SECTION 4
PERFORMANCE, CALIBRATION, AND MAINTENANCE

WARNING

TO AVOID PERSONAL INJURY FROM ELECTRIC SHOCK DO NOT REMOVE INSTRUMENT COVERS OR PERFORM ANY MAINTENANCE OTHER THAN DESCRIBED IN THIS MANUAL. INSTALLATION AND MAINTENANCE PROCEDURES DESCRIBED IN THIS MANUAL ARE TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY.

4.1 PERFORMANCE TESTS

The following procedures describe methods for comparing VideoBridge performance with its published specifications. These tests are made via simplified testing procedures rather than by exercising the millions of combinations of test frequencies, test levels, and L, R, and C ranges. If the test results are found to be out of specification limits, check that controls are properly set, then proceed to Section 4.2 Calibration.

When large numbers of measurements are made at a particular frequency, test level, and/or parameter, these performance tests can be customized to include the specific testing needs.

NOTE: Allow a 10 minute warm up period before conducting any performance tests.

NOTE: A proper offset zero calibration must be performed on the test leads or test fixture before doing any performance test or instrument calibration. This is to ensure measurement validity and repeatability. See Sections 2.3.4 and 2.3.5 for more information on lead/fixture calibration.

Equipment Required	Recommended Model/Type
Resistance Standards:	
1Ω +/- 0.01%	ESI Model SR1
10Ω +/- 0.01%	ESI Model SR1
100Ω +/- 0.01%	ESI Model SR1
1kΩ +/- 0.01%	ESI Model SR1
10kΩ +/- 0.01%	ESI Model SR1
100kΩ +/- 0.01%	ESI Model SR1
1MΩ +/- 0.01%	ESI Model SR1
Capacitance Standards:	
1nF +/- 0.01%	Genrad 1404A, 3-term, air
100nF +/- 0.01%	Genrad 1409T, 3-term, Silvered mica
Frequency Counter:	
20Hz to 200kHz +/- 0.001%	Hewlett Packard 5316
Digital Multimeter:	
AC voltage 20mV, 200mV, 2V RMS full scale	Fluke 8600
AC current 2mA, 20mA, 200mA RMS full scale	
Bandwidth 20Hz to 20kHz Accuracy +/- 0.5%	
Low Gauge Wire	RG-11/U coax shielding braid
Connector Cable:	ESI P/N 53155
1 BNC-to-BNC cable, 5 foot length	
Shielding Plate:	
Approximately 80 x 100mm	

4.1.1 Frequency Accuracy Test

NOTE: Functions are displayed in direct format unless otherwise noted.

STEP 1. VideoBridge setup:

Function	Cs, D
Range	AUTO
Frequency	150kHz
Test level	1000mV
Measurement speed	MEDium
Measurement mode	SINGLE

STEP 2. Connect a BNC-to-BNC cable between the frequency counter input and the VideoBridge HI DRIVE (HD) unknown terminal. Leave the other unknown terminals unconnected.

STEP 3. The counter should read 150kHz +/- 15Hz (6.667us +/- 0.0007us).

STEP 4. Set VideoBridge frequency to: 100kHz.

STEP 5. The counter should read 100kHz +/- 10Hz (10.000us +/- 0.001us).

STEP 6. Set VideoBridge frequency to: 20kHz.

STEP 7. The counter should read: 20kHz +/- 2Hz (50.000us +/- 0.005us).

STEP 8. Set VideoBridge frequency to: 3750Hz.

STEP 9. The counter should read: 3750.00Hz +/- 0.37Hz (266.667us +/- 0.027us).

STEP 10. Set VideoBridge frequency to: 1000Hz.

STEP 11. The counter should read: 1000.00Hz +/- 0.10Hz (1000.00us +/- 0.10us).

STEP 12. Set VideoBridge frequency to: 248.96Hz

NOTE: The VideoBridge will display 249.0Hz due to internal rounding off.

STEP 13. The counter should read: 248.96Hz +/- 0.025Hz (4.01667ms +/- 0.0004ms).

STEP 14. Set VideoBridge frequency to: 30Hz.

STEP 15. The counter should read: 30.000Hz +/- 0.003Hz (33.3333ms +/- 0.003ms).

STEP 16. Set VideoBridge frequency to: 20Hz

STEP 17. The counter should read: 20.000Hz +/- 0.002Hz (50.000ms +/- 0.005ms).

NOTE: This frequency test uses the VideoBridge sinewave signal for the frequency counter input. Some counter types have improved stability in readout with a squarewave signal input. If this is the case, use internal bus pin 67 (FO) and instrument chassis ground for counter input. This signal can be taken from pin 67 of either the Analog Card (J7) or the Digital Card (J6).

4.1.2 Range Resistor Accuracy Test

STEP 1. VideoBridge setup:

Function	(Rs) %DEViation, Rs
Range	AUTO
Frequency	100Hz
Test level	100mA
Measurement speed	MEDium
Measurement mode	SINGLE
Nominal value	1 ohm (or value listed on standard)

NOTE: To achieve this setup, key the following sequence:

Push <G/R> <XCHG> <G/R> <value of standard> <blue> <NOM> <blue> <%>

STEP 2. Perform a zero calibration by pushing the blue key and the CAL key. To "Close Unknown", remember to use a piece of low gauge wire to short the KELVIN KLIPS® together.

STEP 3. Connect the 1Ω standard resistor, making a 4-terminal connection. Connect the guard lead to the resistor case (shield).

NOTE: If a proper 4-terminal connection has not been made, the error message "OVERLOAD!-- SUPPLYING xx MA" will appear at the bottom of the display.

STEP 4. Set VideoBridge measurement mode to CONTinuous.

STEP 5. The display should read: .000%Rs +/- 0.1%.

STEP 6. Connect the 10Ω standard resistor.

STEP 7. Set VideoBridge to nominal value 10Ω.

STEP 8. The display should read: .000%Rs +/- 0.05%.

STEP 9. Connect the 100Ω standard resistor.

STEP 10. Set VideoBridge test level to 1000mV.

STEP 11. Set VideoBridge to nominal value 100.

STEP 12. The display should read: .000%Rs +/- 0.05%

STEP 14. Connect the 1kΩ standard resistor.

STEP 15 Set VideoBridge to nominal value 1000.

STEP 16. The display should read: .000%Rs +/- 0.05%.

STEP 17. Connect the 10kΩ standard resistor.

STEP 18. Set VideoBridge to nominal value 10k.

STEP 19. The display should read: .000%Rs +/- 0.05%.

STEP 20. Connect the 100kΩ standard resistor.

STEP 21. Set VideoBridge to nominal value 100k.

STEP 22. The display should read: .000%Rs +/- 0.05%.

STEP 23. Connect the 1MΩ standard resistor.

STEP 24. Set VideoBridge to nominal value 1M.

STEP 25. The display should read: .000%Rs +/- 0.1%.

4.1.3 Capacitor Accuracy Test

STEP 1. VideoBridge setup for 1nF accuracy test:

Function	(Cs) %DEViation, D
Range	AUTO
Frequency	100Hz
Test level	1000mV
Measurement speed	MEDium
Measurement mode	CONTinuous
Nominal value	1nF (or value listed on standard)

NOTE: From the previous setup, press <C>, then <D>.

STEP 2. Position the KELVIN KLIPS of the test leads to the width required to measure the 1nF standard capacitor and perform a zero calibration. Be sure to maintain this distance between KLIPS during and after calibration, taking care not to move or wiggle the leads. Remember to place a piece of low gauge wire (RG-11/U coax shielding braid works well) between the KLIPS to "Close Unknown".

STEP 3. To ensure adequate shielding against the effects of stray capacitance, insert a plate of conductive material between the terminals of the 1nF standard capacitor. Make sure the plate is securely connected to the capacitor case.

STEP 4. Set VideoBridge frequency to 1,000Hz and perform a zero calibration.

STEP 5. Set VideoBridge frequency to 10,000Hz and perform a zero calibration.

STEP 6. Set VideoBridge frequency to 100,000Hz and perform a zero calibration.

STEP 7. Reset VideoBridge frequency to 100Hz.

STEP 8. Connect the lnF capacitance standard to the test leads. Connect the guard lead to the capacitor case (shield). Maintain the shield between the KELVIN KLIPS if the capacitor terminals are closely spaced.

STEP 9. The display should read: .000%Cs +/- 0.1% and .00000 to .00040 D.

STEP 10. Set VideoBridge frequency to: 1000Hz.

STEP 11. The display should read: .000%Cs +/- 0.05% and .00000 to .00025 D.

STEP 12. Set VideoBridge frequency to: 10,000Hz.

STEP 13. The display should read: .000%Cs +/- 0.05% and .0000 to .0010 D.

STEP 14. Set VideoBridge frequency to: 100,000Hz.

STEP 15. The display should read: .000%Cs +/- 1.0% and .0000 to .0030 D.

STEP 16. VideoBridge setup for 100nF accuracy test:

Function	(Cs) %DEViation, D
Range	AUTO
Frequency	100Hz
Test level	1000mV
Measurement speed	MEDium
Measurement mode	CONTinuous
Nominal value	100nF (or value listed on standard)

STEP 17. If the space between the terminals of the 100nF standard capacitor is different than the 1nF standard, perform a zero calibration on the KELVIN KLIPS at the new width for 100Hz, 1kHz, 10kHz and 100kHz. Return test frequency to 100Hz.

STEP 18. Connect the test leads to the 100nF capacitance standard, making a 4-terminal connection. Connect the guard lead to the capacitor case (shield).

STEP 19. The display should read: .000%Cs +/- 0.05% and .00000 to .00040 D.

STEP 20. Set VideoBridge frequency to: 1,000Hz.

STEP 21. The display should read: .000% Cs +/- 0.02% and .00000 to .00025 D.

STEP 22. Set VideoBridge frequency to: 10,000Hz.

STEP 23. The display should read: .000%Cs +/- 0.05% and .0000 to .0010D.

STEP 24. Set VideoBridge frequency to: 100,000Hz.

STEP 25. The display should read: .000%Cs +/-1.0% and .0000 to .0030D.

4.1.4 Test Level Accuracy Test

STEP 1. VideoBridge setup:

Function	Cs, D
Range	AUTO
Frequency	1000Hz
Test level	1500mV
Measurement speed	MEDium
Measurement mode	SINGLE

NOTE: Return to direct display by pressing <DIR>.

STEP 2. Connect the test leads to an AC voltmeter input. Set the voltmeter to the 2V full scale range.

STEP 3. Push VideoBridge SINGLE key.

STEP 4. The AC voltmeter should read: 1500mV +/- 62mV.

STEP 5. Set VideoBridge test level to: 1000mV.

STEP 6. Push VideoBridge SINGLE key.

STEP 7. The AC voltmeter should read: 1000mV +/- 42mV.

STEP 8. Set VideoBridge test level to: 500mV.

STEP 9. Push VideoBridge SINGLE key.

STEP 10. The AC voltmeter should read: 500mV +/- 22mV.

STEP 11. Set VideoBridge test level to: 200mV.

STEP 12. Push VideoBridge SINGLE key.

STEP 13. The AC voltmeter should read: 200mV +/- 10mV.

STEP 14. Set the AC voltmeter to the 200mV full scale range.

STEP 15. Set VideoBridge test level to: 100mV.

STEP 16. Push VideoBridge SINGLE key.

STEP 17. The AC voltmeter should read: 100mV +/- 6mV.

STEP 18. Set VideoBridge test level to: 50mV.

STEP 19. Push VideoBridge SINGLE key.

STEP 20. The AC voltmeter should read: 50mV +/- 4mV.

STEP 21. Set VideoBridge test level to: 20mV.

STEP 22. Push VideoBridge SINGLE key.

STEP 23. The AC voltmeter should read: 20mV +/- 2.8mV.

STEP 24. Set AC voltmeter to the 20mV full scale range.

STEP 25. Set VideoBridge test level to: 10mV.

STEP 26. Push VideoBridge SINGLE key.

STEP 27. The AC voltmeter should read: 10mV +/- 2.4mV.

STEP 28. Set VideoBridge test level to: 5mV.

STEP 29. Push VideoBridge SINGLE key.

STEP 30. The AC voltmeter should read: 5mV +/- 2.2mV.

STEP 31. Connect the test leads to the AC voltmeter current input. Set the voltmeter to the 200mA full scale range.

STEP 32. Set VideoBridge test level to: 100mA.

STEP 33. Push VideoBridge SINGLE key.

STEP 34. The AC voltmeter should read: 100mA +/- 4.2mA.

STEP 35. Set VideoBridge test level to: 50mA.

STEP 36. Push VideoBridge SINGLE key.

STEP 37. The AC voltmeter should read: 50mA +/- 2.2mA.

STEP 38. Set VideoBridge test level to: 20mA.

STEP 39. Push VideoBridge SINGLE key.

STEP 40. The AC voltmeter should read: 20mA +/- 1.0mA.

STEP 41. Set the AC voltmeter to the 20mA full scale range.

STEP 42. Set VideoBridge test level to: 10mA.

STEP 43. Push VideoBridge SINGLE key.

STEP 44. The AC voltmeter should read: 10mA +/- 0.6mA.

STEP 45. Set VideoBridge test level to: 5mA.

STEP 46. Push VideoBridge SINGLE key.

STEP 47. The AC voltmeter should read: 5mA +/- 0.4mA.

STEP 48. Set VideoBridge test level to: 2mA.

STEP 49. Push VideoBridge SINGLE key.

STEP 50. The AC voltmeter should read: 2mA +/- 0.1mA.

STEP 51. Set the AC voltmeter to the 2mA full scale range.

> **NOTE:** Meter non-linearity may be encountered at this current range. If readings approach or exceed limits, switch back to 20mA range.

STEP 52. Set VideoBridge test level to: 1mA.

STEP 53. Push VideoBridge SINGLE key.

STEP 54. The AC voltmeter should read: 1mA +/- 0.06mA.

STEP 55. Set VideoBridge test level to: 0.5mA.

STEP 56. Push VideoBridge SINGLE key.

STEP 57. The AC voltmeter should read: 0.5mA +/- 0.04mA

STEP 58. Set VideoBridge test level to: 0.1mA.

STEP 59. Push VideoBridge SINGLE key.

STEP 60. The AC voltmeter should read: 0.1mA +/- 0.024mA.

4.2 CALIBRATION

CAUTION

WHEN PERFORMING ANY CALIBRATION OR MAINTENANCE OPERATION, DO NOT REMOVE OR REPLACE CIRCUIT CARDS WHILE THE POWER IS TURNED ON. FAILURE TO TURN POWER OFF MAY RESULT IN ELECTRIC SHOCK OR DAMAGE TO THE INSTRUMENT.

The inherent accuracy of the Model 2150/2160 VideoBridge is based on the high stability of wire-wound range resistors and the frequency stability of the crystal-controlled oscillator. There are no full scale adjustments required. Basic LRC accuracy should remain within specifications for a number of years without maintenance other than occasional (6 month) performance testing.

The calibration trimmers used in the Model 2150/2160 involve two AC zero trims, five high frequency dissipation factor (D) phase trims, and one low frequency D phase trim on the Analog card (P/N 53675) and a coarse/fine adjustment on the Digital card (P/N 53522).

The AC zero trims (Section 4.2.2) are shorted test-lead adjustments. They reduce the amount of digital correction made by the instrument's auto-zero calibration. They only need be retrimmed for different length test-leads than those provided with the instrument.

The dissipation factor (D) trims (Section 4.2.3) set the low D accuracy for each of the range resistors. These are more critical at the higher test frequencies (> 2000Hz) and need to be retrimmed only if performance tests show the D accuracy is out of specification.

The coarse/fine reference adjustment (Section 4.2.5) is set at the factory. It requires no maintenance adjustment and only needs to be retrimmed if it has been adjusted by accident. If necessary, refer to Figure 5-6 for component and trimmer locations.

NOTE: R54 and R55 have no effect on instrument performance. They may be left at any position throughout this procedure.

4.2.1 Equipment Required

NOTE: Most high quality, commercially available polystyrene capacitors will meet the following specifications. Any unconfirmed D factors must be verified by an independent source. The 136nF standard can be made by connecting two 68nF capacitors in parallel. DO NOT USE A DECADE CAPACITOR FOR THIS PROCEDURE.

Dissipation Factor Standard Capacitors: Polystyrene Capacitors +/- 20%,

Cs	F_{test}	D value known to +/-
1uF	40Hz	0.0001
136nF	100kHz	0.0005
10nF	100kHz	0.0003
1nF	100kHz	0.0003
330pF	50kHz	0.0002
150pF	10kHz	0.0001

Digital Ohmmeter: (with test leads) — 0.1% accuracy, minimum 4-1/2 digit display

Extender Card: — ESI P/N 47625

Test Fixture: — Four-terminal, with BNC connections (such as ESI Model 2001, 2003, or 2004)

Connector Cables: — 4 BNC-to-BNC cables, 5 foot length ESI P/N 53155

Shorting Material: — RG-11/U coax shielding braid or #14 (or lower) solid copper wire

Resistor: — 1 ohm, 5%, 0.5W composition or film ESI P/N 57039

4.2.2 Short Circuit Zero Adjustments (Analog)

STEP 1. Instrument setup:

Function	Ls, Rs
Range	Auto
Frequency	1000Hz
Test level	100mA
Measurement speed	MEDium
Measurement mode	CONTinuous

STEP 2. Connect the shorting material between fixture terminals to create a short circuit. Note Rs value displayed on CRT.

STEP 3. Connect a 1 ohm resistor in series with the LO DRIVE (LD) test lead. Be sure to maintain the LD shield connection.

STEP 4. Adjust trimmer R46 (see Figure 4-1) until the CRT display reads the same Rs value as noted in Step 2, +/- 200μΩ.

STEP 5. Disconnect the 1 ohm resistor and repeat steps 2 through 4 until no further adjustment is necessary.

STEP 6. Change the test frequency to 100,000Hz.

STEP 7. Disconnect 1 ohm resistor from LD test lead. Connect shorting material between fixture terminals. Note Rs value.

STEP 8. Connect the 1 ohm resistor in series with the LD test lead. Be sure to maintain the LD shield connection.

STEP 9. Adjust trimmer R45 (see Figure 4-1) until the CRT display reads the same Rs value as noted in Step 7, +/- 800μΩ.

STEP 10. Repeat Steps 7 through 10 until no further adjustment is necessary.

4.2.3 High and Low Frequency (D) Phase Adjustments (Analog)

STEP 8. Instrument setup:

Function	Cs, D
Range	Auto
Frequency	40Hz
Test level	1000mV
Measurement speed	MEDium
Measurement mode	CONTinuous

NOTE: The VideoBridge displays dissipation (D) as a positive value. Therefore, negative and positive values of the resistance component may display the same D reading. When adjusting to a non-zero D, confirm polarity by pressing <G/R>. If ESR is negative, re-adjust for same D with positive ESR.

STEP 9. Perform a zero calibration upon the test fixture (press <blue> <CAL>). Remember to use a piece of low gauge wire (such as RG-11/U shielding braid) to "CLOSE UNKNOWN".

STEP 10. Set VideoBridge frequency to: 10,000Hz.

STEP 11. Perform a zero calibration at this frequency.

STEP 12. Set VideoBridge frequency to: 50,000Hz.

STEP 13. Perform a zero calibration at this frequency.

STEP 14. Set VideoBridge frequency to: 100,000Hz.

STEP 15. Perform a zero calibration at this frequency. The instrument has now stored the zero offsets for these frequencies.

STEP 16. Insert the 136nF dissipation (D) standard into the fixture.

STEP 17. Adjust trimmer R19 (see Figure 4-1) for a D reading of the calibrated value, +/- 0.0005.

STEP 18. Remove the 136nF capacitor and insert the 10nF D standard. Adjust trimmer R20 (see Figure 4-1) for a D reading of the calibrated value, +/- 0.0003.

STEP 19. Remove the 10nF capacitor and insert the 1nF D standard. Adjust trimmer R21 (see Figure 4-1) for a D reading of the calibrated value, +/- 0.0003.

STEP 20. Change the test frequency to 50,000Hz.

STEP 21. Remove the 1nF capacitor and insert the 330pF D standard. Adjust trimmer R22 (see Figure 4-1) for a D reading of the calibrated value, +/- 0.0002.

STEP 22. Change the test frequency to 10,000Hz.

STEP 23. Remove the 330pF capacitor and insert the 150pF D standard. Adjust trimmer R23 (see Figure 4-1) for a D reading of the calibrated value +/- 0.0001.

STEP 24. Change the test frequency to 40Hz.

STEP 25. Remove the 150pF capacitor and insert the 1uF D standard. Use the extender card to position the analog card above the instrument. Adjust trimmer R15 (see Figure 4-1) for a D reading of the calibrated value +/- 0.00010.

4.2.5 Coarse/Fine Reference Adjustment (Digital)

NOTE: This is NOT a normal maintenance adjustment. DO NOT perform this adjustment unless R1 was trimmed by accident. If necessary, refer to Figure 5-6 for component locations.

STEP 26. Turn off instrument power.

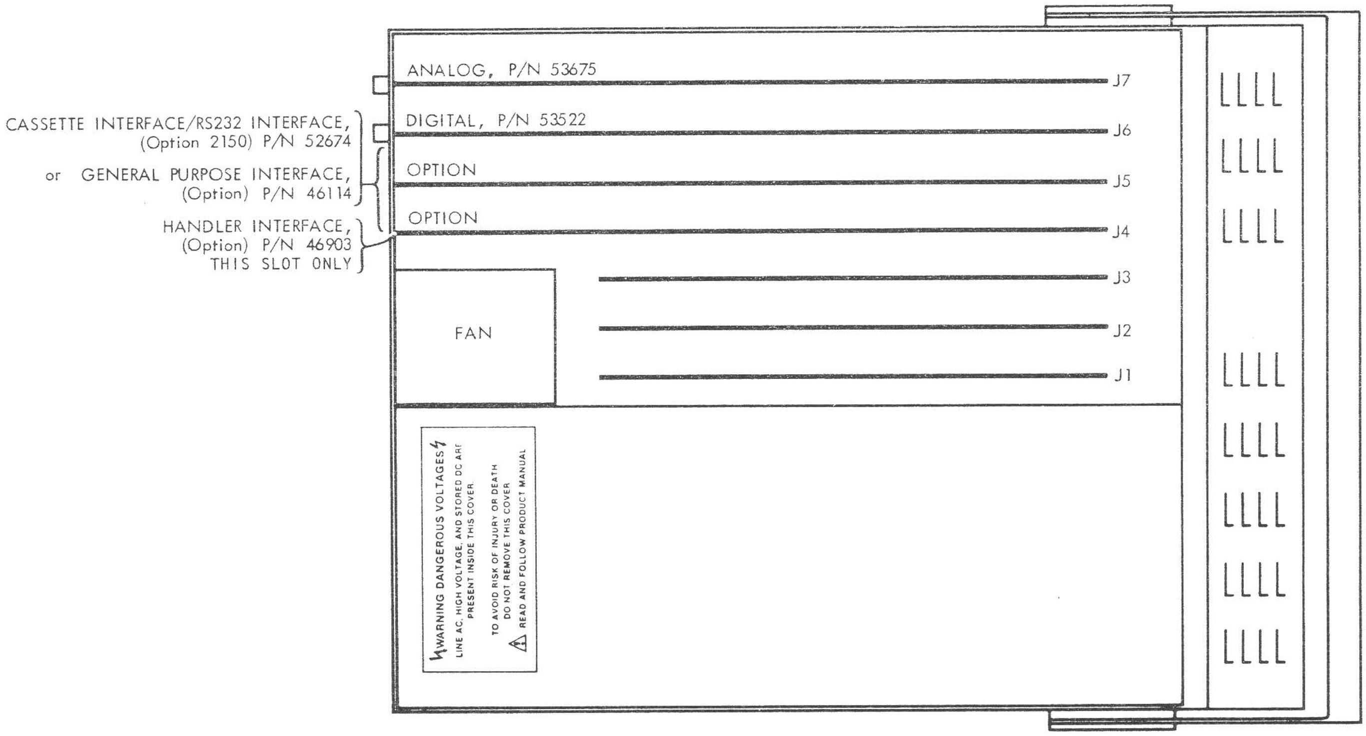
STEP 27. Remove U1 from the Digital circuit assembly, located in J6 of the motherboard.

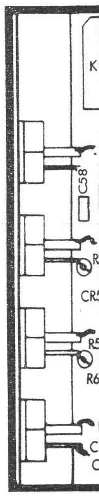
STEP 28. With ohmmeter set to 2MΩ scale, connect one test lead to TP2, the other to Pin 5 of the socket of U1.

STEP 29. Adjust trimmer R1 for a reading of 1.280MΩ, +/- 0.002MΩ.

STEP 30. Disconnect ohmmeter, replace U1. (Take care to observe index orientation and avoid bending the legs of the IC.)

4.2.4 Analog Calibration Summary





SECTION 4.2 STEP NO.	MODEL 2150/2160 SETUP					ADJUSTMENT			
	FUNCTION	MEAS SPEED	FREQ	TEST LEVEL	UNKNOWN VALUE	TRIMMER NO.	CARD P/N	TEST POINT	RESULT
4	L_s, R_s	MED	1 kHz	100 mA	SHORT*	R46	53675	CRT	$\Delta R_s < 200\,\mu\Omega$ **
7	L_s, R_s	MED	100 kHz	100 mA	SHORT*	R45	53675	CRT	$\Delta R_s < 800\,\mu\Omega$ **
9	C_s, D	MED	40 Hz	1000 mV	SHORT / OPEN	—	53675	CRT	Zero Calibration
11	C_s, D	MED	10 kHz	1000 mV	SHORT / OPEN	—	53675	CRT	Zero Calibration
13	C_s, D	MED	50 kHz	1000 mV	SHORT / OPEN	—	53675	CRT	Zero Calibration
15	C_s, D	MED	100 kHz	1000 mV	SHORT / OPEN	—	53675	CRT	Zero Calibration
17	C_s, D	MED	100 kHz	1000 mV	136 nF	R19	53675	CRT	D VALUE ± 0.0005
18	C_s, D	MED	100 kHz	1000 mV	10 nF	R20	53675	CRT	D VALUE ± 0.0003
19	C_s, D	MED	100 kHz	1000 mV	1 nF	R21	53675	CRT	D VALUE ± 0.0003
21	C_s, D	MED	50 kHz	1000 mV	330 pF	R22	53675	CRT	D VALUE ± 0.0002
23	C_s, D	MED	10 kHz	1000 mV	150 pF	R23	53675	CRT	D VALUE ± 0.00010
25	C_s, D	MED	40 Hz	1000 mV	1 µF	R15	53675	CRT	D VALUE ± 0.00010

*Add 1 Ω in series with LO DRIVE (LD) test lead
**$\Delta R_s = R_s(0\,\Omega) - R_s(1\,\Omega)$

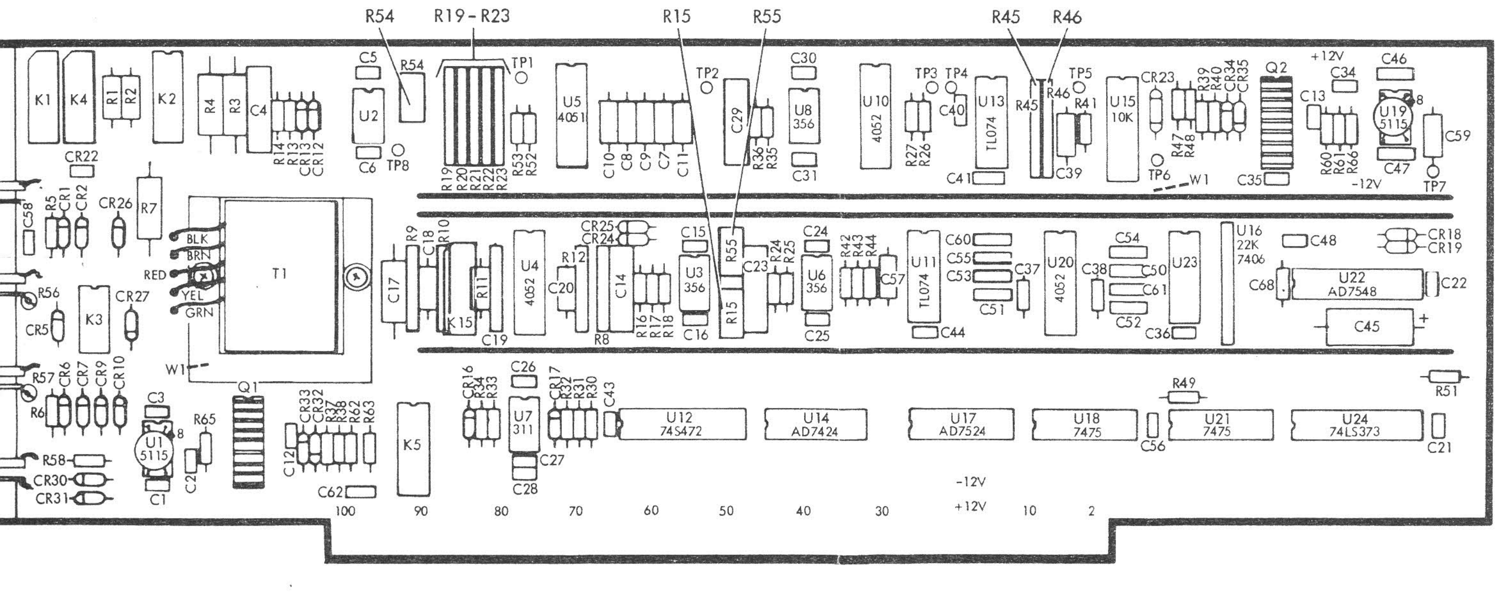


Figure 4-1. Analog Circuit Assembly and Trimmer Locations

4.3 MAINTENANCE

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, and trouble-shooting of the Model 2150/2160.

4.3.1 Preventive Maintenance

WARNING

REMOVAL OF INSTRUMENT COVERS MAY CONSTITUTE AN ELECTRICAL HAZARD AND SHOULD BE ACCOMPLISHED BY QUALIFIED SERVICE PERSONNEL ONLY.

Preventive maintenance performed on a regular basis will improve the reliability of this instrument. It may include cleaning, visual inspection, or even monitoring the operating environment.

4.3.1.1 Cleaning

CAUTION

AVOID THE USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE THE PLASTICS USED IN THIS UNIT. DO NOT APPLY ANY SOLVENT CONTAINING KETONES, ESTERS, OR HALOGENATED HYDROCARBONS (E.G. FREON). TO CLEAN, USE ONLY WATER SOLUBLE DETERGENTS, ETHYL, METHYL, OR ISOPROPYL ALCOHOL.

Exterior. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a cotton-tipped swab, soft, dry cloth, or a cloth dampened with a mild detergent and water.

4.3.1.2 Visual Inspection

This instrument should be inspected occasionally for such defects as broken connections, improperly seated semiconductors, damaged circuit cards, and heat-damaged parts.

The corrective procedure for most visible defects is obvious. If heat damaged components are found, particular care must be taken. Overheating usually indicates other trouble may be present in the instrument. It is important that the cause of overheating be corrected to prevent recurrence of the damage.

4.3.2 Troubleshooting

The following troubleshooting information is provided to augment other sections of this manual. The Circuit Description and Part Lists and Schematic Diagrams sections should be used to full advantage. Section 3 in this manual gives circuit description information while Section 5 contains the part lists and schematic diagrams.

4.3.2.1 Troubleshooting Aids

Schematic Diagrams. Schematic diagrams are provided on foldout pages in Section 5. The electrical value and circuit numbers of each component are shown on the diagrams. Power supply voltages are also shown.

Circuit-Card Illustrations. Illustrations of circuit cards are shown along with the schematic diagrams. Each card-mounted electrical component is identified by its circuit number.

Test Point Locations. Test point locations have been indicated on both the schematic diagrams and the circuit-card illustrations.

Component Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color-coded usually have the value printed on the body.

Multi-pin Connector Identification. Multi-pin connectors are soldered to the circuit cards. They mate with ribbon type cable assemblies to carry signals between cards. Connector pin 1 is indexed with a number 1 etched on the circuit card. Each connector is identified by a P number and can be located by using the circuit card illustration in Section 5 of this manual. P numbers shown on the illustration correspond to the P numbers on the schematic diagrams.

4.3.2.2 Troubleshooting Procedure

WARNING

TO AVOID ELECTRIC SHOCK FROM DANGEROUSLY HIGH VOLTAGES, USE THE FOLLOWING PROCEDURES ONLY WHEN TROUBLESHOOTING THE ANALOG AND DIGITAL MEASUREMENT PORTIONS OF THIS INSTRUMENT. DO NOT USE THIS PROCEDURE TO TROUBLESHOOT THE POWER SUPPLY OR CRT CIRCUITRY.

This troubleshooting procedure checks the simple trouble sources before proceeding with more extensive troubleshooting. The first few checks ensure proper connection and operation. If the trouble is not located by these checks, the remaining steps aid in locating the component. When the defective component is located, it should be replaced using the information given under Corrective Maintenance.

1. **Check Instrument Setup.** Make sure the instrument is properly plugged into a wall socket. Also, check the rear panel line voltage switch and the line fuse to see that they match the line voltage being used.

2. **Visual Check.** Visually check the portion of the instrument in which the trouble is suspected. Many problems can be located by visual indications such as unsoldered connections, broken wires, damaged circuit cards, damaged components, or components bent over and touching.

3. **Check Voltages.** A circuit stage may not be operating due to incorrect supply voltages. Typical supply voltages are given on the diagrams; however, these are not absolute and may vary slightly between instruments.

4. **Trace the Signal.** The analog portion of the circuitry can be checked by tracing the signal with an oscilloscope. By noting where the signal disappears or distorts, the source of trouble can be located.

5. **Check Individual Components.** The following methods are provided for checking the individual components. Components which are soldered in place can sometimes be checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry.

   a. **TRANSISTORS.** It is always best to check transistor operation under operating conditions. Transistors that are soldered to the circuit card should first be checked in-circuit using a dynamic transistor testor; then a replacement can be substituted to verify that the old transistor is bad. Socketed transistors can be checked by substituting a component known to be good; however, be sure that circuit conditions are not such that a replacement might also be damaged. If substitute transistors are not available, check the old transistor out-of-circuit using a dynamic tester. Be sure the power is off before attempting to remove or replace any transistor.

b. **INTEGRATED CIRCUITS.** Analog IC's such as comparators and operational amplifiers can usually be checked in-circuit with a voltmeter or test oscilloscope. An understanding of the device and circuit operation is essential for this type of troubleshooting. (For example, an op amp can be tested by measuring the input and output circuit voltages and comparing this ratio to the ratio of input and feedback resistors.)

Analog IC's that are socketed can also be checked out-of-circuit using a dynamic tester. Digital IC's are best checked in-circuit using a logic probe or voltmeter. Use care when checking voltages and waveforms around DIP (Dual-Inline-Package) IC's so that adjacent leads are not shorted together. A convenient means of connecting a test probe to 14 and 16 pin IC's is with an IC test clip. This device also serves as an extraction tool.

c. **DIODES.** A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter set to the R x 1k scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed.

CAUTION

DO NOT USE AN OHMMETER SCALE THAT HAS A HIGH INTERNAL CURRENT. HIGH CURRENTS MAY DAMAGE THE DIODES UNDER TEST.

d. **RESISTORS.** Check resistors with an ohmmeter. Resistor tolerance is given in the Parts List. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

e. **CAPACITORS.** A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter that will not exceed the voltage rating of the capacitor. (Be careful to observe correct polarity when checking electrolytic capacitors.) The resistance reading should be high after the capacitor has been discharged. An open capacitor can best be detected with an LRC bridge, or by checking whether the capacitance passes AC signals.

4.4 CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair.

4.4.1 Obtaining Replacement Parts

Standard Parts. All electrical and mechanical replacement parts for the Model 2150/2160 can be obtained from Electro Scientific Industries, Inc. However, many of the electronic components can be obtained through local sources. Before purchasing or ordering replacement parts, check the parts list in Section 5 for value, tolerance, rating, and description.

> **NOTE:** When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect the performance of the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Order all special parts directly from Electro Scientific Industries.

4.4.2 VideoBridge - CRT Face Plate Cleaning

The VideoBridge's CRT is protected by a removable face plate. To clean the face plate, use the following procedure.

Face Plate Removal Procedure (Figure 4-2)

STEP 1. Loosen the thumb screw holding the CRT face plate in place by turning it counterclockwise.

STEP 2. Remove the face plate by carefully pivoting it away from the holding slot.

STEP 3. Place the face plate on a non-abrasive cloth for cleaning.

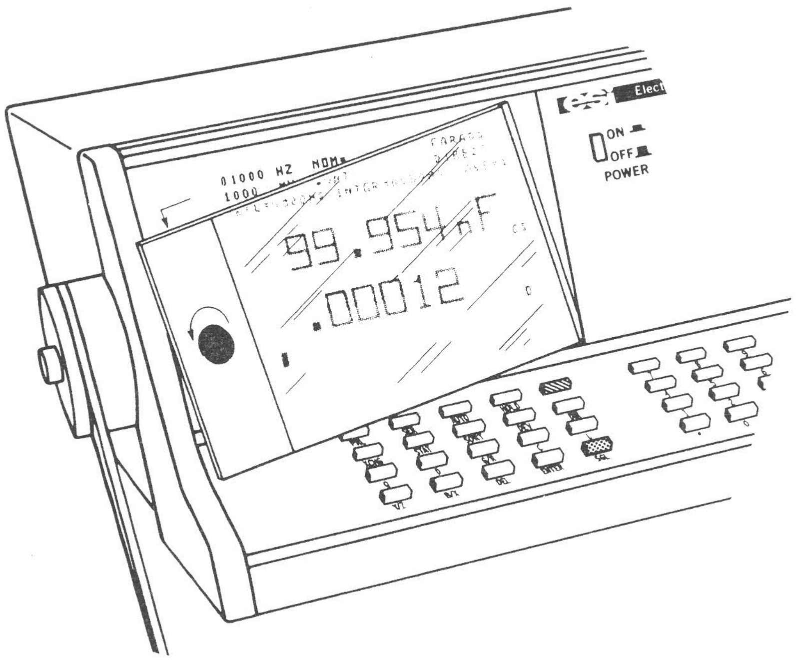


Figure 4-2. Face Plate Removal Procedure

Face Plate Cleaning Procedure

The chromafilter (CRT) surface treatment is impervious to most conventional cleaning agents. To clean, a non-abrasive cloth or paper wipe should be employed with any of the following:

Commercially available window cleaners
Mild detergent
Ammonia and water
Isopropyl Alcohol

NOTE: Do not use acetone or freon.

Face Plate Replacement Procedure

Perform steps 1-3 (above) in reverse order.

4.4.3 VideoBridge - CRT Removal/Replacement

4.4.3.1 CRT Precautions

Handling

The cathode-ray tube (CRT) is very delicate and requires special care when handling. Wear protective safety goggles and clothing when handling the CRT. Avoid striking the CRT against anything that might crack the glass or otherwise cause it to implode.

Storing

Store the CRT in a protective carton whenever possible. If that is not possible, store in a protected location. The storage location should include a soft, smooth surface to protect it against damage or scratching the faceplate.

WARNING

HANDLE THE CRT WITH CARE. ROUGH HANDLING OR SCRATCHING CAN CAUSE THE CRT TO IMPLODE. TO AVOID PERSONAL INJURY FROM IMPLOSION WEAR PROTECTIVE GOGGLES AND CLOTHING WHEN WORKING WITH THE CRT. ONLY WORK WITH THE CRT IF YOU ARE QUALIFIED TO DO SO.

Disposing

Cathode-ray tube disposal requires special precautions be taken. A CRT can be extremely dangerous. Do not dispose of the CRT by putting it in the garbage; it could cause physical injury. To properly dispose of the CRT, save and re-use the package in which the replacement CRT was shipped. If the original packaging is unfit for use or not available, repackage the CRT as follows:

STEP 1. Obtain a carton of corrugated cardboard having inside dimensions of not less than six inches more than the CRT dimensions; this will allow for cushioning.

STEP 2. Surround the unit with polyethylene sheeting to protect the CRT.

STEP 3. Cushion the CRT on all sides by tightly packing dunnage of urethane foam between the carton and the CRT allowing three inches on all sides.

STEP 4. Seal the carton with shipping tape or an industrial stapler.

STEP 5. Send the CRT to the location from which the new CRT was obtained.

WARNING

THE CRT IS CAPABLE OF STORING A HIGH VOLTAGE CHARGE AFTER POWER HAS BEEN REMOVED. TO PREVENT PERSONAL INJURY FROM ELECTRIC SHOCK, USE AN OSHA OR UL APPROVED SHORTING STRAP TO DISCHARGE ALL HIGH VOLTAGE POINTS TO CHASSIS GROUND. THIS PROCEDURE MUST BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

4.4.3.2 CRT Removal/Replacement Procedure

STEP 1. Instrument Preparation. Turn instrument power OFF and remove all external connections.

STEP 2. Outer Cover. Remove the five rear panel 8 x 32 screws holding the outer cover and slide cover off.

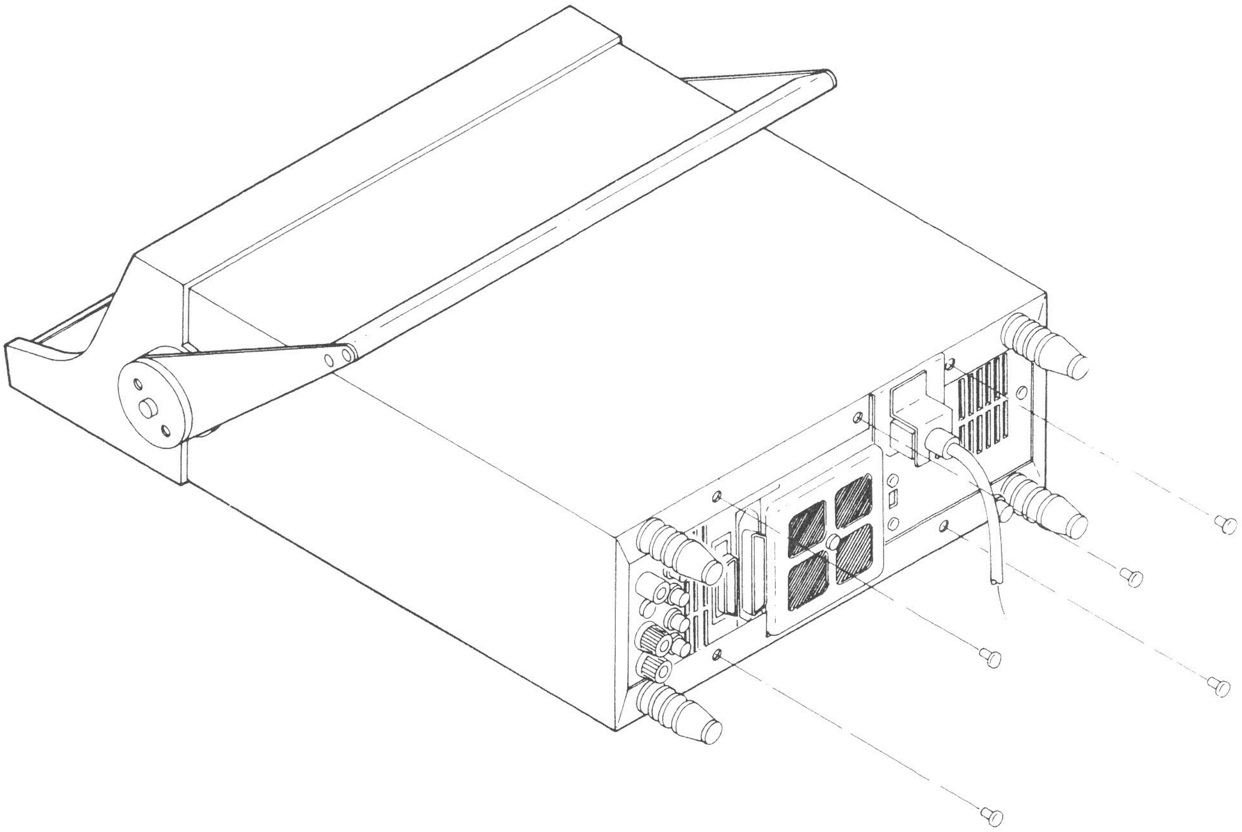
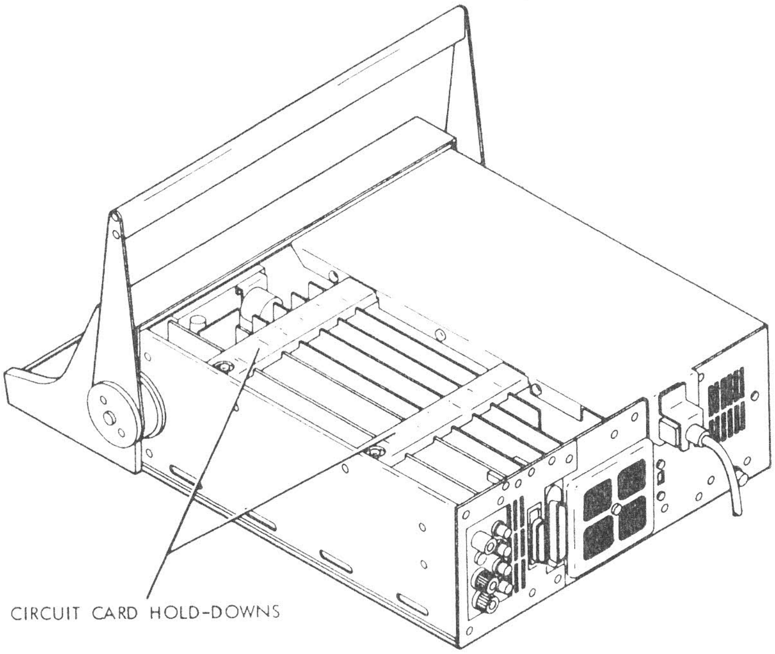
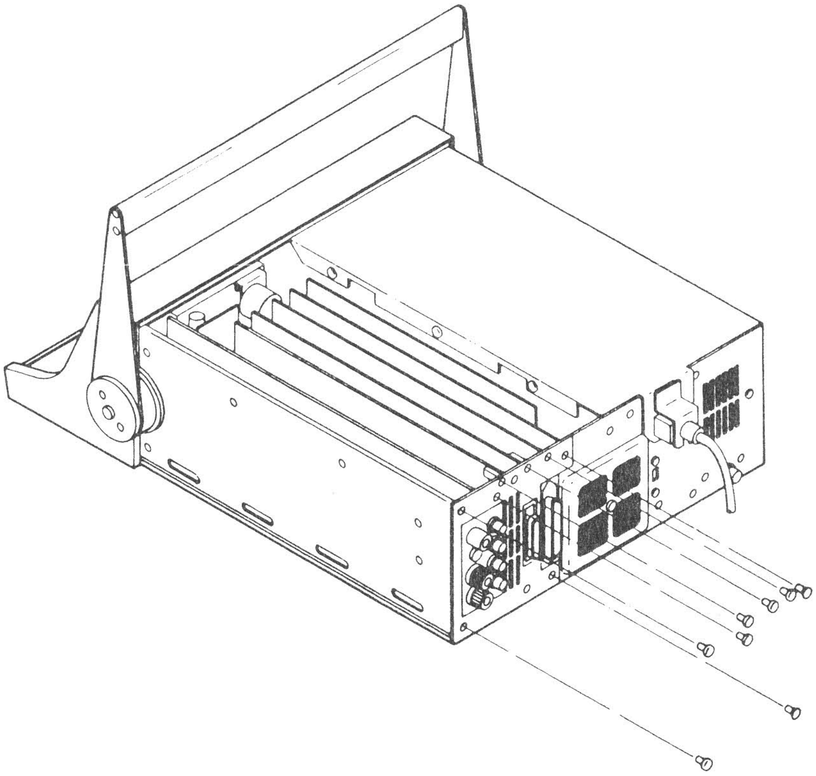


Figure 4-3. Model 2160 Rear View

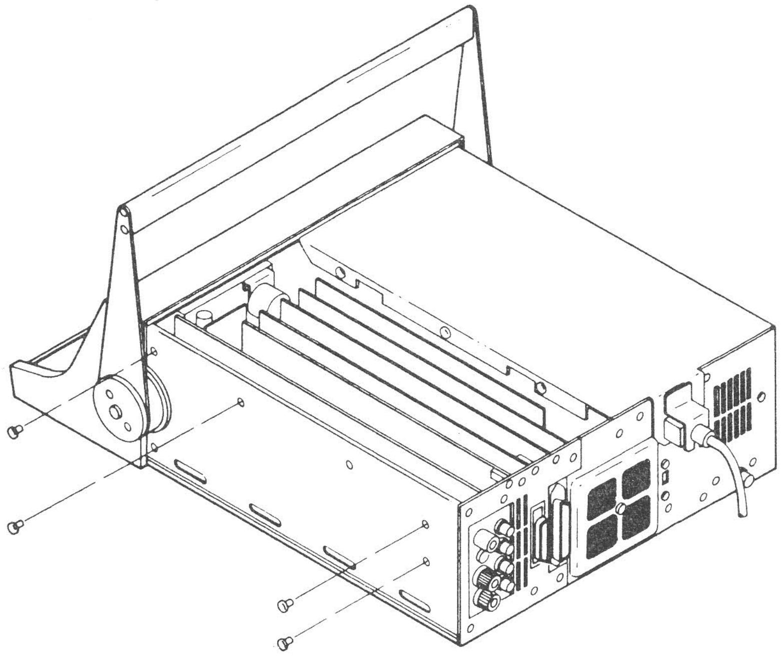
STEP 3. Circuit Card Hold-Downs. Remove the screws securing the two plastic circuit card hold-downs and remove.



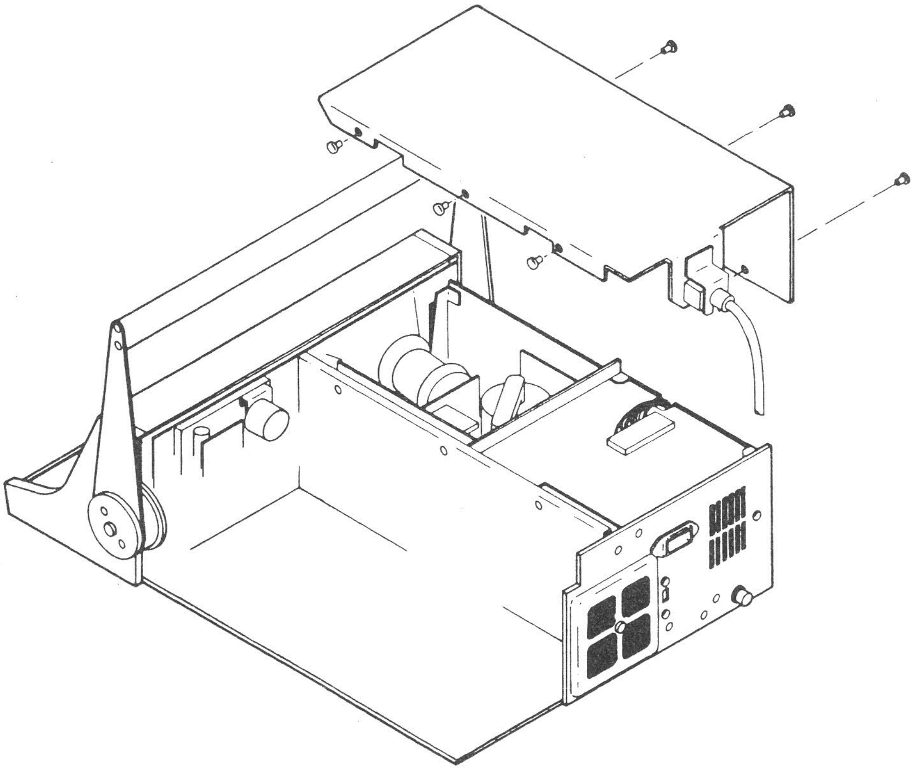
STEP 4. Rear Panel (left side). Remove the eight screws holding the rear panel (left side).



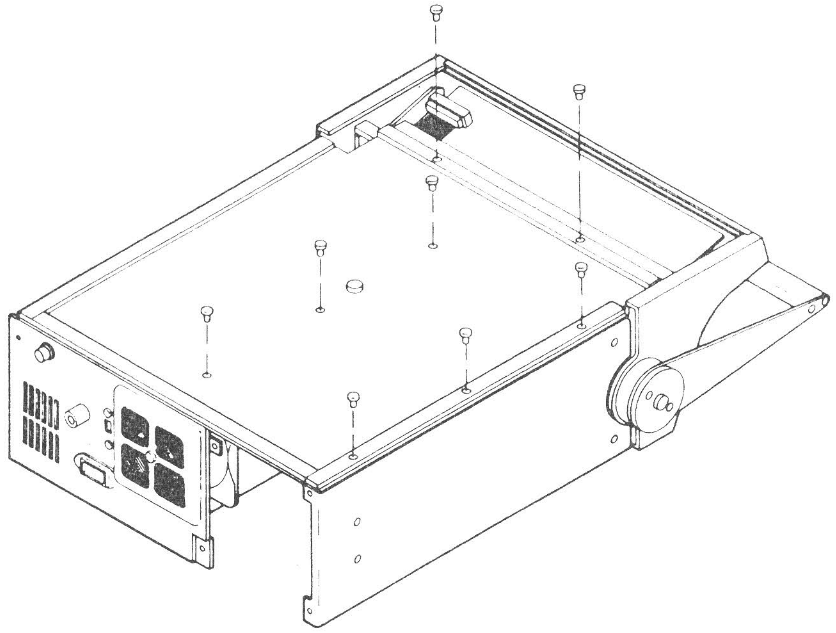
STEP 5. Circuit Assemblies. Remove four screws located on instruments left side. Remove all circuit assemblies.



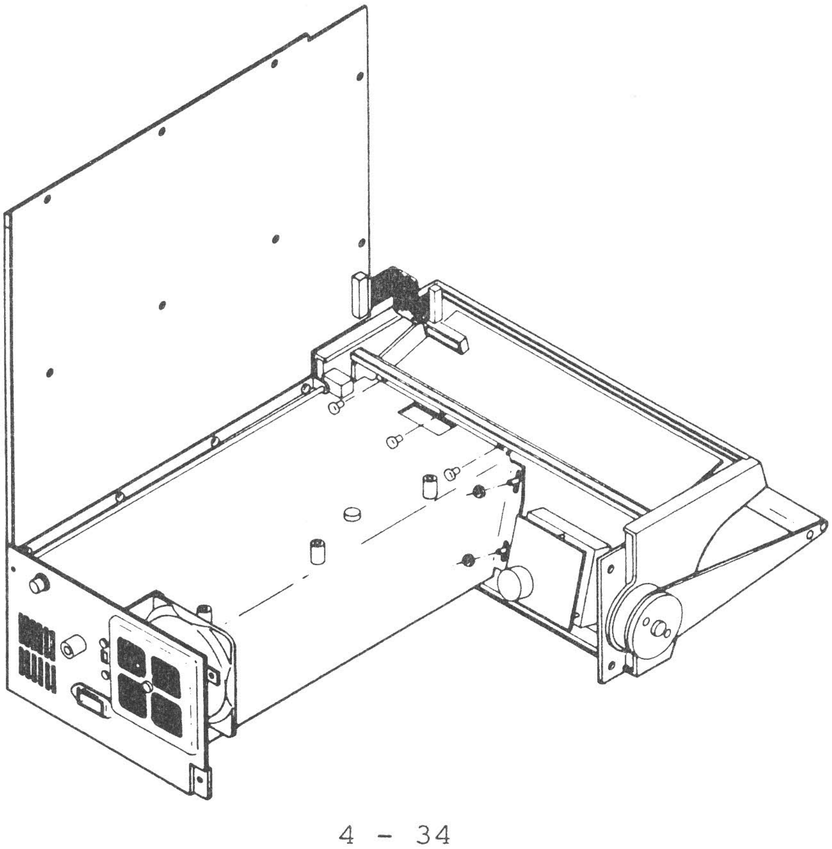
STEP 6. CRT Enclosure Cover. Remove the six screws securing the CRT enclosure cover. Remove this cover by sliding toward the back of the instrument until the power cord plug clears the instrument's power receptacle, then lift upwards.



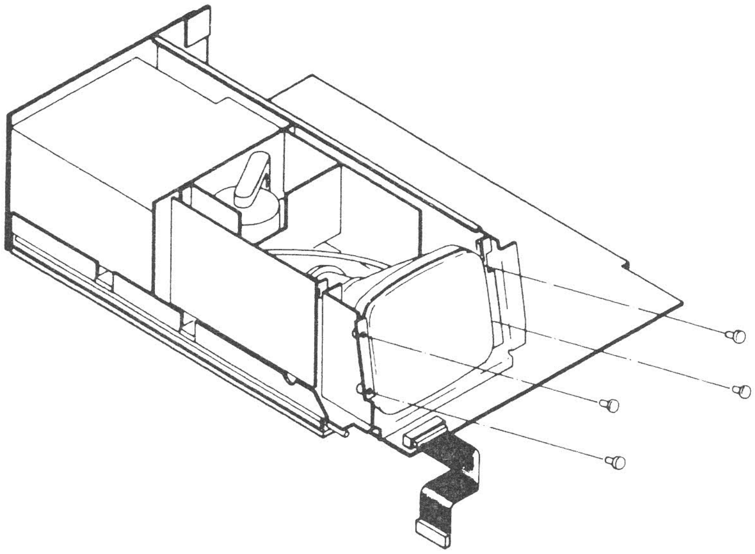
STEP 7. Motherboard. Turn instrument over to rest top-side down. Remove the eight screws, unplug the keyboard, and hinge the motherboard out of the way.



STEP 8. Front Panel. Remove the three screws and two nuts holding the VideoBridge front panel to the CRT enclosure. Set the front panel off to the side.



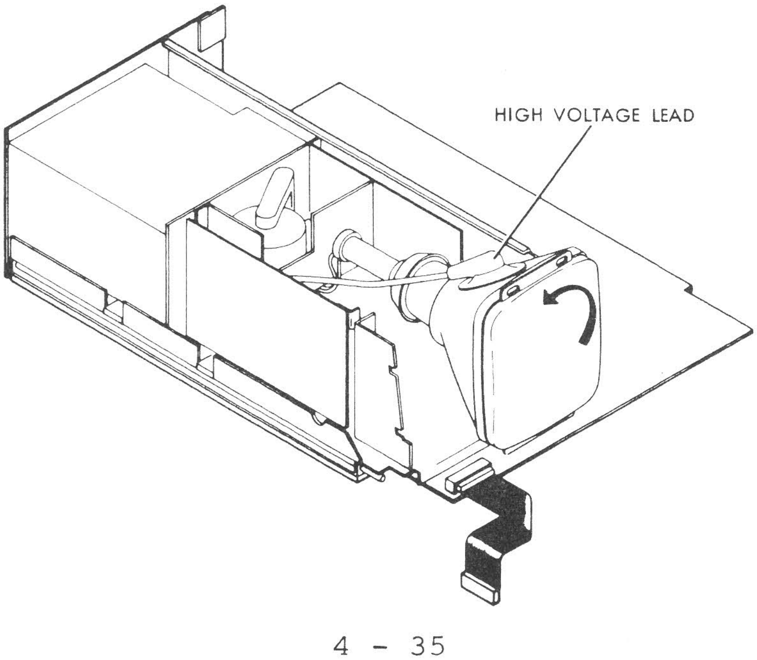
STEP 9. Cathode-Ray Tube. Turn instrument right-side up. Remove the four screws holding the CRT (2 on each side).



STEP 10. High Voltage Plug. Rotate the CRT counter-clockwise until the High Voltage anode lead is facing up. Remove the High voltage lead.

WARNING

HANDLE THE CRT WITH CARE. ROUGH HANDLING OR SCRATCHING CAN CAUSE THE CRT TO IMPLODE. TO AVOID PERSONAL INJURY FROM IMPLOSION WEAR PROTECTIVE GOGGLES AND CLOTHING WHEN WORKING WITH THE CRT. ONLY WORK WITH THE CRT IF YOU ARE QUALIFIED TO DO SO.



STEP 11a. Cathode-Ray Tube Rear Connector. Carefully pull the CRT out approximately 2 inches or until the rear plug can be removed.

OR

STEP 11b. Cathode-Ray Tube Rear Connector. Unplug the CRT connector from the Deflection circuit card.

STEP 12. To install a new CRT reverse the above procedure, carefully observing all caution notices.

4.4.4 Component Replacement

WARNING

DISCONNECT ALL POWER TO THE INSTRUMENT BEFORE REPLACING COMPONENTS. FAILURE TO DO SO MAY RESULT IN ELECTRICAL SHOCK.

Semiconductor Replacement. Replacement semiconductors should be of the original type or a direct replacement. If the replacement semiconductor is not of the original type, check the manufacturer's basing diagram for proper lead identification.

Free Standing Components. When replacing any components that are free-standing (not directly mounted to circuit cards), be sure to place the new components in the same physical location and position as the old components. If this is not done, there may be a possibility of components touching and causing a short circuit.

4.5 REPACKAGING FOR SHIPMENT

If the Model 2150/2160 is to be shipped back to ESI for service or repair, contact the factory (Instruments Business Unit Repair) and ask for an RMA # for the instrument. Before returning the unit, attach a tag showing:

owner and the name of an individual at your firm that can be contacted

address

RMA # (Return of Material Authorization)

complete instrument serial number

a description of the service required

Save and re-use the package in which your instrument was shipped. This package was especially designed for the 2150/2160 to protect the instrument should the package fall or be dropped. If the original package is unfit for use or is not available, contact ESI for instructions.