

SERVICE MANUAL
MODEL C64 COMPUTER
FEB. 1985 PN-314001-02

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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

C-64

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. will be available in manual form through the Service Department in November of 1984. 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 326166-02 |
| LED Plate | C 326160-01 |
| Nameplate | C 326161-01 |
| Lamp Holder Set | C 903820-03 |
| LED Assembly | C 1001039-01 |

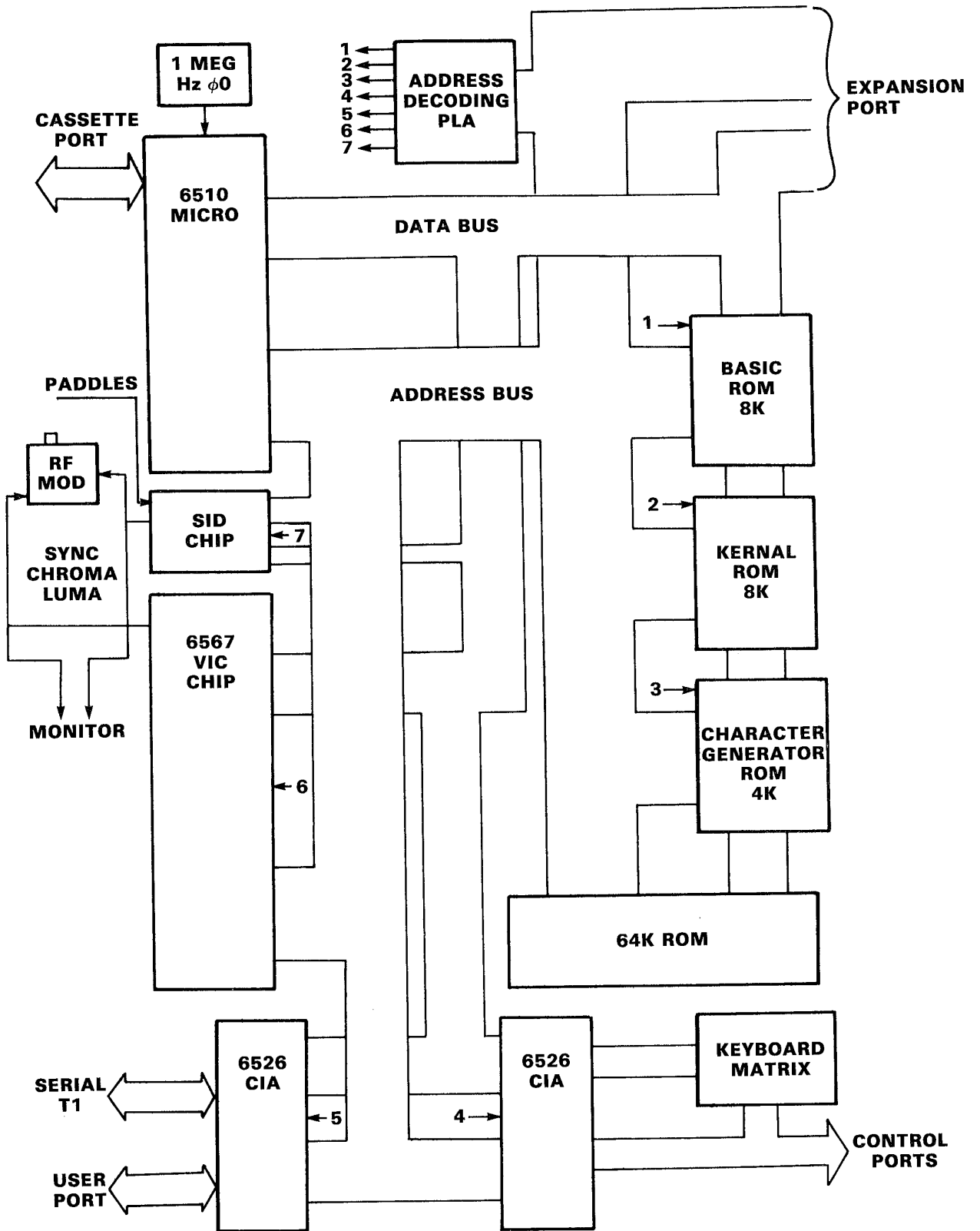
BOTTOM CASE ASSY

| | |
|----------------------|-------------|
| 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 |

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 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.

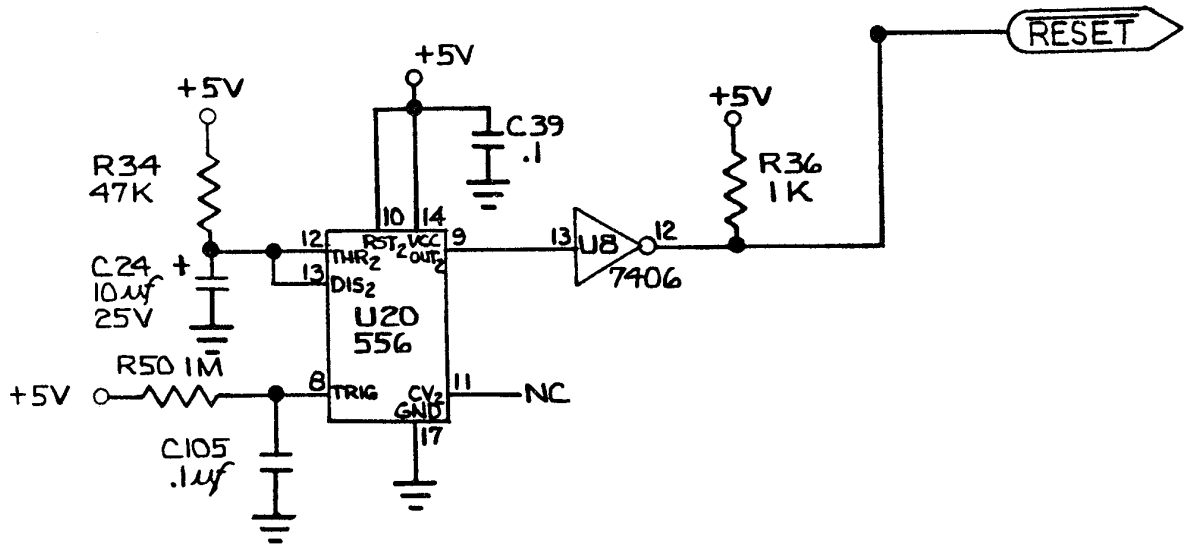
+5VDC CAN Generation

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.

CR6 rectifies the 9VAC input. The output is 9VDC unregulated, and not filtered. This supply powers the cassette motor transistor amplifier circuits, and the RF modulator on the C64B version.

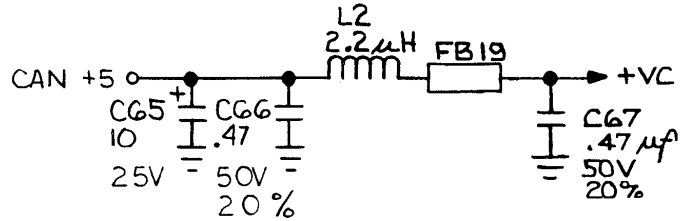
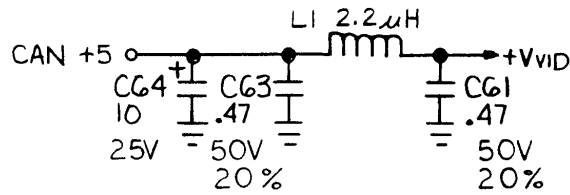
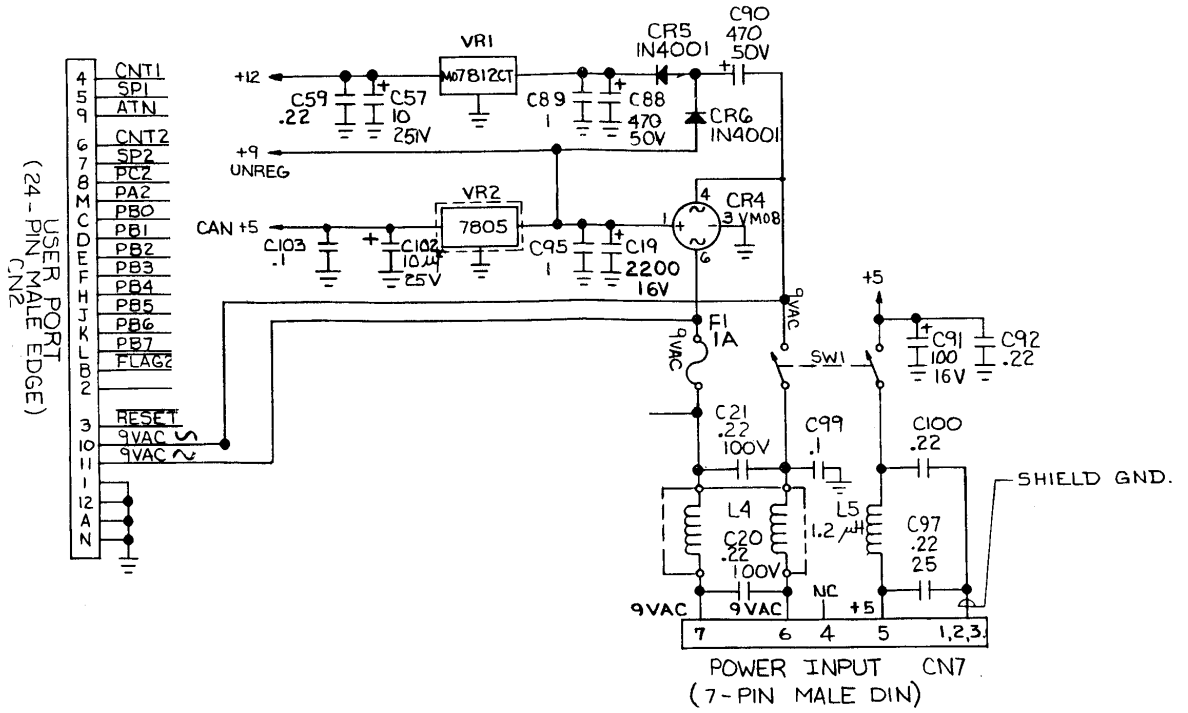
C64 CIRCUIT THEORY



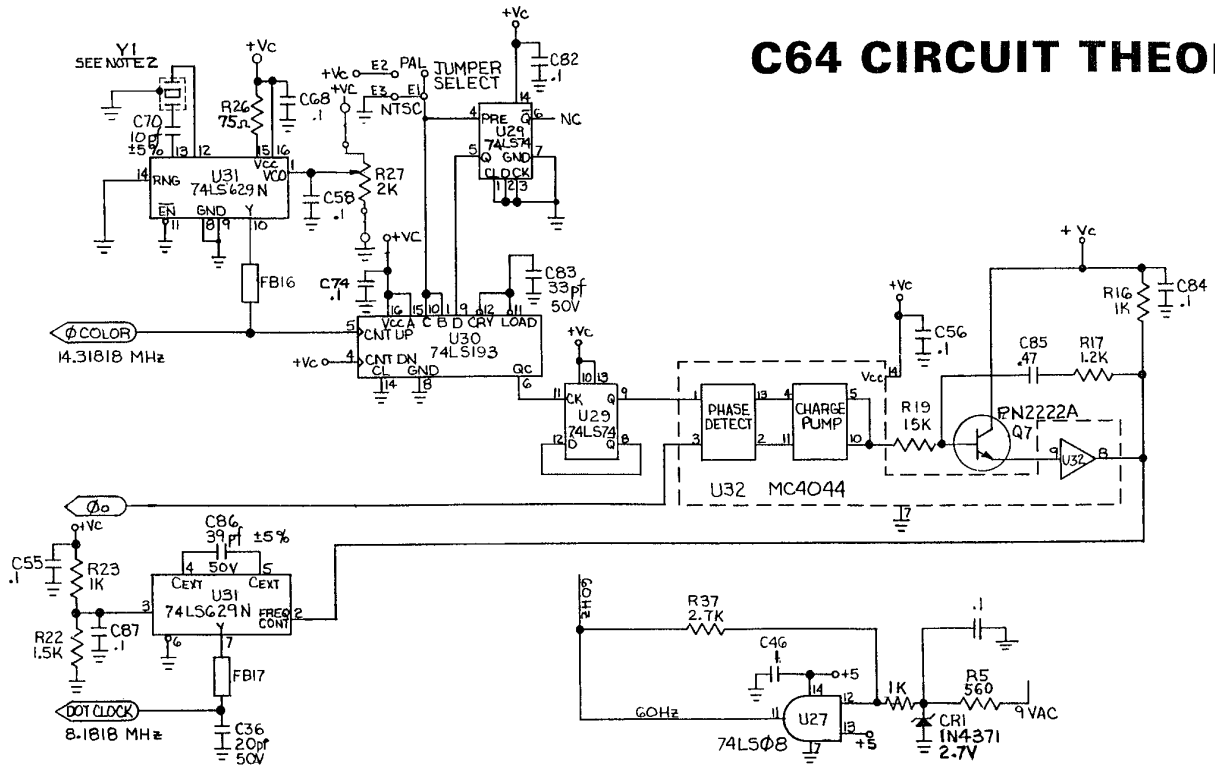
Reset Logic Circuits.

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

C64 CIRCUIT THEORY

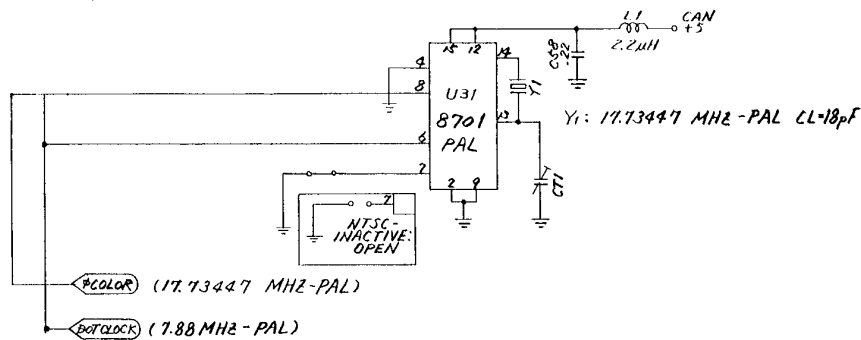


C64 CIRCUIT THEORY



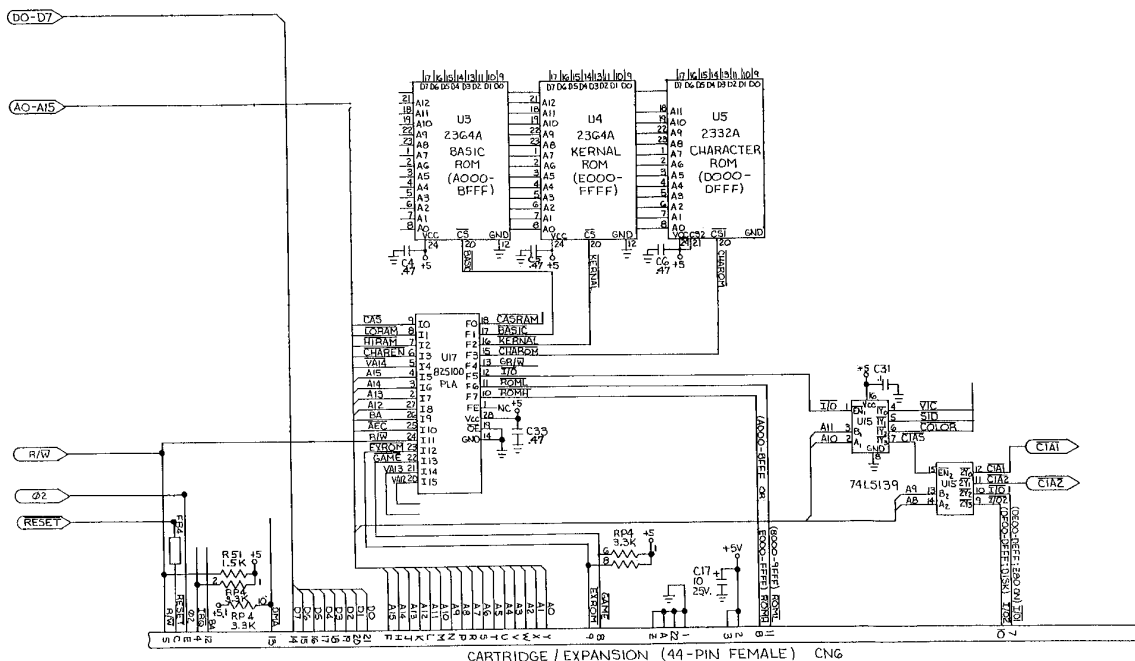
The C64 Clock Circuits.

Crystal Y1 develops a 16MHz 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.

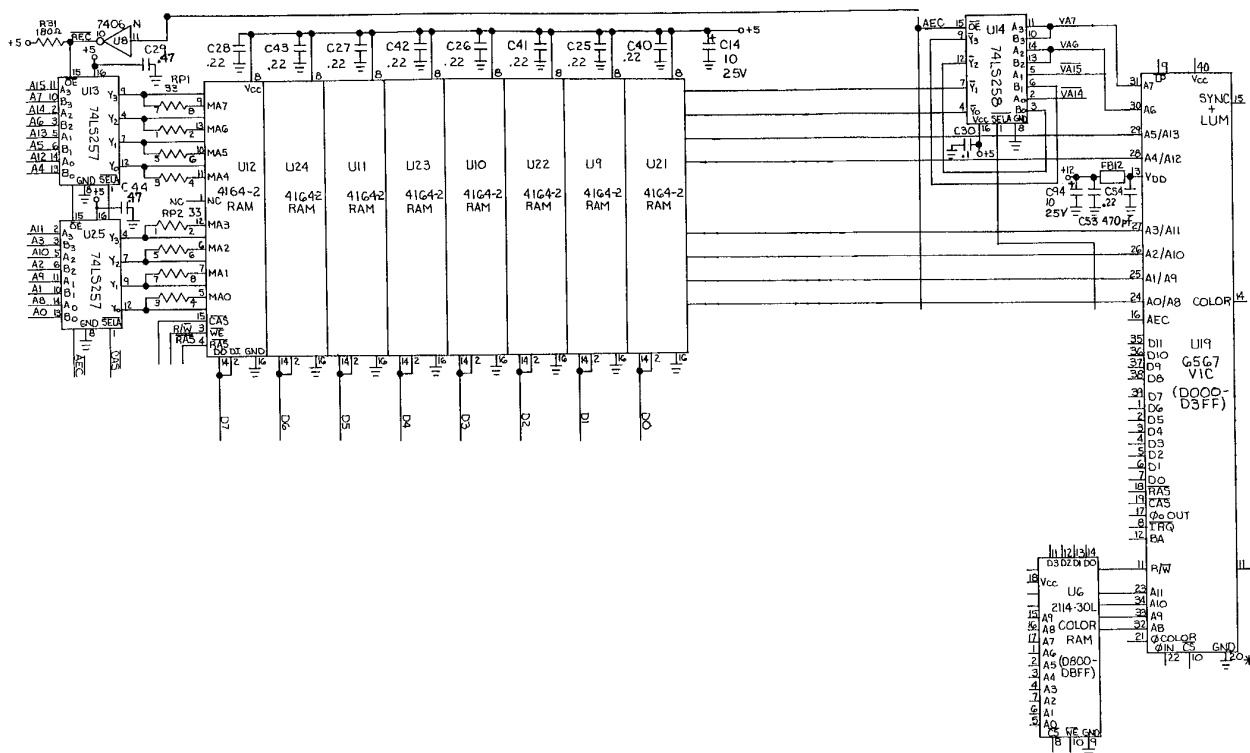
| | |
|-----------|-----------------|
| VIC IC | \$D000 - \$D02E |
| SID IC | \$D400 - \$D7FF |
| Color Ram | \$D800 - \$DBFF |
| CIA1 | \$DC00 - \$DC0F |
| CIA2 | \$DD00 - \$DD0F |
| I/O 1 | \$DE00 - \$DEFF |
| I/O 2 | \$DF00 - \$DFFF |

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.

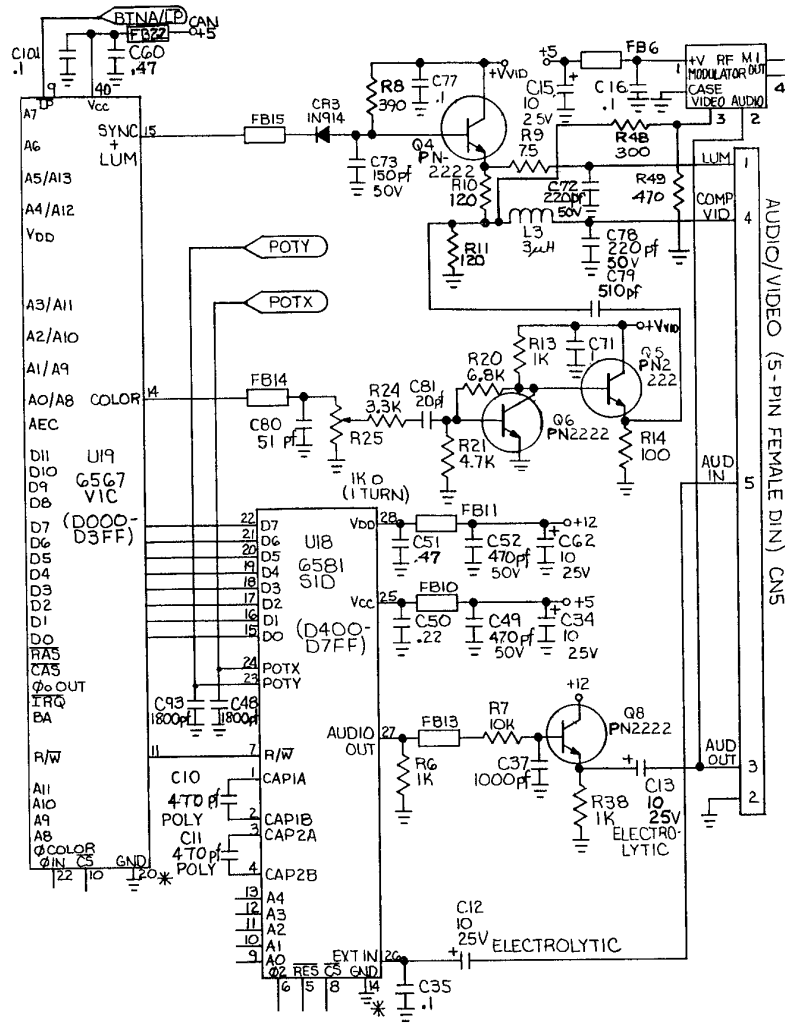


RAM Control Logic.

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.

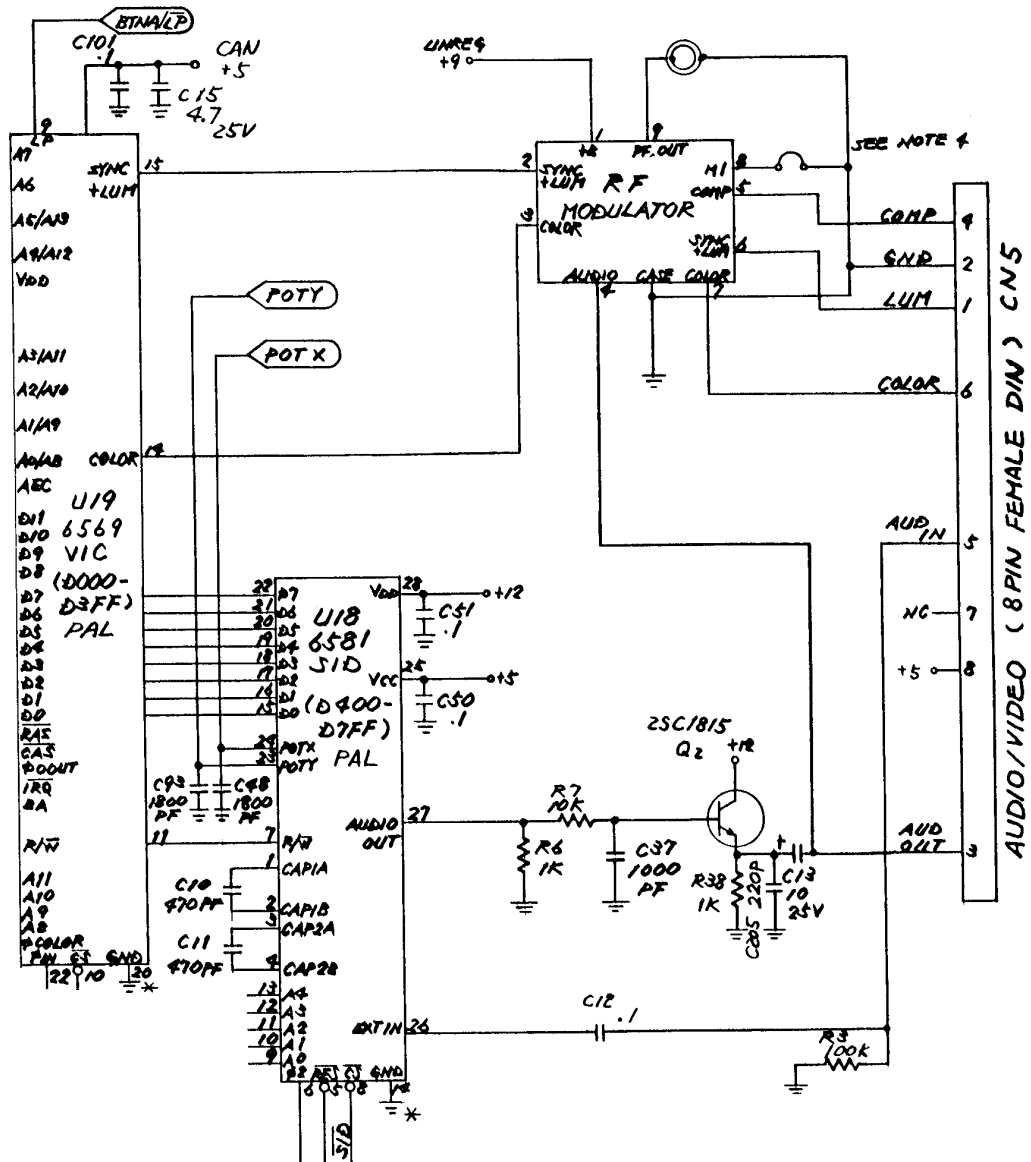
C64 CIRCUIT THEORY



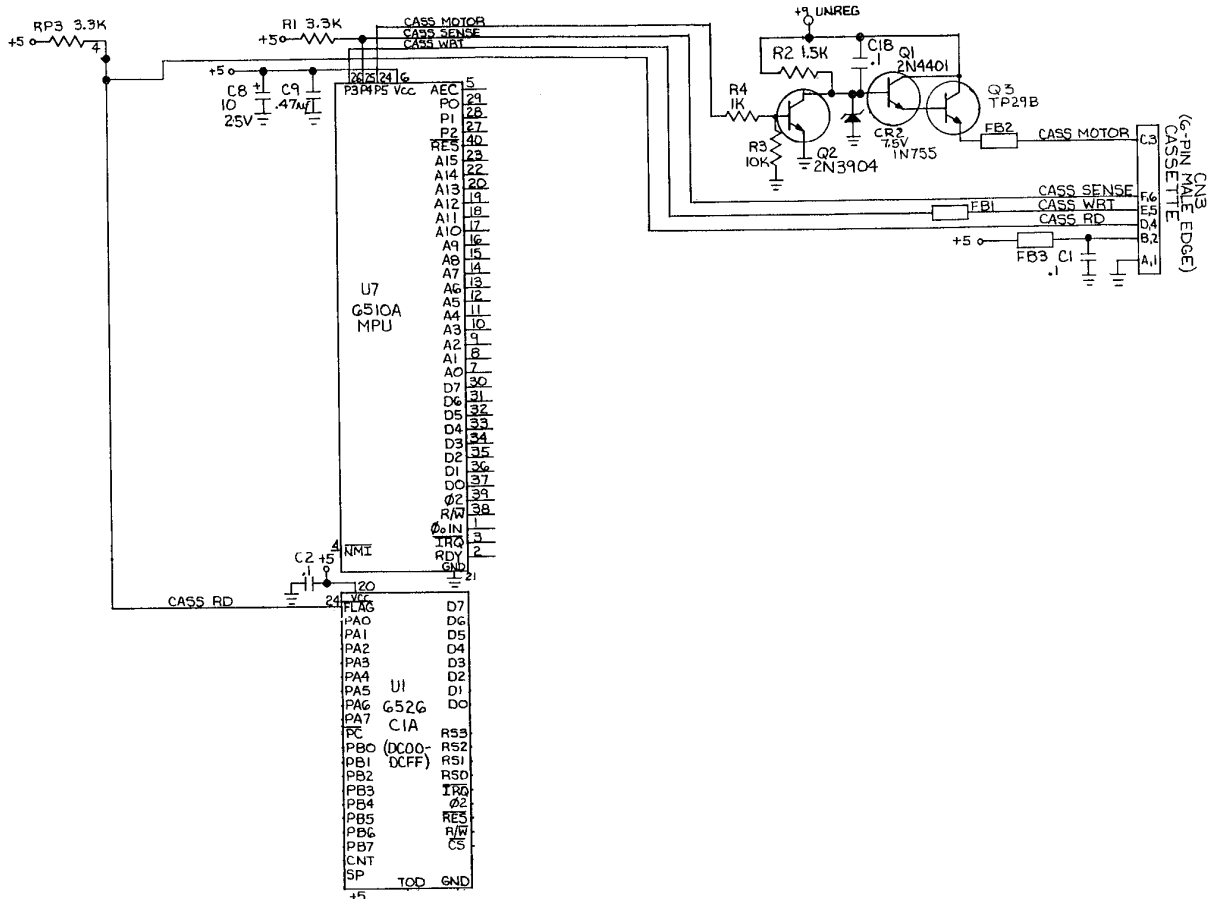
5 Pin Video and Audio Output Circuits.

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

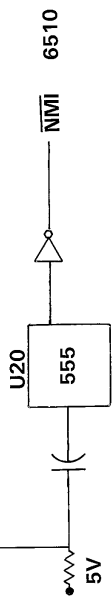
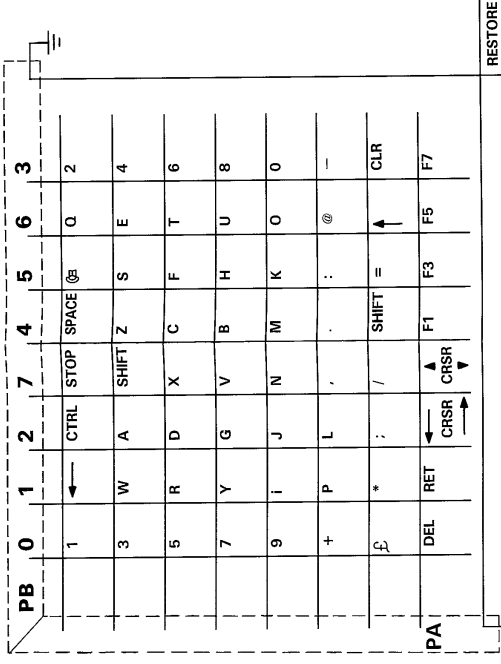


U19 is the Video Interface Chip (VIC). Sync (horizontal and vertical), and luminance (video) is output on pin 15. This signal is passed to pin 2 of the RF modulator. Color is output on pin 14, and passed to pin 3 of the modulator. Light Pen inputs are sensed by the VIC IC on pin 9. U18 is the Sound Interface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

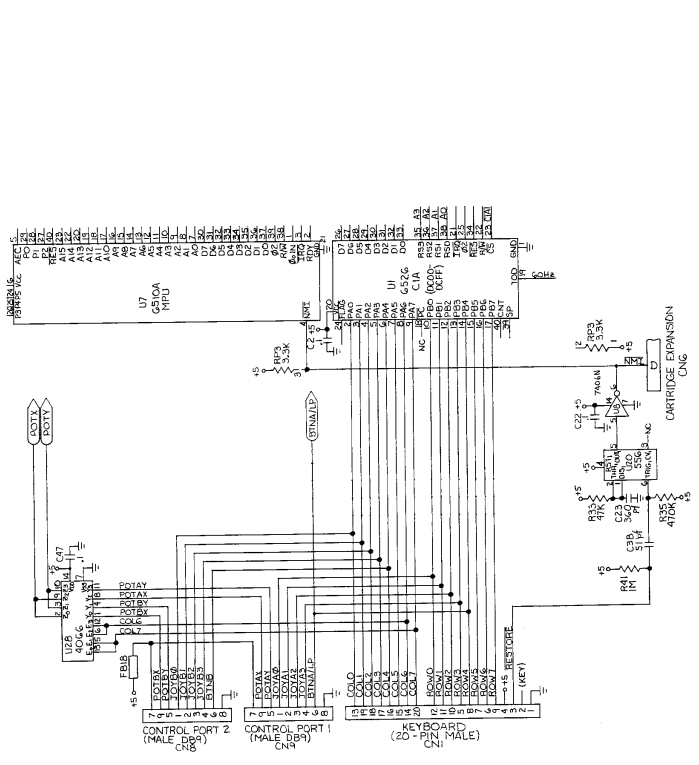
Joystick Interface.

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.

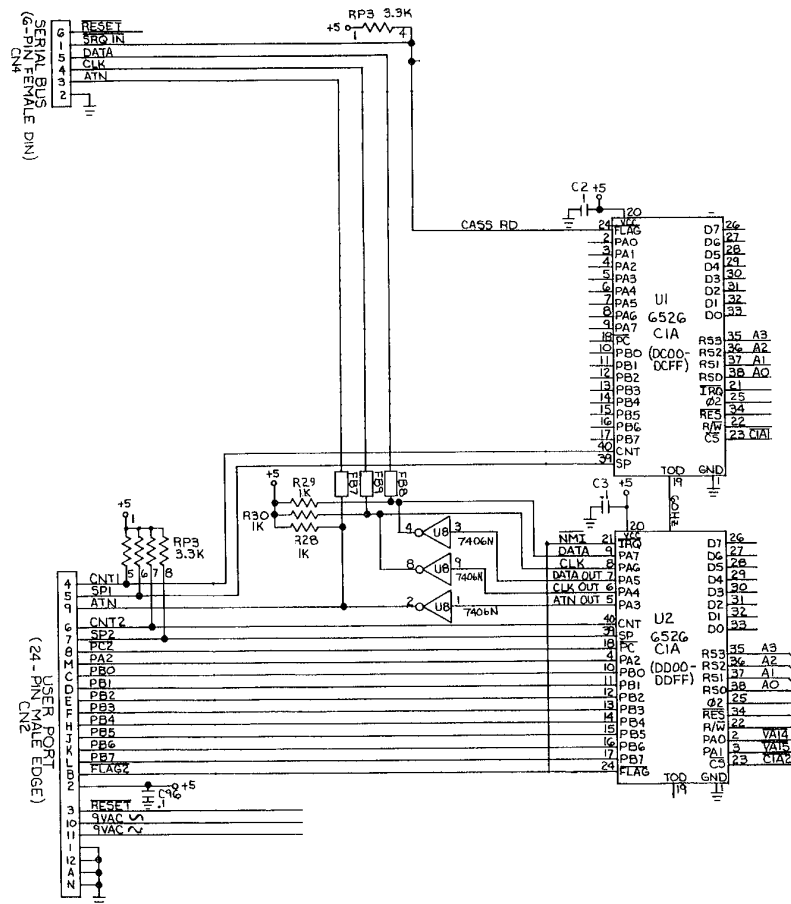


Keyboard, Joystick, and Paddle Interface Circuits.

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.

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. 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. Intermittent graphics. | Check U7 (6510 MPU) |
| 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 (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 U4 (ROM) |

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 U16 (4066 IC) |
| 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 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

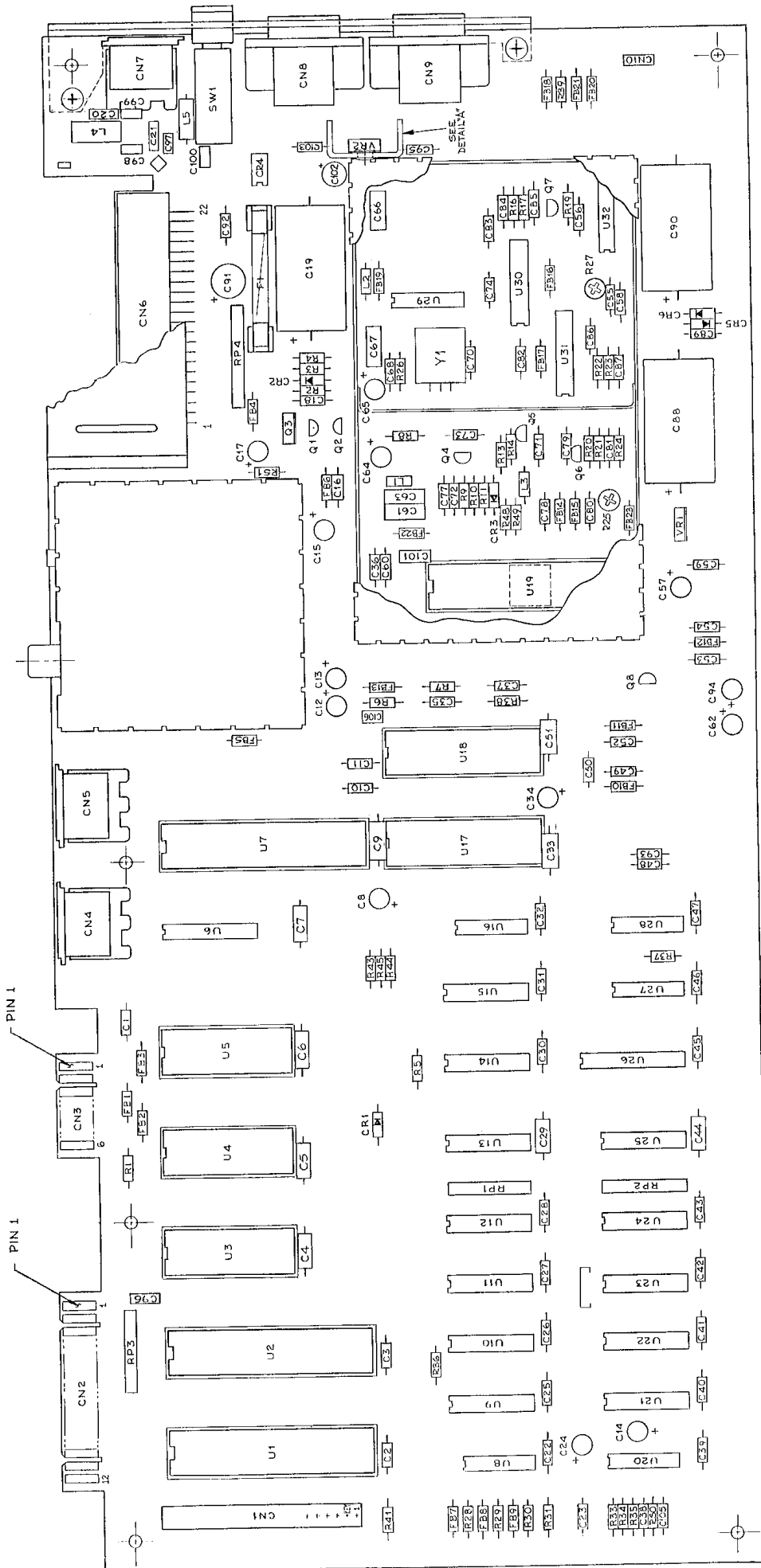
To date there are 4 versions of 64 PCB assemblies in use.

| 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) | 250407-04 | 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.



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 906109-01 | 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 | 903361-01 |
| C56 | Ceramic | .1 μ F, 50V | CN5 | 5 Pin Din | 903362-01 |
| C57 | Electrolytic | 10 μ F, 25V, +50%, -10% | CN6 | 44 Pin Card Edge | 906100-02 |
| C58 | Ceramic | .1 μ F, 50V | CN7 | 7 Pin Din | 906130-01 |
| C59 | Ceramic | .22 μ F, 50V | CN8,9 | Plug Assy, 9 Pin Rt. Angle | 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 | 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 | 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 | 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 | 326265-01 |
| C81 | Ceramic | 20 pF, 50V | | Shield Cap | 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 | Ø2 |
| 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 | Ø2 | Ø2 clock input. Connected to processor common Ø2 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. |

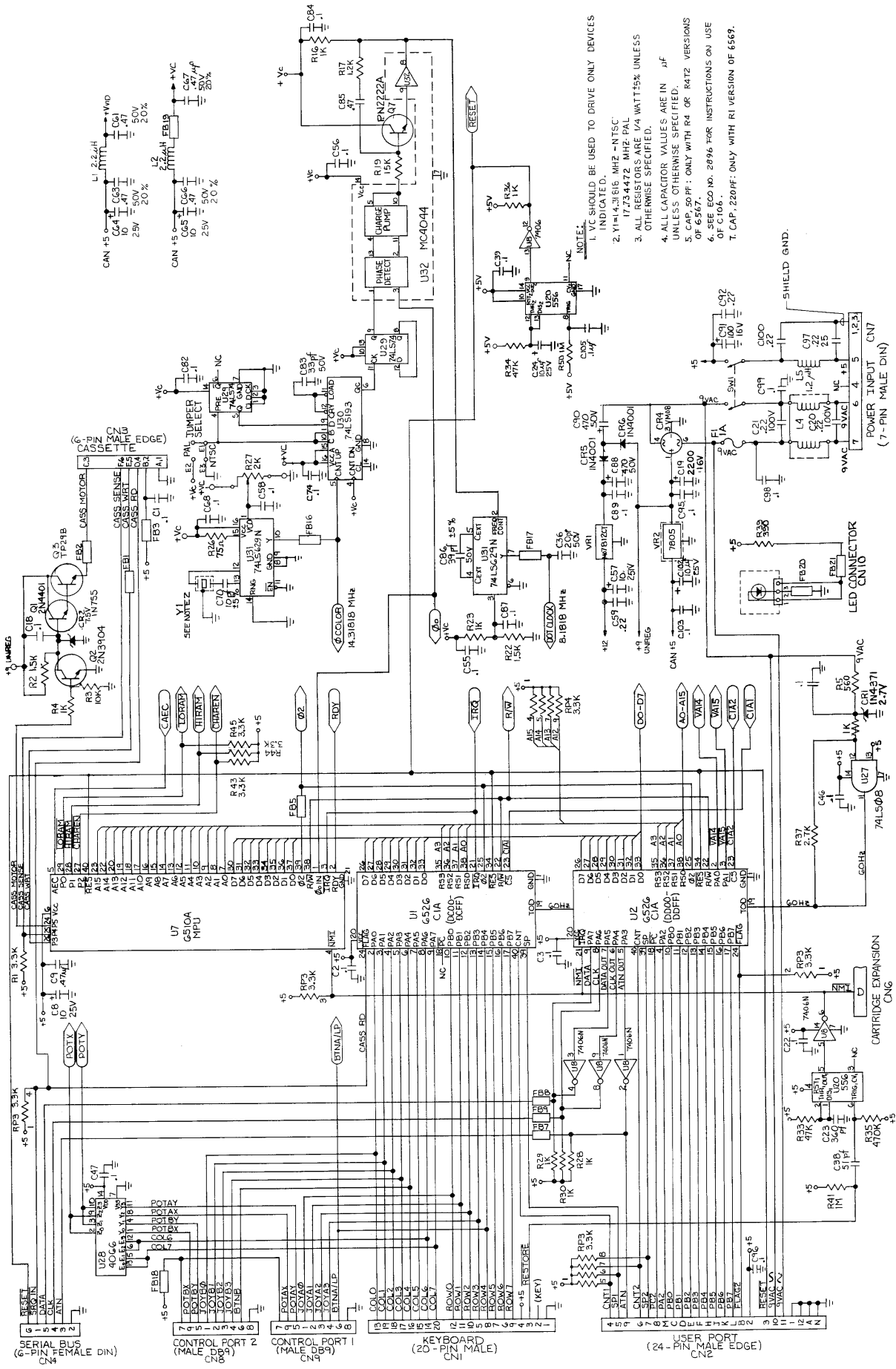
**U18 — 906112-01
6581 SOUND INTERFACE
DEVICE (SID)**

**PIN
ASSIGNMENT**

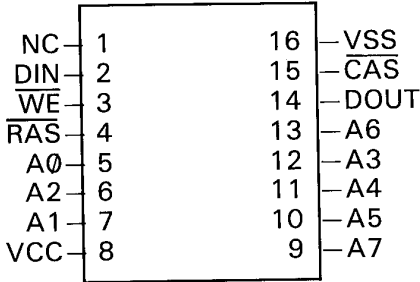
| | | | |
|-----|----|----|--------|
| CAP | 1A | 28 | 12V |
| CAP | 1B | 27 | A.OUT |
| CAP | 2A | 26 | EXT IN |
| CAP | 2B | 25 | 5V |
| RES | 5 | 24 | POT X |
| Ø2 | 6 | 23 | POT Y |
| R/W | 7 | 22 | D7 |
| CS | 8 | 21 | D6 |
| A0 | 9 | 20 | D5 |
| A1 | 10 | 19 | D4 |
| A2 | 11 | 18 | D3 |
| A3 | 12 | 17 | D2 |
| A4 | 13 | 16 | D1 |
| GND | 14 | 15 | D0 |

| | | |
|---------|-----------|---------------------------------------------------------------------------------------------------------------|
| 1,2,3,4 | CAP1A,1B | Capacitor filter connections. |
| 5 | 2A, 2B | Reset input. A low pulse initializes the SID. |
| 5 | RES | Reset input. A low pulse initializes the SID. |
| 6 | Ø2 | 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

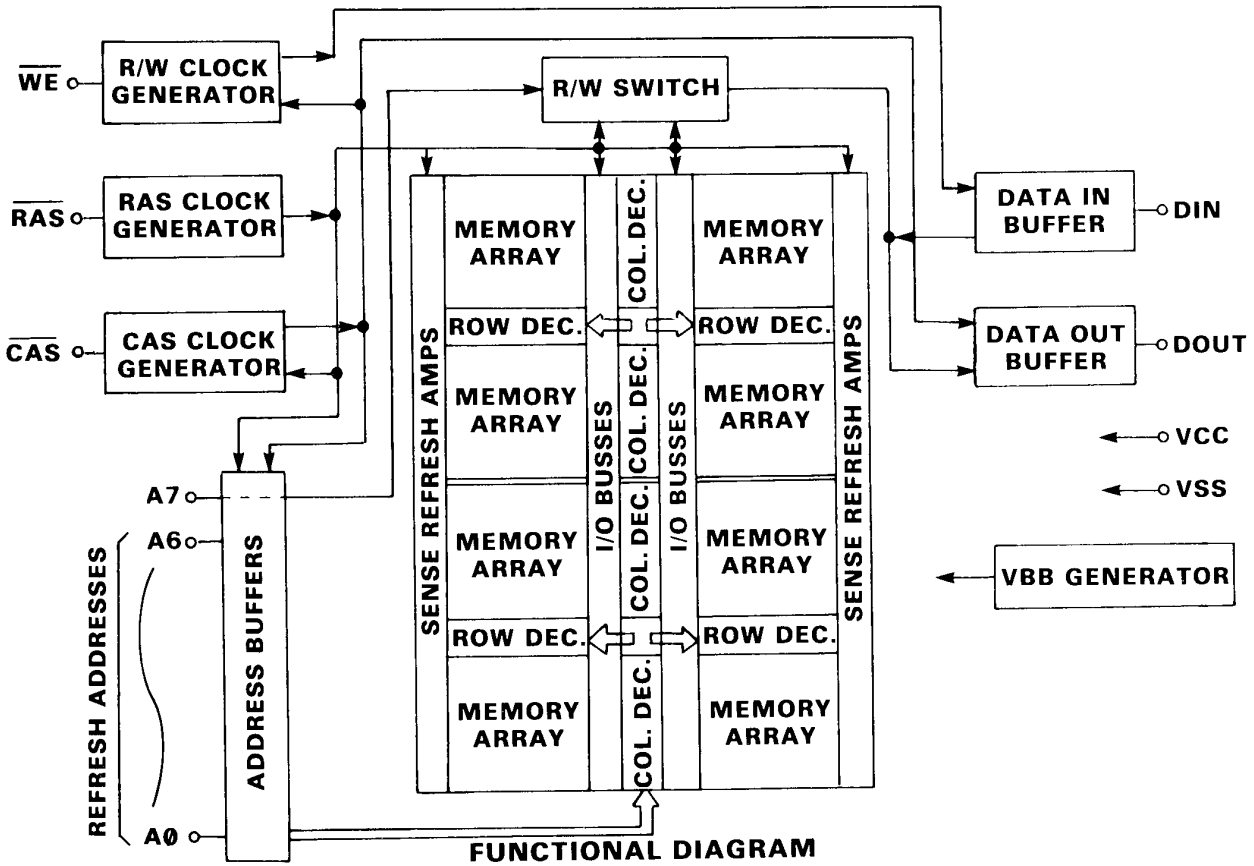


PIN CONFIGURATION

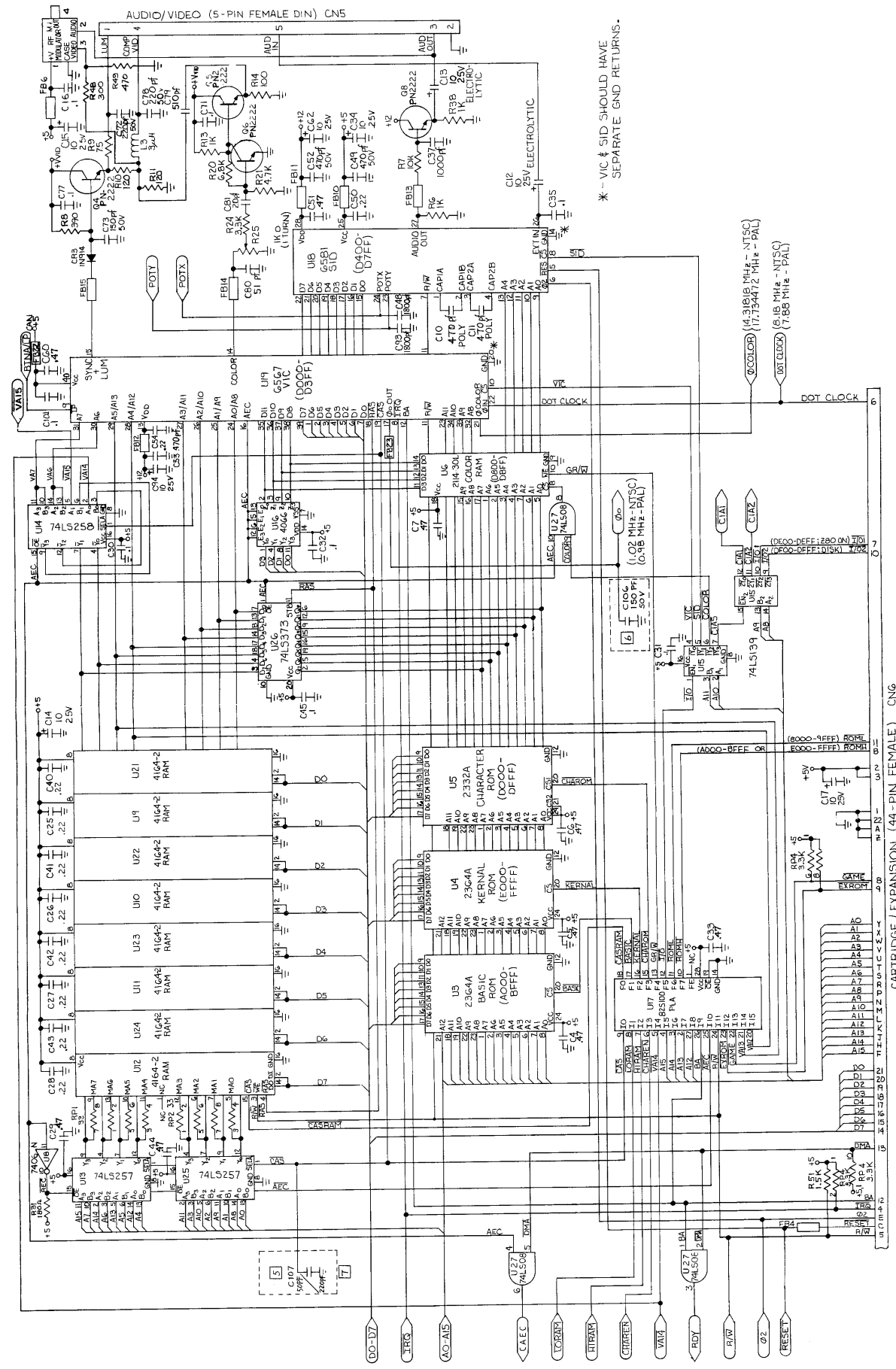


U9 ~ 12, U21 ~ 24
64K DYNAMIC RAM
901505-01

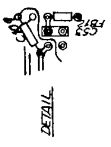
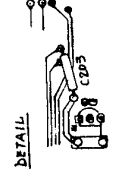
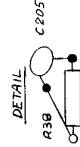
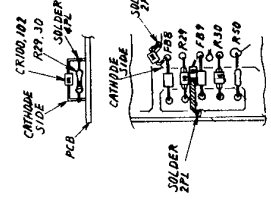
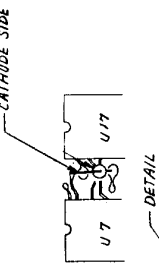
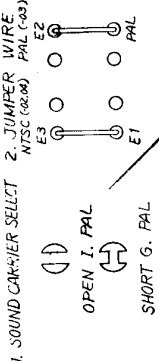
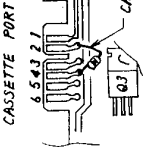
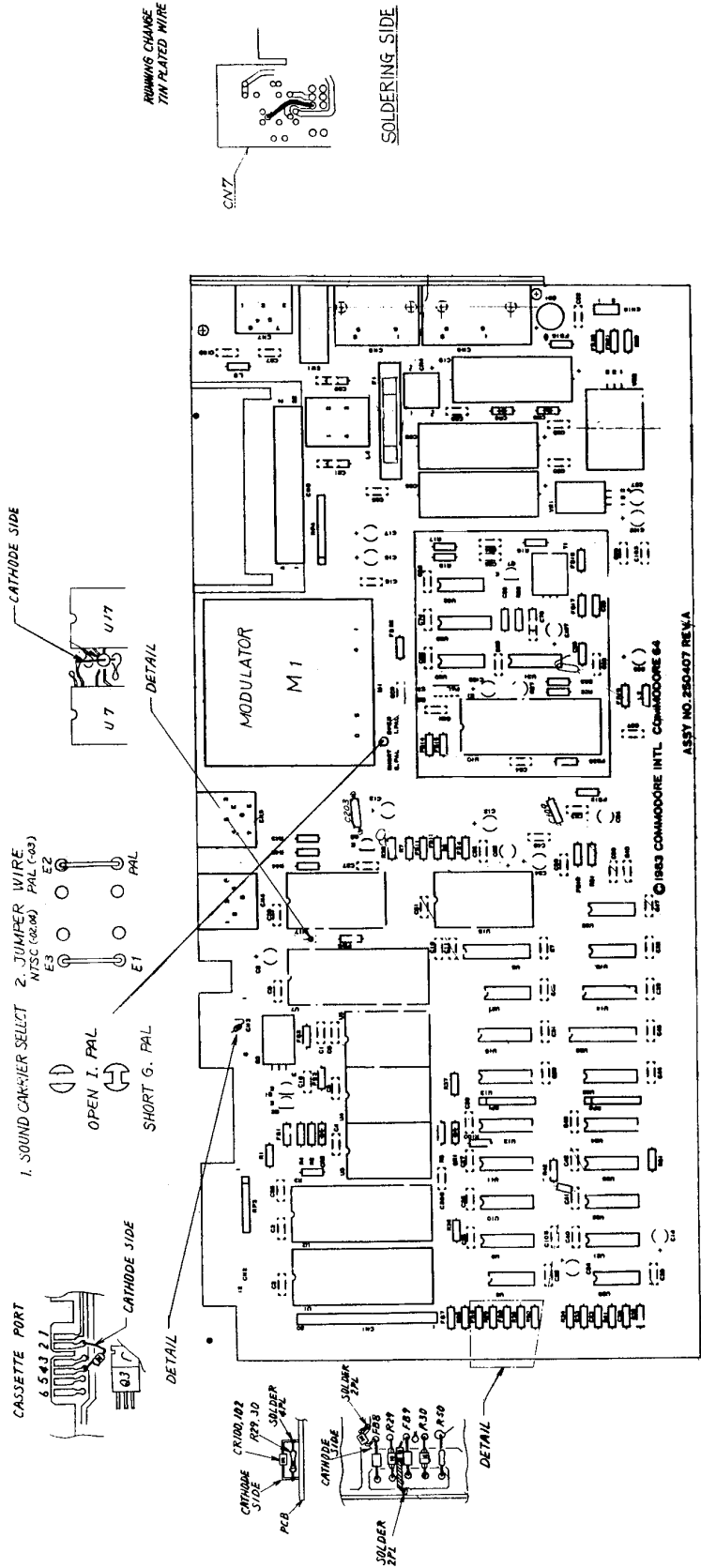
| COMMODORE PART NUMBER | APPROVED SOURCE 1 OF SUPPLY | VENDOR PART NUMBER | ACCESS TIME (ns) | CYCLES (ns) | POWER | |
|-----------------------|-----------------------------|--------------------|------------------|-------------|-------------|-------------------|
| | | | | | ACTIVE (MW) | STANDBY (MAX)(MW) |
| 901505-01 | HITACHI | HM4864-3 | 200 | 335 | 330 | 20 |
| 901505-01 | NEC | 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 | MICRON TECHNOLOGY | MT4264-3 | 200 | 385 | 300 | 30 |
| 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



* - V/C & SID SHOULD HAVE SEPARATE GND RETURNS.



- 6 TO FIX HEATSINK TO VOLTAGE REGULATOR SCREW M3X10 AND NUT HEXAGON M3 ARE USED. EYELET CAN SUBSTITUTE.
- 5 R101, IT IS SUITABLE FOR 6569 REV.1 AND 6567 REV.3. 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 251765 (U17 ITEM 186), DO NOT USE THIS CAPACITOR.

BOARD LAYOUT #250407-04

PARTS LIST — PCB ASSEMBLY # 250407-04

C — Indicates Commodore Stocked Part Number

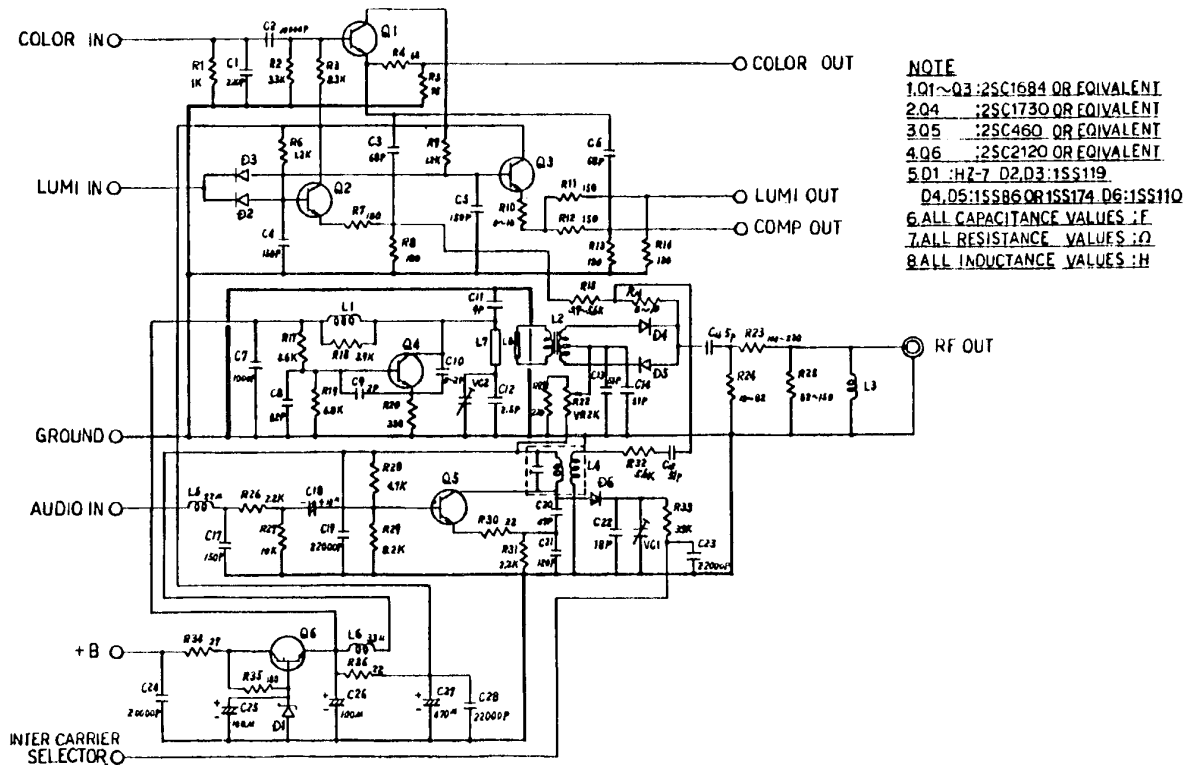
| INTEGRATED CIRCUITS | | | RESISTORS (Continued) | | | |
|-------------------------------------------------------------------------------|-------------------|------------------|-----------------------|-----------------------------------------|------------------------|------------------------|
| U1,U2 | 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 906109-01 | 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 | RR7 | 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)

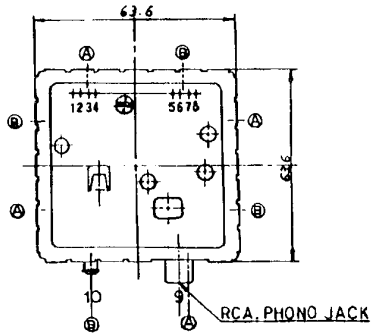
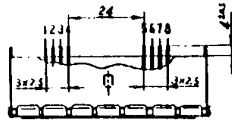
C – Indicates Commodore Stocked Part Number

| 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 | 903361-01 |
| C66,67,68 | Ceramic | .1 μ F, 25V | CN5 | 8 Pin Din | 325573-01 |
| C70 | Film | 16 pF, 5% | CN6 | 44 Pin Card Edge | 906100-02 |
| C74,82 | Ceramic | .1 μ F, 25V | CN7 | 7 Pin Din | 251116-01 |
| C83 | Ceramic | 82 pF, 5% | CN8,9 | Plug Assy, 9 Pin MINID | 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 | 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 FB7-23 | Ferrite Bead | 903025-01 |
| C100 | Ceramic | .22 μ F, 25V | | Connector Panel (Power, ON, OFF) | 251095-01 |
| C101 | Ceramic | .1 μ F, 50V, +80%, -20% | | Cartridge Guide | 326116-01 |
| C102 | Electrolytic | 10 μ F, 25V, +50%, -10% | | Shield Box | 251023-01 |
| C103 | Ceramic | .1 μ F, 25V | | Shield Cap | 251024-01 |
| C104 | | | | | |
| C105 | Ceramic | .1 μ F, 25V | | | |
| C108 | Electrolytic | 10 μ F, 25V, 20% | | | |
| C200 | Ceramic | .1 μ F, 25V | | | |

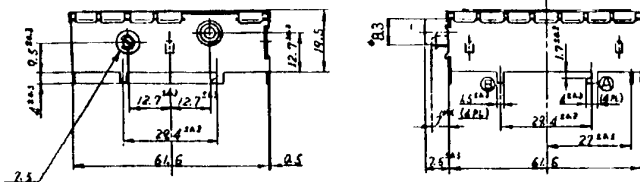
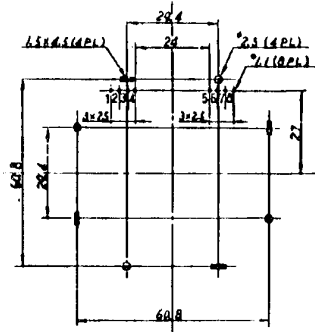
MODULATOR SCHEMATIC #251025



NOTE
 1.Q1~Q3: 2SC1684 OR EQUIVALENT
 2.Q4 : 2SC1730 OR EQUIVALENT
 3.Q5 : 2SC460 OR EQUIVALENT
 4.Q6 : 2SC2120 OR EQUIVALENT
 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

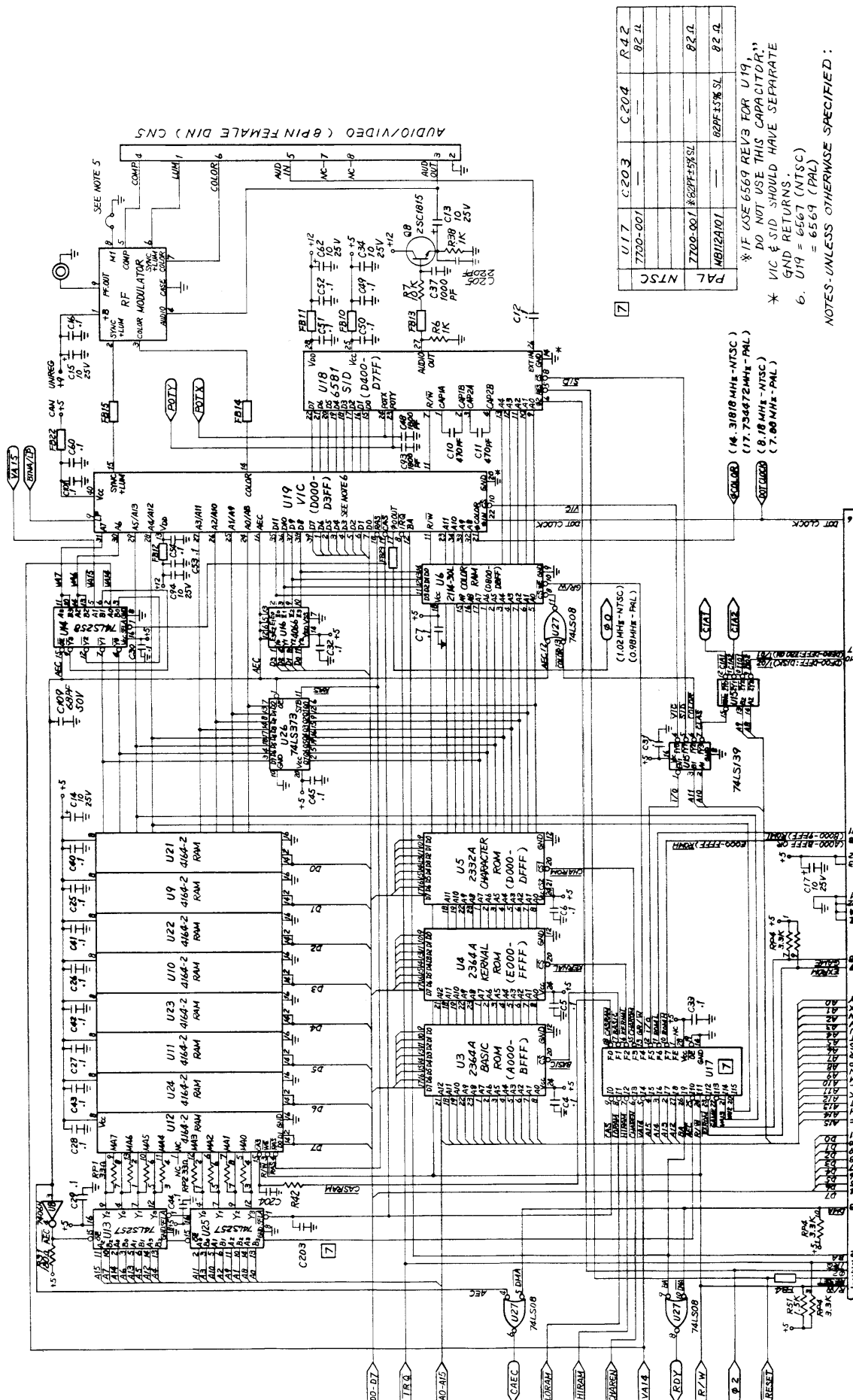


| NO | TERMINALS |
|----|------------------------|
| 1 | +B |
| 2 | SYNC + LUM SIG. INPUT |
| 3 | COLOR SIG. INPUT |
| 4 | AUDIO SIG. INPUT |
| 5 | COMP. SIG. OUTPUT |
| 6 | SYNC + LUM SIG. OUTPUT |
| 7 | COLOR SIG. OUTPUT |
| 8 | INTER CARRIER SELECTOR |
| 9 | RF. OUTPUT |
| 10 | CHANNEL TRIMMER |



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



| | | | |
|----------|------|------|------|
| U17 | C203 | C204 | R42 |
| 7200-001 | | | 82 Ω |
| PAL NTSC | | | |
| U18 | | | 82 Ω |
| 7200-001 | | | 82 Ω |
| PAL | | | 82 Ω |

* IF USE 6569 REVS FOR U19
DO NOT USE THIS CAPACITOR!
* VIC & SID SHOULD HAVE SEPARATE
GND RETURNS.
6. U19 = 6567 (NTSC)
= 6569 (PAL)

CARTRIDGE/EXPANSION (48 PIN 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 |

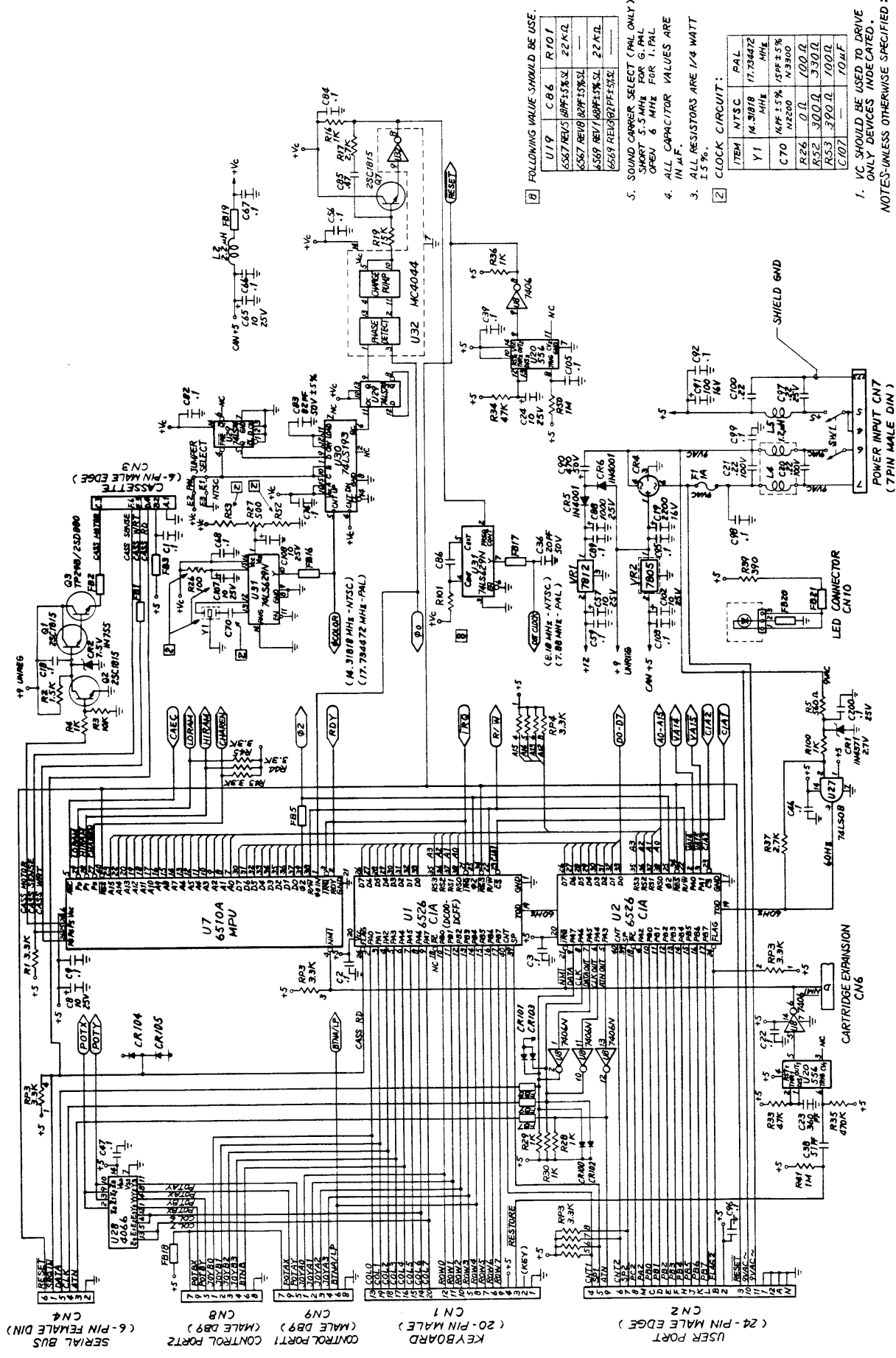
| | | |
|-------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | O1 | Phase 1 clock input. This clock input 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. |

**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)**

SCHEMATIC #251138 SHEET 2 OF 2



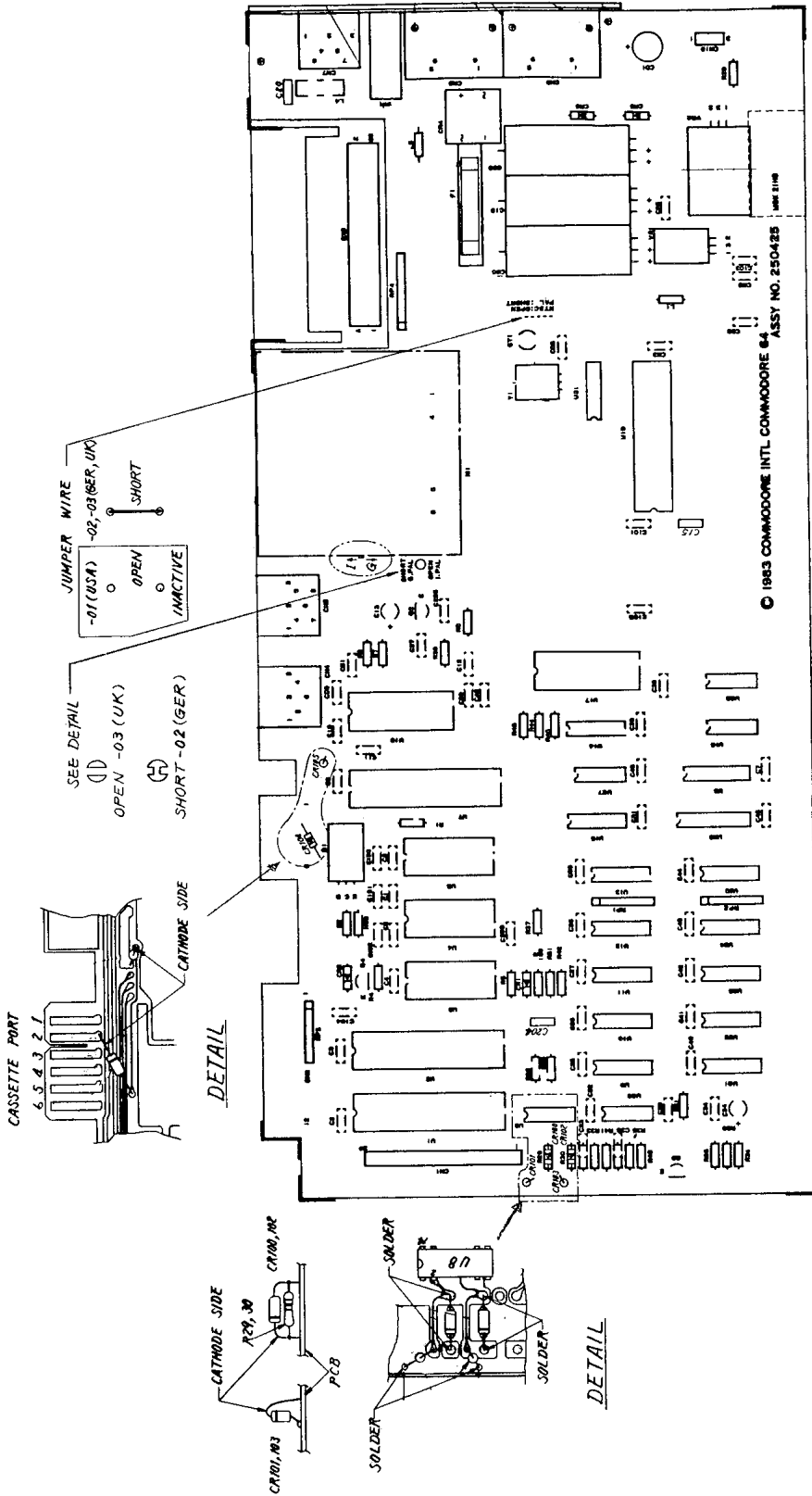
- [1] FOLLOWING VALUE SHOULD BE USE.
- | | | |
|-----------|------------|--------|
| U19 | C86 | R101 |
| 6527 REV1 | 68PF 5% SL | 22 K Ω |
| 6527 REV1 | 68PF 5% SL | 22 K Ω |
| 6527 REV1 | 68PF 5% SL | 22 K Ω |
- [2] SOUND CARRIER SELECT (PAL ONLY)
SHORT 5.5 MHz FOR G.PAL
OPEN 6 MHz FOR I.PAL
- [3] ALL CAPACITOR VALUES ARE IN μF.
- [4] ALL RESISTORS ARE 1/4 WATT 1.5%.

[5] CLOCK CIRCUIT:

| ITEM | NTSC | PAL |
|------|----------|-----------|
| C99 | 14.31818 | 17.734472 |
| Y1 | MHE | MHE |
| C70 | 10PF ±5% | 15PF ±5% |
| R26 | 0 Ω | 100 Ω |
| R52 | 300 Ω | 300 Ω |
| R53 | 300 Ω | 100 Ω |
| C107 | 10 μF | 10 μF |

- [6] VC SHOULD BE USED TO DRIVE ONLY DEVICES INDICATED. NOTES-UNLESS OTHERWISE SPECIFIED:

USER PORT (24 - PIN MALE EDGE) CN2
KEYBOARD (20 - PIN MALE) CN1
CONTROL PORT1 (MALE DB9) CN9
CONTROL PORT2 (MALE DB9) CN8
SERIAL BUS (6 - PIN FEMALE DIN) CN4
CASS. SP. (6 - PIN MALE EDGE) CN7
LED CONNECTOR CN10
POWER INPUT CN7 (7 PIN MALE DIN)



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

DETAIL "C" SOUND CARRIER SELECT

BOARD LAYOUT #250425-01

PARTS LIST — PCB ASSEMBLY #250425-01

C — Indicates Commodore Stocked Part Number

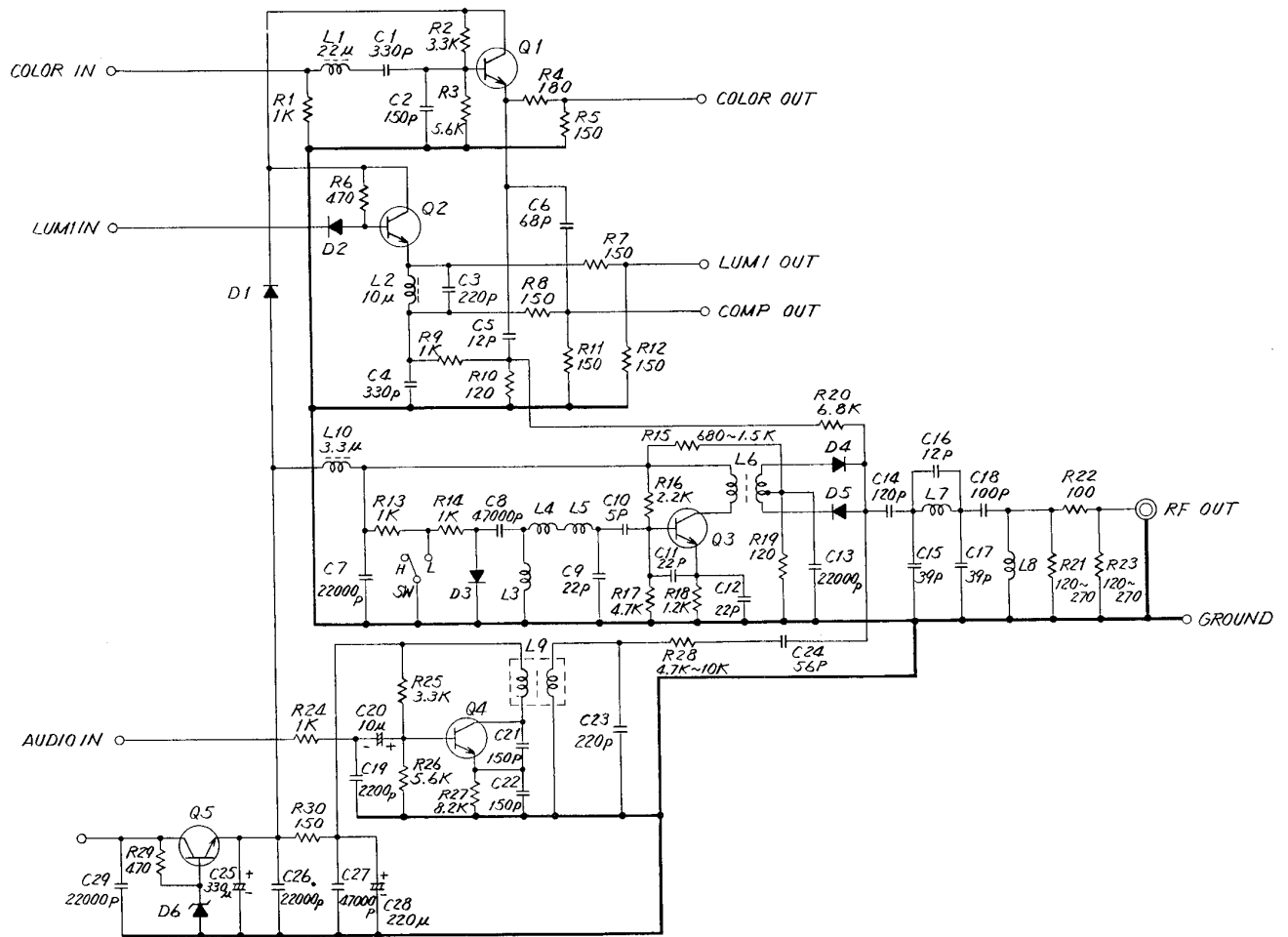
| INTEGRATED CIRCUITS | | | | RESISTORS (Continued) | | | |
|-------------------------------------------------------------------------------|--------------------------|----------------|----------------|------------------------------|--------------------------------------------------|---------------------------------|------|
| 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 | 906109-01 | 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: 390 pF | |
| U31 | 7701/8701 | C | 251527-01 | C24 | Electrolytic | 22 μ F, 25V, +50%, -10% | |
| TRANSISTORS | | | | C31,33,34 | Ceramic | .1 μ F, 25V | |
| Q1 | TIP29 A | | 902653-01 | C37 | Ceramic | 1000 pF, 50V, 10% B | |
| Q2-4 | 2SC1815 | C | 902693-01 | C38 | Ceramic | 51 pF, 50V, 5% SL | |
| DIODES | | | | C39-46 | Ceramic | .1 μ F, 25V | |
| CR1 | 2.7V Zener IN4371 | | 906103-02 | C48 | Ceramic | 1800 pF, 50V, 10% B | |
| CR2 | 6.8V Zener IN754A | | | C50,51,53 | Ceramic | .1 μ F, 25V | |
| CR4 | Bridge S2V310 | C | 251026-01 sub: | C59 | Ceramic | .1 μ F, 25V | |
| | DBA20B | C | 251026-02 sub: | C88 | Electrolytic | 1000 μ F, 25V | |
| | DBA20C | C | 251026-03 | C90 | Electrolytic | 470 μ F, 50V | |
| CR5,6 | Rectifier IN4001 | | 900750-01 | C91 | Electrolytic | 100 μ F, 16V, +50%, -10% | |
| CR9, CR12-16, 100-105 | IN4148 sub: IN914 | | | C93 | Ceramic | 1800 pF, 50V, 10% B | |
| RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise. | | | | C101 | Ceramic | .1 μ F, 50V, +80%, -20% | |
| R1 | 3.3K | R26 | 3.3K | C102 | Ceramic | .1 μ F, 25V | |
| R2 | 470 | R31 | 180 | C150-152 | Ceramic | 470 pF, 50V, 10% | |
| R3 | 100K | R33 | 47K | C153 | Ceramic | 68 pF, 50V, 5% | |
| R4 | 1K | R34 | 47K | C154 | Ceramic | 470 pF, 50V, 10% | |
| R5 | 560 | R35 | 470K | C200 | Ceramic | .1 μ F, 25V | |
| R6 | 1K | R37 | 2.7K | C204 | Ceramic | 150 pF, 50V, 10% | |
| R7 | 10K | R38 | 1K | C205 | Ceramic | 220 pF, 50V, 5% | |
| | | | | 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 | 903361-01 | VR1 | Voltage Regulator MC7812CT | 901527-01 |
| CN5 | 8 Pin Din | 325573-01 | VR2 | Voltage Regulator MC7805CT | 901527-02 |
| CN6 | 44 Pin Card Edge | 906100-02 | M1 | Modulator | 251696-01 |
| CN7 | 7 Pin Din | 251116-01 | | Connector Panel (Power, ON, OFF) | 251095-01 |
| CN8,9 | Plug Assy, 9 Pin MINID | 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 | | | |

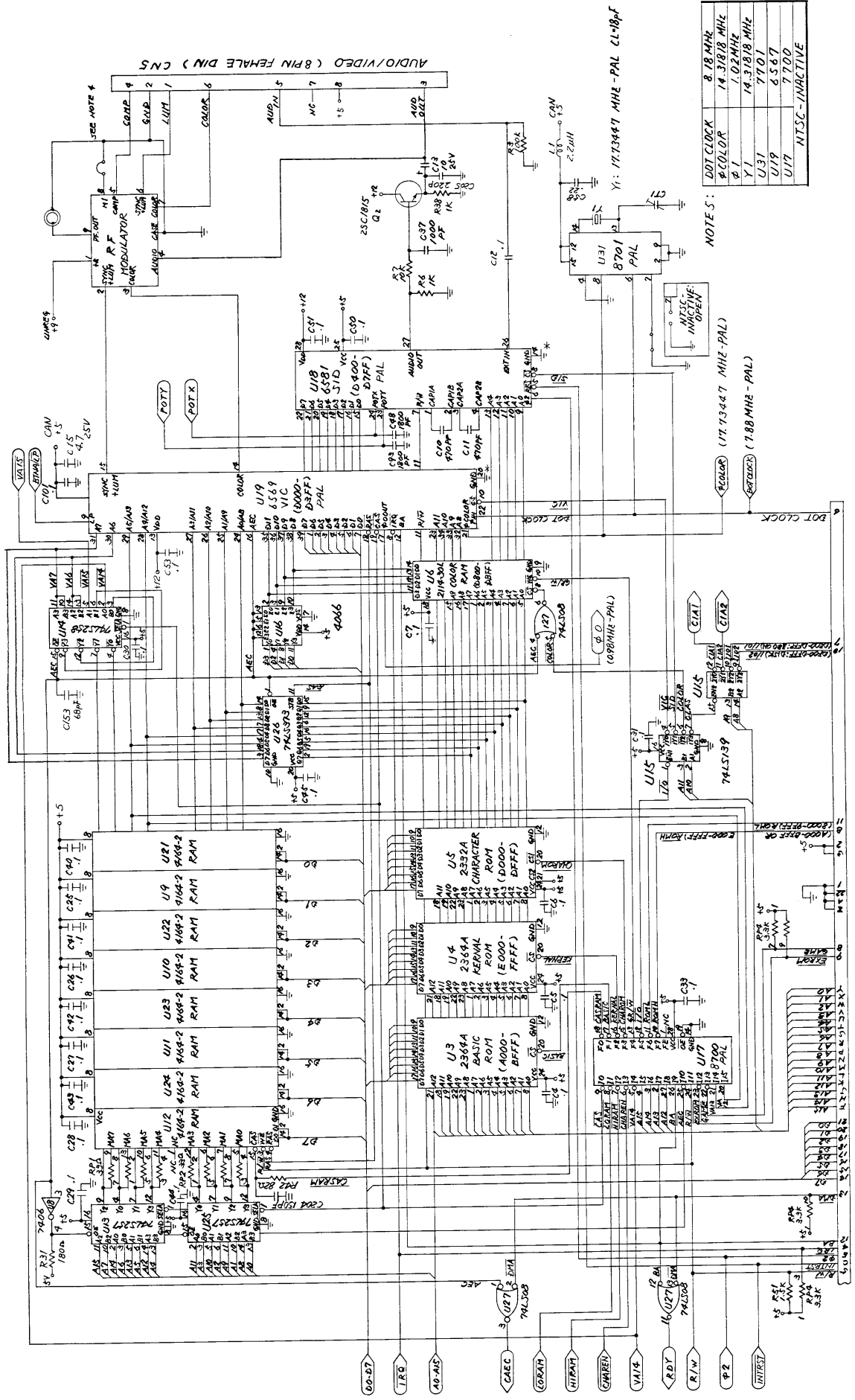
MODULATOR SCHEMATIC #251696



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



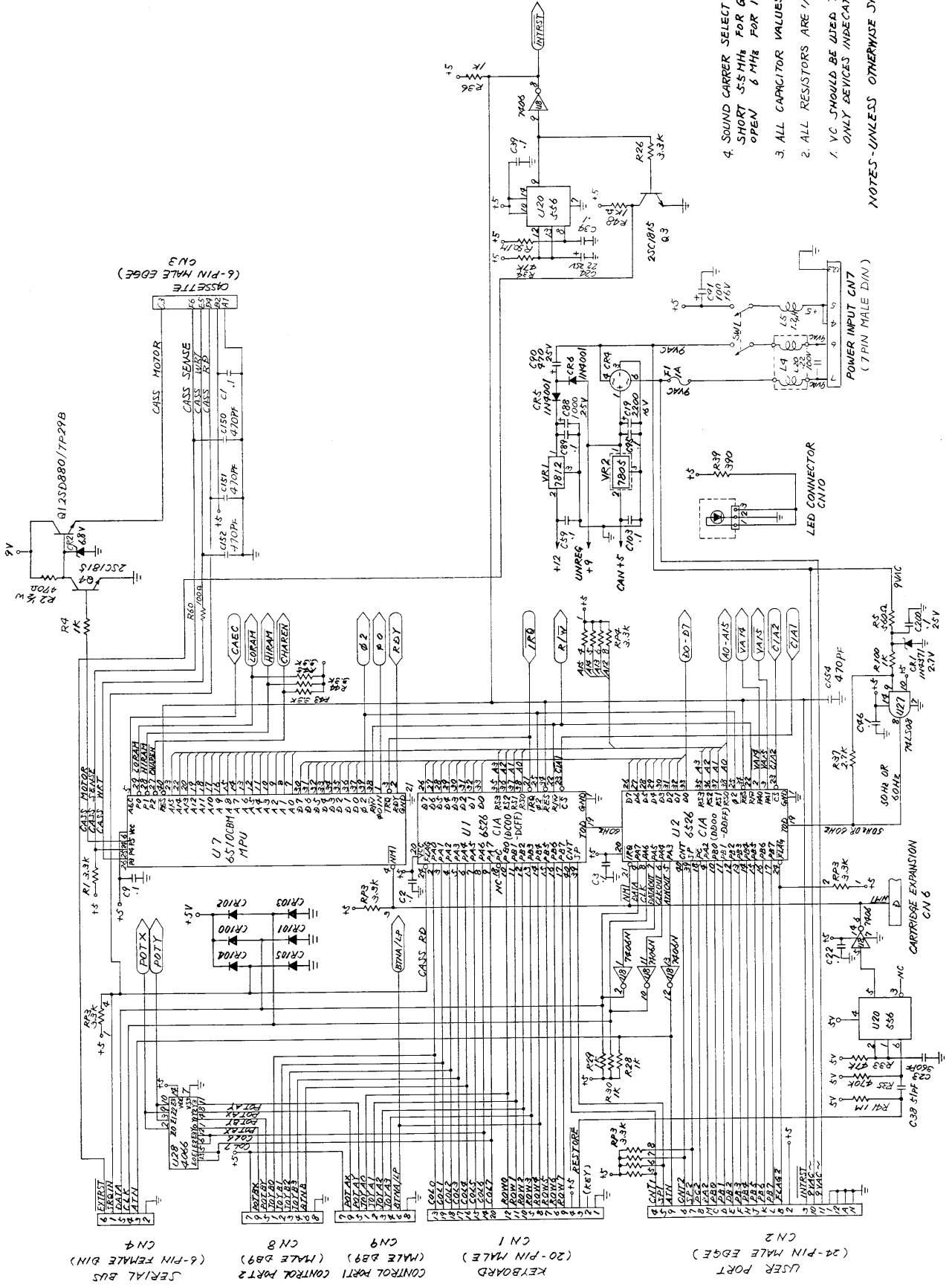
**PIN
ASSIGNMENT**

| | | | |
|----------|----|----|---------|
| 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



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

NOTES-UNLESS OTHERWISE SPECIFIED: