MAINTENANCE

This section of the manual contains information for conducting preventive maintenance, troubleshooting, and corrective maintenance on the 2235 Oscilloscope.

STATIC-SENSITIVE COMPONENTS

The following precautions are applicable when performing any maintenance involving internal access to the instrument.

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. Table 6-1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

When performing maintenance observe the following precautions to avoid component damage:

1. Minimize handling of static-sensitive components.

2. Transport and store static-sensitive components or assemblies in their original containers or on a metal rail. Label any package that contains static-sensitive components or assemblies.

3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these components. Servicing static-sensitive components or assemblies should be performed only at a static-free work station by qualified service personnel.

4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.

5. Keep the component leads shorted together whenever possible.

6. Pick up components by their bodies, never by their leads.

Table 6-1
Susceptibility to Static Discharge Damage

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a]Voltage equivalent for levels: (Voltage discharged from a 100 pF capacitor through a resistance of 100 Ω.)

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V(est.)
2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
3 = 250 V 6 = 600 to 800 V 9 = 1200 V

7. Do not slide the components over any surface.

8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.

9. Use a soldering iron that is connected to earth ground.

10. Use only approved antistatic, vacuum-type desoldering tools for component removal.

PREVENTIVE MAINTENANCE

INTRODUCTION

Preventive maintenance consists of cleaning, visual inspection, lubrication, and checking instrument performance. When accomplished regularly, it may prevent instrument malfunction and enhance instrument reliability. The severity of the environment in which the instrument is used determines the required frequency of maintenance. An appropriate time to accomplish preventive maintenance is just before instrument adjustment.

GENERAL CARE

The cabinet minimizes accumulation of dust inside the instrument and should normally be in place when operating the oscilloscope. The optional front-panel cover provides both dust and damage protection for the front panel and crt face, and it should be in place whenever the instrument is stored or is being transported.

INSPECTION AND CLEANING

The instrument should be visually inspected and cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket, preventing efficient heat dissipation. It also provides an electrical conduction path that could result in instrument failure, especially under high-humidity conditions.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use a nonresidue-type cleaner, preferably isopropyl alcohol, denatured ethyl alcohol, or a solution of 5% mild detergent with 95% water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Exterior

INSPECTION. Inspect the external portion of the instrument for damage, wear, and missing parts; use Table 6-2 as a guide. Instruments that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance. Deficiencies found that could cause personal injury or could lead to further damage to the instrument should be repaired immediately.

CAUTION

To prevent getting moisture inside the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

CLEANING. Loose dust on the outside of the instrument can be removed with a soft cloth or small soft-bristle brush. The brush in particularly useful for dislodging dirt on and around the controls and connectors. Dirt that remains can be removed with a soft cloth dampened in a mild detergent-and-water solution. Do not use abrasive cleaners. Clean the light filter and the crt face with a soft lint-free cloth dampened with either denatured alcohol or a mild detergent-and-water solution.

Interior

To gain access to internal portions of the instrument for inspection and cleaning, refer to the "Removal and Replacement Instructions" in the "Corrective Maintenance" part of this section.

INSPECTION. Inspect the internal portions of the instrument for damage and wear, using Table 6-3 as a guide. Deficiencies found should be repaired immediately. The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

Table 6-2
External Inspection Checklist

Item	Inspect For	Repair Action
Cabinet and Front Panel	Cracks, scratches, deformations, and damaged hardware or gaskets.	Touch up paint and replace defective parts.
Front-panel Controls	Missing, damaged, or loose knobs, buttons, and controls.	Repair or replace missing or defective items.
Connectors	Broken shells, cracked insulation, and deformed contacts. Dirt in connectors.	Replace defective parts. Clean or wash out dirt.
Carrying Handle	Correct operation.	Replace defective parts.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items, frayed cables, and defective parts.

Table 6-3
Internal Inspection Checklist

Item	Inspect For	Repair Action
Circuit Boards	Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating.	Clean solder corrosion with an eraser and flush with isopropyl alcohol. Resolder defective connections. Determine cause of burned items and repair. Repair defective circuit runs.
Resistors	Burned, cracked, broken, or blistered.	Replace defective resistors. Check for cause of burned component and repair as necessary.
Solder Connections	Cold solder or rosin joints.	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Replace defective capacitors. Clean solder connections and flush with isopropyl alcohol.
Wiring and Cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace defective wires or cables.
Chassis	Dents, deformations, and damaged hardware.	Straighten, repair, or replace defective hardware.

If any electrical component is replaced, conduct a Performance Check of the affected circuit and of other closely related circuit (see Section 4). If repair or replacement work is done on any of the power supplies, conduct a complete Performance Check and, if so indicated, an instrument readjustment (see Section 5).

CAUTION

To prevent damage from electrical arcing, ensure that circuit boards and components are dry before applying power to the instrument.

CLEANING. To clean the interior, blow off dust with dry, low-pressure air (approximately 9 psi). Remove any remaining dust with a soft brush or a cloth dampened with a solution of mild detergent and water. A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.

If these methods do not remove all the dust or dirt, the instrument may be spray washed using a solution of 5% mild detergent and 95% water as follows:

1. Gain access to the parts to be cleaned (see "Removal and Replacement Instructions").

2. Spray wash dirty parts with the detergent-and-water solution; then use clean water to thoroughly rinse them.

3. Dry all parts with low-pressure air.

SWITCH CONTACTS. The VOLTS/DIV and THE SEC/DIV Switches are mounted circuit-boards within the instrument. Care must be exercised to preserve the high-frequency characteristics of these switches. Switch maintenance is seldom necessary, but if it is required, observe the following precautions.

1. The VOLTS/DIV switches contain cam-actuated contacts.

CAUTION

Most spray-type circuit coolants contain Freon 12 as a propellant. Because many Freons adversely affect switch contacts, do not use a spray-type coolants.

The only recommended circuit coolants for the volts-division attenuators are dry ice (CO) and isopropyl alcohol.

a. Use only isopropyl alcohol as a cleaning solution, especially in the area of the vertical Attenuator circuit board. Carbon-based solvents will damage the board material.

b. Apply the alcohol with a small, camel-hair brush. Do not use cotton-tipped applicators when cleaning contacts.

2. The SEC/DIV switch is comprised of rotary-activated contacts.

CAUTION

Use only hot deionized or distilled water, 55°C (131°F), to clean the timing switch in this instrument. Tap water contains impurities which are left as residuals after evaporation.

a. Spray hot water into the slots at the top of each switch housing while rotating the switch control knob. Spray only for approximately five seconds, using an atomizing spray device.

b. Dry both the switch and the circuit board on which it is mounted, using dry low-pressure air.

c. Bake the switch and the circuit board in an oven at 75°C (167°F) for 15 minutes to eliminate all moisture.

d. Spray a very small amount (only about a 1/2-second squirt) of a recommended lubricant, such as No Noise, into the slots at the top of the switch housing.

e. Rotate the switch control knob about 180° and again spray a very small amount of lubricant into each slot.

LUBRICATION

Most of the potentiometers used in this instrument are permanently sealed and generally do not require periodic lubrication. All switches, both rotary- and lever-type, are installed with proper lubrication applied where necessary and will rarely require any additional lubrication. Therefore, a regular periodic lubrication program for the instrument is not recommended.

SEMICONDUCTOR CHECKS

Periodic checks of the transistors and other semiconductors in the oscilloscope are not recommended. The best check of semi-conductor performance is actual operation in the instrument.

PERIODIC READJUSTMENT

To ensure accurate measurements, check the performance of this instrument after every 2000 hours of operation, or if used infrequently, once each year. In addition, replacement of components may necessitate readjustment of the affected circuits.

Complete Performance Check and Adjustment instructions are given in Sections 4 and 5. The Performance Check Procedure can also be helpful in localizing certain trouble in the instrument. In some cases, minor problems may be revealed or corrected by readjustment. If only a partial adjustment is performed, see the interaction chart, Table 5-1, for possible adjustment interactions with other circuits.

TROUBLESHOOTING

INTRODUCTION

Preventive maintenance performed on a regular basis should reveal most potential problems before an instrument malfunctions. However, should troubleshooting be required, the following information is provided to facilitate location of a fault. In addition, the material presented in the "Theory of Operation" and the "Diagrams" sections of this manual may be helpful while troubleshooting.

TROUBLESHOOTING AIDS

Schematic Diagrams

Complete schematic diagrams are located on tabbed foldout pages in the "Diagrams" section. The portions of circuitry that are mounted on each circuit board are enclosed within heavy black lines. Also within the black lines, near either the top or the bottom edge, are the assembly number and name of the circuit board.

Component numbers and electrical values of components in this instrument are shown on the schematic diagrams. Refer to the first page of the "Diagrams" section for definitions of the reference designators and symbols used to identify components.

Circuit Board Illustrations

Circuit board illustrations (showing the physical location of each component) are provided for use in conjunction with each schematic diagram. Each board illustration can be found on the back side of a foldout page, preceding the schematic diagram(s) to which it relates. If more than one schematic diagram is associated with a particular circuit board, the board illustration is located on a left-hand page preceding the diagram with which the board is first associated.

Also provided in the "Diagrams" section is an illustration of the bottom side of the Main circuit board. This drawing facilitates troubleshooting by showing the connection pads and the location of components that are mounted on the top side of the board. Probing of Main board component signals that are inaccessible from the top side can be achieved without the necessity of disassembling portions of the instrument.

Waveform test-point locations are also identified on the circuit board illustration by hexagonal-outlined numbers that correspond to the waveform numbers appearing on both the schematic diagram and the waveform illustration.

Circuit Board Locations

An illustration depicting the location of a circuit board within the instrument is shown on the foldout page adjacent to the circuit board illustration.

Circuit Board Interconnection Diagram

A circuit board cable distribution diagram and connector-pin locator table is provided in the "Diagrams" section to aid in tracing a signal path or power source between boards. All wires, plug and jack numbers are shown along with wire or pin numbers.

Power Distribution Diagram

A Power Distribution diagram 8 is provided to aid in troubleshooting power-supply problems. This diagram shows service jumpers used to remove power from the various circuit boards. Excessive loading on a power supply by a circuit board can be isolated to the faulty board by disconnecting appropriate service jumpers.

Grid Coordinate System

Each schematic diagram and circuit board illustration has a grid border along its left and top edges. A table located adjacent to each schematic diagram lists the grid coordinates of each component shown on that schematic. To aid in physically locating a component on the respective circuit board, this table also lists the circuit-board grid coordinate of each component.

Adjacent to each circuit board illustration is an alphanumeric listing of every component mounted on that board. A second column in this listing identifies the schematic diagram in which each component can be found. These component-locator tables are especially useful when more than one schematic diagram is associated with a particular circuit board.

Troubleshooting Charts

The troubleshooting charts contained in the "Diagrams" section are to be used as an aid in locating malfunctioning circuitry. To use the charts, begin with the Troubleshooting Guide. This chart will help identify a particular problem area for further troubleshooting.

Note that some troubleshooting-procedure boxes on each chart contain numbers along their lower edges. These numbers identify the applicable schematic diagram(s) to be used when performing the action specified in the box.

Both General and Specific notes may be called out in the troubleshooting-chart boxes. These notes are located on the inner panels of the foldout pages. Specific Notes contain procedures or additional information to be used in performing the particular troubleshooting step called for in that box. General Notes contain information that pertains to the overall troubleshooting procedure.

Some malfunctions, especially those involving multiple simultaneous failures, may require more elaborate troubleshooting approaches with references to circuit descriptions in the "Theory or Operation" section of this manual.

Component Color Coding

Information regarding color codes and markings of resistors and capacitors is located in the color-coding illustration (Figure 9-1) at the beginning of the "Diagrams" section.

RESISTOR COLOR CODE. Resistors used in this instrument are carbon-film, composition, or precision metal-film types. They are color coded with the EIA color code; however, some metal-film resistors may have the value printed on the body. The color code is interpreted by starting with the strip that is nearest to one end of the resistor. Composition resistors have four stripes; these represent two significant figures, a multiplier, and a tolerance value. Metal-film resistors have five stripes which represent three significant figures, a multiplier, and a tolerance value.

CAPACITOR MARKINGS. Capacitance values of common disc capacitors and small electrolytics are marked on the side of the capacitor body. White ceramic capacitors are color code in picofarads, using a modified EIA code.

Dipped tantalum capacitors are color coded in microfarads. The color dot indicates both the positive lead and the voltage rating. Since these capacitors are easily destroyed by reversed or excessive voltage, be careful to observe the polarity and voltage rating.

DIODE COLOR CODE. The cathode end of each glass-encased diode is indicated by either a stripe, a series of stripes, or a dot. For most silicon or germanium diodes marked with a series of stripes, the color combination of the stripes identifies three digits of the Tektronix Part Number, using the resistor color-code system (e.g., a diode having either a pink or a blue strip at the cathode end, then a brown-gray-green stripe combination, indicates Tektronix Part Number 152-0185-00). The cathode and anode ends of a metal-encased diode can be identified by the diode symbol marked on its body.

Semiconductor Lead Configurations

Figure 9-2 in the "Diagrams" section shows the lead configurations for semiconductor devices used in the instrument. These lead configurations and case styles are typical of those available at completion of the design of the instrument. Vendor changes and performance improvement changes may result in changes of case styles or lead configurations. If the device in question does not appear to match the configuration in Figure 9-2, examine the associated circuitry or consult a semiconductor manufacturer's data sheet.

Multipin Connectors

Multipin connector orientation is indicated by two triangles: one on the holder and one on the circuit board. Slot numbers are usually molded into the holder. When a connection is made to circuit-board pins, ensure that the triangle on the holder and the triangle on the circuit board are aligned with each other (see Figure 6-1).

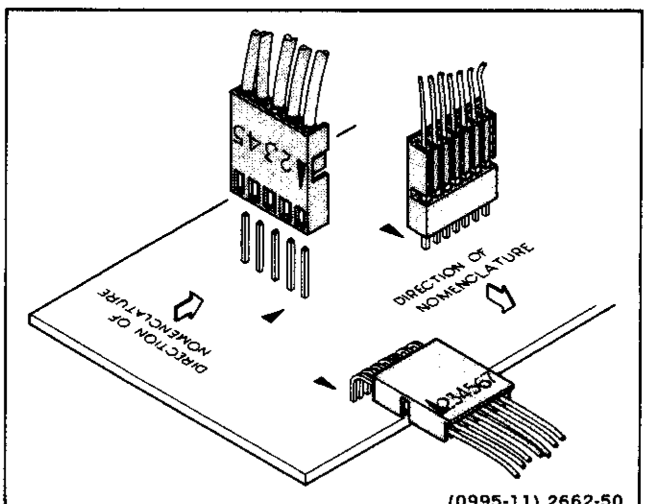

Figure 6-1. Multi-connector holder orientation.

TROUBLESHOOTING EQUIPMENT

The equipment listed in Table 4-1, or equivalent equipment, may be useful when troubleshooting this instrument.

TROUBLESHOOTING TECHNIQUE

The following procedure is arranged in an order that enables checking simple trouble possibilities before requiring more extensive troubleshooting. The first four checks ensure proper control settings, connections, operation, and adjustment. If the trouble is not located by these checks, the remaining steps will aid in locating the defective component. When the defective component is located, replace it, using the appropriate replacement procedure given under "Corrective Maintenance" in this section.

CAUTION

Before using any test equipment to make measurements on static-sensitive, current-sensitive, or voltage-sensitive components or assemblies, ensure that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

1. Check Control Settings

Incorrect control settings can give a false indication of instrument malfunction. If there is any question about the correct function or operation of any control, refer to either the "Operating Instructions" (Section 2) in this manual or to the instrument Operators Manual.

2. Check Associated Equipment

Before proceeding, ensure that any equipment used with this instrument is operating correctly. Verify that input signals are properly connected and that the interconnecting cables are not defective. Check the power-input-source voltages.

WARNING

To avoid electrical shock, disconnect the instrument from the power-input source before performing visual inspection.

3. Visual Check

Perform a visual inspection. This check may reveal broken connections or wires, damaged components, semiconductors not firmly mounted, damaged circuit boards, or other clues.

WARNING

Dangerous potentials exist at several points throughout this instrument. If it is operated with the cabinet removed, do not touch exposed connections or components.

4. Check Instrument Performance and Adjustment

Check the performance of either of those circuits where trouble appears to exist or the entire instrument. The apparent trouble may only be the result of misadjustment. Complete performance check and adjustment instructions are given in Sections 4 and 5 of this manual.

5. Isolate Trouble to a Circuit

To isolate problems to a particular area, use the trouble symptom to help identify the circuit in which the trouble is located. Refer to the troubleshooting charts in the "Diagrams" section as an aid in locating a faulty circuit.

6. Check Power Supplies

WARNING

For safety reasons an isolation transformer must be connected whenever troubleshooting is done in the Preregulator and the Inverter Power Supply sections.

Check the power supplies whenever trouble symptoms appear in more than one circuit. The correct output voltage and ripple for each supply should be measured between the supply test point and chassis ground (see Table 6-4 and associated circuit board illustration). Voltages may be measured either by an DMM or an oscilloscope, while the ripple measurements are accomplished only with an oscilloscope. Before checking power-supply circuitry set the A INTENSITY control to minimum brightness and the A SEC/DIV switch to X-Y mode.

When measuring ripple, use a 1X probe with a bayonet signal tip attached to the probe tip to minimize stray pickup.

Insert the bayonet signal tip to the first test point indicated in Table 6-4 and touch the bayonet ground tip to the chassis ground near the test point. The ripple values listed in Table 6-4 are based on a system limited in bandwidth to 30 kHz (greater bandwidth will result in higher readings).

If power supply voltages and ripple are within the listed ranges, the supply can be assumed to be operating correctly. If any are outside these ranges, the supply may be either misadjusted or operating incorrectly. Use the "Power Supply, Display, and Z-Axis" section in the "Adjustment" procedure to adjust the −8.6 V supply.

A defective component elsewhere in the instrument can create the appearance of a power-supply problem and may also affect the operation of other circuits.

Table 6-4
Power Supply Limits and Ripple

Power Supply	Test Point	Reading (Volts)	P-P Ripple (mV)
−8.6 V	TP961	−8.56 to −8.64	1.5
+5.2 V	W968	+5.04 to +5.36	3.0
+8.6 V	W960	+8.43 to +8.77	1.5
+30 V	W956	+29.1 to +30.9	20.0
+100 V	W954	+97.0 to +103.0	40.0

7. Check Circuit Board Interconnections

After the trouble has been isolated to a particular circuit, again check for loose or broken connections and heat-damaged components.

8. Check Voltages and Waveforms

Often the defective component can be located by checking the appropriate voltage or waveform in the circuit. Typical voltages are listed on the schematic diagrams. Waveforms are shown adjacent to the schematics, and waveform test points are indicated on both the schematics and circuit board illustrations by hexagonal-outlined numbers.

NOTE

Voltages and waveforms given on the schematic diagrams are not absolute and may vary slightly between instruments. To establish operating conditions similar to those used to obtain these readings, see the "Voltage and Waveform Setup" conditions in the "Diagrams" section for the preliminary equipment setup. Note the recommended test equipment, initial front-panel control settings, and cable-connection instructions. The control-setting changes (from initial setup) required to obtain the given waveforms and voltages are located on the waveform-diagram page.

WARNING

To avoid electric shock, always disconnect the instrument from the power input source before removing or replacing components.

9. Check Individual Components

The following procedures describe methods of checking individual components. Two-lead components that are soldered in place are most accurately checked by first disconnecting one end from the circuit board. This isolates the measurement from the effects of surrounding circuitry. See Figure 9-1 for value identification or Figure 9-2 for typical semiconductor lead configuration.

CAUTION

When checking semiconductors, observe the static-sensitive precautions located at the beginning of this section.

TRANSISTORS. A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a known good component. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

When troubleshooting transistors in the circuit with a voltmeter, measure both the emitter-to-base and emitter-to-collector voltages to determine whether they are consistent with normal circuit voltages. Voltages across a transistor may vary with the type of device and its circuit function.

Some of these voltage are predictable. The emitter-to-base voltage for a conducting silicon transistor will normally range from 0.6 to 0.8 V. The emitter-to-collector voltage for a saturated transistor is about 0.2 V. Because these values are small, the best way to check them is by connecting a sensitive voltmeter across the junction rather than comparing two voltages taken with respect to ground. If the former method is used, both leads of the voltmeter must be isolated from ground.

If values less than these are obtained, either the device is shorted or no current is flowing in the external circuit. If values exceed the emitter-to-base values given, either the junction is reverse biased or the device is defective. Voltages exceeding those given for typical emitter-to-collector values could indicate either a nonsaturated device operating normally or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across the resistors in series with it; if it is open, no voltage will be developed across the resistors in series with it, unless current is being supplied by a parallel path.

CAUTION

When checking emitter-to-base junctions, do not use an ohmmeter range that has either a high internal current or voltage. High current or high voltage can damage the transistor. Reverse biasing the emitter-to-base junction with a high current may degrade the transistor's current-transfer ratio (Beta).

A transistor emitter-to-base junction also can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The junction resistance should be very high in one direction and very low when the meter leads are reversed.

When troubleshooting a field-effect transistor, the voltage across its elements can be checked in the same manner as previously described for other transistors. However, remember that in the normal depletion mode of operation, the gate-to-source junction is reverse biased; in the enhanced mode, the junction is forward biased.

INTEGRATED CIRCUITS. An integrated circuit (IC) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential to troubleshooting a circuit having an IC. Use care when checking voltages and waveforms around the IC so that adjacent leads are not shorted together. The grabber tip or an IC test clip provides a convenient means of clipping a test probe to an IC.

CAUTION

When checking a diode, do not use an ohmmeter range that has a high internal current. High current can damage the diode. Checks on diodes can be performed in much the same manner as on transistor emitter-to-base junctions; use a dynamic tester, such as the TEKTRONIX 576 Curve Tracer.

DIODES. A diode can be checked for either an open or a shorted condition by measuring the resistance between terminals with an ohmmeter set to a range having a low internal source current, such as the R X 1 kΩ range. The diode resistance should be very high in one direction and very low when the meter leads are reversed.

When conducting, silicon diodes should have 0.6 to 0.8 V across their junctions, and schottky diodes should have 0.2 to 0.4 V across their junctions. Higher readings indicate that they are either reverse biased or defective, depending on polarity.

RESISTORS. Check resistors with an ohmmeter. Refer to the "Replaceable Electrical parts" list for the tolerances of resistors used in this instrument. A resistor normally does not require replacement unless its measured value varies widely from its specified value and tolerance.

INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit.

CAPACITORS. A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter set to one of the highest ranges. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after the capacitor is charged to the output voltage of the ohmmeter. An open capacitor can be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

10. Repair and Adjust the Circuit

If any defective parts are located, follow the replacement procedures given under "Corrective Maintenance" in this section. After any electrical component has been replaced, the performance for that particular circuit should be checked, as well as the performance of other closely related circuits. Since the power supplies affect all circuits, performance of the entire instrument should be checked if work has been done in any of the power supplies or if the power transformer has been replaced. Readjustment of the affected circuitry may be necessary. Refer to the "Performance Check Procedure" and "Adjustment Procedure" (Sections 4 and 5) and to Table 5-1 (Adjustment Interactions).

CORRECTIVE MAINTENANCE

INTRODUCTION

Corrective maintenance consists of component replacement and instrument repair. This part of the manual describes special techniques and procedures required to replace components in this instrument. If it is necessary to ship your instrument to a Tektronix Service Center for repair or service, refer to the "Repackaging for Shipment" instructions at the end of this section.

MAINTENANCE PRECAUTIONS

To reduce the possibility of personal injury or instrument damage, observe the following precautions.

1. Disconnect the instrument from the ac power input source before removing or installing components.

2. Use care not to interconnect instrument grounds which may be at difference potentials (cross grounding).

OBTAINING REPLACEMENT PARTS

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can usually be obtained from a local commercial source. Before purchasing or ordering a part from a source other than Tektronix, Inc., please check the "Replaceable Electrical Parts" list (Section 7) for the proper value, rating, tolerance, and description.

NOTE

Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts

In addition to the standard electronic components, some special parts are used in this instrument. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. The various manufacturers can be identified by referring to the "Cross Index-Mfr Code Number to Manufacturer" at the beginning of the "Replaceable Electrical Parts" list. Most of the mechanical parts used in this instrument were manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., be sure to include all of the following information:

1. Instrument type (include modification or option numbers).

2. Instrument serial number.

3. A description of the part (if electrical, include its component number).

4. Tektronix part number.

MAINTENANCE AIDS

The maintenance aids listed in Table 6-5 include items required for performing most of the maintenance procedures on this instrument. Equivalent product may be substituted for the examples given, provided their characteristics are similar.

INTERCONNECTIONS

Pin connectors are used to connect wires to the interconnecting pins. They are grouped together and mounted in a plastic holder and should be removed, reinstalled, or replaced as a unit. If an individual wire or connector in the assembly is faulty, the entire cable assembly should be replaced. To provide correct orientation of this multipin connector when it is reconnected to its mating pins, an arrow is stamped on the circuit board, and a matching arrow is molded into the plastic housing of the multipin connector. Be sure these arrows are aligned with each other when the multipin connector is reinstalled.

NOTE

The individual wires on the Front Panel & Filter circuit boards to the Main circuit board may be replaced individually. The pins from the Alternate SYNC Board may also be replaced individually.

Table 6-5
Maintenance Aids

Description	Specifications	Usage	Example
1. Soldering Iron	15 to 25 W.	General soldering and unsoldering.	Antex Precision Model C.
2. Torx Screwdrivers	Torx tips #T7, #T9, #T10, #T15 and #T20.	Assembly and disassembly.	Tektronix Part Numbers (#T7) 003-1293-00 (#T9) 003-0965-00 (#T10) 003-0814-00 (#T15) 003-0966-00 (#T20) 003-0866-00
3. Nutdrivers	1/4 inch, 5/16 inch, 1/2 inch, and 9/16 inch	Assembly and disassembly.	Xcelite #8, #10, #16, and #18.
4. Open-end wrench	9/16 inch	Assembly and disassembly.	
5. Hex Wrenches	0.050 inch and 1/16 inch.	Assembly and disassembly	Allen Wrenches
6. Long-nose Pliers		Component removal and replacement.	
7. Diagonal Cutters		Component removal and replacement.	
8. Vacuum Solder Extractor	No static charge retention	Unsoldering components.	Pace Model PC-10.
9. Lubricant	No-Noise.	Switch lubrication.	Tektronix Part Number 006-0442-02.
10. Pin-replacement kit		Replace circuit board connector pins.	Tektronix Part Number 040-0542-00.
11. Isolation Transformer		Isolate the instrument from the ac-power-source outlet.	Tektronix Part Number 006-5953-00.
12. 1X Probe		Power supply ripple check.	TEKTRONIX P6101 Probe (1X). Part Number 010-6101-03.
13. Bayonet Ground Assembly		Signal interconnection.	Tektronix Part Number 013-0085-00.

TRANSISTORS AND INTEGRATED CIRCUITS

Transistors and integrated circuits should not be replaced unless they are actually defective. If unsoldered from the circuit board during routine maintenance, return them to their original board locations. Unnecessary replacement or transposing of semiconductor devices may affect the adjustment of the instrument. When a semiconductor is replaced, check the performance of any instrument circuit that may be affected.

Any replacement components should be of the original type or a direct replacement. Bend transistor leads to fit their circuit board holes and cut the leads to the same length as the original component. See Figure 9-2 for typical lead-configuration illustrations.

To remove a soldered dual-in-line packaged (DIP) IC, do not heat adjacent conductors consecutively. Apply heat to pins at alternate sides and ends of the IC as solder is removed. Allow a moment for the circuit board to cool before proceeding to the next pin.

The heat-sink-mounted power supply transistors are insulated from the heat sink. In addition, a heat-sink compound is used to increase heat transfer capabilities. Reinstall the insulators and replace the heat-sink compound when replacing these transistors. The compound should be applied to both sides of the insulators and should be applied to the bottom side of the transistor where it comes in contact with the insulator.

NOTE

After replacing a power transistor, check that the collector is not shorted to the heat sink before applying power to the instrument.

SOLDERING TECHNIQUES

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used to remove or replace parts. General soldering techniques, which apply to maintenance of any precision electronic equipment, should be used when working on this instrument.

WARNING

To avoid an electric-shock hazard, observe the following precautions before attempting any soldering: turn the instrument off, disconnect if from the ac power source, and allow approximately three minutes for the power-supply capacitors to discharge.

Use rosin-core wire solder containing 63% tin and 37% lead. Contact your local Tektronix Field Office or representative to obtain the names of approved solder types.

When soldering on circuit boards or small insulated wires, use only a 15- to 25-watt, pencil-type soldering iron. A higher wattage soldering iron can cause etched circuit conductors to separate from the board base material and melt the insulation on small wires. Always keep the soldering-iron tip properly tinned to ensure best heat transfer from the iron tip to the solder joint. To protect heat-sensitive components, either hold the component lead with long-nose pliers or place a heat block between the component body and the solder joint. Apply only enough solder to make a firm joint. after soldering, clean the area around the solder connection with an approved flux-removing solvent (such as isopropyl alcohol) and allow it to air dry.

CAUTION

Attempts to unsolder, remove, and resolder leads from the component side of a circuit board may cause damage to the reverse side of the circuit board.

The following techniques should be used to replace a component on any of the circuit boards:

1. Touch the vacuum desoldering tool to the lead at the solder connection. Never place the iron directly on the board; doing this may damage the board.

NOTE

Some components are difficult to remove from the circuit board due to a bend placed in each lead during machine insertion of the component. The purpose of the bent leads is to hold the component in place during a solder-flow manufacturing process that solders all the components at once. To make removal of machine-inserted components easier, straighten the component leads on the reverse side of the circuit board with a small screwdriver or pliers. It may be necessary to remove the circuit board to gain access to the component leads on the reverse side of the circuit board. Circuit-board removal and reinstallation procedures are discussed later in this section.

2. When removing a multipin component, especially an IC, do not heat adjacent pins consecutively. Apply heat to pins at alternate sides and ends of the IC as solder is removed. Allow a moment for the circuit board to cool before proceed to the next pin.

CAUTION

Excessive heat can cause the etched circuit conductors to separate from the circuit board. Never allow the solder extractor tip to remain at one place on the board for more than three seconds. Solder wick, spring-actuated or squeeze-bulb solder suckers, and heat blocks (for desoldering multipin components) must not be used. Damage caused by poor soldering techniques can void the instrument warranty.

3. To replace the component, bend the leads of the replacement item to fit the holes in the circuit board. If the component is replaced while the board is installed in the instrument, cut the leads so they protrude only a small amount through the reverse side of the circuit board. Excess lead length may cause shorting to other conductive parts.

4. Insert the leads into the holes of the board so that the replacement component is positioned the same as the original component. Most components should be firmly seated against the circuit board.

5. Touch the soldering iron to the connection and apply enough solder to make a firm solder joint. Do not move the component while the solder hardens.

6. Cut off any excess lead protruding through the circuit board (if not clipped to size in step 3).

7. Clean the area around the solder connection with an approved flux-removing solvent. Be careful not to remove any of the printed information from the circuit board.

REMOVAL AND REPLACEMENT INSTRUCTIONS

The exploded view drawings in the "Replaceable Mechanical Parts" list (Section 9) may be helpful during the removal and reinstallation of individual subassemblies or components. Circuit board and component locations are shown in the "Diagrams" section.

Cabinet

WARNING

To avoid electric shock, disconnect the instrument from the ac-power-input source before removing or replacing any component or assembly.

To remove the instrument cabinet, perform the following steps:

1. Disconnect the power cord from the instrument. For instruments with a power-cord securing clamp; remove the Phillips-head screw holding the power-cord securing clamp before disconnecting the power cord.

2. Remove the screw from the right-rear side of the cabinet and two screws from the rear panel. Then remove the rear panel.

3. Pull the front panel and attached chassis forward and out of the cabinet.

To reinstall the cabinet, perform the following steps:

4. Slide the chassis frame into the cabinet from the front until the cabinet is fully into the front-panel groove and the rear of the cabinet is flush with the rear of the chassis.

5. Align the rear-panel and the side mounting holes with the screw holes in the chassis frame and reinstall the three screws removed in step 2.

CAUTION

To ensure that the cabinet is grounded to the instrument chassis, the screw at the right rear side of the cabinet must be tightly secured.

6. Reconnect the power cord (reinstall the securing clamp and screw removed in step 1 if applicable).

Cathode-Ray Tube

WARNING

Use care when handling a crt. Breakage of the crt may cause high-velocity scattering of glass fragments (implosion). Protective clothing and safety glasses should be worn. Avoid striking the crt on any object which may cause it to crack or implode. When storing a crt, either place it in a protective carton or set it face down on a smooth surface in a protected location with a soft mat under the faceplate.

To remove the crt, perform the following steps:

1. Disconnect four deflection-plate wires at the middle of the crt neck and unplug the Trace Rotation connector (P9006) from the Front-Panel circuit board (note the connection locations and wire colors for reinstallation reference).

WARNING

The crt anode lead and the High-Voltage Multiplier output lead retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, disconnect the High-Voltage Multiplier lead from the crt anode lead and ground both leads to the main instrument chassis.

2. Unplug the crt anode lead connector from the High-Voltage Multiplier lead located on left side of Power-Supply shield and discharge it to the chassis.

3. Remove two front panel screws that retain the plastic crt frame and light filter to the front panel. Remove the crt frame and light filter from the instrument.

4. With the rear of the instrument facing you, place the fingers of both hands over the front edge of the front subpanel. Then, using both thumbs, press forward gently on the crt funnel near the front of the crt. When the crt base pins disengage from the socket, remove the crt and the crt shield through the instrument front subpanel. Place the crt in a safe place until it is ready to reinstall. If the plastic crt corner pads fall out, save them for reinstallation.

5. Remove the crt socket cover and cap from the rear of the crt socket for reinstallation.

To reinstall the crt, perform the following steps:

6. Reinstall any plastic crt corner pads that are out of place. Insert the crt, crt shield, anode lead, and Trace Rotation leads through the front-panel opening. Make sure all pins are straight and that the indexing keys on the crt base, socket, and shield are aligned. Make sure that the ground clip makes contact only with the outside of the crt shield.

7. Push the crt base into the socket. Verify that the crt base and socket are flush together as viewed from the rear and that the crt is seated properly in the front-panel opening.

8. Reinstall the crt socket cap and cover to the rear of the crt socket (removed in step 5).

9. Reinstall the crt frame and light filter; then secure them with two front panel screws (removed in step 3).

10. Reconnect the crt anode lead to the High-Voltage Multiplier (disconnected in step 2).

11. Reconnect the four deflection-plate wires and the Trace Rotation connector (disconnected in step 1).

Power-Supply Shield

To remove the Power-Supply shield, perform the following steps:

1. Remove the screw from the plastic power-supply cover on the bottom section of the Main circuit board. Press gently on the rear of the cover and slide it forward.

2. Remove the screw securing the Power-Supply shield to the Main circuit board (located at the bottom of the circuit board near the middle right side of the frame).

3. Remove two screws securing the left rear of the Power-Supply shield to the back of the chassis frame.

4. Remove the crt anode lead from the anode clip on the side of the Power-Supply shield.

5. Remove the screw from the front upper right-hand corner of the Power-Supply shield.

6. Lift the shield up and out of the chassis frame by removing the right rear corner first.

To reinstall the Power-Supply shield, perform the following steps:

7. Insert the shield into the chassis frame. Make sure that the shield's right and back edges are in their chassis frame guides, that the crt socket-wire assembly is in its cutout, and that the Alt Sweep board is in its plastic holder.

8. Reinstall the screw at the upper right-hand corner of the shield (removed in step 5).

9. Reinstall the crt anode lead into the anode clip on the side of the Power-Supply shield (removed in step 4).

10. Reinstall two screws securing the shield to the back of the chassis frame (removed in step 3).

11. Reinstall the screw holding the shield to the Main circuit board at the right side of the frame (removed in step 2).

12. Reinstall the plastic power-supply cover on the bottom of the Main circuit board and secure both the shield and the cover with one screw (removed in step 1).

Filter Circuit Board

To remove the Filter circuit board, perform the following steps.

1. Remove the Power-Supply shield (see the "Power-Supply Shield" removal procedure).

2. Remove the five wires to the Filter circuit board by unsoldering two wires from the Main circuit board, two from the line filter, and one wire from the fuse holder (pull the protective cap completely off the fuse holder before unsoldering).

3. Remove two screws securing the Filter circuit board to the back of the chassis frame. Lift the Filter circuit board out of the instrument.

To reinstall the Filter circuit board, perform the following steps.

4. Reinstall two screws securing the Filter circuit board to the back of the chassis frame (removed in step 3).

5. Resolder the five wires from the Filter circuit board to the Main circuit board, line filter, and fuse holder (unsoldered in step 2).

6. Reinstall the Power-Supply shield (see the "Power-Supply Shield" reinstallation procedure).

Alt Sweep Circuit Board

To remove the Alt Sweep circuit board, perform the following steps:

1. Use a vacuum-desoldering tool to unsolder the 27 pins (between the Alt Sweep circuit board and the Main circuit board) from the Main circuit board.

2. Remove the Alt Sweep circuit board from the instrument by unclipping it from the plastic holder attached to the Power-Supply shield.

To reinstall the Alt Sweep circuit board, perform the following steps:

3. Insert the 27 pins of the Alt Sweep circuit board into the Main circuit board.

4. Reinstall the Alt Sweep circuit board into the plastic holder attached to the Power-Supply shield.

5. Resolder the 27 pins to the Main circuit board (unsoldered in step 1).

Attenuator Circuit Board

To remove the Attenuator circuit board, perform the following steps:

1. Use a 1/16-inch Hex-key wrench to loosen the set screws on both the CH 1 and the CH 2 VOLTS/DIV Variable knobs and remove the knobs.

2. Set the CH 1 and the CH 2 VOLTS/DIV switches to the same position. Note switch positions for reinstallation reference; then remove the knobs by pulling them straight out from the front panel.

3. Place the instrument on its side and remove two screws securing the Attenuator board to the subpanel (located underneath the CH 1 and CH 2 input connectors).

4. Unsolder the resistors from the CH 1 and CH 2 input connectors.

5. Remove the following connectors from the Attenuator circuit board, noting their locations for reinstallation reference:

   a. P9103, a four-wire connector located behind the CH 1 VOLTS/DIV switch assembly.

   b. P9108, a four-wire connector located behind the CH 2 VOLTS/DIV switch assembly.

   c. P9091, a three-wire connector located between the Channel 1 and Channel 2 Variable potentiometers at the rear of the Attenuator circuit board.

6. Remove four screws securing the Top shield to both the Attenuator circuit board and the bottom shield.

7. Remove two screws and the ground strap from the rear of the Attenuator circuit board.

8. Pull the Attenuator board straight back from the front of the instrument until the circuit board interconnecting pins are disengaged and the switch shafts are clear of both the Front-Panel circuit board and the two AC-GND-DC switch shafts (located between the front-panel and the subpanel.

To reinstall the Attenuator circuit board, perform the following steps:

9. Insert the two VOLTS/DIV switch shafts and the AC-GND-DC switch shafts into the front panel holes. Ensure that the interconnecting pins are aligned with the Front-Pan-

el circuit board connectors and that the two resistors (soldered to the bottom of the Attenuator circuit board) do not touch the Front-Panel circuit board. Push the Attenuator circuit board forward and, at the same time press the front end of the board down slightly. Align the two AC-GND-DC switch shafts with the front-panel holes by moving either the Channel 1 or the Channel 2 AC-GND-DC switch knob.

10. Reinstall two screws and ground strap to the rear of the Attenuator circuit board (removed in step 7).

11. Replace the top shield and reinstall the four screws and ground strap from the rear of the attenuator board to the top shield (removed in step 6).

12. Reconnect three connectors to the Attenuator circuit board disconnected in step 5.

13. Place the instrument on its side and reinstall two screws to the subpanel (removed in step 4).

14. Resolder the resistors to the CH 1 and CH 2 input connectors (disconnected in step 3).

15. Reinstall the two VOLTS/DIV knobs at the positions noted in step 2.

16. Rotate the two Variable control shafts fully clockwise to their calibrated detent positions.

17. Reinstall the Variable knobs onto their shafts (with lettering horizontal and right-side up) and tighten the set screws.

Timing Circuit Board

To remove the Timing circuit board, perform the following steps.

1. Use a 1/16-inch Hex-key wrench to loosen the set screw of the SEC/DIV Variable knob.

2. Lock the A and B SEC/DIV knobs together and note the position for reinstallation reference. Use a 1/4-inch nut driver to remove the nut securing the B SEC/DIV knob; pull off the knob and collet from the shaft assembly.

3. Use a 1/16-inch Hex-key wrench to loosen two set screws securing the A SEC/DIV dial to the shaft assembly.

4. Remove the following connectors from the Timing circuit board.

   a. P9705, an eight-wire connector located at the rear of the Timing circuit board.

   b. P9700, a 10-wire connector located on the right edge of the Timing circuit board.

5. Remove one screw at the rear of the Attenuator circuit board (securing both the Attenuator and the Timing circuit boards to the Bottom shield).

6. Remove the remaining three screws securing the Timing circuit board to the Bottom shield.

7. Pull the Timing circuit board straight back from the front of the instrument until the circuit board interconnecting pins are disengaged and the switch shaft is clear of the Front-Panel circuit board.

To reinstall the Timing circuit board, perform the following steps:

8. Insert the SEC/DIV switch shaft through the hole in the Front-Panel circuit board, ensuring that the interconnecting pins are aligned with the Front-Panel connectors. Push the Timing circuit board forward into position.

9. Reinstall three screws securing the Timing circuit board to the bottom shield (removed in step 6).

10. Reinstall the remaining screw at the rear of the Attenuator circuit board securing both the Attenuator and the Timing circuit boards to the bottom shield (removed in step 5).

11. Reconnect two connectors to the Timing circuit board (disconnected in step 4).

12. Reinstall the A SEC/DIV dial in the position noted in step 3 and secure it with two set screws.

13. Reinstall the collet and the B SEC/DIV knob at the position noted in step 2 and secure it with the nut.

14. Reinstall the SEC/DIV Variable knob onto its shaft (with lettering horizontal and right-side up) and tighten the set screw.

Bottom Shield, Attenuator and Timing Circuit-Board Module

Removal of the module consisting of the Bottom shield and the Attenuator and Timing circuit boards is accomplished by the following steps:

1. Perform steps 1 through 5 under the "Attenuator Circuit Board" removal procedure.

2. Perform steps 1 through 4 under the "Timing Circuit Board" removal.

3. Place the instrument on its side and remove four screws holding the Bottom shield to the Main circuit board.

4. Pull the Bottom shield, along with the Attenuator and Timing circuit boards straight back from the front of the instrument until the interconnecting pins on both circuit boards are disengaged and the switch shafts are clear of the holes in the Front-Panel circuit board; then lift out the entire assembly through the top of the instrument.

5. If accessibility to the bottom of either the Attenuator or the Timing circuit board is desired refer to steps 6 and 7 of the "Attenuator Circuit Board" removal procedure and to steps 5 and 6 of the "Timing Circuit Board" removal procedure.

To reinstall the Bottom shield-Attenuator-Timing assembly, perform the following steps:

6. If one or both of the circuit boards was removed, reinstall the circuit board(s) to the Bottom shield by referring to steps 10 and 11 of the "Attenuator Circuit Board" reinstallation procedure and to steps 9 and 10 of the "Timing Circuit Board" reinstallation procedure.

7. Insert the three switch shafts through the holes in both the Front-Panel circuit board and the front panel (refer to the "Attenuator Circuit Board" and the "Timing Circuit Board" reinstallation procedures).

8. Reinstall the four screws holding the Bottom shield to the Main circuit board (removed in step 3).

9. Complete reinstallation of the module by performing steps 12 through 17 of the "Attenuator Circuit Board" reinstallation procedure and steps 11 through 14 of the "Timing Circuit Board" reinstallation procedure.

Front-Panel Circuit Board

1. Remove the crt (see the "Cathode-Ray Tube" removal procedure).

2. Remove the Bottom shield, Attenuator, and Timing circuit-board module (see the preceding removal procedure).

3. Remove the knobs from the following control shafts by pulling them straight out from the front panel:

   a. Channel 1 and Channel 2 POSITION,

   b. A/B SWP SEP,

   c. Horizontal POSITION,

   d. A TRIGGER LEVEL,

   e. B TRIGGER LEVEL.

4. Unsolder both the resistor to the EXT INPUT center connector and the wire strap to the EXT INPUT ground lug.

5. Unsolder the single wire from the PROBE ADJUST connector and the two wires from the VAR HOLDOFF control (leading to the Front-Panel circuit board).

6. Remove the following screws:

   a. Three screws securing the upper part of the Front-Panel circuit board to the front panel.

   b. Two recessed frame-securing screws at the left-rear corner of the chassis frame.

   c. Two screws holding the Main circuit board to the chassis frame.

   d. One screw securing the delay line to the chassis frame on the left side of the instrument.

   e. Two recessed frame-securing screws at the right front corner.

7. Pull the front-left frame assembly apart from the rear-right frame assembly.

NOTE

At this point, any component on the Front-Panel circuit board may be accessed for removal and replacement. Skip to step 11 of this procedure after component replacement. If circuit board replacement is intended, continue with the remaining disassembly steps.

8. Use a vacuum-desoldering tool to unsolder the 39 wire straps from the Main circuit board (connecting to the Front-Panel circuit board).

9. Remove the Front-Panel circuit board from the instrument and clean the wire-strap holes on the Main circuit board of any remaining solder.

NOTE

If a vacuum-desoldering tool is not available, lift each strap out of the Main circuit board as the joint is heated.

To reinstall the Front-Panel circuit board, perform the following steps:

10. Insert and resolder the 39 wire straps on the Front-Panel circuit board into their corresponding holes in the Main circuit board (unsoldered in step 8).

11. Align the two chassis frame assemblies disassembled in step 7, making sure the POWER switch extension-shaft button is properly placed in the front panel.

12. Reinstall four chassis-frame securing screws, two screws securing the Main circuit board to the chassis frame, and one screw securing the delay line to the chassis frame (removed in step 6, parts b through e).

13. Push the Front-Panel circuit board forward and insert the control shafts, push buttons, and three-position slide switches into their corresponding front-panel holes.

14. Reinstall three screws securing the Front-Panel circuit board to the front-panel (removed in step 6, part a).

15. Resolder the single wire to the PROBE ADJUST connector and the two wires to the VAR HOLDOFF control (unsoldered in step 5).

16. Resolder the resistor to the EXT INPUT center connector and the wire strap to the EXT INPUT ground lug (unsoldered in step 4).

17. Replace the front-panel knobs (removed in step 3).

18. Reinstall the Bottom shield, Attenuator, and Timing circuit-board module (see the preceding reinstallation procedure).

19. Reinstall the crt (see the "Cathode-Ray Tube" reinstallation procedure).

Main Circuit Board

All components on the Main circuit board are accessible either directly or by removing either the crt, the Bottom shield, Attenuator, Timing circuit-board module, or the Power-Supply shield. Removal of the Main circuit board is required only when it is necessary to replace the board with a new one.

To remove the Main circuit board, perform the following steps:

1. Disconnect the three-wire B DELAY TIME POSITION potentiometer connector (P4644) from the Main circuit board (located in front of the Power-Supply shield).

2. Remove the Alt Sweep circuit board (see "Alt Sweep Circuit Board" removal procedure).

3. Remove the Power-Supply shield and plastic power-supply cover (see "Power-Supply Shield" removal procedure).

4. Unsolder five wires from the Filter circuit board (leading to the Main circuit board).

5. Remove connectors from the Attenuator and Timing circuit boards, noting their locations for reinstallation reference.

6. Remove the FOCUS control shaft assembly by pulling it straight out from the front panel.

7. Remove the POWER switch extension-shaft assembly by first pressing in the POWER button to the ON position. Then insert a scribe (or similar tool) into the notch between the end of the switch shaft and the end of the extension shaft and gently pry the connection apart. Push the extension shaft forward, then sideways, to clear the switch shaft. Finally, pull the extension shaft back and out of the instrument.

8. Disconnect P9001 and P9002 from the rear of the Main circuit board near the fuse holder.

9. Unsolder the rear-panel EXT Z AXIS connector wire from the Main circuit board.

10. Remove two screws securing the power-supply transistor heat-sink assembly (at the right side of the chassis frame.

WARNING

The crt anode lead and the output terminal to the High-Voltage Multiplier will retain a high-voltage charge after the instrument is turned off. To avoid electrical shock, ground the crt side of the anode lead to the main instrument chassis.

11. Disconnect the crt anode lead from the High-Voltage Multiplier anode lead by carefully pulling the anode plug out of the jack. Discharge the plug tip to the chassis.

12. Unsolder two sets of crt socket wires from the Main circuit board, noting wire color and position for reinstallation reference.

13. Unsolder two sets of delay-line wires from the Main circuit board, noting wire color and position for reinstallation reference.

14. Remove three screws securing the Bottom shield to the Main circuit board.

15. Remove three screws securing the Main circuit board to the instrument chassis frame (one under the EXT Z AXIS connector and two along the left side of the Main circuit board).

16. Use a vacuum-desoldering tool to unsolder the 39 wire straps (connecting the Main circuit board to the Front-Panel circuit board) from the Main circuit board.

NOTE

If a vacuum-desoldering tool is not available, lift each wire strap out of the Main circuit board as the joint is heated. Use care to maintain, as nearly as possible, the original shape and spacing of the wire straps to facilitate replacing the circuit board.

17. Push the wire-strap connection end of the Main circuit board down until it is clear of all wire strap ends; then remove it through the bottom of the instrument frame. Ensure that the wire straps are not bent out of place.

To replace the Main circuit board, use the following procedure:

18. Place the Main circuit board into the chassis frame, ensuring that the board is in the guides at the rear and right side of the frame and that the 39 wire straps are inserted into their corresponding holes.

19. Reinstall three screws securing the Main circuit board to the chassis frame (removed in step 15).

20. Resolder 39 wire straps to the Main circuit board.

21. Reinstall three screws holding the bottom shield to the Main circuit board (removed in step 14).

22. Resolder two sets of delay-line wires at the locations noted in step 13.

23. Resolder two sets of crt socket wires at the locations noted in step 12.

24. Reconnect the crt anode lead to the High-Voltage Multiplier anode lead (disconnect in step 11).

25. Reinstall two securing screws in the power-supply transistor heat sink assembly (removed in step 10).

26. Insert and resolder the EXT Z AXIS connector wire into the Main circuit board (removed in step 9).

27. Reconnect P9001 and P9002 to the Main circuit board (removed in step 8).

28. Insert the POWER switch extension-shaft assembly into the front panel (from the rear). Push the POWER switch to the ON lock position and align the extension shaft with the switch shaft. Press them together gently until they snap into place.

29. Reinstall the FOCUS control shaft assembly (removed in step 6).

30. Reconnect the connectors to the Attenuator and Timing circuit boards (removed in step 5).

31. Resolder five wires from the Filter circuit board to the Main circuit board (unsoldered in step 4).

32. Reinstall the Power-Supply shield and plastic power-supply cover (see "Power-Supply Shield" reinstallation procedure).

33. Reinstall the Alt Sweep circuit board (see "Alt Sweep Circuit Board" reinstallation procedure).

34. Reconnect the B DELAY TIME POSITION potentiometer connector (P9644) to the Main circuit board (disconnected in step 1).

REPACKAGING FOR SHIPMENT

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing; owner (with address) and the name of an individual at your firm that can be contacted. Include complete instrument serial number and a description of the service required.

Save and reuse the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect its finish. Obtain a carton of corrugated cardboard having a carton test strength of 275 pounds and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

SELECTABLE COMPONENTS

If desired, the trigger-system bandwidth of the oscilloscope may be reduced from the normal 20 MHz to frequencies shown in Table 6-6. To alter the bandwidth, remove C419 (component number A1C419 on Diagram 3) from the Main Circuit Board using the steps in the "Soldering Techniques" part of the "Maintenance" section. The capacitor should be a non-polarized type such as a disc-ceramic or equivalent.

Table 6-6
Trigger Bandwidth Alteration

Trigger Bandwidth	Capacitor Value
20 MHz	180 pF
10 MHz	390 pF
5 MHz	750 pF
1 MHz	3300 pF
50 kHz	0.068 μF
10 kHz	0.33 μF