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	• 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 Daisey 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

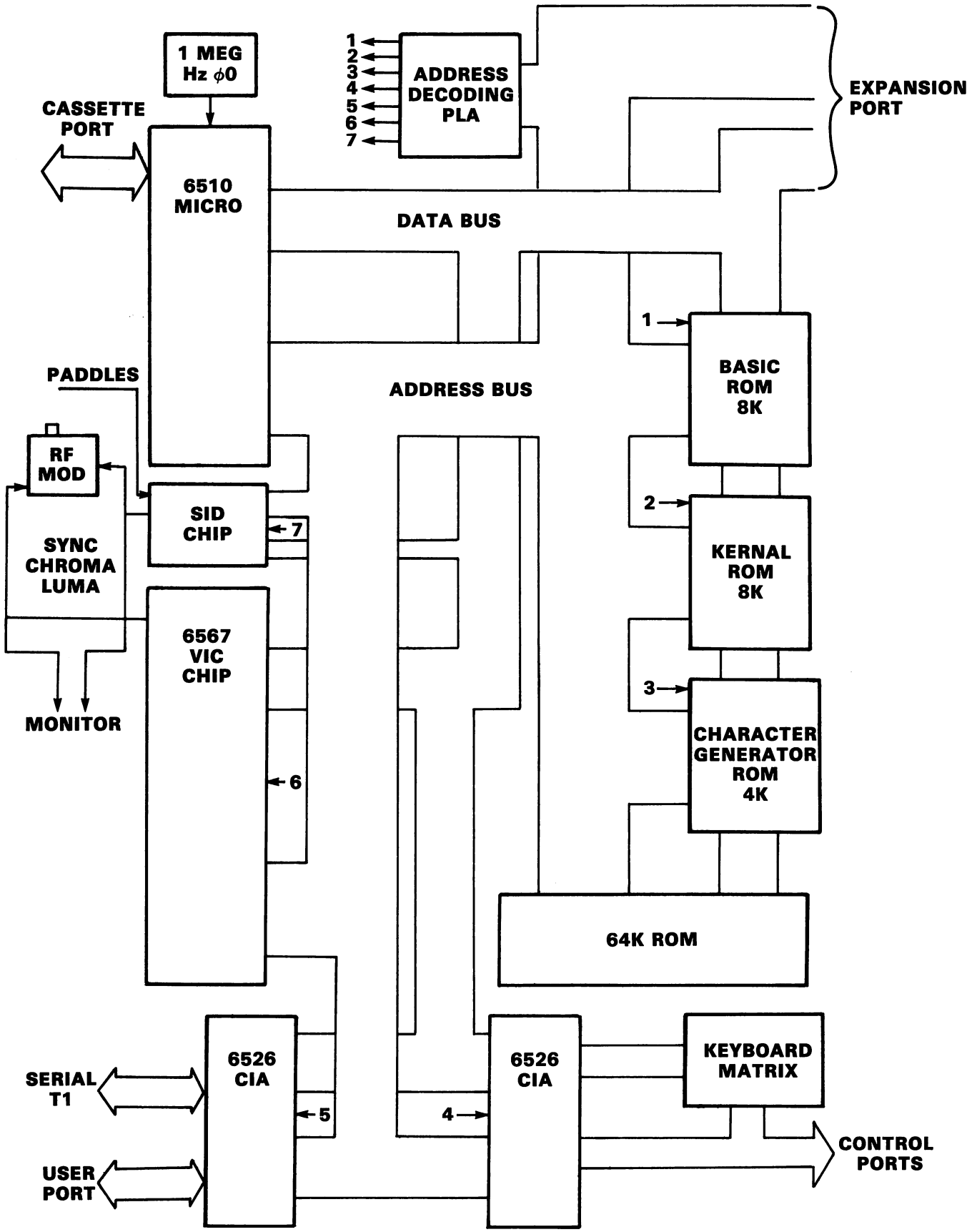
MAIN CASE ASSY

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



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.

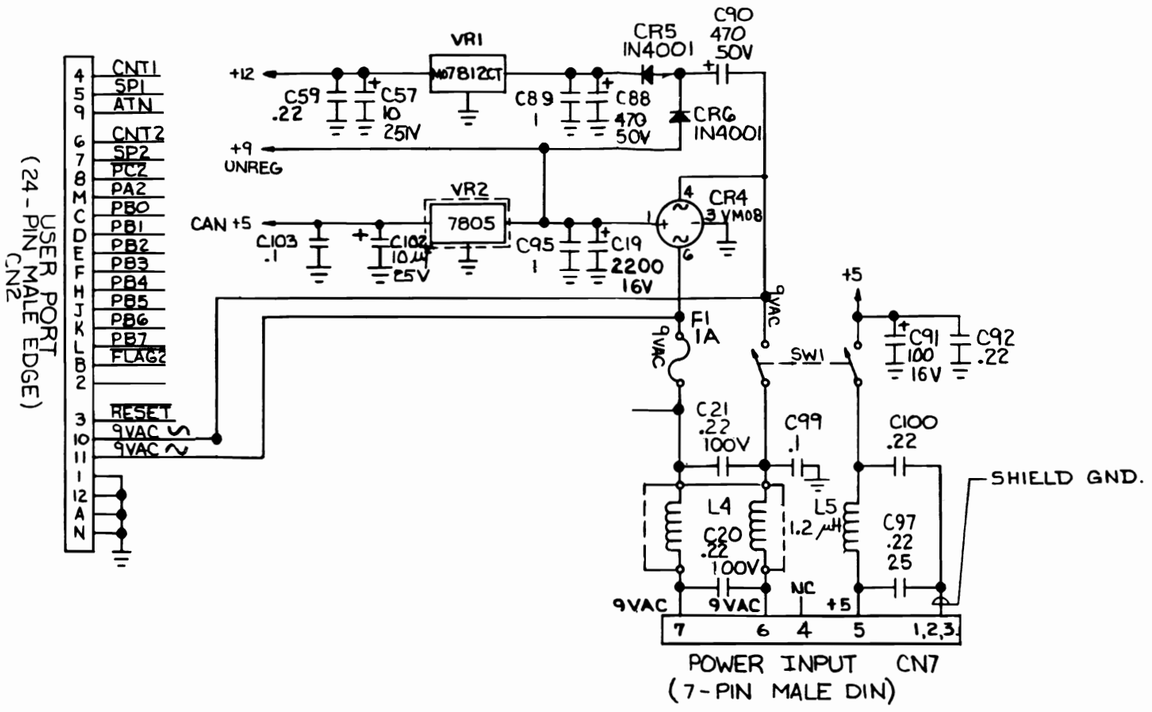
The Power Supply.

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.

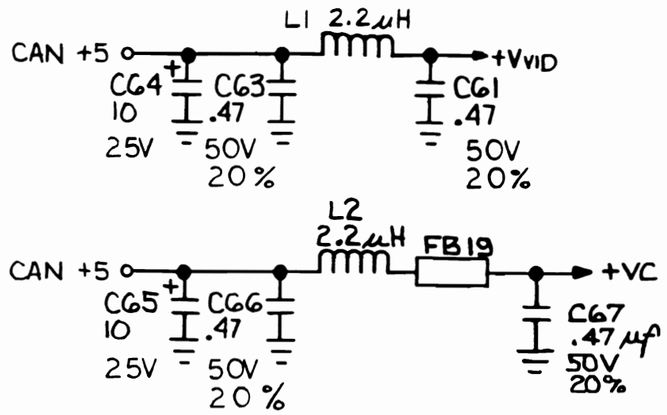


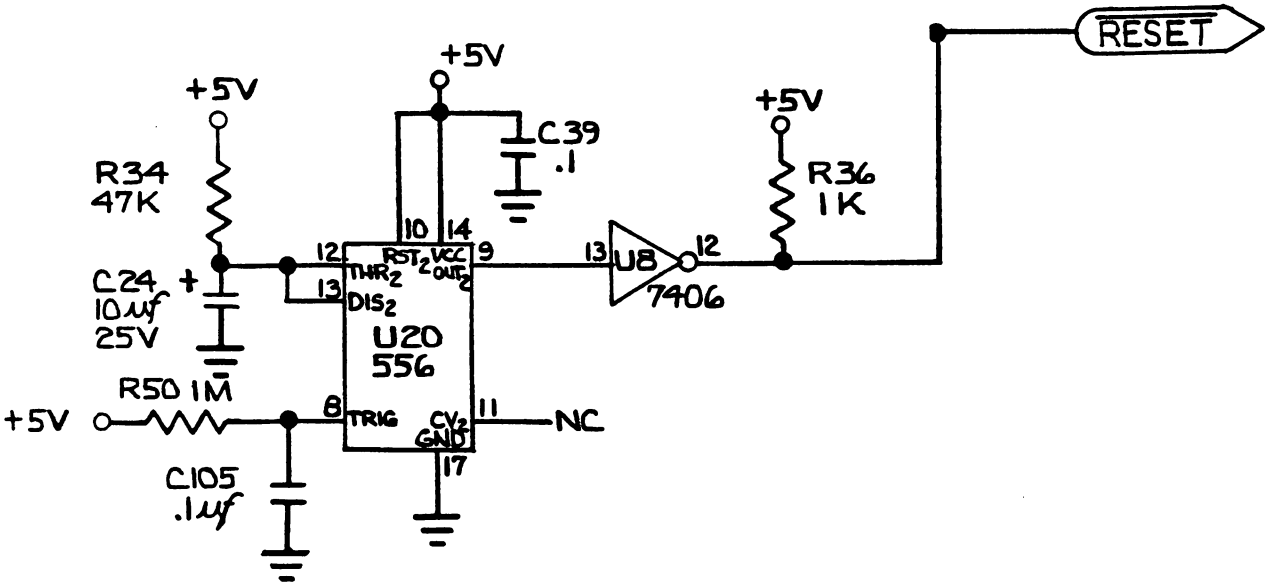
+5VDC CAN Generation

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.

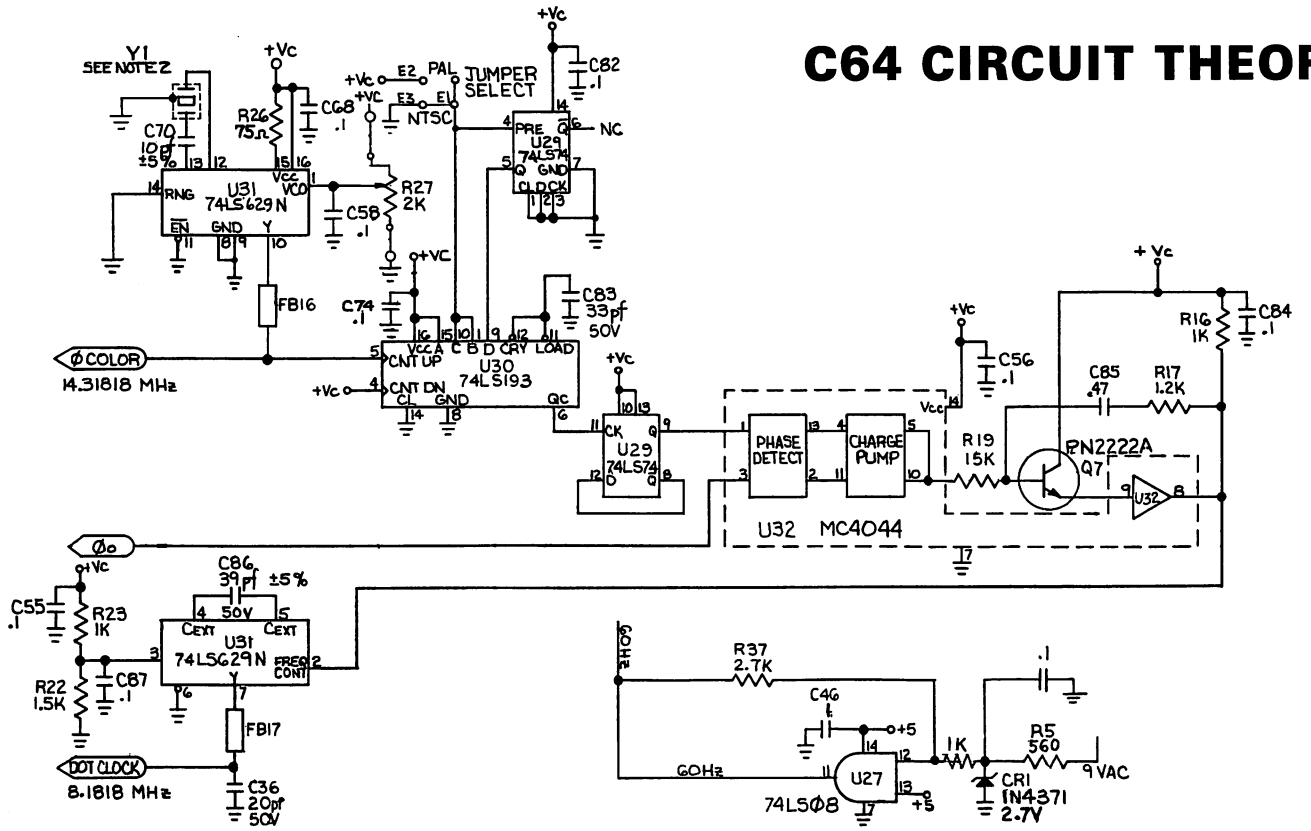
CR4 rectifies the 9VAC input. The output is 9VDC unregulated. This supply powers the cassette motor transistor amplifier circuits, and the RF modulator on the C64B version.





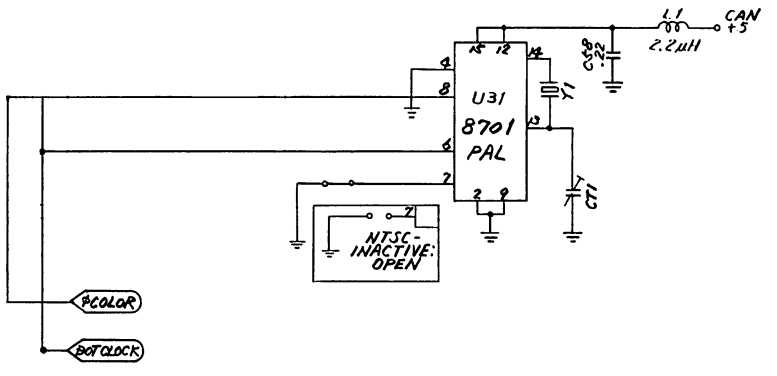
Reset Logic Circuits.

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 x R34 x C24 ≈ .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.



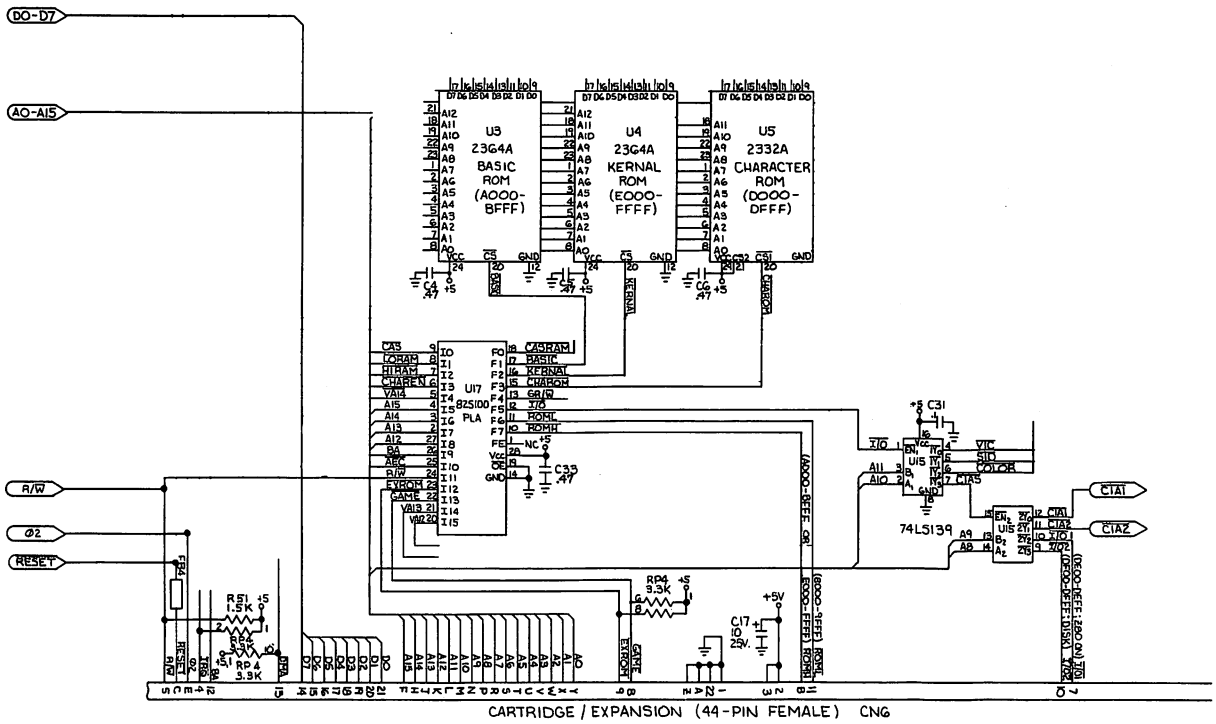
The C64 Clock Circuits.

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.



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.

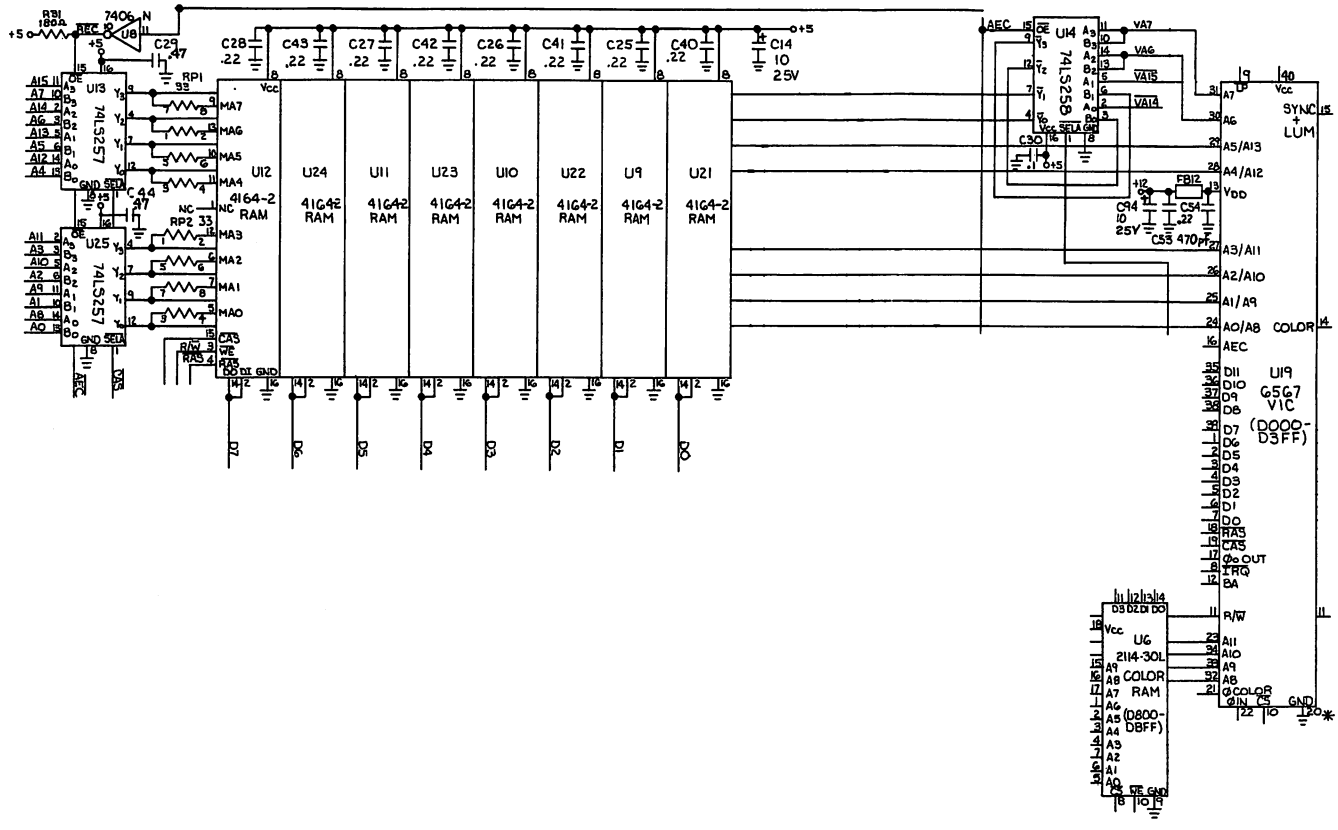
VIC IC	$D000 - $D02E
SID IC	$D400 - $D7FF
Color Ram	$D800 - $DBFF
CIA1	$DC00 - $DC0F
CIA2	$DD00 - $DD0F
I/O 1	$DE00 - $DEFF
I/O 2	$DF00 - $DFFF

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.

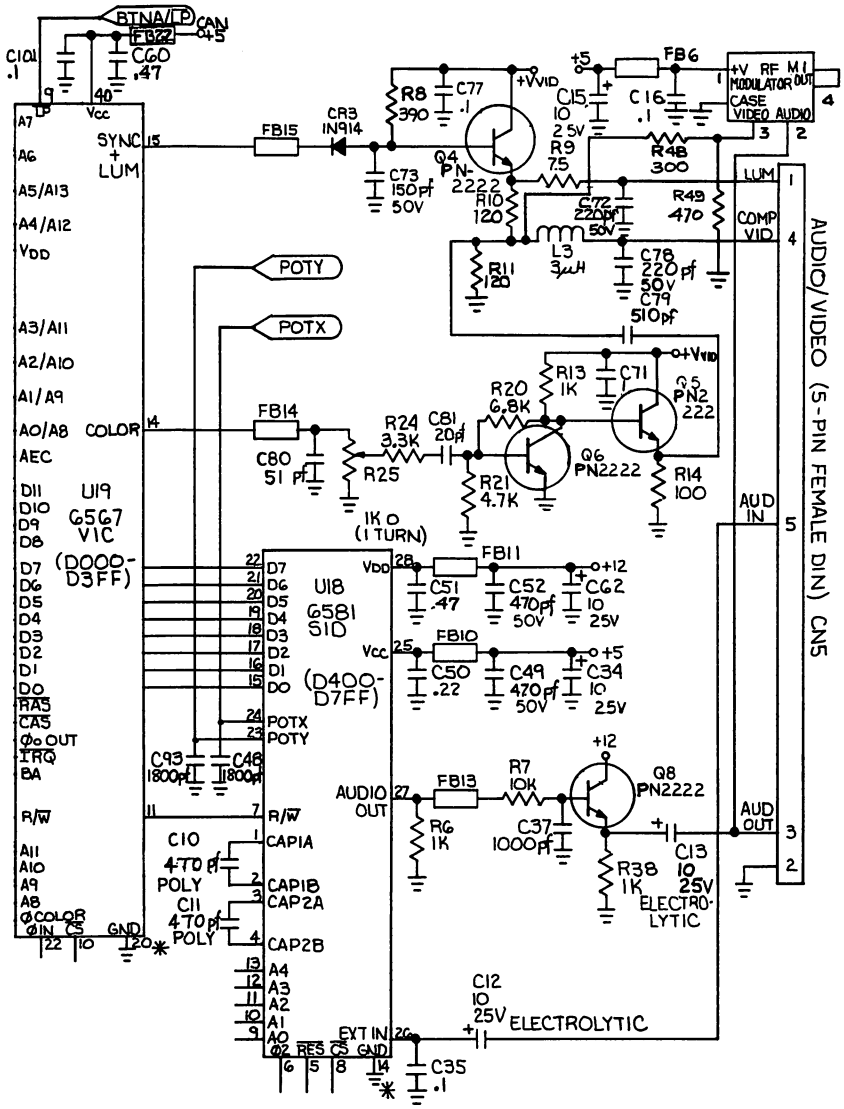
The expansion port is an extension of the microprocessor address, data, and control bus. ROML decodes addresses $8000 - $9FFF, and ROMH decodes addresses $E000 - $FFFF. These are outputs from the PLA used to select the cartridge inserted in the expansion port. I/O 1 input from U15 decodes addresses $DE00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



RAM Control Logic.

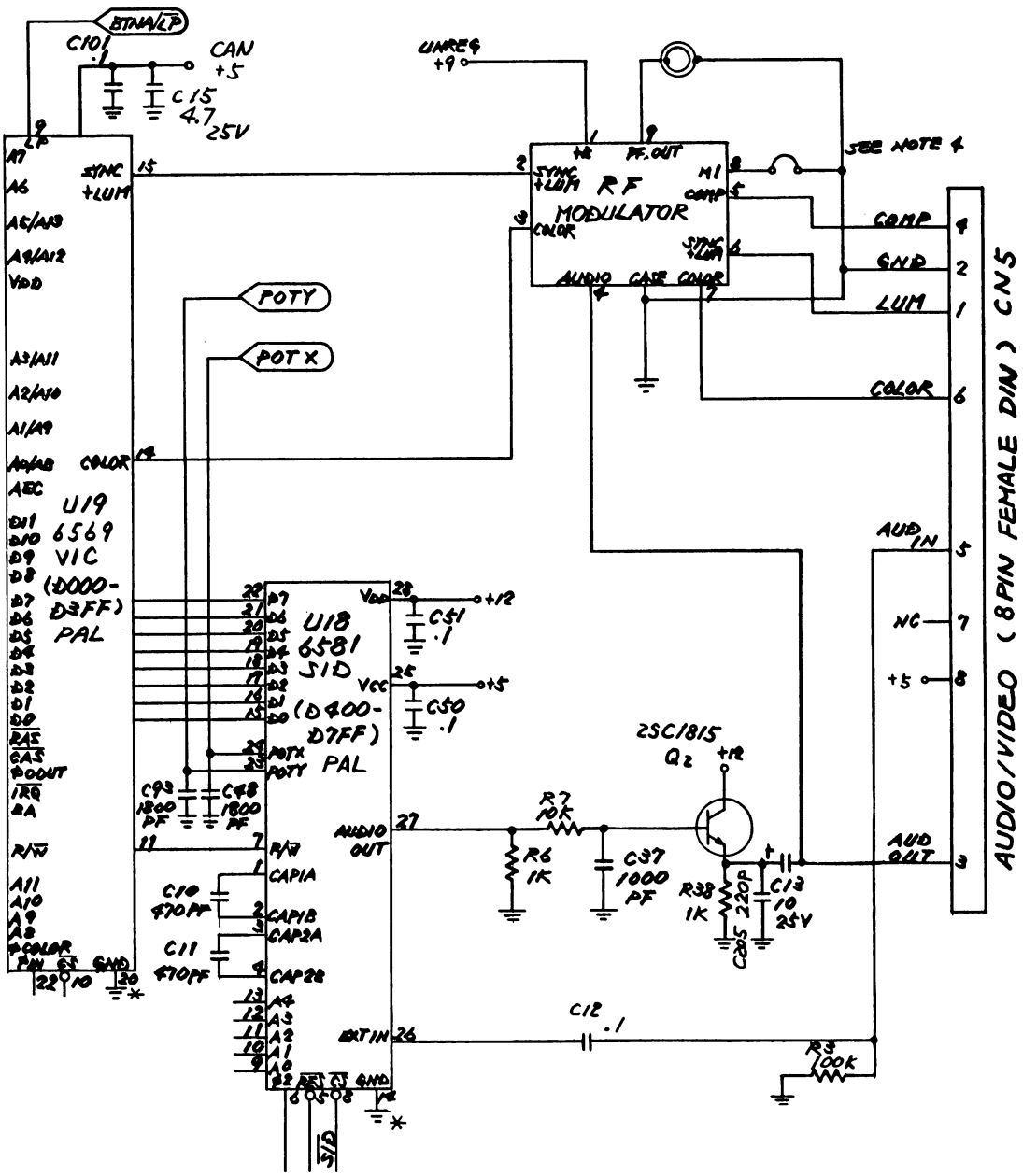
U13 and U25 are multiplexers. The address outputs from the microprocessor are passed to RAM via U13 and U25 when the output Address Enable Control (AEC) from the VIC IC is ''high''. When AEC is ''low'' the VIC IC outputs refresh addresses on pins 24 - 31. AEC goes ''low'' when the system clock, phase 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.



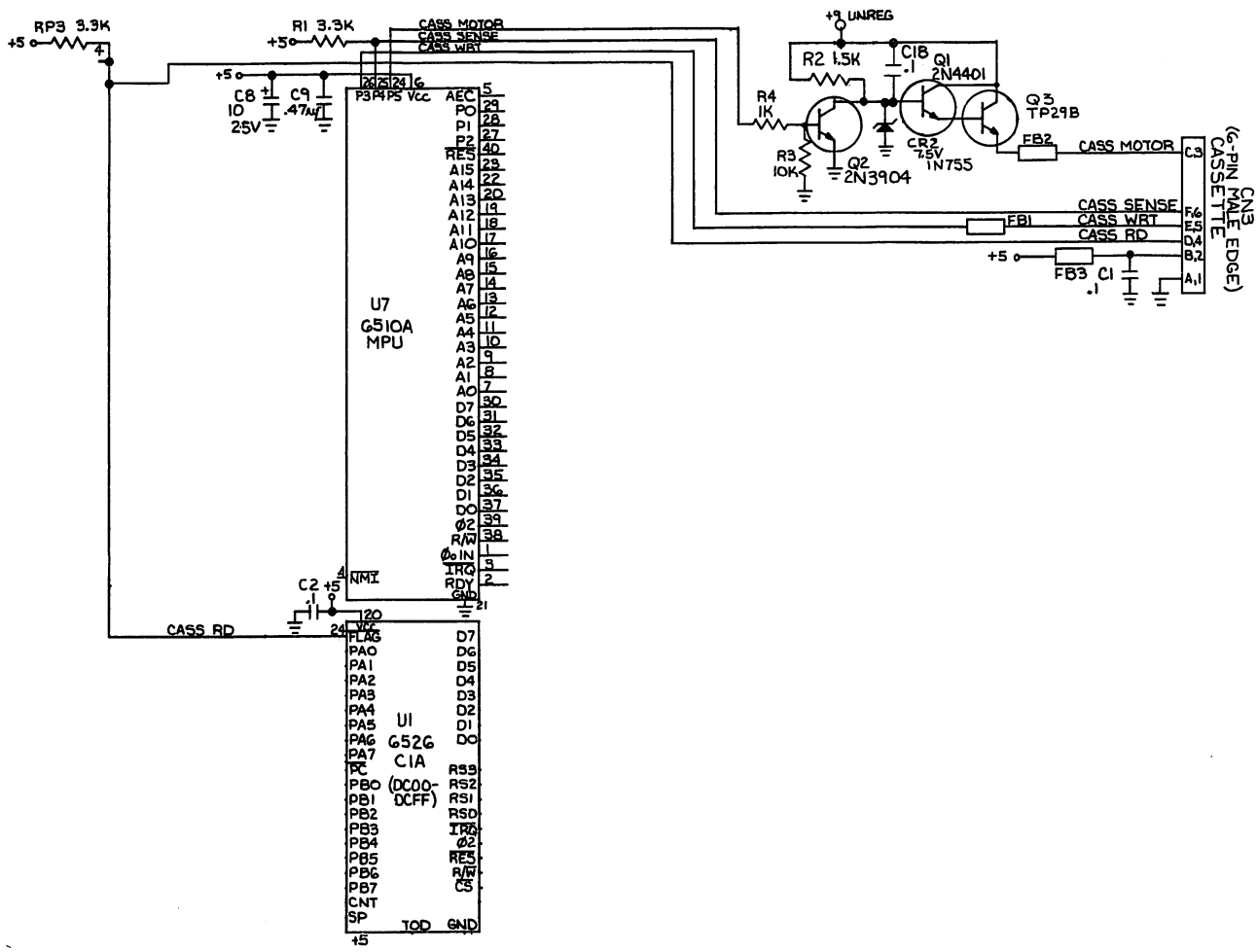
5 Pin Video and Audio Output Circuits.

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.



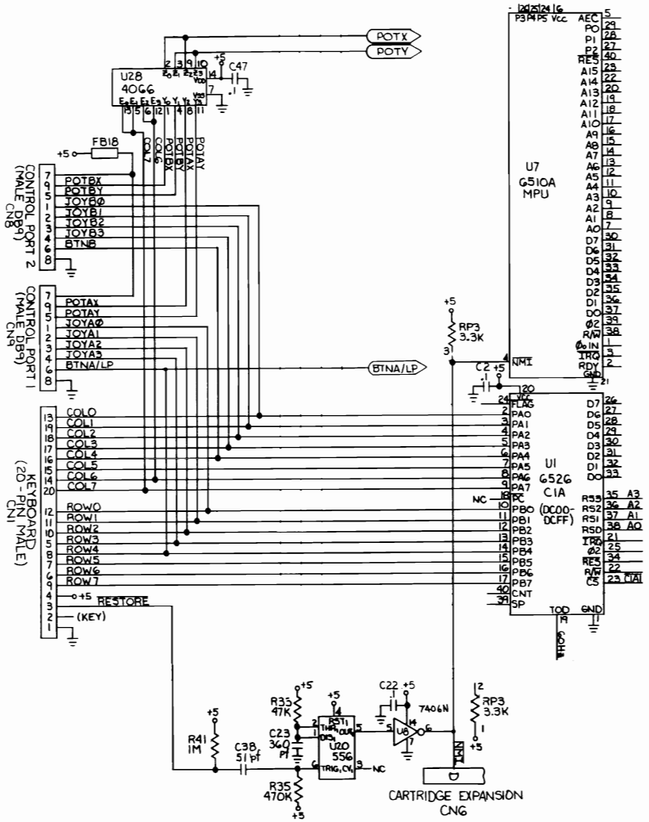
8 Pin Video and Audio Output Circuits. Refer to schematic 251469

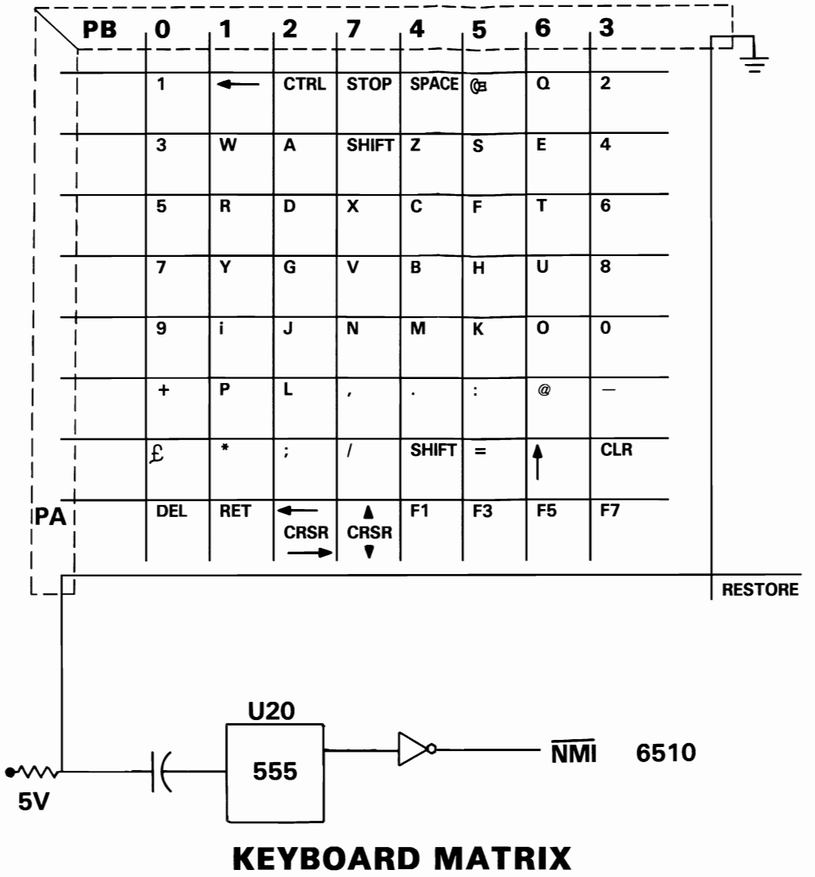
U19 is the Video Interface Chip (VIC). Sync (horizontal and vertical), and luminance (video) is output on pin 15. This signal is passed to pin 2 of the RF modulator. Color is output on pin 14, and passed to pin 3 of the modulator. Light Pen inputs are sensed by the VIC IC on pin 9. U18 is the Sound Interface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



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.

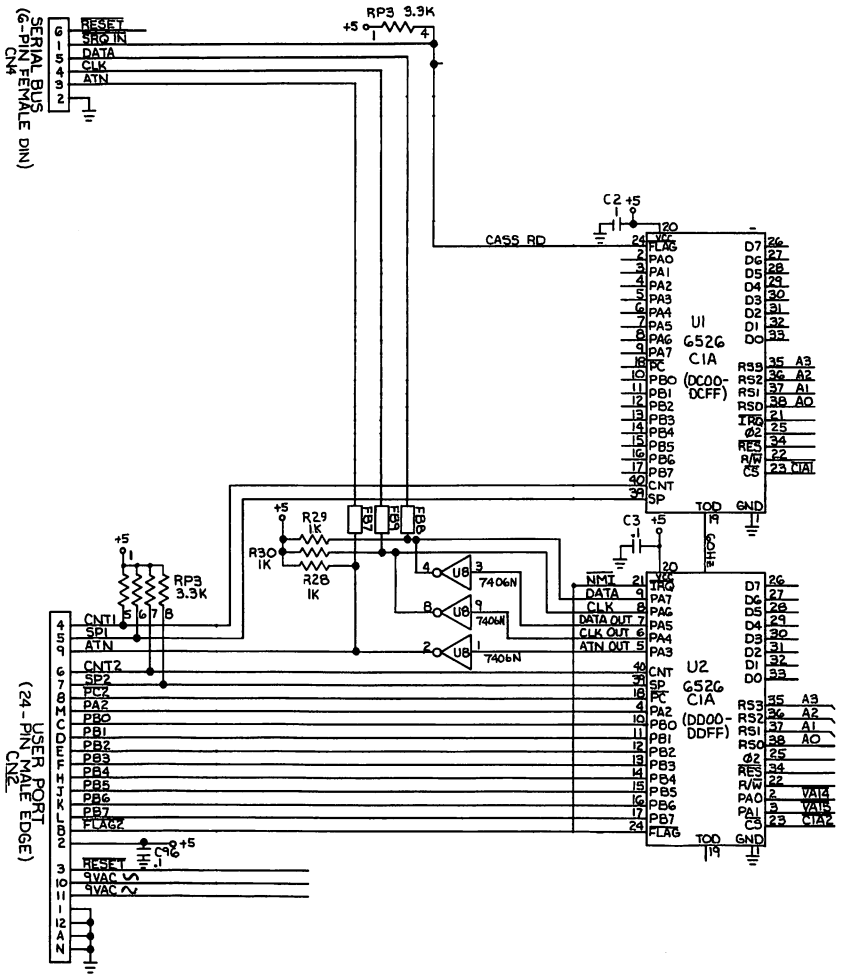
Joystick Interface.

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.



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 (PB0 - 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:

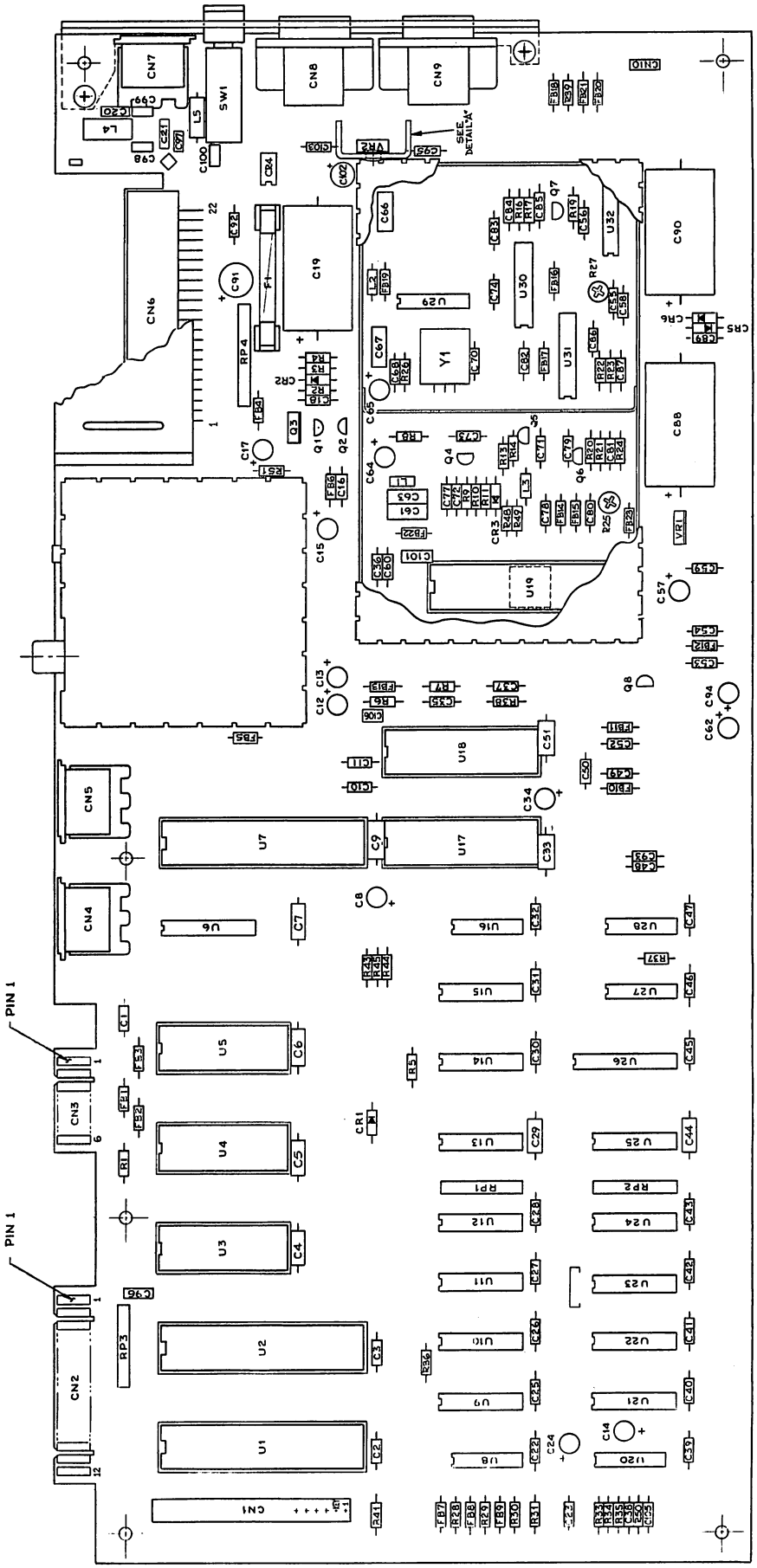
1) Resistors 28, 29, 30, 36, 48 were reduced to Resistor Pack RP5.

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		
U1,U2	6526 CIA	C 906108-01
U3	2364 Basic ROM	C 901226-01
U4	2364 Kernal ROM	C 901227-03
U5	2332 Char ROM	C 901225-01
U6	2114L-30 RAM	901453-01
U7	6510 μ Processor	C 906107-01
U8	7406	901522-06
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
U29	74LS74	901521-06
U30	74LS193	901521-26
U31	74LS629	901521-68
U32	MC4044	906128-01

TRANSISTORS		
Q1	2N4401	902652-01
Q2	2N3904	902658-01
Q3	TIP29 B	902653-01
Q4-8	2N2222	902686-01

DIODES		
CR1	2.7V Zener IN4371	
CR2	7.5V Zener IN755	
CR3	IN914	
CR4	Bridge, Varo VM08	906129-01
CR5,6	Rectifier IN4001	

RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.

R1	3.3K	R7	10K
R2	1.5K	R8	390
R3	10K	R9	75
R4	1K	R10	120
R5	560	R11	120
R6	1K	R13	1K

RESISTORS (Continued)

R14	100	R30	1K
R16	1K	R31	180
R17	1.2K	R33	47K
R19	15K	R34	47K
R20	6.8K	R35	470K
R21	4.7K	R37	2.7K
R22	1.5K	R38	1K
R23	1K	R39	390
R24	3.3K	R41	1M
R25	Pot 1K	R43	3.3K
R26	75	R44	3.3K
R27	Pot 2K	R45	3.3K
R28	1K	R46	2K
R29	1K	R51	1.5K

NOTE: The input video line requires a 470 ohm, 1/4 watt, resistor soldered to ground.

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		
C1-3	Ceramic	.1 μF, 50V
C4-7	Ceramic	.47 μF, 50V, 20%
C8	Electrolytic	10 μF, 25V, +50%, −10%
C9	Ceramic	.47 μF, 50V, 20%
C10,11	Ceramic	470 pF, 50V
C12-15	Electrolytic	10 μF, 25V, +50%, −10%
C16	Ceramic	.1 μF, 50V
C17	Electrolytic	10 μF, 25V, +50%, −10%
C18	Ceramic	.1 μF, 50V
C19	Electrolytic	2200 μF, 16V
C20,21	Film	.22 μF, 100V, 20%
C22	Ceramic	.1 μF, 50V
C23	Ceramic	360 pF, 50V
C24	Electrolytic	10 μF, 25V, +50%, −10%
C25-28	Ceramic	.22 μF, 50V
C29	Ceramic	.47 μF, 50V, 20%
C30,31,32	Ceramic	.1 μF, 50V
C33	Ceramic	.47 μF, 50V, 20%
C34	Electrolytic	10 μF, 25V, +50%, −10%
C35	Ceramic	.1 μF, 50V
C36	Ceramic	20 pF, 50V
C37	Ceramic	1000 pF, 50V

PARTS LIST — PCB ASSEMBLY #326298 (Continued)

C — Indicates Commodore Stocked Part Numbers

CAPACITORS (Continued)		
C38	Ceramic	51 pF, 50V
C39	Ceramic	.1 μF, 50V
C40-43	Ceramic	.22 μF, 50V
C44	Ceramic	.47 μF, 50V, 20%
C45,46,47	Ceramic	.1 μF, 50V
C48	Ceramic	1800 pF, 50V
C49	Ceramic	470 pF, 50V
C50	Ceramic	.22 μF, 50V
C51	Ceramic	.47 μF, 50V, 20%
C52,53	Ceramic	470 pF, 50V
C54	Ceramic	.22 μF, 50V
C55	Ceramic	.1 μF, 50V
C56	Ceramic	.1 μF, 50V
C57	Electrolytic	10 μF, 25V, +50%, −10%
C58	Ceramic	.1 μF, 50V
C59	Ceramic	.22 μF, 50V
C60,61	Ceramic	.47 μF, 50V, 20%
C62	Electrolytic	10 μF, 25V, +50%, −10%
C63	Ceramic	.47 μF, 50V, 20%
C64,65	Electrolytic	10 μF, 25V, +50%, −10%
C66,67	Ceramic	.47 μF, 50V, 20%
C68	Ceramic	.1 μF, 50V
C69		
C70	Mica	10 pF, 500V, 5%
C71	Ceramic	.1 μF, 50V
C72	Ceramic	220 pF, 50V
C73	Ceramic	150 pF, 50V
C74	Ceramic	.1 μF, 50V
C77	Ceramic	.1 μF, 50V
C78	Ceramic	220 pF, 50V
C79	Ceramic	510 pF, 50V
C80	Ceramic	51 pF, 50V
C81	Ceramic	20 pF, 50V
C82	Ceramic	.1 μF, 50V
C83	Mica	33 pF, 500V, 5%
C84	Ceramic	.1 μF, 50V
C85	Ceramic	.47 μF, 50V, 20%
C86	Mica	39 pF, 500V, 5%
C87	Ceramic	.1 μF, 50V
C88	Electrolytic	470 μF, 50V
C89	Ceramic	.1 μF, 50V
C90	Electrolytic	470 μF, 50V
C91	Electrolytic	100 μF, 16V
C92	Ceramic	.22 μF, 50V
C93	Ceramic	1800 pF, 50V

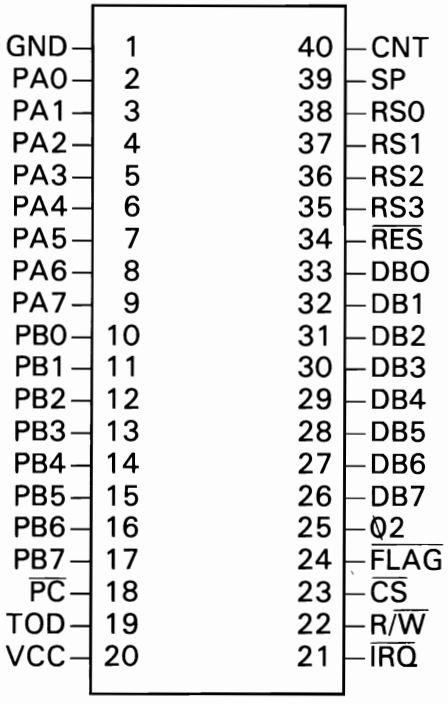
CAPACITORS (Continued)		
C94	Electrolytic	10 μF, 25V, +50%, −10%
C95,96	Ceramic	.1 μF, 50V
C97	Ceramic	.22 μF, 25V
C98,99	Ceramic	.1 μF, 50V, 20%
C100	Ceramic	.22 μF, 25V
C101	Ceramic	.1 μF, 50V, 20%
C102	Electrolytic	10 μF, 25V, +50%, −10%
C103	Ceramic	.1 μF, 50V
C105	Ceramic	.1 μF, 50V

CONNECTORS		
CN1	Header Assy, 20 Pin	903331-20
CN4	6 Pin Din	C 903361-01
CN5	5 Pin Din	C 903362-01
CN6	44 Pin Card Edge	C 906100-02
CN7	7 Pin Din	C 906130-01
CN8,9	Plug Assy, 9 Pin Rt. Angle	C 906126-01
CN10	Header Assy, 3 Pin	

MISCELLANEOUS		
L1,2	Coil Inductor 2.2 μH	901151-17
L3	Coil Inductor 3.0 μH	901151-21
L4	Line Filter Assy	C 906127-01
L5	Coil Inductor 1.2 μH	901152-01
Y1	Crystal 14.31818 MHz	C 900558-01
SW1	Rocker Switch DPDT	C 904500-01
VR1	Voltage Regulator MC7812CT	901527-01
VR2	Voltage Regulator MC7805CT	901527-02
M1	Modulator	C 326130-01
F1	Fuse, Normal Blo, 250V, 1.5A	
FB1-23	Ferrite Bead	903025-01
	Connector Panel (ON, OFF, Joystick)	326299-01
	Cartridge Guide	326116-01
	Shield Box	C 326265-01
	Shield Cap	C 326267-01

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

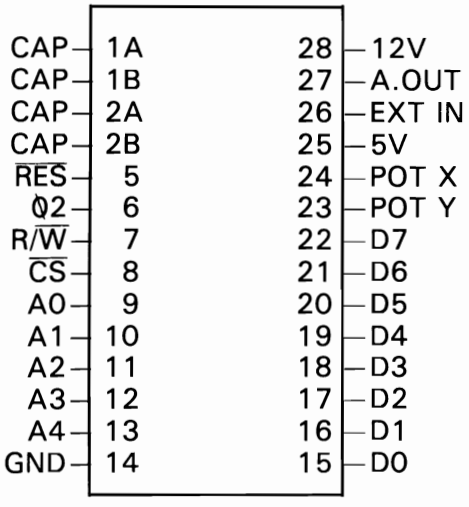
PIN ASSIGNMENT



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	02	02 clock input. Connected to processor common 02 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.

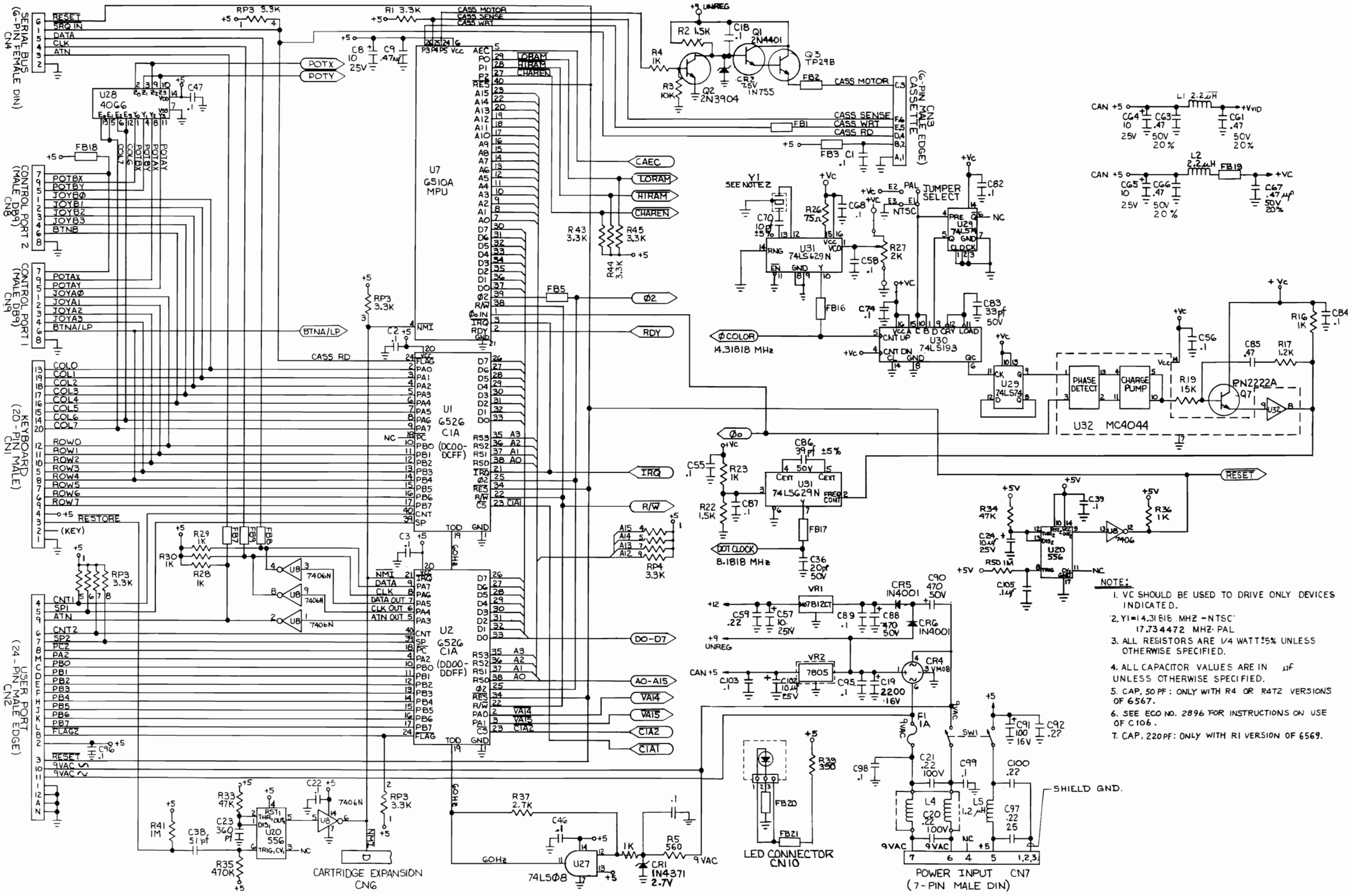
U18 — 906112-01
6581 SOUND INTERFACE DEVICE (SID)

PIN ASSIGNMENT

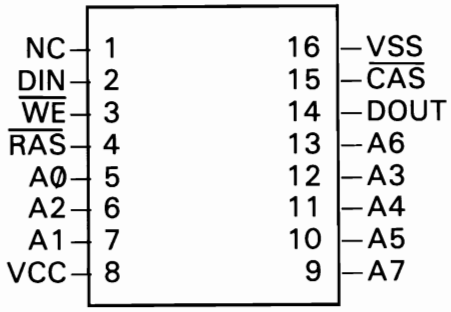


1,2, 3,4	CAP1A,1B 2A, 2B	Capacitor filter connections.
5	RES	Reset input. A low pulse initializes the SID.
6	02	Processor phase 2 clock input.
7	R/W	Processor read/write input.
8	CS	Chip select input.
9-13	A0-A4	Address lines from processor.
14	GND	Dc ground connection.
15-22	D0-D7	Data Bus connections.
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

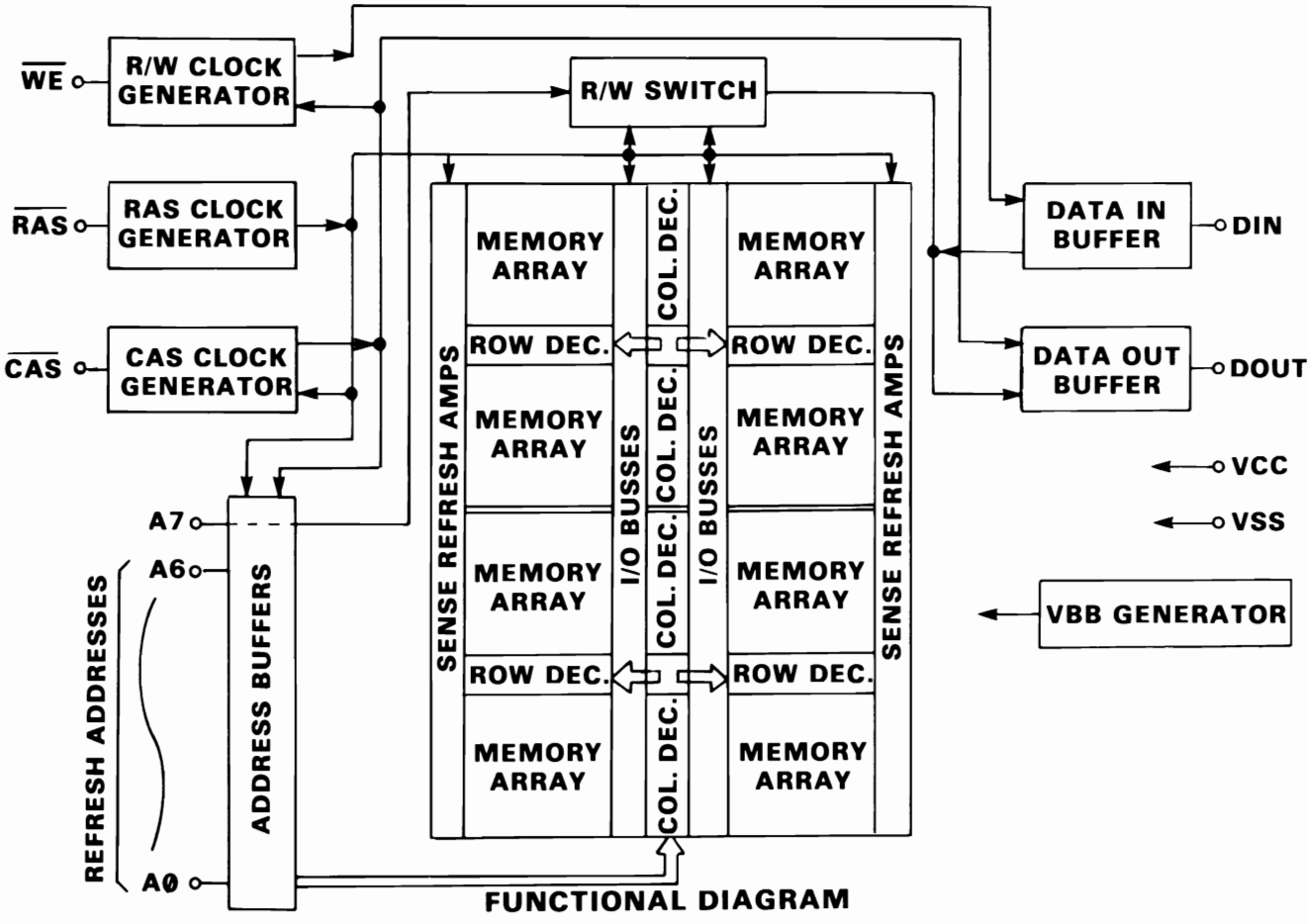


PIN CONFIGURATION



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

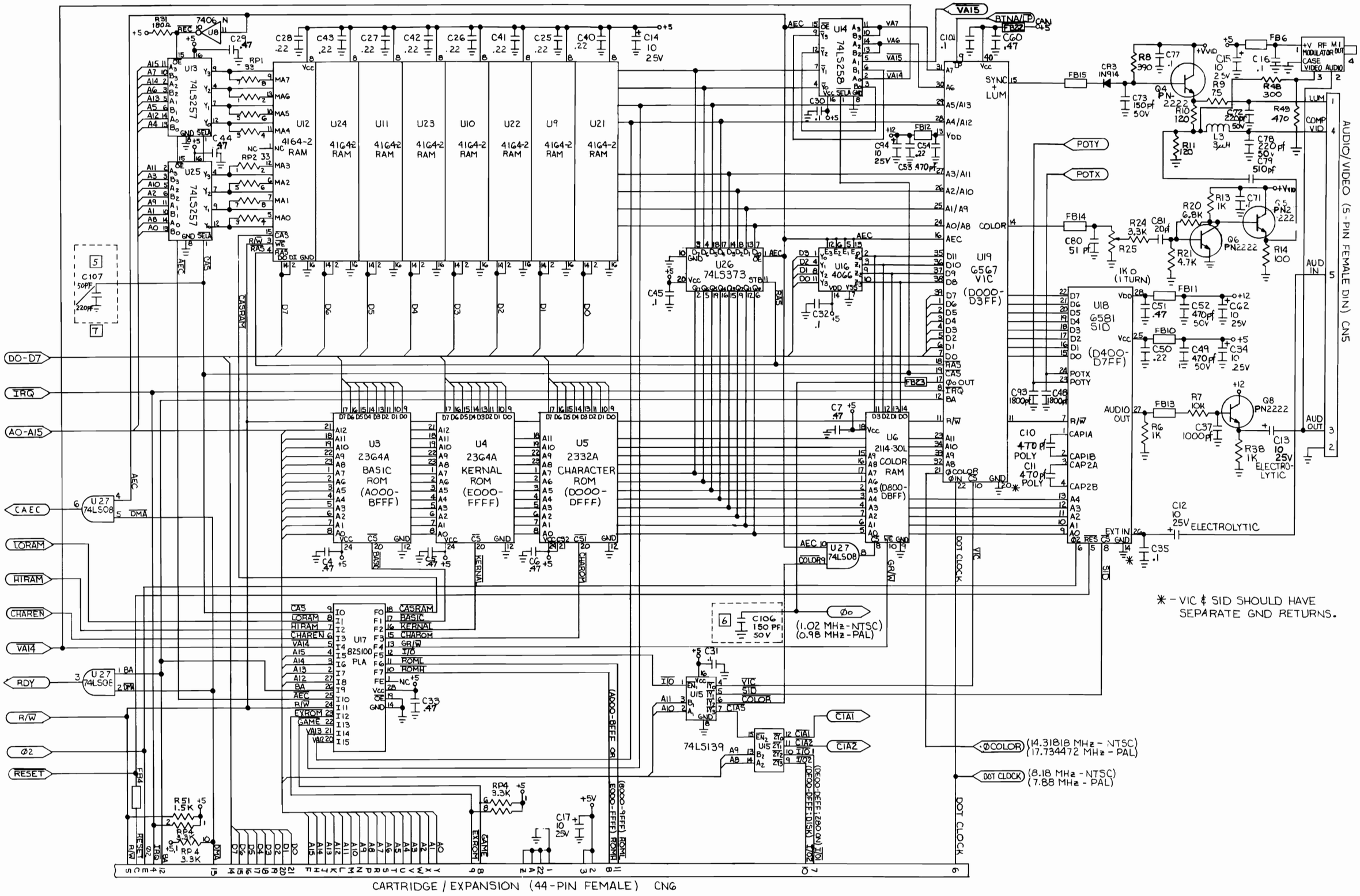
COMMODORE PART NUMBER	APPROVED SOURCE 1 OF SUPPLY	VENDOR PART NUMBER	ACCESS TIME (ns)	CYCLES (ns)	POWER	
					ACTIVE (MW)	STANDBY (MAX)(MW)
901505-01	HITACHI	HM4864-3	200	335	330	20
901505-01	NEC	μPD4164-2	200	375	250	28
901505-01	MITSUBISHI	M5K416NS-20	200	330	275	28
901505-01	MOSTEK	MK4564N-20	200	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

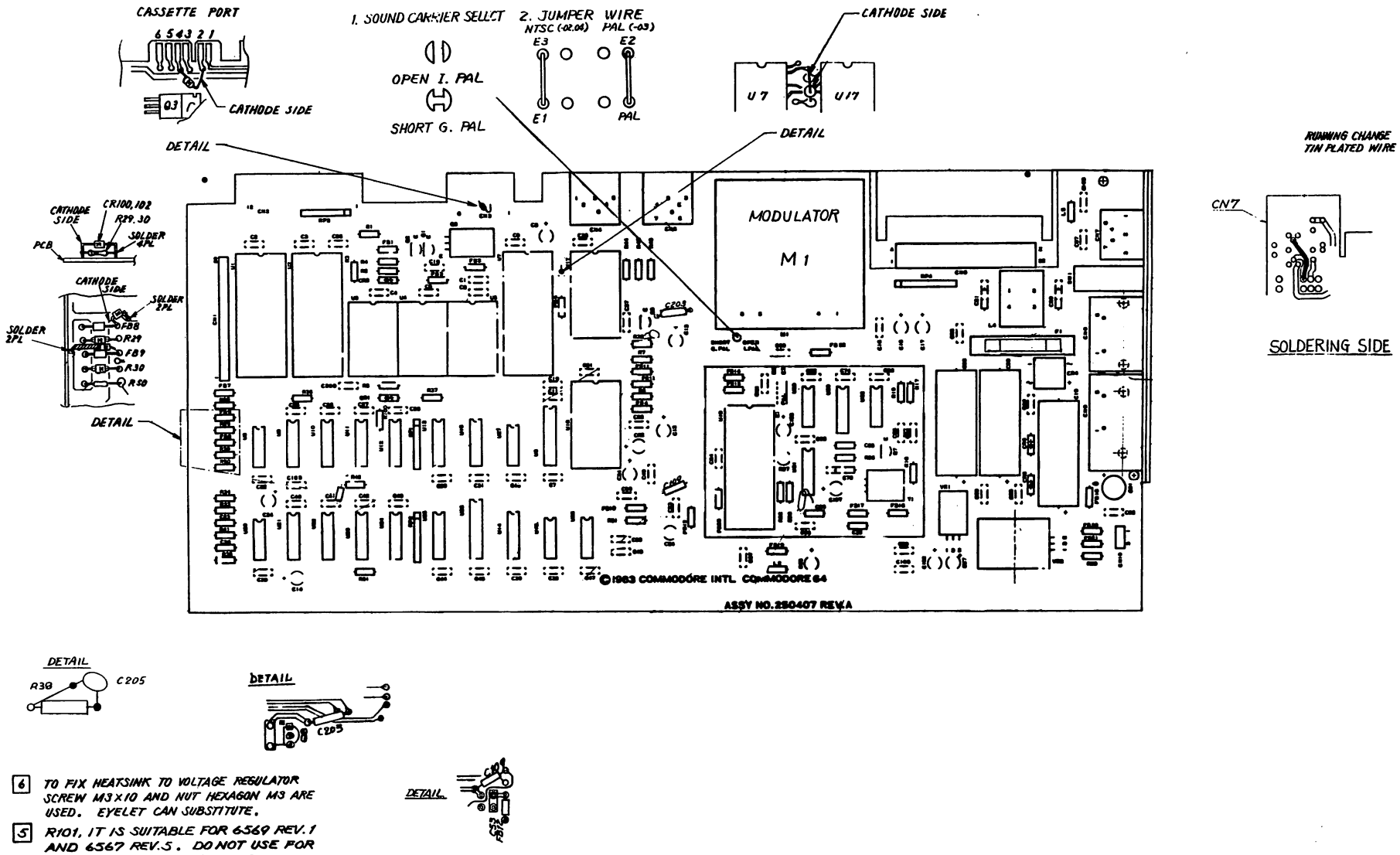


FUNCTIONAL DIAGRAM

SCHEMATIC #326106 SHEET 2 OF 2

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





6 TO FIX HEATSINK TO VOLTAGE REGULATOR SCREW M3×10 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.

4 C204, IT IS SUITABLE FOR MB112A101.

3 C203, IT IS SUITABLE FOR 6569 REV.1. BUT WHEN USE 251183 (U17 ITEM 186), DO NOT USE THIS CAPACITOR.

BOARD LAYOUT #250407-04

PARTS LIST — PCB ASSEMBLY #250407-04

C — Indicates Commodore Stocked Part Number

INTEGRATED CIRCUITS

U1,U2	6526 CIA	C 906108-01
U3	2364 Basic ROM	C 901226-01
U4	2364 Kernal ROM	C 901227-03
U5	2332 Char ROM	C 901225-01
U6	2114L-20 RAM	901453-01
U7	6510 μ Processor	C 906107-01
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
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

RESISTORS (Continued)

R26	Jumper Wire	R39	390
R27	Pot 500Ω	R41	1M
R28	1K	R42	82
R29	1K	R43	3.3K
R30	1K	R44	3.3K
R31	180	R45	3.3K
R33	47K	R50	1M
R34	47K	R51	1.5K
R35	470K	R52	300
R36	1K	R53	390
R37	2.7K	R100	1K
R38	1K	R101	22K

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)

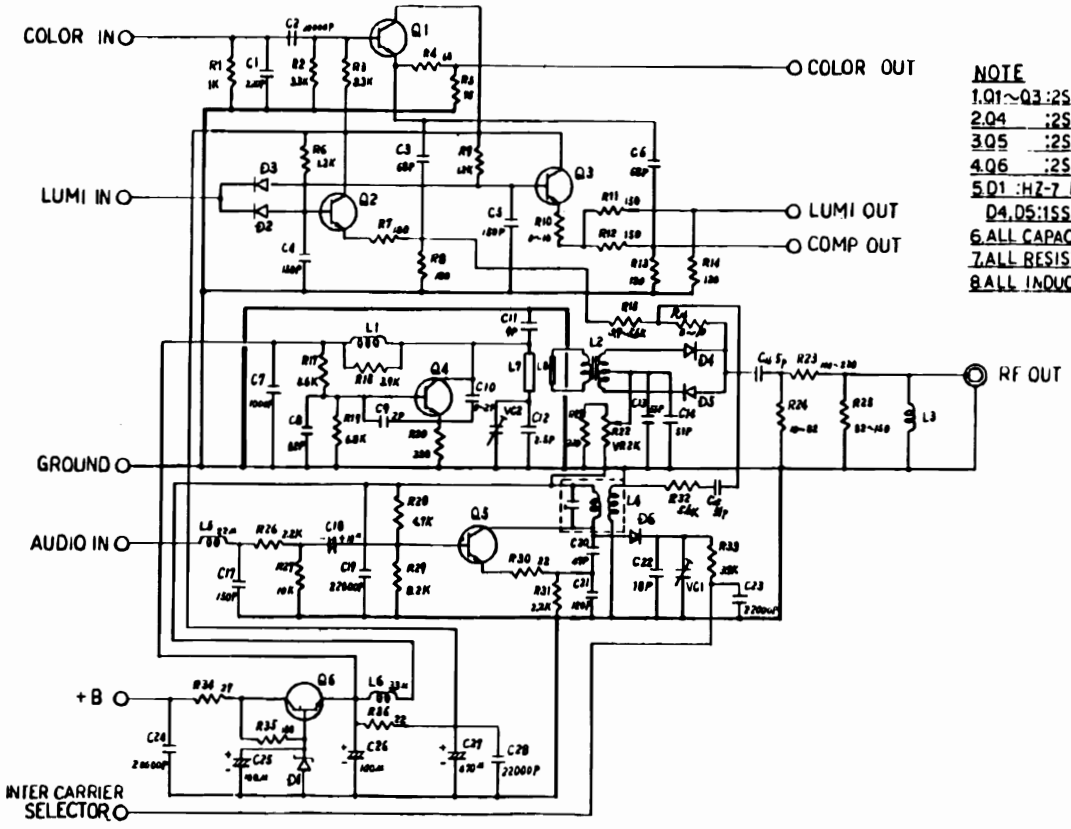
C — Indicates Commodore Stocked Part Number

CAPACITORS (Continued)		
C59,60	Ceramic	.1 μF, 25V
C62,65	Electrolytic	10 μF, 25V, +50%, −10%
C66,67,68	Ceramic	.1 μF, 25V
C70	Film	16 pF, 5%
C74,82	Ceramic	.1 μF, 25V
C83	Ceramic	82 pF, 5%
C84	Ceramic	.1 μF, 25V
C85	Ceramic	.47 μF, 50V, 10%
C88	Electrolytic	1000 μF, 25V
C89	Ceramic	.1 μF, 25V
C90	Electrolytic	470 μF, 50V
C91	Electrolytic	100 μF, 16V, +50%, −10%
C92	Ceramic	.1 μF, 25V
C93	Ceramic	1800 pF, 50V, 10% B
C94	Electrolytic	10 μF, 25V, +50%, −10%
C95,96	Ceramic	.1 μF, 25V
C97	Ceramic	.22 μF, 25V
C98,99	Ceramic	.1 μF, 50V, +80%, −20%
C100	Ceramic	.22 μF, 25V
C101	Ceramic	.1 μF, 50V, +80%, −20%
C102	Electrolytic	10 μF, 25V, +50%, −10%
C103	Ceramic	.1 μF, 25V
C104		
C105	Ceramic	.1 μF, 25V
C108	Electrolytic	10 μF, 25V, 20%
C200	Ceramic	.1 μF, 25V

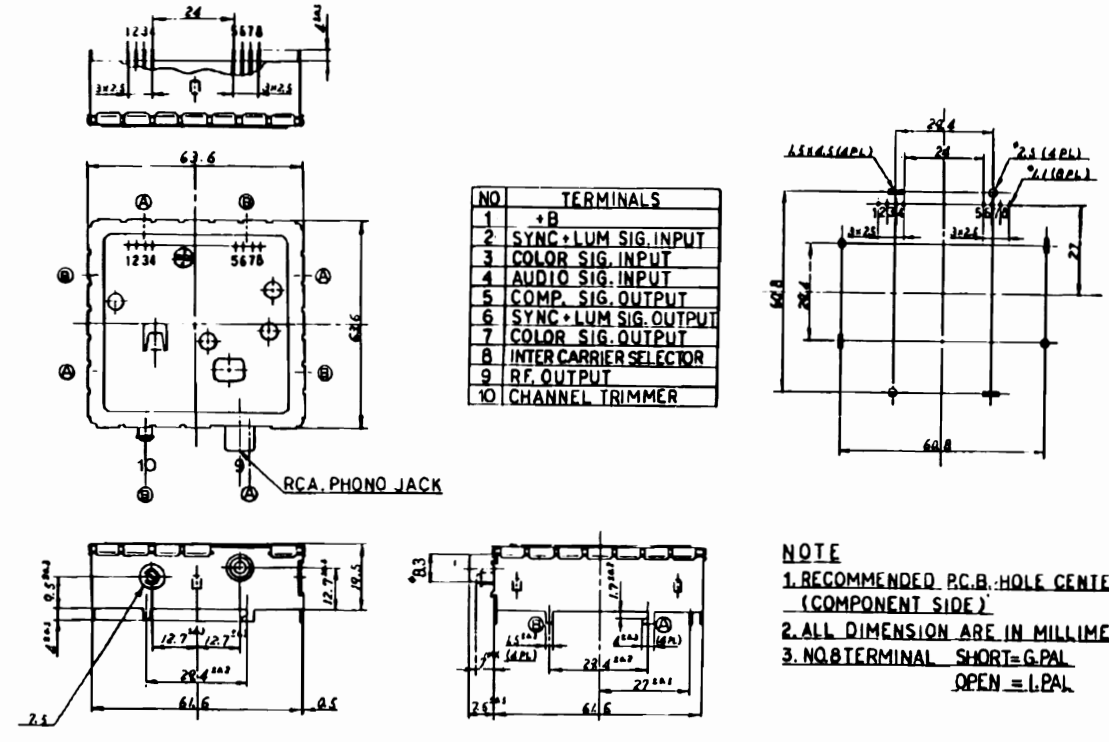
CONNECTORS		
CN1	Header Assy, 20 Pin	903331-20
CN4	6 Pin Din	C 903361-01
CN5	8 Pin Din	C 325573-01
CN6	44 Pin Card Edge	C 906100-02
CN7	7 Pin Din	C 251116-01
CN8,9	Plug Assy, 9 Pin MINID	C 906126-01
CN10	Header Assy, 3 Pin	903332-03

MISCELLANEOUS		
L2	Coil Inductor 2.2 μH	901151-17
L4	Coil Inductor 1.2 μH	325570-01
L5	Choke Coil	C 325559-02
Y1	Crystal 14.31818 MHz	C 900558-01
SW1	Rocker Switch DPDT	904500-01
VR1	Voltage Regulator MC7812CT	901527-01
VR2	Voltage Regulator MC7805CT	901527-02
M1	Modulator	C 251080-01
F1	Fuse, Normal Blo, 250V, 1.5A	
FB1-5 FB7-23	Ferrite Bead	903025-01
	Connector Panel (Power, ON, OFF)	251095-01
	Cartridge Guide	326116-01
	Shield Box	C 251023-01
	Shield Cap	C 251024-01

MODULATOR SCHEMATIC #251025



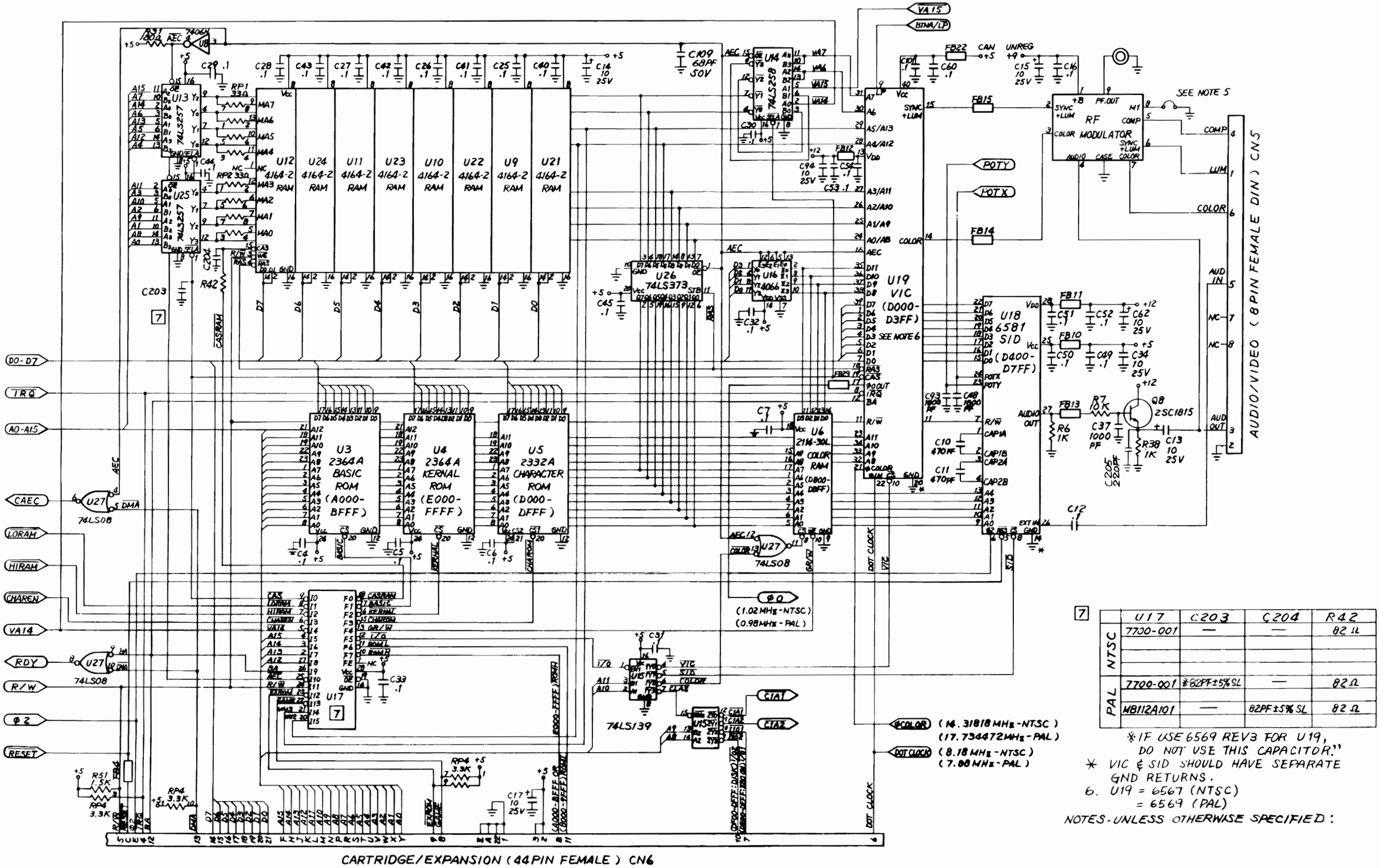
NOTE
1. Q1~Q3 : 2SC1684 OR EQIVALENT
2. Q4 : 2SC1730 OR EQIVALENT
3. Q5 : 2SC460 OR EQIVALENT
4. Q6 : 2SC2120 OR EQIVALENT
5. D1 : HZ-7 D2, D3 : 1SS119
   D4, D5 : 1SS86 OR 1SS174 D6 : 1SS110
6. ALL CAPACITANCE VALUES : F
7. ALL RESISTANCE VALUES : Ω
8. ALL INDUCTANCE VALUES : H



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.PAL
   OPEN = L.PAL

SCHEMATIC #251138 SHEET 1 OF 2



7		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."

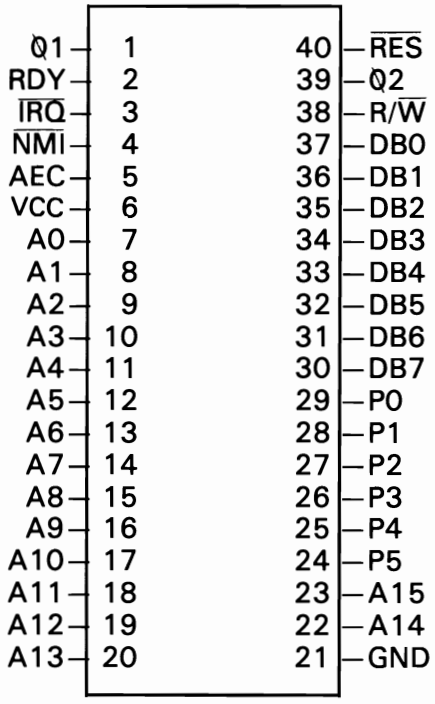
* VIC & SID SHOULD HAVE SEPARATE GND RETURNS.

6. U19 = 6567 (NTSC)
   = 6569 (PAL)

NOTES - UNLESS OTHERWISE SPECIFIED:

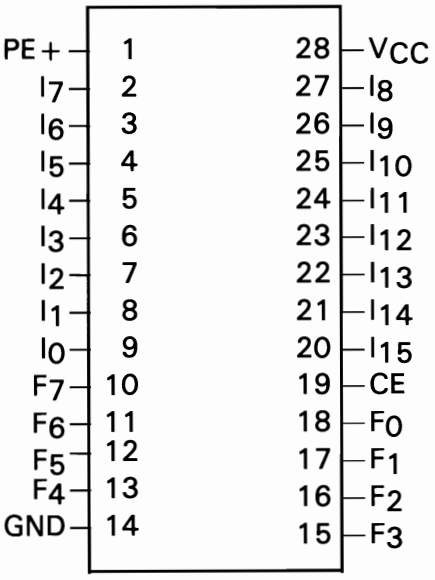
U7 — 906107-01
6510 MICROPROCESSOR

PIN ASSIGNMENT



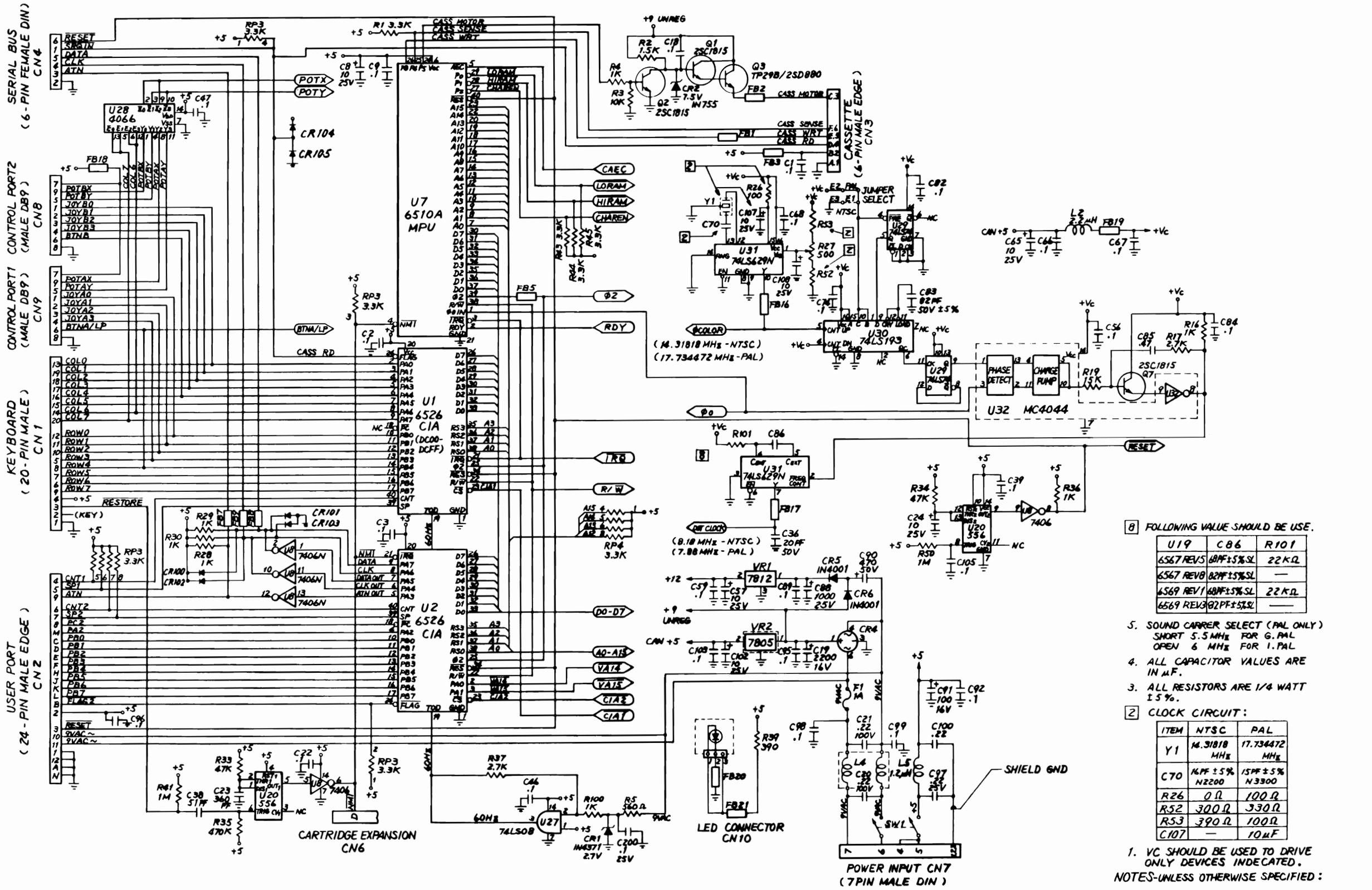
1	Ø1	Phase 1 clock input. This clock input is used to develop the internal overlapping phase 2 clock. 1 MegHz or 2 MegHz speeds.
2	RDY	Single step operation input. A low applied will cause the processor to halt. The current address line being fetched will be on the address bus. Can also be used to interface 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 22,23	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.
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	02	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.

PIN ASSIGNMENT



U17 — 906114-01
PROGRAMMABLE LOGIC ARRAY (PLA)

SCHEMATIC #251138 SHEET 2 OF 2



8 FOLLOWING VALUE SHOULD BE USE.

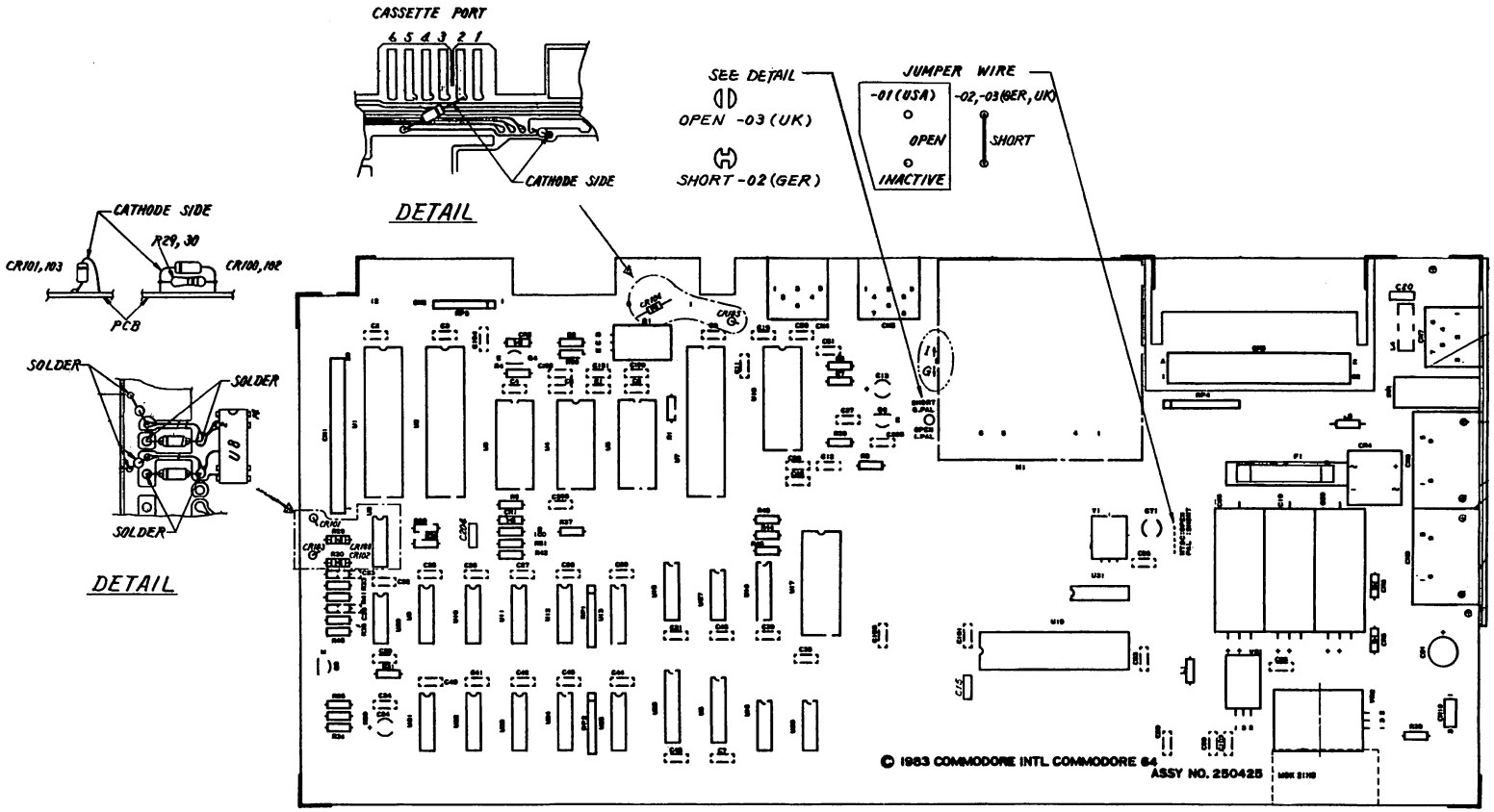
U19	C86	R101
6567 REV5	68PF ±5% SL	22KΩ
6567 REV8	82PF ±5% SL	—
6569 REV1	68PF ±5% SL	22KΩ
6569 REV3	82PF ±5% SL	—

5. SOUND CARRER SELECT (PAL ONLY)
   SHORT 5.5 MHz FOR G.PAL
   OPEN 6 MHz FOR I.PAL
4. ALL CAPACITOR VALUES ARE IN μF.
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	—	10μF

1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDECATED.

NOTES-UNLESS OTHERWISE SPECIFIED:



SOUND CARRIER SELECT	MODULATOR				
	NTSC	PAL			
		P/N 251025-01		P/N 251697-01	
		-02 (GER)	-03 (UK)	-02 (GER)	-03 (UK)
JUMPER	DON'T CARE	OPEN	SHORT	DON'T CARE	DON'T CARE
SWITCH	DON'T CARE	DON'T CARE	DON'T CARE	G POSITION	I POSITION

DETAIL "C" SOUND CARRIER SELECT

BOARD LAYOUT #250425-01

PARTS LIST — PCB ASSEMBLY #250425-01

C — Indicates Commodore Stocked Part Number

INTEGRATED CIRCUITS

U1,U2	6526 CIA	C 906108-01
U3	2364 Basic ROM	C 901226-01
U4	2364 Kernal ROM	C 901227-03
U5	2332 Char ROM	C 901225-01
U6	2114L-20 RAM	901453-01
U7	6510 μ Processor	C 906107-01
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

Q1	TIP29 A	902653-01
Q2-4	2SC1815	C 902693-01

DIODES

CR1	2.7V Zener IN4371	906103-02
CR2	6.8V Zener IN754A	
CR4	Bridge S2V310	C 251026-01 sub:
	DBA20B	C 251026-02 sub:
	DBA20C	C 251026-03
CR5,6	Rectifier IN4001	900750-01
CR9, CR12-16, 100-105	IN4148 sub: IN914	

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

RESISTORS (Continued)

R39	390	R50	1M
R41	1M	R51	1.5K
R42	82	R60	100
R43	3.3K	R100	1K
R44	3.3K	R101	22K
R45	3.3K		

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, 1/4 W
RP5	1KΩ, 6 Pin

CAPACITORS

C1-7	Ceramic	.1 μF, 25V
C9	Ceramic	.1 μF, 25V
C10,11	Ceramic	470 pF, 50V, 10%
C12	Ceramic	.1 μF, 25V
C13	Electrolytic	10 μF, 25V, +50%, −10%
C15	Tantalum	4.7 μF, 16V, 20%
C19	Electrolytic	2200 μF, 16V
C20	Film	.22 μF, 100V, 20%
C22	Ceramic	.1 μF, 25V
C23	Ceramic	360 pF, 50V, 10% sub: 390 pF
C24	Electrolytic	22 μF, 25V, +50%, −10%
C31,33,34	Ceramic	.1 μF, 25V
C37	Ceramic	1000 pF, 50V, 10% B
C38	Ceramic	51 pF, 50V, 5% SL
C39-46	Ceramic	.1 μF, 25V
C48	Ceramic	1800 pF, 50V, 10% B
C50,51,53	Ceramic	.1 μF, 25V
C59	Ceramic	.1 μF, 25V
C88	Electrolytic	1000 μF, 25V
C90	Electrolytic	470 μF, 50V
C91	Electrolytic	100 μF, 16V, +50%, −10%
C93	Ceramic	1800 pF, 50V, 10% B
C101	Ceramic	.1 μF, 50V, +80%, −20%
C102	Ceramic	.1 μF, 25V
C150-152	Ceramic	470 pF, 50V, 10%
C153	Ceramic	68 pF, 50V, 5%
C154	Ceramic	470 pF, 50V, 10%
C200	Ceramic	.1 μF, 25V
C204	Ceramic	150 pF, 50V, 10%
C205	Ceramic	220 pF, 50V, 5%
CT1	Trimmer	40 pF

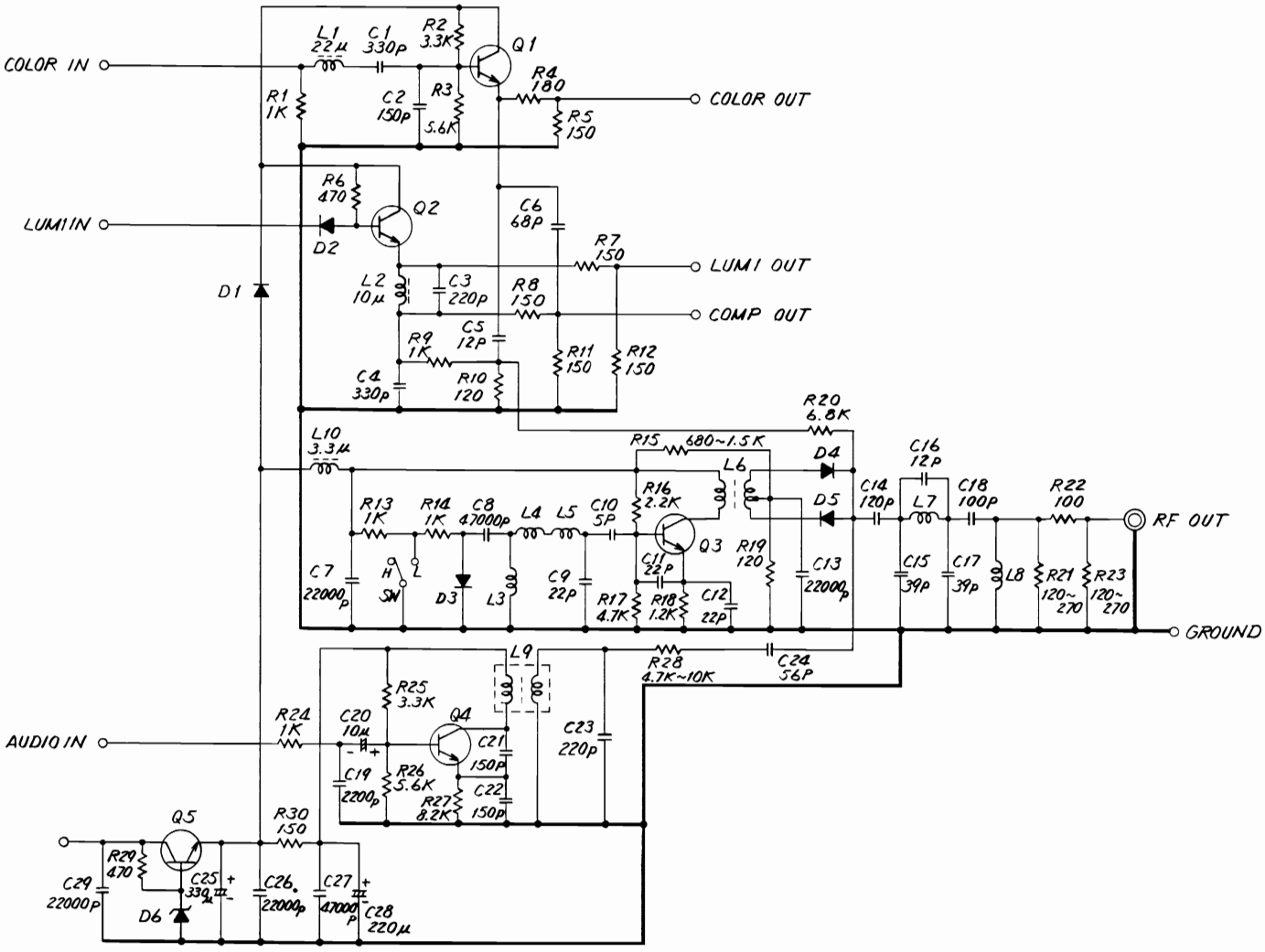
PARTS LIST — PCB ASSEMBLY #250425-01 (Continued)

C — Indicates Commodore Stocked Part Number

CONNECTORS		
CN1	Header Assy, 20 Pin	903331-20
CN4	6 Pin Din	C 903361-01
CN5	8 Pin Din	C 325573-01
CN6	44 Pin Card Edge	C 906100-02
CN7	7 Pin Din	C 251116-01
CN8,9	Plug Assy, 9 Pin MINID	C 251057-01
CN10	Header Assy, 3 Pin	903332-03
MISCELLANEOUS		
L1	Coil Inductor 2.2 μH	901151-17
L4	Line Filter Assy	C 251701-01
L5	Coil Inductor 1.2 μH	901152-01
Y1	Crystal 14.31818 MHz	C 251467-01

MISCELLANEOUS (Continued)		
SW1	Rocker Switch DPDT	904500-01
VR1	Voltage Regulator MC7812CT	901527-01
VR2	Voltage Regulator MC7805CT	901527-02
M1	Modulator	C 251696-01
	Connector Panel (Power, ON, OFF)	251095-01
	Cartridge Guide	326116-01
F1	Fuse, Normal Blo, 250V, 1.5A	

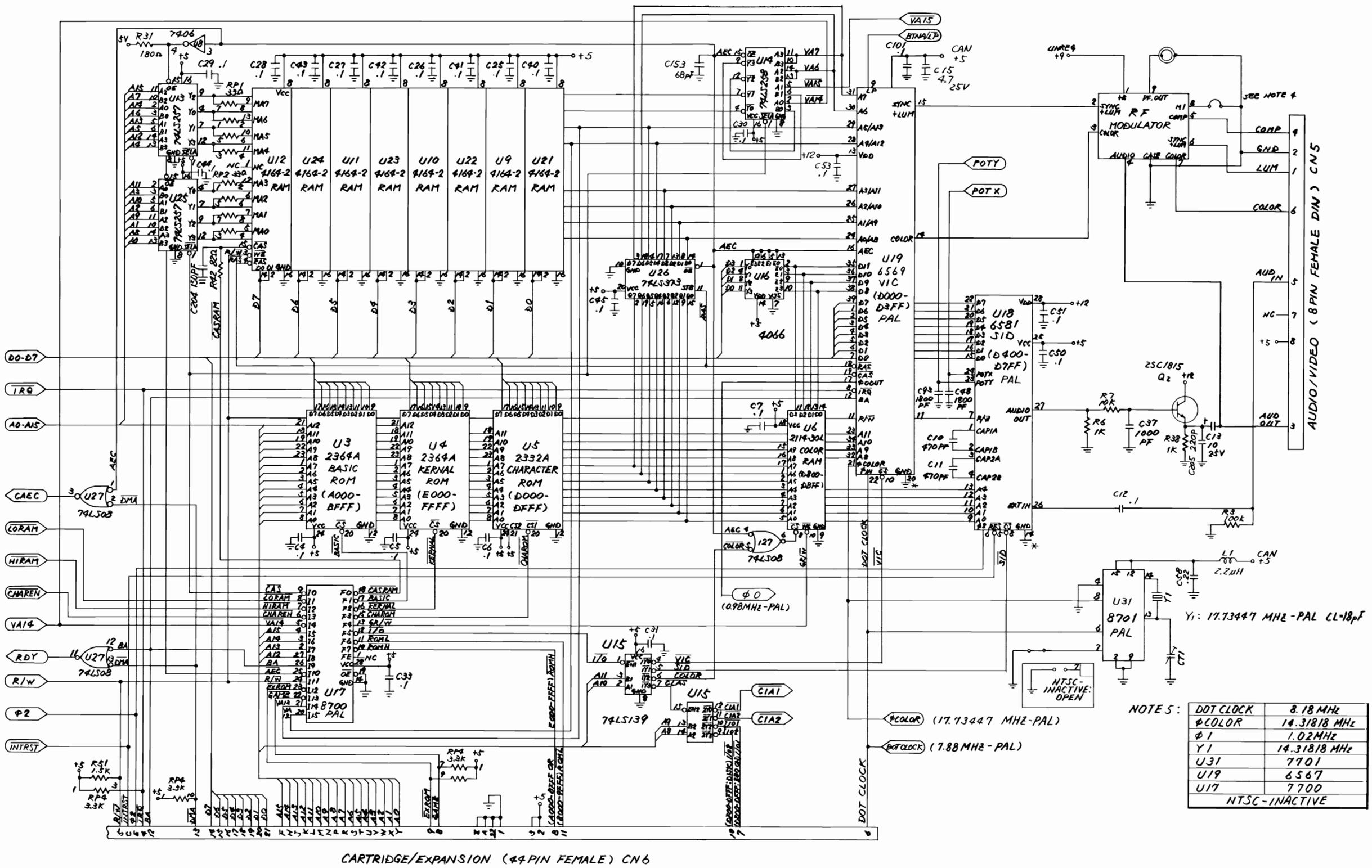
MODULATOR SCHEMATIC #251696



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

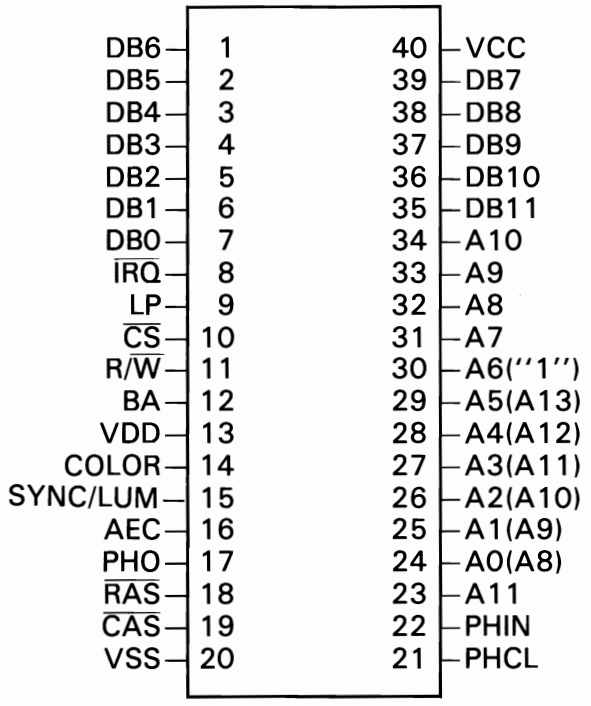
SCHEMATIC #251469 SHEET 1 OF 2



NOTE 5:

DOT CLOCK	8.18 MHz
ΦCOLOR	14.31818 MHz
Φ1	1.02MHz
Y1	14.31818 MHz
U31	7701
U19	6567
U17	7700
NTSC-INACTIVE	

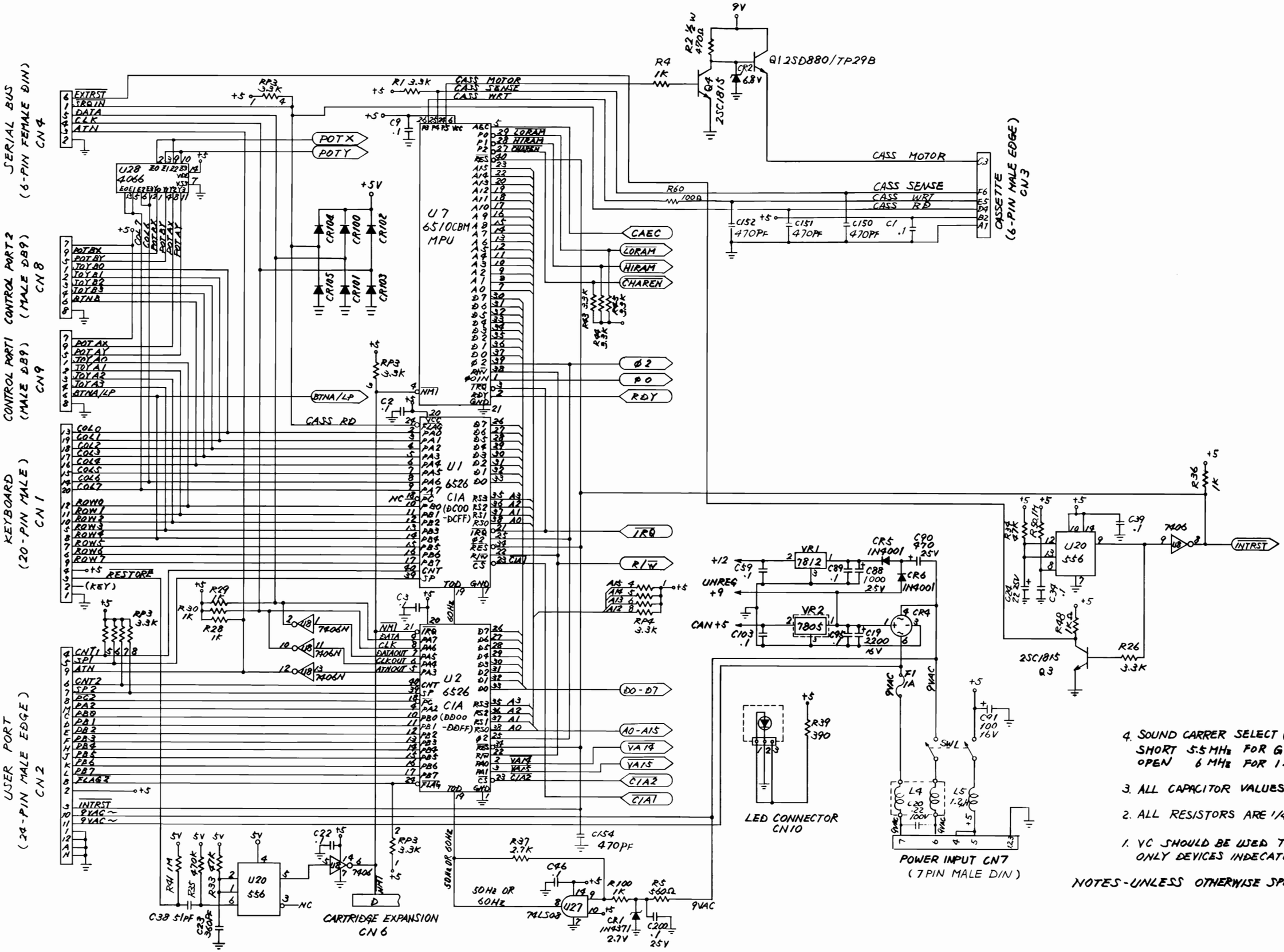
PIN ASSIGNMENT



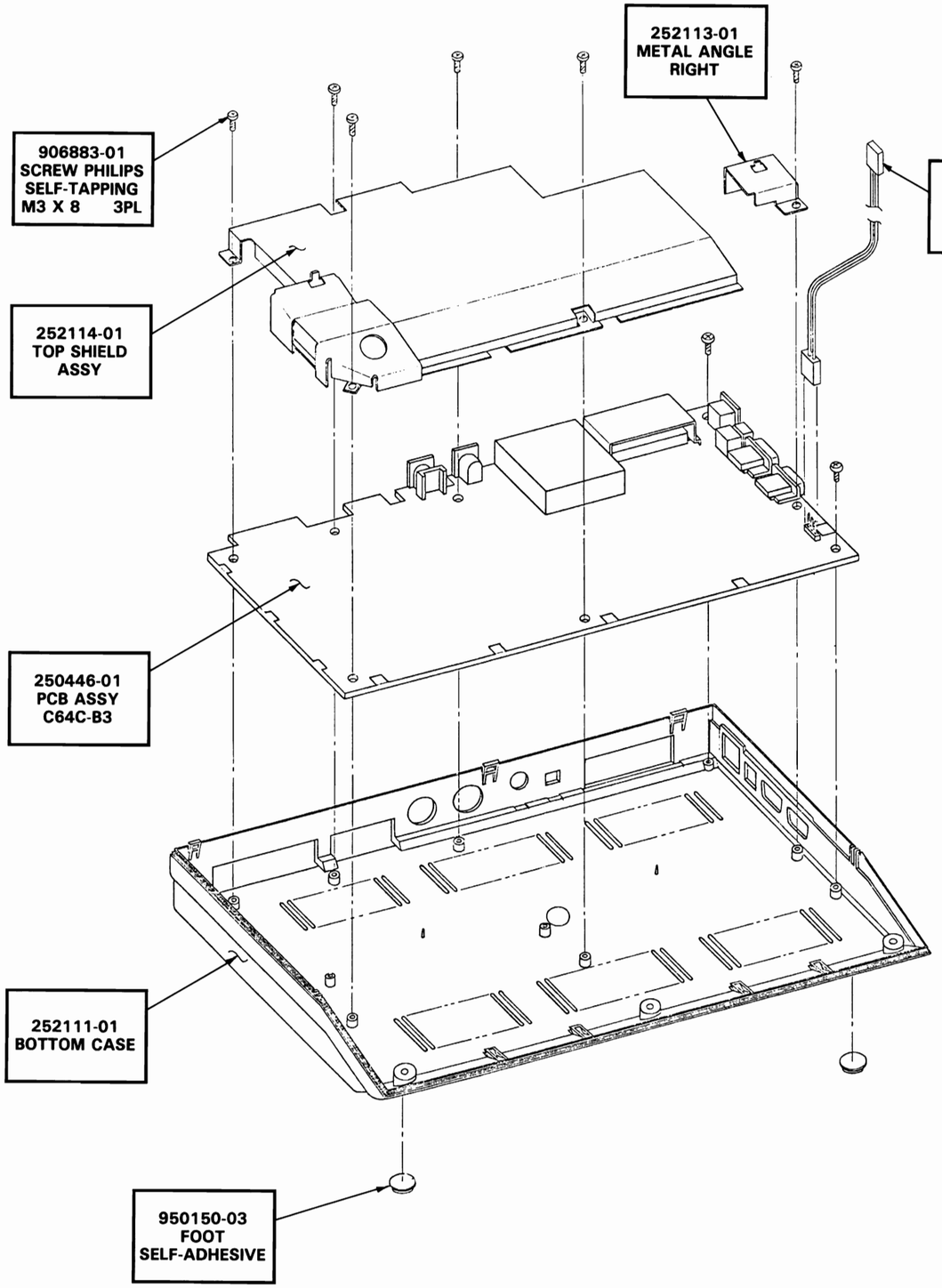
U19 — 906109-01 MULTIPLEXED ADDRESSES IN PARENTHESES

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	PH0	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.

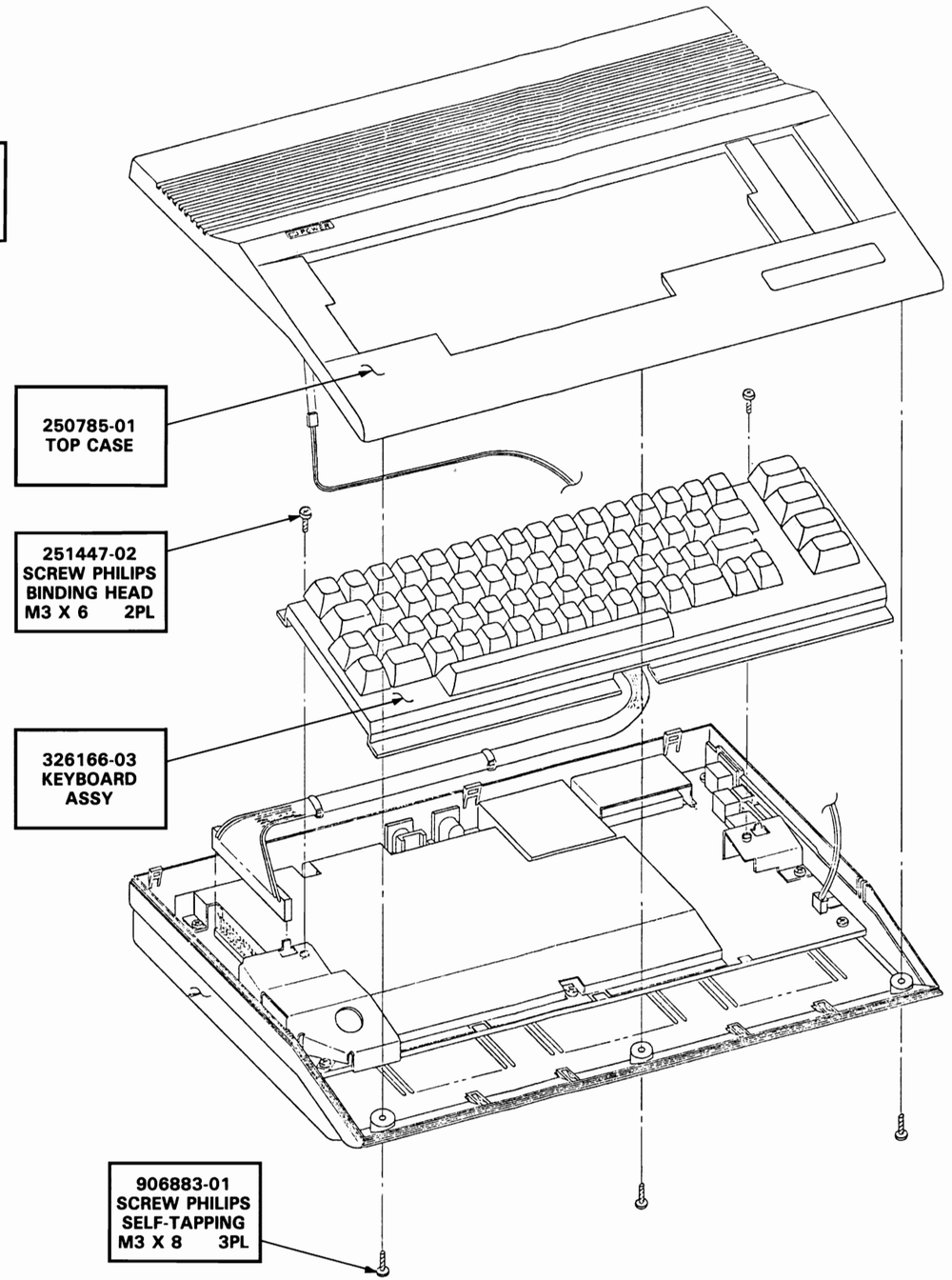
SCHEMATIC #251469 SHEET 2 OF 2



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

U1, U2	LSI CIA 6526	906108-01
U19	LSI VIC NTSC 6567	906109-01
U18	LSI SID 6581 R3	906112-01
U31	LSI CLK GEN 8701T6	251527-08
	LSI CLK GEN 8701L6	251527-09 Sub:
U7	LSI MPU 6510	906107-01
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:
	MEM SRAM 1KX4 Bit 150NS 2114-15	901453-09 Sub:
	MEM SRAM 1KX4 Bit 120NS 2114-12	901453-10 Sub:
U9, U10	MEM DRAM 64KX4 Bit 150NS	390083-02
U3	MEM ROM Basic C64 2364B-161	901226-01
U4	MEM ROM Kernal C64 2364B-273	901227-03
U5	MEM ROM Char C64 2332C-250	901225-01
U20	LIN Dual Timer NE556	901523-03
U16, U28	LIN CMOS SW/3UF 4066B	901502-01
U13, U25	TTL 74LS257A	315033-01
U26	TTL 74LS373	901521-29
U15	TTL 74LS139	901521-18
U27	TTL 74LS08	901521-03
U14	TTL 74LS258A	390010-01
U8	TTL 7406	901522-06
	TTL 7416	901522-14 Sub:

TRANSISTORS

Q1	NPN Power 2SD880	902694-01
	NPN Power TIP29A	902653-01 Sub:
	NPN Power 2SD476	902694-02 Sub:
	NPN Power 2SD313	902694-03 Sub:
	NPN Power 2SD1310	251294-01 Sub:
	NPN Power 2SD1266	902694-04 Sub:
Q2-Q4	NPN Small Signal 2SC1815	902693-01
	NPN Small Signal 2SC945	902671-01 Sub:
	NPN Small Signal 2SC2458	251526-01 Sub:
	NPN Small Signal 2SC2785	251895-01 Sub:

DIODES

CR5, CR6	Rect 1A 60V IN4001	900750-01
CR1	Zener .5W 2.7V IN4371	906103-02
	Zener 2.7V	251286-04 Sub:
	Zener 2.7V	251286-05 Sub:
	Zener 2.7V	251286-06 Sub:
	Zener 2.7V	906103-03 Sub:
	Zener 2.7V	906103-04 Sub:
	Zener 2.7V	906103-05 Sub:
CR2	Zener .5W 6.8V	900927-01
	Zener .5W 6.8V	900927-02 Sub:
CR4	Brdg Rect 2A 100V S2VB10	251026-01

DIODES (Continued)

CR4	Brdg Rect 2A 100V DBA20B	251026-02 Sub:
	Brdg Rect 2A 200V DBA20C	251026-03 Sub:
	Brdg Rect 2A 100V DBA20B-K15	251026-04 Sub:
CR9,12-16	Switching Prefmd IN4148	251819-01
	Switching Prefmd IN914	251819-16 Sub:
	Switching Prefmd IN4148	251819-22 Sub:

RESISTORS — All are carbon 1/4 watt, 5% unless noted

R42	CF 82 Ohm	901550-74
R60	CF 100 Ohm	901550-49
R31	CF 180 Ohm	901550-100
R39	CF 390 Ohm	901550-57
R5	CF 560 Ohm	901550-30
R4,6,38,100	CF 1K Ohm	901550-01
R51	CF 1.5K Ohm	901550-69
R37	CF 2.7K Ohm	901550-23
R1,26,43-45	CF 3.3K Ohm	901550-02
R7	CF 10K Ohm	901550-20
R33,34	CF 47K Ohm	901550-22
R3	CF 100K Ohm	901550-07
R35	CF 470K Ohm	901550-82
R41,50	CF 1M Ohm	901550-84
R2	CF 470 Ohm 1/2W 5%	901600-38
RP1, RP2	NTWK SIP 33 Ohm 8 Pin	902422-03
RP5	NTWK SIP 1K Ohm 6 Pin	902441-22
RP3	NTWK SIP 3.3K Ohm 8 Pin	902442-29
RP4	NTWK SIP 3.3K Ohm 10 Pin	902410-06

CAPACITORS

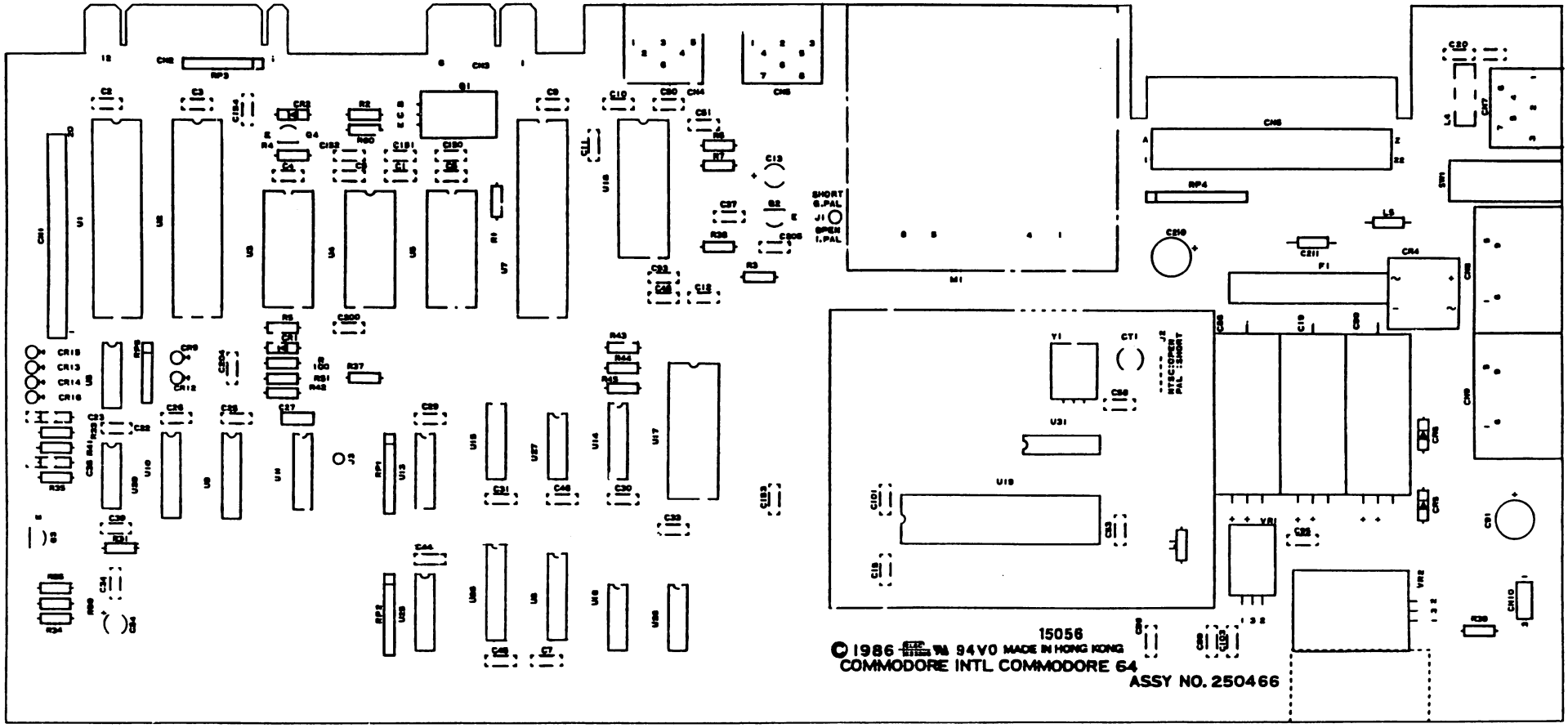
C38	Axl 51pF 5% SL	251078-24
	Ceramic Disc 51pF 50V 5% SL	251072-33 Sub:
	Ceramic Disc 56pF 50V 5% SL	251072-19 Sub:
C153	Ceramic Disc 68pF 50V 5%	900010-51
C204	Ceramic Disc 150pF 50V SL-K 10%	251071-24
C205	Ceramic Disc 220pF 50V 5% SL	251072-26
C23	Ceramic Axl 360pF 10% B	251078-51
	Ceramic Disc 390pF 50V Y5P-K	251069-03 Sub:
C10,11, 150-152, 154	Ceramic Disc 470pF 50V Y5P-K	251069-04
C37	Ceramic Disc 1000pF 50V Y5P-K	251069-08
C48,93	Ceramic Disc 1800pF 50V Y5P-K	251069-11
C1-7,9,12, 22,25,26, 30,31,33, 34,39,45, 50,51,53, 59,89,95, 101,103,29, 44,46	Ceramic Disc .1μF 25V Y5V-Z +80 −20%	251075-06
C1-7,9,12 22,25,26, 30,31,33, 34,39,45, 46,50,101, 103,29,44	Ceramic Disc 0.1μF 12V 20%	900303-02 Sub:
C58	Ceramic Disc .22μF 25V Y5V-Z	251075-07

CAPACITORS (Continued)		
C20	Film Rdl .22μF 100V 20%	251875-01
	Film Rdl .22μF 100V 20%	900150-11 Sub:
	Film Rdl .22μF 100V 20%	900150-12 Sub:
C211	Ceramic Axl .1μF 50V	900461-28
C15	Tant Rdl 4.7μF 16V 20%	900410-13
C13 (C210)	Electrolytic Rdl 10μf 25V −10 +50%	900100-01
C13	Electrolytic Rdl 10μF 25V 20%	251079-16 Sub:
	Electrolytic Rdl 10μF 25V 20%	251894-35 Sub:
C24	Electrolytic Rdl 22μF 25V	900100-24
	Electrolytic Rdl 22μF 25V 20%	251894-36 Sub:
C91	Electrolytic Rdl 100μF 16V −10 +50%	900100-40
	Electrolytic Rdl 100μF 16V 20%	251894-27 Sub:
C90	Electrolytic Axl 470μF 25V	900101-49
C88	Electrolytic Axl 1000μF 25V	900101-50
C19	Electrolytic Axl 2200μF 16V	900101-33
C200	Electrolytic Rdl 2.2μF	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

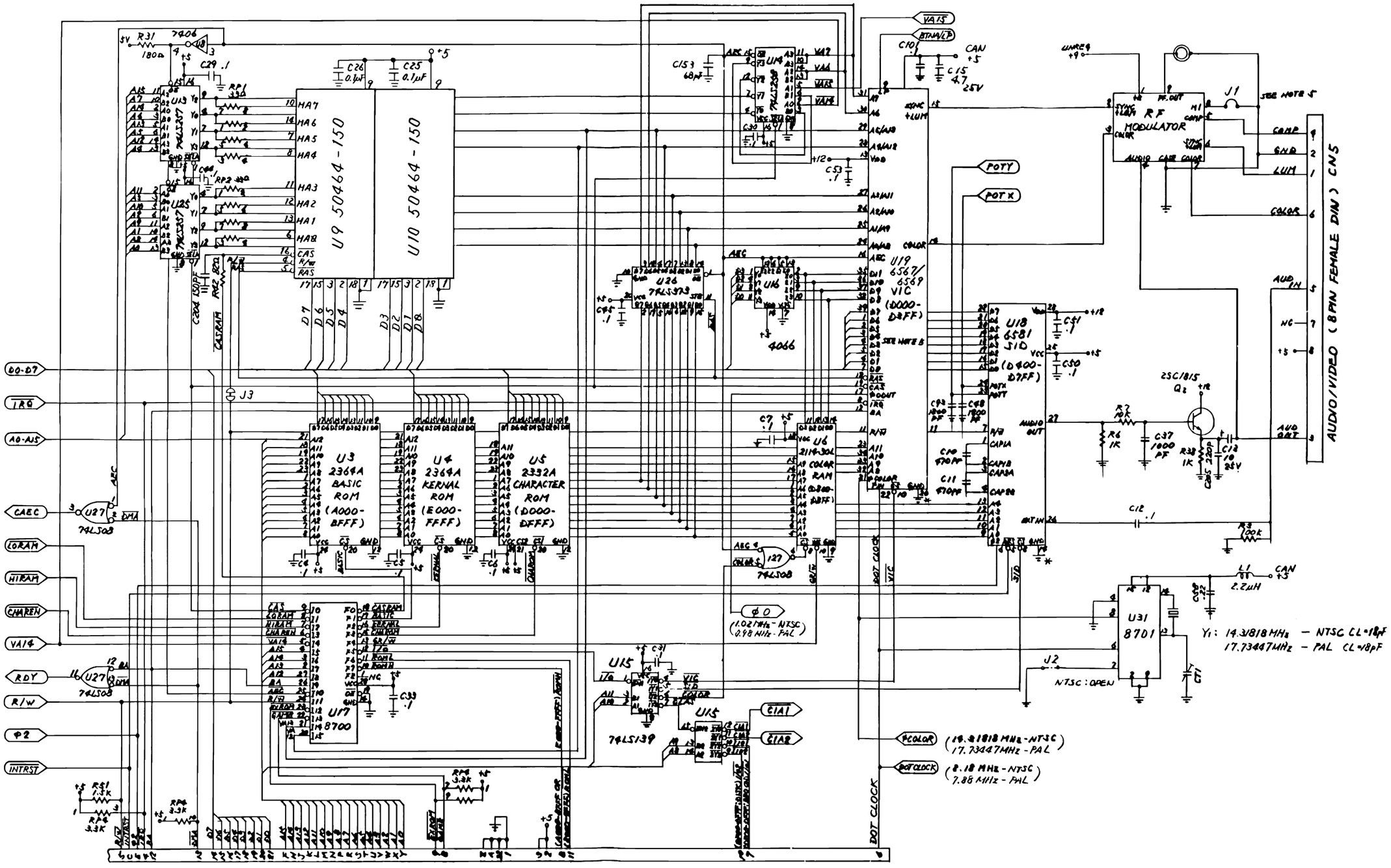
CONNECTORS (Continued)		
CN1	Header w/LKG Sil 2.54 CTR 20 Pin	903364-02
	Header 20 Pin	903331-20 Sub:
CN10	Header Sil 2.54 CTR 3 Pin	903332-03
CN5	Din Female R-Angle 8 Pin	325573-01
	Din Female R-Angle 8 Pin	325573-02 Sub:
	Din Female R-Angle 8 Pin	325573-03 Sub:
	Din Female R-Angle 8 Pin	325573-04 Sub:
CN8,9	Submin D Male R-Angle 9 Pin	906126-01
	Mini Din 9 Pin	251057-01 Sub:
SW1	Switch Rocker DPDT	904500-91
	Switch Power Rocker	252182-01

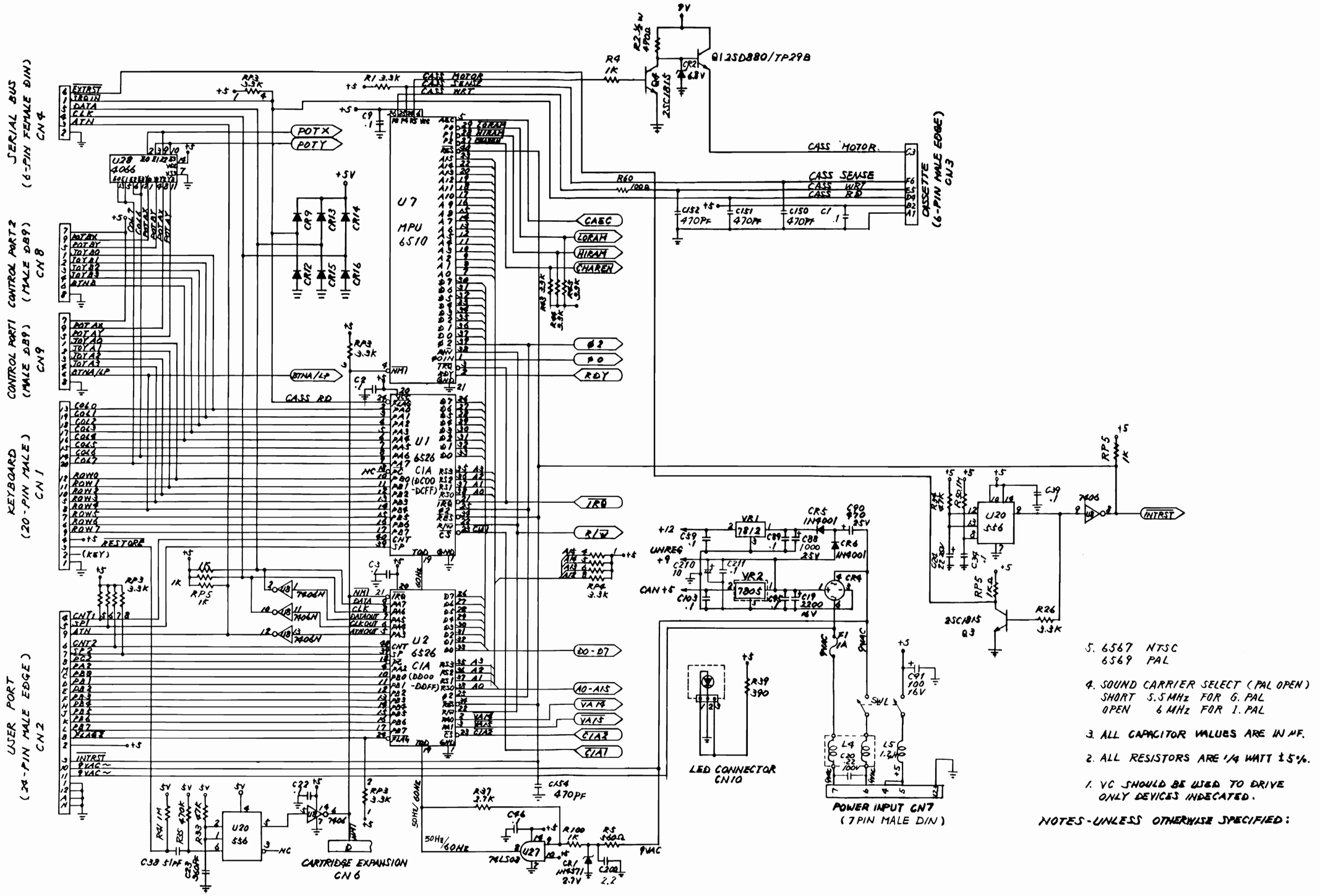
MISCELLANEOUS		
Y1	Xtal 14.31818 MHZ HC-49/U	251467-01
Y1	Xtal 17.73447 MHZ HC-49/U	251468-01
L1	Inductor Coil 2.2μH	901151-17
L5	Inductor Coil 1.2μH	325570-01
L4	Line Filter 5A	251701-01
VR1	IC Volt Regulator +12V MC7812CT	901527-01
VR2	IC Volt Regulator +5V MC7805CT	901527-02
M1	RF Modulator NTSC C64	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

SCHEMATIC #252278 (sheet 1 of 2)





5. 6567 NTSC
   6569 PAL

4. SOUND CARRIER SELECT (PAL OPEN)
   SHORT 5.5MHz FOR G. PAL
   OPEN 6 MHz FOR I. PAL

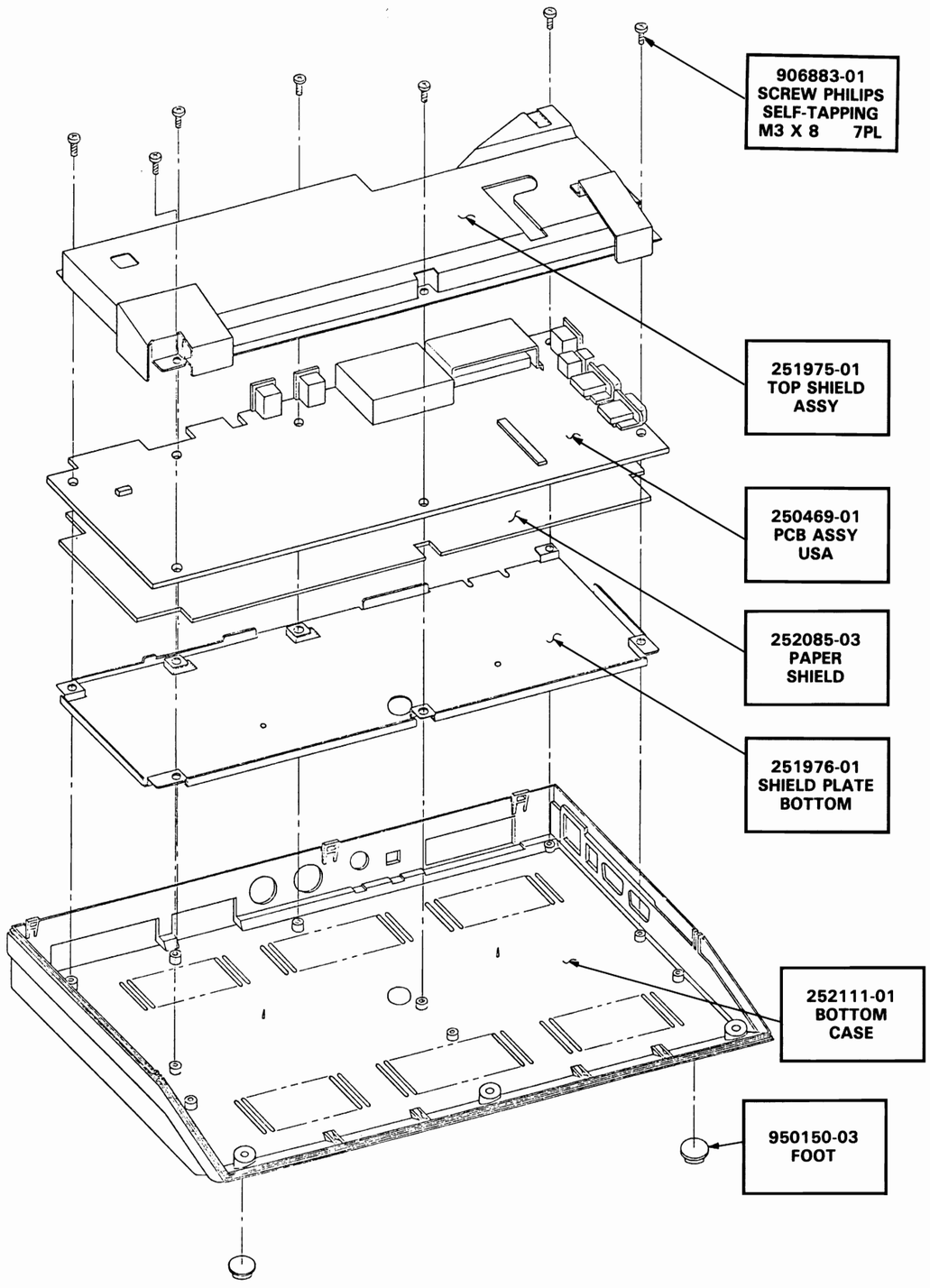
3. ALL CAPACITOR VALUES ARE IN MF.

2. ALL RESISTORS ARE 1/4 WATT ±5%.

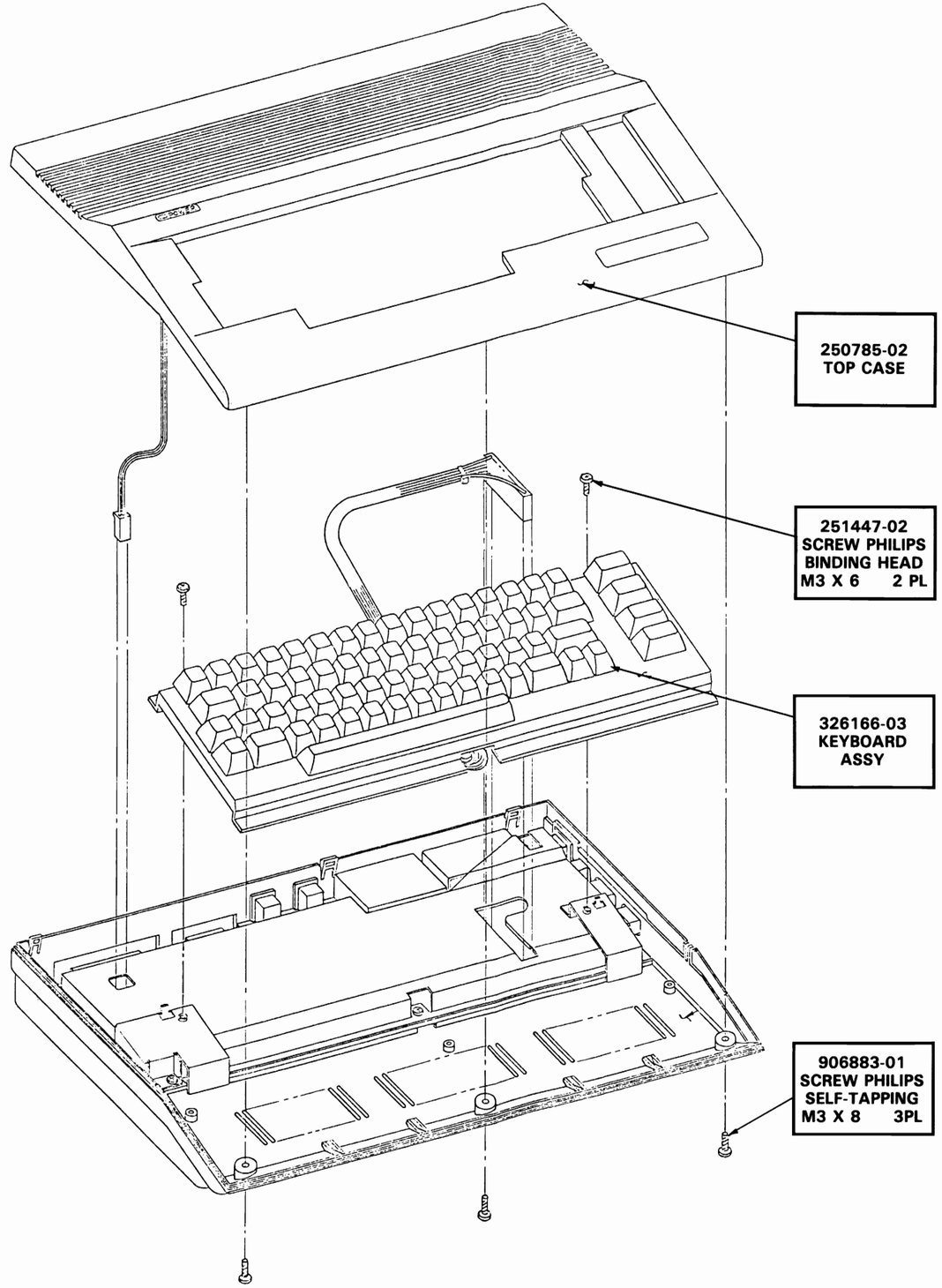
1. VC SHOULD BE USED TO DRIVE ONLY DEVICES INDECATED.

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		
U6	8500	318012-01
U1,2	6526	906108-01
U7	8567	318014-01
U7	8562	318027-01
U9	8580	318013-01
U5	2332 ROM CHAR US PAL	901225-01
U5,4	128K ROM US PAL	251913-01
U18,21	4066	901502-01
U22	7406	901522-06
U3	74LS08	901521-03
U23	74LS14	901521-30
U20	8701T6	251527-08
U19	2114 (200 NSEC)	901453-07
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		
CR3,4	1N4001	900750-01
CR5,9,11-21	1N914 *r*	251819-16
CR5,9,11-21	IN4148 *r*	251819-01
CR1	Zener RD6.8EB	900927-01
CR6	Zener RD3.0EB1	906103-04
CR1	Zener IN754A	900927-02
CR6	Zener RD3.0FB2	906103-05
CR7	Zener RD10ESB2	252313-63
CR7	Zener RD13ESB2	252313-75
CR7	Zener HZ11A1	252337-61
CR7	Zener HZ12B2	252337-74
CR2	Bridge Rectifier S2VB10	251026-01
CR2	Bridge Rectifier DBA20B	251026-02
CR2	Bridge Rectifier DBA20C	251026-03

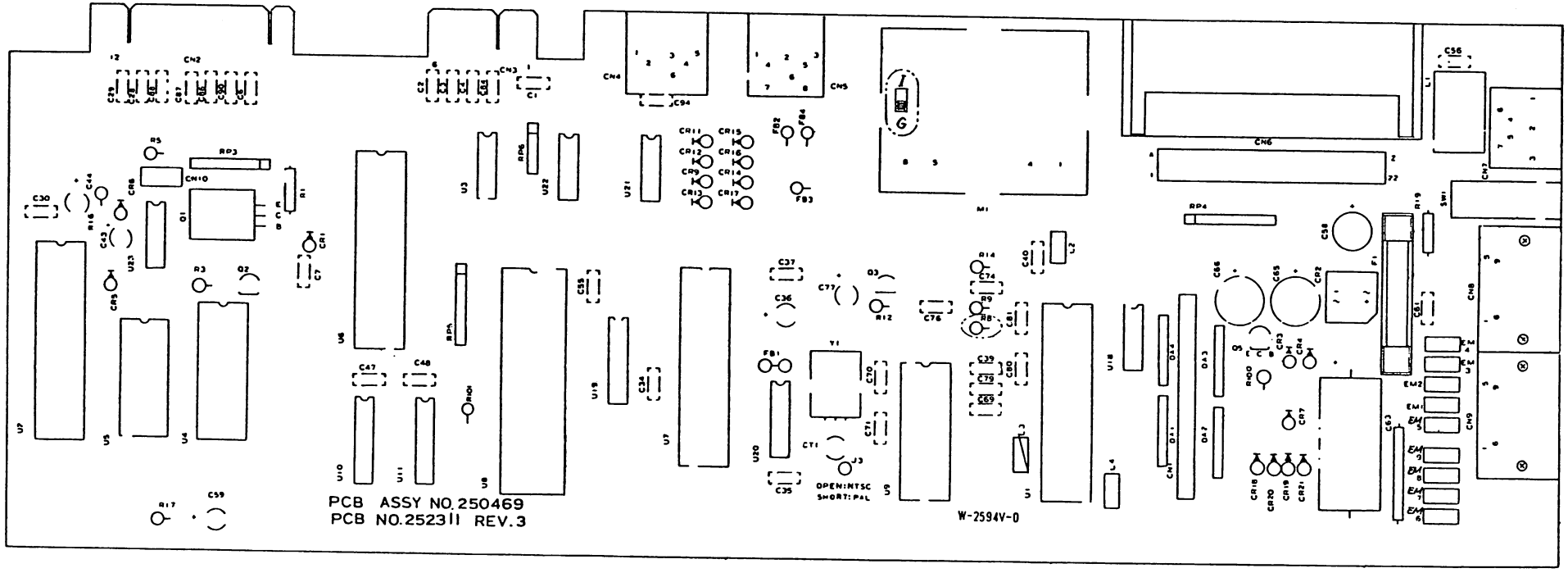
TRANSISTORS		
Q1	2SD880	902694-01
Q2,3	2SC1815	902693-01
Q1	TIP29A	902653-01
Q1	2SD476*k*C	902694-02
Q1	2SD313E/F	902694-03
Q1	2SD1310	251294-01
Q2,3	2SC945	902671-01
Q2,3	2SC2458	251526-01
Q5	NPN 900nN	252338-01

CAPACITORS		
C2-4,6,76,90	Ceramic *r* 470pF 50V	251069-04
C74	Ceramic *r* 1000pF 50V	251069-08
C80,81	Ceramic *r* 2200pF 25V	251069-12
C1,7,28-30, 34,35,37,39, 40,47,48,55, 61,69,79,84	Ceramic *r* 0.1μF 25V	251075-06
C70,71	Ceramic *r* 22000pF 50VM	251304-71
C94	Ceramic *r* 150pF 50V	251070-24
C86-88	Ceramic *r* 220pF 50V	251071-26

CAPACITORS (continued)		
C44	Electrolytic *r* 2.2μF 50V	251079-06
C59	Electrolytic *r* 4.7μF 25V	900100-11
C77	Electrolytic *r* 10μF 25V	900100-01
C58	Electrolytic *r* 100μF 16V	900100-40
C65	Electrolytic *r* 220μF 25V	900100-03
C63	Electrolytic *a* 1000μF 16V	900101-52
C36	Electrolytic *r* 47μF 16V	900100-33
C43	Electrolytic *r* 220μF 16V	900100-18
C66	Electrolytic *r* 470μF 35V	900301-35
C80,81	Ceramic *r* 1800pF 50V 10% B	251069-11
C63	Electrolytic *a* 2200μF 16V	900101-33
C70,71	Ceramic *r* 22000pF 25V M	251074-09
CT-1	Trimmer 7.7-40pF	251029-02

RESISTORS		
R2	Wound 20 ohm 5W 5%	251756-02
R5	Carbon 390 ohm 1/4W 5%	251068-65
R16	Carbon 560 ohm 1/4W 5%	251068-69
R3,12 (8)	Carbon IK ohm 1/4W 5%	251068-76
R9,17	Carbon 10 ohm 1/4W 5%	251068-101
R14	Carbon 100K ohm 1/4W 5%	251068-126
R1	Carbon 470 ohm 1/2W 5%	901600-38
R101	Carbon 100 ohm 1/4 5%	251068-51
R19	Carbon 10 ohm 1/2W 5%	901600-14
R100	Carbon 1.8K ohm 1/4W 5%	251068-82
RP6	Pack 1K ohm 6 PIN	902441-22
RP4	Pack 3.3K ohm 9 PIN	902412-07
RP3,5	Pack 3.3K ohm 8 PIN	902442-29

MISCELLANEOUS		
EMI-9	EMI Filter 270pF	251842-01
FB1	Ferrite Bead, 2 Turn	252214-01
L3,4	RF Choke Coil	252341-01
L1	Line Filter 8 Terminal	251878-02
L1	Line Filter 8 Terminal	251878-01
Y1	Crystal 14.31818 MHz	251467-01
Y1	Crystal 17.73447 MHz	251468-01
	Jumper Wire	200018-15
L2	Coil Inductor 2.2μH	901151-17
M1	Modulator NTSC	252405-01
	Socket, IC 16 Pin	904150-02
	Socket, IC 28 Pin	904150-05
	Socket, IC 40 Pin	904150-06
F1	Fuse, Normal Blo 250V 1.5A	903556-18
	Fuse, Clip	906102-02
SW1	Switch, Rocker DPDT	904500-01
SW1	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

CASSETTE (6 PIN MALE EDGE) CN 3

SERIAL BUS (6PIN FEMALE DIN) CN 4

KEY BOARD (62PIN MALE) CN 1

CONTROL PORT 2 (MALE DB9) CN 3

CONTROL PORT 1 (MALE DB9) CN 5

USER PORT (24 PIN MALE EDGE) CN 2

POWER INPUT CN7 (7 PIN MALE)

LED CONNECTOR CN10

CARTRIDGE/EXPANSION (44PIN FEMALE) CN6

AUDIO/VIDEO (8 PIN FEMALE DIN) CN5

U1 6526 C1A (DC00-DCFF)

U2 6526 C1A (DD00-DDFF)

U4 23128B KERNAL & BASIC ROM (E000-FFFF & A000-BFFF)

U5 2332C CHARACTER ROM (D000-DFFF)

U6 MPU

U7 VIC (D000-D3FF)

U8 U11 50464-150 / U10 50464-150

U9 U19 2114 (D800-DBFF)

U18 4066

U20 8701

U21 4066

U22: 74C06
U23: 74LS14
U3: 74LS08

- [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 CONECTION J3 OPEN : NTSC
  J3 SHORT : PAL
- [4] DOT CLOCK : 8.18 MHz FOR NTSC
  7.88 MHz FOR PAL
- [3] Y1 : 14.31818 MHz FOR NTSC CL = 18P
  17.734472 MHz FOR PAL CL = 18P
- 2. ALL CAPACITOR VALUES ARE IN μF.
- 1. ALL RESISTORS ARE 1/4 WATT ±5%.

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