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OPERATION AND MAINTENANCE MANUAL

CINEMATRONICS, INC. 1466 PIONEER WAY EL CAJON, CA. 92020

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SECTION 2 INSTALLATION

INTRODUCTION

Tailgunner is a one player game with dual controls providing ease of operation for right and left handed players. The video display generates 2 levels of intensity, and the audio system generates 6 different sounds during play. The player has control over a moveable sight on the screen by means of a proportional joystick control, which is used for aiming at oncoming spacecraft as they appear on screen. The player has control, by means of a fire button, over a Phasor cannon which, when depressed causes two energy bursts, originating from the bottom corners of the screen, to intersect at the current location of the moveable sight and destroy enemy spacecraft. The player also has control of an energy force shield. When this is activated, it appears on the screen and prevents any enemy spacecraft from passing by. Shield time counts down as used (at the rate of 5 units per second), and once the shield energy reaches zero the shield cannot be reactivated and the player must rely on his skill at destroying ships with his Phasor cannons to prevent any ships from passing by. As soon as ten enemy spacecraft have passed off screen, the game is over. Spacecraft enter the screen in groups of three, and until all three have either been destroyed by Phasor fire or passed off screen, another group will not enter. As more ships are destroyed, the succeeding groups become more evasive and move faster. After inserting the necessary amount of money (one or two coins), 1 credit will be displayed on the screen, and when the start button is depressed the game begins. The amount of shield energy can be changed by switches on the CPU Board, as can the amount of coins per credit.

SECTION 2

INSTALLATION

RECEIVING INSPECTION

Your game was shipped in ready-to-play condition. However, after removal of the shipping carton, a brief visual examination is suggested.

Naturally, you'll want to make note of any physical damage to the game cabinet and its external components for freight claim purposes. Considering the quality of the shipping carton, any damage to the exterior would indicate possible interior damage as well.

The "guts" of the game should also undergo a brief examination for: loose mounting hardware (check to be sure that the major components are still securely mounted); disconnected or loose wires, cables or harnesses; electronic devices loose in their sockets; etc.

At this time the game serial number should be logged. Please remember that the game serial number will be required if you need service from your distributor.

ELECTRICAL REQUIREMENTS

Unless specified otherwise, your game was shipped to operate at 115 VAC, 50/60 Hz. Two other voltage settings are possible. The power supply chassis has a table which shows the voltage options and fusing requirements.

A good earth ground is essential for the

proper operation of this game or for that matter any electronic device. Problems with instability and erratic operation of computer-type devices can usually be traced to an ineffective ground system.

INITIAL ADJUSTMENTS

NOTE

When the game is connected to AC power, one of the game sounds may be heard. This is normal.

The audio level (volume) can be easily adjusted and THIS IS ACHIEVED BY ROTATION OF THE ONLY CONTROL ON THE AUDIO CIRCUIT BOARD. The audio level should compete with other machines ''on the floor'' to maximize play time.

Display brightness is another easy adjustment. The monitor assembly has several adjustments, but the brightness control is the only one which does not require a "screwdriver" for rotation. Keep the brightness at the correct level for appeal.

OPERATOR OPTIONS

The option switch is located on the logic or game board. It is not necessary to remove the board from the cabinet to set the options. In fact, the option switch and audio control can be reached easily through the coin door opening. Table 2-1 will assist you with your selections:

LOGIC BOARD OPTION SELECT TABLE

The following chart diagrams the switch settings of the option switches for ''TAILGUNNER''. The 7 station switch is located at position E-2 on the logic board.

SWITCHES	SHIELD POINTS							OPTIONS: Coins Per Credit		
	15	20	30	40	50	60	70	80		
Switch #1	ON	ON	OFF	OFF	ON	ON	OFF	OFF	X	X
Switch #2	ON	OFF	ON	OFF	ON	OFF	ON	OFF	X	X
Switch #3	Х	Х	Х	Х	Х	Х	Х	Х	OFF	ON
Switch #4	Х	Х	Х	Х	Х	Х	Х	Х	Х	X
Switch #5	Х	X	X	Х	Х	Х	Х	Х	X	X
Switch #6	ON	ON	ON	ON	OFF	OFF	OFF	OFF	Х	Х
Switch #7	Х	Х	Х	Х	Х	Х	Х	Х	X	Х

NOTE								
ON	=	CLOSED	=	LOGIC	0			
OFF	=	OPEN	=	LOGIC	1			
х	=	NO EFFE						

SECTION 3 GENERAL INFORMATION

SECTION 3

GENERAL INFORMATION

Your Cinematronics game is designed much the same as conventional video games. The major exception is the use of an alternate means of visual display ... the patented Vectorbeam tm* monitoring system.

However, the game is built of the same basic building blocks as any other video game:

The <u>Power Supply</u> provides all necessary voltages for each separate electronic assembly as well as the AC lighting required throughout the game.

The Central Processing Unit contains circuitry to strobe and interpret all input functions which include the player control panel switches and all coin and credit information and generates all the digital signals used to provide the visual display and control the audio effects. 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 for the display.

The <u>Audio Board</u> consists of a noise generator and wave shaping circuits which produce different game sounds 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 each for horizontal and vertical deflection, and a number of other controlling signals for the cathode drive circuit and switching of 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 type 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 synchronous pattern. Vertical information is forming a matrix-type pattern of mathematically possible illumination points on the face of 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 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. 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 phosphors 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 the entire path of phosphors crossed by the electron beam, in any 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 possibilities. This is also supported by the ability to accommodate 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 generating 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 therfore the understanding of the theory of operation, both the CPU logic and the display electronics.

^{*}Vectorbeam ^{tm*} is Cinematronic's service mark for video game repair and education services.

SECTION 4 VECTOR THEORY

SECTION 4

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 in Figure 4-1.

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 generated using a vector system is shown in Figure 4-2.

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.

This is accomplished by the two twelve-bit codes (words) applied to the DAC-80s 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 4096 possiblities for each 12 bit word.)

It is also important to remember the function of the LF 13331 analog switch and its output RC network. 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 4-3.)

Therefore, when a line appears on the CRT, it is actually only part 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 is illuminated.

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

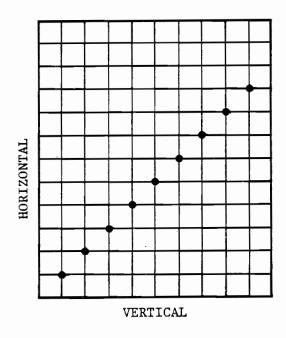


Figure 4-1. Graphical Representation of a Matrix

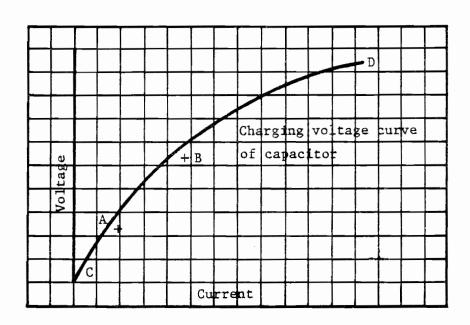


Figure 4-3. Non-linear Charging Voltages

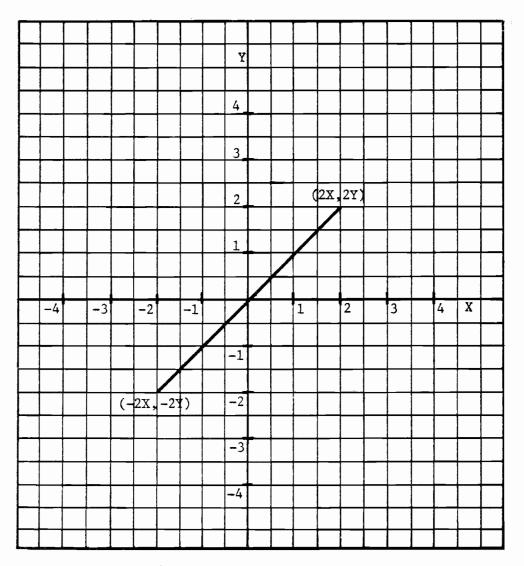


Figure 4-2. Line using Vector System

When a line appears on the CRT, it is actually only part (section A-B,) of the entire path taken between the beginning and ending points of the vector (section C-D). Section 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.

SECTION 5 THEORY OF OPERATION

SECTION 5

THEORY OF OPERATION

GENERAL DESCRIPTION

This section describes the principles of operation of the major circuit functions of the Cinematronics Video Arcade Game. The system's general functional description is followed by detailed circuit schematics which are included as Appendix A. The schematics used in this manual are similar in nature to those used by most industrial electronic firms.

MONITOR DISPLAY

The Vectorbeam tm monitor is unlike the conventional TV monitor in that it displays vectors (lines) generated from X-Y coordinates recieved from the logic board. The horizontal points are X (width) and the vertical points are Y (length). The X and Y logic signals originate from the logic board.

The Vectorbeam tm monitor can be divided into two basic sections: one is the deflection amplifier and the other is the voltage and cathode drive circuits.

The deflection amplifier can be further divided into two identical channels: one for the vertical deflection and one for the horizontal deflection. The operation of the vertical channel will be discussed; however, the same theory of operation pertains to the horizontal channel.

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 is applied to pin one, and the least significant bit is applied to pin twelve. The DAC-80 makes the necessary conversion from digital signals to analog signals which are outputted as analog voltage signals on pin fifteen (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. An R.C. network, which is used to create line length and line position on the screen is found at the outputs.

Output fifteen from the switch routes the analog signal through a 5K potentiometer (R102), a 10K 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 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 impendence and the capacitor C101 determines the position on the screen of the vector line.

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

At the output of U102, there is a resistor 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 closer to the edges of the screen. Potentiometer (R109), adjusts 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 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.

R122, R123, and C102 form a RC network, which compensates for any counter EMF 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 ICs 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-80s 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, and the high voltage tripler.

The intensity and beam blanking control circuitry is composed of U7, Q1, Q2, Q3, Q8 and associated components. The cathode voltage rides at +88. The beam is turned on by a more negative voltage. At the anode of CR4 negative pulses can be seen, these are the beam on pulses. For normal intensity the pulses will go down to approximately 40V, for double intensity, 20V. Pins 3 and 4 of U7 is the normal intensity control gate which receives information from the CPU. Pin 1 and 2 is the double intensity control gate. When a Hi going Lo signal is on pin 3 of U7 pin 4 will be a Lo going Hi turning on Q3 on the Hi transition. Q3 acts as a switch connecting the series network of R11, R9 and R10 to ground creating a voltage divider network. R11 is the manual intensity control. When 2 of U7 goes Hi Q1 turns on for the duration of the pulse connecting just R9 and R11 to ground, thus lowering the voltage at the anode of CR4 lower still because of the lower resistance, than with normal intensity. Q2 is used as a switch to enable Q1 and Q3. Its purpose is to shut off the beam when the power is turned off. Q8 is a beam on delay to prevent phosphor burns if someone was to unplug and plug in the machine rapidly.

R111 is the brightness potentiometer, which adjusts the amplitude of the negative spikes used for brightness and intensification.

** 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 (refer to Vector Generator description).

CPU BOARD

The processor hardware can be broken down into five basic functional blocks as shown in Figure 5-1. The arrows indicate the possible data flow directions between the various blocks. The ALU and Control block are the main components of the processor while the Memory and I/O blocks may be thought of as merely peripherals. Figure 5-2 is a detailed block diagram of the processor. The numbers in each block correspond to the entries in Table 5-1, which lists the IC numbers of the main components of each functional block.

The following is a brief description of each block shown in Figure 5-1. The numbers beside each functional block name are the numbers in Figure 5-2 which correspond to a particular function.

RAM (6)

The RAM is implemented with three read/write static memories configured as a 256×12 bit block. Data can be transferred to or from this memory via the ALU block. The processor uses this RAM as a scratch pad.

ROM (10)

The ROM is configured as an 8K x 8 bit block of memory. These memory locations contain the program instructions and/or data. It is accessed via the processor control unit.

I/O 19, 17, 18

The I/O block consists of 8 output lines implemented with a bit addressable latch, 24 input lines implemented with data selectors, and two 12 bit registors which are connected to the X Y display deflection circuits via D/A convertors.

Arithmetic Unit 1,2,3,4,5

The arithmetic unit performs all the arithmetic processing for the system. It consists primarily of two 12 bit accumulators, an arithmetic logic unit and various data selectors. The accumulators can function as temporary storage registers for arithmetic

functions upon the data in the accumulators. The data selectors are used to select the various sources of data which will be processed.

Control Unit (15,16,14,7,8,9,11,12,13)

The control unit is the heart of the processor. It performs all instruction decoding operations and generates all the necessary control signals which the rest of the hardware requires to function correctly.

The following is a discussion of each block shown in Figure 5-2.

1. Accumulator Selector

The accumulator selector consists of 3 quad data selectors. They are used to select the output of either the primary or secondary accumulator for processing by various other sections of the systems.

2 & 3 Primary and Secondary Accumulators

The two 12 bit accumulators are implemented with quad bidirectional shift registers. The primary accumulator consists of S4, P4, M4. The secondary accumulator consists of T4, R4, N4. All data manipulation in the processor is accomplished using these two accumulators. All output data flows through these registers.

4. Arithmetic Logic Unit (ALU)

The ALU is used to perform all necessary arithmetic functions within the processor. The ALU is implemented using three 24LS181 (N6M6L6) function generators, three 74LS85 (N9,M9,L9) 4 bit magnitude comparators, and a 74S182 (L4) look ahead carry generator. The data which the ALU manipulates can come from four different sources. The first source is the contents of the accumulators via the accumulator selector. The second and third sources are the ROM and RAM data outputs via the ALU data selector (N11, M11, L11) and the fourth source is the external input selector (E4, D4, C4).

Data Selector

The data selector is used to read data into the ALU from either the RAM or ROM memory. Note that the ROM data is only 8 bits wide while the RAM data is 12 bits wide.

RAM Storage

The system RAM consists of three 9101C high speed static memory chips connected as a 256 x 12 bit block. The block is 12 bits wide in order to allow the contents of an accumulator to be stored. The processor uses the RAM as temporary storage of program variables, data pointers or any other data of a dynamic nature.

7. RAM Address Selector/Register

The output of this register is tied directly to the address lines of the RAM. It consists of a multiplexer which routes address data from either the ROM or RAM locations to the RAM address lines. The capability to use RAM data to select RAM addresses is the basis for the indirect addressing mode of the processor.

Page Selector

The page selector is used to latch the high order 4 bits of a RAM access instructions.

9. ROM Data Register

The register is used to temporarily hold data from the ROM during an instruction fetch.

10. ROM Memory

The ROM memory consists of the actual memory chips plus a data selector and latch

circuit. The latch is used to improve the memory access time during a two byte instruction fetch by allowing one byte of the instruction to be latched while the RAM address lines are decoded for the other byte. The data selector can then be used to rapidly access both bytes of the instruction by switching between the latch and memory outputs.

11. Instruction Register

The instruction register is a latch which holds the current op code as read from ROM. Its output is tied to the instruction decode circuitry which in turn generates the necessary signals to execute the instruction.

12. System Sequencer

The system sequencer is used to decode an instruction op code and to generate the appropriate timed sequence of signals which execute the instruction. The op code is decoded by using it as the address data to a set of decoder ROMS. The outputs of the decoder ROMS are then synchronized with the system clock and used to control the various system functional blocks.

13. Line Length Counter

The line length counter is used during the process of drawing a vector to control the length of a vector, by turning off the beam at a pre-determined time after the vector is intiated. The counter is loaded with a value from a line length ROM and then counts up until it overflows which in turn generates a signal to indicate the vector has been finished.

14. Program Address Selector

This selector is used to provide the address data to the program ROM. It selects either the program address counter output or the accumulator selector output and routes this data to the ROM address lines. The ability to use the accumulator contents as address data allows the program to randomly access data tables stored in the ROM or to compute a branch address after a conditional test.

15. Program Address Counter

This is a 12 bit counter whose output defines the next location in ROM to be accessed. It is normally clocked sequentially to step through a program. However, it can be loaded with data from the program address register which is how the jump instructions are implemented.

16. Program Address-Register

This register is a latch used for temporary storage of an address which will be loaded into the program counter during a jump instruction. The input data to this latch can come from either the program ROM or the scratch-pad RAM.

17. Input Selector

The input selector is used to read the state of one of the 24 input lines into the selected accumulator. There are 16 primary inputs and 8 secondary inputs. During an input instruction the upper 11 bits of the accumulator are set to zero while the least significant bit reflects the state of the input line. All input lines have pull up resistors on them so that they will read high if they are left unconnected.

18. Output Selector

The output selector is a bit addressable latch used to control the 8 output lines. During an output instruction the selected output line is set to the complement of the least significant bit of the accumulator. The output lines are used to control the audio board, display intensity and the mechanical coin counter.

19. Display Registers

The display registers are the interface between the processor and the display driver circuits. These registers are latches into which the contents of the accumulators can be stored. The outputs are tied to D/A converters which provide the input voltage to the display deflection amplifiers.

AUDIO BOARD

The sound generation circuitry is composed of the following functional blocks: Audio Power Amp with volume control, Explosion sound, Wideband Noise Generator, Background Rumble, Force Shield Hum, Shield Bounce, Hyperspace, and Phasor Cannon sound. All discrete sounds are tied together at a summing junction and then fed to R70 (The input to the power amp). Each sound is triggered by a low going digital pulse from the trigger port (IC23), which is software controlled by the CPU Board.

FUNCTIONAL BLOCKS

Each functional block is listed on SD205200 by its functional name (Example: Explosion). The Power Amplifier is composed of IC19, Q6, Q7, R75 and their associated components. IC19 is a preamplifier which directly feeds the push-pull power amp, Q7 and Q6. Adjusting R75 will change the amount of feedback to the preamp causing an increase or decrease in volume at the speaker. Under no circumstances should the Power Amplifier drive a speaker of less than 8 ohms impedance.

The Wideband Noise Generator is a common signal source for providing wideband random noise to the discrete audio sections of the board. The noise generator works as follows: diode D1 is a zener diode with random noise levels of typically 200 micro volts generated at its internal junction. This noise will be present at the anode of D1 across resistor R1. The noise is amplified by a factor of 1000 by IC1 and coupled to IC2. IC2 is a band equalizing signal limiter which will balance out the amplitude of the noise frequencies by amplifying the weaker signals

and attenuating the stronger signals. The output of IC2 should appear as wideband clipped noise with an amplitude of 1.2 volts peak to peak. IC3 will amplify the noise to approximately 5 volts peak to peak at which time it is ready for use by the sound circuits.

The Explosion sound functions as follows: Wideband noise is filtered by IC9, which is an op amp integrator, and injected into pin 2 of IC10. A negative going pulse of approximately 400 ns from pin 4 of IC23 fires a one shot, IC12. The output of IC12 then goes to 5 volts for a time determined by the RC time constant of C15 & R39. This brings Q3 into conduction charging C16 to + 5 volts, turning on IC10. Once the pulse from IC12 has ended, C16 will discharge to minus 15 volts causing decaying explosion sound as IC10's output amplitude fades.

The Background Rumble sound utilizes the explosion circuit just explained. By maintaining a low level output from the trigger port on pin 5 of IC6, Q5 is kept in conduction causing IC10 to conduct at a low level of amplification, which is determined by the value of R43. This allows a low amplitude level of noise to be constantly heard at the speaker.

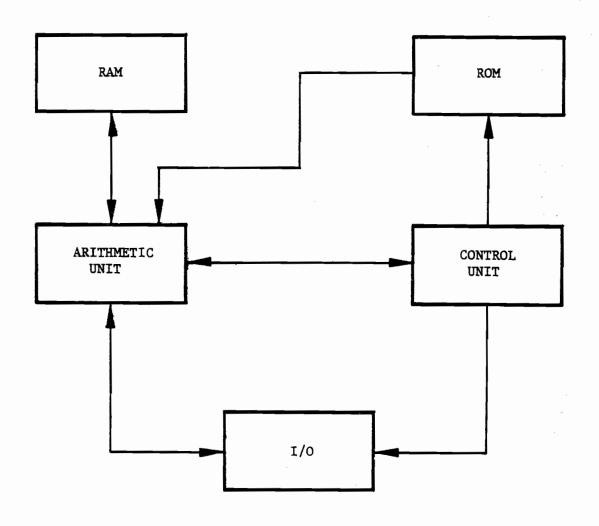
The Shield Hum sound is composed of two 555 square wave oscillators IC16 and IC17. The output of each oscillator is fed into a RC filter network where the square wave is converted into a sinusoidal waveform. The outputs are then combined at pin 2 of IC13. Whenever pin 13 of IC4 goes to a low logic level, Q5 conducts turning on IC13 at an amplitude level determined by the value of R47 until pin 13 of IC4 goes back to a high logic level.

The Shield Bounce sound functions in nearly the same manner as Shield Hum. Two 555 oscillators feed 5 volt square waves into their corresponding dividers IC18. Then the outputs are combined at pin 2 of IC22. Filtered wideband noise is also injected at pin 2 of IC22. IC12 is a one shot which is triggered from IC23. When pin 12 goes to a low level, Q8 conducts charging C44 to + 5 volts and turning on IC22. When the one shot resets it turns off Q8. C44 then discharges to minus 15 volts creating a decaying envelope out of IC22.

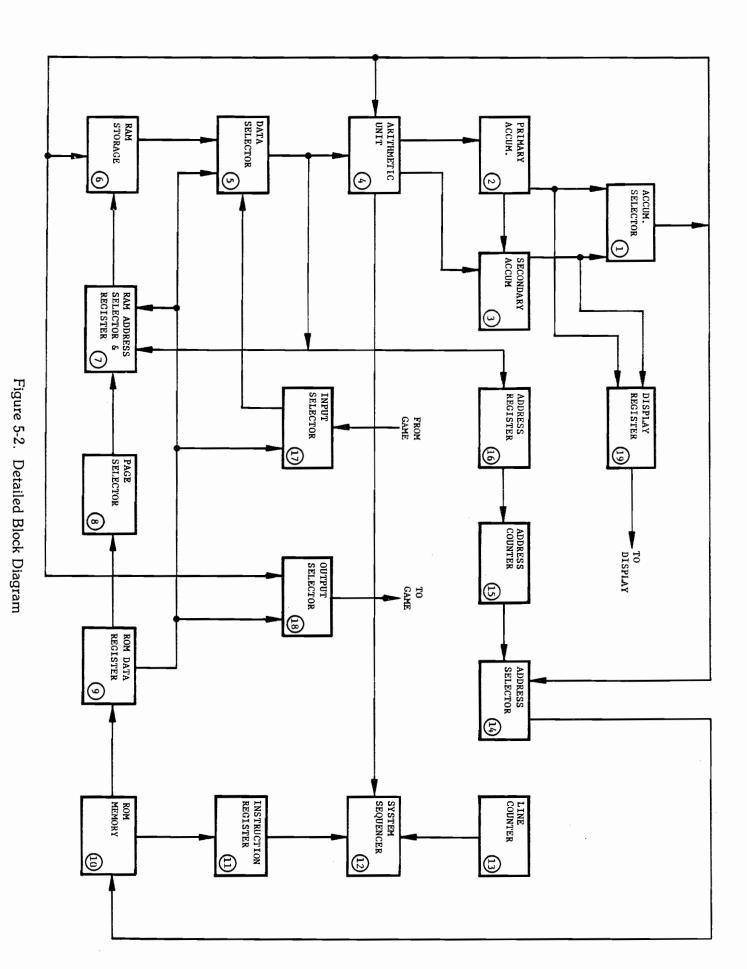
The Phasor sound is created by ramping a VCO (IC11), from a high frequency to a low frequency while feeding the signal into a divider (IC8). When pin 4 of IC4 goes to a low level, pin 6 goes low enabling $\frac{1}{2}$ of IC8. At this time pin 4 of IC6 goes from its low state enabling C13 to charge, which changes the voltage at pin 3 of IC11 causing the frequency shift. The output signal is then converted to a 5 volt sqare wave by Q1 and fed into IC8 through IC5. The digital outputs of IC8 are fed into R35-38 and R21, R22, and C8 converting them into an analog signal. When pin 4 of IC4 returns to a high logic level, IC8 is disabled permitting no sound out and C13 is grounded through IC6 causing the VCO to return to its highest frequency.

The Hyperspace sound is created in the same way as the Phasor sound except that instead of low frequency sweep it goes from a low to a high frequency. When pin 1 of IC4 goes low, pin 3 goes low, enabling ½ of IC8. Pin 6 of IC5 goes high and pin 2 of IC6 goes low discharging C6 which sweeps the VCO. The rest of the circuitry is identical to the Phasor sound.

The Trigger port is an 8 bit addressable latch whose inputs come from the output latch on the main logic board through a ribbon cable to J4. The outputs of IC23 are at a high level until the proper commands are received from the CPU board. All sounds are low level actuated.



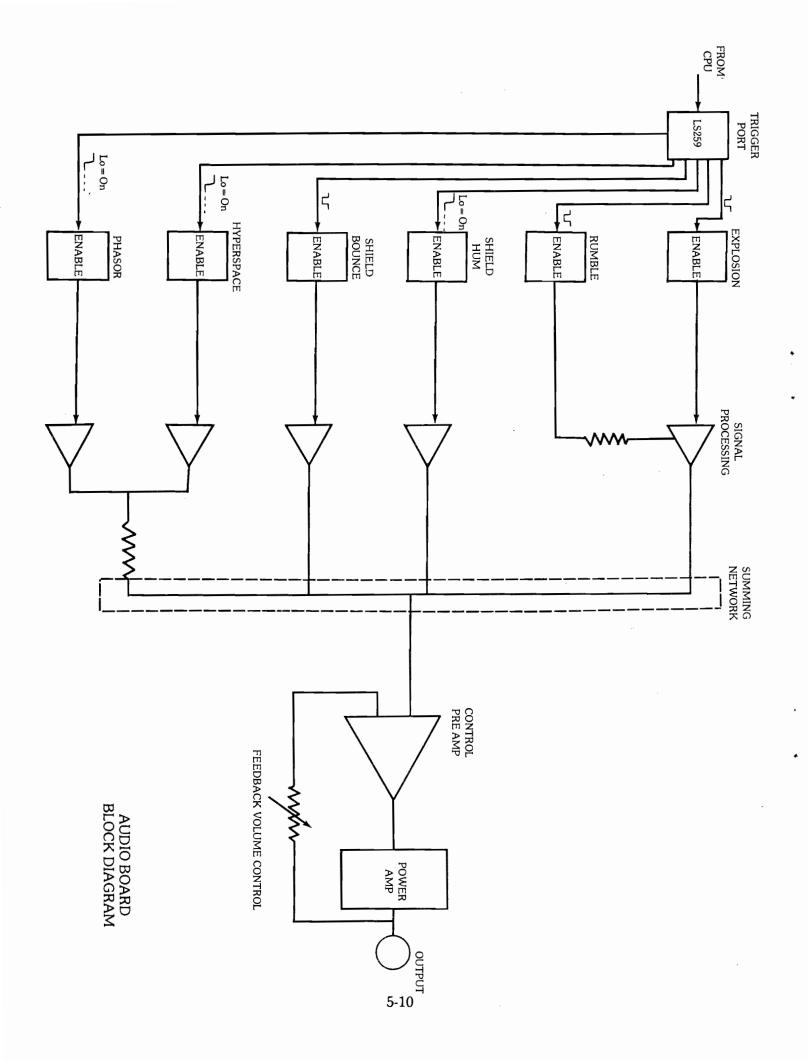
 $Figure \, 5\text{-}1. \,\, Functional \,\, Block \,\, Diagram$



5-8

TABLE 5-1. BLOCK NUMBERS AND COMPONENT I.C.

- 1. T-2, R-2, N-2
- 2. S-4, P-4, M-4
- 3. T-4, R-4, N-4
- 4. N-6, M-6, L-6, N-9, M-9, L-9
- 5. N-11, M-11, L-11
- 6. N-14, M-14, L-14
- 7. J-12, I-12
- 8. H-12
- 9. S-13
- 10. U-7, R-7, T-7, P-7, U-9, T-9, U-11, T-11
- 11. T-13
- 12. A-8, G-10, F-10, G-14, F-14, E-14, D-14, C-14
- 13. E-6, D-6, E-8, H-8, G-8, F-8
- 14. S-9, R-9, P-9
- 15. S-11, R-11, P-11
- 16. P-13, R-13
- 17. E-4, D-4, C-4
- 18. F-2
- 19. S-2, R-2, M-2

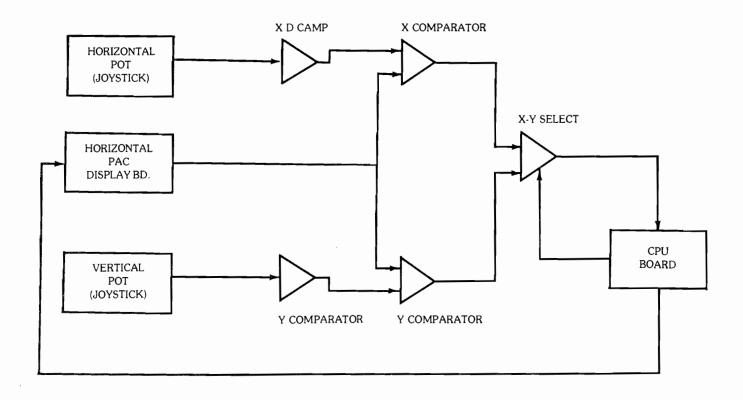


JOYSTICK CONTROL CIRCUITRY

The Joystick circuitry is used in conjunction with the CPU Board to perform an analog to digital conversion. The X & Y pots on the joystick control work in the same manner with identical circuitry. One end of each pot is connected to +15 and the other end to -15V. The center wiper of each pot goes to its corresponding circuitry. The voltage off the pot is fed into the input of a noninverting DC amp, the capacitors on the input are used to smooth out the response when moving the joystick quickly to prevent jerkiness, then into a comparator. The other input to the comparator comes from the horizontal digital to analog converter on the display board. The

comparator is comparing these two signals and feeding them back into the CPU. The 7406 is being controlled by the CPU to select either the X or the Y signals. The CPU reads the signal from the comparators. For example, take the vertical pot; if the joustick is moved left, the voltage changes and is compared with the output of the DAC, which reflects the actual location of the sight on the screen. Then the comparator reflects the difference and feeds it to the CPU, which then reads this change and outputs to the display board a new location for the sight, in proportion to the speed and location of the pots on the joystick control. This new location is fed back to the comparator on the joystick circuitry and compared again until location matches the position of the joystick control.

BLOCK DIAGRAM JOYSTICK CONTROL CIRCUITRY



SECTION 6
MAINTENANCE

TABLE 6-1. TROUBLESHOOTING GUIDE

PROBLEM	PROBABLE SOLUTIONS		
No picture	Listen for audible "clatter" from the Vector circuitry on the display board. If the clatter is present, then the DAC's and the analog switch (LF13331) are operational and the problem is in the intensity circuitry.		
	If game audio is present, the problem is in the monitor. If the audio is distorted or absent, the problem is usually on the logic board. Check IC F-2 pins 4, 5, 6, 7, 9 & 12.		
	Check the neck of the CRT for a glowing filament. If there is no glow check the black and brown wires of the CRT connector for 6.3 VAC between them. Check IC C-8 pin 6 on the CPU with a logic probe. Pin 6 should be low indicating that the CPU is not continuously resetting.		
	Be sure all connections are made to the display board and CPU.		
	Connect a scope to the yellow wire leading to the CRT connector. Set brightness full clockwise. There should be data pulses of 50 volts P-P at an 80-100 volt base. If no data pulses are present, connect a scope probe to pin 2 of IC U7 and check for data pulses. If data is present, check Q1 and Q2 with an ohmeter or a transistor tester.		
	Check J2 pin 14 for +25 volts unfiltered.		
	Check CRT neck for broken pins or other damage.		
	Check the seating of the CRT plug and insure that proper connections are being made.		
Narrow line on display	Check for an open winding in the yoke coils.		
	Check for bad connections of yoke wires to display board.		
	Check for continuity between display board and power transistor on heat sinks Q110, Q111, Q210, and Q211. Check for faulty power transistors Q110, Q111, Q210 and Q2211. Also check for broken solder connections on circuit board molex connector socket pins.		
Half of picture missing	Left half: Check Q208, Q206, Q210 Right half: Check Q209, Q207, Q211 Top half: Check Q109, Q107, Q111 Bottom half: Q108, Q106, Q110		

TABLE 6-1. TROUBLESHOOTING GUIDE (Continued)

PROBLEM	PROBABLE SOLUTIONS
No high voltage	On display board, check DC voltage output of IC U3. It should be +18
The mgm venage	volts DC. If not present, check for +25 volts present at the input to U3.
	Check DC voltage output of IC U5. It should be -18 volts DC. If not present, check for -25 volts present at the input to U5.
	Lift the winding from pin 3 of the high voltage XFMR T1. Measure $+18$ volts. If the $+18$ volts is present, check for a shorted Q4, shorted capacitors C20, and C19, bad diodes CR7, and CR8.
	Check for 6 kilovolts at black wire of XFMR T1.
Dotted display	Check for faulty analog switch U1. Inspect yoke connections to display board. Check for open yoke windings. Check for proper +25 and -25 volts DC. Check operation of DACS U101 and U201.
No audio sound	Check for an open speaker coil. Check transistors 2N6292 and 2N6107 and other nearby output components on audio board with an ohmeter or transistor tester.
	Check for open wiper on volume control of audio board.
	Verify that CPU is fully operational.
Coin counter is inoperative	Check transistor 2N6292 on logic PCB with ohmeter or transistor tester.
	Disconnect coin counter molex connector. Measure DC voltage on red wire. Meter should read +25 volts DC.
	Check power connector (J1) to logic board.
	Check electrical connection at pin 3 to J1.

TABLE 6-1. TROUBLESHOOTING GUIDE (Continued)

PROBLEM	PROBABLE SOLUTIONS			
No brightness control	Check intensity pot R11 for open wiper or internal short. Check for open capacitor C17. Check for bad solder connections to R11.			
Circuit Breakers Trip	Disconnect power to display board. If circuit breakers continue to blow, check for a shorted speaker coil. Verify that the ± 15 and ± 15 volt regulators are operating properly. Verify that the output power transistors on the audio board are good with an ohmeter or a transistor tester.			
	Check IC C-8 pin 6 on the CPU with a logic probe. Pin 6 should be low indicating that the CPU is not in continuous reset. Measure the voltage at IC T-13 pins 10 and 20 with an accurate voltmeter. The meter should read between 4.8 and 5.1 volts DC for normal system operation.			
	Remove connectors J3 and J4 on the display board and check power transistors Q110, Q111, Q210, and Q211 located on the heatsinks with an ohmeter or transistor tester. Check diodes CR12 and CR15 located on the display circuit board.			
	Disconnect the CRT yoke wires from the display board and remove CRT socket. Re-apply power to the display board and reset circuit breakers if necessary. If the breakers do not blow then check transistors Q208, Q209 and Q204 in the horizonal deflection circuit and transistors Q108, Q109, and Q104 in the vertical deflection circuit with an ohmeter of transistor tester.			
	Check the horizonal and vertical DACS for proper supply voltages at pins $13,\ 14,\ \text{and}\ 22.$			
	Measure outputs of amplifiers U102 and U202 with a scope for $\underline{A+2}$ volt P-P signal centered at zero volts.			
Picture on display jitters	Check the vertical size adjustment R109 for wiper noise by turning the wiper briskly while observing the screen. Then readjust for proper screen size.			
	Check for bad solder connections on R109.			
	Repeat the above two steps for horizonal size adjustment R209.			
	Check DAC U201 and U101 for bad solder connections.			
	Check all molex connectors for good connections.			
	Check analog switch U1 for faulty operation, loose connections to socket or poor solder connections.			

AUXILLARY CONTROL PCB ASSEMBLY PL205204

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY
11 12 13 14	T-18R ref WL205204-1 ref WL205204-2 ref WL205204-3	Wire #2		2 1 1 1
		COIN METER ASSEMBLY		
		PL205404		
1 2 3 4		Coin Meter Diode Molex Connector Molex Pins, Fem.	É2B65D IN4003 03-09-2038 02-09-1118	1 1 1 2
		COIN DOOR ASSEMBLY		
		PL205601		
1 2 3 4 5 6 7	2165	Coin Door Lock Assy. Coin Mechanisms 3/16" x ½" Carriage Blt. Blk. Ox. #10 InternalTooth Lk. Washer #10 x 24 Hex Nuts ½" Cable Clamps		1 1 2 12 12 12 12 2
		2081 POWER SUPPLY HARNESS		
		PL205410		
1 2 3 4 5 6 7 8 9	:	Molex Connector Display Board Molex Conn-Logic Bd., Power Supply Molex Connector Audio Board Molex Connector Coin Meter Molex Pins, Female Molex Pins, Male Cable ties Speaker Term. Lugs Molex Conn. Power Supply AC	03-09-2153 03-04-1122 03-09-1093 03-09-1038 02-09-1118 02-09-2118 T-18R 03-09-1041	1 2 1 23 15 20 2

A/C CORD ASSEMBLY

PL205408

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY
1 2		Power Cord #16 Spade Lug	54-17238 C10-401-P	1 3
		LOGIC BOARD ASSEMBLY		
		PL205201		
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 38 39 39 30 30 30 30 30 30 30 30 30 30 30 30 30	37-25LS181 37-74LS00 37-74LS02 37-74LS04 37-74LS08 37-74LS10 37-74LS27 37-74LS32 37-74LS85 37-74LS86 37-74LS157 37-74LS157 37-74LS157 37-74LS163 37-74LS164 37-74LS164 37-74LS257 37-74LS259 37-74LS25 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S02 37-74S03 37-74S04 37-74S08 37-74S158	IC, ALU IC, Nand Gate IC, Nor Gate IC, Hex Inverter IC, And Gate IC, Nor Gate IC, Nor Gate IC, Nor Gate IC, Or Gate IC, Or Gate IC, Quad D Latch IC, Mag, Comparator IC, Exclusive Or IC, Dual J-K Flop IC, 10F8 Multiplier IC, Quad Data Sel. IC, Binary Counter IC, 8 Bit Shift Reg. IC, 4 Bit Shift Reg. IC, 7ri-State Quad. IC, 8 Bit Latch IC, Quad Mux IC, Octal D Flop IC, Dual 4 Bit Counter IC, Nand Gate IC, Nor Gate IC, Nor Gate IC, Or Gate IC, Or Gate IC, Ougad Mux. IC, Look Ahead Carry IC, Nor Gate IC, Output Buffer IC, Ram 256 x 4 IC, Prom Drom 1 IC, Prom Drom 2 IC, Prom Drom 5 IC, Prom Drom 6		$egin{array}{cccccccccccccccccccccccccccccccccccc$

LOGIC BOARD ASSEMBLY PL205201

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68	SW205001 SW205002 2076B 10-5331 10-5471 10-5102 10-5222 10-5103 10-5303 10-5564 19-002 27-050-024 27-101-681 23-350-330 23-350-331	Masked ROM 7 Pole Dip. Switch Crystal,20.0 mhz IN914B Diode Transistor Transistor Molex, Conn, 12 Pin Ansley Conn. 16 Pin Ansley Conn. 26 Pin Ansley Conn. 34 Pin 14 Pin Socket 16 Pin Socket Circuit Board 330 1/4w 5% C 470 1/4w 5% C 1 K 1/4w 5% C 2.2K 1/4w 5% C 30K 1/4w 5% C 30K 1/4w 5% C 10K 1/4w 5% C 560K 1/4w 5% C 1K Res. Dip. Pak Cap02uf 50V Disc Cap. 680pf 100V Disc Cap. 33uf 35V Tant Test Points 16 Pin Jumpers	JS8722-07 MP200CTS IN914B 2N3904 2N6292 09-18-5127 609-1622M 609-2622M 609-3422 CA14S10SD CA16S10SD	1 1 1 2 2 1 1 1 1 2 1 2 1 2 1 2 1 2 1
		DISPLAY ASSEMBLY (MONITOR) PL205403		
1 2 3 4 5 6 7 8 9 10 11 12 13	19VARP4 SA205405 SA205409 LF13331 SA205406 2105B 171C	CRT 19" Heatsink Assy. Display Sub-Assy. Analog Switch Yoke Assembly High Voltage Cage Spring #10-1/2" Flat Washer #10-1" Fender Washer #10-1/2" Hex Hd. Sms. Label-High Voltage Label-Factory Adj. Only #6 x 1/2" Hex Head S.M.S.		1 1 ref 1 ref 1 1 ref 1 4 4 4 1

DISPLAY ASSEMBLY (MONITOR) PL205403

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY
14 15 16 17 18	3066 3063 3065 2169A 2170A	#6 Lock Washer Int. 6-32 x ½ M.S. 6-32 Hex Nut Mounting Brkt. LH Mounting Brkt. RH		3 3 3 1 1
		DISPLAY BOARD ASSEMBLY PL205203		
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 36 36 37 38 38 38 38 38 38 38 38 38 38 38 38 38	10-5101 10-5102 10-5103 10-5150 10-5182 10-5201 10-5222 10-5302 10-5330 10-5331 10-5470 10-5471 10-5562 10-5682 10-5821 11-5103 11-5122 11-5470 11-5475 11-5822 12-5103 12-5270 12-5361	Res. 100 ohm ½w 5% Car. Res. 1K ¼w 5% Carbon Res. 10K ¼w 5% Carbon Res. 15 ohm ¼w 5% Car. Res. 1.8K ¼w 5% Carbon Res. 200 ohm ¼w 5% Car. Res. 2.2K ¼w 5% Carbon Res. 3K ¼w 5% Carbon Res. 33 ohm ¼w 5% Car. Res. 330 ohm ¼w 5% Car. Res. 47 ohm ¼w 5% Car. Res. 470 ohm ¼w 5% Car. Res. 5.6K ¼w 5% Carbon Res. 6.8K ¼w 5% Carbon Res. 6.8K ¼w 5% Carbon Res. 820 ohm ¼w 5% Car. Res. 10K ½w 5% Carbon Res. 1.2K ½w 5% Carbon Res. 4.7 ohm ½w 5% Car. Res. 10K ½w 5% Carbon Res. 1.2K ½w 5% Carbon Res. 1.2K ½w 5% Carbon Res. 1.2K ½w 5% Car. Res. 4.7M ½w 5% Car. Res. 4.7M ½w 5% Car. Res. 8.2K ½w 5% Carbon Res. 1.1K 1w 5% Car. Res. 10K 1w 5% Car. Res. 100 ohm ½w 5% Car. Res. 150 ohm ¼w 5% Car. Res. 150 ohm ¼w 5% Car. Res. 150 ohm ½w 5% Car. Res. 150 ohm ½w 5% Car. Res. 150 ohm 1w 5% Car. Res. 500 ohm 8w 5% Car. Res. 500 ohm 6w 5% Car.	3386-P1-101 3386-P-1-502	4 2 4 2 1 2 2 3 2 1 6 4 3 1 2 2 2 4 1 4 3 1 2 2 2 1 2 1 2 1 2 1 2 2 1 2 1 2 2 1 2 2 1 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 2 1 2 1 2 2 1 2 1 2 1 2 1 2 2 1 2 1 2 2 1 2 1 2 1 2 2 2 2 1 2 2 2 1 2 2 1 2 1 2 2 1 2 2 2 2 1 2

DISPLAY BOARD ASSEMBLY PL205203

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY
37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 61 62 63 64 66 67 68 69 70 71 72 73 74	37-7406 37-7815 37-7818 37-7915 37-7918 37-TL081 37-DAC80 33-2N2102 33-2N3904 33-2N5210 33-2N5320 33-2N5322 33-2N5550 33-T1P41C 41-3006 03-09-1152 02-09-2134 09-18-5061 609-3422-M 2071E 23-350-024 23-350-104 23-350-104 23-350-220 24-101-106 24-101-505 24-151-106 24-500-476 24-500-506 24-601-104 27-050-104 27-050-104 27-050-503 29-024-224 CA16S10SD 37-7805	I.C. Hex Inverter O.C. I.C. + 15V Regulator I.C. + 18V Regulator I.C 15V Regulator I.C 18V Regulator I.C 18V Regulator I.C. TL081 OP Amp. Digital to Analog Conv. Transistor Transistor Transistor Transistor Transistor Transistor Transistor Transistor Choke 100MH 2A Connector Housing Pins Male Solder Tail Connector Molex Wafercon Connector 34 Pin Etch Board Cap02 35V Cap1 35V Cap1 35V Cap4.7 35V Cap2.2 35V Tant Cap. 10 MFD 100V Axial Cap. 5MFD 100V Axial Cap. 5MFD 50V Cap1MFD 50V Cap1MFD 600V Cap1MFD 600V Cap1MFD Disc 50V Cap1MFD Disc. Cap025MFD 50V Cap1MFD Disc. Cap022MFD 200V Cap1MFD 100V I6 Pin Socket I.C. 7805 + 5V	Miller 5250 Molex Molex Molex Ansley	111112243272411118211111141115112222711
1 2 3 4	746 03-09-1063 02-09-1118 02-09-2118	Yoke, Broy Molex Connector Molex Pins-Female Molex Pins-Male		1 1 3 1

MONITOR HEATSINK ASSEMBLY PL205405

ITEM	PART NUMBER	DESCRIPTIO	DN	MFGR. PART NO.	QTY
1 2 3 4 5 6	2107-A 2179 2178 2134	Heat Sink Transistor Transistor Washers Greaseless Heatsink Harness, Long Heatsink Harness, Short Label''Warning''		2N5876 2N5878	2 2 2 4 1 1
8		6-32 X ½'' M.S., P.H.D. DISPLAY SUB-AS PL205409		3062	8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	2084D AE205203 3064 HV18 MH919TOL JAIN056103UA 22030B 6045-B4 3083 3084 3085	Chassis Display BD. Assembly #6 X ½" Sheet Metal Scre Hi Voltage XFMR Toler Hi Varo Trippler Al 10K Pot Allen Bradley Heatsink-Thermalloy Heatsink-Thermalloy CRT Socket 8-32 X ½ Ms. Phil. HD 8-32 Nuts #8 Lock Washer .05mf @ 1500VDC, Cap. Wire 9", 18 Gage Lug, Gnd. #6 X ½ Sheetmetal Sc. 3/16" Diam 3" Heatshrink 3/16" Diam 2" Heatshrink (Audio to Display Harness Neon Bulb	R13 Tubing k Tubing		1 1 ref 6 1 1 1 6 3 1 2 2 2 2 1 1 2 2 2 1 ref 2
		AUDIO BOARD-TAI PL205202			
1 2 3 4 5 6		Diode-Zener Diode-IN914 Cap. 470pf 50V Disc. Cap002uf 50V Disc. Cap005uf 50V Disc. Cap01uf 50V Disc.	REF. DES. D1 D2, 3, 4, 5, 6, 7, D 8, 9 D10, 11 C34, 35, 36 C17 C11, 41 C3, 18, 19 C20, 23, 30	IN5240 IN914	1 10 3 1 2

AUDIO BOARD-TAILGUNNER PL205202

ITEM	PART NUMBER	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY
7 8		Cap05uf 50V Disc. Cap1uf 50V Disc.	C14, 31 C2, 4, 7, 9, 10, C12,13, 21, 22 C27, 32, 33, C42,		2
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23		Cap22uf .35V Tant. Cap47 35V Tant. Cap68 35V Tant. Cap. 1uf 35V Tant Cap. 2.2uf 35V Tant Cap. 3.3uf 35V Tant Cap. 3.3uf 35V Tant Cap. 4.7uf 35V Tant. Cap. 10uf 35V Tant. Cap. 15uf 35V Tant. Cap. 33uf 35V Tant. Cap. 33uf 35V Tant. Cap. 33uf 35V Tant. Cap. 100uf 25V Elect. Res. 100 OHMS ½W 5% C Res. 330 OHMS ¼W 5% C Res. 470 OHMS ¼W 5% C	C 49, 50 & C51 C25 C28 & 29 C6 C8 C44 C45, 46, 47, 48 C26 C15, 16, 43 C24 C46, 47, 48, 49 C1, C5		16 1 2 1 1 4 1 3 1 4 2 1 3 3
25 26 27 28 29		Res. 4/0 OHMS ¼W 5% C Res. 1K ¼W 5% Carbon Res. 2K ¼W 5% Carbon Res. 2.7K ¼W 5% Carbon Res. 4.7K ¼W 5% Carbon Res. 9.1K ¼W 5% Carbon Res. 10K ¼W 5% Carbon	R10, 16, 22, 34, R 45, 60, 81, 88, R 92, 93 R58 R21, 27, 28 R48, 49, 78, 79 R54, 57, 61, 94 R12 R6, 8, 15, 17,23, R 26, 30, 33, 35,		10 1 7 4 1
30 31 32 33 34 35 36 37 38 39 40 41 42 43		Res. 15K ½W 5% Carbon Res. 20K ¼W 5% Carbon Res. 22K ¼W 5% Carbon Res. 30K ¼W 5% Carbon Res. 39K ¼W 5% Carbon Res. 47K ¼W 5% Carbon Res. 68K ¼W 5% Carbon Res. 82K ¼W 5% Carbon Res. 91K ¼W 5% Carbon Res. 100K ¼W 5% Carbon Res. 150K ¼W 5% Carbon Res. 150K ¼W 5% Carbon Res. 220K ¼W 5% Carbon Res. 220K ¼W 5% Carbon Res. 330K ¼W 5% Carbon	R 59, 64, 67, 83, R 87, 91 R66 R14, 18, 32 R36, 62, 65, 68 R22 R44, 69 R19, 37 R9, 24, 74, 76, R 77, 85, 89 R40 R20, 38 R84 R39, 80 R53 R63 R47 R11, 25, 52, 82		15 1 7 1 2 2 7 1 2 1 2 1 1 4

AUDIO BOARD-TAILGUNNER PL205202

ITEM	PART NUMBER	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY.
44 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 70 71 72 73 74 75 76 77 78 80 81 82	74LS125 74LS123 LM555 6071B 6072B 09-18-5094 09-18-5069 609-1622M AW205202 CA-165-105D 09-18-5062	Res. 360K ½W 5% Carbon Res. 390K ¼W 5% Carbon Res. 470K ¼W 5% C Res. 560K ¼W 5% C Res. 820K ¼W 5% C Res. 910k 4w 5% C Res. 100K Pot Trans. 2N3904 NPN Trans. 2N3906 PNP Trans. 2N6292 NPN Trans. 2N6107 PNP I.C. TL081 I.C. LS125 I.C. 7404 I.C. 7406 I.C. LS393 I.C. CA3080 I.C. LS123 I.C. 555 IC. 7915 IC. 7915 IC. 7815 IC. 1S259 Heatsink-Thermalloy Heatsink-Thermalloy Conn. Molex 9 Pin Conn. Molex 9 Pin Conn. Molex 6 Pin Conn. Ansley 16 Pin 4-40 X ½ Ms. Rhl. Hd. #4 Lock Wshr. Internal 4-40 Hex Nut Circuit Board 16 Pin Socket-Solder Tail Conn. Molex 6 Pin	R51 R55 R2, 4, R43 R50 R56 R1,7,13,31 R75, 86, 90 Q1,2,9, 10 Q3,4,5,8 Q6 Q7 IC 1,2,3,7,9,11, 19,24,25,26,27 IC4 IC5 IC6,28 IC8,18 IC10,13,22 IC12 IC 14,15,16,17 IC20 IC21 IC23		1 1 2 1 1 1 4 3 4 4 1 1 1 1 1 2 2 2 1 1 4 4 4 1 1 1 1 1
		2708 PROM BOARD AS (KLUDGE TO C 38-10522-01			
1 2 3 4 5		Heatsink Heatsink 4-40 Hex Nut 4-40 Mach. Screw 3/8'' Phil. Panhead Test Points	11SU5, HSU6 11SU5, HSU6	6072B 6071B	2 2 6 6 2

2708 PROM BOARD ASSEMBLY (KLUDGE TO CPU) 38-10522-01

ITEM	PART NUMBER	DESCRIPTION	REF. DES.	MFGR. PART NO.	QTY
6 7 8 9 10 11 12 13		24 Pin Dip Socket +12V Voltage Reg. -5V Voltage Reg. 2 Line to 4 Line Decod. 3.3uf Tant. Cap. 35V .02uf Cap. Disc. 50V PC Board 24 Pin Dip Cable	U1-U8 U10 U11	7812 7905 74LS139 80-10518A CA-D24P-02-	8 1 1 1 4 7 1 2
14		Game Proms	205A-1 Thru	261-CC-10 2708	8
15		1/4'' Swag Spacer #6 Through Hole for .090 BD.	205D-2	1533-C-6-B-1 Mfr. Raf.	2
16		4-40 X ½'' Phil. Pan Head Screw		IVIII. Nai.	2
17 18 19 20 21	MP203611 03-09-1063 02-09-1118 02-09-2118	#4 Hex Nut Mounting Brkt. 6 Pin Molex Male Molex Pins Female Molex Pins Male			2 1 1 2 1
22	ref. WL38-10522-01 ref.	Wire #1			1
23	WL38-10522-01 ref.	Wire #2			1
24 25	WL38-10522-01 T-18R	Wire #3 Ty Wrap		·	1
		JOYSTICK ASSEN PL205413	ИBLY		
1 2 3 4 5 6 7 8 9 10 11 12 13 14	900-098 09-50-3031 08-50-0126 03-09-1063 02-09-1118 ref. WL205413-1 ref. WL205413-2 ref. WL205413-3 ref. WL205413-4 ref. WL205413-5 ref. WL205413-6 ref. WL205413-7 ref. WL205413-8	Wire#5 Wire#6 Wire#7	al	T18R	1 2 1 5 2 1 1 1 1 1 7

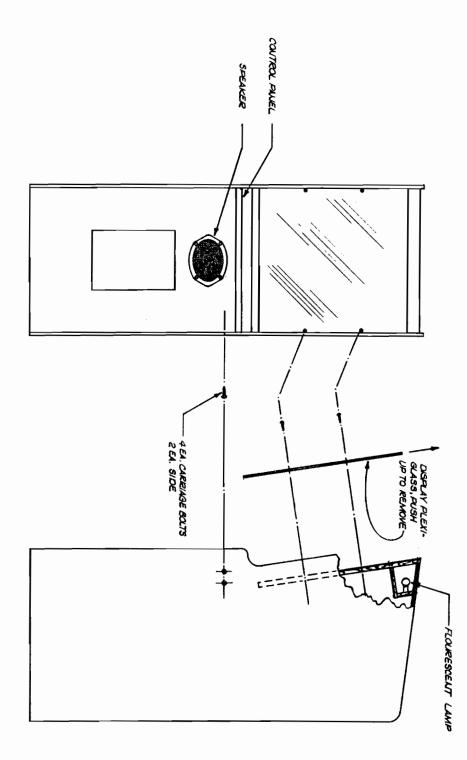
AUDIO TO JOYSTICK WIRE HARNESS ASSEMBLY PL205412

ITEM	PART NUMBER	DESCRIPTION	MFGR. PART NO.	QTY.
1 2 3 4 5 6 7 8 9 10	09-18-5094 02-09-1118 02-09-2118 T-18R ref. WL205412-1 ref. WL205412-2 ref. WL205412-3 ref. WL205412-4 ref. WL205412-5	Wire #3 Wire #4		1 4 6 5 1 1 1 1
1 2 3 4 5 6 7	03-09-1063 02-09-1118 ref. WL205411-1 ref. WL205411-2 ref. WL205411-3 ref. WL205411-4 T-18R			1 1 1 1 3

APPENDIX A

Assembly Drawings, Schematics & Wiring Diagrams

DATE APPROVED

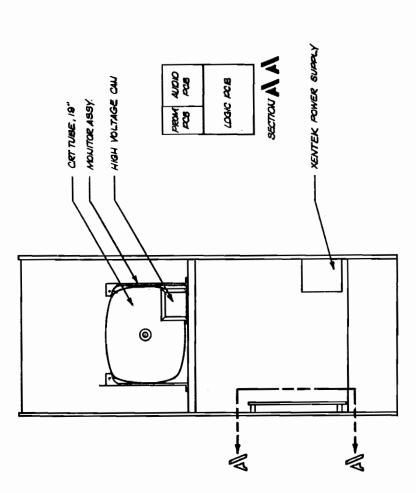


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2	FINISH: FIN
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1	CINEMATRONICS IND DWG TITLE FROUT CABILLET A: ILLUSTRATION MODEL NO. DWG DWG NO. SIZE MILEOSO COOSE IDENT.
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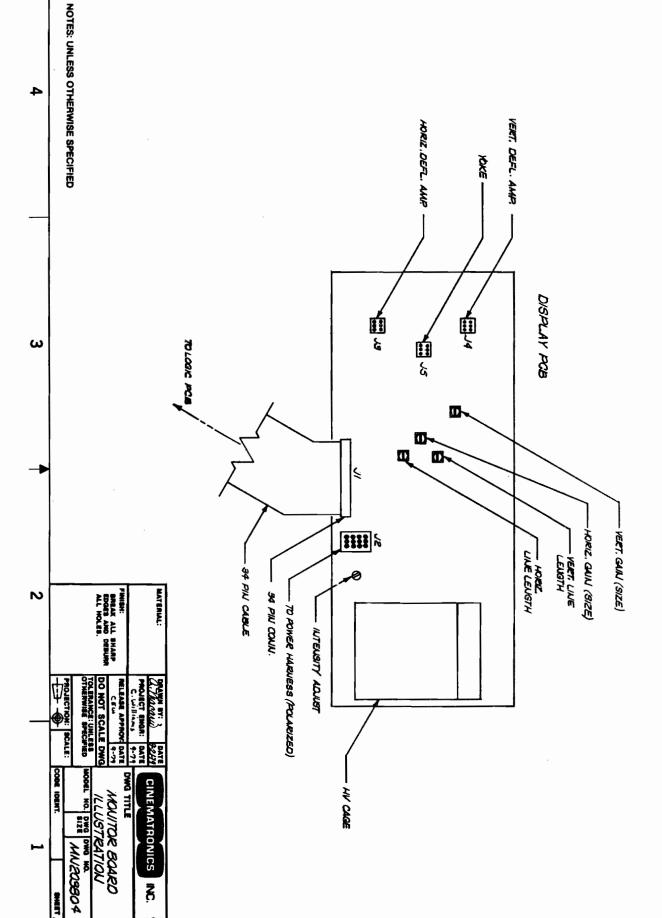
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INC.



CINEMATRONICS INC. 62.000 DWG THLE REAR CABINET ASSY.	1231	Size MURDSON 4	CODE IDENT. SHEET / OF /	1
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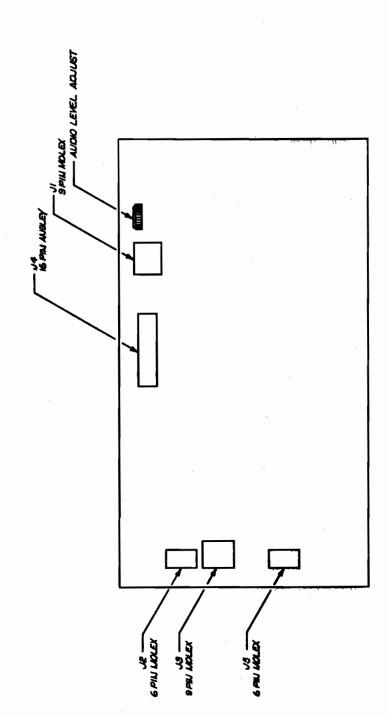


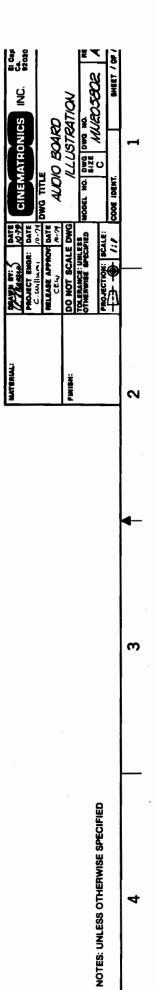
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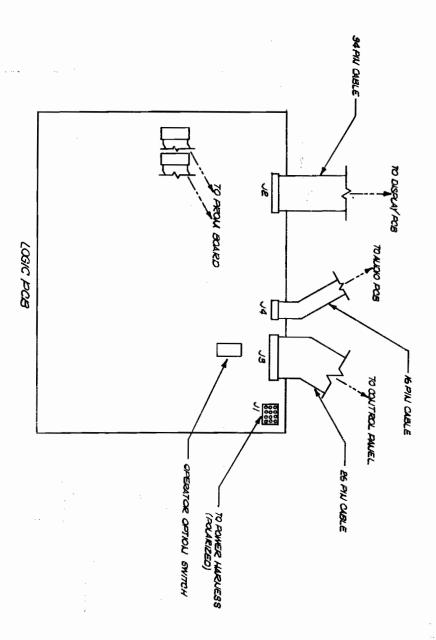
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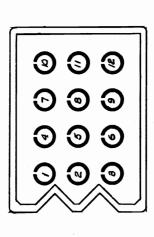




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REVISIONS



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JI CONNECTOR DATA	HOILDHIA	CHASSIS GUD	TXFMR LUG#3	TXFMR LUG #1	G.SVAC GUD	6.31AC	SPOT KILL (25UUE)	+251	-257	121	+51/	+5V RETURN	# 85 V RETURU
JI COULUE	PIN LICE WIRE COLOR	ORN/YEL	WHT	BLK	GRU/YEL	ORG	BRN	烙	DRN N	aen Cen	LUS	BLK	CTEN
	DINTO	/-//	2 -//	<i>8-1</i> ∩	71-4	3	71-6	7-10	31-8	6-//	01-10	11-17	31-10
				$\overline{\triangleleft}$			Ø	1	A				

A SAMP IULINE FUSE.

A SAMP IULIUE FUSE.

A SAMP INLINE CIRCUIT BREAKER CB 1.

A SAMP IULINE CIRCUIT BREKER CB C.

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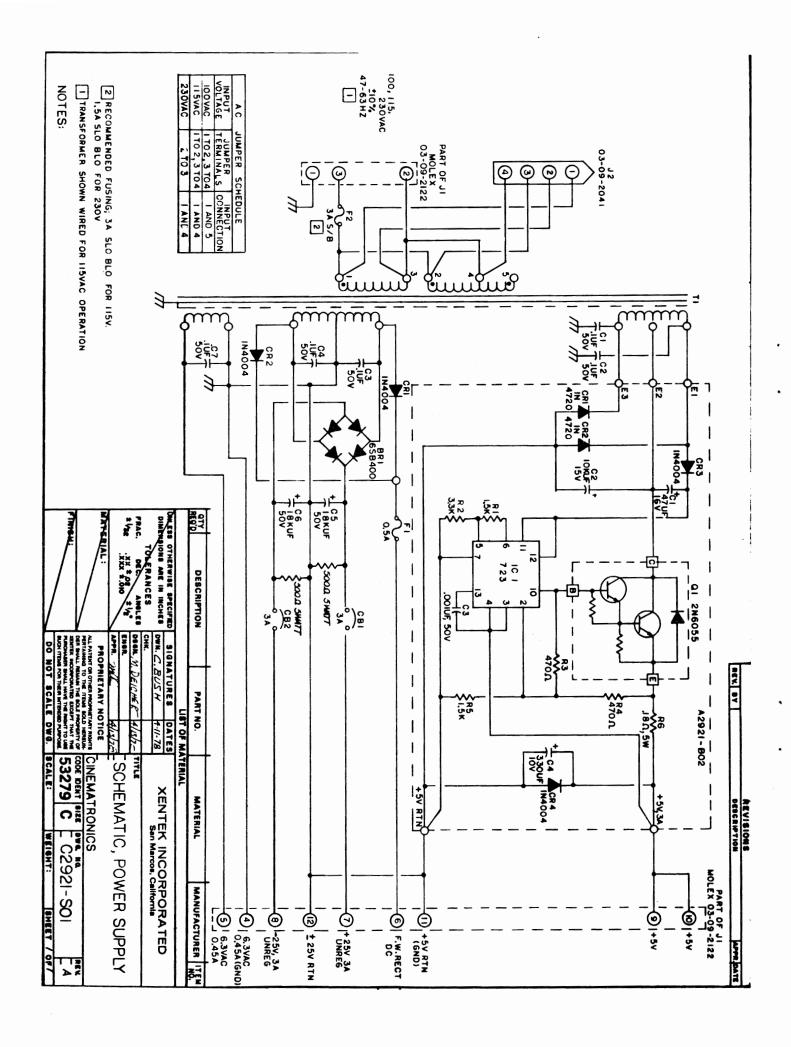
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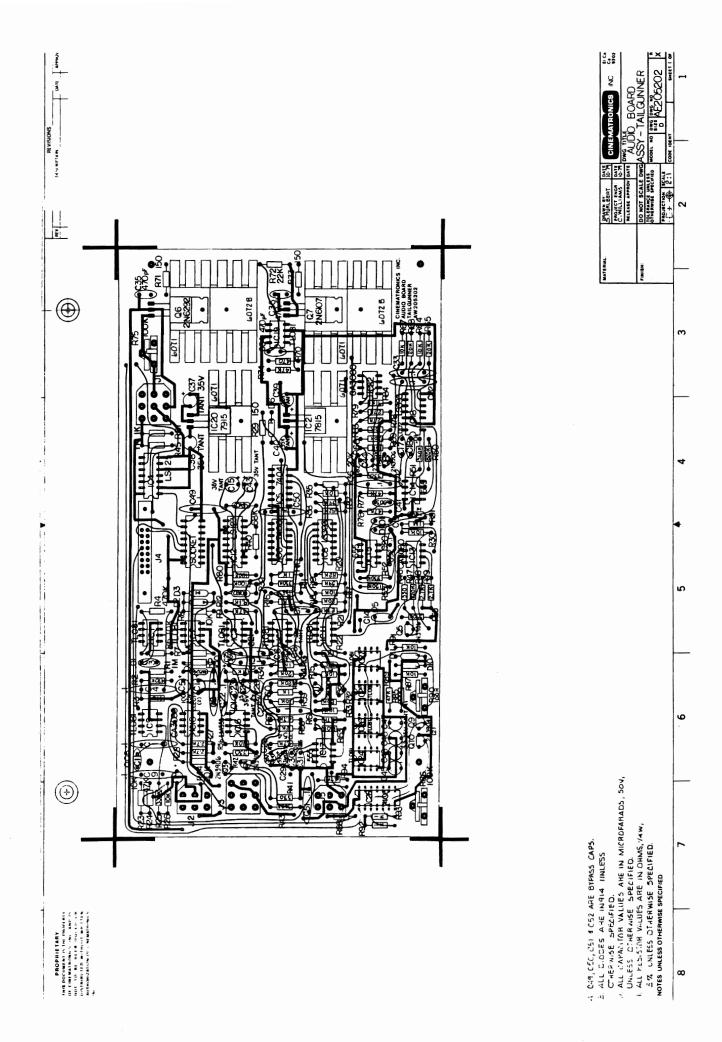
	JE CONINE	JE CONNECTOR DATA
PINKA	PIN NO WIRE COLOR	FUNCTION
1-26	NYB	IME FIRE #1
J8-2	OKEB	TXFMR LUG#S
J2-3	O3X	TXFMR LUG # 2
12-4	73/	TXFMR LUGAG

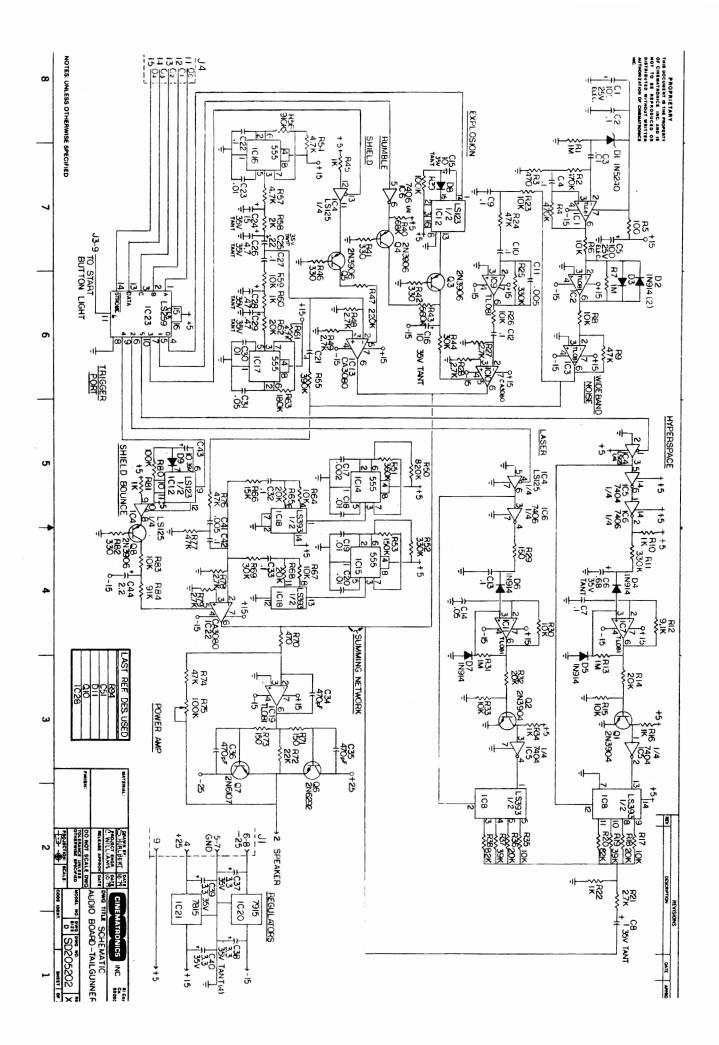
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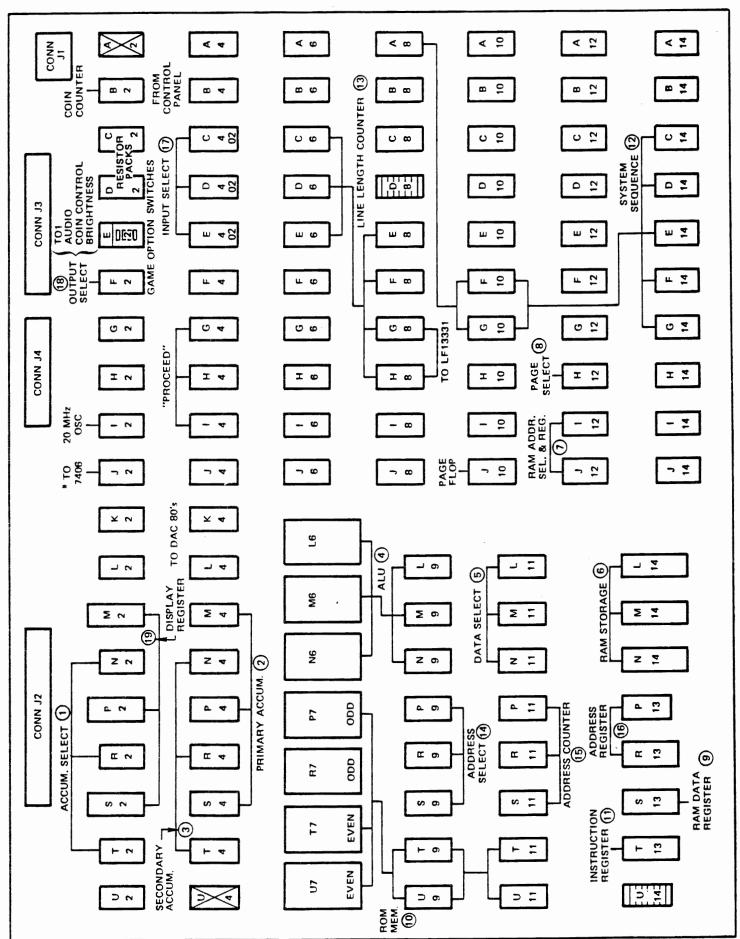
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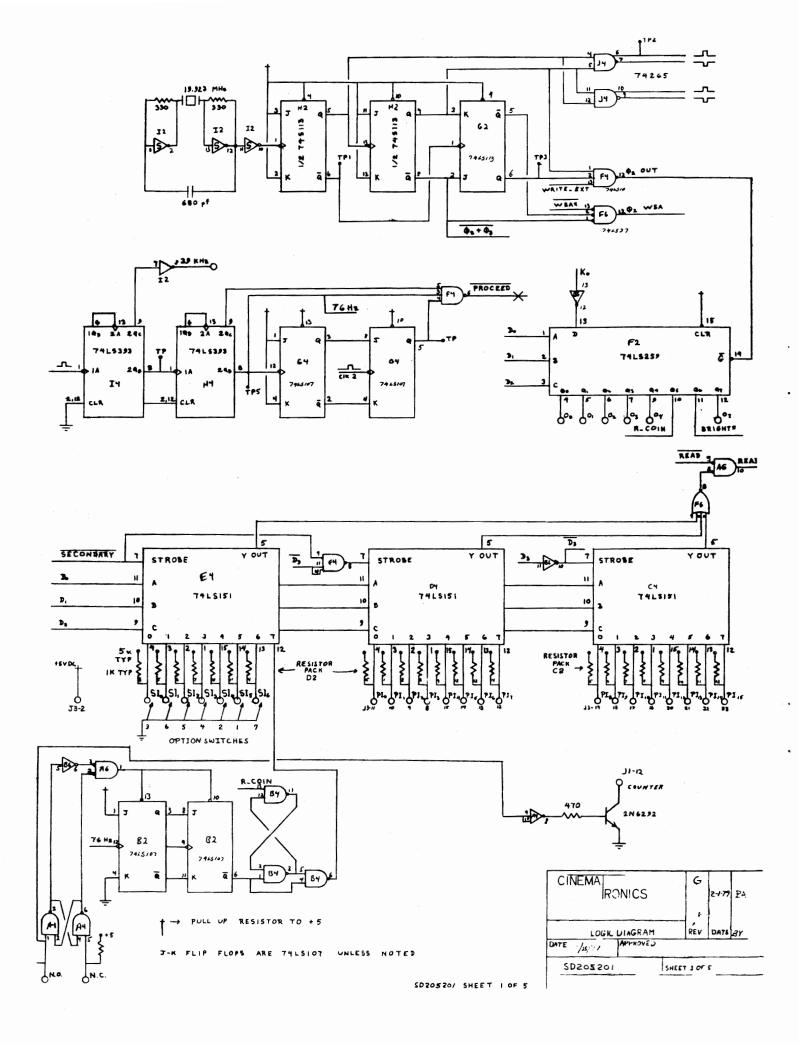


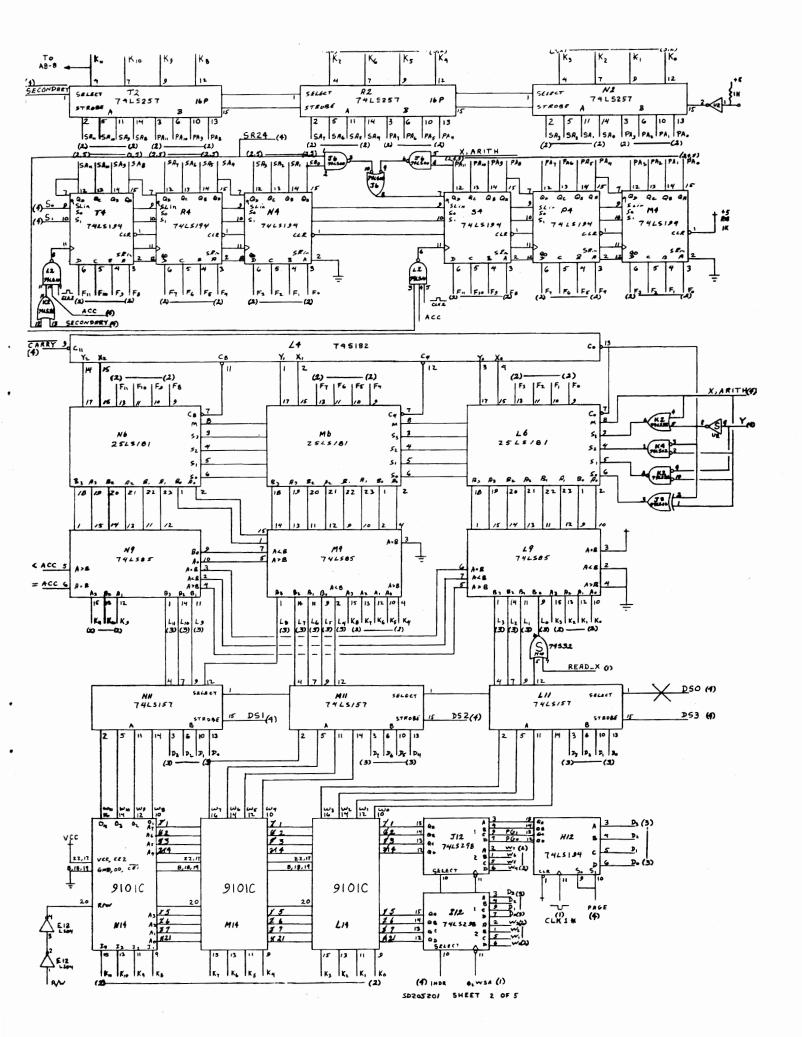


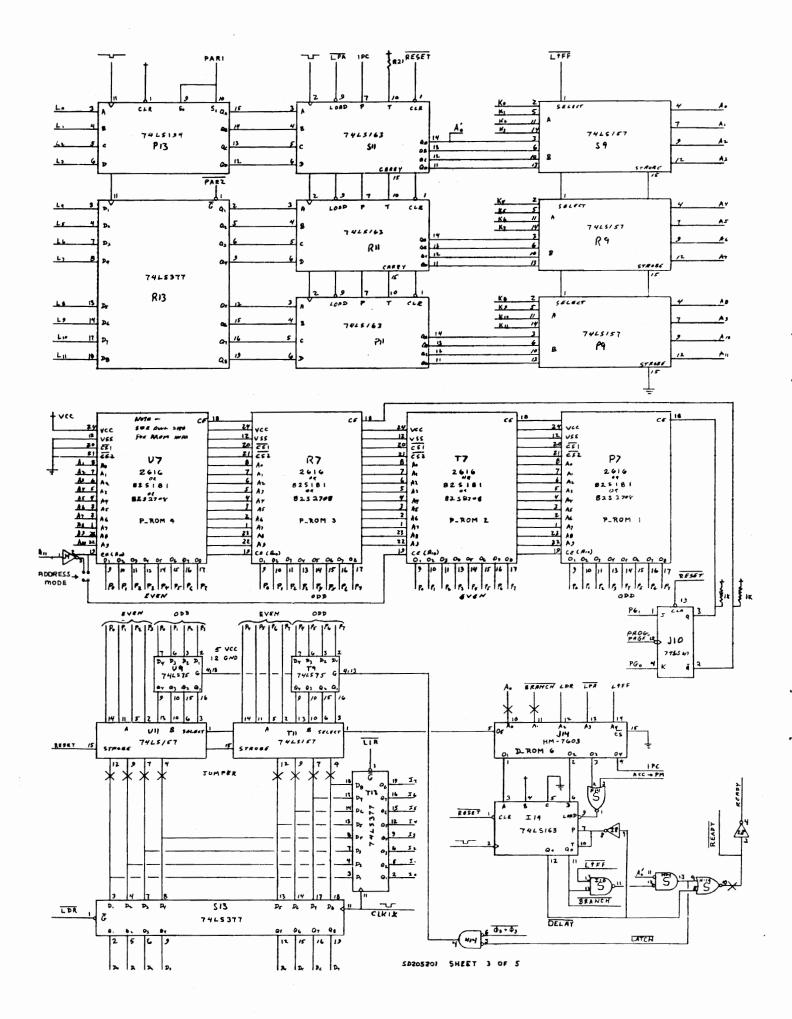


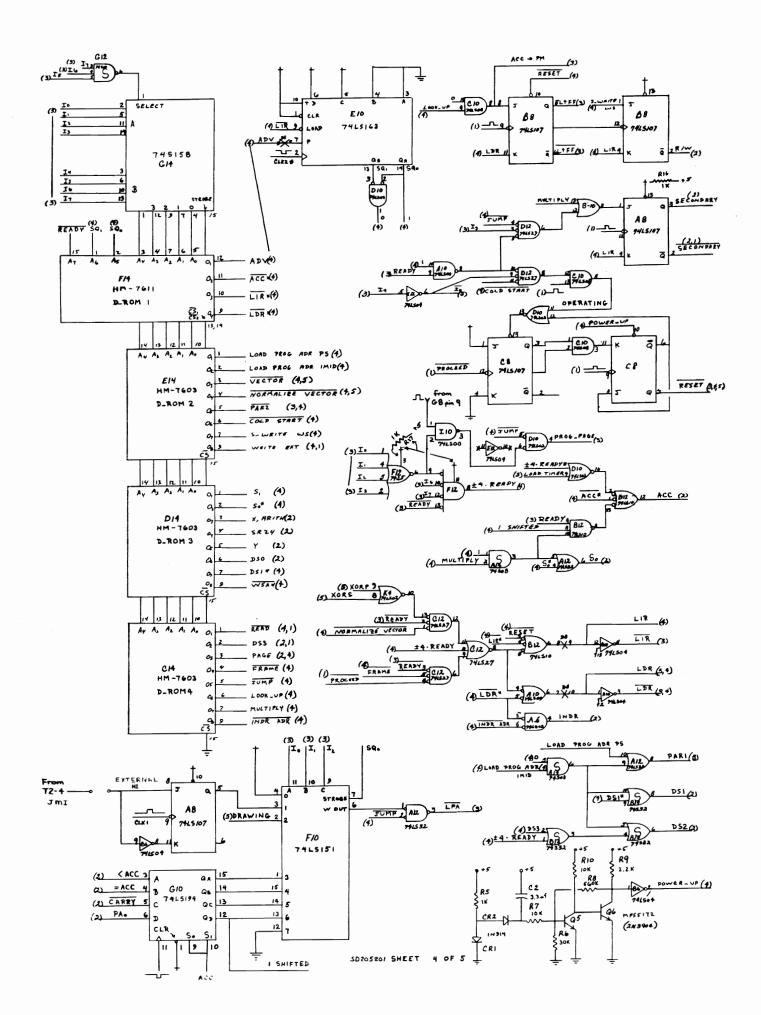


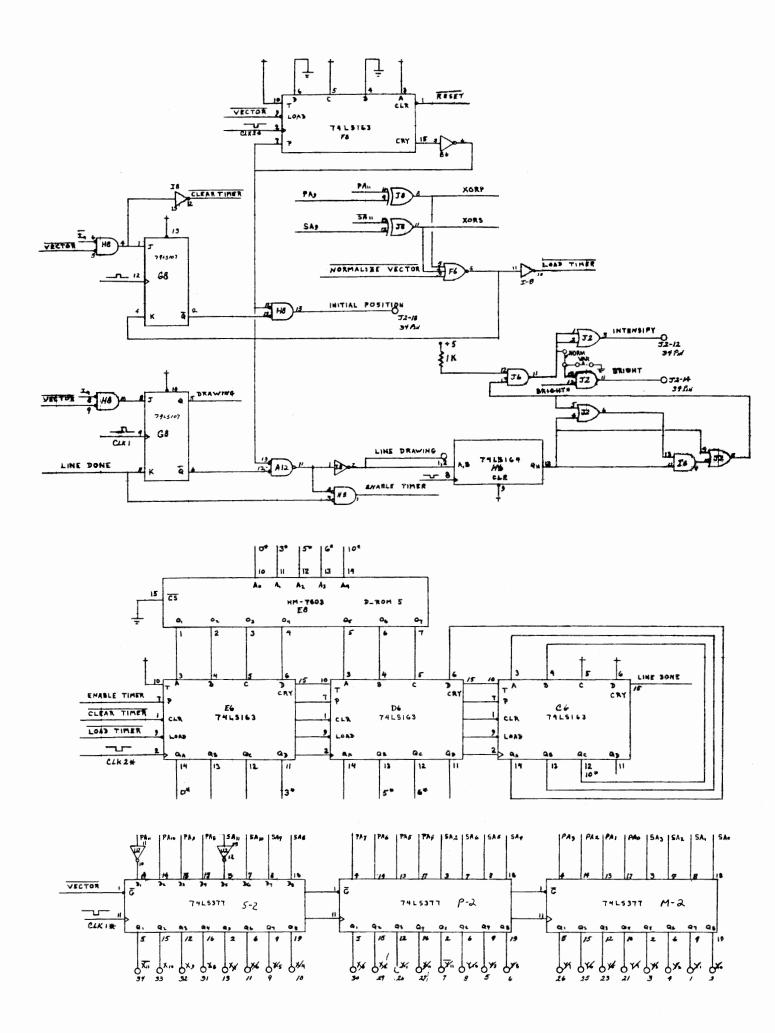
*OR 16-LEVEL INTENSITY CIRCUITRY





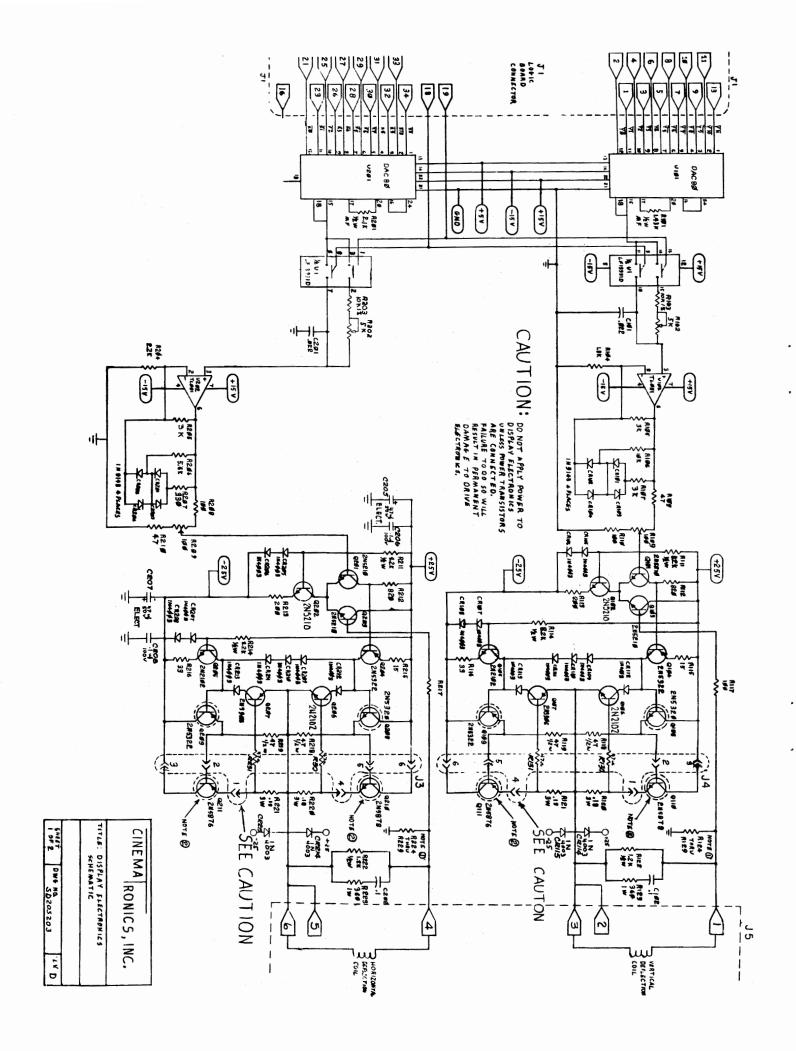


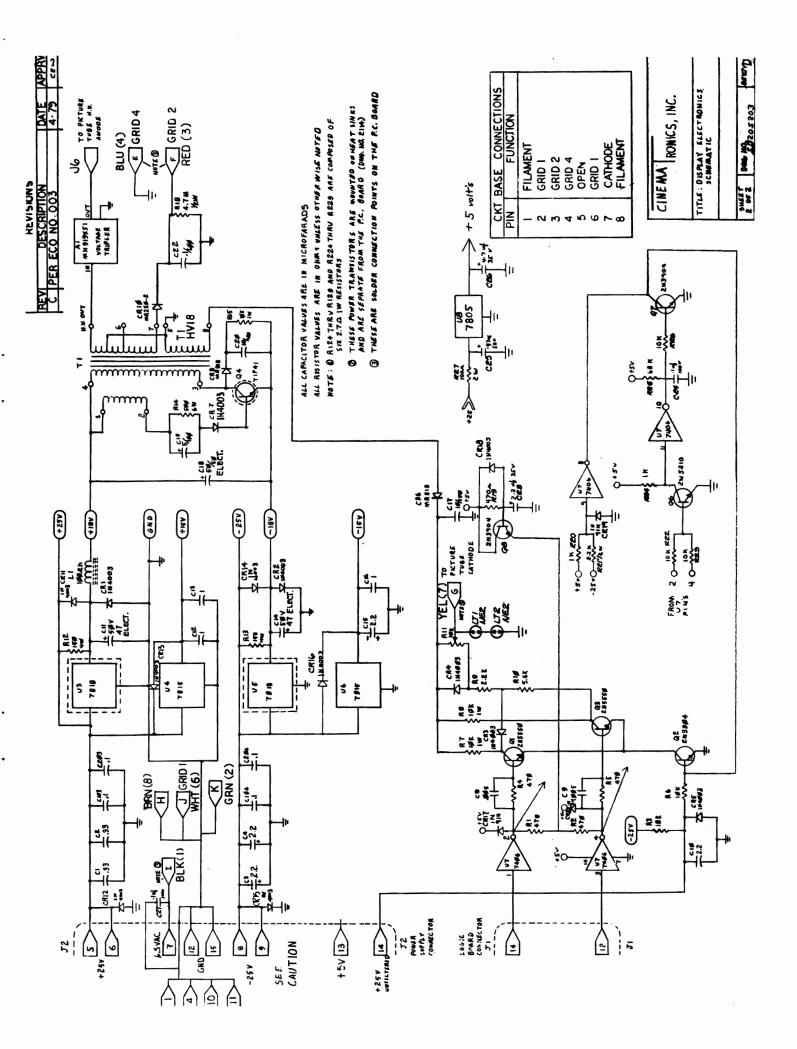




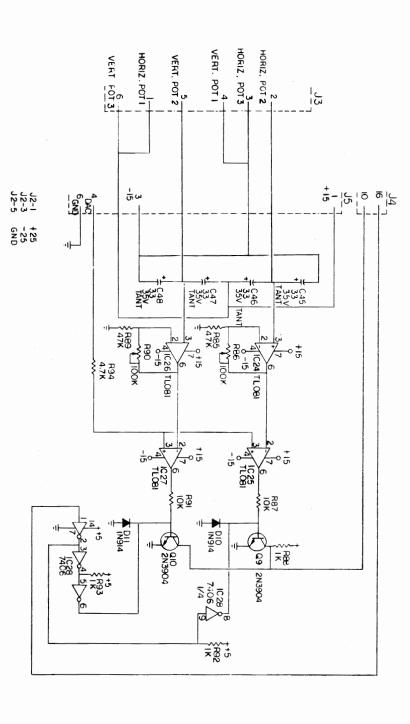
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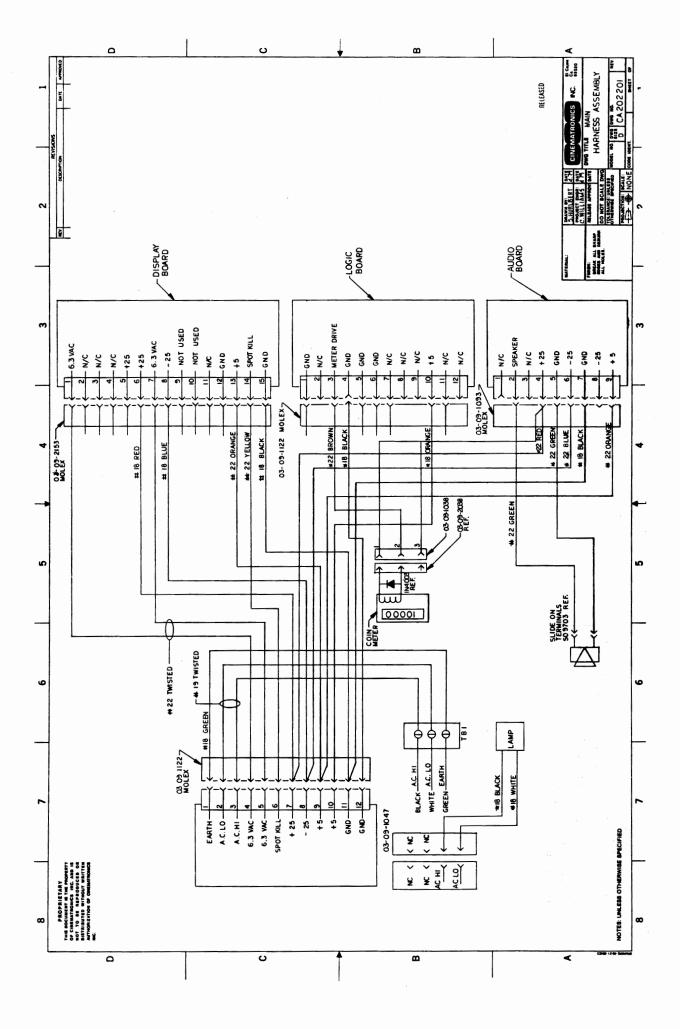
JOYSTICK CIRCUITRY

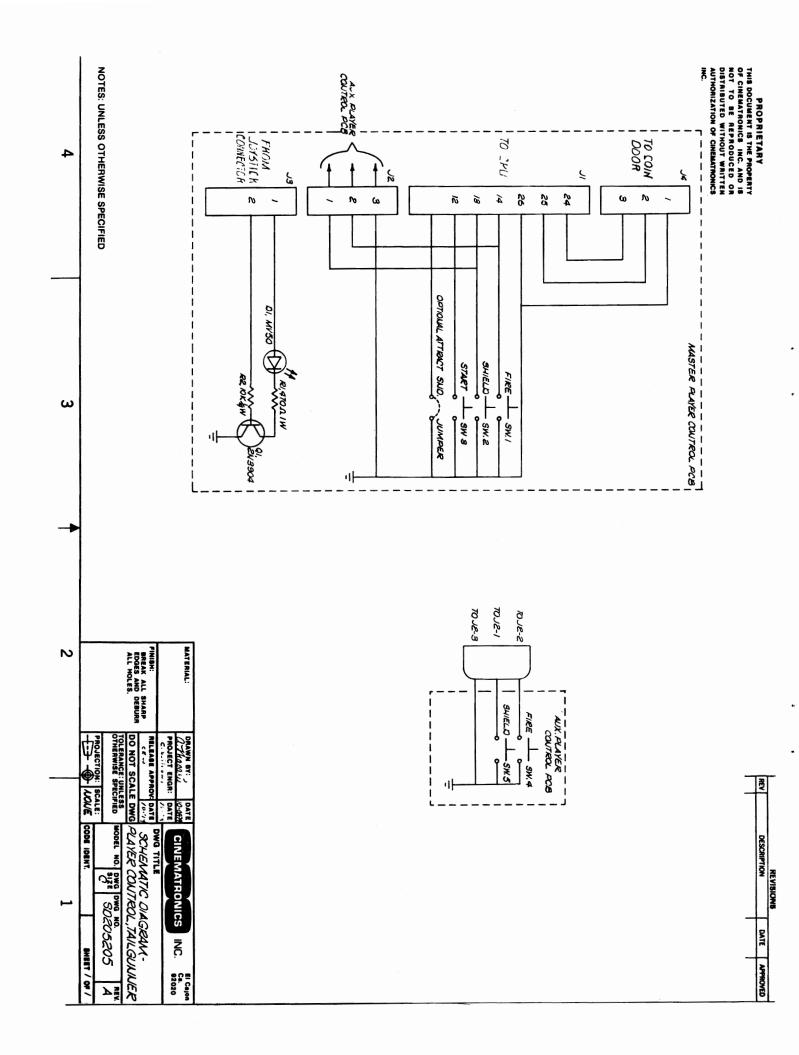
4 ALL DIODES AND 1:914 UNLESS OTHERWISE SPECIFIED.
3 C-19 C5C, AND C51 ARE BYPASS CAPS. (.14, 50V)
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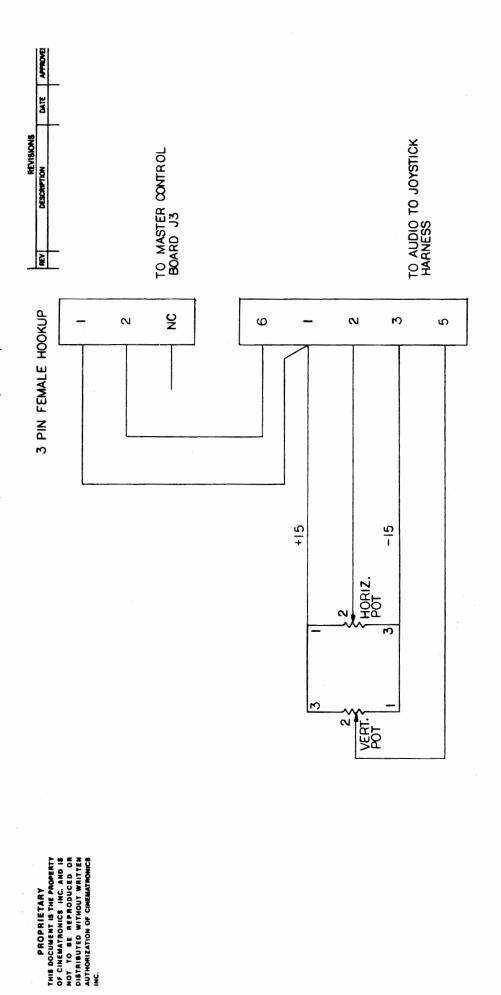
2 ALL RESISTOR VALUES ARE IN OHMS I/AW, 5% UNLESS OTHERWISE SPECIFIED.

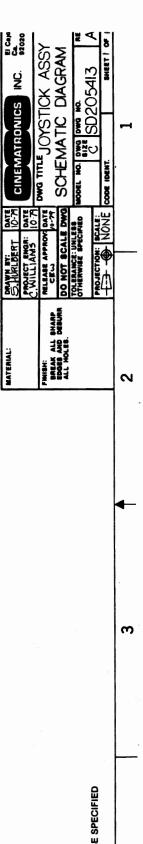
1. ALL CAPACITOR VALUES ARE IN MICHOFAHADS, 50V, DISC. UPLESS OFHERWISE SPECIFIED. NOTES: UNLESS OTHERWISE SPECIFIED 6 5 ω AUDIO BOARD TAILGUNNEI NICE INC STORE 205202 X

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