SPACE WARS™

THE CENTER OF ATTENTION
FOR YEARS TO COME

SERVICE AND OWNERS MANUAL

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SPACE WARS SERVICE

AND

OWNER'S MANUAL

CONTENTS

INTRODUCTION

****

Dear Space Wars Owner:

This manual is provided to allow the owner of the Space Wars game and personnel assigned to service the game a greater understanding of its operation. It is hoped that the deeper understanding of your Space Wars game will aid in reducing any down time that may be encountered by providing better technical assistance and general information pertaining to upkeep and parts procedure.

Also contained within this manual can be found information pertaining to your Space Wars warranty, and repair procedures for any defective assemblies under warranty.

Your Space Wars game is designed to provide you and your customers maximum return in both profits and enjoyment throughout the longevity of the game. Please take the time to read through this manual as it will help to keep your investment in good order.

Thank you!

Frank Sola
Service Department
Cinematronics, Inc.

GENERAL INFORMATION

Generally speaking, your Space Wars game is designed much the same as conventional video games. The only major exception to this is the fact that the Space Wars game is provided with an alternate means of visual display: the patented Vectorbeam tm * monitoring system.

The game is, however, built of the same basic building blocks as any other video game.

The <u>Power Supply</u> which provides all necessary voltages to power each separate electronics assembly as well as all lighting required throughout the game. It must be noted that there are "on board" regulators provided for certain voltages needed on both the audio logic board and the display printed circuit board. The plus five (+5) volts d.c. regulated voltage for the central processing logic board (CPU) is developed totally on the power supply. This same voltage is used where needed on the audio logic board and also the display printed circuit board.

The <u>Central Processing Unit</u>, contains circuitry to strobe and interpret all input functions including the player control panel switches and all coin and credit information and to create all the digital signals used in providing the visual display. It also contains all the software (i.e., machine language and game personality memory) needed to control the game operation and to generate the proper vectors needed to display.

* "Vectorbeam tm" is Cinematronics service mark for video game repair and educational services.

In fact, the CPU logic board contains a great portion of the vector generating system, which also includes the display unit. The CPU logic board also controls the switching (electrically) of the audio printed circuit board.

The Audio Board, as in many other video games, is comprised of a noise generator and the associated wave shaping circuits as well as a number of amplifiers. The various audio tones are simply switches to the output amplifier stages on command from the CPU logic board.

The Vectorbeam tm * Display Electronics is the final form of interpretation of the CPU's calculations. The CPU logic informs the display electronics unit of information regarding line length and line placement on the CRT. This is accomplished with two twelve-bit words, one each for horizontal and vertical deflection, and a number of other controlling signals for the cathode drive circuit and switching in the deflection circuits.

The major difference between the vector generator and raster scan type monitors is the means by which the cathode beam is directed (deflection) across the screen.

In the raster scan types of display the electron beam from the cathode to the anode of the CRT is constantly deflected (scanned) across the face of the CRT in a series of horizontal lines that trace from the upper portion of the screen to the bottom in a syncronous pattern. Vertical information is added, also syncronous with the horizontal, forming a matrix-type pattern of mathematically possible illumination points on the CRT. If the cathode current is increased at these points on the screen in matrix-type patterns (similar to placing dots on a piece of graph paper where the lines intersect) coherent video in the form of shapes and alpha-numerics to form the game backgrounds can be displayed.

The vector generator takes a slightly different approach to cathode beam deflection. The results are a much higher degree of resolution and much smoother motion across the screen, as well as the ability to draw true curved lines on the screen. Rather than using a constantly scanning cathode beam, the beam is directed only to points of eventual illumination, using a vectoring form of programming rather than a matrix approach. Basically, the cathode beam is directed between two determined points, and illuminates the entire path of phosphores between these two points, unless blanked by stopping cathode current (i.e.: when the beam moves from one star to another on your screen). The ability to illuminate (1.) direction desired, (which is not possible in a raster scan system) creates a much higher degree of resolution than can be found in a raster scan system, while at the same time creating a much greater number of angle possiblities. This is also supported by the ability to accomodate two twelve-bit words of information, twelve each for vertical and horizontal deflection, and the fact that there is no background illumination from a constantly scanning beam when brightness is turned up. The higher degree of resolution combines with the totally blackened background creating an appearance of depth not found in a raster scan system.

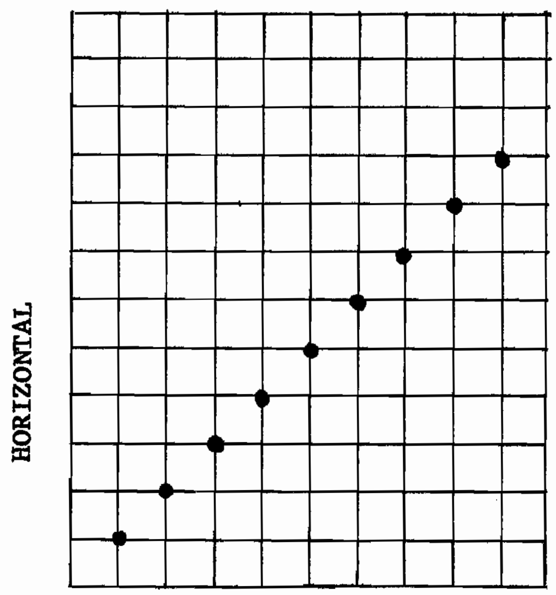
Another major design difference is the fact that no sync. signals are needed to produce vectors on the CRT. This greatly simplifies the hardware design of the system, and therefore the understanding of the theory of operation, of the CPU logic as well as the display electronics.

(1.) The entire path of phosphors crossed by the electron beam, in any

VECTOR THEORY

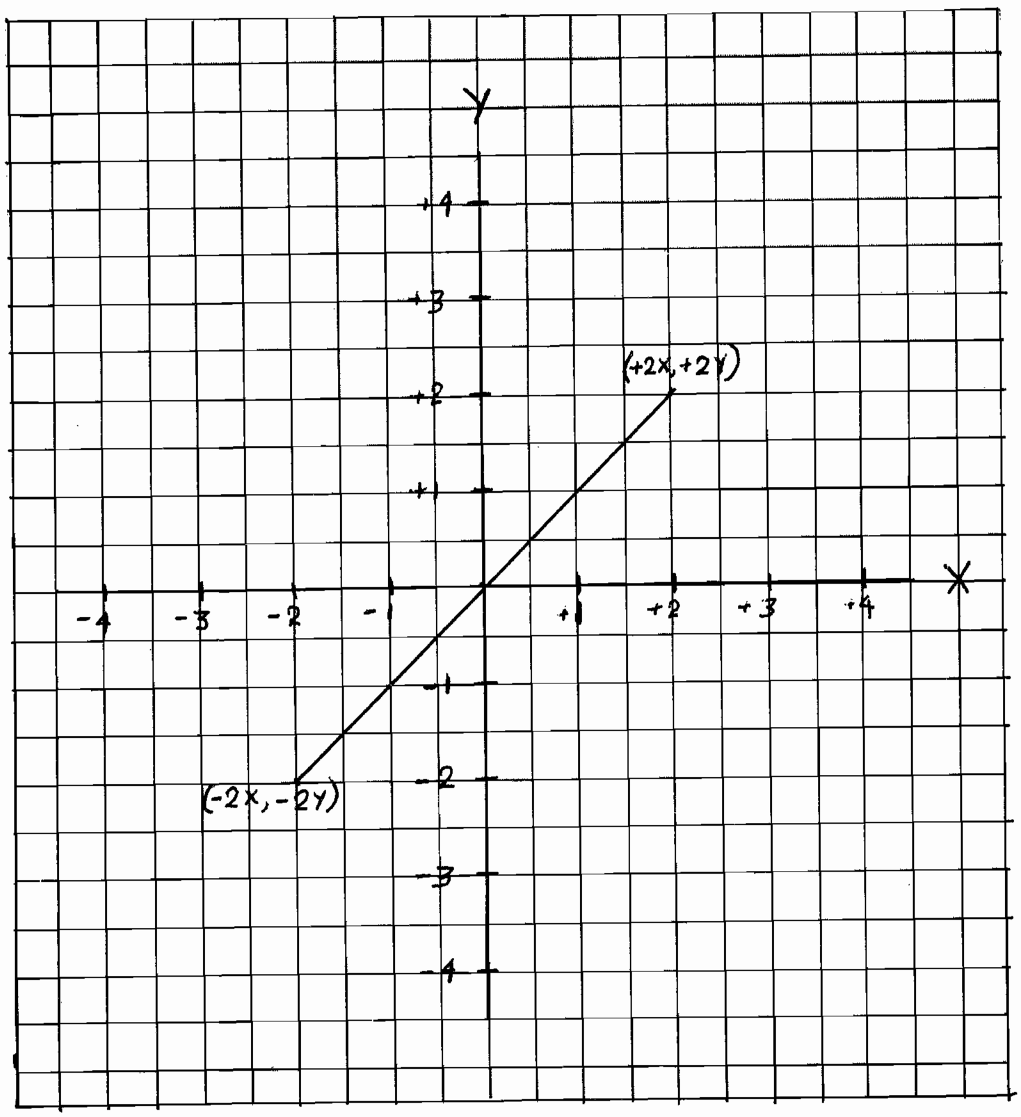
In order to understand the basic concept behind a vector generated display, it is important to have a basic knowledge of vector theory.

As mentioned in the general information section of this manual, the raster scan display uses a matrix type display pattern. A graphical representation of a matrix is shown below in Figure A.



For example, to produce a line on the CRT with a matrix-type pattern, the appropriate intersection points of horizontal and vertical lines are illuminated. The calculations which select these points are made on the logic board, and converted into video information for the monitor to digest. Although there are spaces between the illuminated points, the illusion of a solid line is made by your eyes, and the resolution is determined by the number of available horizontal and vertical lines in the system, and the speed of the sweep.

In the vector display system, there are no horizontal and vertical lines (no sweep) or sync. a line created using a vector system as shown in Figure B., below.



A line is drawn by programming a beginning and ending point of the line to be drawn, and forcing the cathode beam to travel between these two points, illuminating the entire path of phosphorus on the CRT. The angle of the line, the position of the line, and the length of the line are determined simultaneously, and simply, by selecting the proper voltage levels for the beginning and ending points of the line.

The end result of using the vector generator is an immensely increased number of programable point, which is in direct proportion to the word size and the capabilities of the DAC-80 (i.e., greater esolution, definition and smoother motion using minimum of hardware).

CPU LOGIC THEORY

The CPU (central processing unit) logic board used in Space Wars is not a micro-processor, but rather a dedicated TTL processor, much like a mini-computer would use.

The primary advantages of using a dedicated processor versus a micro-processor are that the CPU logic is much faster electroncially, and it has the ability to use a word length designed for a specific task.

The primary disadvantages from a service standpoint, are that the system is heavily software controlled with it's own machine language and op-codes and there are a number of "loops" within the signal paths that are virtually impossible to trouble-shoot using ordinary means and techniques. The speed of the signals occuring on the CPU logic board are also a drawback of sorts, since very fast scopes must be used to analyze the signals.

Because of the difficulty encountered when service is necessary, a factory test fixture, a Hewlett Packard signature analyzer (model 5004A) and a specially prepared set of schematics must be used to repair the board. This trouble-shooting system has been designed to the point where virtually anyone with a minimum of electronics background is able to repair the CPU logic board.

There are, however, a few areas of the CPU logic board that should be understood, as they have a direct relationship with the display electronics, and also because there is not much difficulty in trouble-shooting these areas using conventional methods.

These areas are the IO devices between the CPU logic and monitor, the IO device between the CPU logic and the audio printed circuit board, and the reset circuit which performs self-test functions on the CPU logic board. There are six IO devices between the CPU logic board and the monitor.

Three of these devices are 74LS377, M2, P2, S2, latches, which provide the two twelve-bit words to the DAC-80's. The inputs to these latches eminate from six 74LS194's (M4, P4, S5, N4, R4, T4) which are part of the primary and secondary accumulators.

One IO device is a 74LS32, 2 input And Gate, at location J2. Pin 3 output provides the "intensity" signals to U7 (7406) on the display board. Pin 11 output provides the "brightness" signal to U7 of the display board. As mentioned before, these signals control the various intensity levels of the objects on the CRT, as well as the blanking of CRT cathode current.

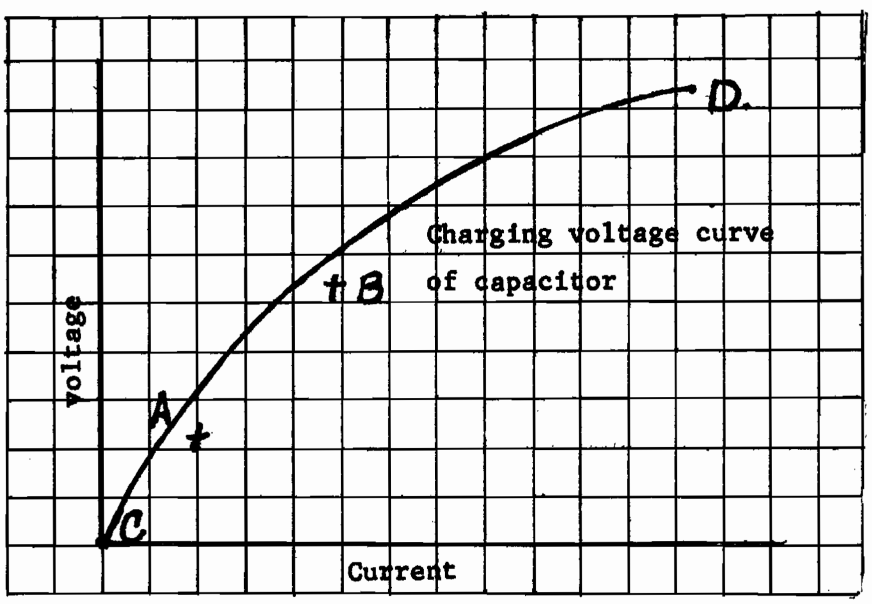
The final two IO devices found on the CPU logic board, that provide control signals to the display board, control the LF 13310 analog switch (U1) on the display board. These devices are found at locations H8, Pin 13 and G8 Pin 5, ("initial position" and "live drawing" respectively).

The IO device that is found at location F2 on the CPU logic board (74LS259) is the switching control output to the audio printed circuit board. Outputs 4,5,6,7,9, and 12 provide the two TL 182 switches on the audio board unit command signals. Output 10 is used in the coin control circuit on the CPU logic board, and output Pin 11 is used in the brightness control circuit.

Considering the fact that all of these devices mentioned are direct IO paths between the game's sub-assemblies, it is generally good trouble-shooting practice to check these IO devices on both assemblies if a problem is felt to be located in one of the two circuits. For example, if the TL182 switch on the audio printed circuit board were to fail, it could, not most likely would, cause the 74LS259 (F2) on the CPU logic board to fail also. If the TL 182 on the audio board is replaced, and the 74LS359 is not checked, there is a good possibility that the new TL182 will also fail, caused by the 74LS259 which was damaged originally. This same situation could occur between any two IO devices found in a problem area, or any board.

This is accomplished by the two twelve-bit codes (words) applied to the DAC-80's on the display board. The DAC-80 will produce a different voltage level at its output for each possible combination of input levels (of which there are 4128 possibilities for each 12 bit word.)

It is also important to remember the function of the LF 1331D (V-2) analog switch and its output RC network (see monitor theory). Because we are dealing with reactive components in C101 and C201 on the display board, the charging voltages found are non-linear by nature. (See Figure C., below).



Therefore, when a line appears on the CRT, it is actually only part (section A-B, Figure C) of the entire path taken between the beginning and ending points of the vector (C-D). The section of A-B is chosen as the most linear portion of the charge curve, and illuminated

Sections C-A and B-D are blanked at the cathode, and points A and B chosen by controlling the analog switch (V-1) on the display board. Again, these calculations are all performed on the CPU logic board.

The final area on the CPU logic board to consider is the reset circuit. If a failure on the CPU logic board occurs, in any of approximately 90% of the signals present on the board, a reset condition will occur. This reset condition will "shut down" the CPU logic and prevent any information from reaching the DAC-80 inputs of the display board. If this condition occurs, the two 25V circuit breakers (or fuses) will let go due to the saturation of the four output transistors in the deflection circuits on the display board. It is therefore essential to determine, if these breakers have tripped, whether the reset condition exists on the CPU logic board since the problem will appear at first sight to be in the monitor. The reset signal (actually reset) is found at C8 Pin 5 (74LS107) on the CPU logic board. It is necessary to use a logic probe with a very fast response (faster than 20 Nano seconds) or an oscilloscope with a horizontal sweep of at least 100 MHZ in order to see the reset signal which is a steady state high when the CPU logic board is functioning properly, and pulse is low or stays low when the CPU loigc board fails. It is also important to note that there are only a few controlling signals that will cause a reset to occur, (i.e., power up reset, cold start, etc.) By determining which of these signals causes a reset to occur, the section of the CPU logic board that has the actual failure can be isolated. This can be a very helpful tool in trying to isolate a problem on the CPU logic board.

VECTORBEAM MONITOR OPERATION

The vectorbeam tm monitor can be divided into two basic sections. One section is the deflection amplifiers, and the other section is the high voltage and cathode drive circuit.

The deflection amplifier can be further divided into two indentical channels: one for vertical deflection, and one for horizontal deflection. We will describe the operation of only one channel (vertical) and the same theory of operation will also hold true for the horizontal section.

Digital information, in the form of a twelve-bit word, is applied to the input of the DAC-80 digital to analog converter (U101) on pins one through twelve. The most significant bit (MSB) is applied to pin one, and the least significant bit is applied to pin twelve. The DAC-80 makes the necessary c onversion from digital signals to analog signals which are outputted as analog voltage signals on Pin fifteen (which is proportional in level depending on the input word applied). The result is a positive and negative voltage signal about its reference voltage (remember, there is no "sync" signal present, and the signal is not true video as seen in raster scan monitors).

From the DAC-80 the analog signal is then sent to a high-speed analog switch, (U1). The analog switch has two parallel inputs for the display signal, and two controlling inputs which select one of two outputs from the switch. At the outputs is found an R.C. network, which is used to create line length and line position on the screen.

Output fifteen from the switch routes the analog signal through a 5K potentiometer (R102), an 11k resistor, (R103) and to the input of U102 op-amp. The time constant developed by these two resistors and the capacitor (C101) determine the length of the vector line seen on the screen. Adjusting of the potentiometer will adjust the length of the vertical lines seen on the screen.

Output ten from the analog switch routes the signal directly to the input of U102 op-amp, and the resulting time constant of the op-amp input impedence and the capacitor C101 determines the position on the screen of the vector line.

Op Amp, U102, serves a dual purpose: one, it acts as a buffer between the deflection amplifiers and the analog switch; and two, it acts as an "edge gain" amplifier (i.e., height).

At the output of U102, there is a resistor amp, diode network consisting of R105-R110, and CR101 - CR104. This resistor diode network is used to compensate for the non-linear characteristics of the CRT near the edges of the screen. If this circuit were not used, any object displayed on the screen would increase in size as it moved closed to the edges of the screen. Also contained in the circuit is a potentiometer (R109), which adjust the height of the pictures.

From the wiper of R109, the signal proceeds to Q101, which is the first stage of deflection amplification. Q103 is an emitter coupled with Q101 to provide a degenerative feedback loop from the yoke. Q102 is used to provide a constant current source to both emitters.

At this point, the deflection circuit can again be divided into two identical circuits. One circuit, which controls the lower half of the screen, is comprised of Q104, Q106, Q108, and Q110. The other circuit, which controls the upper half of the screen is comprised of Q105, Q107, Q109, and Q111. **

Q104, Q108 and Q110 are three stages of amplification, while Q106 is used as current limiting protection for Q108 and Q110. The same holds true for the other configuration of Q105, Q107, Q109 and Q111. R124 through R129 are used as a current divider network for the yoke.

** In the horizontal section of the deflection amplifier, Q204, Q206, Q208, and Q210 control the left hand side of the screen, and Q205, Q207, Q209, and Q211 control the right hand side of the screen. By dividing the screen in this manner, four quadrants of deflection area have been developed (see vector theory chapter.)

R122, R123, and C102 form a RC network, which compensates for any CEMF that may develop by the expanding and collapsing of the deflection coil's electromagnetic field.

The high voltage and cathode circuitry is the second section of the monitor. This section also contains the necessary voltage regulation to power the IC's located on the display board as well as develop the high voltage.

U4 and U6 provide plus 15V and minus 15V respectively to power the DAC-80's and the TL081 op-amps on the display board.

U3 and U5 provide plus 18V and minus 18V used in the high voltage transformer (T-1) and oscillator (the oscillator circuit is necessary because there is no horizontal sync. used to develop the high voltage pulses.) The oscillator circuit is comprised of primary windings, Q4 and associated discreet components.

The high voltage 18KV is developed by T1 secondary windings, the high voltage tripler, and the focus circuitry. The potentiometer, R16, is used to adjust the focus of the cathode beam.

One of the secondary windings of T1 develops the necessary cathode voltage, which when measured at the cathode of CR6 should read 88VDC. The cathode circuitry in the vectorbeam tm monitor is comprised of U7, a 7406 IC used for buffering logic signals which control brightness and blanking. It also contains the transistors, Q1, and Q2, and Q3, and then associated discreet components.

Q1, and the first gate of U7 control the brightness of the cathode signals upon command of the CPU logic board. Q3 and the second gate of U7 control the intensity (blanking) of the cathode signals, also upon command of the CPU board. Q2 is used as a power failure protection for the cathode circuit in the event of a loss of 25V power supply voltage. This protection aids in avoiding phosphor burning on the CRT. R111 is the brightness potentiometer, which adjusts the amplitude of the negative spikes used for brightness and intensification.

TROUBLE SHOOTING HINTS

Read carefully before servicing game. Because of a number of design criteria in your Space Wars game, a problem that arises will generally cause one or both of the twenty five (25) volt fuses or breakers in the power supply to blow. When this occurs, the following procedures will aid in locating the fault assembly. It is important that this procedure be followed in the order in which it is written!

1. Unplug the game and short or meter the two filter capacitors found in the power supply. These are the two 20,000 micro-fared capacitors mounted near the transformer. They will maintain a charge when the fuse(s) are blown.

2. Replace the fuse(s) with MDL-3 Fuses.

3. Disconnect the Molex plug and the ribbon connector from the monitor.

4. Plug in the game again and observe the fuses.

5. If the fuses remain in tact, place a credit on the game.

6. Start a game as if you were going to play, and listen for the game sounds.

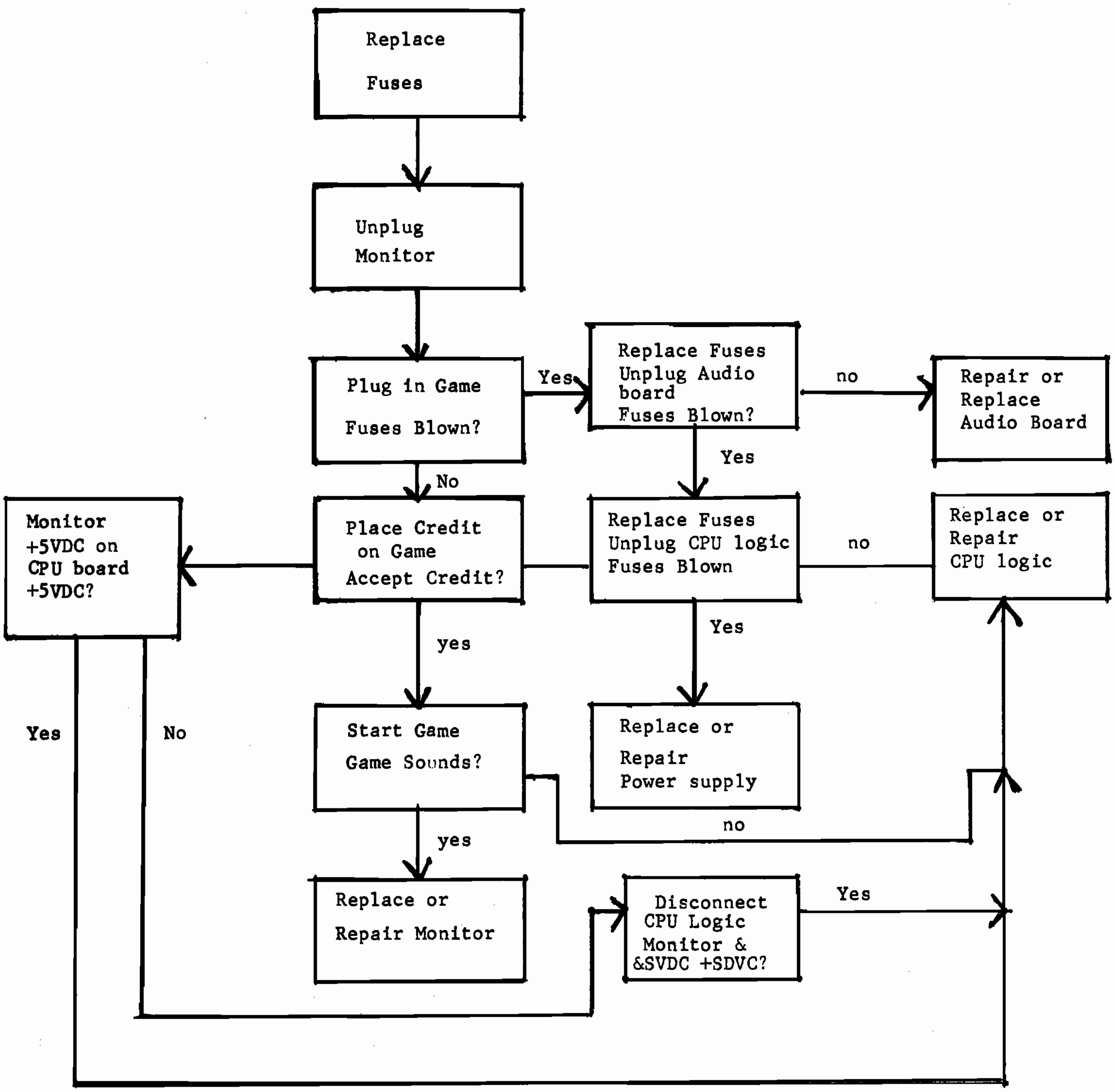
7. If the sounds of the game (acceleration and fire) are present, the problem is in the monitor. If the sounds are not present, or if they are distorted, the problem generally is in the CPU logic board.

The reasoning behind this procedure is that if a failure occurs, in the CPU logic board, it will enter a "constant reset" mode. When the CPU logic board is in this mode of operation, or when there is a lack of computer information at the monitor input (i.e., disconnected a faulty ribbon cable), the monitor will automatically deflect the electron beam off the screen to protect the phosphors in the CRT. When this occurs, the monitor deflection amplifiers will enter a current limiting state and eventually cause the fuses to blow.

For further troubleshooting procedures, use the flow chart provided.

NOTE: It is important to follow steps one and two every time a fuse blows, to protect yourself from electrical shock, and also to protect the game from further damage.

TROUBLE SHOOTING FLOW CHART



SUGGESTED PARTS FOR STOCK

Due to the fact that the vectorbeam tm system is a new type of display technology, there are a number of components used which may have limited availability from your local parts suppliers. It is suggested that the following list of parts be purchased from Cinematronics in the event servicing of your game becomes necessary:

1. TL182 - Analog Switch
2. TL081 - Op Amp
3. 7918 - Regulator IC
4. 7915 - Regulator IC
5. 7818 - Regulator IC
6. 7815 - Regulator IC
7. LF 1331D - High speed analog switch
8. DAC-80 Digital to Analog Convertor **
9. 74LS259 - IC (Texas Instruments only)
10. 74LS32 - IC
11. Set D-ROMS (1-6)
12. Masked ROMS

Note: Contact factory for current prices

WARRANTY FOR SPACE WARS

Cinematronics, Inc. warrants the goods to be free from defects in materials and workmanship under normal use and service for a period of (12) twelve months from the date of delivery on all parts except switches, potentiometers, buttons, fuses and lights, for which the warranty period is of ninty (90) days from the date of delivery. Cinematronics makes no representation or warranties concerning the goods whether express or implied by operation of law or otherwise, including those of merchantability or fitness for any particular purpose, or with respect of patent infringement, except as may be specifically made herein, to the repair or replacement of such parts which have been returned to Cinematronics plant at purchaser's expense and which examination shall disclose to Cinematronics satisfaction to have been so defective and to be the shipment of such repaired or replacement parts to the purchaser F.O.B. the shipper point.

This warranty does not apply to any Cinematronics product which has been altered or repaired by unauthorized personal or service facilities or any products which have had the unit serial number altered or removed.

Upon acceptance of the goods, the purchaser agrees to assume all liabilities for damage and/or bodily injury by the purchaser or any other c laims arising from the use or service of the goods by any person. Purchaser further agrees to idemnify Cinematronics, Inc. from any liability, claim, cause of action or litigation resulting from the use or misuse of the goods by any person.

RETURN AND ORDERING PROCEDURES

When it becomes necessary to return items to the factory for repair or replacement, or to order parts from the factory, the following procedure must be used:

1. All items returned must be accompanied by a credit memo which includes the items returned, the serial number of the unit from which they came, and whether the units are for credit against advance replacements or for repair or replacement and return.

2. When the items are for credit against advance replacement, reference must be made to the Cinematronics invoice that was received with the advance replacement item(s).

3. All items and/or parts ordered from Cinematronics, whether in or out of warranty, must be placed with a Distributors purchase order, either by mail or verbally by telephone.

4. Advance replacement items may be obtained from the factory, when available, using the same procedure as when ordering parts.

5. All items received as advance replacements will after a period of thirty (30) days, become customer property, and applicable charges and prices will be applied, if Cinematronics, Inc. has not received the defective units to credit against the original invoice(s).

6. In all situations convered above, and in all other situations, the warranty offered by Cinematronics, is applicable, and should be fully understood.

OPERATORS ADJUSTMENT OF

SPACE WARS

The Cinematronics Space Wars video game using the patented vectorbeam™ monitor has three adjustments inside the cabinet which can be set by the operator.

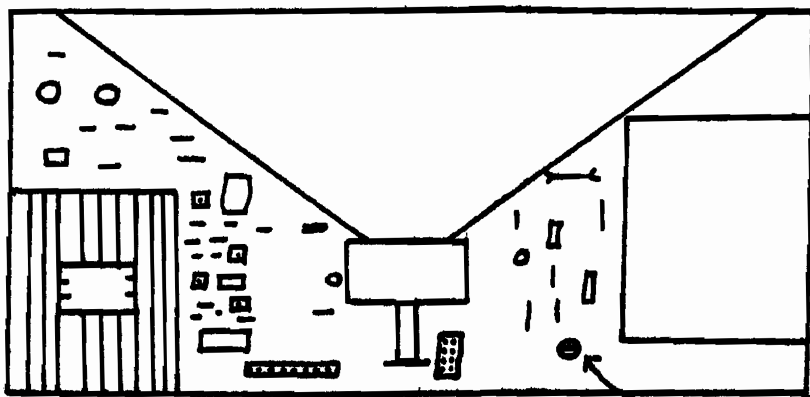
1. Sound effects volume (see SOUND BOARD DRAWING: FIGURE 3)
2. Display intensity (see MONITOR CHASSIS LAYOUT: FIGURE 2)
3. Game time per coin adjustments (see LOGIC BOARD LAYOUT: Figure 4)

NOTE: All other adjustments inside the game cabinet are factory adjustments to be reset if necessary by authorized personnel only. Incorrect adjustments may permanently damage the machine.

FUSES: The Space Wars game has three fuses located on the power supply chassis. Replace blown fuses with 3 AMP slow blow fuses.

WARNING!

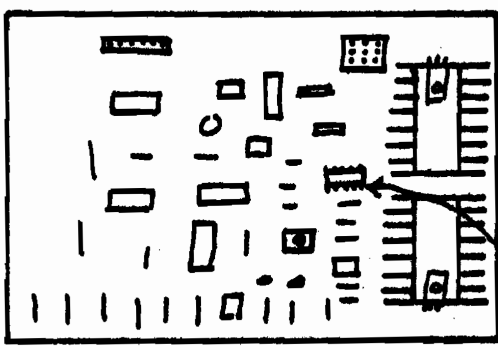
DO NOT CONNECT OR DISCONNECT WIRES OR CABLES INSIDE THE MACHINE WITH THE POWER ON. DAMAGE WILL OCCUR AND WARRANTY WILL BE VOID.



VECTORBEAM™ MONITOR

figure 2

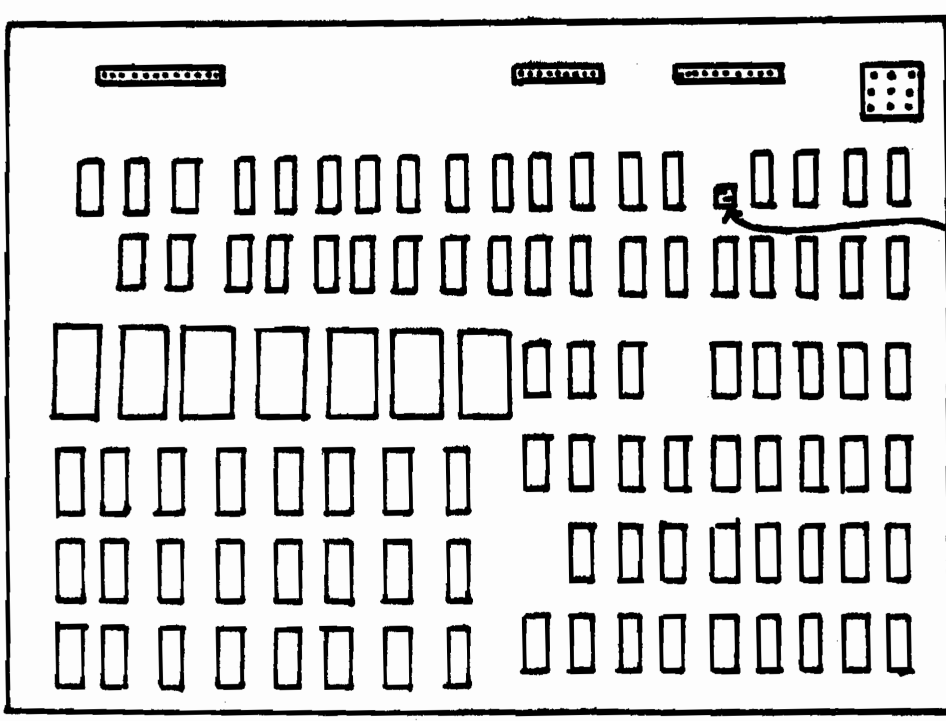
BRIGHTNESS CONTROL



AUDIO BOARD

figure 3

VOLUME CONTROL



LOGIC BOARD

figure 4

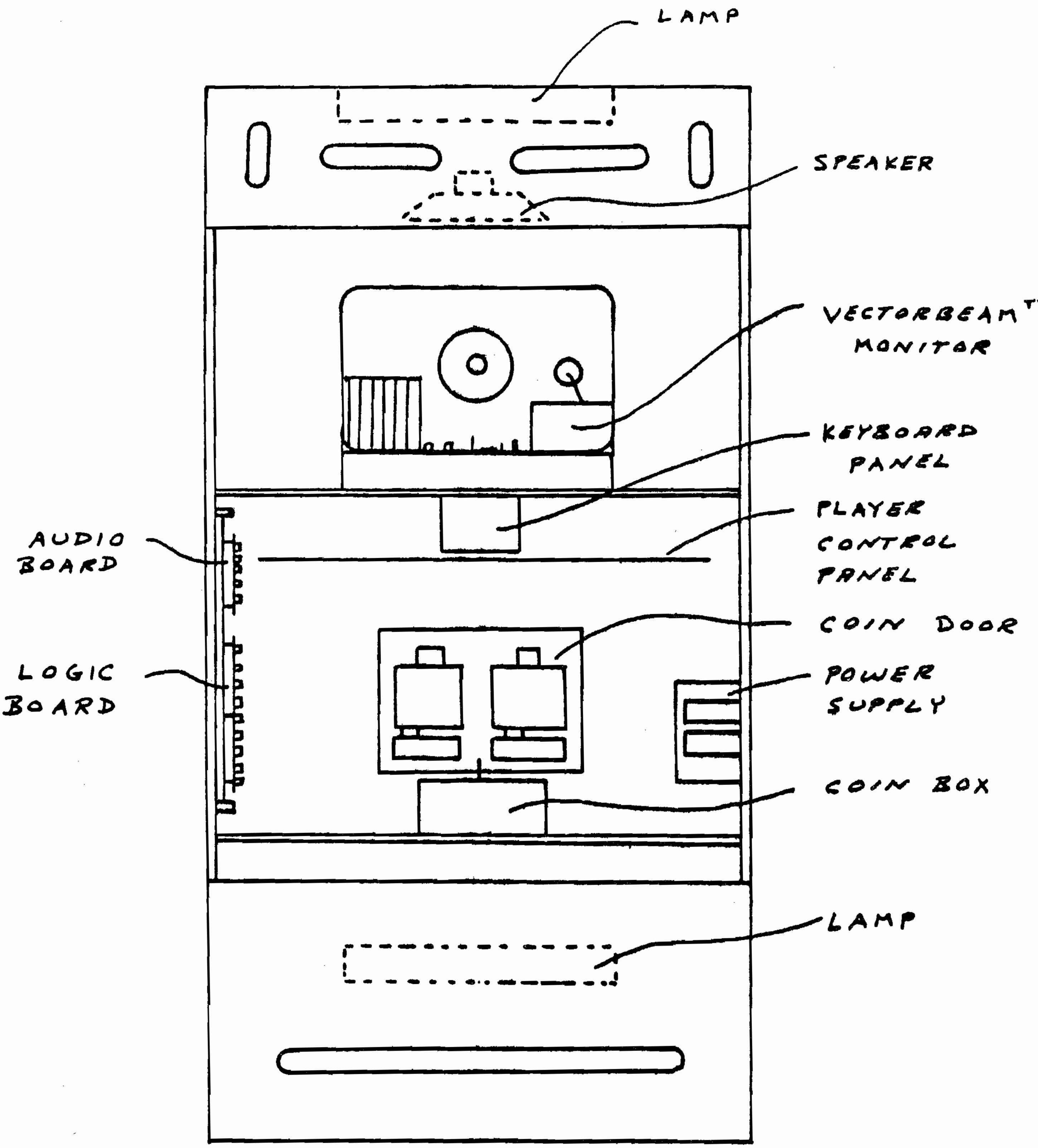
GAME TIME PER COIN

1:00

1:30

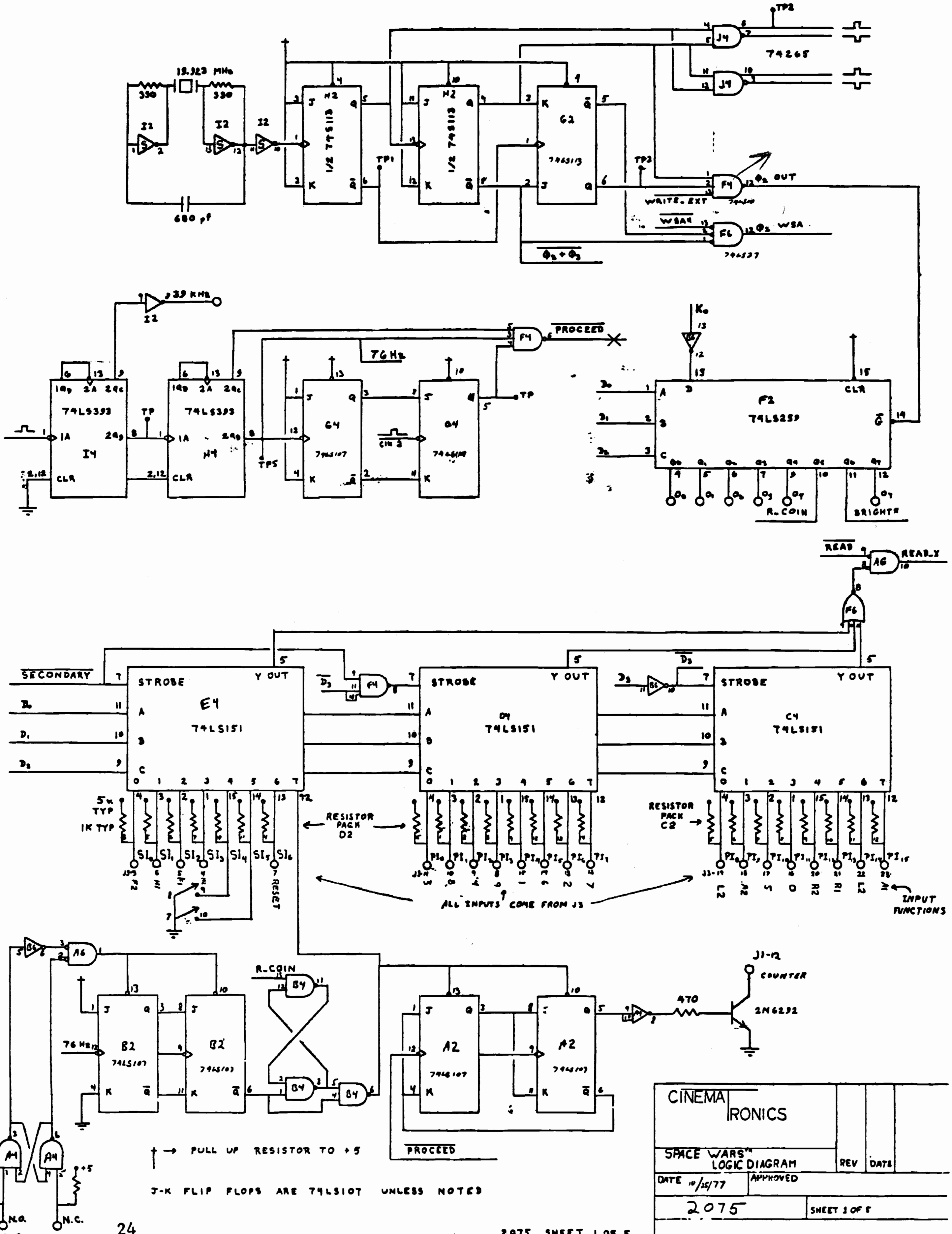
2:00

:45

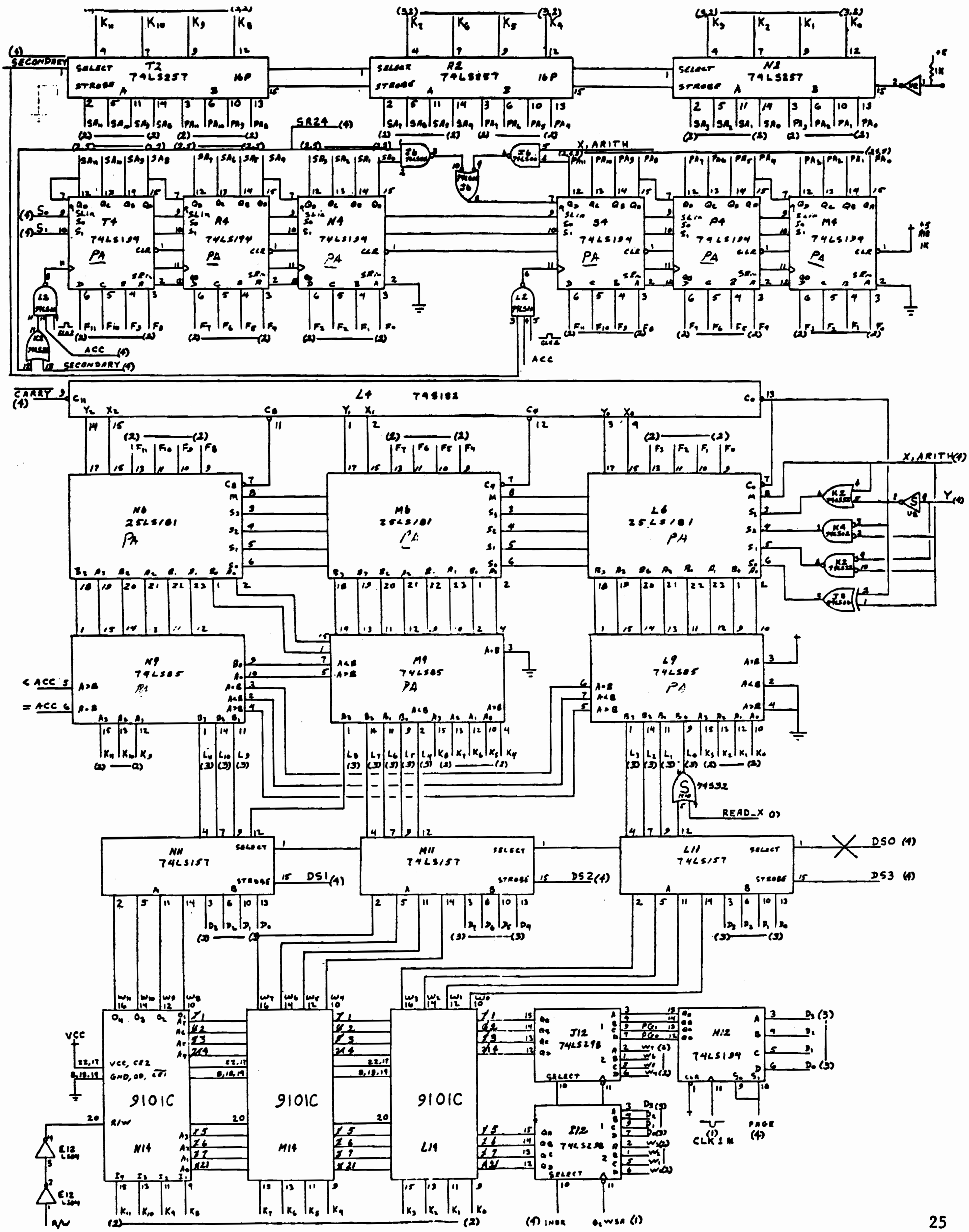


SPACE WARS

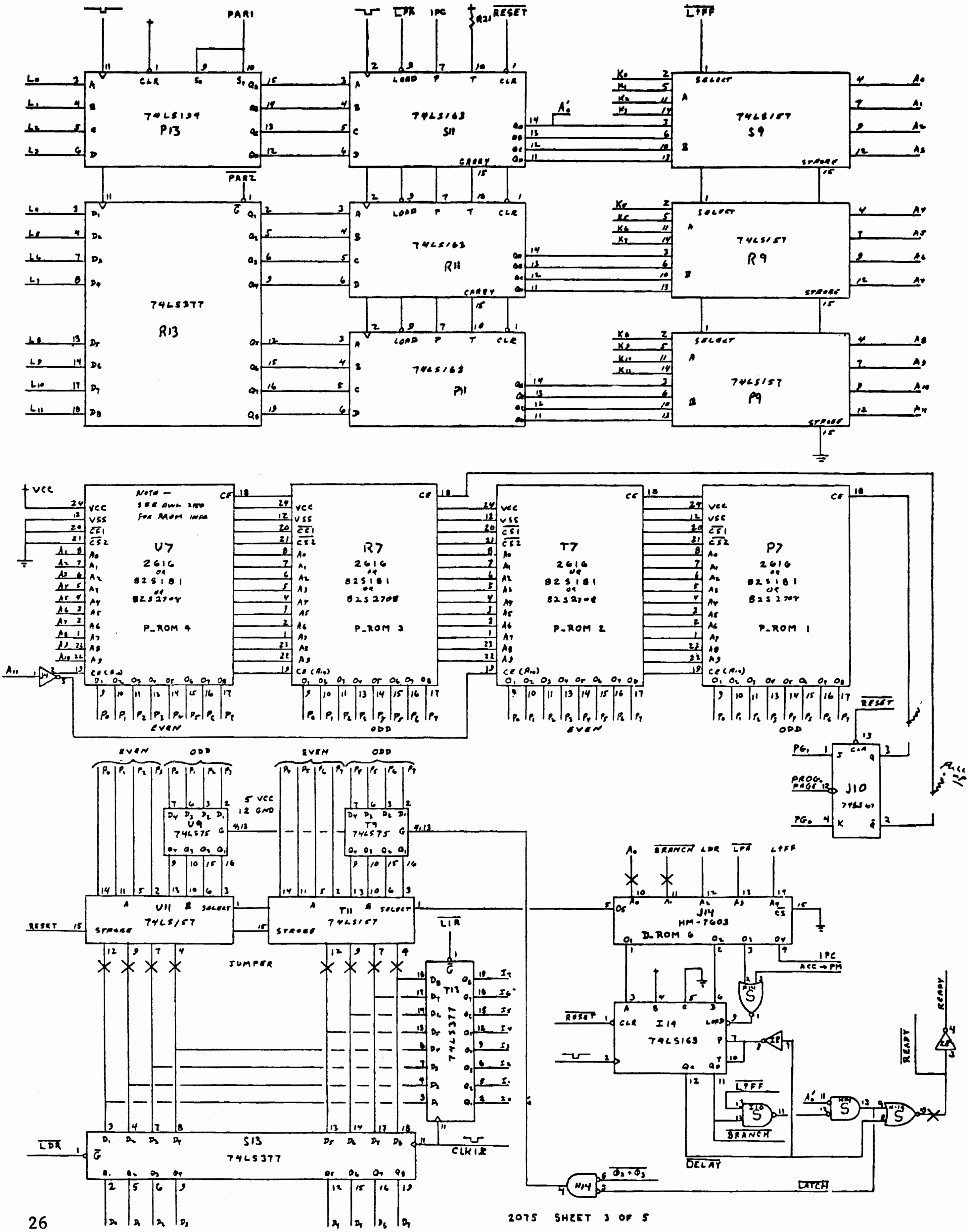
(CABINET REAR VIEW)



19.923 MHz
330
680 pf
1/2 74S113
74S113
74265
WRITE_EXT
WSAR
Φ₂ OUT
Φ₂ WSA
Φ₂ + Φ₃
74LS393
39 KHz
PROCEED
76 Hz
74LS107
F2
74LS259
R_COIN
BRIGHT
READ
READ_X
SECONDARY
STROBE
Y OUT
E4
74LS151
D4
74LS151
C4
74LS151
5K TYP
1K TYP
RESISTOR PACK D2
RESISTOR PACK C2
RESET
ALL INPUTS COME FROM J3
INPUT FUNCTIONS
J1-12
COUNTER
470
2N6292
PROCEED
↑ → PULL UP RESISTOR TO +5
J-K FLIP FLOPS ARE 74LS107 UNLESS NOTED
CINEMATRONICS
SPACE WARS™ LOGIC DIAGRAM
REV
DATE
DATE 10/25/77
APPROVED
2075
SHEET 1 OF 5
N.O.
N.C.



2075 SHEET 2 OF 5



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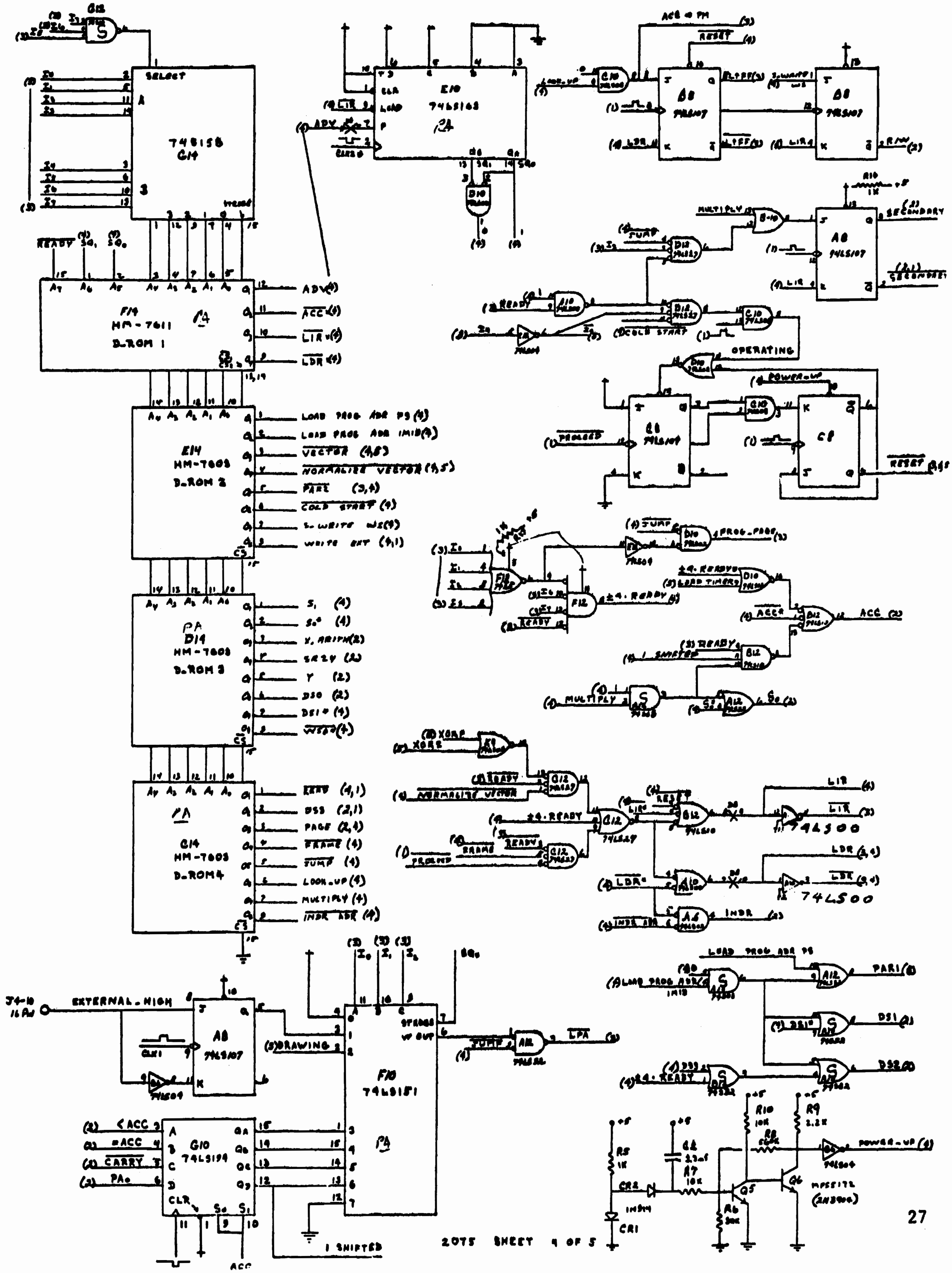
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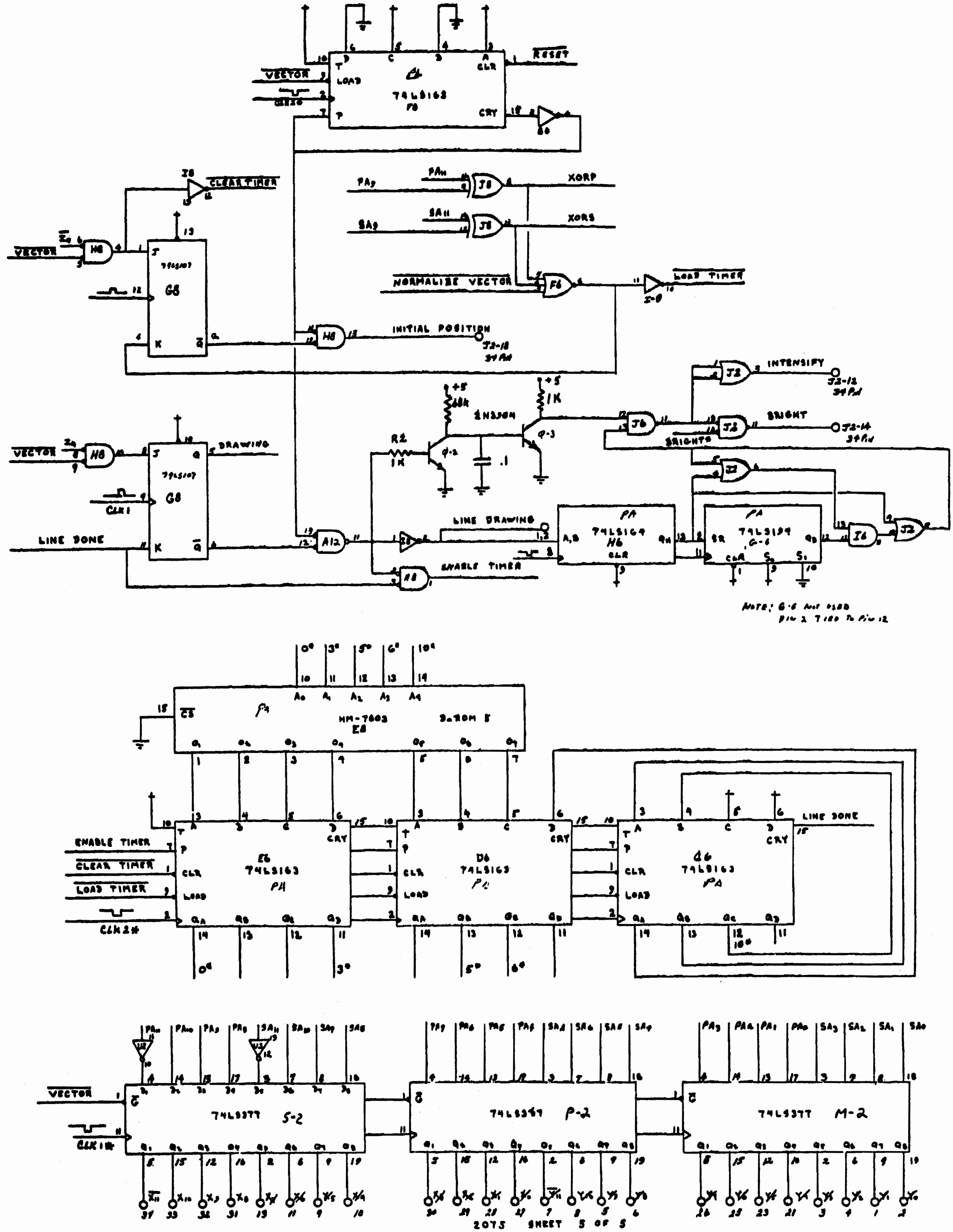
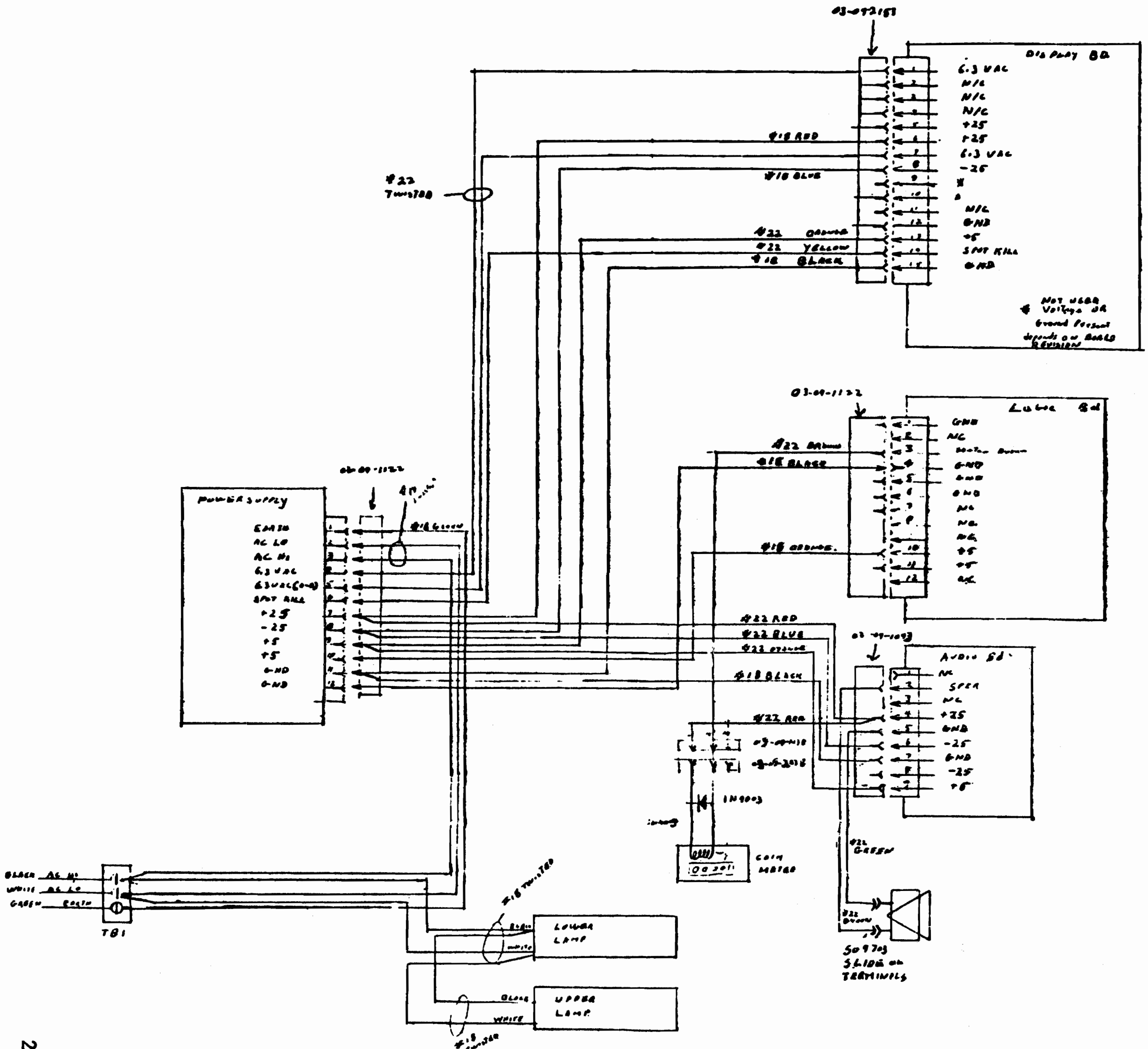
G14
SELECT
F14
HM-7611
D-ROM 1
E14
HM-7603
D-ROM 2
D14
HM-7603
D-ROM 3
C14
HM-7603
D-ROM4
E10
74LS163
B8
74LS107
A8
74LS107
C8
74LS107
F10
74LS151
G10
74LS194
ADV
ACC
LIR
LDR
LOAD PROG ADR PS
LOAD PROG ADR IMIB
VECTOR
NORMALIZE VECTOR
PARI
COLD START
WRITE EXT
READY
MULTIPLY
SECONDARY
OPERATING
POWER-UP
RESET
PROCEED
JUMP
PROG-PROC
LOAD TIMERS
XORE
INDR
EXTERNAL-HIGH
DRAWING
STROBE
LPA
CARRY
I SHIFTED
PAGE
FRAME
LOOK-UP
INDR ADR
74LS00
DS1
DS2
MPS6512
(2N3904)
IN914
CR1
CR2
2075 SHEET 4 OF 5


RESET
VECTOR
LOAD
74LS163
CRY
CLEAR TIMER
XORP
XORS
NORMALIZE VECTOR
LOAD TIMER
INITIAL POSITION
INTENSIFY
BRIGHT
DRAWING
LINE DONE
LINE DRAWING
ENABLE TIMER
74LS164
74LS194
HM-7603
74LS163
ENABLE TIMER
CLEAR TIMER
LOAD TIMER
LINE DONE
VECTOR
74LS377
2075 SHEET 5 OF 5

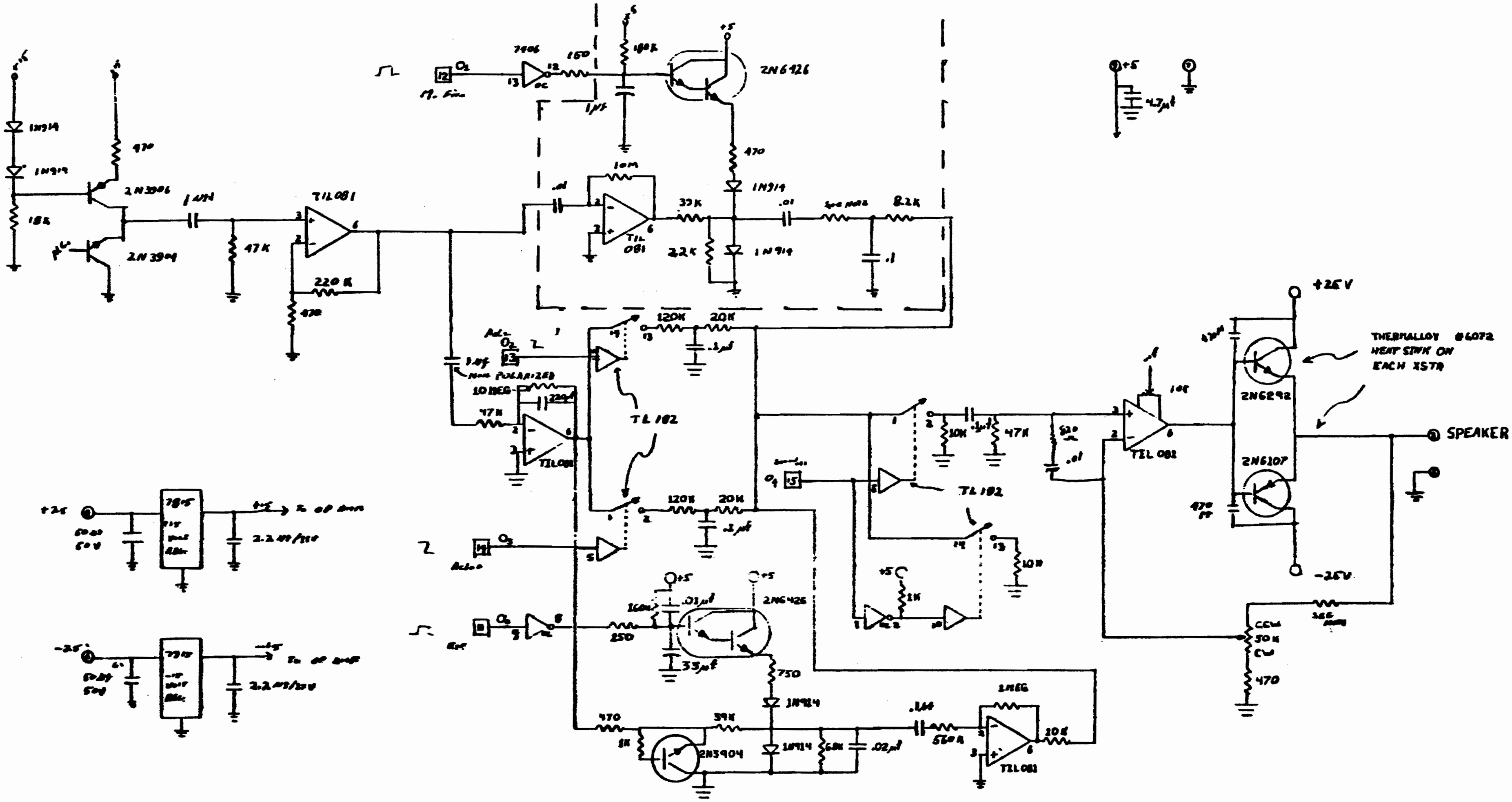


A REV ADDED NOTE TO DISPLAY BOARD 1-24-78

CINEMATRONICS INC.

SPACE WARS CABLING

2081 A

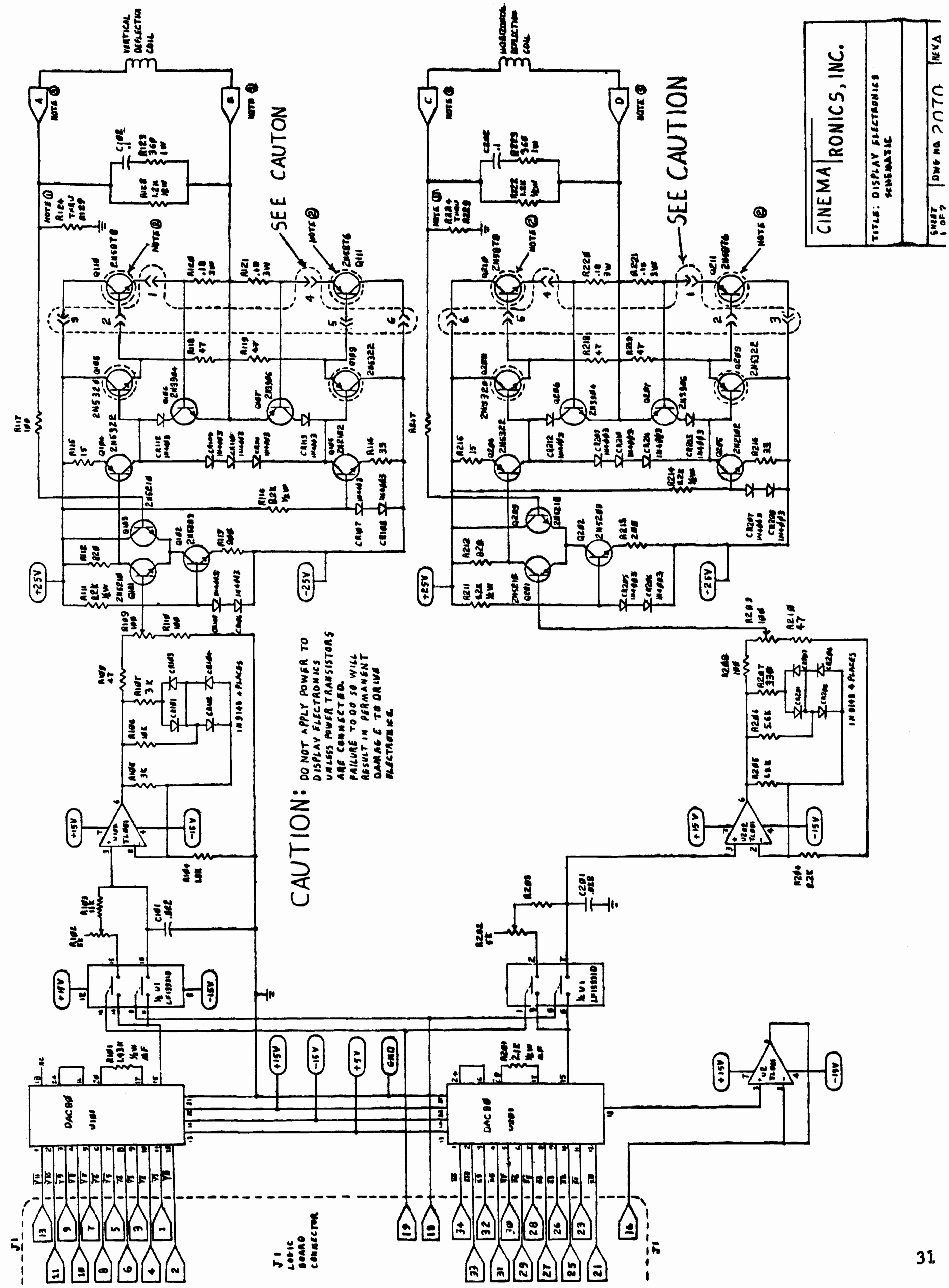


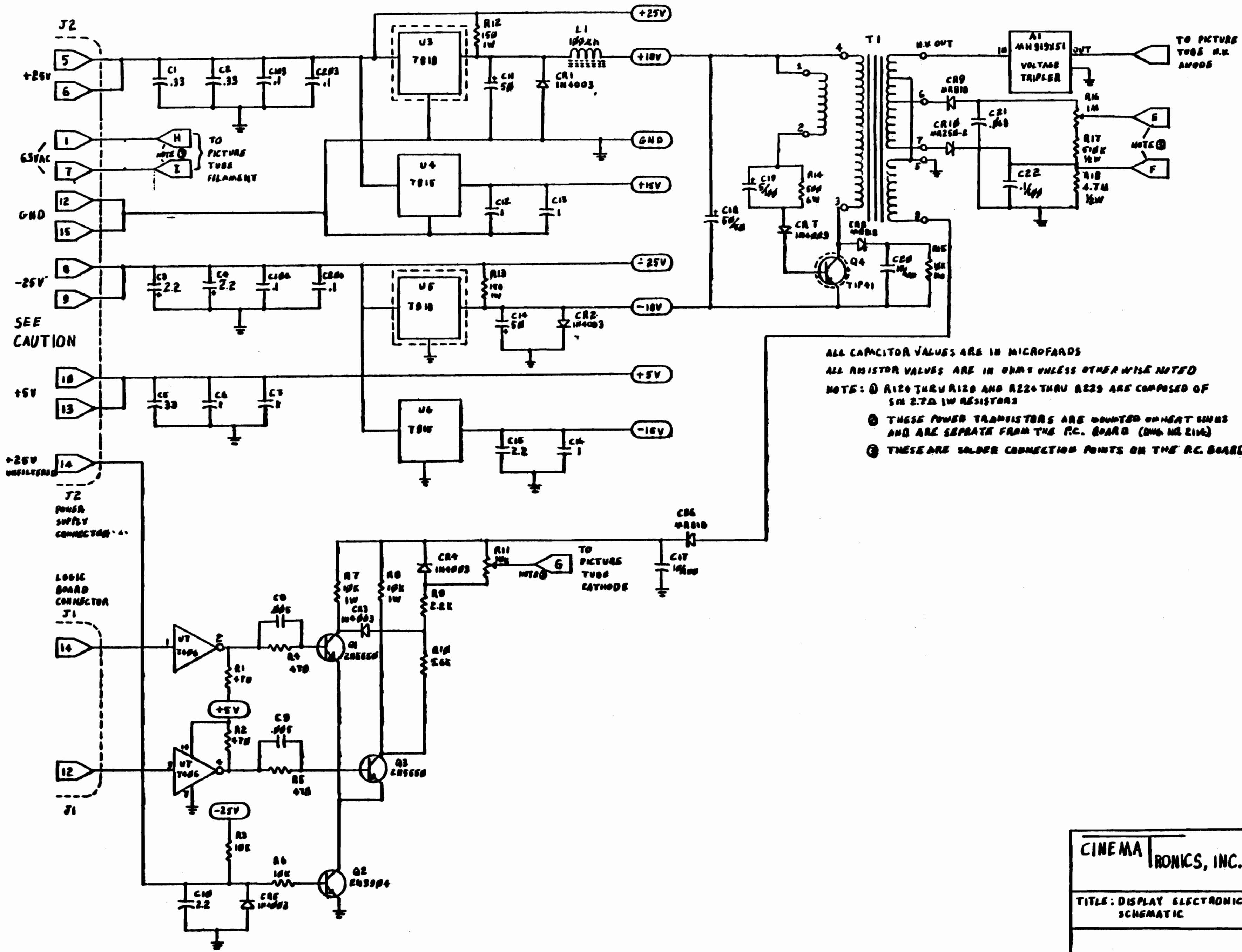
NOTE: TRIM RESISTOR

□ Ribbon Connector 16 Pin Dipsocket

○ Molex Connector 9 Pin

CINEMA RONICS, INC.	REV / DATE
TITLE: SPACE WARS AUDIO BOARD	APPROVED:
DATE: 3 Oct. 77	
DRAWING #	REV


CINEMATRONICS, INC.
TITLE: DISPLAY ELECTRONICS SCHEMATIC
VERTICAL DEFLECTION COIL
HORIZONTAL DEFLECTION COIL
SEE CAUTON
SEE CAUTION
CAUTION: DO NOT APPLY POWER TO DISPLAY ELECTRONICS UNLESS POWER TRANSISTORS ARE CONNECTED. FAILURE TO DO SO WILL RESULT IN PERMANENT DAMAGE TO DRIVE ELECTRONICS.
J1 LOGIC BOARD CONNECTOR



ALL CAPACITOR VALUES ARE IN MICROFARADS

ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED

NOTE: ① R124 THRU R128 AND R224 THRU R229 ARE COMPOSED OF 5% 2.7Ω 1W RESISTORS

② THESE POWER TRANSISTORS ARE MOUNTED ON HEAT SINKS AND ARE SEPRATE FROM THE P.C. BOARD (DWG. NO. 2114)

③ THESE ARE SOLDER CONNECTION POINTS ON THE P.C. BOARD

CINEMATRONICS, INC.		
TITLE: DISPLAY ELECTRONICS SCHEMATIC		
SHEET 2 OF 2	DWG. NO. 2070	N/A

CINEMATRONICS, INC.