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Date 26 December 1974

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Subject COSMAC Coin Machine - Status Report

The coin operated amusement device market was discussed in an earlier report. This market includes pinball machines, video games, etc. We have been looking at the application of COSMAC in this area. So far, things look very promising. This report discusses our philosophy, approach, progress, plans, etc.

Philosophy and Approach

A variety of amusement-type coin machines could be developed using COSMAC. We have initially decided to build on our FRED experience. This requires the minimum development effort and yields the shortest lead time for a final product.

Our initial machine will be a general purpose computer system. We will plan to exploit the computer theme via styling, game design, etc. A minimum cost system will be developed first. This lets us have a product prototype in the shortest time. The minimum cost system also provides a reference with which future enhanced machines can be compared.

The machine will utilize ROM for program storage. 2K bytes appear to be sufficient initially. The ROM will be contained on a small plug-in card. A variety of different ROM cards can be sold. Each ROM card will convert the machine to a different set of games. This will give the basic machine a long life. New games will not require redesigning the machine because operators (users) can easily convert the machine to play new games in the field.

I/O approaches must be carefully chosen to maintain low final product cost, minimize development effort, and achieve a general purpose machine. A dot matrix TV display of the type used in the FRED project satisfies our requirements. Alpha-numeric displays are not as flexible, require higher resolution circuits (more costly), and extend development time. Such extension of development time would have included postponement of software effort until the new display formats could be evaluated, designed, and constructed. Prior experience has already verified the usefulness of the FRED type display format for a wide variety of games. Hardware design is completed and an LSI chip already exists for the required interface. For the coin machine, the display will be expanded to provide an array of 32x64 dots. This will almost fill the TV screen and greatly enhances display capability. This display circuitry has been tested with a monitor (versus a standard TV set) and yielded excellent results.

A number of game machine input approaches are possible. These include simple pushbuttons, keyboards, light guns, joy sticks, steering wheels, etc. Our initial choice was limited by considerations of flexibility, development effort,

and end cost. Other considerations must include ruggedness and reliability. Input transducers for coin-operated machines receive severe abuse by players and vandals. We have looked at keyboards, buttons, light guns, card readers, and joy sticks. Simple pushbuttons are the least expensive, most rugged, and most general-purpose input transducers. They are readily available and have already been life tested. They are also consistent with our computer theme philosophy. Initially, we are providing 5 buttons for each player. This seems sufficient for a number of 1 and 2 player games. Interface circuitry is trivial.

A prototype of a minimum-cost, general-purpose, game-playing machine will be constructed during the first half of 1975. A number of sample programs will be developed concurrently for demonstration and field testing. Alternative I/O approaches and enhanced systems will be investigated at a later date.

Hardware

Three distinct hardware development efforts are required. First, a system suitable for program development and debug is required. A suitable system has been designed and constructed and is currently being used for software development. It includes 2K bytes of RAM which simulate the ROM of a final machine. This RAM can be loaded by a self-contained cassette unit or HEX keyboard (initial program entry). The ability to record program cassettes and extensive program preparation/debug facilities are also provided.

A second hardware system will be required as a breadboard prototype for the final product. This system will simulate the final system exactly. It differs from the first system in that no program preparation or debug facilities are included. It will also be packaged to simulate a final system and can be used for demonstration/field testing. It will differ from the final system in its use of PROM rather than ROM and will be hand-wired rather than using a printed-circuit board. Physical packaging will be in the form of a table top unit and optional pedestal to facilitate transportation and demonstration. This system is currently being designed for construction in the first half of 1975.

The third hardware system will be the final product. All electronics will be packaged on a single 8"x10" P.C. board. A socket will be provided to accept a variety of ROM plug-in cards. The design of the final system should be completed by a product line group. Final product design could start as early as the first quarter of 1975 and run concurrently with prototype testing and software development. The mechanical design (box, control panel, etc) would benefit greatly from an early start. We do not currently plan to proceed to a final product design within our group.

Figure 1 illustrates the block diagram of the proposed minimum system. Figure 2 illustrates the input panel layout. Figure 3 shows a proposed package.

The final system will require about 40 chips (excluding ROM). 2K bytes of ROM can be provided on 1 chip. 512 bytes of RAM will be required for TV display and variables. Four 256x4 RAM chips will suffice. Other LSI chips include the 2 COSMAC chips and a custom TV chip (available from FRED project). All other chips are readily available - SSI and MSI types (mixed 4000 COS/MOS and 7400 TTL).

Assuming \$50. for the COSMAC chip set, \$30. for the custom LSI TV chip, \$30. for ROM, and \$20. for RAM, a total chip cost of \$180. is possible. These could all be mounted on a single 8"x10" P.C. card for a total electronics package cost of \$250. Adding \$140. for a TV monitor (includes system power supply and audio amplifier) results in a cost of under \$400. This leaves \$200. for cabinet, switch panel, coin box, and assembly. The resulting \$600. manufacturing cost is consistent with a competitive selling price target of \$1200.

Software

We are simultaneously trying to do two things in the area of coin-machine software. First, we are developing a number of game programs for demonstration and test of the prototype hardware system. Two games have been designed, and others are in development. These games (unlike home games) must be quick to learn and fast to play. Two minutes is normal for a 25¢ machine to maximize return. These games must be novel and simple enough to prevent frustration on the part of new players. They must also provide continuing challenge for experienced players. They must appeal to the maximum range of age and sex. They must stay within the memory and I/O capability of our low-cost general-purpose hardware. Satisfying this unique set of criteria is a non-trivial task.

Concurrent with game development is the design of new game programming languages. Such languages facilitate developing and experimenting with new games and provide more efficient use of our small memory capacity. These interpretive languages will also be invaluable to future programmers of the coin machine. It is anticipated that programming will become a continuing effort in order to satisfy the secondary market for new ROM's. Rather than spending an inordinate amount of time on one inefficient general-purpose language, we are developing a number of special-purpose ones. Each is suitable for a group of games. So far, two such languages have been developed. Others will be investigated as the need arises.

All software is being developed exactly as it will go into the prototype PROM and/or final product ROM. This will eliminate the future need for recoding and resulting unexpected problems and costs.

Conclusions

For a new understaffed project, a great deal has been accomplished:

- a. A market study has been completed,
- b. Useful contacts within the trade established,
- c. Specifications developed for a practical minimum system,
- d. Hardware system designed and built for program preparation/testing,
- e. Product prototype design underway, and
- f. Software development underway with several demonstration programs now running.

The project to date is considered to be a very healthy one, for the following

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reasons:

- a. Marketing and distribution problems and costs will be minimal because of existing industry-wide distribution systems.
- b. Ideal initial COSMAC application since the system is completely self-contained, requiring only 5 volts and 20 μ sec instruction time.
- c. The general-purpose hardware estimate (40 chips) compares very favorably with existing special-purpose machines (~125 chips).
- d. Only cabinet and software are now unknowns, and no major problems are expected for either one.

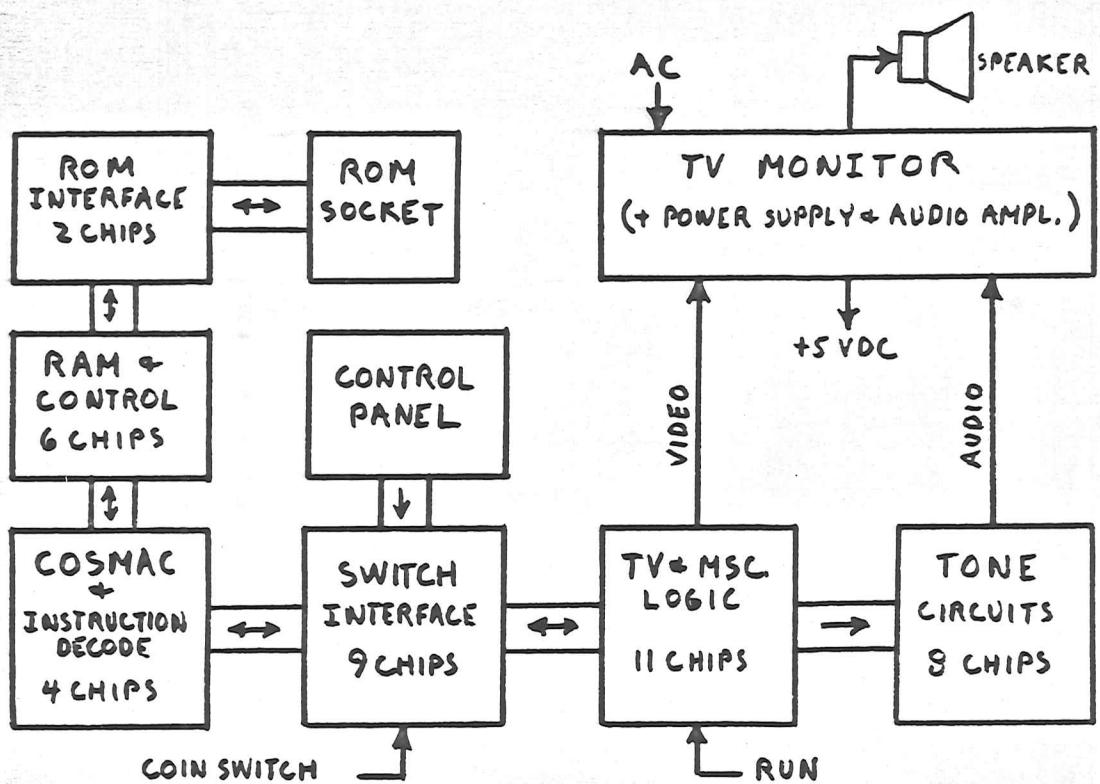


FIGURE 1 - COIN MACHINE BLOCK DIAGRAM

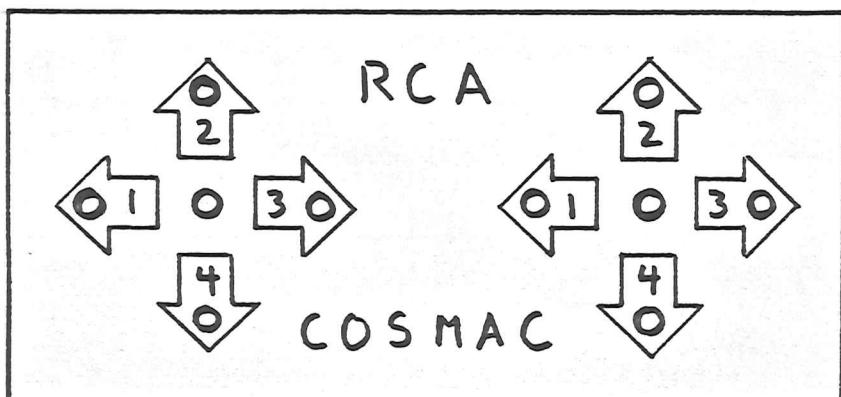


FIGURE 2 - SWITCH LAYOUT

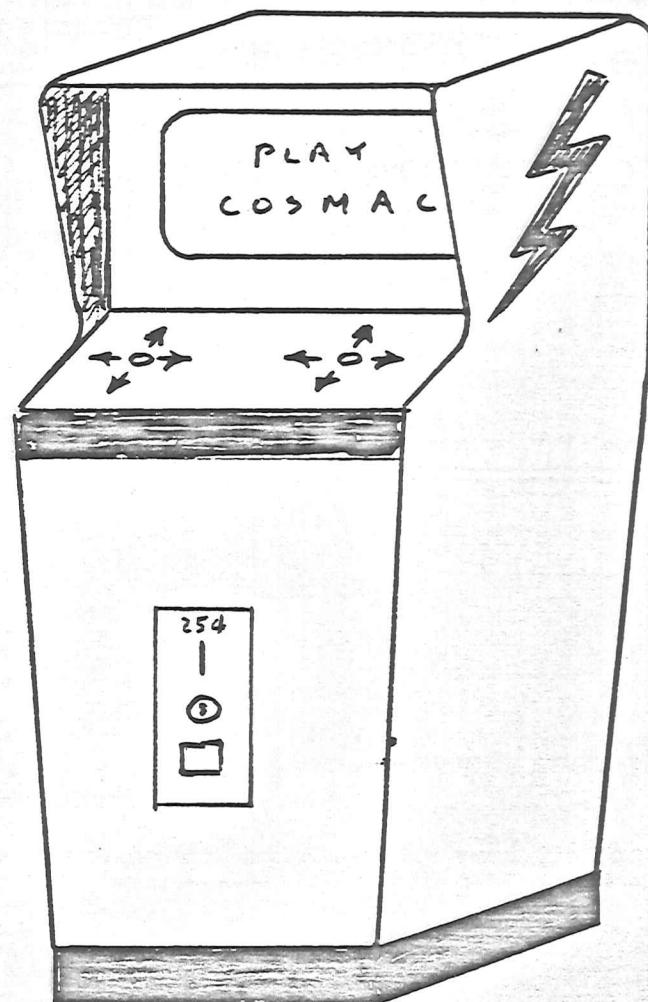
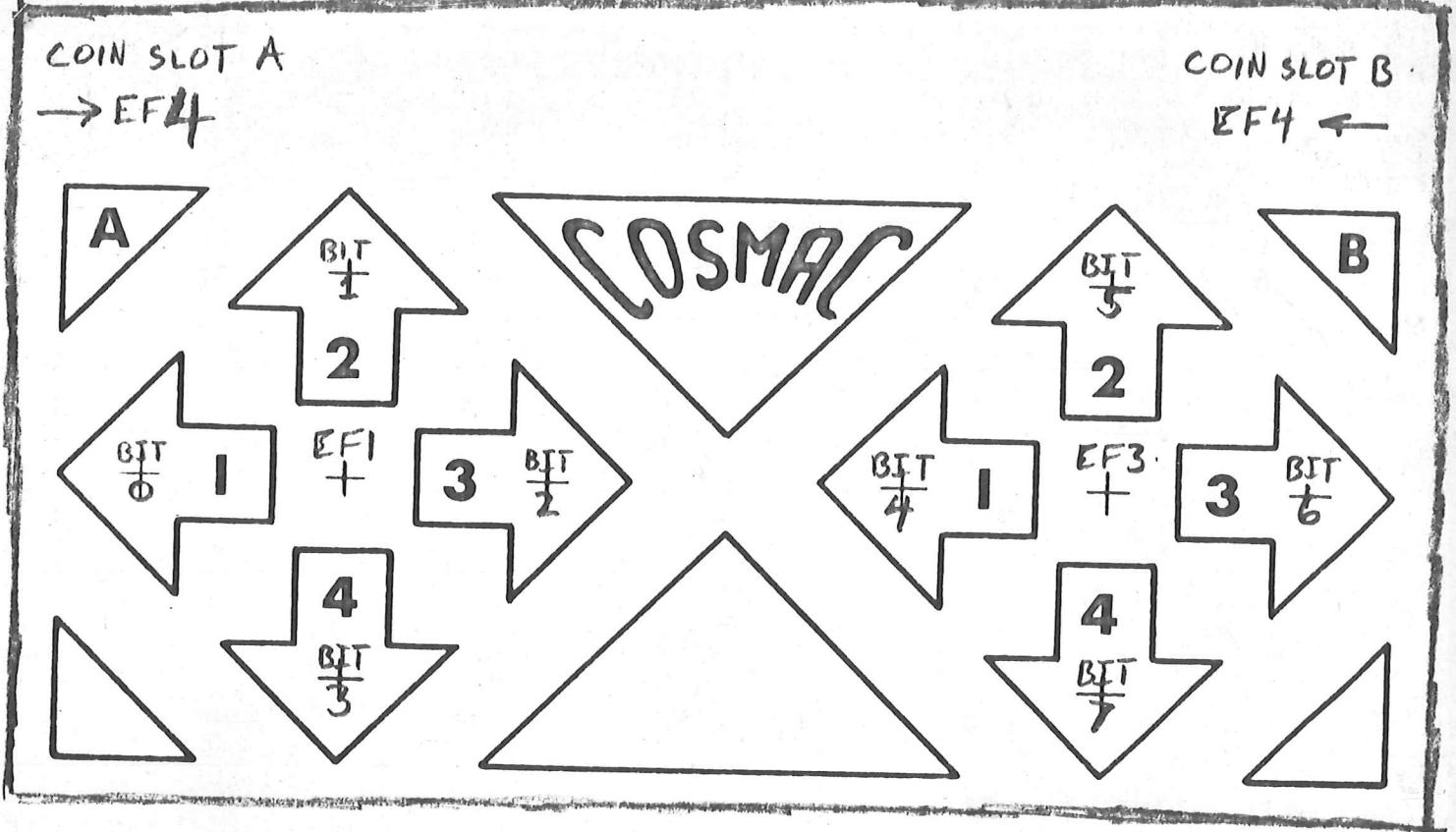


FIGURE 3

JW

COSMAC COIN GAME PANEL



COSMAC COIN GAME INSTRUCTIONS

INPUT ($GE = \text{BIT } \phi \rightarrow \text{SWITCHES} \rightarrow M(x)$)
 (SW. PRESSED = 1) -

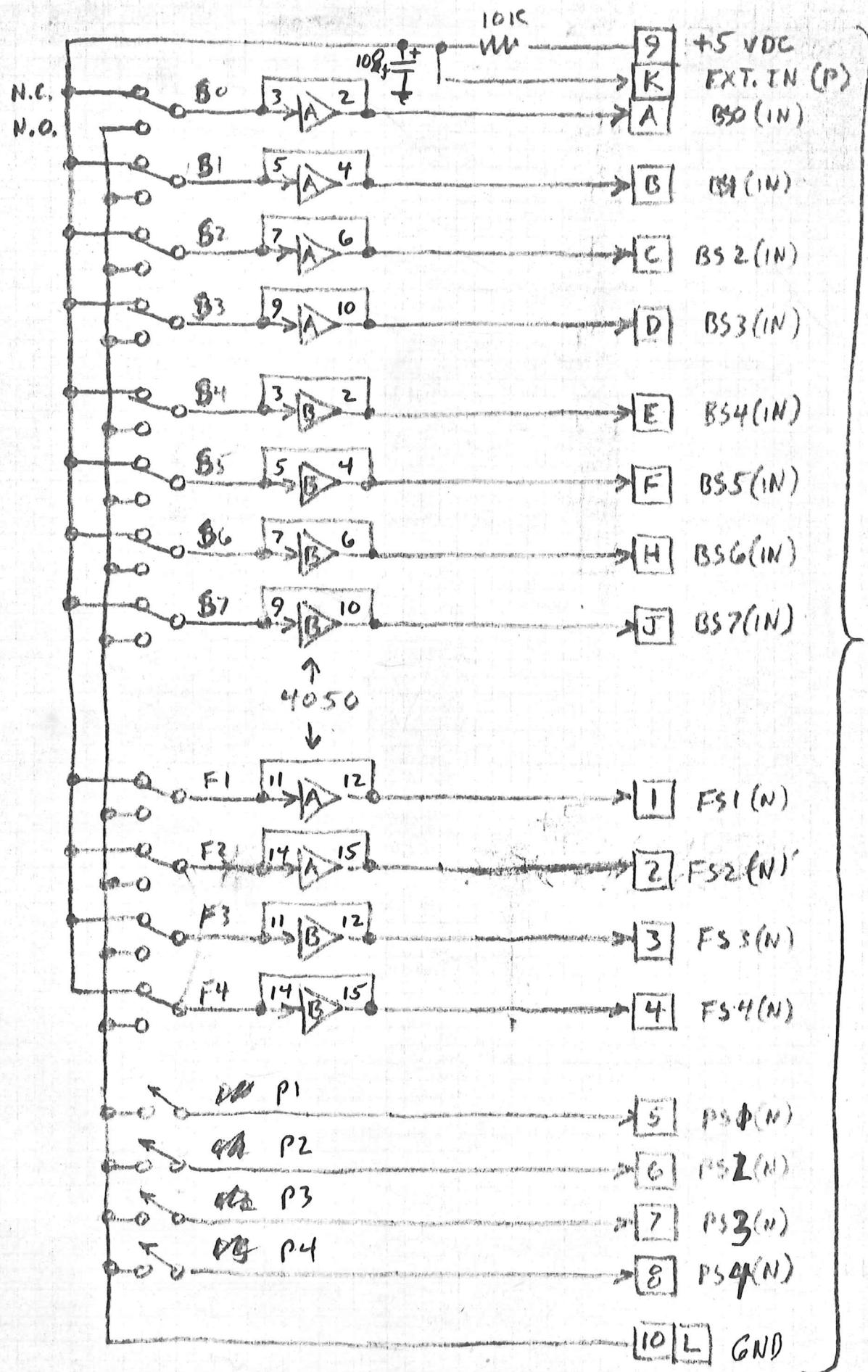
DISPLAY ($61 + M(x) = \phi 2$ SELECTS TV OUTPUT CHANNEL
 $62 + M(x) = \phi 3$ TURNS ON 32x64 DISPLAY AFTER TV SELECT)

TONE OUTPUT ($63 + M(x) = \phi 4$ SETS $EFF = 1$ } EFF FED TO SPEAKER
 $63 + M(x) = \phi \phi$ SETS $EFF = \phi$ } FOR PROGRAMMED TONES)

OPTIONAL SOUNDS ($65 + M(x) = KK$ SETS OPTIONAL OUTPUT SOUND EFFECTS CIRCUITS)

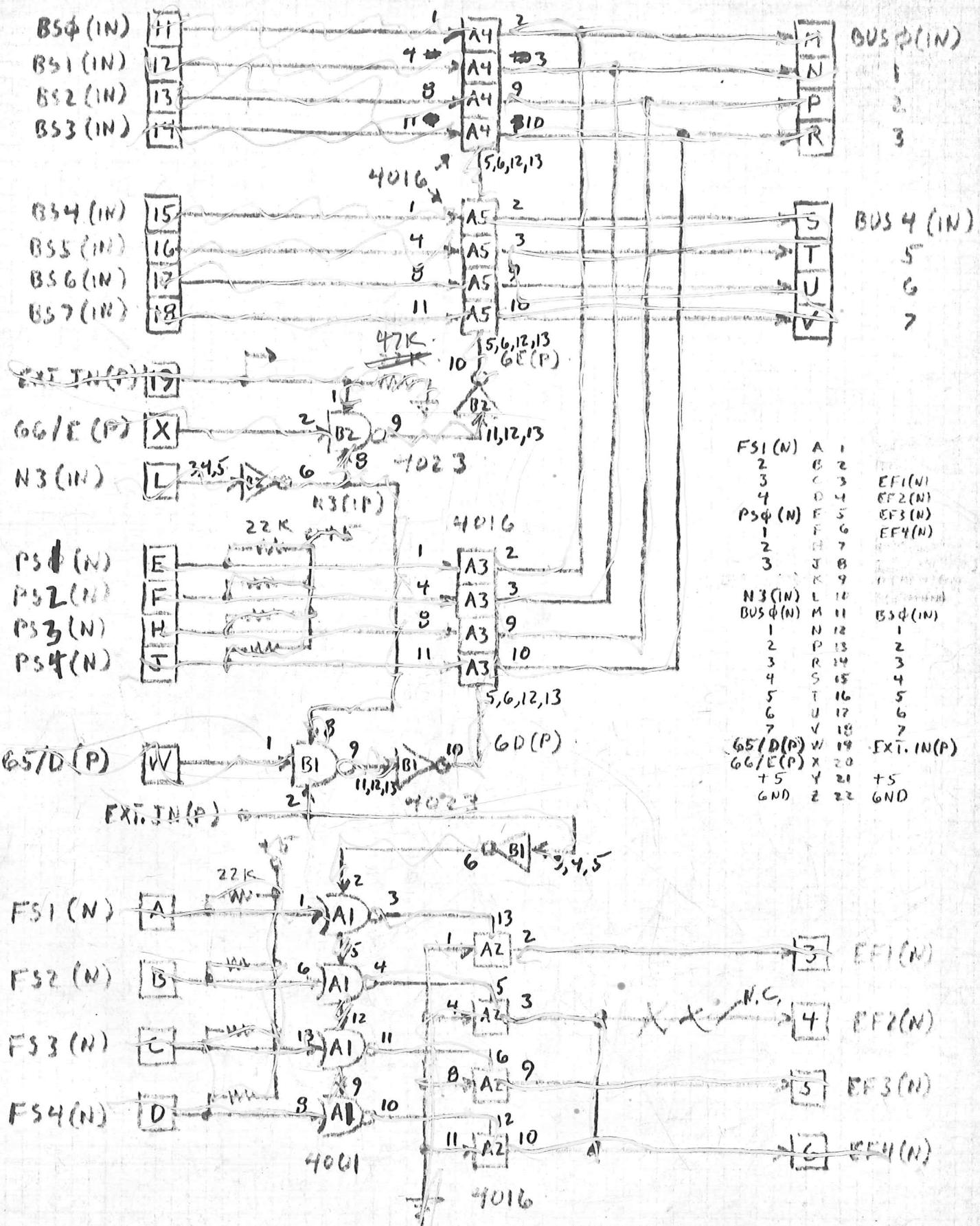
PARAMETER INPUT ($60 = \phi P$ (FROM 4 PARAMETER BIT SWITCHES) $\rightarrow M(x)$)

COSMAC COIN GAME PANEL LOGIC



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COIN GAME CKTS
COSMAC CARD A9.



COIN GAME CKTS.
COSMAC CARD A9

	A	B	C	D	E	
1	.4001	.4023				1
2						2
3	.4016	.4023				3
4	.4016					4
5	.4016					5
6						6
21						
22						

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J/O PANEL ADDITIONS
COSMAC CARD B1

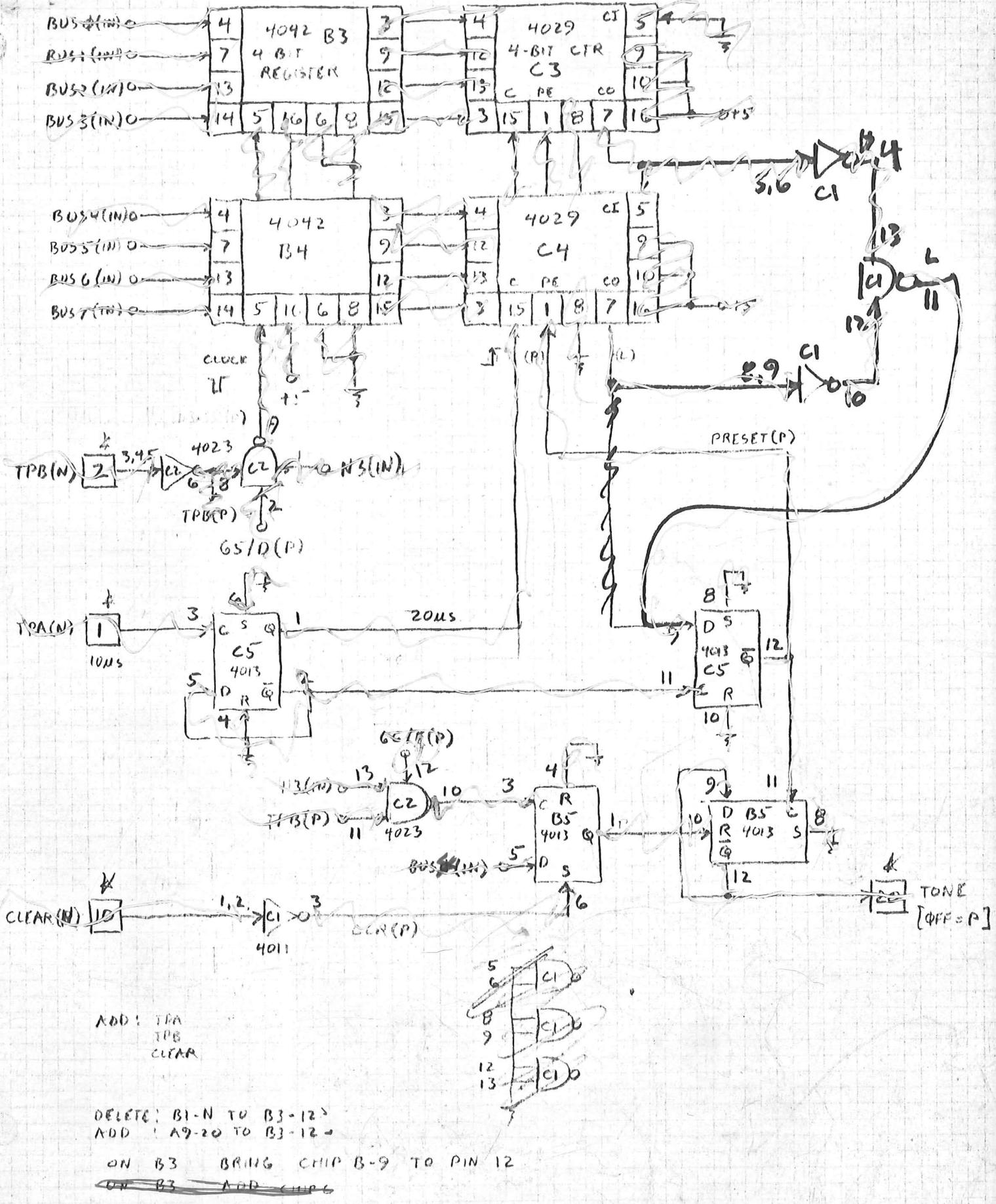
20 PIN EXTERNAL CONNECTION SOCKET

		CARD B1 PINS	<u>ADD THESE BACK PANEL WIRES</u>
1	1	FS1(N)	→ A9-A
2	2	FS2(N)	→ A9-B
3	3	FS3(N)	→ A9-C
4	4	FS4(N)	→ A9-D
5	5	PSΦ(N)	→ A9-E
6	6	PS1(N)	→ A9-F
7	7	PS2(N)	→ A9-H
8	8	PS3(N)	→ A9-J
9	Y,21	+5	
10	Z,22	GND	
A	A	BSΦ(IN)	→ A9-11
B	B	BS1(IN)	→ A9-12
C	C	BS2(IN)	→ A9-13
D	D	BS3(IN)	→ A9-14
E	E	BS4(IN)	→ A9-15
F	F	BS5(IN)	→ A9-16
H	H	BS6(IN)	→ A9-17
J	J	BS7(IN)	→ A9-18
K	K	EXT. IN(P)	→ A9-19
L	Z,22	GND	

ALSO ADD: A9-L TO A45-15 [N3(IN)]
 A9-W TO B3-10 [65/D(P)]
 A9-X TO B3-11 [66/E(P)]

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COSMAC CARD A9



COIN GAME CKTS
COSMAC CARD A9

	A	B	C	D	E	
1						
2	.4001	.4023	.4011			1
:						
3	.4016	.4023	.4023			2
4	.4016	.4042	.4029			3
5	.4016	.4013	.4013			4
6						5
21						
22						

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**INSTRUCTIONS FOR THE
RCA COSMAC COMPUTER
GAME SYSTEM**

BY

JOE WEISBECKER

JANUARY, 1975

GENERAL

This computer incorporates the RCA COSMAC LSI microprocessor and can be used in a variety of ways. It represents an advanced home computer for 1978. Most of the control switches are only used when writing new programs or developing new applications for the computer. When playing games, most of these switches can be ignored. The procedures for using the computer to play several different games is described below.

SETTING UP THE COMPUTER

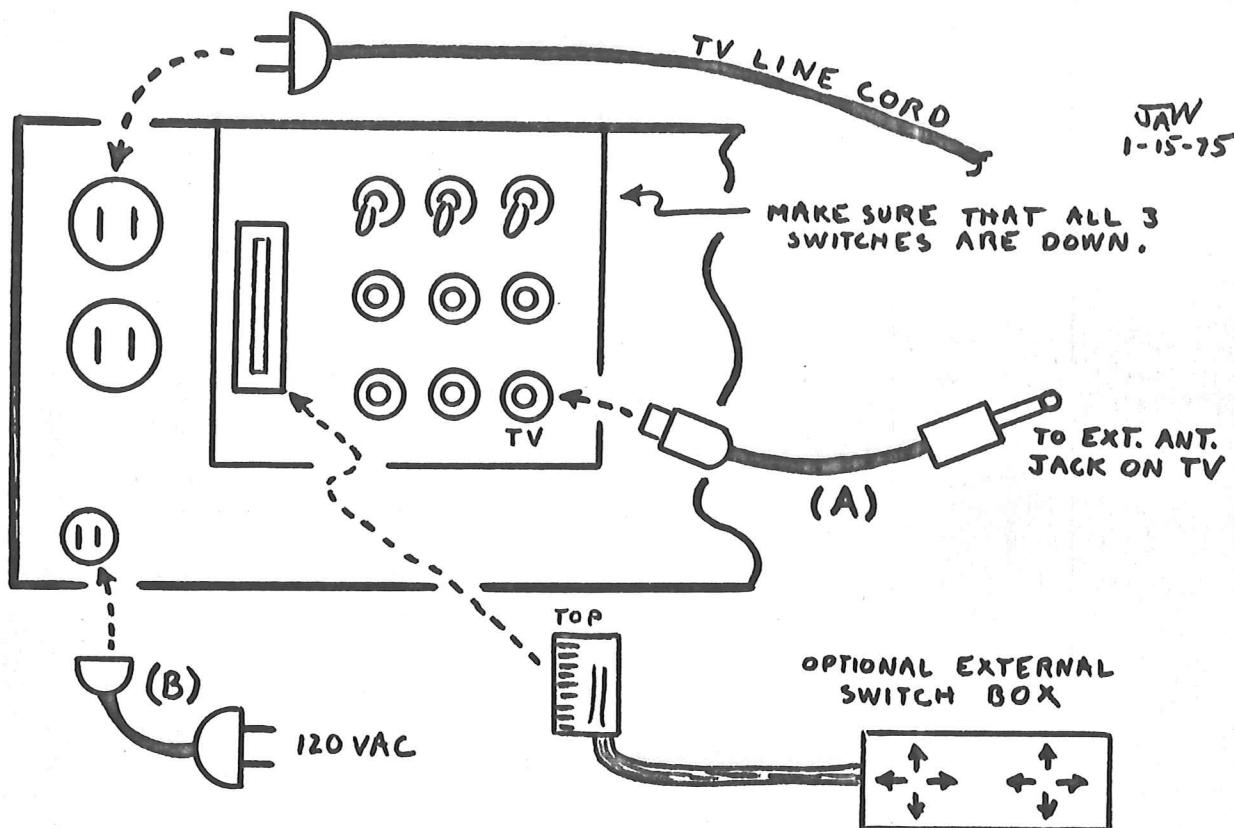


FIGURE 1 - BACK PANEL

Figure 1 illustrates how the computer is set up for use. Two special connecting cords are supplied. Use cord (A) to connect the computer to the external antenna jack of the TV. Use cord (B) to connect the computer to a 120 VAC. wall outlet. The TV set can be plugged into either of the two AC. outlets at the back of the computer. Leave the TV turned on since these outlets are controlled by the computer on-off switch. The external switch box only has to be connected for games in which it's used. Initially, leave the switch box disconnected. Make sure that all three back panel switches are in the down position. The computer is now ready for use.

LOADING PROGRAMS

Place all front panel toggle switches in the down position. Pushing the upper right hand corner switch, turns the computer on or off. Turn it on. Select the desired game cassette and put it in the cassette player. All cassette controls are labeled. REWIND the cassette. Set the yellow computer LOAD switch to the up position. Now PLAY the cassette. After several seconds, flashing display lights under the load switch will indicate that the program on the cassette is being transferred to memory. The computer will automatically stop the tape and turn off the green tape light after the cassette program has been transferred to the computer memory. Loading programs will take between 20 and 40 seconds. When the green TAPE light goes out, return the LOAD switch to its down position.

To summarize, loading a program requires the following steps:

1. All switches down
2. REWIND cassette
3. LOAD switch up
4. PLAY cassette
5. LOAD switch down (After TAPE light is off)

After the program is loaded the computer is ready to run. The loaded program remains in memory until power is turned off or a new program is loaded.

Incorrect program loading will prevent proper computer operation. If the display lights (under the load switch) don't flicker while loading then check to make sure that the cassette was properly rewound. If the red ERROR light comes on during the program load operation, rewind the cassette and repeat the load procedure. If problems persist, then the tape in the cassette may have been damaged and will have to be replaced.

For all games the TV should be tuned to channel 8 with sound turned all the way down. Adjust TV fine tuning, brightness, and contrast for best picture (black background with white dots). Make these adjustments after loading and running the Jackpot Game.

JACKPOT GAME (Programmed by Joyce Weisbecker)

Load the jackpot cassette program as described above. With LOAD down, place the green RUN switch in its up position. STOP the cassette. "\$10" should appear on the TV screen. Adjust TV for best picture.

Pushing any keyboard position (labeled 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F on front panel) will cause \$1 to be subtracted from your initial \$10. Three changing symbols will also appear on TV. Pressing any keyboard position will freeze the first symbol. Press two more times to freeze the remaining two symbols. If you freeze three different symbols you win \$2. If you freeze three identical symbols you win \$5 or \$10. After the computer shows whether you won or lost, press any keyboard position to play again. The computer shows how much money you have. If you go broke, you lose. If you accumulate \$50 you break the bank. To play a new game just flip the green RUN switch down - then up again.

SPACE WAR GAME (Programmed by C.T. Wu)

Load the space war cassette program, leave the cassette on PLAY. With LOAD down, flip RUN up. Two spots representing enemy space ships will appear on TV. The right spot is controlled by the computer. Your spot/ship is on the left. Move it up and down by pressing keyboard positions 1 or 3. Fire at computer ship by pressing 2. If you hit the computer ship 16 times first, you win. Sound effects are recorded on the cassette. Adjust the front panel VOLUME knob (next to ON button) for desired loudness. After 16 hits by either ship, flip RUN down then up to start a new game.

MATCH GAME (Programmed by A. Marcantonio)

Load the match cassette. STOP the cassette. This game is for two players (1 and 2). The object is to find matching pairs of symbols. With LOAD down, flip RUN up. Press keyboard position 1 to start game. A 4 x 4 array of symbols will flash on TV screen. The 16 keyboard positions represent symbol positions on the TV. Player 1 presses two keyboard positions trying to find two matching symbols. If he finds two that match, they are replaced by 1 on the TV. He then gets another turn. If he doesn't find two matching symbols it is player 2's turn next. Turns alternate in this fashion until all symbols have been matched. Players always get extra turns for finding matching symbols. Count 1's and 2's showing to determine winner of game. Flip RUN down then up and press 1 to start a new game. Pressing keyboard positions other than 1 to start provide different sets of starting symbols.

ACEY-DUECY (Programmed by Joe Weisbecker)

Load the Acey-Duecy program. STOP the cassette. With LOAD down flip RUN up. Two playing card values appear in the upper left corner of the TV. \$25 appears in the upper right corner. This is the money you have. The flashing question marks mean that the computer is waiting for you to place your bet. You will bet that the value of the next card dealt by the computer lies between the two card values shown (not equal to either). Bet by pressing any keyboard position (2 = \$2, 8 = \$8, A = \$10, F = \$15). You can bet a maximum of \$15 (Press F) and a minimum of \$1 (Press 1). You can't bet more than you have. You have to get \$100 to break the bank. Flip RUN down then up to play again.

SPOT SPEEDWAY (Programmed by A. Robbi)

Load the program and STOP the cassette. With LOAD down flip RUN up. You must maneuver a moving spot from the small gap in center of left edge of race course to matching gap at right edge. Pressing keyboard position 2 starts moving spot and clock. Pressing keyboard positions 6, 8, B, and D will change direction of spot (6-up, 8-left, B-down, D-right). Press C and spot will gradually decelerate. Press A and spot will gradually accelerate until you lose control. Spot starts in the accelerate mode so press C before spot speeds out of control. If spot hits an obstacle you lose. After skill is developed, players can compete for fastest times. Press 2 to restart.

DEDUCE (Programmed by Joe Weisbecker)

Load the program and STOP the cassette. With LOAD down flip RUN up. The computer will choose a 4 digit random number which you must guess within 15 turns to win. No two digits in the number are the same. Enter your first guess by pressing 4 keyboard digits. The computer than provides some clues. 0 2 means 2 of the digits you entered match two digits of the unknown number but are not in the correct position. 0 means none of your digits are in the correct position. 2 1 means you have 2 digits right and in the proper position and 1 digit right but in the wrong position. Can you develop a strategy for always guessing the number within 15 tries? Flip the RUN switch down then up to play again.

LIFE (Programmed by M. Blecker)

Load the program and STOP the cassette. With LOAD down flip RUN up. A flashing dot appears in the upper left corner of the TV screen. Press keyboard positions 1, 2, 3, and 5 to move the dot within a 32 x 32 position field (1-left, 2-up, 3-right, 5-down). Press 4 to permanently write a spot on the TV screen in the position of the flashing dot. Move the flashing dot to a permanent spot position and press 6 to erase the permanent spot from the TV screen. TV pictures can be created in this manner.

The game of LIFE has been described in Scientific American. A cell colony is represented by a group of dots on the TV screen. For example, draw an array of dots in the shape of a "T" in the center of the screen. Use 5 dots for the top and 7 down. Now press "0". The computer will now calculate a new generation of cells based on adjacency relationships of the previous generation. For example, a single cell with no neighbors will die. A cell with 3 immediate neighbors results in the birth of a new cell. New generations are shown at 30 second intervals.

This program shows how computers can be used for simulation. It is easy to change cell birth and death rules to observe long term effects over many generations of a starting cell colony.

BOWL/TAG GAME (Programmed by Joe Weisbecker)

This program requires the attachment of the optional switch box (see Fig. 1). After connecting this switch box, load the program. STOP the cassette. With LOAD down, flip RUN up. Adjust the sound VOLUME to the desired level. The computer is now simulating the type of TV game machine found in shopping centers, restaurants, school recreation rooms, etc. Normally you put in 25 cents to play. Hold down one of the small red buttons on the sides of the switch box to simulate putting your quarter in the machine. Press 1 or 2 on the A side of the switch box to select the tag game or the bowling game.

The tag game assigns moving arrows to two players who can then chase each other around the TV screen by pressing their direction switches. Catching the other players arrow before he catches you gives you one point. The game ends after several minutes and you must put in another quarter to play again.

The bowling game lets two players compete at a simple, simulated, TV bowling alley. Button 3 rolls the ball. Buttons 2 and 4 let you move the ball up or down after you've rolled. This game ends after 6 frames have been played.

CONCLUSION

There is virtually no limit to the number of different uses for this computer. A variety of additional recreational and educational programs are available and new ones are being developed. The above games represent only a small sample of what is possible. Uses other than games are discussed elsewhere.

FEL-1 (FRED II. EXPERIMENTAL LANGUAGE) - SUMMARY

ENNN	GO TO MMM	
1MMM	"DO PROGRAM AT MMM"	
026E	RETURN TO INSTRUCTION FOLLOWING LAST 1MMM	1
3XKK	SKIP NEXT INSTRUCTION IF VX ≠ KK	
5XKK	VX + KK → VX, SKIP NEXT INSTRUCTION IF VX(FINAL) = 00	
CXYΦ	SKIP NEXT INSTRUCTION IF VX ≠ VY	
2KKK		
4XKK	RR • KK → VX (RR = 8 BIT RANDOM NUMBER)	
OR → BX Y1	VX/VY → VX (CHANGES VΦ)	
AND → BX Y2	VX • VY → VX (CHANGES VΦ)	
PLUS → BX Y4	VX + VY → VX ($\Phi_1 \rightarrow V\Phi$ IF $VX+VY > FF$, $\Phi_0 \rightarrow V\Phi$ IF $VX+VY \leq FF$)	
MINUS → BX Y5	VX - VY → VX ($\Phi_1 \rightarrow V\Phi$ IF $VX > VY$, $\Phi_0 \rightarrow V\Phi$ IF $VX < VY$)	
7X3E	SHIFT VX LEFT 4 BITS	
7X41	SHIFT VX RIGHT 4 BITS	
7X52	CONVERT VX TO 3 DIGIT DECIMAL → M(A, A+1, A+2), VX, A UNCHANGED	
ANMM	MMM → A	
BMMM	MMM → B	
7X1E	M(A) → VX	
7X21	M(B) → VX	
7X24	VX → M(A)	
7X27	VX → M(B)	
7X2A	VX → LEAST SIGNIFICANT BYTE OF A	
7X30	VX → MOST SIGNIFICANT BYTE OF A	
7X34	VX → LEAST SIGNIFICANT BYTE OF B	
7X38	LEAST SIG. BYTE OF A → VX	
7X3B	MOST SIG. BYTE OF A → VX	
7F6F	A+1 → A	
EX7A	HEX KEYBD. ON, WAIT FOR BYTE → VX	
EX8Φ	HEX KEYBD. ON, BYTE READY → VX, IF BYTE NOT READY SKIPNEXT INSTR.	4
Φ268	HEX KEYBD. OFF	
9XY5	5x5 PATTERN → TV { VX = PATTERN ADDRESS IN PAGE 03 (CHANGED)	
9XY8	8x8 PATTERN → TV { VY = TV CELL # (UNCHANGED)	
Φ078	CLEAR TV DISPLAY	
Φ25C	TV ON	
Φ24Φ	TV OFF	
6ΦΦ3	START TAPE (AUDIBLE)	
6ΦΦ1	START TAPE (INAUDIBLE)	
EΦ87	SKIP NEXT INSTRUCTION IF TAPE IS RUNNING	6
6ΦΦΦ	STOP TAPE (SPEAKER OFF)	
7X48	VX DELAY (TAPE ON, SPKR OFF)	
DXYΦ	VX TONE, VY DELAY (TAPE ON, SPKR OFF)	
ΦNMM	EXECUTE M.I. PROGRAM AT MMM, P=3, D4 TO RETURN	
Φ22F	COPY VΦ-VF, A, B → ΦIEΦ-EF, FΦ-F3 (STACK)	
EΦ93	READ TAPE → M(A) CONCURRENT, PRECEDED BY TV OFF & START TAPE, TEST EF2 / RI(0) FOR END, A NOT CHANGED	8
E3AΦ	WRITE TAPE FROM M(A) TO M(06FF), PRECEDED BY TV OFF & START TAPE.	
EX9D	RI(0) → VX	
EXBD	EXT. BUS → VX	
EXBF	VX → EXT. BUS	
EX9I	VX → EXT. CONTROL REGISTER (4 BITS)	
EΦBA	SKIP NEXT INSTRUCTION IF EXT. FLAG = 1 (EF3)	

VD, VE, VF = TIMERS (DECREMENTED 60 TIMES/SEC. WHEN TV ON)
 PROGRAMS START AT 4ΦΦ. TV = 7ΦΦ-7FF

NO.

PROGRAM

DATE

PAGE

	S	P	X	M	(m)	INSTRUCTION	comments
card					6 0	1	
					2	3	
					4	5	
					6	7	
					8	9	
					A	B	
					C	D	
					E	F	
					0		
					2		
					4		
					6		
					8		
					A		
					C		
					E		
					0		
					2		
					4		
					6		
					8		
					A		
					C		
					E		
					0		
					2		
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					C		
					E		
					0		
					2		
					4		
					6		
					8		
					B		
					A		
					C		
					E		
					0		
					2		
					4		
					6		
					8		
					A		
					C		
					E		
					0		
					2		
					4		
					6		
					8		
					A		
					C		
					E		
					0		

NO.

PROGRAM PUZZLE

DATE

PAGE

S	P	X	M	(m)	INSTRUCTION	comments
card				400	0078	CLR DISP
	2				21C0	V1 = C0 (P) PAT #
	4				2200	V2 = 10 CELL #
	6				2301	V3 = 01 CNTR
	8				B600	600 → B
	A				1422	B\$L
	C				21C5	C5 → V1 (u)
	E				1422	B\$L
	410				21CA	CA → V1 (z)
	2				1422	B\$L
	4				21CA	CA → V1 (z)
	6				1422	B\$L
	8				21BC	BC → V1 (l)
	A				1422	B\$L
	C				21B5	B5 → V1 (E)
	4E				1422	B\$L
	420				F430	
	2				7134	V1 → LSB of B
	4				7121	M(B) → V1
	6				8234	V2 + V3 → V2
	8				9125	5x5 V1 PAT to V2 cell
	A				026C	LNK
	C				E47A	KIE on BYTE → V4
	E				F438	GOTO 438 (START GAME)
card	430				025C	
	2				F42C	TEMP
	4					
	6					
	8				0078	CLR DISP
	A				2700	00 → V1 TIMER
	C				21F0	F0 → V1 (0)
	E				2200	00 → V2
	40				1450	B\$L
	2				21F1	F0 → V1 (z)
	4				2201	01 → V2
	6				1450	B\$L
	B				21F1	F1 → (V1)(z)
	A				2208	08 → V2
	C				1450	
	E				F458	
card	50				7134	V1 → LSB of B
	2				7121	M(B) → I
	4				9128	8x8 PAT
	6				026E	LNK
	8				025C	
	A				21F5	
	C				220E	CELL OF
	E				1450	

JAW

PUZZLE PARTS

NO.

PROGRAM

DATE

PAGE

S	P	X	M	(m)	INSTRUCTION	comments
1					3C0	
	1				FFFF	
	2				FFFF	
	4				FF FF	
	6				FFF.F	
	8				FFFF	
2	A				FFFF	
	C				FCFB	
3	E				F OFO	
card	3D0				FFFF	
	2				FFFF	
	4				3F1F	
	6				OFOF	
	8				FO FO	
4	A				F8 FC	
	C				FFFF	
	E				FFFF	
5	3E0				OFOF	
card	2				1F3F	
	4				FFFF	
	6				FFFF	
	8				FO FO	
6	A				F8 FC	
	C				3F1F	
	E				OFOF	
7	3FO				OFDF	
card	2				1F3F	
	4				FCFB	
	6				FO FO	
	8				0000	
	A				0000	
	C				0000	
	E				0000	
	O					
	0					
	2					
	4					
	6					
	B					
	A					
	C					
	E					
	O					
	2					
	4					
	6					
	B					
	A					
	C					
	E					
	O					
	2					
	4					
	6					
	B					
	A					
	C					
	E					

ALPHA NUMERIC TABLE

NO.

PROGRAM

DATE

PAGE

	S	P	X	M	(m)	INSTRUCTION	comments
card				6B0	6B1	B2 50	@ A
				6B2	3	22 40	B C
				6B4	5	26 37	D E
				6B6	7	3B AE	F G
				6B8	9	53 A1	H I
				6BA	B	A6 86	J K
				6BC	D	99 77	L M
				6BE	F	7E 48	N O
				6CO	6C1	96 AA	P Q
				6C2	3	73 6F	R S
				6C4	5	91 56	T U
				6C6	7	8A 7A	V W
				6C8	9	82 8C	X Y
				6CA	B	9D BA	Z E
				6CC	D	C5 B6	\]
card				6CE	F	C0 60	^ -
				6DO	6D1	5F D2	SPACE !
				6D2	3	DB EO	" #
				6D4	5	EA E5	\$ %
				6D6	7	8F SD	+ '
				6D8	9	CDEF	()
				6DA	B	F4 8F	* +
				6DC	D	FA 62	/ -
				6DE	E	F9 F9	• •
				6EO	6E1	4B 10	Φ 1
				6E2	3	2E 2A	2 3
				6E4	5	19 32	4 5
				6E6	7	44 14	6 7
				6E8	9	4C 1E	8 9
				6EA	B	6A D6	: ;
card				6EC	D	C9 66	< =
				6EE	F	C7 5A	> ?
				6FO	6F1	C0 C8	□ □
				6F2	6F3	DO D8	□ □
				6F4	6F5	EO E8	□ □
				6F6	6F7	FO F8	□ BLNK
				B	9		
				A	B		
				C	D		
				E	F		
				O			
				2			
				4			
				6			
				8			
card				A			
				C			
				E			

NO.

PROGRAM

DATE

PAGE

	S	P	X	M	(m)	INSTRUCTION	comments
card						21F3	F3 → V1
			46	0		2215	15 → V2
			2			1450	B4, 4
			4			7448	DELAY ← F480 1490 KF → V4
			6			E480	
			8			1490	
			A			21F7	
			C			2205	
			E			1450	
			70			21F7	
			2			2215	
			4			1450	
			6			7448	
			8			E480	
			A			1490	
			C			F45A	
			E				
card			80				
			2				
			4				
			6				
			8				
			A				
			C				
			E				
card			90			E57A	KEN → V5
			2				V5 → LB OF B
			4				m(B) → V2
			6				
			8				
			A				
			C				
			E				
card			A0				
			2				
			4				
			6				
			B				
			A				
			C				
			E				
			O				
			2				
			4				
			6				
			8				
			A				
			C				
			E				

JAW

2

0D 07 02 03 04
08 09 0A 0C 0E

4 6

8

4 = SUB 1 from Vcell#

6 = ADD " TO "

2 = SUB 8 FROM "

8 = ADD 8 TO "

MOVE SUBROUTINE

A' KEY ON BYTE TO VY NO THEN SKP

Go to B'

BACK TO A'

B' VY → LSB OF B (TABLE address)

m(B) → VX

SKIP NXT INST IF VY ≠ 4

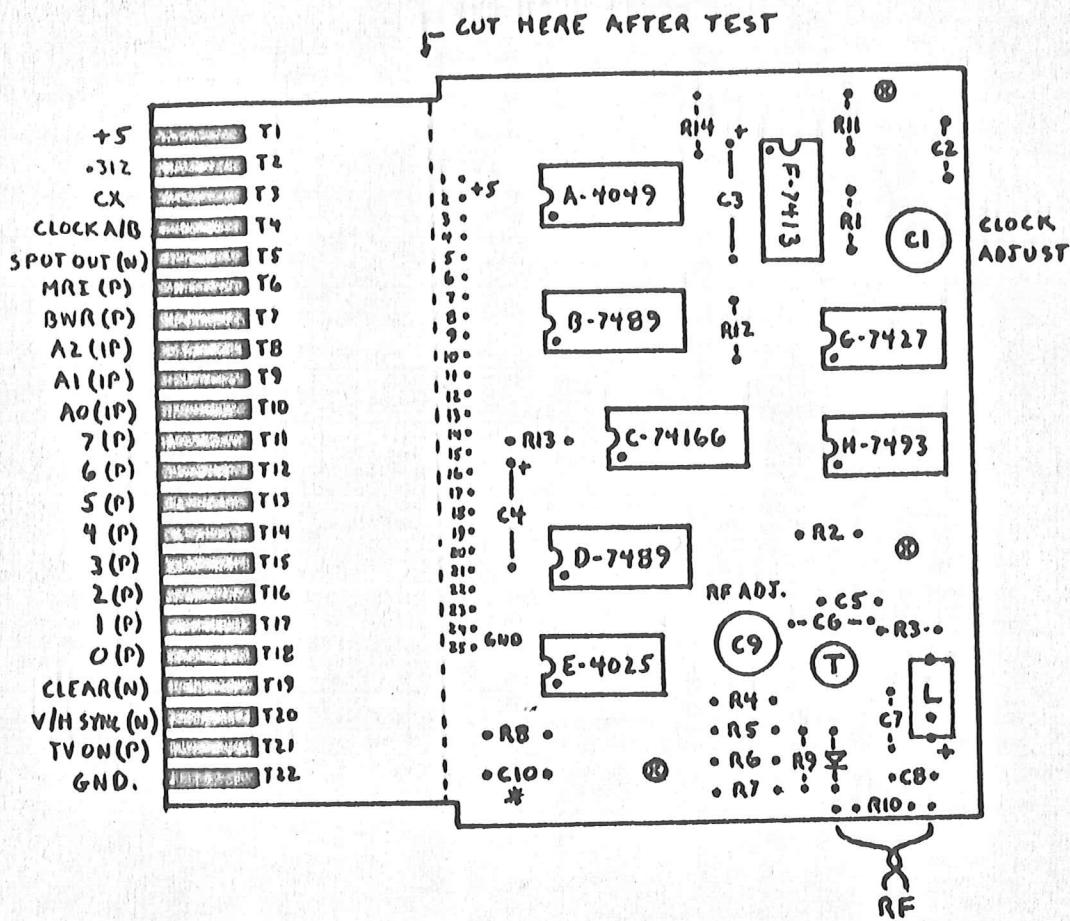
SKIP NXT INST IF VY ≠ 6

SKIP NXT INST IF VY ≠ 2

SKIP NXT INST IF VY ≠ 8

fin

FRED II TV LINE BUFFER P.C. CARD.



R1 - 320 360
 R2 - 150
 R3 - 22K
 R4 - 330
 R5 - 47K
 R6 - ~~47~~ 1K
 R7 - 10K
 RB - 47K
 R9 - ~~47~~ 1K
 R10 - 150
 R11 - 2K
 R12 - 2K
 R13 - 2K
 R14 - 2K

C1 - 15-60p\$ TRIMMER
 C2 - 550p\$
 C3 - 22μ\$
 C4 - 10μ\$
 C5 - .2μ\$
 C6 - .005μ\$
 C7 - 68p\$
 C8 - 12p\$
 C9 - 15-60p\$ TRIMMER
 C10 - OPTIONAL HORIZ. SHIFT.

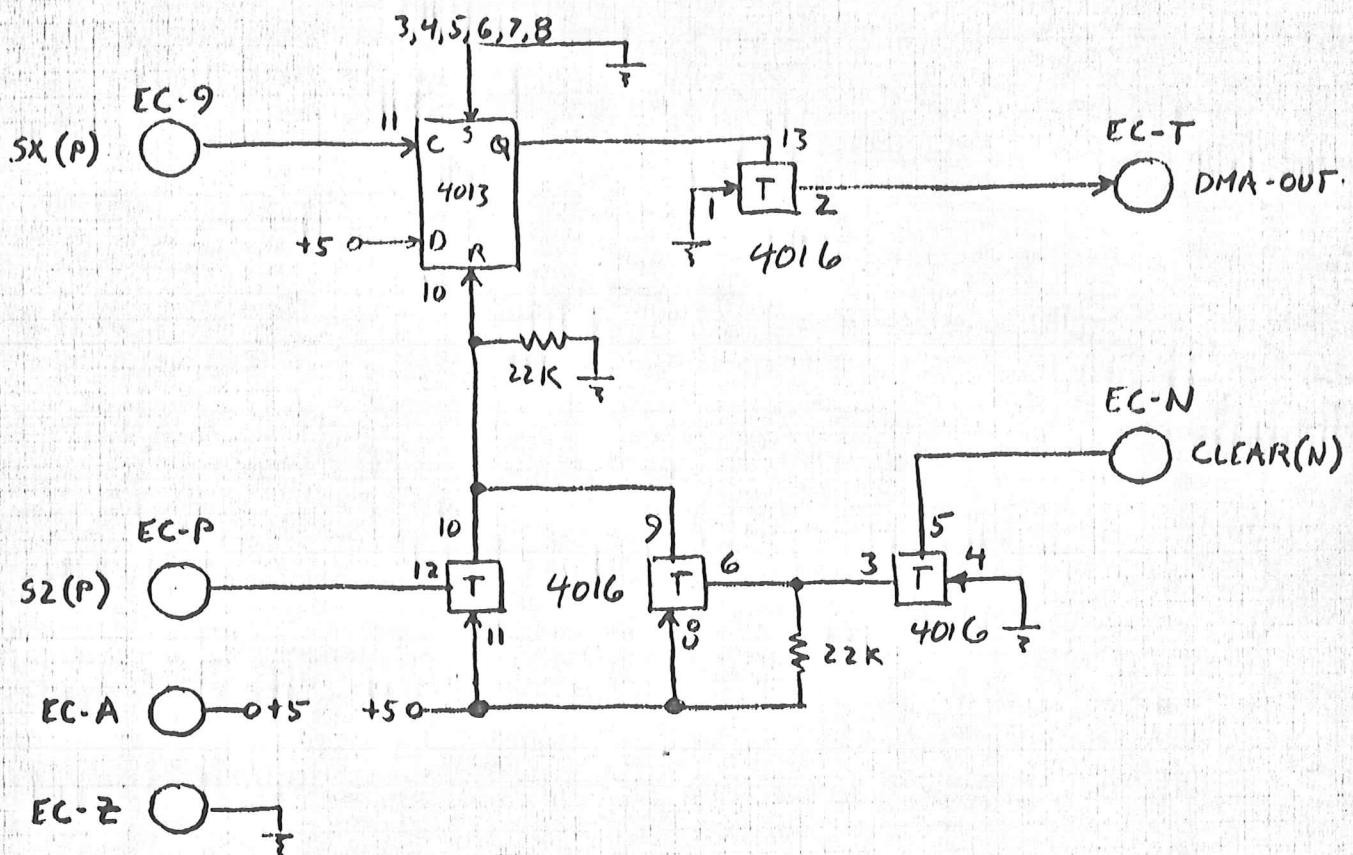
T - 2475
 L - 4.5 TURNS #20, 1/4" O.D.
 TAP 1-TURN FROM + END.

ADJUST C1 FOR V SYNC = 60Hz. (COSMAC MACHINE CYCLE = 10ms)
 ADJUST C9 FOR TV CHANNEL #4

JAW

M TEST CARD

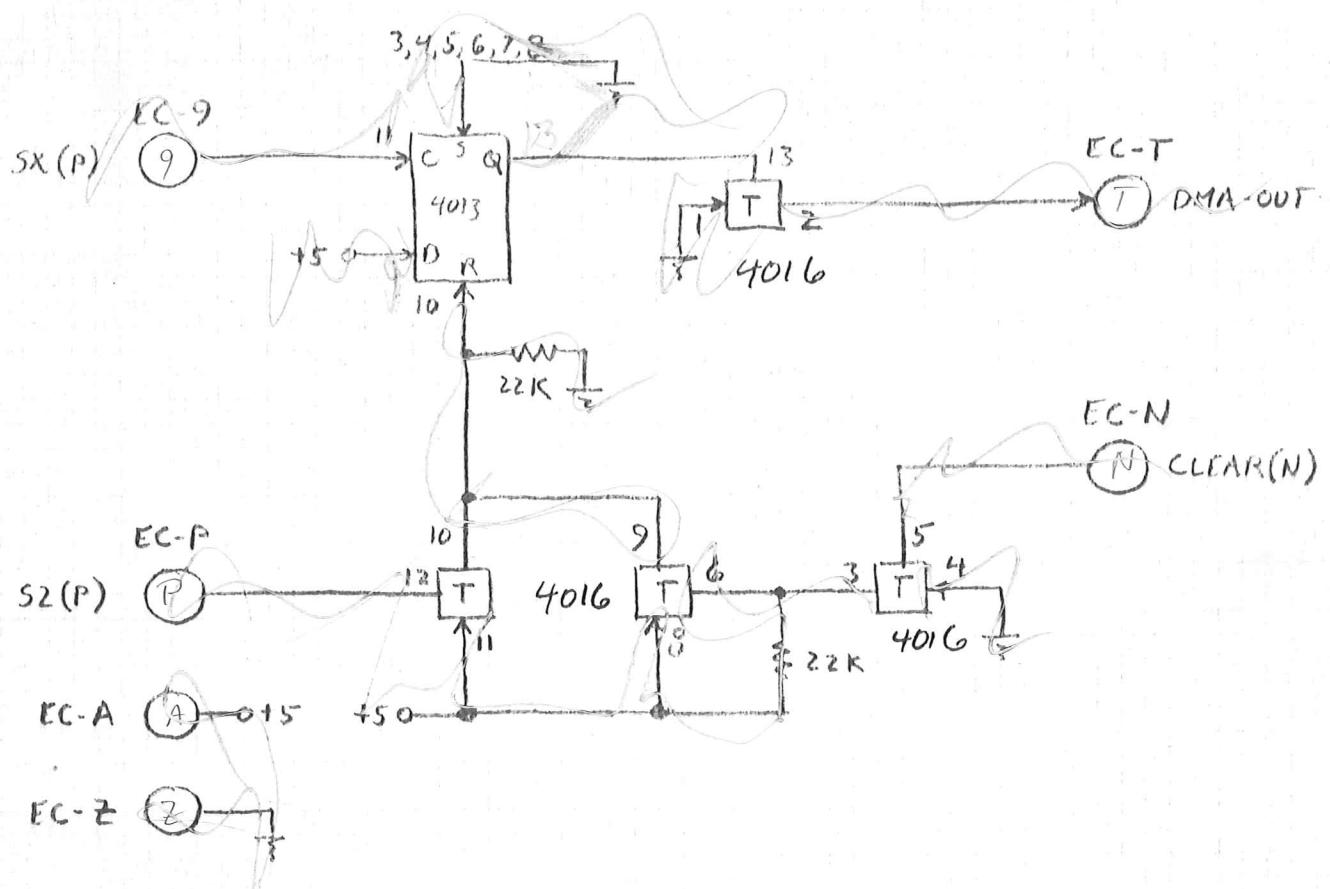
CONNECT SX(P) PAD-B → EC-9



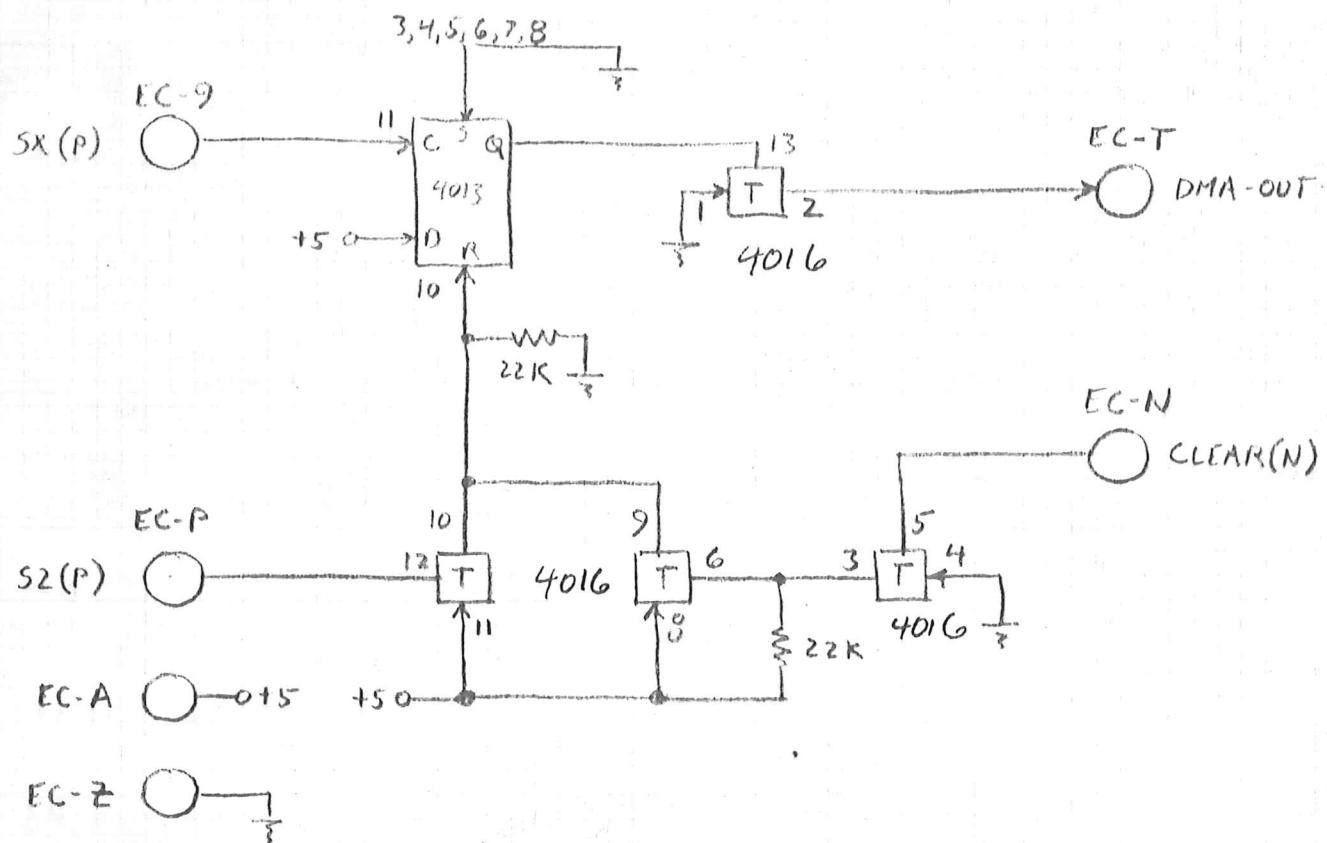
TV RUN IN WR FF T

Y X H K

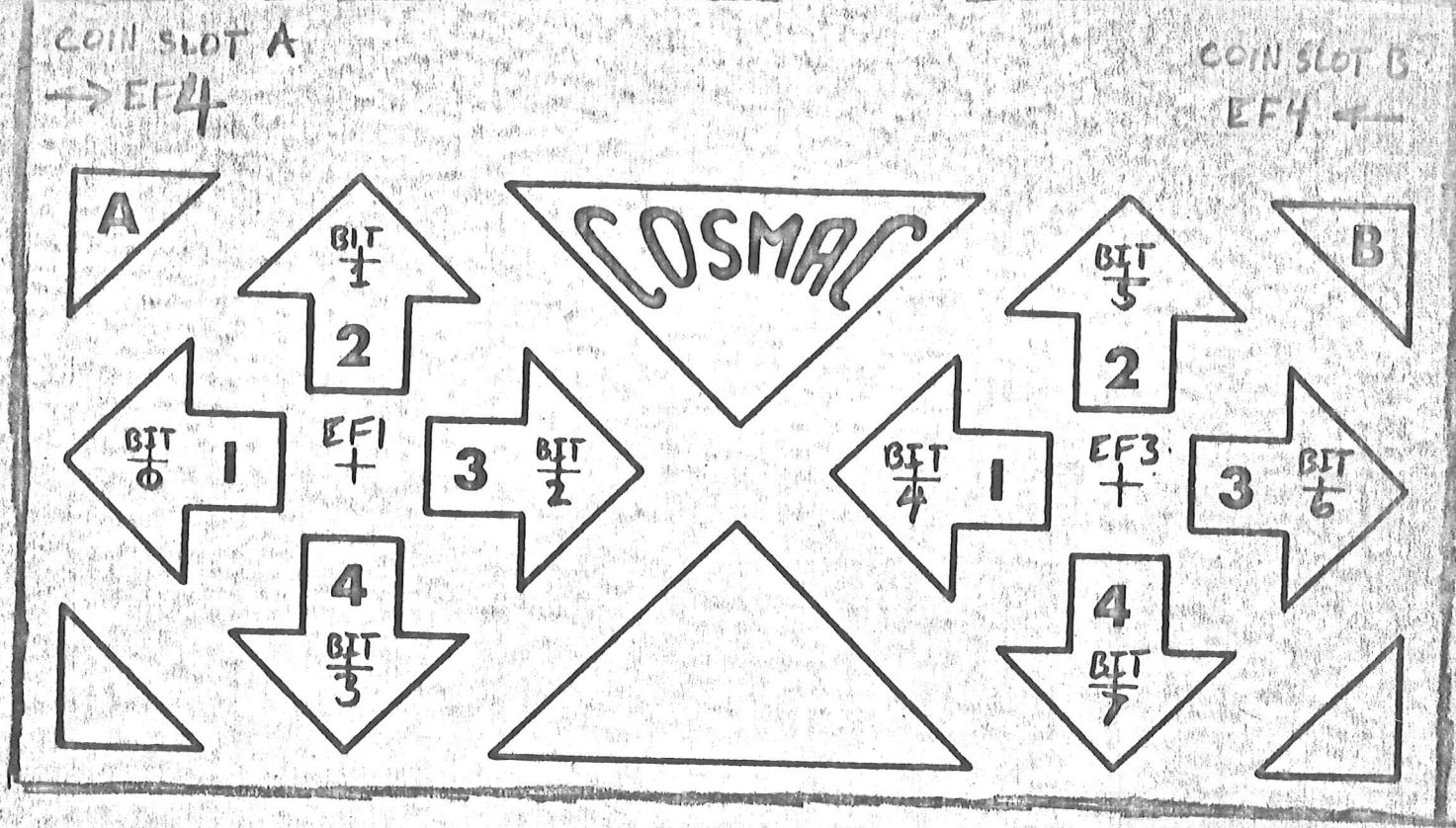
CONNECT SA(P) PNO-B → EC-9



CONNECT SX(P) P&D-B → EC-9



COSMAC COIN GAME PANEL



COSMAC COIN GAME INSTRUCTIONS

INPUT ($6E = \text{BIT } \phi-7 \text{ SWITCHES} \rightarrow M(x)$)
 $(\text{SW. PRESSED} = 1) - (x+\phi)$)

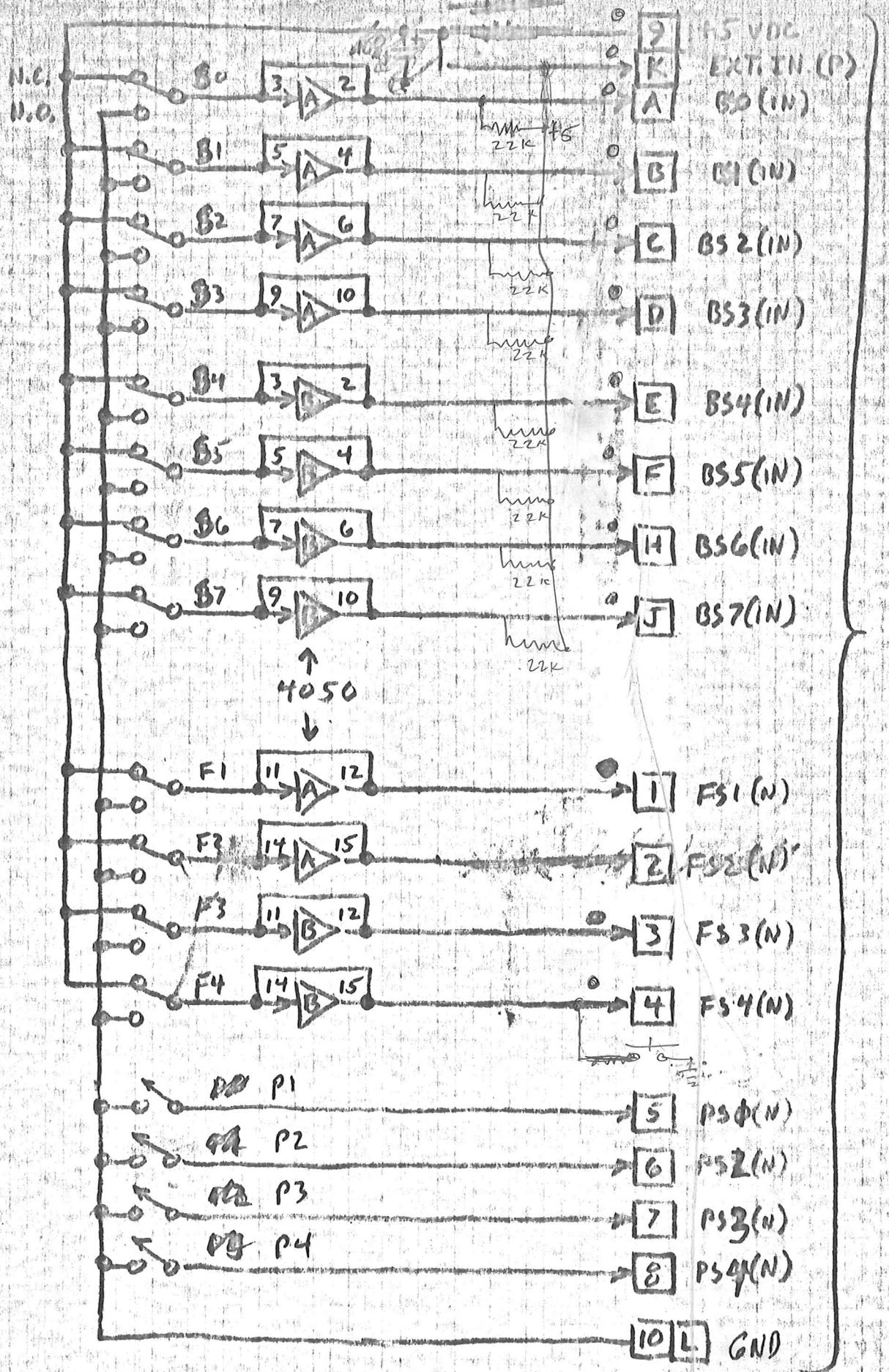
DISPLAY ($61 + M(x) = \phi 2$ SELECTS TV OUTPUT CHANNEL
 $62 + M(x) = \phi 3$ TURNS ON 32×64 DISPLAY AFTER TV SELECT)

TONE OUTPUT ($63 + M(x) = \phi 4$ SETS $EFF = 1$)
 $63 + M(x) = \phi \phi$ SETS $EFE = 0$) \Rightarrow EFF FED TO SPEAKER
 $(x+1)$ $EFE = 1$ FOR PROGRAMMED TONES
 $(x+1)$ $EFE = 0$ DISABLES PRESET TONE GENERATOR)

PRESET TONE GENERATOR ($65 + M(x) = KK$ EXTERNAL
 $(x+1)$ SETS A TONE GENERATOR FREQUENCY
 $66 + M(x) = \phi \phi$ EFF MUST = ϕ (NORMAL RESET STATE))
 $66 + M(x) = \phi \phi$ DISABLES TONE GEN.
 $(x+1)$ ENABLES TONE GEN.)

PARAMETER INPUT ($6D = \phi P$ (FROM 4 PARAMETER BIT SWITCHES) $\rightarrow M(x)$)
 $(x+\phi)$)

COSMAC COIN GAME PROJECT



PLUGS INTO 20 PIN SOCKET ON B1

JTW 11-20-74

TONE TEST

FRED 1.5

00	4Φ	—
01	9Φ	$\phi\phi \rightarrow D$
2	B3	$D \rightarrow R1(3)$
3	A3	$D \rightarrow R0(3)$
04	43	$M(3) \rightarrow D$
5	23	3-1
6	AD AD	$D \rightarrow R0(D)$
7	EΦ	$\phi \rightarrow X$
8	63	SET EEE
9	4Φ 04	—
0 A	2D	$D = 1$
B	BD BD	$R0(D) \rightarrow D$
C	3A	$D = \phi\phi?$
D	ΦA	NO
E	43	$M(3) \rightarrow D$
F	23	3-1
1 Φ	AD AD	$D \rightarrow R0(D)$
1	63	RES. EEE
2	ΦΦ	—
3	2D	$D = 1$
4	BD BD	$R0(D) \rightarrow D$
5	3A	$D = \phi\phi?$
6	13	NO
7	61	SEL. KEY
8	Φ1	PROG. → KEY
9	62	—
A	Φ1	EE1 = 1?
B	3C	NO
C	Φ4	3 → X
D	E3	68
E	68	$\phi \rightarrow X$
F	EP	GO TO
2Φ	3Φ	—
1	Φ4	—

OR DO + R(3)

$M(3) \rightarrow R1(D)$

P=4	00	—
	1 F8	$\phi\phi \rightarrow D$
GD	2 9Φ	$\phi\phi$
	3 B2	$D \rightarrow R1(2)$
	4 A2	$D \rightarrow R0(2)$
	5 F2	2 → X
	6 6E	$SW \rightarrow M(X)$
	7 3Φ	REPEAT
	8 6	—
	9 A	—
	B	—
	C	—
	D	—
	E	—
	F	—

TAPE WRITE

COSMAC - WIRING CHANGES
FOR WRITE

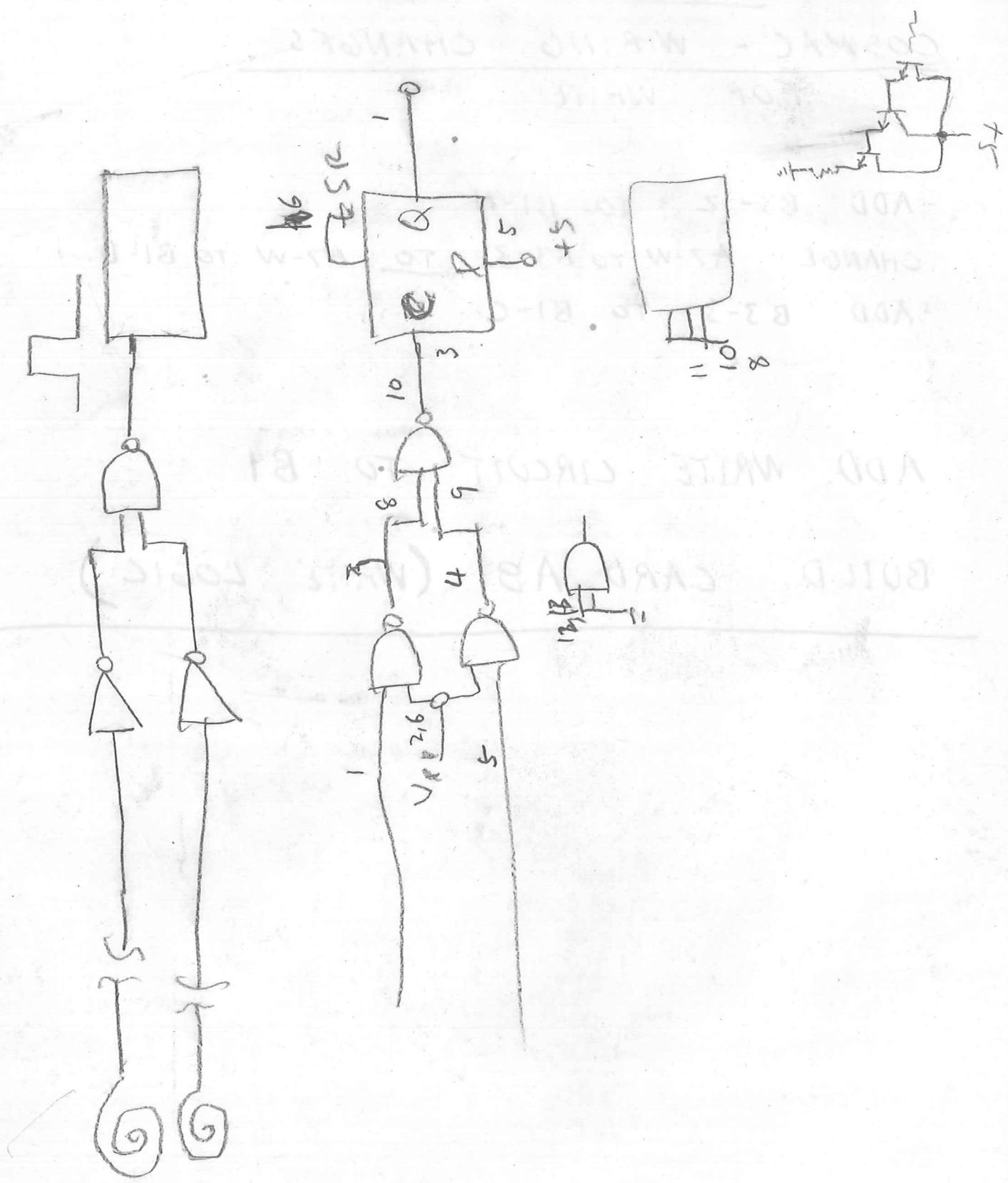
ADD B3-12 TO B1-N

CHANGE A7-W TO B3-3 TO A7-W TO B1-D.

ADD B3-3 TO B1-C.

ADD. WRITE CIRCUIT TO B1

BUILD CARD A8 (WRITE LOGIC.)



CUT THESE PCS FROM $\frac{1}{4}$ " PLEX SUPPLIED

QUAN

ALL DIM IN INCHES

1 - $9\frac{3}{4} \times 5\frac{7}{16}$

1 - $3\frac{13}{16} \times 5\frac{7}{16}$

1 - $6\frac{5}{8} \times 5\frac{7}{16}$

1 - $3\frac{13}{16} \times 5\frac{7}{16}$

2 - $6\frac{9}{16} \times 1$

1 - $6\frac{7}{8} \times \frac{5}{8}$

1 - $6\frac{5}{8} \times \frac{5}{8}$

1 - $7\frac{1}{8} \times \frac{5}{8}$

1 - $6\frac{3}{16} \times \frac{3}{8}$

THESE FROM $\frac{3}{16}$ " PLEX

1 - $14 \times 9\frac{3}{4}$

1 - $5\frac{5}{8} \times 9\frac{3}{4}$

1 - $7\frac{1}{8} \times 3\frac{1}{4}$

1 - $3 \times 3\frac{1}{4}$

2 - $5\frac{7}{16} \times \frac{3}{8}$

THESE FROM $\frac{1}{8}$ " PLEX

1 - $14\frac{3}{8} \times 9\frac{3}{4}$

1 - $7\frac{7}{16} \times 5\frac{3}{4}$

2 - $7\frac{1}{8} \times 5\frac{7}{16}$

1 - $6\frac{5}{16} \times 5\frac{3}{4}$

1 - $1\frac{25}{32} \times 5\frac{7}{16}$

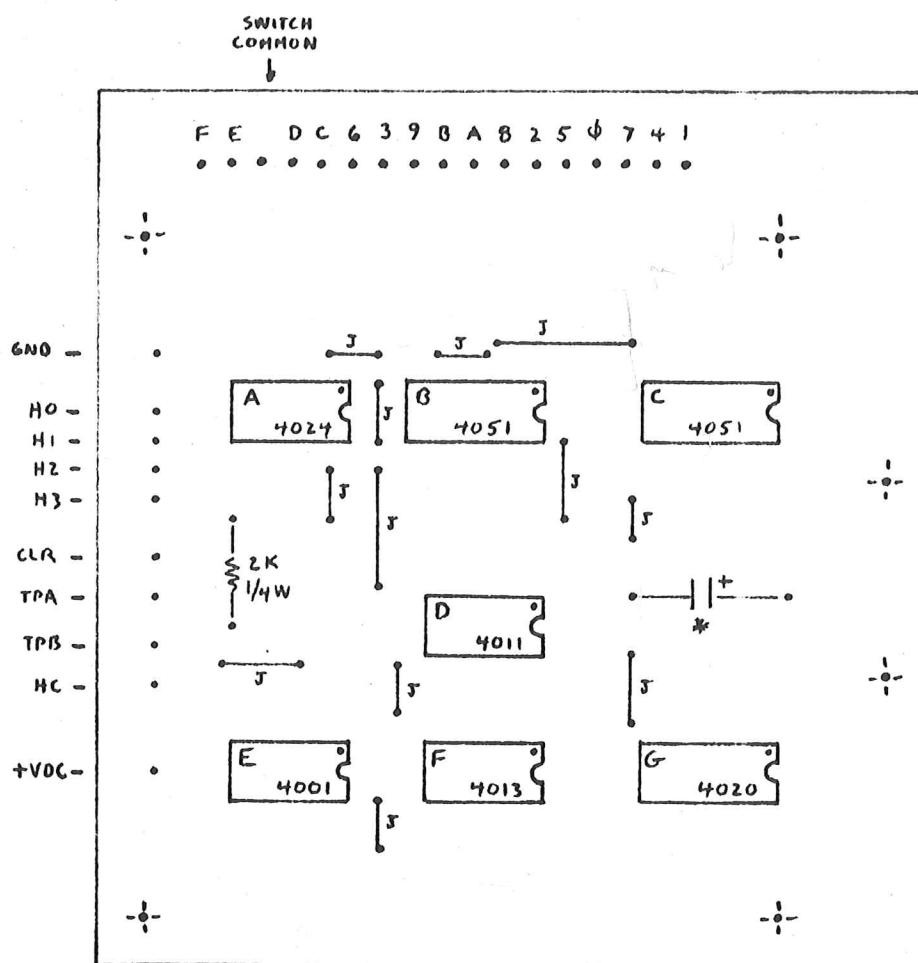
1 - $6\frac{9}{16} \times 5\frac{3}{16}$

2 - $1\frac{1}{2} \times 5\frac{7}{16}$

1 - $4\frac{7}{16} \times 3\frac{3}{8}$

1 - $\frac{3}{8} \times 5\frac{7}{16}$

7 - $\frac{5}{32} \times 5\frac{7}{16}$



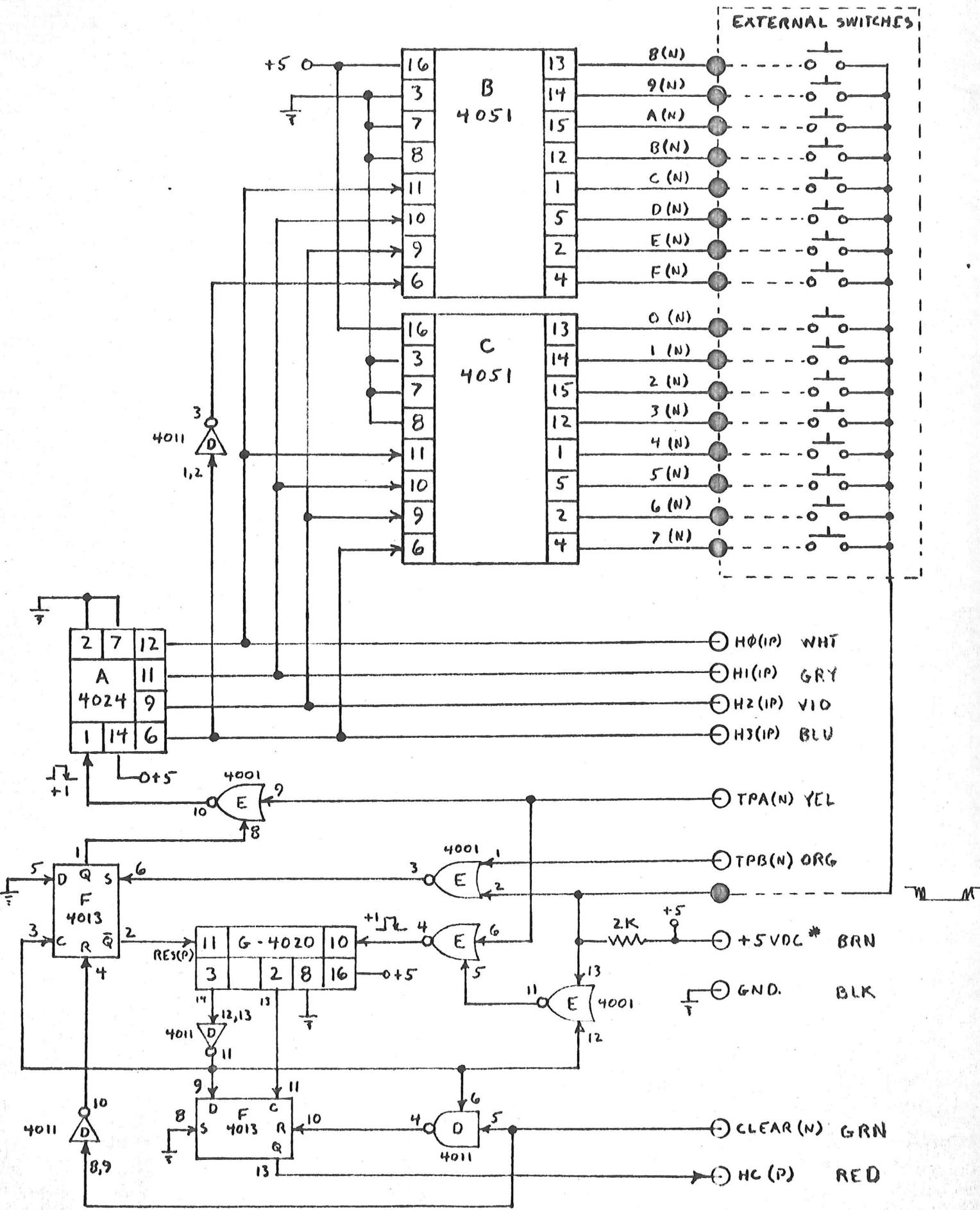
HEX KEYBOARD DECODE AND DEBOUNCE

COMPONENT SIDE

* OPTIONAL FILTER CAP.

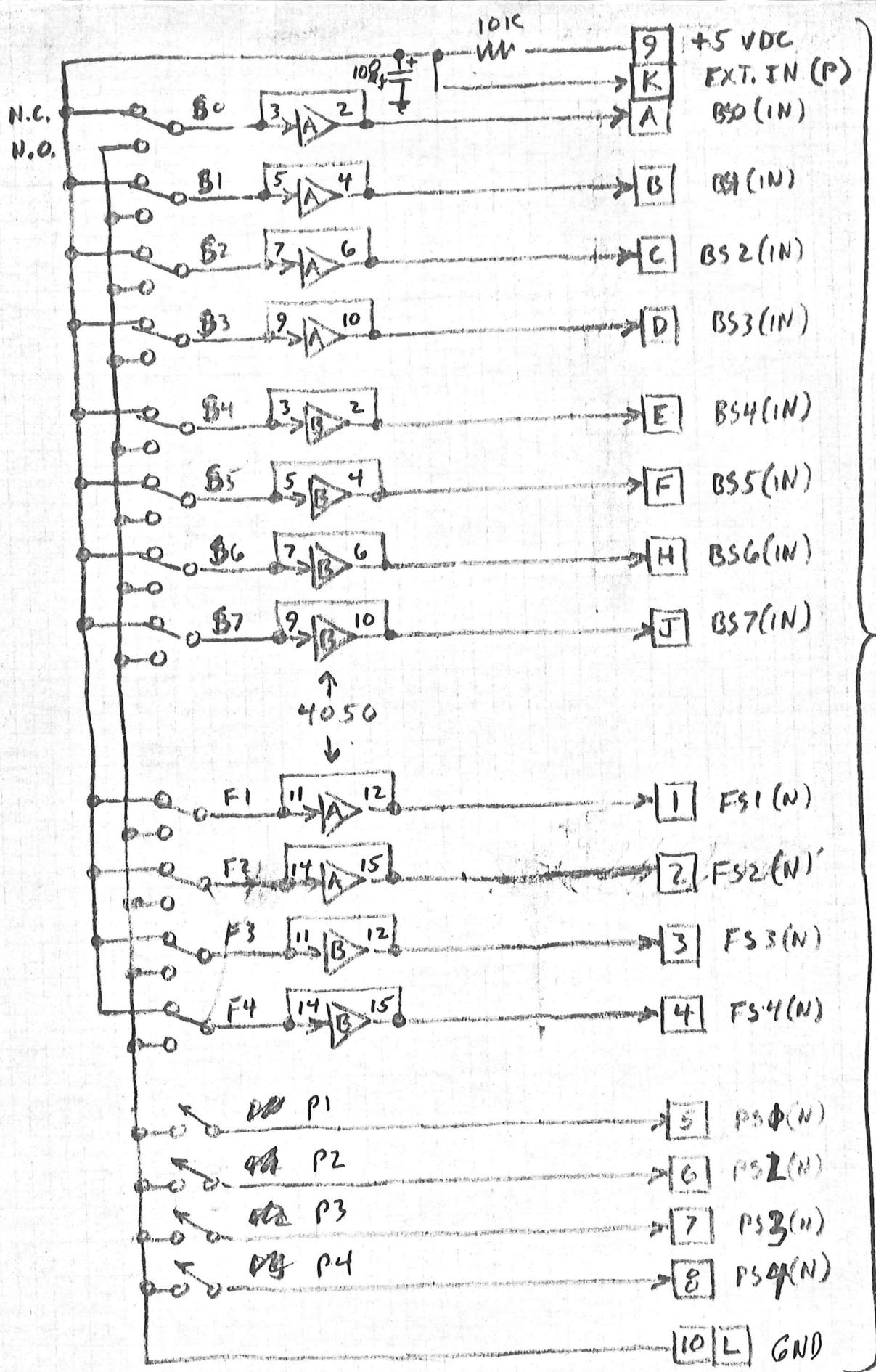
JAW 8-1-74

FRED-II HEX SWITCH DECODE & DEBOUNCE CARD



JW B-1-74

PLUGS INTO 20 PIN SOCKET ON B1

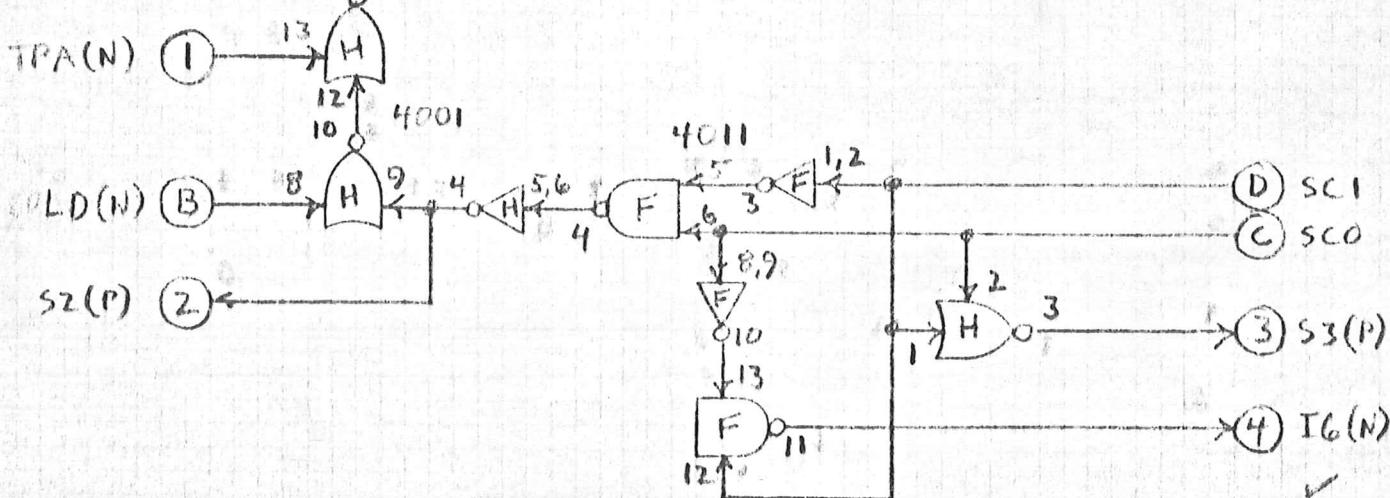
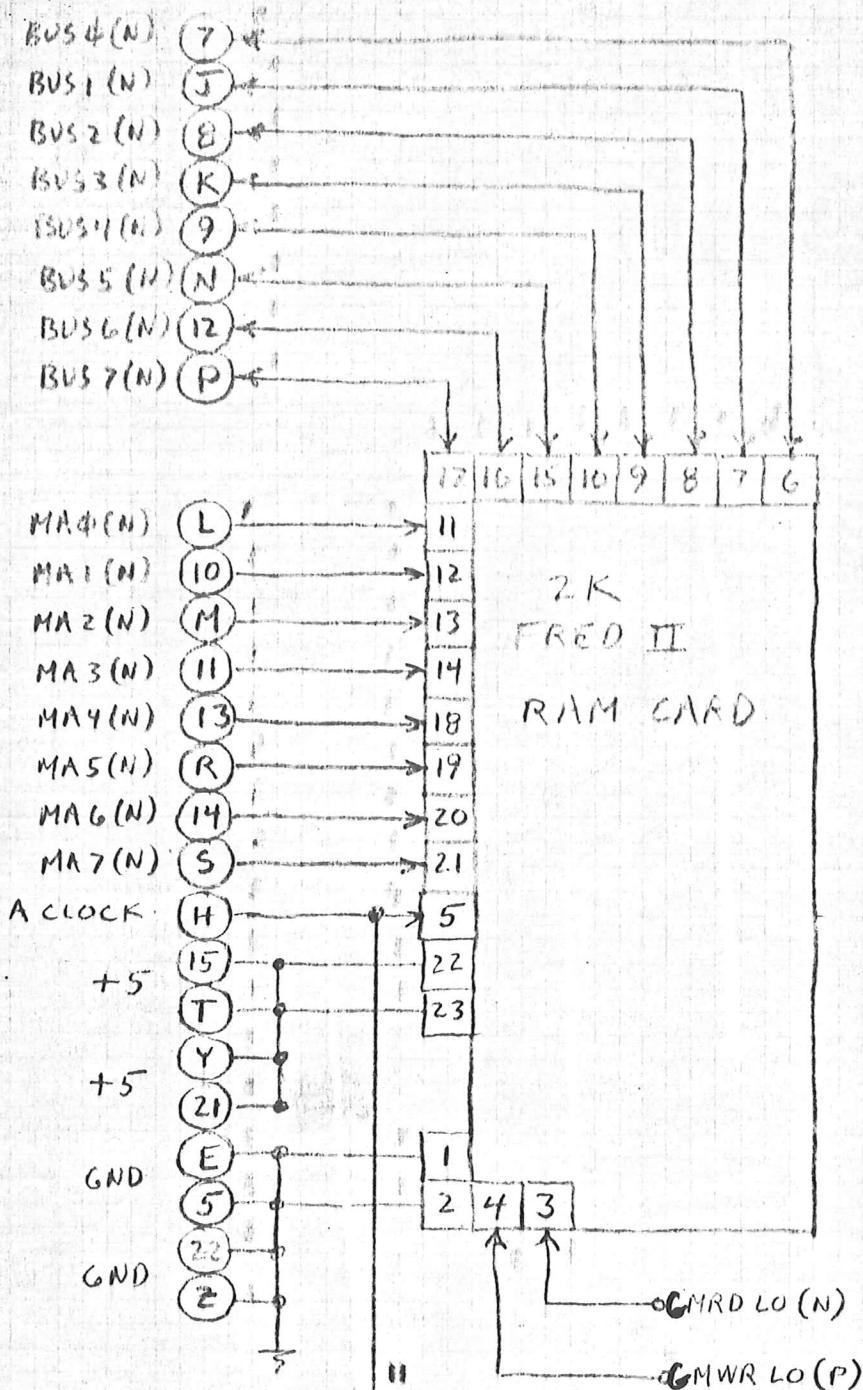


JAW 11-20-74

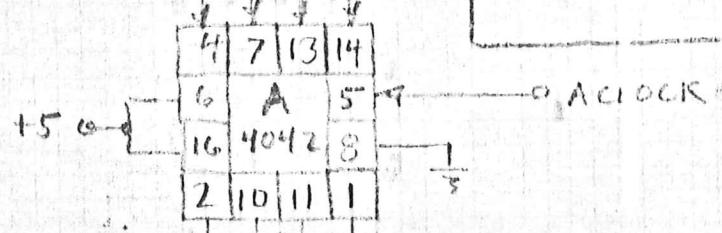
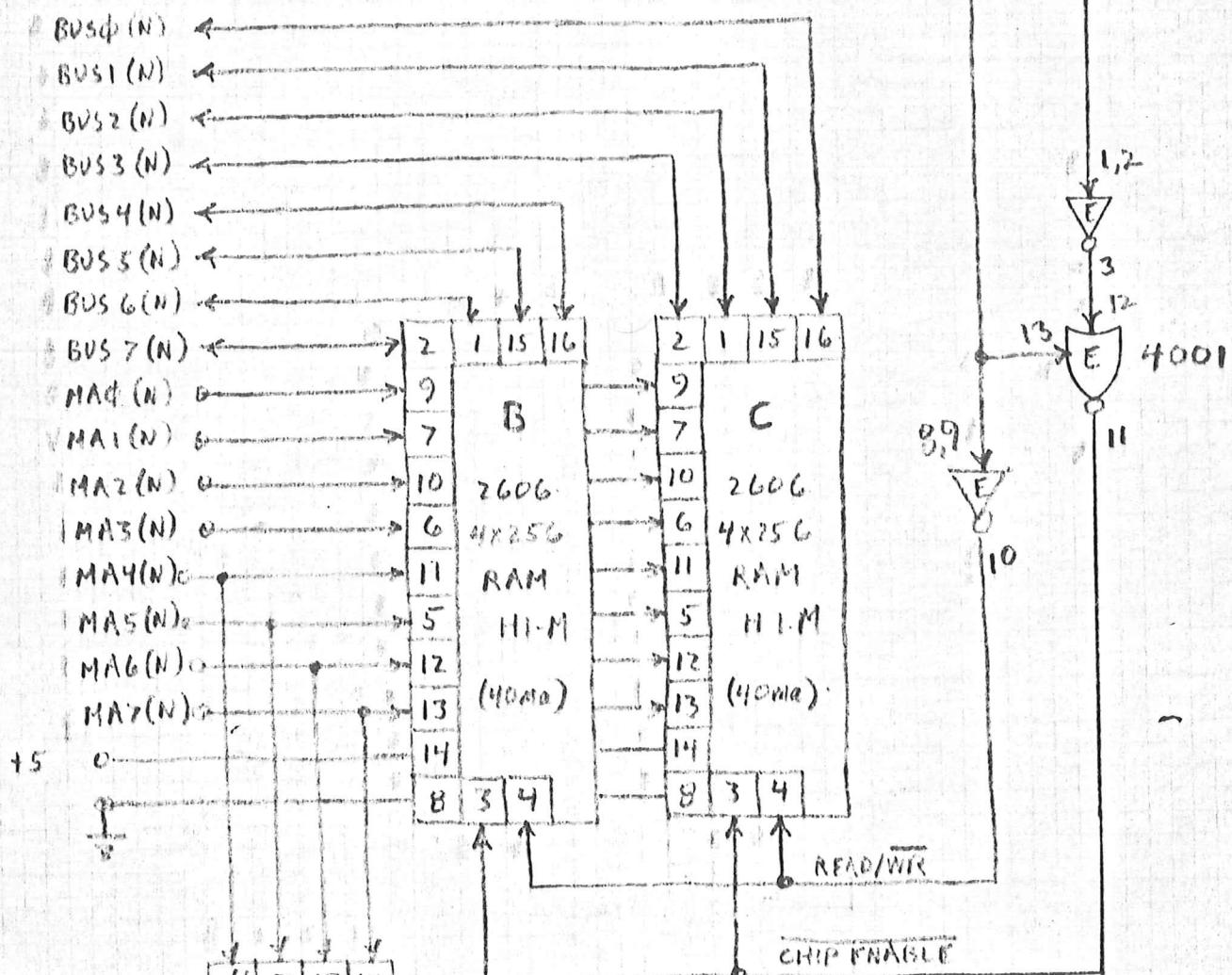
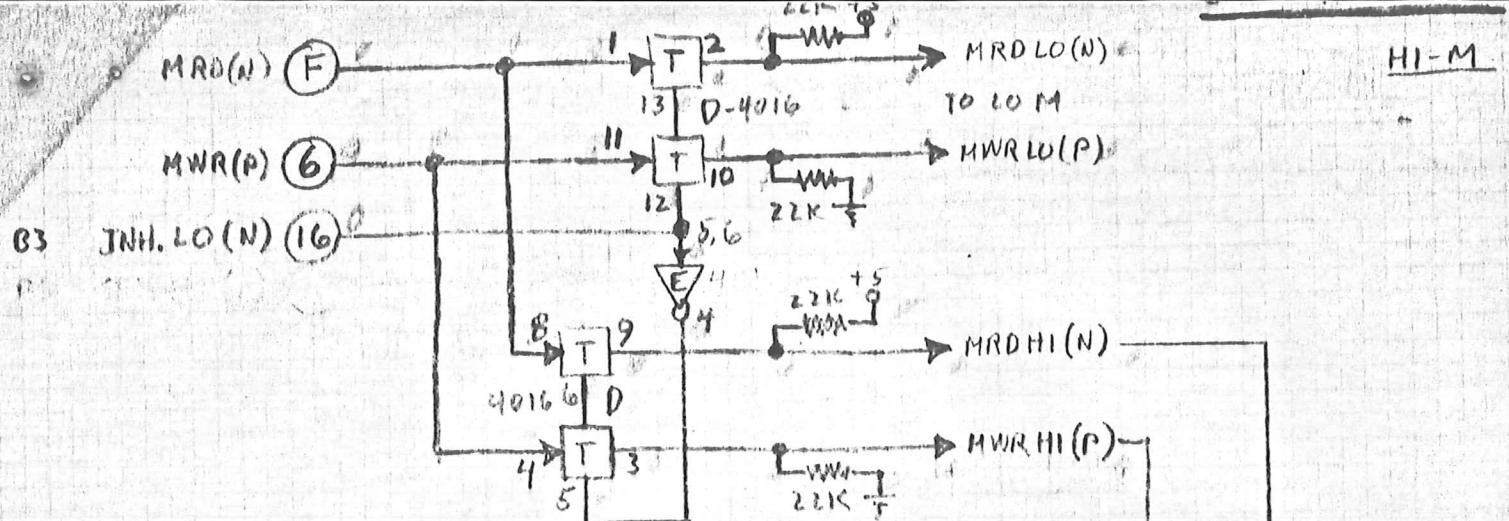
CARD A12 - RAM.

LO + M.

A 1	TPA(N)
LD(N)	B 2 S2(P)
SCO	C 3 S3(P)
BC 1	D 4 I6(N)
GND	E 5 GND
MRD(N)	F 6 MWR(P)
A CLOCK	H 7 BUS 4(N)
BUS 1(N)	J 8 BUS 2(N)
BUS 3(N)	K 9 BUS 4(N)
MAΦ(N)	L 10 MA1(N)
MA2(N)	M 11 MA3(N)
BUSS(N)	N 12 BUSS(N)
BUSS(N)	P 13 MA4(N)
MAS(N)	R 14 MA6(N)
MA7(N)	S 15 MA7(N)
+5	T 16 JNH LD(N)
	U 17 A4 (IN)
	V 18 A5 (IN)
	W 19 AG (IN)
	X 20 AT (IN)
+5	Y 21 +5 (IN)
GND	Z 22 GND



JAW 11-1-74 ✓

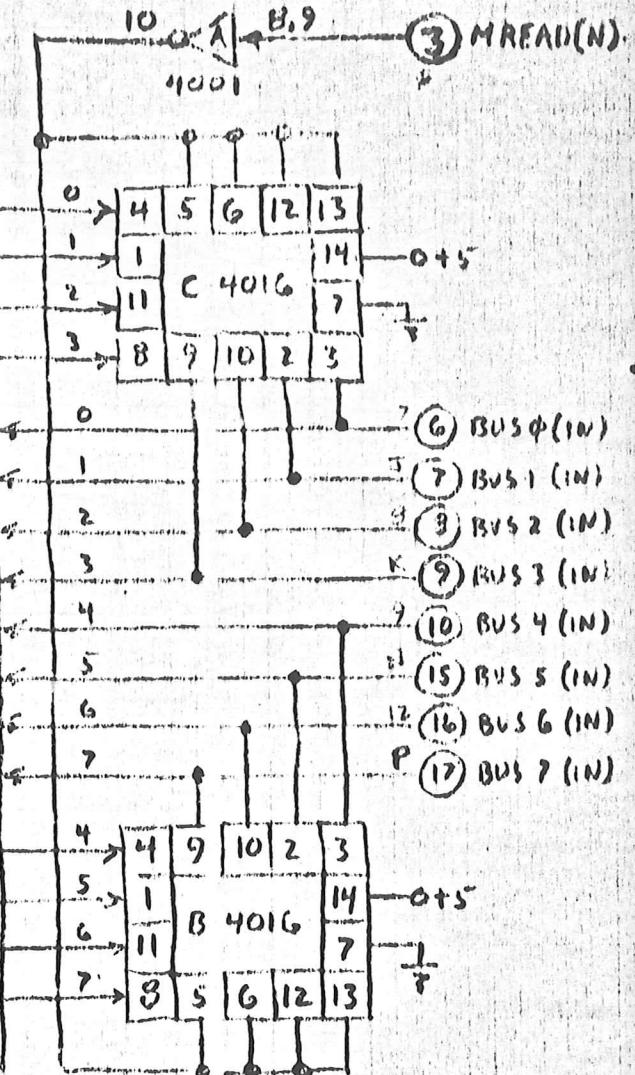
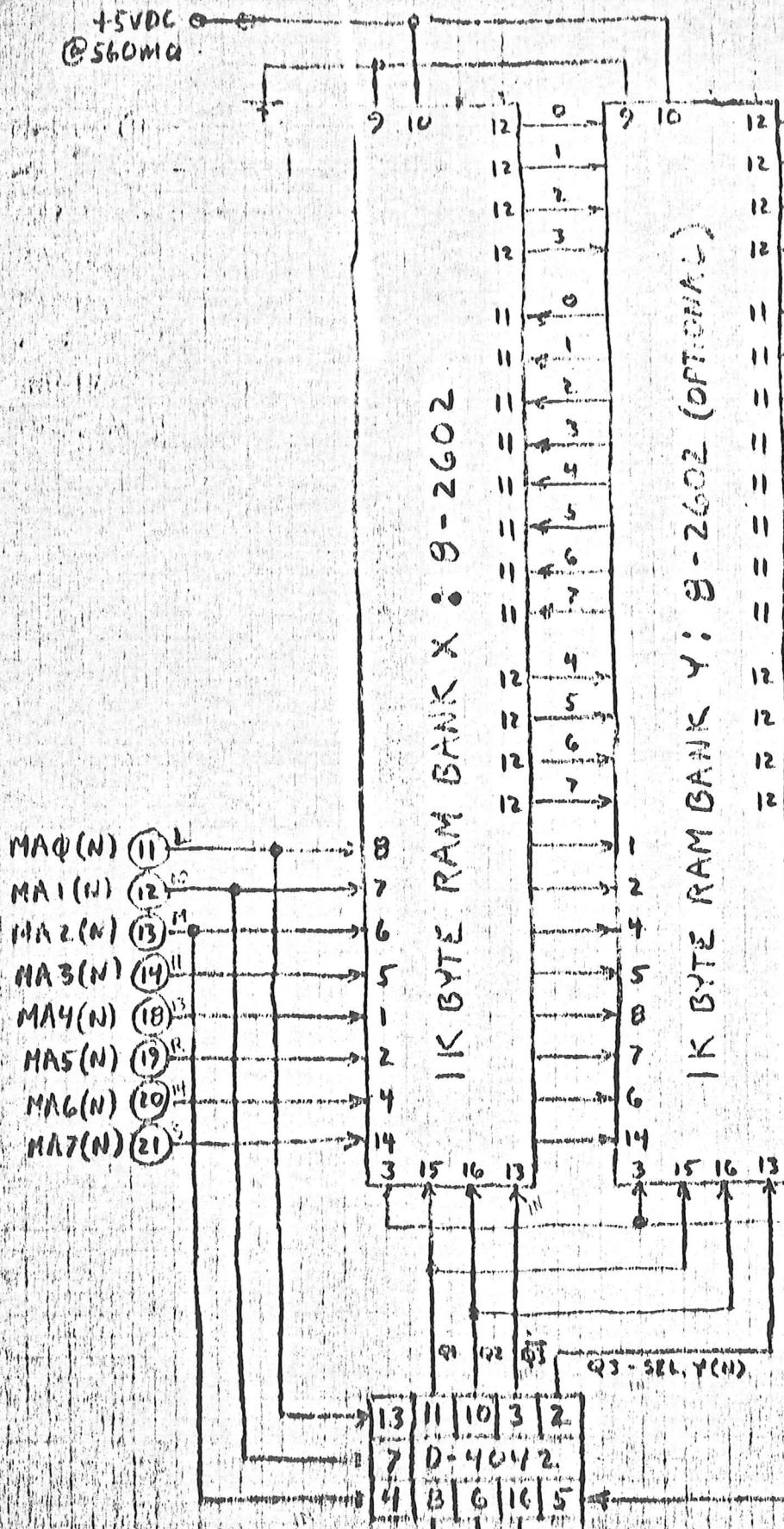


(m) (m) (m) (m)) B3

JAW 11-1-74 ✓

FRED II - ZIE R.A.M. P.C. CARD

+5VDC @ 560mA



+5.0 - 15 T +5VDC

(1) (2) GROUND

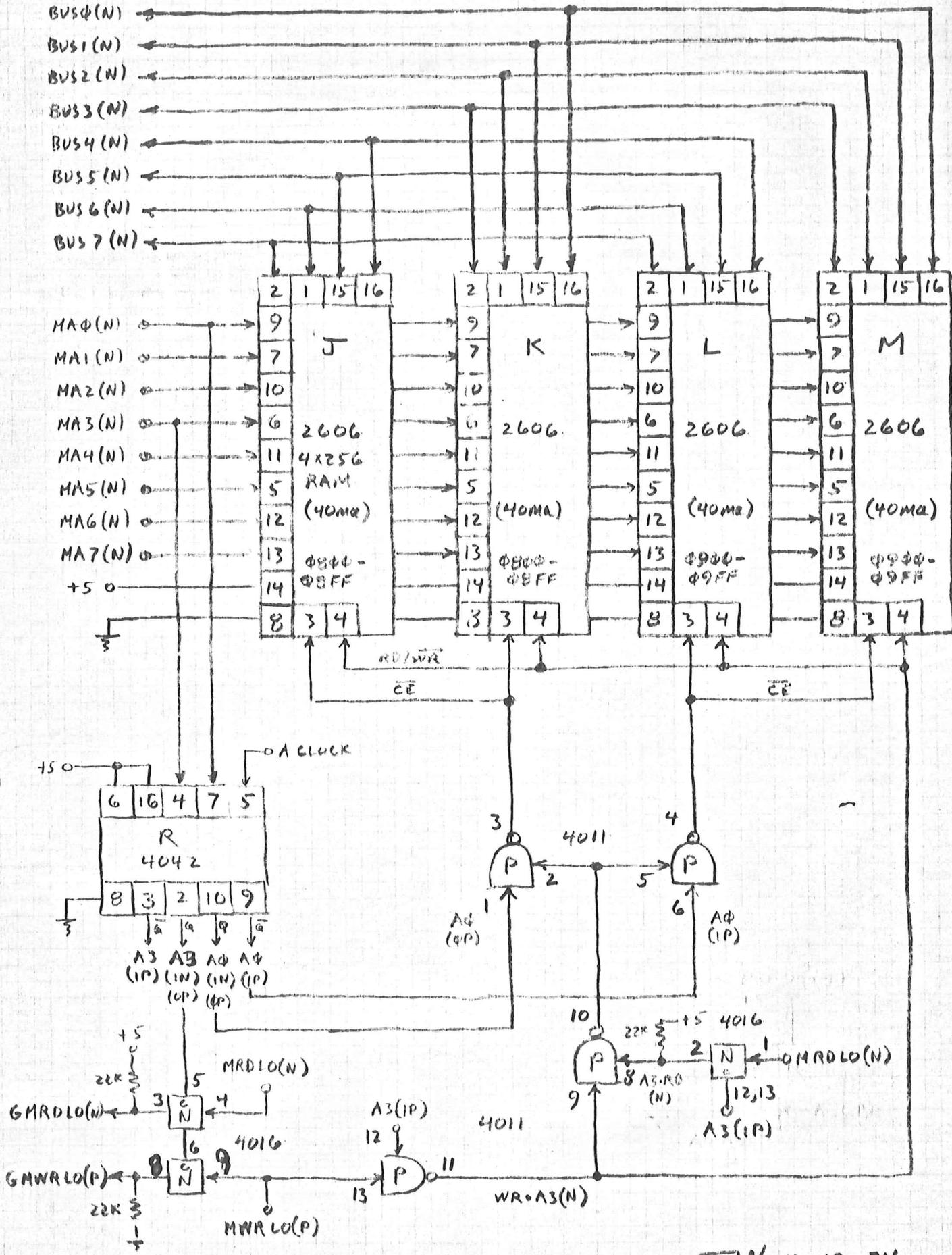
3,4,11 1,2,5,6,12,13

(11) MWR(A)

⑤ A CLOCK

CARD A12-RAM.

512 BYTES @ $\Phi B00 \rightarrow \Phi DFF$



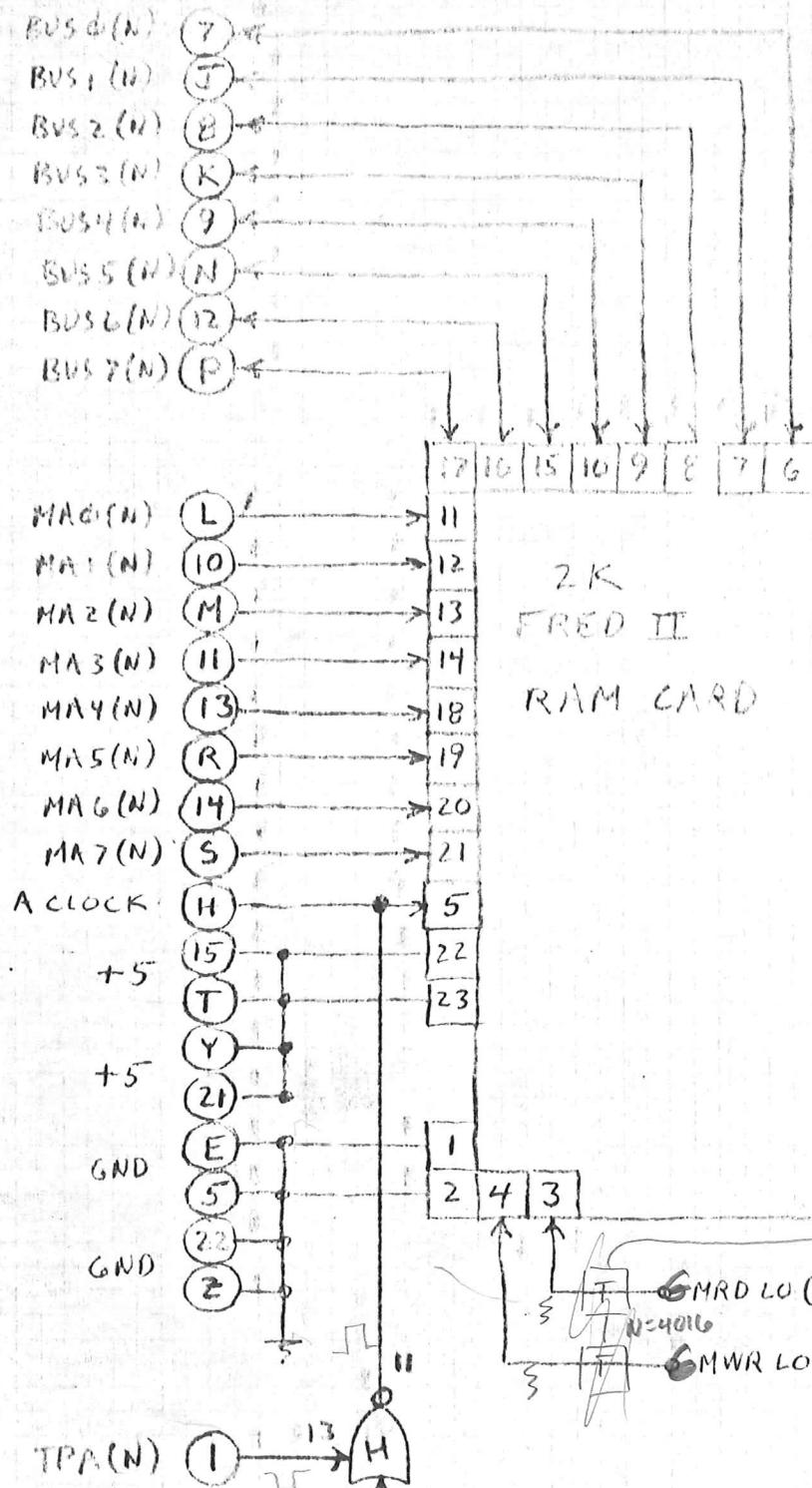
JAW 12-12-74

CARD A12 - COMPONENT SIDE.

2	H	F 4011	R 4042	
	4001	(S)	N 4016	P 4011
			L 2606	M 2606
			J 2606	K 2606
22	A 4042	B 2606	C 2606	D 4016
				E 4001

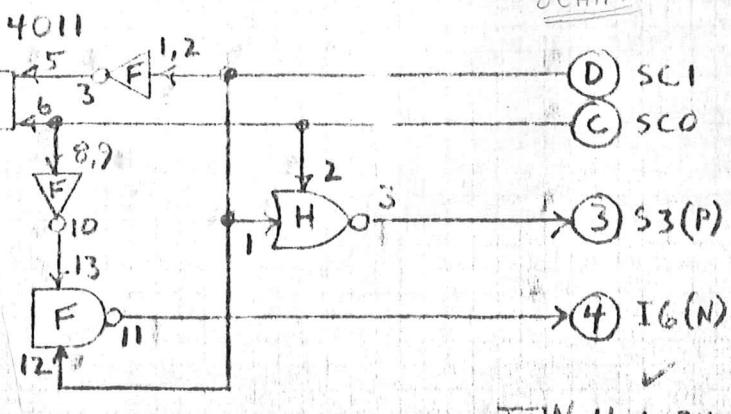
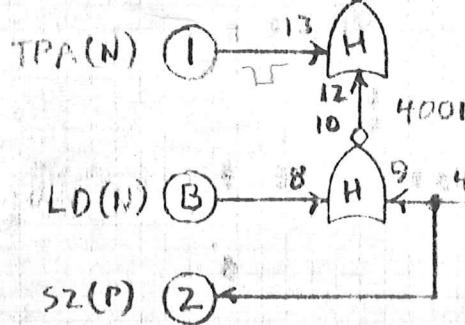
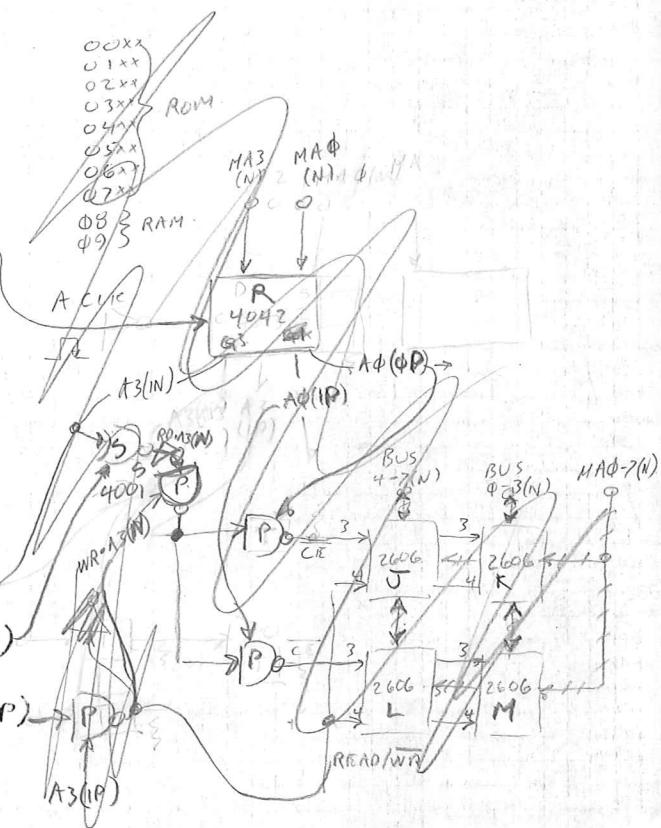
CARD A12 - RAM

LO-M



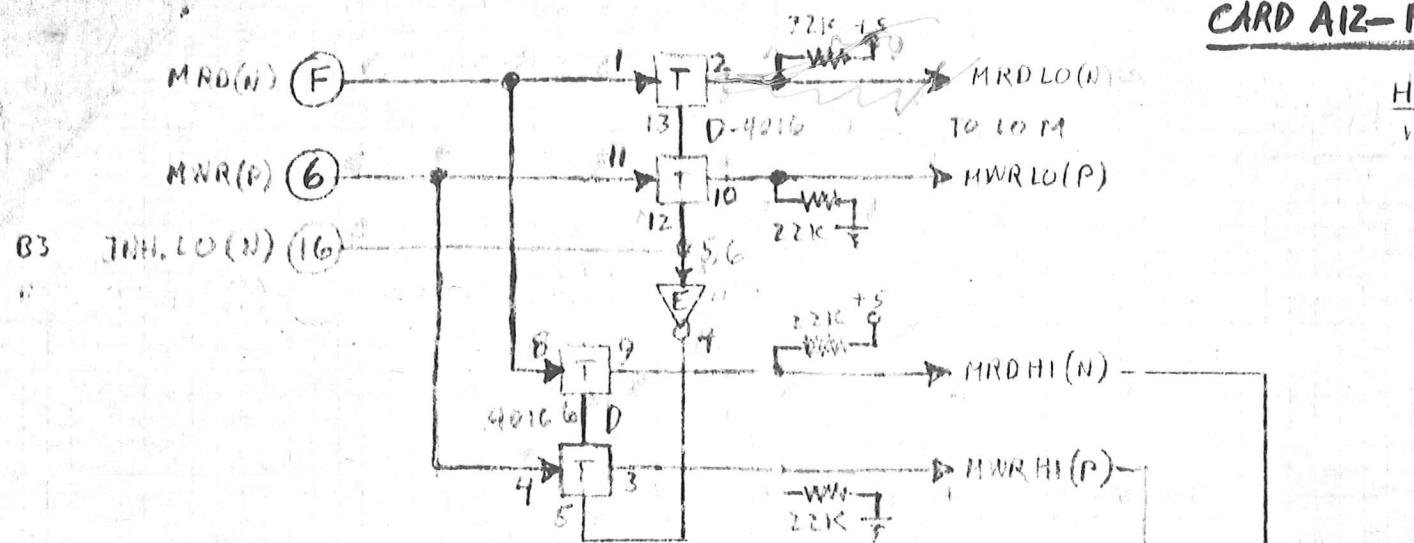
2 K
FRED II
RAM CARD

LD(N)	A 1	TPA(N)
S2(P)	B 2	S2(P)
SCO	C 3	S3(P)
SCI	D 4	I6(N)
GND	E 5	GND
MRD(N)	F 6	MWR(P)
ACLC(L)	H 7	BUS 1(N)
BUS 1(N)	J 8	BUS 2(N)
BUS 3(N)	K 9	BUS 4(N)
MA0(N)	L 10	MA1(N)
MA2(N)	P 11	MA3(N)
BUS 5(N)	N 12	BUS 6(N)
BUS 7(N)	P 13	MA4(N)
MA5(N)	R 14	MA5(N)
MA6(N)	S 15	+5
MA7(N)	T 16	IN11 LO(N)
	U 17	A4 (IN)
	V 18	A5 (IN)
	W 19	A6 (IN)
	X 20	A7 (IN)
	Y 21	+5 (IN)
	Z 22	GND



JAW 11-1-74

CARD A12-RAM



BVS0(N)

BVS1(N)

BVS2(N)

BVS3(N)

BVS4(N)

BVS5(N)

BUS 6(N)

BUS 7(N)

MA1(N)

MA1(N)

MA2(N)

MA3(N)

MA4(N)

MA5(N)

MA6(N)

MA7(N)

+5

0

8

10

12

13

14

16

18

20

22

24

26

28

30

32

34

36

38

40

42

44

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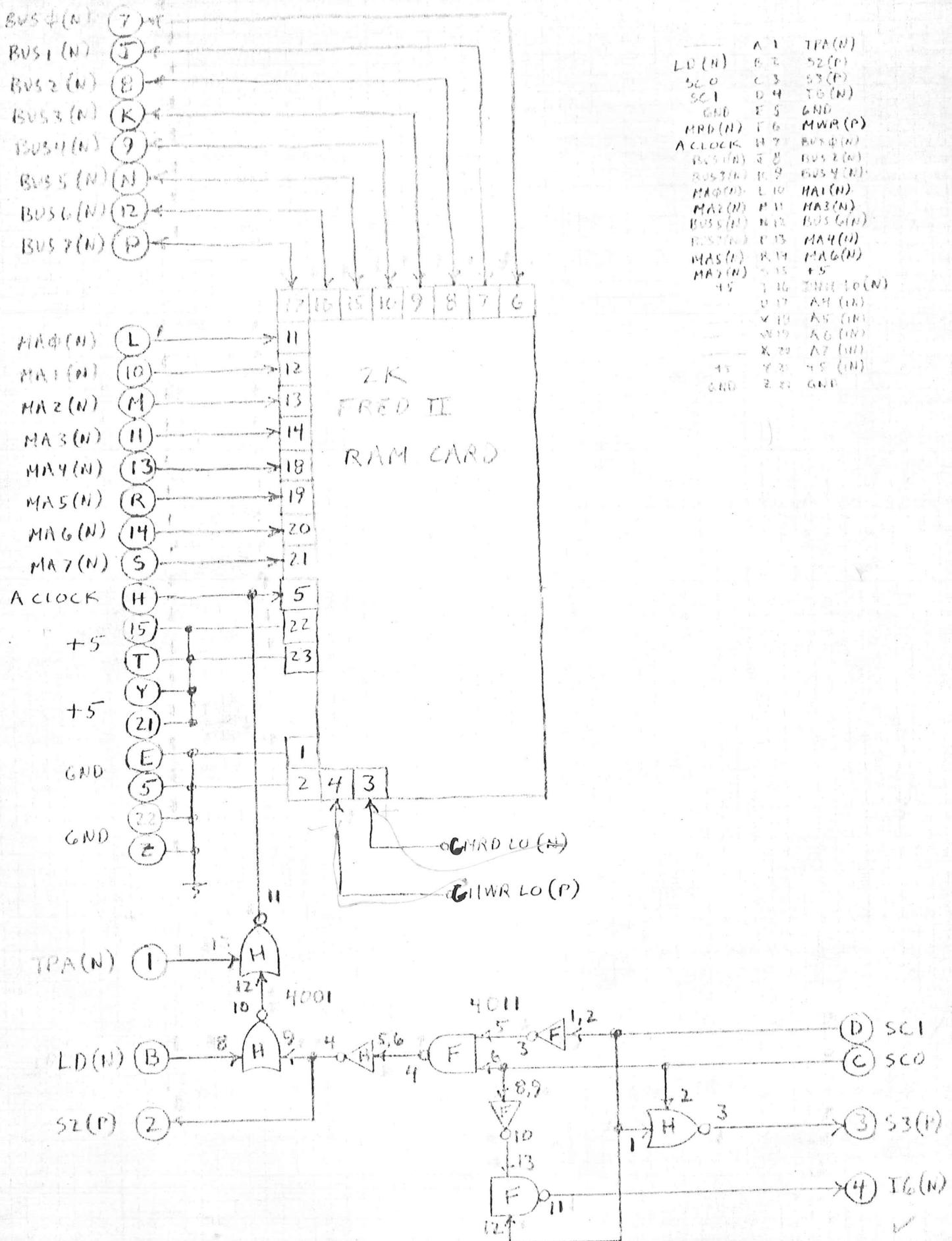
375

376

377

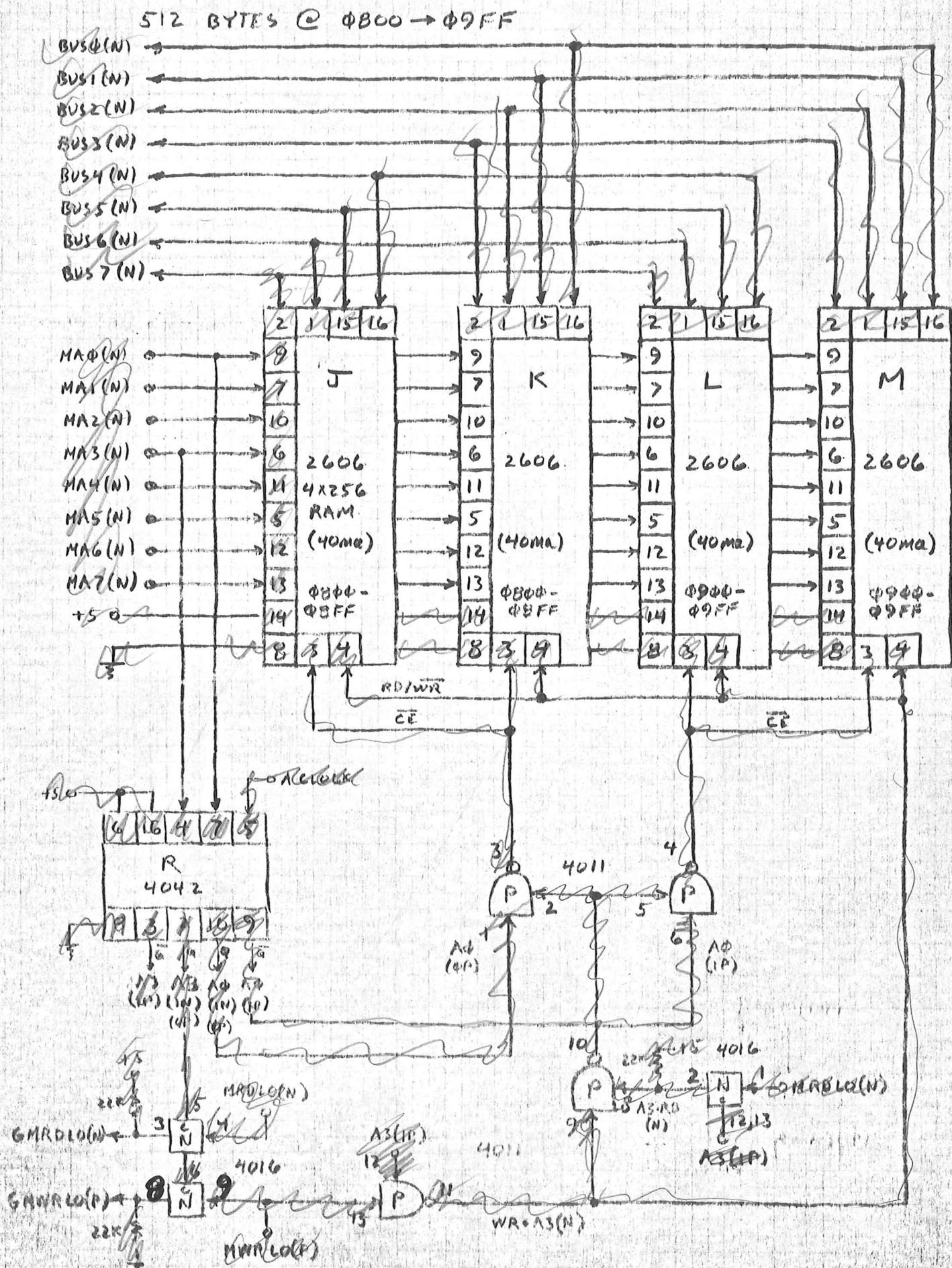
378

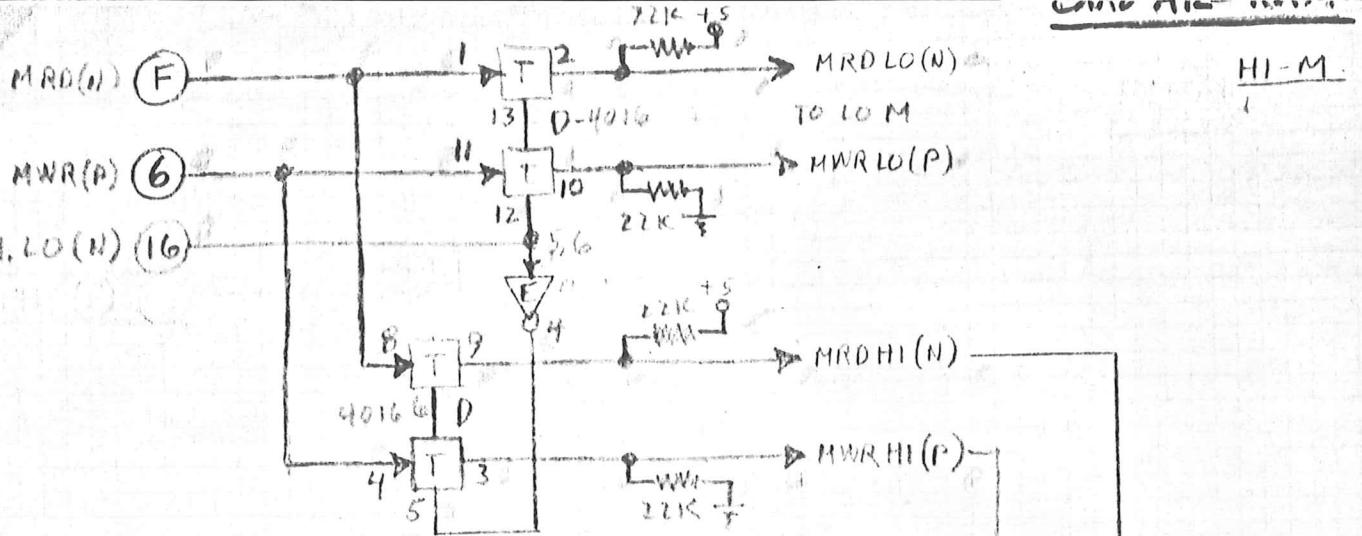
L O - M



JAW 11-1-24

CARD A12 - RAM





BUS₀(N)

BUS₁(N)

BUS₂(N)

BUS₃(N)

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83 JMH, LO (H) (16)

100 JMH, HI (N)

101 JMH, HI (P)

102 JMH, LO (P)

103 JMH, LO (N)

104 JMH, HI (N)

105 JMH, HI (P)

106 JMH, LO (P)

107 JMH, LO (N)

108 JMH, HI (N)

109 JMH, HI (P)

110 JMH, LO (P)

111 JMH, LO (N)

112 JMH, HI (N)

113 JMH, HI (P)

114 JMH, LO (P)

115 JMH, LO (N)

116 JMH, HI (N)

117 JMH, HI (P)

118 JMH, LO (P)

119 JMH, LO (N)

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123 JMH, LO (N)

124 JMH, HI (N)

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127 JMH, LO (N)

128 JMH, HI (N)

129 JMH, HI (P)

130 JMH, LO (P)

131 JMH, LO (N)

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140 JMH, HI (N)

141 JMH, HI (P)

142 JMH, LO (P)

143 JMH, LO (N)

144 JMH, HI (N)

145 JMH, HI (P)

146 JMH, LO (P)

147 JMH, LO (N)

148 JMH, HI (N)

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163 JMH, LO (N)

164 JMH, HI (N)

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166 JMH, LO (P)

167 JMH, LO (N)

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233 JMH, HI (P)

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292 JMH, HI (N)

293 JMH, HI (P)

294 JMH, LO (P)

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296 JMH, HI (N)

297 JMH, HI (P)

298 JMH, LO (P)

299 JMH, LO (N)

300 JMH, HI (N)

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302 JMH, LO (P)

303 JMH, LO (N)

304 JMH, HI (N)

305 JMH, HI (P)

306 JMH, LO (P)

307 JMH, LO (N)

308 JMH, HI (N)

309 JMH, HI (P)

310 JMH, LO (P)

311 JMH, LO (N)

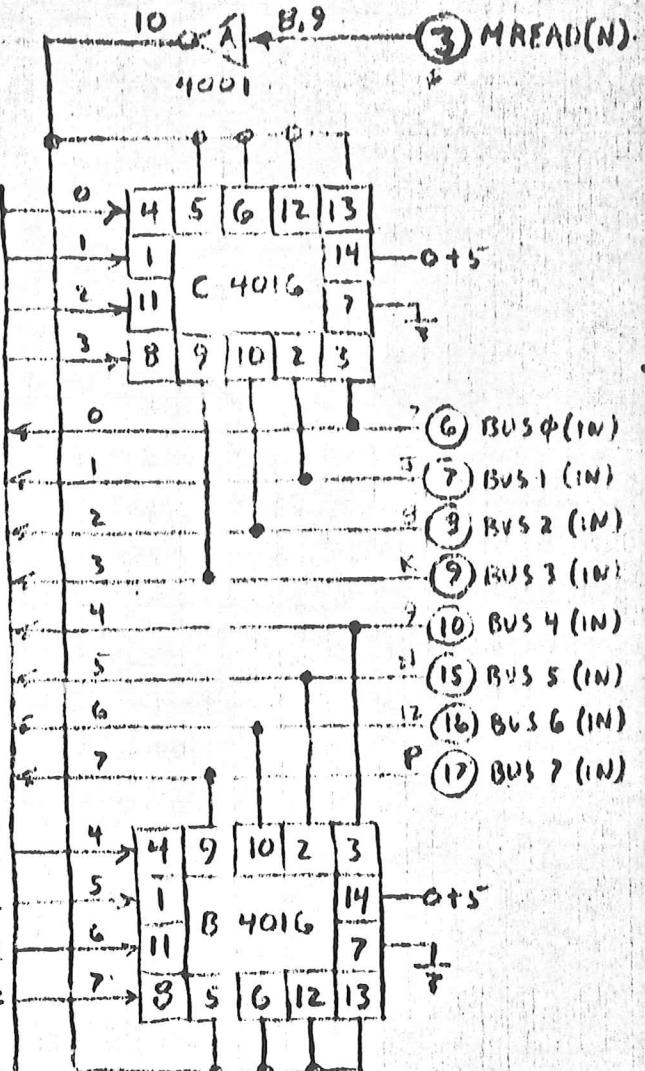
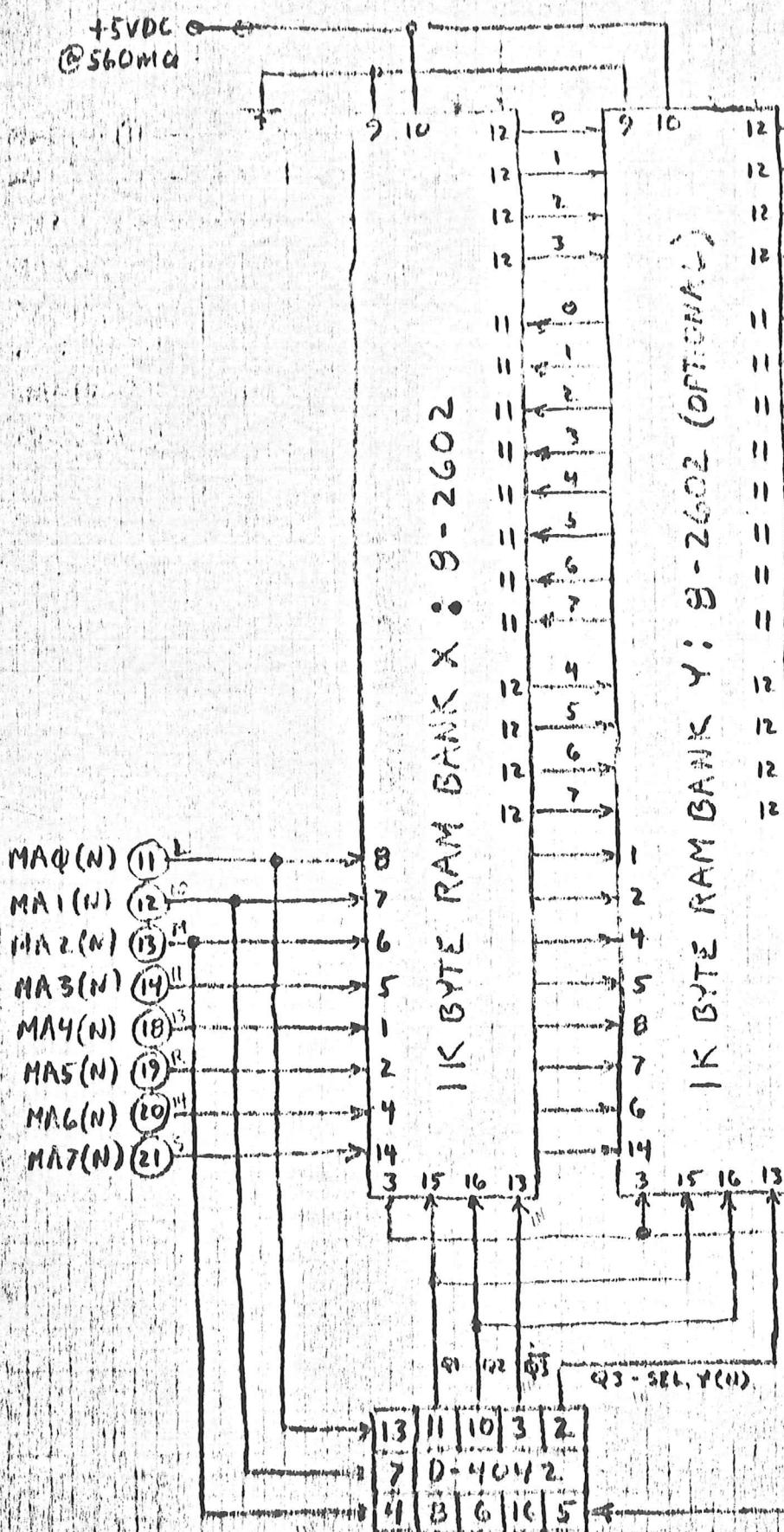
312 JMH, HI (N)

313 JMH, HI (P)

314 JMH, LO (P)

</div

FRED II - 2K RAM P.C. CARD



CARD A12 - COMPONENT SIDE.

2		H 4001	F 4011	R 4042	
			()	N 4016	P 4011
				L 2606	M 2606
				J 2606	K 2606
21		()		()	
22		A 4042	B 2606	C 2606	D 4016
					E 4001

KLD

256

16

1536

256

4096

600mA

LEVEL VOLUME

COSMAC

POWER

VOLUME

+

3.0

+

3.5

3.5

SX

LHT

RHT

LOAD HI

STEP

KEY

HEX

SHIFT

LOAD

RUN

ADDRESS BYTE

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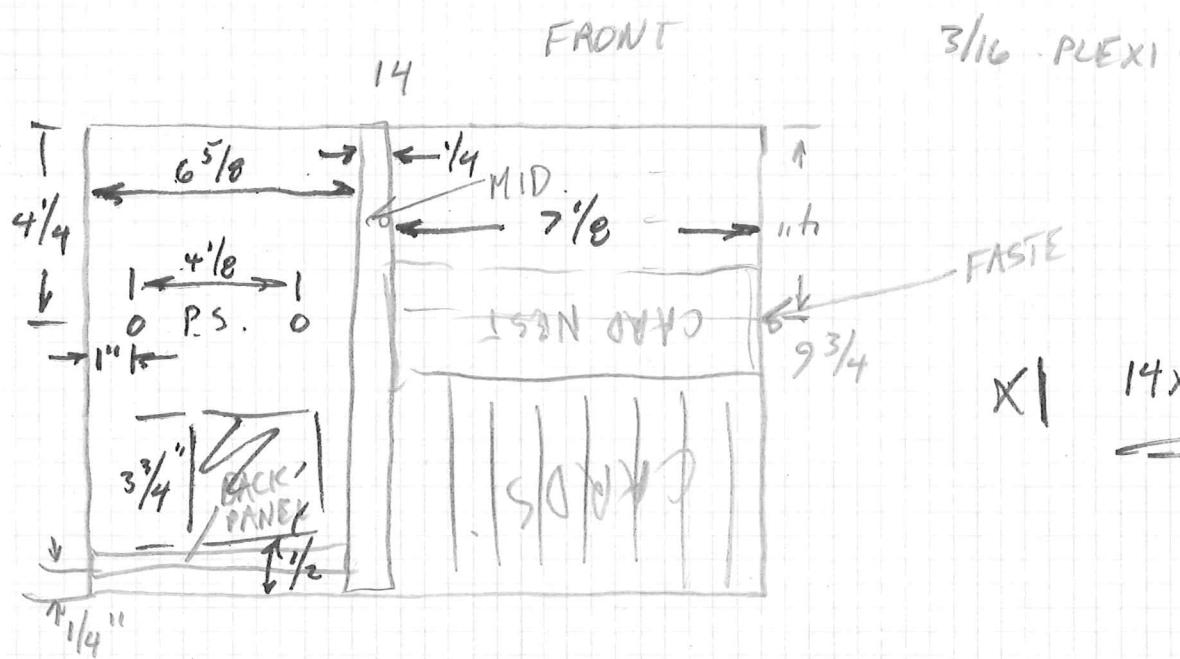
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3.0

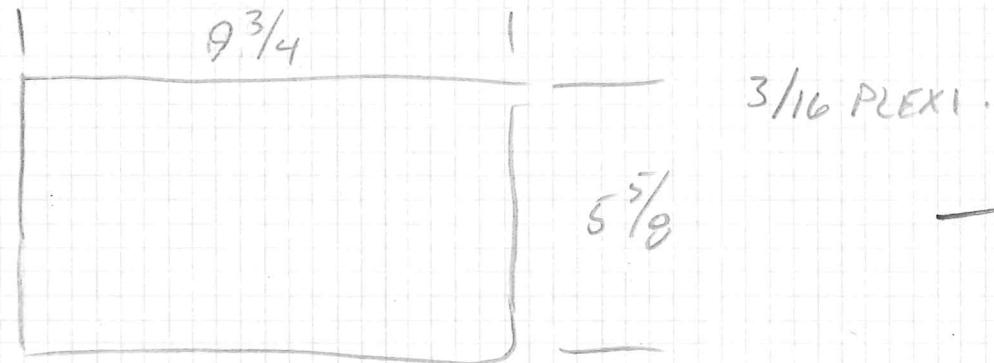
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3.0

BASE



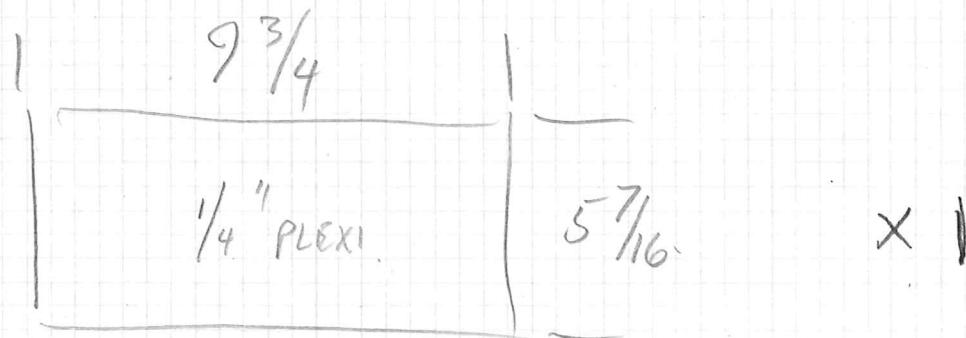
SIDES



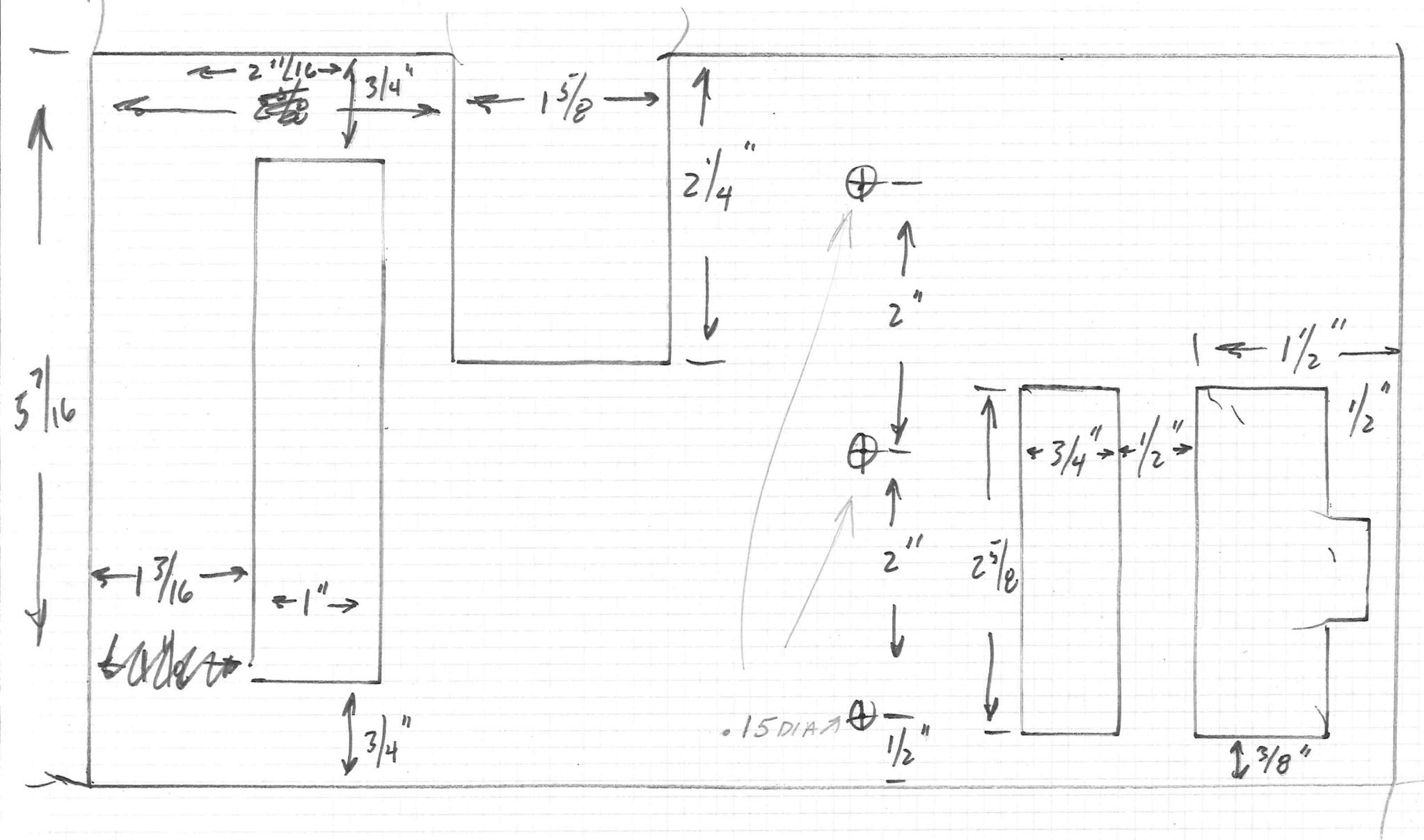
- X 2

1. FASTEN CARD NEST TO BOTTOM & SIDE

MID. SECTION



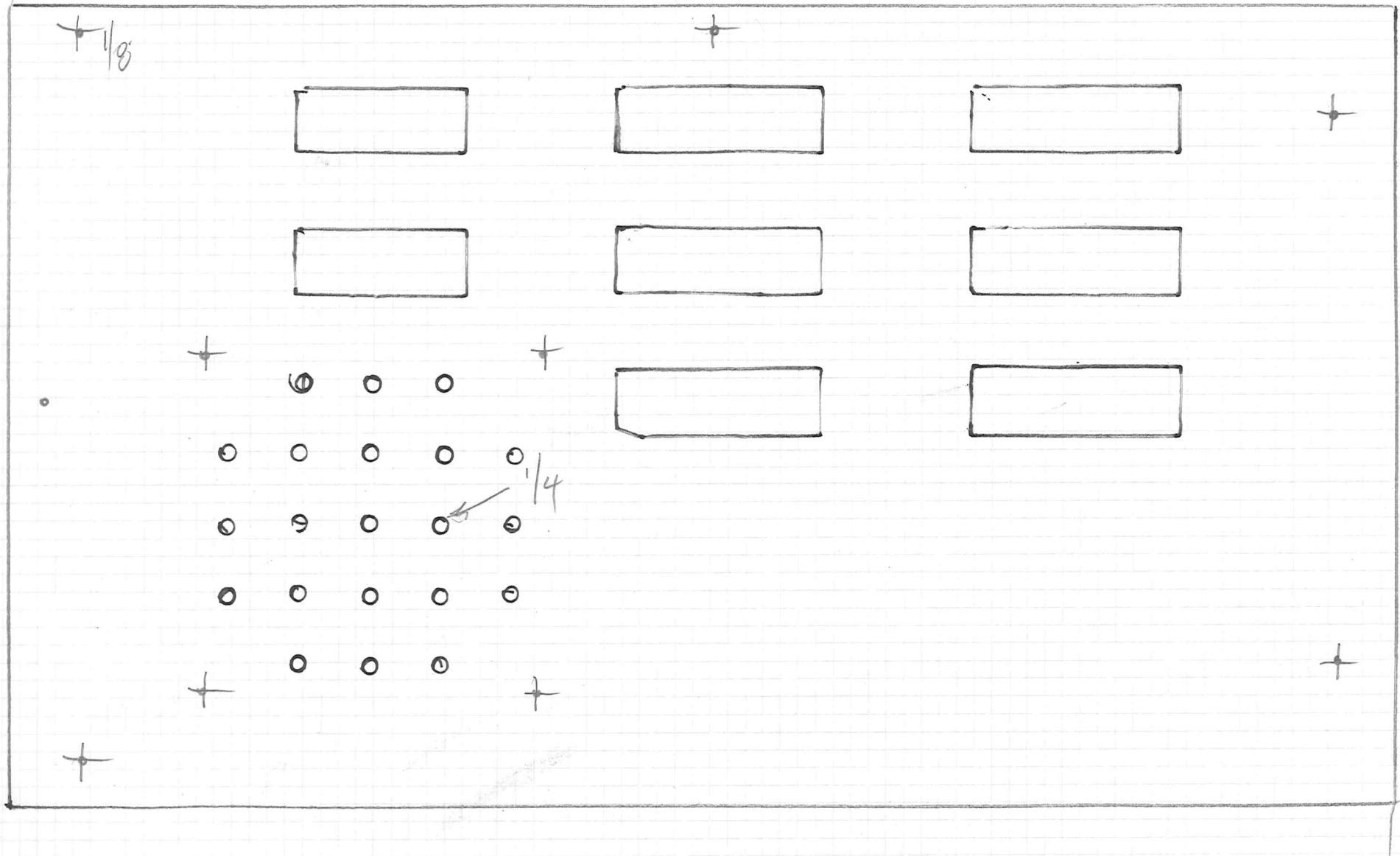
$\leftarrow 9\frac{3}{4} \rightarrow$

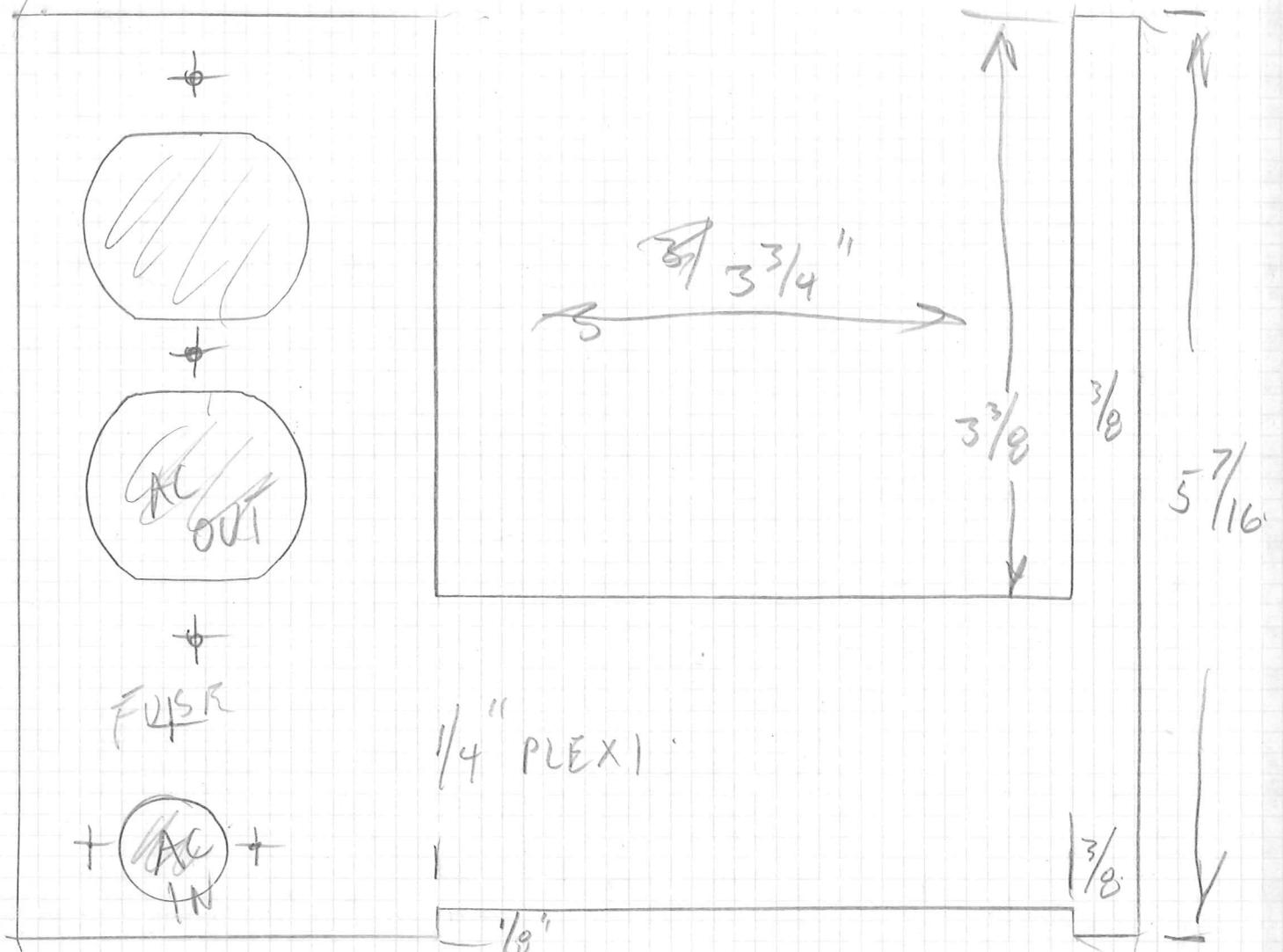


MID SECTION $\frac{1}{4}$ " PLEXI

SIDE

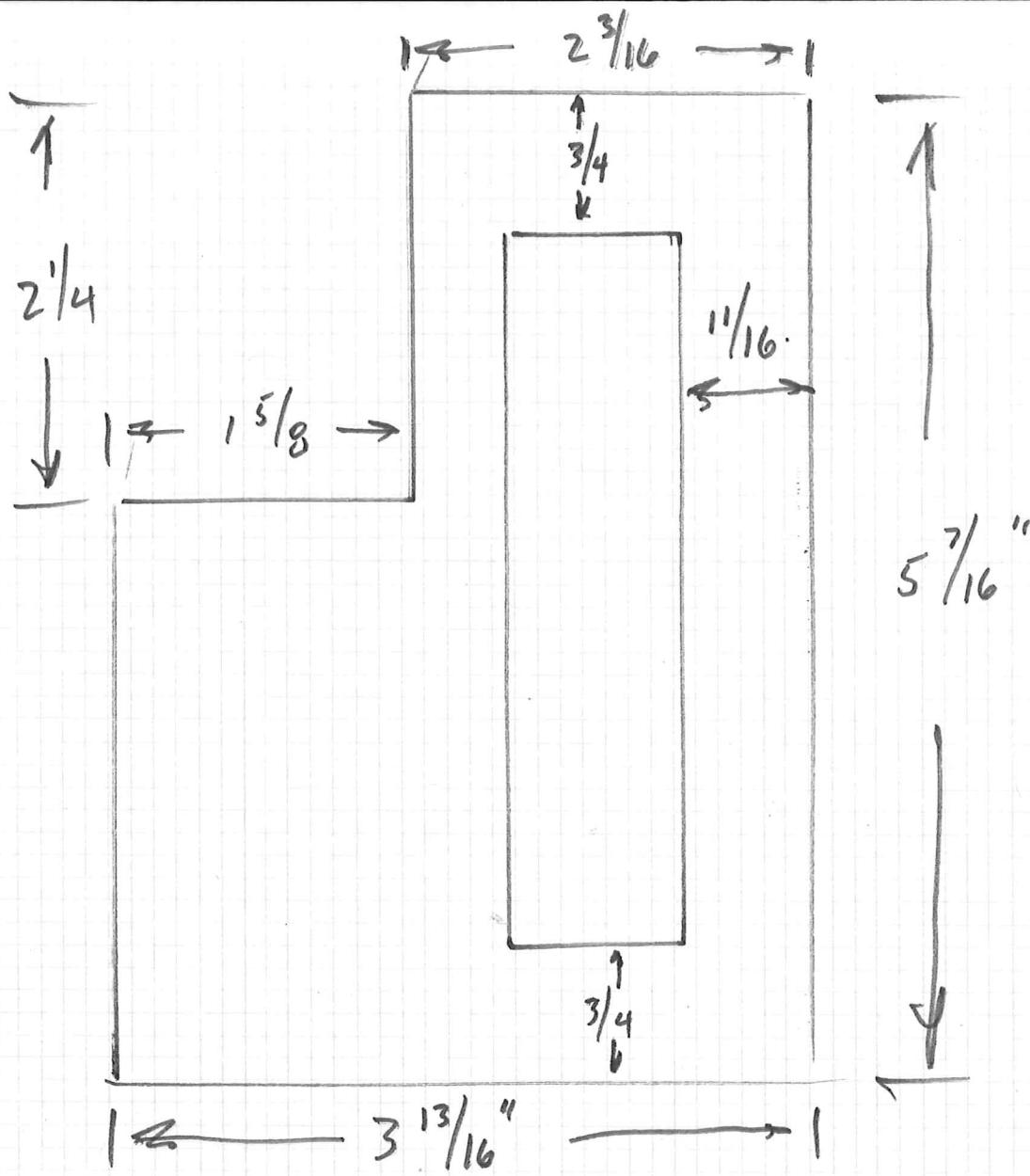
$9\frac{3}{4} \times 5\frac{5}{8} \times \frac{3}{16}$





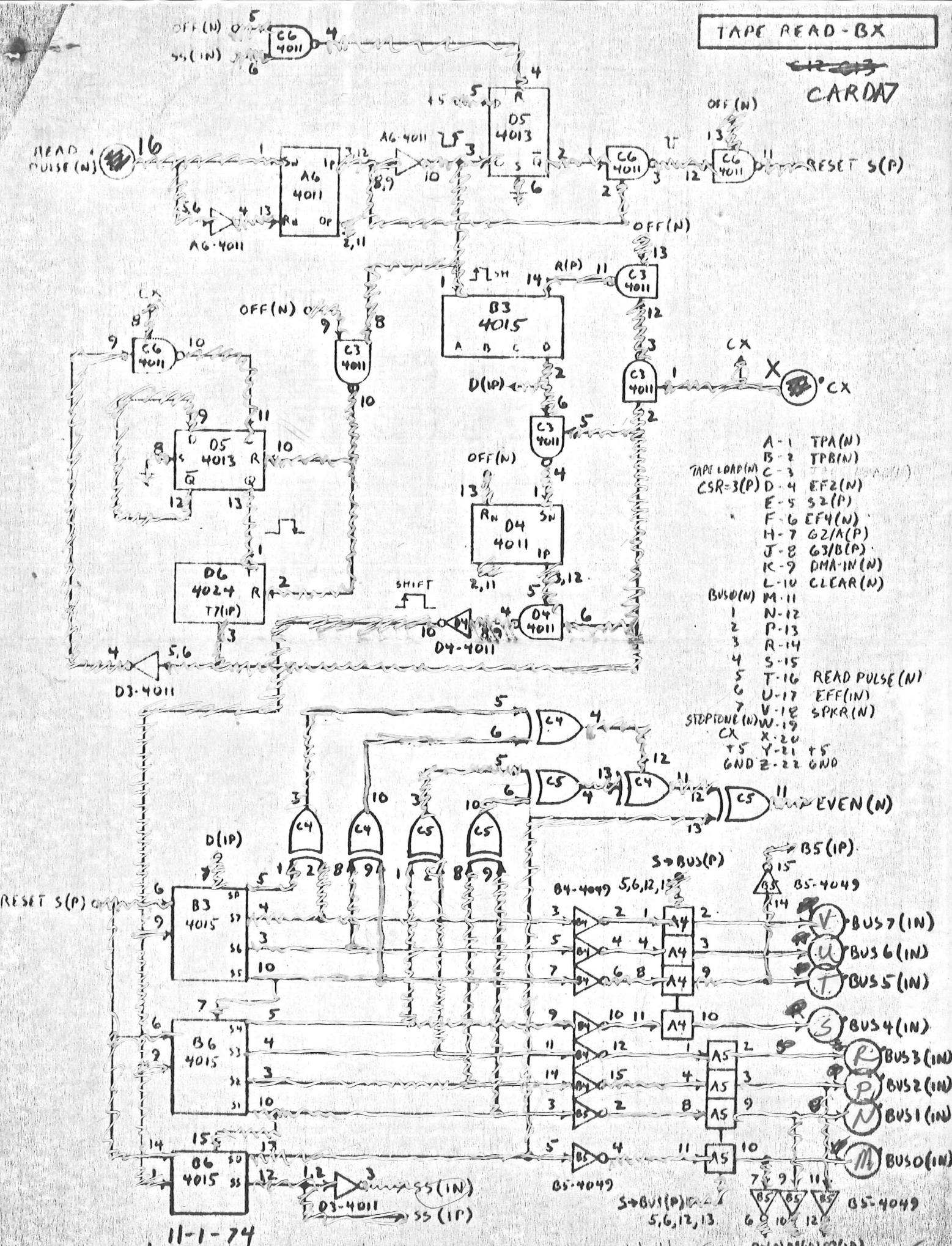
BACK PANEL

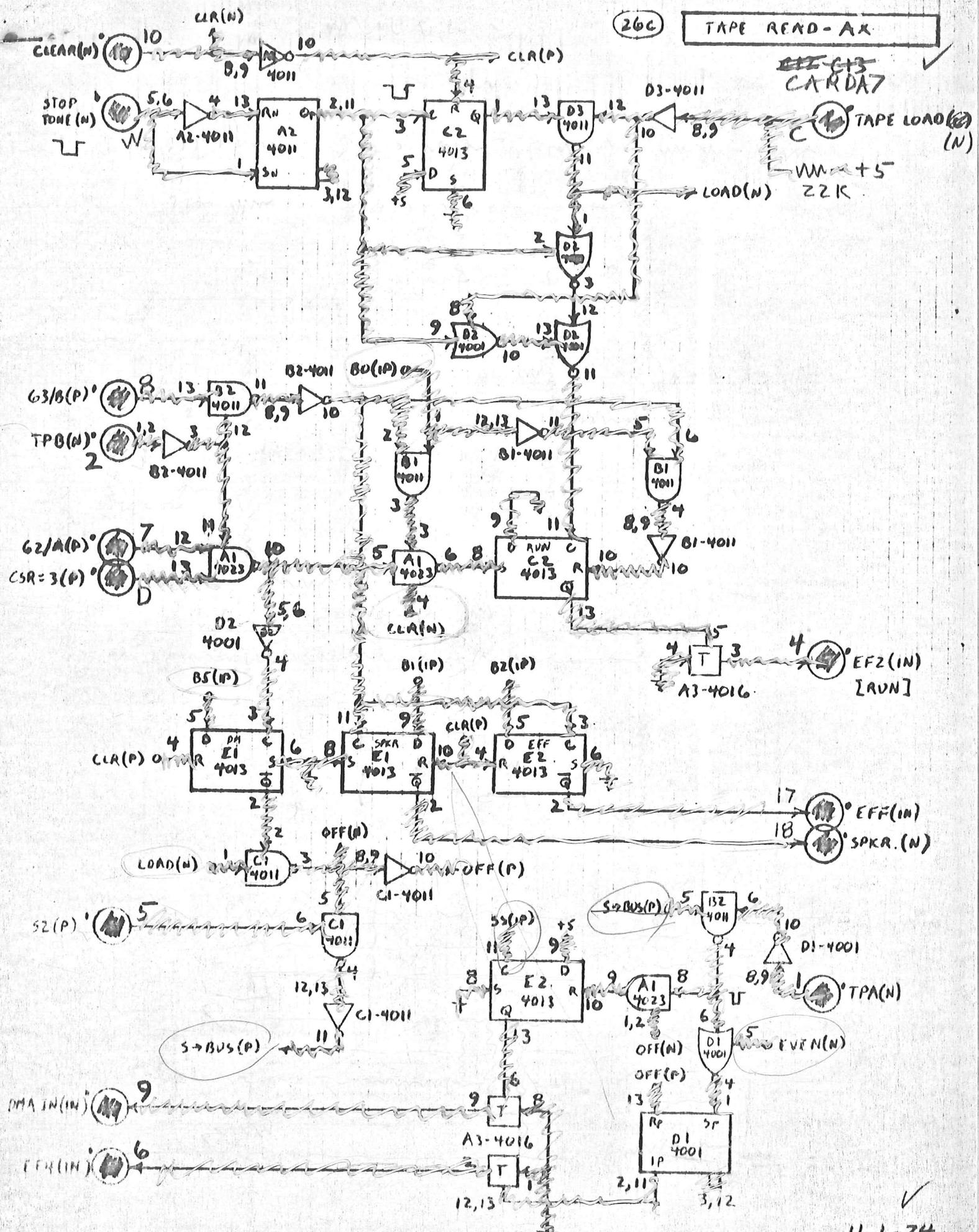
$6\frac{5}{8}$ "



CARD GUIDE

$\frac{1}{4}$ " PLEXI.





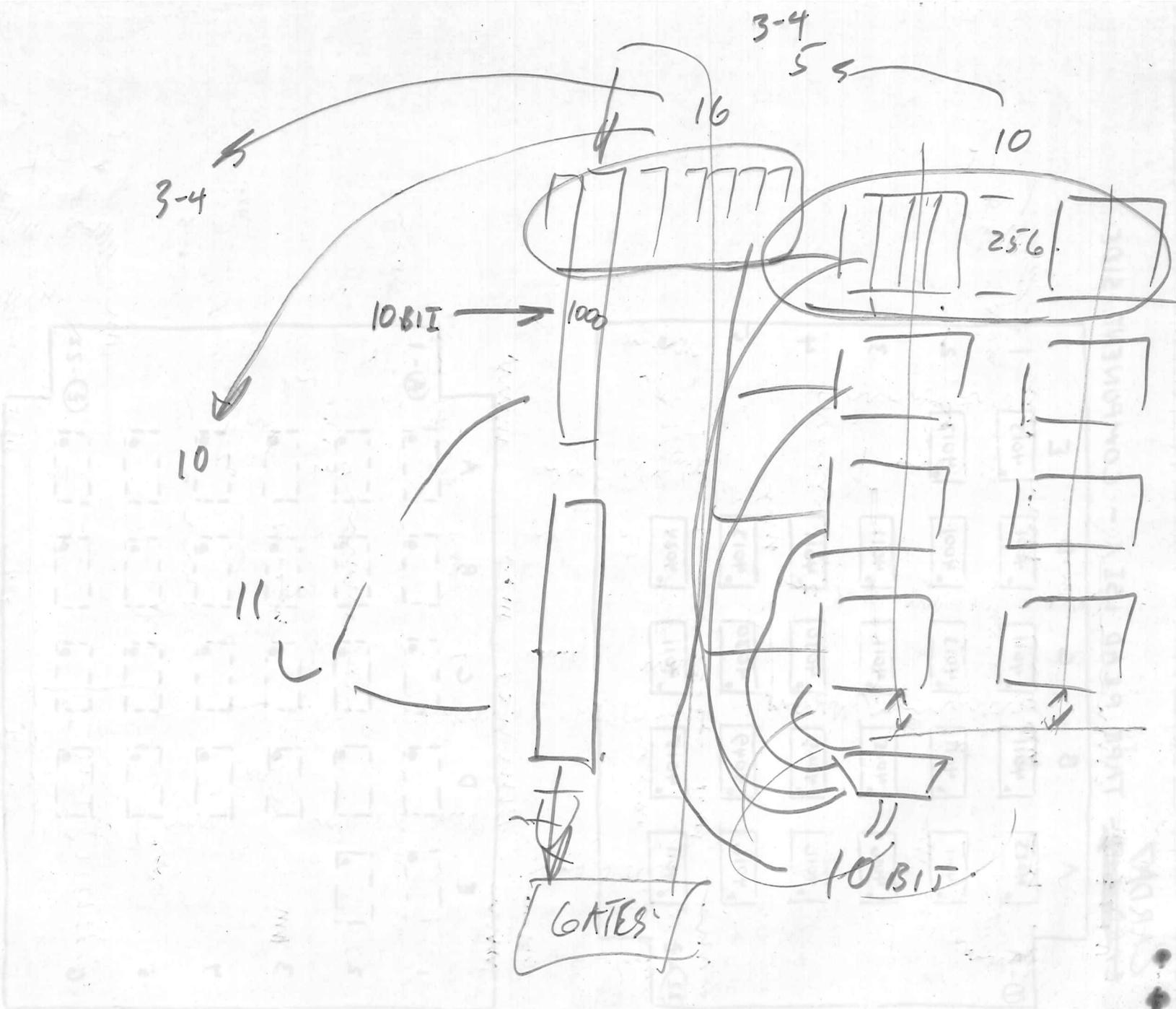
11-1-74

CARDAT
 CARDS - 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

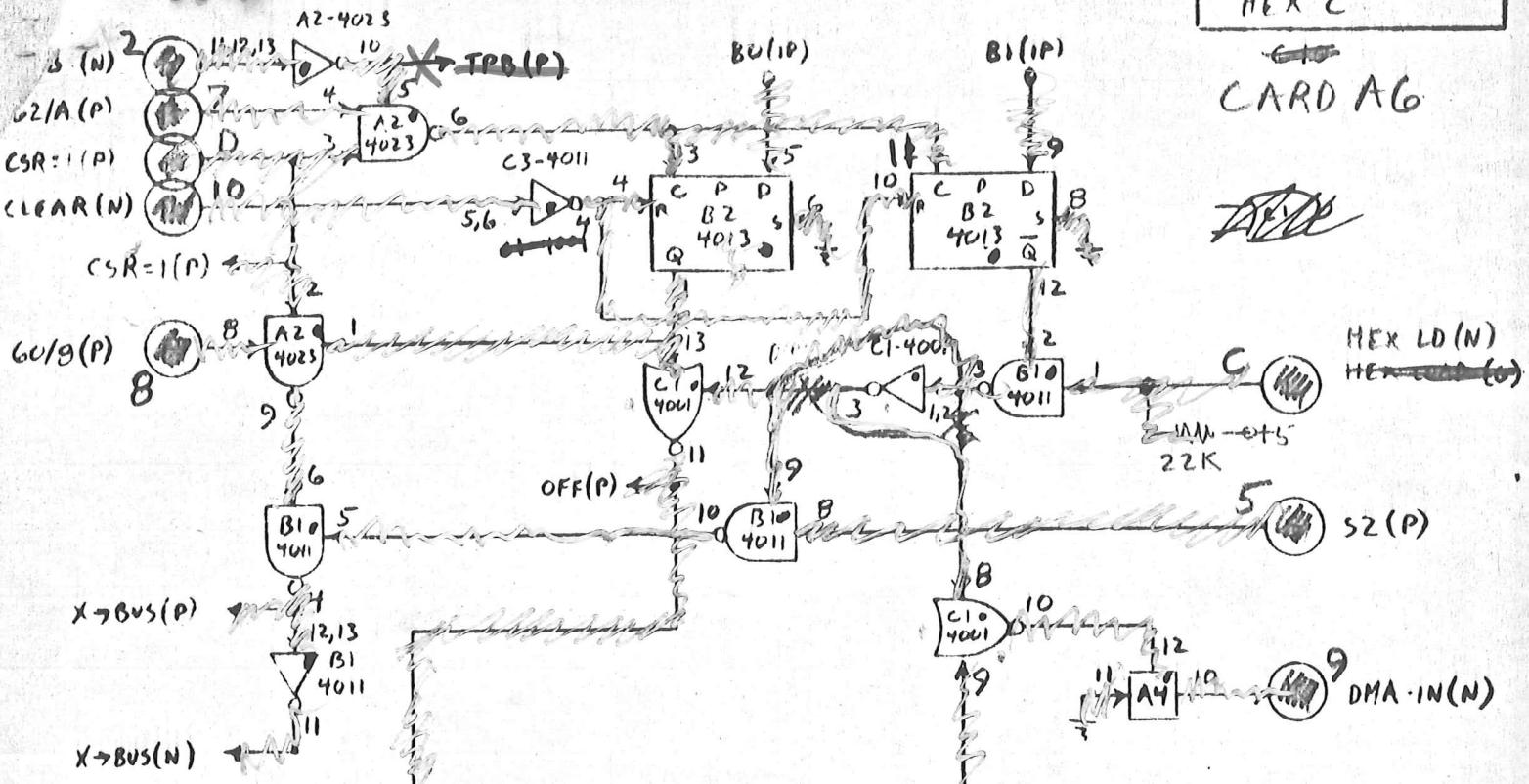
	B	D	C	B	A	
1	[]	[]	[]	[]	[]	(1)-1
2	[]	[]	[]	[]	[]	
3	[]	[]	[]	[]	[]	
4	[]	[]	[]	[]	[]	
5	[]	[]	[]	[]	[]	
6	[]	[]	[]	[]	[]	(2)-22

11-1-74
 JAW + 15-24



HEX C

CARD A6

HEX LD (N)
HEX LD (C)

S2 (P)

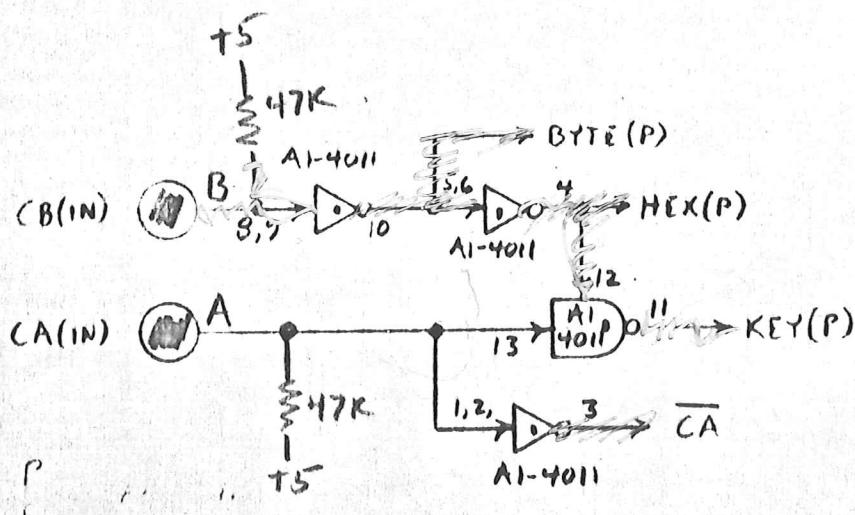
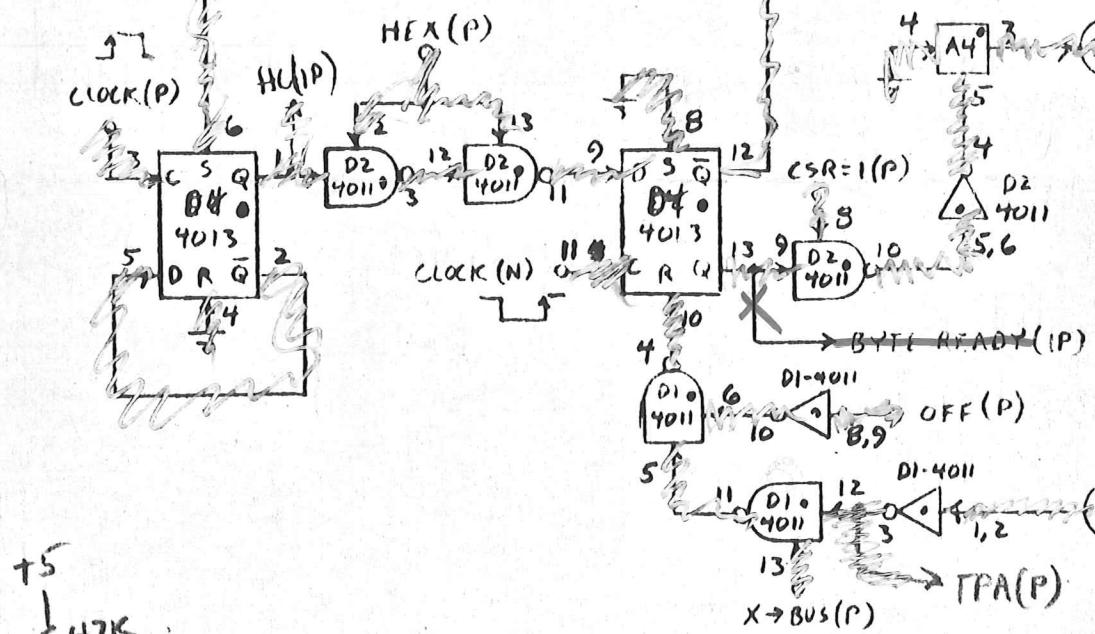
DMA-IN (N)

3 EPI (IN)

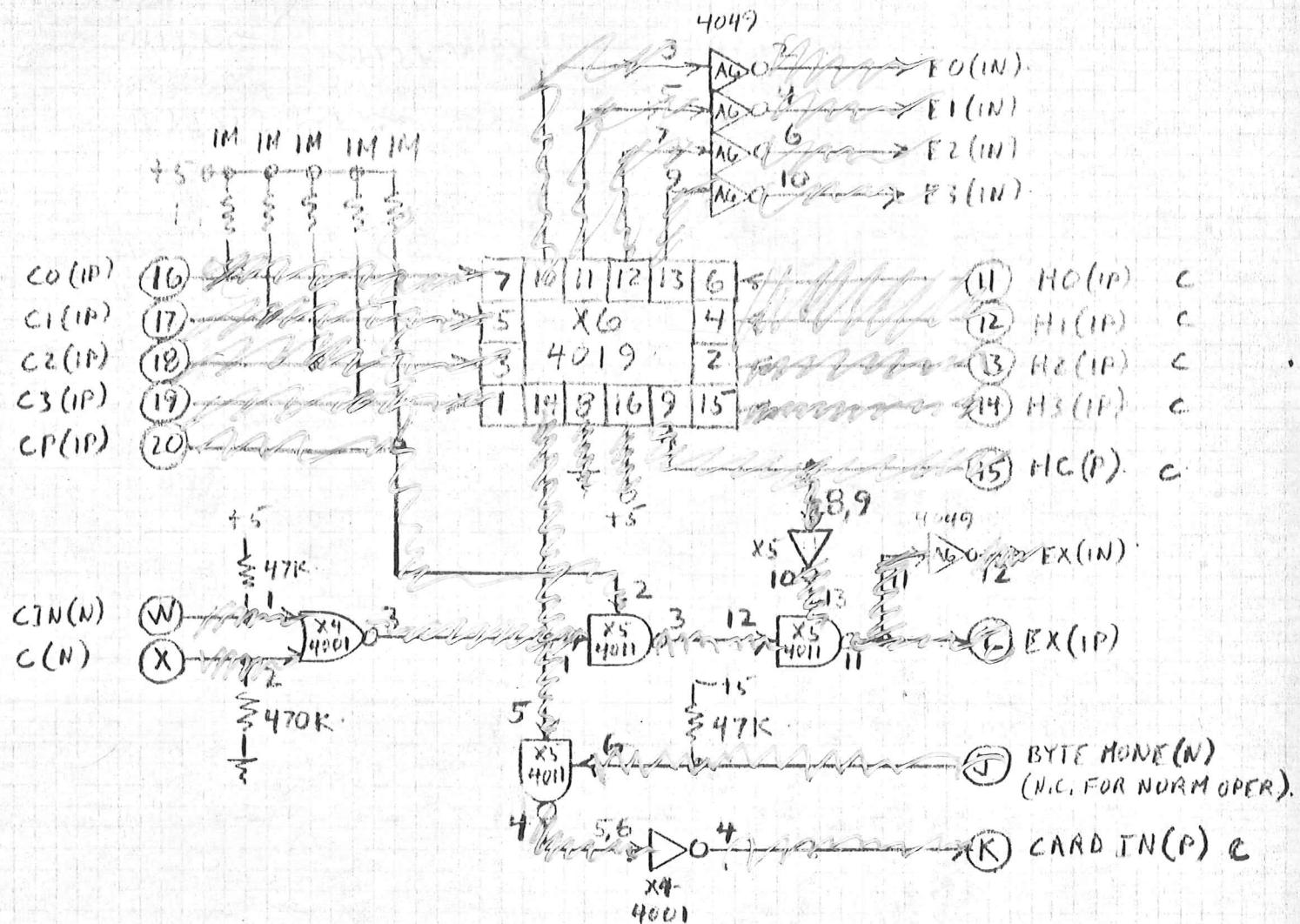
TPA (N)

TPA (P)

X-BUS (P)

✓ 11-1-74
JAW CH 29-74

HEX-CARD A6



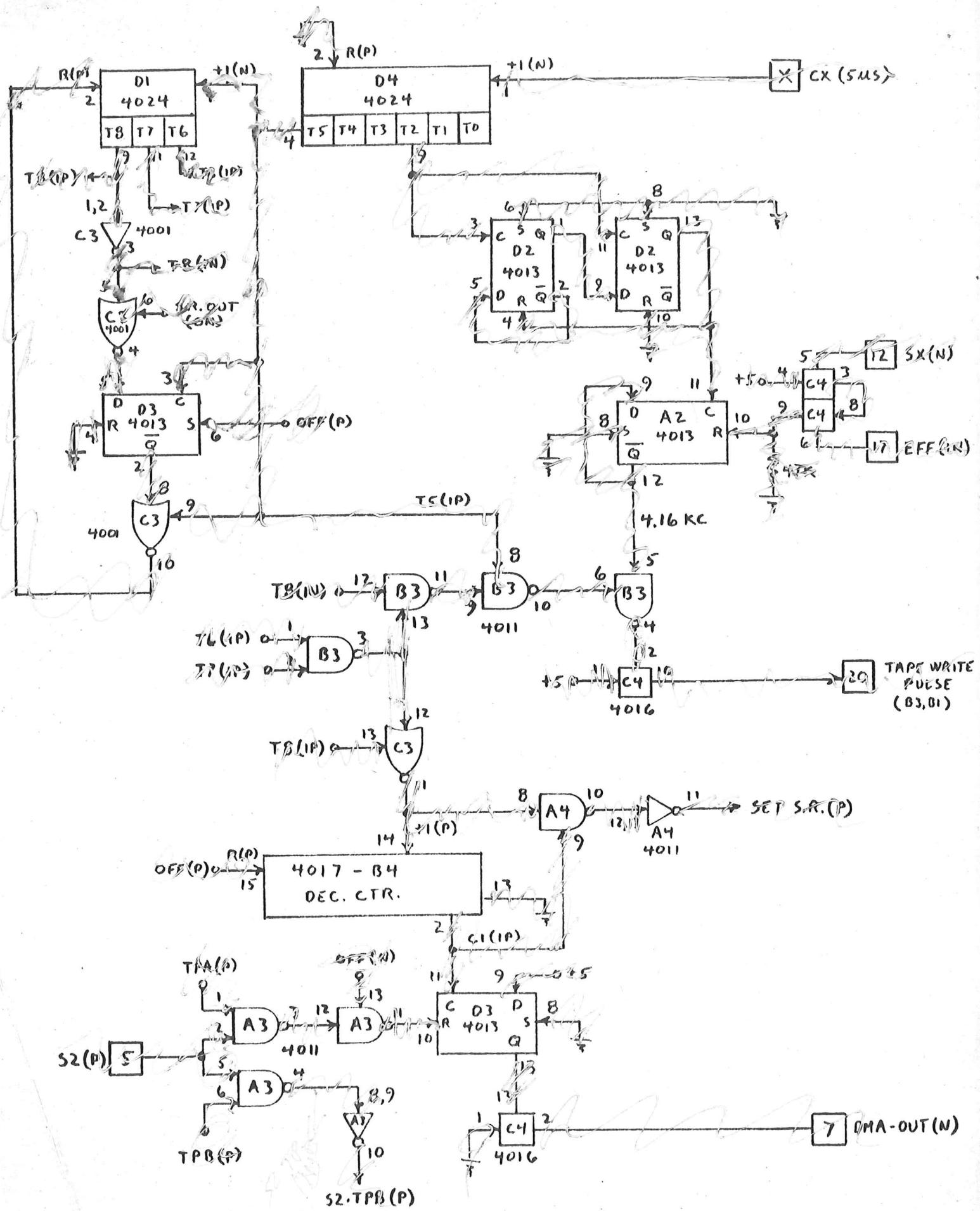
CA(N)	A	1	TIA(N)
CB(N)	B	2	TF3(N)
HEX ID(N)	C	3	E11(N)
CSR=1(P)	D	4	
	E	5	S2(P)
	F	6	TF4(N)
	G	7	G2/A(P)
	H	8	COL2(P)
BYTE MODE(N)	I	9	DMA IN(N)
CARD IN(P)	K	10	CSTAR(N)
EX(P)	L	11	HO(P)
BUSQ(N)	H	12	H1(P)
	N	13	H2(P)
	P	14	H3(P)
	R	15	H4(P)
	S	16	CD(P)
	T	17	C1(P)
	U	18	C2(P)
	V	19	C3(P)
CIN(N)	W	20	CP(P)
C(N)	X	21	+5
15	Y	22	GND
GND	Z	23	

HEX-CARD A6

CARD A6 - HEX IN - COMPONENT SIDE

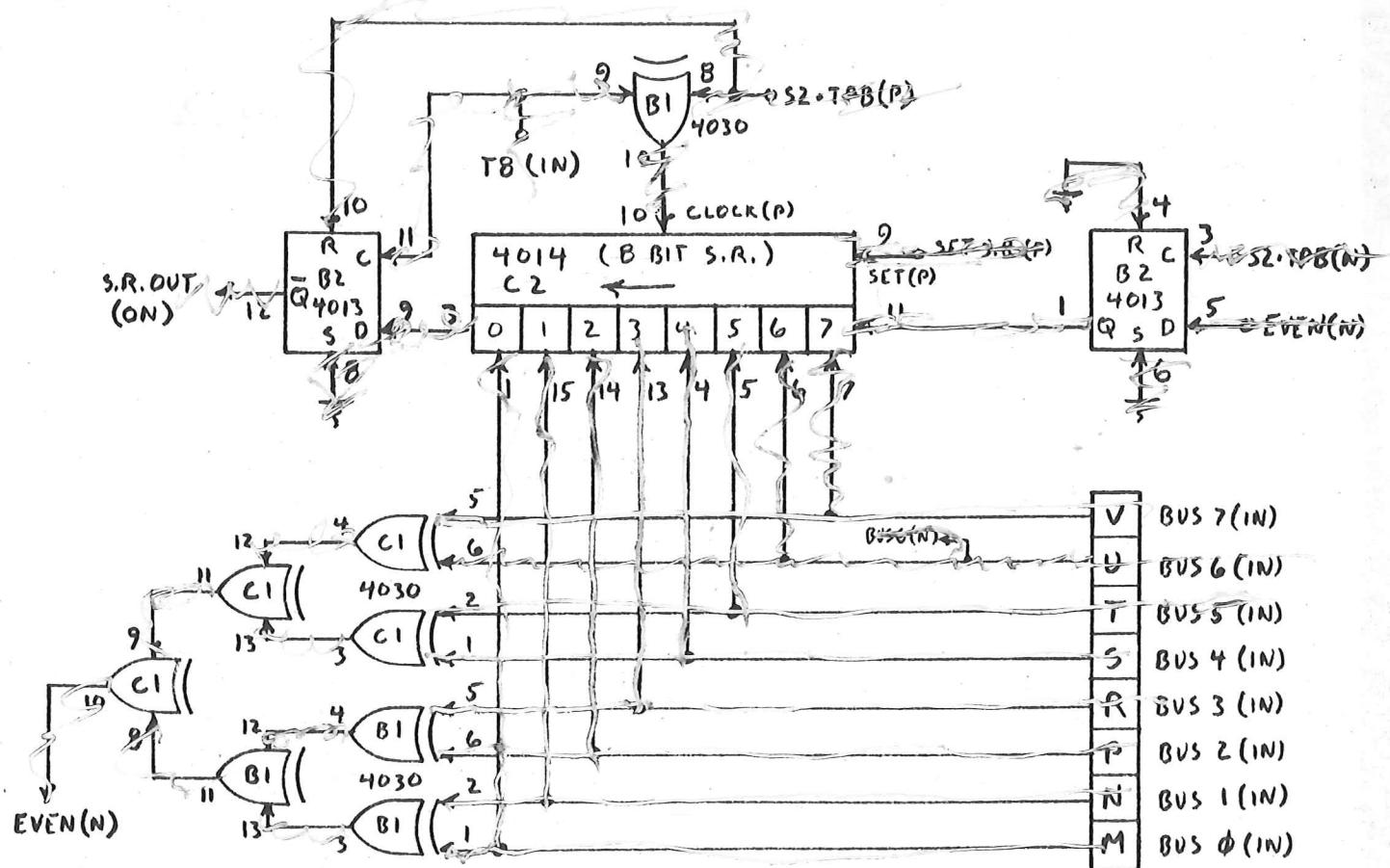
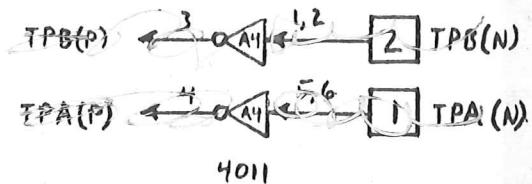
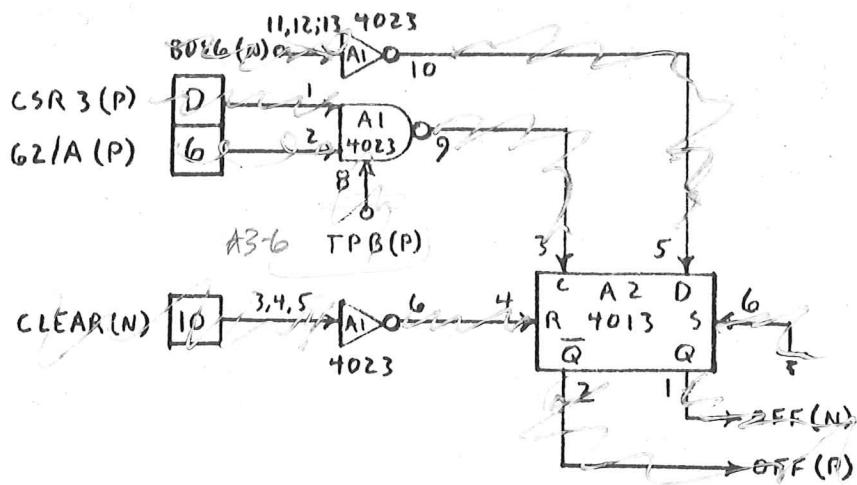
X	A	B	C	D	
1	4011	4011	4001	4011	1
	4023	4013	4042	4011	2
	4016	4013	4011	4025	3
	4001	4016	4024	4011	4
	4011	4016	4001	4030	5
22	4019	4049	4023	4011	6

TAPE WRITE
COSMAC CARD AB



JAN 11-20-74

TAPE WRITE
COSMAC CARD A8



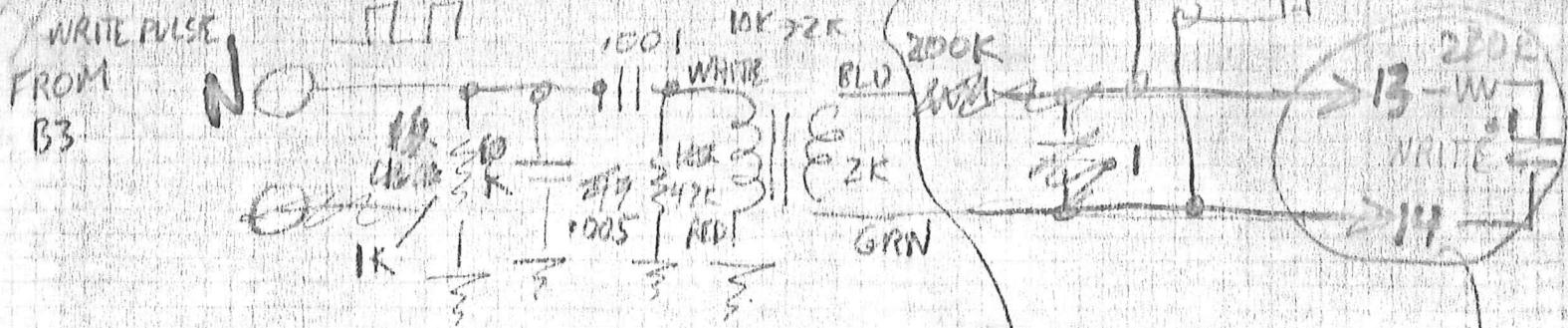
JAN 11-20-74

TAPE WRITE
C14

	1	2	3	4	A	B	C	D
1	A1 4023	A2 4013	A3 4011	A4 4011				
2	B1 4030	B2 4013	B3 4011	B4 4017				
3	C1 4030	C2 4014	C3 4011	C4 4016				
4	D1 4020	D2 4013	D3 4013	D4 4016				

22

TAN 10-8-74

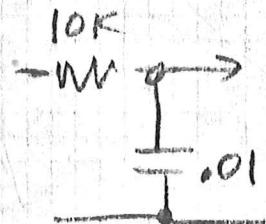


ARCHER
273-1378

AT PLUG FOR MIKE INPUT.

CARD
B1

PANASONIC WITH ALC



RCA AUX INPUT
ALC OFF

CHANGES

ADD B3-12 TO B1-N (OFF AIR PULSE)
CHANGE A1-W TD B3-B TO A1-W TO B1-D
ADD B3-3 TO B1-C

ADD STOP TIME
TMI. BW

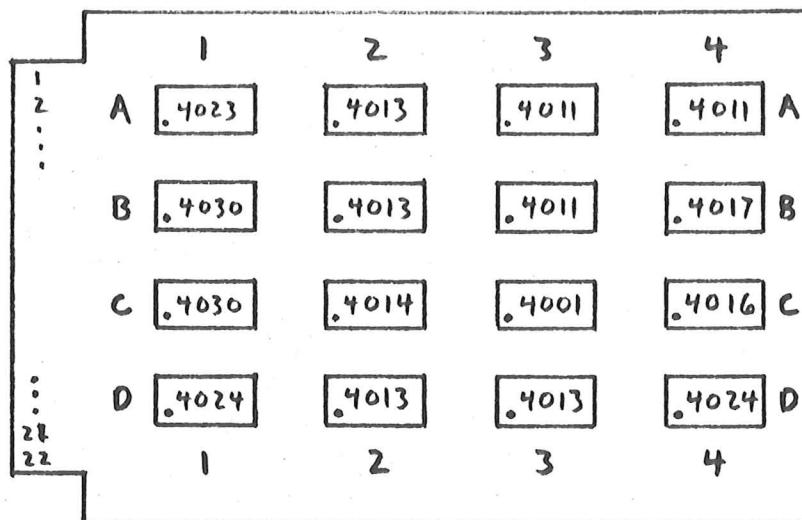
MSC. P.C. CHANGES

CUT ~~RED~~ CLEAR LINE ON TV BUFFER P.C. CARD

ADD JUMPER

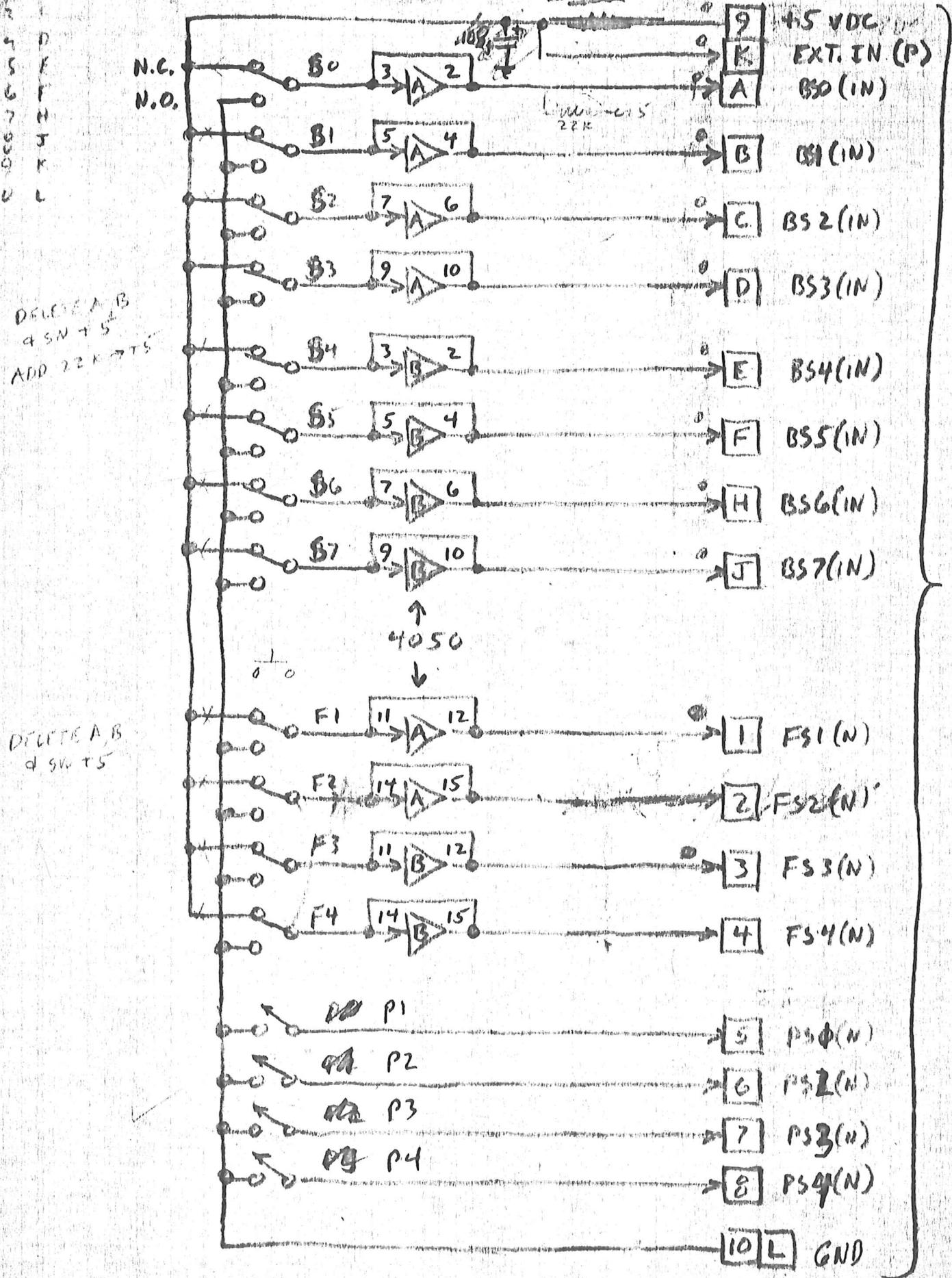
ON HEX DECODE & DEBOUNCE P.C. CARD.

TAPE WRITE
COSMAC CARD A8



A	1	TPA(N)
B	2	TPB(N)
C	3	
CSR:3(P)	D	4
E	5	S2(P)
F	6	62/A(P)
H	7	DMA-OUT(N)
J	8	
K	9	
L	10	CLEAR(N)
BUSΦ(N)	M	11
I	N	12 SX(N)
Z	P	13
3	R	14
4	S	15
5	T	16
6	U	17 EFF(IN)
7	V	18
	W	19
CX	X	20 TAPE WRITE PULSE
+5	Y	21 +5
GND	Z	22 GND

CC MAC COIN GAME PANEL LOGIC



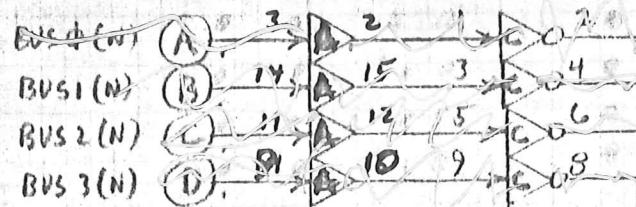
JANV. 11-20-74

TV BFR - RELAYS CARD B2

4050

7404

41.P.



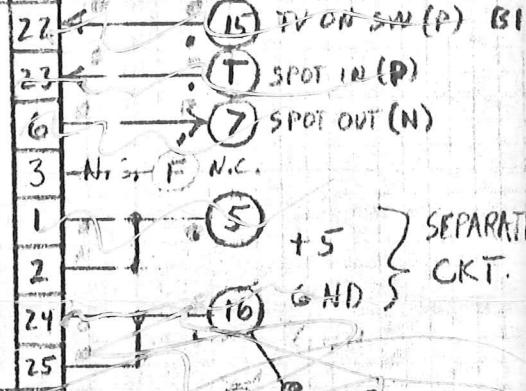
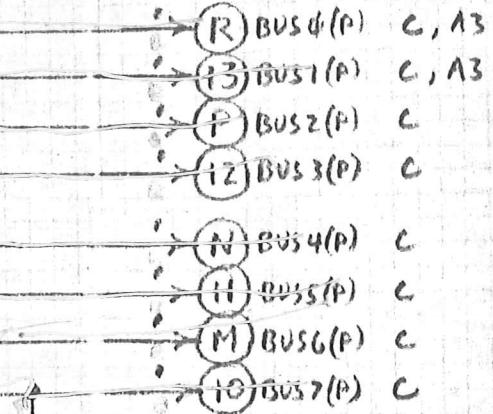
16

(14)

N.C. 20 9 18 17 16 15 14 13 12

- A3 A0(P) (L) → 11
 A3 A1(P) (9) → 10
 A3 A2(P) (K) → 9
 A3 BWR(P) (B) → 8
 A3 MRT(P) (J) → 7
 A3 V/H SYNC(N) (S) → 21
 CX (5MS) (G) → 4
 A4 CLOCK 1.25NS (H) → 5
 13

TV LINE
BUFFER
P.C. CARD



C BLANK A (14) → 12 7404

C BLANK B (E) → 10 7404

B3 RUN(N) (V) → RVN RELAY



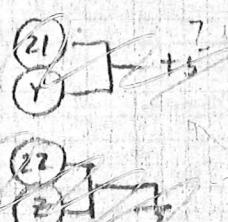
(W) AON(1) B1
 (X) AON(2) B1

B3 SPKR ON(N)
 SPKR RLY (17) → 7

SPKR RLY

(18) D.R (N.O) B3
 (19) SR (N.C.) B3

(20) VOL. A. C



BUS 0(N) A 1
 1
 2
 3
 4
 BLANK B E 5
 F 6
 G 7
 CX 8
 CLOCK H 9
 MRT(P) J 10
 A2(P) K 11
 A0(P) L 12
 BG(P) M 13
 B7(P) N 14
 B5(P) O 15

BUS 4(N) 7
 5
 6
 7
 8
 9
 SPOT OUT(H) I
 GND I
 A1(P) J
 A0(P) K
 B7(P) L
 B5(P) O

BUS 1(P) N 16
 B2(P) P 17
 B0(P) R 14
 V/H SYNC(N) S 15
 SPOT IN(P) T 16
 TVRF U 17
 RUN(N) V 18
 A1N(1) W 19
 A1N(2) X 20
 GND Z 21

B3(P) N 18
 B1(P) P 19
 BLANK R 15
 TV ON SW P 16
 GND U 18
 SPKR IN V 19
 GND W 20
 VOL. A Y 21
 GND Z 22

3 EMP. 1
 1, 41

JAN 11-1-74

OFF(N) 0x5
SS(IN) 0x6

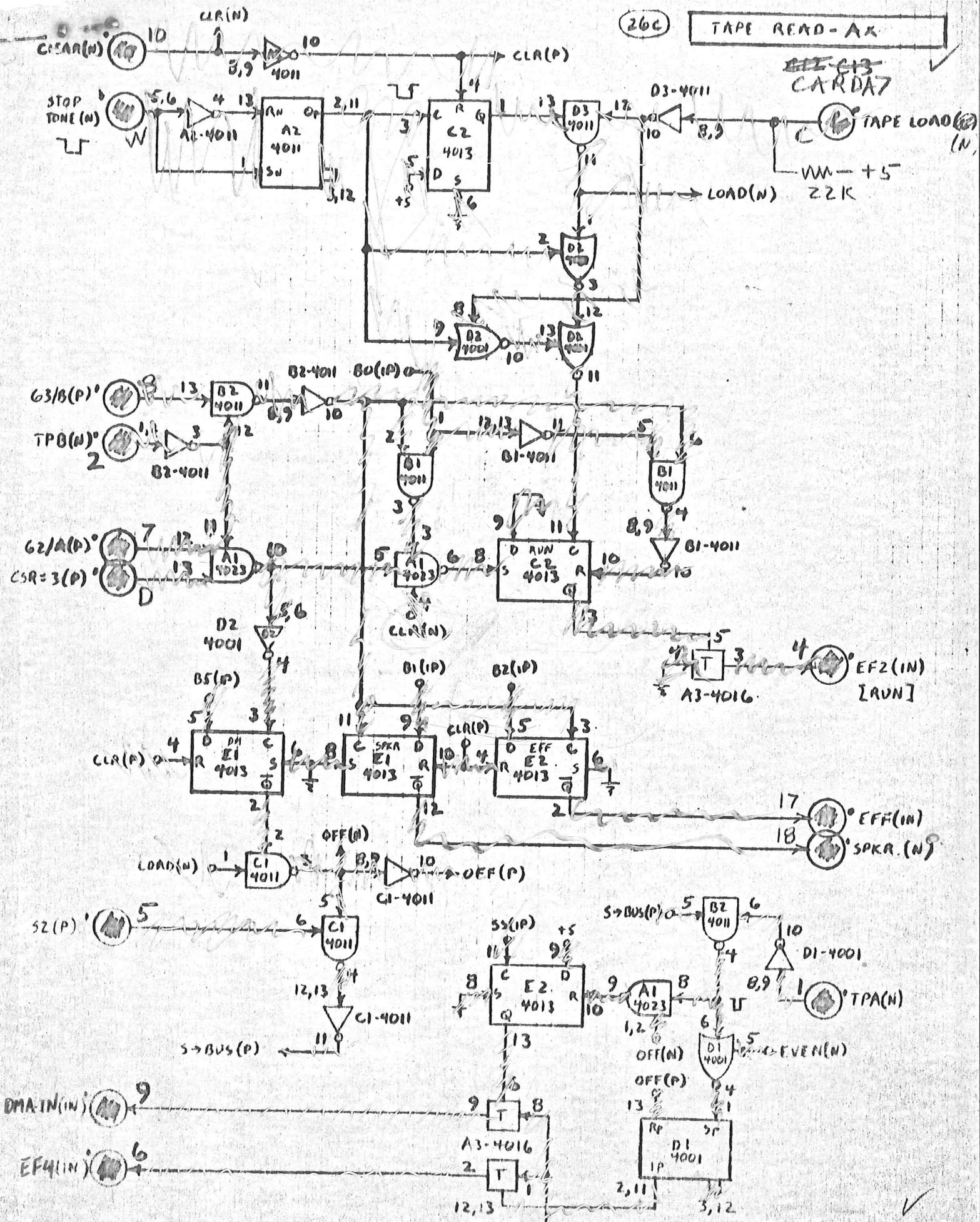
TAPE READ - BX

HEAD 1
NOISE(N) 0x16

+5V 0x5
D5 4013 R
A6 4011 L 0x3
B7 0x10

OFF(N) 0x9
C6 4011 D 0x3
11 0x12
12 0x13
13 0x14
14 0x15
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1057 0x4C
1058 0x4D
1059 0x4E
1060 0x4F
1061 0x4G
1062 0x4H
1063 0x4I
1064 0x4J
1065 0x4K
1066 0x4L
1067 0x4M
1068 0x4N
1069 0x4O
1070 0x4P
1071 0x4Q
1072 0x4R
1073 0x4S
1074 0x4T
1075 0x4U
1076 0x4V
1077 0x4W
1078 0x4X
1079 0x4Y
1080 0x4Z
1081 0x4A
1082 0x4B
1083 0x4C
1084 0x4D
1085 0x4E
1086 0x4F
1087 0x4G
1088 0x4H
1089 0x4I
1090 0x4J
1091 0x4K
1092 0x4L
1093 0x4M
1094 0x4N
1095 0x4O
1096 0x4P
1097 0x4Q
1098 0x4R
1099 0x4S
1100 0x4T
1101 0x4U
1102 0x4V
1103 0x4W
1104 0x4X
1105 0x4Y
1106 0x4Z
1107 0x4A
1108 0x4B
1109 0x4C
1110 0x4D
1111 0x4E
1112 0x4F
1113 0x4G
1114 0x4H
1115 0x4I
1116 0x4J
1117 0x4K
1118 0x4L
1119 0x4M
1120 0x4N
1121 0

(26c) TAPE READ - AR



11-1-74

JAN 15 1974

CARDAT
CARDS - TAPE READ LSIX - COMPONENT SIDE

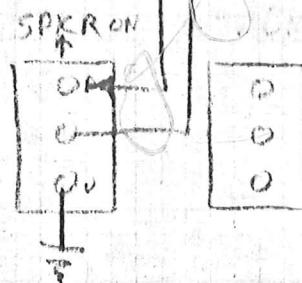
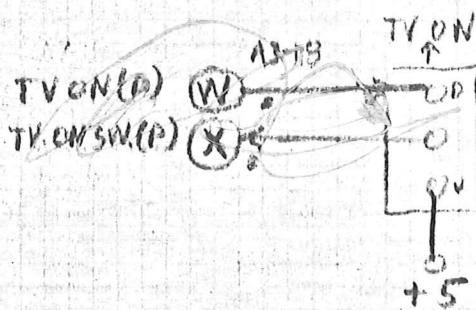
	A	B	C	D	E	
(1)-A	.4023	.4011	.4011	.4001	.4013	1
	.4011	.4011	.4013	.4001	.4013	2
	.4016	.4015	.4011	.4011		3
	.4016	.4049	.4030	.4011		4
	.4016	.4049	.4030	.4013		5
22-2	.4011	.4015	.4011	.4024		6

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

11-1-74
JAW ~~4-15-74~~

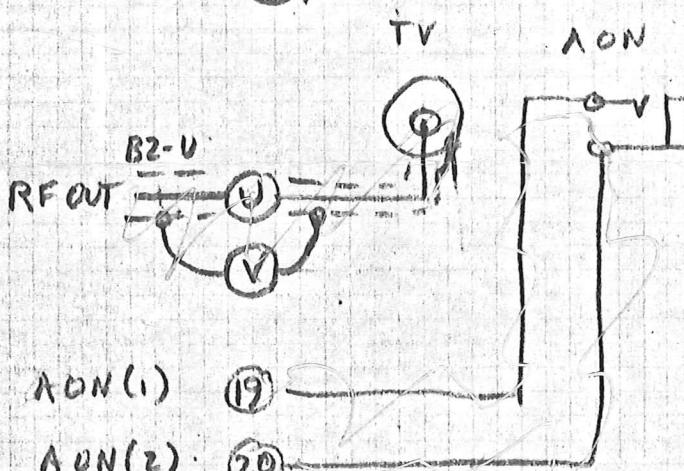
T/O PANEL - CARD B1

+5 → TV ON(P) → C → TV ON SW(P) → B2-15



ANIB
M SPKR(N)
L SPKR SW(N)
B2-16

WR SIGNAL OUT



WR

EFF

TV AON

B2-U

RF OUT

AON

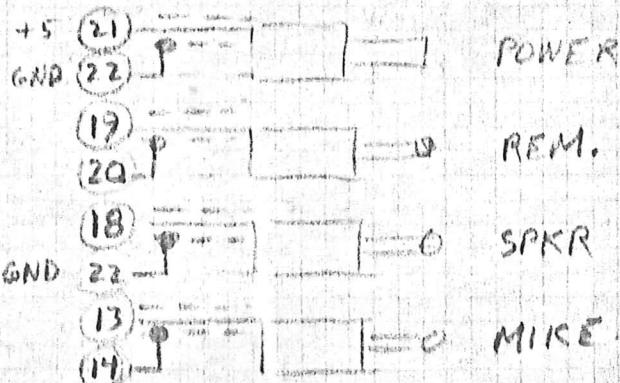
AIN

B2-U

(18) S.R.(N.O.)

AON(1) (19)

AON(2) (20)



JAW 11-1-74

250 - 500 mA

CASSETTE 250 mA

CONTR. PANEL

40
16
0
24
40
64

B

5V & 3A PS

2.7P

16 (15) (14) (13) (12) (11) (10) (9) (8) (7) (6) (5) (4) (3) (2) (1)

2.8A 250 mA

CLOCK - DOT TV BFR

TAPP RELAYS

TONE ADAPTER - OUT AMP

I/O JACKS &
TEST SWITCHES

3

17

TV CHIP

M

700 mA

TAPE
WRITE

COMBINE
ON 6

WHEN LSI
CHIPS
ARE AVAIL.

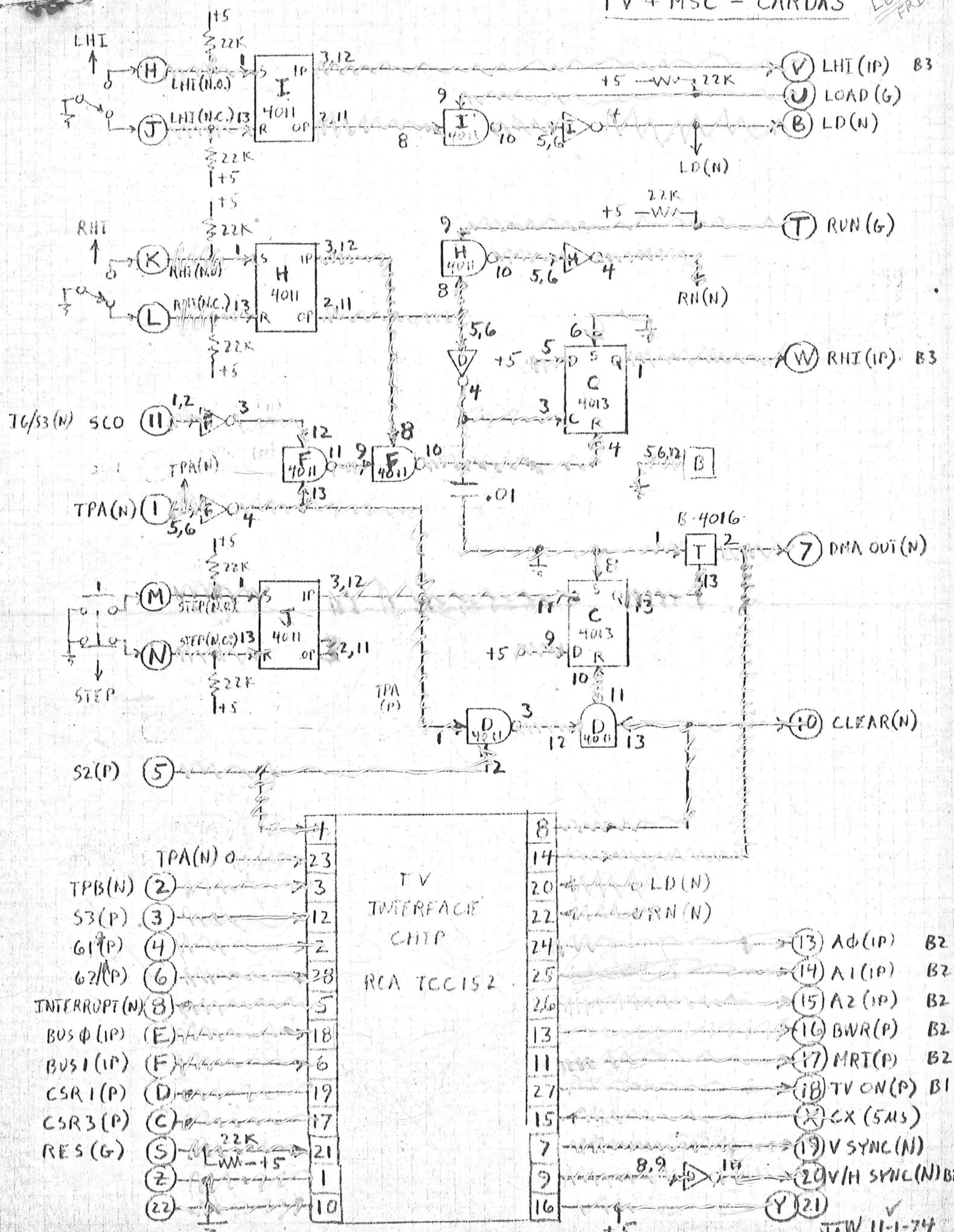
COSMAC

TV CHIP
256 BYTE
UTIL. M & CONTROL
80mA

✓	CONTROL PANEL DISPLAY	=	250	-	500 mA
	2K RAM	=	650	-	700 mA
	256 BYTE UTILITY RAM	=	80	-	80 mA
	DOT TV BFR	=	250	-	300 mA
✓	CASSETTE UNIT	=	250	-	300 mA
<hr/>					
			1480A	1.830A	

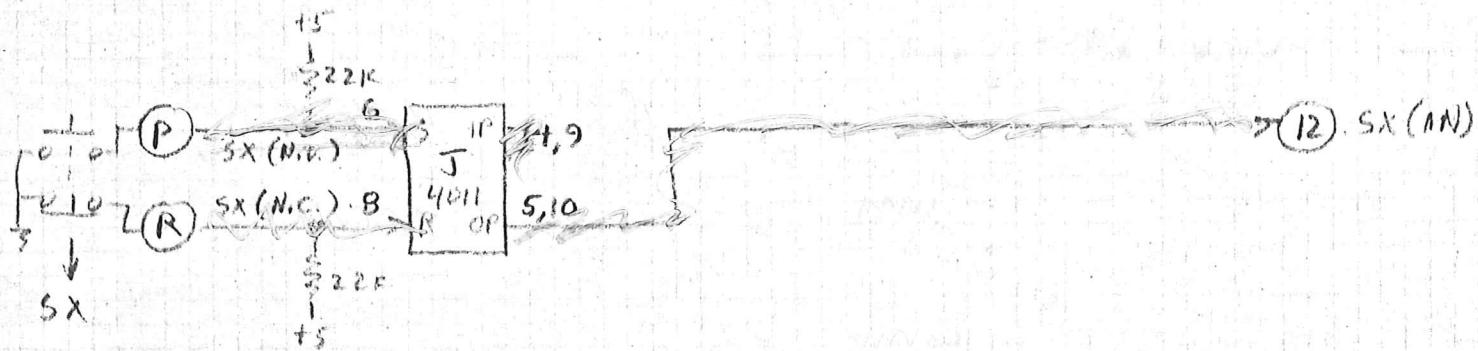
(IA)

SEPARATE 5VDC SUPPLY FOR CONTROL PANEL DISPLAY & CASSETTE
500 - 500 mA REG. - 14 308K



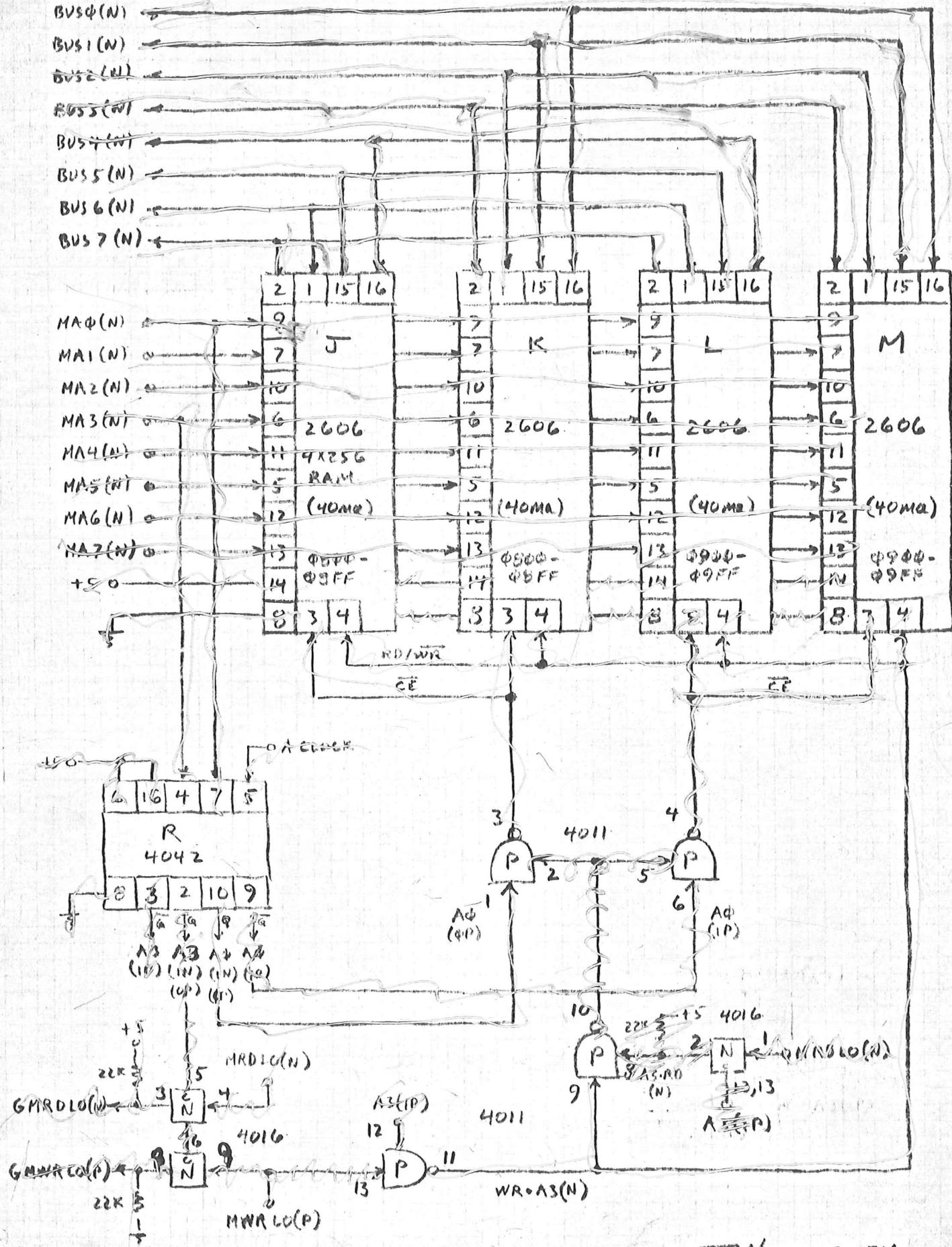
TV 4 - MSC - CARD A3

A	I	TPA(N)
LD(N)	B	TPB(N)
CSP+3(P)	C	S3(P)
CSC=1(P)	D	6119(P)
BVS 4(M)	E	S2(P)
BVS 1(IP)	F	627A(P)
LHT N.C.	G	DMA OUT(N)
LHT N.C.	H	7 NTFR.(N)
RHT N.D.	I	
RHT N.C.	K	
RHT N.C.	L	CLEAR(N)
STEP N.C.	M	SCO
STEP N.C., N	N	SX(IP)
SX N.D.	P	A0(I)
SX N.C.	R	A1(I)
RES(6)	S	A2(IP)
RVS(6)	T	BWA(P)
READ(6)	U	MRI(P)
LME(11)	V	F104(P)
RMS(11)	W	V3/M6(N)
C	X	V/H SYNC(N)
Z	Y	45
GND	Z	GND



CARD A12-RAM.

512 BYTES @ \$800 → \$9FF



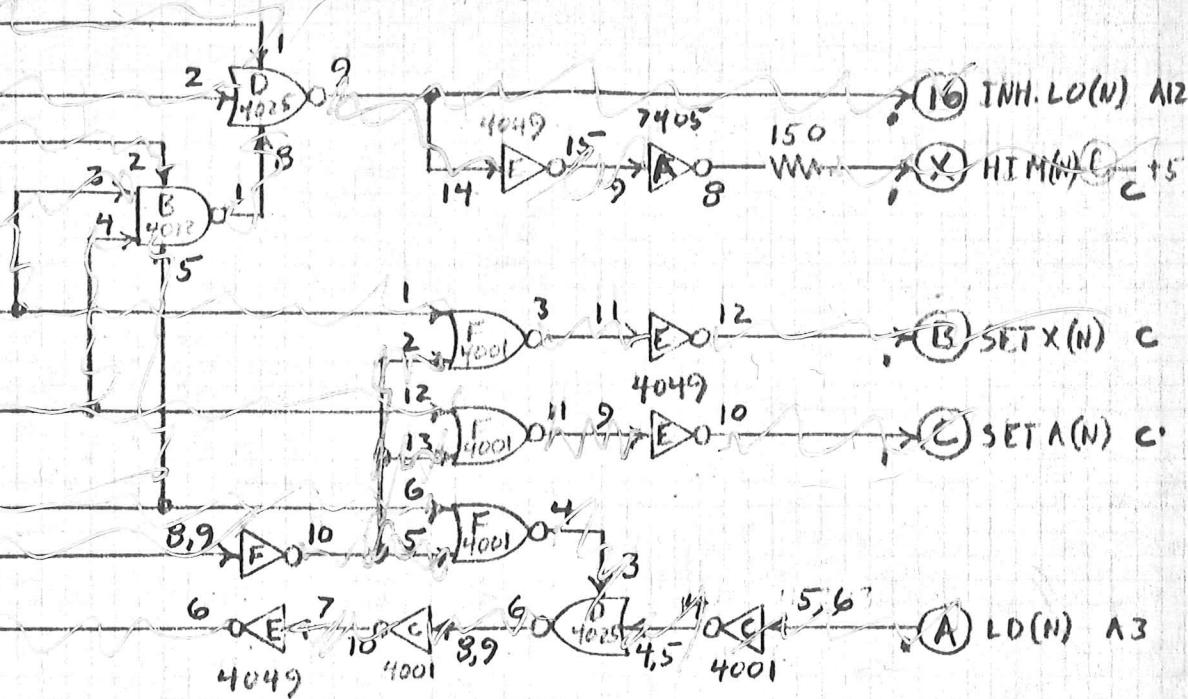
JAW 12-12-74

MSC - CARD B3

A3 RHT(P) (W)

A3 LHT(P) ✓

A12 A7(M) (20)



4049 7465

$F2(N) \rightarrow E > 0^2 \rightarrow A > 0^2 \rightarrow F \text{ RUN}(N) B2$

4049

F4(N) J → E O 4 → A O 4 → 150 m → K ERR C

4065-
B1 SPKR B.W. i 11/12/13 D G

EEG (IND) M 9,10 B + 33.52 WVV O + 5

A6 EX(IP) (N) → AC → 3 → 11,12

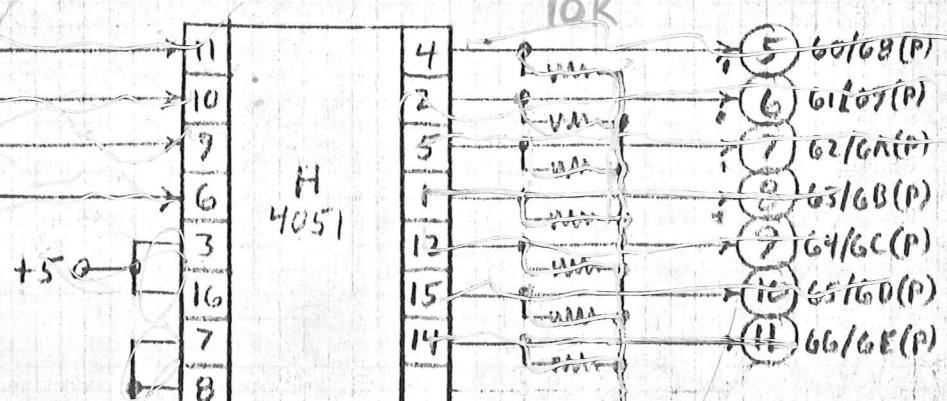
4001

NO (W) 5

NI (W) (T)

M2 (W) (H)

THE END

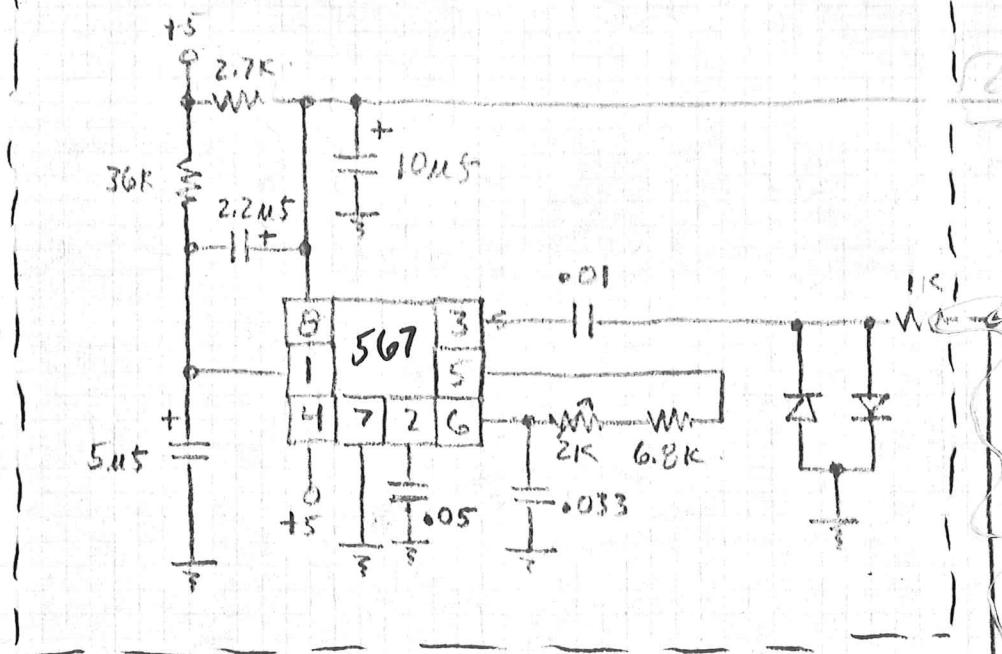


35 PINS

JAN 11-1-74

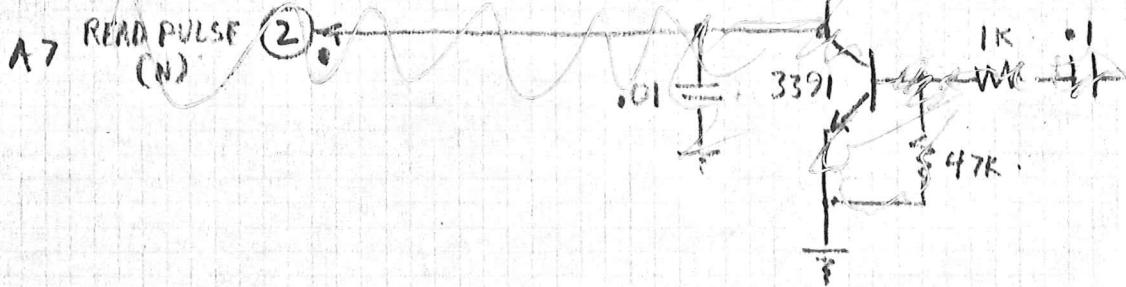
TONE & READ CKTS - CARD B3

- TONE CIRCUIT -



STOP TONE
(N) A7

① S.R.(N.O.)
AUDIO IN B2



A7 READ PULSE
(N)

②

WRITE CIRCUIT

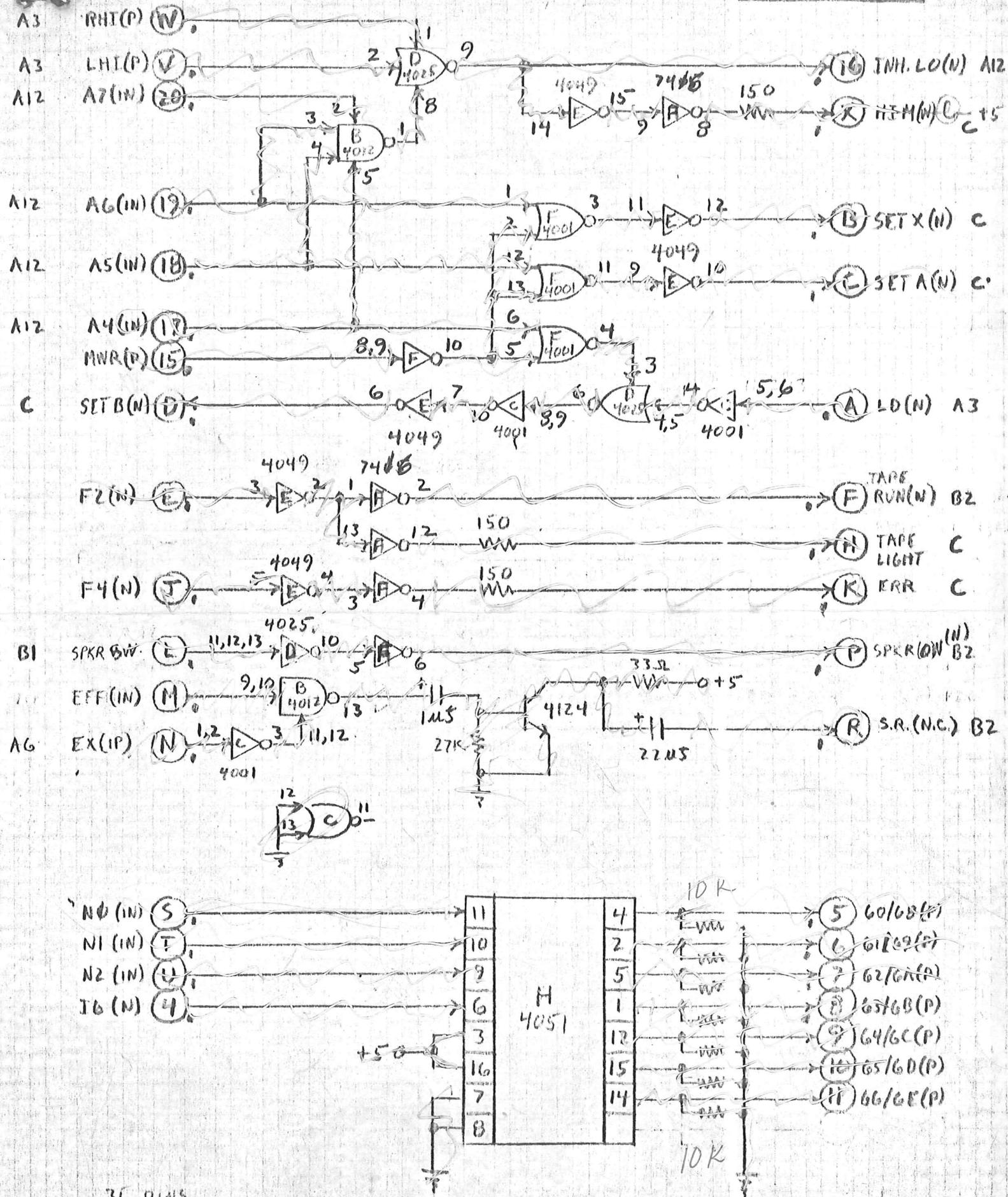
TAPE
WRITE PULSE
(P)

⑬

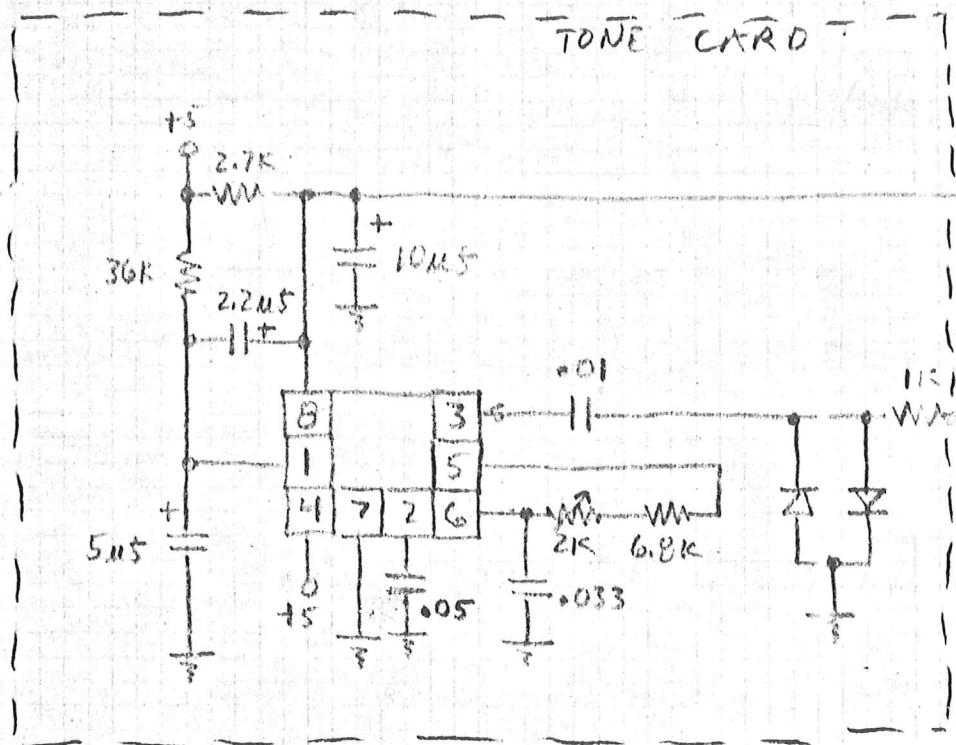
⑭ JS WRITE
SIGNAL
OVT.
CONA

JAW 11-1-74 V

LD(N)	A	1	S.R.(N.O.)
SETX(N)	B	2	READ PULSE
SET A(N)	C	3	AUDIO IN
SET B(N)	D	4	3.6(N)
F2(N)	E	5	0.0169(P)
RVN(N)	F	6	61/62(D)
TAPE LIGHT	H	7	62/63(P)
F4(N)	I	8	63/64(P)
ERR LIGHT	K	9	64/65(P)
SPKR SW	L	10	65/66(P)
BT1(N)	M	11	66/67(P)
BT1(P)	N	12	TAPE WR PULSE
SPKR ON(N)	P	13) WRITE SIG.
S.R.(N.O.)	R	14	OUT
NO (N)	S	15	MWA(P)
N1 (N)	T	16	TNH LD(N)
N2 (N)	U	17	A4 (IN)
LHT(P)	V	18	A5 (IN)
RHT(P)	W	19	A6 (IN)
HIGHLIGHT	X	20	A7 (IN)
+5	Y	21	+5
GND	Z	22	GND



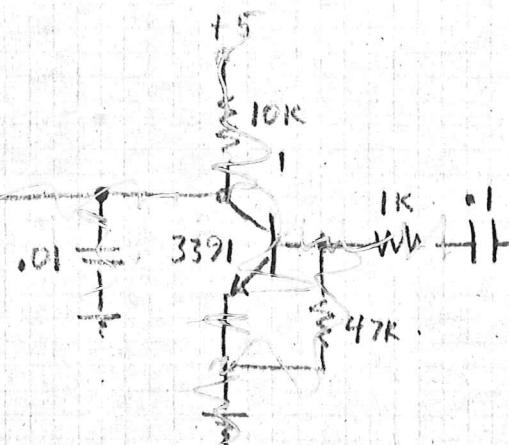
TONE & READ CKTS - CARD B3



STOP TONE
(N) 17

① S.R.(N.O.)
AUDIO IN B2

A7 READ PULSE (2)



LD(N)	A	1	S.R.(N.O.)
SETX(N)	B	2	READ PULSE
SETA(N)	C	3	AUDIO IN
SETB(N)	D	4	T6(N)
F2(N)	E	5	00/00(P)
RUN(N)	F	6	01/00(P)
	G	7	02/GA(P)
	H	8	03/0B(P)
	I	9	04/0C(P)
	J	10	05/0D(P)
	K	11	06/0E(P)
	L	12	TAPE WR PULSE
	M	13	WRITE SIG.
	N	14	RD(P)
	O	15	MWA(P)
	P	16	TNH LD(N)
	Q	17	A4(N)
	R	18	A5(N)
	S	19	A6(N)
	T	20	A7(N)
	U	21	+5
	V	22	GND

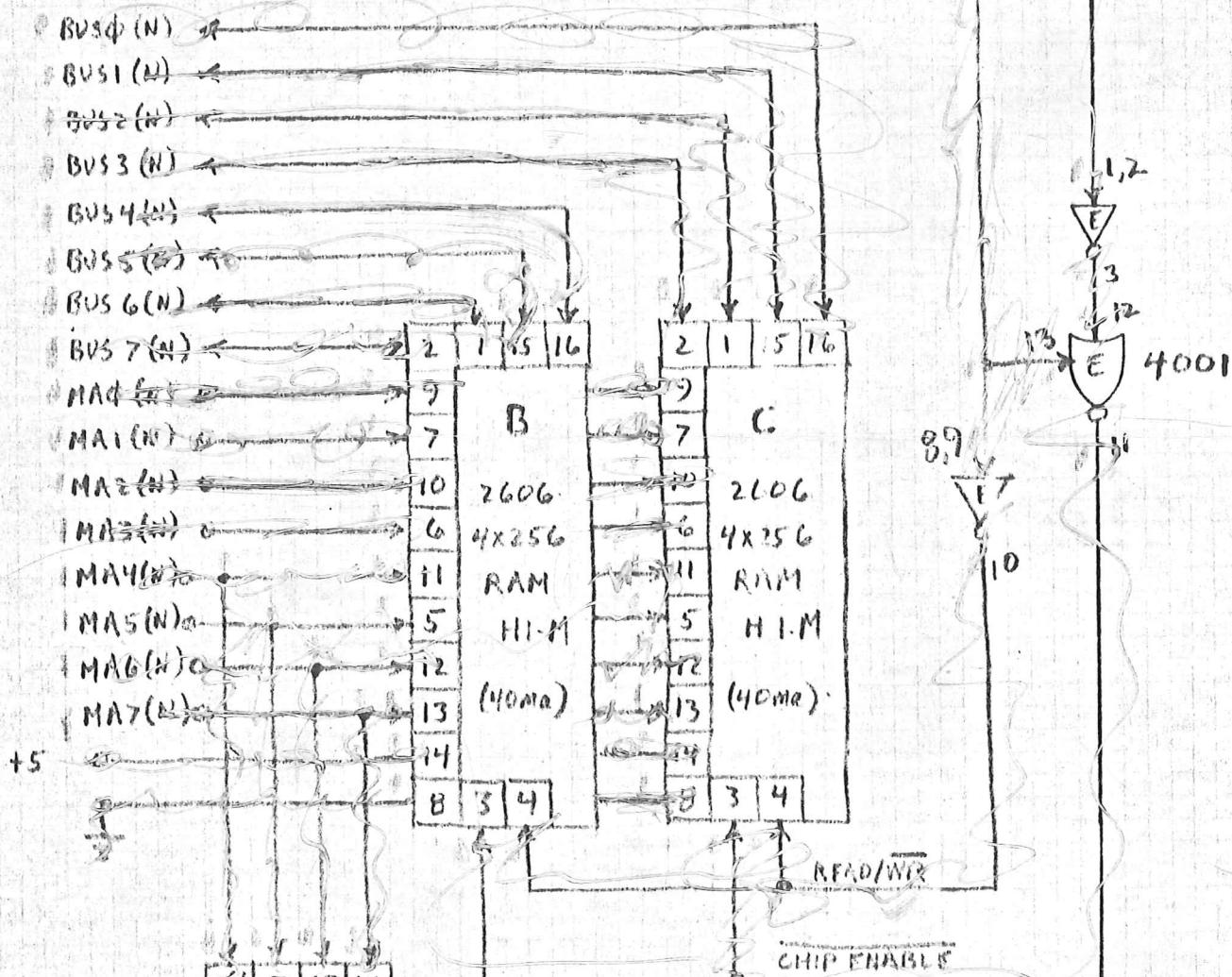
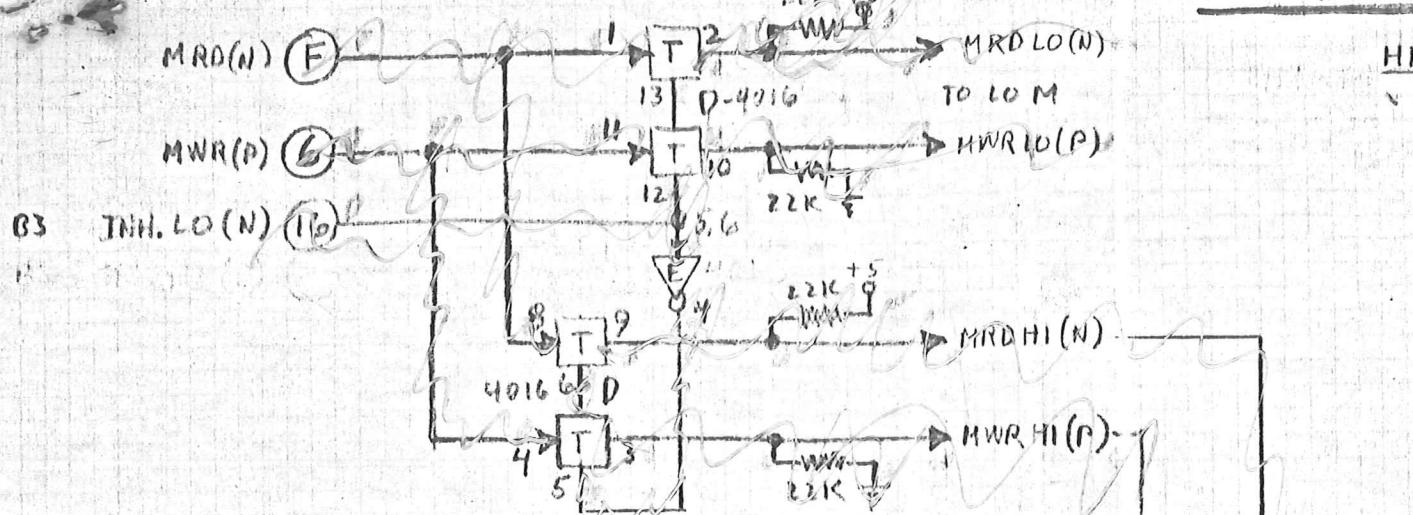
WRITE CKT.

TAPE
WRITE PULSE (12)

WRTTE
SIGNAL
OVT.
COAX

JAW 11-1-74

CARD A12-RAM

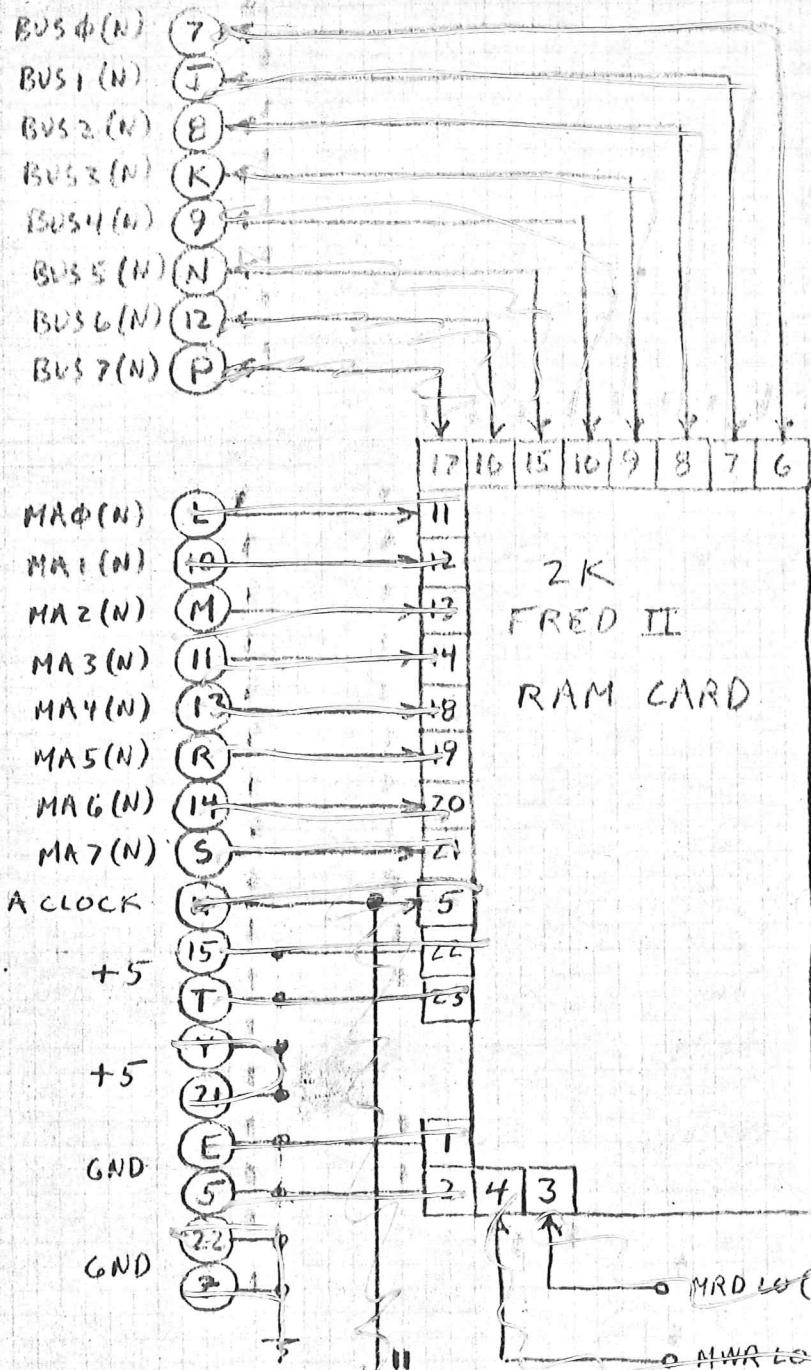


A4 AS AG A7
(IN) (IN) (IN) (IN)) B3

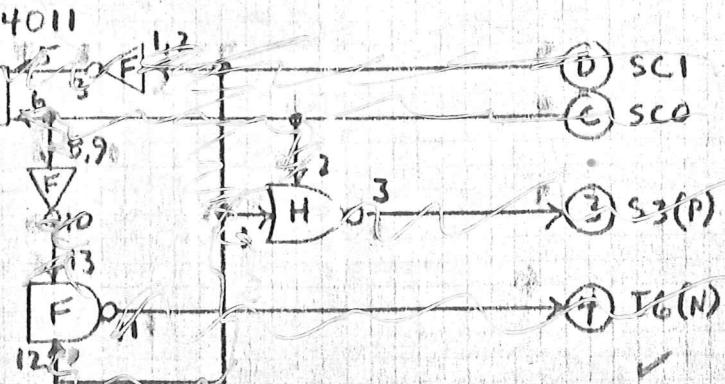
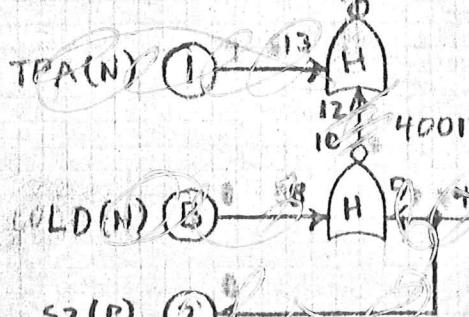
JAN 11-1-74 ✓

CARD A12-RAM.

L O - M .

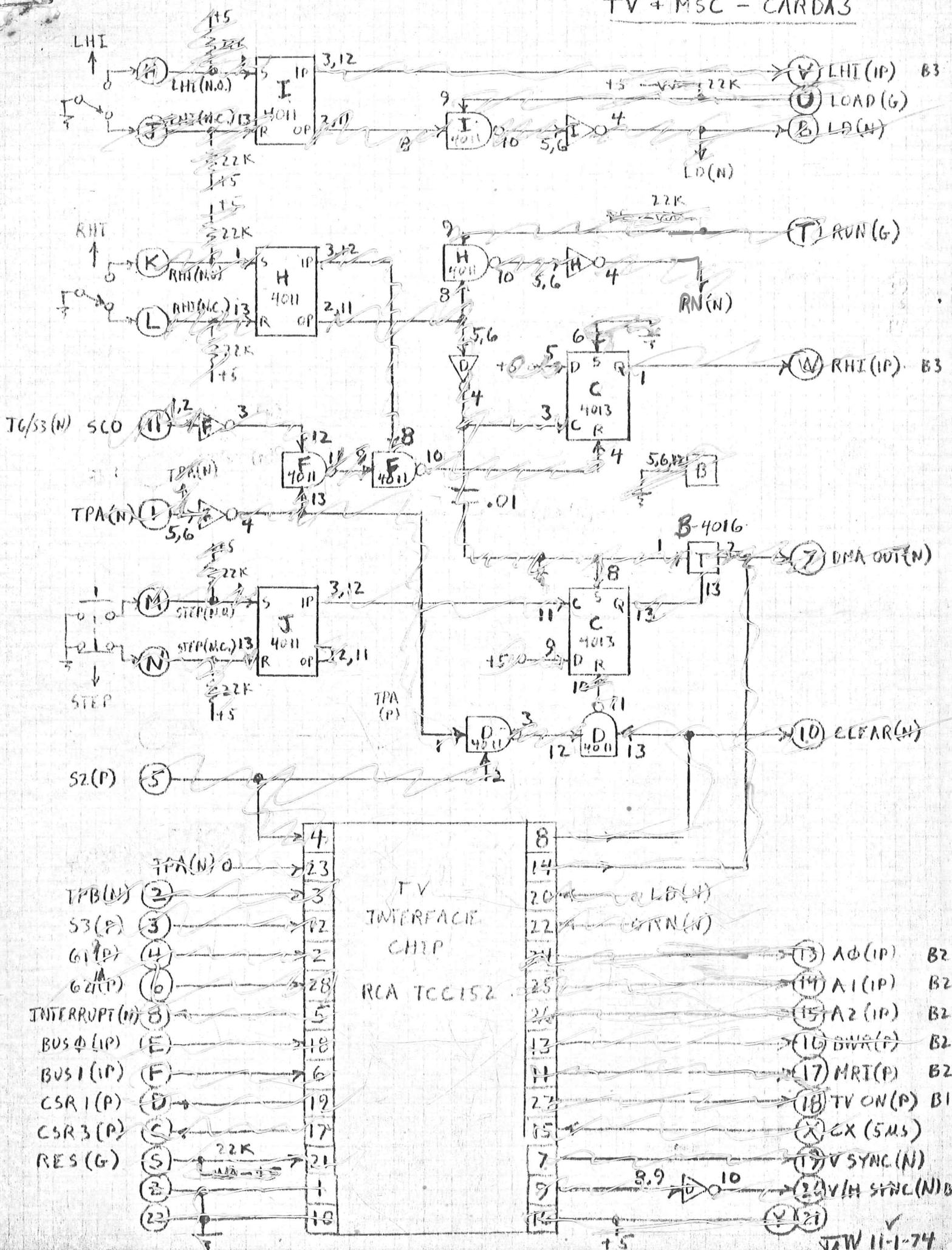


- MRD Lo(N) } FROM PAGE 1
- MWD Lo(p)



JAW 11-1-24

TV + MSC - CARD A3



TV + MSC - CARD A3

	A	I	TPA(N)
CSP+3(P)	B	2	TPB(N)
CSP+1(P)	C	3	S3(P)
BUS φ(D)	D	4	6119(P)
BUS 1(IP)	E	5	S2(P)
LHD N.C.	F	6	621A(P)
LHD N.C.	G	7	DMA PVT(N)
LHD N.C.	H	8	T INTER.(N)
RHI N.N.	K	9	
RHI N.C.	L	10	CLEAR(H)
S1CP N.D.	M	11	SCO
S1EP N.C.	N	12	SX(IP)
SX N.C.	P	13	A0(IP)
SX N.C.	R	14	A1(IP)
RFS(6)	S	15	A2(IP)
RVS(6)	T	16	BWR(P)
LOAD(6)	U	17	MRI(P)
LHE(IP)	V	18	TVOW(P)
RHS(IP)	W	19	V3TAG(N)
CX	X	20	V/H SYNC(N)
VS	Y	21	VS
GRD	Z	22	GRD

