

SERVICE MANUAL

C64/C64C

MARCH, 1992

PN-314001-03

 **Commodore**

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Commodore Business Machines, Inc.

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C64 COMPUTER

GENERAL DESCRIPTION

- 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

- 64K RAM

ROM

- 20K ROM Standard (includes operating system and BASIC interpreter)

MICROPROCESSOR

- 6510A Microprocessor—1.02 MHz clock
- Compatible with the 6502

DISPLAY

- 40 Columns X 25 lines of text

COLORS

- 16 Background, border and character colors

CHARACTERS

- Upper & lower case letters, numerals and symbols
- Reverse characters
- All PET graphic characters

DISPLAY MODES

- Text characters
- High resolution graphics

RESOLUTION

- 320 X 200 Pixels

SPRITES

- 8 independent sprites
- Each consists of 24 X 21 pixels and up to 4 colors
- Each independently expandable horizontally and vertically
- Collision detection for sprite to sprite and data to sprite collisions

SOUND

- 6581 Sound Interface Device includes 3 independent tone generators—each with 9 octaves
- Each voice includes programmable ADSR generator (Attack, Decay, Sustain, Release) and control of sawtooth, triangle, square, variable pulse and noise waveforms
- Full filtering capabilities with low, high and band pass filters
- External sound input

KEYBOARD

- Full size typewriter style design

KEYS

- 66 Keys total
- 2 Cursor control keys
- 4 Function keys (up to 8 user defined/programmable functions possible)
- Upper and lower case character set
- Graphic character set

INPUTS/OUTPUTS

- User port
- Serial port
- ROM cartridge port
- 2 Joystick/paddle ports
- Video port
- C1530 Cassette drive interface port

FEATURES

- Built-in BASIC 2.0—over 70 commands, statements and functions
- Full screen editor

PERIPHERALS

- C1541 Disk drive
- C1530 Datasette
- MPS 801 Dot matrix printer
- MPS 802 Dot matrix printer
- MPS 803 Dot matrix printer
- DPS 1101 Daisy wheel printer
- C1520 Plotter/Printer
- C1702 Color monitor
- CM141 Color monitor

POWER REQUIREMENTS

- 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

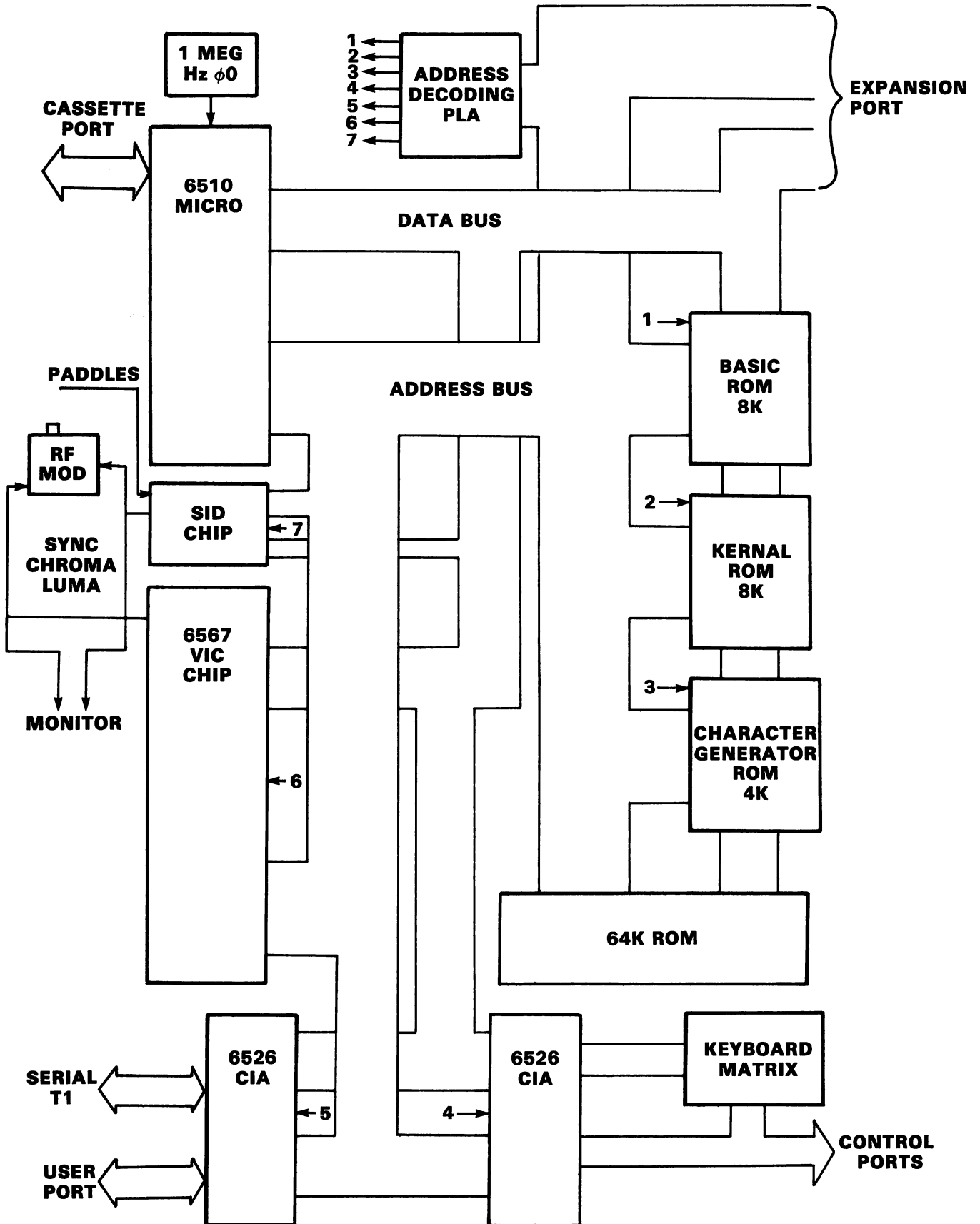
MAIN CASE ASSY

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



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

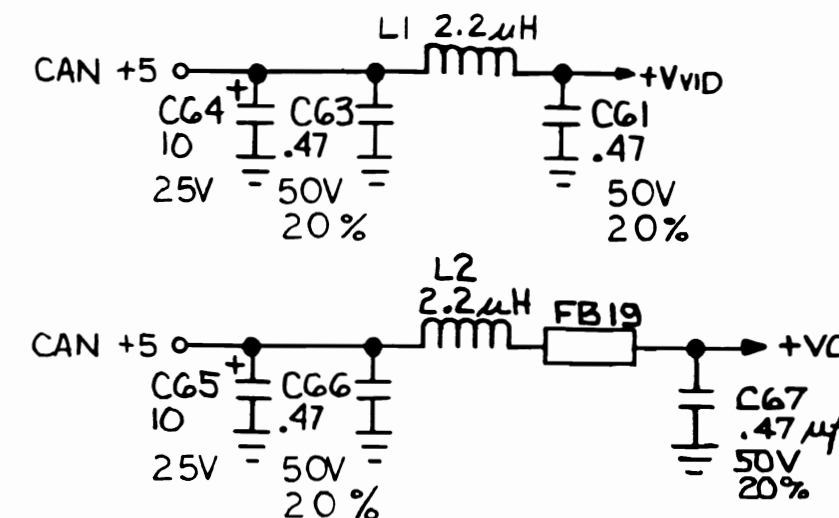
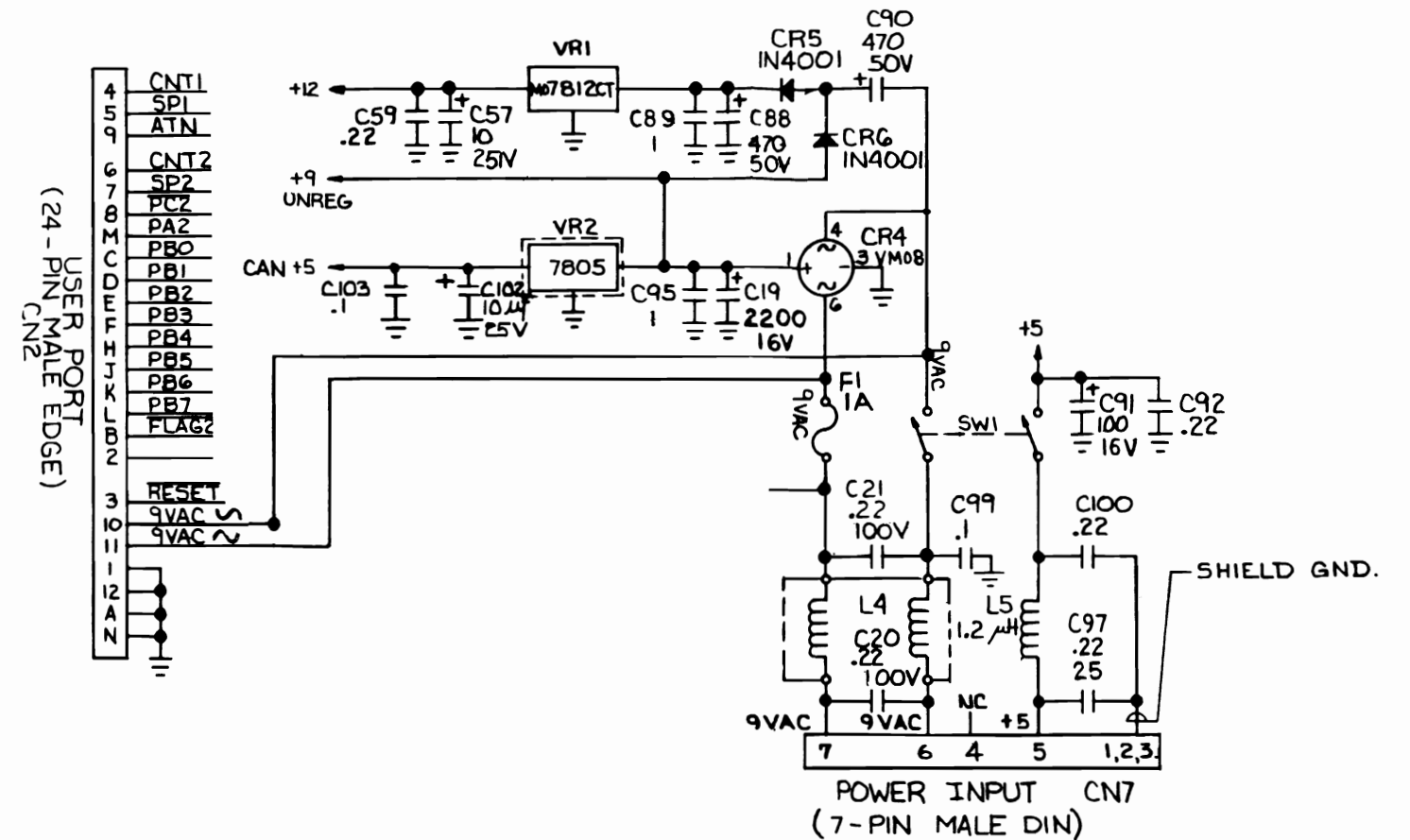
9VAC is added to 9VDC through CR6, and rectified by CR5. The unregulated DC output is filtered by C88 and C89 then regulated at 12VDC by VR1. The regulated output is filtered by C57 and C59. The 12VDC supplies the VIC and SID IC, and the audio amplifiers.

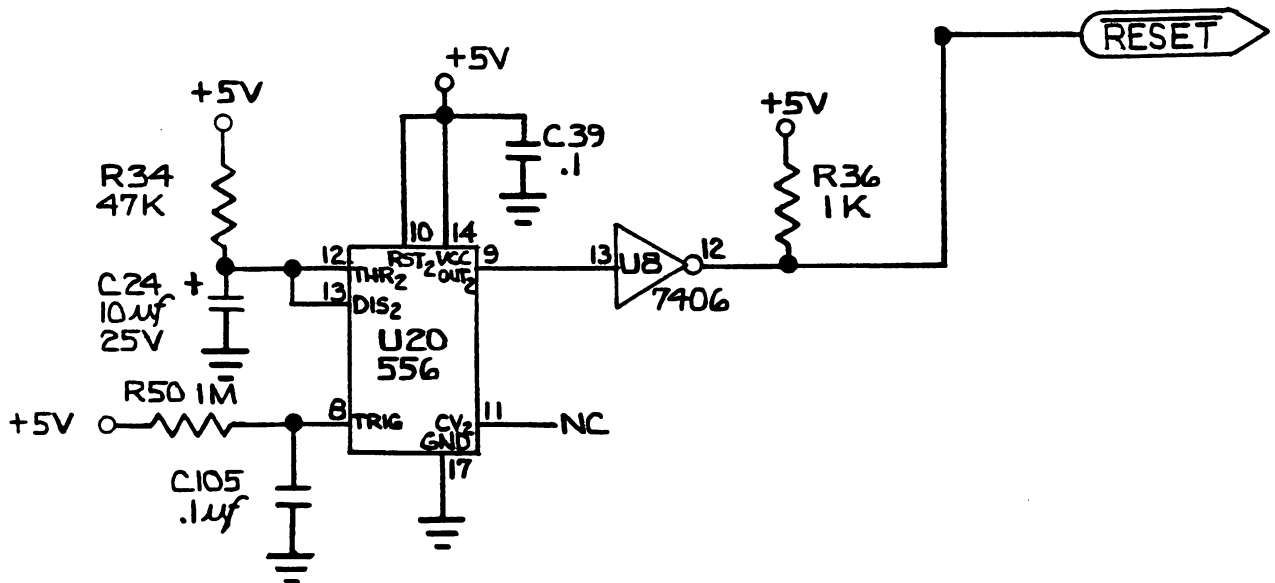
+5VDC CAN Generation

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.

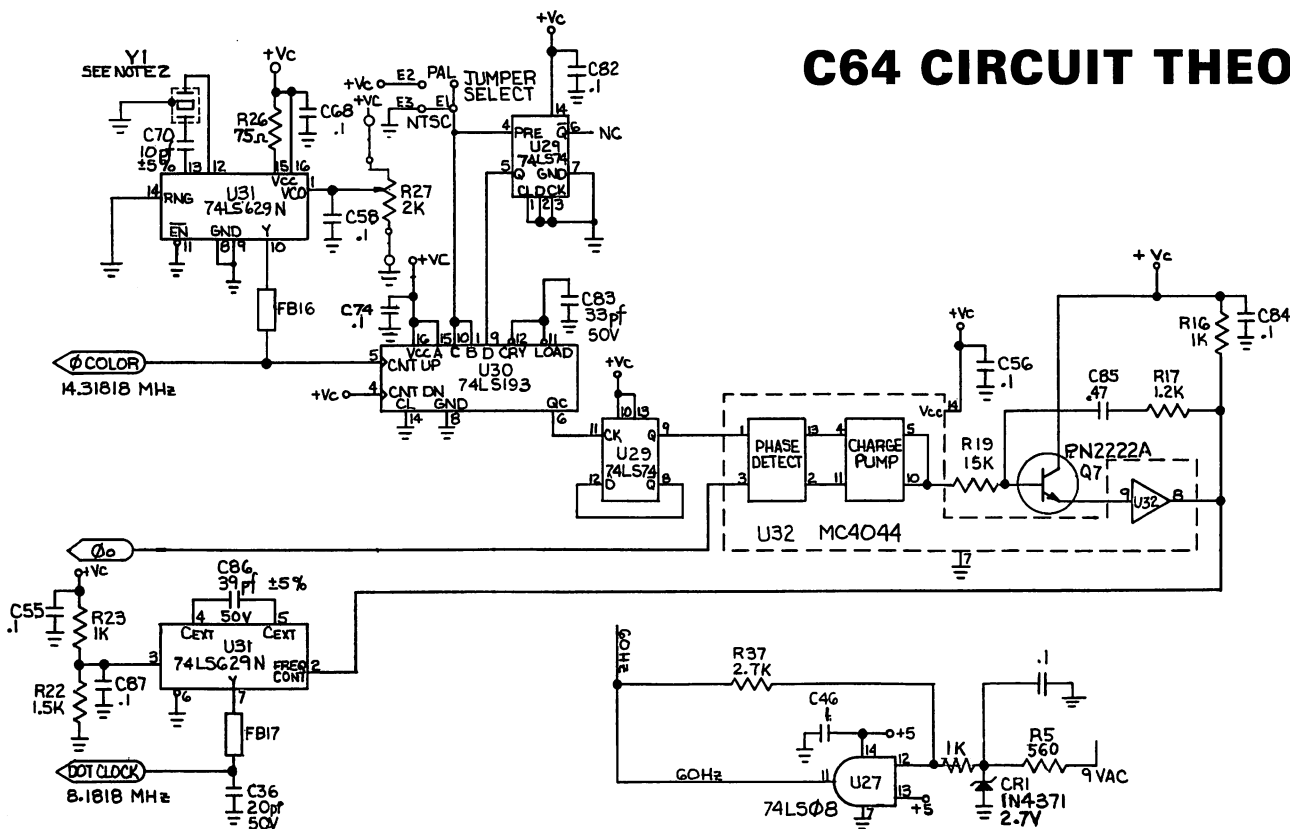




Reset Logic Circuits.

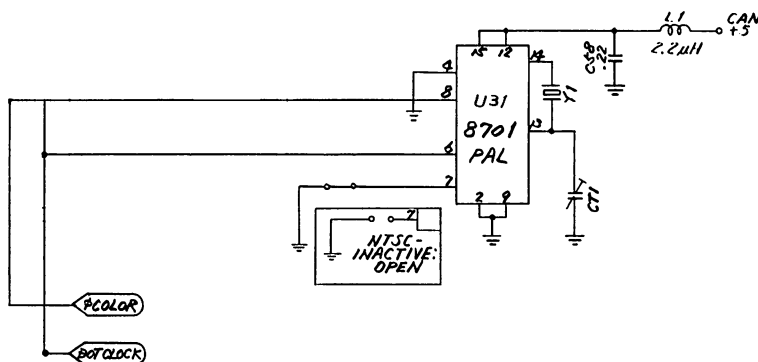
U20 is a 556 IC timer configured as a one shot multivibrator. The output pulse width is determined by the size of R34 and C24. $\text{Pulse width} = 1.1 \times R34 \times C24 \approx .5 \text{ seconds}$. The output on pin 9 is "high" active. The output of U8 is "low" active. Reset initializes all the 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.

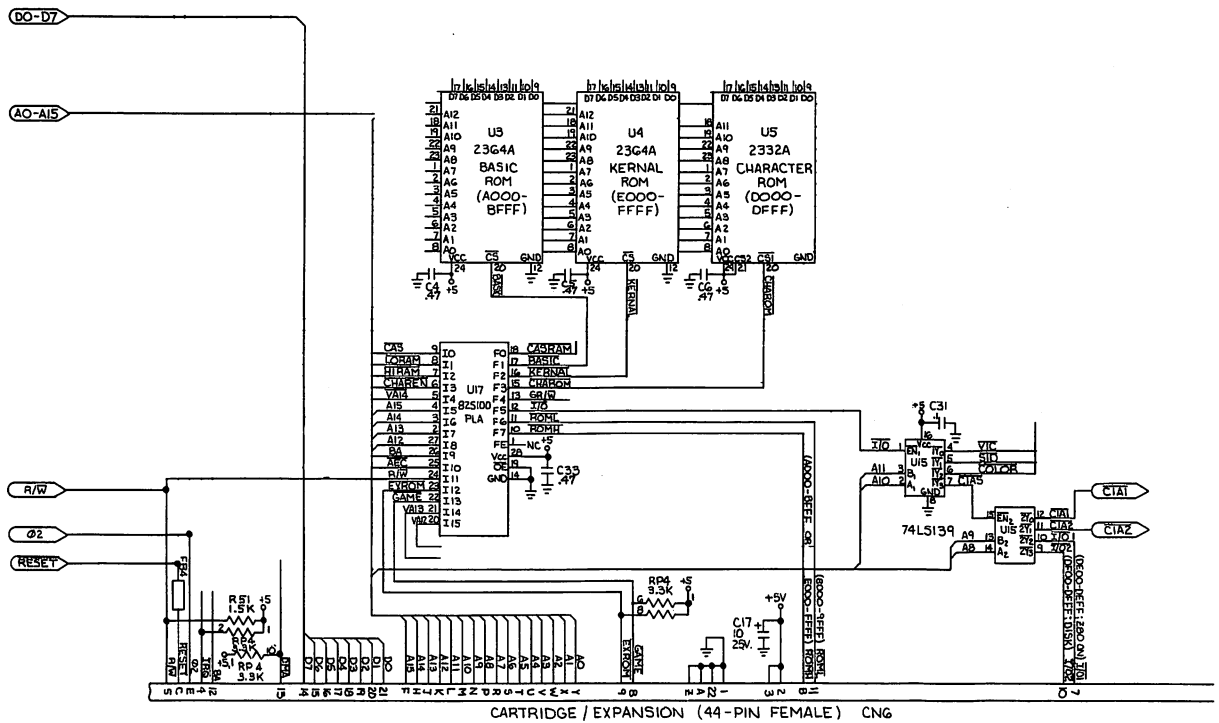
Crystal Y1 develops a 14.31818MHz fundamental frequency clock signal. U31 is a Dual Voltage Controlled Oscillator. The output on pin 10 is a 14.31818 MHz clock signal called the color clock. R27 can be adjusted to obtain exact output frequency. U30 is a frequency divider that outputs a 2MHz signal on 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

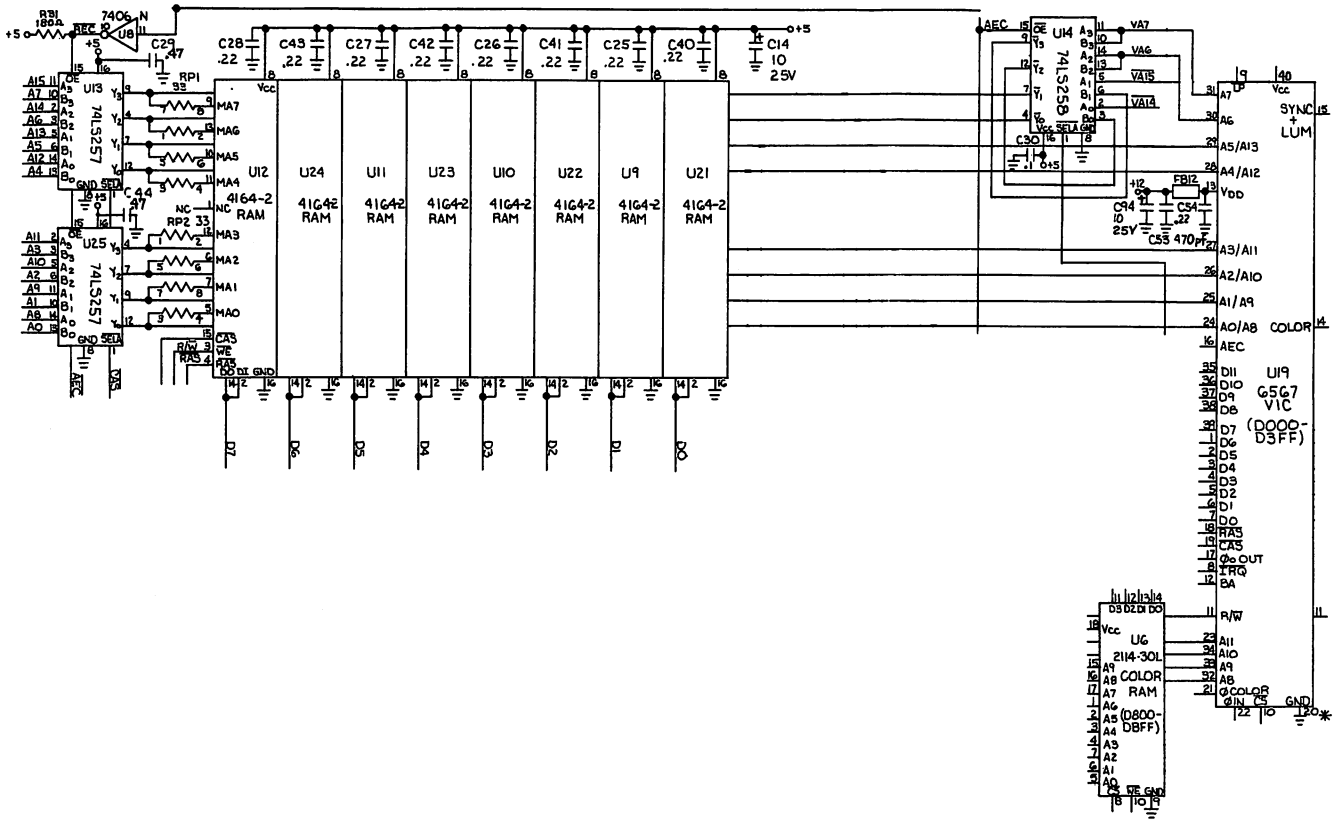
ROM Address Decoding.

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

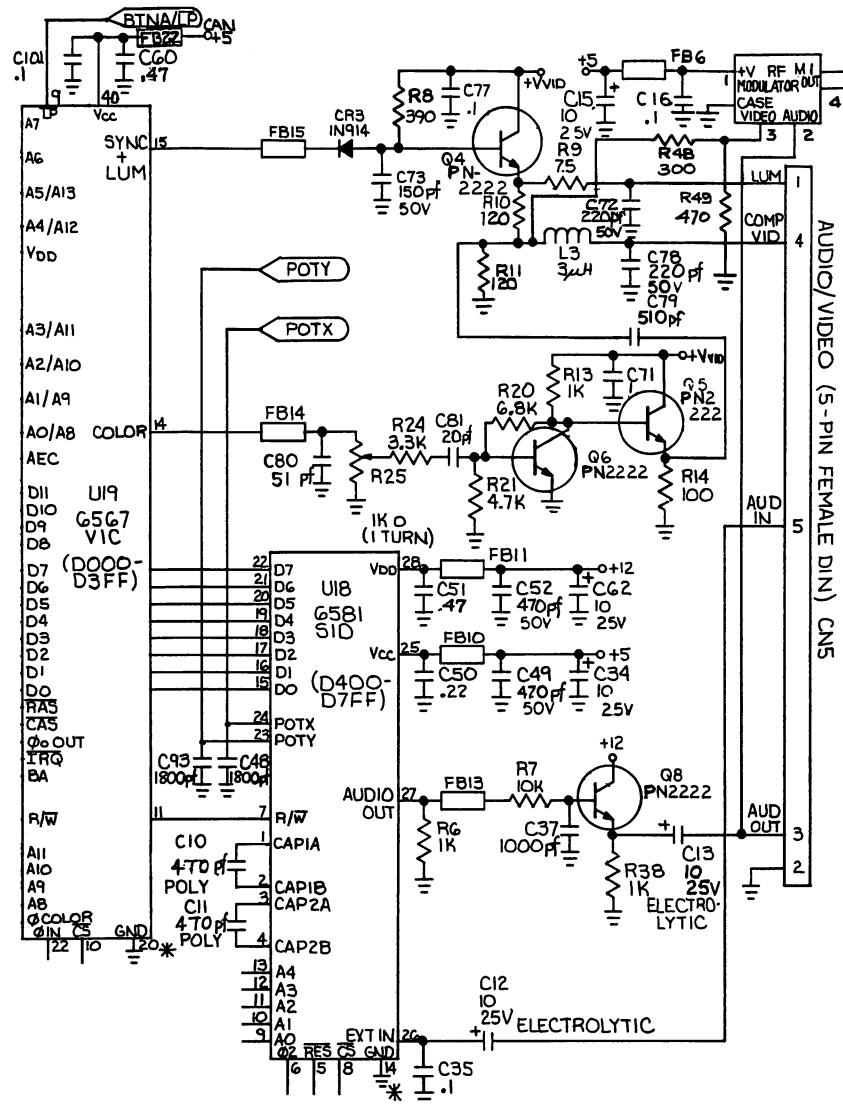


RAM Control Logic.

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.

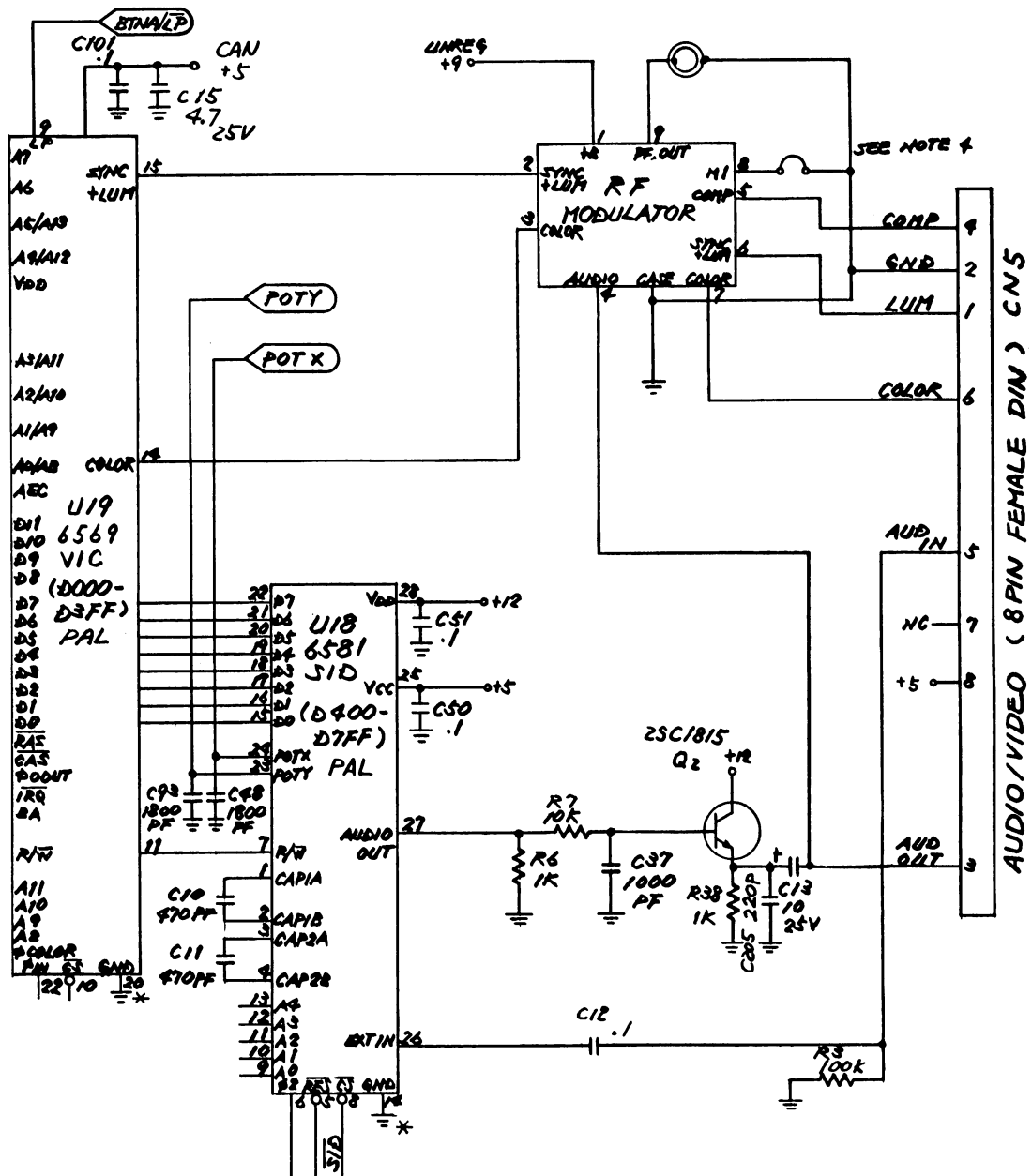
C64 CIRCUIT THEORY



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.

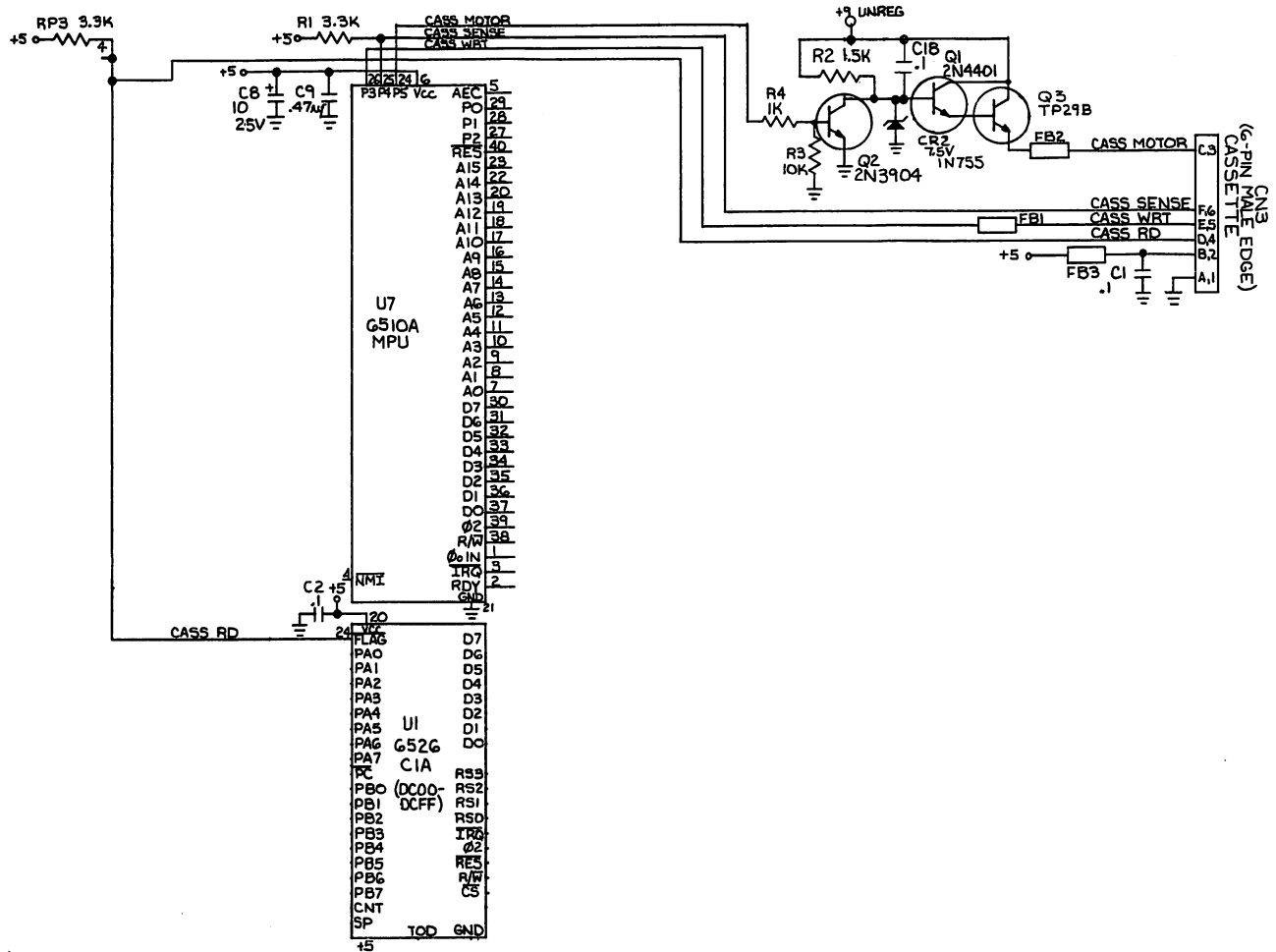
C64 CIRCUIT THEORY



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

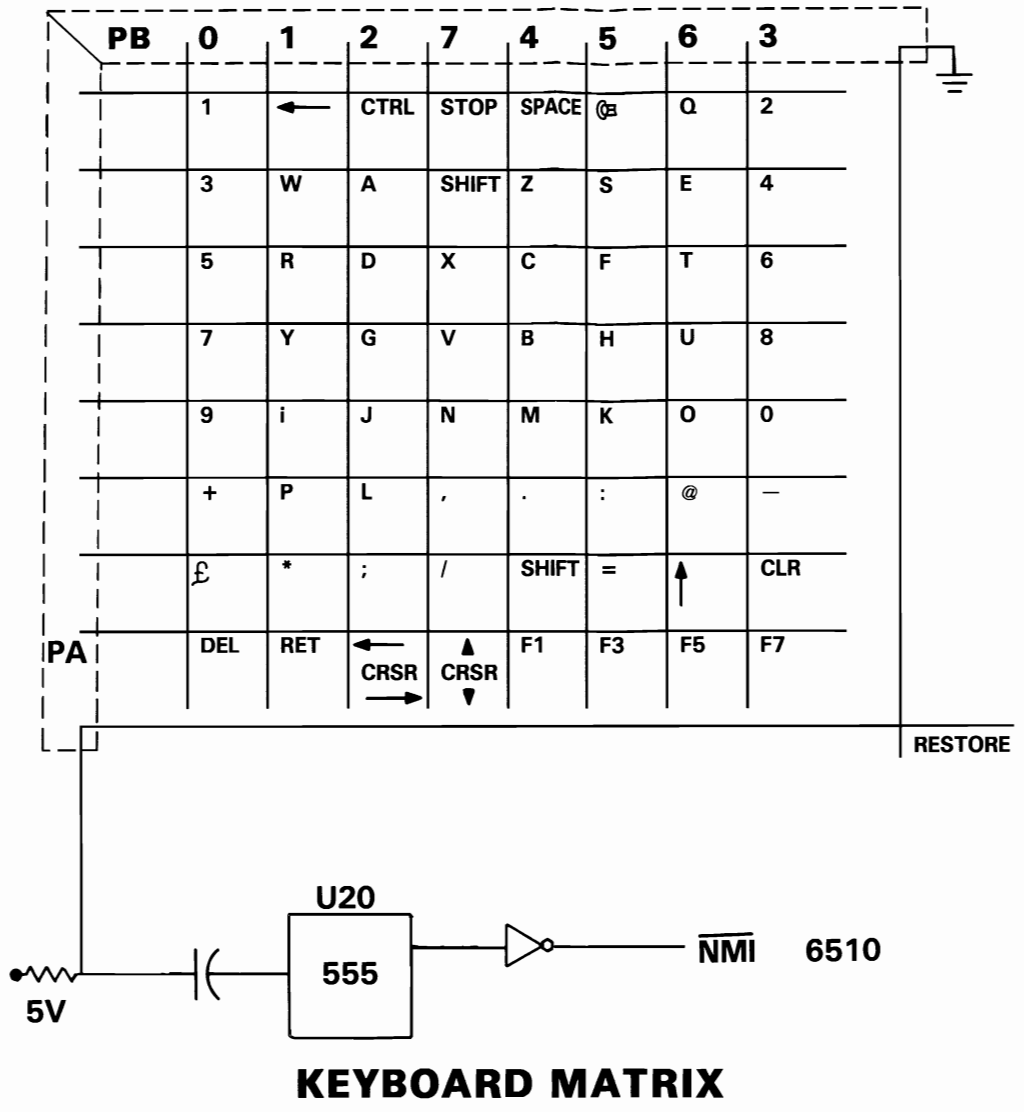
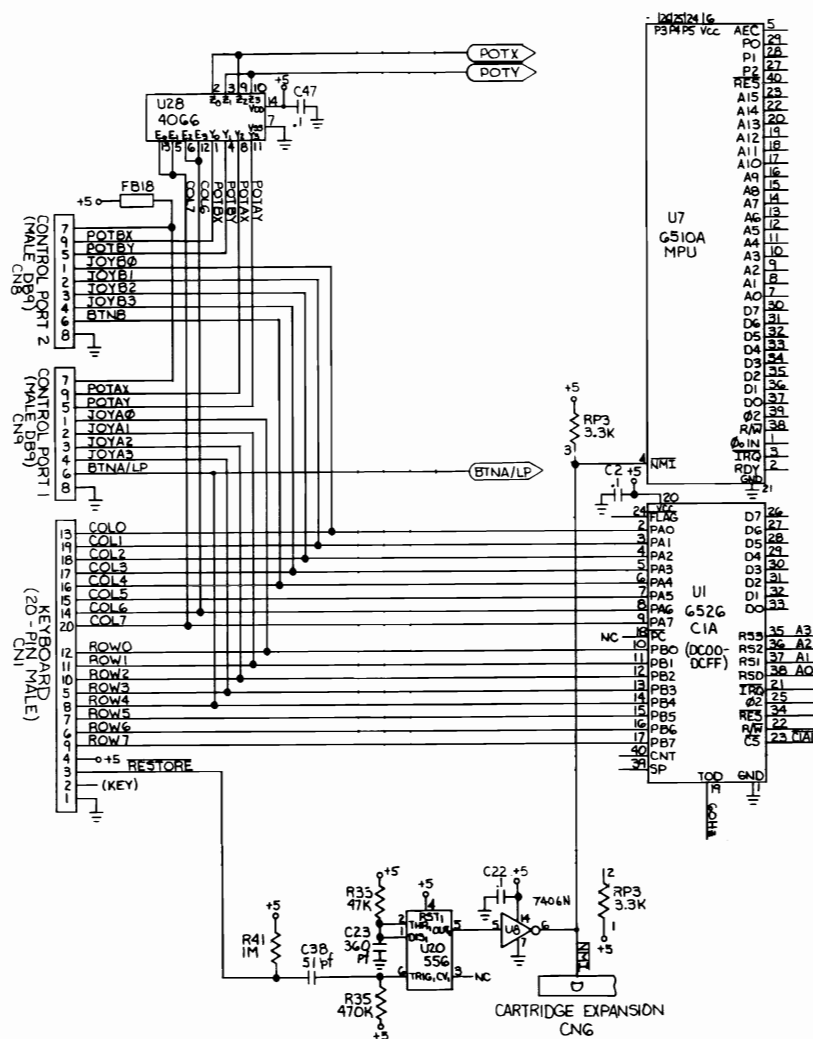
U19 is the Video Interface Chip (VIC). Sync (horizontal and vertical), and luminance (video) is output on pin 15. This signal is passed to pin 2 of the RF modulator. Color is output on pin 14, and passed to pin 3 of the modulator. Light Pen inputs are sensed by the VIC IC on pin 9. U18 is the Sound Interface 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 (P0-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 Vb 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.



KEYBOARD MATRIX

Keyboard, Joystick, and Paddle Interface Circuits.

Keyboard Interface.

U1 is a Complex Interface Adapter (CIA). Both parallel ports are used to decode the keyswitches on the keyboard. Parallel port A signals (PA0 - PA7) are outputs. Parallel port B signals (PB0 - PB7) are inputs. A "0" bit is shifted through the parallel port A, when a key is depressed on the keyboard, the "0" bit is returned on one of the parallel port B inputs. A program in the KERNAL ROM generates the shifting "0" bit output on parallel port A, and decodes the signals returning on the parallel port B inputs. Depressing the restore key causes U20 to trigger. U8 pin 6 goes "low" generating a Non-Maskable Interrupt (NMI) at the processor. This causes the processor to execute a subroutine which initializes the I/O Interfaces. If the STOP key is depressed at the same time, BASIC flags are also initialized.

Joystick Interface.

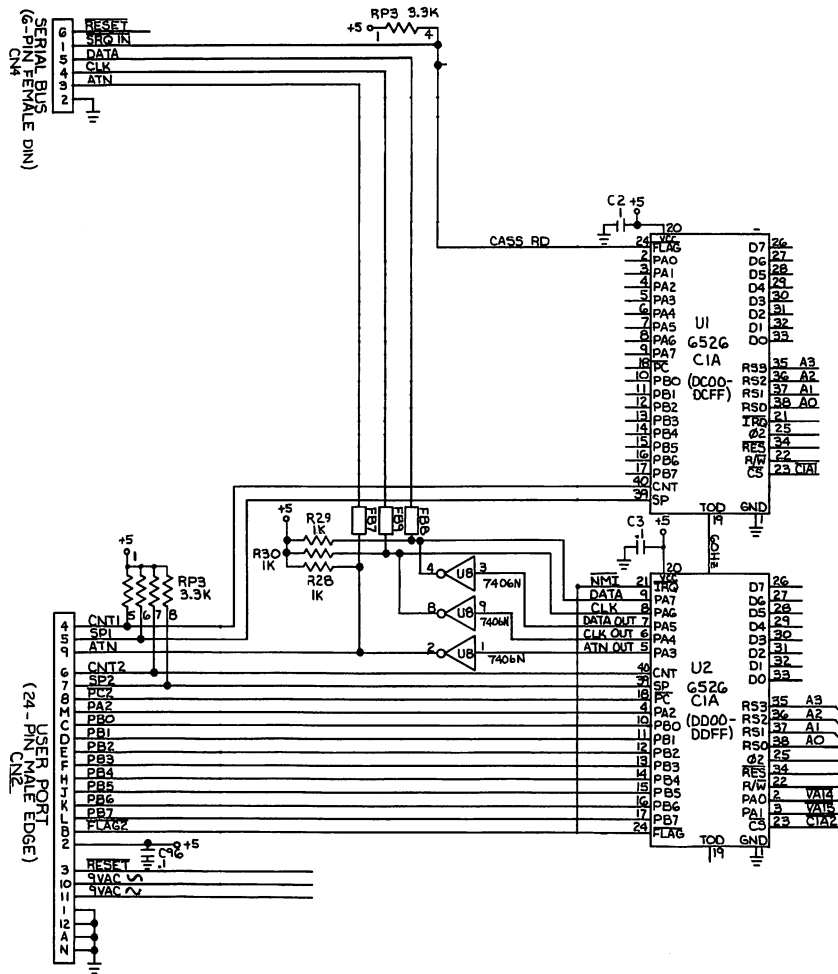
U1 also controls the joystick. Parallel port A accepts inputs from the B joystick connected to control port 2. Parallel port B accepts inputs from the A joystick connected to control port 1. When the joystick is moved up, down, left, right, or the fire button is depressed, a ground potential is applied to the appropriate input of U1.

Paddle Interface.

A Variable resistor is connected to adjusting knob on the paddle. When the knob is rotated, the resistance varies controlling the time constant of an RC network. The Voltage developed across the capacitor is input to an A/D converter internal to the SID chip U18. The digital output is stored in one of the SID registers. The paddle position can be determined by the reading the contents of the appropriate register. U28 is a 4066 CMOS switch. The signals from the paddles are passed to the SID chip when the Enable inputs (E0 - E3) of U28 are "high".

NOTE: U1 port assignments are incorrect on schematics. Refer to Keyboard Matrix for correct assignments.

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 (KERNAL 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

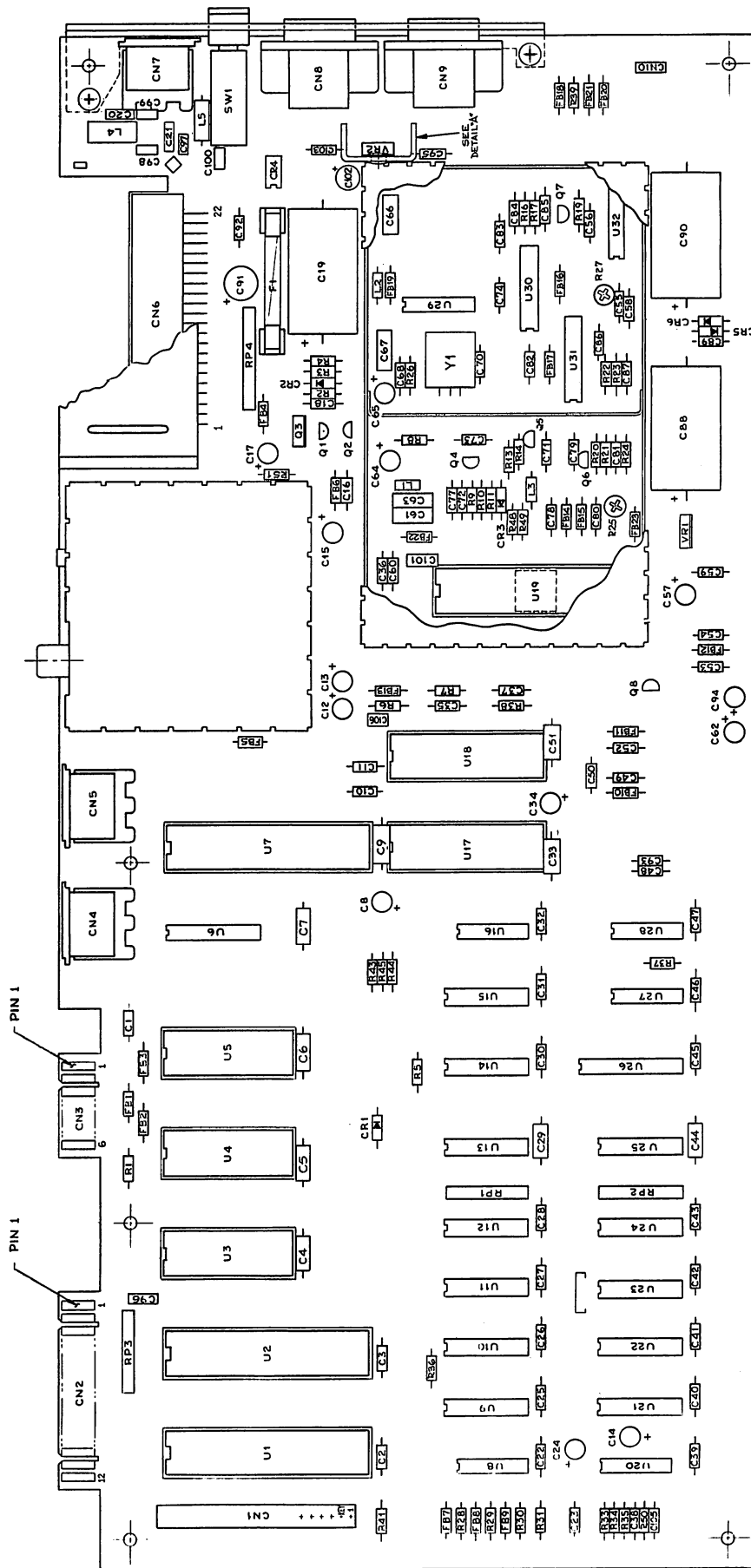
- These boards are interchangeable with casework, keyboard, etc.; however, care must be taken to provide the customer with a unit that is compatible with their monitor and cable.
- When component level repairs are necessary, be certain to acquire the appropriate part for the board you are repairing. 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	CONNECTORS		
C54	Ceramic	.22 μ F, 50V	CN1	Header Assy, 20 Pin	903331-20
C55	Ceramic	.1 μ F, 50V	CN4	6 Pin Din	C 903361-01
C56	Ceramic	.1 μ F, 50V	CN5	5 Pin Din	C 903362-01
C57	Electrolytic	10 μ F, 25V, +50%, -10%	CN6	44 Pin Card Edge	C 906100-02
C58	Ceramic	.1 μ F, 50V	CN7	7 Pin Din	C 906130-01
C59	Ceramic	.22 μ F, 50V	CN8,9	Plug Assy, 9 Pin Rt. Angle	C 906126-01
C60,61	Ceramic	.47 μ F, 50V, 20%	CN10	Header Assy, 3 Pin	
C62	Electrolytic	10 μ F, 25V, +50%, -10%	MISCELLANEOUS		
C63	Ceramic	.47 μ F, 50V, 20%	L1,2	Coil Inductor 2.2 μ H	901151-17
C64,65	Electrolytic	10 μ F, 25V, +50%, -10%	L3	Coil Inductor 3.0 μ H	901151-21
C66,67	Ceramic	.47 μ F, 50V, 20%	L4	Line Filter Assy	C 906127-01
C68	Ceramic	.1 μ F, 50V	L5	Coil Inductor 1.2 μ H	901152-01
C69			Y1	Crystal 14.31818 MHz	C 900558-01
C70	Mica	10 pF, 500V, 5%	SW1	Rocker Switch DPDT	C 904500-01
C71	Ceramic	.1 μ F, 50V	VR1	Voltage Regulator MC7812CT	901527-01
C72	Ceramic	220 pF, 50V	VR2	Voltage Regulator MC7805CT	901527-02
C73	Ceramic	150 pF, 50V	M1	Modulator	C 326130-01
C74	Ceramic	.1 μ F, 50V	F1	Fuse, Normal Blo, 250V, 1.5A	
C77	Ceramic	.1 μ F, 50V	FB1-23	Ferrite Bead	903025-01
C78	Ceramic	220 pF, 50V		Connector Panel (ON, OFF, Joystick)	326299-01
C79	Ceramic	510 pF, 50V		Cartridge Guide	326116-01
C80	Ceramic	51 pF, 50V		Shield Box	C 326265-01
C81	Ceramic	20 pF, 50V		Shield Cap	C 326267-01
C82	Ceramic	.1 μ F, 50V			
C83	Mica	33 pF, 500V, 5%			
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	O2
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	PB0-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.

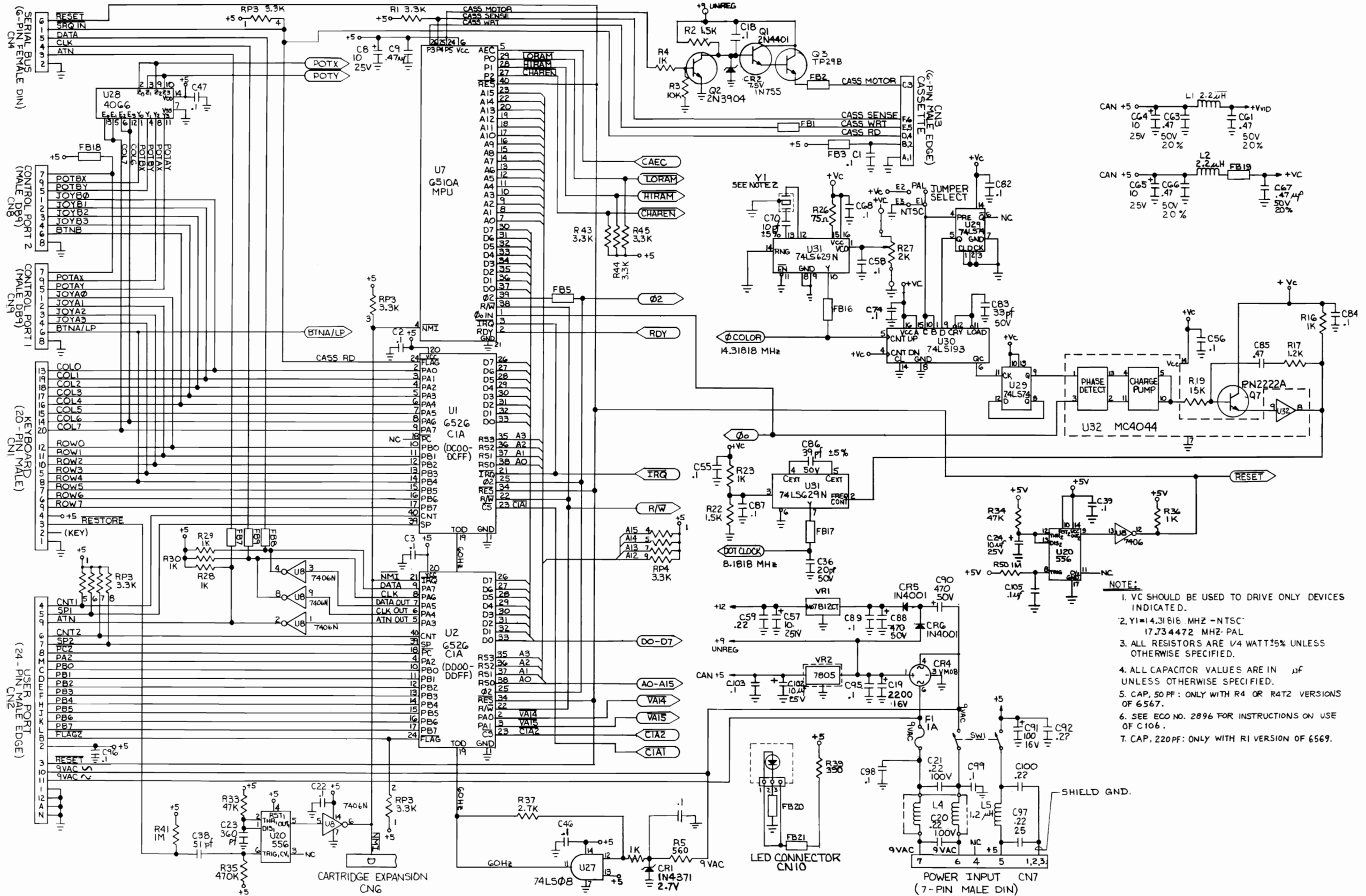
**U18 – 906112-01
6581 SOUND INTERFACE
DEVICE (SID)**

**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
O2	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

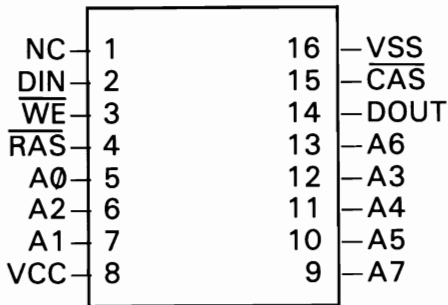
1,2,3,4	CAP1A,1B 2A, 2B	Capacitor filter connections.
5	RES	Reset input. A low pulse initializes the SID.
6	O2	Processor phase 2 clock input.
7	R/W	Processor read/write input.
8	CS	Chip select input.
9-13	A0-A4	Address lines from processor.
14	GND	Dc ground connection.
15-22	D0-D7	Data Bus connections.
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



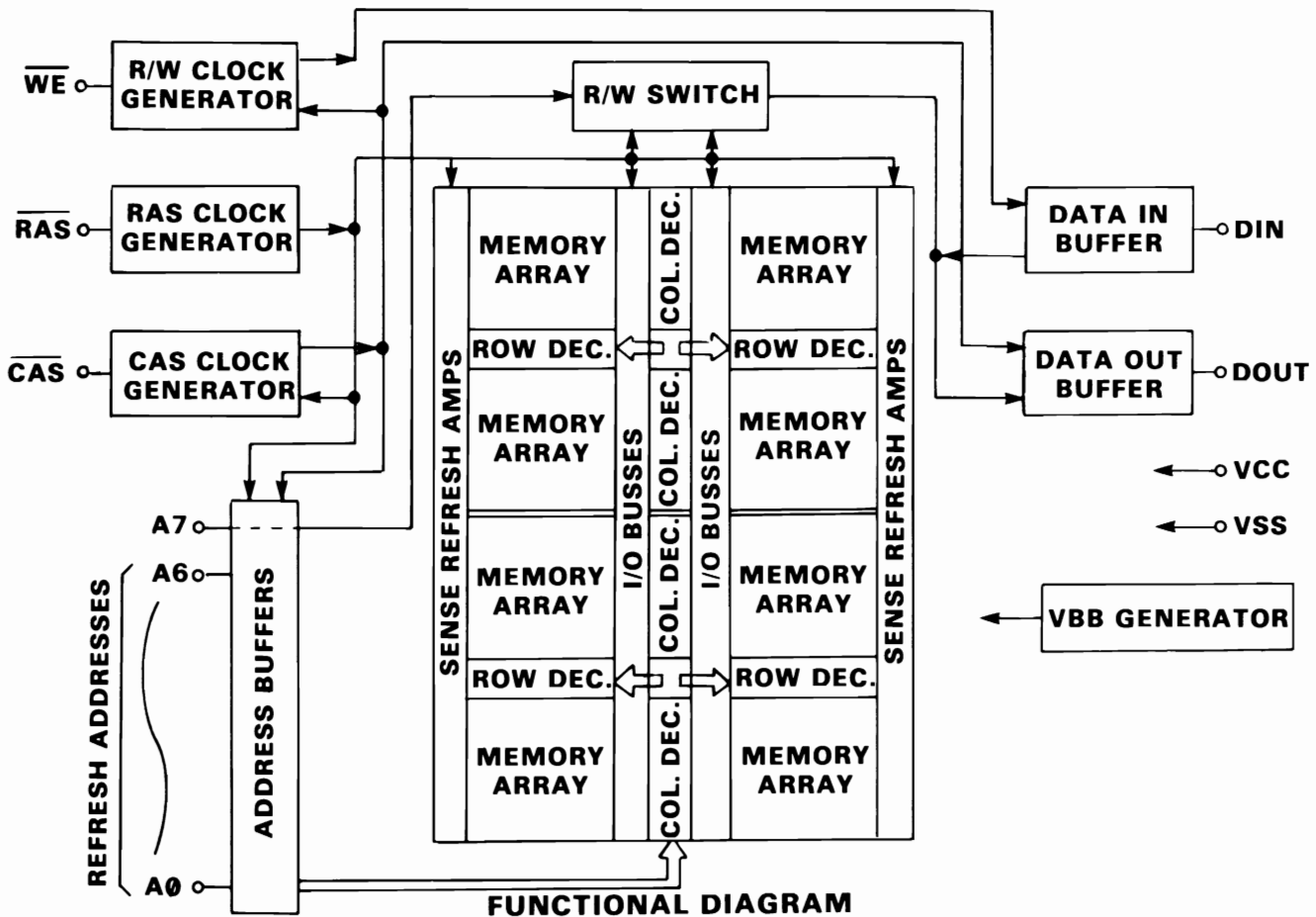
- NOTE:**
1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDICATED.
 2. Y1=14.31818 MHZ -NTSC
17.734472 MHZ-PAL
 3. ALL RESISTORS ARE 1/4 WATT±5% UNLESS OTHERWISE SPECIFIED.
 4. ALL CAPACITOR VALUES ARE IN µF UNLESS OTHERWISE SPECIFIED.
 5. CAP. 50 PF: ONLY WITH R4 OR R4T2 VERSIONS OF 6567.
 6. SEE ECO NO. 2896 FOR INSTRUCTIONS ON USE OF C106.
 7. CAP. 220PF: ONLY WITH R1 VERSION OF 6569.

PIN CONFIGURATION



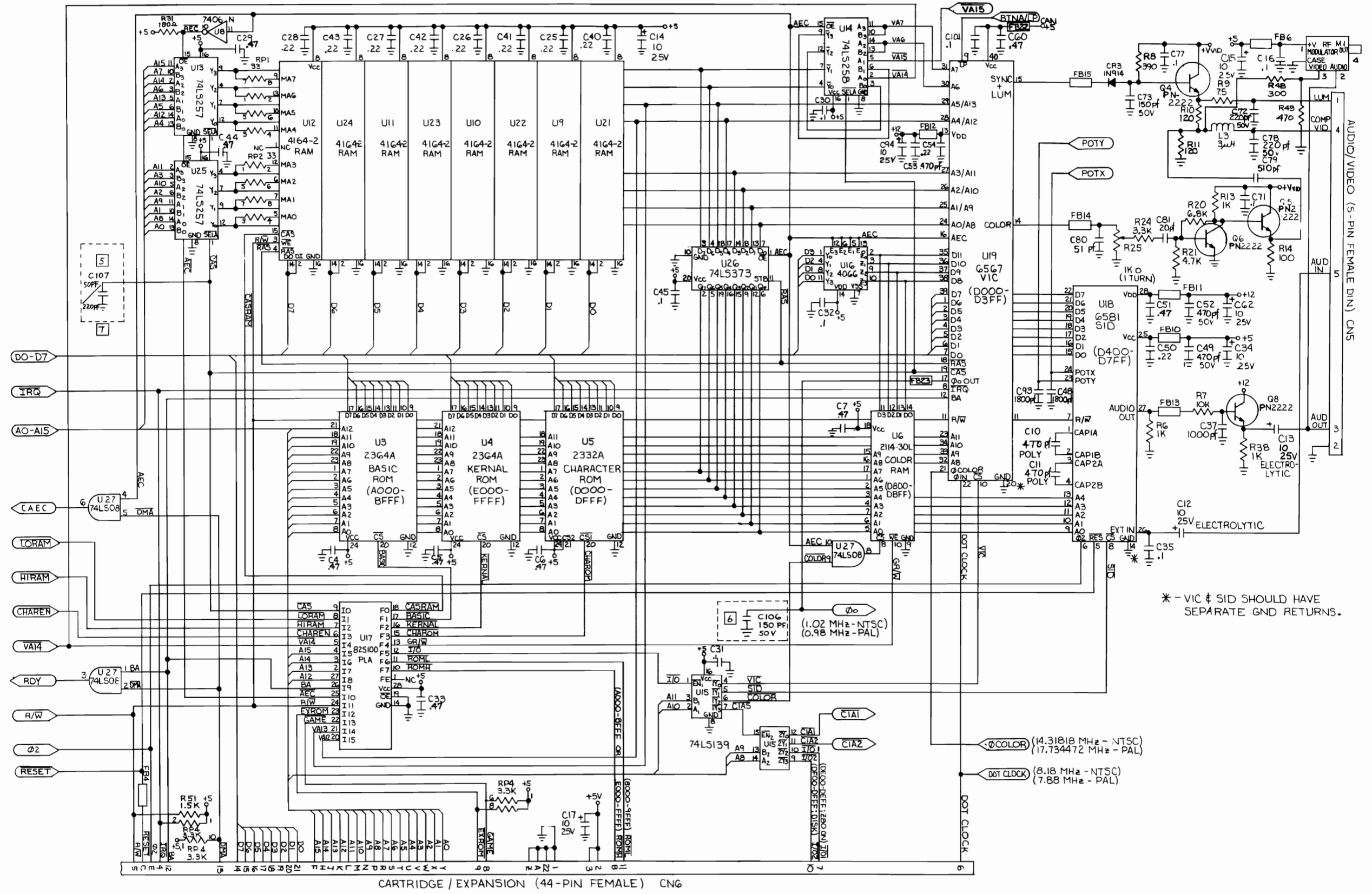
U9 ~ 12, U21 ~ 24
64K DYNAMIC RAM
901505-01

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



SCHEMATIC #326106 SHEET 2 OF 2

R	TANDBY	(MAX)(MW)
20		
28		
28		
22		
23		
20		
27.5		
20		
28		
20		
22		



* - VIC & SID SHOULD HAVE SEPARATE GND RETURNS.

PARTS LIST — PCB ASSEMBLY # 250407-04

C — Indicates Commodore Stocked Part Number

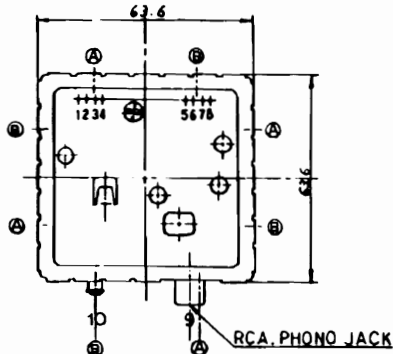
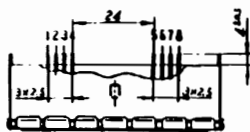
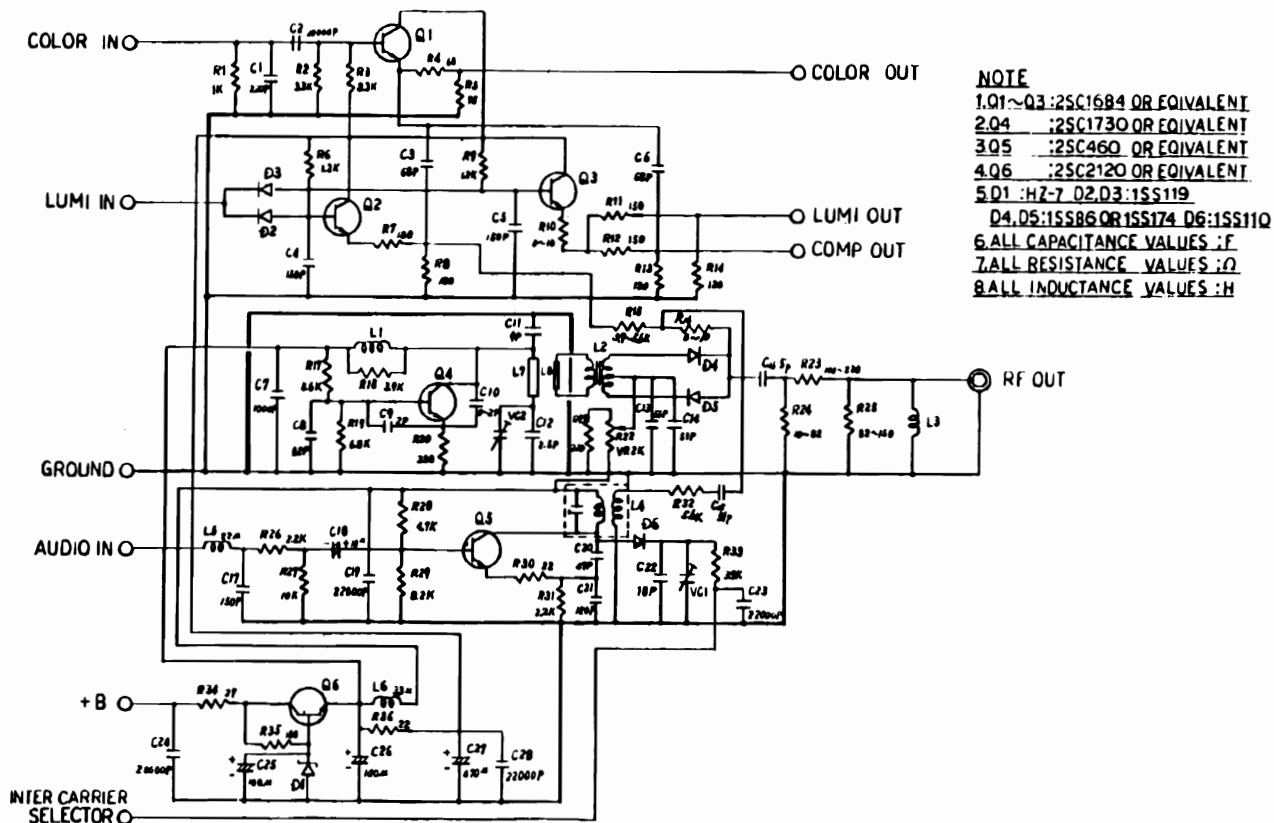
INTEGRATED CIRCUITS				RESISTORS (Continued)			
U1,U2	6526 CIA	C	906108-01	R26	Jumper Wire	R39	390
U3	2364 Basic ROM	C	901226-01	R27	Pot 500Ω	R41	1M
U4	2364 Kernal ROM	C	901227-03	R28	1K	R42	82
U5	2332 Char ROM	C	901225-01	R29	1K	R43	3.3K
U6	2114L-20 RAM		901453-01	R30	1K	R44	3.3K
U7	6510 μ Processor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

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

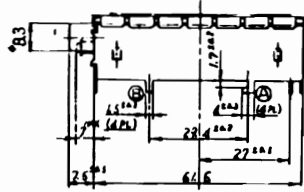
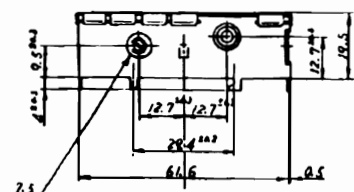
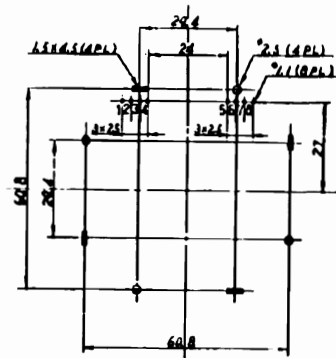
C – Indicates Commodore Stocked Part Number

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%	MISCELLANEOUS		
C88	Electrolytic	1000 μ F, 25V	L2	Coil Inductor 2.2 μ H	901151-17
C89	Ceramic	.1 μ F, 25V	L4	Coil Inductor 1.2 μ H	325570-01
C90	Electrolytic	470 μ F, 50V	L5	Choke Coil	C 325559-02
C91	Electrolytic	100 μ F, 16V, +50%, –10%	Y1	Crystal 14.31818 MHz	C 900558-01
C92	Ceramic	.1 μ F, 25V	SW1	Rocker Switch DPDT	904500-01
C93	Ceramic	1800 pF, 50V, 10% B	VR1	Voltage Regulator MC7812CT	901527-01
C94	Electrolytic	10 μ F, 25V, +50%, –10%	VR2	Voltage Regulator MC7805CT	901527-02
C95,96	Ceramic	.1 μ F, 25V	M1	Modulator	C 251080-01
C97	Ceramic	.22 μ F, 25V	F1	Fuse, Normal Blo, 250V, 1.5A	
C98,99	Ceramic	.1 μ F, 50V, +80%, –20%	FB1-5	Ferrite Bead	903025-01
C100	Ceramic	.22 μ F, 25V	FB7-23		
C101	Ceramic	.1 μ F, 50V, +80%, –20%		Connector Panel (Power, ON, OFF)	251095-01
C102	Electrolytic	10 μ F, 25V, +50%, –10%		Cartridge Guide	326116-01
C103	Ceramic	.1 μ F, 25V		Shield Box	C 251023-01
C104				Shield Cap	C 251024-01
C105	Ceramic	.1 μ F, 25V			
C108	Electrolytic	10 μ F, 25V, 20%			
C200	Ceramic	.1 μ F, 25V			

MODULATOR SCHEMATIC #251025

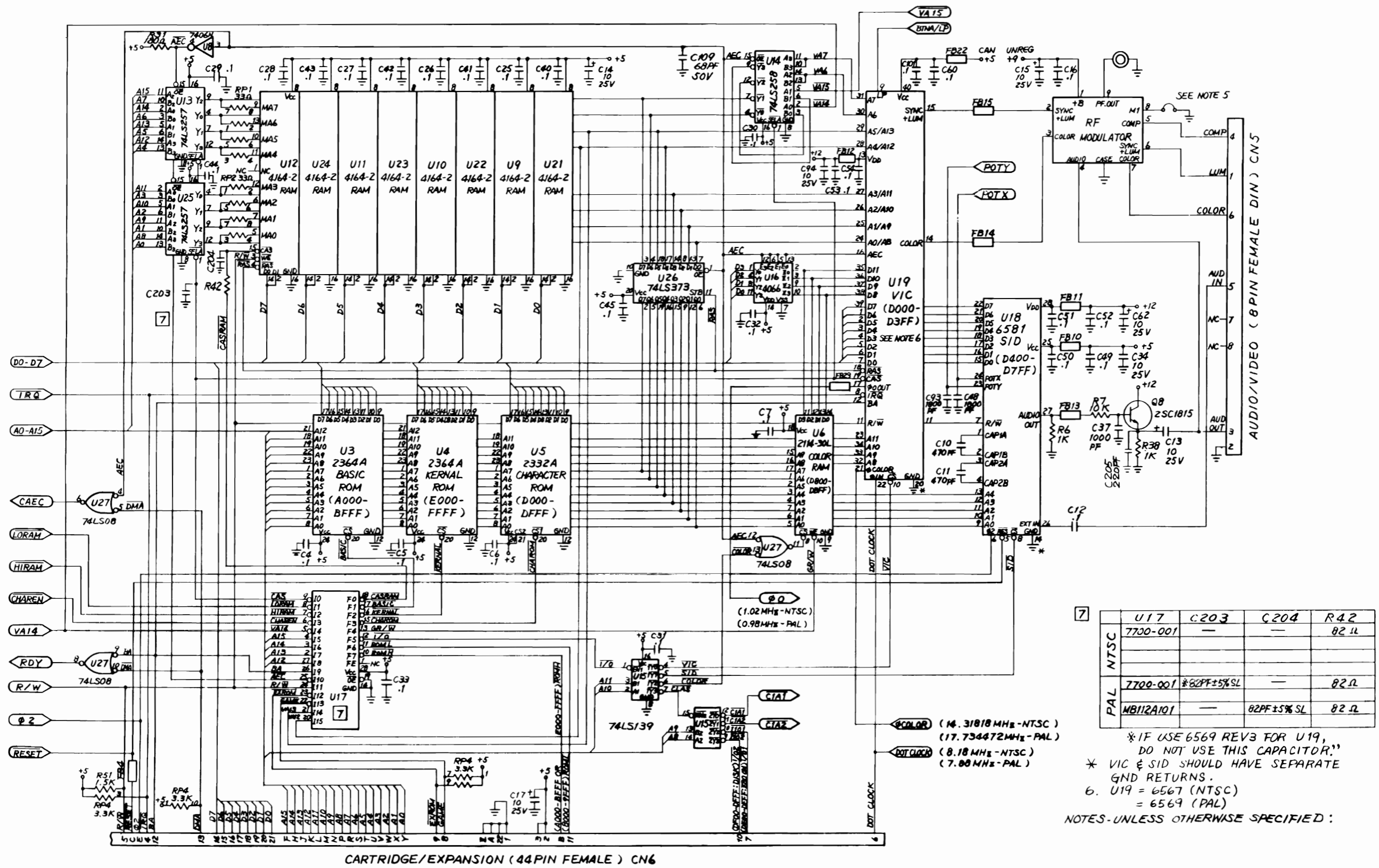


NO	TERMINALS
1	+B
2	SYNC + LUM SIG. INPUT
3	COLOR SIG. INPUT
4	AUDIO SIG. INPUT
5	COMP. SIG. OUTPUT
6	SYNC + LUM SIG. OUTPUT
7	COLOR SIG. OUTPUT
8	INTER CARRIER SELECTOR
9	RF. OUTPUT
10	CHANNEL TRIMMER



NOTE
 1. RECOMMENDED PCB HOLE CENTERS (COMPONENT SIDE)
 2. ALL DIMENSION ARE IN MILLIMETERS
 3. NO. 8 TERMINAL SHORT = G.PAL OPEN = L.PAL

SCHEMATIC #251138 SHEET 1 OF 2



	U17	C203	C204	R42
NTSC	7700-001	—	—	82 Ω
PAL	7700-001	*82PF±5%SL	—	82 Ω
	MB112A101	—	82PF±5%SL	82 Ω

* IF USE 6569 REV3 FOR U19, DO NOT USE THIS CAPACITOR.
 * VIC & SID SHOULD HAVE SEPARATE GND RETURNS.
 6. U19 = 6567 (NTSC) = 6569 (PAL)
 NOTES-UNLESS OTHERWISE SPECIFIED :

CARTRIDGE/EXPANSION (44PIN FEMALE) CN6

**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	P0
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

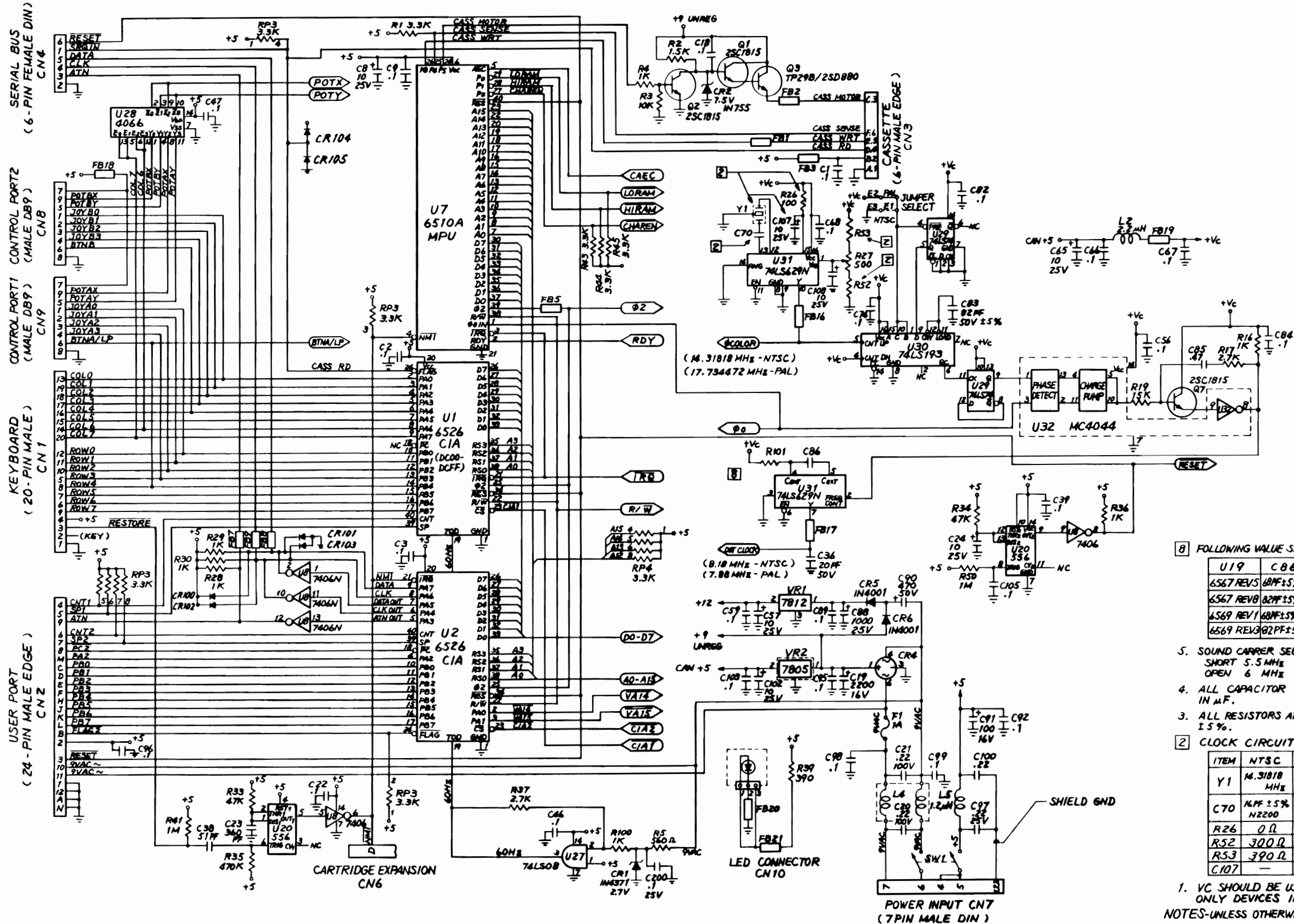
**PIN
ASSIGNMENT**

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

**U17 – 906114-01
PROGRAMMABLE
LOGIC ARRAY (PLA)**

1	O1	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		
21	GND	Dc ground connection.
24-29	P0-P5	I/O bidirectional port. This port can be controlled via memory locations 0000 and 0001. 0001 = Output register 0000 = Data direction register
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.

SCHEMATIC #251138 SHEET 2 OF 2



8) FOLLOWING VALUE SHOULD BE USE.

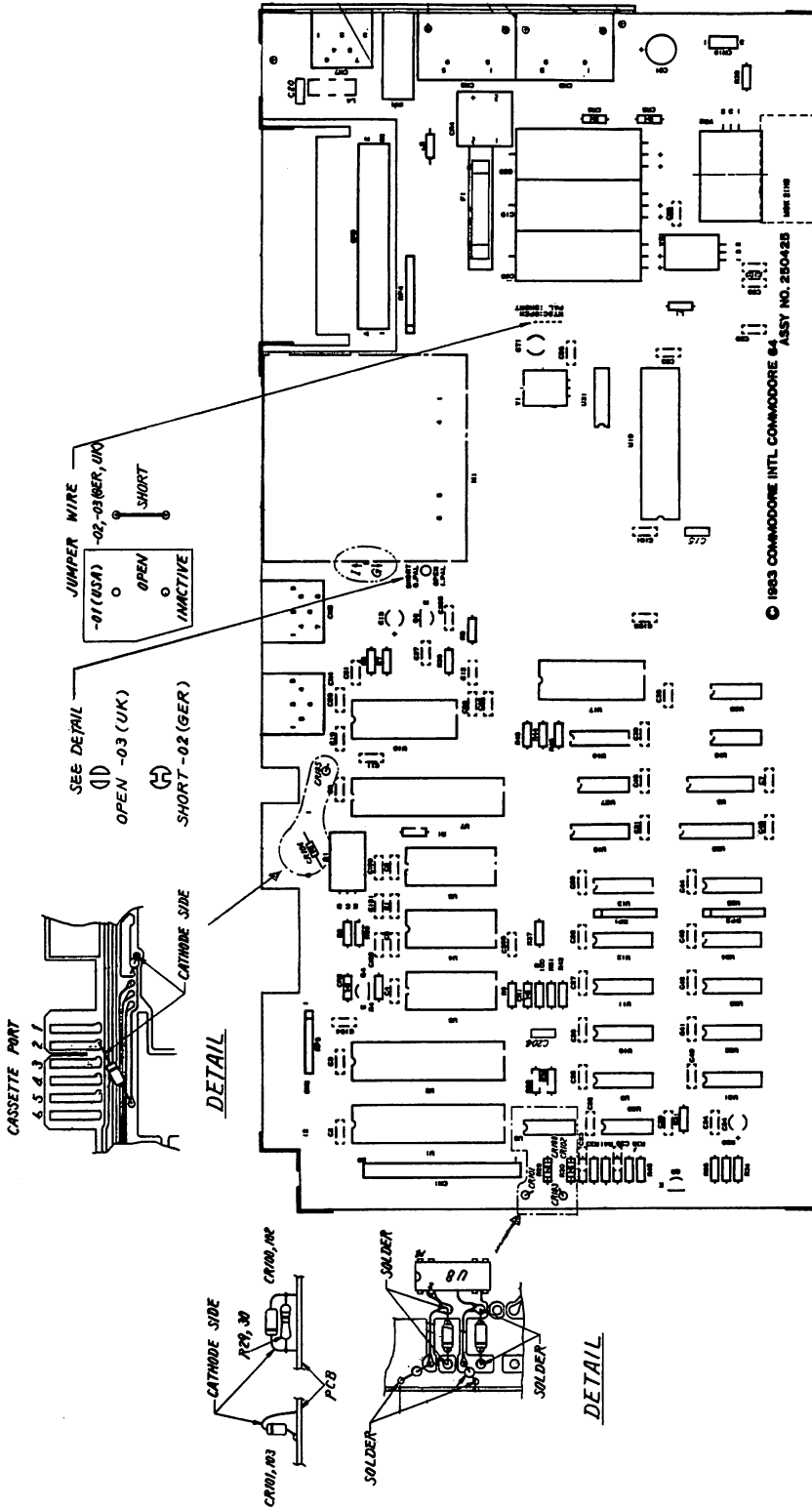
	U19	C86	R101
6567 REV5	60PF±5%SL	22KΩ	
6567 REV8	82PF±5%SL		
6569 REV1	60PF±5%SL	22KΩ	
6569 REV3	82PF±5%SL		

5. SOUND CARRIER SELECT (PAL ONLY) SHORT 5.5MHZ FOR G.PAL OPEN 6 MHZ FOR I.PAL
4. ALL CAPACITOR VALUES ARE IN M.F.
3. ALL RESISTORS ARE 1/4 WATT ±5%.

2) CLOCK CIRCUIT:

ITEM	NTSC	PAL
Y1	14.31818 MHz	17.734472 MHz
C70	16PF ±5% N2200	15PF ±5% N3300
R26	0Ω	100Ω
R52	300Ω	330Ω
R53	390Ω	100Ω
C107		10MF

1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDEICATED.
NOTES-UNLESS OTHERWISE SPECIFIED:



SOUND CARRIER SELECT	MODULATOR	
	NTSC	PAL
JUMPER	DON'T CARE	PA1 251025-01
	DON'T CARE	PA1 251697-01
SWITCH	DON'T CARE	-02 (GER) -03 (UK)
	DON'T CARE	DON'T CARE
	DON'T CARE	DON'T CARE
	DON'T CARE	POSITION POSITION

DETAIL 'C' SOUND CARRIER SELECT

BOARD LAYOUT #250425-01

PARTS LIST — PCB ASSEMBLY # 250425-01

C — Indicates Commodore Stocked Part Number

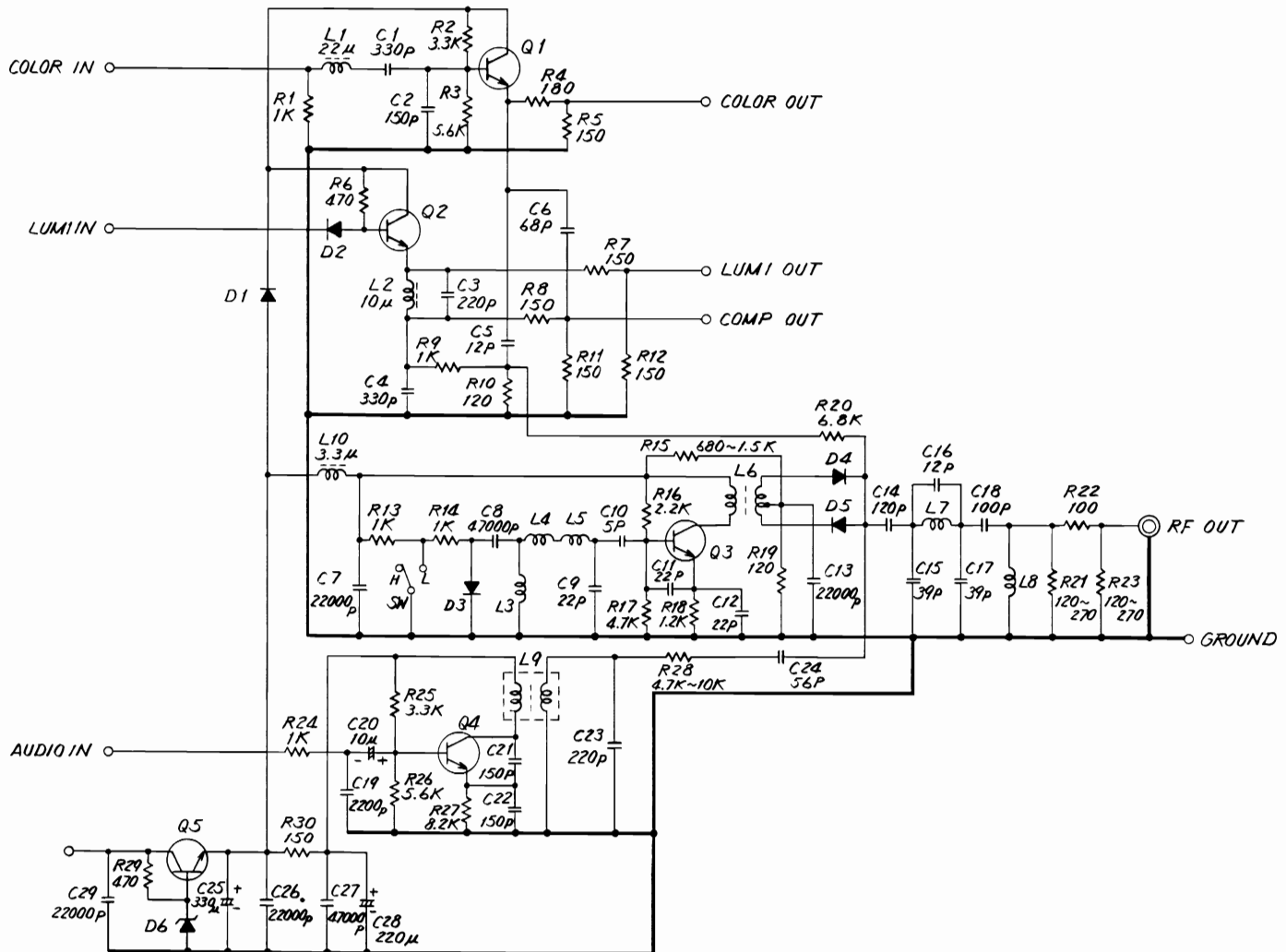
INTEGRATED CIRCUITS				RESISTORS (Continued)			
U1,U2	6526 CIA	C	906108-01	R39	390	R50	1M
U3	2364 Basic ROM	C	901226-01	R41	1M	R51	1.5K
U4	2364 Kernal ROM	C	901227-03	R42	82	R60	100
U5	2332 Char ROM	C	901225-01	R43	3.3K	R100	1K
U6	2114L-20 RAM		901453-01	R44	3.3K	R101	22K
U7	6510 μ Processor	C	906107-01	R45	3.3K		
U8	7406		901522-06 sub:	RESISTOR PACKS			
	7416		901522-14	RP1,2	33 Ω , 8 Pin (Bourns No. 4308R-102-330)		
U9-U12	4164 (200 nS)		901505-01	RP3	3.3K Ω , 8 Pin (Bourns No. 4308R-101-332)		
U13	74LS257		901521-57	RP4	3.3K Ω , 10 Pin, 1/4 W		
U14	74LS258		901521-58	RP5	1K Ω , 6 Pin		
U15	74LS139		901521-18	CAPACITORS			
U16	4066		901502-01	C1-7	Ceramic	.1 μ F, 25V	
U17	82S100 PLA	C	906114-01	C9	Ceramic	.1 μ F, 25V	
U18	6581 SID	C	906112-01	C10,11	Ceramic	470 pF, 50V, 10%	
U19	6567 VIC II	C	906109-04	C12	Ceramic	.1 μ F, 25V	
U20	LM556		901523-03	C13	Electrolytic	10 μ F, 25V, +50%, -10%	
U21-U24	4164 (200 nS)		901505-01	C15	Tantalum	4.7 μ F, 16V, 20%	
U25	74LS257		901521-57	C19	Electrolytic	2200 μ F, 16V	
U26	74LS373		901521-29	C20	Film	.22 μ F, 100V, 20%	
U27	74LS08		901521-03	C22	Ceramic	.1 μ F, 25V	
U28	4066		901502-01	C23	Ceramic	360 pF, 50V, 10% sub:	
U31	7701/8701	C	251527-01			390 pF	
TRANSISTORS				C24	Electrolytic	22 μ F, 25V, +50%, -10%	
Q1	TIP29 A		902653-01	C31,33,34	Ceramic	.1 μ F, 25V	
Q2-4	2SC1815	C	902693-01	C37	Ceramic	1000 pF, 50V, 10% B	
DIODES				C38	Ceramic	51 pF, 50V, 5% SL	
CR1	2.7V Zener IN4371		906103-02	C39-46	Ceramic	.1 μ F, 25V	
CR2	6.8V Zener IN754A			C48	Ceramic	1800 pF, 50V, 10% B	
CR4	Bridge S2V310	C	251026-01 sub:	C50,51,53	Ceramic	.1 μ F, 25V	
	DBA20B	C	251026-02 sub:	C59	Ceramic	.1 μ F, 25V	
	DBA20C	C	251026-03	C88	Electrolytic	1000 μ F, 25V	
CR5,6	Rectifier IN4001		900750-01	C90	Electrolytic	470 μ F, 50V	
CR9,	IN4148 sub:			C91	Electrolytic	100 μ F, 16V, +50%, -10%	
CR12-16,	IN914			C93	Ceramic	1800 pF, 50V, 10% B	
100-105				C101	Ceramic	.1 μ F, 50V, +80%, -20%	
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.				C102	Ceramic	.1 μ F, 25V	
R1	3.3K	R26	3.3K	C150-152	Ceramic	470 pF, 50V, 10%	
R2	470	R31	180	C153	Ceramic	68 pF, 50V, 5%	
R3	100K	R33	47K	C154	Ceramic	470 pF, 50V, 10%	
R4	1K	R34	47K	C200	Ceramic	.1 μ F, 25V	
R5	560	R35	470K	C204	Ceramic	150 pF, 50V, 10%	
R6	1K	R37	2.7K	C205	Ceramic	220 pF, 50V, 5%	
R7	10K	R38	1K	CT1	Trimmer	40 pF	

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			

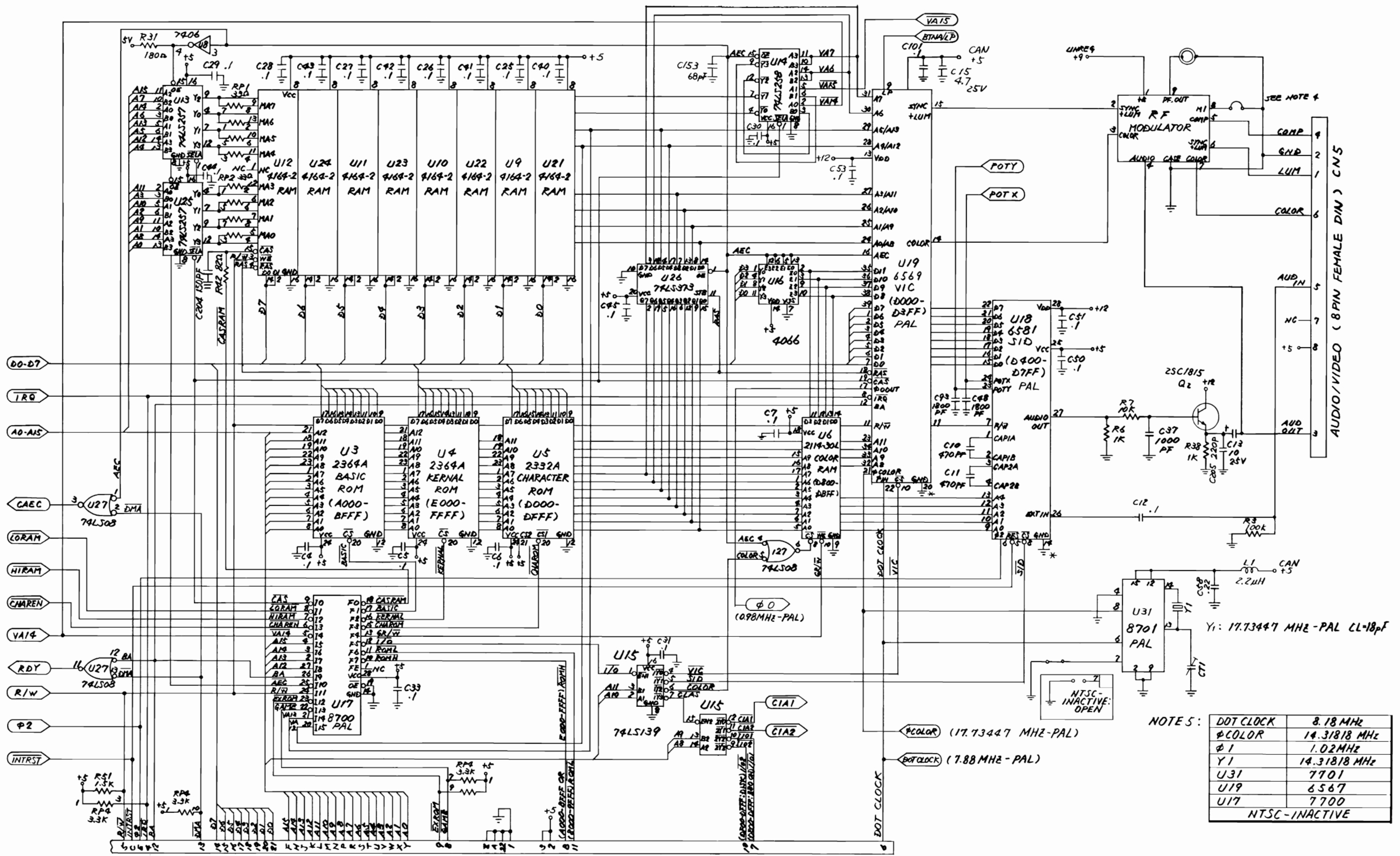
MODULATOR SCHEMATIC #251696



NOTES

1. D1, D2 : MA151K OR EQUIVALENT
2. D3 : MA57 OR EQUIVALENT
3. D4, D5 : 1SS198 OR EQUIVALENT
4. D6 : HZ-7A1 OR EQUIVALENT
5. Q1, Q2 : 2SC2405 OR EQUIVALENT
6. Q3, Q4 : 2SC2778 OR EQUIVALENT
7. Q5 : 2SC2120Y OR EQUIVALENT
8. COMPONENT PARTS VALUE : R= Ω , C=F, L=H

SCHEMATIC #251469 SHEET 1 OF 2



CARTRIDGE/EXPANSION (49 PIN FEMALE) CN6

NOTE 5:

DOT CLOCK	8.18 MHz
Φ COLOR	14.31818 MHz
Φ 1	1.02 MHz
Y 1	14.31818 MHz
U31	7701
U19	6567
U17	7700
NTSC-INACTIVE	

**PIN
ASSIGNMENT**

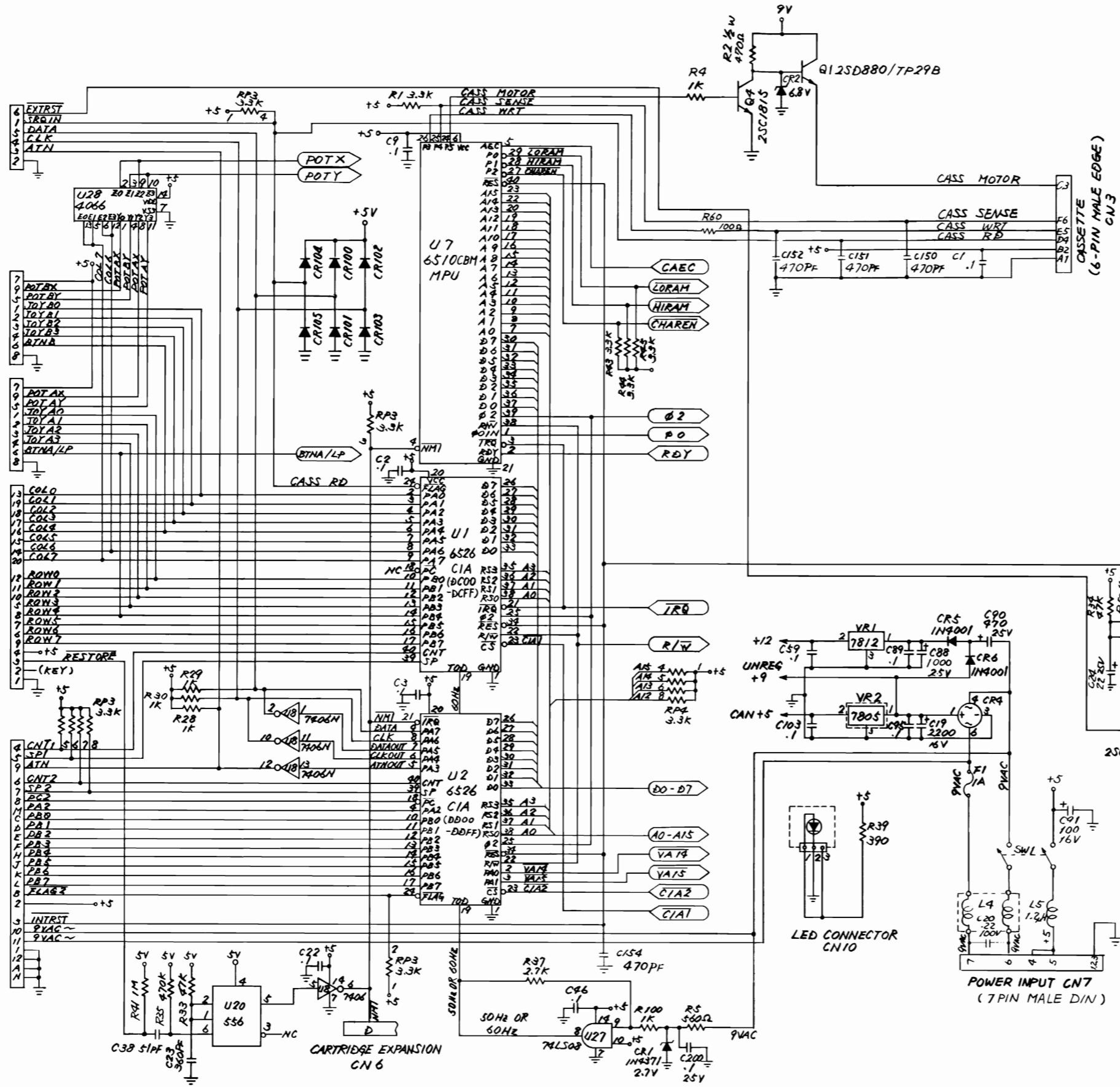
DB6	1	40	VCC
DB5	2	39	DB7
DB4	3	38	DB8
DB3	4	37	DB9
DB2	5	36	DB10
DB1	6	35	DB11
DB0	7	34	A10
IRQ	8	33	A9
LP	9	32	A8
CS	10	31	A7
R/W	11	30	A6("1")
BA	12	29	A5(A13)
VDD	13	28	A4(A12)
COLOR	14	27	A3(A11)
SYNC/LUM	15	26	A2(A10)
AEC	16	25	A1(A9)
PHO	17	24	A0(A8)
RAS	18	23	A11
CAS	19	22	PHIN
VSS	20	21	PHCL

**U19 – 906109-01
MULTIPLEXED
ADDRESSES IN PARENTHESES**

1-7/39	DB0-DB7	Processor data bus connections. Bidirectional data.
8	IRQ	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.
10	CS	Chip select input. A low signal selects the VIC 11.
11	R/W	Processor read/write connection.
12	BA	Bus available output. A low pulse output indicates the VIC 11 chip wants controls of the processor network to process faster video operations that the system clock can handle.
13	VDD	12VDC input.
14	COLOR	Output contains chrominance, color reference burst, and color of display data.
15	SYNC/ LUM	Output containing video, horizontal and vertical sync, and luminance information.
16	AEC	Address enable output. This is usually connected to the processor AEC input, controlling the address bus. AEC = 0 processor address bus disabled, refresh ram. AEC = 1 processor address bus enabled. This allows transparent refresh operations.
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 micro-processor 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.

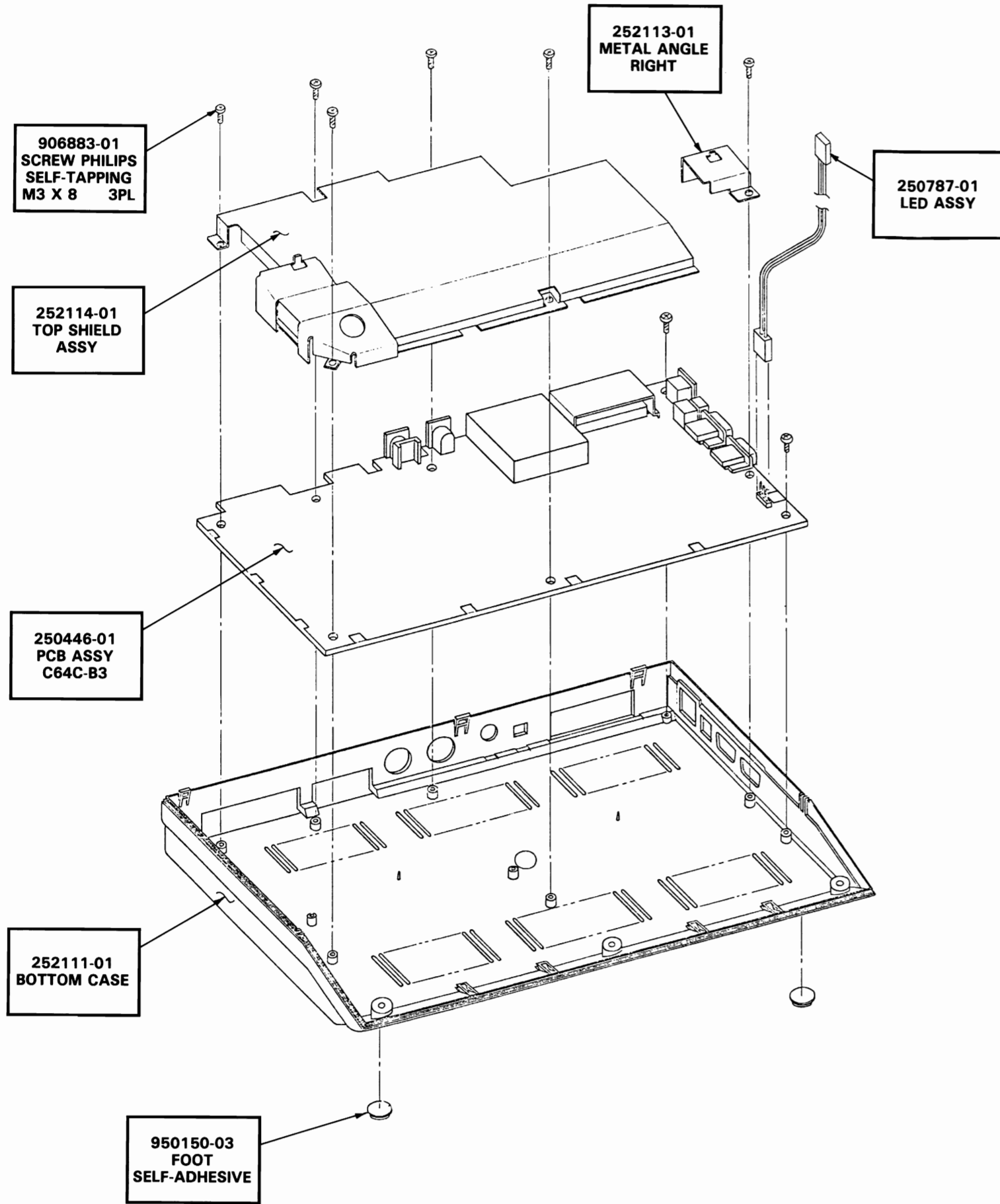
SCHEMATIC #251469 SHEET 2 OF 2

SERIAL BUS (6-PIN FEMALE DIN) CN 4
 CONTROL PORT2 (MALE DB9) CN 8
 CONTROL PORT1 (MALE DB9) CN 9
 KEYBOARD (20-PIN MALE) CN 1
 USER PORT (24-PIN MALE EDGE) CN 2

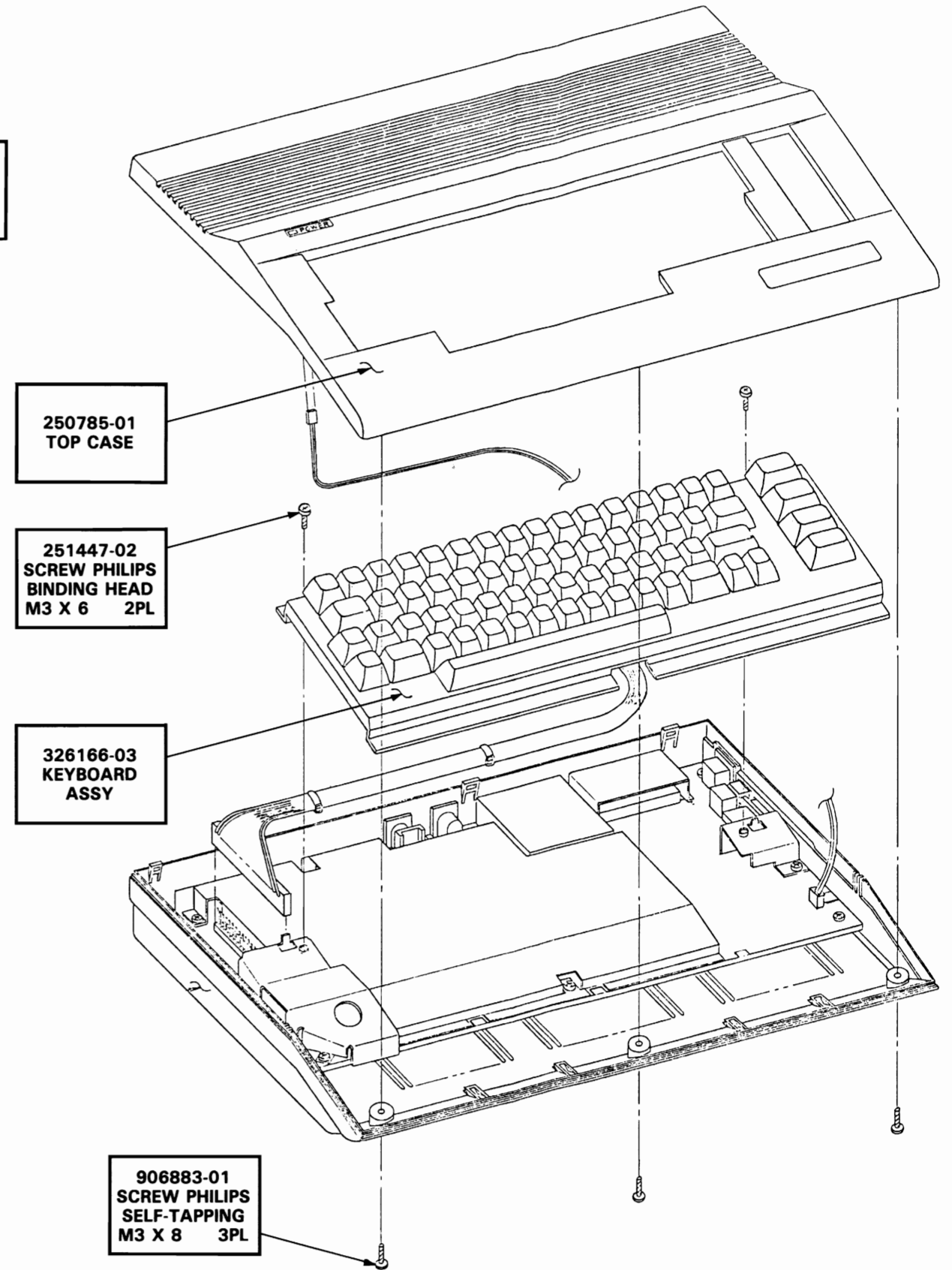


4. SOUND CARRIER SELECT (PAL ONLY)
 SHORT 5.5 MHz FOR G.PAL
 OPEN 6 MHz FOR I.PAL
3. ALL CAPACITOR VALUES ARE IN µF
2. ALL RESISTORS ARE 1/4 WATT ±5%.
1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDICATED.
- NOTES-UNLESS OTHERWISE SPECIFIED:

BOTTOM CASE ASSEMBLY C64-B3



MAIN ASSEMBLY C64-B3



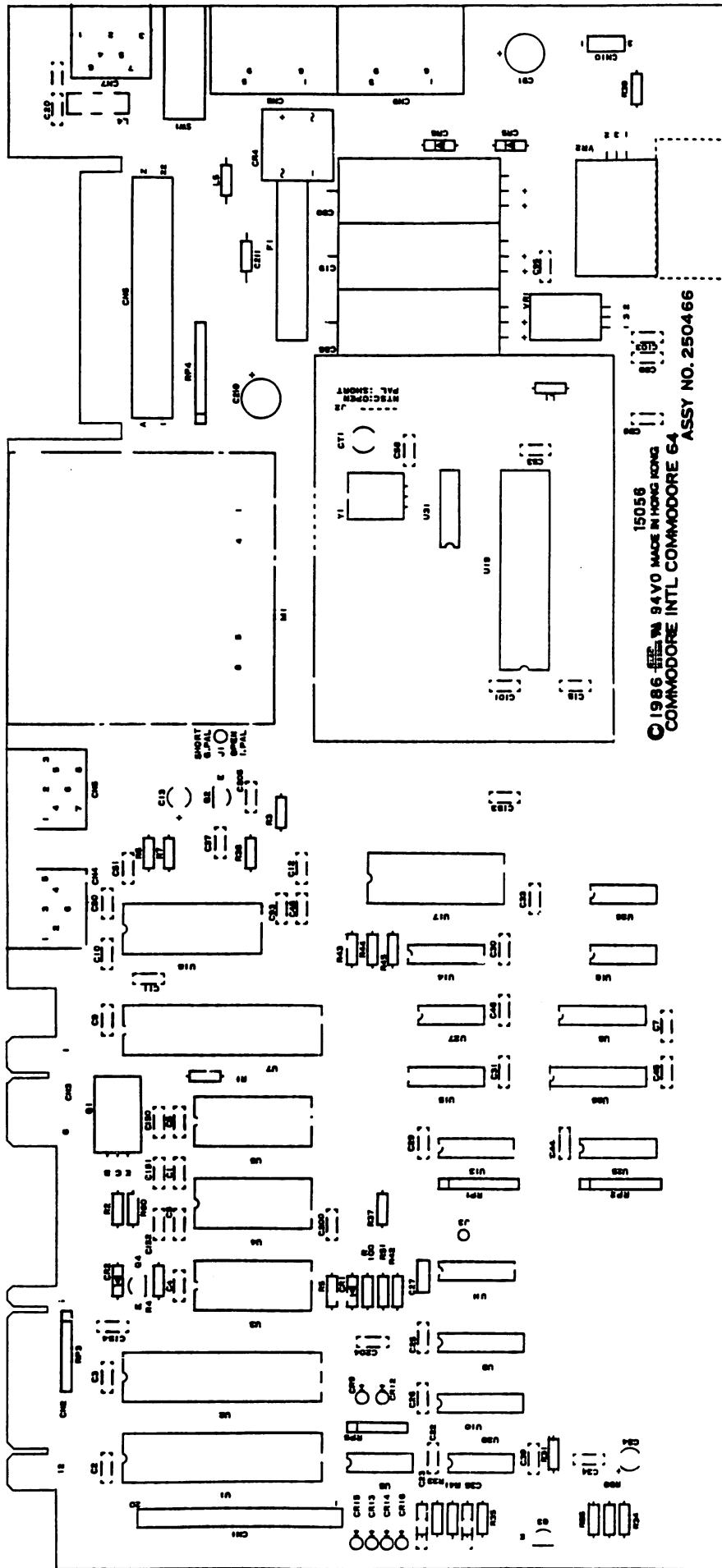
PARTS LIST

PCB ASSEMBLY #250466-01 C64-B3

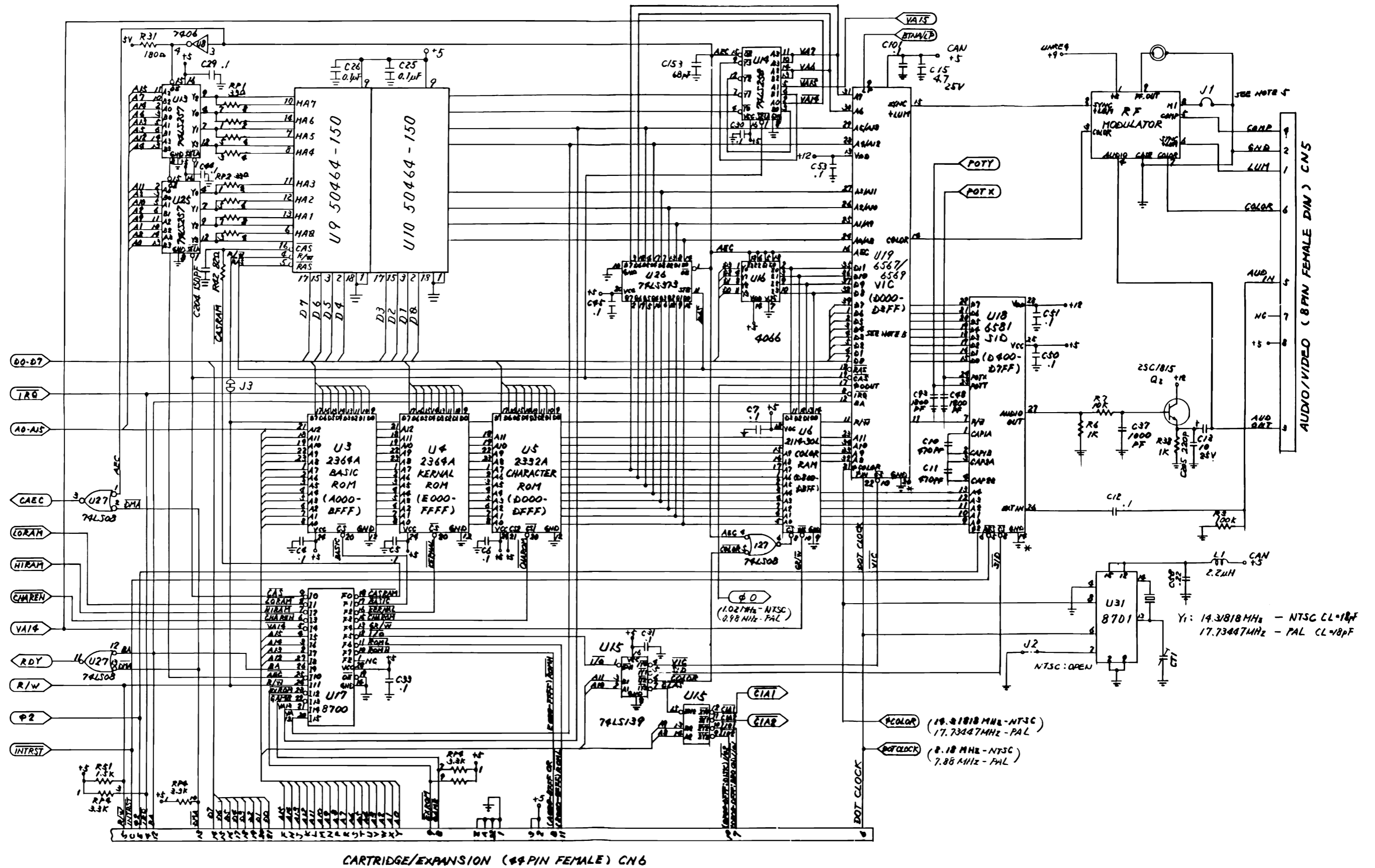
Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-reference for TTL chips, Transistors, etc. are available in manual form through the 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	CR9,12-16	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	RESISTORS — All are carbon 1/4 watt, 5% unless noted		
U6	MEM SRAM 1KX4 Bit	901453-07	R42	CF 82 Ohm	901550-74
	200NS 2114		R60	CF 100 Ohm	901550-49
U6	MEM SRAM 1KX4 Bit	901453-08 Sub:	R31	CF 180 Ohm	901550-100
	200NS 5114-2 CMOS		R39	CF 390 Ohm	901550-57
	MEM SRAM 1KX4 Bit	901453-09 Sub:	R5	CF 560 Ohm	901550-30
	150NS 2114-15		R4,6,38,100	CF 1K Ohm	901550-01
	MEM SRAM 1KX4 Bit	901453-10 Sub:	R51	CF 1.5K Ohm	901550-69
	120NS 2114-12		R37	CF 2.7K Ohm	901550-23
U9, U10	MEM DRAM 64KX4 Bit	390083-02	R1,26,43-45	CF 3.3K Ohm	901550-02
	150NS		R7	CF 10K Ohm	901550-20
U3	MEM ROM Basic C64	901226-01	R33,34	CF 47K Ohm	901550-22
	2364B-161		R3	CF 100K Ohm	901550-07
U4	MEM ROM Kernal C64	901227-03	R35	CF 470K Ohm	901550-82
	2364B-273		R41,50	CF 1M Ohm	901550-84
U5	MEM ROM Char C64	901225-01	R2	CF 470 Ohm 1/2W 5%	901600-38
	2332C-250		RP1, RP2	NTWK SIP 33 Ohm 8 Pin	902422-03
U20	LIN Dual Timer NE556	901523-03	RP5	NTWK SIP 1K Ohm 6 Pin	902441-22
U16, U28	LIN CMOS SW/3UF 4066B	901502-01	RP3	NTWK SIP 3.3K Ohm 8 Pin	902442-29
U13, U25	TTL 74LS257A	315033-01	RP4	NTWK SIP 3.3K Ohm 10 Pin	902410-06
U26	TTL 74LS373	901521-29	CAPACITORS		
U15	TTL 74LS139	901521-18	C38	Axl 51pF 5% SL	251078-24
U27	TTL 74LS08	901521-03		Ceramic Disc 51pF 50V 5% SL	251072-33 Sub:
U14	TTL 74LS258A	390010-01		Ceramic Disc 56pF 50V 5% SL	251072-19 Sub:
U8	TTL 7406	901522-06	C153	Ceramic Disc 68pF 50V 5%	900010-51
	TTL 7416	901522-14 Sub:	C204	Ceramic Disc 150pF 50V SL-K 10%	251071-24
TRANSISTORS			C205	Ceramic Disc 220pF 50V 5% SL	251072-26
Q1	NPN Power 2SD880	902694-01	C23	Ceramic Axl 360pF 10% B	251078-51
	NPN Power TIP29A	902653-01 Sub:		Ceramic Disc 390pF 50V Y5P-K	251069-03 Sub:
	NPN Power 2SD476	902694-02 Sub:	C10,11,	Ceramic Disc 470pF 50V Y5P-K	251069-04
	NPN Power 2SD313	902694-03 Sub:	150-152,		
	NPN Power 2SD1310	251294-01 Sub:	154		
	NPN Power 2SD1266	902694-04 Sub:	C37	Ceramic Disc 1000pF 50V Y5P-K	251069-08
Q2-Q4	NPN Small Signal 2SC1815	902693-01	C48,93	Ceramic Disc 1800pF 50V Y5P-K	251069-11
	NPN Small Signal 2SC945	902671-01 Sub:	C1-7,9,12,	Ceramic Disc .1μF 25V Y5V-Z	251075-06
	NPN Small Signal 2SC2458	251526-01 Sub:	22,25,26,	+ 80 -20%	
	NPN Small Signal 2SC2785	251895-01 Sub:	30,31,33,		
DIODES			34,39,45,		
CR5, CR6	Rect 1A 60V IN4001	900750-01	50,51,53,		
CR1	Zener .5W 2.7V IN4371	906103-02	59,89,95,		
	Zener 2.7V	251286-04 Sub:	101,103,29,		
	Zener 2.7V	251286-05 Sub:	44,46		
	Zener 2.7V	251286-06 Sub:	C1-7,9,12	Ceramic Disc 0.1μF 12V 20%	900303-02 Sub:
	Zener 2.7V	906103-03 Sub:	22,25,26,		
	Zener 2.7V	906103-04 Sub:	30,31,33,		
	Zener 2.7V	906103-05 Sub:	34,39,45,		
CR2	Zener .5W 6.8V	900927-01	46,50,101,		
	Zener .5W 6.8V	900927-02 Sub:	103,29,44		
CR4	Brdg Rect 2A 100V S2VB10	251026-01	C58	Ceramic Disc .22μF 25V Y5V-Z	251075-07

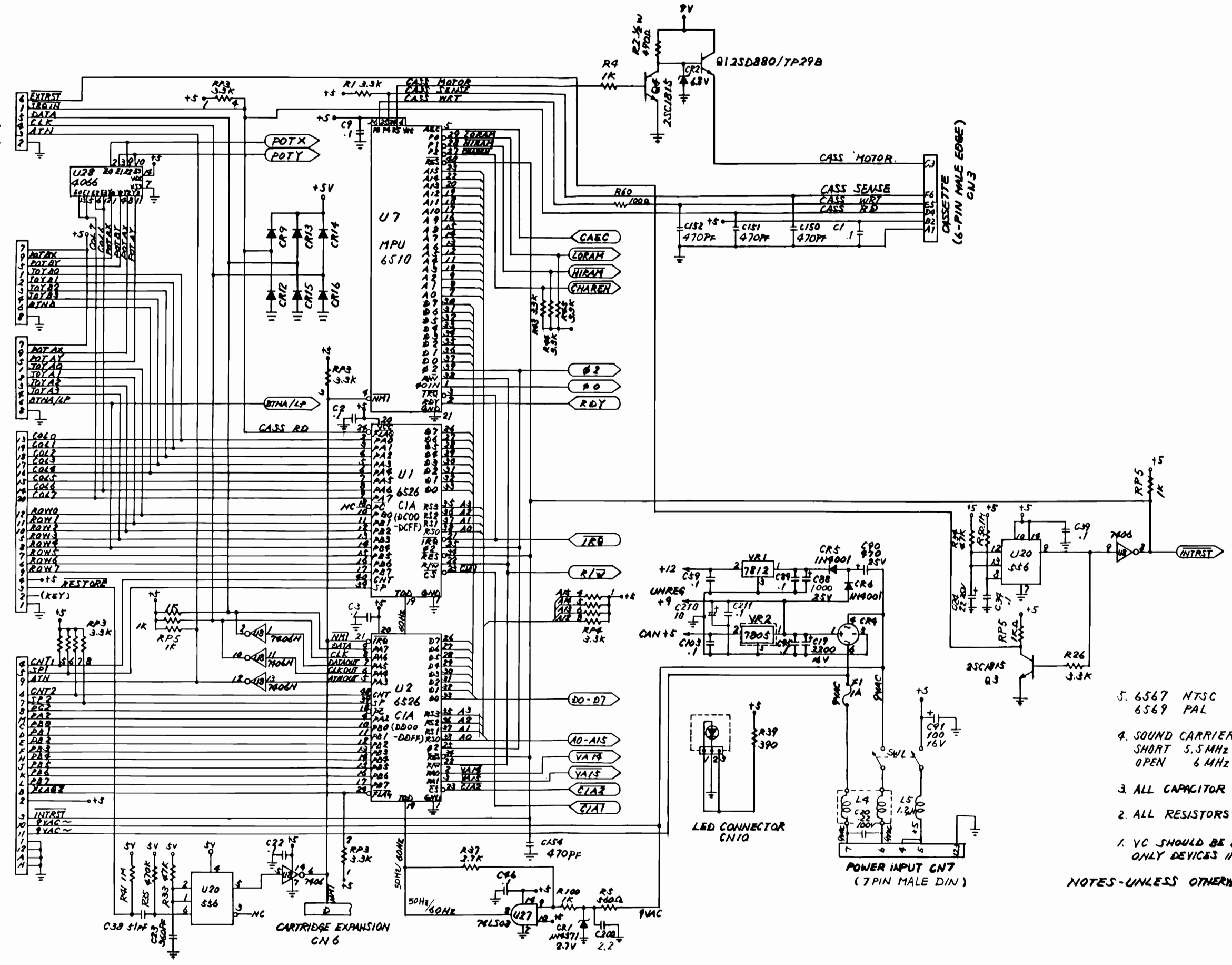
CAPACITORS (Continued)			CONNECTORS (Continued)		
C20	Film Rdl .22 μ F 100V 20%	251875-01	CN1	Header w/LKG Sil 2.54 CTR 20 Pin	903364-02
	Film Rdl .22 μ F 100V 20%	900150-11 Sub:		Header 20 Pin	903331-20 Sub:
	Film Rdl .22 μ F 100V 20%	900150-12 Sub:	CN10	Header Sil 2.54 CTR 3 Pin	903332-03
C211	Ceramic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



B-3
BOARD LAYOUT
PCB ASSEMBLY #250446



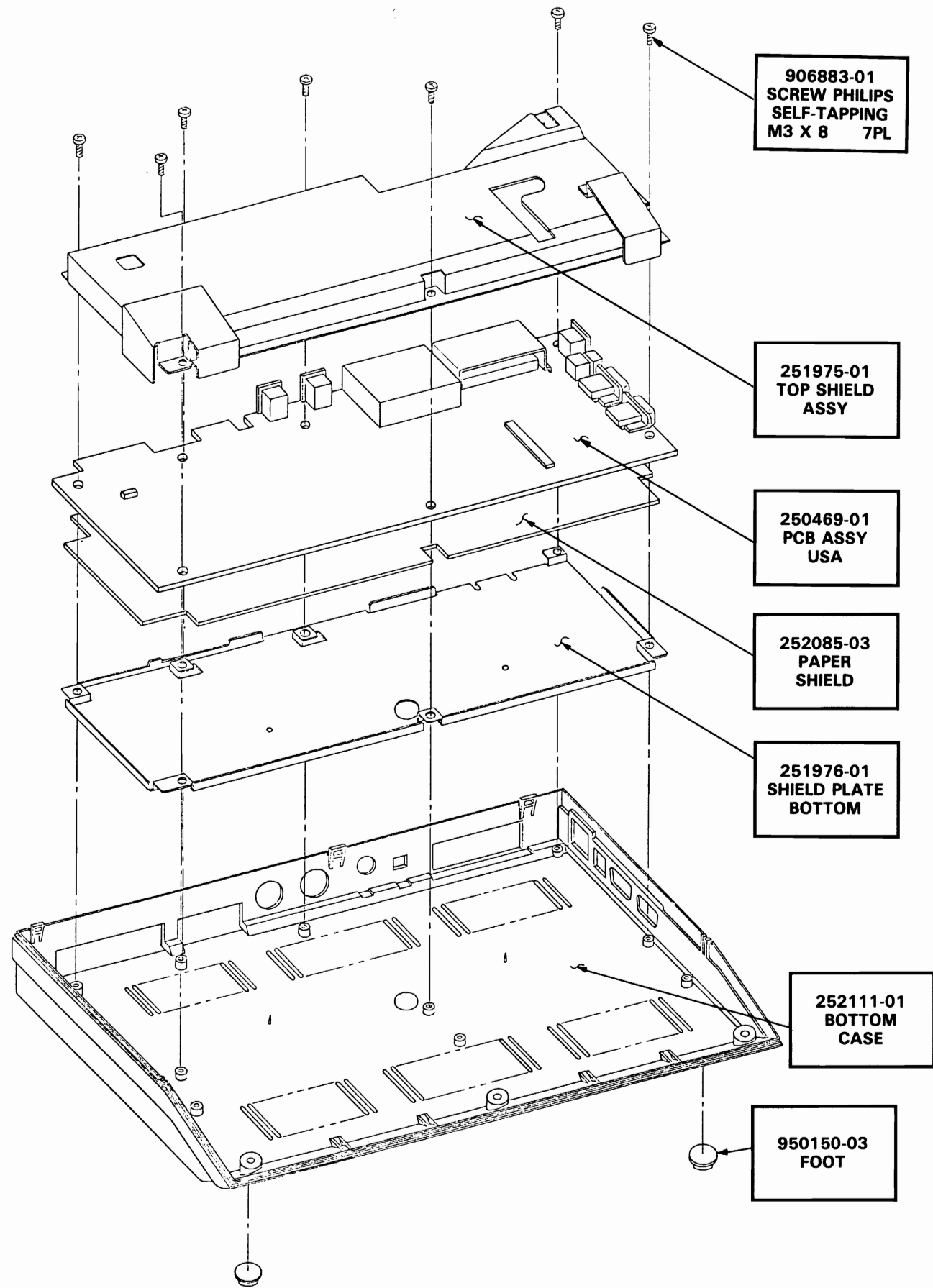
SERIAL BUS (6-PIN FEMALE DIN) CN4
 CONTROL PORT2 (MALE DB9) CN8
 CONTROL PORT1 (MALE DB9) CN9
 KEYBOARD (20-PIN MALE) CN1
 USER PORT (24-PIN MALE EDGE) CN2



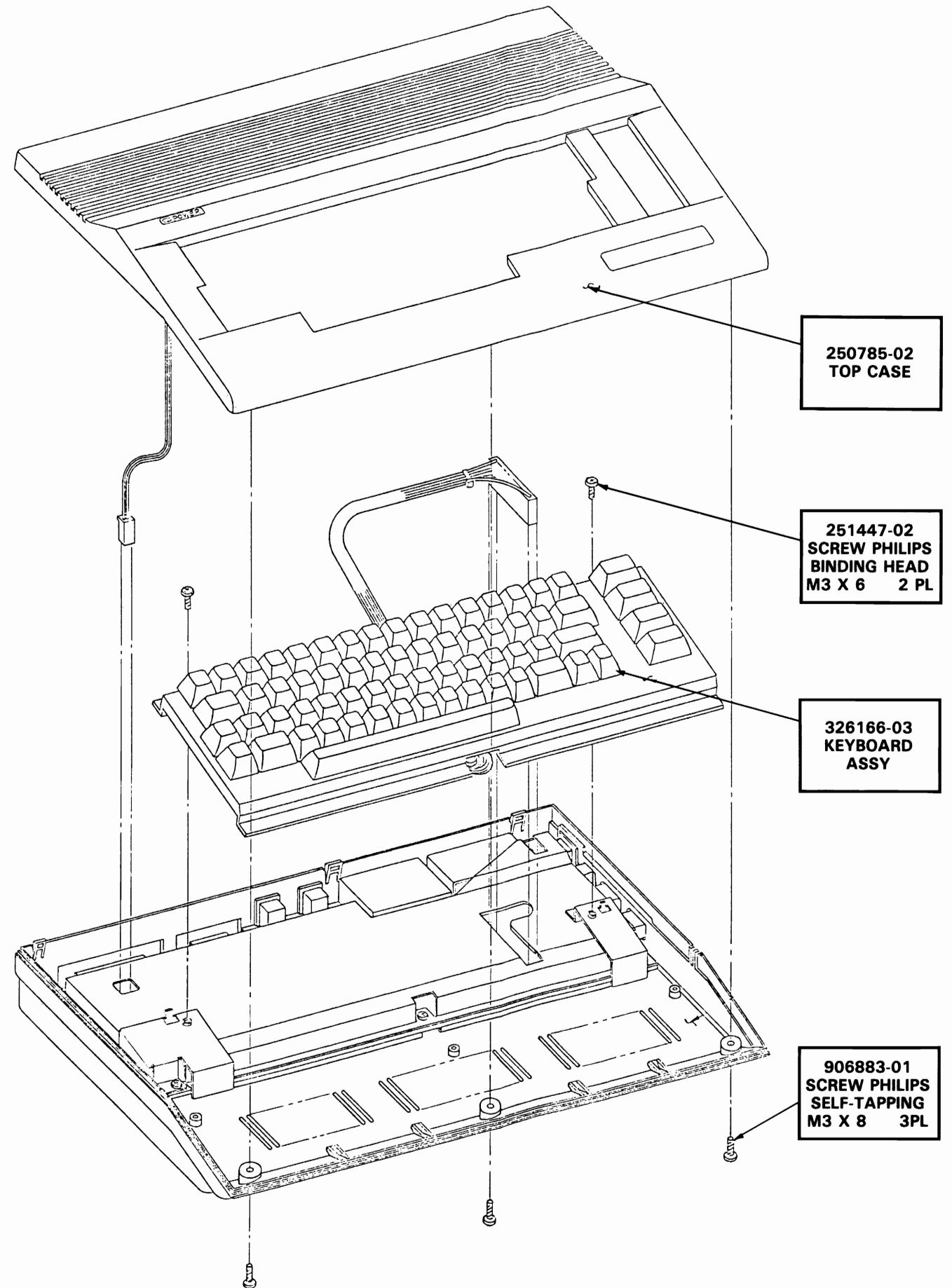
- 5. 6567 NTSC
6569 PAL
- 4. SOUND CARRIER SELECT (PAL OPEN)
SHORT 5.5MHz FOR G. PAL
OPEN 6 MHz FOR I. PAL
- 3. ALL CAPACITOR VALUES ARE IN MF.
- 2. ALL RESISTORS ARE 1/4 WATT ±5%.
- 1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDICATED.

NOTES-UNLESS OTHERWISE SPECIFIED:

BOTTOM CASE ASSEMBLY C64E



MAIN ASSEMBLY C64E

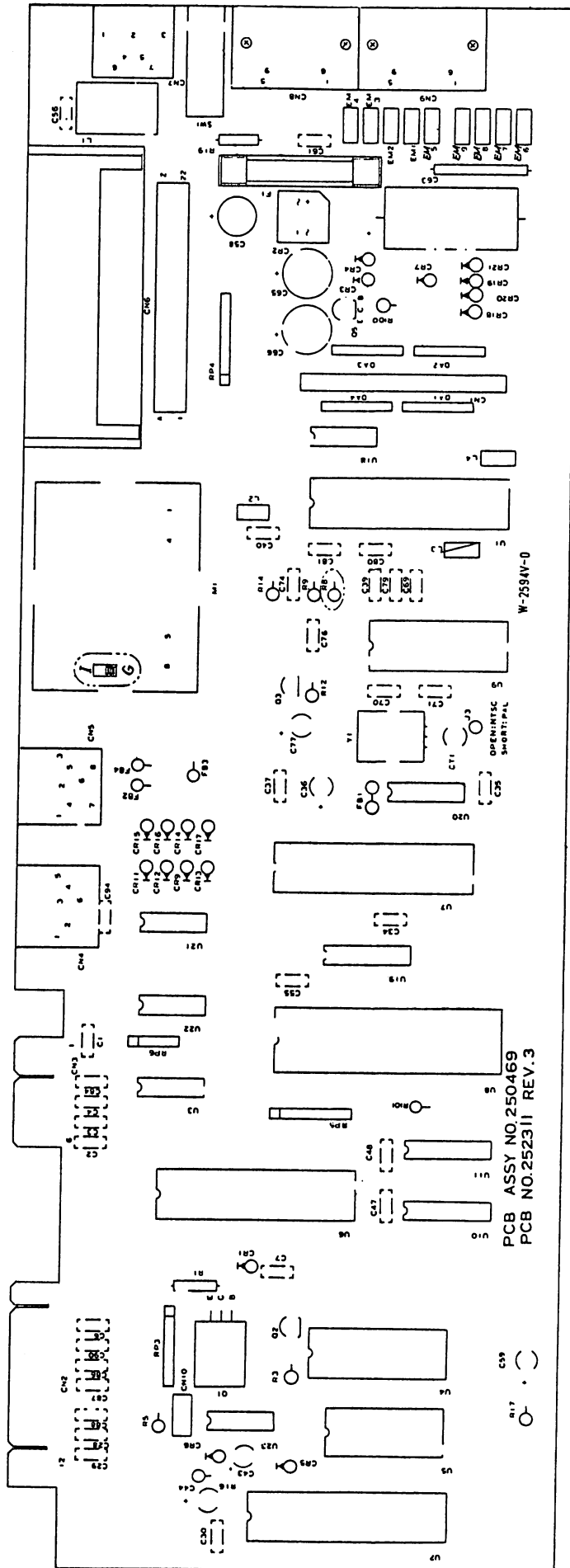


PARTS LIST

PCB ASSEMBLY #250469-01 C64-E

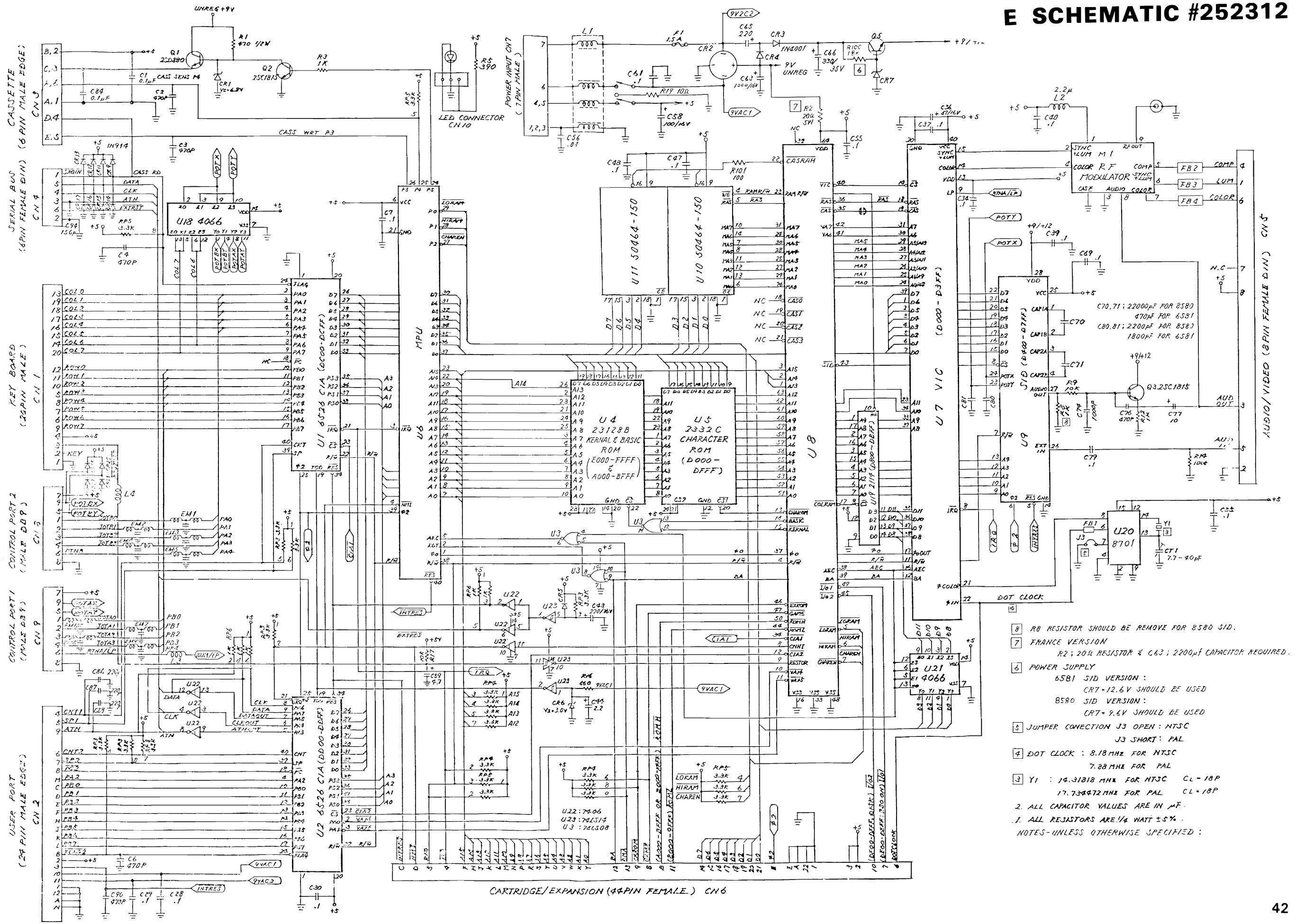
PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-references for TTL chips, Transistors, etc. are available in manual form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

INTEGRATED CIRCUITS			CAPACITORS (continued)		
U6	8500	318012-01	C44	Electrolytic r 2.2μF 50V	251079-06
U1,2	6526	906108-01	C59	Electrolytic r 4.7μF 25V	900100-11
U7	8567	318014-01	C77	Electrolytic r 10μF 25V	900100-01
U7	8562	318027-01	C58	Electrolytic r 100μF 16V	900100-40
U9	8580	318013-01	C65	Electrolytic r 220μF 25V	900100-03
U5	2332 ROM CHAR US PAL	901225-01	C63	Electrolytic a 1000μF 16V	900101-52
U5,4	128K ROM US PAL	251913-01	C36	Electrolytic r 47μF 16V	900100-33
U18,21	4066	901502-01	C43	Electrolytic r 220μF 16V	900100-18
U22	7406	901522-06	C66	Electrolytic r 470μF 35V	900301-35
U3	74LS08	901521-03	C80,81	Ceramic r 1800pF 50V 10% B	251069-11
U23	74LS14	901521-30	C63	Electrolytic a 2200μF 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	RESISTORS		
U20	8701L6	251527-09	R2	Wound 20 ohm 5W 5%	251756-02
U10,11	64 x 4 D-RAM	390083-07	R5	Carbon 390 ohm 1/4W 5%	251068-65
U19	2114, (150 NSEC)	901453-09	R16	Carbon 560 ohm 1/4W 5%	251068-69
U22	7416	901522-14	R3,12 (8)	Carbon 1K ohm 1/4W 5%	251068-76
U8	Memory Controller	251715-01	R9,17	Carbon 10 ohm 1/4W 5%	251068-101
DIODES			R14	Carbon 100K ohm 1/4W 5%	251068-126
CR3,4	1N4001	900750-01	R1	Carbon 470 ohm 1/2W 5%	901600-38
CR5,9,11-21	1N914 r	251819-16	R101	Carbon 100 ohm 1/4 5%	251068-51
CR5,9,11-21	1N4148 r	251819-01	R19	Carbon 10 ohm 1/2W 5%	901600-14
CR1	Zener RD6.8EB	900927-01	R100	Carbon 1.8K ohm 1/4W 5%	251068-82
CR6	Zener RD3.0EB1	906103-04	RP6	Pack 1K ohm 6 PIN	902441-22
CR1	Zener IN754A	900927-02	RP4	Pack 3.3K ohm 9 PIN	902412-07
CR6	Zener RD3.0FB2	906103-05	RP3,5	Pack 3.3K ohm 8 PIN	902442-29
CR7	Zener RD10ESB2	252313-63	MISCELLANEOUS		
CR7	Zener RD13ESB2	252313-75	EMI-9	EMI Filter 270pF	251842-01
CR7	Zener HZ11A1	252337-61	FB1	Ferrite Bead, 2 Turn	252214-01
CR7	Zener HZ12B2	252337-74	L3,4	RF Choke Coil	252341-01
CR2	Bridge Rectifier S2VB10	251026-01	L1	Line Filter 8 Terminal	251878-02
CR2	Bridge Rectifier DBA20B	251026-02	L1	Line Filter 8 Terminal	251878-01
CR2	Bridge Rectifier DBA20C	251026-03	Y1	Crystal 14.31818 MHz	251467-01
TRANSISTORS			Y1	Crystal 17.73447 MHz	251468-01
Q1	2SD880	902694-01		Jumper Wire	200018-15
Q2,3	2SC1815	902693-01	L2	Coil Inductor 2.2μH	901151-17
Q1	TIP29A	902653-01	M1	Modulator NTSC	252405-01
Q1	2SD476kC	902694-02		Socket, IC 16 Pin	904150-02
Q1	2SD313E/F	902694-03		Socket, IC 28 Pin	904150-05
Q1	2SD1310	251294-01		Socket, IC 40 Pin	904150-06
Q2,3	2SC945	902671-01	F1	Fuse, Normal Blo 250V 1.5A	903556-18
Q2,3	2SC2458	251526-01		Fuse, Clip	906102-02
Q5	NPN 900nN	252338-01	SW1	Switch, Rocker DPDT	904500-01
CAPACITORS			SW1	Switch, Power Rocker	252182-01
C2-4,6,76,90	Ceramic r 470pF 50V	251069-04		Cartridge Guide	326116-01
C74	Ceramic r 1000pF 50V	251069-08	CN7	Screw, Self-Tapping M3 X 6	906883-03
C80,81	Ceramic r 2200pF 25V	251069-12	CN4	7 Pin Din	251116-01
C1,7,28-30,34,35,37,39,40,47,48,55,61,69,79,84	Ceramic r 0.1μF 25V	251075-06	CN5	6 Pin Din	252166-01
C70,71	Ceramic r 22000pF 50VM	251304-71	CN5	8 Pin Din	252168-01
C94	Ceramic r 150pF 50V	251070-24	CN6	44 Pin Card Edge	906100-02
C86-88	Ceramic r 220pF 50V	251071-26	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



- 8 R8 RESISTOR SHOULD BE REMOVE FOR 8580 SID.
 - 7 FRANCE VERSION
R2: 20Ω RESISTOR & C63; 2200μF CAPACITOR REQUIRED.
 - 6 POWER SUPPLY
6581 SID VERSION:
CR7-12.6V SHOULD BE USED
8580 SID VERSION:
CR7= 9.6V SHOULD BE USED
 - 5 JUMPER CONNECTION J3 OPEN: NTSC
J3 SHORT: PAL
 - 4 DOT CLOCK: 8.18MHZ FOR NTSC
7.28MHZ FOR PAL
 - 3 Y1: 14.31818 MHZ FOR NTSC CL-18P
17.734972MHZ FOR PAL CL-18P
2. ALL CAPACITOR VALUES ARE IN μF.
1. ALL RESISTORS ARE 1/4 WATT ±5%.
- NOTES-UNLESS OTHERWISE SPECIFIED:



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