

SERVICE MANUAL

C64/C64C

MARCH, 1992

PN-314001-03

 **Commodore**

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Commodore Business Machines, Inc.
1200 Wilson Drive, West Chester, Pennsylvania 19380 U.S.A.

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C64 COMPUTER

GENERAL DESCRIPTION

	<ul style="list-style-type: none">The "All Purpose" Commodore 64 is the complete computer for education, home or small business applications. Supported by quality peripherals and a full range of software, the Commodore 64 is perfect for the family. No other computer can offer such variety of uses and applications at such an affordable price.
MEMORY	<ul style="list-style-type: none">64K RAM
ROM	<ul style="list-style-type: none">20K ROM Standard (includes operating system and BASIC interpreter)
MICROPROCESSOR	<ul style="list-style-type: none">6510A Microprocessor—1.02 MHz clockCompatible with the 6502
DISPLAY	<ul style="list-style-type: none">40 Columns X 25 lines of text
COLORS	<ul style="list-style-type: none">16 Background, border and character colors
CHARACTERS	<ul style="list-style-type: none">Upper & lower case letters, numerals and symbolsReverse charactersAll PET graphic characters
DISPLAY MODES	<ul style="list-style-type: none">Text charactersHigh resolution graphics
RESOLUTION	<ul style="list-style-type: none">320 X 200 Pixels
SPRITES	<ul style="list-style-type: none">8 independent spritesEach consists of 24 X 21 pixels and up to 4 colorsEach independently expandable horizontally and verticallyCollision detection for sprite to sprite and data to sprite collisions
SOUND	<ul style="list-style-type: none">6581 Sound Interface Device includes 3 independent tone generators—each with 9 octavesEach voice includes programmable ADSR generator (Attack, Decay, Sustain, Release) and control of sawtooth, triangle, square, variable pulse and noise waveformsFull filtering capabilities with low, high and band pass filtersExternal sound input
KEYBOARD	<ul style="list-style-type: none">Full size typewriter style design
KEYS	<ul style="list-style-type: none">66 Keys total2 Cursor control keys4 Function keys (up to 8 user defined/programmable functions possible)Upper and lower case character setGraphic character set
INPUTS/OUTPUTS	<ul style="list-style-type: none">User portSerial portROM cartridge port2 Joystick/paddle portsVideo portC1530 Cassette drive interface port
FEATURES	<ul style="list-style-type: none">Built-in BASIC 2.0—over 70 commands, statements and functionsFull screen editor
PERIPHERALS	<ul style="list-style-type: none">C1541 Disk driveC1530 DatasetteMPS 801 Dot matrix printerMPS 802 Dot matrix printerMPS 803 Dot matrix printerDPS 1101 Daisey wheel printerC1520 Plotter/PrinterC1702 Color monitorCM141 Color monitor
POWER REQUIREMENTS	<ul style="list-style-type: none">120 Volts, 60 Hz

Specifications subject to change without notice.

PARTS LIST

C64

PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-references for TTL chips, Transistors, etc. are available in manual form through the Service Department, order part #314000-01. Unique or non-standard parts will be stocked by Commodore and are indicated on the parts list by a "C".

TOP CASE ASSY

Top Case	C 326113-01
Keyboard	C 326165-02
LED Plate	C 326160-01
Nameplate	C 326161-01
Lamp Holder Set	C 903820-03
LED Assembly	C 1001039-01

BOTTOM CASE ASSY

Bottom Case	C 326114-01
Foot, Self-Adhesive	C 950157-04
PCB Shield Plate	C 326131-01
PCB Insulation Sheet	C 326288-01

ACCESSORIES

Users Manual	C 320974
Power Supply	C 251053-02
RF Cable	C 326189-01
Switch Box	C 904778-01

C64C PARTS LIST

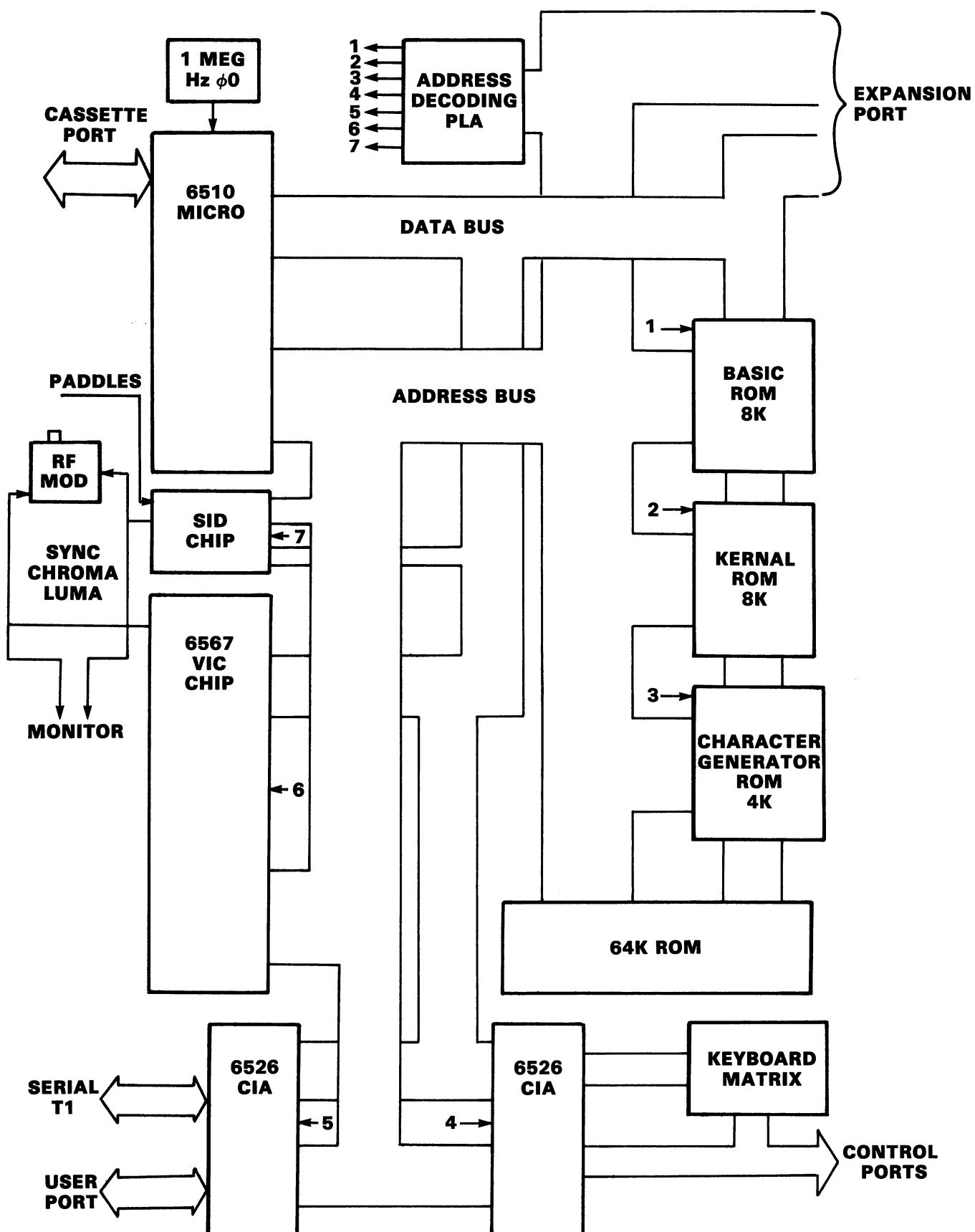
MAIN CASE ASSY

Top Case, B3	250785-01
Top Case, E	250785-02
Keyboard B3, E	326166-03

BOTTOM CASE ASSY

Top Shield Assembly, B3	252114-01
Top Shield Assembly, E	251975-01
Medal Angle, RT, B3	252113-01
Paper Shield, E	252085-03
Shield Plate, Bottom E	251976-01
Bottom Case, B3, E	252111-01
Foot B3, E	950150-03

C-64 BLOCK DIAGRAM



C64 CIRCUIT THEORY

There are three versions of the C64. The C64 with a five pin connector video output (326106), The C64 with an eight pin connector video output (251138), and the C64B which has improved system clock circuit design (251469). Most circuit theory explanations will be the same for all three versions. Refer to schematic 326106 unless noted otherwise.

The Power Supply.

The external power supply generates a regulated 5VDC and 9VAC. 5VDC is applied to pins 5 and 1 of CN7 on the C64 pcb. Filtered by L5,C97, and C100 it is then controlled by on/off switch S1. This 5VDC output supplies the microprocessor logic.

9VAC is applied to pins 6 and 7 of CN7 on the C64 pcb. + 12VDC, + 5VDC CAN and 9VDC unregulated are outputs that are derived from this 9VAC supply. The 9VAC supply is made available on pins 10 and 11 of the USER PORT CN2.

12VDC Generation

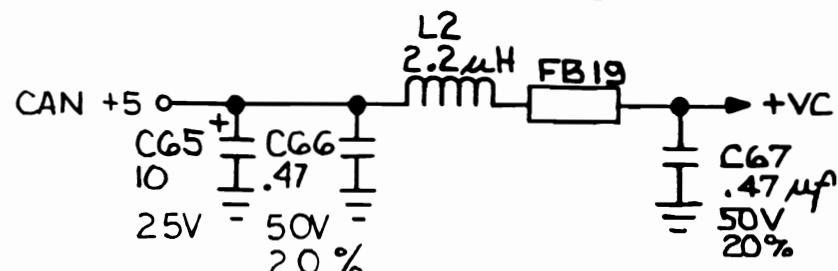
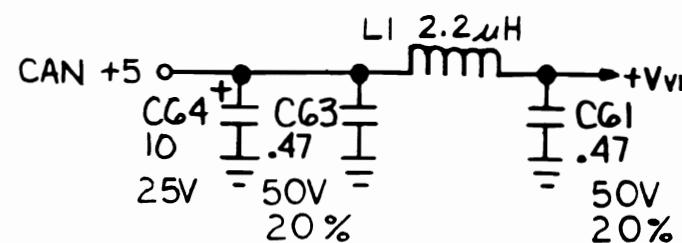
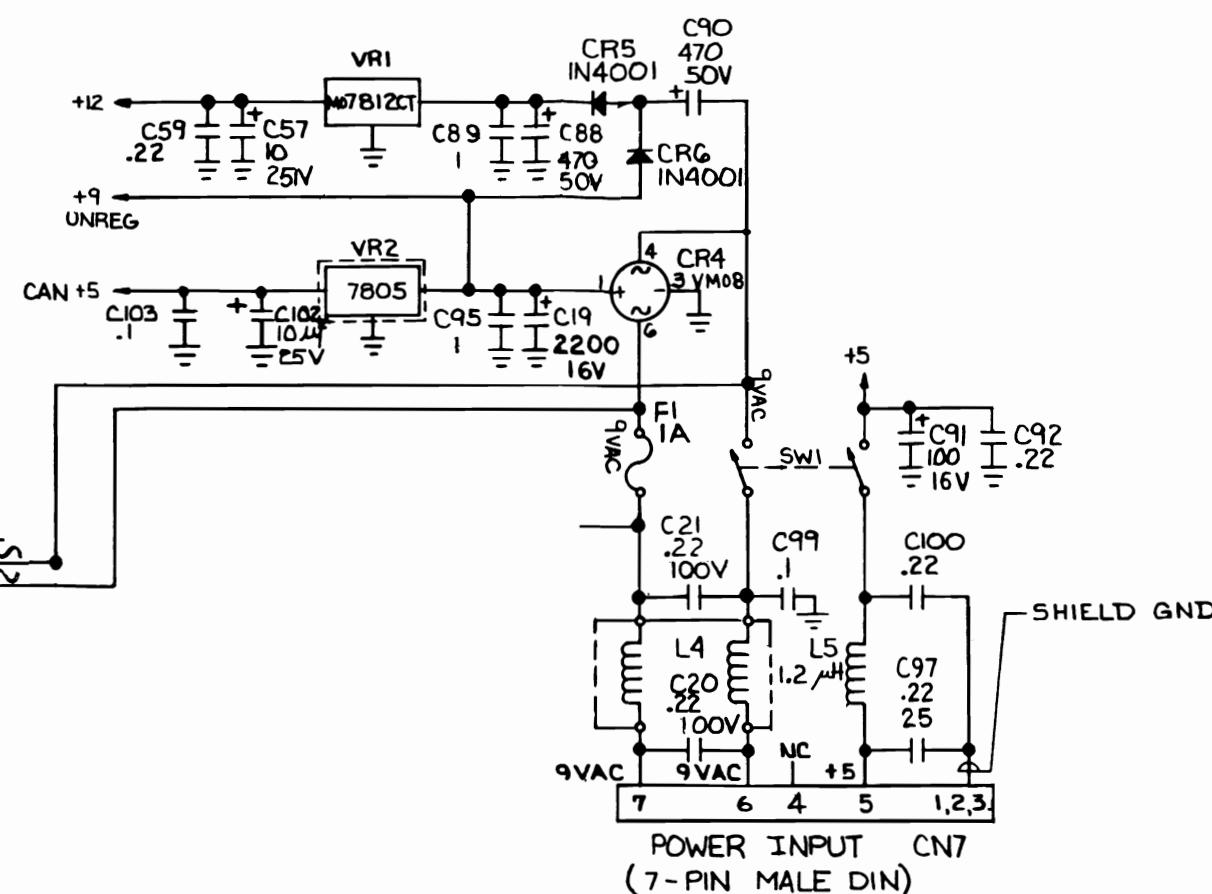
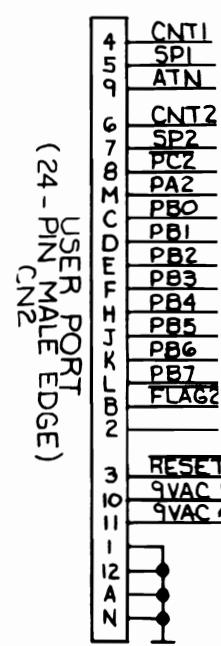
9VAC is added to 9VDC through CR6, and rectified by CR5. The unregulated DC output is filtered by C88 and C89 then regulated at 12VDC by VR1. The regulated output is filtered by C57 and C59. The 12VDC supplies the VIC and SID IC, and the audio amplifiers.

+5VDC CAN Generation

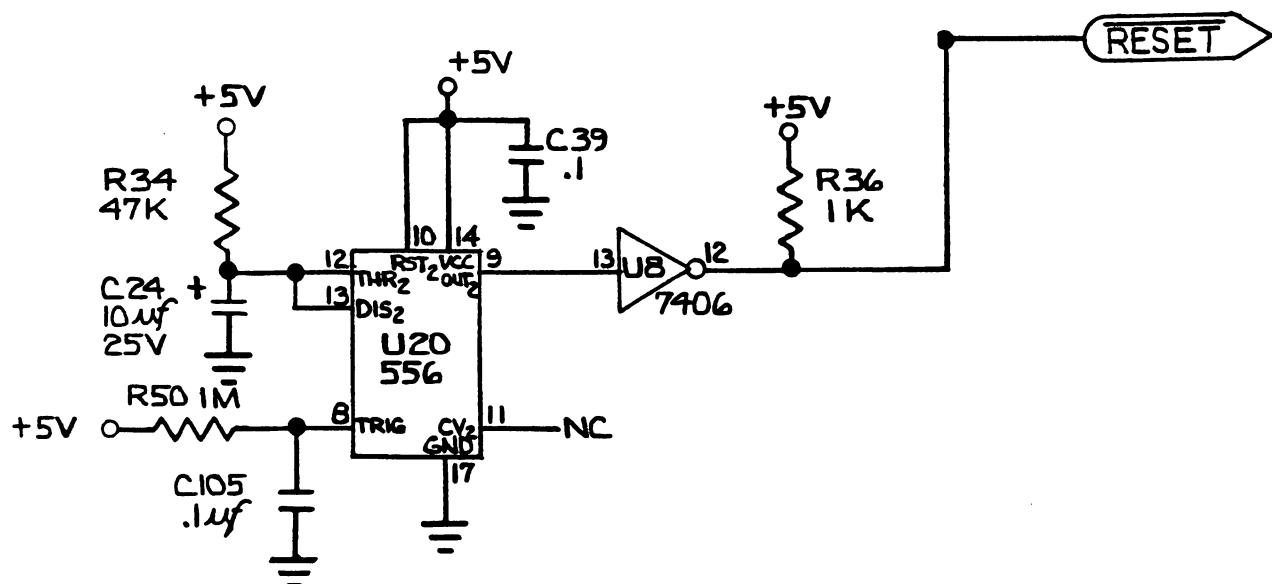
9VAC is rectified by CR4. The unregulated DC output is filtered by C19, and C95 then regulated at 5VDC by VR2. The regulated output is filtered by C102 and C103. The output called 5VDC CAN is separated and individually filtered into two outputs called Vvid and Vc. Vvid is the 5VDC supply for the video circuits, and Vc is the 5VDC supply for the clock circuits.

9VDC Unregulated Generation.

CR4 rectifies the 9VAC input. The output is 9VDC unregulated. This supply powers the cassette motor transistor amplifier circuits, and the RF modulator on the C64B version.



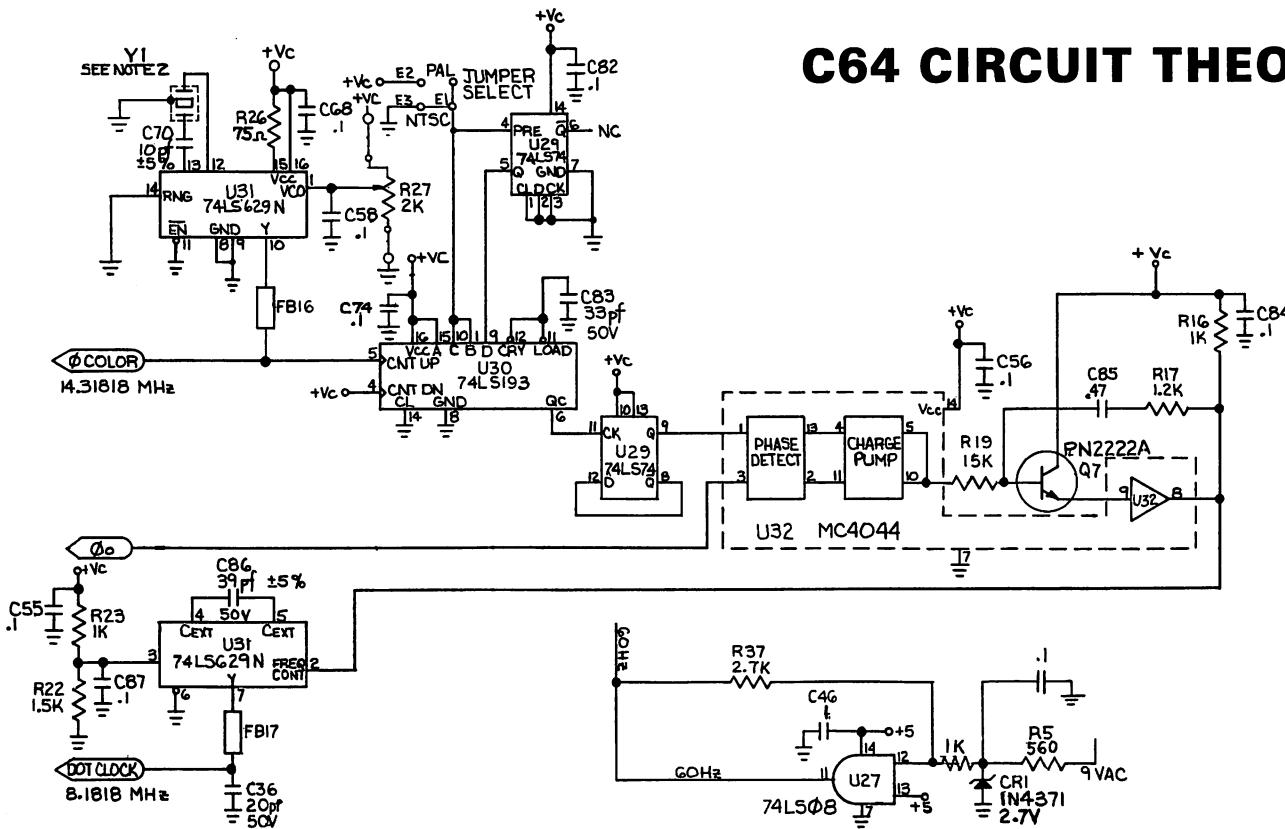
C64 CIRCUIT THEORY



Reset Logic Circuits.

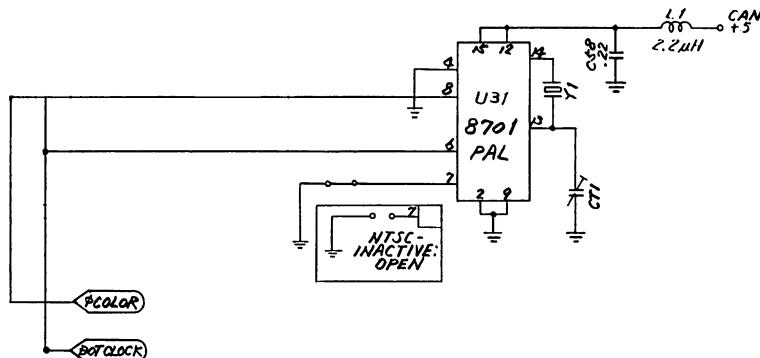
U20 is a 556 IC timer configured as a one shot multivibrator. The output pulse width is determined by the size of R34 and C24. Pulse width = $1.1 \times R34 \times C24 \approx .5$ seconds. The output on pin 9 is "high" active. The output of U8 is "low" active. Reset initializes all the processor logic and causes the processor to load the program counter register with the address of the first instruction of the operating system program called the KERNAL. The starting address is stored in locations \$FFFC and \$FFFD. The first instruction is decoded and executed giving KERNAL control of the computer operations. The reset pulse occurs when turning the power on to the computer.

C64 CIRCUIT THEORY



The C64 Clock Circuits.

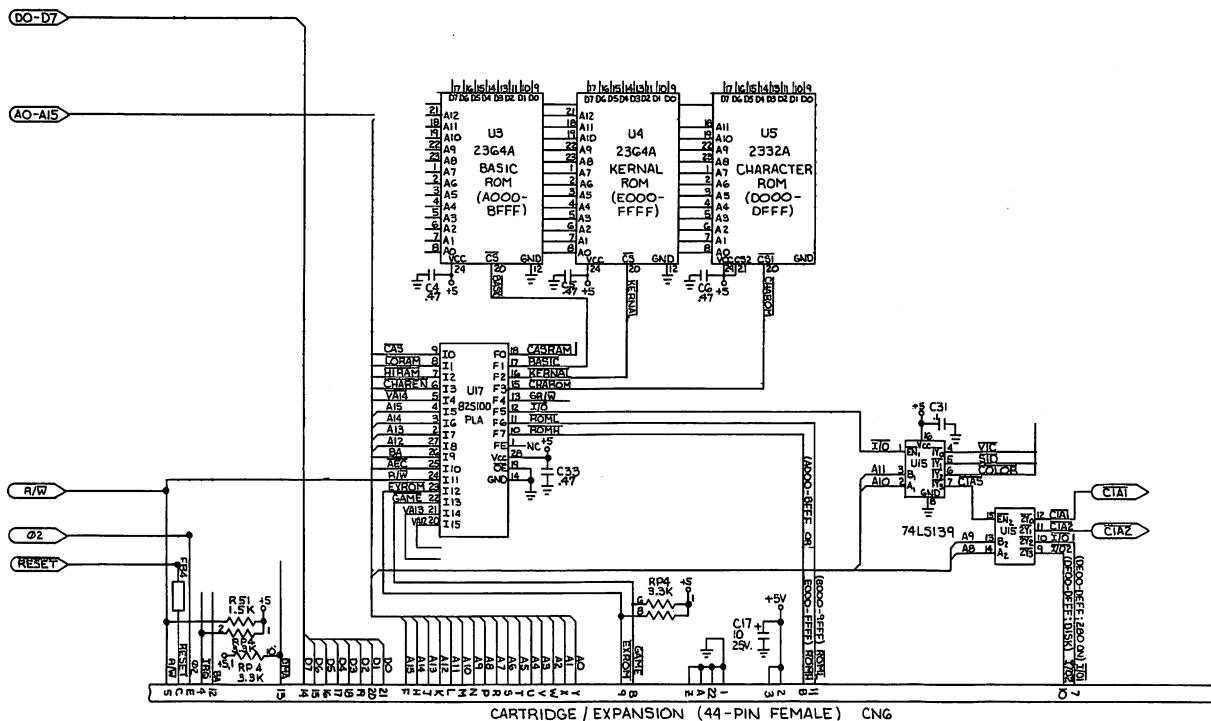
Crystal Y1 develops a 14.31818MHz fundamental frequency clock signal. U31 is a Dual Voltage Controlled Oscillator. The output on pin 10 is a 14.31818 MHz clock signal called the color clock. R27 can be adjusted to obtain exact output frequency. U30 is a frequency divider that outputs a 2MHz signal on pin 6. U29 is a D flip flop which outputs a 1MHz signal on pin 9. U32 is a Phase/Frequency Detector which compares the output of the U29 to the phase 0 clock, and outputs a dc voltage on pin 8 that is proportional to the phase difference between the inputs. The second half of the Dual Voltage Controlled Oscillator U31 generates an 8.1818MHz clock signal called the DOT Clock. The VIC IC divides the DOT clock by eight and outputs this as the phase 0 clock on pin 17. The output of the Phase/Frequency Detector is applied to the frequency control input pin 2 of U31. This causes tracking of the dot clock and the color clock because one input, pin 3 of U32, is the phase 0 clock which is derived from the dot clock, and the other input pin 1 of U32, is derived from the color clock.



The C64B Clock Circuits. Refer to schematic 251469

Crystal Y1 develops the fundamental 16MHz clock signal. U31 is a Clock Generator IC that outputs the 8.1818MHz DOT clock on pin 6, and the 14.31818 MHz color clock on pin 8.

C64 CIRCUIT THEORY



I/O and ROM Address Decoding and Expansion Port.

I/O Address Decoding Logic.

U17 is a Programmable logic array (PLA). The output F5 on pin 12 called I/O goes "low" when any of the I/O devices controlled by U15 are selected. The addresses are listed below for each device.

VIC IC	\$D000 - \$D02E
SID IC	\$D400 - \$D7FF
Color Ram	\$D800 - \$DBFF
CIA1	\$DC00 - \$DC0F
CIA2	\$DD00 - \$DD0F
I/O 1	\$DE00 - \$DEFF
I/O 2	\$DF00 - \$DFFF

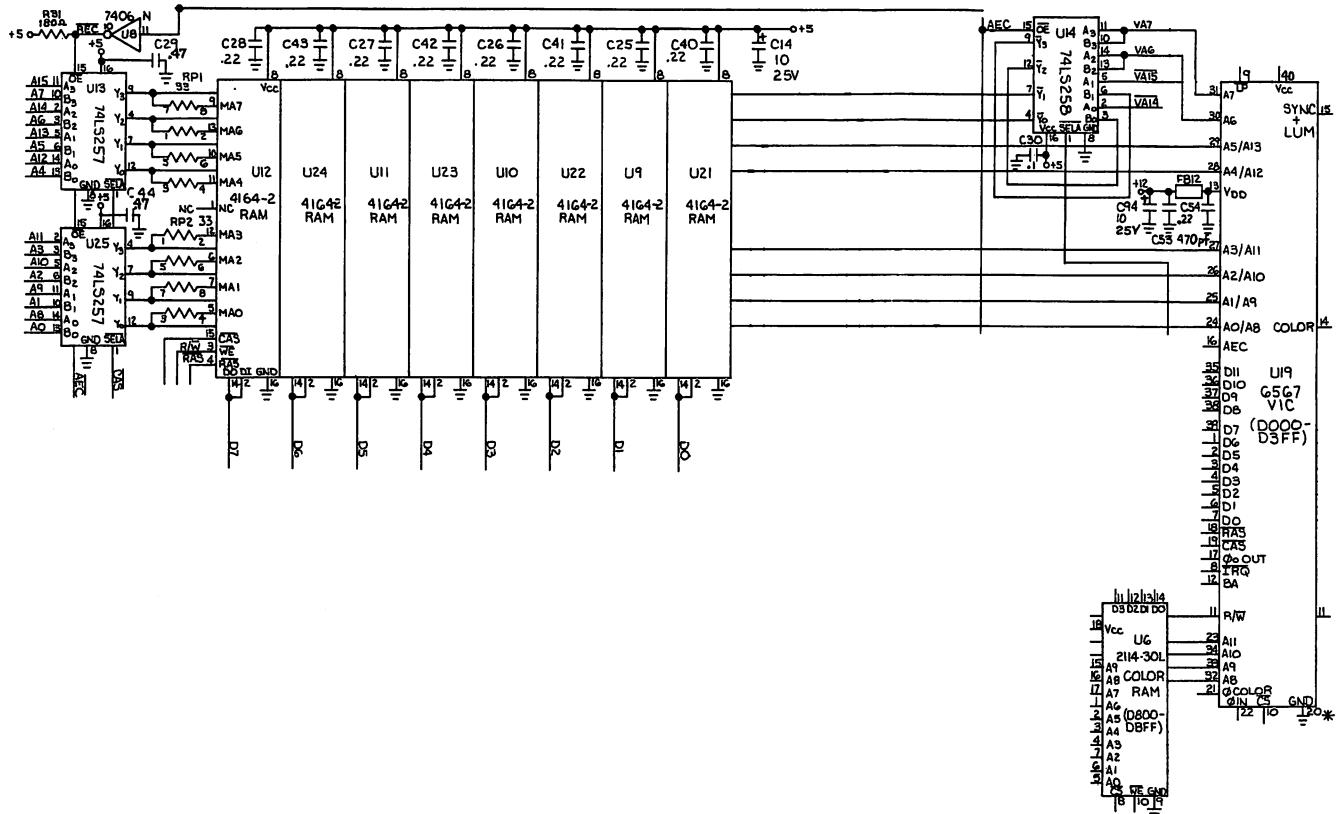
ROM Address Decoding.

Basic ROM resides at locations \$A000 - \$BFFF. The output F1 pin 17 of the PLA U17 goes "low" when the BASIC ROM is selected. The KERNAL ROM resides at locations \$E000 - \$FFFF. The output F2 pin 16 of the PLA U17 goes "low" when the KERNAL ROM is selected. The CHARACTER GENERATOR ROM resides at locations \$D000 - \$DFFF. The output F3 pin 15 of the PLA U17 goes "low" when the Character Generator ROM is selected.

The Expansion Port Connections.

The expansion port is an extension of the microprocessor address, data, and control bus. ROML decodes addresses \$8000 - \$9FFF, and ROMH decodes addresses \$E000 - \$FFFF. These are outputs from the PLA used to select the cartridge inserted in the expansion port. I/O 1 input from U15 decodes addresses \$DE00 - \$DEFF. I/O 2 output from U15 decodes addresses \$DF00 - \$DFFF.

C64 CIRCUIT THEORY

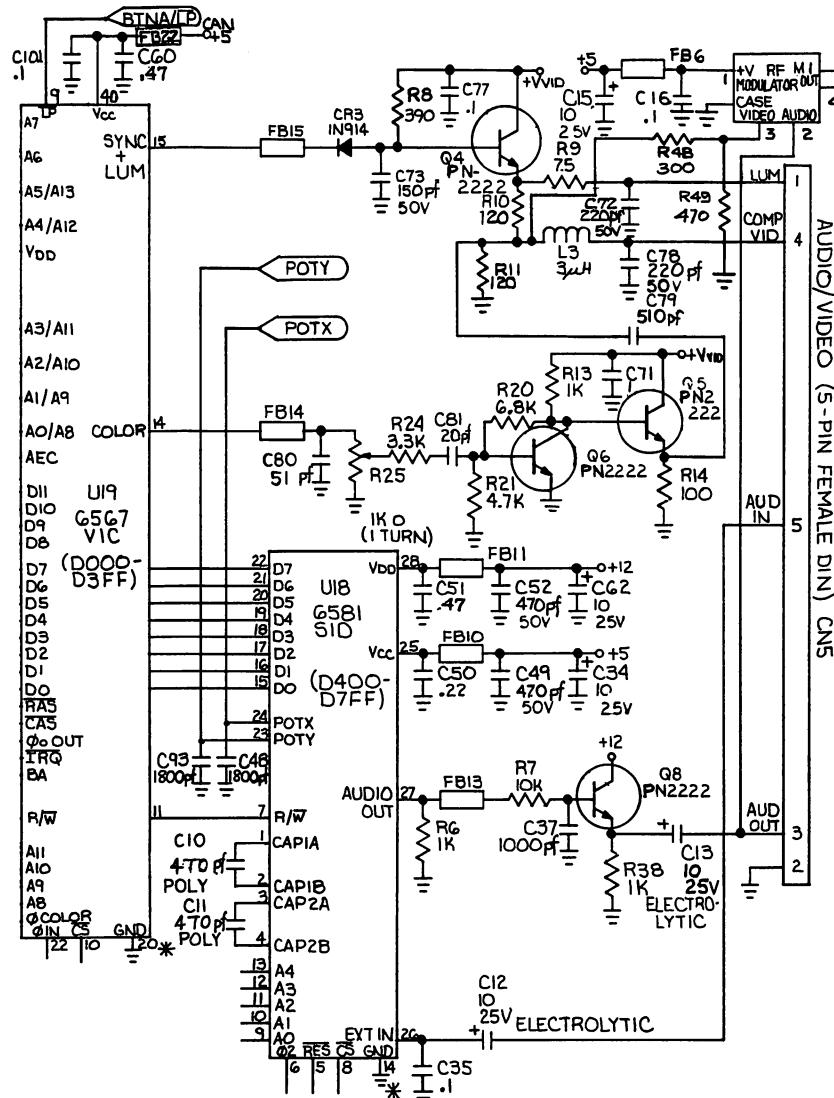


RAM Control Logic.

U13 and U25 are multiplexers. The address outputs from the microprocessor are passed to RAM via U13 and U25 when the output Address Enable Control (AEC) from the VIC IC is "high". When AEC is "low" the VIC IC outputs refresh addresses on pins 24 - 31. AEC goes "low" when the system clock, phase 2, is "low". Since all I/O decoding occurs when phase 2 is "high", refresh is transparent to the processor.

Eight 4164 DRAMS provide 64k bytes of memory. One 2114 RAM (U6) provides 512 bytes of memory allocated for screen color data storage.

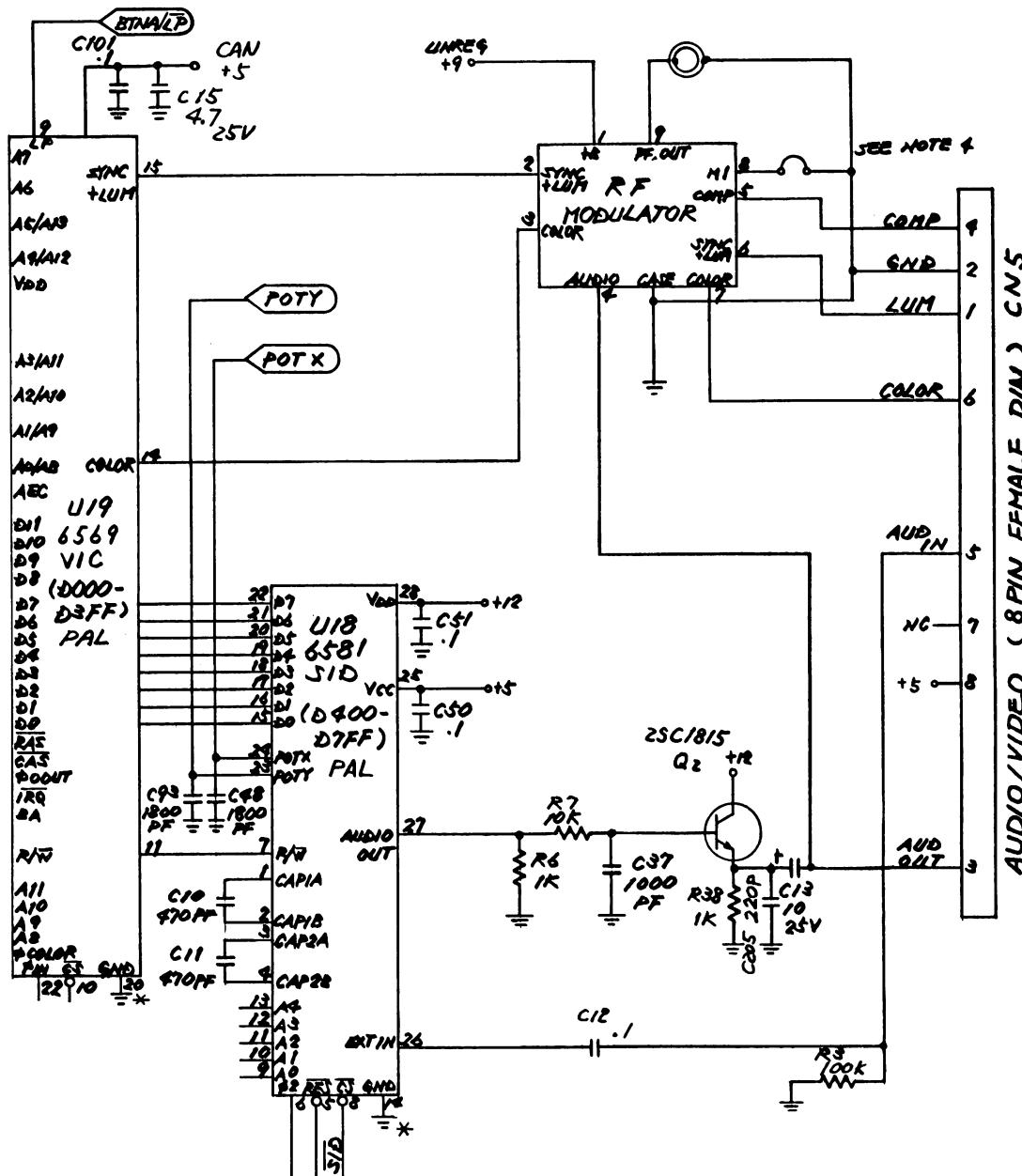
C64 CIRCUIT THEORY



5 Pin Video and Audio Output Circuits.

Pin 15 of the VIC IC is the sync/luminance output. Pin 14 is the color output. A composite video output is created by mixing sync/luminance and color. The composite output is applied to the RF modulator, and also passed to the monitor connector CN5 on pin 4. The color output is not made available on the monitor connector CN5 as on the 8 pin version, and the RF modulator mixes audio with the composite video producing the TV RF output, unlike the 8 pin version RF modulator which creates the composite video output.

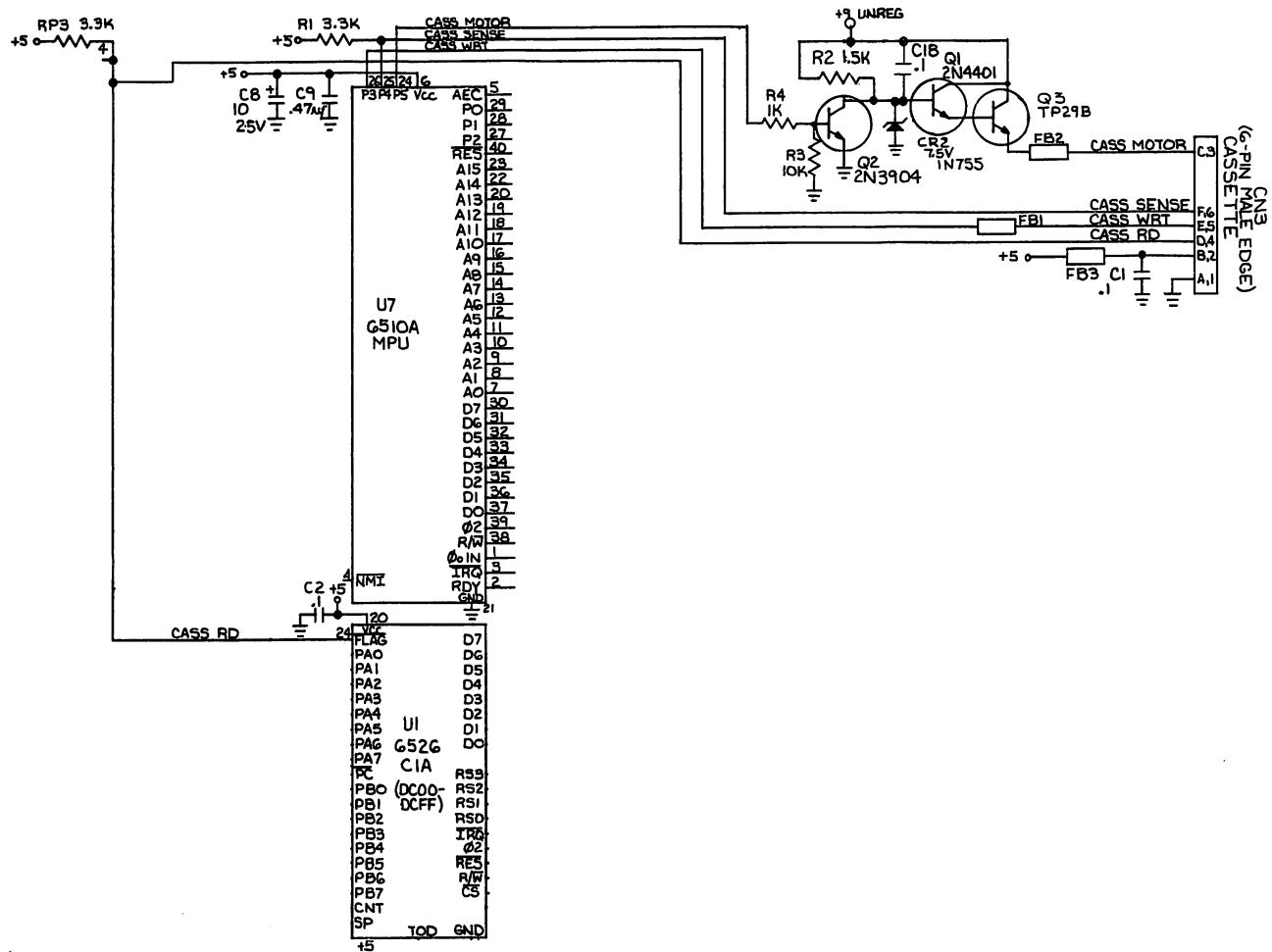
C64 CIRCUIT THEORY



8 Pin Video and Audio Output Circuits. Refer to schematic 251469

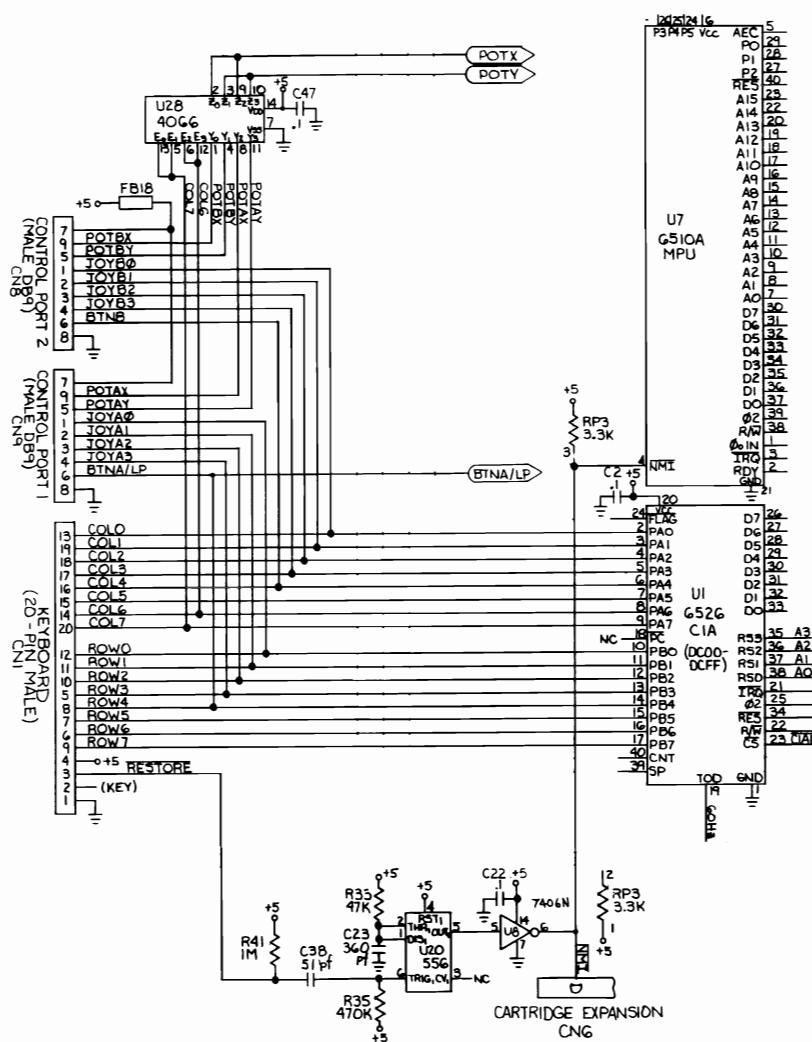
U19 is the Video Interface Chip (VIC). Sync (horizontal and vertical), and luminance (video) is output on pin 15. This signal is passed to pin 2 of the RF modulator. Color is output on pin 14, and passed to pin 3 of the modulator. Light Pen inputs are sensed by the VIC IC on pin 9. U18 is the Sound Interface Device IC (SID). The audio output is on pin 27, and audio input is on pin 26. The RF modulator mixes sync/luminance, color, and audio out, generating a TV composite signal on pin 5. The RF modulator also passes the VIC outputs to the monitor connector CN5. Audio out on pin 27 is amplified by Q2, and output on pin 3 of CN5. Audio in is applied to pin 5 of CN5, then to pin 26 of the SID IC. Inputs from paddles connected to one of the control ports are monitored by the SID IC on pins 23 and 24.

C64 CIRCUIT THEORY

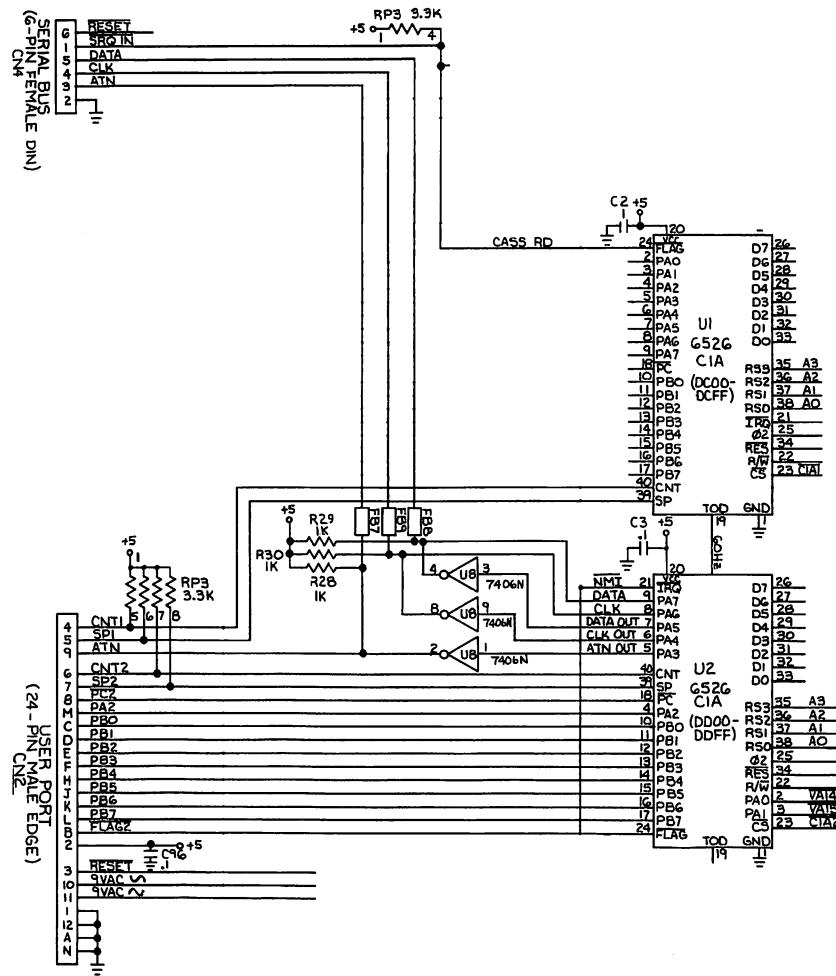


The Cassette Interface Circuits.

U7 is a 6510 microprocessor. One of the features of the 6510 is a built in parallel I/O port (PO-P5). P3 - P5 control most of the cassette interface circuitry. P3 pin 26 of U7 outputs the write data signal to connector CN3 on pins E and 5. P4 is an input that senses the play switch depressed on the cassette deck. P5 is an output that controls the cassette motor. When P5 goes "low", Q2 cuts off, CR2 regulates V_b of Q1 at 7.5 volts, this forward biases Q1 and Q3, passing current through the cassette motor coil. U1 is a Complex Interface Adapter (CIA). Parallel ports, serial outputs, and Timers are standard features of the CIA. Read data enters on pins D, 4 of CN3. U1 accepts the read data signal on the FLAG input pin 24.



C64 CIRCUIT THEORY



The Serial Interface and User Port Circuits.

The Serial Interface.

U2 is a Complex Interface Adapter (CIA). Parallel port signals PA3-PA7 control the serial bus interface. PA3 is the Attention (ATN) output. This signal is inverted by U8 before being transmitted to a device on the bus. PA4 is the Clock output. Data transmitted from the C64 to a device on the bus is synchronized by this clock signal. U8 inverts the output PA4. PA5 is the data output. U8 inverts this output also. Data transmitted from a device on the bus to the C64 is synchronized by a clock generated by the transmitting device. The Clock signal is input on PA6. Data transmitted from a device on the bus to the C64 is input on PA7. When a device on the bus wants to communicate with the C64, SRQ IN goes "low" indicating service is requested.

The User Port.

Parallel port B of U2 (PBO - PB7) is made available on the user port. Parallel data transfers with external devices are made very easily through this parallel port. SP2 and SP1 are bi-directional serial ports. CNT1 and CNT2 are bi-directional synchronizing clock signals for each serial port.

64 TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE SOLUTION
Blank screen on power up.	Check External Power Supply U4 (KERNEL ROM), U17 (PLA) U7 (6510 MPU), U3 (ROM) U8 (7406 IC), U19 (VIC II) U9-U12 (4164 RAM) U21-U24 (4164 RAM) VR2, CR4, VR1
Out of memory error on power up.	Check U9-U12 (4164 RAM) U21-U24 (4164 RAM) * * * * USE DIAGNOSTIC TEST — DISK
No cursor displayed. Intermittent blank screen.	Check U1, U15, U7 Check U2, U7
Powers up with graphic display and blinking cursor.	Check U14 (74LS258 IC)
Powers up with all the characters displayed as blocks.	Check U26 (74LS373 IC)
Intermittent display.	Check C88 (Possible Bad Connection)
Powers up with 'PRESS PLAY ON TAPE' message and the display blanks.	Check U7 (6510 MPU) R1 (Possible Bad Connection)
On power up the cursor locks up.	Check U7 (6510 MPU) U20 (556 IC)
When 'RETURN' is pressed after a run command, the cursor goes back to home position.	Check U3 (ROM)
Poke command does not work.	Check U3 (ROM)
Joystick does not operate correctly.	Check U1, U28 (6526 CIA)
Wrong frequency.	Check C70
No character lettering is displayed on the screen.	Check U3 (ROM) U2 (CIA)
Graphic characters instead of letters displayed.	Check U19 (VIC II)
Power up message appears but no cursor.	Check U1, U15, U7 and U4

64 TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE SOLUTION
Cursor jumps back to home position.	Check U7 (6510 MPU)
Abnormal colors appear in the letters.	Check U6 (2114 RAM) U16 (4066 IC)
Different characters are displayed and cursor is locked when turned on and off.	Check RAM
System does not reset and the 'RESTORE' key does not work.	Check U20 (556 IC)
White band scrolls down the screen. (60 HZ HUM)	Check External Power Supply VR2 (5V Regulator)
Cursor disappears after the system warms up.	Check U1 (6526 CIA)
SYNTAX ERROR displayed after system warms up.	Check RAM, U3 (ROM)
Wavy screen after the system warms up.	Check External Power Supply U31 (74LS629 IC) U30 (74LS193 IC)
The system resets when it warms up and long programs do not load.	Check U7 (6510 MPU) U3 (ROM)
Keyboard does not operate correctly when the system warms up.	Check U1 (6526 CIA) U3 (ROM)
Black band scrolls through screen when system warms up.	Check External Power Supply C90, C88, CR4 VR2 (5V Regulator)
Cassette motor keeps running.	Check U7 (6510 MPU)
Cassette motor keeps running even after a program is done loading. The TIP 29 transistor gets extremely hot and the fuse may possibly blow.	Check Cassette Port for Shorts R4 (Possibly Open)
The cursor disappears when the cassette is plugged in.	Check U7 (6510 MPU)
Cassette runs extremely slow. The program seems to load but will not run.	Check U7 (6510 MPU)

64 TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE SOLUTION
When loading from a cassette, the 'SYNTAX ERROR' message is displayed.	Check U20 (556 IC)
DEVICE NOT PRESENT ERROR is displayed when disk is used.	Check U1 (6526 CIA) U7 (6510 MPU) R28, R29, R30
Disk drives continue to search when trying to load.	Check U2 (6526 CIA)
When loading from disk and any key of the 4th row of the keyboard is pressed, the cursor goes to home position.	Check U20 (556 IC) R35 (Possible Bad Connection)
When loading from disk, a 'FILE NOT FOUND' message is displayed.	Check U4 (ROM) U2 (6526 CIA)
OUT OF MEMORY ERROR is displayed when disk is used.	Check U20 (556 IC)

C64 BOARD IDENTIFICATION

To date there are 4 versions of 64 PCB assemblies in use.

VERSION	IDENTIFYING FACTORS	PCB ASSY #	SCHEMATIC #
Original	5 pin board (CN5-Video port has 5 pins)	326298-01	326106
A (CR)	8 pin board (CN5-Video port has 8 pins)	250407-01	251138
B	8 pin board (Reduced oscillator circuit)	250425	251469
B-2	8 pin board (Reduced Osc. w/component changes)	250441-01 *	251469

- These boards are interchangeable with casework, keyboard, etc.; however, care must be taken to provide the customer with a unit that is compatible with their monitor and cable.
- When component level repairs are necessary, be certain to acquire the appropriate part for the board you are repairing. Most modulators are different, as are many of the other components.

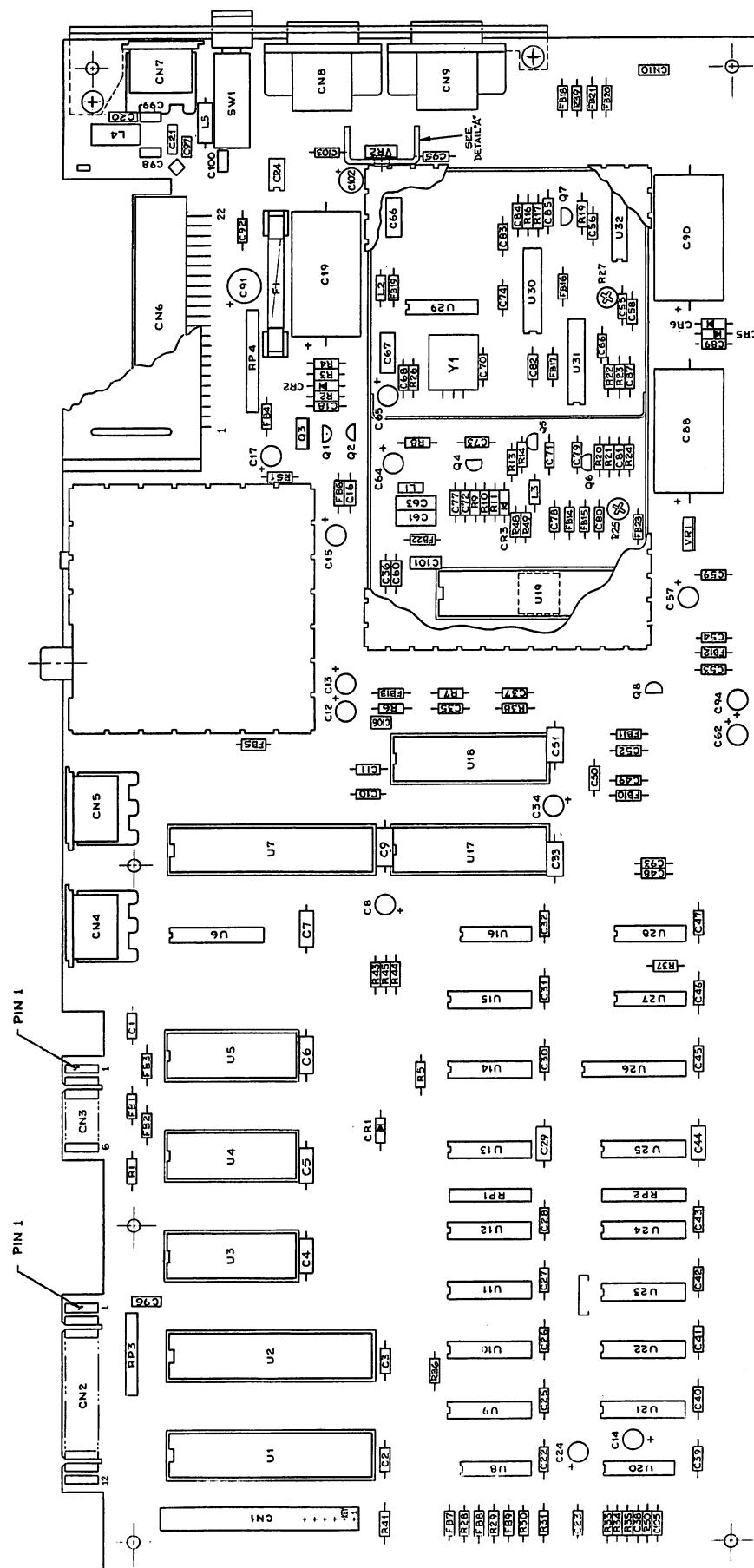
*The 4th version of 64 board was recently developed and only a few may be in the field. It is termed the 64B-2. All circuits remain the same as the 64B (Schematic 251469) with a few component location changes:

- 1) Resistors 28, 29, 30, 36, 48 were reduced to Resistor Pack RP5.
- 2) Diodes CR100-105 are no longer piggybacked. Their new locations are CR9, 12-16.

C64C BOARD IDENTIFICATION

VERSION	IDENTIFYING FACTORS	PCB ASSY#	SCHEMATIC #
B-3	Only 2 RAM chips U9, U10	250446	252278
E	KERNAL/BASIC ROMS Combined into U4 New IC memory controller, U8	250469	252312

BOARD LAYOUT #326298-01



PARTS LIST — PCB ASSEMBLY #326298

C — Indicates Commodore Stocked Part Numbers

INTEGRATED CIRCUITS			RESISTORS (Continued)			
U1,U2	6526 CIA	C 906108-01	R14	100	R30	1K
U3	2364 Basic ROM	C 901226-01	R16	1K	R31	180
U4	2364 Kernal ROM	C 901227-03	R17	1.2K	R33	47K
U5	2332 Char ROM	C 901225-01	R19	15K	R34	47K
U6	2114L-30 RAM	901453-01	R20	6.8K	R35	470K
U7	6510 μ Processor	C 906107-01	R21	4.7K	R37	2.7K
U8	7406	901522-06	R22	1.5K	R38	1K
U9-U12	4164 (200 nS)	901505-01	R23	1K	R39	390
U13	74LS257	901521-57	R24	3.3K	R41	1M
U14	74LS258	901521-58	R25	Pot 1K	R43	3.3K
U15	74LS139	901521-18	R26	75	R44	3.3K
U16	4066	901502-01	R27	Pot 2K	R45	3.3K
U17	82S100 PLA	C 906114-01	R28	1K	R46	2K
U18	6581 SID	C 906112-01	R29	1K	R51	1.5K
U19	6567 VIC II	C 906109-04	NOTE: The input video line requires a 470 ohm, 1/4 watt, resistor soldered to ground.			
U20	LM556	901523-03	RESISTOR PACKS			
U21-U24	4164 (200 nS)	901505-01	RP1,2	33 Ω , 8 Pin (Bourns No. 4308R-102-330)		
U25	74LS257	901521-57	RP3	3.3K Ω , 8 Pin (Bourns No. 4308R-101-332)		
U26	74LS373	901521-29	RP4	3.3K Ω , 10 Pin		
U27	74LS08	901521-03	CAPACITORS			
U28	4066	901502-01	C1-3	Ceramic	.1 μ F, 50V	
U29	74LS74	901521-06	C4-7	Ceramic	.47 μ F, 50V, 20%	
U30	74LS193	901521-26	C8	Electrolytic	10 μ F, 25V, +50%, -10%	
U31	74LS629	901521-68	C9	Ceramic	.47 μ F, 50V, 20%	
U32	MC4044	906128-01	C10,11	Ceramic	470 pF, 50V	
TRANSISTORS				C12-15	Electrolytic	10 μ F, 25V, +50%, -10%
Q1	2N4401	902652-01	C16	Ceramic	.1 μ F, 50V	
Q2	2N3904	902658-01	C17	Electrolytic	10 μ F, 25V, +50%, -10%	
Q3	TIP29 B	902653-01	C18	Ceramic	.1 μ F, 50V	
Q4-8	2N2222	902686-01	C19	Electrolytic	2200 μ F, 16V	
DIODES				C20,21	Film	.22 μ F, 100V, 20%
CR1	2.7V Zener IN4371		C22	Ceramic	.1 μ F, 50V	
CR2	7.5V Zener IN755		C23	Ceramic	360 pF, 50V	
CR3	IN914		C24	Electrolytic	10 μ F, 25V, +50%, -10%	
CR4	Bridge, Varo VM08	906129-01	C25-28	Ceramic	.22 μ F, 50V	
CR5,6	Rectifier IN4001		C29	Ceramic	.47 μ F, 50V, 20%	
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.				C30,31,32	Ceramic	.1 μ F, 50V
R1	3.3K	R7	10K	C33	Ceramic	.47 μ F, 50V, 20%
R2	1.5K	R8	390	C34	Electrolytic	10 μ F, 25V, +50%, -10%
R3	10K	R9	75	C35	Ceramic	.1 μ F, 50V
R4	1K	R10	120	C36	Ceramic	20 pF, 50V
R5	560	R11	120	C37	Ceramic	1000 pF, 50V
R6	1K	R13	1K			

PARTS LIST — PCB ASSEMBLY #326298 (Continued)

C — Indicates Commodore Stocked Part Numbers

CAPACITORS (Continued)			CAPACITORS (Continued)		
C38	Ceramic	.51 pF, 50V	C94	Electrolytic	.10 μ F, 25V, +50%, -10%
C39	Ceramic	.1 μ F, 50V	C95,96	Ceramic	.1 μ F, 50V
C40-43	Ceramic	.22 μ F, 50V	C97	Ceramic	.22 μ F, 25V
C44	Ceramic	.47 μ F, 50V, 20%	C98,99	Ceramic	.1 μ F, 50V, 20%
C45,46,47	Ceramic	.1 μ F, 50V	C100	Ceramic	.22 μ F, 25V
C48	Ceramic	1800 pF, 50V	C101	Ceramic	.1 μ F, 50V, 20%
C49	Ceramic	470 pF, 50V	C102	Electrolytic	.10 μ F, 25V, +50%, -10%
C50	Ceramic	.22 μ F, 50V	C103	Ceramic	.1 μ F, 50V
C51	Ceramic	.47 μ F, 50V, 20%	C105	Ceramic	.1 μ F, 50V
C52,53	Ceramic	470 pF, 50V			
C54	Ceramic	.22 μ F, 50V			
C55	Ceramic	.1 μ F, 50V			
C56	Ceramic	.1 μ F, 50V			
C57	Electrolytic	10 μ F, 25V, +50%, -10%			
C58	Ceramic	.1 μ F, 50V			
C59	Ceramic	.22 μ F, 50V			
C60,61	Ceramic	.47 μ F, 50V, 20%			
C62	Electrolytic	10 μ F, 25V, +50%, -10%			
C63	Ceramic	.47 μ F, 50V, 20%			
C64,65	Electrolytic	10 μ F, 25V, +50%, -10%			
C66,67	Ceramic	.47 μ F, 50V, 20%	L1,2	Coil Inductor 2.2 μ H	901151-17
C68	Ceramic	.1 μ F, 50V	L3	Coil Inductor 3.0 μ H	901151-21
C69			L4	Line Filter Assy	C 906127-01
C70	Mica	10 pF, 500V, 5%	L5	Coil Inductor 1.2 μ H	901152-01
C71	Ceramic	.1 μ F, 50V	Y1	Crystal 14.31818 MHz	C 900558-01
C72	Ceramic	220 pF, 50V	SW1	Rocker Switch DPDT	C 904500-01
C73	Ceramic	150 pF, 50V	VR1	Voltage Regulator MC7812CT	901527-01
C74	Ceramic	.1 μ F, 50V	VR2	Voltage Regulator MC7805CT	901527-02
C77	Ceramic	.1 μ F, 50V	M1	Modulator	C 326130-01
C78	Ceramic	220 pF, 50V	F1	Fuse, Normal Blo, 250V, 1.5A	
C79	Ceramic	510 pF, 50V	FB1-23	Ferrite Bead	903025-01
C80	Ceramic	51 pF, 50V		Connector Panel (ON, OFF, Joystick)	326299-01
C81	Ceramic	20 pF, 50V		Cartridge Guide	326116-01
C82	Ceramic	.1 μ F, 50V		Shield Box	C 326265-01
C83	Mica	33 pF, 500V, 5%		Shield Cap	C 326267-01
C84	Ceramic	.1 μ F, 50V			
C85	Ceramic	.47 μ F, 50V, 20%			
C86	Mica	39 pF, 500V, 5%			
C87	Ceramic	.1 μ F, 50V			
C88	Electrolytic	470 μ F, 50V			
C89	Ceramic	.1 μ F, 50V			
C90	Electrolytic	470 μ F, 50V			
C91	Electrolytic	100 μ F, 16V			
C92	Ceramic	.22 μ F, 50V			
C93	Ceramic	1800 pF, 50V			

U1, U2 – 906108-01
6526 COMPLEX INTERFACE
ADAPTER (CIA)

**PIN
ASSIGNMENT**

GND	1	40	CNT
PA0	2	39	SP
PA1	3	38	RS0
PA2	4	37	RS1
PA3	5	36	RS2
PA4	6	35	RS3
PA5	7	34	RES
PA6	8	33	DB0
PA7	9	32	DB1
PB0	10	31	DB2
PB1	11	30	DB3
PB2	12	29	DB4
PB3	13	28	DB5
PB4	14	27	DB6
PB5	15	26	DB7
PB6	16	25	Q2
PB7	17	24	FLAG
PC	18	23	CS
TOD	19	22	R/W
VCC	20	21	IRQ

1	VSS	Ground Connection.
2-9	PA0-PA7	Parallel port a signals. Bidirectional parallel port.
10-17	PBO-PB7	Parallel port b signals. Bidirectional parallel port.
18	PC	Handshake output. A low pulse is generated after a read or write on port b.
19	TOD	Time of day clock input. Programmable 50hz or 60hz input.
20	VCC	5VDC input.
21	IRQ	Interrupt output to microprocessor input IRQ.
22	R/W	READ/WRITE input from microprocessor's R/W output.
23	CS	Chip select input. A low pulse will activate CIA.
24	FLAG	Negative edge sensitive interrupt input. Can be used as a handshake line for either parallel port.
25	O2	O2 clock input. Connected to processor common O2 clock.
26-33	DB0-DB7	Bidirectional data bus. Connects to processor data bus.
34	RES	Low active reset input. Initializes CIA.
35-38	RS0-RS3	Register select inputs. Used to select all internal registers for communications with the parallel ports, time of day clock, and serial port (SP).
39	SP	Serial Port bidirectional connection. An internal shift register converts microprocessor parallel data into serial data, and visa-versa.
40	CNT	Count input. Internal timers can count pulses applied to this input. Can be used for frequency dependent operations.

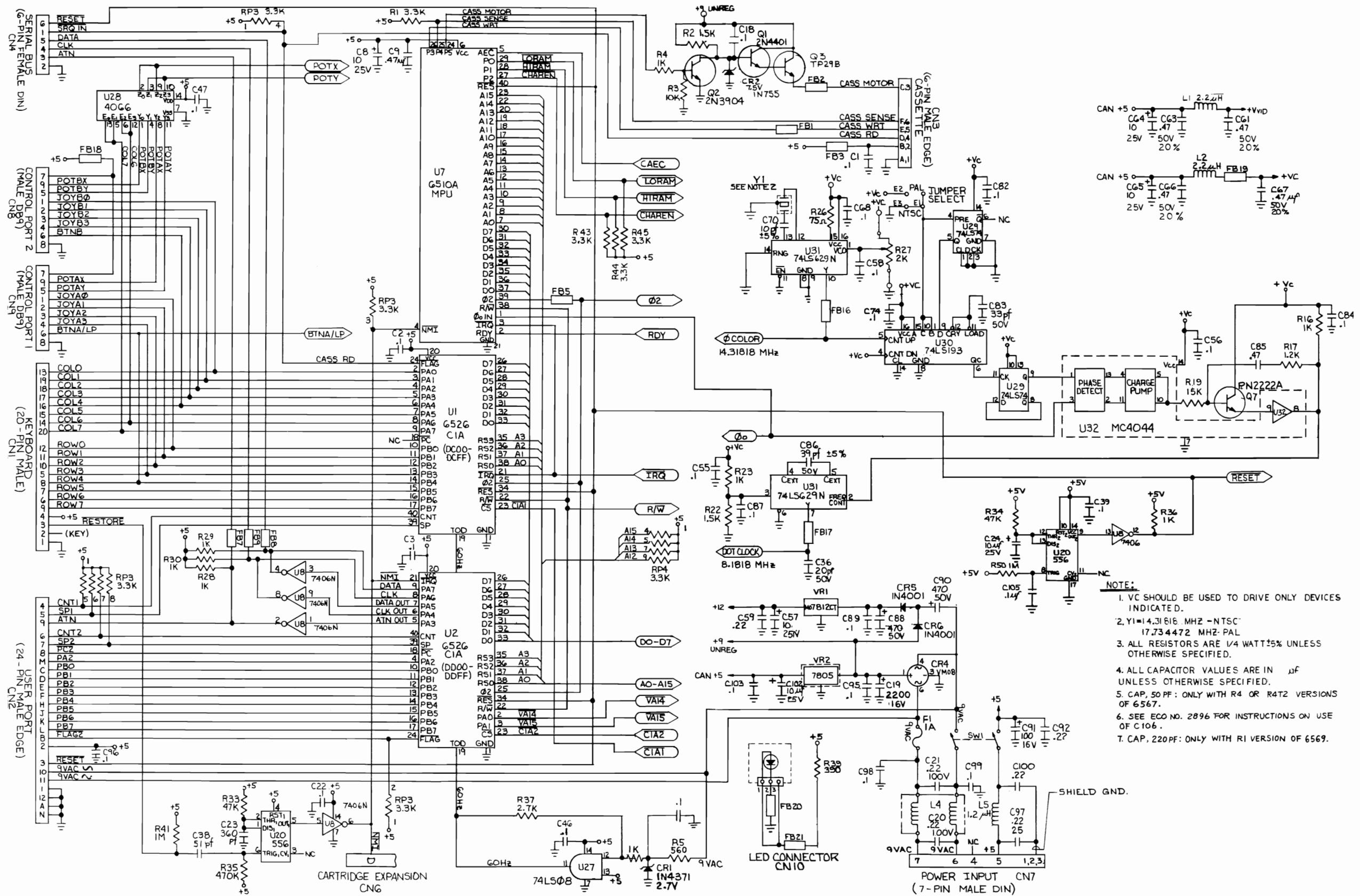
U18 – 906112-01
6581 SOUND INTERFACE
DEVICE (SID)

**PIN
ASSIGNMENT**

CAP	1A	28	12V
CAP	1B	27	A.OUT
CAP	2A	26	EXT IN
CAP	2B	25	5V
RES	5	24	POT X
Q2	6	23	POT Y
R/W	7	22	D7
CS	8	21	D6
A0	9	20	D5
A1	10	19	D4
A2	11	18	D3
A3	12	17	D2
A4	13	16	D1
GND	14	15	D0

1,2, 3,4	CAP1A,1B 2A, 2B	Capacitor filter connections.
5	RES	Reset input. A low pulse initializes the SID.
6	O2	Processor phase 2 clock input.
7	R/W	Processor read/write input.
8	CS	Chip select input.
9-13	A0-A4	Address lines from processor.
14	GND	Dc ground connection.
15-22	D0-D7	Data Bus connections.
23	POT Y	Input to a A/D converter used to detect the value of a variable resistor. Commonly connected to game paddles.
24	POT X	Same as POT Y.
25	VCC	5VDC.
26	EXT IN	External audio input.
27	Audio out	Audio output. Should be AC coupled to audio amp.
28	Vdd	12VDC.

SCHEMATIC #326106 SHEET 1 OF 2

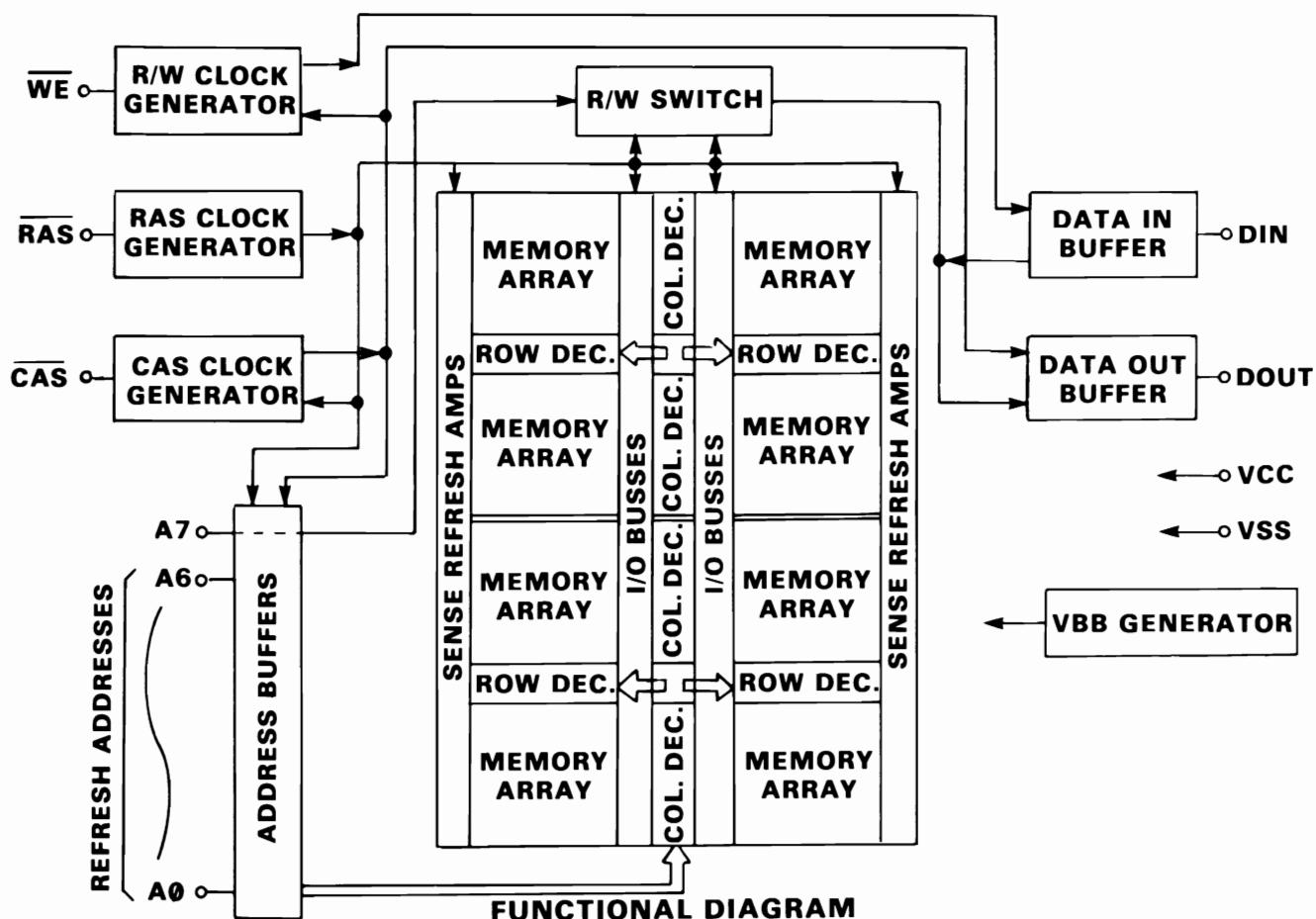


PIN CONFIGURATION

NC	1	16	VSS
DIN	2	15	CAS
WE	3	14	DOUT
RAS	4	13	A6
A0	5	12	A3
A2	6	11	A4
A1	7	10	A5
VCC	8	9	A7

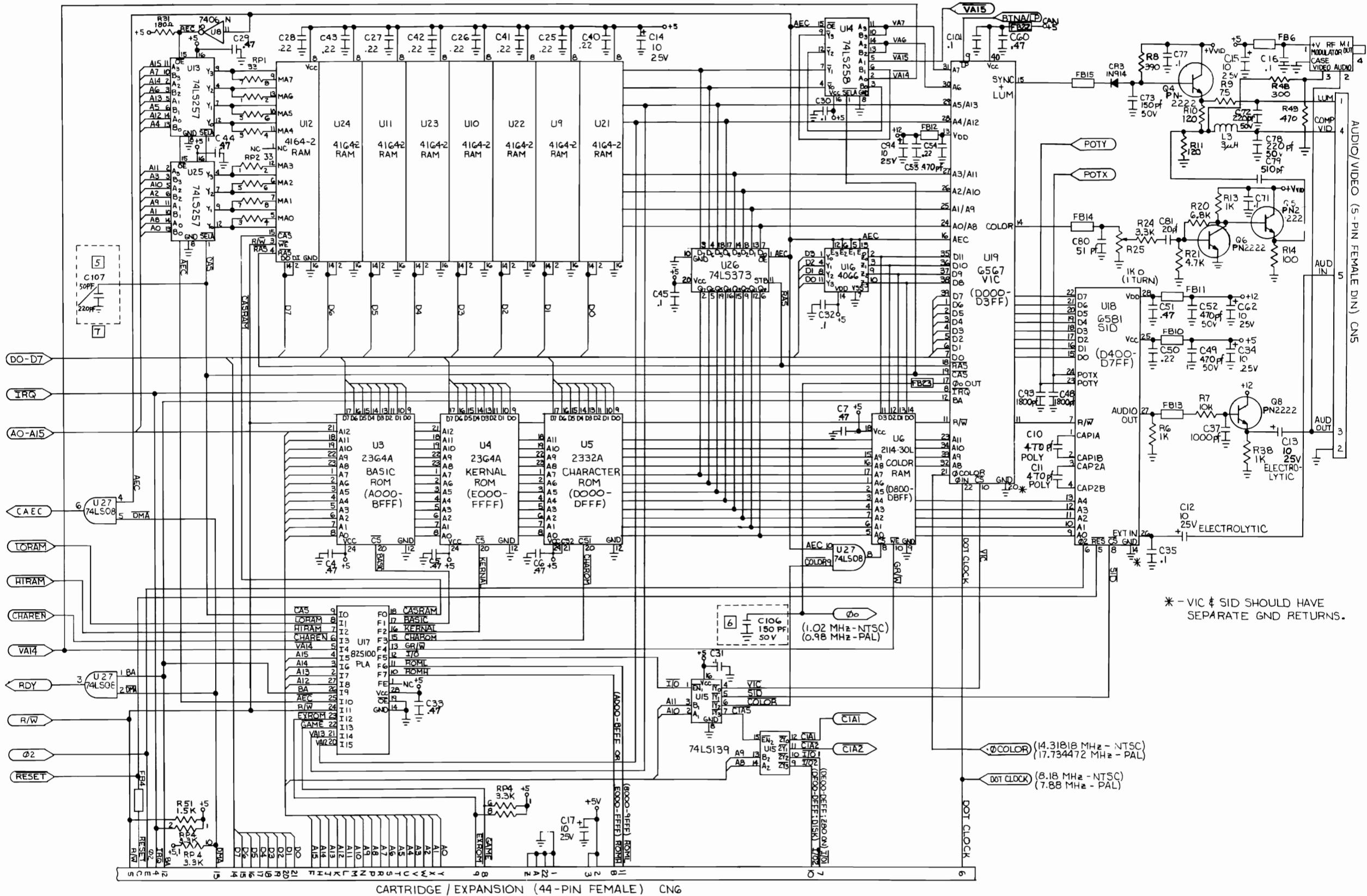
**U9 ~ 12, U21 ~ 24
64K DYNAMIC RAM
901505-01**

COMMODORE PART NUMBER	APPROVED SOURCE 1 OF SUPPLY	VENDOR PART NUMBER	ACCESS TIME (ns)	CYCLES (ns)	POWER	
					ACTIVE (MW)	STANDBY (MAX) (MW)
901505-01	HITACHI	HM4864-3	200	335	330	20
901505-01	NEC	μ PD4164-2	200	375	250	28
901505-01	MITSUBISHI	M5K416NS-20	200	330	275	28
901505-01	MOSTEK	MK4564N-20	200	345	300	22
901505-01	OKI	MSM3764-20	200	330	248	23
901505-01	HITACHI	HM4864P-3	200	335	330	20
901505-01	MATSUSHITA (PANASONIC)	MN4164P-20	200	330	275	27.5
901505-01	SIEMENS	HYB4164-3	200	330	150	20
901505-01	SHARP	LH2164-Z1	200	330	248	28
901505-01	HITACHI	HM4864AP-3	200	330	242	20
901505-01	TOSHIBA	TMM4164AP-20	200	330	275	22

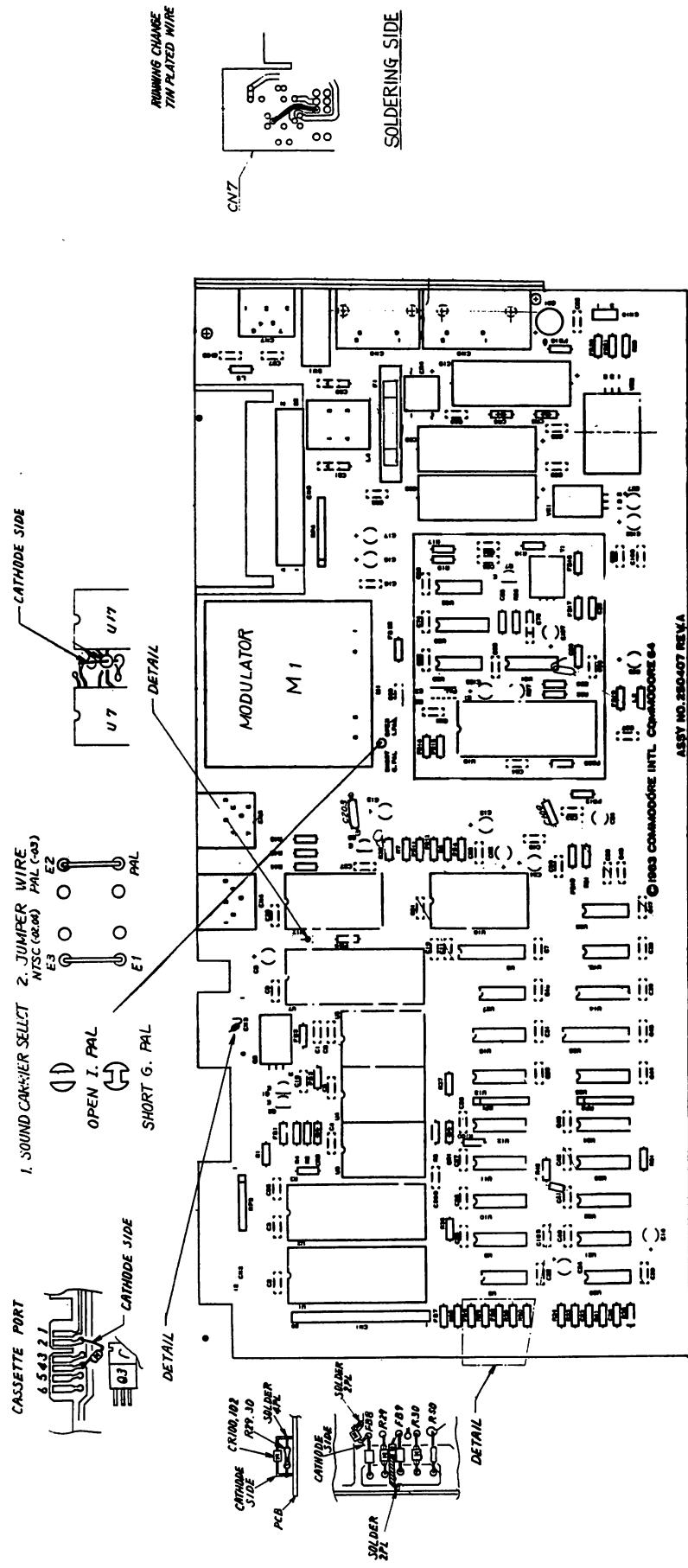


FUNCTIONAL DIAGRAM

SCHEMATIC #326106 SHEET 2 OF 2



BOARD LAYOUT #250407-04



- 4** TO FIX HEATSINK TO VOLTAGE REGULATOR SCREW M3 X10 AND NUT HEXAGON M3 ARE USED. EYELET CAN SUBSTITUTE.

5 R101, IT IS SUITABLE FOR 6569 REV.1 AND 6567 REV.5. DO NOT USE FOR 6567 REV.8 OR 6569 REV.3.

6 C204, IT IS SUITABLE FOR MBM112A/10 C203, IT IS SUITABLE FOR 6569 REV.1 BUT WHEN USE 251103 (UTI ITEM 186), DO NOT USE THIS CAPACITOR.

7 R101, IT IS SUITABLE FOR 6569 REV.1 AND 6567 REV.5. DO NOT USE FOR 6567 REV.8 OR 6569 REV.3.

PARTS LIST — PCB ASSEMBLY #250407-04

C — Indicates Commodore Stocked Part Number

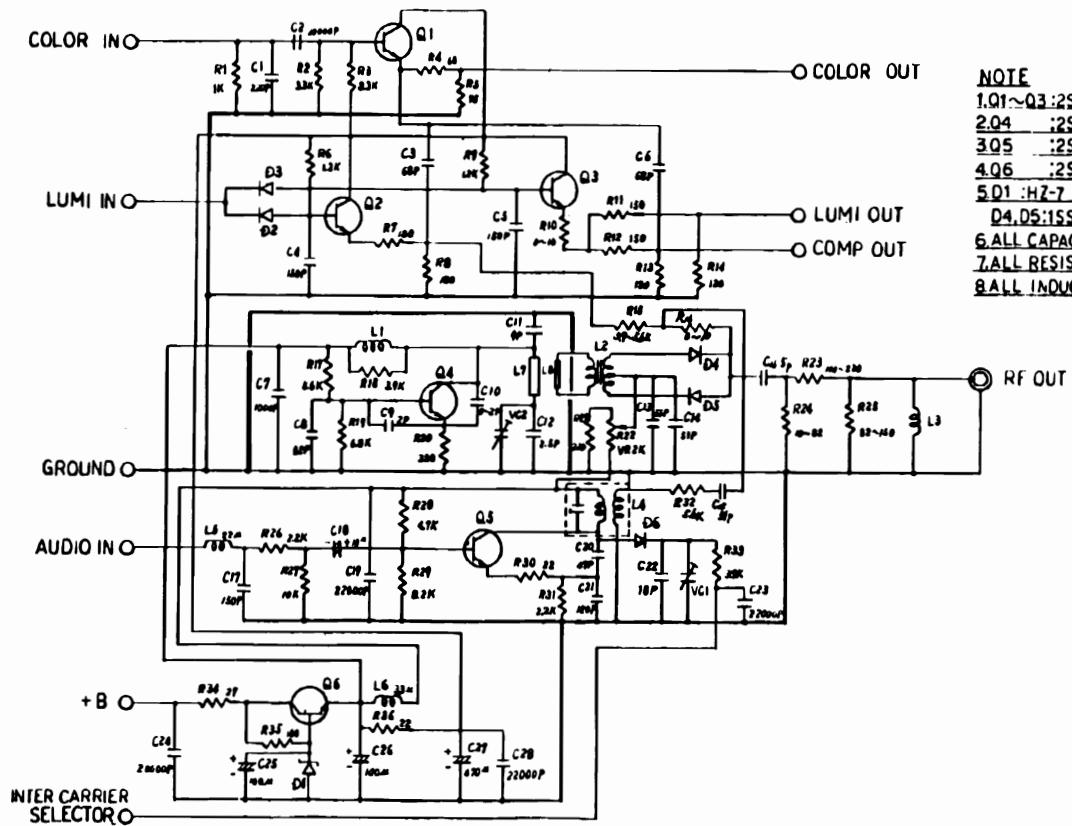
INTEGRATED CIRCUITS			RESISTORS (Continued)			
U1,U2	6526 CIA	C 906108-01	R26	Jumper Wire	R39	390
U3	2364 Basic ROM	C 901226-01	R27	Pot 500Ω	R41	1M
U4	2364 Kernal ROM	C 901227-03	R28	1K	R42	82
U5	2332 Char ROM	C 901225-01	R29	1K	R43	3.3K
U6	2114L-20 RAM	901453-01	R30	1K	R44	3.3K
U7	6510 μ Processor	C 906107-01	R31	180	R45	3.3K
U8	7406	901522-06 sub:	R33	47K	R50	1M
	7416	901522-14	R34	47K	R51	1.5K
U9-U12	4164 (200 nS)	901505-01	R35	470K	R52	300
U13	74LS257	901521-57	R36	1K	R53	390
U14	74LS258	901521-58	R37	2.7K	R100	1K
U15	74LS139	901521-18	R38	1K	R101	22K
U16	4066	901502-01				
U17	82S100 PLA	C 906114-01				
U18	6581 SID	C 906112-01				
U19	6567 VIC II	C 906109-04				
U20	LM556	901523-03				
U21-U24	4164 (200 nS)	901505-01				
U25	74LS257	901521-57				
U26	74LS373	901521-29				
U27	74LS08	901521-03				
U28	4066	901502-01				
U29	74LS74	901521-06				
U30	74LS193	901521-26				
U31	74LS629	901521-68				
U32	MC4044	906128-01				
TRANSISTORS						
Q1,2	2SC1815	C 902693-01 sub:				
Q3	TIP29 A	902653-01				
Q7,8	2SC1815	C 902693-01				
DIODES						
CR1	2.7V Zener IN4371	906103-02				
CR2	7.5V Zener IN755	900941-01				
CR4	Bridge S2VB10	C 251026-01				
	DBA20B	C 251026-02				
	DBA20C	C 251026-03				
CR5,6	Rectifier IN4001	900750-01				
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.						
R1	3.3K	R6	1K			
R2	1.5K	R7	10K			
R3	10K	R16	1K			
R4	1K	R17	2.7K			
R5	560	R19	15K			
RESISTOR PACKS						
RP1,2	33Ω, 8 Pin (Bourns No. 4308R-102-330)					
RP3	3.3KΩ, 8 Pin (Bourns No. 4308R-101-332)					
RP4	3.3KΩ, 10 Pin					
CAPACITORS						
C1-7	Ceramic	.1 μF, 25V				
C8	Electrolytic	10 μF, 25V, + 50%, - 10%				
C9	Ceramic	.1 μF, 25V				
C10,11	Ceramic	470 pF, 50V, 10%				
C12	Ceramic	.1 μF, 25V				
C13,14,15	Electrolytic	10 μF, 25V, + 50%, - 10%				
C16	Ceramic	.1 μF, 25V				
C17	Electrolytic	10 μF, 25V, + 50%, - 10%				
C18	Ceramic	.1 μF, 25V				
C19	Electrolytic	2200 μF, 16V				
C20,21	Film	.22 μF, 100V, 20%				
C22	Ceramic	.1 μF, 25V				
C23	Ceramic	360 pF, 50V, 10%				
C24	Electrolytic	10 μF, 25V, + 50%, - 10%				
C25-33	Ceramic	.1 μF, 25V				
C34	Electrolytic	10 μF, 25V, + 50%, - 10%				
C35	Ceramic	.1 μF, 50V				
C36	Ceramic	20 pF, 50V, 5% SL				
C37	Ceramic	1000 pF, 50V, 10% B				
C38	Ceramic	51 pF, 50V, 5% SL				
C39-47	Ceramic	.1 μF, 25V				
C48	Ceramic	1800 pF, 50V, 10% B				
C49-54	Ceramic	.1 μF, 25V				
C55	Ceramic	.1 μF, 50V				
C56	Ceramic	.1 μF, 25V				
C57	Electrolytic	10 μF, 25V, + 50%, - 10%				
C58	Ceramic	.1 μF, 50V				

PARTS LIST – PCB ASSEMBLY #250407-04 (Continued)

C – Indicates Commodore Stocked Part Number

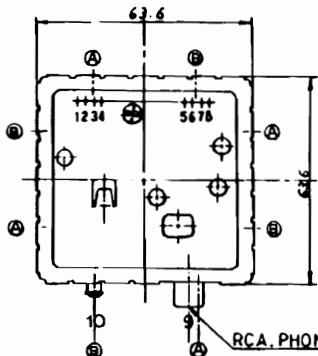
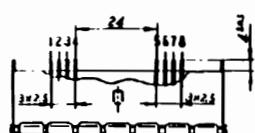
CAPACITORS (Continued)			CONNECTORS		
C59,60	Ceramic	.1 μ F, 25V	CN1	Header Assy, 20 Pin	903331-20
C62,65	Electrolytic	10 μ F, 25V, +50%, -10%	CN4	6 Pin Din	C 903361-01
C66,67,68	Ceramic	.1 μ F, 25V	CN5	8 Pin Din	C 325573-01
C70	Film	16 pF, 5%	CN6	44 Pin Card Edge	C 906100-02
C74,82	Ceramic	.1 μ F, 25V	CN7	7 Pin Din	C 251116-01
C83	Ceramic	82 pF, 5%	CN8,9	Plug Assy, 9 Pin MINID	C 906126-01
C84	Ceramic	.1 μ F, 25V	CN10	Header Assy, 3 Pin	903332-03
C85	Ceramic	.47 μ F, 50V, 10%			
C88	Electrolytic	1000 μ F, 25V			
C89	Ceramic	.1 μ F, 25V	L2	Coil Inductor 2.2 μ H	901151-17
C90	Electrolytic	470 μ F, 50V	L4	Coil Inductor 1.2 μ H	325570-01
C91	Electrolytic	100 μ F, 16V, +50%, -10%	L5	Choke Coil	C 325559-02
C92	Ceramic	.1 μ F, 25V	Y1	Crystal 14.31818 MHz	C 900558-01
C93	Ceramic	1800 pF, 50V, 10% B	SW1	Rocker Switch DPDT	904500-01
C94	Electrolytic	10 μ F, 25V, +50%, -10%	VR1	Voltage Regulator MC7812CT	901527-01
C95,96	Ceramic	.1 μ F, 25V	VR2	Voltage Regulator MC7805CT	901527-02
C97	Ceramic	.22 μ F, 25V	M1	Modulator	C 251080-01
C98,99	Ceramic	.1 μ F, 50V, +80%, -20%	F1	Fuse, Normal Blo, 250V, 1.5A	
C100	Ceramic	.22 μ F, 25V	FB1-5	Ferrite Bead	903025-01
C101	Ceramic	.1 μ F, 50V, +80%, -20%	FB7-23		
C102	Electrolytic	10 μ F, 25V, +50%, -10%		Connector Panel (Power, ON, OFF)	251095-01
C103	Ceramic	.1 μ F, 25V		Cartridge Guide	326116-01
C104	Ceramic	.1 μ F, 25V		Shield Box	C 251023-01
C105	Ceramic	.1 μ F, 25V		Shield Cap	C 251024-01
C108	Electrolytic	10 μ F, 25V, 20%			
C200	Ceramic	.1 μ F, 25V			

MODULATOR SCHEMATIC #251025

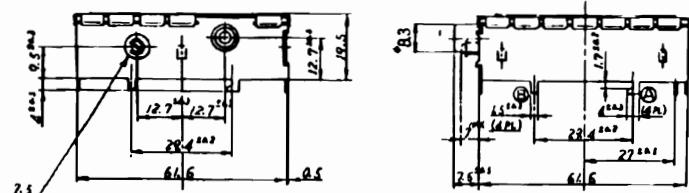
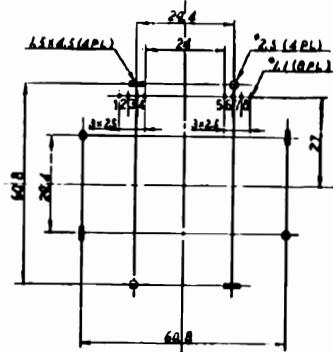


NOTE

- 1.01 ~Q3 :2SC1684 OR EQUIVALENT
 2.04 :2SC1730 OR EQUIVALENT
 3.05 :2SC460 OR EQUIVALENT
 4.06 :2SC2120 OR EQUIVALENT
 5.01 :H27-2, D3: ISS119
D4.05: ISS86 OR ISS174 D6: ISS11Q
6. ALL CAPACITANCE VALUES : F
7. ALL RESISTANCE VALUES : Ω
8. ALL INDUCTANCE VALUES : H



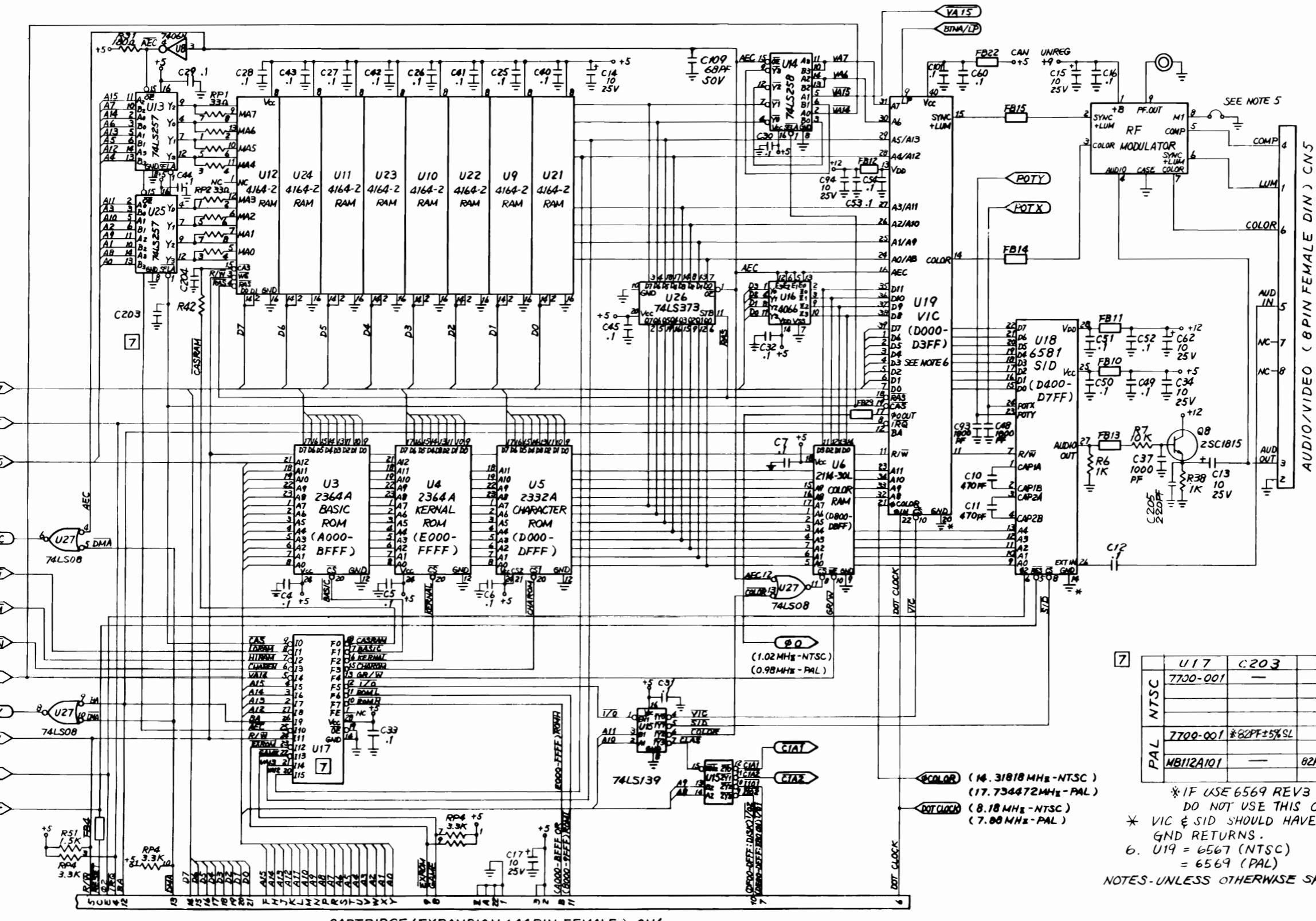
NO	TERMINALS
1	+B
2	SYNC + LUM SIG. INPUT
3	COLOR SIG. INPUT
4	AUDIO SIG. INPUT
5	COMP. SIG. OUTPUT
6	SYNC + LUM SIG. OUTPUT
7	COLOR SIG. OUTPUT
8	INTER CARRIER SELECTOR
9	RF. OUTPUT
10	CHANNEL TRIMMER



NOTE

1. RECOMMENDED P.C.B. HOLE CENTERS
(COMPONENT SIDE)
2. ALL DIMENSION ARE IN MILLIMETERS
3. NO.8 TERMINAL SHORT = G.P.A.L
OPEN = I.P.A.L

SCHEMATIC #251138 SHEET 1 OF 2



U7 – 906107-01
6510 MICROPROCESSOR

**PIN
ASSIGNMENT**

Q1	1	40	—RES
RDY	2	39	—Q2
IRQ	3	38	—R/W
NMI	4	37	—DB0
AEC	5	36	—DB1
VCC	6	35	—DB2
A0	7	34	—DB3
A1	8	33	—DB4
A2	9	32	—DB5
A3	10	31	—DB6
A4	11	30	—DB7
A5	12	29	—PO
A6	13	28	—P1
A7	14	27	—P2
A8	15	26	—P3
A9	16	25	—P4
A10	17	24	—P5
A11	18	23	—A15
A12	19	22	—A14
A13	20	21	—GND

1	01	Phase 1 clock input. This clock input is used to develop the internal overlapping phase 2 clock. 1 MegHz or 2 MegHz speeds.
2	RDY	Single step operation input. A low applied will cause the processor to halt. The current address line being fetched will be on the address bus. Can also be used to interface slower devices to the microprocessor.
3	IRQ	Interrupt request input. When a low pulse is applied a jump to a location specified by the contents of FFFE and FFFF will occur to service the interrupt, if the interrupt mask flag is not set. This is a maskable interrupt.
4	NMI	Non-maskable interrupt input. A low transition will cause a jump to a location specified by FFFA and FFFB to a subroutine which will service the interrupt.
5	AEC	Address enable control input. A low applied to will cause the address bus to enter hi impedance state, so other devices can control the address bus.
6	VCC	5VDC input.
7-20	A0-A15	Address bus outputs. Unidirectional bus used to address memory and I/O devices. The address bus can be disabled by controlling the AEC input.
22,23		Dc ground connection.
21	GND	I/O bidirectional port. This port can be controlled via memory locations 0000 and 0001. 0001 = Output register 0000 = Data direction register
24-29	PO-P5	Bidirectional data bus. This is the bus that passes the data to or from any I/O device or memory.

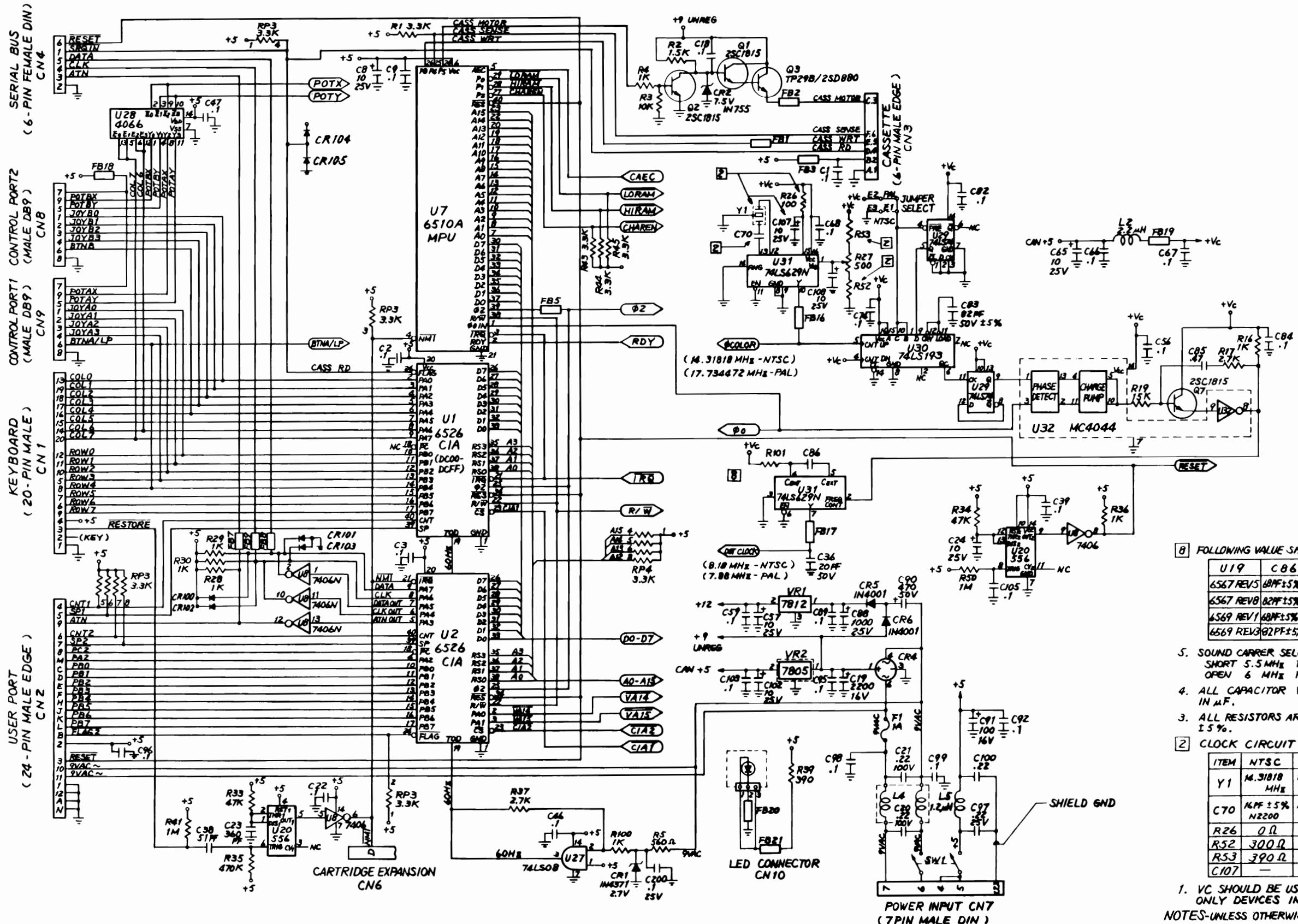
**PIN
ASSIGNMENT**

PE +	1	28	—VCC
I7	2	27	—I8
I6	3	26	—I9
I5	4	25	—I10
I4	5	24	—I11
I3	6	23	—I12
I2	7	22	—I13
I1	8	21	—I14
I0	9	20	—I15
F7	10	19	—CE
F6	11	18	—F0
F5	12	17	—F1
F4	13	16	—F2
GND	14	15	—F3

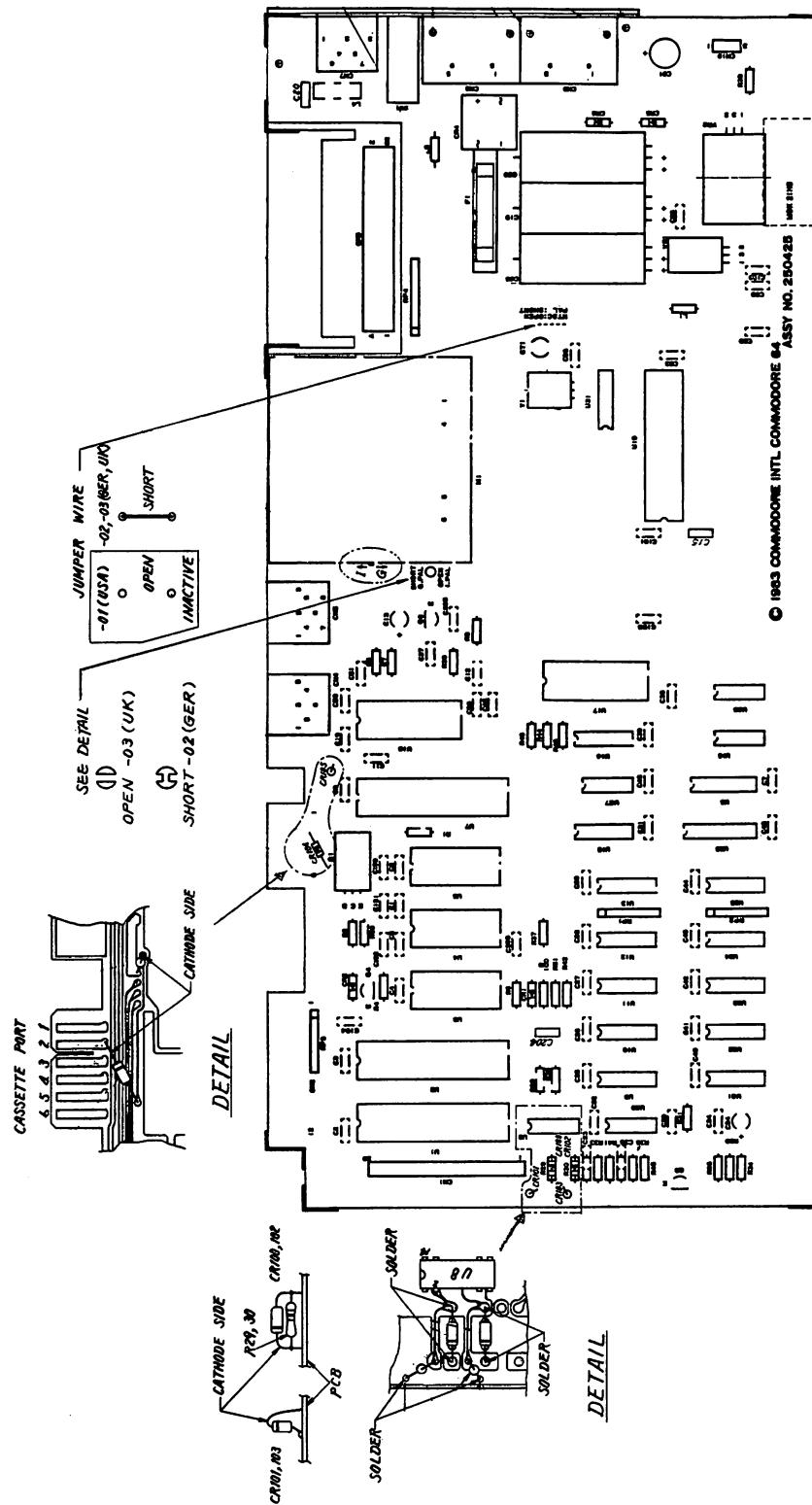
30-37	DB0-DB7	Bidirectional data bus. This is the bus that passes the data to or from any I/O device or memory.
38	R/W	Read/Write output. The processor generates a low level when writing, and a high level when reading. This signal is usually decoded for read or write operations to memory or I/O.
39	O2	Phase 2 output. The processor generates this clock signal from the phase 1 clock applied. The two clock signals are 180 degrees out of phase. The phase 2 clock is used in decoding I/O and memory on the positive half cycle.
40	RES	Reset input interrupt. A low pulse causes a jump to a subroutine specified by FFFC and FFFD, which will initialize all processor controlled devices. This occurs during a power up sequence.

U17 – 906114-01
PROGRAMMABLE
LOGIC ARRAY (PLA)

SCHEMATIC #251138 SHEET 2 OF 2



BOARD LAYOUT #250425-01



MODULATOR	
SOUND SELECT	PAL
NTSC	P/N 251025-01
-02 (GER)	P/N 251025-01
-03 (UK)	-03 (UK)
JUMPER	OPEN
DON'T CARE	DON'T CARE
SWITCH	OPEN
DON'T CARE	DON'T CARE
	SOUND CARRIER SELECT

DETAIL "C" SOUND CARRIER SELECT

PARTS LIST — PCB ASSEMBLY #250425-01

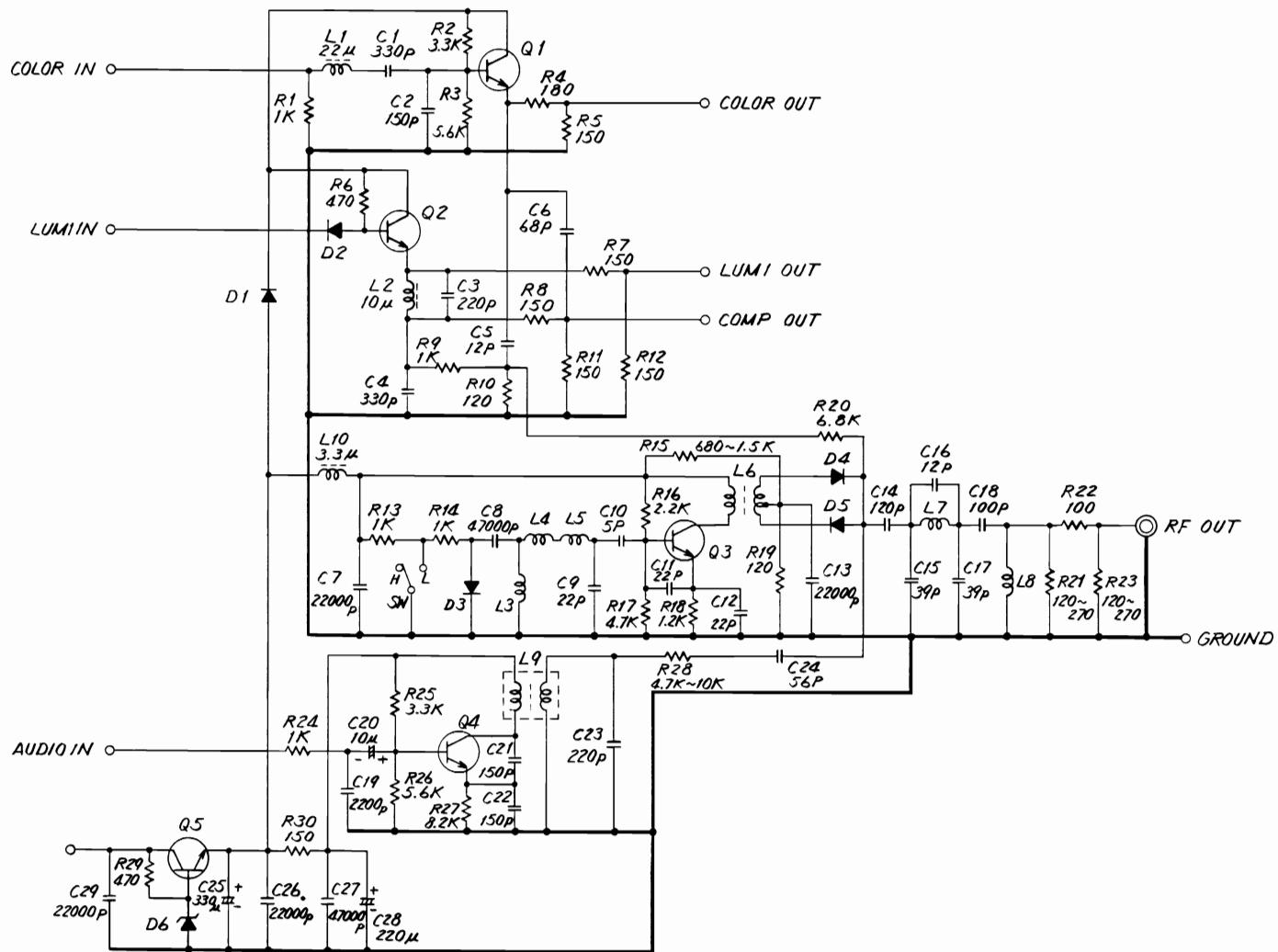
C — Indicates Commodore Stocked Part Number

INTEGRATED CIRCUITS				RESISTORS (Continued)			
U1,U2	6526 CIA	C 906108-01		R39	390	R50	1M
U3	2364 Basic ROM	C 901226-01		R41	1M	R51	1.5K
U4	2364 Kernal ROM	C 901227-03		R42	82	R60	100
U5	2332 Char ROM	C 901225-01		R43	3.3K	R100	1K
U6	2114L-20 RAM	901453-01		R44	3.3K	R101	22K
U7	6510 μ Processor	C 906107-01		R45	3.3K		
U8	7406	901522-06 sub:					
	7416	901522-14					
U9-U12	4164 (200 nS)	901505-01					
U13	74LS257	901521-57					
U14	74LS258	901521-58					
U15	74LS139	901521-18					
U16	4066	901502-01					
U17	82S100 PLA	C 906114-01					
U18	6581 SID	C 906112-01					
U19	6567 VIC II	C 906109-04					
U20	LM556	901523-03					
U21-U24	4164 (200 nS)	901505-01					
U25	74LS257	901521-57					
U26	74LS373	901521-29					
U27	74LS08	901521-03					
U28	4066	901502-01					
U31	7701/8701	C 251527-01					
TRANSISTORS				CAPACITORS			
Q1	TIP29 A	902653-01		C1-7	Ceramic	.1 μ F, 25V	
Q2-4	2SC1815	C 902693-01		C9	Ceramic	.1 μ F, 25V	
DIODES				C10,11	Ceramic	470 pF, 50V, 10%	
CR1	2.7V Zener IN4371	906103-02		C12	Ceramic	.1 μ F, 25V	
CR2	6.8V Zener IN754A			C13	Electrolytic	10 μ F, 25V, +50%, -10%	
CR4	Bridge S2V310	C 251026-01 sub:		C15	Tantalum	4.7 μ F, 16V, 20%	
	DBA20B	C 251026-02 sub:		C19	Electrolytic	2200 μ F, 16V	
	DBA20C	C 251026-03		C20	Film	.22 μ F, 100V, 20%	
CR5,6	Rectifier IN4001	900750-01		C22	Ceramic	.1 μ F, 25V	
CR9,	IN4148 sub:			C23	Ceramic	360 pF, 50V, 10% sub: 390 pF	
CR12-16, 100-105	IN914			C24	Electrolytic	22 μ F, 25V, +50%, -10%	
				C31,33,34	Ceramic	.1 μ F, 25V	
				C37	Ceramic	1000 pF, 50V, 10% B	
				C38	Ceramic	51 pF, 50V, 5% SL	
				C39-46	Ceramic	.1 μ F, 25V	
				C48	Ceramic	1800 pF, 50V, 10% B	
				C50,51,53	Ceramic	.1 μ F, 25V	
				C59	Ceramic	.1 μ F, 25V	
				C88	Electrolytic	1000 μ F, 25V	
				C90	Electrolytic	470 μ F, 50V	
				C91	Electrolytic	100 μ F, 16V, +50%, -10%	
				C93	Ceramic	1800 pF, 50V, 10% B	
				C101	Ceramic	.1 μ F, 50V, +80%, -20%	
				C102	Ceramic	.1 μ F, 25V	
				C150-152	Ceramic	470 pF, 50V, 10%	
				C153	Ceramic	68 pF, 50V, 5%	
				C154	Ceramic	470 pF, 50V, 10%	
				C200	Ceramic	.1 μ F, 25V	
				C204	Ceramic	150 pF, 50V, 10%	
				C205	Ceramic	220 pF, 50V, 5%	
				CT1	Trimmer	40 pF	
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.							
R1	3.3K	R26	3.3K				
R2	470	R31	180				
R3	100K	R33	47K				
R4	1K	R34	47K				
R5	560	R35	470K				
R6	1K	R37	2.7K				
R7	10K	R38	1K				

PARTS LIST — PCB ASSEMBLY # 250425-01 (Continued)**C — Indicates Commodore Stocked Part Number**

CONNECTORS			MISCELLANEOUS (Continued)		
CN1	Header Assy, 20 Pin	903331-20	SW1	Rocker Switch DPDT	904500-01
CN4	6 Pin Din	C 903361-01	VR1	Voltage Regulator MC7812CT	901527-01
CN5	8 Pin Din	C 325573-01	VR2	Voltage Regulator MC7805CT	901527-02
CN6	44 Pin Card Edge	C 906100-02	M1	Modulator	C 251696-01
CN7	7 Pin Din	C 251116-01		Connector Panel (Power, ON, OFF)	251095-01
CN8,9	Plug Assy, 9 Pin MINID	C 251057-01		Cartridge Guide	326116-01
CN10	Header Assy, 3 Pin	903332-03	F1	Fuse, Normal Blo, 250V, 1.5A	
MISCELLANEOUS					
L1	Coil Inductor 2.2 μ H	901151-17			
L4	Line Filter Assy	C 251701-01			
L5	Coil Inductor 1.2 μ H	901152-01			
Y1	Crystal 14.31818 MHz	C 251467-01			

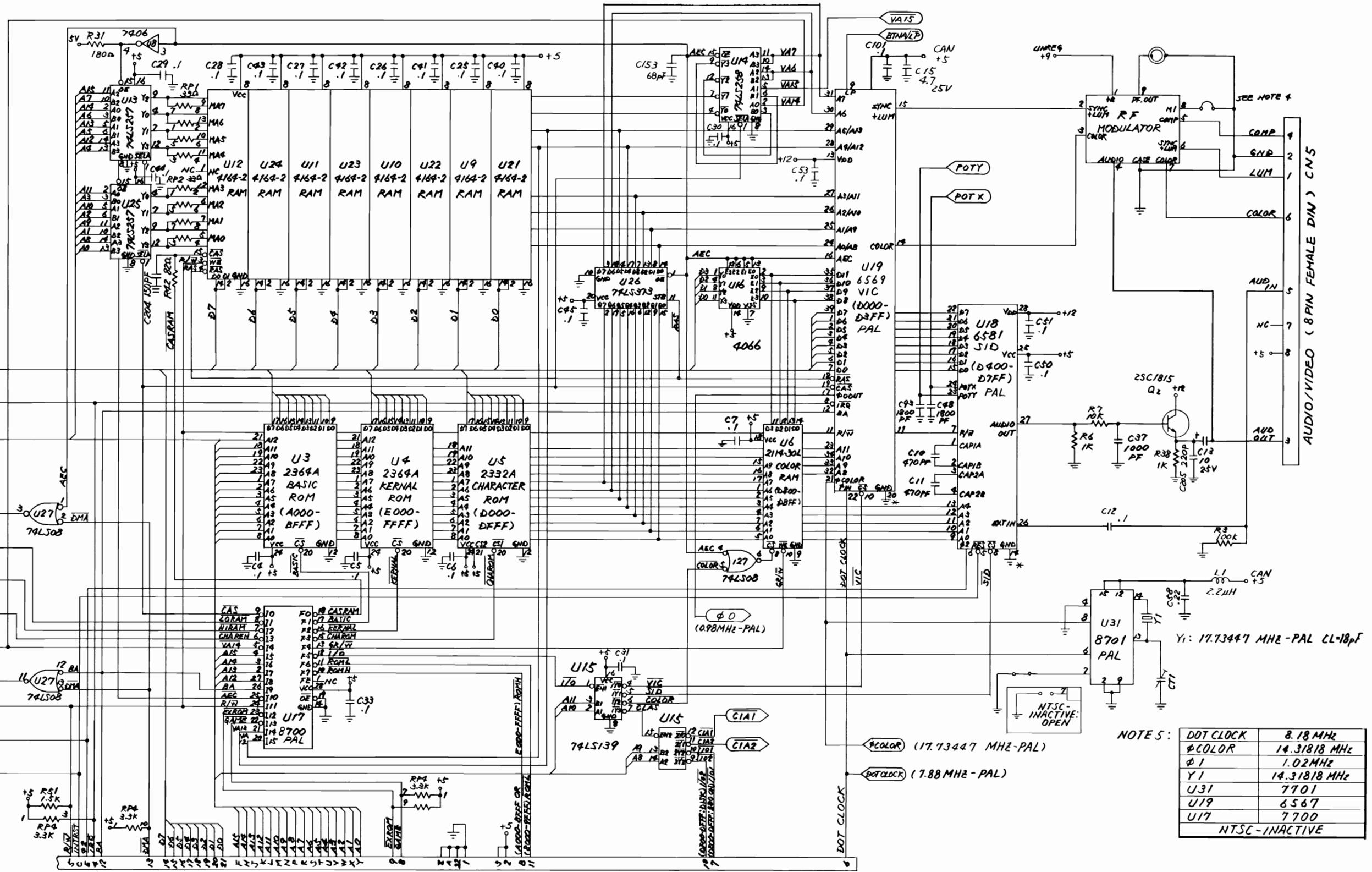
MODULATOR SCHEMATIC #251696



NOTES

1. D1, D2 : MA151K OR EQUIVALENT
2. D3 : MAST OR EQUIVALENT
3. D4, D5 : ISS198 OR EQUIVALENT
4. D6 : HZ-7A1 OR EQUIVALENT
5. Q1, Q2 : ZSC2405 OR EQUIVALENT
6. Q3, Q4 : ZSC2778 OR EQUIVALENT
7. Q5 : ZSC2120Y OR EQUIVALENT
8. COMPONENT PARTS VALUE : R = Ω , C = F, L = H

SCHEMATIC #251469 SHEET 1 OF 2

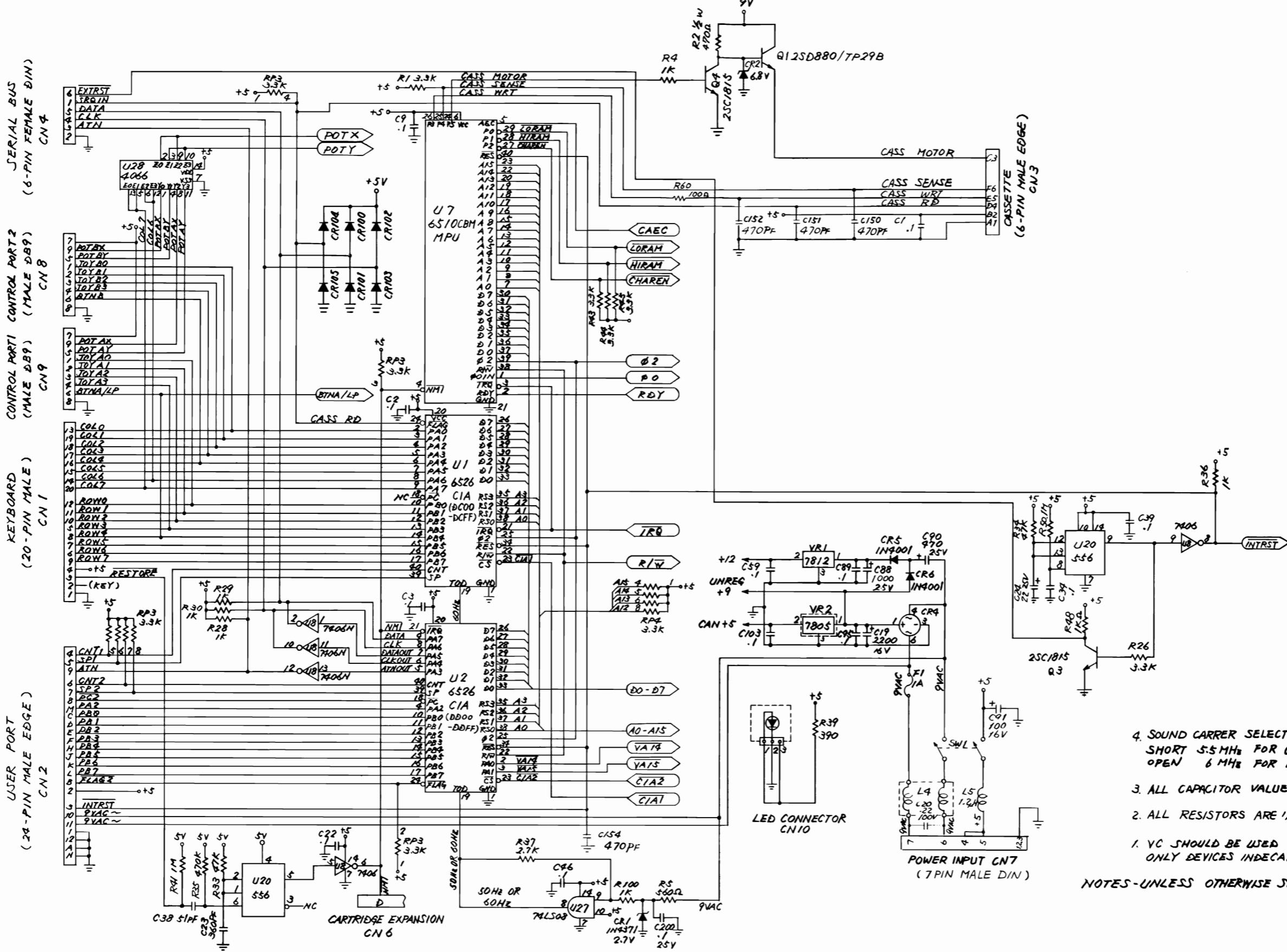


CARTRIDGE/EXPANSION (44 PIN FEMALE) CN6

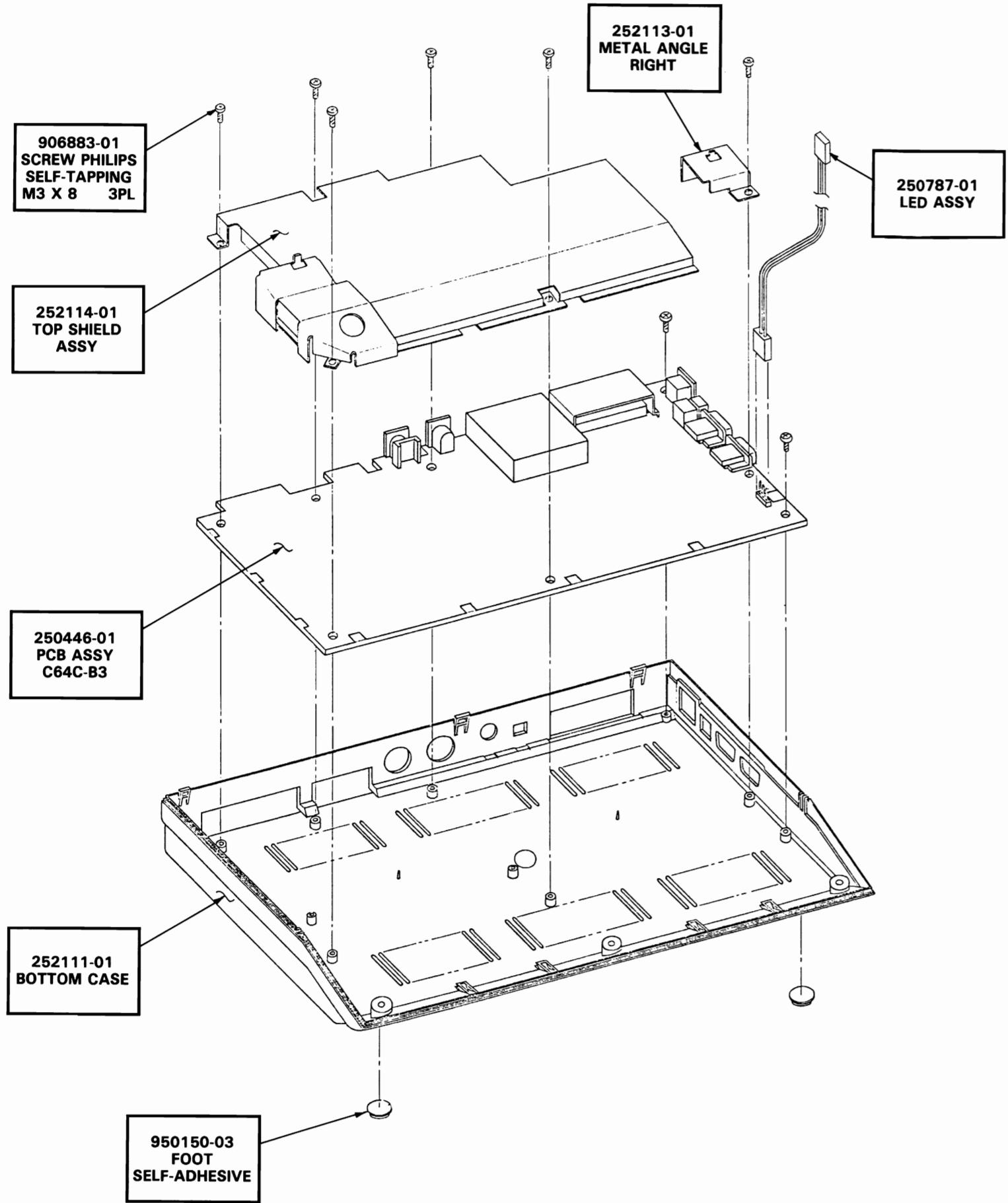
NOTE 5:	DOT CLOCK	8.18 MHz
	Φ COLOR	14.31818 MHz
	Φ I	1.02MHz
	Y I	14.31818 MHz
	U31	7701
	U19	8587
	U17	7700
	NTSC - INACTIVE	

PIN ASSIGNMENT					
DB6	1	40	VCC	1-7/39	DB0-DB7
DB5	2	39	DB7		Processor data bus connections. Bidirectional data.
DB4	3	38	DB8	8	IRQ
DB3	4	37	DB9		Interrupt output. Generates a interrupt signal to the processor indicating service is needed. The light pen input can be acknowledged thru use of this interrupt.
DB2	5	36	DB10	10	CS
DB1	6	35	DB11		Chip select input. A low signal selects the VIC 11.
DB0	7	34	A10	11	R/W
IRQ	8	33	A9		Processor read/write connection.
LP	9	32	A8	12	BA
CS	10	31	A7	13	VDD
R/W	11	30	A6("1")	14	COLOR
BA	12	29	A5(A13)		Output contains chrominance, color reference burst, and color of display data.
VDD	13	28	A4(A12)	15	SYNC/LUM
COLOR	14	27	A3(A11)		Output containing video, horizontal and vertical sync, and luminance information.
SYNC/LUM	15	26	A2(A10)	16	AEC
AEC	16	25	A1(A9)		Address enable output. This is usually connected to the processor AEC input, controlling the address bus.
PHO	17	24	A0(A8)		AEC = 0 processor address bus disabled, refresh ram.
RAS	18	23	A11		AEC = 1 processor address bus enabled. This allows transparent refresh operations.
CAS	19	22	PHIN		
VSS	20	21	PHCL		
U19 – 906109-01 MULTIPLEXED ADDRESSES IN PARENTHESES		17	PHO		Phase 0 output. Generated from the phase in signal.
		18	RAS		Row address strobe output. Selects proper row when addressing dynamic ram for read/write operations or refresh.
		19	CAS		Column address strobe output. Selects proper column when addressing dynamic memory for read or write operation.
		20	VSS		Ground connection.
		21	PHCL		Color clock, 14.31818 MHZ NTSC.
		22	PHIN		Clock input. Determines the dot transfer rate to the display.
		23-24	A0-A13		Dual function address bus. During a microprocessor read or write operation (AEC = 1), A0 thru A5 are inputs used to address 47 internal registers. When AEC = 0 = 02 is low, then A0 thru A13 are outputs used to refresh dynamic memory.
		35-38	D8-D11		Data bus extension. Color display memory data.
			A8-A11		Address bus extension. Color display memory addressing.
		40	VCC		5VDC input.

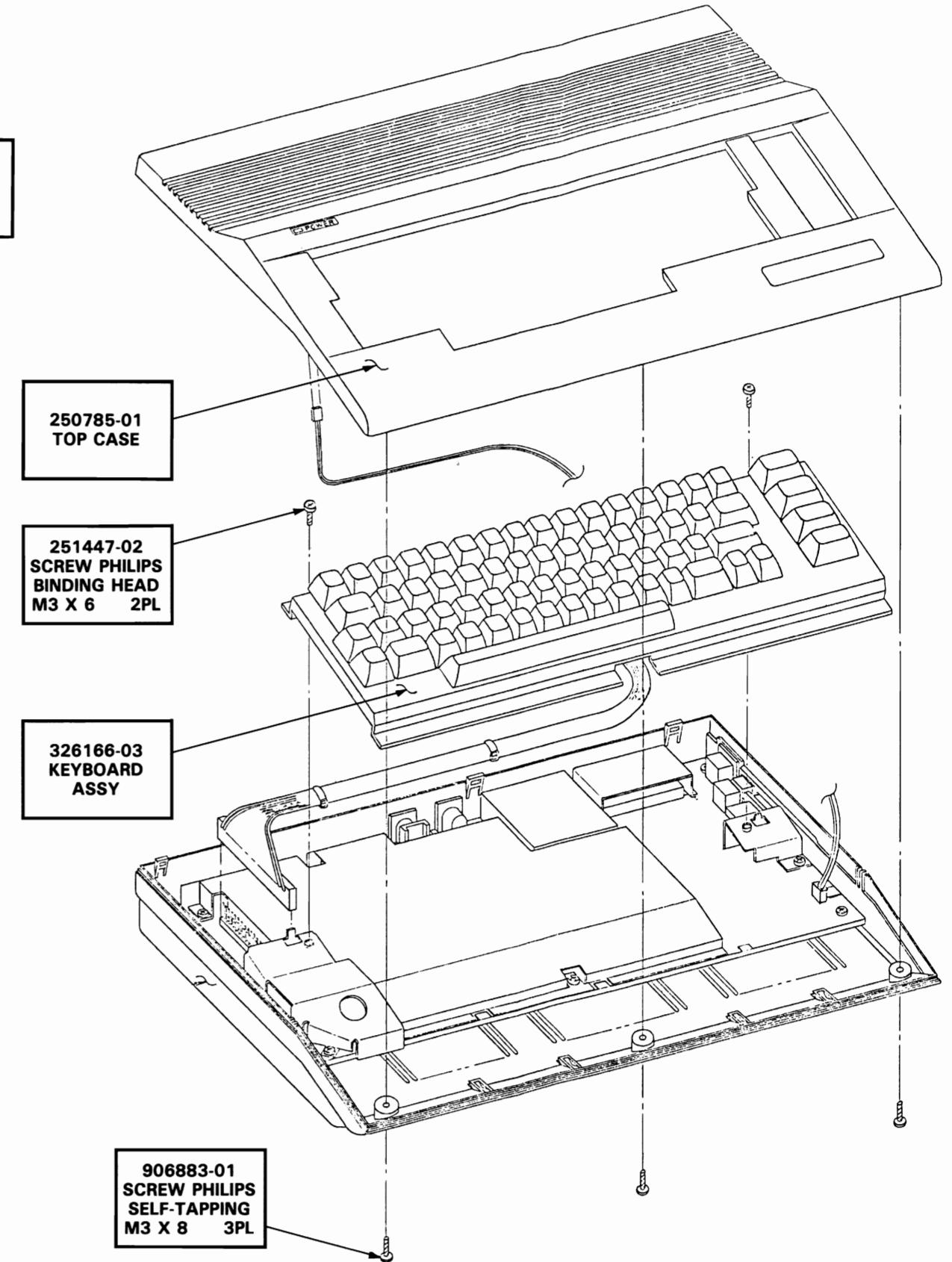
SCHEMATIC #251469 SHEET 2 OF 2



BOTTOM CASE ASSEMBLY C64-B3



MAIN ASSEMBLY C64-B3



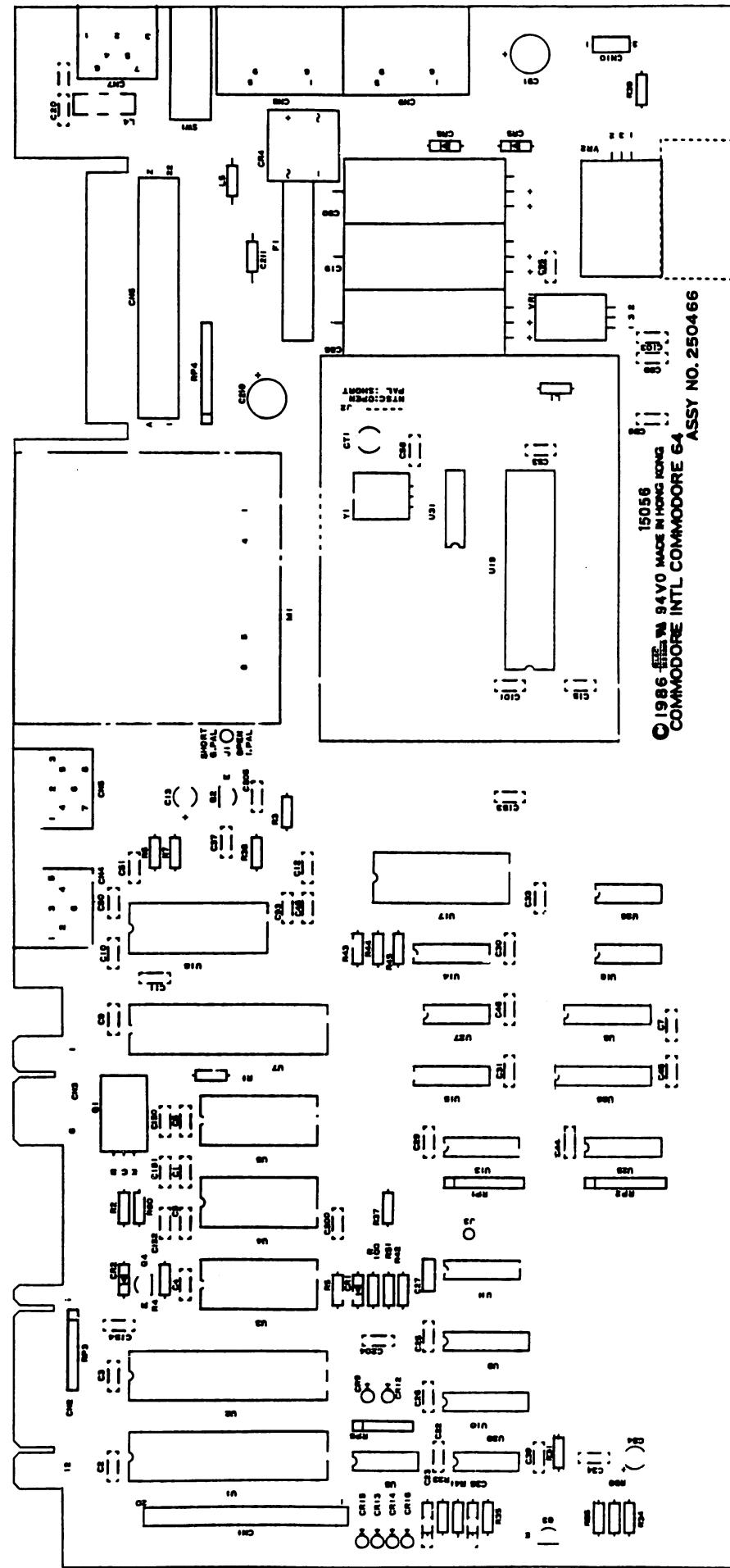
PARTS LIST

PCB ASSEMBLY #250466-01 C64-B3

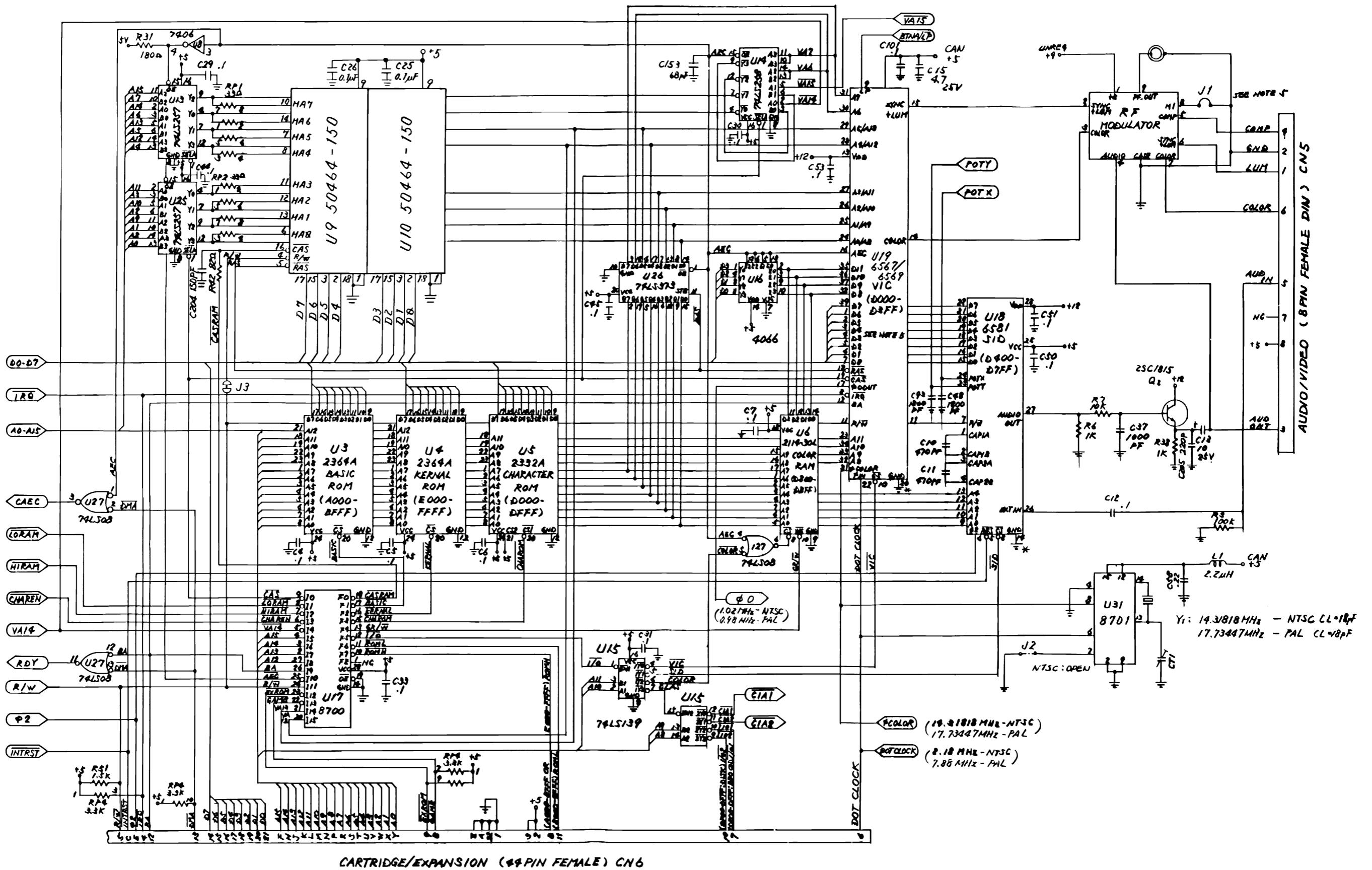
Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-reference for TTL chips, Transistors, etc. are available in manual form through the Service Department, order part #314000-01.

INTEGRATED CIRCUITS			DIODES (Continued)		
U1, U2	LSI CIA 6526	906108-01	CR4	Brdg Rect 2A 100V DBA20B	251026-02 Sub:
U19	LSI VIC NTSC 6567	906109-01		Brdg Rect 2A 200V DBA20C	251026-03 Sub:
U18	LSI SID 6581 R3	906112-01		Brdg Rect 2A 100V DBA20B-K15	251026-04 Sub:
U31	LSI CLK GEN 8701T6	251527-08		Switching Prefmd IN4148	251819-01
	LSI CLK GEN 8701L6	251527-09 Sub:		Switching Prefmd IN914	251819-16 Sub:
U7	LSI MPU 6510	906107-01		Switching Prefmd IN4148	251819-22 Sub:
U17	PLA 82S100 8700-001	906114-01			
U6	MEM SRAM 1KX4 Bit 200NS 2114	901453-07			
U6	MEM SRAM 1KX4 Bit 200NS 5114-2 CMOS	901453-08 Sub:	R42	CF 82 Ohm	901550-74
	MEM SRAM 1KX4 Bit 150NS 2114-15	901453-09 Sub:	R60	CF 100 Ohm	901550-49
	MEM SRAM 1KX4 Bit 120NS 2114-12	901453-10 Sub:	R31	CF 180 Ohm	901550-100
U9, U10	MEM DRAM 64KX4 Bit 150NS	390083-02	R39	CF 390 Ohm	901550-57
U3	MEM ROM Basic C64 2364B-161	901226-01	R5	CF 560 Ohm	901550-30
U4	MEM ROM Kernal C64 2364B-273	901227-03	R4,6,38,100	CF 1K Ohm	901550-01
U5	MEM ROM Char C64 2332C-250	901225-01	R51	CF 1.5K Ohm	901550-69
U20	LIN Dual Timer NE556	901523-03	R37	CF 2.7K Ohm	901550-23
U16, U28	LIN CMOS SW/3UF 4066B	901502-01	R1,26,43-45	CF 3.3K Ohm	901550-02
U13, U25	TTL 74LS257A	315033-01	R7	CF 10K Ohm	901550-20
U26	TTL 74LS373	901521-29	R33,34	CF 47K Ohm	901550-22
U15	TTL 74LS139	901521-18	R3	CF 100K Ohm	901550-07
U27	TTL 74LS08	901521-03	R35	CF 470K Ohm	901550-82
U14	TTL 74LS258A	390010-01	R41,50	CF 1M Ohm	901550-84
U8	TTL 7406	901522-06	R2	CF 470 Ohm 1/2W 5%	901600-38
	TTL 7416	901522-14 Sub:	RP1, RP2	NTWK SIP 33 Ohm 8 Pin	902422-03
TRANSISTORS			RP5	NTWK SIP 1K Ohm 6 Pin	902441-22
Q1	NPN Power 2SD880	902694-01	RP3	NTWK SIP 3.3K Ohm 8 Pin	902442-29
	NPN Power TIP29A	902653-01 Sub:	RP4	NTWK SIP 3.3K Ohm 10 Pin	902410-06
	NPN Power 2SD476	902694-02 Sub:			
	NPN Power 2SD313	902694-03 Sub:			
	NPN Power 2SD1310	251294-01 Sub:			
	NPN Power 2SD1266	902694-04 Sub:			
	NPN Small Signal 2SC1815	902693-01			
	NPN Small Signal 2SC945	902671-01 Sub:			
Q2-Q4	NPN Small Signal 2SC2458	251526-01 Sub:			
	NPN Small Signal 2SC2785	251895-01 Sub:			
DIODES					
CR5, CR6 CR1	Rect 1A 60V IN4001	900750-01	C38	Ax1 51pF 5% SL	251078-24
	Zener .5W 2.7V IN4371	906103-02		Ceramic Disc 51pF 50V 5% SL	251072-33 Sub:
	Zener 2.7V	251286-04 Sub:		Ceramic Disc 56pF 50V 5% SL	251072-19 Sub:
	Zener 2.7V	251286-05 Sub:		Ceramic Disc 68pF 50V 5%	900010-51
	Zener 2.7V	251286-06 Sub:		Ceramic Disc 150pF 50V SL-K 10%	251071-24
	Zener 2.7V	906103-03 Sub:		Ceramic Disc 220pF 50V 5% SL	251072-26
	Zener 2.7V	906103-04 Sub:		Ceramic Axl 360pF 10% B	251078-51
	Zener 2.7V	906103-05 Sub:		Ceramic Disc 390pF 50V Y5P-K	251069-03 Sub:
	Zener .5W 6.8V	900927-01		Ceramic Disc 470pF 50V Y5P-K	251069-04
	Zener .5W 6.8V	900927-02 Sub:			
CR2	Brdg Rect 2A 100V S2VB10	251026-01			
CR4					

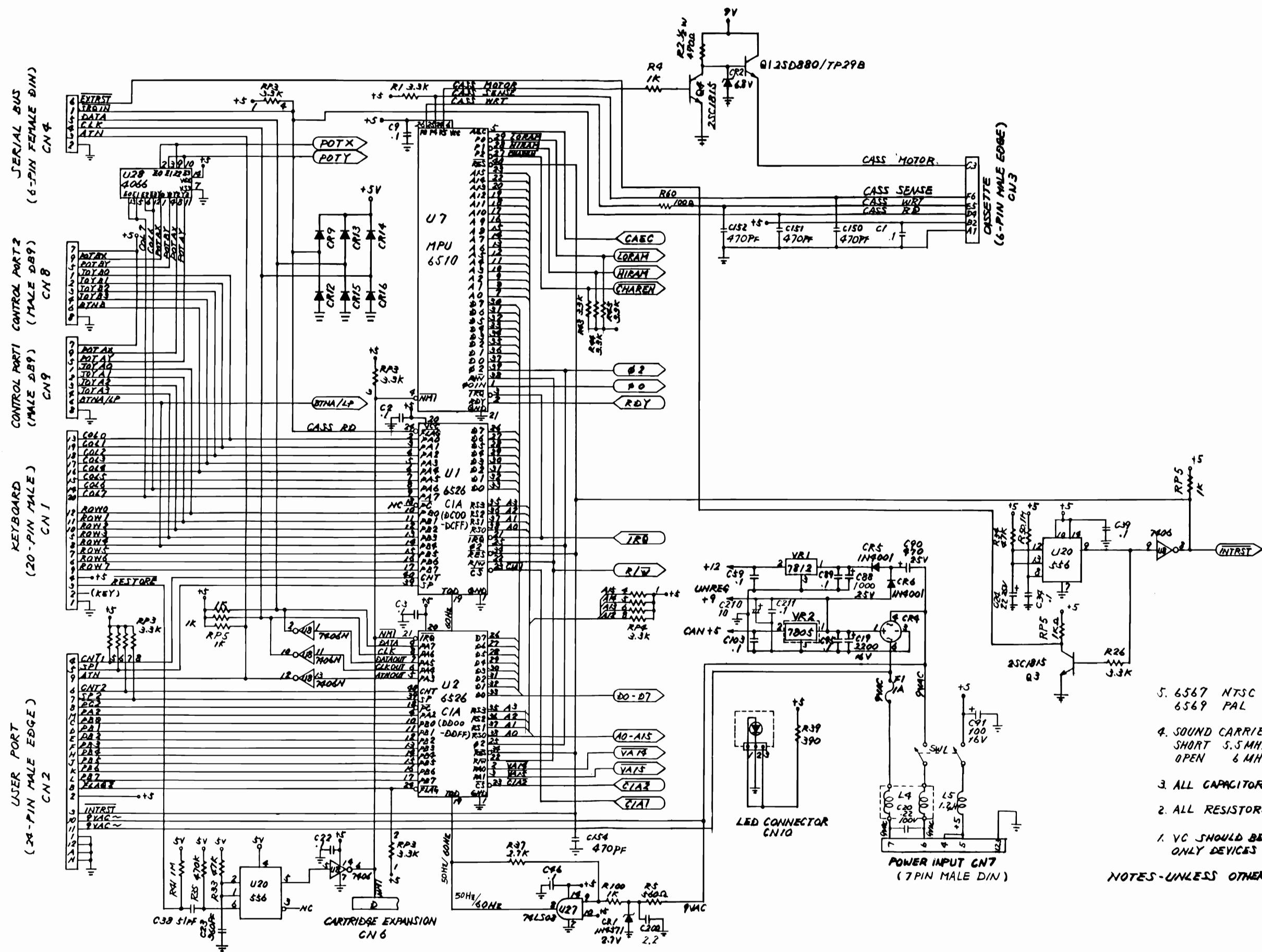
CAPACITORS (Continued)			CONNECTORS (Continued)		
C20	Film Rdl .22 μ F 100V 20% Film Rdl .22 μ F 100V 20% Film Rdl .22 μ F 100V 20%	251875-01 900150-11 Sub: 900150-12 Sub:	CN1	Header w/LKG Sil 2.54 CTR 20 Pin Header 20 Pin	903364-02 903331-20 Sub:
C211	Ceramic Axl .1 μ F 50V	900461-28	CN10	Header Sil 2.54 CTR 3 Pin	903332-03
C15	Tant Rdl 4.7 μ F 16V 20%	900410-13	CN5	Din Female R-Angle 8 Pin	325573-01
C13 (C210)	Electrolytic Rdl 10 μ f 25V - 10 + 50%	900100-01	CN8,9	Din Female R-Angle 8 Pin	325573-02 Sub:
C13	Electrolytic Rdl 10 μ F 25V 20%	251079-16 Sub:		Din Female R-Angle 8 Pin	325573-03 Sub:
C24	Electrolytic Rdl 10 μ F 25V	251894-35 Sub:		Din Female R-Angle 8 Pin	325573-04 Sub:
C91	Electrolytic Rdl 22 μ F 25V	900100-24	SW1	Submin D Male R-Angle 9 Pin	906126-01
	Electrolytic Rdl 22 μ F 25V 20%	251894-36 Sub:		Mini Din 9 Pin	251057-01 Sub:
	Electrolytic Rdl 100 μ F 16V - 10 + 50%	900100-40		Switch Rocker DPDT	904500-91
	Electrolytic Rdl 100 μ F 16V 20%	251894-27 Sub:		Switch Power Rocker	252182-01
C90	Electrolytic Axl 470 μ F 25V	900101-49			
C88	Electrolytic Axl 1000 μ F 25V	900101-50			
C19	Electrolytic Axl 2200 μ F 16V	900101-33			
C200	Electrolytic Rdl 2.2 μ F	251079-06			
CT-1	Trim 6.5-40pF	251029-02			
CONNECTORS					
CN7	Din Female R-Angle 7 Pin	251116-01			
	Din Female R-Angle 7 Pin	251116-02 Sub:			
	Din Female R-Angle 7 Pin	251116-03 Sub:			
CN6	Card Edge 44 Pin	906100-02			
CN4	Din Female R-Angle 6 Pin Shield Type	252166-01			
	Din Female R-Angle 6 Pin Shield Type	252387-01			
MISCELLANEOUS					
			Y1	Xtal 14.31818 MHZ HC-49/U	251467-01
			Y1	Xtal 17.73447 MHZ HC-49/U	251468-01
			L1	Inductor Coil 2.2 μ H	901151-17
			L5	Inductor Coil 1.2 μ H	325570-01
			L4	Line Filter 5A	251701-01
			VR1	IC Volt Regulator + 12V MC7812CT	901527-01
			VR2	IC Volt Regulator + 5V MC7805CT	901527-02
			M1	RF Modulator NTSC C64	251696-01
			F1	Fuse, Nor Blo 250V 1.5A	903556-18
			Use on F1	Fuse, Clip	906102-01



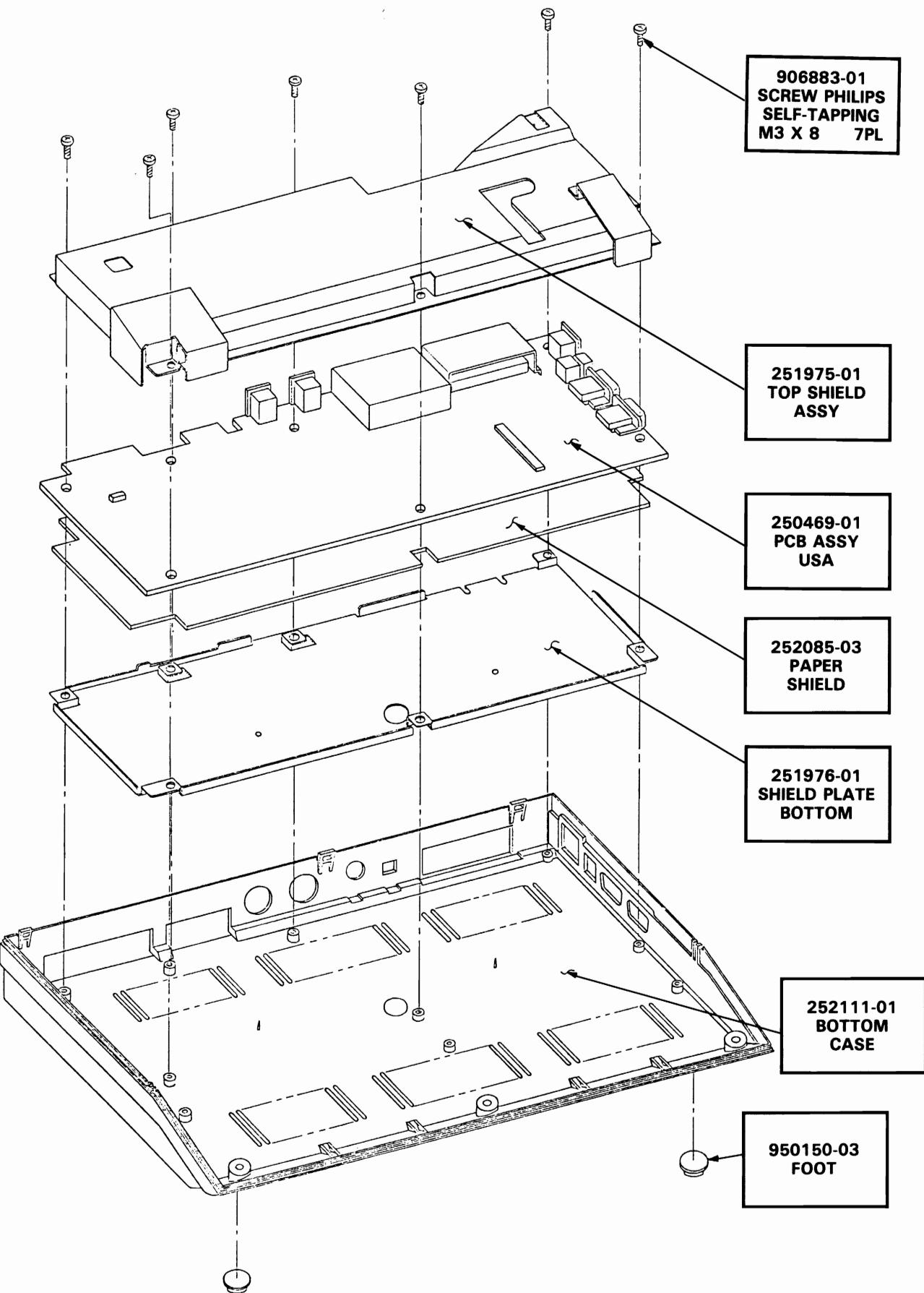
B-3
BOARD LAYOUT
PCB ASSEMBLY #250446



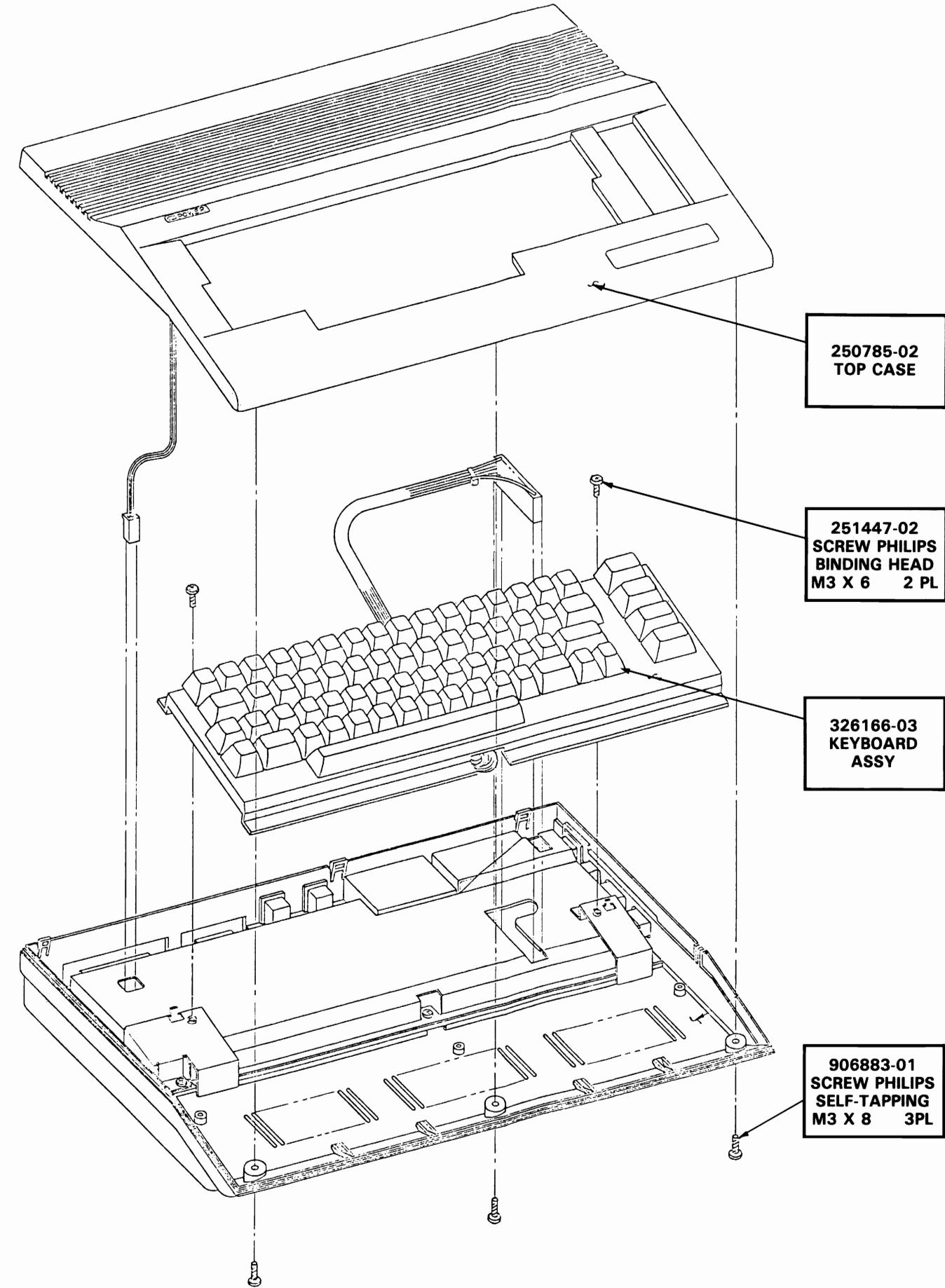
CARTRIDGE/EXPANSION (8PIN FEMALE) CN6



BOTTOM CASE ASSEMBLY C64E



MAIN ASSEMBLY C64E

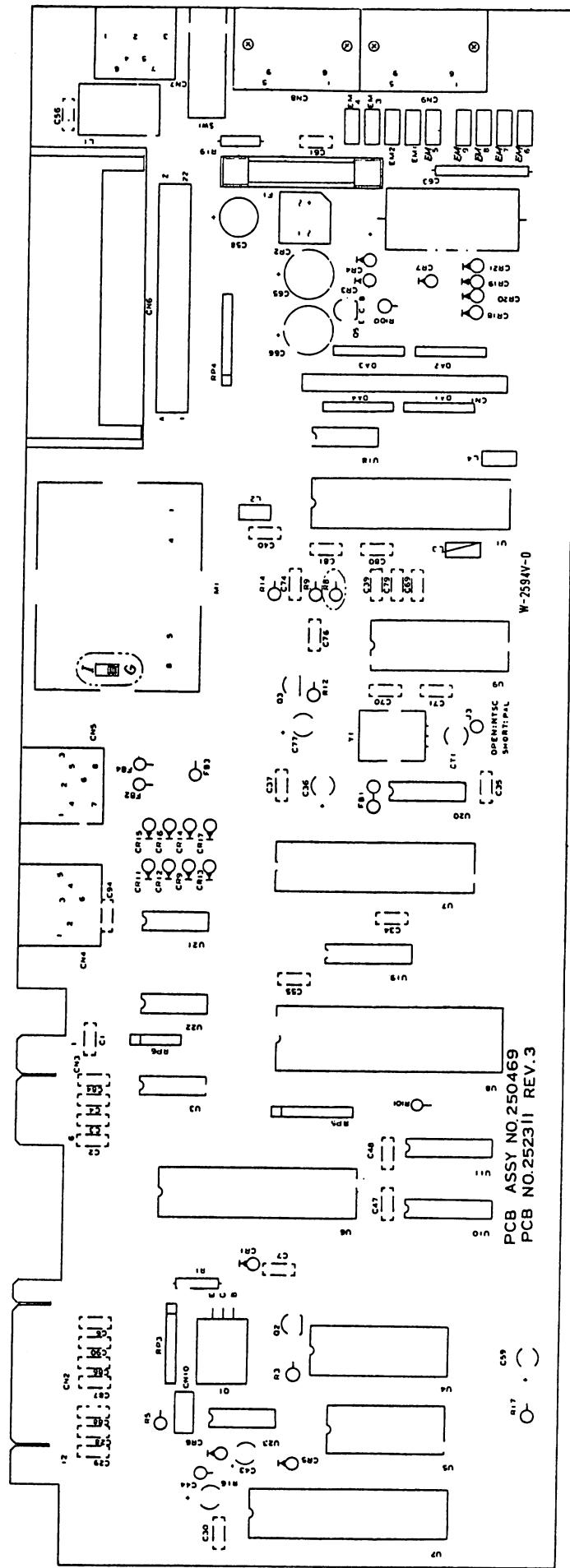


PARTS LIST

PCB ASSEMBLY #250469-01 C64-E

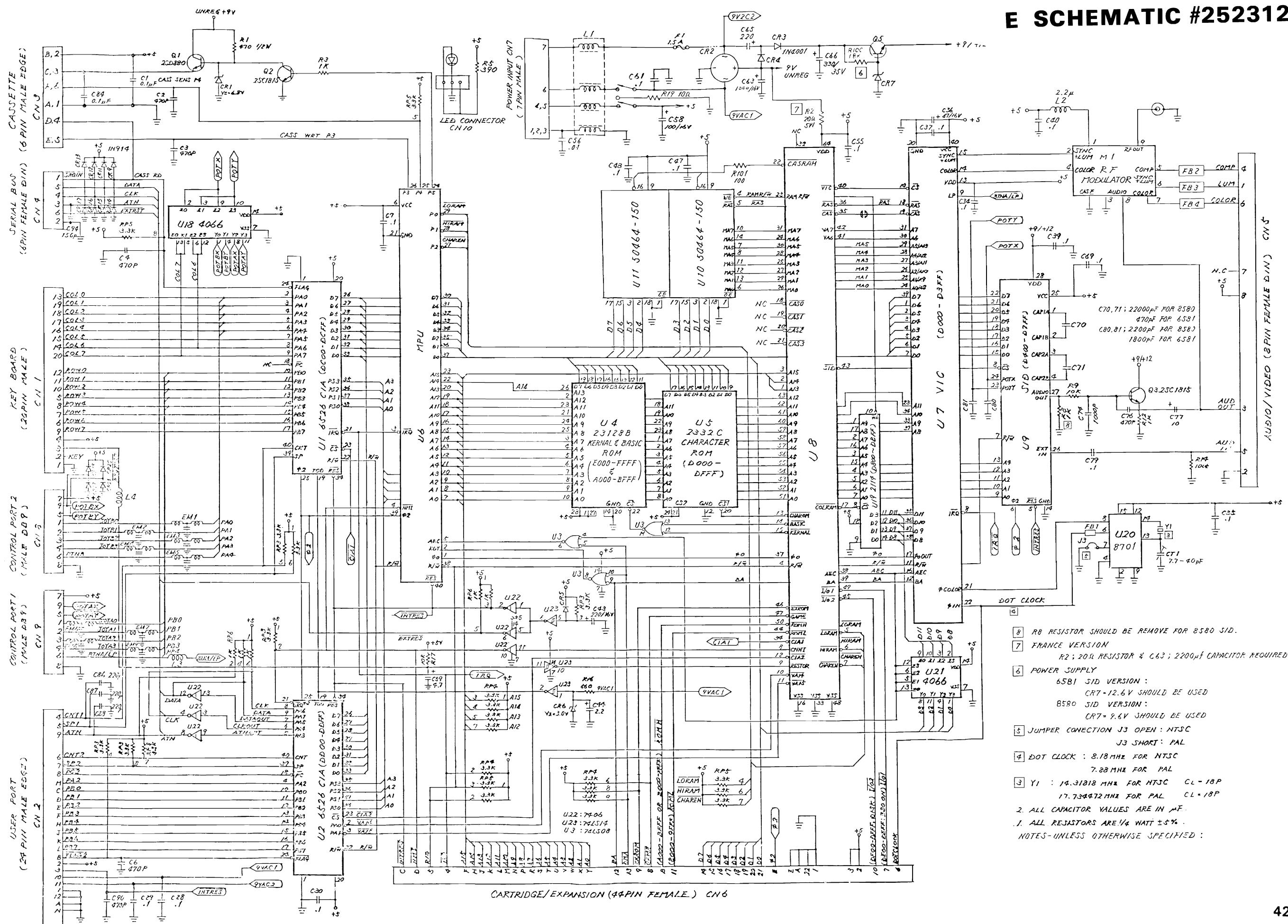
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INTEGRATED CIRCUITS			CAPACITORS (continued)		
U6	8500	318012-01	C44	Electrolytic r $2.2\mu F$ 50V	251079-06
U1,2	6526	906108-01	C59	Electrolytic r $4.7\mu F$ 25V	900100-11
U7	8567	318014-01	C77	Electrolytic r $10\mu F$ 25V	900100-01
U7	8562	318027-01	C58	Electrolytic r $100\mu F$ 16V	900100-40
U9	8580	318013-01	C65	Electrolytic r $220\mu F$ 25V	900100-03
U5	2332 ROM CHAR US PAL	901225-01	C63	Electrolytic a $1000\mu F$ 16V	900101-52
U5,4	128K ROM US PAL	251913-01	C36	Electrolytic r $47\mu F$ 16V	900100-33
U18,21	4066	901502-01	C43	Electrolytic r $220\mu F$ 16V	900100-18
U22	7406	901522-06	C66	Electrolytic r $470\mu F$ 35V	900301-35
U3	74LS08	901521-03	C80,81	Ceramic r $1800pF$ 50V 10% B	251069-11
U23	74LS14	901521-30	C63	Electrolytic a $2200\mu F$ 16V	900101-33
U20	8701T6	251527-08	C70,71	Ceramic r $22000pF$ 25V M	251074-09
U19	2114 (200 NSEC)	901453-07	CT-1	Trimmer 7.7-40pF	251029-02
U9	6581	906112-01			
U20	8701L6	251527-09			
U10,11	64 x 4 D-RAM	390083-07			
U19	2114, (150 NSEC)	901453-09			
U22	7416	901522-14			
U8	Memory Controller	251715-01			
DIODES			RESISTORS		
CR3,4	1N4001	900750-01	R2	Wound 20 ohm 5W 5%	251756-02
CR5,9,11-21	1N914 r	251819-16	R5	Carbon 390 ohm $1/4W$ 5%	251068-65
CR5,9,11-21	IN4148 r	251819-01	R16	Carbon 560 ohm $1/4W$ 5%	251068-69
CR1	Zener RD6.8EB	900927-01	R3,12 (8)	Carbon 1K ohm $1/4W$ 5%	251068-76
CR6	Zener RD3.0EB1	906103-04	R9,17	Carbon 10 ohm $1/4W$ 5%	251068-101
CR1	Zener IN754A	900927-02	R14	Carbon 100K ohm $1/4W$ 5%	251068-126
CR6	Zener RD3.0FB2	906103-05	R1	Carbon 470 ohm $1/2W$ 5%	901600-38
CR7	Zener RD10ESB2	252313-63	R101	Carbon 100 ohm $1/4$ 5%	251068-51
CR7	Zener RD13ESB2	252313-75	R19	Carbon 10 ohm $1/2W$ 5%	901600-14
CR7	Zener HZ11A1	252337-61	R100	Carbon 1.8K ohm $1/4W$ 5%	251068-82
CR7	Zener HZ12B2	252337-74	RP6	Pack 1K ohm 6 PIN	902441-22
CR2	Bridge Rectifier S2VB10	251026-01	RP4	Pack 3.3K ohm 9 PIN	902412-07
CR2	Bridge Rectifier DBA20B	251026-02	RP3,5	Pack 3.3K ohm 8 PIN	902442-29
CR2	Bridge Rectifier DBA20C	251026-03			
TRANSISTORS			MISCELLANEOUS		
Q1	2SD880	902694-01	EMI-9	EMI Filter 270pF	251842-01
Q2,3	2SC1815	902693-01	FB1	Ferrite Bead, 2 Turn	252214-01
Q1	TIP29A	902653-01	L3,4	RF Choke Coil	252341-01
Q1	2SD476kC	902694-02	L1	Line Filter 8 Terminal	251878-02
Q1	2SD313E/F	902694-03	L1	Line Filter 8 Terminal	251878-01
Q1	2SD1310	251294-01	Y1	Crystal 14.31818 MHz	251467-01
Q2,3	2SC945	902671-01	Y1	Crystal 17.73447 MHz	251468-01
Q2,3	2SC2458	251526-01	L2	Jumper Wire	200018-15
Q5	NPN 900nN	252338-01	M1	Coil Inductor $2.2\mu H$	901151-17
CAPACITORS			F1	Modulator NTSC	252405-01
C2-4,6,76,90	Ceramic r $470pF$ 50V	251069-04		Socket, IC 16 Pin	904150-02
C74	Ceramic r $1000pF$ 50V	251069-08		Socket, IC 28 Pin	904150-05
C80,81	Ceramic r $2200pF$ 25V	251069-12		Socket, IC 40 Pin	904150-06
C1,7,28-30, 34,35,37,39, 40,47,48,55, 61,69,79,84	Ceramic r $0.1\mu F$ 25V	251075-06	SW1	Fuse, Normal Blo 250V 1.5A	903556-18
C70,71	Ceramic r $22000pF$ 50VM	251304-71	SW1	Fuse, Clip	906102-02
C94	Ceramic r $150pF$ 50V	251070-24		Switch, Rocker DPDT	904500-01
C86-88	Ceramic r $220pF$ 50V	251071-26		Switch, Power Rocker	252182-01
				Cartridge Guide	326116-01
				Screw, Self-Tapping M3 X 6	906883-03
			CN7	7 Pin Din	251116-01
			CN4	6 Pin Din	252166-01
			CN5	8 Pin Din	252168-01
			CN6	44 Pin Card Edge	906100-02
			CN8,9	9 Pin Mini D	251057-01
			CN4	6 Pin Din	252387-01
			CN1	Header Pin, 20 Pin	903364-01
			CN1	Header Assy, 20 Pin	903331-20
			CN10	Header Assy, 8 Pin	903332-03
			CN5	8 Pin Din	252452-01
			CN8,9	9 Pin Mini D	251057-02



**E BOARD LAYOUT
PCB ASSEMBLY #250469**

E SCHEMATIC #252312





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