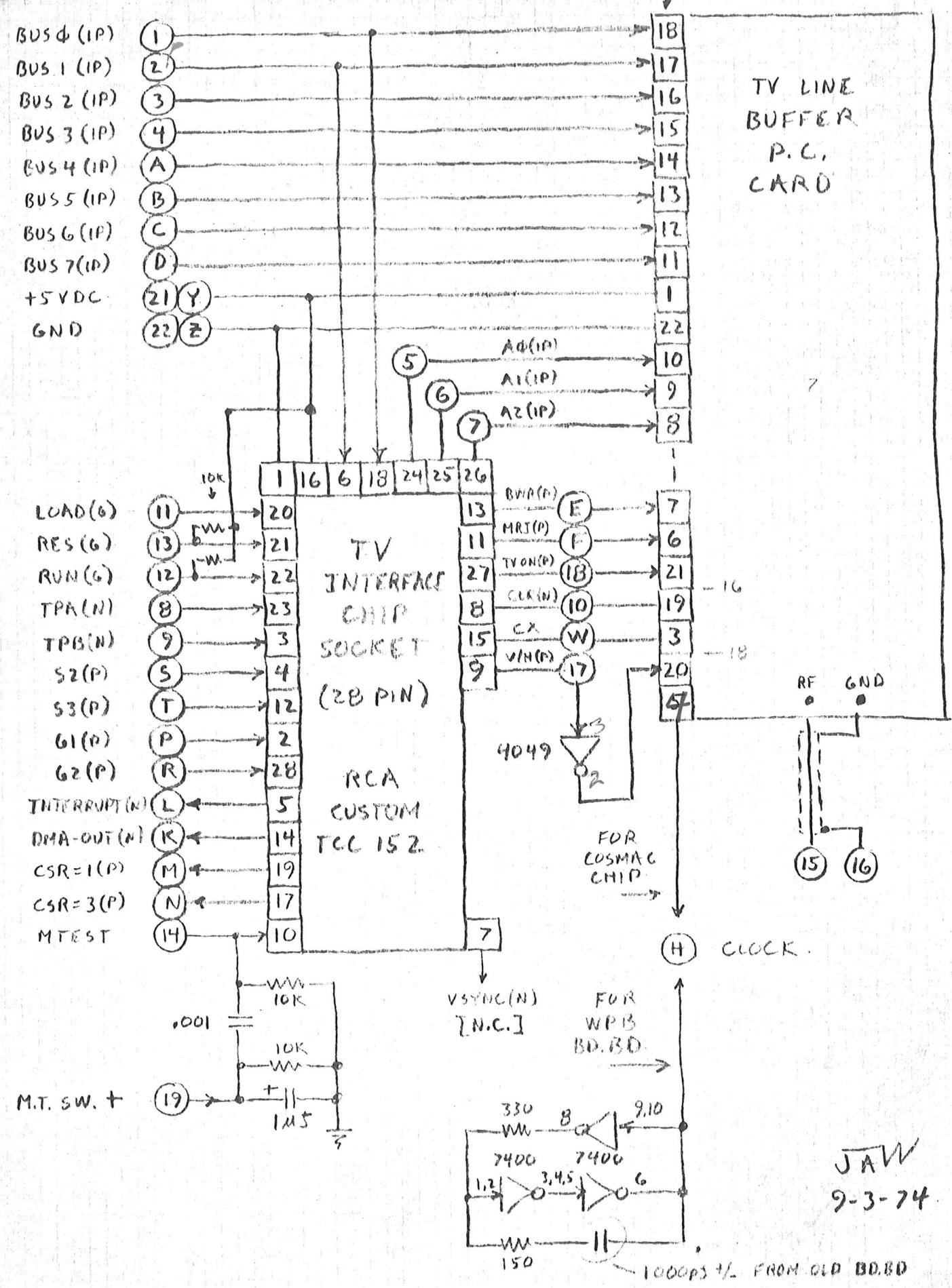


- | | |
|---------------|---------------------|
| 1. Address 6 | 16. Address 7 |
| 2. Address 5 | 15. Address 8 |
| 3. Read/Write | 14. Address 9 |
| 4. Address 1 | 13. Chip Select |
| 5. Address 2 | 12. Data Out |
| 6. Address 3 | 11. Data In |
| 7. Address 4 | 10. V _{CC} |
| 8. Address 0 | 9. Ground |

PART IDENTIFICATION

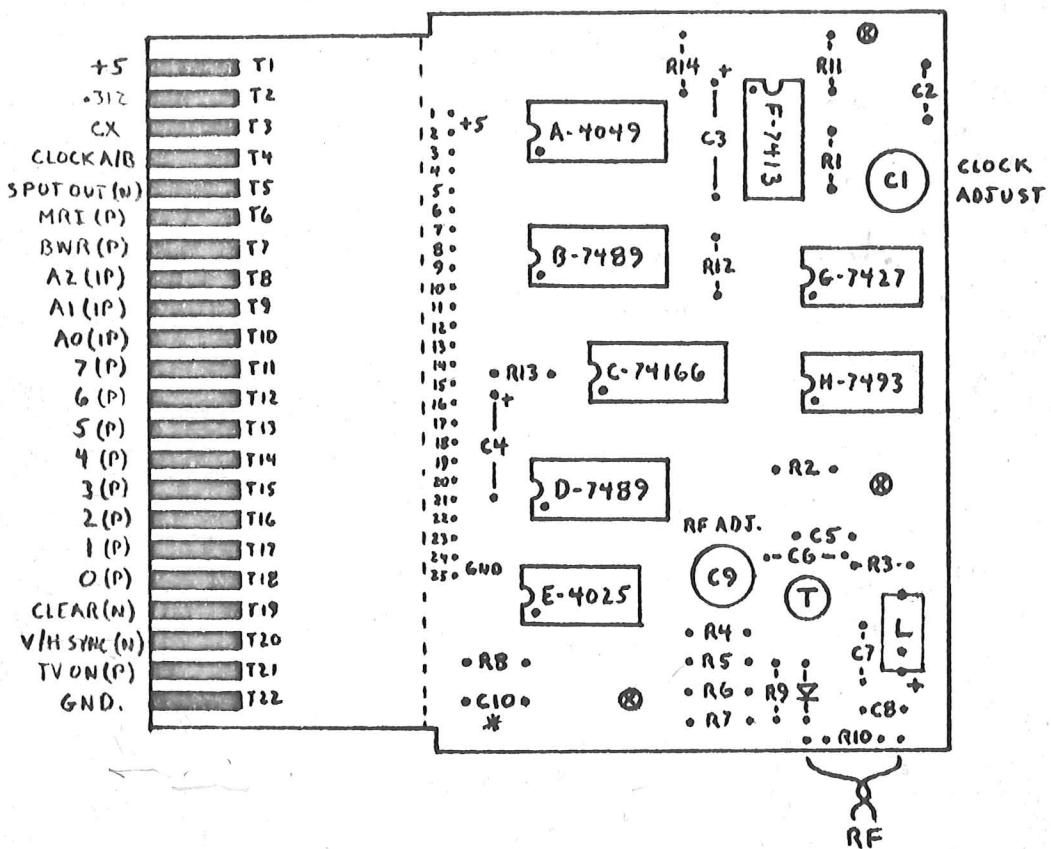
TYPE	PACKAGE	T _A	OP. TEMP. RANGE
2602B	16-Pin Plastic DIP	1 μ s	0-70°C
2602-1B	16-Pin Plastic DIP	500ns	0-70°C
2602 I	16-Pin Ceramic DIP	1 μ s	0-70°C
2602-1I	16-Pin Ceramic DIP	500ns	0-70°C

BREADBOARD TV CARD (C5).



FRED II TV LINE BUFFER P.C. CARD.

CUT HERE AFTER TEST



R1 - 300

R2 - 150

R3 - 22K

R4 - 330

R5 - 47K

R6 - 4.7K

R7 - 10K

R8 - 47K

R9 - 4.7K

R10 - 150

RII - 2K

R12 - 2K

R13 - 2K

R14 - 2K

C1 - 15-60pf TRIMMER

C2 - 550pf

C3 - 22uf

C4 - 10uf

C5 - .2uf

C6 - .005uf

C7 - 68pf

C8 - 12 pf

C9 - 15-60pf TRIMMER

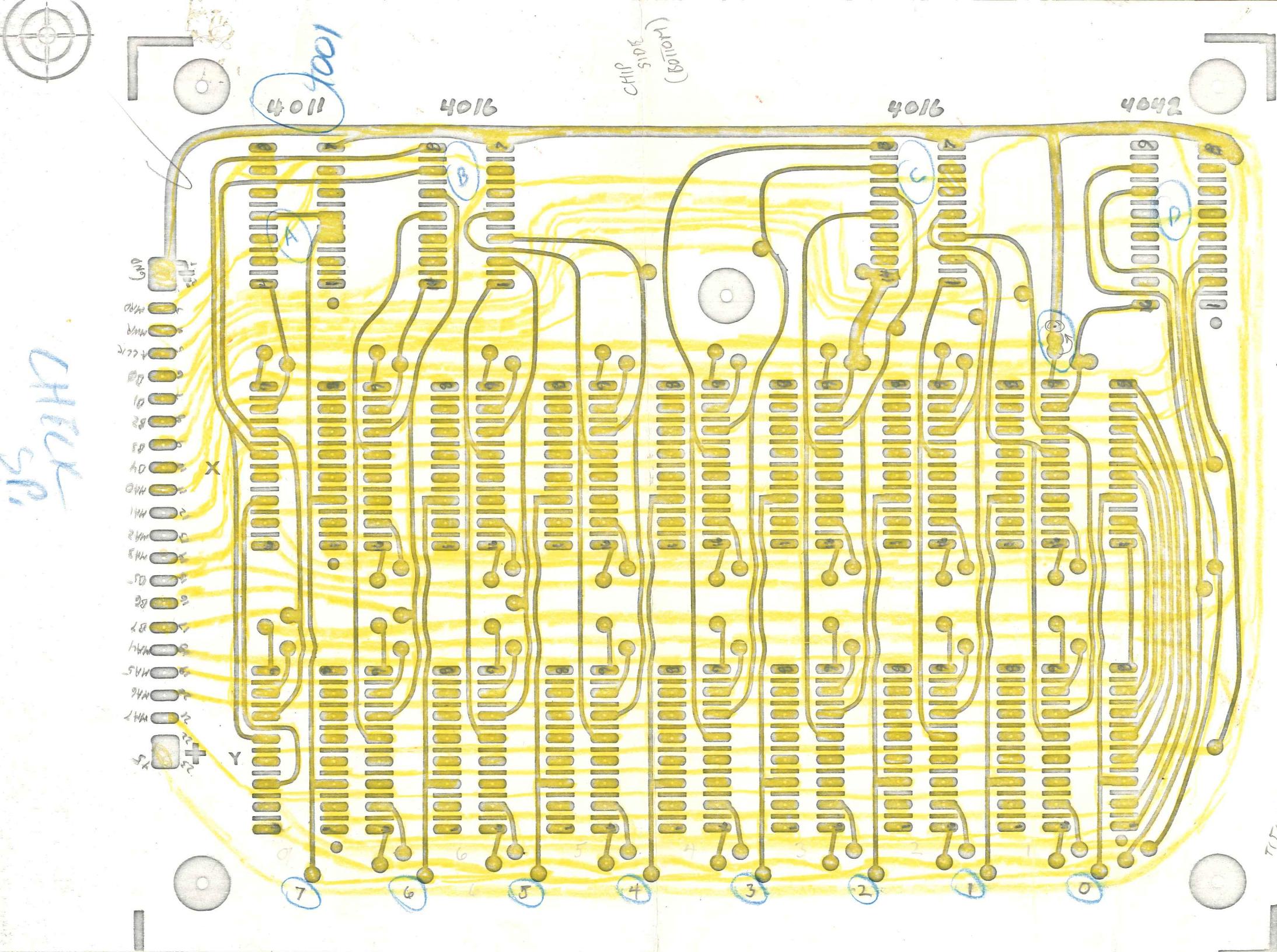
C10 - OPTIONAL HORIZ. SHIFT.

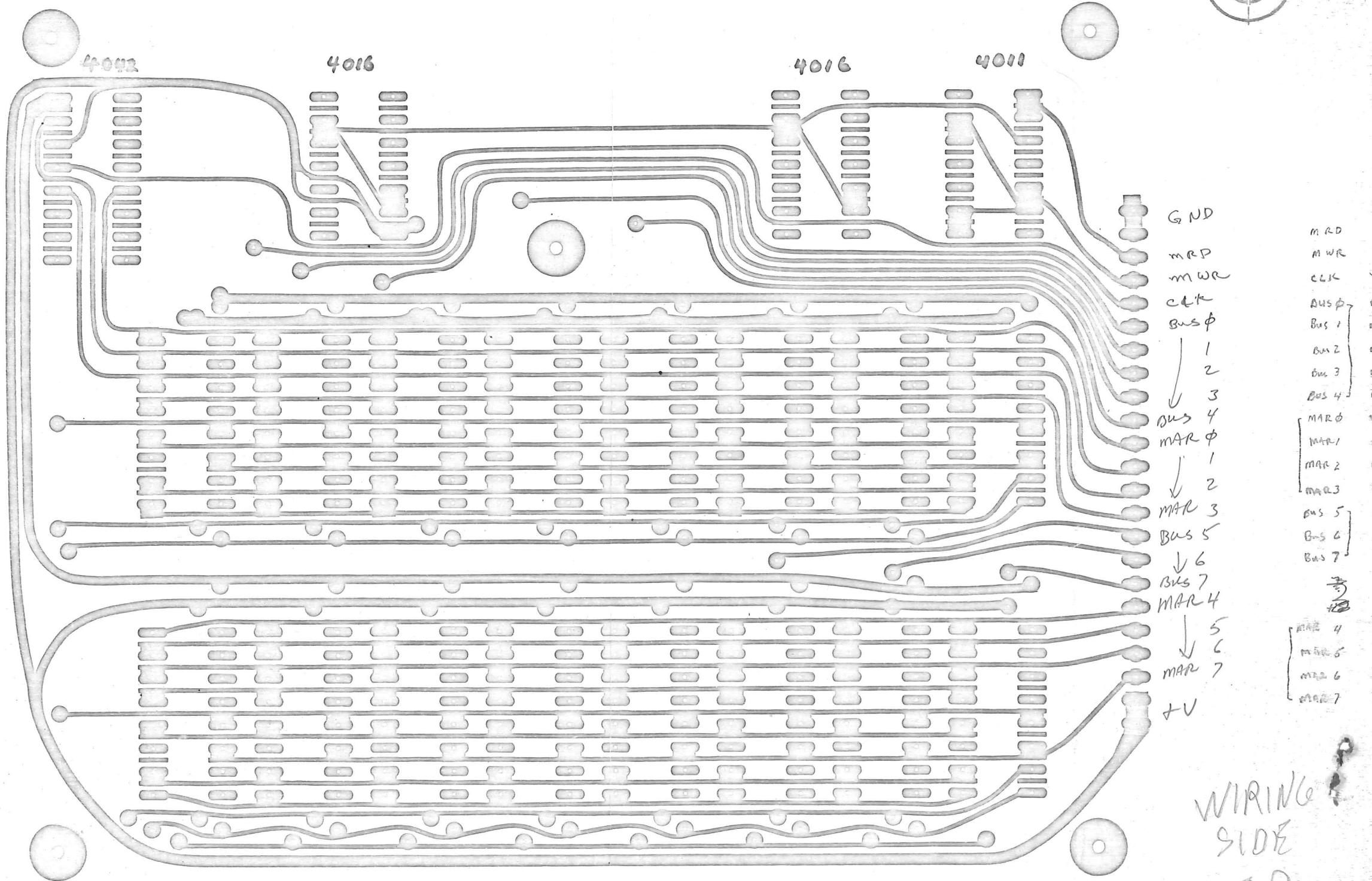
T - 2475

L - 4.5 TURNS #20, 1/4" O.D.

TAP 1-TURN FROM + END.

JAW





To B. J. Call

Location 3-118

Date 7/30/74

From A. F. Dietrich

Location Model Shop

Telephone 2288

Subject FRED Case

Breakdown of actual time spent on fabrication of ten Fred Case:

Cabinet Shop	14 hrs.
Model Shop Machining	82 "
Assembly *	50 "
	<hr/>
	146 hrs.

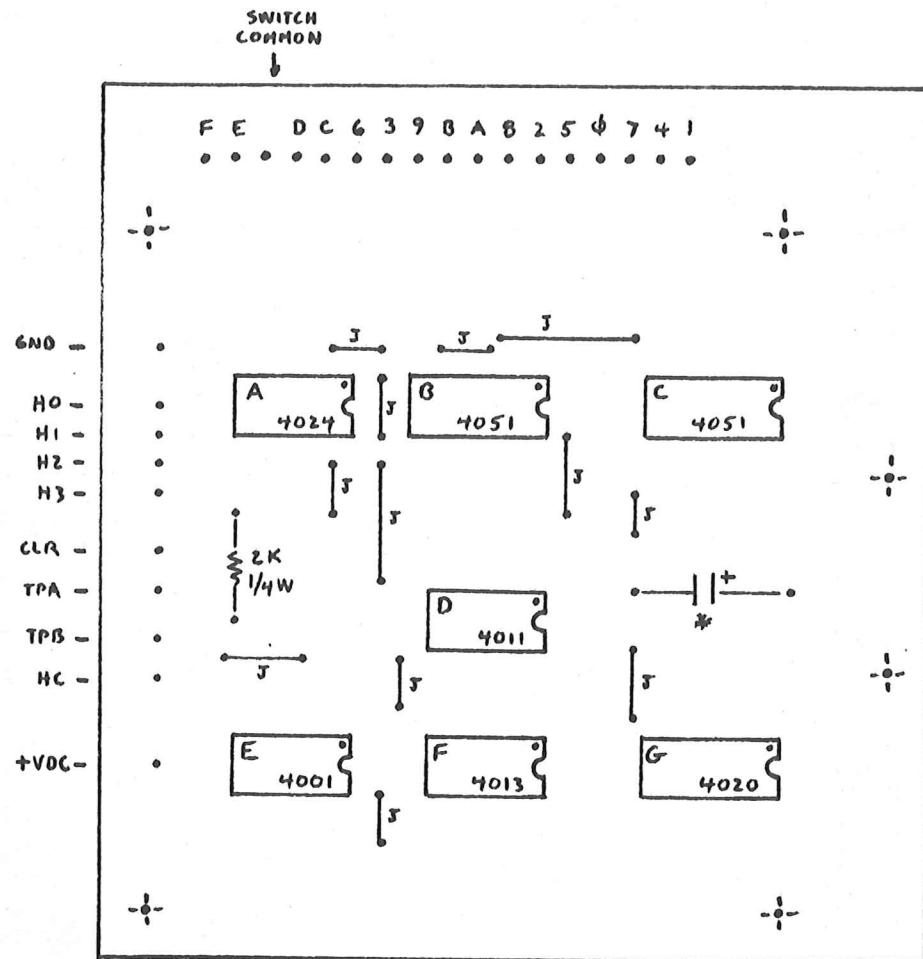
Estimate for twenty unit no assembly

Cabinet Shop	20 hrs.
Model Shop	120 "

* Assembly time of 50 hrs. includes additional work of machining bottom screens and rework to provide for a stand-off.

/ tr

A. F. Dietrich



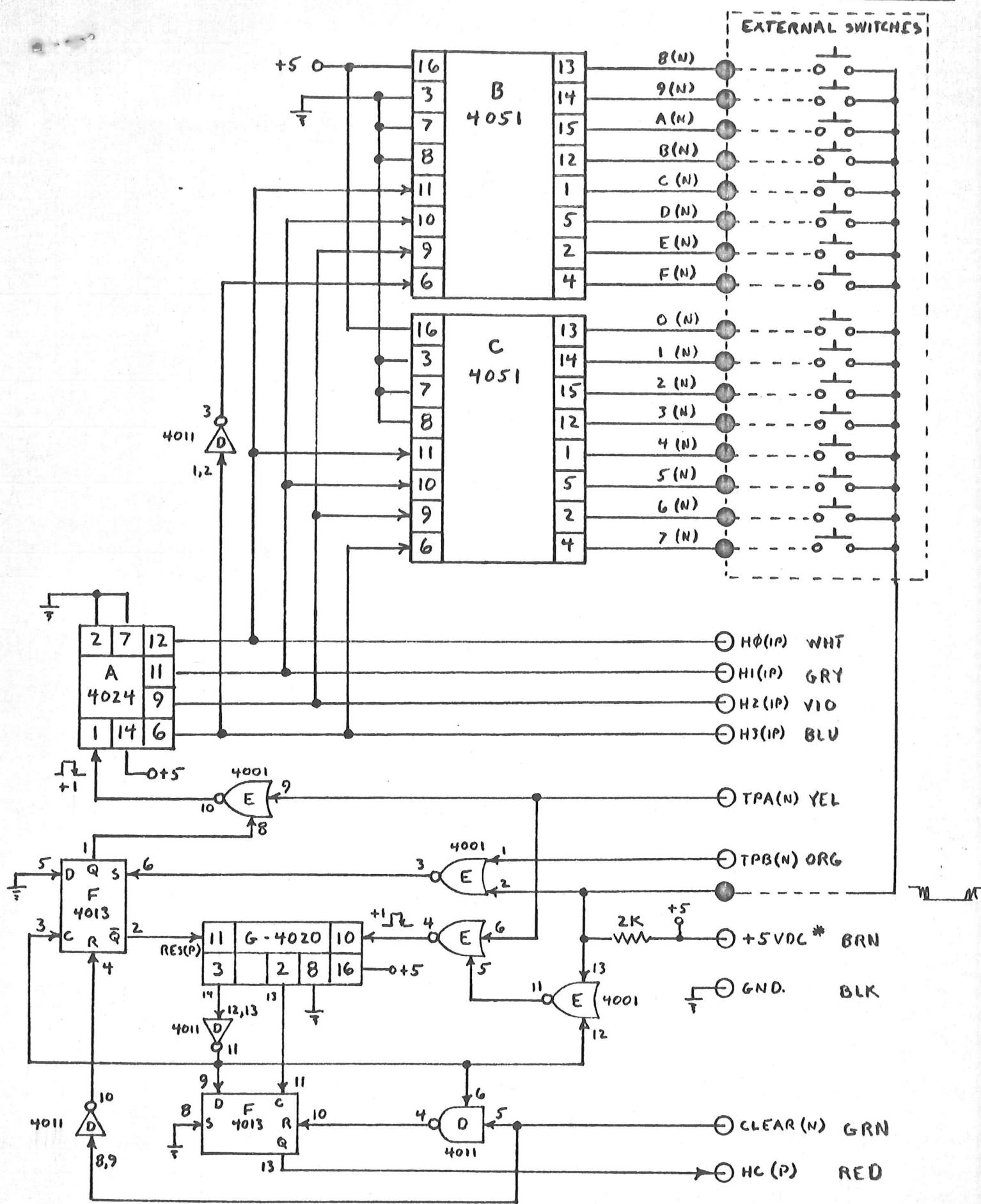
HEX KEYBOARD DECODE AND DEBOUNCE COMPONENT SIDE

* OPTIONAL FILTER CAP.

* NOTE ADD JUMPER BETWEEN PINS 8 & 9
ON CHIP D

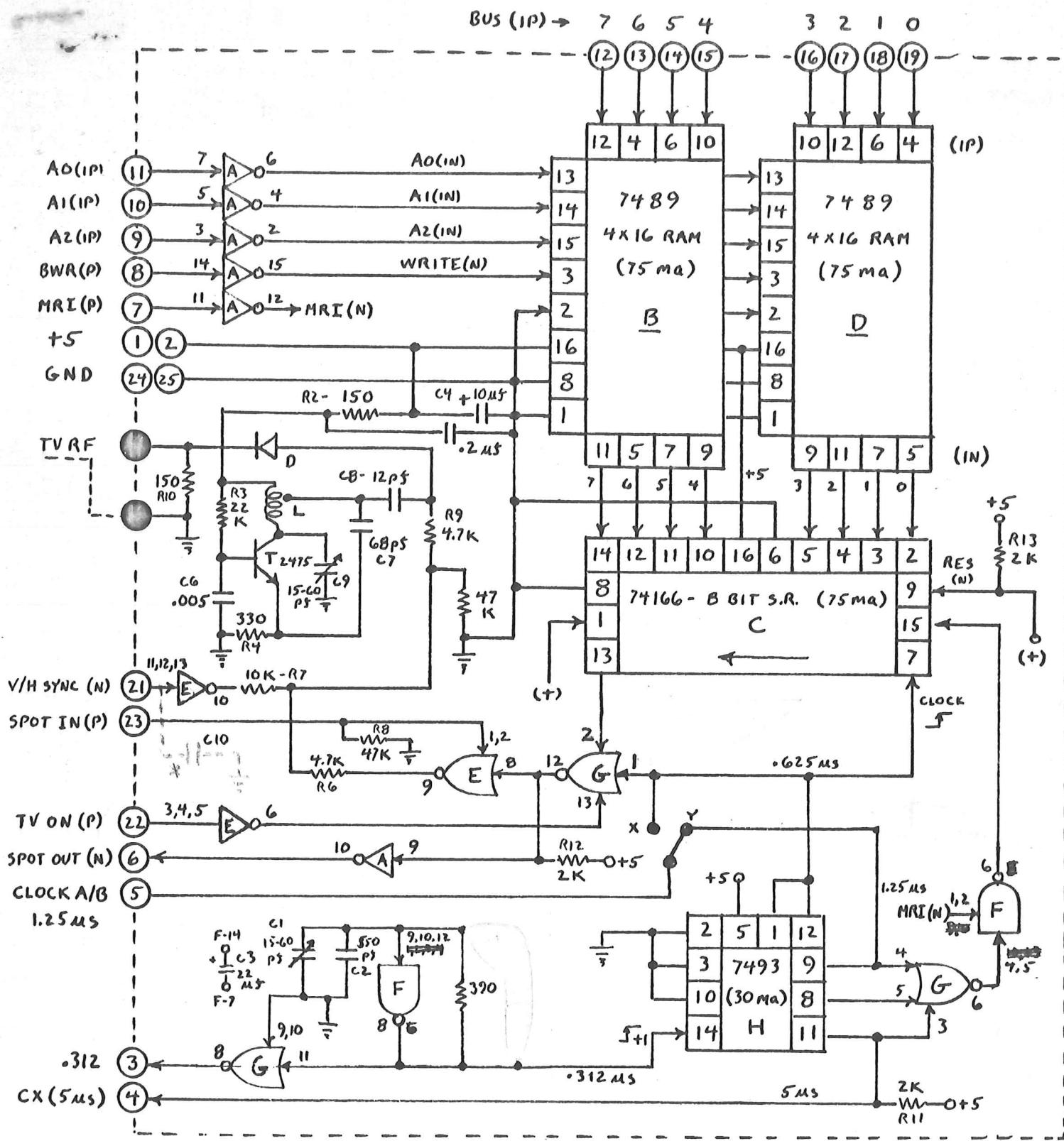
JAW 8-1-74

FRED-II HEX SWITCH DECODE + DEBOUNCE CARD



JAW B-1-74

FRED II - TV LINE BUFFER P.C. CARD



A-4049

F-7413

B-7489

G-7427

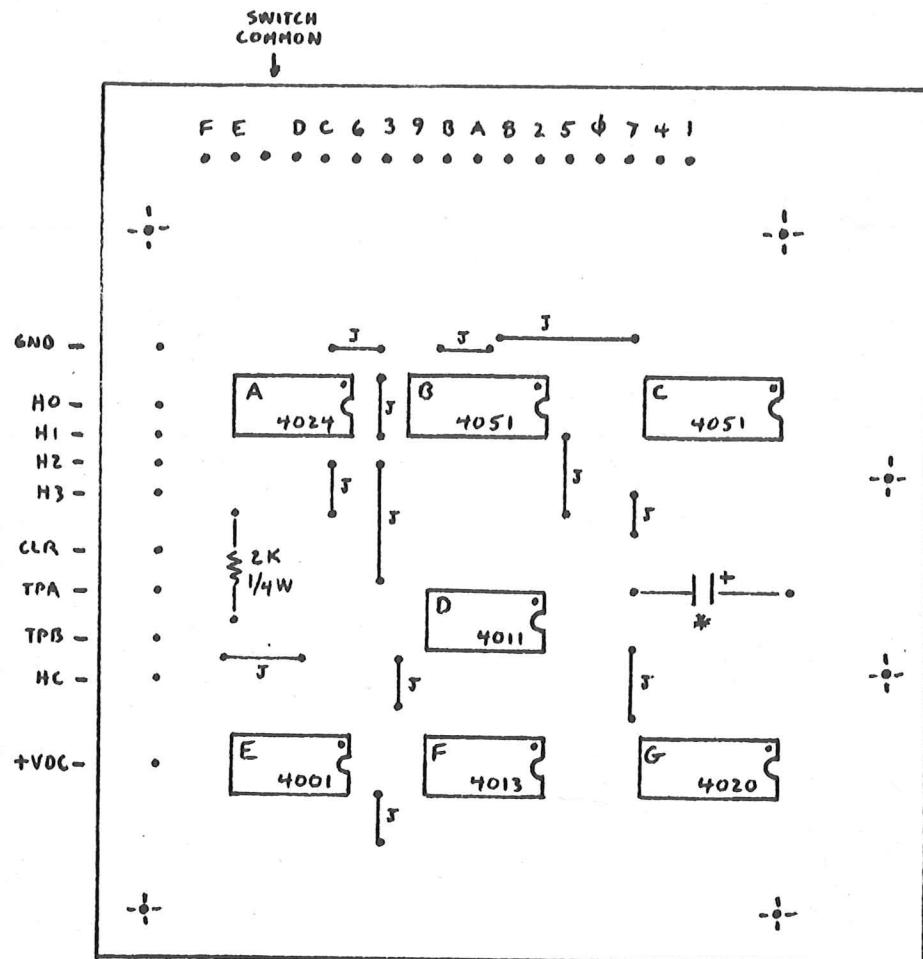
C-74166

H-7493

D-7489

E-4025

JAW 8-1-74



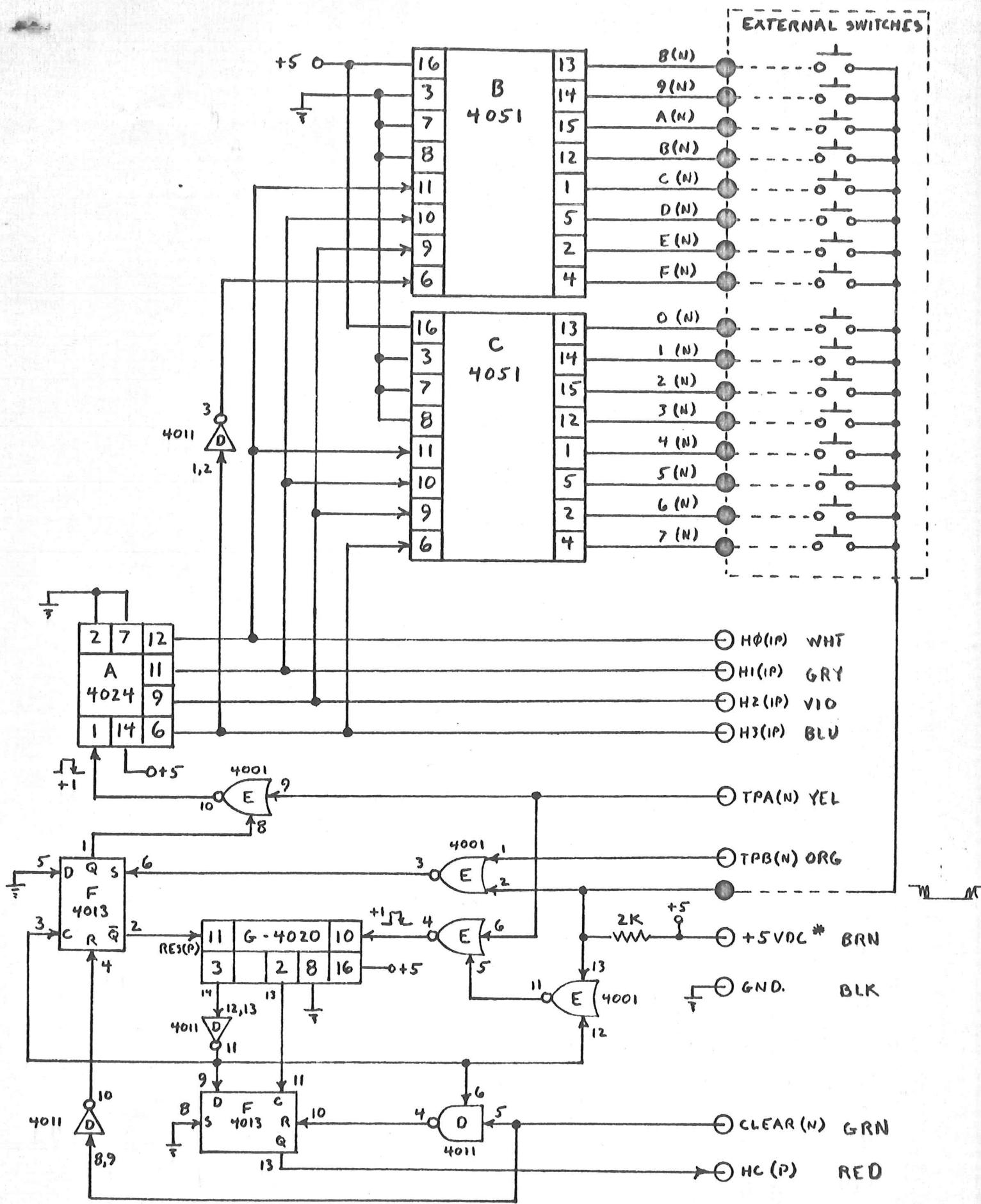
HEX KEYBOARD DECODE AND DEBOUNCE COMPONENT SIDE

* OPTIONAL FILTER CAP.

* NOTE ADD JUMPER BETWEEN PINS 8+9
ON CHIP D

JAW 8-1-74

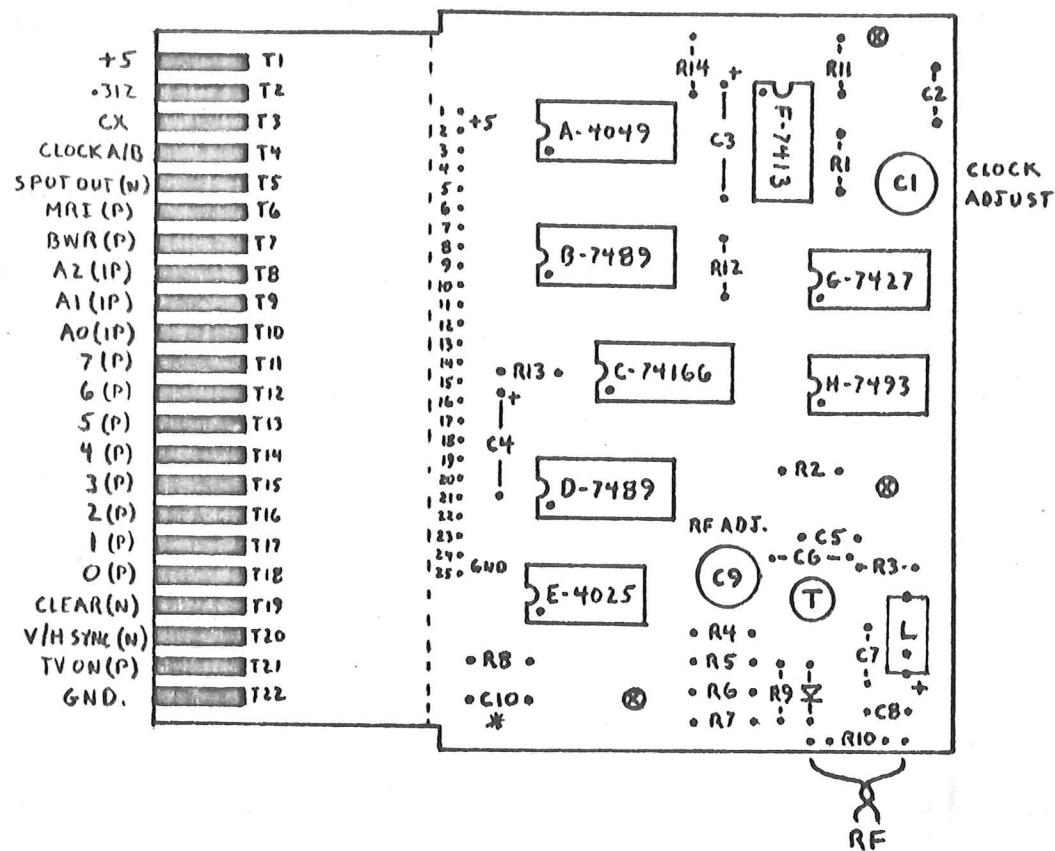
FRED-II HEX SWITCH DECODE + DEBOUNCE CARD



JAW B-1-74

FRED II TV LINE BUFFER P.C. CARD.

CUT HERE AFTER TEST



R1 - 390

R2 - 150

R3 - 22 K

R4 - 330

R5 - 47 K

R6 - 4.7 K

R7 - 10 K

R8 - 47 K

R9 - 4.7 K

R10 - 150

R11 - 2 K

R12 - 2 K

R13 - 2 K

R14 - 2 K

C1 - 15-60 pS TRIMMER

C2 - 550 pS

C3 - 22 uF

C4 - 10 uF

C5 - .2 uF

C6 - .005 uF

C7 - 68 pF

C8 - 12 pF

C9 - 15-60 pS TRIMMER

C10 - OPTIONAL HORIZ. SHIFT.

T - 2475

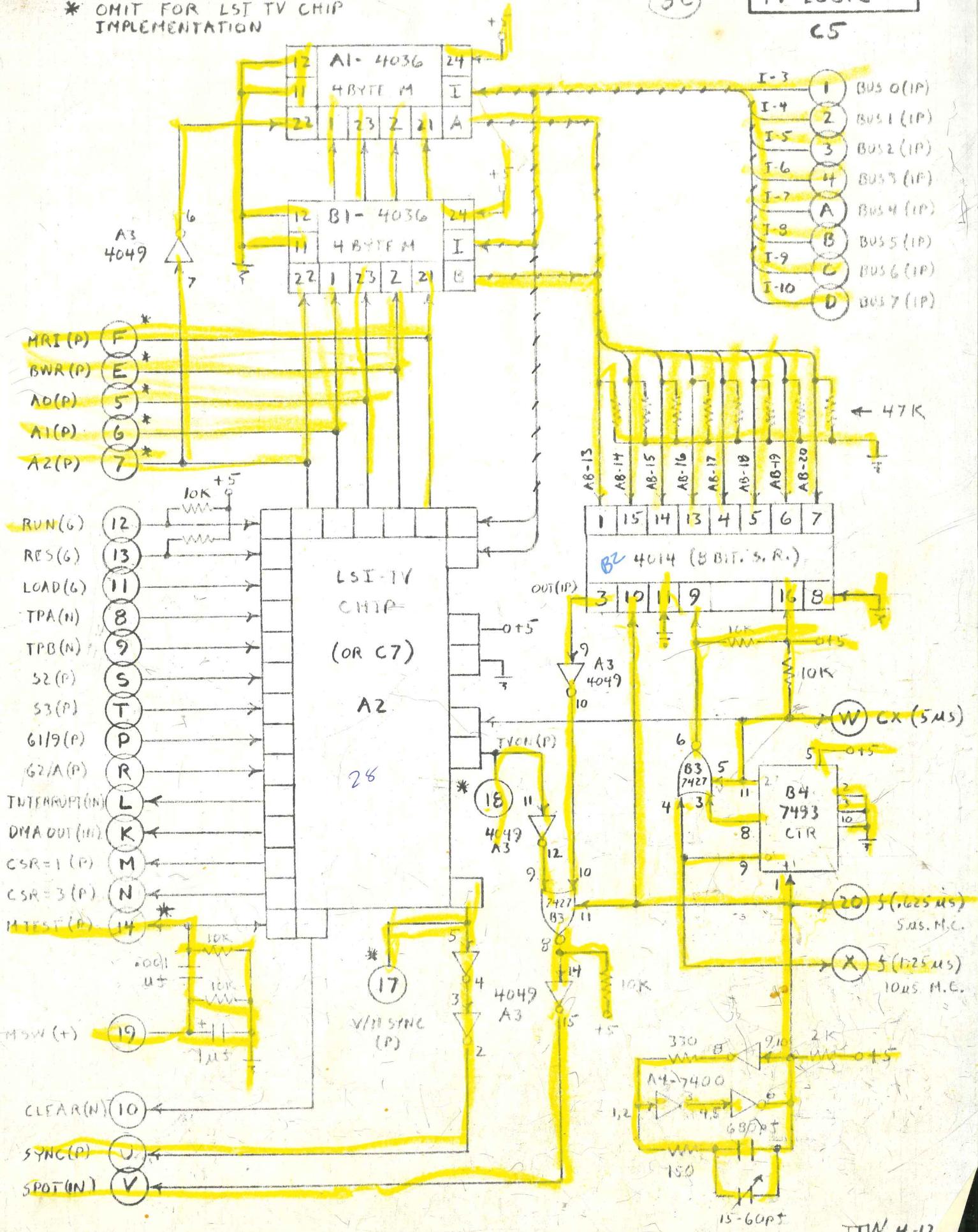
L - 4.5 TURNS #20, 1/4" O.D.
TAP 1-TURN FROM + END.

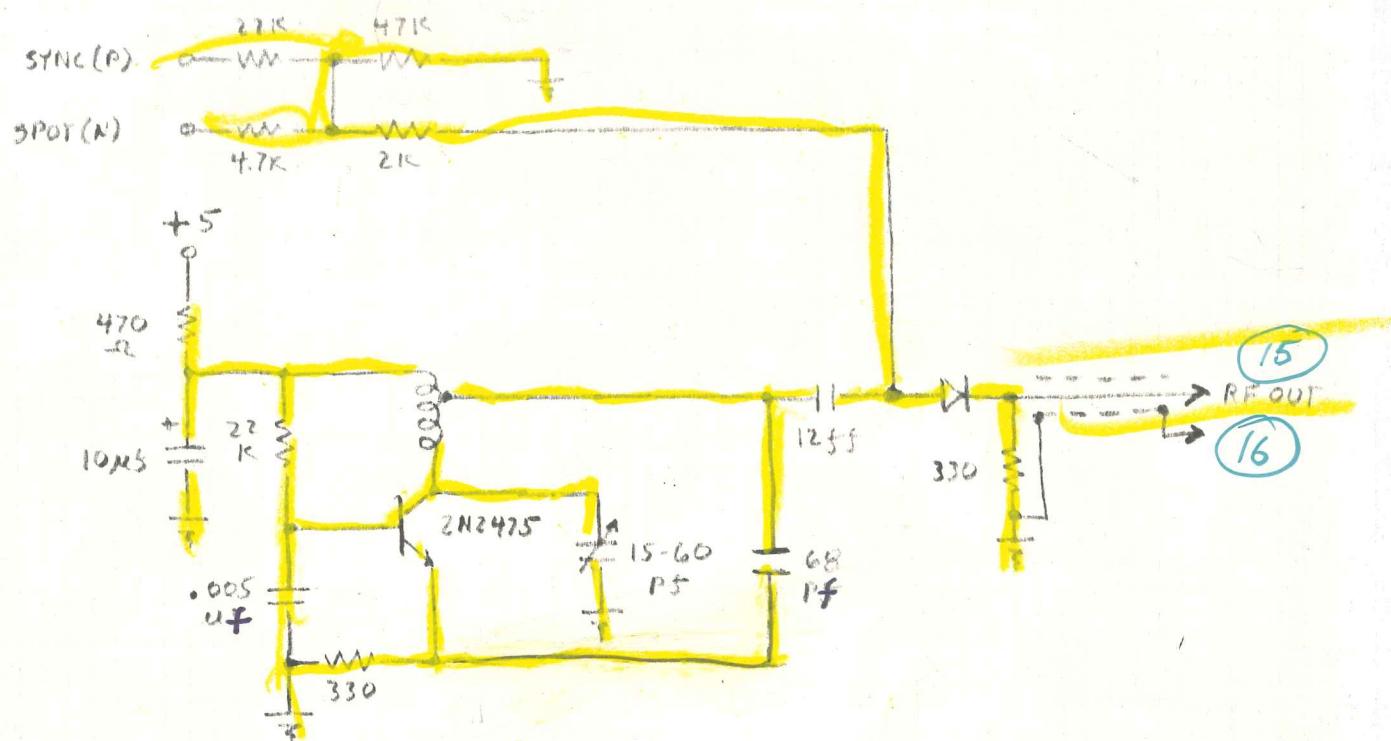
JAW

* OMIT FOR LSI TV CHIP
IMPLEMENTATION

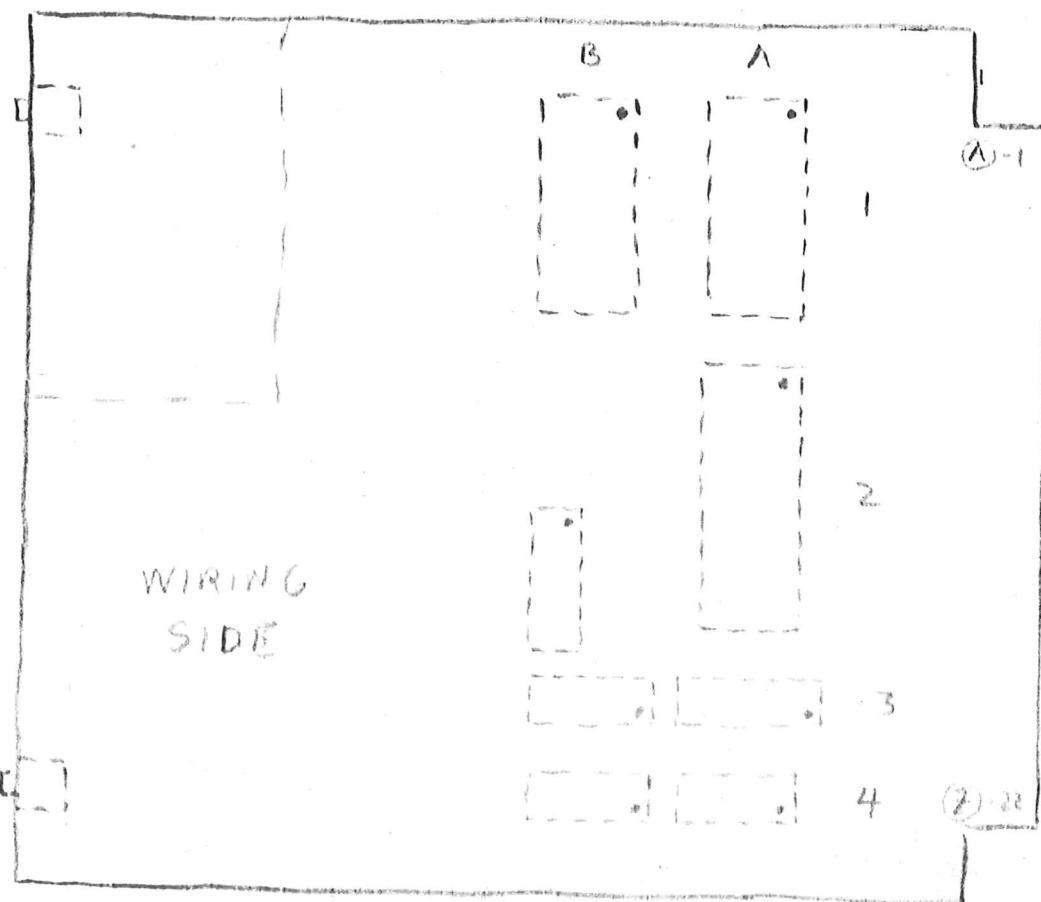
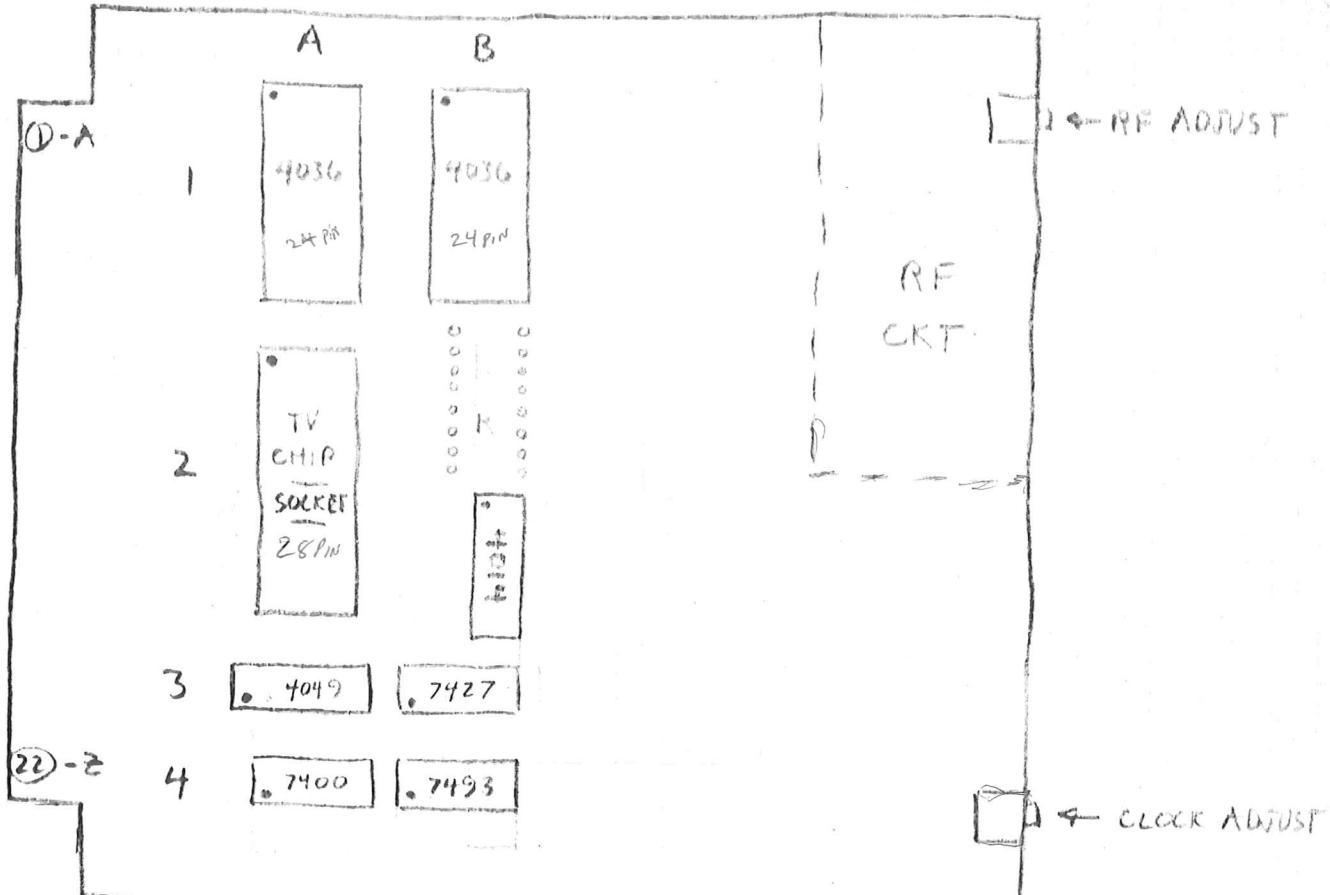
TV LOGIC

65





CARD C5 - TV LOGIC - COMPONENT SIDE

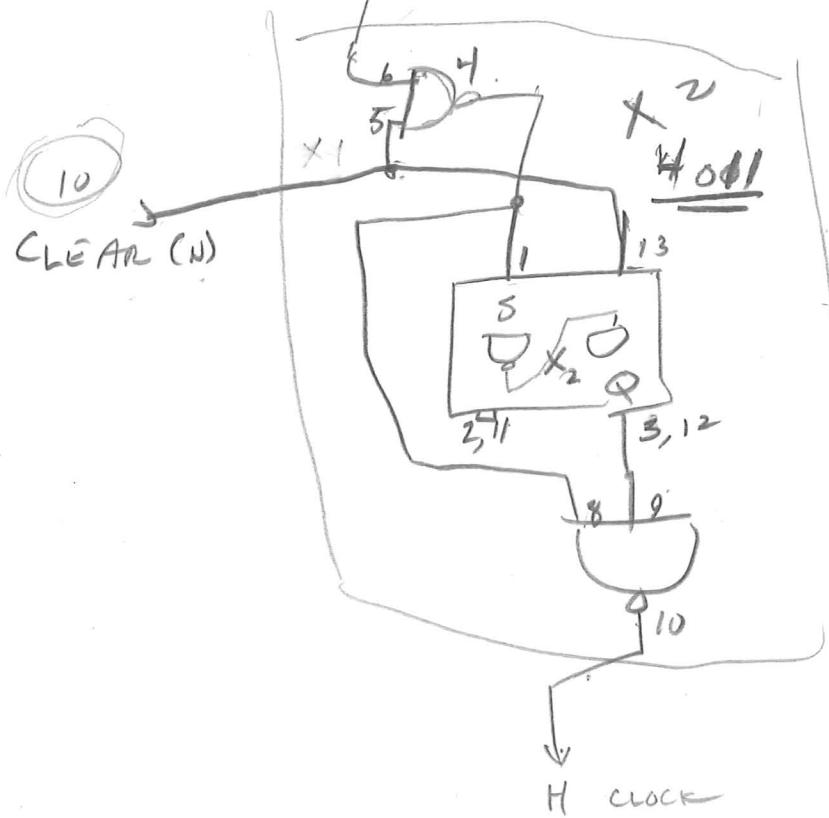


NO TRIMMER

1000 PF INSTEAD OF
680 PF

7400 7400
~~X1~~

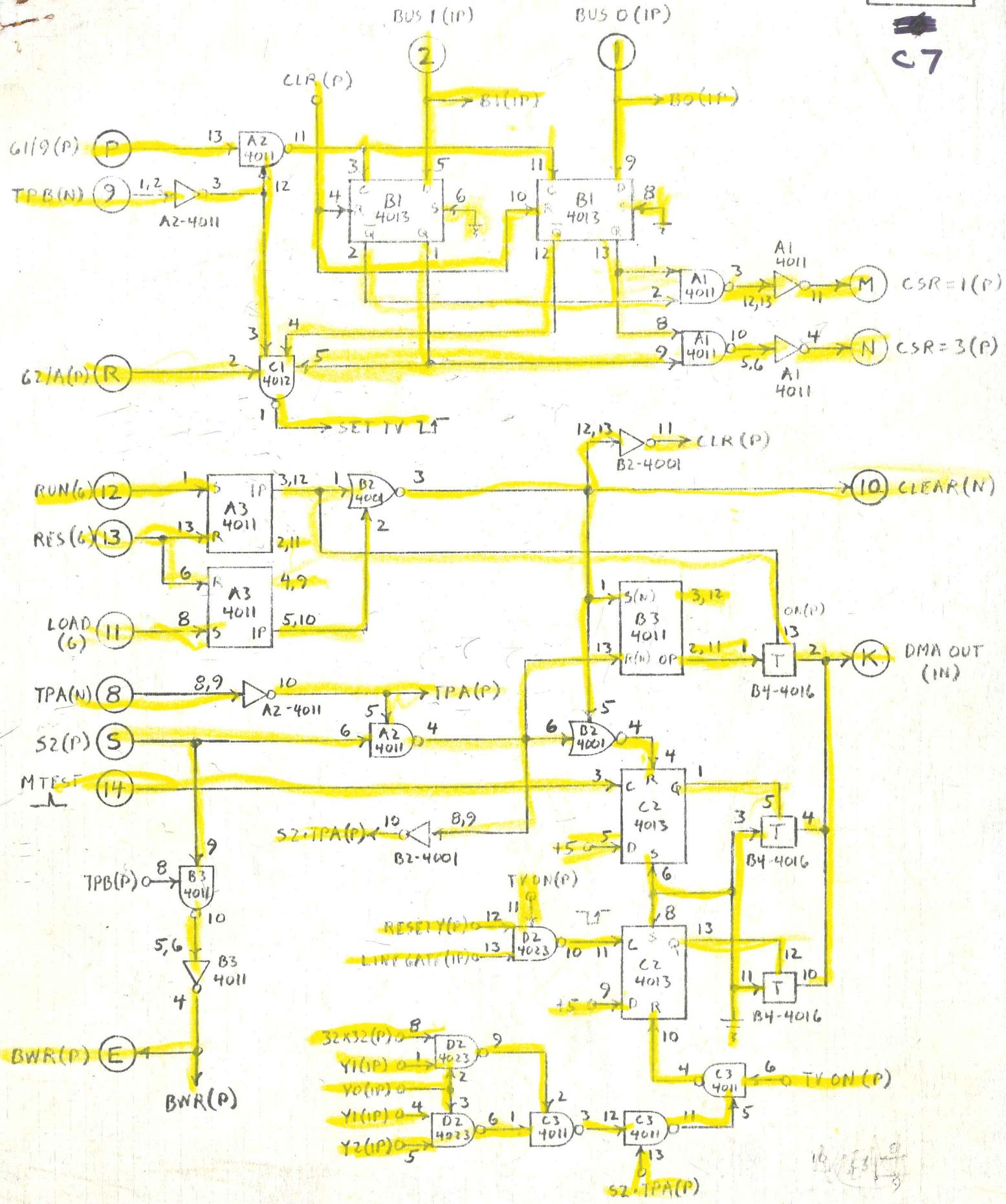
6,9,10



2,3,4,5,6,7,8,9

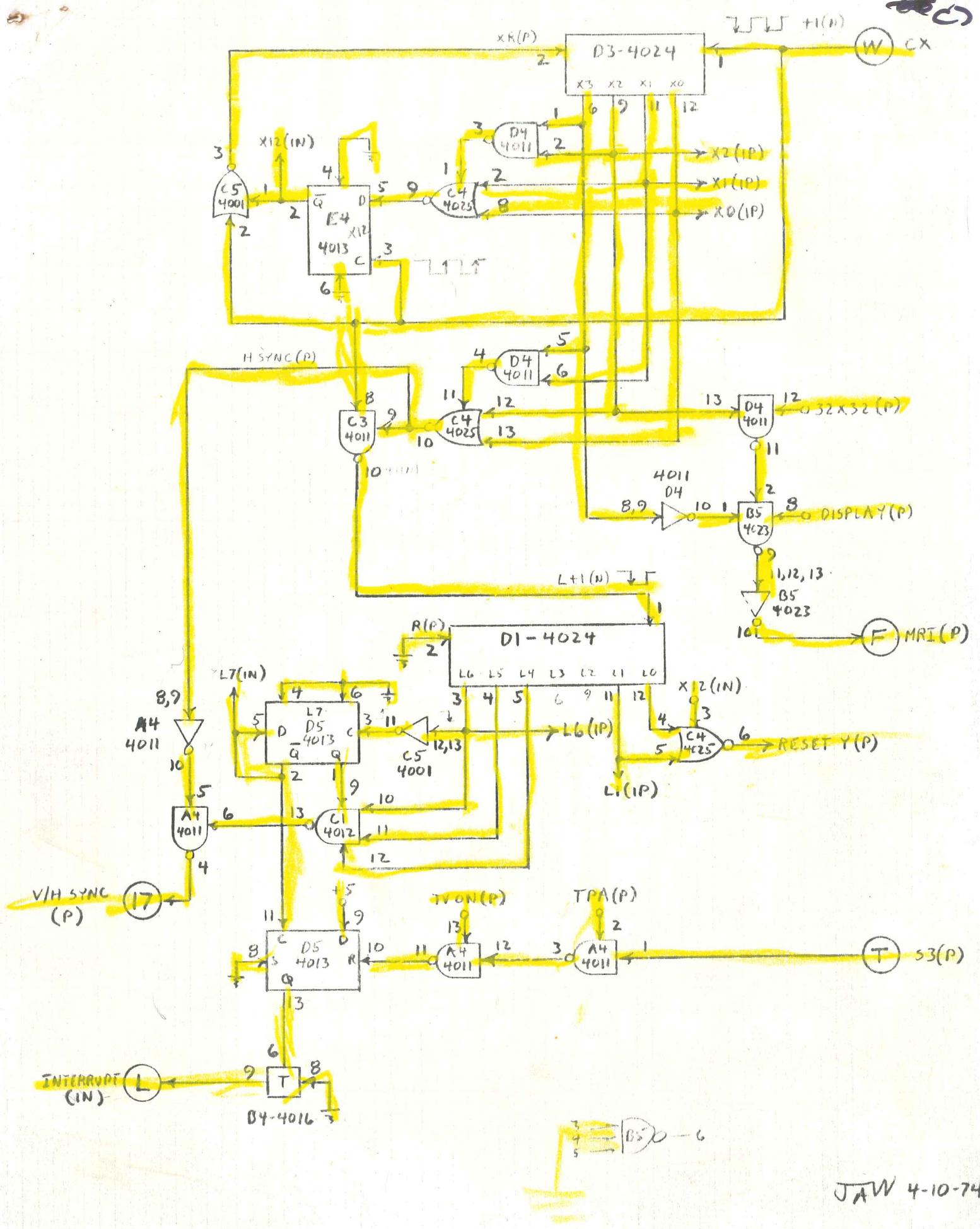
TV-AX

C7



JAW 4-10-74

TV-BX

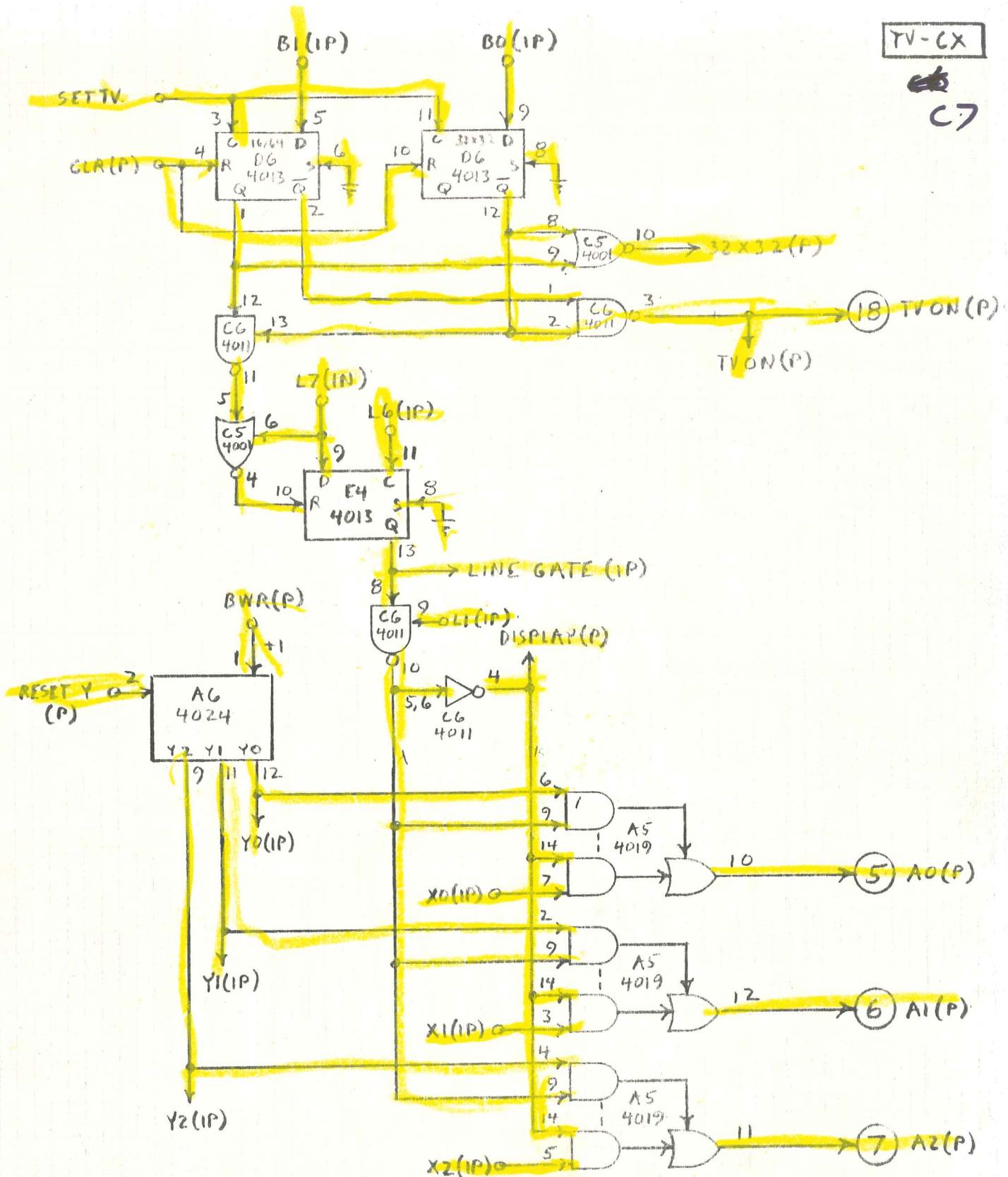
~~SC~~

JAW 4-10-74

TV-CX

C6

C7



JAW 4-10-74

C7
CARD 6 - TV LSI - COMPONENT SIDE

	A	B	C	D	E	
①-A	4011	4013	4012	4024		1
	4011	4001	4013	4023		2
	4011	4011	4011	4024		3
	4011	4016	4025	4011	4013	4
	4019	4023	4001	4013		5
②-Z	4024	#23	4011	4013		6

TOP
↑
BOTTOM

	E	D	C	B	A	
1						①-1
2						
3						
4						
5						
6						②-22

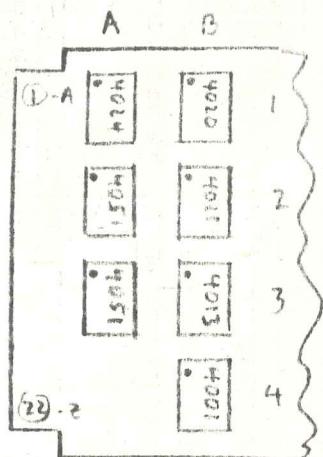
WIRING SIDE

JAW 4-10-74

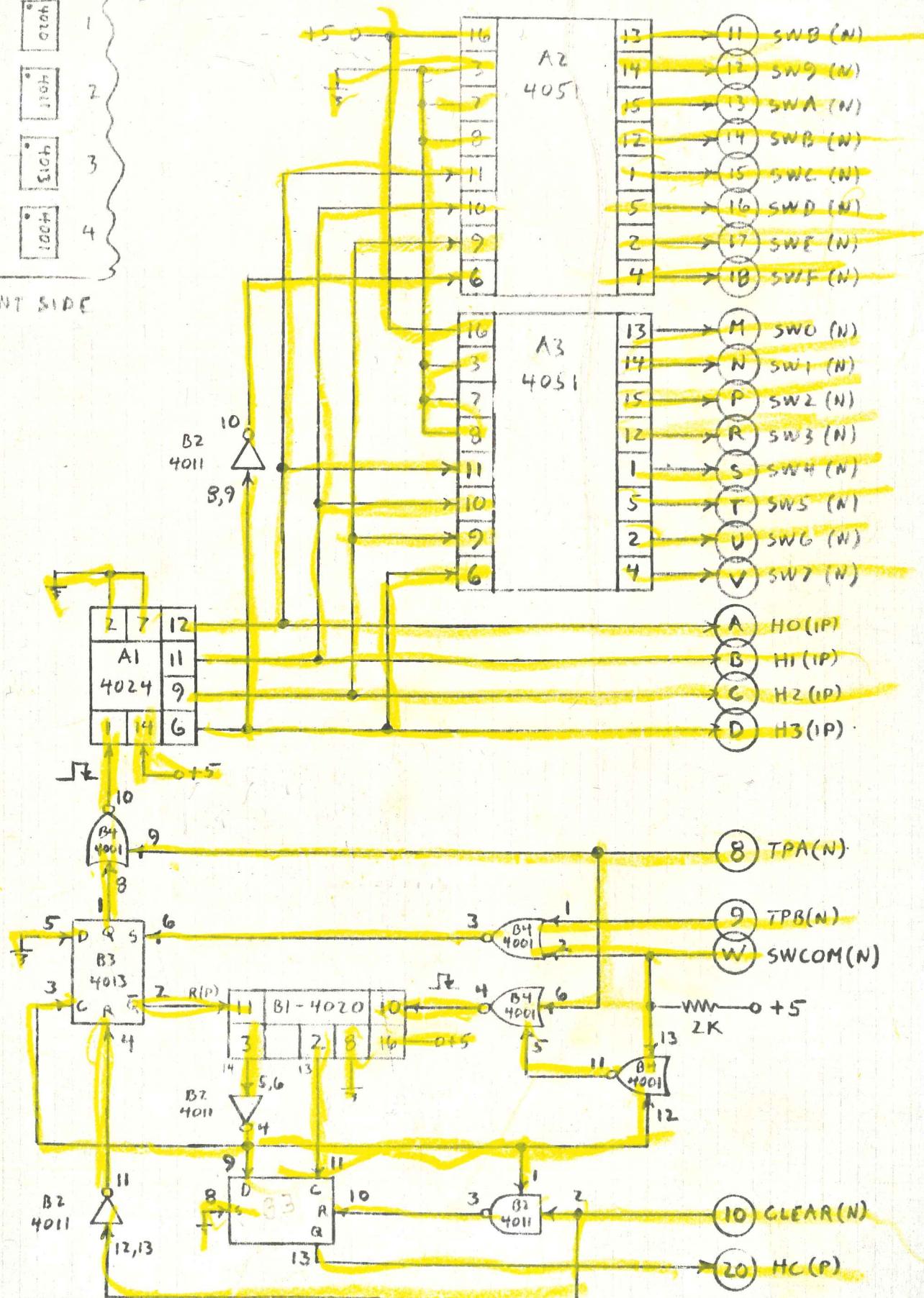
76

SW. DECODE + DEBOUNCE

C16



COMPONENT SIDE



JAW 4-15-74

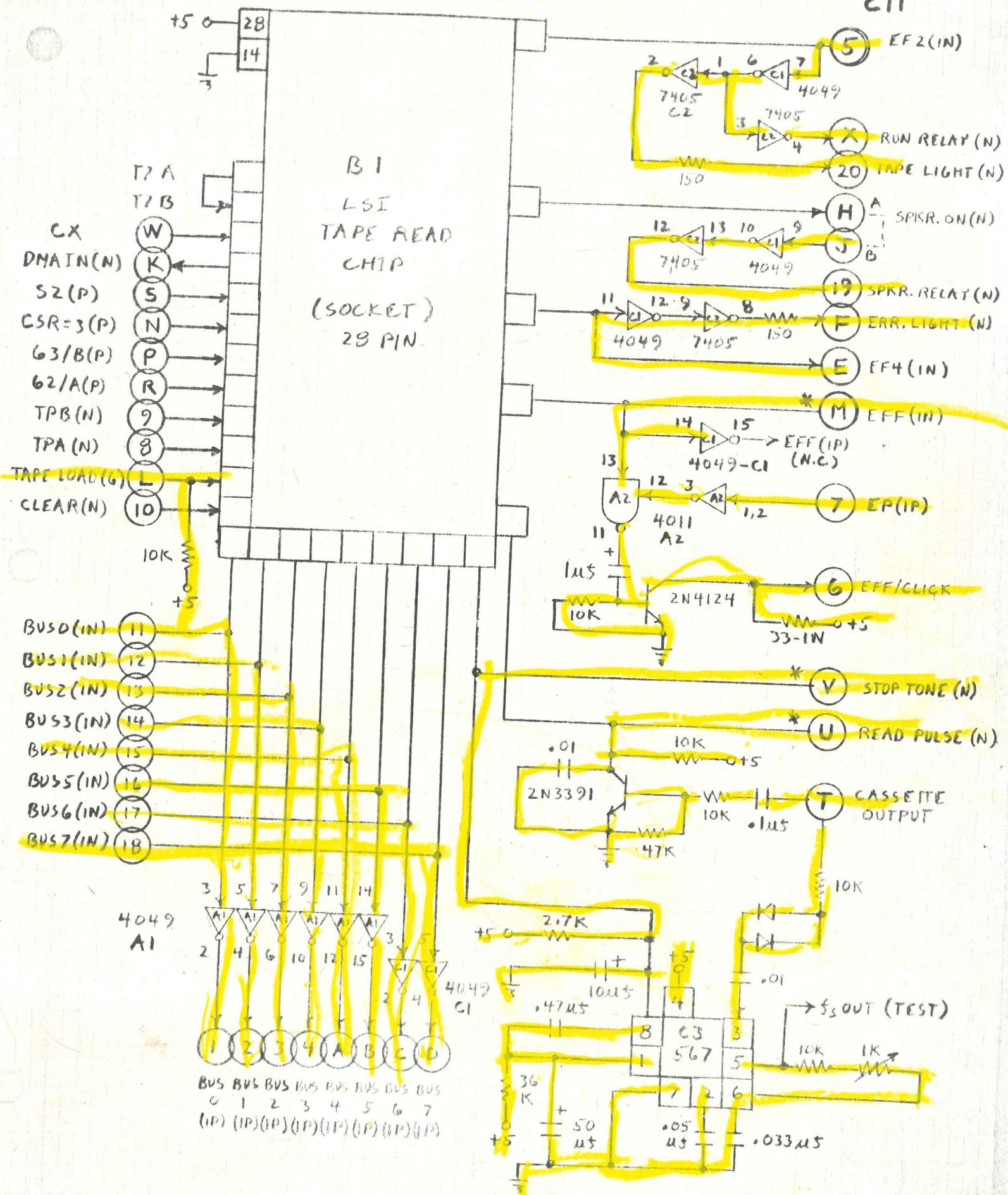
BRD PII	CH X	CH Y	BRD PII	CH X	CH Y	CH X	CH Y
1	17		B	26		10	17
2	16	22	C	6		11	18
3	34		D	27		12	19
4	33		E	8		13	20
5	32		F	9		14	23
6	31		G	10		18	21
7	30		H			21	16
8	29		I				
9	28		J				
10	27	15	K				
11	23		L				
12	24		M	5	24		
15	9		N	4	25		
16	8		P	3	26		
17	7		R	2	27		
18	6		S	39	2		
19	19		T	38	3		
20	22		U	37	4		
21	140	128	V	36	5		
22	2035	14	W	15			
			X	140	128		
			Y	2035	14		

- 5,6,8,9 TO GND

66

CASSETTE INPUT LOGIC

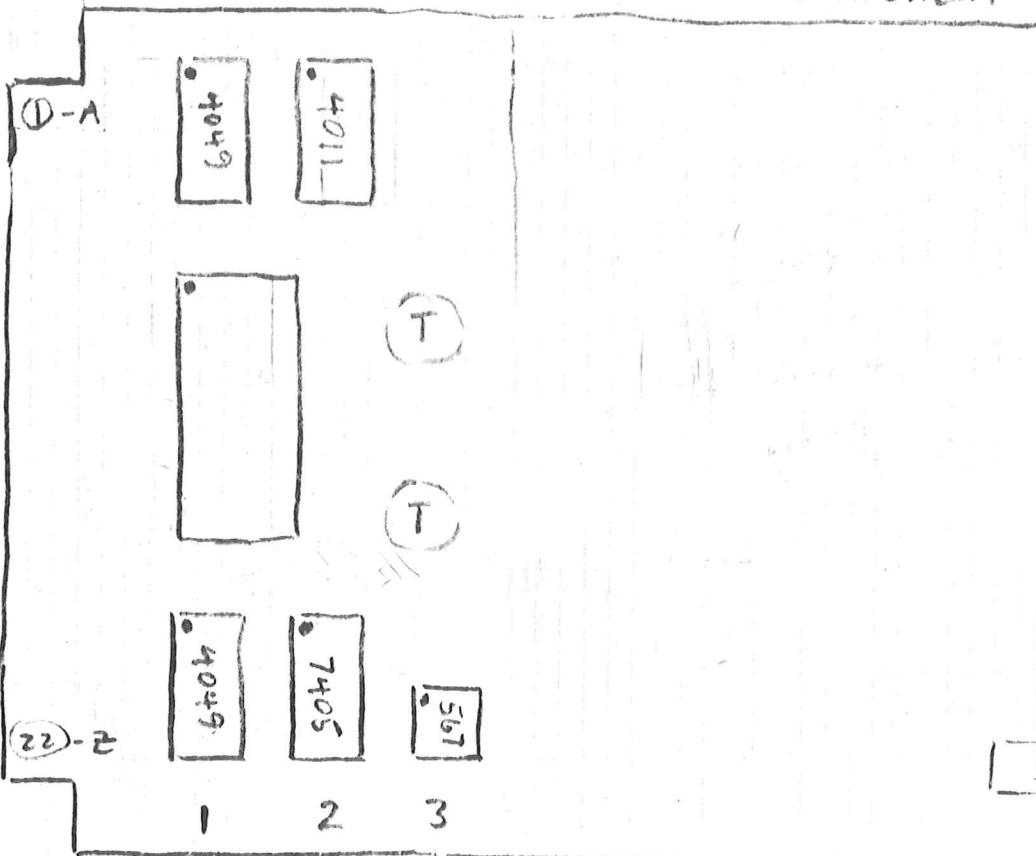
CII



JW 4-14-24

CARD II - CASSETTE INPUT LOGIC- COMPONENT SIDE

A



B

T

T

C

22-2

4049

7405

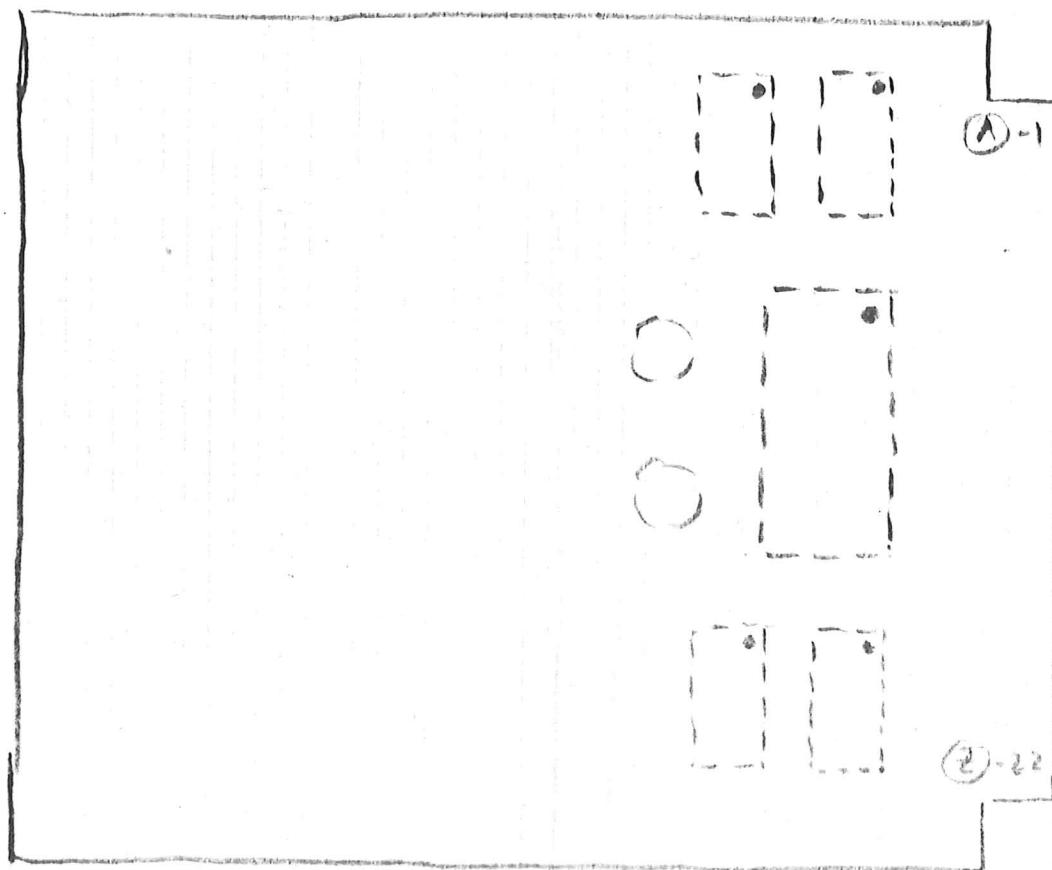
567

1

2

3

STOP TONE
ADJUST



WIRING SIDE

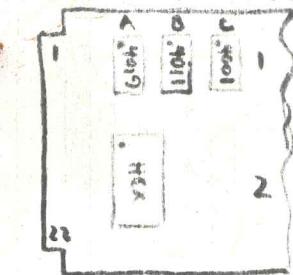
JAW 4-12-74

COMPONENT SIDE

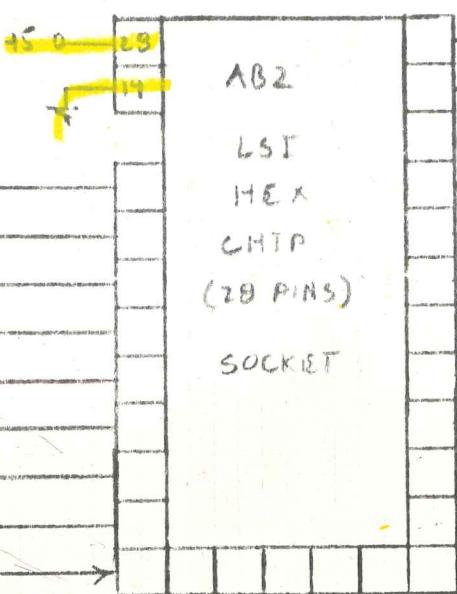
4C

HEX LOGIC

CB

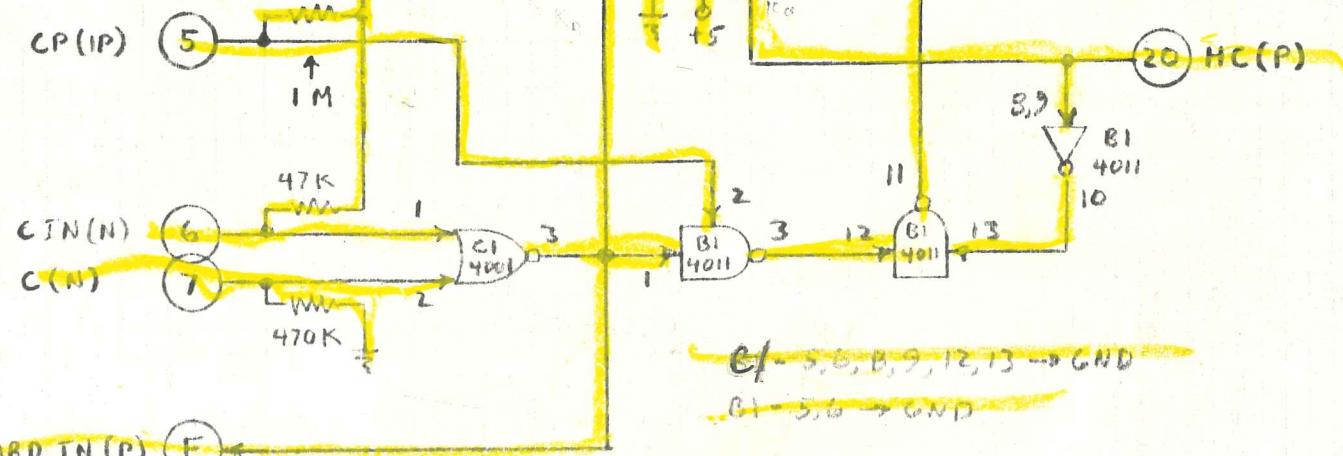
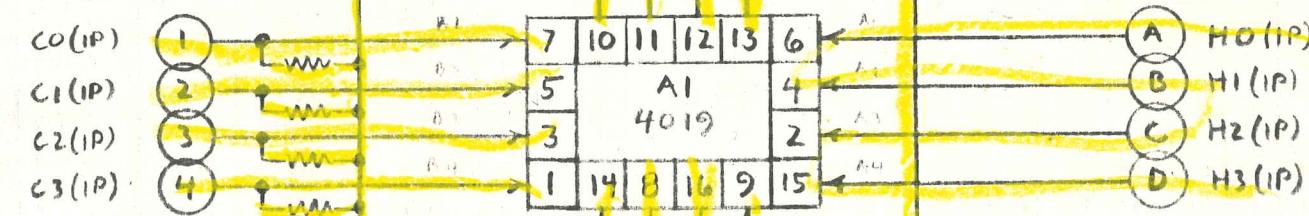
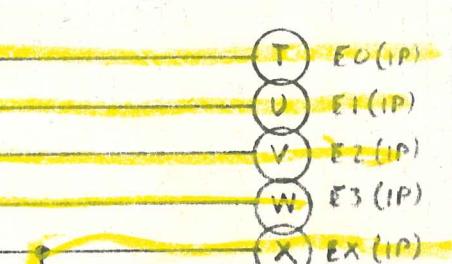
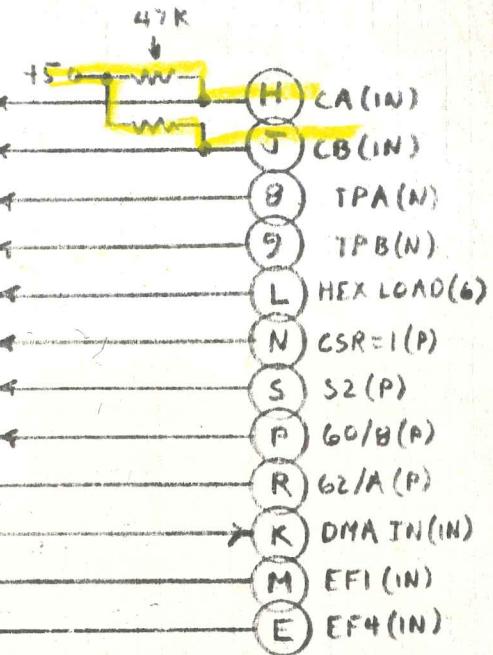


BUS 0 (IN) 11
BUS 1 (IN) 12
BUS 2 (IN) 13
BUS 3 (IN) 14
BUS 4 (IN) 15
BUS 5 (IN) 16
BUS 6 (IN) 17
BUS 7 (IN) 18
CLEAR(N) 10

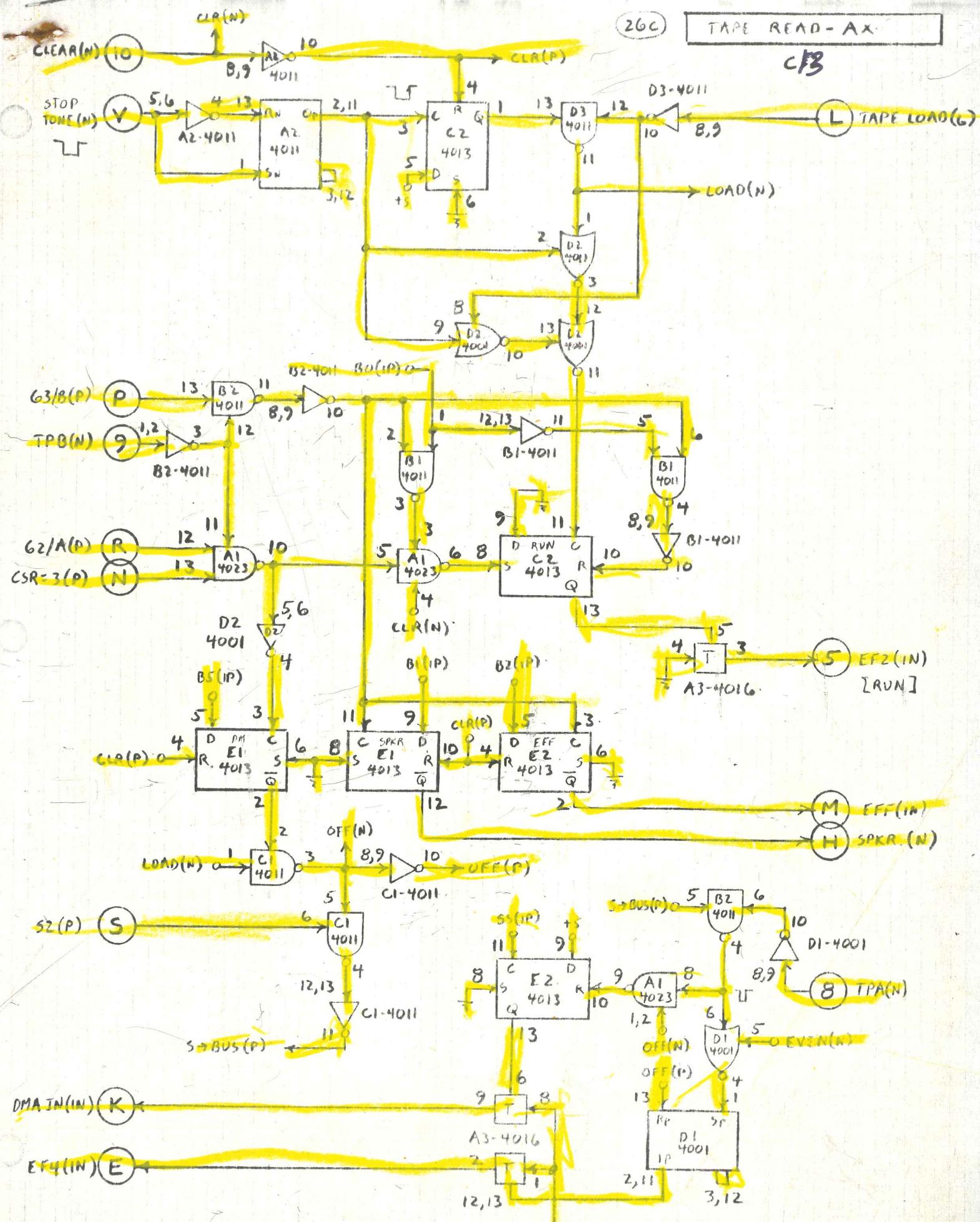


AB2
LSI
HEX
CMTP
(28 PINS)

SOCKET



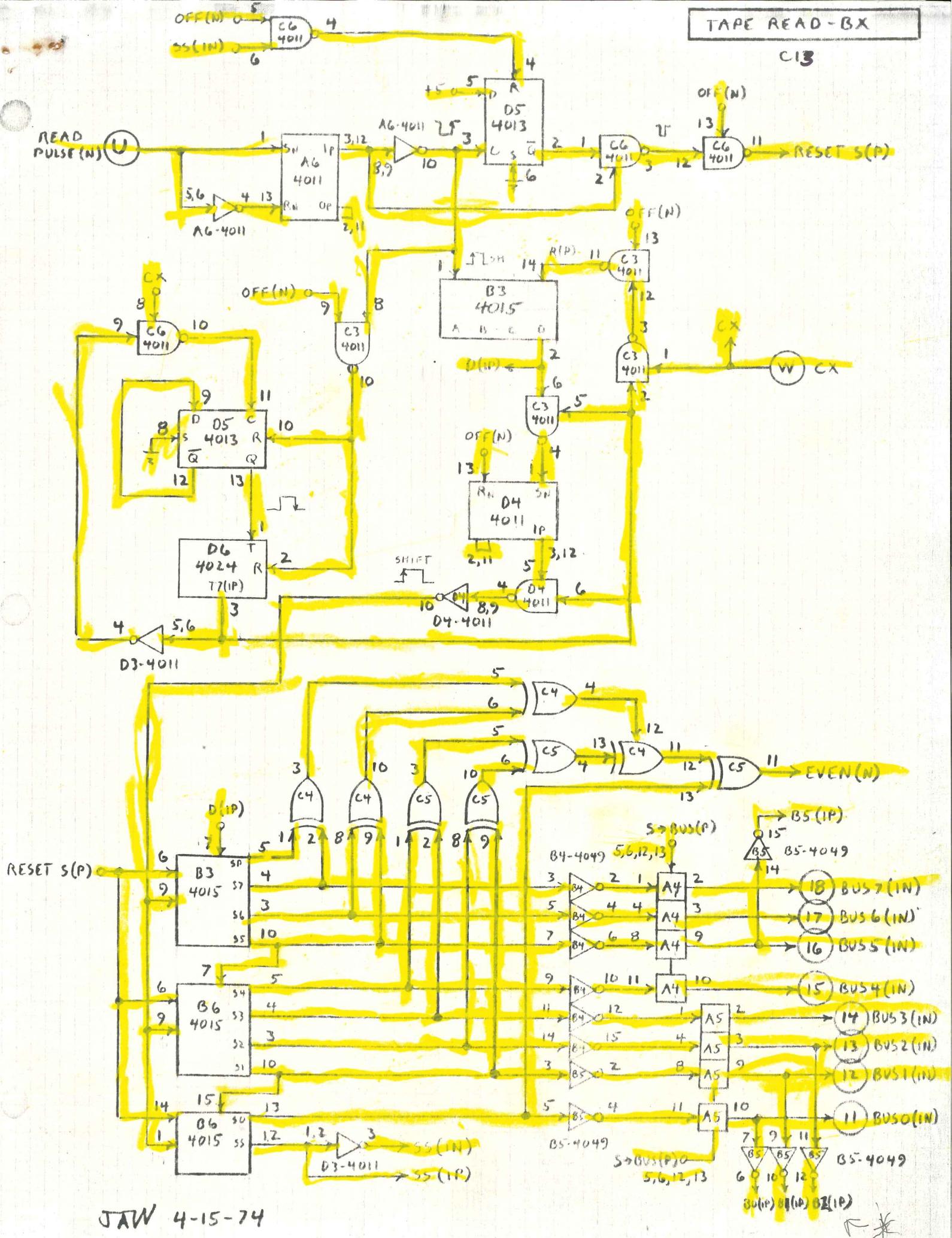
JAN 4-15-74



JAW 4-15-74

TAPE READ-BX

C13

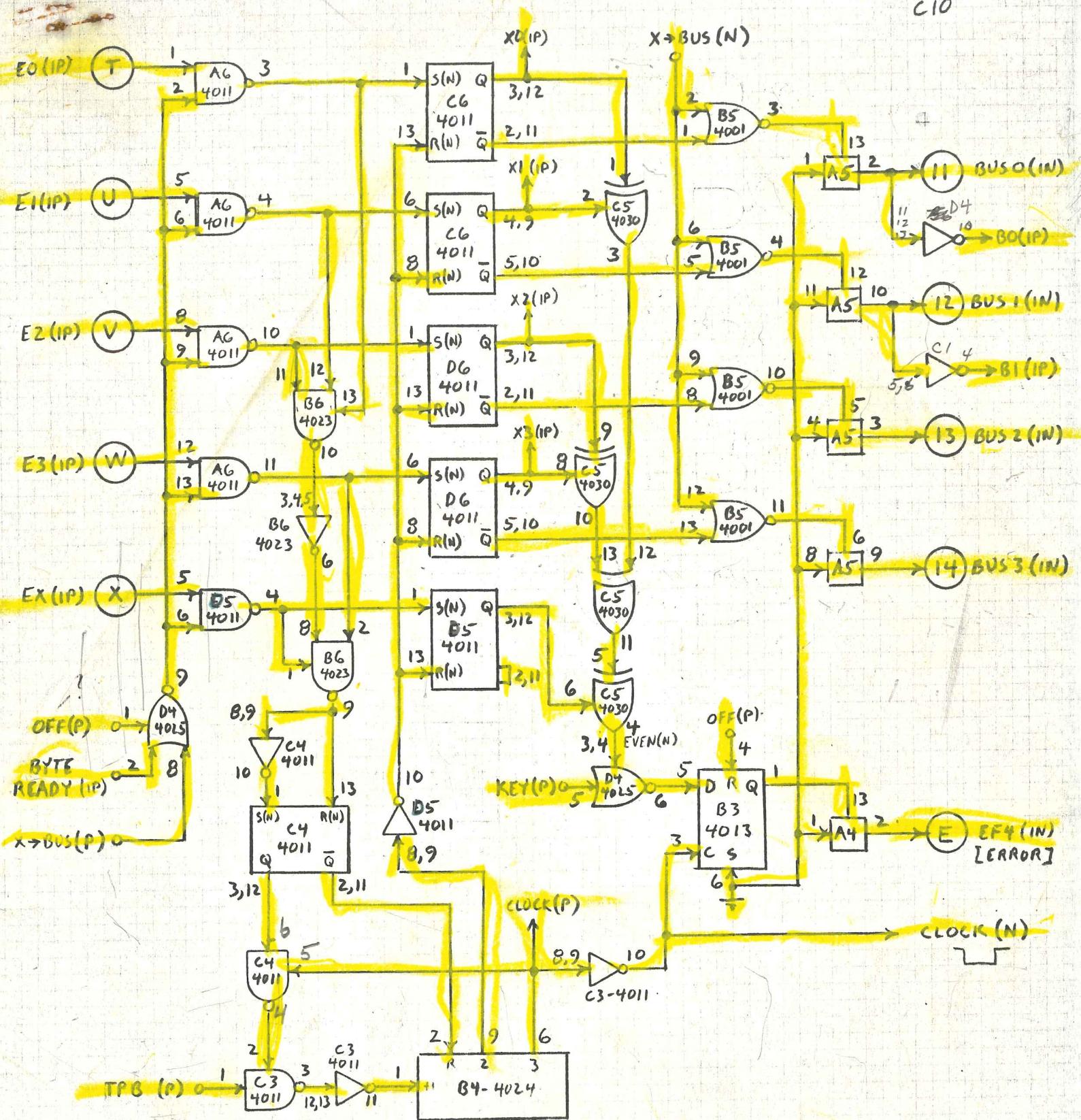


CARD C13 - TAPE READ LSIX - COMPONENT SIDE

	A	B	C	D	E	
(1)-A	.4023	.4011	.4011	.4001	.4013	1
	.4011	.4011	.4013	.4001	.4013	2
	.4016	.4015	.4011	.4011		3
	.4016	.4049	.4030	.4011		4
	.4016	.4049	.4030	.4013		5
(2)-2	.4011	.4015	.4011	.4024		6

	R	D	C	B	A	
1	[]	[]	[]	[]	[]	(1)-1
2	[]	[]	[]	[]	[]	
3	[]	[]	[]	[]	[]	
4	[]	[]	[]	[]	[]	
5	[]	[]	[]	[]	[]	
6	[]	[]	[]	[]	[]	(2)-22

JAW 4-15-74

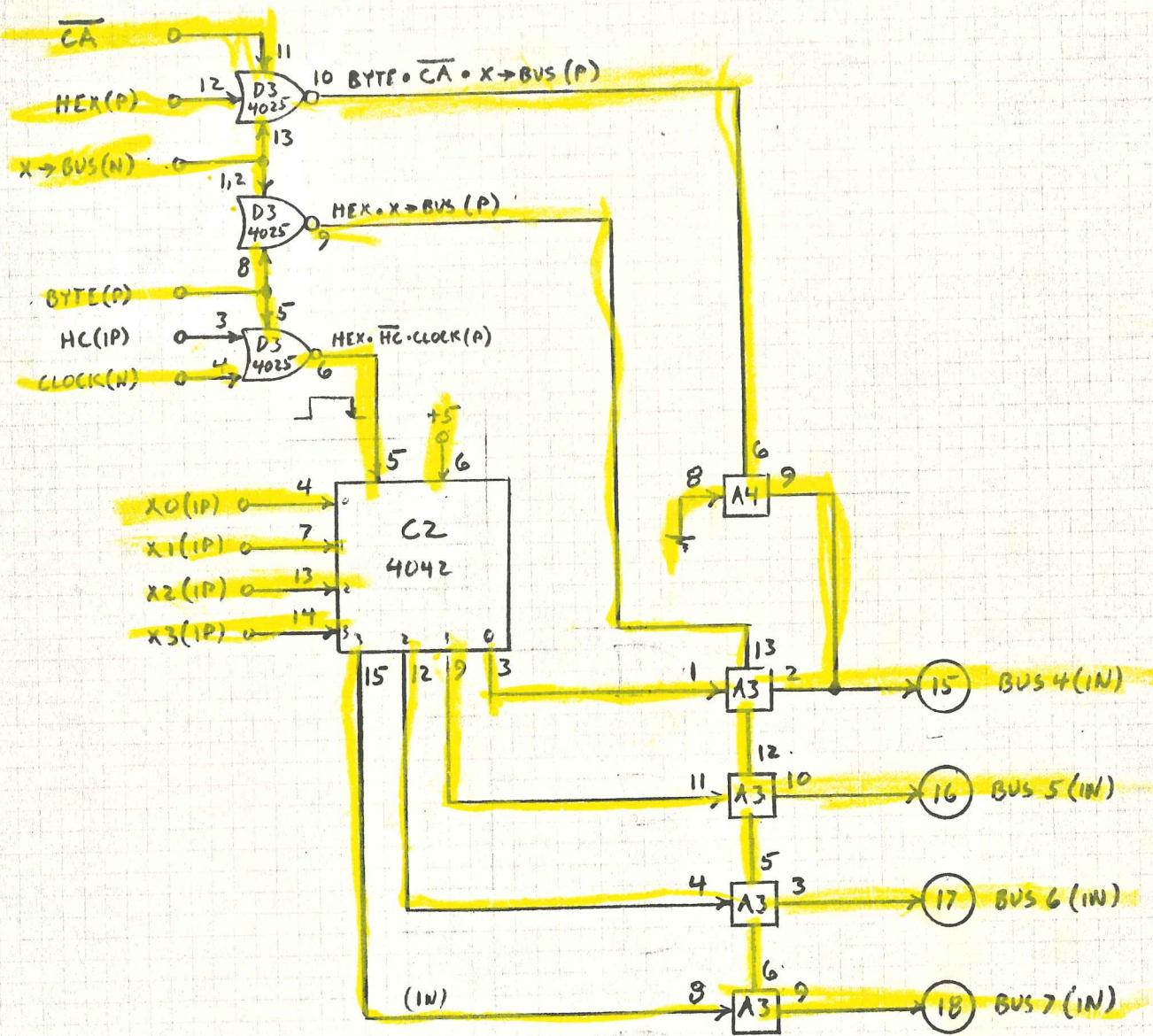


11
12
13
86
12 + 10

5
6
21
4

B3 - 8, 9, 10, 11 TO GND
B6 - 11, 12, 13 TO GND
E1 - 5, 6 TO GND

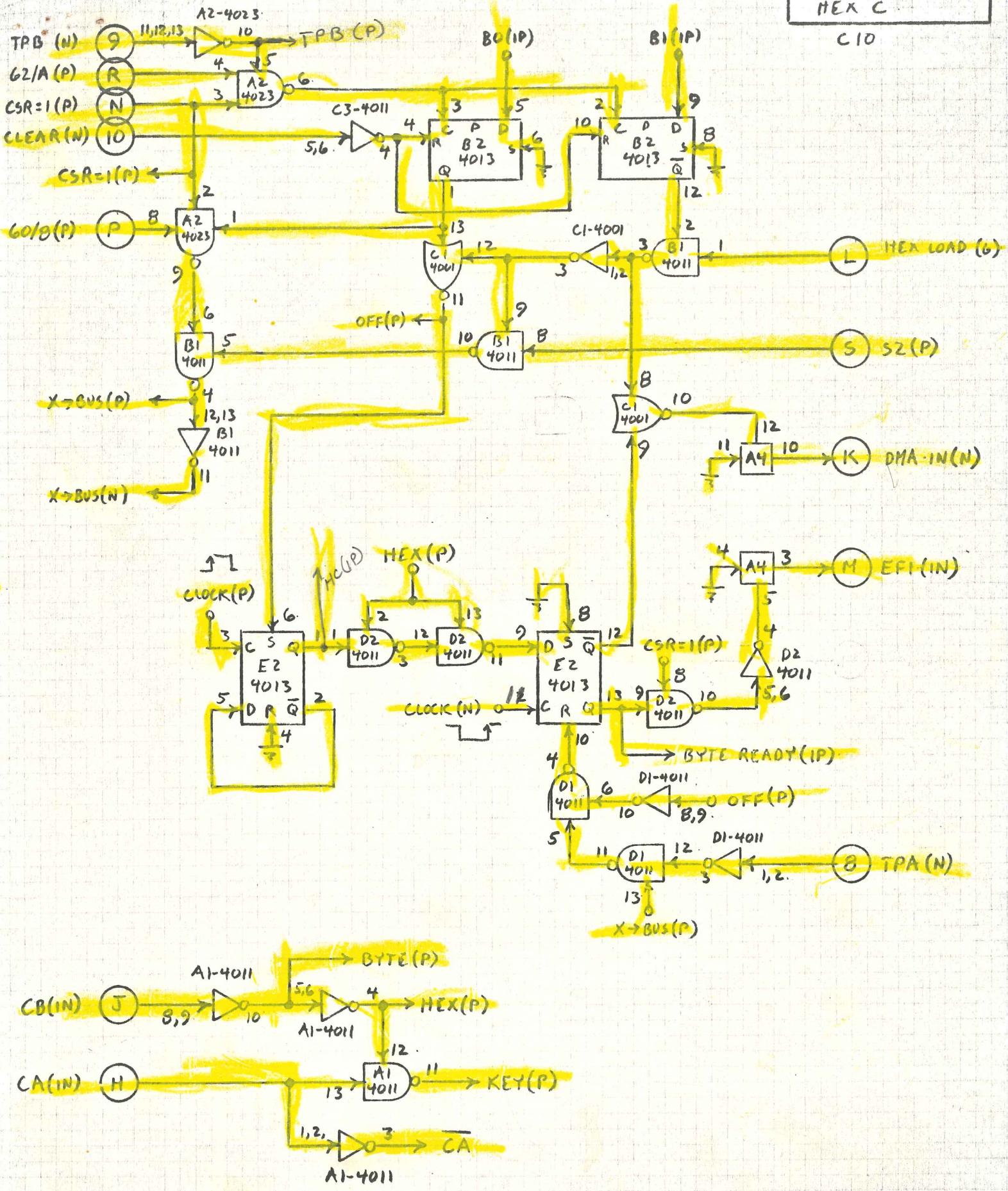
JAN 4-29-74



JAW 4-29-74

HEX C

C10

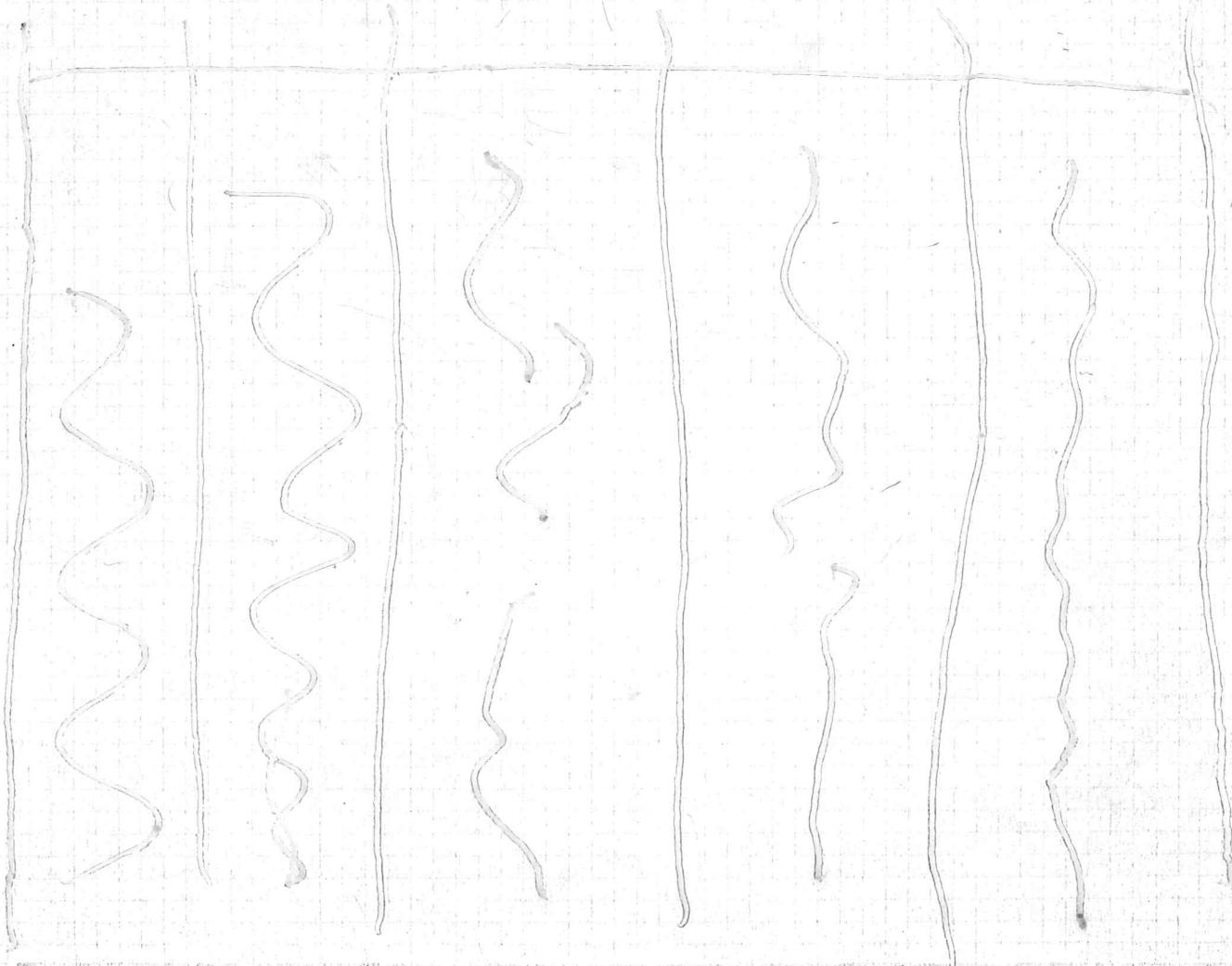


JAW 4-29-74

CARD C10 - HEX LSI - COMPONENT SIDE

	A	B	C	D	E	
①-A	.4011	.4011	.4001	.4011		1
	.4023	.4013	.4042	.4011	.4013	2
	.4016	.4013	.4011	.4025		3
	.4016	.4024	.4011	.4025		4
	.4016	.4001	.4030	.4011		5
②-B	.4011	.4023	.4011	.4011		6

TOP
↓
BOTTOM



WPB COSMAC
COS/MOS BREADBOARD

↓

A-IP-90

A-IP-89

A-IP-88

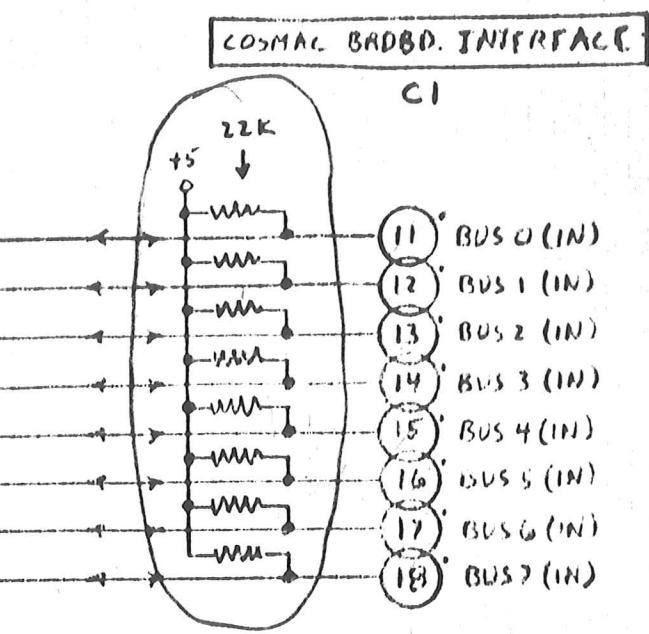
A-IP-87

A-IP-86

A-IP-85

A-IP-84

A-IP-83



A1
4049

A-IP-35

A-IP-36

A-IP-37

A-IP-38

A-IP-39

A-IP-40

A-IP-41

A-IP-42

A-IP-23

A-IP-24

A-IP-25

A-IP-26

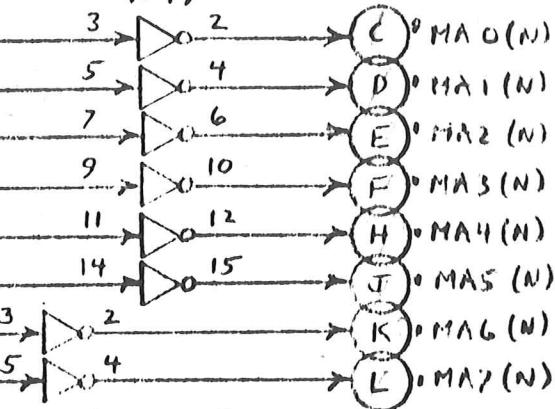
A-IP-43

A-IP-27

A-IP-44

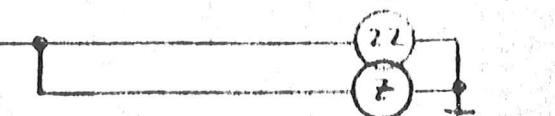
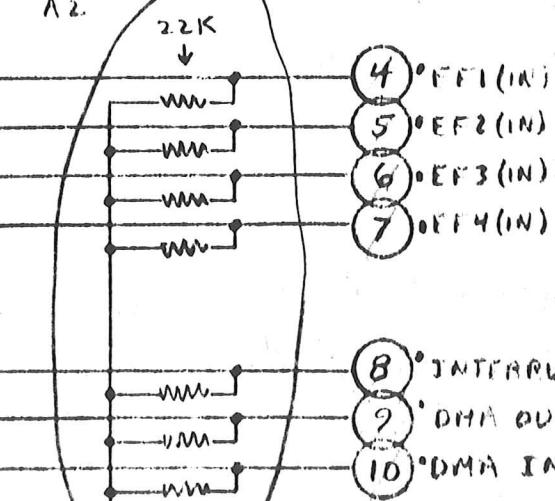
+5 VDC

GND.



A2
4049

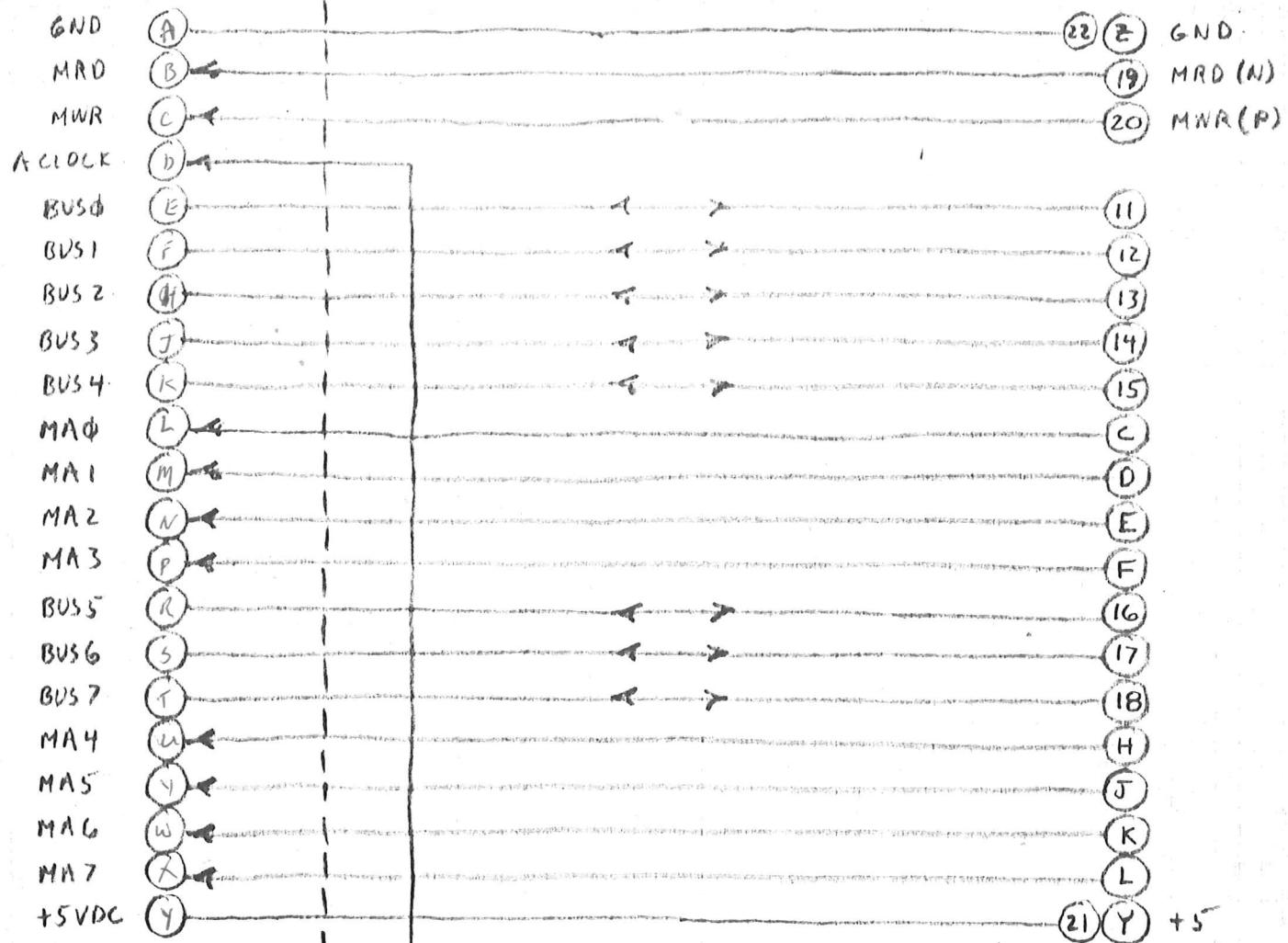
A2



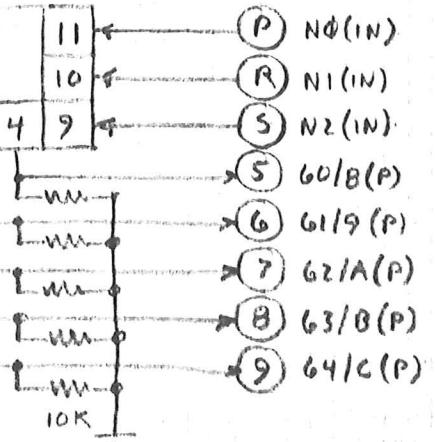
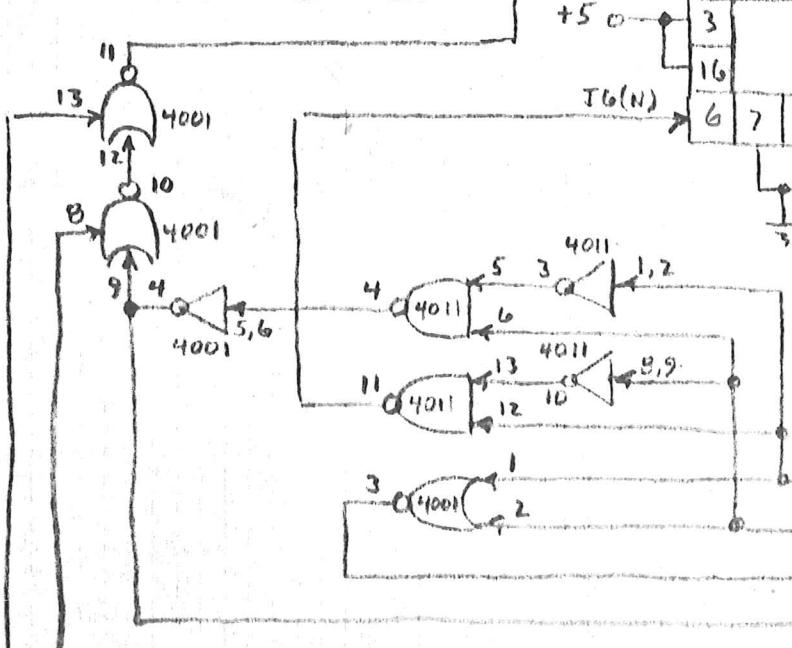
JAN 4-14-74

FRED II - RAM CARD TEST EXTENDER*

RAM TEST PINS



+5 → 3
16 → 16
4051
TG(N) → 6 7 8 12 1 5 2 4 9



* FOR USE WITH FRED II BREADBOARD

JAW 8-1-74

0	6003	START TAPE
2	E17A	HEX BRD ON W FOR BYTE → V1
4	3106	SKIP NEXT INS. IF V1 ≠ 06
6	F40A	GO TO ADDRESS 40A
8	F402	GO TO ADDRESS 402
A	0078	CLEAR TV DISPLAY
C	025C	TV ON
E	A600	600 → POINTER A A = M(600)
I0	2208	0B → V2
I2	15A0	DO PROGRAM AT 5A0
I4	E087	SKIP NxtINS. IF TAPE STOPPED
I6	F414	GO TO 414
I8	6063	START TAPE
IA	E087	SKIP IF STOPPED
IC	F41A	GO TO 41A
IE	0240	TV OFF
I20	0078	CLR TV DISP
I2	6003	START TAPE
I4	E087	SKIP IF STOPPED
I6	F424	GO TO 424
I8	05B0	EXECUTE M.L PROG AT 5B0 P=3 D4 TO RETURN
IA	6003	START TAPE
IE	025C	TV ON
I2E	21D0	D0 → V1
I0	221A	1A → V2
I2?	9121	.
I4	21C9	C9 → V1
I6	2212	12 → V2
I8	F5C0	GO TO 5C0
IA	E87A	KEON BYTE → V8
I4E	3808	SKIP IF V8 ≠ 0A
IE	F442	GO TO 442
I0	F43A	GO TO 43A
I2	2C05	05 → V1
I4	4807	RR. D7 → V8
I6	B300	300 → B
I8	7834	V8 → LSB OF B
IA	7321	M(B) → V3
I6	240D	0D → V4
I2	9345	285X5 PAT → TV V3 ← CLEARED V4 ← UNINITIALIZED

450 2E60
2 E780
4 F474
6 3E00
8 F45C
A F452
C 3D00
E F56A
O 15F2
2 F444
4 0078
6 A608
8 2208
A 15A0
C 0672
E F488
O 0000
2 0000
4 E780
6 F47A
8 F456
A 1580
C 3160
E F484
O 15F2
2 F444
4 A610
6 F468
8 6003
A 0078
C 2516
8 2609
O 2709
2 9758
4 27D1
6 9768
8 F640
A E17A
C 310A
E F442
O F49A
2 2C04
4 ZE40
6 E180
8 F4B4
A 3E00
G F4E6
E 3D00
O FG48

4B2 F4AG
158C
3200
F4AA
8254
27CO
9758
CO 251F
8522
C560
F4CE
27DP
9758
F4AA
27E1
9758
A610
G66A
0078
2210
15AO
A618
2200
15AO
0672
F506
4105
158C
3200
F4E6
8264
4FO F5FA
4F2 261F
8622
C560
F4CE
27D1
9768
2E40
500 F4AE
502 4608
F4DY
6003
0078
2609
27D1
9768
E087
F510
6000
A680
2C00

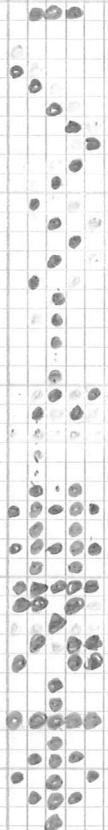
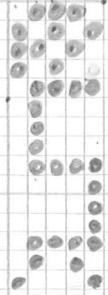
(@)

[]

SPACE

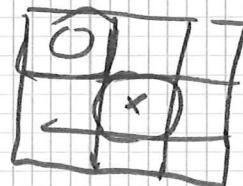
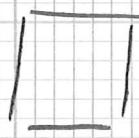
- / \ >

11

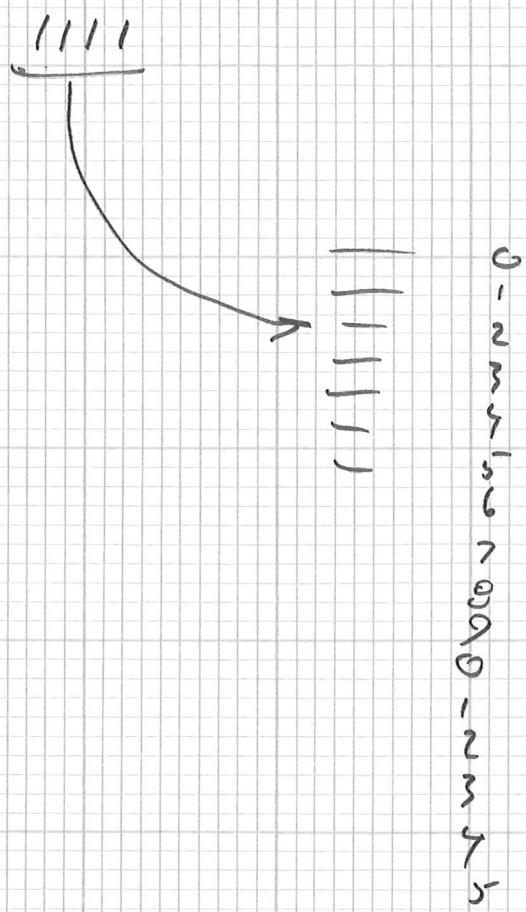


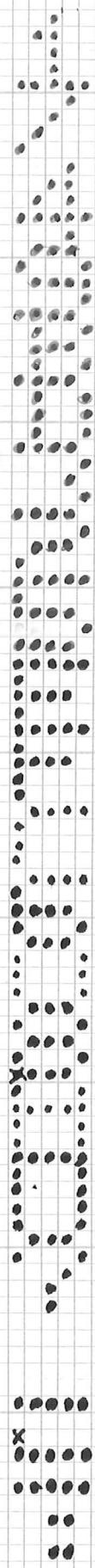
0000100014
0000000000 5
1,0010
100011
 $16+3=19$

1110
1010
11000
 $16+12$
 $\overline{24}$



1 2 3
4 5 6
7 8 9



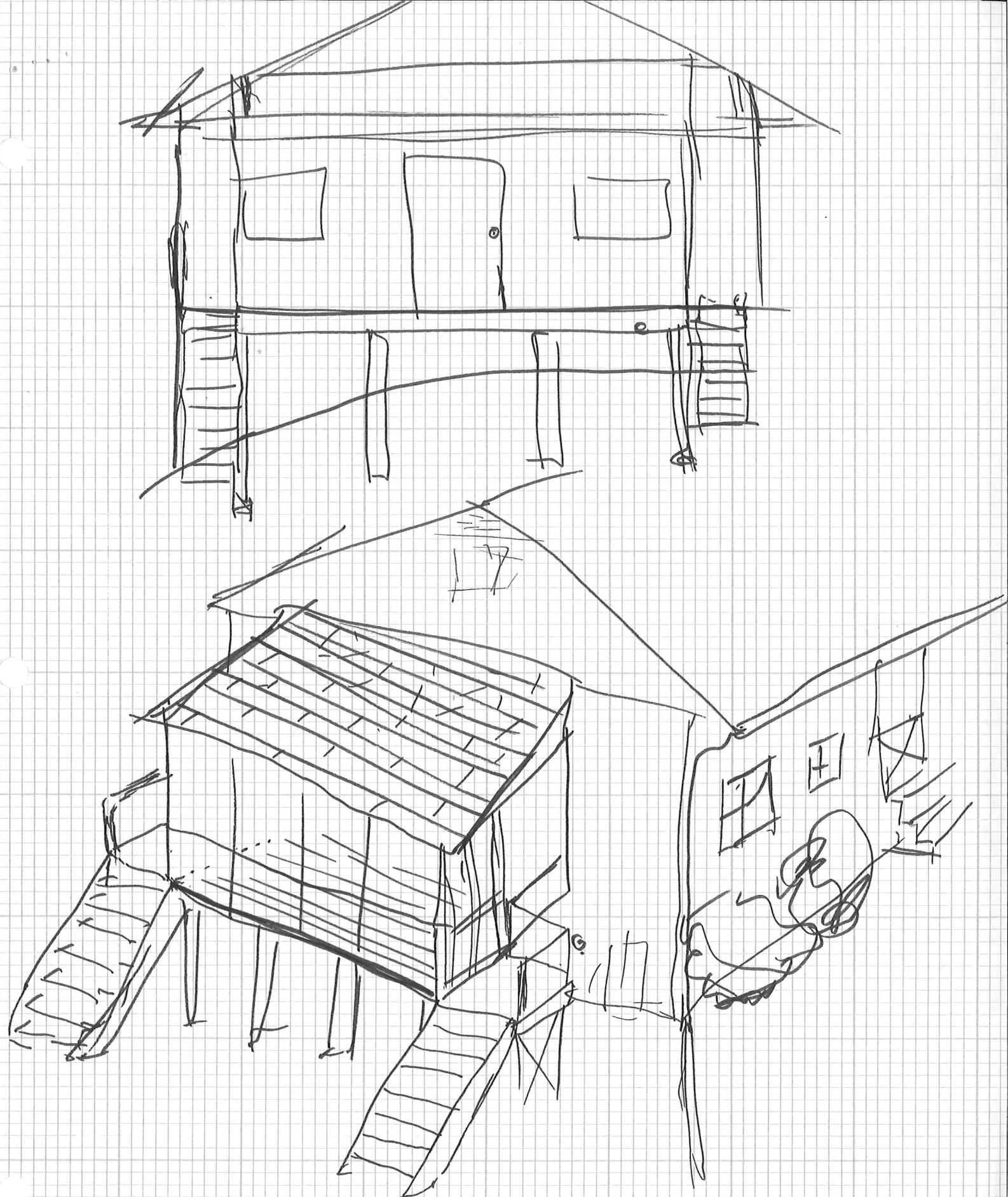


G →
B 2
B 3
4
5
6
7
8
9
A
C
D
C
F
O
1
2
3
4
C
O
6
7
8
9
A
B
C
D
E
F
G
D
I



B 8
5
6
5
3
0
4
0
4
3
2
2
0
2
C
3
2
2
0
2
8
4
2
6
0
0
4
0
2
0
1
0
6
8
0
4
0
6
8
1
0
6
8
0
4
0
8
8
0
0
4

D	Z	0
3	Y	1
6	C	0
7	E	0
8	B	0
9	A	0
D	B	2
C	C	2
D	E	4
E	F	4
E	O	0
1	O	2
3	O	8
4	O	7
5	O	7
6	O	2
7	O	7
8	O	6
9	O	1
E	A	0
F	B	3
F	C	5
E	D	3
F	E	7
F	F	4
1	O	2
2	O	2
3	O	0
F	4	5
5	O	4
6	O	3
7	O	7
K	9	3
4	O	8
5	O	4
6	O	0
7	O	0
8	O	0
9	O	0
PERIOD	D	0
COMM R	E	1
		0



OPERATING'. $\Phi IF_1 = A1, A\phi$, $\Phi IF_2, 3 = B1, B\phi$
 $\Phi IE\phi - \Phi EF = V\phi - VF$

Φ = RVN PROGRAM @ M(Φ 4 Φ)

A = READ M(XXX)

B = WRITE M(XXX)

C = WRITE TAPE (MΦΦΦ - MΦΦE).

LANGUAGE FILE-1

16-1 BYTE VARIABLES VΦ - VF

VΦ = OVERFLOW FOR 8 INSTRUCTIONS.

VD, VE, VF = TIMERS. IF TV ON.

2 M POINTERS A & B.

PROGRAMS @ 4ΦΦ - 6FE

128

128

128

F D

394 BYTES FOR
PROGRAM

1111.111
1111111
6 BE

	00	01	02	03	04	05	06	07	
08	09	0A	0B	0C	0D	0E	0F		
10	11	12	13	14	15	16	17		xxx11111
18	19	1A	1B	1C	1D	1E	1F		

10 ADDR V4 CELL # = 14

~~2548~~ = 5

V5 = ~~03XX~~

0001 0100

1111 1000

0000 1100

11111

0000 1100

0000 0100

1111 1000

11111100

0001 1111

0001 1100

B3ΦΦ

M(A) → V2 = Φ2

V2 → L.S. B. B=3Φ2

M(B) → V3 = 2E

9345

0000 0010
0001 1111
0001 1100

03E

~~ESTATE~~
~~4A 07~~
~~1580~~
~~F~~ → ~~V3~~
 ↓
~~W1 W3 = MELLIN.~~
~~53 01~~
~~00~~ → ~~V3~~
~~V3 + 01~~

~~A → 600~~
~~601~~ → ~~02~~
~~A → 602~~ → ~~05~~
~~72IE~~ → ~~400 - 6FF~~
~~700 → 7FF~~

~~53 FF~~
~~V3 = 0~~
~~F~~
~~→~~

START (AVD)

EΦ87 3

TAPE RANGE 31ΦΦ.

TAPE STOPPED \$STOP STOP

31ΦΦ

A 6ΦΦ 000 → A

7352.

V3 = CELL * 0

V4 = CELL * □

→ V5

V5 ≠ V3

→ 0

21ΦΦ

ΦΦ → V1

HEX → V1

ΦΦ → V2

V1 ≠ Φ2

↑ → V2 F →

V1 ≠ Φ4

← → V2

V1 = d6

→ → V2

→ V1 ≠ Φ8

↓ → V2

HEX → V1

V1 ≠ Φ8?

F

F

→ D0

V2 ≠ ΦΦ

V2 = ΦΦ

F

→ D0

S →	3 G F	3 C	0 0 0 0
	7 D	4 4	0 0 0 0
	1	3 8	0 0 0 0
	2	4 D 4	0 0 0 0
R →	7 3	7 8	0 0 0 0
	4	4 4	0 0 0 0
	5	7 8	0 0 0 0
M →	7 7	4 4	0 0 0 0
	8	6 C	0 0 0 0
	9	5 4	0 0 0 0
W →	7 A	4 4	0 0 0 0
	B	4 4	0 0 0 0
	C	5 4	0 0 0 0
N →	D	6 C	0 0 0 0
	7 E	4 4	0 0 0 0
	F	6 4	0 0 0 0
	B D	5 4	0 0 0 0
X →	1	4 C	0 0 0 0
	8 2	4 4	0 0 0 0
	3	2 8	0 0 0 0
	4	1 D	0 0 0 0
K →	5	2 8	0 0 0 0
	8 6	4 4	0 0 0 0
	7	4 8	0 0 0 0
	8	7 4	0 0 0 0
V →	9	4 8	0 0 0 0
	8 A	4 4	0 0 0 0
	B	4 4	0 0 0 0
Y →	8 C	4 4	0 0 0 0
	D	2 8	0 0 0 0
	F	1 D	0 0 0 0
+ →	8 F	1 4	0 0 0 0
	9 D	1 D	0 0 0 0
T →	9 1	7 C	0 0 0 0 0 0
	2	1 D	0 0 0 0 0 0
	3	1 D	0 0 0 0 0 0
	4	1 D	0 0 0 0 0 0
P →	5	1 D	0 0 0 0 0 0
	9 6	7 8	0 0 0 0 0 0
	7	4 4	0 0 0 0 0 0
L →	8	7 8	0 0 0 0 0 0
	9 9	4 4	0 0 0 0 0 0
	A	4 0	0 0 0 0 0 0
	B	4 4	0 0 0 0 0 0
Z →	C	4 4	0 0 0 0 0 0
	9 D	7 C	0 0 0 0 0 0
	E	4 B	0 0 0 0 0 0
	F	1 D	0 0 0 0 0 0
I →	A D	2 D	0 0 0 0 0 0
	A 1	7 C	0 0 0 0 0 0
	2	1 4	0 0 0 0 0 0
	3	1 4	0 0 0 0 0 0
	4	1 4	0 0 0 0 0 0
	5	7 C	0 0 0 0 0 0

J →	3 A 6	4 4	0 0 0 0
	7	4 4	0 0 0 0
	8	4 4	0 0 0 0
Q →	9	4 4	0 0 0 0
	A A	3 8	0 0 0 0
	B	4 4	0 0 0 0
	C	4 4	0 0 0 0
G →	D	4 C	0 0 0 0
	A E	3 C	0 0 0 0
	F	4 4	0 0 0 0
	B D	5 C	0 0 0 0
	1	4 4	0 0 0 0
	2	3 8	0 0 0 0



27 BYTES

(OPTIONAL PATTERN
OR PROGRAM SPACE.)

NOTE: 37D - 3FF = 144 BYTES
WHICH CAN BE USED FOR
PROGRAMS, TABLES, OR
PATTERNS IF FULL 16-N
PATTERN SET IS NOT REQUIRED

355 → 3 FF

PATT ADDRESSES (* STANDARD - REMAINDER CAN BE OMITTED WITHOUT AFFECTING UTILITY)

*	O - 48	M - 77
*	I - 14	N - 7E
*	2 - 2E	P - 9G
*	3 - 2A	Q - AA
*	4 - 19	R - 73
*	5 - 32	S - 6F
*	6 - 44	T - 91
*	7 - 14	U - 56
*	B - 4C	V - BA
*	9 - 1E	W - 7A
*	A - 5D	X - 82
*	B - 22	Y - 8C
*	C - 4D	Z - 9D
*	D - 26	*UNDER - 6D
*	F - 37	*BLANK - 5F
*	F - 3B	+ - 8F
*	G - AE	- - 62
*	H - 53	? - 5A
*	I - A1	' - 5D
*	J - AG	“ - 6A
*	K - 86	= - 66
L - 99		

ALL PATT. ADDRESSES
ARE IN PAGE #3

ASCII CONVERSION TABLE (IF NEEDED)

44 - B2	②	32	2D - 5F	SPACE
Φ1 - 54	A	21	- D2	!
Φ2 - 22	B	22	- DB	"
Φ3 - 44	C	23	- EO	#
Φ4 - 26	D	24	- EA	\$
Φ5 - 37	E	25	- F5	%
Φ6 - 3B	F	26	- 8F	+
Φ7 - AE	G	27	- 5D	,
Φ8 - 53	H	28	- CD	(
Φ9 - A1	I	29	- EF)
ΦA - A6	J	2A	- F4	*
ΦB - 86	K	2B	- 8F	+
ΦC - 99	L	2C	- FA	-
ΦD - 77	M	2D	- 62	.
ΦE - 48	N	2E	- F9	<
ΦF - 96	O	3D - 48	- 14	>
I1 - AA	P	31	- 14	?
I2 - 73	Q	32	- 2E	
I3 - 6F	R	33	- 2A	
I4 - 91	S	34	- 19	
I5 - 56	T	35	- 32	
I6 - 8A	U	36	- 44	
I7 - 7A	V	37	- 14	
I8 - 82	W	38	- 4C	
I9 - 8C	X	39	- 1E	
IA - 9D	Y	3A	- 6A	
IB - BA	Z	3B	- D6	
IC - C5]	3C	- CD	
ID - B6	\	3D	- 66	
IE - CO	^	3E	- C7	
IF - 60	*	3F	- 5A	

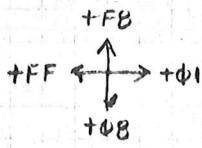
UNDER

EXAMPLES

6 SET N, SET A = 1ST DATA BYTE, SET B=TABLE
 2 M(A) \rightarrow VX
 16 2 CONVERT VX YIA M(B)
 BYTES 2 VX \rightarrow M(A)
 2 A+1
 2 LOOP N TIMES

6 SET A TO PARAMETER LIST, TV OFF, SET N
 2 M(A) \rightarrow VY
 16 2 A+1
 BYTES 2 M(A) \rightarrow VY
 2 A+1
 2 TONE + DELAY
 2 LOOP N TIMES

TV CELL[#] IN VX



$\uparrow =$
 IF \rightarrow V
 F9 \rightarrow VY
 VX + VY \rightarrow VX
 VX = IF \rightarrow VX (FOR WRAP AROUND)

44 41 42 43 44 45 46 47
 48 49 4A 4B 4C 4D 4E 4F
 10 11 12 13 14 15 16 17
 18 19 1A 1B 1C 1D 1E 1F

TO FIND PAT[#] IN TV CELL. VX=CELL[#]

TV TABLE \rightarrow B (244)

TO READ/WRITE PAT[#]/ADDR @ TV TABLE USE B

SHOW VX SCORE

8 SETN, SET B(TO HEX/DEC TABLE), SET A (TO WORK AREA), SET VY=TV CELL[#]
 2 CONV. VX \rightarrow M(A) 3 DIG. DEC.
 2 M(A) \rightarrow VX
 2 A+1
 2 CONV. VX \rightarrow PAT. ADDR
 2 PAT. \rightarrow TV @ VY CELL
 2 VY+1
 2 LOOP N TIMES

22 BYTES
 11 MACROS

0 1 2 3 4 5 6 7 8 9 A B C D E F
0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0

~~FEL-1~~
FEL-1
FREDDI EXPERIMENTAL
LANGUAGE

1. -ΦΗΜΜ -X ALLOC. M.L. @ HMM P=3 04 TO RET
 2. -IMMM -X BR & LINK TO MMM DO PROG. @ MMM
 2. -ΦΖΦΕ -X RETURN FROM BR&LINK REND DO
 2. -FHMM -X GO TO MMM
 2. -2XKIC -X KK → VX
 2. -3XKK -X SKIP NEXT INSTRUCTION IF VX ≠ KK
 2. -4XKK -X RR+KIC → VX
 2. -5XKR -X VX+KR → VX, SKIP NEXT INSTRUCTION IF VX₃ = ΦΦ. (IF KR=FF, VR=01)
 2. -6ΦΦ3 -X TAPE ON (AUDIBLE)
 2. -6ΦΦ1 -X TAPE ON (INAUDIBLE)
 2. -6ΦΦΦ -X STOP TAPE (SPKR OFF → COMPUTER → SPKR)
 4. -7A1E -X M(A) → VX
 4. -7A21 -X M(B) → VX
 4. -7A24 -X VX → M(A)
 4. -7A27 -X VX → M(B)
 4. -7A2A -X VX → L.S. BYTE OF A
 4. -7A3Φ -X VX → M.S. BYTE OF A
 4. -7A34 -X VX → L.S. BYTE OF B
 4. -7A3B -X L.S. BYTE OF A → VX
 4. -7A3B -X M.S. BYTE OF A → VX
 4. -7F6F -X A+1
 4. -7A52 -X CONVERT VX TO 3-BIT DECIMAL → M(A,A+1,A+2) A₃=A₁. VX₃=VX_i
 4. -7A3E -X SHIFT VX LEFT 4 BITS
 4. -7A41 -X SHIFT VX RIGHT 4 BITS
 4. -7A48 -X VX DELAY (TAPE ON, SPKR OFF)
 2. -8XY4 -X VX+VY → VX, VΦ
 2. -8XY5 -X VX-VY → VX, VΦ
 2. -8XY2 -X VX*VY → VX (CHANNELS VΦ)
 2. -8XY1 -X VX/VY → VX (CHANNELS VΦ)

FEL-1

41
4Φ1
4ΦΦ1

1. -EX7A -X HEX ON, WAIT FOR BYTE → VX
 1. -EX8Φ -X HEX ON, IF EΦ1=1 BYTE → VX, IF EΦ1=0 SKIP NEXT INSTR.
 1. -EX8D -X EXT. BUS → VX
 1. -EX8F -X VX → EXT. BUS
 1. -EX91 -X VX → KXT, CONTROL REGIST.
 1. -EX9D -X ERI(Φ) → VX {FOR TAPE READ END TEST}
 2. -DXYΦ -X VX TUNE, VY DELAY (TAPE RUN, SPKR OFF) SIREN, STOP TUNE, M(A) → VX, VY LOOP FOR MUSIC
 2. -ΛΜΜΜ -X ΜΝΜ → Α
 2. -ΒΜΜΜ -X ΜΜΜ → Β
 2. -CXΥΦ -X SKIP NEXT IF VX ≠ VY
 2. -DXY5 -X 5x5 PAT → TV, VX=PAT. ADDR IN PAGE Φ3, VY=TV CELL ^{*NOTE VY₅=VY₀}
 2. -9XY8 -X 8x8 PAT → TV, VX=PAT. ADDR IN PAGE Φ3, VY=TV CELL ^{VX₅=UNDEFINED}
 1. -ΦΦ93 -X READ TAPE → M(A) A₃=A₁ = CONCURRENT EΦΦ1, EΦ2/R# FOR END (PROCESED BY RUN+SPKR CONTR.)
 1. -E3AΦ -X WRITE TAPE FROM M(A)=M(Φ6FF), DON'T STOP MFF A₃=A₁
 1. -EΦΦΑ -X SKIP NEXT IF EΦΦ1=A₃=A₁
 1. -EΦΦ7 -X SKIP NEXT IF TAPE ON (RUNNING)
 1. -ΦΦ78 -X CUR TV
 2. -Φ24Φ -X TV OFF
 2. -Φ25C -X TV ON (INITIALIZE FIRST)
 2. -Φ268 -X HEX OFF
 2. -Φ22F -X COPY VΦ-VY, A,B → STACK @ ΦΙΕΦ-ΕΦ, ΕΦ, ΦΙ, ΦΖ, ΦΞ (UTILITY)

67	203	3. 31 → 14
43	141	2. 11 → 11
47	59	3. 6Φ → R3
43	46	3. 3Φ → R3
67	203	1. 144
232	144	2. 18 → 18
232	144	3. 3Φ → R3

13d4 - FF	= HEX/DEC PATTERN → PATTERN ADDRESS TABLE (17 BYTES)
4311 - AF	= 5x5 DM PATTERNS (159 BYTES)
09B0 - FF	= SPECIAL 5x8 PATTERNS / EXPANSION SPACE (80 BYTES)
	(25 GBITES)
0000 - FF	= UTILITY
0100 - FF	= CONTROL & MACRO SUBROUTINES
0200 - FF	= SS ROUTINES (P=C) & MACRO SUBROUTINES
0300 - FF	= 5x8 PATTERNS / 8x8 PATTERNS / EXPANSION SPACE

~~XXII 2000 - 01
210 LIF 3 TV CELL TABLE - CELLS → PMT. ADDRESS~~

- RAM 16 $\Phi_1 \Phi\Phi - \Phi F$) VF-VF (VD,E,F = TIMERS - CHANGED BY INT.)
 RAM 4 $\Phi_{11}\Phi - 13$) DPA(10,11) DPG(12,13)
 RAM 32 $\Phi_1 C\Phi - DF$) INSTRUCTION DECODE TABLE (32 BYTES)
 RAM 32 $\Phi_1 C\Phi - EF$) STACK (32 BYTES)
 RAM 32 $\Phi_1 F\Phi - FF$)

CAN BE MOVED
IN RAM LEAVING 84 BYTES FOR TAP READ SUBROUTINES IN ROM

R(0)	DMA POINTER	
R(1)	INTERRUPT P.C.	Φ1 INT.
R(2)	STACK POINTER	Φ1 STK
R(3)	MICRO P.C. (MACRO INTERPRETIVE / M.L.)	REFUR WITH D4 CALL
R(4)	MACRO CALL POINTER	Φ1 CALL
R(5)	MACRO P.C.	(d4Φ AFTER UTILITY)
R(6)	Φ1ΦX @ BEGINNING OF MACRO ALWAYS Φ1 -	
R(7)	Φ1ΦY @ BEGINNING OF MACRO	
R(8)	EXECUTE SUB SUB IN PAGE Φ2 & RETURN TO P3. Φ1 SS	
R(9)	RANDOM NUMBER VARIABLE. (+1 IN INT.).	
R(A)	{ MISC. AVAIL}	
R(B)	} FOR M.L.	
R(C)	TEMP IN PH CALL, SUB SUB P.C. RETURN WITH D3 → P3	
R(D)	USED IN INTERRUPT.	
R(E)	{ AVAIL FOR M.L.}	
R(F)		

PAGE 0 - INITIAL

J7

UTILITY

CLR TV & KIC → VX

25

91

124

15

255

PAGE 1 - TABLES, VARIABLES, & CONSTANTS, SFR

CALL

INTERRUPT

EXEC. SS

RI/RDF → D PGSS

E INSTRUC.

86

42

36

8

9

76

256

PAGE 2 - WR4/15(DF) SS

9 INSTR. PATT → IV

TV OFF → SS

AB → R(A), R(B) SS

A = B TEST SS

HEX ON SS

SH. VX LEFT 4 SS

B INSTR.

D INSTR.

4 INSTR. RR/KIC

27

33

14

13

7

11

22

11

19

26

160

99

286

157

99

1 BRAKING) 13

F GO TO

d RETURN 5)

3 SKIP IF VX ≠ KIC 8)

5 VX = 1 → GO TO PM1016 9v)

6 TAPE 4)

A,B MM → A,B 13)

C SKIP IF VX ≠ V 4)

d TV OFF 6)

d TV ON 12)

d HEX OFF 6)

d COPY 17)

97

45

Q11

START
 $P = \phi$

INITIAL

1	F8	$\phi \phi$
2	$\phi 1$	$\phi 1$
3	B1	$D \rightarrow RI(1)$
4	B2	$RI(2)$
5	B4	$RI(4)$
6	B8	$RI(8)$
7	F8	INT. $\rightarrow D$
8	19	INT
9	A1	$D \rightarrow RD(1)$
A	F8	$STR \rightarrow D$
B	FF	STR
C	A2	$D \rightarrow R\phi(2)$
D	F8	CALL $\rightarrow D$
E	3B	CALL
F	A4	$D \rightarrow AD(4)$
I	ϕ	$SS \rightarrow D$
1	66	SS
2	A8	$D \rightarrow RD(8)$
3	94	$\phi \phi \rightarrow D$
4	B5	$D \rightarrow RI(5)$
5	F8	UTIL $\rightarrow D$
G	84	UTIL
7	A5	$D \rightarrow R\phi(5)$
9	D4	$DH \rightarrow UTIL$

L.S.A $\rightarrow VX$ \rightarrow $\phi \phi 3 8$ BA $\rightarrow AD(A) \rightarrow A$

$M.S.A \rightarrow VX$ \rightarrow $\phi \phi 3 B$ 56 $D \rightarrow M(6)$

$4 \rightarrow P$ 34

$RI(A) \rightarrow D$ 35

$D \rightarrow M(6)$

$4 \rightarrow P$

SH.VXL4 \rightarrow $\phi 3 E$ $D8$ $\rightarrow DO SH.VX LEFT 4$

$4 \rightarrow P$

SH.VXR4 \rightarrow $\phi 4 I$ $F\phi$ $\rightarrow M(X) \rightarrow D$

3

4

5

6

7

VX DELAY \rightarrow $\phi 4 8$ $E3$ $\rightarrow 3 \rightarrow R$

USES R(F)

9

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z

$\rightarrow 3 \rightarrow R$

$M(G) \rightarrow D, G+1$

$D \rightarrow RI(F)$

TAPE ON \rightarrow

(SPKR ON)

$F-1$

$RI(F) \rightarrow D$

$D \rightarrow D\phi?$

NO

$4 \rightarrow P$

$M(X) \rightarrow D$

$D \rightarrow RI(F)$

$VX \rightarrow RI(F)$

20

20

20

$14 \rightarrow D$

14

$D \rightarrow R\phi(?)$

$A-1$

$A+1$

$\phi \phi \rightarrow D$

$D \rightarrow M(A)$

$H(?) \rightarrow D, H+1$

$2-1$

$M(X) \rightarrow D \rightarrow D$

$DF=1?$

NO

$D \rightarrow M(6)$

$M(A) \rightarrow D, A+1$

$A-1$

$D \rightarrow \phi 1$

$\phi 1$

$D \rightarrow M(A)$

$GOTO$

$W(?) \rightarrow D, 7+1$

SHIFT

$DF=1?$

NO

$RI(F) \rightarrow D$

$D \rightarrow M(6)$

$D4+RET$

72

56

$D \rightarrow M(6)$

73

16

$6+1$

74

$0A$

75

56

$D \rightarrow M(6)$

58

$9F$

$5G$

$D4$

53

618

54

55

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255

256

257

258

259

→ 26 B E3
 9 61
 A 01
 B 62
 C 00
 D D4

3 → X
 SEL HEX
 ()
 HEX OFF
 ()
 4 → P RET

→ 26 E 42
 F 05
 7 42
 1 A5
 2 D4

STK → D, STK+1
 D → RI(S)
 STK → D, STK+1
 D → RI(S)
 4 → P RET

→ 27 3 96
 4 0F
 5 FB
 6 10
 7 AF
 8 4F
 9 BA
 A 4F
 B AA
 C 4F
 D BB
 E 4F
 F AB
 0 D3

RI(G) → D, 01
 D → RI(F)
 10 → D
 10
 D → RI(F)
 H(F) → D, F+1
 D → RI(A)
 M(F) → D, F+1
 D → RI(A)
 H(F) → D, F+1
 D → RI(B)
 M(F) → D, F+1
 D → RI(B)
 3 → P

(J2) → 2B 1 45
 KK>VA
 2 56
 3 D4

M(S) → D, STK+1
 D → M(G)
 4 → P

GAP → 2 8 4 FB D3 35
 5 FB
 6 RF 14
 7 ZFAF
 8 BF 2F
 9 3A BF
 0 A 07 3A
 B 30 99
 C 00 30
 D 00 00

TIME → D
 (TIME)
 D → RI(F)
 F+1 ← 20
 RI(F) → D 020
 020
 NO
 GO TO

→ 2 B E 46
 F BE
 9 F 8
 1 6E
 2 A6
 3 47
 4 BF
 5 DB
 6 BA
 7 15
 8 04

M(G) → D, 671
 D → RI(E) TONES
 GE → D
 ()
 D → RI(G) RI(F) → D PG
 M(7) → D, 7+1
 D → RI(F)
 DO TONE SS
 ()
 5+1
 4 → P RET

(TD)
 VX TONE
 VY DLY
 P=3

200
 160
 360

→ 29 9 22
 A F8
 B D3
 C 52
 D 22
 E 45
 F F9
 A 0
 1
 2
 3
 4
 5
 6
 7
 8
 9
 A
 B
 C
 D
 E
 F
 G

(J3)
 P=3

STK = 1
 D3 → D
 D3
 D → STK
 STK = 1
 M(S) → D, S+1
 D/F/G
 F/G
 D → STK
 6 → X
 M(7) → D, 7+1

2 → P

D → M(G)

G/H → D
 D/G

D → R0(G)

01 → D
 DF = 1?

YES
 SHIFT
 D → M(G)

D4 RET

3 → P

72 → D

D → R0(G)

G2 → D
 DF = 1?

NO
 PARITY+1

D+G3
 G3

D → R0(F)

C → X

SET EFF 0-RVN

()
 RI(E) → D

D-G1 T
 G1
 D=GG?

NO
 RES EFF

(SET RVN)
 F-1

G → P
 D=GG? → F0/F1 → D

NO
 GO TO

40+40H 160 160

160

1F R0(7) = G1
 G2
 G3
 G4
 G0
 G1

n = 2400us ≈ 4.17 KC (STOP TONE)
 200 3.57
 320 3.13
 360 2.79
 520 1.92
 780 1.28

(WR0/1)

<p>$\xrightarrow{P=3}$</p> <p>(I4) $P=3$</p> <p>$\text{PRI, KK} \rightarrow \text{VX}$</p> <p>(19)</p>	<p>$\xrightarrow{2 CA}$</p> <p>$\begin{array}{l} B \\ C \\ D \\ E \\ F \\ 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \\ A \\ B \\ C \end{array}$</p> <p>$\begin{array}{l} 19 \\ B9 \\ A7 \\ E7 \\ 99 \\ F4 \\ 22 \\ 52 \\ FG \\ E2 \\ F4 \\ B9 \\ 56 \\ EG \\ 45 \\ F2 \\ 56 \\ 12 \\ D4 \end{array}$</p> <p>$\xrightarrow{2 DD}$</p> <p>(I9) $P=3$</p>	<p>$R(9)+1 \quad (+1 \text{ in TV INT. ROUTINE})$</p> <p>$R\Phi(9) \rightarrow D$</p> <p>$D \rightarrow R\Phi(7)$</p> <p>$7 \rightarrow X$</p> <p>$R(9) \rightarrow D$</p> <p>$D+M(?) \rightarrow P$</p> <p>$STK = 1$</p> <p>$D \rightarrow STK$</p> <p>$SHR + D \rightarrow P$</p> <p>$2 \rightarrow X$</p> <p>$STK + D \rightarrow P$</p> <p>$D \rightarrow RI(?)$</p> <p>$D \rightarrow M(6)$</p> <p>$6 \rightarrow X$</p> <p>$M(5) \rightarrow D, S+1$</p> <p>$D \rightarrow M(6) \rightarrow D$</p> <p>$D \rightarrow M(6)$</p> <p>$S+1$</p> <p>$4 \rightarrow P, D \neq P$</p> <p>$5 RI \quad M(5) \rightarrow D, S+1$</p> <p>$D \neq F$</p> <p>$\neq F$</p>	<p>$R(9)+1 \quad (+1 \text{ in TV INT. ROUTINE})$</p> <p>$R\Phi(9) \rightarrow D$</p> <p>$D \rightarrow R\Phi(7)$</p> <p>$7 \rightarrow X$</p> <p>$R(9) \rightarrow D$</p> <p>$D+M(?) \rightarrow P$</p> <p>$STK = 1$</p> <p>$D \rightarrow STK$</p> <p>$SHR + D \rightarrow P$</p> <p>$2 \rightarrow X$</p> <p>$STK + D \rightarrow P$</p> <p>$D \rightarrow RI(?)$</p> <p>$D \rightarrow M(6)$</p> <p>$6 \rightarrow X$</p> <p>$M(5) \rightarrow D, S+1$</p> <p>$D \rightarrow M(6) \rightarrow D$</p> <p>$D \rightarrow M(6)$</p> <p>$S+1$</p> <p>$4 \rightarrow P, D \neq P$</p> <p>$5 RI \quad M(5) \rightarrow D, S+1$</p> <p>$D \neq F$</p> <p>$\neq F$</p>																																								
			<p>TV CELL ADDR</p> <p>1 6</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>VR</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td></td></tr> <tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td></td></tr> <tr><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td></tr> <tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td></td></tr> </table>	0	0	0	1	0	1	0	VR	1	0	1	1	0	0	0		1	0	1	1	0	1	0		0	1	1	1	1	1	1		1	0	0	0	1	1	0	
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7	5	5	6
7	6	D	4
7	7	Φ	4
7	8	9	3
7	9	A	A
	A	F	8
	B	Φ	B
	C	B	A
7	D	2	A
	E	9	3
7	F	5	A
8	Φ	8	A
	1	3	A
	2	7	D
8	3	D	4

$D \rightarrow M(\alpha)$
D 4
 $\Phi\phi \rightarrow D$
 $D \rightarrow R\psi(\Lambda)$
 $\Phi B \rightarrow D$
 ΦB
 $D \rightarrow R1(\Lambda)$
 $A = 1$ ←
 $\Phi\phi \rightarrow D$
 $D \rightarrow N(\Lambda)$
 $R\psi(\Lambda) \rightarrow D$
 $D = \psi\psi?$
 NO
 $4 \rightarrow P \cdot R$

UTILITY:
RUN - EXTER MODE BYTE!
 ϕ = EXEC, @ $\phi 4040$
A = READ M (xYY)
B = WRITE M (xYY)
C = M(404-6FF) \rightarrow TAPE
LDR-TONE-DATA-TONE

$$\begin{aligned} V\Phi - VF &= M(IE\Phi - IEF) \\ AI, A\Phi &= M(IF\Phi, FI) \\ BI, B\Phi &= M(IF_2, F_3) \end{aligned}$$

STOP TAPE.
 COPY VF-VF,A,B → STK. \oplus 180 →
 HEX ON, BYTE → VI (MODE)
 $V \neq \Phi$
 GOTO 4ΦΦ →
 $V \neq \Phi$.
 GOTO WRT →
 TV ON
 CLR TV
 HEX BYTE → V2 (Φx)
 V2 → M.S.A BYTE
 HEX BYTE → V2 ($\Phi x, 1$)
 HEX BYTE → V3 ($\Phi x \Phi$)
 DO PACK V2/V3 → V2
 V2 → L.S.A BYTE (Φx)
 $\Phi \Phi \rightarrow V9$
 M.S.A BYTE → V2 ←
 TV CELL # → V4 (L.S.)
 UNPACK + SHOW V2]
 L.S.A BYTE → V2]
 TV CELL # → V4 (L.S.)
 UNPACK + SHOW V2]
 $M(A) \rightarrow V2$]
 TV CELL # → V4 (L.S.)
 UNPACK + SHOW V2]
 $V9 \neq \Phi$]
 $A+1(V9=1)$
 HEX BYTE → V2 (WAIT)
 $\Phi 1 \rightarrow V9$
 $VI \neq \Phi$ A
 $VI=RDM$ →
 HEX → V3 (WAIT)
 DO PACK V2/V3 → V2.
 $V2 \rightarrow M(A)$
 GO TO →

Φ CA	Φ 268	HEX OFF
C	21 FF	5 SEC DELAY → V1
E	71 48	V1 DELAY (TAPE ON, SPKR ON)
DΦ	21 40	1 SEC DELAY → V1
Z	22 Φ1	STOP TONE → V2
4	D2 1Φ	TONE + DELAY
G	71 48	V1 DELAY
8	AΦ CΦ	ΦΦΦ → A
A	FΦ DC	ΦΦΦ → B
C	E3 AΦ	WRITE TAPE [M(A) - M(B-1)]
E	D2 1Φ	TONE + DELAY
EΦ	FΦ EΦ	END LOOP ↴
PACK →	Φ E2	SH. V2 LEFT 4 BITS
V2/V3 → V2	4	V2/V3 → V2
	6	RETURN
UNPACK ↴	Φ E8	Φ3Φ4 → B (HEX/DEC TABLE)
SHOW V2	A	ΦF → V3
	C	V3 = V2 → V3 L.S.
	E	SHIFT V2 R 4 BITS
FΦ	73 34	V3 → L.S. B BYTE
Z	73 21	M(B) → V3
4	93 45	V3 PAIT → V4 CELL *
G	54 E8 FF	V4 = 1
FB	72 34	V2 → L.S. B BYTE
A	72 21	M(B) → V2
C	92 45	V2 PAIT → V4 CELL *
E	Φ2 6E	RETURN

$\rightarrow \Phi_1 \Phi \Phi$ 14 01 VΦ
 VARIABLES 1 ΦΦ V1
 (16 BITES) 2 &Φ V2
 3 ΦΦ V3
 4 ΦΦ V4
 5 ΦΦ V5
 6 ΦΦ V6
 7 ΦΦ V7
 8 ΦΦ V8
 9 ΦΦ V9
 A ΦΦ VA
 B ΦΦ VB
 C ΦΦ VC
 D ΦΦ VD
 E ΦΦ }
 VF } TIMERS
 VF } ONLY

$\Phi_1 \Phi F$
 $\Phi_1 \Phi \Phi$
 $\Phi_1 \Phi \Phi$
 RI-DPA
 RI-DPA
 RI-DPB
 RI-DPB
 RΦ-DPA
 RΦ-DPB
 100,0
 1010
 110
 ENDF $\rightarrow \Phi_1 \Phi \Phi$
 STK $\rightarrow D, STK+1$
 STK $\rightarrow PA, STK+1$ RET.
 INT. $\rightarrow \Phi_1 \Phi \Phi$
 P=1
 36

1	7	42	STK $\rightarrow D, STK+1$
2	7	42	STK $\rightarrow PA, STK+1$ RET.
3	22		STK = 1
4	78		T \rightarrow STK
5	22		STK = 1
6	52		D \rightarrow STK
7	F8		D \rightarrow STK
8	Φ7		D \rightarrow STK
9	FΦ		D \rightarrow STK
10	ΦΦ		$\Phi_1 \Phi \Phi \rightarrow R(\Phi)$
11	AΦ		$\Phi_1 \Phi \Phi \rightarrow R(\Phi)$
12	19	9+1	
13	86	RΦ(G) \rightarrow D	
14	B0	D \rightarrow RI(D)	
15	FB	ΦD \rightarrow D	
16	ΦD	ΦD	
17	A6	D \rightarrow RΦ(G)	
18	46	M(G) \rightarrow D, G+1	
19	26	G-1	
20	32	D $=$ ΦΦ?	
21	31	YES	
22	AD	D \rightarrow RΦ(D)	
23	2D	R(D)-1	
24	BD	RΦ(D) \rightarrow D	
25	56	D \rightarrow M(G)	
26	16	G+1	
27	86	RΦ(G) \rightarrow D	
28	FB	D \neq 1Φ	
29	1Φ	1Φ	
30	3A	D $=$ ΦΦ?	
31	29	NO	
32	90	R1(D) \rightarrow D	
33	A6	D \rightarrow RΦ(G)	
34	3Φ	GO TO	
35	17	ENDI	

CALL $\rightarrow \Phi_1 3B$
 P=4

(42)

94 $\Phi_1 \rightarrow D$
 C B6 $D \rightarrow RI(G) \times$
 D B7 $D \rightarrow RI(7) \times$
 E BC $D \rightarrow RI(C)$
 F 45 $M(5) \rightarrow D, 5+1$
 4Φ AC $D \rightarrow RΦ(C)$
 1 FA $D \cdot GF$
 2 ΦF ΦF
 3 A6 $D \rightarrow RD(G) = \Phi_1 \Phi X = R(G)$
 4 BC $RΦ(C) \rightarrow D$
 5 FG SH
 6 FG SH
 7 FG SH
 8 FG SH
 9 32 D = ΦΦ?
 A 64 YES - I = Φ - ML

4 B F9 D/Cd
 C C4 Φ
 D AC D $\rightarrow RΦ(C) = \Phi_1 C I$
 E 45 M(5) $\rightarrow D, 5+1$
 F 25 5-1

5Φ FG SH
 1 FG SH
 2 FG SH
 3 FG SH

4 A7 D $\rightarrow RΦ(7) = \Phi_1 \Phi Y = R(Y)$
 5 4C M(C) $\rightarrow D, C+1$
 6 B3 D $\rightarrow RI(3)$
 7 BC RΦ(C) $\rightarrow D$

8 FC D + GF
 9 ΦF ΦF
 A AC D $\rightarrow RΦ(C)$
 B 4C M(C) $\rightarrow D, C+1$
 C A3 D $\rightarrow RΦ(3)$

D D3 3 → P → MACRO. NL.
 E 3Φ 2 → P → D4
 F 3B GO TO → CALL
 G 86 RΦ(G) $\rightarrow D$
 H 1 B3 D $\rightarrow RI(3)$
 I 2 45 M(5) $\rightarrow D, 5+1$
 J 3 3Φ GO TO

K 5C RΦ(G) $\rightarrow D$
 L 65 DC C $\rightarrow P$
 M(3) $\rightarrow D, 3+1$
 N D $\rightarrow RΦ(c)$
 O Φ2 $\Phi_2 \rightarrow D$
 P 43 Φ2 D $\rightarrow RI(c)$
 Q 7 AG 60 TO

R 8 FB 71 RI(F) $\rightarrow D$
 S 9 Φ2 8 F C $\rightarrow P$
 T 7 Φ 7 D $\rightarrow RΦ(F) \rightarrow D$
 U 6 D 71 GO TO

V 6 D 71 RI(F) $\rightarrow D$
 W 7 Φ 71 C $\rightarrow P$
 X 6 D 71 RΦ(F) $\rightarrow D$
 Y 7 F 71 GO TO

Z 7 Φ 71 C $\rightarrow P$
 A 6 D 71 RI(F) $\rightarrow D$
 B 7 Φ 71 C $\rightarrow P$
 C 6 D 71 RΦ(F) $\rightarrow D$
 D 7 F 71 GO TO

E 7 Φ 71 C $\rightarrow P$
 F 6 D 71 RI(F) $\rightarrow D$
 G 7 Φ 71 C $\rightarrow P$
 H 6 D 71 RΦ(F) $\rightarrow D$
 I 7 F 71 GO TO

(IE) →	Φ 1 7 5	D 8	DO AB → R(A)R(B)
P=3	6	7 3	()
?	7	E G	G → X
?	8	4 5	M(5) → D, 5+1
?	9	A 3	D → RΦ(3)
HEX →	7 A	D 8	DO HEX ON
WAIT	B	4 6	() G → X
?	7 C	3 C	EF1 = 1? □
?	D	7 C	NO
HEX →	7 E	6 8	HEX → M(x) □
SKIP	F	0 4	D4
?	8 0	D 8	DO HEX ON
?	1	4 6	()
?	2	3 4	EF1 = 1? □
EF2 →	3	7 E	YES
SKIP	8 4	1 5	5+1 □
?	5	1 5	5+1
?	6	D 4	D4
EF3 →	8 7	3 5 3 D	EF2 = 1? □
SKIP	8	8 4	NO → □
?	9	D 4	D4
?	8 A	3 6	EF3 = 1? □
?	B	8 4	YES → □
?	C	0 4	D4
EAT,BUS+VX →	8 D	6 E	E BUS → M(x)
?	E	D 4	D4
?	8 F	6 6	M(x) → E BUS
?	9 0	D 4	D4
?	9 1	6 4	M(x) → E.C.R.
RD.TAPE →	2	D 4	D4
?	9 3	9 A	R1(A) → D
?	4	BΦ	D → R1(Φ)
?	5	B A	RΦ(A) → D
?	6	A Φ	D → RΦ(Φ)
?	7	E 3	3 → X
?	9 8	6 1	SEL TAPE
?	9	4 3	()
?	A	6 2	TAPE READ
?	B	2 Φ	()
?	C	D 4	D4
?	9 D	9 Φ	R1(Φ) → D
RI(Φ) → VX	E	5 6	D → M(Φ)
?	F	D 4	D4
WR.TAPE →	1 A Φ	-	-
?	1	-	-
?	1 A 2	-	-
?	3	-	-
?	4	-	-
WR.TAPE →	Φ 1 A 5	B 6	Rd(6) → D #3"
?	6	B E	D → R1(E) = BH, ERPS
NEAT BYTE →	Φ 1 A 7	9 3	#1 → D
?	8	F 6	SH (1 → DF)
?	9	A B	D → RD(B) (D → PARITY)
?	A	F B	Φ B → D
?	B	Φ B	Φ B
?	C	A E	D → RΦ(E) = N
?	D	4 A	M(A) → D, A↑D
?	E	B B	D → RI(B) = WRITE.BYTE
?	F	D 8	DO WR#HS(DF) D3
?	B Φ	B Φ	() WR.ST.BIT.

Φ 1 D T	9 B	RI(B) → D	20
2	F 6	SH → DF	20
3	B B	D → RI(B)	20
4	D C	DO WR#HS(DF) DC	20
5	2 E	E - 1	
6	8 E	RΦ(E) → D	
7	3 A	D = ΦΦ?	
8	B 1	NO	
9	8 B	RΦ(C) → D	
A	F 6	SH → DF	
B	D C	DO WR#HS(DF) DC	
C	D 8	DO A = B TEST	280 - 340
D	8 1	()	
E	3 A	D = ΦΦ?	20
F	A 7	NO	NEXT BYTE
	4 → P		
INSTR. DECOPIC TABLE	1	Φ 2	
	2	Φ 2	
	3	Φ 2	
	4	Φ 2	
	5	Φ 2	
	6	Φ 2	
	7	Φ 4	
	8	Φ 2	
	9	Φ 2	
	A	Φ 2	
	B	Φ 2	
	C	Φ 2	
	D	Φ 2	
	E	Φ 1	
	F	Φ 2	
	1	Φ Φ	
	2	Φ Φ	
	3	Φ Φ	
	4	Φ Φ	
	5	Φ Φ	
	6	Φ Φ	
	7	Φ 9	
	8	Φ 9	
	9	Φ D	
	A	Φ Φ	
	B	Φ 9	
	C	Φ B	
	D	Φ E	
	E	Φ 5	
	F	Φ 5	

NRW

WR TAPE 01 A \oplus B6
P=3
NEXT BYTE → A 2 93
3 F6
4 AB
5 FB
6 08
? AE
8 4A
9 BB
A DB
1 AB B \oplus 85
AC 9B
D FG
E BB
F DC
B 0 2 E
1 BE
2 3A
3 AC
4 BB
5 F6
6 DC
7 8A
8 3A
9 A2
A 9A
B FB
C \oplus 7
D 3A
E A2
F D4
C \oplus 4 \oplus

R \oplus (G) \rightarrow D (d3)
D \rightarrow RI(E) : BIT FREQ
 $\oplus 1 \rightarrow D$ ←
SHIFT (1 \rightarrow DF, $\oplus\oplus \rightarrow D$)
D \rightarrow R \oplus (B) = PARITY
 $\oplus B \rightarrow D$
 $\oplus B$
D \rightarrow R \oplus (E) = N
M(A) \rightarrow D, ATI
D \rightarrow RI(B) : WRITE BYTE
DO WR \oplus 1 S(DF) DC
E-1
WR, ST, BIT.
RI(B) \rightarrow D ←
SH \rightarrow DF
D \rightarrow RI(B)
DO WR \oplus 1 S(DF) DC
E-1
R \oplus (E) \rightarrow D
D = $\oplus\oplus^2$
NO
R \oplus (B) \rightarrow D
SH \rightarrow DF
DO WR \oplus 1 S(DF) (DC)
R \oplus (A) \rightarrow D
D = $\oplus\oplus^2$. NEXT BYTE →
NO
RI(A) \rightarrow D
D \oplus $\oplus 7$.
 $\oplus 7$
D = $\oplus\oplus^2$
NO
 $4 \rightarrow P$

→ 244 F8 14 → D
 TA
 MNN → A
 P=3
 1 1Φ 1Φ
 2 A7 D → RD(?) ←
 3 86 RΦ(6) → D
 4 57 D → M(?)
 5 17 7+1
 6 45 M(5) → D, 5+1
 7 57 D → M(?)
 8 D4 4 → P

→ 249 F8 12 → D
 TB P=3
 HMM → B
 P=3
 1 A 12 12
 2 B 34 GO TO
 C Φ2

→ 24D 15 5+1
 (I) P=3
 BR3LINK
 1 Φ 85 RΦ(5) → D
 F 22 STR-1
 1 52 D → STR
 1 95 RI(5) → D
 2 22 STR-1
 3 52 D → STR
 4 25 5-1

→ 215 8645 RΦ(6) → D
 (TF) P=3
 AUTO 1 B5A5 D → RI(5)
 1 4586 M(5) → D, 5+1 ←
 8 A5B5 D → RΦ(5)
 9 D4D4 D4 RET

→ 21A 46EG M(6) → D, 6+1
 (J5) P=3
 VX+PVX
 GU200MM
 LF-VX+PVX
 SKP, P10, P24=04
 1 B 2645 6-1
 C FFF4 D=Φ1 → D
 D Φ156 Φ1
 E 5632 D → M(6)
 F 3A2B D=ΦΦ?
 G 17D4 NO ←

→ 223 45 M(5) → D, 5+1
 (I3) P=3
 SKIP IF
 VX+PVX
 2 E6 6 → X ←
 5 F3 D=ΦΦ?
 6 32 D=ΦΦ?
 7 2A YES ←
 8 15 #5+1 ←
 9 15 5+1 ←

→ 22B 15 5+1 ←
 (IC) P=3
 SKIP IF
 VX+PVX
 2 47 M(7) → D, 7+1
 3 Φ GO TO
 4 24

→ 22F F8 14 → D
 COPY P=3
 1 A6
 2 96
 3 B7
 4 FB
 5 EΦ
 6 A7
 7 46
 8 57
 9 17
 A 87
 B FB
 C F4
 D 3A
 E 37
 F D4
 G E3
 H 61
 I 42
 J 62
 K 4Φ
 L D4
 M EC
 N 61
 O 41
 P 62
 Q 4Φ
 R D4
 S EC
 T 61
 U 42
 V 62
 W 4Φ
 X D4
 Y EC
 Z 61
 → 240 E3
 TV OFF P=3
 1 61
 2 42
 3 62
 4 4Φ
 5 D4
 6 EC
 7 61
 8 41
 9 62
 A 41
 B EG
 C D3
 D 61
 E 6
 F F4
 G F4
 H 56
 I F4
 J 56
 K F4
 L 56
 M F4
 N 56
 O F4
 P 56
 Q 56
 R F4
 S 56
 T 56
 U D3
 V 56
 W 56
 X D3
 Y 56
 Z F4

→ 246 EC HEX ON
 1 61 D → RΦ(5)
 2 42 RΦ(6) → D
 3 62 D → RΦ(5)
 4 4Φ D → RΦ(5)
 5 D4 D → RΦ(5)
 6 EC D → RΦ(5)
 7 61 D → RΦ(5)
 8 41 D → RΦ(5)
 9 62 D → RΦ(5)
 A 41 D → RΦ(5)
 B EG D → RΦ(5)
 C D3 D → RΦ(5)
 D 61 D → RΦ(5)
 E 6 D → RΦ(5)
 F F4 D → RΦ(5)
 G F4 D → RΦ(5)
 H 56 D → RΦ(5)
 I F4 D → RΦ(5)
 J 56 D → RΦ(5)
 K F4 D → RΦ(5)
 L 56 D → RΦ(5)
 M F4 D → RΦ(5)
 N 56 D → RΦ(5)
 O F4 D → RΦ(5)
 P 56 D → RΦ(5)
 Q 56 D → RΦ(5)
 R F4 D → RΦ(5)
 S 56 D → RΦ(5)
 T 56 D → RΦ(5)
 U D3 D → RΦ(5)
 V 56 D → RΦ(5)
 W 56 D → RΦ(5)
 X D3 D → RΦ(5)
 Y 56 D → RΦ(5)
 Z F4 D → RΦ(5)

→ 24D E6 SH.VX4L P=C
 1 61 SH.32 ←
 2 5Φ ←
 3 4Φ ←
 4 56 ←
 5 F4 ←
 6 56 ←
 7 56 ←
 8 D3 ←
 9 E5 ←
 A 63 ←
 B D4 ←
 C 4Φ ←
 D 56 ←
 E 56 ←
 F 56 ←
 G 56 ←
 H 56 ←
 I 56 ←
 J 56 ←
 K 56 ←
 L 56 ←
 M 56 ←
 N 56 ←
 O 56 ←
 P 56 ←
 Q 56 ←
 R 56 ←
 S 56 ←
 T 56 ←
 U 56 ←
 V 56 ←
 W 56 ←
 X 56 ←
 Y 56 ←
 Z 56 ←

→ 258 E5 (I6) P=3 TAPE CONTR.
 1 63 ←
 2 D4 ←
 3 BΦ ←
 4 AΦ ←
 5 FΦ ←
 6 FΦ ←
 7 ΦΦ ←
 8 AΦ ←
 9 FΦ ←
 A 63 ←
 B D4 ←
 C 4Φ ←
 D 56 ←
 E 56 ←
 F 56 ←
 G 56 ←
 H 56 ←
 I 56 ←
 J 56 ←
 K 56 ←
 L 56 ←
 M 56 ←
 N 56 ←
 O 56 ←
 P 56 ←
 Q 56 ←
 R 56 ←
 S 56 ←
 T 56 ←
 U 56 ←
 V 56 ←
 W 56 ←
 X 56 ←
 Y 56 ←
 Z 56 ←

→ 25C FΦ P=3
 1 63 ←
 2 D4 ←
 3 BΦ ←
 4 AΦ ←
 5 FΦ ←
 6 FΦ ←
 7 ΦΦ ←
 8 AΦ ←
 9 FΦ ←
 A 63 ←
 B D4 ←
 C 4Φ ←
 D 56 ←
 E 56 ←
 F 56 ←
 G 56 ←
 H 56 ←
 I 56 ←
 J 56 ←
 K 56 ←
 L 56 ←
 M 56 ←
 N 56 ←
 O 56 ←
 P 56 ←
 Q 56 ←
 R 56 ←
 S 56 ←
 T 56 ←
 U 56 ←
 V 56 ←
 W 56 ←
 X 56 ←
 Y 56 ←
 Z 56 ←

→ 267 D4
 1 63 ←
 2 D4 ←
 3 BΦ ←
 4 AΦ ←
 5 FΦ ←
 6 FΦ ←
 7 ΦΦ ←
 8 AΦ ←
 9 FΦ ←
 A 63 ←
 B D4 ←
 C 4Φ ←
 D 56 ←
 E 56 ←
 F 56 ←
 G 56 ←
 H 56 ←
 I 56 ←
 J 56 ←
 K 56 ←
 L 56 ←
 M 56 ←
 N 56 ←
 O 56 ←
 P 56 ←
 Q 56 ←
 R 56 ←
 S 56 ←
 T 56 ←
 U 56 ←
 V 56 ←
 W 56 ←
 X 56 ←
 Y 56 ←
 Z 56 ←

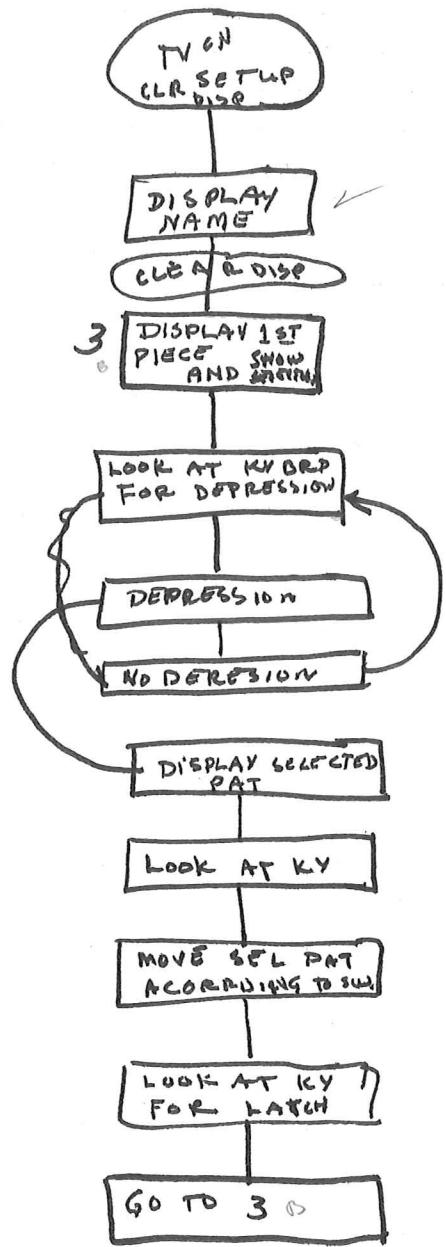
NO.

PROGRAM

DATE

PAGE

	S	P	X	M	(m)	INSTRUCTION	comments
card					400	025L	TV ON
					2	E180	RR-KK → VX // VX = PATT #
					4	D150	B300
					6	D150	300 → B PNTR
					8	402	V
					A		
					C		
					E		
					410		
					2		
card					4		
					6		
					8		
					A		
					C		
					E		
					420		
					2		
					4		
					6		
card					8		
					A		
					C		
					E		
					430		
					2		
					4		
					6		
					B		
					A		
card					C		
					E		
					440		
					2		
					4		
					6		
					8		
					A		
					C		
					E		
card					450		
					2		
					4		
					6		
					8		
					A		
					C		
					E		



CMAR₃
from KEY BRD TO TV IN CELL
SEQUENCE

400	025C	TV ON	OK
402	0078	CLR DISP	
4	2300	SET V3 = 00	
6	E17A	KOY ON "BYTE → V1	
8	0300	300 → B	
A	7134	V1 TO LSB OF B	B = PATTERN #
C	7221	MOVE B → V2	V2 = PAT#
E	2401	SETN 4 = 1	> V3
10	9235	→ ADD V4 + V3 = CELL#)
2	8344	5x5 PAT	←
4	3320	SKP NTRINS IF V3 ≠ 20	
6			
8			
A			
C			
E			
20			

FEL-1 (FRED II EXPERIMENTAL LANGUAGE) - SUMMARY

BRANCH
INSTR.

VARIABLE
AND
CONSTANT
MANIPULATION

POINTER
CONTROL
AND
MANIPULATION

HEX
ID

TV
ID

LAST
COUNTED
MAY
END
TEST
FOR
COUNTER
OVERFLOW

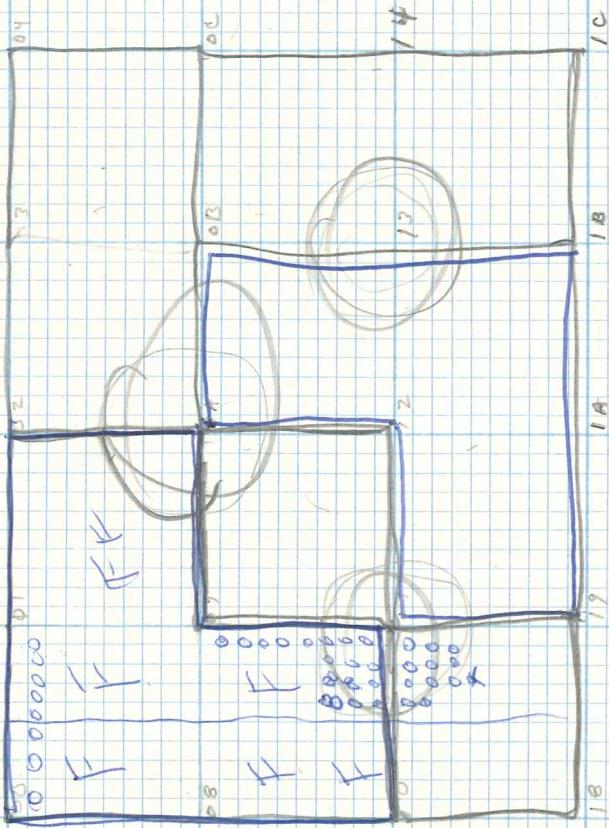
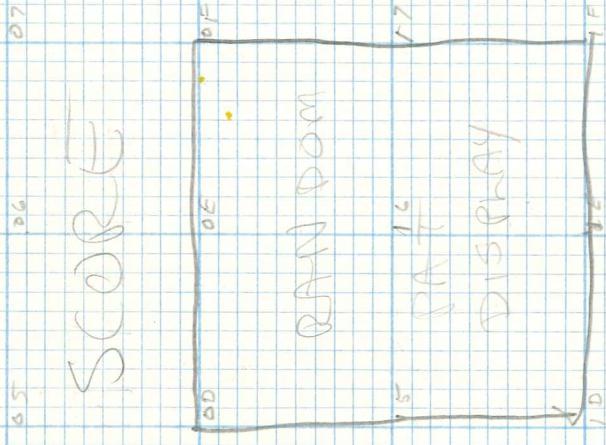
	FNMM 1MMH 026E 3XRR 5XRR CXYΦ	GO TO MMM "DO PROGRAM AT MMM RETURN TO INSTRUCTION FOLLOWING LAST 1MMH SKIP NEXT INSTRUCTION IF VX ≠ RR $VX+RR \rightarrow VX$, SKIP NEXT INSTRUCTION IF $VX(FINAL) = \Phi\Phi$ SKIP NEXT INSTRUCTION IF $VX \neq VY$	1
	2XRR 4XRR BXY1 BXY2 BXY4 BXY5 7X3E 7X41 7X52	$RR \rightarrow VX$ <small>→ THE 8 BIT CONSTANT TO VARIABLE X</small> $RR+RR \rightarrow VX$ ($RR = 8$ BIT RANDOM NUMBER) $VX/VY \rightarrow VX$ (CHANGES VΦ) $VX+VY \rightarrow VX$ (CHANGES VΦ) $VX+VY \rightarrow VX$ ($\Phi\Phi \rightarrow V\Phi$ IF $VX+VY > FF$, $\Phi\Phi \rightarrow V\Phi$ IF $VX+VY \leq FF$) $VX-VY \rightarrow VX$ ($\Phi\Phi \rightarrow V\Phi$ IF $VX > VY$, $\Phi\Phi \rightarrow V\Phi$ IF $VX \leq VY$) SHIFT VX LEFT 4 BITS SHIFT VX RIGHT 4 BITS CONVERT VX TO 3 DIGIT DECIMAL $\rightarrow M(A, A+1, A+2), VX, A$ UNCHANGED	2
	ANMM BNMM 7X1E 7X21 7X24 7X27 7X2A 7X3Φ 7X34 7X38 7X3B 7F6F	$MM \rightarrow A$ $MM \rightarrow B$ $M(A) \rightarrow VX$ $M(B) \rightarrow VX$ $VX \rightarrow M(A)$ $VX \rightarrow M(B)$ $VX \rightarrow$ LEAST SIGNIFICANT BYTE OF A $VX \rightarrow$ MOST SIGNIFICANT BYTE OF A $VX \rightarrow$ LEAST SIGNIFICANT BYTE OF B LEAST SIG. BYTE OF A $\rightarrow VX$ MOST SIG. BYTE OF A $\rightarrow VX$ $A+1 \rightarrow A$	3
	E87A E88Φ 0268	HEX KEYBD. ON, WAIT FOR BYTE $\rightarrow VX$ HEX KEYBD. ON, BYTE READY $\rightarrow VX$, IF BYTE NOT READY SKIPNEXT INSTR. HEX KEYBD. OFF	4
	9XY5 9XY8 0Φ78 025C 024Φ	5A5 PATTERN $\rightarrow TV$ { $VX =$ PATTERN ADDRESS IN PAGE 03 (CHANGED) BKB PATTERN $\rightarrow TV$ { $VY = TVCELL$ <small>UNCHANGED</small> }	5
	6ΦΦ3 6ΦΦ1 EΦ87 6ΦΦΦ 7X4Φ DXYΦ	CLEAR TV DISPLAY TV ON TV OFF START TAPE (AUDIBLE) START TAPE (INAUDIBLE) SKIP NEXT INSTRUCTION IF TAPE IS RUNNING <small>SILENTLY</small> STOP TAPE (SPEAKER OFF) VX DELAY (TAPE ON, SPKR OFF). VX TONE, VY DELAY (TAPE ON, SPKR OFF)	6
	ΦMMH 022F EΦ93 E3AΦ E89D	EXECUTE H.L. PROGRAM AT MMM, P=3, D4 TO RETURN COPY $VΦ-VF, A, B \rightarrow ΦΙΕΦ-EF, FΦ-F3$ (STACK) READ TAPE $\rightarrow M(A)$ CONCURRENT, PRECEDED BY TV OFF + START TAPE, TEST EF2 / RI(0) FOR END, A NOT CHANGED WRITE TAPE FROM $M(A)$ TO $M(06FF)$, PRECEDED BY TV OFF + START TAPE. $RI(\Phi) \rightarrow VX$	7
	E8BD E8BF E89I EΦ8A	EXT. BUS $\rightarrow VX$ $VX \rightarrow$ EXT. BUS $VX \rightarrow$ EXT. CONTROL REGISTER (4 BITS) SKIP NEXT INSTRUCTION IF EXT. FLAG = 1 (EF3)	8

VD, VE, VF = TIMERS (DECREMENTED 60 TIMES/SEC. WHEN TV ON)
 PROGRAMS START AT 40Φ. TV ∈ 70Φ-7FF

HEX/DEC PAT # CONV. TABLE		3	4	Φ	4	8	Φ
		1	2	1	2	E	1
		2	3	2	A		2
		3	4	1	9		3
		4	5	3	2		4
		5	6	4	4		5
		6	7	1	4		6
		7	8	4	C		7
		8	9	1	E		8
		9	A	5	Φ		9
		A	B	2	2		A
		B	C	4	4		B
		C	D	2	6		C
		D	E	3	7		D
		E	F	3	Β		E
		F					F
1 →	3	1	Φ	1	4		
		1		3	Φ		
		2		1	Φ		
		3		1	Φ		
7 →	1	4		7	C		
		5		Φ	8		
		6		1	Φ		
		7		2	Φ		
		8		4	Φ		
		9		4	8		
4 →	1	A		1	8		
		B		2	8		
		C		7	C		
		D		Φ	Β		
7 →	1	8		3	8		
		F		4	4		
		Φ		3	C		
				4	4		
B →	2	2		7	B		
		3		2	4		
		4		3	8		
		5		2	4		
D →	2	6		7	8		
		7		2	4		
		8		2	4		
		9		2	4		
3 →	2	A		7	9		
		B		Φ	4		
		C		1	8		
		D		Φ	4		
2 →	2	E		7	8		
		F		Φ	4		
		Φ		3	8		
				4	Φ		
5 →	3	2		7	C		
		3		4	Φ		
		4		7	Β		
		5		Φ	4		
		6		7	8		

E →	3 3 7	7 C	• • • •
	3 3	4 4	•
	9	7 8	• • • •
	A	4 φ	•
F →	3 B	7 C	• • • • •
	C	4 4	•
	D	7 8	• • • •
	E	4 4	•
	F	4 4	•
C →	4 φ	3 C	• • • •
	I	4 4	•
	Z	4 φ	•
	3	4 4	•
G →	4 4	3 C	• • • •
	5	4 φ	•
	6	7 8	• • • •
	7	4 4	•
O →	4 8	3 8	• • • •
	9	4 4	•
	A	4 4	•
B →	4 C	3 8	• • • •
	D	4 4	•
	E	3 8	• • • •
	F	4 4	•
A →	5 φ	3 8	• • • •
	I	4 4	•
H →	5 3	7 C	• • • •
	4	4 4	•
J →	5 5	7 C	• • • •
	6	4 4	•
	7	4 4	•
	8	4 4	•
	9	4 4	•
? →	5 A	3 8	• • • •
	B	4 4	•
	C	φ 8	•
' →	5 D	1 φ	•
	E	1 φ	•
LANK →	5 F	φ φ	•
NDER →	6 3	φ φ	•
- →	6 1	φ φ	•
	2	4 4	•
	3	φ φ	•
	4	7 C	•
	5	4 4	•
	6	4 4	•
	7	7 C	• • • •
	8	4 4	•
	9	7 C	• • • •
	A	4 4	•
	B	1 B	•
	C	4 φ	•
	D	1 8	•
	E	4 4	•

NO.	PROGRAM		DATE	PAGE
	S P X M (m)	INSTRUCTION	comments	
card	0		CLR DISP, TV ON	
	2		SET CELL #	
	4		SET ADDER = 1 $\nabla 3$	
	6		300 \rightarrow B	
	8		SET V2 \rightarrow 96 (P)	
	A		$\nabla \rightarrow$ GO TO DISPLAY RUTIN	
	C		SET V2 \rightarrow 56 (U)	
	E		GO	
	0		SET V2 \rightarrow 9D (Z)	
	2		9D (Z)	
card	4		99 (E)	
	6			
	8			
	A			
	C		37 (E)	
	E		V2 \rightarrow LBR OB	
	0		ADD 1 \rightarrow V1 + V3 \rightarrow V1	
	2		B \rightarrow V2	
	4		DISPLAY V2, V1, 5	
	6		END BACK	
card	8			
	A			
	C			
	E			
	400	0078	LBR DISP	
	2	025C	TV ON	
	4	2110	10 \rightarrow V1	
	6	2301	01 \rightarrow V3	
	8	B300	300 \rightarrow B	
	A	2200	00 \rightarrow V2	
card	C	1420	GOTO 420 BRLNK	
	E	2201	01 \rightarrow	
	10	1420		
	2	2202		
	4	1420		
	6	2203		
	8	1420		
	A	2204		
	C	1420		
	E	2205		
card	20	7234		
	2	8134		
	4	7221		
	6	9215		
	8	026E		
	A			
	C			
	E			



PA.
63.0
DATE
CALPHAD