# Service Manual

# TDS 640
# Digitizing Oscilloscope
# 070-8508-00

Tektronix
Test and Measurement

WARNING
The following servicing instructions are for use by qualified service personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to any service.

Please check for CHANGE INFORMATION at the rear of this manual.

First Printing FEB 1992

**Instrument Serial Numbers**

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

| | |
|---|---|
| B010000 | Tektronix, Inc., Beaverton, Oregon, USA |
| E200000 | Tektronix United Kingdom, Ltd., London |
| J300000 | Sony/Tektronix, Japan |
| H700000 | Tektronix Holland, NV, Heerenveen, The Netherlands |

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

Printed in U.S.A.

## WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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# Safety Summary

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the Digitizing Oscilloscope. This safety information applies to all operators and service personnel.

## Symbols and Terms

These two terms appear in manuals:

- CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.
- WARNING statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:

Static-Sensitive Devices

These symbols appear on equipment:

DANGER
High Voltage

Protective
ground (earth)
terminal

ATTENTION
Refer to
manual

## Specific Precautions

Observe all of the following precautions to ensure your personal safety and to prevent damage to either the TDS 640 or equipment connected to it.

### Do Not Perform Service While Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

### Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections or components while power is on. Disconnect power before removing protective panels, soldering, or replacing components.

### Power Source

The TDS 640 is intended to operate from a power source that will not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

### Grounding the Digitizing Oscilloscope

The TDS 640 is grounded through the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle where earth ground has been verified by a qualified service person. Do this before making connections to the input or output terminals of the TDS 640.

Without the protective ground connection, all parts of the TDS 640 are potential shock hazards. This includes knobs and controls that may appear to be insulators.

### Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition.

### Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your product, and which is identical in type, voltage rating, and current rating.

### Do Not Remove Covers or Panels

To avoid personal injury, do not operate the TDS 640 without the panels or covers.

## Do Not Operate in Explosive Atmospheres

The TDS 640 provides no explosion protection from static discharges or arcing components. Do not operate the TDS 640 in an atmosphere of explosive gasses.

## Electric Overload

Never apply a voltage to a connector on the TDS 640 that is outside the range specified for that connector.

# Specification

**Replace this page with the tab divider of the same name.**

# Product Description

This section begins with a general description of the traits of the TDS 640 Digitizing Oscilloscope. Three subsections follow, one for each of three classes of traits: *nominal traits, warranted characteristics,* and *typical characteristics*.

## General

The Tektronix TDS 640 Digitizing Oscilloscope is a portable, four-channel instrument suitable for use in a variety of test and measurement applications and systems. Key features include:

- Four input channels, CH 1, CH 2, CH 3, and CH 4, each with a record length of 2,000 samples and 8-bit vertical resolution.
- A maximum sample rate of 2 GSamples/second, on all four channels simultaneously, with an analog bandwidth of 500 MHz.
- Extensive triggering capabilities such as edge, logic, and pulse.
- Limit testing and template generation capability.
- Full programmability and printer/plotter output.
- Advanced functions such as continuously-updated measurements.
- Specialized display modes, such as infinite and variable persistence.
- A unique graphical user interface (GUI), an on-board help mode, and a logical front-panel layout which combine to deliver a new standard in usability.

## User Interface

This Digitizing Oscilloscope uses a combination of front-panel buttons, knobs, and on-screen menus to control its many functions. The front-panel controls are grouped according to function: vertical, horizontal, trigger, and special. Within each group, any function likely to get adjusted often, such as vertical positioning, or the time base setting, is set directly by its own front-panel knob.

### Menus

Those functions for which control settings are usually changed less often, such as vertical coupling and horizontal mode, are set indirectly. That is, pressing one (sometimes two) front-panel button(s), such as vertical menu, displays a menu of functions at the bottom of the screen that are related to that button. (For the vertical-menu button, the menu displayed contains the functions such as coupling, bandwidth, etc.) Using the buttons below this *main* menu to select a function, such as coupling, displays a *side* menu of settings for that function, such as AC, DC, or GND (ground) coupling, at the right side of the screen. Use the buttons to the right of the menu to select a setting, such as DC.

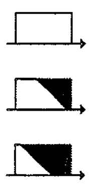
### Indicators

Several on-screen readouts help you keep track of the settings for various functions, such as vertical and horizontal scale and trigger level. There are also readouts to display the results of measurements made using cursors or using the automatic parameter extraction feature (called measure) and readouts to display the status of the instrument.

### General Purpose Knob

Menus can also be used to assign the general purpose knob to adjust a selected parameter function. The method employed is the same as for *selecting* a function, except the final selection in the side menu causes the general purpose knob to *adjust* some function, such as the position of measurement cursors on screen, or the setting for a channel's fine gain.

### GUI



The user interface also makes use of a GUI, or Graphical User Interface, to make setting functions and interpreting the display more intuitive. Some menus and status are displayed using iconic representations of function settings such as those shown here for full, 100 MHz, and 20 MHz bandwidth. Such icons allow you to more readily determine status or the available settings.

## Signal Acquisition System

The signal acquisition system provides four full-featured vertical channels with calibrated vertical scale factors from 1 mV to 10 V per division. All four channels can be acquired simultaneously.

Each of the four channels can be displayed, vertically positioned, and offset, can have their bandwidth limited (100 MHz or 20 MHz) and their vertical coupling specified. Fine gain can also be adjusted.

Besides the four channels, up to three math waveforms and four reference waveforms are available for display. (A math waveform results when you specify dual waveform operations, such as add, on any two channels; a reference waveform results when you save a live waveform in a reference memory.)

## Horizontal System

There are three horizontal display modes: main only, main intensified, and delayed only. You can select among various horizontal record length settings (see Table 1-1).

**Table 1-1: Record Length versus Divisions per Record**

| Record Length | Divisions per Record (50 Samples/Division) |
|---|---|
| 2000 | 40 divs |
| 1000 | 20 divs |
| 500 | 10 divs |

Both the delayed only display and the intensified zone on the main intensified display, may be delayed by time with respect to the main trigger. Both can be set to display immediately after the delay (delayed runs after main mode); the delayed display can also be set to display at the first valid trigger after the delay (delayed-triggerable mode).

The delayed display (or the intensified zone) may also be delayed by a selected number of events. In such a case, the events source is the delayed-trigger source. For any events signal, the delayed-trigger system conditions the signal by determining the source, coupling, etc., of that signal.

## Trigger System

The triggering system comprises a rich set of features for triggering the signal acquisition system. Types of trigger signals recognized are as follows:

- **Edge** (main- and delayed-trigger systems): This familiar type of triggering is fully configurable for source, slope, coupling, mode (auto or normal), and holdoff.
- **Logic** (main-trigger system): This type of triggering can be based on pattern (asynchronous) or state (synchronous). In either case, logic triggering is configurable for sources, for boolean operators to apply to those sources, for logic pattern or state on which to trigger, for mode (auto or normal), and for holdoff. Time qualification may be selected in pattern mode.
- **Pulse** (main-trigger system): Pulse triggering is configurable for triggering on runt or glitch pulses, or on pulse widths or periods inside or outside limits that you specify. It is also configurable for source, polarity, mode, and holdoff.

You can choose where the trigger point is located within the acquired waveform record by selecting the amount of pretrigger data displayed. Presets of 20%, 50%, and 80% of pretrigger data can be selected in the horizontal menu, or the general purpose knob can be assigned to set pretrigger data to any value within the 20% to 80% limits.

## Acquisition Control

Depending on your measurement requirements, you can specify the mode and manner in which signals are acquired and processed:

- You can select the mode for interpolation of points sampled on non-repetitive signals (linear or sin x/x). This can increase the apparent sample rate on the waveform when maximum real-time rates are reached.
- Sample, envelope, and average modes can be used to acquire signals.
- The acquisition can be set to stop after a single acquisition (or sequence of acquisitions if acquiring in average or envelope modes), or after a limit condition has been met.

## On-Board User Assistance

Two features that help you set up the Digitizing Oscilloscope to make your measurements are help and autoset.

### Help

Help displays operational information about any front-panel control. When help mode is in effect, manipulating any front-panel control causes the Digitizing Oscilloscope to display information about that control. When help is first invoked, an introduction to help is displayed on screen.

### Autoset

Autoset automatically sets up the Digitizing Oscilloscope for a viewable display based on the input signal.

## Measurement Assistance

Once you have set up to make your measurements, the cursor and measure features can help you quickly make those measurements.

### Cursor

Three types of cursors are provided for making parametric measurements on the displayed waveforms. Horizontal bar cursors (H Bar) measure vertical parameters (typically volts). Vertical bar cursors (V Bar) measure horizontal parameters (typically time or frequency) and now extend to the top and bottom of the screen. Paired cursors measure both amplitude and time simultaneously. These are delta measurements; that is, measurements based on the difference between two cursors.

Both H Bar and V Bar cursors can also be used to make absolute measurements; that is measurements relative to a defined level or event. For the H Bars, either cursor can be selected to read out its voltage with respect to any channels ground reference level. For the V Bars, it's time with respect to the trigger point (event) of the acquisition and the cursors can control the portion of the waveform on which automatic measurements are made.

For time measurements, units can be either seconds or Hertz (for 1/time).

### Measure

Measure can automatically extract parameters from the signal input to the Digitizing Oscilloscope. Any four out of the more than 25 parameters available can be displayed to the screen. The displayed parameters are extracted continuously and the results updated on-screen as the Digitizing Oscilloscope continues to acquire waveforms.

### Digital Signal Processing (DSP)

An important component of the multiprocessor architecture of this Digitizing Oscilloscope is Tektronix's proprietary digital signal processor, the DSP. This dedicated processor supports advanced analysis of your waveforms when doing such compute-intensive tasks as interpolation, waveform math, and signal averaging. It also teams with a custom display system to deliver specialized display modes (See *Display*, later in this description.)

## Storage and I/O

Acquired waveforms may be saved in any of four nonvolatile REF (reference) memories. Any or all of the saved waveforms may be displayed for comparison with the waveforms being currently acquired.

The source and destination of waveforms to be saved may be chosen. Assignment can be made to save any of the four channels to any REF memory or to move a stored reference from one REF memory to another. Reference waveforms may also be written into a REF memory location via the GPIB interface.

The Digitizing Oscilloscope is fully controllable and capable of sending and receiving waveforms over the GPIB interface (IEEE Std 488.1–1987/IEEE Std 488.2–1987 standard). This feature makes the instrument ideal for making automated measurements in a production or research and development environment that calls for repetitive data taking. Self-compensation and self-diagnostic features built into the Digitizing Oscilloscope to aid in fault detection and servicing are also accessible using commands sent from a GPIB controller.

Another standard feature is hardcopy. This feature allows you to output waveforms and other on-screen information to a variety of graphic printers and plotters from the Digitizing Oscilloscope's front panel, providing hard copies without requiring you to put the Digitizing Oscilloscope into a system-controller environment. The hard copies obtained are WYSIWYG (What-You-See-Is-What-You-Get), based on what is displayed at the time hardcopy is invoked.

## Display

The TDS 640 Digitizing Oscilloscope offers flexible display options. You can customize the following attributes of your display:

- Intensity: waveforms, readouts, graticule, etc.
- Style of waveform display(s): vectors or dots, intensified or non-intensified samples, and infinite or variable persistence.
- Display format: XY or YT and graticule type.
- Interpolation mode: linear or sin x/x.

### Zoom

This Digitizing Oscilloscope also provides an easy way to focus in on those waveform features you wish to examine up close. By invoking zoom, you can magnify the waveform parameter using the vertical and horizontal controls to expand (or contract) and position it for viewing.

# Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the TDS 640 Digitizing Oscilloscope. Electrical and mechanical traits are included.

Nominal traits are described using simple statements of fact such as "identical" for the trait "Input Channels, Number of," rather than in terms of limits that are performance requirements.

**Table 1-2: Nominal Traits – Signal Acquisition System**

| Name | Description | |
|---|---|---|
| Bandwidth Selections | 20 MHz, 100 MHz, and FULL (500 MHz) | |
| Samplers, Number of | Four, simultaneous | |
| Digitized Bits, Number of | 8 bits[1] | |
| Input Channels, Number of | Four, all identical, called CH1, CH2, CH3, and CH4[2] | |
| Input Coupling | DC, AC, or GND | |
| Input Impedance Selections | 1 MΩ or 50 Ω | |
| Ranges, Offset | **Volts/Div Setting** | **Offset Range** |
| | 1 mV/div–99.5 mV/div | ±1 V |
| | 100 mV/div–995 mV/div | ±10 V |
| | 1 V/div–10 V/div | ±100 V |
| Range, Position | ±5 divisions | |
| Range, Sensitivity, CH 1 - CH 4 | 1 mV/div to 10 V/div[3] | |

[1]Displayed vertically with 25 digitization levels (DLs) per division and 10.24 divisions dynamic range with zoom off. A DL is the smallest voltage level change that can be resolved by the 8-bit A-D Converter, with the input scaled to the volts/division setting of the channel used. Expressed as a voltage, a DL is equal to 1/25 of a division times the volts/division setting.

[2]The input characteristics (*Input Coupling, Input Impedance Selections, etc.*) apply to all channels except where otherwise specified.

[3]The sensitivity ranges from 1 mV/div to 10 V/div in a 1-2-5 sequence of coarse settings. Between a pair of adjacent coarse settings, the sensitivity can be finely adjusted. The resolution of such a fine adjustment is 1% of the more sensitive of the pair. For example, between 50 mV/div and 100 mV/div, the volts/division can be set with 0.5 mV resolution.

**Table 1-3: Nominal Traits – Time Base System**

| Name | Description |
|---|---|
| Range, Sample-Rate[1,3] | 10 Samples/sec to 2 GSamples/sec on four channels simultaneously. |
| Range, Interpolated Waveform Rate[2,3] | 5 GSamples/sec to 100 GSamples/sec<br>(200 ps/Sample to 10 ps/Sample) |
| Range, Seconds/Division | 500 ps/div to 5 s/div |
| Range, Time Base Delay Time | 16.5 ns to 250 seconds at 10 μs/div and faster.<br>15.152 ns to 250 seconds at 25 μs/div and slower. |
| Record Length Selection | 500 samples, 1000 samples, 2000 samples. |

[1]The range of real-time rates, expressed in samples/second, at which a digitizer samples signals at its inputs and stores the samples in memory to produce a record of time-sequential samples.

[2]The range of waveform rates for interpolated waveform records.

[3]The Waveform Rate (WR) is the equivalent sample rate of a waveform record. For a waveform record acquired by real-time sampling of a single acquisition, the waveform rate is the same as the real-time sample rate; for a waveform created by interpolation of real-time samples from a single acquisition, the waveform rate is faster than the real time sample rate. For both cases, the waveform rate is 1/(Waveform Interval) for the waveform record, where the waveform interval (WI) is the time between the samples in the waveform record.

**Table 1-4: Nominal Traits – Triggering System**

| Name | Description | |
|---|---|---|
| Range, Delayed Trigger Time Delay | 16.5 ns to 250 seconds at 10 μs/div and faster.<br>15.152 ns to 250 seconds at 25 μs/div and slower. | |
| Range, Events Delay | 2 to 10,000,000 | |
| Range (Time) for Pulse-Glitch or Pulse-Width Triggering | 2 ns to 1 s | |
| Ranges, Trigger Level or Threshold | **Source** | **Range** |
| | Any Channel | ±12 divisions from center of screen |
| | Auxiliary | ±8 V |
| | Line | ±300 V |

**Table 1-5: Nominal Traits – Display System**

| Name | Description |
|---|---|
| Video Display Resolution | 640 pixels horizontally by 480 pixels vertically in a display area of 5.2 inches horizontally by 3.9 inches vertically |
| Waveform Display Graticule | Single Graticule: 401 × 501 pixels, 8 ×10 divisions, where divisions are 1 cm by 1 cm |
| Waveform Display Grey Scale | Sixteen levels in infinite-persistence and variable-persistence display styles |

**Table 1-6: Nominal Traits – GPIB Interface, Output Ports, and Power Fuse**

| Name | Description |
|---|---|
| Interface, GPIB | GPIB interface complies with IEEE Std 488.1-1987 and IEEE Std 488.2-1987 |
| Logic Polarity for Main- and Delayed-Trigger Outputs | Negative TRUE. High to low transition indicates the trigger occurred. |
| Fuse Rating | Either of two fuses[1] may be used: a .25″ × 1.25″ (UL 198.6, 3AG): 6 A FAST, 250 V, or a 5 mm × 20 mm, (IEC 127): 5 A (T), 250 V. |

[1]Each fuse type requires its own fuse cap.

**Table 1-7: Nominal Traits—Mechanical**

| Name | Description |
|---|---|
| Cooling Method | Forced-air circulation with no air filter |
| Construction Material | Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass laminate. Cabinet is aluminum and is clad in Tektronix Blue vinyl material. |
| Finish Type | Tektronix Blue vinyl-clad aluminum cabinet |
| Weight | Standard Digitizing Oscilloscope<br>12.3 kg (27 lbs), with front cover. 20.0 kg (44 lbs), when packaged for domestic shipment.<br>Rackmount Digitizing Oscilloscope<br>12.3 kg (27 lbs) plus weight of rackmount parts, for the rackmounted Digitizing Oscilloscope (Option 1R). 20.5 kg (45 lbs), when the rackmounted Digitizing Oscilloscope is packaged for domestic shipment.<br>Rackmount conversion kit<br>2.3 kg (5 lbs), for the rackmount coversion kit only; 3.6 kg (8 lbs), when the kit is packaged for domestic shipping. |
| Overall Dimensions | Standard Digitizing Oscilloscope<br>Height: 193 mm (7.6 in), with the feet installed.<br>Width: 445 mm (17.5 in), with the handle.<br>Depth: 434 mm (17.1 in), with the front cover installed.<br>Rackmount Digitizing Oscilloscope<br>Height: 178 mm (7.0 in).<br>Width: 483 mm (19.0 in).<br>Depth: 558.8 mm (22.0 in). |

# Warranted Characteristics

This subsection lists the various *warranted characteristics* that describe the TDS 640 Digitizing Oscilloscope. Electrical and environmental characteristics are included.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

***NOTE***

*In these tables, those warranted characteristics that are checked in the procedure* Performance Verification, *found in Section 4, appear in* **boldface type** *under the column* **Name**.

As stated above, this subsection lists only warranted characteristics. A list of *typical characteristics* starts on page 1-17.

## Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the oscilloscope has been adjusted at an ambient temperature between +20°C and +30°C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between 0°C and +50°C (unless otherwise noted).

**Table 1-8: Warranted Characteristics – Signal Acquisition System**

| Name | Description | |
|---|---|---|
| **Accuracy, DC Gain[3]** | ±1.5%. At 1 mV/div the following equation applies: ±[1.5% + 0.02 (T–25°C)] for T ≥ 25°C | |
| **Accuracy, DC Voltage Measurement, Averaged[3]** | **Measurement Type** | **DC Accuracy** |
| | Average of ≥16 waveforms | ±(DC Gain × \|Reading – Net Offset[1]\| + Offset Accuracy + 0.06 div) |
| | Delta volts between any two averages of ≥16 waveforms[2] | ±(DC Gain × \|Reading\| + 0.1 div + 0.3 mV) |

[1]**Net Offset = Offset – (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this Voltage level.**

[2]**The samples must be acquired under the same setup and ambient conditions.**

[3]**To ensure the most accurate measurements possible, run an SPC calibration first. When using the TDS 640 Digitizing Oscilloscope at a Volts/Div setting of <5 mV/div, an SPC calibration should be run once per week to ensure that instrument performance levels meet specifications.**

**Table 1-8: Warranted Characteristics – Signal Acquisition System (Cont.)**

| Name | Description | |
|---|---|---|
| **Accuracy, Offset[3]** | **Volts/Div Setting** | **Offset Accuracy** |
| | 1 mV/div – 99.5 mV/div | ±(0.2% × \|Net Offset[1]\| + 1.5 mV + 0.6 div) |
| | 100 mV/div – 995 mV/div | ±(0.35% × \|Net Offset[1]\| + 15 mV + 0.6 div) |
| | 1 V/div – 10 V/div | ±(0.35% × \|Net Offset[1]\| + 150 mV + 0.6 div) |
| **Analog Bandwidth, DC-50 Ω Coupled, or DC-1 MΩ Coupled with P6139A Probe** | **Volts/Div** | **Bandwidth[4]** |
| | 5 mV/div – 10 V/div | DC – 500 MHz |
| | 2 mV/div – 4.98 mV/div | DC – 300 MHz |
| | 1 mV/div – 1.99 mV/div | DC – 200 MHz |
| Cross Talk (Channel Isolation) | ≥100:1 at 100 MHz and ≥30:1 at the rated bandwidth for the channel's sensitivity rating, for any two channels having equal volts/division settings | |
| **Delay Between Channels, Full Bandwidth** | ≤250 ps for any two channels with equal volts/division and coupling settings | |
| Input Impedance, DC-1 MΩ Coupled | 1 MΩ ±0.5% in parallel with 10 pF ±2 pF | |
| Input Impedance, DC-50 Ω Coupled | 50 Ω ±1% with VSWR ≤1.3:1 from DC – 500 MHz | |
| Input Voltage, Maximum, DC-1 MΩ, AC-1 MΩ, or GND Coupled | ±400 V (DC + peak AC); derate at 20 dB/decade above 1 MHz | |
| Input Voltage, Maximum, DC-50 Ω or AC-50 Ω Coupled | 5 V rms, with peaks less than or equal to ±30 V | |
| Lower Frequency Limit, AC Coupled | ≤10 Hz when AC–1 MΩ Coupled; ≤200 kHz when AC-50 Ω Coupled[5] | |

**[1]Net Offset = Offset – (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this Voltage level.**

**[3]To ensure the most accurate measurements possible, run an SPC calibration first. When using the TDS 640 Digitizing Oscilloscope at a Volts/Div setting of <5 mV/div, an SPC calibration should be run once per week to ensure that instrument performance levels meet specifications.**

**[4]The limits given are for the ambient temperature range of 0°C to +30°C. Reduce the upper bandwidth frequencies by 2.5 MHz for each °C above +30°C.**

**[5]The AC Coupled Lower Frequency Limits are reduced by a factor of 10, when 10X passive probes are used.**

**Table 1-9: Warranted Characteristics – Time Base System**

| Name | Description | |
|---|---|---|
| **Accuracy, Long Term Sample Rate and Delay Time** | ± 100 ppm over any ≥1 ms interval | |
| **Accuracy, Delta Time Measurement** | **Conditions** | **Time Measurement Accuracy[1,2]** |
| | Single Shot, Sample Mode, 100 MHz Bandwith selected | ± (1 WI + 100 ppm × \|Reading\| + 500 ps) |
| | Single Shot, Sample Mode, 20 MHz Bandwidth selected | ± (1 WI + 100 ppm × \|Reading\| + 1.3 ns) |
| | Repetitive, ≥ 8 Averages, Full Bandwidth selected | ± (1 WI + 100 ppm × \|Reading\| + 200 ps) |

[1]For input signals ≥ 5 divisions in amplitude and a slew rate of ≥ 2.0 divisions/ns at the delta time measurement points. Signal must have been acquired at a volts/division setting of ≥ 5 mV/division.

[2]The WI (waveform interval) is the time between the samples in the waveform record. Also, see the footnotes for *Sample Rate Range or Interpolated Waveform Rates* in Table 1-3, on page 1-8.

**Table 1-10: Warranted Characteristics – Triggering System**

| Name | Description | | |
|---|---|---|---|
| **Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering** | **Time Range** | **Accuracy** | |
| | 2 ns to 1 μs | ±(20% × \| Setting \| + 0.5 ns) | |
| | 1.02 μs to 1 s | ±(100 ns + 0.01% × \| Setting \| ) | |
| **Accuracy, Trigger Level or Threshold, DC Coupled[2]** | **Trigger Source** | **Accuracy** | |
| | Any Channel | ±(2% × \| Setting – Net Offset[1] \| + 0.2 div × \| Volts/div Setting \| + Offset Accuracy) | |
| | Auxiliary | ±(6% × \| Setting \| + 8% of p-p signal + 100 mV) | |
| **Sensitivity, Edge-Type Trigger, DC Coupled[3]** | **Trigger Source** | **Sensitivity** | |
| | Any Channel | 0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz | |
| | Auxiliary | 0.25 volts from DC to 50 MHz | |
| Width, Minimum Pulse and Rearm, for Pulse Triggering | **Pulse Class** | **Minimum Pulse Width** | **Minimum Rearm Width** |
| | Glitch | 2 ns | 2 ns + 5% of Glitch Width Setting |
| | Runt | 2.5 ns | 2.5 ns |
| | Width | 2 ns | 2 ns + 5% of Width Upper Limit Setting |

[1]Net Offset = Offset – (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.

[2]Valid for signals having rise and fall times $\geq$ 20 ns.

[3]The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

**Table 1-11: Warranted Characteristics—Output Ports, Probe Compensator, and Power Requirements**

| Name | Description | |
|---|---|---|
| **Logic Levels, Main- and Delayed-Trigger Outputs** | **Characteristic** | **Limits** |
| | Vout (HI) | ≥2.5 V open circuit; ≥1.0 V into a 50 Ω load to ground |
| | Vout (LO) | ≤0.7 V into a load of ≤4 mA; ≤0.25 V into a 50 Ω load to ground |
| **Output Voltage and Frequency, Probe Compensator** | **Characteristic** | **Limits** |
| | Voltage | 0.5 V (base-top) ±1% into a load of ≥50 Ω |
| | Frequency | 1 kHz ±5% |
| **Output Voltage, Signal Out (CH 3[1])** | 20 mV/division ±20% into a 1 MΩ load; 10 mV/division ±20% into a 50 Ω load | |
| Source Voltage | 90 to 250 VAC rms, continuous range | |
| Source Frequency | 47 Hz to 63 Hz | |
| Power Consumption | ≤300 W (450 VA) | |

[1] CH 3 signal out is only present at the rear panel if CH 3 is selected as the trigger source for the main and/or delayed trigger systems.

**Table 1-12: Warranted Characteristics—Environmental**

| Name | Description |
|---|---|
| Atmospherics | Temperature:<br>0°C to +50°C, operating; -40°C to +75°C, non-operating<br>Relative humidity:<br>0 to 95%, at or below +40°C; 0 to 75%, from +41°C to 50°C<br>Altitude:<br>To 15,000 ft. (4570 m), operating; to 40,000 ft. (12,190 m), non-operating |
| Dynamics | Random vibration:<br>0.31 g rms, from 5 to 500 Hz, 10 minutes each axis, operating;<br>3.04 g rms, from 5 to 500 Hz, 10 minutes each axis, non-operating |
| Emissions | Meets or exceeds the EMC requirements of the following standards:<br>MIL-STD-461C<br>CE-03, part 4, curve #1, RE-02, part 7<br>VDE 0871, Category B<br>FCC Rules and Regulations, Part 15, Subpart J, Class A |
| User-Misuse Simulation | Electrostatic Discharge Susceptibility: Up to 8 kV with no change to control settings or impairment of normal operation; up to 15 kV with no damage that prevents recovery of normal operation |

# Typical Characteristics

This subsection contains tables that list the various *typical characteristics* which describe the TDS 640 Digitizing Oscilloscope.

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

This subsection lists only typical characteristics. A list of warranted characteristics starts on page 1-11.

**Table 1-13: Typical Characteristics – Signal Acquisition System**

| Name | Description | |
|---|---|---|
| Accuracy, DC Voltage Measurement, Not Averaged | **Measurement Type** | **DC Accuracy** |
| | Any Sample | ±(1.5% × \| Reading – Net Offset[1] \| + Offset Accuracy + 0.13 div + 0.6 mV) |
| | Delta Volts between any two samples[2] | ±(1.5% × \| Reading \| + 0.26 div + 1.2 mV) |
| Frequency Limit, Upper, 100 MHz Bandwidth Limited | 100 MHz | |
| Frequency Limit, Upper, 20 MHz Bandwidth Limited | 20 MHz | |
| Calculated Rise Time[3] | **Volts/Div Setting** | **Calculated Rise Time[3]** |
| | 5 mV/div–10 V/div | 800 ps |
| | 2 mV/div–4.98 mV/div | 1.1 ns |
| | 1 mV/div–1.99 mV/div | 1.6 ns |

**[1]Net Offset = Offset – (Position x Volts/Div). Net Offset is the voltage level at the center of the A-D converter's dynamic range. Offset Accuracy is the accuracy of this voltage level.**

**[2]The samples must be acquired under the same setup and ambient conditions.**

**[3]The numbers given are valid 0°C to +30°C and will increase as the temperature increases due to the degradation in bandwidth. Rise time is calculated from the bandwidth. It is defined by the following formula:**

$$\text{Rise Time (ns)} = \frac{400}{\text{BW (MHz)}}$$

**Note that if you measure rise time, you must take into account the rise time of the test equipment (signal source, etc.) that you use to provide the test signal. That is, the measured risetime ($RT_m$) is determined by the instrument risetime ($RT_i$) and the risetime of the test signal source (RTgen) according to the following formula:**

$$RT_m{}^2 = RT_i{}^2 + RT_{gen}{}^2$$

**Table 1-13: Typical Characteristics—Signal Acquisition System (Cont.)**

| Name | Description | | | | |
|---|---|---|---|---|---|
| Step Response Settling Errors | **Volts/Div Setting** | **± Step Response** | **Settling Error (%)[4] at** | | |
| | | | **20 ns** | **100 ns** | **20 ms** |
| | 1 mV/div - 99.5 mV/div | ≤2 V | ≤0.5 | ≤0.2 | ≤0.1 |
| | 100 mV/div – 995 mV/div | ≤20 V | ≤1.0 | ≤0.5 | ≤0.2 |
| | 1 V/div - 10 V/div | ≤200 V | ≤1.0 | ≤0.5 | ≤0.2 |

**[4]The values given are the maximum absolute difference between the value at the end of a specified time interval after the mid-level crossing of the step, and the value one second after the mid-level crossing of the step, expressed as a percentage of the step amplitude.**

**Table 1-14: Typical Characteristics—Triggering System**

| Name | Description | |
|---|---|---|
| Input, Auxiliary Trigger | The input resistance is ≥1.5 kΩ; the maximum safe input voltage is ±20 V (DC + peak AC). | |
| Error, Trigger Position, Edge Triggering | **Acquisition Mode** | **Trigger-Position Error[1,2]** |
| | Sample, Average | ±(1 WI + 1 ns) |
| | Envelope | ±(2 WI + 1 ns) |
| Holdoff, Variable, Main Trigger | Minimum: For any horizontal scale setting, the *minimum* holdoff for a 1x or 5x setting is 10 times that setting, but is never shorter than 1 μs or longer than 5 s. The *minimum* holdoff for a 2.5x setting is 8 times that setting.<br>Maximum: For any horizontal scale setting, the *maximum* holdoff is at least 2 times the minimum holdoff for that setting, but is never longer than 10 times the minimum holdoff for that setting. | |
| Lowest Frequency for Successful Operation of "Set Level to 50%" Function | 50 Hz | |
| Sensitivity, Edge Trigger, Not DC Coupled[3] | **Trigger Source** | **Typical Signal Level for Stable Triggering** |
| | AC | Same as the DC-coupled limits for frequencies above 60 Hz. Attenuates signals below 60 Hz. |
| | Noise Reject | Three and one-half times the DC-coupled limits. |
| | High Frequency Reject | One and one-half times the DC-coupled limits from DC to 30 kHz. Attenuates signals above 30 kHz. |
| | Low Frequency Reject | One and one-half times the DC-coupled limits for frequencies above 80 kHz. Attenuates signals below 80 kHz. |

**[1]The trigger position errors are typically less than the values given here. These values are for triggering signals having a slew rate at the trigger point of ≥ 2 division/ns.**

**[2]The waveform interval (WI) is the time between the samples in the waveform record. Also, see the footnote for the characteristics *Sample Rate Range or Interpolated Waveform Rates* in Table 1-3, on page 1-8.**

**[3]The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not "roll" across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.**

**Table 1-14: Typical Characteristics—Triggering System (Cont.)**

| Name | Description |
|---|---|
| Sensitivities, Logic Trigger/Pulse Trigger/ Events Delay, DC Coupled[4] | 1.0 division, from DC to 100 MHz with a minimum slew rate of 25 divs/μs at the trigger level or the threshold crossing. |
| Sensitivities, Pulse-Type Runt Trigger[5] | 1.0 division, from DC to 200 MHz with a minimum slew rate of 25 divs/μs at the trigger level or the threshold crossing. |
| Sensitivities, Pulse-Type Trigger Width and Glitch[6] | 1.0 division, with a minimum slew rate of 25 divs/μs at the trigger level or the threshold crossing. For <5 nsec pulse width or rearm time, 2 divisions are required. |
| Width, Minimum Pulse and Rearm, for Logic Triggering or Events Delay[7] | 5 ns |

**[4]The minimum signal levels required for stable logic or pulse triggering of an acquisition, or for stable counting of a DC-coupled, events-delay signal. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events.)**

**[5]The minimum signal levels required for stable runt pulse triggering of an acquisition. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events.)**

**[6]The minimum signal levels required for stable pulse width or glitch triggering of an acquisition. Also, see the footnote for *Sensitivity, Edge-Type Trigger, DC Coupled* in this table. (Stable counting of events is counting that misses no events.)**

**[7]The minimum pulse width and rearm width required for logic-type triggering or events delaying to occur.**

**Table 1-15: Typical Characteristics—Data Handling and Reliability**

| Name | Description |
|---|---|
| Time, Data-Retention, Nonvolatile Memory[1,2] | 5 years |

**[1]The times that reference waveforms, stored setups, and calibration constants are retained when there is no power to the oscilloscope.**

**[2]Data is maintained by small lithium-thionyl-chloride batteries internal to the memory ICs. The amount of lithium is so small in these ICs that they can typically be safely disposed of with ordinary garbage in a sanitary landfill.**

# Operating Information

**Replace this page with the tab divider of the same name.**

# Using this Manual

This section contains information needed to properly use this manual to service the TDS 640 Digitizing Oscilloscope, as well as general information critical to safe and effective servicing of this oscilloscope.

## Before Servicing

This manual is for servicing the TDS 640 Digitizing Oscilloscope. To prevent injury to yourself or damage to the oscilloscope, do the following before you attempt service:

- Be sure you are a qualified service person;
- Read the Safety Summary found at the beginning of this manual;
- Read *Strategy for Servicing* and *Supplying Operating Power* in this section.

When using this manual for servicing, be sure to heed all warnings, cautions, and notes.

## Strategy for Servicing

STOP Throughout this manual, any field-replaceable component, assembly, or part of this oscilloscope is referred to generically as a module.

This manual contains all the information needed for periodic maintenance of the TDS 640 Digitizing Oscilloscope. (Examples of such information are procedures for checking performance and for readjustment.) Further, it contains all information for corrective maintenance down to the module level. This means that the procedures, diagrams, and other troubleshooting aids help isolate failures to a specific module, rather than to components of that module. Once a failure is isolated, replace the module with a fresh unit obtained from the factory.

All modules are listed in Section 10, *Replaceable Parts List.* To isolate a failure to a module, use the fault isolation procedures found in Section 6, *Maintenance Information.* To remove and replace any failed module, follow the instructions in *Removal and Installation Procedures*, also found in Section 6.

## Manual Structure

This manual is divided into sections, such as *Specification and Theory of Operation*. Further, it is divided into subsections, such as *Product Description* and *Removal and Installation Procedures.*

Sections containing procedures also contain introductions to those procedures. Be sure to read these introductions because they provide information needed to do the service correctly and efficiently. The following is a brief description of each manual section.

- *Specification*—contains a product description of the TDS 640 Digitizing Oscilloscope and tables of the characteristics and descriptions that apply to it.
- *Operating Information*—is this section. It includes a description of how this manual is structured, as well as general information and operating instructions at the level needed to safely power on and service this oscilloscope. A statement of the service strategy that this manual supports, and instructions for shipment of the Digitizing Oscilloscope are found in this section.
- *Theory of Operation*—contains circuit descriptions that support general service and fault isolation.
- *Performance Verification*—contains a collection of procedures for confirming that this Digitizing Oscilloscope functions properly and meets warranted limits.
- *Adjustment Procedures*—contains a collection of procedures for adjusting this Digitizing Oscilloscope to meet warranted limits.
- *Maintenance*—contains information and procedures for doing preventive and corrective maintenance of this Digitizing Oscilloscope. Instructions for cleaning, for module removal and installation, and for fault isolation to a module are found here.
- *Options*—contains information on servicing any of the factory-installed options that may be present in your oscilloscope.
- *Replaceable Electrical Parts List*—contains a statement referring you to *Replaceable Parts,* where both electrical and mechanical modules are listed. See below.
- *Diagrams*—contains a block diagram and an interconnection diagram useful for isolating failed modules.
- *Replaceable Parts List*—includes a table of all replaceable modules, their descriptions, and their Tektronix part numbers.

## Manual Conventions

This manual uses certain conventions which you should become familiar with before doing service.

### Modules

Throughout this manual, any replaceable component, assembly, or part of this Digitizing Oscilloscope is referred to generically as a module. In general, a module is an assembly, like a circuit board, rather than a component, like a resistor or an integrated circuit. Sometimes a single component is a module; for example, each chassis part of the oscilloscope is a module.

### Safety

Symbols and terms related to safety appear in the Safety Summary found at the beginning of this manual.

### Symbols

Besides the symbols related to safety, this manual uses the following symbols:


The “stop sign” icon labels information which must be read in order to correctly do service and to avoid incorrectly using or applying service procedures.

The clock icon labels procedure steps which require a pause to wait for the oscilloscope to complete some operation before you can continue.

Various icons such as the example icon at the left are used in procedures to help identify certain readouts and menu functions on screen.

## Tektronix Service

Tektronix provides service to cover repair under warranty as well as other services that may provide a cost-effective answer to your service needs.

Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians, trained on Tektronix products, are best equipped to service your TDS 640 Digitizing Oscilloscope. Tektronix technicians are appraised of the latest information on improvements to the product as well as the latest new options to the product.

### Warranty Repair Service

Tektronix warrants this product for three years from date of purchase, excluding probes for which the warranty is one year. (The warranty appears on the back of the title page in this manual.) Tektronix technicians provide warranty service at most Tektronix service locations worldwide. Your Tektronix product catalog lists all service locations worldwide.

### Repair or Calibration Service

The following services may be purchased to tailor repair and/or calibration of your TDS 640 Digitizing Oscilloscope to fit your requirements.

**Option 9C** – When you order your TDS 640 Digitizing Oscilloscope with option 9C, it is shipped with a *Certificate of Calibration and Test Data Report.* This certificate provides traceability to the National Institute of Standards and Technology (NIST). It certifies procedures used to calibrate the oscilloscope comply with U. S. Military Standard 45662A.

**At-Depot Service** – Tektronix offers several standard-priced adjustment (calibration) and repair services:

- A single repair and/or adjustment.
- Calibrations using equipment and procedures that meet the traceability standards specific to the local area.
- Annual maintenance agreements that provide for either calibration and repair or calibration only of the oscilloscope.

Of these services, the annual maintenance agreement offers a particularly cost-effective approach to service for many owners of the TDS 640 Digitizing Oscilloscope. Such agreements can be purchased to span several years.

**On-Site Service** – The annual maintenance agreement can be purchased with on-site service, with repair and calibration done at your facility. This service reduces the time your oscilloscope is out of service when calibration or repair is required.

### Self Service

Tektronix supports repair to the module level by providing *Module Exchange* and *Module Repair and Return*.

**Module Exchange** – This service reduces down time for repair by allowing you to exchange most modules for remanufactured ones. Tektronix ships you an updated and tested exchange module from the Beaverton, Oregon service center, typically within 24 hours. Each module comes with a 90-day service warranty.

**Module Repair and Return** – This service returns to you within 10 days the same module that you shipped to Tektronix. The module shipped is repaired, tested, and returned to you from the Beaverton, Oregon service center. It is *not* updated to match current modules of the same type. Again, each module comes with a 90-day service warranty.

**For More Information** – Contact your local Tektronix service center or sales engineer for more information on any of the repair or adjustment services just described.

## Finding Other Information

The TDS 640 Digitizing Oscilloscope comes with the following manuals:

*TDS 640 User Manual* contains a tutorial to quickly show you how to operate the TDS 640 Digitizing Oscilloscope and an in depth discussion of how to more completely use its features. Applications are also discussed.

*TDS 640 Reference* contains a brief overview of oscilloscope operation.

*TDS 600 Family Programmer Manual* contains information for programmed operation via the GPIB interface. Included is the complete command set, setup information, and programming examples.

## Supplying Operating Power

STOP Read all information and heed all warnings in this subsection before connecting the TDS 640 Digitizing Oscilloscope to a power source.

**WARNING**

*AC POWER SOURCE AND CONNECTION. The* TDS 640 Digitizing Oscilloscope *operates from a single-phase power source. It has a three-wire power cord and two-pole, three-terminal grounding type plug. The voltage to ground (earth) from either pole of the power source must not exceed the maximum rated operating voltage, 250 volts.*

*Before making connection to the power source, be sure the TDS 640 Digitizing Oscilloscope has a suitable two-pole, three-terminal grounding-type plug.*

*GROUNDING. This instrument is safety Class 1 equipment (IEC designation). All accessible conductive parts are directly connected through the grounding conductor of the power cord to the grounded (earthing) contact of the power plug.*

**WARNING**

*The power input plug must be inserted only in a mating receptacle with a grounding contact where earth ground has been verified by a qualified service person. Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric shock hazard.*

*For electric shock protection, the grounding connection must be made before making connection to the instrument's input or output terminals.*

## Power Cord Information

A power cord with appropriate plug configuration is supplied with each TDS 640 Digitizing Oscilloscope. Table 2-1 gives the color-coding of the conductors in the power cord. If you require a power cord other than the one supplied, refer to *Table 2-2: Power Cord and Plug Identification.*

**Table 2-1: Power-Cord Conductor Identification**

| Conductor | Color | Alternate Color |
|---|---|---|
| Ungrounded (Line) | Brown | Black |
| Grounded (Neutral) | Light Blue | White |
| Grounded (Earthing) | Green/Yellow | Green |

## Operating Voltage

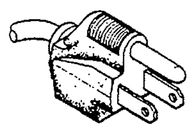
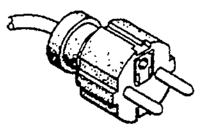
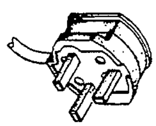
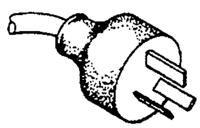
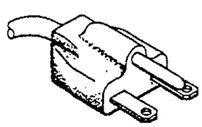
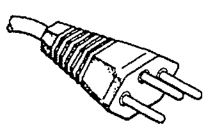
This oscilloscope operates with any line voltage from 90–250 VAC rms with any line frequency from 47–63 Hz. There are two fuses, either of which may be used throughout the line voltage and frequency ranges. (The two fuses are not totally interchangeable as each requires a different fuse cap.)

## Memory Backup Power

Memory modules with on-board batteries allow the TDS 640 Digitizing Oscilloscope to retain some types of data upon loss of the AC power source. The stored adjustment constants, saved front-panel settings, current front-panel settings (instrument status), and waveforms saved in memory are retained.

The on-board batteries of the memory modules have a shelf life of about five years. Partial or total loss of stored settings upon power on may indicate that the memory modules need to be replaced.

**Table 2-2: Power Cord and Plug Identification**

| Plug Configuration | Usage (Max Rating) | Reference Standards & Certification | Option # |
|---|---|---|---|
|  | North America<br>125 V/6 A | ANSI C73.11[1]<br>NEMA 5-15-P[2]<br>IEC 83[3]<br>UL[10]<br>CSA[11] | Standard |
|  | Europe<br>220 V/16 A | IEC 83[3]<br>CEE (7), II, IV, VII[4]<br>VDE[8]<br>SEMKO[9] | A1 |
|  | United Kingdom<br>240 V/13 A | IEC 83[3]<br>BSI 1363[5] | A2 |
|  | Australia<br>240 V/10 A | AS C112[6]<br>ETSA[12] | A3 |
|  | North America<br>240 V/15 A | ANSI C73.20[1]<br>NEMA 6-15-P[2]<br>IEC 83[3]<br>UL[10]<br>CSA[11] | A4 |
|  | Switzerland<br>220 V/10 A | SEV[7] | A5 |

[1]ANSI—American National Standards Institute
[2]NEMA—National Electrical Manufacturers' Association
[3]IEC—International Electrotechnical Commission
[4]CEE—International Commission on Rules for the Approval of Electrical Equipment
[5]BSI—British Standards Institute
[6]AS—Standards Association of Australia
[7]SEV—Schweizerischer Elektrotechnischer Verein
[8]VDE—Verband Deutscher Elektrotechniker
[9]SEMKO—Swedish Institute for Testing and Approval of Electrical Equipment
[10]UL—Underwriters Laboratories
[11]CSA—Canadian Standards Association
[12]ETSA—Electricity Trust of South Australia

## Operating Environment

The following environmental requirements are provided to ensure proper operation and long instrument life.

### Operating Temperature

The TDS 640 Digitizing Oscilloscope can be operated where the ambient air temperature is between 0° and +50°C and can be stored in ambient temperatures from -40° to +75°C. After storage at temperatures outside the operating limits, allow the chassis to stabilize at a safe operating temperature before applying power.

### Ventilation Requirements

The TDS 640 Digitizing Oscilloscope is cooled by air drawn in and exhausted through its cabinet side panels by an internal fan. To ensure proper cooling of the instrument, allow at least two inches clearance on both sides and ¾ inch on the bottom of the Digitizing Oscilloscope. (The feet on the bottom of the oscilloscope provide the required clearance when set on flat surfaces.) The top of the oscilloscope does not require ventilation clearance.

**CAUTION**

*If air flow is restricted, the Digitizing Oscilloscope's power supply may temporarily shut down.*

## Applying and Interrupting Power

Consider the following information when you power on or power off the instrument, or when power is interrupted due to an external power failure.

### Power On

Upon power on, the oscilloscope runs its power-on self check. If it passes, the oscilloscope displays a "passed" status message and a prompt to press CLEAR MENU to continue. If it fails, the oscilloscope displays a diagnostic log that identifies the area(s) that failed and a prompt to press CLEAR MENU to continue. See Section 6, *Maintenance*, for information on diagnostics and fault isolation.

### Power Off

**CAUTION**

*DO NOT power off the oscilloscope when either running a signal path compensation or when doing any of the adjustments described in Section 5,* Adjustment Procedures. *To do so might result in the loss of internally stored adjustment constants.*

In general, do not power off the instrument when doing operations that affect the data types listed in Table 2-3. Wait for the instrument to finish the operation when doing adjustments, saving waveforms, or saving setups.

Improper power off or unexpected loss of power to the oscilloscope can result in the following corruptions of non-volatile RAM (NVRAM). The following table describes the messages displayed when power is restored after an abnormal power off.

**Table 2-3: Effects of Corrupted Data**

| Corrupted Data Type | Results |
|---|---|
| *Adjustment Constants:* | |
| ■ Signal Path Compensation | A signal path compensation is required. |
| ■ Voltage Reference | A voltage reference adjustment is required (Section 5). |
| ■ Frequency Response | A frequency response adjustment is required (Section 5). |
| *Error Log* | Errors logged are lost. |
| *Reference Waveforms* | Waveform Lost. |
| *Saved Setups* | Setup Lost. |

## Repackaging Instructions

Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds and with an inside dimension at least six inches greater than the instrument dimensions.

If the instrument is being shipped to a Tektronix Service Center, enclose the following information: the owner's address, name and phone number of a contact person, type and serial number of the instrument, reason for returning, and a complete description of the service required.

Seal the shipping carton with an industrial stapler or strapping tape.

Mark the address of the Tektronix Service Center and also your own return address on the shipping carton in two prominent locations.

## Installed Options

Your instrument may be equipped with one or more instrument options. Except for the line-cord options described by Table 2-2 (on page 2-9 of this section), all options and optional accessories are listed and described in Section 7, *Options*. For further information and prices of instrument options, see your Tektronix Products catalog or contact your Tektronix Field Office.

# General Operating Instructions

Before doing service, read the following operating instructions. These instructions are at the level appropriate for servicing this Digitizing Oscilloscope. The complete operator's instructions are found in the *User Manual.*

Additional instructions are integrated into the service procedures found in later sections of this manual. For instance, the procedures found in the section *Performance Verification* contain instructions for making the front-panel settings required to check each instrument characteristic included there. Also, the general instructions for operating this Digitizing Oscilloscope's internal diagnostic routines are found in Section 6, *Maintenance.* You may also find the *Product Description* in Section 1 useful for understanding how the oscilloscope functions.

## Screen Layout

The screen layout is illustrated in Figure 2-1 on page 2-14. Note that the figure illustrates a full graticule; you may also select a grid, crosshair, or frame graticule from the display menu.

## Basic Procedures

### How to Power On

Push the principal power switch found on the rear panel of the Digitizing Oscilloscope, then push the **ON/STBY** (standby) switch to toggle the Digitizing Oscilloscope into operation. The switch at the rear panel is the true power disconnect switch. The **ON/STBY**(standby) switch simply toggles operation on and off.

***WARNING***

*The principal power switch at the rear panel is the true power disconnect switch. The* **ON/STBY** *(standby) switch simply toggles operation on and off. When connected to a power source and when the principal power switch is on, the internal power supplies and much of the other circuitry of this Digitizing Oscilloscope are energized regardless of the setting of the* **ON/STBY** *switch.*

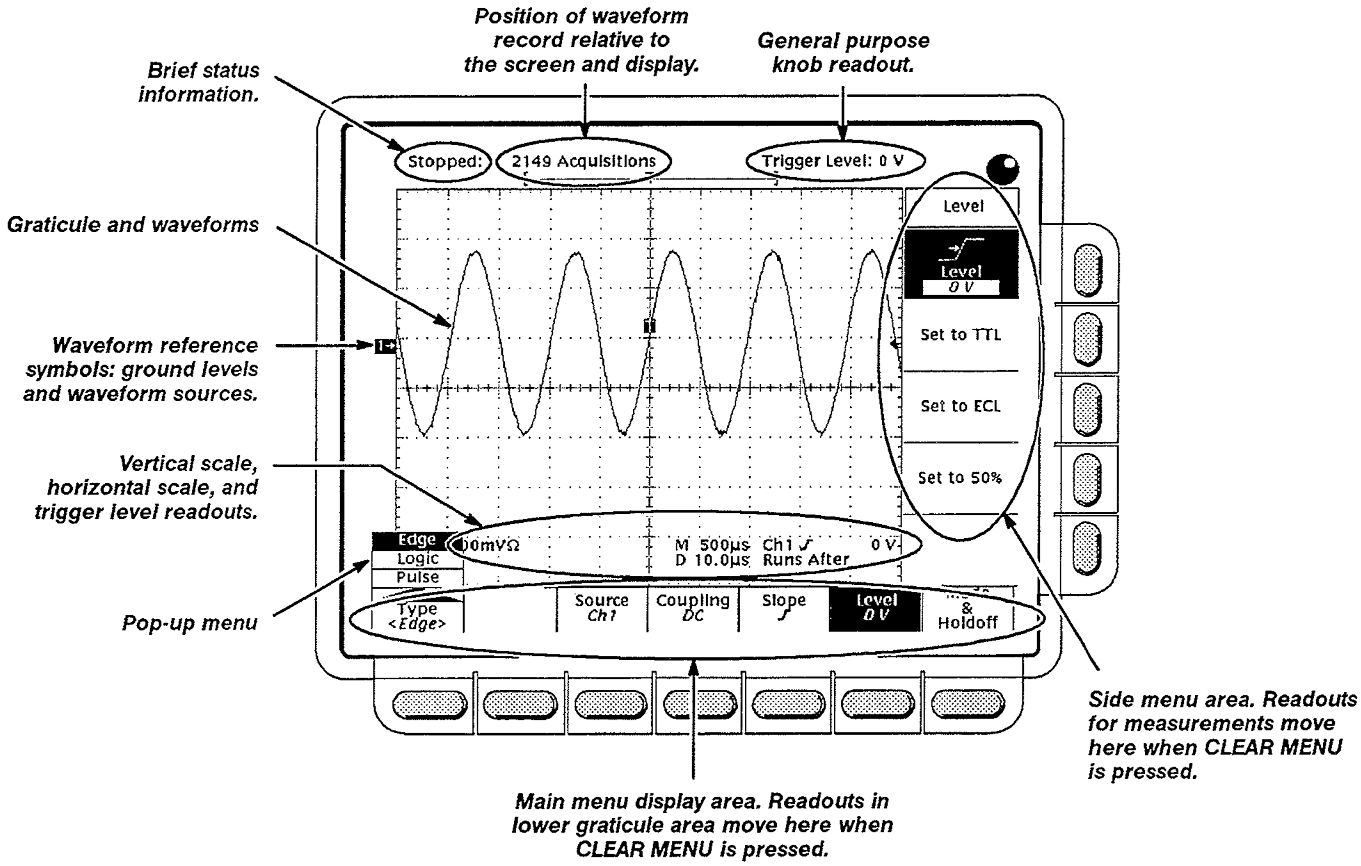



**Figure 2-1: Map of Display Functions**

## How to Use Help

Push the **HELP** front-panel button to enter help mode. Front-panel knobs and buttons now display information about their function when turned or pushed. Push **HELP** again to exit help mode.

To get help information on a menu item, display the menu desired (if you are in help mode, exit help first). Push **HELP**. Now the menu buttons display information about their function when pushed.

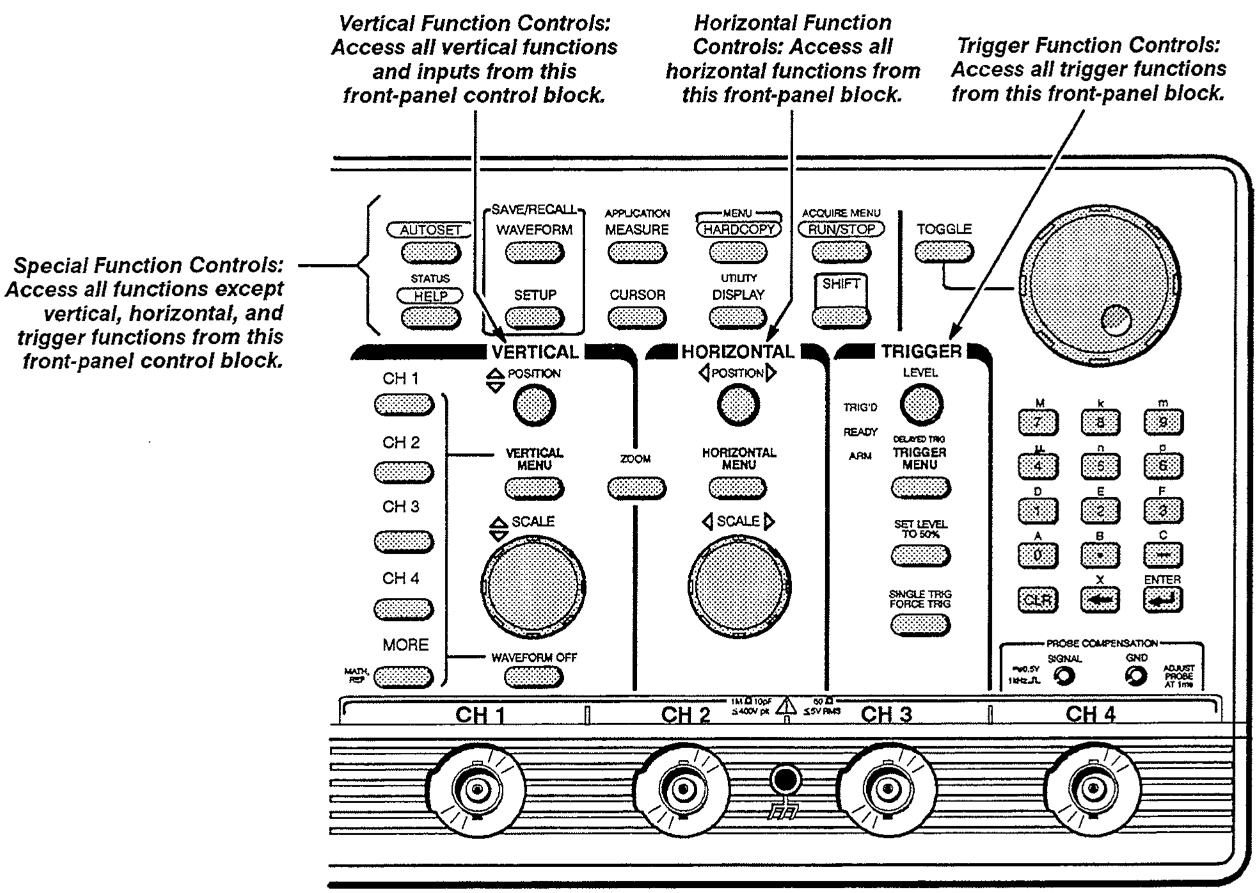
## How to Use the Status Menu

Push the **SHIFT**, then the **STATUS** front-panel buttons to display the status menu. You will find messages reflecting the state of the acquisition system, whether it is running or stopped (and if it is stopped, why), as well as setup-related information.

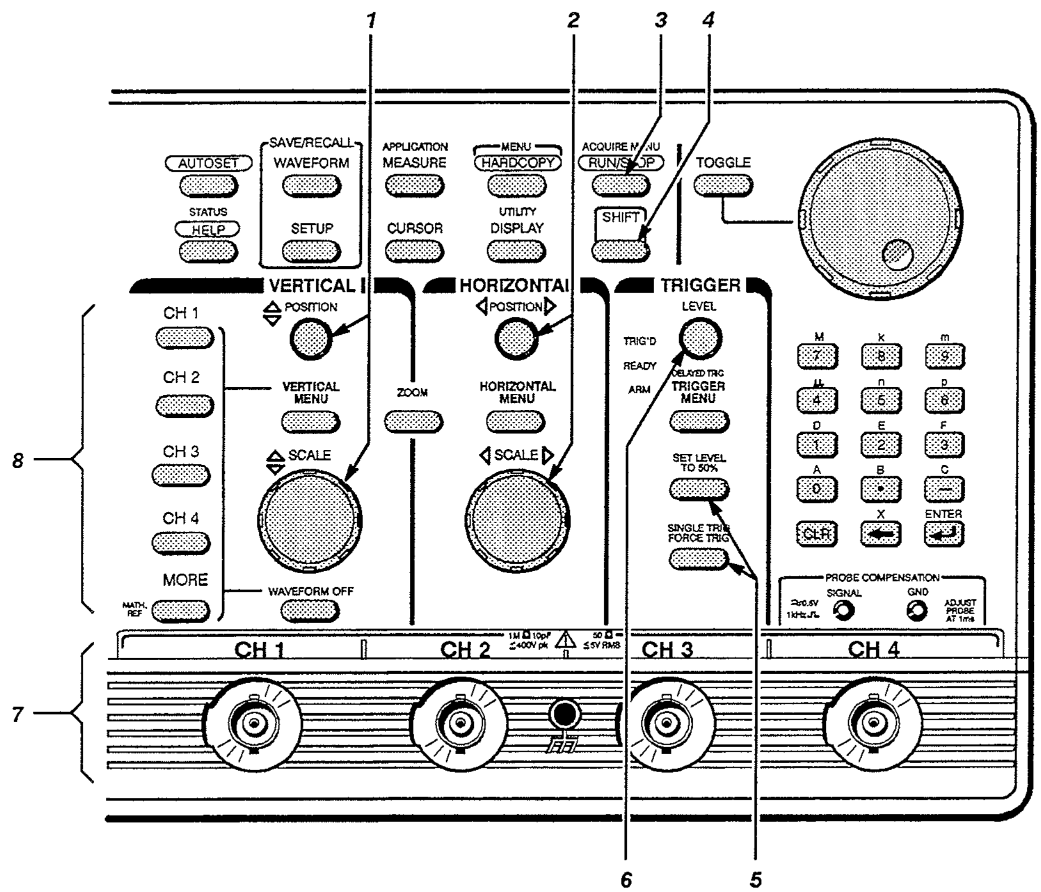
## How to Set Functions

Most functions can be set either by using one (or two) front-panel button(s) or knob(s), or by pushing a front-panel button to use a main menu, and then a side-menu button to set the function. The following steps illustrate both procedures.

1. Locate the block that contains the function to be set.



2. Select the waveform source(s). Position, scale, and set trigger level for waveform source(s) directly from the front-panel. (Examples of possible control selections are given in the steps that follow.)




a. Input waveforms into these channels (7). Example: **CH 1**.

b. Push any channel's button (8) to display its waveform. The last channel turned on determines which waveform is positioned and scaled. The indicator above the channel last selected is lighted. Example: Push **CH 1**; then **CH 2**.

c. Vertically (1) and horizontally (2) scale and position the waveform(s) selected. Example: Set the scale to 100 mV/div and center the waveform on screen.

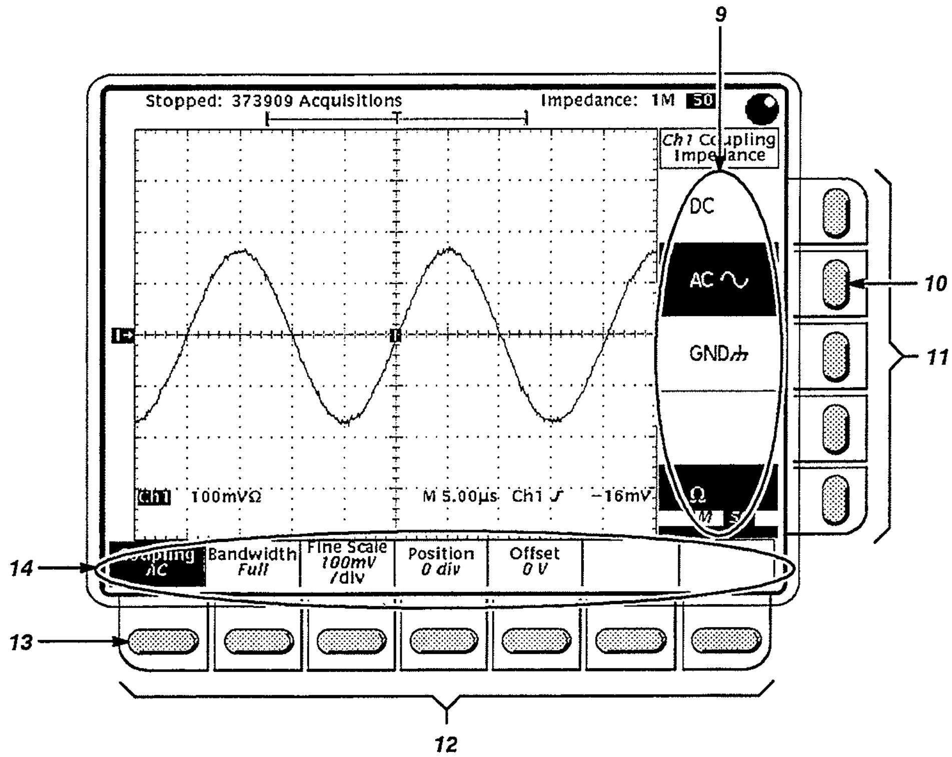
d. Stop and start acquiring waveforms (3). Example: Push **RUN/STOP** if not acquiring.

e. Adjust trigger level (6) to trigger the waveform(s) selected or use these buttons (5) to either set a trigger level at the mid-amplitude level of the selected waveform or to force a single trigger. Example: Push **SET LEVEL TO 50%**.

3. Set all other functions using menus.

   a. Choose the waveform source (8) first if setting a vertical function; else skip to step b. Example: Push **CH 2**.

   b. Push **SHIFT** (4) if the function to be set is highlighted in blue; else skip to step c.




   c. Push the front-panel button that corresponds to the menu containing the function. A main menu (14) for selecting among related functions appears. Example: Push **VERTICAL MENU**.

      Note the two labels: the top label is a function to choose from; the bottom label tells you the current setting for that function. **Offset** is currently set to ***0 V***.

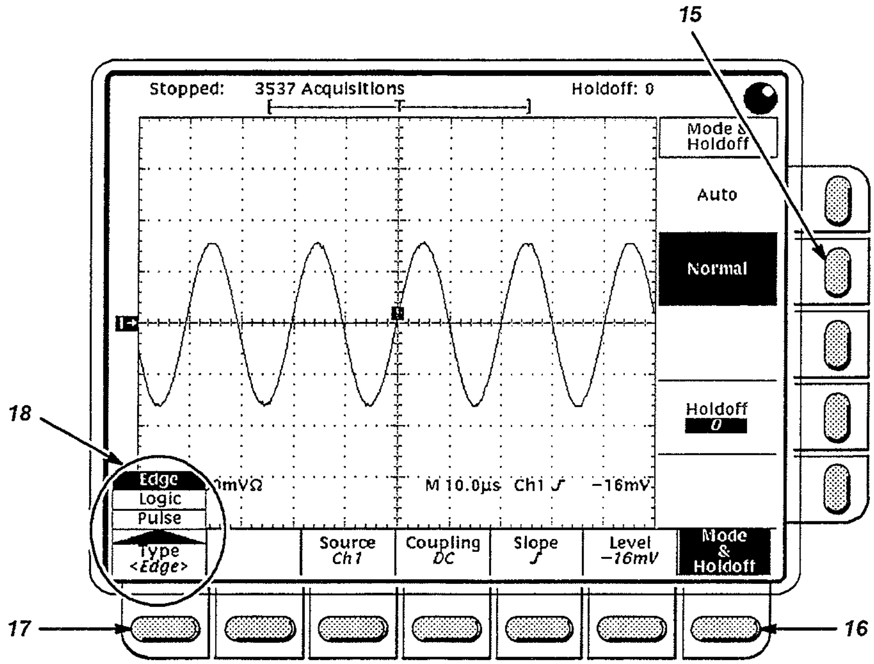
   d. Select a function from the main menu using the main-menu buttons (12). A side menu for selecting among that the available settings for that function appears. Example: Push **Coupling** (13).

   e. Select the setting for the function from the side menu (9) using the side-menu buttons (11). Example: Push **AC** (10).

## How to Set Complex Functions

A few functions require more than just two levels (main and side) of menus to completely specify their settings. In such cases, either the main menu, the side menu, or both are modified to supply additional choices. The procedures that follow show both schemes.

1. Set up a function using pop-up menus:



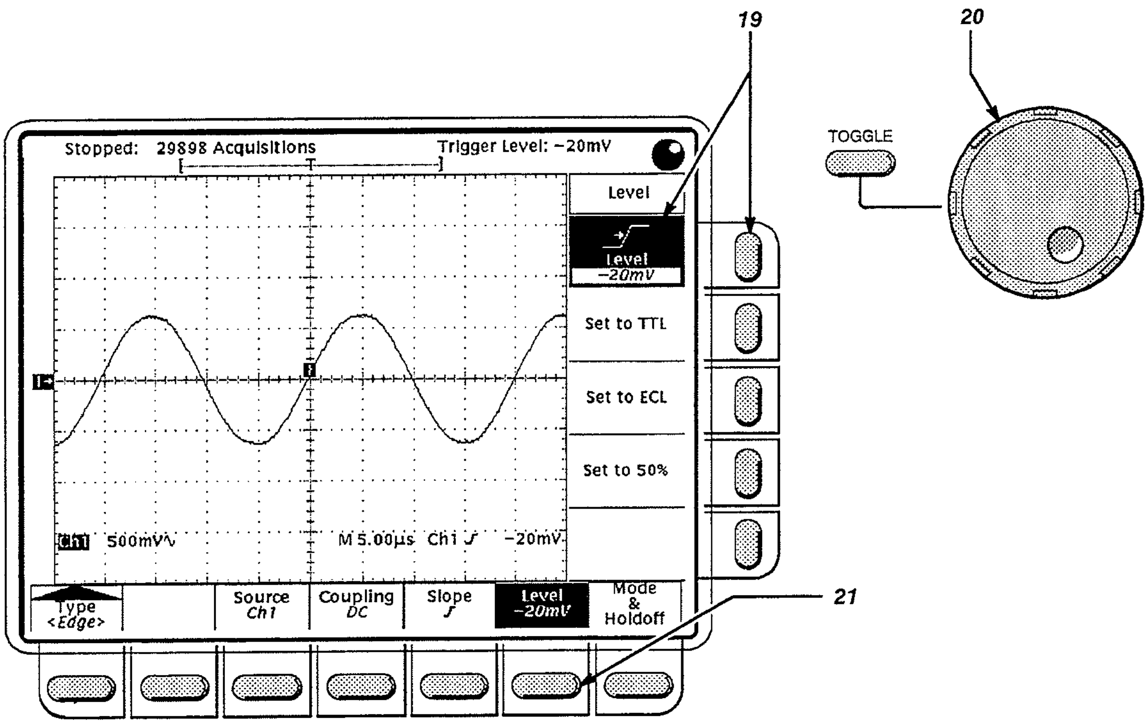

a. For some selections, pushing a main-menu button pops up a menu (18) of subfunctions. Example: Push **Type** (17).

   Note the pop-up menu for **Type** is set to **Edge.** All the main-menu buttons to the right of the pop-up menu are labeled with subfunctions of **Edge**.

b. Pushing the button that popped up the menu (17) toggles through the pop-up menu choices. Example: Repeatedly push **Type** to toggle through the pop-up menu. Notice the other main-menu button labels change accordingly. Toggle back to **Edge**.

c. Complete the setting of the desired mode by selecting from the main menu and the side menu that results. Example: Push **Mode & Holdoff** (16), and then push **Normal** (15).

2. Set up a function using the general purpose knob (20). (The examples of possible menu selections in the substeps that follow assume you've pushed **TRIGGER MENU**.)




a. Pushing some main-menu buttons displays a side menu with labels containing readouts that can be varied. Example: Push **Level** (21).

b. Pushing the side-menu button **Level** assigns the general purpose knob to control the readout appearing in the button label. It also copies the readout to the general purpose knob readout area in the right corner of the screen. Example: Push **Level** (19).

c. Use the general purpose knob (20) to adjust the trigger level to the setting desired. Example: Turn the knob to **–20 mV**.

**More About the General Purpose Knob**—As you've just seen, the general purpose knob can be used to extend the number of choices available to a side menu button. The general purpose knob can also be assigned to control the following functions:

- Cursor positioning
- Display intensities
- Delay time
- Gated measurements
- Number of events
- Template generation

- Trigger position
- Holdoff
- Offset
- Variable persistence

In all cases, the menus are used to select the function to which the general purpose knob is assigned. The following attributes apply to this knob:

- Depending on the function it is assigned to control, the general purpose knob may vary numerical readouts, position objects (cursors) on screen, or select between icon-label settings that show up in side-menu labels.
- The general purpose knob has a readout area at the upper right corner of the screen. (See Figure 2-1.) This readout always reflects the name and value of the function that the general purpose knob is currently controlling.
- Whenever the general purpose knob assignment is changed, a knob icon appears immediately to the left of the general purpose knob readout to notify you of the assignment change. The icon is removed as soon as you use the general purpose knob to change the value of the function it is assigned to.
- To assign the general purpose knob to control a function, display the menu containing the function; then select the function. (Note that not all functions can be controlled by the general purpose knob.)
- Whenever the menu is removed, the general purpose knob is not assigned and doesn't control any function. (An exception is the cursor function. If cursors are turned on, removing the menu leaves the knob assigned to control the cursors until reassigned by selecting another menu and function that uses the knob.)
- When the **SHIFT** button is lit, the general purpose knob becomes a coarse adjustment. When the **SHIFT** button is not lit, the general purpose knob becomes a fine adjustment.
- The general purpose knob also has a **TOGGLE** button. The toggle button is used to toggle the knob between the control of either of the two cursors displayed when H-bar or V-bar cursors are turned on in the cursor menu.

**Display and Utility Menus**—Using the techniques described for using menus, you can access and change functions in the display menu and utilities menu. In the Display menu, you can set the following functions:

- Intensity: waveforms, readouts, graticule, etc.
- Style of waveform display(s): vectors or dots, intensified or non-intensified samples, and infinite or variable persistence.
- Display format: XY or YT.
- Graticule format: type.
- Waveform interpolation filter and readout options.

From the Utility menu, you can configure the GPIB port (talk/listen, address, etc.) and access internal routines for self diagnostics and self compensation. Instructions for setting up communication over the GPIB are found in Section 5, *Adjustment Procedures.*

# Theory of Operation

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# Circuit Description

This section describes the electrical operation of the TDS 640 Digitizing Oscilloscope using the major circuit blocks or modules.

This section has two main parts:

- **Logic Conventions** describes how logic functions are discussed and represented in this manual.
- **Module Overview** describes circuit operation from a functional-circuit block perspective.

## Logic Conventions

The TDS 640 Digitizing Oscilloscope contains many digital logic circuits. This manual refers to these circuits with standard logic symbols and terms. Unless otherwise stated, all logic functions are described using the positive-logic convention: the more positive of the two logic levels is the high (1) state, and the more negative level is the low (0) state. Signal states may also be described as "true" meaning their active state or "false" meaning their non-active state. The specific voltages that constitute a high or low state vary among the electronic devices.

Active-low signals are indicated by a tilde prefixed to the signal name (~RESET). Signal names are considered to be either active-high, active-low, or to have both active-high and active-low states.

## Module Overview

This module overview describes the basic operation of each functional circuit block as shown in Figure 9-2.

### General

The Tektronix TDS 640 Digitizing Oscilloscope is a portable, four-channel instrument. Each channel provides a calibrated vertical scale factor. All of the four channels can be simultaneously acquired at the maximum digitizing rate of 2 GSamples/sec.

### Input Signal Path

A signal enters the oscilloscope through a probe connected to a BNC on the A15 Attenuator board.

**Attenuators** – Circuitry in the attenuator selects the input coupling, termination, and the attenuation factor. The processor system, by way of the acquisition system, controls the attenuators. For example, if 50 Ω input termination is selected and the input is overloaded, the processor system switches the input to the 1 MΩ position.

**Probe Coding Interface** – Probe coding interface signals pass through the A15 Attenuator to the acquisition system, where they are sensed and controlled.

**Acquisition System** – The acquisition system amplifies the input signals, samples them, converts them to digital signals, and controls the acquisition process under direction of the processor system. The acquisition system includes the trigger, acquisition timing, and acquisition mode generation and control circuitry.

**D1 Bus** – The acquisition system passes the digital values representing the acquired waveform through the A14 D1 Bus to the A11 DRAM Processor/Display board. This happens after a waveform acquisition is complete if the digital signal processor in the processor system requests the waveform.

**Processor System** – The processor system contains a 68020 microprocessor that controls the entire instrument. It also includes a GPIB interface and a digital signal processor. The digital signal processor processes each waveform as directed by software downloaded from the A13 Firmface by the system processor. Waveforms and any text to be displayed are passed on to the display system. The A11 DRAM Processor/Display board contains both the processor and display systems.

**Display System** – Text and waveforms are processed by different parts of the display circuitry. The display system sends the text and waveform information to the tube assembly as a video signal. The display system also generates and sends vertical (VSYNC) and horizontal (HSYNC) sync signals to the tube assembly.

## Voltage Controlled Oscillator (VCO)

Master clocks for the acquisition system are generated by the circuitry on the A10 Acquisition board. The circuitry makes up a phased locked loop. The master clock is divided down by the A10 Acquisition circuitry under control of the processor system.

## Firmface

The A13 Firmface contains the firmware program for the oscilloscope. The firmware can be reprogrammed by reburning the ROMs using the GPIB and an external software package.

## Tube Assembly

All information (waveforms, text, graticules, and pictographs) is displayed by the A20 Display (tube) assembly. It generates the high voltages necessary to drive the display tube. It also contains the video amplifier, horizontal oscillator, and the vertical and horizontal yoke driver circuitry.

## Front Panel

The processor system sends instructions to and receives information from the Front Panel Processor on the A12 Front Panel board. The Front Panel Processor reads the front-panel switches and ports. Any changes in their settings are reported to the processor system. The Front Panel Processor also turns the LEDs on and off and generates the bell signal.

Front-panel menu switches are also read by the Front Panel Processor. The processor sends any changes in menu selections to the processor system. The **ON/STBY** switch is one of the menu switches. However, it is not read by the Front Panel Processor, but passes through the A12 Front Panel board and the A11 DRAM Processor/Display board to the low voltage power supply.

The front panel also generates the probe compensation signals **SIGNAL** and **GND**.

## Rear Panel

The **GPIB** connector provides access to stored waveforms, and allows external control of the oscilloscope.

## Low Voltage Power Supply

The low voltage power supply is a switching power converter with active power factor control. It supplies power to all of the circuitry in the oscilloscope.

The principal **POWER** switch, located on the rear panel, controls all power to the oscilloscope including the Low Voltage Power Supply. The **ON/STBY** switch, located on the front panel, also controls all of the power to the oscilloscope except for part of the circuitry in the Low Voltage Power Supply.

The power supply sends a power fail (~PF) warning to the processor system if the power is going down.

## Fan

The fan provides forced air cooling for the oscilloscope. It connects to +25 V from the Low Voltage Power Supply by way of the A11 DRAM Processor/Display module.

# Performance Verification

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# Brief Procedures

The *Self Tests* use internal routines to confirm basic functionality and proper adjustment. No test equipment is required to do these test procedures.

The *Functional Tests* utilize the probe-compensation output at the front panel as a test-signal source for further verifying that the oscilloscope functions properly. A standard-accessory probe, included with this oscilloscope, is the only equipment required.

## General Instructions

These procedures verify the TDS 640 Digitizing Oscilloscope.

Besides the *Brief Procedures,* the set of procedures that can be used to verify oscilloscope performance includes the *Performance Tests,* found later in this section. You may not need to perform all of these procedures, depending on what you want to accomplish:

- To rapidly confirm that the oscilloscope functions and was adjusted properly, just do the procedures under *Self Tests*, which begin on page 4-4.

  **Advantages:** These procedures are quick to do, require no external equipment or signal sources, and perform extensive functional and accuracy testing to provide high confidence that the oscilloscope will perform properly. They can be used as a quick check before making a series of important measurements.

- To further check functionality, first do the *Self Tests* just mentioned; then do the procedures under *Functional Tests* that begin on page 4-6.

  **Advantages:** These procedures require minimal additional time to perform, require no additional equipment other than a standard-accessory probe, and more completely test the internal hardware of the oscilloscope. They can be used to quickly determine if the oscilloscope is suitable for putting into service, such as when it is first received.

- If more extensive confirmation of performance is desired, do the *Performance Tests*, beginning on page 4-11, after doing the *Functional* and *Self Tests* just referenced.

  **Advantages:** These procedures add direct checking of warranted specifications. They require more time to perform and suitable test equipment is required. (See *Equipment Required* beginning on page 4-11.)

If you are not familiar with operating this oscilloscope, read *General Operating Instructions* in Section 2 of this manual. These instructions will acquaint you with the use of the front-panel controls and the menu system.

## Conventions

Throughout these procedures the following conventions apply:

- Each test procedure uses the following general format:

  Title of Test

  Equipment Required

  Prerequisites

  Procedure

- Each procedure consists of as many steps, substeps, and subparts as required to do the test. Steps, substeps, and subparts are sequenced as follows:

1. First Step
   a. First Substep
      - First Subpart
      - Second Subpart
   b. Second Substep
2. Second Step

- In steps and substeps, the lead-in statement in italics instructs you what to do, while the instructions that follow tell you how to do it, as in the example step below, *"Initialize the oscilloscope"* by doing "Press save/recall **SETUP**. Now, press the main-menu button...".

  *Initialize the oscilloscope:* Press save/recall **SETUP**. Now, press the main-menu button **Recall Factory Setup**; then the side-menu button **OK Confirm Factory Init**.

- Where instructed to use a front-panel button or knob, or select from a main or side menu, or verify a readout or status message, the name of the button or knob appears in boldface type: "press **SHIFT**; then **UTILITY**", "press the main-menu button **System**" until **Cal** is highlighted in the pop-up menu. Verify that the status message is ***Pass*** in the main menu under the **Voltage Reference** label.

STOP The symbol at the left is accompanied by information you must read to do the procedure properly.

- Refer to Figure 4-1: "Main menu" refers to the menu that labels the seven menu buttons under the display; "side menu" refers to the menu that labels the five buttons to the right of the display. "Pop-up menu" refers to a menu that pops up when a main-menu button is pressed.

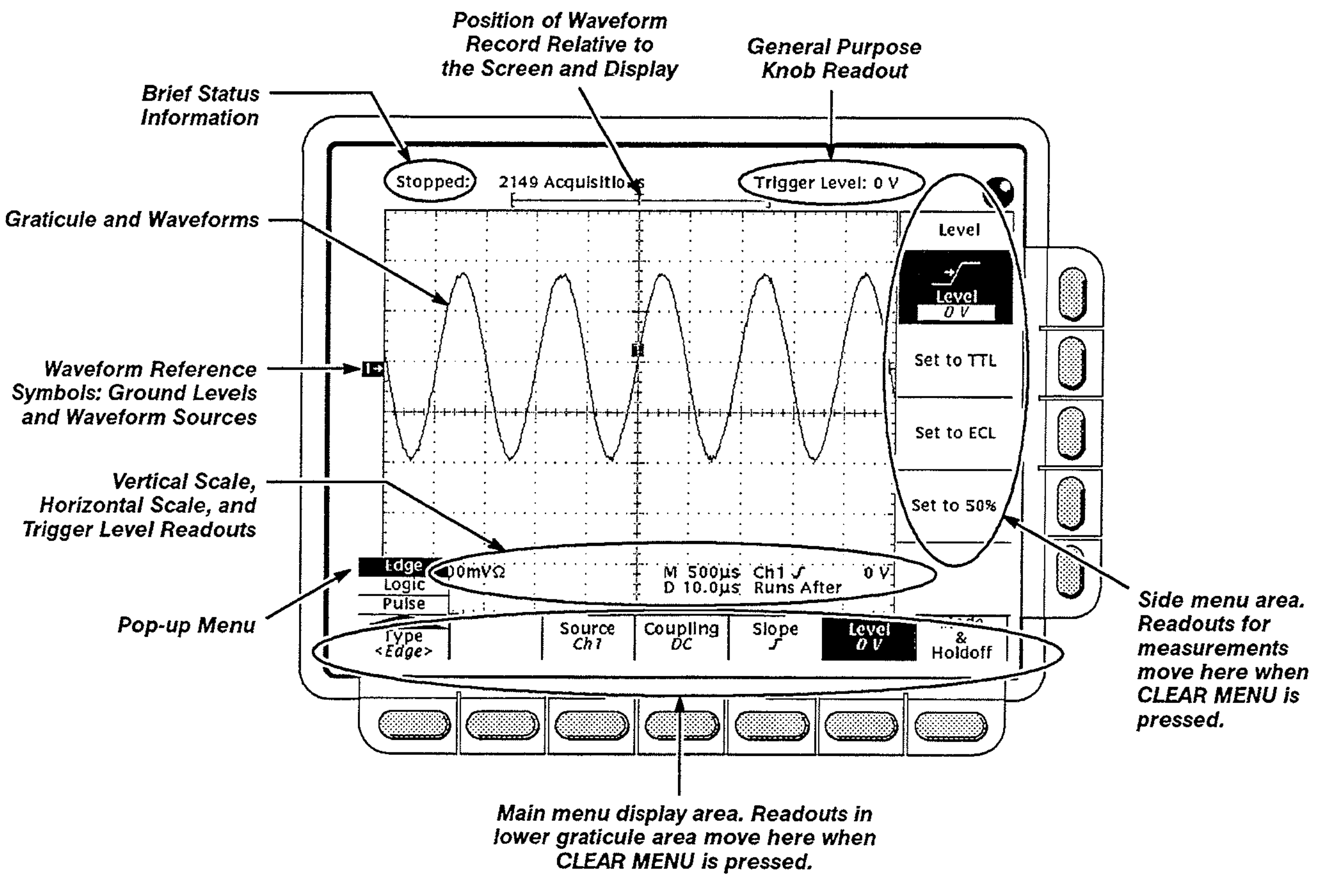



**Figure 4-1: Map of Display Functions**

## Self Tests

This procedure uses internal routines to verify that the oscilloscope functions and was adjusted properly. No test equipment or hookups are required.

### Verify Internal Adjustment, Self Compensation, and Diagnostics

**Equipment Required:** None.

**Prerequisites:** Power on the Digitizing Oscilloscope and allow a 20 minute warm-up before doing this procedure.

**Procedure:**

1. *Verify that internal diagnostics pass:* Do the following substeps to verify passing of internal diagnostics.

   a. *Display the System diagnostics menu:*

      - Press **SHIFT**; then press **UTILITY**.
      - Repeatedly press the main-menu button **System** until **Diag/Err** is highlighted in the pop-up menu.

   b. *Run the System Diagnostics:*

      - First disconnect any input signals from all four channels.
      - Press the main-menu button **Execute**; then press the side-menu button **OK Confirm Run Test**.

   c. *Wait:* The internal diagnostics do an exhaustive verification of proper oscilloscope function. This verification will take up to two minutes. While it progresses, a "clock" icon (shown at left) is displayed on-screen. When finished, the resulting status will appear on the screen.

   d. *Confirm no failures are found:* Verify that no failures are found and reported on-screen.

   e. *Confirm the three adjustment sections have passed status:*

      - Press **SHIFT**; then press **UTILITY**.
      - Press the main-menu button **System** until **Cal** is highlighted in the pop-up menu.
      - Verify that the word ***Pass*** appears in the main menu under the following menu labels: **Voltage Reference**, **Frequency Response**, and **Pulse Trigger**. (See Figure 4-2.)

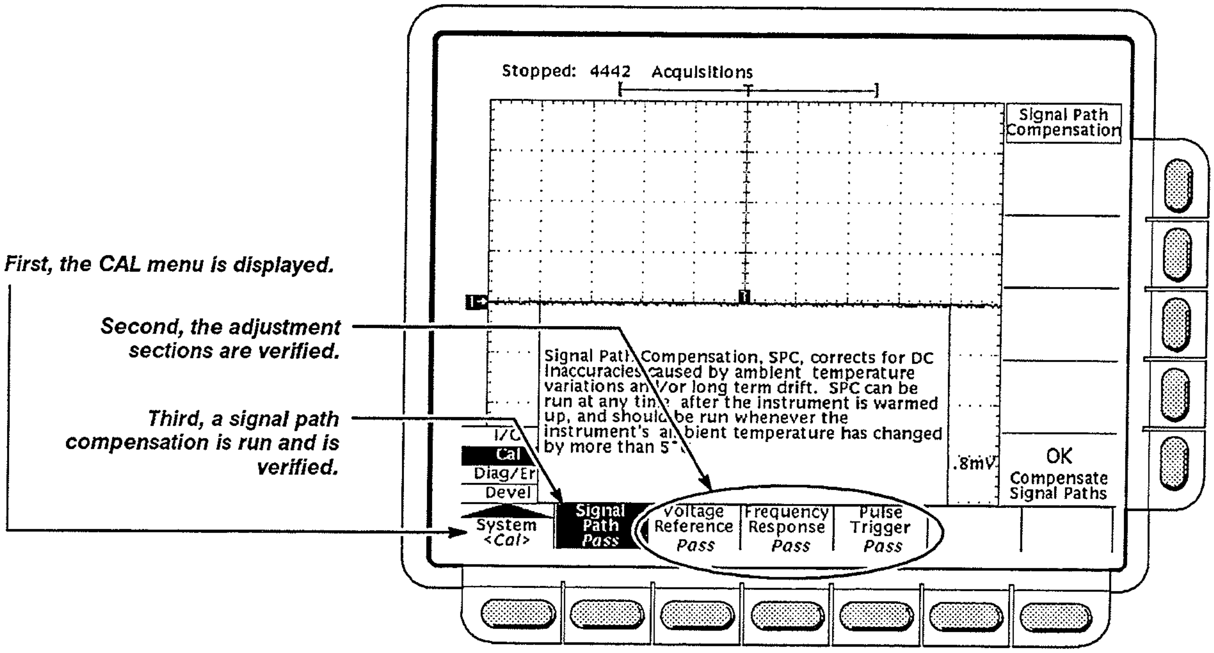



Figure 4-2: Verifying Adjustments and Signal-Path Compensation

f. *Run the signal-path compensation:* Press the main-menu button **Signal Path**; then press the side-menu button **OK Compensate Signal Paths**.

g. *Wait:* Signal-path compensation runs in about one to two minutes. While it progresses, a "clock" icon (shown at left) is displayed on-screen. When compensation completes, the status message will be updated to *Pass* or *Fail* in the main menu (see step h).

h. *Confirm signal-path compensation returns passed status:* Verify that the word ***Pass*** appears under **Signal Path** in the main menu. (See Figure 4-2.)

2. *Return to regular service:* Press **CLEAR MENU** to exit the system menus.

## Functional Tests

The purpose of these procedures is to confirm that the oscilloscope functions properly. The only equipment required is one of the standard-accessory probes.

**WARNING**

*The standard P6205 probes supplied with this oscilloscope provide an extremely low loading capacitance (<2 pF) to ensure the best possible signal reproduction. These probes should not be used to measure signals exceeding ±10 volts, or errors in signal measurement will be observed. Above 40 volts, damage to the probe may result. To make measurements beyond ±10 volts, use either the P6139A probe (good to 500 volts), or refer to the catalog for a recommended probe.*

STOP: These procedures verify functions; that is, they verify that the oscilloscope features *operate*. They do *not* verify that they operate within limits.

Therefore, when the instructions in the functional tests that follow call for you to verify that a signal appears on-screen "that is about five divisions in amplitude" or "has a period of about six horizontal divisions," etc., do *NOT* interpret the quantities given as limits. Operation within limits is checked in *Performance Tests*, which begin on page 4-11.

STOP: DO NOT make changes to the front-panel settings that are not called out in the procedures. Each verification procedure will require you to set the oscilloscope to certain default settings before verifying functions. If you make changes to these settings, other than those called out in the procedure, you may obtain invalid results. In this case, just redo the procedure from step 1.

When you are instructed to press a menu button, the button may already be selected (its label will be highlighted). If this is the case, it is not necessary to press the button.

## Verify All Input Channels

**Equipment Required:** One P6139A or P6205 probe.

**Prerequisites:** None.

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*

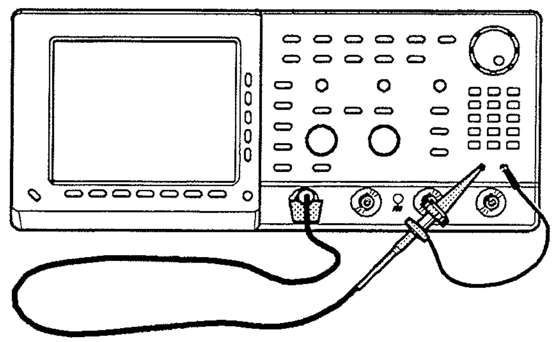


**Figure 4-3: Universal Test Hookup for Functional Tests**

   a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**.

   b. *Initialize the oscilloscope:*

      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init.**

2. *Verify that all input channels operate:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already set up for verification from step 1.*

   a. *Select an unverified channel:*

      - Press **WAVEFORM OFF** to remove the channel just verified from display.
      - Press the front-panel button that corresponds to the channel you are to verify.
      - Move the probe to the channel you selected.

   b. *Set up the selected channel:*

      - Press **AUTOSET** to obtain a viewable, triggered display in the selected channel.
      - Set the horizontal **SCALE** to 250 μs. Press **CLEAR MENU** to remove any menu that may be on the screen.

   c. *Verify that the channel is operational:* Confirm that the following statements are true.

- The vertical scale readout for the channel under test shows a setting of 200 mV, and a square-wave probe-compensation signal about 2.5 divisions in amplitude is on-screen. (See Figure 4-1 on page 4-3 to locate the readout.)
- The vertical **POSITION** knob moves the signal up and down the screen when rotated.
- Turning the vertical **SCALE** knob counterclockwise decreases the amplitude of the waveform on-screen, turning the knob clockwise increases the amplitude, and returning the knob to 200 mV returns the amplitude to about 2.5 divisions.

d. *Verify that the channel acquires in all acquisition modes:* Press **SHIFT**; then press **ACQUIRE MENU**. Use the side menu to select, in turn, each of the three hardware acquire modes and confirm that the following statements are true. Refer to the icons at the left of each statement as you confirm those statements.

- **Sample** mode displays an actively acquiring waveform on-screen. (Note that there is noise present on the peaks of the square wave.)

- **Envelope** mode displays an actively acquiring waveform on-screen with the noise displayed.

- **Average** mode displays an actively acquiring waveform on-screen with the noise reduced.

e. *Test all channels:* Repeat substeps a through d until all four input channels are verified.

3. *Remove the test hookup:* Disconnect the probe from the channel input and the probe-compensation terminals.

## Verify the Time Base

**Equipment Required:** One P6139A or P6205 probe.

**Prerequisites:** None.

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*

   a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**. (See Figure 4-3 on page 4-7.)

   b. *Initialize the oscilloscope:*

   - Press save/recall **SETUP**.
   - Press the main-menu button **Recall Factory Setup**; then press the side-menu button **OK Confirm Factory Init**.

c. *Modify default settings:*
   - Press **AUTOSET** to obtain a viewable, triggered display.
   - Set the horizontal **SCALE** to 250 μs.
   - Press **CLEAR MENU** to remove the menus from the screen.

2. *Verify that the time base operates:* Confirm the following statements.
   a. One period of the square-wave probe-compensation signal is about four horizontal divisions on-screen for the 250 μs horizontal scale setting (set in step 1c).
   b. Rotating the horizontal **SCALE** knob clockwise expands the waveform on-screen (more horizontal divisions per waveform period), counter-clockwise rotation contracts it, and returning the horizontal scale to 250 μs returns the period to about four divisions.
   c. The horizontal **POSITION** knob positions the signal left and right on-screen when rotated.
3. *Remove the test hookup:* Disconnect the probe from the channel input and the probe-compensation terminals.

## Verify the Main and Delayed Trigger Systems

**Equipment Required:** One P6139A or P6205 probe.

**Prerequisites:** None.

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*
   a. *Hook up the signal source:* Install the probe on **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**. (See Figure 4-3 on page 4-7.)
   b. *Initialize the oscilloscope:*
      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.
   c. *Modify default settings:*
      - Press **AUTOSET** to obtain a viewable, triggered display.
      - Set the horizontal **SCALE** for the **M** (main) time base to 250 μs.
      - Press **TRIGGER MENU**.
      - Press the main-menu button **Mode & Holdoff**.
      - Press the side-menu button **Normal**.
      - Press **CLEAR MENU** to remove the menus from the screen.

2. *Verify that the main trigger system operates:* Confirm that the following statements are true.
   - The trigger level readout for the main trigger system changes with the trigger-**LEVEL** knob.
   - The trigger-level knob can trigger and untrigger the square-wave signal as you rotate it. (Leave the signal *un*triggered, which is indicated by the display not updating.)
   - Pressing **SET LEVEL TO 50%** triggers the signal that you just left untriggered. (Leave the signal triggered.)
3. *Verify that the delayed trigger system operates:*
   a. *Select the delayed time base:*
      - Press **HORIZONTAL MENU**.
      - Press the main-menu button **Time Base**.
      - Press the side-menu button **Delayed Triggerable**; then press the side-menu button **Delayed Only**.
      - Set the horizontal **SCALE** for the **D** (delayed) time base to 250 μs.

   b. *Select the delayed trigger level menu:*
      - Press **SHIFT**; then press **DELAYED TRIG**.
      - Press the main-menu button **Level**; then press the side-menu button **Level**.

   c. *Confirm that the following statements are true*:
      - The trigger-level readout for the delayed trigger system changes with the general purpose knob.
      - The general purpose knob can trigger and untrigger the square-wave probe-compensation signal as you rotate it. (Leave the signal *un*triggered, which is indicated by the display not updating.)
      - Pressing the side-menu button **Set to 50%** triggers the probe-compensation signal that you just left untriggered. (Leave the signal triggered.)

   d. *Verify the delayed trigger counter:*
      - Press the main-menu button **Delay by *Time***.
      - Use the keypad to enter a delay time of 1 second. Press **1**, then press **ENTER**.
      - Verify that the trigger **READY** indicator on the front panel flashes about once every second as the waveform is updated on-screen.
4. *Remove the test hookup:* Disconnect the standard-accessory probe from the channel input and the probe-compensation terminals.

# Performance Tests

This subsection contains a collection of procedures for checking that the TDS 640 Digitizing Oscilloscope performs as warranted.

The procedures are arranged in four logical groupings: *Signal Acquisition System Checks*, *Time Base System Checks, Triggering System Checks*, and *Output Ports Checks*. They check all the characteristics that are designated as checked in Section 1, *Specification.* (The characteristics that are checked appear in **boldface** type under *Warranted Characteristics* in Section 1.)

STOP These procedures *extend* the confidence level provided by the basic procedures described on page 4-1. The basic procedures should be done first, then these procedures performed if desired.

## Prerequisites

The tests in this subsection comprise an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The cabinet must be installed on the Digitizing Oscilloscope.
- You must have performed and passed the procedures under *Self Tests,* found on page 4-4, and those under *Functional Tests,* found on page 4-6.
- A signal-path compensation must have been done within the recommended calibration interval and at a temperature within ±5°C of the present operating temperature. (If at the time you did the prerequisite *Self Tests,* the temperature was within the limits just stated, consider this prerequisite met.)
- The Digitizing Oscilloscope must have been last adjusted at an ambient temperature between +20°C and +30°C, must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperature between 0°C and +50°C. (The warm-up requirement is usually met in the course of meeting the first prerequisite listed above.)

**Related Information** – Read *General Instructions* and *Conventions* that start on page 4-1. Also, if you are not familiar with operating the Digitizing Oscilloscope, read *General Operating Instructions* in Section 3 of this manual before doing any of these procedures.

## Equipment Required

These procedures use external, traceable signal sources to directly check warranted characteristics. The required equipment list follows this introduction.

**Table 4-1: Test Equipment**

| Item Number and Description | Minimum Requirements | Example | Purpose |
|---|---|---|---|
| 1. Attenuator,10X (three required) | Ratio: 10X; impedance 50 Ω; connectors: female BNC input, male BNC output | Tektronix part number 011-0059-02 | Signal Attenuation |
| 2. Attenuator, 5X | Ratio: 5X; impedance 50 Ω; connectors: female BNC input, male BNC output | Tektronix part number 011-0060-02 | Signal Attenuation |
| 3. Adapter, BNC female to Clip Leads | BNC female to Clip Leads | Tektronix part number 013-0076-00 | Signal Coupling for Probe Compensator Output Check |
| 4. Terminator, 50 Ω | Impedance 50 Ω; connectors: female BNC input, male BNC output | Tektronix part number 011-0049-01 | Signal Termination for Channel Delay Test |
| 5. Cable, Precision Coaxial (two required) | 50 Ω, 36 in, male to male BNC connectors | Tektronix part number 012-0482-00 | Signal Interconnection |
| 6. Connector, Dual-Banana (two required) | Female BNC to dual banana | Tektronix part number 103-0090-00 | Various Accuracy Tests |
| 7. Connector, BNC "T" | Male BNC to dual female BNC | Tektronix part number 103-0030-00 | Checking Trigger Sensitivity |
| 8. Coupler, Dual-Input | Female BNC to dual male BNC | Tektronix part number 067-0525-02 | Checking Delay Between Channels |
| 9. Generator, DC Calibration | Variable amplitude to ±104 V; accuracy to 0.1% | Data Precision 8200 | Checking DC Offset, Gain, and Measurement Accuracy |
| 10. Generator, Calibration | 500 mV square wave calibrator amplitude; accuracy to 0.25% | TEKTRONIX PG 506A[1] | To check accuracy of the CH 3 Signal Out |
| 11. Generator, Leveled Sine Wave, Medium-Frequency | 200 kHz to 250 MHz; Variable amplitude from 5 mV to 4 V p-p into 50 Ω | TEKTRONIX SG 503 Leveled Sine Wave Generator[1] | Checking Trigger Sensitivity at low frequencies |
| 12. Generator, Leveled Sine Wave, High-Frequency | 250 MHz to 500 MHz; Variable amplitude from 500 mV to 4 V p-p into 50 Ω; 6 MHz reference | TEKTRONIX SG 504 Leveled Sine Wave Generator[1] with a TM 500 Series Power Module with SG 504 Output Head | Checking Analog Bandwidth and Trigger Sensitivity at high frequencies |
| 13. Generator, Time Mark | Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm | TEKTRONIX TG 501A Time Mark Generator[1] | Checking Sample-Rate and Delay-time Accuracy |

[1]**Requires a TM 500 or TM 5000 Series Power Module Mainframe.**

**Table 4-1: Test Equipment (Cont.)**

| Item Number and Description | Minimum Requirements | Example | Purpose |
|---|---|---|---|
| 14. Probe, 10X, included with this instrument | A P6205 probe[2] | Tektronix number P6205 | Signal Interconnection |

**[2]Warning: The Standard P6205 probes supplied with this oscilloscope provide an extremely low loading capacitance (<2pF) to ensure the best possible signal reproduction. These probes should not be used to measure signals exceeding ±10V, or errors in signal measurement will be observed. Above 40V, damage to the probe may result. To make measurements beyond ±10V, use either the P6139A probe (good to 500V), or refer to the catalog for a recommended probe.**

## Signal Acquisition System Checks

These procedures check those characteristics that relate to the signal-acquisition system and are listed as checked under *Warranted Characteristics* in Section 1, *Specification.*

### Check Accuracy of Offset (Zero Setting)

**Equipment Required:** None.

**Prerequisites:** The oscilloscope must meet the prerequisites listed on page 4-11.

1. *Preset the instrument controls:*
   a. *Initialize the oscilloscope:*
      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.
      - Press **CLEAR MENU** to remove the menus from the screen.

   b. *Modify the default settings:*
      - Set the horizontal **SCALE** to 1 ms.
      - Press **SHIFT**; then press **ACQUIRE MENU**.
      - Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
      - Press **DISPLAY**.
      - Press the main-menu button **Graticule**; then press the side-menu button **Frame**.
      - Press **CURSOR**.
      - Press the main-menu button **Function**; then press the side-menu button **H Bars**.
      - Press **CLEAR MENU**.
      - Be sure to disconnect any input signals from all four channels.

2. *Confirm input channels are within limits for offset accuracy at zero offset:* Do the following substeps – test CH 1 first, *skipping substep a since CH 1 is already set up to be checked from step 1.*
   a. *Select an unchecked channel:* Press **WAVEFORM OFF** to remove the channel just confirmed from the display. Then, press the front-panel button that corresponds to the channel you are to confirm.

Table 4-2: DC Offset Accuracy (Zero Setting)

| Vertical Scale Setting | Vertical Position and Offset Setting[1] | Offset Accuracy Limits |
|---|---|---|
| 1 mV | 0 | ±1.45 mV |
| 100 mV | 0 | ±68.5 mV |
| 1 V | 0 | ±685 mV |

[1]**Vertical position is set to 0 divisions and vertical offset to 0 V when the oscilloscope is initialized in step 1.**

b. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 4-2 that is not yet checked. (Start with the first setting listed.)

c. *Display the test signal:* The baseline DC test level was initialized for all channels in step 1 and is displayed as you select each channel and its vertical scale. Be sure *not* to use the vertical **POSITION** knob while checking any channel for accuracy of offset, since varying the position invalidates the check.

d. *Measure the test signal:* Rotate the general purpose knob to superimpose the active cursor over the baseline DC test level. (Ignore the other cursor.)

e. Read the measurement results at the absolute (@:) cursor readout, not the delta (Δ:) readout on screen.

f. *Check against limits:* Do the following subparts in the order listed.

- CHECK that the measurement results are within the limits listed for the current vertical scale setting.
- Repeat substeps b through f until all vertical scale settings listed in Table 4-2, are checked for the channel under test.

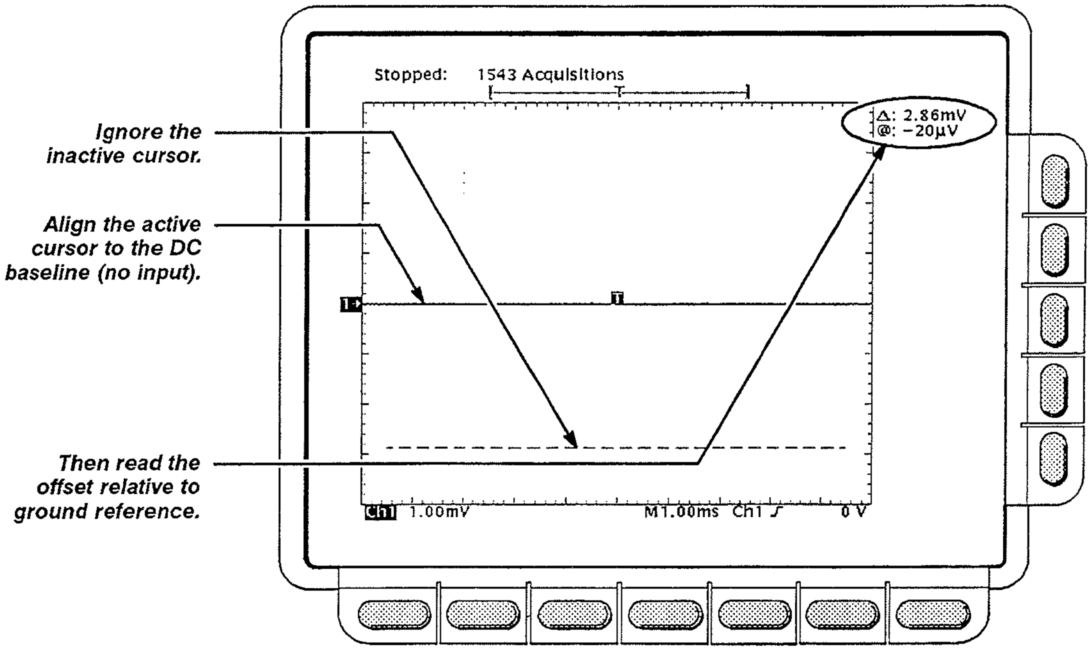



**Figure 4-4: Measurement of DC Offset Accuracy at Zero Setting**

g. *Test all channels:* Repeat substeps a through f for all input channels.

3. *Disconnect the hookup:* No hookup was required.

## Check DC Gain and Voltage Measurement Accuracy

**WARNING**

*Performance of this procedure requires input voltages up to 92 VDC. Be sure to set the DC calibration generator to 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure.*

**Equipment Required:** Two dual-banana connectors (Item 6), one BNC T connector (Item 7), one DC calibration generator (Item 9), and two precision coaxial cables (Item 5).

**Prerequisites:** The oscilloscope must meet the prerequisites listed on page 4-11.

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

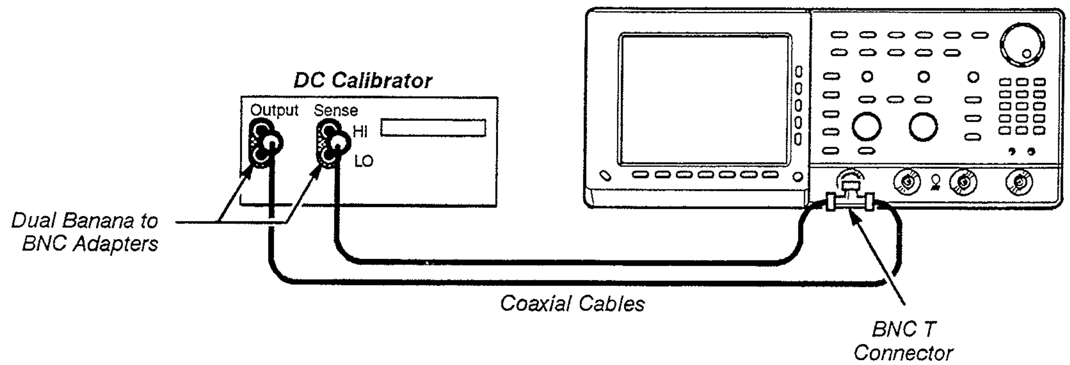



**Figure 4-5: Initial Test Hookup**

a. *Hook up the test-signal source:*

- Set the output of a DC calibration generator to 0 volts.
- Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
- Connect the Sense output of the generator through a second dual-banana connector followed by a 50 Ω precision coaxial cable to the other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

c. *Modify the default settings:*

- Press **SHIFT**; then **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
- Press **CURSOR**.
- Press the main-menu button **Function**; then press the side-menu button **H Bars**.
- Press **DISPLAY**.
- Press the main-menu button **Graticule**; then press the side-menu button **Frame**.

2. *Confirm input channels are within limits for DC delta voltage accuracy:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already selected from step 1.*

a. *Select an unchecked channel:*

- *Set the generator output to 0 V.*
- Press **WAVEFORM OFF** to remove the channel just confirmed from the display.
- Press the front-panel button that corresponds to the next channel you are to confirm.
- Move the test hook up to the channel you select.

b. *Display the test signal:*

- Press **VERTICAL MENU**. Press the main-menu button **Position.**
- Use the keypad to set vertical position to -2.5 divisions (press **-2.5**, then **ENTER**, on the keypad).

c. *Measure the test signal:*

- Press **CURSOR**. Use the general purpose knob to precisely align the active cursor to the DC baseline level on screen.
- Set the generator output to 500 mV.
- Press **TOGGLE**. Use the general purpose knob to precisely align the alternate cursor to the 500 mV DC test level on screen.
- Press **CLEAR MENU**. Read the measurement results from the delta (Δ:) readout, not the absolute (@:) readout. See Figure 4-6.

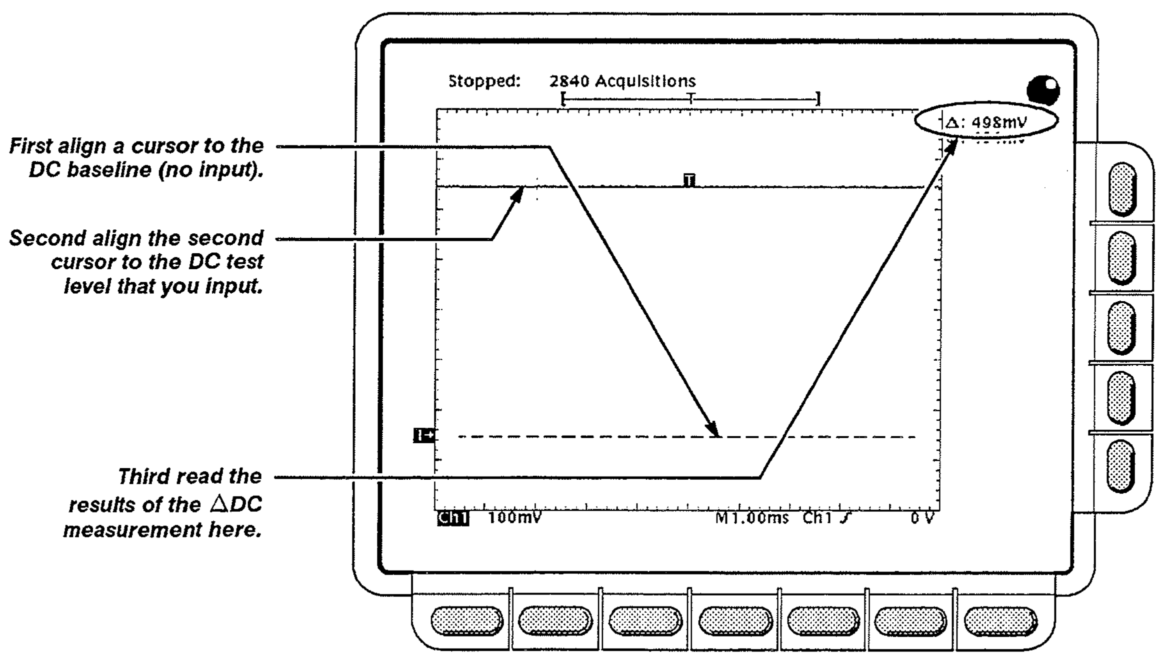



**Figure 4-6: Measurement of the DC Accuracy for Delta Measurements**

d. *Check against limits:* CHECK that the Δ: readout on screen is within 482 mV to 518 mV.

e. *Test all channels:* Repeat substeps a through d for all four channels.

3. *Reestablish the initial test hookup setup:*

a. *Hook up the test-signal source:*

- Set the output of the DC calibration generator to 0 volts.
- Move the BNC T connector back to **CH 1**.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

c. *Modify the default settings:*

- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
- Press **DISPLAY**.
- Press the main-menu button **Graticule**; then press the side-menu button **Frame**.

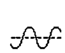
4. *Confirm input channels are within limits for DC accuracy at maximum offset and position:* Do the following substeps—test CH 1 first, *skipping substep a since CH 1 is already selected from step 3.*

a. *Select an unchecked channel:*

- Press **WAVEFORM OFF** to remove the channel just confirmed from the display.
- Press the front-panel button that corresponds to the channel you are to confirm.
- *Set the generator output to 0 V.*
- Move the test hookup to the channel you selected.

b. *Turn on the measurement Mean for the channel:*

- Press **MEASURE**, then press the main-menu button **Select Measurement for CHx**.



- Press the side-menu button **more** until the menu label **Mean** appears in the side menu (its icon is shown at the left). Press the side-menu button **Mean**.
- Press **CLEAR MENU**.

c. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 4-3 that is not yet checked. (Start with the first setting listed.)

**Table 4-3: DC Accuracy**

| Scale Setting | Position Setting (Divs) | Offset Setting | Generator Setting | Accuracy Limits |
|---|---|---|---|---|
| 5 mV | -5 | +1 V | +1.040 V | +1.0329 V to +1.0471 V |
| | +5 | -1 V | -1.040 V | -1.0329 V to -1.0471 V |
| 200 mV | -5 | +10 V | +11.6 V | +11.405 V to +11.795 V |
| | +5 | -10 V | -11.6 V | -11.405 V to -11.795 V |
| 1 V | -5 | +92 V | +100 V | +98.81 V to +101.19 V |
| | +5 | -92 V | -100 V | -98.81 V to -101.19 V |

d. *Display the test signal:*

- Press **VERTICAL MENU**. Press the main-menu button **Position**.
- Use the keypad to set vertical position to –5 divisions (press **–5**, then **ENTER**, on the keypad). The baseline level will move off screen.
- Press the main-menu button **Offset**.
- Use the keypad to set vertical offset to the positive-polarity setting listed in the table for the current vertical scale setting. The baseline level will remain off screen.
- Set the generator to the level and polarity indicated in the table for the vertical scale, position, and offset settings you have made. The DC test level should appear on screen. (If it doesn't return, the DC accuracy check is failed for the current vertical scale setting of the current channel.)

e. *Measure the test signal:* Press **CLEAR MENU**. Read the measurement results at the **Mean** measurement readout. See Figure 4-7.

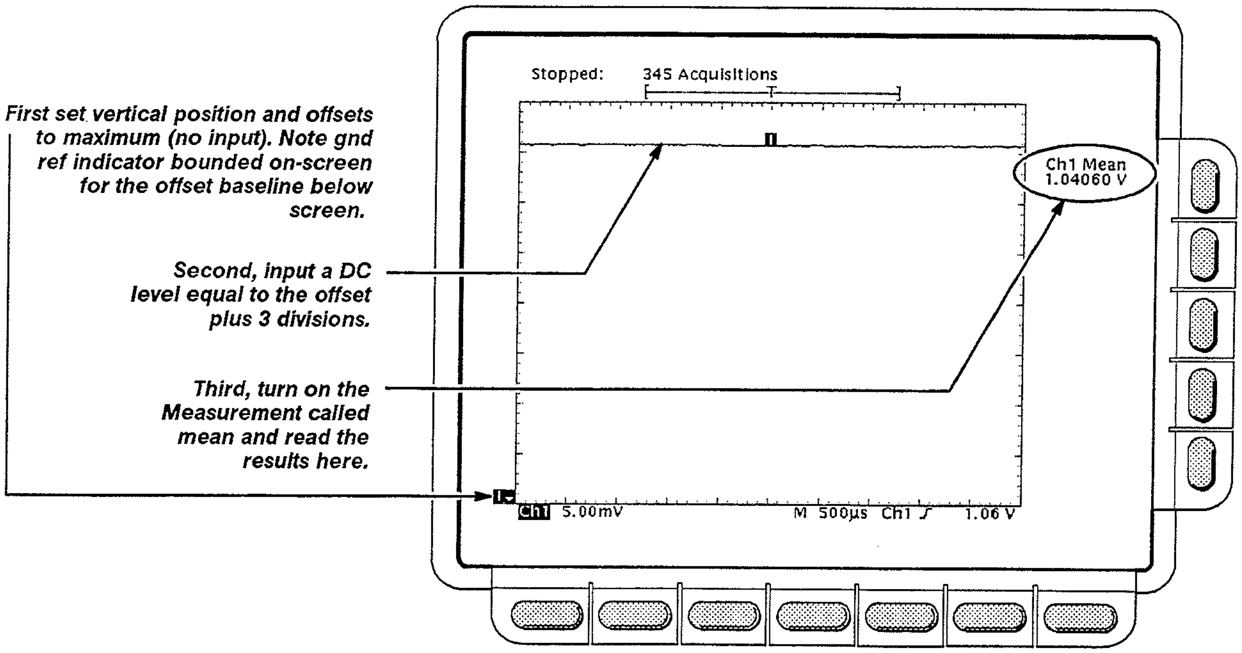



**Figure 4-7: Measurement of DC Accuracy at Maximum Offset and Position**

f. *Check against limits:*

- CHECK that the readout for the measurement **Mean** readout on screen is within the limits listed for the current vertical scale and position/offset/generator settings.
- Repeat substep d, reversing the polarity of the position, offset, and generator settings as is listed in the table.
- CHECK that the **Mean** measurement readout on screen is within the limits listed for the current vertical scale setting and position/offset/generator settings.
- Repeat substeps c through f until all vertical scale settings, listed in Table 4-3, are checked for the channel under test.

g. *Test all channels:* Repeat substeps a through f for all four channels.

5. *Disconnect the hookup:*

a. *Set the generator output to 0 V.*

b. Disconnect the cable from the generator output at the input connector of the channel last tested.

## Check Analog Bandwidth

**Equipment Required:** One high-frequency leveled sine wave generator and its leveling head (Item 12), one medium-frequency leveled sine wave generator and its leveling head (Item 11), and two 10X attenuators (Item 1).

**Prerequisites:** *See page 4-11.*

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

   a. *Initialize the oscilloscope:*

   - Press save/recall **SETUP**. Press the main-menu button **Recall Factory Setup**; then press the side-menu button **OK Confirm Factory Init**.

   b. *Modify the default settings:*

   - Press **TRIGGER MENU**. Press the main-menu button **Coupling**.
   - Press the side-menu button **Noise Rej**. (When checking 1 mV, press the side-menu button **HF Rej**.)
   - Set the horizontal **SCALE** to 50 ns. (When checking 1 mV set the horizontal **SCALE** to 10 μs.) Press **SHIFT**; then press **ACQUIRE MENU**.
   - Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
   - Press **Measure**. Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.

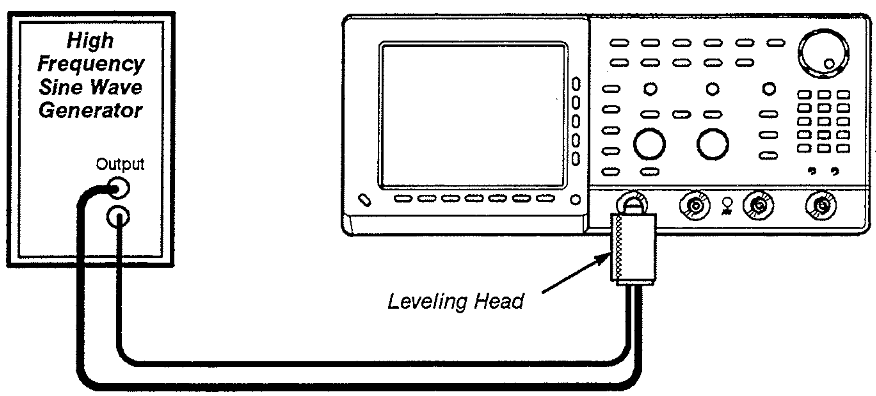



**Figure 4-8: Initial Test Hookup**

   c. *Hook up the test-signal source:* Connect, through its leveling head, the sine wave output of a high-frequency leveled sine wave generator to **CH 1**. Set the output of the generator to a reference frequency of 6 MHz. (When checking 1 mV use a medium-frequency leveled sine wave generator, Item 11, and set the output of the generator to a reference frequency of 50 kHz.)

2. *Confirm the input channels are within limits for analog bandwidth:* Do the following substeps—test CH 1 first, *skipping substeps a and b since CH 1 is already set up for testing from step 1.*

   a. *Select an unchecked channel:*

      - Press **WAVEFORM OFF** to remove the channel just confirmed from display.
      - Press the front-panel button that corresponds to the channel you are to confirm.
      - Move the leveling head to the channel you selected.

   b. *Match the trigger source to the channel selected:*

      - Press **TRIGGER MENU**.Press the main-menu button **Source**; then press the side-menu button that corresponds to the channel selected.

   c. *Set its input impedance:*

      - Press **VERTICAL MENU**; then press the main-menu button **Coupling**.
      - Press the side-menu button Ω to toggle it to the 50 Ω setting.

   d. *Set the vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 4-4 not yet checked. (Start with the 100 mV setting.)

**Table 4-4: Analog Bandwidth**

| Vertical Scale | Attenuators (10X) | Reference Amplitude (at 6 MHz) | Horizontal Scale | Test Frequency | Limits |
|---|---|---|---|---|---|
| 100 mV | none | 600 mV (6 divisions) | 1 ns | 500 MHz | ≥424 mV |
| 1 V | none | 5 V (5 divisions) | 1 ns | 500 MHz | ≥3.535 V |
| 500 mV | none | 3 V (6 divisions) | 1 ns | 500 MHz | ≥2.121 V |
| 200 mV | none | 1.2 V (6 divisions) | 1 ns | 500 MHz | ≥848 mV |
| 50 mV | 1 | 300 mV (6 divisions) | 1 ns | 500 MHz | ≥212 mV |
| 20 mV | 1 | 120 mV (6 divisions) | 1 ns | 500 MHz | ≥848 mV |
| 10 mV | 1 | 60 mV (6 divisions) | 1 ns | 500 MHz | ≥424 mV |
| 5 mV | 2 | 30 mV (6 divisions) | 1 ns | 500 MHz | ≥212 mV |
| 2 mV | 2 | 12 mV (6 divisions) | 1 ns | 300 MHz | ≥8.48 mV |
| 1 mV | 2 | 6 mV (6 divisions) | 1 ns | 200 MHz | ≥4.24 mV |

   e. *Display the test signal:* Do the following subparts to first display the reference signal and then the test signal.

      - Press **MEASURE**; then press the main-menu button **Select Measurement for CHx**.

- Press the side-menu button **more** until the menu label **Pk-Pk** appears in the side menu (its icon is shown at the left). Press the side-menu button **Pk-Pk**.

- Repeatedly press the side-menu button **–more–** until **Frequency** appears in the side menu (its icon is shown at the left). Press the side-menu button **Frequency**.
- Press **CLEAR MENU**.
- Set the generator output so the CHx Pk-Pk readout equals the reference amplitude in Table 4-4 that corresponds to the vertical scale set in substep d.
- Press the front-panel button **SET LEVEL TO 50%** as necessary to trigger a stable display.

f. *Measure the test signal:*

- Set the frequency of the generator, as shown on screen, to the test frequency in Table 4-4 that corresponds to the vertical scale set in substep d.
- Set the horizontal **SCALE** to the horizontal scale setting in Table 4-4 that corresponds to the vertical scale set in substep d. Press **SET LEVEL TO 50%** as necessary to trigger the signal.
- Read the results at the CHx Pk-Pk readout, which will automatically measure the amplitude of the test signal.

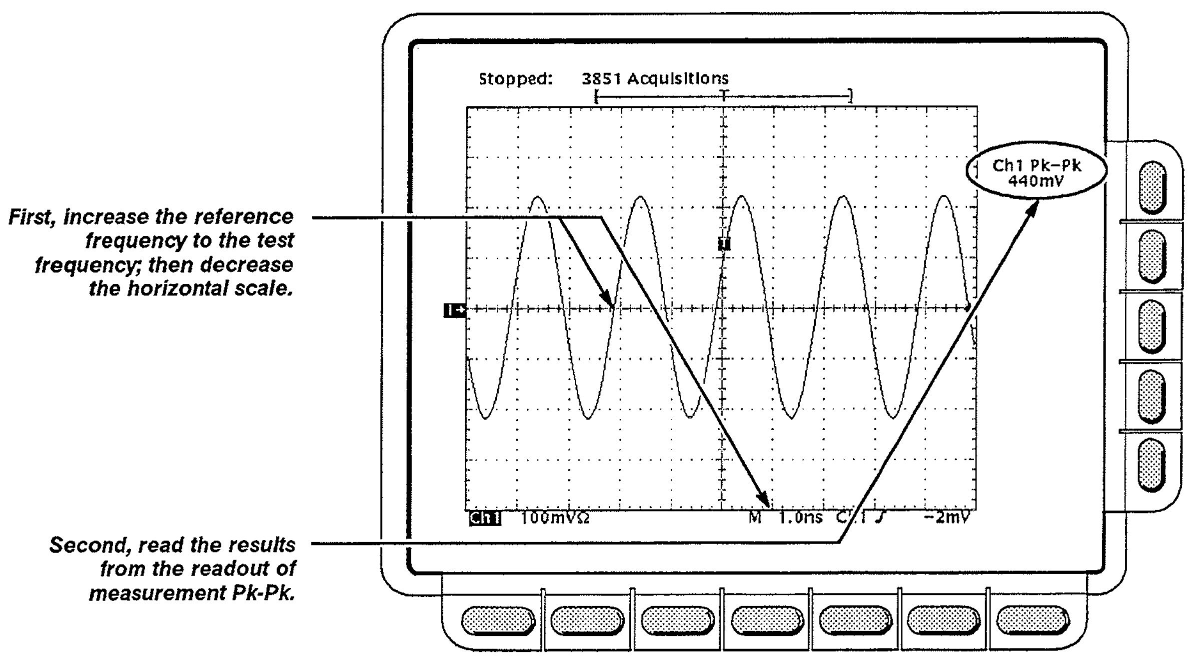



**Figure 4-9: Measurement of Analog Bandwidth**

g. *Check against limits:*

- CHECK that the **Pk-Pk** readout on screen is within the limits listed in Table 4-4 for the current vertical scale setting.
- When finished checking, set the horizontal **SCALE** back to the 50 ns setting.

STOP Checking each channel's bandwidth at all vertical scale settings is time consuming and unnecessary. You may skip checking the remaining vertical scale settings in Table 4-4 (that is, skip the following substep, h) if this digitizing oscilloscope has performed as follows:

- Passed the 100 mV vertical scale setting just checked in this procedure.
- Passed the *Verify Internal Adjustment, Self Compensation, and Diagnostics* procedure found under *Self Tests,* on page 4-4.

***NOTE***

*Passing the signal path compensation confirms the signal path for all vertical scale settings for all channels. Passing the internal diagnostics ensures that the factory-set adjustment constants that control the bandwidth for each vertical scale setting have not changed.*

h. *Check remaining vertical scale settings against limits (optional):*

- If desired, finish checking the remaining vertical scale settings for the channel under test by repeating substeps d through g for each of the remaining scale settings settings listed in Table 4-4 for the channel under test.
- When doing substep e, skip the subparts that turn on the CHx Pk-Pk measurement until you check a new channel.
- Install/remove 10X attenuators between the generator leveling head and the channel input as is needed to obtain the six division reference signals listed in the table.

i. *Test all channels:* Repeat substeps a through g for all four channels.

3. *Disconnect the hookup:* Disconnect the test hook up from the input connector of the channel last tested.

## Check Delay Between Channels

**Equipment Required:** One medium-frequency leveled sine wave generator (Item 11), one precision coaxial cable (Item 5), one 50 Ω terminator (Item 4), and a dual-input coupler (Item 8).

**Prerequisites:** *See page 4-11.*

**Procedure:**

STOP DO NOT use the vertical position knob to reposition any channel while doing this check. To do so invalidates the test.

1. *Install the test hookup and preset the instrument controls:*

   a. *Initialize the front panel:*

      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init.**

   b. *Modify the initialized front-panel control settings:*

      - Do *not* adjust the vertical position of any channel during this procedure.
      - Set the horizontal **SCALE** to 500 ps.
      - Press **SHIFT**; then press **ACQUIRE MENU**.
      - Press the main-menu button **Mode**, and then press the side-menu button **Average 16**.

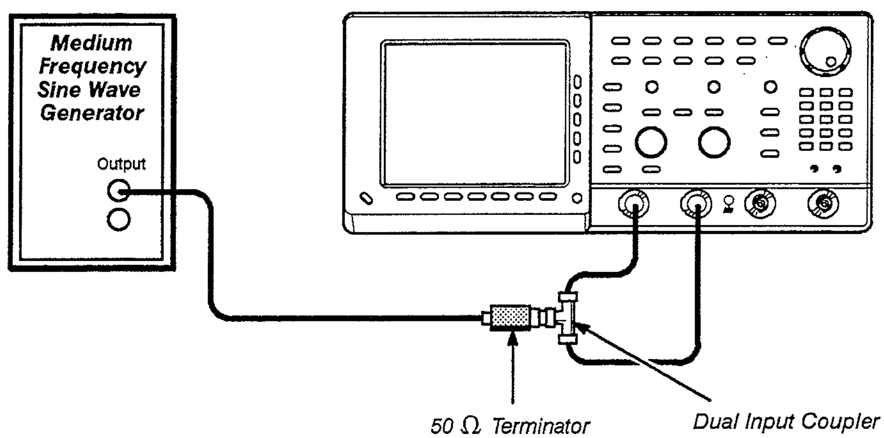



**Figure 4-10: Initial Test Hookup**

c. *Hook up the test-signal source:*

- Connect, through a 50 Ω precision coaxial cable followed by a 50 Ω termination, the sine wave output of a medium-frequency sine wave generator to a dual-input coupler.
- Connect the coupler to both **CH 1** and **CH 2**.

2. *Confirm CH 1 through CH 4 are within limits for channel delay:*

a. *Set up the generator:* Set the generator frequency to 250 MHz and the amplitude for about six divisions in CH 1.

Hint: as you are adjusting the generator amplitude, push **SET LEVEL TO 50%** frequently to speed up the updating of the waveform amplitude on screen.

b. *Save a CH 2 waveform:* Press **CH 2**; then press save/recall **WAVEFORM**. Now, press the main-menu button **Save Waveform**; then press the side-menu button **To Ref 2**.

c. *Save CH 3 waveform:* Move the coupler from **CH 2** to **CH 3**, so that **CH 1** and **CH 3** are driven. Press **CH 3**; then press the side-menu button **To Ref 3**.

d. *Display all test signals:*

- Press **WAVEFORM OFF** twice to remove CH 2 and CH 3 from the display.
- Move the coupler from **CH 3** to **CH 4**, so that CH 1 and CH 4 are driven. Press **CH 4** to display.
- Now, press the front-panel button **MORE**. Press the main-menu buttons **Ref 2** and **Ref 3**.

e. *Measure the test signal:*

- Locate the point on the rising edge of the left-most waveform where it crosses the center horizontal graticule line. This is the *time reference point* for this waveform. Note the corresponding *time reference point* for the right-most waveform. See Figure 4-11.
- Press **CURSOR**.
- Press the main-menu button **Function**; then press the side-menu button **V Bars**.
- Press **CLEAR MENU**.
- Rotate the General Purpose knob to align one cursor to the *time reference point* of the left-most waveform edge and the other cursor to the *time reference point* of the right-most waveform edge. (Press **TOGGLE** to switch between the two cursors.) See Figure 4-11.

- Read the measurement results at the Δ: cursor readout, not the @: readout on screen.

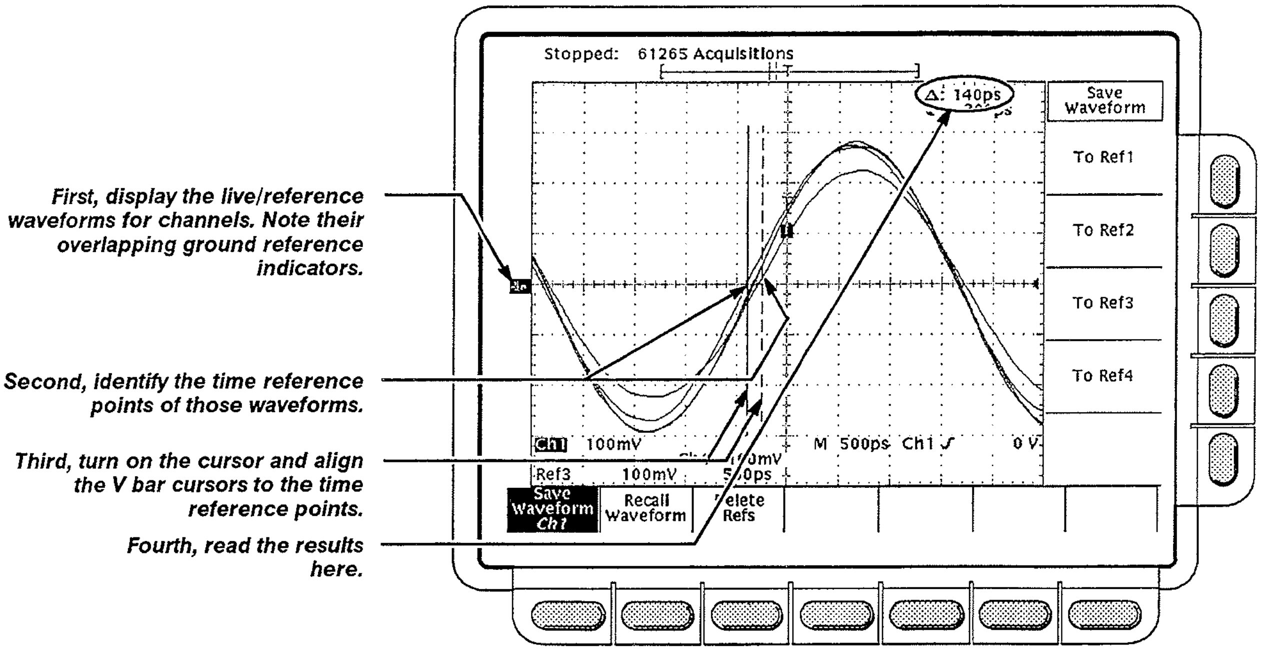



**Figure 4-11: Measurement of Channel Delay**

f. *Check against limits:* CHECK that the cursor readout on screen is ≤250 ps.

3. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connectors of the channels.

## Time Base System Checks

These procedures check those characteristics that relate to the Main and Delayed time base system and are listed as checked under *Warranted Characteristics* in Section 1, *Specification.*

### Check Accuracy for Long-Term Sample Rate, Delay Time, and Delta Time Measurements

**Equipment Required:** One time-mark generator (Item 13) and one precision coaxial cable (Item 5).

**Prerequisites:** *See page 4-11.*

**Procedure:**

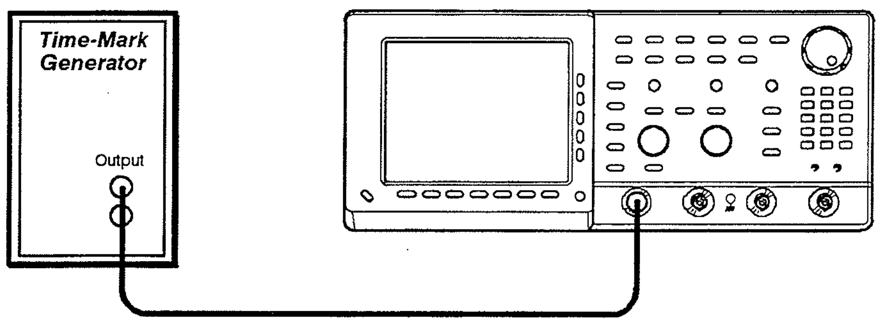



**Figure 4-12: Initial Test Hookup**

1. *Install the test hookup and preset the instrument controls:*

   a. *Hook up the test-signal source*: Connect, through a 50 Ω precision coaxial cable, the time-mark output of a time-mark generator to **CH 1**. Set the output of the generator for 10 ms markers.

   b. *Initialize the oscilloscope:*

      - Press save/recall **SETUP**. Press the main-menu button **Recall Factory Setup**. Press the side-menu button **OK Confirm Factory Init**.

   c. *Modify the initialized front-panel control settings:*

      - Set the vertical **SCALE** to 500 mV.
      - Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Press the side-menu button Ω to toggle it to the **50 Ω** setting.
      - Press **SET LEVEL TO 50%**.
      - Use the vertical **POSITION** knob to center the test signal on screen.
      - Set the horizontal **SCALE** of the Main time base to 1 ms.

- Press **TRIGGER MENU**; then press the main-menu button **Mode & Holdoff**. Press the side-menu button **Normal**.
- Press **SET LEVEL TO 50%**.
- Press **HORIZONTAL MENU**. Press the main-menu button **Record Length**; then press the side-menu button **1000 samples in 20 divs**.
- Press the main-menu button **Trigger Position**. Press the side-menu button **Pretrigger**. Press the side-menu button **Set to 20%**.

2. *Confirm Main and Delayed time bases are within limits for accuracies:*

   a. *Display the test signal:*

      - Adjust the horizontal **POSITION** so the trigger **T** is aligned to the center vertical graticule line.
      - Press the main-menu button **Time Base**. Press the side-menu buttons **Delayed Only** and **Delayed Runs After Main**.

   b. *Measure the test signal*:

      - Set the horizontal **SCALE** of the **D** (delayed) time base to 250 ns.
      - Use the keypad to set delayed time to 10 ms. (Press **10**, then **SHIFT**, then **m** followed by **ENTER**.) The value you enter will be rounded to the nearest multiple of 4.125 ns and shown at the top of the display.

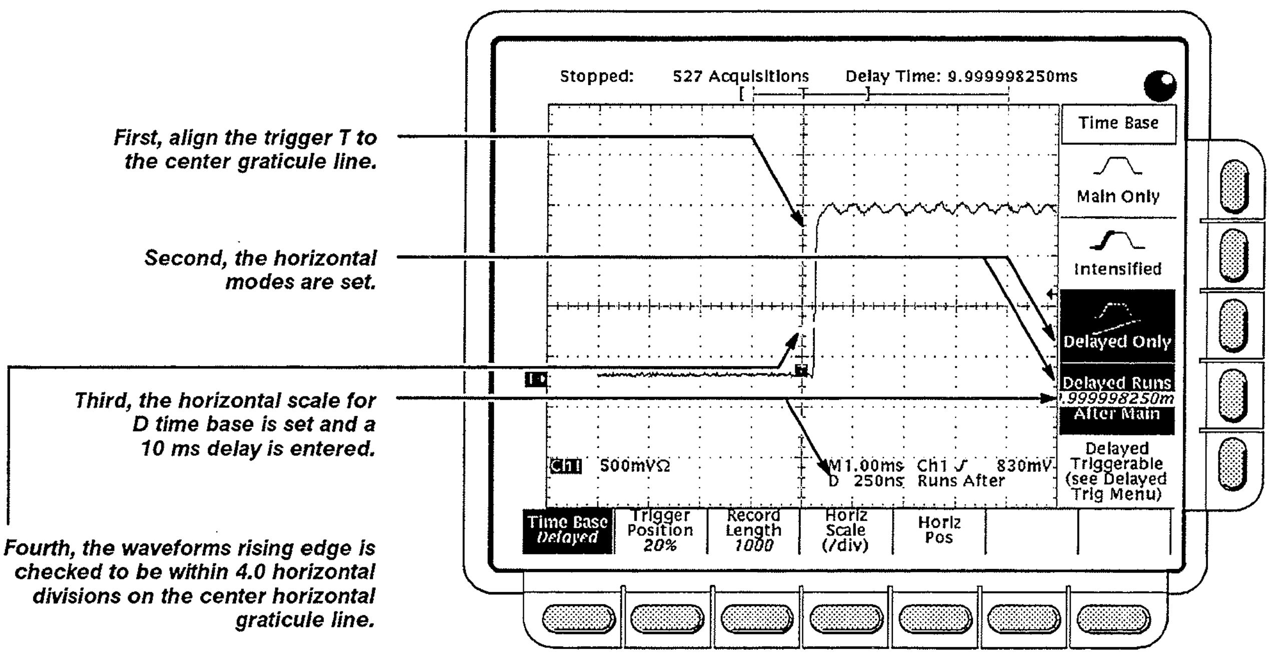



**Figure 4-13: Measurement of Accuracy—Long-Term and Delay Time**

c. *Check long-term sample rate and delay time accuracies against limits:* CHECK that the rising edge of the marker crosses the center horizontal graticule line at a point within ±4.0 divisions of center graticule.

d. *Check delta-time accuracy against limits:*

- Press the side-menu button **Main Only**. Set horizontal **SCALE** to 2.5 ns.
- Set the output of the generator for 20 ns markers.
- Press **SET LEVEL TO 50%**.
- Press **SHIFT**; then press **ACQUIRE MENU**. Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
- Press **MEASURE**.
- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measurement for Ch1**.
- Press the side-menu button **–more–**, until **PERIOD** appears in the side menu. Press **PERIOD**.
- Press **CLEAR MENU**.
- CHECK that the readout for **CH 1 Per** is within 19.760 ns to 20.240 ns.

3. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of **CH 1**.

## Trigger System Checks

These procedures check those characteristics that relate to the Main and Delayed trigger systems and are listed as checked under *Warranted Characteristics* in Section 1, *Specification.*

### Check Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering

**Equipment Required:** One medium-frequency leveled sine wave generator (Item 11), one 10X attenuator (Item 1), and one precision coaxial cable (Item 5).

**Prerequisites:** *See page 4-11.*

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

   a. *Initialize the instrument:*

   - Press save/recall **SETUP**.
   - Press the main-menu button **Recall Factory Setup**.
   - Press the side-menu button **OK Confirm Factory Init**.

   b. *Modify the default setup:*

   - Press **VERTICAL MENU**.
   - Press the main-menu button **Coupling**; then press the side-menu button Ω to select 50 Ω coupling.
   - Set the horizontal **SCALE** to 10 ns.

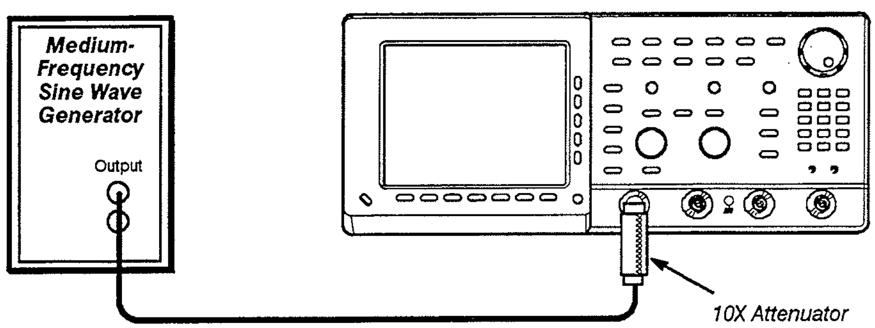



**Figure 4-14: Initial Test Hookup**

   c. *Hook up the test-signal source:* Connect, through a 50 Ω precision coaxial cable, followed by a 10X attenuator, the output of a medium-frequency leveled sine wave generator (Item 11) to CH 1.

2. *Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (Horizontal Scale ≤1 μs):*

   a. *Display the test signal:* Set the output of the sine wave generator for a 100 MHz, five-division sine wave on screen. Press **SET LEVEL TO 50%**.

   b. *Set the trigger mode:* Press **TRIGGER MENU**. Now press the main-menu button **Mode & Holdoff**; then press the side-menu button **Normal**.

   c. *Set upper and lower limits that ensure triggering:*

      - Press the main-menu button **Type**; then repeatedly press the same button until **Pulse** is highlighted in the menu that pops up.
      - Press the main-menu button **Class**; then repeatedly press the same button until **Width** is highlighted in the menu that pops up.
      - Press the main-menu button **Trig When**; then press the side-menu button **Within Limits.**
      - Press the side-menu button **Upper Limit**. Use the keyboard to set the upper limit to 10 ns: press **10**; then **SHIFT**; then **n**; then **ENTER**.
      - Press the side-menu button **Lower Limit**. Use the keypad to set the lower limit to 2 ns.

   d. *Check against limits:*

      - Press **SET LEVEL TO 50%**.
      - While doing the following subparts, monitor the display (it will stop acquiring) and the front-panel light **TRIG** (it will extinguish) to determine when triggering is lost.
      - Use the general purpose knob to *increase* the **Lower Limit** readout until triggering is lost.
      - CHECK that the **Lower Limit** readout, after the oscilloscope loses triggering, is within 2.5 ns to 7.5 ns, inclusive.
      - Use the keypad to return the **Lower Limit** to 2 ns and reestablish triggering.
      - Press the side-menu button **Upper Limit**; then use the general purpose knob to slowly *decrease* the **Upper Limit** readout until triggering is lost.
      - CHECK that the **Upper Limit** readout, after the oscilloscope loses triggering, is within 2.5 ns to 7.5 ns, inclusive.

Scan by Zenith



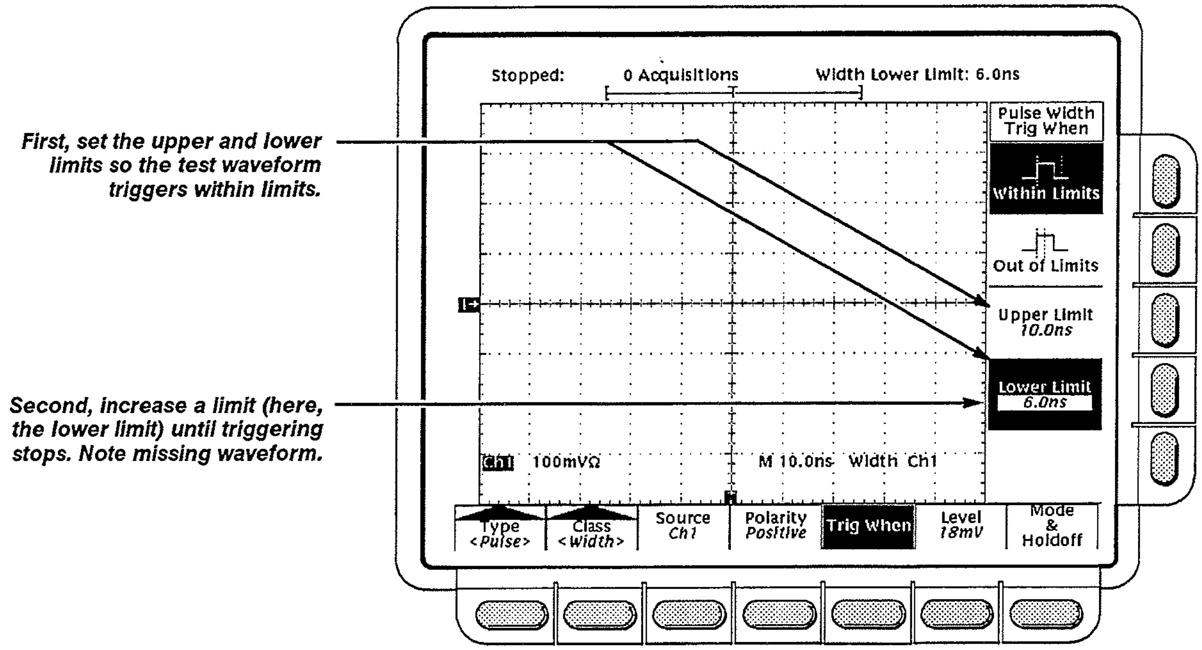



**Figure 4-15: Measurement of Time Accuracy for Pulse and Glitch Triggering**

3. *Confirm the trigger system is within time-accuracy limits for pulse-glitch or pulse-width triggering (horizontal scale >1 μs):*

   a. *Set upper and lower limits that ensure triggering at 250 kHz:*

      - Press the side-menu button **Upper Limit**. Use the keyboard to set the upper limit to 4 μs.
      - Press the side-menu button **Lower Limit**. Use the keypad to set the lower limit to 500 ns.

   b. *Display the test signal:*

      - Set the horizontal **SCALE** to 5 μs.
      - Set the output of the sine wave generator for a 250 kHz, five-division sine wave on screen. Set the vertical **SCALE** to 20 mV (the waveform will overdrive the display).
      - Press **SET LEVEL TO 50%**.

   c. *Check against limits:* Do the following subparts in the order listed.

      - Use the general purpose knob to *increase* **Lower Limit** readout until triggering is lost.
      - CHECK that the **Lower Limit** readout, after the oscilloscope loses triggering, is within 1 μs to 3 μs, inclusive.
      - Use the keypad to return the **Lower Limit** to 500 ns and reestablish triggering.

- Press the side-menu button **Upper Limit**; then use the general purpose knob to slowly *decrease* the **Upper Limit** readout until triggering is lost.
- CHECK that the **Upper Limit** readout, after the oscilloscope loses triggering, is within 1 μs to 3 μs, inclusive.

4. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of **CH 1**.

## Check Accuracy, Trigger-Level or Threshold, DC Coupled

**Equipment Required:** One DC calibration generator (Item 9), one BNC T connector (Item 7), and two precision coaxial cables (Item 5).

**Prerequisites:** The oscilloscope must meet the prerequisites listed under *Performance Tests*, on page 4-11.

**Procedure:**

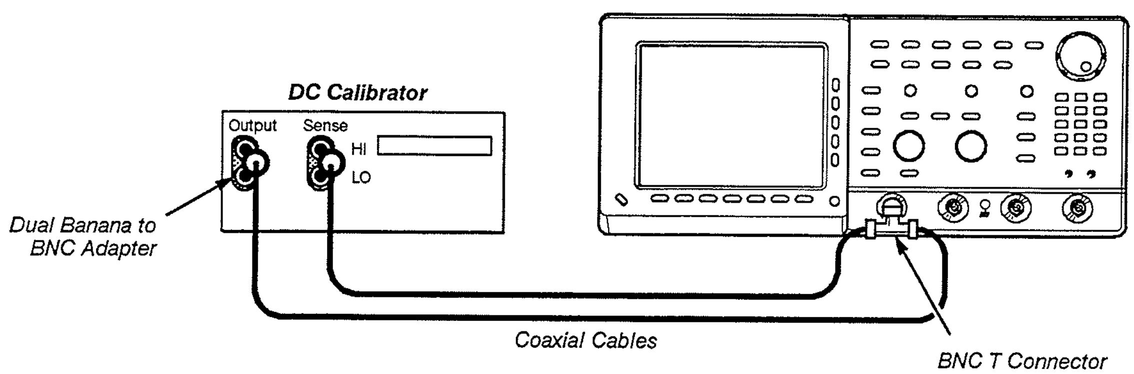



**Figure 4-16: Initial Test Hookup**

1. *Install the test hookup and preset the instrument controls:*
   a. *Hook up the test-signal source:*
      - Set the output of the DC calibration generator to 0 volts.
      - Connect the output of the DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
      - Connect the Sense output of the generator, through a second dual-banana connector followed by a 50 Ω precision coaxial cable, to other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

b. *Initialize the oscilloscope:*

- Press save/recall **Setup**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

2. *Confirm Main trigger system is within limits for Trigger-level/Threshold accuracy:*

a. *Display the test signal:*

- Press **VERTICAL MENU**, then press the main-menu button **Position**.
- Use the keypad to set vertical position to –3 divisions (press **–3**, then **ENTER**, on the keypad.) The baseline level will move down three divisions.
- Press the main-menu button **Offset**.
- Use the keypad to set vertical offset to +10 volts. The baseline level will move off screen.
- Set the standard output of the DC calibration generator to +10 volts. The DC test level will appear on screen.

b. *Measure the test signal:*

- Press **SET LEVEL TO 50%**.
- Press **TRIGGER MENU**.
- Read the measurement results from the readout below the label **Level** in the menu; not the trigger readout in the graticule area.

c. *Check against limits:*

- CHECK that the **Level** readout in the main menu is within 9.863 V to 10.137 V, inclusive.

- Press the main-menu button **Slope**; then press the side-menu button for negative slope. (See icon at left.) Repeat substep b.
- CHECK that the **Level** readout in the main menu is within 9.863 V to 10.137 V, inclusive.

3. *Confirm Delayed trigger system is within limits for Trigger-level/Threshold accuracy:*

a. *Select the Delayed time base:*

- Press **HORIZONTAL MENU**.
- Press the main-menu button **Time Base**.
- Press the side-menu buttons **Delayed Only** and **Delayed Trigger-able**.
- Set **D** (delayed) horizontal **SCALE** to 500 μs.

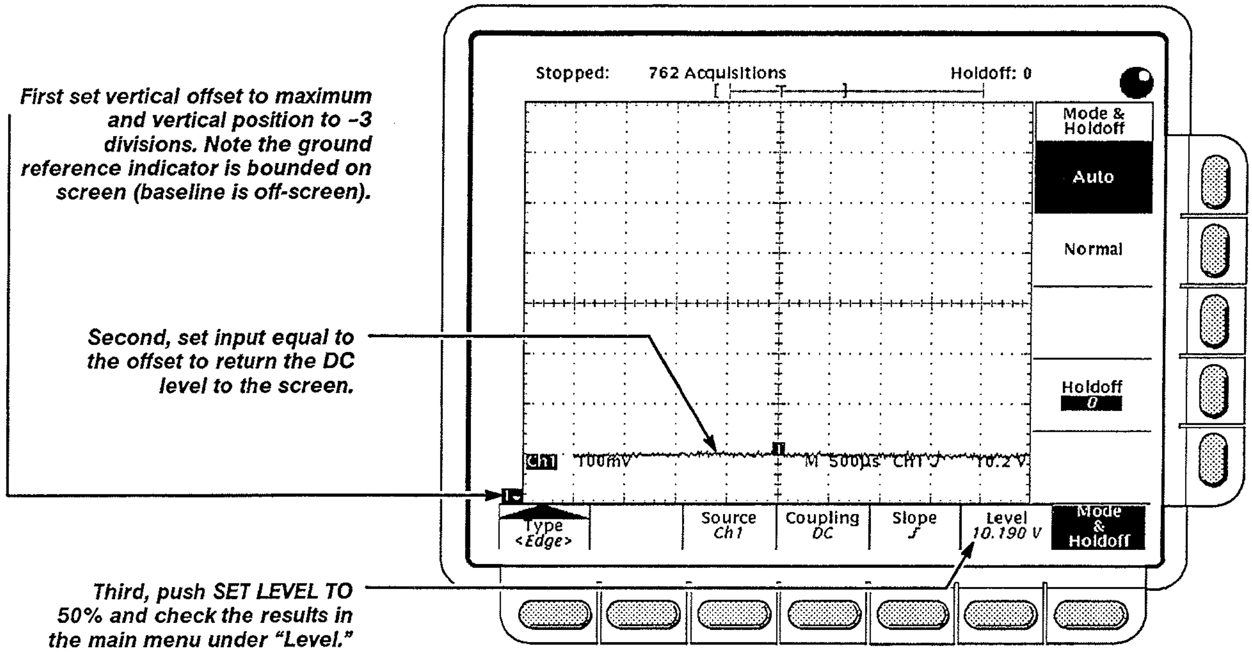



**Figure 4-17: Measurement of Trigger-Level Accuracy**

b. *Select the Delayed trigger system:*

- Press **SHIFT**; then press the front-panel button **DELAYED TRIG**.
- Press the main-menu button **Level**.

c. *Measure the test signal:* Press the *side-menu button* **SET TO 50%**. Read the measurement results in the side menu below the label **Level**.

d. *Check against limits:* Do the following subparts in the order listed.

- CHECK that the **Level** readout in the side menu is within 9.863 V to 10.137 V, inclusive.

- Press the main-menu button **Slope**; then press the side-menu button for negative slope. (See icon at left.) Press the main-menu button **Level**. Repeat substep c.
- CHECK that the **Level** readout in the side menu is within 9.863 V to 10.137 V, inclusive.

4. *Modify the initialized front-panel control settings:*

a. *Select the Delayed time base:*

- Set **D** (delayed) horizontal **SCALE** to 10 μs.
- Press **HORIZONTAL MENU**.
- Press the main-menu button **Time Base**.
- Press the side-menu buttons **Main Only**.

- Set **M** (main) horizontal **SCALE** to 10 μs.

b. *Repeat steps 2 (substeps b and c only) and 3 (exclude the horizontal* ***SCALE*** *change in substep 3a.)*

5. *Disconnect the hookup:*

a. *First set the output of the DC calibration generator to 0 volts.*

b. Disconnect the cable from the generator output at the input connector of **CH 1**.

## Sensitivity, Edge Trigger, DC Coupled

**Equipment Required:** One medium-frequency leveled sine wave generator (Item 11), one high-frequency leveled sine wave generator (Item 12), two precision 50 Ω coaxial cables (Item 5), and one 10X attenuator (Item 1) one BNC T connector (Item 7), and one 5X attenuator (Item 2).

**Prerequisites:** *See page 4-11.*

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

a. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

b. *Modify the initialized front-panel control settings:*

- Set the horizontal **SCALE** for the **M** (main) time base to 25 ns.
- Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**.
- Press the side-menu button **Delayed Only**; then press the side-menu button **Delayed Triggerable**.
- Set the horizontal **SCALE** for the **D** (delayed) time base to 25 ns; then press the side-menu button **Main Only**.
- Press **TRIGGER MENU**; then press the main-menu button **Mode & Holdoff**. Press the side-menu button **Normal**.
- Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Press the side-menu button Ω select the 50 Ω setting.
- Press **SHIFT**; then press **ACQUIRE MENU**. Press the main-menu button **Mode**; then press the side-menu button **Average 16**.

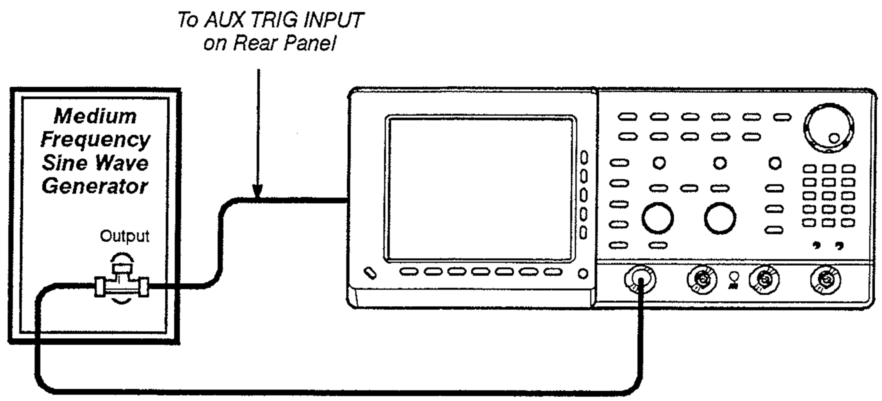



**Figure 4-18: Initial Test Hookup**

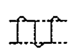
c. *Hook up the test-signal source:*

- Connect the signal output of a medium-frequency sine wave generator to a BNC T connector.
- Connect one output of the T connector to **CH 1** through a 50 Ω precision coaxial cable.
- Connect the other output of the T connector through a second 50 Ω precision coaxial cable to the **AUX TRIG INPUT** at the rear panel. See Figure 4-18.

2. *Confirm Main and Delayed trigger systems are within sensitivity limits (50 MHz):*

a. *Display the test signal:*

- Set the generator frequency to 50 MHz.
- Press **MEASURE.**
- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max.**
- Press the main-menu button **Select Measurement for Ch1.**



- Press the side-menu button **–more–** until **Amplitude** appears in the side menu (its icon is shown at the left). Press the side-menu button **Amplitude.**
- Press **SET LEVEL TO 50%.**
- Press **CLEAR MENU.**
- Set the test signal amplitude for about three divisions on screen. Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 350 mV. (Readout may fluctuate around 350 mV.)
- Disconnect the 50 Ω precision coaxial cable at **CH 1** and reconnect it to **CH 1** through a 10X attenuator.

b. *Check the Main trigger system for stable triggering at limits:*

- Read the following definition: A stable trigger is one that is consistent; that is, one that results in a uniform, regular display triggered on the selected slope (positive or negative). This display should *not* have its trigger point switching between opposite slopes, nor should it "roll" across the screen. At horizontal scale settings of 2 ms/division and faster, **TRIG'D** will remain constantly lit. It will flash for slower settings.
- Press **TRIGGER MENU**; then press the main-menu button **Slope**.
- Press **SET LEVEL TO 50%**. CHECK that a stable trigger is obtained for the test waveform on both the positive and negative slopes. (Use the side menu to switch between trigger slopes; use the **TRIGGER LEVEL** knob to stabilize the trigger if required.)
- Leave the Main trigger system triggered on the positive slope of the waveform before continuing to the next step.

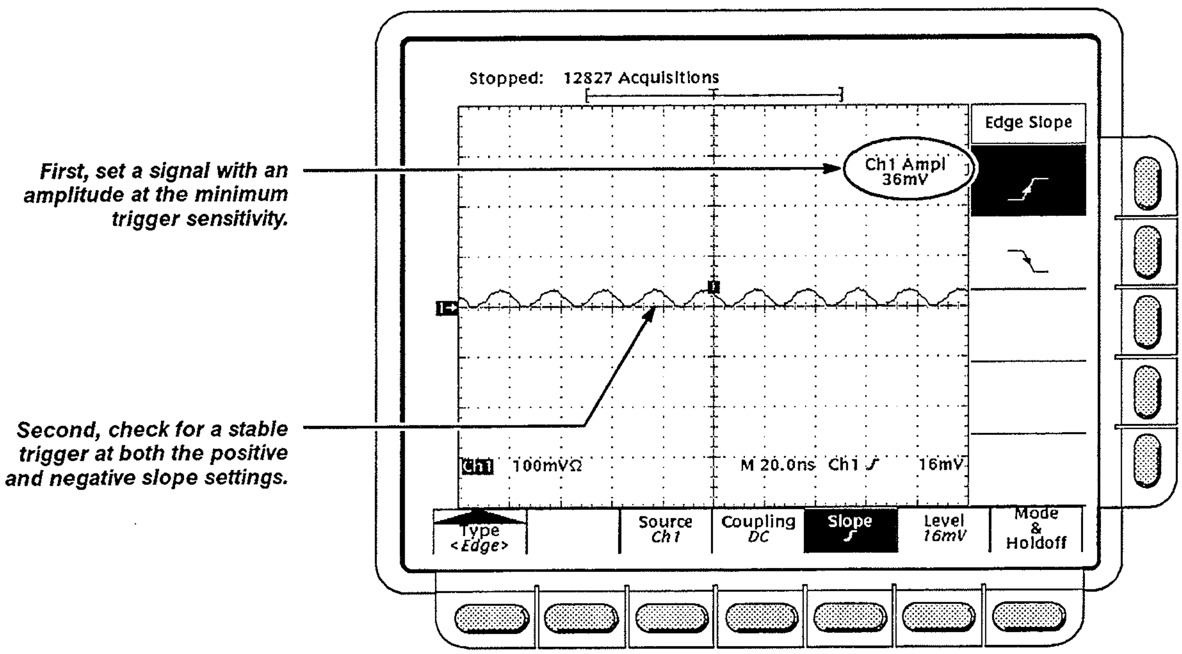



**Figure 4-19: Measurement of Trigger Sensitivity**

c. *Check Delayed trigger system for stable triggering at limits:* Do the following subparts in the order listed.

- Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**. Press the side-menu button **Delayed Only**; then press **Delayed Triggerable** in the same menu.
- Press **SHIFT**; then press **DELAYED TRIG**. Press the main-menu button **Level**.

- Press the side-menu button **SET TO 50%**. CHECK that a stable trigger is obtained for the test waveform for both the positive and negative slopes of the waveform. (Use the **TRIGGER LEVEL** knob to stabilize the Main trigger if required. Use the general purpose knob to stabilize the Delayed trigger if required.) Press the main-menu button **Slope**; then use the side menu to switch between trigger slopes.
- Leave the Delayed trigger system triggered on the positive slope of the waveform before continuing to the next step. Also, return to the main time base: Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**. Press the side-menu button **Main Only**.

3. *Confirm the AUX Trigger input:*

   a. *Display the test signal:*

   - Remove the 10X attenuator and reconnect the cable to **CH 1**.
   - Set the test signal amplitude for about 2.5 divisions on screen.
   - Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 250 mV. (Readout may fluctuate around 250 mV.)

   b. *Check AUX trigger source for stable triggering at limits:* Do the following in the order listed.

   - Use the definition for stable trigger from step 2.
   - Press **TRIGGER MENU**; then press the main-menu button **Source**.
   - Press the side-menu button **–more–** until the side-menu label **Auxiliary** appears; then press **Auxiliary**.
   - Press **SET LEVEL TO 50%**. CHECK that a stable trigger is obtained for the test waveform on both the positive and negative slopes. Press the main-menu button **Slope**; then use the side menu to switch between trigger slopes. Use the general purpose knob to stabilize the trigger if required.
   - Leave the Main trigger system triggered on the positive slope of the waveform before proceeding to the next check.
   - Press the main-menu button **Source**; then press the side-menu button **–more–** until **CH 1** appears. Press **CH 1**.

4. *Confirm that the Main and Delayed trigger systems are within sensitivity limits (500 MHz):*

   a. *Hook up the test-signal source:* Disconnect the hookup installed in step 1. Connect, through its leveling head, the signal output of a high-frequency leveled sine wave generator to **CH 1**.

   b. *Set the Main and Delayed Horizontal Scales:*

   - Set the horizontal **SCALE** to 500 ps for the **M** (Main) time base.

- Press **HORIZONTAL MENU**. Now press the main-menu button **Time base**; then press the side-menu button **Delayed Trigger-able**.
- Press the side-menu button **Delayed Only**.
- Set the horizontal **SCALE** to 500 ps for the **D** (Delayed) time base. Press the side-menu button **Main Only**.

c. *Display the test signal:*

- Set the generator frequency to 500 MHz.
- Set the test signal amplitude for about five divisions on screen. Now fine adjust the generator output until the **CH 1 Amplitude** readout indicates the amplitude is 500 mV. (Readout may fluctuate around 500 mV.)
- Disconnect the leveling head at **CH 1** and reconnect it to **CH 1** through a 5X attenuator.

d. Repeat step 2, substeps b and c only, since only the 500 MHz frequency is to be checked here.

5. *Confirm that the Main and Delayed trigger systems couple trigger signals from all channels:* Doing the procedure *Check Analog Bandwidth,* which begins on page 4-22, checks coupling. If you have not done that procedure, do so after finishing this procedure. See the following note.

***NOTE***

*Steps 1 through 4 confirmed trigger sensitivity for the Main and Delayed triggering systems using the CH 1 input. Doing the procedure* Check Analog Bandwidth *ensures that trigger signals are coupled from all four channels.*

6. *Disconnect the hookup:* Disconnect the cable from the channel last tested.

## Output Signal Checks

The procedure that follows checks those characteristics of the output signals that are listed as checked under *Warranted Characteristics* in Section 1, *Specification*. The oscilloscope outputs these signals at its front and rear panels.

### Check Outputs—CH 3, Main and Delayed Trigger

**Equipment Required:** Two 50 Ω precision cables (Item 5), and one calibration generator (Item 9).

**Prerequisites:** See page 4-11. Also, the Digitizing Oscilloscope must have passed *Check Accuracy for DC Gain and Voltage Measurements* on page 4-16.

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

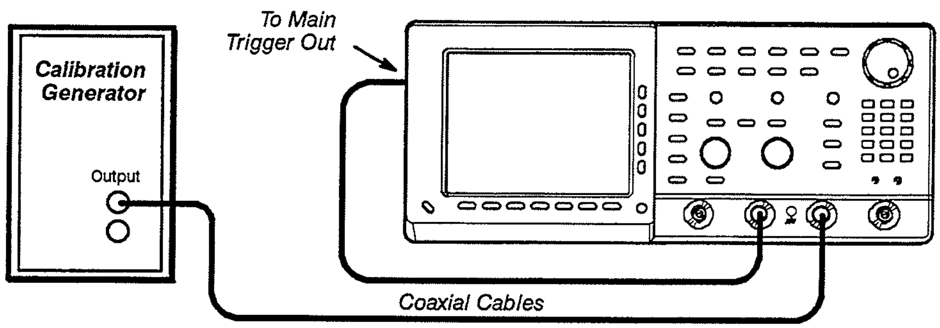



**Figure 4-20: Initial Test Hookup**

a. *Hook up test-signal source 1:*

- Connect the standard amplitude output of a calibration generator through a 50 Ω precision coaxial cable to **CH 3**.
- Set the output of the calibration generator to 0.500 V.

b. *Hook up test-signal source 2:* Connect the **Main Trigger Out** at the rear panel to **CH 2** through a 50 Ω precision cable.

c. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

d. *Modify the initialized front-panel control settings:*

- Press **AUTOSET**. Set the horizontal **SCALE** to 250 μs.
- Press **SHIFT**; then press **ACQUIRE MENU**.

- Press the main-menu button **Mode**; then press the side-menu button **Average**.
- Select **64** averages.

2. *Confirm Main and Delayed Trigger outputs are within limits for logic levels:*

   a. *Display the test signal:*

   - Press **WAVEFORM OFF** to turn off CH 1.
   - Press **CH 2** to display that channel.
   - Set the vertical **SCALE** to 1 V.
   - Use the vertical **POSITION** knob to center the display on screen.

   b. *Measure logic levels:*

   - Press **MEASURE**; then press the main-menu button **Select Measurement for Ch2**.
   - Repeatedly press the side-menu button **-more-** until **High** and **Low** appear in the side menu (their icons are shown at the left). Press both side-menu buttons **High** and **Low**.

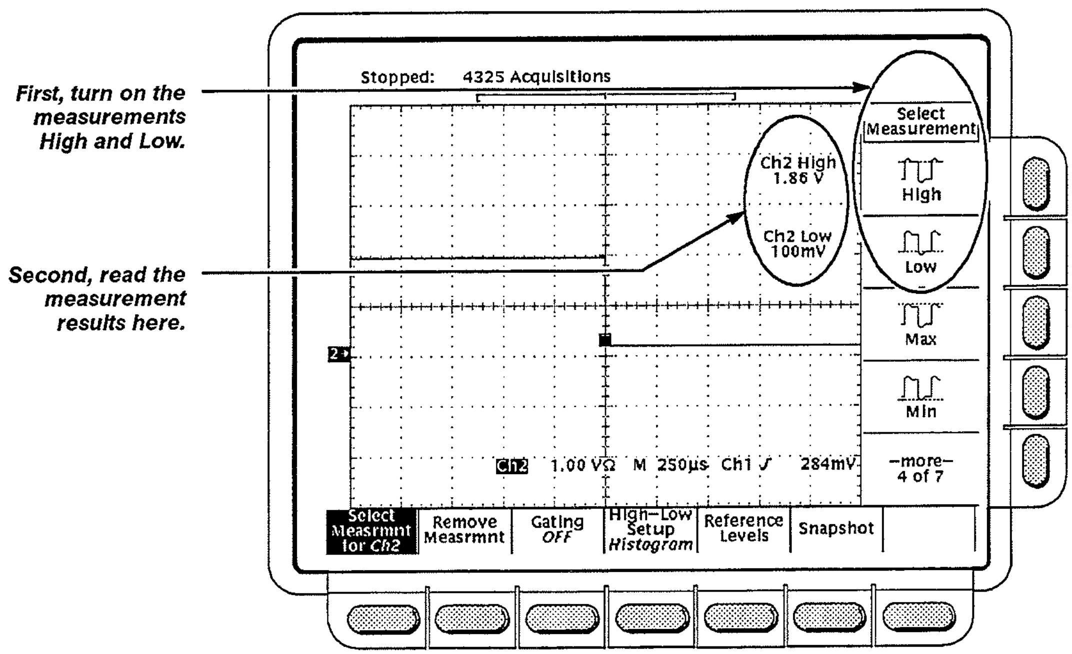



**Figure 4-21: Measurement of Main Trigger Out Limits**

   c. *Check Main Trigger output against limits:*

   - CHECK that the **Ch2 High** readout is ≥2.5 volts and that the **Ch2 Low** readout is ≤0.7 volts.

- Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Now press the side-menu button Ω to toggle it to the 50 Ω setting.
- CHECK that the **Ch2 High** readout is ≥1.0 volt and that the **Ch2 Low** readout ≤0.25 volts.

d. *Check Delayed Trigger output against limits:*

- Move the precision 50 Ω cable from the **Main Trigger Output** BNC to the **Delayed Trigger Output** BNC.
- CHECK that the **Ch2 High** readout is ≥1.0 volt and that the **Ch2 Low** readout ≤0.25 volts.
- Press the side-menu button Ω to select the 1 MΩ setting.
- Press **CLEAR MENU**.
- CHECK that the **Ch2 High** readout is ≥2.5 volts and that the **Ch2 Low** readout is ≤0.7 volts.
- CHECK that the **Ch2 High** readout is ≥1.0 volt and that the **Ch2 Low** readout ≤0.25 volts.

3. *Confirm CH 3 output is within limits for gain:*

a. *Measure gain:*

- Move the precision 50 Ω cable from the **DELAYED TRIGGER OUTPUT** BNC to the **CH 3 SIGNAL OUT** BNC.
- Push **TRIGGER MENU**.
- Press the main-menu button **Source**
- Press the side-menu button **Ch3**.
- Set vertical **SCALE** to 20 mV.
- Press **SET LEVEL TO 50%**.
- Press **MEASURE**; then press the main-menu button **Select Measurements for Ch2**.

- Repeatedly press the side-menu button **-more-** until **Pk-Pk** appears in the side menu (its icon is shown at the left). Press the side-menu button **Pk-Pk**.
- Press **CLEAR MENU**.

b. *Check against limits:*

- CHECK that the readout **Ch2 Pk-Pk** is between 80 mV and 120 mV, inclusive.
- Press **VERTICAL MENU**; then press the side-menu button Ω to toggle to the 50 Ω setting.
- Press **CLEAR MENU**.

- CHECK that the readout **Ch2 Pk-Pk** is between 40 mV and 60 mV, inclusive.

4. *Disconnect the hookup:* Disconnect the cables from the channel inputs and the rear panel outputs.

## Check Probe Compensator Output

**Equipment Required:** One female BNC to clip adapter (Item 3), two dual-banana connectors (Item 6), one BNC T connector (Item 7), two 50 Ω precision cables (Item 5), and one DC calibration generator (Item 9).

**Prerequisites:** See page 4-11. Also, the Digitizing Oscilloscope must have passed *Check Accuracy—Long-Term Sample Rate, Delay Time, and Delta Time Measurement* on page 4-29.

**Procedure:**

1. *Install the test hookup and preset the instrument controls:*

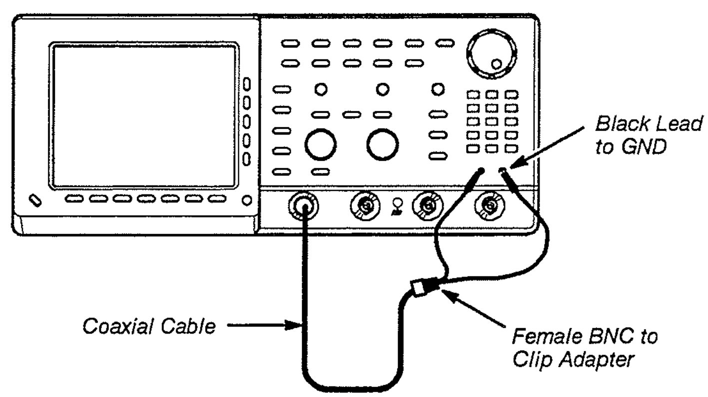



**Figure 4-22: Initial Test Hookup**

a. *Hook up test-signal:*

- Connect one of the 50 Ω cables to **CH 1**.
- Connect the other end of the cable just installed to the female BNC to clips adapter.
- Connect the red-coded clip on the adapter just installed to the **PROBE COMPENSATION SIGNAL** on the front panel; connect the black-code clip to **PROBE COMPENSATION GND**.

b. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init.**

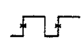
c. *Modify the initialized front-panel control settings:*

- Set the horizontal **SCALE** to 250 µs.
- Press **SET LEVEL TO 50%**.
- Use the vertical **POSITION** knob to center the display on screen.
- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu button **Average**.
- Select **128** averages.

2. *Confirm that the Probe Compensator signal is within limits for frequency:*

a. *Measure the frequency of the probe compensation signal:*

- Press **MEASURE**; then press the main-menu button **Select Measurement for Ch1**.



- Repeatedly press the side-menu button **-more-** until **Frequency** appears in the side menu (its icon is shown at the left). Press the side-menu button **Frequency**.
- See Figure 4-23.

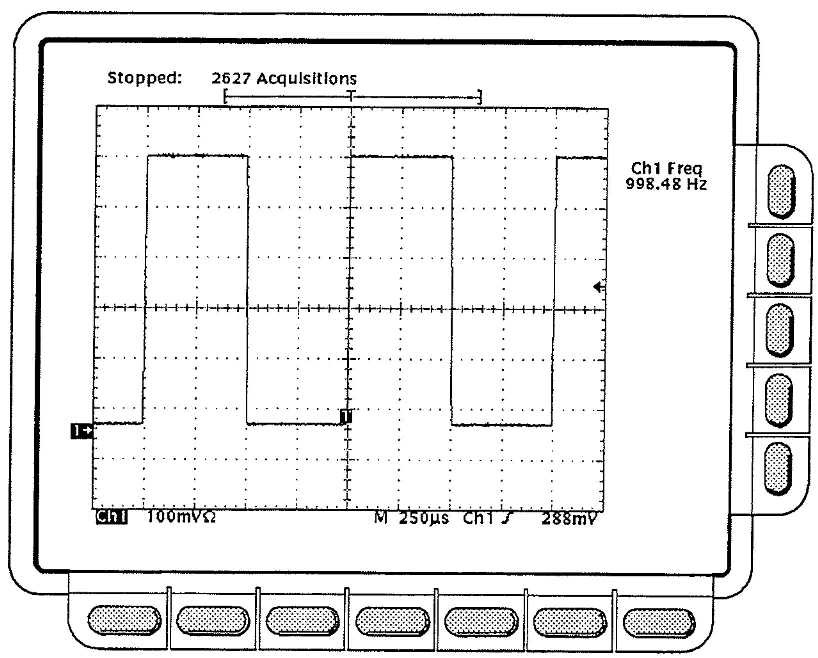



**Figure 4-23: Measurement of Probe Compensator Frequency**

b. *Check against limits:* CHECK that the **CH 1 Freq** readout is within 950 Hz to 1.050 kHz, inclusive.

c. *Save the probe compensation signal in reference memory:*

- Press **SAVE/RECALL WAVEFORM**; then press the main-menu button **Save Waveform Ch 1**.
- Press the side-menu button **Ref 1** to save the probe compensation signal in reference 1.
- Disconnect the cable from **CH 1** and the clips from the probe compensation terminals.
- Press **MORE**; then press the main-menu button **Ref 1** to displayed the stored signal.
- Press **CH 1**.

d. *Hook up the DC standard source:*

- Set the output of a DC calibration generator to 0 volts.
- Connect the output of a DC calibration generator through a dual-banana connector followed by a 50 Ω precision coaxial cable to one side of a BNC T connector.
- Connect the Sense output of the generator through a second dual-banana connector followed by a 50 Ω precision coaxial cable to the other side of the BNC T connector. Now connect the BNC T connector to **CH 1**.

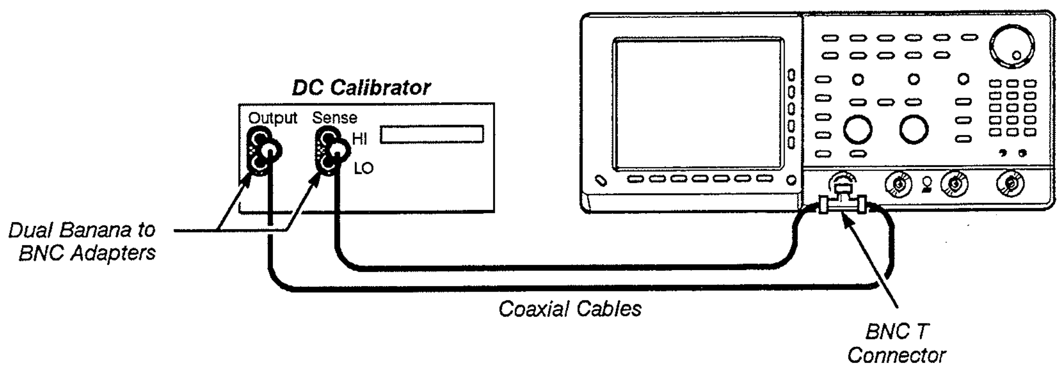



**Figure 4-24: Subsequent Test Hookup**

e. *Measure amplitude of the probe compensation signal:*

- Press **SHIFT**; then press **ACQUIRE MENU**. Press the side-menu button **AVERAGE 16**.
- Adjust the output of the DC calibration generator until it precisely overlaps the top (upper) level of the stored probe compensation signal. (This value will be near 500 mV.)
- Record the setting of the DC generator.

- Adjust the output of the DC calibration generator until it precisely overlaps the base (lower) level of the stored probe compensation signal. (This value will be near zero volts.)
- Record the setting of the DC generator.

f. Press **CLEAR MENU** to remove the menus from the display. See Figure 4-25.

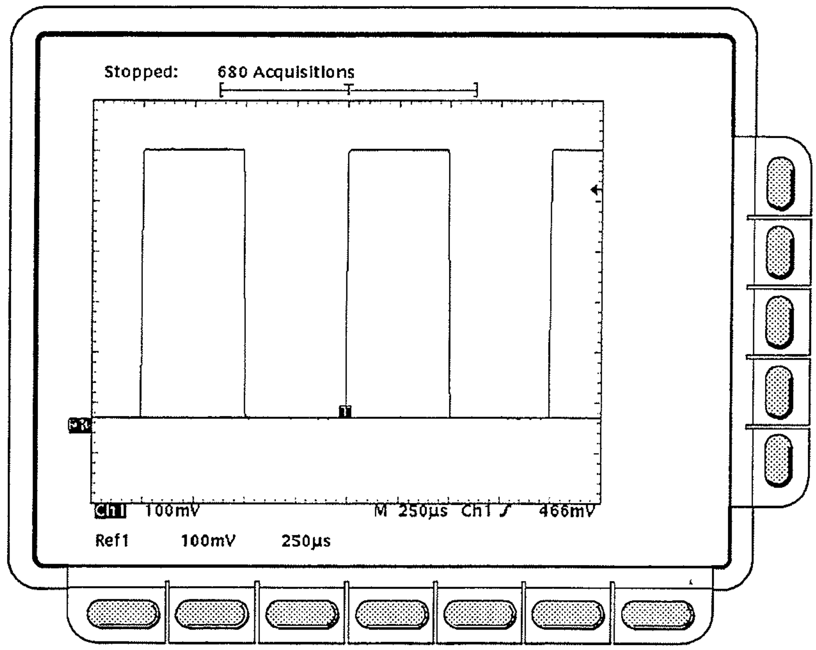



**Figure 4-25: Measurement of Probe Compensator Amplitude**

g. *Check against limits:*

- Subtract the value just obtained (base level) from that obtained previously (top level).
- CHECK that the difference obtained is within 495 mV to 505 mV, inclusive.

3. *Disconnect the hookup:* Disconnect the cable from **CH 1**.

# Adjustment

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# Adjustment Procedures

This section contains information needed to adjust your TDS 640 Digitizing Oscilloscope.

**Description**—The *Adjustment Procedures* are divided into six subsections:

- General information about adjusting the TDS 640 Digitizing Oscilloscope.
- A list of equipment required to perform the adjustments.
- The written procedures for installing and using the *TDS 640 Adjustment Software*.
- The *TDS 640 Adjustment Software* included with this manual. The material found in the subsections listed above should be read before using the adjustment software.
- A written procedure for manually adjusting the optional P6139A probe.
- A written procedure for manually adjusting the display assembly.

**Purpose**—This procedure is used to return the digitizing oscilloscope to conformance with its *Warranted Characteristics* as listed in Section 1, *Specification*. It can also be used to optimize the performance of the oscilloscope.

**Adjustment Interval**—As a general rule, these adjustments should be done every 2000 hours of operation or once a year if the oscilloscope is used infrequently.

## Requirements for Performance

Before you do this procedure, you need to address the following requirements.

### Personnel

This procedure is only to be performed by trained service technicians.

### Warm-Up Period

This oscilloscope requires a 20 minute warm-up time in a 20°C to 30°C environment before it is adjusted. Adjustments done before the operating temperature has stabilized may cause errors in performance.

### Access

Except when adjusting the display assembly, the cabinet is not removed. Instead, you enable the internal adjustment constants of the oscilloscope to be written. Two small holes in the chassis allow service personnel to insert a tool and push a switch to enable or disable the writing of new adjustment constants to non-volatile RAM.

The procedure that follows will tell you how and when to enable and disable the writing of adjustment constants. Be sure to disable the switch when you have finished adjusting the oscilloscope.

### System

The following computer and peripherals are required to adjust this oscilloscope.

**Computer**—An IBM® PC™ or a strict compatible is required. The system must also be equipped as follows:

- Eight MHz clock speed or faster.
- DOS 3.2 or higher.
- 640K Resident RAM with 580K Available RAM.
- A hard drive.
- A high-density floppy drive: 3.5 inch (1.44 M) or 5.25 inch (1.2 M).
- A GPIB board—National Instruments® GPIB-PCII, GPIB-PCIIA or GPIB-PCII/IIA. (A PC-GPIB Package that includes the PCII/IIA is available—Tektronix part number 118-8688-00).
- Suitable keyboard and monitor.

### Optional Peripherals

Installation of a math coprocessor in your system is strongly recommended to decrease the time required to adjust the oscilloscope.

### Test Equipment

The equipment list, starting on page 5-5, lists all test equipment required to adjust this oscilloscope.

## Usage

The following topics cover what is required of you when adjusting the oscilloscope and what is done by the software. Also, the performance of individual adjustments is discussed.

## Performing the Adjustments

When using the adjustment software, you will not be required to manually adjust any circuits. As you run the calibration tests, the software adjusts the circuits using external standards you provide in response to prompts on the computer screen. Your role, then, is to provide those test signals and to prompt the computer to continue.

Since the display-assembly and P6139A probe adjustment require manual adjustment of circuit components, they are not part of the adjustment software. Written procedures for these adjustments start on page 5-11.

If you are using the optional P6139A probe, do the manual adjustment procedures found at the end of this section.

## Complete Adjustment

A complete adjustment is the performance of all adjustments on the *TDS 640 Adjustment Software,* in sequence, plus the P6139A probe adjustment (if you are using the optional P6139A probe).

Throughout this section, "complete adjustment" is used as just defined.

## Individual Adjustments

The adjustment software contains three classes of adjustments as shown in Table 5-1. Each class contains one or more individual calibration tests (CATS) and an internal compensation routine (SPC). The TDS 640 *Adjustment Software* provides you with instructions for running each of the tests.

All these software-based adjustments are made internally by the adjustment software, and all adjustments can be done without removal of the oscilloscope cabinet.

**Signal Path Compensation (SPC)** – This internal routine is not an adjustment. It is a temperature compensation routine that compensates for the current operating temperature to optimize oscilloscope performance.

**Table 5-1: Calibration Tests**

| Class of Adjustment | CATS Tests |
|---|---|
| Voltage Reference | CVR_CAL<br>TEMPERATURE_SET<br>SPC |
| Frequency Response | SPC<br>HF_CAL |
| Pulse Trigger | SPC<br>TRIG_POS_CAL<br>PNP_LATENCY<br>GLITCH_TRIG_CAL |

## Partial Adjustment

The adjustment software will allow you to make individual adjustments. However, usually all adjustments are made unless you are adjusting circuits in the course of troubleshooting the oscilloscope. Read the information under *Complete Adjustment*, *Adjustment After Repair,* and *Adjustment Dependencies* before doing an individual adjustment.

## Adjustment After Repair

After the removal and replacement of a module due to electrical failure, you must either do a complete adjustment or no adjustment is required, depending on the module replaced. See Table 5-2.

**Table 5-2: Adjustments Required for Module Replaced**

| Module Replaced | Adjustment Required |
|---|---|
| Acquisition Board | Complete Adjustment |
| Attenuator Board | Complete Adjustment |
| Front Panel Assembly | None Required |
| Firm Face Board | None required[1] |
| Low Voltage Power Supply | Complete Adjustment |
| Processor Board | Complete Adjustment |
| Display Assembly | Display Adjustment Only |

[1]If a firmware upgrade is done, a complete adjustment is required.

## Adjustment Dependencies

Some adjustments depend on successful prior completion of other adjustments. For example, all the CATS tests associated with the Voltage Reference Adjustment class must be passed before any other adjustments can be successfully completed. The following table lists the adjustments and their dependencies.

**Table 5-3: Adjustments and Dependencies**

| Class of Adjustment | Prior Completion Requirements |
|---|---|
| Voltage Reference Adjustment | None |
| Frequency Response Adjustment | Voltage Reference (SPC and all tests) |
| Pulse Trigger Adjustment | Voltage Reference (SPC and all tests) |
| P6139A Probe Adjustment | Voltage Reference and Frequency Response (SPC and all tests) |
| Display Adjustment | None |

## Equipment Required

The test equipment required to adjust the TDS 640 Digitizing Oscilloscope is listed here.

**Table 5-4: Test Equipment, Fixtures, and Supplies**

| Item Number and Description | Minimum Requirements | Example | Purpose |
|---|---|---|---|
| 1. Adapter, BNC-Female-to-BNC-Female | Tektronix 013-0028-00 | Tektronix part number 013-0028-00 | Probe Adjustment |
| 2. Adapter, Probe Tip to BNC, 50 Ω termination | Tektronix 013-0227-00 | Tektronix part number 013-0227-00 | Probe Adjustment |
| 3. Adjustment Tool | Less than ⅛ inch diameter and over 2 inches long | Tektronix part number 003-0675-00 | Software-based Adjustments (used as a probe) and Manual Adjustments |
| 4. Attenuator, 10X (Two required) | Ratio: 10X; impedance 50 Ω; connectors: female BNC input, male BNC output | Tektronix part number 011-0059-02 | Software-based Adjustments |
| 5. Attenuator, 2X | Ratio: 2X; impedance 50 Ω; connectors: female BNC input, male BNC output | Tektronix part number 011-0069-02 | Software-based Adjustments |
| 6. Cable GPIB | IEEE Std 488.1-1987/ IEEE Std 488.2-1987 | Tektronix part number 002-0991-01 | Software-based Adjustments |
| 7. Coupler, Dual-Input | | Tektronix part number 067-0525-02 | Software-based Adjustments |
| 8. Cable, Precision Coaxial | 50 Ω, 36 in, male to male BNC connectors | Tektronix part number 012-0482-00 | Software-based Adjustments |
| 9. Connector, Dual-Banana | Female BNC to dual banana | Tektronix part number 103-0090-00 | Software-based Adjustments |
| 10. Generator, Calibration | High Amplitude pulse with variable amplitude of at least 60 V. | TEKTRONIX PG 506A[1] Calibration Generator | Probe Adjustment |
| 11. Generator, DC Calibration | Variable amplitude to ± 104 V; accuracy to 0.1% | Data Precision 8200 | Software-based Adjustments |
| 12. Generator, Leveled Sine Wave, Medium-Frequency | 200 kHz to 250 MHz; Variable amplitude from 5 mV to 4 V p-p into 50 Ω; flatness ≤3 %; harmonic content: 2$^{nd}$ harmonic down –30 dB from fundamental; all others down –40 dB | TEKTRONIX SG 503[1] or SG5030[1] Leveled Sine Wave Generator | Software-based Adjustments |

**Table 5-4: Test Equipment, Fixtures, and Supplies (Cont.)**

| Item Number and Description | Minimum Requirements | Example | Purpose |
|---|---|---|---|
| 13. Generator, Leveled Sine Wave, High-Frequency | 250 MHz to 500 MHz; Variable amplitude from 0.5 V to 4 V p-p into 50 Ω; 6 MHz reference; harmonic content: $2^{nd}$ harmonic down –25 dB from fundamental; all others down –40 dB | TEKTRONIX SG 504[1] Leveled Sine Wave Generator with its leveling head or a TEKTRONIX SG 5030[1] Programmable Leveled Sine Wave Generator with its leveling head | Software-based Adjustments |
| 14. Magnifier, 6X | Standard Tool | | Brightness and Focus Adjustment |
| 15. Photometer | 0.1 to 200 Footlamberts | TEKTRONIX J16 Photometer with J6503 Luminance Probe | Contrast Adjustment |
| 16. Probe, 10X, optional accessory | A P6139A Probe | TEKTRONIX P6139A | Probe Adjustment |
| 17. Pulser, Tunnel Diode | TEKTRONIX 067-0681-01 | TEKTRONIX 067-0681-01 | Probe Adjustment |

[1]Requires a TM 500 or TM5000 Series Power Module Mainframe.

## Adjustment Instructions

The following instructions will guide you through installing the software on your system, setting up the oscilloscope for adjustment, and starting the adjustment of the oscilloscope by the software.

### Hardware Installation

1. *Install the proper GPIB card (see* System *on page 5-2):* Use the manual accompanying your GPIB card to install and configure that card.
2. *Configure the GPIB card:*
   a. This software is designed to be compatible with cards configured for PCII and PCIIA operation. The following table lists the default card settings.
   b. If these settings conflict with your hardware setup, see your GPIB card manual for alternate settings.
   c. If you have more than one GPIB card installed, this adjustment software assumes the first card (referenced 0). See your GPIB card manual for information on how to determine which card is your "0" card.

**Table 5-5: GPIB Board Configuration[1]**

| Board Settings | GPIB-PCII | GPIB-PCIIA |
|---|---|---|
| Base I/O Address (hex) | 2B8 | 2E1 |
| Interrupt Line | 7 | 7 |
| DMA Channel | 1 | 1 |

**[1]Systems using the combination card (GPIB-PCII/IIA) can be configured as either a GPIB-PCII or a GPIB-PCIIA.**

### Software Installation

STOP: ALWAYS use this installation procedure when installing this software on a new computer. This installation program uses parameters you supply (see step 2, substep a) to create a custom start-up file on your hard disk directory. After installation, you will be instructed to run this start-up batch file whenever you do software-based adjustments, so it can configure your computer properly before it runs the adjustment program. Do *not* simply copy the software files from one computer to another, since the start-up batch file you copy may not match the computer you copy it to.

1. *Create a working disk:* Using the proper DOS commands, copy the *TDS 640 Adjustment Software* disk to a working disk.

2. *Install the software to hard disk:*

   a. Install your working disk in a floppy drive and type *install.* You will be asked to specify the hard disk on which to install the adjustment software. You will also be prompted to specify several GPIB-card configuration parameters.

   b. The adjustment software will be installed in a directory called *TDS640.ADJ* on your hard drive.

3. *Store your installation disk:* Remove your installation disk and store in a secure place.

## Software-Based Adjustments

**Equipment Required:** All items that are listed for "Software-based Adjustments" under "Purpose" in Table 5-4 starting on page 5-5.

1. *Hook up the oscilloscope:*

   a. Connect the GPIB cable (Item 6) to the GPIB port at the computer rear panel. (When multiple GPIB cards are installed, connect to the GPIB0 card.)

   b. Connect the GPIB cable (Item 6) to the GPIB port at the oscilloscope rear panel.

   c. Power on the oscilloscope.

2. *Set up the oscilloscope:*

   a. Press **SHIFT**; then press **UTILITY**.

   b. Repeatedly press the main-menu button **System** until **I/O** is highlighted in the pop-up menu.

   c. Press the side-menu button **TALK/LISTEN**.

   d. Use the keypad to set any address between 0 and 29.

3. *Enable the adjustment constants to be written:*

   a. Locate the two small access holes on the right side of the oscilloscope cabinet near the front.

   b. Insert the adjustment tool (Item 3) in the hole nearest the front of the oscilloscope about ½ inch to engage the rocker switch.

   c. Push to rock the switch to its unprotected (enabled) position.

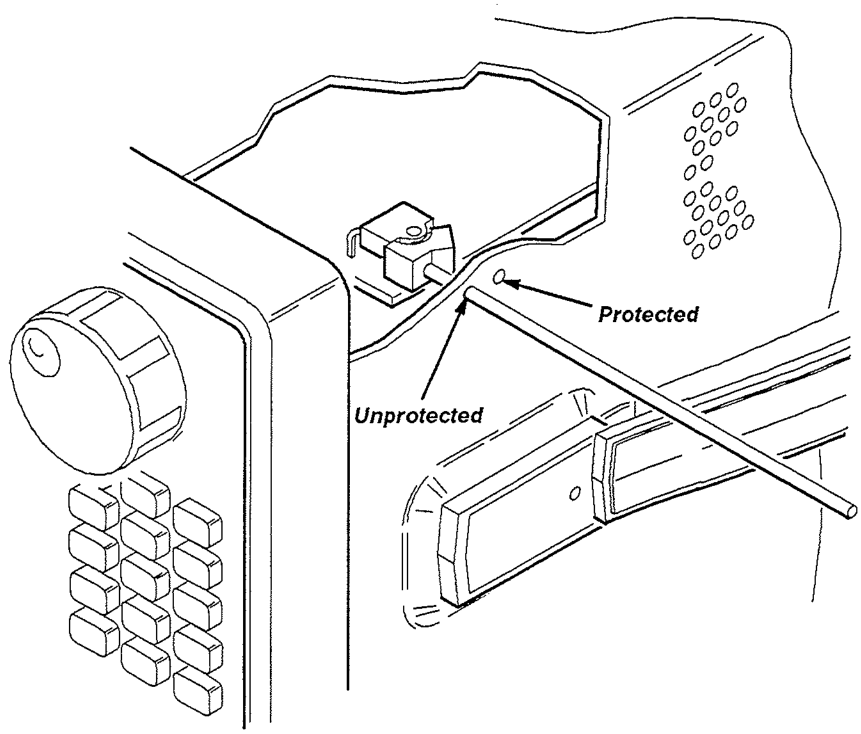


**Figure 5-1: Accessing the Protection Switch**

   d. Type ADJ640.

   e. Follow the instructions as prompted on your computer screen.

4. *Let the oscilloscope warm up:* Allow a 20 minute warm-up period before you begin step 5.

5. *Start the adjustment software:*

   a. Change drives to your hard drive.

   b. Change directories to TDS640.ADJ.

6. *When adjustment has been completed:*

**CAUTION**

*Be sure to disable the NVRAM Protection switch as instructed below to protect the adjustment constants against alteration.*

   a. Locate the two small access holes on the right side of the oscilloscope cabinet near the front. (See Figure 5-1.)

   b. Insert the adjustment tool (Item 3) in the hole nearest the *rear* of the oscilloscope about ½ inch to engage the rocker switch.

c. Push to rock the switch to its protected (disabled) position.

d. To do a complete adjustment as defined on page 5-3, you must also do the procedure *Probe Adjustment for the P6139A Probe* on page 5-11, if you are using the optional P6139A probe.

## Probe Adjustment for the P6139A Probe

It is not necessary to do this procedure to perform a complete adjustment unless you are using the optional P6139A probe.

This probe adjustment is divided into three parts: *Compensate the Probe, Measure the Probe Bandwidth*, and *Adjust the Probe – High Frequency Response.* If probe bandwidth is within required limits, you will be instructed to *not* do the high frequency response adjustment.

### Compensate the Probe

**Equipment Required:** One P6139A probe (Item 16).

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*

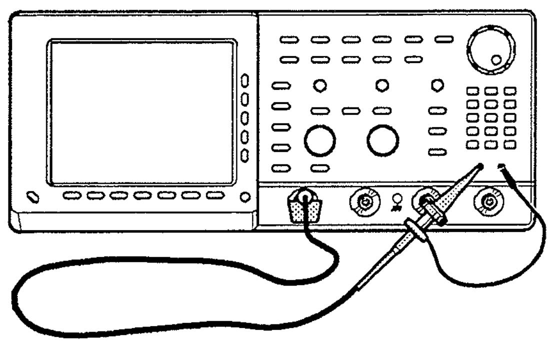

**Figure 5-2: Hookup for Probe Compensation**

   a. *Hook up test-signal source:* Install the optional-accessory probe to **CH 1**. Connect the probe tip to **PROBE COMPENSATION SIGNAL** on the front panel; connect the probe ground to **PROBE COMPENSATION GND**.

   b. *Initialize the oscilloscope:*

      - Press save/recall **SETUP**.
      - Press the main-menu button **Recall Factory Setup**.
      - Press the side-menu button **OK Confirm Factory Init**.

   c. *Modify the initialized front-panel control settings:*

      - Press **AUTOSET**. Set the horizontal **SCALE** to 250 $\mu$s.
      - Press **SET LEVEL TO 50%** as required to trigger the signal.
      - Press **SHIFT**; then press **ACQUIRE MENU**.
      - Press the main-menu button **Mode**. Then press the side-menu button **Average 16**.

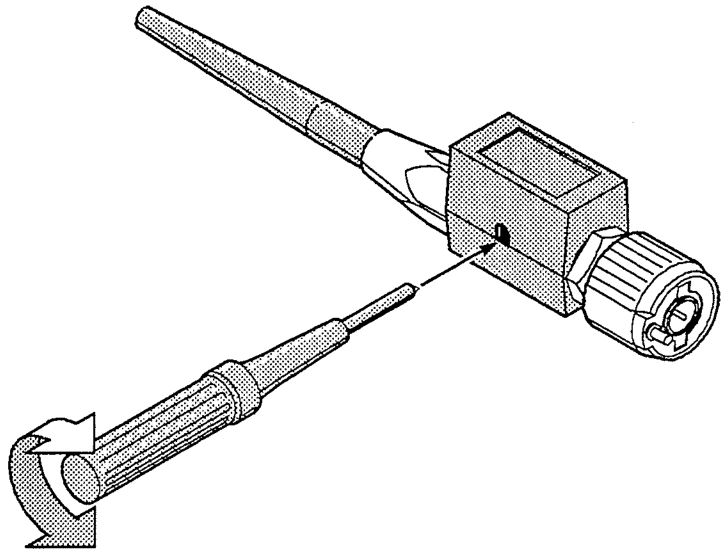

**Figure 5-3: Performing Probe Compensation**

2. *Compensate the Probe:*
   a. Locate the probe compensation hole in the side of the probe body.
   b. Using the probe compensation tool, adjust the probe for best square wave compensation (flat as possible across its top).

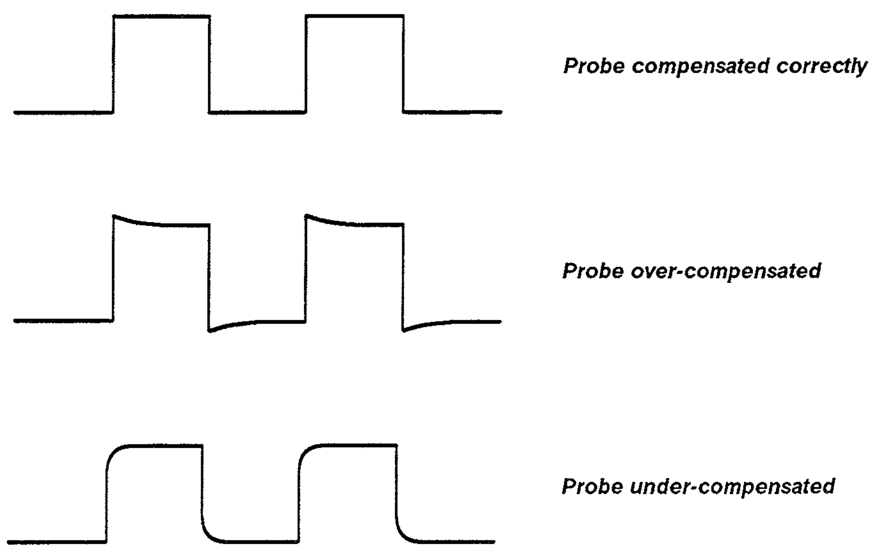


**Figure 5-4: Proper and Improper Probe Compensation**

3. *Disconnect the hookup:* Disconnect the probe from the probe compensator terminals; leave probe installed on CH 1 and leave the oscilloscope control setup as is for doing the next part of probe adjustment.

## Measure Probe Bandwidth

**Equipment Required:** One high-frequency sine wave generator with its leveling head (Item 13), one BNC-female-to-female BNC adapter (Item 1), one BNC-to-probe tip adapter (Item 2), and one P6139A 10X probe (Item 16).

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*

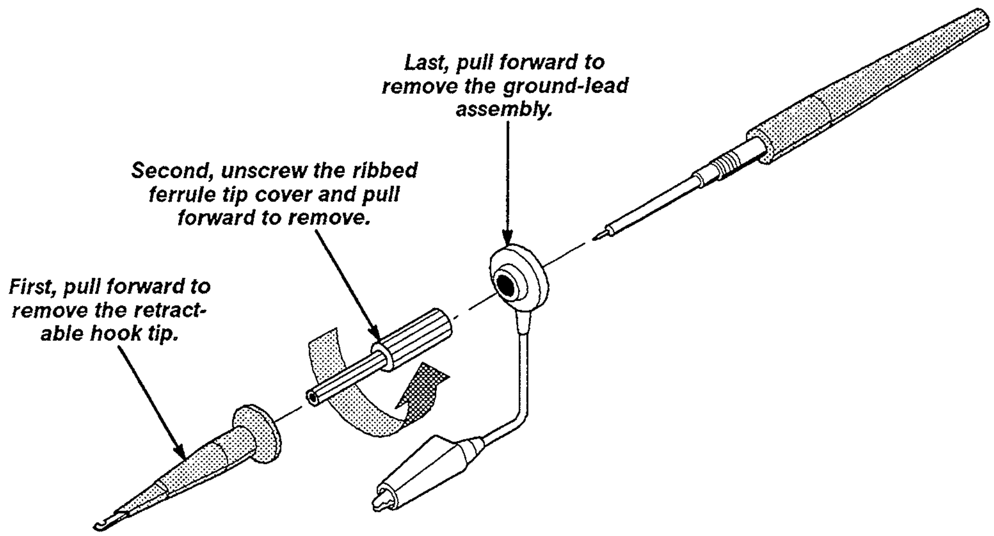


**Figure 5-5: Exposing the Inner Probe Tip**

a. *Expose the Inner Probe Tip:* Follow the instructions in Figure 5-5.

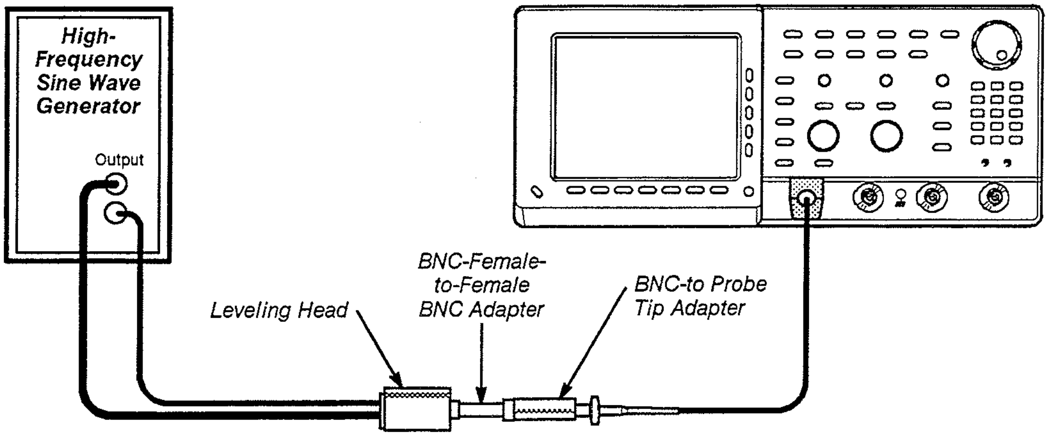


**Figure 5-6: Initial Test Hookup**

b. *Hook up test-signal source:*

- Connect the output of a high-frequency sine wave generator, through its leveling head, to a female-to-female adapter.
- Connect the female-to-female adapter to a BNC-to-probe tip adapter.
- Plug the probe tip from the probe on CH 1 into the BNC-to-probe tip adapter.

c. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

d. *Modify the initialized front-panel control settings:*

- Set the vertical **SCALE** to 500 mV.
- Set the horizontal **SCALE** to 100 ns.
- Push **SET LEVEL TO 50%** as required to trigger the signal.
- Press **SHIFT**. Then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Average 16**.
- Press **MEASURE**.
- Press the main-menu button **Hi-Low Setup**. Then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measurement for Ch1**.
- Repeatedly press the side-menu button **–more–** until **Pk-Pk** appears in the side menu. Press the side-menu button **Pk-Pk**.

- Press **CLEAR MENU**.

2. *Confirm that the Probe Compensator signal is within limits for bandwidth:*

   a. *Display and measure the test signal:*

      - Monitor the **CH 1 Pk-Pk** readout while you set the output of the generator for a 3.0 V (6 division), 6 MHz reference signal.
      - Set the horizontal **SCALE** to 1 ns and set the frequency of the generator to 500 MHz.
      - Read the measurement results at the CH 1 Pk-Pk readout on screen.

   b. *Check against limits:* CHECK that the **CH 1 Pk-Pk** readout is greater than or equal to 2.1 V.

3. *Disconnect the hookup:*

   a. Unplug the probe from BNC-to-probe tip adapter.

   b. If substep 2b was passed, the probe adjustment is finished. Reverse the instructions in Figure 5-5, page 5-13, to reinstall the retractable hook probe tip.

   c. If substep 2b was *not* passed, leave the probe tip exposed. Remove the probe from CH 1 and go on to the next procedure *Adjust the Probe—High Frequency Response*.

## Adjust the Probe—High Frequency Response

Do not perform this procedure until you have first completed the procedures *Compensate the Probe* and *Measure Probe Bandwidth* on pages 5-11 and 5-13, respectively.

Do not perform this procedure if you have successfully completed *Measure Probe Bandwidth.* Probe adjustment is complete.

**Equipment Required:** One calibration generator (Item 10), one 50 Ω precision cable (Item 8), one tunnel diode pulser (Item 17), one female-to-female adapter (Item 1), one BNC to probe adapter (Item 2), one 10X attenuator (Item 4), and one P6139A 10X probe (Item 16).

**Procedure:**

1. *Install the test hookup and preset the oscilloscope controls:*

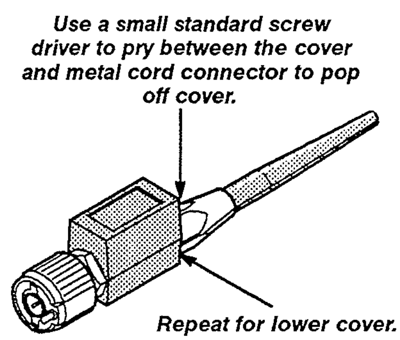


**Figure 5-7: Exposing the Probe Body**

   a. *Access Inner Probe Tip and Adjustment Ports:*

      - The probe tip should be exposed from the procedure *Measure Probe Bandwidth.* If not, follow the instructions in Figure 5-5 to expose the probe tip.
      - Follow the instructions in Figure 5-7 to remove the probe body covers.

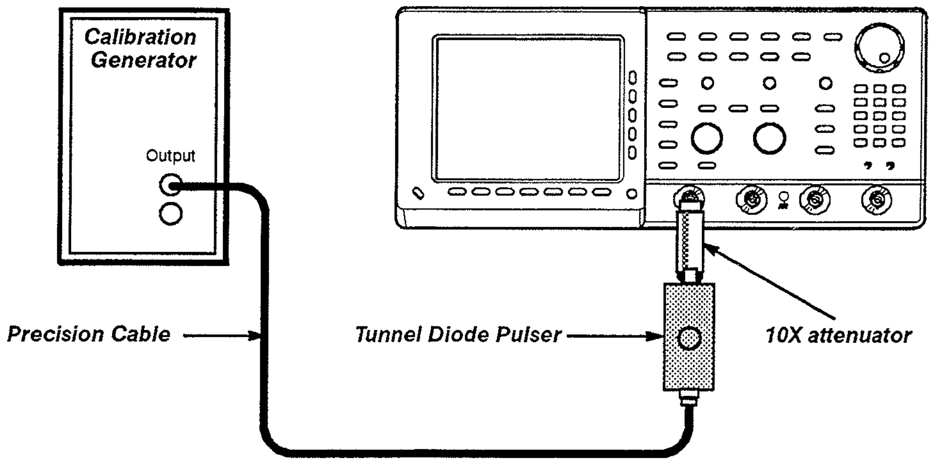


**Figure 5-8: Initial Test Hookup**

b. *Hook up test-signal source:*

- Connect the high-amplitude output of a calibration generator, through a 50 Ω precision cable to the input of a tunnel diode pulser.
- Connect the output of the tunnel diode pulser through a 10X attenuator to CH 1.
- Set the triggering level of the tunnel diode pulser to minimum.

c. *Initialize the oscilloscope:*

- Press save/recall **SETUP**.
- Press the main-menu button **Recall Factory Setup**.
- Press the side-menu button **OK Confirm Factory Init**.

d. *Modify the initialized front-panel control settings:*

- Set vertical **SCALE** to 5 mV.
- Push **SET LEVEL TO 50%** as required to trigger the signal.
- Press **VERTICAL MENU**. Then press the main-menu button **Coupling**. Press the side-menu button Ω to toggle to 50 Ω coupling.
- Press **CLEAR MENU**.

2. *Adjust the Probe:*

a. *Display and store the reference signal:*

- Set the high-amplitude output of the generator to ≥60 V *at the input to the tunnel diode pulser*.
- Set the **Period** (repetition rate) to 10 kHz.

- Advance the triggering level of the tunnel diode pulser until a five to six division square wave appears on screen. Do not advance the knob any further than required to achieve stable amplitude.
- Use the vertical **POSITION** to center the displayed waveform on screen.
- Press **SHIFT**; then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Average 16**.
- Push **SET LEVEL TO 50%** as required to trigger the signal.
- Advance the horizontal **SCALE** to 5 ns.
- Press **HORIZONTAL MENU**.
- Press the main-menu button **Trigger Position**; press the side-menu button **Set to 20%**.
- Press **SAVE WAVEFORM.**
- Press the main-menu button **Save Waveform.** Then press the side-menu button **To Ref 1**.
- Press **MORE**. Then push the main-menu button **Ref 1**.

b. *Display the test signal:*

- Disconnect the tunnel diode pulser at CH 1 and remove the 10X attenuator.
- Connect the output of the tunnel diode pulser through a BNC-female-to-BNC-female adapter to a BNC-to-probe tip adapter.
- Install the probe on CH 1.
- Plug the probe tip from the probe into the BNC-to-probe tip adapter.
- Press **VERTICAL MENU**; then press **CH 1**.
- Press the main-menu button **Coupling**. Then press the side-menu button Ω to toggle to 1 MΩ coupling.
- Push **SET LEVEL TO 50%** as required to trigger the signal.
- Adjust the triggering level of the tunnel diode pulser until a five to six division square wave appears on screen. Do not advance the knob any further than required to achieve stable amplitude.

c. *Make the adjustments:*

- Locate the various adjustments in Figure 5-9.
- Manually adjust the front-corner response of the probe to best match the response of the Ref 1 waveform. Note that it is more important to match the response during the first 5 ns than during the entire first 20 ns the adjustments affect.

- See Figure 5-10 to see what areas on the front corner that the various adjustments affect.

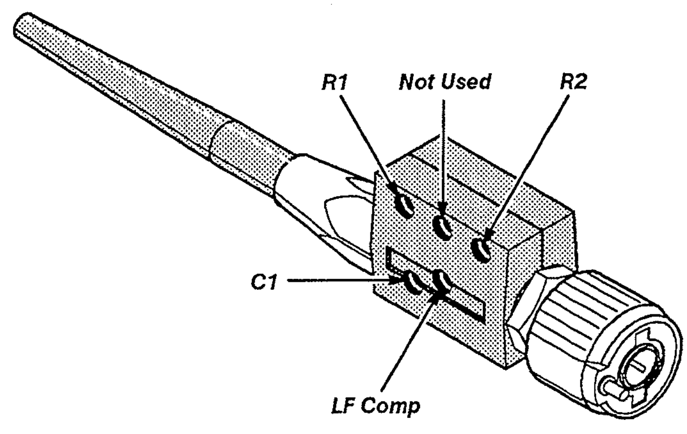


**Figure 5-9: Locations of P6139A Probe Adjustments**

d. *Recheck Probe Bandwidth:*

- Redo the procedure *Adjust Probe—High Frequency Response* to check if probe now meets its bandwidth requirement.
- If the bandwidth requirement is met, adjustment is complete. Skip to step 3.
- If the bandwidth requirement is *not* met, redo this procedure, increasing front corner overshoot slightly relative to the stored waveform.
- Repeat this step (d) until the bandwidth requirement is met.

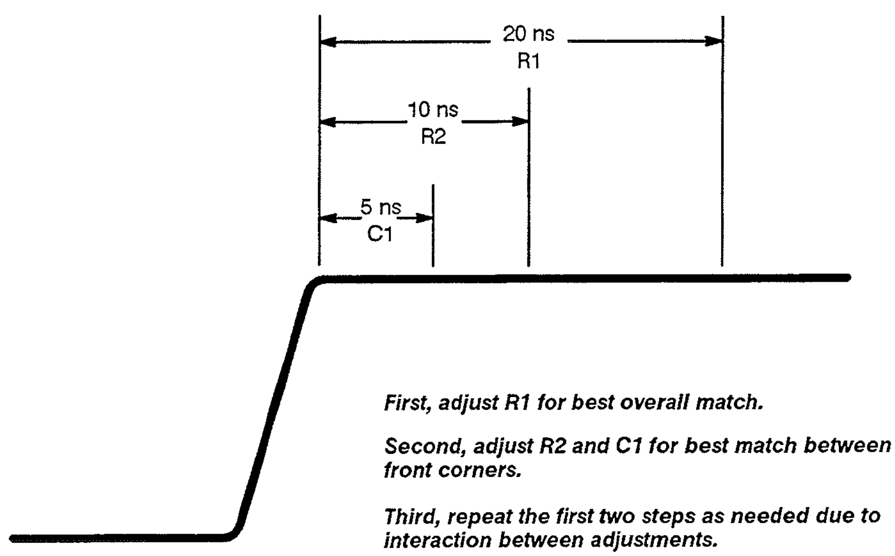


**Figure 5-10: Adjustments versus Front-Corner Response**

3. *Disconnect the hookup:* Unplug the probe from the BNC-to-probe tip adapter. Reverse the instructions in Figure 5-5, page 5-13, to reinstall the retractable probe tip.

## Display Assembly Adjustment

STOP It is not necessary to do this procedure to perform a complete adjustment. Only use this procedure to adjust the display assembly if it has been repaired or if brightness and contrast have become unsatisfactory.

### Brightness and Contrast Adjustment

**Equipment Required:** One 6X magnifier (Item 14) and one J16 Photometer with a J6503 Luminance Probe (Item 15).

**Procedure:**

1. *Access the inside of the oscilloscope:* See *Removal and Installation Procedures* in Section 6 to remove the cabinet.
2. *Adjust the display brightness:*
   a. *Display the Composite test pattern:*
   - Leave the oscilloscope powered off.
   - Set the DIP switch, located near the front of the A11 DRAM Processor/ Display, as follows:

| Switch No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Open | | | | | | X | X | |
| Closed | X | X | X | X | X | | | X |

   - Power on the oscilloscope.
   - Press **SHIFT**; then press **UTILITY**.
   - Repeatedly press the main-menu button **System** until **Diag/Err** is highlighted in the pop-up menu.
   - Repeatedly press the main-menu button **Area** until **Display** is highlighted in the pop-up menu.
   - Repeatedly press the side-menu button **-more-** until **Composite** appears in the side menu. Push **Composite**.
   - Press the main-menu button **EXECUTE**; then press the side-menu button **Ok Confirm Run Test**.

b. *Make the brightness adjustment:*

- Locate R569 (BRIGHTNESS). It is one of two adjustments on the left side of the instrument located just ahead of the fan. It is the adjustment nearest the fan.
- Observe the luminance patches using a 6X magnifier.
- Adjust R569 (BRIGHTNESS) until the background raster lines in the 5% luminance patch (see Figure 5-11) just disappear, while the lines in the 10% luminance patch are just visible, when both are viewed through the magnifier.

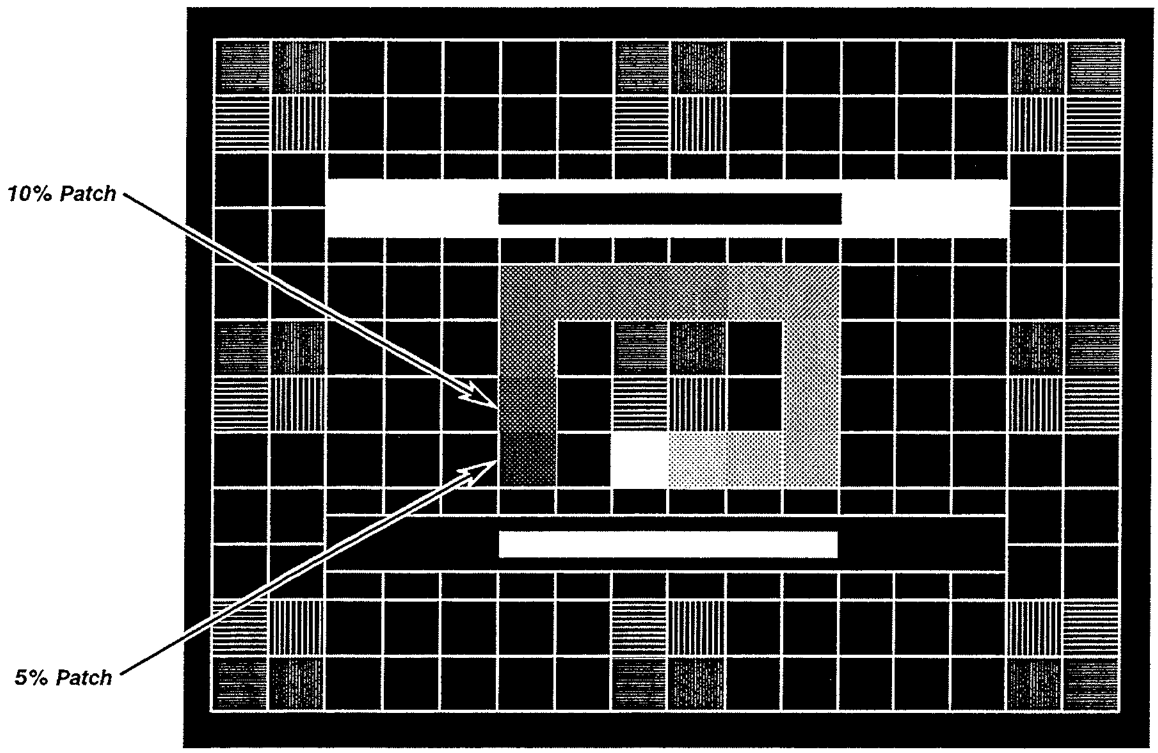


**Figure 5-11: Five and Ten Percent Luminance Patches**

3. *Adjust the display contrast:*

a. *Display the White Field test pattern:*

- Press the center main-menu button to display the main-menu.
- Press the main-menu button **Tests**.
- Repeatedly press the side-menu button **–more–** until **White Field** appears in the side menu. Push **White Field**.
- Press the main-menu button **EXECUTE**; then press the side-menu button **Ok Confirm Run Test**.

b. *Make the contrast adjustment:*

- Locate R572. It is one of two adjustments on the left side of the instrument located just ahead of the fan. It is the adjustment nearest the front of the oscilloscope.
- Monitor the luminance at center screen using a J16 photometer and a luminance probe.
- Adjust R572 (CONTRAST) for a reading of 50 foot lamberts if the gray display shield is installed; adjust for 110 foot lamberts if shield is missing.

***NOTE***

*The adjustments for contrast and brightness interact with each other.*

4. *Restore the oscilloscope to normal operation:*

a. Restore the dip switch to the settings that follow:

| Switch No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Open | | | | | | | | |
| Closed | X | X | X | X | X | X | X | X |

b. Power off the oscilloscope.

c. See *Removal and Installation Procedures* in Section 6 to reinstall the cabinet and other modules removed in step 1.

# Maintenance

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# Maintenance Information

This section contains the information needed to do periodic and corrective maintenance on the TDS 640 Digitizing Oscilloscope.The following subsections are included:

- **Maintenance Information** – Introduction plus general information on preventing damage to internal modules when doing maintenance.
- **Inspection and Cleaning** – Information and procedures for inspecting the oscilloscope and cleaning its external and internal modules.
- **Removal and Installation Procedures** – Procedures for the removal of defective modules and replacement of new or repaired modules. Also included is a procedure for disassembly of the oscilloscope for cleaning.
- **Troubleshooting** – Information for isolating failed modules. Included are instructions for operating the oscilloscope's internal diagnostic routines and troubleshooting trees. Most of the trees make use of these internal diagnostic routines to speed fault isolation to a module.

## Procedures Not In This Section

The following sections contain information/procedures related to maintenance.

- Section 2, *Operating Information*, covers instructions useful when operating the oscilloscope in order to troubleshoot it. It also details the service strategy and lists options for obtaining maintenance service and for replacing failed modules.
- Section 3, *Theory of Operation*, contains a circuit description at the module, or block, level.
- Section 4, *Performance Verification*, contains procedures that may be useful in isolating problems to modules by testing oscilloscope performance.
- Section 5, *Adjustment Procedures*, addresses after repair adjustment and the interval between periodic adjustments. It contains a procedure for adjusting the internal circuits of the oscilloscope.
- Section 9, *Diagrams*, contains a block diagram using individual modules as blocks and an interconnection diagram showing connections between the modules.
- Section 10, *Replaceable Parts List,* lists all field replaceable modules by part number.

## Preventing ESD

**CAUTION**

*Static discharge can damage any semiconductor component in this oscilloscope.*

### Precautions

When performing any service which requires internal access to the oscilloscope, adhere to the following precautions to avoid damaging internal modules and their components due to electrostatic discharge (ESD).

1. Minimize handling of static-sensitive modules.
2. Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive modules.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Do service of static-sensitive modules only at a static-free work station.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Handle circuit boards by the edges when possible.
6. Do not slide the modules over any surface.
7. Avoid handling modules in areas that have a floor or work-surface covering capable of generating a static charge.

### Susceptibility to ESD

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.

**Table 6-1: Relative Susceptibility to Static-Discharge Damage**

| Semiconductor Classes | Relative Susceptibility Levels[1] |
|---|---|
| MOS or CMOS microcircuits or discrete circuits, or linear microcircuits with MOS inputs (most sensitive) | 1 |
| ECL | 2 |
| Schottky signal diodes | 3 |
| Schottky TTL | 4 |
| High-frequency bipolar transistors | 5 |
| JFET | 6 |
| Linear microcircuits | 7 |
| Low-power Schottky TTL | 8 |
| TTL (least sensitive) | 9 |

[1]Voltage equivalent for levels (voltage discharged from a 100 pF capacitor through resistance of 100 ohms):

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

# Inspection and Cleaning

*Inspection and Cleaning* describes how to inspect for dirt and damage on, and how to clean the exterior and interior of the TDS 640 Digitizing Oscilloscope. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent oscilloscope malfunction and enhance its reliability.

Preventive maintenance consists of visually inspecting and cleaning the oscilloscope and using general care when operating it.

How often to do maintenance depends on the severity of the environment in which the oscilloscope is used. A proper time to perform preventive maintenance is just before oscilloscope adjustment.

## General Care

The cabinet helps keep dust out of the oscilloscope and should normally be in place when operating the oscilloscope. The oscilloscope's front cover protects the front panel and display from dust and damage. Install it when storing or transporting the oscilloscope.

## Inspection and Cleaning Procedures

Inspect and clean the oscilloscope as often as operating conditions require. The collection of dirt on components inside can cause them to overheat and breakdown. (Dirt acts as an insulating blanket, preventing efficient heat dissipation.) Dirt also provides an electrical conduction path that could cause an oscilloscope failure, especially under high-humidity conditions.

**CAUTION**

*Avoid the use of chemical cleaning agents which might damage the plastics used in this oscilloscope. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

## Inspection – Exterior

Inspect the outside of the oscilloscope for damage, wear, and missing parts, using Table 6-2 as a guide. Oscilloscopes that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance. Immediately repair defects that could cause personal injury or lead to further damage to the oscilloscope.

**Table 6-2: External Inspection Check List**

| Item | Inspect For | Repair Action |
|---|---|---|
| Cabinet, front panel, and cover | Cracks, scratches, deformations, damaged hardware or gaskets. | Replace defective module. |
| Front-panel knobs | Missing, damaged, or loose knobs. | Repair or replace missing or defective knobs. |
| Connectors | Broken shells, cracked insulation, and deformed contacts. Dirt in connectors. | Replace defective modules. Clear or wash out dirt. |
| Carrying handle, bail, cabinet feet. | Correct operation. | Replace defective module. |
| 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 modules. |

## Cleaning Procedure – Exterior

**CAUTION**

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

1. Remove loose dust on the outside of the oscilloscope with a lint free cloth.
2. Remove remaining dirt with a lint free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Clean the light filter protecting the monitor screen with a lint-free cloth dampened with either isopropyl alcohol or, preferably, a gentle, general purpose detergent-and-water solution.

## Inspection – Interior

To access the inside of the oscilloscope for inspection and cleaning, refer to the *Removal and Installation Procedures* in this section.

Inspect the internal portions of the oscilloscope for damage and wear, using Table 6-3 as a guide. Defects found should be repaired immediately.

If any electrical module is replaced, check Table 5-2 in Section 5 to see if it is necessary to adjust the oscilloscope.

**CAUTION**

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

**Table 6-3: Internal Inspection Check List**

| Item | Inspect For | Repair Action |
|---|---|---|
| Circuit boards | Loose, broken, or corroded solder connections. Burned circuit boards. Burned, broken, or cracked circuit-run plating. | Remove failed module and replace with a fresh module. |
| Resistors | Burned, cracked, broken, blistered condition. | Replace failed module and replace with a fresh module. |
| 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. | Remove damaged module and replace with a fresh module from the factory. |
| Semiconductors | Loosely inserted in sockets. Distorted pins. | Firmly seat loose semiconductors. Remove devices that have distorted pins. Carefully straighten pins (as required to fit the socket), using long-nose pliers, and reinsert firmly. Ensure that straightening action does not crack pins, causing them to break off. |
| Wiring and cables | Loose plugs or connectors. Burned, broken, or frayed wiring. | Firmly seat connectors. Repair or replace modules with defective wires or cables. |
| Chassis | Dents, deformations, and damaged hardware. | Straighten, repair, or replace defective hardware. |

## Cleaning Procedure — Interior

STOP If, after doing steps 1 and 2, a module is clean upon inspection, skip the remaining steps.

1. Blow off dust with dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint free cloth dampened in isopropyl alcohol (75% solution) and rinse with warm deionized water. (A cotton-tipped applicator is useful for cleaning in narrow spaces and on circuit boards.)
3. If steps 1 and 2 do not remove all the dust or dirt, the oscilloscope may be spray washed using a solution of 75% isopropyl alcohol by doing steps 4 through 8.
4. Gain access to the parts to be cleaned by removing easily accessible shields and panels (see "Removal and Installation Procedures").
5. Spray wash dirty parts with the isopropyl alcohol and wait 60 seconds for the majority of the alcohol to evaporate.
6. Use hot (120°F to 140°F) deionized water to thoroughly rinse them.
7. Dry all parts with low-pressure, deionized air.
8. Dry all components and assemblies in an oven or drying compartment using low-temperature (125°F to 150°F) circulating air.

## Lubrication

There is no periodic lubrication required for this oscilloscope.

# Removal and Installation Procedures

This subsection contains procedures for removal and installation of all mechanical and electrical modules. Any electrical or mechanical module, assembly, or part listed in Section 10 of this manual is a module.

## Preparation – Please Read

**WARNING**

*Before doing this or any other procedure in this manual, read the Safety Summary found at the beginning of this manual. Also, to prevent possible injury to service personnel or damage to this oscilloscope's components, read* Before Servicing and Supplying Operating Power *in Section 2, and* Preventing ESD *in this section.*

This subsection contains the following:

- This preparatory information that you need to properly do the procedures that follow.
- List of tools required to remove all modules.
- Three module locator diagrams for finding the External Modules (see Figure 6-1), Outer-Chassis Modules (see Figure 6-2), and Inner-Chassis Modules (see Figure 6-3) in this oscilloscope.
- Procedures for removal and reinstallation of the electrical and mechanical modules.
- A disassembly procedure for removal of all the major modules from the oscilloscope at one time and for reassembly of those modules into the oscilloscope. Such a complete disassembly is normally only done when completely cleaning the oscilloscope. (Instructions for doing the actual cleaning are found under *Inspection and Cleaning* at the beginning of this section.)

**WARNING**

*Before doing any procedure in this subsection, disconnect the power cord from the line voltage source. Failure to do so could cause serious injury or death.*

## List of Modules

Section 10 lists all modules.

## General Instructions

**READ THESE GENERAL INSTRUCTIONS BEFORE REMOVING A MODULE.**

First read over the *Summary of Procedures* that follows to understand how the procedures are grouped. Then read *Equipment Required* for a list of the tools needed to remove and install modules in this oscilloscope.

If you are disassembling this oscilloscope for cleaning, go to the procedure *Disassembly for Cleaning* on page 6-48.

If you are removing a module for service, begin by doing the procedure *Access Procedure* (page 6-15). By following the instructions in that procedure, you remove the module to be serviced while removing the minimum number of additional modules.

## Summary of Procedures

The procedures are described in the order in which they appear in this section. In addition, you can look up any procedure for removal and reinstallation of any module in the *Table of Contents* of this manual.

- The *Access Procedure* on page 6-15 first directs you to any procedure(s) (if any) that are required to access the module to be serviced, then it directs you to the procedure to remove that module.
- *Procedures for External Modules* on page 6-15 are procedures for removing modules the removal of which do not require internal access to the oscilloscope.
- *Procedures for Outer-Chassis Modules* on page 6-30 are procedures for removing modules the removal of which require access internal to the instrument but external to the chassis.
- *Procedures for Inner-Chassis Modules* on page 6-41 are procedures for removing modules the removal of which require access internal to the instrument and internal to the chassis.
- *Disassembly for Cleaning* on page 6-35 is a procedure, based on the removal procedures just described, that removes all modules for cleaning. Instructions for cleaning are found in *Inspection and Cleaning*, which begins this section.

***NOTE***

*Read the cleaning procedure before disassembling the oscilloscope for cleaning.*

**Equipment Required** – Most modules in this oscilloscope can be removed with a screwdriver handle mounted with a size T-15, Torx® screwdriver tip. *Use this tool whenever a procedure step instructs you to remove or install a screw unless a different size screwdriver is specified in that step.* All equipment required to remove and reinstall each module is listed in the first step of its procedure.

**Table 6-4: Tools Required for Module Removal**

| Item No. | Name | Description | Tektronix Part Number |
|---|---|---|---|
| 1 | Screwdriver handle | Accepts Torx®-driver bits | 003-0301-00 |
| 2 | T-15 Torx tip | Torx®-driver bit for T-15 size screw heads | 003-0966-00 |
| 3 | T-20 Torx tip | Torx®-driver bit for T-20 size screw heads | 003-0866-00 |
| 4 | T-20 Torx tip | Special Tool: Narrow Torx®-driver bit for T-20 size screw heads (Fan removal only) | 003-1457-01 |
| 5 | Flat-bladed screwdriver | Screwdriver for removing standard-headed screws | |
| 6 | Needle-Nose Pliers | Standard tool | |
| 7 | Nutdriver, ¼ inch | Standard tool | |
| 8 | Retaining Ring Pliers | Standard tool; 1⅛ inch minimum throw | |
| 9 | Angle-Tip Tweezers | Standard tool | |
| 10 | Pliers | Standard tool | |

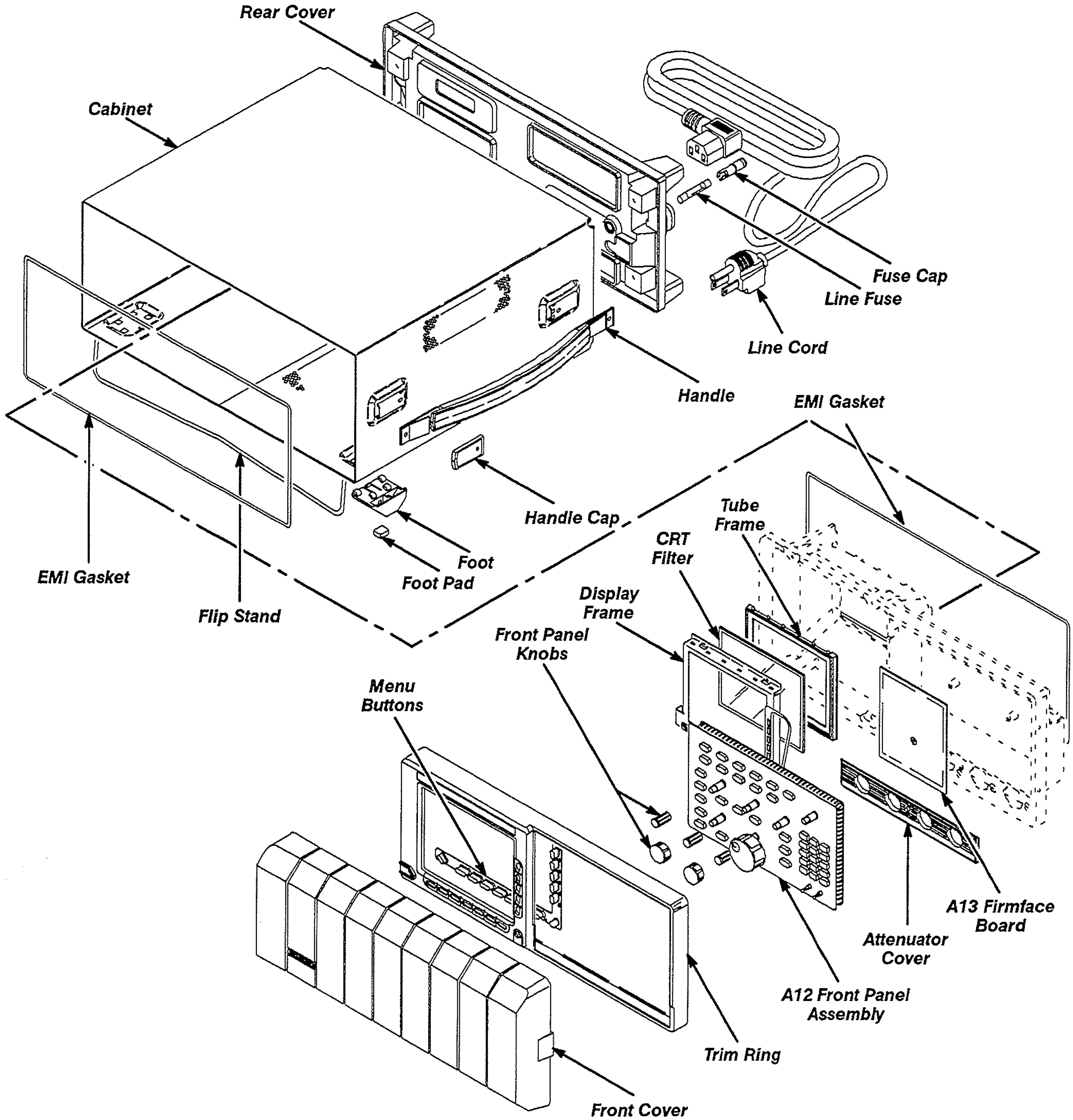



**Figure 6-1: External Modules**

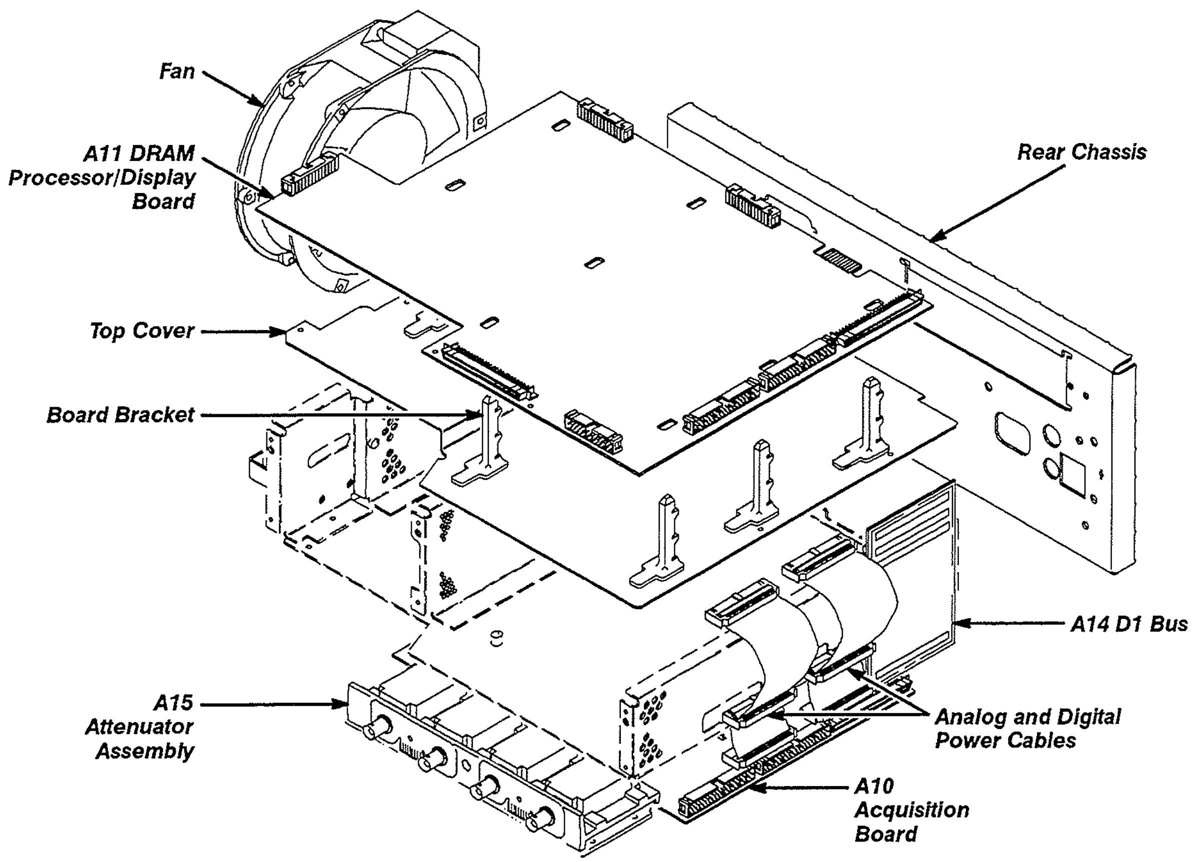



**Figure 6-2: Outer-Chassis Modules**

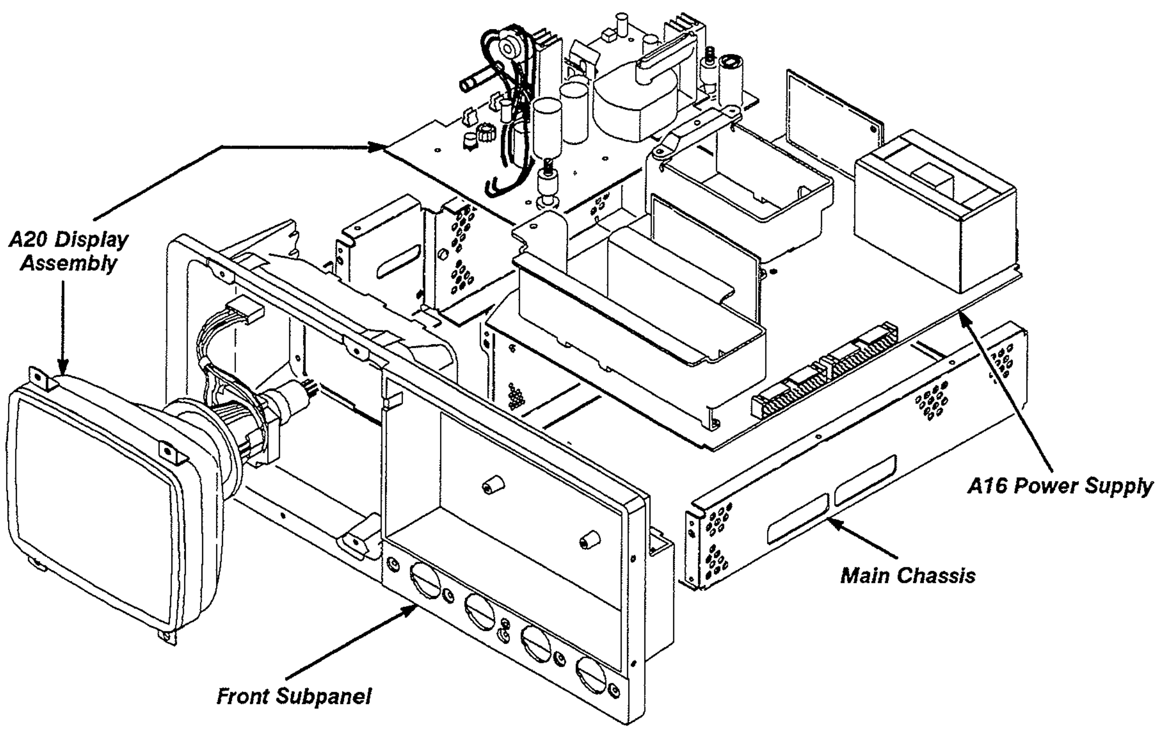



**Figure 6-3: Inner-Chassis Modules**

## Access Procedure

Begin with this procedure when you have identified a module to be removed for service and have read *General Instructions* found earlier in this section.

1. *Locate module to be removed:*

   a. Find the module to be removed in the module locator diagrams, Figures 6-1 through 6-3.

   b. Once the module is found, note from the title of the figure whether the module is an external, outer-chassis mounted, or inner-chassis mounted part.

2. *If the module is externally mounted, no internal access is required; remove the module:* Find and do the procedure whose title matches the name of the module to be removed under *Procedures for External Modules* (page 6-16).

3. *If the module is an outer- or inner-chassis module, access the inside of the instrument:*

   a. First do the procedure *Line Fuse and Line Cord*; then do the procedure *Rear Cover and Cabinet.* Both are found under *Procedures for External Modules* immediately following this procedure.

   b. After completing those procedures, return to this procedure and continue with step 4.

4. *If the module is an outer-chassis module, remove it:*

   a. If removing the attenuator or display-frame assembly, first do the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel,* found under *Procedures for External Modules* (page 6-16).

   b. Find and do the procedure whose title matches the name of the module to be removed under *Procedures for Outer-Chassis Modules* , on page 6-30.

5. *If the module is an inner-chassis module, access the inner-chassis:*

   a. If removing the display tube, display-driver board, or the front subpanel, first do the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel,* found under *Procedures for External Modules.* Also remove the display-frame assembly found under *Procedures for External Modules,* on page 6-16.

   b. Also, if removing the front subpanel, do *A12 Front-Panel Assembly and A13 Firmface Board* and *A15 Attenuator Assembly,* also found under *Procedures for External Modules.*

   c. Do, in the order listed, the three procedures *A14 D1 Bus and Analog-Power and Digital-Power Cables*, *A11 Processor/Display Board* and *Top Cover* found under *Procedures for Outer-Chassis Modules* , page 6-30.

   d. Find and do the procedure whose title matches the name of the module to be removed under *Procedures for Inner-Chassis Modules*, page 6-41.

6. *Reinstall all modules removed:* Read the instructions found at the end of the procedure that removes the module to be serviced—they will guide you in reinstalling all modules removed.

## Procedures for External Modules

Do the *Access Procedure* (page 6-15) before doing any procedure in this collection.

The following procedures are found here and are listed in order presented.

- *Front-Panel Knobs*
- *Line Fuse and Line Cord*
- *EMI Gaskets*
- *Rear Cover and Cabinet*
- *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel*
- *A12 Front-Panel Assembly and A13 Firmface Board*
- *Display Frame*
- *Cabinet Modules*

### Front-Panel Knobs

1. *Assemble equipment and locate modules to be removed:* Have an angled-tip tweezers (Item 9) handy. Find the knob(s) to be removed on the front panel.
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
3. *Remove the knob(s):* Grasp any knob you wish to remove and pull it straight out from the front panel slightly to create some clearance between the base of the knob and the front panel. Insert the tweezers between the knob and front panel and use them to remove the knob.
4. *Reinstallation:* To reinstall, align knob to shaft and push it in until it snaps.

Scan by Zenith



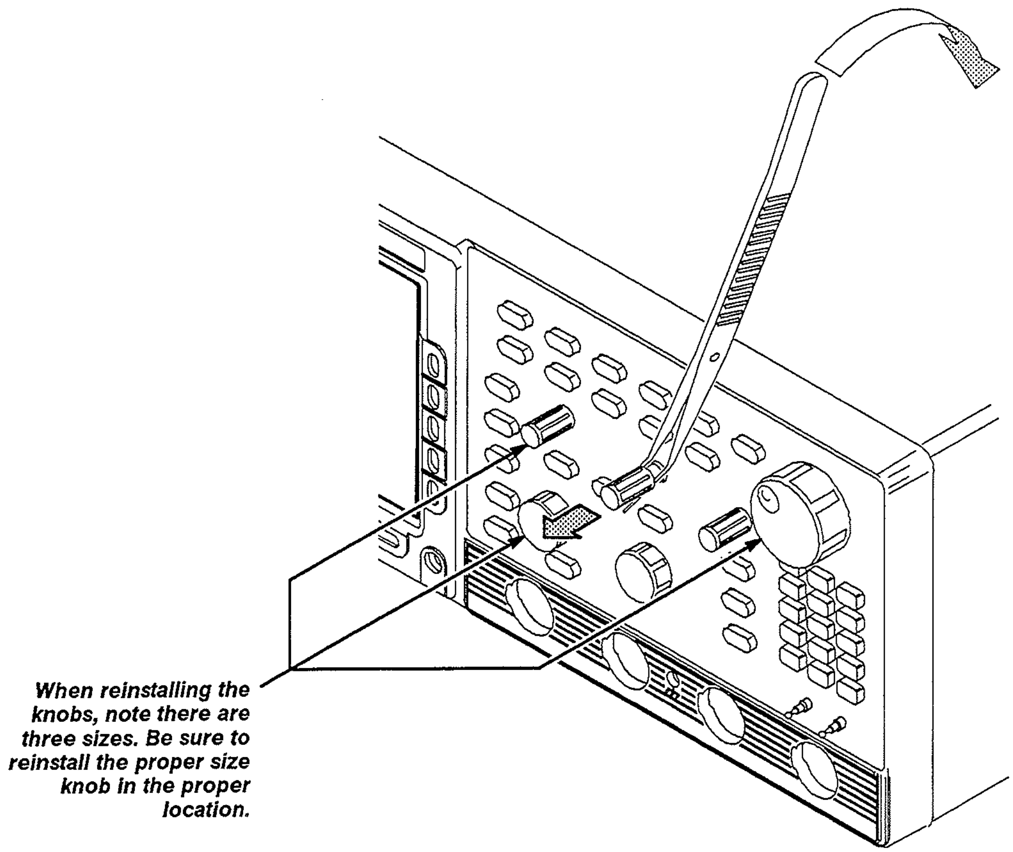



**Figure 6-4: Knob Removal**

## Line Fuse and Line Cord

1. *Assemble equipment and locate modules to be removed:* Have a flat-bladed screwdriver (Item 5) handy. Locate the line fuse and line cord in the locator diagram *External Modules*, Figure 6-1.
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you. If you are servicing the line fuse, do the next step; if you are servicing the line cord, skip to step 4.

3. *Remove line fuse:* Find the fuse cap on the rear panel. (See Figure 6-5.) Now, remove the fuse cap by turning it counter clockwise using a flat-bladed screwdriver, and remove the line fuse. Reverse procedure to reinstall.
4. *Remove line cord:* Find the line cord on the rear cover. (See Figure 6-5.) Now, remove the line-cord retaining clamp by first unplugging the line cord from its receptacle. Next, grasp both the line cord and the retaining clamp and rotate it 90 degrees counter-clockwise. Pull the line cord and clamp away to complete the removal. Reverse procedure to reinstall.
5. *Reinstallation:* Do in reverse steps 3 and 4 to reinstall the line cord and then the line fuse.

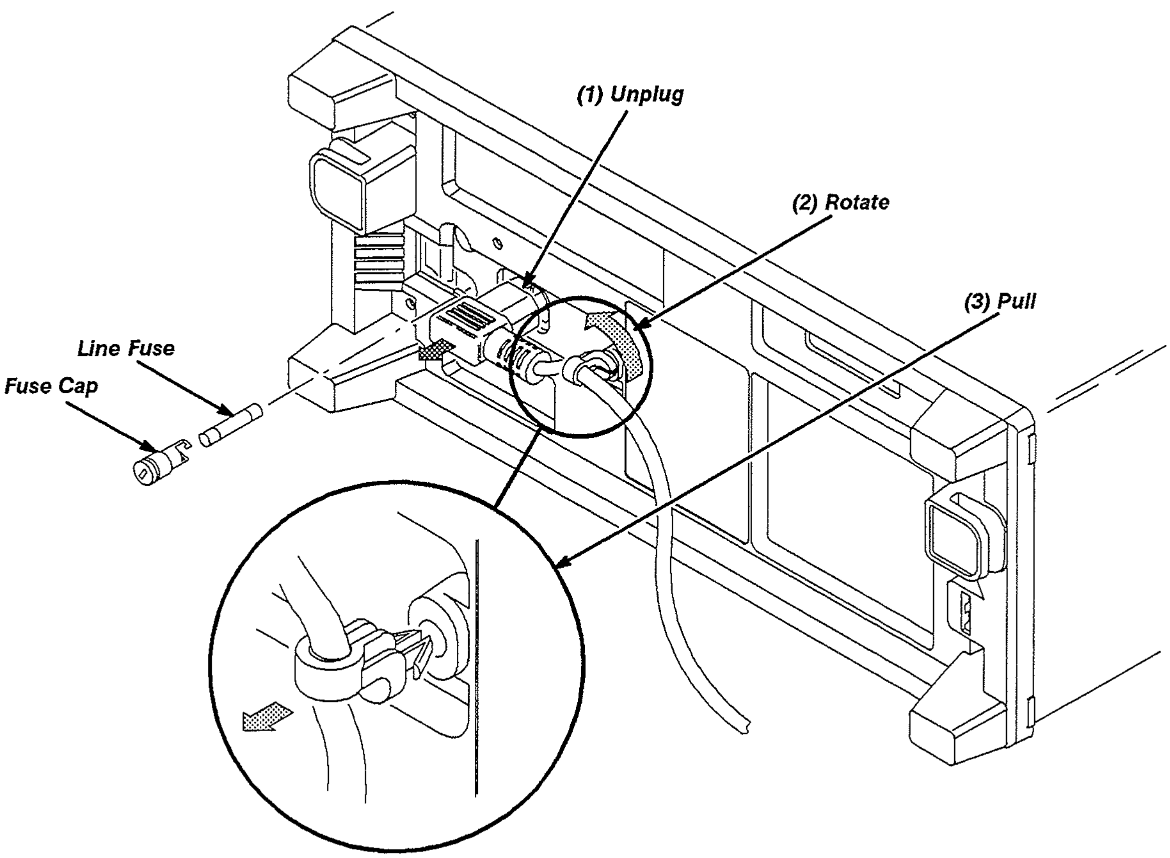



**Figure 6-5: Line Fuse and Line Cord Removal**

## EMI Gaskets

See *Rear Cover and Cabinet* procedure on page 6-19.

## Rear Cover and Cabinet

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-20 Torx® tip (Items 1 and 3).
   b. Make sure the oscilloscope's front cover is installed; if it's not, install it by snapping its edges over the trim ring.
   c. Locate the rear cover and cabinet in the locator diagram *External Modules*, Figure 6-1.
2. *Orient the oscilloscope:* Set the oscilloscope so its face is down with its front cover on the work surface and its bottom facing you.
3. *Disconnect the line cord:* Unplug the line cord from its receptacle at the rear cover.
4. *Remove rear cover:* Remove the four screws securing the rear cover to the oscilloscope. Lift off the rear cover.
5. *Remove the cabinet:*
   a. At the rear of the cabinet, grasp its left and right edges.
   b. Pull upward to slide the cabinet off the oscilloscope. Take care not to bind or snag the cabinet on the oscilloscope's internal cabling as you remove it.

STOP DO NOT do steps 6 through 8 to remove the EMI gasket(s) unless they must be replaced due to damage. If you are not replacing those gaskets, skip to step 9.

When reinstalling EMI gaskets and/or the oscilloscope cabinet, carefully follow the instructions given. Unless they are performed properly, the oscilloscope may not meet its emissions requirements (EMI).

6. *Assemble equipment and locate modules to be removed:*
   a. Have handy a pair of needle-nose pliers (Item 6).
   b. Locate the modules to be removed in the locator diagram *External Modules*, Figure 6-1.
7. *Remove the EMI gaskets:*
   a. Look for the point where the ends of the gasket touch in the channel at the rear edge of the cabinet.
   b. Use a pair of needle-nose pliers to pry up one of the ends.
   c. Grasp the EMI gasket, and gently pull it out of the its channel.
   d. Repeat substeps a through c to remove the gasket from its channel on the front casting.
8. *Reinstallation of EMI gaskets:* Press each EMI gasket back into its groove at the rear edge of the cabinet or front casting. Make sure the ends of the gasket touch, but do not overlap, when installing. (Cut off excess length if required to prevent overlap.)

9. *Reinstallation of cabinet and rear cover:*

   a. Do in reverse order steps 3 and 4 to reinstall the cabinet.

   b. Take care not to bind or snag the cabinet on internal cabling; redress cables an necessary.

   c. When sliding the cabinet, be sure that the front edge of the cabinet aligns with the groove containing the EMI shield on the front casting.

   d. Be sure that the ridge around the rear chassis slides into the groove containing a second EMI cable on the rear of the cabinet.

   e. When reinstalling the four screws at the rear panel, tighten them to 16 foot-lbs torque.

   f. See the procedure *Line Fuse and Line Cord* to reinstall the line cord, which completes the oscilloscope reassembly.

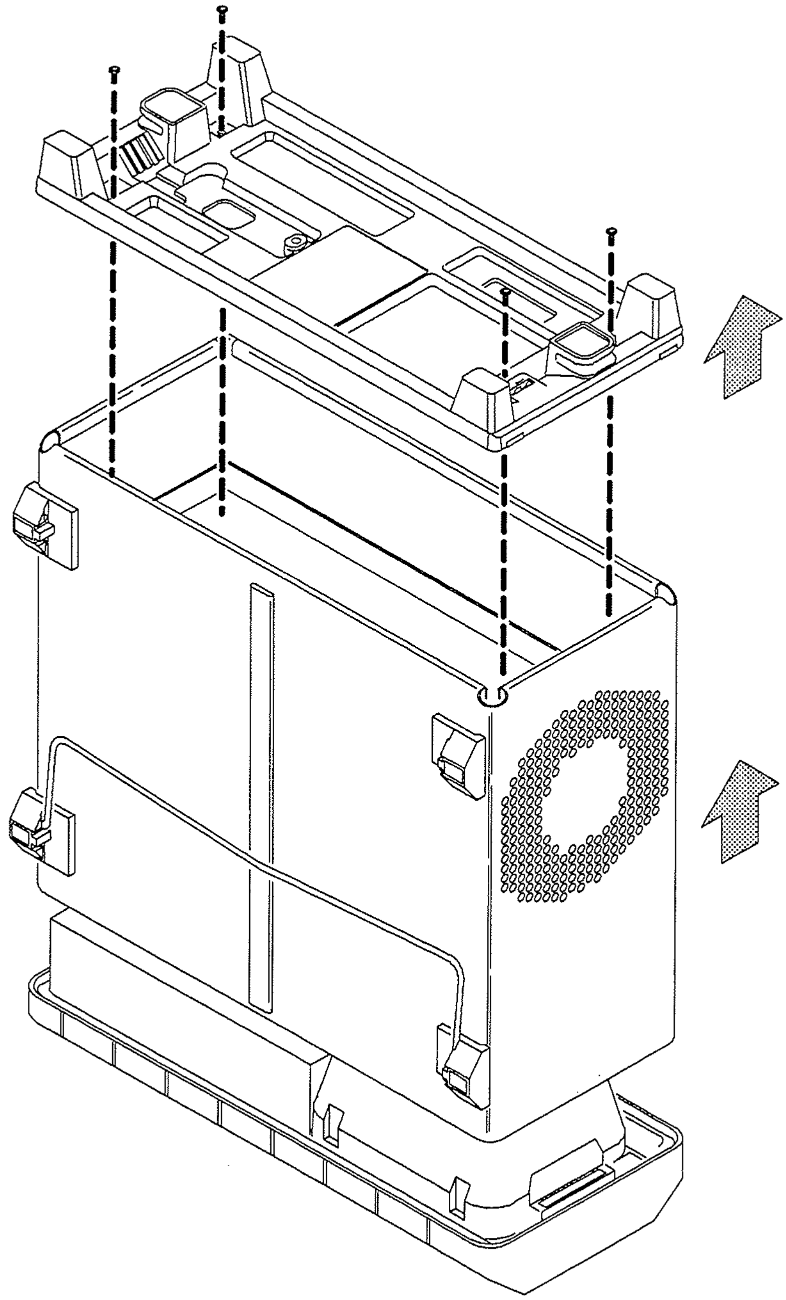


**Figure 6-6: Rear Cover and Cabinet Removal**

## Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel

1. *Assemble equipment and locate modules to be removed:* No tools are needed. Locate the modules to be removed in the locator diagram *External Modules*, Figure 6-1.
2. *Orient the oscilloscope:* Set the oscilloscope so its rear is down on the work surface and its bottom is facing you.
3. *Remove the front cover:* Grasp the front cover by its left and right edges and snap it off of the front subpanel. (When reinstalling, align and snap back on.)

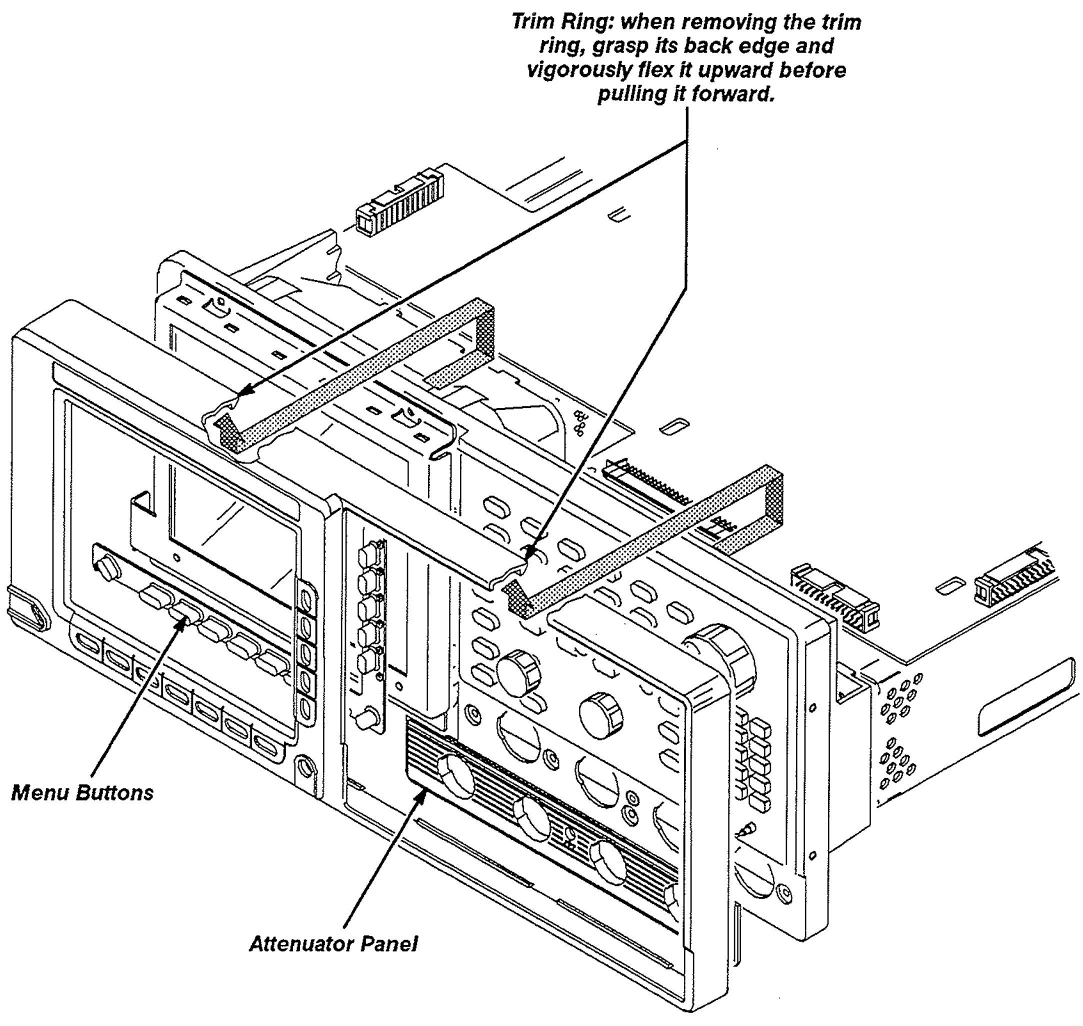



**Figure 6-7: Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel Removal (Front Cover not Shown)**

STOP: DO NOT touch the carbon contact points on the menu buttons installed in the trim ring. Also, do not touch the contacts on the flex circuit exposed when you remove the trim ring.

4. *Remove the trim ring:* Grasp the trim ring by its top edge and pry it up and lift it forward to snap it off of the front subpanel. If servicing the menu buttons, lift them out of the trim ring. (When reinstalling, reinsert the menu buttons, align the trim ring to the front subpanel and press it back on.)

5. *Remove the attenuator panel:* Gently pry, using your fingers, the snap-off/snap-on attenuator panel away from the front subpanel to remove it. (When reinstalling, use your hands to press it back on.)

6. *Reinstallation:* Do in reverse steps 3–5 to reinstall the attenuator panel, menu buttons, trim ring, and the front cover, following the reinstallation instructions found in each step.

## A12 Front-Panel Assembly and A13 Firmface Board

**NOTE**

*This procedure includes removal and reinstallation instructions for the front panel and front panel buttons. Unless either of those modules are being serviced, do not do step 4, "Further disassembly of front-panel assembly."*

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
   b. Locate the modules to be removed in the locator diagram *External Modules*, Figure 6-1.
   c. Do the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel,* steps 1–5, immediately preceding this procedure.
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
3. *Remove the front-panel assembly:*
   a. Lift the front-panel assembly out of the front subpanel until you can reach the interconnect cable connecting it to the processor/display board.
   b. Disconnect that cable at J2 of the processor/display board. Disconnect the flex-board connector at P3 of the front-panel assembly. (The flex board is part of the display-frame assembly.)
   c. Finally, lift the front-panel assembly out of the front subpanel to complete the removal.

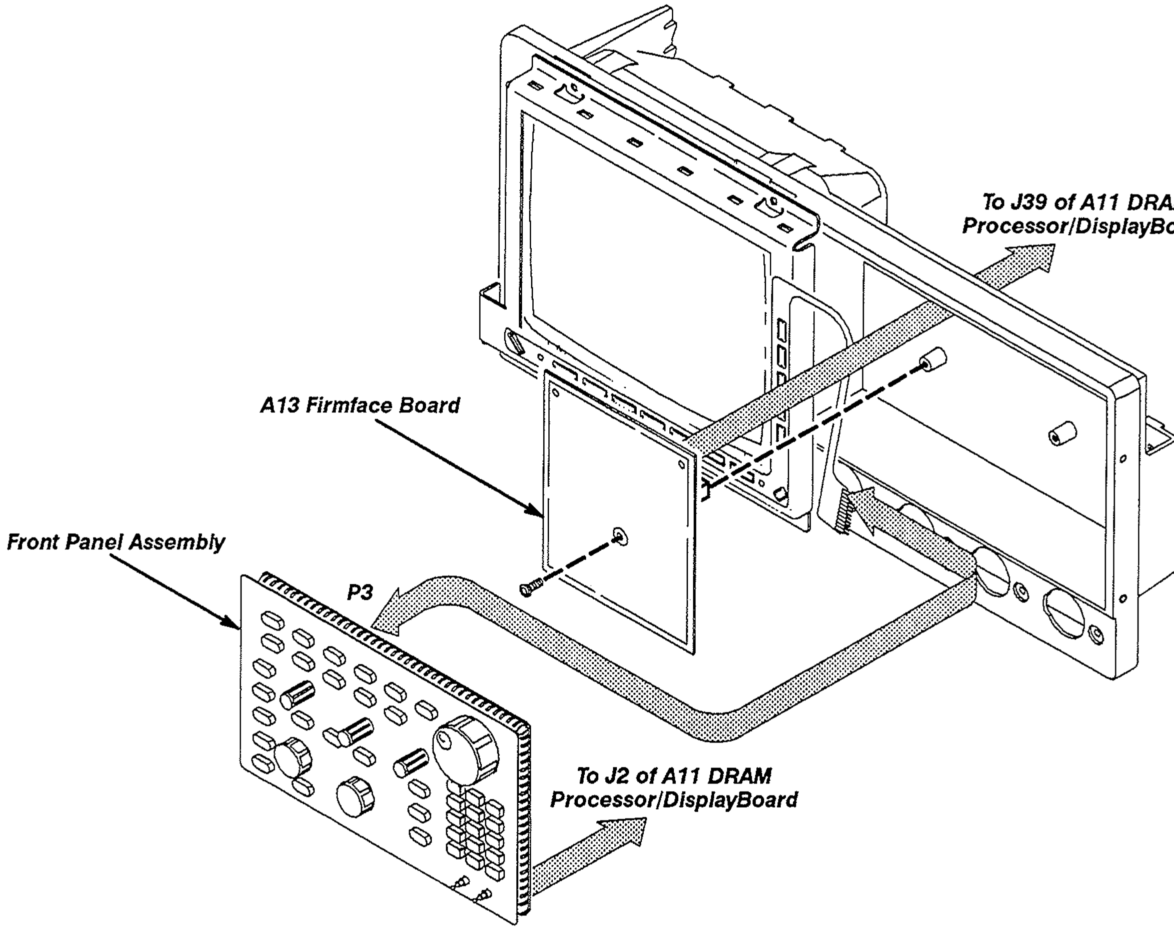



**Figure 6-8: A12 Front-Panel Assembly and A13 Firmface Board Removal**

4. *Further disassembly of front-panel assembly:* If the front panel or the front-panel buttons are to be serviced, do the following substeps:

   a. Remove the front-panel control knobs from the front-panel assembly using the method described in *Front-Panel Knobs* on page 6-16.

   b. Remove the eight screws mounting the front-panel board to the front panel.

   c. Now hand disassemble the front-panel assembly components using Figure 6-9 as a guide. Reverse procedure to reassemble, using the same Figure 6-9 as a guide.

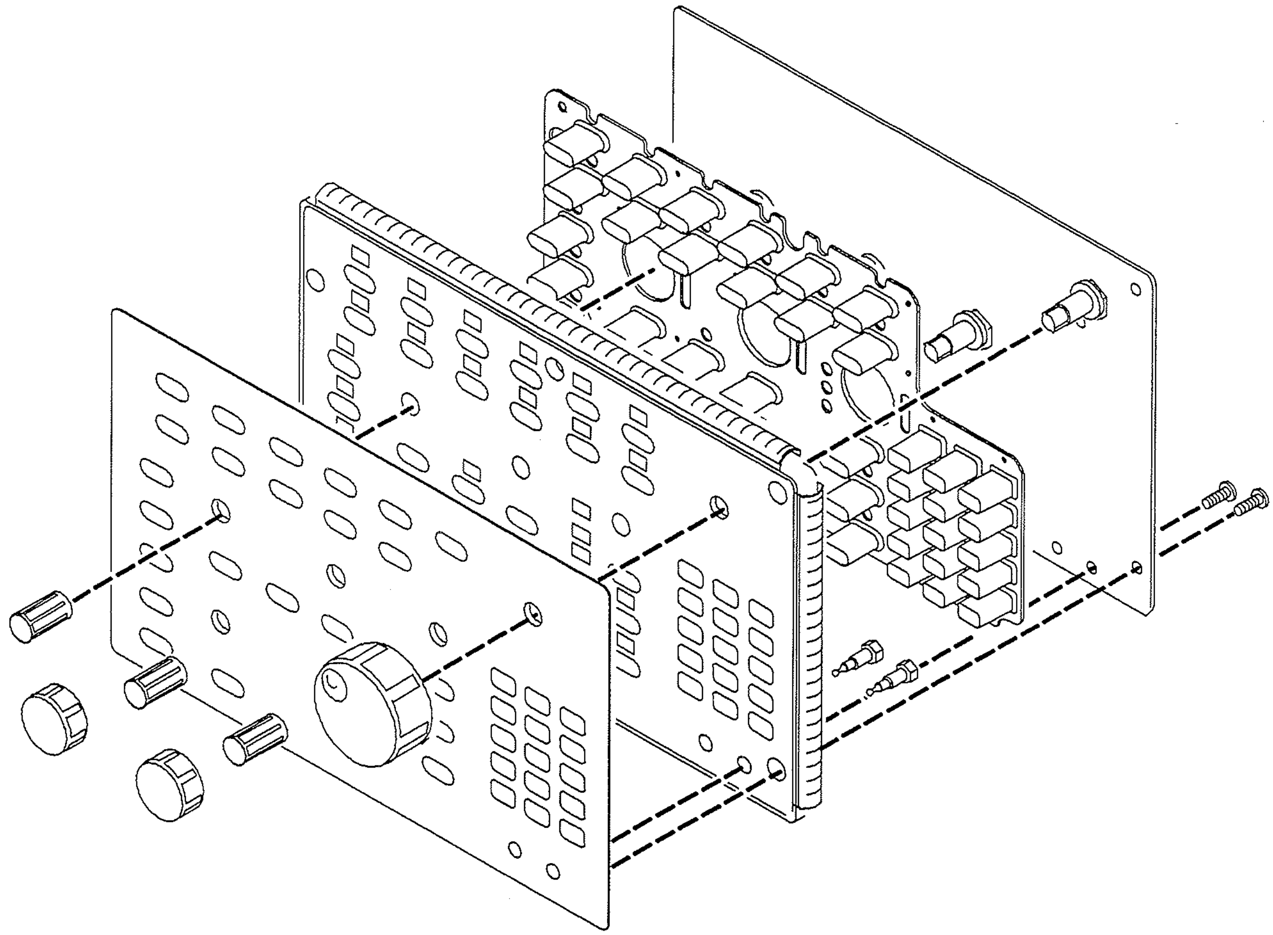


**Figure 6-9: Disassembly of Front-Panel Assembly**

5. *Remove the Firmface board:* Remove the three screws that secure the firmface board to the front subpanel. Now, grasp the firmface board and lift it straight out, disconnecting it from the Processor/Display board at J39, which is connected to J2 of the Firmface board. (See Figure 6-8 on page 6-25.)

6. *Reinstallation:* If the front-panel assembly was further disassembled in step 4, then reverse substeps 4a–4c to reassemble, using Figure 6-9 as a guide. Then do in reverse order steps 3 and 5, reversing the procedure outlined in each step. Last, reinstall the trim ring and, if desired, the front cover, referring to the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22).

## Display-Frame Assembly

1. *Assemble equipment and locate modules to be removed:* Have handy a screwdriver with a size T-15 Torx® (Items 1 and 2). Locate the modules to be removed in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front is facing you.

3. *Remove the display-frame assembly:*

   a. Do the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22) to remove the front cover and trim ring.

   b. Lift the front-panel assembly out of the front subpanel until you can reach J2 on the front-panel assembly. Disconnect the flex cable coming from the display-frame assembly at J39 of the front-panel assembly.

   c. Remove the three screws securing the display-frame assembly to the front subpanel and remove that assembly.

4. *Reinstallation:*

   a. Do, in reverse order, substeps 3b–3c, reversing each step to reinstall the display-frame assembly. Then see the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22) to complete reassembly of the oscilloscope.

## Cabinet Modules

1. *Assemble equipment and locate modules to be removed:* Have handy a pair of needle-nose pliers (Item 6). Locate the modules to be removed in the locator diagram *External Modules* (see Figure 6-1).
2. *Orient the oscilloscope:* Set the oscilloscope so the left side is down on the work surface and its handle is facing upwards.
3. *Remove the handle:*
   a. Insert the tips of a pair on needle-nose pliers (Item 6) into the hole of either handle cap. Push and hold to depress the handle release.
   b. While holding the handle released, pull it out of the slot in the handle cap. Repeat procedure to remove the handle from the other handle cap.
   c. Reverse procedure to reinstall.
4. *Remove the handle caps:*
   a. Insert the retaining ring pliers (Item 8) into the opening created in the handle cap when you removed the handle.
   b. While using the pliers to expand the handle cap outward, grasp it and snap it off.
   c. Repeat procedure to remove the remaining cap as needed; push the cap(s) back on to reinstall.
5. *Remove the flip stand:* Grasp the flip stand by both sides near where it joins each flip stand foot. Now compress the flip stand until the flip stand ends clear the flip stand feet to complete the removal.
6. *Remove the flip stand foot (or feet):*
   a. Do *Rear Cover and Cabinet* procedure (page 6-19) to gain access to inside of the cabinet.
   b. Working from inside the cabinet, push the two retainers to release the flip stand foot you wish to remove and lift it away from the outside of the cabinet.
   c. Repeat procedure to remove as many of the remaining feet as needed; insert the two retainers back in their slots in the cabinet and snap into place any flip stand foot removed.
7. *Reinstallation:* If any flip stand feet were removed, reinstall as directed in step 6c; then see *Rear Cover and Cabinet* procedure (page 6-19) to reinstall the rear cover and cabinet. Do in reverse order steps 3 and 5, reversing each step, to reinstall the flip stand, then the handle caps (if removed), then the handle.

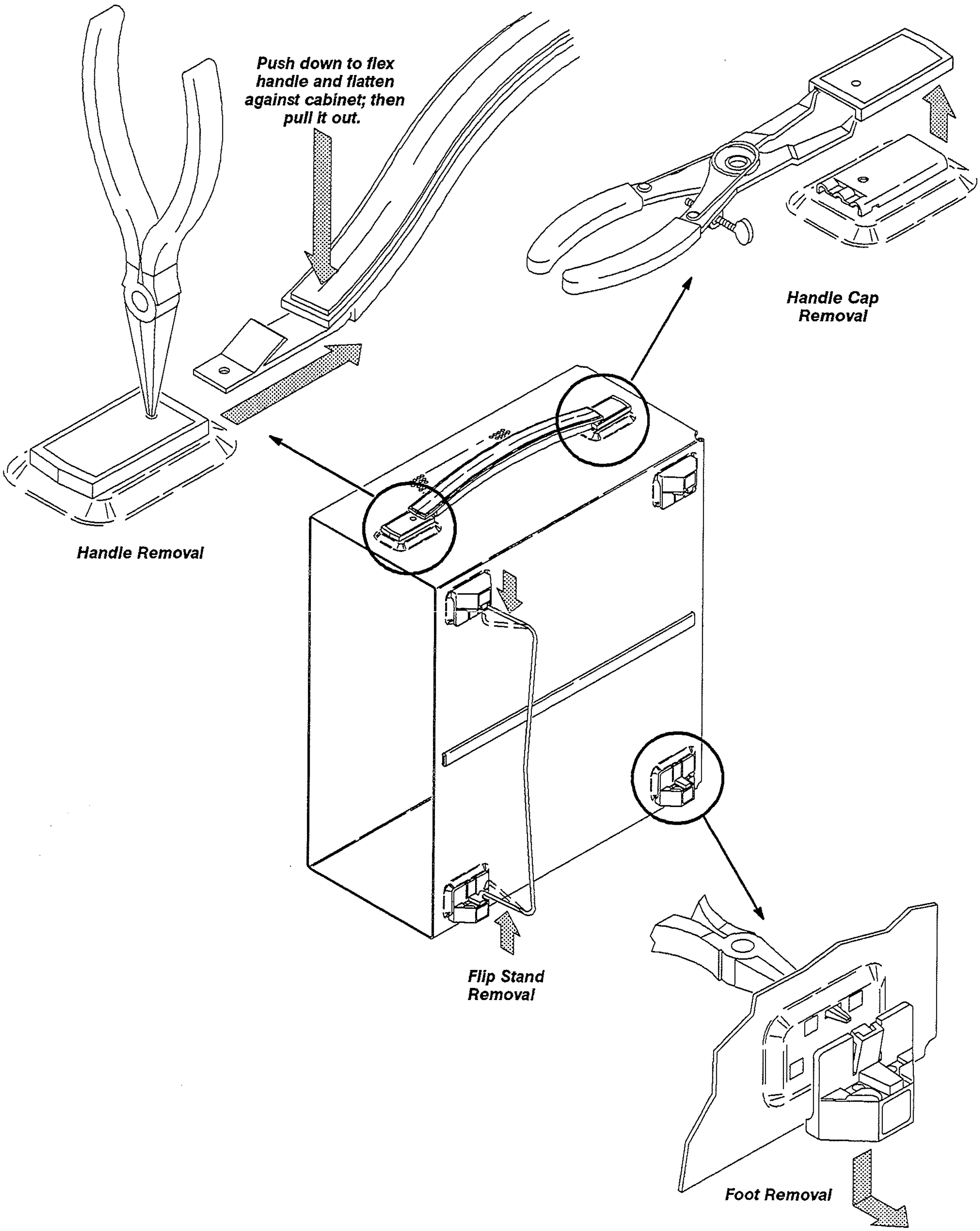



Figure 6-10: Cabinet Modules Removal

## Procedures for Outer-Chassis Modules

You should have completed the *Access Procedure* before doing any procedure in this collection. The procedures found here, listed in order presented, follow.

- *A15 Attenuator Assembly*
- *Fan*
- *A14 D1 Bus and Analog-Power and Digital-Power Cables*
- *A11 Processor/Display Board*
- *Top Cover and Board Brackets*
- *Rear-Panel Cables*
- *A10 Acquisition Board*
- *Rear Chassis*

### A15 Attenuator Assembly

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
   b. Locate the modules to be removed in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.
2. *Orient the oscilloscope:* Set the oscilloscope so its top is down on the work surface and its front is facing you.
3. *Remove the Attenuator Assembly:*
   a. Unplug each of the four interconnect cables that connect the attenuators to the Acquisition board from its jack on the Acquisition board. See Figure 6-31.
   b. Unplug the ribbon interconnect cable that plugs in from the attenuator at J1153. See Figure 6-31.
   c. Now, remove the four screws the heads of which you exposed when you removed the attenuator panel.
   d. Complete the removal by lifting the attenuator assembly out of the front subpanel. Reverse the procedure to reinstall. Be careful to plug each cable into its correct jack—Figure 6-31 shows the correct orientation.
4. *Reinstallation:* Do in reverse order substeps 3a–3d, reversing the removal instructions in each substep to reinstall the assembly. Then see the following procedures, in the order listed, to complete reassembly of the oscilloscope.
   - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-16)
   - *Rear Cover and Cabinet* (page 6-19)

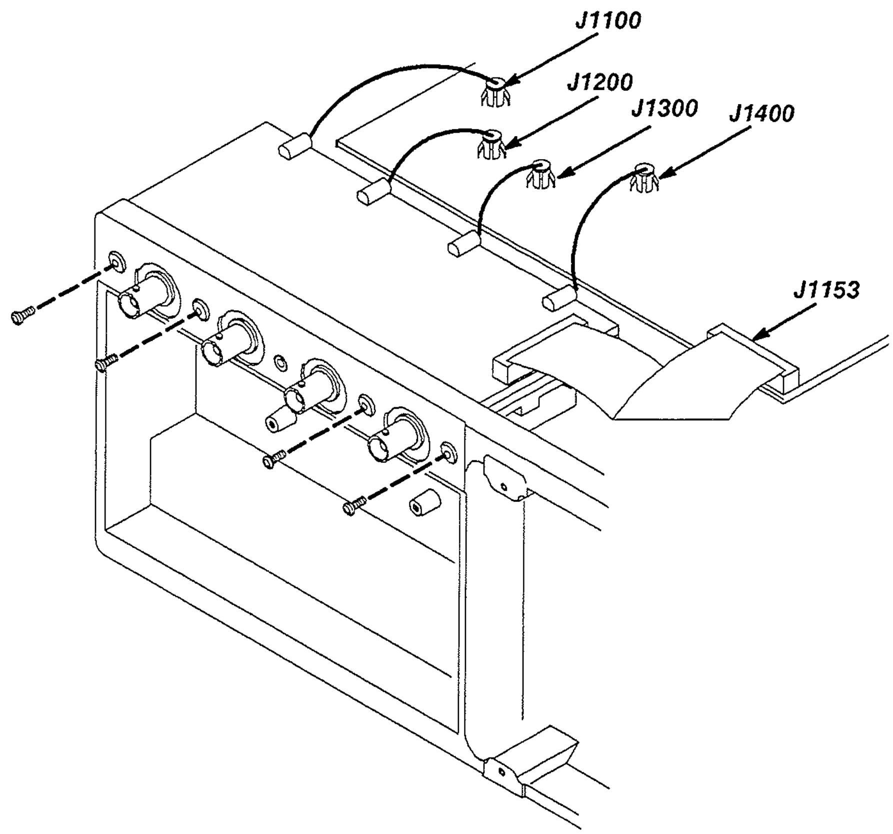



**Figure 6-11: Attenuator Interconnect Cable Routing and Jack Locations**

## Fan

1. *Assemble equipment and locate module to be removed:* Have handy a screwdriver with a size T-20 Torx® tip (Items 1 and 3). Locate the fan in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its left side is facing you.
3. *Disconnect the fan from processor/display board:* Unplug the fan's power cable from J20.
4. *Remove the fan:* Remove the two screws securing the fan to the main chassis and lift the fan away from the chassis.
5. *Reinstallation:* Do in reverse order substeps 3 and 4, reversing the removal instructions in each substep to reinstall the assembly. See the procedure *Rear Cover and Cabinet* (page 6-19) to complete reassembly of the oscilloscope.

## A14 D1 Bus and Analog-Power and Digital-Power Cables

1. *Assemble equipment and locate modules to be removed:* Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2). Find the modules to be removed in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.
2. *Orient the oscilloscope:* Set the oscilloscope so its left side is down on the work surface and its front is facing you.
3. *Remove the D1 bus:* Grasp the D1 bus and pull it up from the oscilloscope to unplug it from its two plug-in connectors. (J28 is the connector on the processor/display board; J100 is on the acquisition board.) Reverse these removal instructions to reinstall.
4. *Remove the analog-power and digital-power interconnect cables:*
   a. Unplug the analog-power cable at J26 on the display processor board, at J5 on the low-voltage power supply, and at J700 on the acquisition board.
   b. Unplug the digital-power cable at J27 on the display processor board, at J6 on the low-voltage power supply, and at J101 on the acquisition board.

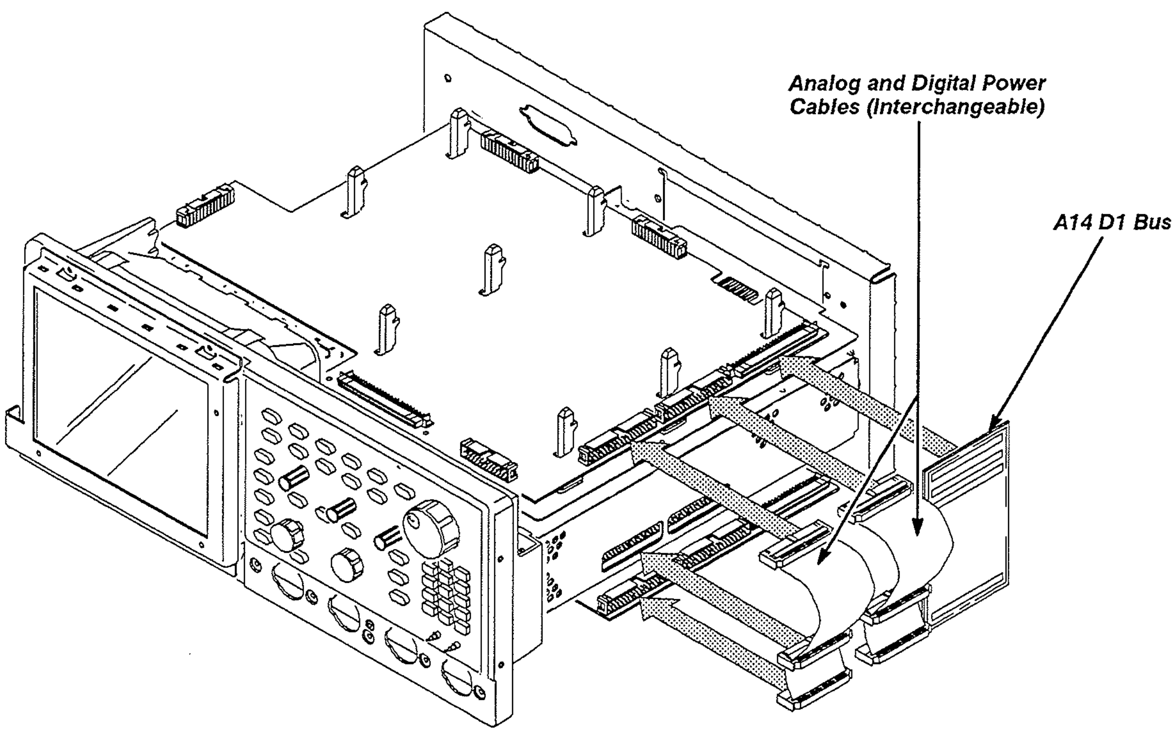



**Figure 6-12: A14 D1 Bus and Analog-Power and Digital-Power Cables Removal**

5. *Reinstallation:*

   a. Do in reverse order steps 3 and 4, reversing the procedure outlined in each step to reinstall the assembly.

   b. When installing the D1 bus be sure to orient it so the single connector at the bottom of the bus plugs into the acquisition board.

   c. See the following procedures, in the order listed, to complete reassembly of the oscilloscope.

   - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
   - *Rear Cover and Cabinet* (page 6-19)

## A11 Processor/Display Board

*Additional modules Removed:* D1 bus and analog-and digital-power cables.

1. *Assemble equipment and locate modules to be removed*

   a. Have handy a screwdriver with a size T-20 Torx® tip (Items 1 and 2).

   b. Locate the modules to be removed in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.

   c. Do the procedure *A14 D1 Bus and Analog-Power and Digital-Power Cables* that immediately precedes this procedure to remove those interconnect cables.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.

3. *Disconnect the fan from processor/display board:* Unplug the fan's power cable from J20.

4. *Remove the processor/display board:* Use Figure 6-13 as a guide while doing the following substeps:

   a. Working from the rear panel, remove the two screws mounting the support bracket in the rear panel. Then lift it out from the rear panel.

   b. Unplug the interconnect cable from the GPIB connector on the rear cover at J35 of the processor/display board. Disconnect the bus cable at J5.

   c. Grasp the board by its right and left sides and pull it towards the rear of the oscilloscope. This will disconnect the processor/display board from its connection to the firmface board at J39 and, at the same time, release it from the eight board mounts securing the board above the top cover.

   d. Lift the board up away from the oscilloscope chassis to complete the removal.

5. *Reinstallation:*

   a. Do, in reverse order, steps 3 through 5 reversing the removal instructions of each step to reinstall the processor/display board. (Be sure to simultaneously align the firmface board for connection at J39 when remounting the board to the eight board mounts in substep 4c.)

   b. See the procedures *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32) and *Rear Cover and Cabinet* (page 6-19) to complete reassembly of the oscilloscope.

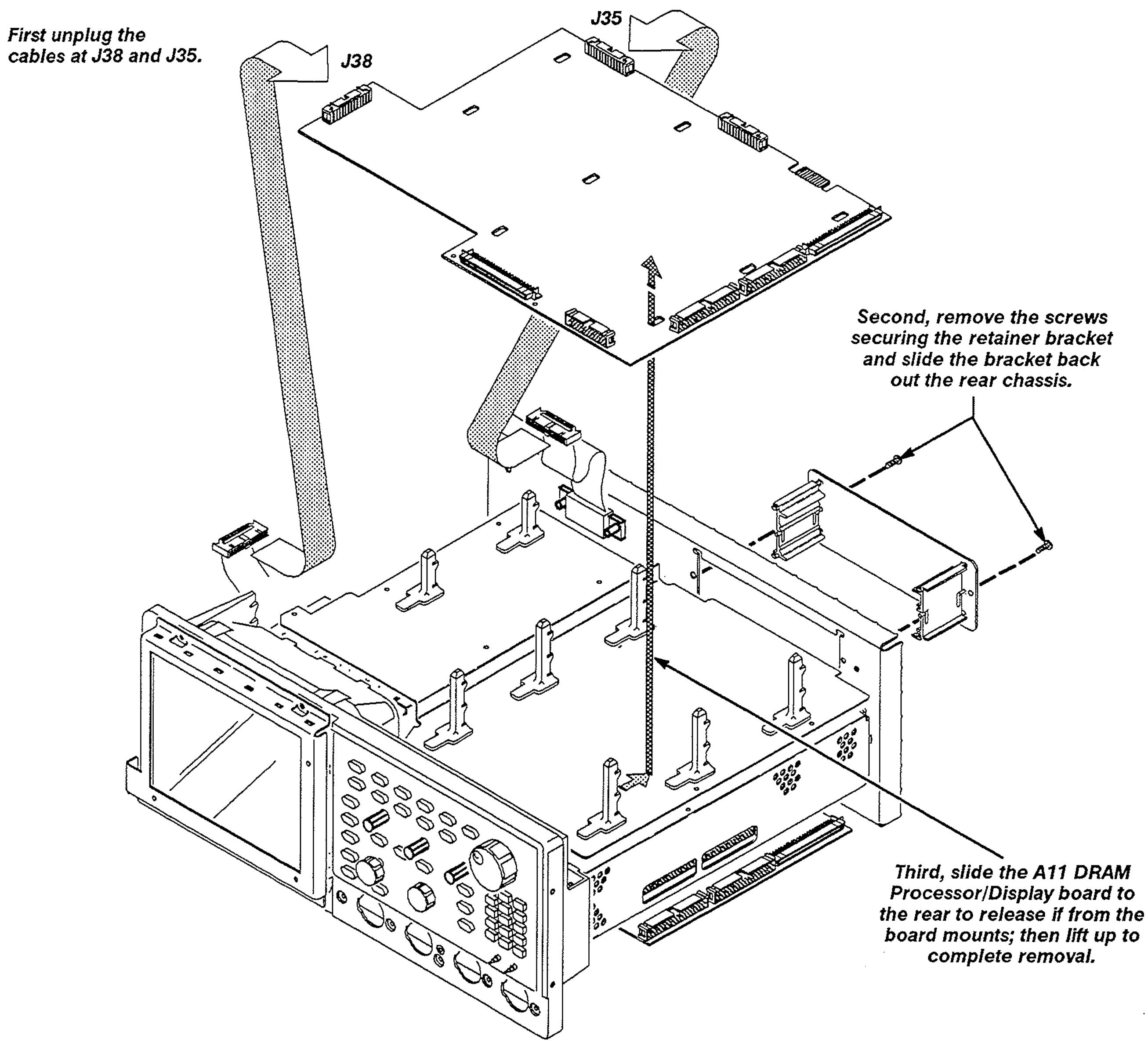



**Figure 6-13: A11 Processor/Display Removal**

## Top Cover and Board Brackets

1. *Assemble equipment and locate modules to be removed:*

   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2) and, if removing any *board mount*, a flat-bladed screwdriver (Item 5).

   b. Locate the modules to be removed in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.

   c. Do the procedures *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32) and *A11 Processor/Display Board* (page 6-34) to remove those modules.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front is facing you.

3. *Remove the top cover:* Remove the 12 screws securing the top cover to the main chassis, then slide it back until its front edge clears the retainers in the front subpanel. Lift the top cover away to complete removal.

4. *Remove the board mount(s):* From the top side of the top cover, use the flat-bladed screwdriver to pry up the retainer lug until it clears the slot in the front cover. While holding the lug clear of the slot, push the mount towards the rear until it releases. (When reinstalling, be sure to align the lug properly and be sure it snaps into its slot.)

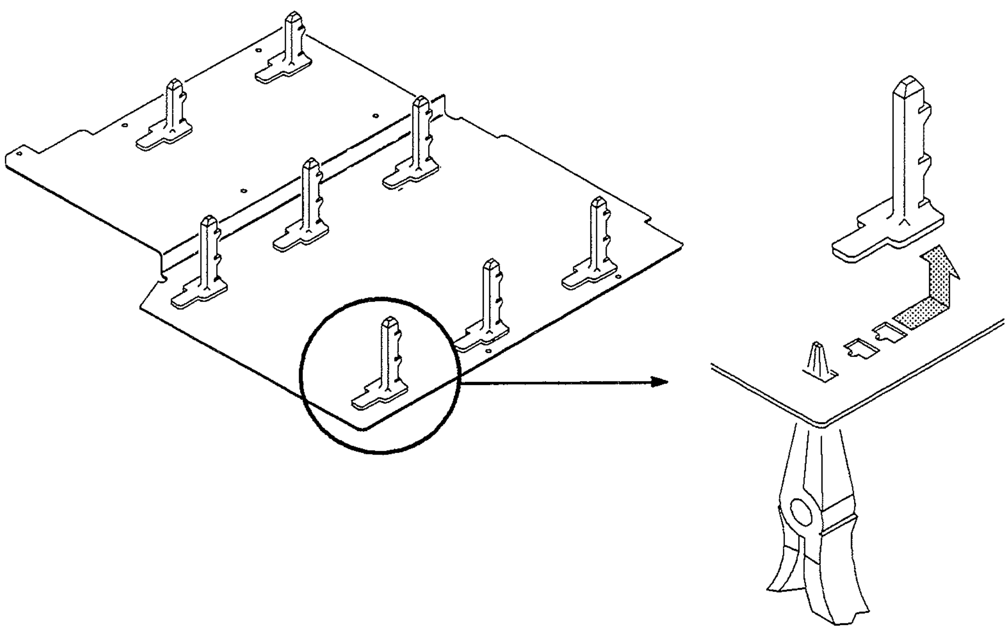


**Figure 6-14: Board Bracket Removal**

5. *Reinstallation:*

   a. Do in reverse order steps 3 and 4, reversing the procedure outlined in each step to reinstall the assembly. Then see the following procedures, in the order listed, to complete reassembly of the oscilloscope.

      - *A11 Processor/Display Board* (page 6-34)
      - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
      - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
      - *Rear Cover and Cabinet* (page 6-19)

## GPIB Cable

1. *Assemble equipment and locate modules to be removed:* Have handy a ¼ inch nut driver (Item 7).
2. *If removing the GPIB cable, do the following substeps:*
   a. Unplug the GPIB cable from its jack (J35) of the processor/display board.
   b. Working from the rear panel and using the ¼ inch nut driver, unscrew the two hex-headed mounting posts that secure the cable to the rear chassis.
   c. Working from inside the oscilloscope, lift the cable out of the rear chassis.
3. *If removing any cable connected to the rear panel BNC connectors, do the following:*
   a. Do the procedure *A10 Acquisition Board,* on page 6-37.
   b. Using a pair of needle nose pliers, reach between the main chassis and the rear chassis and unplug the cable to be removed.
   c. For the cables CH 3 SIGNAL OUT or AUX TRIGGER INPUT, disconnect the cable from its cable clamp on the main chassis
   d. Note the cable's color code for later reinstallation; then lift it away from the oscilloscope to remove it.
4. *Reinstallation:* Reverse substeps in step 2 and 3 to reinstall any cables removed. See *A10 Acquisition Board* to reinstall the acquisition board if it was removed.

## A10 Acquisition Board

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
   b. Locate the modules to be removed, including those listed under *Additional Modules Removed* in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.
   c. Do the procedure *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32) to remove the D1 bus and the interconnect cables.
2. *Orient the oscilloscope:* Set the oscilloscope so its top is down on the work surface and its front is facing you.
3. *Remove the Acquisition Board:* Use Figure 6-15 as a guide.
   a. Unplug each of the four interconnect cables that connect the attenuators to the acquisition board from its jack on the Acquisition board.
   b. Unplug the ribbon interconnect cable that plugs in from the attenuator at J1153.

c. Disconnect the cables from CH 3 SIGNAL OUT (at J1201), AUX TRIG INPUT (at J1550), MAIN TRIG OUT (at J1002), DELAYED TRIG OUT (at J1003).

d. Remove the two screws used to secure the noise reduction shield to the rear chassis.

e. Remove the eight screws that mount the acquisition board to the main chassis and lift the board away from the main chassis to complete removal.

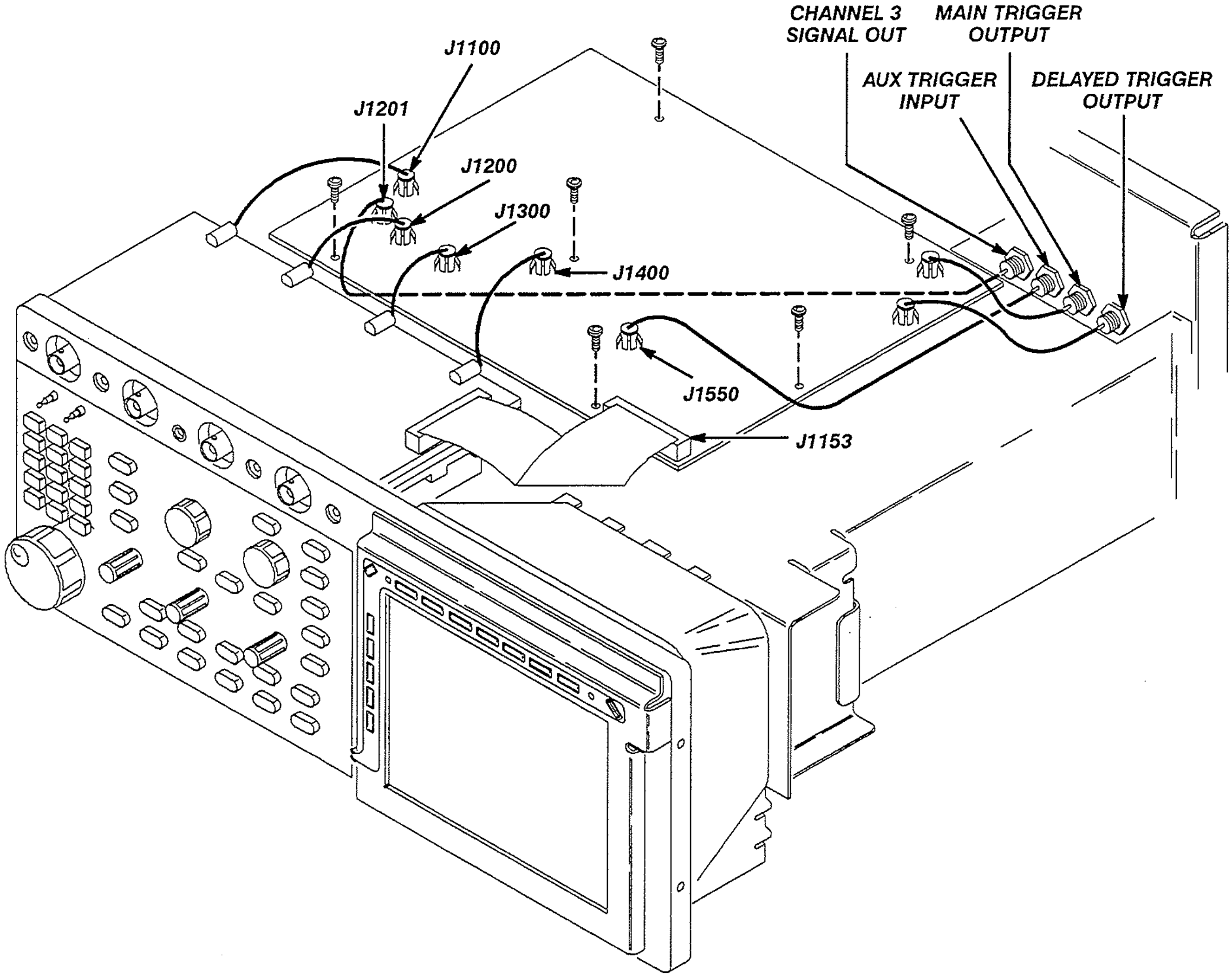



**Figure 6-15: A10 Acquisition Board Removal**

4. *Reinstallation:* Do, in reverse order, substeps 3a–3 reversing each step to reinstall the *acquisition board*. Then see the following procedures, in the order listed, to complete reassembly of the oscilloscope:

   - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32).
   - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22).
   - *Rear Cover and Cabinet* (page 6-19).

## Rear Chassis

1. *Assemble equipment and locate modules to be removed:*

   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2) and a T-20 Torx® tip (Items 1 and 2).

   b. Locate the modules to be removed, including those listed under *Additional Modules Removed* in the locator diagram *Outer-Chassis Modules*, Figure 6-2, page 6-13.

   c. Install the front cover if it's not already installed.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.

3. *Remove the rear chassis:* Use Figure 6-16 as a guide when doing the following substeps:

   a. Unplug the GPIB interconnect cable at J32 of the processor/display board.

   b. Remove the 6 screws securing the rear chassis to the main chassis and the two screws securing it to the low-voltage power-supply shield.

   c. Lift the rear chassis up slightly to access the cables connected to it. Disconnect those cables from CH 3 SIGNAL OUT (at J1201), AUX TRIG IN (at J1550), MAIN TRIG OUT (at J1002), DELAYED TRIG OUT (at J1003), all found on the acquisition board.

4. *Reinstallation:* Do, in reverse order, substeps 3a–3b, reversing each step to reinstall the rear chassis. Then see the following procedures, in the order listed, to complete reassembly of the oscilloscope.

   - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
   - *Rear Cover and Cabinet* (page 6-19)

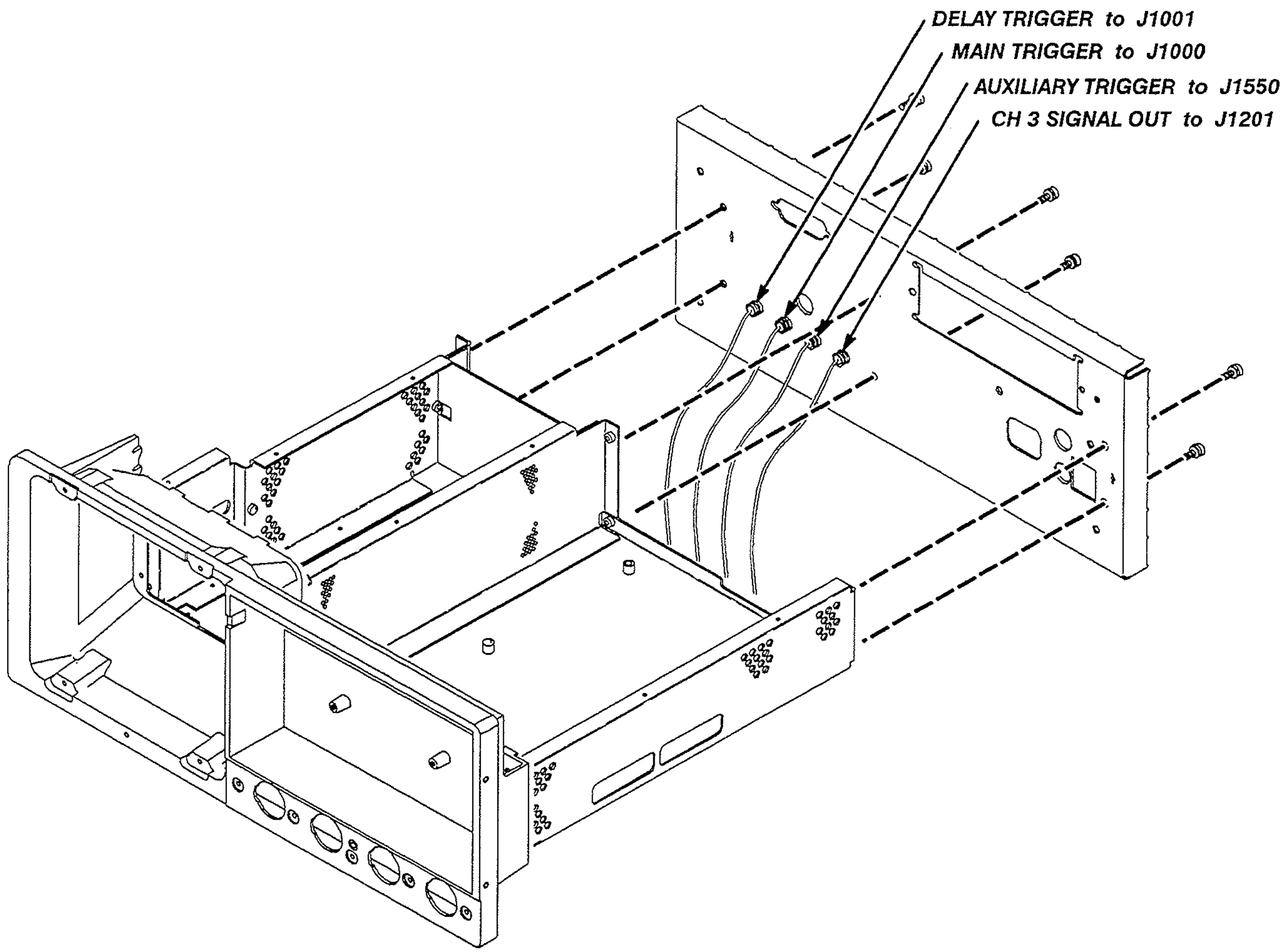



**Figure 6-16: Rear Chassis Removal**

## Procedures for Inner-Chassis Modules

You should have completed the *Access Procedure* (page 6-15) before doing any of the procedures for the Inner–Chassis modules. The procedures are presented in the following order:

*A16 Low Voltage Power Supply*

*A20 Display Assembly and Supply Fuse*

*Front Subpanel*

*Main Chassis*

### A16 Low Voltage Power Supply

1. *Assemble equipment and locate modules to be removed:* Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2). Locate the modules to be removed in the locator diagram *Inner-Chassis Modules*, Figure 6-2, page 6-13.
2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.
3. *Remove the low-voltage power Supply:*
   a. Working from the rear of the oscilloscope, remove the two screws securing the low-voltage power supply to the rear chassis. See Figure 6-17.
   b. Now, working from the top of the oscilloscope, remove the seven screws, indicated in Figure 6-17, that mount the supply to the main chassis.
   c. Grasp the supply at the points indicated in the same figure and lift the board up out of the oscilloscope to complete removal.
4. *Reinstallation:* Do, in reverse order, substeps 3a through 3c reversing each step to reinstall the low-voltage power supply. Then see the following procedures to complete the reassembly:
   - *Top Cover and Board Brackets* (page 6-35)
   - *A11 Processor/Display Board* (page 6-34)
   - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
   - *Rear Cover and Cabinet* (page 6-19)

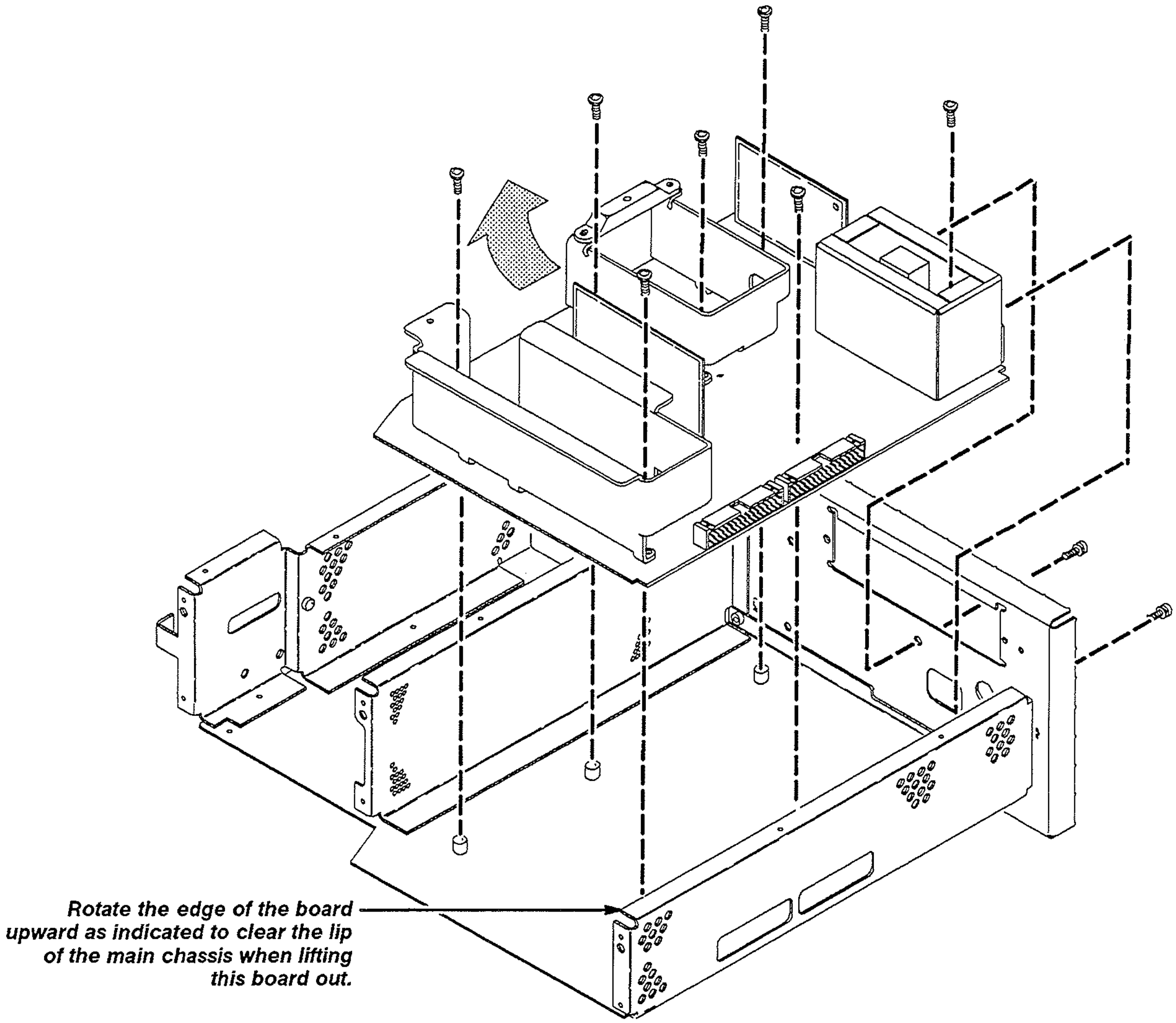



**Figure 6-17: A16 Low Voltage Power Supply Removal**

## A20 Display Assembly and Supply Fuse

***NOTE***

*The display and the display-driver board are a single module and must be removed and replaced as such. They are listed as a single module in the* Replaceable Parts List.

1. *Assemble equipment and locate modules to be removed:* Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2). Locate the modules to be removed in the locator diagram *Inner-Chassis Modules*, Figure 6-2, page 6-13.

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its rear is facing you.

3. *Remove the high-voltage fuse:* If you are servicing this fuse, remove the fuse from its fuse holder. Reverse the procedure to reinstall.

**WARNING**

***Display tube handling:*** *Use care when handling a display tube. If you break a display tube it may implode, scattering glass fragments with high velocity and possibly injuring you. Wear protective clothing, including safety glasses (preferably a full-face shield). Avoiding striking the display tube with or against any object.*

***Display tube storage:*** *Store the display tube face down in a protected location, placing it on a soft, nonabrasive surface to prevent scratching the face plate.*

4. *Remove the display tube:*

   a. Take the precautions outline in the warning above. Reference Figure 6-18 while doing the following substeps.

   b. Unplug the display tube connector from the back of the display tube and the display tube yoke connector from the display circuit board (J340).

   c. Remove the two screws that secure the band circling the front of display tube to the front subpanel. Carefully guide display tube forward to partially remove it from the front subpanel and to access the anode lead connected to the display tube.

**WARNING**

*High-voltage is present on the anode lead. Before unplugging the anode in the following substep, you must discharge it: ground a flat-bladed screwdriver (Item 5) with an insulated handle to the chassis through a suitable grounding strap. Next, probe under the insulating cap of the anode lead and touch the lead's metal conductor to discharge. Repeat. After unplugging the anode in substep d, touch its metal conductor to the chassis for a few minutes to further ensure discharge.*

   d. Discharge the anode lead as described in the immediately proceeding ***WARNING,*** unplug it from the display tube, and discharge that lead (again see ***WARNING***).

e. Be sure you have read the ***WARNING*** on display tube handling and storage found at the start of this display tube removal procedure. Then pull the display tube out through the front subpanel to complete removal. Store as directed in the previous ***WARNING*** message.

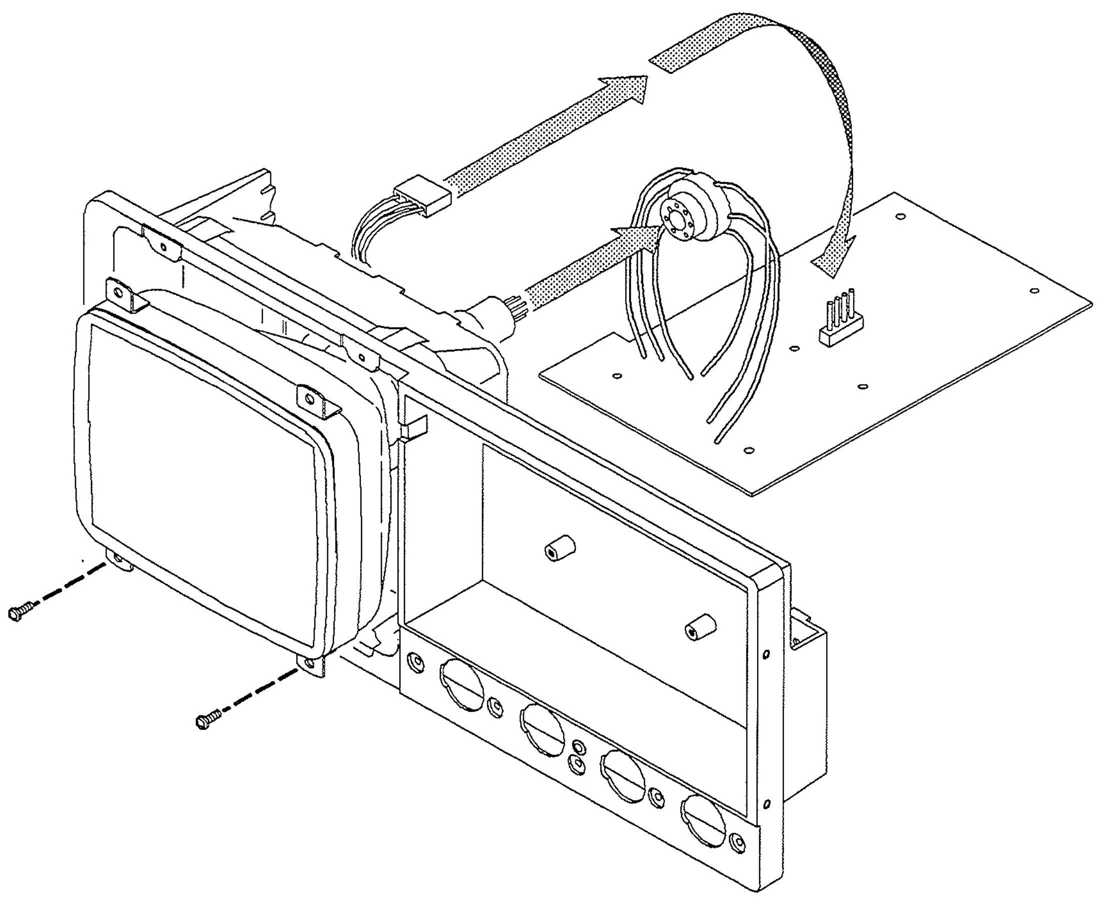


**Figure 6-18: Display Assembly Removal**

5. *Remove the display supply board:* Use Figure 6-19 as a guide.

   a. Remove the six screws that mount the display-driver board to the main chassis.

   b. Now, grasp the display-driver board at the points indicated and move the board forward about an inch to clear the retainer built into the left side of the main chassis.

   c. Once the retainer is cleared, work from the front and top to tilt the board so its right edge is up and its left side is down and lift it out of the top of the oscilloscope's main chassis.

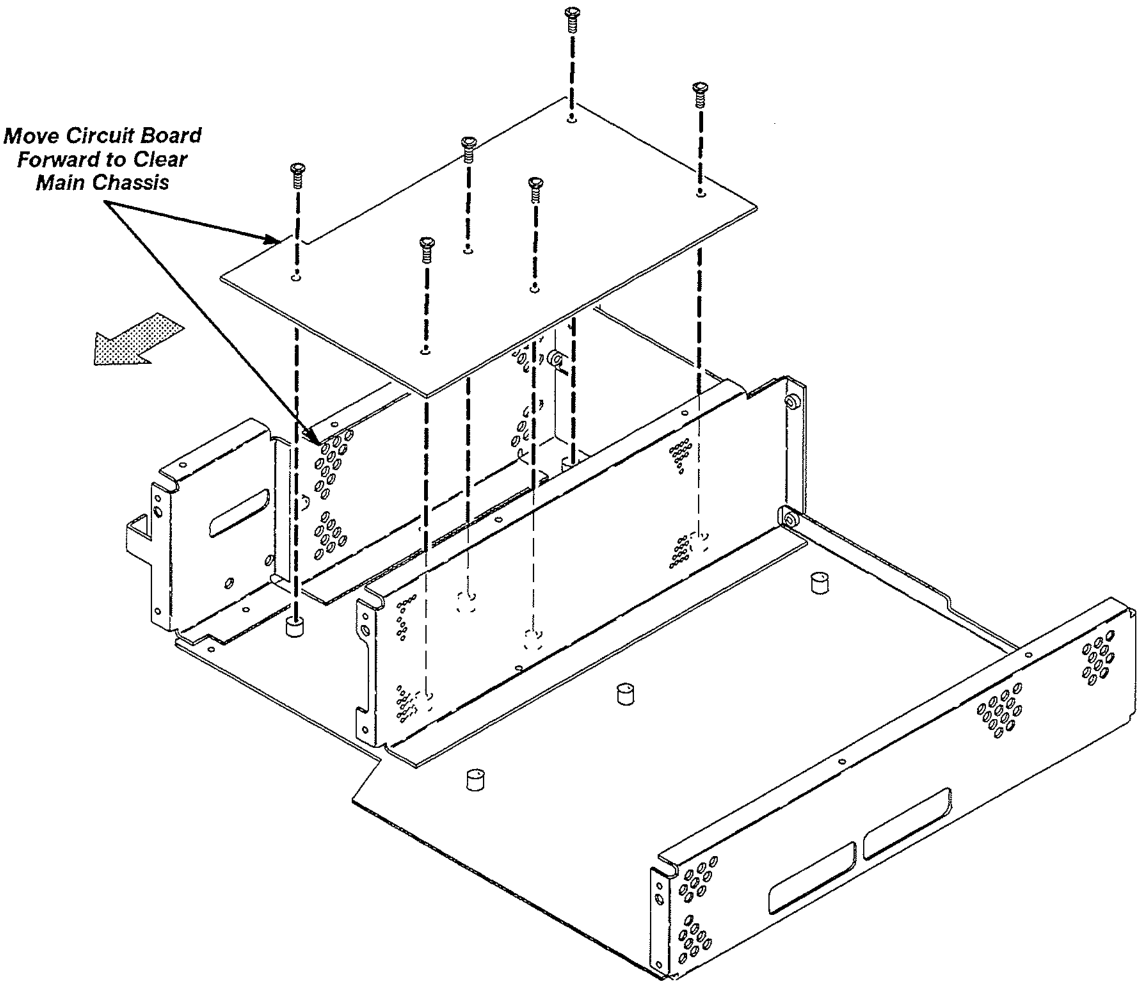



**Figure 6-19: Display Driver Board Removal**

6. *Reinstallation:*

   a. Do, in reverse order, substeps 5a–5c, reversing each step to reinstall Display-Driver board.

   b. Do, in reverse order, substeps 4a–4e, reversing each step to reinstall the display tube if removed.

   c. See step 3 to reinstall the supply fuse if it was removed.

   d. See the following procedures, in order, to complete reassembly of the oscilloscope:

      - *Top Cover and Board Brackets* (top cover only) on page 6-35
      - *A11 Processor/Display Board* (page 6-34)
      - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
      - *Display-Frame Assembly*

- *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
- *Rear Cover and Cabinet* (page 6-19) (completes reassembly)

## Front Subpanel

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2).
   b. Do the procedure *A20 Display Assembly and Supply Fuse* (page 6-42). Do not remove the display-driver board.
   c. Locate the modules to be removed in the locator diagram *Inner-Chassis Modules*, Figure 6-2, page 6-13.
2. *Orient the oscilloscope:* Set the oscilloscope so its rear is down on the work surface and its bottom is facing you.
3. *Remove the front subpanel:* Remove the six screws securing the front subpanel to the main chassis. (See Figure 6-20 for screw locations.) Lift the front subpanel up away from the main chassis to complete the removal.
4. *Reinstallation:* Do the following substeps to reinstall the front subpanel and reassemble the remainder of the oscilloscope:
   a. Align the front subpanel to the main chassis, taking care to ensure that the main chassis slips into its alignment slot on the front subpanel (see magnified view, Figure 6-20.) Then reinstall the six screws removed in step 3.
   b. See the procedure *A20 Display Assembly and Supply Fuse* (page 6-42) to reinstall the display-frame assembly and display tube.
   c. See the following procedures, in the order listed, for instructions for reinstalling the remaining modules.
      - *A12 Front-Panel Assembly and A13 Firmface Board*
      - *Top Cover and Board Brackets* (page 6-35)
      - *A11 Processor/Display Board* (page 6-34)
      - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
      - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
      - *Rear Cover and Cabinet* (page 6-19)

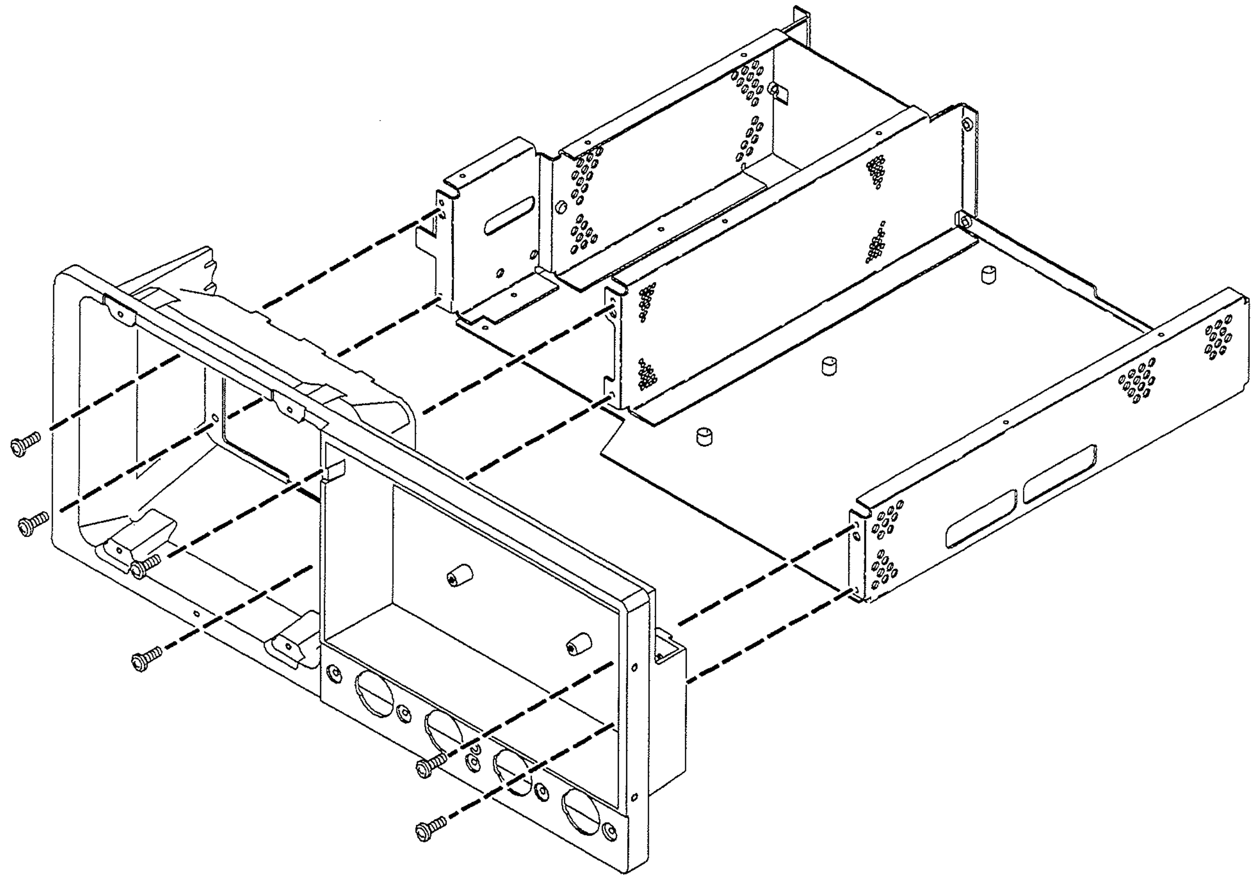


**Figure 6-20: Front Subpanel Removal**

## Main Chassis

*Additional Modules Removed:* All.

1. *Remove the main chassis:* Since the removal of the main chassis requires the removal of virtually all modules, do the procedure *Disassembly for Cleaning* that follows. While doing *Disassembly for Cleaning,* you will remove the front-panel assembly. Ignore the instructions to disassemble that assembly.
2. *Reinstallation:* See reinstallation instructions in *Disassembly for Cleaning.*

## Disassembly for Cleaning

This procedure is for disassembly of the TDS 640 Digitizing Oscilloscope into its individual modules so they can be cleaned. For the cleaning instructions, see *Inspection and Cleaning*, which begins this section.

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a size T-15 Torx® tip (Items 1 and 2), a T-20 Torx® tip (Item 3), a flat-bladed screwdriver (Item 6-11), and a pair of angle-tip tweezers (Item 6-11).
   b. Familiarize yourself with the modules illustrated in Figure 3-1.
2. *Remove external modules:* Do in order the following procedures. They are found under *Procedures for External Modules* which starts on page 6-16.
   a. *Line Fuse and Line Cord* (page 6-17)
   b. *Rear Cover and Cabinet* (page 6-19)
   c. *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
   d. *Front Subpanel* (page 6-46) and *Display-Frame Assembly*
3. *Remove the outer-chassis modules:* Do in order the following procedures. They are found under *Procedures for Outer-Chassis Modules* which start on page 6-30.
   a. *Fan* (page 6-31)
   b. *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
   c. *A11 Processor/Display Board* (page 6-34)
   d. *Top Cover and Board Brackets* (page 6-35)
   e. *A15 Attenuator Assembly*
   f. *A10 Acquisition Board* (page 6-37)
4. *Remove the inner-chassis modules:* Do in order the following procedures. They are found under *Procedures for Inner-Chassis Modules* which start on page 6-41.
   a. *A16 Low Voltage Power Supply* (page 6-41)
   b. *A20 Display Assembly and Supply Fuse* (page 6-42)
5. *Disassemble the chassis:*
   a. Set the assembly so its bottom is down on the work surface and its front is facing you.
   b. Remove the six screws securing the front subpanel to the main chassis. (See Figure 6-20 for screw location.)
   c. Lift the front subpanel up away from the main chassis.
   d. Now remove the five screws securing the rear chassis to the main chassis and separate the two chassis. (See Figure 6-16 for screw location.)

6. *Reassembly:* Do the following substeps:

   a. *Reassemble the chassis:* Align the rear chassis to the main chassis and reinstall the five screws removed in step 5; align the front sub-panel to the main chassis and reinstall the six screws removed in step 5.

**NOTE**

*The following substeps refer you to procedures for installing each module removed. When reinstalling the modules, ignore any instructions that require connecting a cable or bus to an module that you have not yet installed. The necessary connections will be made when you install the missing module later.*

   b. *Reinstall the inner-chassis modules:* Do in the order listed the following procedures. When doing these procedures, do their steps in reverse order. These procedures are found under *Procedures for Inner-Chassis Modules* which start on page 6-41.

      - *A20 Display Assembly and Supply Fuse* (page 6-42)
      - *A16 Low Voltage Power Supply* (page 6-41)

   c. *Reinstall the outer-chassis modules:* Do in the order listed the following procedures. When doing these procedures, do their steps in reverse order. These procedures are found under *Procedures for Outer-Chassis Modules* which start on page 6-30.

      - *A15 Attenuator Assembly* (page 6-30)
      - *Top Cover and Board Brackets* (page 6-35)
      - *A11 Processor/Display Board* (page 6-34)
      - *A14 D1 Bus and Analog-Power and Digital-Power Cables* (page 6-32)
      - *Fan* (page 6-32)
      - *A10 Acquisition Board* (page 6-37)

   d. *Reinstall external modules:* Do in the order listed the following procedures. When doing these procedures, do the steps in reverse order. These procedures are found under *Procedures for External Modules* which starts on page 6-16.

      - *Front Subpanel* (page 6-46)
      - *Display-Frame Assembly* (page 6-42)
      - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-22)
      - *Rear Cover and Cabinet* (page 6-19)
      - *Line Fuse and Line Cord* (page 6-17)

# Troubleshooting

This subsection contains information and procedures designed to help you isolate faulty modules in the oscilloscope. If a module needs to be replaced, follow the *Removal and Installation Procedures* located in this section.

## Diagnostics

The oscilloscope has two levels of internal diagnostics that focus on verifying, adjusting, and if need be, isolating faulty modules.

Both levels of internal diagnostics report any bad modules and/or interfaces. If a bad module and/or interface is found, use the troubleshooting procedures in this section to determine which module needs to be replaced.

The two levels of diagnostics are the short confidence set and the extended set that tests the oscilloscope circuitry in-depth and takes more time. At power-up, the oscilloscope automatically executes the short set. The extended set is optional and is executed by using the following procedure:

Prerequisites: Power on the oscilloscope and allow a 20 minute warm-up before doing this procedure.

1. *Display the System diagnostics menu:*
   a. Press **SHIFT**; then press **UTILITY**.
   b. Repeatedly press the main-menu button **System** until **Diag/Err** is highlighted in the pop-up menu.
2. *Run the System Diagnostics:* Press the main-menu button **Execute**; then press the side-menu button **OK Confirm Run Test**.
3. *Wait:* The internal diagnostics do an exhaustive verification of proper oscilloscope function. This verification will take about two minutes. When finished, the oscilloscope will display a report of any bad modules and/or interfaces.

## Firmware Updates

The TDS 640 Firmware updates are easy to do. Simply install the Firmware disks on your PC and follow the instructions in the README file located on the first disk.

### NOTE

*You must set the Protection switch to the unprotected position before updating the Firmware. Figure 6-21 shows how to set the switch. After loading the Firmware, be sure you set the switch back to the protected position and cycle power.*

If you want to order a Firmware update, see *Optional Accessories*, *Replaceable Parts List* in Section 10 for the part number.

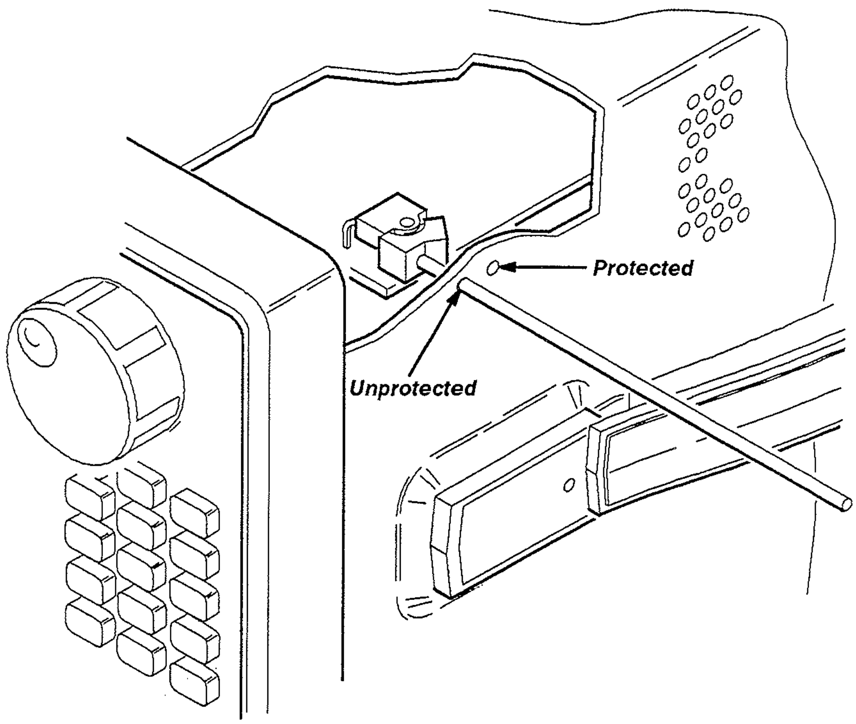



**Figure 6-21: Accessing the Protection Switch**

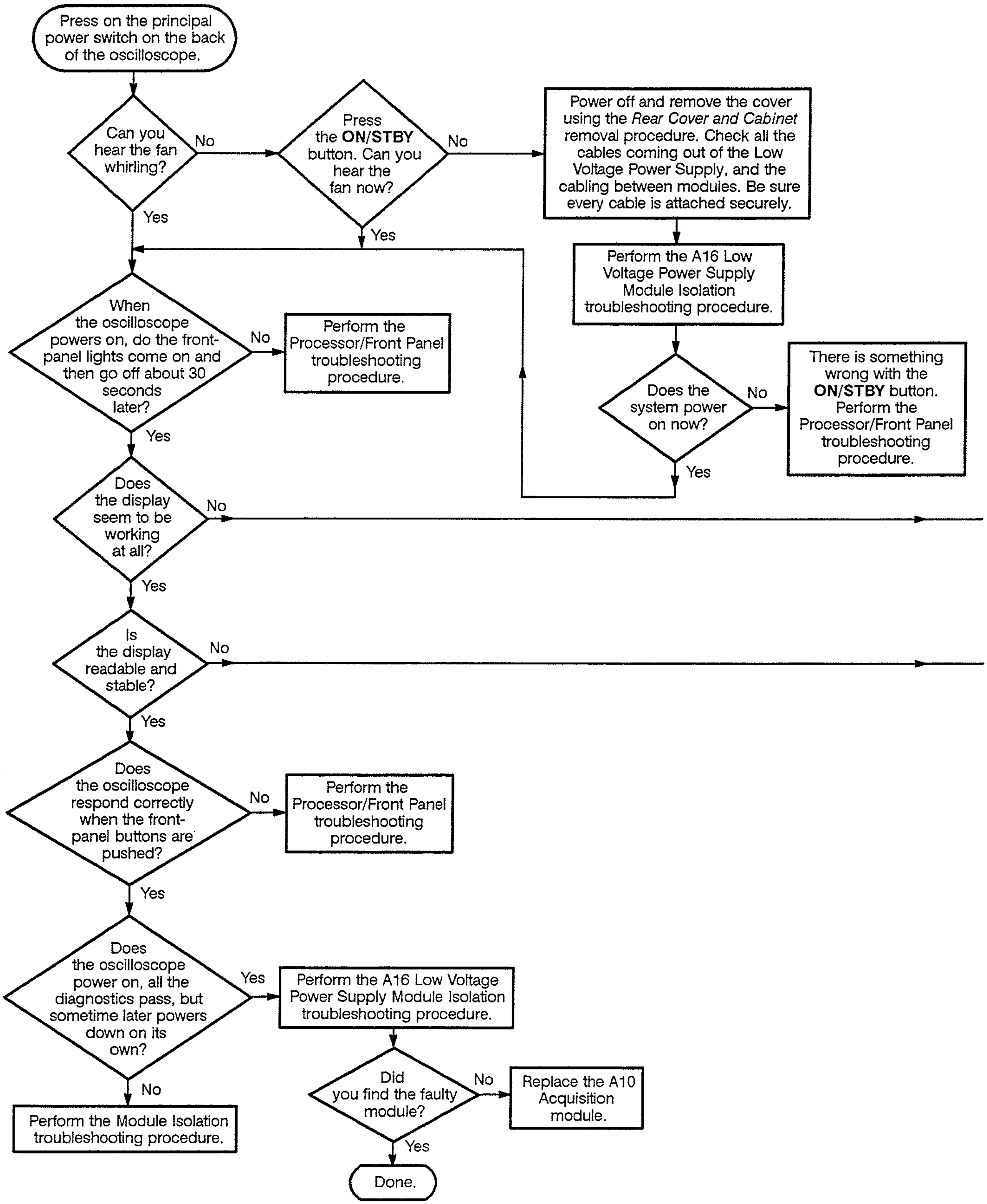
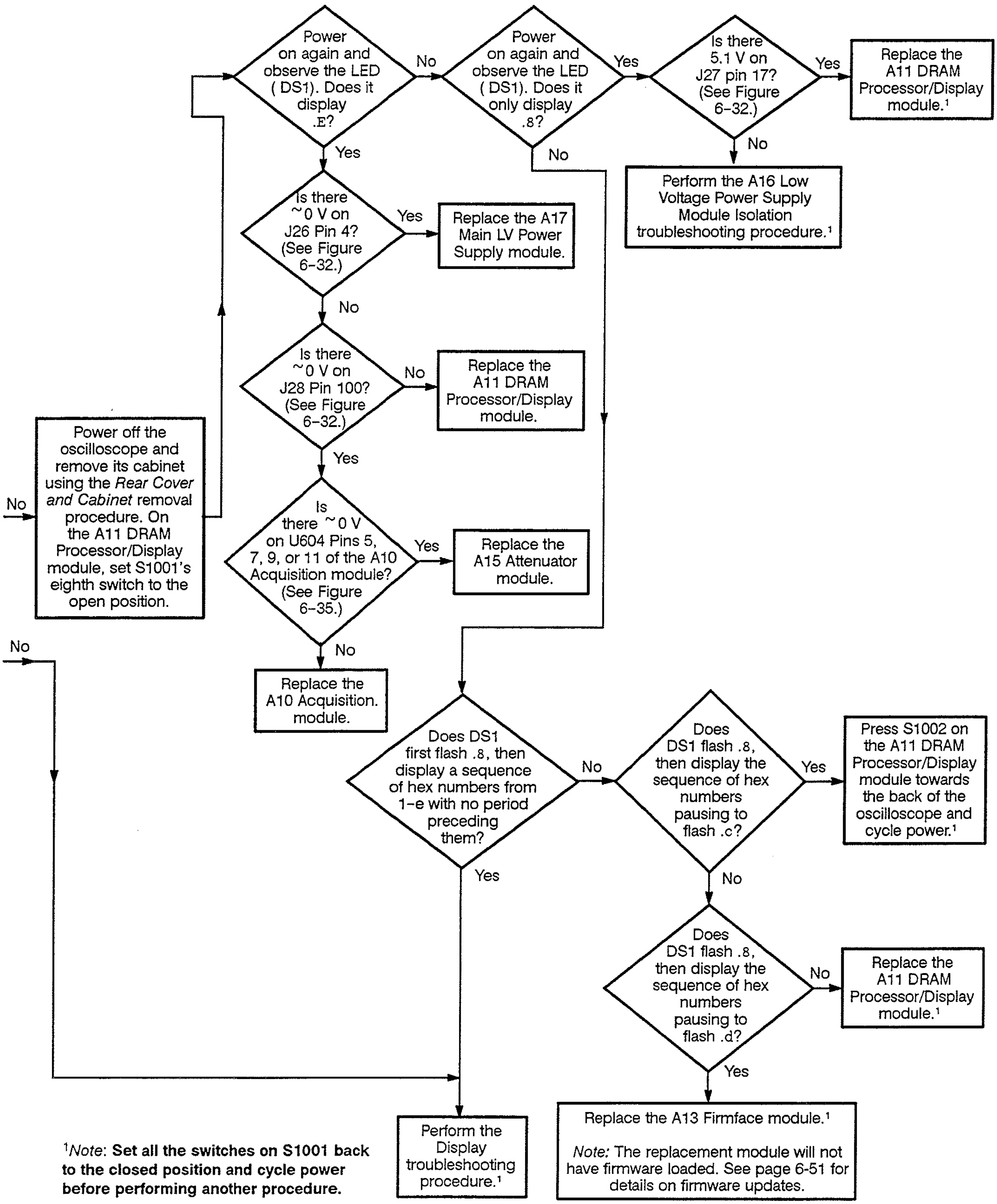



**Figure 6-22: Primary Troubleshooting Procedure**




[1]*Note*: **Set all the switches on S1001 back to the closed position and cycle power before performing another procedure.**

**Figure 6-22: Primary Troubleshooting Procedure (Cont.)**

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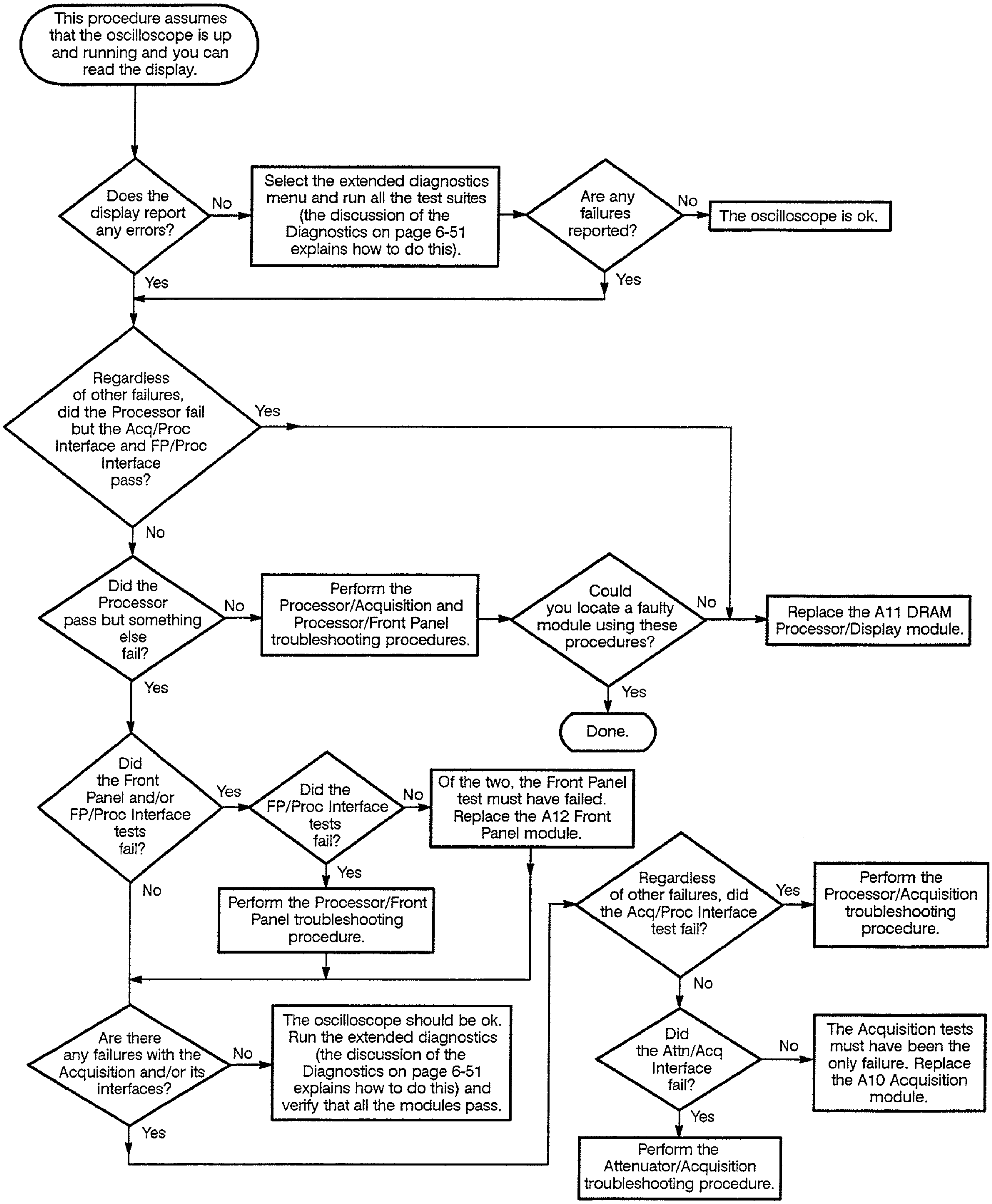


**Figure 6-23: Module Isolation Troubleshooting Procedure**

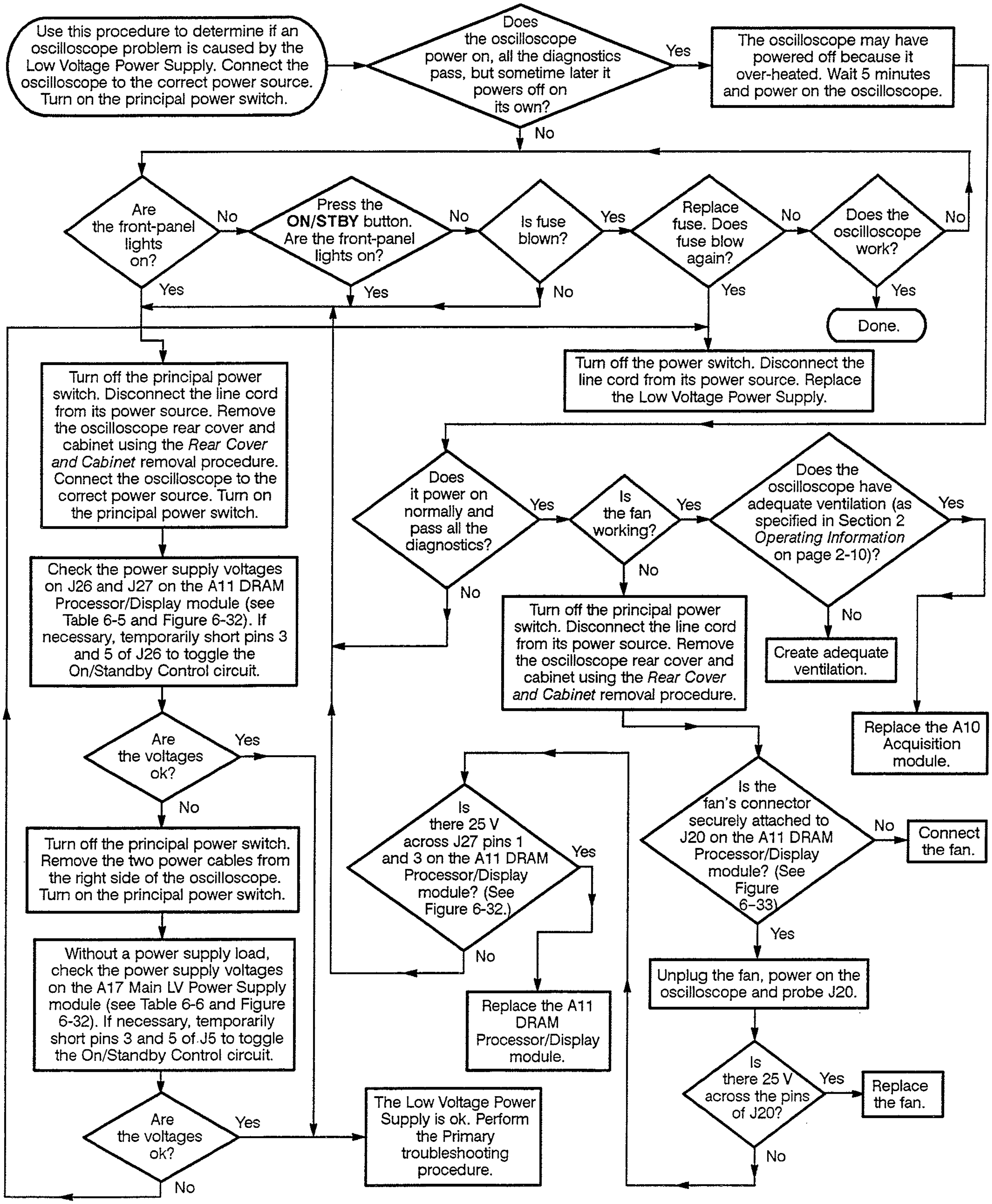


**Figure 6-24: A16 Low Voltage Power Supply Module Isolation Troubleshooting Procedure**

**Table 6-5: Normal Supply Voltages (Measured on J26 and J27 on the A11 DRAM Processor/Display Module)**

| Supply | Lower Limit | Upper Limit |
|---|---|---|
| Ground (J26 or J27 pin 15) | | |
| +5.1 VA (J27 pin 5) | +5.0 V | +5.2 V |
| +5.1 VB (J27 pin 17) | +5.0 V | +5.2 V |
| +25 V (J27 pin 1) | +23.5 V | +27.5 V |
| +5 V (J26 pin 39) | +4.9 V | +5.1 V |
| -5.1 V (J26 pin 17) | -4.9 V | -5.2 V |
| +15 V (J26 pin 11) | +14.7 V | +15.3 V |
| −15 V (J26 pin 7) | −14.7 V | −15.3 V |

**Table 6-6: No-Load Supply Voltages (Measured on J5 and J6 on the A17 Main LV Power Supply Module)**

| Supply | Lower Limit | Upper Limit |
|---|---|---|
| Ground (J5 or J6 pin 15) | | |
| +5.1 VA (J6 pin 5) | +4.95 V | +5.25 V |
| +5.1 VB (J6 pin 17) | +4.95 V | +5.25 V |
| +25 V (J6 pin 1) | +23.5 V | +27.5 V |
| +5 V (J5 pin 39) | +0.59 V | +0.81 V |
| -5.1 V (J5 pin 17) | −0.39 V | -0.61 V |
| +15 V (J5 pin 11) | +1.05 V | +1.75 V |
| −15 V (J5 pin 7) | −1.05 V | −1.75 V |

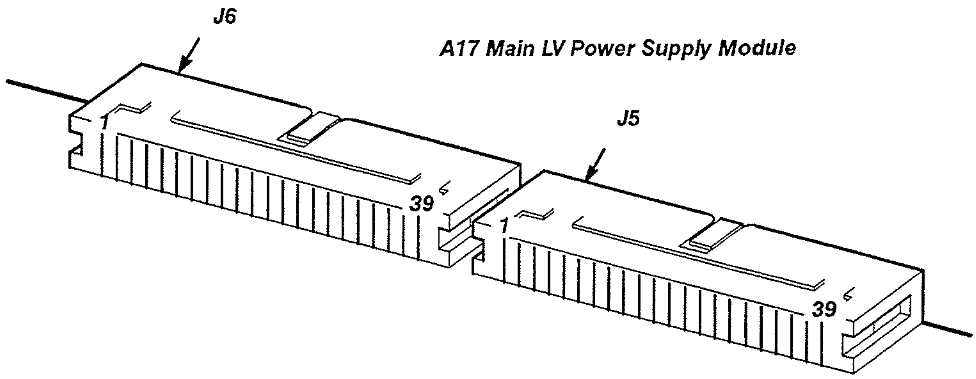


Figure 6-25: Power Supply Voltage Measurement Locations

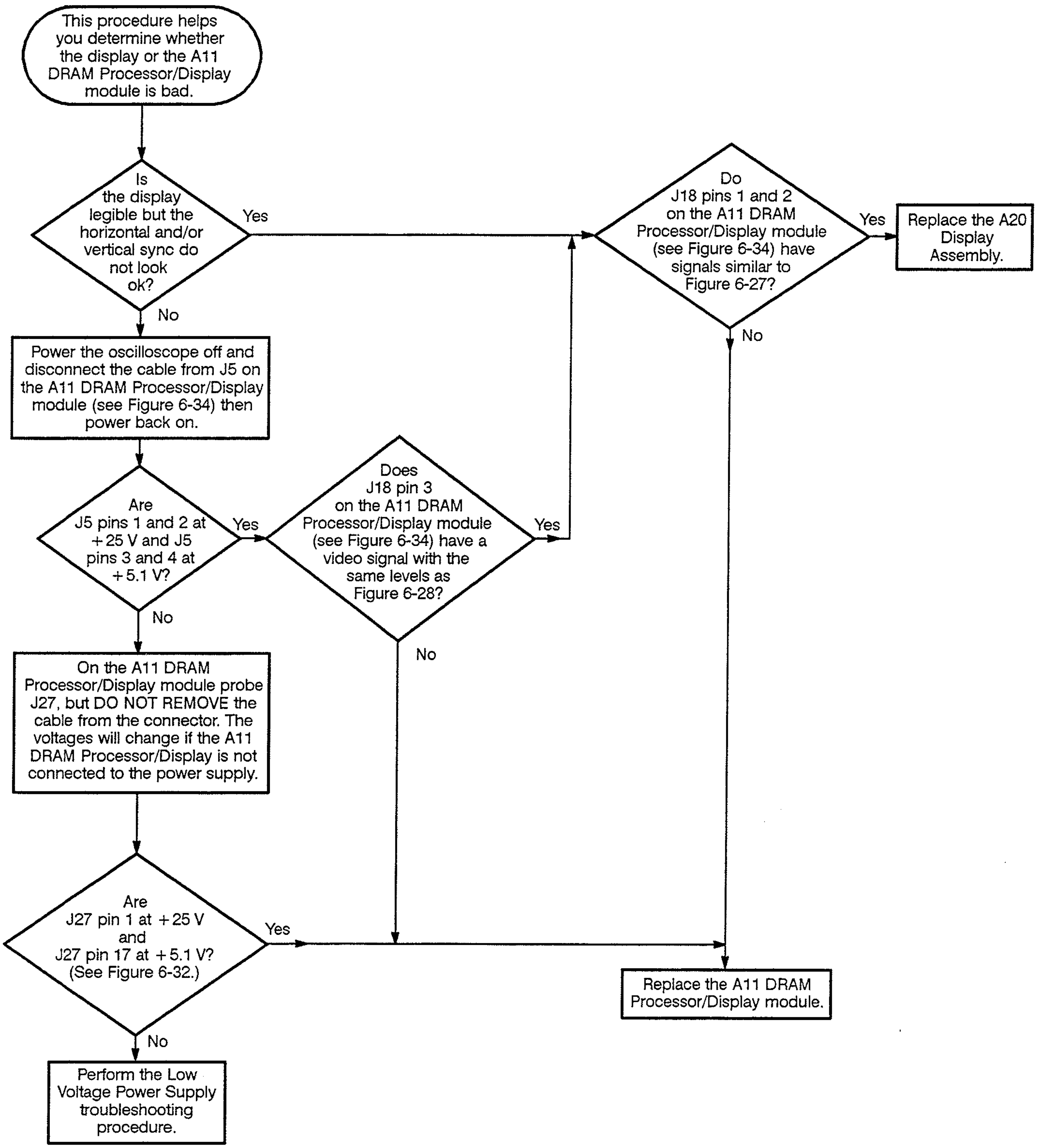


**Figure 6-26: Display Troubleshooting Procedure**

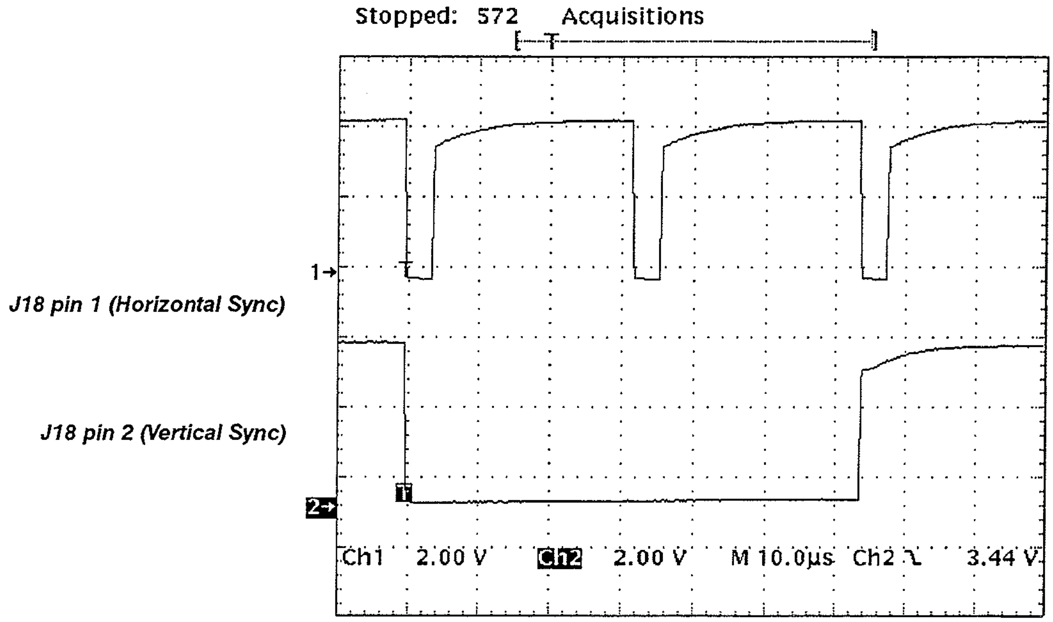


**Figure 6-27: Horizontal and Vertical Sync Signals**

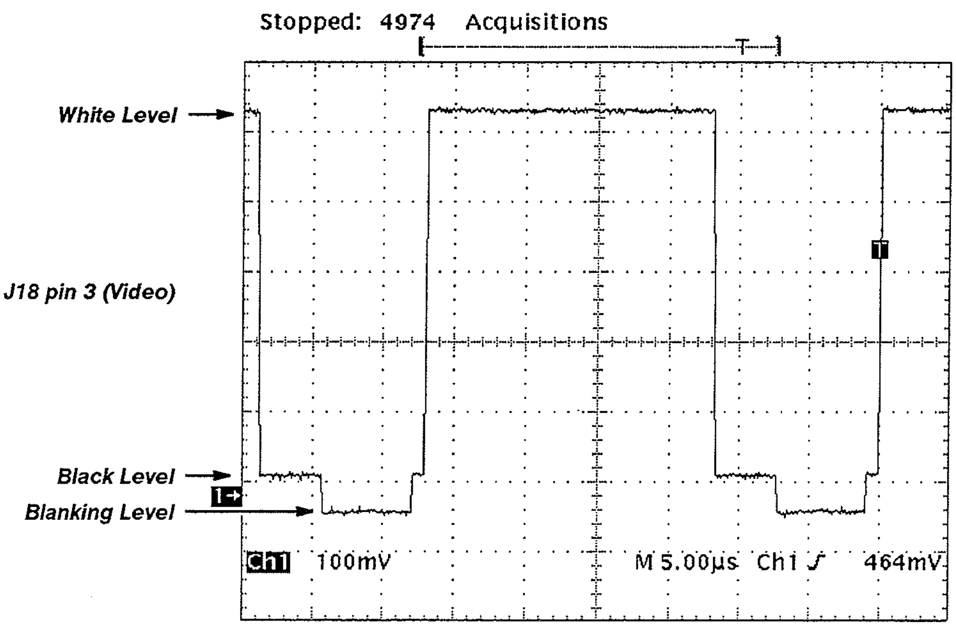


**Figure 6-28: A Video Signal with White, Black, and Blanking Levels**

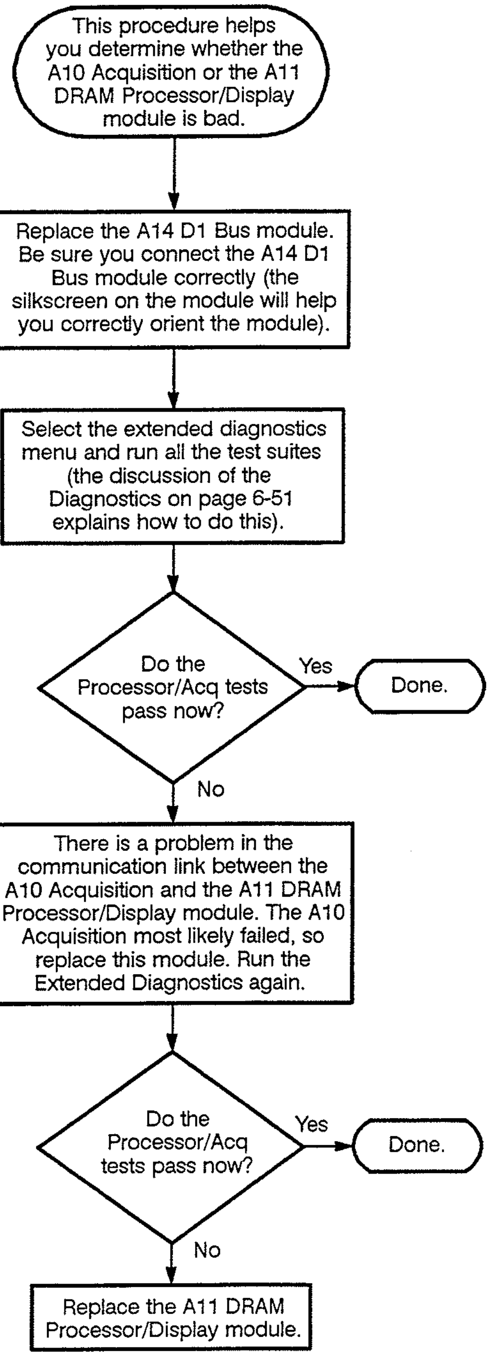


**Figure 6-29: Processor/Acquisition Troubleshooting Procedure**

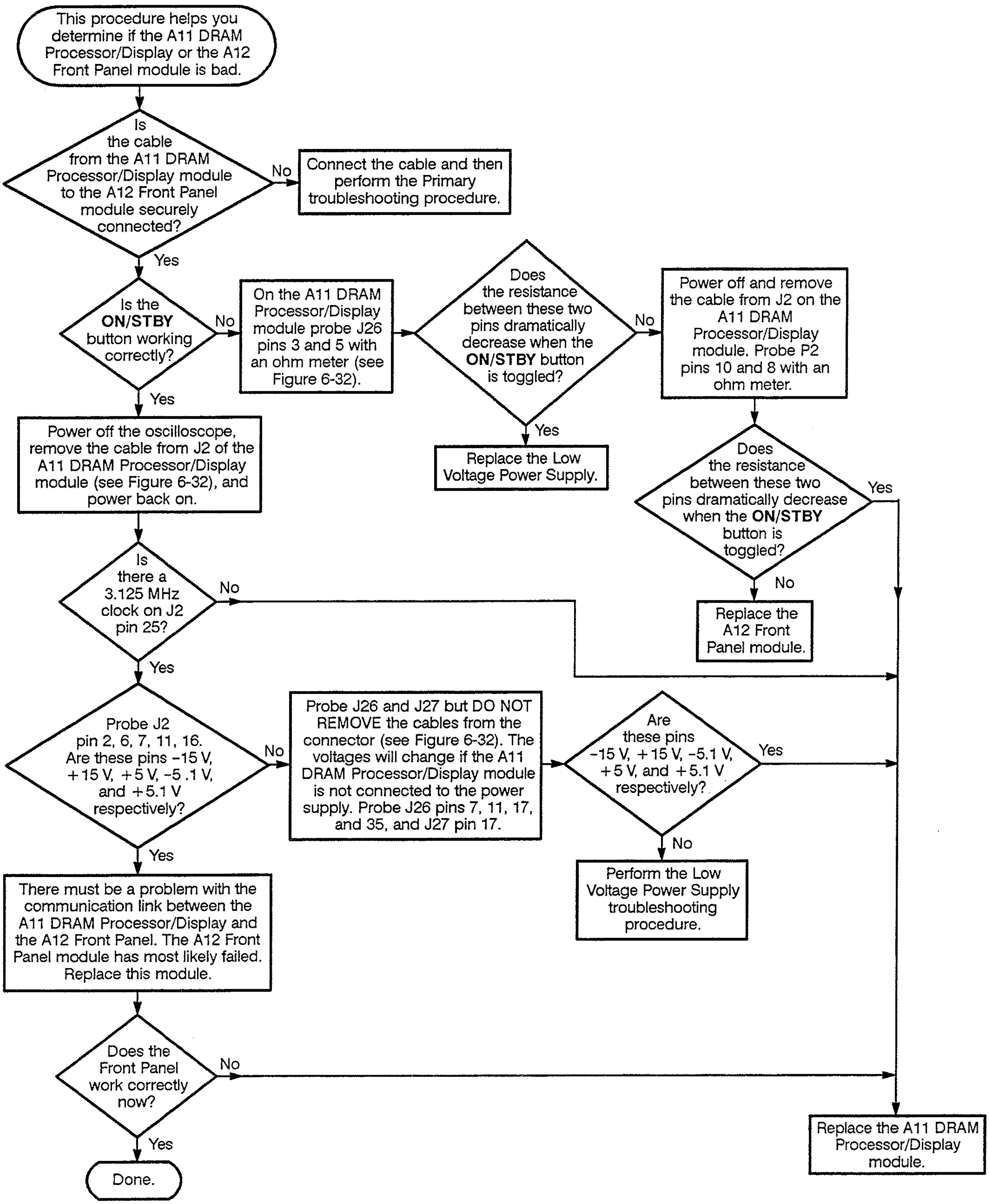


**Figure 6-30: Processor/Front Panel Troubleshooting Procedure**

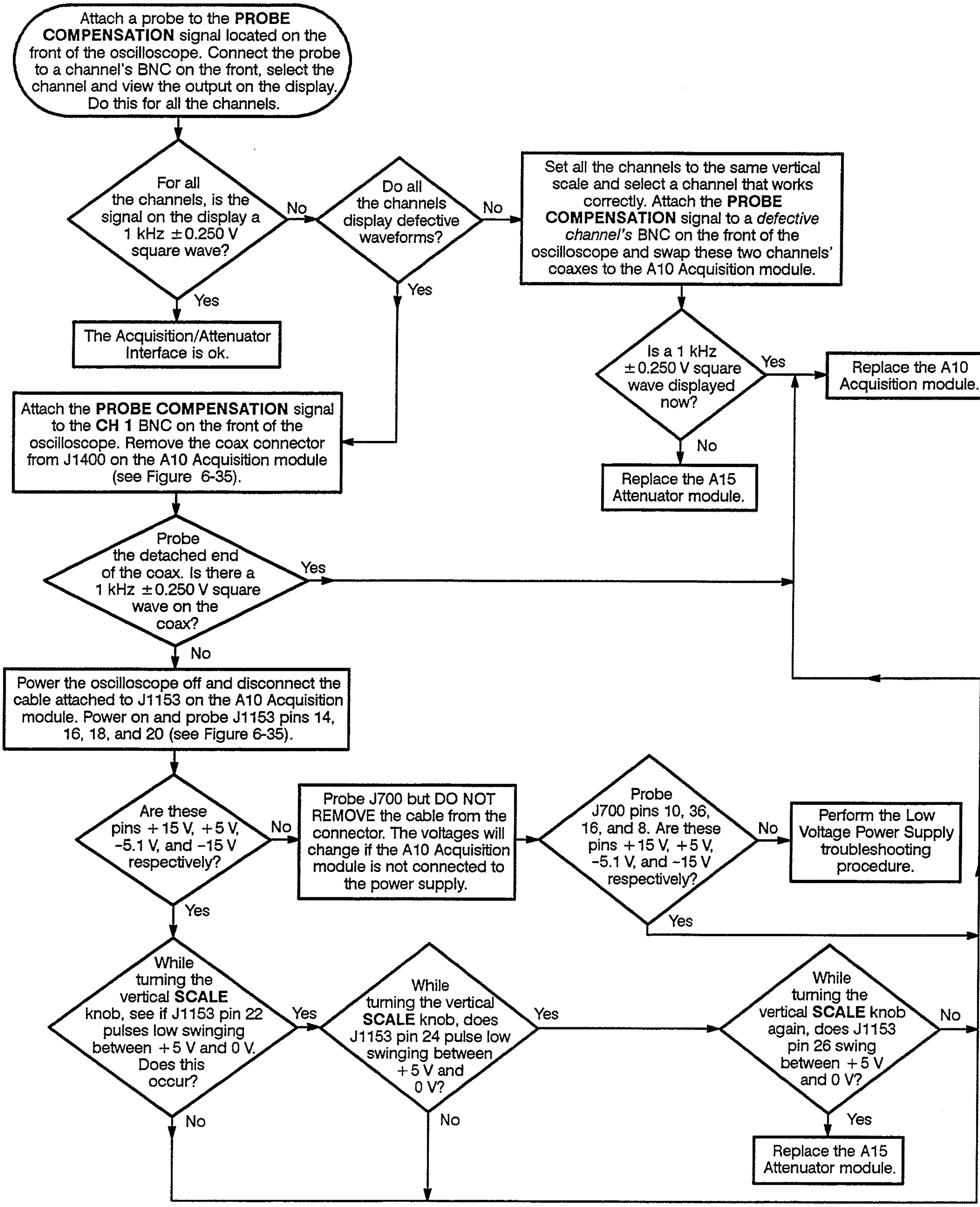


**Figure 6-31: Attenuator/Acquisition Troubleshooting Procedure**

**CAUTION** *Only probe points specified in the procedures. You can cause catastrophic damage if you attempt to probe other points.*

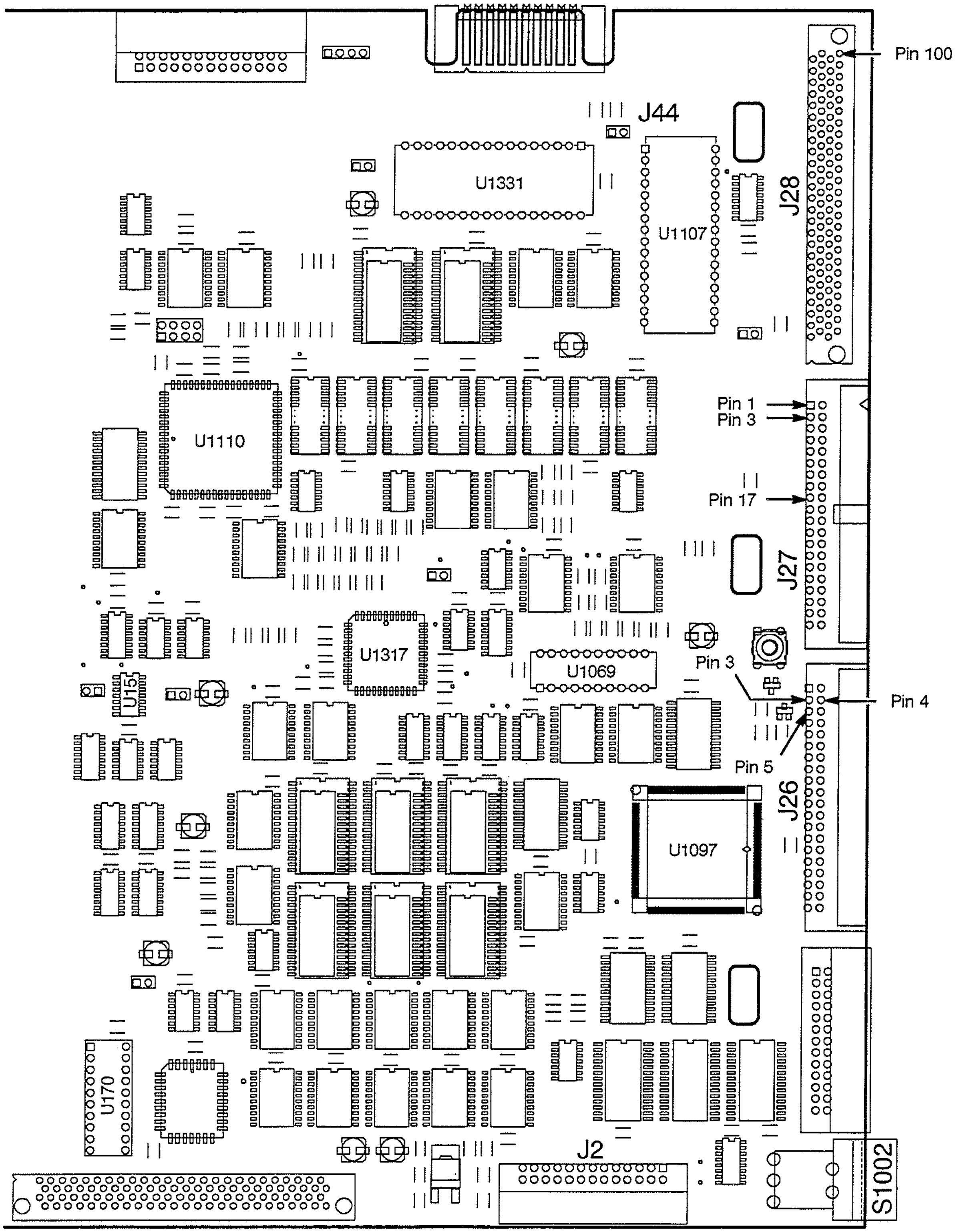


**Figure 6-32: A11 DRAM Processor/Display Module (View of Right Side)**

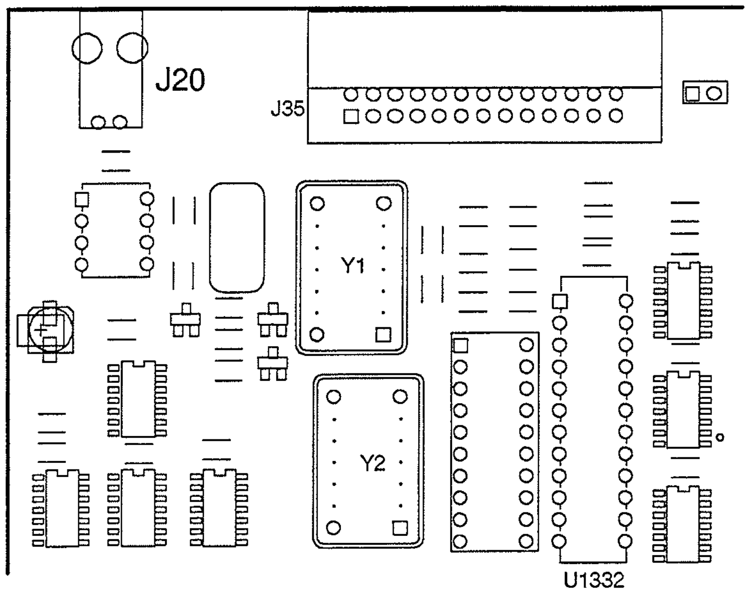


Figure 6-33: A11 DRAM Processor/Display Module (View of Upper Left Corner)

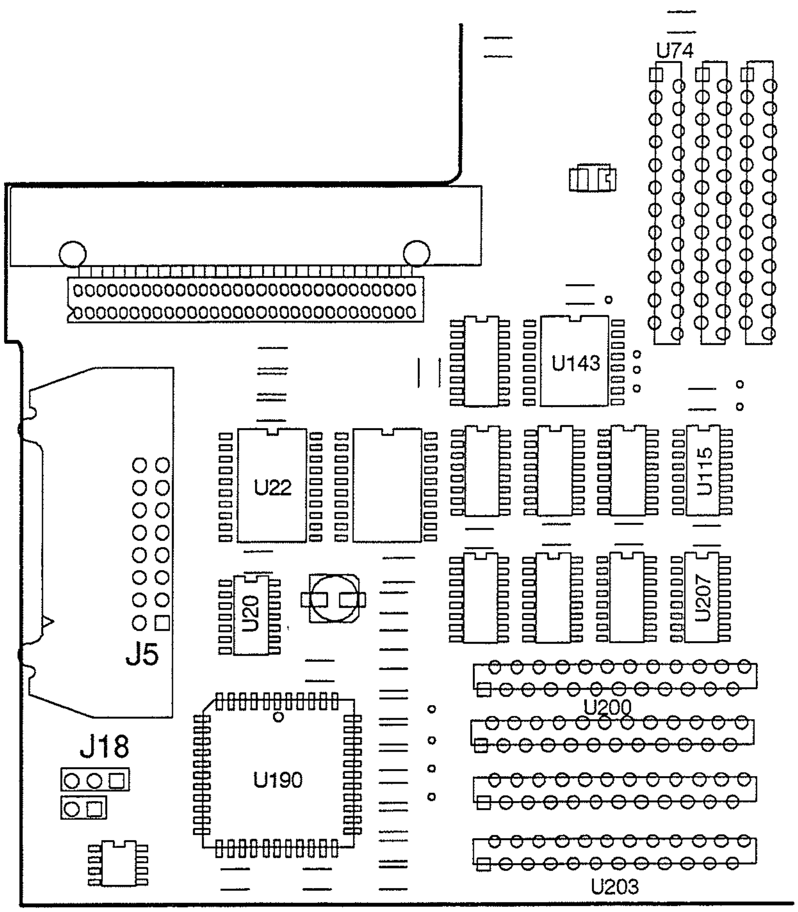


**Figure 6-34: A11 DRAM Processor/Display Module (View of Lower Left Corner)**

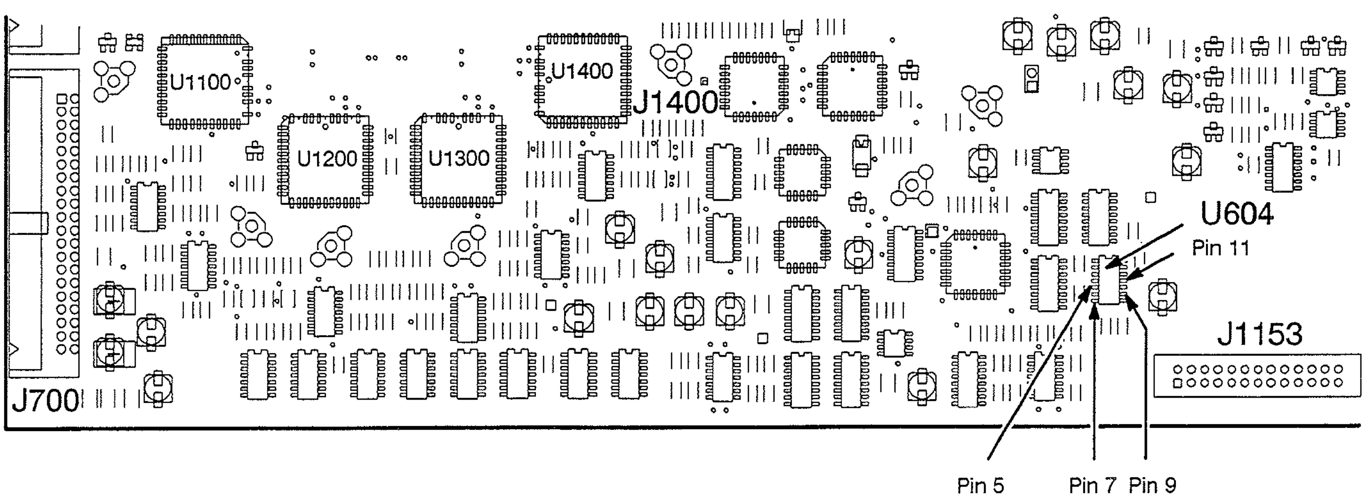


**Figure 6-35: A10 Acquisition Module (View of Lower Left Corner)**

# Options

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# Options and Accessories

This section describes the various options as well as the standard and optional accessories that are available for the TDS 640 Digitizing Oscilloscope.

## Options

The following options are available:

### Options A1 – A5: International Power Cords

Besides the standard North American, 110 V, 60 Hz power cord, Tektronix ships any of five alternate power cord configurations with the oscilloscope when ordered by the customer.

**Table 7-1: International Power Cords**

| Option | Power Cord |
|---|---|
| A1 | Universal European – 220 V, 50 Hz |
| A2 | UK – 240 V, 50 Hz |
| A3 | Australian – 240 V, 50 Hz |
| A4 | North American – 240 V, 60 Hz |
| A5 | Switzerland – 220 V, 50 Hz |

### Option B1: Service Manual

When Option B1 is ordered, Tektronix ships a service manual (this manual) with the oscilloscope.

### Option 1K: K218 Oscilloscope Cart

When Option 1K is ordered, Tektronix ships a K218 Oscilloscope Cart with the oscilloscope.

### Warranty-Plus Service Options

The following options add to the services available with the standard warranty. (The standard warranty appears in the User Manual on the back side of the title page.)

- **Option M2:** When Option M2 is ordered, Tektronix provides five years of warranty/remedial service.

- **Option M3:** When Option M3 is ordered, Tektronix provides five years of warranty/remedial service and four oscilloscope calibrations.
- **Option M8:** When Option M8 is ordered, Tektronix provides four calibrations and four performance verifications, one of each in the second through the fifth years of service.

## Option 1P: HC100 4 Pen Plotter

With this option, Tektronix ships a four-color plotter designed to make waveform plots directly from the digitizing oscilloscope without requiring an external controller. It handles A4 and US letter size media.

## Option 1R: Rackmounted TDS 640 Digitizing Oscilloscope

Tektronix ships the oscilloscope, when ordered with Option 1R, configured for installation in a 19-inch wide instrument rack. Customers with oscilloscopes not configured for rackmounting can order a rackmount kit (016–1136–00) for field conversions.

Instructions for rackmounting the digitizing oscilloscope are shipped with the option 1R.

## Option 2F: Advanced DSP Math

With this option, the oscilloscope can compute and display three advanced math waveforms: integral of a waveform, differential of a waveform, and an FFT (Fast Fourier Transform) of a waveform.

## Option 4D: Delete Four Probes — (TDS 640 only)

With this option, Tektronix ships the digitizing oscilloscope without the four P6205 Active Probes normally included as standard accessories.

## Option 13: RS-232/Centronics Hardcopy Interface

With this option, Tektronix ships the digitizing oscilloscope with a RS-232 and a Centronics interface that can be used to obtain hardcopies of the oscilloscope screen.

## Option 24: Add Four Passive Probes

With this option, Tektronix ships four passive 10X P6139A probes.

## Option 29: TD100 Data Manager

With this option, Tektronix ships a TD100 Data Manager.

### Option 9C: Certificate of Calibration and Test Data Report

Tektronix ships a Certificate of Calibration which states this instrument meets or exceeds all warranted specifications and has been calibrated using standards and instruments whose accuracies are traceable to the National Institute of Standards and Technology, an accepted value of a natural physical constant, or a ratiometric calibration technique. The calibration is in compliance with U.S. MIL–STD–45662A. This option also includes a test data report for the instrument.

## Standard Accessories

The following standard accessories are included with the digitizing oscilloscope:

**Table 7-2: Standard Accessories**

| Accessory | Part Number |
|---|---|
| User Manual | 070–8506–01 |
| Programmer Manual | 070–8318–04 |
| Reference | 070–8505–00 |
| Front Cover | 200–3696–00 |
| U.S. Power Cord | 161–0230–01 |
| Probes (qty. four) 10X Active; 750 MHz | P6205 (single unit) |
| P6205 Probe Manual | 070–8202–00 |

### Probe Accessories

These are accessories to the standard probe listed previously (P6205). Except for the probe-tip-to-circuit board adapter, they can also be ordered separately.

**Table 7-3: Probe Accessories**

| Accessory | Part Number |
|---|---|
| Retractable Hook Tip | 013–0107–06 |
| Body shell, tip cover | 204–1049–00 |
| Probe-Tip-to-Circuit Board Adapter (qty. two standard, optionally available in package of 25 as 131–4353–00) | No customer orderable part number for double unit |
| 6-Inch Ground Lead | 196–3198–02 |
| Low Inductance Ground Lead | 214–4125–00 |

**Table 7-3: Probe Accessories**

| Accessory | Part Number |
|---|---|
| Marker Rings Set (qty. eighteen rings which includes two each of nine colors) | 016–0633–00 |
| Ground Cover | 166–0404–01 |
| 6-Inch Alligator Clip Ground Lead | 196–3120–00 |
| IC Test Tip (qty. one standard, optionally available in package of 10 as 015–0201–07) | No customer orderable part number for single unit |
| SMT KlipChip™ | 206–0364–00 |

## Optional Accessories

You can also order the following optional accessories:

**Table 7-4: Optional Accessories**

| Accessory | Part Number |
|---|---|
| TDS 640 Service Manual | 070–8508–00 |
| Plotter (GPIB and Centronics Standard) | HC100 |
| Oscilloscope Cart | K218 |
| Rack Mount Kit (for field conversion) | 016–1136–00 |
| Oscilloscope Camera | C9 |
| Oscilloscope Camera Adapter | 016–1154–00 |
| Soft-Sided Carrying Case | 016–0909–01 |
| Transit Case | 016–1135–00 |
| GPIB Cable (1 meter) | 012–0991–01 |
| GPIB Cable (2 meter) | 012–0991–00 |

### Accessory Probes

The following optional accessory probes are recommended for use with your digitizing oscilloscope:

- P6101A 1X, 15 MHz, passive probe.
- P6156 10X, 3.5 GHz, passive, low capacitance, (low impedance Zo) probe provides 100X, when ordered with Option 25.
- P6139A 10X, passive probe.
- P6009 passive, high voltage probe, 100X, 1500 VDC + Peak AC

- P6015A passive high voltage probe, 1000X, 20 kVDC + Peak AC (40 kV peak for less than 100 ms)
- P6205 750 MHz probe bandwidth. Active (FET) voltage probe.
- P6204 active, high speed digital voltage probe. FET. DC to 1 GHz. DC offset. 50 Ω input. Use with 1103 Tekprobe Power Supply for offset control.
- P6046 active, differential probe, 1X/10X, DC to 100 MHz, 50 Ω input.
- A6501 Buffer Amplifier (active fixtured), 1 GHz, 1 MΩ, 10X.
- P6501 Option 02: Microprobe with TekProbe power cable (active fixtured), 750 MHz, 1 MΩ, 10X.
- AM 503S — DC/AC Current probe system, AC/DC. Uses A6302 Current Probe.
- AM 503S Option 03: DC/AC Current probe system, AC/DC. Uses A6303 Current Probe.
- P6021 AC Current probe. 120 Hz to 60 MHz.
- P6022 AC Current probe. 935 kHz to 120 MHz.
- CT–1 Current probe — designed for permanent or semi-permanent in-circuit installation. 25 kHz to 1 GHz, 50 Ω input.
- CT–2 Current probe — designed for permanent or semi-permanent in-circuit installation. 1.2 kHz to 200 MHz, 50 Ω input.
- CT–4 Current Transformer — for use with the AM 503S (A6302) and P6021. Peak pulse 1 kA. 0.5 Hz to 20 MHz with AM 503S (A6302).
- P6701A Opto-Electronic Converter, 500 to 950 nm, DC to 850 MHz 1 V/mW.
- P6703A Opto-Electronic Converter, 1100 to 1700 nm, DC to 1 GHz 1 V/mW.
- P6711 Opto-Electronic Converter, 500 to 950 nm, DC to 250 MHz 5 V/mW.
- P6713 Opto-Electronic Converter, 1100 to 1700 nm, DC to 300 MHz 5 V/mW.
- TVC 501 Time-to-voltage Converter. Time delay, pulse width and period measurements.

## Probe Accessories

The following optional accessories are recommended for use with the standard probe listed under *Standard Accessories.*

**Table 7-5: Probe Accessories**

| Accessory | Part Number |
|---|---|
| Connector, BNC: BNC to Probe Tip Adapter | 013–0084–01 |
| Connector, GR: 50 Ω, GR to Probe Tip Adapter | 017–0088–00 |
| Dual Lead Adapter | 015–0325–00 |
| Probe Holder: Black ABS | 352–0351–00 |
| IC Protector Tip, Package of 10 | 015–0201–07 |
| IC Protector Tip, Package of 100 | 015–0201–08 |
| Marker Ring Set: Two each of nine colors | 016–0633–00 |
| SMT KlipChip™: 20 Adapters | SMG50 |
| Low-Inductance Spring-Tips: Two each of five different springs and insulator | 016–1077–00 |
| Bayonet Ground Assembly | 013–0085–00 |
| Probe Tip-to-Chassis Adapter | 131–0258–00 |

## Accessory Software

The following optional accessories are Tektronix software products recommended for use with your digitizing oscilloscope:

**Table 7-6: Accessory Software**

| Software | Part Number |
|---|---|
| EZ-Test Program Generator | S45F030 |
| Wavewriter: AWG and waveform creation | S3FT400 |
| TekTMS: Test management system | S3FT001 |
| LabWindows | S3FG910 |

## Warranty

The full warranty statements for this digitizing oscilloscope, the probes, and the products listed above, appear on the back of the title page in the User Manual.

# Electrical Parts List

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# Replaceable Electrical Parts List

The modules that make up this instrument are often a combination of mechanical and electrical subparts. Therefore, all replaceable modules are listed in Section 10, *Replaceable Parts List.* Refer to that section for part numbers when using this manual.

# Diagrams

**Replace this page with the tab divider of the same name.**

# Diagrams

This section contains the interconnection diagram and the block diagram for the TDS 640 Digitizing Oscilloscope.

## Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975. Abbreviations are based on ANSI Y1.1-1972.

Logic symbology is based on ANSI/IEEE Std 91-1984 in terms of positive logic. Logic symbols depict the logic function performed and can differ from the manufacturer's data.

The tilde (~) preceding a signal name indicates that the signal performs its intended function when in the low state.

Other standards used in the preparation of diagrams by Tektronix, Inc. are:

- Tektronix Standard 062-2476 Symbols and Practices for Schematic Drafting
- ANSI Y14.159-1971 Interconnection Diagrams
- ANSI Y32.16-1975 Reference Designations for Electronic Equipment
- MIL-HDBK-63038-1A Military Standard Technical Manual Writing Handbook

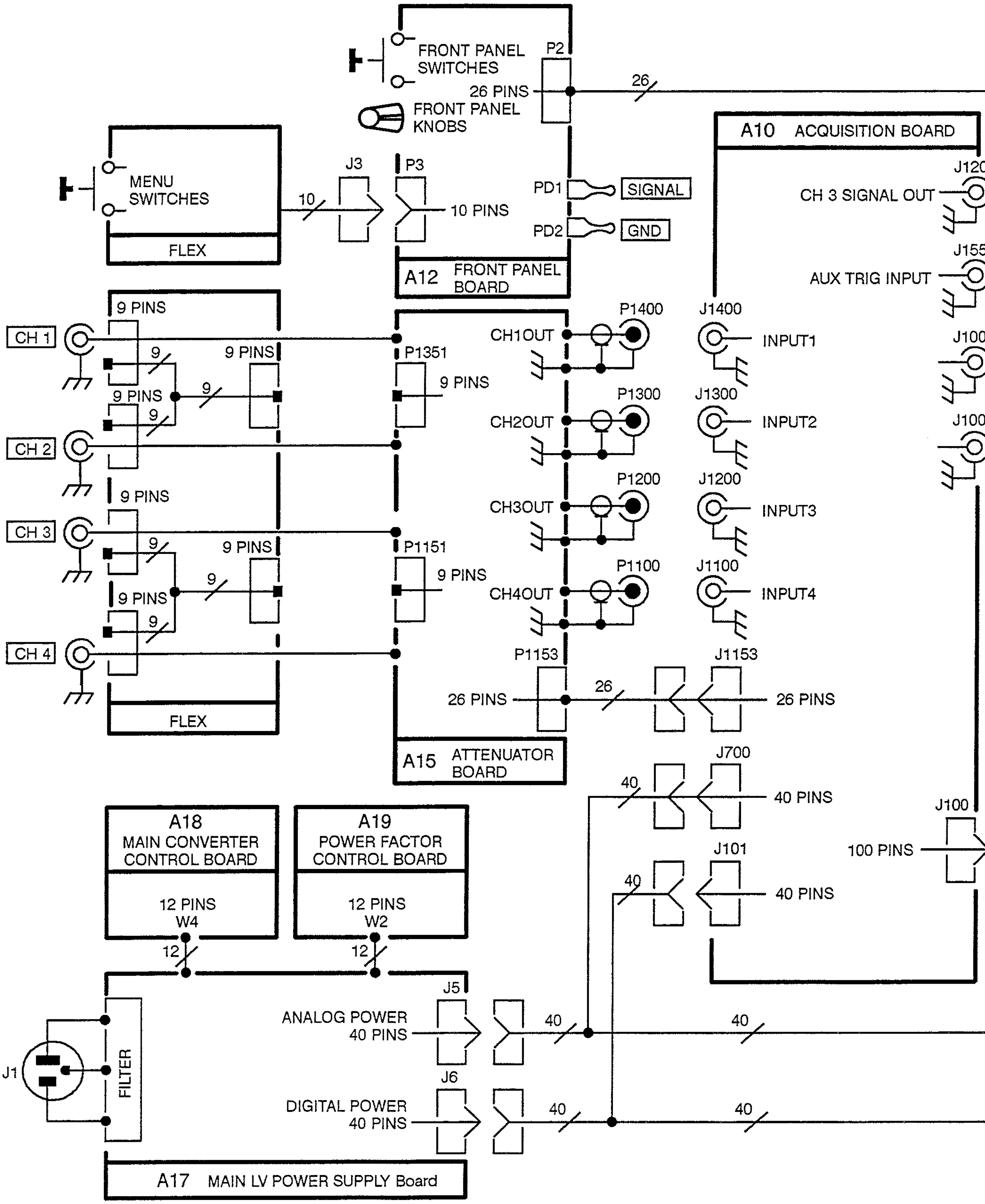


**Figure 9-1: TDS 640 Interconnections**

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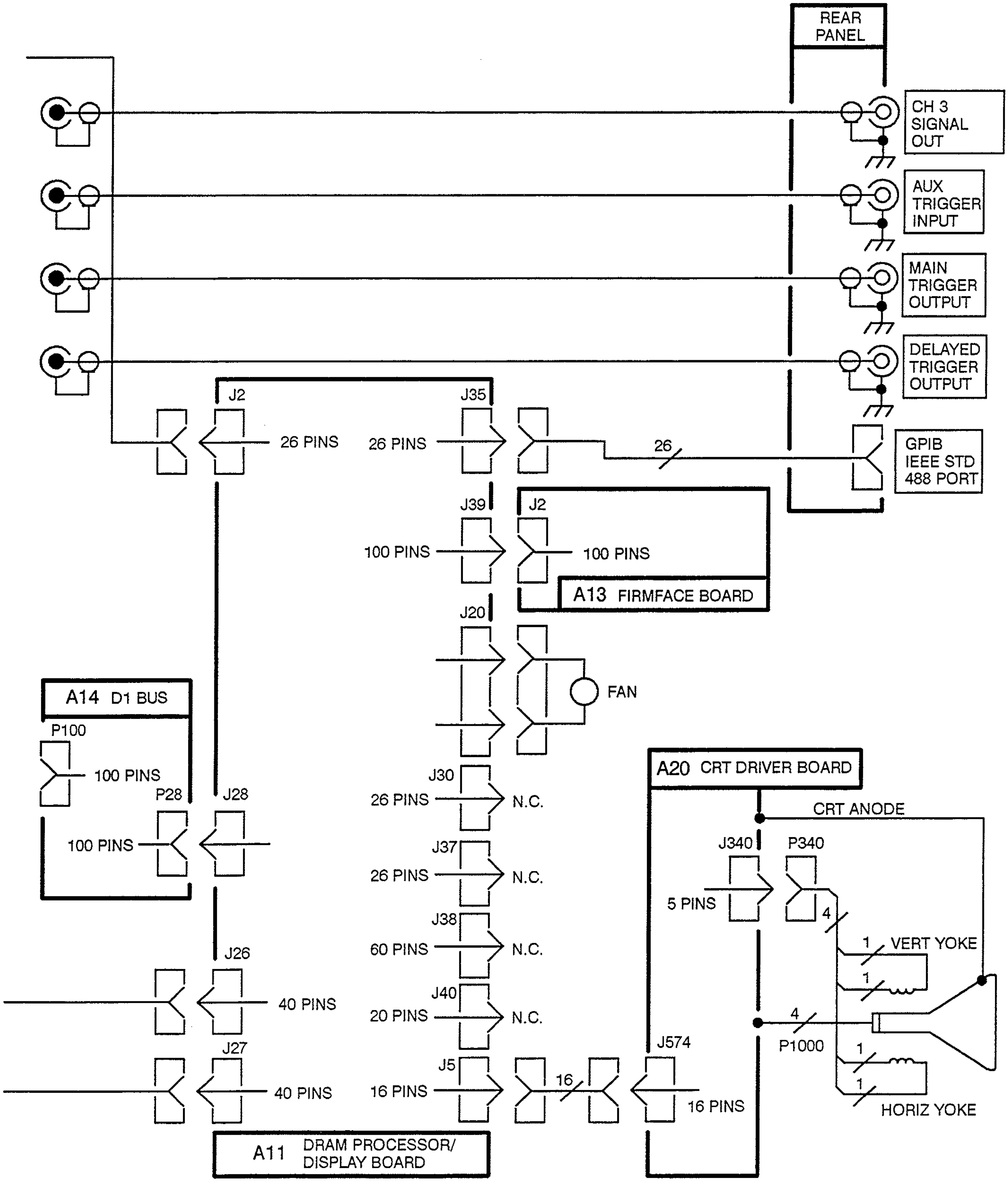


Figure 9-1: TDS 640 Interconnections (Cont.)

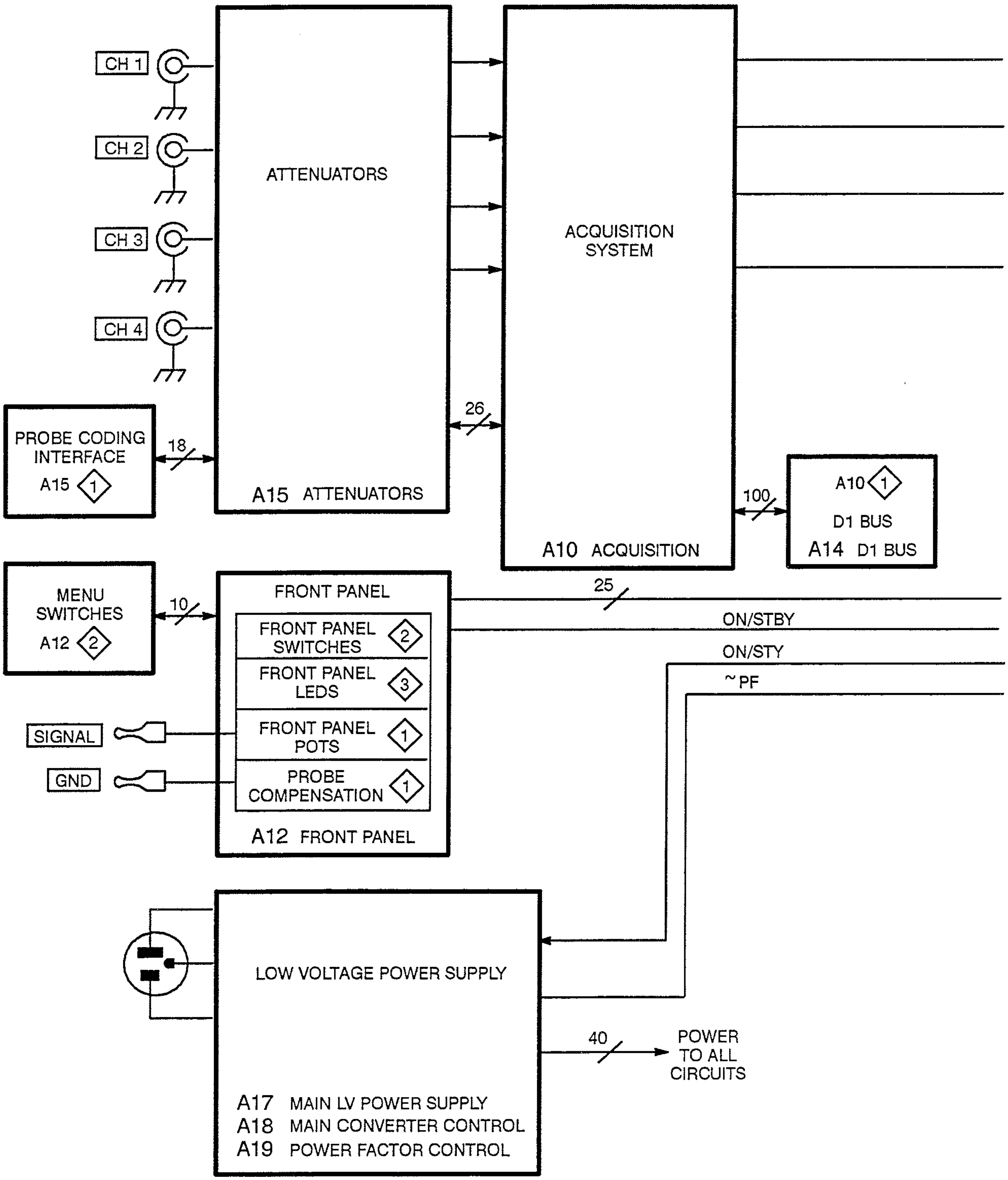


**Figure 9-2: TDS 640 Block Diagram**

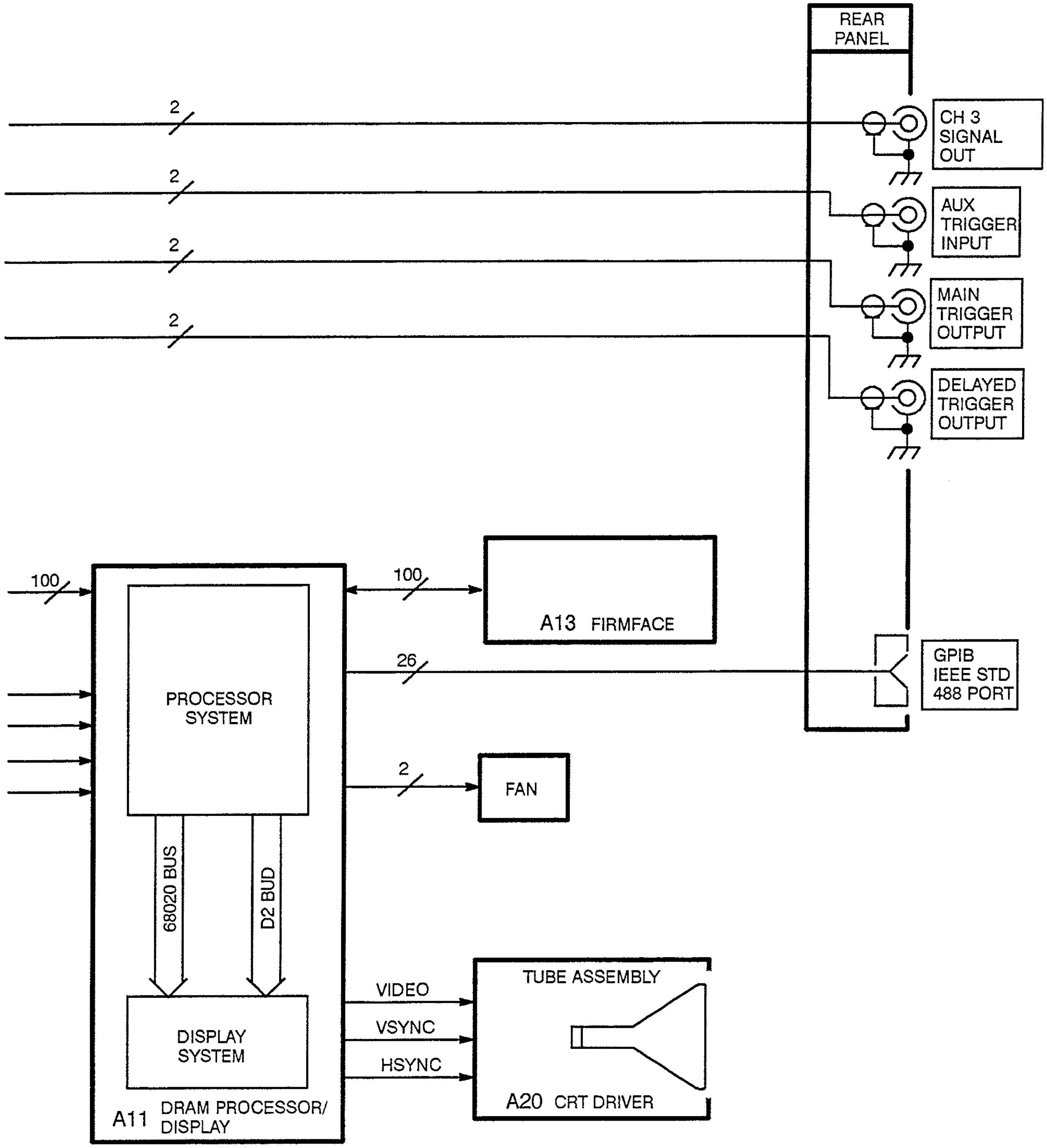


**Figure 9-2: TDS 640 Block Diagram (Cont.)**

# Parts List

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# Replaceable Parts List

This section contains a list of the modules that are replaceable for the TDS 640 Digitizing Oscilloscope. Use this list to identify and order replacement parts.

## Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

Change information, if any, is located at the rear of this manual.

### Module Replacement

The TDS 640 Digitizing Oscilloscope is serviced by module replacement so there are three options you should consider:

- **Module Exchange.** In some cases you may exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEKWIDE, ext. 6630.
- **Module Repair.** You may ship your module to us for repair, after which we will return it to you.
- **New Modules.** You may purchase new replacement modules in the same way as other replacement parts.

## Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find all the information you need for ordering replacement parts.

### Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

### Indentation System

This parts list is indented to show the relationship between items. The following example is of the indentation system used in the Description column:

*1 2 3 4 5 Name & Description*

*Assembly and/or Component*
*Attaching parts for Assembly and/or Component*
*(END ATTACHING PARTS)*
*Detail Part of Assembly and/or Component*
*Attaching parts for Detail Part*
*(END ATTACHING PARTS)*
*Parts of Detail Part*
*Attaching parts for Parts of Detail Part*
*(END ATTACHING PARTS)*

Attaching parts always appear at the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. Attaching parts must be purchased separately, unless otherwise specified.

### Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

# CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|---|---|---|---|
| S3629 | SCHURTER AG H<br>C/O PANEL COMPONENTS CORP | 2015 SECOND STREET | BERKELEY CA 94170 |
| TK0IK | MODERN METALS | UNIT A/K, 5/F GOLD KING IND.<br>BLDG NO. 35-41 TAI LIN ROAD | KWAI-CHUNG N.T. HONG KONG |
| TK0488 | CURRAN COIL SPRING INC | 635 NW 16TH | PORTLAND OR 97209-2206 |
| TK1163 | POLYCAST INC | 9898 SW TIGARD ST | TIGARD OR 97223 |
| TK1465 | BEAVERTON PARTS MFG CO | 1800 NW 216TH AVE | HILLSBORO OR 97124-6629 |
| TK1899 | MINNESOTA MINING AND MFG CO | 5400 RT B<br>PO BOX 1228 | COLUMBIA MO 65205 |
| TK2162 | DERBY MFG | 24350 STATE ROAD 23 SOUTH | SOUTH B<br>END IN 46614-9696 |
| TK2230 | COMAIR ROTRON INC<br>SAWYER INDUSTRIAL PKY | 12 NORTH ST | SAUGERTIES NY 12477-1096 |
| TK2338 | ACC MATERIALS | ED SNYDER<br>BLDG 38-302 | BEAVERTON OR 97077 |
| TK2432 | UNION ELECTRIC | 15/F #1, FU-SHING N. ROAD | TAIPEI, TAIWAN ROC |
| TK2469 | UNITREK CORPORATION | 3000 LEWIS & CLARK WAY<br>SUITE #2 | VANCOUVER WA 98601 |
| 0JR05 | TRIQUEST CORP | 3000 LEWIS AND CLARK HWY | VANCOUVER WA 98661-2999 |
| 0J9P9 | GEROME MFG CO INC | PO BOX 737 | NEWBERG OR 97132 |
| 0KB01 | STAUFFER SUPPLY | 810 SE SHERMAN | PORTLAND OR 97214 |
| 00779 | AMP INC | 2800 FULLING MILL<br>PO BOX 3608 | HARRISBURG PA 17105 |
| 11536 | OPTICAL COATING LABORATORY INC | 2789 NORTHPOINT PKWY | SANTA ROSA CA 95407-7350 |
| 75915 | LITTELFUSE INC<br>SUB TRACOR INC | 800 E NORTHWEST HWY | DES PLAINES IL 60016-3049 |
| 76814 | NORTHERN ENGRAVING CORP | 803 S BLACK RIVER ST | SPARTA WI 54656-2221 |
| 80009 | TEKTRONIX INC | 14150 SW KARL BRAUN DR<br>PO BOX 500 | BEAVERTON OR 97077-0001 |

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 1-1 | 437-0399-00 | | | 1 | CABINET,SCOPE: | 0J9P9 | ORDER BY DESC |
| -2 | 200-3695-01 | | | 1 | COVER,REAR: | 80009 | 200369501 |
| -3 | 161-0230-01 | | | 1 | CABLE ASSY,PWR,:3,18 AWG,92.0 L, (STANDARD ACCESSORY) | TK2432 | ORDER BY DESC |
| -4 | 200-2264-00 | | | 1 | CAP,FUSEHOLDER:3AG FUSES, (AMERICAN) | S3629 | FEK 031 1666 |
| | 200-2265-00 | | | 1 | CAP,FUSEHOLDER:5 X 20MM FUSES, (EUROPEAN) | S3629 | FEK 031.1663 |
| -5 | 159-0013-00 | | | 1 | FUSE,CARTRIDGE:3AG,6A,250V,FAST BLOW (AMERICAN) | 75915 | 312006 |
| | 159-0210-00 | | | 1 | FUSE,CARTRIDGE:DIN 5 X 20MM,5AMP,250V (EUROPEAN) | S3629 | TYPE FST 034-31 |
| -6 | 367-0247-01 | | | 1 | HANDLE,CARRYING:11.54 L,W/CLIP | 80009 | 367024701 |
| -7 | 200-2191-00 | | | 2 | CAP,RETAINER:PLASTIC | 0JR05 | ORDER BY DESC |
| -8 | 348-1110-00 | | | 4 | FOOT,CABINET:FRONT | TK1163 | ORDER BY DESC |
| -9 | 348-1254-00 | | | 4 | PAD,FOOT:TEK BLUE,SANTOPREME | TK1163 | ORDER BY DESC |
| -10 | 348-0875-00 | | | 1 | FLIPSTAND,CAB.: | TK0488 | ORDER BY DESC |
| -11 | 348-1109-01 | | | 2 | GASKET,SHIELD:348-1109-00 CUT 45.0 L | 80009 | 348110901 |
| -12 | 200-3696-00 | | | 1 | COVER,FRONT:PLASTIC (STANDARD ACCESSORY) | TK1163 | ORDER BY DESC |
| -13 | 386-5954-00 | | | 1 | PANEL,INPUT:PLASTIC,ATTENUATOR | 80009 | 386595400 |
| -14 | 366-2112-00 | | | 2 | KNOB:LARGE,FLUTED | TK1163 | ORDER BY DESC |
| -15 | 366-2111-00 | | | 3 | KNOB:SMALL,FLUTED | TK1163 | ORDER BY DESC |
| -16 | 366-2114-00 | | | 1 | KNOB:LARGE,DETENTED | TK1163 | ORDER BY DESC |
| -17 | 101-0127-00 | | | 1 | TRIM,DECORATIVE:FRONT | TK1163 | ORDER BY DESC |
| | 334-7965-00 | | | 1 | MARKER,IDENT:MKD TDS640 | 76814 | ORDER BY DESC |
| -18 | 650-2298-00 | | | 1 | REPLACABLE ASSY:FRAME DISPLAY | 80009 | 650229800 |
| -19 | 378-0366-00 | | | 1 | FILTER,LT,CRT:6.75X5.50,DARK GRAY | 11536 | ORDER BY DESC |
| -20 | 386-6211-00 | | | 1 | RETAINER,FILTER:5 X 6,PLASTIC | TK1163 | ORDER BY DESC |
| -21 | 671-1701-01 | | | 1 | CIRCUIT BD ASSY:FIRMFACE | 80009 | 671170101 |
| -22 | 214-4287-00 | | | 1 | ACTUATOR:ELASTOMER MAT,FRONT PANEL | TK0IK | ORDER BY DESC |
| -23 | 614-0897-00 | | | 1 | FRONT PNL ASSY: | 80009 | 614089700 |

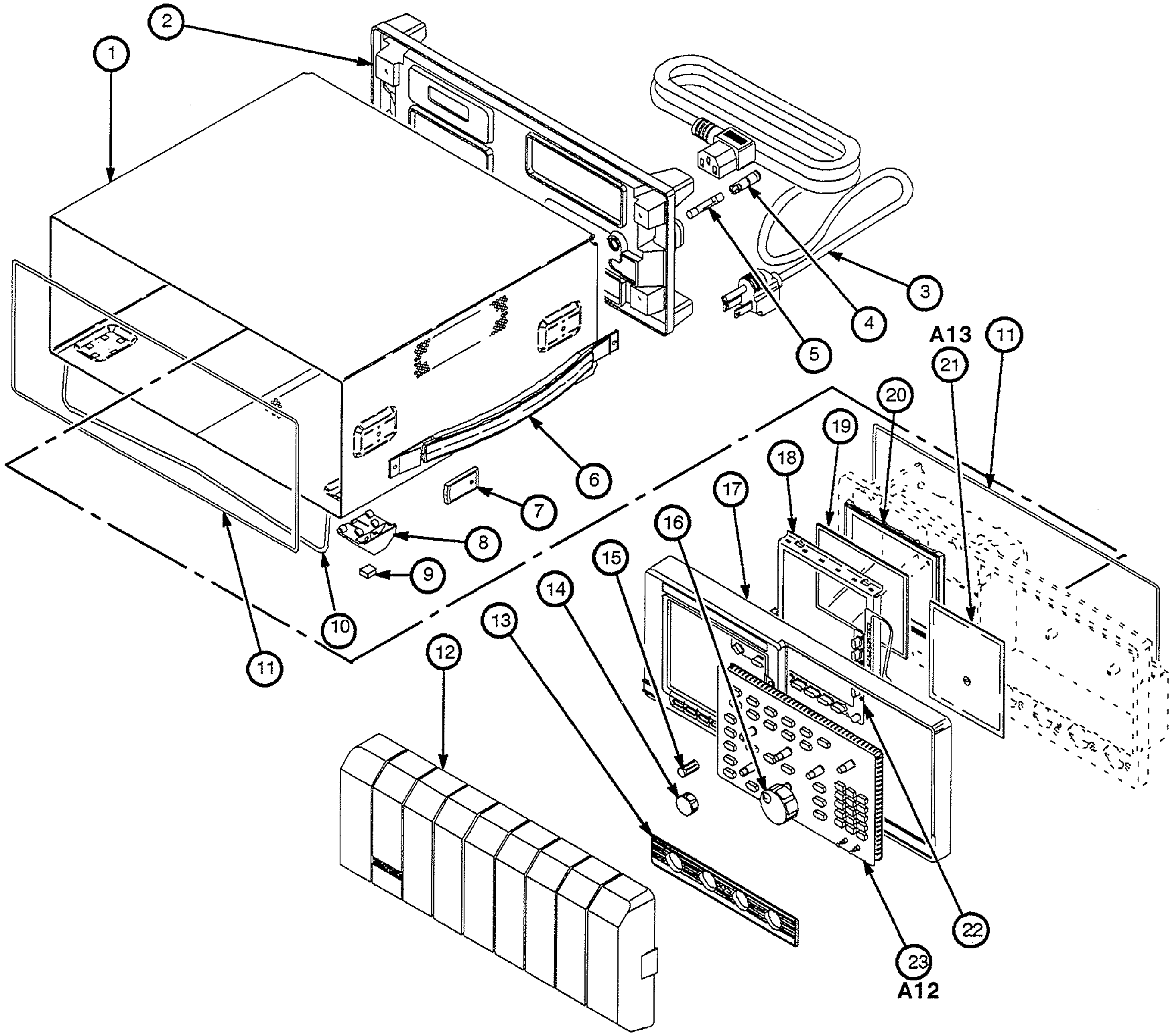


**Figure 10-1: External Modules**

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 2-1 | 119-3413-00 | | | 1 | FAN,TUBEAXIAL:48 VDC,22W,3350RPM,235 CFM | TK2230 | 032150 |
| -2 | 671-2002-01 | | | 1 | CIRCUIT BD ASSY:PROCESSOR DISPLAY | 80009 | 671200201 |
| -3 | 441-1902-00 | | | 1 | CHASSIS,SCOPE:REAR | 0J9P9 | ORDER BY DESC |
| -4 | 211-0730-00 | | | 2 | SCR,ASSEM WSHR:6-32 X 0.375,PNH,STL,T15 | 0KB01 | ORDER BY DESC |
| -5 | 103-0269-00 | | | 2 | ADAPTER,CONN:SMA TO PELTOLA | 24931 | 39JR198-1 |
| -6 | 210-0465-00 | | | 1 | NUT,PLAIN,HEX:0.25-32 X 0.375,BRS | 0KB01 | ORDER BY DESC |
| -7 | 334-7966-01 | | | 1 | MARKER,IDENT:MKD BNC | 80009 | 334796601 |
| -8 | 407-3825-00 | | | 2 | BRACKET,CKT BD:PLASTIC,REAR | TK1163 | ORDER BY DESC |
| -9 | 386-5872-00 | | | 1 | PLATE,REAR:ALUMINUM,STD | 0J9P9 | ORDER BY DESC |
| -10 | 211-0730-00 | | | 2 | SCR,ASSEM WSHR:6-32 X 0.375,PNH,STL,T15 | 0KB01 | ORDER BY DESC |
| -11 | 671-1568-00 | | | 1 | CIRCUIT BD ASSY:D1 BUS; | 80009 | 671156800 |
| -12 | 671-2109-00 | | | 1 | CIRCUIT BD ASSY:EVE ACQUISITION | 80009 | 671210900 |
| -13 | 346-0266-00 | | | 1 | STRAP,CABLE:PLASTIC | 80009 | 346026600 |
| -14 | 174-1519-00 | | | 2 | CA ASSY,SP,ELEC:2 X 20,0.1 X 0.1,28 AWG | TK1899 | ORDER BY DESC |
| -15 | 337-3816-00 | | | 1 | SHIELD,ELEC:RAM,ALUMINUM | 80009 | 337381600 |
| -16 | 119-4092-01 | | | 1 | ATTENUATOR:FOUR CHANNEL ATTEN | 80009 | 119409201 |
| -17 | 407-3878-00 | | | 2 | BRACKET,CKT BD:PLASTIC | TK1163 | ORDER BY DESC |
| -18 | 407-3877-00 | | | 2 | BRACKET,CKT BD:PLASTIC | TK1163 | ORDER BY DESC |
| -19 | 441-1901-00 | | | 1 | CHASSIS,SCOPE:TOP | 0J9P9 | ORDER BY DESC |
| | 174-1524-00 | | | 1 | CA ASSY,SP,ELEC:26/24 PIN,GPIB (A11J35 TO BACK PANEL) | TK2469 | ORDER BY DESC |
| | 174-1525-00 | | | 1 | CA ASSY,SP,ELEC:2 X 8-13,28 AWG (A11J2 TO FRONT PANEL) | TK2469 | ORDER BY DESC |
| | 175-2929-00 | | | 1 | CABLE ASSY,RF:50 OHM COAX,18.0 L,9-6 (A10J1201 TO CH3 OUTPUT) | 80009 | 175292900 |
| | 175-8029-00 | | | 1 | CABLE ASSY,RF:50 OHM COAX,12.0 L,9-2 (A10J1550 TO AUX TRIG INPUT) | 80009 | 175802900 |
| | 174-2031-00 | | | 1 | CABLE ASSY,RF:50 OHM COAX,6.5 L (A10J1000 TO MAIN TRIG OUTPUT) (A10J1001 TO DELAYED TRIG OUTPUT) | TK2338 | 174-2031-00 |

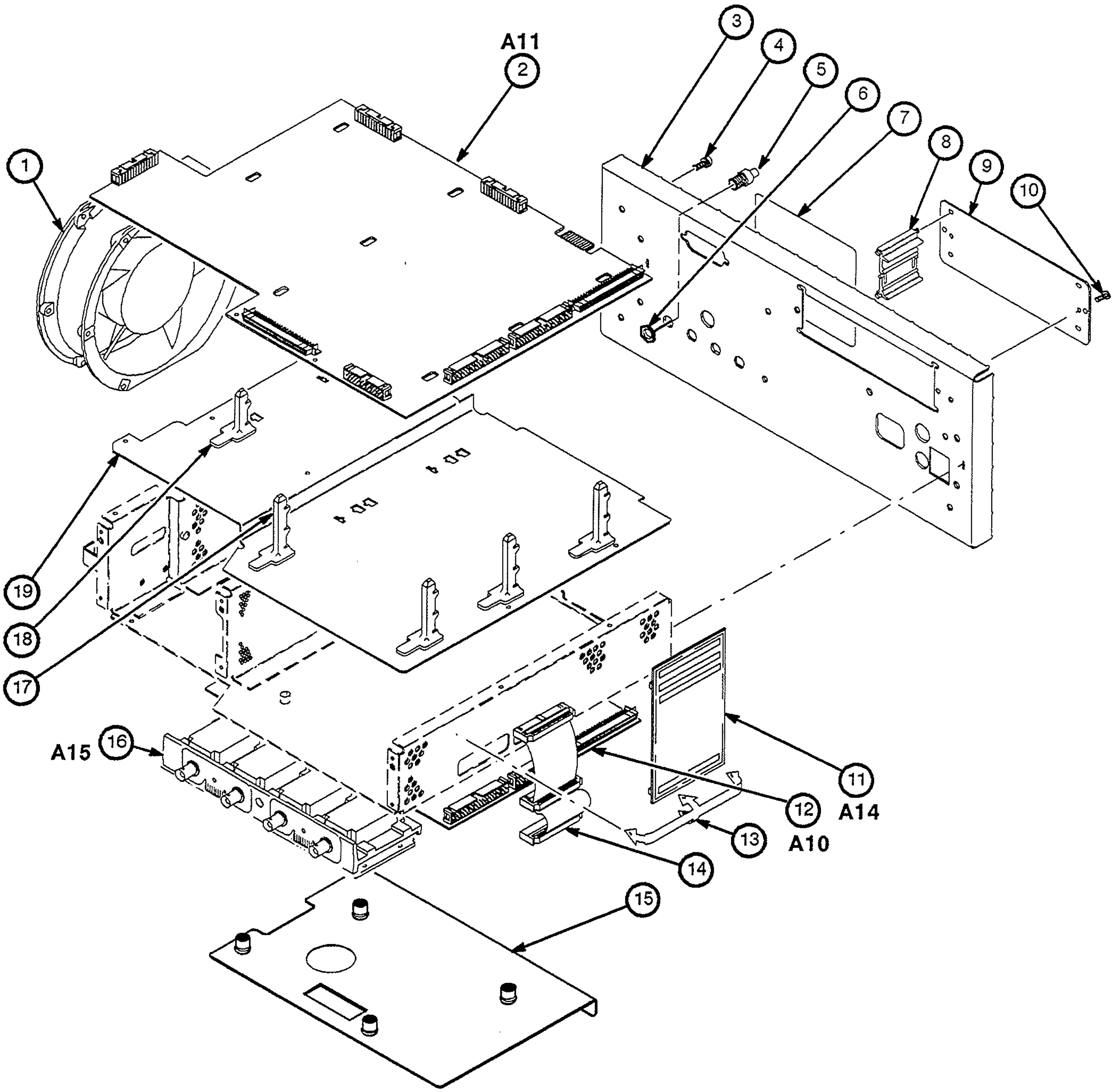


Figure 10-2: Outer-Chassis Modules

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| 3-1 | 640-0071-00 | | | 1 | DISPLAY,MONOCHR:7 INCH | 80009 | 640007100 |
| -2 | 119-4415-00 | | | 1 | POWER SUPPLY:SWITCHING,300W,MULT OUT | 80009 | 119441500 |
| -3 | 441-1900-00 | | | 1 | CHASSIS,SCOPE:MAIN | 0J9P9 | ORDER BY DESC |
| -4 | 386-5871-00 | | | 1 | SUBPANEL,FRONT:ALUMINUM | TK2465 | 386-5871-00 |

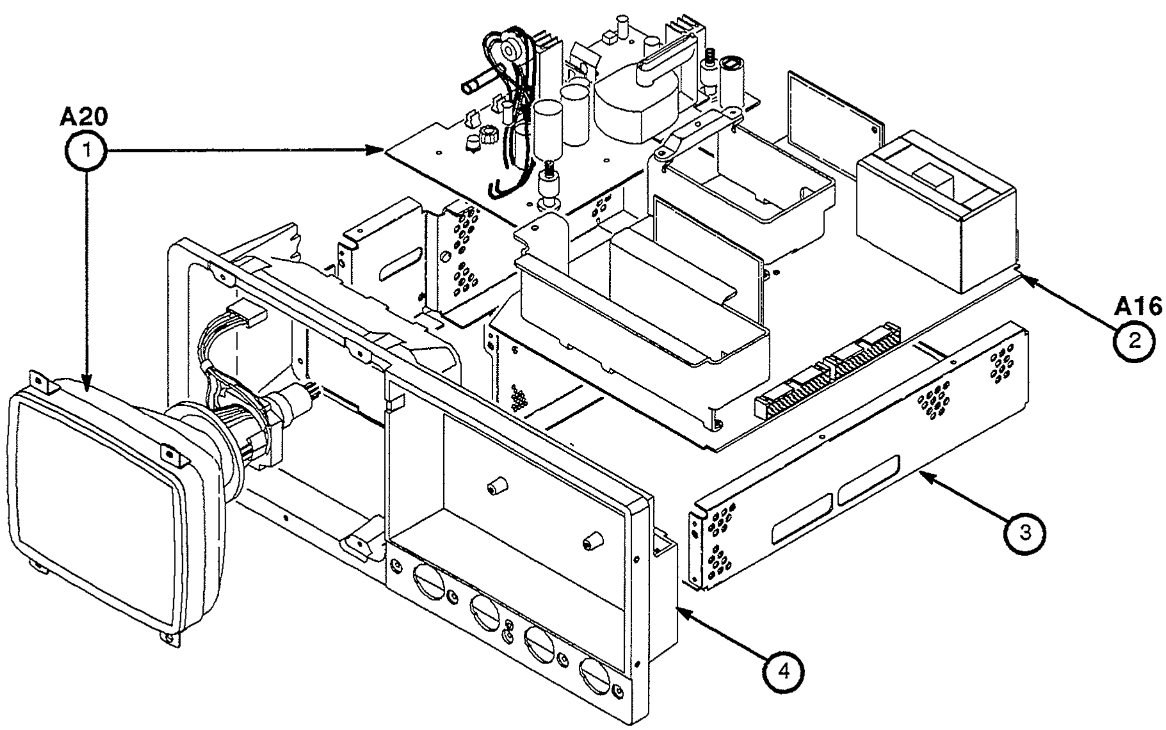


Figure 10-3: Inner-Chassis Modules

| Fig. & Index No. | Tektronix Part No. | Serial No. Effective | Dscont | Qty | 12345 Name & Description | Mfr. Code | Mfr. Part No. |
|---|---|---|---|---|---|---|---|
| | | | | | **STANDARD ACCESSORIES** | | |
| | ----------- | | | | ACCESSORY PKG:FOUR,P6205,10X,750MHZ | | |
| | 070-8505-00 | | | 1 | MANUAL,TECH:REFERENCE,TDS620/TDS640 | 80009 | 070850500 |
| | 070-8506-00 | | | 1 | MANUAL,TECH:USER,TDS620/TDS640 | 80009 | 070850600 |
| | 070-8318-02 | | | 1 | MANUAL,TECH:PRGM,TDS400/500/600 FAMILY | 80009 | 070831802 |
| | 070-8202-00 | | | 1 | MANUAL,TECH:P6205 | 80009 | 070820200 |
| | | | | | **OPTIONAL ACCESSORIES** | | |
| | 012-0991-00 | | | 1 | CABLE,COMPOSITE:IDC,GPIB:2M,24 COND | 00779 | 553577-3 |
| | 012-0991-01 | | | 1 | CABLE,GPIB:LOW EMI,1 METER | 00779 | 553577-2 |
| | 016-0909-01 | | | 1 | CASE,CARRYING:SOFTSIDED FOR 3002C | TK2162 | 0587 |
| | 016-1135-00 | | | 1 | CASE,CARRYING:26 X 22 X 15,HARD TRANSFER | 80009 | 016113500 |
| | 016-1136-00 | | | 1 | MOUNTING KIT:RACK MOUNT KIT,TDS500 | 80009 | 016113600 |
| | 016-1154-00 | | | 1 | HOOD ASSEMBLY:2KDSO | 80009 | 016115400 |
| | 070-8508-00 | | | 1 | MANUAL,TECH:SERVICE,TDS640 | 80009 | 070850800 |

# Index

Replace this page with the tab divider of the same name.

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