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Service Manual

Tektronix

TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscope

070–8713–03

Warning
The servicing instructions are for use by qualified 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 performing service.

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:

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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

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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 Oscilloscopes. 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 520A, 524A, 540A, & 544A 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 520A, 524A, 540A, & 544A 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 Oscilloscopes

The TDS 520A, 524A, 540A, & 544A are 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 520A, 524A, 540A, & 544A.

Without the protective ground connection, all parts of the TDS 520A, 524A, 540A, & 544A 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 520A, 524A, 540A, & 544A without the panels or covers.

Do Not Operate in Explosive Atmospheres

The TDS 520A, 524A, 540A, & 544A provide no explosion protection from static discharges or arcing components. Do not operate the TDS 520A, 524A, 540A, & 544A in an atmosphere of explosive gasses.

Electric Overload

Never apply a voltage to a connector on the TDS 520A, 524A, 540A, & 544A that is outside the range specified for that connector.

Replace this page with the Tab named Specifications

Specifications

This subsection begins with a general description of the traits of the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. Three subsections follow, one for each of three classes of traits: *nominal traits, warranted characteristics,* and *typical characteristics*.

General Product Description

The Tektronix TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes are portable, four-channel instruments suitable for use in a variety of test and measurement applications and systems. Key features include:

- 500 MHz maximum analog bandwidth.
- 1 Gigasample/second maximum digitizing rate (TDS 540A and 544A); 500 Megasamples/second maximum digitizing rate (TDS 520A and 524A).
- Four-channel acquisition — the TDS 540A and 544A offer four full-featured channels; the TDS 520A and 524A offer two full-featured channels and two channels with limited vertical scale selections: 100 mV, 1 V, and 10 V.
- Extensive triggering capabilities: such as edge, logic, and glitch. Video trigger (Option 05) is also available. The video trigger modes are NTSC, PAL, SECAM, HDTV, and FlexFormat™ (user definable format).
- Waveform Math — Invert a single waveform and add, subtract, and multiply two waveforms. On the TDS 524A, 544A, and other TDS 500A equipped with option 2F, integrate or differentiate a single waveform or perform an FFT (fast fourier transform) on a waveform to display its magnitude or phase versus its frequency.
- Eight-bit digitizers.
- Up to 15,000-point record length per channel (50,000-point with option 1M).
- Full GPIB software programmability. Hardcopy output using GPIB, RS-232, or Centronics ports (RS-232 and Centronics is standard on the TDS 524A and 544A and optional, as option 13, on the TDS 520A and 540A).
- Complete measurement and documentation capability.
- Intuitive graphic icon operation blended with the familiarity of traditional horizontal and vertical knobs.
- On-line help at the touch of a button.
- A full complement of advanced functions, like continuously-updated measurements, results and local pass/fail decision making.

- Specialized display modes, such as variable persistence (with color coding on the TDS 524A and 544A), dot or vector mode, sin(x)/x or linear display filters, and, on the TDS 524A and 544A, user selectable color palettes. The “Fit to Screen” feature compresses the entire waveform record to fit on the screen.
- A complement of advanced acquisition modes such as peak-detect, high-resolution, sample, envelope, and average. The FastFrame™ feature acquires waveforms in rapid succession with a minimum of dead time between acquisitions. FastFrame™ allows acquisition rates of up to 50,000 frames per second.
- 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.
- VGA output for driving remote monitors.
- A 1.44 Mbyte, DOS 3.3 or later, floppy disk drive for saving waveforms, color images, and oscilloscope setups (standard on the TDS 524A and 544A and optional, as option 1F, on the TDS 520A and 540A). Also, all TDS 500A have built-in NVRAM storage for saving waveforms and setups.
- On the 524A and 544A, a color display for distinguishing among waveforms, their measurements, and associated text.

User Interface

Use a combination of front-panel buttons, knobs, and on-screen menus to control the many functions of these oscilloscopes. The front-panel controls are grouped according to function: vertical, horizontal, trigger, and special. Set a function you adjust often, such as vertical positioning or the time base setting, directly by its own front-panel knob. Set functions which you change less often, such as vertical coupling and horizontal mode, indirectly using selected menus.

Menus

Pressing one (sometimes two) front-panel button(s), such as vertical menu, displays a *main* menu of related functions, such as coupling, bandwidth, etc., at the bottom of the screen. Pressing a main-menu button, 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. Pressing a side-menu button selects a setting such as DC.

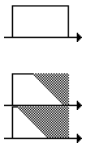
Indicators

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

General Purpose Knob

Assign the general purpose knob to adjust a selected parameter function. More quickly change parameters by toggling the **SHIFT** button. Use the same method as for *selecting* a function, except the final side-menu selection assigns the general purpose knob to *adjust* some function, such as the position of measurement cursors on screen, or the setting for a channels 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

TDS 540A and 544A: The signal acquisition system provides four 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 TDS 540A and 544A 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.

TDS 520A and 524A: The signal acquisition system provides four vertical channels. Two are full-featured vertical channels (CH1 and CH2) with calibrated vertical scale factors from 1 mV to 10 V per division. The other two are auxiliary channels (AUX1 and AUX2) with three calibrated deflection factors of 100 mV, 1 V, and 10 V per division. Any two of the four channels can be acquired simultaneously.

Each of the four TDS 520A and 524A channels can be displayed, vertically positioned, and offset. CH1 and CH2 can also have their bandwidth limited (100 MHz or 20 MHz), their vertical coupling specified, and fine gain adjusted.

On all TDS 520A, 524A, 540A, & 544A: Besides the four channels, up to three math waveforms and four reference waveforms are available for display. (A math waveform results when dual waveform operations, such as add, are specified 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.

A feature called “Fit to Screen” allows the user to view entire waveform records within the 10 division screen area. In other words, waveforms are compressed to fit on the screen. The exception is that, with Option 1M, 50,000 point records are displayed over a 15 division time span. (see Table 1-1)

Table 1-1: Record Length vs. Divisions per Record, Samples Per Division, and Sec/Div Sequence

Record Length	Divisions per Records	
	Samples/Division (Sec/Div Sequence)	
	Fit to Screen OFF 50 (1–2–5)	Fit to Screen ON 50 (1–2–5)
50000[1]	1000 divisions	10 divisions
15000[2]	300 divisions	15 divisions
5000	100 divisions	10 divisions
2500	50 divisions	10 divisions
1000	20 divisions	10 divisions
500	10 divisions	10 divisions

1 The 50,000 samples in 1,000 division record is only available with Option 1M.

2 The maximum record length of 15,000 samples (50,000 samples with Option 1M) is selectable with all acquisition modes except Hi Res. In Hi Res, the maximum record length is 5,000 samples (15,000 samples with Option 1M).

FastFrame™ allows multiple triggered acquisitions to occur with a minimum of “dead time” between acquisitions. A maximum of 910 acquisition sequences (frames) are possible with 50 points per record (frame length) when a 50,000 point waveform record length is available (with option 1M).

You can delay by time with respect to the main trigger both the delayed display and the intensified zone on the main intensified display. You can set them 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).

You can also delay by a selected number of events the delayed display (or the intensified zone). In this 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 supports a varied set of features for triggering the signal-acquisition system. Trigger signals recognized include:

- **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-qualified logic triggering can also be specified.
- **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.
- **Video** (with option 05: Video Trigger): Video triggering is compatible with standard NTSC, PAL, SECAM, and HDTV formats. An additional feature called FlexFormat™ (flexible format) allows the user to define the video format on which to trigger.

You can choose where the trigger point is located within the acquired waveform record by selecting the amount of pretrigger data displayed. Select presets of 10%, 50%, and 90% of pretrigger data in the horizontal menu, or assign the general purpose knob to set pretrigger data to any value within the limits of trigger position resolution.

Acquisition Control

You can specify a mode and manner to acquire and process signals.

- Select equivalent-time sampling on repetitive signals or interpolation of points sampled on non-repetitive signals. Both can increase apparent sample rate on the waveform when maximum real-time rates are reached. The apparent sample rate can be increased, even further, by using the FastFrame™ feature. Acquisition rates of 50,000 Frames/Second are possible using FastFrame™.
- Use peak-detect, high-resolution, sample, envelope, and average modes can be used to acquire signals.
- Set the acquisition to stop after a single acquisition (or sequence of acquisitions if acquiring in average or envelope modes).
- Select channel sources for compliance with limit tests. You can direct the TDS to signal you or generate hard copy output based on the results. Also, you can create templates for use in limit tests.

On-Board User Assistance

Help and autoset can assist you in setting up the Digitizing Oscilloscope to make your measurements.

Help

Help displays operational information about any front-panel control. When help mode is in effect, manipulating any front-panel control causes the 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 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).

When the video trigger option installed (Option 05), the video line number can be selected using the vertical cursors. IRE amplitude (NTSC) can be measured using the horizontal cursors with or without the video trigger option installed.

Measure

Measure can automatically extract parameters from the signal input to the Digitizing Oscilloscopes. Any four out of the more than 20 parameters available can be displayed to the screen. The waveform parameters are measured continuously with the results updated on-screen as the Digitizing Oscilloscopes continues to acquire waveforms.

Digital Signal Processing (DSP)

An important component of the multiprocessor architecture of this Digitizing Oscilloscopes 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 or, if available, on a 3.5 inch, DOS 3.3-or-later compatible disk. The disk is standard on the TDS 524A and 544A. It is available as option 1F on the 520A and 540A. 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 Oscilloscopes 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 Oscilloscopes 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 Oscilloscopes front panel, providing hard copies without requiring you to put the Digitizing Oscilloscopes into a system-controller environment. You can make hardcopies in a variety of popular output formats, such as PCX, TIFF, BMP, RLE, EPS, Interleaf, and EPS mono or color. You can also save hardcopies in a disk file in any of the formats above. The hardcopies obtained are based on what is displayed on-screen at the time hardcopy is invoked. The hardcopies can be stamped with date and time and spooled to a queue for printing at a later time. You can output screen information via GPIB, RS-232C, or Centronics interfaces.

Display

The TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes offer flexible display options. You can customize the following attributes of your display:

- Color: Waveforms, readouts, graticule, etc. on the TDS 524A and 544A;
- Intensity: waveforms, readouts, and graticule;
- Style of waveform display(s): vectors or dots, intensified or non-intensified samples, infinite persistence, and variable persistence with color coding;
- Interpolation method: Sin(x)/x or Linear;
- Display format: xy or yt with various graticule selections including NTSC and PAL to be used with video trigger.

Zoom

This Digitizing Oscilloscopes 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 tables that list the electrical and mechanical *nominal traits* that describe the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

Nominal traits are described using simple statements of fact such as “Four, all 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)	
Digitizers, Number of	TDS 540A and 544A: Four, all identical TDS 520A and 524A: Two, both identical	
Digitized Bits, Number of	8 bits[1]	
Input Channels, Number of	TDS 540A and 544A: Four, all identical, called CH1 – CH4 TDS 520A and 524A: Two full-featured (CH1 and CH2), plus two limited, auxiliary inputs (AUX1 and AUX2)	
Input Coupling[2]	DC, AC, or GND	
Input Impedance Selections	1 MΩ or 50 Ω	
Ranges, Offset, TDS 540A, 544A, and CH1 and CH2 on TDS 520A and 524A	**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
Ranges, Offset, AUX1 and AUX2 on TDS 520A and 524A	**Volts/Div Setting**	**Offset Range**
	100 mV/div	±0.5 V
	1 V/div	±5.0 V
	10 V/div	±50 V
Range, Position	±5 divisions	
Range, Sensitivity	TDS 540A and 544A: 1 mV/div to 10 V/div[3] TDS 520A and 524A: CH1 and CH2: 1 mV/div to 10 V/div[3] TDS 520A and 524A: AUX1 and AUX2: 100 mV/div, 1 V/div, 10 V/div	

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 both full-featured and auxiliary inputs 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] TDS 540A, 544A	**Number of Channels On**	**Sample-Rate Range**
	1	5 Samples/s − 1 GSamples/s
	2	5 Samples/s − 500 MSamples/s
	3 or 4	5 Samples/s − 250 MSamples/s
Range, Sample-Rate[1,3] TDS 520A, 524A	**Number of Channels On**	**Sample-Rate Range**
	1	5 Samples/s − 500 MSamples/s
	2	5 Samples/s − 250 MSamples/s
Range, Equivalent Time or Interpolated Waveform Rate[2,3]	500 MSamples/s to 100 GSamples/s	
Range, Seconds/Division	500 ps/div to 10 s/div	
Record Length[4]	500 samples, 1000 samples, 2500 samples, 5000 samples, 15000 samples. A record length of 50000 samples is available with Option 1M. Up to four 50 K waveform records may be saved in NVRAM with Option 1M installed.	
FastFrame™	Maximum Frame Rate: 50,000 Frames/Second Frame Length Range: 50 points/Frame to 5,000 Points/Frame Maximum Number of Frames: 910 Frames at 50 Points/Frame (with Option 1M, 50,000 Record Length) 227 Frames at 50 Points/Frame (standard configuration of 15,000 Record Length)	

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 equivalent time or 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 or by equivalent-time sampling of multiple acquisitions, the waveform rate is faster than the real time sample rate. For all three 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.

4 The maximum record length of 15,000 samples (50,000 samples with Option 1M) is selectable with all acquisition modes except Hi Res. In Hi Res, the maximum record length is 5,000 samples (15,000 samples with Option 1M).

Table 1-4: Nominal Traits — Triggering System

Name	Description	
Range, Delayed Trigger Time Delay	16 ns to 250 s	
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 (TDS 540A & 544A only)	±4 V
	Line	±300 V
Video Trigger Modes of Operation (Option 05 Video Trigger)	Supports the following video standards: ■ NTSC (525/60) − 2 field mono or 8 field ■ PAL (625/50) − 2 field mono, 8 field ■ SECAM ■ HDTV − (787.5/60) (1050.60) (1125/60) (1250/60) ■ FlexFormat™ (user definable standards) User can specify: field rate, number of lines, sync pulse width and polarity, line rate, and vertical interval timing.	

Table 1-5: Nominal Traits — Display System

Name	Description
Video Display	7 inch diagonal, with a display area of 5.04 inches horizontally by 3.78 inches vertically
Video Display Resolution	640 pixels horizontally by 480 pixels vertically
Waveform Display Graticule	Single Graticule: 401 × 501 pixels, 8 × 10 divisions, where divisions are 1 cm by 1 cm
Waveform Display Colors/Grey Scale	TDS 524A and 544A: Sixteen colors in infinite-persistence or variable persistence display with color coding. TDS 520A and 540A: Sixteen levels in infinite-persistence and variable persistence display styles.

Table 1-6: Nominal Traits — Interfaces, Output Ports, and Power Fuse

Name	Description
Interface, GPIB	GPIB interface complies with IEEE Std 488−1987
Interface, RS-232	RS-232 interface complies with EIA/TIA 574 (talk only) (optional, as option 13, on TDS 520A and 540A)
Interface, Centronics	Centronics interface complies with Centronics interface standard C332-44 Feb 1977, REV A (optional, as option 13, on TDS 520A and 540A)
Interface, Video	VGA video output with levels that comply with ANSI R5343A standard. DB-15 connector.
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 TDS 524A and 544A Digitizing Oscilloscopes 13.7 kg (30 lbs), with front cover. 25.1 kg (55 lbs), when packaged for domestic shipment. Standard TDS 520A and 540A Digitizing Oscilloscopes 12.3 kg (27 lbs), with front cover. 20.0 kg (44 lbs), when packaged for domestic shipment. Rackmount TDS 524A and 544A Digitizing Oscilloscopes 13.7 kg (30 lbs) plus weight of rackmount parts, for the rackmounted Digitizing Oscilloscopes (Option 1R). Rackmount TDS 520A and 540A Digitizing Oscilloscopes 12.3 kg (27 lbs) plus weight of rackmount parts, for the rackmounted Digitizing Oscilloscopes (Option 1R). Rackmount conversion kit 2.3 kg (5 lbs), parts only; 3.6 kg (8 lbs), parts plus package for domestic shipping.
Overall Dimensions	Standard Digitizing Oscilloscopes Height: 193 mm (7.6 in), with the feet installed. Width: 445 mm (17.5 in), with handle. Depth: 434 mm (17.1 in), with front cover installed. Rackmount Digitizing Oscilloscopes Height: 178 mm (7.0 in). Width: 483 mm (19.0 in). Depth: 558.8 mm (22.0 in).

Warranted Characteristics

This subsection lists the electrical and environmental *warranted characteristics* that describe the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

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 1-21.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the scope 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 +4° C and +50° C (unless otherwise noted).

Table 1-8: Warranted Characteristics — Signal Acquisition System

Name	Description	
Accuracy, DC Gain	±1% (For all sensitivities from 1 mV/div to 10 V/div with offsets from 0 V to ±100 V.)	
Accuracy, Offset **TDS 540A and 544A (all channels),** **TDS 520A and 524A (CH1 and CH2)**	**Volts/Div Setting**	**Offset Accuracy**
	1 mV/div − 99.5 mV/div	±(0.2% × Net Offset[1] + 1.5 mV + 0.1 div × volts/div setting)
	100 mV/div − 995 mV/div	±(0.35% × Net Offset[1] + 15 mV + 0.1 div × volts/div setting)
	1 V/div − 10 V/div	±(0.35% × Net Offset[1] + 150 mV + 0.1 div × volts/div setting)
Accuracy, Offset **TDS 520A and 524A** **(AUX1 and AUX2)**		**Offset Accuracy** ±(1% × Net Offset[1] + 0.1 div × volts/div setting)

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

Name	Description	
Analog Bandwidth, DC-50 Ω Coupled or DC-1 MΩ Coupled	**Volts/Div**	**Bandwidth[4]**
	5 mV/div – 10 V/div	DC – 500 MHz
	2 mV/div – 4.98 mV/div	DC – 350 MHz
	1 mV/div – 1.99 mV/div	DC – 250 MHz
Cross Talk (Channel Isolation)	≥100:1 at 100 MHz and ≥30:1 at the derated bandwidth for any two channels having equal volts/division 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 ≤ ±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 × Volts/Div). Net Offset is the nominal voltage level at the center of the A-D converter 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 oscilloscope at a Volts/Div setting ≤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	±25 ppm over any ≥1 ms interval

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% of setting + 0.5 ns)	
	1.02 µs to 1 s	±(100 ns + .0025% of setting)	
Sensitivity, Edge-Type Trigger, DC Coupled[1]	**Trigger Source**	**Sensitivity**	
	TDS 540A, 544A (CH1 − CH4) TDS 520A, 524A (CH1, CH2)	0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz	
	TDS 520A, 524A (AUX1, AUX2)	0.55 division from DC to 50 MHz, increasing to 1.5 division at 500 MHz	
	Auxiliary (TDS 540A, 544A only)	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
Jitter (Option 05 Video Trigger)	17 ns_{p-p} on HDTV signal; 60 ns_{p-p} on NTSC or PAL signal		
Input Signal Sync Amplitude for Stable Triggering (Option 05 Video Trigger)	0.6 division to 4 division (1 division to 4 divisions in Numerical Field)		

[1] **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 — Interfaces, Output Ports 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**
	Output Voltage	0.5 V (base-top) ±1% into a ≥50 Ω load
	Frequency	1 kHz ±5%
Output Voltage, Channel 3 Signal Out	20 mV/division ±10% into a 1 MΩ load; 10 mV/division ±10% 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)	

Table 1-12: Warranted Characteristics — Environmental, Safety, and Reliability

Name	Description
Atmospherics	Temperature with floppy disk (optional on TDS 520A and 540A): Operating: +4° C to +50° C; Non-operating: −22° C to +60° C Temperature without floppy disk: Operating: 0° C to +50° C; Non-operating: −40° C to +60° C Relative humidity with floppy disk (optional on TDS 520A and 540A): Operating: To 80%, at or below +29° C; Operating: To 20%, at or below +50° C Non-operating: To 90%, at or below +40° C; Non-operating: To 5%, at or below +50° C Relative humidity without floppy disk: Operating: To 95%, at or below +40° C; Operating: To 75%, from +41° C to +55° C Altitude: To 4570 m (15,000 ft.), operating; To 12190 m (40,000 ft.), non-operating
Dynamics	Random vibration without floppy disk installed: 0.31 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, operating; 3.07 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, non-operating
Emissions	Meets or exceeds the requirements of the following standards: Vfg. 243/1991 Amended per Vfg. 46/1992 FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, 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 by the user

Typical Characteristics

The tables in this subsection list the *typical characteristics* that describe the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

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

Table 1-13: Typical Characteristics — Signal Acquisition System

Name	Description	
Accuracy, Delta Time Measurement	For single-shot acquisitions using single-shot sample acquisition modes.[1] Time Measurement Error ≤ .15* Si + (25 ppm × |Reading|) + (Time Per Div ÷ 1000) Add 50 ps (typical) Channel Skew for 2 channel measurements. Sample calculation: To measure the width of a 65.5 ns pulse at 1 GS/sec sampling, Time Measurement Error ≤ (0.15 × 1 ns) + (2.5×10^{-5})(65.5 ns) + (50 ns/div ÷ 1000) ≤ 0.15 ns + 0.002 ns + 0.05 ns ≤ 202 ps	
Delay Between Channels, Full Bandwidth, Equivalent Time	≤ 250 ps for any two channels with equal volts/division and coupling settings	
Frequency Limit, Upper, 100 MHz Bandwidth Limited	100 MHz	
Frequency Limit, Upper, 20 MHz Bandwidth Limited	20 MHz	
Calculated Rise Time[2]	**Volts/Div Setting**	**Rise Time**
	5 mV/div – 10 V/div	800 ps
	2 mV/div – 4.98 mV/div	1.2 ns
	1 mV/div – 1.99 mV/div	1.6 ns
Nonlinearity	< 1 DL, differential; ≤ 1 DL, integral, independently based	

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

Name	Description				
Step Response Settling Errors TDS 540A and 544A, all channels, TDS 520A and 524A, CH1, CH2 only	**Volts/Div Setting**	**Step Amplitude**	**Settling Error (%)[3]**		
			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

1 The limits are given for signals having pulse height ≥ 5 div, reference level = 50% mid-point, filter set to Sin (x) /x acquired at ≥ 5 mV/div, $1.4 \leq {}^{Tr}/_{Si} \leq 5$, where S_i is the hardware sample interval and t_r is the signal rise time.

2 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:

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

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 rise time (RT_m) is determined by the instrument rise time (RT_i) and the rise time of the test signal source (RTgen) according to the following formula:

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

3 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 — Time Base System

Name	Description
Aperture Uncertainty	≤5 ps

Table 1-15: Typical Characteristics — Triggering System

Name	Description	
Accuracy, Trigger Level or Threshold, DC Coupled	**Trigger Source**	**Accuracy[2]**
	Any Channel	±(2% of (Setting − Net Offset) + 0.3 div × volts/div setting + Offset Accuracy)
	Auxiliary (TDS 540A & 544A only)	±(6% of Setting + 8% of p-p signal + 100 mV)
Input, Auxiliary Trigger	The input resistance is ≥1.5 kΩ; the maximum safe input voltage is ±20 V (DC + peak AC).	
Trigger Marker Position, Edge Triggering	**Acquire Mode**	**Trigger-Position Marker[1,2]**
	Sample, Hi-Res, Average	±(1 WI + 1 ns)
	Peak Detect, Envelope	±(2 WI + 1 ns)
Holdoff, Variable, Main Trigger	Minimum: For any horizontal scale setting, the *minimum* holdoff is 10 times that setting, but is never less than 1 µs or longer than 5 s. Maximum: For any horizontal scale setting, the *maximum* holdoff is at least 2 times the minimum holdoff for that setting, but is never more than 10 times the minimum holdoff for that setting.	
Width, Minimum Pulse and Rearm, for Logic Triggering or Events Delay[3]	5 ns	
Lowest Frequency for Successful Operation of "Set Level to 50%" Function	30 Hz	
Sensitivity, Edge Trigger, Not DC Coupled[4]	**Trigger Coupling**	**Typical Signal Level for Stable Triggering**
	AC	Same as DC-coupled limits[5] for frequencies above 60 Hz. Attenuates signals below 60 Hz.
	Noise Reject	Three and one half times the DC-coupled limits.[5]
	High Frequency Reject	One and one half times the DC-coupled limits[5] from DC to 30 kHz. Attenuates signals above 30 kHz.
	Low Frequency Reject	One and one half times the DC-coupled limits[5] for frequencies above 80 kHz. Attenuates signals below 80 kHz.
Sensitivities, Logic-Type Trigger/Events Delay, DC Coupled[6]	1.0 division, from DC to 100 MHz with a minimum slew rate of 25 divisions/µs at the trigger level or the threshold crossing.	
Sensitivities, Pulse-Type Runt Trigger[6]	1.0 division, from DC to 200 MHz with a minimum slew rate of 25 divisions/µs at the trigger level or the threshold crossing.	

Table 1-15: Typical Characteristics — Triggering System (Cont.)

Name	Description
Sensitivities, Pulse-Type Trigger Width and Glitch[6]	1.0 division with a minimum slew rate of 25 div/µs at the trigger level or the threshold crossing. For <5 nsec pulse width or rearm time, 2 divisions are required.
Sensitivities, Derating Aux Channel Trigger (TDS 520A & 524A)	All trigger sensitivity specifications are derated by 50% for AUX 1 and AUX2 inputs.
Sync Width (Option 05 Video Trigger)	min. 400 ns for HDTV signals
Sync Duty Cycle (Option 05 Video Trigger)	min. 50 to 1
Hum Rejection (Option 05 Video Trigger)	NTSC and PAL: −20 dB without any trigger spec deterioration. Triggering will continue down to 0 dB with some performance deterioration.

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 ±0.5 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* and *Equivalent Time or Interpolated Waveform Rates* in Table 1-3 on page 1-10.

3 The minimum pulse width and rearm width required for logic-type triggering or events delaying to occur.

4 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.

5 See the characteristic *Sensitivity, Edge-Type Trigger, DC Coupled* in Table 1-10, which begins on page 1-17.

6 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.)

Table 1-16: Typical Characteristics — Data Handling

Name	Description
Time, Data-Retention, Nonvolatile Memory[1,2]	Battery life is ≥ 5 years
Floppy disk Standard on TDS 540A, 544A Option 1F on TDS 520A, 524A	3.5 inch, 720 K or 1.44 Mbyte, DOS 3.3-or-later compatible

1 The time 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.

Replace this page with the tab named Operating Information

Using This Manual

This section contains information needed to properly use this manual to service the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes, as well as general information critical to safe and effective servicing of these oscilloscopes.

Before Servicing

This manual is for servicing the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. 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



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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. (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, *Mechanical Parts List* To isolate a failure to a module, use the fault isolation procedures found in Section 6, *Maintenance.* 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 *Specifications 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.

- *Specifications* — contains a product description of the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes 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 Oscilloscopes 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 Oscilloscopes functions properly and meets warranted limits.
- *Adjustment Procedures* — contains a collection of procedures for adjusting this Digitizing Oscilloscopes to meet warranted limits.
- *Maintenance* — contains information and procedures for doing preventive and corrective maintenance of this Digitizing Oscilloscopes. 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.
- *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.
- *Mechanical 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 Oscilloscopes 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes to fit your requirements.

Option 9C — Each of the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes, when ordered with option 9C, is shipped with a *Certificate of Calibration and Test Data.* 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes come with the following manuals:

TDS 520A, 524A, 540A, & 544A User Manual contains a tutorial to quickly show you how to operate the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes and an in depth discussion of how to more completely use its features. Applications are also discussed.

TDS 520A, 524A, 540A, 544A, 620A, 640A, & 644A Reference contains a brief overview of oscilloscope operation.

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

Supplying Operating Power



Read all information and heed all warnings in this subsection before connecting the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes to a power source.

WARNING

AC POWER SOURCE AND CONNECTION. The TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes *operate 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 520A, 524A, 540A, or 544A 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 520A, 524A, 540A, & 544A 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 Figure 2-1 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

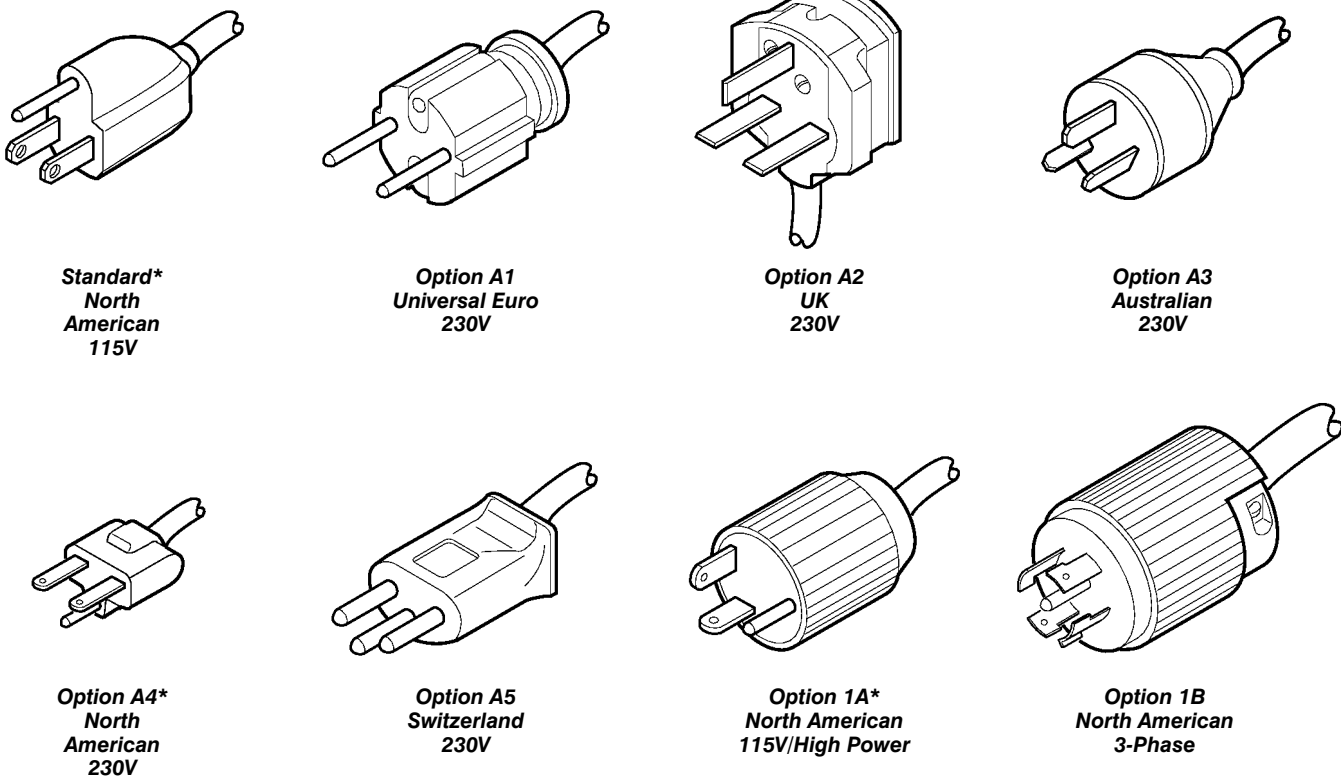
Operating Voltage

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 TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes 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.



Standard
North
American
115V

Option A1
Universal Euro
230V

Option A2
UK
230V

Option A3
Australian
230V

Option A4
North
American
230V

Option A5
Switzerland
230V

Option 1A
North American
115V/High Power

Option 1B
North American
3-Phase

** Canadian Standards Association certification*

includes these power plugs for use in the North American power network

Figure 2-1: Power-Cord Plug Identification

Operating Environment

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

Operating Temperature

The TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes can be operated where the ambient air temperature is between +4° (0° without the floppy disk) and +50° C and can be stored in ambient temperatures from −22° (−40° without the floppy disk) to +60° 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes are 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 3/4 inch on the bottom of the Digitizing Oscilloscopes. (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 Oscilloscopess power supply may temporarily shut down.

Applying and Interrupting Power

Consider the following information when you power up or power down 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 2-2. 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 2-2: 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 owners 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 2-1 (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

This subsection contains general operating instructions for the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. The complete operators 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 Section 4 *Performance Verification* contain instructions for making the front-panel settings required to check each instrument characteristic included there. Also, the general instructions for operating 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 2-2 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

Before doing service, read the following operating instructions. These instructions are at the level appropriate for servicing this Digitizing Oscilloscopes.

How to Power On

Push the principal power switch found on the rear panel of the Digitizing Oscilloscopes, then push the **ON**/**STBY** (standby) switch to toggle the Digitizing Oscilloscopes 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 Oscilloscopes are energized regardless of the setting of the* **ON**/**STBY** *switch.*

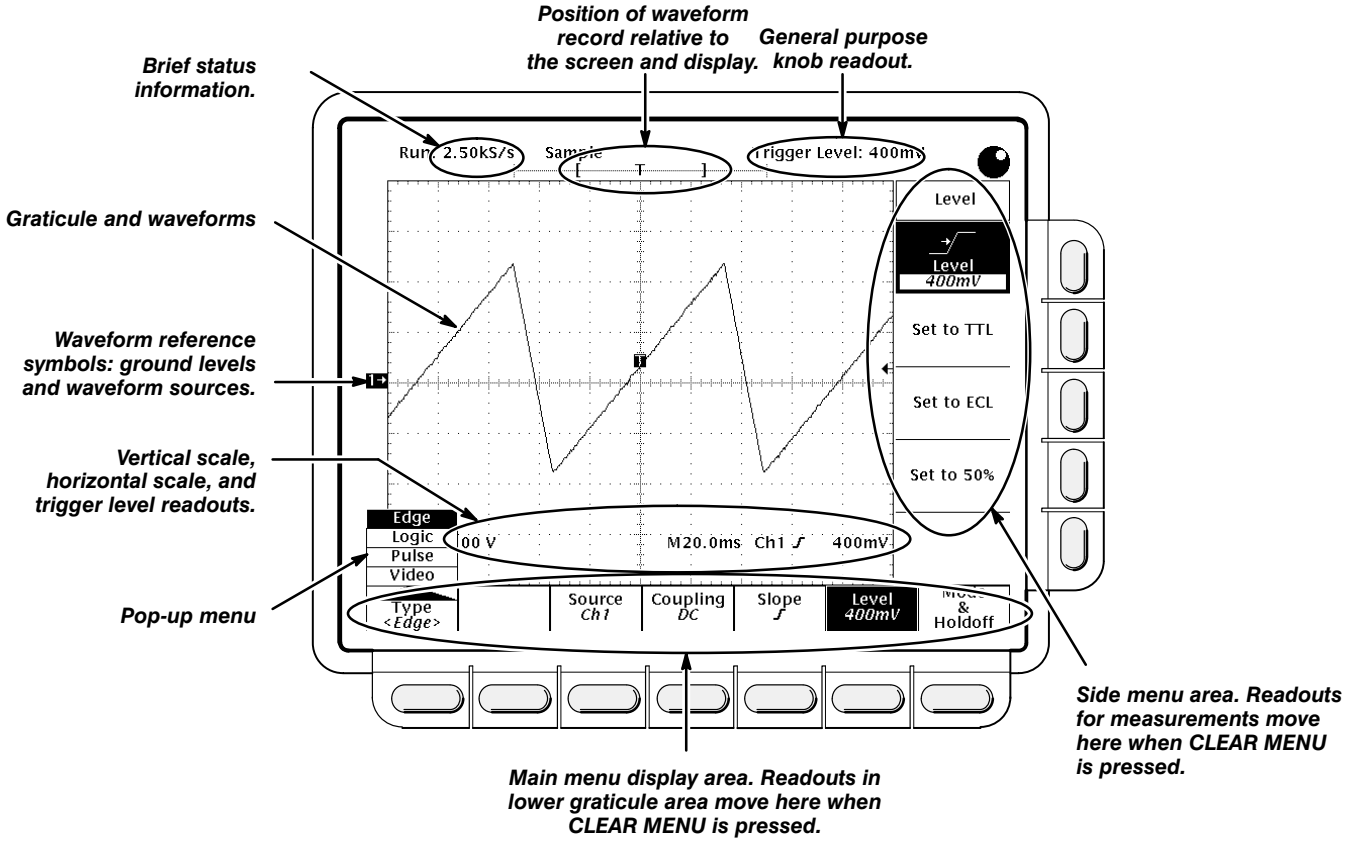


Figure 2-2: Map of Display Functions

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.

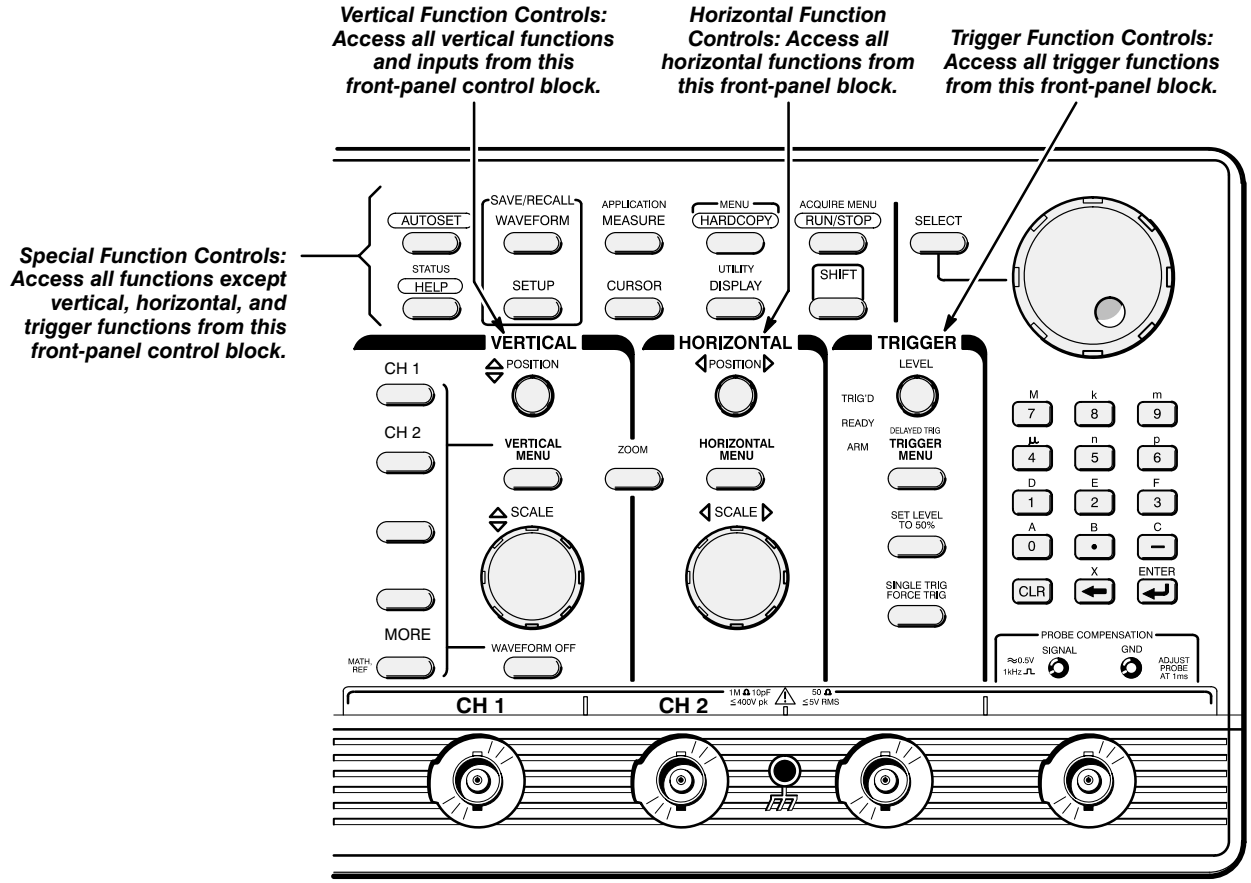
How to Use the Status Menu

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.

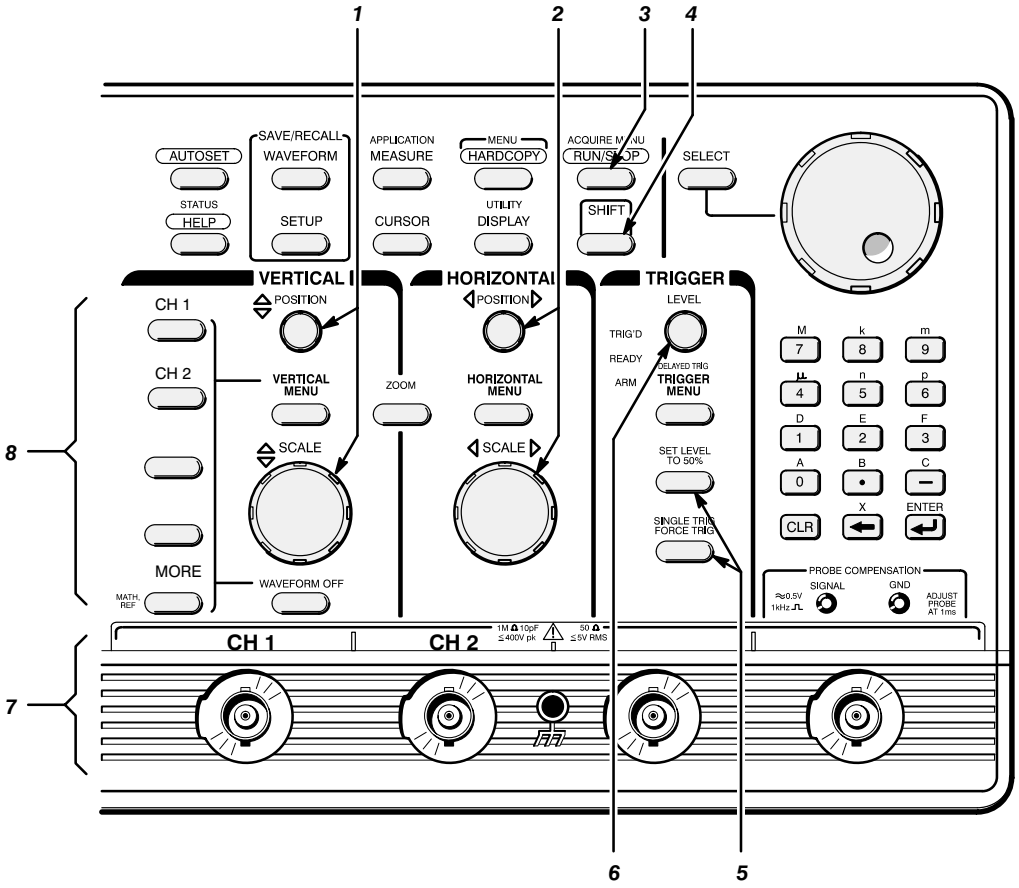
How to Set Functions

Most functions can be set either by using one or two front-panel buttons or knobs, or by pushing a front-panel button to use a main menu, and then a side menu 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 channels 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.

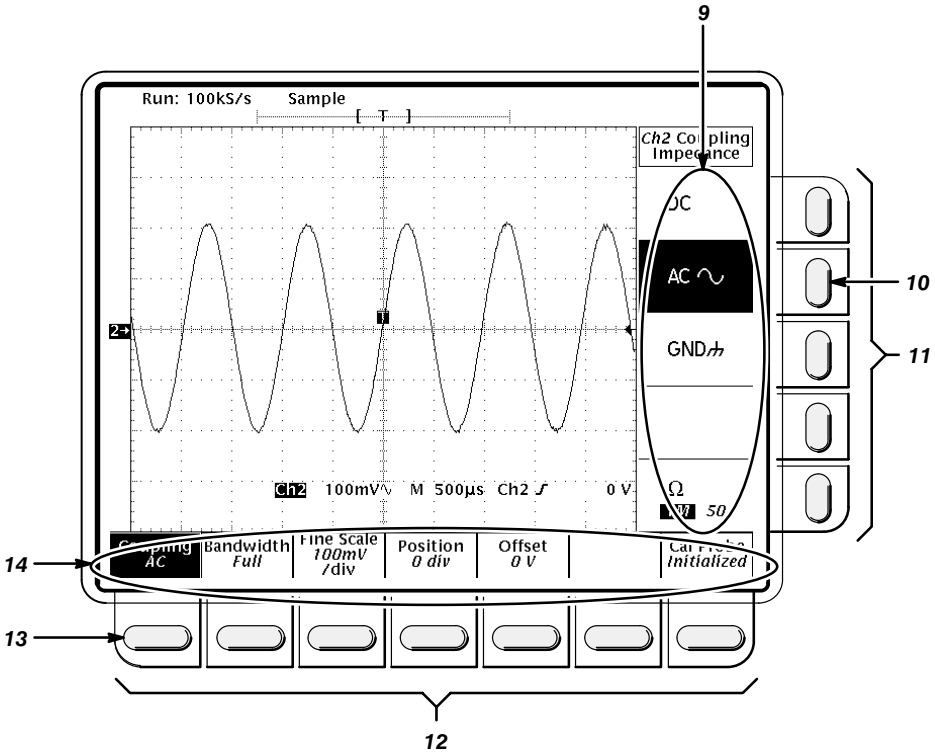
d. Stop and start acquiring waveforms (3). Example: Push **RUN**/**STOP** if not acquiring.

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***.

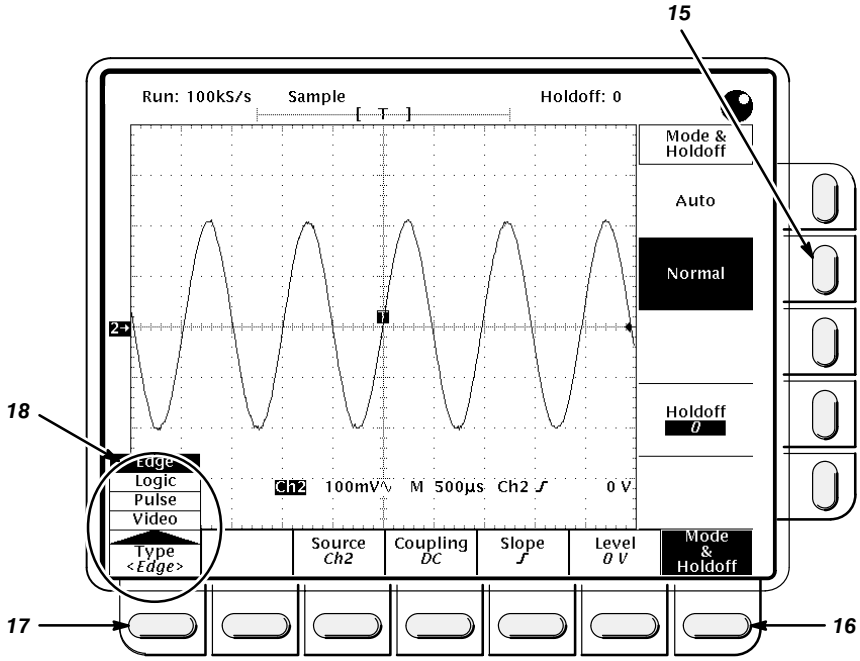
   d. Select a function from the main menu using the main menu buttons (12). A side menu for selecting among that the available settings for that function appears. Example: Push **Coupling** (13).

   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:



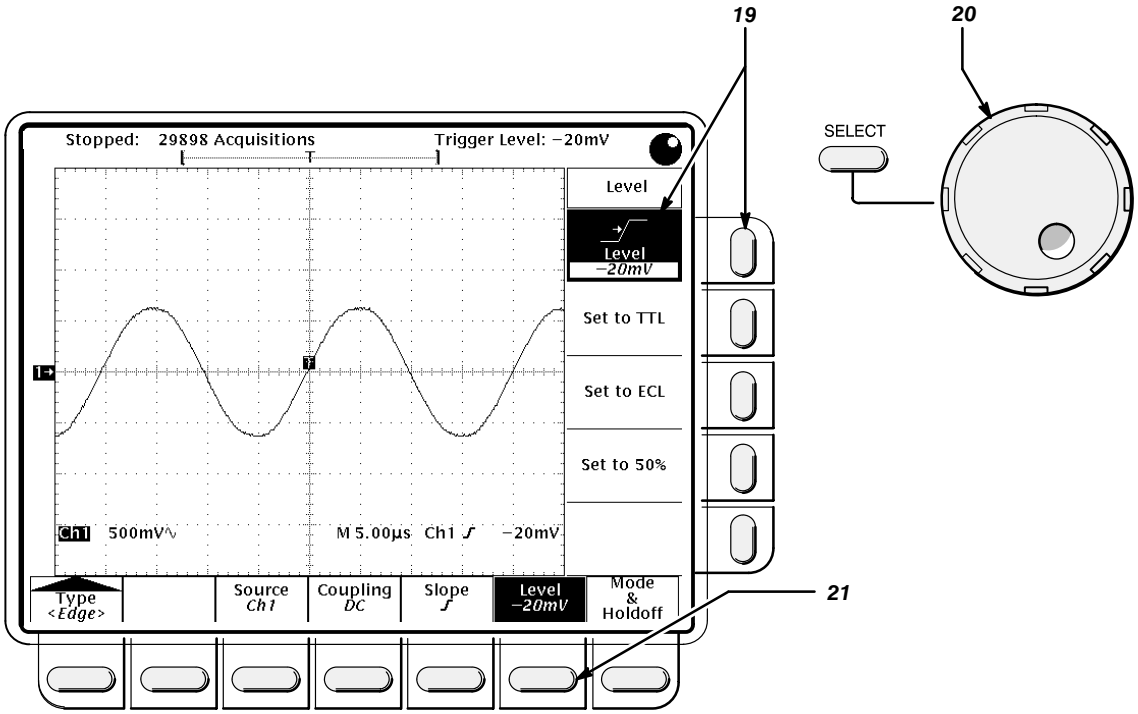
   a. For some selections, pushing a main-menu button pops up a menu (18) of subfunctions. Example: Push **Type** (17).

      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 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 assigns the 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
- Number of events
- 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. Once assigned, the general purpose knob can change parameters by toggling the **SHIFT** button.
- The general purpose knob has a readout area at the upper right corner of the screen. (See Figure 2-2.) 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.)
- The general purpose knob also has a **SELECT** button. This 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:

- Color: waveforms, readouts, graticule.
- Intensity: waveforms, readouts, graticule.
- 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*.

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Circuit Description

This section describes the electrical operation of the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes contain 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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes are portable, four-channel instruments. Each channel provides a calibrated vertical scale factor. All of the four channels can be acquired simultaneously.

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, 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 includes the firmware. It also includes a GPIB interface. You can reprogram the firmware from a remote controller using the GPIB and an external software package.

The processor also includes a digital signal processor. This signal processor processes each waveform as directed 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. A VGA-compatible video output is at the rear of the Digitizing Oscilloscope.

Voltage Controlled Oscillator (VCO)

Master clocks for the acquisition system are generated by a voltage controlled oscillator on the A21 VCO Board and 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.

Tube Assembly

All information (waveforms, text, graticules, and pictographs) is displayed by the A20 (for the TDS 520A and 540A) or the A30/31/32 (for the TDS 524A and 544A) Display system. The Display system 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 potentiometers. 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.

You can make hardcopies on the GPIB, RS-232 and Centronics ports.

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 off.

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.

Replace this page with the Tab named Performance Verification

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

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 this 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 this 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 4-15, 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* on page 4-16.)

If you are not familiar with operating this oscilloscope, read the TDS 520A, 524A, 540A, 544A, & 644A Reference or the TDS 520A, 524A, 540A, & 544A User manual. These contain instructions that 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: 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 **ACQUIRE MENU**", "press the main-menu button **Coupling**", or "verify that the status message is ***Pass***.



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.

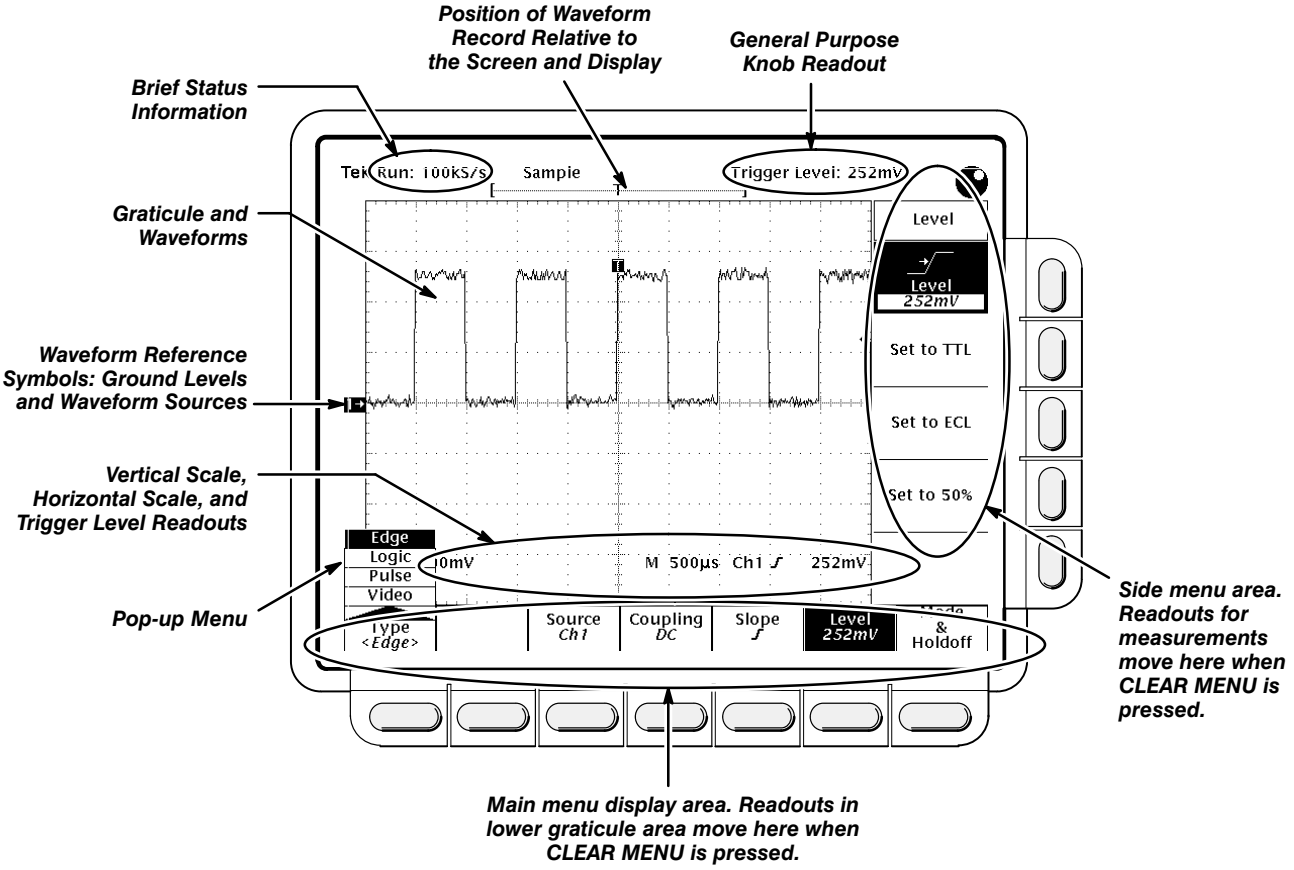


Figure 4-1: Map of Display Functions

Self Tests

This procedure uses internal routines to verify that this 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 Oscilloscopes 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:* 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. At some time during the wait, a “clock” icon (shown at left) will appear on-screen. When the verification is 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.)

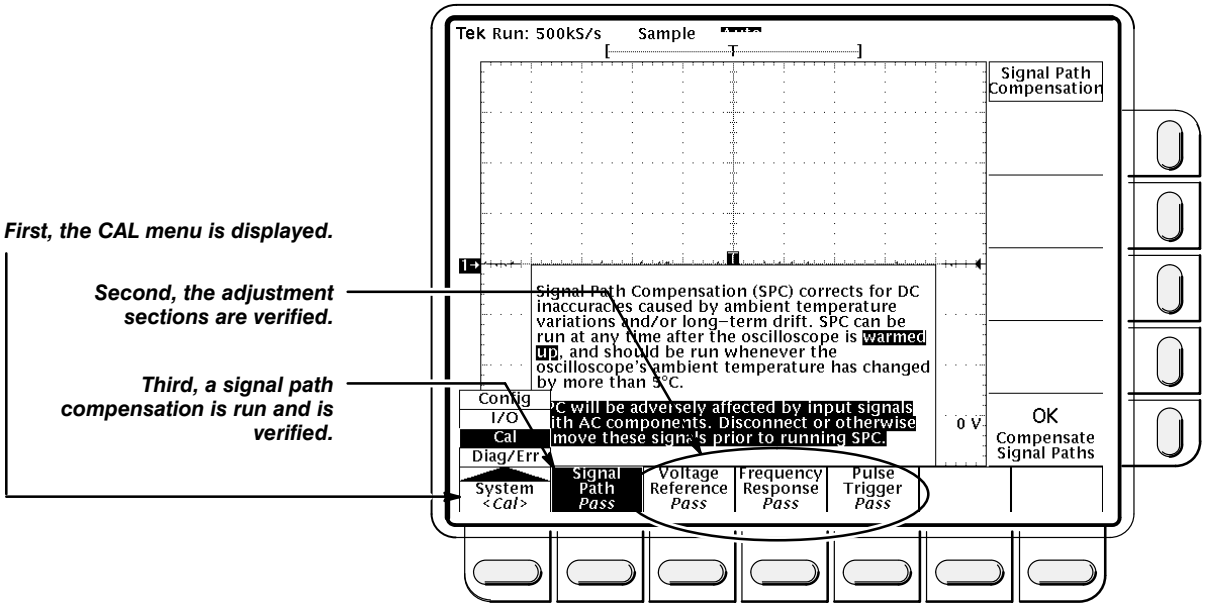


Figure 4-2: Verifying Adjustments and Signal-Path Compensation



When doing steps f and g, do not turn off the oscilloscope until signal-path compensation completes. If you interrupt (or lose) power to the instrument while signal-path compensation is running, a message is logged in the oscilloscope error log. If such a case occurs, rerun 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 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 this oscilloscope functions properly. The only equipment required is one of the standard-accessory probes and, to check the file system, a 3.5 inch. 720 K or 1.44 Mbyte floppy disk.

STOP

These procedures verify functions; that is, they verify that 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 4-15.

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 probe.

Prerequisites: None.

Procedure:

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

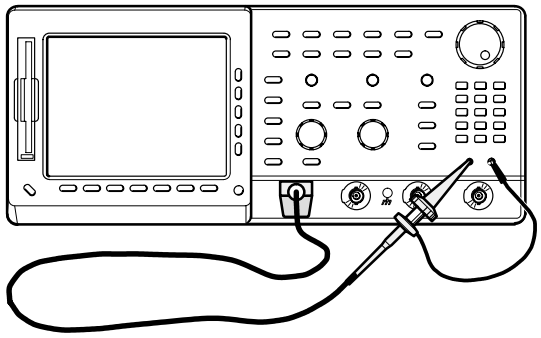


Figure 4-3: Universal Test Hookup for Functional Tests

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 from display the channel just verified.
- 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 200 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 five 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.)



- **Peak Detect** mode displays an actively acquiring waveform on-screen with the noise present in Sample mode “peak detected.”



- **Hi Res** mode displays an actively acquiring waveform on-screen with the noise that was present in Sample mode reduced.



- **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 like in Hi Res mode.



TDS 520A and 524A only: Substep e will have you repeat the previous substeps to check all input channels. Be sure to check only CH 1 and CH 2 when testing the TDS 520A or 524A. (Step 3 will test the AUX 1 and AUX 2 inputs.) When testing the TDS 540A or 544A, test all four channels, CH 1 through CH 4.)

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

3. *TDS 520A and 524A Only: Verify auxiliary inputs operate:* Perform the following substeps when checking the AUX 1 and AUX 2 inputs only.

   a. *Select an auxiliary channel:*

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

   b. *Set up the selected channel:* Press **AUTOSET** to obtain a viewable display in the selected channel.

      The display obtained might not trigger stably because autoset cannot provide more than about ½ division of probe compensation signal amplitude in an auxiliary channel equipped with a 10X probe. This amount is less than the minimum trigger sensitivity for auxiliary channel trigger sources; therefore, triggering is not required.

   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 1 V, and a square-wave probe-compensation signal about ½ division 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 to 10 V decreases the amplitude of the waveform on-screen. (The amplitude will drop to near zero when doing this substep.)
      - Returning the knob to 1 V returns the amplitude to about ½ division.

   d. *Verify that the channel acquires in all acquisition modes:* Disconnect the probe ground lead from the probe-compensation terminal. Do step 2, substep d to verify the five acquire modes.

e. *Test all channels:* Repeat substeps a through d to verify AUX 2.

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

Verify the Time Base

Equipment Required: One P6139A 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 4-6.)

   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 200 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 five horizontal divisions on-screen for the 200 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), and that counterclockwise rotation contracts it, and that returning the horizontal scale to 200 µs returns the period to about five 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 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 4-6.)

   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 200 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.)
      - 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 200 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 tru*e:

- The trigger-level readout for the delayed trigger system changes as you turn 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.)
- 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.

Verify the File System (Optional on TDS 520A and 540A)

Equipment Required: One P6139A probe and one 720 K or 1.44 Mbyte, 3.5 inch DOS compatible disk. You can use a disk of your own or you can use the Programming Examples Software 3.5 inch disk (Tektronix part number 063−1134−00) contained in the TDS Family Programmer Manual (Tektronix part number 070−8709−01).

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 4-6.)
   b. *Insert the test disk:* Insert the disk in the disk drive to the left of the monitor.
      - Position the disk so the metal shutter faces the drive.
      - Position the disk so the stamped arrow is on the top right side. In other words, place the angled corner in the front bottom location.
      - Push the disk into the drive until it goes all the way in and clicks into place.
   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 default settings:*
      - Press **AUTOSET** to obtain a viewable, triggered display.
      - Set the horizontal **SCALE** for the **M** (main) time base to 200 µs (one click clockwise). Notice the waveform on the display now shows two cycles instead of five.
      - Press **CLEAR MENU** to remove the menus from the screen.
   e. *Save the settings:*
      - Press **SETUP**.
      - Press the main-menu button **Save Current Setup**; then press the side-menu button **To File**.
      - Turn the general purpose knob to select the file to save. Choose `TEK?????.SET` (or `fdo:`). With this choice, you'll save a file starting with `TEK`, then containing 5-numbers, and a `.SET` extension. For example, the first time you run this on a blank, formatted disk or on the Example Programs Disk, the TDS will assign the name `TEK00000.SET` to your file. If you ran the procedure again, the TDS would increment the name and call the file `TEK00001.SET`.

- Press the side-menu button **Save To Selected File**.

2. *Verify the file system works:*
   - Press **AUTOSET** to restore the 500 µs time base and the five cycle waveform.
   - Press the main-menu button **Recall Saved Setup**; then press the side-menu button **From File**.
   - Turn the general purpose knob to select the file to recall. For example, if you followed the instructions above and used a blank disk, you had the TDS assign the name TEK00000.SET to your file.
   - Press the side-menu button **Recall From Selected File**.
   - Verify that Digitizing Oscilloscope retrieved the saved setup from the disk. Do this by noticing the horizontal **SCALE** for the **M** (main) time base is again 200 µs and the waveform shows only two cycles just as it was when you saved the setup.
3. *Remove the test hookup:*
   - Disconnect the standard-accessory probe from the channel input and the probe-compensation terminals.
   - Remove the disk from the disk drive. Do this by pushing in the tab at the bottom of the disk drive.

Performance Tests

This subsection contains a collection of procedures for checking that TDS 520A, 524A, 540A, and 544A Digitizing Oscilloscopes perform as warranted. Since the procedures cover models with both two full-featured channels (TDS 520A and 524A) and four full-featured models (TDS 540A and 544A), instructions that apply only to one of the model types are clearly identified. Otherwise, all test instructions apply to both the two and four channel models.

The procedures are arranged in five logical groupings: *Signal Acquisition System Checks, Time Base System Checks, Triggering System Checks*, O*utput Signal Checks*, and *Video Trigger Checks*. They check all the characteristics that are designated as checked in Section 1, *Specifications.* (The characteristics that are checked appear in **boldface** type under *Warranted Characteristics* in Section 1.)



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 Oscilloscopes.
- 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 Oscilloscopes 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 +4° 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.

Equipment Required

These procedures use external, traceable signal sources to directly check warranted characteristics. The required equipment list is shown in Table 4-1.

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	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
4	Cable, Precision 50 Ω Coaxial (two required)	50 Ω, 36 inch, male to male BNC connectors	Tektronix part number 012−0482−00	Signal Interconnection
5	Connector, Dual-Banana (two required)	Female BNC to dual banana	Tektronix part number 103−0090−00	Various Accuracy Tests
6	Connector, BNC "T"	Male BNC to dual female BNC	Tektronix part number 103−0030−00	Checking Trigger Sensitivity
7	Coupler, Dual-Input	Female BNC to dual male BNC	Tektronix part number 067−0525−02	Checking Delay Between Channels
8	Generator, DC Calibration	Variable amplitude to ±110 V; accuracy to 0.1%	Data Precision 8200, with 1 kV option installed	Checking DC Offset, Gain, and Measurement Accuracy
9	Generator, Calibration	500 mV square wave calibrator amplitude; accuracy to 0.25%	PG 506A[1]	To check accuracy of the CH 3 Signal Out (TDS 540A and 544A only)
10	Generator, Leveled Sine Wave, Medium-Frequency	200 kHz to 250 MHz; Variable amplitude from 5 mV to 5.5 V_{p-p} into 50 Ω	Tektronix SG 503 Leveled Sine Wave Generator[1]	Checking Trigger Sensitivity at low frequencies
11	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 its Leveling Head	Checking Analog Bandwidth and Trigger Sensitivity at high frequencies
12	Generator, Time Mark	Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm	Tektronix TG 501 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
13 Generator, Calibration	500 mV square wave calibrator amplitude; accuracy to 0.25%	PG 506A[1]	Use to check accuracy of the CH 3 Output
14 Probe, 10X, included with this instrument	A P6139A probe	Tektronix number P6139A	Signal Interconnection
15 Adapter, BNC female to Clip Leads	BNC female to Clip Leads	Tektronix part number 013−0076−00	Signal Coupling for Probe Compensator Output Check
16 Generator, Video Signal	Provides PAL compatible outputs.	Tektronix TSG 121	Used to Test Video Option 05 Equipped Instruments Only
17 Oscillator, Leveled Sine-wave Generator	60 Hz. Sine Wave	Tektronix part number SG 502	Used to Test Video Option 05 Equipped Instruments Only
18 Pulse Generator		Tektronix part number PG 502	Used to Test Video Option 05 Equipped Instruments Only
19 Cable, 75 Ω Coaxial	75 Ω, 36 inch, male to male BNC connectors	Tektronix part number 012−1338−00	Used to Test Video Option 05 Equipped Instruments Only
20 Termination, 75 Ω	Impedance 75 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011−0102−01	Used to Test Video Option 05 Equipped Instruments Only

Test Record

Photocopy the next four pages and use them to record the performance test results for your instrument.

TDS 500A Test Record

Instrument Serial Number: _____ Certificate Number: _____
Temperature: _____ RH %: _____
Date of Calibration: _____ Technician: _____

Performance Test		Minimum	Incoming	Outgoing	Maximum
Offset Accuracy					
CH1 Offset	+1 mV	− 1.6 mV	_____	_____	+ 1.6 mV
	+100 mV	− 25 mV	_____	_____	+ 25 mV
	+1 V	− 250 mV	_____	_____	+ 250 mV
CH2 Offset	+1 mV	− 1.6 mV	_____	_____	+ 1.6 mV
	+100 mV	− 25 mV	_____	_____	+ 25 mV
	+1 V	− 250 mV	_____	_____	+ 250 mV
CH3 Offset	+1 mV	− 1.6 mV	_____	_____	+ 1.6 mV
	+100 mV	− 25 mV	_____	_____	+ 25mV
	+1 V	− 250 mV	_____	_____	+ 250 mV
CH4 Offset	+1 mV	− 1.6 mV	_____	_____	+ 1.6 mV
	+100 mV	− 25 mV	_____	_____	+ 25 mV
	+1 V	− 250 mV	_____	_____	+ 250 mV
DC Voltage Measurement Accuracy (Averaged)					
CH1	5 mV Vert scale setting, −5 Div position setting	+ 1.0355 V	_____	_____	+ 1.0445 V
CH1	5 mV Vert scale setting, +5 Div position setting	− 1.0445 V	_____	_____	− 1.0355 V
CH1	200 mV Vert scale setting, −5 Div position setting	+ 11.525 V	_____	_____	+ 11.675 V
CH1	200 mV Vert scale setting, +5 Div position setting	− 11.675 V	_____	_____	− 11.525 V
CH1	1 V Vert scale setting, −5 Div position setting	+ 107.450 V	_____	_____	+ 108.550 V
CH1	1 V Vert scale setting, +5 Div position setting	− 108.550 V	_____	_____	− 107.450 V
CH2	5 mV Vert scale setting, −5 Div position setting	+ 1.0355 V	_____	_____	+ 1.0445 V
CH2	5 mV Vert scale setting, +5 Div position setting	− 1.0445 V	_____	_____	− 1.0355 V

TDS 500A Test Record (Cont.)

Instrument Serial Number: _____ Certificate Number: _____
Temperature: _____ RH %: _____
Date of Calibration: _____ Technician: _____

Performance Test		Minimum	Incoming	Outgoing	Maximum
CH2	200 mV Vert scale setting, −5 Div position setting	+ 11.525 V	_____	_____	+ 11.675 V
CH2	200 mV Vert scale setting, +5 Div position setting	− 11.675 V	_____	_____	− 11.525 V
CH2	1 V Vert scale setting, −5 Div position setting	+ 107.450 V	_____	_____	+ 108.550 V
CH2	1 V Vert scale setting, +5 Div position setting	− 108.550 V	_____	_____	− 107.450 V
CH3	5 mV Vert scale setting, −5 Div position setting	+ 1.0355 V	_____	_____	+ 1.0445 V
CH3	5 mV Vert scale setting, +5 Div position setting	− 1.0445 V	_____	_____	− 1.0355 V
CH3	200 mV Vert scale setting, −5 Div position setting	+ 11.525 V	_____	_____	+ 11.675 V
CH3	200 mV Vert scale setting, +5 Div position setting	− 11.675 V	_____	_____	− 11.525 V
CH3	1 V Vert scale setting, −5 Div position setting	+ 107.450 V	_____	_____	+ 108.550 V
CH3	1 V Vert scale setting, +5 Div position setting	− 108.550 V	_____	_____	− 107.450 V
CH4	5 mV Vert scale setting, −5 Div position setting	+ 1.0355 V	_____	_____	+ 1.0445 V
CH4	5 mV Vert scale setting, +5 Div position setting	− 1.0445 V	_____	_____	− 1.0355 V
CH4	200 mV Vert scale setting, −5 Div position setting	+ 11.525 V	_____	_____	+ 11.675 V
CH4	200 mV Vert scale setting, +5 Div position setting	− 11.675 V	_____	_____	− 11.525 V
CH4	1 V Vert scale setting, −5 Div position setting	+ 107.450 V	_____	_____	+ 108.550 V
CH4	1 V Vert scale setting, +5 Div position setting	− 108.550 V	_____	_____	− 107.450 V

TDS 500A Test Record (Cont.)

Instrument Serial Number: _____ Certificate Number: _____
Temperature: _____ RH %: _____
Date of Calibration: _____ Technician: _____

Performance Test	Minimum	Incoming	Outgoing	Maximum
Analog Bandwidth				
CH1 100 mV	424 mV	_____	_____	N/A
CH2 100 mV	424 mV	_____	_____	N/A
CH3 100 mV	424 mV	_____	_____	N/A
CH4 100 mV	424 mV	_____	_____	N/A
Delay Between Channels				
Delay Between Channels	N/A	_____	_____	250 ps
Time Base System				
Long Term Sample Rate/ Delay Time @ 500 ns/10 ms	−2.5 Div	_____	_____	+2.5 Div
Delta Time @ 5 ns (100 MHz)	19.760 ns	_____	_____	20.240 ns
Trigger System Accuracy				
Pulse-Glitch or Pulse-WIdth, Hor. scale ≤ 1 µs				
Lower Limit	2.5 ns	_____	_____	7.5 ns
Upper Limit	2.5 ns	_____	_____	7.5 ns
Pulse-Glitch or Pulse-WIdth, Hor. scale > 1 µs				
Lower Limit	1 µs	_____	_____	3 µs
Upper Limit	1 µs	_____	_____	3 µs
Main Trigger, DC Coupled)	9.940 V	_____	_____	10.060 V
Delayed Trigger, DC Coupled)	9.940 V	_____	_____	10.060 V
Output Signal Checks				
MAIN TRIGGER OUTPUT, 1 M Ω	High ≥ 2.5 V	_____	_____	Low ≤ 0.7 V
MAIN TRIGGER OUTPUT, 50 Ω	High ≥ 1.0 V	_____	_____	Low ≤ 0.25 V
DELAYED TRIGGER OUTPUT, 50 Ω	High ≥ 1.0 V	_____	_____	Low ≤ 0.25 V
DELAYED TRIGGER OUTPUT, 1 M Ω	High ≥ 2.5 V	_____	_____	Low ≤ 0.7 V
CH 3 SIGNAL OUTPUT, 1 M Ω	Pk-Pk ≥ 90 mV	_____	_____	Pk-Pk ≤ 110 mV
CH 3 SIGNAL OUTPUT, 50 Ω	Pk-Pk ≥ 45 mV	_____	_____	Pk-Pk ≤ 55 mV

TDS 500A Test Record (Cont.)

Instrument Serial Number: _____ Certificate Number: _____
Temperature: _____ RH %: _____
Date of Calibration: _____ Technician: _____

Performance Test	Minimum	Incoming	Outgoing	Maximum
Probe Compensator Output Signal				
Frequency (CH1 Freq.)	950 Hz	_____	_____	1050 Hz
Voltage (difference)	495 mV	_____	_____	505 mV

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, *Specifications.*

Check Accuracy of Offset (Zero Setting)

Equipment Required: None.

Prerequisites: The oscilloscope must meet the prerequisites listed on page 4-15.

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 **ACQUIRE MENU**.
      - Press the main-menu button **Mode**; then press the side-menu button **Hi Res**.
      - 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**.

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.



Follow these rules to match this procedure to the model of the oscilloscope under test:

Models TDS 540A, 544A Only—When using Table 4-2 to test CH 1—CH 4; ignore the columns for AUX 1 & AUX 2 settings and limits.

Model TDS 520A, 524A Only—Use Table 4-2 to test input channels; use the columns for CH 1—CH 4 when testing CH 1 and CH 2; use the columns for AUX 1 and AUX 2 when testing those channels.

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

Vertical Scale Setting		Vertical Position	Offset Accuracy Limits	
CH 1 – CH 4	AUX 1 & AUX 2	and Offset Setting[1]	CH 1 – CH 4	AUX 1 & AUX 2
1 mV	100 mV	0	±1.6 mV	±10 mV
100 mV	1 V	0	±25 mV	±100 mV
1 V	10 V	0	±250 mV	±1 V

[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 (see Figure 4-4).

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.

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

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

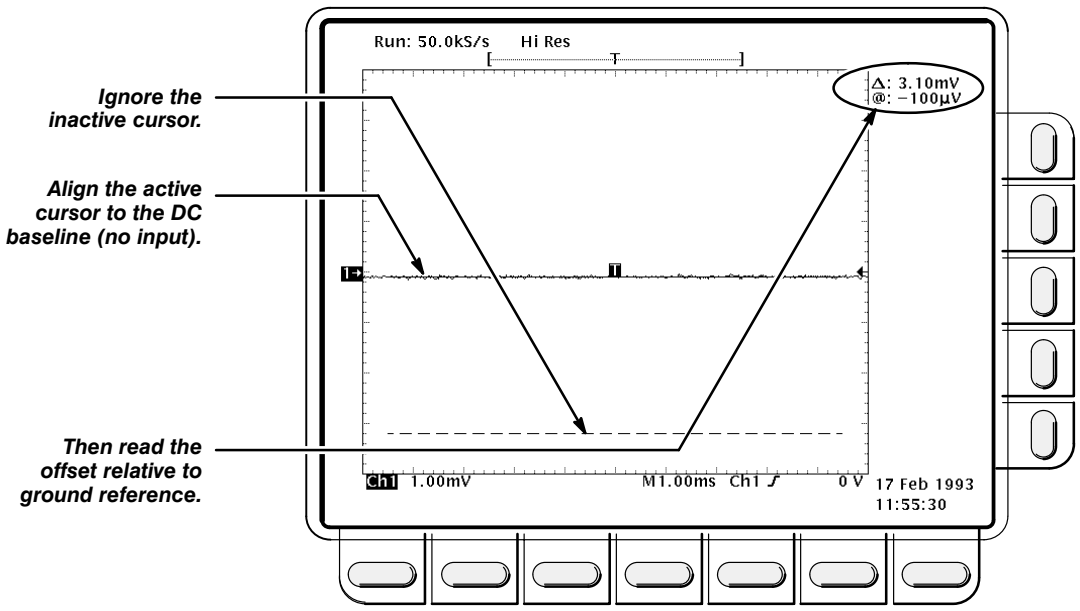


Figure 4-4: Measurement of DC Offset Accuracy at Zero Setting

Check DC Gain and Voltage Measurement Accuracy

WARNING

Performance of this procedure requires input voltages up to 130 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 5), one BNC T connector (Item 6), one DC calibration generator (Item 8), and two precision coaxial cables (Item 4).

Prerequisites: The oscilloscope must meet the prerequisites listed on page 4-15.

Procedure:

1. *Install the test hookup and preset the instrument controls (see Figure 4-5):*

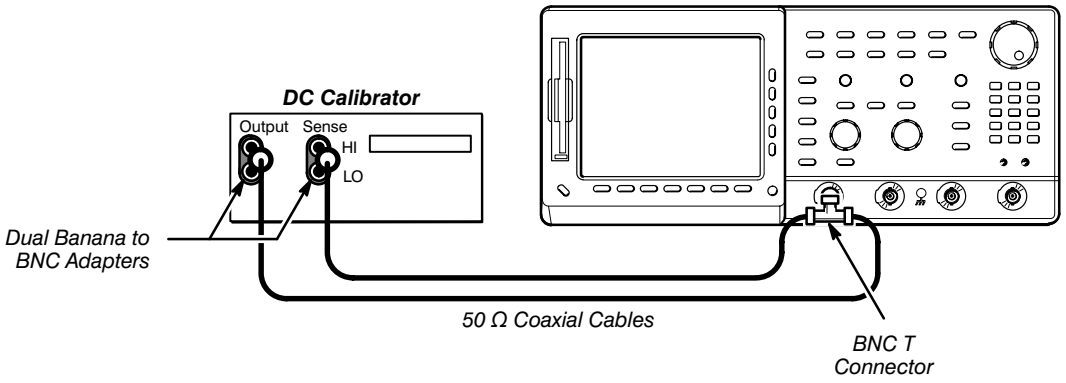


Figure 4-5: Initial Test Hookup

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 **SELECT**. 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 on page 4-28.

   d. *Check against limits:* CHECK that the **Δ:** readout on screen is within 485 mV to 515 mV (see Figure 4-6).

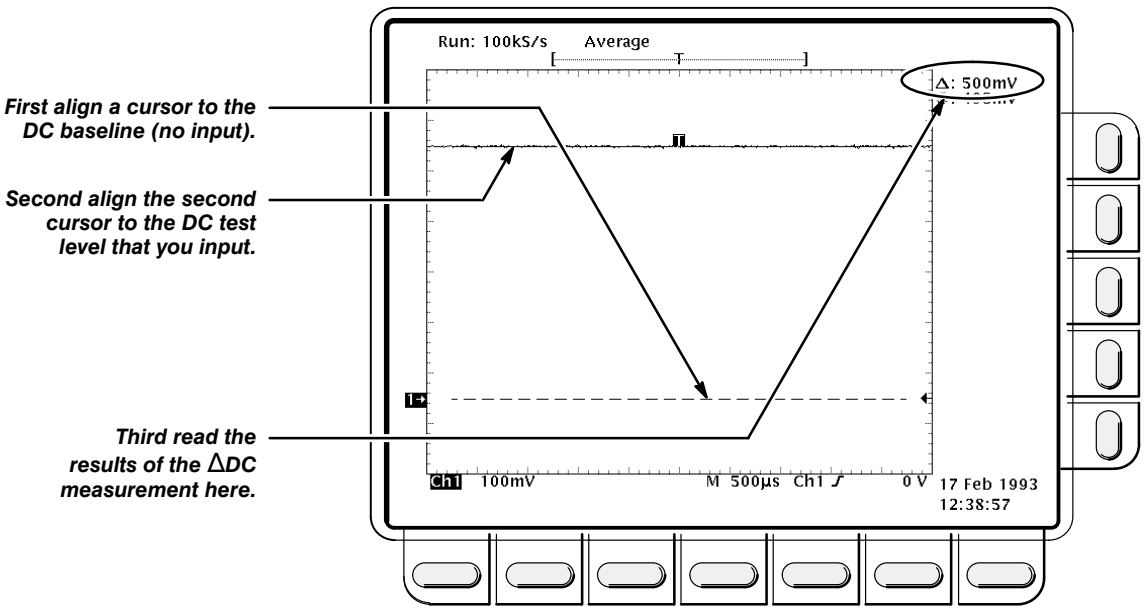


Figure 4-6: Measurement of the DC Accuracy for Delta Measurements

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 a 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 **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 select.

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

   - Press **MEASURE**, then press the main-menu button **Select Measrmnt 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**.



Follow these rules to match this procedure to the model of the oscilloscope under test:

Models TDS 540A, 544A Only—Use Table 4-3 to test CH 1—CH 4; ignore Table 4-4 AUX 1 & AUX 2 settings and limits.

Model TDS 520A, 524A Only—Use Table 4-3 to test CH 1 and CH 2 only; use Table 4-4 to test AUX 1 and AUX 2 only.

   c. *Set its vertical scale:* Set the vertical **SCALE** to one of the settings listed in Table 4-3 (and Table 4-4 for the TDS 520A and 524A) that is not yet checked. (Start with the first setting listed.)

Table 4-3: DC Accuracy: CH 1 – CH 4

Scale Setting	Position Setting (Divs)	Offset Setting	Generator Setting	Accuracy Limits
5 mV	−5	+1 V	+1.040 V	+1.0355 V to +1.0445 V
	+5	−1 V	−1.040 V	−1.0355 V to −1.0445 V
200 mV	−5	+10 V	+11.6 V	+11.525 V to +11.675 V
	+5	−10 V	−11.6 V	−11.525 V to −11.675 V
1 V	−5	+100 V	+108 V	+107.450 V to +108.550 V
	+5	−100 V	−108 V	−107.450 V to −108.550 V

Table 4-4: DC Accuracy: AUX 1–AUX 2

Scale Setting	Position Setting (Divs)	Offset Setting	Generator Setting	Accuracy Limits
100 mV	−5	+0.5 V	+1.3 V	+1.271 V to +1.329 V
	+5	−0.5 V	−1.3 V	−1.271 V to −1.329 V
1 V	−5	+5 V	+13 V	+12.710 V to +13.290 V
	+5	−5 V	−13 V	−12.710 V to −13.290 V
10 V	−5	+50 V	+130 V	+127.10 V to +132.90 V
	+5	−50 V	−130 V	−127.10 V to −132.90 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.

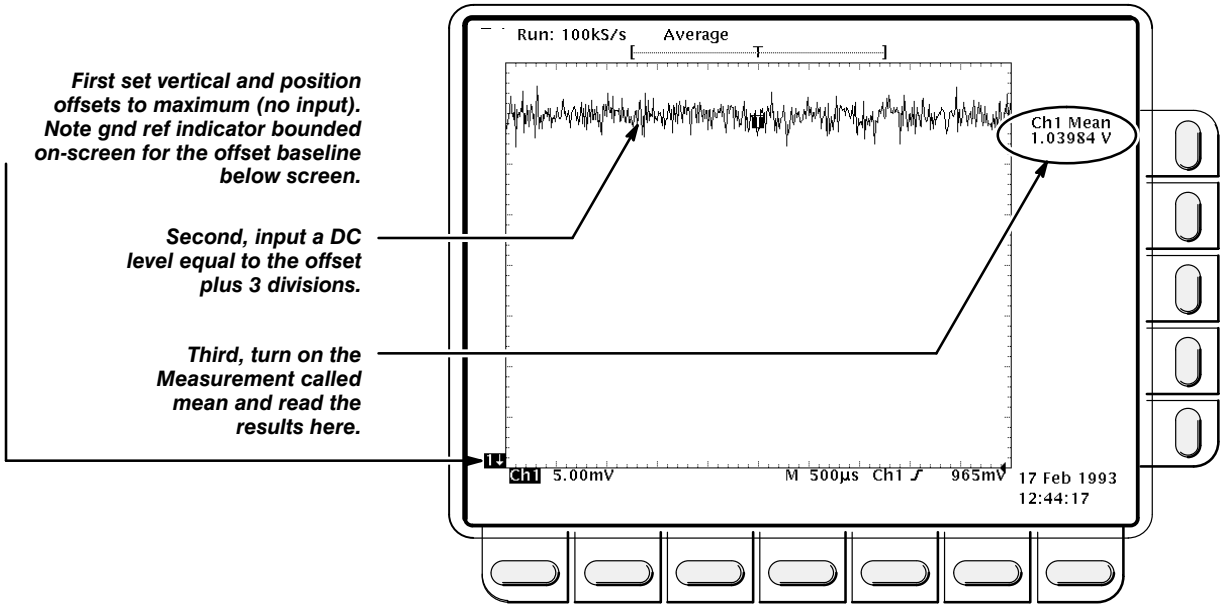


Figure 4-7: Measurement of DC Accuracy at Maximum Offset and Position

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 step 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 settings listed in Table 4-3 (and Table 4-4 for the TDS 520A and 524A) 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. Then 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 11), plus two10X attenuators (Item 1).

Prerequisites: *See page 4-15.*

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 default settings:*

   - Set the horizontal **SCALE** to 50 ns.
   - Now press **SHIFT**, then **ACQUIRE MENU**.
   - Press the main-menu button **Mode**; then press the side-menu button **Average 16**.
   - Press **TRIGGER MENU**.
   - Press the main-menu button **Coupling**; then press the side-menu button **Noise Rej**.
   - Press **Measure**. Now press the main-menu button **High−Low Setup**; then press the side-menu button **Min−Max**.

   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. See Figure 4-8.

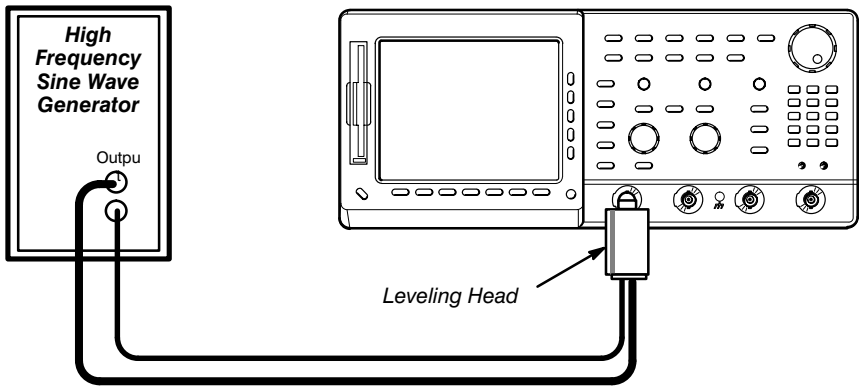


Figure 4-8: Initial Test Hookup

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 select.

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

      - Press **TRIGGER MENU**.
      - Press the main-menu button **Source**.
      - 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 **Ω** button 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 4-5 not yet checked. (Start with the 100 mV setting.)

Table 4-5: 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	≥ 84 mV
10 mV	1	60 mV (6 divisions)	1 ns	500 MHz	≥ 42 mV
5 mV	2	30 mV (6 divisions)	1 ns	500 MHz	≥ 21 mV
2 mV	2	12 mV (6 divisions)	2 ns	350 MHz	≥ 8.48 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 Measrmnt for *CHx***.
- Now 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**.
- Press **CLEAR MENU**.
- Set the generator output so the CHx Pk-Pk readout equals the reference amplitude in Table 4-5 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:*

- Increase the frequency of the generator output to the test frequency in Table 4-5 that corresponds to the vertical scale set in substep d.
- Set the horizontal **SCALE** to 1 ns. Press **SET LEVEL TO 50%** as necessary.
- Read the results at the CHx Pk-Pk readout, which will automatically measure the amplitude of the test signal. See Figure 4-9.

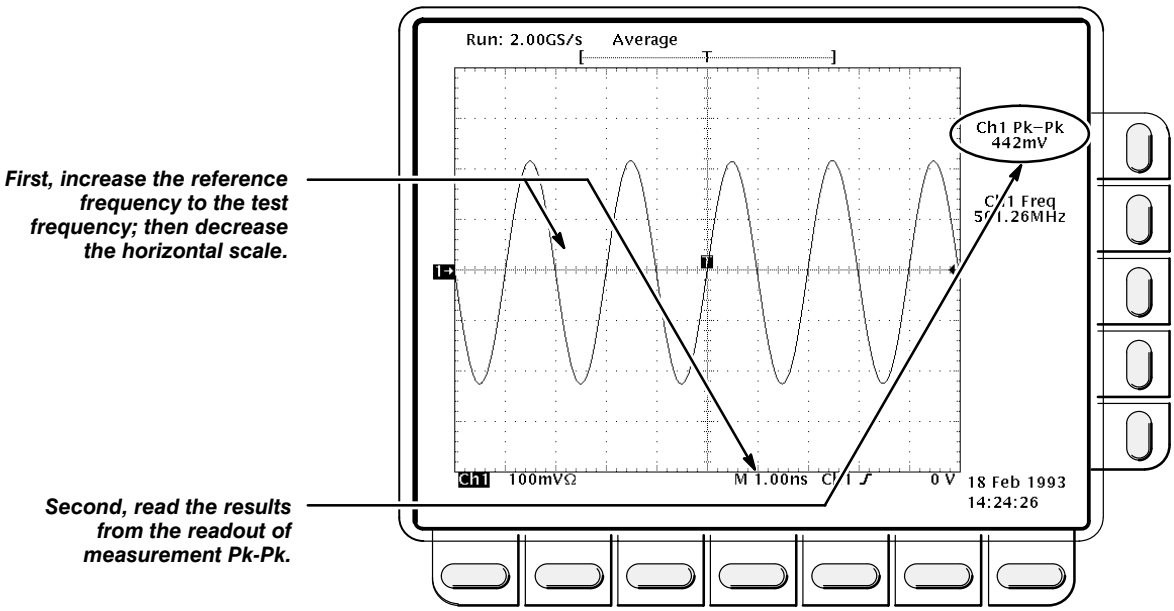


Figure 4-9: Measurement of Analog Bandwidth

g. *Check against limits:*

- CHECK that the **Pk-Pk** readout on screen is within the limits listed in Table 4-5 for the current vertical scale setting.
- When finished checking, set the horizontal **SCALE** back to the 50 ns setting.



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 4-5 (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 4-5 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 10), one precision, 50 Ω, coaxial cable (Item 4), one 50 Ω terminator (Item 3), and a dual-input-coupler (Item 7).

Prerequisites: *See page 4-15.*

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 **ACQUIRE MENU**.
      - Press the main-menu button **Mode**, and then press the side-menu button **Average 16**.
   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. See Figure 4-10.

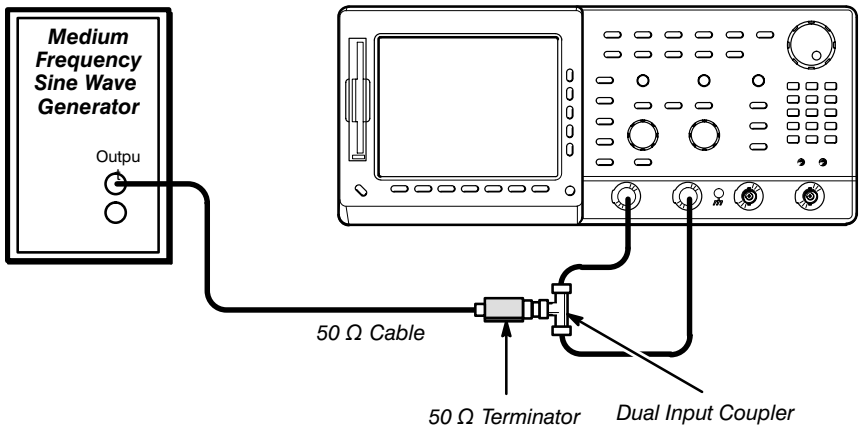


Figure 4-10: Initial Test Hookup

- Connect the coupler to both **CH 1** and **CH 2**.

2. *Confirm CH 1 through CH 4 (CH 2 for 520A and 524A) are within limits for channel delay:*

   a. *Set up the generator:* Set the generator frequency to 250 MHz and the amplitude for about five 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.



      TDS 520A and 524A only: Press CH 2; then skip to substep e and continue this check. If testing a TDS 540A or 544A model, continue with the next substep, b.

   b. *Save a CH 2 waveform:* Press **CH 2**; then press save/recall **WAVEFORM**. Now, press the main-menu button **Save Wfm *Ch2***; 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**.
      - 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 right-most waveform. See Figure 4-11.
      - Press **CURSOR**; 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 **SELECT** to switch between the two cursors.) See Figure 4-11.

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

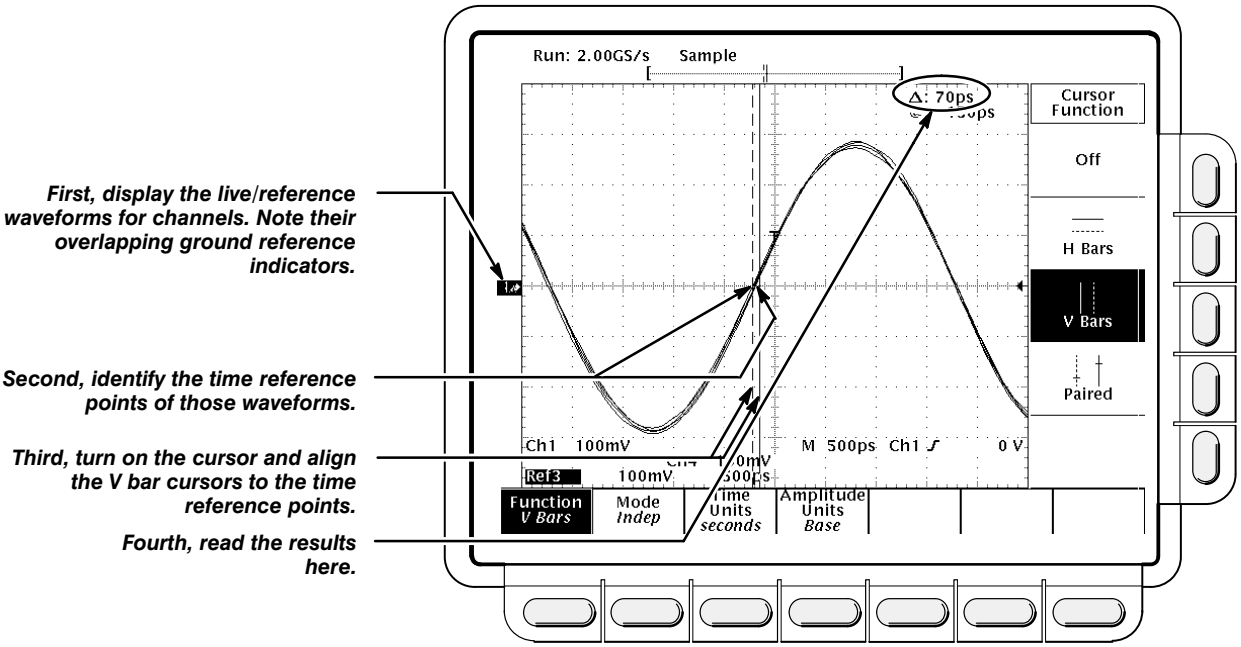


Figure 4-11: Measurement of Channel Delay

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, *Specifications.*

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

Equipment Required: One time-mark generator (Item 12) and one precision coaxial cable (Item 4).

Prerequisites: *See page 4-15.*

Procedure:

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. See Figure 4-12.

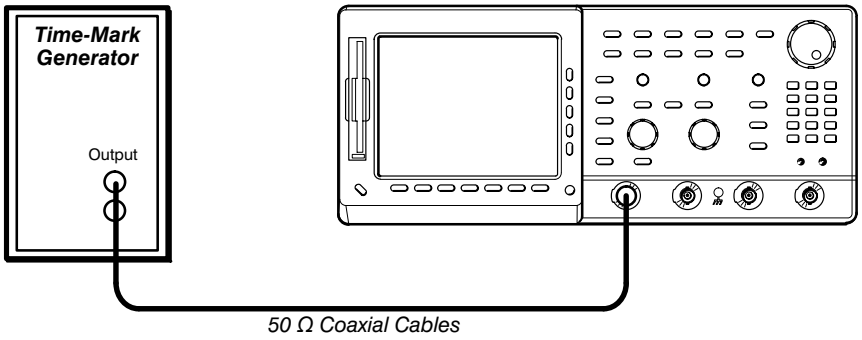


Figure 4-12: Initial Test Hookup

   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 **Ω** button to **50 Ω**.
   - 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**. Now 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 points in 20 divs**.
- Press the main-menu button **Trigger Position**. Press the side-menu button **Pretrigger**; then set pretrigger to 20%: press **20**, then **ENTER**, on the keypad.

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 100 ns.
   - Use the keypad to set delayed time to 10 ms. (Press **10**, then **SHIFT**, then **m** followed by **ENTER**.)

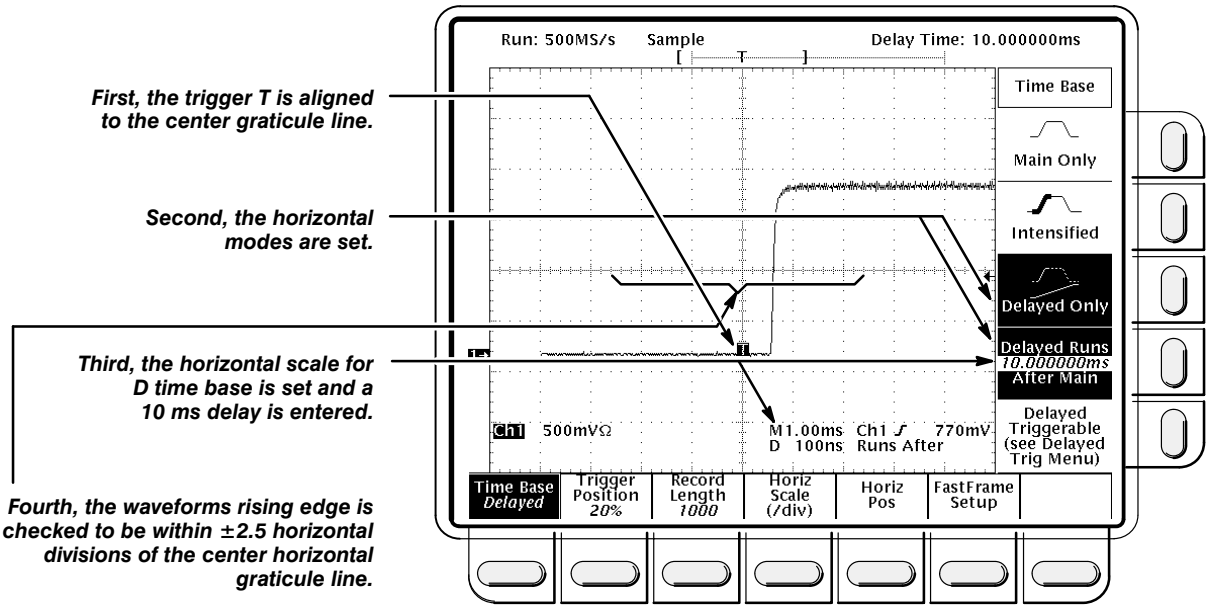


Figure 4-13: Measurement of Accuracy — Long-Term and Delay-Time

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 ±2.5 divisions of center graticule. See Figure 4-13.

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

- Press the side-menu button **Main Only**. Set horizontal **SCALE** to 2 ns.
- Set the output of the generator for 20 ns markers.
- Press **SET LEVEL TO 50%**.
- Press **SHIFT**; then **ACQUIRE MENU**. Next, press the main-menu button **Mode**. Finally, press the side-menu button **Average**.
- Enter **8**, for eight averages, on the keypad.
- Press **MEASURE**.
- Press the main-menu button **High-Low Setup**; then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measrmnt 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, *Specifications.*

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

Equipment Required: One medium-frequency leveled sine wave generator (Item 10), one 10X attenuator (Item 1), and one precision, 50 Ω, coaxial cable (Item 4).

Prerequisites: *See page 4-15.*

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 **Ω** button to select **50 Ω** coupling.
      - Set the horizontal **SCALE** to 10 ns.
   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 10) to CH 1. See Figure 4-14.

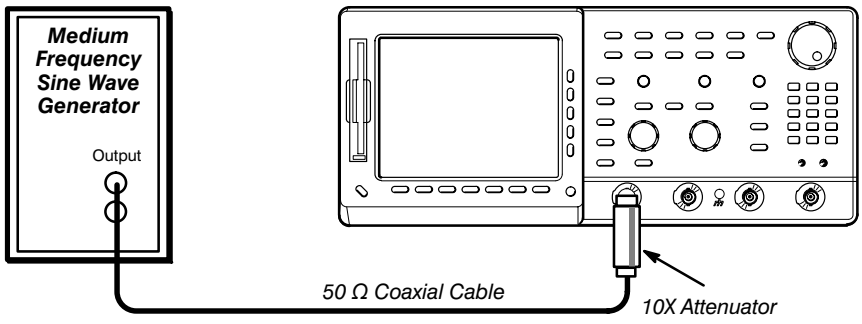


Figure 4-14: Initial Test Hookup

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 the side-menu button **Normal**.

   c. *Set upper and lower limits that ensures 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 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 the **Upper Limit** readout until triggering is lost.
      - CHECK that the **Upper Limit** readout is within 2.5 ns to 7.5 ns, inclusive.

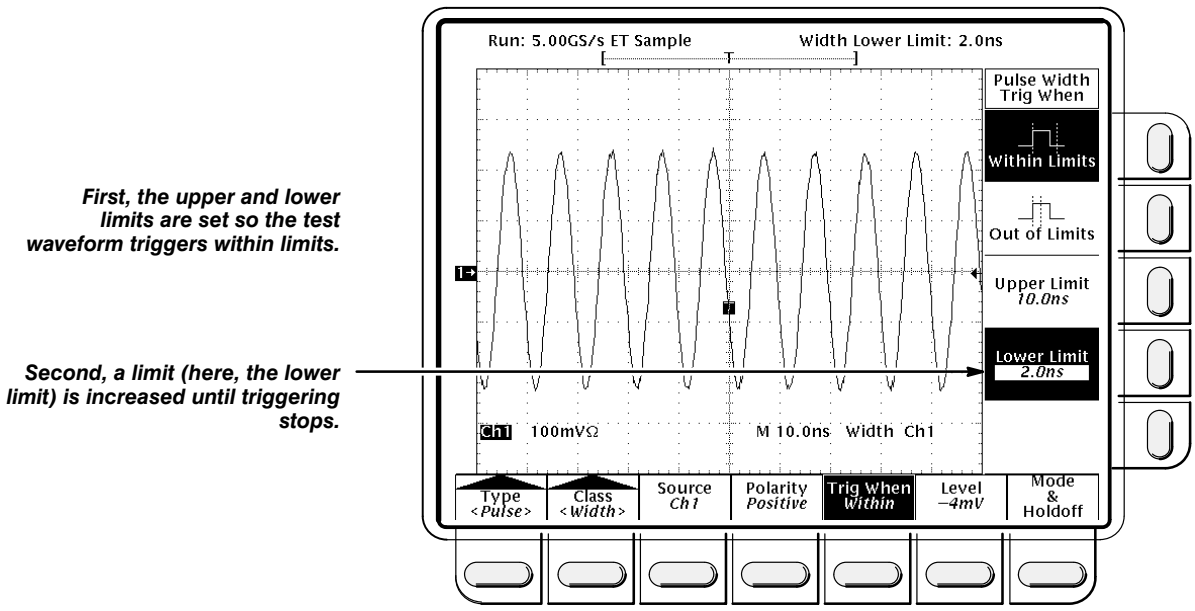


Figure 4-15: Measurement of Time Accuracy for Pulse and Glitch Triggering

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 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 the **Upper Limit** readout until triggering is lost.
- CHECK that the **Upper Limit** readout 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 8), one BNC T connector (Item 6), and two precision, 50 Ω, coaxial cables (Item 4).

Prerequisites: The oscilloscope must meet the prerequisites listed on page 4-15.

Procedure:

1. *Install the test hookup and preset the instrument controls:*
   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. See Figure 4-16.
      - 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**. See Figure 4-16.

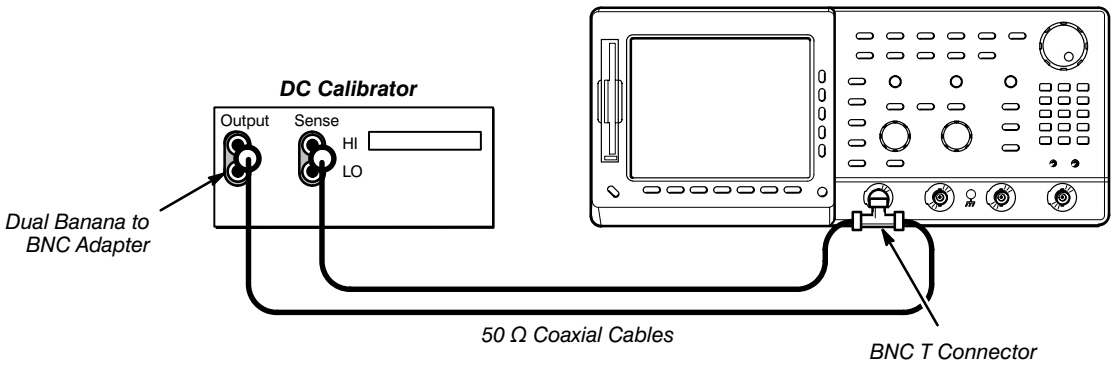


Figure 4-16: Initial Test Hookup

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. *Select Delayed Triggerable:*

- Press **HORIZONTAL MENU**.
- Press the main-menu button **Time Base**.
- Press the side-menu button **Delayed Triggerable**.

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

a. *Display the test signal:*

- Press **VERTICAL MENU**. 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. Press **10**, then **ENTER**. The baseline level will move off-screen.
- Set the standard output of a 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 9.940 V to 10.060 V, inclusive.



- Press **TRIGGER MENU**. 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 9.940 V to 10.060 V, inclusive. See Figure 4-17.

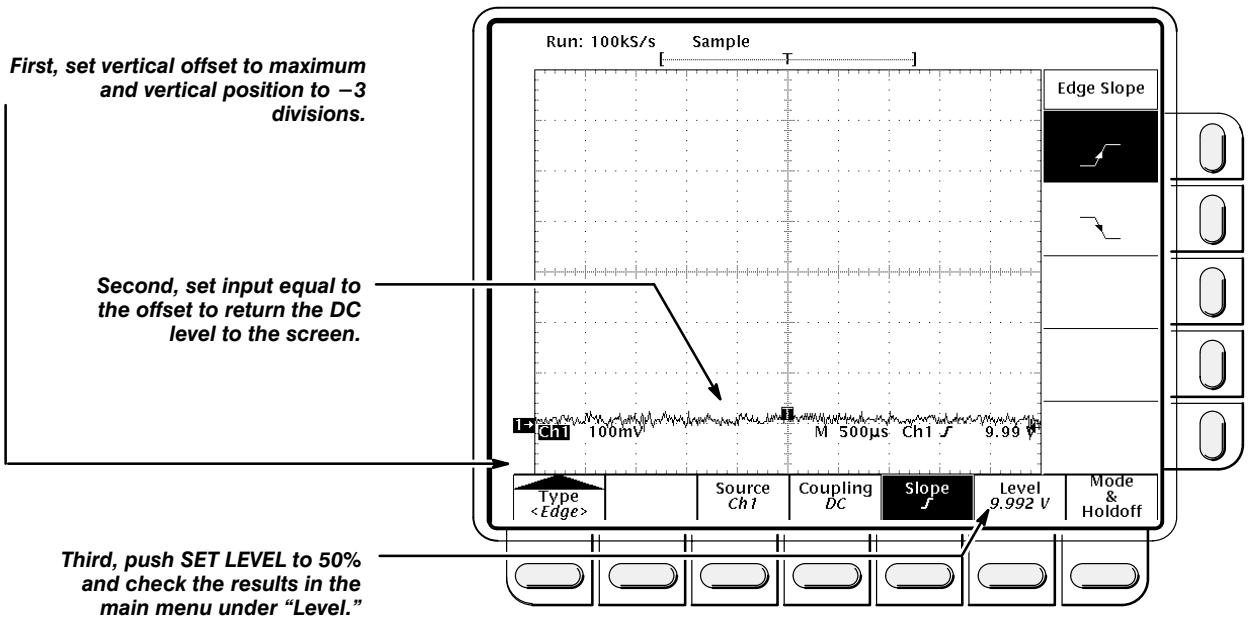


Figure 4-17: Measurement of Trigger-level Accuracy

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 Triggerable**.
      - Set **D** (delayed) horizontal **SCALE** to 500 µs.

   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%**. The **TRIG'D** indicator should be lit. 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 9.940 V to 10.060 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 9.940 V to 10.060 V, inclusive.

4. *Disconnect the hookup:*
   a. *First set the output of the DC calibration generator to 0 volts.*
   b. Then 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 10), one high-frequency leveled sine wave generator (Item 11), one precision 50 Ω coaxial cable (Item 4), and one 10X attenuator (Item 1). When checking the TDS 540A and 544A, a BNC T connector (Item 6), a 5X attenuator (Item 2), and a second precision 50 Ω coaxial cable (Item 4) are also required.

Prerequisites: *See page 4-15.*

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 20 ns.
      - Press **HORIZONTAL MENU**; then press the main-menu button **Time Base**.
      - Press the side-menu button **Delayed Only**; then the side-menu button **Delayed Triggerable**.
      - Set the horizontal **SCALE** for the **D** (delayed) time base to 20 ns; then press the side-menu button **Main Only**.
      - Press **TRIGGER MENU**; then press the main-menu button **Mode & Holdoff**. Now press the side-menu button **Normal**.
      - Press **VERTICAL MENU**; then press the main-menu button **Coupling**. Now press the side-menu **Ω** button and select the **50 Ω** setting.
      - Press **SHIFT**; then press **ACQUIRE MENU**. Now press the main-menu button **Mode**; then the side-menu **Average 16** button.

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

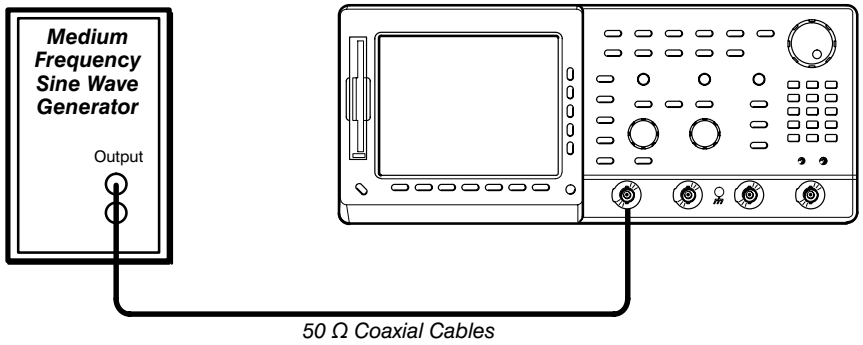


Figure 4-18: Initial Test Hookup—TDS 520A and 524A Only

- TDS 520A and 524A only: Connect, through a 50 Ω precision coaxial cable, the signal output of a medium-frequency sine wave generator to **CH 1**. See Figure 4-18.

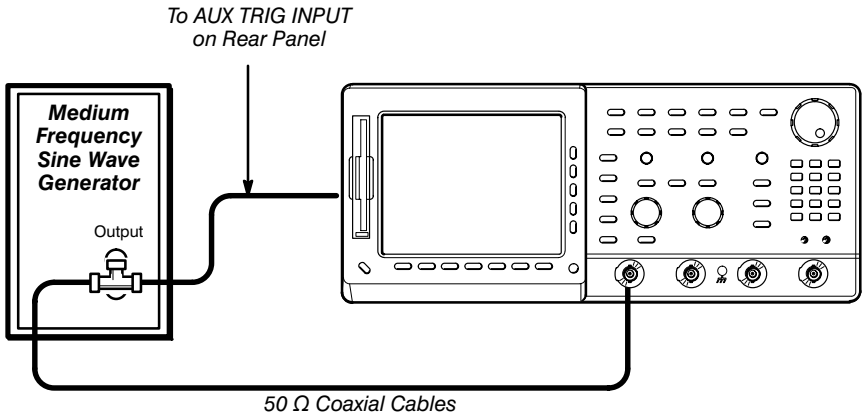


Figure 4-19: Initial Test Hookup—TDS 540A and 544A Only

- TDS 540A and 544A only: 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 to the **AUX TRIG INPUT** at the rear panel. See Figure 4-19.

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 Measrmnt 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 for 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.) See Figure 4-20.

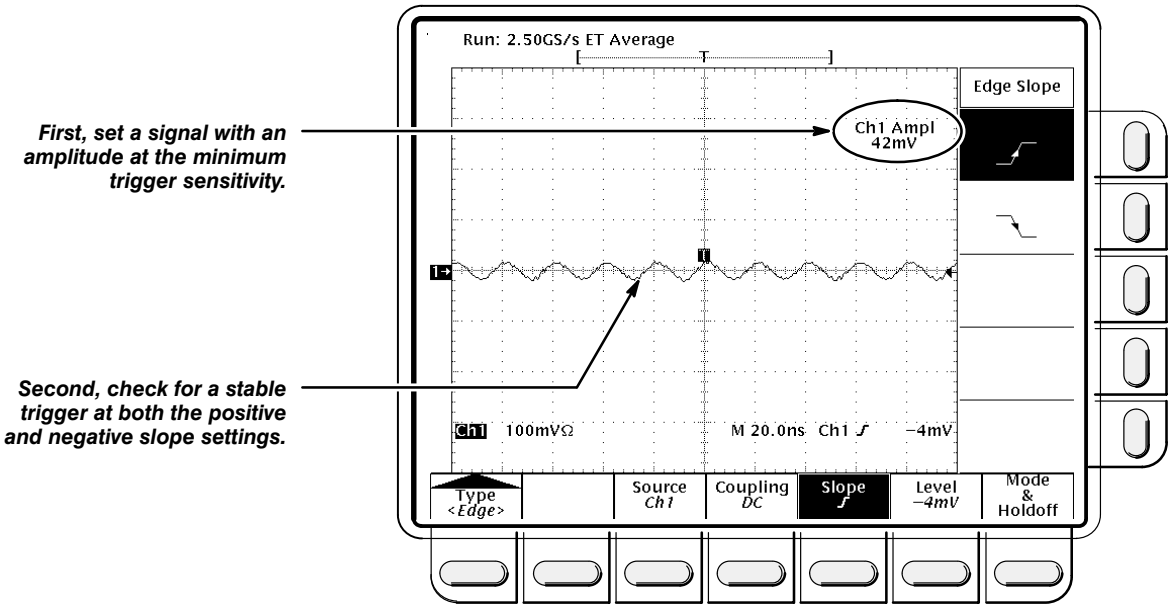


Figure 4-20: Measurement of Trigger Sensitivity

- Leave the Main trigger system triggered on the positive slope of the waveform before continuing to the next step. (The Main trigger system must be triggered to check the delayed trigger system in the next step.)

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**. Now press the side-menu button **Delayed Only**.
- 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 General Purpose knob to stabilize the 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**. Now press the side-menu button **Main Only**.

STOP

TDS 520A and 524A only: Skip to step 4 since the TDS 520A and 524A are not equipped with an AUX Trigger input. If testing the TDS 540A or 544A, continue with step 3.

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 the 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 **TRIGGER LEVEL** 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 Triggerable**.
   - 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 4-32, 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.*

When checking delayed triggering sensitivity at 500 MHz, the waveform record may have some missing interpolated record points. The waveform is still stably triggered. (See definition of a stable trigger earlier in this procedure.)

6. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of 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, *Specifications.* The oscilloscope outputs these signals at its front and rear panels.

Check Outputs — CH 3 and Main and Delayed Trigger (TDS 540A and 544A only)

Equipment Required: Two 50 Ω precision cables (Item 4), and one calibration generator (Item 9).

Prerequisites: See page 4-15. Also, this Digitizing Oscilloscopes must have passed *Check Accuracy — Long-Term Sample Rate, Delay time, Time Measurement* on page 4-39 and *Check Accuracy for DC Gain and Voltage Measurements* on page 4-25.

Procedure:

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

   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**. See Figure 4-21.
      - 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. See Figure 4-21.

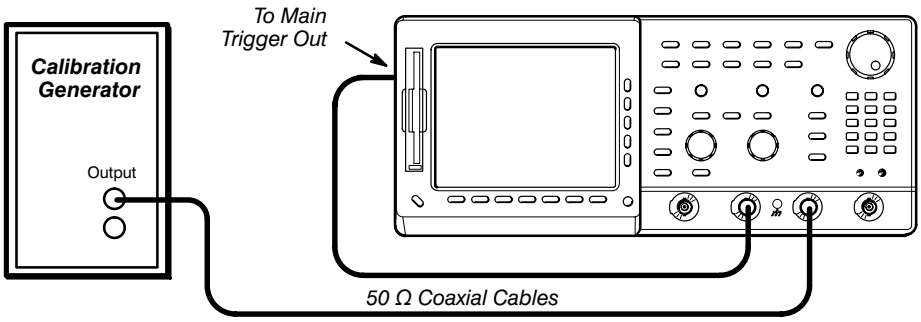


Figure 4-21: Initial Test Hookup

   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 horizontal **SCALE** to 200 µs.
- Press **SHIFT**; then **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Hi Res**.

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; then press **CH 2** to display that channel. Set the vertical **SCALE** to 1 V.
- Press **TRIGGER MENU**.
- Press the main-menu button **Source**; then press the side-menu button **CH 3**. Press **SET LEVEL TO 50%**.
- Use the vertical **POSITION** knob to center the display on screen.

b. *Measure logic levels:*

- Press **MEASURE**; then press the main-menu button **Select Measrmnt 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**. See Figure 4-22.

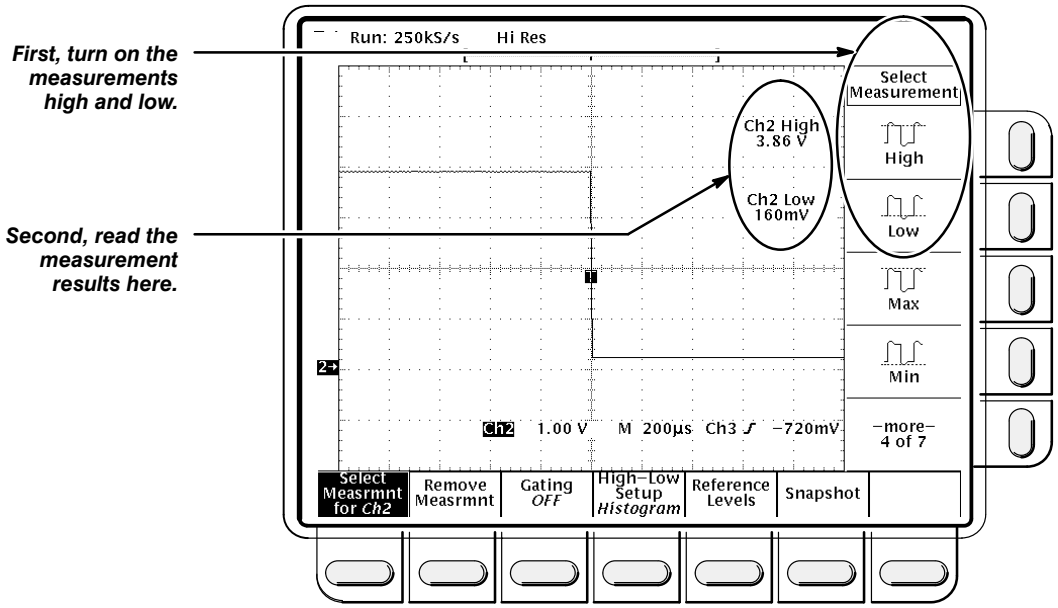


Figure 4-22: Measurement of Main Trigger Out Limits

c. *Check Main Trigger output against limits:*

- CHECK that the **Ch2 High** readout is ≥2.5 volts and that the **Ch2 Low** readout is ≤700 mV.
- 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 ≤250 mV.

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 ≤250 mV.
- Press the side-menu button **Ω** 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 ≤700 mV.

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

a. *Measure gain:*

- Move the precision 50 Ω cable from the rear-panel **DELAYED TRIGGER OUTPUT** BNC to the rear-panel **SIGNAL OUTPUT** BNC.
- Push **SHIFT**. Then push **DELAYED TRIG**.
- Press the main-menu button **Source**. Then press the side-menu button **Ch3**.
- Push **HORIZONTAL MENU**.
- Push the main-menu button **Time Base**. Then press the side-menu button **Delayed Triggerable**.
- Set vertical **SCALE** to 100 mV.
- Press **MEASURE**; then press the main-menu button **Select Measrmnt 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 90 mV and 110 mV, inclusive.
- Press **VERTICAL MENU**; then press the side-menu button **Ω** to toggle to the 50 Ω setting.
- Set vertical **SCALE** to 10 mV; then press **CLEAR MENU**.
- CHECK that the readout **Ch2 Pk-Pk** is between 45 mV and 55 mV, inclusive.

4. *Disconnect the hookup:* Disconnect the cable from the generator output at the input connector of the channel last tested.

Check Probe Compensator Outputs

One female BNC to clip adapter (Item 15), two dual-banana connectors (Item 5), one BNC T connector (Item 6), two 50 Ω precision cables (Item 4), and one DC calibration generator (Item 8).

Prerequisites: See page 4-15. Also, this Digitizing Oscilloscopes must have passed *Check Accuracy — Long-Term Sample Rate, Delay time, Time Measurement* on page 4-39 and *Check Accuracy for DC Gain and Voltage Measurements* on page 4-25.

Procedure:

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

a. *Hook up test-signal:*

- Connect **CH 1** to **PROBE COMPENSATION SIGNAL** and to **PROBE COMPENSATION GND** through a precision coaxial cable and a BNC to clip adapter. See Figure 4-23.

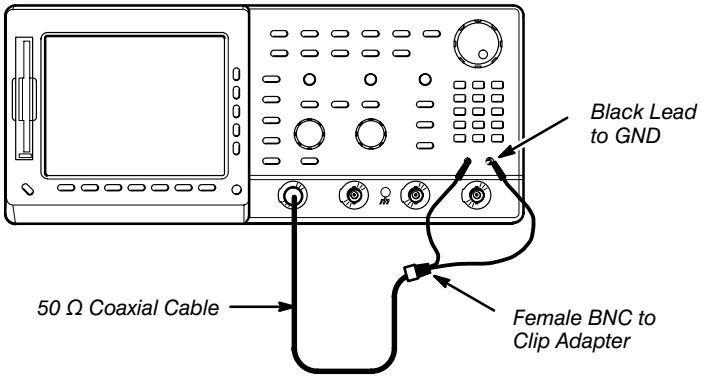


Figure 4-23: Initial Test Hookup

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 100 mV as required.
- Set the horizontal **SCALE** to 200 µs.
- Press **Set Level to 50%** and use the **VERTICAL POSITION** knob to center the display on screen.
- Press **SHIFT**; then **ACQUIRE MENU**.
- Press the main-menu button **Mode**; then press the side-menu **Average** button.
- Select **128** averages. On the keypad, type **128**; then press **ENTER**.

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 Measrmnt 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**.
- Press **CLEAR MENU** to remove the menus from the display. See Figure 4-24.

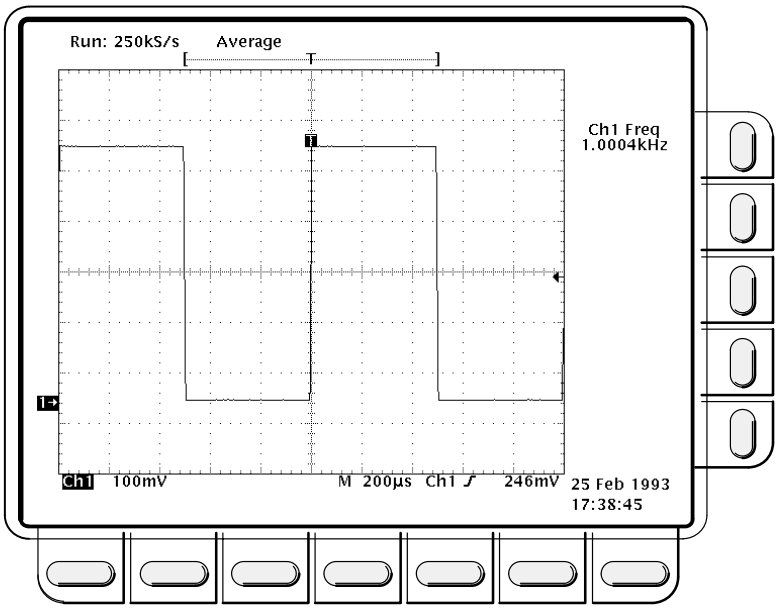


Figure 4-24: Measurement of Probe Compensator Frequency

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

3. *Confirm that the Probe Compensator signal is within limits for amplitude:*

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

- Press **SAVE/RECALL WAVEFORM**; then press the main-menu button **Save Wfm *Ch 1***.
- Press the side-menu button to **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**.

b. *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. See Figure 4-25.
- 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**. See Figure 4-25.

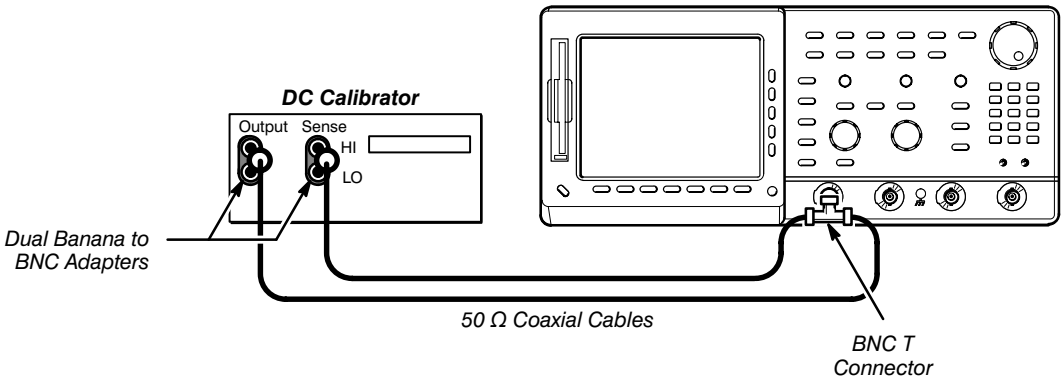


Figure 4-25: Subsequent Test Hookup

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

- Press **SHIFT**; then **ACQUIRE MENU**. Then use the keypad to set **AVERAGE** to **16** in the side menu.

- Adjust the output of 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 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.

d. Press **CLEAR MENU** to remove the menus from the display. See Figure 4-26.

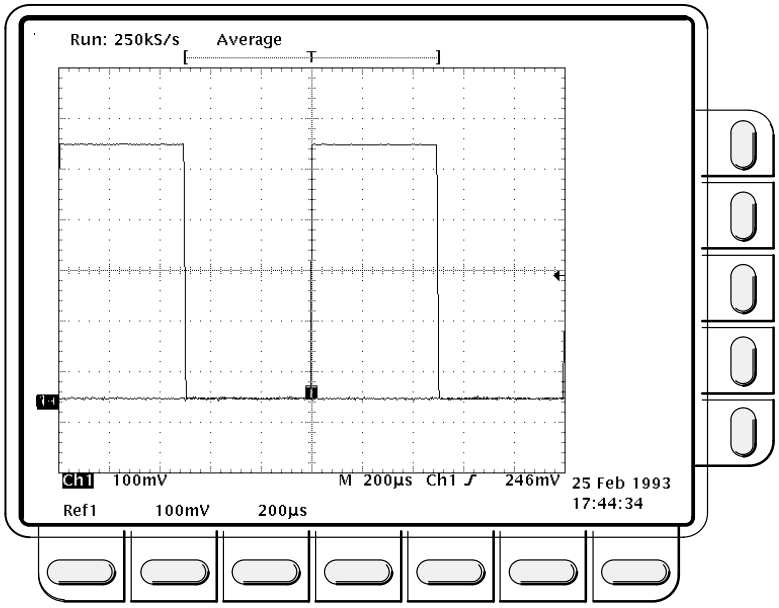


Figure 4-26: Measurement of Probe Compensator Amplitude

e. *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.

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

Option 05 Video Trigger Checks

Equipment Required: PAL signal source (Item 16), 60 Hz. sine wave generator (Item 17), pulse generator (Item 18), 75 Ω Cable (Item 19), 75 Ω terminator (Item 20), 50 Ω cable (Item 4), 50 Ω terminator (Item 3).

Check Video Trigger

Prerequisites: See page 4-15. These prerequisites include running the signal path compensation routine.

Procedure:

1. Setup digitizing oscilloscope to factory defaults by completing the following steps:
   a. Press save/recall **SETUP**.
   b. Press the main-menu **Recall Factory Setup**.
   c. Press the side-menu **OK Confirm Factory Init**.
   d. Wait for the Clock Icon to leave the screen.
   e. CONFIRM the digitizing oscilloscope is setup as shown below.

      Channel: CH1

      Volt/div: 100 mV

      Horizontal scale: 500 µs/div
2. Setup digitizing oscilloscope for TV triggers by completing the following steps:
   a. Press **TRIGGER MENU**.
   b. Press the main-menu **Type** pop-up until you select **Video**.
   c. Press the main-menu **Standard** pop-up until you select **625**/**PAL**.
   d. Press the main-menu **Line**.
   e. Use the keypad to set the line number to 7 (press **7**, then **ENTER**).
   f. Press **VERTICAL MENU**.
   g. Press the main-menu **Bandwidth**.
   h. Select **100 MHz** from the side menu.
   i. Press the main-menu **Fine Scale**.
   j. Use the keypad to set the fine scale to **282mV** (press **282**, **SHIFT**, **m**, then **ENTER**).
   k. Press **HORIZONTAL MENU**.
   l. Press the main-menu **Horiz Scale**.
   m. Use the keypad to set the horizontal scale to 200 ns (press **200**, **SHIFT**, **n,** then **ENTER**).

3. Check Jitter vs. Signal Amplitude

   a. Setup equipment for Jitter Test (See Figure 4-27).

   - Connect one of the rear panel composite outputs marked **COMPST** on the TSG121 through a 75 Ω cable and a 75 Ω terminator to the oscilloscope CH1 input.
   - Press the PAL signal source **100% FIELD** control (the fourth TSG121 front-panel button from the left).

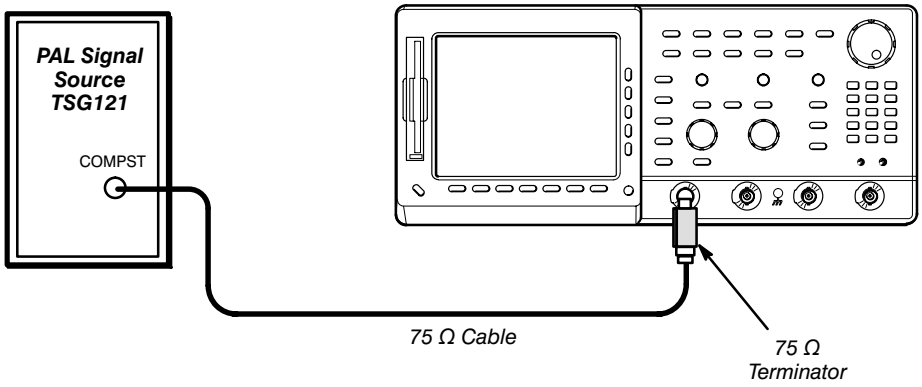


Figure 4-27: Jitter Test Hookup

   b. CHECK that the oscilloscope lights up its front panel **TRIG'D** LED and it displays the waveform on screen (See Figure 4-28).

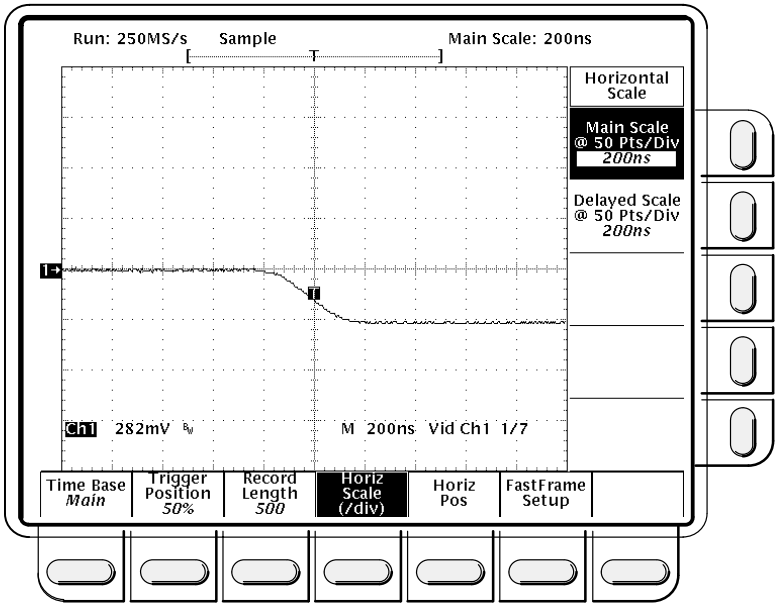


Figure 4-28: Jitter Test Displayed Waveform

- CONFIRM that the **TRIG'D** LED is lit and the waveform is displayed on screen.

c. Press **SHIFT**; then **ACQUIRE MENU**.

d. Press the main-menu **Mode**.

e. Select the side-menu **Average**. It should be already set to 16.

f. Press the main-menu **Create Limit Test Template**.

g. Press the side-menu **V Limit**.

h. Use the keypad to set V Limit to 100 mdiv (press **100**, **SHIFT**, **m**, then **ENTER**)

i. Press the side-menu **OK Store Template**.

j. Press **MORE**.

k. Press the main-menu **Ref1**.

l. Press **CH1**.

m. Press **SHIFT**; then **ACQUIRE MENU**.

n. Press the main-menu **Limit Test Setup**.

o. Toggle the side-menu **Limit Test** to **ON**.

p. Toggle the side-menu **Ring Bell if Condition Met** to **ON**.

q. Press the main-menu **Mode**.

r. Press the side-menu **Envelope**.

s. Use the keypad to set envelope to use 100 acquisitions (press **100**, then **ENTER**).

t. Press the main-menu **Stop After** button.

u. Press the side-menu **Single Acquisition Sequence.**

v. CONFIRM that the oscilloscope successfully makes 100 acquisitions. If not successful, the oscilloscope bell will ring. When the word **Run** in the top left corner of the display changes to **STOP**, the test is complete (See Figure 4-29).

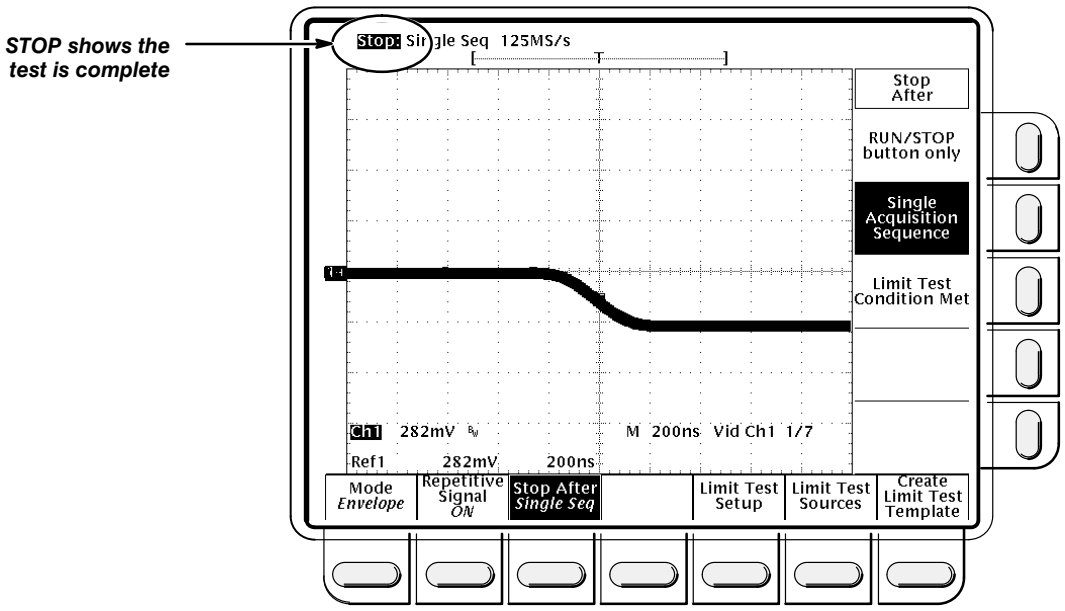


Figure 4-29: Jitter Test When Completed

w. Press the main-menu **Limit Test Setup**.

x. Toggle the side-menu **Ring Bell if Condition Met** to **OFF**.

y. Toggle the side-menu **Limit Test** to **OFF**.

4. Check Triggered Signal Range.

   Setup oscilloscope for Triggered Signal Test.

   a. Press **MORE**.

   b. Press **WAVEFORM OFF**.

   c. Press **HORIZONTAL MENU**.

   d. Use the keypad to set the horizontal scale time-per-division (**Horiz Scale (/div)**) to 50 µs (press **50**, **SHIFT**, **µ**, then **ENTER**).

   e. Press **SHIFT**; then **ACQUIRE MENU**.

   f. Press the main-menu **Stop After**.

   g. Press the side-menu **RUN/STOP button only**.

   h. Press the main-menu **Mode**.

   i. Press the side-menu **Sample**.

   j. Press **RUN/STOP**.

   k. Press **VERTICAL MENU**.

   l. Use the keypad to set fine scale to 300 mV (press **300**, **SHIFT**, **m,** then **ENTER**).

m. CONFIRM that the **TRIG'D** LED stays on and that the waveform on screen is stable. ie; does not move horizontally or vertically. Also, CONFIRM that the waveform on the screen has one positive pulse and a number of negative pulses (See Figure 4-30).

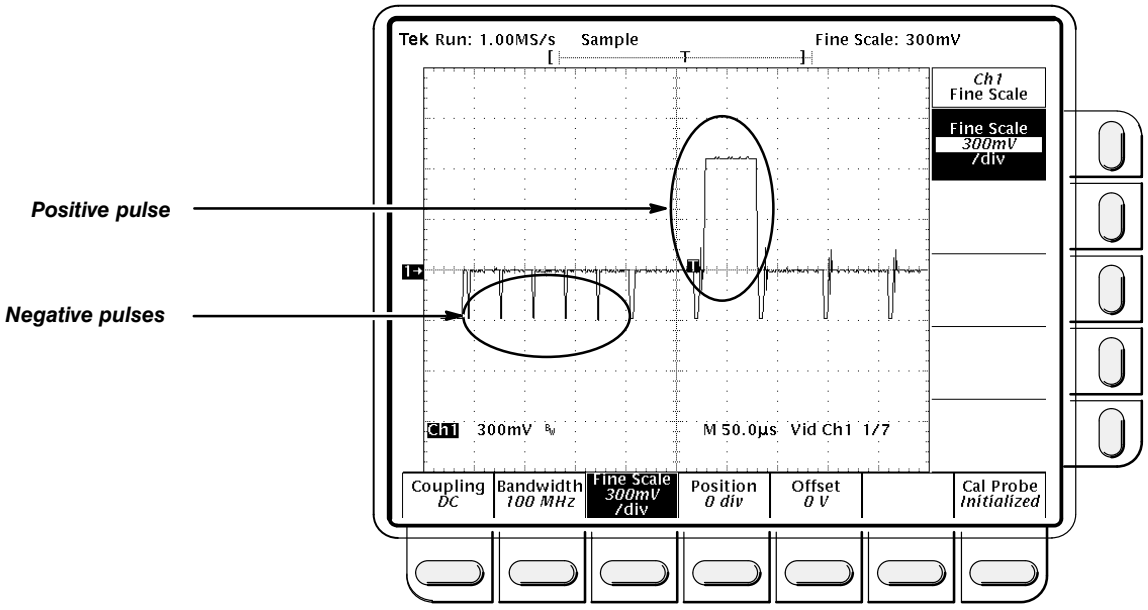


Figure 4-30: Triggered Signal Range Test – 300 mV

n. Use the keypad to set the fine scale to 75 mV (press **75**, **SHIFT**, **m**, then **ENTER**).

o. CONFIRM that the **TRIG'D** LED stays lit and that the waveform on screen is stable. ie; does not move horizontally or vertically. Also, CONFIRM that the waveform on the screen has one positive pulse and a number of negative pulses (See Figure 4-31).

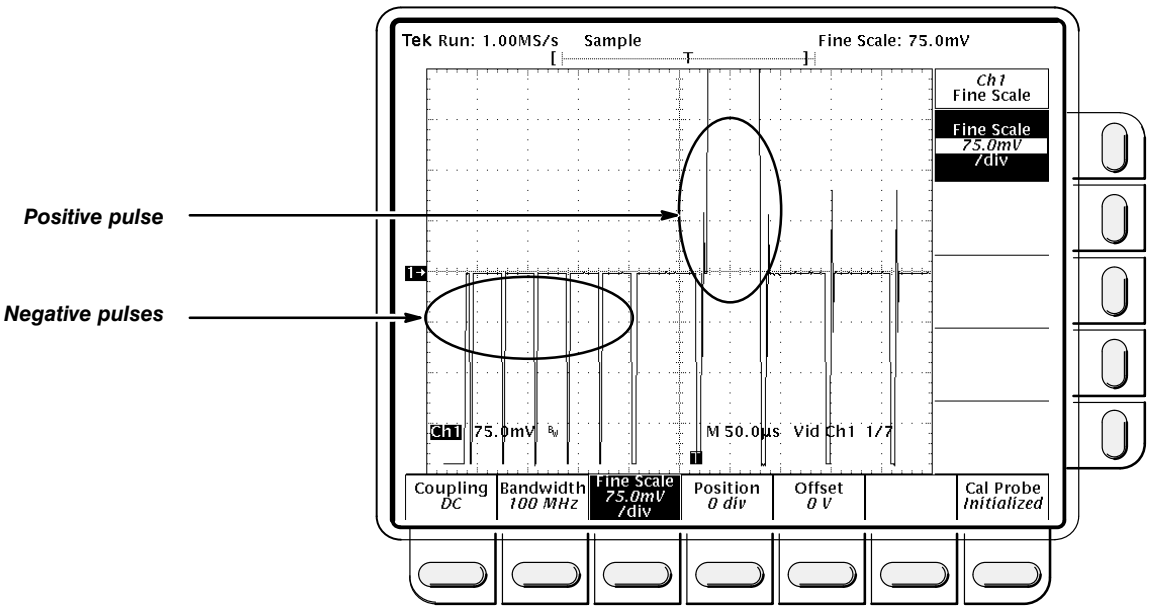


Figure 4-31: Triggered Signal Range Test – 75 mV

p. Disconnect all test equipment (TSG121) from the digitizing oscilloscope.

5. Check 60 Hz Rejection.

   a. Setup oscilloscope for 60 Hz Rejection Test.

      - Use the keypad to set the Ch1 Fine Scale to 282 mV (press **282**, **SHIFT m**, then **ENTER**)**.**
      - Press **WAVEFORM OFF**.
      - Press **CH2**.
      - Press **VERTICAL MENU**.
      - Use the keypad set the fine scale to 2 V (press **2**, then **ENTER**).
      - Press **HORIZONTAL MENU**.
      - Use the keypad to set the horizontal scale time-per-division (**Horiz Scale (/div)**) to 5 ms (press **5**, **SHIFT**, **m**, then **ENTER**).

   b. Setup 60 Hz signal generator (SG 502).

      - Connect the output of the SG 502 to the CH2 input through a 50 Ω cable (See Figure 4-32).

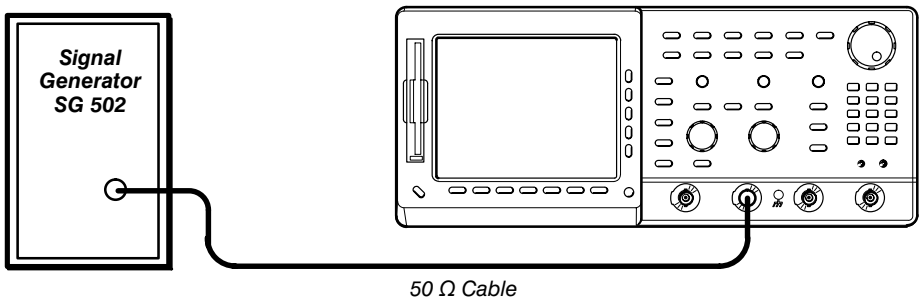


Figure 4-32: 60 Hz Rejection Test Hookup

- Adjust the SG 502 for three vertical divisions of 60 Hz signal (See Figure 4-33). The signal will not be triggered. That is, it will run free.

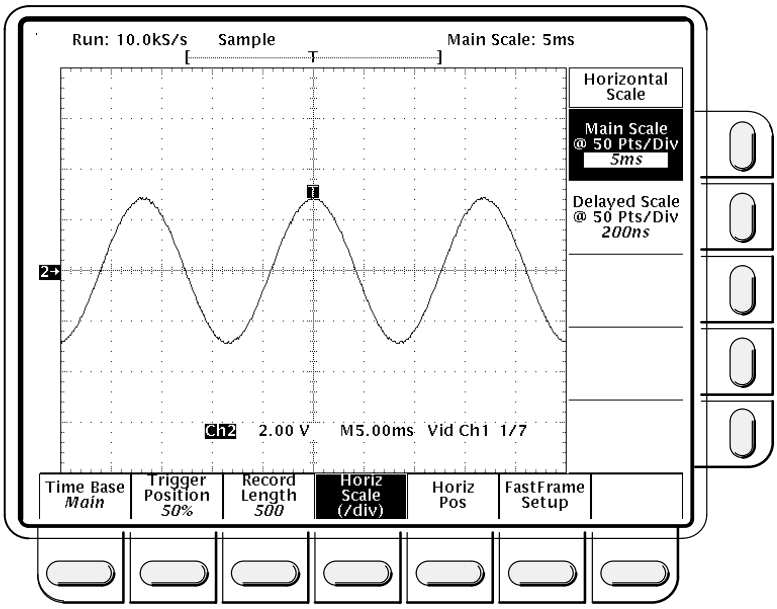


Figure 4-33: 60 Hz Rejection Test Setup Signal

c. Check 60 Hz rejection.

- Use the keypad to set the the horizontal scale time-per-division (**Horiz Scale (/div)**) to 50 µs (press **50**, **SHIFT**, **µ**, then **ENTER**).
- Reconnect the output of the signal generator (SG 502). Connect the PAL signal source's composite signal connector (labelled **COMPST** on the TSG 121) to a 75 Ω cable and a 75 Ω terminator. Connect both signals to the CH1 input through a BNC T (See Figure 4-34).

- Press **VERTICAL MENU**.
- If needed, press the main-menu **Fine Scale**.
- Use the keypad to set fine scale to 500 mV (press **500**, **SHIFT**, **m**, then **ENTER**).
- Connect another the PAL signal source's composite signal connector (labelled **COMPST** on the TSG 121) through a 75 Ω cable and a 75 Ω terminator to the CH2 input (See Figure 4-34).

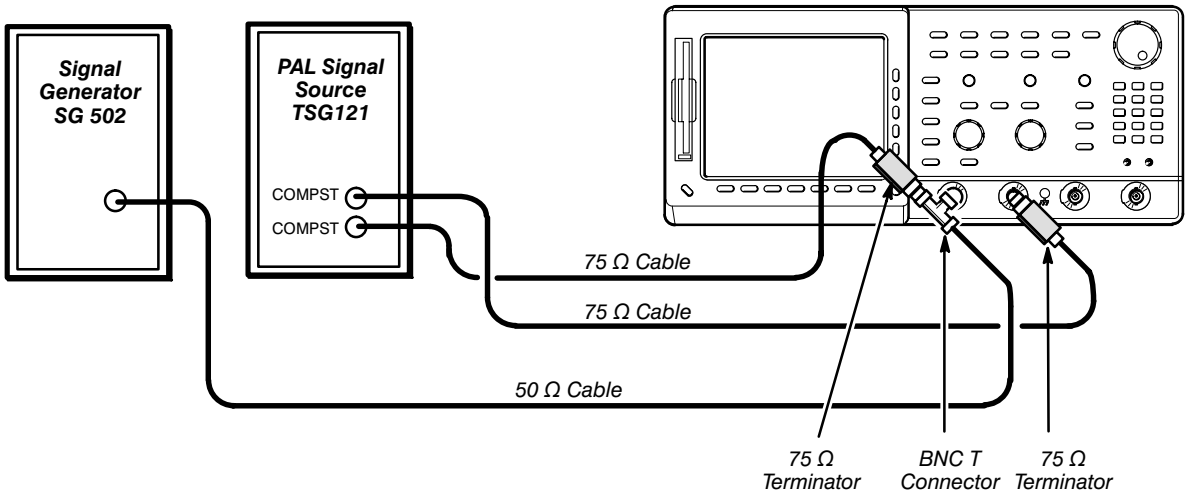


Figure 4-34: Subsequent 60 Hz Rejection Test Hookup

- CONFIRM that the **TRIG'D** LED stays on and that the waveform on screen is stable. Stable means the waveform does not move horizontally or vertically. Also, confirm that the waveform on the screen has one positive pulse and a number of negative pulses (See Figure 4-35).

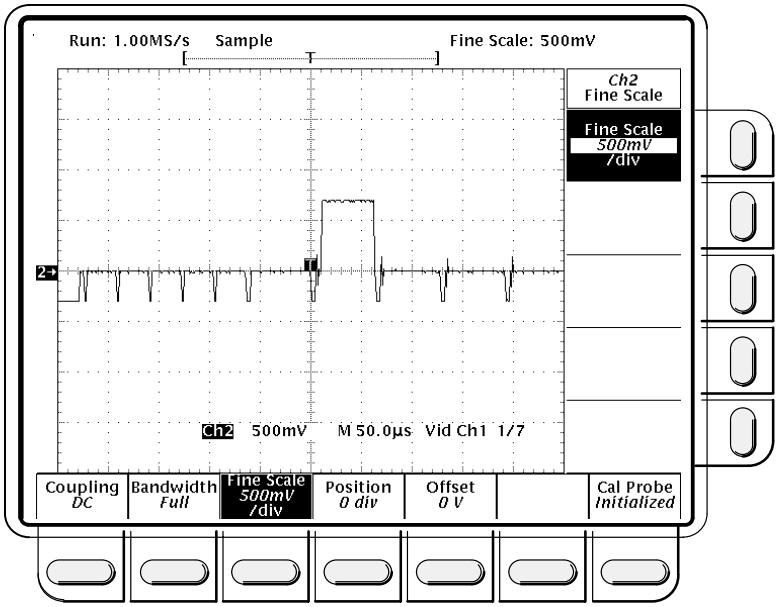


Figure 4-35: 60 Hz Rejection Test Result

- Disconnect all test equipment from the digitizing oscilloscope.

6. Check Line Count Accuracy.

   a. Setup oscilloscope for Line Count Accuracy Test.

      - Press **WAVEFORM OFF**.
      - Press **CH1**.
      - Press **HORIZONTAL MENU**.
      - Press the main-menu **Record Length**.
      - Press, if needed, the side-menu **−more− 1 of 2**.
      - Press the side-menu **5000 points in *100divs***.
      - Press the main-menu **Horiz Scale (/div)**.
      - Use the keypad to set the horizontal scale to 200 ns (press **200**, **SHIFT**, **n**, then **ENTER)**.

   b. Check Line Count Accuracy.

      - Connect a composite output signal from the PAL signal source (on the TSG 121 this refers to the signal at the rear labelled **COMPST**) to the CH1 input through a 75 Ω cable and a 75 Ω terminator (See Figure 4-36).

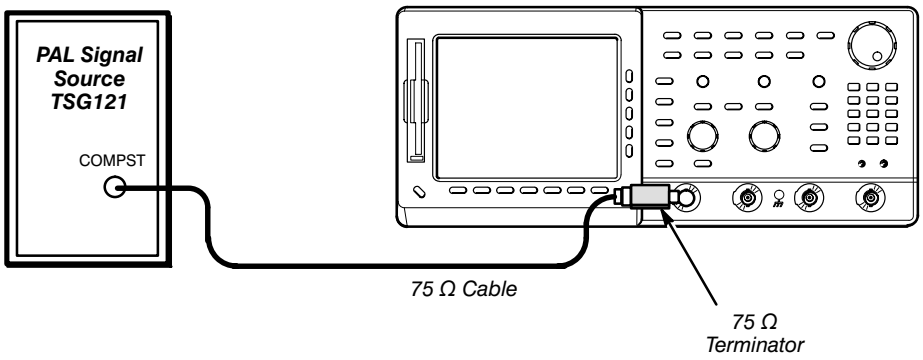


Figure 4-36: Line Count Accuracy Test Hookup

- Press the main-menu **Trigger Position**.
- Press the side-menu to **Set to 50%**.
- Press the main-menu **Horiz Pos**.
- Press the side-menu to **Set to 50%**.
- Use the **HORIZONTAL POSITION** knob to move the falling edge of the sync pulse to two divisions to the left of center screen (See Figure 4-37).

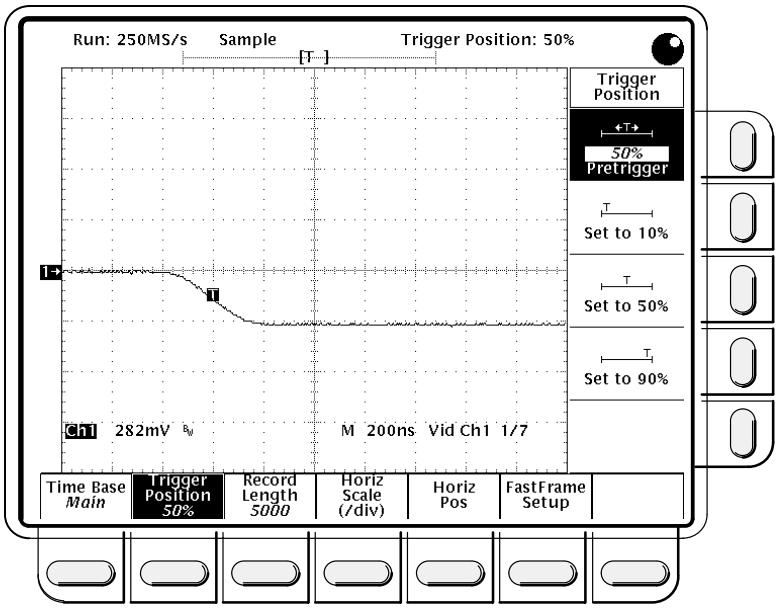


Figure 4-37: Line Count Accuracy Test Setup Waveform

- Press **CURSOR**.
- Press the main-menu **Function**.

- Press the side-menu **V Bars**.
- Using the General Purpose knob, place the left cursor directly over the trigger “T” icon.
- Press **SELECT**.
- Turn the General Purpose knob to adjust the right cursor for a cursor delta reading of **6.780us**.
- Use the **HORIZONTAL POSITION** knob to position the right cursor to center screen.
- Verify that the cursor is positioned on a positive slope of the burst signal (See Figure 4-38).

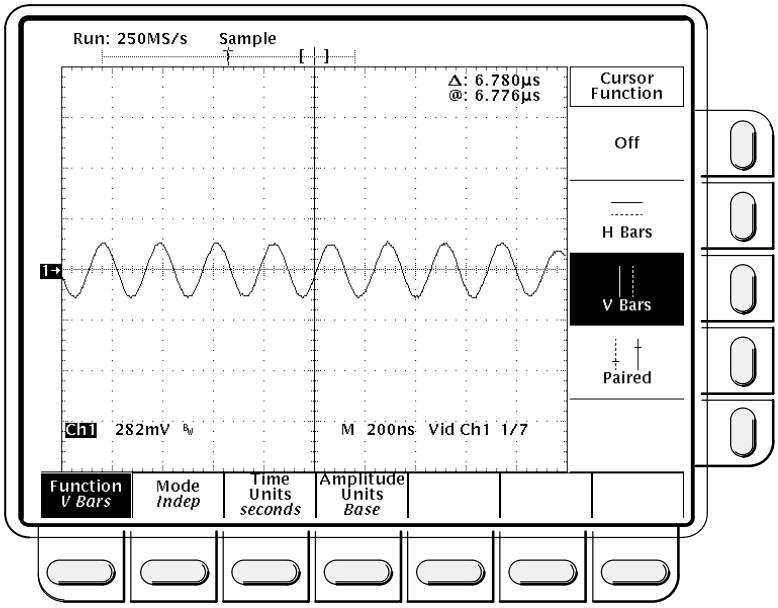


Figure 4-38: Line Count Accuracy Correct Result Waveform

- Disconnect all test equipment (TSG 121) from the digitizing oscilloscope.
- Turn off cursors by pressing **CURSOR**, then the main-menu **Function** button, and, finally, **Off** from the side menu.

7. Check the Sync Duty Cycle.

   a. Setup digitizing oscilloscope for Sync Duty Cycle Test.

   - Press **TRIGGER MENU**.
   - Press the **Standard** pop-up to select **FlexFmt**. (Trigger **Type** should already be set to **Video**)
   - Press the main-menu **Setup**.

- Press the side-menu **Field Rate**.
- Use the keypad to set the field rate to 60.05 Hz (press **60.05**, then **ENTER**).
- Press the side-menu **Lines**.
- Use the keypad to set the field rate to 793 lines (press **793**, then **ENTER**).
- Press the side-menu **Fields**.
- Use the keypad to set the number of fields to 1 (press **1**, then **ENTER**).
- Press the side-menu **Sync Width**.
- Use the keypad to set the width to 400 ns (press **400**, **SHIFT**, **n**, then **ENTER**).
- Press the side-menu **−more− 1 of 2**. Then press **V1 Start Time**.
- Use the keypad to set V1 start time to 10.10 µs (press **10.10**, **SHIFT**, **µ**, then **ENTER**).
- Press the side-menu **V1 Stop Time**.
- Use the keypad to set V1 stop time to 10.50 µs (press **10.50**, **SHIFT**, **µ**, then **ENTER**).
- Press the main-menu **Type** pop-up to select **Edge**.
- Press **HORIZONTAL MENU**.
- Press the main-menu **Record Length**.
- Select the side-menu **1000 points in 20div**. (if needed, first press the side-menu **−more− 2 of 2**).
- Turn the **HORIZONTAL POSITION** knob to position the trigger 'T' two divisions to the left of the center screen.
- Press **MEASURE**.
- If needed, press the main-menu **Select Measrmnt**.
- Press the side-menu **Negative Width**.
- Press the side-menu **Period**.

b. Setup the pulse generator (PG502) for Sync Duty Cycle Test

- Set **PULSE DURATION** to 50 ns.
- Set **PERIOD** to 10 µs.
- Set **OUTPUT (VOLTS)** to **−1** for **LOW LEVEL** and **+1** for **HIGH LEVEL**.
- Depress the **COMPLEMENT** button.
- Be sure **BACK TERM** is depressed (in).

c. Check Sync Duty Cycle

- Connect the pulse generator (PG502) through a 50 Ω cable and a 50 Ω terminator to the oscilloscope CH1 input (See Figure 4-39).

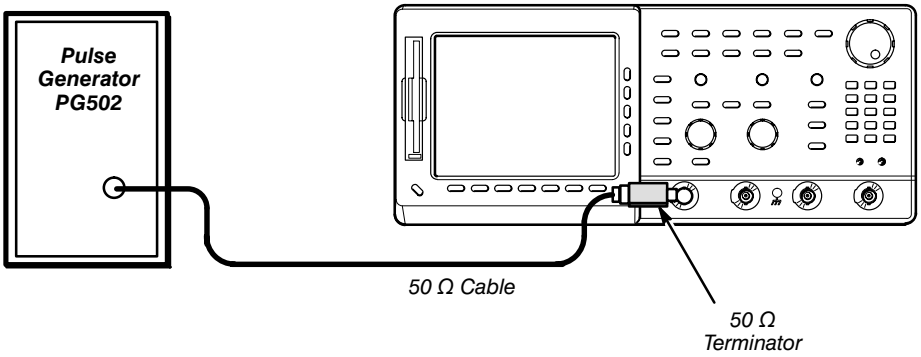


Figure 4-39: PG502 Setup for Sync Duty Cycle Test

- Turn the pulse generator **OUTPUT (VOLTS)** control until the signal on the oscilloscope shows a one division negative going pulse (See Figure 4-40).

NOTE

You may need to adjust the trigger level control to obtain a stable trigger.

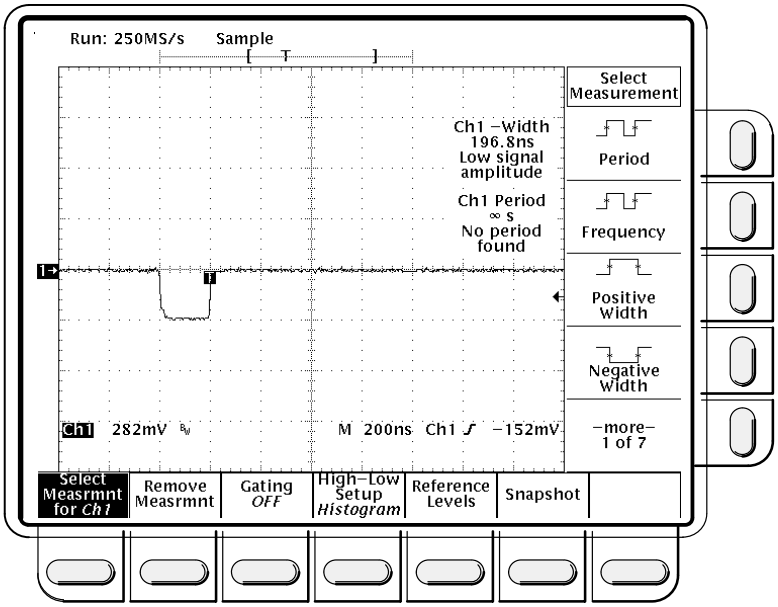


Figure 4-40: Sync Duty Cycle Test: One-Div Neg Pulse Waveform

- Turn the pulse generator **PULSE DURATION** variable control to adjust the negative pulse so the oscilloscope **CH1 − Width** measurement displays **400ns +/−10 ns**.
- Turn the **HORIZONTAL SCALE** knob to set the oscilloscope time base to **5 µs/div**.
- Turn the pulse generator PERIOD variable control to adjust the period until the oscilloscope **CH1 Period** measurement reads **21.000µs −25/+50 ns** (See Figure 4-41). Read note shown below.

NOTE

The pulse duration and period adjustments are critical in making this measurement. If the pulse duration and/or the duty cycle are not stable, the FLEXFMT function may not function. You must take care when making these adjustments.

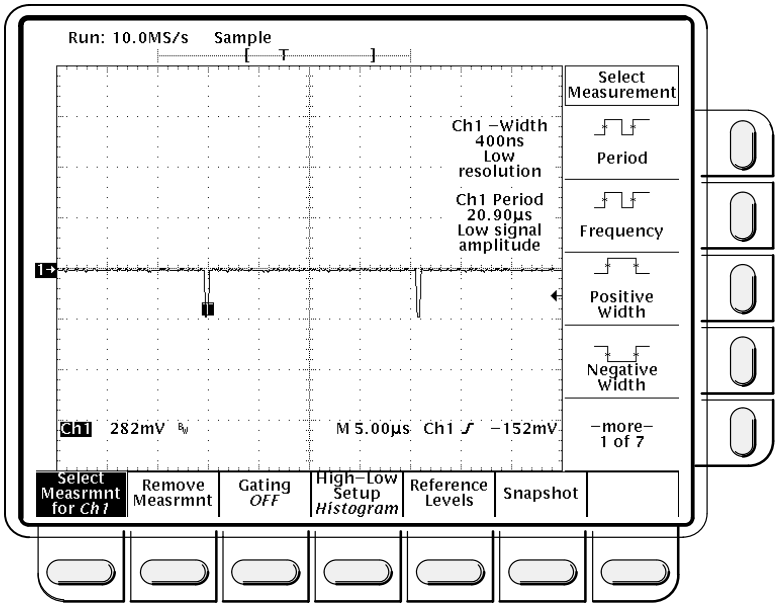


Figure 4-41: Sync Duty Cycle Test: Critically Adjusted Pulse

- Press **TRIGGER MENU**.
- Press the main-menu **Type** pop-up until you select **Video**.

  If the **TRIG'D** LED is not on, check that the **CH1 – Width** and **CH1 Period** measurements are adjusted correctly (see note above). CONFIRM that the setup is correct and the oscilloscope will trigger.
- CONFIRM that the **TRIG'D** LED is on and the waveform is stable.
- Disconnect the signal source from CH1, wait a few seconds, then reconnect the signal.
- CONFIRM that the **TRIG'D** LED is on and the waveform is stable.
- Press **Sync Polarity**.
- Press **Pos Sync**.
- Push the pulse generator **COMPLEMENT** button out.
- CONFIRM that the **TRIG'D** LED is on and the waveform is stable.
- Disconnect the signal source from CH1, wait a few seconds, then reconnect the signal.
- CONFIRM that the **TRIG'D** LED is on and the waveform is stable.
- Disconnect all test equipment (TSG 121) from the oscilloscope.
- Press save/recall **SETUP**, press the main-menu button **Recall Factory Setup**, and the side-menu **OK Confirm Factory Init**.

Replace this page with the Tab named Adjustment Procedures

Adjustment Procedures

This section contains information needed to adjust TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes to bring them to conformance with the *Warranted Characteristics* as listed in the *Specifications* section of this manual.

The *Adjustment Procedures* are divided into seven subsections as follows:

- General Information gives basic start-up information.
- Equipment Requirements and Options provides information about computer system, peripheral, and test equipment needed to perform the adjustment procedures.
- Adjustments contains general information about using *TDS 520A, 524A, 540A, & 544A Adjustment Software* and adjustment dependencies.
- Equipment Required is a list of equipment needed to perform the adjustments.
- Adjustment Instructions provides procedures for installing and using the *TDS 520A, 524A, 540A, & 544A Adjustment Software* (included with this manual). Read the material found in this section before using the adjustment software.
- Probe Adjustment is a procedure for manually adjusting the P6139A probe.
- Display Assembly Adjustment is a procedure for manually adjusting the display assembly.

General Information

This procedure is to be performed only 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. Performance errors may occur if adjustments are done before the operating temperature has stabilized.

Access

Do not remove the cabinet except when adjusting the display assembly. The internal adjustment constants of the oscilloscope are enabled or disabled through two small holes in the chassis.

Equipment Requirements and Options

The following computer system, peripherals, and test equipment are required to adjust this oscilloscope:

Computer System and Peripheral Requirements

- An IBM® PC™ or a strict compatible is required
- Eight MHz clock speed or faster.
- DOS 3.2 or higher.
- 640K Resident RAM with 550K 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 S3FG210).
- Suitable keyboard and monitor.

Optional Peripherals

Installation of a math coprocessor integrated circuit (IC) in your system is not required, but 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.

Adjustments

The following topics describe what you must do to adjust the oscilloscope and what is done by the software. Individual adjustment performance and adjustment dependencies are also discussed.

Performing the Adjustments

These procedures are used to return the 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.

As a general rule, these adjustments should be done every 2000 hours of operation or once a year if used infrequently.

You will not be required to manually adjust any circuits when using the adjustment software. The software adjusts the circuits using external standards you provide in response to prompts on the computer screen. Your function is to provide those test signals and to prompt the computer to continue.

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

Complete Adjustment

A *complete adjustment*, is defined as the performance of all adjustments on the *TDS 520A, 524A, 540A, & 544A Adjustment Software,* in sequence, plus the *Probe Adjustment* (see page 5-11).

Individual Adjustments

The adjustment software contains three classes of adjustments. Each class contains one (or more) individual calibration test(s) and may also include a Signal Path Compensation (SPC). The three classes of adjustments are as follows:

- Voltage Reference Adjustment.
- Frequency Response Adjustment
- Pulse Trigger Adjustment

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

This internal routine is not an adjustment. It is a temperature compensation routine that compensates for the current operating temperature to optimize oscilloscope performance.

Partial Adjustment

The adjustment software will allow you to make individual adjustments, however this is not recommended 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 5-1).

Table 5-1: Adjustments Required for Module Replaced

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

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

Adjustment Dependencies

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

Table 5-2: Adjustments and Dependencies

Adjustment	Prior Completion Requirements
Voltage Reference Adjustment	None
Frequency Response Adjustment	Voltage Reference
Pulse Trigger Adjustment	Voltage Reference
Probe Adjustment	Voltage Reference and Frequency Response
Display Assembly Adjustment	None

Equipment Required

The following test equipment is required to adjust the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

Table 5-3: 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 013−0028−00	Probe Adjustment
2	Adapter, Probe Tip to BNC, 50 Ω termination	Tektronix 013−0227−00	Tektronix 013−0227−00	Probe Adjustment
3	Adjustment Tool	Less than 1/8 inch diameter and over 2 inches long	Tektronix 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 60 V to 100 V.	Tektronix PG 506A Calibration Generator[1]	Probe Adjustment
11	Generator, DC Calibration	Variable amplitude to ±10 V; accuracy to 0.05%	Data Precision 8200	Software-based Adjustments

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

Table 5-3: Test Equipment, Fixtures, and Supplies (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
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: 2nd harmonic down −30 dB from fundamental; all others down −40 dB	Tektronix SG 503[1] or SG5030[2] Leveled Sine Wave Generator	Software-based Adjustments
13 Generator, Leveled Sine Wave, High-Frequency	250 MHz to 500 MHz; Variable amplitude from 5 mV to 4 V_{p-p} into 50 Ω; 6 MHz reference; harmonic content: 2nd harmonic down −30 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[2] 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, P6139A 10X	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.**
2 **Requires a 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* Computer System Requirements *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. Table 5-4 on page 5-7 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 5-4: 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



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 520A, 524A, 540A, & 544A Adjustment Software* disk to a working disk.

2. *Install the software to hard disk:*

   a. Install your working disk in a floppy drive then 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 *TDS500.ADJ* on your hard drive.

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

Software-based Adjustments

Equipment Required: All items that are listed for "Software-based Adjustments" under "Purpose" in Table 5-3 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 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:* The protection switch that enables or disables the writing of new adjustment constants to non-volatile RAM (NVRAM) is accessed through one of two small holes in the oscilloscope chassis (see Figure 5-1).

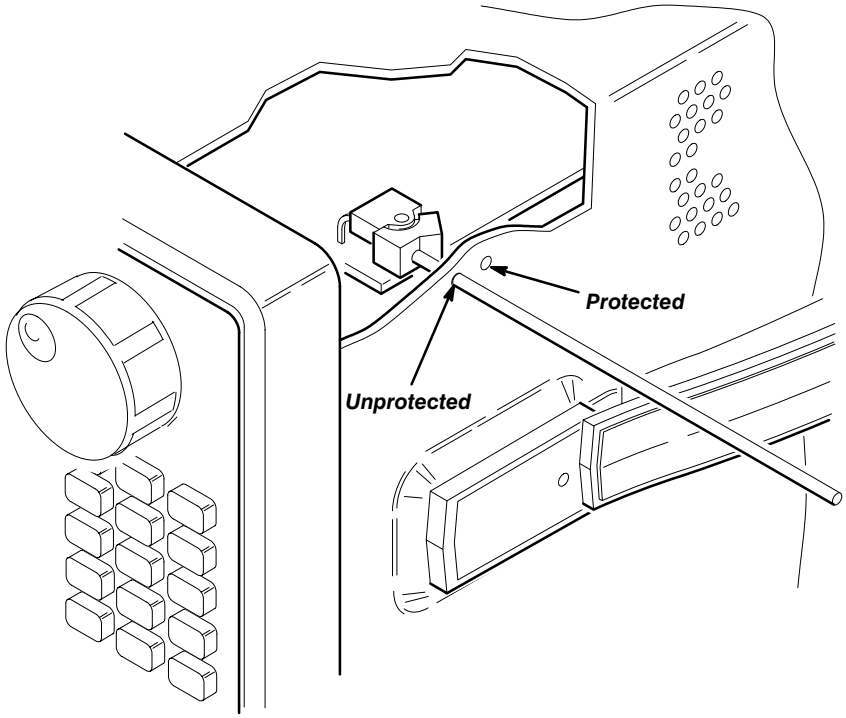


Figure 5-1: Accessing the Protection Switch

   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 1/2 inch to engage the rocker switch.

   c. Use the inserted adjustment tool to push the switch to its unprotected (enabled) position.

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 the drive to the hard drive.

   b. Change directories to *TDS500.ADJ*.

   c. Type *ADJ500.*

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

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 1/2 inch to engage the rocker switch.

c. Using the inserted adjustment tool, push the switch to its protected (disabled) position.

d. To do a complete adjustment as defined on page 5-3, you must also do the *Probe Adjustment* procedure starting on page 5-11.

Probe Adjustment

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) and one adjustment tool (Item 3).

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

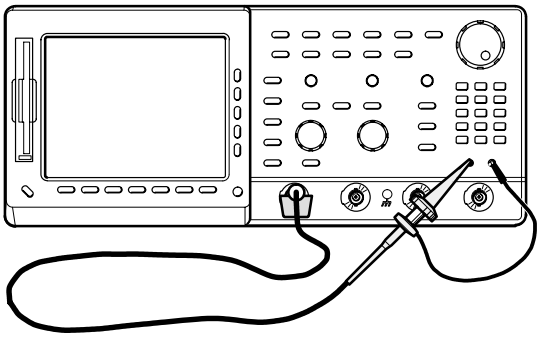


Figure 5-2: Hookup for Probe Compensation

a. *Hook up test-signal source:* Install the standard-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 200 µs.
- Press **SHIFT**. Then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Hi Res**.

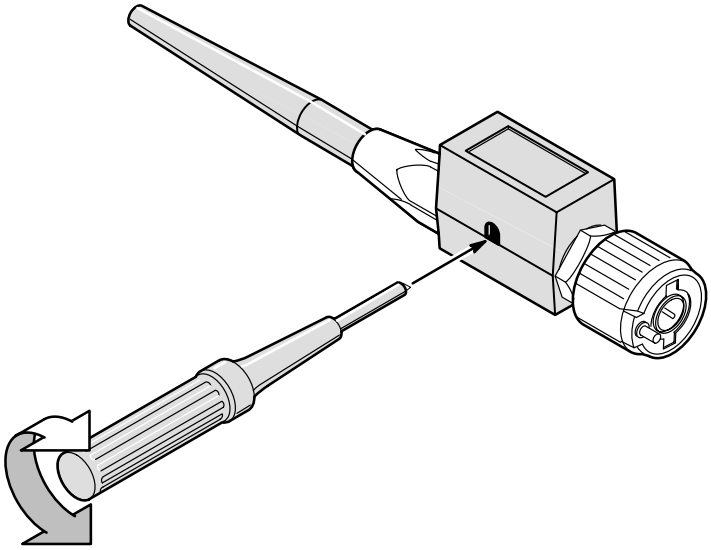


Figure 5-3: Performing Probe Compensation

2. *Compensate the Probe:*

   a. Locate the probe compensation hole in the side of the probe body (see Figure 5-3).

   b. Using the adjustment tool, adjust the probe for best square wave compensation (flat as possible across its across its top).

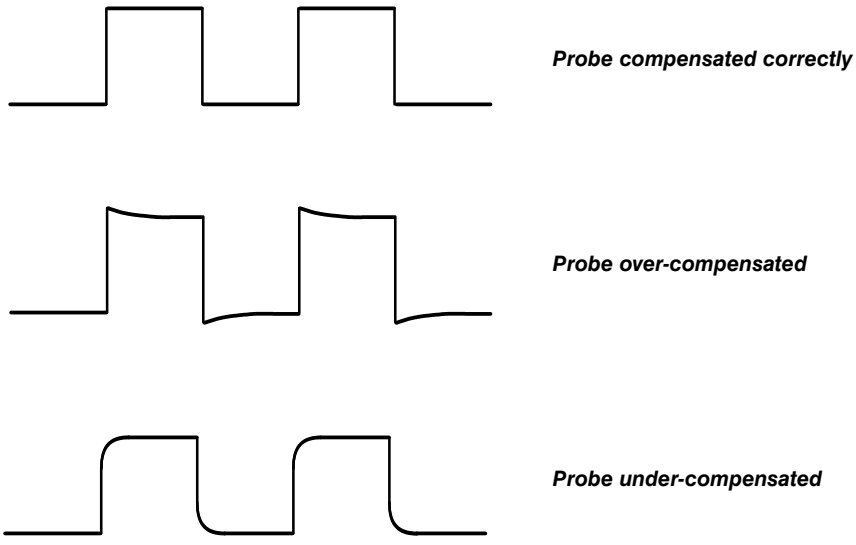


Figure 5-4: Proper and Improper Probe Compensation

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).

1. *Expose the probe tip, install the test hookup, and preset the oscilloscope controls:*

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

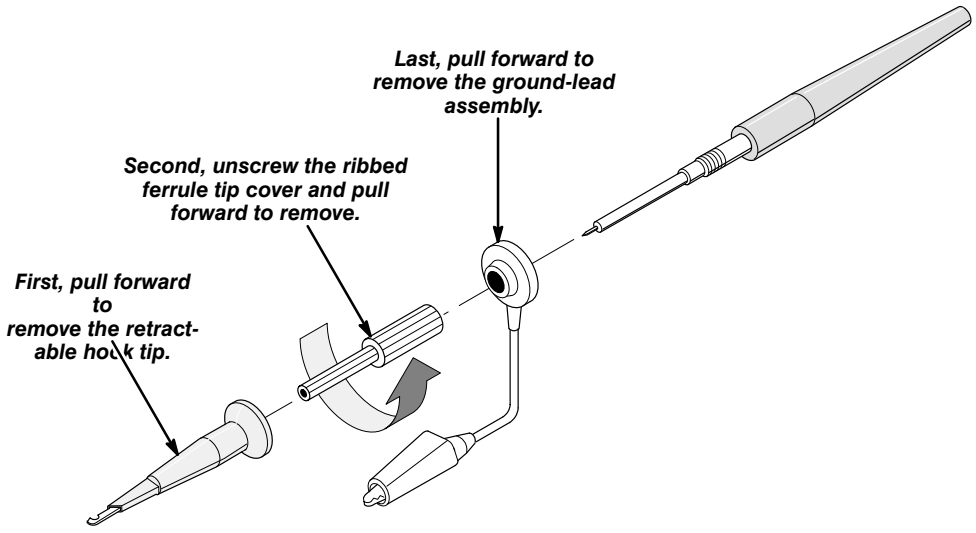


Figure 5-5: Exposing the Inner Probe Tip

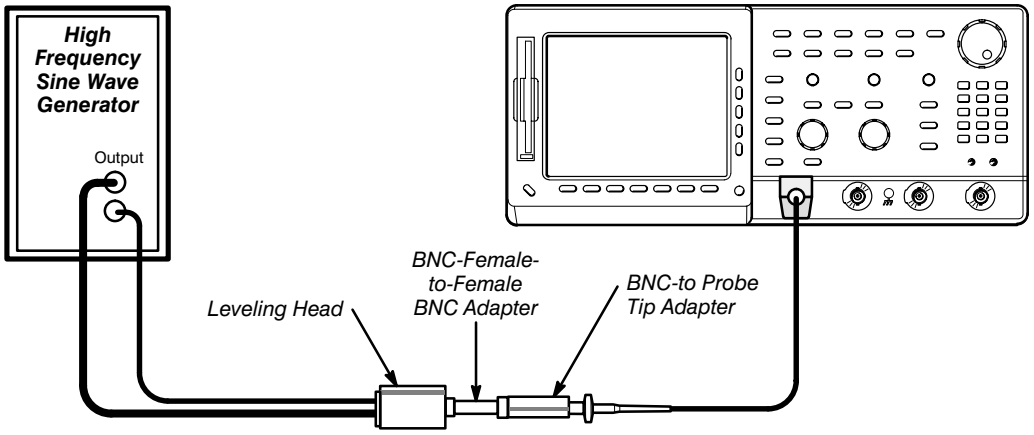


Figure 5-6: Initial Test Hookup

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 (see Figure 5-6).
- 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 50 mV.
- Set the horizontal **SCALE** to 100 ns.
- Press **SHIFT**. Then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Hi Res**.
- Press **MEASURE**.
- Press the main-menu button **Hi-Low Setup**. Then press the side-menu button **Min-Max**.
- Press the main-menu button **Select Measrmnt 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, on 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 P6139 10X probe (Item 16), one 10X attenuator (Item 4), and one small standard screwdriver.

1. *Install the test hookup and preset the oscilloscope controls:*
   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 on page 5-13 to expose the probe tip.

- Follow the instructions in Figure 5-7 to remove the probe body covers.

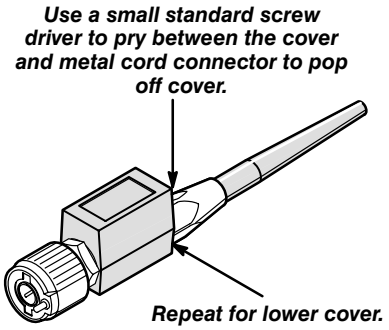


Figure 5-7: Exposing the Probe Body

b. *Hook up the test signal source:*

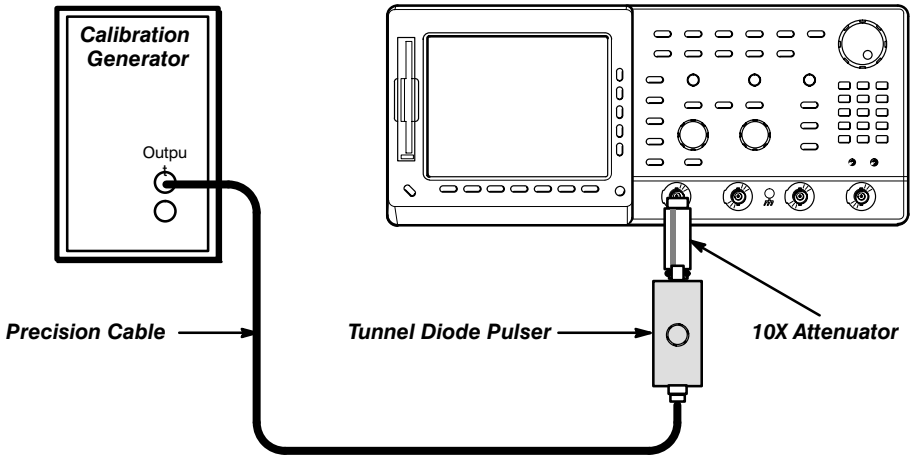


Figure 5-8: Initial Test Hookup

- Connect the high-amplitude output of the calibration generator, through a 50 Ω precision cable to the input of a tunnel diode pulser (see Figure 5-8).
- 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.
- Press **VERTICAL MENU**. Then press the main-menu button **Coupling**. Press the side-menu button Ω to toggle to 50 Ω coupling.
- Press **SHIFT**. Then press **ACQUIRE MENU**.
- Press the main-menu button **Mode**. Then press the side-menu button **Hi Res**.
- Press **CLEAR MENU**.

2. *Adjust the Probe:*

a. *Display and store the reference signal:*

- Set the high-amplitude output of the generator between 60 to 100 V *at the input to the tunnel diode pulser*.
- Advance the triggering level of the tunnel diode pulser until a five to six division square wave appears on screen.
- 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**; and press the side-menu button **10%**.
- Push **SHIFT**; then 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 the main-menu button **Coupling**. Then press the side-menu button Ω to toggle to 1 MΩ coupling.
- Press **HORIZONTAL MENU**.

- Press the main-menu button **Trigger Position**; and press the side-menu button **50%**.

c. *Make the adjustments:*

- Locate the various adjustments in Figure 5-9.

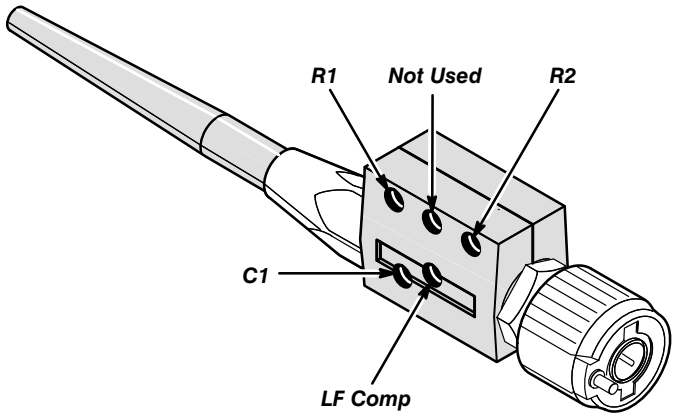


Figure 5-9: Locations of Probe Adjustments

- 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.

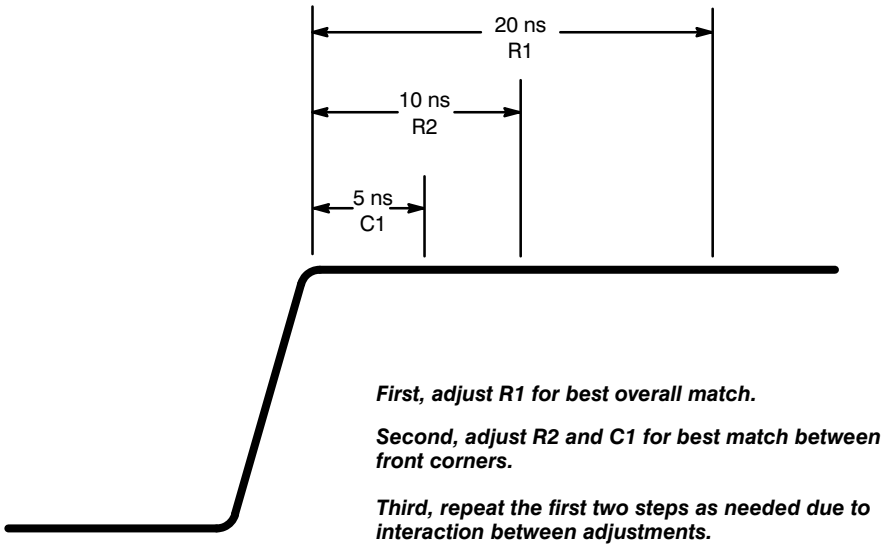


Figure 5-10: Adjustments vs Front-Corner Response

d. *Recheck Probe Bandwidth:*

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

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



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 (TDS 520A and 540A – Monochrome – Only)

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

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** and **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 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 5-12) just disappear, while the lines in the 10% luminance patch are just visible, when both are viewed through the magnifier.

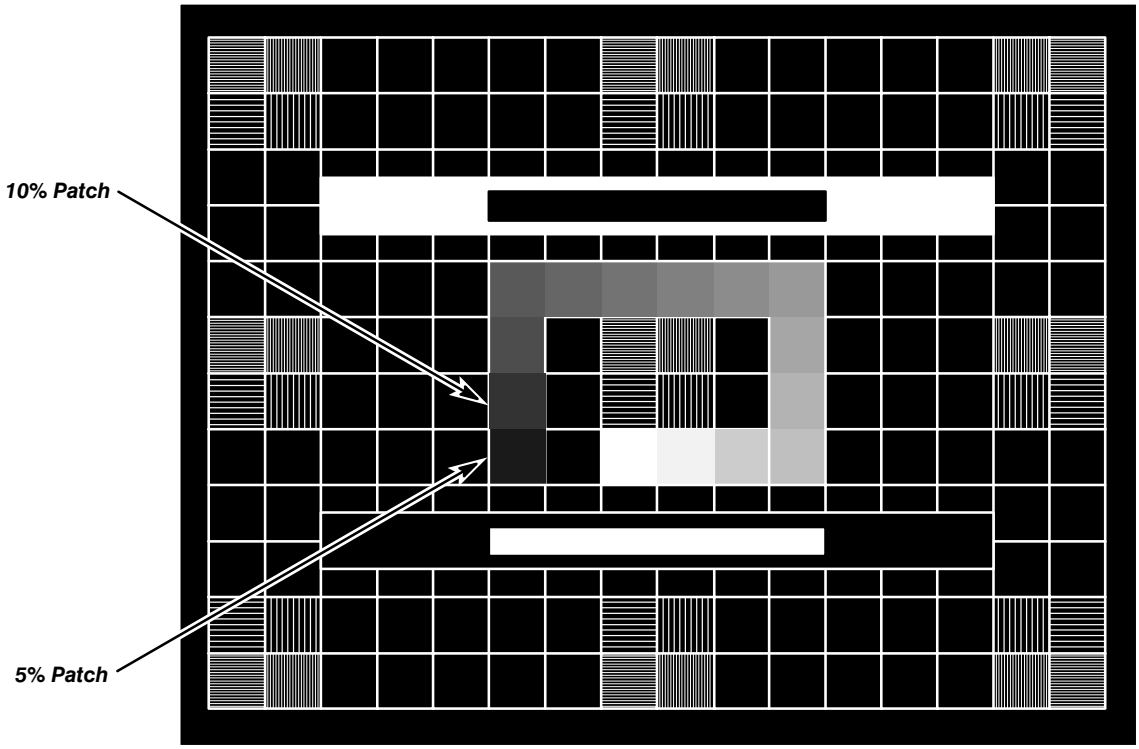


Figure 5-11: TDS 520A/540A Five and Ten Percent Luminance Patches

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 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 the shield is missing.

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.

Rotation, Brightness, and Contrast Adjustment (TDS 524A and 544A − Color − Only)

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 rotation:*
   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. Adjust R401 (TRACE ROTATION) to minimize the display's tilt. Use the frame around the display as a reference. R401 is the second adjustment from the fan.

3. *Adjust the display brightness*
   - Locate R403 (BRIGHTNESS). It is one of the adjustments on the left side of the instrument located just ahead of the fan. It is the fourth adjustment from the fan.
   - Observe the luminance patches using a 6X magnifier.

- Adjust R403 (BRIGHTNESS) until the background raster lines in the 5% luminance patch (see Figure 5-12) just disappear, while the lines in the 10% luminance patch are just visible, when both are viewed through the magnifier.

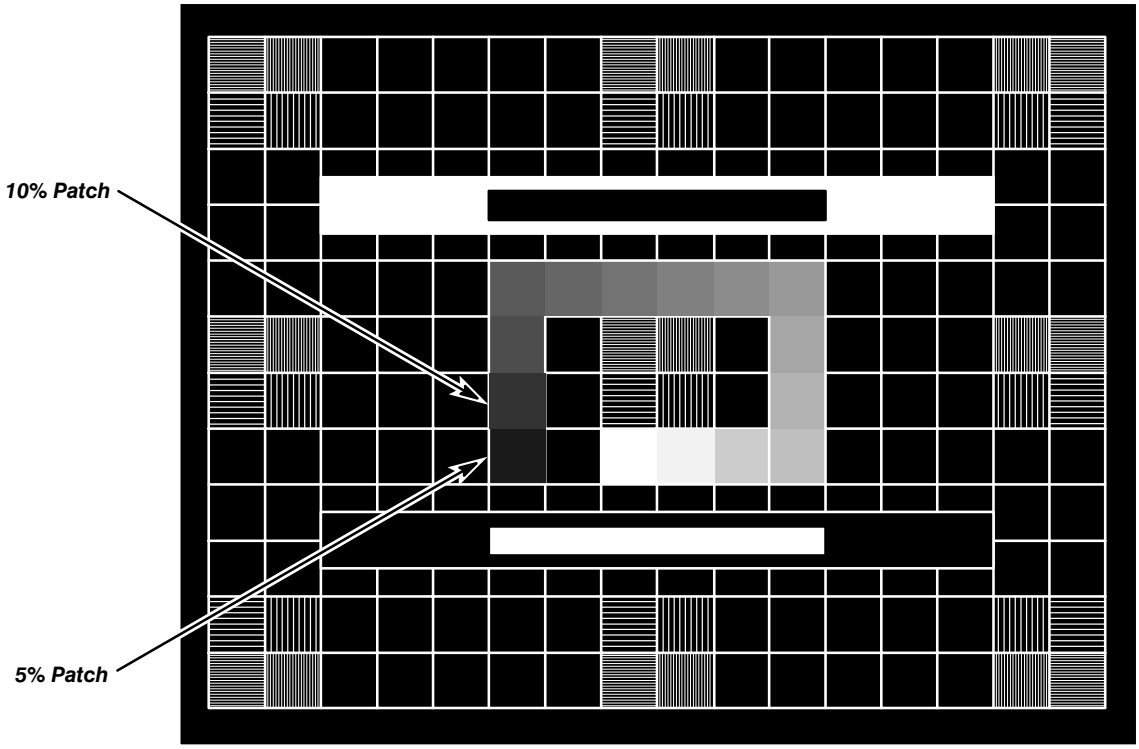


Figure 5-12: TDS 524A/544A Five and Ten Percent Luminance Patches

4. *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 R404. It is one of the adjustments on the left side of the instrument located just ahead of the fan. It is the fifth adjustment from the fan.
      - Monitor the luminance at center screen using a J16 photometer and a luminance probe.

- Adjust R404 (CONTRAST) for a reading of 40 foot lamberts.

NOTE

The adjustments for contrast and brightness interact with each other.

5. *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.

Replace this page with the Tab named Maintenance

Maintenance Information

This section contains the information needed to do periodic and corrective maintenance on the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. Specifically, the following subsections are included:

- **Maintenance Information** — Includes this 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 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, *Mechanical Parts List,* lists all field replaceable modules by part number.

Preventing Electrostatic Discharge (ESD)

CAUTION

Electrostatic 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. Remove anything capable of generating or holding a static charge from the work station surface.
5. When possible handle circuit boards by the edges.
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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. 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 overheating 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. Repair defects that could cause personal injury or lead to further damage to the oscilloscope immediately.

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 5-1 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



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 a 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 modules. A module is any electrical or mechanical module, assembly, or part listed in Section 10, *Mechanical Parts List.* Specifically, the following subsections are included:

- Preparatory information that you need to properly do the procedures that follow.
- List of Equipment required to remove all modules.
- 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* on page 6-5.)
- Three module locator diagrams for finding all the modules in this oscilloscope.

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 oscilloscopes components, read Before Servicing and Supplying Operating Power *in Section 2, and* Preventing Electrostatic Discharge *on page 6-2.*

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, *Mechanical Parts List* lists all modules.

General Instructions



READ THESE GENERAL INSTRUCTIONS BEFORE REMOVING A MODULE.

First read the following *Summary of Procedures* 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 6-60.

If you are removing a module for service, begin by doing *Access Procedure* on page 6-17. This procedure describes how to remove the module to be serviced while removing the minimum number of additional modules.

Summary of Procedures

The following procedures are described in the order in which they appear in this subsection. You can also look up the procedure for removal and reinstallation of any module in the *Table of Contents* of this manual.

- The *Access Procedure* on page 6-16 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 6-17 are procedures for removing modules which do not require internal access to the oscilloscope.
- *Procedures for Outer-Chassis Modules* on page 6-31 are procedures for removing modules which require access internal to the instrument but external to the chassis.
- *Procedures for Inner-Chassis Modules* on page 6-51 are procedures for removing modules which require access internal to the instrument and internal to the chassis.
- *Disassembly for Cleaning* on page 6-35 is a procedure that describes how to remove all modules for cleaning. Instructions for cleaning are found in *Inspection and Cleaning* on page 6-5.

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	Phillips screwdriver	Screwdriver for removing Phillips-head screws	
7	Needle-Nose Pliers	Standard tool	
8	Nutdriver, 1/4 inch	Standard tool	
9	Retaining Ring Pliers	Standard tool; 1-1/8 inch minimum throw	
10	Angle-Tip Tweezers	Standard tool	
11	Pliers	Standard tool	

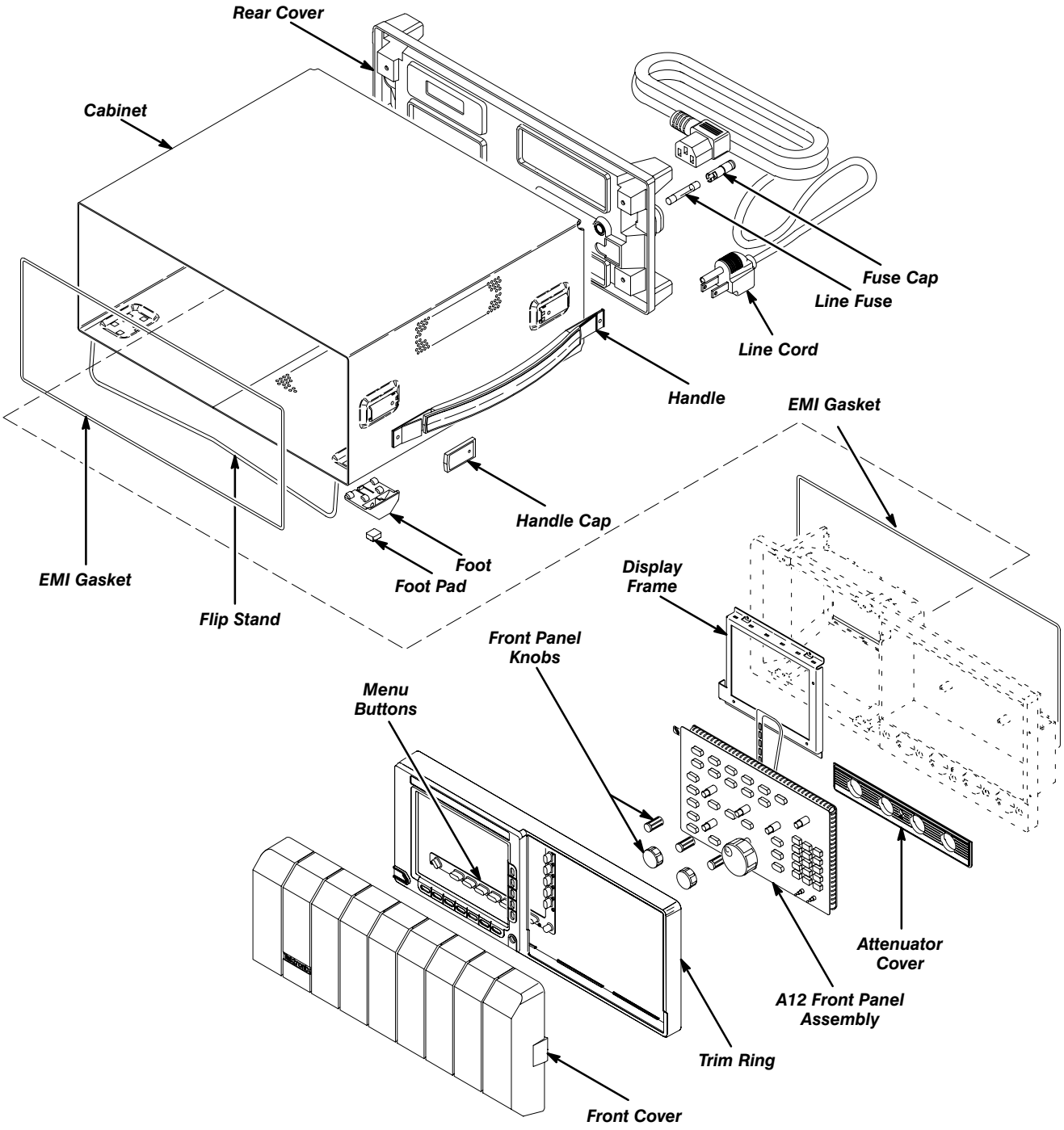


Figure 6-1: External Modules

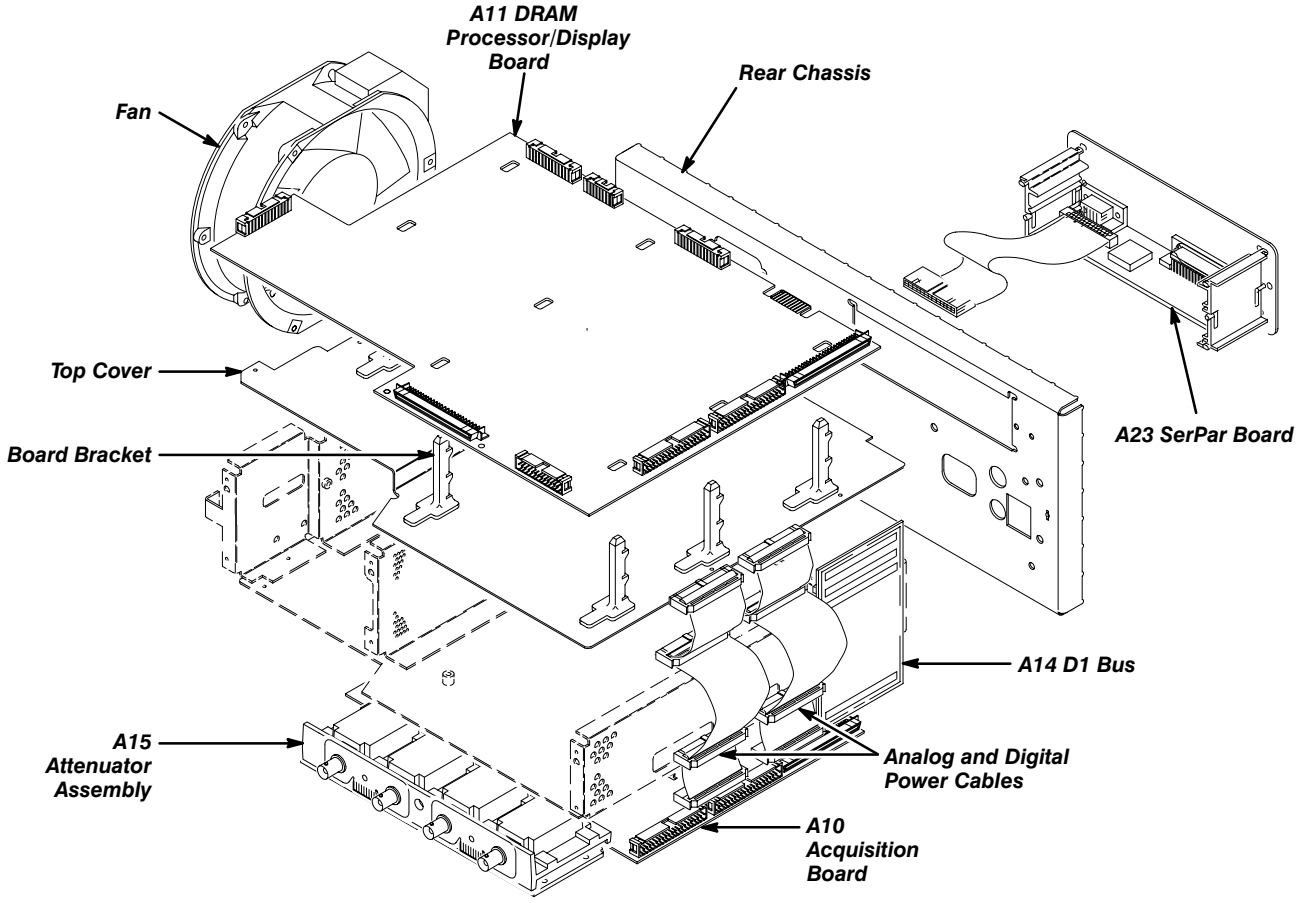


Figure 6-2: Outer-Chassis Modules

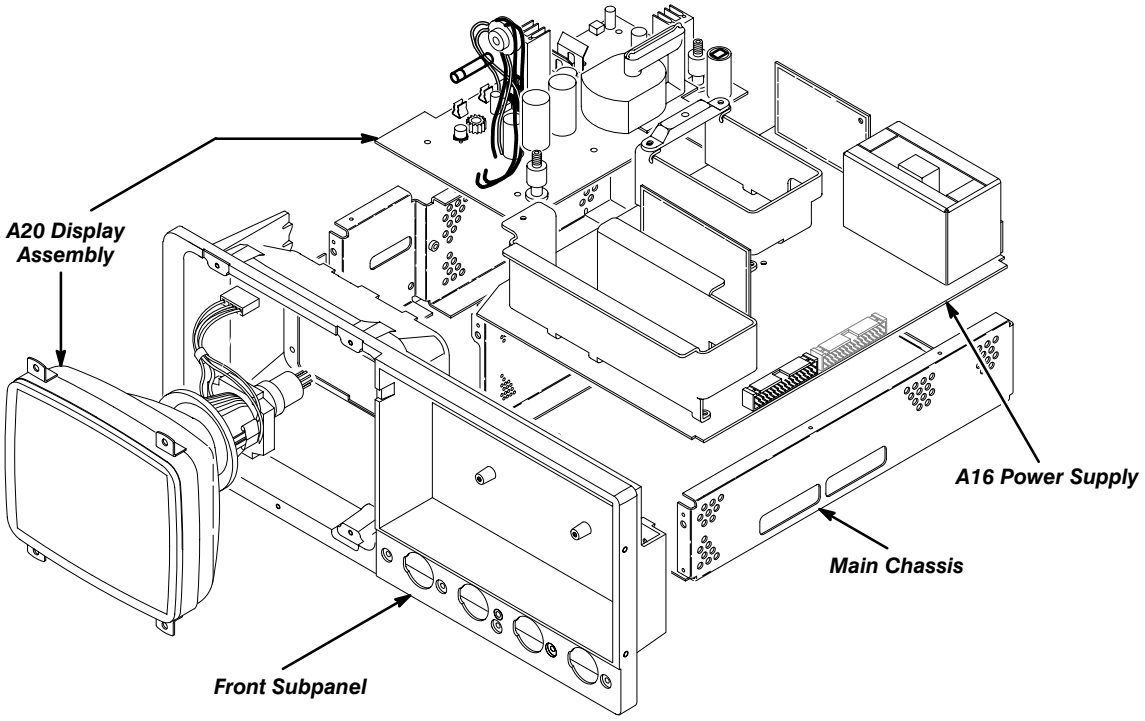


Figure 6-3: Inner-Chassis Modules − TDS 520A or 540A with A20 Display Assembly

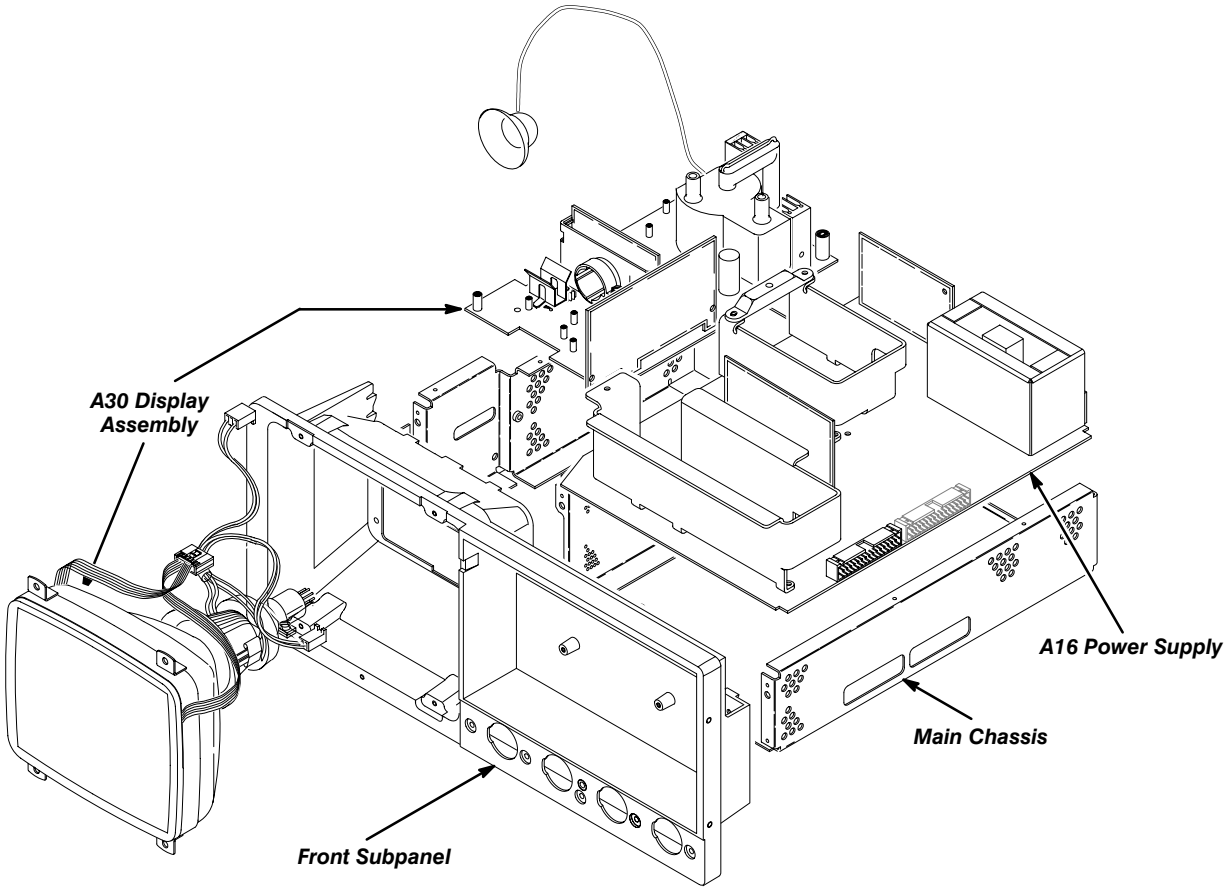


Figure 6-4: Inner-Chassis Modules − TDS 524A or 544A with A30 Display Assembly

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 6-4.

   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 6-17).

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 6-17).

   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 6-31.

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 6-17.

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

   c. Do, in 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 6-31.

   d. Find and do the procedure whose title matches the name of the module to be removed under *Procedures for Inner-Chassis Modules*, page 6-51.

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 6-16) 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*
- *Display Frame*
- *Cabinet Modules*

Front-Panel Knobs

1. *Assemble equipment and locate modules to be removed:* Have handy a angled-tip tweezers (Item 10). 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 the knob, align it to the shaft and push it in until it snaps.

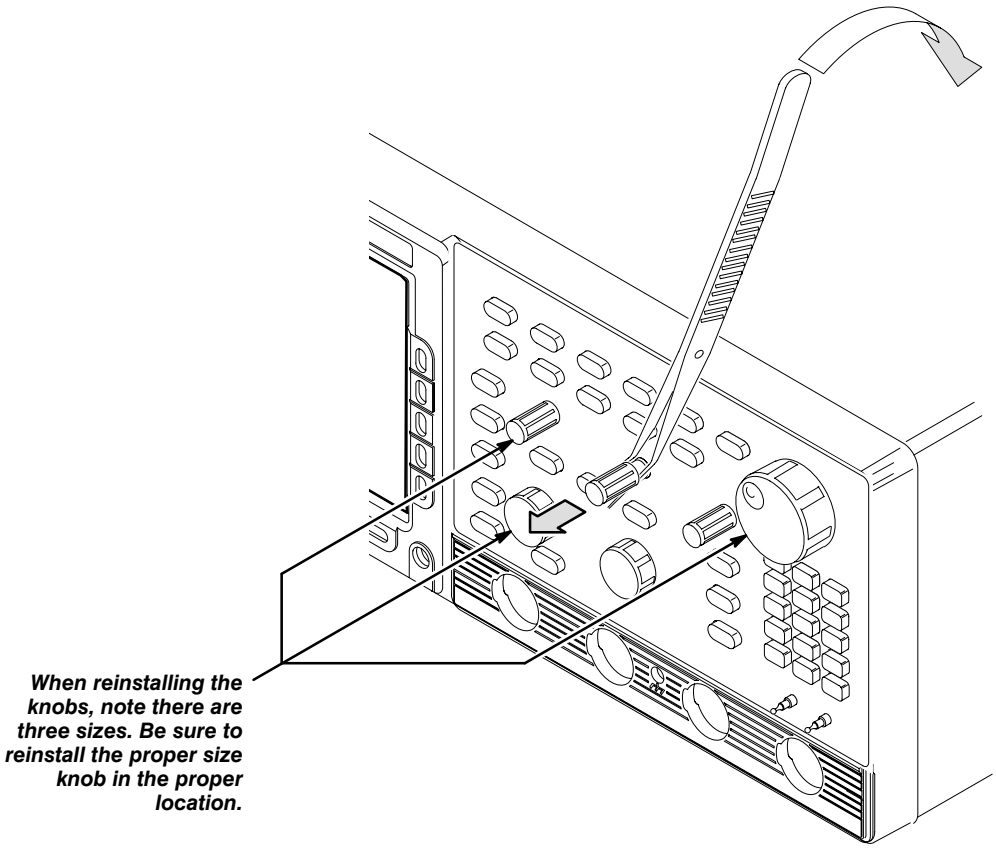


Figure 6-5: Knob Removal

Line Fuse and Line Cord

1. *Assemble equipment and locate modules to be removed:* Have handy a flat-bladed screwdriver (Item 5). 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 6-6.) 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 6-6.) 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.

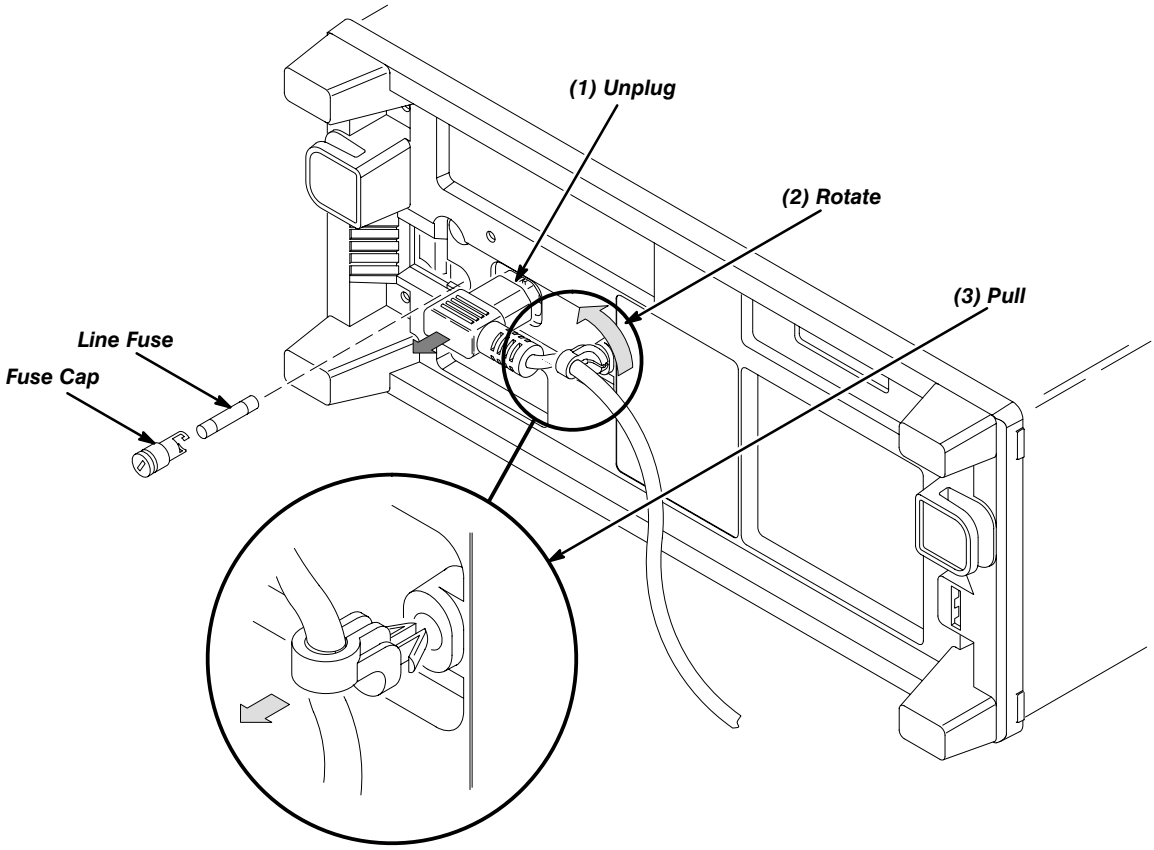


Figure 6-6: Line Fuse and Line Cord Removal

EMI Gaskets

See *Rear Cover and Cabinet* procedure on page 6-20.

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 oscilloscopes 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 oscilloscopes internal cabling as you remove it.



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 7).

   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 the 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 inch-lbs torque.
    f. See the procedure *Line Fuse and Line Cord* to reinstall the line cord. This completes the oscilloscope reassembly.

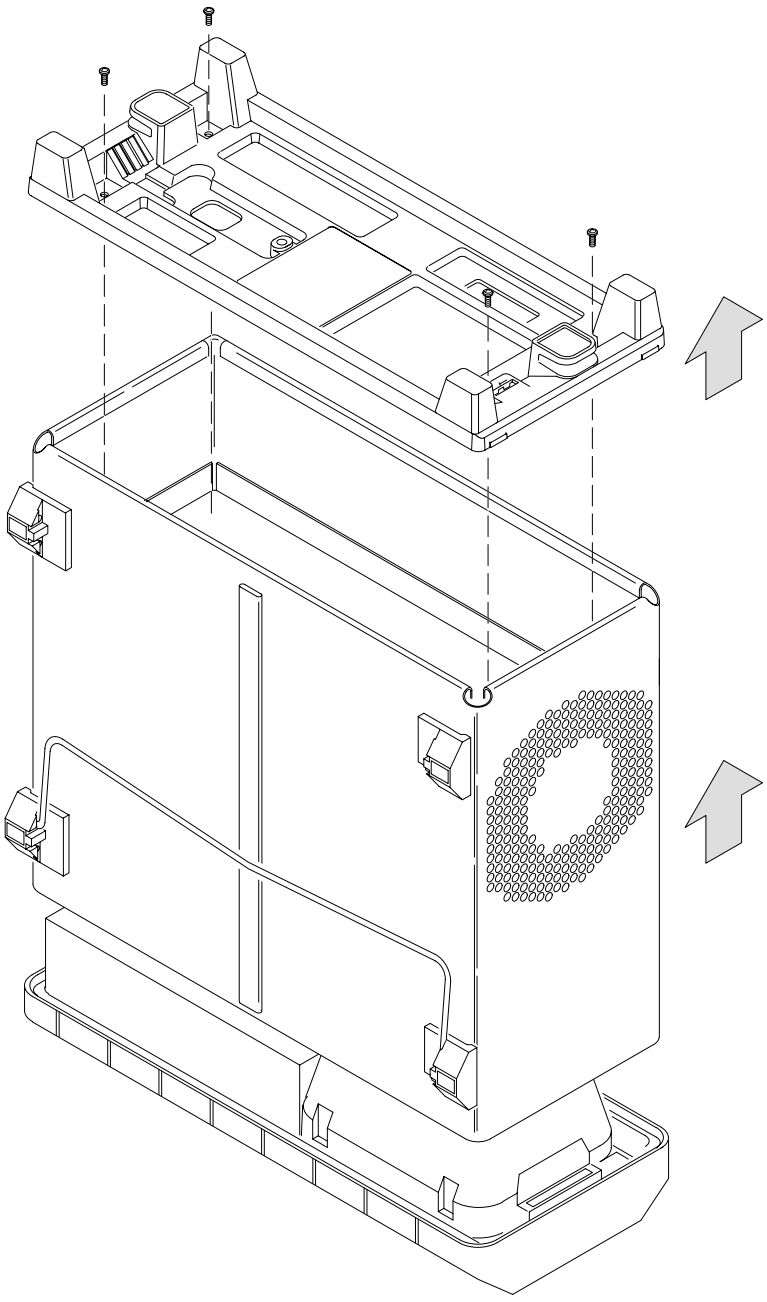


Figure 6-7: Rear Cover and Cabinet Removal

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.)

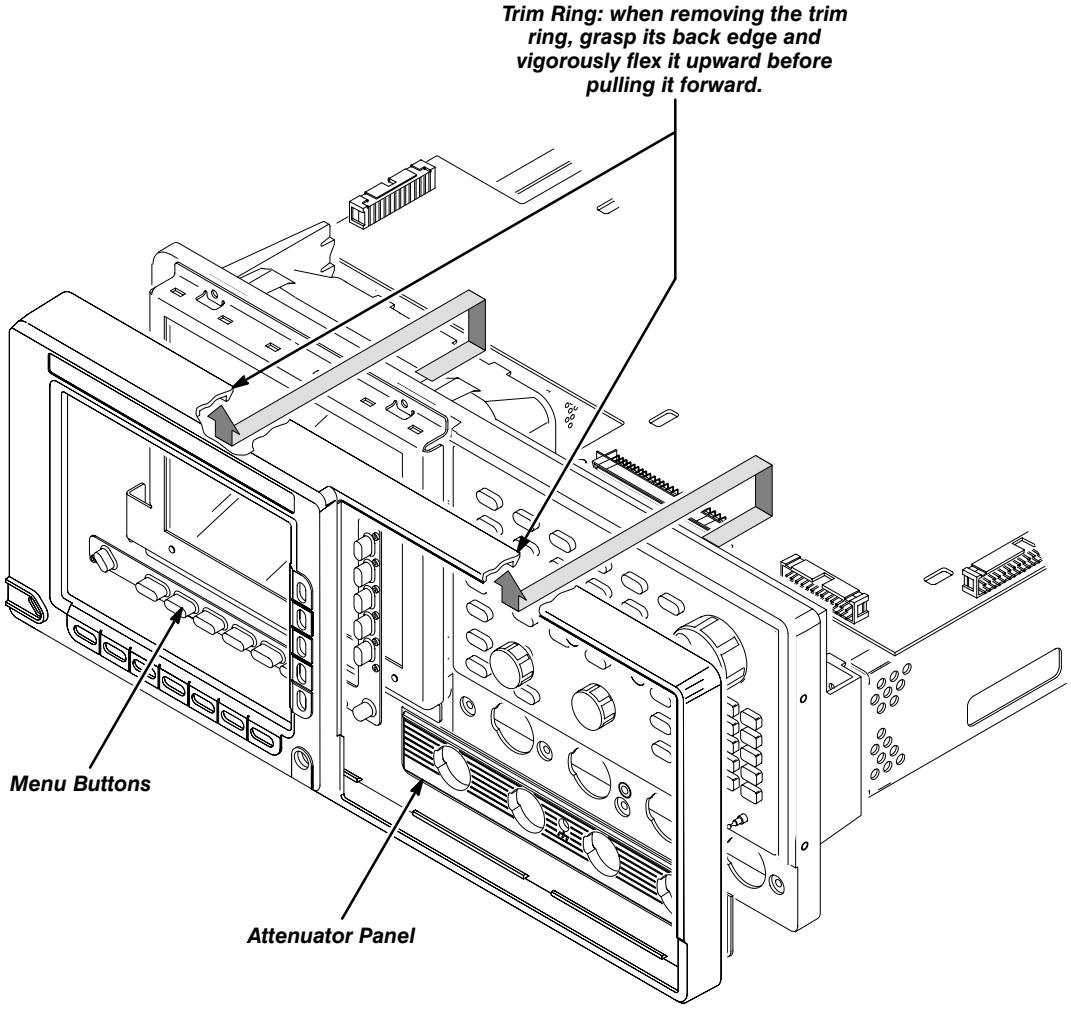


Figure 6-8: Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel Removal (Front Cover not Shown)

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

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.

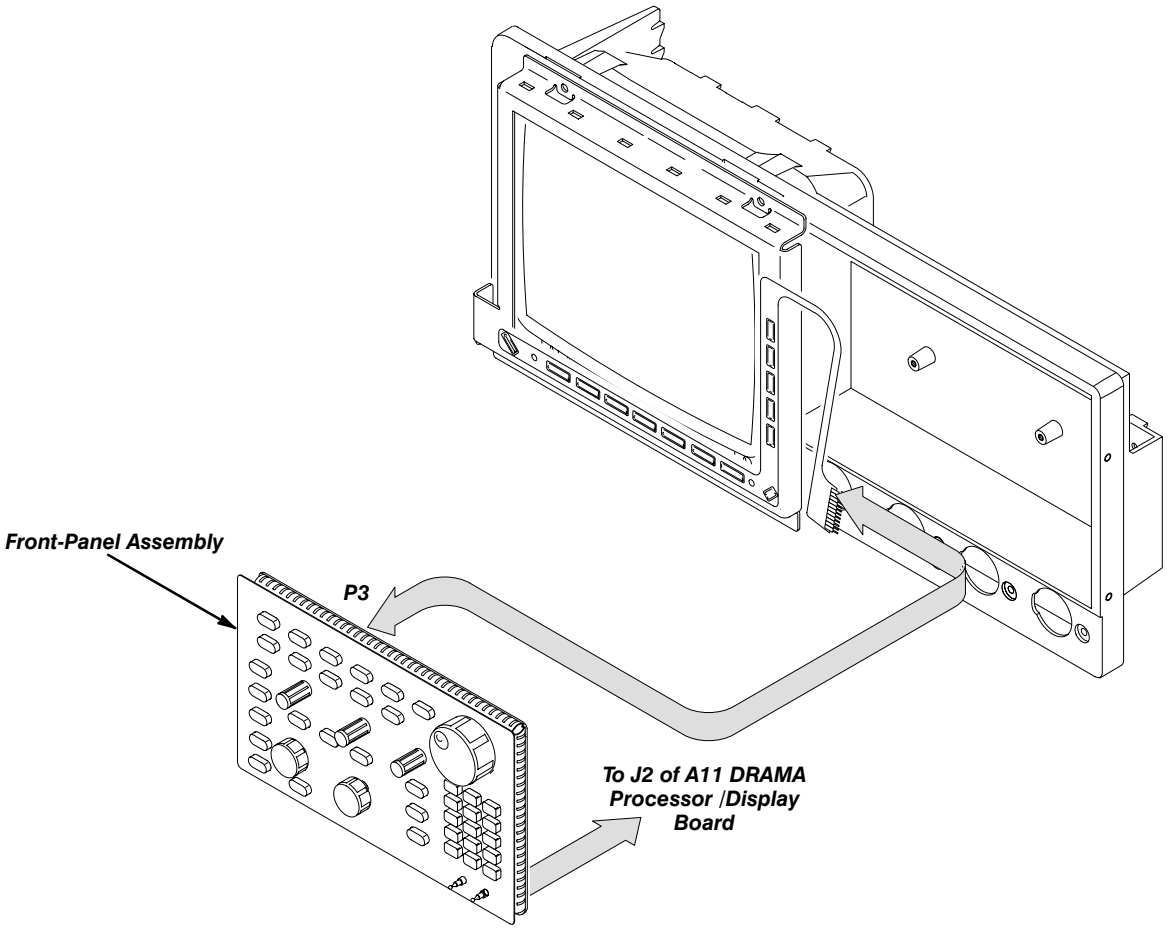


Figure 6-9: A12 Front-Panel Assembly

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 6-17.

   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 6-10 as a guide. Reverse procedure to reassemble, using the same Figure 6-10 as a guide.

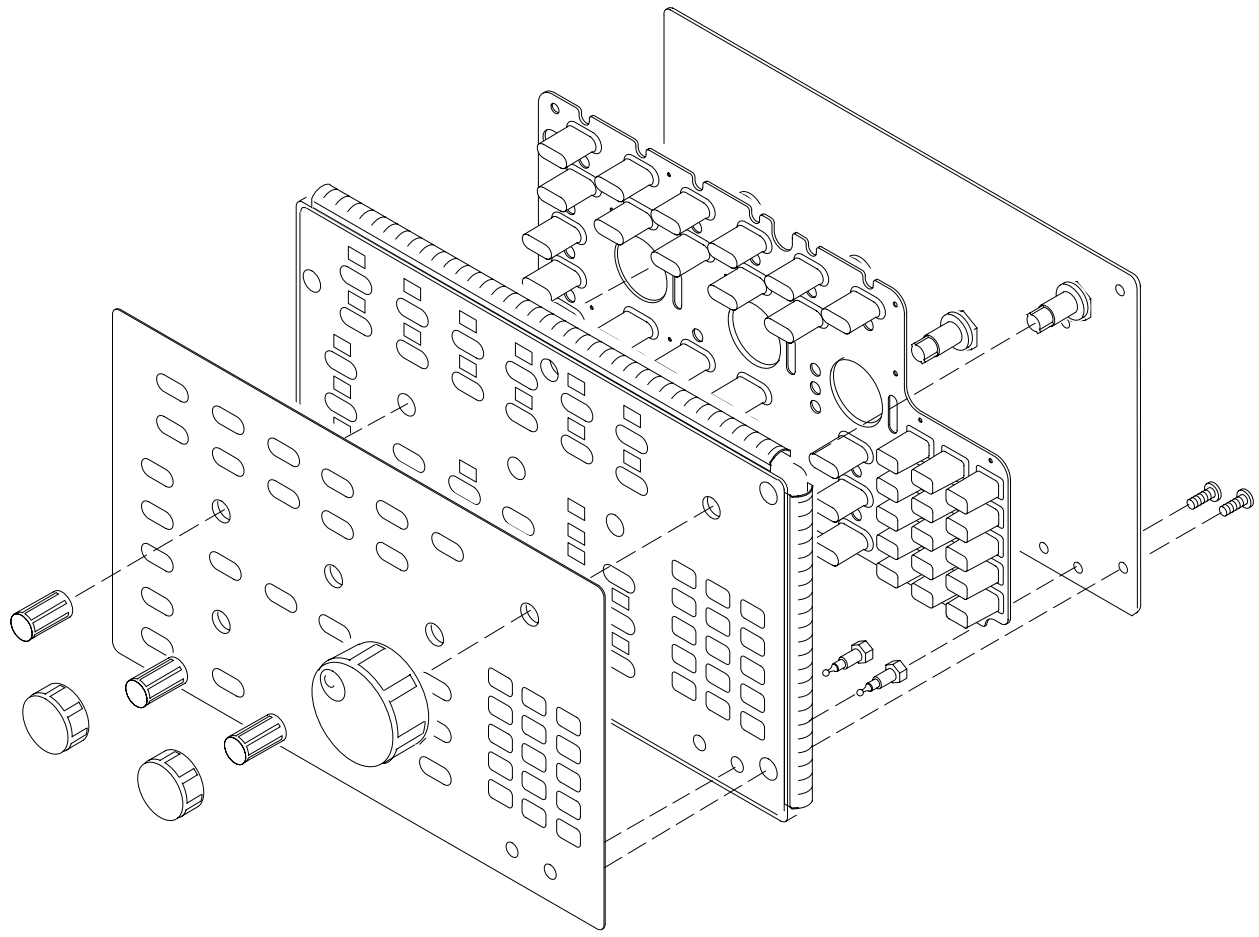


Figure 6-10: Disassembly of Front-Panel Assembly

5. *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 step 3, 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 6-23).

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 6-23) 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. Do the procedure *Floppy Disk* (page 6-47) to remove the floppy disk drive.

d. 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−3d, reversing each step to reinstall the display-frame assembly. Then see the procedure *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23) 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 7). Locate the modules to be removed in the locator diagram *External Modules*.
2. *Orient the oscilloscope:* Set the oscilloscope so 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 7) 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 9) 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* (page 6-20) 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* (page 6-20) 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.

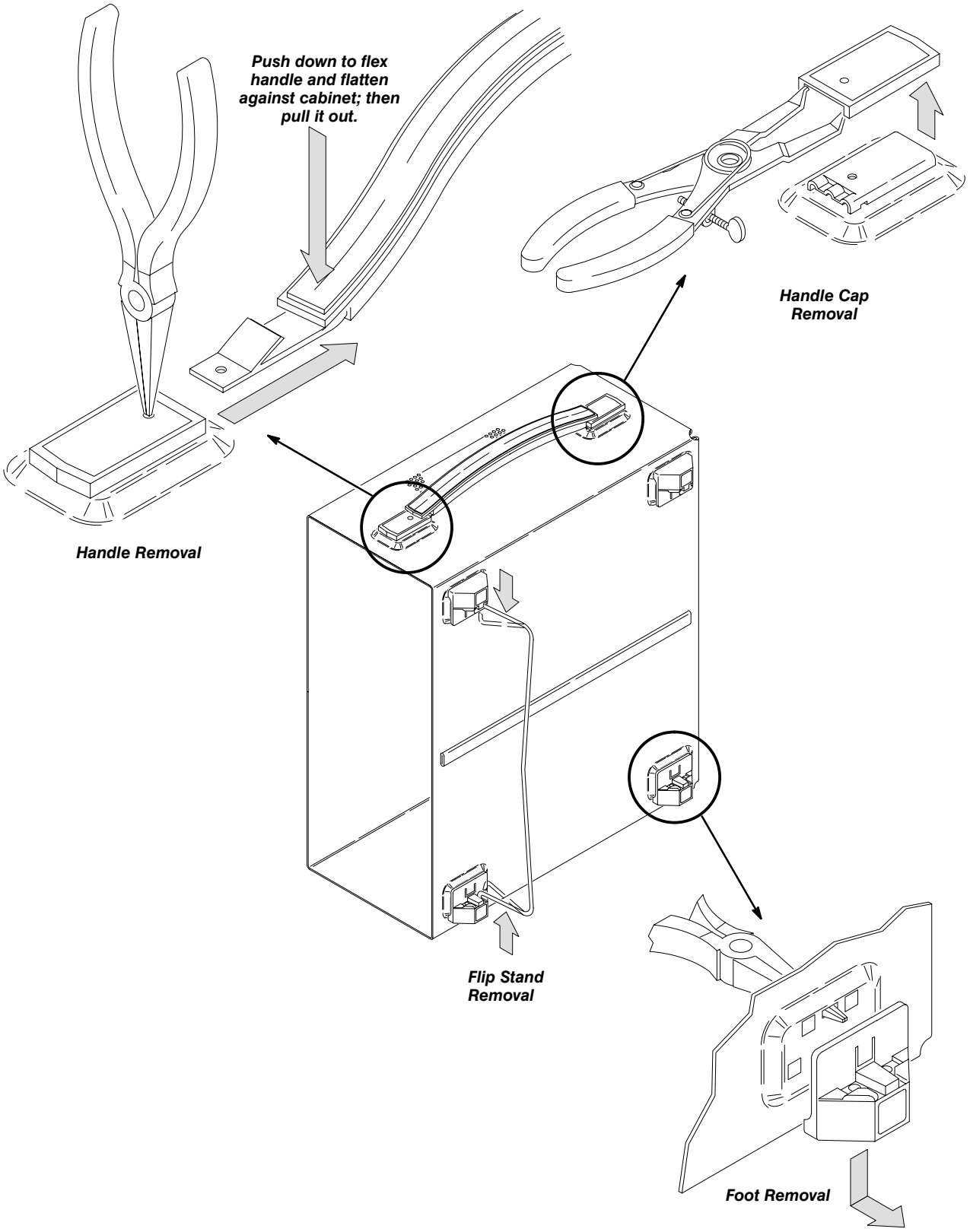


Figure 6-11: Cabinet Modules Removal

Procedures for Outer-Chassis Modules

You should have done 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 Power Cables*
- *A23 SerPar Board*
- *A29 Video Trigger Board*
- *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 6-32.
   b. Unplug the ribbon interconnect cable that plugs in from the attenuator at J1153. See Figure 6-32.
   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 6-32 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 6-17)

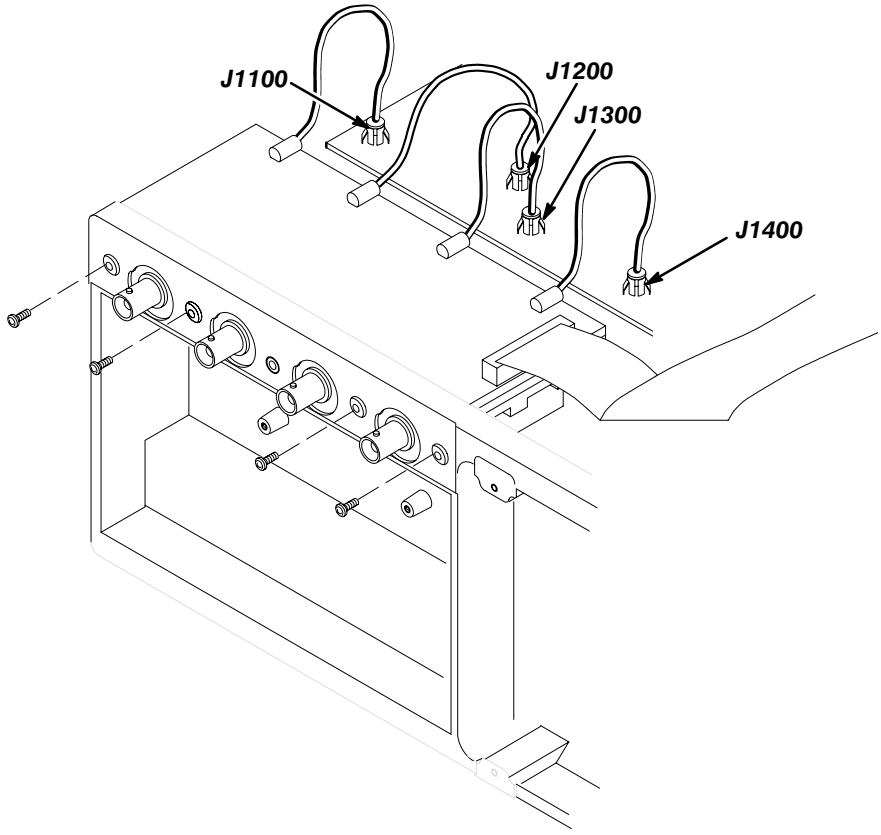


Figure 6-12: Attenuator Interconnect Cable Routing and Jack Locations

- *Rear Cover and Cabinet* (page 6-20)

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 6-20) to complete reassembly of the oscilloscope.

A14 D1 Bus and 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.

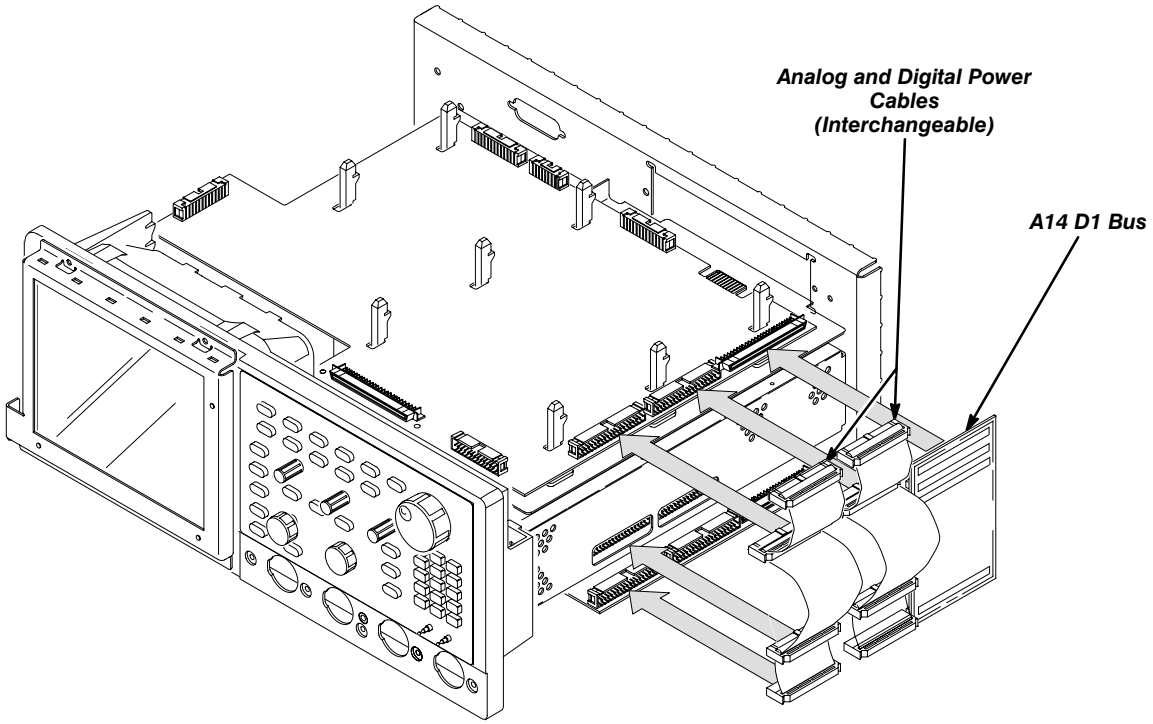


Figure 6-13: A14 D1 Bus and Power Cables Removal

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 6-23)
      - *Rear Cover and Cabinet* (page 6-20)

A23 SerPar Board: RS232/Centronics Hardcopy Interface

1. *Remove circuit board assembly:*

   a. Using a screwdriver with size T-20 Torx® tip, remove the two screws (number 4 in Figure 6-14) securing the rear plate of the circuit board assembly.

   b. Disconnect the cable connector (number 2) from the processor-display circuit board connector (number 1).

   c. Pull out the A23 SerPar Board assembly (number 3).

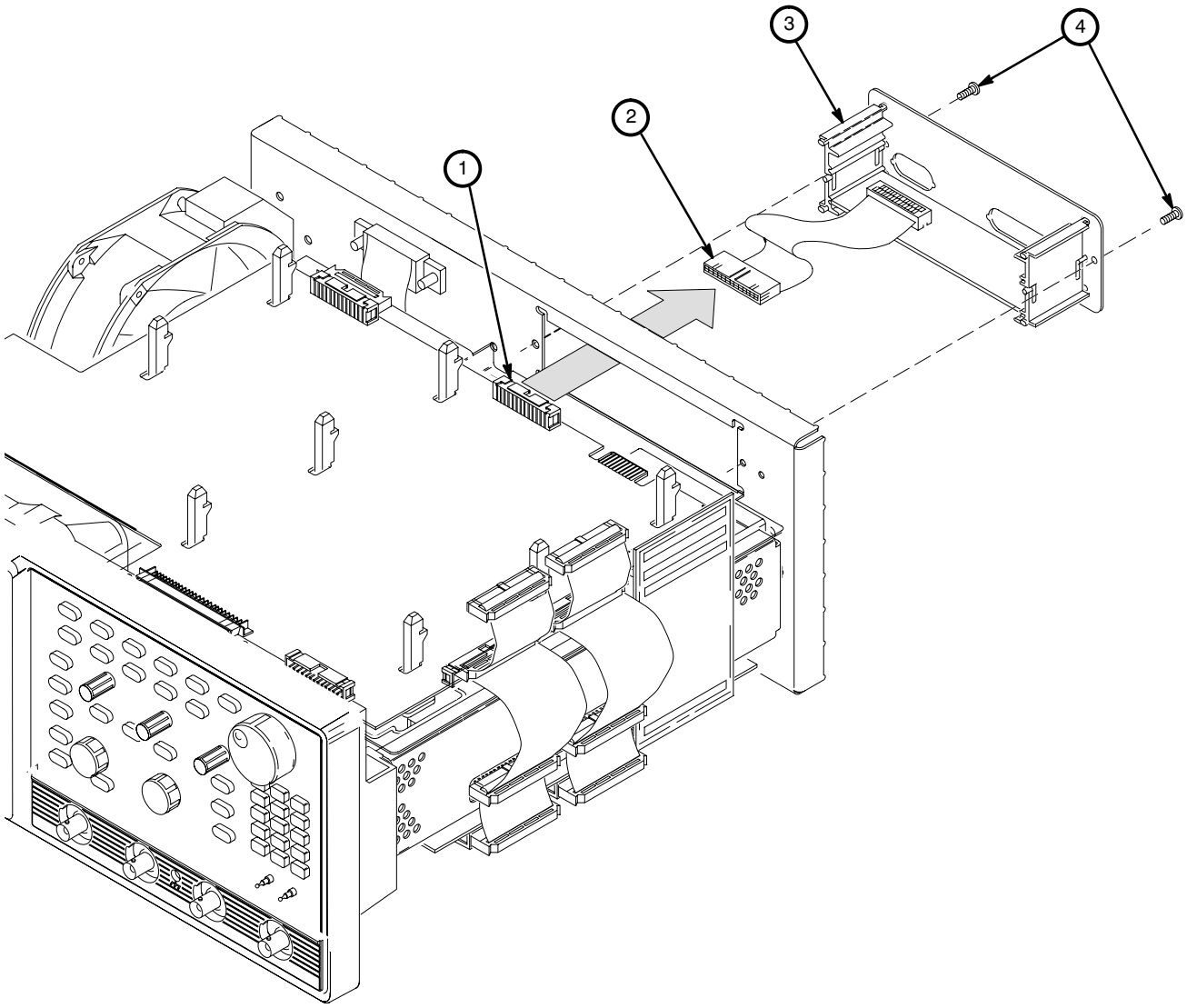


Figure 6-14: Remove Circuit Board Assembly From Oscilloscope

2. *Remove circuit board from assembly:*

   a. Using a 3/16-inch nutdriver, remove the four lock connectors (number 3 in Figure 6-14) securing the circuit board to the rear plate.

   b. Separate the circuit board with attached cable (number 1), from the rear plate with attached brackets (number 2).

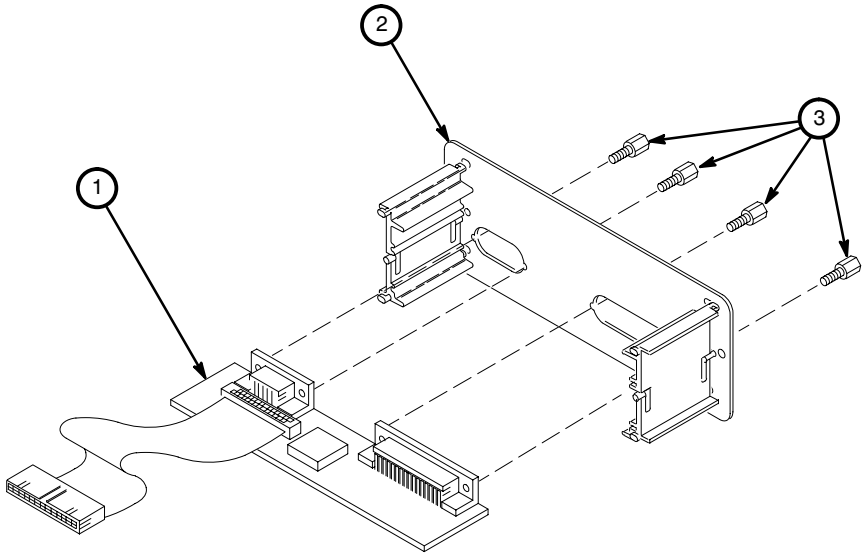


Figure 6-15: Remove Circuit Board From Assembly

3. *Replace circuit board:*

Equipment Required: One screwdriver with a size T-20 Torx® tip and one 3/16-inch nutdriver.

   a. Replace the failed circuit board with a replacement A23 SerPar Board ordered from the factory (see *Replaceable Parts List* for detailed ordering information). Do in reverse order steps a and b of the *Circuit Board Removal From Assembly* procedure on the previous page.

   b. Reinstall the A23 SerPar Board assembly in the oscilloscope. Do in reverse order steps a and b of the *Remove circuit board from assembly* procedure shown above.

   c. 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 6-23).
      - *Rear Cover and Cabinet* (page 6-20).

   d. To ensure the A23 SerPar Board is working correctly, perform the power-up short diagnostics procedure described on page 6-63.

A29 Video Trigger 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 procedures *A14 D1 Bus and Power Cables* and *A23 SerPar Board* that precede this procedure to remove those items. It is **not** necessary to pull the A23 board assembly out entirely nor is it necessary to remove the cable connector from the A23 SerPar board to the A11 Processor/Display board

2. *Orient the oscilloscope:* Set the oscilloscope so its bottom is down on the work surface and its front 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:* Figure 6-16 shows the A29 Video Trigger board (option 05) installed. Use Figure 6-19 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. Disconnect the two power cable connectors (the analog-power and digital-power interconnect cables) from the video board connector and from the processor-display circuit board connector (see number 2 on Figure 6-18).

   c. Remove (or pull loose) the A27 Connector board (see number 3 on Figure 6-18).

   d. Unplug the coax video cable that connects the video board to the acquisition boards (see Figure 6-17).

   e. Slide back and lift up the Video Trigger circuit board (see Figure 6-18).

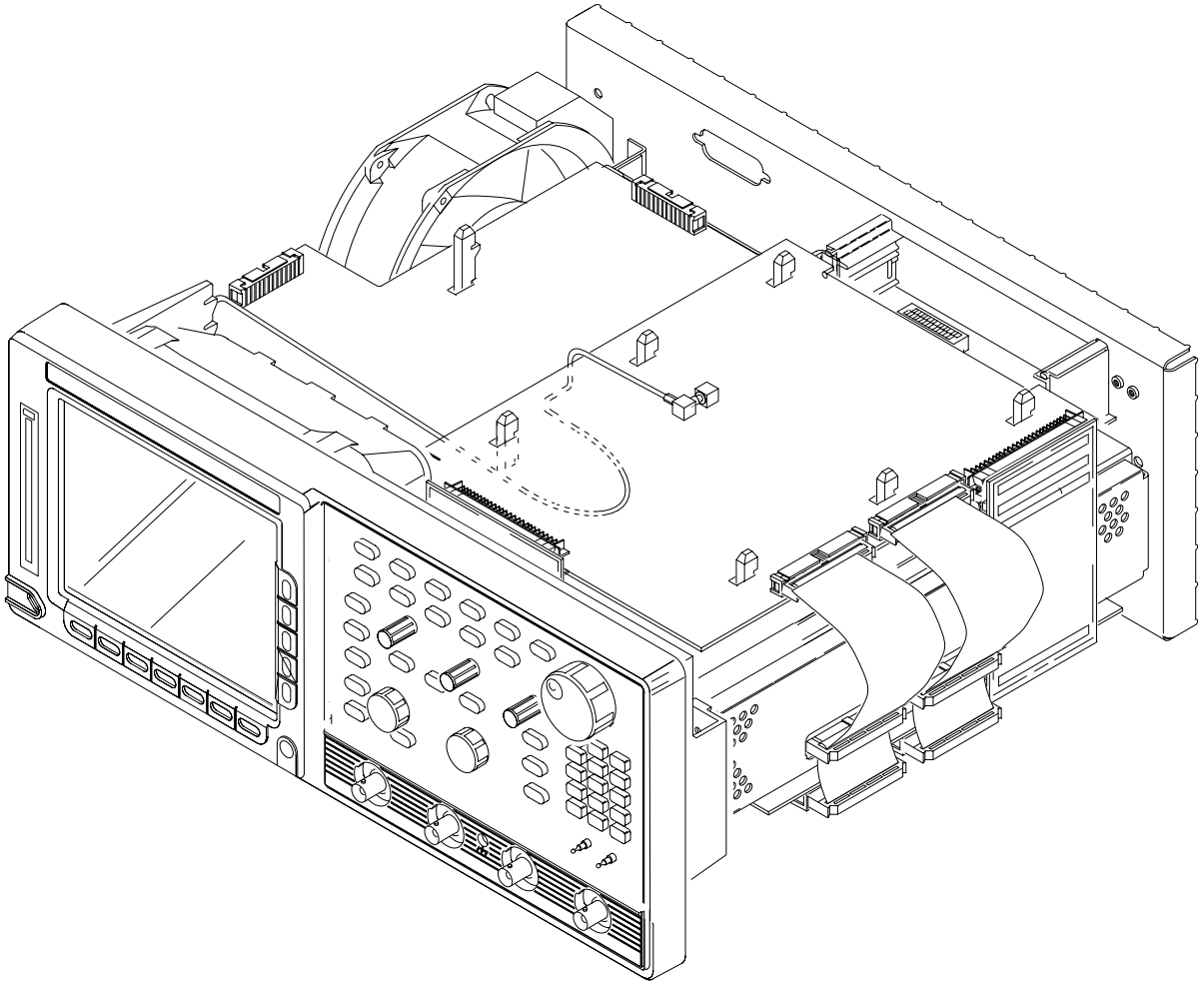


Figure 6-16: Circuit Board Installed

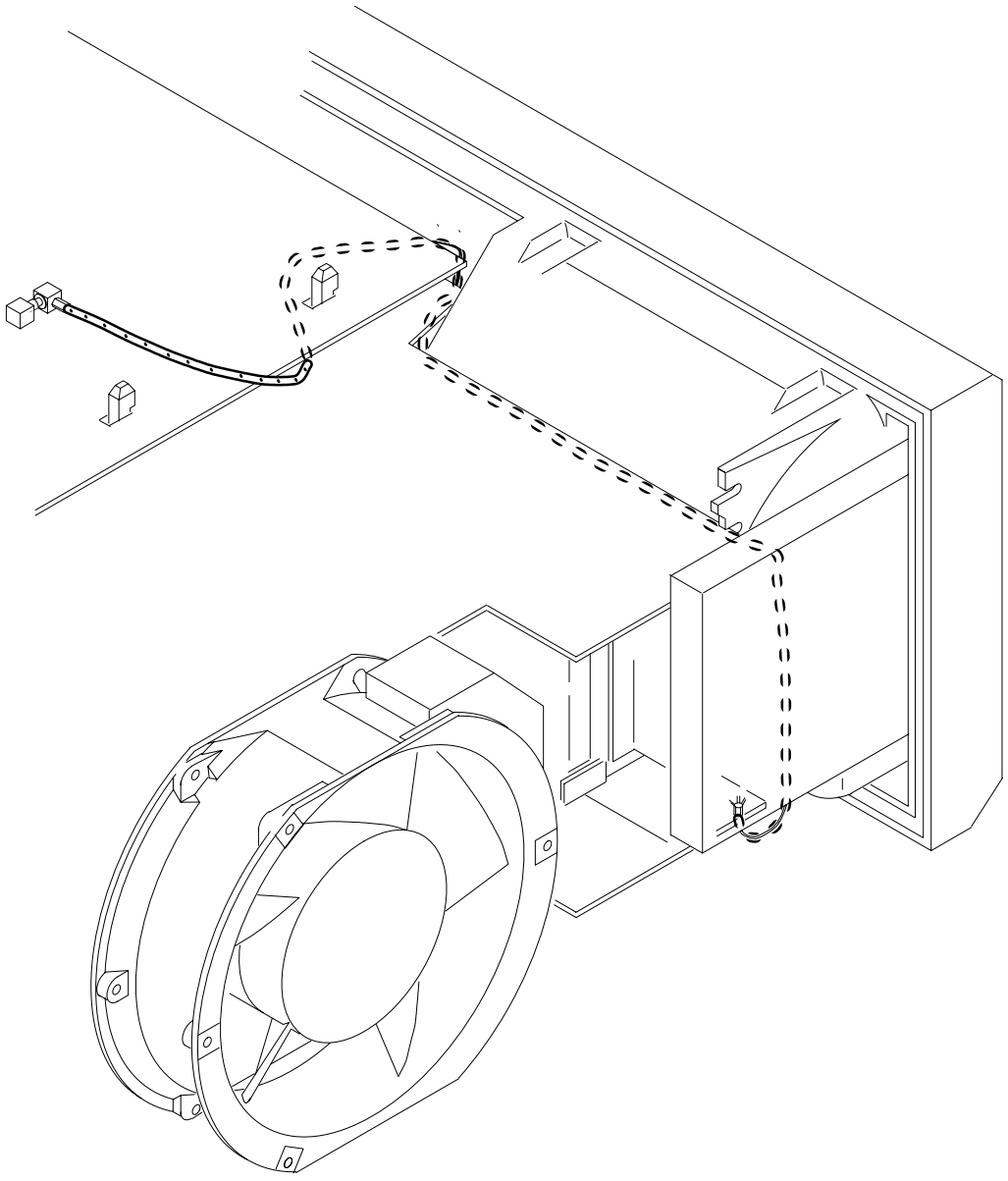


Figure 6-17: Proper Routing of the Video Cable

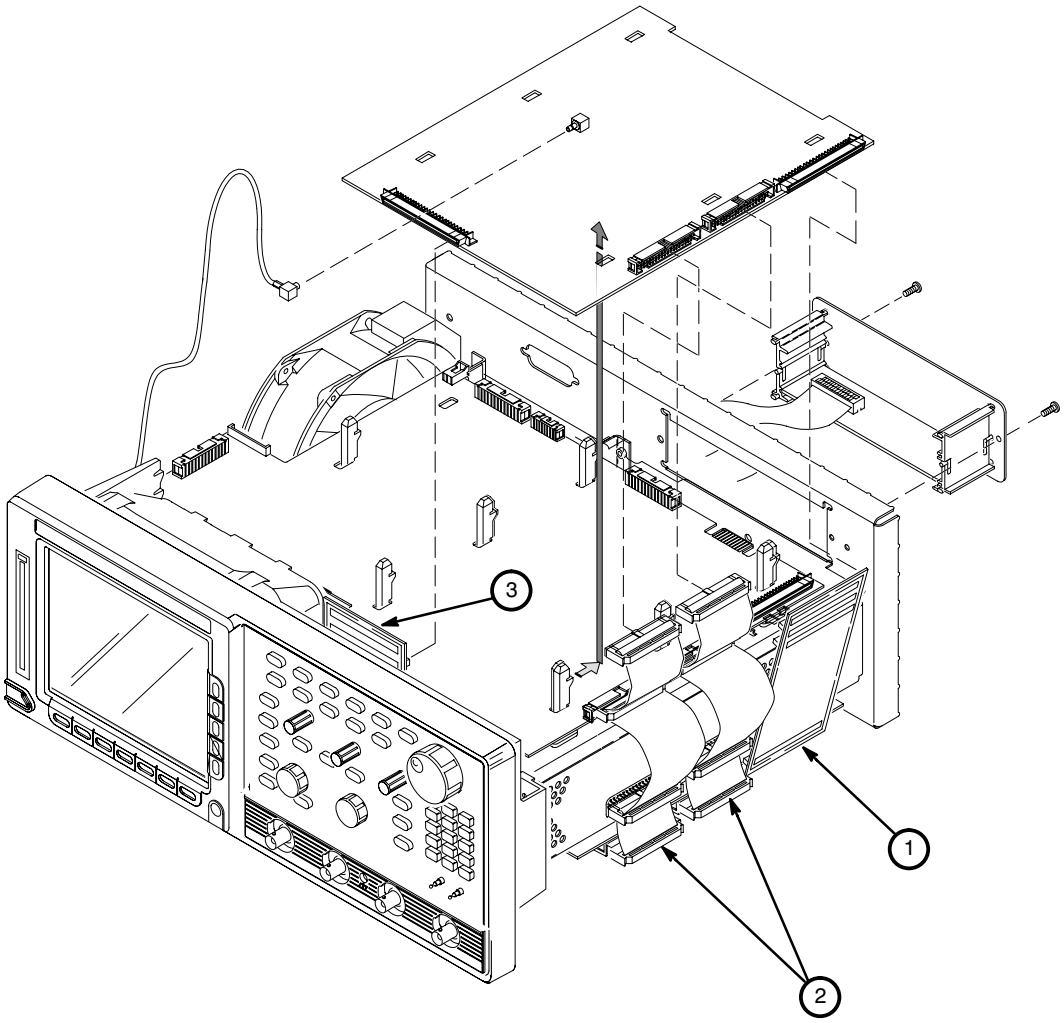


Figure 6-18: Circuit Board Removal

5. *Reinstallation:*

   a. Do, in reverse order, steps a through e. Reverse the removal instructions of each step to reinstall the A29 Video Trigger Board.

NOTE

Be sure to arrange the coax cable around the post as shown in Figures 6-16 and 6-17. Failure to do this may impair performance.

Also, when plugging in the digital bus boards, 1 and 3 in Figure 6-18, make sure that they remain plugged in on both ends.

   b. See the procedures *A14 D1 Bus and Power Cables* (page 6-34), *A23 SerPar Board* (page 6-35) and *Rear Cover and Cabinet* (page 6-20) to complete reassembly of the oscilloscope.

   c. To ensure the Video Trigger is working correctly, perform the *Diagnostics* procedure on page 6-63.

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 procedures *Rear Cover and Cabinet* (page 6-20), *A14 D1 Bus and Power Cables ,* and *A23 SerPar board* that immediately precedes this procedure to remove those items.

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 6-19 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. Unplug J62 video signal connector, J51 Monitor VGA connector, J37 RS232/Centronics connector, and J38 floppy driver connector.

   c. Grasp the board by its right and left sides and pull it towards the rear of the oscilloscope. This will release the processor/display board 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 4, reversing the removal instructions of each step to reinstall the processor/display board.

   b. See the procedures *A14 D1 Bus and Power Cables* (page 6-34), *A23 SerPar Board* (page 6-35), and *Rear Cover and Cabinet* (page 6-20) to complete reassembly of the oscilloscope.

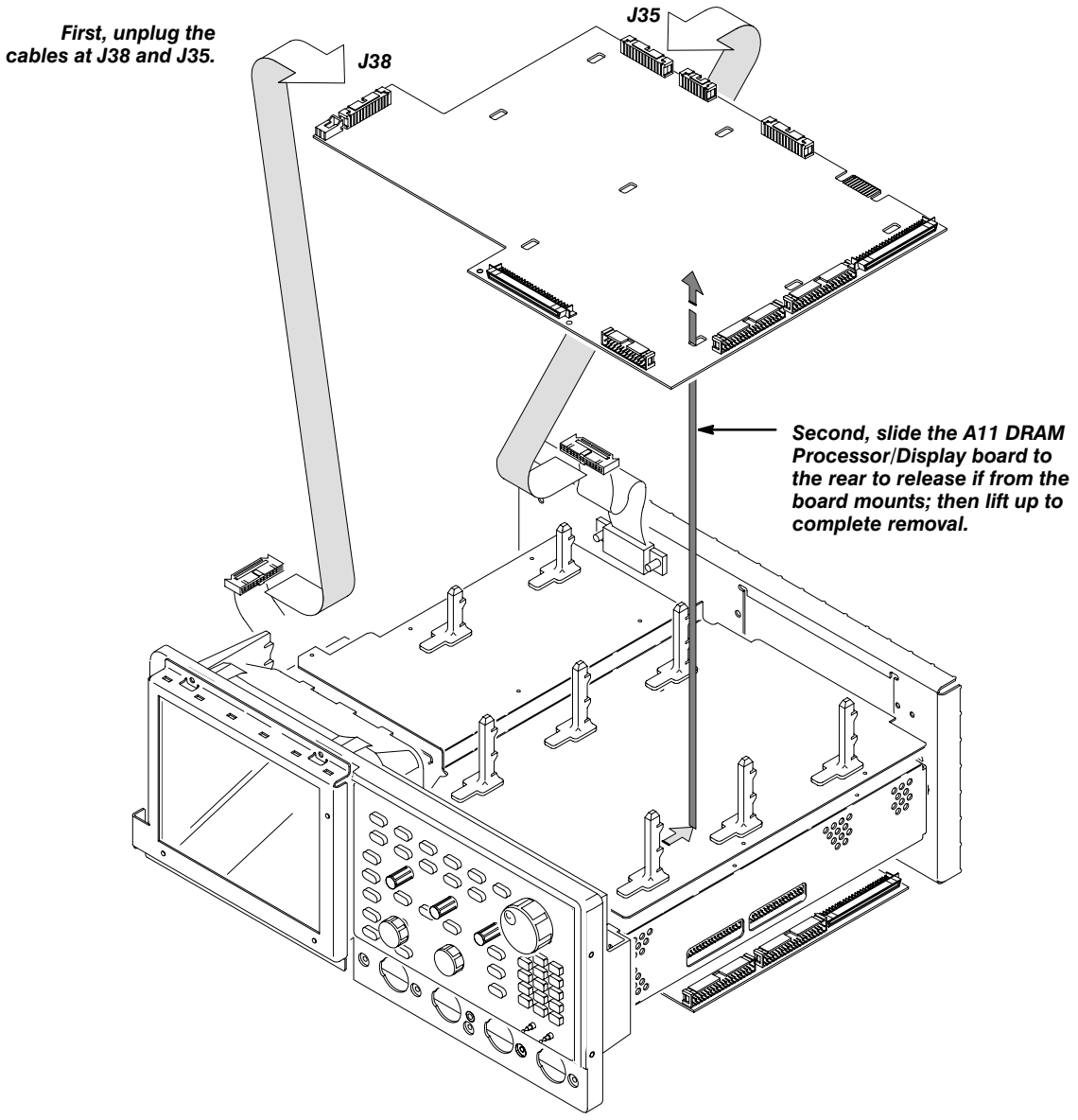


Figure 6-19: A11 Processor/Display Removal

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 Power Cables* (page 6-34), *A23 SerPar Board* (page 6-35), and *A11 Processor/Display Board* (page 6-42) 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 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.)

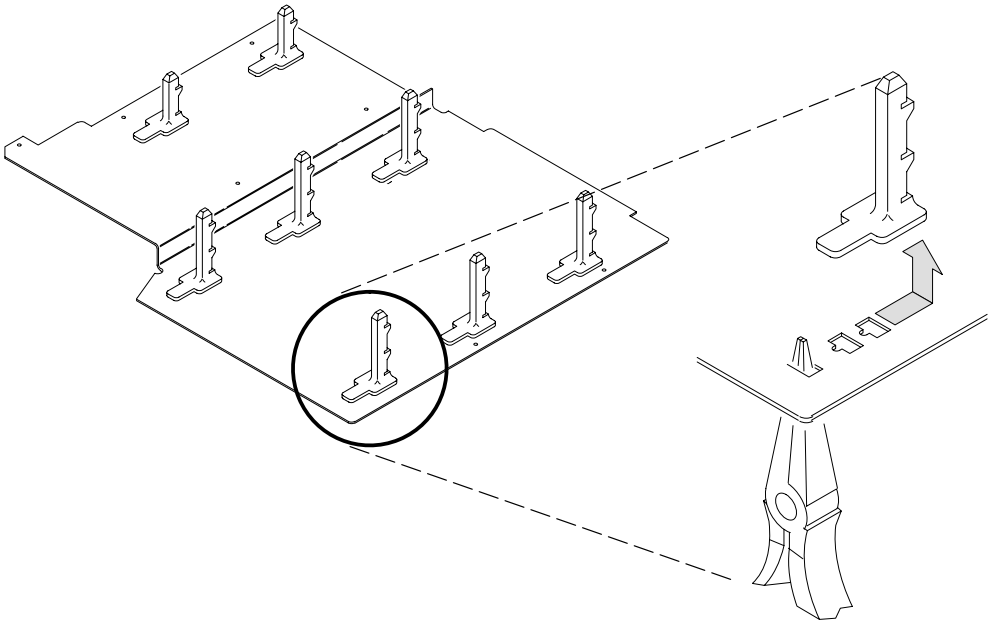


Figure 6-20: Board Bracket Removal

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 6-42)
      - *A14 D1 Bus and Power Cables* (page 6-34)
      - *A23 SerPar Board* (page 6-35)
      - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23)

- *Rear Cover and Cabinet* (page 6-20)

Rear-Panel Cables

1. *Assemble equipment and locate modules to be removed:* Have handy a 1/4 inch nut driver (Item 8).
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 1/4 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 6-45.
   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 OUT or AUX TRIGGER IN, 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 Power Cables* (page 6-34) 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 6-21 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 OUT (at J1201), AUX TRIG IN (at J1550), MAIN TRIG OUT (at J1000), DELAYED TRIG OUT (at J1001).

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.

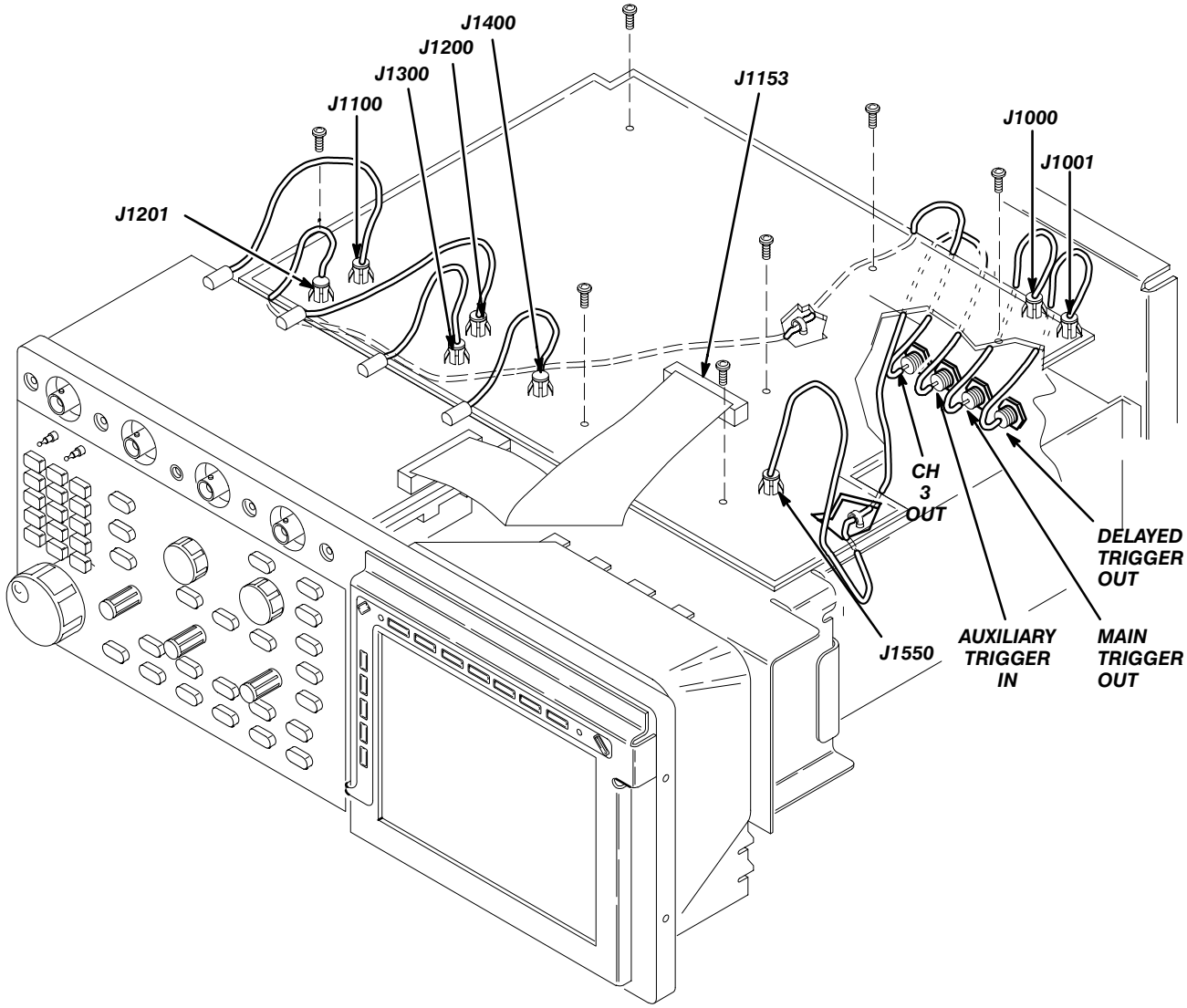


Figure 6-21: A11 Processor/Display Removal

4. *Reinstallation:* Do, in reverse order, substeps 3a−3e, 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 Power Cables* (page 6-34).
   - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23).
   - *Rear Cover and Cabinet* (page 6-20).

Floppy Disk

1. *Assemble equipment and locate modules to be removed:*
   a. Have handy a screwdriver with a small Phillips head.
   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.
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 Floppy Disk:* Use Figure 6-22 as a guide.
   a. Unplug the J38 floppy driver connector (ribbon interconnect cable) that connect the disk drive to the A11 Processor/Display board.
   b. You can either remove the disk drive and shield or the drive, shield, and holding bracket. To remove the drive, shield, and the bracket skip to step c. To remove just the drive and shield, unscrew the 2 retaining Phillips screens on the sides of the disk. Then pull out the disk.
   c. To remove the disk drive, the shield, and the bracket together, remove the two T15 torque screws holding the bracket to the chassis. Then remove the disk, shield, and the bracket as a unit.

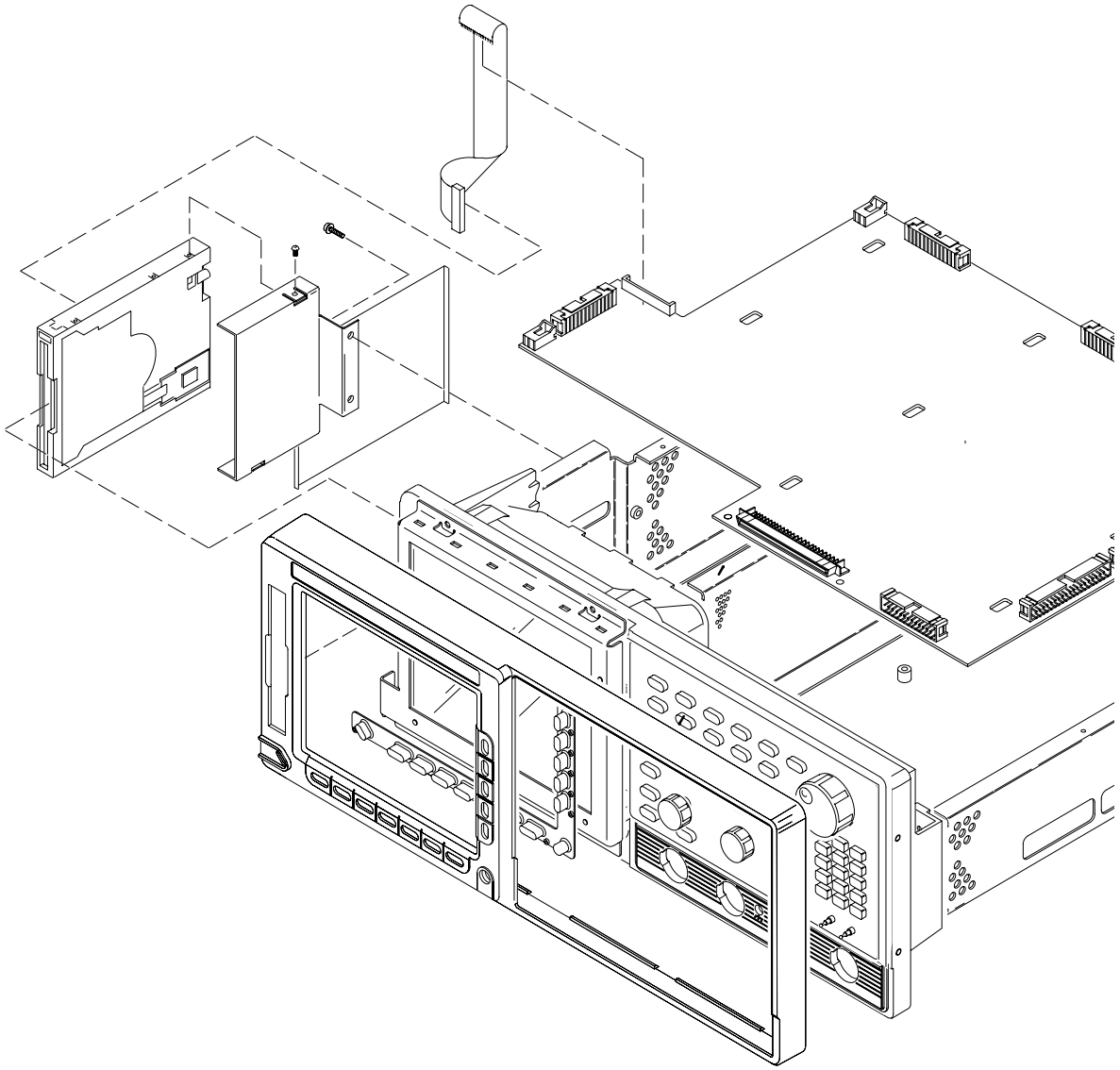


Figure 6-22: Floppy Disk Removal

4. *Reinstallation:* Do, in reverse order, substeps 3c then 3a or 3b then 3a to reinstall the *floppy disk*. 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 6-23).
   - *Rear Cover and Cabinet* (page 6-20).

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 6-23 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 OUT (at J1201), AUX TRIG IN (at J1550), MAIN TRIG OUT (at J1000), DELAYED TRIG OUT (at J1001), 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 Power Cables* (page 6-34)
   - *Rear Cover and Cabinet* (page 6-20)

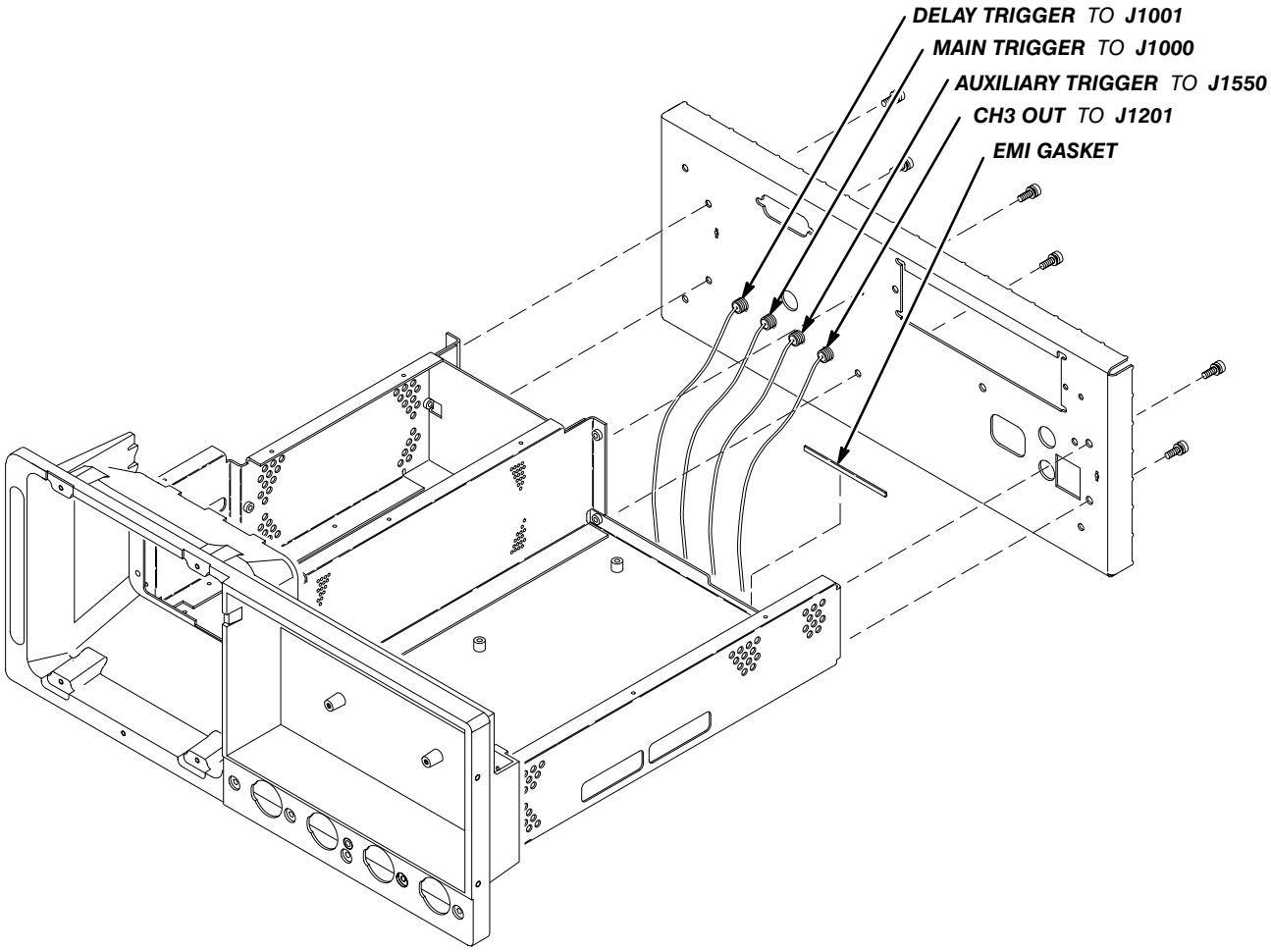


Figure 6-23: Rear Chassis Removal

Procedures for Inner-Chassis Modules

You should have done the *Access Procedure* (page 6-16) before doing any procedure in this collection. The procedures found here, listed in order presented, follow.

A16 Low Voltage Power Supply

A20 or A30 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 6-24.
   b. Now, working from the top of the oscilloscope, remove the seven screws indicated in Figure 3-6 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 6-44)
   - *A11 Processor/Display Board* (page 6-42)
   - *A14 D1 Bus and Power Cables* (page 6-34)
   - *Rear Cover and Cabinet* (page 6-20)

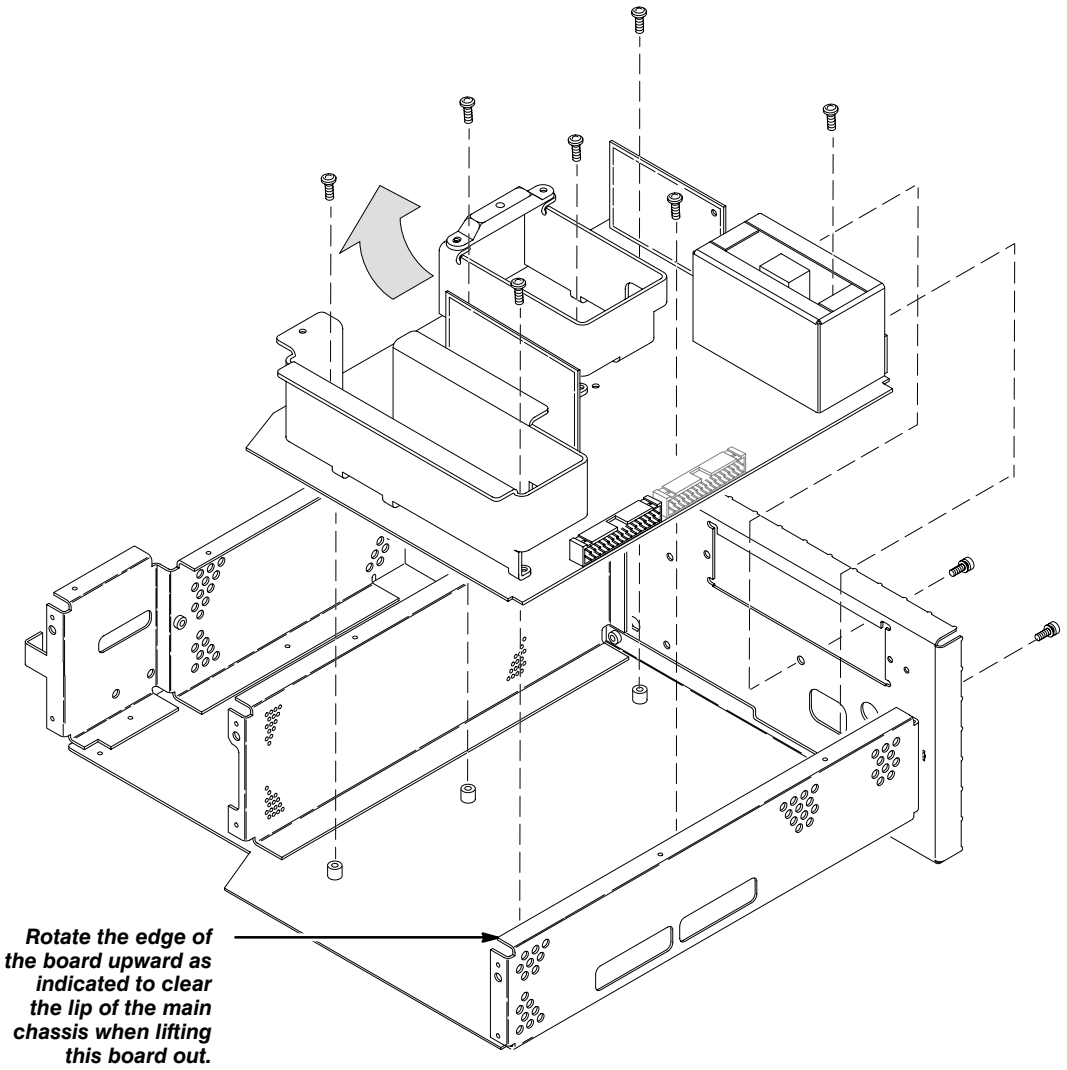


Figure 6-24: A16 Low Voltage Power Supply Removal

A20 or A30 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. *A20 refers to the TDS 520A and 540A monochrome module. A30 refers to the TDS 524A and 544A color module.*

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 6-25 (A30 − TDS 524A and 544A) or Figure 6-26 (A20 − TDS 520A and 540A) while doing the following substeps.
   b. For the TDS 524A and 544A: Unplug the display tube connector from the back of the display tube and the display tube yoke connector from the display circuit board (J170, J305 and J570). Loosen the screw on the video board that holds the CRT sockets. Then pull back on the video board slightly. This separates the board from the socket.

      For the TDS 520A and 540A: 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.

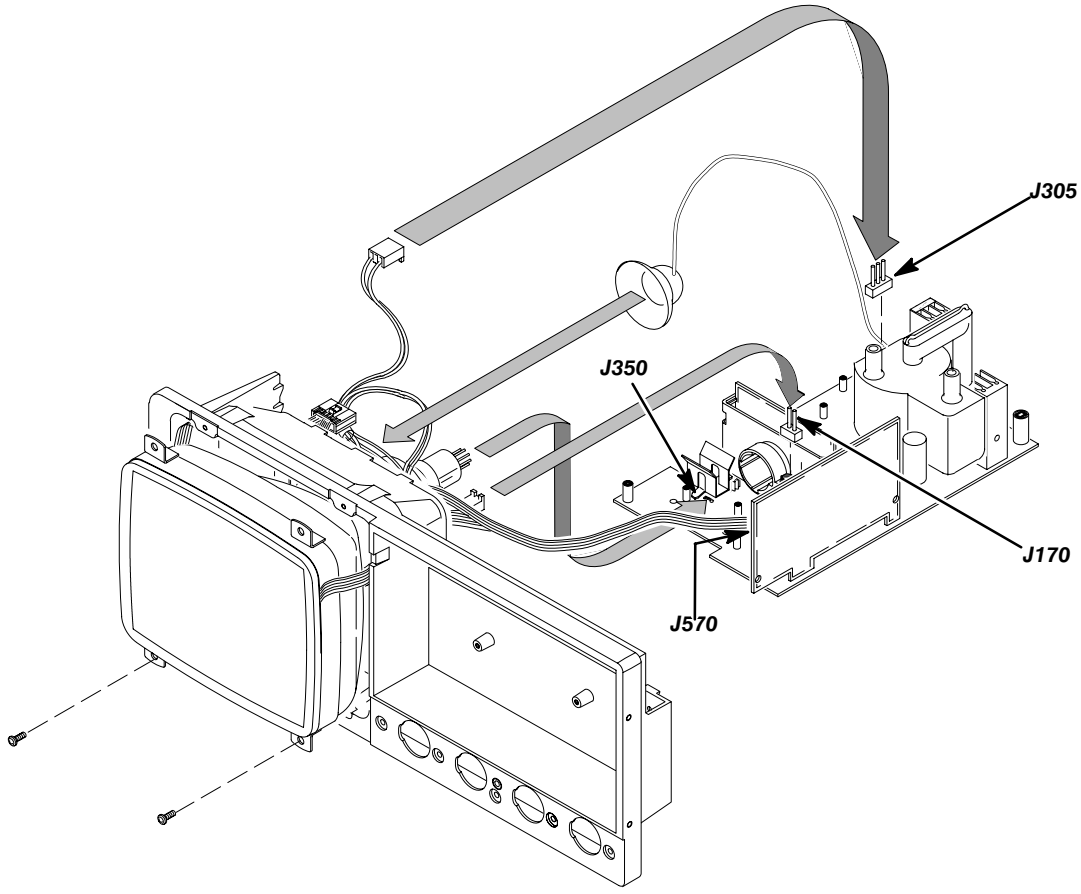


Figure 6-25: Display Assembly Removal − TDS 524A and 544A

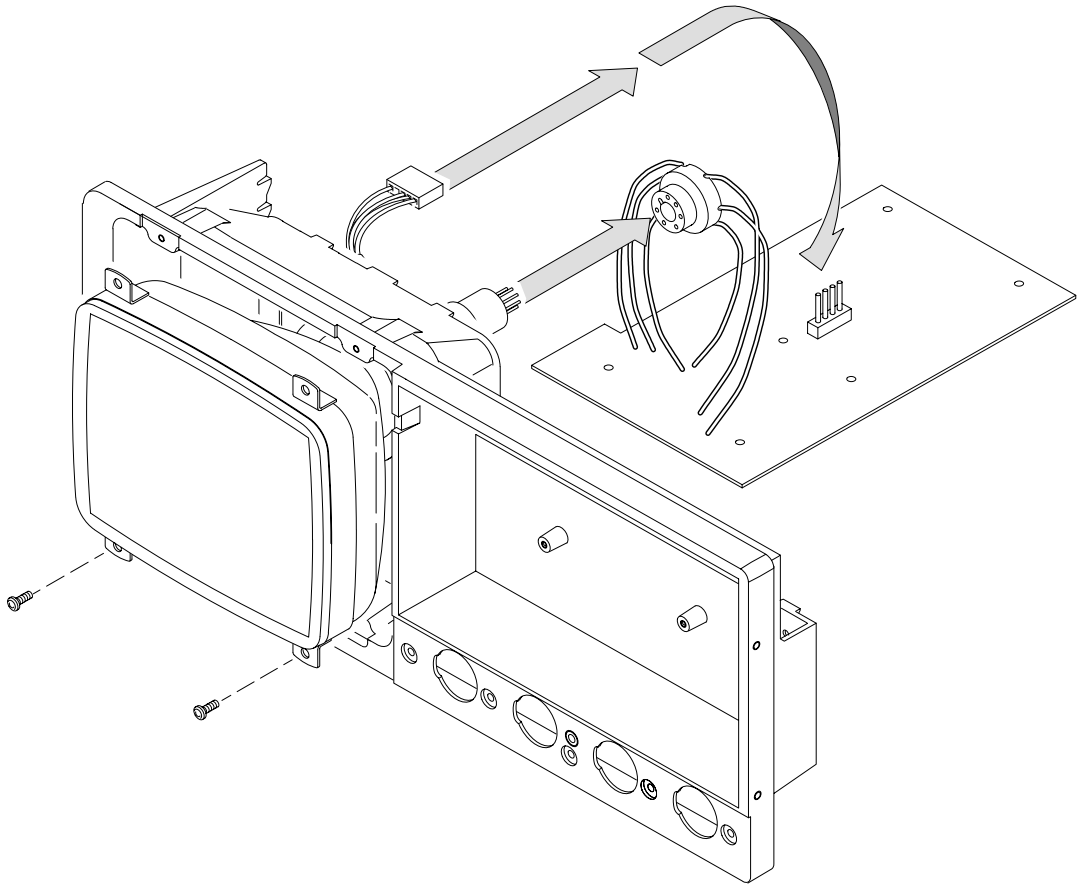


Figure 6-26: Display Assembly Removal − TDS 520A and 540A

5. *Remove the Display-Supply board:* Use Figure 6-27 as a guide.

   a. Remove the six screws that mount the display-driver board to the main chassis.

   b. Grasp the display driver board. 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.

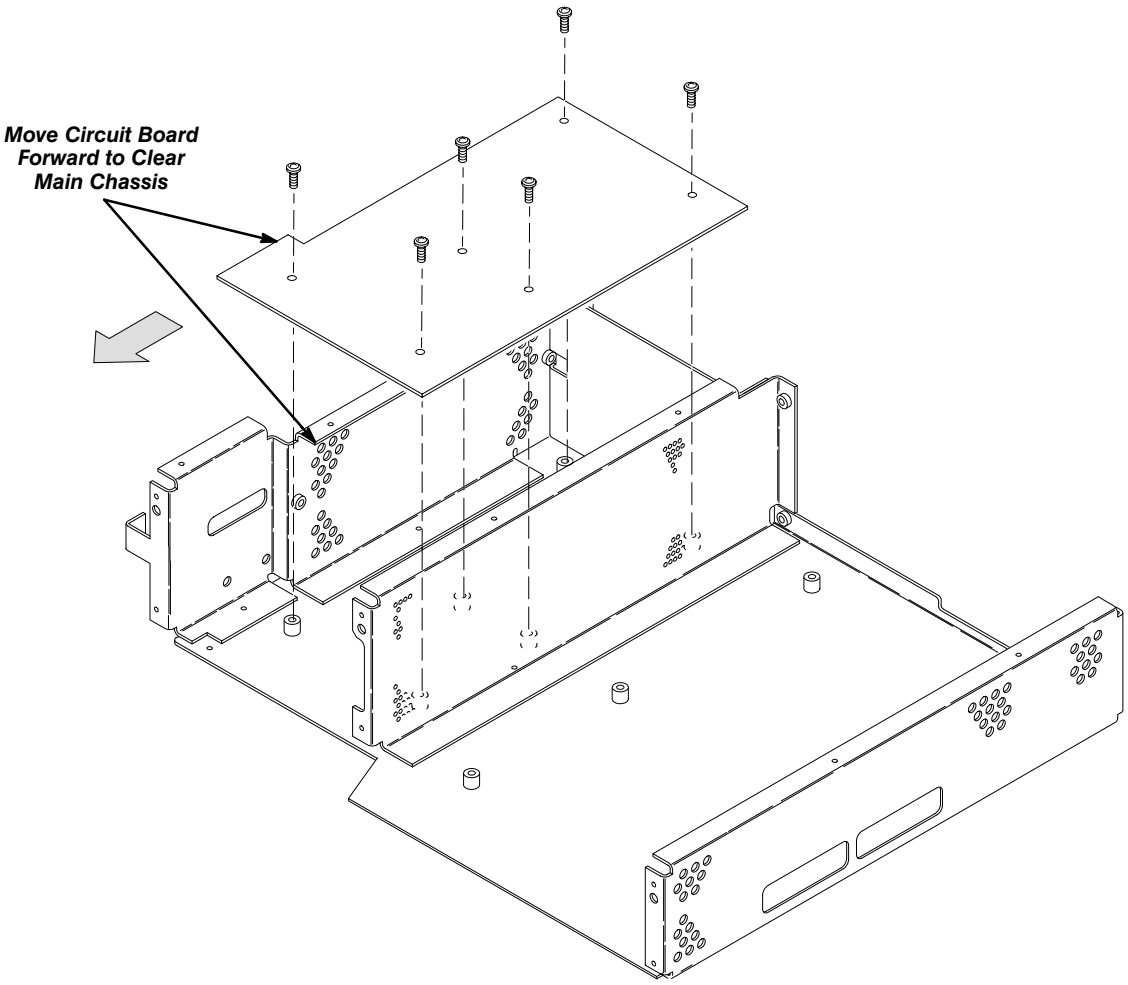


Figure 6-27: Display-Driver Board Removal

6. *Reinstallation:*

   a. Do, in reverse order, substeps 5a−5b, 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. Do the following procedures, in order, to complete reassembly of the oscilloscope:

      - *Top Cover and Board Brackets* (top cover only) on page 6-44
      - *A11 Processor/Display Board* (page 6-42)
      - *A14 D1 Bus and Power Cables* (page 6-34)
      - *Display-Frame Assembly*

- *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23)
- *Rear Cover and Cabinet* (page 6-20) (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 or A30 Display Assembly and Supply Fuse* (page 6-53). 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 6-28 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 6-28.) Then reinstall the six screws removed in step 3.
   b. See the procedure *A20 or A30 Display Assembly and Supply Fuse* (page 6-53) 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*
      - *Top Cover and Board Brackets* (page 6-44)
      - *A11 Processor/Display Board* (page 6-42)
      - *A14 D1 Bus and Power Cables* (page 6-34)
      - *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23)
      - *Rear Cover and Cabinet* (page 6-20)

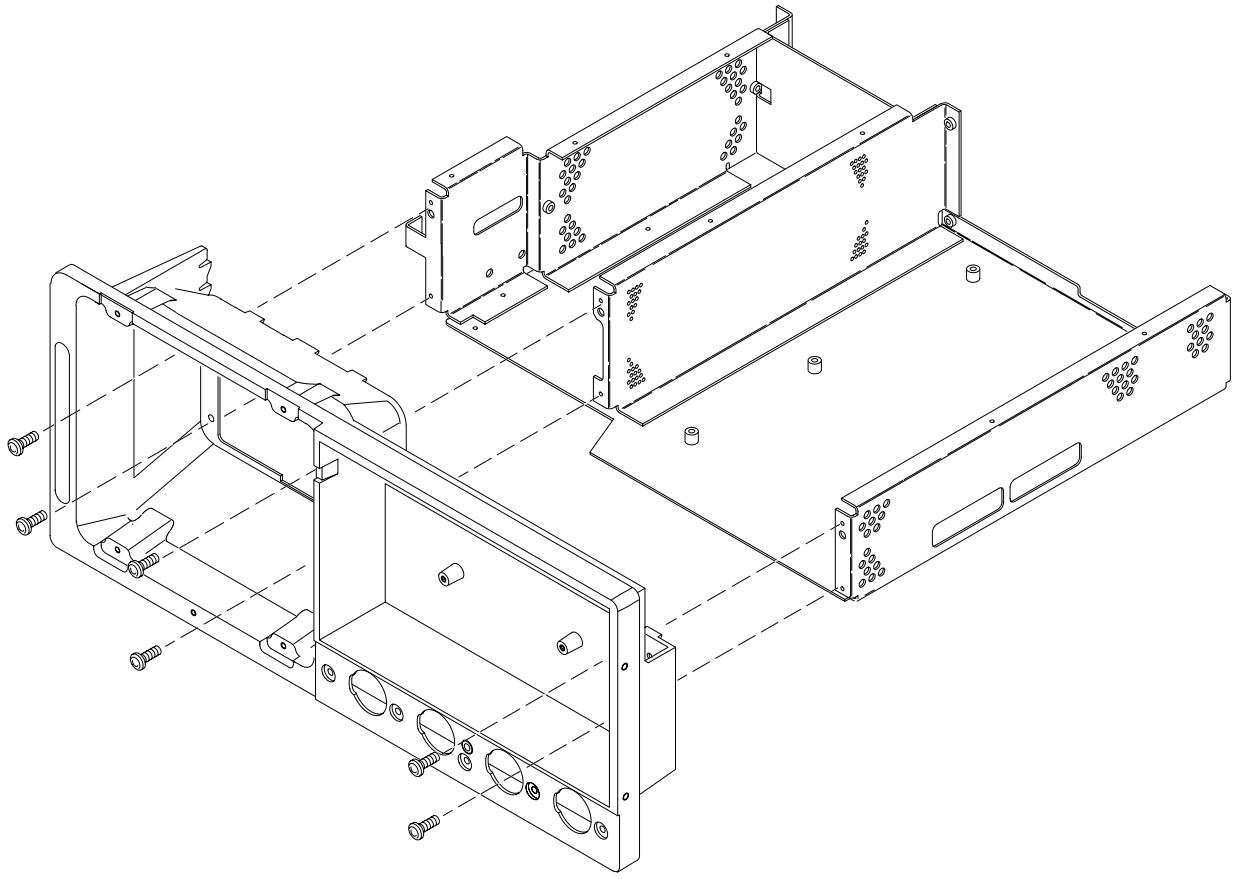


Figure 6-28: Front Subpanel Removal

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 520A, 524A, 540A, & 544A Digitizing Oscilloscopes into their 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 6-17.
   a. *Line Fuse and Line Cord* (page 6-18)
   b. *Rear Cover and Cabinet* (page 6-20)
   c. *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23)
   d. *Front Subpanel* (page 6-58) 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 6-31.
   a. *Fan* (page 6-32)
   b. *A14 D1 Bus and Power Cables* (page 6-34)
   c. *A23 SerPar Board* (page 6-35)
   d. *A29 Video Trigger Board − with option 05* (page 6-37)
   e. *A11 Processor/Display Board* (page 6-42)
   f. *Top Cover and Board Brackets* (page 6-44)
   g. *A15 Attenuator Assembly*
   h. *A10 Acquisition Board* (page 6-45)
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 6-51.
   a. *A16 Low Voltage Power Supply* (page 6-51)
   b. *A20 or A30 Display Assembly and Supply Fuse* (page 6-53)
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 6-28 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 6-23 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 subpanel 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 6-51.

- *A20 or A30 Display Assembly and Supply Fuse* (page 6-53)
- *A16 Low Voltage Power Supply* (page 6-51)

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 6-31.

- *A15 Attenuator Assembly* (page 6-31)
- *Top Cover and Board Brackets* (page 6-44)
- *A11 Processor/Display Board* (page 6-42)
- *A23 SerPar Board* (page 6-35)
- *A29 Video Trigger Board − with option 05* (page 6-37)
- *A14 D1 Bus and Power Cables* (page 6-34)
- *Fan* (page 6-34)
- *A10 Acquisition Board* (page 6-45)

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 6-17.

- *Front Subpanel* (page 6-58)
- *Display-Frame Assembly* (page 6-53)
- *Front Cover, Trim Ring, Menu Buttons, and Attenuator Panel* (page 6-23)
- *Rear Cover and Cabinet* (page 6-20)
- *Line Fuse and Line Cord* (page 6-18)

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* in this section.

TDS 520A, 524A, 540A, & 544A 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 they do find a bad module and/or interface, 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 an extended set that tests the oscilloscope circuitry in-depth and takes more time. At power on, 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 520A, 524A, 540A, & 544A firmware updates are easy to do. Simply install the firmware disks on your PC and follow the instructions in the READ-ME file located on the first disk.

NOTE

You must set the Protection switch to the unprotected position before updating the firmware. Figure 6-29 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*, *Mechanical Parts List* in Section 10 for the part number.

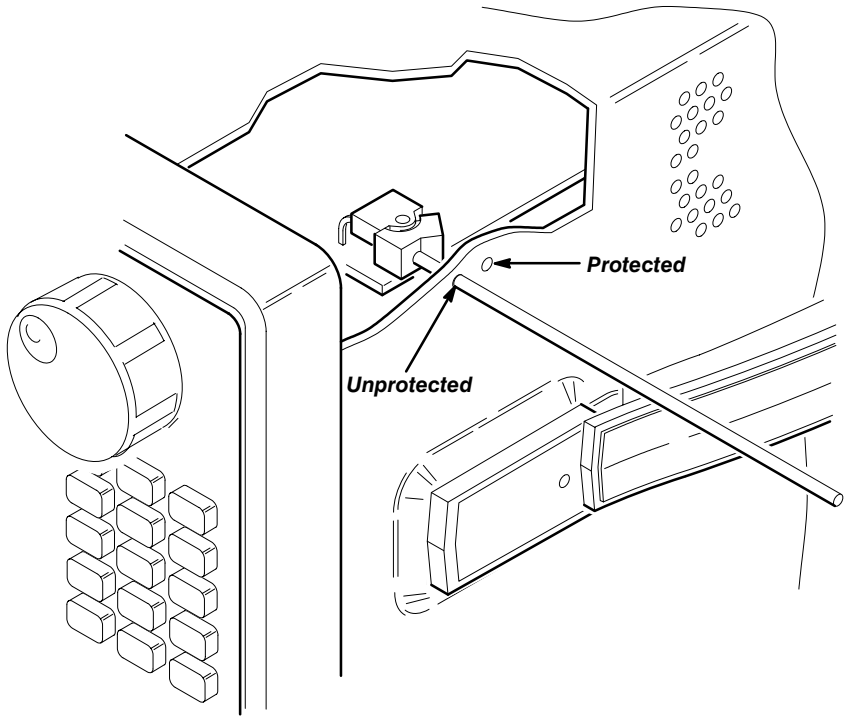
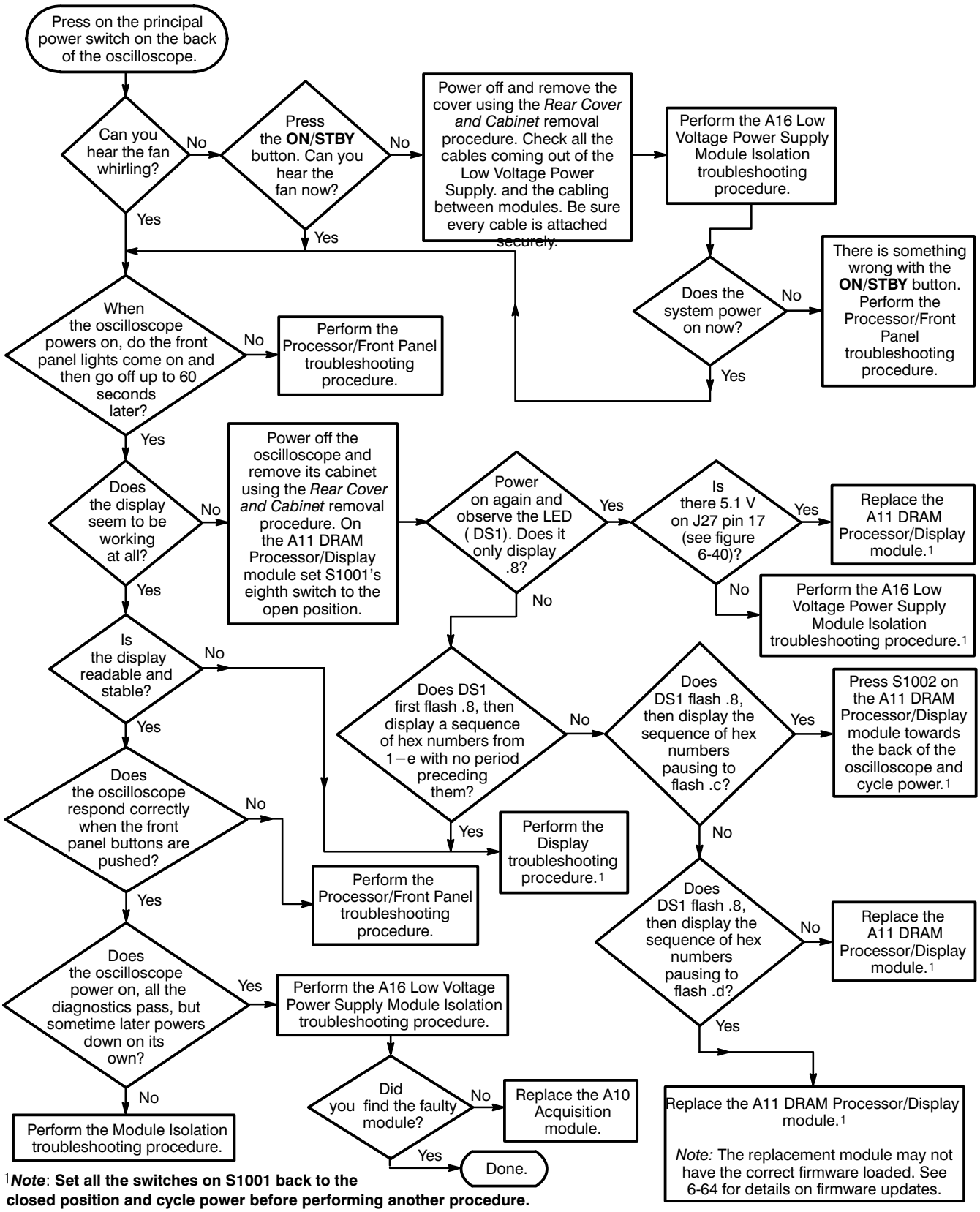


Figure 6-29: Accessing the Protection Switch



1***Note***: **Set all the switches on S1001 back to the closed position and cycle power before performing another procedure.**

Figure 6-30: Primary Troubleshooting Procedure

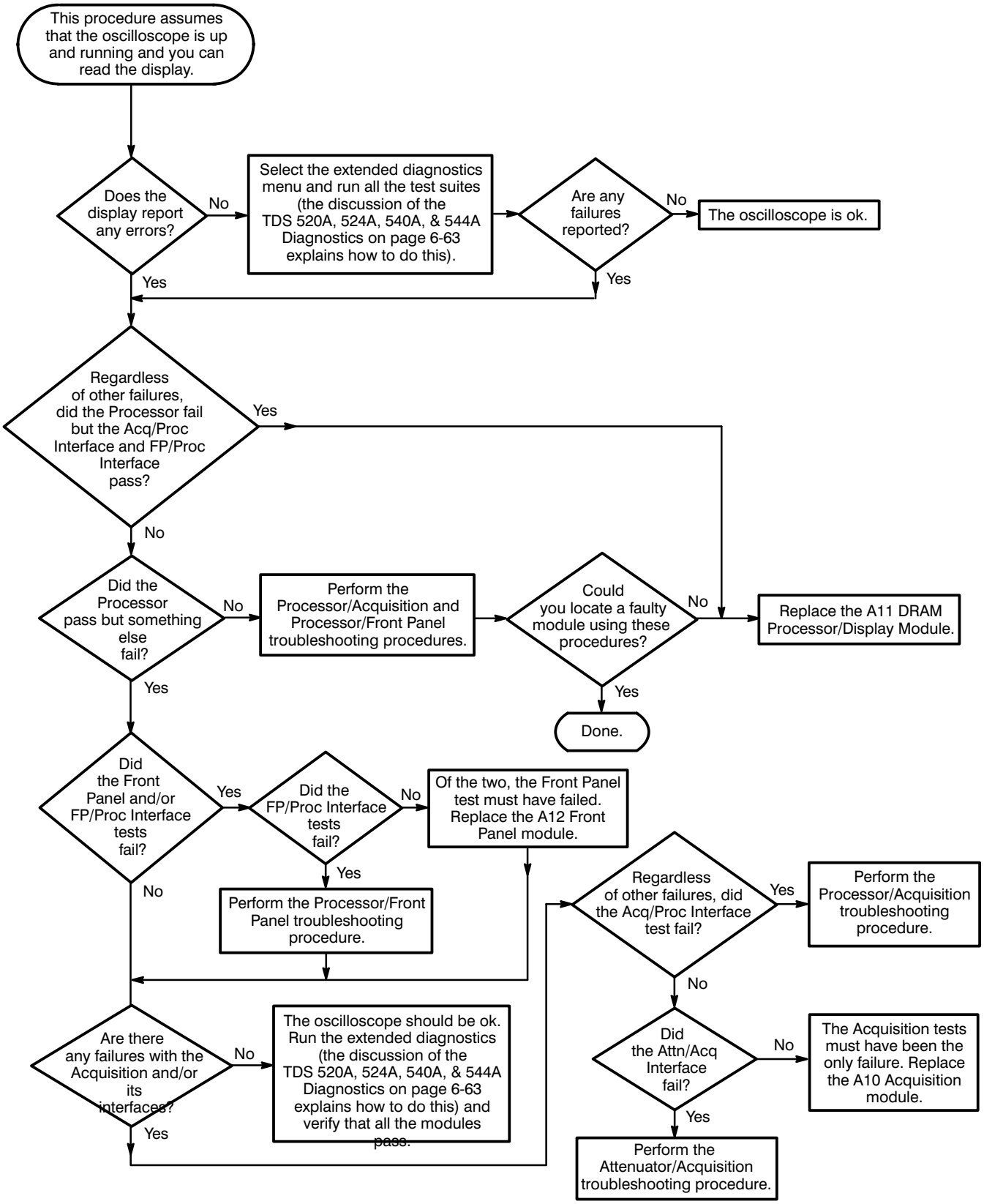


Figure 6-31: Module Isolation Troubleshooting Procedure

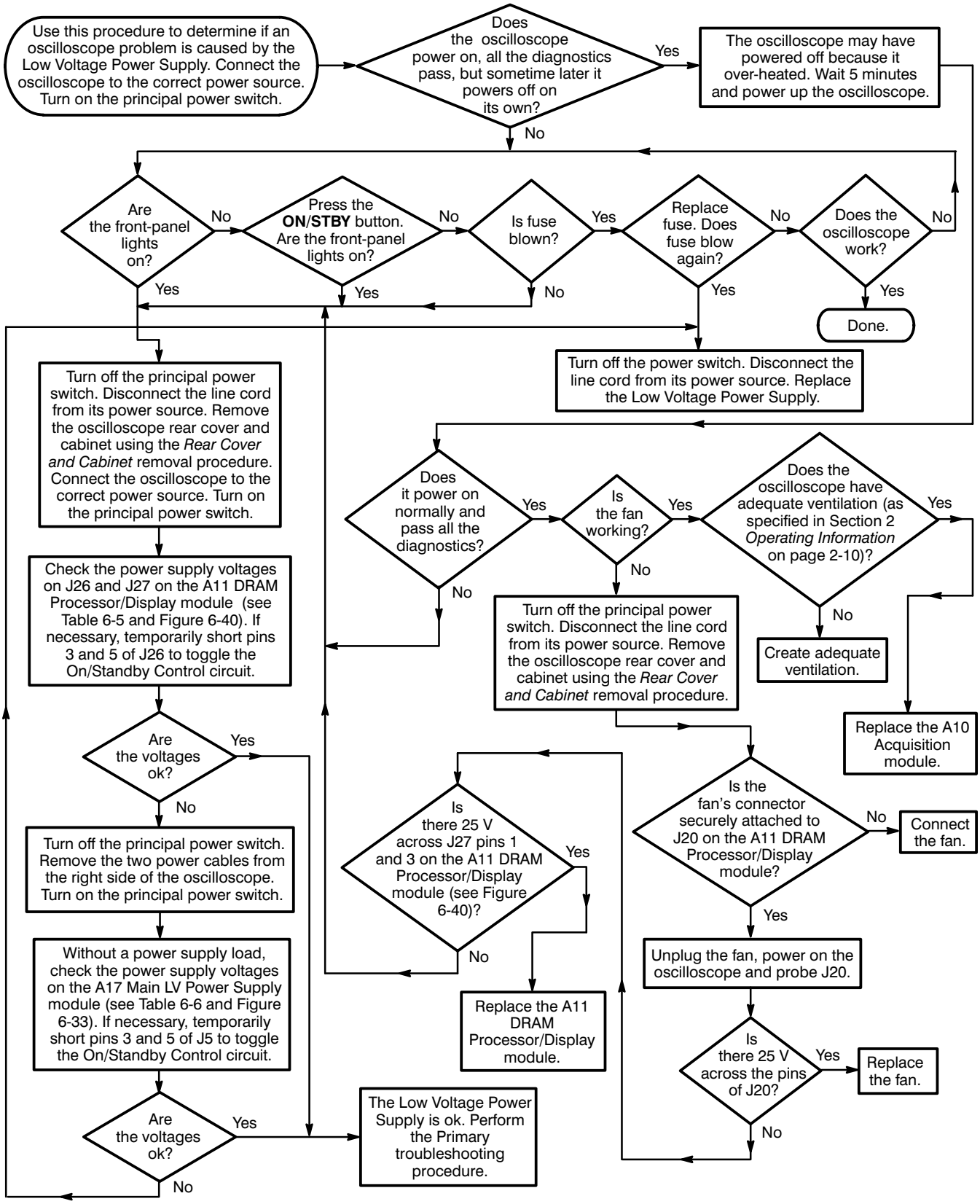


Figure 6-32: A16 Low Voltage Power Supply Module Isolation Troubleshooting Procedure

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

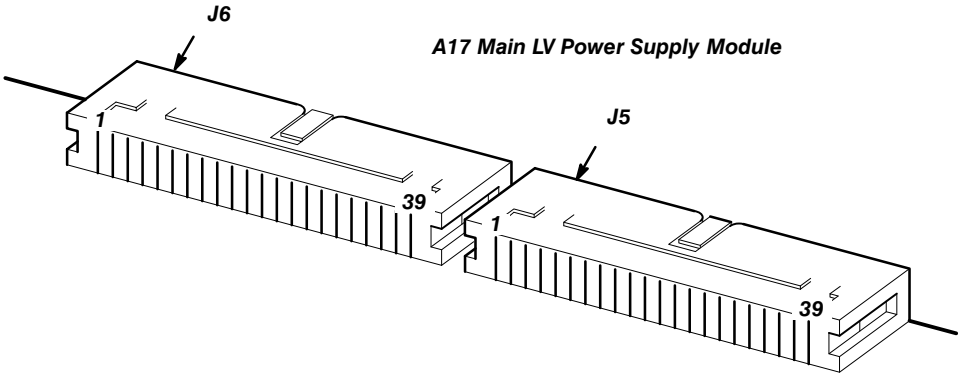


Figure 6-33: Power Supply Voltage Measurement Locations

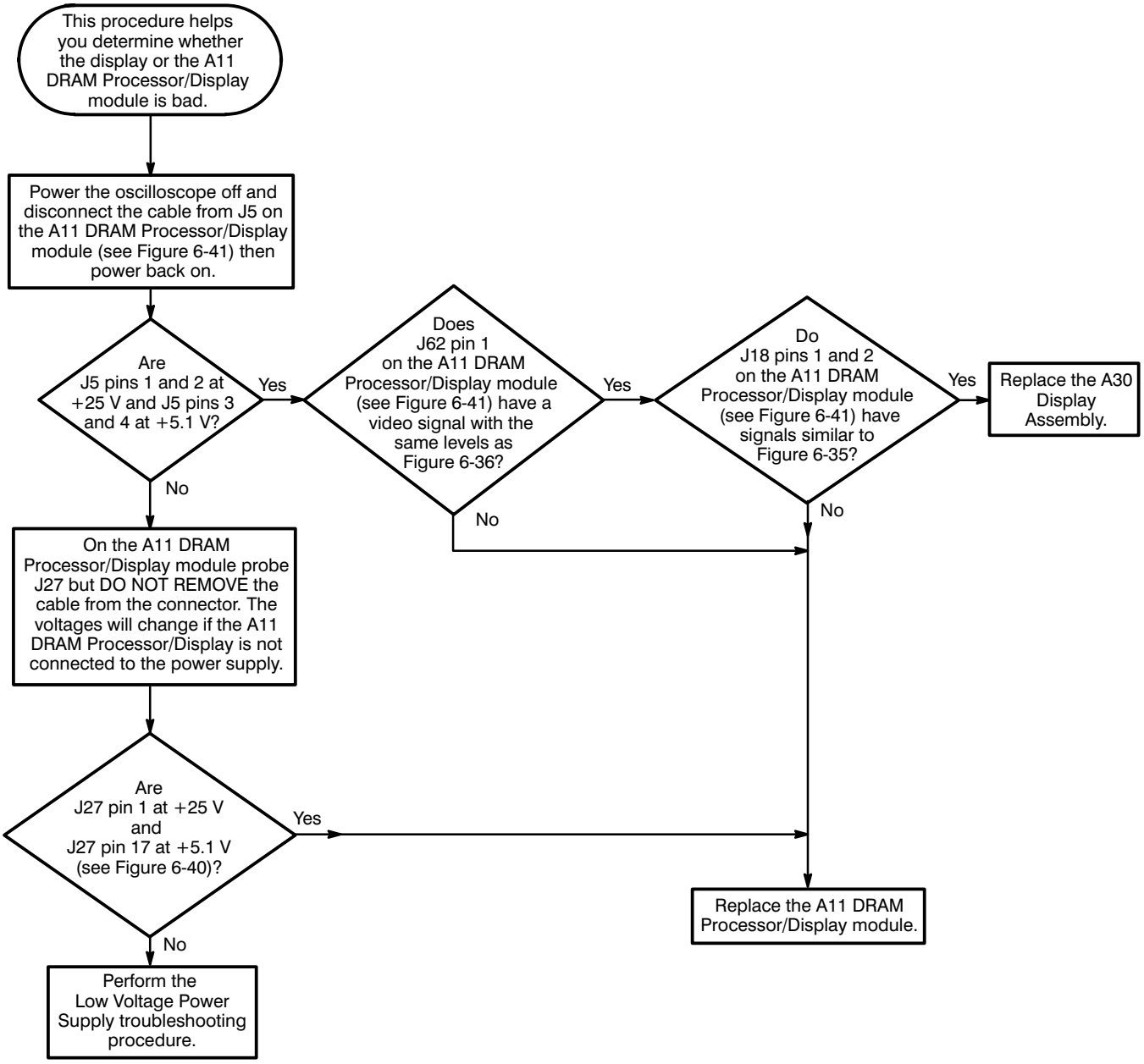


Figure 6-34: Display Troubleshooting Procedure

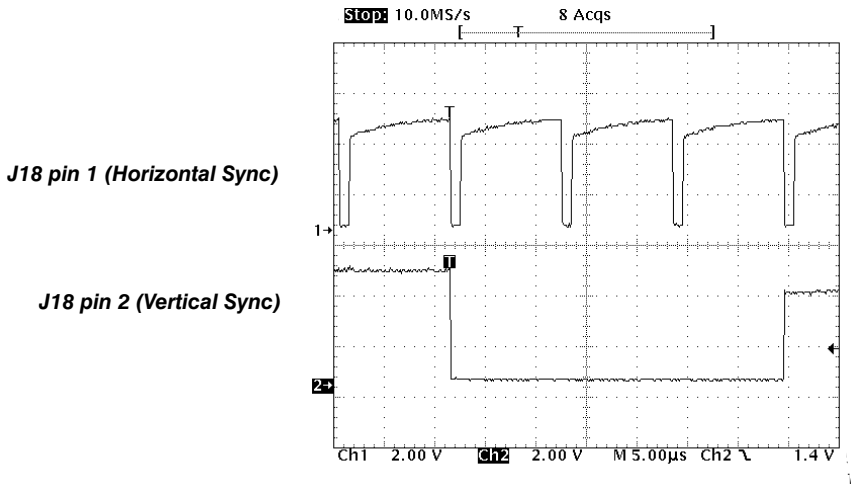


Figure 6-35: Horizontal and Vertical Sync Signals

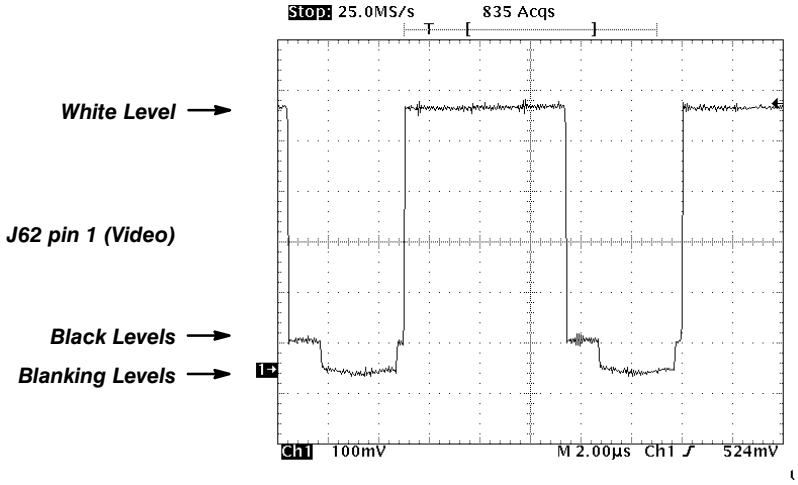


Figure 6-36: A Video Signal with White, Black, and Blanking Levels

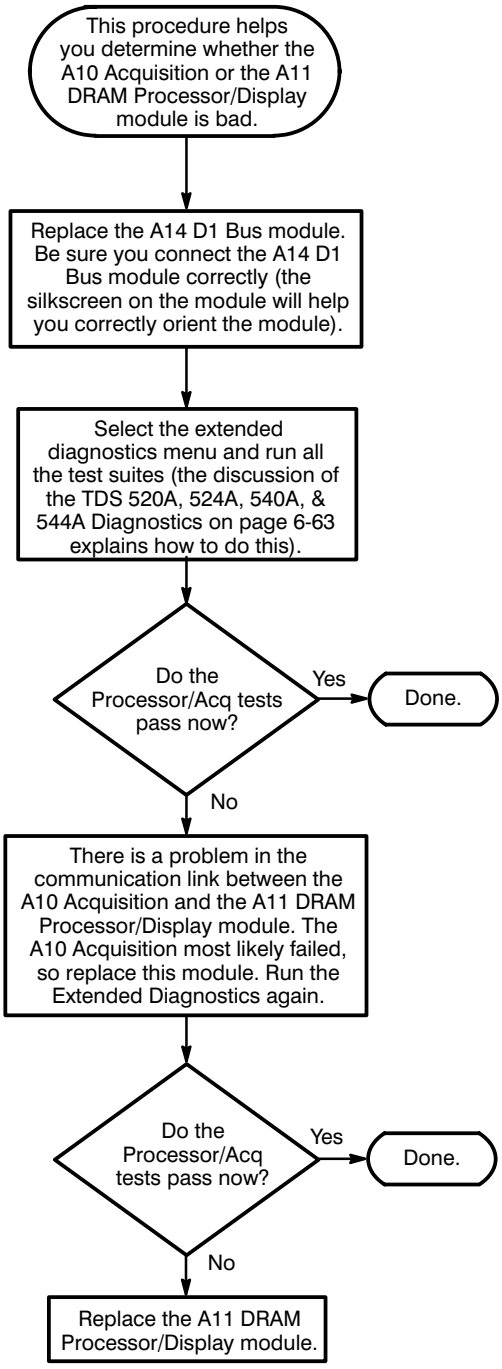


Figure 6-37: Processor/Acquisition Troubleshooting Procedure

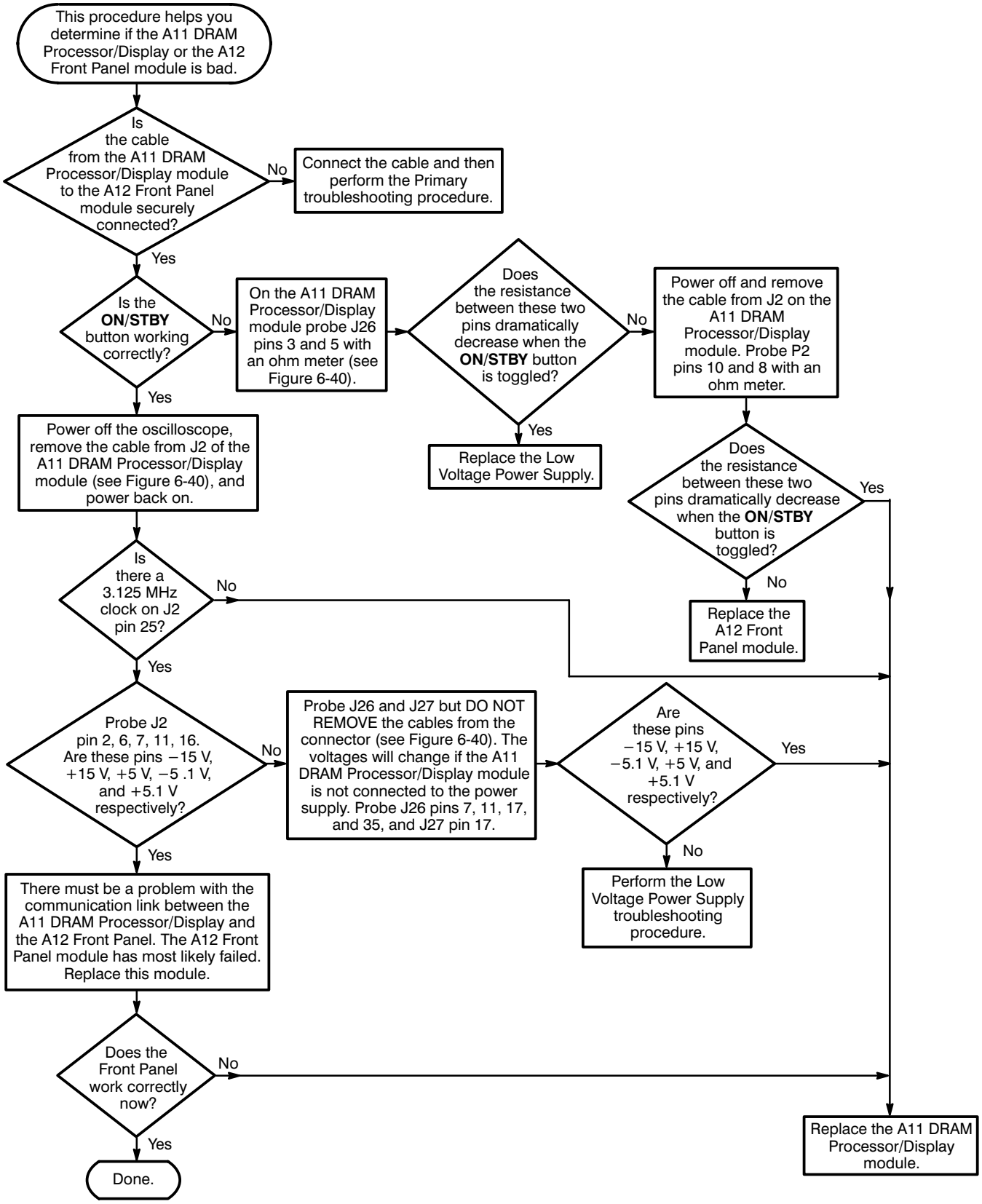


Figure 6-38: Processor/Front Panel Troubleshooting Procedure

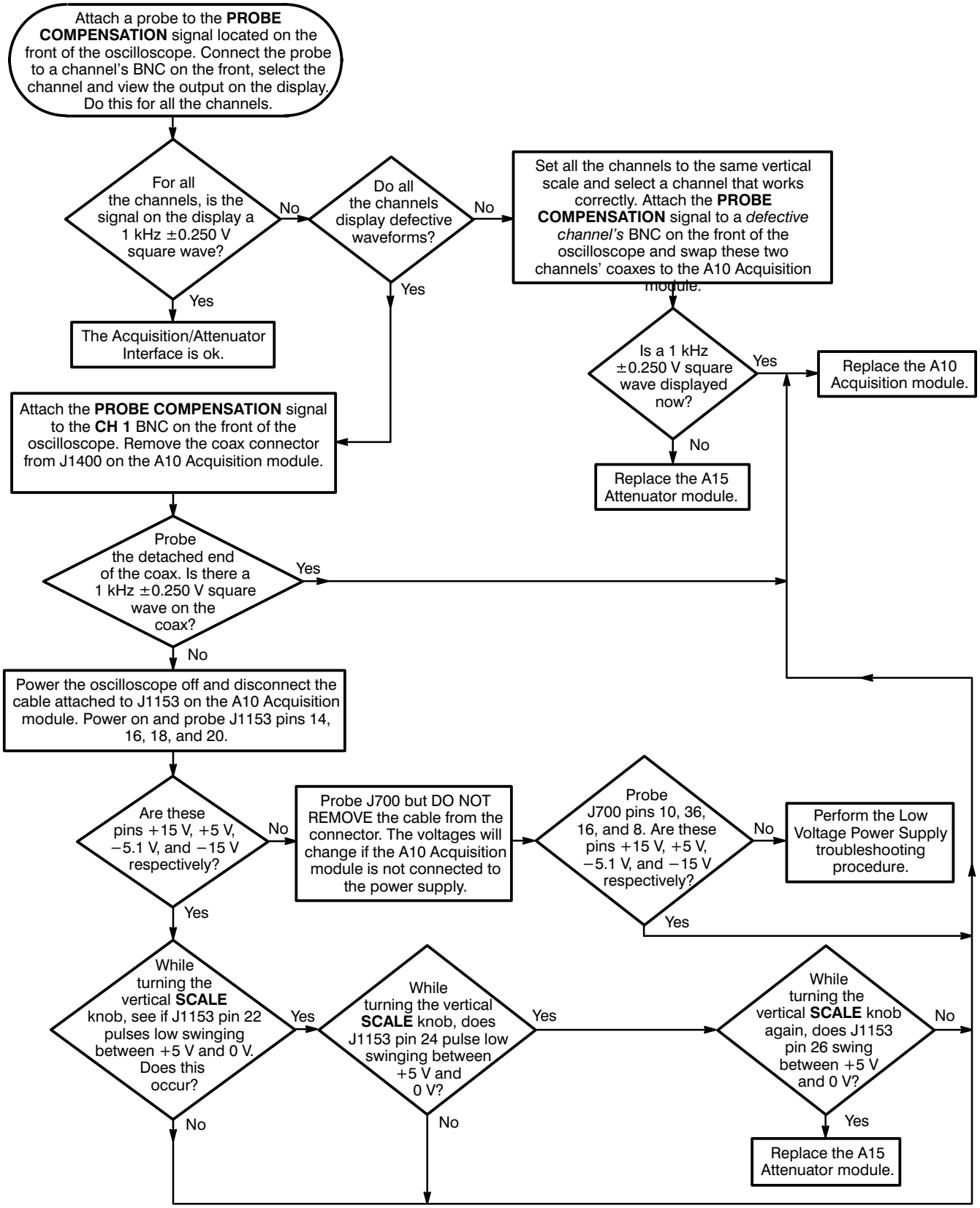


Figure 6-39: Attenuator/Acquisition Troubleshooting Procedure

CAUTION *Probe only those points specified in the procedures. You can cause catastrophic damage if you attempt to probe other points.*

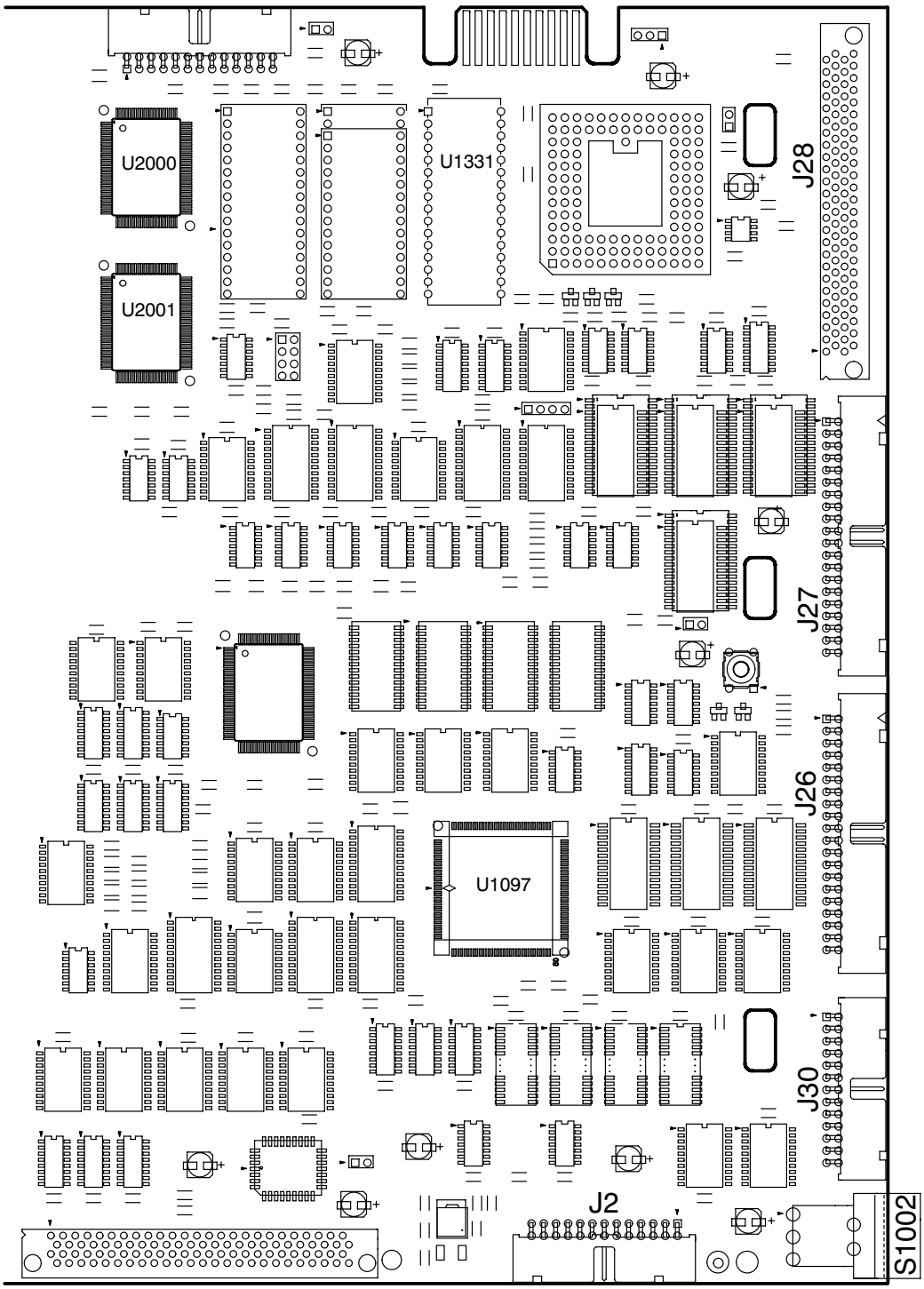


Figure 6-40: A11 DRAM Processor/Display Module (View of Right Side)

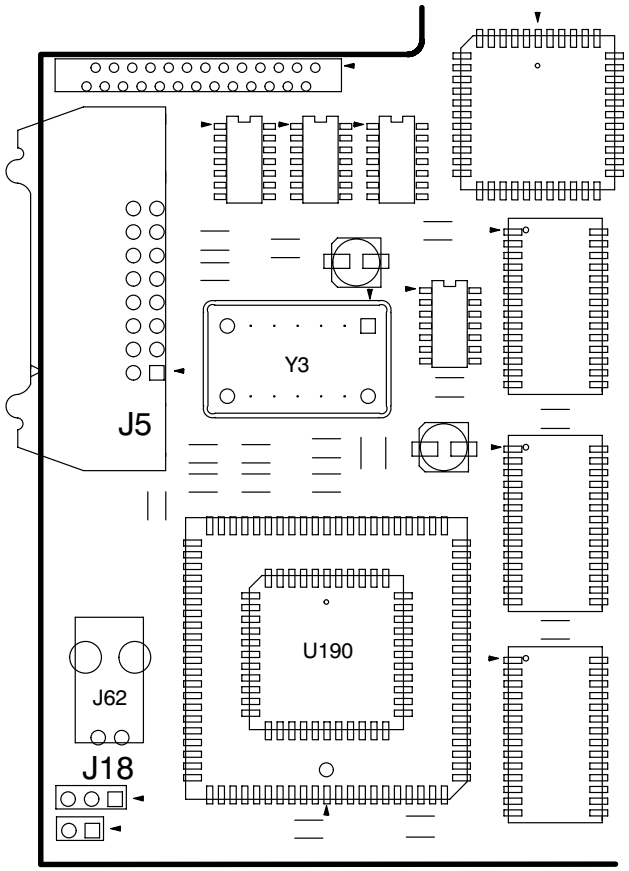


Figure 6-41: A11 DRAM Processor/Display Module (View of Lower Left Corner)

Replace this page with the Tab named Options

Options and Accessories

This section describes the various options as well as the standard and optional accessories that are available for the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

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 with the oscilloscope.

Option 1K: K218 Scope Cart

With this option, Tektronix ships the K218 Scope Cart. The cart can help you transport the oscilloscope around many lab environments.

Option 1M: 50,000 Point Record Length

This option provides a maximum record length of 50,000 points per acquisition (50,000/channel) and nonvolatile RAM storage of up to four 50,000 point records.

Warranty-Plus Service Options

The following options add to the services available with the standard warranty. (The standard warranty appears following the title page in this manual.)

- **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 Digitizing Oscilloscope

Tektronix ships the Digitizing Oscilloscopes, when ordered with Option 1R, configured for installation in a 19 inch wide instrument rack. Customers with instruments not configured for rackmounting can order a rackmount kit (016−1136−00 for field conversions).

Instructions for rackmounting the Digitizing Oscilloscopes are shipped with the option 1R.

Option 05: Video Trigger

With this option, Tektronix ships the instrument with tools for investigating events that occur when a video signal generates a horizontal or vertical sync pulse. It allows you to investigate a range of NTSC, PAL, SECAM, and high definition TV signals.

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 2P: Phaser 200e Color Printer

With this option, Tektronix ships a Tektronix Phaser 200e, 300 dpi, thermal transfer, color printer. It handles letter or A4 size Tektronix thermal paper and transparencies. It can handle laser copy (plain) paper with the ColorCoat Transfer Roll.

Option 23: Active Probes

With this option, Tektronix ships two active high speed voltage probes (the P6205 10X FET).

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 ratio calibration technique. The calibration is in compliance with US 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	070−8710−01
Programmer Manual	070−8709−06
Reference	070−8711−02
Performance Verification	070−8712−01
Front Cover	200−3696−00
U.S. Power Cord	161−0230−01
Probes, quantity four, 10X Passive	P6139A (single unit)

Probe Accessories

These are accessories to the standard probe listed previously (P6139A). 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

Table 7-3: Probe Accessories (Cont.)

Accessory	Part Number
Probe-Tip-to-Circuit Board Adapter (quantity two standard, optionally available in package of 25 as 131−5031−00)	No customer orderable part number for double unit
Six-inch Slip-On Ground Lead	196−3113−02
Low Inductance Ground Lead	195−4240−00
Marker Rings Set (quantity eighteen rings which includes two each of nine colors)	016−0633−00
Ground Collar	343−1003−01
Six-inch Alligator Clip Ground Lead	196−3305−00
Screwdriver: adjustment tool, metal tip	003−1433−00
SMT KlipChip™	206−0364−00
Accessory Pouch	016−0708−00

Optional Accessories

You can also order the following optional accessories:

Table 7-4: Optional Accessories

Accessory	Part Number
TDS 520A, 524A, 540A, & 544A Service Manual	070−8713−03
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 Z_O) probe. Provides 100X, when ordered with Option 25.
- 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
	013−0226−00
Connector, BNC: 50 Ω, BNC to Probe Tip Adapter	013−0227−00
Connector, Probe: Package of 100, compact	131−4244−00
Connector, Probe: Package of 25, compact	131−5031−00
Screwdriver Adjustment Tool, Package of five	003−1433−01
Compact-to-Miniature Probe Tip Adapter	013−0202−02
Probe Tip Holder: (holds three tips)	352−0670−00
Three-inch Slip-On Ground Lead	196−3113−03
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
NOTE *The next four items below can only be used with the Compact-to-Miniature Probe Tip Adapter.*	
Dual-Lead Adapter	015−0325−00
BNC-to-Probe Tip Adapter	013−0084−01
G.R.-to-Probe Tip Adapter, 50 Ω	017−0088−00
Bayonet Ground Assembly	013−0085−00

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 Information

Check for the full warranty statements for this product, the probes, and the products listed above on the first page after the title page of each product manual.

Replace this page with the Tab named Electrical Parts

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, *Mechanical Parts List*. Refer to that section for part numbers when using this manual.

Replace this page with the Tab named Diagrams

Diagrams

This contains the block diagram and the interconnection diagram for the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

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

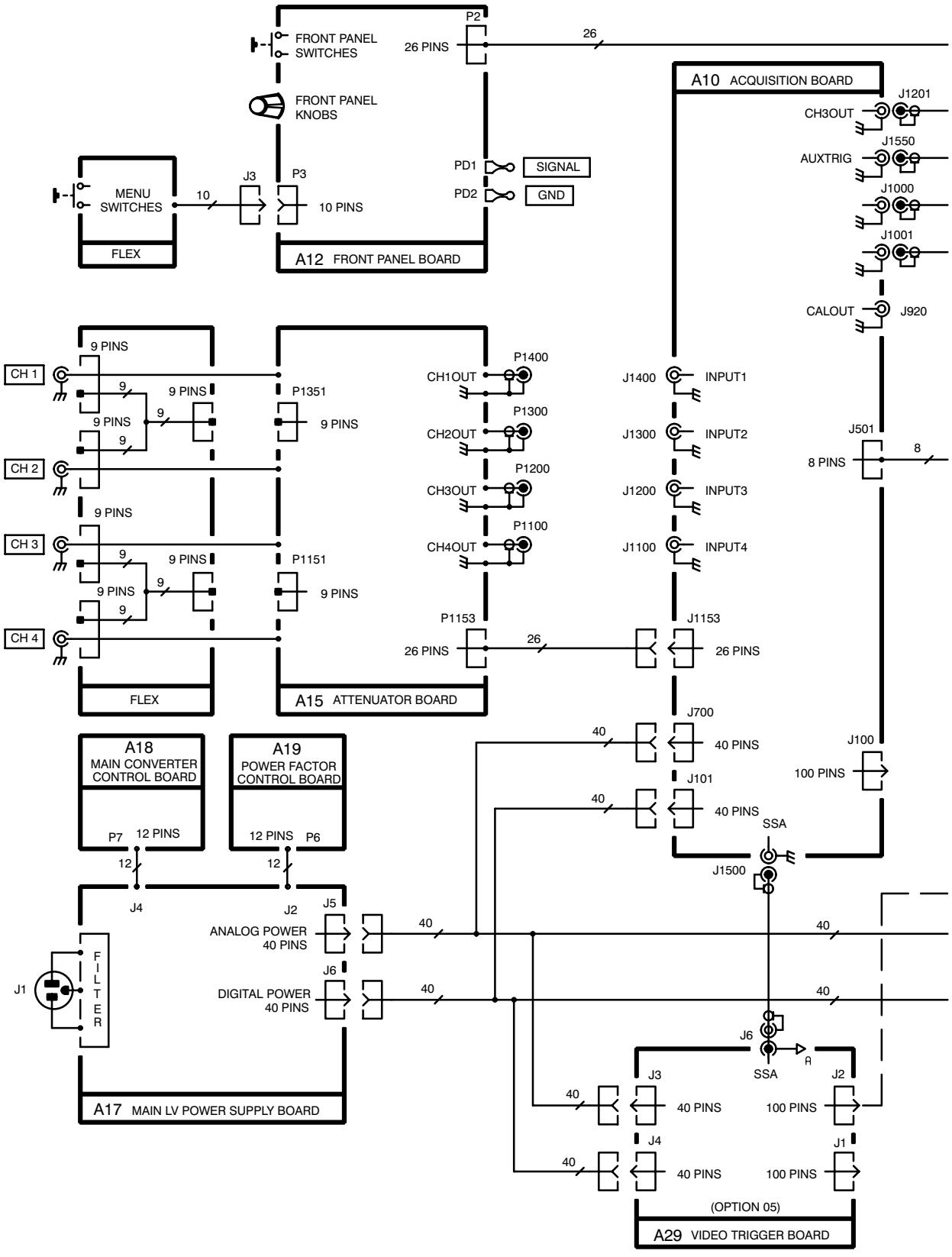


Figure 9-1: Interconnections

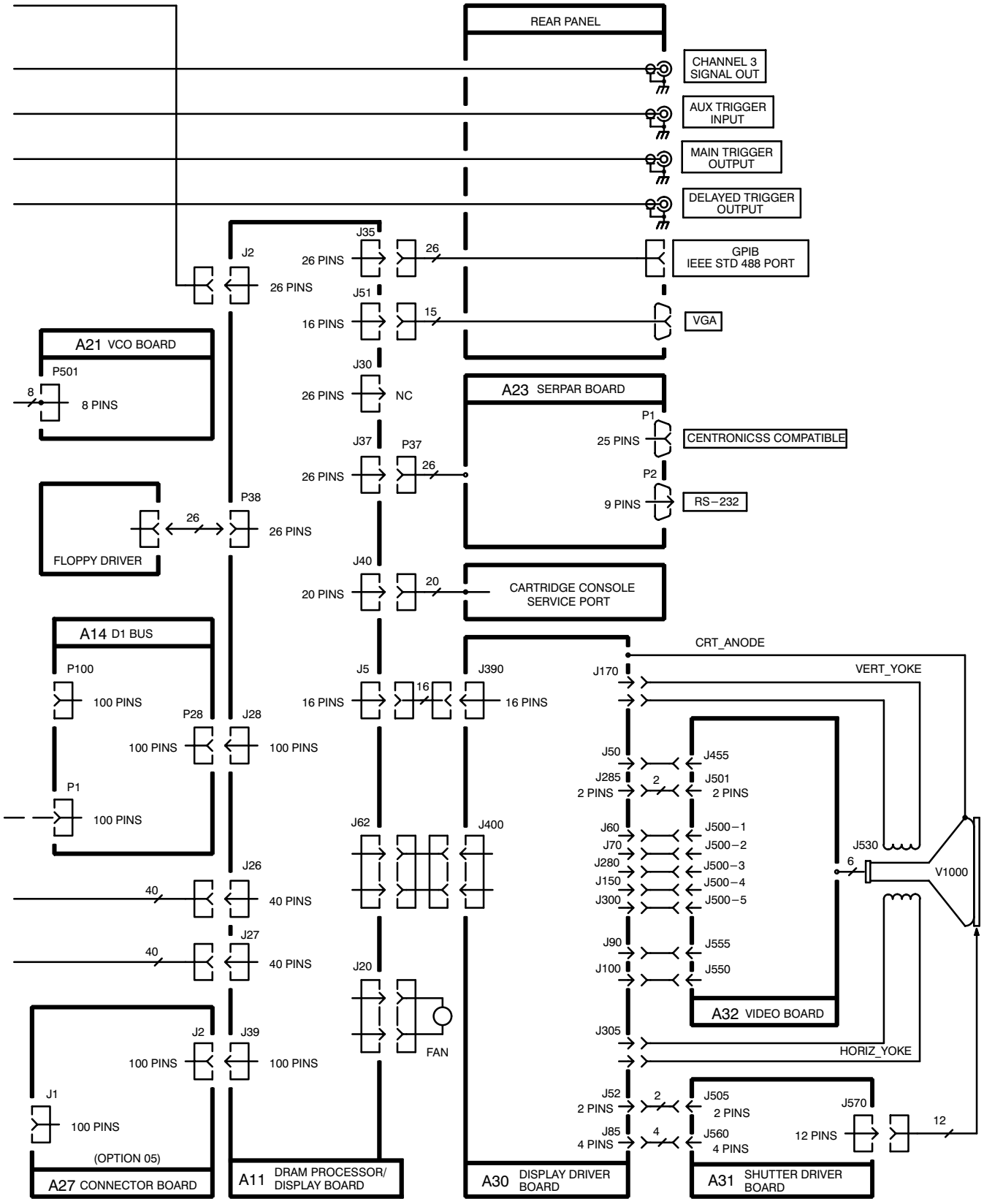


Figure 9-1: Interconnections (Cont.)

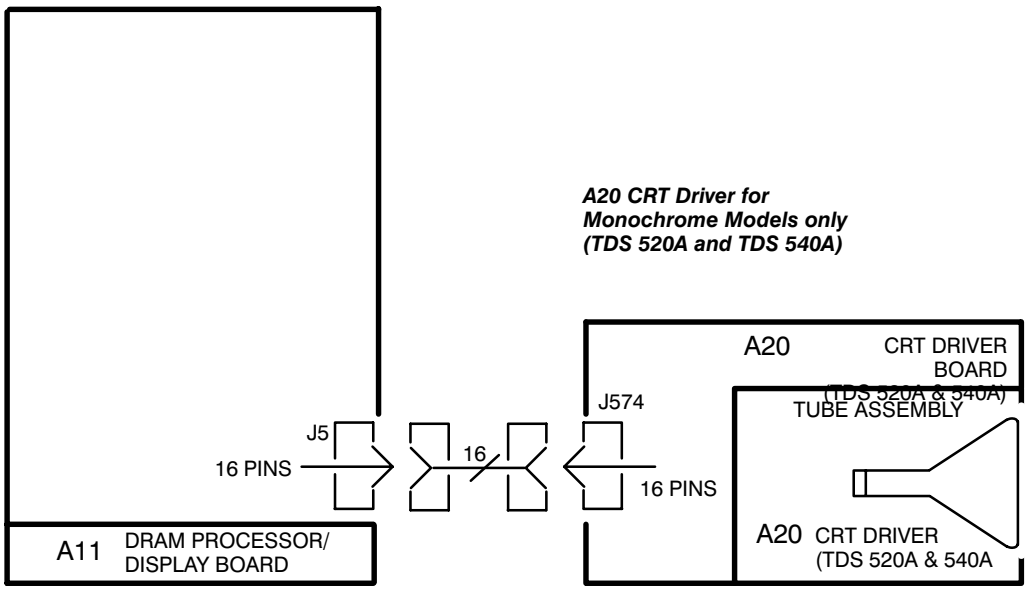


Figure 9-1: Interconnections (Cont.)

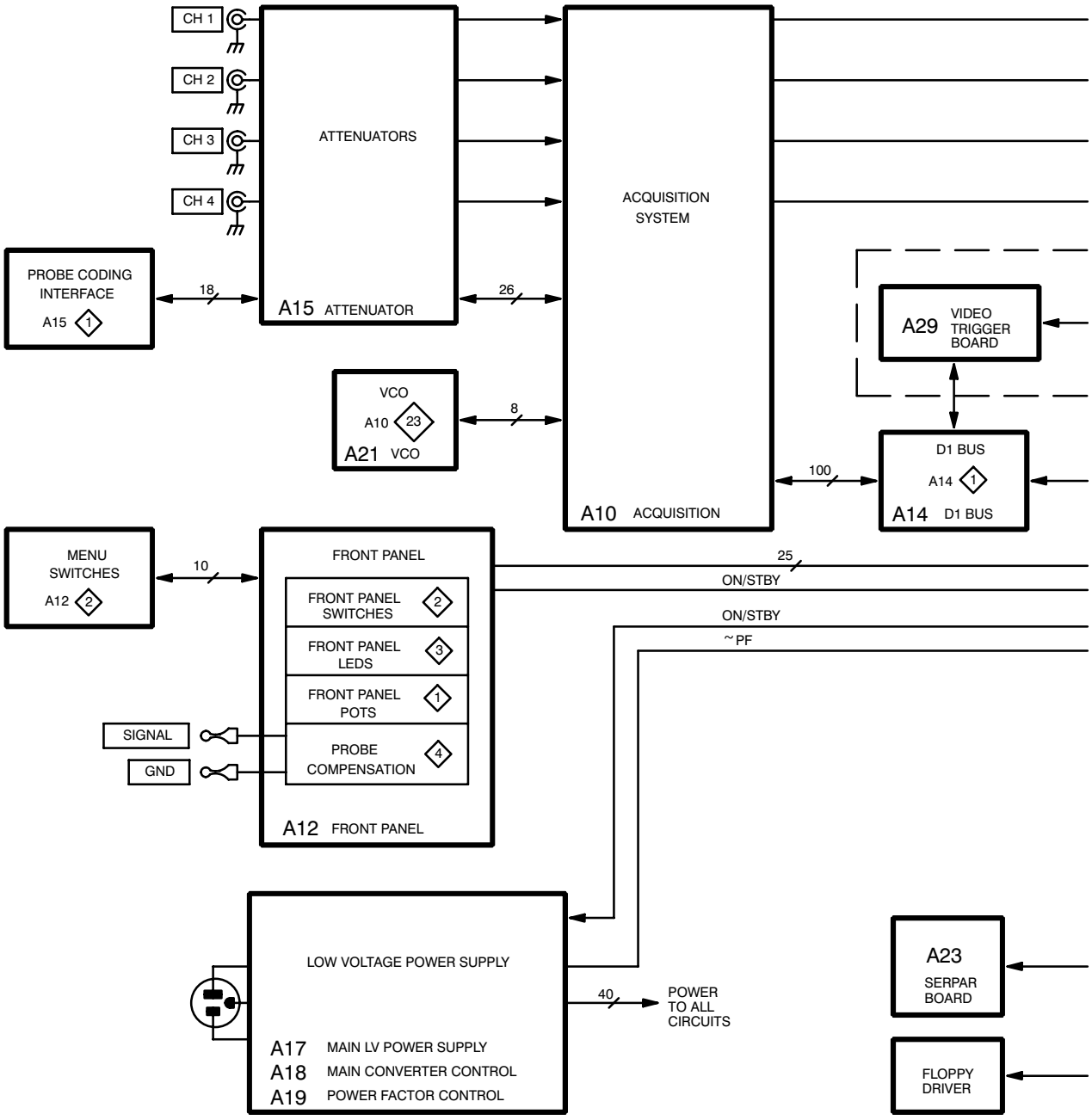


Figure 9-2: Block Diagram

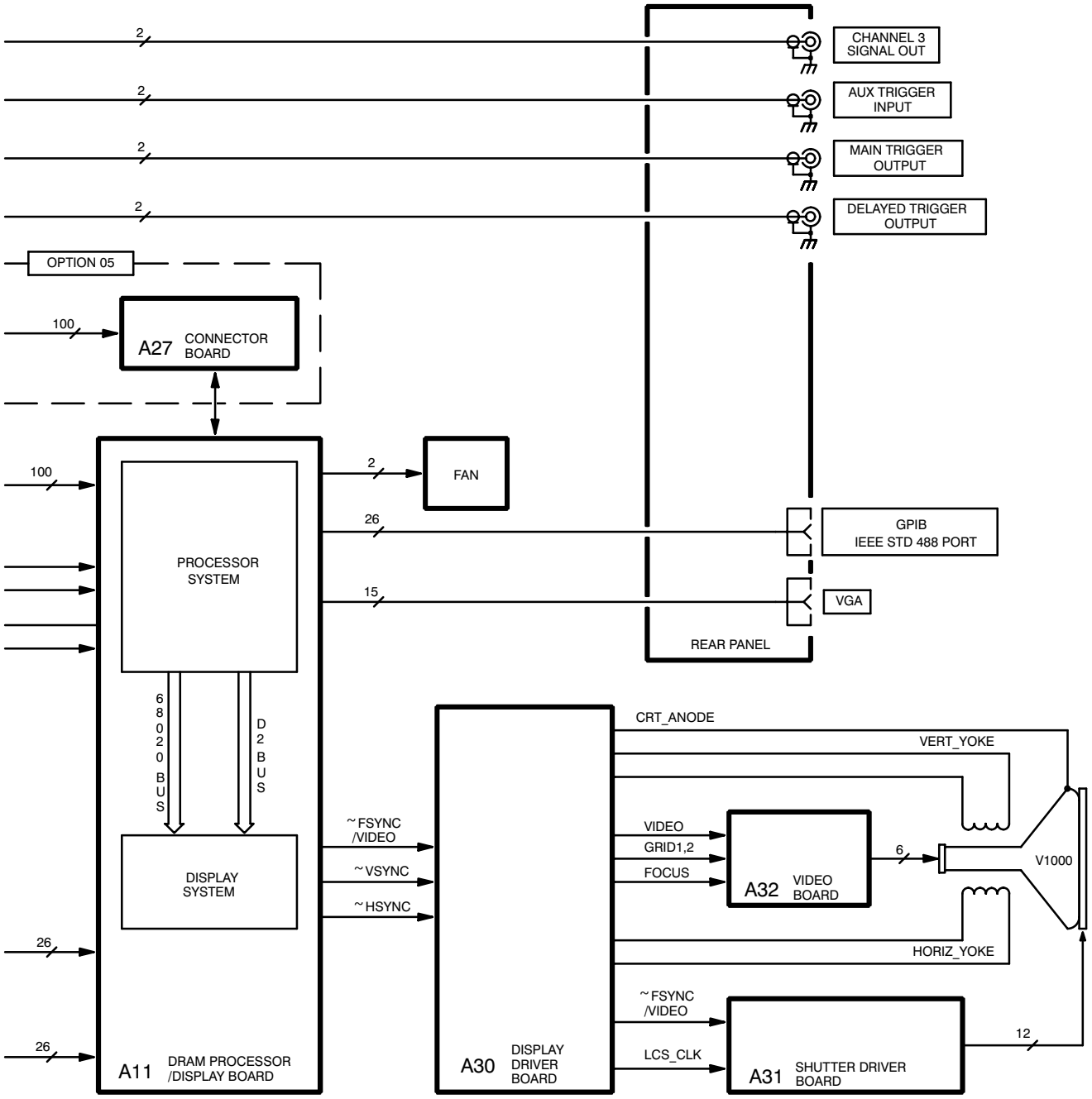


Figure 9-2: Block Diagram (Cont.)

Replace this page with the Tab named Mechanical Parts

Replaceable Parts

This section contains a list of the replaceable modules for the TDS 520A, 524A, 540A, & 544A. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest improvements. Therefore, when ordering parts, it is important to include the following information in your order.

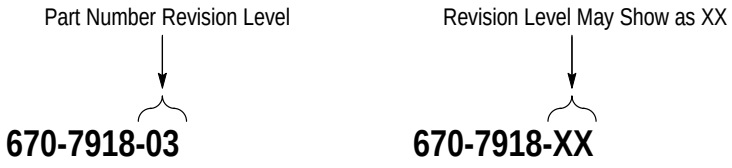
- Part number (see Part Number Revision Level below)
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

Part Number Revision Level

Tektronix part numbers contain two digits that show the revision level of the part. For most parts in this manual, you will find the letters XX in place of the revision level number.



When you order parts, Tektronix will provide you with the most current part for your product type, serial number, and modification (if applicable). At the time of your order, Tektronix will determine the part number revision level needed for your product, based on the information you provide.

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

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-TEK-WIDE, extension 6630.

Module Repair and Return. You may ship your module to us for repair, after which we will return it to you.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the TDS 520A, 524A, 540A, & 544A. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts List Column Descriptions

Column	Column Name	Description
1	Figure & Index Number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix Part Number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial Number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & Description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. Code	This indicates the code of the actual manufacturer of the part.
8	Mfr. Part Number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1–1972.

Mfr. Code to Manufacturer Cross Index

The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
S3109	FELLER	72 VERONICA AVE UNIT 4	SUMMERSET NJ 08873
S3629	SCHURTER AG H C/O PANEL COMPONENTS CORP	2015 SECOND STREET	BERKELEY CA 94170
TK0IK	MODERN METALS	UNIT A/K, 5/F GOLD KING IND. 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 PO BOX 1228	COLUMBIA MO 65205
TK2162	DERBY MFG	24350 STATE ROAD 23 SOUTH	SOUTH BEND IN 46614–9696
TK2193	PHOTO AND SOUND	820 NW 18TH AVENUE	PORTLAND OR 97209
TK2338	ACC MATERIALS	ED SNYDER BLDG 38–302	BEAVERTON OR 97077
TK2354	UNITRACK INDUSTRIES INC	1372 ENTERPRISE PO BOX 1927	WEST CHESTER PA 19380
TK2432	UNION ELECTRIC	15/F #1, FU–SHING N. ROAD	TAIPEI, TAIWAN ROC
TK2469	UNITREK CORPORATION	3000 LEWIS & CLARK WAY SUITE #2	VANCOUVER WA 98601
TK2500	SOLECTEK ACCESSORIES CORP	6370 NANCY RIDGE DR SUITE 109	SAN DIEGO CA 92121
0JR05	TRIQUEST CORP	3000 LEWIS AND CLARK HWY	VANCOUVER WA 98661–2999
0J9P9	GEROME MFG CO INC	PO BOX 737 403 NORTH MAIN	NEWBERG OR 97132
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
0KB05	NORTH STAR NAMEPLATE	1281–S NE 25TH	HILLSBORO OR 97124
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG PA 17105
07416	NELSON NAME PLATE CO	3191 CASITAS	LOS ANGELES CA 90039–2410
1DM20	PARLEX CORPORATION LAMINATED CABLE DIV	7 INDUSTRIAL WAY	SALEM, NH 03079
1GM54	ZYTEC CORPORATION	7575 MARKET PLACE DR	EDEN PRAIRIE MN 55344–3637
1JJ96	KAM ELECTRIC CO	11866 SLATER AVE NE	KIRKLAND WA 98034
22526	BERG ELECTRONICS INC (DUPONT)	857 OLD TRAIL RD	ETTERS PA 17319
24931	SPECIALTY CONNECTOR CO INC	2100 EARLYWOOD DR PO BOX 547	FRANKLIN IN 46131
30817	INSTRUMENT SPECIALTIES CO INC	EXIT 53 RT 80 BOX A	DELAWARE WATER GAP PA 18327
34416	PARSONS MFG CORP	1055 OBRIAN DR	MENLO PARK CA 94025–1408
5Y400	TRIAX METAL PRODUCTS INC DIV OF BEAVERTON PARTS MFG CO	1800 NW 216TH AVE	HILLSBORO OR 97124–6629
5Y921	COMAIR ROTRON, A KLI COMPANY	2675 CUSTOMHOUSE COURT	SAN YSIDRO CA 92173
50356	TEAC AMERICA INC	7733 TELEGRAPH ROAD PO BOX 750	MONTEBELLO CA 90640–6537
53387	MINNESOTA MINING MFG CO	PO BOX 2963	AUSTIN TX 78769–2963
70903	COOPER BELDEN ELECTRONICS WIRE AND CABLE SUB OF COOPER INDUSTRIES INC		
75915	LITTELFUSE INC SUB TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016–3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR 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.
10−1−1	200−3695−XX			1	COVER,REAR:REAR COSMETIC COVER	TK1163	2003695XX
−2	161−0230−XX			1	CABLE ASSY,PWR,:3,18 AWG,92 L,SVT,TAN (STANDARD ACCESSORY)	TK2432	ORDER BY DESC
−3	343−1213−XX			1	CLAMP,PWR CORD:POLYMIDE (STANDARD ACCESSORY)	TK1163	ORDER BY DESC
−4	200−2264−XX			1	CAP,FUSEHOLDER:3AG FUSES (AMERICAN)	S3629	FEK 031 1666
	200−2265−XX			1	CAP,FUSEHOLDER:5 X 20MM FUSES (EUROPEAN)	S3629	FEK 031.1663
−5	159−0013−XX			1	FUSE,CARTRIDGE:3AG,6A,250V,FAST BLOW (AMERICAN)	75915	312006
	159−0210−XX			1	FUSE,CARTRIDGE:DIN 5 X 20MM,5AMP,250V (EUROPEAN)	S3629	TYPE FST 034−31
−6	650−2922−XX			1	CABINET ASSY:W/ATTACHING PARTS	80009	6502922XX
−7	367−0247−XX			1	HANDLE,CARRYING:11.54 L,W/CLIP	80009	3670247XX
−8	200−2191−XX			2	CAP,RETAINER:PLASTIC	0JR05	ORDER BY DESC
−9	437−0399−XX			1	CABINET,SCOPE:	80009	4370399XX
−10	348−1110−XX			4	FOOT,CABINET:	80009	3481110XX
−11	348−1254−XX			4	PAD,FOOT:TEK BLACK,SANTOPRENE	80009	3481254XX
−12	348−0875−XX			1	FLIPSTAND,CAB.:	TK0488	ORDER BY DESC
−13	348−1109−XX			2	GASKET,SHIELD:45.0 L	80009	3481109XX
−14	200−3696−XX			1	COVER,FRONT:PLASTIC (STANDARD ACCESSORY)	80009	2003696XX
−15	101−0142−XX			1	TRIM,DECORATIVE:FRONT	TK1163	ORDER BY DESC
−16	334−8570−XX			1	MARKER,IDENT:MKD TDS544A	07416	3348570XX
	334−8613−XX			1	MARKER,IDENT:MKD TDS520A	80009	3348613XX
	334−8614−XX			1	MARKER,IDENT:MKD TDS540A	80009	3348614XX
	334−8643−XX			1	MARKER,IDENT:MKD TDS524A	80009	3348643XX
−17	214−4287−XX			1	ACTUATOR:ELASTOMER MAT,FRONT PANEL	TK0IK	ORDER BY DESC
−18	366−2114−XX			2	KNOB:LARGE,DETENTED	TK1163	ORDER BY DESC
−19	366−2111−XX			3	KNOB:SMALL,FLUTED	TK1163	ORDER BY DESC
−20	650−2927−XX			1	REPLACEABLE AS:DISPLAY FRAME WITH FLEX	80009	6502927XX
−21	378−0366−XX			1	FILTER,LT,CRT:6.75 X 5.50,DARK GRAY (TDS 520A/540A ONLY)	80009	3780366XX
−22	386−6211−XX			1	RETAINER,FILTER:DUST SEAL ASSY,LEXAN (TDS 520A/540A ONLY)	TK1163	3866211XX
−23	386−5954−XX			1	PANEL,INPUT:PLASTIC,ATTENUATOR	80009	3865954XX
−24	614−0914−XX			1	FRONT PNL ASSY:FRONT PANEL (A12, TDS 540A/544A ONLY)	80009	6140914XX
	614−0918−XX			1	FR PANEL ASSY:FRONT PANEL ASSEMBLY (A12, TDS520/524A ONLY)	80009	6140918XX
−25	366−2170−XX			1	KNOB:DIMPLED GPK,1.7 DIA	TK1163	ORDER BY DESC

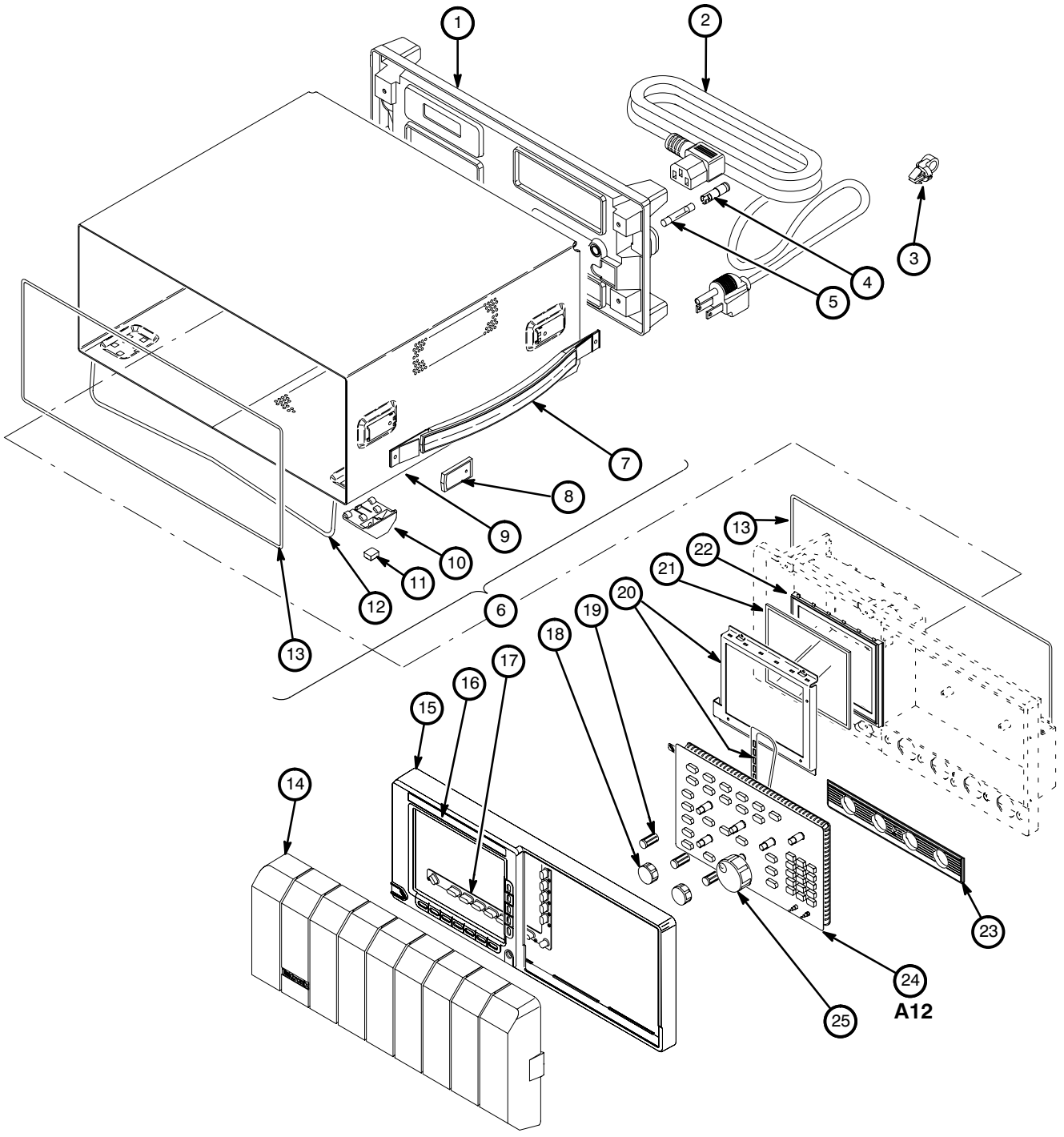


Figure 10-1: Cabinet and Front Panel

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
10−2−1	212−0189−XX			6	SCREW,MACHINE:8−32 X 0.500,PAN HEAD	0KB01	ORDER BY DESC
−2	119−5044−XX			1	FAN,DC:TUBEAXIAL;20−28V,0.275A,5W	5Y921	JQ24F4V/031349
−3	671−2413−XX			1	CIRCUIT BD ASSY:COLOR PROCESSOR DISPLAY (A11, TDS 524A/544A ONLY)	80009	67124130XX
	671−2611−XX			1	CIRCUIT BD ASSY:MONOCHROME PROC DISPLY (A11, TDS 520A/540A ONLY)	80009	6712611XX
−4	441−1902−XX			1	CHASSIS,SCOPE:REAR	0J9P9	ORDER BY DESC
−5	334−7966−XX			1	MARKER,IDENT:MKD W/CONN IDENT,REAR BNC (TDS 540A/544A ONLY)	07416	3347966XX
−6	131−1315−XX			4	CONN,RF JACK:BNC/PNL,50 OHM,FEMALE,STR (TDS 540A/544A ONLY)	24931	28JR306−1
−7	407−3825−XX			2	BRACKET,CKT BD:PLASTIC,REAR	TK1163	ORDER BY DESC
−8	386−5872−XX			1	PLATE,REAR:ALUMINUM,STD (STANDARD ONLY)	0J9P9	ORDER BY DESC
−9	348−1300−XX			2	SHLD,GSKT,ELEK:3.165 L,CLIP ON	30817	0098−0564−XX−03
−10	131−0890−XX			6	LOCK,CONNECTOR:4−40 X 0.312 L,HEX HD,STL (QTY 2 TDS 520A/540A) (QTY 6 TDS 524A/544A) (QTY 4 OPTION 13 ONLY)	00779	205818−2
−11	211−0730−XX			2	SCR,ASSEM WSHR:6−32 X 0.375,PNH,STL	0KB01	ORDER BY DESC
−12	671−2846−XX			1	CIRCUIT BD ASSY:D1 BUS (A14)	80009	6712846XX
−13	672−1408−XX			1	CIRCUIT BD ASSY:ACQUISITION EXPANDED (A10, TDS 540A/544A ONLY)	80009	6721408XX
	672−1417−XX			1	CIRCUIT BD ASSY:ACQUISITION (A10, TDS 520A/524A ONLY)	80009	6721417XX
−14	337−3816−XX			1	SHIELD,ELEC:RAM,ALUMINUM	0J9P9	3373816XX
−15	671−2902−XX			1	CIRCUIT BD ASSY:VCO,TESTED (A21)	80009	6712902XX
−16	119−4092−XX			1	ATTEN MODULE:4 CHAN,50 OHM/1M OHM TERM (A15)	80009	1194092XX
−17	343−0088−XX			2	CLAMP,CABLE:0.062 DIA,PLASTIC (TDS 540A/544A)	80009	3430088XX
−18	407−3878−XX			6	BRACKET,CKT BD:PLASTIC	TK1163	ORDER BY DESC
−19	407−3877−XX			2	BRACKET,CKT BD:PLASTIC	TK1163	ORDER BY DESC
−20	441−1901−XX			1	CHASSIS,SCOPE:TOP	0J9P9	ORDER BY DESC
−21	671−2437−XX			1	CIRCUIT BD ASSY:RS232/CENTRONIC (A23, OPTION 13, TDS 524A/544A ONLY)	80009	6712437XX
−22	386−6182−XX			1	PLATE,REAR:ALUMINUM,RS232/CENTRONIC (OPTION 13, TDS524A/544A ONLY)	0J9P9	3866182XX

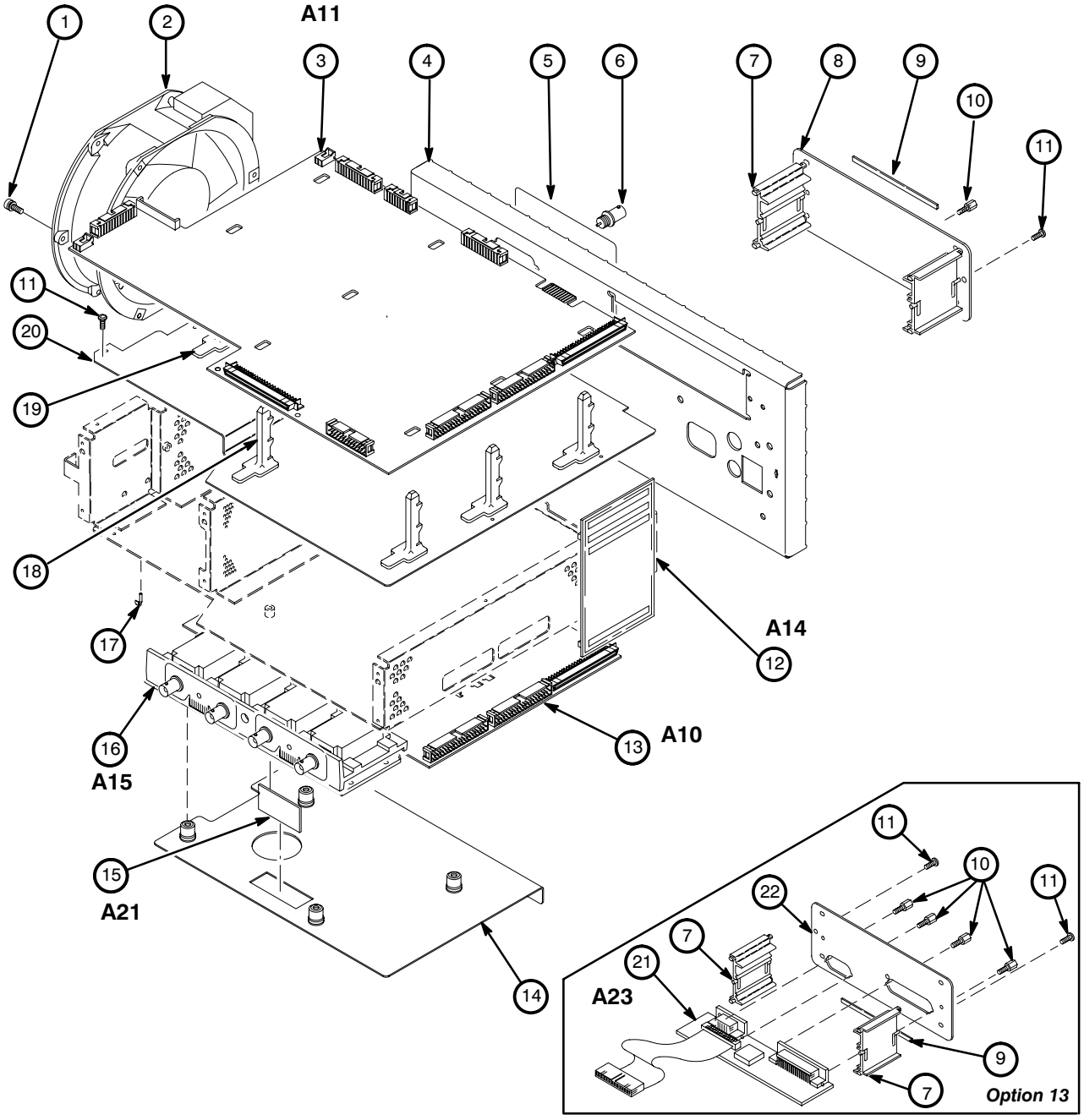


Figure 10-2: Outer-Chassis Modules

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
10−3−1	640−0071−XX			1	DISPLAY,MONOCHR:7 INCH (A20, TDS 520A/540A ONLY)	80009	6400071XX
	640−0077−XX			1	DISPLAY MODULE:COLUMBIA FULL COLOR (A30, TDS 524A/544A ONLY)	80009	6400077XX
−2	407−4099−XX			1	BRKT,PWR SPLY:LVPS,POLYCARBONATE	80009	4074099XX
−3	348−1300−XX			2	SHLD,GSKT,ELEK:3.165 L,CLIP ON	30817	0098−0564−XX−03
−4	119−4415−XX			1	POWER SUPPLY:SWITCHING,300W,MULTI OUT (A16)	1GM54	ORDER BY DESC
−5	441−2017−XX			1	CHASSIS,SCOPE:MAIN W/SHIELD	0J9P9	ORDER BY DESC
−6	386−5871−XX			1	SUBPANEL,FRONT:FINISHED,ALUMINUM	5Y400	3865871XX

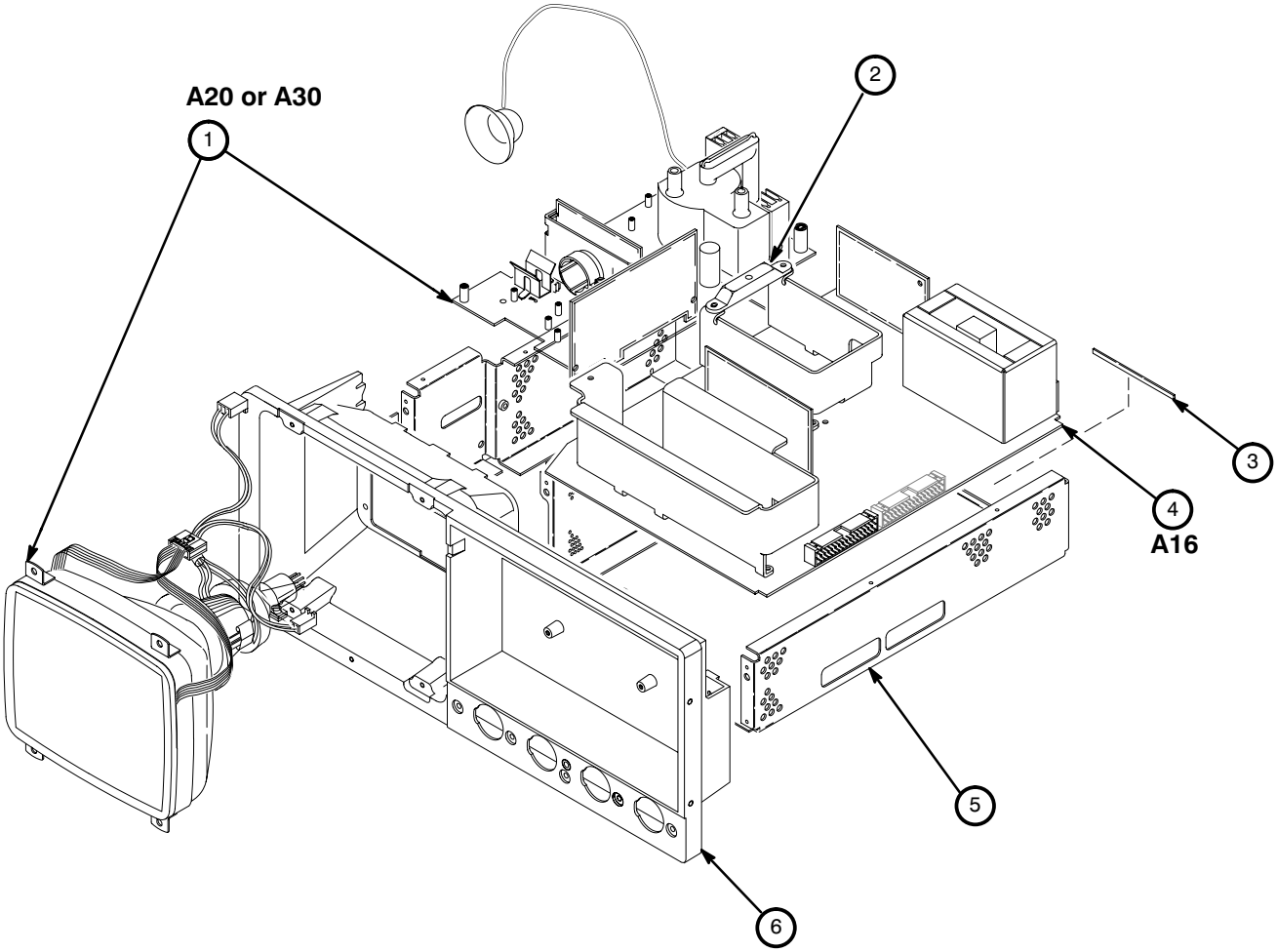


Figure 10-3: Inner-Chassis Modules – A30 Display Shown

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
10−4−1	174−1525−XX			1	CA ASSY,SP,ELEC:2 X 8−13,28 AWG,VIDEO/MON	TK2469	ORDER BY DESC
−2	174−2349−XX			1	CABLE ASSY:7.0 L,2,2 COND,RIBBON,LDI,1X2	TK2354	ORDER BY DESC
−3	174−1524−XX			1	CA ASSY SP:RBN,GPIB;IDC,24,28 AWG,4.275L	TK2469	ORDER BY DESC
	129−1439−XX			2	SPACER,POST:0.17 L,4−40 BRS,0.25 RND (USE WITH 174−1524−XX ONLY)	TK0588	ORDER BY DESC
−4	346−0266−XX			1	STRAP,CABLE:PLASTIC	0KB05	3460266XX
−5	174−1519−XX			2	CA ASSY,SP:RIBBON,;IDC,40,28 AWG,5.4 L	TK1899	ORDER BY DESC
−6	174−1728−XX			1	CA ASSY,SP:RIBBON,;IDC,26,28 AWG,6.0 L	53387	ORDER BY DESC
	174−2031−XX			2	CABLE ASSY,RF:50 OHM COAX,6.5 L,W/BL JKT (A10J1000 TO MAIN TRIGGER OUPUT) (A10J1001 TO DELAYED TRIGGER OUTPUT) (TDS 540A/544A ONLY)	TK2338	1742031XX
	174−2975−XX			1	CA ASSY,SP:RIBBON,;CPR,16,28 AWG,4.0 L (VGA CABLE)	TK2469	ORDER BY DESC
	175−2929−XX			1	CABLE ASSY,RF:50 OHM COAX,18.0 L,9−6 (CHAN 3 SIGNAL OUTPUT) (TDS 540A/544A ONLY)T)	80009	1752929XX
	175−8029−XX			1	CABLE ASSY,RF:50 OHM COAX,12.0 L,9−2,PELT (AUX TRIGGER INPUT) (TDS 540A/544A ONLY)T)	80009	1758029XX

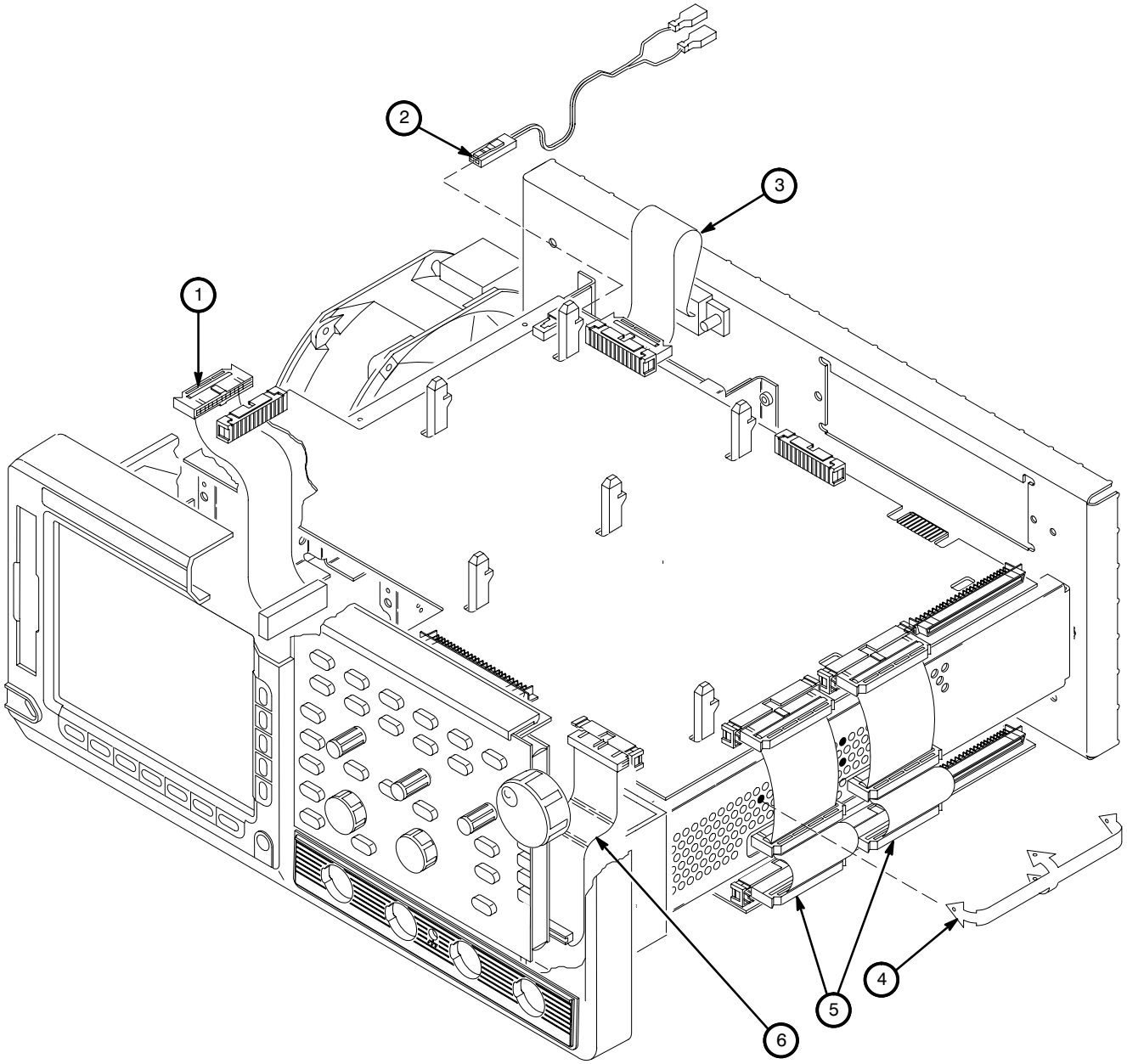


Figure 10-4: Cables

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
10−5−1	119−4547−XX			1	DISK DRIVE:FLOPPY,3.5 INCH;2MB,0.5 IN (TDS 524A/544A ONLY)	50356	FD−05HF
−2	211−0840−XX			1	SCREW,MACHINE:M2.6 X 0.45MM PITCH X 4.0 L (TDS 524A/544A ONLY)	0KB01	.26C4MXPHY
−3	211−0730−XX			2	SCR,ASSEM WSHR:6−32 X 0.375,PNH,STL (TDS 524A/544A ONLY)	0KB01	ORDER BY DESC
−4	174−2964−XX			1	WIRE,ELECTRICAL:FLAT FLEX,JUMPER;26 COND (TDS 524A/544A ONLY)	1DM20	1.00MM−26−7−B
	276−0849−XX			1	CORE,EM:EMI SUPPRESS,RBN CA;RECTANGLE (TDS 524A/544A ONLY)	1JJ96	BFS 33.5 X 8 X
−5	407−4230−XX			1	BRKT,DISK DRIVE:ALUMINUM (TDS 524A/544A ONLY)	0J9P9	407−4230−XX
−6	337−3935−XX			1	SHLD,DISK DRIVE: (TDS 524A/544A ONLY)	80009	3373935XX
	200−4095−XX			1	COV,DISK DRIVE:COSMETIC (TDS 520A/540A ONLY)	TK1163	ORDER BY DESC

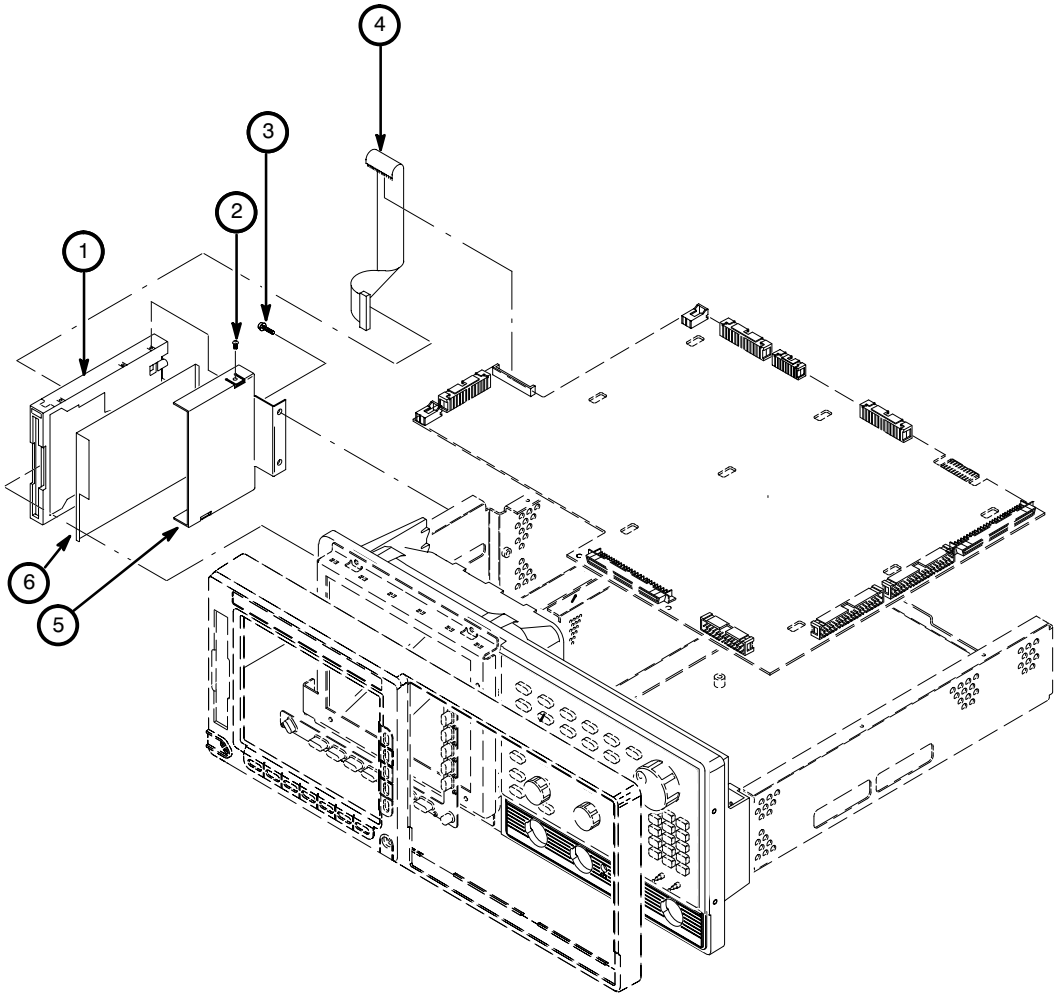


Figure 10-5: Floppy Disk

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
					STANDARD ACCESSORIES		
	−−−−−−−−			1	ACCESSORY PKG:TWO P6139A,1.3M PROBES		
	070−8709−XX			1	MANUAL,TECH:PROGRAMMER	80009	0708709XX
	070−8710−XX			1	MANUAL,TECH:USERS	80009	0708710XX
	070−8711−XX			1	MANUAL,TECH:REFERENCE	80009	0708711XX
	070−8712−XX			1	MANUAL,TECH:RERF VERIF	80009	0708712XX
	−−−−−−−−			1	CABLE ASSY,PWR,:3,18 AWG,92 L,SVT,TAN (STANDARD−SEE FIGURE 10−1−2)		
	161−0104−05			1	CABLE ASSY,PWR,:3,18 AWG,240V,98.0 L (OPTION A3−AUSTRALIAN)	S3109	SAA/3−OD3CCFC3X
	161−0104−06			1	CABLE ASSY,PWR,:3 X 0.75MM SQ,220V,98.0 L (OPTION A1−EUROPEAN)	S3109	VIIGSOPO−HO5VVF
	161−0104−07			1	CABLE ASSY,PWR,:3,1.0MM SQ,240 VOLT,2.5 M (OPTION A2−UNITED KINGDOM)	S3109	ORDER BY DESC
	161−0104−08			1	CABLE ASSY,PWR,:3,18 AWG,98 L,SVT,GREY/BLK (OPTION A4−NORTH AMERICAN)	70903	ORDER BY DESC
	161−0167−00			1	CABLE ASSY,PWR,:3.0 X 0.75,6A,240V,2.5M L (OPTION A5−SWITZERLAND)	S3109	ORDER BY DESC
	343−0170−XX			1	RTNR,CA TO CA:U/W 0.25 OD CABLES (OPTIONS A1,A2,A3,A4,A5)	0JR05	ORDER BY DESC
	−−−−−−−−			1	CLAMP,PWR CORD:POLYMIDE (SEE FIGURE 10−1−3)		
	−−−−−−−−			1	COVER,FRONT:PLASTIC (SEE FIGURE 10−1−14)		
					OPTIONAL ACCESSORIES		
	003−1457−XX			1	BIT,TORX DRIVER:MODIFY THE T−20	TK1465	0031457XX
	012−0991−XX			1	CABLE,COMPOSITE:IDC,GPIB:2 M,24 COND	22526	81190−020
	012−0991−XX			1	CABLE,GPIB:LOW EMI,1 METER	00779	553577−2
	012−1250−XX			1	CABLE,INTCON:SHLD CMPST,PARA CENTRON	TK2193	CACC 3049
	012−1298−XX			1	CABLE,INTCON:RS232C DB25M−DB9F SERIAL	TK2500	C294−9
	012−1388−XX			1	CABLE ASSEMBLY:OSCILLOSCOPE SECURITY	80009	0121388XX
	016−0909−XX			1	CASE,CARRYING:SOFTSIDED FOR 3002C,P,R	TK2162	0587
	016−1135−XX			1	CASE,CARRYING:26 X 22 X 15,HARD TRANSFER	34416	2622RW−7T−7B
	016−1136−XX			1	MOUNTING KIT:RACK MOUNT KIT,TDS500	80009	0161136XX
	016−1145−XX			1	HOOD ASSEMBLY:TDS SERIES	80009	0161145XX
	063−1678−XX			1	SOFTWARE PKG:FW,VERS,1,3.8.3E,1,5.25 (TDS 540A/544A ONLY)	80009	0631678XX
	063−1641−XX			1	SOFTWARE PKG:FW,VERS,1,3.8.4E,1,5.25 (TDS 520A/524A ONLY)	80009	0631641XX
	070−8567−XX			1	MANUAL,TECH:OPT 13 RS−232/CENTRONICS	80009	0708567XX
	070−8582−XX			1	MANUAL,TECH:OPT 2F,ADVANCED DSP MATH	80009	0708582XX
	070−8713−XX			1	MANUAL,TECH:SERVICE	80009	0708713XX
	070−8748−XX			1	MANUAL,TECH:INSTR,TDS OPT 05 VIDEO TRIGG	80009	0708748XX
	C9			1	CAMERA,SCOPE:	80009	C9
	HC100			1	PLOTTER 4 PEN:GPIB/CENTRONICS INPUT CON	80009	HC100
	K218			1	CART:	80009	K218

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