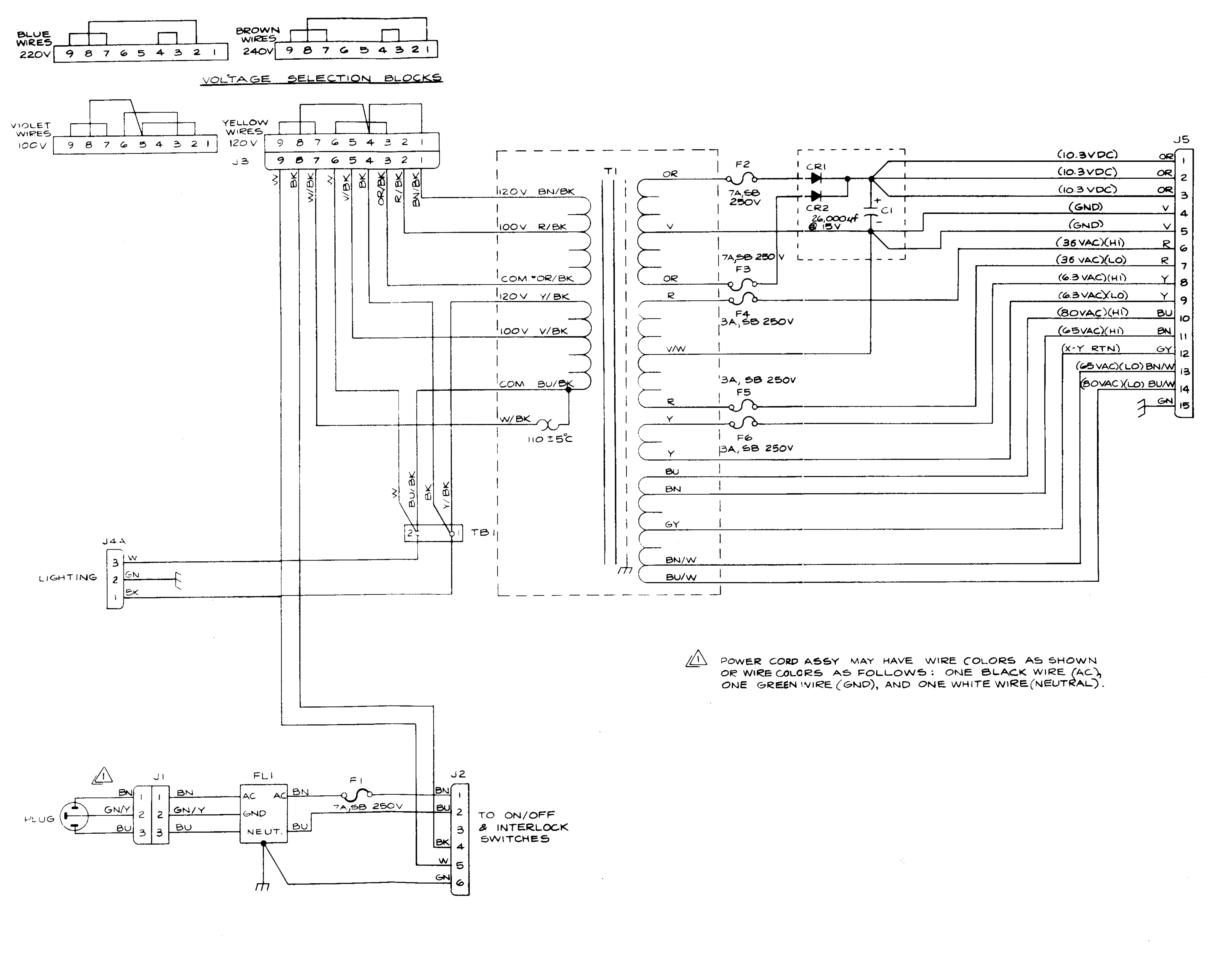
VIDEO POWER SUPPLY WIRING DIAGRAM (034633-01 A)



REGULATOR/AUDIO PCB SCH

Regulator/Audio PCB 034485-01 A

The Regulator/Audio PCB has the dual funct
regulating the +5 VDC logic power to the game P
amplifying the audio from the game PCB.

Regulator Circuit

The regulator consists of voltage regulator Q1,
source power transistor Q3 and Q3's bias transistor
regulator accurately regulates the logic power inpu
game PCB by monitoring the voltage through h
pedance inputs +SENSE and −SENSE. The inp
directly from the +5 VDC and ground inputs to th
PCB. Therefore, the regulator regulates the voltage
game PCB. This eliminates a reduced voltage du
buildup on the wire harness between the regulator
game PCB. Variable resistor R8 is adjusted for the
on the game PCB. Once adjusted, the voltage at the
the game PCB will remain constant at this voltage.

Regulator Adjustment

1. Connect a voltmeter between +5 V and GND tes
of the game PCB.
2. Adjust variable resistor R8 on the Regulator/Au
for +5 VDC reading on the voltmeter.
3. Connect a voltmeter between +5 V REG and
the Regulator/Audio PCB. Voltage reading shal
greater than +5.5 VDC. If greater, try cleanir
connectors on both the game PCB a
Regulator/Audio PCB.
4. If cleaning PCB edge connectors doesn't d
voltage difference, connect minus lead of voltr
GND test point of Regulator/Audio PCB and plus
GND test point of game PCB. Note the voltag
connect minus lead of voltmeter to +5 REG te
on Regulator/Audio PCB and plus lead to +5
point on game PCB. From this you can see
harness circuit is dropping the voltage. Troub
the appropriate harness wire or harness conne

Audio Circuit

The audio circuit contains two independen
amplifiers. Each amplifier consists of a TDA
amplifier with a gain of ten. In Asteroids, the
DISABLE input to the PCB is permanently gr
Therefore, this audio circuit is always on, even w
game is in the attract mode.

The audio circuit is repeated on Sheet 2, Side B, in
more information about its operation.

Drawing Package Supplement

to

ASTEROIDS

Operation, Maintenance, and Service Manual

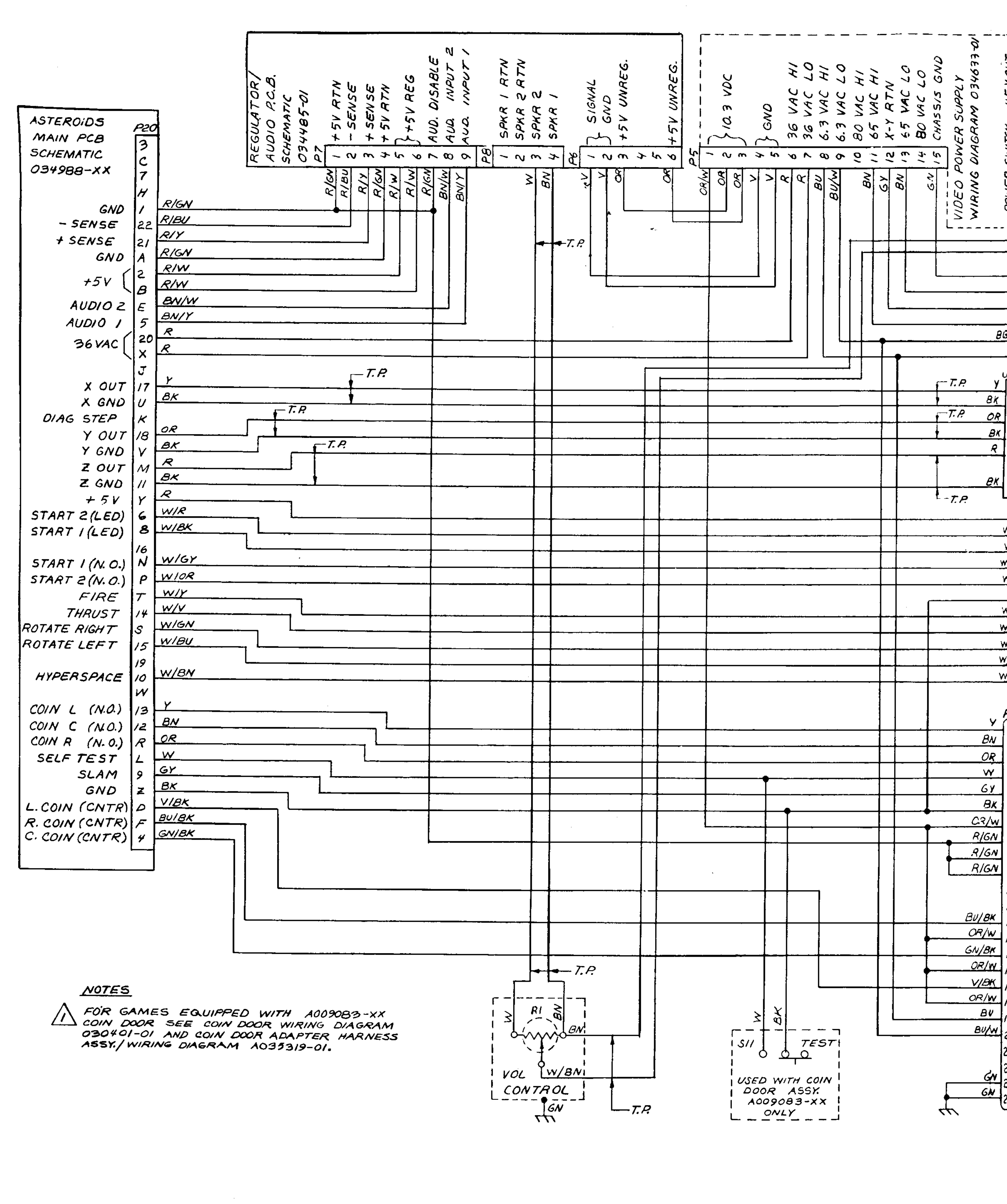
Contents of this Drawing Package

ATARI®

A Warner Communications Company

Sheet 1, Side A
DP-143-02 3rd printing

ASTEROIDS WIRING DIAGRAM (035156-01 B)



SCHEMATIC (034485-01 D)

unctions of
me PCB and

Q1, current
stor Q2. The
input to the
gh high im-
e inputs are
to the game
ltage on the
e due to IR
ator and the
the +5 VDC
t the input of
age.

D test points

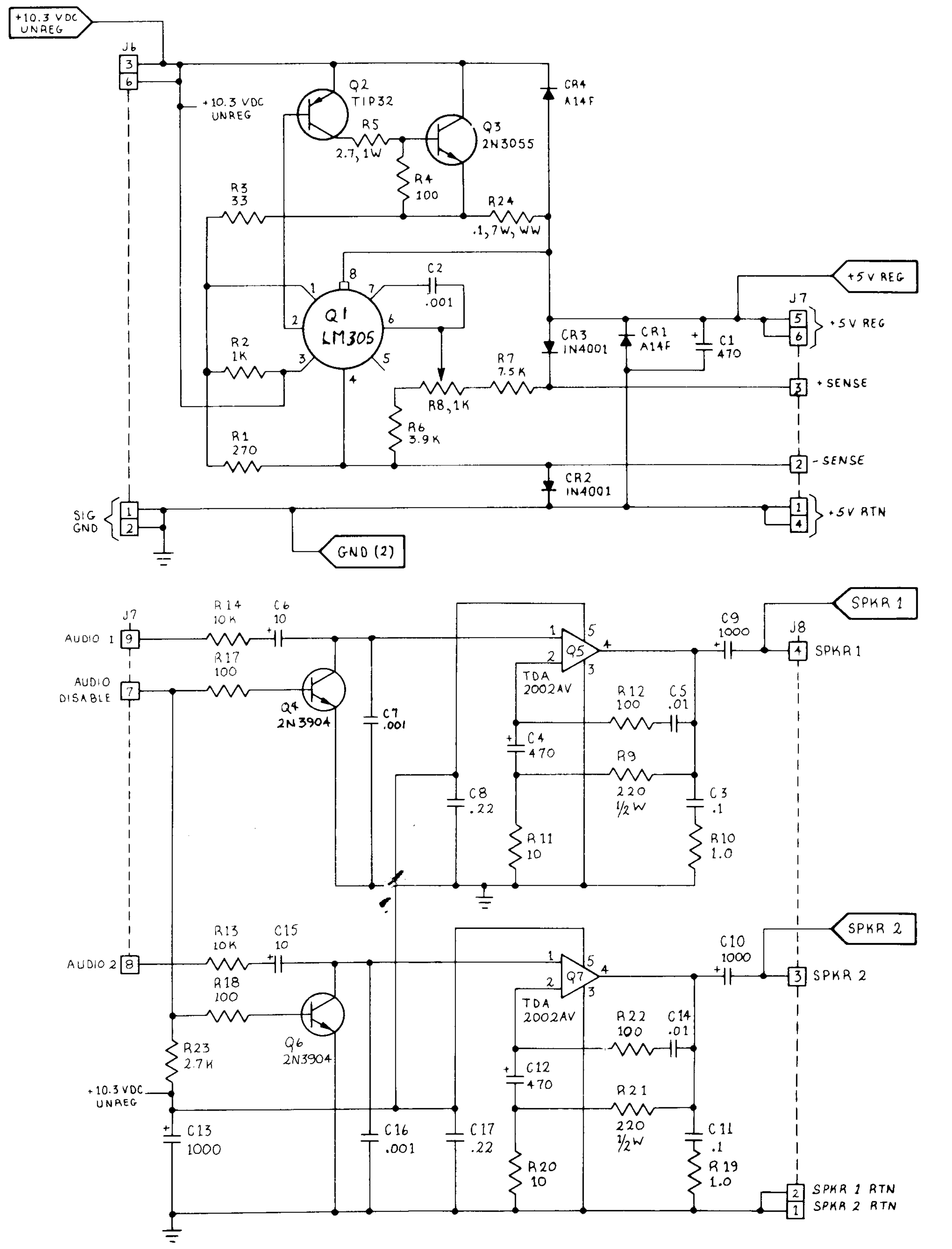
r/Audio PCB

and GND on
shall not be
eaning edge
B and the

n't decrease
voltmeter to
plus lead to
oltage. Now
G test point
+5 V test
see which
roubleshoot
nnector.

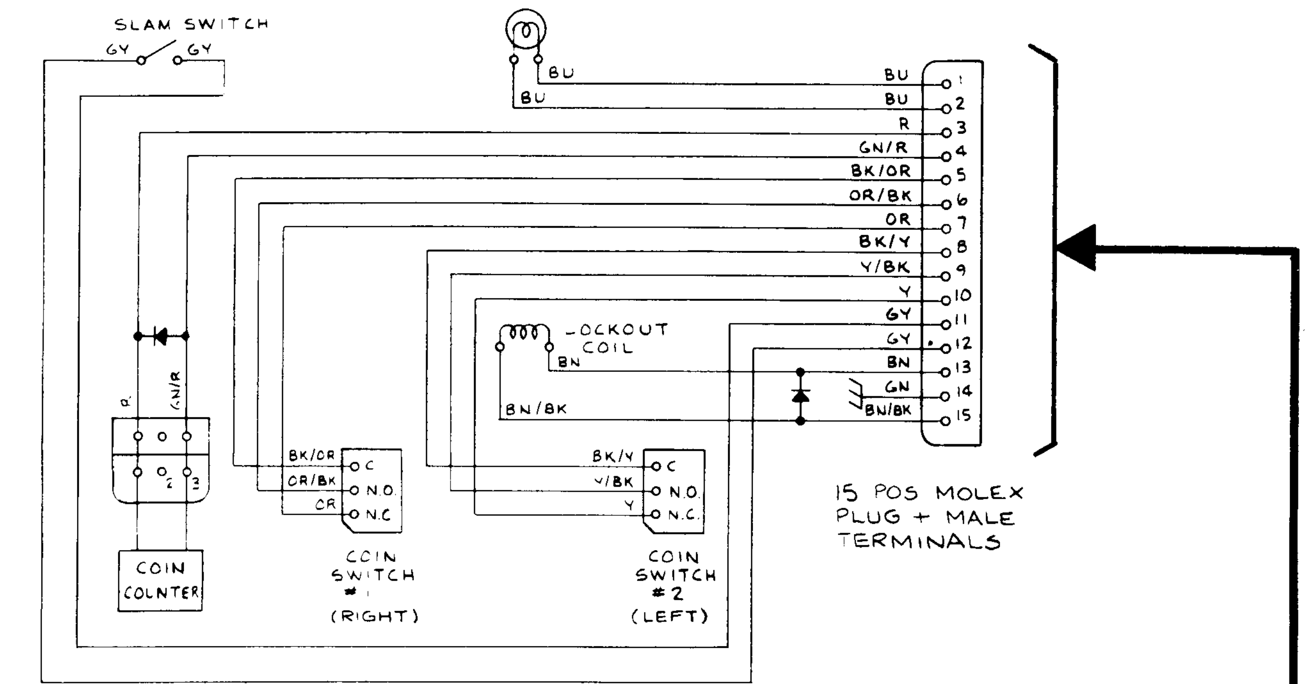
dent audio
TDA2002AV
the AUDIO
grounded.
n while the

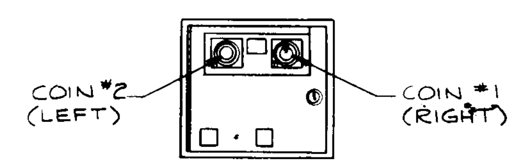
B, including



denotes a test point

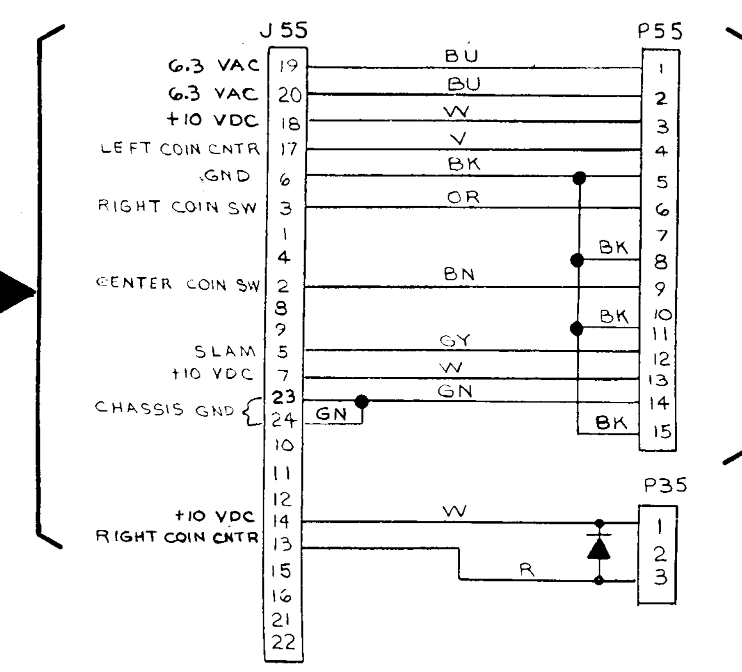
COIN DOOR SCHEMATIC (030401-01 B)

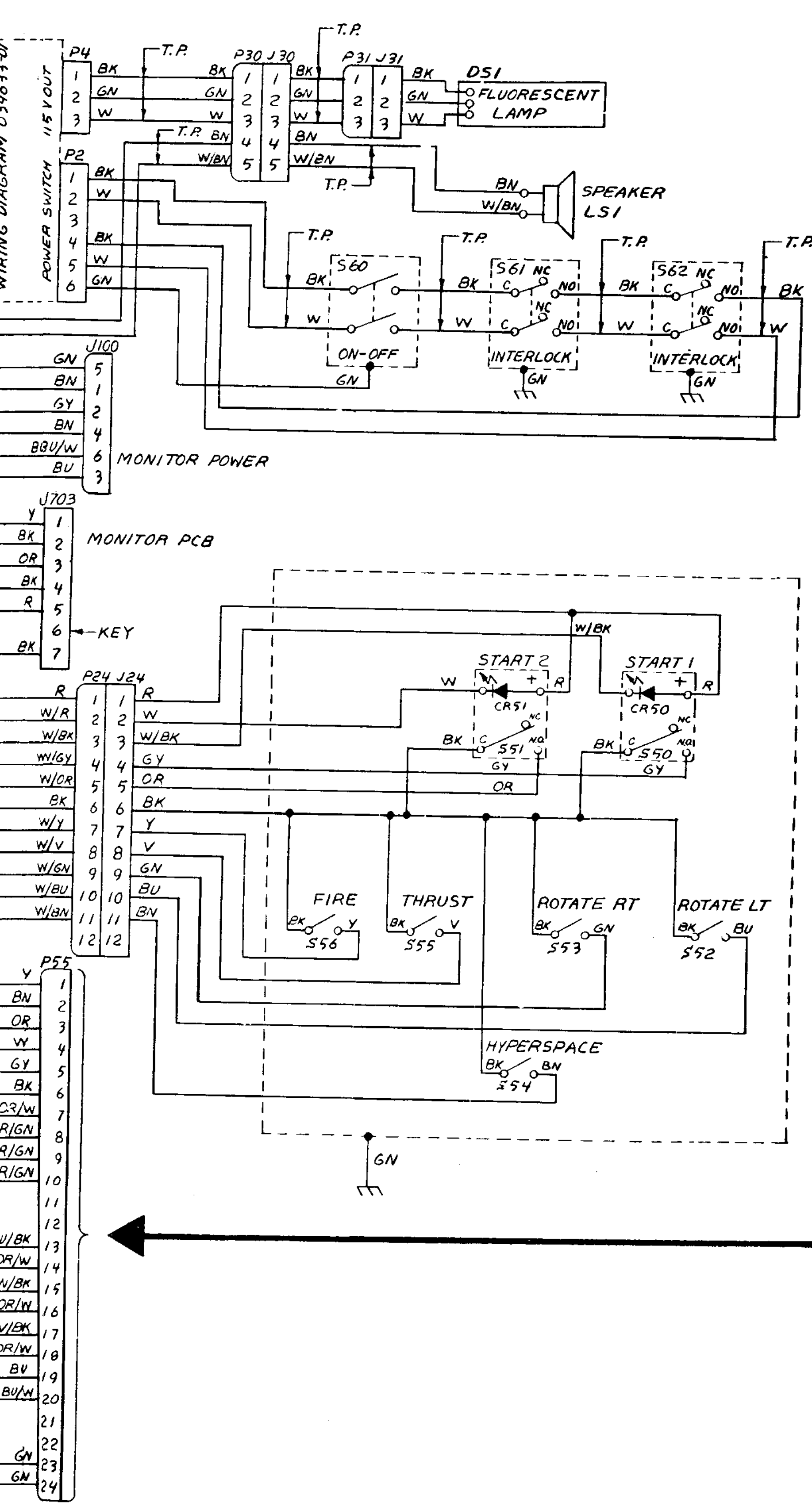




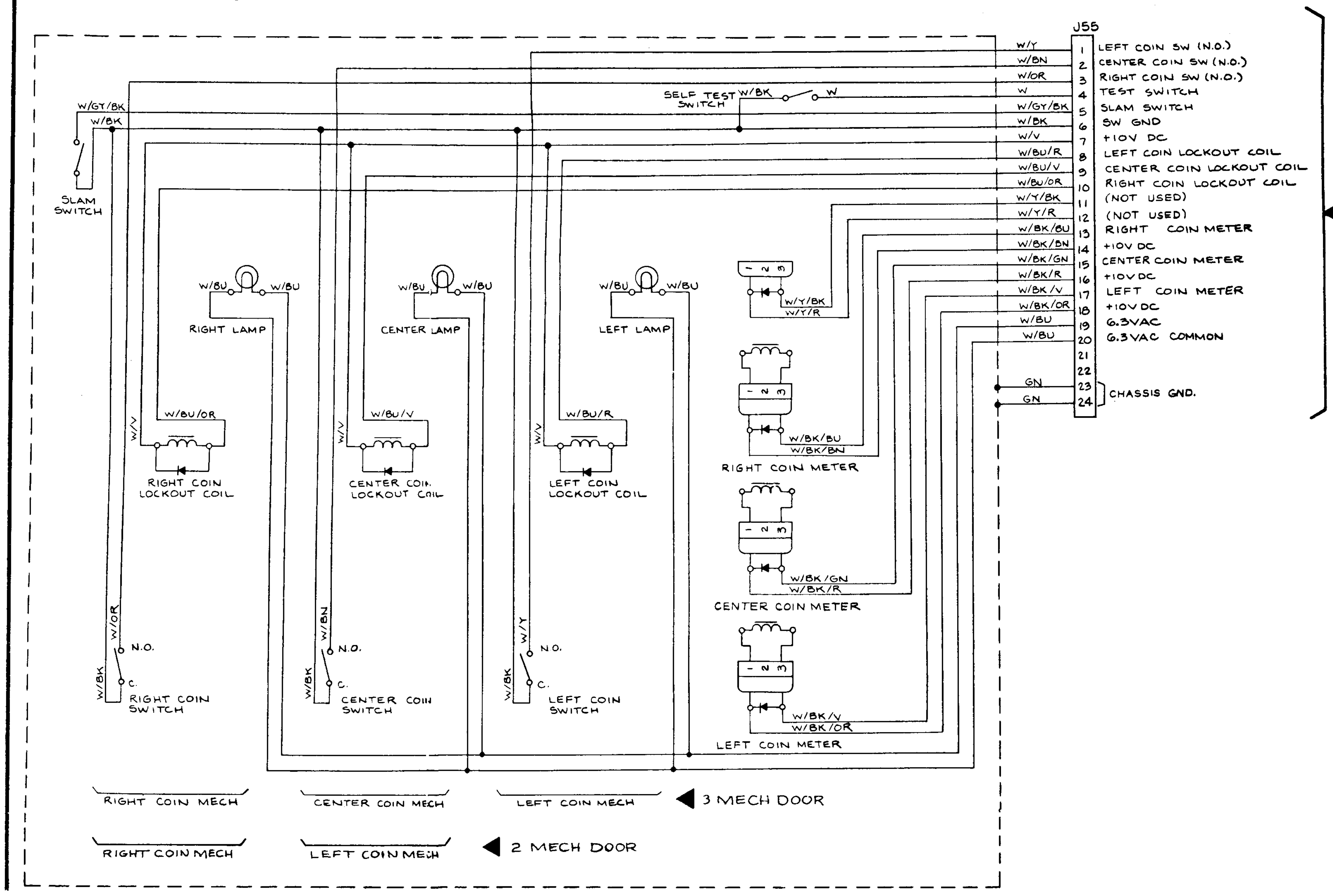
FRONT VIEW OF COIN DOOR

COIN DOOR ADAPTER HARNESS

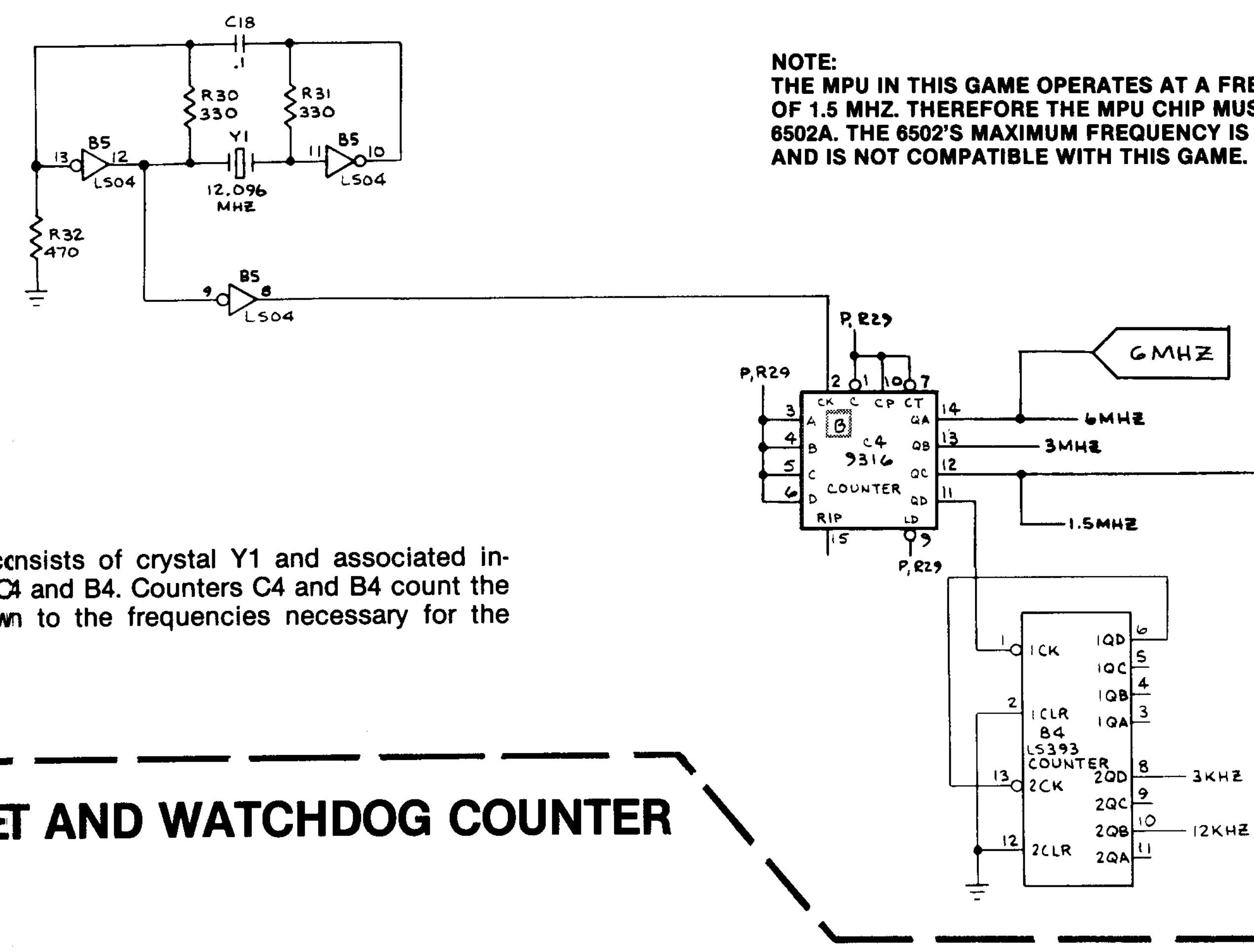




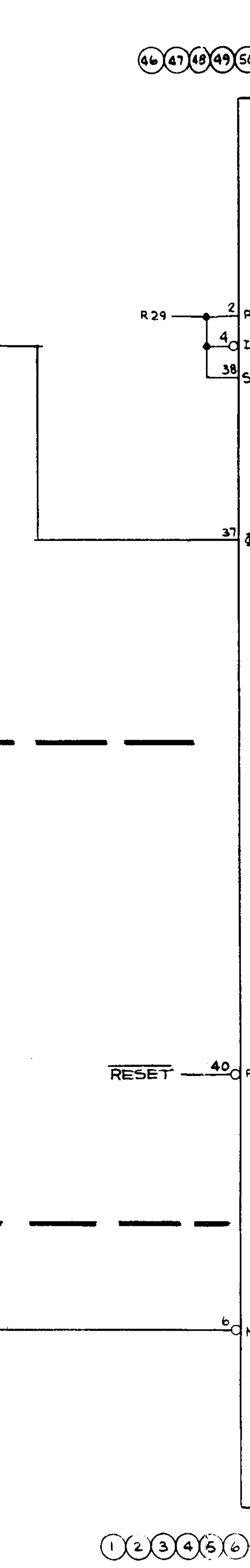
COIN DOOR SCHEMATIC (034988-01 A)



CLOCK CIRCUIT

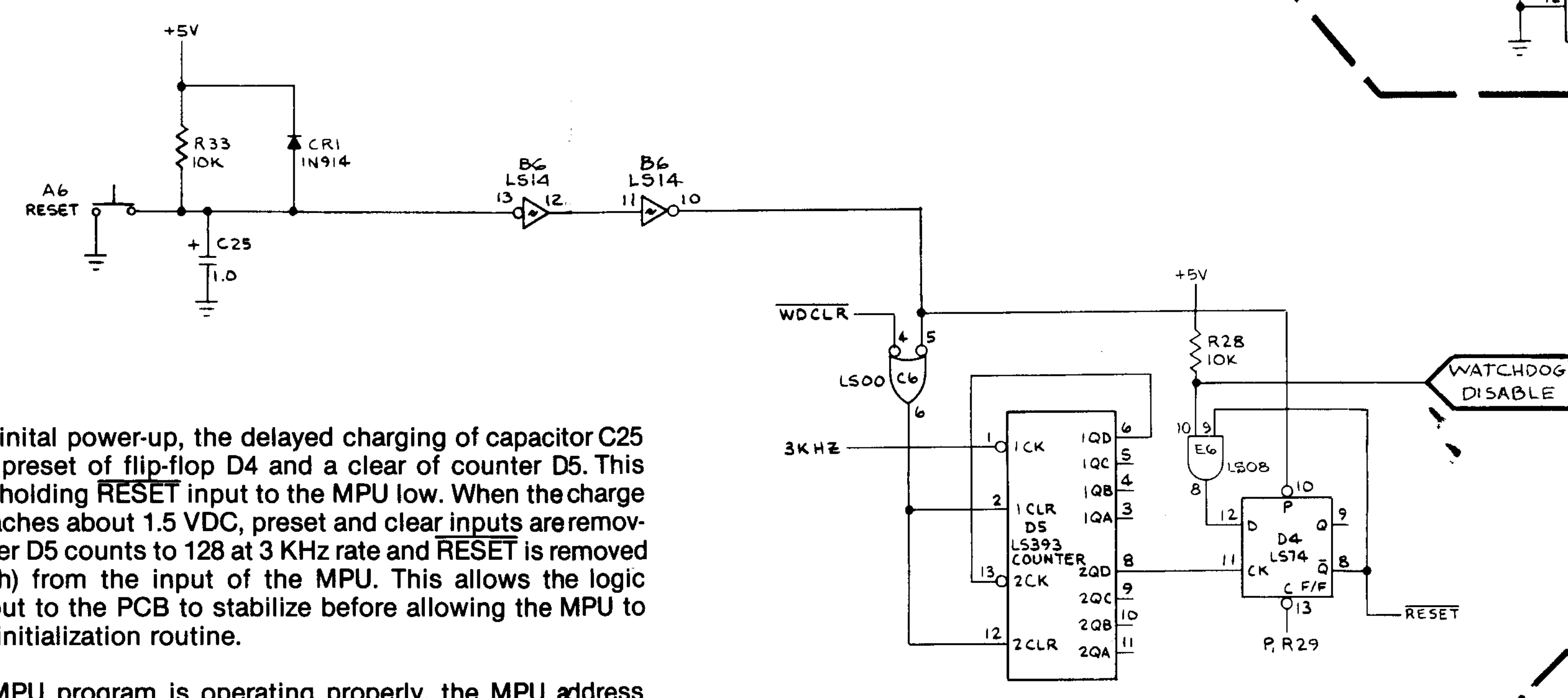


NOTE:
THE MPU IN THIS GAME OPERATES AT A FREQUENCY OF 1.5 MHZ. THEREFORE THE MPU CHIP MUST BE 6502A. THE 6502'S MAXIMUM FREQUENCY IS 1 MHZ AND IS NOT COMPATIBLE WITH THIS GAME.



The clock circuit consists of crystal Y1 and associated inverters and counters C4 and B4. Counters C4 and B4 count the crystal frequency down to the frequencies necessary for the Asteroids game.

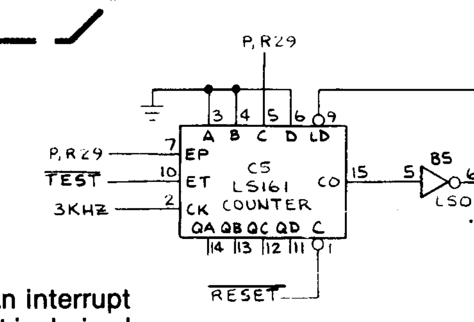
POWER RESET AND WATCHDOG COUNTER



During inital power-up, the delayed charging of capacitor C25 causes a preset of flip-flop D4 and a clear of counter D5. This results in holding $\overline{\text{RESET}}$ input to the MPU low. When the charge of C25 reaches about 1.5 VDC, preset and clear inputs are removed. Counter D5 counts to 128 at 3 KHz rate and $\overline{\text{RESET}}$ is removed (goes high) from the input of the MPU. This allows the logic power input to the PCB to stabilize before allowing the MPU to begin its initialization routine.

If the MPU program is operating properly, the MPU address decoding circuitry will output the $\overline{\text{WDCLR}}$ (Watchdog clear) signal at predetermined intervals. This serves to clear counter D5 before it counts up to the state that will create the $\overline{\text{RESET}}$ condition. If the MPU program strays from its intended sequence and does not output the $\overline{\text{WDCLR}}$ signal, counter D5 will count up to the $\overline{\text{RESET}}$ state and cause the MPU to return to its initialization routine.

NMI COUNTER

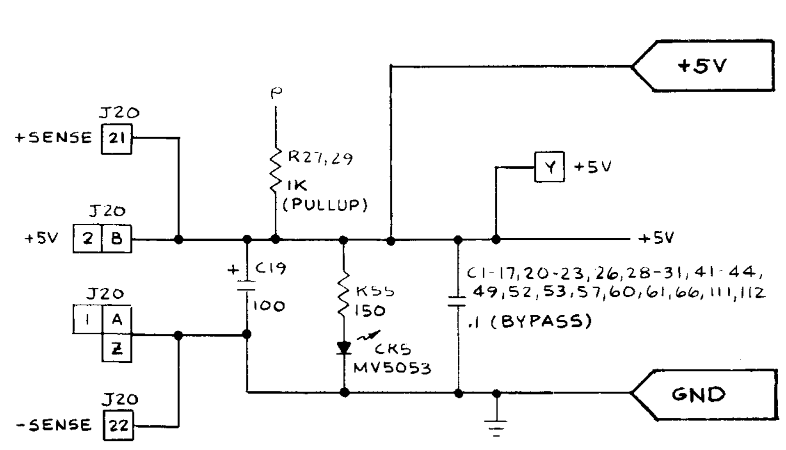


The NMI (non-maskable interrupt) counter causes an interrupt at the NMI input of the MPU every 4 msec. The interrupt is derived by dividing 3 KHz by a factor of 12 through counter C5. The interrupt occurs when pin 6 of inverter B5 goes low. During power-up, the ~~NMI counter is disabled by~~ $\overline{\text{RESET}}$. During Self-Test, the NMI is disabled by $\overline{\text{TEST}}$.

denotes change by indicated revision

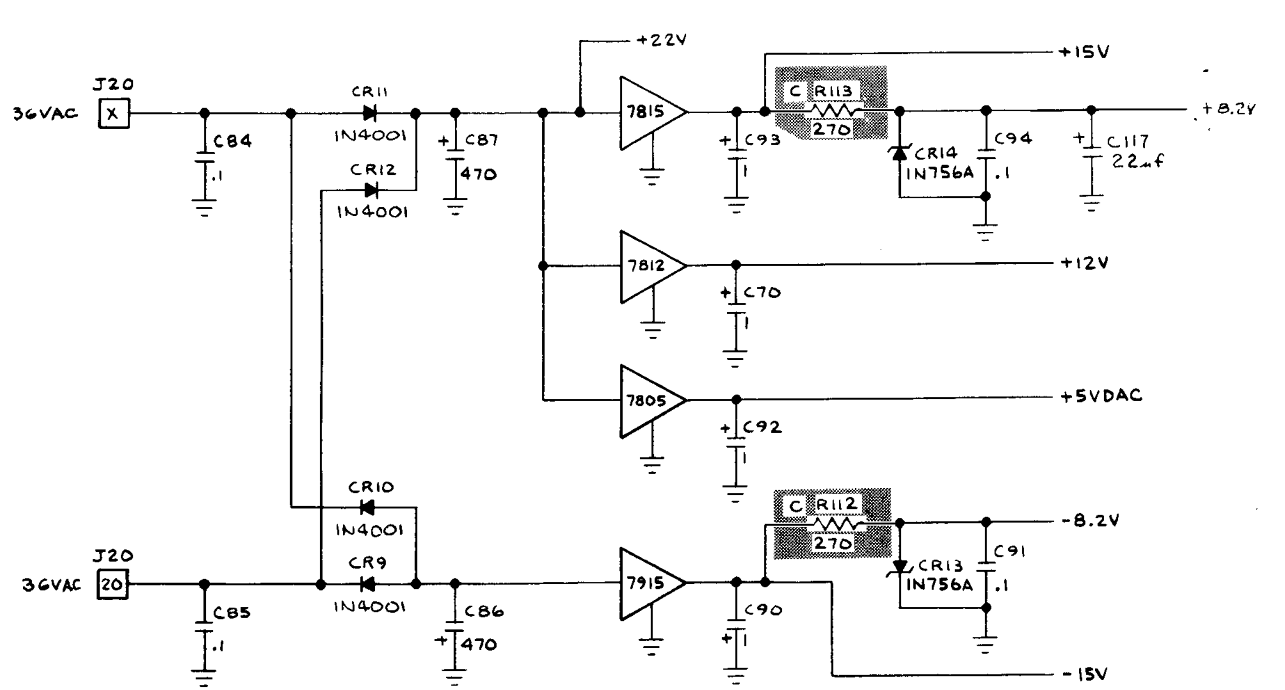
denotes a test point

POWER INPUT



This circuitry consists of the PCB inputs and outputs for the +5 VDC logic power and 36 VAC input to the on board regulators. The +5 VDC inputs and outputs are discussed on Sheet 1, Side A of this schematic set.

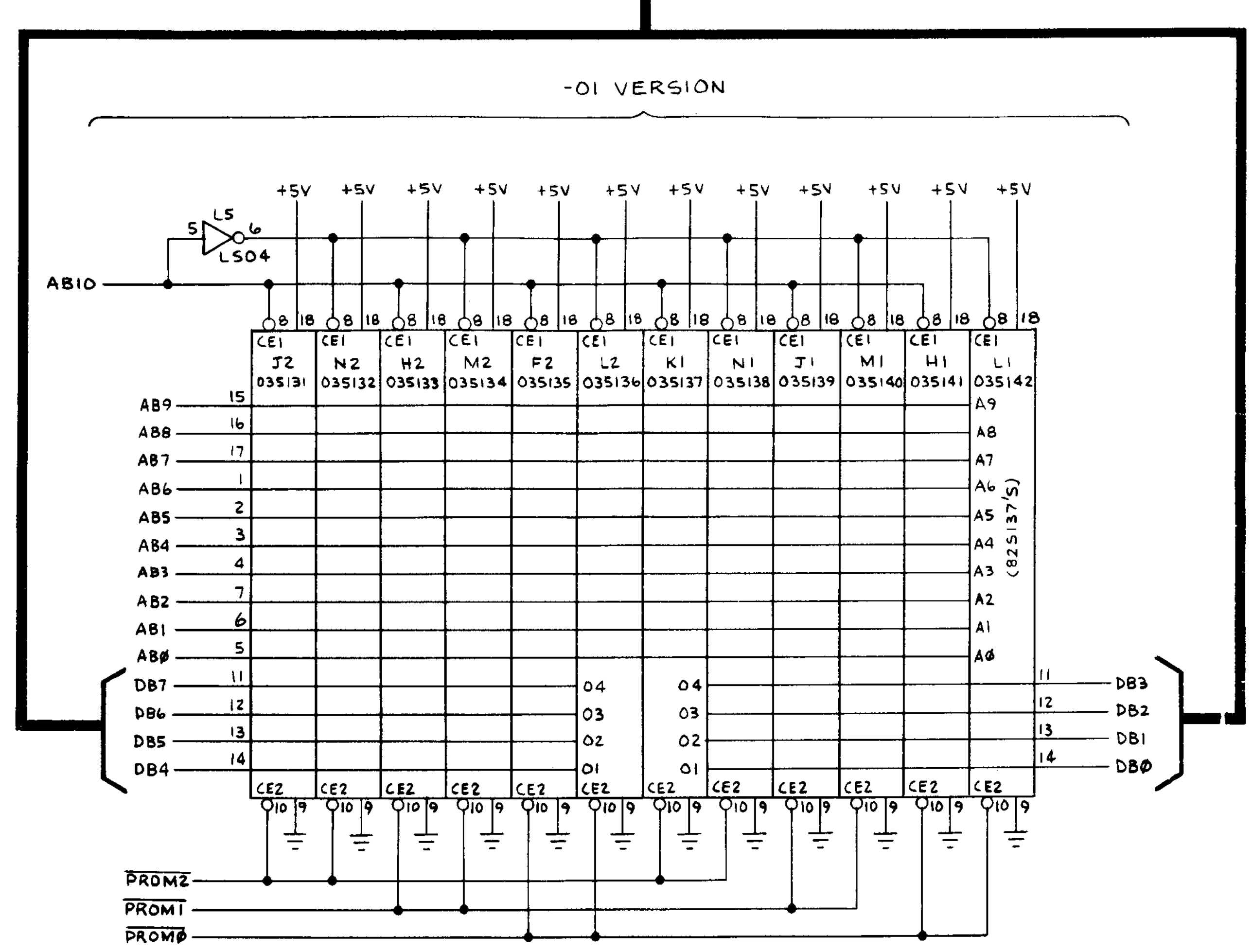
The 36 VAC inputs are received by two full wave rectifiers. Diodes CR9 and CR10 rectify the negative cycle of the input and the 7915 regulates the voltage at −15 VDC. Diodes CR11 and CR12 rectify the positive pulse of the 36 VAC input and the 7815 regulates the voltage at +15 VDC. The 7812 regulates at +12 VDC. The 7805 regulates an additional 5 VDC for the DACs. Zener diode CR14 supplies the +8.2 VDC for the sample and hold circuit. The +22V (unregulated) is used to power operational amplifiers P11 and L8 in the audio output.



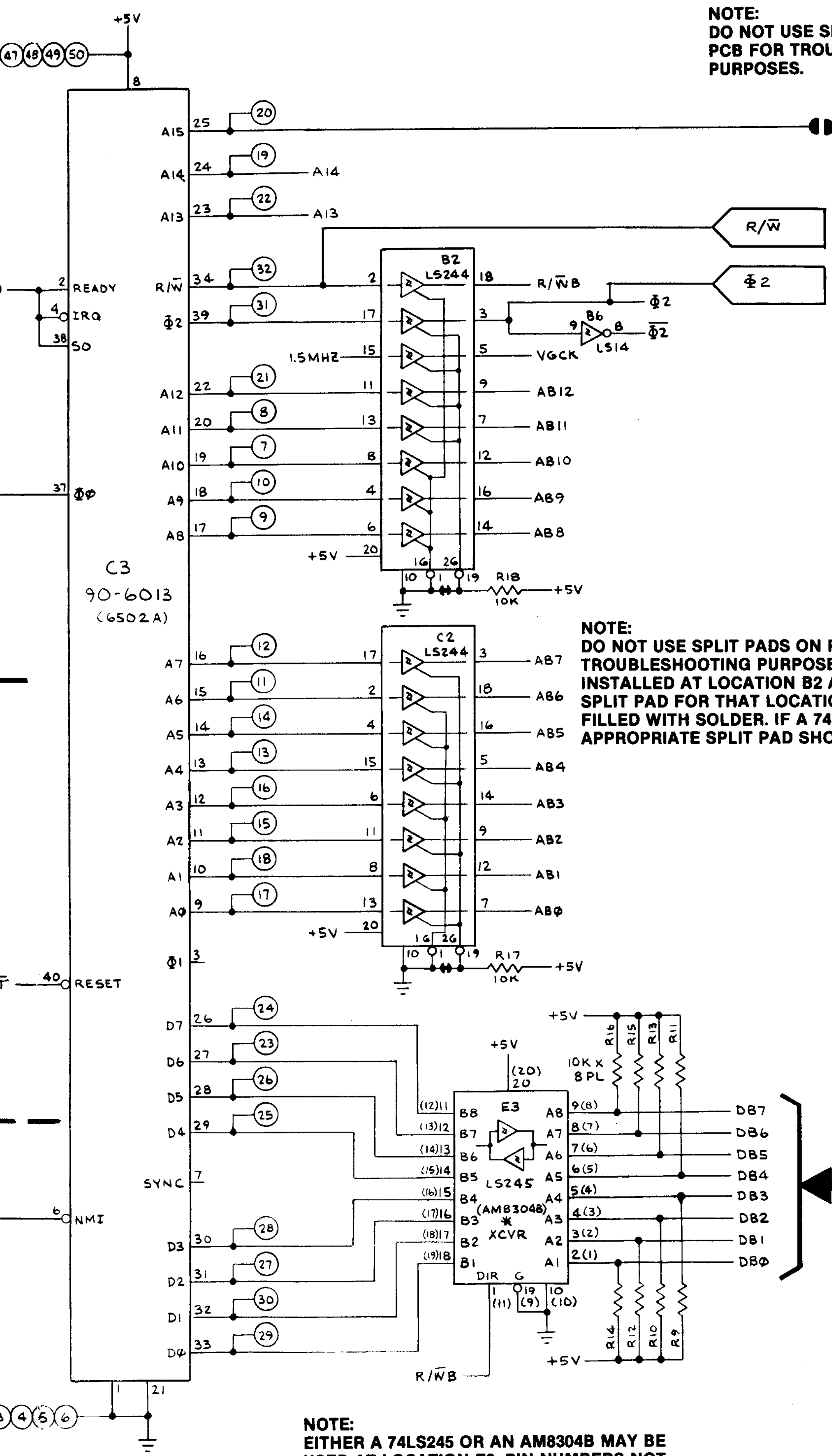
FROM SWITCH INPUTS SHEET 2, SIDE B

ROM/PROM CIRCUITRY

Program Memory for the Asteroids ... tained in PROMs for the -01 version ... ROMs for the -02 version of the PCB ... equivalent to four PROMs. All PROMs ... a common enable must be removed ... ing with a ROM. For example, remo... locations F2, H1, L2 and L1 before ... ROM at location F1.



MPU CIRCUITRY

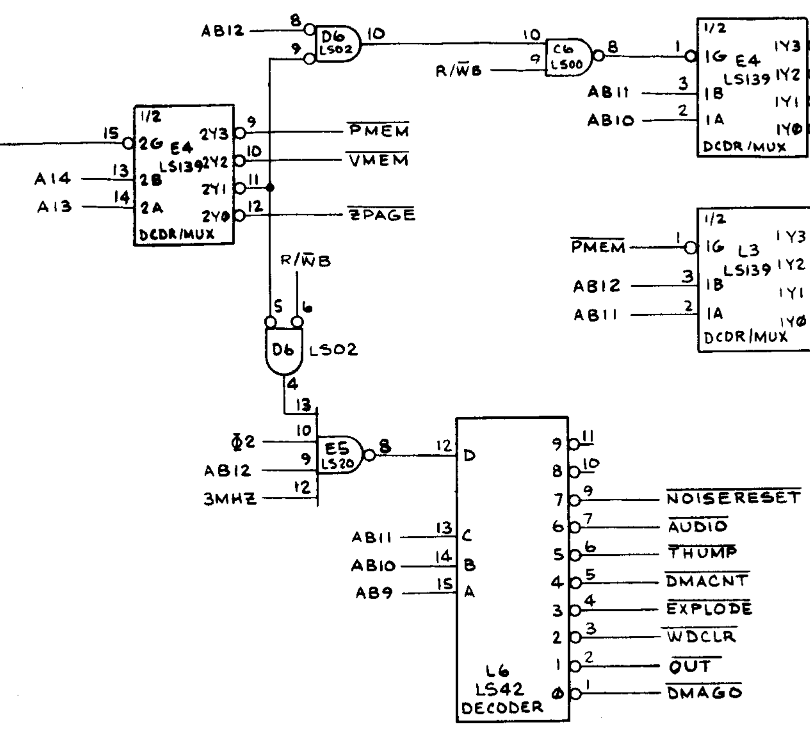


NOTE:
DO NOT USE SPLIT PADS ON PCB FOR TROUBLESHOOTING PURPOSES.

NOTE:
DO NOT USE SPLIT PADS ON PCB FOR TROUBLESHOOTING PURPOSES. IF A 74LS244 IS INSTALLED AT LOCATION B2 AND/OR C2, THE SPLIT PAD FOR THAT LOCATION SHOULD BE FILLED WITH SOLDER. IF A 74LS241 IS USED, THE APPROPRIATE SPLIT PAD SHOULD BE OPEN.

NOTE:
EITHER A 74LS245 OR AN AM8304B MAY BE ~~USED AT LOCATION E3.~~ PIN NUMBERS NOT ENCLOSED IN PARENTHESIS ARE FOR 74LS245. PIN NUMBERS IN PARENTHESIS ARE FOR AN AM8304B.

ADDRESS DECODING CIRCUITRY



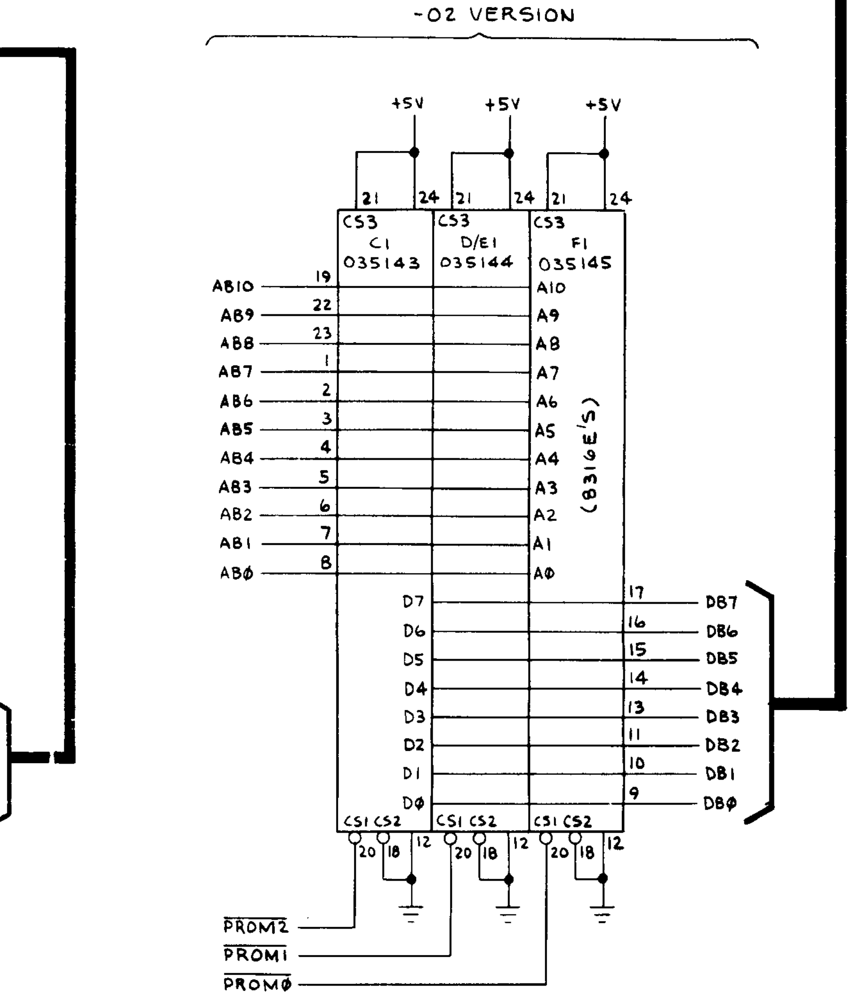
The address decoder performs the function of turning on or enabling the appropriate circuitry at the critical time, so that information can be transferred back and forth between the game circuitry and the MPU. The memory map below is for the Asteroids game.

If you are going to use the Automatic RAM/ROM Tester, please remember to remove MPU C3 and ground the WDOG DISABLE test point.

	ADDRESS																	DATA								
HEXADECIMAL	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	R/W	D7	D6	D5	D4	D3	D2	D1	D0	FUNCTION
0000-01FF		0	0				0	1	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	ZERO & ONE PAGE RAM
0200-02FF		0	0				1	0	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	PLAYER 1 RAM
0300-03FF		0	0				1	1	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	PLAYER 2 RAM
2001		0	1	0	0	0								0	0	1	R	D								3 KHz
2002		0	1	0	0	0								0	1	0	R	D								HALT
2003		0	1	0	0	0								0	1	1	R	D								HYPERSPACE SW
2004		0	1	0	0	0								1	0	0	R	D								FIRE SW
2005		0	1	0	0	0								1	0	1	R	D								DIAG. STEP
2006		0	1	0	0	0								1	1	0	R	D								SLAM SW
2007		0	1	0	0	0								1	1	1	R	D								SELF TEST SW
2400		0	1	0	0	1								0	0	0	R	D								LEFT COIN SW
2401		0	1	0	0	1								0	0	1	R	D								CENTER COIN SW
2402		0	1	0	0	1								0	1	0	R	D								RIGHT COIN SW
2403		0	1	0	0	1								0	1	1	R	D								1 PLYR START SW
2404		0	1	0	0	1								1	0	0	R	D								2 PLYR START SW
2405		0	1	0	0	1								1	0	1	R	D								THRUST SW
2406		0	1	0	0	1								1	1	0	R	D								ROT RIGHT SW
2407		0	1	0	0	1								1	1	1	R	D								ROT LEFT SW
2800		0	1	0	1	0									0	0	R							D	D	OPT SW (SW8, SW7)
2801		0	1	0	1	0									0	1	R							D	D	OPT SW (SW6, SW5)
2802		0	1	0	1	0									1	0	R							D	D	OPT SW (SW4, SW3)
2803		0	1	0	1	0									1	1	R							D	D	OPT SW (SW2, SW1)
3000		0	1	1	0	0	0										W									DMAGO
3200		0	1	1	0	0	1										W								D	2 PLYR START LAMP
3200		0	1	1	0	0	1										W							D		1 PLYR START LAMP
3200		0	1	1	0	0	1										W						D			RAMSEL
3200		0	1	1	0	0	1										W					D				COIN CNTRL LEFT
3200		0	1	1	0	0	1										W				D					COIN CNTRC CENTER
3200		0	1	1	0	0	1										W			D						COIN CNTRR RIGHT
3400		0	0	1	0	1	0										W									WDCLR
3600		0	1	1	0	1	1										W	D	D							EXPLOSION PITCH
3600		0	1	1	0	1	1										W			D	D	D	D			EXPLOSION VOLUME
3A00		0	1	1	1	0	0										W				D					THUMP VOLUME
3A00		0	1	1	1	0	0										W					D	D	D	D	THUMP FREQUENCY
3C00		0	1	1	1	1	0							0	0	0	W	D								SAUCER SOUND
3C01		0	1	1	1	1	0							0	0	1	W	D								SAUCER FIRE SOUND
3C02		0	1	1	1	1	0							0	1	0	W	D								SAUCER SOUND SELECT
3C03		0	1	1	1	1	0							0	1	1	W	D								SHIP THRUST SOUND
3C04		0	1	1	1	1	0							1	0	0	W	D								SHIP FIRE SOUND
3C05		0	1	1	1	1	0							1	0	1	W	D								LIFE SOUND
3E00		0	1	1	1	1	1										W									NOISE RESET
4000-47FF		1	0	0	0	A	A	A	A	A	A	A	A	A	A	A		D	D	D	D	D	D	D	D	VECTOR RAM
5000-57FF		1	0	1	A	A	A	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	D	VECTOR ROM
6800-7FFF		1	1	0	1	A	A	A	A	A	A	A	A	A	A	A	R	D	D	D	D	D	D	D	D	PROGRAM

Asteroids game is con-
l version of the PCB or
f the PCB. One ROM is
ll PROMs connected to
removed before replac-
ple, remove PROMs at
d before replacing with

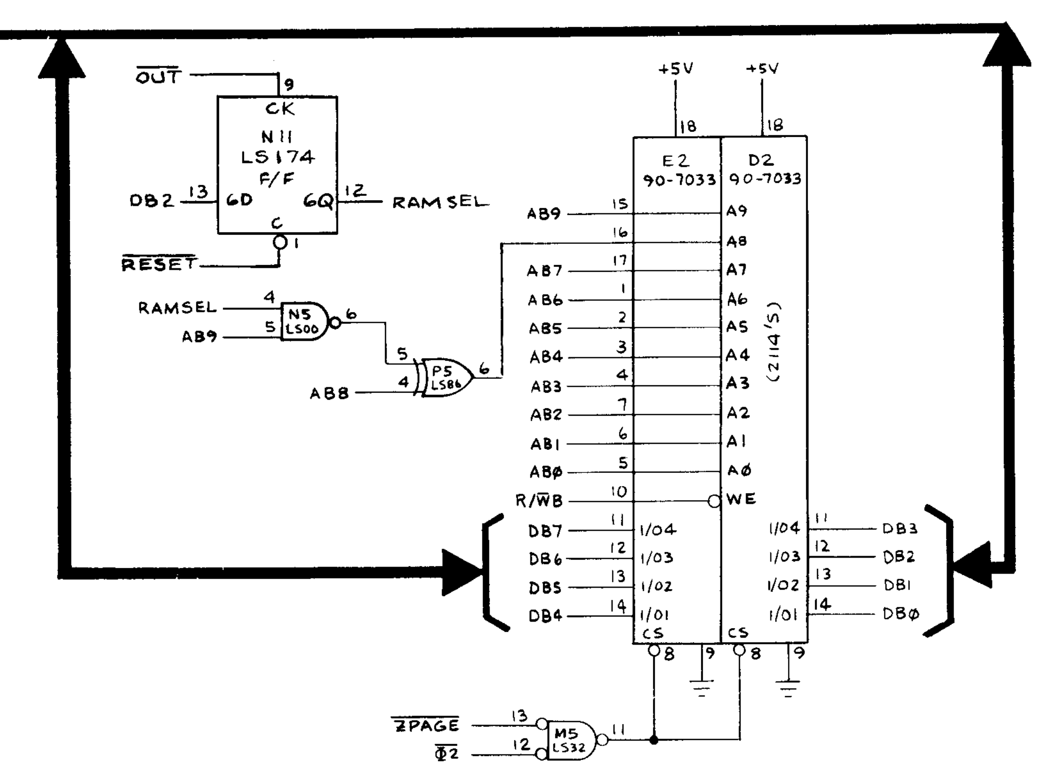
-02 VERSION



RAM CIRCUITRY

The RAM is the temporary storage space for the MPU and is enabled when ZPAGE (Zero Page enable) is low. When R/W̄B (from the MPU) is low, the RAM stores the data byte input (DB0 thru DB7) at the location addressed by the MPU address bus (AB0 thru AB7). When R/W̄B is high, the MPU reads the stored data byte at the addressed location.

The signal RAMSEL, when low, has the effect of swapping pages 2 and 3 within the RAM. This allows greater programming flexibility.



Memory Components and Their Equivalents (Locations Shown in Bold)

-01 P.C. Boards (PROMs)	Alternate -01 P.C. Boards (PROMs)	-02 P.C. Boards (ROMs)
035131-01 **J2**	035150-01 **J2**	035143-01 **C1**
035132-01 **N2**		
035137-01 **K1**	035153-01 **K1**	
035138-01 **N1**		
035133-01 **H2**	035151-01 **H2**	035144-01 **D/E1**
035134-01 **M2**		
035139-01 **J1**	035154-01 **J1**	
035140-01 **M1**		
035135-01 **F2**	035152-01 **F2**	035145-01 **F1**
035136-01 **L2**		
035141-01 **H1**	035155-01 **H1**	
035142-01 **L1**		

ATARI®

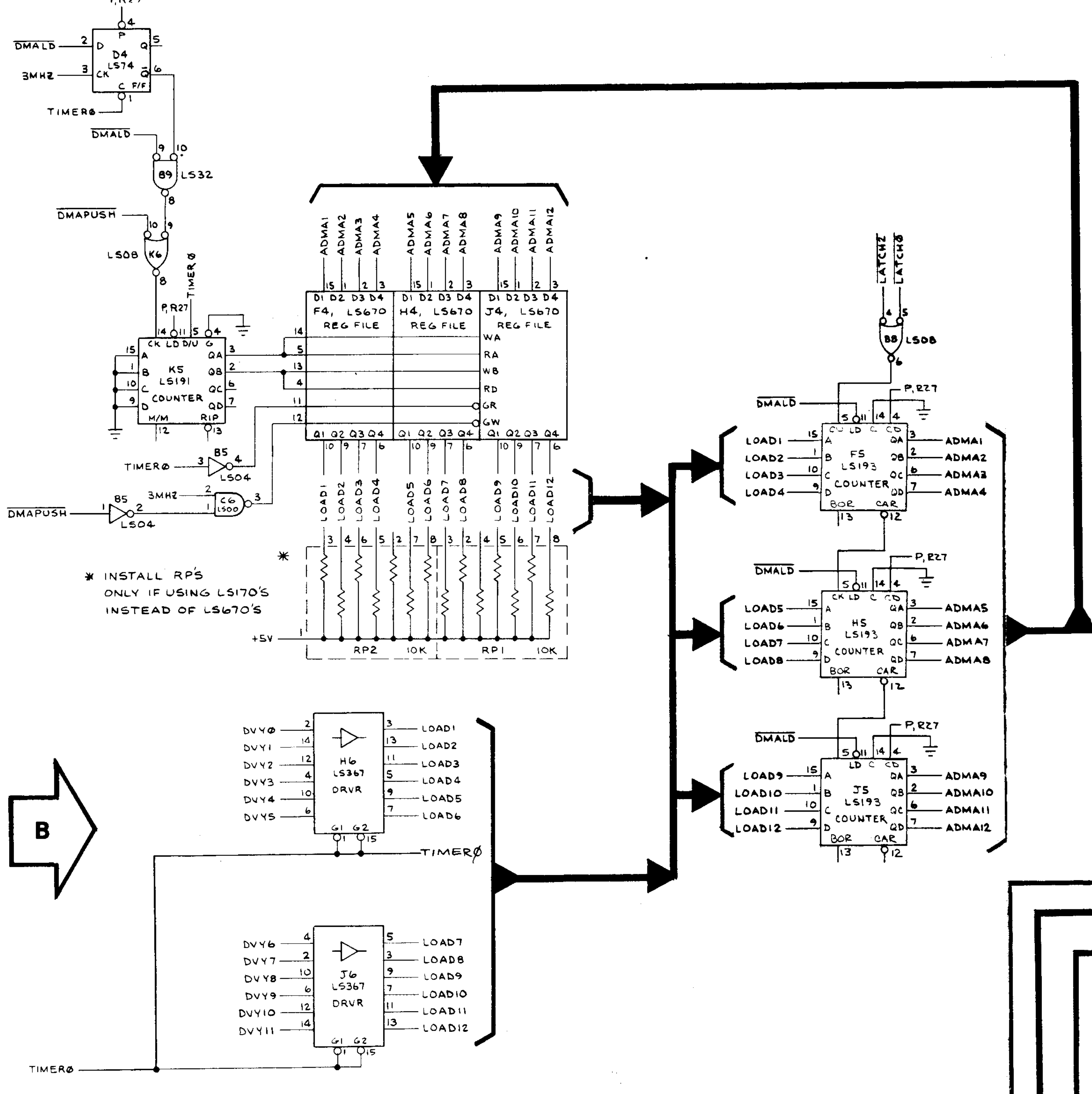
A Warner Communications Company

Sheet 1, Side B

ASTEROIDS Microprocessor

Section of 034986-XX **F**

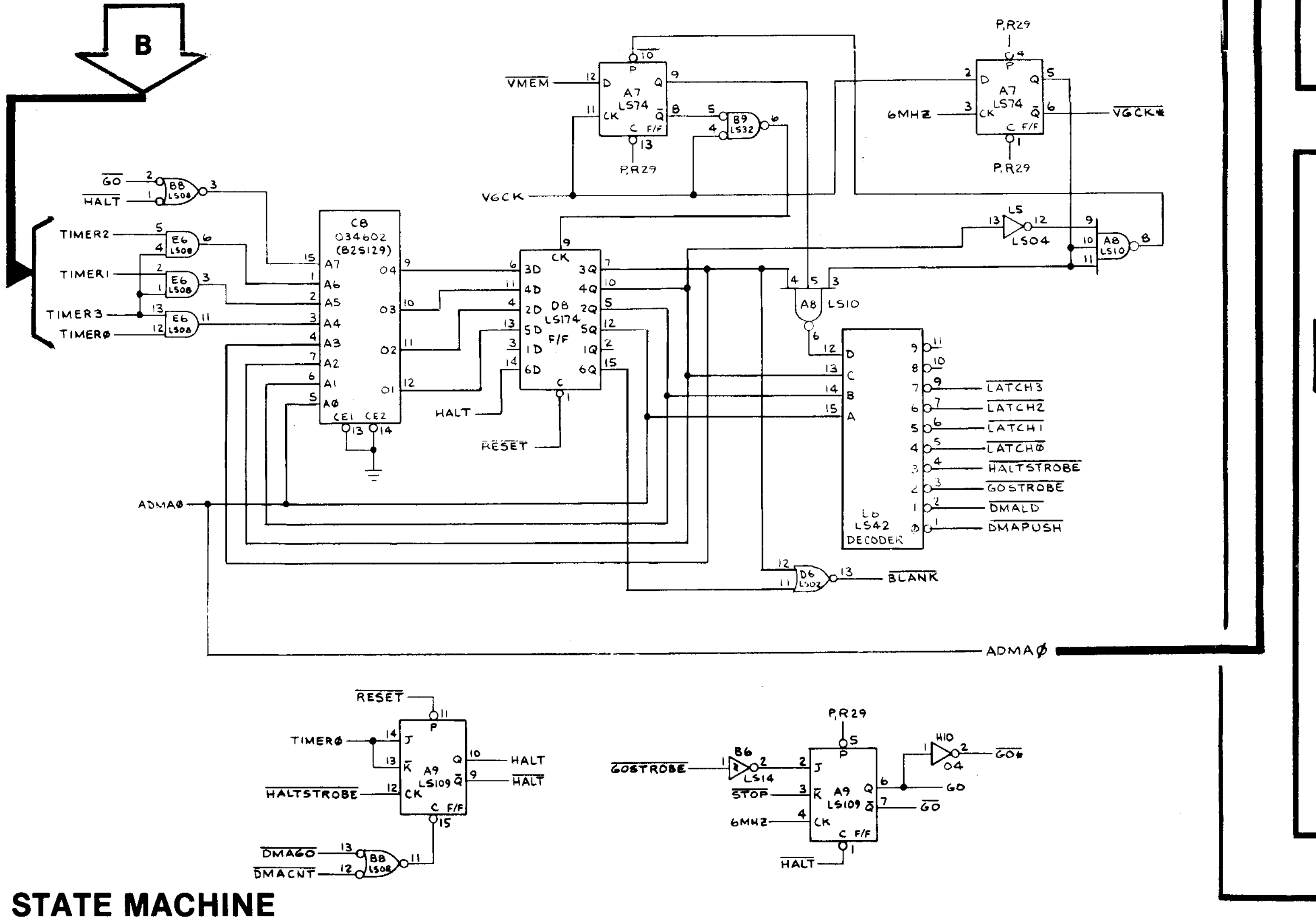
VECTOR GENERATOR PROGRAM COUNTER



Counters F5, H5 and J5 contain the address of the next data byte (instruction) to be fetched from the Vector Generator memory. Because these counters point to the next instruction in memory to be retrieved and performed, they are called the program counter. This program counter is incremented one count (to the next sequential address) each time the information at its current address is loaded into data latch 0 or data latch 2.

The program counter may also be preset to "jump" to a new address. This new address can be loaded into the program counter from the vector generator memory via data latches F7 and H7 and buffers H6 and J6.

The program counter may also be preset to "return" to a previous address which it had stored in its "stack". The stack consists of register files F4, H4, & J4, and down/up counter K5. The stack is a 4-word 12-bit memory, used to save the contents of the program counter for future reference. It is loaded when $\overline{DMAPUSH}$ is low. Immediately after information is written into the stack, counter K5 increments one count. Immediately before loading the program counter from the stack, counter K5 decrements one count.



STATE MACHINE

The state machine is the "master controller" of the vector generator circuitry. It receives instructions from the game MPU, via the vector generator RAM. It carries out these instructions by accessing the appropriate sections of the vector generator ROM memory, using the vector generator program counter to do so. The state machine reads the vector generator ROM data (via Timer 0-3) and decodes this information to determine how it should use this data: 1) to draw a vector; 2) to move the monitor beam to a new position on the monitor display; 3) to "jump" to a new vector memory address; 4) to return to a previous vector memory address; or 5) to tell the game MPU that it has completed its current instructions, and is waiting for its next command.

The state machine consists of input gates B8 and E6, ROM C8, latch D8, clock circuitry A7, and decoder E8. Four bit input TIMER0 thru TIMER3 is the operation code input to the state machine. The A4 thru A6 address input to ROM C8 tells the ROM which instructions to perform. Address inputs A0 thru A3 from latch D8 tells the ROM which state was last performed. The address A7 input $\overline{GO}$ tells the ROM that the position counters are presently drawing a vector. The $\overline{HALT}$ input to A7 tells the ROM that the vector generator has completed its operations.

During initial power-up of the game, the $\overline{HALT}$ signal is preset low. The microcomputer reads the high HALT signal through its switch input port (buffer M10) on data line DB0. This tells the microcomputer that the vector generator is halted and waiting for an instruction. To ensure that the beam is off when the state machine is halted, the high HALT, clocked through latch D8, results in a low $\overline{BLANK}$ to the Z axis output.

The microcomputer outputs an address that results in a $\overline{DMAGO}$ signal that causes $\overline{HALT}$ to go high, and clears the vector generator data latches. This makes TIMER0 thru TIMER3 signals all low. The state machine now begins executing instructions, starting at vector memory location 0.

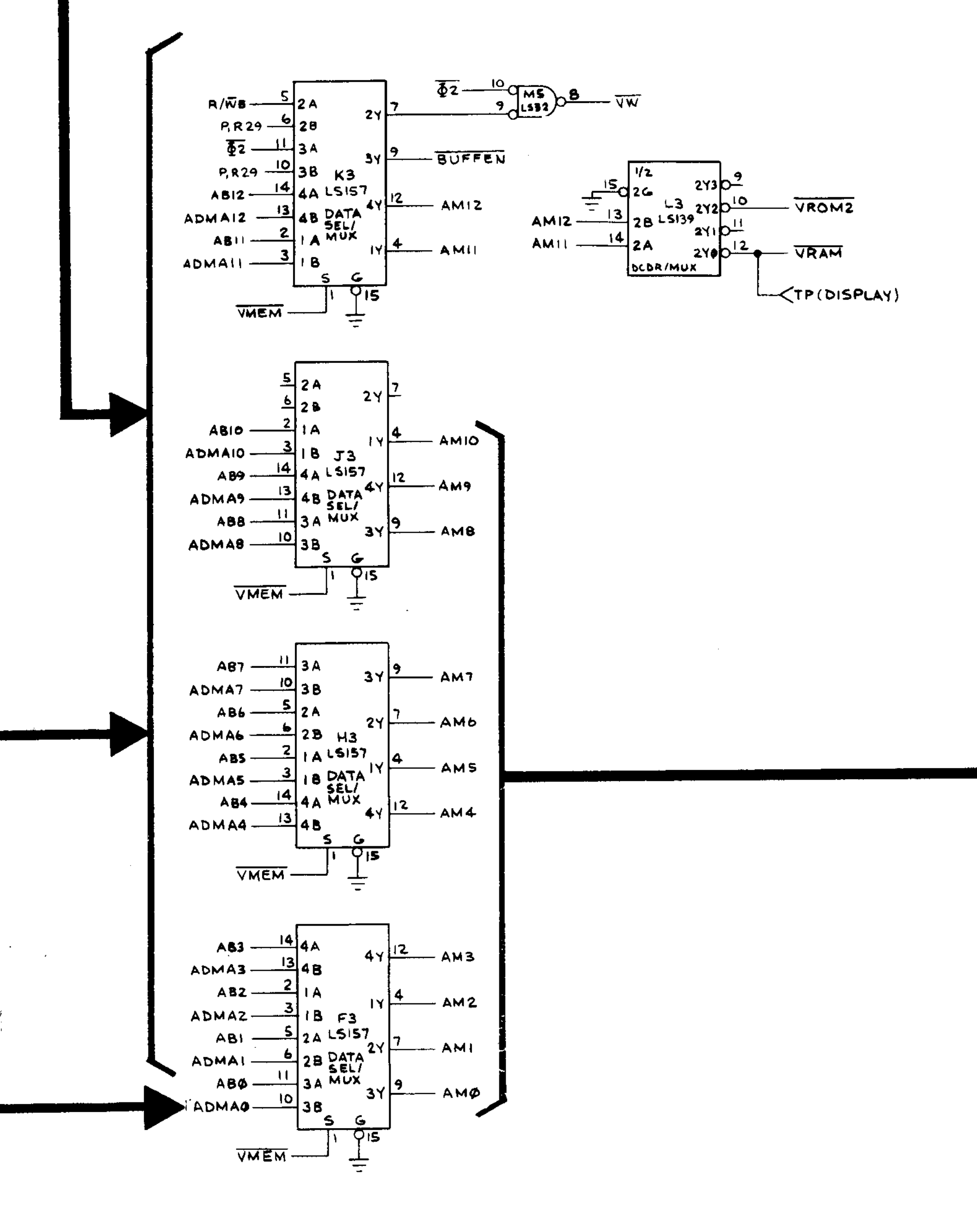
When the state machine receives the operation code for a $\overline{HALT}$ instruction, it outputs a low $\overline{HALTSTROBE}$, setting the HALT flip-flop A9, and suspending state machine operation.

The GO signals load and enable the vector timer and the X and Y position counters and tell the ROM that the vector generator is now actively drawing a vector. The $\overline{HALT}$ input to GO flip-flop A9 sets the outputs to ensure that the vector timer and position counters are not active when the state machine is halted. When a low $\overline{GOSTROBE}$ is clocked through A9, the vector timer and X and Y position counters begin to operate from the GO, $\overline{GO}$ and $\overline{GO^*}$ signals. When $\overline{STOP}$ is clocked through A9, the vector timer has reached its maximum count, and $\overline{GO}$ goes high. This means the vector has been drawn.

The VGCK input to the clock circuitry is a buffered 1.5 MHz clock signal from the microcomputer. This is the same frequency used to clock the MPU of the microcomputer. The signal clocks latch D8 unless the microcomputer is addressing the vector RAM or ROM memories (when $\overline{VMEM}$ goes low). Then the clock input to latch D8 goes high and stays high until $\overline{VMEM}$ goes high.

FROM MICROCOMPUTER SHEET 1, SIDE B

VECTOR GENERATOR MEMORY ADDRESS SELECTOR

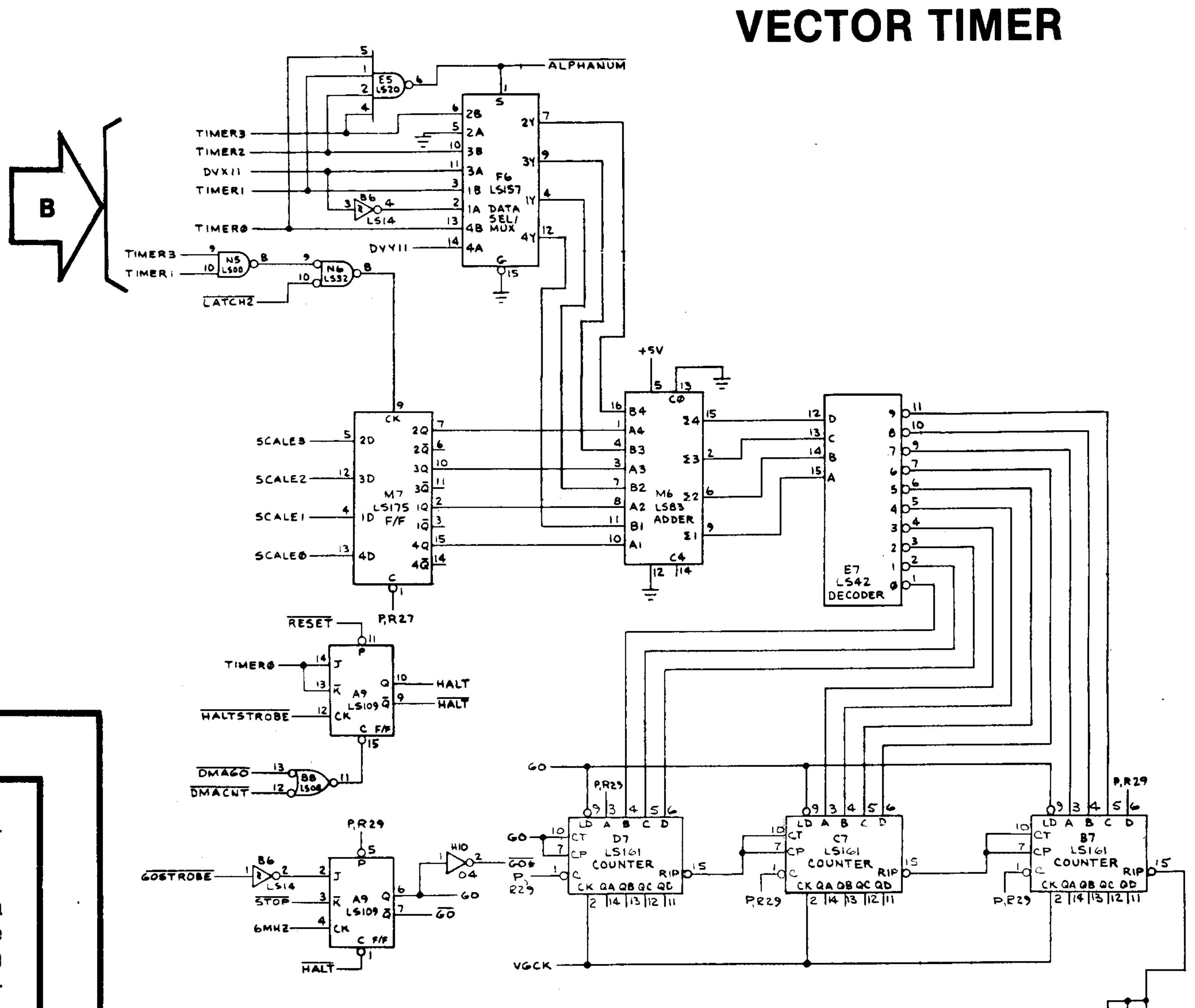


The address selector consists of multiplexers F3, H3, J3 and K3. When $\overline{VMEM}$ is low, the MPU of the microcomputer gains access to the address inputs of the vector generator memory. In this state, $\overline{BUFFEN}$ is from $\Phi 2$ and $\overline{VW}$ (vector generator write) is low when $\overline{\Phi 2}$ and $\overline{R/WB}$ are both low. When $\overline{VMEM}$ is high, the address input to the vector generator memory is from the vector generator program counter and state machine. In this state, $\overline{BUFFEN}$ and $\overline{VW}$ are both held high by the pullup resistors connected to the 2B and 3B inputs of multiplexer K3.

Address decoder L3 decodes address bits A11 and A12, and selects the RAM or one of three ROMs of the vector generator memory.

This address-selecting arrangement allows the game MPU to access the vector generator memory, i.e., write data into the vector generator RAM to instruct the vector generator what it should do next. The address selector can then allow the vector generator program counter and state machine to access this same area of RAM also, and read what instructions were sent to it by the game MPU.

VECTOR TIMER



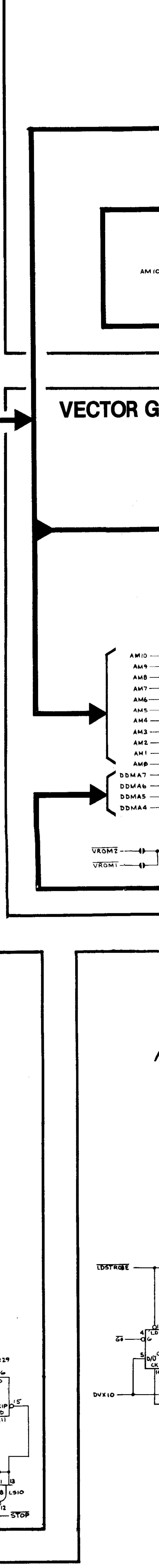
The purpose of the vector timer is to time out the length of time it takes to "draw" an actual vector on the monitor display. During the interval when the X and Y position counters are actually drawing the vector, $\overline{STOP}$ is high. This prevents the vector generator state machine from advancing to its next state until the vector currently being drawn is completed. As soon as the vector has been drawn, $\overline{STOP}$ goes low, allowing the state machine to advance to the next state in its intended sequence.

The vector timer consists of multiplexer F6, decoder E7, LATCH M7, ADDER M6, and counters B7, C7, and D7. M7 contains a scale factor which is added in M6 to the four timer signals. If TIMER0 thru TIMER3 inputs are any state but all high, decoder E7 directly decodes the sum and loads the decoded low into one of the counters. When $\overline{GO}$ goes low, the counters count from the loaded count until the counters all reach their maximum count. This count is a maximum length of 1024. At this time $\overline{STOP}$ goes low and clears the GO flip-flop of the state machine.

If the TIMER signals are all high, $\overline{ALPHANUM}$ goes low and data signals DVX11 and DVY11 are decoded by decoder E7. This is added to the scale factor and loaded into the counters.

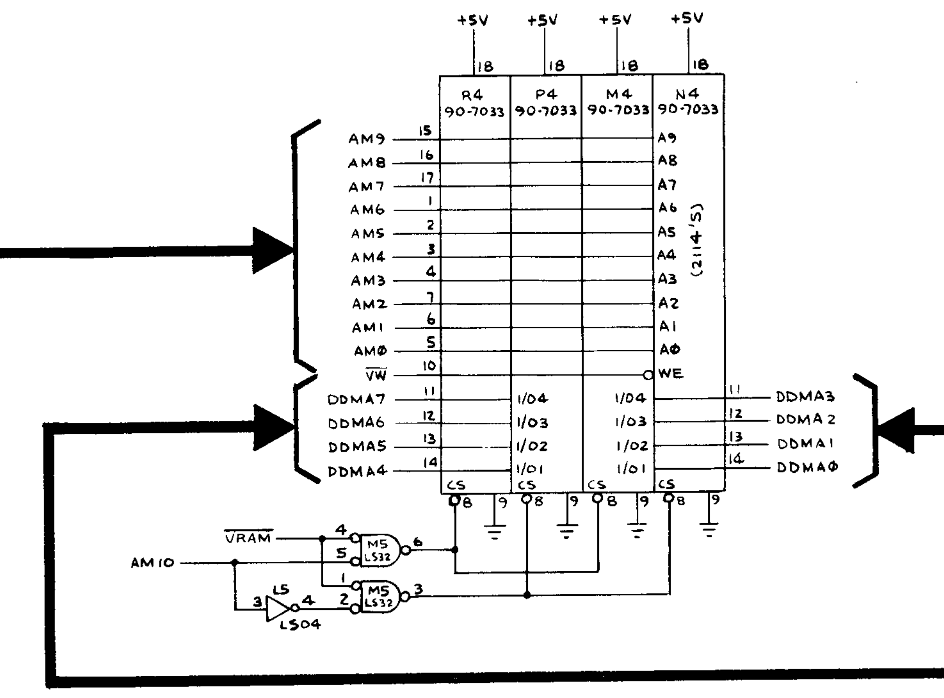
VECTOR GENE

VECTOR G



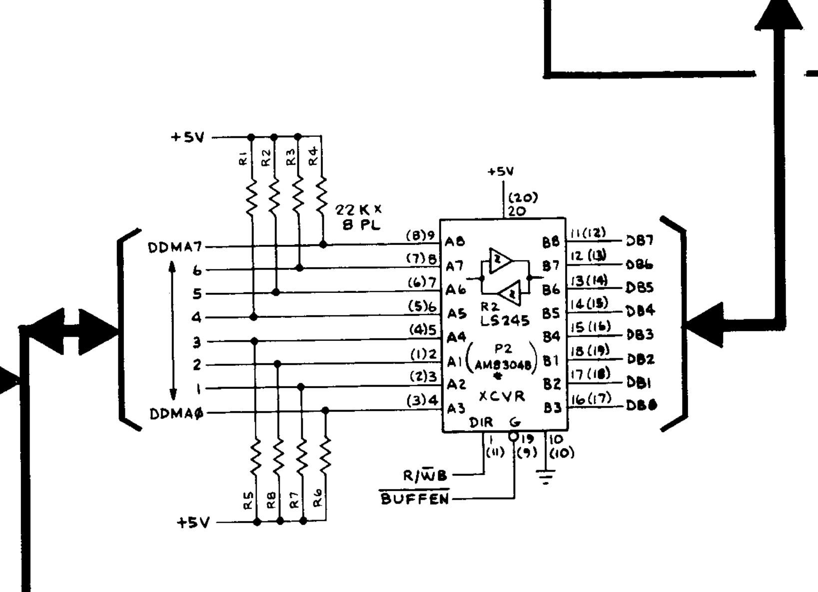
The X and Y position counters are
Therefore, the following description discu
counters.
The X position counters contain rate
down/up counters (C9, D9 and E9),multiple
and associated gates (B8 and H0). The
counters is a 12-bit binary number that r
location of the beam on the monitor scree
the far left side of the screen and 1023 bei
screen. Increasing or decreasing this bi
cause the beam to move to the right or left
generator state machine decodes instruc
and then is capable of using that data to
these counters in one of two ways.
The state machine can preset these co
ferent number from their previous conte
beam to "jump" to a new location on the
taneously, i.e., for drawing a new vector
position than where the previous vector e

TOR GENERATOR RAM



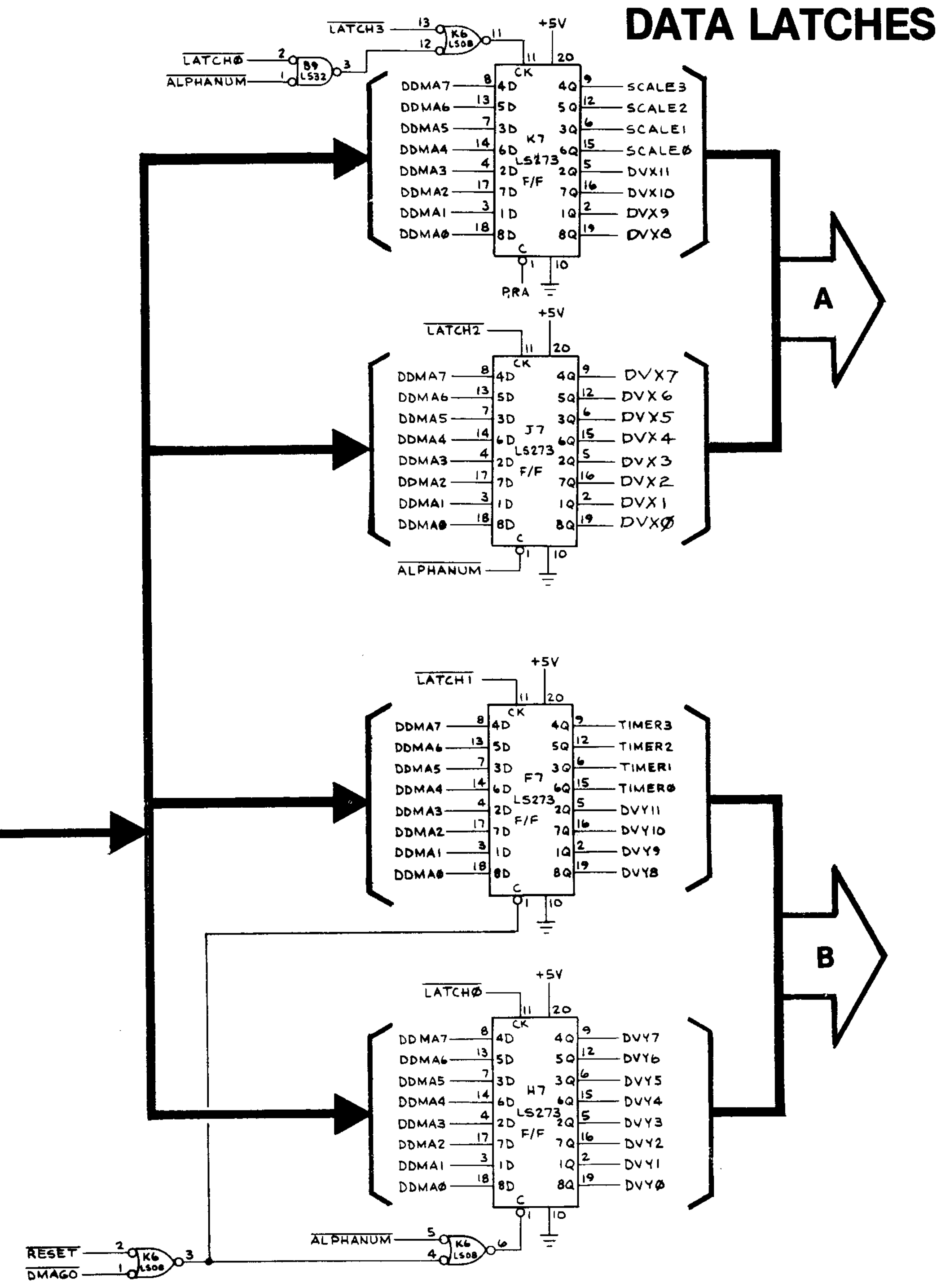
VECTOR GENERATOR DATA BUFFER

TO/FROM MPU DATA BUS SHEET 1, SIDE B

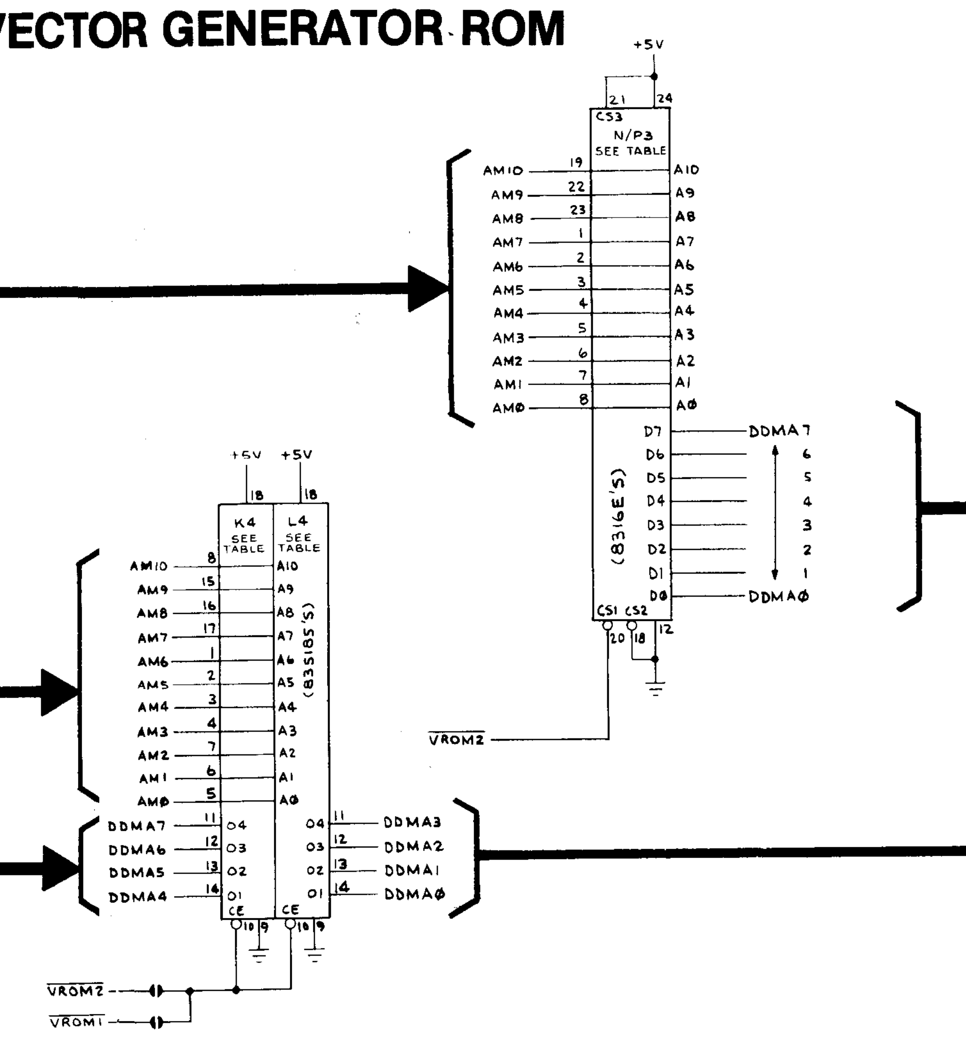


* USE PIN NUMBERS IN PARENTHESES IF BOARD CONTAINS AM8304B INSTEAD OF 74LS145

VECTOR GENERATOR MEMORY DATA LATCHES



ECTOR GENERATOR ROM



VECTOR MEMORY ROM/PROM SUBSTITUTION				SPLIT PAD TO BE BRIDGED AT K/L3
ROM #	LOC	PROM #	LOC	
035127	N/P3	035129	K4	
		035130	L4	
	R3		K4	
			L4	

The vector generator memory consists of 2K of RAM and 4K of ROM. It may be directly accessed by the MPU of the microcomputer through the direct memory access process (DMA). Data is written in from the microcomputer thru data buffer R2 when BUFFEN and R/WB are low.

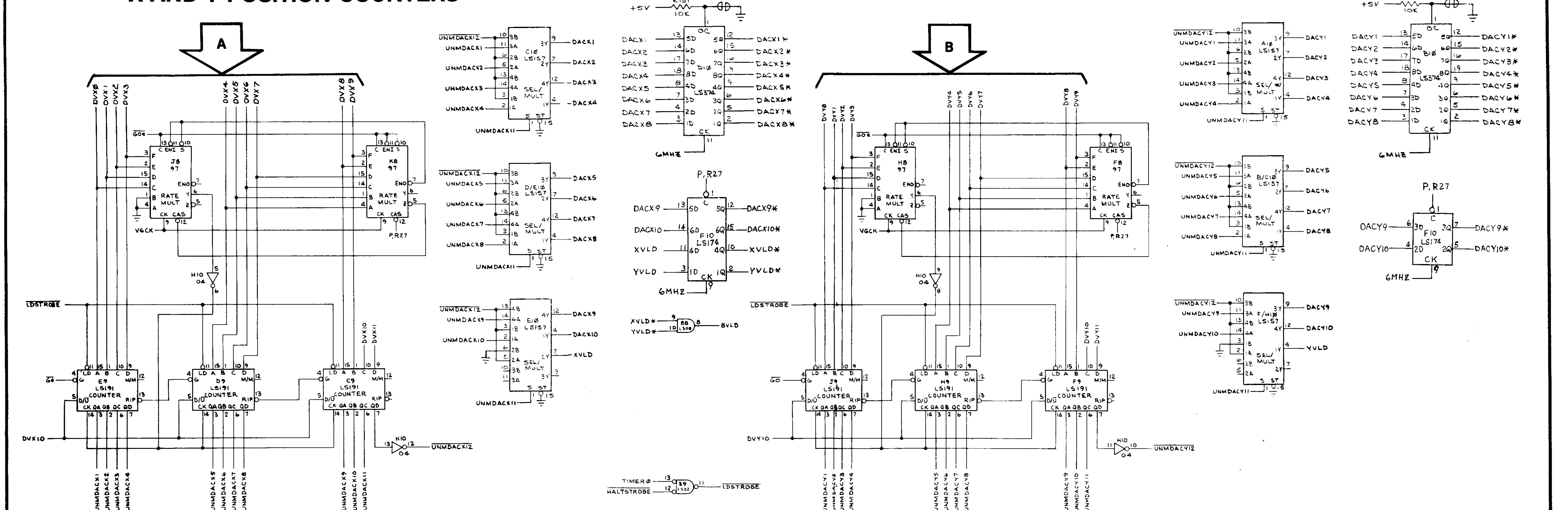
The 2k×8 vector generator program memory chip N/P3 may be substituted with two equivalent 1K×8 chips in location K4 and L4.

denotes change by indicated revision

The data latches consist of latch 0 (H7), latch 1 (F7), latch 2 (J7), and latch 3 (K7). Inputs DDMA0 thru DDMA7 are the data outputs from the vector generator memory.

Latches 0 thru 2 are directly clocked by the rising edge of the LATCH0, LATCH1, and LATCH2 outputs from the vector generator's state machine. Latch 3 is clocked by LATCH3 or by LATCH0, if ALPHANUM is low. Latch 0 is cleared when RESET, DMAGO, or ALPHANUM goes low. Latch 1 is cleared by ALPHANUM.

X AND Y POSITION COUNTERS



on counters are two identical circuits. description discusses only the X position

ters contain rate multipliers (J8 and K8), 09 and E9),multiplexers (D10, E10, and F10), B8 and H0). The output of the down/up ary number that represents the horizontal the monitor screen (or X axis), with 0 being creen and 1023 being the far right side of the decreasing this binary number output will e to the right or left, respectively. The vector ne decodes instructions from its memory, using that data to alter the binary count of of two ways.

an preset these counters to an entirely dif- eir previous contents. This will cause the ew location on the monitor screen instan- ving a new vector from a different starting e previous vector ended. While the beam is "jumping" to this new position, the beam itself is turned off to prevent unwanted lines from appearing on the screen. To preset this new position into the counters, the state generator causes LDSTROBE to go low. At this time, a new 12-bit number (DVX0-11) is loaded into the counters from the vector generator memory data latches.

The state machine can also instruct these counters to count up or down any specific number of counts. This will cause the beam to move to the left or to the right a specific distance relative to where it was. During this beam movement, the beam is turned on with the desired intensity. This is the procedure used to draw a vector on the monitor screen. The direction (to the left or right) and length (0 to 1023) of the vector to be drawn relative to the beam's current position is determined by DVX0-11 (from the vector generator memory data latches). This data contains information that determines how many clock pulses the counters will receive and whether the counters will count up or down.

DVX0-9 memory data is loaded into rate multipliers J8 and K8. The function of these devices is to space the desired number of counter clock pulses at equal intervals over the time period that it will take to draw the desired vector. This insures that vectors of different lengths will still be displayed with the same relative beam intensity. DVX10 and 11 are loaded directly into the counters. DVX10 determines whether the counters count up or down. DVX11 is used to control the select input of multiplexers D10, E10, and F10.

The UNMDACX1 thru UNMDACX10 (X axis unmultiplexed digital-to-analog converter signals) are transferred to the output of the multiplexers and stored at the outputs of the latches on each rising edge of the 6 MHz clock (from the microcomputer clock circuitry). The DACX1* thru DACX10* signals are sent to the digital-to-analog converters (DACs) in the X video output.

The DACX1* thru DACX10* outputs represent the physical placement of the beam on the monitor. The far left of the monitor screen is 0, the center is 512, and the far right is 1023. Therefore, if the DACX1* thru DACX10* signal was greater than 1023, the monitor beam would go off the right side of the screen and start again on the left side of the screen, a "wraparound" condition. To prevent a wraparound, the multiplexers' select input from UNMDACX11 goes high when the count is greater than 1023 or less than 0. This selects UNMDACX12 to be output from the multiplexers to the DACs, forcing all zeros or all ones, and thus keeping the beam on the appropriate side on the screen, instead of allowing it to wraparound.

The XVLD and YVLD (X and Y valid) outputs from the X and Y position counter multiplexers are latched and gated together to enable the Z axis output, BVLD (beam valid).

Sheet 2, Side A

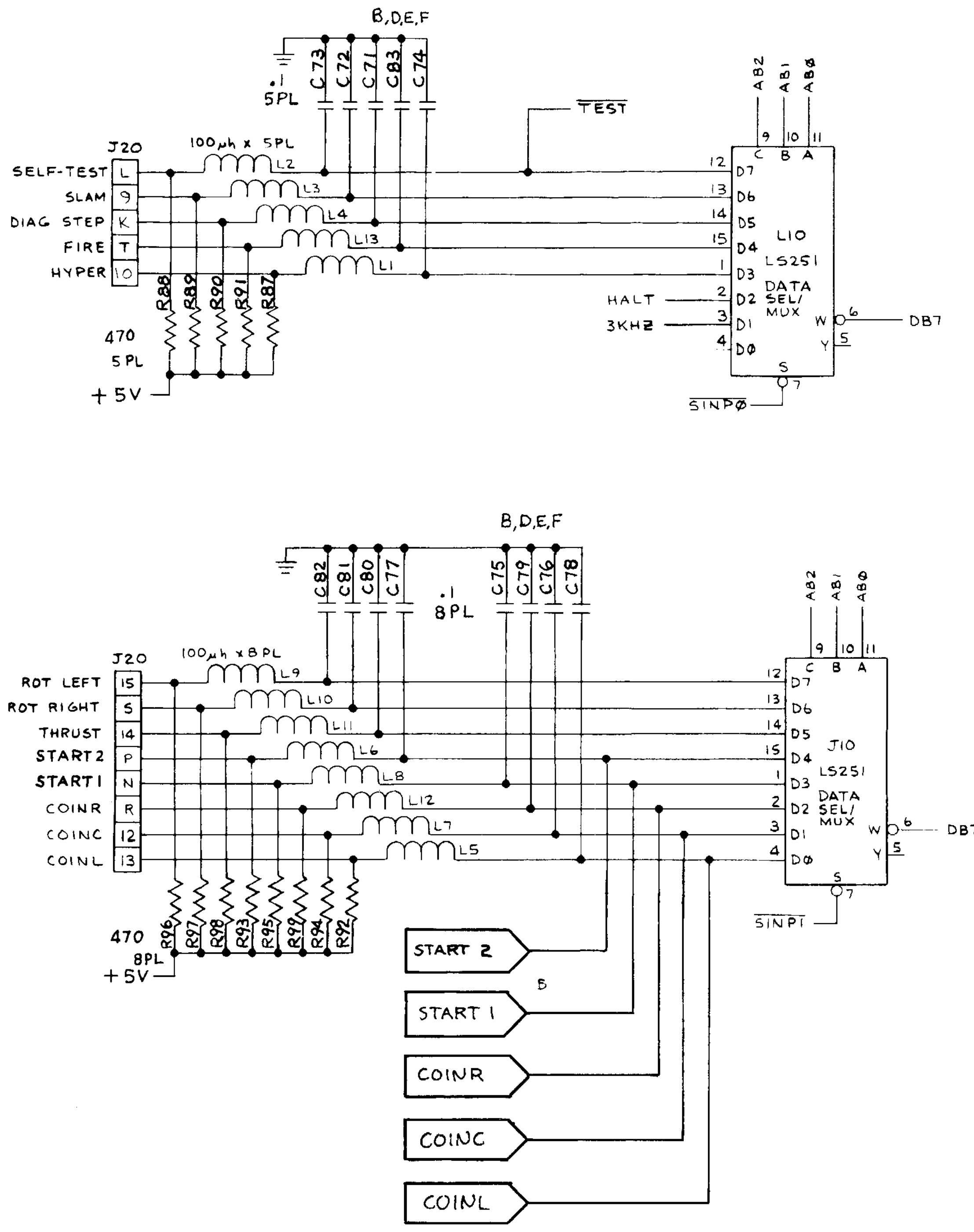
ASTEROIDS
Video Generator
Section of 034986-XX F

ATARI®

A Warner Communications Company

INPUTS

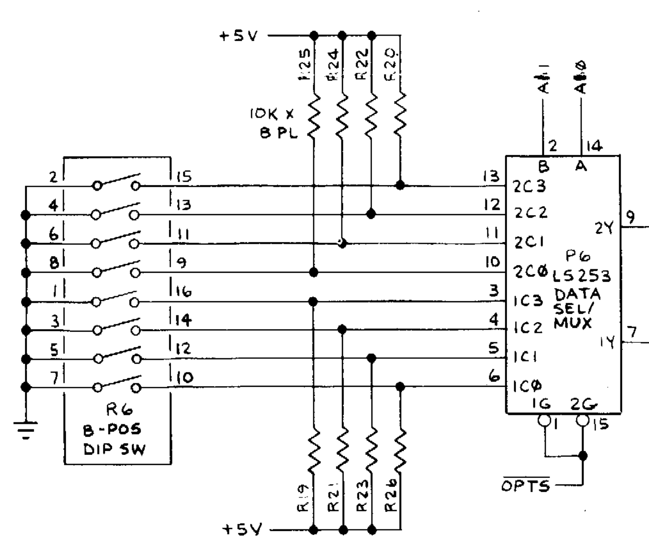
PLAYER INPUT CIRCUITRY



DIAG STEP (diagnostic step), 3 KHz, SELF-TEST SLAM, HALT, FIRE and HYPER inputs are read by the MPU when $\overline{\text{SINP0}}$ (switch input zero enable) is low. Switches to be read are selected by AB0 thru AB2 from the MPU. All inputs are read on DB7. Switch inputs are active when pulled to ground. DIAG STEP, 3 KHz, and SELF-TEST are signals read by the MPU to initiate and control the game's self-test procedure. SLAM is a signal read by the MPU to indicate the status of the antislam switch mounted on the coin door. The MPU reads HALT to determine the state of the vector generator.

The coin door and some control panel switches are read by the MPU when $\overline{\text{SINP1}}$ (switch input one enable) is low. Switches to be read are selected by AB0 thru AB2 from the MPU. All inputs are read on data line DB7. Switch inputs are "on" when pulled to ground.

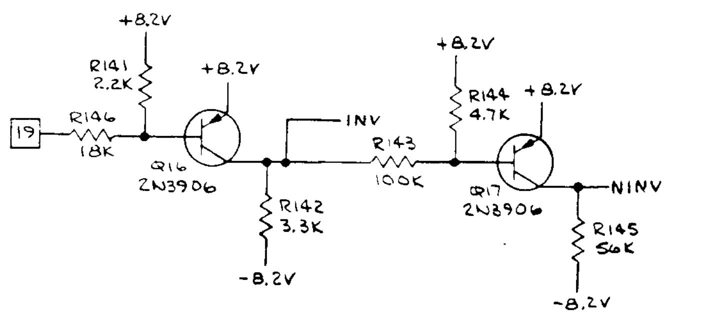
OPTIONS INPUT CIRCUITRY



The game option switches are read by the MPU when $\overline{\text{OPTS}}$ (option switch enable) is low. Switch toggles to be read are selected by AB0 and AB1 from the MPU. Switch toggles 1, 3, 5, and 7 are read on data line DB0 and toggles 2, 4, 6 and 8 are read on DB1. Toggle inputs are "on" when pulled to ground.

denotes change by indicated revision

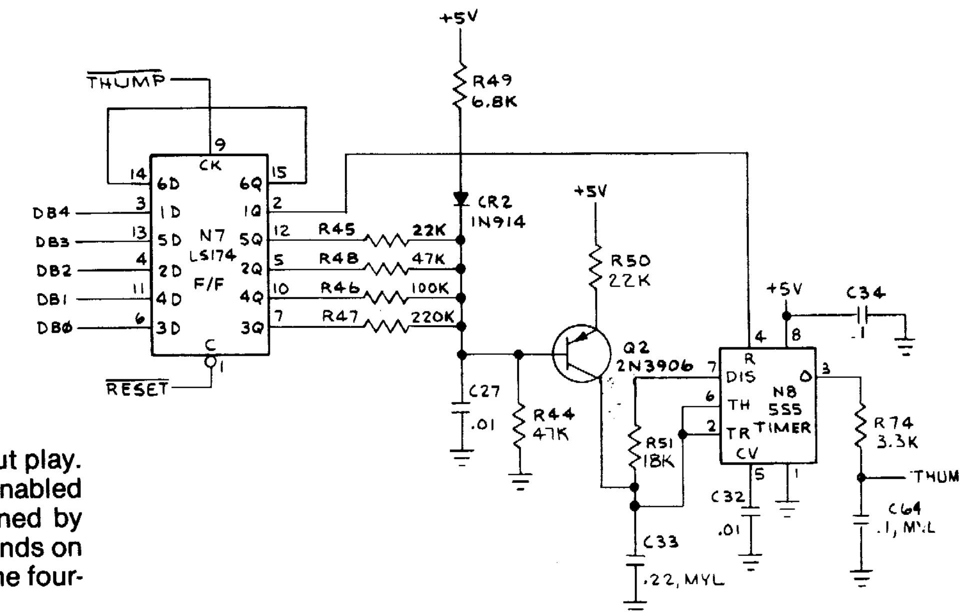
VIDEO INVERTER



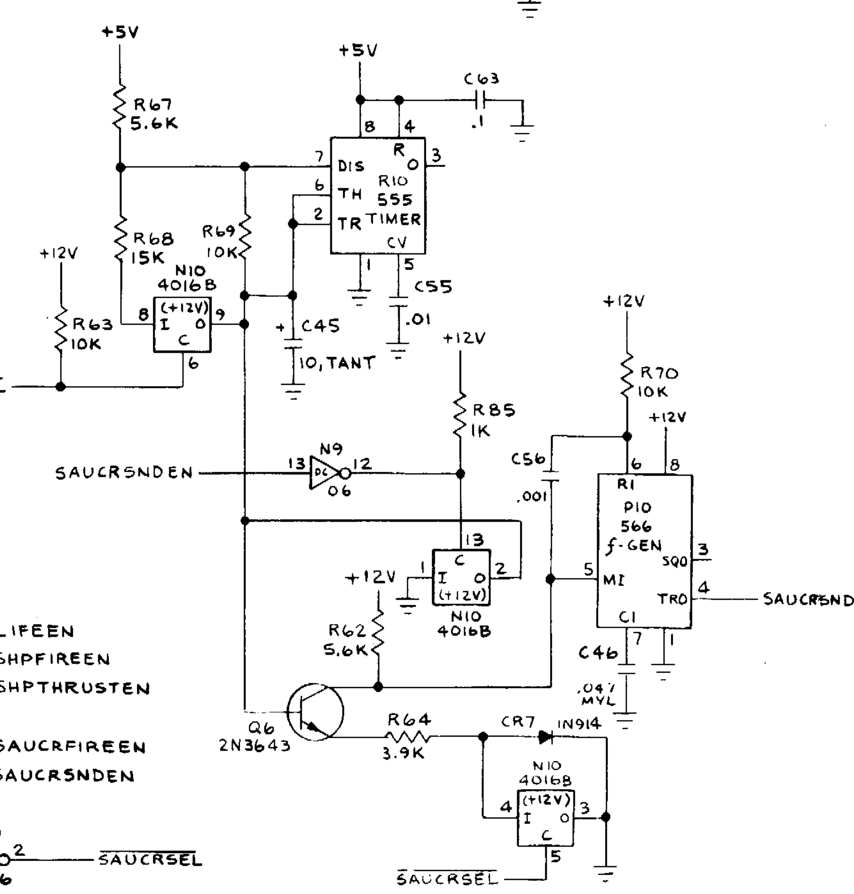
The video inverter circuitry is only used in a cocktail game. In an upright game, pin 19 is unconnected and therefore floats. When pin 19 floats, transistor Q16 is turned off and transistor Q17 is turned on. Therefore, INV is −8.2 VDC and NONINV is about +8.2 VDC. The result is a non-inverted X-axis and Y-axis output.

In a cocktail game, the wiring harness shorts connector J20's output pin 7 input pin 19. When the video of player 1 is being displayed, pins 7 and 19 are +5 VDC. This results in a non-inverted video output. When the video for player 2 is being displayed, pins 7 and 19 are grounded. This causes transistor Q16 to be turned on and Q17 to be turned off. Therefore, INV is +8.2 VDC and NONINV is −8.2 VDC. The result is an inverted X-axis and Y-axis output, causing the monitor's display to be upside down.

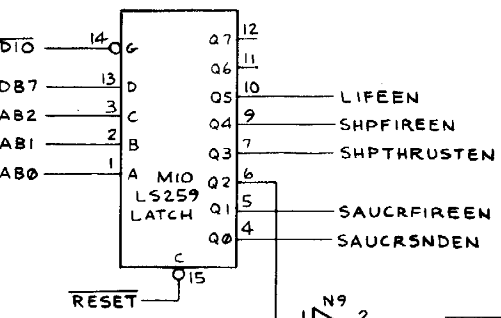
OUTPUTS



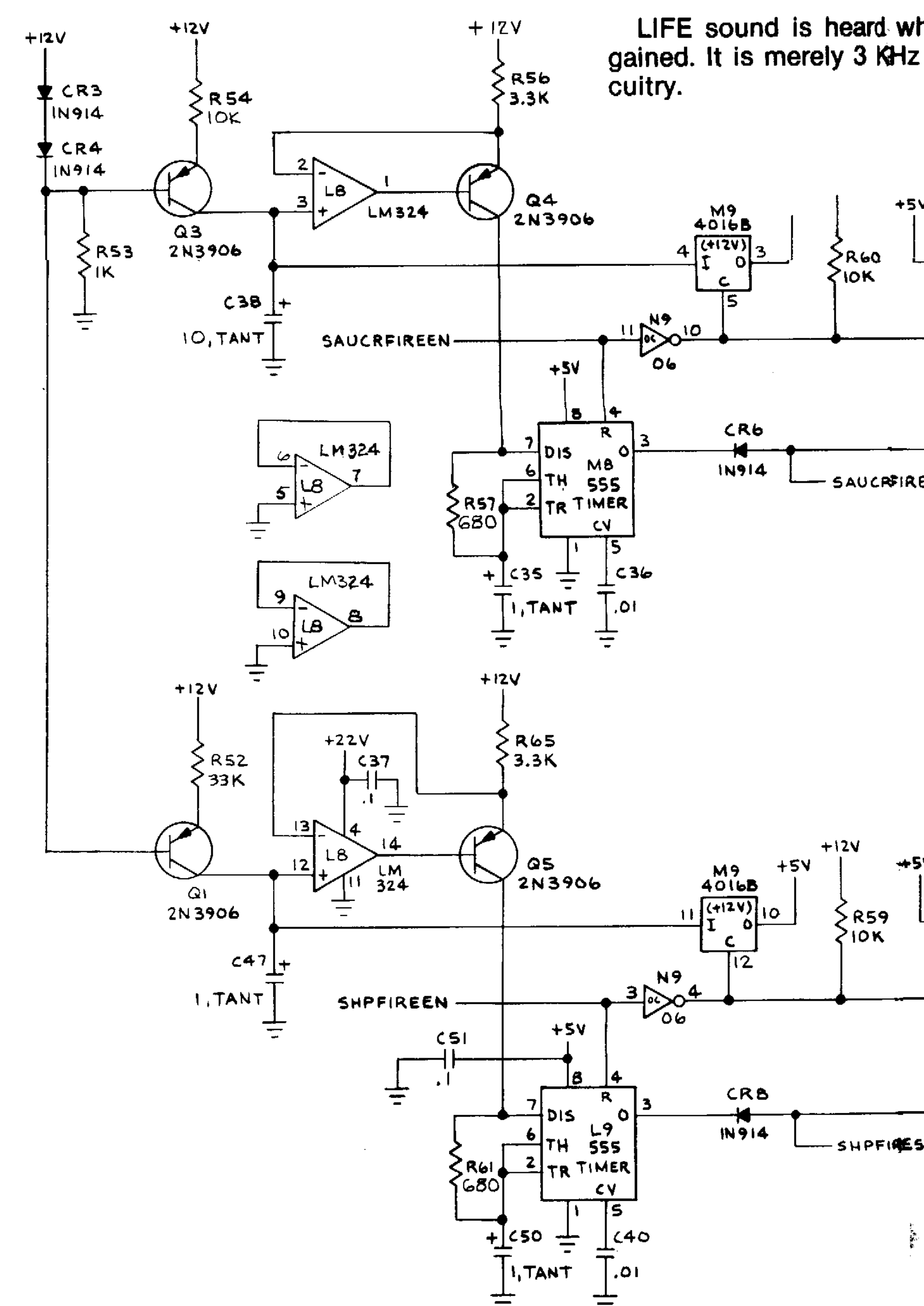
The THUMP sound is heard throughout play. The 555 is connected as an oscillator, enabled by N7 pin 2. The frequency is determined by the current coming out of Q2. This depends on its base voltage, which is derived from the four-bit code in N7.



The SAUCER sound is heard when an enemy saucer appears. The 566 is a voltage-controlled oscillator. Its modulating voltage is derived from the 555. The 555 is a low frequency oscillator. The effect is a warbling sound. $\overline{\text{SAUCRSEL}}$ changes some component values, in order to provide for 2 different saucer sounds.

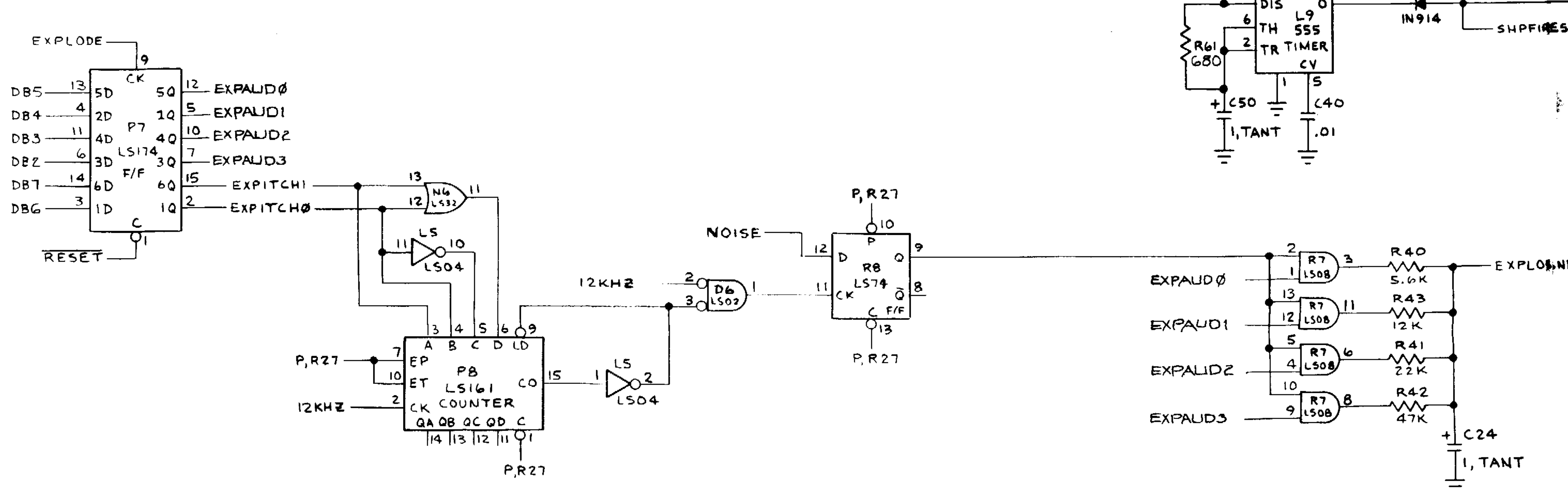


M10 latches control signals to enable different sounds.

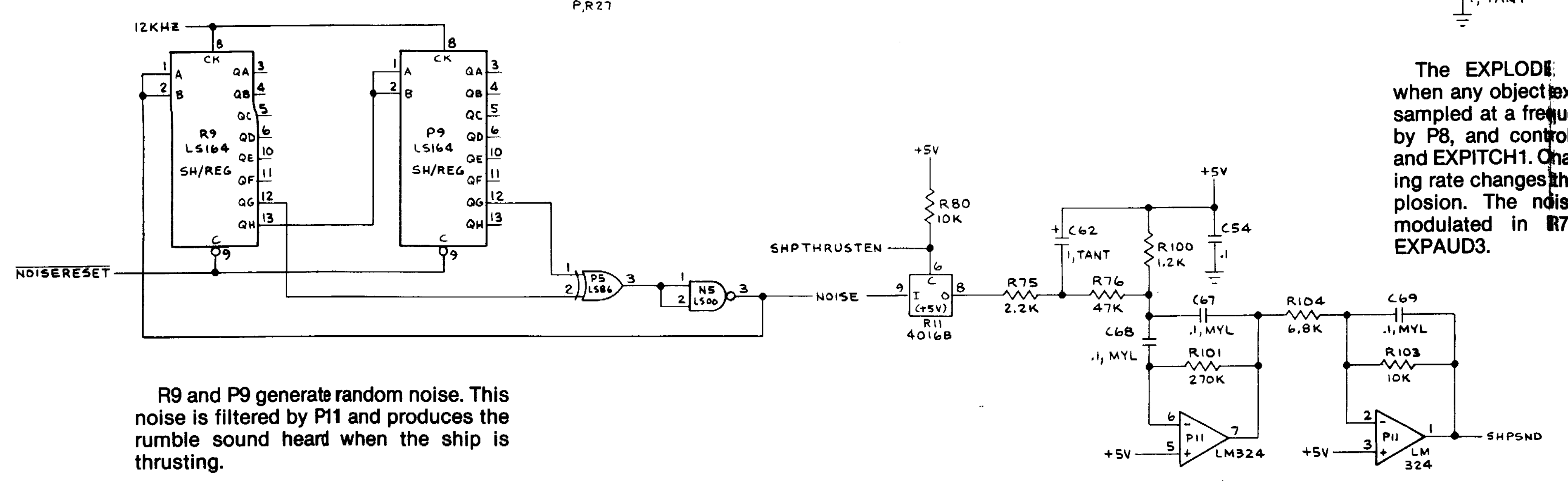


The Fire sounds for the Saucer and the Space Ships are generated by two identical circuits. Each contain a 555 operating as a voltage-controlled oscillator. The Saucer Firesound is initiated by SAUCRFIREEN, and the Space Ship Fire sound is initiated by SHPFIREEN. Each of the 555s is configured in such a way that when they are enabled, they output a signal of a specific frequency and amplitude. This signal begins to decay immediately, both in frequency and amplitude, due to the discharge of the control capacitors (C38 & 39 for Saucer Fire Sound; C47 & 48 for Ship Fire Sound).

LIFE sound is heard wh
gained. It is merely 3 KHz
cuitry.



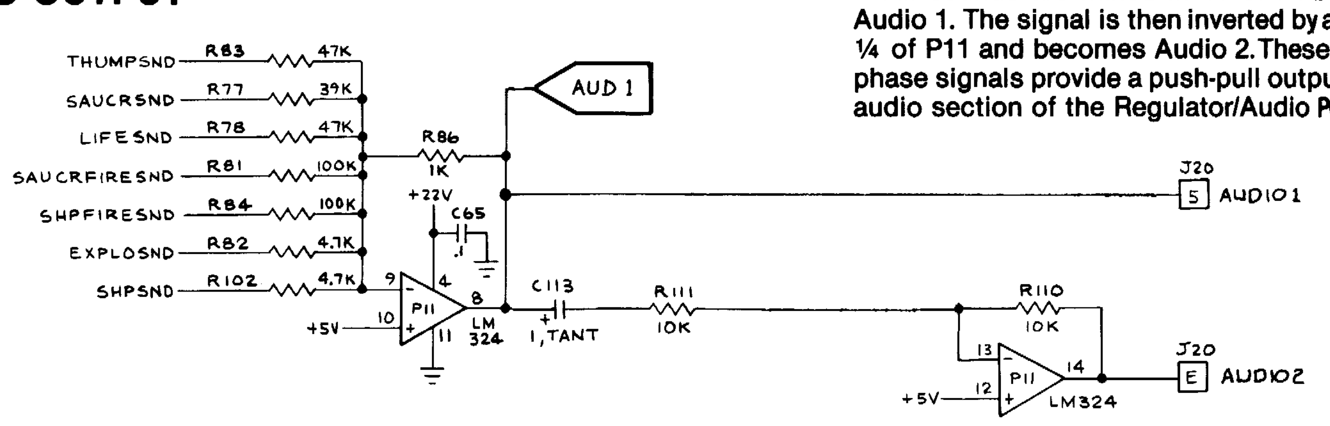
The EXPLODE
when any object ex
sampled at a frequ
by P8, and contro
and EXPITCH1. Cha
ing rate changes th
plosion. The nois
modulated in R7
EXPAUD3.



R9 and P9 generate random noise. This noise is filtered by P11 and produces the rumble sound heard when the ship is thrusting.

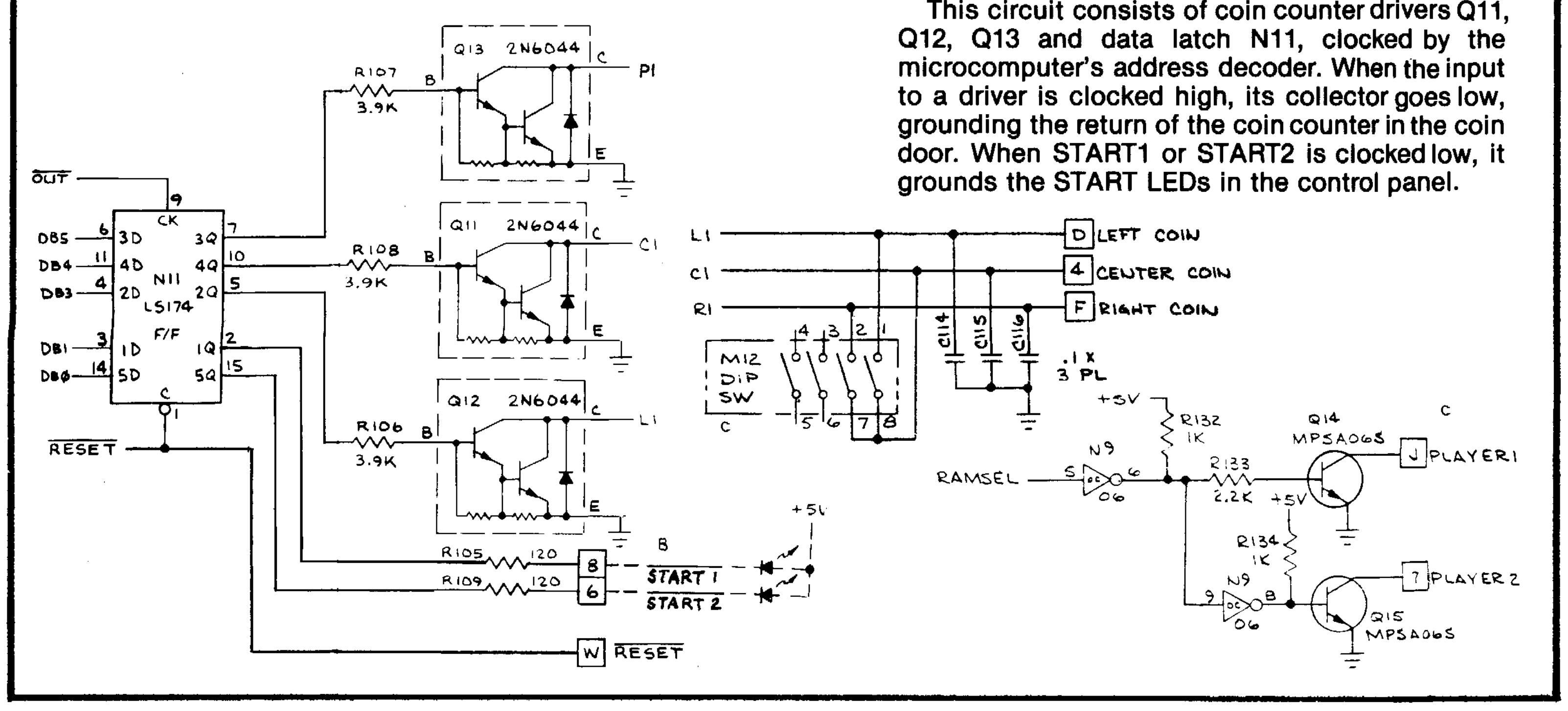
AUDIO OUTPUT

All sounds are mixed in ¼ of P11. This is Audio 1. The signal is then inverted by another ¼ of P11 and becomes Audio 2. These out-of-phase signals provide a push-pull output to the audio section of the Regulator/Audio PCB.



LAMP, LED, AND COIN COUNTER OUTPUT

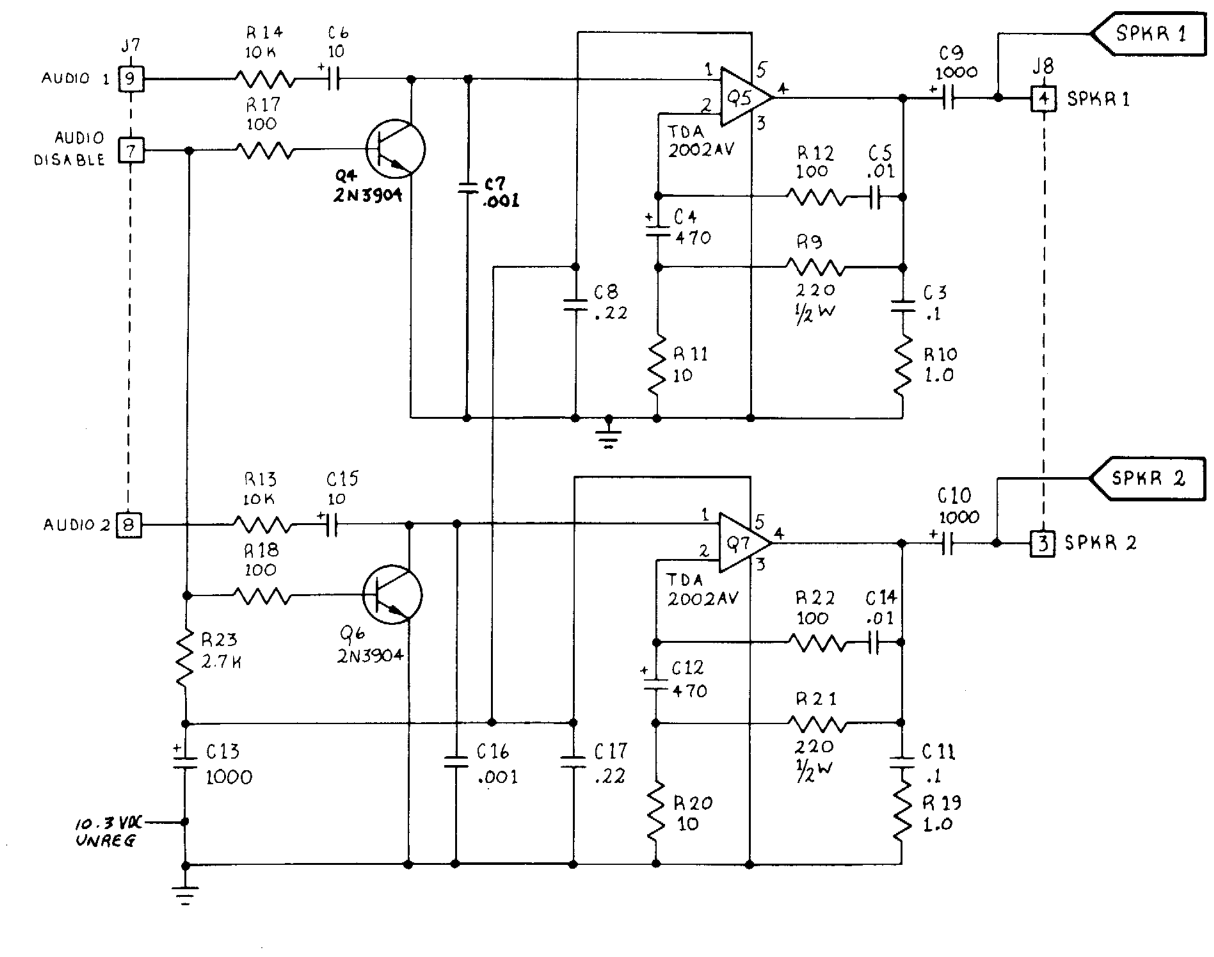
This circuit consists of coin counter drivers Q11, Q12, Q13 and data latch N11, clocked by the microcomputer's address decoder. When the input to a driver is clocked high, its collector goes low, grounding the return of the coin counter in the coin door. When START1 or START2 is clocked low, it grounds the START LEDs in the control panel.



PART OF REGULATOR/AUDIO PCB

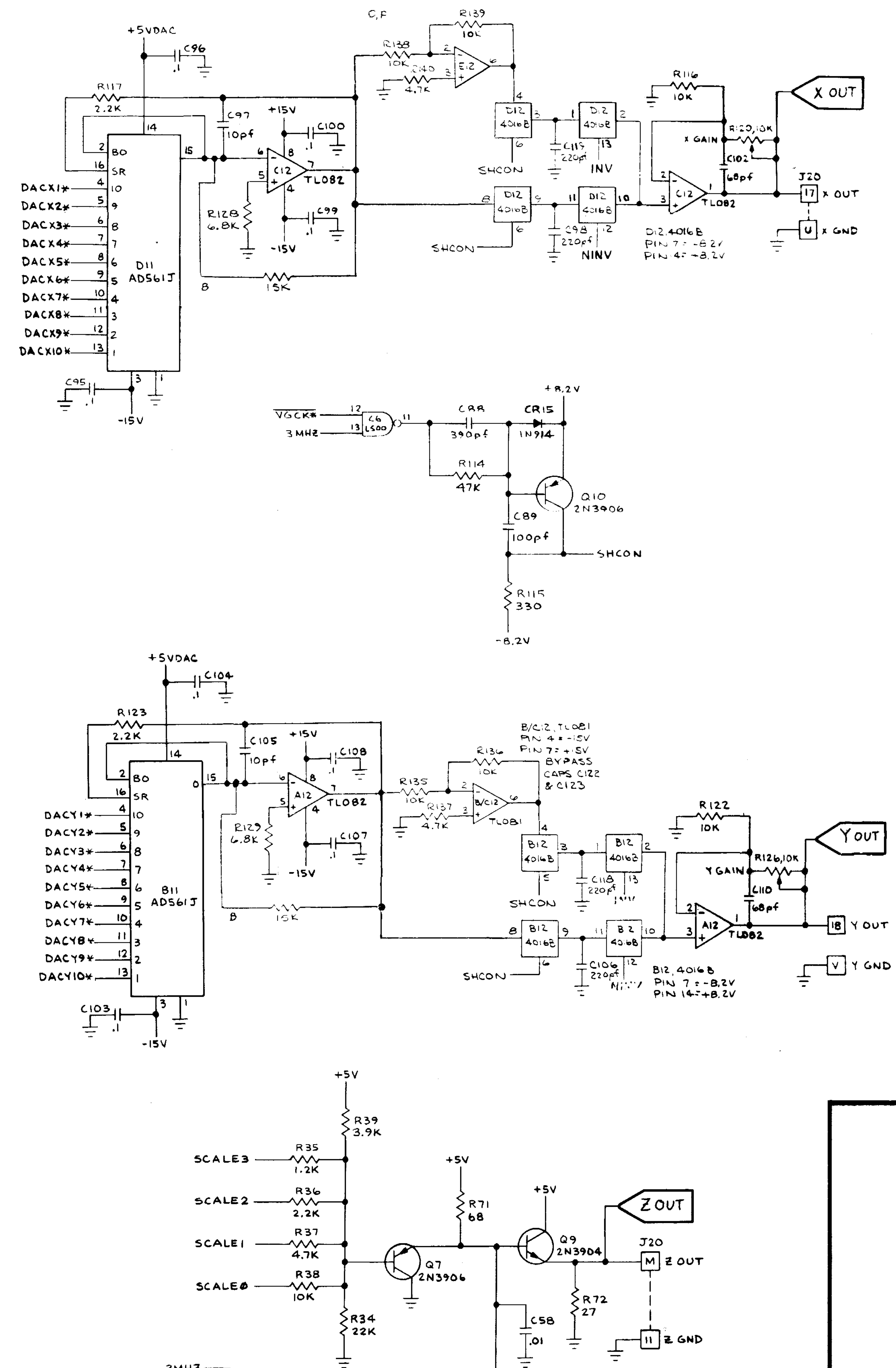
NOTE:
AUDIO AMPLIFIER IS PART OF REGULATOR/AUDIO PCB AND IS REPEATED ON SHEET 1, SIDE A.

Audio inputs AUDIO 1 and AUDIO 2 receive out of phase signals for push-pull operation. AUDIO DISABLE is permanently grounded for continuous audio amplification.



denotes a test point

VIDEO OUTPUTS



The video output circuit consists of three individual circuits; X axis, Y axis, and Z axis video output circuits. The X axis and Y axis video output circuits each consist of a digital-to-analog converter (DAC), current-to-voltage converter, two sample and holds, and amplifier. The Z axis video output circuit consists of a shift register and a summer.

X and Y Outputs

The DACs (D11 and B11) each receive binary numbers from the vector generator's position counters outputs. These numbers represent the location of the beam on the monitor. For the non-inverted X axis, the numbers range from 0 to 1023, where 0 is at the far left of the monitor screen, 512 is at the center, and 1023 is at the far right. For the non-inverted Y axis, the numbers range from 128 to 996, where 128 is at the bottom of the monitor screen, 512 is at the center, and 996 is at the top. When the X axis and Y axis are inverted, the monitor picture is turned upside down. This is used for a two-player cocktail game.

The DACs convert these binary number inputs to current outputs. The DACs' current outputs are applied to the pin 6 inputs of current-to-voltage converters C12 and A12.

From the current-to-voltage converters, the signal is fed to two sample-and-hold circuits: One is non-inverted and the other is inverted. The non-inverted sample and hold consists of one stage of analog switch D12 and capacitor C98 for the X axis, and B12 and C106 for the Y axis. The inverting sample and hold consists of inverter E12, one stage of analog switch D12, and capacitor C119 for the X axis and B/C12, B12 and C118 for the Y axis.

The sample and hold circuits are controlled by SHCON (sample and hold control). SHCON is derived by gating 3 MHz from the microcomputer clock circuitry and VGCK* from the vector generator's state generator. The result of these inputs insures that the non-inverted and inverted analog signals that are applied to the analog switches have sufficiently stabilized before being applied to the sample and hold capacitors.

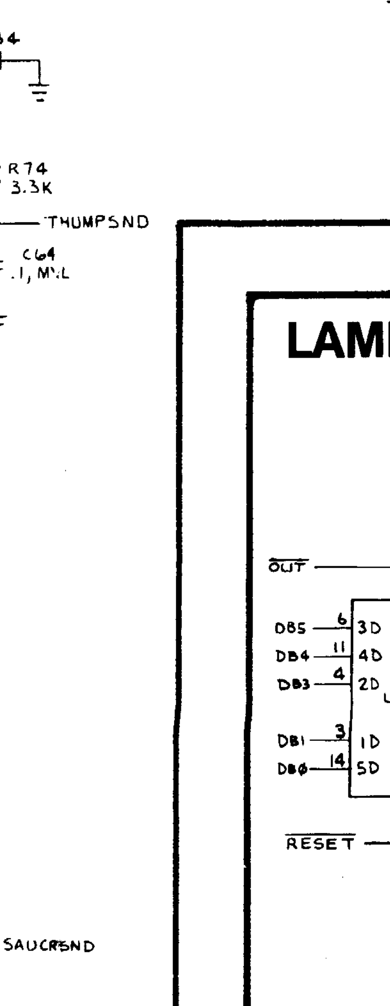
The output swing of SHCON is −8 to +8 VDC. When SHCON is high, the voltage charges or discharges the sample-and-hold capacitors to the X and Y analog voltage value. The voltages are then applied to the inputs of the second analog switch. These switches select either the non-inverted or inverted X-axis and Y-axis outputs. The outputs are then amplified by the second stages of C12 and A12 for an impedance-matched output to the X and Y inputs to the monitor. Since the monitor doesn't have field-adjustable X and Y gains, the gains are adjustable by variable resistors R120 and R126.

Z Output

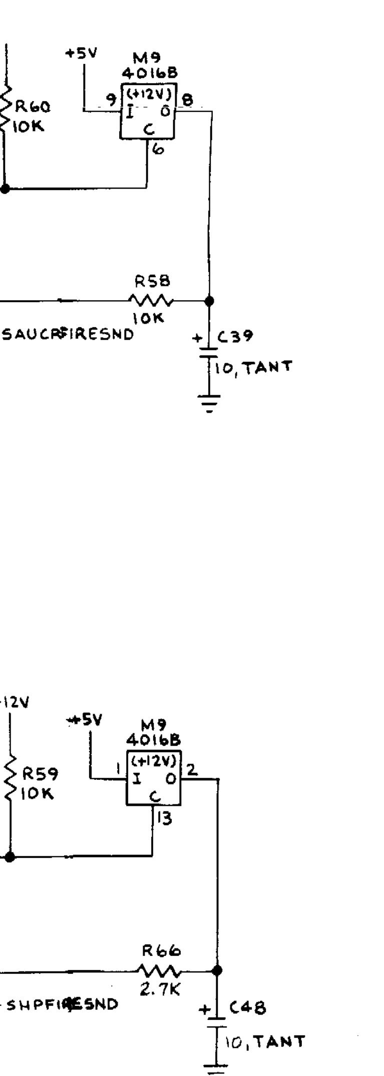
The Z axis video output receives six inputs. BVLD (beam valid), from the output of the vector generator's position counters, tells the Z axis to draw the line. BLANK (vector line blank), from the vector generator's state machine, tells the Z axis to stop drawing a line. SCALE0 thru SCALE3 (grey level shading scale), from the output of the vector generator's data latch, tells the Z axis the grey level shading of the line that is being drawn on the monitor.

When BVLD and BLANK are both high, a high is clocked through shift register K9 that turns transistor Q3 off. This allows the scale inputs to be passed through transistor Q2. When BLANK goes low, a low is clocked through K9, transistor Q3 turns on, and the signal is grounded at the base of transistor Q2.

The scale inputs at the base of transistor Q1 determine Q1's emitter voltage, during the line draw period. The SCALE0 thru SCALE3 resistors R36 thru R39, resistor R35, and resistor R40 result in a range of about +1.0 VDC when all are low and +4.0 VDC when all are high. The emitter of Q1 follows at about +1.7 to 4.7 VDC, while the emitter of transistor Q2 follows at about +1.0 to 4.0 VDC. This output is applied to the Z input of the monitor. Since there are brightness and contrast controls in the monitor, there are no adjustments in this circuit.



heard when an extra life is ... y 3 KHz from the clock cir-



PLODE sound is heard ... bject explodes. Noise is ... a frequency determined ... control bits EXPITCH0 ... CH1. Changing the sampl- ... anges the pitch of the ex- ... he noise is amplitude- ... in R7 by EXPAUD0-

Sheet 2, Side B

ASTEROIDS

Switch Inputs, Coin Counter, LED and Audio Outputs

Section of 034986-XX F

ATARI®

A Warner Communications Company