GENERAL OPERATING INSTRUCTIONS

POWER UP

When the computer is turned On, it will come up ready to program in Commodore Basic. See "Cassette Operation" and "Disk Operation" sections for instructions on loading and saving programs. To run a program after it is loaded, type RUN and press the RETURN key. To stop a program, press the RUN/STOP key. Pressing the RUN/STOP key and RESTORE key at the same time will stop the program and reset the computer to the start condition, without losing the program.

CASSETTE OPERATION

Plug a Datassette cassette recorder onto the six pin edge connector at the rear of the computer. Note: A regular tape recorder will not work on the Commodore 64. To load a program, type LOAD, press the RETURN key and follow the instructions displayed on the monitor screen. To save a program, type SAVE, press the RETURN key and follow the instructions displayed on the screen.

DISK OPERATION

Connect Disk Drive unit to the Serial I/O Port (CN4) located at the rear of the computer. Carefully insert the disk so that the label on the disk is facing up and the notch on the disk is on the left side. Once the disk is inserted, close the protective gate by pushing down on the gate lever. To load a program from the disk, type LOAD "PROGRAM NAME", 8. Press the RETURN key and follow the instructions displayed on the monitor. To SAVE a program, type SAVE "PROGRAM NAME", 8 and press the RETURN key. NOTE: 8 is the code for the disk.

COMMODORE MODEL 64 (1986 VERSION) CC20

CC20 COMMODORE MODEL 64 (1986 VERSION)

INDEX

SAMS™ Howard W. Sams & Co.
4300 West 62nd Street, P.O. Box 7092, Indianapolis, Indiana 46206 U.S.A.

88CC19029 DATE 5-88

SCHEMATIC NOTES

—✳—Circuitry not used in some versions.
- - -Circuitry used in some versions.
⊖ See parts list.
⏚ Ground

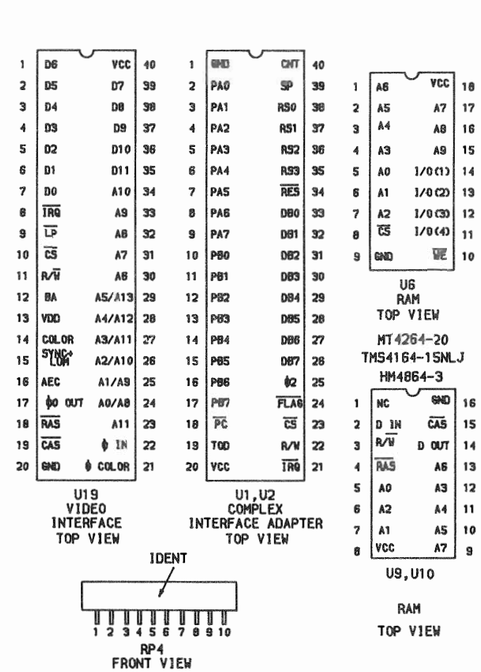
Item numbers in rectangles appear in the alignment/adjustment instructions.
Supply voltage maintained as shown at input.
Voltages measured with digital meter.
Voltages and Waveforms taken with computer turned On, no keys pressed, unless otherwise noted.
Waveforms taken with triggered scope and Sweep/Time switch in Calibrate position, scope input set for DC coupling on 0 reference voltage waveforms. Switch to AC input to view waveforms after DC reference is measured when necessary. Each waveform is 9 cm. width with DC reference voltage given at the bottom line of each waveform.
Time in μsec. per cm, given with p-p reading at the end of each waveform.
Terminal identification may not be found on unit.
Resistors are ½W or less, 5% unless noted.
Value in ( ) used in some versions.

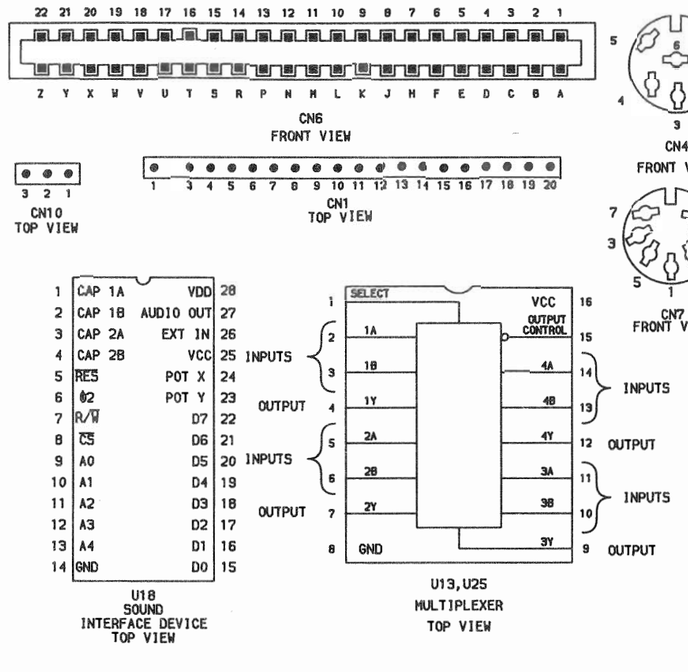
NOTE: Logic probe readings taken with computer turned On, no keys pressed, unless otherwise noted.

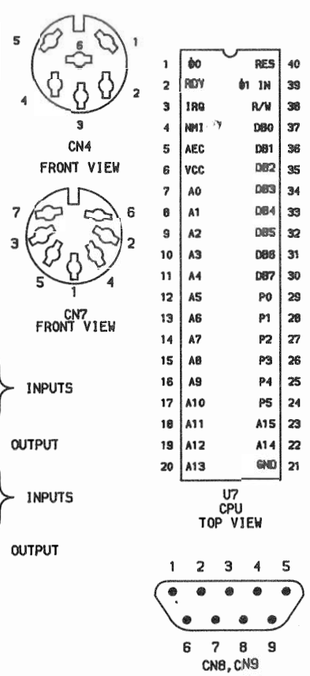
Logic Probe Display
L = Low
H = High
P = Pulse
✳ = Open (No lights On)

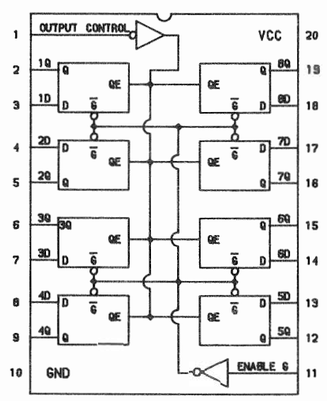
(1) Probe indicates P when any key is pressed.
(2) Probe indicates P when keys 1, 3, 5, 7, 9, +, INST DEL are pressed.
(3) Probe indicates P when keys ←, W, R, Y, I, P, ✳, RETURN are pressed.
(4) Probe indicates P when keys CTRL, A, D, G, J, L,], CRSR are pressed.
(5) Probe indicates P when keys 2, 4, 6, 8, 0, -, CLR/HOME, F7 are pressed.
(6) Probe indicates P when keys Z, C, B, M, >, SHIFT (R), SPACE BAR, F1 are pressed.
(7) Probe indicates P when keys S, F, H, K, [, =, ↵, F3 are pressed.
(8) Probe indicates P when keys Q, E, T, U, O, @, ↑, F5 are pressed.
(9) Probe indicates P when keys RUN/STOP, SHIFT LOCK, SHIFT (L), X, V, N, <, ?, ↑CRSR↓ are pressed.
(10) Probe indicates P during LOAD and SAVE.
(11) Probe indicates P during SAVE.
(12) Probe indicates L when PLAY or RECORD key is pressed.

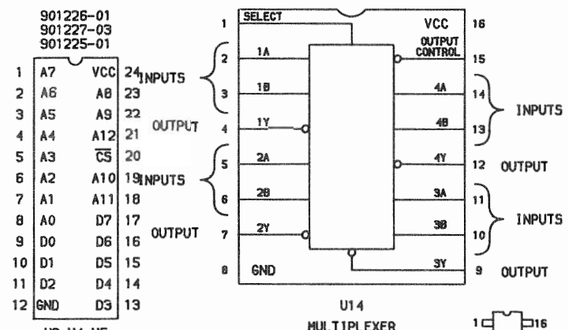
IC PINOUTS & TERMINAL GUIDES

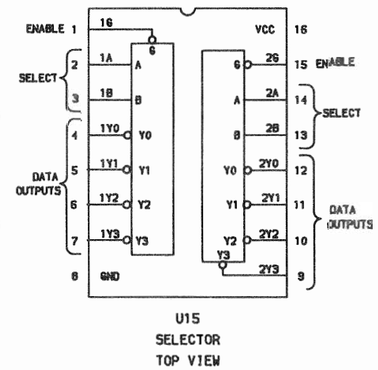


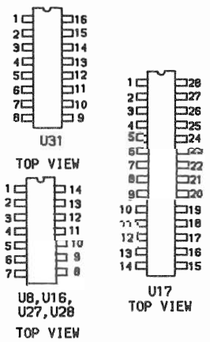


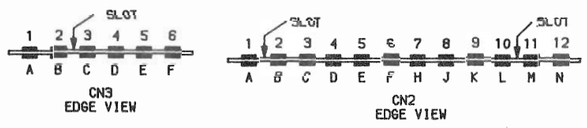


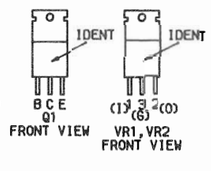


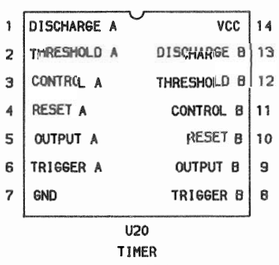












THIS WAVEFORM TAKEN AT PINS 2 THRU 9 OF U1

5V 5ms 0V

KEYBOARD

L3

CABLING: TUBE LINES REDUCE USE OF MULTIPLE LINES

MOS6526 U1 COMPLEX INTERFACE ADAPTER

MOS6510 U7 CPU

CARTRIDGE EXPANSION PORT

CASS WRT

CASS SENSE

2SC1815Y Q4 CASS AMP

2SD313E Q1 PRE DRIVER

DOT CLOCK

NMI

R/W

RESET

Ø2

IRQ

BA

DMA

EX ROM

GAME

ROM L

ROM H

I/O1

I/O2

901226-01 U3 BASIC ROM

901227-03 U4 KERNAL ROM

901225-01 U5 GENERATOR ROM

906114-01 U17 PROGRAM LOGIC ARRAY

74LS257AN U25 MULTIPLEXER

74LS257AN U13 MULTIPLEXER

DM74LS08N PART OF U27

MC14066B U26 QUAD BILATERAL SWITCH

CONTROL PORT 1

CONTROL PORT 2

JOY A0 JOY A1 JOY A2 JOY A3 BUTTON A/LP

JOY B0 JOY B1 JOY B2 JOY B3 BUTTON B

POWER SUPPLY

120VAC 230mA POLARIZED

POWER SW1

9VAC1 9VAC2

CR4 BA20

LM340T12 VR1 VOLT REG

μA7805 VR2 VOLT REG

11.8V SOURCE

4.9V SOURCE

CR99 POWER RED

A PHOTOFACT STANDARD NOTATION SCHEMATIC WITH CIRCUITRACE®

(1) WAVEFORM TAKEN WHILE RUNNING FOLLOWING PROGRAM

```
10 POKE 54296, 15
20 POKE 54278,248
30 POKE 54273, 17
40 POKE 54276, 17
```

PHOTO CIRCUITRACE = 11

SCHEMATIC CIRCUITRACE = 11

COMMODORE
MODEL 64 (1986 VERSION)

DISASSEMBLY INSTRUCTIONS

CABINET TOP

Remove three screws from cabinet bottom. Lift cabinet top enough to disconnect Power Indicator from Connector CN10, on Main Board and remove cabinet top.

KEYBOARD

Remove cabinet top. Disconnect Connector CN1 from Main Board. Remove two screws holding keyboard to shield and remove keyboard.

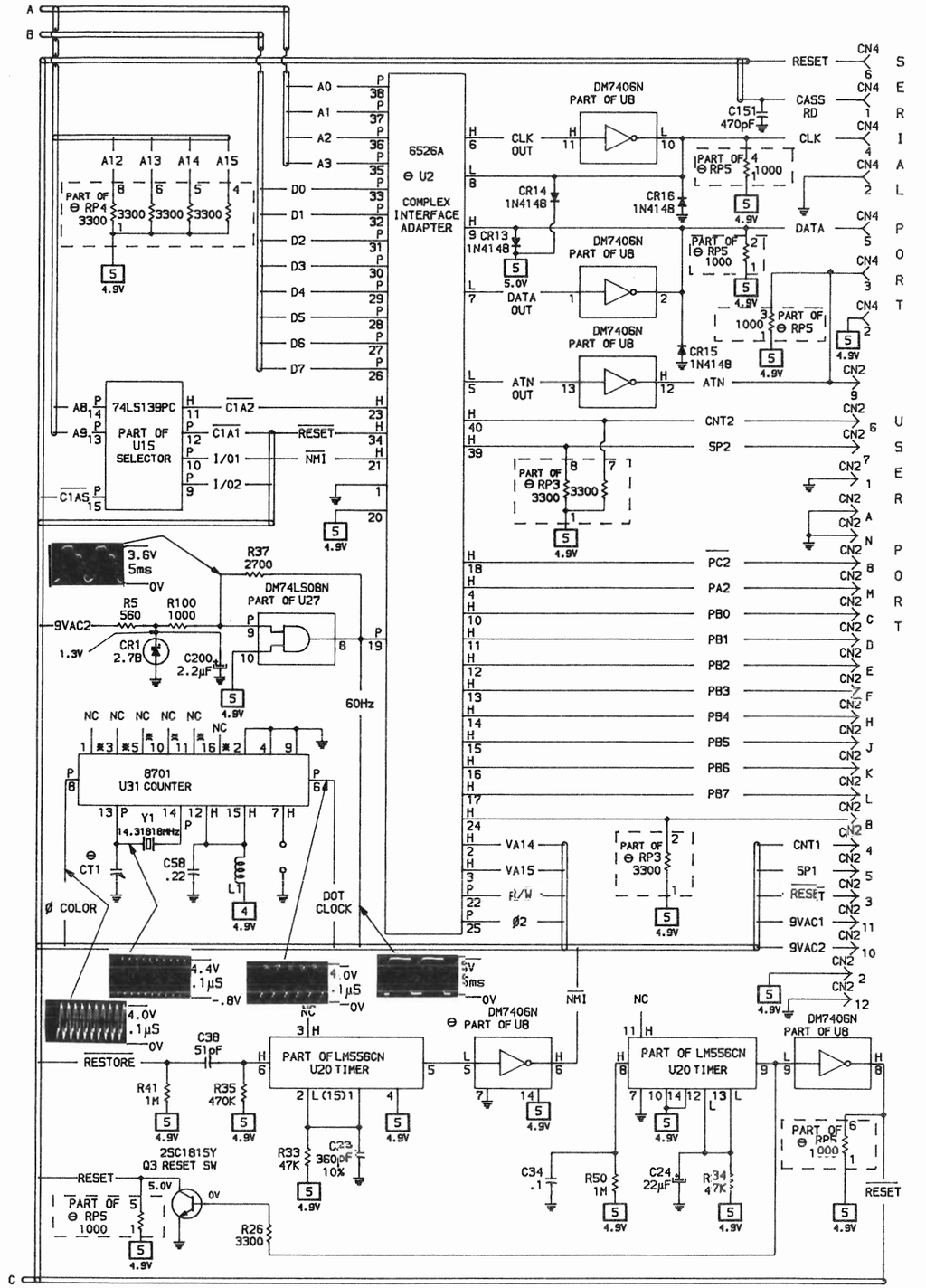
MAIN BOARD

Remove cabinet top and keyboard. Remove five screws holding shield to Main Board and remove shield. Remove three screws holding Main Board to cabinet bottom and remove Main Board. Unsolder ten bottom shield tabs and remove bottom shield.

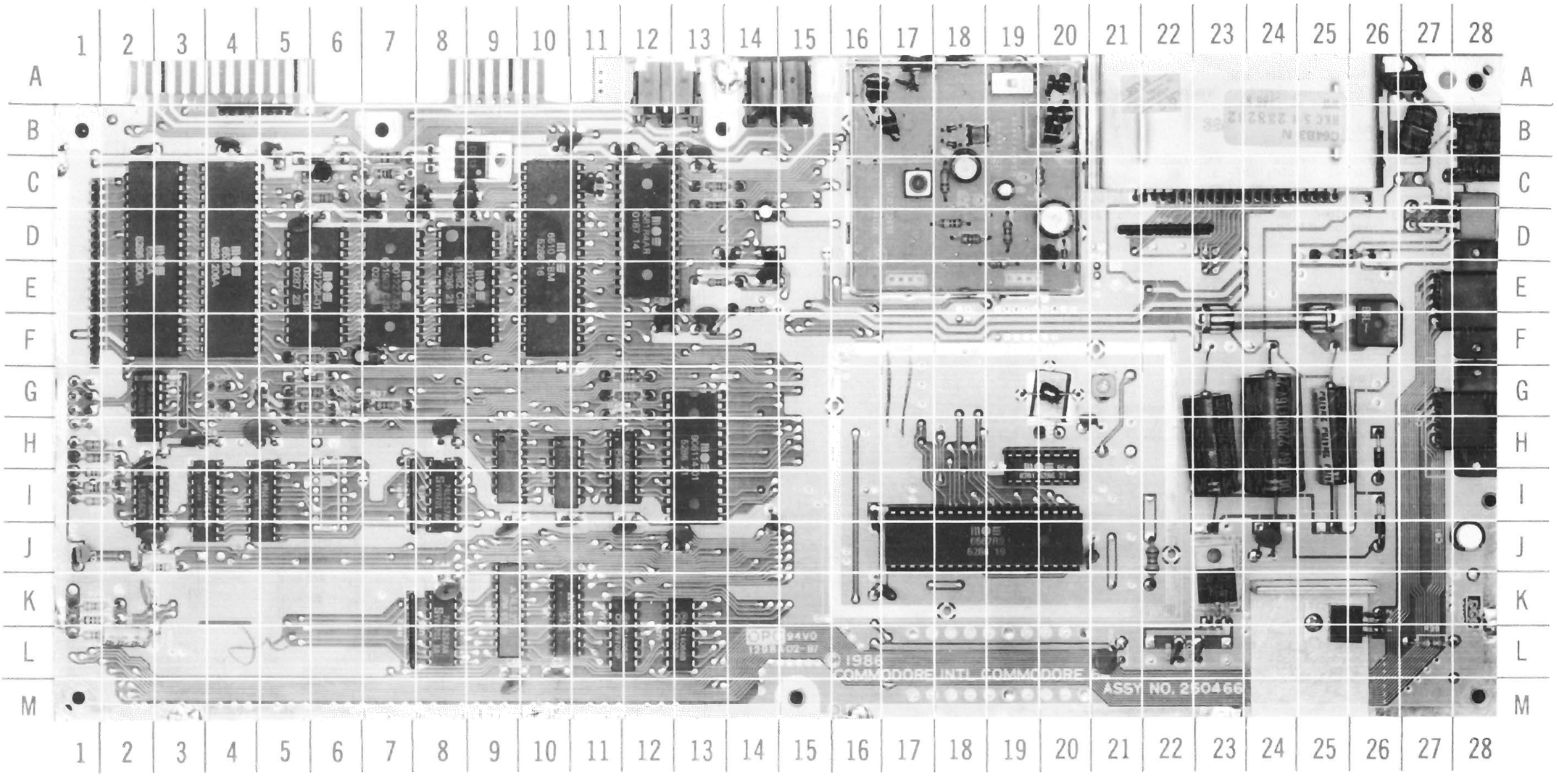
MISCELLANEOUS ADJUSTMENT

14MHz OSCILLATOR

Connect the Input of a frequency counter to pin 13 of IC (U31). Adjust CT1 for a frequency of 14.31818MHz at pin 10.



A PHOTOFACT STANDARD NOTATION SCHEMATIC WITH CIRCUITRACE

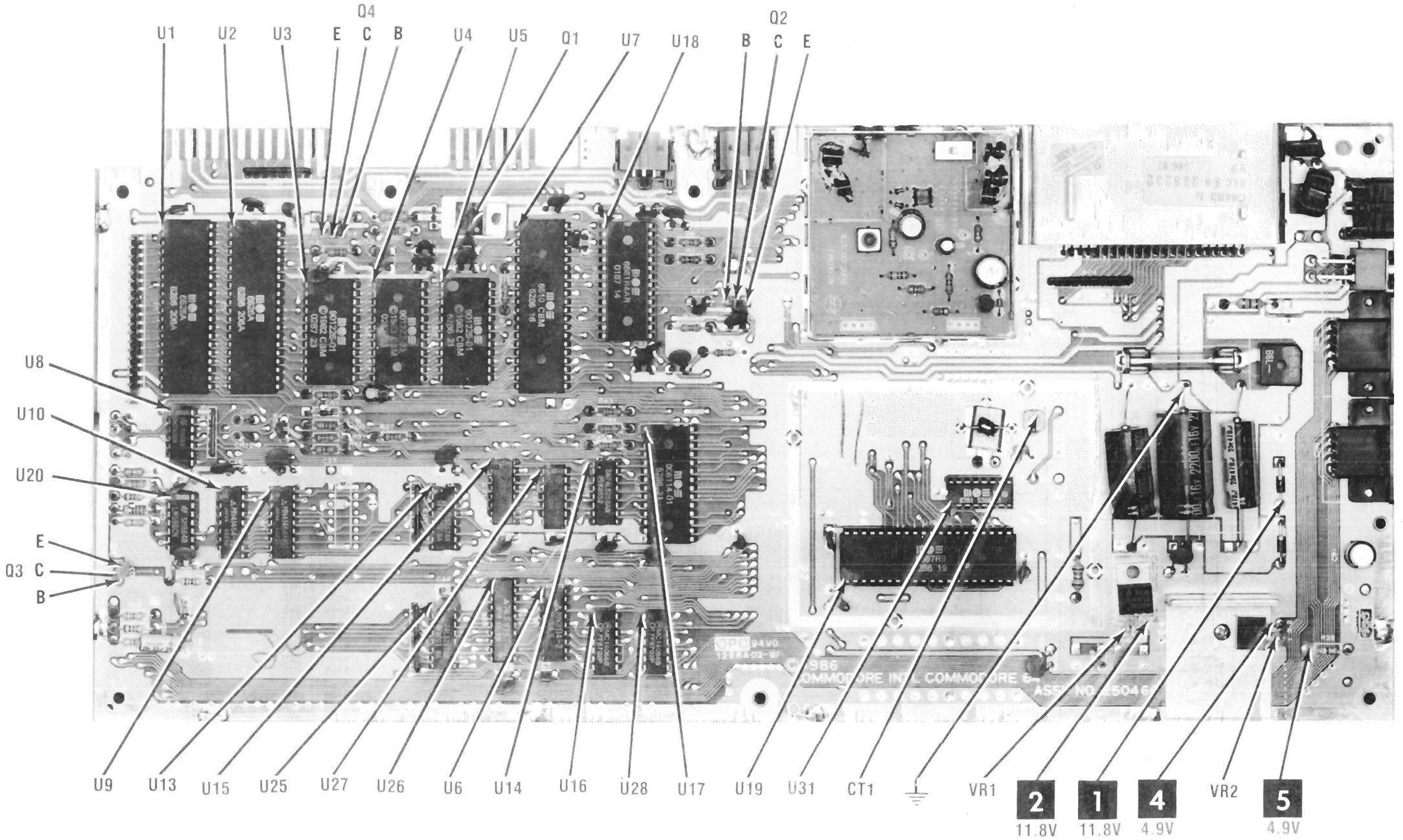


A Howard W. Sams GRIDTRACE™ Photo

BLOCK DIAGRAM

GridTrace LOCATION GUIDE

C1	D-8	F1	F-24
C2	B-2	L1	J-22
C3	B-4	L4	B-27
C4	D-5	L5	D-25
C5	D-7	M1	C-18
C6	D-9	Q1	B-9
C7	L-10	Q2	D-14
C9	B-10	Q3	J-1
C10	B-12	Q4	C-6
C11	C-11	R1	D-9
C12	F-13	R2	C-7
C13	D-14	R3	E-14
C15	K-16	R4	C-6
C19	H-24	R5	F-6
C20	A-27	R6	C-13
C22	H-2	R7	C-13
C23	H-1	R26	K-1
C24	L-2	R31	J-3
C25	H-5	R33	H-1
C26	H-3	R34	K-1
C29	H-8	R35	I-1
C30	I-12	R37	G-7
C31	I-9	R38	E-13
C33	J-13	R39	L-27
C34	K-2	R41	I-1
C37	D-14	R42	H-6
C38	I-1	R43	G-12
C39	J-2	R44	G-12
C44	K-8	R45	G-12
C45	L-9	R50	K-1
C46	I-11	R51	G-6
C48	F-12	R60	C-7
C50	B-12	R100	G-6
C51	B-13	RP1	I-7
C53	J-21	RP2	L-7
C58	H-20	RP3	B-4
C59	L-21	RP4	D-22
C88	H-23	RP5	G-3
C89	L-22	SW1	D-28
C90	H-25	U1	D-3
C91	J-28	U2	D-4
C93	E-12	U3	E-6
C95	J-24	U4	E-7
C101	I-16	U5	E-9
C103	L-23	U6	K-10
C150	C-9	U7	D-10
C151	C-8	U8	G-2
C152	C-7	U9	I-5
C153	I-14	U10	I-3
C154	B-5	U13	I-8
C200	F-7	U14	H-12
C204	G-5	U15	I-9
C205	E-14	U16	L-12
CN1	E-1	U17	H-13
CN2	A-4	U18	D-12
CN3	A-9	U19	J-19
CN4	A-9	U20	I-2
CN5	A-15	U25	L-8
CN6	A-23	U26	K-9
CN7	B-28	U27	I-10
CN8	E-28	U28	L-13
CN9	G-28	U31	H-20
CN10	K-28	VR1	K-23
CR1	G-6	VR2	K-25
CR2	C-6	Y1	G-20
CR4	F-26		
CR5	J-26		
CR6	H-26		
CR9	G-4		
CR12	G-4		
CR13	G-1		
CR14	G-1		
CR15	G-1		
CR16	H-1		
CT1	G-21		



A Howard W. Sams CIRCUITRACE® Photo

SAFETY PRECAUTIONS

1. Use an isolation transformer for servicing.

2. Maintain AC line voltage at rated input.

3. Remove AC power from the Computer before servicing or installing electrostatically sensitive devices. Examples of typical ES devices are integrated circuits and semiconductor "chip" components.

4. Use extreme caution when handling the printed circuit boards. Some semiconductor devices can be damaged easily by static electricity. Drain off any electrostatic charge on your body by touching a known earth ground. Wear a commercially available discharging wrist strap device. This should be removed prior to applying power to the unit under test.

5. Use a grounded-tip, low voltage soldering iron.

6. Use an isolation (times 10) probe on scope.

7. Do not remove or install Boards, Floppy Disk Drives, Printers or other peripherals with Computer AC power On.

8. Do not use freon-propelled sprays. These can generate electrical charges sufficient to damage semiconductor devices.

9. This Computer is equipped with a grounded three-pronged AC plug. This plug must fit into a grounded AC power outlet. Do not defeat the AC plug safety feature.

10. Periodically examine the AC power cord for damaged or cracked insulation.

11. The Computer cabinet is equipped with vents to prevent heat build-up. Never block, cover or obstruct these vents.

12. Instructions should be given, especially to children, that objects should not be dropped or pushed into the vents of the cabinet. This could cause shock or equipment damage.

13. Never expose the Computer to water. If exposed to water, turn the unit Off. Do not place the Computer near possible water sources.

14. Never leave the Computer unattended or plugged into the AC outlet for long periods of time. Remove AC plug from AC outlet during lightning storms.

15. Do not allow anything to rest on AC power cord.

16. Unplug AC power cord from outlet before cleaning Computer.

17. Never use liquids or aerosols directly on the Computer. Spray on cloth and then apply to the Computer cabinet. Make sure the Computer is disconnected from the AC power line.

LINE DEFINITIONS

A0-A15 ..... Address Lines
AEC ..... Address Enable Control
ATN ..... Attention
BA ..... Bus Available
BASIC ..... Basic Interpreter Line
BUTTON A/LP ..... Control Port A Firebutton /Light Pen Connection
BUTTON B ..... Control Port B Firebutton Connection
CAS ..... Column Address Strobe
CAS RAM ..... Column Address Strobe RAM
CASS RD ..... Cassette Read
CASS SENSE ..... Cassette Sensor
CASS WRT ..... Cassette Write
CHAREN ..... Character Generator ROM Control Line
CHAROM ..... Character Generator ROM Control Line
CIA ..... Complex Interface Adapter
CIAS ..... Complex Interface Adapter Select
CLK ..... Clock
CNT ..... Counter
COL0-COL7 ..... Column Address Lines
COLOR ..... System Color
CS ..... Chip Select
D0-D7 ..... Data Lines
DATA ..... Serial Bus Data Line
DMA ..... Direct Memory Access
DOT CLOCK ..... System Timing
EX ROM ..... External ROM
FLAG2 ..... PC Data Transfer Control
GAME ..... Game I/O Line
GR/W ..... Graphics Read/Write
HI RAM ..... Kernal ROM Control Line
I/O ..... Input/Output
IRQ ..... Interrupt Request
JOYA0-A3 ..... Control Port 1 Joystick Connections
JOYB0-B3 ..... Control Port 2 Joystick Connections
KERNAL ..... Kernal ROM Control Line
LO RAM ..... Basic ROM Control Line
LP ..... Light Pen
MA0-MA7 ..... Multiplex Address Lines
NMI ..... Non-Maskable Interrupt
PA0-PA7 ..... User Port I/O Lines
PB0-PB7 ..... User Port I/O Lines
PC2 ..... User Port I/O Line
PLA ..... Program Logic Array
POTAX ..... Port 1 Potentiometer X
POTAY ..... Port 1 Potentiometer Y
POTBX ..... Port 2 Potentiometer X
POTBY ..... Port 2 Potentiometer Y
POTX,Y ..... Potentiometer X,Y
R/W ..... Read/Write
RAS ..... Row Address Strobe
RDY ..... Ready
RESET ..... Reset Computer
RESTORE ..... Pointer Reset to First Data Constant
ROM L ..... Active Low Decoded RAM/ROM Block Line
ROM H ..... Buffered Decoded RAM/ROM Block Line
ROW0-ROW7 ..... Row Address Lines
SID ..... Sound Interface Device
SP1,2 ..... Serial Port 1,2
VA6,7,14,15 ..... Video Address Lines
VIC ..... Video Interface Chip
Ø COLOR ..... Phase Color
Ø 0 ..... Phase 0
Ø 2 ..... Phase Two
9 VAC 1,2 ..... 60Hz Supply
60Hz ..... Time of Day Clock Sync

TEST EQUIPMENT

Test Equipment listed by Manufacturer illustrates typical or equivalent equipment used by SAMS' Engineers to obtain measurements and is compatible with most types used by field service technicians.

TEST EQUIPMENT (COMPUTERFACTS)

Equipment Name	B & K Precision Equipment No.	Sencore Equipment No.
OSCILLOSCOPE	1570A,1590A,1596	SC61
LOGIC PROBE	DP51	
LOGIC PULSER	DP101	
DIGITAL VOM	2830	DVM37,DVM56,SC61
ANALOG VOM	277	
ISOLATION TRANSFORMER	TR110,1604,1653,1655	PR57
FREQUENCY COUNTER	1803,1805	FC71,SC61
COLOR BAR GENERATOR	1211A,1248,1251,1260	CG25,VA62
RGB GENERATOR	1260	
FUNCTION GENERATOR	3020	
HI-VOLTAGE PROBE VOM/DMM Accessory probes	HV-44	HP200
TEMPERATURE PROBE	TP-28	
CRT ANALYZER	467,470	CR70

TROUBLESHOOTING

POWER SUPPLY

The 11.8V source at anode of CR6 is missing. Check Fuse F1. If fuse has opened, check Bridge Rectifier (CR4), Capacitors C19 and C95, and Voltage Regulator (VR2) for shorts.

If fuse is good, check for 10.0VAC between Fuse F1 and Switch SW1. Check Coil L4 by measuring for 10.0VAC at pins 6 and 7 of Power Input Connector (CN7). Check Power Switch (SW1) and connections at CN7. Replace Power Supply if voltage is not correct.

The 11.76V source at pin 2 of Voltage Regulator (VR1) is missing. Check VR1, Diode CR5, Capacitors C88, C89 and C90.

The 4.91V source at positive (+) end of Capacitor C91 is missing. Check Coil L5. If Coil L5 is good, check Power Switch (SW1). Also, check the 4.91V at pin 5 of Power Input Connector (CN7). If voltage is missing, replace Power Supply.

The 4.93V source at pin 2 of Voltage Regulator (VR2) is missing. Check VR2, Capacitors C15, C101 and C103.

MICROPROCESSOR (CPU) OPERATION

Check for pulses on pins 30 thru 37, pins 7 thru 20, and pins 22 and 23 of Microprocessor IC (U7). If the Microprocessor is not working, check pin 40 of IC U7 with the logic probe, while the Computer is turned OFF and back ON again. The logic probe should read Low for about two seconds after turn-on, then read High to reset the Microprocessor.

If the logic probe reading is not correct on pin 40 of IC U7, check the voltages and components associated with the Timer IC (U20). If IC U20 is working, check for pulses on pin 3 of IC U7 and a logic High reading on pin 4 of IC U7. If the reading is not correct on pin 3 of IC U7, check Complex Interface Adapter IC (U1) by substitution. If the reading is not correct on pin 4 of IC U7, check Complex Interface Adapter IC (U2) by substitution.

Check for Read/Write pulses on pin 38 of IC U7. Check for B+ voltage at pin 6 of Read/Write IC U7. Also, check the logic at pins 27, 28, and 29 of IC U7. Check for a clock waveform at pin 39 of IC U7.

VIDEO

No video. Check for a video waveform at pin 15 of Video Interface IC (U19). If the waveform is present, check the RF Modulator unit. If the video waveform is not present, check IC U19 by substitution.

COLOR

No color. Check for a color waveform at pin 14 of Video Interface IC (U19). If the waveform is not present, check IC U19 by substitution. If the colors are not correct, check the adjustment of the 14.31818MHz Oscillator. See "Adjustment" section.

AUDIO

No sound. Type in and run the program below. Check for an audio signal at pin 27 of Sound Interface Device IC (U18). If there is no audio signal present, check IC U18 by substitution. If an audio signal is present, check the voltages and components associated with Transistor Q8.

```
10 POKE 54296, 15
20 POKE 54278, 248
30 POKE 54273, 17
40 POKE 54276, 17
```


LOGIC CHART (Continued)

PIN NO.	IC U8	IC U9	IC U10	IC U13	IC U14	IC U15	IC U16	PIN NO.	IC U17	PIN NO.	IC U17
1	L	L	L	P	P	P	P	1	*	21	P
2	H	P	P	P	H	P	P	2	P	22	H
3	P	P	P	P	P	P	P	3	P	23	H
4	P	P	P	P	P	H	P	4	P	24	P
5	L	P	P	P	H	P	P	5	H	25	P
6	H	P	P	P	P	P	P	6	H	26	P
7	L	P	P	P	P	P	L	7	H	27	P
8	H	P	P	L	L	L	P	8	H	28	H
9	L	H	H	P	P	P	P	9	P		
10	L	P	P	P	P	P	P	10	H		
11	H	P	P	P	P	H	P	11	H		
12	H	P	P	P	P	P	P	12	P		
13	L	P	P	P	P	P	P	13	P		
14	H	P	P	P	P	P	H	14	L		
15		P	P	P	P	P		15	P		
16		P	P	H	H	H		16	P		
17		P	P					17	H		
18		L	L					18	P		
19								19	L		
20								20	P		

PIN NO.	IC U18	PIN NO.	IC U18	PIN NO.	IC U19	PIN NO.	IC U19	PIN NO.	IC U20	IC U25	PIN NO.	IC U26	IC U27	IC U28	IC U31
1	H	21	P	1	P	21	P	1	L	P	1	P	P	*	*
2	H	22	P	2	P	22	P	2	L	P	2	P	H	P	L
3	H	23	P	3	P	23	P	3	H	P	3	P	P	P	*
4	H	24	P	4	P	24	P	4	H	P	4	P	P	*	L
5	H	25	H	5	P	25	P	5	L	P	5	P	P	L	H
6	P	26	H	6	P	26	P	6	H	P	6	P	P	P	P
7	P	27	H	7	P	27	P	7	L	P	7	P	L	L	H
8	P	28	H	8	P	28	P	8	H	L	8	P	P	P	P
9	P			9	H	29	P	9	L	P	9	P	P	P	L
10	P			10	H	30	P	10	H	P	10	L	H	P	*
11	P			11	P	31	P	11	H	P	11	P	P	P	*
12	P			12	P	32	P	12	L	P	12	P	P	P	H
13	P			13	H	33	P	13	L	P	13	P	H	L	P
14	L			14	P	34	P	14	H	P	14	P	H	H	P
15	P			15	P	35	P	15		P	15	P			H
16	P			16	P	36	P	16		H	16	P			*
17	P			17	P	37	P	17			17	P			
18	P			18	P	38	P	18			18	P			
19	P			19	P	39	P	19			19	P			
20	P			20	L	40	H	20			20	H			

LOGIC CHART

PIN NO.	IC U1	PIN NO.	IC U1	PIN NO.	IC U2	PIN NO.	IC U2	PIN NO.	IC U3	PIN NO.	IC U3
1	L	21	P	1	L	21	H	1	P	21	P
2	P	22	P	2	H	22	P	2	P	22	P
3	P	23	P	3	H	23	H	3	P	23	P
4	P	24	H(10)	4	H	24	H	4	P	24	H
5	P	25	P	5	L	25	P	5	P		
6	P	26	P	6	H	26	P	6	P		
7	P	27	P	7	L	27	P	7	P		
8	P	28	P	8	L	28	P	8	P		
9	L(1)	29	P	9	H	29	P	9	P		
10	H(2)	30	P	10	H	30	P	10	P		
11	H(3)	31	P	11	H	31	P	11	P		
12	H(4)	32	P	12	H	32	P	12	L		
13	H(5)	33	P	13	H	33	P	13	P		
14	H(6)	34	H	14	H	34	H	14	P		
15	H(7)	35	P	15	H	35	P	15	P		
16	H(8)	36	P	16	H	36	P	16	P		
17	H(9)	37	P	17	H	37	P	17	P		
18	P	38	P	18	H	38	P	18	P		
19	P	39	H	19	P	39	H	19	P		
20	H	40	H	20	H	40	H	20	H		

PIN NO.	IC U4	PIN NO.	IC U4	PIN NO.	IC U5	PIN NO.	IC U5	PIN NO.	IC U6	PIN NO.	IC U7	PIN NO.	IC U7
1	P	21	P	1	P	21	H	1	P	1	P	21	L
2	P	22	P	2	P	22	P	2	P	2	P	22	P
3	P	23	P	3	P	23	P	3	P	3	P	23	P
4	P	24	H	4	P	24	H	4	P	4	H	24	H(10)
5	P			5	P			5	P	5	P	25	H(12)
6	P			6	P			6	P	6	H	26	L(11)
7	P			7	P			7	P	7	P	27	H
8	P			8	P			8	P	8	P	28	H
9	P			9	P			9	L	9	P	29	H
10	P			10	P			10	P	10	P	30	P
11	P			11	P			11	P	11	P	31	P
12	L			12	L			12	P	12	P	32	P
13	P			13	P			13	P	13	P	33	P
14	P			14	P			14	P	14	P	34	P
15	P			15	P			15	P	15	P	35	P
16	P			16	P			16	P	16	P	36	P
17	P			17	P			17	P	17	P	37	P
18	P			18	P			18	H	18	P	38	P
19	P			19	P					19	P	39	P
20	P			20	P					20	P	40	H

TROUBLESHOOTING (Continued)

KEYBOARD

Keyboard does not work. Check the waveforms at pins 2 thru 8 and pin 19 of Complex Interface Adapter IC (U1). If any of the waveforms are not present, check IC U1 by substitution. If the waveforms are present, check the operation of the keyboard by checking the logic probe readings on pins 9 thru 17 of IC U1. For readings that are not correct, check the keyboard Connector CN1, and the key switches on the keyboard for bad connections. If the keyboard still does not operate correctly, check IC U1 by substitution.

If the RESTORE key is not working, check for 0V on pin 3 of Connector CN1 when the RESTORE key is presed. If the voltage does not drop to 0V, check for a bad connection at Connector CN1 and check the RESTORE key switch with an ohmmeter.

JOYSTICK

Joystick does not work properly. Check the voltages on the pins shown in the chart below, while the appropriate joystick position is activated. The voltages should go from about 5V to less than 0.5V. If any voltage is not correct, check the joystick switches, Connector CN9 for Port 1 and Connector CN8 for Port 2. Also check Complex Interface Adapter IC (U1) by substitution.

PORT 1			PORT 2		
IC	PIN	JOYSTICK POSITION	IC	PIN	JOYSTICK POSITION
U1	10	UP	U1	2	UP
U1	11	DOWN	U1	3	DOWN
U1	12	LEFT	U1	4	LEFT
U1	13	RIGHT	U1	5	RIGHT
U1	14	BUTTON	U1	6	BUTTON

Check the operation of the joystick by loading and running a program that uses the joystick or type into the Computer and run the following program.

```
10 P1 = PEEK (56320)
20 P2 = PEEK (56321)
30 PRINT P1, P2
40 FOR T = 1 TO 400: NEXT T
50 GOTO 10
```

See chart for appropriate joystick ports and positions.

JOYSTICK POSITION	PORT 1	PORT 2
CENTER	255	127
UP	254	126
DOWN	253	125
LEFT	251	123
RIGHT	247	119
BUTTON	239	111

NOTE: OTHER NUMBERS WILL APPEAR IF TWO SWITCHES ON THE JOYSTICK ARE CLOSED AT THE SAME TIME.

PADDLES

Buttons on the paddles do not work. Check the voltages on pins 12 and 13 of Complex Interface Adapter IC (U1) while using Control Port 1 and pins 4 and 5 of IC U1 while using Control Port 2. The voltage should go from 5V to 0V when the appropriate button is pressed. If the voltage does not change, check the button switches with an ohmmeter. Check Connectors CN9 (Control Port 1), and CN8 (Control Port 2) for bad connections. If the voltages check good, check IC U1 by substitution.

If the paddles do not work, check waveforms at pins 23 and 24 of Sound Interface Device IC (U18). If the waveforms are correct, check IC U18 by substitution. If the waveforms are not correct, check the paddle controls and connections with an ohmmeter. If the controls and connections are good, check Quad Bilateral Switch IC (U28) by substitution.

CASSETTE SAVE AND LOAD

Computer will not save a program to a cassette tape. Check for pulses on pin 26 of Microprocessor IC (U7) with a logic probe, while saving a program on tape. If there are no pulses, check IC U7 by substitution. If the pulses are present, check the connections at pin 5 of Connector CN3.

Computer will not load a program from a cassette tape. Check for pulses on pin 24 of Complex Interface Adapter IC (U1) with a logic probe, while loading a program from tape. If the pulses are present, check IC U1 by substitution. If the pulses are not present, check the connections at pin 4 of Connector CN3.

Datassette cassette motor will not start when the recorder is put in Play or Record mode. Check the voltage at pin 25 of IC U7. The voltage on pin 25 should drop from 4.96V to .02V when the Datassette cassette recorder is in the Play or Record mode.

If the voltage does not change, check the connection at pin 6 of Connector CN3. If the voltage is correct, check the voltage at pin 24 of IC U7. The voltage on pin 24 should drop from 2.98V to .08V when the Datassette cassette recorder is put in the Play or Record mode. If the voltage is good, check the voltages and components associated with Transistors Q1 thru Q3.

See the voltage chart below for voltages with the recorder in Play or Record mode.

	E	B	C
Q1	6.5V	6.9V	10.7V
Q4	0V	.07V	6.9V

Note: Voltages taken with Datassette cassette recorder running.

PARTS LIST AND DESCRIPTION (Continued)

When ordering parts, state Model, Part Number, and Description

ELECTROLYTIC CAPACITORS

ITEM No.	RATING	MFGR. PART No.
C15	4.7 16V	

ITEM No.	RATING	MFGR. PART No.

CAPACITORS

ITEM No.	RATING	MFGR. PART No.
CT1	Trimmer Cap	

ITEM No.	RATING	MFGR. PART No.

COILS (RF-IF)

ITEM No.	FUNCTION	MFGR. PART No.
L1 L4	RF Choke AC Line Filter	

ITEM No.	FUNCTION	MFGR. PART No.
L5	RF Choke	

FUSE DEVICES

ITEM NO.	DESCRIPTION	MFGR. PART NO.		NOTES
		DEVICE	HOLDER	
F1	1.5A @ 250VAC Fast Acting			

RESISTORS (Power and Special)

ITEM No.	RATING	REPLACEMENT DATA		
		MFGR. PART No.	NTE PART No.	WORKMAN PART No.
RP1	Resistor Network	(1)		
RP2	Resistor Network	(1)		
RP3	Resistor Network	(2)		
RP4	Resistor Network	(3)		
RP5	Resistor Network	(4)		

(1) 33 5% X4
(2) 3300 5% X7
(3) 3300 5% X9
(4) 1000 5% X5

MISCELLANEOUS

ITEM No.	PART NAME	MFGR. PART No.	NOTES
CR99	LED		Power, Red
L2	Ferrite Bead		
M1	RF Module		
SW1	Switch		Power
Y1	Crystal		14.31818MHz

WIRING DATA

Shielded Hook-up Wire ..... Use BELDEN No. 8401 or 8421 (Single-Conductor)
8208 (Two-Conductor)
General-use Unshielded Hook-up Wire ..... Use BELDEN No. 8529 (Solid) Available in 13 Colors
8522 (Stranded) Available in 13 Colors

PARTS LIST AND DESCRIPTION

When ordering parts, state Model, Part Number, and Description

SEMICONDUCTORS (Select replacement for best results)

ITEM No.	MFGR. PART No./ TYPE No.	NTE PART No.	ECG PART No.	RCA PART No.	ZENITH PART No.	NOTES
CR1	2.7B	NTE5002A	ECG5002A	SK2A7/5002A	903-454	
CR2	6.8B	NTE5014A	ECG5014A	SK6A8/5014A	103-Z9009	
CR4	BA20	NTE5314	ECG5314	SK3987/5314		
CR5,6	1N4001	NTE116	ECG116	SK3311	212-76-02	
CR9	1N4148	NTE519	ECG519	SK3100/519	103-131	
CR12 THRU CR16	1N4148	NTE519	ECG519	SK3100/519	103-131	
Q1	2SD313E	NTE152	ECG152	SK3893/152	121-987-03	*
Q2,3,4	2SC1815Y	NTE85	ECG85	SK3124A/289A	121-Z9065	
U1,U2	6526A					
U3	901226-01					
U4	901227-03					
U5	901225-01					
U6	MN2114-2					
U7	6510					
U8	DM7406N	NTE7406	ECG7406	SK7406	HE-443-698	
U9,10	MM41464-15					
U13	74LS257AN	NTE74LS257	ECG74LS257	SK74LS257	HE-443-802	
U14	SN74LS258AN	NTE74LS258	ECG74LS258	SK74LS258		
U15	74LS139PC	NTE74LS139	ECG74LS139	SK74LS139	HE-443-822	
U16	MC14066B	NTE4066B	ECG4066B	SK4066B	905-369	
U17	906114-01					
U18	6581R4AR					
U19	6567R9					
U20	LM556CN	NTE978	ECG978	SK3689/978	221-Z9152	
U25	74LS257AN	NTE74LS257	ECG74LS257	SK74LS257	HE-443-802	
U26	74LS373	NTE74LS373	ECG74LS373	SK74LS373	HE-443-867	
U27	DM74LS08N	NTE74LS08	ECG74LS08	SK74LS08	HE-443-780	
U28	MC14066B	NTE4066B	ECG4066B	SK4066B	905-369	
U31	8701	NTE966	ECG966	SK3592/966	HE-442-674	
VR1	LM340T12	NTE966	ECG966	SK3592/966	HE-442-674	
	7812P	NTE960	ECG960	SK3591/960	221-Z9043	
VR2	UA7805					
	[uA7805]					

* Lead configuration may vary from original.

PRELIMINARY SERVICE CHECKS (Continued)
PREVENTATIVE MAINTENANCE

ENVIRONMENT

Computers perform best in a clean, cool area that is below 80 degrees Fahrenheit and free of dust and smoke particles. Even though home Computers are not affected by cigarette smoke as much as commerical Computers are affected, it is better to maintain a smoke-free area around the Computer. Do not block cabinet vents of Computer, Monitor, Printer or other power devices.

ELECTRICAL POWER

Variations in the line voltage can affect the Computer. Try to avoid these fluctuations by using an AC receptacle that is on a power line not used by appliances or other heavy current demand devices. A power-surge protector, power-line conditioner or noninterruptible power supply may be needed to cure the problem. DO NOT switch power On and Off frequently.

KEYBOARD

Liquids spilled into the Keyboard can ruin it. Immediately after a spill occurs, disconnect the Computer power plug from AC power outlet. Then, if circuitry or contacts are contaminated, disassemble the Keyboard and carefully rinse the Keyboard printed circuit board with distilled water and let it dry. Use a cotton swab between the keys. Use a nonabrasive contact cleaner and lint-free wipers on accessible connectors and contacts.

DISK DRIVES

Clean the read/write heads of the Disk Drives about once a month or after 100 hours usage. Use only an approved head cleaning kit.

Handle carefully to preserve proper disk head alignment. A sudden bump or jolt to the Disk Drives can knock the disk head out of alignment. If Disk Drive must be transported, place an old disk in slot and close door during transport.

Store disks in their protective covers and never touch the disk surface. Observe the disk handling precautions usually found on the back of disk protective covers.

PRINTERS

Carefully vacuum the Printer regularly. Wipe surface areas clean using a light all-purpose cleaner. Do not clean the machine. The oil will collect abrasive grit and dust. The dust will act as a blanket. This can cause components to overheat and fail.

STATIC ELECTRICITY

Static electricity discharge can affect the Computer. In order to minimize the possibility, use anti-static mats, sprays, tools and materials and maintain good humidity in the Computer environment.

MONITOR

Use an isolation transformer with any Monitor that does not come as part of the system since some Monitors use a HOT chassis (chassis connected to one side of the AC line). The face of the Monitor should never be left on for long periods of time at high brightness level except when pattern is being changed periodically. Use caution when cleaning anti-glare screens to preserve the glare-reduction feature.

PRELIMINARY SERVICE CHECKS

This data provides the user with a time-saving service tool which is designed for quick isolation and repair of computer malfunctions.

Check all interconnecting cables for good connection and correct hook-up before making service checks.

Disconnect all peripherals except the monitor from the computer to eliminate possible external malfunctions. However, problems involving the interaction between computer and a peripheral will require the connection of the device for voltage and logic readings.

Replacement or repair of the keyboard, main board, RF Modulator, or components may be necessary after the malfunction has been isolated.

TEST EQUIPMENT AND TOOLS

TEST EQUIPMENT

Digital Volt/Ohm Meter
Logic Probe

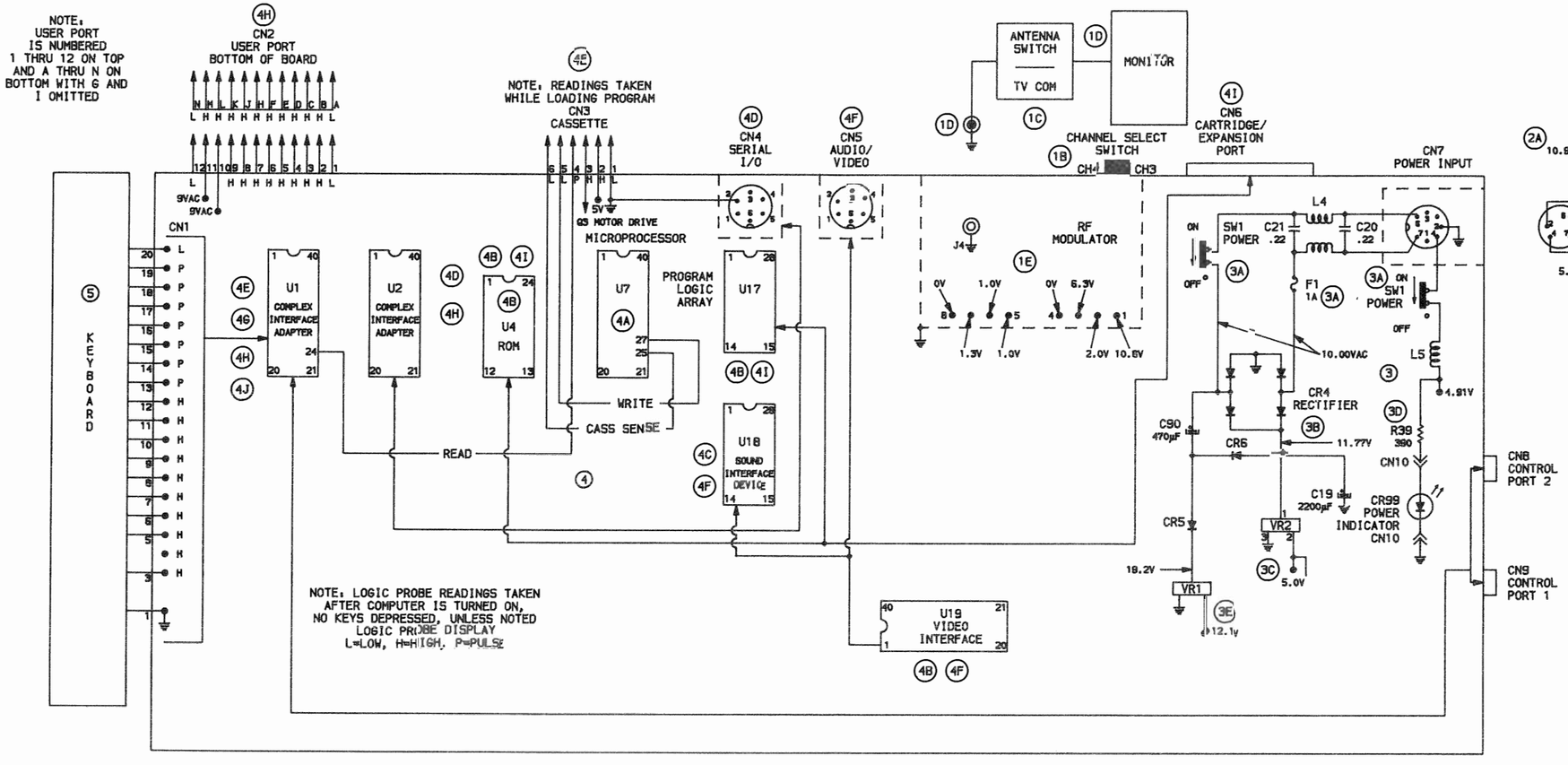
TOOLS

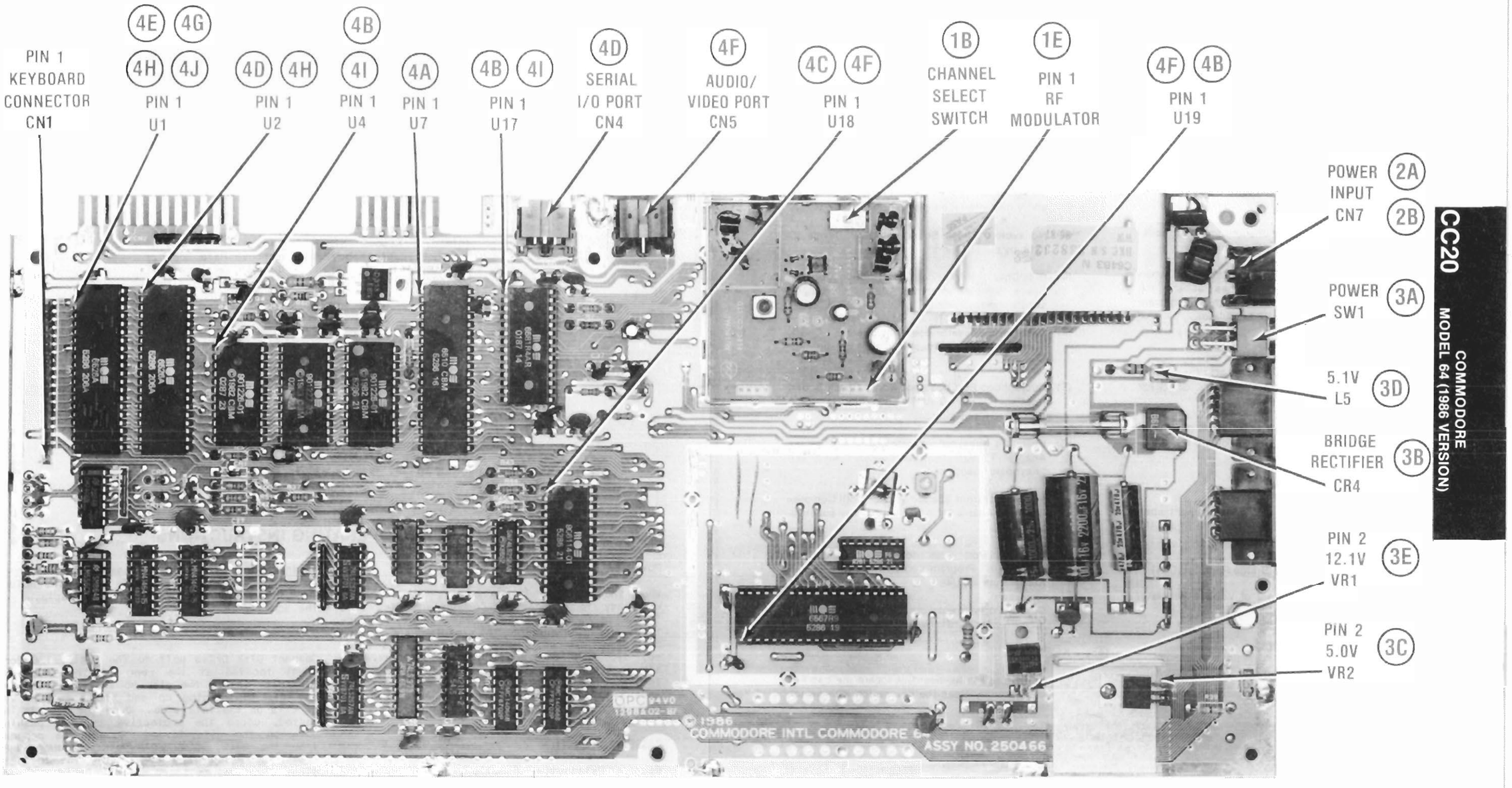
Small Screwdriver
Phillips Screwdriver
Soldering Iron
Desoldering Equipment
Switch Cleaner (non-spray type)

SAMS™ Howard W. Sams & Co.
4300 West 62nd Street, P.O. Box 7092, Indianapolis, Indiana 46206 U.S.A.

88CC19029 DATE 5-88

PRELIMINARY SERVICE CHECKS (Continued)




PIN 1
KEYBOARD
CONNECTOR
CN1
4E 4G
4H 4J
PIN 1
U1
4D 4H
PIN 1
U2
4B
4I
PIN 1
U4
4A
PIN 1
U7
4B 4I
PIN 1
U17
4D
SERIAL
I/O PORT
CN4
4F
AUDIO/
VIDEO PORT
CN5
4C 4F
PIN 1
U18
1B
CHANNEL
SELECT
SWITCH
1E
PIN 1
RF
MODULATOR
4F 4B
PIN 1
U19
POWER
INPUT
CN7
2A
2B
POWER
SW1
3A
5.1V
L5
3D
BRIDGE
RECTIFIER
CR4
3B
PIN 2
12.1V
VR1
3E
PIN 2
5.0V
VR2
3C
CC20
COMMODORE
MODEL 64 (1986 VERSION)
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COMMODORE INTL COMMODORE 64
ASSY NO. 250466

PRELIMINARY SERVICE CHECKS (Continued)

SERVICE CHECKS

MATCH THE NUMBERS ON THE INTERCONNECTING DIAGRAM AND PHOTOS WITH THE NUMBERS ON THE SERVICE CHECKS TO BE PERFORMED.

① RF MODULATOR CHECK

(A) Turn On computer and verify the power indicator LED is lit. Note: If the power indicator LED is not lit, see the "Power Supply Check" and "Main Board (Power Check)" sections.

(B) Verify the channel select switch is on the same channel as the monitor, channel 3 or 4.

(C) Verify the antenna switch is in Computer position.

(D) Check for bad connections and improper hook-up at the monitor and at the computer.

(E) If the computer still does not come up when powered, check the voltages at the RF Modulator connection points. If the voltages are correct, substitute the RF Modulator.

② POWER SUPPLY CHECK

(A) Connect Power Supply to 120VAC. Disconnect power connector CN7 from computer. Check for 10.90VAC across pins 6 and 7 of CN7.

(B) Check for 5.08V across pins 2 and 4 of CN7. If the voltages are not present or are incorrect, replace the power supply.

③ MAIN BOARD (POWER CHECK)

(A) If the power indicator LED does not light when computer is powered, check the Fuse F1 and the Power Switch (SW1).

(B) Check for 11.77V at the Bridge Rectifier (CR4).

(C) Check for 4.93V at pin 2 of Voltage Regulator VR2.

(D) Check for 4.91V at Coil L5.

(E) Check for 11.76V at pin 2 of Voltage Regulator VR1.

④ MAIN BOARD (PROCESSING)

(A) If the power supply checks normal and the computer does not come up when powered, verify Microprocessor IC (U7) is working by checking for pulses on pins 7 thru 20, 22, 23, and 30 thru 37.

(B) If the Microprocessor is working and the computer does not come up, check by substitution Kernal ROM IC (U4), Program Logic Array IC (U17) and Video Interface Chip IC (U19).

(C) No audio. Check Sound Interface Device IC (U18) by substitution.

(D) Disk Drive or Printer does not function properly. Check Complex Interface Adapter IC (U2) by substitution.

(E) Datassette cassette does not operate. Check Complex Interface Adapter IC (U1) by substitution.

(F) Audio/Video Port does not work. Check Sound Interface Device IC (U18), and Video Interface Chip IC (U19) by substitution.

(G) Keyboard does not operate. Check Complex Adapter IC (U1) by substitution. Also see "Keyboard" section.

(H) Modem does not operate. Check both Complex Interface Adapter IC's (U1 and U2) by substitution.

(I) Cartridge Port does not work. Check by substitution Program Logic Array IC (U17) and Kernal Rom IC (U4).

(J) Control Ports do not work. Check Complex Interface Adapter IC (U1) by substitution.

⑤ KEYBOARD

Substitute the keyboard or locate the bad key and carefully clean the key switch with switch cleaner.

PRELIMINARY SERVICE CHECKS (Continued)

DISASSEMBLY INSTRUCTIONS

CABINET TOP

Remove three screws from cabinet bottom. Lift cabinet top enough to disconnect Power Indicator from Connector CN10, on Main Board and remove cabinet top.

KEYBOARD

Remove cabinet top. Disconnect Connector CN1 from Main Board. Remove two screws holding keyboard to shield and remove keyboard.

MAIN BOARD

Remove cabinet top and keyboard. Remove five screws holding shield to Main Board and remove shield. Remove three screws holding Main Board to cabinet bottom and remove Main Board. Unsolder ten bottom shield tabs and remove bottom shield.

MISCELLANEOUS ADJUSTMENT

14MHz OSCILLATOR

Connect the input of a frequency counter to pin 13 of IC (U31). Adjust CT1 for a frequency of 14.31818MHz at pin 10.

GENERAL OPERATING INSTRUCTIONS

POWER UP

When the computer is turned On, it will come up ready to program in Commodore Basic. See "Cassette Operation" and "Disk Operation" sections for instructions on loading and saving programs. To run a program after it is loaded, type RUN and press the RETURN key. To stop a program, press the RUN/STOP key. Pressing the RUN/STOP key and RESTORE key at the same time will stop the program and reset the computer to the start condition, without losing the program.

CASSETTE OPERATION

Plug a Datassette cassette recorder onto the six pin edge connector at the rear of the computer. Note: A regular tape recorder will not work on the Commodore 64. To load a program, type LOAD, press the RETURN key and follow the instructions displayed on the monitor screen. To save a program, type SAVE, press the RETURN key and follow the instructions displayed on the screen.

DISK OPERATION

Connect Disk Drive unit to the Serial I/O Port (CN4) located at the rear of the computer. Carefully insert the disk so that the label on the disk is facing up and the notch on the disk is on the left side. Once the disk is inserted, close the protective gate by pushing down on the gate lever. To load a program from the disk, type LOAD "PROGRAM NAME", 8. Press the RETURN Key and follow the instructions displayed on the monitor. To SAVE a program, type SAVE "PROGRAM NAME", 8 and press the RETURN key. NOTE: 8 is the code for the disk.